

**E**valuation



**R**eport

IMPLEMENTATION OF INNOVATIVE TECHNOLOGY FOR DOD  
ENVIRONMENTAL CLEANUP PROJECTS

Report No. 99-249

September 9, 1999

Office of the Inspector General  
Department of Defense

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### **Acronyms**

BRAC	Base Realignment and Closure
DUSD(ES)	Deputy Under Secretary of Defense (Environmental Security)
DERA	Defense Environmental Restoration Account
DERP	Defense Environmental Restoration Program
ESTCP	Environmental Security Technology Certification Program
MAP	Management Action Plans
NFESC	Naval Facilities Engineering Service Center
SCAPS	Site Characterization Analysis and Penetrometer System
UXO	Unexploded Ordnance



**INSPECTOR GENERAL  
DEPARTMENT OF DEFENSE  
400 ARMY NAVY DRIVE  
ARLINGTON, VIRGINIA 22202-2884**

September 9, 1999

MEMORANDUM FOR DEPUTY UNDER SECRETARY OF DEFENSE  
(ENVIRONMENTAL SECURITY)  
ASSISTANT SECRETARY OF THE NAVY (FINANCIAL  
MANAGEMENT AND COMPTROLLER)  
ASSISTANT SECRETARY OF THE AIR FORCE (FINANCIAL  
MANAGEMENT AND COMPTROLLER)  
DIRECTOR, DEFENSE LOGISTICS AGENCY  
AUDITOR GENERAL, DEPARTMENT OF THE ARMY

SUBJECT: Evaluation Report on Implementation of Innovative Technology for DoD Cleanup  
Projects (Report No. 99-249)

We are providing this report for information and use. We considered management comments on a draft of this report when preparing the final report.

The Deputy Under Secretary of Defense (Environmental Security) comments conformed to the requirements of DoD Directive 7650.3; therefore, no additional comments are required.

We appreciate the courtesies extended to the evaluation staff. Questions on the evaluation should be directed to Mr. William C. Gallagher at (703) 604-9270 (DSN 664-9270) (wgallagher@dodig.osd.mil) or Mr. Michael Claypool at (703) 604-9291 (DSN 664-9291) (mclaypool@dodig.osd.mil). See Appendix F for the report distribution. The evaluation team members are listed inside the back cover.

A handwritten signature in black ink, reading "Robert J. Lieberman".

Robert J. Lieberman  
Assistant Inspector General  
for Auditing

## Office of the Inspector General, DoD

Report No. 99-249  
(Project No. 8CB-0044.00)

September 9, 1999

### Implementation of Innovative Technology For DoD Environmental Cleanup Projects

#### Executive Summary

**Introduction.** The Deputy Under Secretary of Defense (Environmental Security) is responsible for DoD compliance with environmental laws and regulations and promoting technology to obtain better and less expensive environmental cleanup.<sup>1</sup> The Environmental Security Technology Certification Program demonstrates and validates innovative technologies that address DoD environmental requirements for compliance, cleanup, and pollution prevention. For FYs 1998 through 2005, the research and development budget for the program is \$189.9 million, with approximately 35 percent related to cleanup technology.

**Objectives.** The evaluation objective was to determine the effectiveness of technology transfer of environmental research and development cleanup projects within the DoD. We also evaluated whether the Military Departments were planning to use innovative technologies demonstrated by the Environmental Security Technology Certification Program. We also evaluated the management control program as it relates to the evaluation objectives.

**Results.** The Environmental Security Technology Certification Program was demonstrating and validating cleanup technologies that provided cost effective and efficient environmental cleanups at military installations. However, additional actions were needed to optimize the use of new technologies to improve the DoD environmental cleanup program.

Although some progress was made in the use of innovative cleanup technologies, DoD did not maximize implementation<sup>2</sup> of more effective or less costly cleanup technologies. As a result, DoD needs to do more to exploit opportunities to reduce environmental cleanup costs. A discussion of the evaluation results is in the Finding section of the report.

The management controls that we reviewed were effective in that no material management control weakness was identified. See Appendix A for details on the management control program.

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<sup>1</sup> Cleanup includes environmental site characterization and remediation.

<sup>2</sup> Implementation is the application of innovative technologies at cleanup sites.

**Summary of Recommendations.** We recommend that the Deputy Under Secretary of Defense (Environmental Security) expand the use of cooperative agreements as a forum for regulatory consensus; direct the Military Departments to increase peer reviews to provide technical support for the cleanup program; establish a cooperative effort with private sector organizations to identify the best contracting practices and develop initiatives for applying them to DoD cleanup sites; and direct that the Military Departments develop implementation plans for the Environmental Security Technology Certification Program projects that identify the DoD end users, and the proposed methodology to address impediments to implementation. We also recommend the development of goals and performance measures for the use of innovative technology in support of the DoD cleanup mission.

**Management Comments.** The Deputy Under Secretary of Defense (Environmental Security) concurred with the finding and recommendations, and further agreed that environmental technology transfer improvements can be made. The Deputy Under Secretary has formed an Environmental Security Technology Implementation Committee under the Environment, Safety and Occupational Health Policy Board to ensure that the report's recommendations are implemented in a timely fashion. A discussion of management comments is in the Finding section of the report and the complete text is in the Management Comments section.

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## Background

A goal of the DoD environmental technology program is to provide innovative technology alternatives for DoD for environmental cleanups. The use of innovative technologies can substantially reduce costs, accelerate cleanups, and increase the effectiveness of the DoD environmental restoration program. Innovative technologies can be newly developed technologies for environmental hazardous waste cleanup or various commercial or industrial applications that are adopted for cleanup.

**Defense Environmental Restoration Program (DERP).** The Superfund Amendments and Reauthorization Act (SARA) established DERP in October 1986. The SARA authorized funding for DERP and the Defense Environmental Restoration Account (DERA).

The Deputy Under Secretary of Defense (Environmental Security) (DUSD[ES]) is responsible for policy direction and oversight of DERP. The DoD Components (Military Departments and Defense agencies) are responsible for program implementation. Implementation consists of investigating and restoring contaminated sites, including the selection of cleanup remedies in coordination with Federal, State, and local regulatory authorities. The DUSD(ES) is also responsible for unexploded ordnance (UXO) cleanup and the clearance of active ranges. The DUSD(ES) shares the clearance responsibility with the Office of the Director, Test Systems Engineering and Evaluation.

**DoD Contaminated Sites.** The Fiscal Year 1997 DERP Annual Report to Congress, March 31, 1998, identified 9,689 contaminated sites at 758 DoD installations that required some form of environmental cleanup action. In addition, there are 2,500 sites at Formerly Used Defense Sites that require some form of cleanup action. From FY 1999 forward, DERP estimates that it will cost nearly \$20 billion to complete the remaining cleanup work for all known DoD sites.

Many DoD installations are also faced with the task of cleaning up unexploded ordnance, soils, and groundwater contaminated with explosives. A Defense Science Board Task Force report, "Unexploded Ordnance (UXO) Clearance, Active Range UXO Clearance, and Explosive Ordnance Disposal (EOD) Programs," April 1998, estimates that over 15 million acres at 1,500 sites in the United States may contain some level of UXO contamination.

**Environmental Security Technology Certification Program (ESTCP).** The ESTCP was established in 1995. The ESTCP goal is to demonstrate and validate the most promising innovative technologies that target urgent DoD environmental needs for pollution prevention, cleanup, and compliance. These technologies are projected to provide a return on the investment within 5 years through cost avoidances and improved efficiencies. The technology program responds to:

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- concern over the slow pace and high cost of the environmental cleanup of contaminated sites on military installations,
  - congressional direction to conduct demonstrations specifically focused on emerging new technologies, and
  - the need to improve Defense readiness by reducing operational costs caused by environmental cleanup requirements.

**Regulatory Guidance.** Both the SARA and the revised National Contingency Plan of 1990 require that DoD Components consider and evaluate alternative treatment technologies in their decisionmaking process.

- Section 9621(a), title 42, United States Code (42 U.S.C. 9621), “Selection of Remedial Action,” of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), as amended by SARA, mandates, “in evaluating the cost effectiveness of proposed alternative remedial actions, . . . shall take into account the total short- and long-term costs of such actions, including the costs of operation and maintenance for the entire period which such activities will be required.”
- Title 40, section 300.430(e), Code of Federal Regulations, “Feasibility Study Requirements,” of the revised National Contingency Plan requires the lead agency to identify and evaluate suitable technologies, including innovative technologies. Further, (e)(5) requires the “lead agency to develop one or more innovative treatment technologies in the Feasibility Study for further consideration if the technologies offer the potential for comparable or superior treatment performance; fewer or lesser adverse impacts than other available approaches; or lower costs for similar levels of performance than demonstrated treatment technologies.”

**DoD Guidance.** DoD Instruction 4715.7, “Environmental Restoration Program,” April 22, 1996, provides policies that support the development and use of cost-effective innovative cleanup technologies. The instruction also discusses the development of partnerships for restoration activities with Federal, State, and local regulatory agencies for DERP and Base Realignment and Closure (BRAC) environmental programs. The DUSD(ES) “Management Guidance for the DERP,” March 1998, provides additional guidance on environmental program implementation by DoD.

## Objectives

The evaluation objective was to determine the effectiveness of technology transfer of environmental research and development cleanup projects within DoD. We evaluated whether the Military Departments were planning to use innovative technologies demonstrated by the Environmental Security Technology Certification Program. We also evaluated the management control program as it relates to the evaluation objectives.

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# Implementing Innovative Technologies for Environmental Cleanup

Although some progress was being made in the use of innovative cleanup technologies, DoD did not maximize implementation of cleanup technologies that were more effective or less costly than established technologies. This condition occurred because of impediments related to risk aversion, technical support, contractual incentives, and implementation plans. In addition, DoD did not have performance indicators that measured the effectiveness of innovative technology in reducing cleanup costs. As a result, DoD needs to do more to exploit opportunities to reduce environmental cleanup costs.

## Implementing Innovative Technologies

**Implementing Procedures.** Although some progress was being made in the use of innovative cleanup technologies, DoD did not maximize implementation of cleanup technologies that were more effective or less costly. Effective implementation procedures were needed because they would:

- lead to faster and broader acceptance of innovative technologies by DoD cleanup project site managers (end users), contractors, and regulators,
- incorporate the DoD end user and regulator community in the development and implementation of each technology,
- ensure that successfully demonstrated technologies had a real impact on addressing the cleanup needs of DoD installations, and
- respond to congressional and Military Departments' cleanup priorities by expediting environmental cleanup at military installations.

The number of innovative technologies demonstrated and validated under ESTCP may increase as projects funded by the program are completed. Lack of DoD implementation procedures limits the use of those technologies at DoD cleanup sites.

**ESTCP Projects.** From FYs 1995 through 1999, ESTCP initiated 44 cleanup technology projects with a program cost of \$40.8 million. These projects were selected in a two-phase process based on criteria of technical merit, cost benefit of deployment, potential for technology transfer, and whether technology would be demonstrated by more than one service. The proposal criteria required that the innovative technology projects address a well-defined environmental need, be technically mature, and that the demonstration would be completed within 3 years.

The ESTCP guidelines for preparing project proposals require that the proposals include a transition plan that identifies specific end users, describes the approach

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for obtaining regulatory approval, and identifies known barriers to technology application. A project cost and performance report on the results of the cleanup demonstration must be submitted for each completed technology project.

**Completed Technology Projects.** The ESTCP completed demonstrations for 15 technology projects. Of the 15 projects, 9 were successfully validated as effective technologies and 6 were demonstrated as unsuccessful innovative technologies. Even if a project demonstration was unsuccessful, the information could be used by DoD decisionmakers as lessons-learned information. The projects that were demonstrated addressed site characterization as well as in-situ and ex-situ technologies for soil and groundwater cleanup. See Appendix B for the status of the 15 projects.

Of the 9 successful validated technologies, 7 have transferred<sup>1</sup> to the Military Departments for cleanup application by DoD end users. Military Departments did not have implementation plans that identified where these technologies could be applied for current or future DoD-wide cleanups. In addition, they did not have implementation plans that showed where the 31 technology projects that were being demonstrated could be applied if they proved more effective or less costly than established technologies. We could not confirm that additional DoD sites beyond the initial field demonstrations would use the innovative technologies for cleanups.

For example, ESTCP funded a demonstration of phytoremediation of explosives-contaminated groundwater using constructed wetlands and planted lagoons at the Milan Army Ammunition Plant, Milan, Tennessee. The phytoremediation technology successfully demonstrated that it was an effective and less costly remedy than the established granular activated carbon treatment for groundwater contamination. However, the technology was not implemented as the cleanup remedy at Milan. Because there was no implementation plan, we could not determine whether the Army or the other Military Departments intended to use this phytoremediation treatment method to cleanup explosives-contaminated groundwater.

## **Impediments to Using Innovative Technologies**

Environmental experts such as the National Research Council, the Hazardous Waste Action Coalition, the Interstate Technology and Regulatory Cooperation Workgroup, and the Army Science Board have identified impediments that often limited the use of innovative cleanup technologies. We found their analyses to be persuasive. The impediments included:

- risk aversion by community and state regulators to implement innovative technologies,
- lack of technical support for cleanup site managers, and

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<sup>1</sup>Transfer is when a successful innovative technology cost and performance final report is provided to DoD end-users, regulators, and contractors for consideration as a cleanup remedy.

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- lack of contractual incentives for cleanup contractors.

The DoD could take measures to mitigate those impediments and foster the use of ESTCP technologies at DoD cleanup sites. An additional impediment was that the Military Departments did not have implementation plans that maximized DoD-wide applications of innovative cleanup technologies.

**Risk Aversion by Regulators.** An impediment to the acceptance of innovative technologies was risk aversion by DoD cleanup project managers and stakeholders such as regulators, private sector contractors, and local community representatives. Risk aversion stemmed from limited field experience using innovative technologies, limited technology cost and performance data, and potential legal liability. As a result of those uncertainties, established cleanup technologies were often selected as the cleanup remedy. To address this issue, DoD created partnerships among regulators, local communities, and end users to increase regulatory acceptance of new cleanup technologies.

**DoD Cooperative Agreements.** Congress authorized DoD<sup>2</sup> to enter into cooperative agreements with agencies of State or local governments, or Indian tribes, to obtain assistance to demonstrate, validate, and certify environmental technologies, with the objective of increasing regulatory acceptance of innovative technologies.

- The DoD entered into two cooperative agreements with the Interstate Technology and Regulatory Cooperation Workgroup to reduce interstate barriers to the deployment of innovative technologies. The Interstate Technology and Regulatory Cooperation Workgroup is a coalition that represents State and Federal regulators, the environmental industry, and public advisory committees. The agreements provided a mechanism to ensure technologies that were validated and certified in one state are transferable to other states, thereby avoiding duplication of effort and the slowing down of technology implementation.
- The DoD has three cooperative agreements with the California Hazardous Waste Environmental Technology Certification Program. Two agreements were for the ESTCP validation and certification of Site Characterization Analysis and Penetrometer System (SCAPS) sensors (HydroSparge and Thermal desorption). A third agreement is to evaluate the performance of the Benthic Flux Sampling Device for collecting data to quantify the metal fluxes of contaminants across sediment-water interface in marine and aquatic environments of bays and estuaries.

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<sup>2</sup> National Defense Authorization Act for FY 1997, Public Law 104-201, September 23, 1996.

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- The Military Departments and the Defense Logistics Agency entered into a multisite agreement with the Commonwealth of Pennsylvania to assess and eliminate environmental and public health risks at approximately 1,076 sites for which DoD has cleanup responsibility (10 years earlier than DoD planned).

As of May 1999, DoD had not entered into other cooperative agreements as a means of expediting the implementation of specific innovative technologies for DoD-wide cleanup application. State environmental expertise could be used more extensively to achieve acceptability of innovative technologies by regulators.

**Technical Support for Cleanup Site Managers.** The DoD cleanup site managers were not able to develop expertise in all relevant areas of environmental restoration because of time constraints and the broad technical expertise required in the environmental program. Cleanup site managers have multiple functions such as coordinating with regulators, attending community meetings, and performing contract activities. As a result, some cleanup site managers are almost completely dependent upon contractors for technical advice on the selection of cleanup remedies. This could result in the selection of established technologies instead of innovative cleanup technologies.

The Military Departments' independent peer review processes offer an excellent way to foster the selection of innovative cleanup technologies, including the ESTCP technologies. Independent peer review teams sometimes present their technical results to regulators and community representatives in addition to cleanup site managers. Exposure to the technical aspects of innovative cleanup technologies could increase their acceptance by communities and regulators. Technical reviews could also provide cleanup site managers with assistance on how to exit from established treatment technology (such as a pump and treat system) and replace it with innovative technology. See Appendix C for a discussion of the Military Department peer review results.

**Contractual Incentives for Cleanup Contractors.** According to the experts that we relied on, few Government contracts had incentives that encouraged contractors to use innovative technology for cleanup projects. Cleanup contracts were awarded on a cost-reimbursable basis, with no incentives for quick action or cost effectiveness in cleanup technology selection. As an alternative to control costs, fixed-price contracts were awarded for cleanup despite the inherent risks in site restoration that could lead to major contract price increases as site conditions became apparent. With no incentives to reduce costs, there were no incentives for contractors to search for new cleanup solutions.

**Performance-based Cleanup Contracting.** Environmental and industry experts agreed that contracts with performance incentives encouraged faster and cheaper site cleanup and the best use of financial resources. Those contracts were generally referred to as performance-based contracts. However, there was little agreement among industry and DoD contracting officials on the definition of performance-based cleanup contracting, other than to say it meant structuring all aspects of an acquisition around the purpose of the work as opposed to the way it was to be performed. Implementation within DoD

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generally meant using cost reimbursable contracts with some flexibility built in for the contractor to seek alternative approaches for site cleanup, or basing some portion of the award fee on a contractor's performance.

**Alternative Contracting Methods.** Environmental and industry experts have explored additional mechanisms for cleanup contracting.

- The National Research Council recommends that managers of contaminated Federal sites hire cleanup contractors on a fixed-price basis, and establish independent peer review panels to check progress toward cleanup milestones. In the view of the National Research Council, those steps would provide stronger incentives for Federal cleanup contractors to use innovative cleanup solutions because the contractor assumes the risks and rewards for cheaper, faster cleanups. To control costs when contractors seek to recover costs for unpredicted site conditions, a peer review panel could verify that the cost increases were technically justified.
- The Hazardous Waste Action Coalition (an association of engineering and science firms practicing in hazardous waste management) supports the use of performance-based service contracts that respond to environmental cleanup uncertainties. The coalition suggests that performance-based service contracts contain a mix of contract types for discrete tasks, as well as outcome-oriented performance criteria that give the contractor the flexibility to deliver cheaper, faster results. They should include incentives for contractors to meet or exceed the outcome-oriented performance criteria and disincentives for failure to meet minimum criteria. However, the Hazardous Waste Action Coalition does not consider performance-based contracting an appropriate vehicle for UXO cleanup.
- Another approach, used by private industry, is an enhancement of the performance-based concept. It provides a fixed-price contract for guaranteed site cleanup, combined with cost cap and property transfer liability insurance to address the cleanup unknowns. The contractor commits to perform all cleanup necessary to achieve regulatory closure of the site. The result was a comprehensive fixed-price contract that transferred the cleanup costs and liability risks to the contractor and insurance carrier.

Financial incentives for contractors would create market demand for using innovative technologies. Remediation trade associations, private sector cleanup contractors, and site owners have studied alternative contracting approaches and have knowledge and experience that would benefit DoD. The DUSD(ES) should inventory private sector best contracting practices and develop initiatives for expanding their use within DoD.

**Implementation Plan.** The ESTCP transition procedures for each completed project included posting project cost and performance findings on the internet web, in scientific and technical publications, and presenting findings at

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environmental conferences and workshops. These technology transition methods were the primary means of informing DoD decisionmakers, contractors, and regulators about successful innovative cleanup technology.

Although the limited transfer procedures were viable, a proactive implementation plan was needed to ensure maximum DoD-wide consideration and application of successfully demonstrated cleanup technologies. Military Departments have the primary responsibility for linking their installation end user cleanup requirements with the technologies emerging from ESTCP.

The DUSD(ES) "Management Guidance for the DERP," March 1998, requires a management action plan (MAP) or its equivalent as a key document for managing an installation's environmental restoration program. This key document provides an excellent means to develop implementation plans that link ESTCP emerging innovative technology remedies with installation end-user cleanup requirements. See Appendix E for a description of the DoD management action plan information that could be used to develop cleanup technology implementation plans for each DoD Component installation.

## Measuring the Use of Innovative Cleanup Technology

**Technology Goals.** The DUSD(ES) is responsible for developing (in consonance with the Military Departments) and promulgating environmental security goals and objectives, and approving the means of measurement for attaining them. The DUSD(ES) has developed measures of merit and program management indicators to track and report progress toward cleanup goals, including those established in the Defense Planning Guidance. The measures of merit developed by DUSD(ES) address progress toward risk reduction for contaminated sites, the number of sites being cleaned up and closed out, milestones accomplished in the cleanup process, and installations that have remedies in place or cleanup responses completed.

Technology investments, like those funded by the ESTCP and the Military Departments, support the successful completion of the cleanup mission. However, DoD had not established goals for using technology investments in support of its cleanup mission. Therefore, DoD lacked a focused effort to implement its technology investments at actual cleanup sites, and could not determine whether its technology investments were mitigating the long-term DoD cleanup liability. Established goals would target the use of innovative technology and help bridge the gap between technology development and field use.

**Performance Measures.** With the exception of the Navy, DoD technology managers had not developed performance measures to show whether their programs were reducing the cleanup liability or achieving stated program goals.

- Although ESTCP had established execution measures to promote successful project completion, performance measures were not developed for the overall results of the program. Therefore, we were unable to determine whether ESTCP technologies were being used at DoD cleanup sites, or whether the program was mitigating the DoD cleanup liability. Recognizing that ESTCP was still

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evolving, it is important for the DUSD(ES) to establish measures of program effectiveness before the ESTCP projects are ready to be fielded at DoD cleanup sites.

- Except for the Naval Facilities Engineering Service Center, the environmental service centers had not developed performance measures to show whether their technology efforts were reducing the cleanup liability through the use of innovative technology or achieving intended program results.
- The Navy Facilities Engineering Service Center (NFESC) tracked return on investment for its use of innovative technology. The service center tracks the number of users that have implemented innovative technologies, the cost avoidance of using those technologies, and the return on investment for implementing them. According to data, from January 1991 to present, the Navy invested \$13.5 million to develop innovative technologies for use at 205 cleanup sites that resulted in \$288 million in cost avoidance. The data are reported semiannually to the Naval Facilities Engineering Command.

The General Accounting Office and the Science Advisory Board (an advisory group to the Environmental Protection Agency), recognize the difficulty with developing performance measures for science programs. The Science Advisory Board has suggested performance measures for the Superfund Innovative Technology Evaluation Program for developing and implementing innovative treatment technologies. Those suggested measures, similar to what NFESC is using, could be applied to DoD cleanup technology investment programs. The measures included:

- a tabulation of technologies that participated in the program,
- how often those technologies were used for cleanup,
- the number of locations where they were used, and
- measures of reduced costs for cleanup and monitoring.

Our recommendations requiring ESTCP and the Military Departments to develop plans for using innovative technologies should strengthen the implementation process. We believe, however, that DoD should develop performance indicators to measure the extent to which it is mitigating the DoD cleanup liability by using innovative technologies.

## **Realizing Technology Benefits**

DoD Components may have missed opportunities to reduce their environmental cleanup costs because innovative technologies were not used more extensively. In any event, significant opportunities remain for cost reduction.

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**Cleanup Requirements.** The DoD cleanup costs are increasing because more contaminated sites are being identified and regulatory requirements are increasing. Many of these new sites are contaminated by UXOs. The DoD has a critical need for more effective cleanup technologies that would locate and identify UXOs that differ significantly from other technologies used for soil and groundwater cleanup. In an era of limited budgets, Military Department implementation cleanup plans would ensure that innovative technologies for cleanups, such as UXO, were available for use to meet installation cleanup milestones, reduce cleanup costs, and increase military readiness.

**Site Characterization.** According to the Army Corps of Engineers, the Site Characterization and Analysis Penetrometer System (SCAPS) suite of sensor and sampler probes, if used to identify and analyze contaminants, could typically save 25 to 50 percent in cleanup costs per site when compared to established soil drilling and sampling techniques. Using SCAPS could help the Federal government avoid as much as \$750,000,000 in future installation cleanup costs. The ESTCP has successfully demonstrated SCAPS sensors for petroleum products, explosive compounds, and volatile organic compounds that were contaminants prevalent at most military installations. See Appendix E for a description of SCAPS.

**Records of Decision.** The Environmental Protection Agency has included 146 DoD installations on the National Priorities List because of their risk to human health and the environment. At least every 5 years, the DoD Components and the Environmental Protection Agency are required to conduct Records of Decision reviews as stipulated by the National Oil and Hazardous Substance Pollution Contingency Plan.

The reviews evaluate the cleanup remedies that are in place and consider the merits of modifying or changing the previously selected remedies to maximize effectiveness and reduce costs. The reviews provide opportunities to implement newer, more effective cleanup technologies such as those being demonstrated and validated under ESTCP.

**Technology Benefits.** The Military Department peer reviews demonstrate significant DoD-wide cost avoidance using innovative technologies. For example, the Army performed peer cleanup reviews at four BRAC installations. If the installations implement the recommendations, the Army will avoid approximately \$10.0 million in cleanup costs. Also, from 1995 through 1997, Navy tiger team reviews identified life cycle cost avoidance of \$118.2 million. See Appendix C for a discussion of results.

**Cost Avoidances.** Innovative technology use by the Navy demonstrated cost advantages over established technologies. The following figure compares technology cleanup costs at three Navy and Marine Corps installation sites.

Potential Cost Avoidance from Innovative Technologies (millions)				
Cleanup Site	Innovative Technologies	Conventional Costs	Innovative Costs	Cost Avoidances
Moffett Federal Airfield	Permeable Reactive Wall	\$33.0	\$8.00	\$25.00
Marine Corps <sup>3</sup>	Intrinsic Bioremediation	2.8	1.95	0.85
Mayport Naval Station	Bioslurping	4.3	1.00	3.30

According to the Navy, the Moffett Federal Airfield cleanup cost avoidance of \$25 million, achieved by applying permeable wall technology, was about four and one-half times more cost effective than established pump-and-treat technology. ESTCP has successfully demonstrated permeable reactive wall and bioremediation cleanup technologies. See Appendix E for a description of innovative cleanup technology methodologies.

## Conclusion

The use of innovative cleanup innovative technologies can help avoid millions of dollars in environmental cleanup costs compared to using established technologies. Those cost avoidances have been demonstrated by ESTCP and at DoD cleanup sites where innovative technologies have been applied. While not every DoD cleanup site was an appropriate candidate for innovative technologies, their application should be actively promoted and considered to maximize deployment throughout the DoD.

The ESTCP used several passive methodologies, such as workshops, scientific and engineering publications, and Internet sites to publicize results of its technology demonstrations. Those distribution methods have achieved modest results to date. The DoD could achieve wider application of innovative technologies by taking active measures to address the impediments that limit their use. Expanding use of cooperative agreements to obtain regulatory approval, and increased support for cleanup site managers through peer reviews would facilitate the selection of innovative technologies as cleanup remedies. Identifying the best private sector contracting practices and application, where appropriate, within DoD could increase incentives for contractors to use innovative technologies. Developing implementation plans, goals, and performance measures for the use of innovative technologies would help bridge the gap between technology developers and users.

## Recommendations and Management Comments

We recommend that the Deputy Under Secretary of Defense (Environmental Security):

<sup>3</sup> Marine Corps Air-Ground Combat Center, Twenty-Nine Palms, CA.

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**1. Expand the use of cooperative agreements or other appropriate agreements as a forum for regulatory consensus on the demonstration, verification, and certification of innovative environmental cleanup technologies.**

**2. Direct the Military Departments to increase the use of peer reviews to provide technical support for cleanup site managers.**

**3. Establish a cooperative effort with private sector organizations to identify best contracting practices for environmental cleanup and develop initiatives for applying them to DoD cleanup sites.**

**4. Direct that the Military Departments develop implementation plans for using Environmental Security Technology Certification Program technologies and milestone schedules for developing the plans. The implementation plans should:**

**a. Identify DoD end users and proposed methodologies for addressing impediments to use the technologies.**

**b. Be based on the installation management action plans or their equivalent.**

**5. Develop, in consonance with the Military Departments, goals and performance measures for using innovative technology in support of the DoD cleanup mission.**

**Deputy Under Secretary of Defense (Environmental Security)**

**Comments.** The Deputy Under Secretary of Defense (Environmental Security) concurred. To implement the recommendations in a timely fashion, the Deputy Under Secretary has formed an Environmental Security Technology Implementation Committee (Committee) under the Environment, Safety and Occupational Health Policy Board. The officials who will serve on the Committee include the:

- Principal Assistant Deputy Under Secretary of Defense (Environmental Security),
- Deputy Assistant Secretary of the Army (Environment, Safety and Occupational Health),
- Deputy Assistant Secretary of the Navy (Environment and Safety) and,
- Deputy Assistant Secretary of the Air Force (Environment, Safety and Occupational Health).

The first Committee meeting was planned for September 1999.

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# Appendix A. Evaluation Process

## Scope

We reviewed the effectiveness of technology transfer of environmental cleanup projects within the DoD. We reviewed the ESTCP policy, strategy, procedures, and actions associated with innovative cleanup technology projects being demonstrated, validated, and transferred within DoD. In addition, we reviewed the Military Departments' plans and actions to implement those technologies at cleanup sites. We also evaluated the management control program as it relates to the cleanup portion of the ESTCP.

**DoD-Wide Corporate Level Government Performance and Results Act Goals.** In response to the Government Performance Results Act, DoD has established 6 DoD-wide corporate-level performance objectives and 14 goals for meeting these objectives. This report pertains to achievement of the following objectives and goals.

**Objective:** Fundamentally reengineer DoD and achieve a 21st century infrastructure. **Goal:** Reduce costs while maintaining required military capabilities across all DoD mission areas. **(DoD-6)**

**DoD Functional Area Reform Goals.** Most major DoD functional areas have also established performance improvement reform objectives and goals. This report pertains to achievement of the following functional area objectives and goals.

- **Environmental Functional Area. Objective:** Reduce, in a cost-effective manner, risks to human health and the environment attributable to contamination resulting from past DoD Component activities.
- **Goal:** Identify, evaluate, and, where appropriate, remediate contamination resulting from past DoD activities. **(ENV-1.1)**
- **Goal:** Support the development and use of cost-effective innovative technologies and process improvements in the restoration process. **(ENV-1.7)**

**General Accounting Office High-Risk Area.** The General Accounting Office has identified several high-risk areas in the DoD. This report provides coverage of the "Superfund Program Management" and "Defense Infrastructure" high-risk areas.

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## Methodology

**Use of Computer-Processed Data.** We did not use computer-generated data for this evaluation.

**Universe and Sample.** We reviewed 44 ESTCP cleanup projects approved for demonstration and validation from FYs 1995 through 1999. We collected various program documents related to environmental cleanup technology to:

- identify the methods used to demonstrate and validate environmental R&D projects,
- determine to what extent innovative technology is being used at military installations cleanup sites,
- determine how innovative technology is transitioned for application at environmental cleanup sites,
- determine to what extent ESTCP research and development projects are being used or planned to be used at DoD cleanup sites, and
- determine whether DoD has entered into cooperative agreements to accelerate the acceptance of innovative technologies.

**Evaluation Type, Dates, and Standards.** We conducted this performance evaluation from July 1998 through May 1999, in accordance with the evaluation standards issued by the Comptroller General of the United States, as implemented by the Inspector General, DoD. Accordingly, we included tests of management controls considered necessary.

**Contacts During the Evaluation.** We interviewed environmental program managers at the Departments of Army, Navy, and Air Force, and officials in the office of the Deputy Under Secretary of Defense (Environmental Security), Environmental Protection Agency, and the Interstate Technology Regulatory Cooperation Workgroup concerning environmental cleanup technologies.

## Management Control Program

DoD Directive 5010.38, "Management Control Program," August 26, 1996, requires DoD organizations to implement a comprehensive system of management controls that provide reasonable assurance that programs are operating as intended and to evaluate the adequacy of the controls.

**Scope of Review of Management Controls.** We reviewed the adequacy of management controls over ESTCP research and development technical projects. Specifically, we reviewed the Phase I and Phase II proposal documentation required from FYs 1995 through 1999 for transferring demonstrated technologies to DoD-wide cleanup sites. Because we did not identify a materiel weakness, we did not assess management's self-evaluation.

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**Adequacy of Management's Control.** The ESTCP management controls over the research and development technical project Phase I and Phase II processes were adequate as they applied to the evaluation objectives.

## **Summary of Prior Coverage**

During the last five years, there have been three audits and one evaluation that discussed environmental technologies. There also has been one Army Science Board report that addressed groundwater treatment systems and one Defense Science Board report that discussed unexploded ordnance contamination.

## **General Accounting Office**

Report No. 98-249, "Nuclear Waste – Further Actions Needed to Increase the Use of Innovative Cleanup Technologies," September 25, 1998.

Report No. 97-126, "Environmental Protection-Status of Defense Initiatives for Cleanup, Technology, and Compliance," May 29, 1997.

Report No. 96-214, "Managing for Results, Key Steps and Challenges in Implementing GPRA in Science Agencies," July 12, 1996.

## **Inspector General, DoD**

Report No. 98-090, "Evaluation of DoD Waste Site Groundwater Pump-and-Treat Operations," March 12, 1998.

## **Army**

Army Science Board Issue Group report, "Evaluation of the Effectiveness of Existing Groundwater Treatment Systems in the U.S. Army," February 1998.

## **Office of the Under Secretary of Defense for Acquisition and Technology**

Defense Science Board Task Force Report, "Unexploded Ordnance (UXO) Clearance, Active Range UXO Clearance, and Explosive Ordnance Disposal (EOD) Programs," April 1998.

## Appendix B. Innovative Technology Projects

DEMONSTRATION AND VALIDATION OF INNOVATIVE TECHNOLOGIES		
Project Title	Demonstration Successful <sup>1</sup>	Transferred to Service <sup>2</sup>
Bioremediation of Explosives-Contaminated Soils in a Slurry Reactor	YES	YES
Multisensor Towed Array Detection System	YES	YES
Remote Sensing Surface UXO with Active Laser and Passive Infrared Airborne Line Scanner	YES	Not Applicable
High Resolution Seismic Reflection to Characterize and Plan Remediation at Hazardous Wastes Sites	NO	Not Applicable
Natural Attenuation of Explosives in Groundwater	YES	YES
Permeable Reactive Wall Remediation of Chlorinated Hydrocarbons in Groundwater	YES	YES
Peroxone Treatment of Explosives-Contaminated Groundwater	NO	Not Applicable
Joint Small Arms Firing Ranges Remediation	YES	YES
Phytoremediation of Explosives-Contaminated Groundwater Constructed in Wetlands	YES	Not Applicable
Remote Controlled Surface/Near Surface UXO Detector	No	Not Applicable
Electromagnetic Surveys for 3D Imaging of Subsurface Contaminants	NO	Not Applicable
Classification and Mapping of Underwater UXO	NO	Not Applicable
Groundwater Recirculation Well Joint Project	NO	Not Applicable
Tri-Service Site Characterization and Analysis Penetrometer System Demonstration/Validation	YES	YES
POL Sensor Validation of Site Characterization and Analysis Penetrometer System	YES	YES

<sup>1</sup>This innovative technology was shown through ESTCP demonstration and validation to be an acceptable alternative to established technologies.

<sup>2</sup>Transfer is when a successful innovative technology cost and performance report is provided to DoD end users, regulators, and contractors for consideration as a cleanup remedy. Not applicable denotes that a project was not considered for application by DoD components as a cleanup technology.

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## Appendix C. Military Department Peer Reviews

Each Military Department has initiated a peer review process of their environmental cleanup programs. The purpose of the reviews was to provide independent, third party technical analysis of selected installation cleanup programs to ensure that cleanup decisions were risk based, relied on competent site analysis, and that the decisions were cost effective. Because the peer review team was independent of installation cleanup managers, regulators, and stakeholders, they were in an excellent position to recommend and influence the acceptance of innovative technology use that would save cleanup costs.

**Army Reviews.** In 1997, the Army initiated Independent Technical Reviews (previously called peer reviews) of each BRAC environmental program site with projected cleanup costs greater than \$2 million. Four BRAC installations were reviewed initially. If the four BRAC installations implemented the recommendations, the Army could avoid approximately \$10.0 million in cleanup costs. In 1998, 14 of 45 Army BRAC installations were reviewed and 6 additional installations have been reviewed in FY 1999.

Also, the Army initiated Army Groundwater Effectiveness Teams to conduct technical reviews at installations with the largest cleanup programs that employed established groundwater pump and treat systems. The purpose of these reviews was to revisit the original decision to employ pump and treat remedies and to consider more cost effective, innovative technology remedies to replace the established groundwater treatments. The Army has 35 installations with major groundwater pump and treat systems that cost \$25 million annually. The teams would review the treatment systems that cost more than \$250,000 annually. In addition, there were about 70 major pump and treat systems in the planning stages at active installations, and BRAC and Formerly Used Defense Site cleanup programs. They expect to review a maximum of six installations a year.

**Navy Reviews.** The Naval Facilities Engineering Service Center established a peer review process (Cleanup Review Tiger Team) to improve program execution and accelerate cleanup efforts. From 1995 through 1996, the team visited high-cost sites with projected cleanup costs of more than \$1 million. Those sites represented 14 percent of the active Navy cleanup sites and 30 percent of the total estimated cost-to-complete amounts. They consulted with 150 cleanup site managers at approximately 460 sites. The focus was on high cost projects with potential for quality improvement using innovative technologies. The team validated the decisions at many sites, and also recommended changes at 56 sites with potential life-cycle cost avoidances of \$110 million. During 1997, technical reviews identified an additional \$8.2 million in cost avoidance.

**Air Force Reviews.** Air Force Instruction 32-7020, "The Environmental Restoration Program," May 19, 1994, requires that Air Force major commands ensure that all cleanup design, cleanup action, or interim cleanup action plans receive a peer review by an independent team of technical experts. Peer reviews were normally conducted at the end of the feasibility study phase to assess the cleanup alternatives being considered. A peer review was not

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required, however, when plans specified a natural attenuation remedy, a fuel tank removal, or a bioventing technology remedy. The Air Force Center for Environmental Excellence conducted peer reviews for Air Force BRAC installation sites.

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## Appendix D. Guidance for the Defense Environmental Restoration Program

The DUSD(ES) issued, "Management Guidance for the Defense Environmental Restoration Program," March 1998. The guidance outlines procedures and responsibilities for environmental restoration programs. This guidance is intended to supplement DoD Instruction 4715.7, "Environmental Restoration Program," April 22, 1996.

The information includes a requirement for a management action plan (MAP), or its equivalent, as a key document for managing an installation's environmental restoration program. The MAP should outline the total multiyear, integrated, coordinated approach to achieve an installation's environmental restoration goal. The MAP should identify and monitor requirements, schedules, and project funding requirements. It also provides the basis for input into program planning, budget development, and execution decisions.

**MAP Content.** A MAP should be prepared for each installation and formerly used defense sites with future environmental restoration requirements. The following requirements are needed at the individual sites:

- a list of all environmental restoration eligible requirements and an outline of the rationale for the technical approach and corresponding financial requirements,
- prior year funding and future cost estimates for each fiscal year through the entire cleanup process,
- the environmental restoration history at the installation,
- current site status,
- relative risk evaluation status,
- a list of contaminants of concern,
- response actions taken,
- past milestones,
- goals and schedules, and
- justification for funding sites categorized as other than "high" relative risk.

The MAP is intended to be a living document, and should be kept current by all installations and formerly used defense sites with future environmental

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restoration requirements. As a minimum, MAPs should be updated annually with stakeholders, such as the regulatory and local community of an installation.

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## Appendix E. Glossary

**Established Pump-and-Treat Systems** are systems that extract contaminated groundwater and treat it at the surface using established water treatments.

**Passive Treatment Walls** act like chemical treatment zones. Contaminated groundwater comes into contact with the wall, which is permeable, and a chemical reaction takes place. Limestone treatment zones increase the pH, which effectively immobilizes dissolved metals in the saturated zone.

**Phytoremediation** is the general use of plants for remediation of contaminated groundwater.

**Bioremediation (ex situ)** uses microorganisms to degrade organic contaminants in excavated soil, sludge, and solids. The microorganisms break down the contaminants by using them as a food source. The end products typically are CO<sub>2</sub> and H<sub>2</sub>O. Ex situ bioremediation includes a slurry phase in which the soils are mixed in water to form a slurry. Solid-phase bioremediation includes soils that are placed in a cell or building and tilled with added water and nutrients. Land farming and composting are types of solid phase bioremediation.

**Bioremediation (in situ)** uses an oxygen source and sometimes nutrients are pumped under pressure into the soil through wells, or they are spread on the surface for infiltration to the contaminated material. Bioventing is a common form of in situ bioremediation. Bioventing utilizes extraction wells to circulate air with or without pumping air into the ground.

**Natural Attenuation** is the reduction of contaminant concentrations in the environment through biological processes (aerobic and anaerobic biodegradation, plant and animal uptake), physical phenomena, and chemical reactions. These processes take place whether or not other active cleanup measures are in place.

**Records of Decision** are decision documents used to specify the way a site, or part of a site, will be remediated.

**Site Characterization and Analysis Penetrometer System (SCAPS)** technology consists of a 20-ton truck equipped with a cone penetrometer, an on-site data acquisition and analysis, and a suite of sensor and sampler probes. SCAPS has probes that characterize contamination for petroleum products, explosive compounds, heavy metal compounds, volatile organic compounds, and gamma emitting radionuclides. As a probe is pushed into the ground, it collects soil classification as well as contamination information. This technology allows development of an accurate, three-dimensional “map” of subsurface conditions. Real-time data collection allows decisionmakers access to all available data, thereby providing faster cleanup decisions.

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## **Appendix F. Report Distribution**

### **Office of the Secretary of Defense**

Under Secretary of Defense for Acquisition and Technology  
Deputy Under Secretary of Defense (Environmental Security)  
Director, Defense Research and Engineering  
Director, Defense Logistics Studies Information Exchange  
Under Secretary of Defense (Comptroller)  
Deputy Comptroller (Program/Budget)  
Deputy Chief Financial Officer

### **Department of the Army**

Assistant Secretary of the Army (Financial Management and Comptroller)  
Assistant Secretary of the Army (Installations, Logistics, and Environment)  
Auditor General, Department of the Army

### **Department of the Navy**

Assistant Secretary of the Navy (Financial Management and Comptroller)  
Assistant Secretary of the Navy (Installations and Environment)  
Auditor General, Department of the Navy

### **Department of the Air Force**

Assistant Secretary of the Air Force (Financial Management and Comptroller)  
Assistant Secretary of the Air Force (Manpower, Reserve Affairs, Installations and Environment)  
Auditor General, Department of the Air Force

### **Other Defense Organizations**

Director, Defense Contract Audit Agency  
Director, Defense Logistics Agency

### **Non-Defense Federal Organizations**

Office of Management and Budget  
General Accounting Office  
National Security and International Affairs Division  
Technical Information Center

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## **Congressional Committees and Subcommittees, Chairman and Ranking Minority Member**

Senate Committee on Appropriations  
Senate Subcommittee on Defense, Committee on Appropriations  
Senate Committee on Armed Services  
Senate Committee on Governmental Affairs  
House Committee on Appropriations  
House Subcommittee on Defense, Committee on Appropriations  
House Committee on Armed Services  
House Committee on Government Reform  
House Subcommittee on Government Management, Information, and Technology,  
Committee on Government Reform  
House Subcommittee on National Security, Veterans Affairs, and International  
Relations, Committee on Government Reform

# Deputy Under Secretary of Defense (Environmental Security) Comments



OFFICE OF THE UNDER SECRETARY OF DEFENSE

3000 DEFENSE PENTAGON  
WASHINGTON DC 20301-3000

August 5, 1999

MEMORANDUM FOR INSPECTOR GENERAL, DEPARTMENT OF DEFENSE

THROUGH: DEPUTY DIRECTOR, CONGRESSIONAL ACTIONS & INTERNAL REPORTS,  
OUSD(A&T)

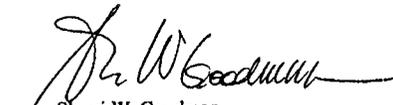
SUBJECT: Comments on Draft Proposed Evaluation Report: "Implementation of Innovative  
Technology for DoD Cleanup Projects" (Project No 8CB-0044)

Thank you for the opportunity to review your draft evaluation report, entitled "Implementation of Innovative Technology for DoD Cleanup Projects." We thoroughly discussed the report during two meetings of the Environment, Safety & Occupational Health Policy Board (ESOHPB). We generally agree with the report's findings and recommendations, and further agree that we can make improvements in technology transfer.

To ensure implementation of the report's recommendations in a timely fashion, I have formed an Environmental Security Technology Implementation Committee (ESTIC) under the ESOHPB, and plan the first meeting in September 1999. The officials who will serve on the ESTIC include the:

- Principal Assistant Deputy Under Secretary of Defense (Environmental Security) (Chair)
- Deputy Assistant Secretary of the Army (Environment, Safety & Occupational Health)
- Deputy Assistant Secretary of the Navy (Environment & Safety)
- Deputy Assistant Secretary of the Air Force (Environment, Safety & Occupational Health)

To advise the ESTIC in its efforts to implement the report's recommendations, I request the services of Mr. William C. Gallagher, Head Environmental Evaluation Division of the Contract Management Directorate, Office of the Inspector General, DoD. My staff point of contact for this matter is Mr. Ed Dyckman, at [edyckman@acq.osd.mil](mailto:edyckman@acq.osd.mil) and 703-614-3089, who will serve as the Executive Secretary to the ESTIC.



Sherri W. Goodman  
Deputy Under Secretary of Defense  
(Environmental Security)

*Environmental Security*



*Defending Our Future*

# **Evaluation Team Members**

The Contract Management Directorate, Office of the Assistant Inspector General for Auditing, DoD, prepared this report.

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