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THE SUPERFUND INNOVATIVE TECHNOLOGY EVALUATION PROGRAM

PROGRESS AND ACCOMPLISHMENTS FISCAL YEAR 1990

A Fourth Report to Congress

Office of Solid Waste and Emergency Response
Office of Research and Development
U.S. Environmental Protection Agency
Washington, DC 20460

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Notice

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Preface

The U.S. Environmental Protection Agency (EPA) established the Superfund Innovative Technology Evaluation (SITE) Program in 1986, following passage of the Superfund Amendments and Reauthorization Act (SARA). The Program's progress and accomplishments for Fiscal Year 1990 are presented in four sections in this Fourth Report to Congress. Section 1 presents an overview of the SITE Program including the statutory authority and history of the program and the four program components and goals. Section 2 discusses the use of innovative alternative technologies for hazardous waste site remediation and the impact the SITE Program is having on their increased use. Section 3 presents the SITE Program's progress and accomplishments over the past year and specific goals for the coming year. Section 4 proposes various program changes and recommends statutory changes that can enhance SITE's ability to meet its overall objectives. Several examples of program products are appended to this report to highlight the technology transfer aspects of the SITE Program.

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Acronymns

AAR	Applications Analysis Report
API	American Petroleum Institute
AETS	Acid Extraction Treatment System
ARAR	Applicable, or Relevant and Appropriate Requirements
AREAL	Atmospheric Research and Exposure Assessment Laboratory
ATTIC	Alternative Treatment Technology Information Center
BBS	Bulletin Board System
BDAT	Best Demonstrated and Available Technology
BTEX	Benzene, Toluene, Ethylbenzene, and Xylene
CERCLA	Comprehensive Environmental Response Compensation and Liability Act
CERI	Center for Environmental Research Information
CES	Chemfix Environmental Services
COLIS	Computerized On-Line Information System
CROW	Contained Recovery of Oily Waste
DCA	Dichloroethane
DOD	Department of Defense
DOE	Department of Energy
DQO	Data Quality Objectives
DSM	Deep Soil Mixing
DWS	Debris Washing System
EMSL-LV	Environmental Monitoring Systems Laboratory - Las Vegas
EPA	U.S. Environmental Protection Agency
ESD	Electroacoustic Soil Decontamination
ETP	Emerging Technologies Program
FTIR	Fourier Transform Infrared
FS	Feasibility Study
FY	Fiscal Year
GC/MS	Gas Chromatograph/Mass Spectrophotometer
HMCRI	Hazardous Materials Control Research Institute
HR-FT-IR	High Resolution Fourier Transform Infrared
HSWA	Hazardous Solid Waste Amendments
IMS	Ion Mobility Spectrophotometer
IRF	Incinerator Research Facility
IWT	International Waste Technologies
JAWMA	Journal of the Air and Waste Management Association
KSU	Kansas State University
LDR	Land Disposal Restrictions
MAH	Monoaromatic Hydrocarbon
MBS	Methanotrophic Bioreactor System

Acronymns (Continued)

MMTP	Monitoring and Measurement Technologies Program
MMS	Mobile Mass Spectrophotometer
NETAC	National Environmental Technology Applications Corporation
NPL	National Priorities List
NTIS	National Technical Information System
OEETD	Office of Environmental Engineering and Technology Demonstration
OMMSQA	Office of Modelling, Monitoring Systems and Quality Assurance
ORD	Office of Research and Development
OSC	On-Scene Coordinator
OSWER	Office of Solid Waste and Environmental Response
OTA	Office of Technology Assessment
PAH	Polycyclic Aromatic Hydrocarbon
PCB	Polychlorinated Biphenyl
PCP	Pentachlorophenol
PRP	Potentially Responsible Party
QA/QC	Quality Assurance/Quality Control
RCRA	Resource Conservation and Recovery Act
R&D	Research and Development
RD&D	Research, Development, and Demonstration
RFP	Request for Proposal
RI	Remedial Investigation
ROD	Record of Decision
RPM	Remedial Project Manager
RREL	Risk Reduction Engineering Laboratory
RTP	Research Triangle Park
SARA	Superfund Amendments and Reauthorization Act
SAB	Science Advisory Board
SITE	Superfund Innovative Technology Evaluation
S/S	Solidification/Stabilization
START	Superfund Technical Assistance Response Teams
STC	Silicate Technology Corporation
SVOC	Semivolatile Organic Compounds
T&E	Test and Evaluation
TCA	Trichloroethane
TCE	Trichloroethene
TCLP	Toxicity Characteristics Leaching Procedure
TEM	Transient Electromagnetic Method
TER	Technology Evaluation Report
TIO	Technology Innovation Office
TIX	Technical Information Exchange
TOC	Total Organic Carbon
UCS	Unconfined Compression Strength
UV	Ultraviolet
VOC	Volatile Organic Compound

Abbreviations

cm	Centimeter
°F	Degrees Fahrenheit
kg	Kilogram
lbs	Pounds
mg	Milligram
mg/l	Milligram/Liter
mm	Millimeter
ppb	Parts Per Billion
ppm	Parts Per Million
psi	Pounds Per Square Inch
sec	Second

Trade Names

AlgaSORB®
BioGenesis™
BioVersal™
Chemfix
CHEMSET®
Decompozon
PACT®
RHM 1000
Tyvek®
Urrichem

Executive Summary

"The Superfund Innovative Technology Evaluation (SITE) program is the U.S. Environmental Protection Agency's (EPA) principal program to advance the development, evaluation, and implementation of innovative alternative technologies for the remediation of contaminated hazardous waste sites." This mission statement, established by EPA's Risk Reduction Engineering Laboratory (RREL), is fully compatible with the legislative mandate for the SITE Program. The Superfund Amendments and Reauthorization Act of 1986 (SARA) directs EPA "to carry out a program of research, evaluation, testing, development and demonstration of alternative or innovative treatment and monitoring and measurement technologies . . . which may be utilized in response actions to achieve more permanent protection of human health and welfare and the environment" [SARA Section 209(b), Section 311(b)(1)].

The SITE Program was the first major program for demonstrating and evaluating full-scale innovative treatment technologies at hazardous waste sites. Having concluded its fourth year, the SITE Program is recognized as a leading advocate of innovative technology development and commercialization for hazardous waste treatment and remediation. In addition, through the demonstration of innovative monitoring and measurement technologies, EPA is promoting faster, more cost-effective site characterization and post-cleanup monitoring methods for Superfund and Resource Conservation and Recovery Act (RCRA) corrective action sites.

This fourth report to Congress documents the impact of the SITE Program through discussing the program's progress and accomplishments over the past year. The report also sets goals for the coming years and makes specific recommendations on achieving those goals.

Use of Innovative Alternative Technologies

The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), as amended by SARA, sets forth requirements for selecting remedies for Superfund sites. Remedial actions must:

- Be protective of human health and the environment.
- Attain or waive applicable, or relevant and appropriate requirements (ARAR).
- Be cost-effective.
- Use permanent solutions and alternative hazardous waste treatment technologies or resource recovery technologies to the maximum extent practicable.
- Satisfy the preference for hazardous waste treatment that reduces toxicity, mobility, or volume.

Alternative treatment technologies are essential to meeting these requirements; however, sufficient information is often not available for a reliable analysis of alternatives using these technologies. Innovative alternative technologies may lack an established track record, have limited treatability and cost data and, as "unproven," may suffer public, state, and private (potentially responsible party) acceptance problems.

The SITE Program is unique in its ability to generate appropriate and relevant information on innovative alternative technologies needed by remedial project managers, consultants, and other decisionmakers. SITE Program data are recognized as reliable, high

quality, and unbiased. The SITE testing and evaluation methods are founded in EPA's research programs, and yet include practical field experience.

SITE Program Progress and Accomplishments

SITE is currently administered by the Office of Research and Development's (ORD) Risk Reduction Engineering Laboratory. Over the past year, RREL's founding partner in SITE, the Office of Solid Waste and Emergency Response (OSWER), established a Technology Innovation Office (TIO) to further advocate and promote the development and use of innovative treatment technologies in the public and private sectors. Likewise, RREL established its Superfund Technical Assistance Response Teams (START), the members of which are often SITE project managers as well, to aid the Regions on complex site remediation problems. Together, these three programs—SITE, TIO, and START—working as an integrated technical team, are a valuable resource on innovative technologies and solutions to hazardous waste problems.

Specifically, the SITE Program integrates the following four components:

- Demonstration Program
- Emerging Technologies Program
- Monitoring and Measurement Technologies Program (MMTP)
- Technology Information Services

Over the past year, SITE has conducted eight field demonstrations of innovative treatment and monitoring and measurement technologies. Through fiscal year 1990, a total of 23 demonstrations have been completed at Superfund remedial and removal sites, private party cleanup sites, state cleanup sites, and EPA and developer test facilities. SITE developers have completed seven emerging technologies projects; three of these developers have been invited to participate in the demonstration program. In addition, six new technologies have been added to the demonstration program and 16 to the emerging program. Currently, a total of 84 technologies are at various stages of completion within the SITE Program.

At the same time, EPA is attempting to attract additional technologies and sites into the program. Initiatives started last year with the Departments of Energy and Defense (DOE and DOD) have resulted in three potential field demonstrations and an expanded emerging technologies program with co-funding from DOE.

Most important, studies by EPA and others show that the program is achieving positive results. Developers report increased client interest in their technologies, Superfund records of decision (RODs) are including the use of innovative treatment technologies, and Federal, state, and private remedial decisionmakers, as well as consultants, are relying on the SITE Program for performance data.

Recommendations and Proposed Changes

Over the past year, RREL has implemented the recommendations in EPA's Management Review of the Superfund Program, as discussed in the third report to Congress. Also, in response to the Superfund program review, RREL conducted a *Management Review of the SITE Program.* The purpose of the review was to evaluate the impact of the SITE Program on Superfund remediation activities and to identify any changes needed to improve the program.

Several program changes have been adopted that are directed at making the SITE Program a more integral component of Regional Office Superfund site activities. The SITE Program will make the design of SITE evaluations sufficiently flexible to meet the Regional Offices' needs for treatability studies before remedy selection is made. SITE demonstration data will be presented to the remedial project manager (RPM) or on-scene coordinator (OSC) on a fast turnaround basis so that the data is available to be factored into the remedy selection decision. The annual SITE solicitation will focus on problem sites rather than on technologies. The SITE Program will take advantage of ongoing remediation activities in the Regions as a source of technology evaluations and technology transfer.

In addition, the SITE Program will utilize sites that are being evaluated under the Superfund Technical Assistance Response Team (START) Program as test sites for SITE evaluations.

Other improvements in the SITE Program include streamlining the demonstration planning process, working more closely with state and private party sites, and restructuring the technology transfer products from the program. A Review Committee is being established to help ensure that the SITE Program is relevant to the needs of the Superfund Program. The Review Committee will be made up of representatives from EPA Regions, Headquarters, developers, states, and the engineering community. The National Environmental Technology Applications Corporation (NETAC) and private groups will be utilized to help move technologies forward.

All initiatives are intended to make the SITE Program more responsive to Superfund Program needs and to make information available on a more timely basis.

SECTION I
SITE PROGRAM OVERVIEW

This section provides an overview of the SITE Program. The legislation mandating the formation of the SITE Program is discussed first, followed by a brief history of the program including selected highlights. The four components of the SITE Program are introduced in this section and a detailed discussion of the progress and accomplishments of each component is provided in Section III.

A. STATUTORY AUTHORITY

The Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) and the Resource Conservation and Recovery Act of 1976 (RCRA) define the national programs for managing hazardous waste sites. The Superfund Amendments and Reauthorization Act of 1986 (SARA) specifically states a preference for remedial actions that permanently and significantly reduce the volume, toxicity, or mobility of hazardous substances and contaminants. The U.S. Environmental Protection Agency (EPA) is required to "select a remedial action that is protective of human health and the environment . . . and that utilizes permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable."

RCRA provides authority for EPA to require corrective actions for past releases at facilities receiving permits for treatment, storage, or disposal of hazardous wastes. Thus, an owner or operator of such a facility must clean up contamination resulting from current or past activities at the site. Also under RCRA, land disposal restrictions (LDRs) require that hazardous wastes be treated using "Best Demonstrated Available Technology" (BDAT) for a specific waste before it can be disposed in a land-based unit.

The Superfund Innovative Technology Evaluation, or SITE, program was formally established as a requirement of SARA. Section 311(b) of CERCLA, as amended by SARA, directs EPA to establish an "Alternative or Innovative Treatment Technology Research and Demonstration Program" including a field demonstration program for testing innovative treatment technologies at Superfund sites. In fulfilling this legislative mandate, EPA's SITE Program provides valuable information to environmental decisionmakers responsible for remediation of hazardous waste sites under both CERCLA and RCRA.

As required by Section 311(e), this report presents the program's accomplishments through Fiscal Year (FY) 1990 and is the fourth annual report to Congress.

B. HISTORY OF THE SITE PROGRAM

As it prepared to reauthorize CERCLA, Congress required the Office of Technology Assessment (OTA) to review the Superfund program and to prepare a strategy for improving the program. One of the three principal goals of the review was "to understand future Superfund needs and how permanent clean-ups can be accomplished in a cost-effective manner for diverse types of sites."[1]

The OTA study concluded that land disposal approaches, even though they may be proven technologies for their original applications in construction engineering, are not effective over the long term in containing hazardous wastes, nor are their immediate costs indicative of the likely long-term costs, including monitoring, operation and maintenance, and the costs of future clean-up actions, especially for cleaning up contaminated ground water. The OTA report further concluded that not enough research, development, and demonstration (RD&D) efforts are devoted to innovative clean-up technologies and that many innovations exist, but few have overcome institutional and other barriers. Considering the high cost of the Superfund program, committing RD&D money for innovative clean-up and site characterization technologies could offer considerable economic advantages in the long term.

The Science Advisory Board's (SAB) Environmental Engineering Committee was concerned that enormous expenditures were being made under Superfund without an adequate technological database to support rehabilitation of hazardous waste disposal sites. In a formal resolution, the SAB committee expressed this concern to the EPA Administrator and to members of Congress who were considering amendments to CERCLA. The resolution recommended a comprehensive RD&D program to develop and demonstrate effective, long-term solutions.

The reauthorized CERCLA established an RD&D program for innovative alternative technologies. In response to the legislation, and after considering the reports and recom-

[1] *Superfund Strategy*, U.S. Congress, Office of Technology Assessment, OTA-ITE-252, April 1985. Washington, DC.

mendations discussed above, ORD and OSWER developed a joint strategy for an RD&D program called the Superfund Innovative Technology Evaluation (SITE) program.

Significant events in the development of the SITE Program are listed below:

March 1986	EPA issues the first annual request for proposals to the SITE Demonstration Program (RFP SITE 001). Twenty technology developers respond to the RFP, and 13 are accepted into the program.
July 1987	First SITE field demonstration is conducted. The Shirco Electric Infrared Incinerator is tested at the Peak Oil Superfund Site in Brandon, Florida.
July 1987	EPA initiates the SITE Emerging Technologies Program as a feeder to the demonstration program. Six developers are accepted into the program, each receiving up to $150,000 per year for two years to develop and test their technologies at a laboratory- or pilot-scale.
January 1988	The first SITE demonstration at an EPA test facility is conducted. American Combustion Technologies, Inc., Pyretron Oxygen Burner was demonstrated at EPA's Incineration Research Facility in Jefferson, Arkansas.
October 1988	EPA co-sponsors the First International Symposium on Field Screening Methods for Hazardous Wastes and Toxic Chemicals.
November 1988	EPA presents SITE findings at the Hazardous Materials Control Research Institute (HMCRI) Superfund '88 conference.
June 1989	EPA completes *A Management Review of the Superfund Program* (90-Day Study), which makes key recommendations for the SITE Program (see below).
June 1989	OSWER and RREL sponsor the first *Forum on Innovative Hazardous Waste Treatment Technologies: Domestic and International* in Atlanta, Georgia, to help introduce promising international technologies through technical papers and poster displays, and to showcase results of the SITE Program.
August 1989	EPA conducts the first demonstration under the Monitoring and Measurement Technologies Program. An immunoassay field kit for pentachlorophenol was demonstrated at the McGillis and Gibbs Superfund site, in conjunction with the BioTrol soil washing technology demonstration.
December 1989	RREL demonstrates its debris washing system, developed by PEI Associates for EPA, at Superfund sites in Hopkinsville, Kentucky, and Lafayette, Georgia.
March 1990	OSWER forms the Technology Innovation Office (TIO) with key staff who have been involved in the SITE Program. The TIO will evaluate potential applications of innovative technologies and other outreach activities to promote their accelerated commercial development and use.
May 1990	RREL commissions a *SITE Program Participant Assessment* in conjunction with the *Second Forum on Innovative Hazardous Waste Treatment Technologies: Domestic and International.*
July 1990	RREL initiates the Superfund Technical Assistance Response Teams (START) program to provide long-term technical engineering support, including treatability studies, to assist EPA Regional offices dealing with complex sites. START staff include SITE technical project monitors and, thus, the program enhances RREL's outreach efforts.
August 1990	RREL completes its internal *Management Review of the SITE Program*, which recommends program and legislative changes.

Management Review of the Superfund Program

In the third report to Congress, EPA discussed the findings of the Agency's *Management Review of the Superfund Program* (90-Day Study) related specifically to the SITE Program. The 90-day study strongly supported the SITE Program and presented six major recommendations aimed at strengthening it to more fully satisfy technology information and development needs. Over the past year, the EPA has addressed each of these recommendations, as follows:

- *Evaluate Performance and Cost of Technologies Already Being Used at Superfund Sites*—OSWER's TIO has begun assessing technologies being used at Superfund sites based on a review of records of decision (RODs). TIO is also assessing the potential applications for hazardous waste remediation technologies on the National Priorities List (NPL) at Superfund sites.

- *Conduct Additional Demonstrations of Innovative Technologies*—EPA has conducted nine innovative technology demonstrations over the past year, including physical, chemical, solidification/stabilization, and combination treatment processes, as well as excavation tech-

niques and monitoring and measurement technologies. Demonstration technologies have expanded to include biological treatment technologies and mixed radiological waste treatment. In addition, EPA's efforts to coordinate with DOE and DOD have resulted in plans for future demonstrations at Rocky Flats (TechTran) and Robins AFB (Wastech).

- *Support Development of Emerging Laboratory- and Pilot-Scale Technologies*—With the cooperation of the DOE, EPA expanded the SITE Emerging Technologies Program. During FY 1990, 16 developers were accepted into the program, bringing the total to 28 technologies that are being funded at the laboratory- and pilot-scale.

- *Evaluate Combinations of Technologies in Addition to Individual Technologies*—The SITE Program has continued to solicit combinations of technologies for demonstration. During FY 1990, EPA demonstrated the AWD Technologies, Inc., integrated vapor extraction and vacuum steam stripping system at Burbank, California. The system is treating ground water and soil contaminated with a variety of volatile organic compounds (VOC). A recent addition to the SITE Program is Bioversal's soil washing and biological treatment system. In this case, the residual waste stream from the soil washing step is treated in a bioreactor. This technology is similar in concept to the BioTrol system that was demonstrated in FY 1989.

- *Provide Rapid Reporting of Demonstration Results through Performance Bulletins and by Placing Results in an Information Clearinghouse, and Reduce Production Time for Reports*—Demonstration bulletins have continued to be an important technology transfer medium for SITE Program results and are generally the first written products following a demonstration. These bulletins are abstracted and compiled annually in the SITE Program Technology Profiles document, which describes all SITE technologies, provides the status of the projects and other technology developments, and lists contacts for information on the technologies. Computer on-line services are also being used by SITE. OSWER's Bulletin Board contains status information, and the Alternative Treatment Technology Information Center (ATTIC) system includes the results of SITE demonstrations. To reduce report production time, EPA has implemented a revised reporting system that places more emphasis on the Applications Analysis Report (AAR). The AAR provides information on process economics, application to various waste sites, and operational experience. Because it is a shorter report with less detailed data than the Technology Evaluation Report, which is also produced after a demonstration, it can be produced more quickly.

- *Suggest Ways to Eliminate Internal Barriers to the Introduction of New Technologies into the Superfund Program*—OSWER's Technology Innovation Office (TIO) was formed over the past year to "increase applications of innovative treatment technology by government and industry to contaminated waste sites, soils and groundwater . . . through the removal of regulatory and institutional impediments and the provision of richer technology and market information to targeted audiences of Federal Agencies, States, consulting engineering firms, responsible parties, technology developers, and the investment community."[2] TIO will influence the increased use of innovative treatment technologies by working with and through knowledgeable individuals and groups both inside and outside EPA, and as a partner with other waste program offices, including the SITE Program.

In conjunction with the *Second Forum on Innovative Hazardous Waste Treatment Technologies: Domestic and International* (May 15-17, 1990), EPA met with developers and asked them to assess the SITE Program. The findings of the *SITE Program Participant Assessment* suggest that the program has been moderately successful in achieving the overall objective of bringing new technologies into use. To improve on this modest success, RREL conducted a *Management Review of the SITE Program* (August 1990) and has implemented additional program changes in response to specific review findings (see Section IV.B).

C. PROGRAM COMPONENTS

Currently, the SITE Program is administered by the Office of Research and Development Risk Reduction Engineering Laboratory headquartered in Cincinnati, Ohio. The SITE Program integrates the following four component programs:

- Demonstration Program
- Emerging Technologies Program
- Monitoring and Measurement Technologies Program
- Technology Information Services

In the **Demonstration Program**, innovative technologies are field-tested on hazardous waste materials. Engineering and cost data are gathered to assess whether the technology is effective for site clean-up. An Applications Analysis Report (AAR) is prepared to evaluate all available information on the specific technology and analyze its overall applicability to other site characteristics, waste types, and waste matrices. A second report, called the Technology Evaluation Report (TER), presents demonstration data such as testing procedures, performance and cost data collected, and quality assurance and quality control standards. Videos, bulletins, and project summaries are also prepared to further define and present demonstration data. This information is distributed to the user community to provide reliable technical data for environmental decisionmaking and to promote the technology's commercial use.

The Demonstration Program currently has 43 developers providing 45 innovative technologies for demonstrations. The projects are divided into the following categories: thermal (9), biological (8), physical and chemical (19), solidification/stabilization (8), and radioactive waste treatment (1).

[2] from OSWER's Technology Innovation Office mission statement.

Several of the technologies involve combinations of these treatment categories. Exhibit I-1 shows the breakdown, by percentage, of technologies currently in the Demonstration Program. Through fiscal year 1990, 18 technology demonstrations have been completed at Superfund remedial and removal sites, private party clean-up sites, state clean-up sites, and EPA and developer test facilities; 17 reports have been published, and others are in various stages of production.

Before a technology can be accepted into the **Emerging Technologies Program (ETP)**, sufficient data must be available to validate its basic concepts. Developers then conduct laboratory- and pilot-scale testing under controlled conditions to apply their innovative treatment processes and develop equipment and operating parameters. The technology's performance is documented, and a report is prepared. If bench and pilot test results are encouraging, the technology developer may be invited to participate in the Demonstration Program.

Thirty-one technologies currently are in the ETP, which may be divided into the following categories: thermal (4), physical and chemical (19), solidification/stabilization (1), and biological (7). These projects vary from electroacoustical decontamination to laboratory- and pilot-scale studies of a laser-stimulated photochemical oxidation process. Exhibit I-2 displays the breakdown, by percentage, of technologies in the ETP.

The **Monitoring and Measurement Technologies Program (MMTP)** explores new and innovative technologies for assessing the nature and extent of contamination and evaluating clean-up levels at Superfund sites. Effective measurement and monitoring technologies are needed to accurately assess the degree of contamination at a site; provide data and information to determine impacts to public health and the environment; supply data to help select the most appropriate remedial action; and monitor the success or failure of a selected remedy. The objectives of this MMTP are to:

- Identify existing technologies that can enhance field monitoring and site characterization.
- Support the development of monitoring capabilities that current technologies cannot address in a cost-effective manner.
- Demonstrate technologies that emerge from the screening and development phases of the program.
- Prepare protocols, guidelines, and standard operating procedures for new methods.

Three measuring and monitoring technologies were demonstrated in Fiscal Year (FY) 1990—a mobile mass spectrometer; an air sector sampler; and an infrared-based long-path air monitor.

Technology Information Services include various activities that support the SITE Program. Data results and status updates from the Demonstration and Emerging Technologies Programs are disseminated to increase awareness of alternative technologies available for use at Superfund sites. The goal of technology transfer activities is to develop interactive communication among individuals requiring up-to-date technical information, through various media, including:

- SITE brochures, publications, reports, videos, and fact sheets.
- Monthly articles in the Journal of the Air and Waste Management Association (JAWMA).
- Pre-proposal conferences on SITE solicitations.
- Public meetings and on-site Demonstration Visitors' Days.
- Seminar series with Regions and states.
- SITE and Technology Innovation Office (TIO) exhibits displayed at nationwide conferences.
- Networks established through associations, centers of excellence, Regions, and states.
- Technical assistance to Regions, state, and clean-up contractors.
- On-line information clearinghouses such as:
  - OSWER Electronic Bulletin Board System (BBS) [Help line: 301/589-8368].
  - Alternative Treatment Technology Information Center (ATTIC) including the Technology Information Exchange/Computer On-line Information System (TIX-COLIS) [System operator: 301/816-9153].

Exhibit I-1. Innovative Treatment Technologies in the Demonstration Program

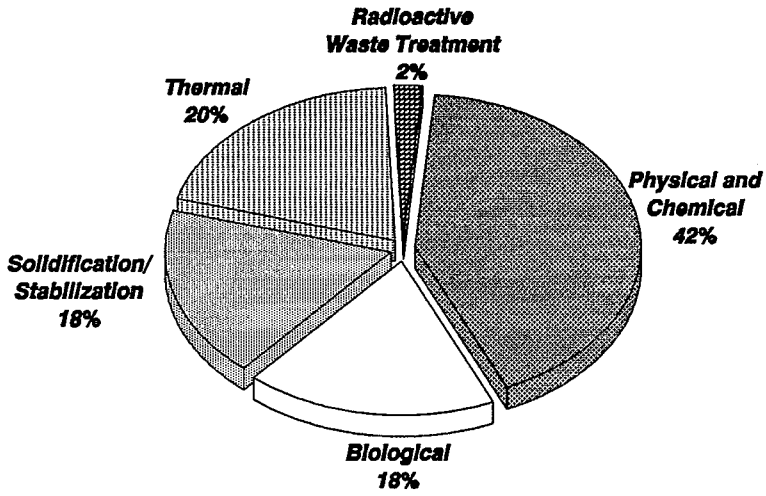
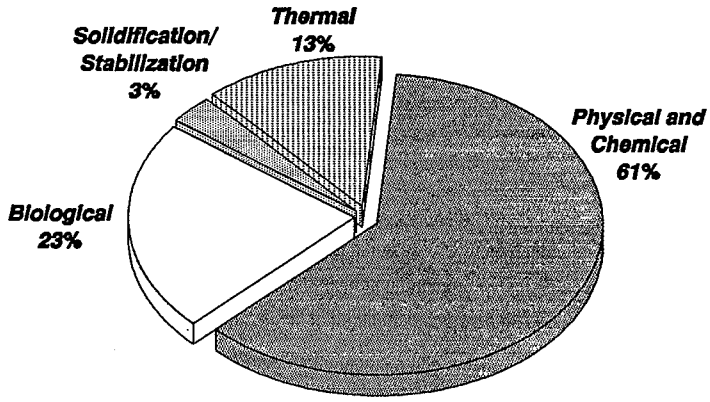


Exhibit I-2. Innovative Treatment Technologies in the Emerging Technologies Program



SECTION II
USE OF INNOVATIVE ALTERNATIVE TECHNOLOGIES

One of the primary goals of the SITE Program is to encourage the development and demonstration of new, innovative alternative treatment and monitoring technologies. This section first defines innovative alternative technologies as a basis for how the SITE Program can effectively promote their use. This is followed by discussions of the barriers and incentives to the use of innovative technologies, and how the SITE Program can facilitate their use. Finally, this section discusses innovative alternative measurement and monitoring technologies specifically, including the need for these technologies and the SITE Program's involvement in the promotion of their use.

A. DEFINITION OF INNOVATIVE ALTERNATIVE TECHNOLOGIES

Innovative technologies are not necessarily new technologies but may be new applications of existing technologies. Technology innovation strives to make things better and cheaper. Technologies in the SITE Program vary in their degree of innovativeness. Based on the 36 responses to EPA's *SITE Program Participation Assessment*, only two projects involve minor modifications to existing waste remediation technology; these two projects can be classified as "incremental." On the other hand, 18 projects are categorized as moderate to radical innovations and use technology that represents moderate to major shifts from existing waste treatment approaches. In addition, 16 projects combine multiple technologies, five of which use newly developed technologies along with existing methods for waste treatment. Clearly, the SITE Program has attracted a variety of innovative technologies.

The phrase "alternative technology" was originally derived from the concept of an alternative to land disposal as a means for treating hazardous source material (i.e., soil, sludge, and solid waste, as opposed to ground water). SARA defines alternative or innovative treatment technologies as "those technologies, including proprietary or patented methods, which permanently alter the composition of hazardous waste through chemical, biological, or physical means so as to significantly reduce the toxicity, mobility, or volume (or combination thereof) of the hazardous waste or contaminated materials being treated. The term also includes technologies that characterize or assess the extent of contamination, the chemical and physical character of the contaminants, and the stresses imposed by the contaminants on complex ecosystems [CERCLA Section 311(b)(10)]." Under the SITE Program, technologies are classified by their development status as follows:

Available (or Existing) Technology—technologies that are fully proven in routine commercial use at hazardous waste sites and for which sufficient performance and cost information are available.

Innovative Technology—any fully developed technology for which cost or performance information is incomplete, thus hindering routine use at hazardous waste sites. An innovative technology requires field testing and evaluation before it is considered proven and ready for commercialization and routine use.

Emerging Technology—a technology in an earlier stage of development. Documentation has involved some laboratory testing, but the technology requires additional laboratory- or pilot-scale testing prior to field testing at hazardous waste sites.

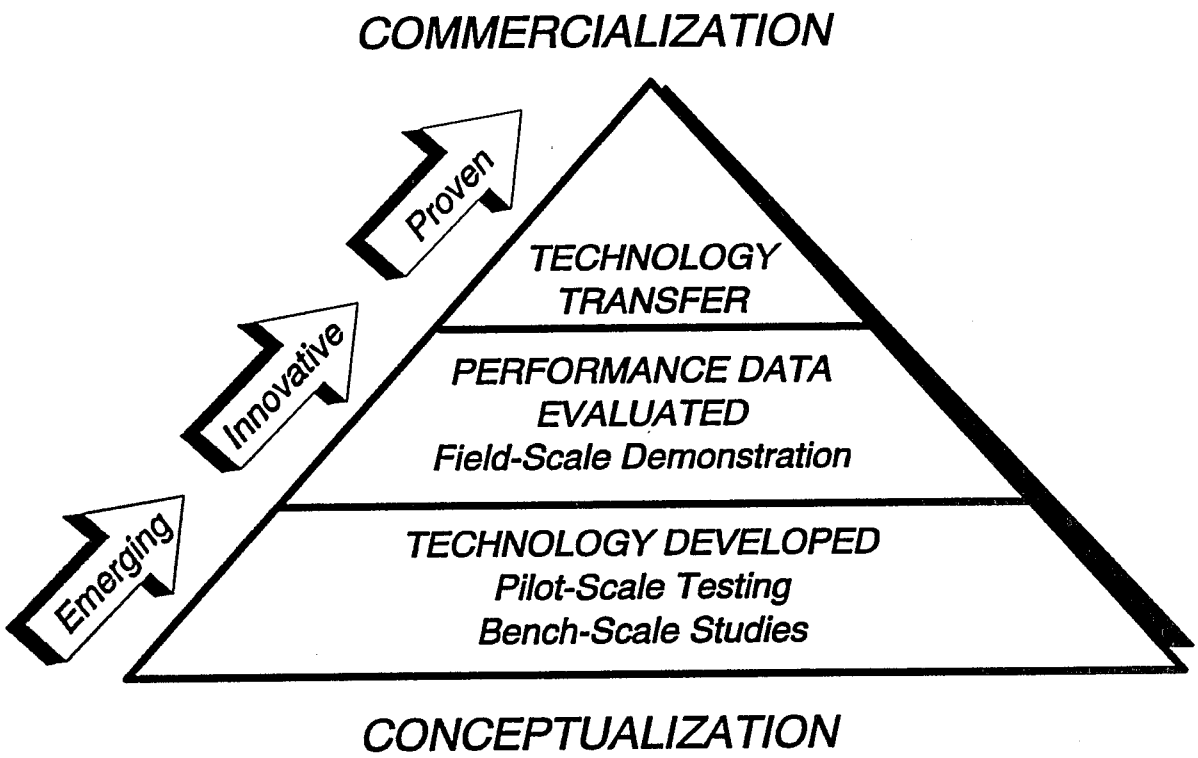
Exhibit II-1 depicts the process of technology development from initial concept to commercial use, and shows the interrelationship between the SITE demonstration and emerging technologies programs. Similar concepts can also be applied to demonstrating and evaluating monitoring and measurement technologies, as defined by SARA and included in the SITE Program.

Commercialization of innovative technologies at hazardous waste sites also requires an understanding of the marketplace for these technologies. Market surveys, such as those by National Environmental Technology Applications Corporation (NETAC) and OSWER's TIO, are important to this final stage of technology development. The SITE Program can then provide the scientific, engineering, and cost data needed to bridge the gap between research and commercial use of innovative technologies.

B. BARRIERS AND INCENTIVES TO THE USE OF INNOVATIVE ALTERNATIVE TECHNOLOGIES

The most critical step in the CERCLA remediation process is the selection of a cleanup remedy for a Superfund site. During the selection process, each potential remedial

Exhibit II-1. Innovative Alternative Technologies



alternative is assessed according to a set of nine evaluation criteria, which are depicted in Exhibit II-2. Some of these factors impede the use of innovative alternative technologies, while others will favor the selection of innovative technologies for future cleanups. Once the alternatives have been evaluated against the criteria, the selected remedy is outlined in a document called a Record of Decision (ROD).

The following briefly describes the nine evaluation criteria that have been developed to address the CERCLA requirements for remedy selection, as well as specific barriers and incentives to the use of innovative alternative technologies for CERCLA site remediation. These criteria are listed in OSWER Directive 9355.3-01, *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA.*

1. Overall Protection of Human Health and the Environment

This criterion assesses how the selected alternative is protective of human health and the environment. The overall protectiveness incorporates many of the other criteria listed below. It evaluates how site risks are eliminated, reduced, or controlled through treatment or engineering controls.

The main barrier preventing use of innovative alternative technologies based on this criterion is the uncertainty associated with the use of a new technology. The lack of an established performance record affects all selection criteria, but most important cannot assure that performance can be achieved on a consistent basis. Because the "overall protectiveness" criterion relates to other criteria, specific barriers and incentives to overall protection are included in the criteria discussions below.

2. Compliance with ARARs

Section 121 of CERCLA mandates that Superfund remedial actions must comply with any Federal and state laws and regulations that are determined to be legally applicable or relevant and appropriate requirements (ARARs) or justify a waiver from such requirements. Three types of ARARs are as follows:

- Location-specific. Example: A requirement prohibiting the location of a RCRA treatment or disposal facility in a floodplain.
- Chemical-specific. Example: Drinking water standards for a particular contaminant.

Exhibit II-2. Criteria for Detailed Analysis of Remedial Alternatives

OVERALL PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT

- How Alternative Provides Human Health and Environmental Protection

COMPLIANCE WITH ARARs

- Compliance with Chemical-Specific ARARs
- Compliance with Action-Specific ARARs
- Compliance with Location-Specific ARARs
- Compliance with Other Criteria

LONG-TERM EFFECTIVENESS AND PERMANENCE

- Magnitude of Residual Risk
- Adequacy and Reliability of Controls

REDUCTION OF TOXICITY MOBILITY, AND VOLUME THROUGH TREATMENT

- Treatment Process Used and Materials Treated
- Amount of Hazardous Materials Destroyed or Treated
- Degree of Expected Reductions in Toxicity, Mobility, and Volume
- Degree to Which Treatment is Irreversible
- Type and Quantity of Residuals Remaining After Treatment

SHORT-TERM EFFECTIVENESS

- Protection of Community During Remedial Actions
- Protection of Workers During Remedial Actions
- Environmental Impacts
- Time Until Remedial Action Objectives are Achieved

IMPLEMENTABILITY

- Ability to Construct and Operate the Technology
- Reliability of the Technology
- Ease of Undertaking Additional Remedial Actions, if necessary
- Ability to Monitor Effectiveness of Remedy
- Ability to Obtain Approvals from Other Agencies
- Coordination with Other Agencies
- Availability of Off-Site Treatment, Storage, and Disposal Services and Capacity
- Availability of Necessary Equipment and Specialists
- Availability of Prospective Technologies

COST

- Capital Costs
- Operating and Maintenance Costs
- Present Worth Cost

STATE ACCEPTANCE

COMMUNITY[1] ACCEPTANCE

Note:
[1] These criteria are assessed following comment on the RI/FS report and the proposed plan.

Source: OSWER Directive 9355.3-01.

- Action-specific. Example: A requirement for a specific technology, such as incineration, for specific types of wastes.

Compliance with ARARs may inhibit the widespread use of innovative alternative technologies at CERCLA sites. For example, a drinking water standard requiring extremely low concentrations of volatile organics may be a relevant and appropriate requirement at a site. However, specific data may be lacking showing that such an ARAR is attainable for a complex array of mixed chemicals. Therefore, decisionmakers may not want to consider the use of an innovative technology in light of this uncertainty. Also, some action-specific ARARs that require the use of a specific "Best Demonstrated Available Technology" may preclude selection of a new, unspecified technology.

Conversely, incentives favoring the use of an innovative technology may also result from the application of certain ARARs. For instance, a site may not be suitable for long-term isolation of wastes due to its location on a floodplain, thus rendering a RCRA-approved landfill cap unsuitable as a remedial alternative. In this case, a permanent remedy involving removal and recycling of the waste materials may be the only way to achieve all applicable requirements. In many cases, the recovery of recyclable materials may entail an innovative separation technology. Similarly, land disposal restriction treatment standards forbid the land disposal of solid wastes in excess of certain concentrations. If an innovative alternative technology is capable of reducing these concentrations below the applicable regulatory levels, then a costly incineration remedy may be avoided.

3. Long-Term Effectiveness and Permanence

This criterion measures the risks associated with a site after remediation. In many cases, wastes are left on-site, thus committing response personnel to long-term monitoring. Two components are addressed: (1) the magnitude of the residual risks, which assesses toxicological properties and migration pathways, and (2) the adequacy and reliability of controls that address the need for long-term monitoring techniques and any resulting controls that may be required.

For some technologies, such as solidification/stabilization (S/S), it is difficult to model and evaluate long-term effects. Factors such as stability and permanence cannot be evaluated in a short-term laboratory setting. These concerns act as significant barriers to the selection of many promising S/S technologies, both within and outside of the Superfund program. In other situations, however, the requirement for a permanent solution can be a strong incentive to the use of innovative alternative technologies. For example, very few technologies are available to permanently remove heavy metal contamination from soils. Such contamination is common at many sites. However, it may be possible to transfer existing separation methods from the mining industry into the environmental engineering practice, thus leading to effective and permanent recycling alternatives. Because many innovative alternative technologies involve separation or destruction of hazardous materials, the requirement for permanent treatment can, if applied uniformly across all sites, strongly favor the use of such technologies.

4. Reduction of Toxicity, Mobility, or Volume Through Treatment

An important new requirement of SARA is the preference for treatment in the technology selection process. This statutory preference focuses on many factors such as the type and quantity of residuals remaining after treatment, the degree to which mobility has been reduced by, for example, precipitation of toxic metal species, and to what extent the effects of treatment are irreversible.

The most important barrier this criterion poses to the use of innovative alternative technologies is the lack of reliable and verified treatability data. A technology's ability to reduce toxicity, mobility, or volume cannot be evaluated without high quality data from similar applications of the technology. Moreover, technologies must be tested using matrices (soil and water) highly similar to those at the actual site in question. Conventional containment alternatives address only the requirement for reducing contaminant mobility. Innovative solidification/stabilization and vitrification technologies reduce contaminant mobility and toxicity or volume. Other innovative treatment technologies are needed to address these requirements for the variety of contaminants and media found at Superfund sites.

5. Short-Term Effectiveness

This criterion evaluates alternatives in terms of their effects on human health and the environment during implementation. For example, dust from excavation of contaminated soils may adversely affect a nearby population.

A barrier to the use of innovative alternative technologies is short-term environmental impact. Because many technologies are developed in laboratories on bench-scale apparatus, emissions of residual wastes are not often evaluated. Also, very few treatment systems are completely closed; therefore, there is always the potential that some hazardous materials may be released during processing. In many cases, the only way to evaluate such releases and their potential effects is through field testing. Regulators and industry personnel may be unwilling to use an innovative technology in the absence of such data. SITE demonstrations provide high quality data addressing all releases and residual wastes from the innovative technology being tested.

6. Implementability

Implementability refers to the technical and administrative feasibility of constructing and operating the alternative, as well as the reliability of the technology in question. Also addressed in implementability evaluations are availability of specialized equipment and services, and trained personnel.

The implementability of a technology is very important in determining whether a particular remedy is suitable for a given site. As stated above, innovative alternative technologies are often first developed in small-scale laboratory ex-

periments, where the primary emphasis is on obtaining technical data such as treatment efficiency. Implementability information, however, is highly site-specific. The lack of such information acts as a barrier to innovative alternative technology development.

The implementability criterion also considers the availability of the required equipment and materials. Innovative technologies may be available from only one vendor, and that vendor may have a limited sizes and numbers of treatment units.

However, certain physical, regulatory, or administrative constraints at a site may inhibit the implementation of conventional treatment methods. This provides incentives for the development and implementation of innovative alternative technologies that are not limited by those constraints.

7. Cost

CERCLA remedial actions must be cost-effective. Costs are broken down into direct capital costs and annual operation and maintenance costs. The distribution of costs over time is critical in determining the tradeoffs between capital-intensive technologies (such as treatment or destruction technologies) and less capital-intensive technologies (such as pump-and-treat systems).

The cost factor is a significant barrier to the use of innovative alternative technologies. Research and development (R&D) costs are generally very high, and thus must be included in the overall cost of a remedial action. Rather than distributing costs among many cleanup operations, R&D costs are often applied to a single site, leading regulatory personnel to conclude that many innovative alternative technologies are too expensive on a site-specific basis. Private sector PRPs often remove innovative alternative technologies from consideration due to the unknown costs of scale-up and field implementation, citing SARA's requirement that remedies be cost-effective. Because of this requirement, a known containment solution such as capping, or treatment alternative such as incineration, may be selected as the alternative at many sites.

However, the site may require extensive remediation in the event of a cap failure. Thus, a very important financial incentive for implementing innovative alternative technologies is that future liabilities can be avoided by specifying solutions involving permanent removal or treatment options.

8. State Acceptance

This criterion evaluates the state's acceptance of the remedial alternative in light of technical, regulatory, and cost concerns. States may hesitate to use innovative technologies given their perceived unreliability. Also, a CERCLA cost-sharing requirement that states pay 10 percent or more for remedial actions may eliminate innovative alternative technologies from consideration.

In other cases, state environmental officials are interested in more stringent cleanup criteria than are technically feasible with currently available technology. Such stringent criteria may act as incentives because they often can be met only through an innovative separation or destruction technology.

9. Community Acceptance

This assessment evaluates issues and concerns the public may have regarding the remedial alternative. Experience has shown that the public is extremely wary of technologies involving conventional thermal destruction, such as incineration, due to a widely held public perception that incineration is a major contributor to air pollution. A common impediment to the use of innovative alternative technologies is public resistance to the siting of industrial or chemical plants, including those intended for the remediation of hazardous waste sites. Once a process is sited, communities often have serious concerns with process releases, even if such releases do not entail significant risk to human health or the environment. The public may also resist the selection of a "new" technology due to uncertainty regarding its overall performance.

On the other hand, the public may want more permanent remedial actions for hazardous waste sites than conventional methods, such as capping, can provide. This provides incentive for the development and use of innovative alternative technologies that provide more permanent solutions to hazardous waste problems.

C. ROLE OF THE SITE PROGRAM IN ADVOCATING INNOVATIVE ALTERNATIVE TECHNOLOGIES

The success of the SITE Program in advocating the use of innovative alternative technologies depends on the program's ability to generate and disseminate information and provide technical assistance for use by remedial project managers in selecting remedial actions. SITE's core Demonstration Program is unique in that it provides information on each of the nine selection criteria described above under actual field conditions. In addition, the SITE Emerging Technologies Program and Monitoring and Measurement Technologies Program (MMTP) provide immediately useful information to decisionmakers. The following paragraphs describe how the SITE Program provides information on innovative alternative technologies so that they can be evaluated against the nine criteria.

1. Overall Protection of Human Health and the Environment

The measure of overall protection is based on avoidance of risk. By their nature, innovative alternative technologies require a certain amount of risk-taking. PRPs and others responsible for evaluating remedial alternatives understand the liabilities associated with an unsuccessful remedial action and, thus, tend to favor "proven" technologies. However, the Superfund program has determined that many proven tech-

nologies, such as capping and slurry walls, do not provide the degree of permanence afforded by treatment alternatives. That is, they may result in a significant residual risk. SITE demonstration reports document the permanent reductions in contaminant levels that can be achieved by a technology, thus, providing data that can be used to predict a given level of permanent protection and reduced overall cost.

2. Compliance with ARARs

The demonstration plan developed for each SITE project lists the ARARs for the demonstration site. In fact, those ARARs often provide the basis on which the success of the technology demonstration is measured. Compliance with federal, state, and local ARARs can all be evaluated by predemonstration screening, treatability studies, and field-scale demonstrations.

3. Long-Term Effectiveness and Permanence

This criterion evaluates the magnitude of risk associated with treatment residuals. As part of the SITE demonstration process, both treatability studies and field testing provide high quality data on treatment residuals; such data can then be used in a risk assessment. Reviewers of the program agree that the production of high quality, unbiased data is a strong element of the program that must not be compromised. Also, many emerging technologies in the SITE Program focus on how to handle treatment residuals resulting from the use of other technologies.

4. Reduction of Toxicity, Mobility, and Volume Through Treatment

The SITE demonstration program uses state-of-the-art field and laboratory analytical procedures to provide high quality data for its technology evaluations. In addition, SITE demonstrations include engineering field measurements to assess volume reductions or, in the case of solidification/stabilization, increases due to treatment. This type of information on toxicity, mobility, and volume is essential to evaluating a technology's potential use at other sites.

In addition, the SITE MMTP is designed to further EPA's ability to determine the toxicity and mobility of contaminants in the environment (see Section II.D).

5. Short-Term Effectiveness

The short-term impacts of a site remediation are difficult to assess without actual field experience. To gain information to support this criterion, each SITE demonstration plan includes a detailed health and safety plan to assure protection of workers and the surrounding community during the demonstration. Through on-site health and safety monitoring during the demonstration, EPA can draw conclusions on the potential impact of an innovative alternative technology during actual site remediation.

6. Implementability

The SITE Program is designed to expand the availability of implementable, innovative alternative technologies. In addition, the demonstration program develops valuable information on the technical and administrative feasibility of these technologies. Mobilization for a SITE demonstration requires all the elements of an actual site remediation, including site preparation, local and state permitting (or variances), arrangements for utilities and other supplies, waste handling, and waste pretreatment, if needed. The results and any problems are then reported to future users of the technology.

7. Cost

The SITE Program addresses cost and financial issues in several ways. In the applications analysis process, EPA evaluates 12 cost categories for using the technology. Decisionmakers and remedial design engineers can evaluate these cost data based on the conditions at a given site. EPA also attempts to verify costs reported by the developer by monitoring all materials and utilities during the demonstration and through comparison with similar technologies. Accurate cost estimates are essential when attempting to justify an innovative approach.

The SITE Program also assists with financing the development of new technologies. The Emerging Technologies Program provides up to $150,000 per year (maximum 2 years) to developers through a cost-sharing cooperative agreement. In the Demonstration Program, EPA pays for site preparation and sampling and analysis, two significant components of any field test. By offsetting some of these development costs, capital costs of developing the technology may be reduced, and the technology is brought to the market sooner.

8. State Acceptance

State preferences and concerns must be considered in selecting a remedy. The issue of state acceptance is addressed after the feasibility study (FS), which includes the evaluation of remedial technologies, is complete. The inter-governmental review process in the SITE Demonstration Program allows both the developer's state and the site's state agencies to review and comment on a proposed demonstration. Twenty-five states have requested to be included in this review process. EPA prepares a fact sheet for state review, and provides additional documents such as the demonstration plan, as requested.

In addition, the SITE Program works with state environmental agencies, such as California's Department of Health Services, in finding demonstration sites and coordinating with state remedial project managers during demonstrations. SITE intends to expand its involvement with state innovative technology assessment programs, as well.

Finally, through SITE's technology transfer activities, information on innovative alternative technologies is disseminated to state personnel to further their understanding, and possible acceptance, of these technologies. State partici-

pation and attendance at on-site Visitors' Days is strongly encouraged.

9. Community Acceptance

The SITE Demonstration Program addresses community acceptance in many ways. First, SITE Program staff coordinate with ongoing EPA Regional community relations activities for the demonstration site, as described in the site's community relations plan. EPA may prepare fact sheets, issue public notices, hold public meetings and workshops, and conduct other community outreach activities in coordination with ongoing activities. (Sample fact sheets are provided in Appendix D.)

The SITE Program also documents the demonstration on videotape and conducts a Visitors' Day for each SITE demonstration. The on-site Visitors' Days is attended by such groups as local officials, press, students, and the general public, as well as technical personnel such as state and regional RPMs and remedial engineering contractors. This provides an opportunity for individuals and groups to view the technology in operation, thus promoting its acceptance.

D. INNOVATIVE MONITORING AND MEASUREMENT TECHNOLOGIES

Monitoring and measurement technologies play a number of critical roles in the EPA process for identifying, characterizing, and remediating hazardous waste sites. The Superfund remedial process begins with initial site discovery and, in such case as a site becomes included on the National Priorities List (NPL), ends with removal from the NPL and, if necessary, an operation and maintenance agreement.

Site characterization is important in remedial investigations. EPA, through its various Superfund contractors and the potentially responsible parties (PRPs), use whatever means are available to gather data and information on the nature and extent of contamination at each site. Site specific information on the nature and extent of contamination is required for use in the Hazard Ranking System (during site assessment), for use in preparing risk assessments, and for selecting the appropriate remedy(s) for the site during the remedial investigation/ feasibility study (RI/FS) phase.

In addition to their role in remedial investigations, monitoring, measurement, and other site characterization technologies play a critical part in evaluating the progress and effectiveness of a selected remedy(s) and in the follow-up monitoring activities after the site is removed from the NPL. Monitoring, measurement, and site characterization technologies also are used in emergency situations (removal actions).

1. Need for Faster and More Cost-Effective Field Methods

Experience has shown that site characterization during the remedial investigation process can take a very long time and is costly. This is due, in large part, to the limited sophistication of the equipment used to collect environmental samples, analytical costs, and quality control requirements. Analytical costs can range from $200 to over $2,000 per sample. The users of site characterization technologies realize that there are tremendous costs associated with data and information gathering during the Superfund remedial process, particularly during the remedial investigation. It has become apparent that faster and more cost-effective means are needed to acquire comparable or better site characterization data directly in the field. In response to this need, a new environmental technology market has evolved that is focused on producing instruments and methods that can be used to generate real-time or near-real-time data and information in the field.

However, site engineers are often reluctant to use any method, other than generally accepted conventional ones, for generating critical data on the nature and extent of contamination at a site. It is generally understood that the data generated with conventional laboratory methods are those recognized by the courts. To meet this stringent requirement, EPA Regions must identify new approaches, and seek assurances through verifiable testing on the capabilities of emerging field screening technologies. Currently, the only sources of information on innovative or alternative technologies available to the Regional staffs are the vendors and the pilot testing that the Regions may be able to conduct during site activities. However, the Regions generally do not have the resources to plan and conduct these demonstrations, nor are they prepared to transfer that information to the other Regions, the states, and others in the user community.

2. The SITE Monitoring and Measurement Technologies Program

The goal of the SITE Monitoring and Measurement Technologies Program (MMTP) is to accelerate the recognition and use of those technologies that have the potential to provide more cost-effective, better, faster, or safer means to detect and monitor contaminants and the geophysical characteristics of Superfund sites. Candidate technologies may come from within the Federal government or from the private sector. Through the program, developers are provided with the opportunity to rigorously evaluate the performance of their technologies. By distributing the results and recommendations of that evaluation the market for the technologies is enhanced. The MMTP is administered by ORD's Environmental Monitoring Systems Laboratory in Las Vegas, Nevada (EMSL-LV).

Technology developers continually inquire as to how they can get approval or endorsement from EPA for their product. Although the Agency does not intend to formally approve or endorse any product, most developers recognize that an evaluation of the technology that their product represents under the Demonstration Program can have a significant positive impact on the commercial success of their product. The developers often note that without recognition by EPA, the Regions are reluctant to use an alternative technology (through various remedial response contracts) or allow its use by others (PRPs and states). The MMTP is, to the best of our knowledge, the only program that exists at the

Federal, state, or private level for demonstrating the performance of monitoring, measurement, and site characterization technologies under field conditions, reporting on the performance, and communicating the results to the user community.

3. Promoting the Use of Innovative Monitoring and Measurement Technologies

Technology developers have directly benefitted from participation in the Program. There have been three technology demonstrations conducted. They include: a side-by-side demonstration of commercially available gas chromatographs; the testing of a portable long-path infrared spectrometer for measuring VOC concentrations in ambient air; and the field testing of a portable mass spectrometer. These technologies have been and will continue to be used by the Agency to support decision making in the field.

In addition to the technologies demonstrated under the Program, the development of emerging technologies has been, in part, supported with resources available through the Program. These technologies include: a field portable x-ray fluorescence spectrometer, a data telemetry/geo-position system, a field portable luminiscope, various immunoassay field kits, ion mobility spectrometers, and innovative methods for the analysis of contaminants in ambient air. The support of emerging technologies is essential for ensuring that a steady stream of technologies are ready for demonstration and made available to the Agency and other potential users. The Agency will directly benefit from having a variety of alternative field screening methods and the environmental technology market will be enhanced.

Finally, as a result of the implementation of the MMTP, EPA has established a central focal point within the Agency, EMSL-LV, where technology developers and users (EPA, other Federal agencies, and private parties) can direct inquires about current and emerging monitoring, measurement, and site characterization technologies. Specifically, this has provided EPA with the means to interact with about 100 technology developers, thereby enhancing the list of candidate technologies for potential users. It has also resulted in the establishment of an extensive communication network between (and within) the EPA, other Federal agencies, and the states. This network has been particularly useful for conveying information on demonstrated and emerging technologies, for avoiding redundancy in research, for planning technology development and demonstration activities, for prioritizing needs, and for exchanging ideas and expertise.

SECTION III
PROGRESS AND ACCOMPLISHMENTS

This section discusses the progress and accomplishments of the SITE Program over the past year. The program's overall accomplishments to foster incentives and overcome barriers are discussed first. This is followed by discussions of the progress of the four major components of the SITE Program: (1) the Demonstration Program, (2) the Emerging Technologies Program, (3) the Monitoring and Measurement Technologies Program, and (4) the Technology Information Services.

A. PROGRAM ACCOMPLISHMENTS TO FOSTER INCENTIVES AND OVERCOME BARRIERS

As discussed in Section II, the success of the SITE Program must be measured by the increased use of innovative technologies for hazardous waste treatment and site monitoring and measurement. SITE provides developers (1) assistance in funding their technology development, (2) the opportunity to test technologies under actual site conditions, and (3) vast information resources and capabilities to disseminate the results of these efforts. The following paragraphs discuss the program's attempts to foster incentives and overcome barriers to the use of innovative technologies.

1. Impact on Developers

Over the past year, EPA has investigated the impact of the SITE Program on developers' success in the marketplace. Through the University of Cincinnati's Center for the Management of Advanced Technology and Innovation, a program assessment was conducted on 45 developers in the emerging technologies and demonstration programs. Twenty-six of the developers reported one or more applications of their technology subsequent to their SITE Program participation. Of the remaining technologies, seven were not yet ready for commercialization; therefore, more than 68 percent of the viable technologies have had some success in the marketplace.

In a follow-up survey of the 20 developers that had completed SITE demonstrations, respondents reported 14 Superfund projects started since the SITE demonstration. In addition, excluding Terra Vac (see paragraph below), these developers reported 13 RCRA corrective actions, 23 other cleanups, and over 300 treatability studies that could potentially lead to other remediation projects.

Individually, several technologies have done extremely well in the marketplace. For example, Terra Vac's in-situ vapor extraction system has been applied at more than 200 sites in the U.S. since 1988. In general, vapor extraction has received increased attention in the selection of remedial alternatives since Terra Vac's system was demonstrated under the SITE Program (December 1987 through April 1988 at the Groveland Wells Superfund Site).

Commercial units of CF Systems Corporation's solvent extraction technology have been sold to Clean Harbors of Braintree, Massachusetts, for wastewater clean-up; and Ensco of Little Rock, Arkansas, for incinerator pretreatment. A unit is also in operation at Star Enterprise of Port Arthur, Texas, treating American Petroleum Institute (API) separate sludge to meet Best Demonstrated and Available Technology (BDAT) standards for organics.

International Waste Technologies (IWT)/Geo-Con, Inc.'s in-situ solidification/stabilization process was selected as the remedial method at a PCB-contaminated G.E. facility in Hialeah, Florida. Full-scale implementation of the technologies is scheduled to begin in December 1990. IWT/Geo-Con, Inc. is also pursuing work in the Netherlands and Norway, demonstrating the SITE Program's international significance.

Other examples of SITE's impact on developers include the increased interest in ultraviolet oxidation processes, specifically the Ultrox Industries system. The Ultrox system was selected as the remedial technology at the Lorenz Barrel and Drum site, where the SITE demonstration took place. Shirco's infrared incinerator was sold to three remediation contractors that are actively marketing the technology for site clean-ups. Three emerging technologies in the program are now ready for field demonstration: Bio-Recovery Systems' AlgaSORB® process, Colorado School of Mines' wetland-based treatment, and Western Research Institute's Contained Recovery of Oily Wastes system.

2. Evolution of START and TIO

The Superfund Technical Assistance Response Team (START) program was formed within RREL to provide assistance to EPA Regional office staff on complex sites. The purpose of the program is to increase the use of treatment technologies, as opposed to containment options, and better ensure the quality of the decision through engineering support to the Regions. EPA understands that complex problems

often require innovative solutions, and RREL can apply the resources of the SITE Program directly to site problems. START program staff, many of whom are also SITE project managers, assist in state-of-the-art technology reviews, technical reviews of PRP generated documents, and in the performance of treatability studies, which may employ innovative technologies. START also provides opportunities for future SITE demonstration sites, and the potential for long-term involvement and evaluation of innovative treatment technologies.

The Technology Innovation Office (TIO) was formed by the Office of Solid Waste and Emergency Response (OSWER) from its SITE Program staff. As SITE demonstration and technology evaluation responsibilities shifted to RREL, the TIO staff evolved to fill a need for a better understanding of the market for innovative treatment technologies. In August, TIO conducted a review of RODs signed for National Priorities List (NPL) sites to assess the use of innovative technologies. Exhibit III-1 portrays the extent to which treatment technologies have been specified for source control remediation at these sites.

As part of OSWER, the TIO has a direct link to EPA's Regional offices as well as a headquarters perspective of overall Superfund program needs. Both START and TIO represent significant efforts in "mainstreaming" the findings of the SITE Program and, thus, providing incentives and overcoming barriers to the use of innovative technologies.

B. DEMONSTRATION PROGRAM

The SITE Demonstration Program develops reliable engineering performance and cost data on innovative treatment technologies so that potential users can evaluate each technology's applicability for a specific waste site. Demonstrations are conducted at hazardous waste sites or under situations that closely simulate actual wastes and site conditions; these include Superfund remedial and removal sites, private party clean-up sites, state clean-up sites, and EPA and developer test facilities.

Data collected during a demonstration are used to assess the performance of the technology, the potential need for pre- and post-processing of the waste, applicable types of wastes and media, potential operating problems, and the approximate capital and operating costs. Demonstration data can also provide insight into long-term operating and maintenance costs and long-term risks.

Technologies are selected for the Demonstration Program primarily through annual requests for proposals (RFPs). Although the process is non-competitive, proposals are reviewed by EPA to determine those that fit into the Demonstration Program and have promise for use at hazardous waste sites. In addition, several technologies have entered the program on a fast-track basis. These technologies were primarily ongoing Superfund projects or private sector activities in which innovative techniques of interest were identified for evaluation.

Cooperative agreements between EPA and the developer set forth responsibilities for conducting the demonstration and evaluating the technology. Developers are generally responsible for operating their innovative systems at a selected site, and are expected to pay the costs to transport equipment to the site, operate the equipment on-site during the demonstration, and remove the equipment from the site. EPA is responsible for project planning, site preparation, sampling and analysis, quality assurance and quality control, reporting, and technology transfer. If the developer is unable to obtain financing elsewhere, EPA may consider bearing a greater portion of the total project cost.

Through fiscal year 1990, five solicitations have been completed, SITE 001 in 1986 through SITE 005 in 1990. The RFP for SITE 006 will be issued in January 1991. A summary of the five completed solicitations is presented in Exhibit III-2. The Demonstration Program has 43 active participants (45 projects), including several fast-track projects. A complete list of the current participants is presented in Appendix B.

The progress and accomplishments of the Demonstration Program can be measured through (1) its ability to attract technologies and sites to participate in the program, (2) the success of completed demonstrations, (3) the evaluations of the completed demonstrations, and (4) the number and quality of new projects for FY 1990. These issues are discussed in the following sections, along with the future needs and direction of the Demonstration Program for continued success.

1. Attracting Technologies and Sites to the Program

As stated above, technologies have been selected for participation primarily through annual solicitations published in the *Commerce Business Daily* and advertised in various environmental trade journals. Proposals are reviewed by a panel of EPA experts based on the following selection criteria:

- *Technology Factors*—including the unit size, transportability, treatment capacity, and availability of the technology; the types and concentrations of waste the technology can handle; materials handling needs of the technology; and the types and quantities of waste streams or residues generated by the technology.

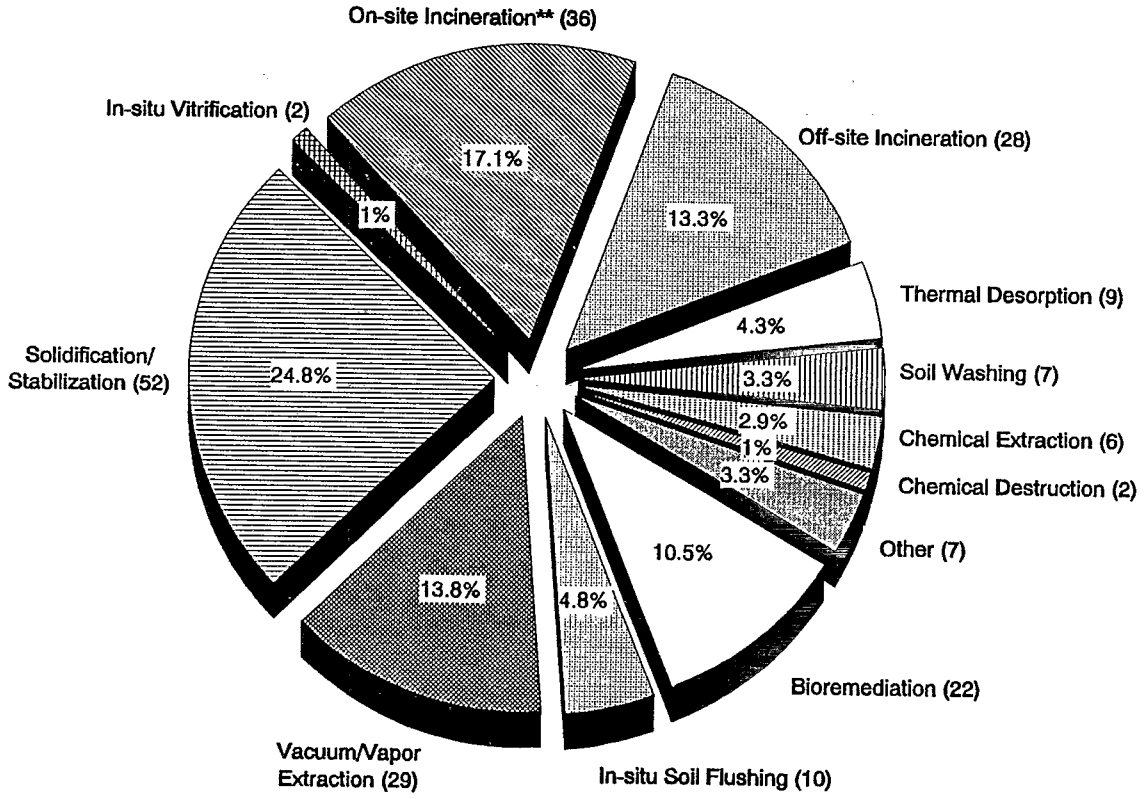
- *Performance Factors*—including the history or background at technology development, available pilot- or field-scale data, applicability to Superfund sites, and advantages over similar technologies.

- *Developer Factors*—including the experience and availability of key personnel, Superfund-related experience, subcontracting needs, marketing strategy, and projected unit costs.

Due to the low response to the SITE 005 solicitation, EPA increased its efforts in FY 1990 to attract technologies to the program through other means. This increased flexibility has also been recommended in various reviews of the

Exhibit III-1. Source Control Treatment—Fiscal Years 1987-1989*

TREATMENT TECHNOLOGIES SPECIFIED - 210
NUMBER OF RODS - 165



* Sources include solids, soils, sludges and liquid wastes; waste sources do not include ground water or surface water

** Also includes sites where location of incineration is to be determined

( ) Number of times this technology was selected

Source: "Selected Data on Innovative Treatment Technologies: For Superfund Source Control and Groundwater Remediation," U.S. EPA, Technology Innovation Office, August 1990.

Exhibit III-2. Summary of Demonstration Program Solicitations

Solicitation	Date RFP Issued	Number of Responses Received	Number Technologies Selected
SITE 001	March 1986	20	13
SITE 002	January 1987	29	11
SITE 003	January 1988	31	12
SITE 004	January 1989	24	12
SITE 005	January 1990	12	6

program. One way to attract technologies is through outreach to EPA Regional offices. RREL's internal management review found that EPA's Regional offices and PRPs are using some innovative technologies at sites and that the SITE Program should move to bring these projects into the program. One recent example of this approach is the demonstration of excavation techniques and foam suppression at the McColl Superfund site in California. RREL had previously demonstrated the Ogden circulating bed combustor on wastes from the site, and continued its support to Region 9 on evaluating a method to control emissions from excavation of the waste for the full site remediation.

The START program has also provided this type of outreach to the Regions. This has resulted in a potential demonstration of the Colorado School of Mines wetlands technology at the Clear Creek site. This project also represents the success of the Emerging Technologies Program as a feeder to the Demonstration Program. As an example of state outreach, the AWD Technologies demonstration combined two proven technologies—in-situ vapor extraction and steam stripping—in an innovative way. The technology was accepted into the SITE Program as an operating system, and was approved by the State of California Department of Health Services for the Burbank Well Field Superfund site.

Other methods that are being implemented to attract technologies to the program include:

- Incorporating market survey information into subsequent solicitations to guide technology developers.
- Inviting developers to address specific site problems, such as those found at wood-preserving, town-gas, or lead-battery sites, thus adding the potential for future work at the site.
- Using the START program to identify sites and technology needs for specific site problems.
- Advertising that technologies may enter the program at any time if the developer has a technology that meets the criteria for selection *and* has a demonstration site.
- Working with more than one developer to build innovative treatment trains for specific site problems.
- Conducting treatability studies on potential technologies at EPA test facilities.

2. Completed Demonstrations

Over the past year, five demonstrations of innovative treatment technologies have been completed under the Demonstration Program. Additionally, three demonstrations were conducted as part of the Monitoring and Measurement Technologies Program (MMTP). The technologies demonstrated during the past year as part of the Demonstration Program, as well as available preliminary results from the demonstrations, are discussed below. A summary of demonstrations completed during FY 1990 is presented in Exhibit III-3. All demonstrations completed through fiscal year 1990 are highlighted in the lists provided in Appendix B. Those technologies demonstrated under the MMTP are discussed in Section III.D of this report.

AWD Technologies, Inc., San Francisco, California, developed an integrated **AquaDetox/SVE System** that simultaneously treats groundwater and soil contaminated with volatile organic compounds, including chlorinated hydrocarbons such as trichloroethylene and perchloroethylene. The integrated system consists of two basic processes: (1) an AquaDetox moderate vacuum stripping tower that uses low-pressure steam to treat contaminated ground water, and (2) a soil gas vapor extraction/reinjection (SVE) process to treat contaminated soil. The two processes form a closed-loop system that provides simultaneous in-situ remediation of contaminated groundwater and soil with no air emissions.

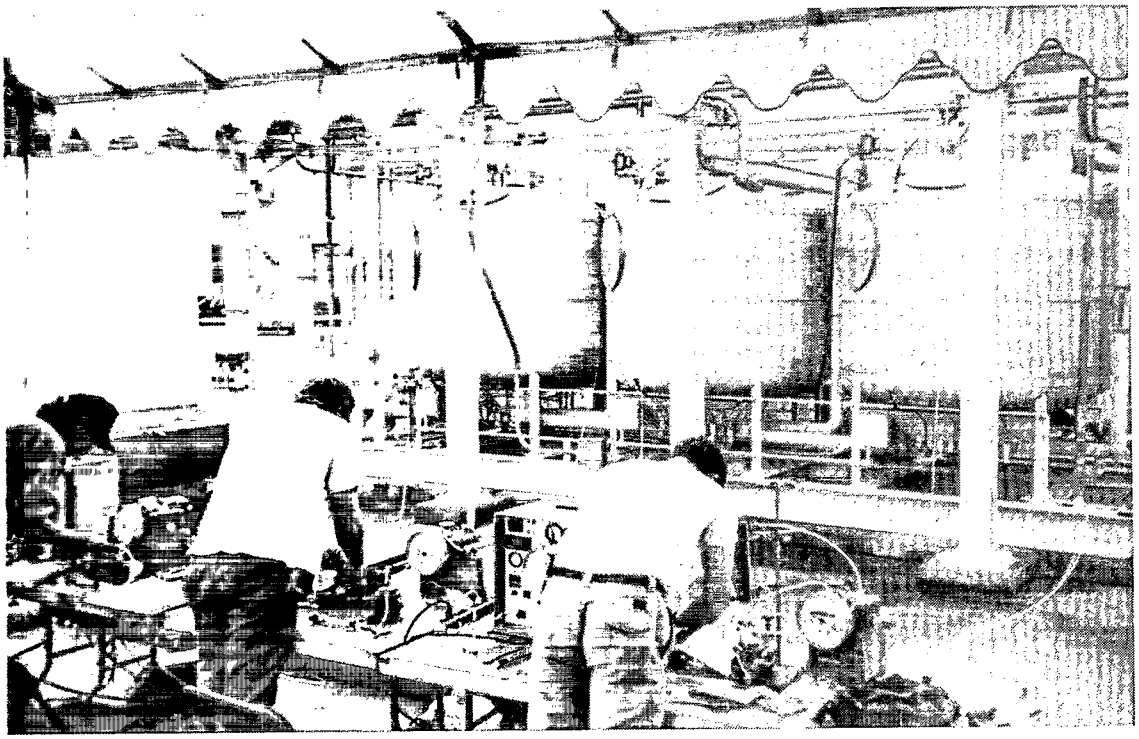
The AWD AquaDetox/SVE System is currently being used at the Lockheed Aeronautical Systems Company in Burbank, California. At this site, the system is treating ground water contaminated with up to 2,200 parts per billion (ppb) trichloroethylene and 11,000 ppb perchloroethylene; and soil gas with a total volatile organic compound concentration of 6,000 parts per million (ppm). A SITE demonstration project of this system was evaluated as part of the ongoing remediation effort at the San Fernando Valley Groundwater Basin Superfund site in Burbank, California. Demonstration testing was conducted in September 1990. Demonstration results are currently being prepared and are expected to be published in early 1991.

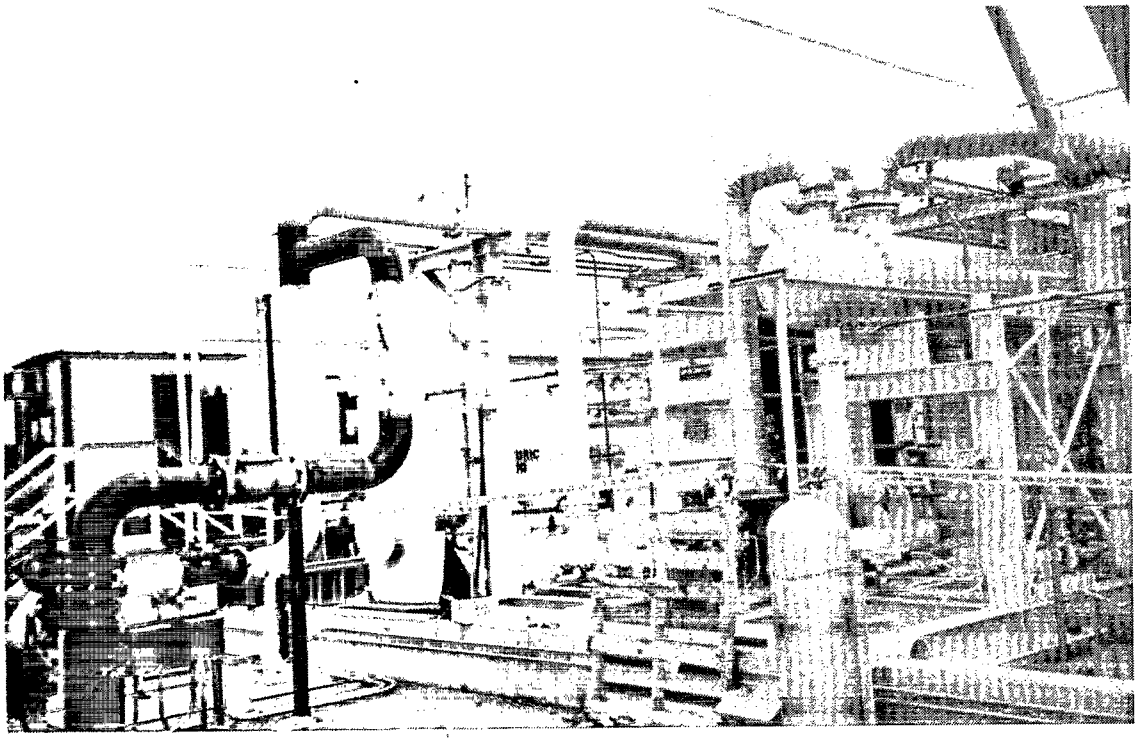
E.I. Dupont deNemours and Company/Oberlin Filter Company, Newark, Delaware, developed a **Membrane Microfiltration** system using Oberlin's automatic pressure filter combined with DuPont's special Tyvek® filter material (Tyvek® T-980) made of spun-bonded olefin. This system is designed to remove metals and other particulates from liquid wastes. Oberlin's automatic pressure filter has two chambers: an upper chamber for feeding waste through the filter, and a lower chamber for collecting the filtered liquid (filtrate). At the start of a filter cycle, the upper chamber is lowered to form a liquid-tight seal against the filter. The waste feed is then pumped into the upper chamber and through the filter. Filtered solids accumulated on the Tyvek® surface, forming a filter cake, while filtrate is collected in the lower chamber. Air is fed into the upper chamber at about 45 pounds per square inch, and used to further dry the cake and remove any liquid remaining in the upper chamber. When the cake is dry, the upper chamber is lifted and the filter cake is automatically discharged. Clean filter material is then drawn

Exhibit III-3. Demonstrations Completed During FY 1990

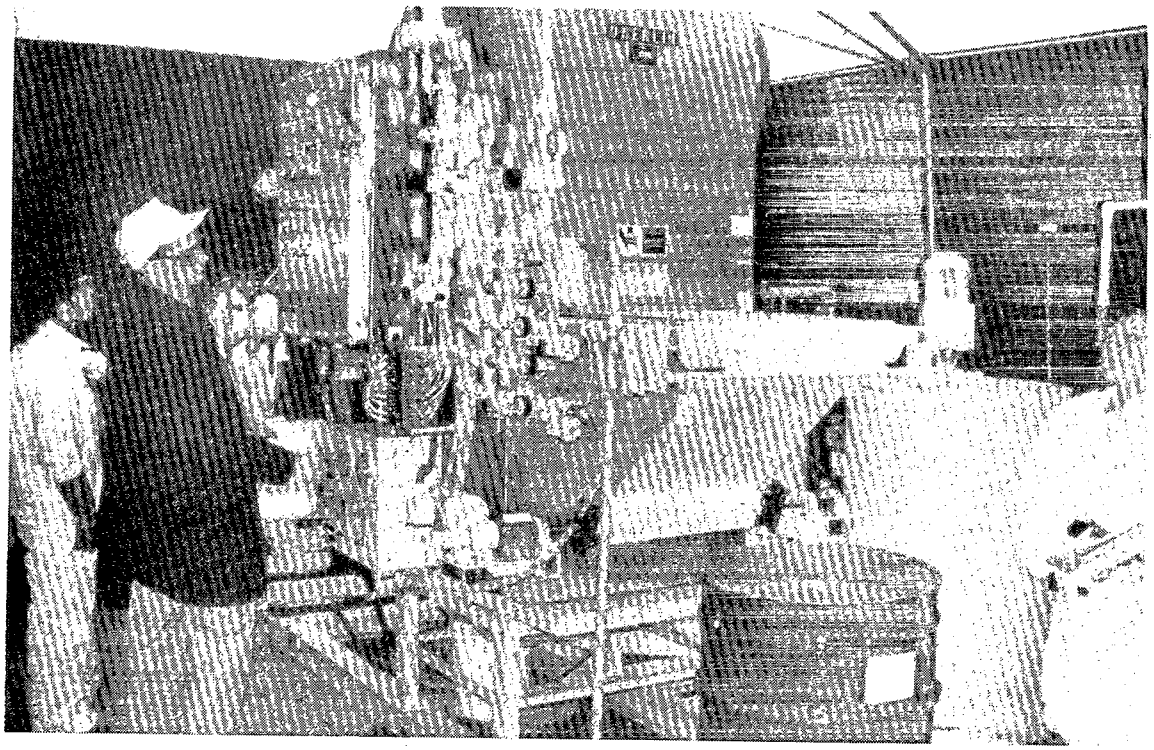
Developer	Technology	Demonstration Site	Date	EPA ORD Contact	Regional Contact
DEMONSTRATION PROGRAM					
AWD Technologies, Inc. San Francisco, CA	Integrated Vapor Extraction and Stream Vacuum Stripping	San Fernando Valley Ground-Water Basin Superfund Site, Burbank, CA	September 1990	Gordon Evans 513/569-7684 Norma Lewis 513/569-7565	Alison Greene EPA Region IX 415/744-1890
E.I. DuPont deNemours and Co., Newark, DE/Oberlin Filter Co., Waukesha, WI	Membrane Microfiltration	Palmerton Zinc Superfund Site, Palmerton, PA	April 1990	John F. Martin 513/569-7758	Tony Koller EPA Region III 215/598-6906
EPA Risk Reduction & Engineering Lab/PEI Associates, Inc., Cincinnati, OH	Debris Washing System	Shavers Farm Superfund Site in Lafayette, GA, and Gray PCB Site in Hopkinsville, KY	December 1989	Naomi Barkley 513/569-7854	Chuck Eger 404/347-3931
EPA Risk Reduction & Engineering Lab/Air and Energy Engineering Research Laboratory/Region 9 Superfund Program	Excavation Techniques and Foam Suppression	McColl Superfund Site, Fullerton, CA	June/July 1990	S. Jackson Hubbard 513/569-7507	John Blevins Region IX 415/974-9103
Silicate Technology Corporation, Scottsdale, AZ	Solidification/Stabilization with Silicate Compounds	Selma Pressure Treating Superfund Site, Fresno, CA	November 1990	Edward R. Bates 513/569-7774	Dave Roberts Region IX 415/744-2227
MONITORING AND MEASUREMENT TECHNOLOGIES PROGRAM					
Bruker Instruments, Inc., Billerica, MA	Mobile Mass Spectrometer	Resolve Inc. Superfund Site North Dartmouth, MA, and Westborough Township Superfund Site, Westborough, MA	August/ September 1990	Steve Billets 702/798-2232	Robert Leger Lorenzo Thonto Region I 617/565-1720
Xontech Corporation, Van Nuys, CA	Air Sector Sampler	Shavers Farm Superfund Site, Lafayette, GA	August 1990	William McClenny 919/541-3158	NA
MDA Scientific, Norcross, GA	Infrared-based Long-path Air Monitor	Shavers Farm Superfund Site, Lafayette, GA	August 1990	William McClenny 919/541-3158	NA

III-1. **AWD Technologies, Inc.'s Aquadetox/SVE System**





III-2. DuPont/Oberlin's Membrane Microfiltration Unit



from a roll into the system for the next cycle. Both the filter cake and the filtrate can be collected and treated further prior to disposal, if necessary. The system can be manufactured as an enclosed unit, requires little or no attention during operation, is mobile, and can be trailer-mounted.

This technology was demonstrated over a four-week period in April and May 1990 at the Palmerton Zinc Superfund site in Palmerton, Pennsylvania. Ground water from the shallow aquifer at the site, contaminated with dissolved heavy metals (such as cadmium, lead, and zinc), was selected as the feed waste for the demonstration. A Demonstration Bulletin summarizing the results of the demonstration was prepared in August 1990. A Technology Evaluation Report, Applications Analysis Report, and video of the demonstration are currently being finalized.

The demonstration results are summarized below:

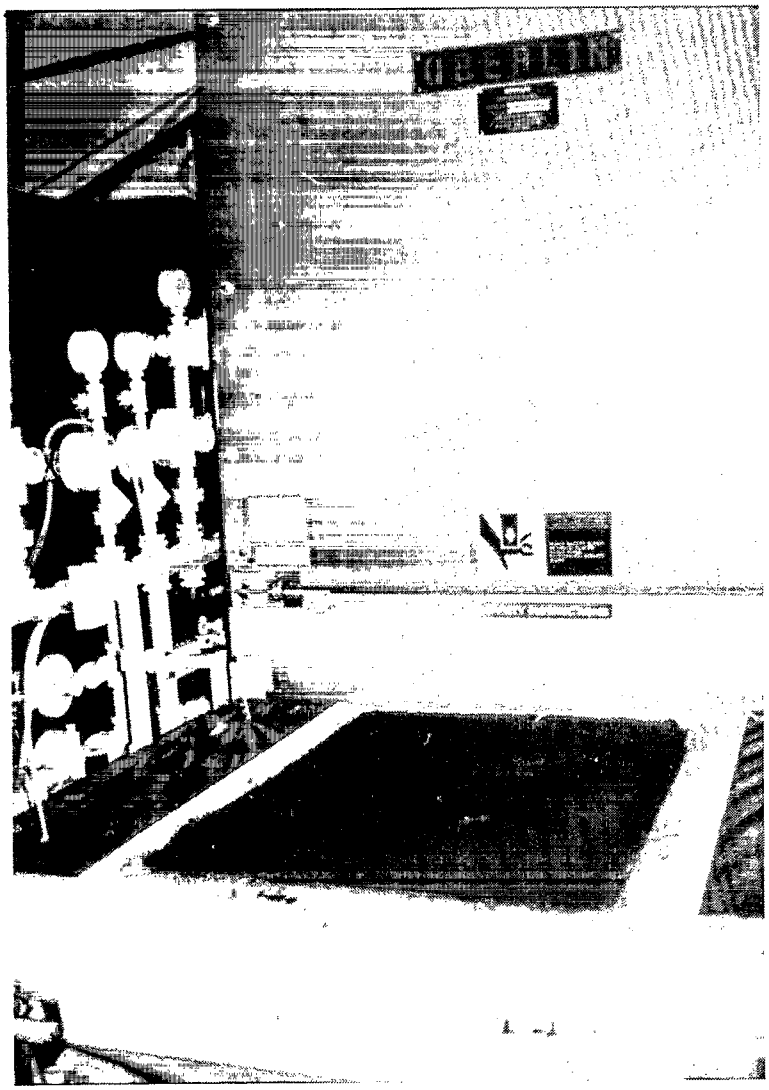
- Removal efficiencies for zinc and total suspended solids ranged from 99.75 to 99.99 percent.
- Solids in the filter cake ranged from 30.5 to 47.1 percent.
- Dry filter cake in all test runs passed the RCRA paint filter liquids test.
- Filtrate met the applicable National Pollution Discharge Elimination System standard for zinc.
- A composite filter cake sample passed the Extraction Procedure Toxicity and Toxicity Characteristics Leaching Procedure tests for metals.

EPA Risk Reduction Engineering Laboratory (RREL) and **PEI Associates, Inc. (PEI)**, Cincinnati, Ohio, developed a **Debris Washing System (DWS)** for treating metallic, masonry, or other solid debris contaminated with pesticides, PCBs, metals, and other contaminants. The system will be commercialized under the Federal Technology Transfer Act with PEI. The DWS consists of 300-gallon spray and wash tanks, surfactant and rinse water holding tanks, and an oil/water separator. In this system, a basket of debris is placed in the spray tank, where it is sprayed with a high-pressure, aqueous detergent solution that is recycled. The debris is then placed in the wash and rinse tank, and sprayed with water at 140 F and 60 psig. The contaminated wash and rinse waters are collected and separated in the oil/water separator. The oil phase from the separator can be disposed or treated, and the aqueous phase is treated by particulate filtration, activated carbon adsorption, and ion exchange.

Field-scale demonstration of the DWS was conducted in EPA Region 4 at the Gray PCB site in Hopkinsville, Kentucky, during December 1989. The results for the demonstration were promising. PCB levels on the surfaces of metallic transformer casings were reduced to less than or equal to 10 micrograms PCB/100 cm^2. All 75 contaminated transformer casings on-site were decontaminated to EPA acceptable clean-up criteria, and sold by Region 4 to a scrap-metal dealer.

The DWS unit was also field-demonstrated at the Shaver's Farm Superfund site in Walker County, Georgia. The contaminants of concern here were the herbicide Dicamba and

III-3. **Filter Cake Discharged from DuPont/Oberlin's Membrane Microfiltration Unit**



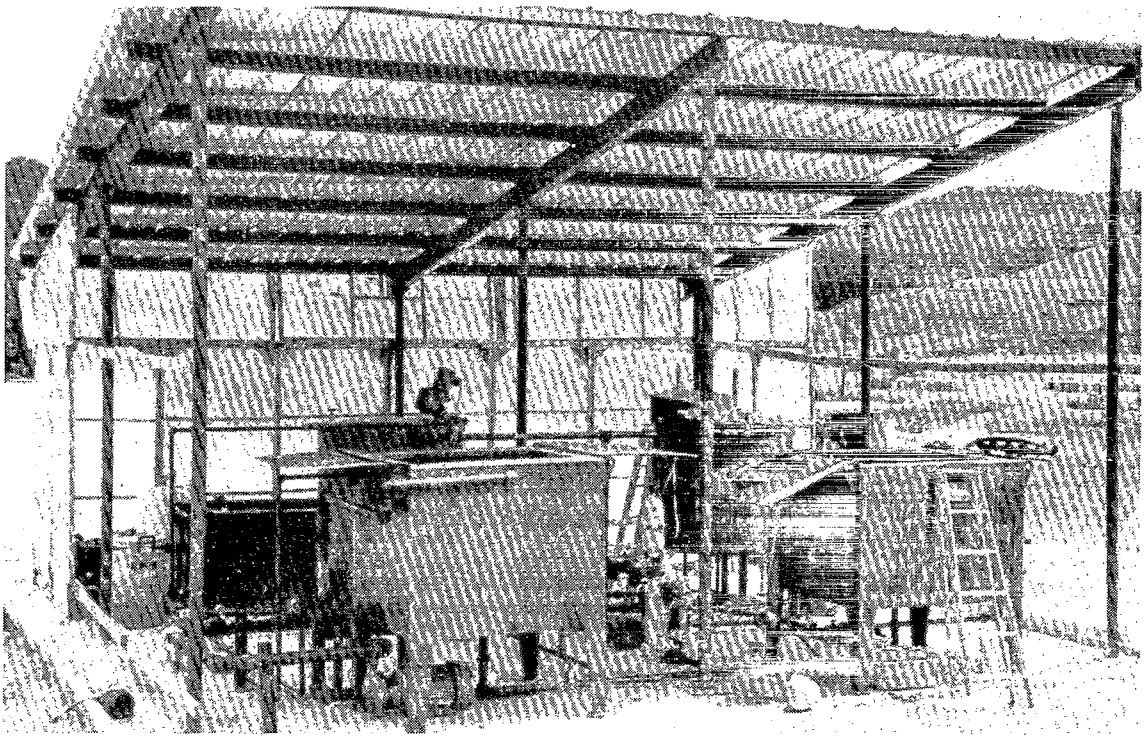
benzonitrile. Fifty-five-gallon drums were cut into sections and run through the DWS. Results from this demonstration are currently being prepared.

In a joint EPA effort involving the **Risk Reduction Engineering Laboratory,** Cincinnati, Ohio, the **Air and Energy Engineering Research Laboratory,** Research Triangle Park, North Carolina, and **Region 9 Superfund Program,** a demonstration of **Excavation Techniques and Foam Suppression Methods** was conducted at the McColl Superfund site in Fullerton, California, during June and July 1990. In this demonstration, an area to be excavated was temporarily enclosed. Air from the enclosure was vented through an emission control system. A vapor suppressant foam was applied to the soil before and after excavation. The purpose of the demonstration was to evaluate the control of emissions during the excavation of soil contaminated with volatile organic compounds and sulfur dioxide.

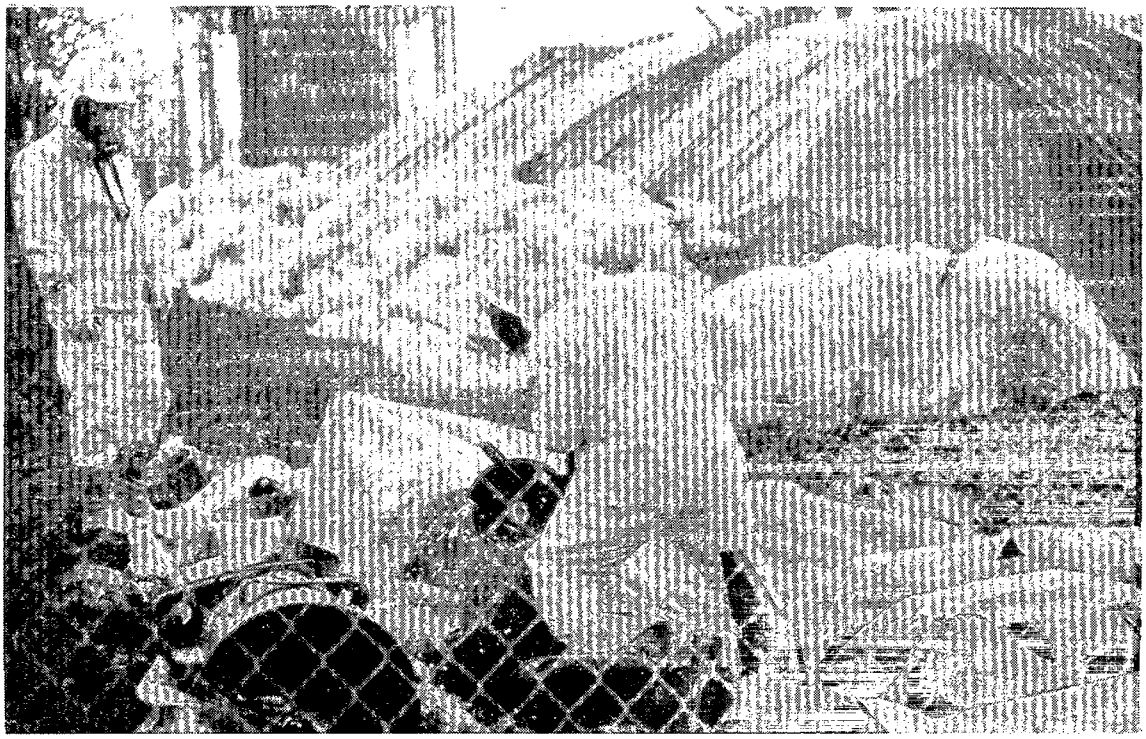
Preliminary results showed that contaminant concentrations within the enclosure were higher than expected, due in part to the foam's inability to form an impermeable membrane over the exposed wastes. The foam reacted with the highly acidic waste, causing degradation of the foam. A complete report of the demonstration results is currently being prepared.

Silicate Technology Corporation (STC), Scottsdale, Arizona, developed a technology for **Solidification/Stabilization with Silicate Compounds.** This combined technology uses silicate compounds for two applications: (1) the fixation and solidification of organics and inorganics in contaminated soils and sludges, (2) the removal of organics from contaminated water. For soils and sludges, proprietary silicate reagents selectively adsorb organic and inorganic contaminants before the waste is mixed with a cement-like material to form a high-strength, non-leaching cement block (monolith). For water, the same reagents can be used in conjunction with granular activated carbon to remove organics. The resulting waste material is then solidified by the first technology. The type and dose of reagents depend on the waste characteristics. The technology can be applied to soils

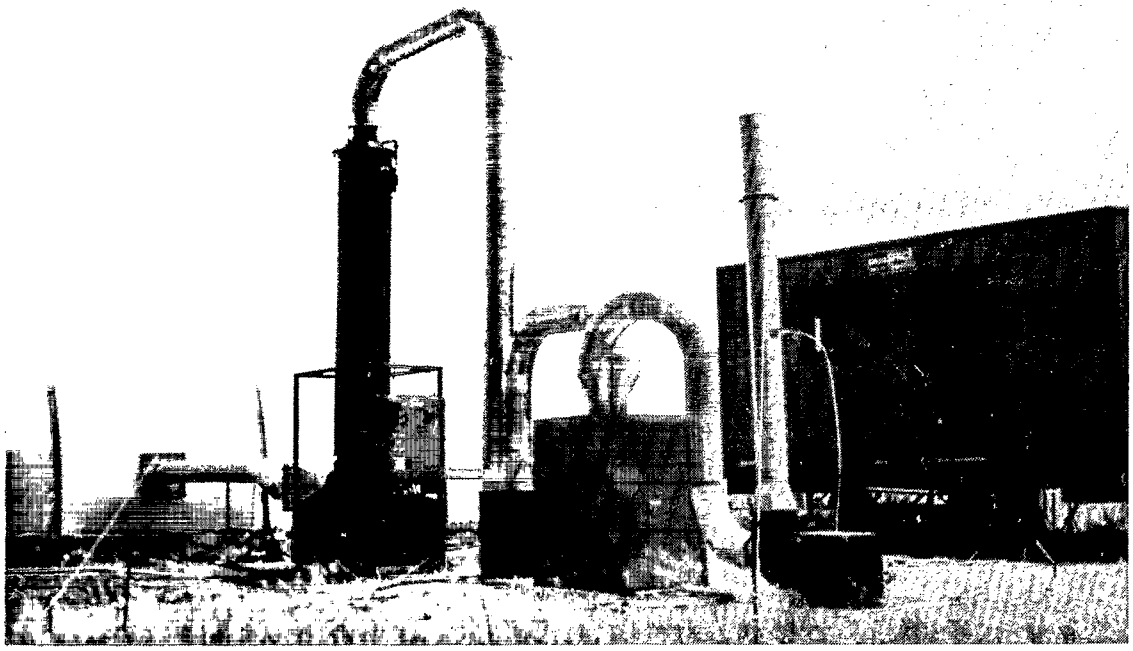
III-4. RREL/PEI's Debris Washing System



III-5. Preparation Activities for RREL/PEI's Debris Washing System Demonstration



III-6. **Enclosure at the McColl Superfund Site Demonstration of Excavation Techniques and Foam Suppression Methods**



III-7. **STC'solidification/Stabilization Process**

and sludges contaminated with high molecular weight organics, metals, and other inorganics. Water contaminated with high molecular weight organics can also be treated.

A demonstration of the STC technology was conducted during November 1990 at the Selma Pressure Treating Superfund site near Fresno, California. Contaminants at the site included pentachlorophenol, chromium, copper, and arsenic. Results from the demonstration have not yet been released.

3. Completed Evaluations of Demonstrations

As discussed earlier, the objective of the Demonstration Program is to develop reliable engineering performance and cost data on innovative, alternative technologies, so that potential users can evaluate each technology's applicability for a specific waste site. Therefore, an important measure of the progress of the program is the evaluation reports of the demonstrated technologies, which are later reviewed by potential users. These reports include the (1) Applications Analysis Report (AAR), which presents information on a technology to help those responsible for selecting and implementing remedial actions determine if the technology merits further consideration as an option for cleaning up a specific site, and (2) the Technology Evaluation Report (TER), which presents a comprehensive description of the demonstration and its results to assist those responsible for a detailed technical evaluation of the technology relative to a specific site and waste. During the past year, six technology demonstrations were evaluated, and reports summarizing the results were prepared. The six technologies and the demonstration results are discussed below.

CF Systems Corporation, Waltham, Massachusetts, demonstrated its **Solvent Extraction** technology. This technology uses liquified gas solvent to extract organics (such as hydrocarbons), oil, and grease from contaminated wastewater, sludges, sediment, and soil. Carbon dioxide is the gas solvent used for aqueous solutions, while propane or butane is used for sediment, sludges, and soils. The contaminated waste stream is fed into an extractor. Solvent (gas condensed by compression) is also fed to the extractor, making nonreactive contact with the waste. Following phase separation of the solvent and organics, treated water is removed from the extractor while the mixture of solvent and organics passes through a valve to the separator where pressure is partially reduced. In the separator, the solvent is vaporized and recycled as fresh solvent. The organics are drawn off from the separator, and either recycled or disposed. The extractor design is different for contaminated wastewaters and semisolids. For wastewaters, a tray tower contactor is used. For semisolids, a series of extractor/decanters operated countercurrently is used.

The pilot-scale system was demonstrated on PCB contaminated sediments from the New Bedford (Massachusetts) Harbor Superfund site during September 1988. PCB concentrations in the harbor ranged from 300 to 2,500 ppm. The TER and AAR were published in 1990. Commercial systems have been sold to Clean Harbors of Braintree, Massachusetts, for wastewater clean-up; and Ensco of Little Rock, Arkansas, for incinerator pretreatment. A unit is in operation at Star Enterprise, Port Arthur, Texas, treating API separator sludge to meet Best Demonstrated and Available Technology (BDAT) standards for organics.

The applications analysis results are summarized below:

- Extraction efficiencies of 90 to 98 percent were achieved on sediments containing between 350 and 2,575 ppm PCBs. PCB concentrations were as low as 8 ppm in the treated sediment.
- Operating problems included solids being retained in the system hardware and foaming in the receiving tanks. The vendor identified corrective measures that will be implemented in the full-scale commercial unit.
- Projected costs for PCB clean-ups are estimated at approximately $150 to $450 per ton, including material handling and pre- and post-treatment costs. These costs are highly sensitive to the utilization factor and job size, which may result in lower costs for large clean-ups.

Chemfix Technologies, Inc., Metairie, Louisiana, developed a **Solidification/Stabilization** technology. The Chemfix technology is an inorganic system in which soluble silicates and silicate setting agents react with polyvalent metal ions and other waste components in a reaction vessel, to produce a chemically and physically stable solid material. It can be used to treat soils, sludges, and other solid wastes contaminated with extractable organics of high molecular weight or heavy metals. The treated waste matrix displays good stability, a high melting point, and a friable texture, and may be similar to soil, depending upon the water content of the feed waste.

This technology was demonstrated in March 1989 at the Portable Equipment Salvage Co. Superfund site in Clackamas, Oregon. Preliminary results are available in a Demonstration Bulletin (October 1989). A single draft report describing the demonstration and future application of this technology was completed. The final demonstration report was completed in early 1990.

The demonstration results are described below:

- The lead and copper concentrations in the TCLP extracts from the treated wastes were 94 to 99 percent less than those from the untreated wastes.
- The volume of the excavated waste material increased from 20 to 50 percent after treatment.
- In the durability tests, the treated wastes showed little or no weight loss after 12 cycles of wetting and drying, or freezing and thawing.
- The unconfined compressive strength (UCS) of the wastes varied from 27 to 307 pounds per square inch (psi) after 28 days, and permeability decreased by more than one order of magnitude.

- The air monitoring data suggested there was no significant volatilization of PCBs during the treatment process.

From Fall 1989 through Winter 1990, Chemfix Technologies, Inc.'s subsidiary Chemfix Environmental Services, Inc. (CES), applied a high solids CHEMSET® reagent protocol approach to the treatment of about 30,000 cubic yards of heavy metal-contaminated waste. The goal of reducing leachable hexavalent chromium to below 0.5 ppm in the TCLP leaching test was met, as well as the goal of producing a synthetic clay cover material with low permeability (less than 1×10^{-6} cm/sec). The production goal of exceeding 400 tons per day was also met, including production during many subfreezing days in December, January, and March. In Summer 1990, CES engaged in another high solids project involving lead; results are not yet available.

International Waste Technologies/Geo-Con, Inc., Wichita, Kansas and Pittsburgh, Pennsylvania, developed an **In-Situ Solidification/Stabilization Process** to immobilize organic and inorganic compounds in wet or dry soils, using reagents (additives) that stabilize the contaminants in a cement-like mass. The basic components of this technology are: (1) Geo-Con's deep soil mixing system (DSM), which uses an auger to deliver and mix the chemicals and the soil in-situ; and (2) a batch mixing plant, which supplies International Waste Technologies' (IWT) proprietary treatment chemicals.

A SITE demonstration of the IWT/Geo-Con, Inc. process was conducted at a PCB-contaminated site in Hialeah, Florida, in April 1988. Two 10 x 20-foot test sectors of the site were treated: one to a depth of 18 feet, and the other to a depth of 14 feet. Ten months after the demonstration, long-term monitoring tests were performed on the treated sectors. The TER and AAR have been published.

The applications analysis results are summarized below:

- Microstructural analyses of the treated soils showed high unconfined compressive strengths and low permeabilities, indicating the potential for long-term durability.
- Data provided by IWT indicate some immobilization of volatile and semivolatile organics, due to organophilic clays present in the IWT reagent.
- The process is economic: $194 per ton of soil for the one-auger machine used in the demonstration; and $111 per ton of soil for a commercial four-auger operation.

Soliditech, Inc., Houston, Texas, developed a **Solidification/Stabilization** technology that immobilizes organic and inorganic compounds, metals, and oil and grease in soils and sludges by binding them in a concrete-like, leach-resistant matrix. In this technology, contaminated waste materials are collected, screened to remove oversized material, and introduced to the batch mixer. The waste material is then mixed with: (1) water, (2) Urrichem (a proprietary chemical reagent), (3) proprietary additives, and (4) pozzolanic material (flyash), kiln dust, or cement (cement was used for the demonstration). Once thoroughly mixed, the treated waste is discharged from the mixer.

The Soliditech process was demonstrated in December 1988 at the Imperial Oil Company/Champion Chemical Company Superfund site in Morganville, New Jersey. Wastes treated during the demonstration were soils and filter cake contaminated with petroleum hydrocarbons, PCBs, other organic chemicals, and heavy metals. A TER was published in February 1990 in two volumes. Volume I is the report and Volume II contains the data to accompany the report. An AAR is currently being published.

Significant results from the Soliditech demonstration are summarized below:

- Chemical analyses of extracts and leachates showed that heavy metals in the untreated waste were immobilized.
- The process solidified both solid and liquid wastes with high organic content (up to 17 percent), as well as oil and grease.
- Volatile organic compounds in the original waste were not detected in the treated waste.
- Physical test results of the solidified waste samples showed: (1) unconfined compressive strengths ranging from 390 to 860 psi, (2) very little weight loss after 12 cycles of wet/dry and freeze/thaw durability tests, (3) low permeability, and (4) increased density after treatment.
- The solidified waste increased in volume by an average of 22 percent. The bulk density of the waste material increased by approximately 35 percent due to solidification.
- Semivolatile organic compounds (phenols) were detected in the treated waste and the TCLP extracts from the treated waste, but not in the untreated waste or its TCLP extracts. The presence of these compounds is believed to result from chemical reactions in the waste treatment mixture.

Toxic Treatments (USA) Inc., San Francisco, California, developed a technology that uses a transportable "detoxifier" treatment unit for **In-Situ Steam and Air Stripping** of soils contaminated with organics such as hydrocarbons and solvents. The two main components of the on-site treatment equipment are the process tower and process train. The process tower contains two counter-rotating hollow-stem drills. Steam is piped to the top of the drills and injected through the cutting blades. The steam heats the ground being remediated, increasing the vapor pressure of the volatile contaminants and thereby increasing the rate at which they can be stripped. Both the air and steam serve as carriers to convey these contaminants to the surface. A metal box, called a shroud, seals the process area above the rotating cutter blades from the outside environment, collects the volatile

contaminants, and ducts them to the process train. In the process train, the volatile contaminants and the water vapor are removed from the off-gas stream by condensation. The condensed water is separated from the contaminants by distillation, then filtered through activated carbon beds and subsequently used as make-up water for a wet cooling tower. Steam is also used to regenerate the activated carbon beds and as the heat source for distilling volatile contaminants from the condensed liquid stream. The recovered concentrated organic liquid can be recycled or disposed.

A SITE demonstration was performed during the week of September 18, 1989 at the Annex Terminal, San Pedro, CA. Twelve soil blocks were treated for VOCs and SVOCs. Various liquid samples were collected from the process during operation, and the process operating procedures were closely monitored and recorded. Post-treatment soil samples were collected and analyzed. Currently, the TER has obtained EPA clearance for publication. The AAR is currently being prepared.

The following results were obtained during the SITE demonstration of the technology:

- Greater that 85 percent of the VOCs in the soil were removed.
- As much as 55 percent of SVOCs in the soil were removed.
- Fugitive air emissions from the process were very low.
- No downward migration of contaminants occurred due to the soil treatment.

Ultrox International, Santa Ana, California, developed an **Ultraviolet (UV) Radiation/Oxidation Process** which uses UV radiation, ozone (O_3) and hydrogen peroxide (H_2O_2) to destroy toxic organic compounds, particularly chlorinated hydrocarbons, in water. This technology is used to treat contaminated groundwater, industrial wastewaters, and leachates containing halogenated solvents, phenol, pentachlorophenol, pesticides, PCBs, and other organic compounds. The Ultrox system consists of a reactor module, an air compressor/ozone generator module, and a hydrogen peroxide feed system. It is skid-mounted and portable, permitting on-site treatment of a wide variety of liquid wastes. Influent to the reactor is simultaneously exposed to UV radiation, ozone, and hydrogen peroxide to oxidize the organic compounds. Off-gas from the reactor passes through an ozone destruction (Decompozon) unit, which reduces ozone levels before air venting. The Decompozon unit also destroys gaseous volatile organic compounds (VOC) stripped off in the reactor. Effluent from the reactor is tested and analyzed prior to disposal.

A field-scale demonstration was completed in March 1989 at the Lorenz Barrel and Drum Superfund site in San Jose, California. The test program was designed to evaluate the performance of the Ultrox System at several combinations of five operating parameters: (1) influent pH, (2) retention time, (3) ozone dose, (4) hydrogen peroxide dose, and (5) UV radiation intensity. The Technology Evaluation Report was published in January 1990. The Applications Analysis Report is currently being published.

The demonstration results are summarized below:

- Removal efficiencies for were about 99 percent for trichloroethene (TCE); about 58 to 85 percent for 1,1-dichloroethane (DCA) and 1,1,1-trichloroethane (TCA), respectively; and about 90 percent for total VOCs.
- For some compounds, including 1,1,1,-TCA, 1,1-DCA, and vinyl chloride, removal from the water phase was due to both chemical oxidation and stripping.
- The Decompozon unit, reduced ozone to less than 0.1 ppm (OSHA standards), with efficiencies greater than 99.9 percent. VOCs present in the air within the treatment system, at approximately 0.1 to 0.5 ppm, were not detected after passing through the Decompozon unit.
- Very low total organic carbon (TOC) removal was found, implying that partial oxidation of organics occurred without complete conversion to CO_2 and H_2O.

4. New Projects for FY 1990

Six technologies from the SITE-005 solicitation were accepted into the Demonstration Program for FY 1990. These included two biological technologies, two chemical/physical treatment technology, one solidification/stabilization technology, and one thermal treatment technology. These technologies are briefly discussed below.

Bioversal USA, Inc., Mount Prospect, Illinois, developed its **BioGenesis™ Soil Cleaning Process**, which uses a specialized truck, gravity and cyclone separators, and a bioreactor to wash soil contaminated with volatile and non-volatile hydrocarbons, including PCBs. Removal efficiencies of 95 to 99 percent can be achieved for soil contaminated with hydrocarbon concentrations of up to 16,000 parts per million (ppm) with a single wash, and up to 45,000 ppm with one or two additional washes. After washing, liquid products are recycled or treated, clean soil is dumped out, and the minimal amount of wastewater produced is sent to the bioreactor. Subsequent biodegradation in the washed soil occurs at an accelerated rate due to contact with **BioVersal™**, a light, alkaline, organic formula used to reduce oil contamination. All equipment is mobile, and treatment can be conducted on-site. Site selection for the demonstration is currently underway.

In-Situ Fixation Company, Chandler, Arizona, developed an **In-Situ Bioremediation Process** for treating soil contaminated with volatile and non-volatile organic compounds. A specialized dual-auger system injects microorganism mixtures, along with required nutrients, and mixes them into contaminated soils for treatment by biodegradation. This injection and mixing process effectively breaks down fluid and soil strata barriers, eliminating pockets of contaminated soil that would otherwise remain untreated. Emission of volatile organics during remediation is minimized by placing

a hood around the auger assembly to capture any off-gases. EPA is currently locating a site to demonstrate this process.

International Environmental Technology/YWC Midwest, North Canton, Ohio, uses a combination of two systems in its **Geolock/Biodrain Treatment Platform** for the in-situ biological treatment of soils contaminated with most organic compounds. First, Geolock, a high density polyethylene tank structure, is installed to define the treatment area, minimize the intrusion of off-site clean water, minimize the potential for release of microorganisms outside the treatment area, and maintain contaminant concentration levels that facilitate treatment. Second, the Biodrain application system is installed within the treatment area. Biodrain delivers bacterial cultures, nutrients, and oxygen, or any other proprietary chemical to the soil, and creates an aerobic environment in the air pore spaces of the soil. Existing or new wells are used to as the water recovery system for removing contaminated water. Preparation of the Quality Assurance Project Plan and site selection for the demonstration have begun.

Sanivan Group, Anjou, Quebec, developed a mobile solvent extraction technology for **Soil Treatment with Extraksol**. The process extracts organic contaminants, such as PCBs, PCP, PAHs, pesticides, and oils, from soils using non-chlorinated, non-persistent, organic solvents. The three-step process, involving (1) soil washing, (2) soil drying, and (3) solvent regeneration, occurs on a flatbed trailer. After washing the contaminated soil with extraction fluid (solvent), solvents are regenerated by distillation and the contaminants are concentrated in the distillation residues. The two major advantages of this process are: (1) it minimizes the amount of solvent required to perform the extraction by regenerating it in a closed loop; and (2) it significantly reduces the volume of contaminants requiring further treatment or off-site disposal by concentrating them in the still bottoms. Site selection for demonstrating this process has begun.

TechTran, Inc., Houston, Texas, uses a **Combined Chemical Binding/Precipitation and Physical Separation of Radionuclides** process to treat water, sludges, and soils contaminated with heavy metals and radioactive wastes. This method involves rapid, turbulent, in-line mixing of a proprietary fine powder (RHM 1000) containing complex oxides and other reactive binding agents, which absorb, adsorb, and chemisorb contaminants from the waste stream. The precipitated, flocculated, and coagulated contaminants are then separated from the water using a two-stage process: (1) particle size and density separation, using clarification and microfiltration; and (2) dewatering, using a filter press. The 70 to 85 percent dry filter cake containing the concentrated contaminants is then collected and stabilized for disposal. The Department of Energy (DOE) is working with EPA to demonstrate and evaluate TechTran's treatment process.

Thermal Waste Management, New Orleans, Louisiana, developed a process for the **Production of Fossil Fuel from Petroleum-Based Sludges**. This is a mobile, low-temperature, recycling process that produces solid fossil fuel, which can be easily handled, from otherwise hazardous, oily petroleum sludges. A screw-flight (auger) dryer is used to dry the petroleum sludges. A light hydrocarbon liquid and water condense from vapors emitted during the drying stages of the process. Hydrocarbons are recycled and the water is treated prior to release. Pilot-scale tests have been conducted on hazardous petroleum refinery sludges, and EPA is working on site selection to conduct a full-scale demonstration of the process.

In addition to the above-mentioned new technologies, three projects have progressed through the Emerging Technologies Program and were invited to participate in the Demonstration Program. These technologies are discussed in Section III.C of this report.

5. Future Needs and Direction

Documentation of viable, cost-effective, innovative alternatives to land disposal of hazardous waste continues to be the driving force behind the SITE Demonstration Program. As the program matures, however, it is apparent that data are needed to not only define individual technologies, but to show how two or more treatment (and monitoring) steps may be combined to tackle complete remediation of a site. Efforts such as the two BioTrol demonstrations have linked soil washing, biological treatment of product water and soil fines, and advanced on-site monitoring; but efforts such as this will need continued emphasis in the future. Plans for FY 1991 include demonstrating technology combinations such as in-situ hot water flushing, in-situ biodegradation, and on-site biological water treatment, as well as integration of water treatment and air treatment technologies.

To further enhance the capability of the program to provide data on treatment trains for specific environmental pollutants, summary reports are needed to analyze results and residuals from completed demonstrations to suggest technology combinations. In some cases it may be necessary to visit complex demonstration sites with additional technologies that may have applicability to differing portions of the waste matrix.

The definition of specific types of waste sites will also be necessary for future operations to target regional needs. The Demonstration Program is in the process of identifying three classes of sites (tentatively, wood-treating, town-gas, and battery reclamation sites) for which clean-up authorities need complete treatment options. Developers will be sought to provide specific and complete site remediation techniques rather than treatment units that only decontaminate portions of the problem area.

In the area of specific unit operations for treating hazardous contaminants, the Program will become more flexible in identifying problem sites or wastes that may be treated a federal or private test facility. This increased flexibility will allow for an increased number and wider variety of demonstration locations. Of more importance than the site location is the documentation of performance that a technology can achieve. Through greater use of both federal and private sites for study, the Program will attempt to maximize the number of clean-up techniques that can be demonstrated and for which high quality treatability data can be reported.

C. EMERGING TECHNOLOGIES PROGRAM

The Emerging Technologies Program (ETP) provides a framework for encouraging bench- and pilot-scale testing and evaluation of technologies that have been proven at the conceptual stage, but require further development. The ETP is essential to the growth of the SITE Program because it helps maintain a flow of viable technologies for consideration in the Demonstration Program, and ultimately as alternatives for use in Superfund site remediation. This becomes more important as the duration of the SITE Program extends, and technologies from the ETP replace completed Demonstration Program projects.

Technologies are solicited for the ETP through Requests for Proposals. Each July, EPA advertises in the *Commerce Business Daily* and trade journals for submittal of preproposals. Following a technical review of these preproposals by a panel of four (two EPA and two external reviewers), 15 to 20 are invited to submit full proposals. Selected technology developers receive a maximum of two years' funding, under cooperative agreement with EPA, to enable them to move their technologies toward commercialization. The program provides awards of up to $150,000 per year, with a maximum of $300,000 over 2 years. However, second-year funding depends on the achievement of significant progress during the first year. Four solicitations have been issued in November 1987 (E01), July 1988 (E02), July 1989 (E03), and July 1990 (E04).

Through cooperative efforts and funding between EPA and DOE, SITE has expanded the ETP by 17 to a total of 31 technologies during the past year. A complete list of participants in the program is presented in Appendix C. Continued expansion is shown by the excellent response to the most recent solicitation (E04). After technical review of the 74 preproposals submitted, 20 were asked to submit full proposals. A summary of the four ETP solicitations is presented in Exhibit III-4. The selection of the E04 projects is expected in early 1991.

The progress and accomplishments of the ETP can be measured through the success of completed projects and the number and quality of new projects for FY 1990. These issues are discussed in the following sections, along with the future needs and direction for ETP to continue moving in a positive direction.

1. Completed Projects in the Emerging Technologies Program

Work under the ETP has been completed for seven E01 projects. These projects included technologies designed for chemical treatment/ultrafiltration, in-situ electroacoustic decontamination, biological sorption, wetlands-based treatment, laser-induced photochemical destruction, soil washing, and contained recovery of oily waste using steam and hot water. Of the seven completed E01 projects, three have been invited to participate in the SITE Demonstration Program, one is working on funding toward full-scale demonstration, one has been demonstrated at the pilot scale, and two did not receive second-year funding. The invitation of three technologies to the Demonstration Program shows that the ETP provides a flow of technologies into that program.

Atomic Energy of Canada, Ltd., Chalk River, Ontario, prepared a laboratory-scale demonstration technology to extract dissolved toxic metals from groundwater. The technology uses a **Chemical Treatment/Ultrafiltration** combination to selectively remove dissolved metal ions from dilute aqueous waste solutions.

Results from bench-scale tests conducted during the first year showed removal efficiencies of up to 99 percent for cadmium and mercury, 90 percent for lead, and 10 to 35 percent for arsenic. During the second year of funding, a pilot-scale unit achieved metal removal efficiencies ranging from 85 to 90 percent, depending on the operating conditions. Unlike the bench-scale results, some metal loss occurred within the pilot-scale unit, and higher polyelectrolyte concentrations were required. A field demonstration of the pilot-scale unit was conducted in September 1990 on groundwater at a uranium tailings site near Elliot Lake, Ontario. Results from the field demonstration are not yet available.

Battelle Memorial Institute, Columbus, Ohio, investigated the **Electroacoustic Soil Decontamination (ESD)** process for in-situ treatment of soils contaminated with fuel oil, organic compounds, and heavy metals. This technology decontaminates soils through the application of electrical (direct current) and acoustic fields, which facilitate the transport of liquids through soils. The process consists of electrodes and an acoustic source.

The developer was unable to acquire second-year funding; therefore, the project had to be discontinued. Phase I results indicate that ESD is technically feasible for the removal of inorganic species, such as zinc and cadmium, from clayey soils, but only marginally effective for hydrocarbon removal. An EPA report for the first-year investigation is available through the National Technical Information Service (NTIS).

Bio-Recovery Systems, Inc., Las Cruces, New Mexico, tested its AlgaSORB™ technology for the removal and recovery of heavy metal ions from ground water. AlgaSORB™ is a **Biological Sorption Process** based on the affinity of algae cell walls for heavy metal ions.

The AlgaSORB™ sorption process was tested on mercury-contaminated groundwater at a hazardous waste site in Oakland, California, during Fall 1989 to determine optimum flow rates, binding capacities, and the efficiency of stripping agents. A final EPA report of the results from this testing is now available. Bio-Recovery Systems, Inc. has been invited to participate in the SITE Demonstration Program.

Colorado School of Mines, Golden, Colorado, investigated a constructed **Wetlands-Based Treatment** technology that uses natural geochemical and biological processes inherent in a man-made wetland ecosystem to accumulate and remove metals from influent waters.

Exhibit III-4. **Summary of Emerging Technology Program Solicitations**

Solicitation	Date	Number of Preproposals Submitted	Number of Proposals Submitted	Number of Projects Selected
E01	November 1987	80	15	7
E02	July 1988	60	17	7
E03	July 1989	47	18	17
E04	July 1990	74	20	*

* E04 projects were expected to be selected in March 1991.

Under first- and second-year funding, a pilot-scale system was built to assess the effectiveness of constructed wetlands in treating the effluent from the Big Five Tunnel near Idaho Springs, Colorado. Optimum results from two years of operation showed that concentrations of zinc were reduced by 97 percent; aluminum, cadmium and lead concentrations were reduced by 90 to 100 percent; iron concentrations were reduced by 80 percent; copper concentrations were reduced to below detection limits; and pH was raised from 2.9 to 6.5. The Colorado School of Mines has been invited to participate in the SITE Demonstration Program.

Energy and Environmental Engineering, Inc., East Cambridge, Massachusetts, investigated a technology designed to photochemically oxidize organic compounds in wastewater by applying ultraviolet radiation using a laser. The **Laser Induced Photochemical Oxidative Destruction Process** is envisioned as a final treatment step to reduce organic contamination in groundwater and industrial wastewater to acceptable discharge limits.

Testing of the pilot-scale system under the ETP showed greater than 95 percent destruction removal efficiency for several target compounds, including chlorobenzene, chlorophenol, phenol, benzene, and dichloroethene. Preliminary cost evaluation shows the process to be competitive compared to other ultraviolet oxidation processes and carbon adsorption. The process is now entering the initial phases of commercialization, with the company offering to conduct treatability studies for prospective clients. Full-scale pilot facility for a SITE Program demonstration will be proposed.

Harmon Environmental Services, Inc. (formerly Envirite Field Services, Inc.), Auburn, Alabama, conducted a series of laboratory tests on a **Soil Washing Process** that uses a blend of solvents to wash soil contaminated with high molecular weight organic compounds, such as PCBs. The solvents are removed from the soil by steam stripping. The solvent from each wash is then delivered to a reclamation system, where it is distilled and the contaminants collected in the still bottom for disposal.

The developer was unable to acquire second-year funding; therefore, the project had to be discontinued. Phase I testing showed the technology successfully cleaned metal foil, paper and sand, clay soils, high-organic soils, and soils mixed with organic matter (such as leaves). Although the testing emphasized PCB decontamination, results showed that the technology can also remove chlorodibenzofurans and most types of petroleum products and oils. An interim report of the first-year test results has been prepared.

Western Research Institute, Laramie, Wyoming, developed a its **Contained Recovery of Oily Waste (CROW) Process** to recover oily hazardous waste from soils by adapting technology presently used for secondary petroleum recovery and primary production of heavy oil and tar sand bitumen. Steam and hot water displacement are used to move accumulated oily wastes and water aboveground for treatment.

This technology was tested at the laboratory- and pilot-scale. A final draft report of the results of these tests was prepared and is currently undergoing EPA review. This technology has been invited to participate in the SITE Demonstration Program.

3. New Projects for FY 1990

The seven projects accepted under the E02 solicitation have received second-year funding (see the third Report to Congress for descriptions). In addition to the E02 projects, 17 new bench- or pilot-scale technologies were accepted under the E03 solicitation in July 1989, and will be active in the ETP during FY 1990. These include five biological, six chemical/physical, one solidification/stabilization, two materials handling, and three thermal treatment methods. Each new project is briefly described below.

ABB Environmental Services, Inc., Wakefield, Massachusetts, has proposed a **Two-Zone Plume Interception In-Situ Treatment Strategy** for a mixture of chlorinated and non-chlorinated organic solvents in saturated soil and groundwater. The first zone is anaerobic and promotes the reductive dechlorination of highly chlorinated solvents, such as perchloroethylene. Immediately downgradient is the second zone, where special aerobic conditions encourage the biological oxidation of the partially dechlorinated products from the first zone, as well as other compounds. In preparation for eventual field testing, two-zone in-situ treatment was applied in bench-scale aquifer simulators to determine optimal treatment parameters. These investigations began in September 1990.

Alcoa Separations, Warrendale, Pennsylvania, is developing a **Bioscrubber** technology that digests organic emissions from soil, water, or air decontamination processes. The bioscrubber contains Alcoa's activated carbon medium as a support for microbial growth. This unique medium with increased microbial population and enhanced bioactivity provides effective conversion of diluted organics into carbon dioxide, water, and other non-hazardous compounds. Initial project preparations, such as equipment purchase and preliminary experimental design, are underway. During 1991, data from bench-scale testing should be available. A pilot-scale installation is scheduled for completion in late 1991 or early 1992.

BioTrol, Inc., Chaska, Minnesota, is testing its **Methanotrophic Bioreactor System (MBS)**, which is an

aboveground remedial technology for water contaminated with halogenated hydrocarbons. This system is designed to treat chlorinated aliphatic compounds, such as trichloroethylene and vinyl chloride, whose degradation depends on the process of cometabolism, which is attributed to the specificity of certain enzyme systems. BioTrol claims that the methane monooxygenase enzyme of methanotrophic bacteria has the most promise. Bench-scale experiments on two system configurations of the MBS will be conducted during the first several months of the program. Later in the first year of the project, pilot-scale testing of the more promising configuration will be initiated in the field to show the feasibility if this bioreactor technology.

Boliden Allis, Inc., Milwaukee, Wisconsin, is developing the **Pyrokiln Thermal Encapsulation Process**, which is designed to improve conventional rotary kiln hazardous waste incineration by introducing inorganic additives with the waste to promote slagging or thermal encapsulation reactions near the kiln discharge end. The thermal encapsulation is augmented using other additives in the kiln or in the air pollution control baghouse to stabilize metals in the flyash. The process thermally treats soils and sludges contaminated with both organics and metals. The system will be further evaluated in bench-scale tests and a continuous-flow pilot-scale kiln at Boliden Allis, Inc.'s Process Research and Test Center in Oak Creek, Wisconsin.

Center for Hazardous Materials Research, Pittsburgh, Pennsylvania, is testing its **Acid Extraction Treatment System (AETS)**. This system is a soil washing process that uses concentrated hydrochloric acid as the washing medium to extract contaminants from soils. Following treatment, soil may be disposed or used as fill material. AETS has been tested in the laboratory on a limited, bench-scale basis. Plans for further testing include using the system on samples of contaminated soils from Superfund sites to establish optimal operating parameters and refine the acid regeneration/recovery process.

Electrokinetics, Baton Rouge, Louisiana, is developing an in-situ separation/removal process for extracting heavy metals and organic contaminants from soils. The process involves **Electro-Osmosis**, which uses electricity to affect chemical concentrations and groundwater flow by facilitating the movement of fluid between soil particles. Bench-scale laboratory studies of electro-osmosis, investigating the removal of heavy metals, radionuclides, and organics, will be completed by the end of 1991. Pilot-scale field studies investigating the removal of radionuclides and organics are scheduled for completion by the end of 1992, after which the technology will be available for full-scale implementation.

Electron Beam Research Facility, Florida International University, is working in conjunction with the University of Miami to develop a technology that involves **High Energy Electron Irradiation** of contaminated aqueous solutions and sludges (Exhibit III-5). Upon irradiation, a large number of very reactive chemical species, including hydrogen peroxide, are formed and react with organic contaminants, transforming them to non-toxic by-products. A full-scale facility in Miami, Florida, will be used for testing to determine removal efficiency for complex mixtures of hazardous organic contaminants, and the organic reaction by-products formed.

Energy and Environmental Research Corporation, Irvine, California, is developing a **Hybrid Fluidized Bed System** designed to treat contaminated soils and sludges by incinerating all organic compounds, and extracting and detoxifying volatile metals. The system consists of three stages: (1) a spouted bed, which rapidly heats solids and sludges to extract volatile organic and inorganic compounds; (2) a fluidized bed afterburner, which incinerates the organic compounds that escape the spouted bed; and (3) a high temperature particulate soil extraction system, which removes clean, processed soil from the effluent gas stream.

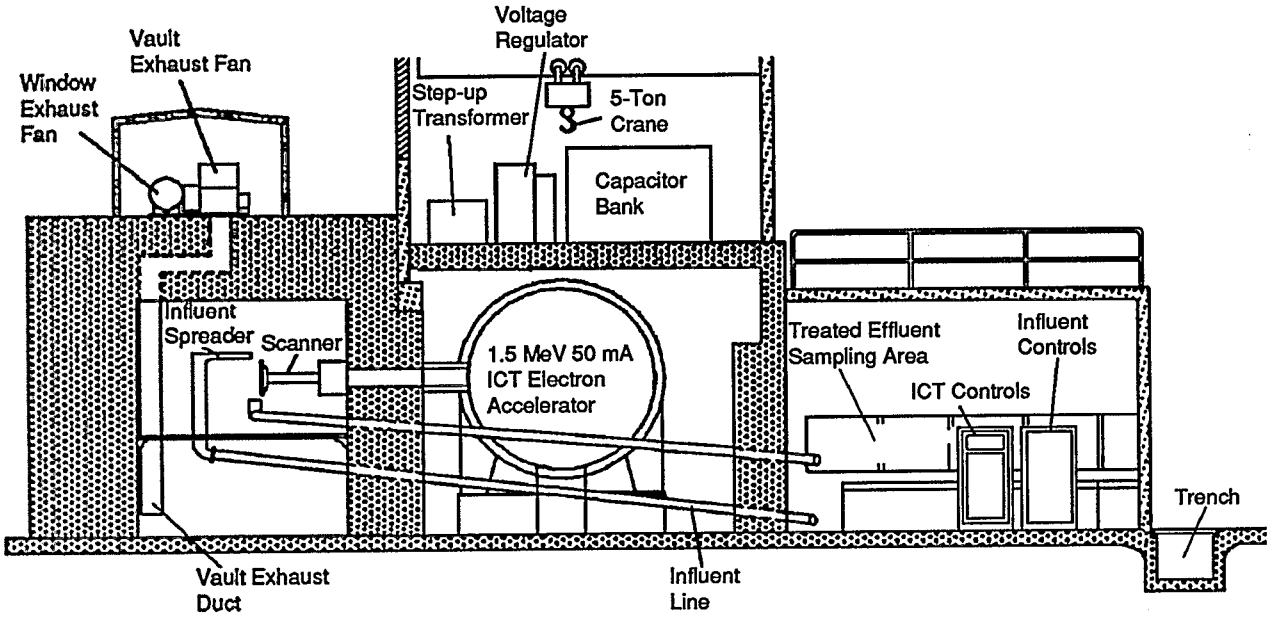
Ferro Corporation, Independence, Ohio, is investigating **Waste Vitrification Through Electric Melting**. The technology involves placing electrodes in contaminated soil, sediments, or sludges to supply electric current, which converts the contaminated media into oxide glasses, rendering them non-toxic and suitable for landfilling. The low toxic emission rate of an electric melter may make it more advantageous than fossil-fuel melters for vitrifying toxic wastes. Initial testing of the electric melting technology is scheduled for late 1990 to early 1991. This testing will focus on developing a glass composition suitable to meet EP Toxicity and TCLP leaching protocols, and determining emission rates for the system.

Institute of Gas Technology, Chicago, Illinois, is developing a three-stage **Fluid Extraction-Biological Degradation Process** for the remediation of organic contaminants from soil (Exhibit III-6). The process involves three distinct technologies: (1) fluid extraction and separation, which removes organics from contaminated solids; (2) separation, which transfers pollutants from an extract to a biologically-compatible solvent; and (3) biological treatment, which degrades organic pollutants to innocuous by-products. Testing of the process is scheduled to begin upon U.S. EPA approval of the developer's work plan and quality assurance project plan.

Institute of Gas Technology is also developing a two-stage, **Fluidized Bed/Cyclonic Agglomerating Incinerator** based on a combination of technologies. In this combined system, solid, liquid, and gaseous organic contaminants from soils and sludges can be efficiently destroyed, while solid inorganic contaminants are confined within a glassy matrix suitable for disposal in a landfill. A batch fluidized-bed unit is currently being modified for testing to establish operating parameters for soil agglomeration, upon U.S. EPA approval of the quality assurance project plan. A pilot-plant unit is also being designed.

IT Corporation, Knoxville, Tennessee, is investigating a two-step, in-situ **Photolytic/Biological Detoxification Process** for shallow soil contamination. The first step in the process is to degrade organic contaminants using ultraviolet (UV) radiation. Degradation is enhanced by adding detergent-like chemicals (surfactants) to mobilize the contaminants. Biological degradation, the second step, is then used to

Exhibit III-5. The Electron Beam Research Facility, Miami, Florida



further destroy the organic contamination and detoxify the soil. The rate of photolytic degradation is several times faster with artificial UV light than with natural sunlight. Bench-scale testing of the process on soils contaminated with PCBs and dioxins will take place during the end of 1990 and the first half of 1991. Pilot-scale tests are scheduled for the following year.

Montana College of Mineral Science & Technology, Butte, Montana, is investigating the application of an **Air-Sparged Hydrocyclone** to recover low-concentrations of metals from aqueous hazardous waste streams (Exhibit III-7). This flotation technique was originally developed during the early 1980s for metals recovery from the very fine particle fraction of industrial mining waste, by fast flotation in a centrifugal field. Testing of this technology, to determine the technology's commercial applicability to treat aqueous hazardous waste streams, will begin upon U.S. EPA approval of a quality assurance project plan.

New Jersey Institute of Technology, Newark, New Jersey, is developing the **Ghea Associates Process**, which uses selected detergent-like chemicals (surfactants) in aqueous solution to extract both inorganic and organic contaminants from soil. The resulting mixture is purified by separating out the surfactant/contaminant complex, and splitting it into a surfactant fraction, which is recovered for repeated use, and a contaminants fraction, which can be disposed. Preliminary treatability studies have been conducted. Further testing is scheduled to occur upon U.S. EPA approval of a work plan and quality assurance project plan.

J.R. Simplot Company, Boise, Idaho, is developing a technology that involves the bioremediation of soils and sludges contaminated with nitroaromatics, such as TNT and pesticides. This **Anaerobic Biological Process** involves introducing starch and anaerobic, starch-degrading bacteria to saturated soils and sludges. After anaerobic conditions have been established, nitroaromatic-degrading microbes are injected to initiate contaminant destruction. Bench-scale demonstrations of the process have been conducted, and the J.R. Simplot Company now plans to scale up its process to the pilot size.

Trinity Environmental Technologies, Inc., Mound Valley, Kansas, is investigating an **Ultrasonic Detoxification Process** for PCB-contaminated solids, soils, and sludges (Exhibit III-8). The process consists of five stages: prescreening, caustic addition, ultrasonic irradiation, product testing, and separation/neutralization. The process will be tested at Trinity's permitted facility when construction of a small scale processor is completed. Data gathered will be used to determine operational parameters for mobile processing units.

Exhibit III-6. Schematic of the Institute of Gas Technology's Fluidized Bed/Cyclonic Agglomerating Incinerator

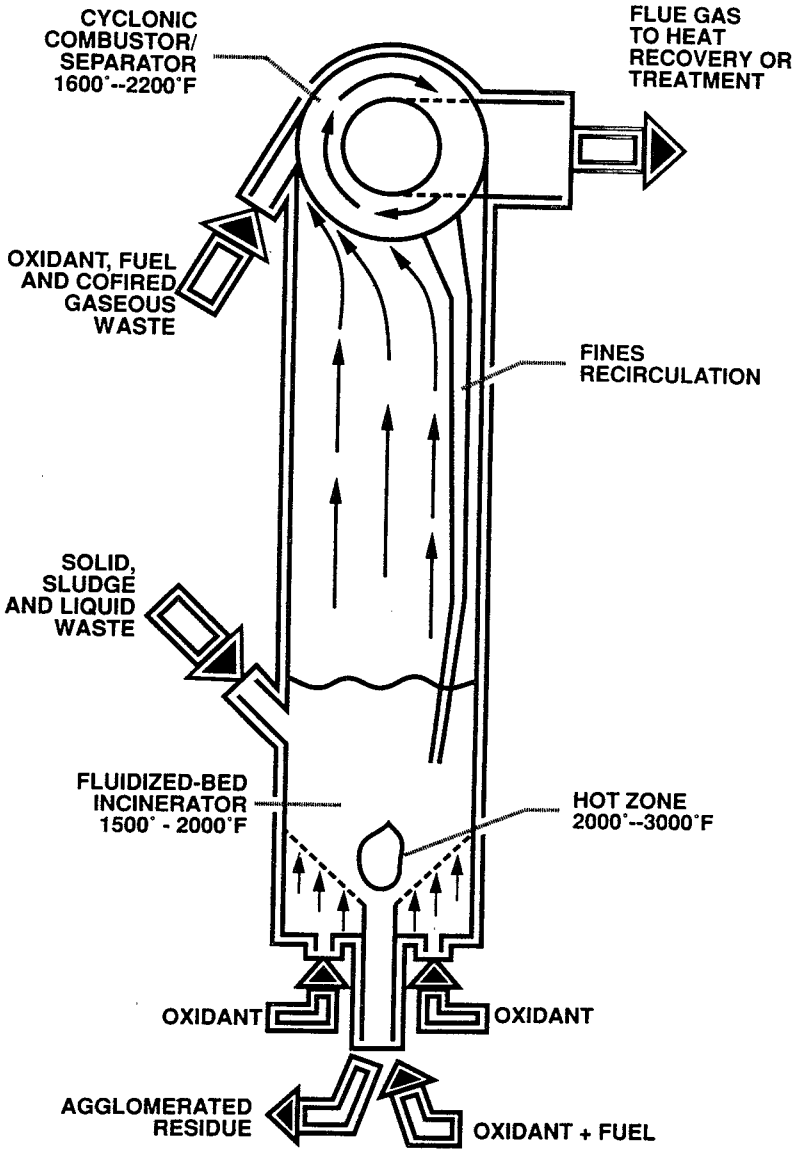


Exhibit III-7. Schematic of the Montana College of Mineral Science and Technology's Air-Sparged Hydrocyclone

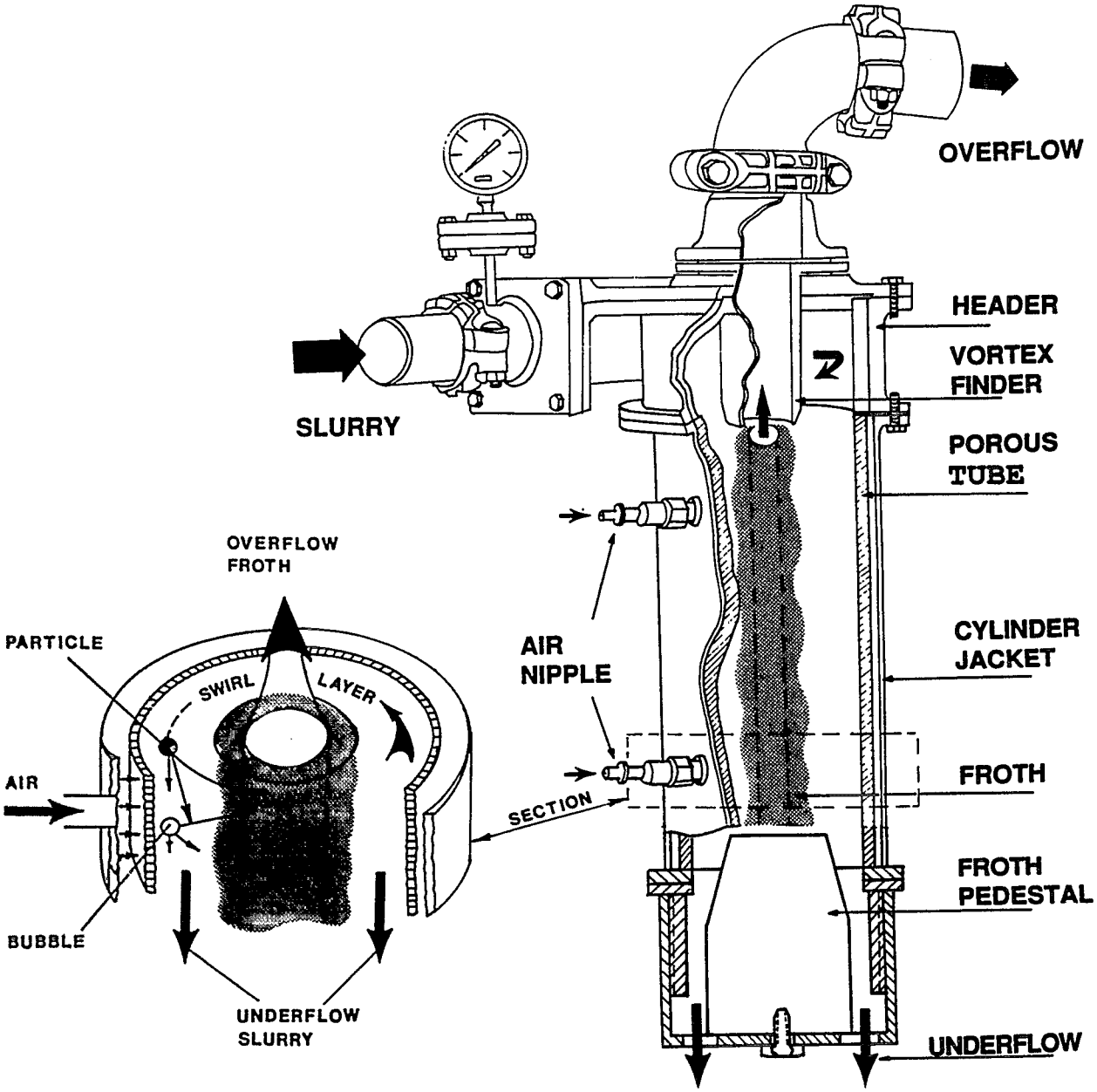
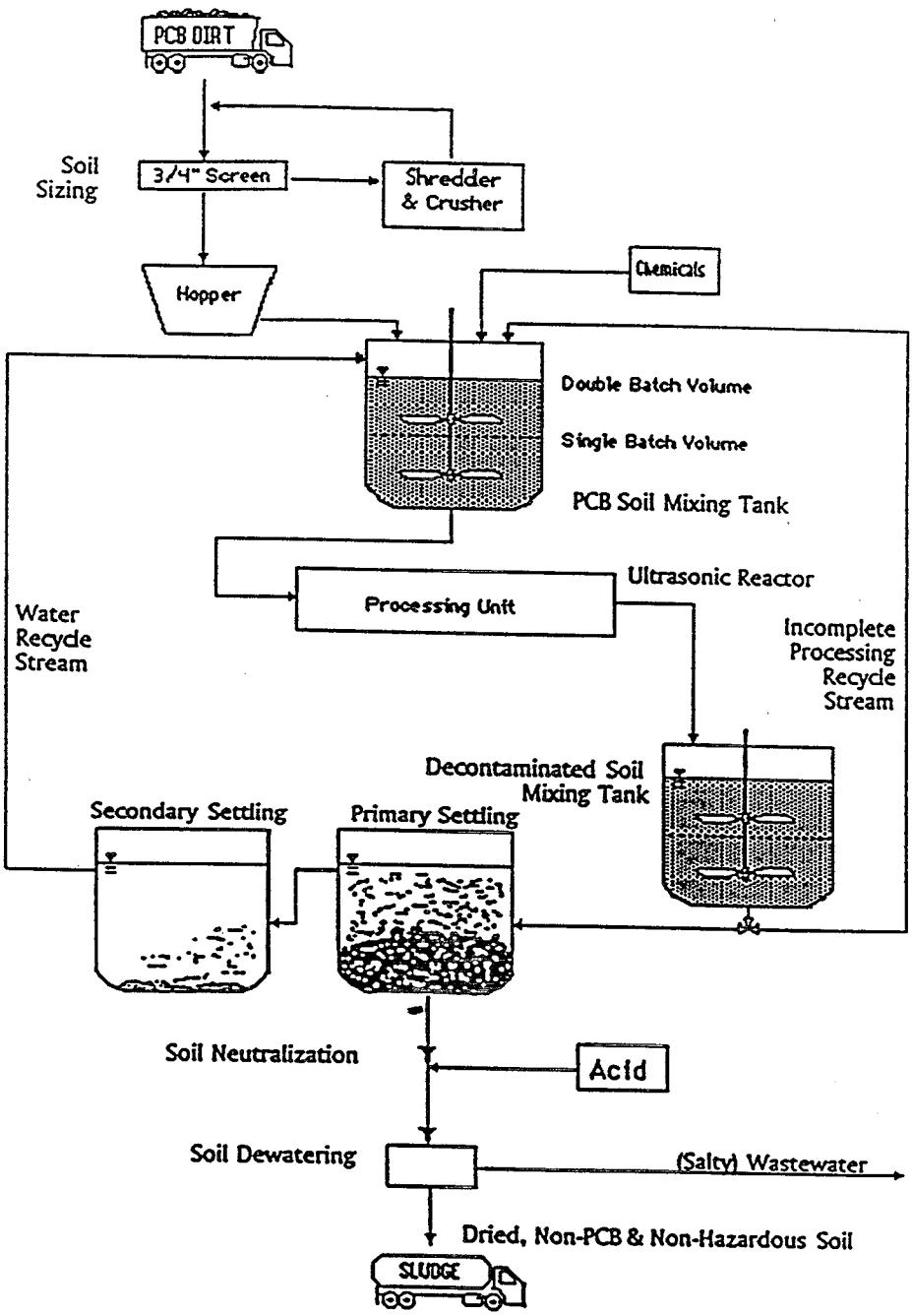


Exhibit III-8. Flow Diagram for Trinity Environmental Technologies, Inc.'s Ultrasonic Detoxification Process



University of South Carolina, Columbia, is developing an innovative strategy for the **In-Situ Mitigation of Acid Water**. The strategy works by modifying the hydrology and geochemistry of the site. This is accomplished through land surface reconstruction and selective placement of limestone. Pilot-scale studies of this technique are expected to be completed by the summer of 1991.

4. Future Needs and Direction

The goal of the Emerging Technology Program is to support the development of innovative alternative technologies by assisting in the research and development of bench- to pilot-scale technologies. Responses from the 1990 solicitation for preproposals totaled 74, indicating a high interest among the private sector to further develop their processes. This strong response illustrates a trend for the program that identifies a need for the developer to establish the knowledge and information to create a commercial process applicable for clean-up actions. Ultimately, the motivating force for the developer is commercialization. A variety of innovative processes are currently being developed and show promise as valuable future technologies. The key factor to success for the ETP will be the flexibility in the magnitudes of research capabilities. Through the Emerging Technology Program, a variety of facilities are available to meet researchers' needs as well as program needs. These facilities include DOD, DOE, and EPA laboratories and pilot facilities.

Since the beginning of the Emerging Technology Program four years ago, six projects have completed their research efforts and are ready to enter the Demonstration Program. Currently, three developers have been invited to demonstrate their processes. In FY 1991, the streamlining procedure for "graduating" technologies from one program to the other will be implemented. Alternative options will also be developed for those technologies that contain field-ready segments for demonstration but require further development in other areas under the existing project plan.

D. MONITORING AND MEASUREMENT TECHNOLOGIES PROGRAM

Monitoring, measurement, and other site characterization technologies are an integral part of and required in several phases of the Superfund remedial process. The costs to characterize a Superfund site are substantial. As much as 80 percent of the costs of the remedial investigation/feasibility study process are attributable to site characterization. These costs are a direct result of sampling, analysis, and the associated quality assurance activities. Therefore, the capabilities of field screening and field analytical methods to yield immediate or quick-turnaround environmental data will (1) result in major savings in both cost and time for Superfund remediation, (2) will decrease the human and ecological risks associated with contaminants at Superfund sites, and (3) will enhance the Agency's ability to manage such risks. In addition to the obvious advantages offered by field methodologies (e.g., generation of real-time data, higher sampling density, and effective detection of hot spots), they also improve the pace of clean-up at a reduced cost and instill a higher degree of confidence in the clean-up.

The two categories of technologies included in the SITE Program are (1) treatment technologies which may serve as alternatives to land disposal of hazardous wastes, and (2) monitoring and measurement technologies for contaminants occurring at hazardous waste sites. The Monitoring and Measurement Technologies Program (MMTP) is a much smaller component of SITE which addresses the very critical needs of field screening. It is administered by the Environmental Monitoring Systems Laboratory in Las Vegas, Nevada (EMSL-LV). Historically, EMSL-LV, and the other Office of Modeling, Monitoring Systems and Quality Assurance (OMMSQA) laboratories, have been supporting the development and demonstration of innovative monitoring and measurement techniques as part of OMMSQA's mission. The monitoring and measurement technologies demonstration portion of the SITE Program provides a special opportunity and allows synergism to occur in identifying and demonstrating relevant technologies that exist within and outside the federal government and which may provide less expensive, better, faster, and/or safer means to characterize contamination at hazardous waste sites.

Products from the various research, development, and demonstration activities conducted under this Program enhance the Agency's ability to perform statistically-valid sampling and field analytical programs that yield effective site characterization coupled with immediate or quick-turnaround environmental data acquisition.

The MMTP has focused on emerging technologies as well as those that are ready for field demonstration. The following sections discuss the FY 1990 technology demonstration activities and the plans for FY 1991 and beyond.

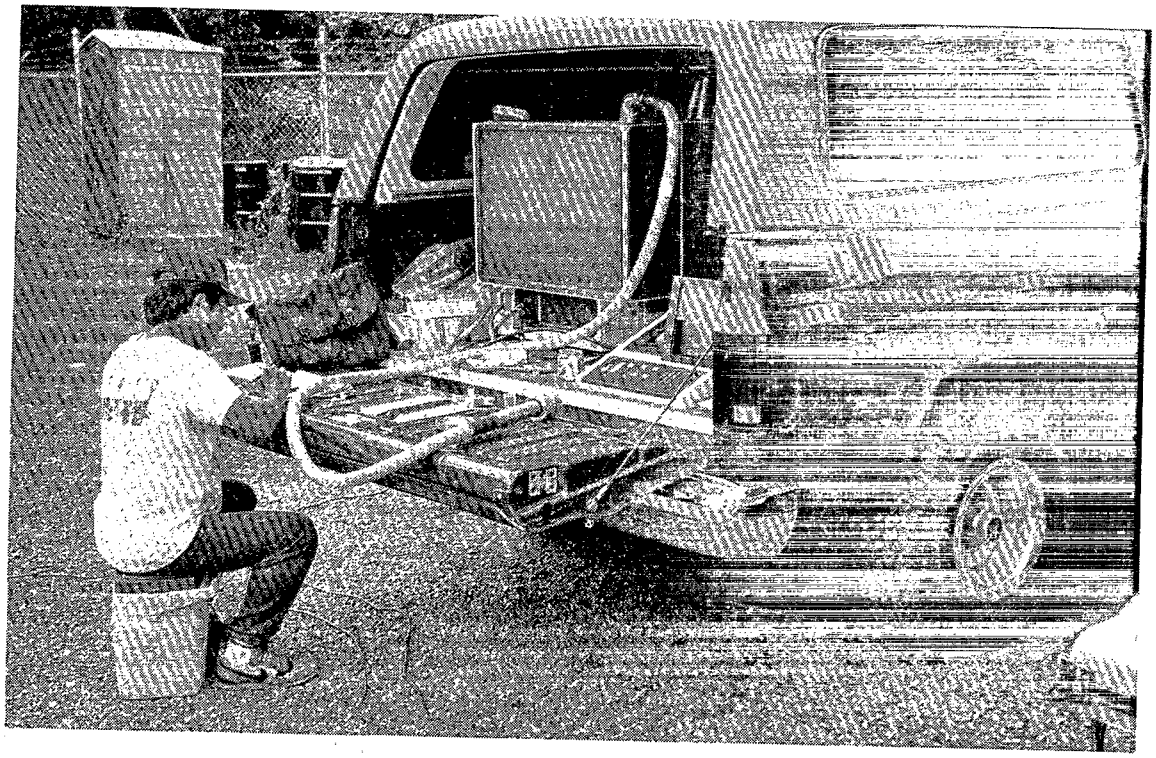
1. Technology Demonstration Activities

One of the most prominent Program activities that occurred during the fiscal year was the demonstration of a **mobile mass spectrometer**. Currently, laboratory-based gas chromatograph/mass spectrometers (GC/MSs) are the preferred EPA analytical tools for identifying and quantifying organic contaminants in samples collected from Superfund sites. The development of a mobile mass spectrometer that is rugged enough to withstand a variety of field conditions has attracted considerable interest for use as a field method.

The purpose of the MMS demonstration was to evaluate the technology for on-site detection of polychlorinated biphenyls (PCBs), volatile organic compounds (VOCs), and polynuclear aromatic hydrocarbons (PAHs) under field conditions. The MMS demonstration focused on the analysis of soil and water samples and was designed to assess whether the technology is capable of yielding rapid, accurate, and cost-effective analyses of the above-mentioned pollutants in soil and water at Superfund sites. Bruker Instruments, Inc. of Billerica, Massachusetts was identified by EPA as having a promising candidate for a demonstration under the MMTP.

Two Superfund sites were selected, both located in Region I. One site was the Re-Solve, Inc. facility located in North Dartmouth, Massachusetts. Samples from this site were analyzed for VOCs in water (e.g., carbon tetrachloride,

III-8. **Mobile Mass Spectrometer**



benzene, methylene chloride, acetone, 1,2-dichloroethylene) and PCBs in soil. The other site was the Westborough Township Superfund site located in Westborough, Massachusetts. The samples at this site were analyzed for PAHs, including benzo(a)anthracene, chrysene, naphthalene, acenapthalene, fluorene, and pyrene.

The results of the analyses from the samples collected at the two sites are being compared to analyses of splits of those same samples by GC/MS at off-site, fixed laboratory locations. The preliminary results show that the MMS worked well for the analysis of PCBs in soil. The method performance factors, such as sensitivity, linear range, and reproducibility were found to be equivalent to that obtained using a conventional GC/MS instrument. The Project Report describing the demonstration, the results, recommendations, and conclusions will be available in FY 1991.

The potential of **immunoassays** as cost-effective alternatives to gas chromatography and mass spectrometry procedures for use in rapid, large-scale environmental monitoring studies is under active investigation. Investigators in the EMSL-LV immunoassay research and development program works with developers under SITE to characterize and evaluate new immunoassay methods in the laboratory and, when appropriate, in the field.

In FY 1989 the MMTP successfully demonstrated two immunoassay methods in conjunction with a treatment technology demonstration. The joint demonstration of a bioreactor and an immunoassay field kit (for pentachlorophenol) was conducted at the McGillis and Gibbs Superfund site in New Brighton, Minnesota, and set a precedent for future ventures.

In FY 1990, an **immunoassay field kit** for measuring benzene, toluene, ethylbenzene, and xylene (BTEX) in water was identified as an excellent candidate for a SITE demonstration. Early in the second quarter, EMSL-LV and RREL-CI began to discuss conducting another joint treatment technology/monitoring technology demonstration. Unfortunately, the company that owned the treatment technology opted not to continue in the SITE Demonstration Program. Although the demonstration of the immunoassay technology is not dependent on a specific treatment technology, it was judged that, in at least the case involving immunoassays, the most cost-effective approach to evaluating technologies is to conduct joint technology demonstrations when possible. Therefore, EMSL-LV decided to postpone the immunoassay demonstration until FY 1991, when another joint demonstration can be pursued.

The research, development, and demonstration of air monitoring technologies is another important facet of the MMTP. In FY 1990, two technologies were tested at the

Shavers Farm Superfund site in Lafayette, Georgia, to monitor ambient concentrations of organics during remediation. The testing at Shavers Farm was administered by the Atmospheric Research and Exposure Assessment Laboratory (AREAL-RTP) in Research Triangle Park, North Carolina.

One of the technologies tested was a **sector sampler** which consists of a wind direction sensor and a whole air sampler that is capable of supplying a constant flow of ambient air into one of two SUMMA canisters. One canister is used to measure in-sector concentrations and the other is used to measure out-sector concentrations of contaminants in ambient air. Sector sampling is an extremely important and useful tool for identifying contributions from landfills when numerous point sources of contamination coexist in an area being monitored. Xontech Corporation of Van Nuys, California, was identified by EPA as having a promising candidate for testing under the Program. Xontech Corporation provided prototype instruments for use in the FY 1989 Delaware SITE Study (as described in the third SITE Report to Congress). The instruments tested at Shavers Farm represented an improved version and one which has begun to find a place in the commercial market.

Preliminary results from the Shavers Farm exercise indicate that the sector sampling equipment performed very well in delineating emissions from the Superfund site in the presence of other sources of contamination. A draft report on the performance of the technology is expected in FY 1991.

The other technology used at Shavers Farm was an FTIR-based, long-path monitor. This type of system is used to make open, long-path length spectroscopic measurements of chemical emissions from sites. The operating principle of the monitor is based on selective absorption of infrared radiation by target gases. Increasing the path-length enhances detection limits for particular gases at low concentrations. The configuration of the system is to have the source and receiver at one end of a monitoring path and a retroreflector at the other end. The pathlength is typically 300 meters long, giving a total pathlength of 600 meters. Sample collection and analysis is not required, however, canister samplers can be used to collect point samples along the path length to confirm the spectroscopic measurements. MDA Scientific of Norcoss, Georgia (formerly Tecan Remote Environmental Monitoring Systems) was identified by EPA as having a suitable candidate for testing under the Program.

As with the sector samplers, MDA Scientific also participated in the FY 1989 Delaware SITE Study. The system tested at Shavers Farm was a modified version of that used in the Delaware Study. Preliminary results indicate that there was significant improvement in the signal to noise ratio (factor of 7) and that the detection limits over the experimental pathlength were single to double digit ppbv, depending on the compound. MDA Scientific has begun marketing the improved version of the FTIR-based system.

In addition to the long-path monitor testing administered from AREAL-RTP, EMSL-LV has also supported fundamental research, development, and testing of a long-path IR system through a cooperative agreement with Kansas State University (KSU). FY 1990 was the second year of a three-year cooperative agreement with KSU. A small portion of SITE resources went to support additional testing of the system at a number of sites with differing contaminant compositions. Preliminary results indicate that the calculated detection limits for 20-25 of the most commonly used industrial solvents range from 6 to 130 parts per million. The technology enhancements that occurred as a result of this effort have had a direct, positive impact on the commercial market, as MDA Scientific has improved its commercial system based on the work supported at both AREAL-RTP and EMSL-LV.

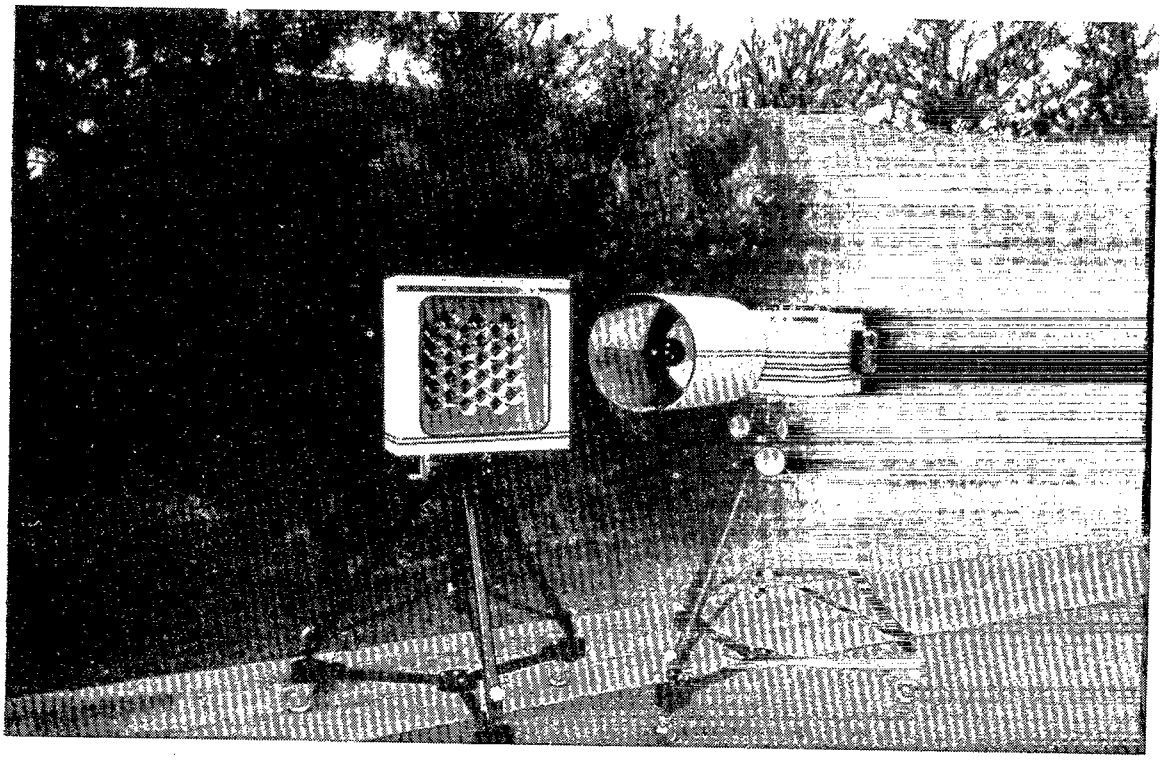
Ion mobility spectrometry (IMS) is another novel technology that was identified during FY 1990 as a potential candidate for a SITE Program demonstration. Initial investigation into the feasibility of using IMS technology for on-site contaminant analysis looked promising. However, it was determined that none of the commercially available ion mobility spectrometers (six different developers, four of which had units that were potential candidates for the program) were engineered for environmental monitoring applications. Therefore, it was decided to conduct a pilot demonstration in the developers laboratories in lieu of a full-scale field demonstration. This provided the developers with an opportunity to analyze performance evaluation materials (prepared and shipped to each developer by the EMSL-LV) in their own laboratories to determine the applicability of their instruments to environmental samples. Of the four candidate ion mobility spectrometer developers, two chose to participate during FY 1990. Results from the laboratory demonstration are expected in the first quarter of FY 1991. Preliminary results showed the need for more attention by the developers to sampling procedures, though the overall technology looks very promising for field use.

Late in FY 1990, the EMSL-LV entered into an Interagency Agreement with the U.S. Department of Energy's Lawrence Berkeley Laboratory to evaluate the performance and applicability of a relatively new **transient electromagnetic method (TEM)**, and the associated numerical interpretive models, for use in characterizing Superfund or other hazardous waste sites. This geophysical method is used to identify and map conductive bodies in the subsurface (e.g., buried drums and contaminant plumes).

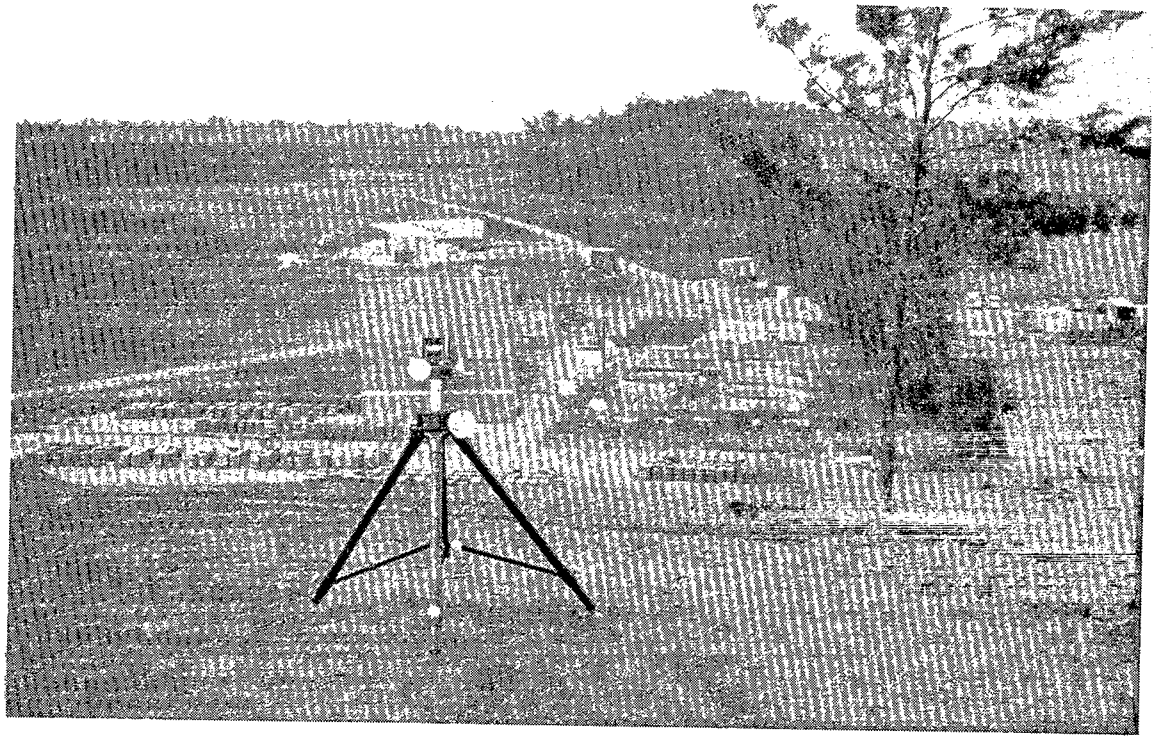
The TEM SITE Program activity is designed to evaluate the effectiveness of new 3-D interpretation methods and promote their acceptance if merited. The workplan was completed and it was judged that the project can:

- provide insights to develop procedures and policies that encourage informed selection and use of TEM measurements;
- will lead to the identification of constraints and limitations on the use of TEM measurements during the RI/FS process, and;
- demonstrate the application of 3-D modeling techniques for the interpretation of electromagnetic data.

III-9. MDA's Fourier Transform Infrared (FTIR) Spectrometer



III-10. MDA FTIR Remote Sensor



The activity is scheduled to be completed by the end of FY 1992.

2. Future Activities

There are a number of exciting demonstrations and research and development (emerging technologies) opportunities that are under consideration.

- A side-by-side demonstration of commercially available high resolution long-path Fourier-transform infrared (HR-FT-IR) spectrometers is being planned for the second or third quarter. HR-FT-IR is used to detect ambient concentrations of volatile organic compounds emitted from sites. This demonstration will be a joint activity involving AREAL-RTP, the U.S. EPA Region VII Environmental Services Division, and the EMSL- LV.

- A demonstration of a prototype field portable global positioning system is being considered. The technology is used to determine the latitude and longitude of sampling locations. The demonstration will be a joint effort between the technology developer, DOE's Los Alamos National Laboratory, and the EMSL-LV.

- A number of commercially available field kits for measuring various contaminants in soil, water, and air were identified during FY 1990. Some of these kits will be demonstrated in conjunction with other SITE demonstrations, as resources and time permit.

- Some of the SITE Program resources will be used to support emerging site characterization technologies. A few of the candidates being considered include:

  - a novel method for installing contaminant detection technologies in the vadose zone.

  - a new method for sampling ground-water from monitoring wells.

  - the use of personal sampling devices in air monitoring applications.

  - a laser, microbial assay for the detection and measurement of contaminants in soil and water.

  - an electromagnetic borehole flowmeter for the determination of ground-water now velocity and direction.

  - the development of quality assurance/quality control procedures for FTIR systems.

E. TECHNOLOGY INFORMATION SERVICES

Technology Information Services are an integral part of the SITE Program, involving public participation, information dissemination, and technically assisting other parts of the SITE Program. The purpose of technology transfer activities is to develop a framework for exchanging information about existing innovative treatment technologies to help those environmental decisionmakers evaluate hazardous waste clean-up options. The information that is distributed discusses the benefits and short-comings of specific technologies. Initially, the SITE Program's primary audience for such information was Regional and State managers of Superfund clean-up activities, the audience for data generated by SITE Program activities has grown and evolved to include Regional and State Managers of RCRA Corrective Action Clean-up Activities, other Federal and State agencies involved in hazardous waste mitigation and clean-up, potentially responsible parties (PRPs), the engineering community, the pollution control industry, and the public, including affected communities, public interest groups, and local officials. Several of the developers involved in the FY 1990 SITE Program have indicated to EPA that information generated by program activities have greatly helped potential users/buyers familiarize themselves with the innovative technologies and their capabilities.

The major accomplishments of the Technology Information Services component of the SITE Program during FY 1990 include:

- EPA hosted an international forum on innovative hazardous waste treatment technologies that was attended by approximately 680 representatives from the U.S. and several foreign countries. The purpose of the of the conference was to introduce promising international technologies through technical papers and poster displays, and to discuss the status and results of the technologies tested under the SITE Program.

- Numerous publications were prepared and distributed including nine Technology Evaluation Reports, eight Applications Analysis Reports, seven SITE videos, two program status brochures, and numerous project fact sheets, technical project update bulletins, technical papers and posters.

- Visitors' Days for three demonstrations including on-site briefings, were held to introduce the public to the technology, and to observe field activities. Attendance ranged from 25 to 130 visitors.

1. SITE Reports, Brochures, Publications, and Videos

SITE reports, including Technology Evaluation Reports and Applications Analysis Reports, are prepared following the completion of each demonstration and analysis of laboratory findings. Seventeen of these reports were completed in FY 1990. The Technology Evaluation Report documents the performance data resulting from the demonstration. This report includes a description of the process and site characteristics, the objectives of the demonstration, sampling and analysis procedures, performance data, and information about the QA/QC program. This report evaluates how and whether the objectives of the demonstration were met. The Applications Analysis Report evaluates available information on the technology and presents the applicability of each technology to other site and waste characteristics. The scenarios pre-

sented in the AAR can be applied to both Superfund and RCRA Corrective Action clean-up activities. Limited copies and summaries of these reports are distributed by EPA, and additional copies are available through the National Technical Information Service for a fee. A list of publications, including information on obtaining the documents, is provided in Appendix A.

SITE Program status brochures contain brief descriptions of the SITE Program, technologies currently being tested, and the progress and accomplishments of the program to date. Additionally, the brochure discusses how an interested party can obtain information about the SITE Program, who should apply, how to apply, what transpires under the program, and when the next solicitation for new participants will occur. The brochures are prepared annually for the RREL Symposium and the Superfund Conference and exhibition. Each year approximately 500 to 900 participants attend the RREL Symposium and 3,000 participants attend the Superfund Conference. The brochures have provided an opportunity for potential SITE Program participants to familiarize themselves with the program's objectives and requirements and prepare their technologies for potential inclusion in the program. Approximately I 5,000 copies of each of these brochures were printed and distributed in FY 1990.

Monthly articles concerning SITE Program are published in the Journal of the Air and Waste Management Association. The articles present the SITE Program and its progress and accomplishments to a variety of audiences.

EPA has updated the *Superfund Innovative Technology Evaluation Program: Technology Profiles* originally published in 1988. The document includes an overview of the SITE Program, a list of the program participants, and profiles on each of the technologies, including a description of the technology, a discussion on waste applicability, the status of the demonstration, and an EPA and technology developer contact for further information. The purpose of the III - 51 Technology Profiles is to provide environmental decisionmakers and other interested individuals with a ready reference on technologies participating in the SITE Demonstration and Emerging Technologies Programs. Developers indicated to EPA that the technology profiles were a very useful and primary source for inquiries about their technologies.

As part of each technology demonstration, a videotape is prepared documenting demonstration activities and discussing the result of the documentation. The purpose of the videotape is to give Regional and state site remediation manages and other interested parties a brief (10-15 minute) synopsis of the SITE Program, the technology being tested, documentation goals and objectives, and the results of the tests performed at the demonstration. Each videotape includes actual footage of the treatment system in operation at the demonstration site, and uses computer animation to further characterize the components of and processes within the system. Final videotapes of each of the completed demonstrations are distributed to each of the Regions, that interested remediation managers can initially familiarize themselves with a particular technology that may be suitable as part of the clean-up remedy for their sites. Videotapes for E. I. Dupont deNemours and Company/Oberlin Filter Company (Membrane Microfiltration) and AWD Technologies, Inc. (AquaDetox/Seil Vapor Extraction) are currently in the post-production phase.

2. Public Participation and Visitors' Days

Public participation is an integral part of the SITE Program. Public participation allows the program the opportunity to disseminate information widely and encourage interaction about innovative technologies to a variety of interested individuals and groups. Prior to the final selection of a demonstration site, a public notice and public comment period about the proposed demonstration are initiated. Public notices announcing the public comment period are usually presented in local newspapers and also in fact sheets distributed to individuals on the mailing list for the site and to other potentially interested parties. Public notice fact sheets have been sent to up to 3,200 persons for a particular demonstration. Following completion of the public comment period, a responsiveness summary addressing any public concerns is developed.

During the demonstration, a Visitors' Day is sponsored by EPA to provide first-hand observation of the technology during field use and discussions with the SITE Program Managers, developers and technical personnel. During the past six months, Visitors' days were conducted for two demonstrations and were attended by Federal, state, and local agency personnel, PRPs, individuals from the engineering and pollution control industry, technology competitors, the media, public interest groups, and citizens from the affected communities. The Visitors Days were attended by up to 110 persons, with many other individuals expressing interest but unable to attend. EPA provides a Visitors' Day packet to all individuals expressing interest in the technology demonstration. This community outreach tool is rather comprehensive, providing descriptions of the technology, the site, the waste, the goals and objectives of the demonstration, the sampling and the analysis parameters of the site, diagrams of the technology, and a list of contacts.

3. Conferences, Meetings, and Seminars

On May 15-17, 1990, EPA hosted the **Second Forum on Innovative Hazardous Waste Treatment Technologies: Domestic and International** in Philadelphia, Pennsylvania. The conference was attended by approximately 680 representatives from the U.S. and several foreign countries. During the conference, scientists and engineers representing government agencies, industry, and academia, attended 35 presentations describing successful case studies of physical/chemical, biological, thermal, and stabilization treatment methods. In addition, case studies of applied technologies were presented by EPA's Superfund contractors. Domestic and International scientists and vendors presented over 50 posters explaining their treatment methods and results.

EPA continued planning and coordination of the **Second International Symposium on Field Screening Methods**

for Hazardous Wastes and Toxic Chemicals, which is scheduled for February 12-14, 1991 in Las Vegas, Nevada. The purpose of the symposium is to bring an international view to the problems and potential solutions involved with the characterization and monitoring of hazardous wastes and toxic chemicals. By the close of FY 1990, EPA received about 150 abstracts. The Symposium program will have one plenary session, ten technical sessions, 60 poster presenters, and 70 technology exhibitors. EPA expects about 800 delegates to attend the conference, representing various Federal and state agencies, technology developers, academicians, and venture capitalists.

Last year, in an effort to speed up the site selection process, EPA initiated **Regional SITE Coordinator's Meetings**, with the purpose to identify potential site demonstration sites for new technologies recently accepted into the program. These meetings continued in FY 1990, with one taking place in Cincinnati, Ohio, following the receipt of proposals from the SITE-005 solicitation. The objective of these meetings was expanded in FY 1990 to include obtaining information from the regions about the kind of alternative technologies they most need to remedy regional hazardous waste clean-up operations. To accomplish this objective, RREL designated members of its staff to serve as Regional Coordinators.

Preproposal Conferences on SITE Solicitations are held annually. These conferences present the SITE Program to developers in an effort to attract new participants to the program.

In FY 1989, Atmospheric Research and Exposure Assessment Laboratory demonstrated and tested five air monitoring technologies at a number of Superfund sites near New Castle, Delaware (the Delaware SITE Study). The results of the Delaware SITE Study were presented in a special session of the 1990 EPA Air and Waste Management Association International Symposium on **Measurement of Toxic and Related Air Pollutants** (April 30 - May 4, 1990).

4. Electronic Information Systems

To facilitate the transfer of information on alternative technologies, EPA scheduled a seminar series for FY 1990. The objective of the seminar series is to further educate regional and state personnel on the alternative technologies in the SITE Program. The seminars were one-day sessions, during which detailed information on completed SITE demonstrations was be presented. Two seminars took place in FY 1990: one in Region IV on December 14, 1989 and a second in Region III on January 11, 1990. Each region chose five completed demonstrations of interest to the region for presentation.

All the community outreach and technology transfer activities will continue through FY 1991.

Alternative Treatment Technology Information Center (ATTIC) is a comprehensive, automated information retrieval system that integrates data on hazardous waste treatment technologies into a centralized, searchable source. Initiated in November 1987, a prototype version became operational in May 1989. ATTIC's four major components include a hotline, an electronic bulletin board, a reference library, and a computerized information network. Additionally, hard copies of information are provided upon request. The purpose of ATTIC is to provide users with technical information on alternative methods hazardous waste treatment. The user community is comprised of EPA headquarters and regional staff, participating state environmental agencies, and numerous remediation contractors. ATTIC is available through any modem-equipped IBM compatible PC using standard communications software. Users can employ the system independently, or can use an ATTIC system operator to assist them.

ATTIC contains data obtained from the SITE Program and other federal and state agencies, including abstracts and executive summaries from over 900 documents and reports, which are the core of the ATTIC Database. Contributors to the ATTIC Database are the SITE Program, states, industry, NATO, DOD/DOE, Records of Decisions (RODs), and treatability studies. In addition to the ATTIC Database, the ATTIC system contains resident databases already developed, as well as an online commercial database. The ATTIC resident databases include RREL (Water) Treatability Database, RSKERL Soil Transport and Fate Database, EPA Library Hazardous Waste Collection Database, Cost of Remedial Action Model, and Geophysics Advisor Expert System.

The OSWER electronic bulletin board system (BBS) was set up to facilitate communication and technology transfer among EPA staff in Regional offices, headquarters, state and local government personnel, EPA contractors, and research laboratories. The BBS offers up- to-date information about the current status of each of the SITE technology demonstrations, as well as providing messages, files, computer programs, databases, and information on conferences.

EPA's Technical Information Exchange (TIX) Computerized On-Line Information System (COLIS) provides technical information involving hazardous waste technologies and assists users in locating materials from other sources. The system contains the complete text of each published SITE Program Applications Analysis Report.

SECTION IV
SITE PROGRAM PROPOSED CHANGES AND RECOMMENDATIONS

This section summarizes the importance of the SITE Program in achieving the Nation's goal of cleaning up Superfund and other hazardous waste sites. SITE has worked towards fulfilling its statutory mandate, and is implementing program changes to further its mission. This report concludes with EPA's outlook for the SITE Program in view of the recent reauthorization of CERCLA.

A. STATUTORY MANDATE

Since its inception in 1986, the SITE Program has been pursuing its legislative mandate. The program structure and operation have been in conformance with and committed to the spirit of SARA. EPA has established a demonstration program [Section 311 (b)(5)(A) of CERCLA], conducted annual solicitations [subparagraph B], received applications [C], selected projects [D], selected Superfund sites [E], developed demonstration plans [F], and conducted demonstrations [G and H]. Funding has been offered to developers in compliance with the restrictions in Section 311 (b)(5)(J). The program has attempted to initiate 10 field demonstrations per year as called for by Section 311 (b)(6). In fact, in most years, more than 10 technologies have been brought into the program.

In the period between establishment of the SITE Program through passage of SARA in 1986 and today, the Superfund program has come under increasing pressure to speed up the decisionmaking and cleanup processes. While the Superfund program has been called upon to adopt more cost-effective innovative technologies, the individual remedial project manager (RPM) is often held accountable to complete a given site's remedial investigation and feasibility study (RI/FS) in 22 months. While there may be time within this 22-month process for small- scale treatability studies, it is, even under the best of circumstances, difficult to manipulate the larger (in many cases full-scale) equipment desired for SITE demonstrations. Thus, in the push of day-to-day activities, the RPMs are reluctant to assume the additional, voluntary "burden" of hosting a SITE demonstration.

The SITE Program suffers, too, from many of the field problems that have hampered the Superfund program. Site characterization and cleanup can go much slower than planned. Cautious states, PRPs, and local air and water authorities can hold up the process. Community relations can be complicated by bringing in untested equipment. Complex test plans and data reports require planning and interpretive time, and the demand for speed in the RI/FS process forces RPMs (and their support contractors) to lean heavily on established technologies. Only in rare circumstances will a Region consider a SITE demonstration after a record of decision (ROD) has been signed for the site. Since EPA Regions have long since begun the RI/FS process for most of their priority sites, it is unlikely that these sites will be offered to host SITE demonstrations. In this context, the prospect that multiple sites can be considered for any one demonstration is an extremely remote possibility.

B. PROPOSED PROGRAM CHANGES

In August 1990, RREL completed its *Management Review of the SITE Program.* The study was initiated as a follow-up to the Administrator's 90-day *Management Review of the Superfund Program, and subsequent Management Review of the Superfund Program—Implementation Plan.*

While all these efforts dealt with the SITE Program from a broad perspective, EPA believed that a more thorough assessment was required on the part of those individuals most familiar with the program. The process used in conducting the study was to interview knowledgeable, involved, and experienced EPA personnel at the headquarters level, Office of Research and Development (ORD), Office of Solid Waste and Emergency Response (OSWER), Office of Environmental Engineering and Technology (OEETD), and the Risk Reduction Engineering Laboratory and several Regional Offices. Other groups that were interviewed included select Centers of Excellence, several state and other government agencies, and private sector groups. Questions covering broad categories of the SITE Program were used as discussion topics for the interviews. These categories included: (1) program structure, (2) management issues, (3) marketing and outreach, (4) technology transfer, and (5) recommendations for consideration as part of CERCLA reauthorization in November 1991.

The interview responses were analyzed by SITE personnel. These responses and the knowledge of the SITE Program personnel were then used to formulate conclusions and recommendations presented in the study report. The SITE Program personnel who conducted the review were im-

pressed with degree of interest all respondents showed in making the SITE Program work.

The one aspect of the SITE Program appreciated by all participants is the high quality of unbiased data generated under this program. EPA Regions, in spite of their desire to have more data more quickly, do not wish to see this achieved through sacrifices in quality. The SITE Program does not intend to reduce the level of quality assurance of the core demonstration program. Rather, the goal of faster data turnaround will be pursued through more intense emphasis on applications analyses, as opposed to detailed data presentations, and through lower level intermediate studies, such as treatability studies.

As a result of RREL's management review, the SITE Program has begun to implement the following 15 program changes in the study areas described above:

1. Initiate a SITE Treatability Program

OSWER guidance to the Regions places a heavy emphasis on the need to conduct treatability studies. There should be a marked increase both in general treatability studies and in treatability studies of innovative technologies as the Regions move to implement this guidance. This movement represents a marked opportunity for the SITE Program to provide service to the Regions. A SITE treatability program could:

- Conduct treatability studies by developers accepted into the SITE Program.
- Incorporate treatability studies of innovative technologies planned by the Regions into the SITE Program.

2. Conduct Pilot Programs of Close Support with Selected EPA Regions

Under this proposed pilot program, the Regions and SITE would agree to work closely together. The Regions would examine the SITE technologies for fits to demonstration sites. RPMs who participate would be allowed some relief from time schedules for participation in the SITE Program. The SITE Program would evaluate the Region's RODs to determine if any proposed cleanup technologies would qualify as SITE demonstration projects. In addition, the SITE Program would conduct SITE treatability studies where there are sites and SITE matches.

3. Initiate a Cooperative Effort with the State of California

California has conducted an innovative technology assessment program for several years. While it differs in many respects from EPA's SITE Program, its program's objectives are very similar to SITE's. In order to facilitate its pursuit of "targets of opportunity," the SITE Program will meet with officials of the California program.

4. Establish an Advisory Committee for the SITE Program

An advisory group, consisting of Federal and state regulatory personnel, technology developers' representatives, hazardous waste remediating contractors, and private company representatives, will be established to oversee the operation of the SITE Program and provide recommendations for methods to improve its operation and "track-record." This committee would meet twice a year at the RREL where a current program orientation would be conducted for the members. They, in turn, would provide a critique or debriefing on their observations at the end of the day. Within 2 weeks of the meeting they would provide formal written comments of the program that would highlight the strong and weak points and provide recommendations for future directions.

5. Shift the Emphasis of the Solicitation Process to Sites Rather than Technologies

Within the universe of Superfund sites, most can be grouped into various categories. One option would be to issue requests for technologies to work at specific sites, for example, wood treating facilities, coal gasification plants, or lead storage battery sites.

6. Streamline the Demonstration Planning Process

SITE management intends to use the data quality objectives (DQO) process for planning demonstrations. This process involves the use of an early planning meeting among all interested parties to clearly define a demonstration and, thus, sampling and analytical objectives. In this manner, the demonstration plan can be compressed into a usable, concise document requiring only the essential sampling and analysis.

7. Utilize the START Program as a Source of Test Sites and Technologies for the SITE Program

The START program works very closely with Regional Superfund personnel to provide technical assistance on remedy selection. There are currently 22 sites in the START program with additional sites to be added each year. The START team leaders are in a position to appreciate any confluence of needs between START sites and the SITE Program. As Regional personnel become more comfortable with, and reliant on, the START team leaders, opportunities to mesh SITE and site needs can be pursued.

8. Pursue Opportunities to have Multiple Demonstrations at a Single Site or a Single Facility

In most cases a single remedial action technology or unit operation will not be adequate to remediate an uncontrolled hazardous waste site. Several individual technologies need to be combined in order to effectively clean-up the site. This recommendation would take advantage of various institu-

tional approaches to demonstrate multiple technologies. Certain sites like Rocky Mountain Arsenal and the Petro Processors site in Louisiana offer the opportunity of having a wide range of types and quantities of contaminants which would readily lend themselves to a "treatment-train" concept.

Also, ORD's Test and Evaluation (T&E), Center Hill, and Incineration Research (IRF) facilities are single controlled environmental testing facilities, where a waste can be brought in and treated by a multiple treatment system approach. SITE management feels strongly that both of these options offer promise and they will be pursued at the earliest opportunity.

9. Emphasis to Evaluation Contractors that Quality and Timeliness Will Affect Their Award Fees

Two new evaluation contracts will be in place before the beginning of FY 1991. Quality and timeliness will be the major parameters in determination of award fees under these contracts. SITE management will meet with its project managers to emphasize the importance of fully utilizing the award fee process.

10. Prepare an "Information Document" for RPMs, OSCs, PRPs and Their Related Associations on the Benefits of Participation in the SITE Program

This document would consist of a listing of all technologies that need site matching, a brief abstract of the technology, the kind of contaminants it proposes to treat, and some of the benefits of participating in the SITE Program, such as providing all of the analytical support not only for full-scale demonstrations, but also for treatability studies.

11. Designate Program Staff to Regional SITE Coordination

RREL Regional SITE coordinators would facilitate SITE Program activities in the Region, assist in technology transfer activities, and identify areas of mutual benefit. The implementation would involve assigning one individual for each of EPA's 10 Regions. These individuals would continue to serve as project managers on SITE demonstration projects.

12. Utilize NETAC to Help Move Successful Graduates of the Emerging Technologies Program to the Demonstration Program

The National Environmental Technologies Applications Corporation (NETAC) was established in 1988 through a Cooperative Agreement between the University of Pittsburgh Trust and EPA. NETAC is a unique organization designed to provide an integrated and systematic approach for accelerating the development, regulatory acceptance and commercialization of priority environmental technologies from various public and private sources. NETAC provides a wide range of client services to technology developers. These services include third-party technical evaluations, market and competitive position assessments, business development assistance, regulatory advice, and assistance in leveraging financial investments for promising ventures.

13. Explore the Use of Centers of Excellence, Associations, and Clean Sites to Gain Access to Private Sites and Technologies

SITE Program management will meet with officials at research centers, trade associations, and private consulting groups to pursue "targets of opportunity" for the SITE Program. In many instances, private firms may have significant economic incentive to utilize innovative technologies for cleanup of sites. While most of these sites are not Superfund sites the problems encountered are equivalent to those found at Superfund sites.

14. Develop Summary Reports for Technology Types and Waste-Specific Treatment Trains

First, a technology summary report will be generated to abstract and compare similar technologies. The first attempt at this activity will be to produce a general profile of solidification/stabilization technologies already demonstrated. This profile will address effectiveness of each system, pollutants controlled, long-term data, and analysis of applicability.

In the second type of document, a treatment train will be developed for cleanup of a characteristic site using one or more SITE technologies. The treatment system presented will cover excavation/site preparation, primary treatment, treatment or disposal of residuals, scrubbing of air streams, polishing of wash and decontamination water, and site restoration. This report will be directed at the design of a complete clean-up system to illustrate methods by which various technologies can complement each other and provide a total remediation concept.

15. Improve Data Feed-Back on Demonstration Projects

In an effort to improve the benefits that Regions can derive from participation in the SITE Program, emphasis lust be placed on timely turn around of the demonstration's analytical results. Given the time span between the end of the demonstration and the publication of official SITE results, efforts must be made to share data as soon as possible.

C. PROGRAM OUTLOOK

EPA implemented the SITE Program in accordance with the SARA mandate, as well as its perceived legislative intent. SITE is providing a valuable resource to the Superfund remedial and removal and RCRA corrective action programs, and has grown to meet the changing needs of these programs. The reauthorization of CERCLA offers EPA's ORD the opportunity to continue its cooperative efforts with

EPA Regions, states, other federal agencies, private parties, and developers in providing the technologies needed for site cleanups. The investment of time and money in the SITE Program by EPA and the commercial developers should continue to show long-term dividends through the availability of more permanent solutions to hazardous waste site problems. The SITE Program is fulfilling a need of the Superfund program in accordance with its statutory mandate. The SITE Program has become an integral part of the EPA's effort to use innovative alternatives for hazardous waste site cleanups.

APPENDIX A

REPORTS AVAILABLE

EPA

Documents Available from the U.S. EPA Risk Reduction Engineering Laboratory Superfund Technology Demonstration Division*

General Publications

- ❑ Technology Profiles (EPA/540/5-90/006)

Demonstration Project Results

American Combustion—Oxygen Enhanced Incineration

- ❑ Technology Evaluation (EPA/540/5-89/008)
- ❑ Applications Analysis (EPA/540/A5-89/008)

CF Systems Corp.—Solvent Extraction

- ❑ Technology Evaluation (EPA/540/5-90/002)
- ❑ Applications Analysis (EPA/540/A5-90/002)

Chemfix Technologies, Inc.—Chemical Fixation/Stabilization

- ❑ Technology Evaluation (EPA/540/5-89/011a)
- ❑ Applications Analysis (EPA/540/A5-89/011)

Hazcon—Solidification

- ❑ Technology Evaluation (EPA/540/5-89/001a)
- ❑ Applications Analysis (EPA/540/A5-89/001)

IWT In-Situ Stabilization

- ❑ Technology Evaluation (EPA/540/5-89/004a)
- ❑ Applications Analysis (EPA/540/A5-89/004)

Shirco—Infrared Incineration

- ❑ Technology Evaluation—Peake Oil (EPA/540/5-88/002a)
- ❑ Technology Evaluation—Rose Township (EPA/540/5-89/007a)
- ❑ Applications Analysis (EPA/540/A5-89/010)

Soliditech, Inc.—Solidification

- ❑ Technology Evaluation (EPA/540/5-89/005a)
- ❑ Applications Analysis (EPA/540/A5-89/005)

Terra Vac—Vacuum Extraction

- ❑ Technology Evaluation (EPA/540/5-89/003a)
- ❑ Applications Analysis (EPA/540/A5-89/003)

Ultrox International—UV Ozone Treatment for Liquids

- ❑ Technology Evaluation (EPA/540/5-89/012)
- ❑ Applications Analysis (EPA/540/A5-89/012)

Emerging Program Reports

Bio-Recovery Systems—Removal and Recovery of Metal Ions from Groundwater

- ❑ EPA/540/5-90/005a

Development of Electro-Acoustic Soil Decontamination (ESD) Process for In Situ Applications

- ❑ EPA/540/5-90/004

❑ Check hereif you would like your name placed on the SITE mailing list

Your Name, Mailing Address, and Phone (please print)

MAIL THIS FORM TO:
ORD Publications
26 W. Martin Luther King Dr. (G72)
Cincinnati, Ohio 45268

* Documents ordered through ORD Publications are free of charge.

United States Environmental Protection Agency
Superfund Technology Demonstration Division
RREL/RCB Videotape Library

Videotapes documenting U.S. EPA Risk Reduction Engineering Laboratory (RREL) SITE Demonstrations as well as Releases Control Branch (RCB) projects have been combined into two 1/2-inch VHS (NTSC) format tapes. Each tape is available at a cost of $35.00 per copy, shipping and handling fee included. (Note: $10.00 additional charge per tape for international shipments).

Copies	*Number*	*Videotape Title*
_____	S1*	Superfund Innovative Technology Evaluation (SITE) Program—compilation of six technology demonstrations, including:
		- Shirco Infrared Incineration System, Peak Oil, Brandon, FL, August 1987
		- Shirco Infrared Incineration System, Demode Road Site, Rose Twp., MI, Nov. 1987
		- Hazcon Solidification Process, Douglassville, PA, October 1987
		- IWT/GEO-CON In-Situ Stabilization/Solidification, Hialeah, FL, April 1988
		- Terra Vac Vacuum Extraction System, Groveland, MA, January 1988
		- CF Systems Solvent Extraction Unit, New Bedford, MA, March 1989
	R1	RREL/RCB Research Program, including
		- Synthetic Soils Matrix
		- Dioxin and the Mobile Incineration System
		- Mobile Carbon Regeneration System
		- Mobile Soils Washing System
		- Mobile In-Situ Containment/Treatment Unit

* A Second SITE Program compilation video (S2) will be released soon.

These tapes can be requested in two ways:

(1) Send personal or company check, payable to "Foster Wheeler Enviresponse," to:

Foster Wheeler Enviresponse Videotape Request
8 Peach Tree Hill Road
Livingston, NJ 07039
Attn: Ms. Marilyn Avery (Allow 2-3 weeks for delivery)

(2) Send personal or company check, payable to "United States Department of Treasury," to:

U.S. EPA, Superfund Technology Demonstration Division
RREL, FOIA Videotape Request
26 West Martin Luther King Drive
Cincinnati, Ohio 45268 (Allow 6-8 weeks for delivery)

(REQUESTS WILL NOT BE HONORED WITHOUT PREPAYMENT BY CHECK)

Tapes should be sent to the following (Please print or attach business card):

Name: _____

Company: _____

Address: _____

City, State, Zip: _____

APPENDIX B

DEMONSTRATION PROGRAM PARTICIPANTS

SITE Demonstration Program Participants

Developer	Technology	Technology Contact	EPA Project Manager	Waste Media	Applicable Waste	
					Inorganic	Organic
Allied Signal Corporation [formerly Detox, Inc.] Morristown, NY (003)	Submerged Aerobic Fixed-Film Reactor	David Allen 201-455-5595	Ronald Lewis 513-569-7856 FTS 684-7856	Ground Water, Wastewater	Certain Metals Inhibit the Process	Readily Biodegradable Organic Compounds
American Combustion Technologies, Inc. Norcross, GA (001)	Pyretron Oxygen Burner	Gregory Gitman 404-662-8156	Laurel Staley 513-569-7863 FTS 684-7863	Soil, Sludge, Solid Waste	NA	Non-specific
AWD Technologies, Inc. San Francisco, CA (004)	Integrated Vapor Extraction and Steam Vacuum Stripping	David Bluestein 415-876-1504	Norma Lewis/ Gordon Evans 513-569-7665/ 513-569-7684	Ground Water, Soil	NA	Volatile Organic Compounds
BioTrol, Inc. Chaska, MN (003)	Biological Aqueous Treatment System	John Sheldon 612-448-2515	Mary Stinson 908-321-6683 FTS 340-6683	Liquid Waste, Ground Water	Nitrates	Chlorinated and Nonchlorinated Hydrocarbons, Pesticides
BioTrol, Inc. Chaska, MN (003)	Soil Washing System	John Sheldon 612-448-2515	Mary Stinson 908-321-6683 FTS 340-6683	Soil	Metals	High Molecular Weight Organics, PAHs, PCP, PCBs, and Pesticides
BioVersal USA, Inc. Mount Prospect, IL (005)	BioGenesis Processor Extraction of Hydrocarbons	Mohsen C. Amiran 708-228-7316	Diana Guzman 513-569-7819 FTS 684-7819	Soil	NA	Volatile and Nonvolatile Hydrocarbons
CF Systems Corporation Waltham, MA (002)	Solvent Extraction	Chris Shallice 617-890-1200	Laurel Staley 513-569-7863 FTS 684-7863	Soil, Sludge, Wastewater	NA	PCBs, Volatile, and Semivolatile Organics, Petroleum By-products
Chemfix Technologies, Inc. Metairie, LA (002)	Solidification/ Stabilization	Philip Baldwin 504-831-3600	Edwin Barth 513-669-7669 FTS 684-7669	Soil, Sludge, Solids, Waste, Electroplating Wastes	Heavy Metals	High Molecular Weight Organics
Chemical Waste Management, Inc. Geneva, IL (003)	X*TRAX™ Low-Temperature Thermal Desorption	Carl Swanstrom 708-513-4578	Paul dePercin 513-569-7797 FTS 684-7797	Soil, Sludge, Other Solids	NA	Volatile and Semivolatile Organics, PCBs
Dehydro-Tech Corporation East Hanover, NJ (004)	Carver-Greenfield Process for Extraction of Oily Waste	Thomas Holcombe 201-887-2182	Laurel Staley 513-569-7863 FTS 684-7863	Soil, Sludge	NA	PCBs, Dioxin, Oil-Soluble Organics
E.I. DuPont deNemours and Co./Oberlin Filter Co. Newark, DE (003)	Membrane Microfiltration	Ernest Mayer 302-366-3652	John Martin 513-569-7758 FTS 684-7758	Ground Water, Leachate, Wastewater, Electroplating Rinsewaters	Heavy Metals, Cyanide, Uranium	Non-specific
Ecova Corpoartion Redmand, WA (003)	In-Situ Biological Treatment	Michael Nelson 206-883-1900	Naomi Barkley 513-569-7854 FTS 684-7854	Water, Soil, Sludge, Sediment	NA	Chlorinated and Nonchlorinated Organic
EPOC Water, Inc. Fresno, CA (004)	Precipitation and Microfiltration, and Sludge Dewatering	Ray Groves 209-291-8144	S. Jackson Hubbard 513-569-7507 FTS 684-7507	Sludge, Wastewater, Leachable Soil	Heavy Metals	Pesticides, Oil, and Grease

NA = Non Applicable

Completed Demonstrations

(Continued)

SITE Demonstration Program Participants (Continued)

Developer	Technology	Technology Contact	EPA Project Manager	Waste Media	Applicable Waste	
					Inorganic	Organic
Excalibur Enterprises, Inc. New York, NY (004)	Soil Washing/Catalytic Ozone Oxidation	Lucas Boeve 212-484-2699	Norma Lewis 513-569-7665 FTS 684-7665	Soil, Sludge, Leachate, Ground Water	Cyanide	Semivolatiles, Pesticides, PCBs, PCP, Dioxin
EPA RREL/Air and Energy Engineering Research Laboratory/Region 9 Superfund Program	Excavation Techniques and Foam Suppression Methods	Dick Gerstle 513-782-4700	S.Jackson Hubbard 513-569-7507 FTS 684-7507	Soil	Volatile Inorganics	Volatile Organics
Exxon Chemicals, Inc./ Rio Linda Chemical Co. Long Beach, CA (004) [2 Demonstrations]	Chemical Oxidation/Cyanide Destruction	Tony Kurpakus 213-597-1937	Teri Shearer 513-569-7949 FTS 684-7949	Ground Water, Wastewater, Leachate	Cyanide	Non-specific
Freeze Technologies Corp. Raleigh, NC (003)	Freezing Separation	James A. Heist 919-850-0600	S.Jackson Hubbard 513-569-7507 FTS 684-7507	Liquids	Non-specific	Non-specific
GeoSafe Corporation Kirkland, WA (002)	In-Situ Vitrification	James Hansen 206-822-4000	Teri Shearer 513-569-7949 FTS 684-7949	Soil, Sludge	Non-specific	Non-specific
Horsehead Resources Development Co. Inc. (004)	Flame Reactor	John Pusater 412-773-2279	Donald Oberacker 513-569-7510 FTS 684-7510	Soil, Sludge, Industrial Solid Residues	Metals	NA
IM-Tech [formerly Hazcon, Inc.] Oakwood, TX (001)	Solidification/ Stabilization	Ray Funderburk 800-227-6543	Paul dePercin 513-569-7797 FTS 684-7797	Soil, Sludge	Heavy Metals	Non-specific
In-Situ Fixation Co. Chandler, AZ (005)	In-Situ Bioremediation	Richard P. Murray 602-821-0409	Edward J. Opatken 513-569-7855 FTS 684-7855	Soil, Sludge	NA	Biodegradable Organics
International Environmental Technology/YWC Midwest North Canton, OH (005)	Geolock/Bio-drain Treatment	Lynn D. Sherman 216-499-8181	Randy Parker 513-569-7271 FTS 684-7271	Soil	NA	Most
International Waste Technologies/Geo-Con, Inc. Wichita, KS (001)	In-Situ Solidification/ Stabilization	Jeff Newton 316-269-2660 Brian Jasperse 412-856-7700	Mary Stinson 908-321-6683 FTS 340-6683	Soil, Sediment	Non-specific	PCBs, PCP, Other Non-specific Organic Compounds
Ogden Environmental Services San Diego, CA (001)	Circulating Fluidized Bed Combustor	Harold Diot 619-455-2613	Joseph McSorley 919-541-2920 FTS 629-2920	Soil, Sludge, Slurry	NA	Halogenated and Nonhalogenated Organic Compounds
QUAD Environmental Technologies Corp. Northbrook, IL (004)	Chemtact Gaseous Waste Treatment	Harold Rafson 312-564-5070	Ronald Lewis 513-569-7856 FTS 684-7856	Gaseous Waste Streams	Non-specific	Volatile Organics
Recycling Sciences International, Inc. Chicago IL (004)	Desorption and Vapor Extraction System	William C. Meenan 312-559-0122	Laurel Staley 513-569-7863 FTS 684-7863	Soil, Sludge, Sediment	Volatile Organics	Volatile and Semivolatile Organics including PCBs, PAHs, PCP, some Pesticides

NA = Non Applicable

Completed Demonstrations

(Continued)

SITE Demonstration Program Participants (Continued)

Developer	Technology	Technology Contact	EPA Project Manager	Waste Media	Applicable Waste	
					Inorganic	Organic
Remediation Technologies, Inc. [formerly MoTec] Austin, TX (002)	Liquid/Solid Contact Digestion	Randy Kabrick 512-477-8661	Ronald Lewis 513-569-7856 FTS 684-7856	Soil, Sludge, Liquid Waste	NA	Halogenated and Nonhalogenated Organic Compounds, Pesticides
Resources Conservation Co. Bellevue, WA (001)	Solvent Extraction (BEST)	Paul McGough 206-828-2400	Edward Bates 513-569-7774 FTS 684-7774	Soil, Sludge	NA	Non-specific Organics, Oil
Retech, Inc. Ukiah, CA (002)	Plasma Reactor	R.C. Eschenbach 707-462-6522	Laurel Staley 513-569-7863 FTS 684-7863	Liquids, Soil Sludge	Metals	Non-specific
Risk Reduction Engineering Laboratory Cincinnati, OH	Debris Washing System	Michael Taylor 513-782-4801	Naomi Barkley 513-569-7854 FTS 684-7854	Soil Debris	Non-specific	Non-specific Organics, PCBs, Pesticides
Sanivan Group Anjou, Quebec (005)	Soil Treatment with Extrasol	Peter Z. Colak 514-355-3351	Mark Meckes 513-569-7348 FTS 684-7348	Soil	NA	PCBs, PCP, PAH, MAH, Pesticides, Oils, Hydrocarbons
S.M.W. Seiko, Inc. Redwood City, CA (004)	In-Situ Solidification/ Stabilization	David Yang 415-591-9646	S. Jackson Hubbard 513-569-7507 FTS 684-7507	Soil	Metals	Semivolatile Organic Compounds
Separation and Recovery Systems, Inc. Irvine, CA (002)	Solidification/ Stabilization	Joseph DeFranco 714-261-8860	Walter Grube 513-569-7798 FTS 684-7798	Sludge	Low Level Metals	Acidic Sludges with at Least 5% Hydrocarbons
Shirco Infrared Systems, Inc. Redmond, WA (001) [2 Demonstrations]	Infrared Thermal Destruction	Several Vendors (see Technology Profile)	Howard Wall 513-569-7691 FTS 684-7691	Soil, Sediment	NA	Non-specific
Silicate Technology Corp. Scottsdale, AZ (003)	Solidification/ Stabilization with Silicate Compounds	Steve Pegler 602-941-1400	Edward R. Bates 513-569-7774 FTS 684-7774	Soil, Sludge, Ground Water	Metals, Cyanide, Ammonia	High Molecular Weight Organics
Soliditech, Inc. Houston, TX (002)	Solidification/ Stabilization	Bill Stallworth 713-497-8558	Walter Grube 513-569-7798 FTS 684-7798	Soil, Sludge	Metals	Non-specific
Techtran, Inc. Houston, TX (005)	Chemical Binding/ Precipitation and Physical Separation	Tod S. Johnson 713-896-8205	Annette Gatchett 513-569-7697 FTS 684-7697	Aqueous Solutions	Heavy Metals	Non-specific
Thermal Waste Management New Orleans, LA (005)	Production of Fossil Fuel from Petroleum-Based Sludges	George Lane 504-525-9722	Paul dePercin 513-569-7797 FTS 684-7797	Sludge	NA	Petroleum Sludge
Terra Vac, Inc. San Juan, PR (001)	In-Situ Vacuum Extraction	James Malot 809-723-9171	Mary Stinson 908-321-6683 FTS 340-6683	Soil	NA	Volatile and Semivolatile Organic Compounds

NA = Non Applicable

Completed Demonstrations

(Continued)

SITE Demonstration Program Participants (Continued)

Developer	Technology	Technology Contact	EPA Project Manager	Waste Media	Applicable Waste	
					Inorganic	Organic
Toxic Treatments (USA) Inc. San Francisco, CA (003)	In-Situ Steam/Air Stripping	Philip La Mori 415-391-2113	Paul dePercin 513-569-7797 FTS 684-7797	Soil	NA	Volatile Organic Compounds and Hydrocarbons
Ultrox International, Inc. Santa Ana, CA (003)	Ultraviolet Radiation and Ozone Treatment	David Fletcher 714-545-5557	Norma Lewis 513-569-7665 FTS 684-7665	Ground Water, Leachate, Wastewater	NA	Halogenated Hydrocarbons, Volatile Organic Compounds, Pesticides, PCBs
Wastech, Inc. Oak Ridge, TN (004)	Solidification/ Stabilization	E. Benjamin Peacock 615-483-6515	Edward R. Bates 513-569-7774 FTS 684-7774	Soil, Sludge, Liquid Waste	Non-specific, Radio-active	Non-specific
Zimpro/Passavant, Inc. Rothschild, WI (002)	PACT®/Wet Air Oxidation (Powdered activated carbon and biological treatment)	William Copa 715-359-7211	John Martin 513-569-7758 FTS 684-7758	Ground Water, Industrial Wastewater, Leachate	NA	Biodegradable Volatile and Semivolatile Organic Compounds

NA = Non Applicable

Completed Demonstrations

APPENDIX C

EMERGING TECHNOLOGIES PROGRAM PARTICIPANTS

SITE Demonstration Program Participants

Developer	Technology	Technology Contact	EPA Project Manager	Waste Media	Applicable Waste	
					Inorganic	Organic
ABB Environmental Services, Inc. Wakefield, MA (E03)	Two-Zone Plume Interception In-Situ Treatment Strategy	Dr. Margaret Findley 617-245-6606	Ronald Lewis 513-569-7856 FTS 684-7856	Solids, Liquids	NA	Chlorinated and Nonchlorinated Solvents
Alcoa Separations Warrendale, PA (E03)	Bioscrubber	Paul K.T. Liu 412-772-1332	Naomi P. Barkley 513-569-7854 FTS 684-7854	Soil, Water, Air	NA	Most Organics
Atomic Energy of Canada, Ltd. Chalk River, Ontario (E01) [Project Completed]	Chemical Treatment/ Ultrafiltration	Leo P. Buckley 613-584-3311	John F. Martin 513-569-7758 FTS 684-7758	Ground Water	Heavy Metals	NA
Babcock & Wilcox Co. Alliance, OH (E02)	Cyclone Furnace	Lawrence P. King 216-821-9110	Laurel Staley 513-569-7863 FTS 684-7863	Solids, Soil	Non-specific	Non-specific
Battelle Memorial Institute Columbus, OH (E01) [Project Completed]	In-Situ Electroacoustic Decontamination	H.S. Muralidhara 614-424-5018	Diana Guzman 513-569-7819 FTS 684-7819	Soil	Heavy Metals	NA
Bio-Recovery Systems, Inc., Las Cruces, NM (E01) [Project Completed]	Biological Sorption	Dennis W. Darnall 505-646-5888	Naomi P. Barkley 513-569-7854 FTS 684-7854	Ground Water, Leachate, Wastewater	Heavy Metals	NA
BioTrol, Inc. Chaska, MN (E03)	Methanotrophic Bioreactor System	Jeffrey Petola 612-488-2515	David L. Smith 513-569-7856 FTS 684-7856	Water	NA	Halogenated Hydrocarbons
Boliden Allis, Inc. Milwaukee, WI (E03)	Pyrokiln Thermal Encapsulation Process	John Lees 414-475-3862	Marta K. Richards 513-569-7783 FTS 684-7783	Soil, Sludge	Most Metallic Com-pounds	Most Organics
Center for Hazardous Materials Research Pittsburgh, PA (E03)	Acid Extraction Treatment System	Stephen W. Paff 412-826-5320	Diana Guzman 513-569-7819 FTS 684-7819	Soil	Heavy Metals	Most Organics
Colorado School of Mines Golden, CO (E01) [Project Completed]	Wetlands-Based Treatment	Thomas Wildeman 303-273-3642	Edward Bates 513-569-7774 FTS 684-7774	Acid Mine Drainage	Metals	NA
Electrokinetics Baton Rouge, LA (E03)	Electro-Osmosis	Yalcin B. Acar 504-388-3992	Diana Guzman 513-569-7819 FTS 684-7819	Soil	Heavy Metals and Other Inorgan-ics	NA
Electron Beam Research Facility, Florida International University and University of Miami Miami, FL (E03)	High Energy Electron Irradiation	William J. Cooper 305-554-3049	Frank Alvarez 513-569-7631 FTS 684-7631	Aqueous Solutions and Sludges	NA	Most Organics
Electro-Pure Systems, Inc., Amherst, NY (E02)	Alternating Current Electro-coagulation Process	Clifton W. Farrell 716-691-2610	Naomi P. Barkley 513-569-7854 FTS 684-7854	Ground Water, Wastewater, Leachate	Heavy Metals	Petroleum By-products, Coal-Tar Derivatives

NA = Non Applicable

(Continued)

SITE Demonstration Program Participants (Continued)

Developer	Technology	Technology Contact	EPA Project Manager	Waste Media	Applicable Waste	
					Inorganic	Organic
Energy and Environmental Engineering, Inc. East Cambridge, MA (E01) [Project Completed]	Laser Induced Photochemical Oxidize Destruction	James H. Porter 617-666-5500	Ronald Lewis 513-569-7856 FTS 684-7856	Ground Water, Wastewater	NA	Non-specific
Energy and Environmental Research Corporation Irvine, CA (E03)	Hybrid Fluid Bed System	D. Gene Taylor 714-859-8851	Teri Shearer 513-569-7949 FTS 684-7949	Solids, Sludges	Volatile Inorganics	Most Organics
Enviro-Sciences, Inc Randolph, NJ (E02)	Low Energy Solvent Extraction Process	Werner Steiner 201-361-8840	S. Jackson Hubbard 513-569-7507 FTS: 684-7507	Soil, Sediments, Sludge	NA	PCBs, Other Non-specific Organic Compounds
Ferro Corporation Independence, OH (E03)	Waste Vitrification Through Electric Melting	Emilio D. Spinosa 216-641-8580	Randy Parker 513-569-7271 FTS: 684-7271	Soils, Sediments, Sludges	Most Inorganics	Non-specific
Harmon Environmental Services, Inc. (formerly Envirite Field Services, Inc.) Auburn, AL (E01) [Project Completed]	Soil Washing	William C. Webster 205-821-9253	S. Jackson Hubbard 513-569-7507 FTS 684-7507	Soils	NA	Heavy Organic Compounds
Institute of Gas Technology Chicago, IL (E03)	Fluid Extraction-Biodegradation Process	W. Kennedy Gauger 312-567-3947	Annette Gatchett 513-569-7697 FTS 684-7697	Soil	NA	Most Organics
Institute of Gas Technology Chicago, IL (E03)	Fluidized Bed Agglomeration/ Incineration	Amir Rehmat 312-567-5899	Teri Shearer 513-569-7949 FTS 684-7949	Solid, Liquid, Gas	Most Solid Inorganics	Most Organics
IT Corporation Knoxville, TN (E02)	Batch Steam Distillation/ Metal Extraction	Robert D. Fox 615-690-3211	Ronald Lewis 513-569-7856 FTS 684-7856	Soil, Sludge	Heavy Metals	Non-specific
IT Corporation Knoxville, TN (E03)	Photolytic/ Biological Soil Detoxification	Robert D. Fox 615-690-3211	Randy A. Parker 513-569-7271 FTS 684-7271	Soil	NA	PCBs, Other Non-Specific Organic Compounds
Membrane Technology and Research, Inc. Menlo Park, CA (E02)	Membrane Process for Removal of Volatile Organics from Contaminated Air Streams	Dr. J.G. Wijmans 415-328-2228	Paul R. dePercin 513-569-7797 FTS 684-7797	Gaseous Waste Streams	NA	Halogenated and Nonhalogenated Compounds
Montana College of Mineral Science Butte, MT (E03)	Air-Sparged Hydrocyclone	Theodore Johnson 406-496-4112	Eugene F. Harris 513-569-7862 FTS 684-7862	Aqueous Solutions	Low-concentration Metals	NA
New Jersey Institute of Technology Newark, NJ (E03)	Ghea Associates Process (Surfactant Extraction)	Joe Bozzelli 201-596-3459	Annette Gatchett 513-569-7697 FTS 684-7697	Mixtures	Most Inorganics	Most Organics

NA = Non Applicable

(Continued)

SITE Demonstration Program Participants (Continued)

Developer	Technology	Technology Contact	EPA Project Manager	Waste Media	Applicable Waste	
					Inorganic	Organic
J.R. Simplot Company Boise, ID (E03)	Anaerobic Biological Process	Douglas K. Sell 208-389-7265	Wendy Davis-Hoover 513-569-7206 FTS 684-7206	Soil, Sludge	NA	Nitroaromatics
Trinity Environmental Technologies, Inc. Mound Valley, KS (E03)	Ultrasonic Detoxification	Duane P. Koszalka 316-328-3222	Norma Lewis and Kim Krelton 513-569-7665 FTS 684-7665	Solids	NA	PCBs and Other Chlorinated Compounds
University of South Carolina Columbia, SC (E03)	In-Situ Mitigation of Acid Water	Frank T. Caruccio 803-777-4512	Roger C. Wilmoth 513-569-7509 FTS 684-7509	Acid Drainage	Most Metals	NA
University of Washington, Dept. of Civil Engineering Seattle, WA (E02)	Adsorptive Filtration	Mark Benjamin 206-543-7645	Norma Lewis 513-569-7665 FTS 684-7665	Ground Water, Leachate, Wastewater	Metals	NA
Wastewater Tech. Centre Burlington, Ontario (E02)	Cross-Flow Pervaporation System	Abbas Zaidi 416-336-4605	John Martin 513-569-7758 FTS 684-7758	Ground Water, Leachate, Wastewater	NA	Volatile Organic Compounds
Western Research Institute Laramie, WY (E01) [Project Completed]	Contained Recovery of Oily Wastes	James Speight 307-721-2011	Eugene F. Harris 513-569-7862 FTS 684-7862	Soil	NA	Coal Tar Derivatives, Petroleum By-products

NA = Non Applicable

APPENDIX D

SAMPLE FACT SHEETS

United States Environmental Protection Agency | Office of Solid Waste and Emergency Response | Office of Research and Development | 9380.1-03AFS May 1991

EPA

Superfund Innovative Technology Evaluation Program

SITE Program Fact Sheet

SITE PROGRAM OVERVIEW

The Superfund Innovative Technology Evaluation (SITE) program supports development of technologies for assessing and treating waste from Superfund sites. The SITE program was authorized by the Superfund Amendments and Reauthorization Act of 1986 with the goal of identifying technologies, other than land disposal, that are suitable for treating Superfund wastes. The program provides an opportunity for technology developers to demonstrate their technologies' capability to successfully process and remediate Superfund waste. EPA evaluates the technology and provides an assessment of potential for future use for Superfund cleanup actions. The SITE program has currently evaluated and/or supported RD and D efforts for more than 100 innovative treatment technologies. The SITE program is administered by EPA's Risk Reduction Engineering Laboratory (RREL) in Cincinnati, Ohio.

This fact sheet describes the four components of the SITE Program with particular emphasis on the Demonstration Program, which conducts evaluation demonstrations of operating alternative technologies. This page of the fact sheet summarizes the overall SITE Program. Subsequent pages provide additional detail about each program component. This fact sheet also contains a list of contacts for further information, and an order form for technology transfer publications and videos.

COMPONENTS OF THE SITE PROGRAM

The SITE program integrates four related components, the Demonstration Program, the Emerging Technologies Program, the Measurement and Monitoring Technologies Program, and the Technology Transfer Program.

DEMONSTRATION PROGRAM

The Demonstration Program provides engineering, cost, reliability, and applicability data on new Superfund remediation technologies by sponsoring field demonstrations of pilot or full-scale technologies. Technology developers demonstrate their methods on selected wastes, and EPA analyzes, evaluates and disseminates the test results. Typically, no funding is made available to the developer during this process. Figure 1 illustrates the categories of technologies currently enrolled in the Demonstration Program.

Innovative Technologies Program

This supplement to the Demonstration Program was established to encourage private sector development and commercialization of EPA-developed hazardous waste treatment technologies for use at Superfund sites. The Federal Technology Transfer Act of 1986 authorized the EPA/industry partnership that is necessary to bring these technologies to commercialization. This will enable EPA laboratories to collaborate with industry, thus facilitating development of the technologies and reducing the market risk.

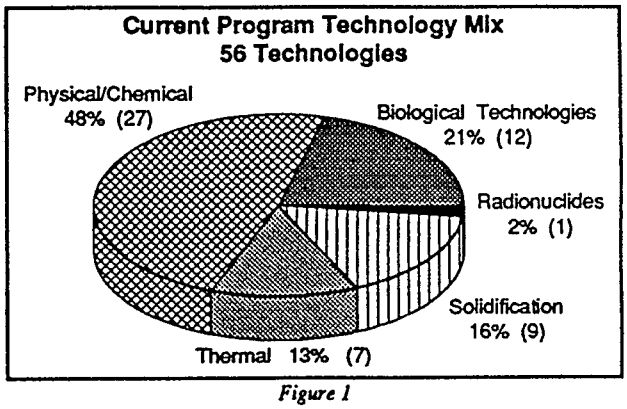


Figure 1

EMERGING TECHNOLOGIES PROGRAM

The Emerging Technologies Program (ETP) supports the development of new, innovative technologies by following laboratory and bench-scale technologies through pilot-scale testing. The ETP provides up to two years of financial assistance to private developers for technology research and development through cooperative agreements.

MEASUREMENT AND MONITORING TECHNOLOGIES PROGRAM

The Measurement and Monitoring Technologies Program (MMTP) is designed to improve the accuracy of Superfund site characterization efforts. The MMTP tests the ability of advanced technologies to assess the nature and extent of contamination, and evaluate cleanup levels. Funding is generally not provided to developers under this program.

TECHNOLOGY TRANSFER

The Technology Transfer portion of the SITE program disseminates information from the other three programs to increase awareness and use of alternative technologies for assessing and remediating Superfund sites. Technology transfer occurs through reports, brochures, videos, seminars, public meetings and site visits, conference exhibits, and technical support to EPA Regions, States, and Superfund contractors.

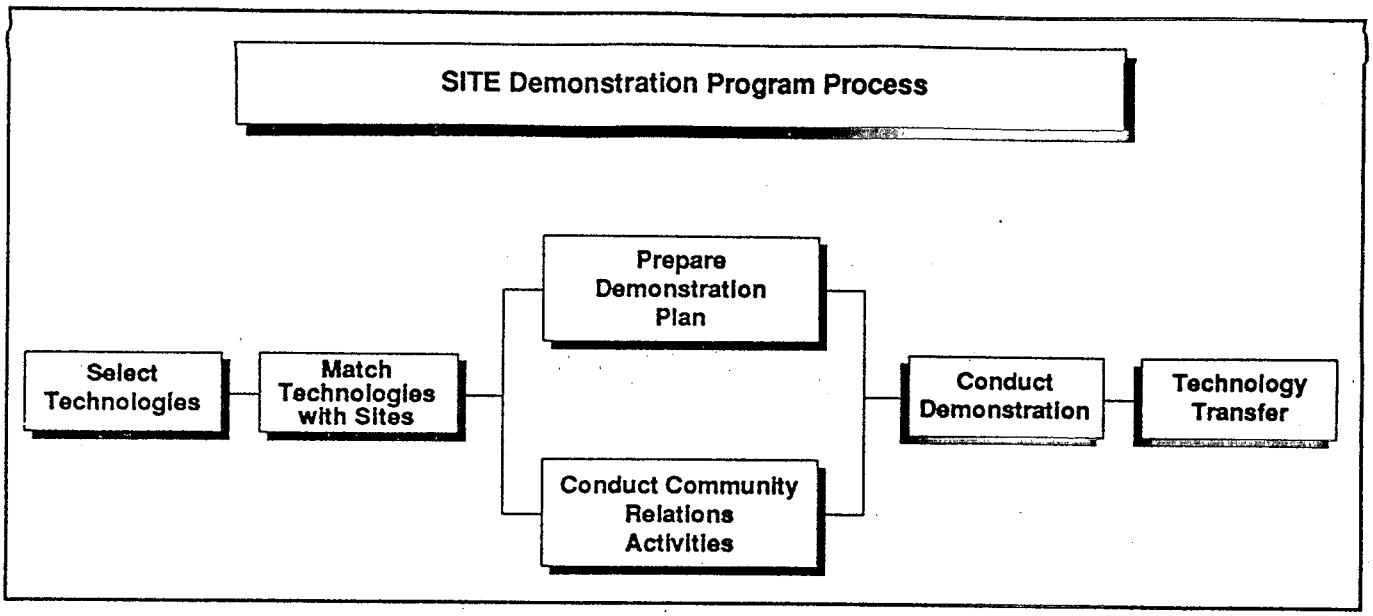


Figure 2

DEMONSTRATION PROGRAM PROCESS

The Demonstration Program selects technologies and conducts field demonstrations through the process illustrated in Figure 2. Each step in the process is discussed below.

Select Technologies: In January of each year EPA solicits applications for the demonstration program. Developers submit proposals which are reviewed and accepted by EPA.

Match Technologies with Site: EPA and the developer select a site for the demonstration based on several considerations: the developer's waste and location preferences, relevance of the technology to the site cleanup, and Regional needs. EPA meets with Regional and State representatives, the developer and other interested parties to visit sites prior to making a final selection.

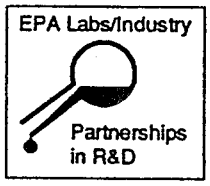
Prepare Demonstration Plan: EPA develops a Demonstration Plan that details how to sample waste for testing, prepare the selected site for the demonstration, dispose of residual materials, and evaluate the technology in the field. Both EPA and the technology developer must approve the Demonstration Plan.

Conduct Community Relations Activities: In most cases, opportunity for public comment is required prior to the actual demonstration. EPA prepares fact sheets on the demonstration, designates a period for the public to comment, and may hold local public meetings and/or land site visits.

Conduct Demonstrations: The demonstration of the selected technology can last from a few days to several months. The technology developer is financially responsible for mobilizing and operating the technology. EPA prepares the site, provides utilities, collects samples, performs QA field and laboratory audits, and evaluates the results. EPA also handles the logistical arrangements for a Visitor's Day where the Regional and State officials, the public and interested professionals are invited to view the demonstration.

Conduct Technology Transfer: After the demonstration, EPA prepares an Applications Analysis Report that assesses the overall applicability of the technology to other sites and wastes, and includes technology cost, performance, and reliability information. In addition, EPA prepares a Technology Evaluation Report which presents a summary of the demonstration and evaluation results. Contact John Martin at 513-569-7758 for further information.

Innovative Technologies Program



Through cooperative research and development agreements (CRDAs), EPA laboratories will work closely with industry to develop and commercialize on-site destruction and hazardous waste cleanup technologies. Through the program, EPA is involved in the development of a variety of technologies. Examples include:

- Mobile Debris Washer;
- Base Catalytic Destruction System (BCD - APEG -KPEG);
- Volume Reduction Unit (VRU); and
- Excavation Technique and Foam Suppression Methods.

For further information on this program, contact Steve James at (513) 569-7877.

EMERGING TECHNOLOGIES PROGRAM (ETP) HIGHLIGHTS

The Emerging Technologies Program is supporting 30 technologies and is currently planning to fund 13 projects from the 1990 solicitation. Solicitation for preproposals occurs in July of each year, the selected developers are then invited to submit a Cooperative Agreement Application for review. Final selection of projects is made in March of each year.

Table 1

Completed Field Demonstrations

REGION	SITE/ DEVELOPER	DESCRIPTION	PROJECT MANAGER
I	Groveland Wells, MA; Terra Vac. Inc.	In-Situ vacuum extraction of VOCs in soil	Mary Stinson FTS: 340-6683 201-321-6683
II	New Bedford Harbor, MA; CF Systems Corp.	Solvent Extraction to Remove PCBs from sediments	Laurel Staley FTS: 684-7863 513-569-7863
	Imperial Oil, NJ; Soliditech, Inc.	Solidification/ stabilzation of heavy metals and organics	Walter Grube FTS: 684-7798 513-569-7798
III	Douglassville, PA; Hazcon, Inc. (IM-TECH)	Solidification/ stabilization of volatile and semi-volatiles, organics, PCBs, and heavy metals	Paul dePercin FTS: 684-7797 513-569-7797
	Palmerton, PA; E.I. DuPont DeNemours & Co.	Membrane Microfiltration	John Martin FTS: 684-7758 513-569-7758
	Monaca, PA; Horsehead Resource Development Co.	Flame Reactor	Donald Oberacker FTS: 684-7510 513-569-7510
IV	G.E. Hialeah, FL; International Waste Technology	In-situ solidification of PCBs	Mary Stinson FTS: 340-6683 201-321-6683
	Peak Oil, FL; Shirco Infrared System, Inc.	Transportable IR thermal processing systems for treatment of PCBs, organics, lead, and other metals in soil and sludge material	Howard Wall FTS: 684-7691 513-569-7691
	Risk Reduction Engineering Lab, Cincinnati, OH (Kentucky and Georgia locations)	Debris Washing System	Naomi Barkley FTS: 684-7854 513-569-7854
V	Rose Township, MI; Shirco IR Systems, Inc.	Infrared Incinerator System	Howard Wall FTS: 684-7691 513-569-7691
	McGillis & Gibbs, MN; Biotrol	Soil washing	Mary Stinson, FTS: 340-6683 201-321-6683
	McGillis & Gibbs, MN; Biotrol	Biotreatment of groundwater	Mary Stinson FTS: 340-6683 201-321-6683
VI	EPA's Combustion Research Facility, AR; American Combustion Technologies, Inc.	Pyretron oxygen and airburner for use with a rotary kiln incinerator	Laurel Staley FTS: 684-7863 513-569-7863
IX	Lorentz Barrel and Drum, CA; Ultrox International, Inc.	UV/ozone oxidation of orgaincs in groundwater	Norma Lewis FTS: 684-7665 513-569-7665
	McColl Site Fullerton, CA; Excavation Techniques	Excavation & Foam Suppression of Volatiles	Jack Hubbard FTS: 684-7507 513-569-7507
	Lockheed Site Burbank, CA; AWD Technologies, Inc.	Integrated In-Situ Vapor Extraction & Steam Vacuum Stripping Process	Gordon Evans FTS: 684-7684
	McColl Site, CA; Ogden Environmental Services	Circulating fluidized bed combustor	Douglas Grosse FTS: 684-7844 513-569-7844
	Annex Terminal, San Pedro, CA; Toxic Treatments, Inc.	In-situ steam - airstripping of volatile organics in soil	Paul DePercin FTS: 684-7797 513-569-7797
	Selma Site, Fresno, CA; Silicate Technology Corp.	Silicate Compounds by Solidification/ Stabilization	Edward Bates FTS: 684-7774 513-569-7774
X	Portable Equipment Company, OR; Chemfix Technologies, Inc.	Chemical fixation/ stabilization of organics and inorganics in waste slurries	Ed Barth FTS: 684-7669 513-569-7669

SITE PROGRAM DOCUMENTS

The following SITE demonstration project publications are available from EPA. Indicate your choice by checking the appropriate box(es) on the order form below. The form may be copied.*

General Publications

☐ Technology Profiles (EPA/540/5-90/006)

Project Results

American Combustion - Oxygen Enhanced Incineration

☐ Technology Evaluation (EPA/540/5-89/008)

☐ Applications Analysis (EPA/540/A5-89/008)

CF Systems Corp. - Solvent Extraction

☐ Technology Evaluation (EPA/540/5-90/002)

☐ Applications Analysis (EPA/540/A5-90/002)

Chemfix Technologies, Inc. - Chemical Fixation/Stabilization

☐ Technology Evaluation (EPA/540/5-89/011)

☐ Applications Analysis (EPA/540/A5-89/011)

Hazcon - Solidification

☐ Technology Evaluation (EPA/540/5-89/001a)

☐ Applications Analysis (EPA/540/A5-89/001)

IWT In-Situ Stabilization

☐ Technology Evaluation (EPA/540/5-89/004a)

☐ Applications Analysis (EPA/540/A5-89/004)

Shirco-Infrared Incineration

☐ Technology Evaluation - Peak Oil (EPA/540/5-88/002a)

☐ Technology Evaluation - Rose Township (EPA/540/5-89/007a)

☐ Applications Analysis (EPA/540/A5-89/007)

Soliditech, Inc. - Solidification

☐ Technology Evaluation (EPA/540/5-89/005a)

☐ Applications Analysis (EPA/540/A5-90/005)

Terra Vac - Vacuum Extraction

☐ Technology Evaluation (EPA/540/5-89/003a)

☐ Applications Analysis (EPA/540/A5-89/003)

Ultrox International - Ultraviolet Ozone Treatment for Liquids

☐ Technology Evaluation (EPA/540/5-89/012)

☐ Applications Analysis (EPA/540/A5-89/012)

☐ Check here if you would like your name placed on the SITE mailing list

Your Name and Mailing Address (please print)

MAIL TO: **ORD Publications**
26 W. Martin Luther King Drive (G72),
Cincinnati, Ohio 45268

* Documents ordered through ORD Publications are free of charge.

SITE VIDEOCASSETTES

SITE Program videos are also available on selected sites for a small fee. These videos contain footage of actual field demonstration activities, including Visitor Day programs. For further information contact Marilyn Avery, Foster Wheeler Enviresponse, Inc., 8 Peach Tree Hill Rd., Livingston, N.J. 07039, Phone: 908-906-6860.

This is a co-funding effort between the developer and EPA, with EPA funding up to $150,000 each year. Funding for the second year is determined by the progress of the first year's research. Funding support for the program has also been received from the Department of Energy, and the Department of Defense (Air Force).

Several projects completed from the first year solicitation are being invited into the Demonstration Program. Program emphasis is being placed on innovative processes, that may be capable of field scale efforts in the second year of research. This provides a stronger basis for moving into the Demonstration Program. Contact Norma Lewis at 513/569-7758 for further information.

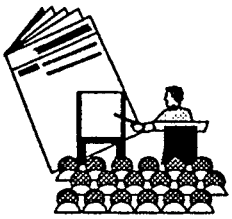
MEASUREMENT AND MONITORING TECHNOLOGIES PROGRAM OBJECTIVES

The Measurement and Monitoring Technologies Program, based at EPA's Environmental Monitoring System Laboratory in Las Vegas, Nevada, sponsors research on advanced Superfund site assessment technologies. MMTP objectives include:

- Identifying existing technologies that can enhance field monitoring and site characterization;
- Supporting development of monitoring capabilities that cannot be cost-effectively addressed with current technology;
- Demonstrating those technologies that emerge from the screening and development phases of the program; and
- Preparing protocols, guidelines and standard operating procedures for new methods.

For further information on MMTP, please contact Eric Koglin, FTS 545-2432 or (702) 798-2432.

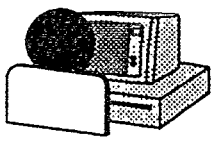
TECHNOLOGY TRANSFER ACTIVITIES



Technical information gathered through all of the SITE programs is exchanged through a variety of activities. Data results and status updates are disseminated to increase awareness of alternative technologies available for use at Superfund sites. A wide array of media are utilized to reach decision makers involved in Superfund sites including:

- SITE brochures, publications, reports, videos and fact sheets;
- Pre-proposal conferences on SITE solicitations;
- Public meetings and on-site visitors' days;
- Seminar series;
- SITE exhibit displayed at nationwide conferences;
- Innovative technologies program exhibition;
- Networking through forums, professional associations, centers of excellence, regions, and states; and
- Journal articles.

Alternative Treatment Technology Information Center (ATTIC)



The Alternative Treatment Technology Information Center (ATTIC) is an information retrieval network that can provide up-to-date technical information on innovative treatment methods for hazardous wastes. Information available through the ATTIC database includes abstracts and executive summaries from over 1200 technical documents and reports. These abstracts and summaries, delineated by technology, are categorized into five groups: (1) Thermal Treatment; (2) Biological Treatment; (3) Solidification/Stablilzation Processes; (4) Chemical Treatment; and (5) Physical Treatment. The Attic Database provides the user with access to innovative technology demonstration studies, a variety of treatability, cost analysis models, migration and sampling databases, underground storage tank case histories and remediation ideas. The ATTIC network can also enable access to expert assistance, a calender of events, and a list of publications.

ATTIC can be accessed through an online system, a system operator or through a disk-based version. For assistance and/or information call the ATTIC operator at 301-816-9135.

SITE PROGRAM CONTACTS

ORD/RREL Contacts:

Demo Program	John Martin FTS 684-7758 513-569-7758	Emerging Program	Norma Lewis FTS 684-7665 513-569-7665

Regional Contacts:

REGION	NAME	REGION	NAME
1	Diana King FTS 833-1676 617-573-9676	6	Don Williams FTS 255-2197 214-655-2197
2	Peter Moss FTS 264-4703 212-264-4703	7	Dana Trugley FTS 276-7705 913-551-7705
3	Paul Leonard FTS 597-8485 215-597-8485	8	Gerald Snyder FTS 330-7504 303-294-7405
4	John Risher FTS 347-1586 404-347-1586	9	John Blevins FTS 484-2241 415-744-2241
5	Steve Ostrodka FTS 886-3011 312-886-3011	10	John Barich FTS 399-8562 206-533-8562

Headquarters Contacts:

OSWER /TIO	John Quander FTS 398-8845 703-308-8845	ORD/ OEETD	Richard Nalesnik FTS 382-2583 202-382-2583

SITE DEMONSTRATION PROGRAM ACCOMPLISHMENTS

The Agency has successfully completed 20 field technology demonstrations at Superfund sites as indicated in Table 1. In addition, four measurement and monitoring technologies have been field demonstrated. SITE project results may be obtained by contacting the EPA Center for Environmental Research Information (CERI) at (513) 569-7562 or FTS 684-7562.

EPA **FACT SHEET** SEPTEMBER 1990

SITE
SUPERFUND INNOVATIVE TECHNOLOGY EVALUATION

Proposed Demonstration of the Carver/Greenfield Process PAB Oil Site, Vermilion Parish, Louisiana

INTRODUCTION

The U.S. Environmental Protection Agency (EPA) is proposing a technology demonstration at the PAB Oil site under its Superfund Innovative Technology Evaluation (SITE) program. The SITE program was created to evaluate new and promising treatment technologies for addressing hazardous waste sites.

The proposed technology to be demonstrated is the Carver-Greenfield (C-G) process, developed by Dehydrotech Corporation of East Hanover, New Jersey. The demonstration will measure the effectiveness of the technology in separating oily wastes into their oil, water, and solid phases. The technology is designed to reduce the volume of wastes requiring final treatment or disposal by concentrating hazardous organics into the oily phase.

TECHNOLOGY DESCRIPTION

The Carver-Greenfield (C-G) process (Figure 1) is a physical process designed to separate oil-soluble organic contaminants from sludges, soils, and liquids. The process involves adding a "carrier" oil to the waste, which removes hazardous organics from contaminated soil particles and concentrates them into the oil phase. First, the waste and carrier oil are mixed together in a tank. The mixture is fed into a high-efficiency evaporator where the water is removed. Finally, the dry mixture is transferred to a centrifuge that separates the oil from the soil particles. The oil is then distilled to recover reusable oils. Solids undergo an additional step for further decontamination.

By-products from the process include: (1) a clean, dry solid, (2) a water product virtually free of solids and oils, and (3) a concentrated mixture of the extracted oil-soluble compounds.

Commercially, the C-G process has been used to treat meat by-product waste, municipal sewage, paper mill waste, brewery wastes, pharmaceutical plant wastes, and leather dying wastes.

PURPOSE OF FACT SHEET:

- Notify the public of a proposed technology demonstration.
- Announce a 30-day comment period to obtain community input (see Public Involvement section).

TECHNOLOGY DEMONSTRATION

The PAB Oil site was selected for this proposed demonstration because the site contains petroleum wastes and contaminated soils. The C-G process is well-suited for the treatment of such materials and is capable of dewatering liquid wastes, as well as decontaminating solid particles. Therefore, this site is considered highly compatible with the capabilities of the technology.

The proposed demonstration is tentatively scheduled for January 1991, and will last for about two weeks. Approximately 400 gallons of oily waste and contaminated soil is proposed to be treated during the technology demonstration. Three test runs will be conducted. All process equipment will be installed in an 8 by 50 foot trailer.

EPA is preparing a detailed demonstration plan that outlines the methods and procedures for testing and evaluating this technology. All treatment by-products will be disposed in accordance with all applicable local, state, and federal regulations. After the demonstration, EPA will compile and analyze the data and publish it in a Technology Evaluation Report and an Applications Analysis Report. The results from this demonstration may be useful in identifying remedies for similarly contaminated sites across the country.

SITE DESCRIPTION AND HISTORY

The 17-acre PAB Oil site is located on Route 167, between Lafayette and Abbeville, in Vermilion Parish,

Louisiana. From 1979 until 1982, the site operated as a disposal facility for oilfield waste, and contains three surface impoundments that were used to separate oil and water from drilling muds. As a result of this operation, site soils became contaminated with petroleum hydrocarbons and hazardous substances.

Because of the contamination and potential threat to local ground water the site was placed on the National Priority List (NPL) on March 31, 1989. The NPL is EPA's list of top priority sites that are eligible for a remedy under the Superfund program.

Currently, a Remedial Investigation (RI) work plan is being developed. The RI will identify the nature and extent of contamination at the site.

PUBLIC INVOLVEMENT

Because public participation is an important part of this project, the EPA is sponsoring a 30-day public comment period from September 23 through October 23, 1990. You are encouraged to give your written or oral comments to:

Laurel Staley
U.S. EPA SITE Project Manager
26 West Martin Luther King Drive
Cincinnati, Ohio 45268
(513) 569-7665

All comments will be carefully considered. A Responsiveness Summary that addresses the public's comments will be prepared.

Specific questions about the PAB Oil site should be directed to:

Verne McFarland
Community Relations Coordinator
U.S. EPA (6H-MC)
1445 Ross Avenue
Dallas, Texas 75202-2733
(214) 655-2240
1-800-533-3508

or

Jamie Van Buskirk
Remedial Project Manager
U.S. EPA (6H-EA)
1445 Ross Avenue
Dallas, Texas 75202-2733
(214) 655-6582

Media inquiries should be directed to Roger Meacham, U.S. EPA Region 6 Press Officer at (214) 655-2200.

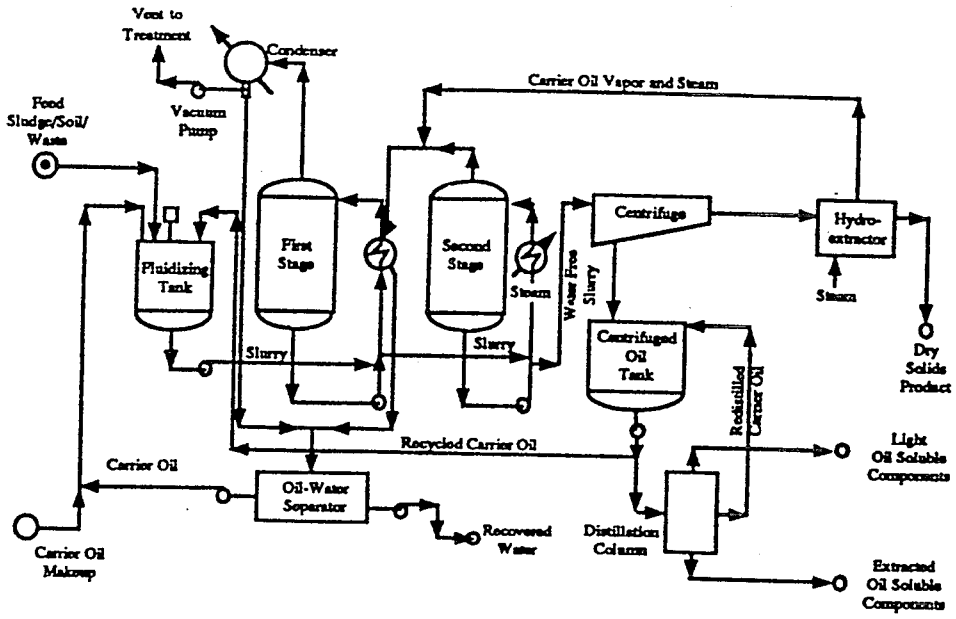


Figure 1. Simplified Carver-Greenfield process flow diagram.

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APPENDIX E

SAMPLE DEMONSTRATION BULLETINS

United States
Environmental Protection
Agency

EPA/540/M5-89/005
August 1989

EPA

SITE
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TECHNOLOGY EVALUATION

Demonstration Bulletin

Solidification/Stabilization Process

Soliditech, Inc.

TECHNOLOGY DESCRIPTION: The Soliditech solidification/stabilization technology mixes hazardous waste materials in soils or sludges with pozzolanic material (cement, fly ash, or kiln dust), a proprietary additive called Urrichem, other proprietary additives, and water. The process is designed to aid in the physical and chemical immobilization of the hazardous waste constituents by binding them in a leach-resistant matrix.

After the contaminated waste material is collected and screened to remove oversized material, it is introduced to a batch mixer. Each waste material is mixed with proprietary chemical reagents and additives, water, and cement. Figure 1 is a schematic of the process.

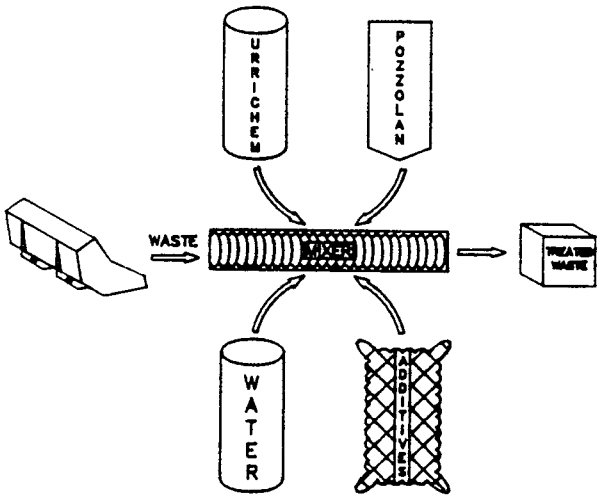

Figure 1. Soliditech process schematic.

Once thoroughly mixed, the treated waste is discharged from the mixer and allowed to harden. The treated waste is a solidified mass with significant unconfined compressive strength, high stability, and a rigid texture similar to concrete. Batch mixers of various capacities are available to treat different volumes of waste.

WASTE APPLICABILITY: This technology is intended for the treatment of soils and sludges contaminated with organic compounds, metals, inorganic compounds, and oil and grease.

DEMONSTRATION RESULTS: The Soliditech process was demonstrated December 5-8, 1988, at the Imperial Oil Company/Champion Chemicals Superfund site in Morganville, New Jersey. In the past, this location contained both chemical processing and oil reclamation facilities.

Physical test results of the solidified waste samples were very good. Unconfined compressive strengths ranged from 390 to 860 psi. Wet/dry and freeze/thaw durability test results were excellent, showing no or very little weight loss after 12 cycles. Permeability of the treated waste was very low.

TCLP extraction tests indicated reduced leaching of all metals except those contributed by the cement or other additives (aluminum, calcium, chromium, and sodium). No volatile organic compounds were detected in the TCLP leachates of the treated wastes. Several semivolatile organic compounds (phenols) were detected in the treated wastes that were either not present or present at lower concentrations in the untreated waste. The presence of these compounds has not been explained but may be due to a chemical reaction. Oil and grease was found to leach from the treated waste at the same or at slightly higher concentrations than from the untreated waste. Raw

waste contained from 2,000 to 50,000 times more oil and grease than leachates from the treated waste.

Key findings from the Soliditech demonstration are summarized below.

- Chemical analyses of TCLP, EP, BET, and ANS 16.1 leachates showed that heavy metals present in the untreated waste were immobilized by treatment.
- The process solidified solid and liquid wastes with high organic content (up to 17%) containing oil and grease.
- Volatile organic compounds were not detected in the treated waste and were assumed to be lost during waste collection, screening, and treatment.
- Excellent physical properties were measured in the treated waste including low permeability, high unconfined compressive strength, and resistance to weathering.
- Semivolatile organic compounds (phenols) were detected in the treated waste and the TCLP leachate from the treated waste; but not in the untreated waste or its TCLP leachate.
- Oil and grease content of the untreated waste ranged from 2.8 to 17.3 percent. Oil and grease content of the solidified waste ranged from 4.6 to 7.7 percent. Oil and grease content of the TCLP leachate of both the untreated and treated wastes was in the 1.4 to 12 ppm range.
- The solidified wastes increased in volume an average of 22 percent. The bulk density of the waste material increased by approximately 35 percent due to solidification.
- The pH of the solidified waste ranged from 11.7 to 12.0. The pH of the untreated waste ranged from 3.4 to 7.9.
- PCBs were not detected in any TCLP leachates, whether the waste was treated or not.
- Visual observation of the broken pieces of the solidified waste showed the presence of dark inclusions approximately 1 mm in diameter, which may be untreated waste. Microstructural studies are ongoing.

A Technology Evaluation Report and an Applications Analysis Report describing the complete demonstration will be available in the Winter of 1989/1990.

FOR FURTHER INFORMATION:

EPA Project Manager:
Walter E. Grube, Jr.
U.S. EPA
Risk Reduction Engineering Laboratory
26 West Martin Luther King Drive
Cincinnati, OH 45268
513-569-7798 (FTS: 684-7798)

United States
Environmental Protection
Agency

Center for Environmental Research
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EPA/540/M5-89/012
November 1989

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TECHNOLOGY EVALUATION

Demonstration Bulletin

Ultraviolet Radiation and Oxidation

Ultrox International

TECHNOLOGY DESCRIPTION: The ultraviolet (UV) radiation/oxidation treatment technology developed by Ultrox International uses a combination of UV radiation, ozone, and hydrogen peroxide to oxidize organic compounds in water. Various operating parameters can be adjusted in the Ultrox® system to enhance the oxidation of organic contaminants. These parameters include hydraulic retention time, oxidant dose, UV radiation intensity, and influent pH level.

A schematic of the Ultrox system is shown in Figure 1. The treatment system is delivered on four skid-mounted modules, and includes the following major components:

- UV radiation/oxidation reactor module
- Ozone generator module
- Hydrogen peroxide feed system
- Catalytic ozone decomposer (Decompozon) unit for treating reactor off-gas

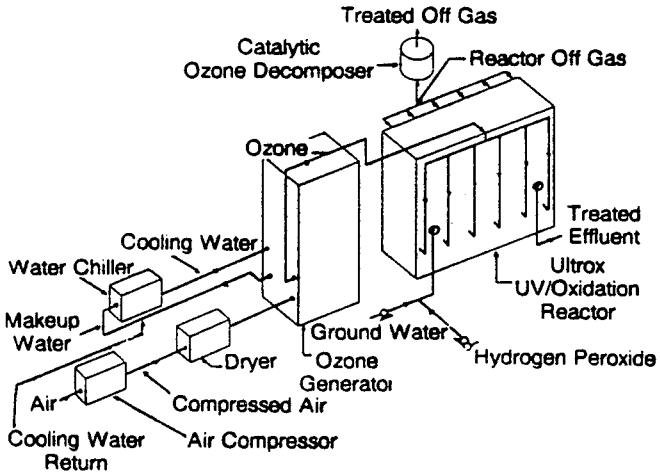

Figure 1. Isometric view of Ultrox System.

The commercial-size reactor used for the SITE Demonstration is 3 feet long by 1.5 feet wide by 5.5 feet high. The reactor is divided by five vertical baffles into six chambers. Each chamber contains four UV lamps as well as a diffuser which uniformly bubbles and distributes ozone gas into the groundwater being treated.

WASTE APPLICABILITY: This treatment technology is intended to destroy dissolved organic contaminants, including chlorinated hydrocarbons and aromatic compounds, that are present in wastewater or groundwater with low levels of suspended solids, oils, and grease.

DEMONSTRATION RESULTS: The SITE Demonstration was conducted at a former drum recycling facility in San Jose, California, over a 2-week period in February and March 1989. Approximately 13,000 gallons of groundwater contaminated with volatile organic compounds (VOC) from the site were treated in the Ultrox system during 13 test runs. During the first 11 runs, the 5 operating parameters were adjusted to evaluate the system. The last 2 runs were conducted under the same conditions as Run 9 to verify the reproducibility of the system's performance.

To evaluate the performance of each run, the concentrations of indicator VOCs in the effluent were analyzed overnight. Three of the 44 VOCs identified in the groundwater at the site were selected as indicator VOCs. These indicator VOCs were trichloroethylene (TCE); 1,1 dichloroethane (1,1-DCA); and 1,1,1-trichloroethane (1,1,1-TCA). TCE was selected because it is a major volatile contaminant at the site, and the latter two VOCs were selected because they are relatively difficult to oxidize.

Key findings from the Ultrox demonstration are summarized as follows:

- The groundwater treated by the Ultrox system met the applicable National Pollutant Discharge Elimination System (NPDES) standards at the 95 percent confidence level. Success was obtained by using a hydraulic retention time of 40 minutes; ozone dose of 110 mg/L; hydrogen peroxide dose of 13 mg/L; all 24 UV lamps operating; and influent pH at 7.2 (unadjusted).
- There were no volatile organics detected in the exhaust from the Decompozon unit.
- The Decompozon unit destroyed ozone in the reactor off-gas to levels less than 0.1 ppm (OSHA Standards). The ozone destruction efficiencies were observed to be greater than 99.99 percent.
- The Ultrox system achieved removal efficiencies as high as 90 percent for the total VOCs present in the groundwater at the site. The removal efficiencies for TCE were greater than 99 percent. However, the maximum removal efficiencies for 1,1-DCA and 1,1,1-TCA were about 65 and 85 percent, respectively (Table 1).

Table 1. Performance Data During Reproducible Runs

	Mean Influent (µg/L)	Mean Effluent (µg/L)	Percent Removal
Run Number: 9			
TCE	65	1.2	98
1,1-DCA	11	5.3	54
1,1,1-TCA	4.3	0.75	83
Total VOCs	170	16	91
Run Number: 12			
TCE	52	0.55	99
1,1-DCA	11	3.8	65
1,1,1-TCA	3.3	0.43	87
Total VOCs	150	12	92
Run Number: 13			
TCE	49	0.63	99
1,1-DCA	10	4.2	60
1,1,1-TCA	3.2	0.49	85
Total VOCs	120	20	83

- Within the treatment system, the removals of 1,1-DCA and 1,1,1-TCA appear to be due to both chemical oxidation and stripping. Specifically, stripping accounted for 12 to 75 percent of the total removals for 1,1,1-TCA, vinyl chloride, and other VOCs.
- No semivolatiles, PCBs, or pesticides were found in the groundwater at the site. Among the VOCs, the contaminant present at the highest concentration range (48 to 85 µg/L) was TCE. The groundwater also had contaminants such as 1,1-DCA and 1,1,1-TCA in the concentration ranges of 10 to 13 µg/L and 3 to 5 µg/L, respectively.
- The organics analyzed by Gas Chromatography (GC) methods represent less than 2 percent of the total organic carbon (TOC) present in the water. Very low TOC removal occurred, which implies that partial oxidation of organics (and not complete conversion to carbon dioxide and water) took place in the system.

A Technology Evaluation Report and an Application Analysis Report describing the complete demonstration will be available in the Spring of 1990.

FOR FURTHER INFORMATION:

EPA Project Manager:
Norma M. Lewis
U.S. EPA
Office of Research and Development
Risk Reduction Engineering Laboratory
26 West Martin Luther King Drive
Cincinnati, OH 45268
(513) 569-7665 (FTS: 684-7665)

United States
Environmental Protection
Agency

Center for Environmental Research
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SITE
SUPERFUND INNOVATIVE
TECHNOLOGY EVALUATION

Demonstration Bulletin

In-Situ Steam/Hot-Air Soil Stripping

Toxic Treatment (USA) Inc.

TECHNOLOGY DESCRIPTION: This technology uses steam and hot air to strip volatile organics from contaminated soil. The treatment equipment is mobile and treats the soil in-situ without need for soil excavation or transportation. The organic contaminants volatilized from the soil are condensed and collected by the process treatment train, resulting in a small volume of concentrated organic liquid waste for transportation, disposal, or recycle.

A process tower supports and controls a pair of hollow augers (Figure 1) which are moved vertically through the soil. The augers are rotated synchronously in opposite directions during the treatment process to break up the soil and ensure through-flow of gases. Steam, at 400°F, and compressed air, at 275°F, are piped through the augers to nozzles located on the cutter blades. Heat from the injected steam and hot air vaporizes the volatile organics, and the gas flow carries the contaminants to the soil surface. A steel shroud (a 10′ by 6′ by 7′ box) covers the 7′4" by 4′ area of soil undergoing treatment. The suction port of a blower keeps the area underneath the shroud at a vacuum to assist the flow of gases from the soil, and to ensure against leakage to the outside environment.

The off-gases are pulled by the blower from the shroud to the treatment train, where water and organics are removed by condensation in coolers and carbon adsorption beds. The air is filtered and recycled to the soil by a compressor. Water is removed from the liquid stream with a 4-stage separator followed by batch distillation, and is then recycled to a cooling tower. The condensed organics are collected and held for removal and transportation.

WASTE APPLICABILITY: This technology is designed to be used on soil contaminated with volatile organics to a maximum depth of 30 feet. Semivolatiles may potentially be removed by this technology.

DEMONSTRATION RESULTS: Demonstration of this technology was conducted at the Annex Terminal site in San Pedro, California, in September 1989 as part of an extensive testing program. Site characterization investigations indicated that the soil was contaminated

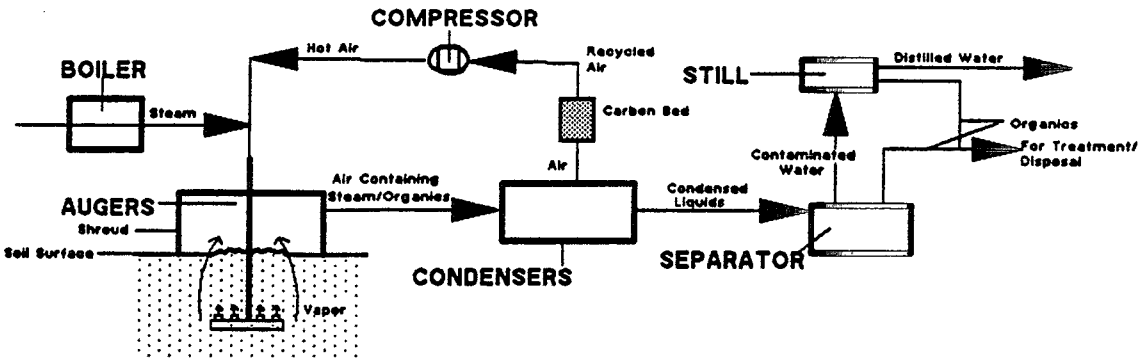

Figure 1. Process Flow Diagram.

with significant amounts of chlorobenzene, trichloroethene, tetrachloroethene, phthalates, and other volatile and semivolatile organics. Twelve soil blocks (7'4" by 4') were treated to 5-foot depth during the SITE Demonstration. Pre- and post-treatment composite soil samples were collected from 5-foot vertical corings. Fluorescein dye was added to four blocks to evaluate migration of contaminants from the treated blocks. In addition, air emission monitoring was conducted at the soil surface for potential off-gas emissions. Extensive process operating data were collected, such as steam and air flow rates, and organic concentration in the gases collected in the shroud. Laboratory activities conducted for the Demonstration included analysis of volatile and semivolatile organic compounds, soil physical characteristics, and dye concentrations.

The Demonstration showed that:

- Removal efficiencies of volatile organic compounds were greater than 90%.
- Semivolatile organic compounds were also removed, but at a lower efficiency.
- Downward migration of compounds is not significant.
- Fugitive emissions around the area being treated and previously treated areas are low.

A Technical Evaluation Report describing the complete Demonstration will be available in the Fall of 1990.

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