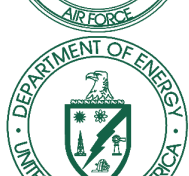


# FEDERAL REMEDIATION TECHNOLOGIES ROUNDTABLE

## ANNUAL SUMMARY OF ACTIVITIES: August 2012



This fact sheet summarizes the activities of the Federal Remediation Technologies Roundtable (FRTR) over the last year. The FRTR is an interagency working group that encourages cooperation among member agencies to promote development and use of new technologies for improved remediation of hazardous waste sites. Primary members of the FRTR include the U.S. Department of Defense (DoD), the U.S. Department of Energy (DOE), the U.S. Department of the Interior (DOI), the U.S. National Aeronautics and Space Administration (NASA), the U.S. Nuclear Regulatory Commission (NRC), and the U.S. Environmental Protection Agency (EPA).

The roundtable has met twice each year to share information since it was established in May 1990. Meeting summaries and presentations are available on the FRTR website at [www.frtr.gov](http://www.frtr.gov). Recent meetings have focused on Low Cost Treatment Technologies for Soil and Groundwater (May 2010), Characterization of Contamination in Fractured Media (November 2010), and Green and Sustainable Remediation (May 2011). The 43rd FRTR meeting, held in November 2011, focused on optimization; the objectives of the meeting were as follows:

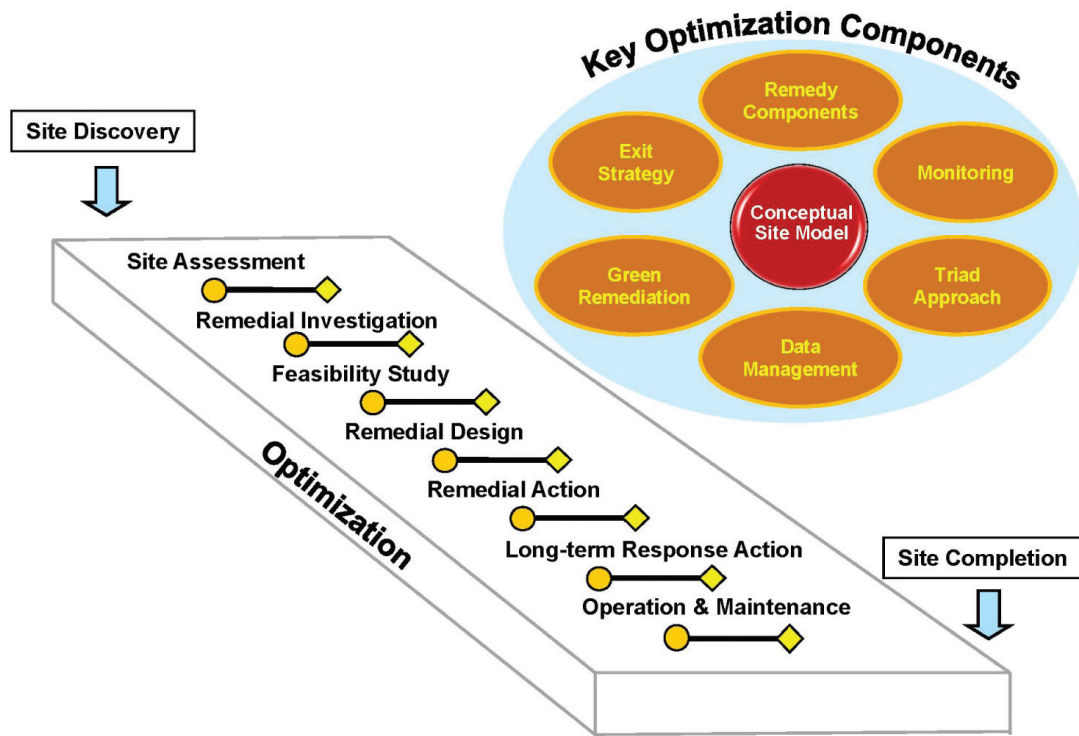
- ◆ Improve communication and common understanding of optimization.
- ◆ Share experience and lessons learned in advancing best practices.
- ◆ Outline key issues and develop shared strategies to address them.

This fact sheet highlights ongoing efforts by the FRTR member agencies to better understand optimization. Optimization is a systematic site review by a team of independent technical experts at any phase of the cleanup process to identify opportunities to improve remedy protectiveness, effectiveness, and cost efficiency, and to facilitate progress toward completion of site work. As part of an

### FRTR HIGHLIGHTS

- ◆ 26 new cost and performance case studies posted on the FRTR website.
- ◆ Summary and presentations from the FRTR meeting on Optimization (November 2011) posted on the FRTR website.
- ◆ More than 140 cost and performance reports are currently available under the FRTR's long-term monitoring and optimization focus area. Case studies can be searched and downloaded at [www.costperformance.org/optimization/search.cfm](http://www.costperformance.org/optimization/search.cfm).
- ◆ The EPA's Office of Superfund Remediation and Technology Innovation (OSRTI) is planning to release its *National Strategy to Expand Superfund Optimization Practices from Site Assessment to Site Completion* in 2012. Under the strategy, optimization practices from site assessment to site completion will be formalized as an operating business model for the Superfund Remedial Program.
- ◆ The U.S. Army Corps of Engineers (USACE) has developed checklists to facilitate Remediation System Evaluations (RSEs). These checklists facilitate the optimization review process by including suggestions of involved parties, data that should be reviewed, references for evaluating a system or process, and typical performance problems. For more information, visit [www.environmental.usace.army.mil/rse\\_checklist.htm](http://www.environmental.usace.army.mil/rse_checklist.htm).

Optimization Applies to Cleanup Activities from Site Assessment to Site Completion



**Remediation Optimization ([www.frtr.gov/optimization/](http://www.frtr.gov/optimization/))**

The FRTR considers Remediation Process Optimization to be a systematic monitoring and evaluation approach that is conducted to identify and respond to changes in remedy operation and performance. This approach increases protectiveness, reduces cost, reduces cleanup times, and improves advancement towards site closeout.

- **General** – Information on definitions of optimization terms, points of contact of FRTR members, optimization tools, processes, and optimization projects.
- **Optimization Case Studies** – Database of optimization case studies by FRTR members.
- **Monitoring Optimization** – Methodology for optimizing long-term monitoring programs.
- **Simulation Optimization** – Mathematical optimization methods and groundwater simulation models to optimize pumping locations, plume containment rates, and cleanup rates.
- **Treatment Technology Optimization** – In situ and ex situ remediation technologies information.

optimization review, the review team examines site documents, assesses the level of protectiveness at the site, evaluates the performance of the remedy, reviews cost efficiency, and considers strategies to achieve site closure. The early focus of optimization was at sites with operating remedies and large groundwater monitoring networks. In the past several years however, optimization has been applied to all stages of cleanup with beneficial results. Thus,

optimization helps to identify improvements during any stage of the site cleanup process.

As part of the technology transfer effort, FRTR has facilitated information sharing by collecting reports pertaining to optimization. These reports can be accessed on the FRTR website at [www.frtr.gov/optimization/default.htm](http://www.frtr.gov/optimization/default.htm).

## Superfund Remediation Optimization Factsheet

The EPA's Office of Superfund Remediation and Technology Innovation is currently developing a fact sheet that discusses the role of optimization in the decision making process within the Superfund remediation process.

### FRTR Member Agencies Optimization Efforts

FRTR member agencies are implementing a variety of tools to support their optimization initiatives. Some of the tools are unique to the developing agency, while others can be used within any agency's program. Tools include: standard operating procedures (SOPs), web-enabled resources, and specialty software to evaluate site contamination, to identify optimization options, and to calculate costs and benefits for alternative approaches.

### Optimization-Related Efforts within the DoD

The Naval Facilities Engineering Command (NAVFAC) is developing a Management and Monitoring Approach that refines the way site information is evaluated, including methods for evaluating data to identify remediation trends. The approach provides a template for presenting cleanup goals, documenting optimization endeavors, and presenting exit strategies in a clear manner. As a part of this approach, Navy Remedial Project Managers are using a Monitoring Report Template to standardize the way information is presented.

The Navy is also updating its 2004 optimization policy to incorporate sustainability and the use of SiteWise as a requirement during feasibility studies. SiteWise is an analytical tool that assesses environmental footprints associated with remedial actions. Aspects such as greenhouse gas emissions, water consumption, energy consumption, air pollutant emissions, and worker safety are evaluated.

Efforts within the U.S. Air Force (USAF) include use of optimization software to assist in developing long-term monitoring programs. One such program, the Monitoring and Remediation Optimization System (MAROS), developed for the Air Force Center for Engineering and the Environment (AFCEE), uses site-specific information to optimize monitoring

plans and efficiently attain cleanup goals with cost savings.

Efforts are also under way to promote optimization within the USAF's performance-based contracting (PBC) remediation environment. Within the next three to four years, the USAF expects to have its installations remediated through contract mechanisms that include PBC or performance based remediation (PBR). PBR emphasizes the responsibility of the contractor in making suitable optimization decisions by specifying the desired remedy outcomes but allowing the contractor flexibility in determining the methods and application for treatment.

### Optimization-Related Efforts within the USACE

The USACE Hazardous, Toxic and Radioactive Waste Center of Expertise (EM CX) has performed RSEs on federal sites for other branches of DoD, the EPA, DOE, and NASA. The USACE conducts these reviews under Military Interdepartmental Purchase Requests to identify ways to save money; decrease the time to site closure; meet protectiveness and remedy performance requirements of the National

## Recent Activities of the Federal Remediation Technologies Roundtable Green Remediation Subgroup

The EPA's OSRTI released the report *"Methodology for Understanding and Reducing a Project's Environmental Footprint."* This resource presents green remediation metrics to be used for contaminated site cleanup and an approach for quantifying these metrics. The document focuses on:

1. The rationale behind the methodology, the value of evaluating environmental footprints, and the associated level of effort and cost,
2. Considerations for assessing and using the analytical results, and
3. Illustrative approaches to reducing project environmental footprints.

This document can be downloaded from the CLU-IN website at: [www.cluin.org/greenremediation/methodology/docs/GC\\_Footprint\\_Methodology\\_Feb2012.pdf](http://www.cluin.org/greenremediation/methodology/docs/GC_Footprint_Methodology_Feb2012.pdf).



## AFCEE Long-Term Monitoring Optimization Tools

The AFCEE has developed the Geostatistical Temporal Spatial Optimization and the Monitoring and Remediation Optimization System software. These optimization tools have been peer-reviewed in recognized international journals (for example, *Environmetrics* and *Groundwater*) and have been accepted by the DoD environmental community and the EPA's Office of Superfund Remediation and Technology Innovation as valuable tools. These tools have been used at sites across the USAF in the LTMO stage. Use of optimization methodologies has shown reductions of sampling budgets by 20 to 40 percent in case studies and technical literature. AFCEE currently offers optimization LTMO training and assistance to installations in monitoring programs across the USAF. For more information, visit [www.afcee.af.mil/resources/restoration/lrm/index.asp](http://www.afcee.af.mil/resources/restoration/lrm/index.asp).

Contingency Plan; verify project goals and closure criteria; and confirm proper use and maintenance of government property. To facilitate the RSEs, the USACE developed checklists that guide review teams through the RSE process. The checklists include suggestions of parties that should be involved in the RSE, data that should be reviewed, technical references to support evaluation of a system or process, and typical performance problems. Most of the checklists are treatment system-specific (such as the Soil Vapor Extraction Subsurface Performance Checklist or the Advance Oxidation Technologies Checklist). The checklists and other optimization tools can be accessed at [www.environmental.usace.army.mil/rse\\_checklist.htm](http://www.environmental.usace.army.mil/rse_checklist.htm).

The USACE also is currently evaluating the benefits of LTMO for Army cleanup programs. An optimization project in progress at the time of the meeting was comparing the software MAROS with the USAF's 3-Tiered Monitoring Optimization (3TMO) tool. The three tiers include Site Screening, Data Compilation, and Analysis (Qualitative, Temporal, and Spatial).

### Optimization-Related Efforts within the EPA

The EPA's OSRTI is planning to release its *National Strategy to Expand Superfund Optimization Practices*

## Optimization-Related Resources

- 1. The EPA's Remedy Optimization website:** This website provides the EPA definition of remedy optimization and its key components. In addition, the site provides key optimization guidance documents, documents on optimizing pump and treat systems, and prior summary and analysis reports that discuss the site-specific implementation of recommendations made and their progress toward implementation. For more information, visit [www.epa.gov/superfund/cleanup/postconstruction/optimize.htm](http://www.epa.gov/superfund/cleanup/postconstruction/optimize.htm).
- 2. The EPA's Remediation Optimization Focus Area on its Contaminated Site Cleanup Information website:** This website, developed by the EPA's Technology Innovation and Field Services Division, describes optimization reviews performed at various stages in the cleanup process (previously referred to as RSEs, independent design reviews, and LTMO), identifies optimization training sponsored by the EPA, and provides access to prior optimization review reports. This website is being updated to include information on the optimization strategy, provide easier access to optimization reports, and identify more sources of optimization training. For more information, visit [www.cluin.org/optimization](http://www.cluin.org/optimization).
- 3. Navy's Optimization Workgroup:** The Navy established the Optimization Work Group to provide counsel on optimization of remedial actions and monitoring to Navy Installation Restoration Managers. The purpose of the workgroup is to facilitate efficient, protective, and cost-effective site closeouts. The workgroup is made up of representatives from each of the Navy's Facilities Engineering Commands, the Naval Facilities Engineering Service Center, the Naval Facilities Engineering Command, and the Marine Corps Headquarters. For more information, visit [www.portal.navfac.navy.mil/portal/page/portal/navfac/navfac\\_ww\\_pp/navfac\\_nfesc\\_pp/environmental/erb/wg-opt](http://www.portal.navfac.navy.mil/portal/page/portal/navfac/navfac_ww_pp/navfac_nfesc_pp/environmental/erb/wg-opt).

from Site Assessment to Site Completion in 2012. Under the strategy, existing optimization methods will be unified. The main objectives of the strategy are to eliminate redundancy between the optimization processes, integrate optimization into program processes and pipeline activities, facilitate technology transfer, remove technical barriers, simplify the optimization process, leverage lessons learned for new optimization projects, integrate optimization activities into the design and characterization phases, and improve optimization technical support. A draft of the strategy, developed by the EPA's National Optimization Strategy Workgroup under the supervision of Superfund Headquarters, has been prepared and is composed of four development and implementation elements: planning and outreach, integration and training, implementation, and measurement and reporting. Future activities planned include finalizing the strategy, utilizing

optimization experience and principles to impact Remedial Program business practices, collecting and leveraging optimization lessons learned to new optimization projects, applying optimization practices throughout the cleanup process, performing optimization reviews at 20 to 30 sites annually, developing a training program, and refining how optimization review efforts and implemented recommendations are measured and reported.

The EPA has used optimization software to assist in the evaluation of LTM programs at a number of Superfund sites. These tools include MAROS software developed for the AFCEE. MAROS was recently used at the Applied Materials Building 1 (AM1) Superfund site in Santa Clara, California. Use of optimization software has resulted in cost savings and promotes accelerated site closure.

## REMEDIATION CASE STUDIES AND TECHNOLOGY ASSESSMENT REPORTS

A major activity of the FRTR throughout the year is to collect and distribute information from federal and state agencies on the use of new technologies at their sites. Each year, the FRTR compiles reports and makes them available at the website – [www.frtr.gov](http://www.frtr.gov). The "What's New" section is updated monthly and provides notices about meetings, conferences, and publications of relevance to FRTR stakeholders.

The FRTR website provides case studies and reports in four categories: Remediation Technology, Site Characterization and Monitoring, Long-Term Monitoring and Optimization, and Remediation Technology Assessment. The case studies share data collected by member agencies and are based on real experiences and lessons learned in selecting and implementing site characterization and treatment technologies to delineate and remediate soil and groundwater contamination at hazardous waste sites. Remediation case study reports describe the performance and cost of technology applications for full-scale and large-scale demonstration projects.

### REMEDIATION TECHNOLOGY COST AND PERFORMANCE CASE STUDIES

More than 410 Remediation Technology Cost and Performance Case Studies (treatment or containment) are available on the FRTR website. Recently, three new cost and performance case studies for remediation technologies have been added. These case studies address the use of in situ remediation technologies for contaminated soil and groundwater. Prepared by DoD's Environmental Security Technology Certification Program (ESTCP) and the EPA, these case studies provide data on the cost and performance of various technologies including electrolytic reactive barriers, radio frequency heating, and the application of lime to treat a range of contaminants such as energetic compounds, explosives, metals, and dense nonaqueous phase liquid (DNAPL).

### SITE CHARACTERIZATION AND MONITORING REPORTS

This focus area includes reports on field-based site characterization and monitoring technologies and documents experiences and lessons learned in field demonstrations and full-scale applications; more than

195 reports are currently available. Four new reports have been added addressing the characterization of inorganic and organic chemicals, unexploded ordnance, and chlorinated solvents (provided by the USACE, the EPA, and DoD ESTCP).

### LONG-TERM MONITORING AND OPTIMIZATION CASE STUDY REPORTS

This focus area includes reports that describe long-term monitoring and optimization efforts that involve evaluations of groundwater monitoring programs and hydraulic optimization. More than 140 reports are currently available under this focus

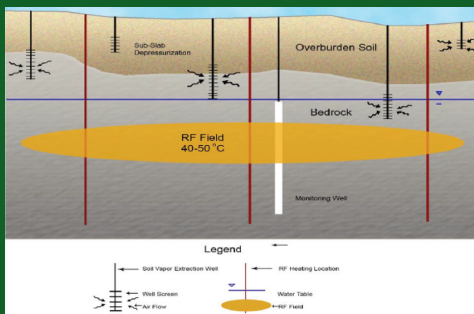
area. Twelve new documents have been recently added. Eleven of the reports focus on evaluations of extraction systems used for remediation; one report describes an evaluation of a LTM program.

### REMEDICATION TECHNOLOGY ASSESSMENT REPORTS

The reports in this focus area provide broad assessments of technologies based on results from field experience gained from multiple sites. Seven new reports were added to this focus area, bringing the total to 101. The DoD ESTCP and the Interstate Technology and Regulatory Council (ITRC) each

## RADIO FREQUENCY HEATING IN FRACTURED ROCK AT AN ACTIVE MANUFACTURING FACILITY IMPACTED BY RESIDUAL TCA DNAPL

### Highlight of New Remediation Technology Cost and Performance Report



This cost and performance report was prepared by the EPA's OSRTI program. This demonstration used a radio frequency heating system and Soil Vapor Extraction System (SVE) to remediate 1,1,1-trichloroethane (TCA) DNAPL-contaminated groundwater at the site. The radio frequency heating system used electromagnetic energy to reduce TCA DNAPL contamination in groundwater. Site investigation results indicated that residual DNAPL and elevated dissolved-phase concentrations were present in the source area. This contamination is attributable to the historical use of TCA at the active manufacturing facility on site.

Radio frequency heating was selected as the treatment technology after several studies and tests were conducted to evaluate which technology was best suited to treat residual contamination in the bedrock fracture network. Several advantages of using radio frequency heating were presented, including: (1) the ability to focus the thermal energy on the contaminated groundwater in the bedrock fractures and (2) the ability to heat over a volume independent of the poor fracture interconnectivity. In addition, the site's hydrogeological characteristics were favorable.

The radio frequency heating system was made up of nine 30.5-meter-deep boreholes. Antennas were installed in four wells in a square array and were connected to a radio frequency generator via transmission lines. Fiber optic thermometry was used to monitor groundwater temperature throughout the radio frequency heating system. This system was operated for 36 months at a maximum output of 19 kilowatts.

An SVE system consisting of 26 extraction points and a sub-slab depressurization system of 12 shallow overburden extraction wells was installed to treat volatile organic compound vapors in the source area. This system also incorporated 14 deep overburden and shallow bedrock extraction wells located in the source area. Over the course of its operation, 144 pounds of volatile organic compound-contaminated material was captured.

The use of radio frequency heating to treat TCA contamination at the site was considered a success. TCA groundwater concentrations were reduced by 97 percent by May 2010. Over the course of the treatment, groundwater temperature was increased from 21 degrees Celsius to 52 degrees Celsius. This increased temperature accelerated the dissolution rate of TCA, increased the biodegradation rate, and improved conditions for abiotic transformation.

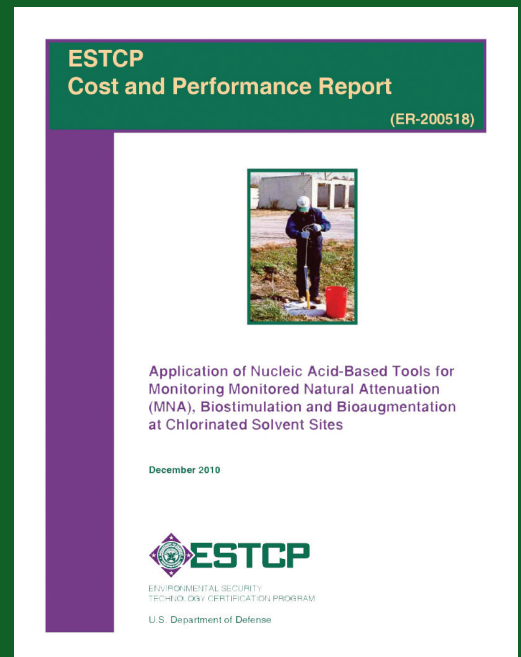
provided three reports; NAVFAC provided one report. The DoD ESTCP reports describe technology demonstrations to evaluate the use of (1) thermal treatment technologies for DNAPL source zone treatment, (2) a field-portable gas chromatograph mass spectrometer unit to characterize semivolatile compounds in groundwater, and (3) geostatistical evaluation in optimizing the long-term monitoring of groundwater. The ITRC reports provide technical

guidance on (1) an integrated DNAPL site strategy, (2) biofuel release prevention, behavior, and remediation, and (3) development of performance specifications for solidification/stabilization. The NAVFAC report describes technology demonstrations to evaluate the use of the reagent persulfate as part of in situ chemical oxidation treatment at four sites.

## APPLICATION OF NUCLEIC ACID-BASED TOOLS FOR MONITORING MONITORED NATURAL ATTENUATION (MNA), BIOSTIMULATION, AND BIOAUGMENTATION AT CHLORINATED SOLVENT SITES

### Highlight of New Characterization Report

This cost and performance report was prepared by the DoD Environmental Security Technology Certification Program. It describes a demonstration using nucleic acid-based tools to identify chlorinated solvent contaminant sites where long-term monitored natural attenuation (MNA) was appropriate by detecting and quantifying bacteria-specific biomarker genes that indicate anaerobic bioremediation. Field demonstrations were conducted at six DoD sites undergoing MNA remediation or biostimulation. The primary objectives of the demonstration were to (1) evaluate the use of nucleic acid-based tools in identifying sites suitable to MNA, (2) predict sites that would be amenable to biostimulation, (3) predict sites where biodegradation is not suitable, and (4) provide a guidance protocol to remedial project managers (RPMs) and contractors on the use of nucleic acid-based tools. During this demonstration, methods of groundwater sample collection were evaluated, nucleic acid-based tools were used to identify bacteria-specific biomarker genes, and study data were evaluated to identify correlations between the amounts of specific biomarker genes detected in demonstration samples and the reduction of contaminant concentrations at the sites. The use of nucleic acid-based tools was found to be reliable for determining anaerobic bioremediation conditions. The report includes information regarding technology performance, cost assessment, and implementation issues associated with using nucleic acid-based tools. The report also provides a guidance protocol to advise RPMs and contractors on how to apply nucleic acid-based technology for site characterization at DoD contaminated sites.





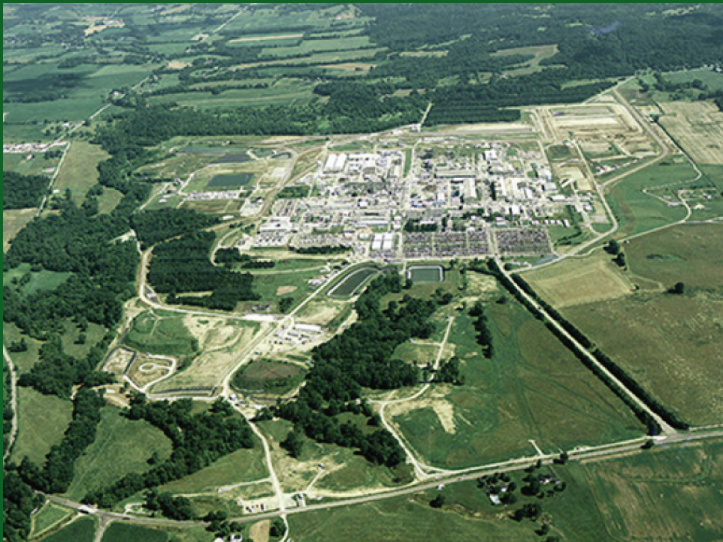
## APPLIED MATERIALS BUILDING 1: LONG TERM MONITORING STRATEGY

### Highlight of New Long-Term Monitoring Program Evaluation Case Study Report

This Long-Term Monitoring Strategy Report prepared by the EPA, presents the results of a review of site data at the Applied Materials Building 1 Superfund Site in Santa Clara, California. The groundwater extraction remedy was terminated in 2003 due to low recovery of contaminants of concern. A 2010 5-year review at the site indicated that remedial goals for groundwater were generally achieved but the site was intermittently exceeding remedial goals. This report documents how site data were reviewed to develop a strategy for site closure. The CSM and site data review indicated that: (1) hydrogeology at the site was consistent, (2) the source area appeared to be reduced and was not transporting mass downgradient, (3) biodegradation and abiotic chemical degradation processes were active and contaminant concentrations continued to decrease, and (4) the vertical and horizontal extent of the contaminant plume had been fully delineated. The statistical dataset evaluation indicated that contaminant concentrations in several areas had achieved remedial goals, but concentrations in several wells remain slightly above the remedial action objectives. The evaluation and report concludes that further active remediation is not required and recommends annual sampling of wells remaining in the sampling program.

## DEMONSTRATION AND VALIDATION OF THE GEOSTATISTICAL TEMPORAL-SPATIAL ALGORITHM (GTS) FOR OPTIMIZATION OF LONG- TERM MONITORING (LTM) OF GROUNDWATER AT MILITARY AND GOVERNMENT SITES

### Highlight of New Remediation Technology Assessment Report



This cost and performance report was prepared by the DoD ESTCP. The report reviews the performance of Geostatistical Temporal-Spatial (GTS) groundwater optimization software developed by MacStat Consulting and Science Applications International Corporation for the AFCEE. The software was demonstrated at three sites: the Air Force Plant 44 Site in Tucson, Arizona, the Former Nebraska Ordnance Plant Site in Mead, Nebraska, and the Fernald United States Department of Energy Site in Ross, Ohio. The report summarizes (1) the effectiveness of the software as an optimization tool in evaluating spatial and temporal redundancies at the demonstration sites as well as the software's ability in providing reproducible results, (2) its effectiveness in flagging anomalous measurements,

(3) its ability to identify sampling network inadequacies, and (4) its recommendations on coordinate locations regarding the placement of new wells to address network inadequacies. The report also includes a description of the technology, identifies how sites were selected for the demonstration, provides an overview of evaluation methods, provides cost assessment methods and results, and presents implementation issues associated with use of the software.



## REMEDIATION SYSTEM EVALUATION FOR THE BAYTOWN TOWNSHIP SUPERFUND SITE

### Highlight of New Remediation System Evaluation Report

This RSE report prepared by the USACE Environmental and Munitions Center of Expertise for the EPA presents findings associated with the evaluation of remediation efforts at the Baytown Township Superfund Site in Lake Elmo, Minnesota. A hydraulic barrier system was selected in the March 2007 Proposed Plan. This hydraulic barrier was composed of a groundwater extraction system and an air stripping treatment system. The goals of the RSE included the following: (1) minimize contaminant plume migration, (2) reduce contaminant levels in the aquifer to meet drinking water standards, and (3) decrease the amount of time groundwater from downgradient private residential wells is treated with granular activated carbon (GAC) filters. The report presents evaluation findings regarding plume capture data, groundwater contaminant trends, the performance and effectiveness of the remediation systems, the costs associated with each remediation system and the monitoring program, and the success of the systems in regards to protecting human health and the environment. Based on RSE findings, the report presents several recommendations, some of which are: (1) employing in situ chemical oxidation inside the source area in a phased approach, (2) evaluating groundwater concentration rebound and installing additional monitoring wells or piezometers if needed, (3) implementing PBC for source area treatment, (4) measuring the water levels of the monitoring wells on a recurring basis when the hydraulic barrier system is shut down and also when turned on to assess the inward gradient toward the extraction wells and capture zone influence, (5) performing a MAROS analysis downgradient and within the source area to assess the migration of contaminants, and (6) employing a more demanding monitored natural attenuation program to reduce TCE concentrations in the source area.

## COST AND PERFORMANCE REPORT FOR PERSULFATE TREATABILITY STUDIES

### Highlight of New Remediation Technology Assessment Report

This cost and performance report was prepared by the Navy Facilities Engineering Command. This report evaluated and presented conclusions regarding the effectiveness of in situ chemical oxidation (ISCO) treatment at the following installations: Naval Air Station (NAS) North Island, Alleghany Ballistics Laboratory, NAS Alameda, and Marine Corps Base Quantico. A persulfate reagent was introduced at each demonstration site for the in situ remediation of chlorinated volatile compounds, DNAPLs, 1,2,4-trichlorobenzene, TCE, perchloroethylene, dichloroethylene, and vinyl chloride contaminated groundwater. Performance objectives for the demonstrations were to further develop and evaluate the use of persulfate as an in situ reagent to reduce contaminant concentrations, evaluate the use of persulfate as part of an in situ source treatment to reduce contaminant concentrations involving DNAPLs, and evaluate whether the use of persulfate shortens the time needed to obtain site closure. The report summarizes the results of the data collection and evaluation and provides findings and lessons learned that can be used by program managers who are considering persulfate in ISCO remediation technologies. Some specific lessons learned included: (1) COCs reduction was observed at all the sites after persulfate was injected but the reductions were not uniform due to the inability to evenly distribute the reagent throughout the treatment areas; (2) ISCO using persulfate is more successful at sites that exhibit more permeable materials such as sands; (3) ISCO elevates metals concentrations in groundwater so consideration must be made regarding long-term monitoring; (4) depending on site-specific conditions, it may not be necessary to introduce an activating agent. The report also includes descriptions of the technologies, provides an overview of evaluation methods, provides cost assessment methods and results, and presents implementation issues associated with the technologies.



United States  
Environmental Protection  
Agency

Office of Solid Waste and  
Emergency Response  
(5203P)

National Service Center for  
Environmental Publications  
P.O. Box 42419  
Cincinnati, OH 45242

Official Business  
Penalty for Private Use \$300

EPA-542-F-12-027  
August 2012  
[www.epa.gov](http://www.epa.gov)  
[www.frtr.gov](http://www.frtr.gov)

**FEDERAL REMEDIATION TECHNOLOGIES ROUNDTABLE (FRTR)  
SUMMARY OF ACTIVITIES: August 2012 (EPA-542-F-12-027) – ORDERING INFORMATION**

This FRTR fact sheet is available free of charge from the U.S. Environmental Protection Agency (EPA) National Service Center for Environmental Publications (NSCEP), while supplies last. To order, mail a request to:

**EPA/National Service Center for Environmental Publications, P.O. Box 42419, Cincinnati, OH 45242  
Or FAX to (513) 489-8695. In addition, telephone orders may be placed at (800) 490-9198 or (513) 489-8190.**



*Federal  
Remediation  
Technologies  
Roundtable*



**ANNUAL SUMMARY  
OF ACTIVITIES:  
August 2012**

