

# The Superfund Innovative Technology Evaluation Program

## ANNUAL REPORT TO CONGRESS FY 2004



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## **Notice**

The U.S. Environmental Protection Agency, through its Office of Research and Development, partially funded and collaborated in the research described here under our contract No. 68-C-00-186 to Environmental Quality Management, Inc. It has been subjected to the Agency's peer and administrative review and has been approved for publication as an EPA document. Mention of trade names or commercial products does not constitute endorsement or recommendation for use.

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## Foreword

The U.S. Environmental Protection Agency (EPA) is charged by Congress with protecting the Nation's land, air, and water resources. Under a mandate of national environmental laws, the Agency strives to formulate and implement actions leading to a compatible balance between human activities and the ability of natural systems to support and nurture life. To meet this mandate, EPA's research program is providing data and technical support for solving environmental problems today and building a science knowledge base necessary to manage our ecological resources wisely, understand how pollutants affect our health, and prevent or reduce environmental risks in the future.

The National Risk Management Research Laboratory (NRMRL) is the Agency's center for investigation of technological and management approaches for preventing and reducing risks from pollution that threaten human health and the environment. The focus of the Laboratory's research program is on methods and their cost-effectiveness for prevention and control of pollution to air, land, water, and subsurface resources; protection of water quality in public water systems; remediation of contaminated sites, sediments and ground water; prevention and control of indoor air pollution; and restoration of ecosystems. NRMRL collaborates with both public and private sector partners to foster technologies that reduce the cost of compliance and to anticipate emerging problems. NRMRL's research provides solutions to environmental problems by: developing and promoting technologies that protect and improve the environment; advancing scientific and engineering information to support regulatory and policy decisions; and providing the technical support and information transfer to ensure implementation of environmental regulations and strategies at the national, state, and community levels.

This publication has been produced as part of the Laboratory's strategic long-term research plan. It is published and made available by EPA's Office of Research and Development to assist the user community and to link researchers with their clients.

Sally Gutierrez, Director  
National Risk Management Research Laboratory

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## Acronyms

ANSI/ASQC	American National Standard Institute, Assistance for Environmental Data Collection and Environmental Technology Programs
DNAPL	Dense non-aqueous phase liquids
DOD	Department of Defense
DOE	Department of Energy
ECOS	Environmental Council of States
EPA	Environmental Protection Agency
ESTCP	Environmental Security and Technology Certification Program
ETV	Environmental Technologies Verification
FY	Fiscal year
GPR	Ground penetrating radar
IDC	Interagency DNAPL Consortium
ITRC	Interstate Technology and Regulatory Council
MHI	Mitsubishi Heavy Industries
MMT	Monitoring and Measurement Technologies
NELP	Navy Environmental Leadership Program
NPL	National Priorities List
NRC	National Research Council
ORD	Office of Research and Development
PAHs	Polynuclear aromatic hydrocarbons
PCBs	Polychlorinated biphenyls
REACHIT	Remediation Characterization Innovative Technologies
RCI	White House Rapid Commercialization Initiative
SITE	Superfund Innovative Technology Evaluation
TIP	Technology Innovation Program
TPH	Total petroleum hydrocarbon
VOC	Volatile Organic Compound

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## **Executive Summary**

The Superfund Innovative Technology Evaluation (SITE) Program has successfully promoted the development, commercialization, and implementation of innovative hazardous waste treatment technologies for 18 years. SITE offers a mechanism for conducting joint technology demonstration and evaluation projects at hazardous waste sites involving the private sector, EPA, and other federal and state agencies. The program provides environmental decision-makers with relevant data on new, viable remediation technologies that may have performance or cost advantages compared to conventional treatment technologies.

The SITE Program focuses on the remediation needs of the hazardous waste remediation community through program planning; matching priority sites with innovative cleanup solutions; technology field demonstrations; and information dissemination. The report summarizes the progress and findings of the SITE Program in FY 2004. The report is prepared in accordance with the statutory requirements of CERCLA (42 USC 9660).



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## SITE Program Description and FY04 Accomplishments

### Background

The SITE Program is composed of a Demonstration Program, a Monitoring and Measurement Technology (MMT) Program, and information transfer. SITE offers a mechanism for conducting joint technology demonstration and evaluation projects at hazardous waste sites through the involvement of the private sector, EPA, and other federal and state agencies. Appendix A presents a further description of program principles, implementation, and historical results.

SITE's Demonstration Program evaluates and verifies innovative technologies at selected hazardous waste sites to provide reliable performance, costs, and applicability information for site cleanup decision-making. The MMT Program evaluates technologies that detect, monitor, and measure hazardous and toxic substances to provide more cost-effective and accurate methods for producing real-time data during site characterization and remediation.

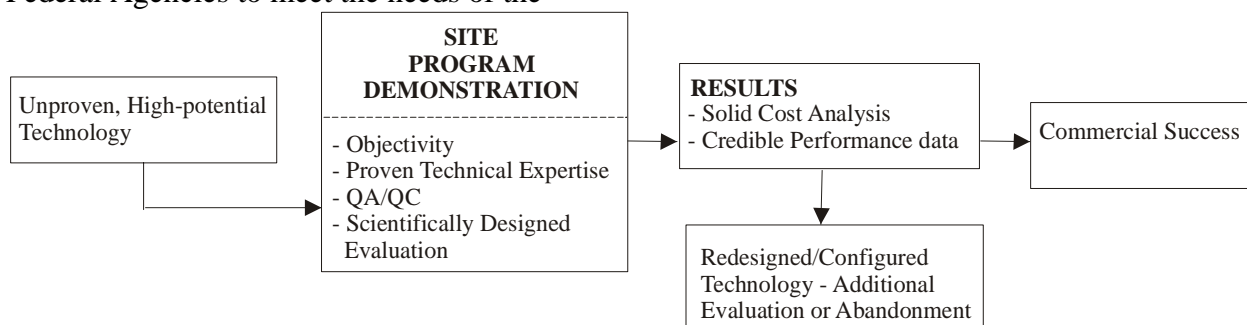
The MMT Program has leveraged its resources with EPA's Environmental Technology Verification Program and other Federal Agencies to meet the needs of the

Program and reduce the backlog of applications submitted by developers of innovative technologies in a cost-effective and timely manner.

To further advance the MMT Program, a technical advisory group was formed to assist demonstration design, outreach activities, and the selection of technologies. This group of technology advocates includes representation from the EPA Regional offices and acts to ensure that the products of the demonstrations address issues relevant to EPA. Recent focus has been placed on the need for in-situ remediation technologies to more cost-effectively remediate sites.

The SITE Program's information transfer activities disseminate technical information, including engineering, performance, and cost data, to assist in removing barriers for use of innovative and alternative technologies.

Figure 1 presents the basic elements of the SITE Program process flow from unproven technologies to commercial success.



**Figure 1.** SITE Program Process Flow

## Completed Demonstrations in FY04

In FY 2004, the SITE Program completed demonstrations of four treatment technologies. Two demonstrations were conducted at the same site. The Monitoring

and Measurement Technology Program completed demonstrations of five technologies. The completed demonstrations are presented in Table 1 and a more detailed description of the demonstrations follow.

<b>Table 1. SITE Projects Completed in FY04</b>			
<b>Developer Location</b>	<b>Developer</b>	<b>Demonstration Treatment Technology</b>	<b>Site Location</b>
CA	ARCO	Evaluation of a semi-passive alkaline lagoon, innovative acid mine drainage (AMD) and acid rock drainage (ARD) treatment technology.	Leviathan Mine Site, CA
CA	State of California and EPA Region 9	Evaluation of an innovative active lime AMD and ARD treatment system operated in biphasic and monophasic modes.	Leviathan Mine Site, CA
OH	U.S. EPA	Treatability study for the evaluation of the Base Catalyzed Decomposition (BCD) process at the Warren County Landfill Site, Warrenton, NC. This chemical dechlorination process will determine the ability of the BCD process to chemically dechlorinate the PCBs and dioxin in the soils.	Warrenton, NC
NV	University of Nevada, Reno	Evaluation of an innovative acid mine drainage (AMD) treatment technology. Sulfate reducing bacteria in bioreactors generate H <sub>2</sub> S gas which reacts with the water column to precipitate metals and raise the pH of the AMD.	Leviathan Mine Site, CA
<b>Monitoring and Measurement Technology</b>			
<b>Developer Location</b>	<b>Developer</b>	<b>Dioxin Testing in Soils and Sediments</b>	<b>Site Location</b>
DE	Strategic Diagnostics	Immunoassay and Colorimetry	Saginaw, Michigan
ME	Cape Technologies	DFI Immunoassay	Saginaw, Michigan
NC	Xenobiotics	Cell Based Immunoassay	Saginaw, Michigan
NC	Hybrizyme	Immunoassay and Colorimetry	Saginaw, Michigan
VA	Wako Chemicals	Dioxin Elisa Kit	Saginaw, Michigan

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## **Active and Semi-Passive Lime Treatment of Acid Mine Drainage at Leviathan Mine, California (2 technologies)**

The U.S. Environmental Protection Agency (EPA) National Risk Management Research Laboratory (NRMRL), in cooperation with EPA Region IX, the State of California, and the Atlantic Richfield Company (ARCO), evaluated lime treatment of acid mine drainage (AMD) and acid rock drainage (ARD) at the Leviathan Mine Superfund site located in Alpine County, California. Two lime treatment systems in operation at the mine in 2002 and 2003 were evaluated: an active lime treatment system operated in biphasic and monophasic modes, and a semi-passive alkaline lagoon treatment system.

The initial fixed costs to construct the lime treatment systems were (1) \$1,021,415 for the active lime treatment operated in monophasic mode (2) \$1,261,076 for the active lime treatment system operated in biphasic mode, and (3) \$297,482 for the semi-passive alkaline lagoon treatment system.

Both treatment systems were shown to be extremely effective at neutralizing acidity and reducing the concentrations of the 10 target metals in the AMD and ARD flows at Leviathan Mine to below EPA discharge standards. Although the influent concentrations for the primary target metals were up to 3,000 fold above the EPA discharge standards, both lime treatment systems were successful in reducing the concentrations of the primary target metals in the AMD and ARD to between 4 and 20 fold below EPA discharge standards. In addition, the active lime treatment system operated in biphasic mode was shown to be very effective at separating arsenic from the AMD prior to precipitation of other metals, subsequently reducing the total volume of hazardous solid waste produced by the

treatment system. Separating the arsenic into a smaller solid waste stream significantly reduces materials handling and disposal costs.

Based on the success of lime treatment at the Leviathan Mine site, the state of California will continue to treat AMD at the site using the active lime treatment system in biphasic mode, and ARCO will continue to treat ARD using the semi-passive alkaline lagoon treatment system.

There are 79 abandoned mine land sites on the national priority list (NPL), nearly all of which have significant AMD/ARD problems similar to the Leviathan site. These sites are located primarily in the West, in EPA Regions 8, 9, and 10. Accordingly, the successful performance of the active- and semi-passive lime treatment systems as demonstrated on the AMD and ARD at the Leviathan site indicates a high potential for applicability of these technologies to these other AMD/ARD sites.

## **Compost-Free Biological Treatment of Acid Rock Drainage**

Compost-free bioreactor technology utilizes sulfate-reducing bacteria nurtured to generate sulfides that scavenge dissolved metals to form metal sulfide precipitates. Unlike compost bioreactors, this technology uses a liquid carbon source and a rock matrix rather than a compost or wood chip matrix that is consumed by bacteria and collapses over time.

The SITE demonstration consisted of monthly sampling events of the bioreactor treatment system with periods of extended inaccessibility due to winter snowfall. Through the SITE demonstration, EPA collected chemical data on the system's influent and effluent streams, documented

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metals removal and reduction in acidity within the system's unit operations, and recorded operational information pertinent to the evaluation of the treatment system. EPA evaluated the treatment system based on removal efficiencies for primary and secondary target metals, comparison of effluent concentrations to interim discharge standards (pre-risk assessment and record of decision) mandated by EPA in 2002, and on the characteristics of resulting metals-enriched solid wastes. Removal efficiencies of individual unit operations were also evaluated.

The compost-free bioreactor treatment system was shown to be extremely effective at neutralizing acidity and reducing the concentrations of the five target and five secondary metals in the ARD flows at Leviathan Mine to below EPA-mandated discharge standards. The solids generated by this technology were not found to be hazardous under state or federal standards or to pose a threat to water quality.

The initial fixed costs to construct bioreactor treatment system are \$836,617 for the treatment system operated in gravity flow mode, and \$864,119 for the treatment system operated in recirculation mode.

There are 79 abandoned mine land sites on the national priority list (NPL), nearly all of which have significant AMD/ARD problems similar to the Leviathan site. These sites are located primarily in the west, in EPA Regions 8, 9, and 10. Accordingly, the successful performance of the compost-free biological treatment technology as demonstrated on the AMD and ARD at the Leviathan site indicates a high potential for applicability of this technology to these other AMD/ARD sites.

## **Base Catalyzed Decomposition Process**

The objective of the study was to evaluate the effectiveness of the BCD process to chemically dechlorinate the PCB- and dioxin-contaminated effluent oils generated by the thermal desorption of PCB- and dioxin-contaminated soils at the Warren County Landfill in North Carolina. The BCD process relies on catalytic hydrogenation. In this type of process, a hydrogen donor in the untreated material supplies hydrogen ions that replace chlorine atoms in the chlorinated contaminants. The chlorinated contaminants are reduced to less-toxic unchlorinated compounds and the chlorine is displaced as a chloride ion.

Results of the pilot-scale treatability tests performed on condensate oil indicate that the BCD dechlorination process effectively removes PCBs and dioxins below detection levels of 5 ppm. Full-scale BCD tests were not possible because there was not enough condensate oil generated for the full-scale BCD system to treat. An economic analysis was not performed because the technology was evaluated at less than full-scale.

PCBs are ranked fifth on the CERCLA priority list of hazardous substances (prioritization of substances based on a combination of their frequency, toxicity, and potential for human exposure at NPL sites). PCB-, dioxin-, and other chlorinated compound-contaminated CERCLA sites are located throughout the U.S. Chlorinated organics are prevalent in most Superfund sites, many of which have significant environmental impact problems similar to the Warren County landfill site. Accordingly, the successful performance of the Base Catalyzed Decomposition Process as demonstrated on the Warren County site's PCB/dioxin-contaminated soils and process condensate oils indicates a high potential for applicability of these technologies to this and other similar sites.

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## **Detailed Description of Monitoring & Measurement Technology Activities in FY04**

The MMT Program completed a demonstration of technologies to determine dioxin in soils and sediments. The X-ray fluorescence (XRF) technology for measuring inorganic contaminants in soil, or water matrices, was first tested in 1997, and was judged to be an ideal candidate for retesting. The XRF developers made an appeal to submit their state-of-the-art technologies to a new evaluation. Significant improvements in electronics, design, and data analysis along with a number of new companies (a total of five) not in existence at the time of the original study made this technology an ideal candidate for the SITE MMT Program. This project initiated in FY04 and is ongoing.

### **Ongoing Demonstrations**

Table 2 identifies the projects that are undergoing demonstration in FY04. There are six on-going treatment technology demonstrations.

### **Future Activity**

The SITE Program will continue to emphasize the need for technologies that focus on types of contaminated sites rather than single contaminants. Five technology demonstrations are planned to be initiated in FY05. These demonstration are listed in Appendix A.

<b>Table 2. SITE Ongoing Projects in FY 04</b>			
<b>Developer Location</b>	<b>Developer</b>	<b>Demonstration Treatment Technology</b>	<b>Site Location</b>
CT	University of Connecticut	Evaluation of the DUOX (Dual Oxidation) technology for the remediation of chlorinated organics. The DUOX technology utilizes two different chemical oxidants (potassium permanganate and sodium persulfate) injected into the subsurface for the oxidation of the chlorinated solvent contaminants.	Vernon, CT
DE	Remediation Technology Development Forum and Hazardous Substance Research Center, SW	Evaluation of an innovative capping design (Aquablok™) to reduce the exposure of contaminants in the sediments of the Anacostia River.	Washington, DC.
HI	University of Hawaii	Evaluation of the use of Intermittent Up-Flow Anaerobic Bioreactor (IUFAB) technology for treatment of PCB-contaminated oil.	Pearl Harbor, HI
IL	GTI	Evaluation of the treatment of PCB-contaminated sediments including an investigation for the beneficial reuse of the treated sediments.	Bayonne, NJ
VA	Biogenesis Enterprises, Inc.	Evaluation of a sediment washing process. Dredged sediment is treated in order to meet applicable criteria for beneficial use of the sediment.	Venice, Italy and New Jersey
WA	Port of Ridgefield	Evaluation of steam-enhanced remediation, which is an in situ thermal treatment soil cleanup technology. The technology involves installation of a steam injection system and an aggressive vapor and liquid extraction system for the reduction of organic contaminants.	Ridgefield, WA
<b>Monitoring and Measurement Technology</b>			
<b>Developer Location</b>	<b>Developer</b>	<b>XRF Demonstration</b>	<b>Site Location</b>
IL	Oxford Instruments Analytical	XRF Analyzer Lab-X3500	Kennedy Space Center, FL
MA	Innov-X Systems, Inc.	XRF Analyzer, XT400	Kennedy Space Center, FL
MA	Niton Corp.	XRF Analyzer, XIT700 Series	Kennedy Space Center, FL
MA	RONTEC USA, Inc.	XRF Analyzer PicoTAX	Kennedy Space Center, FL
NY	Xcalibur XRF Services, Inc.	XRF Analyzer Elvax	Kennedy Space Center, FL
TX	Rigaku, Inc.	XRF Analyzer 25X mini	Kennedy Space Center, FL

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**Appendix A**

**DETAILED SITE PROGRAM DESCRIPTION AND PROGRESS**

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## Detailed SITE Program Description and Progress

The Demonstration Program is the flagship of the SITE Program. Its objective is to conduct field demonstrations and high-quality performance verifications of viable remediation technologies at sites that pose high risks to human health and/or the environment, are common throughout a region or the nation, or where existing remediation methods are inadequate, unsafe, or too costly. The SITE Program solicits applications annually from those responsible for cleanup operations at hazardous waste sites. A panel of SITE Program scientists, engineers, and associated environmental experts reviews the applications to identify those technologies that best represent solutions for the most pressing environmental problems. The resulting data and reports are intended for use by decision-makers in selecting remediation options and for increasing credibility in innovative applications.

The Demonstration Program has participated with 154 remediation technology vendors. Eight applications for participation in the Demonstration Program were received in response to the 2004 solicitation. The program typically receives 10 to 20 applications annually.

The Demonstration Program has successfully demonstrated 153 technologies, including 4 during FY 04. SITE's Monitoring and Measuring Technologies (MMT) Program has completed 47 projects to date, with 1 more ongoing.

### Program Principles

The SITE Program is defined by the following four operating principles: (1) program planning, (2) matching priority sites with innovative cleanup solutions,

(3) technology field demonstrations, and (4) information dissemination.

### Program Planning

SITE Program direction and strategies are evaluated each year based on input from the user community and other private- and public-sector stakeholders to ensure that the program continues to focus on validating the most sought-after remediation technologies. As part of the overall program planning process, the SITE Program has developed and is implementing a quality management plan based on American National Standard Institute Specifications and Guidelines for Quality Assistance for Environmental Data Collection and Environmental Technology Programs (ANSI/ASQC). The Site Quality Management Plan will document the EPA SITE Program quality system and will encompass the management and technical activities necessary to plan, implement, and assess the quality assurance, and quality control operations applied to all SITE Projects. The Quality Management Plan will document the requirement for Quality Assurance Project Plans for all SITE Evaluation Projects. SITE Quality Assurance Project Plans are currently developed at a level that supports the development of environmental regulations and standards (Category II). It is important that the SITE Program quality requirements are met during planning, implementation and reporting of SITE demonstrations, and evaluations.



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## Program Implementation

The SITE Program was established under section 209(b) of the Superfund Amendments and Reauthorization Act (SARA) (Section 311(b) of CERCLA, as amended) to evaluate technologies for the treatment of hazardous waste. Support for the SITE program is part of the Agency's base Superfund Research Program budget. Resources to support SITE are provided by Congress via the Agency's Superfund appropriation.

The SITE Program is a partnership between the public and private sectors, where the costs and responsibilities are shared by EPA, hazardous waste site owners, and technology developers. EPA enters into cooperative arrangements with site owners and technology developers, under which innovative technologies are demonstrated at selected hazardous waste sites. EPA evaluates the new technologies based on the demonstration results, and compiles and publishes rigorous engineering, performance, and cost data intended to aid in decisions regarding the use of the technologies at other hazardous waste sites. The program generates credible and unbiased technology cost and performance data needed by remedial project managers, consultants, and other environmental decision makers. EPA promotes easy and rapid access to this information, allowing project managers to make timely decisions in selecting cleanup remedies.

### Matching Priority Sites with Innovative Cleanup Solutions

The SITE Program solicits and prioritizes hazardous waste sites, and then seeks appropriate technologies for demonstration at these sites. Priority sites are selected based on feedback from the user community, including federal and state agencies. Matching a site with a technology

is a flexible process, and a site owner has the option of evaluating multiple technologies. If no specific technology or vendor is identified by a site, technologies and vendors are matched by the SITE Program and other interested parties, which may include state and federal regulators and other public representatives.

An important aspect of technology selection is that more than one technology may be introduced for review and demonstration. This aspect allows for matching the most appropriate and feasible technology to a particular site. General technology needs of the user community are identified by soliciting input from working groups, forums, personal communication, and hazardous waste publications. With this continuous input, the SITE Program will continue to focus on the needs of the remediation community and the more pressing problems at contaminated sites.

**The selection of sites for the program is based on the research needs of EPA, as well as other federal and state agencies.**

### Technology Field Demonstrations

SITE Program technology demonstrations are increasingly conducted in partnership with other EPA offices, other federal agencies, states, private industry, and universities. These partnerships reduce the overall costs of demonstrations to EPA, accelerate remediation of some of the most problematic sites at federal and state facilities, and significantly subsidize the technology vendors via site/logistical costs. One example of interagency partnerships is with DoD, Navy and the DoD Environmental Security Technologies Certification Program (ESTCP) in the field demonstration and evaluation of an innovative treatment technology for sediments contaminated with heavy metals.

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Innovative remediation and monitoring/ measurement technology/ demonstration projects are presented by developer state and by demonstration site state in Appendices A and B, respectively.

### **Information Dissemination**

Electronic documents are accessible through the internet at the SITE Program web page (<http://www.epa.gov/ORD/SITE>), Environmental Technologies Verification (ETV) web site (<http://www.epa.gov/etv>), and a site supported by the EPA Office of Solid Waste and Emergency Response Technology Innovation Program (TIP) (<http://clu-in.org>). Several technology databases and publications summarize information about innovative treatment technologies and associated vendors, and are useful tools in identifying potential technology demonstration candidates or serving as directories for technology vendors. SITE Program and other federal demonstrations are also documented in Innovative Remediation Technologies: Field Scale Demonstration Projects in North America, 2<sup>nd</sup> Edition Year 2000 Report (<http://clu.in.or/products/nairt>). Descriptions of selected databases and publication ordering information are provided in Appendix C.

The following mechanisms are used by the SITE Program to disseminate information and increase interaction with the user community:

- ▶ Program-specific brochures and exhibits
- ▶ Conferences, workshops, and technical working groups
- ▶ Publications and videotapes (via the Internet:  
<http://www.epa.gov/ord/SITE/reports.html>)
- ▶ Hard copies available from EPA's National Center for Environmental

Publications, 513-569-8190 or 1-800-490-9192

- ▶ Electronic media, including the Internet
- ▶ Technical assistance to regions, states, and remediation contractors
- ▶ Technology seminars

### **Promotion of Innovative Technologies**

SITE's mission is to promote the development and application of innovative technologies that reduce or eliminate risks to human health and the environment due to contamination. The goal of the program is to interact with the technology user community, understand its needs, integrate those needs with EPA's research mission, and expeditiously address those needs. Identifying and responding to the technology needs of the remediation community is the driving force behind today's SITE Program.

**Responding to technology needs is the driving force behind the SITE Program.**

The need for credible and reliable data for innovative technologies is significant. Often, Records of Decision (RODs—official records documenting selection of Superfund site cleanup methods) indicate that innovative technologies were not chosen due to a lack of verified performance and implementability. The SITE Program serves to fill this need for credible evaluations so that more effective, cost-efficient methods can be used on remediation problems.

The types and numbers of innovative technologies selected for remediation at Superfund sites increased significantly after the passage of the Superfund Amendments and Reauthorization Act (SARA). Since then, the number has continued to rise,

indicating increased credibility and confidence in a number of innovative treatment technologies.

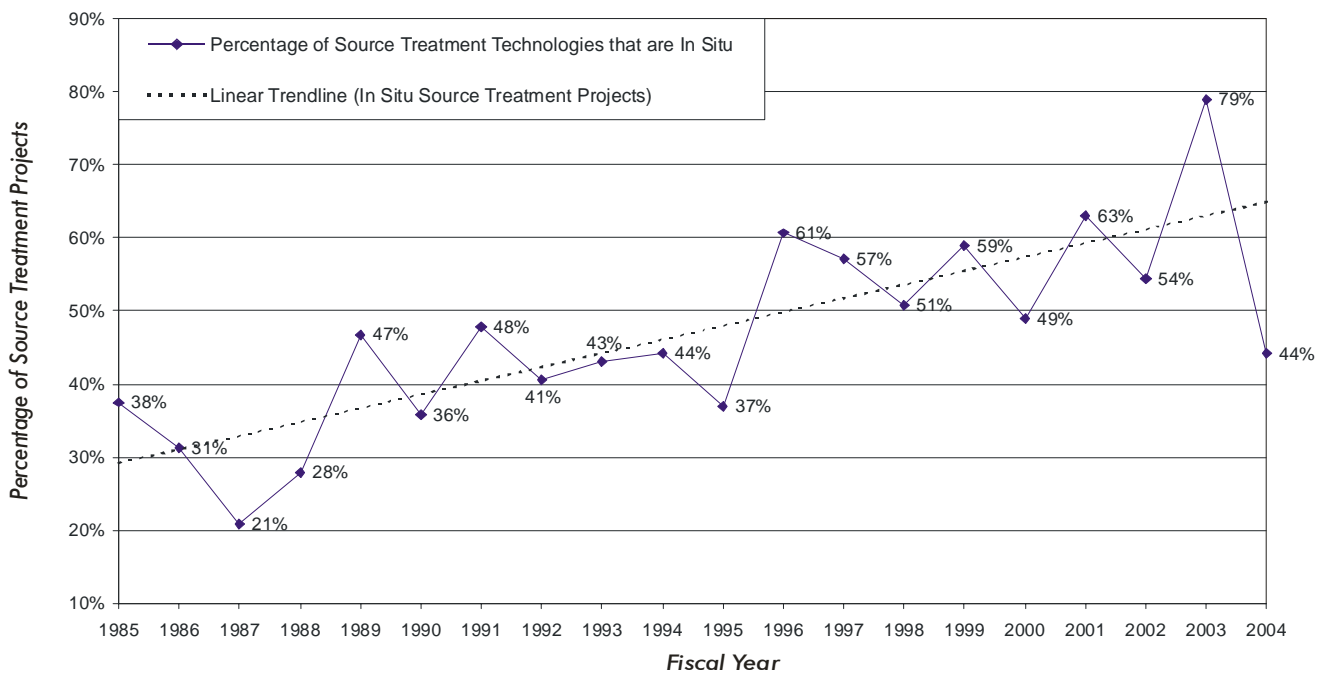
During the first 12 years of the SITE Program, an emphasis was placed on innovative technologies for permanent treatment that usually required the removal (ex situ) of soil or groundwater. Most field demonstrations during this period in the program's history involved ex situ physical/chemical and thermal technologies that could be field tested in a matter of days or weeks. In the last several years, the very nature of ex situ technologies, which typically involve the excavation of contaminated soil or removal by pumping of groundwater, and subsequent treatment and/or transport/ disposal have become increasingly limited in their applicability. These cost/technical/ political related limitations include:

- Complex contamination and subsurface matrices which are not amenable to removal

- Mega sites whose sheer expanse and volume of contaminated media preclude ex situ technologies from consideration
- Lack of approved landfills in close proximity for excavation/transportation/ disposal to be cost-effective

As a result, in situ technologies are increasingly the only alternative. The need for innovative, in situ technologies that are more cost-effective, result in less secondary waste, and are less intrusive will continue to increase. The SITE Program has recognized this need and has emphasized the development of in situ technologies.

Figure A-1 presents the number of in situ technologies as a percentage of all treatment technologies for source control by fiscal year. Over time, use of in situ technologies has been increasing, as the trendline in Figure A-1 shows. A 5-year moving average of the percentage of in situ treatment technologies shows a generally steady increase from 28 percent (FY1985-1988) to 65 percent (FY1999-2004).



**Figure A-1:** Superfund Remedial Actions: In Situ Technologies for Source Media for Source Control (FY1985 - FY2004)

SOURCE: U.S. EPA Office of Solid Waste and Emergency Response, Treatment Technologies for Site Cleanup: Annual Status Report Draft, 12th Edition.

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Several factors may play a role in this upward trend in the use of in situ treatment technologies. Because in situ technologies require no excavation, risk from exposure to contaminated media is reduced, compared with levels of risk associated with technologies that do require excavation. Also, in situ technologies typically are much less harsh on the natural habitat/environment than ex situ technologies. Further, for large sites where excavation and materials handling for ex situ technologies can be expensive, in situ technologies are often more cost-effective.

As selected innovative technologies discussed in SITE Program Annual Reports to Congress prior to 2002 have become more accepted, increasingly used, and considered the baseline for remediation, they are now viewed as conventional technologies for comparison to newer technologies. These former innovative technologies, which often performed very successfully, have thus advanced from the SITE Program. They include, but are not limited to:

- Air Sparging
- Soil Vapor Extraction
- Ex Situ Thermal Desorption
- Filtration
- Soil Washing
- Most ex situ remediation

The SITE Program plans to continue to periodically evaluate whether technologies that are no longer considered innovative should be added to the baseline of conventional technologies. The Program conducted this review in FY 2002.

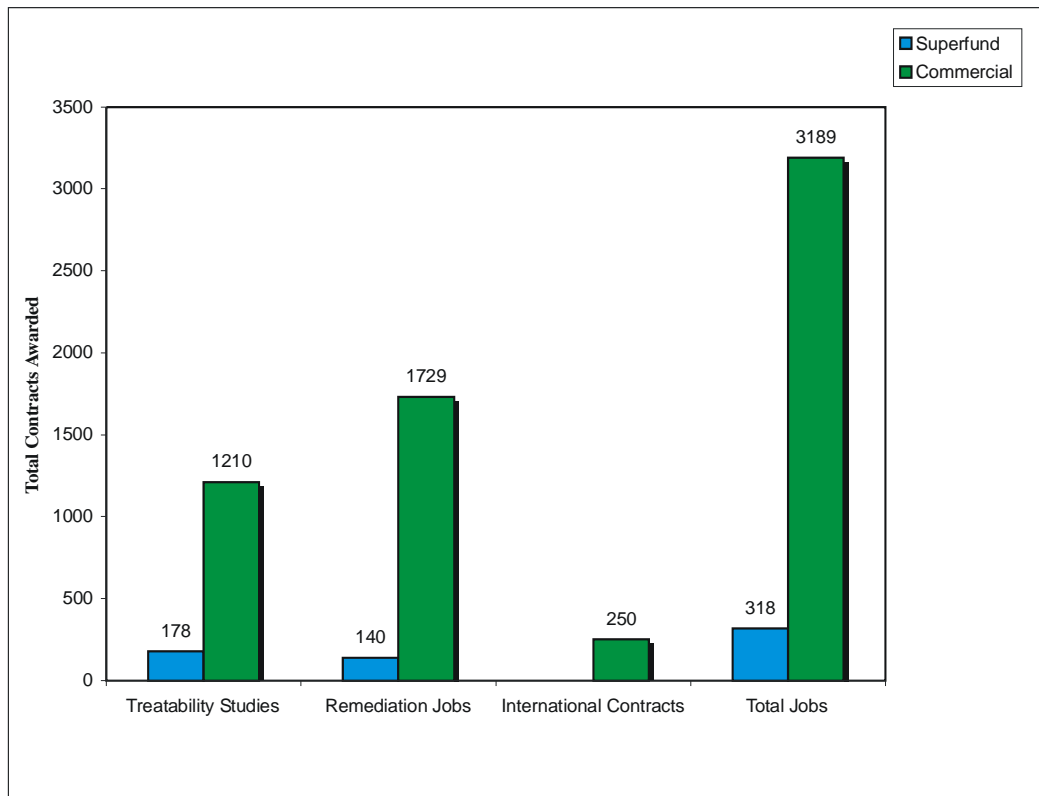
### **Historical Vendor Benefits**

Technology vendors are a central part of the SITE Program, providing remediation services for sites requiring cleanup solutions. As part of the SITE Program, vendors provide historical

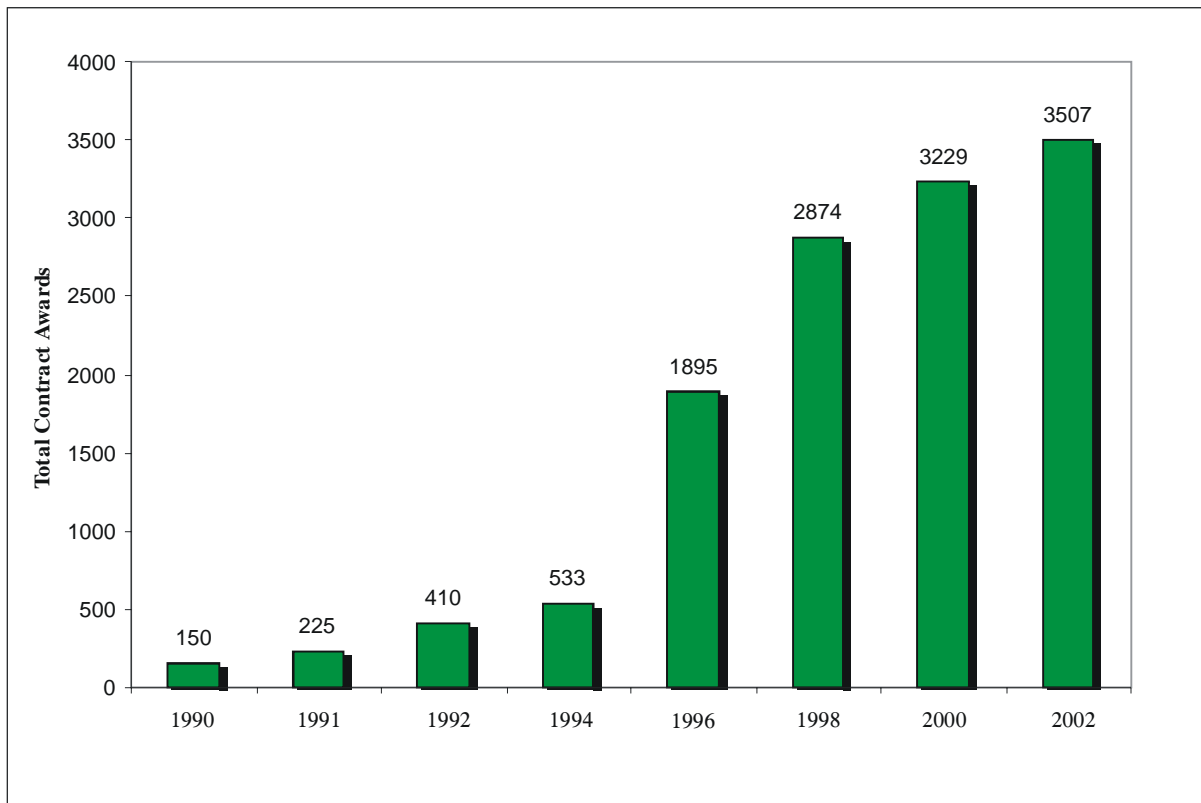
information on jobs they have performed for the technologies they have demonstrated. Vendors experience various benefits by participating in the SITE Program, namely increased exposure market share, technical acceptance, and recognition. Increased acceptance of innovative technologies is demonstrated by the level of commercial activity experienced by SITE Program vendors. For example, cumulative information reported in 2002 indicates that since completing SITE demonstration projects, vendors have received contracts for 2,119 cleanups and 1,388 treatability studies (Figure A-2). Vendor surveys were not conducted in 2004.

As part of an ongoing SITE Program evaluation initiated in 1989, 87 vendors have provided information regarding sales of their technologies. Following participation in the SITE Program, 63 percent of the responding vendors were awarded remediation contracts using technologies demonstrated in the SITE Program. Thirty-four percent of the reporting vendors have been awarded ten or more contracts each. Over 35 percent reported one or more international contracts, identifying 40 countries where jobs were contracted. Figure A-3 provides a historical perspective of growth in the number of contracts awarded to SITE vendors from 1990 to 2002.

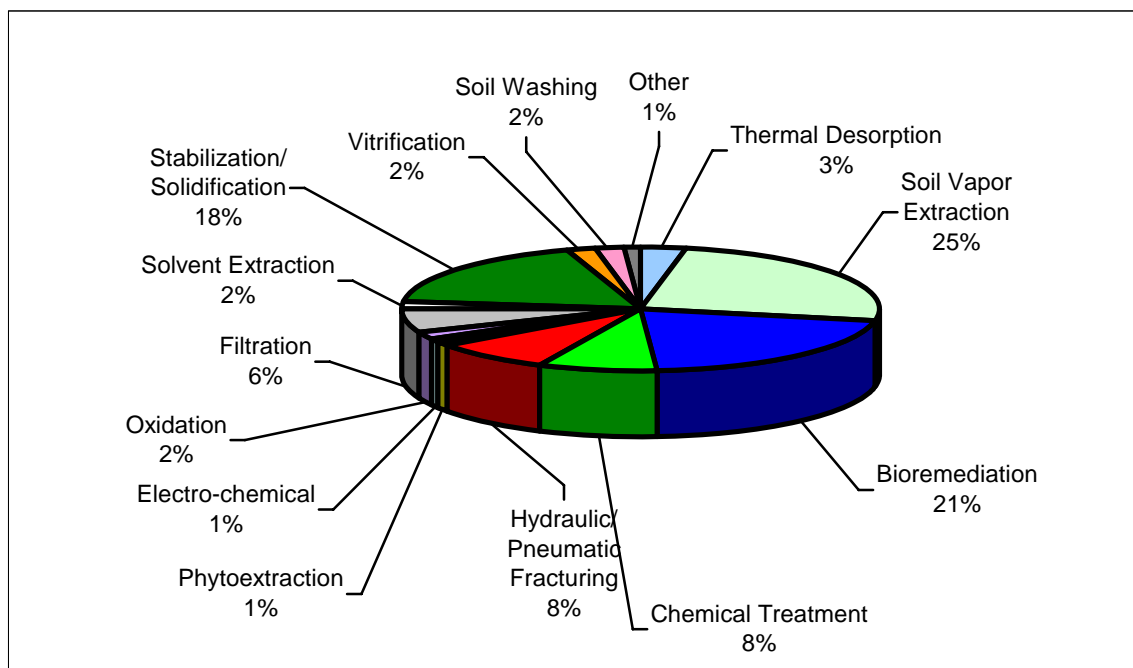
The 2002 Demonstration Program vendor information has been broken down by technology type to ascertain which technologies demonstrated the greatest commercial success. Figure A-4 shows the share by technology type of the 3,507 remediation and treatability contracts awarded to vendors. It is clear from this chart that soil vapor extraction and bioremediation technologies have had the most commercial success; in particular, soil vapor extraction can no longer be considered an innovative technology, as discussed earlier in this section.



**Figure A-2.** Categorization of contracts awarded to SITE vendors following program participation.  
(Source: 2002 vendor information)



**Figure A-3.** Total Number of contracts awarded to SITE vendors after program participation  
(Source: 1990-2002 vendor information)



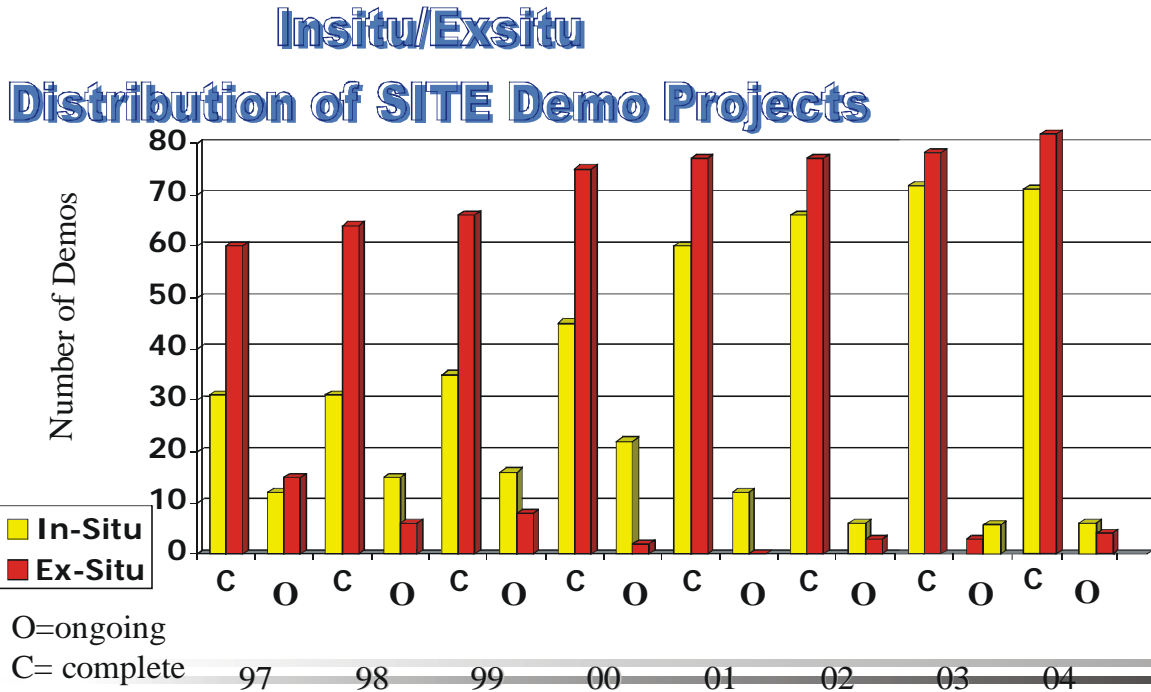
**Figure A-4.** Share of 3,507 total contracts awarded to SITE demonstration vendors by technology type  
(Source: 1990-2002 vendor information)

As shown in Figure A-5, 82 completed SITE projects have been ex situ and 71 in-situ, with a marked increase in ongoing in-situ technology demonstrations as compared with ex situ since 1997.

In addition to the 87 Demonstration Program vendors, information was obtained from 1999 to 2002 from 18 vendors that participated in the MMT Program. This information clearly demonstrated the benefits that vendors receive from the program, indicating that 73 percent of the vendors sold more than 25 units since their demonstration in the SITE Program. Over 60 percent of the vendors indicated that their

technologies were used on international remediation projects. In total, the MMT vendors reported selling over 4,200 units on 1,043 jobs, including 56 international jobs.

Overall, vendor information shows that SITE technology developers in the Demonstration and MMT Programs are achieving commercial success for demonstrated technologies. The impact of the SITE Program continues to be significant, as illustrated by the volume of vendor contracts from 1990-2002 (Figure A-3).



**Figure A-5.** History of Ex Situ vs. In Situ Distribution of SITE Demonstration Projects

**Innovative Technology Highlights -- SITE Program Case Studies**

This section presents case studies of innovative remediation technologies for vendors that have participated in the SITE Program. The case studies provide brief descriptions on the use and status of representative technologies. It is typical of the SITE Program and represents the SITE Program’s approach to promoting innovative technologies by identifying user needs. In response to user needs, the SITE Program assessed the performance of a chemical oxidation technology and steam enhanced remediation projects.

**Case Study 1: Steam Enhanced Remediation at Loring Air Force Base**

The U.S. EPA SITE Program evaluated the Steam Enhanced Remediation (SER) technology for the recovery of volatile organic compounds (VOCs) from fracture limestone. The evaluation was conducted at an abandoned quarry at the former Loring Air Force Base (AFB) in

Limestone, Maine. The project was carried out by United States Environmental Protection Agency (U.S. EPA) Office of Research and Development (ORD) National Risk Management Research Laboratory (NRMRL), U.S. EPA’s SITE Program, U.S. EPA Region I, Maine Department of Environmental Protection (MEDEP), SteamTech Environmental Services, Inc, the United States Air Force (USAF), and experts from academia on characterization of fractured rock and steam injection remediation.

*Technology Description*

SER is an in situ thermal cleanup technology for the reduction of organic contaminants. Steam is injected into the contaminated area and vapor, water, and contaminants are extracted via extraction wells. Specific objectives for the research project included determining if SER could: 1) heat the target area for remediation, 2) enhance contaminant recovery, and 3) reduce contaminant concentrations in the rock and groundwater.

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Construction of the system was initiated in August 2002, and the extraction system started operating on August 30 of that year. Steam injection was initiated on September 1, 2002 and continued until November 19, 2002. Throughout operations, EPA's SITE program collected effluent vapor and water samples to document the recovery rate and amount of contaminants recovered. SteamTech collected temperature data using 22 thermocouple strings, and documented changes in subsurface resistivity caused by temperature increases or by steam replacing water in the fractures using electrical resistance tomography (ERT).

#### *Status*

Effluent vapor and water samples collected at the site showed that after approximately three weeks of operations, the extraction rates started to increase, and they continued to increase for the duration of the project. The highest extraction rates were achieved at the end of the project, after steam injection had ceased and air injection was increased. This is believed to be due to air stripping of VOCs at the higher subsurface temperatures, which carried the vaporized contaminants to extraction wells. Effluent samples showed that more than 7.4 kg (16.2 lbs) of contaminants were recovered during the project, of which 5.0 kg (11.12 lbs) were chlorinated VOCs, 0.55 kg (1.22 lbs) were gasoline range organics (GRO), and 1.77 kg (3.9 lbs) were diesel range organics (DRO). Results of the evaluation indicated that for large, simple-to-moderately complex fractured rock sites, SER may be an effective and cost-effective remediation technology for VOCs.

#### ***Case Study 2: In-Situ Duox™ Chemical Oxidation Technology Demonstration***

The U.S. EPA SITE Program is evaluating the feasibility of applying the Duox™ chemical oxidation technology to chlorinated solvent contaminated media at

the Roosevelt Mills site in Vernon, Connecticut. The demonstration began in 2001. The Roosevelt Mills site is a former woolen mill that included dry cleaning and metal plating operations. Operations at the site have led to the contamination of soil and ground water. The parties involved in the technology demonstration include the U.S. EPA SITE Program, the Environmental Research Institute at the University of Connecticut (the developer) and the Town of Vernon, Connecticut.

#### *Technology Description*

The Duox™ technology destroys unsaturated chlorinated solvents by utilizing a combination of two oxidants. The most economical oxidants typically used are sodium persulfate and potassium permanganate. The in-situ chemical oxidation process involves the injection of a solution containing one or more oxidants into the subsurface to mineralize the target contaminants.

The process typically involves injection of the sodium persulfate into the subsurface. The sodium persulfate mineralizes target contaminants and satisfies the soil oxidant demand. The sodium persulfate also reduces the quantity of potassium permanganate needed to mineralize the target compounds. The sequential dual treatment process can be repeated as many times as necessary to reduce contaminant concentrations. The costs to remediate chlorinated solvent sites using the Duox™ Technology could be significantly less than conventional remediation methods.

#### *Status*

Results of the technology evaluation, which consisted of conducting a lab-based treatability study of the Duox™ Technology for both dissolved chlorinated organics in groundwater, as well as free-phase PCE in the shallow fill material, have indicated that



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permanganate alone and in combination with persulfate is feasible in remediating chlorinated solvents in the site groundwater as well as in soil samples. The remediation project will reduce the risk to public health from the chlorinated solvents. In addition, the costs involved in the remediation using the Duox™ Technology are significantly lower than the original cost estimates involving other remediation methods. Following remediation of the site, a developer has proposed to convert the abandoned site into a mixed use retail/housing complex.

### ***Case Study 3: Steam-Enhanced Remediation at Port of Ridgefield***

The U.S. EPA SITE Program is evaluating Steam-Enhanced Remediation (SER) technology at the Lake River Industrial Site (LRIS) at the Port of Ridgefield (PoR) in Ridgefield, Washington. SER is designed to remove non-aqueous phase liquid (NAPL) contamination from surface and subsurface soils as well as groundwater, while preventing migration of contamination from the site.

The former wood-treating company on the LRIS site used a variety of wood-treating chemicals, including creosote, pentachloro-phenol (PCP) dissolved in a carrier oil, chromated copper arsenate, and copper naphthenate, for the purpose of treating milled lumber, utility poles, and pilings.

#### ***Technology Description***

SER is an *in situ* thermal soil cleanup technology that is being applied through a steam injection system and an aggressive vapor- and liquid-extraction system for the reduction of organic contaminants from the source zone. The fundamental approach of SER is to sweep the treatment volume with steam and to extract vapor, water, and contaminants with

extraction wells. This removal action is designed to maximize NAPL removal from the area; to prevent migration of contamination from the site by establishing pneumatic and hydraulic control between the source area and the Ridgefield National Wildlife Refuge (RNWR), which abuts the LRIS; and to collect data to refine design parameters for the full-scale remedial operation, which will immediately follow the removal action.

#### ***Status***

Steam was first applied at the site in May 2004. Two SITE sampling events have been conducted at the PoR. During SITE's demonstration field work, samples of the off-gas stream from the well field, the gas stack to the atmosphere, the liquids and solids collected in the SER receiving tanks, and the treated water were collected to determine the effectiveness of the treatment and to evaluate any impacts to the RNWR. Samples of groundwater from the EPA-installed well clusters in the RNWR and in three peripheral locations on site were also collected. Analyses and the associated

“The SITE Program has helped start us in 1991, and has provided unimpeachable confirmation of the capabilities of BioGenesis washing technology. Thirteen years later, BioGenesis is working with SITE in an international cooperation project in Venice and on New Jersey’s effort to clean up the Passaic River. Such longevity in organizational relationships speaks for itself in showing that SITE efficiently serves the needs of both government and commercial stakeholders.”

Charles L. Wilde,  
Executive Vice President  
Biogenesis Enterprises, Inc.

validation are currently being performed.

The SITE Program continues to emphasize the need for technologies that focus more on types of contaminated sites rather than single contaminants (i.e., wood preserving sites, manufactured gas plant sites). Most sites are not contaminated with a single contaminant, but with mixtures including by-products formed from normal degradation. Recent applications have led the SITE Program to move in this direction.

Based on input from the multi-agency review board, a list of new priority areas are:

- Sediments
- Mining Issues\Acid Mine Drainage
- Manufactured Gas Plants
- Wood Treating\Preserving
- Pesticide Manufacturers\Formulators

Table A-1 outlines the contaminant areas of interest, and Table A-2 describes the demonstrations that are planned for FY 05.

<b>Table A-1. Future Contaminant Emphasis Areas</b>		
<b>Groundwater/Surface Water</b>	<b>Sediments</b>	<b>Soils</b>
DNAPL\Chlorinated Solvents	PCBs	DNAPL
Arsenic, Mercury or other Heavy Metals	Arsenic, Mercury, or other Heavy Metals	Arsenic, Mercury, or other Heavy Metals
PCBs	PAHs	Chlorinated Solvents
	Pesticides	PCBs

<b>Table A-2. SITE Program Projects Planned for FY 05</b>			
<b>Site Name/Location</b>	<b>Technology</b>	<b>Project Description</b>	<b>Proposed Schedule</b>
Oscar 2 Pier Site Pearl Harbor, Hawaii	Microbial cell technology	Evaluate anaerobic biological removal of PCBs in oil	Demonstration FY05
Venice, Italy and Passaic River, New Jersey	BioGenesis™ Sediment washing system	Evaluate innovative treatment for PCB-contaminated sediment	Venice Demonstration FY05 New Jersey Demonstration FY05
Former MEC Site Hudson, New Hampshire	XDD In-situ chemical oxidation	In-situ chemical oxidation of chlorinated organics in groundwater	Demonstration FY05
Grand Plaza Shopping Center Dallas, Texas	Triad Site Characterization Vapor Intrusion	Remediation of chlorinated solvents and vapor intrusion	Demonstration FY05
Navy Dodge Pond Site Niantic, Connecticut	Bauxite sediment capping and treatment	Evaluation of in-situ capping and treatment for metal-contaminated sediment	Demonstration FY05

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## **Partnerships for Success**

### ***Federal to Federal Interface***

The SITE Program continues to recognize the importance of cooperation between federal agencies to find common areas of need and interest. Interfacing with other federal agencies is an important aspect of enhancing the benefits of technology demonstrations. It allows for leveraging resources, expedited performance, cost information exchange, and cross-fertilization of technical expertise between agencies. In addition, this type of collaboration encourages the implementation of innovative approaches by federal end users in a more expedited manner and, in many cases, implementation at other non-federal site locations.

### ***Federal to State Interface***

Where there are common environmental areas of interest, it is equally important to have federal to state interactions, as it is to have federal-to-federal cooperation. Cooperation with organizations such as the Environmental Council of States (ECOS) and Interstate Technology Regulatory Council (ITRC) promotes partnerships and builds confidence within the environmental community that proven innovative technology can provide more effective and less-expensive environmental protection.

The ITRC provides a mechanism to interact with multiple state regulatory agencies and state specific verification programs. The ITRC is a state-led national coalition dedicated to achieving better environmental protection through the use of innovative technologies.

An example of the federal-to-state/local government interface is demonstrated at the Anacostia River SITE Demonstration. The city of Washington,

DC and the U.S. EPA's Hazardous Substance Research Center are collaborating on the development of innovative capping technologies for contaminated sediment. A visitor's day was held at the Anacostia River site in April 2004 to discuss the technologies with public interest groups and stakeholders. Louisiana Senator Landrieu and Washington D.C. Mayor Anthony Williams attended the visitors' day.

### **Information Transfer**

Information transfer is accomplished through a number of mechanisms. While the Internet information distribution is an effective mechanism, meetings, published documentation, and conferences remain an essential part of technical information dissemination.

Coordination with existing remediation workgroups and programs is also essential. The SITE Program continues to work cooperatively with numerous programs, such as DOD's ESTCP Program, the Environmental Council of States (ECOS) sponsored ITRC, and the DOE's Science and Technology Program.

ITRC Team meetings and special site tours have been conducted near SITE Program field demonstrations in order to capitalize on the participation of multiple States.

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**Appendix B**

**SITE PROJECTS**  
**(Alphabetically by Developer State)**

## SITE PROJECTS - BY DEVELOPER STATE

Developer	Technology	Contact	Program	Status
<b>Alabama</b>				
CMS Research Corporation Birmingham, AL	Portable Gas Chromatograph	H. Ashley Page 205-773-6911	Monitoring and Measurement Technologies	Completed 1992
<b>Alaska</b>				
Arctic Foundations Anchorage, AK	Freeze Barrier	Ed Yarmak 907-562-2741	Demonstration	Completed 1998
Brice Environmental Service Corp. (BESCOP) Fairbanks, AK	Soil Washing Plant	Craig Jones 907-452-2512	Demonstration	Completed 1992
<b>Arizona</b>				
Arizona State University Tempe, AZ	Photocatalytic Oxidation and Air Stripping	Gregory Raupp 606-965-2828 Elliot Berman 352-867-1320	Emerging Technology	Completed 1999
STC Omega (formerly Silicate Technology Corporation) Scottsdale, AZ	Solidification and Stabilization Treatment	Stephen Pelger Scott Larsen 602-948-7100	Demonstration	Completed 1990
<b>California</b>				
Analytical and Remedial Technology, Inc., Milpitas, CA	Automated Sampling and Analytical Platform	Gary Hopkins 408-263-8931	Monitoring and Measurement Technologies	Completed 1991
ARCO CA	Lime Lagoons	Baffy Duff 406-563-5211	Demonstration	Completed 2004
Berkeley Environmental Restoration Center (formerly Udell Technologies, Inc.) Emeryville, CA	In situ Enhanced Extraction	Kent Udell 510-642-2928 Steve Collins 510-643-1300	Demonstration	Completed 1993
Binax Corp., Antox Division Sunnyvale, CA	Immunoassay for PCB in Soil	Richard Lankow 408-752-1353	Monitoring and Measurement Technologies	Completed 1992
COGNIS, Inc. Santa Rosa, CA	Biological/ Chemical Treatment	Steve Rock U.S. EPA 513-569-7149	Emerging Technology	Completed 1995
Eco Mat, Inc. Hayward, CA	Biological Denitrification	Kim Halley 510-783-5885	Demonstration	Completed 2000

## SITE PROJECTS - BY DEVELOPER STATE

Developer	Technology	Contact	Program	Status
<b>California (continued)</b>				
Energy and Environmental Research Corporation Irvine, CA	Hybrid Fluidized Bed System	Richard Koppang 714-859-8851	Emerging Technology	Completed 1992
Energy and Environmental Research Corporation Irvine, CA	Reactor Filter System	Neil Widmer 714-859-8851	Emerging Technology	Completed 1995
Environmental Biotechnologies Montara, CA	Microbial Composting	Douglas Munnecke 415-596-1020	Emerging Technology Demonstration	Completed 1999 Completed
EPOC Water, Inc. Fresno, CA	Precipitation, Microfiltration, Sludge Dewatering	Scott Jackson 209-291-8144	Demonstration	Completed 1993
General Atomics (formerly Ogden Environmental Services) San Diego, CA	Circulating Bed Combuster	Robert Goforth 619-455-2499	Demonstration	Completed 1989
	Acoustic Barrier Separator	Anthony Gattuso 619-455-2910	Emerging Technology	Completed 1995
Geokinetics Berkeley, CA	Electrokinetics	Steven Clark 510-704-2940	Demonstration	Completed 2000
Geokinetics Berkeley, CA	Closed Loop Lead Recovery	Steven Clark 510-704-2940	Demonstration	Completed 2002
Geokinetics & Duke Engineering	Electrokinetic Heating & Surfactant Flushing	Steven Clark 510-704-2940	Demonstration	Completed 1999
GIS\Solutions, Inc. Concord, CA	GIS\Key Environmental Data Management Software	Garry Reid 510-827-5400	Demonstration	Completed 1993
Groundwater Technology Government Services, Inc. Concord, CA	Biological Composting	Ronald Hicks 510-671-2387	Emerging Technology	Completed 1995
Hughes Environmental Systems, Inc. Manhattan Beach, CA	Steam Enhanced Recovery Process	Paul De Percin U.S. EPA 513-569-7797	Demonstration	Completed 1993
Integrated Water Resources, Inc.	Stripping of TCE	805-565-0996	Demonstration	Completed 2002
Lockheed Martin Missiles & Space Co., Inc. Palo Alto, CA	Electrokinetic Remediation	Steven H. Schwartzkopf 415-424-3176	Demonstration	Completed

## SITE PROJECTS - BY DEVELOPER STATE

Developer	Technology	Contact	Program	Status
<b>California (continued)</b>				
Magnum Water Technology El Segundo, CA	CAV-OX Process	Dale Cox 310-322-4143 Jack Simser 310-640-7000	Demonstration	Completed 1993
Membrane Technology and Research, Inc. Menlo Park, CA	VaporSep Membrane Process	Marc Jacobs Doug Gottschlich 415-328-2228	Emerging Technology	Completed 1991
North American Technologies Aprotex San Ramon, CA	Oleofilter	Cathryn Wimberly 916-366-6185	Demonstration	Completed
NOVATERRA, Inc. (formerly Toxic Treatments USA, Inc.) Los Angeles, CA	In-situ and Air Stripping	Philip LaMori 310-328-9433	Demonstration	Completed 1989
Praxis Environmental Services Burlingame, CA	In-situ Steam Enhanced Extraction	Lloyd Stewart 415-641-9044	Demonstration	Completed 1997
Pulse Sciences, San Leandro, CA	X-Ray Treatment (Aqueous)	Vernon Bailey 510-632-5100 ext. 227	Emerging Technology	Completed 1994
	X-Ray Treatment (Soils)	Vernon Bailey 510-632-5100 ext. 227	Emerging Technology	Completed
Radian Corporation (formerly AWD Technologies, Inc.) Walnut Creek, CA	Integrated Vapor Extraction and Steam Vacuum Stripping	David Bluestein 415-227-0822	Demonstration	Completed 1990
Regenesis	Biological Treatment, HRC of Organics	Dr. Stephen Koenigberg 949-366-8000	Demonstration	Completed 2002
Retech, Inc. Ukiah, CA	Plasma Arc Vitrification	Ronald Womack Leroy B. Leland 707-462-6522	Demonstration	Completed 1991
Rochem Separation Systems, Inc. Torrance, CA	Rochem Disc Tube Module System	David LaMonica 310-370-3160	Demonstration	Completed 1994
Roy F. Weston Sherman Oaks, CA	In well Air Stripping	Jeff Bannon 818-971-4900 Eric Klingel 704-660-1673	Demonstration	Completed 1994
Simulprobe Technologies, Inc.	Core Barrel Soil Sampler	Richard Laton 415-883-8787	Monitoring and Measurement Technologies	Completed
SIVE Services Dixon, CA	Steam Injection and Vacuum Extraction	Douglas Dieter 916-678-8358	Demonstration	Exited

## SITE PROJECTS - BY DEVELOPER STATE

Developer	Technology	Contact	Program	Status
<b>California (continued)</b>				
SRI Instruments Torrance, CA	Portable Gas Chromatograph	Douglas Gavilanes 310-214-5092	Monitoring and Measurement Technologies	Completed 1992
State of California	Biphasic Lime Treatment	Chris Stetler 530-542-5461	Demonstration	Completed 2004
Steam Tech Environmental Services Bakersfield, CA	In-situ Thermal (Steam Injection)	Hank Sowers 661-322-6478	Demonstration	Completed 2003
Terra-Kleen Response Group, Inc. Del Mar, CA	Solvent Extraction	Alan Cash 619-558-8762	Demonstration	Completed 1994 Completed 1997
Texaco, Inc. S. El Monte, CA	Entrained-Bed Gasification	John Wintor 310-908-7387	Demonstration	Completed 1994
Thermatrix, Inc. (Formerly Purus, Inc.) San Jose, CA	Photolytic Oxidation	Steve McAdams 408-453-0490	Emerging Technology	Completed 1992
U.S. EPA Region IX San Francisco, CA	Excavation and Foam Suppression of Volatiles	John Blevins 415-744-2400	Demonstration	Completed 1990
U.S. Filter (formerly Ultrox) Santa Ana, CA	Ultraviolet Radiation and Oxidation	John Lowry 412-722-1247	Demonstration	Completed 1989
Weiss Associates Emeryville, CA	Electrochemical Geoxidation	Joe Lovenitti 510-450-6141	Demonstration	Completed 2003
Xon Tech, Inc. Van Nuys, CA	Xon Tech Sector Sampler	Matt Young 818-787-7380	Monitoring and Measurement Technologies	Completed 1991
X-19 Biological Products, Inc.	Microbial Degradation of PCBs	Paul E. Gill 408-970-9485	Demonstration	Completed 2002
<b>Colorado</b>				
CF Systems Corporation Arvada, CO	Solvent Extraction	L.V. Benningfield 303-420-1550	Demonstration	Completed 1988
	Batch Organics Extraction Unit	L.V. Benningfield 303-420-1550	Demonstration	Completed
Colorado Dept. of Health Denver, CO	Wetland-Based Treatment for Mineral Mine Drainage	Jim Lewis 303-692-3390	Demonstration	Completed 1999
Colorado School of Mines, Golden, CO and Colorado Department of Health Denver, CO	Wetlands-Based Treatment	Thomas Wildeman 303-273-3642	Emerging Technology	Completed



## SITE PROJECTS - BY DEVELOPER STATE

Developer	Technology	Contact	Program	Status
<b>Colorado (continued)</b>				
General Environmental Corporation Englewood, CO	Electrocoagulation	Carl Dalrymple 303-761-6960	Demonstration	Completed 1995
Pintail Systems, Inc. Aurora, CO	Biodegradation of Cyanide	Caren Caldwell 303-367-8443	Demonstration	Completed 1998
	Biostabilization of Lead	Leslie Thompson 303-367-8443	Demonstration	Completed 2000
	Biostabilization of Mercury Mining Wastes	Leslie Thompson 303-367-8443	Demonstration	Completed
	Biological Stabilization of Arsenic in Soils	Leslie Thompson 303-367-8443	Demonstration	Completed 2000
Region 8 and State of Colorado	Multiple Innovative Passive mine Drainage Technologies	Victor Kettlapper 303-312-6578	Demonstration	Completed 2001
Rocky Mountain Remediation Services Golden, CO	Environmental Soil Amendment (Stabilization)	Jim Barthel 303-215-6620	Demonstration	Completed
Smith Environmental Technologies Corporation (formerly Canonie Environmental Services Corp.) Englewood, CO	Low Temperature Thermal Aeration	Joseph Hutton 303-790-1747	Demonstration	Completed 1992
	Anaerobic Thermal Processor	Joseph Hutton 303-790-1747	Demonstration	Completed 1991
<b>Connecticut</b>				
Dexsil Corporation Hamden, CT 4 demonstrations	Environmental Test Kits (PCB) Chlor-N-Soil L2000 PCB/Chloride Analyzer	Jack Mahon 203-288-3509	Monitoring and Measurement Technologies	Completed 1993
University of Connecticut	Permanganate/Persulfate Oxidation Treatment for PCE	George Hoag 860-486-2781	Demonstration	Ongoing
Milestone Monroe, CT	Thermal Decomposition, Atomic Absorption	Stephen Billets U.S. EPA 702-798-2232	Monitoring and Measurement Technologies	Completed 2003
E.I. DuPont de Nemours and Co. and Oberlin Filter Co. Newark, DE and Waukesha, WI	Membrane Microfiltration	Ernest Mayer 302-774-2277	Demonstration	Completed 1990

## SITE PROJECTS - BY DEVELOPER STATE

Developer	Technology	Contact	Program	Status
<b>Delaware</b>				
Hewlett-Packard (formerly MTI Analytical Instruments) Wilmington, DE	Portable Gas Chromatograph	Hewlett- Packard 800-227-9770 Bob Belair 302-633-8487	Monitoring and Measurement Technologies	Completed 1992
Remediation Technology Development Forum, HSRC	Innovative Capping Design	Richard Jensen 302-695-4685	Demonstration	Ongoing
Strategic Diagnostics Inc. (formerly Ensys, Inc.) Newark, DE	Immunoassay for PCP	Tim Lawruk 800-544-8881 302-456-6782	Monitoring and Measurement Technologies	Completed 1993
	Immunoassay and Colorimetry for Dioxin	Bob Ferguson 1-800-544-8881	Monitoring and Measurement Technologies	Completed 2004
<b>Florida</b>				
Funderburk and Associates Apollo Beach, FL	Dechlorination and Immobilization	Ray Funderburk 800-723-8847	Demonstration	Completed 1997
High Voltage Environmental Applications, Inc./Florida International University and University of Miami Miami, FL	High-Energy Electron Irradiation (Aqueous)	William Cooper 910-962-3450	Emerging Technology	Completed 1993
			Demonstration	Completed 1994
High Voltage Environmental Applications, Inc. Miami, FL	High Energy Electronic Beam (Solids)	William Cooper 305-593-5330	Emerging Technology	Completed
PCP, Inc. West Palm Beach, FL	Ion Mobility Spectrometry	Martin Cohen 407-683-0507	Monitoring and Measurement Technologies	Completed 1991
<b>Georgia</b>				
American Combustion, Inc. Norcross, GA	PYRETRON Thermal Destruction	Gregory Gitman 404-564-4180	Demonstration	Completed 1988
ETG., Inc. Norcross, GA	Long-Path Fourier Transform Infrared Spectrometer	Orman Simpson 404-242-0977	Monitoring and Measurement Technologies	Completed 1992
Sonotech, Inc. Atlanta, GA	Frequency Tunable Pulse Combustion System	Ben Zinn 404-894-3033	Demonstration	Completed 1995
Williams Environmental Services, Inc. (Formerly Harmon Environmental Services, Inc.) Stone Mountain, GA	Soil Washing	S. Jackson Hubbard (U.S. EPA) 513-569-7507	Emerging Technology	Exited 1992

## SITE PROJECTS - BY DEVELOPER STATE

Developer	Technology	Contact	Program	Status
<b>Hawaii</b>				
University of Hawaii	Microbial Cell Technology	Dr. Ping-Yi Yang 808-956-8459	Demonstration	Ongoing
<b>Idaho</b>				
Aquatic Research Instruments	Sediment Core Sampler	Will Young 208-768-2222	Monitoring and Measurement	Completed
Aquatic Research Instruments	Russian Peat Borer	Will Young 208-768-2222	Monitoring and Measurement Technologies	Completed
Argonne National Laboratory West Idaho Fall, ID	Phytoremediation of Radionuclides	Scott Lee 208-533-7829	Demonstration	Ongoing
Art's Manufacturing and Supply	AMST <sup>TM</sup> Dual-Tube Liner Soil Sampler	Brian Anderson 800-635-7330	Monitoring and Measurement Technologies	Completed
	AMST <sup>TM</sup> Split Core Sampler	Brian Anderson 800-635-7330	Monitoring and Measurement Technologies	Completed 1999
J.R. Simplot Co. Pocatello, ID	Anaerobic Biological Process	Russell Kaake 208-235-5620	Emerging Technology	Completed 1993
	Anaerobic Biological Process	Tom Yergovich 209-858-2511	Demonstration	Completed 1994
Morrison Knudsen Corp./STG Technologies Boise, ID	Grouting Technique	Kathryn Levihn Rick Raymond 208-386-6115	Demonstration	Completed
Process Technologies, Inc. Boise, ID	Photolytic Destruction of SVE off-gases	Michael Swan 208-385-0900	Demonstration	Exited
U.S. DOE/ Duke Engineering Lockheed, ID	Surfactant Enhanced Acquirer Remediation	Michael Shook 208-526-6945	Demonstration	Completed 1999
<b>Illinois</b>				
Allied Signal Corporation Des Plaines, IL	Submerged Aerobic Fixed Film Reactor	Steve Lupton 708-391-3500	Demonstration	Completed
Argonne National Laboratory East	Phytoremediation of Radionuclides	Christina Negri	Demonstration	Completed 2003
GTI Des Plaines, IL	Thermal Sediment Reuse Technology	Anil Goyal 847-768-0605	Demonstration	Ongoing
Oxford Instruments	XRF Analyzer	Ruhre Gehrien	Monitoring and Measurement Technologies	Ongoing

## SITE PROJECTS - BY DEVELOPER STATE

Developer	Technology	Contact	Program	Status
<b>Illinois (continued)</b>				
Institute of Gas Technology	Chemical and Biological Treatment	Robert Kelley 847-768-0722	Emerging Technology	Completed 1993
	Fluid Extraction-Biological Degradation Process	Albert Paterek 847-768-0720	Emerging Technology	Completed 1992
	Fluidized-Bed Cyclonic Agglomerating Incinerator	Mike Mensinger 847-768-0602 Amir Rehmat 847-768-0588	Emerging Technology	Completed
Institute of Gas Technology	Superficial Extraction/Liquid Phase Oxidation of Waste	Mike Mensinger 847-768-0602	Emerging Technology	Completed
OHM Environmental (formerly RUST Remedial Services, Inc.) Lombard, IL	X-TRAX Thermal Desorption	Dick Ayen 803-646-2413	Demonstration	Completed 1992
Recycling Sciences, Inc. Chicago, IL	Desorption and Vapor Extraction System	William Meenan 312-663-4269	Demonstration	Completed
Wheelabrator Clean Air Systems (formerly Chemical Waste Management) Schaumburg, IL	Evaporation and Chemical Oxidation	Bob Hernquist 708-706-6900	Demonstration	Completed
<b>Indiana</b>				
Bio-Rem, Inc. Butler, IN	Augmented In-situ Subsurface Bioremediation Process	David Mann 219-868-5823 800-428-4626	Demonstration	Completed 1993
Geoprobe Salina, KS	Soil, Water, Vapor Sampling Cone Penetrometer	Wes McCall Tom Omli 800-436-7762	Monitoring and Measurement Technologies	Completed 1995
Sevenson Environmental Services, Inc. Munster, IN	Chemical Stabilization of Mercury Mining Wastes	Steve Chisick 219-836-0116	Demonstration	Exited
Sevenson Environmental Services, Inc. Munster, IN	MAECTITE® Treatment Process	Chuck McPheeters 219-836-0116	Demonstration	Completed 2000
Soil Tech, ATP Systems Inc Porter, IN	Thermal Desorption	Joe Hutton 219-926-8651	Demonstration	Completed 1992
<b>Iowa</b>				
Clements Associates, Inc.	JMC Environmentalist's Subsoil Probe	Jim Clements 515-792-8285	Monitoring and Measurement Technologies	Completed

## SITE PROJECTS - BY DEVELOPER STATE

Developer	Technology	Contact	Program	Status
<b>Kansas</b>				
Geoprobe Systems Salina, KS	Large Bore Soil Sampler	Wesley McCall Tom Oml 800-436-7762	Monitoring and Measurement Technologies	Completed
<b>Kentucky</b>				
Microsensor System, Inc. Bowling Green, KY	Portable Gas Chromatograph	Norman Davis 502-752-1353	Monitoring and Measurement Technologies	Completed 1995
<b>Louisiana</b>				
Advanced Remediation Mixing, Inc. (Formerly Chemfix Technologies, Inc.) Kenner, LA	Solidification and Stabilization	Sam Pizzitola 504-461-0466	Demonstration	Completed 1989
Electrokinetics, Inc. Baton Rouge, LA	Electrokinetic Remediation	Elif Acar 504-388-3992	Emerging Technology  Demonstration	Completed 1989  Exited
	Electro-Klean Electrokinetic Soil Remediation	Elif Acar 504-753-8004	Emerging Technology	Exited
SBP Technologies, Inc. Baton Rouge, LA	Membrane Separation and Bioremediation	Clayton Page 504-755-7711	Demonstration	Completed 1995
<b>Maine</b>				
Cape Technologies South Portland, ME	DFI Immunoassay for Dioxin	Bob Harrison 207-741-2995	Monitoring and Measurement Technologies	Completed 2004
<b>Maryland</b>				
Quadrel Services, Inc.	Emflux® Soil-Gas Survey System	Bruce Tucker Paul Henning 301-874-5510	Monitoring and Measurement Technologies	Completed
W. L. Gore and Associates, Inc.	Gore-Scrubber® Passive Soil Gas Sampler	Ray Fenstermacher 410-392-7600	Monitoring and Measurement Technologies	Completed
<b>Massachusetts</b>				
ABB Environmental Services, Inc. Wakefield, MA	Anaerobic/ Aerobic Sequential Bioremediation	Willard Murray 617-245-6606	Emerging Technology	Completed 1998
Harding Lawson Associates (formally ABB Environmental Services, Inc.) Wakefield, MA	Two-Zone Plume Interception In-situ Treatment Strategy	Jaret Johnson Willard Murray 617-245-6606	Emerging Technology	Completed
Harding-Lawson Engineers Wakefield, MA	In-situ Anerobic-aerotic Bioremediation	William Murray 617-245-6606	Demonstration	Completed 2003

## SITE PROJECTS - BY DEVELOPER STATE

Developer	Technology	Contact	Program	Status
Massachusetts (continued)				
Bruker Instruments Billerica, MA	Bruker Mobile Environmental Monitor	Dr. Brian Abraham 508-667-9580	Monitoring and Measurement Technologies	Completed
HNU Systems, Inc. Newtown, MA	Portable Gas Chromatograph	Jack Driscoll 800-724-6690 617-964-6690	Monitoring and Measurement Technologies	Completed 1992
HNU Systems, Inc. Newtown, MA	Portable X-Ray Fluorescence Spectrometer	Jack Driscoll 800-724-6690 617-964-6690	Monitoring and Measurement Technologies	Completed 1995
Innov-X Systems, Inc. Woburn, MA	XRF Analyzer	Rose Koch 781-938-5005	Monitoring and Measurement Technologies	Ongoing
KSE, Inc. Amherst, MA	Air II Photocatalytic Technology for Air Streams	James Kittrell 413-549-5506	Demonstration	Completed 1999
Maxymillian Technologies, Inc. (formerly Clean Berkshires) Lanesboro, MA	High Temperature Thermal Process	Jim Maxymillian 413-499-3050	Demonstration	Completed 1993
Millipore Corporation Bedford, MA	EnviroGard PCB Immunoassay Test Kit	Alan Weiss 617-275-9200	Monitoring and Measurement Technologies	Completed 1992
	Immunoassay for PCP (Soil, Water)	Alan Weiss 617-275-9200	Monitoring and Measurement Technologies	Completed 1993
Niton Corporation Bedford, MA	Portable X-Ray Fluorescence Spectrometer	Don Sackett 781-275-9275	Monitoring and Measurement Technologies	Completed 1995
Niton Corp. Billerica, MA	X-Ray Fluorescence Analyzer	Debbie Schatzlein	Monitoring and Measurement Technologies	Completed 2003
	XRF Analyzer	Debbie Schatzlein	Monitoring and Measurement Technologies	Ongoing
Ohmicron Corporation Newton, MA	Immunoassay for PCP in Soil	Mary Hayes 215-860-5115	Monitoring and Measurement Technologies	Completed 1993
PSI Technology Co. Andover, MA	Immobilize and Decontaminate Metals in Aggregate Solids	Joseph Morency 508-689-0003	Emerging Technology	Completed 1993
Rontel USA, Inc. Carlisle, MA	XRF Analyzer	Paul Smith 978-266-2900	Monitoring and Measurement Technologies	Ongoing
Terra-Therm LLC Fitchburg, MA	In-Situ Thermal	Ralph Baker 978- 343-0300	Demonstration	Completed 2002
UV Technologies, Inc. (formerly Energy and Environmental Engineering, Inc.) East Cambridge, MA	Laser-Induced Photochemical Oxidative Destruction	John Roll James Porter 617-666-5500	Emerging Technology	Completed 1993

## SITE PROJECTS - BY DEVELOPER STATE

Developer	Technology	Contact	Program	Status
<b>Michigan (and Mississippi)</b>				
Army Corps of Engineers	Phytoremediation	Detroit, MI and Vicksburg, MS	Demonstration	Completed 2003
Limnotech Ann Arbor, MI	In-Situ Hydrogen-Enhanced Remediation	John Wolfe 734-332-1200	Demonstration	Ongoing
<b>Minnesota</b>				
BioTrol Inc. Eden Prairie, MN	Biotreatment of Groundwater	Dennis Chilcote 612-942-8032	Demonstration	Completed 1989
BioTrol, Inc. Eden Prairie, MN	Methanotropic Bioreactor System	Durell Dobbins 612-942-8032	Emerging Technology	Completed 1992
BioTrol, Inc. Eden Prairie, MN	Biological Aqueous Treatment System	Durell Dobbins 612-942-8032	Demonstration	Completed 1989
BioTrol, Inc. Eden Prairie, MN	Soil Washing System	Dennis Chilcote 612-942-8032	Demonstration	Completed 1989
Membrane Corporation Minneapolis, MN	Membrane Gas Transfer in Waste Remediation	Charles Gantzer 612-378-2160	Emerging Technology	Discontinued
<b>Missouri</b>				
COGNIS TERRAMET Gross, MO	Removal of Lead from Soils	Lou Magdits 573-626-3476	Demonstration	Completed 1994
<b>Montana</b>				
Montana College of Mineral Science and Technology Butte, MT	Air-Sparged Hydrocyclone	Theodore Jordan 406-496-4112 406-496-4193	Emerging Technology	Completed 1994
	Campbell Centrifugal Jig	Gordon Ziesing 406-496-1573 406-496-4193	Emerging Technology	Ongoing
<b>Nebraska</b>				
University of Nebraska Lincoln, NE	Spray Irrigation	Ray Spalding 402-483-3931	Demonstration	Completed 1996
<b>Nevada</b>				
U.S. EPA Las Vegas, NV	Field Analytical Screening Program (FASP)	Howard Fribush 703-603-8831 Larry Jack 702-798-2373	Demonstration	Completed 1996
University of Nevada, Reno Reno, NV	Passive Constructed Wetlands	Tim Tsukamoto 775-784-4413	Demonstration	Ongoing
<b>New Hampshire</b>				
XDD, LLC Stratham, NH	In-Situ Chemical Oxidation	Ken Sperry 484-224-3031	Demonstration	Ongoing

## SITE PROJECTS - BY DEVELOPER STATE

Developer	Technology	Contact	Program	Status
New Jersey				
Accutech Inc Keyport, NJ and New Jersey Institute of Technology Newark, NJ	Pneumatic Fracturing Extraction and Hot Gas Injection	John Liskowitz 908-739-6444	Demonstration	Completed 1992
ART International, Inc. (formerly Enviro Sciences, Inc.) Denville, NJ	Low-Energy Solvent Extraction Process	Werner Steiner 201-627-7601	Emerging Technology	Completed 1994
Dehydro-Tech. Corporation Somerville, NJ	Carver-Greenfield Process for Extraction of Oily Waste	Theodore Trowbridge 908-904-1606	Demonstration	Completed 1991
Geotech Development Corporation Newark, NJ	Cold Top Vitrification	William Librizzi 201-596-5846 Thomas Tate 610-337-8515	Demonstration	Exited
Envirogen, Inc. Lawrenceville, NJ	Microbial Degradation/ Solvent Extraction	Ronald Unterman (609) 936-9300	Demonstration	Completed 2000
Metorex Ewing, NJ	XRF	John Patterson 609-406-9000	Monitoring and Measurement Technologies	Completed 2003
M.L. ENERGIA, Inc. Princeton, NJ	Reductive Photo- Dechlorination Treatment	Moshe Lavid 609-799-7970	Emerging Technology	Completed 1995
M.L. ENERGIA, Inc. Princeton, NJ	Reductive Photo-Thermal Oxidation Processes for Chlorocarbons	Moshe Lavid 609-799-7970	Emerging Technology	Completed
New Jersey Institute of Technology, Hazardous Substance Management Research Center Newark, NJ	Pneumatic Fracturing/ Bioremediation	John Schuring 201-596-5849 David Kosson 908-445-4346	Emerging Technology	Completed 1992
New Jersey Institute of Technology Newark, NJ and GeoTech Development Corporation King of Prussia, PA	Cold Top Vitrification	William Librizzi 201-596-5846 Thomas Tate 610-337-8515	Demonstration	Exited
New Jersey Institute of Technology Newark, NJ	GHEA Associates Process	Itzhak Gottlieb 201-226-4642	Emerging Technology	Completed 1992
Phytotech, Inc. Monmouth, NJ	Phytoextraction of metal from soil	Burt Ensley 908-438-0900	Demonstration	Completed 1998
Sentex Sensing Technology, Inc. Ridgefield, NJ	Portable Gas Chromatograph	Amos Linenberg 201-945-3694	Monitoring and Measurement Technologies	Completed 1992
Solucorp Saddle Back, NJ	Molecular Bonding System	Robert Kuhn 914-623-2333	Demonstration	Completed



## SITE PROJECTS - BY DEVELOPER STATE

Developer	Technology	Contact	Program	Status
<b>New Mexico</b>				
Billings and Associates, Inc. Albuquerque, NM	Subsurface Volatilization and Ventilation System	Gale Billings 505-345-1116 Don Breneman 713-676-5324	Demonstration	Completed 1994
Commodore Advanced Sciences, Inc. Albuquerque, NM	Set Process for PCBs in soil	Mark Jones 505-872-6803	Demonstration	Completed 2000
Resource Management and Recovery (formerly Bio-Recovery Systems, Inc.) Las Cruces, NM	AlgaSorb Biological Sorption	Mike Hosea 505-382-9228	Emerging Technology	Completed 1990
Sandia National Laboratories Albuquerque, NM	Electrokinetic Extraction in Unsaturated Soils	Eric Lindgren 505-844-3820 Earl Mattson 505-856-3311	Demonstration	Completed 1999
Thermo Nutech (formerly TMA Eberline) Albuquerque, NM	Segmented Gate System for Radioactive Materials	Jeff Brown 423-481-0683	Emerging Technology	Completed
<b>New York</b>				
Pasacelsian Ithaca, NY	Cellular Receptor Immunoassay for Dioxin	Amy Hall 888-689-4224	Monitoring and Measurement Technology	Completed 2004
Photovac International, Inc. Deer Park, NY	Portable Gas Chromatograph	Mark Collins 516-254-4199	Monitoring and Measurement Technologies	Completed 1992
SBP Technologies, Inc. White Plains, NY	Bioventing, Air Sparging, Biological Treatment for Ground Water (multi-developer project with State of New York)	Richard Desrosiers 914-694-2280 Nick Kolak 518-457-3372	Demonstration	Completed 1995
RECRA Environmental, Inc. (formerly Electro-Pure Systems, Inc.) Amherst, NY	Alternating Current Electrocoagulation Technology	Kenneth Kinecki 800-527-3272	Emerging Technology	Completed 1992
State University of New York at Oswego Oswego, NY	Photocatalytic Treatment for Sediments	Ronald Scudato Jeffrey Shiarenzelli 315-341-3639	Emerging Technology	Completed 1995
Texaco Syngas, Inc. White Plains, NY	Gasification Process	John Winter 316-251-4000 ext. 536	Demonstration	Completed 1994
Xcalibur XRF Services, Inc. Islandia, NY	XRF Analyzers	631-435-9749	Monitoring and Measurement Technologies	Ongoing
Xerox Corporation Webster, NY	Ground Water Extraction	Ron Hess 716-422-3694 Phil Mook 916-643-5443	Demonstration	Completed 1995

## SITE PROJECTS - BY DEVELOPER STATE

Developer	Technology	Contact	Program	Status
<b>North Carolina</b>				
Hybrizyme Raleigh, NC	Immunoassay and Colorimetry for Dioxin	Randy Allen 919-783-9595	Monitoring and Measurement Technologies	Completed 2004
MTI, Inc. Wilmington, NC	Anodic Stripping Voltametry	Stephen Billets U.S. EPA 702-798-2232	Monitoring and Measurement Technologies	Completed 2003
Xenobiotics Durham, NC	Cell Based Immunoassay for Dioxin	Jeff Sturkey 919-688-4804	Monitoring and Measurement Technologies	Completed 2004
<b>Ohio</b>				
ASC/EMR Wright Patterson AFB Dayton, OH	Phytoremediation of TCE in Groundwater	Greg Harvey 513-255-7716	Demonstration	Completed 1998
Babcock and Wilcox Alliance Research Center Alliance, OH	Cyclone Vitrification	Lawrence King 216-829-7576	Demonstration	Completed 1991
Battelle Memorial Institute Columbus, OH	In-situ Electroacoustic Soil Decontamination	Satya Chauhan 614-424-4812	Emerging Technology	Completed
Commodore Environmental Columbus, Ohio	Solvated Electron Treatment of Chlorinated Organics	Neil Dronby 614-297-0365	Demonstration	Completed 1996
Ferro Corporation Independence, OH	Waste Vitrification Through Electric Melting	S.K. Muralidhar 216-641-8580	Emerging Technology	Completed
IT Corporation Cincinnati, OH	Chelation/ Electro-deposition of Toxic Metals from Soil	Radha Krishnan 513-782-4700	Emerging Technology	Completed
IT Corporation (formerly OHM Remediation Services Corp.) Findlay, OH	Oxygen Microbubble In-situ Bioremediation	Douglas Jerger 423-690-3211	Emerging Technology	Completed 1998
Monsanto/ Dupont Cincinnati, OH	In-situ Electroosmosis of TCE in soil/ Groundwaters "Lasagna Process"	Thomas Holdsworth 513-569-7675	Demonstration	Completed 1998
Ohio Lumex Co. Twinsburg, OH	Atomic Absorption Spectroscopy	Stephen Billets U.S. EPA 702-798-2232	Monitoring and Measurement Technologies	Completed 2003
University of Dayton Research Institute Dayton, OH	Photothermal Detoxification Unit (PDU)	Berry Dellinger John Graham 513-229-2846	Emerging Technology	Completed 1994
US EPA Mobile Volume Reduction Unit Cincinnati, Ohio	Soil Washing	Richard Griffith 908-321-6629	Demonstration	Completed 1992
U.S. EPA NRMRL Cincinnati, OH	Bioventing	Paul McCauley 513-569-7444	Demonstration	Completed 1997

## SITE PROJECTS - BY DEVELOPER STATE

Developer	Technology	Contact	Program	Status
<b>Ohio (continued)</b>				
U.S. EPA NRMRL and ETG Environmental Cincinnati, OH	Base-Catalyzed Dechlorination Process	George Huffman 513-569-7341 Yei-Shong Shieh 215-832-0700	Demonstration	Completed 1993
U.S. EPA Risk Reduction Engineering Laboratory and IT Corporation Cincinnati, OH	Debris Washing System	Michael Taylor 513-782-4700	Demonstration	Completed 1990
U.S. EPA Risk Reduction Engineering Laboratory and FRX, Inc. Cincinnati, OH	Hydraulic Fracturing	William Slack 513-469-6040	Demonstration	Completed 1992
U.S. EPA NRMRL Cincinnati, OH	Alternate Cover Assessment Program (ACAP)	Steve Rock 513-569-7149	Demonstration	Completed 2001
U.S. EPA NRMRL Cincinnati, OH	Base Catalyzed Decomposition	Terry Lyons 513-569-7589	Demonstration	Completed 2004
<b>Oklahoma</b>				
Geo-Microbial Technologies, Ochelata, OK	Technology for Metals Release and Removal from Wastes	Donald Hitzman 918-535-2281	Emerging Technology	Completed 2001
<b>Oregon</b>				
Metorex, Inc. Bend, OR	Field Portable X-Ray Fluorescence (FPXRF)	Jim Pasmore 800-229-9209 541-385-6748	Monitoring and Measurement Technologies	Completed 1995
<b>Pennsylvania</b>				
Aluminum Company of America (formerly Alcoa Separations Technology, Inc.) Pittsburgh, PA	Bioscrubber	Paul Liu 412-826-3711	Emerging Technology	Completed 1993
Calgon Carbon Oxidation Technologies (formerly Peroxidation Systems, Inc.) Pittsburgh, PA	Perox-Pur Chemical Oxidation	Bertrand Dussert 412-787-6681	Demonstration	Completed 1995
Center for Hazardous Materials Research Pittsburgh, PA	Acid Extraction Treatment System	Stephe Paff 412-826-5321	Emerging Technology	Completed 1992
Center for Hazardous Materials Research Pittsburgh, PA	Organics Destruction and Metals Stabilization	B Stephe Paff 412-826-5321 Brian Bosilovich 412-826-5321	Emerging Technology	Completed 1995

## SITE PROJECTS - BY DEVELOPER STATE

Developer	Technology	Contact	Program	Status
<b>Pennsylvania (continued)</b>				
Concurrent Technologies (formerly Center for Hazardous Materials Research) Pittsburgh, PA	Lead Smelting	Brian Bosilovich 412-826-5321	Emerging Technology	Completed 1993
MacTec-SPB Technologies Company Pittsburgh, PA	In Well Vapor Stripping of Ground Water	Mark McGlathery 800-444-6221	Demonstration	Completed 1999
Geo-Con, Inc. Monroeville, PA 2 Demonstrations	In-situ Solidification/ Stabilization	Linda Ward Robert Hayden 412-856-7700	Demonstration	Completed 1988
Horsehead Resource Development Co. Inc. Monaca, PA	Flame Reactor	Regis Zagrocki 610-826-8810	Demonstration	Completed
Lewis Environmental Services, Inc. Pittsburgh, PA	Soil Leaching Process	Tom Lewis III 412-322-8100	Emerging Technology	Exited
Strategic Diagnostics, Inc. Newtown, PA	Immunoassay for PCP	Craig Kostyshyn 215-860-5115 ext. 634	Monitoring and Measurement Technologies	Completed 1993
Remediation Technologies, Inc. Pittsburgh, PA	Slurry Biodegradation	David Nakles 412-826-3340	Demonstration	Completed 1991
R.E. Wright Middletown, PA	Bioventing, Air Sparging, Biological Treatment for Ground Water (multi- developer project with state of New York)	Richard Cronce 717-944-5501	Demonstration	Completed 1992
Roy F. Weston, Inc. West Chester, PA	Thermal Desorption	Mike Cosmos 215-430-7423	Demonstration	Completed 1992
Roy F. Weston, Inc. West Chester, PA	Steam Regeneration Adsorption System (Ambersorb)	John Thoroughgood 610-701-3728 Deborah Plantz 215-537-4061	Emerging Technology	Completed 1995
Vortec Corp Collegeville, PA	Oxidation and Vitrification Process	James Hnat 610-489-2255	Emerging Technology  Demonstration	Completed 1993  Exited
South Carolina				
E&C Williams Summerville, SC	Chemical Stabilization of Mercury Mining Wastes	Charlie Williams 843-821-4200	Demonstration	Completed 2001
University of South Carolina Columbia, SC	In-situ Mitigation of Acid Water	Frank Caruccio 803-777-4512	Emerging Technology	Completed 1995

## SITE PROJECTS - BY DEVELOPER STATE

Developer	Technology	Contact	Program	Status
<b>Tennessee</b>				
Bergmann USA Gallatin, TN	Soil and Sediment Washing Technology	George Jones 615-230-2217	Demonstration	Completed 1992
Brown and Root Environmental/ Illinois Institute of Technology Oak Ridge, TN	Radio Frequency Heating	Clifton Blanchard 423-483-9900	Demonstration	Completed 1994
IT Corporation Knoxville, TN	Batch Steam Distillation and Metal Extraction	Stuart Shealy 423-690-3211	Emerging Technology	Completed 1992
	Eimco Biolift Slurry Reactor as developed by Tekno Associates	Kandi Brown 423-690-3211	Emerging Technology	Completed 1992
	Mixed Waste Treatment Process	Ed Alperin 615-690-3211	Emerging Technology	Completed 1995
IT Corporation Knoxville, TN	Photocatalytic and Biological Soil Detoxification	Duane Graves 423-690-3211	Emerging Technology	Completed 1993
WASTECH, Inc. Oak Ridge, TN	Solidification/ Stabilization	Terrence Lyons U.S. EPA 513-569-7859	Demonstration	Completed 1991
<b>Texas</b>				
Geokinetics and Duke Engineering	Electrokinetic Flushing & Surfactant Flushing	Harry Linnemeyer 512-425-2000 Steven Clark 510-704-2940	Demonstration	Completed 1999
EET, Inc. Bellaire, TX	PCB/Metals Extraction from Porous Surfaces	Tim Tarrillion 713-662-0727	Demonstration	Completed 1997
ENSR Consulting Engineering and Larson Engineering Houston, TX	Bioventing, Air Sparging, Biological Treatment for Ground Water (multi- developer project with the State of New York)	David Ramsden (ENSR) 713-520-6802 N. Sathi-yakumar 716-272-7310	Demonstration	Completed 1995
Filter Flow Technology, Inc. League City, TX	Colloid Polishing Method	Todd Johnson 713-334-6080	Demonstration	Completed 1992
Fugro Geosciences, Inc. Houston, TX	Laser Fluorescence PAH, BTEX Screening Cone Penetrometer	Andrew Taer 713-778-5580	Monitoring and Measurement Technologies	Completed 1996
Hanby Environmental Laboratory Wimberly, TX	PCP Test Kit	John Hanby 512-847-1212	Monitoring and Measurement Technologies	Completed 1993
Hrubetz Environmental Services, Inc. Dallas, TX	HRUBOUT Process	Barbara Hrubetz Michael Hrubetz 214-363-7833	Demonstration	Completed 1993
Rigaku, Inc. Woodlands, TX	XRF Analyzer	John Martin 281-363-1033	Monitoring and Measurement Technologies	Ongoing

## SITE PROJECTS - BY DEVELOPER STATE

Developer	Technology	Contact	Program	Status
<b>Texas (continued)</b>				
Solidtech, Inc. Houston, TX	Solidification and Stabilization	Bill Stallworth 713-497-8558	Demonstration	Completed 1988
Star Organics Dallas, TX	Injection Soil Amendment (Stabilization)	Phil Clarke 214-522-0742	Demonstration	Completed 1999
TN Spectrace Round Rock, TX	Portable X-Ray Fluorescence Spectrometer	Peter Barry 512-388-9100	Monitoring and Measurement Technologies	Completed 1995
Micro-Bac International, Inc.	Microbial Degradation of PCBs	Todd Kenney 512-310-9000	Demonstration	Completed 2002
University of Houston Houston, TX	Concentrated Salt Extraction of Lead	Dennis Clifford 713-743-4266	Emerging Technology	Completed 1999
Western Product Recovery Group, Inc. Houston, TX	CCBA Physical and Chemical Treatment	Donald Kelly 713-493-9321 Bert Elkins 619-749-8856	Emerging Technology	Completed 1994
<b>Utah</b>				
Phytokinetics, Inc. North Logan, UT	Phytoremediation of Soils	Ari Ferro 801-750-0985	Emerging Technology  Demonstration	Completed 1999  Completed 1999
<b>Vermont</b>				
Green Mountain Laboratories	Biodegradation of PCBs in Soils	Adam Longee 802-223-1468	Demonstration	Completed 2000
<b>Virginia</b>				
BioGenesis Enterprises, Inc. Fairfax Station, VA	Soil Washing/ Biological Treatment	Charles Wilde 703-913-9700	Demonstration	Completed 1992
BioGenesis Enterprises, Inc. Springfield, VA	Sediment Washing System	Charles Wilde 703-913-9700	Demonstration	Ongoing
BWX Tech., Inc. (Affiliate of Babcock and Wilcox Co. Lynchburg, VA	Cyclone Furnace	Evan Reynolds 804-522-6000	Emerging Technology  Demonstration	Completed 1992  Completed 1991
Dynaphore, Inc. Richmond, VA	Removal of Dissolved Heavy Metals via FORAGER Sponge	Norman Rainer 804-288-7109	Demonstration	Completed 1994
ITT Industries Roanoke, VA	Enhanced In-Situ Bioremediation of Chlorinated Compounds	Rosann Kryczkowski 540-362-7356	Demonstration	Completed 1999
Wako Chemicals Richmond, VA	Dioxin Elisa Kit	Emmy Leung 877-714-1920	Monitoring and Measurement Technology	Completed 2004
<b>Washington</b>				
ECOVA Corporation Redmond, WA	Bioslurry Reactor	Alan Jones 206-883-1900	Demonstration	Completed 1991

## SITE PROJECTS - BY DEVELOPER STATE

Developer	Technology	Contact	Program	Status
<b>Washington (continued)</b>				
Geosafe Corporation Richland, WA	In-situ Vitrification	James Hansen Matthew Haass 509-375-0710	Demonstration	Completed 1994
Ionics/ Resources Conservation Co. Bellevue, WA	BEST Solvent Extraction	William Hines 206-828-2400	Demonstration	Completed 1992
Keeco	Chemical Stabilization of Mercury Mining Wastes	Amy Anderson 888-977-9156	Demonstration	Completed 2001
Port of Ridgefield	Steam Enhanced Remediation	Brent Grening 360-887-3873	Demonstration	Ongoing
Remediation Technologies, Inc. (ReTec) Seattle, WA	Methanotrophic Biofilm Reactor	Hans Stroo 206-624-9349	Emerging Technology	Completed 1995
Remediation Technologies, Inc. (ReTec) Seattle, WA	Liquid and Soils Biological Treatment	Merv Cooper 206-624-9349	Demonstration	Completed 1994
Scitec Corporation Richland, WA	Field Portable X-Ray Fluorescence	Steve Santy 800-466-5323 509-783-9850	Monitoring and Measurement Technologies	Completed 1995
University of Washington Seattle, WA	Adsorptive Filtration	Mark Benjamin 206-543-7645	Emerging Technology	Completed 1992
Wilder Construction	Matcon Modified Asphalt Cap	W. Randall Garrett 800-484-9404	Demonstration	Completed 2001
<b>Wisconsin</b>				
Minergy	Thermal Sediment Reuse Technology	Terry Carroll 920- 727-1411	Demonstration	Completed 2001
Svedala Industries (formerly Allis Mineral Systems) Oak Creek, WI	Pyrokin Thermal Encapsulation Process	Jim Kidd 414-798-6341 Glenn Heian 414-762-1190	Emerging Technology	Completed 1993
US EPA/ NRMRL US- DA Forest Products Lab Madison	Fungus Treatment Technology	Richard Lamar 608-231-9469	Demonstration	Completed 1991
University of Wisconsin, Madison, WI	Photoelectro-catalytic Treatment of Metals and Organics in Water	Marc Anderson 608-262-2674 Charles Hill, Jr. 608-263-4593	Emerging Technology	Completed
<b>Wyoming</b>				
Western Research Institute Laramie, WY	Contained Recovery of Oily Wastes (CROW)	James Speight 307-721-2011	Emerging Technology  Demonstration	Completed 1991  Completed 1997

## SITE PROJECTS - BY DEVELOPER STATE

Developer	Technology	Contact	Program	Status
<b>Canada</b>				
Atomic Energy of Canada, Limited Chalk River, Ontario	Ultrasonic-Acid Leachate Treatment for Mixed Wastes	Shiv Vijayan 613-583-3311 ext. 3220/6057	Emerging Technology	Completed
Atomic Energy of Canada, Limited Chalk River, Ontario	Chemical Treatment and Ultrafiltration	Leo Buckley 613-584-3311	Emerging Technology	Completed 1993
Cone Tech Investigations Vancouver, British Columbia	Resistivity, pH, Seismic, Temperature, Cone Penetrometer	Ward Phillips 604-327-4311	Monitoring and Measurement Technologies	Completed 1992
ELI Ecologic International, Inc. Rockwood, Ontario	Thermal Gas Phase Reduction Process and Thermal Desorption	Jim Nash 519-856-9591	Demonstration	Completed 1992
EnviroMetal Technologies, Inc.	In Situ Reactive Barrier	John Vogan 519-824-0432	Demonstration	Completed 2000
EnviroMetal Technologies, Inc. Guelph, Ontario 2 Demonstrations	Metal Enhanced Abiotic Degradation	William Matulewicz 609-722-6700	Demonstration	Completed 1995  Completed
			Ex-situ  In-situ	
Geosyntec Guelph, Ontario	Emulsified Zero-valent Iron for DNAPL Remediation	Suzanne O'Hara 519-822-2230	Demonstration	Completed 2003
Grace Dearborn, Inc. Mississauga, Ontario	Daramend Process	Alan Seech Paul Bucen 905-272-7480	Demonstration	Completed 1994
Matrix Photocatalytic Limited (formerly Nutech Environmental) London, Ontario, Canada	TiO <sub>2</sub> Photocatalytic Treatment of Aqueous Waste Streams	Bob Henderson 519-660-8669	Emerging Technology	Completed 1994
Matrix Photocatalytic Limited	TiO <sub>2</sub> Photocatalytic Air Treatment	Bob Henderson 519-660-8669	Demonstration	Completed 1995
Toronto Harbour Comission Toronto, Ontario	Soil Recycling	Dennis Lang 416-863-2047	Demonstration	Completed 1992
Wastewater Technology Centre Burlington, Ontario	Cross-Flow Pervaporation System	Chris Lipski 905-639-6320	Emerging Technology	Completed 1992
Zenon Environmental Systems, Inc. Burlington, Ontario	Bioreactor Integrated with an Ultrafiltration Membrane System	Lisa Ashton 905-639-6320 ext. 244	Demonstration	Completed 1995
Zenon Environmental Systems, Inc. Burlington, Ontario	Cross-Flow Pervaporation System	Phil Canning Tony Tonelli 905-639-6320	Demonstration	Completed 1995
Zenon Environmental Systems, Inc. Burlington, Ontario	ZenoGem Process	Chris Lipski 905-639-6320	Demonstration	Completed 1995



## SITE PROJECTS - BY DEVELOPER STATE

Developer	Technology	Contact	Program	Status
<b>England/United Kingdom</b>				
AEA Technology (formerly Warren Spring Laboratory) Oxfordshire, England	Physical and Chemical Treatment	Steve Barber 011-44-1235- 463062	Emerging Technology	Completed 1994
Graseby Ionics, Limited Waterford Herts, England	Ion Mobility Spectrometry	John Brokenshire 011-44-1923- 816166 Martin Cohen 561-683-0507	Monitoring and Measurement Technologies	Completed 1990
<b>Italy</b>				
Gruppo Italimpresse (developed by Shirco Infrared Systems, Inc.) (formerly ECOVA) Rome, Italy 2 Demonstrations	Infrared Thermal Destruction	John Cioffi 206-883-1900	Demonstration	Completed 1987
<b>Puerto Rico</b>				
Terra Vac, Inc. San Juan, PR	In-situ Vacuum Extraction	James Malot 787-725-8750	Demonstration	Completed

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**Appendix C**

**SITE TECHNOLOGY DEMONSTRATION SITES  
(Alphabetically by Demonstration Site State)**

## TECHNOLOGY DEMONSTRATION SITES - BY SITE STATE

Demonstration Location	Technology	Contact	Program	Status
<b>Alaska</b>				
Fairbanks, AK ABE Superfund Site (Region 10)	Soil Washing	Brice Environmental Services Corporation (BESCORP) Fairbanks, AK Craig Jones 907-452-2515	Demonstration	Completed 1992
<b>Arizona</b>				
Phoenix, AZ Pesticide Site (Region 9)	Low Temperature Thermal Aeration	Smith Environmental Services (formerly Canonie) Englewood, CO Joe Hutton 219-926-8651	Demonstration	Completed 1992
Phoenix, AZ Pesticide Site (Region 9)	Anaerobic Thermal Processor	Smith Environmental Services (formerly Canonie) Englewood, CO Joe Hutton 219-926-8651	Demonstration	Completed
Phoenix, AZ Williams AFB (Region 9)	In-situ Subsurface Bioremediation	Bio-Rem Butler, IN David O. Mann 219-868-5823	Demonstration	Completed 1993
<b>Arkansas</b>				
Jefferson, AR Incineration Research Facility (IRF) (Region 6)	Tunable-Pulse Combustion	Sonotech, Inc. Atlanta, GA Ben Zinn 404-894-3033	Demonstration	Completed 1995
	Pyreton Burner (Thermal Destruction)	American Combustion Technologies Norcross, GA Gregory Gitman 404-564-4180	Demonstration	Completed 1988
<b>California</b>				
Burbank, CA Lockheed Site (Region 9)	Integrated In-situ Vapor Extraction and Steam Vacuum Stripping Process	Radian Corporation (formerly AWD Technologies, Inc.) Walnut Creek, CA David Bluestein 415-227-0822	Demonstration	Completed 1990
Clear Lake, CA	Biostabilization of Mercury Mining Wastes	Pintail Systems, Inc. Aurora, CO Leslie Thompson 303-367-8443	Demonstration	Completed
Clear Lake, CA	Chemical Stabilization of Mercury Mining Wastes	Sevenson, W.C. Munster, IN Steve Chisick 219-836-0116	Demonstration	Exited

## TECHNOLOGY DEMONSTRATION SITES – BY SITE STATE

Demonstration Location	Technology	Contact	Program	Status
California (continued)				
Clear Lake, CA	Chemical Stabilization of Mercury Mining Wastes	E&C Williams Summerville, SC Charlie Williams 84-821-4200	Demonstration	Completed 2001
Edwards AFB, CA (Region 9)	CAV-OX Oxidation Process	Magnum Water Technology El Segundo, CA Dale Cox 310-640-7000	Demonstration	Completed 1993
Fresno, CA Selma Site (Region 9)	Entrained-Bed Gasfication	Texaco, Inc. S. El Monte, CA John Wintor 310-908-7387	Demonstration	Completed 1994
Fresno, CA Selma Site (Region 9)	Silicate Compounds by Solidification/ Stabilizoiin	STC Omega (formerly Silicate Technology Corporation) Scottsdale, AZ Steve Pegler 602-948-7100	Demonstration	Completed 1990
Fullerton, CA McColl Superfund Site (Region 9)	Excavation and Foam Suppression of Volatiles	U.S. EPA Region 9 San Francisco, CA Jon Blevins 415-744-2400	Demonstration	Completed 1990
Huntington Beach, CA Rainbow Disposal (Region 9)	Steam Injection/ Vacuum Extraction (SIVE)	Hughes Environmental Manhattan Beach, CA (No longer a vendor for SIVE) Paul De Percin U.S. EPA 513-569-7797	Demonstration	Completed 1993
Jackson, CA Pintail Systems, Inc. (Region 9)	Biological Stabilization of Arsenic in Soils	Pintail Systems, Inc. Aurora, CO Leslie Thompson 303-367-8443	Demonstration	Completed 2000
Leviathan Mine Site (Region 9)	Biphasic Lime Treatment	State of CA Chris Stetler 530-542-5461	Demonstration	Completed 2004
Leviathan Mine Site (Region 9)	Passive Constructed Wetlands	University of NV, Reno Tim Tsukamoto 775-784-4413	Demonstration	Ongoing
Leviathan Mine Site (Region 9)	Lime Lagoons	ARCO Barry Duff 406-563-5211	Demonstration	Completed 2004
Livermore, CA Lawrence Livermore National Laboratory (LLNL) (Region 9)	Chemical Oxidation Perox-Pure	Calgon Carbon Oxidation Technologies (formerly Peroxidation Systems, Inc.) Pittsburgh, PA Bertrand Dussert 412-787-6681	Demonstration	Completed 1995

## TECHNOLOGY DEMONSTRATION SITES – BY SITE STATE

Demonstration Location	Technology	Contact	Program	Status
California (continued)				
Livermore, CA LLNL (Region 9)	In-situ Enhanced Extraction	Berkley Environmental Restoration (formerly Udell Technologies, Inc.) Emeryville, CA Kent Udell 510-653-9477	Demonstration	Completed 1993
March AFB, CA (Region 9)	In well Air Stripping	Roy Weston Woodland Hills, CA Jeff Bannon 818-971-4900	Demonstration	Completed 1994
Port Hueneme, CA Naval Facilities Engineering Service Center (Region 9)	Solvated Electron Treatment of Chlorinated Organics	Commodore Environmental Columbus, OH Neil Dronby 614-297-0365	Demonstration	Completed 1996
Redding, CA Iron Mountain Superfund Site	Precipitation, Microfiltration, Sludge Dewatering	EPOC Water, Inc. Fresno, CA Scott Jackson 209-291-8144	Demonstration	Completed 1993
Sacramento, CA McClellan AFB (Region 9)	Photolytic Destruction for SVE Off-gases	Process Technologies, Inc. Boise, ID Michael Swan 208-385-0900	Demonstration	Exited
Sacramento, CA McClellan AFB (Region 9)	Groundwater Extraction	Xerox Two Phase Extraction Webster, NY Ron Hess 716-422-3694	Demonstration	Completed 1995
San Diego, CA	Circulating Bed Cumbuster	General Atomics (formerlt Ogden Environmental Services) San Diego, CA Robert Goforth 619-455-2499	Demonstration	Completed 1989
San Diego, CA Naval Air Station North Island (NASNI) (Region 9)	In Well Vapor Stripping of Ground Water	MACTEC Environmental, Inc. Pittsburgh, PA Mark McGlathery 800-444-6221	Demonstration	Completed 1999
San Diego, CA NASNI Site 9 (Region 9)	Cross-flow Pervaporation System for Removal of VOCs from Groundwater	Zenon Environmental, Inc. Burlington, Ontario, Canada Phil Canning 905-639-6320	Demonstration	Completed 1995
San Francisco, CA Westin Hotel (Region 9)	GIS/KEY Software for HW Site Data Management	GIS Solutions, Inc. Concord, CA Garry Reid 510-827-5400	Demonstration	Completed 1993

## TECHNOLOGY DEMONSTRATION SITES – BY SITE STATE

Demonstration Location	Technology	Contact	Program	Status
<b>California (continued)</b>				
San Jose, CA Lorentz Barrel and Drum Site (Region 9)	Ultraviolet Ozone Treatment for Liquids	US Filter (formerly Ultrox International, Inc) Santa Ana, CA John Lowry 412-772-1247	Demonstration	Completed
San Pedro, CA Annex Terminal (Region 9)	In-situ Steam/Air Stripping	Novaterra, Inc. (formerly Toxic Treatment, Inc.) Torrance, CA Phil La Mori 310-328-9433	Demonstration	Completed 1989
Santa Barbara, CA Santa Marie Health Care Services (UST Site) (Region 9)	Soil Washing/Geological Treatment	BioGenesis Enterprises (formerly BioVersal USA) Fairfax Station, VA Charles Wilde 703-250-3442 Mohsen Amiran 708-827-0024	Demonstration	Completed 1992
South El Monte, CA (Region 9)	Gasification Process	Texaco Syngas, Inc. White Plains, NY John Winter 316-251-4000 ext. 536	Demonstration	Completed 1994
<b>Colorado</b>				
Clear Creek, CO Burleigh Tunnel (Region 8)	Wetland-Based Treatment for Mineral Mine Drainage	Colorado Department of Health Denver, CO Jim Lewis 303-692-3390	Demonstration	Completed 1999
Denver, CO Rocky Flats (Region 8)	Colloid Polishing Method	Filter Flow Technology League City, TX Tod Johnson 713-334-6080	Demonstration	Completed 1992
Denver, CO DOE Rocky Flats (Region 8)	Core Barrel Soil Sampler	Simulprobe Technologies, Inc. CA Richard Laton 415-883-8787	Monitoring and Measurement	Completed
Denver, CO (Region 8)	Dual Tube Liner Soil Sampler	Art's Manufacturing and Supply American Falls, ID Brian Anderson 800-635-7330	Monitoring and Measurement	Completed
Denver, CO (Region 8)	Electrocoagulation	General Environmental Inc. (formerly Hydrologics, Inc.) Englewood, CO Carl Dalrymple 303-761-6960	Demonstration	Completed 1995
Denver, CO (Region 8)	EMFLUX Soil Gas Survey System	Quadrel Services, Inc. MD Bruce Tucker Paul Henning 301-874-5510	Monitoring and Measurement	Completed

## TECHNOLOGY DEMONSTRATION SITES – BY SITE STATE

Demonstration Location	Technology	Contact	Program	Status
<b>Colorado (continued)</b>				
Denver, CO (Region 8)	Gore-Scrubber Passive Soil Gas Sampler	W. L. Gore and Associates, Inc. Elkton, MD Ray Fenstermacher 410-392-7600	Monitoring and Measurement	Completed
Denver, CO (Region 8)	JMC Environmentalist's Subsoil Probe	Clements Associates, Inc. IA Jim Clements 515-792-8285	Monitoring and Measurement	Completed
Denver, CO (Region 8)	Large Bore Soil Sampler	Geoprobe Systems Salina, KS Wesley McCall Tom Omli 800-436-7762	Monitoring and Measurement	Completed
Rocky Flats, CO (Region 8)	In-situ Reactive Barrier	EnviroMetal Technologies, Inc. Guelph, Ontario John Vogan 519-824-0432	Demonstration	Completed 2000
Rocky Mountain Arsenal, CO (Region 8)	Biological Treatment, HRC of Organics	Regenesis CA Stephen Koenigsberg 949-366-8000	Demonstration	Completed 2002
Rocky Mountain Arsenal, CO (Region 8)	In-Situ Thermal	Terra-Therm LLC Ralph Baker 978-343-0300	Demonstration	Completed 2002
Summitville, CO (Region 8)	Multiple Innovative Passive mine Drainage Technologies	Region 8 and State of CO Victor Kettelapper 303-312-6578	Demonstration	Completed 2001
<b>Connecticut</b>				
Roosevelt Mills Vernon, CT	Permanganate/ Persulfate Oxidation Treatment for PCE	Univ. of Connecticut George Hoag 860-486-2781	Demonstration	Ongoing
<b>Delaware</b>				
Dover, DE (Region 3) & Elgin, IL (Region 5)	Matcon Modified Asphalt Cap	Wilder Construction Co., WA W. Randall Garrett 800-484-9404	Demonstration	Completed 2001
<b>District of Columbia</b>				
Anacostia River Washington, D.C. (Region 3)	Innovative Capping Design	Remediation Technology Development Forum, HSRL	Demonstration	Ongoing

## TECHNOLOGY DEMONSTRATION SITES – BY SITE STATE

Demonstration Location	Technology	Contact	Program	Status
Florida				
Brandon, FL Peak Oil Superfund Site (Region 4)	Infrared Incinerator	Grupo Italimprese (Ecova Europa) (formerly ECOVA) Rome, Italy John Cioffi 206-883-1900	Demonstration	Completed 1987
Cape Canaveral, FL (Region 4)	Dynamic Underground Stripping of TCE	Integrated Water Resources, Inc. 805-565-0996	Demonstration	Completed 2002
Cape Canaveral, FL (Region 4)	Emulsified Zero-valent Iron for DNAPL Remediation	Geosyntec Guelph, Ontario Suzanne O'Hara 519-822-2230	Demonstration	Completed 2003
Hialeah, FL General Electric Service Shop	In-situ Solidification/Stabilization	Geo-Con, Inc. Monroville, PA Linda Ward Robert Hayden 412-856-7700	Demonstration	Completed 1988
Kennedy Space Center, FL (Region 4)	XRF Analyzer	Innov-X Systems, Inc. Woburn, MA Rose Koch 781-938-5005	Monitoring and Measurement Technologies	Ongoing
Kennedy Space Center, FL (Region 4)	XRF Analyzer	Niton Corp. Billerica, MA Debbie Schatzlein	Monitoring and Measurement Technologies	Ongoing
Kennedy Space Center, FL (Region 4)	XRF Analyzer	Oxford Instruments Analytical Chicago, IL Ruhre Gehrlein	Monitoring and Measurement Technologies	Ongoing
Kennedy Space Center, FL (Region 4)	XRF Analyzer	Rigaku, Inc. Woodlands, TX John Martin 281-363-1033	Monitoring and Measurement Technologies	Ongoing
Kennedy Space Center, FL (Region 4)	XRF Analyzer	Rontec USA, Inc. Carlisle, MA Paul Smith 978-266-2900	Monitoring and Measurement Technologies	Ongoing
Kennedy Space Center, FL (Region 4)	XRF Analyzer	Xcalibur XRF Services, Inc. Islandia, NY 631-435-9749	Monitoring and Measurement Technologies	Ongoing
Pensacola, FL American Creosote Works (Region 4)	Filtration	SBP Technologies, Inc. Baton Rouge, LA Clayton Page 504-755-7711	Demonstration	Completed 1992



## TECHNOLOGY DEMONSTRATION SITES – BY SITE STATE

Demonstration Location	Technology	Contact	Program	Status
<b>Florida (continued)</b>				
Pensacola, FL Escambia Wood Preserving Site (Region 4)	Soil Washing	U.S. EPA Mobile Volume Reduction Unit Cincinnati, OH Richard Griffith 908-321-6629	Demonstration	Completed 1992
Petroleum Products Corporation Miami, FL	Oleofilter	North American Technologies Aprotek San Ramon, CA Cathryn Wmberly 916-366-6185	Demonstration	Completed
<b>Georgia</b>				
Chickamuga, GA and Hopkinsville, GA (Region 4)	Debris Washing System	U.S. EPA NRMRL Cincinnati, OH Mike Taylor 512-782-4700	Demonstration	Completed 1990
Warner Robins, GA Robins AFB (Region 4)	Stabilization of Organics	WASTECH, Inc. Oak Ridge, TN Benjamin Peacock 615-483-6515	Demonstration	Completed 1991
<b>Hawaii</b>				
Ford Island, HI (Region 9)	In-Situ Hydrogen- Enhanced Remediation	Limno-Tech, Inc. Ann Arbor, MI John Wolfe 734-332-1200	Demonstration	Ongoing
Pearl Harbor, HI (Region 9)	PCB/Metals Extraction from Porous Surfaces	EET Inc. Bellaire, TX Tim Tarrillion 713-662-0727	Demonstration	Completed 1997
Pearl Harbor, HI Naval Facility (Region 9)	Electrokinetics	Geokinetics CA Steven Clark 510-704-2940	Demonstration	Completed 2000
Pearl Harbor, HI Naval Facility (Region 9)	Electrokinetic Flushing & Surfactant Flushing	Geokinetics and Duke Engineering TX Steven Clark 510-704-2940 Harry Linnemeyer 512-425-2000	Demonstration	Completed 1999
Pearl Harbor, HI Naval Facility (Region 9)	Set Process for PCBs in Soil	Commodore Advanced Sciences, Inc. Albuquerque, NM Mark Jones 505-872-6803	Demonstration	Completed 2000
Pearl Harbor, HI Naval Facility (Region 9)	Closed Loop Lead Recovery	Geokinetics CA Stephen Clark 510-704-2940	Demonstration	Completed 2002

## TECHNOLOGY DEMONSTRATION SITES – BY SITE STATE

Demonstration Location	Technology	Contact	Program	Status
<b>Hawaii (continued)</b>				
Pearl Harbor, HI (Region 9)	Microbial Cell Technology	University of Hawaii Honolulu, HI Dr. Ping-Yi Yang 808-956-8459	Demonstration	Ongoing
<b>Idaho</b>				
Aberjona River	Sediment Core Sampler	Aquatic Research ID Will Young (208) 768-2222	Monitoring and Measurement	Completed
INEEL Lab	Phytoremediation	Argonne National Laboratory West Idaho Fall, ID Scott Lee (208) 533-7829	Demonstration	Completed 2003
<b>Illinois</b>				
Chicago, IL (Region 4)	Hydraulic Fracturing	U.S. EPA/ NRMRL Cincinnati, OH William Slack 513-469-6040	Demonstration	Completed 1992
Elgin, IL (Region 5) & Dover, DE (Region 3)	Matcon Modified Asphalt Cap	Wilder Construction Co., WA W. Randall Garrett 800-484-9404	Demonstration	Completed 2001
Waukegan Harbor, IL (Region 5)	Thermal Desorption	SoilTech, ATP Systems Inc. Porter, IN Joe Hutton 219-926-8651	Demonstration	Completed 1992
<b>Indiana</b>				
Gary, IN Indiana Harbour (Region 5)	Solvent Extraction	Ionics/Resources Conservation, Co. Bellevue, WA Bill Hines 206-828-2400	Demonstration	Completed 1992
<b>Iowa</b>				
Albert City, IA (Region 7)	Core Barrel Soil Sampler	Simulprobe Technologies, Inc. CA Richard Laton 415-883-8787	Monitoring and Measurement	Completed
Albert City, IA (Region 7)	Dual Tube Liner Soil Sampler	Art's Manufacturing and Supply American Falls, ID Brian Anderson 800-635-7330	Monitoring and Measurement	Completed



## TECHNOLOGY DEMONSTRATION SITES – BY SITE STATE

Demonstration Location	Technology	Contact	Program	Status
<b>Maine</b>				
Loring AFB Caribou, ME (Region 1)	In-situ Thermal (Steam Injection)	Steam Tech Environmental Services Bakersfield, CA Hank Sowers 661-322-6478	Demonstration	Completed 2003
<b>Massachusetts</b>				
Boston, MA (Region 1)	AMS Split Core Sampler	Art's Manufacturing and Supply ID Brian Anderson 800-635-7330	Monitoring and Measurement	Completed 1999
Boston, MA (Region 1)	Russian Peat Borer	Aquatic Research Instruments ID Will Young 208-768-2222	Monitoring and Measurement	Completed
Grafton, MA (Region 1)	Anerobic-aerotic Bioremediation	Harding-Lawson Engineers, MA Willard Murray 781-245-6606	Demonstration	Completed 2003
Groveland, MA Groveland Wells Superfund Site	In-situ Vacuum Extraction	Terra Vac, Inc. San Juan, PR James Malot 787-725-8750	Demonstration	Completed
New Bedford, MA (Region 1)	Batch Organics Extraction Unit	CF Systems Corporation Arvada, CO L.V. Benningfield 303-420-1550	Demonstration	Completed
New Bedford, MA (Region 1)	Solvent Extraction	CF Systems Corporation Arvada, CO L.V. Benningfield 303-420-1550	Demonstration	Completed 1988
North Dartmouth, MA Resolve Superfund Site (Region 1)	Thermal Desorption	OHM Environmental (formerly Chemical Waste Management Inc.) Lombarda, IL Dick Ayen 803-846-2413	Demonstration	Completed 1992
<b>Michigan</b>				
Adrian, MI Anderson Development (Region 5)	Thermal Desorption (physical)	Roy F. Weston, Inc. West Chester, PA Michael Cosmos 215-430-7423	Demonstration	Completed 1992
Bay City, MI Bay City Municipal Landfill (Region 5)	Thermal Gas Phase Reduction Process and Thermal Desorption	ELI Eco Logic International, Inc. Rockwood, Ontario, Canada Jim Nash 519-856-9591	Demonstration	Completed 1992

## TECHNOLOGY DEMONSTRATION SITES – BY SITE STATE

Demonstration Location	Technology	Contact	Program	Status
Michigan (continued)				
Buchanan, MI Electro-Voice (Region 5)	Subsurface Volatilization and Ventilation System (SVVS)	Billings & Associates, Inc. Albuquerque, NM Gale Billings 505-345-1116	Demonstration	Completed 1994
Detroit, MI (Region 5)	Debris Washing System	U.S. EPA/ NRMRL Cincinnati, Ohio Donald Sanning 513-569-7444	Demonstration	Completed 1990
Essexville, MI Saginaw Bay Confined Disposal Facility (Region 5)	Sediment Soil Washing	Bergmann, USA Gallatin, TN George Jones 615-230-2217	Demonstration	Completed 1992
Grand Ledge, MI Parsons Chemical Site (Region 5)	In-situ Vitrification	Geosafe Corporation Richland, WA James Hansen 509-375-0710	Demonstration	Completed 1994
Rose Township, MI (Region 5)	Infrared Incinerator	Grupo Italimprese (Ecova Europa) (formerly ECOVA) Jon Cioffi 206-883-1900	Demonstration	Completed 1987
Saginaw, MI (Region 5)	Immunoassay and Colorimetry for Dioxin	Strategic Diagnostics Bob Ferguson 800-544-8881	Monitoring and Measurement Technologies	Completed 2004
Saginaw, MI (Region 5)	Cell Based Immunoassay for Dioxin	Xenobiotics Jeff Sturkey 919-688-4804	Monitoring and Measurement Technologies	Completed 2004
Saginaw, MI (Region 5)	DFI Immunoassay for Dioxin	Cape Technologies Bob Harrison 207-741-2995	Monitoring and Measurement Technologies	Completed 2004
Saginaw, MI (Region 5)	Dioxin Elisa Kit	Emmy Leung 877-714-1920	Monitoring and Measurement Technologies	Completed 2004
Saginaw, MI (Region 5)	Immunoassay and Colorimetry for Dioxin	Hybrizyme Randy Allen 919-783-9595	Monitoring and Measurement Technologies	Completed 2004
St. Joseph, MI	Submerged Aerobic Fixed Film Reactor	Allied Signal Corporation Des Plains, IL Steve Lupton 708-391-3500	Demonstration	Completed
Minnesota				
McGillis & Gibbs Superfund Site New Bridge, MN (Region 5)	Biotreatment of Groundwater	BioTrol, Inc. Eden Prairie, MN Dennis Chilcote 612-942-8032	Demonstration	Completed 1989

## TECHNOLOGY DEMONSTRATION SITES – BY SITE STATE

Demonstration Location	Technology	Contact	Program	Status
<b>Minnesota (continued)</b>				
McGillis & Gibbs Superfund Site New Bridge, MN (Region 5)	Soil Washing	BioTrol, Inc. Eden Prairie, MN Dennis Chilcote 612-942-8032	Demonstration	Completed 1989
McGillis & Gibbs Superfund Site New Bridge, MN (Region 5)	Biological Aqueous Treatment System	BioTrol, Inc. Eden Prairie, MN Dennis Chilcote 612-942-8032	Demonstration	Completed 1989
Minneapolis, MN Private Oil Refining Company (Region 5)	Soil Washing/ Biological Treatment	BioGenesis Enterprises, Inc. (formerly BioVersal USA) Fairfax Station, VA Charles Wilde 703-250-3442 Mohsen Amiran 708-827-0024	Demonstration	Completed 1992
New Brighton, MN Twin Cities Army Ammunition Plant (TCAAP) (Region 5)	Removal of Lead from Soils	COGNIS TARRAMET Goss, MO Lou Magdits 573-626-3476	Demonstration	Completed 1994
St. Louis Park, MN (Region 5)	Bioventing (air-injection)	U.S. EPA/NRMRL Cincinnati, OH Paul McCauley 513-569-7444	Demonstration	Completed 1997
<b>Mississippi</b>				
Brookhaven, MS Brookhaven Wood Preserving (Region 4)	Fungus Treatment Technology	U.S. EPA/NRMRL USDA-Forest Products Lab Madison, WI Richard Lamar 608-231-9469	Demonstration	Completed 1991
<b>Montana</b>				
Butte, MT Butte-Silverbow Site (Region 8)	Plasma Heat	Retech, Inc. Ukiah, CA R.C. Eschenback 707-462-6522	Demonstration	Completed 1991
Butte, MT (Region 8)	Chemical Stabilization of Mercury Mining Waste	E&C Williams, SC Charlie Williams 843-821-4200 and Keeco, WA Amy Anderson 888-977-9156	Demonstration	Completed 2001
Mike Horse Mine, MT (Region 8)	Grouting Technique	Morrison Knudsen Corporation Boise, ID Kathryn Levihn Rick Raymondi 208-386-6115	Demonstration	Completed 1996

## TECHNOLOGY DEMONSTRATION SITES – BY SITE STATE

Demonstration Location	Technology	Contact	Program	Status
<b>Montana (continued)</b>				
St. Louis, MT Welldon Spring (Region 7)	Anaerobic Biological Destruction of TNT in Soil	J.R. Simplot Company Pocatello, ID Tom Yergovich 209-858-2511	Demonstration	Completed 1994
<b>Nebraska</b>				
Hastings, NE (Region 7)	Spray Irrigation	University of Nebraska- Lincoln Hasting, NE Ray Spalding 402-783-3931	Demonstration	Completed 1996
<b>Nevada</b>				
Battle Mountain, NV (Region 9)	Biodegradation of Cyanide	Pintail Systems, Inc. Aurora, CO Caren Caldwell 303-367-8443	Demonstration	Completed 1998
<b>New Hampshire</b>				
Hudson, NH (Region 1)	In-Situ Chemical Oxidation	Ken Sperry 484-224-3031	Demonstration	Ongoing
Milford, NH Savage Superfund Site (Region 1)	Surfactant Enhanced Aquifer Remediation	U.S. DOE, Duke Engineering G. Michael Shook 208-526-6945	Demonstration	Completed 1999
Plaistow, NH (Region 1)	Biodegradation of PCB's in Soils	Green Mountain Laboratories Montpelier, VT Adam Longee 802-223-1468	Demonstration	Completed 2000
<b>New Jersey</b>				
Bayonne, NJ (Region 2)	Thermal Sediment Reuse Technology	GTI Des Plaines, IL Anil Goyal 847-768-0605	Demonstration	Ongoing
Edison, NJ EPA (Region 2)	Solvent Extraction Carver- Greenfield Process	Dehydro Tech Corporation East Hanover, NJ Theodore Trowbridge 908-904-1606	Demonstration	Completed 1991
Hillsborough, NJ (Region 2)	Pneumatic Fracturing, Extraction and Hot Gas Injection	Accutech, Inc. Keyport NJ & New Jersey Institute of Technology, Newark, NJ John Liskowitz 908-739-6444	Demonstration	Completed 1992
Millville, NJ Nascoilte Site (Region 2)	Bioreactor Integrated with an Ultrafiltration Membrane System	Zenon Environmental, Inc. Burlington, Ontario, Canada Lisa Ashton 905-639-6320 ext. 244	Demonstration	Completed 1995

## TECHNOLOGY DEMONSTRATION SITES – BY SITE STATE

Demonstration Location	Technology	Contact	Program	Status
<b>New Jersey (continued)</b>				
Millville, NJ Nascoilte Site (Region 2)	ZenoGem Process	Zenon Environmental, Inc. Burlington, Ontario, Canada Chris Lipski 905-639-6320	Demonstration	Completed
Morganville, NJ Imperial Oil Co., Inc. Site (Region 3)	Solidification	Solidtech, Inc. Houston, TX Bill Stallworth 713-497-8558	Demonstration	Completed 1988
New Jersey (Region 2) and Venice, Italy	Sediment Washing System	Biogenesis Enterprises, Inc. Charles Wilde 703-913-9700	Demonstration	Ongoing
Pedricktown, NJ National Lead Industries (Region 2)	Removal of Dissolved Metals	Dynaphore/ Forager Sponge Richmond, VA Norman Rainer 804-288-7109	Demonstration	Completed 1994
Trenton, NJ (Region 2)	Phytoextraction of Metal from Soil	Phytotech, Inc. Monmouth, NJ Burt Ensley 908-438-0900	Demonstration	Completed 1998
Wayne, NJ (Region 2)	Ex-situ Metal- enhanced Abiotic Degredation	EnviroMetal Technologies, Inc. Guelph, Ontario William Matulewicz 609-722-6700	Demonstration	Completed 1995
<b>New Mexico</b>				
Albuquerque, NM (Region 6)	Electrokinetic Extraction in Unsaturated Soils	Sandia National Laboratories, Albuquerque, NM Eric Lindgren 505-844-3820	Demonstration	Completed 1999
<b>New York</b>				
Brant, NY Wide Beach (Region 2)	Thermal Desorption Dechlorination	SoilTech, ATP Systems, Inc. Porter, IN Joe Hutton 219-926-8651	Demonstration	Completed 1992
Brockport, NY Sweden-3 Chapman Site (Region 2)	Biovault, Bioventing and Groundwater Circulation Biological Treatment Process (multi-developer project)	NY State Bioremediation and SBP Technologies, Inc. White Plains, NY Clayton Page 504-755-7711	Demonstration	Completed 1995



## TECHNOLOGY DEMONSTRATION SITES – BY SITE STATE

Demonstration Location	Technology	Contact	Program	Status
<b>New York (continued)</b>				
Niagara Falls, NY (Region 2)	Cold Top Vitrification	New Jersey Institute of Technology (NJIT) Newark, NJ and Geo Tech Development Corporation, King of Prussia, PA William Librizzi 201-596-5846 Thomas Tate 610-337-8515	Demonstration	Exited
Upstate NY (Region 2)	In-situ Metal- enhanced Abiotic Degredation	EnviroMetal Technologies, Inc. Guelph, Ontario John Vogan 519-824-0432	Demonstration	Completed
Utica, NY (Region 2)	High Temperature Thermal Processor	Maxymillian Technologies, Inc. (Formerly Clean Berkshires) Lanesboro, MA Jim Maxymillian 413-499-3050	Demonstration	Completed 1993
Utica, NY Town Gas Site (Region 2)	Slurry Biodegradation	Remediation Technologies Inc. (ReTec) (formerly Mo Tec Inc.) Pittsburgh, PA David Nakles 412-826-3340	Demonstration	Completed 1991
<b>North Carolina</b>				
Morrisville, NC Koppers Site (Region 4)	Base-Catalyzed Destruction (Dehalogenation)	U.S. EPA/ NRMRL Cincinnati, OH George Huffman 513-569-7341 Environmental Inc. Blue Bell, PA Yei-Shong Shieh 215-832-0700	Demonstration	Completed 1993
Warrenton, NC (Region 4)	Base Catalyzed Decomposition	U.S. EPA NRMRL, Cincinnati, OH Terry Lyons 513-569-7589	Demonstration	Completed 2004
<b>Ohio</b>				
Aliance, OH Babcock & Wilcox Alliance Research Center (Region 5)	Cyclone Vitrification	Babcock & Wilcox Alliance Research Center Alliance, OH Lawrence King 216-829-7576	Demonstration	Completed 1991
Cincinnati, OH EPA T&E Facility (Region 5)	Bioslurry Reactor	ECOVA Corporation Redmond, WA Alan Jones 206-883-1900	Demonstration	Completed 1991

## TECHNOLOGY DEMONSTRATION SITES – BY SITE STATE

Demonstration Location	Technology	Contact	Program	Status
<b>Ohio (continued)</b>				
Crooksville, OH Pintail Systems, Inc. (Region 5)	Biostabilization of Lead	Pintail Systems, Inc. Aurora, CO Leslie Thompson 303-367-8443	Demonstration	Completed 2000
Dayton, OH (Region 5)	Hydraulic Fracturing	U.S. EPA/ NRMRL Cincinnati, OH William Slack 513-469-6040	Demonstration	Completed 1992
DOE Fernald Facility, OH (Region 5)	Solvent Extraction	Terra Kleen Corporation (name changed back from Severson Extraction Technology, Inc.) Del Mar, CA Alan Cash 619-558-8762	Demonstration	Completed 1997
Roseville/ Crooksville, OH	Envirobond Soil Amendment (Stabilization)	Rocky Mountain Remedation Services Jim Barthel 303-215-6620	Demonstration	Completed
Roseville/ Crooksville, OH	Injection Soil Amendment (Stabilization)	Star Organics Phil Clarke 214-522-0742	Demonstration	Completed
<b>Oregon</b>				
Clackamas, OR Portable Equipment Co. Site (Region 10)	Chemical Fixation/ Stabilization	Advanced Remediation Mixing, Inc. (formerly Chemfix Technologies, Inc.) Metairie, LA Sam Pizzitola 504-461-0466	Demonstration	Completed 1989
<b>Pennsylvania</b>				
Douglassville, PA (Region 3)	Solidification/ Stabilization	Hazcon and Funderburk & Associates) Apollo Beach, FL Ray Funderburk 813-645-9620	Demonstration	Completed 1987
Monaca, PA	Flame Reactor	Horsehead Resource Development Co., Inc. Regis Zagrocki 610-826-8810	Demonstration	Completed
Palmerton, PA Palmerton Zinc Pile (Region 3)	Membrane Microfiltration	E.I. DuPont DeNemours & Company Newark, DE Oberlin Filter Company Waukesha, WI Ernest Mayer 302-774-2277	Demonstration	Completed 1990

## TECHNOLOGY DEMONSTRATION SITES – BY SITE STATE

Demonstration Location	Technology	Contact	Program	Status
<b>Pennsylvania (continued)</b>				
Stroudsburg, PA (Region 3)	Contained Recovery of Oil Wastes	Western Research Institute Laramie, WY James Speight 307-721-2011	Demonstration	Completed 1997
<b>Rhode Island</b>				
Central Landfill, RI (Region 1)	Reverse Osmosis: Disc-Tube Module Technology	ROCHEM Separations, Inc. Torrence, CA David LaMonica 310-370-3160	Demonstration	Completed 1994
N. Smithfield, RI (Region 1)	AIR II Photocatalytic Technology for Air Streams	KSE, Inc. Amhurst, MA James Kittrell 413-549-5506	Demonstration	Completed 1999
<b>South Carolina</b>				
Savannah River Site, SC (Region 4)	High Energy Irradiation for Destruction of Organics in Aqueous Solutions and Sludge	High Voltage Environmental Application, Inc. Florida and International University Miami, FL William Cooper 910-962-3450	Demonstration	Completed 1994
<b>Tennessee</b>				
Oak Ridge, TN (Region 4)	Photocatalytic Aqueous Phase Organics Destruction Matrix	Matrix, Inc. London, ON Robert Henderson 519-660-8669	Demonstration	Completed 1995
Oak Ridge, TN DOE Oak Ridge Facility (Region 4)	Freeze Barrier	Arctic Foundations Anchorage, AK Ed Yarmak 907-562-2741	Demonstration	Completed 1998
Oak Ridge, TN (Region 4)	Thermal Decomposition Atomic Absorption	Milestone Monroe, CT Stephen Billets U.S. EPA 702-798-2232	Monitoring and Measurement Technologies	Completed 2003
Oak Ridge, TN (Region 4)	Anodic Stripping Voltammetry	MTI, Inc. Wilmington, NC Stephen Billets U.S. EPA 702-798-2232	Monitoring and Measurement Technologies	Completed 2003
Oak Ridge, TN (Region 4)	XRF	Metorex Ewing, NJ Stephen Billets U.S. EPA 702-798-2232	Monitoring and Measurement Technologies	Completed 2003

## TECHNOLOGY DEMONSTRATION SITES – BY SITE STATE

Demonstration Location	Technology	Contact	Program	Status
<b>Tennessee (continued)</b>				
Oak Ridge, TN (Region 4)	Atomic Absorption Spectroscopy	Ohio Lumex Twinsburg, OH Stephen Billets U.S. EPA 702-798-2232	Monitoring and Measurement Technologies	Completed 2003
Oak Ridge, TN (Region 4)	XRF	Niton Corp. Billerica, MA Stephen Billets U.S. EPA 702-798-2232	Monitoring and Measurement Technologies	Completed 2003
<b>Texas</b>				
Fort Worth, TX Carswell AFB (Region 6)	Phytoremediation of TCE in Groundwater	ASC/EMR Wright Patterson AFB Dayton, Ohio Greg Harvey 513-255-7716	Demonstration	Completed 1998
Goldthwaite, TX Lower Colorado River Authority Electrical Substation	Microbial Degradation/ Solvent Extraction	Envirogen, Inc. Lawrenceville, NJ Ronald Unterman 609-936-9300	Demonstration	Completed 2000
Goldthwaite, TX (Region 6)	Microbial Degradation of PCBs	Micro-BAC Int., TX 512-310-9000 X-19 Biological Products, CA 408-970-9485	Demonstration	Completed 2002
San Antonio, TX Kelly AFB (Region 6)	Hot Air Injection	Hrubetz Environmental Services, Inc. Dallas, TX Michael or Barbara Hrubetz 214-363-7833	Demonstration	Completed 1993
San Antonio, TX Kelly AFB (Region 6)	Radio-Frequency Heating	IITRI/NUS IITRI-Chicago, IL and Haliburton/NUS Oak Ridge, TN Clifford Blanchard 615-483-9900	Demonstration	Completed 1994
San Antonio, TX Kelly AFB (Region 6)	Radio-Frequency Heating	KAI/HNUS Oak Ridge, TN Cliff Blanchard 615-483-9900	Demonstration	Completed 1994
<b>Utah</b>				
Hill AFB, UT (Region 8)	Steam Injection/ Vacuum Extraction	Praxis Environmental Services San Francisco, CA Dr. Lloyd Steward 415-641-9044	Demonstration	Completed 1997

## TECHNOLOGY DEMONSTRATION SITES – BY SITE STATE

Demonstration Location	Technology	Contact	Program	Status
<b>Utah (continued)</b>				
Midvale Slag, UT	Molecular Bonding System	Solucorp Saddleback, NJ Robert Kuhn 914-623-2333	Demonstration	Completed
Ogden, UT Chevron Transfer Facility	Phytoremediation of Petroleum in Soil and Groundwater	Phytokinetics, Inc. Logan, UT Ari Ferro 801-750-0985	Demonstration	Completed 1999
<b>Virginia</b>				
Roanoke, VA ITT Night Vision Facility (Region 3)	Enhanced In-situ Bioremediation of Chlorinated Compounds	ITT Industries Roanoke, VA Rosann Kryczkowski 540-362-7356	Demonstration	Completed 1999
<b>Washington</b>				
Ellensburg, WA (Region 10)	Anaerobic Biological Destruction of Dinoseb in Soil	J. R. Simplot Company Pocatello, ID Tom Yergovich 209-858-2511	Demonstration	Completed July 1993
Whatcom Waterway Bellingham, WA	Electrochemical Geooxidation	Weiss Associates Joe Lovenitti	Demonstration	Completed 2003
Ridgefield, WA (Region 10)	Steam Enhanced Remediation	Port of Ridgefield Brent Grening 360-887-3873	Demonstration	Ongoing
<b>Wisconsin</b>				
Fox River, WI (Region 5)	Thermal Sediment Reuse Technology	Minergy, WI Terry Carroll 920-727-1411	Demonstration	Completed 2001
Green Bay, WI (Region 5)	AMS Split Core Sampler	Art's Manufacturing and Supply ID Brian Anderson 800-635-7330	Monitoring and Measurement	Completed 1999
Green Bay, WI (Region 5)	Russian Peat Borer	Aquatic Research Instruments ID Will Young 208-768-2222	Monitoring and Measurement	Completed
Sparta, WI U.S. DOD Fort McCoy (Region 5)	MAECTITE® Treatment Process	Sevenson Environmental Services, Inc. Munster, IN Chuck McPheeters 219-836-0116	Demonstration	Completed 2000
Jones Island CDF Milwaukee, WI (Region 5)	Phytoremediation	Army Corps of Engineers (Vicksburg, MS and Detroit MI)	Demonstration	Completed 2003

## TECHNOLOGY DEMONSTRATION SITES – BY SITE STATE

Demonstration Location	Technology	Contact	Program	Status
Various locations in U.S.				
10 sites around the nation	Alternate Cover Assessment Program (ACAP)	U.S. EPA NRMRL	Demonstration	Completed 2001
Canada				
Toronto, Canada Toronto Port Industrial Division	Treatment Train for Contaminated Soils	Toronto Harbor Commissioners Toronto, Canada Dennis Lang 416-863-2047	Demonstration	Completed 1992
Trenton, Ontario Domtar Wood Preserving Site	Bioremediation	GRACE Bioremediation Technologies Mississauga, Ontario, Canada Alan Seech 905-272-7480	Demonstration	Completed 1994
Italy				
Venice, Italy and New Jersey	Sediment Washing System	Biogenesis Enterprises, Inc. Charles Wilde 703-913-9700	Demonstration	Ongoing

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**Appendix D**

**ELECTRONIC TECHNICAL INFORMATION RESOURCES**

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## EPA Sources of Information on Innovative Remediation and Site Characterization Technologies

Listed below are U.S. Environmental Protection Agency (EPA) sources of information on Innovative Remediation and Site Characterization Technologies. Sources of information include: electronic information sources in the form of databases or Internet sites, as well as programs, partnerships and organizations accessible on the Internet.

### REMEDIATION TECHNOLOGIES

#### *Electronic Information Sources*

**Innovative Remediation Technologies: Field-Scale Demonstration Projects in North America Second Edition Database.** The searchable database contains information about 600 completed innovative technology field demonstration projects in North America. The purpose of the database is to consolidate key information from innovative demonstration projects into a single source and present that information in a format that enables the user to easily identify innovative technologies that may be appropriate to the user's particular site remediation needs. The database, which is limited to completed demonstration projects and a small number of full-scale cleanup efforts, does not include emerging technologies or laboratory-scale projects. A summary report, EPA 542-B00/004 of the same name is available from EPA's National Service Center for Environmental Publications or accessed free of charge from the CLU IN Internet site at <<http://clu-in.org/products/nairt>>.

**Hazardous Waste Clean-Up Information (CLU-IN) Home Page.** CLU-IN is a streamlined source of information about innovative remediation and site characterization technologies for hazardous waste cleanup professionals. It provides access to information about programs, organizations, publications, and other tools for EPA and other Federal and State personnel, consulting engineers, technology developers and vendors, remediation contractors, researchers, community groups, and individual citizens. Access to various pools of information is presented in the form of downloadable publications and databases. Sources of additional information on the Internet also are presented through a series of links. CLU-IN is sponsored by EPA's Technology Innovation Office (TIO). For additional information about the CLU-IN home page, call (301) 589-5318. CLU-IN can be accessed through the Internet at <<http://clu-in.org>>.

**Innovative Treatment Technologies: Annual Status Report (ASR) Eleventh Edition EPA/542/R-03/009 and ASR Search System.** This report contains information about remedies selected at contaminated waste sites. The sites include Superfund remedial and removal sites and some non-Superfund sites being remediated by the U.S. Department of Energy (DOE), the U.S. Department of Defense (DoD), or under the RCRA corrective action

program. The ASR online site cleanup information system includes Superfund site-specific data such as remedy selected, contaminants and media treated, project status, and site contact. The online database is available at <http://cfpub.epa.gov/asr>. If you have questions or comments about the system, please call EPA's TIP at (703) 603-9904. The report can be ordered or downloaded free of charge from the CLU-IN Internet site at <<http://clu-in.org/asr>>. To order a copy of the report by phone, call EPA's National Service Center for Environmental Publications at (800) 490-9198 or (513) 489-8190.

**EPA Remediation and Characterization Innovative Technologies (EPA REACH IT).** EPA REACH IT, sponsored by EPA's Technology Innovation Program (TIP), is a system that lets environmental professionals use the power of the Internet to search, view, download, and print information about innovative remediation and characterization technologies. EPA REACH IT provides information about more than 750 service providers that offer characterization technologies. EPA REACH IT combines information from three established EPA databases, the Vendor Information System for Innovative Treatment Technologies (VISITT), the Vendor Field Analytical and Characterization Technologies System (Vendor FACTS), and the Innovative Treatment Technologies (ITT), to give users access to comprehensive information about treatment and characterization technologies and their applications. It combines information submitted by technology service providers about remediation and characterization technologies with information from EPA, the U.S. Department of Defense (DoD), the U.S. Department of Energy (DOE), and state project managers about sites at which innovative technologies are being deployed. EPA REACH IT can be accessed through the Internet at <http://www.epareachit.org>. It is best viewed using Netscape Navigator or Microsoft Internet Explorer, version 4.0 or higher. In 2006 EPA will replace the online system with simplified, downloadable database or spreadsheet.

**Site Remediation Technology Infobase.** The Site Remediation Technology Infobase was founded by EPA and prepared for the federal agencies participating in the Federal Remediation Technologies Roundtable. It provides information on federal cleanup programs; federal site remediation technology development assistance programs, and databases; federal electronic resources for site remediation; other electronic resources for site remediation

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technology information; a bibliography of selected federal publications on alternative and innovative site remediation technologies; technology survey reports; and technology program contacts for DOD, DOE, and EPA. It can be accessed through the Internet at:

<http://www.frtr.gov/publications/infobse/98.html>.

**Cost and Performance Catalog of Case Studies.** The Cost and Performance Catalog of Case Studies is a joint effort of Federal Remediation Technologies Roundtable members to publish case study reports on full- and demonstration-scale remediation projects. As of May 2001, member agencies of the Roundtable have completed 274 cost and performance case study reports. The reports (March 1995-May 2001) can be accessed by the Cost and Performance Case Studies Search:

<http://bigisland.ttclients.com/frtr/search.html>.

**Remediation Technologies Screening Matrix and Reference Guide, Version 3.0.** The Remediation Technologies Screening Matrix and Reference Guide, Version 3.0, prepared for federal agencies participating on the Federal Remediation Technology Roundtable (FRTR), provides a “yellow pages” of remediation technologies information. The guide is intended to assist remedial project managers (RPM) to screen and evaluate candidate cleanup technologies and select the best remedial alternative(s) for contaminated installations, facilities, or waste sites. The guide also assists environmental professionals in gathering essential descriptive information on the respective technologies. The guide incorporates cost and performance data to the maximum extent available and focuses primarily on demonstrated technologies. However, information on emerging technologies also is included in the guide. The guide can be accessed through the Internet at <http://www.frtr.gov>.

**TechDirect.** TechDirect, hosted by EPA’s TIP, is an information service that highlights new publications and events of interest to environmental professionals. Information about site characterization and remediation technologies is available through this Internet subscription service. Once a month, the service distributes by electronic mail a message describing the availability of publications and announcements of events. For publications, the message explains how to obtain a hard copy or how to download an electronic version from the Internet. For additional information about TechDirect, contact Jeff Heimerman at (703) 603-7191 or by E-mail at [heimerman.jeff@epamail.epa.gov](mailto:heimerman.jeff@epamail.epa.gov). TechDirect can be accessed through the Internet at <http://clu-in.org>.

### **Programs, Partnerships, And Organizations**

**EPA Library Network Program.** The EPA National Library Network Program is a repository of information

from EPA’s Headquarters, Regional and Field Offices, Research Centers, and specialized laboratories throughout the country. The Library Network provides access to its collection through the On-line Library System (OLS), a menu-driven database of the library’s holdings. The OLS provides users with the ability to perform online searches by author, title, or keyword. The EPA National Library Network Program can be accessed through the Internet at <http://www.epa.gov/natlibra>.

**Federal Remediation Technologies Roundtable (FRTR).** FRTR is an interagency working group that provides a forum for the exchange of information regarding the development and demonstration of innovative technologies for the remediation of hazardous waste sites. The forum also synthesizes the technical knowledge that Federal Agencies have compiled and provides a more comprehensive record of performance and cost of the technologies. Participating agencies include DoD, the U.S. Army Corps of Engineers, the U.S. Navy, the U.S. Air Force, DOE, the U.S. Department of the Interior, and EPA. FRTR can be accessed through the Internet at <http://www.frtr.gov>.

**Ground-Water Remediation Technologies Analysis Center (GWRTAC).** GWRTAC was established through a cooperative agreement between the National Environmental Technology Applications Center (NETAC) of the Center for Hazardous Materials Research (CHMR) and EPA. The goal of GWRTAC is to compile, analyze, and disseminate information about innovative ground-water remediation technologies to industry, the research community, contractors, government, investors, and the public. The center currently is compiling information to be included in databases of interactive case studies and vendor information that will be available on the GWRTAC Internet site. GWRTAC can be accessed through the Internet at <http://www.gwrtac.org>.

**Office of Research and Development (ORD).** ORD, under the Assistant Administrator, Paul Gray, Ph. D., is the scientific and technological arm of EPA. Comprised of three headquarters offices, three national research laboratories and two national centers, ORD is organized around a basic strategy of risk assessment and risk assessment management to remediate environmental and human health problems. ORD focuses on the advancement of basic peer-reviewed scientific research and the implementation of cost-effective, common sense technology. Fundamental to ORD’s mission is a partnership with the academic scientific community through extramural research grants and fellowships to help develop the sound environmental research necessary to ensure effective policy and regulatory decisions. ORD also implements such programs as the Superfund Innovative Technology Evaluation (SITE) program which focuses on

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treatment technologies and EPA's Environmental Technology Verification Program (ETV) which focuses on site characterization technologies. ORD can be accessed through the Internet at <http://www.epa.gov/ORD/>.

**Remediation Technologies Development Forum (RTDF).** RTDF was established by EPA to foster public-private partnerships that would conduct laboratory and applied research to develop, test, and evaluate innovative remediation technologies. RTDF's home page provides access to information about various remediation technologies currently being designed, developed and evaluated through seven action teams of RTDF including: the Bioremediation of Chlorinated Solvents Consortium, the LASAGNA™ Partnership, the Permeable Reactive Barriers Action Team, the Sediments Remediation Action Team, the In-Place Inactivation and Natural Ecological Restoration Technologies (IINERT) Soil-Metals Action Team, the Phytoremediation of Organics Action Team, and the *In Situ* Flushing Action Team. RTDF can be accessed through the Internet at <http://www.rtdf.org>.

**Superfund Innovative Technology Evaluation (SITE) Demonstration Program.** The SITE Demonstration program was established by EPA's Office of Solid Waste and Emergency Response and the Office of Research and Development to encourage the development and implementation of innovative treatment technologies for the remediation of hazardous waste sites, and monitoring and measurement. Through the program, technologies are field-tested on hazardous waste materials and engineering and cost data are gathered on the innovative technology so that potential users can assess the technology's applicability to a particular site. Data collected during the field demonstrations 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 waste matrices, potential operating problems, and approximate capital and operating costs. The collected information is then provided in a Innovative Technology Evaluation Report, Technology Capsule, and Demonstration Bulletin. These reports evaluate all available information on the technology and analyze its overall applicability to other site characteristics, waste types, and waste matrices. Testing procedures, performance and cost data, and quality assurance and quality standards also are presented. The SITE Demonstration program can be accessed through the Internet at <http://www.epa.gov/ORD/SITE/>.

**Interstate Technology and Regulatory Council (ITRC).** ITRC is a state-led coalition working together with industry and stakeholders to achieve regulatory acceptance of environmental technologies. ITRC consists of more than 35 states, the District of Columbia, multiple federal partners, industry participants, and other stakeholders, cooperation to break down barriers and reduce compliance

costs, making it easier to use new technologies and helping states maximize resources. Originating in 1995 from a previous initiative by the Western Governors Association (WGA). ITRC brings together a diverse mix of environmental experts and stakeholders from both the public and private sectors to broaden and deepen technical knowledge and streamline the regulation of new environmental technologies. ITRC accomplishes its mission in two ways: it develops guidance documents and training courses to meet the needs of both regulators and environmental consultants, and it works with state representatives to ensure that ITRC products and services have maximum impact among state environmental agencies and technology users. ITRC technical work teams develop guidance documents and both classroom and Internet-based training courses to meet the information needs of regulatory staff, technology vendors, and environmental consultants. These products help state environmental agencies gain valuable technical knowledge and develop consistent regulatory approaches for reviewing and approving specific technologies. State regulators lead ITRC technical teams, which rely on broad-based participation from federal agencies, industry, academia, and other stakeholders in building collective knowledge and collaborative products. ITRC can be accessed through the Internet at <http://www.itrcweb.org>.

**Technology Innovation Program (TIP).** The U.S. Environmental Protection Agency's (EPA) TIP was created in 1990 to act as an advocate for new technologies. TIP's mission is to increase the application of innovative treatment technologies to contaminated waste sites, soils, and groundwater. To meet that mission, TIP has expanded its focus from treatment technologies to include site characterization technologies in order to improve the remediation process. TIP has encouraged and relied on cooperative ventures with other partners to accomplish many of its goals. This effort to effectively use resources has led to numerous joint efforts that have enhanced the state of both remediation and site characterization. For additional information about TIP, contact Jeff Heimerman of EPA's TIP at (703) 603-7191. TIP can be accessed through the Internet at <http://clu-in.org/tiomiss.cfm>.

## SITE CHARACTERIZATION TECHNOLOGIES

### *Electronic Sources of Information*

**EPA, National Exposure Research Laboratory - Hazardous Waste Site Characterization (on CD-ROM) (EPA 600-C-96-001).** The Hazardous Waste Site Characterization CD-ROM, developed by NERL's ESD-LV, compiles guidance documents and related software to aid environmental professionals in the complex, multidisciplinary, characterizing of hazardous waste sites.

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The CD-ROM is a compilation of computer programs related to EPA's RCRA and Superfund programs that can be printed, as well as searched by key words. Using the CD-ROM requires a personal computer with DOS Version 3.0 or higher, 640K of Ram, and 3 MB of hard disk space. A math co-processor is recommended but not required. The CD-ROM can be ordered on-line through the NTIS Internet site at <[www.ntis.gov](http://www.ntis.gov)>.

**Field Sampling and Analysis Technologies Matrix.** The Matrix, developed by participating agencies of the Federal Remediation Technologies Roundtable (FRTR), is a matrix and reference guide that is intended to provide users with an understanding of the site characterization technologies available to them and the applicability of various technologies to their particular problem(s). The Matrix provides a general understanding of state-of-the-art technologies for site characterization. The Matrix and reference guide also enhances technology information transfer and provides much needed comparison among competing technologies. The Matrix can be accessed through the Internet at <<http://www.frtr.gov/site>>.

**TechDirect.** TechDirect, hosted by EPA's TIP, is an information service that highlights new publications and events of interest to environmental professionals. Information about site characterization and remediation technologies are available through this Internet subscription service. Approximately once a month, the service distributes by electronic mail a message describing the availability of publications and announcements of events. For publications, the message explains how to obtain a hard copy or how to download an electronic version from the Internet. To subscribe to TechDirect and view archived messages, go to <<http://clu-in.org/newsletters>>.

### ***Programs, Partnerships, and Organizations***

**Consortium for Site Characterization and Technology (CSCT).** CSCT was established as one of 12 pilot projects currently implemented by EPA's Environmental Technology Verification (ETV) Program. The CSCT is a partnership program among the U.S. Environmental Protection Agency (EPA), the U.S. Department of Defense (DoD), and the U.S. Department of Energy (DOE) that is responsible for evaluating and verifying the performance of innovative site characterization technologies. The CSCT provides support to technology developers, evaluates and verifies data generated during demonstrations, and develops and disseminates information about the performance of site characterization technologies. CSCT can be accessed through the Internet at <<http://clu-in.org/csct.htm>>.

**Environmental Technology Verification Program.** The ETV program seeks to provide credible performance data on environmental technologies from independent third

parties under the auspices of EPA. It verifies the performance of innovative technical solutions to problems that threaten human health or the environment. Managed by EPA's ORD, ETV was created to substantially accelerate the entrance of new environmental technologies into domestic and international marketplaces. It supplies buyers of technologies, developers of those technologies, consulting engineers, states, and EPA regions with high-quality data on the performance of new technologies. ETV expands on past verification efforts, such as those conducted under the SITE program for remediation technologies. ETV currently implements 10 pilot projects, including the Consortium for Site Characterization Technology (CSCT). The ETV program can be accessed through the Internet at <<http://www.epa.gov/etv>>.

**EPA Library Network Program.** The EPA National Library Network Program is a repository of information from EPA's Headquarters, Regional and Field Offices, Research Centers, and specialized laboratories throughout the country. The Library Network provides access to its collection through the On-line Library System (OLS), a menu-driven database of the library's holdings. The OLS provides users with the ability to perform online searches by author, title, or keyword. The material on OLS is updated every two weeks. The EPA National Library Network Program can be accessed through the Internet at <<http://www.epa.gov/natlibra>>.

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**Appendix E**

**GLOSSARY OF REMEDIATION TECHNOLOGIES**

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This Appendix presents definitions and brief discussions of several innovative remediation technologies. Established/conventional technologies (including pump and treat, stabilization, vitrification, incineration, and excavation/disposal) are being replaced by these state-of-the-art, typically more cost-effective technologies. These established/conventional technologies are also discussed in this Appendix.

### **Innovative Remediation Technologies**

BIOREMEDIATION uses microorganisms to degrade organic contaminants in either excavated or in situ soil, sludge, and solids. The microorganisms break down contaminants by using them as a food source or cometabolizing them with a food source. Land farming, biopiles, composting, and slurry-phase bioremediation are examples of ex situ applications. Bioventing is a common form of in situ bioremediation which uses extraction wells to circulate air through the ground.

CHEMICAL TREATMENT, also known as chemical reduction/oxidation, typically converts hazardous contaminants to nonhazardous or less toxic compounds that are more stable, less mobile, or inert. The oxidizing agents most commonly used for treatment of hazardous contaminants in soil are ozone, hydrogen peroxide, hypochlorites, chlorine, chlorine dioxide, potassium permanganate, and Fentons reagent (hydrogen peroxide and iron). Cyanide oxidation and dechlorination are examples of chemical treatment. This method may be applied in situ or ex situ, to soils, sludges, sediments, and other solids, and may also be applied for the in situ treatment of groundwater.

ELECTROCHEMICAL REMEDIATION involves the passage of AC/DC current to mineralize organic compounds and to mobilize and remove metal contaminants. The electrical field created within the soil or sediment causes redox reactions that mineralize the organics and increase mobilization of metals. The metals migrate to the electrodes where they are deposited and removed.

IN SITU SOIL FLUSHING: large volumes of water, at times supplemented with surfactants, cosolvents, or treatment compounds, are applied to the soil or injected into the groundwater to raise the water table into the contaminated soil zone. Injected water and

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treatment agents are isolated within the underlying aquifer and recovered together with flushed contaminants.

PHYTOREMEDIATION is a process that uses plants (roots, shoots, tissues, and leaves) to remove, transfer, stabilize, or destroy contaminants in soil, sediment, and groundwater. Phytoremediation applies to all biological, chemical, and physical processes that are influenced by plants and that aid in cleanup of the contaminated substances. Plants can be used in site remediation, both through the mineralization of toxic organic compounds and through the accumulation and concentration of heavy metals and other inorganic compounds from soil into aboveground shoots. Phytoremediation may be applied in situ or ex situ, to soils, sludges, sediments, other solids, or groundwater.

DUAL-PHASE EXTRACTION, also known as multi-phase extraction, uses a vacuum system to remove various combinations of contaminated groundwater, separate-phase petroleum product, and vapors from the subsurface. The system lowers the water table around the well, exposing more of the formation. Contaminants in the newly exposed unsaturated zone are then accessible to soil vapor extraction. Once above ground, the extracted vapors or liquid-phase organics and ground water are separated and treated.

NANOTECHNOLOGY is described as the ability to work at the molecular level to create structures with new organizations and characteristics. Applications of this emerging technology include advances in pollution prevention, detection, and waste treatment, and remediation. Nanotechnology may allow for the removal of contaminants to levels currently unattainable and in a cost-effective manner.

SOLIDIFICATION/STABILIZATION (S/S) reduces the mobility of hazardous substances and contaminants in the environment through both physical and chemical means. The S/S process physically binds or encloses contaminants within a stabilized mass. S/S is performed both ex situ and in situ. Ex situ S/S requires excavation of the material to be treated, and the resultant material must be disposed. In situ S/S uses auger/caisson systems and injector head systems to add binders to the contaminated soil or waste without excavation, and the resultant material is left in place.

SOLVENT EXTRACTION uses an organic solvent as an extractant to separate organic and metal contaminants from soil. The organic solvent is mixed with contaminated soil in an extraction unit. The extracted solution is then passed through a separator, where the



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contaminants and extractant are separated from the soil. Organically bound metals may be extracted along with the target organic contaminants.

**IN SITU THERMAL DESORPTION:** wastes are heated so that organic contaminants and water volatilize. Typically, a carrier gas or vacuum system transports the volatilized water and organics to a gas treatment system.

**THERMALLY ENHANCED RECOVERY** uses heat to increase the volatilization rate of organics and facilitate extraction. Volatilized contaminants are typically removed from the vadose zone using soil vapor extraction. Specific types of these thermally enhanced recovery techniques include Contained Recovery of Oily Waste (CROW™), radio frequency heating, conductive heating, steam heating, in situ steam stripping, hot air injection, dynamic underground stripping, in situ thermal desorption, and electrical resistance heating. Thermally enhanced recovery is usually applied to contaminated soil, but may also be applied to groundwater.

**VITRIFICATION** uses an electric current to melt contaminated soil at elevated temperatures (1,600 to 2,000°C or 2,900 to 3,650°F). Upon cooling, the vitrification product is a chemically stable, leach-resistant, glass and crystalline material similar to obsidian or basalt rock. The high temperature component of the process destroys or removes organic materials. Radionuclides and heavy metals are retained within the vitrified product. Vitrification may be conducted in situ or ex situ.

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

### **Conventional Remediation Technologies**

**AIR SPARGING** involves the injection of air or oxygen through a contaminated aquifer. Injected air traverses horizontally and vertically in channels through the soil column, creating an

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underground stripper that removes volatile and semivolatile organic contaminants by volatilization. Soil Vapor Extraction is usually implemented in conjunction with air sparging to remove the generated vapor-phase contamination from the unsaturated zone. Oxygen added to the contaminated groundwater and vadose-zone soils also can enhance biodegradation of contaminants below and above the water table.

**EX SITU THERMAL DESORPTION:** wastes are heated so that organic contaminants and water volatilize. Typically, a carrier gas or vacuum system transports the volatilized water and organics to a gas treatment system.

**SOIL VAPOR EXTRACTION (SVE)** is used to remediate the zone of soil which is unsaturated with contaminated groundwater. A vacuum is applied to the soil to control the flow of air and remove volatile and some semivolatile organic contaminants from the soil.

For **SOIL WASHING**, contaminants are absorbed onto fine soil particle surfaces and are separated from bulk soil in a water-based system on the basis of particle size. The wash water may be augmented with a basic leaching agent, surfactant, or chelating agent or by adjustment of pH to help remove organics and heavy metals. Soils and wash water are mixed ex situ in a tank or other treatment unit. The wash water and various soil fractions are usually separated using gravity settling.

**VERTICAL ENGINEERED BARRIERS (VEBs)** are subsurface barriers made of an impermeable material designed to contain or divert groundwater. VEBs can be used to contain contaminated groundwater, divert uncontaminated groundwater from a contaminated area, or divert contaminated groundwater from a drinking water intake or other protected resource.

**INCINERATION** involves the ex situ destruction of contaminated soil, sludge, and sediment in high temperature (1,800 - 2,200°F) combustion devices. A typical hazardous waste incinerator consists of a rotary kiln (primary combustion chamber), an afterburner (secondary combustion chamber), connected to an air pollution control system, all of which are controlled and monitored.

**PUMP-AND-TREAT** involves removal of contaminated groundwater from the subsurface. Treatment and discharge or reinjection is one of the most widely used ground-water remediation technologies. The pump and treat remediation approach is used at about three-quarters of the Superfund sites where ground water is contaminated and at most sites where cleanup is required by the Resource Conservation and Recovery Act and state laws. It is often

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associated with treatment technologies such as Air Stripping and Liquid -phase Granular Activated Charcoal. Although the effectiveness of pump and treat systems has been called into question after two decades of use, this approach remains a necessary component of most ground-water remediation efforts and can be appropriate for both restoration and plume containment.