

**Technology Profiles**  
**Eleventh Edition**

**Volume 2**  
**Emerging Technology Program**

**National Risk Management Research Laboratory  
Office of Research and Development  
U.S. Environmental Protection Agency  
Cincinnati, Ohio 45268**

---

---

## **NOTICE**

The development of this document was funded by the U.S. Environmental Protection Agency (EPA) under Contract No. 68-W-01-032, Task Order 14, to Computer Sciences Corporation. The document was subjected to the Agency's administrative and peer review and was approved for publication as an EPA document. Mention of trade names or commercial products does not constitute endorsement or recommendation for use at any particular hazardous waste site.

---

---

## FOREWORD

The U.S. Environmental Protection Agency 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 is the Agency's center for investigation of technological and management approaches for preventing and reducing risks from pollution that threatens 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 the EPA's Office of Research and Development to assist the user community and to link researchers with their clients.

Hugh W. McKinnon, Director  
National Risk Management Research Laboratory

---

---

## ABSTRACT

The Superfund Innovative Technology Evaluation (SITE) Program, now in its sixteenth year is an integral part of EPA's research into alternative cleanup methods for hazardous waste sites around the nation. The SITE Program was created to encourage the development and routine use of innovative treatment and monitoring and measurement technologies. Under the program, EPA enters into cooperative agreements with technology developers. These developers research and refine their innovative technologies at bench- or pilot-scale and then, with EPA's support, demonstrate them at hazardous waste sites. As a result, the SITE Program provides environmental decision-makers with data on new, viable treatment technologies that may have performance or cost advantages compared to traditional treatment technologies.

This document is intended as a reference guide for those interested in technologies participating in the SITE Demonstration, Emerging Technology, and Measurement and Monitoring Programs. The two-page profiles are organized into two sections for each program, completed and ongoing projects, and are presented in alphabetical order by developer name. Reference tables for SITE Program participants precede the sections and contain EPA and developer contacts. Inquiries about a SITE technology evaluation or the SITE Program should be directed to the specific EPA project manager; inquiries on the technology process should be directed to the specific technology developer.

Each technology profile contains (1) a technology developer and process name, (2) a technology description, including a schematic diagram or photograph of the process, (3) a discussion of waste applicability, (4) a project status report, and (5) EPA project manager and technology developer contacts. The profiles also include summaries of demonstration results, if available. The technology description and waste applicability sections are written by the developer. EPA prepares the status and demonstration results sections.

A Trade Name Index and Applicability Index are also included in the back of this document. The Applicability Index is organized by 11 media categories, 19 waste categories, and 14 technology categories.

# TABLE OF CONTENTS

	Page
NOTICE .....	ii
FOREWORD .....	iii
ABSTRACT .....	iv
ACKNOWLEDGMENTS .....	x
SITE PROGRAM DESCRIPTION .....	1
SITE PROGRAM CONTACTS .....	6
<u>Completed Emerging Technology Program Projects</u>	
ACTIVE ENVIRONMENTAL TECHNOLOGIES, INC. .... (formerly EET, Inc.) (TechXtract® Decontamination Process) .....	8
ARIZONA STATE UNIVERSITY/ZENTOX CORPORATION .....	10
(Photocatalytic Oxidation with Air Stripping) .....	10
ART INTERNATIONAL, INC. .... (formerly ENVIRO-SCIENCES, INC.) (Low-Energy Extraction Process) .....	12
ATOMIC ENERGY OF CANADA, LIMITED .....	14
(Chemical Treatment and Ultrafiltration) .....	14
ATOMIC ENERGY OF CANADA LIMITED .....	16
(Ultrasonic-Aided Leachate Treatment) .....	16
BATTELLE MEMORIAL INSTITUTE .....	18
(In Situ Electroacoustic Soil Decontamination) .....	18
BIOTROL® .....	20
(Methanotrophic Bioreactor System) .....	20
BWX TECHNOLOGIES, INC. .... (an affiliate of BABCOCK & WILCOX CO.) (Cyclone Furnace) .....	22
COGNIS, INC. ....	24
(Biological/Chemical Treatment) .....	24
COGNIS, INC. ....	26
(TERRAMET® Soil Remediation System) .....	26
COLORADO DEPARTMENT OF PUBLIC HEALTH AND ENVIRONMENT .....	28
(Constructed Wetlands-Based Treatment) .....	28
(formerly Center for Hazardous Materials Research) (Acid Extraction Treatment System) .....	30
CONCURRENT TECHNOLOGIES .....	32
(formerly Center for Hazardous Materials Research) (Organics Destruction and Metals Stabilization) .....	32
CONCURRENT TECHNOLOGIES .....	34
(formerly Center for Hazardous Materials Research) (Smelting Lead-Containing Waste) .....	34
EBERLINE SERVICES, INC. .... (formerly Thermo Nutech, Inc./TMA Thermo Analytical, Inc.) (Segmented Gate System) .....	36
ELECTROKINETICS, INC. ....	38
(In Situ Bioremediation by Electrokinetic Injection) .....	38

## TABLE OF CONTENTS (Continued)

	Page
<u>Completed Emerging Technology Program Projects (Continued)</u>	
ELECTROKINETICS, INC. . . . .	40
(Electrokinetic Soil Processing) . . . . .	40
ENERGIA, INC. . . . .	42
(Reductive Photo-Dechlorination Treatment) . . . . .	42
ENERGIA, INC. . . . .	44
(Reductive Thermal and Photo-Thermal Oxidation Processes for Enhanced Conversion of Chlorocarbons) . . . . .	44
ENERGY AND ENVIRONMENTAL RESEARCH CORPORATION . . . . .	46
(Reactor Filter System) . . . . .	46
ENERGY AND ENVIRONMENTAL RESEARCH CORPORATION . . . . .	48
(Hybrid Fluidized Bed System) . . . . .	48
ENVIRONMENTAL BIOTECHNOLOGIES, INC. . . . .	50
(Microbial Composting Process) . . . . .	50
FERRO CORPORATION . . . . .	52
(Waste Vitrification Through Electric Melting) . . . . .	52
GAS TECHNOLOGY INSTITUTE . . . . .	54
(Chemical and Biological Treatment) . . . . .	54
GAS TECHNOLOGY INSTITUTE . . . . .	56
(Fluid Extraction-Biological Degradation Process) . . . . .	56
GAS TECHNOLOGY INSTITUTE . . . . .	58
(Fluidized-Bed/Cyclonic Agglomerating Combustor) . . . . .	58
GAS TECHNOLOGY INSTITUTE . . . . .	60
(Supercritical Extraction/Liquid Phase Oxidation) . . . . .	60
GENERAL ATOMICS, NUCLEAR REMEDIATION TECHNOLOGIES DIVISION . . . . .	62
(Acoustic Barrier Particulate Separator) . . . . .	62
GEO-MICROBIAL TECHNOLOGIES, INC. . . . .	64
(Metals Release and Removal from Wastes) . . . . .	64
HARDING ESE, A MACTEC COMPANY . . . . .	66
(formerly ABB Environmental Services, Inc.) (Two-Zone, Plume Interception, In Situ Treatment Strategy) . . . . .	66
HIGH VOLTAGE ENVIRONMENTAL APPLICATIONS, INC. . . . .	68
(High-Energy Electron Beam Irradiation) . . . . .	68
IT CORPORATION . . . . .	70
(Batch Steam Distillation and Metal Extraction) . . . . .	70
IT CORPORATION . . . . .	72
(Chelation/Electrodeposition of Toxic Metals from Soils) . . . . .	72
IT CORPORATION . . . . .	74
(Mixed Waste Treatment Process) . . . . .	74
IT CORPORATION . . . . .	76
(formerly OHM Remediation Services Corporation) (Oxygen Microbubble In Situ Bioremediation) . . . . .	76
IT CORPORATION . . . . .	78
(Photolytic and Biological Soil Detoxification) . . . . .	78

## TABLE OF CONTENTS (Continued)

	Page
<u>Completed Emerging Technology Program Projects (Continued)</u>	
IT CORPORATION .....	80
(Tekno Associates Bioslurry Reactor) .....	80
KSE, INC. ....	82
(Adsorption-Integrated-Reaction Process) .....	82
KVAERNER ENERGY & ENVIRONMENT .....	84
(formerly Davy International Environmental Division)	
(Chemical Treatment) .....	84
MATRIX PHOTOCATALYTIC INC. ....	86
(Photocatalytic Air Treatment) .....	86
MATRIX PHOTOCATALYTIC INC. ....	88
(Photocatalytic Aqueous Phase Organic Destruction) .....	88
MEDIA & PROCESS TECHNOLOGY .....	90
(formerly Aluminum Company of America and	
Alcoa Separation Technology, Inc.)	
(Bioscrubber) .....	90
MEMBRANE TECHNOLOGY AND RESEARCH, INC. ....	92
(VaporSep® Membrane Process) .....	92
METSO MINERALS INDUSTRIES, INC.	
(formerly Svedala Industries, Inc.)	
.....	94
( <u>PYROKILN THERMAL ENCAPSULATION</u> Process) .....	94
MONTANA COLLEGE OF MINERAL	
SCIENCE AND TECHNOLOGY .....	96
(Air-Sparged Hydrocyclone) .....	96
MONTANA COLLEGE OF MINERAL	
SCIENCE AND TECHNOLOGY .....	98
(Campbell Centrifugal Jig) .....	98
NEW JERSEY INSTITUTE OF TECHNOLOGY HAZARDOUS SUBSTANCES	
MANAGEMENT RESEARCH CENTER .....	100
(formerly Hazardous Substance Management Research Center at New Jersey	
Institute of Technology and Rutgers, the State University of New Jersey)	
(Pneumatic Fracturing and Bioremediation Process) .....	100
NEW JERSEY INSTITUTE OF TECHNOLOGY .....	102
(GHEA Associates Process) .....	102
PHYTOKINETICS, INC. ....	106
(Phytoremediation Process) .....	106
PINTAIL SYSTEMS, INC. ....	108
(Spent Ore Bioremediation Process) .....	108
PSI TECHNOLOGIES,	
A DIVISION OF PHYSICAL SCIENCES INC. ....	110
(Metals Immobilization and Decontamination of Aggregate Solids) .....	110
PULSE SCIENCES, INC. ....	112
(X-Ray Treatment of Aqueous Solutions) .....	112
PULSE SCIENCES, INC. ....	114
(X-Ray Treatment of Organically Contaminated Soils) .....	114
RECRA ENVIRONMENTAL, INC. ....	116
(formerly Electro-Pure Systems, Inc.)	
(Alternating Current Electrocoagulation Technology) .....	116

## TABLE OF CONTENTS (Continued)

	Page
<u>Completed Emerging Technology Program Projects (Continued)</u>	
REMEDIATION TECHNOLOGIES, INC. ....	118
(Biofilm Reactor for Chlorinated Gas Treatment) .....	118
RESOURCE MANAGEMENT & RECOVERY .....	120
(formerly Bio-Recovery Systems, Inc.)	
(AlgaSORB <sup>®</sup> Biological Sorption) .....	120
ROY F. WESTON, INC. ....	122
(Ambersorb <sup>®</sup> 563 Adsorbent) .....	122
STATE UNIVERSITY OF NEW YORK AT OSWEGO, ENVIRONMENTAL RESEARCH CENTER .....	124
(Electrochemical Peroxidation of PCB-Contaminated Sediments and Waters) .....	124
THERMATRIX, INC. ....	126
(formerly PURUS, INC.)	
(Photolytic Oxidation Process) .....	126
TRINITY ENVIRONMENTAL TECHNOLOGIES, INC. ....	128
(PCB- and Organochlorine-Contaminated Soil Detoxification) .....	128
UNITED KINGDOM ATOMIC ENERGY AUTHORITY .....	130
(formerly AEA Technology Environment)	
(Soil Separation and Washing Process) .....	130
UNIVERSITY OF DAYTON RESEARCH INSTITUTE .....	132
(Photothermal Detoxification Unit) .....	132
UNIVERSITY OF HOUSTON .....	134
(Concentrated Chloride Extraction and Recovery of Lead) .....	134
UNIVERSITY OF SOUTH CAROLINA .....	136
(In Situ Mitigation of Acid Water) .....	136
UNIVERSITY OF WASHINGTON .....	138
(Adsorptive Filtration) .....	138
UNIVERSITY OF WISCONSIN-MADISON .....	140
(Photoelectrocatalytic Degradation and Removal) .....	140
UV TECHNOLOGIES, INC. ....	142
(formerly Energy and Environmental Engineering, Inc.)	
(UV CATOX <sup>™</sup> Process) .....	142
UV TECHNOLOGIES, INC. ....	144
(formerly Energy and Environmental Engineering, Inc.)	
(UV CATOX <sup>™</sup> Process) .....	144
VORTEC CORPORATION .....	146
(Oxidation and Vitrification Process) .....	146
WESTERN PRODUCT RECOVERY GROUP, INC. ....	148
(Coordinate, Chemical Bonding, and Adsorption Process) .....	148
WESTERN RESEARCH INSTITUTE .....	150
(Contained Recovery of Oily Wastes) .....	150
ZENON ENVIRONMENTAL INC. ....	152
(Cross-Flow Pervaporation System) .....	152



---

---

## TABLE OF CONTENTS (Continued)

	Page
<u>Ongoing Emerging Technology Program Projects</u>	
EARTH TECH, INC. ....	154
(formerly ITT Night Vision (In Situ Enhanced Bioremediation of Groundwater) ....	154
ELECTRO-PETROLEUM, INC. ....	156
(Electro-Kinetically Aided Remediation [EKAR]) ....	156
HARDING ESE, A MACTEC COMPANY ....	158
(formerly ABB Environmental Services, Inc.) (Two-Zone, Plume Interception, In Situ Treatment Strategy) ....	158
LEWIS ENVIRONMENTAL SERVICES, INC./ HICKSON CORPORATION ....	160
(Chromated Copper Arsenate Soil Leaching Process) ....	160
MATRIX PHOTOCATALYTIC INC. ....	162
(Photocatalytic Air Treatment) ....	162
PROCESS TECHNOLOGIES INCORPORATED ....	164
(Photolytic Destruction of Vapor-Phase Halogens) ....	164
SELENTEC ENVIRONMENTAL TECHNOLOGIES, INC. ....	166
(Selentec MAG*SEP <sup>SM</sup> Technology) ....	166
TRADE NAME INDEX ....	168
APPLICABILITY INDEX ....	181

### LISTS OF FIGURES

<b>1</b>	<i>Development of Innovative Technologies</i> ....	2
<b>2</b>	<i>Innovative Technologies in the Demonstration Program</i> ....	3
<b>3</b>	<i>Innovative Technologies in the Emerging Technology Program</i> ....	4

### LIST OF TABLES

<b>3</b>	Completed SITE Emerging Technology Program Projects as of September 2002 ....	335
----------	---	-----

---

---

## **ACKNOWLEDGMENTS**

The project manager responsible for the preparation of this document is Teri Richardson of EPA's National Risk Management Research Laboratory in Cincinnati, Ohio. This document was prepared under the direction of Robert Olexsey, Director of the Land Remediation and Pollution Control Division. Key program area contributors for EPA include Annette Gatchett, and Randy Parker. Special acknowledgment is given to the individual EPA SITE project managers and technology developers who provided guidance and technical support.

Computer Sciences Corporation prepared this document under the direction and coordination of Teri Richardson and Annette Gatchett.

---

---

## SITE PROGRAM DESCRIPTION

The U.S. Environmental Protection Agency's (EPA) Superfund Innovative Technology Evaluation (SITE) Program, now in its sixteenth year, encourages the development and implementation of (1) innovative treatment technologies for hazardous waste site remediation, and (2) characterization and monitoring technologies for evaluating the nature and extent of hazardous waste site contamination.

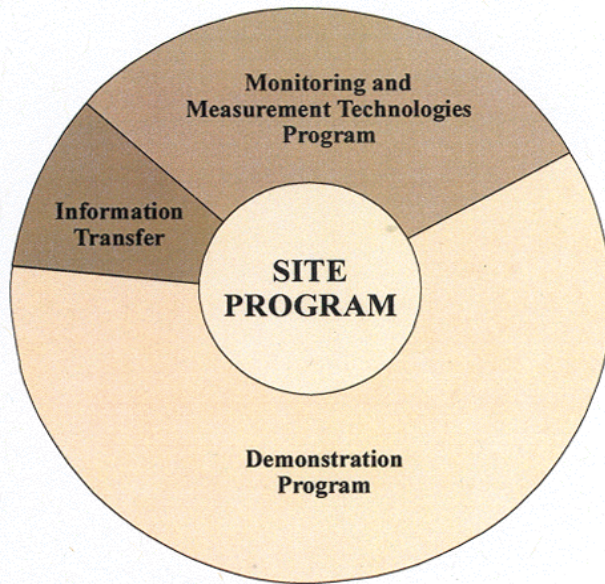
The SITE Program was established by EPA's Office of Solid Waste and Emergency Response (OSWER) and the Office of Research and Development (ORD) in response to the 1986 Superfund Amendments and Reauthorization Act (SARA), which recognized a need for an "Alternative or Innovative Treatment Technology Research and Demonstration Program." The SITE Program is administered by ORD's National Risk Management Research Laboratory (NRMRL), headquartered in Cincinnati, Ohio.

The SITE Program includes the following key elements:

- **Demonstration Program** - Conducts and evaluates demonstrations of promising innovative technologies to provide reliable performance, cost, and applicability information for site cleanup decision-making
- **Emerging Technology Program** - Support of the Emerging Technology Program ended in 1998 after completion of all committed projects in the Program
- **Monitoring and Measurement Technologies** - Evaluates technologies that detect, monitor, and measure hazardous and toxic substances to provide better, faster, and more cost-effective methods for producing real-time data during site characterization and remediation
- **Information Transfer Activities** - Disseminates technical information, including engineering, performance, and cost data, on innovative technologies to remove impediments for using innovative technologies

This Technology Profiles document describes completed and ongoing projects in the Demonstration, Emerging Technology, and Characterization and Monitoring Programs. Figure 1 shows the relationship among the programs and depicts the process of technology development from initial concept to commercial use.

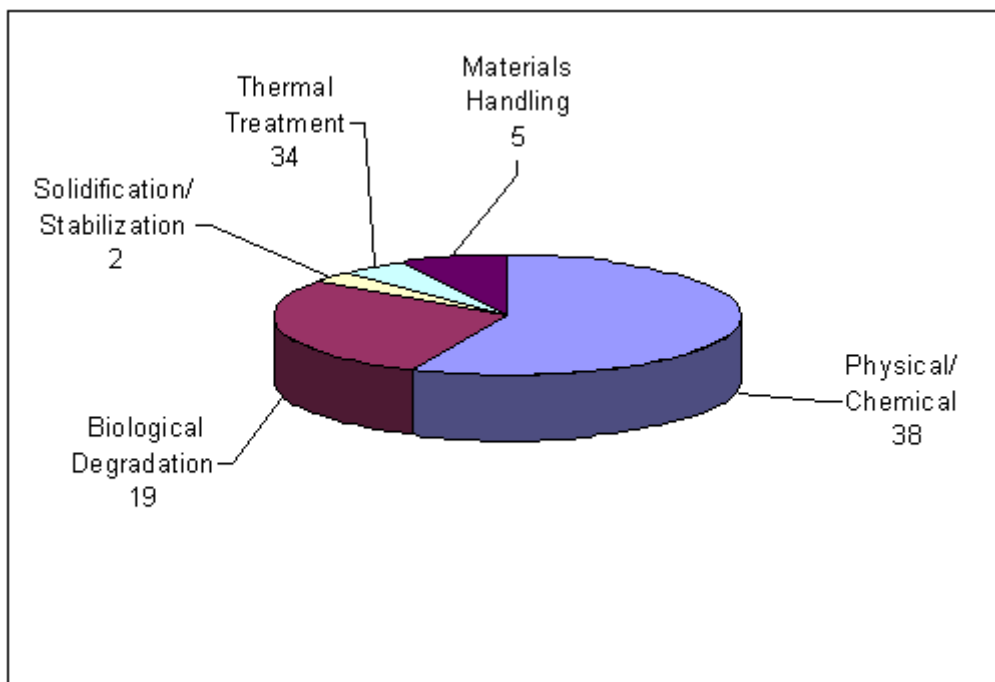
In the Demonstration Program, the technology is field-tested on hazardous waste materials. Engineering and cost data are gathered on the innovative technology so that potential users can assess the technology's applicability to a particular site. Data collected during the field demonstration are used to assess the performance of the technology, the potential need for pre- and post-processing of the waste, applicable types of wastes and waste matrices, potential operating problems, and approximate capital and operating costs.



**Figure 1** *Development of Innovative Technologies*

At the conclusion of a SITE demonstration, EPA prepares an Innovative Technology Evaluation Report (ITER), Technology Capsule, and Demonstration Bulletin. Often, a videotape of the demonstration is also prepared. 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 control standards are also presented. These demonstration documents are distributed by EPA to provide reliable technical data for environmental decision-making and to promote the technology's commercial use.

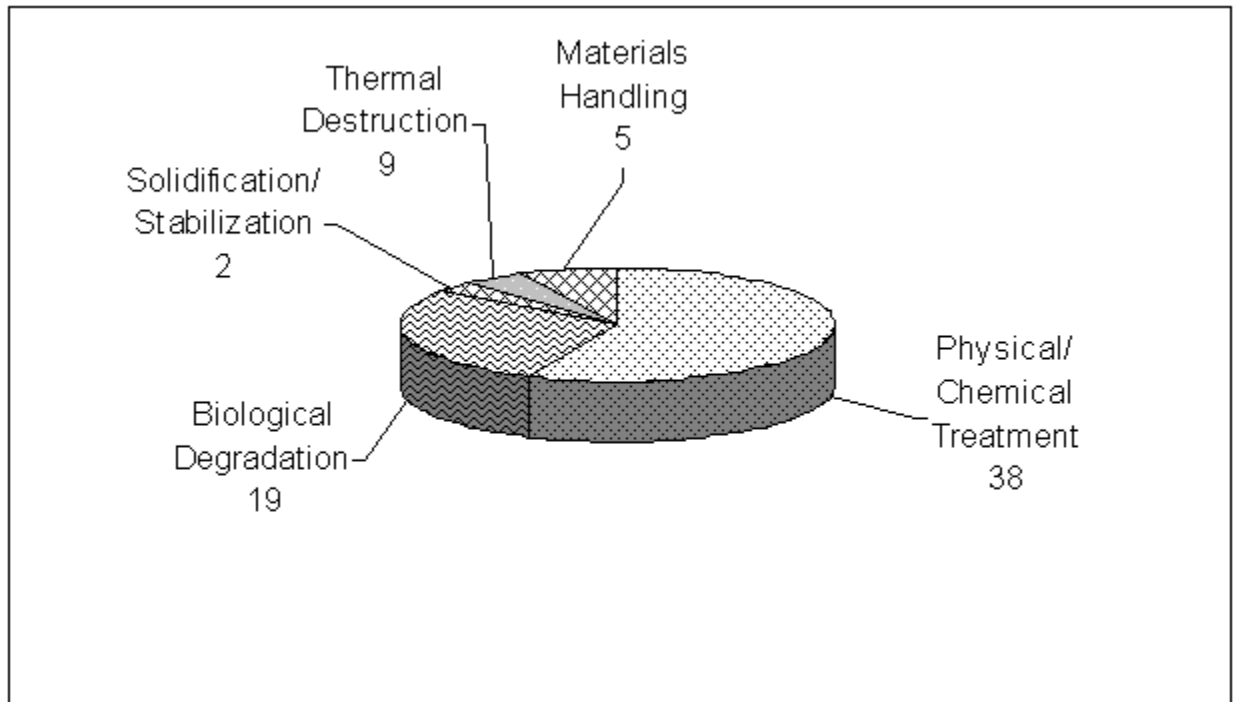
The Demonstration Program currently has 147 program participants conducting 141 demonstrations. Of these projects 128 demonstrations are complete and 13 are ongoing. The projects are divided into the following categories: thermal treatment (34), biological degradation (28), physical/chemical treatment (50), solidification/stabilization (13), phytoremediation (5), soil washing (4), materials handling (3), and other (4). Several technologies represent more than one treatment category.



**Figure 2:** *Innovative Technologies in the Emerging Technology Program*

Figure 2 shows the breakdown of technologies in the Demonstration Program. Profiles for technologies demonstrated under the Demonstration Program are located in Volume I.

EPA has provided technical and financial support to 77 projects in the Emerging Technology Program. Seventy-three are completed and four have exited the program. Eighteen Emerging Technology Program projects participated in the Demonstration Program. The seventh-three active technologies are divided into the following categories: thermal destruction (9), physical/chemical treatment (38), biological degradation (19), solidification/stabilization (2), and materials handling (5). Figure 3 displays the breakdown of technologies in the Emerging Technology Program. Profiles for technologies demonstrated under the Emerging Technology Program are located in Volume II.



**Figure 3:** Innovative Technologies in the Demonstration Program

The Monitoring and Measurement Technologies (MMT) Program’s goal is to assess innovative and alternative monitoring, measurement, and site characterization technologies. To date, 38 technology demonstrations have occurred under the MMT Program. These demonstrations have included four cone penetrometers, 6 field portable X-ray fluorescence units, 6 portable gas chromatographs, 4 spectrophotometers, 12 field test kits, and 6 soil samplers. Profiles for technologies demonstrated under the MMT Program are located in Volume III.

In the Technology Transfer Program, technical information on innovative technologies in the Demonstration Program, Emerging Technology Program, and MMT Program is disseminated to increase the awareness and promote the use of innovative technologies for assessment and remediation at Superfund sites. The goal of technology transfer activities is to promote communication among individuals requiring current technical information for conducting site investigations and cleanups.

The Technology Transfer Program reaches the environmental community through many media, including:

- Program-specific regional, state, and industry brochures
- On-site Visitors’ Days during SITE demonstrations
- Demonstration videotapes
- Project-specific fact sheets to comply with site community relations plans
- ITERs, Demonstration Bulletins, Technology Capsules, and Project Summaries

- 
- The SITE Exhibit, displayed nationwide and internationally at conferences
  - Networking through forums, associations, regions, and states
  - Technical assistance to regions, states, and remediation cleanup contractors

SITE information including an electronic version of this document, is available through the following on-line information clearinghouses:

SITE Program Home Page: <http://www.epa.gov/ORD/SITE>

Cleanup Information Bulletin Board System (CLU-IN)

Help Desk: 301-589-8368; Internet Access: <http://www.clu-in.org>

Technical reports may be obtained by calling the National Service Center for Environmental Publications in Cincinnati, Ohio. To find out about newly published documents or to be placed on the SITE mailing list, call or write to:

USEPA/NSCEP  
P. O. Box 42419  
Cincinnati, OH 45242-2419  
1-800-490-9198

## SITE PROGRAM CONTACTS

The SITE Program is administered by EPA's Office of Research and Development (ORD), specifically the National Risk Management Research Laboratory (NRMRL). For further information on the SITE Program or its component programs contact:

### Land Remediation and Pollution Control Division

Robert Olexsey  
U.S. Environmental Protection Agency  
26 West Martin Luther King Drive  
Cincinnati, Ohio 45268  
513-569-7861  
Fax: 513-569-7620

### SITE Program

Annette Gatchett  
U.S. Environmental Protection Agency  
26 West Martin Luther King Drive  
Cincinnati, Ohio 45268  
513-569-7697  
Fax: 513-569-7620

### Monitoring and Measurement Program

Stephen Billets  
U.S. Environmental Protection Agency  
P. O. Box 93478  
Las Vegas, Nevada 89193-3478  
702-798-2232  
Fax: 702-798-2261

### Emerging Technology Program

Randy Parker  
U.S. Environmental Protection Agency  
26 West Martin Luther King Drive  
Cincinnati, Ohio 45268  
513-569-7271  
Fax: 513-569-7620

### Remediation and Control Branch

John Martin  
U.S. Environmental Protection Agency  
26 West Martin Luther King Drive  
Cincinnati, Ohio 45268  
513-569-7758  
Fax: 513-569-7620

### Treatment and Destruction Branch

Laurel Staley  
U.S. Environmental Protection Agency  
26 West Martin Luther King Drive  
Cincinnati, Ohio 45268  
513-569-7863  
Fax: 513-569-7620

### SITE Management Support Branch

Teri Richardson  
U.S. Environmental Protection Agency  
26 West Martin Luther King Drive  
Cincinnati, Ohio 45268  
513/569-7949  
Fax: 513-569-7676