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## Memorandum Report

# Improving Nationwide Effectiveness of Pump-and-Treat Remedies Requires Sustained and Focused Action to Realize Benefits

Report No. 2003-P-000006

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**Abbreviations**

CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
DoD	Department of Defense
EPA	Environmental Protection Agency
MtBe	Methyl Tertiary-Butyl Ether
NAPL	Nonaqueous Phase Liquid
OSWER	Office of Solid Waste and Emergency Response
RSE	Remediation System Evaluation



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY  
WASHINGTON, D.C. 20460

OFFICE OF  
INSPECTOR GENERAL

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**MEMORANDUM**

**SUBJECT:** Memorandum Report:  
Improving Nationwide Effectiveness of Pump-and-Treat Remedies Requires  
Sustained and Focused Action to Realize Benefits  
Assignment No. 2002-0000326

**FROM:** Carolyn Copper  
Director for Hazardous Waste Issues  
Office of Program Evaluation

**TO:** Marianne Lamont Horinko  
Assistant Administrator  
Office of Solid Waste and Emergency Response

This memorandum communicates our final findings on key issues we observed during our evaluation of the Nationwide Superfund-Financed Pump and Treat Optimization Project conducted by the Environmental Protection Agency's (EPA's) Office of Solid Waste and Emergency Response (OSWER). Our evaluation of this project occurred while OSWER and its contractors were completing or implementing key phases of the project. Based on progress we observed during our evaluation, we are not making specific recommendations in this memorandum report. Therefore, no response is required. However, we collected and analyzed information unique to this project and have observations we believe will facilitate achieving environmental and fiscal benefits. This memorandum is our final product under Inspector General assignment number 2002-0000326.

**Results in Brief**

As part of its fiscal 2000-2001 Superfund Reforms Strategy, OSWER committed to optimizing the performance of Superfund-financed groundwater pump-and-treat systems. Generally, the Nationwide Optimization Project has produced valuable information on the cost and performance of these pump-and-treat systems. Among other things, this project has identified at least 241 recommendations for improvements to about 17 of the 20 Superfund-financed pump-and-treat systems evaluated. It has also identified important ways that existing Superfund-financed systems, as well as non-Superfund-financed systems, can be managed more effectively.

Information we obtained from EPA Regions and States that are or will be managing some of the evaluated systems generally indicates that the optimization project was valuable, useful, and identified opportunities to save Superfund dollars. Our results indicate that about one half of all recommendations made during the optimization project were fully implemented or are in progress. Regions disagreed with less than 10 percent of the recommendations, while others have been deferred (we could not determine the precise impact of the deferred recommendations). Overall, we believe that important and useful progress has been made in implementing recommendations.

However, we believe that more focused, specific, and organized action and plans are needed by OSWER to accurately track, analyze, and report on the environmental and fiscal benefits associated with implementing recommendations from the optimization project. Without this, there is risk that a beneficial opportunity to acquire information on how effective the optimization project is for producing environmental or cost savings results will be lost. In the long term, it will be difficult to determine the environmental and cost benefits of optimization projects such as this if accurate and meaningful information on the results they produce has not been collected or analyzed. Among the actions needed are setting priorities for which sites or recommendations are most critical to track, establishing a time line for tracking actions, and establishing credible metrics to measure environmental and cost benefit outcomes associated with implementing optimization project recommendations. These actions should also be incorporated in the work plans of future optimization projects EPA will implement or has recently implemented.

## **Purpose of Review**

Although we had initially identified a need to examine the effectiveness of Superfund pump-and-treat groundwater cleanup remedies, we discovered that OSWER had already initiated a nationwide review of the costs and performance of Superfund-financed pump-and-treat systems with the goal of optimizing these systems. Therefore, we did not initiate a separate independent review.

Our evaluation questions were:

- What are the scope and objective(s) of EPA's nationwide optimization project for Superfund-financed groundwater pump-and-treat systems?
- Based on the optimization project's planned time line, what progress has been made to date?
- What are the key findings to date concerning cost, effectiveness, and optimization recommendations for the Superfund-financed pump-and-treat systems?
- What are EPA's and participating Region's and/or State's plans to apply the findings and recommendations of the nationwide optimization project?

Details on what we found are presented in the Findings section.

## Background

In 1999, EPA reported that groundwater contamination is present at the majority of Superfund and Resource Conservation and Recovery Act corrective action sites. Pumping contaminated groundwater from the subsurface and treating the water to rid it of contamination has been a generally accepted means of remediation in the Superfund program. In January 2002, EPA reported that although the number of Records of Decision selecting the pump-and-treat remedy decreased from 92 percent in 1986 to 30 percent in 1999, pump-and-treat remedies are still the most common groundwater cleanup remedies used at National Priority List sites. September 2002 data from EPA indicates that pump-and-treat technology has also been used most frequently to remediate MtBE (methyl tertiary-butyl ether), found in gasoline which are commonly stored in underground storage tanks.

EPA estimates that over 700 groundwater pump-and-treat systems are operating at National Priority List sites. While currently 88 are Superfund financed, many of the 700-plus systems are expected to operate for decades, resulting in substantial costs to Federal or State governments or responsible private parties. The average annual operating cost for a Superfund-financed pump-and-treat system was recently determined by EPA contractors to be \$570,000.

A Department of Defense (DoD) Inspector General report, "Evaluation of DoD Waste Site Groundwater Pump-And-Treat Operations" (98-090, March 12, 1998), noted that studies of pump-and-treat remedies in isolation (not compared to other remedies) report pump-and-treat is often ineffective in meeting groundwater restoration goals, particularly when nonaqueous phase liquids (NAPLs), which do not dissolve in water, are present. EPA reported that NAPLs have been observed or are suspected in the subsurface at approximately 40 percent of the Superfund-financed sites profiled in the optimization project. Some researchers have concluded that, with few exceptions, remediation of contaminated groundwater using pump-and-treat "is impossible and prohibitively expensive."<sup>1</sup> This does not necessarily suggest poor remedy selection or design decisions. Rather, as EPA has reported, the science of NAPLs has evolved over time and their potential presence may not have been recognized during remedy selection and design.

OSWER's fiscal 2000-2001 Superfund Reform Strategy included a commitment to optimize Superfund-financed pump-and-treat systems. In an October 2000 memo, the Acting Director of OSWER's Office of Emergency Removal and Response announced the optimization project, whose goals were to "encourage systematic review and modification to existing P&T [pump-and-treat] systems to enhance overall remedy effectiveness and cost effectiveness, without compromising protectiveness or other objectives of the Superfund program...." The method for evaluating pump-and-treat systems in the optimization project was the U.S. Army Corps of Engineers Remediation System Evaluation (RSE) methodology. This is one standard method of evaluating remediation systems (in this case, pump-and-treat) to discover operating inefficiencies

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<sup>1</sup> Voudrias, E.A. (2001), Pump-and-Treat Remediation of Groundwater Contaminated by Hazardous Waste: Can It Really Be Achieved? Global Network for Environmental Science and Technology: the International Journal, 3 (1), pp. 1-10.

that could increase operational costs and jeopardize the effectiveness and efficiency of the system. The RSE process is conducted over a relatively short period (less than one week), and involves reviewers independent of the site operation. The project team conducting the RSEs for EPA's pump-and-treat optimization project included EPA contractor staff, members of the U.S. Army Corps of Engineers, and the EPA Project Officer in the Technology Innovation Office.

## Scope and Methodology

We performed our evaluation from November 2001 through December 2002. To address our evaluation questions, we interviewed the full range of individuals who were involved with planning, implementing, or providing administrative support and oversight to the Nationwide Optimization Project. This included staff in EPA Headquarters, OSWER/Office of Emergency Removal and Response (specifically the Technology Innovation Office); the U.S. Army Corps of Engineers; and an EPA contractor. We also reviewed optimization project documents or deliverables as they were completed and made available to us. These included the following reports:

- Superfund Financed Groundwater Pump and Treat Systems: Summary of Selected Cost and Performance Information (EPA 542-R-01-021a), December 2001.
- Pilot Project to Optimize Superfund-Financed Pump and Treat Systems: Summary Report and Lessons Learned (EPA 542-R-02-008a), November 2002.
- All 20 RSE reports produced for the optimization project.

In addition, we interviewed State officials in Massachusetts, New York, Pennsylvania, and South Carolina, and officials at EPA Regions 1, 2, 3, 4, and 10. We asked the Regions and States to provide their perspectives on the value and utility of the information produced during the RSE process, the effectiveness of EPA's "top-down" approach for optimizing pump-and-treat remedies, and what it would require to implement the RSE recommendations. We based our selection of these States and Regions on criteria found in the RSE reports as well as Record of Decision cleanup goals associated with the 20 sites where RSEs were conducted. Specifically, we identified those sites where: (1) the goal of the pump-and-treat system in the Record of Decision indicated containment and groundwater restoration, (2) RSE results indicated that the current pump-and-treat system would not achieve the Record of Decision objective, and (3) 5-year reviews indicated that systems' performance and effectiveness was not sufficient. Generally required under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), five-year reviews provide an opportunity to evaluate whether implemented cleanup remedies remain protective of human health and the environment. Our evaluation also included a review of literature concerning aspects of the Superfund program, and other evaluation procedures we considered necessary for the purpose of expressing an opinion based on our objectives.

We performed this evaluation in accordance with *Government Auditing Standards*, issued by the Comptroller General of the United States, as they apply to performance audits.

## **Findings**

Superfund reforms were implemented in 1993 to address stakeholder criticism and to make the Superfund program work faster, fairer, and more efficiently. The reforms consist of various initiatives and pilot programs intended to effect changes on both a programmatic and site level, within the CERCLA framework. As part of its fiscal 2000-2001 Superfund Reforms Strategy, OSWER committed to optimizing the performance of Superfund-financed groundwater pump-and-treat systems. The Office of Emergency Removal and Response, as the lead office on the optimization project, formally announced it in October 2000.

We found that, generally, the pump-and-treat optimization project has produced valuable information and recommendations for improvement regarding the cost and performance of Superfund-financed pump-and-treat systems. However, we found there was room for improvement in the tracking of benefits resulting from the project. Details follow.

### ***Phases 1 and 2***

Phases 1 and 2 of the three-phase Nationwide Pump and Treat Optimization project have been successfully implemented and completed.

Phase 1 identified and compiled the cost and performance data for all 88 Superfund-financed pump-and-treat systems. We found there is value merely in the information that was produced by the project team.

As part of Phase 2, approximately 30 percent (20) of 67 operational Superfund-financed pump-and-treat systems across the nation were evaluated to identify possible improvements in remedy cost and effectiveness. EPA's Phase 2 results showed that improvements in system effectiveness, cost reduction, and other technical improvements could be made at 85 percent (17 of 20) of the evaluated systems. To assist EPA and the States in eventually closing out the sites, the project team also identified recommendations regarding site closeout at 80 percent (16 of 20) of the evaluated sites where evidence suggested the presence of NAPLs. These recommendations indicated that 65 percent (13 of 20) of the evaluated sites should consider alternate technologies to replace pump-and-treat or to supplement it with more aggressive source removal.

Recommendations to improve pump-and-treat effectiveness generally focused on improvements in delineating groundwater plumes and improving the collection and analysis of data to evaluate the effectiveness of systems. For example, at one Superfund site, EPA's project team noted that at the time of the site visit, water quality samples from multiple locations in the treatment process train and from monitoring wells were being collected and analyzed for volatile organic compounds and inorganics, but the resulting data were not evaluated or reported to the EPA or the site manager. EPA also reported that some pump-and-treat systems were overdesigned (had

components that were no longer necessary) due to changes that had occurred at the site over time, and some systems needed to replace faulty or inefficient equipment. The project team also determined that labor costs could be reduced at some sites without sacrificing the effectiveness of the remedy. Implementation of the recommendations is estimated to result in a 36 percent reduction in annual operation and maintenance costs, which were reported to be \$13.3 million for the 20 pump-and-treat systems evaluated. However, one-time capital investments to implement the recommendations could potentially raise operation and maintenance costs for the evaluated sites by 46 percent.

In addition to the specific recommendations to improve the performance, cost, or effectiveness of pump-and-treat systems, the EPA project team also made some overall observations on lessons learned from the RSE process and recommendations to maximize the benefits of the RSE process. These are detailed in the relevant EPA reports. EPA has taken, and continues to take, some important action to address the lessons learned and suggestions. Some of the more significant include:

- Developing fact sheets on “Implementation of RSE Recommendations: Technical Assistance Resources Available to RPMs [Remedial Program Managers]” and “Elements of Effective Management of Operating Pump and Treat Systems.”
- Conducting presentations for various Federal and State representatives and Internet seminars discussing results and lessons learned from the nationwide optimization study.
- Providing contractor support for technical assistance on implementing recommendations.
- Sponsoring a conference on “In Situ Treatment of Groundwater Contaminated with Non-Aqueous Phase Liquids.”

### ***Stakeholder Reaction Thus Far***

Interviews we conducted with representatives of EPA Regions (Division Directors, Branch Chiefs, Remedial Project Managers) and States (Deputy Division Directors, Project Officers) that are, or will be, managing some of the evaluated systems generally indicate that the optimization project was valuable, useful, and identified opportunities for costs savings. Generally, we received more positive than negative comments on the RSE process and optimization project. EPA Superfund Regional Management in all four Regions we visited believed that the RSE process was helpful, indicating that RSEs were a good management tool and provided a good overview of site conditions and effectiveness of the pump-and-treat remedy. One Division Director would like to have RSEs performed on all sites, provided that funds were available. State environmental program representatives indicated that the RSE results confirmed potential problems that the State had been concerned with, identified problem areas that EPA needed to address before site turnover to the States, and found the process particularly useful because the RSE was an independent third party review of the pump-and-treat system. Areas that EPA representatives expressed some trouble with included concerns that RSE recommendations would not be implemented in cases where the benefits of system optimization may accrue to States rather than EPA; difficulty implementing recommendations that were impractical because



of State laws; a burdensome and inadequately organized system for followup; and concerns that the timing of RSEs may need to be revised to get the most benefits from the evaluation process.

### ***Implementation and Tracking/Phase 3***

Phase 3 of the project is ongoing and generally involves project tracking, including capturing progress towards implementing the RSE recommendations.

Approximately 22 percent of the 241 recommended improvements identified by EPA's project team and agreed to by the Regions have been fully implemented, about 31 percent are in the process of being implemented, and 47 percent have been deferred for various reasons. Of the 47 percent that were deferred, the two most common reasons given were that implementation of the recommendation was dependent upon Regions completing other RSE recommendations, and that the Region could not perform the function in fiscal 2002 but believed it could accomplish the function in fiscal 2003. For example, at one Superfund site, EPA recommended additional sampling points to better determine the extent of the groundwater contamination. However, the Region postponed this recommendation until data is analyzed for the 5-year review in September 2003. Other reasons for deferral included funding, awaiting transfer of a site to a potentially responsible party, or the site was transferred to the State. We were unable to determine the precise impact of the deferred recommendations.

Significant "lessons learned" from the optimization project that have not yet been implemented include:

- Develop fact sheets entitled "Best Practices for Capture Zone Analysis" and "Groundwater Optimization: Benefits and Approaches."
- Delivery of four regional training events on the capture zone analysis fact sheet.
- Develop guidance on exit strategies, overdesign, and contracting.
- Track progress on implementation of RSE recommendations.
- Follow up on sites containing NAPL contamination that are unlikely to reach cleanup levels with existing remedial actions, and sites where contractor issues were specifically identified.
- Conduct an additional four to six pump-and-treat RSEs at Superfund-financed sites.
- Summarize implementation efforts and costs and send memo to Regional managers on progress.
- Determine an appropriate time for the next followup call for each site.

At the end of our field work, it was not clear that EPA's project team had a milestone for completion of Phase 3 of the project, nor that Phase 3 was complete. However, fact sheets EPA released early in the project indicated that project tracking would be completed by the end of fiscal 2002. We believe that successful implementation and completion of Phase 3 must be

equally included in the measure of success or impact associated with the optimization project. Although the EPA project team has identified or completed several important activities associated with Phase 3, we believe the Phase 3 activities need to be amended to include more organized focus on actions to accurately track the environmental and cost savings results achieved from implementing the evaluation recommendations. These activities are likely to involve setting priorities for which sites or recommendations are most critical to track, establishing a time line for tracking actions, and establishing credible metrics to measure environmental and cost benefit outcomes associated with implementing optimization project recommendations. These actions should also be incorporated in the work plans of future optimization projects EPA will, or has recently, implemented.

### ***Conclusion***

Progress on the Nationwide Superfund-Financed Pump and Treat Optimization Project has been promising to date, and the project has produced valuable information and recommendations. This progress needs to be sustained and measured in a way that permits a better understanding of the environmental and fiscal advantages of investing in optimization studies. Without this, there is risk that EPA will lose an opportunity to acquire information on how effective the optimization project is for producing environmental or cost savings results. In the long term, it will be difficult to determine the environmental and cost benefits of optimization projects such as this if accurate and meaningful information on the results they produce has not been collected or analyzed.

### ***Additional Issue***

Although we did not have an opportunity to review this issue in detail, we also observed that there is a potential duplication of decisionmaking information obtained from RSEs and 5-year reviews. Although there are statutory and technical differences among these two evaluation methods, they both render an opinion on the effectiveness of a cleanup remedy. This may create perceptions of duplication of effort or, upon further examination, suggest that one of these methods may generate more reliable conclusions concerning remedy protectiveness.

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If you have any questions regarding this report, please call me at (202) 566-0829.

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