PHYSICAL\CHEMICAL TREATMENT TECHNOLOGY RESOURCE GUIDE

Office of Solid Waste and Emergency Response
Technology Innovation Office
Washington, DC 20460

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ABSTRACTS OF PHYSICAL/CHEMICAL TREATMENT TECHNOLOGY RESOURCES

GUIDANCE

Air/Superfund National Technical Guidance Study Series: Estimation of Air Impacts for the Excavation of Contaminated Soil.
Eklund, B.; Smith, S.; and Hendler, A., Radian Corp., Austin, TX, U.S. Environmental Protection Agency, Research Triangle Park, NC, Office of Air, Office of Air Quality Planning and Standards, March 1992

EPA Document Number: EPA/450/1-92/004

NTIS Document Number: PB92-171925/XAB

Analysis of the air impacts associated with cleaning up Superfund sites is frequently required prior to actual cleanup. Such analyses depend on estimates rather than on field measurements. This report provides procedures for estimating the emissions of volatile organic compounds (VOCs) and the ambient air concentrations associated with the excavation of contaminated soil. Excavation is an integral part of any Superfund site remediation that involves removal or ex situ treatment such as incineration, thermal desorption, bioremediation, or solidification/stabilization. The report contains procedures to evaluate the effect of the concentration of the contaminants in the soil and the excavation rate on the emission rates and on the ambient air concentrations at selected distances from the excavation site. Health-based ambient air action levels are also provided for comparison to the estimated ambient concentrations.

Air/Superfund National Technical Guidance Study Series: Models for Estimating Air Emission Rates from Superfund Remedial Actions.
Eklund, B. and Albert, C., Radian Corp., Austin, TX, U.S. Environmental Protection Agency, Washington, DC, Office of Solid Waste and Emergency Response, Office of Emergency and Remedial Response, March 1993

EPA Document Number: EPA/451/R-93/001

NTIS Document Number: PB93-186807/XAB

The report is a compendium of models (equations) for estimating air emissions from Superfund sites undergoing remediation. These models predict emission rates of volatile organic compounds (VOCs) and particulate matter (PM) from both area and point sources. The following remedial processes are covered: air stripping, soil vapor extraction, thermal desorption, thermal destruction (incineration), excavation, dredging, solidification/stabilization, and bioremediation. Emission estimation methods are also presented for landfills, lagoons, and spills/leaks/open waste pits. The models contained in the compendium may not accurately predict emissions for all possible scenarios.

Assessing UST Corrective Action Technologies: Site Assessment and Selection of Unsaturated Zone Treatment Technologies, Report for October 1987 - September 1989.

Lyman, W. J. and Noonan, D. C., Camp, Dresser and McKee, Inc., Boston, MA, U.S. Environmental Protection Agency, Cincinnati, OH, Office of Research and Development, Risk Reduction Engineering Laboratory, March 1990

EPA Document Number: EPA/600/2-90/011

NTIS Document Number: PB90-187220/XAB

A methodology is presented for evaluating the likely effectiveness of five soil treatment technologies at sites where petroleum products have contaminated the unsaturated zone. The five soil treatment technologies are: soil venting, biorestoration, soil flushing, hydraulic barriers, and excavation. The evaluation consists of a site assessment, selection of a treatment technology, and performance monitoring and follow-up measurements. The overall focus of the manual is on making a preliminary screening of what soil treatment technologies would likely be effective at a given underground storage tank site. Factors that are critical to the successful implementation of each technology are represented, and site conditions that are favorable for each factor are discussed.

Chemical Dehalogenation Treatability Studies Under CERCLA: An Overview, Fact Sheet.
McNelly, G., IT Corp., Sharonville, OH, U.S. Environmental Protection Agency, Cincinnati, OH, Office of Research and Development, Risk Reduction Engineering Laboratory, May 1992

EPA Document Number: EPA/540/R-92/013B

NTIS Document Number: PB92-169275/XAB

Systematically conducted, well-documented treatability studies are an important component of remedy evaluation and selection under the Superfund program. The fact sheet focuses on chemical dehalogenation treatability studies conducted in support of remedy selection that is conducted prior to the Record of Decision (ROD). The fact sheet presents a standard guide for designing and implementing a chemical dehalogenation treatability study.

Guidance on Remedial Actions for Superfund Sites with PCB Contamination.
U.S. Environmental Protection Agency, Washington, DC, Office of Emergency and Remedial Response, August 1990

EPA Document Number: EPA/540/G-90/007

NTIS Document Number: PB91-921206/XAB

The document describes the recommended approach for evaluating and remediating Superfund sites with PCB contamination. It should be used as a guide in the investigation and remedy selection process for PCB-contaminated Superfund sites. The guidance provides preliminary remediation goals for various media that may be contaminated and identifies other considerations important to ensuring protection of human health and the environment. In addition, potentially applicable or relevant and appropriate requirements (ARARs) and "to-be-considered" criteria pertinent to Superfund sites with PCB contamination and their integration into the RI/FS and remedy selection process are summarized. The guidance also describes how to develop remedial alternatives for PCB contaminated materials that are consistent with Superfund program expectations and ARARs. To identify the areas for which a response action should be considered, starting point concentrations (preliminary cleanup goals) for each media are identified.

Guide for Conducting Treatability Studies Under CERCLA: Chemical Dehalogenation, Final Report.
McNelly, G., IT Corp., Sharonville, OH, U.S. Environmental Protection Agency,

Cincinnati, OH, Office of Research and Development, Risk Reduction Engineering Laboratory, May 1992

EPA Document Number: EPA/540/R-92/013A

NTIS Document Number: PB92-169044/XAB

Systematically conducted, well-documented treatability studies are an important component of the remedial investigation/feasibility study (RI/FS) process and the remedial design/remedial action (RD/RA) process under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). The guide, which presents information on treatability studies involving chemical dehalogenation of soils and sludges, is intended to supplement the information in the final generic guide. The guide describes a three-tiered approach for conducting treatability studies, which consists of (1) remedy screening, (2) remedy selection, and (3) RD/RA. The purpose of remedy-screening studies for chemical dehalogenation technologies is to determine if the technology is chemically feasible for the contaminants/matrix of concern. The guide also presents detailed, technology-specific information on the preparation of a Work Plan and a Sampling and Analysis Plan for chemical dehalogenation treatability studies. Elements discussed include test objectives, experimental design and procedures, equipment and materials, sampling and analysis procedures, quality assurance/quality control procedures, and data analysis and interpretation. See Guide for Conducting Treatability Studies under CERCLA: Chemical Dehalogenation, Final Report, Fact Sheet (EPA/540/R-92/013A, PB92-231307/XAB) for more information.

Guide for Conducting Treatability Studies Under CERCLA: Soil Washing, Interim Guidance, Final Report.
Rawe, J., Science Applications International Corp., Cincinnati, OH, U.S. Environmental Protection Agency, Cincinnati, OH, Office of Research and Development, Risk Reduction Engineering Laboratory, September 1991

EPA Document Number: EPA/540/2-91/020A

NTIS Document Number: PB92-170570/XAB

Systematically conducted, well-documented treatability studies are an important component of the remedial investigation/feasibility study (RI/FS) process and the remedial design/remedial action (RD/RA) process under the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA). The studies provide valuable site-specific data necessary to aid in the selection and implementation of the remedy. The manual focuses on soil washing treatability studies conducted in support of remedy selection prior to developing the Record of Decision. The manual presents guidance for designing and implementing a soil washing treatability study. In addition, it provides an overview of general information for determining whether soil washing technology may be effective in designing and conducting soil washing treatability studies for remedy selection, assistance in interpreting data obtained from remedy selection treatability studies, and guidance to estimate costs associated with remedy design and full-scale soil washing remedial action. The manual is not intended to serve as a substitute for communication with regulators or investigation of reports nor as the sole basis for the selection of soil washing as a particular remediation technology. Soil washing must be used in conjunction with other treatment technologies since it generates residuals. The manual is designed to be used in conjunction with the Guide for Conducting Treatability Studies Under CERCLA; Interim Final.

Guide for Conducting Treatability Studies Under CERCLA: Solvent Extraction, Interim Guidance.
Rawe, J., Science Applications International Corp., Cincinnati, OH, U.S. Environmental Protection Agency, Cincinnati, OH, Office of Research and Development, Risk Reduction Engineering Laboratory, August 1990

EPA Document Number: EPA/540/R-92/016A

NTIS Document Number: PB92-239581/XAB

Systematically conducted, well-documented treatability studies are an important component of remedy evaluation and selection under the Superfund Program. This manual focuses on solvent extraction treatability studies. This manual presents a standard guide for designing and implementing solvent extraction treatability studies. The manual presents a description of and discusses the applicability and limitations of solvent extraction technologies and defines the prescreening and field measurement data needed to determine if treatability testing is required. It also presents an overview of the process of conducting treatability tests and the applicability of tiered treatability testing for the evaluation of solvent extraction technologies. The specific goals of each tier of testing are defined and performance levels are presented that should be met at the remedy screening level before additional tests are conducted at the next tier. See Guide for Conducting Treatability Studies Under CERCLA: Solvent Extraction Quick Reference Fact Sheet (EPA/540-R-92/016B, PB92-239599/XAB) for more information.

Guide for Conducting Treatability Studies Under CERCLA: Thermal Desorption Remedy Selection, Interim Guidance.
Rawe, J., Science Applications International Corp., Cincinnati, OH, U.S. Environmental Protection Agency, Cincinnati, OH, Office of Research and Development, Risk Reduction Engineering Laboratory, September 1992

EPA Document Number: EPA/540/R-92/074A

NTIS Document Number: PB93-126597/XAB

Systematically conducted, well-documented treatability studies are an important component of remedy evaluation and selection under the Superfund program. The manual focuses on thermal desorption remedy selection treatability studies conducted in support of remedy selection that is conducted prior to the Record of Decision (ROD). The manual presents a standard guide for designing and implementing a thermal desorption remedy selection treatability study. The manual presents a description of and discusses and defines the prescreening and field measurement data needed to determine if treatability testing is required. It also presents an overview of the process of conducting treatability tests and the applicability of tiered treatability testing for evaluation of thermal desorption technologies. The specific goals of each tier of testing are defined and performance levels are presented that should be met at the remedy screening level before additional tests are conducted at the next tier. The elements of a treatability study work plan are also defined with detailed discussions on the design and execution of the remedy screening treatability study. See Guide for Conducting Treatability Studies under CERCLA: Thermal Desorption Quick Reference Fact Sheet (EPA/540/R-92/074B, PB93-121325/XAB) for more informtaion.

Procuring Innovative Technologies at Remedial Sites: Q's and A's and Case Studies.
U.S. Environmental Protection Agency, Washington, DC, Office of Solid Waste and Emergency Response, April 1992

EPA Document Number: EPA/542/F-92/012

NTIS Document Number: PB92-232388/XAB

The fact sheet is designed to assist EPA Remedial Project Managers (RPMs) and Contracting Officers (COs) with the procurement of innovative treatment technologies. RPMs, COs, and U.S. Army Corps of Engineers (COE) personnel were interviewed to obtain information on their experiences in procuring innovative technologies. EPA's Technology Innovation Office (TIO) has documented case histories of experiences with acquiring innovative technologies in the Superfund program. Remedial sites chosen for inclusion in the review were Fund-lead sites that had started or completed the procurement of an innovative technology, including bioremediation, thermal desorption, vacuum extraction, chemical treatment, chemical extraction, and in situ soil flushing. The results of these interviews are presented in a question and answer format. In addition, specific detailed information on each site is presented in tabular form.

Selection of Control Technologies for Remediation of Lead Battery Recycling Sites, Engineering Bulletin.
Foster Wheeler Enviresponse, Inc., Edison, NJ, U.S. Environmental Protection Agency, Cincinnati, OH, Office of Research and Development, Risk Reduction Engineering Laboratory, September 1992

EPA Document Number: EPA/540/S-92/011

NTIS Document Number: PB93-121333/XAB

The objective of this bulletin is to provide remedial project managers (RPMs), potentially responsible parties (PRPs), and their supporting contractors with information to facilitate the selection of treatment alternatives and cleanup services at lead battery recycling sites (LBRS). This bulletin condenses and updates the information presented in the EPA technical resource document (TRD) entitled "Selection of Control Technologies for Remediation of Lead Battery Recycling Sites," (PB92-114537, July 1991). This bulletin consolidates useful information on LBRS such as the following: description of types of operations commonly conducted, and wastes generated at LBRS; technologies implemented or selected for LBRS remediation; case studies of treatability studies on LBRS wastes; past experience regarding the recyclability of materials that are found at LBRS; and profiles of potentially applicable innovative treatment technologies.

OVERVIEW/PROGRAM DOCUMENTS

Amendment to the Best Demonstrated Available Technology (BDAT) Background Document for Wastes from the Petroleum Refining Industry K048, K049, K050, K051, K052, Final Report.
Kinch, R. and Vorbach, J., Versar, Inc., Springfield, VA, U.S. Environmental Protection Agency, Washington, DC, Office of Solid Waste and Emergency Response, Office of Solid Waste, May 1990

EPA Document Number: EPA/530/SW-90/060R

NTIS Document Number: PB90-234451/XAB

The background document provides the Agency's technical support and rationale for the development of treatment standards for the constituents to be regulated for the above-mentioned wastes. The amendment presents the K048-K052 solvent extraction and incineration data used to develop the treatment standards for non-wastewaters; presents the K048 incinerator scrubber water data used to develop the treatment standards for cyanide in wastewaters; and provides EPA's rationale and technical support for various treatment standards.

An Overview of Underground Storage Tank Remediation Options.
U.S. Environmental Protection Agency, Office of Solid Waste and Emergency Response, Office of Underground Storage Tanks, October 1993

EPA Document Number: EPA/510/F-93/029

EPA developed a series of fact sheets to answer basic questions about selected alternative cleanup technologies and to provide an easy way to compare technologies. This fact sheet covers soil remediation technologies, including those pertaining to in situ soil vapor extraction, in situ bioremediation/bioventing, ex situ bioremediation/biomounding, on-site low temperature thermal desorption, ex situ bioremediation/land farming, in situ passive biodegradation, excavation and off-site treatment, and excavation with off-site landfill disposal.

Citizen's Guide to In Situ Soil Flushing, Technology Fact Sheet.
U.S. Environmental Protection Agency, Washington, DC, Office of Solid Waste and Emergency Response, March 1992

EPA Document Number: EPA/542/F-92/007

NTIS Document Number: PB92-233113/XAB

The fact sheet contains a description of what in situ soil flushing is, how it works, why to consider in situ soil flushing, if soil flushing will work at the site, where it is being selected, and how to obtain more information. In addition, it covers the contaminant's effect on determining the appropriate flushing solution in the treatment process. It also contains a description of the following three types of fluids: water only, water plus additives such as acids, bases, or surfactants, and organic solvents.

Citizen's Guide to Soil Washing, Technology Fact Sheet.
U.S. Environmental Protection Agency, Washington, DC, Office of Solid Waste and Emergency Response, March 1992

EPA Document Number: EPA/542/F-92/003

NTIS Document Number: PB92-233097/XAB

Soil washing is a technology that uses liquids (sometimes combined with chemical additives) and a mechanical process to scrub soils. The scrubbing removes hazardous contaminants and concentrates them into smaller volume. After the soil washing process is completed, the smaller volume of soil, which contains the majority of the fine silt and clay particles, can be further treated by other methods (such as incineration or bioremediation) or disposed of according to State and Federal regulations.

Citizen's Guide to Solvent Extraction, Technology Fact Sheet.
U.S. Environmental Protection Agency, Washington, DC, Office of Solid Waste and Emergency Response, March 1992

EPA Document Number: EPA/542/F-92/004

NTIS Document Number: PB92-233089/XAB

Solvent extraction is a treatment technology that uses a solvent (a fluid that can dissolve another substance) to separate or remove hazardous organic contaminants from sludges, sediments, or soil. Solvent extraction does not destroy contaminants. It concentrates them so they can be recycled or destroyed. It is used in combination with other technologies to destroy the separated concentrated contaminants. When the soil enters an extractor (a tank where the contaminated soil is mixed with the solvent), the soil is separated into three components, or fractions: solvent with dissolved contaminants, solids, and water. Contaminants are concentrated into each of these fractions. For example, PCBs (polychlorinated biphenyls) concentrate in the contaminated solvent mixture, while metals are left behind in the solids and water.

Citizen's Guide to Thermal Desorption.
U.S. Environmental Protection Agency, Washington, DC, Office of Solid Waste and Emergency Response, March 1992

EPA Document Number: EPA/542/F-92/006

NTIS Document Number: PB92-232396/XAB

Thermal desorption is an innovative treatment technology that treats soils contaminated with hazardous wastes by heating the soil at relatively low temperatures (200-1000° F) so that contaminants with low boiling points will vaporize (turn into gas) and, consequently, separate from the soil. There are three steps in thermal desorption: (1) heating the soil to vaporize the contaminants; (2) treating the vaporized contaminants; and (3) testing the treated soil.

Cleaning Excavated Soil Using Extraction Agents: A State-of-the-Art Review, Final Report, June 1985 - January 1989.
Raghaven, R.; Coles, E.; and Dietz, D., Foster Wheeler Enviresponse, Inc., Livingston, NJ, U.S. Environmental Protection Agency, Cincinnati, OH, Office of Research and Development, Risk Reduction Engineering Laboratory, June 1989

EPA Document Number: EPA/600/2-89/034

NTIS Document Number: PB89-212757/XAB

The report presents a state-of-the-art review of soil washing technologies and their applicability to Superfund sites in the United States. The review includes Superfund site soil and contamination characteristics, as well as soil cleaning technologies, their principles of operation, and process parameters. The technical feasibility of using soil washing technologies at Superfund sites in the United States is assessed. Contaminants are classified as volatile, hydrophilic, or hydrophobic organics; PCBs; heavy metals; or radioactive material. Soils are classified as either sand, silt, clay, or waste fill. Three generic types of extractive treatments are identified for cleaning excavated soils: water washing augmented with a basic or surfactant agent to remove organics and water washing with an acidic or chelating agent to remove organics and heavy metals; organics-solvent washing to remove hydrophobic organics and PCBs; and air or steam stripping to remove volatile organics.

Cleaning Up the Nation's Waste Sites: Markets and Technology Trends.
U.S. Environmental Protection Agency, Office of Solid Waste and Emergency Response, Washington, DC, April 1993

EPA Document Number: EPA/542/R-92/012

This report captures information on the future demand for remediation services for all major cleanup programs in the U.S., including Superfund, Resource Conservation and Recovery Act (RCRA) corrective action, underground storage tanks, State programs, and Federal agencies such as the Departments of Defense and Energy. This report contains market information on the innovative technologies used to remediate sites contaminated with volatile organic compounds (VOCs), semi-volatile organic compounds (semi-VOCs), and other contaminants. This market information should help innovative technology vendors, developers, and investors direct their research, development, and commercialization effort towards pertinent waste programs and problems.

Control Technologies for Defunct Lead Battery Recycling Sites: Overview and Recent Developments, Volume 3.
Royer, M. D.; Selvakumar, A.; and Gaire, R., Foster Wheeler Enviresponse, Inc., Edison, NJ, U.S. Environmental Protection Agency, Cincinnati, OH, Office of Research and Development, Risk Reduction Engineering Laboratory, 1992

EPA Document Number: EPA/600/A-92/019

NTIS Document Number: PB92-150416/XAB

At least 29 lead battery recycling sites are or have been slated for investigation and possible remediation under the Superfund program. The paper condenses information regarding the characteristics and remediation of these sites. The information provided includes: (1) description of operations commonly conducted and wastes generated, (2) technologies implemented or selected for site remediation, (3) case studies of treatability studies on common wastes, (4) past experience regarding the recyclability of materials found at the sites, and (5) profiles of potentially applicable innovative treatment technologies.

Developments in Chemical Treatment of Contaminated Soil, Symposium Paper.
Davila, B. and Roulier, M. H., U.S. Environmental Protection Agency, Cincinnati, OH, Office of Research and Development, Risk Reduction Engineering Laboratory, 1992

EPA Document Number: EPA/600/A-92/030

NTIS Document Number: PB92-152933/XAB

The U.S. Environmental Protection Agency's Office of Research and Development (ORD) is examining processes for remedial action at Superfund sites and corrective action at operating disposal sites. Recent legislation emphasizes destruction and detoxification of contaminants, rather than containment or storage of contaminated soils. Chemical treatment appears promising because it can destroy or greatly change many contaminants. Oxidation, reduction, neutralization, hydrolysis, dehalogenation, and UV/photolysis are chemical processes currently used for above ground treatment. Temperature and physical and chemical characteristics of soil are some operating parameters that control the effectiveness of these processes. Excalibur catalytic ozone technology, Exxon and Rio Linda cyanide destruction, and Trinity ultrasonic detoxification are innovative technologies that have been, or are currently being considered, for pilot-scale demonstrations.

Dioxin Treatment Technologies, Background Paper.
U.S. Environmental Protection Agency, Office of Technology Assessment, Washington, DC, November 1991

NTIS Document Number: PB92-152511/XAB

The term dioxin encompasses all aromatic organic chemicals known as dibenzo-p-dioxins. The dibenzo-p-dioxins of greatest concern to public and environmental health belong to a group of chemicals called halogenated dioxins. Because of the public's concern, OTA was asked to prepare an analysis of alternative technologies for treating soil and other materials contaminated by dioxin. The analysis is thus focused on the efficacy, availability, and merits of various technologies that could be used to treat dioxin contamination. The report evaluates the various technologies that are proven and readily available to be applied as well as those still in the research stage. It compares the advantages and limitations of these technologies, and explores the factors that will determine whether they may actually be applied to a dioxin cleanup operation.

Electrokinetic Remediation of Unsaturated Soils.
Lindgren, E. R.; Kozak, M. W.; and Mattson, E. D., U.S. Department of Energy, Sandia National Laboratories, Albuquerque, NM, 1992

NTIS Document Number: DE93-000741/XAB

Heavy-metal contamination of soil and ground water is a widespread problem in the DOE weapons complex, and for the nation as a whole. Electrokinetic remediation is one possible technique for in situ removal of such contaminants from unsaturated soils. Large spills and leaks can contaminate both the soil above the water table as well as the aquifer itself. Electrodes are implanted in the soil, and a direct current is imposed between the electrodes. The charged particles in the soil water will migrate to the oppositely charged electrode (electromigration and electrophoresis), and concomitant with this migration, a bulk flow of water is induced, usually toward the cathode (electroosmosis). The combination of these phenomena leads to a movement of contaminants toward the electrodes. The direction of contaminant movement will be determined by a number of factors, among which are type and concentration of contaminant, soil type and structure, interfacial chemistry of the soil-water system, and the current density in the soil pore water. Contaminants arriving at the electrodes may potentially be removed from the soil by one of several methods, such as electroplating or adsorption onto the electrode, precipitation or co-precipitation at the electrode, pumping of water near the electrode, or complexing with ion-exchange resins. Experimental results are described on the removal of sodium dichromate and food dye from soil.

Engineering Issue: Considerations in Deciding to Treat Contaminated Soils In Situ.
U.S. Environmental Protection Agency, December 1993

EPA Document Number: EPA/540/S-94/500

NTIS Document Number: PB94-177771/XAB

The purpose of this issue paper is to assist in deciding whether consideration of in situ treatment of contaminated soil is worthwhile and to assist in the process of selection and review of in situ technologies. This document addresses issues associated with assessing the feasibility of in situ treatment and selecting appropriate in situ technologies which include an understanding of the characteristics of the contaminants, the site, the technologies, and how these factors and conditions interact to allow for effective delivery, control, and recovery of treatment agents and/or the contaminants. The document focuses on established and innovative in situ treatment technologies that are already available or should be available for full-scale application within 2 years. Technologies discussed include in situ solidification/stabilization, soil vapor extraction, biotreatment, bioventing, in situ vitrification, radio frequency heating, soil flushing, steam / hot air injection and extraction, and delivery and recovery systems. This document is intended to assist in the identification of applicable alternatives early in the technology screening process and is not a source for final determinations.

EPA Engineering Issue: Technology Alternatives for the Remediation of PCB-Contaminated Soil and Sediment.
Davila, B.; Whitford, K.W.; Saylor, E.S., Science Applications International Corporation, McLean, VA, U.S. Environmental Protection Agency, Risk Reduction Engineering Laboratory, Cincinnati, OH, October 1993

EPA Document Number: EPA/540/S-93/506

NTIS Document Number: PB94-144250/XAB

This document is primarily intended to familiarize On-Scene Coordinators (OSC) and Remedial Project Managers (RPM) with information on established, demonstrated, and emerging technology alternatives for remediating PCB-contaminated soil and sediment. The information contained in this document includes process descriptions, site requirements, performance examples, process residuals, innovative systems, and EPA contacts. Estimated costs, advantages, and limitations for each technology are presented as well as information on current research and failed treatment technologies. The secondary purpose of this document is to provide information on characteristics of PCBs, regulations affecting PCB remediation, sampling and data collection methods applicable to PCB contamination, analytical methods used to quantify PCB contamination, and sources of further information.

Fifth Forum on Innovative Hazardous Waste Treatment Technologies: Domestic and International, Proceedings, Chicago, Illinois, May 3-5, 1994.
U.S. Environmental Protection Agency, Office of Solid Waste and Emergency Response, Technology Innovation Office, Office of Research and Development, Washington, DC, Risk Reduction Engineering Laboratory, Cincinnati, OH, May 1994

EPA Document Number: EPA/540/R-94/503

On May 3-5, 1994, the U.S. Environmental Protection Agency's Technology Innovation Office and Risk Reduction Engineering Laboratory hosted an international conference in Chicago, Illinois to exchange solutions to hazardous waste treatment problems. During the conference, scientists and engineers representing government agencies, industry, and academia attended over 40 technical presentations and case studies describing domestic and international technologies for the treatment of waste, sludges, and contaminated soils at uncontrolled hazardous waste disposal sites. A Session was also held on opportunities in research and commercialization, which included presentations on export assistance programs and partnerships with EPA in developing innovative technologies. This compendium includes the abstracts of the presentations from the conference and many of the posters that were on display.

Final Best Demonstrated Available Technology (BDAT) Background Document for Vanadium-Containing Wastes (P119 and P120), Volume 19.
Rosengrant, L. and Craig, R. M., Versar, Inc., Springfield, VA, U.S. Environmental Protection Agency, Washington, DC, Office of Solid Waste and Emergency Response, Office of Solid Waste, May 1990

EPA Document Number: EPA/530/SW-90/059S

NTIS Document Number: PB90-234196/XAB

The background document presents the Agency's technical support and rationale for developing regulatory standards for these wastes. Sections 2 through 6 present waste-specific information for P119 and P120 wastes. Section 2 presents the number and location of facilities affected by the land disposal restrictions, the waste-generating processes, and waste characterization data. Section 3 discusses the technologies used to treat the wastes (or similar wastes), and Section 4 presents available performance data, including data upon which the treatment standards are based. Section 5 explains EPA's determination of BDAT. Treatment standards for vanadium wastes are determined in Section 6.

Fourth Forum on Innovative Hazardous Waste Treatment Technologies: Domestic and International, Technical Papers, San Francisco, California, November 17-19, 1992.
U.S. Environmental Protection Agency, Office of Solid Waste and Emergency Response, Technology Innovation Office, Office of Research and Development, Washington, DC, Risk Reduction Engineering Laboratory, Cincinnati, OH, February 1993

EPA Document Number: EPA/540/R-93/500

On November 17-19, 1992, the U.S. Environmental Protection Agency's Technology Innovation Office and Risk Reduction Engineering Laboratory, the Department of Energy, the Corps of Engineers, and the California Environmental Protection Agency hosted an international conference in San Francisco, California, to exchange solutions to hazardous waste treatment problems. This conference was attended by approximately 1,000 representatives from the U.S. and 25 foreign countries. During the conference, scientists and engineers representing government agencies, industry, and academia attended 42 technical presentations and case studies describing domestic and international technologies for the treatment of waste, sludges, and contaminated soils at uncontrolled hazardous waste disposal sites. Technologies included physical/chemical, biological, thermal, and stabilization techniques. Presentations were made by EPA, their Superfund Innovative Technology Evaluation (SITE) program participants, other federal and state agencies and their contractors, international scientists, and vendors. This document contains abstracts of the presentations from the conference and many of the posters that were on display.

Handbook on In Situ Treatment of Hazardous Waste-Contaminated Soils, Report for May 1988 - July 1989.
Chambers, C. D.; Willis, J.; Giti-Pour, S.; Zieleniewski, J. L.; and Rickabaugh, J. F., PEI Associates, Inc., Cincinnati, OH, Cincinnati University, OH, U.S. Environmental Protection Agency, Cincinnati, OH, Office of Research and Development, Risk Reduction Engineering Laboratory, January 1990

EPA Document Number: EPA/540/2-90/002

NTIS Document Number: PB90-155607/XAB

The handbook is intended to assemble state-of-the-art information on in situ treatment technologies for hazardous waste-contaminated soils. Detailed information is provided on the following specific in situ treatment technologies: soil flushing, degradation, control of volatile materials, and chemical and physical separation technologies. The information presented is detailed enough to provide the reader with adequate data for an initial evaluation of the applicability of a technology in certain situations, yet general enough to be useful and informative to those whose backgrounds are not highly technical. Extensive references are provided for those who wish to seek more detail on a given topic. The Risk Reduction Engineering Laboratory is continuing with its research on in situ treatment to improve technologies discussed in the handbook and to explore new technologies.

Handbook: Remediation of Contaminated Sediments.
Voskuil, T., Equity Associates, Inc., Knoxville, TN, U.S. Environmental Protection Agency, Office of Research and Development, Washington, DC, April 1992

EPA Document Number: EPA/625/6-91/028

NTIS Document Number: PB93-116275/XAB

The handbook focuses on small site contaminated sediments remediation with particular emphasis on treatment technologies. It is designed to provide a succinct resource booklet for individuals with responsibilities for the management of contaminated sediments. The handbook is organized to address the major concerns facing contaminated sediment remediation. Chapter I describes the physical and chemical characteristics of sediment, with special emphasis on ways in which sediment property changes affect contaminant mobility. Chapter II addresses sediment toxicity assessment and describes the current status of the EPA effort to address this important topic. Chapter III discusses sampling techniques and analytical and modeling methods used to characterize contaminated sediments. Chapter IV describes removal and transport options. Chapter V presents pre-treatment technologies. Chapter VI, the primary focus of the handbook, describes four major classes of treatment technologies. The chapter offers a comprehensive overview of specific treatment technologies and addresses applicability, limitations, and demonstrated results; it also presents references for further information. Finally, Chapter VII reviews disposal alternatives for contaminated sediments that are not treated.

Innovative Technology: B.E.S.T. Solvent Extraction Process, Fact Sheet, Final.
U.S. Environmental Protection Agency, Washington, DC, Office of Solid Waste and Emergency Response, Office of Emergency and Remedial Response, November 1989

EPA Document Number: EPA/9200.5-253/FS

NTIS Document Number: PB90-274218/XAB

The fact sheet provides technology description, site characteristics affecting treatment feasibility, technology considerations, and technology status for the B.E.S.T. solvent extraction process. The sheet describes the B.E.S.T. process as using one or more secondary or tertiary amines to separate toxic wastes and oils from sludges or soils.

Innovative Technology: Glycolate Dehalogenation, Fact Sheet, Final.
U.S. Environmental Protection Agency, Washington, DC, Office of Solid Waste and Emergency Response, Office of Emergency and Remedial Response, November 1989

EPA Document Number: EPA/9200.5-254/FS

NTIS Document Number: PB90-274226/XAB

The fact sheet provides technology description, site characteristics affecting treatment feasibility, technology considerations, and technology status for glycolate dehalogenation. The sheet describes the process as being potentially effective in detoxifying specific types of aromatic organic contaminants, particularly dioxins and PCBs.

Innovative Technology: Soil Washing, Fact Sheet, Final.
U.S. Environmental Protection Agency, Washington, DC, Office of Solid Waste and Emergency Response, Office of Emergency and Remedial Response, November 1989

EPA Document Number: EPA/9200.5-250/FS

NTIS Document Number: PB90-274184/XAB

The fact sheet provides technology description, site characteristics affecting treatment feasibility, technology considerations, and technology status for soil washing. The fact sheet describes how soil washing can be potentially beneficial in the separation/segregation and volumetric reduction of hazardous materials in solids, sludges, and sediments.

Innovative Treatment Technologies: Annual Status Report (Fifth Edition).
Fiedler, L., U.S. Environmental Protection Agency, Washington, DC, Office of Solid Waste and Emergency Response, Technology Innovation Office, September 1993

EPA Document Number: EPA/542/R-93/003

NTIS Document Number: PB93-133387/XAB

This yearly report (formerly published semi-annually) documents and analyzes the selection and use of innovative treatment technologies at Superfund sites and some non-Superfund sites under the jurisdiction of DOD and DOE. The information will allow better communication between experienced technology users and those who are considering innovative technologies to clean up contaminated sites. In addition, the information will enable technology vendors to evaluate the market for innovative technologies in Superfund for the next several years. It also will be used by the Technology Innovation Office to track progress in the application of innovative treatment technologies.

Innovative Treatment Technologies: Overview and Guide to Information Sources.
Quander, J. and Kingscott, J., U.S. Environmental Protection Agency, Washington, DC, Office of Solid Waste and Emergency Response, Technology Innovation Office, October 1991

EPA Document Number: EPA/540/9-91/002

NTIS Document Number: PB92-179001/XAB

The document is a compilation of information on innovative treatment technologies being used in the Superfund program and is intended to assist site project managers, consultants, responsible parties, and owner/operators in their efforts to identify current literature on innovative treatment technologies for hazardous waste remediation on corrective action. The technologies addressed in the guide include the following: incineration, thermal desorption, soil washing, solvent extraction, dechlorination, bioremediation, vacuum extraction, vitrification, and ground water treatment. Also included in the guide for the user's reference are summary statistics of EPA's selection and application of innovative treatment technologies between 1982 and 1990. In addition, the guide provides for each technology a detailed description, status of development and application, strengths, weaknesses and materials handling considerations. A comprehensive bibliography for each technology can be found within each chapter.

In Situ Soil Flushing, Engineering Bulletin.
U.S. Environmental Protection Agency, Washington, DC, Office of Solid Waste and Emergency Response, Office of Emergency and Remedial Response, October 1991

EPA Document Number: EPA/540/2-91/021

NTIS Document Number: PB92-180025/XAB

In situ soil flushing is the extraction of contaminants from the soil with water or other suitable aqueous solutions. Soil flushing is accomplished by passing the extraction fluid through in-place soils using an injection or infiltration process. Extraction fluids must be recovered and, when possible, are recycled. The method is potentially applicable to all types of soil contaminants. Soil flushing enables the removal of contaminants from the soil and is most effective on impermeable soils. An effective collection system is required to prevent migration of contaminants and potentially toxic extraction fluids to uncontaminated areas of the aquifer. Soil flushing, in conjunction with in situ bioremediation, may be a cost-effective means of soil remediation at certain sites. Typically, soil flushing is used in conjunction with other treatments that destroy contaminants or remove them from the extraction fluid and ground water.

Overview of Conventional and Innovative Land-Based Thermal Technologies for Waste Disposal.
Oberacker, D. A., U.S. Environmental Protection Agency, Cincinnati, OH, Office of Research and Development, Risk Reduction Engineering Laboratory, 1990

EPA Document Number: EPA/600/D-90/214

NTIS Document Number: PB91-136929/XAB

For more than the past two decades, the U.S. EPA has been aggressive in its research, development, performance testing, and encouragement of the regulated use of proven thermal destruction (or incineration) technologies for the environmentally acceptable treatment and disposal of combustible waste streams. Nationally, significant percentages of residential solid waste, municipal sewage sludge, and a variety of industrial, chemical, and agricultural wastes are routinely treated by thermal systems. The paper is an overview of the state-of-the-art of land-based incineration, emphasizing both conventional and innovative hazardous waste thermal treatment technologies and regulatory performance standards. High temperature systems, low-temperature thermal desorption, pyrolysis units, heat recovery, and newer systems involving fluidized beds, oxygen-enriched combustion, plasma-arc units, and solar-assisted incineration, etc. are discussed.

Overview of In Situ Waste Treatment Technologies.
Walker, S.; Hyde, R. A.; Piper, R. B.; and Roy, M. W., EG&G Idaho, Inc., Idaho Falls, U.S. Department of Energy, Washington, DC, 1992

NTIS Document Number: DE92-018012/XAB

In situ technologies are becoming an attractive remedial alternative for eliminating environmental problems. In situ treatments typically reduce risks and costs associated with retrieving, packaging, and storing or disposing waste and are generally preferred over ex situ treatments. Each in situ technology has specific applications, and, in order to provide the most economical and practical solution to a waste problem, these applications must be understood. This paper presents an overview of thirty different in situ remedial technologies for buried wastes or contaminated soil areas. The objective of this paper is to familiarize those involved in waste remediation activities with available and emerging in situ technologies so that they may consider these options in the remediation of hazardous and/or radioactive waste sites. Several types of in situ technologies are discussed, including biological treatments, containment technologies, physical/chemical treatments, solidification/stabilization technologies, and thermal treatments. Each category of in situ technology is briefly examined in this paper. Specific treatments belonging to these categories are also reviewed. Much of the information on in situ treatment technologies in this paper was obtained directly from vendors and universities and this information has not been verified.

Overview of the Department of Energy's Soil Washing Workshop.
EG&G Energy Measurements, Inc., Las Vegas, NV, Remote Sensing Laboratory, U.S. Department of Energy, Washington, DC, September 1991

NTIS Document Number: DE92-014985/XAB

The Soil Washing Workshop was convened in Las Vegas, Nevada, on August 28-29, 1990 at the request of C.W. Frank, Associate Director, Office of Technology Development, U.S. Department of Energy (DOE). The purpose of the workshop was to determine the status of existing soil washing technologies and their applicability to specific soil contamination problems at DOE sites and at Superfund sites of the U.S. Environmental Protection Agency (EPA). From the workshop deliberations, a course of action was recommended in developing soil washing technologies. Presentations were given describing the soil contamination problems at various DOE sites. The factors addressed for each site included: type of contamination (organic, heavy metals, radionuclides, etc.), sources of contamination (leaking tanks, ponds, soil columns, pipes, etc.), types of soils that are contaminated, magnitude of the problem, current site activities (remediation), other considerations that impact the use of soil washing technology (e.g., environmental, site policies, etc.), and regulations and standards the sites are required to meet. Major findings and presentations of the workshop are presented.

PCB Management Technologies for Natural Gas Transmission and Distribution Systems, Topical Report, October 1989 - March 1990.
Woodyard, J. P.; Fitzgerald, M.; Jones, G.; Sheehan, G.; and Davisson, C., Weston (Roy F.), Inc., Walnut Creek, CA, Gas Research Institute, Chicago, IL, December 1990

NTIS Document Number: PB91-185041/XAB

As part of a program to assist gas companies in selecting and implementing cost effective PCB management technologies, a review of available technologies for a variety of contamination scenarios in gas transmission and distribution was performed. Fluids containing PCBs were used as lubricants in gas and air compressor systems throughout the gas transmission and distribution industries. Treatment technologies for the potentially contaminated media (pipelines, condensate, soil, sludge, water, building, equipment, and tanks) include thermal treatment, chemical dechlorination, landfill, physical separation, and bioremediation. Pigging technology has been the traditional method for decontaminating pipeline, though solvent flushing and swabbing are available for precut pipeline sections. Pipeline PCB-contaminated condensate is commonly incinerated, but chemical dechlorination is another option for treatment. PCB-contaminated soils and sludges have been either disposed of through use of landfills or by thermal treatment. Several other technologies have been investigated and some are commercially available. PCB-contaminated water is typically treated through commercial incineration or filtration/carbon absorption. Decontamination of equipment and buildings includes a variety of fundamental effective techniques. Relevant sampling and analysis techniques were also reviewed.

Presumptive Remedies: Site Characterization and Technology Selection for CERCLA Sites with Volatile Organic Compounds in Soils, Fact Sheet.
U.S. Environmental Protection Agency, Washington, DC, Office of Solid Waste and Emergency Response, September 1993

EPA Document Number: EPA/540/F-93/048

NTIS Document Number: PB93-963346/XAB

Presumptive remedies are preferred technologies for common categories of sites, based on historical patterns of remedy selection and EPA's scientific and engineering evaluation of performance data on technology implementation. The fact sheet identifies the presumptive remedies for Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) sites with soils contaminated by volatile organic compounds (VOCs). Soil vapor extraction (SVE), thermal desorption, and incineration are the presumptive remedies for Superfund sites with VOC-contaminated soil assuming the site characteristics meet certain criteria.

Reductive Dehalogenation: A Subsurface Bioremediation Process, Journal Article: Published in Remediation, v1n1, Winter 1990/1991.
Sims, J. L.; Suflita, J. M.; and Russell, H. H., U.S. Environmental Protection Agency, Robert S. Kerr Environmental Research Laboratory, Ada, OK, Utah Water Research Laboratory, Logan, Oklahoma University, Norman, Department of Botany and Microbiology, 1990

EPA Document Number: EPA/600/J-90/259

NTIS Document Number: PB91-144873/XAB

Introduction and large-scale production of synthetic halogenated organic chemicals over the last fifty years has resulted in a group of contaminants that tend to persist in the environment and resist both biotic and abiotic degradation. The low solubility of these types of contaminants, along with their toxicity and tendency to accumulate in food chains, make them particularly relevant targets for remediation activities. Among the mechanisms that result in dehalogenation of some classes of organic contaminants are stimulation of metabolic sequences through introduction of electron donor and acceptor combinations; addition of nutrients to meet the needs of dehalogenating microorganisms; possible use of engineered microorganisms; and use of enzyme systems capable of catalyzing reductive dehalogenation. The current state of research and development in the area of reductive dehalogenation is discussed along with possible technological application of relevant processes and mechanisms for the remediation of soil and ground water contaminated with chlorinated organics. In addition, an overview of research needs is suggested, which might be of interest for development of in situ systems to reduce the mass of halogenated organic contaminants in soil and ground water.

Reductive Dehalogenation of Organic Contaminants in Soils and Ground Water, Ground Water Issue.
Sims, J. L.; Suflita, J. M.; and Russell, H. H., U.S. Environmental Protection Agency, Robert S. Kerr Environmental Research Laboratory, Ada, OK, January 1991

EPA Document Number: EPA/540/4-90/054

NTIS Document Number: PB91-191056/XAB

Introduction and large scale production of synthetic halogenated organic chemicals over the last 50 years has resulted in a group of contaminants that tend to persist in the environment and resist both biotic and abiotic degradation. The low solubility of these types of contaminants, along with their toxicity and tendency to accumulate in food chains, make them particularly relevant targets for remediation activities. Although the processes involved in dechlorination of many of these organic compounds are well understood in the fields of chemistry and microbiology, technological applications of these processes to environmental remediation are relatively new—particularly at pilot or field scale. It is well established, however, that there are several mechanisms that result in dehalogenation of some classes of organic contaminants, often rendering them less offensive environmentally. These include; stimulation of metabolic sequences through introduction of electron donor and acceptor combinations; addition of nutrients to meet the needs of dehalogenating microorganisms; possible use of engineered micro-organisms; and use of enzyme systems capable of catalyzing reductive dehalogenation.

Role of Innovative Remediation Technologies.
Doesburg, J. M., Battelle Pacific Northwest Laboratories, Richland, WA, Environmental Management Operations, U.S. Department of Energy, Washington, DC, May 1992

NTIS Document Number: DE92-015072/XAB

There are currently over 1200 sites on the U.S. Superfund's National Priorities List (NPL) of hazardous waste sites, and there are over 30,000 sites listed by the Comprehensive Environmental Responsibility, Compensation, and Liability Information System (CERCLIS). The traditional approach to remediating sites in the U.S. has been to remove the material and place it in a secure landfill, or in the case of groundwater, pump and treat the effluent. These technologies have proven to be very expensive and don't really fix the problem. The waste is just moved from one place to another. In recent years, however, alternative and innovative technologies have been increasingly used in the U.S. to replace the traditional approaches. This paper will focus on just such innovative remediation technologies in the U.S., looking at the regulatory drivers, the emerging technologies, some of the problems in deploying technologies, and a case study.

Separation of Heavy Metals: Removal from Industrial Wastewaters and Contaminated Soil.
Peters, R. W. and Shen, L., Argonne National Laboratory, IL, Energy Systems Division, U.S. Department of Energy, Washington, DC, May 1993

NTIS Document Number: DE93-008657/XAB

This paper reviews the applicable separation technologies relating to removal of heavy metals from solution and from soils to present the state-of-the-art in the field. Each technology is briefly described and typical operating conditions and technology performance are presented. Technologies described include chemical precipitation (including hydroxide, carbonate, or sulfide reagents), coagulation/flocculation, ion exchange, solvent extraction, extraction with chelating agents, complexation, electrochemical operation, cementation, membrane operations, evaporation, adsorption, solidification/stabilization, and vitrification. Several case histories are described, with a focus on waste reduction techniques and remediation of lead-contaminated soils. The paper concludes with a short discussion of important research needs in the field.

Soil Washing as a Potential Remediation Technology for Contaminated DOE Sites.

Devgun, J. S.; Beskid, N. J.; Natsis, M. E.; and Walker, J. S., Argonne National Laboratory, IL, U.S. Department of Energy, Washington, DC, 1993

NTIS Document Number: DE93-009205/XAB

Frequently detected contaminants at U.S. Department of Energy (DOE) sites include radionuclides, heavy metals, and chlorinated hydrocarbons. Remediation of these sites requires application of several technologies used in concert with each other, because no single technology is universally applicable. Special situations, such as mixed waste, generally require innovative technology development. This paper, however, focuses on contaminated soils, for which soil washing and vitrification technologies appear to have wide ranging application potential. Because the volumes of contaminated soils around the DOE complex are so large, soil washing can offer a potentially inexpensive way to effect remediation or to attain waste volume reduction. As costs for disposal of low-level and mixed wastes continue to rise, it is likely that volume-reduction techniques and in situ containment techniques will become increasingly important. This paper reviews the status of the soil washing technology, examines the systems that are currently available, and discusses the potential application of this technology to some DOE sites, with a focus on radionuclide contamination and, primarily, uranium-contaminated soils.

Soil Washing Treatment, Engineering Bulletin.
Science Applications International Corp., Cincinnati, OH, U.S. Environmental Protection Agency, Washington, DC, Office of Solid Waste and Emergency Response, Office of Emergency and Remedial Response, September 1990

EPA Document Number: EPA/540/2-90/017

NTIS Document Number: PB91-228056/XAB

Soil washing is a water-based process for mechanically scrubbing soils ex situ to remove undesirable contaminants. The process removes contaminants from soils in one of two ways: by dissolving or suspending them in the wash solution (which is later treated by conventional wastewater treatment methods) or by concentrating them into a smaller volume of soil through simple particle size separation techniques (similar to those used in sand and gravel operations). Soil washing systems incorporating both removal techniques offer the greatest promise for application to soils contaminated with a wide variety of heavy metal and organic contaminants. The concept of reducing soil contamination through the use of particle size separation is based on the finding that most organic and inorganic contaminants tend to bind, either chemically or physically, to clay and silt soil particles. At the present time, soil washing is used extensively in Europe and has had limited use in the United States. During 1986-1989, the technology was one of the selected source control remedies at eight Superfund sites. The bulletin provides information on the technology applicability, the types of residuals resulting from the use of the technology, the latest performance data, site requirements, the status of the technology, and where to go for further information.

Solvent Extraction Processes: A Survey of Systems in the SITE Program, Journal Article: Published in Journal of Air and Waste Management Association, v42, p. 118-1121, August 1992.
Meckes, M. C.; Renard, E.; Rawe, J.; and Wahl, G., U.S. Environmental Protection Agency, Cincinnati, OH, Office of Research and Development, Risk Reduction Engineering Laboratory, 1992

EPA Document Number: EPA/600/J-92/404

NTIS Document Number: PB93-131795/XAB

Solvent extraction of contaminated soils, sludges, and sediments has been successfully completed at a number of Superfund sites. Each commercialized process uses a unique operating system to extract organic contaminants from solids. These operating systems may be classified by the properties of the solvents each utilizes: (1) standard solvents, (2) near-critical fluids/liquified gases, and (3) critical solution temperature solvents. The paper discusses pre-treatment and post-treatment requirements, and discusses the operating systems of the solvent extraction system currently in the Superfund Innovative Technology Evaluation (SITE) Program. Future demonstrations of these technologies by the U.S. EPA's SITE Program will provide additional information regarding the efficacy of these processes.

Solvent Extraction Treatment, Engineering Bulletin.
Science Applications International Corporation, Cincinnati, OH, U.S. Environmental Protection Agency, Washington, DC, Office of Solid Waste and Emergency Response, Office of Emergency and Remedial Response, September 1991

EPA Document Number: EPA/540/2-90/013

NTIS Document Number: PB91-228015/XAB

Solvent extraction does not destroy wastes but is a means of separating hazardous contaminants from soils, sludges, and sediments, thereby reducing the volume of the hazardous waste that must be treated. Generally, it is used as one in a series of unit operations and can reduce the overall cost for managing a particular site. It is applicable to organic wastes and is generally not used for treating inorganics and metals. The technology uses an organic chemical as a solvent and differs from soil washing, which generally uses water or water with wash improving additives. During 1989, the technology was one of the selected remedies at six Superfund sites. Commercial-scale units are in operation. There is no clear solvent extraction technology leader by virtue of the solvent employed, type of equipment used, or mode of operation. The final determination of the lowest cost alternative will be more site-specific than process equipment dominated. Vendors should be contacted to determine the availability of a unit for a particular site. The bulletin provides information on the technology applicability, the types of residuals produced, the latest performance data, site requirements, the status of the technology, and sources for further information.

Summary of Treatment Technology Effectiveness for Contaminated Soil.
U.S. Environmental Protection Agency, Washington, DC, Office of Solid Waste and Emergency Response, Office of Emergency and Remedial Response, June 1990

NTIS Document Number: PB92-963351/XAB

The document presents the results of a study conducted by the Office of Emergency and Remedial Response that collected soil treatment data and analyzed the effectiveness of thermal destruction, dechlorination, bioremediation, low temperature thermal desorption, chemical extraction, soil washing, and immobilization on contaminant treatability groups. The document presents the recommendations developed for the treatment of contaminated soil.

Superfund Engineering Issue: Treatment of Lead-Contaminated Soils.
U.S. Environmental Protection Agency, Office of Emergency and Remedial Response, Washington, DC, April 1991

EPA Document Number: EPA/540/2-91/009

NTIS Document Number: PB91-921291/XAB

This bulletin summarizes the contents of a seminar on treatment of lead-contaminated soils presented on August 28, 1990, to Region V Superfund and RCRA personnel by members of EPA's Engineering and Treatment Technology Support Center located in the Risk Reduction Engineering Laboratory (RREL) in Cincinnati, Ohio. The seminar was developed to provide Regional Remedial Project Manager

(RPMs) and On-Scene Coordinators (OSCs) with an overview of the state-of-the-art technology for treatment of lead-contaminated soils. The seminar was organized to address site characterization issues and actual treatment technologies. The treatment technologies were divided into two categories: demonstrated and emerging technologies. The demonstrated technologies included extraction processes (e.g., soil washing and acid leaching) and solidification/stabilization techniques. The emerging technologies included in situ vitrification, electrokinetics, and flash smelting. The remainder of the bulletin summarizes information concerning data needs for site and soil characterization and the applicability of the discussed treatment technologies.

Superfund Innovative Technology Evaluation (SITE) Program: Innovation Making a Difference.
U.S. Environmental Protection Agency, Office of Research and Development, Risk Reduction Engineering Laboratory, Cincinnati, OH, May 1994

EPA Document Number: EPA540/F-94/505

The Superfund Innovative Technology Demonstration (SITE) Program encourages commercialization of innovative technologies for characterizing and remediating hazardous waste site contamination through four components: Demonstration; Emerging Technology; Monitoring and Measurement Programs; and Technology Transfer Activities. The information presented in this brochure addresses the demonstration segment of the program. The demonstration component evaluates promising innovative remedial technologies on site and provides reliable performance, cost and applicability information for making cleanup decisions. This document lists the advantages of the SITE Program as well as statistics such as the percentage of RODs using innovative technology, cost savings with innovative technologies for 17 sites, and market activities as reported by SITE vendors.

Superfund Innovative Technology Evaluation Program: Technology Profiles (Sixth Edition).
U.S. Environmental Protection Agency, Office of Emerency and Remedial Response, Office of Research and Development, November 1993

EPA Document Number: EPA/540/R-93/526

The Superfund Innovative Technology Evaluation (SITE) Program evaluates new and promising treatment and monitoring and measurement technologies for cleanup of hazardous waste sites. The program was created to encourage the development and routine use of innovative treatment technologies. 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. Each technology profile presented in this document 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.

Surfactants and Subsurface Remediation, Journal Article: Published in Environmental Science Technology, v26n12, p. 2324-2330, 1992.
West, C. C. and Harwell, J. H., U.S. Environmental Protection Agency, Robert S. Kerr Environmental Research Laboratory, Ada, OK, Oklahoma University Research Institute, Norman, 1992

EPA Document Number: EPA/600/J-93/005

NTIS Document Number: PB93-149854/XAB

Because of the limitations of pump-and-treat technology, attention is now focused on the feasibility of surfactant use to increase its efficiency. Surfactants have been studied for use in soil washing and enhanced oil recovery. Although similarities exist between the applications, there are significant differences in the objectives of the technologies and the limitations placed on surfactant use. In this article we review environmental studies concerned with the fate and transport of surface-active compounds in the subsurface environment and discuss key issues related to their successful use for in situ aquifer remediation, particularly with respect to nonaqueous-phase liquids.

Synopses of Federal Demonstrations of Innovative Site Remediation Technologies, Third Edition.
Federal Remediation Technologies Roundtable, U.S. Environmental Protection Agency, Washington, DC, Office of Solid Waste and Emergency Response, Technology Innovation Office, October 1993

EPA Document Number: EPA/542/B-93/009

NTIS Document Number: PB93-144111/XAB

The collection of abstracts, compiled by the Federal Remediation Technologies Roundtable, describes field demonstrations of innovative technologies to treat hazardous waste. This document updates and expands information presented in the second edition of the collection. The collection is intended to be an information resource for hazardous waste site project managers for assessing the availability and viability of innovative technologies for treating contaminated ground water, soils, and sludge. This document represents a starting point in the review of technologies available for application to hazardous waste sites. This compendium should not be looked upon as a sole source for this information – it does not represent all innovative technologies nor all technology demonstrations performed by these agencies. Only Federally sponsored studies and demonstrations that have tested innovative remedial technologies with site-specific wastes under realistic conditions as a part of large pilot- or full-scale field demonstrations are included. Those studies included represent all that were provided to the Federal Remediation Technologies Roundtable at the time of publication. Information collection efforts are ongoing.

Technologies of Delivery or Recovery for the Remediation of Hazardous Waste Sites.
Murdoch, L.; Patterson, B.; Losonsky, G.; and Harrar, W., Cincinnati University, OH, Department of Civil and Environmental Engineering, U.S. Environmental Protection Agency, Cincinnati, OH, Risk Reduction Engineering Laboratory, January 1990

EPA Document Number: EPA/600/2-89/066

NTIS Document Number: PB90-156225/XAB

Techniques to recover contaminants or deliver treating material at contaminated sites are described in the report. Few of the 17 described delivery or recovery techniques are in use today. New technologies, used in other industries such as petroleum extraction or mining, show promise for remediation of contaminated sites, but require investigation to affirm their suitability for in situ remediation. The following 17 technologies are described: colloidal gas aphrons; hydraulic fracturing; radial drilling; ultrasonic methods; kerfing; electro-kinetics; jet slurrying; CO2 injection; polymer injection; vapor extraction; steam stripping; hot brine injection; in situ combustion; radio frequency heating; cyclic pumping; soil flushing; and ground freezing. Each description of a technology includes an explanation of the basic processes involved, the optimal site conditions for use, the current status of research, the personnel currently involved in research, and a list of references.

Technologies to Remediate Hazardous Waste Sites.
Falco, J.W., Battelle Pacific Northwest Laboratories, Richland, WA, U.S. Department of Energy, March 1990

NTIS Document Number: DE90-011946/XAB

Technologies to remediate hazardous wastes must be matched with the properties of the hazardous materials to be treated, the environment in which the wastes are imbedded, and the desired extent of remediation. Many promising technologies are being developed and applied to remediate sites including biological treatment, immobilization techniques, and in situ methods. The management and disposal of hazardous wastes is changing because of Federal and State legislation as well as public concern. Future waste management systems will emphasize the substitution of alternatives for the use of hazardous materials and process waste recycling. On site treatment will also become more frequently adopted.

Technology Catalogue, First Edition.
Department of Energy, Office of Environmental Management, Office of Technology Development, Washington, DC, February 1994

DOE Document Number: DOE/EM-0138P

NTIS Document Number: DE94-008866/XAB

The catalogue provides performance data on the technologies developed by the Office of Technology Development (OTD) to scientists and engineers assessing and recommending technical solutions within the Department's clean-up and waste management programs, as well as to industry, other Federal and State agencies, and academic community. The Technology Catalogue features technologies that have been successfully demonstrated in the field through Integrated Demonstrations (IDs) and are considered sufficiently mature to be used in the near term. The Catalogue also discusses the status of the development of these innovative technologies. Forty-three technologies are featured: 22 characterization/monitoring technologies and 21 remediation technologies.

Thermal Desorption Treatment, Engineering Bulletin.
Oberacker, D.; Lafornara, P.; and dePercin, P., Science Applications International Corp., Cincinnati, OH, U.S. Environmental Protection Agency, Washington, DC, Office of Solid Waste and Emergency Response, Office of Emergency and Remedial Response, May 1991

EPA Document Number: EPA/540/2-91/008

NTIS Document Number: PB91-228080/XAB

Thermal desorption is an ex situ means to physically separate volatile and some semivolatile contaminants from soil, sediments, sludges, and filter cakes. For wastes containing up to 10% organics, thermal desorption can be used alone for site remediation. Site-specific treatability studies may be necessary to document the applicability and performance of a thermal desorption system. Thermal desorption is applicable to organic wastes and generally is not used for treating metals and other inorganics. Depending on the specific thermal desorption vendor selected, the technology heats contaminated media between 200-1000 degrees F, driving off water and volatile contaminants. Off gases may be burned in an afterburner, condensed to reduce the volume to be disposed, or captured by carbon adsorption beds. The bulletin provides information on the technology applicability, limitations, the types of residuals produced, the latest performance data, site requirements, the status of the technology, and sources for further information.

VOCs in Arid Soils: Technology Summary.
U.S. Department of Energy, Office of Environmental Management, Office of

Technology Development, Washington, DC, February 1994

DOE Document Number: DOE/EM-0136P

NTIS Document Number: DE94-008864/XAB

The Office of Technology Development at the U.S. Department of Energy developed cost effective mechanisms for assembling a group of related and synergistic technologies to evaluate their performance individually or as a complete system in correcting waste management and environmental problems from cradle to grave called Integrated Demonstrations. An Integrated Demonstration for Volatile Organic Compounds (VOCs) in Arid Soils is discussed in this document. The document discusses technologies to clean up VOCs and associated contaminants in soil and groundwater at arid sites and includes information on drilling, characterization and monitoring, retrieval of contaminants, above ground treatment of contaminants, and in ground treatment of contaminants. Technologies discussed include, heavy-weight cone penetrometer drilling, directional drilling, ResonantSonicSM drilling, borehole samplers, halosnifs, portable acoustic wave sensors, unsaturated wave apparatus, and supercritical fluid extraction / field detection. Processes and technologies used to complete them which are discussed include in-well vapor stripping, off-gas membrane separation, supported liquid membranes, steam reforming, turnable hybrid plasma, and in situ bioremediation of groundwater.

STUDIES AND DEMONSTRATIONS

Documents Focusing on Test Design

100 Area Soil Washing Treatability Test Plan.
U.S. Department of Energy, Richland, WA, Richland Field Office, March 1993

NTIS Document Number: DE93-012617/XAB

This test plan describes specifications, responsibilities, and general methodology for conducting a soil washing treatability study as applied to source unit contamination in the 100 Area. The objective of this treatability study is to evaluate the use of physical separation systems and chemical extraction methods as a means of separating chemically and radioactively contaminated soil fractions from uncontaminated soil fractions. The purpose of separating these fractions is to minimize the volume of soil requiring permanent disposal. It is anticipated that this treatability study will be performed in two phases of testing, a remedy screening phase and a remedy selection phase. The remedy screening phase consists of laboratory- and bench-scale studies performed by Battelle Pacific Northwest Laboratories (PNL) under a work order issued by Westinghouse Hanford Company (Westinghouse Hanford). This phase will be used to provide qualitative evaluation of the potential effectiveness of the soil washing technology. The remedy selection phase consists of pilot-scale testing performed under a separate service contract. The remedy selection phase will provide data to support evaluation of the soil washing technology in future feasibility studies for Interim Remedial Measures (IRMs) or final operable unit (OU) remedies. Performance data from these tests will indicate whether applicable or relevant and appropriate requirements (ARARs) or cleanup goals can be met at the site(s) by application of soil washing. The remedy selection tests will also allow estimation of costs associated with implementation to the accuracy required for the Feasibility Study.

300-FF-1 Physical Separations CERCLA Treatability Test Plan, Revision 1.
U.S. Department of Energy, Richland, WA, Richland Field Office, May 1993

NTIS Document Number: DE93-014915/XAB

This test plan describes specifications, responsibilities, and general procedures to be followed to conduct physical separations soil treatability tests in the north process pond of the 300-FF-1 Operable Unit at the Hanford Site. The overall objective of these tests is to evaluate the use of physical separations systems as a means of concentrating chemical and radioactive contaminants into fine soil fractions, thereby minimizing waste volumes. If successful, the technology could be applied to cleanup millions of cubic meters of contaminated soils at Hanford and other sites. In this document, physical separations refers to a simple and comparatively low cost technology to potentially achieve a significant reduction in the volume of contaminated soils without the use of chemical processes. Removal of metals and radioactive contaminants from the fine fraction of soils may require additional treatment such as chemical extraction, electromagnetic separation, or stabilization. Investigations/testing of these technologies are recommended to assess the economic and technical feasibility of additional treatment, but are not within the scope of this test. This plan provides guidance and specifications for two proposed treatability tests. The main body of this test plan discusses the tests in general and items that are common to both tests. Attachment A discusses in detail the EPA system test and Attachment B discusses the vendor test.

Chemical Dehalogenation Treatment: Base-Catalyzed Decomposition Process (BCDP), Technical Data Sheet.
Naval Energy and Environmental Support Activity, Port Hueneme, CA, July 1992

NTIS Document Number: PB93-182939/XAB

The Base-Catalyzed Decomposition Process (BCDP) is an efficient, relatively inexpensive treatment process for polychlorinated biphenyls (PCBs). It is also effective on other halogenated contaminants such as insecticides, herbicides, pentachlorophenol (PCP), lindane, and chlorinated dibenzodioxins and furans. The heart of BCDP is the rotary reactor in which most of the decomposition takes place. The contaminated soil is first screened, processed with a crusher and pugmill, and stockpiled. Next, in the main treatment step, this stockpile is mixed with sodium bicarbonate (in the amount of 10% of the weight of the stockpile) and heated for about one hour at 630 degrees F in the rotary reactor. Most (about 60% to 90%) of the PCBs in the soil are decomposed in this step. The remainder are volatilized, captured, and decomposed.

Engineering Considerations for the Recovery of Cesium from Geologic Materials.
Whalen, C., Jason Associates Corp., San Diego, CA, U.S. Department of Energy, Washington, DC, May 1993

NTIS Document Number: DE93-015092/XAB

Sorption coefficients for cesium in a variety of media have been compiled from a search of the open literature. The sorption coefficient, or K(sub d)S, is a description of a dissolved substance's tendency to attach to a solid substrate. The compilation of K(sub d)S reported here for cesium demonstrates that this element readily sorbs onto geological material. As a result of this sorption, the mass transport of cesium in the environment will be retarded. This retarded mass transport, characterized by the retardation factor, can be expected to be significant when compared to water velocities through porous-sorbing medium, such as geologic materials. K(sub d)S for cesium are in the range of 100 m(ell)/g up to 10,000 m(ell)/g. K(sub d)S is also an important parameter in the design of engineered systems for the purpose of recovering cesium from soils. The engineering design is based on a material-balance description of the extraction process. The information presented in this report provides a basis to predict the movement of cesium through geologic materials and also to design and predict the performance of extraction processes such as soil washing.

EPA's Mobile Volume Reduction Unit for Soil Washing, Conference Paper.
Masters, H. and Rubin, B., Foster Wheeler Enviresponse, Inc., Livingston, NJ, U.S. Environmental Protection Agency, Cincinnati, OH, Office of Research and Development, Risk Reduction Engineering Laboratory, 1991

EPA Document Number: EPA/600/D-91/202

NTIS Document Number: PB91-231209/XAB

The paper discusses the design and initial operation of the U.S. Environmental Protection Agency's (EPA) Mobile Volume Reduction Unit (VRU) for soil washing. Soil washing removes contaminants from soils by dissolving or suspending them in the wash solutions (which can be later treated by conventional waste water treatment methods) or by volume reduction through simple particle size separation techniques. Contaminants are primarily concentrated in the fine-grained (<0.063 mm, 0.0025 inch) soil fraction. The VRU is a pilot-scale mobile system for washing soil contaminated with a wide variety of heavy metal and organic contaminants. The unit includes state-of-the-art washing equipment for field applications.

Hanford Site: Physical Separations CERCLA Treatability Test Plan.
U.S. Department of Energy, Richland, WA, Richland Field Office, March 1992

NTIS Document Number: DE93-002048/XAB

This test plan describes specifications, responsibilities, and general procedures to be followed to conduct a physical separations soil treatability test in the North Process Pond of the 300-FF-1 Operable Unit at the Hanford Site, Washington. The objective of this test is to evaluate the use of physical separation systems as a means of concentrating chemical and radioactive contaminants into fine soil fractions, thereby minimizing waste volumes. If successful, the technology could be applied to clean up millions of cubic meters of contaminated soils in waste sites at Hanford and other sites. It is not the intent of this test to remove contaminated materials from the fine soils. Physical separation is a simple and comparatively low cost technology to potentially achieve a significant reduction in the volume of contaminated soils. Organic contaminants are expected to be insignificant for the 300-FF-I Operable Unit test, and further removal of metals and radioactive contaminants from the fine fraction of soils will require secondary treatment such as chemical extraction, electromagnetic separation, or other technologies. Additional investigations/testing are recommended to assess the economic and technical feasibility of applying secondary treatment technologies but are not within the scope of this test. This plan provides guidance and specifications for the treatability test.

Hanford Site: Soil Washing: A Preliminary Assessment of its Applicability to Hanford.
Gerber, M. A.; Freeman, H. D.; Baker, E. G.; and Riemath, W. F., Battelle Pacific Northwest Laboratories, Richland, WA, U.S. Department of Energy, Washington, DC, September 1991

NTIS Document Number: DE91-018654/XAB

Soil washing is being considered for treating soils at the U.S. Department of Energy's (DOE) Hanford Site. As a result of over 50 years of operations to produce plutonium for the U.S. Department of Defense and research for DOE, soils in areas within the site are contaminated with hazardous wastes and radionuclides. In the soil washing process, contaminated soil is mixed with a liquid and then physically and/or chemically treated to dissolve the contaminants into solution and/or concentrate them in a small fraction of the soil. The purpose of this procedure is to separate the contaminants from the bulk of the soil. The key to successful application is to match the types of contaminant sand soil characteristics with physical-chemical methods that perform well under the existing conditions. The applicability of soil washing to Hanford Site contaminated soils must take into account both the characteristics of the oil and the type of contamination. Hanford soils typically contain up to 90% sand, gravel, and cobbles, which generally are favorable characteristics for soil washing. For example, in soil samples from the north pond in the 300 Area, 80% to 90% of the soil particles were larger than 250 (mu) m. The principal contaminants in the soil are radionuclides, heavy metals, and nitrate and sulfate salts. For most of the sites, organic contaminants are either not present or are found in very low concentration.

Innovative Operational Treatment Technologies for Application to Superfund Site: Nine Case Studies, Final Report.
Young, C.; Schmoyer, B.; Edison, J.; Roeck, D.; and Ball, J., U.S. Environmental Protection Agency, Washington, DC, Office of Solid Waste and Emergency Response, April 1990

EPA Document Number: EPA/540/2-90/006

NTIS Document Number: PB90-202656/XAB

Nine case studies are presented in a report that was designed to identify and obtain operational data from ongoing and completed remediation efforts. The case studies are presented as appendices, and provide process description, performance, operational, and cost data. The nine appendices present case studies on the following topics: incineration of explosives and contaminated soils, ground water extraction with air stripping, ground water biodegradation treatment system, ground water extraction and treatment, ground water extraction with air stripping and soil vacuum extraction, ground water extraction with physical, chemical and biological treatment, and chemical treatment of groundwater and soil flushing.

McClellan Air Force Base: Soil Treatability Testing Work Plan for PCB-Contaminated Soil: Installation Restoration Program (IRP), Stage 7, Final Report, February 1992 - September 1992.
Radian Corp., U.S. Air Force, Sacramento, CA, October 1992

NTIS Document Number: AD-A257 731/0/XAB

This work plan has been prepared for McClellan AFB as part of the Soil Remedial Technologies Screening Project, the purpose of which is to identify potentially applicable soil treatment technologies for contaminants found in Operable Unit (OU) B soils. The work plan presents the rationale and procedures for treatability testing of two technologies applicable to polychlorinated biphenyl (PCB), dioxin, and furan contaminated soil. The work plan proposes bench-scale testing of the treatment technologies on soil collected from Study Area 12 (SA-12) where PCB, dioxin, and furan contamination have been detected in samples collected over a wide area, and where initial discussions with agency personnel indicate that treatment of the soil will be required as part of the SA-12 remediation effort. The two technologies selected for testing are: glycolate dechlorination using the APEG-PLUS process available from GRC Environmental, Inc. and the Base-Catalyzed Desorption Process (BCDP) developed by the U.S. Environmental Protection Agency.

Sequential Extraction Evaluation of Soil Washing for Radioactive Contamination.
Gombert, D., Westinghouse Idaho Nuclear Company, Inc., Idaho Falls, U.S. Department of Energy, Washington, DC, 1992

NTIS Document Number: DE92-041326/XAB

This paper describes an experimental plan for evaluating soil washing technology for potential application to radioactively contaminated soils at the Idaho National Engineering Laboratory (INEL). The sequential extraction methodology is based on micronutrient bioavailability studies wherein the soil matrix is chemically dissected to selectively remove particular fixation mechanisms independently. A mechanism-specific extractant has the potential for greater removal efficiency than a broad-spectrum extractant, such as acid, while using a less aggressive chemistry and reducing resultant water treatment and dissolved solids handling problems.

STUDIES AND DEMONSTRATIONS (CONT'D)

Documents Focusing on the Study Results

Abiotic Transformation of Carbon Tetrachloride in the Presence of Sulfide and Mineral Surfaces.
Kriegman-King, M. R. and Reinhard, M., Stanford University, CA, Department of Civil Engineering, U.S. Environmental Protection Agency, Robert S. Kerr Environmental Research Laboratory, Ada, OK, 1992

EPA Document Number: EPA/600/A-92/097

NTIS Document Number: PB92-179738/XAB

Abiotic transformations, such as reductive dehalogenation and nucleophilic substitution, can influence the fate of halogenated aliphatic compounds in aqueous environments. Sulfide, commonly found in hypoxic environments such as landfill leachate, hazardous waste plumes, and salt marshes, can act as an electron donor (Schreier, 1990; Kriegman-King and Reinhard, 1991) or as a nucleophile (Schwarzenbach, et al., 1985; Haag and Mill, 1988, Barbash and Reinhard, 1989) to promote transformation of halogenated organics. In subsurface environments, transformation rates of halogenated organic compounds may be influenced by mineral surfaces, in addition to the aqueous chemistry (Estes and Vilker, 1989, Schreier, 1990; Kriegman-King and Reinhard, 1991; Curtis, 1991). The purpose of the work is to show the effect of mineral surfaces in the presence of sulfide on the carbon tetrachloride (CTET) transformation rate. Laboratory studies were conducted to identify and quantify the environmental parameters that govern the transformation rate of CTET. The parameters studied were temperature, pH, mineral surface area, and sulfide concentration.

Applications Analysis Report: SITE Program, CF Systems Organics Extraction System, New Bedford, Massachusetts, Final Report.
Valentinetti, R., Science Applications International Corporation, McLean, VA, U.S. Environmental Protection Agency, Cincinnati, OH, Office of Research and Development, Risk Reduction Engineering Laboratory, August 1990

EPA Document Number: EPA/540/A5-90/002

NTIS Document Number: PB91-113845/XAB

The report summarizes the results of a Superfund Innovative Technology Evaluation (SITE) demonstration of the CF Systems critical fluid organics extraction system at the New Bedford Harbor, Massachusetts, Superfund site. It also provides a review of those conditions which this technology is best suited for, as well as comments by CF Systems Corporation. The technology depends on the ability of organic pollutants to solubilize in the process solvent, a liquefied gas. The pollutants treated include polychlorinated biphenyls (PCBs) and polynuclear aromatic hydrocarbons.

Bench-Scale Evaluation of Alternative Biological Treatment Processes for the Remediation of Pentachlorophenol- and Creosote-Contaminated Materials: Slurry-Phase Bioremediation, Journal Article: Published in Environmental Science and Technology, v25n6, p. 1055-1061, 1991.

Mueller, J. G. ; Lantz, S. E.; Blattmann, B. O.; and Chapman, P. J., U.S. Environmental Protection Agency, Environmental Research Laboratory, Gulf Breeze, FL, 1991

EPA Document Number: EPA/600/J-91/331

NTIS Document Number: PB92-129683/XAB

Performance data on slurry-phase bioremediation of pentachlorophenol (PCP)- and creosote-contaminated sediment and surface soil were generated at the bench-scale level. Aqueous slurries, containing 0.05% Triton X-100 to facilitate the soil washing process and to help stabilize the suspensions, were prepared from sediment and surface soil freshly obtained from the American Creosote Works Superfund site at Pensacola, Florida. Excluding PCP, benzo(b)fluoranthene, benzo(k)-fluoranthene, and indeno(123-cd)pyrene, slurry-phase bioremediation of highly contaminated sediment (pH adjusted) resulted in rapid and extensive biodegradation (3-5 days to biodegrade > 50% of targeted compounds) of monitored constituents. Data suggest that slurry-phase bioremediation strategies can be effectively employed to remediate creosote-contaminated materials.

Carver-Greenfield Process (Trade Name) Dehydro-Tech Corporation, Applications Analysis Report, Final Report.
PRC Environmental Management, Inc., Cincinnati, OH, U.S. Environmental Protection Agency, Cincinnati, OH, Office of Research and Development, Risk Reduction Engineering Laboratory, September 1992

EPA Document Number: EPA/540/AR-92/002

NTIS Document Number: PB93-101152/XAB

The report evaluates the Dehydro-Tech Corporation's Carver-Greenfield (C-G) Process and focuses on the technology's ability to separate waste mixtures into their constituent solid, organic, and water fractions while producing a solid residual that meets applicable disposal requirements. The report presents performance and economic data from the U.S. Environmental Protection Agency's Superfund Innovative Technology Evaluation (SITE) demonstration and three case studies. The C-G Process demonstration was conducted as a part of the SITE Program at the Risk Reduction Engineering Laboratory's Releases Control Branch facility in Edison, New Jersey, using drilling mud waste from the PAB Oil Superfund site in Abbeville, Louisiana. The system generated a treated solids product that passed Toxicity Characteristic Leaching Procedure (TCLP) criteria for volatiles, semivolatiles and metals. Potential wastes that might be treated by the technology include industrial residues, Resource Conservation and Recovery Act wastes, Superfund wastes, and other wastes contaminated with organic compounds. Economic analyses indicate that the cost of using the C-G Process is about $523/ton of which $302 is for site-specific expenses.

CF Systems Organics Extraction Process New Bedford Harbor, MA: Applications Analysis Report.
U.S. Environmental Protection Agency, Office of Research and Development, Risk Reduction Engineering Laboratory, Cincinnati, OH, August 1990

EPA Document Number: EPA/540/A5-90/002

NTIS Document Number: PB91-113845/XAB

This document discusses the Superfund Innovative Technology Evaluation (SITE) Program Demonstration of the CF Systems organics extraction technology. The SITE Program Demonstration was conducted concurrently with dredging studies managed by the U.S. Army Corps of Engineers at the New Bedford Harbor Superfund site in Massachusetts to obtain specific operating and cost information that could be used in evaluating the potential applicability of this technology to Superfund sites. Contaminated sediments were treated by CF Systems' Pit Cleanup Unit (PCU) that extracts organics from contaminated soils based on their solubility in a mixture of liquefied propane and butane. This document contains evaluations of the unit's performance, operating conditions, health and safety considerations, equipment and system materials handling problems, and projected economics.

Chemical Dehalogenation Treatment: APEG Treatment, Engineering Bulletin.
Science Applications International Corporation, Cincinnati, OH, U.S. Environmental Protection Agency, Washington, DC, Office of Solid Waste and Emergency Response, Office of Emergency and Remedial Response, September 1990

EPA Document Number: EPA/540/2-90/015

NTIS Document Number: PB91-228031/XAB

The chemical dehalogenation system discussed in the report is alkaline metal hydroxide/polyethylene glycol (APEG), which is applicable to aromatic halogenated compounds. The metal hydroxide that has been most widely used for this reagent preparation is potassium hydroxide (KOH) in conjunction with polyethylene glycol (PEG) (typically, average molecular weight of 400 Daltons) to form a polymeric alkoxide referred to as KPEG. However, sodium hydroxide has also been used in the past and most likely will find increasing use in the future because of patent applications that have been filed for modification to this technology. This new approach will expand the technology's applicability and efficacy and should reduce chemical costs by facilitating the use of less costly sodium hydroxide. A variation of this reagent is the use of potassium hydroxide or sodium hydroxide/tetraethylene glycol, referred to as ATEG, that is more effective on halogenated aliphatic compounds. In some KPEG reagent formulations, dimethyl sulfoxide (DMSO) is added to enhance reaction rate kinetics, presumably by improving rates of extraction of the haloaromatic contaminants. Previously developed dehalogenation reagents involved dispersion of metallic sodium in oil or the use of highly reactive organosodium compounds. The reactivity of metallic sodium and these other reagents with water presented a serious limitation to treating many waste matrices; therefore, these other reagents are not discussed in this bulletin and are not considered APEG processes.

Demonstration of Remedial Action Technologies for Contaminated Land and Ground Water, Volume 1, Final Report, November 1986 - November 1991.
Olfenbuttel, R. F.; Dahl, T. O.; Hinsenveld, M.; James, S. C.; and Lewis, N., NATO Committee on the Challenges of Modern Society, Brussels, U.S. Environmental Protection Agency, Cincinnati, OH, Office of Research and Development, Risk Reduction Engineering Laboratory, February 1993

EPA Document Number: EPA/600/R-93/012A

NTIS Document Number: PB93-218238/XAB

This document demonstrates the selection of remedies at complex hazardous waste sites. Topics covered in this document include: thermal technologies, stabilization/solidification technologies, soil vapor extraction technologies, physical/chemical extraction technologies, chemical treatment of contaminated soils (APEG), and microbial treatment technologies.

Demonstration of Thermal Stripping of JP-4 and Other VOCs from Soils at Tinker Air Force Base Oklahoma City, Oklahoma, Final Report, September 1988 - March 1990.
Marks, P. J.; Noland, J. W.; and Nielson, R. K., Roy F. Weston, Inc., West Chester, PA, U.S. Air Force, March 1990

NTIS Document Number: AD-A222 235/4/XAB

The patented Low Temperature Thermal Treatment (LT3) System was previously proven to be successful in treating soils contaminated with volatile organic compounds and petroleum hydrocarbons. This demonstration broadened the applicability to include soils contaminated with aviation fuel and other halogenated solvents. Several tests were conducted to verify the effectiveness of the LT3 System. While meeting all goal cleanup objectives, a processing rate of 20,000 lbs/hr was demonstrated with a projected LT3 System processing cost of $86/ton. A number of system changes and process improvements are recommended. The system proved to be an efficient, cost-effective, and commercially available remediation alternative for decontaminating soils.

Effect of a Base-Catalyzed Dechlorination Process on the Genotoxicity of PCB-Contaminated Soil, Journal Article: Published in Chemosphere, v24n12, p. 1713-1720, June 1992.
DeMarini, D. M.; Houk, V. S.; Kornel, A.; and Rogers, C. J., U.S. Environmental Protection Agency, Research Triangle Park, NC, Office of Research and Development, 1992

EPA Document Number: EPA/600/J-92/433

NTIS Document Number: PB93-141323/XAB

The researchers evaluated the genotoxicity of dichloromethane (DCM) extracts of PCB-contaminated soil before and after the soil had been treated by a base-catalyzed dechlorination process, which involved heating a mixture of the soil, polyethylene glycol, and sodium hydroxide to 250-350° C. This dechlorination process reduced by over 99% the PCB concentration in the soil, which was initially 2,200 ppm. The DCM extracts of both control and treated soils were not mutagenic in strain TA100 of Salmonella, but they were mutagenic in strain TA98. The base-catalyzed dechlorination process reduced the mutagenic potency of the soil by approximately one-half. The DCM extracts of the soils before and after treatment were equally genotoxic in a prophage-induction assay in E.coli, which detects some chlorinated organic carcinogens that were not detected by the Salmonella mutagenicity assay. These results show that treatment of PCB-contaminated soil by this base-catalyzed dechlorination process did not increase the genotoxicity of the soil.

Efficiency of Dioxin Recovery from Fly Ash Samples During Extraction and Cleanup Process, March 1989, Final Report, August 19, 1987 - September 19, 1988.
Finkel, J. M.; James, R. H.; and Baughman, K. W., Southern Research Institute, Birmingham, AL, U.S. Environmental Protection Agency, Research Triangle Park, NC, Atmospheric Research and Exposure Assessment Laboratory, March 1989

EPA Document Number: EPA/600/3-90/010

NTIS Document Number: PB90-183393/XAB

The work supported Environmental Monitoring Systems Laboratory, U.S. Environmental Protection Agency in its effort to monitor the hazardous composition, if any, of fly ash from various types of incinerators using different types of combustible materials. The analytical determination of dioxins in environmental samples in the parts per billion, trillion, and quadrillion levels requires meticulous, time-consuming, and very complex sample preparation and analysis procedures. A major part of the task was devoted to the evaluation of various extraction techniques of fly ash and cleanup of sample extracts by column chromatography. Several chromatographic media and eluting solvents were investigated. Each step in the sample preparation was evaluated by using 14C-radio labeled 2,3,7,8-tetrachlorodibenzo-p-dioxin and octochlorodibenzo-p-dioxin as a tracer. Radio labeled dioxin allows the analyst to stop and evaluate each step of the procedure, each extract, and each column eluate fraction by liquid scintillation computing. To validate the radiometric assay, dioxin was confirmed by gas chromatography/mass spectrometry. The report contains recovery data of spiked 2,3,7,8-tetrachlorodibenzo-p-dioxin and octochlorodibenzo-p-dioxin in carbon-free fly ash and fly ash containing from 0.1% to 10% carbon.

E.I. DuPont De Nemours & Company/Oberlin Filter Company Microfiltration Technology: Applications Analysis Report.
U.S. Environmental Protection Agency, Office of Research and Development, Risk Reduction Engineering Laboratory, Cincinnati, OH, October 1991

EPA Document Number: EPA/540/A5-90/007

NTIS Document Number: PB92-119023/XAB

This document discusses the Superfund Innovative Technology Evaluation (SITE) Program Demonstration of the DuPont/Oberlin microfiltration technology. This document evaluates the microfiltration technology's ability to remove metals (present in soluble or insoluble form) and particulates from liquid wastes while producing a dry filter cake and a filtrate that meet applicable disposal requirements. In addition, it presents economic data from the SITE demonstration, and discusses the potential applicability of the technology. The DuPont/Oberlin microfiltration technology combines Oberlin's automatic pressure filter with DuPont's new microporous Tyvek filter media. It is designed to remove particles that are 0.1 micron in diameter, or larger, from liquid wastes, such as contaminated ground water. This report also summarizes the results from three case studies. All three facilities treated process waste waters containing metals and total suspended solids (TSS) ranging from several parts per million to several percent.

Engineering-Scale Evaluation of Thermal Desorption Technology for Manufactured Gas Plant Site Soils, Topical Report July 1988-August 1989.
Helsel, R.; Alperin, E.; and Groen, A., IT Corp., Knoxville, TN, Gas Research Institute, Chicago, IL, Illinois Hazardous Waste Research and Information Center, Savoy, November 1989

NTIS Document Number: PB90-172529/XAB

As part of a program to evaluate and develop technologies for remediation of contaminated soils at manufactured gas plant (MGP) sites, pilot plant tests of a thermal desorption treatment technology were performed. Coal-tar-contaminated soil samples from three MGP sites were characterized, and bench-scale treatability tests were performed to establish treatment conditions to use for the pilot tests. A series of 11 pilot tests were completed using an indirectly heated rotary desorber operating at 30 to 60 kilograms/hour of soil. Treatment conditions of 300 degrees C and 400 degrees C and soil residence times of 5 and 9 minutes were used. Total polycyclic aromatic hydrocarbon concentrations were reduced to between 150 and 1 part per million (ppm) from initial levels of 2000 to 400 ppm, depending on treatment conditions. Temperature, residence time, and soil type all had a significant effect on treatment efficiency. Reasonable agreement was found among results from the static, batch, bench-scale test apparatus and the dynamic, continuous pilot plant.

EPA Site Demonstration of the BioTrol Soil Washing Process, Journal Article: Published in Journal of Air and Waste Management Association, v42n1, p. 96-103, 1991.
Stinson, M. K.; Skovronek, H. S.; and Ellis, W. D., U.S. Environmental Protection Agency, Cincinnati, OH, Office of Research and Development, Risk Reduction Engineering Laboratory, Science Applications International Corp., Paramus, NJ, 1992

EPA Document Number: EPA/600/J-92/051

NTIS Document Number: PB92-150655/XAB

A pilot-scale soil washing process, patented by BioTrol, was demonstrated on soil that was contaminated by wood treating waste. The BioTrol Soil Washing was demonstrated in a treatment train sequence with two other pilot-scale units of BioTrol technologies for treatment of waste streams from the soil washer. The three technologies of the treatment train were: the BioTrol Soil Washer (BSW), the BioTrol Aqueous Treatment System (BATS), and the Slurry Bioreactor (SBR). The BioTrol processes were evaluated on pentachlorophenol (PCP) and polynuclear aromatic hydrocarbons (PAHs), which were the primary soil contaminants at the site. The sandy site soil, consisting of less than 10% of fines, was well suited for treatment by soil washing. The BSW successfully separated the feed soil (100% by weight) into 83% of washed soil, 10% of woody residues, and 7% of fines. The soil washer achieved up to 89% removal of PCP and PAHs, based on the difference between their levels in the feed soil and in the washed soil. The BATS degraded up to 94% of PCP in the process water from soil washing. The SBR achieved over 90% removals of PCP and 70-90% removals of PAHs, respectively, from the soil washing. Cost of a commercial-scale soil washing, assuming use of all three technologies, was estimated to be $168 per ton of treated soil.

Evaluation of Alternative Treatment Technologies for CERCLA Soils and Debris, Summary of Phase 1 and Phase 2.
Locke, B. B.; Arozarena, M. M.; Chambers, C. D.; Hessling, J. A.; and Alperin, E., PEI Associates, Inc., Cincinnati, OH, International Technology Corporation, Knoxville, TN, Bruck, Hartman and Esposito, Inc., Cincinnati, OH, U.S. Environmental Protection Agency, Cincinnati, OH, Office of Research and Development, Risk Reduction Engineering Laboratory, September 1991

EPA Document Number: EPA/600/2-91/050

NTIS Document Number: PB91-240572/XAB

The study was conducted in two phases. In the first phase, a synthetic soil matrix was prepared as a theoretical composite of Superfund soils nationwide. In the second phase, soils from actual Superfund sites were treated. Three treatment technologies were evaluated in both phases: (1) chemical treatment (KPEG), (2) physical treatment (soil washing), and (3) low-temperature thermal desorption. The Phase 1 study also included the evaluation of incineration and stabilization. Comparison of results obtained in the treatment of Superfund soils and the synthetic soils reveals that the trend in contaminant removals was similar for both types of soils. The percentage removal, however, was higher for synthetic soils than for actual Superfund soils. This can be attributed to the fact that the synthetic soils were spiked and tested without allowing much time for sorption of the contaminant onto the soils. In contrast, the actual Superfund soils had weathered for long periods of time before treatment was attempted; therefore, contaminant removal was shown to be more difficult on the actual soils.

Evaluation of a Subsurface Oxygenation Technique Using Colloidal Gas Aphron Injections into Packed Column Reactors.
Wills, R. A. and Coles, P., University of Wyoming Research Corp., Laramie, Western Research Institute, U.S. Department of Energy, Washington, DC, November 1991

NTIS Document Number: DE93-000240/XAB

Bioremediation may be a remedial technology capable of decontaminating subsurface environments. The objective of this research was to evaluate the use of colloidal gas aphron (CGA) injection, which is the injection of micrometer-size air bubbles in an aqueous surfactant solution, as a subsurface oxygenation technique to create optimal growth conditions for aerobic bacteria. Along with this, the capability of CGAs to act as a soil-washing agent and free organic components from a coal-tar-contaminated matrix was examined. Injection of CGAs may be useful for remediation of underground coal gasification (UCG) sites. Because of this, bacteria and solid material from a UCG site located in northeastern Wyoming were used in this research. CGAs were generated and pumped through packed column reactors (PCRs) containing post-burn core materials. For comparison, PCRs containing sand were also studied. Bacteria from this site were tested for their capability to degrade phenol, a major contaminant at the UCG site and were also used to bioaugment the PCR systems. In this study we examined: (1) the effect of CGA injection on dissolved oxygen concentrations in the PCR effluents, (2) the effect of CGA, H2O, and phenol injections on bacterial populations, (3) the stability and transport of CGAs over distance, and (4) CGA injection versus H2O injection as an oxygenation technique.

Evaluation of Modifications to Extraction Procedures Used in Analysis of Environmental Samples from Superfund Sites, Journal Article: Published in Journal of the Association of Official Analytical Chemists, v72n4, p. 602-608, 1989.
Valkenburg, C. A.; Munslow, W. D.; and Butler, L. C., Lockheed Engineering and Sciences Company, Inc., Las Vegas, NV, U.S. Environmental Protection Agency, Las Vegas, NV, 1989

EPA Document Number: EPA/600/J-89/061

NTIS Document Number: PB90-103516/XAB

Recoveries from an aqueous sample of the semi-volatile analytes listed on the EPA Target Compound List are compared using six different methylene chloride extraction procedures. Four experimental designs incorporating a continuous extraction apparatus are evaluated, and two experimental designs using separatory funnel methods are tested. In addition, two concentration procedures are compared, and the loss of analytes associated with both extraction and concentration procedures are determined. These studies indicate that the most efficient and economical technique for the extraction of these compounds from an aqueous matrix is a single continuous extraction procedure performed at 2 pH.

Evaluation of Soil Washing Technology: Results of Bench-Scale Experiments on Petroleum-Fuels Contaminated Soils.
Loden, M. E., Camp, Dresser and McKee, Inc., Cambridge, MA, U.S. Environmental Protection Agency, Cincinnati, OH, Office of Research and Development, Risk Reduction Engineering Laboratory, June 1991

EPA Document Number: EPA/600/2-91/023

NTIS Document Number: PB91-206599/XAB

The U.S. Environmental Protection Agency, through its Risk Reduction Engineering Laboratory's Releases Control Branch, has undertaken research and development efforts to address the problem of leaking underground storage tanks (USTs). Under this effort, EPA is currently evaluating soil washing technology for cleaning up soil contaminated by the release of petroleum products from leaking underground storage tanks. Soil washing is a dynamic physical process that remediates contaminated soil via two mechanisms—particle separation and dissolution of the contaminants into the wash water. As a result of the washing process, a significant fraction of the contaminated soil is cleaned and can be returned into the original excavation or used as cleaned "secondary" fill or aggregate material. Since the contaminants are more concentrated in the fine soil fractions, their separation and removal from the bulk soil increases the overall effectiveness of the process. Subsequent treatment will be required for the spent wash waters and the fine soil fractions. The soil washing program evaluated the effectiveness of soil washing technology in removing petroleum products (unleaded gasoline, diesel/home heating fuel, and waste crankcase oil) from an EPA-developed Synthetic Soil Matrix (SSM) and from actual site soils. Operating parameters such as contact time, wash water volume, rinse water volume, wash water temperature, and effectiveness of additives were investigated.

Feasibility of Hydraulic Fracturing of Soil to Improve Remedial Actions.
Murdoch, L. C.; Losonsky, G.; Cluxton, P.; Patterson, B.; and Klich, I., Cincinnati University, OH, U.S. Environmental Protection Agency, Cincinnati, OH, Office of Research and Development, Risk Reduction Engineering Laboratory, April 1991

EPA Document Number: EPA/600/2-91/012

NTIS Document Number: PB91-181818/XAB

Hydraulic fracturing, a method of increasing fluid flow within the subsurface, should improve the effectiveness of several remedial techniques, including pump and treat, vapor extraction, bioremediation, and soil flushing. The technique is widely used to increase the yields of oil wells, but is untested under conditions typical of contaminated sites. The project consisted of laboratory experiments, where hydraulic fractures were created in a triaxial pressure cell, and two field tests, where fractures were created at shallow depths in soil. The lab tests showed that hydraulic fractures are readily created in clayey silt, even when it is saturated and loosely-consolidated. Many of the lab observations can be explained using parameters and analyses based on linear elastic fracture mechanics. Following the field tests, the vicinity of the bore holes was excavated to reveal details of the hydraulic fractures. Maximum lengths of the fractures, as measured from the borehole to the leading edge, averaged 4.0 m, and the average area was 19 sq m. Maximum thickness of sand ranged from 2 to 20 mm, averaging 11 mm. As many as four fractures were created from a single borehole, stacked one over the other at vertical spacing of 15 to 30 cm.

Field Applications of the KPEG (Potassium Polyethylene Glycolate) Process for Treating Chlorinated Wastes.
Taylor, M. L.; Wentz, J. A.; Dosani, M. A.; Gallagher, W.; and Greber, J. S., PEI Associates, Inc., Cincinnati, OH, U.S. Environmental Protection Agency, Cincinnati, OH, Office of Research and Development, Risk Reduction Engineering Laboratory, Civil Engineering Laboratory (Navy), Port Hueneme, CA, July 1989

EPA Document Number: EPA/600/2-89/036

NTIS Document Number: PB89-212724/XAB

The KPEG chemical dechlorination process was identified at the Franklin Research Center in Philadelphia, Pennsylvania in 1978 for the dechlorination of polychlorinated biphenyls (PCBs) in oil. Further process development, primarily by the U.S. EPA Risk Reduction Engineering Laboratory, has focused on the dechlorination of PCBs and other potentially toxic halogenated aromatic compounds such as tetrachlorodibenzodioxin that contaminate soils. In 1987, in Moreau, New York a pilot-scale treatment system was demonstrated on PCB-contaminated soil in batches of 35 lbs each. The demonstration was the first attempt to dechlorinate PCB-contaminated soil in a reactor/mixer at a scale larger than that used in the laboratory. Analytical results of the demonstration indicated an average PCB reduction of 99.7%, thus illustrating the efficacy of the potassium polyethylene glycolate (KPEG) technology at a larger scale and warranting assessment for scale-up.

Geophysical Monitoring of Active Hydrologic Processes as Part of the Dynamic Underground Stripping Project.

Newmark, R. L., Lawrence Livermore National Laboratory, CA, U.S. Department of Energy, Washington, DC, May 1992

NTIS Document Number: DE92-018058/XAB

Lawrence Livermore National Laboratory, in collaboration with the University of California at Berkeley and Lawrence Berkeley Laboratory, is conducting the Dynamic Underground Stripping Project (DUSP), an integrated project demonstrating the use of active thermal techniques to remove subsurface organic contamination. Complementary techniques address a number of environmental restoration problems: (1) steam flood strips organic contaminants from permeable zones, (2) electrical heating drives contaminants from less permeable zones into the more permeable zones from which they can be extracted, and (3) geophysical monitoring tracks and images the progress of the thermal fronts, providing feedback and control of the active processes. The first DUSP phase involved combined steam injection and vapor extraction in a "clean" site in the Livermore Valley consisting of unconsolidated alluvial interbeds of clays, sands and gravels. Steam passed rapidly through a high-permeability gravel unit, where in situ temperatures reached 117 degrees C. An integrated program of geophysical monitoring was carried out at the clean site. The researchers performed electrical resistance tomography (ERT), seismic tomography (crossborehole), induction tomography, passive seismic monitoring, a variety of different temperature measurement techniques, and conventional geophysical well logging.

Hanford Site: Hanford Site Annual Waste Reduction Report, 1990.
Nichols, D. H., U.S. Department of Energy, Richland, WA, Richland Operations Office, March 1991

NTIS Document Number: DE91-010110/XAB

The U.S. Department of Energy-Richland Operations (DOE-RL) has developed and implemented a Hanford Site Waste Minimization and Pollution Prevention Awareness Plan that provides overall guidance and direction on waste minimization and pollution prevention awareness to the four contractors who manage and operate the Hanford Site for the DOE-RL. Waste reduction at DOE-RL will be accomplished by following a hierarchy of environmental protection practices. First, eliminate or minimize waste generation through source reduction. Second, recycle (i.e., use, reuse, or reclaim) potential waste materials that cannot be eliminated or minimized. Third, treat all waste that is nevertheless generated to reduce volume, toxicity, or mobility before storage or disposal. The scope of the waste reduction program will include non-hazardous, hazardous, radioactive-mixed, and radioactive wastes. Hazardous waste generation was reduced by 148,918 kg during the 1990 reporting period, which was primarily the result of source reduction efforts involving excess materials and product substitution. Radioactive-mixed waste production was reduced by more than 4,000 metric tons. The driving force for this increased savings over previous years was an anticipated shortage of adequate tank storage space. Adjusting the solvent extraction start-up parameters at the PUREX facility and better management of waste during transfers to tank storage account for more than 90% of the total reduction. Recycling of low-level waste amounted to 612 kg, and source reduction of TRU waste contributed another 800 kg in savings. A detailed breakdown of waste reduction accomplishments by waste type and method is provided.

In Situ Biodegradation Treatment.
U.S. Environmental Protection Agency, Office of Emergency and Remedial Response, Washington, DC, Office of Research and Development, Cincinnati, OH, April 1994

EPA Document Number: EPA/540/S-94/502

In situ biodegradation may be used to treat low-to-intermediate concentrations of organic contaminants in place without disturbing or displacing the contaminated media. Although this technology has been used to degrade a limited number of inorganics, specifically cyanide and nitrate, in situ biodegradation is not generally employed to degrade inorganics or to treat media contaminated with heavy metals. During in situ biodegradation, electron acceptors (e.g., oxygen and nitrate), nutrients, and other amendments may be introduced into the soil and groundwater to encourage the growth of an indigenous population capable of degrading the contaminants of concern. These supplements are used to control or modify site-specific conditions that impede microbial activity and, thus, the rate and extent of contaminant degradation. Depending on site-specific clean-up goals, in situ biodegradation can be used as the sole treatment technology or in conjunction with other biological, chemical, and physical technologies in a treatment train. In the past, in situ biodegradation has often been used to enhance traditional pump and treat technologies. As of Fall 1993, in situ biodegradation was being considered or implemented as a component of the remedy at 21 Superfund sites and 38 RCRA, Underground Storage Tank, Toxic Substances Control Act, and Federal sites with soil, sludge, sediment, or groundwater contamination. This bulletin provides information on the technology's applicability, the types of residuals produced, the latest performance data, the site requirements, the status of the technology, and sources for further information.

Low Temperature Thermal Treatment (LT3R) Technology Roy F. Weston, Inc., Applications Analysis Report.
U.S. Environmental Protection Agency, Office of Research and Development, Risk Reduction Engineering Laboratory, Cincinnati, OH, December 1992

EPA Document Number: EPA/540/AR-92/019

NTIS Document Number: PB94-124047/XAB

This document discusses the Superfund Innovative Technology Evaluation (SITE) Program Demonstration of the Low Temperature Thermal Treatment (LT3) system's ability to remove volatile organic compounds (VOC) and semi volatile organic compounds (SVOC) from solid wastes. This evaluation is based on treatment performance, cost data, and five case studies. The LT3 system thermally desorbs organic compounds from contaminated soil without heating the soil to combustion temperatures. During the development of the LT3 system, Weston conducted bench- and pilot-scale tests and collected treatability data for the following wastes: coal tar, drill cuttings (oil-based mud), leaded and unleaded gasoline, No. 2 diesel fuel, JP4 jet fuel, petroleum hydrocarbons, halogenated and nonhalogenated solvents, OVSs, SVOCs, and polynuclear aromatic hydrocarbons (PAH). The document also discusses the applicability of the LT3 system based on compliance with regulatory requirements, implementability, short-term impact, and long-term effectiveness.

Method for the Supercritical Fluid Extraction of Soils/Sediments.
Lopez-Avila, V. and Dodhiwaia, N.S., Mid-Pacific Environmental Laboratory, Inc., Mountain View, CA, Environmental Monitoring Systems Laboratory, Las Vegas, NV, U.S. Environmental Protection Agency, Office of Research and Development, November 1990

EPA Document Number: EPA/600/4-90/026

NTIS Document Number: PB91-127803/XAB

Supercritical fluid extraction has been publicized as an extraction method that has several advantages over conventional methods, and it is expected to result in substantial cost and labor savings. This study was designed to evaluate the feasibility of using supercritical fluid extraction as a sample extraction method for pollutants and matrices of concern to the EPA. Various matrices were spiked with compounds from several classes of pollutants and were extracted with supercritical carbon dioxide, with and without modifiers. Based on the results, a preliminary protocol was developed, which was then tested with additional simple and complex matrices. Another important segment of this work was to study the influence of variables on recoveries. The results of this study indicate that supercritical fluid extraction with carbon dioxide, with or without modifiers, is an attractive method for the extraction of organic contaminants from environmental solid matrices. Potential advantages of the method include less solvent use and disposal, reduced manpower requirement, and increased speed and selectivity. However, more developmental work has to be done before supercritical fluid extraction becomes an easy-to-use, off-the-shelf method.

On-Site Engineering Report for the Low-Temperature Thermal Desorption Pilot-Scale Test on Contaminated Soil.
Smith, M. L.; Groen, A.; Hessling, J.; and Alperin, E., IT Environmental Programs, Inc., Cincinnati, OH, IT Corp., Knoxville, TN, U.S. Environmental Protection Agency, Cincinnati, OH, Office of Research and Development, Risk Reduction Engineering Laboratory, July 1992

EPA Document Number: EPA/600/R-92/142

NTIS Document Number: PB92-216936/XAB

Performance of the thermal desorption process for removal of organic contaminants, mostly polynuclear aromatic hydrocarbons (PAHs), from soils was evaluated. The Superfund Site soil tested was a fine sandy soil contaminated with creosote. An optimum operating temperature of 550 degrees and an optimum operating residence time of 10 minutes, determined from bench studies, were used in the pilot-scale desorber. Contaminants removed from the soil were captured or destroyed in the associated air pollution control equipment. Test results showed that greater than 99% of the PAHs were removed from the soil. The concentration of total PAHs averaged 4629 mg/Kg in the pretreated soils and were below detection in the post-treated soils.

perox-pureTM Chemical Oxidation Technology Peroxidation Systems, Inc.: Applications Analysis Report.
U.S. Environmental Protection Agency, Office of Research and Development, Risk Reduction Engineering Laboratory, Cincinnati, OH, July 1993

EPA Document Number: EPA/540/AR-93/501

NTIS Document Number: PB94-130325/XAB

This document discusses the Superfund Innovative Technology Evaluation (SITE) Program Demonstration of the perox-pure' chemical oxidation technology's ability to remove volatile organic compounds (VOC) and other organic contaminants present in liquid wastes. The perox-pure' chemical oxidation technology was developed to destroy dissolved organic contaminants in water. The technology uses ultraviolet (UV) radiation and hydrogen peroxide to oxidize organic compounds present in water at parts per million levels or less. This treatment technology produces no air emission and generates no sludge or spent media that require further processing, handling, or disposal. Economic data and the results from three case studies are also summarized in this report. The contaminants of concern in these case studies include acetone, isopropyl alcohol (IPA), TCE, and pentachlorophenol (PCP).

Physical and Morphological Measures of Waste Solidification Effectiveness.
Grube, W. E., U.S. Environmental Protection Agency, Cincinnati, OH, Office of Research and Development, Risk Reduction Engineering Laboratory, 1991

EPA Document Number: EPA/600/D-91/164

NTIS Document Number: PB91-226340/XAB

The paper describes and discusses physical testing to characterize wastes treated by the Soliditech cement-solidification/stabilization process. In addition, morphological measures included documented observations and measurements of components of structure and form of the treated materials. The paper provides data to relate easily measured physical and morphological properties with intensive chemical extraction and solute leachability information obtained from standardized tests.

Physical/Chemical Treatment of Mixed Waste Soils.
Morris, M. I.; Alperin, E. S.; and Fox, R. D., Oak Ridge National Laboratory, TN, U.S. Department of Energy, Washington, DC, 1991

NTIS Document Number: DE91-009143/XAB

This report discusses the results and findings of the demonstration testing of a physical/chemical treatment technology for mixed wastes. The principal objective of the tests was to demonstrate the capability of the low temperature thermal separation (LTTS) technology for rendering PCB-contaminated mixed waste soils as non-hazardous and acceptable for low level radioactive waste disposal. The demonstration testing of this technology was a jointly conducted project by the U.S. Department of Energy (DOE), the Martin Marietta Energy Systems (Energy Systems), Waste Management Technology Center at the Oak Ridge National Laboratory, and IT Corporation. This pilot-scale demonstration program testing of IT's thermal separator technology in Oak Ridge was conducted as part of the DOE Model Program. This program has private industry, regulators, and universities helping to solve DOE waste management problems. Information gained from the DOE Model is shared with the participating organizations, other Federal agencies, and regulatory agencies. The following represent the most significant findings from these demonstration tests: Thermal separation effectively separated PCB contamination from a mixed waste to enable the treated soil to be managed as low level radioactive waste. At the same operating conditions, mercury contamination of 0.8 ppm was reduced to less than 0.1 ppm. The majority of uranium and technetium in the waste feeds oil remained in the treated soil. Radionuclide concentration in cyclone solids is due to carry-over of entrained particles in the exit gas and not due to volatilization/condensation. Thermal separation also effectively treated all identified semi-volatile contaminants in the waste soil to below detection limits with the exception of di-n-butylphthalate in one of the two runs.

Removal of Creosote from Soil by Thermal Desorption.
Lauch, R. P.; Herrmann, J. G.; Smith, M. L.; Alperin, E.; and Groen, A., International Technology Corp., Knoxville, TN, U.S. Environmental Protection Agency, Cincinnati, OH, Office of Research and Development, Risk Reduction Engineering Laboratory, 1991

EPA Document Number: EPA/600/D-91/276

NTIS Document Number: PB92-126838/XAB

Performance of the thermal desorption process for removal of organic contaminants, mostly polynuclear aromatic hydrocarbons (PAHs), from soils was evaluated. A Superfund site soil that was contaminated with creosote was tested. An operating temperature of 550 degrees C and an operating residence time of 10 minutes at temperature, determined from bench studies, were used in the pilot scale desorber. Test results showed that greater than 99% of the PAHs were removed from the test soil. The concentrations of total PAHs in the soil before and after treatment averaged 4629 mg/kg and below detection limits respectively.

Results of Treatment Evaluations of Contaminated Soils.

Esposito, P.; Hessling, J.; Locke, B. B.; Taylor, M.; and Szabo, M., PEI Associates, Inc., Cincinnati, OH, U.S. Environmental Protection Agency, Cincinnati, OH, Hazardous Waste Engineering Research Laboratory, August 1988

EPA Document Number: EPA/600/D-88/181

NTIS Document Number: PB88-250204/XAB

Soil and debris from Superfund sites must be treated to minimize their threat to human health and the environment as part of remedial actions at such sites. Studies were conducted on the effectiveness with which five treatment processes removed or immobilized synthetic soils containing volatile and semivolatile organics and metals. The treatment technologies were soil washing, dechlorination with potassium polyethylene glycol (KPEG), incineration, low temperature thermal desorption and solidification/fixation. The paper describes the production of four synthetic soils containing varying levels of contaminants and reports the effectiveness of the five treatment methods.

Separation of Hazardous Organics by Low Pressure Membranes: Treatment of Soil-Wash Rinse-Water Leachates, Report for January 1990 - January 1992.
Bhattacharyya, D. and Kothari, A., Kentucky University, Lexington, Department of Chemical Engineering, U.S. Environmental Protection Agency, Cincinnati, OH, Office of Research and Development, Risk Reduction Engineering Laboratory, March 1992

EPA Document Number: EPA/600/R-92/035

NTIS Document Number: PB92-153436/XAB

Soil washing is a promising technology for treating contaminated soils. In the present work, low-pressure, thin-film composite membranes were evaluated to treat the soil-wash leachates so that the treated water could be recycled back to the soil washing step. Experiments were done with SARM (Synthetic Analytical Reference Matrix) soils. Membrane performance was evaluated with leachates obtained from different wash solutions. The effect of fine suspensions in the leachates was also studied. A solution-diffusion model was modified to include an adsorption resistance term in water flux, and this term was correlated with bulk concentration using the Freundlich isotherm. The correlation was then used to predict water flux drop at different bulk concentrations or to predict water flux at different recoveries. Thin-film composite membranes were found to effectively treat the leachate from rinse water used to wash contaminated soil. In addition, feed preozonation significantly improved water flux.

SITE Demonstration of the CF Systems Organics Extraction System, Journal Article: Published in Journal Air and Waste Management Association, v40n6, p. 926-931, June 1990.
Valentinetti, R.; McPherson, J.; and Staley, L., U.S. Environmental Protection Agency, Cincinnati, OH, Office of Research and Development, Risk Reduction Engineering Laboratory, Science Applications International Corporation, McLean, VA, Vermont Agency of Natural Resources, Waterbury, 1990

EPA Document Number: EPA/600/J-90/275

NTIS Document Number: PB91-145110/XAB

The CF Systems Organic Extraction System was used to remove PCBs from contaminated sediment dredged from the New Bedford Harbor. This work was done as part of a field demonstration under the Superfund Innovative Technology Evaluation (SITE) program. The purpose of the SITE program is to provide an independent and objective evaluation of innovative processes. The purpose of this paper is to present the results of the SITE demonstration of this technology. Results of the demonstration tests show that the system, which uses high pressure liquefied propane, successfully removed PCBs from contaminated sediments in New Bedford Harbor. Removal efficiencies for all test runs exceeded 70%. Some operational problems occured during the demonstration that may have affected the efficiency with which PCBs were removed from the dredged sediment. Large amounts of residues were generated from the demonstration. Costs for using this process are estimated to be between $150/ton and $450/ton.

Solvent Extraction for Remediation of Coal Tar Sites, Final Report.
Luthy, R. G.; Dzombak, D. A.; Peters, C.; Ali, M. A.; and Roy, S. B., Carnegie-Mellon University, Pittsburgh, PA, Department of Civil Engineering, Geological Survey, Reston, VA, Water Resources Division, September 1992

NTIS Document Number: PB93-118347/XAB

This document presents the results of an initial assessment of the feasibility of solvent extraction for removing coal tar from the subsurface, or for treating contaminated soil excavated at manufactured gas plant (MGP) sites. In situ solvent extraction would involve injection, recovery, and reclamation for reinjection of an environmentally-benign, water-miscible solvent. Both laboratory experiments and engineering evaluations were performed to provide a basis for the initial feasibility assessment. Laboratory work included identification and evaluation of promising solvents, measurement of fundamental properties of coal tar-solvent-water systems, and measurement of rates of dissolution of coal tar in porous media into flowing solvent-water solutions. Engineering evaluations involved identification of common hydrogeologic features and contaminant distributions at MGP sites and identification and evaluation of possible injection-recovery well deployment schemes.

Superfund Innovative Technology Evaluation: Demonstration Bulletin, Soil Washing System.
U.S. Environmental Protection Agency, Center for Environmental Research Information, July 1991

EPA Document Number: EPA/540/M5-91/003

The three component technologies of the BioTrol Soil Washing System (BSWS), tested in the SITE demonstration were a Soil Washer, an Aqueous Treatment System and a Slurry Bio-Reactor. This document highlights the demonstration processes, provides flowcharts, and indicates the results of the demonstration.

Technology Evaluation Report: BioTrol Soil Washing System for Treatment of a Wood Preserving Site,
Volume 1.
Skovronek, H. S.; Ellis, W.; Evans, J.; Kitaplioglu, O.; and McPherson, J., Science Applications International Corp., McLean, VA, U.S. Environmental Protection Agency, Cincinnati, OH, Office of Research and Development, Risk Reduction Engineering Laboratory, December 1991

EPA Document Number: EPA/540/5-91/003A

NTIS Document Number: PB92-115310/XAB

The report presents and evaluates the extensive database from the SITE Program demonstration at the MacGillis and Gibbs wood treatment facility in New Brighton, Minnesota. Soil washing and segregation, biotreatment of contaminated process water, and biodegradation of a slurry of the contaminated fines from the soil washing were evaluated over several weeks of operation. The contaminants of concern were pentachlorophenol (PCP) and polynuclear aromatic hydrocarbons (PAHs). The results indicate that the soil washer effectively segregates contaminated soil into coarse, relatively uncontaminated sand constituting the largest output fraction and a much smaller fraction of fine clay/silt particles retaining about 30% of the original contamination. PCP removal efficiency from the feed soil is 87%-89% (vendor's claim: 90%). Contaminated woody material is also segregated. Operational variations and their impact on output qualities and quantities are described. Biotreatment of process water from the soil washing successfully degraded 91-94% of the PCP. The results for the slurry biological treatment of the contaminated fines indicated that >90% removal of PCP and PAHs probably can be achieved with a fully acclimated system operating at steady state. Combined operating and capital equipment cost for an integrated system are estimated to be $168/ton of soil treated. Incineration of the woody debris is a major cost factor. Costs are also presented by process since specific applications may require different configurations of the three units.

Technology Evaluation Report: SITE Program. CF Systems Organics Extraction System, New Bedford, Massachusetts, Volume 2, Final Report.
Valentinetti, R., Science Applications International Corporation, McLean, VA, U.S. Environmental Protection Agency, Cincinnati, OH, Office of Research and Development, Risk Reduction Engineering Laboratory, January 1990

EPA Document Number: EPA/540/5-90/002

NTIS Document Number: PB90-186503/XAB

The report summarizes the results of a Superfund Innovative Technology Evaluation (SITE) demonstration of the CF Systems critical fluid organics extraction system at the New Bedford Harbor, Massachusetts Superfund site. The technology depends on the ability of organic pollutants to solubilize in the process solvent, a liquefied gas. The pollutants treated include polychlorinated biphenyls (PCBs) and polynuclear aromatic hydrocarbons. The report examines the performance of the process in terms of PCB extraction efficiency, variation in process operating conditions, potential health and safety impacts, equipment and handling problems, and projected system economics. Volume 2 contains sampling and analytical reports and operating log data. See Volume 1 (EPA/540/5-90/002, PB90-186495/XAB) for more information.

Technology Evaluation Report. SITE Program Demonstration, Resources Conservation Company, Basic Extractive Sludge Treatment (B.E.S.T. (Trade Name)), Grand Calumet River, Gary, Indiana, Volume 2, Part 3.
Wagner, T., Science Applications International Corporation, McLean, VA, U.S. Environmental Protection Agency, Cincinnati, OH, Office of Research and Development, Risk Reduction Engineering Laboratory, July 1993

EPA Document Number: EPA/540/R-92/079D

NTIS Document Number: PB93-227155/XAB

The report summarizes the findings of an evaluation of the Basic Extractive Sludge Treatment (B.E.S.T.) solvent extraction technology developed by Resources Conservation Company (RCC). During the demonstration test, the B.E.S.T. system was used to treat composited sediments from two areas of the Grand Calumet River. Contaminant concentration reductions of 96 percent for total polynuclear aromatic hydrocarbons (PAHs) and greater than 99 percent for total polychlorinated biphenyls (PCBs) were achieved for Sediment A. Contaminant concentration reductions of greater than 99 percent for total PAHs and greater than 99 percent for total PCBs were achieved for Sediment B. Removal efficiencies in excess of 98 percent were realized for both sediments for oil and grease (O&G). See Volume 1 (EPA/540/R-92/079A, PB93-227122/XAB), Volume 2 Part 1 (EPA/540/R-92/079B, PB93-227130/XAB), and Volume 2 Part 2 (EPA/540/R-92/079C, PB93-227148/XAB), for more information.

Technology Evaluation Report: The Carver-Greenfield Process, Dehydro-Tech Corporation.
PRC Environmental Management, Inc., Cincinnati, OH, U.S. Environmental Protection Agency, Cincinnati, OH, Office of Research and Development, Risk Reduction Engineering Laboratory, August 1992

EPA Document Number: EPA/450/R-92/002

NTIS Document Number: PB92-217462/XAB

The report evaluated the ability of Dehydro-Tech Corporation's (DTC) Carver-Greenfield Process to separate oil contaminated waste drilling muds to their constituent solids, oil, and water fractions. The Carver-Greenfield Process (C-G) was developed by DTC in the late 1950s and is licensed in over 80 plants worldwide. The technology is designed to separate solid-liquid mixtures into three product streams: a clean, dry solid; a water product substantially free of solids and organics; and a concentrated mixture of extracted organics. A mobile pilot plant was used for the demonstration. The C-G Process demonstration was conducted at EPA's Edison, New Jersey facility in August, 1991. Waste drilling muds from the PAB Oil and Chemical Services, Inc. (PAB Oil) site in Vermilion Parish, Louisiana were processed in the demonstration. PAB Oil, which ceased operation in 1983, operated three oil drilling mud separation pits from which the waste material used in the demonstration was collected.

Thermal Desorption of Petroleum Contaminated Soils.
Troxler, W. L.; Yezzi, J. J.; Cudahy, J. J.; and Rosenthal, S. I., Foster Wheeler Enviresponse, Inc., Livingston, NJ, Focus Environmental, Inc., U.S. Environmental Protection Agency, Cincinnati, OH, Office of Research and Development, Risk Reduction Engineering Laboratory, 1992

NTIS Document Number: PB93-158806/XAB

The U.S. Environmental Protection Agency recently funded a study that addresses the treatment of soils contaminated by petroleum hydrocarbons using low temperature thermal desorption (LTTD). The paper summarizes some of the results of that study. LTTD has become a major petroleum contaminated soil remediation technology. The paper defines LTTD and discusses fundamental thermal desorption mechanisms such as hydrocarbon vapor pressure, steam stripping, and soil characteristics. Full-scale LTTD equipment such as asphalt kilns, rotary dryers, thermal screws, and indirect-fired calciners are described. Typical off-gas treatment equipment such as afterburners, baghouses, wet scrubbers, carbon, and condensation/recovery are also discussed. Full-scale LTTD performance data, such as hydrocarbon destruction efficiency, carbon monoxide and particulate stack concentrations, and soil total petroleum hydrocarbon residuals are summarized.

Toronto Harbour Commissioners (THC) Soil Recycle Treatment Train: Applications Analysis Report.
U.S. Environmental Protection Agency, Office of Research and Development, Risk Reduction Engineering Laboratory, Cincinnati, OH, April 1993

EPA Document Number: EPA/540/AR-93/517

NTIS Document Number: PB94-124674/XAB

This document discusses the Superfund Innovative Technology Evaluation (SITE) Program Demonstration of the Toronto Harbour Commissioners (THC) soil treatment train which is designed to treat inorganic and organic contaminants in soils without utilizing incineration processes. The THC consists of three soil remediation technologies which are attrition soil washing, inorganic removal by chelation, and chemical and biological treatment to reduce organic contaminants. The goals of this study were to evaluate the technical effectiveness and economics of a treatment process sequence and to assess the potential applicability of the process to other wastes and/or other Superfund and hazardous waste sites. The results indicated the following: gravel and sand products met the THC criteria for reuse as fill material at industrial and commercial sites but fine soil did not meet the criteria; the attrition soil wash plant produced a gravel and a sand that achieved the primary THC criteria; the metals contamination levels actually encountered during pilot-scale processing of the test soil were so low that there was no need to use the metals removal process; and the bioslurry process exhibited limited reduction in oil and grease.

Utilization of Uranium Industry Technology and Relevant Chemistry to Leach Uranium from Mixed-Waste Solids.
Mattus, A. J. and Farr, L. L., Oak Ridge National Laboratory, TN, U.S. Department of Energy, Washington, DC, 1991

NTIS Document Number: DE91-016761/XAB

Methods for the chemical extraction of uranium from a number of refractory uranium-containing minerals found in nature have been in place and employed by the uranium mining and milling industry for nearly half a century. These same methods, in conjunction with the principles of relevant uranium chemistry, have been employed at the Oak Ridge National Laboratory (ORNL) to chemically leach depleted uranium from mixed-waste sludge and soil. The removal of uranium may result in the reclassification of the waste as hazardous, which may then be delisted. The delisted waste might eventually be disposed of in commercial landfill sites. This paper generally discusses the application of chemical extractive methods to remove depleted uranium from a biodenitrification sludge and a storm sewer soil sediment from the Y-12 weapons plant in Oak Ridge. Some select data obtained from scoping leach tests on these materials are presented along with associated limitations and observations that might be useful to others performing such test work.

Waste Battery Acid: Use or Disposal, Final Report.
George, L. C. and Schluter, R. B., Bureau of Mines, Rolla, MO, Rolla Research Center, 1992

NTIS Document Number: PB92-176155/XAB

The U.S. Bureau of Mines evaluated the potential of using simple methodologies to convert waste battery acid containing approximately 300 to approximately 2,000 ppm metal ions into recyclable products. Several recycling approaches tested, including ion adsorption, ion exchange, and solvent extraction, were not successful in producing battery-grade acid due to metallic impurities in the waste acid that were extremely difficult to remove. Waste acid samples contained metal ions that were common to those associated with brass flue dust, another waste material. The recycling potential of the waste acid was significantly improved by utilization of the waste acid, instead of virgin sulfuric acid, to extract Zn from the brass flue dust. The waste acid was also utilized to extract Cu and Cd from sludge wastes. Several neutralization schemes designed to reduce the quantity of hazardous sludge generated were also evaluated as alternatives to the conventional lime-neutralization process.

OTHER RESOURCE GUIDES

Bioremediation Resource Guide.
U.S. Environmental Protection Agency, Office of Solid Waste and Emergency Response, Technology Innovation Office, Washington, DC, September 1993
(see abstract below)

EPA Document Number: EPA/542/B-93/004

Ground Water Treatment Technology Resource Guide.
U.S. Environmental Protection Agency, Office of Solid Waste and Emergency Response, Technology Innovation Office, Washington, DC, September 1994
(see abstract below)

EPA Document Number: EPA/542/B-94/009

Soil Vapor Extraction (SVE) Treatment Technology Resource Guide.
U.S. Environmental Protection Agency, Office of Solid Waste and Emergency Response, Technology Innovation Office, Washington, DC, September 1994

EPA Document Number: EPA/542/B-94/007

These documents are intended to support decision-making by Regional and State Corrective Action permit writers, Remedial Project Managers (RPMs), On-Scene Coordinators, contractors, and others responsible for the evaluation of innovative treatment technologies. These guides direct managers of sites being remediated under RCRA, UST, and CERCLA to bioremediation, ground water, physical/chemical, and soil vapor extraction treatment technology resource documents, databases, hotlines, and dockets, and identify regulatory mechanisms (e.g., Research Development and Demonstration Permits) that have the potential to ease the implementation of these technologies at hazardous waste sites. Collectively, the Guides provide abstracts of over 330 guidance reports, overview/program documents, studies and demonstrations, and other resource guides, as well easy-to-use Resource Matrices that identify the technologies and contaminants discussed in each abstracted document.