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Strategic Environmental Research
and Development Program

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EXECUTIVE SUMMARY

The Strategic Environmental Research and Development Program (SERDP) is the Department of Defense's environmental science and technology program. To fulfill its mission to address environmental requirements through innovative research and share that information across federal and private organizations, SERDP executes the program in partnership with the Department of Energy and the Environmental Protection Agency. SERDP fully leverages complementary programs within the Department of Defense and solicits participation from other public and private research organizations. This report provides a summary of SERDP's activities and its most significant accomplishments for FY 2009, SERDP's plans for FY 2010, and new research activities to be addressed in FY 2011. The report responds directly to the requirements as stated in Title 10, U.S.C. section 2902, as modified.

The organization and management of SERDP is described in Section I–SERDP Structure. As directed by the SERDP Council, the Executive Director and Program Office Staff implement the Program with the recommendations from the SERDP Scientific Advisory Board (SAB) and the support of SERDP technical committees (STCs) to meet high-priority, DoD mission-related environmental needs. SERDP conducts and manages basic research through advanced technology development in four technology Focus Areas: Environmental Restoration, Munitions Management, Sustainable Infrastructure, and Weapons Systems and Platforms. SERDP establishes clear technical goals and employs key metrics to assess and ensure the quality and success of the Program.

Section II–Investment Strategy and Performance describes Program accomplishments during FY 2009 within the two broad investment strategy areas: Sustainable Training and Testing Ranges and Reducing Current and Future Liabilities. Lists of specific projects funded in FY 2009 in these areas and those projects planned for funding in FY 2010 are also provided in Section II. Significant accomplishments for SERDP in FY 2009 are represented by five projects that received the annual SERDP Project of the Year awards. The awards are presented at the annual Partners in Environmental Technology Technical Symposium & Workshop and were awarded for the following projects in each of the four Focus Areas: Environmental Restoration - Phytoremediation for the Containment and Treatment of Energetic and Propellant Material Releases on Testing and Training Ranges, and a second project, Sustainable Range Management of RDX and TNT by Phytoremediation with Engineered Plants; Munitions Management – Wide Area Detection and Identification of Underwater UXO Using Structural Acoustic Sensors; Sustainable Infrastructure - Application of Landscape Mosaic Technology to Compliment Coral Reef Resource Mapping and Monitoring; and Weapons Systems and Platforms - Alternative for Perchlorates in Incendiary Mix and Pyrotechnic Formulations for Projectiles. SERDP sponsored two technical workshops in FY 2009 that have proven to be invaluable forums for identifying high-priority environmental needs. These workshops led to the identification of research topic areas for which proposals will be requested for projects to be funded in FY 2011.

In each fiscal year cycle, SERDP must manage ongoing research, solicit and select new research projects, and plan future research initiatives and funding distribution for each Focus Area. Section III–Management Actions provides an overview of SERDP Program management actions in FY 2009, including activities, achievements, and recommendations of the SERDP Council, Executive Director, and SAB, as well as the planned research initiatives for the Program in FY 2010. In FY 2009, SERDP was appropriated $63.038M for the funding and management of 184 research projects. The FY 2010 appropriation of $69.128M will be used for approximately 166 projects, including both continuing and new start projects.

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Acronyms and Abbreviations

4ADNT	4-amino dinitrotoluene
AFFF	aqueous film forming foam
As	arsenic
ASETSDefense	Advanced Surface Engineering Technologies for a Sustainable Defense
BAA	Broad Agency Announcement
BRAC	base realignment and closure
CAAA	Clean Air Act Amendments
ClO_4^-	perchlorate
CO	carbon monoxide
Cr^{6+}	hexavalent chromium
DCE	dichloroethene
DCERP	Defense Coastal/Estuarine Research Program
DMM	discarded military munitions
DNAPL	dense, non-aqueous phase liquid
DoD	Department of Defense
DOE	Department of Energy
DTIC	Defense Technical Information Center
DUSD(I&E)	Deputy Under Secretary of Defense (Installations and Environment)
DUSD/S&T	Deputy Under Secretary of Defense for Science and Technology
EMI	electromagnetic induction
EPA	Environmental Protection Agency
ESA	Endangered Species Act
ESOH	Environmental, Safety, and Occupational Health
ESTCP	Environmental Security Technology Certification Program
EWG	Executive Working Group
FUDS	formerly used defense site
FY	fiscal year
HAP	hazardous air pollutants
HC	hexachloroethane
HMX	octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine
HSR-MS	High Shear Rotary Membrane System
IM	insensitive munition
IPR	in-progress review
ISCO	In Situ Chemical Oxidation
JSF	Joint Strike Fighter
LO	low-observable
MC	Munitions Constituents
MIMS	Micro Ion Mobility Sensor
MM	Munitions Management
MMPA	Marine Mammal Protection Act
MR	munitions response

Acronyms and Abbreviations (continued)

MRP	Munitions Response Program
NDMA	N-nitrosodimethylamine
NEPA	National Environmental Policy Act
NESHAP	National Emission Standards for Hazardous Air Pollutants
NOx	nitrogen oxide
ODS	ozone depleting substances
ODUSD(I&E)	Office of the Deputy Under Secretary of Defense (Installations and Environment)
OEM	original equipment manufacturer
ORAP	Operational Range Assessment Program
OSHA	Occupational Safety and Health Administration
PAH	polycyclic aromatic hydrocarbon
Pb	lead
PCB	polychlorinated biphenyl
PFOA	perfluorooctanoic acid
PFOS	perfluorooctane sulfonic acid
PI	principal investigator
PM	particulate matter
R&D	research and development
RAM	radar absorbing materials
RCRA	Resource Conservation and Recovery Act
RDT&E	research, development, test, and evaluation
RDX	hexahydro-1,3,5-trinitro-1,3,5-triazine
S&T	Science and Technology
SAB	Scientific Advisory Board
SEAP	Sediment Ecosystem Assessment Protocol
SEED	SERDP Exploratory Development
SERDP	Strategic Environmental Research and Development Program
SI	Sustainable Infrastructure
SON	Statement of Need
SROC	Senior Readiness Oversight Council
STC	SERDP Technical Committee
TCP	1,2,3-trichloropropane
TER-S	threatened, endangered, and at risk species
TES	Threatened and Endangered Species
TNT	2,4,6-trinitrotoluene
UHC	unburned hydrocarbon
UXO	unexploded ordnance
VC	vinyl chloride
VOC	volatile organic compounds
WP	Weapons Systems and Platforms

I. SERDP STRUCTURE

A. Background

Established in 1991, the Strategic Environmental Research and Development Program (SERDP) is the Department of Defense's (DoD) environmental Science and Technology (S&T) program. This report provides a summary of SERDP's activities and significant accomplishments during fiscal year (FY) 2009, its plans for FY 2010, and new research initiatives to be addressed in FY 2011. The report responds directly to the reporting requirements as stated in Title 10, U.S.C. §2902. The report also contains a summary of the actions and recommendations of the SERDP Scientific Advisory Board (SAB) during FY 2009.

i. Authorizing Legislation

In 1990, Public Law 101 510 (Title 10, U.S.C., §§2901-2904) established SERDP to be funded by the DoD and planned and executed in partnership with the Department of Energy (DOE) and the Environmental Protection Agency (EPA). SERDP fully leverages complementary research programs within the Army, Navy, and Air Force, and those of the DOE and the EPA. SERDP has taken full advantage of the intrinsic capabilities of the participating organizations. This feature makes SERDP unique, as it can tap the vast technical resources of the Federal research infrastructure to address the needs of the Departments' most pressing environmental matters. In addition, SERDP also has successfully engaged in directly funding the private sector and academia, further widening the spectrum of technological capability and innovation.

ii. Mission

SERDP's mission can be found in the statute and is paraphrased below. Specifically, the four purposes of SERDP are to:

SERDP addresses DoD and congruent DOE environmental matters of concern through cooperative research.

- Address environmental matters of concern to the DoD and the DOE by supporting basic and applied research and development of technologies that can enhance the capabilities of the Departments to meet their environmental obligations.
- Identify research, technologies, and other information developed by the DoD and the DOE for national defense purposes that would be useful to governmental and private organizations involved in the development of energy technologies and of technologies to address environmental restoration, waste minimization, hazardous waste substitution, and other environmental concerns and to share such research, technologies, and other information with such governmental and private organizations.
- Furnish other governmental organizations and private organizations with data, enhanced data collection capabilities, and enhanced analytical capabilities for use in the conduct of environmental research.
- Identify technologies developed by the private sector that are useful for DoD and DOE defense activities concerning environmental restoration, hazardous and solid waste minimization and prevention, and hazardous material substitution and provide for the use of such technologies in the conduct of such activities.

This mission, crafted more than 18 years ago, remains highly relevant, and while significant successes have been achieved, a number of difficult technical challenges remain and additional challenges are emerging.

iii. Requirements

SERDP is a "requirements driven" program that responds directly to defense requirements generated by the Services and sanctioned by the Deputy Under Secretary of Defense (Installations and Environment) [DUSD(I&E)]. It is critical that the limited funds available for environmental technology research and development (R&D) be focused on the highest priority requirements of the Services.

The DoD's environmental issues fall into two major categories. The first is the sustainability of the Department's Training and Testing Ranges. Many of these ranges are under restrictions due to environmental issues and, in a few extreme cases, ranges have had to curtail activities. Access to adequate training ranges in perpetuity is essential to maintain military readiness. To assure this access, environmental issues associated with the ranges must be addressed. The second category is the reduction of current and future liabilities. Current liabilities are associated with the remediation of contamination from past practices. These liabilities are relatively well known and have been estimated to total nearly $14 billion. However, that estimate does not include the liability from emerging contaminants such as perchlorate (ClO_4^-). In addition, the estimated known current liability for unexploded ordnance (UXO) in the Munitions Response Program (MRP) exceeds $18 billion. Future liabilities may result from the toxic and hazardous materials used in and emissions from today's weapons and platforms. Through the aggressive development of new, benign materials and industrial processes as well as control technologies, the use and release of these materials to the environment can be reduced or eliminated while actually improving the performance of weapons systems and system components. Technology has proven to be capable of significantly reducing the cost of addressing all of these liabilities.

These two major categories of environmental issues have a direct impact on DoD's ability to perform its primary mission of maintaining military readiness for national defense. For the ease of managing the program, SERDP places all research efforts to address these issues into one of four focus areas: Environmental Restoration, Munitions Management, Sustainable Infrastructure, and Weapons Systems and Platforms. In the course of addressing DoD's highest priority environmental needs, SERDP also has helped solve other significant national and international environmental problems by applying DoD's technical capabilities, analytical systems, and information.

B. SERDP Management Structure

SERDP is a multiagency program funded by the DoD. Pursuant to Title 10, U.S.C. §§2901-2904, SERDP receives general oversight and policy guidance from the SERDP Council, which is composed of members from the DoD, DOE, and EPA. Also included in this authorizing language is a requirement for an Executive Director to lead the day-to-day Program activities, as well as a Scientific Advisory Board (SAB) that is charged with providing advice and recommendations to the SERDP Council on projects/proposals reviewed. The SAB also may advise the Council regarding other programmatic, funding, or technically related issues with respect to the Program. The organizational structure shown in Figure I-1 was established by the SERDP Council and Executive Director to support Program needs.

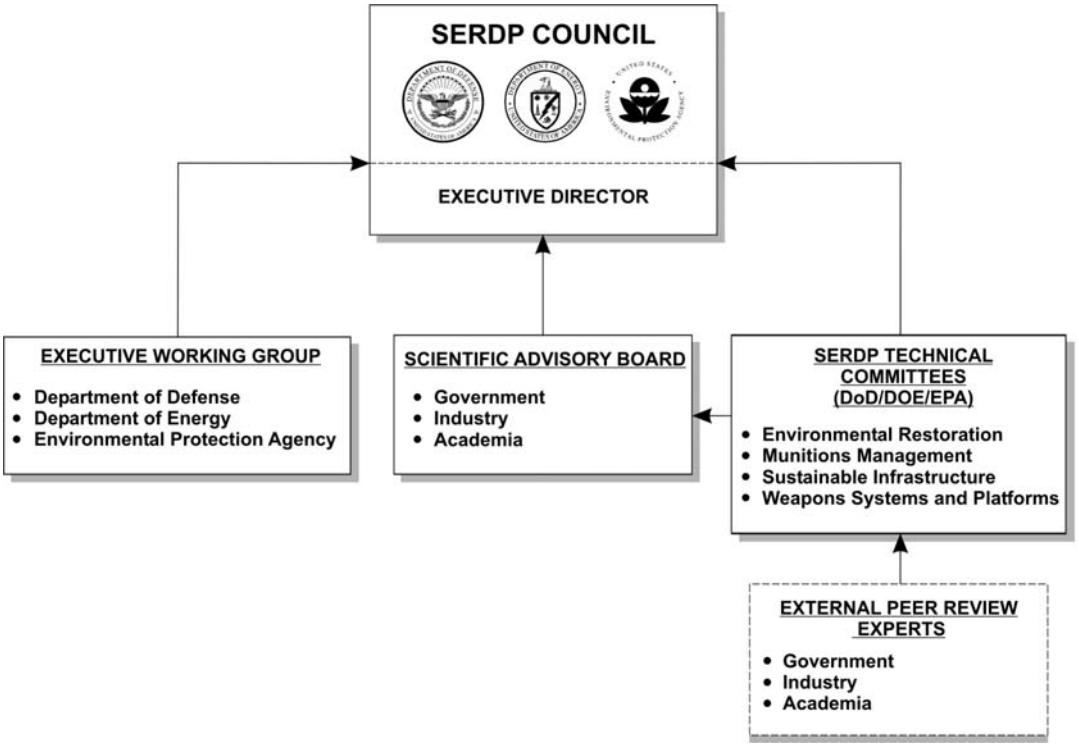


Figure I-1. SERDP Organization.

i. SERDP Council

Established by law, SERDP's multi-agency Council ensures integrated, nonduplicative research.

Title 10, U.S.C. §2902 established the SERDP Council to oversee the management of SERDP. Specifically, this Council prescribes policies and procedures to implement the Program and, uniquely, is the sole funding approval authority. As such, the Council may enter into contracts, grants, and other agreements in accordance with other applicable law to carry out the mission of SERDP. Congress intended the Council to be a multiagency membership body to promote maximum exchange of information and to minimize duplication of environmentally related research, development, and demonstration activities through close coordination with the military departments and Defense agencies; the DOE; the EPA, other departments and agencies of the federal, state, and local governments; and other organizations engaged in environmentally related research.

DoD and DOE Council representatives alternate as Chair.

Consistent with the SERDP statute and with facilitating multiagency cooperation, the Secretary of Defense has designated the Deputy Under Secretary of Defense for Science and Technology (DUSD/S&T) as chairperson for each odd-numbered fiscal year, and the Secretary of Energy has designated the Director of the Office of Science to serve as chair for each even-numbered year. Other members are assigned per guidance provided in the SERDP statute. The following are the Council members who served during FY 2009.

SERDP Council Members - FY 2009

Mr. Alex Beehler
Assistant Deputy Under Secretary of Defense
Environment, Safety, and Occupational Health
U.S. Department of Defense
and
Mr. Curtis Bowling
Assistant Deputy Under Secretary of Defense
(Acting)
Environment, Safety, and Occupational Health
U.S. Department of Defense
and
Dr. Dorothy Robyn
Deputy Under Secretary of Defense
Installations & Environment
U.S. Department of Defense

General James Cartwright
Vice Chairman
Joint Chiefs of Staff
U.S. Department of Defense

Brig. General Jonathan George
Principal Assistant Deputy Administrator
Defense Programs
National Nuclear Security Administration
U.S. Department of Energy
and
Brig. Gen. Garrett Harencak
Principal Assistant Deputy Administrator
National Nuclear Security Administration
U.S. Department of Energy

Dr. Mark Gilbertson
Deputy Assistant Secretary for Engineering and
Technology
Office of Environmental Management
U.S. Department of Energy

Dr. George Gray
Assistant Administrator
Office of Research and Development
U.S. Environmental Protection Agency
and
Mr. Lek Kadeli
Assistant Administrator (Acting)
Office of Research and Development
U.S. Environmental Protection Agency

Mr. Mike Hanson
Engineering and Industrial Support
U.S. Coast Guard

Dr. Walter Jones
Executive Director
Office of Naval Research
U.S. Navy

Mr. Michael McGhee
Deputy Assistant Secretary of the Air Force
Installations, Environment, and Logistics
U.S. Air Force

Dr. Ray Orbach
Under Secretary for Science
Office of Science
U.S. Department of Energy
and
Dr. Patricia Dehmer
Deputy Director for Science Programs
Office of Science
U.S. Department of Energy
and
Dr. William Brinkman
Director, Office of Science
U.S. Department of Energy

Dr. John Parmentola
Office of the Assistant Secretary of the Army
Acquisitions, Logistics, and Technology
U.S. Army
and
Dr. Cary Chabalowski
Acting Director, Research & Laboratory Management
Office of the Assistant Secretary of the Army
Acquisitions, Logistics, and Technology
U.S. Army

Dr. Andre van Tilborg
Deputy Under Secretary of Defense
Science & Technology
U.S. Department of Defense
and
Dr. David Honey
Director, Research
AT&L Research Directorate
U.S. Department of Defense

Dr. Jeffrey Marqusee (Ex Officio Member)
Executive Director
Strategic Environmental Research and
Development Program
U.S. Department of Defense

ii. Executive Working Group

The Executive Working Group (EWG) is an extension of the Council and serves as a working-level representation of the Council. This body, while not established by law, facilitates SERDP policy preparation, investment strategy considerations, and annual program plan development.

iii. SERDP Scientific Advisory Board

SAB members focus on technical quality.

Established in accordance with the SERDP statute, the SERDP SAB assures that the Program maintains clear focus on technical quality. The SAB has the authority to make recommendations to the Council regarding technologies, research, projects, programs, activities, and, if appropriate, funding within the scope of SERDP. The SAB is composed of no more than 14 and no less than 6 members who are jointly appointed by the Secretary of Defense and the Secretary of Energy in consultation with the Administrator of the EPA.

To ensure that SERDP objectives are congruent with the Administration's goals, two members of the SAB are mandated in the statute—the Science Advisor to the President, or his/her designee, and the Administrator of the National Oceanic and Atmospheric Administration, or his/her designee. Similarly, to ensure that regional and global environmental issues are appropriately addressed in SERDP, at least one member should represent the interests of State governments and one member should represent environmental public interest groups. The list below reflects SAB membership in FY 2009.

Scientific Advisory Board Members - FY 2009

Dr. Sandy Andelman
Conservation International

Dr. Jeffrey Daniels
The Ohio Sate University

Mr. Joseph Francis
Nebraska Department of Environmental Quality

Dr. Kevin Geiss
White House Office of Science and Technology Policy
and
Dr. Jon Kolak
White House Office of Science and Technology Policy

Dr. Perry McCarty
Stanford University

Dr. James Mercer
GeoTrans, Incorporated

Dr. Ellen Mihaich, Chair
Environmental and Regulatory Resources, LLC

Dr. William Neff
National Oceanic and Atmospheric Administration

Dr. Michael Rosenzweig
University of Arizona

Dr. Jeffrey Siirola
Eastman Chemical Company

Dr. Joseph Suflita
University of Oklahoma

Dr. John Warner
Warner Babcock Institute for Green Chemistry

The statute directs the SAB to review all projects with a value in excess of $1,000,000. Many years ago, the SERDP Council modified this direction by requesting that each new start project and every continuing project exceeding $900,000 per year be reviewed by the SAB.

iv. Executive Director and Program Office Staff

Title 10, Title 10, U.S.C. authorizes an Executive Director to direct and focus the day-to-day efforts of SERDP. Dr. Jeffrey Marqusee is the SERDP Executive Director, and continues as the Director of the Environmental Security Technology Certification Program (ESTCP). The Executive Director is a non-voting member of the SERDP Council and a voting member of the EWG. Co-location of the SERDP and ESTCP offices has served to facilitate transition of SERDP technologies to demonstration and validation. The balance of the SERDP federal staff consisted of the Deputy Director, four technical Program Managers, and one Financial Officer who has been detailed from the military Services' R&D infrastructure. These individuals include:

- Dr. Anne Andrews – Deputy Director of SERDP and ESTCP
- Dr. Andrea Leeson – Program Manager for Environmental Restoration
- Dr. Herb Nelson – Program Manager for Munitions Management
- Mr. Bruce Sartwell – Program Manager for Weapons Systems and Platforms
- Dr. John Hall – Program Manager for Sustainable Infrastructure
- Ms. Jina Banks – Financial Officer.

v. SERDP Technical Committees

The breadth of technical knowledge demanded by SERDP exceeds that of the limited number of staff in the SERDP Office. Consequently, SERDP must rely on the technical skills offered by the participating Services and Agencies to assist in the technical aspects of program development, program monitoring, and technology transfer. For each of the technology focus areas, a SERDP Technical Committee (STC) was established to help solicit and review technical proposals, formulate and recommend the annual program plan, conduct technical reviews of the ongoing projects, and facilitate technology transfer according to the needs of their users in the field. STCs offer several advantages over conventional R&D management schemes. First, their members are selected by the Services and Agencies as represented on the Council. Second, they bring not only a wealth of understanding of the needs of their organization, but also knowledge of related completed or ongoing research efforts. This knowledge helps SERDP to avoid duplication of effort and promote joint and cooperative funding of projects.

vi. Peer Reviewers

SERDP supports a peer review process to foster technical excellence.

Assisting the STCs and the Program Office in their quest to select quality research proposals are independent Peer Reviewers. Following the model established by the National Science Foundation, SERDP proposals undergo an independent Peer Review. The results, scores, and evaluation comments from this review are provided directly to the STCs who use this information to develop their recommended list of new projects each fiscal year. These same peer review results are provided to the SAB for consideration during their proposal review and deliberations.

C. SERDP Management

The SERDP Council ensures that the Program focuses on the mission needs of the DoD and empowers the EWG with developing goals and an investment strategy that will help SERDP satisfy these mission needs successfully. The SERDP management goals and investment strategy then are shared with the STCs and SAB. By leveraging complementary research programs, SERDP is able to avoid duplication of effort and to facilitate the transfer and implementation of innovative research and technology – maximizing advancements in the state of the science and engineering for DoD. SERDP establishes clear

technical goals and employs four key metrics to assess the quality and success of the Program, as described here.

i. Technical Goals

In 1993, the EWG assembled to develop the broad framework within which to develop the annual SERDP program plan. Included in this document are the SERDP goals, which are to:

- Resolve environmental concerns in ways that enhance military operations, improve military systems' effectiveness, and help ensure the safety of personnel.
- Support technology and process developments that reduce operational and life-cycle costs, including those associated with environmental cleanup and costs of full compliance with environmental laws and regulations.

SERDP achieves its goals by promoting cooperative environmental technology development and by maintaining a strong effort in information dissemination. Specifically, SERDP succeeds by:

SERDP promotes cooperative environmental technology development and information transfer.

- Promoting the effective exchange of information regarding environmentally related research and development activities.
- Ensuring that SERDP R&D activities complement, but do not duplicate, Tri-Service R&D programs and other ongoing activities.
- Providing appropriate access to data that are relevant to environmental matters of concern to the DoD and DOE.
- Facilitating the transfer of DoD and DOE environmental information and technology to other sectors of society that may be able to use them to advance national environmental objectives.
- Emphasizing multiservice, interdepartmental research and development projects and using the unique capabilities of the partnering federal agencies, private industry, and academia to solve the Departments' environmental problems.

ii. Key Objectives

SERDP pursues four key objectives to maintain the quality and enhance the success of the Program.

1. Address the highest priority defense, mission-relevant environmental requirements, with emphasis on multiservice issues.

The Executive Director and his staff work hand in hand with Office of the Deputy Under Secretary of Defense (Installations and Environment) [ODUSD(I&E)] to address the Department's highest priority environmental requirements. Through focused Statements of Need (SONs), the Executive Director seeks cooperatively funded and executed projects to address high-priority multiservice needs.

In addition to receiving research requirements directly from the Services via the Technical Committees, SERDP often holds workshops to explore the state-of-science, technology gaps, and opportunities for research in areas where it may be difficult to identify specific or emerging needs. In FY 2009, SERDP sponsored three workshops: Coral Reef Monitoring and Assessment; ASETSDefense: Sustainable Surface Engineering for Aerospace and Defense; and Environmentally Sustainable Energetics.

2. Achieve universal, world-class technical excellence.

World class research is the cornerstone of SERDP projects. Continuing the successful solicitations of past years, SERDP solicited proposals from the Federal, academic and private sectors. SERDP continued to use external Peer Reviewers in addition to the multi-service multi-agency review committees to ensure that technically sound proposals performed by world class researcher's are selected for funding.

3. Emphasize and promote technology transfer.

Transfer of technology from research to the DoD user community is one of the key objectives of SERDP. This objective is achieved by supporting applied research and technology demonstrations that respond directly to high-priority, DoD mission-related environmental needs. The colocation of ESTCP with SERDP has helped to facilitate technology transitions between Programs, into other Agencies' certification programs, and to the DoD user community.

4. Ensure sound fiscal and technical management.

Timely and accurate financial and technical reporting are key to SERDP's success. The SERDP Executive Director and Program Managers ensure that the Program complies with the DoD fiscal guidance. Effective controls include periodic fiscal and technical review of projects and implementing corrective actions to promote effective use of limited R&D resources. Online management information systems ensure timely reporting of financial and technical progress against proposed project milestones and facilities analysis by Project Managers.

iii. Proposal Solicitations

SERDP takes pride in the fact that funds for new projects are available to industry, academic, and federal researchers alike, and the SERDP Council continues to be pleased with SERDP's ability to reach out to this broad pool of researchers through a Broad Agency Announcement (BAA) and a Federal Call for Proposals. SERDP annually issues two solicitations for proposals—a "Core" solicitation that has traditionally been used to fund multi-year projects and a SEED solicitation. The SEED Program is designed to provide initial funding for high-risk, high-payoff proof of concept projects. SEED projects are funded at a level not to exceed $150,000 in total cost and approximately one year in duration. Successful SEED efforts may compete for additional funds in the following years.

II. INVESTMENT STRATEGY AND PERFORMANCE

A. Approach

As a leader in the field of environmental science and technology R&D, SERDP provides solutions to priority environmental matters of concern to the DoD and the DOE. Since its inception in 1991, SERDP has conducted detailed science and technology gap analyses to identify high-priority and emerging environmental science and technology requirements and has developed a comprehensive outreach program. Through these efforts, the Program has supported hundreds of science and technology projects yielding innovative and cost-saving methods and tools that DoD installations have utilized to meet their environmental responsibilities.

SERDP's investment strategy aims to provide DoD with the best available solutions to its toughest environmental challenges, including (1) sustainable training and testing ranges and (2) reduction of current and future liabilities. This section describes the scope of each investment area and includes a listing of all SERDP projects funded in FY 2009, new projects selected for FY 2010, SERDP-sponsored technical workshops conducted in FY 2009 and planned for FY 2010, and initiatives planned for FY 2011. This section also highlights the SERDP FY 2009 Projects of the Year, which represent the most significant advancements in science and technology resulting from SERDP projects and that highlight the potential cost savings and improved performance resulting from the implementation of these technologies.

B. Sustainable Training and Testing Areas

The impacts of environmental regulation on military training and testing operations have slowly grown over time and the Department now faces serious limitations in its ability to provide realistic training. The DoD's Senior Readiness Oversight Council (SROC) recognizes six key environmental areas impacting the training and testing ranges: (1) UXO and Munitions Constituents (MC), (2) Threatened and Endangered Species (TES), (3) Maritime Sustainability, (4) Air Quality, (5) Noise, and (6) Urban Encroachment. As the number of available operational ranges decreases, existing ranges are being used more extensively. To ensure that the remaining ranges continue to provide realistic settings for training, installations need to be managed to support training without causing irreversible damage and to reduce restoration costs. Management tools and innovative technologies are needed to enable maximum use of ranges, preserving mission capabilities into the future, while sustainably managing the land to meet obligations under a variety if environmental laws. SERDP is investing in science and technology R&D efforts to address these critical range issues, as well as those associated with military installations as a whole and their adjacent lands.

i. Munitions Constituents

Scope of Problem

The use of munitions is an integral part of the military's testing and training. Energetic materials, including propellants, explosives, and pyrotechnics, are widely used by DoD, and an estimated 500 million pounds of energetic materials are produced each year, generating significant amounts of hazardous waste. The MC that are of primary environmental concern include 2,4,6-trinitrotoluene (TNT), hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX), octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX),

and perchlorate, which have been identified in soil and groundwater at former and current ammunition manufacturing sites as well as on military testing and training ranges. There is also a growing concern that the accumulation of unexploded or unconsumed MC residues on military testing and training ranges represents a threat to human health and the environment. These residues, which can take the form of discrete "chunks" or very fine particles, may dissolve and leach into groundwater or be transported off-site in runoff (Figure II-1). The DoD requires range management practices that effectively reduce quantities of MC residuals and that minimize disruptions in testing and training activities. DoD also requires the Operational Range Assessment Program (ORAP) to identify MC migration and anticipate future releases. Other challenges include developing appropriate remedial actions to address site contamination and treating contaminated soil and groundwater to ensure regulatory compliance.

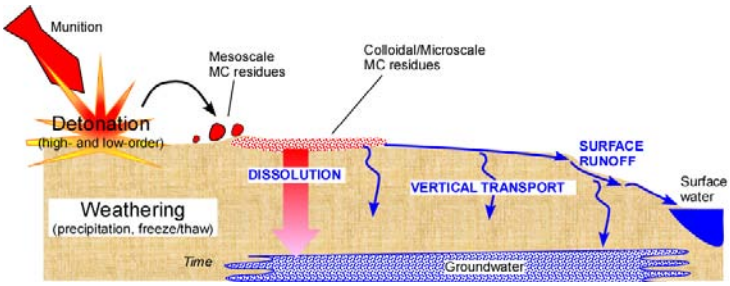


Figure II-1: The formation and fate of MC at operational ranges.

Overview of Investment

SERDP seeks to provide range managers with techniques to assess potential soil or groundwater contamination, to remediate such contamination, and to reduce or eliminate future contamination. To achieve these goals, it is necessary to determine how these compounds are released into the environment. Data on the physical, chemical, and biological properties of MC are essential to understand the fate and transport of MC released in the environment. With an understanding of how these materials move and are transformed in the environment, reliable and scientifically defensible risk assessments can be developed, along with protocols to mitigate the impacts. This knowledge supports the development, design, and management of sustainable training and testing ranges.

The distribution of MC contamination in soil and groundwater is highly heterogeneous, requiring unique sampling protocols and technologies to accurately characterize and monitor them. SERDP research has led to the development of the most appropriate sampling protocols. Further, when MCs are released into the environment, treatment or containment technologies for soil and groundwater are required. Range managers require techniques that are applicable to small and large areas, as well as technologies that prevent MCs from migrating off ranges. Finally, although technology developments have improved munitions manufacturing, there remains a small percentage of rounds that malfunction, resulting in low-order (incomplete) detonations or duds, which represent a continuing source of MC contamination on ranges. Elimination of toxic or hazardous materials from munitions will significantly reduce the cost of sustaining training and testing ranges for the military. The following initiatives have been funded by SERDP to accomplish the Program's objectives for MC:

FY 2009 Projects

- Evaluation of Alternative Causes of Wide-Spread, Low Concentration Perchlorate Impacts to Groundwater (ER-1429), Geosyntec Consultants (Completed)
- Novel Electrochemical Process for Treatment of Perchlorate in Waste Water (ER-1433), Pacific Northwest National Laboratory
- Identification and Characterization of Natural Sources of Perchlorate (ER-1435), U.S. Air Force, Aeronautical Systems Center
- Defining Munitions Constituent (MC) Source Terms in Aquatic Environments on DoD Ranges (ER-1453), U.S. Navy, Space and Naval Warfare Systems Center (Completed)

- A Portable Fiberoptic Surface Enhanced Raman Sensor for Real-Time Detection and Monitoring of Perchlorate and Energetics (ER-1602), Oak Ridge National Laboratory
- The Molecular Microbiology of Nitroamine Degradation in Soils (ER-1608), University of Washington
- Improving Understanding of the Fate and Transport of Munitions Constituents to Enhance Sustainability of Operational Ranges (ER-1688), University of Delaware
- Mobility of Particulate and Dissolved Munitions Constituents in the Vadose Zone at Operational Ranges (ER-1690), Oak Ridge National Laboratory
- Dissolution Rate of Propellant Energetics from Nitrocellulose Matrices (ER-1691), U.S. Army Corps of Engineers, Cold Regions Research and Engineering Laboratory
- An Assessment of Aquifer/Well Flow Dynamics: Identification of Parameters Key to Passive Sampling and Application of Downhole Sensor Technologies (ER-1704), ProHydro, Inc.
- Lab-on-a-Chip Sensor for Monitoring Perchlorate in Ground and Surface Water (ER-1706), U.S. Army Corps of Engineers, Engineer Research and Development Center, Construction Engineering Research Laboratory (Completed)

FY 2010 New Start Projects

- Developing Quantum Chemical and Polyparameter Models for Predicting Environmentally Significant Parameters for New Munition Compounds (ER-1734), University of Delaware
- Fully In Silico Calibration of Empirical Predictive Models for Environmental Fate Properties of Novel Munitions Compounds (ER-1735), Oregon Health and Science University
- Development of an Environmental Fate Simulator for New and Proposed Military-Unique Munition Compounds (ER-1736), Ecosystems Research Division, Environmental Protection Agency

FY 2011 Initiatives

In the FY 2011 solicitation, SERDP released one SON concerning **Munitions Constituents**.

Improved Assessment of Munitions Constituent Source Terms on Operational Ranges - The objective of this Statement of Need (SON) is to develop cost effective methods for assessment of the munitions constituent source term on large, operational ranges. In particular, methods must be developed to provide improved estimates of surface and near surface soil contaminant loading as well as estimates of contaminant groundwater flux from impacted areas. Proposals should focus on one or more of the following objectives: (1) Develop methods or tools for utilizing the multi-increment sampling methodology (U.S. EPA 8330B) on large, operational ranges in a cost effective manner to estimate the source term and soil contaminant loading. Improved statistical sampling techniques that provide estimates and uncertainties for the magnitude of munitions constituents in surface and near surface soils are needed; (2) Develop improved methods for placing wells and techniques for sampling/monitoring groundwater effectively to assess or bound the contaminant flux from large, operational ranges; and/or (3) Improve predictive techniques for determining the potential for off-site migration of munitions constituents based on soil loading and/or contaminant flux into groundwater.

ii. Threatened, Endangered and At-Risk Species

Scope of Problem

Fig II-2: The Federally Endangered Shortnose Sturgeon is an aquatic species of management concern to DoD.

The DoD serves as steward for more than 29 million acres of land across the United States as well as for huge offshore operating areas and surrounding airspace over land and sea. Protection of threatened, endangered, and at-risk species (TER-S) inhabiting those areas also falls under DoD responsibility and, as a result, the agency is responsible for more TER-S per acre than any other federal land manager. DoD's TER-S responsibilities present daunting challenges for the military mission. Training activities, for example, have been curtailed because of inadequate information about the impact of military operations on TER-S or their habitats (Figure II-2). In these situations, the U.S. Fish and Wildlife Service is forced to act conservatively on the side of species protection, halting all military activities until it can determine an appropriate response. Consequently, DoD requires a holistic and efficient approach that integrates land management, military training demands, and sound ecosystem responses on its installations to ensure that mission training activities and schedules are not unnecessarily impaired.

Overview of Investment

SERDP's goal is to provide DoD managers with the tools they need to fulfill their TER-S responsibilities while supporting the military mission on their installations. New tools and methods are required to more rapidly and cost-effectively identify and monitor plant and animal TER-S, particularly in inaccessible areas (e.g., impact zones). Inventories and impact studies are needed especially for species that either are the source of restrictions or have the potential to cause restrictions. In addition, methodologies are needed to manage ranges as entire ecosystems that provide habitat for TER-S and other species. Finally, these management tools need to account for land outside the installation that contributes to and impacts the ecosystem on the base. The following initiatives have been funded by SERDP to accomplish the Program's goal.

FY 2009 Projects

- Advanced Monitoring of Migratory Birds on Military Lands (SI-1438), University of Wisconsin (Completed)
- Habitat Connectivity for Multiple Rare, Threatened and Endangered Species on and around Military Installations (SI-1471), University of North Carolina at Chapel Hill
- Examination of Habitat Fragmentation and Effects on Species Persistence in the Vicinity of Naval Base Point Loma and Marine Corps Air Station Miramar, San Diego, California (SI-1473), U.S. Navy, Naval Facilities Engineering Command, Southwest Division (Completed)
- Managing Declining Pine Stands for the Restoration of Red-Cockaded Woodpecker Habitat (SI-1474), U.S. Forest Service
- An Ecoinformatic Approach to Developing Recovery Goals and Objectives (SI-1475), University of Maryland
- A Risk Assessment Framework for Defining Scientifically-Defensible Recovery Goals for Listed Species (SI-1477), U.S. Geological Survey (Completed)
- Forecasting the Relative and Cumulative Effects of Multiple Stressors on At-Risk Populations (SI-1541), University of Washington

- Identification and Management of Multiple Threats to Rare and Endangered Plant Species (SI-1542), Cornell University
- Population Viability Analysis of the Endangered Shortnose Sturgeon (*Acipenser brevirostrum*) (SI-1543), Oak Ridge National Laboratory
- Development of Habitat Trading Programs for Military Installations and their Neighbors through Adaptive Management (SI-1656), Michigan State University
- Developing Dynamic Reference Models and a Decisions Support Framework for Southeastern Ecosystems: An Integrated Approach (SI-1696), Joseph W. Jones Ecological Research Center
- Integrated Climate Change and Threatened Bird Population Modeling to Mitigate Operations Risks on Florida Military Installations (SI-1699), U.S. Army Corps of Engineers, Engineer Research and Development Center, Construction Engineering Research Laboratory

FY 2010 New Start Projects

- Understanding and Combating the Fire-enhancing Impact of Non-Native Annuals in Desert Scrub through the Tools of Population and Landscape Ecology (SI-1721), Rutgers, The State University of New Jersey, Newark
- Integrated Spatial Models of Non-Native Plant Invasion, Fire Risk, and Wildlife Habitat to Support Conservation on Military Lands in the Arid Southwest (SI-1722), Northern Arizona University
- Predictive Tools to Manage Altered Fire Regimes Caused by Plant Invasions in the Mojave Desert (SI-1723), Pacific Northwest National Laboratory
- Hydroecology of Intermittent and Ephemeral Streams: Will Landscape Connectivity Sustain Aquatic Organisms in a Changing Climate? (SI-1724), University of Washington
- Watershed to Local Scale Characteristics and Function of Intermittent and Ephemeral Streams on Military Lands (SI-1725), Colorado State University
- Structure and Function of Ephemeral Streams in the Arid and Semiarid Southwest: Implications for Conservation and Management (SI-1726), Arizona State University
- An Ecohydrological Approach to Managing Intermittent and Ephemeral Streams on Department of Defense Lands in the Southwestern United States (SI-1727), University of Arizona

FY 2011 Initiatives

In the FY 2011 solicitation, SERDP released one SON concerning **Threatened, Endangered, and At-Risk Species**.

Ecology and Management of Source-Sink Populations – The objective of this SON is to improve our understanding of source-sink dynamics for subpopulations and populations of species of relevance to DoD resource managers. A source habitat contains a self-supporting subpopulation in which reproduction exceeds mortality and any excess individuals are available to emigrate to other habitat patches. Within sink habitats, mortality exceeds reproduction. This SON is specifically seeking research that (1) improves our understanding of the role source-sink dynamics play in structuring populations and maintaining species persistence across multiple spatial scales and (2) improves a manager's ability to determine whether a habitat patch and its resident subpopulation is functioning as a source or sink and apply appropriate management strategies. The desired outcome is knowledge that (1) assists resource managers in distinguishing source habitats from sink habitats for individual species, (2) elucidates the role of environmental fluctuation, especially as these fluctuations may be altered under climate change, in determining source-sink dynamics and their effect on population persistence, and (3) provides resource managers appropriate strategies for managing species that are subject to source-sink dynamics.

iii. Maritime Sustainability

Scope of Problem

Although anthropogenic stressors of marine resources are primarily associated with commercial shipping and fishing operations, maritime military operations may also have contributed to stresses on these systems. Marine mammals are protected under the Marine Mammal Protection Act (MMPA), Endangered Species Act (ESA), and National Environmental Policy Act (NEPA), and there is growing concern that anthropogenic sound may have detrimental effects on marine mammals. The Navy has a high-priority requirement for (1) developing an understanding of the potential impacts of sonar on marine mammals, as well as (2) collecting data on the locations and seasonal population densities of marine mammals within areas used for military training.

DoD operations in aquatic environments can also impact coral reef and other benthic communities. Assessment of reef health and the distinction of anthropogenic and natural stressors on marine environments has helped in the formulation of adaptive management strategies for these aquatic systems.

Overview of Investment

SERDP research contributes to our basic scientific understanding of the factors, both natural and anthropogenic, that hinder the sustainable use of marine ecosystems. Additionally, SERDP research efforts aim to develop and demonstrate methods and technologies that can minimize the adverse impacts (Figure II-3). The following projects have been funded by SERDP to accomplish the Program's objectives:

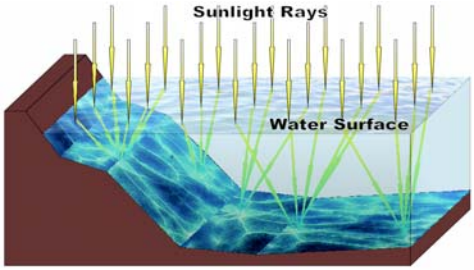


Figure II-3: Model of sunlight flickering used in coral reef Mosaicing Software.

FY 2009 Projects

- Application of Landscape Mosaic Technology to Complement Coral Reef Resource Mapping and Monitoring (SI-1333), University of Miami (Completed)
- Analysis of Biophysical, Optical, and Genetic Diversity of DoD Coral Reef Communities Using Advanced Fluorescence and Molecular Biology Techniques (SI-1334), Rutgers University

FY 2009 Workshop

SERDP Coral Reef Monitoring & Assessment Workshop

Over the past four years, SERDP has funded the development of two technologies for assessing and monitoring coral reef health: 1) high-resolution (millimeter scale) video-mosaicing technology, capable of rapidly surveying and providing a permanent visual record for benthic areas over 100s of square meters in size (University of Miami) and 2) advanced bio-optical techniques for non-destructive assessment of selective natural and anthropogenic stresses using fluorescence induction and relaxation sensors (Rutgers University).

In FY 2009, SERDP sponsored a workshop at the Rosenstiel School of Marine and Atmospheric Science, University of Miami. The primary goals of the workshop were to (1) understand the DoD perspective on coral reef assessment and monitoring needs, (2) understand other potential user perspectives (i.e., in addition to DoD) on what their coral reef monitoring and assessment needs are and how these two SERDP-developed technologies may help address those needs, and (3) identify how the two approaches/technologies are complementary to each other and how they can be integrated to meet end-user needs.

FY 2011 Initiatives

In the FY 2011 solicitation, SERDP released one SON concerning **Maritime Sustainability.**

Behavioral Ecology of Cetaceans – The objective of this SON is to develop the underlying science and supporting technology needed to improve our understanding of the effects of anthropogenic sound, in particular Navy Sonar, on the behavior of cetaceans. Specific objectives include (1) improving our understanding of the baseline behavioral ecology of key cetaceans of management concern in the absence of significant anthropogenic acoustic stimuli and (2) developing needed technologies and tools that enhance both our ability to collect baseline behavioral data and future efforts to quantify potential responses to anthropogenic sound. The desired outcome is improved knowledge that provides an understanding of the baseline behavioral ecology of priority species and taxonomic groups of cetaceans that can be used to help set protective and defensible dose-response thresholds. An additional expected benefit is development of a suite of sensors, platforms, software, and tag attachments to detect, locate, and identify individual marine mammals.

iv. Air Quality

Scope of Problem

Military ranges are under increasing public scrutiny with respect to potential environmental hazards to nearby communities. In urban centers along the east and west coasts, for example, military training activities are being scrutinized for contributing to local and regional air quality problems (Figure II-4). Although DoD facilities and operations can be significant sources of air pollutants and fugitive dust emissions, complex meteorological conditions create considerable uncertainty in tracking and identifying pollutants or their sources. Because nonconformance with existing and proposed standards and regulations can curtail military testing, training activities, and ultimately affect mission readiness, a pressing need exists to obtain reliable information on air emissions from military activities in regard to their characterization, dispersion, impacts, monitoring, and mitigation.

Figure II-4: Riverside Fire Laboratory-Research on transition of surface fires to crown fires.

Overview of Investment

SERDP is developing new scientific technologies that will measure air quality factors affected by military platforms, weapons, and operations on training ranges while taking into account varying atmospheric conditions and terrain. SERDP has also identified a need for technologies that can monitor, reduce, eliminate, or control the generation of air emissions from military operations. The following initiatives have been funded by SERDP to accomplish the Program's objectives:

FY 2009 Projects

- Particulate Matter Emissions Factors for Dust from Unique Military Activities (SI-1399), Desert Research Institute (Completed)
- Development of Emission Factors for Dust Generated by Unique Military Activities (SI-1400), U.S. Army Corps of Engineers, Engineer Research and Development Center (Completed)
- Characterization of Emissions and Air Quality Modeling for Predicting the Impacts of Prescribed Burns at DoD Lands (SI-1647), Georgia Institute of Technology

- New Tools for Estimating and Managing Local/Regional Air Quality Impacts of Prescribed Burns (SI-1648), University of California, Riverside
- Advanced Chemical Measurements of Smoke from DoD-Prescribed Burns (SI-1649), Pacific Northwest National Lab
- Feasibility of New Technology to Comprehensively Characterize Air Emissions (WP-1672), U.S. Army Corps of Engineers, Engineer Research and Development Center, Construction Engineering Research Laboratory

FY 2010 New Start Projects

- Fugitive Dust Emissions: Development of a Real-time Monitor (SI-1728), Clarkson University
- Characterizing and Quantifying Emissions and Transport of Fugitive Dust Emissions Due to Department of Defense Activities (SI-1729), Desert Research Institute
- Development of a Windbreak Dust Predictive Model and Mitigation Planning Tool (SI-1730), University of Utah

v. Noise

Scope of Problem

The availability of airspace for military training and operations is a serious concern for the DoD. Military installations that were originally located in remote areas, far from public view, are now in the midst of densely populated areas. Noise caused by live fire training and flight operations may be considered increasingly incompatible with nearby communities. In its June 2000 report, the Joint Strike Fighter (JSF) Overarching Integrated Product Team raised concerns over potential noise emissions and noise regulations threatening to impact future JSF operations.

The ability to accurately model noise associated with flight operations has allowed the DoD to provide legally defensible noise assessments of its operations and to comply with requirements of the NEPA. However, the existing environmental noise models used by the DoD are not appropriate for the newest generation of fighter aircraft, which have high performance engines and vectored thrust capabilities. New, updated noise models that include the new aircraft and take advantage of today's computational capabilities are needed to assess potential restrictions imposed on training activities and to protect bases and airspace for training. Additionally, DoD needs to characterize, evaluate, and predict noise generated by military activities that may adversely effect structures. For example, shaking of civilian houses by military impulse noise events is alleged to result from earth-borne vibration. Additionally, powerful sound waves emitted by military training activities such as firing large guns and detonation of explosives can travel long distances in the atmosphere, are audible under some propagation conditions, and can even cause buildings to shake and rattle.

Overview of Investment

SERDP provides tools for predicting and monitoring noise levels from military operations and for understanding and mitigating impacts to humans, animals, and structures (Figure II-5). Noise complaints from surrounding communities represent a growing issue impacting military operations and, to meet upcoming challenges, the DoD must keep

Figure II-5: Measuring the engine noise of an F404 aircraft engine on a test stand.

abreast of the latest models and technologies to measure, monitor, and reduce noise impacts from its operations. In sum, development and refinement of noise models are needed to (1) keep pace with new aircraft and weapons; (2) assess impacts on humans and animals; and (3) calibrate and predict how noise impacts man-made structures above the ground, travels from the air into and through the ground, and potentially damages foundations of structures. The following projects have been funded by SERDP to accomplish the Program's objectives:

FY 2009 Projects

- Investigation of Community Attitudes Toward Military Blast Noise (SI-1546), U.S. Army Corps of Engineers, Engineer Research and Development Center, Construction Engineering Research Laboratory
- The Reduction of Advanced Military Aircraft Noise (WP-1583), Penn State University
- Mechanical Chevrons and Fluidics for Advanced Military Aircraft Noise Reduction (WP-1584), U.S. Navy, Navy Research Laboratory (Completed)
- Development and Implementation of Metrics for Identifying Military Impulse Noise (SI-1585), University of Pittsburgh (Completed)

vi. Ecosystem-Based Management and Climate Change

Scope of Problem

DoD's mission requires maneuver, training, and testing land to maintain readiness through realistic training opportunities. However, repeated use of heavy vehicles (such as tanks) can have serious impacts on the land including loss of vegetation, soil destabilization, erosion, and invasion by non-native species (Figure II-6). Development pressures in surrounding areas can further constrain military operations by compounding DoD's environmental compliance requirements. Collectively, these factors affect the sustainability of military land and adjacent waters, marine ranges and, ultimately, the DoD's ability to meet mission requirements.

Figure II-6: M-1 Abrams training at Ft. Benning Georgia.

Ecosystem-based management encompasses a broad array of strategies, tools, and techniques including cross-boundary resource management; ecological process management; invasive species management; approaches and metrics for assessing ecosystem health at different, but relatable, spatial scales; hierarchical management approaches (versus single species management approaches); ecosystem dynamics; and restoration ecology. In addition, ecosystem-based management has a human community dimension as surrounding communities partner with military installations to attack system-level issues regionally.

Overview of Investment

SERDP invests in technologies and tools that enable installations to actively manage the ecological systems that support the realistic training scenarios military training requires, while preserving the long-term viability of installation and regional ecosystem health. Two key SERDP research priorities in this area are (1) advancing management techniques that limit environmental damage and mitigate or minimize restoration requirements and (2) developing models that support successful adaptive management of DoD training and testing areas. The following initiatives have been funded by SERDP to accomplish these objectives:

FY 2009 Projects

- Allelochemical Control of Non-Indigenous Invasive Plant Species Affecting Military Testing and Training Activities (SI-1388), Colorado State University (Completed)
- Effectiveness of Selected Native Plants as Competitors with Non-Indigenous and Invasive Knapweed and Thistle Species (SI-1389), U.S. Army Corps of Engineers, Engineer and Research Development Center (Completed)
- SERDP's Defense Coastal/Estuarine Research Program (DCERP) (SI-1413), RTI International
- Developing Functional Parameters to Develop a Science-Based Vehicle Cleaning Program to Reduce Transport of Non-Native Invasive Plant Species (SI-1545), Montana State University
- Development of a Watershed Modeling System for Fort Benning Using the USEPA BASINS Framework (SI-1547), AQUA TERRA Consultants
- Realizing the Potential of the Effective Area Model: Refining the Software and Incorporating Recent Advances to Maximize Usefulness on Military Installations (SI-1597), Northern Arizona University
- The Potential for Restoration to Break the Grass/Fire Cycle in Dryland Ecosystems in Hawaii (SI-1645), U.S. Forest Service
- Development and Use of Genetic Methods for Assessing Aquatic Environmental Condition and Recruitment Dynamics of Native Stream Fishes on Pacific Islands (SI-1646), Tulane University
- Assisted Migration as a Management Tool in Coastal Ecosystems Threatened by Sea Level Rise (SI-1692), Southern Illinois University
- Temporal and Spatial Patterns of Pine Mortality in the Southeastern United States (SI-1693), U.S. Forest Service, Southern Research Station
- Development of Ecological Reference Models and an Assessment Framework for Streams on the Atlantic Coastal Plain (SI-1694), Savannah River National Laboratory
- Developing and Testing a Robust, Multi-Scale Framework for the Recovery of Longleaf Pine Understory Communities (SI-1695), Washington University
- Developing Dynamic Reference Models and a Decision Support Framework for Southeastern Ecosystems: An Integrated Approach (SI-1696), Joseph W. Jones Ecological Research Center

FY 2010 New Start Projects

- Understanding and Combating the Fire-Enhancing Impact of Non-Native Annuals in Desert Scrub through the Tools of Population and Landscape Ecology (SI-1721), Rutgers, The State University of New Jersey, Newark
- Integrated Spatial Models of Non-Native Plant Invasion, Fire Risk, and Wildlife Habitat to Support Conservation on Military Lands in the Arid Southwest (SI-1722), Northern Arizona University
- Predictive Tools to Manage Altered Fire Regimes Caused by Plant Invasions in the Mojave Desert (SI-1723), Pacific Northwest National Laboratory
- Hydroecology of Intermittent and Ephemeral Streams: Will Landscape Connectivity Sustain Aquatic Organisms in a Changing Climate? (SI-1724), University of Washington
- Watershed to Local Scale Characteristics and Function of Intermittent and Ephemeral Streams on Military Lands (SI-1725), Colorado State University

- Structure and Function of Ephemeral Streams in the Arid and Semiarid Southwest: Implications for Conservation and Management (SI-1726), Arizona State University
- An Ecohydrological Approach to Managing Intermittent and Ephemeral Streams on Department of Defense Lands in the Southwestern United States (SI-1727), University of Arizona
- Purifying and Testing Gecko Skin Compounds, a Promising Attractant for Small Brown Treesnakes (SI-1731), Colorado State University
- Development of Non-Prey Baits for Delivery of Acetaminophen to Brown Treesnakes (*Boiga irregularis*) on Guam (SI-1732), USDA/National Wildlife Research Center
- A Phylogenetic Strategy for Identifying a Biological Control Agent for Non-Native Populations of the Brown Treesnake (*Boiga irregularis*) (SI-1733), U.S. Geological Survey

FY 2011 Initiatives

In the FY 2011 solicitation, SERDP released two SONs concerning **Ecosystem-Based Management and Climate Change**.

Ecological Forestry and Carbon Management – The objective of this SON is to develop the fundamental and applied science required to manage and restore forested ecosystems on DoD lands in accordance with the principles of ecological forestry. Of particular interest are the interactions between ecological forestry-based silvicultural prescriptions and carbon management in the context of maintaining other desired ecosystem services such as military mission support and native biodiversity. The desired outcome is improved knowledge that provides an understanding of the carbon cycle for DoD forested ecosystems and its use within an ecological forestry context to identify how ecologically-based forest management versus other land uses contributes to an installation's carbon footprint. An additional expected benefit is the identification of ecologically-based silvicultural practices that improve life-cycle carbon management while sustaining other desired ecosystem services.

Impacts of Climate Change on Alaskan Ecological Systems – The objective of this SON is to improve our understanding of the potential impacts of climate change to ecological systems that can occur on DoD testing and training lands in Alaska. Of particular concern are climate change impacts that could lead to state changes in ecological systems. The desired outcome is improved knowledge that (1) provides an understanding of the ecology of Alaskan ecological systems of concern to DoD resource managers, (2) provides an understanding of how multiple anthropogenic stressors, including climate change, and their interactions impact these ecological systems that support military training and testing capabilities, (3) identifies potential management interventions to mitigate the impacts of the above stressors, and (4) contributes to the theory of regime shifts to improve our overall understanding of how to detect and prevent state changes in ecological systems.

vii. Cultural Resources

Scope of Problem

DoD administers 29 million acres of public land containing some of the nation's most significant historic and prehistoric cultural resources. More specifically, DoD owns or controls more than 115,000 archeological sites, 73 National Historic Landmarks, and nearly 600 entries listed on the National Register of Historic Places (encompassing over 19,000 individual historic properties). Management of these resources, in compliance with existing laws and regulations, has proven costly to the military, both financially and operationally. Training restrictions imposed by cultural resource regulations impact the DoD mission, and proper identification and assessment of such sites can require many man hours and significant financial resources.

Overview of Investment

SERDP research seeks to develop the science, tools, and techniques needed to manage cultural resources on installations and ranges. In particular, technologies for the rapid and cost-effective detection and evaluation of archeological and other cultural resources, such as historical properties, are needed by installation managers to reduce the potential for training restrictions due to possible disturbance of these assets (Figure II-7).

Figure II-7: Prehistoric pit house excavation illustrating intact deposits/features immediately below disturbed upper soil stratum.

FY 2009 Projects

- Physical and Geophysical Measurement of Replicated Military Training Impacts to Archaeological Sites (SI-1697), Pacific Northwest National Laboratory
- Identifying Military Impacts on Archeological Deposits Based on Differences in Soil Organic Carbon and Chemical Elements at Soil Horizon Interfaces (SI-1698), U.S. Army Corps of Engineers, Engineer Research and Development Center, Construction Engineering Research Laboratory

viii. Sea Level Rise

Scope of Problem

It is vital that DoD be able to continue to operate in coastal settings because of the unique and critical realistic training venues that coastal environments provide. However, because of the near certainty of climate change and subsequent sea level rise, many coastal DoD installations are vulnerable to losing operational capabilities if sea level rise impacts their current infrastructure and training regimes (Figure II-8). Understanding these potential impacts will be critical to developing appropriate long-term management strategies.

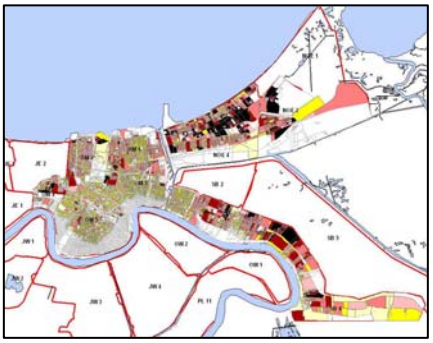


Figure 11-8: Systems-Scale Risk Assessment New Orleans

Overview of Investment

SERDP research seeks to develop analysis methods and assessments necessary to determine the impacts of various increases in sea level and associated phenomena including, but not limited to (1) inundation of land, (2) increased storm and flood damage, (3) loss of wetlands, (4) changes in erosion patterns and rates, (5) salt water intrusion in surface and ground waters, (6) rising water tables, and (7) changes in tidal flows and currents. These physical effects will impact coastal DoD installations to a differing degree depending on the geomorphology of the installation and its surrounding area as well as the nature and location of the built infrastructure on the installation.

FY 2009 Projects

- Effects of Near-Term Sea-Level Rise on Coastal Infrastructure (SI-1700), Florida State University
- Risk Quantification for Sustaining Coastal Military Installation Assets and Mission Capabilities (SI-1701), U.S. Army Corps of Engineers, Engineer Research and Development Center, Coastal and Hydraulics Lab

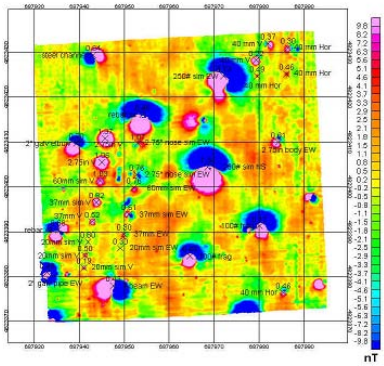
- Shoreline Evolution and Coastal Resiliency at Three Military Installations: Investigating the Potential for and Impacts of Loss of Protecting Barriers (SI-1702), Woods Hole Oceanographic Institute
- A Methodology for Assessing the Impact of Sea-Level Rise on Representative Military Installations in the Southwestern United States (SI-1703), U.S. Navy, Space and Naval Warfare Systems Center

C. Reducing Current and Future Liabilities

i. Munitions Response

Scope of Problem

The cleanup of UXO presents a major challenge to DoD. It also is a challenge for active military installations seeking to manage their operational ranges as sustainable assets. There are nearly 3,400 military munitions response sites including active bases, base realignment and closure (BRAC) installations, and formerly used defense site (FUDS) properties that, collectively, encompass more than 29 million acres of land. Current projected estimates to clean up this land are in the tens of billions of dollars. Because existing technology does not detect all UXO that may be present at a site and does not reliably discriminate between UXO and nonhazardous materials, UXO characterization and remediation activities are extremely expensive and often yield unsatisfactory results. Field experience indicates that more than 99 percent of objects excavated in the course of a UXO remediation are nonhazardous (i.e., false alarms), and, as a result, most of the cost to remediate a UXO site is associated with excavating non-ordnance items. New technologies are needed that are capable of detecting UXO with much higher degrees of accuracy and reliability to ensure that DoD receives the maximum return on investment for its UXO remediation efforts.



Overview of Investment

Several stages in the munitions response (MR) process require technology development. The current inventory of MR sites contains vast tracts of land that may be contaminated with military munitions. Much of this land, however, was likely within an installation boundary but never saw munitions use. Technology is required to assess potentially contaminated sites to identify those that actually contain munitions and to collect data to support regulatory decisions on those sites that do not. This is termed "wide area assessment".

Figure II.9 & II.10: Above: An example of an anomaly map produced from geophysical data. Below: Examples of excavated munitions.

Once a site has been identified, it must be mapped with sensors to detect subsurface munitions so that they may be removed (see Figures II.9 & II.10). The two primary sensors used for this detailed mapping are magnetometers and electromagnetic induction sensors, both of which respond to subsurface metal. On most MR sites, harmless metallic objects such as munitions parts and fragments, as well as non-military objects including barbed wire, nails, rebar, and so forth, far outnumber intact munitions. Technologies are needed that can reliably discriminate munitions from these other non-hazardous objects, so that

cleanup resources can be used most cost-effectively. Systems are also needed that can detect munitions in environments with challenging terrain and geology, which limit current systems.

SERDP invests in all aspects of MR technology, including sensor development, modeling, processing, supporting technologies, and system integration. Historically, the focus of this investment has been on technologies suitable for sites on land. Recently, interest in munitions in the underwater environment has increased and SERDP expanded its investment in science and technology for this application.

The following initiatives have been funded by SERDP to accomplish the Program's objectives in the area of UXO:

FY 2009 Projects

- Standardized UXO Technology Demonstration Sites (MM-1300), U.S. Army, Aberdeen Test Center
- Improving Detection and Discrimination of UXO in Magnetic Environments (MM-1414), Colorado School of Mines (Completed)
- New Man-Portable Vector Time Domain Electromagnetic Induction Sensor and Physically Complete Processing Approaches for UXO Discrimination Under Realistic Field Conditions (MM-1443), U.S. Army Corps of Engineers, Cold Regions Research and Engineering Laboratory (Completed)
- Compact, Low-Noise Magnetic Sensor with Fluxgate (DC) and Induction (AC) Modes of Operation (MM-1444), Quasar, Inc. (Completed)
- Development of Autonomous UAV Helicopter-Magnetometer System for Wide Area Assessment (MM-1509), Idaho National Laboratory
- Development of a Micro-Fabricated Total-Field Magnetometer (MM-1512), Geometrics, Inc.
- Wide Area Detection and Identification of Underwater UXO Using Structural Acoustic Sensors (MM-1513), U.S. Navy, Naval Research Laboratory
- An EM System with Dynamic Multi-Axis Transmitter and Tensor Gradiometer Receiver (MM-1534), G&G Sciences (Completed)
- High-Accuracy Multisensor Geolocation Technology to Support Geophysical Data Collection at MEC Sites (MM-1564), The Ohio State University
- Inertial/GPS Integrated Geolocation System For Detection and Recovery of Buried Munitions (MM-1565), The Ohio State University
- Miniature Wide-Band Atomic Magnetometer (MM-1568), Geometrics, Inc. (Completed)
- A Complex Approach to UXO Discrimination: Combining Advanced EMI Forward and Statistical Signal Processing (MM-1572), Dartmouth University (Completed)
- Simultaneous Inversion of UXO Parameters and Background Response (MM-1573), Sky Research, Inc. (Completed)
- Electromagnetic Induction Modeling for UXO Detection and Discrimination Underwater (MM-1632), Dartmouth University (Completed)
- Selecting Optimal Models for Inverting Electromagnetic Induction Data (MM-1637), Sky Research, Inc. (Completed)
- Integration of Advanced Statistical Analysis Tools and Geophysical Modeling (MM-1657), Duke University

- Magnetic Surface Modes and UXO/Clutter Classification and Discrimination (MM-1658), SAIC, Inc.
- Superconducting Magnetic Tensor Gradiometer System for Detection of Underwater Military Munitions (MM-1661), Sky Research, Inc.
- Analysis of Next Generation Sensor Data (MM-1662), SAIC, Inc.
- Isolating and Discriminating Overlapping Signatures in Cluttered Environments (MM-1664), U.S. Army Corps of Engineers, Cold Regions Research and Engineering Laboratory
- Full Scale Measurement and Modeling of the Acoustic Response of Proud and Buried Munitions at Frequencies from 1-30 kHz (MM-1665), University of Washington
- Sonar Detection and Classification of Underwater UXO and Environmental Parameters (MM-1666), U.S. Navy, Naval Surface Warfare Center- Panama City
- Hand-Held UXO Discriminator (MM-1667), Lawrence Berkley National Laboratory
- Advanced Signal Processing for Detailed Site Characterization and Target Discrimination (MM-1669), BAE Systems

FY 2010 New Start Projects

- Bulk Magnetization Effects in EMI-Based Classification and Discrimination (MM-1711), SAIC, Inc.
- Bistatic Portable Electromagnetic Induction Sensor with Integrated Positioning (MM-1712), U.S. Army Corps of Engineers, Cold Regions Research and Engineering Laboratory
- Innovative Processing, Feature Development and Specialized Data Collection for Underwater Munitions Advanced Classifier Design (MM-1713), BAE Systems
- Exploiting VLF/LF Electric and Magnetic Fields for Underwater Munitions Characterization (MM-1714), SAIC, Inc.

Figure II-11: An example of an underwater Automated Unmanned Vehicle (AUV). These platforms are used to survey underwater munitions safely and cost-effectively.

- Cost-Aware Design of a Discrimination Strategy for Unexploded Ordnance Cleanup (MM-1715), Clarkson University
- High Sensitivity Magnetoresisitive Sensors for Both DC and EMI Magnetic Field Mapping (MM-1716), University of Nebraska
- Buried Underwater Munitions and Clutter Discrimination (MM-1717), U.S. Army Corps of Engineers, Engineer Research and Development Center
- A Low Frequency Electromagnetic Sensor for Underwater Geo-location (MM-1719), Dartmouth College
- All Aspect, Mixed Aperture Processing for Imaging of Buried, Underwater Unexploded Ordnance (MM-1720), EdgeTech

FY 2011 SONs

In the FY 2011 solicitation, SERDP released four SONs concerning **Munitions Response.** Three Core Solicitations and one SEED Solicitation were released.

Advanced Technologies for Detection, Discrimination, and Remediation of Military Munitions – The objective of this SON is to develop sensors, signal processing methodologies, sensor platforms, supporting technologies, or remediation technologies to address the diverse challenges associated with the cleanup of DoD munitions-contaminated terrestrial sites (sites contaminated with UXO, discarded military munitions (DMM) and related items). Capabilities are needed for a wide variety of site conditions, particularly those with difficult geology, terrain and vegetation, and complex munitions and clutter distributions. Many sites or sections of sites have sparsely distributed subsurface munitions and clutter items that can clearly be separated, while other areas have almost continuously overlapping suspected items, which need to be assessed and removed. Munitions ranging in size from 20-mm projectiles to 2000-lb bombs must be detected and discriminated from other non-hazardous items in the subsurface, although proposals need not address the entire range of potential munitions.

SEED SON: Advanced Technologies for Detection, Discrimination, and Remediation of Military Munitions on Land and Underwater – The objective of this SEED SON is similar to the Core Munitions Response SON described above, except that it requests high-risk, high-payoff proposals and it also addresses munitions in the underwater environment. Similarly, responses to this SEED SON need not address the entire range of potential munitions or sites.

Improvements in the Detection and Remediation of Underwater Military Munitions – The objective of this SON is to significantly improve the ability of the DoD to detect, characterize, and remediate military munitions found at underwater sites. Capabilities are needed for a wide variety of aquatic environments such as ponds, lakes, rivers, estuaries, and coastal and open ocean areas. Munitions ranging from 20-mm projectiles to 2000-lb bombs must be detected and discriminated from other non-hazardous items, although proposals need not address the entire range of potential munitions with a single solution. Technologies applicable in waters up to 120 feet deep are of primary interest.

Tools to Support Informed Decisions on Munitions Responses Sites – The objective of this SON is to develop the procedures and tools required for site managers to make decisions at Munitions Response sites based on quantitative and transparent criteria. The focus is on the needs of individual site managers and teams to answer questions such as what is the likelihood that unexploded ordnance (UXO) will be encountered at the site before and after remediation, how to prioritize anomalies for digging in a principled way, and when to stop digging.

ii. Chlorinated Solvents – Dissolved Phase Dense Non-Aqueous Phase Liquids

Scope of Problem

Chlorinated solvents are by far the most pervasive group of soil and groundwater contaminants at DoD facilities. A recent estimate indicates that DoD owns more than 3,000 sites in the United States that are contaminated with chlorinated solvents. These sites are characterized by wide ranges of chlorinated solvent concentrations, and the subsurface environmental conditions and contaminant distributions are often complex. Many of these sites also have identifiable dense, non-aqueous phase liquids (DNAPL) source zones, and these sources are particularly difficult to remediate, resulting in substantial and long-term contaminant plumes. At many sites the complete cleanup of DNAPL contaminant sources has been considered technically impracticable; therefore, the typical response action has been containment by pumping and treating the contaminated groundwater. New technologies such as thermal treatment, chemical oxidation, bioremediation, and enhanced physical removal (e.g., using cosolvents or surfactants), however, are designed to remove the subsurface sources of DNAPLs. Under appropriate conditions, these technologies can remove a large fraction of the total DNAPL mass and accelerate remediation. However the contaminant concentrations over a large area may be relatively low, and active remediation can be cost-inefficient. Also of concern in recent years has been the migration of vapors from these groundwater plumes into surface and sub-surface structures. The fate and transport of vapors in soil is difficult to predict and measure since vapor intrusion into buildings reflects a combination of natural processes including advection, diffusion, biodegradation, pressure fluctuations caused by wind, temperature, and diurnal cycles, and occupant activities in buildings.

Overview of Investment

SERDP develops and promotes technologies to cost-effectively remediate chlorinated solvents in soil and groundwater. Technologies to detect and assess the presence and extent of both DNAPL source zones and dissolved plumes are essential (Figure II-12). In addition, there is a need to understand the benefits of source zone treatment—particularly of in-situ technologies. SERDP is also supporting research into alternative, environmentally benign solvents as well as new processes that do not require the use of chlorinated solvents to enable the DoD to eliminate its release of these materials to the environment. The following initiatives have been funded by SERDP to accomplish these Program objectives:

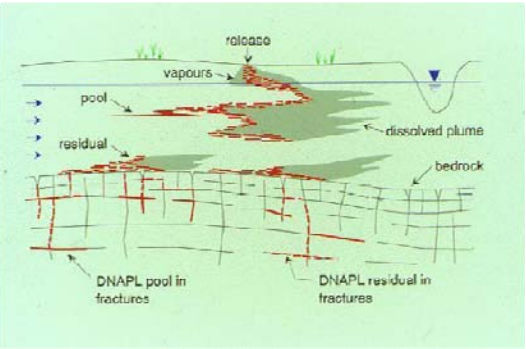


Figure II-12: Conceptual model of chlorinated solvent plume transport and targeting.

FY 2009 Projects

- In Situ Thermal Remediation of DNAPL Source Zones (ER-1458), Oregon Health and Science University (Completed)
- Fundamental Study of the Delivery of Nano-Iron to DNAPL Source Zones in Naturally Heterogeneous Field Systems (ER-1485), Carnegie Mellon University
- Development and Optimization of Targeted Nanoscale Iron Delivery Methods for Treatment of NAPL Source Zones (ER-1487), Tufts University (Completed)
- Enhanced Reactant-Contaminant Contact through the Use of Persulfate In Situ Chemical Oxidation (ISCO) (ER-1489), Washington State University (Completed)

- Contaminant Mass Transfer During Boiling in Fractured Geologic Media (ER-1553), Clemson University (Completed)
- DNAPL Dissolution in Bedrock Fractures and Fracture Networks (ER-1554), Shaw Environmental and Infrastructure, Inc.
- A Comparison of Pump-and-Treat, Natural Attenuation, and Enhanced Biodegradation to Remediate Chlorinated Ethene-Contaminated Fractured Rock Aquifers (ER-1555), U.S. Geological Survey (Completed)
- Characterization of Microbes Capable of Using Vinyl Chloride as a Sole Carbon and Energy Source by Anaerobic Oxidation (ER-1556), Clemson University
- Elucidation of the Mechanisms and Environmental Relevance of cis-Dichloroethene and Vinyl Chloride Biodegradation (ER-1557), Geosyntec Consultants
- Microbial DCE and VC Oxidation and the Fate of Ethene and Ethane Under Anoxic Conditions (ER-1558), U.S. Geological Survey (Completed)
- Cryogenic Collection of Complete Subsurface Samples for Molecular Biological Analysis (ER- 1559), Oregon Health and Science University
- Impacts of Sampling and Handling Procedures on DNA- and RNA-based Microbial Characterization and Quantification (ER-1560), North Carolina State University (Completed)
- Standardized Procedures for Use of Nucleic Acid-Based Tools (ER-1561), U.S. Navy, Naval Facilities Engineering Service Center
- Prokaryotic cDNA Subtraction: A Method to Rapidly Identify Functional Gene Biomarkers (ER-1563), University of Texas at Austin (Completed)
- BioReD: Biomarkers and Tools for Reductive Dechlorination Site Assessment, Monitoring, and Management (ER-1586), Georgia Institute of Technology
- Application of Microarrays and qPCR to Identify Phylogenetic and Functional Biomarkers Diagnostic of Microbial Communities that Biodegrade Chlorinated Solvents to Ethene (ER-1587), University of California at Berkeley
- Molecular Biomarkers for Detecting, Monitoring, and Quantifying Reductive Microbial Processes (ER-1588), Stanford University
- New Cost-Effective Method for Long-Term Groundwater Monitoring Programs (ER-1601), Groundwater Services, Inc.
- Micro Ion Mobility Sensor (MIMS) for In Situ Monitoring of Contaminated Groundwater (ER-1603), Oak Ridge National Laboratory
- Novel Sensor for Real-Time Characterization and Monitoring of Chlorinated Hydrocarbons in Groundwater (ER-1605), U.S. Navy, Naval Facilities Engineering Service Center
- Computational and Experimental Investigation of Contaminant Plum Response to DNAPL Source Zone Architecture and Depletion in Porous and Fractured Media (ER-1610), University of Waterloo
- Practical Cost-Optimization of Characterization and Remediation Decisions at DNAPL Sites with Consideration of Prediction Uncertainty (ER-1611), University of Tennessee
- Metric Identification and Protocol Development for Characterizing DNAPL Source Zone Architecture and Associated Plume Response (ER-1612), Tufts University

- Predicting DNAPL Source Zone and Plume Response Using Site-Measured Characteristics (ER-1613), University of Florida
- The Impact of DNAPL Source-Zone Architecture on Contaminant Mass Flux and Plume Evolution in Heterogeneous Porous Media (ER-1614), University of Arizona
- Quantifying the Presence and Activity of Aerobic, Vinyl Chloride-Degrading Microorganisms in Dilute Groundwater Plumes by Using Real-Time PCR (ER-1683), University of Iowa
- Semi-Passive Oxidation-Based Approaches for Control of Large, Dilute Groundwater Plumes of Chlorinated Ethylenes (ER-1684), The Ohio State University
- Coupled Diffusion and Reaction Processes in Rock Matrices: Impact on Dilute Groundwater Plumes (ER-1685), Shaw Environmental and Infrastructure, Inc.
- Integrated Field-Scale, Lab-Scale, and Modeling Studies for Improving our Ability to Assess the Groundwater to Indoor Air Pathway at Chlorinated Solvent-Impacted Groundwater Sites (ER-1686), Arizona State University
- Vapor Intrusion from Entrapped NAPL Sources and Groundwater Plumes: Process Understanding and Improved Modeling Tools for Pathway Assessment (ER-1687), Colorado School of Mines
- Improved Understanding of Sources of Variability in Groundwater Sampling for Long-Term Monitoring Programs (ER-1705), GSI Environmental, Inc.

FY 2010 New Start Projects

- Impact of Clay – DNAPL Interactions on Transport and Storage of Chlorinated Solvents in Low Permeability Zones (ER-1737), University of Michigan
- The Importance of Sorption in Low-Permeability Zones on Chlorinated Solvent Plume Longevity in Sedimentary Aquifers (ER-1738), University at Buffalo, The State University of New York
- The Behaviour of Compound Specific Stable Isotopes During the Storage of Chlorinated Solvents in Low-Permeability Zones through Diffusion and Sorption (ER-1739), University of Waterloo
- Basic Research Addressing Contaminants in Low-Permeability Zones (ER-1740), Colorado State University

iii. Heavy Metals

Scope of Problem

Preventing the corrosion of metal components in military vehicles, aircraft, and weapon systems is a multibillion dollar challenge. Typically, corrosion is prevented by the application of sealants and coatings containing chromium as the primary corrosion inhibiting substance. Hexavalent chromium, however, has been designated as hazardous and work is underway to reduce or eliminate hexavalent chromium from sealants and coatings in compliance with either current or pending Occupational Safety and Health Administration (OSHA) requirements. In addition, the Under Secretary of Defense for Acquisition, Technology and Logistics issued a memo on April 8, 2009, "Minimizing the Use of Hexavalent Chromium (Cr^{6+})," that requires DoD to reduce usage of Cr^{6+} processes and materials, while ensuring performance and cost-effectiveness continue to be met. Accordingly, DoD and DOE have committed to replace chromate-based sealants and metal finishing in current and next generation weapons systems. Strategic investments in chromate elimination research have been made, and these efforts have contributed significantly to our understanding of corrosion protection by chromates.

Thousands of DoD sites (including those undergoing closure or realignment) require remediation of contaminated soil—a process that can be prohibitively expensive. Heavy metals are among the most common soil contaminants on these facilities, particularly cadmium, arsenic, chromium, and lead. SERDP has funded considerable research to identify environmentally acceptable levels and ecological screening levels of heavy metal contaminants in soil. Efforts also are underway to develop rapid, routine methods for measuring the bioavailability of heavy metals for plants and soil invertebrates.

Overview of Investment

SERDP develops and promotes techniques and technologies that cost-effectively: (1) evaluate the presence and disposition of heavy metals; (2) detect, monitor, and remediate hazardous metals and metal compounds in soil and groundwater; and (3) develop new materials and processes that better prevent their release or that eliminate the need for toxic metal compounds.

Evaluating the presence and disposition of metals in soil continues to be an expensive and time-consuming laboratory process. Metals may be complexed or otherwise bound to materials in the soil matrix, and some of these binding methods are strong enough to resist acidic and enzymatic breakdown (i.e., bioavailability) by plant and animal species. Because regulatory limits often are set based on the total metal in the soil, cleanup limits can be overly conservative.

Figure II-13: Chromate alternatives are studied to understand what gives them corrosion protection properties.

The development of environmentally benign alternatives to heavy metals that provide the same functionality and result in no loss in military performance is imperative Figure II-13); however, until alternatives are developed for all applications, new technologies to recycle metal plating baths and control emissions and waste are needed. The following initiatives have been funded by SERDP to accomplish the Program's objectives in this area:

FY 2009 Projects

- An Integrated Field and Laboratory Study of the Bioavailability of Metal Contaminants in Sediments (ER-1494), Stony Brook University, Marine Sciences Research Center
- Biological Processes Affecting Bioaccumulation, Transfer, and Toxicity of Metal Contaminants in Estuarine Sediments (ER-1503), Dartmouth College
- Corrosion Finishing/Coating Systems for DoD Metallic Substrates Based on Non-Chromate Inhibitors and UV Curable, Zero Valent Materials (WP-1519), University of Missouri-Rolla (Completed)
- Ultra-High Efficiency/Low Hydrogen Embrittlement Nanostructured Zinc-Based Electrodeposits as Environmentally Benign Cadmium-Replacement Coatings for High-Strength Fasteners (WP-1616), Integran Technologies, Inc. (Completed)
- Environmentally Friendly Anticorrosion Coatings for High-Strength Fasteners (WP-1617), PPG Industries, Inc. (Completed)
- Corrosion Protection Mechanisms of Rare-Earth Compounds Based on Cerium and Praseodymium (WP-1618), University of Missouri-Rolla

- Scientific Understanding of Non-Chromated Corrosion Inhibitors Function (WP-1620), The Ohio State University
- Scientific Understanding of the Mechanisms of Non-Chromate Corrosion Inhibitors (WP-1621), Southwest Research Institute
- Accelerated Dynamic Corrosion Test Method Development (WP-1673), Luna Innovations
- Dynamic Multivariate Accelerated Corrosion Test Protocol (WP-1674), U.S. Air Force, Air Force Research Laboratory
- Wash Primer Replacement Based on the Superprimer Technology (WP-1675), ECOSIL Technologies, LLC
- Environmentally Friendly Zirconium Oxide Pretreatment (WP-1676), PPG Industries, Inc.

FY 2010 New Start Projects

- Antimony(V) Adsorption by Variable-Charge Minerals (ER-1741), The University of Tennessee
- Mechanisms and Permanence of Sequestered Pb and As in Soils: Impact on Human Bioavailability (ER-1742), The Ohio State University
- Bioavailability and Methylation Potential of Mercury Sulfides in Sediments (ER-1744), Duke University
- Coupling Between Pore Water Fluxes, Structural Heterogeneity, and Biogeochemical Processes Controls Contaminant Mobility, Bioavailability, and Toxicity in Sediments (ER-1745), Northwestern University
- Predicting the Fate and Effects of Resuspended Metal Contaminated Sediments (ER-1746), University of Michigan
- Development of an Electrochemical Surrogate for Copper, Lead, and Zinc Bioaccessibility in Aquatic Sediments (ER-1748), U.S. Geological Survey
- The Biology of Bioavailability: The Role of Functional Ecology in Exposure Processes (ER-1750), U.S. Army Corps of Engineers, Army Engineer Research and Development Center
- The Role of Trace Elements in Tin Whisker Growth (WP-1751), Boeing Company
- Microstructurally Adaptive Constitutive Relations and Reliability Assessment Protocols for Lead Free Solder (WP-1752), State University of New York Binghamton
- Tin Whisker Testing and Modeling (WP-1753), BAE Systems
- Contributions of Stress and Oxidation on the Formation of Whiskers in Pb-Free Solders (WP-1754), Savannah River National Laboratory

FY 2009 Workshops

ASETSDefense '09: Sustainable Surface Engineering for Aerospace and Defense, Westminster, Colorado: ASETSDefense (Advanced Surface Engineering Technologies for a Sustainable Defense) is a DoD initiative sponsored by SERDP and ESTCP. Its objective is to facilitate the implementation of new, environmentally friendly technologies for surface engineering (coatings and surface treatments) by providing DoD organizations and the supply chain ready access to information on alternatives to coating processes that create manufacturing and sustainment problems because of ESOH issues. ASETSDefense workshops are a forum for DoD and industry engineers to share information and lessons learned on modern coating technologies to reduce environmental and health hazards. Formal and informal discussions are an integral part of these workshops, with opportunities for participants to hold side meetings for discussion of specific technologies and issues.

The 2009 Workshop covered all ESOH coating issues in new and legacy aircraft, vehicles and ships. The meeting was geared toward providing engineering information to authorizing agencies, System Program Offices, depot engineers and the commercial supply chain. It focused on hexavalent chromium to assist DoD organizations with meeting the requirements of the April 8, 2009 memo issued by the Under Secretary of Defense for Acquisition, Technology and Logistics, titled "Minimizing the Use of Hexavalent Chromium (Cr^{6+})." This memo requires reducing DoD usage of Cr^{6+} processes and materials, while ensuring performance and cost effectiveness. The memo points to SERDP and the ASETSDefense database for knowledge on RDT&E efforts and experience with implementation of alternatives. This workshop focused on reducing or eliminating Cr^{6+} and also cadmium while maintaining, or even improving, performance. The emphasis was on the practical issues of what options are available, what has been approved and implemented and what works best in different situations, while identifying the gaps in capabilities and knowledge. At the same time, users were updated on current projects and new industry developments, including materials, processes and test methods.

FY 2011 Initiatives

In the FY 2011 Solicitation, SERDP released four SONs concerning **Heavy Metals**.

Development of Alternatives to Copper-Beryllium and Aluminum-Beryllium Alloys for Military Applications: The objective of this SON is to design and develop materials that would be capable of replacing copper-beryllium (Cu-Be) and aluminum-beryllium (Al-Be) alloys that are currently used on military weapons systems. The alternative materials must meet all of the performance requirements associated with the current alloys as well as exhibit significantly reduced toxicity. Exposure to Be has been reported to produce a range of diseases including lung cancer and Chronic Beryllium Disease. Department of Defense employees are exposed to Be dust and fumes as a result of the wearing of Be-containing alloys during operation and during machining and other fabrication operations involving these alloys. Because of the uncertainty in determining a "safe" exposure level, the National Research Council recommends that DoD eliminate as many job tasks involving exposure to Be particles as possible and to minimize the number of workers performing those tasks. Developing alternatives to these alloys would reduce the health risk to these employees, and would reduce the costs associated with employee monitoring and testing as well as exposure mitigation procedures.

Understanding the Corrosion Protection Requirements for Adhesive Bond Primers: The objective of this SON is to develop an understanding of the corrosion protection requirements for primers used to prepare substrates for structural adhesive bonding. Adhesive bonding primers are widely used in the aerospace industry and DoD maintenance facilities. A quantitative understanding is needed for the physical, mechanical, corrosion inhibiting, and application properties that make up a superior structural adhesive bond primer. The proposed research will benefit the environment and enhance worker safety by leading to development of replacements for hexavalent chromium in bond primer applications, thereby significantly reducing emissions and exposure from operations including OEM preparation of surfaces for structural adhesive bonding and depot-level bonded repairs performed on military assets. It will also benefit military operations by reducing the logistical burdens associated with the handling and disposal of hazardous waste. As a result of new regulations, increased costs of hazardous waste disposal, and an increased awareness of the costs associated with employees' health and safety, it has become imperative to develop structural adhesive bonding primers that do not contain chromates.

In Situ Remediation of Contaminated Aquatic Sediments - The objective of this SON is to develop innovative technologies for in situ remediation of contaminated aquatic sediments. Research may focus on development of new amendments, active caps, or other treatment methodology, as well as development of platforms or methods for delivery of amendments or active caps. Proposers should consider the following issues when developing and assessing the efficacy of their proposed technology:

- Ability to achieve chemical degradation or sequestration
- Bioavailability of sequestered contaminants
- Amendment placement, distribution, and stability
- Long-term effectiveness of amendment or active cap.

The focus of this SON is contaminated marine, estuarine, brackish, and freshwater sediments. Contaminants of most concern in sediments include polycyclic aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), and various metals and metalloids. While often a single type of contaminant dominates the risk and concomitant cleanup criteria at a given site or portion of a site, there are also many instances where a range of organic and inorganic contaminants are present and for these situations, the development of multifunctional amendments is a high priority.

Improved Understanding of Impacts to Groundwater Quality Post-Remediation - The objective of this SON is to develop an improved understanding of the near- and long-term impacts to groundwater quality after implementation of common in situ remediation approaches. In addition, development of methods to predict and/or monitor such impacts and adjust remediation strategies to minimize negative effects while achieving remedial goals is of interest. Common treatment approaches result in removal of chemical contamination of concern, but may produce an aquifer that is degraded in terms of other important groundwater quality parameters. This SON is focused on one or more of the following objectives:

- Improve our understanding of the impacts to groundwater quality due to implementation of common remediation approaches such as enhanced anaerobic remediation, thermal treatment, or in situ chemical oxidation.
- Develop methods and/or tools that will predict the near-term impacts of remediation efforts on groundwater quality and allow for the assessment of strategies to minimize negative effects while achieving remedial goals.
- Develop methods and/or tools to predict the long-term impacts to groundwater quality from remediation efforts and the potential for aquifer recovery.

Groundwater quality parameters of importance include dissolved metals, organic carbon amounts and quality, methane and otherwise hazardous gas generation, and geochemical parameters affecting natural attenuation processes.

iv. Sediments Management

Scope of Problem

Aquatic sediments are often the ultimate receptors of contaminants in effluent from DoD activities. Sediment contamination problems are particularly difficult because of the tendency for contaminants to be retained within sediments for a long time. According to an estimate by the U.S. EPA, approximately 10% or 1.2 billion cubic yards of the sediment underlying the country's surface water is sufficiently contaminated with toxic pollutants to pose potential risks to fish and to humans and wildlife that eat fish. This represents the upper five centimeters of sediment, where many bottom-dwelling organisms live, and where the primary exchange processes between the sediment and overlying surface water occur. Adverse ecological effects in fish from contaminated sediments include fin rot, increased tumor frequency, and reproductive toxicity. In addition, contaminated sediments can pose a threat to human health when pollutants in sediments accumulate in edible, aquatic organisms. However, the amount of contaminant available to the organisms exposed to the sediment is unclear, often resulting in overly conservative cleanup limits.

Sediment contaminants include a wide variety of compounds, such as, PAHs, PCBs, various metals and metalloids, and military-unique compounds such as MC. The sediment contamination problem is exacerbated by the need to periodically dredge deposited sediments to maintain navigable depths in waterways. Nearly 300 million cubic yards of sediment are dredged from U.S. ports, harbors, and waterways each year. It is estimated that approximately 5% to 10% of these dredged materials are impacted with organic and inorganic contaminants. As estuarine and coastal sites, in particular, fall under increasing scrutiny, the number of DoD sites requiring action is likely to increase. Efforts also are underway to develop rapid, routine methods for measuring the bioavailability of contaminants in sediment for plants and invertebrates.

Overview of Investment

Contaminated aquatic sediments represent a particularly complex issue that is growing in significance. SERDP is currently investing in R&D efforts to (1) improve understanding of the basic science in sediment management, (2) develop effective tools to characterize and manage these sites to reduce risk to human health and the environment (Figure II-14), and (3) gain regulatory acceptance of new restoration technologies. The following projects have been funded by SERDP to accomplish the Program's objectives for Sediments Management:

Figure II-14: Sediments from the Borden sand quarry showing an example of preliminary 'stair step' excavations.

FY 2009 Projects

- Quantifying Enhanced Microbial Dehalogenation Impacting the Fate and Transport of Organohalide Mixtures in Contaminated Sediments (ER-1492), Rutgers University
- Reactive Capping Mat Development and Evaluation for Sequestering Contaminants in Sediments (ER-1493), U.S. Navy, Naval Facilities Engineering Service Center (Completed)
- An Integrated Field and Laboratory Study of the Bioavailability of Metal Contaminants in Sediments (ER-1494), Stony Brook University, Marine Sciences Research Center (Completed)
- Modeling and Decision Support Tools Based on the Effects of Sediment Geochemistry and Microbial Populations on Contaminant Reactions in Sediments (ER-1495), Carnegie Mellon University
- Innovative In Situ Remediation of Contaminated Sediments for Simultaneous Control of Contamination and Erosion (ER-1501), Savannah River National Laboratory (Completed)
- Biological Processes Affecting Bioaccumulation, Transfer, and Toxicity of Metal Contaminants in Estuarine Sediments (ER-1503), Dartmouth College
- Sediment Ecosystem Assessment Protocol (SEAP): An Accurate and Integrated Weight-of-Evidence Based System (ER-1550), Wright State University
- Bacterial and Benthic Community Response to Inorganic and Organic Sediment Amendments (ER-1551), U.S. Navy, Space and Naval Warfare Systems Center (Completed)
- Measurement and Modeling of Ecosystem Risk and Recovery for In Situ Treatment of Contaminated Sediments (ER-1552), Stanford University

FY 2010 New Start Projects

- The Importance of Sorption in Low-Permeability Zones on Chlorinated Solvent Plume Longevity in Sedimentary Aquifers (ER-1738), University at Buffalo, The State University of New York

- Bioavailability and Methylation Potential of Mercury Sulfides in Sediments (ER-1744), Duke University
- Coupling Between Pore Water Fluxes, Structural Heterogeneity and Biogeochemical Processes Controls Contaminant Mobility, Bioavailability, and Toxicity in Sediments (ER-1745), Northwestern University
- Predicting the Fate and Effects of Resuspended Metal Contaminated Sediments (ER-1746), University of Michigan
- Robust Means for Estimating Black Carbon-Water Sorption Coefficients of Organic Contaminants in Sediments (ER-1747), Massachusetts Institute of Technology
- Development of an Electrochemical Surrogate for Copper, Lead, and Zinc Bioaccessibility in Aquatic Sediments (ER-1748), U.S. Geological Survey
- Verifying Food Web Bioaccumulation Models by Tracking Fish Exposure and Contaminant Uptake (ER-1749), Environmental Protection Agency – Potomac Yards South
- The Biology of Bioavailability: The Roles of Functional Ecology in Exposure Processes (ER-1750), U.S. Army Corps of Engineers, Engineer Research and Development Center

FY 2011 Initiatives

In the FY 2011 Solicitation, SERDP released one SEED SON concerning **Sediments Management**.

In Situ Remediation of Contaminated Aquatic Sediments - The objective of this Statement of Need (SON) is to develop innovative technologies for in situ remediation of contaminated aquatic sediments. Research may focus on development of new amendments, active caps, or other treatment methodology, as well as development of platforms or methods for delivery of amendments or active caps. Proposers should consider the following issues when developing and assessing the efficacy of their proposed technology: (1) Ability to achieve chemical degradation or sequestration; (2) Bioavailability of sequestered contaminants; (3) Amendment placement, distribution, and stability; and/or (4) Long-term effectiveness of amendment or active cap. The focus of this SON is contaminated marine, estuarine, brackish, and freshwater sediments.

v. Air Emissions

Scope of Problem

The 1990 Clean Air Act Amendments (CAAA), the Resource Conservation and Recovery Act (RCRA), and state and local regulations restrict the emission of air pollutants such as volatile organic compounds (VOCs). The production of ozone depleting substances (ODS) also has been banned under national policy and international (Montreal) protocol. Further, federal and state environmental agencies have been authorized to regulate particulate matter (PM) and PAH emitted from mobile and local sources.

Military bases increasingly are being identified as point sources of these air pollutants and are being held accountable for their emissions. DoD directives require significant reductions in hazardous air emissions and development of alternative materials and processes that meet environmental restrictions but that still allow DoD to continue operations in support of its national security

Figure II-15: Measuring emissions from a C-130H aircraft.

mission. Air emissions are generated from many sources on military installations—from painting and stripping of military equipment to weapon system platforms such as ships, airplanes, and ground vehicles that were originally designed for system performance (but without concern for air emissions) (Figure II-15). The Services and SERDP are supporting R&D of technologies that will reduce or eliminate air emissions regulated by the 10-year Surface Coating National Emission Standards for Hazardous Air Pollutants (NESHAP).

Overview of Investment

SERDP develops and promotes technologies and/or materials that eliminate, reduce, control, measure, and characterize environmentally damaging VOCs, hazardous air pollutants (HAPs), particulates, and ODSs from DoD platforms, weapons systems, and industrial processes. There is a need for technologies to rapidly detect and classify these compounds, and the control of these releases is required. Environmentally benign alternatives include new materials to replace these compounds, new processes that eliminate use of these compounds, and new processes that reduce or eliminate the production of these compounds as a by-product. In addition, developing a fundamental understanding of the formation and properties of air emissions enables the development and optimization of technologies and approaches to reduce them. SERDP has funded the following initiatives to accomplish the Program's objectives:

FY 2009 Projects

- Predictive Chemical and Statistical Modeling of Particulate Matter Formation in Turbulent Combustion with Application to Aircraft Engines (WP-1574), Stanford University
- Aromatic Radicals-Acetylene Particulate Matter Chemistry (WP-1575), University of Illinois (Completed)
- Effects of Soot Structure on Oxidation Kinetics (WP-1576), University of Utah (Completed)
- Combustion Science to Reduce PM Emissions for Military Platforms (WP-1577), U.S. Air Force, Air Force Research Laboratory
- Predicting the Effects of Fuel Composition and Flame Structure on Soot Generation in Turbulent Non-Premixed Flames (WP-1578), Sandia National Laboratory (Completed)
- Quantifying Sulfate, Organics, and Lubrication Oil in Particles Emitted from Military Aircraft Engines (WP-1625), Aerodyne Research, Inc.
- Measurement and Modeling of Volatile Particle Emissions from Military Aircraft (WP-1626), Carnegie Mellon University
- Development and Application of Novel Sampling Methodologies for Study of Volatile Particulate Matter in Military Aircraft Emissions (WP-1627), Oak Ridge National Laboratory

FY 2011 Initiatives

In the FY 2010 Solicitation, SERDP released one SON concerning **Air Emissions**.

Combustion Science to Predict Emissions From Military Platforms Burning Alternative Fuels: The objective of this SON is to advance the fundamental combustion science needed to predict the impact of alternate fuels on emissions from military gas turbine engines. Modeling and experimental approaches designed to improve our understanding and ability to predict the formation and evolution processes of nitrogen oxides (NOx), non volatile particulate matter (PM), unburned hydrocarbon (UHC), and carbon monoxide (CO) emissions when burning alternative fuels are requested. Computationally efficient and accurate models are needed for predicting both the impact on emissions from existing gas turbine engine designs and for designing next generation low-emissions, high-fuel-efficient military gas turbine engines burning alternative fuels. The fundamental understanding of NOx, PM, CO, and UHC emissions process

will result in models that can predict the impact of alternate fuels on engine emissions and become tools for optimizing the design of low emissions, fuel tolerate, and fuel efficient gas turbine combustion systems, reducing the substantial time and expense of engine testing to qualify each new fuel.

vi. Energetic Materials

Scope of Problem

Military munitions containing energetic materials are an essential part of the defense arsenal. They include not only gun rounds, missile propellants, and explosives, but also pyrotechnic materials such as flares and smokes. Millions of pounds of energetic materials are made each year, producing significant quantities of hazardous wastes (Figure II-16). These compounds are often found in the soil and groundwater at former and current ammunition manufacturing and load, assemble, and pack plants. The predominant energetic chemicals of environmental concern include TNT and RDX, which were often used in combination, and HMX. In addition, the amino reductive transformation products of TNT, such as 4-amino dinitrotoluene (4ADNT), are also toxic and have been detected in soil and groundwater.

Figure II-16: Hazardous waste can be produced from the emissions from Open Detonation operations.

Overview of Investment

To reduce current liabilities, SERDP is working to (1) improve the fundamental understanding of the microbial processes that degrade these contaminants and (2) search for ways to improve on these natural processes to remediate munitions contaminants. To reduce future liabilities, SERDP is working to develop new propellants, pyrotechnics, and explosive materials that will reduce or eliminate the release of toxic materials to the environment, yet still meet mission performance requirements. The following initiatives have been funded by SERDP to accomplish the Program's objectives in the area of Energetic Materials:

FY 2009 Projects

- Novel Electrochemical Process for Treatment of Perchlorate in Waste Water (ER-1433), Pacific Northwest National Laboratory
- Clean Electrochemical Synthesis of Alkylnitro Compounds (WP-1460), ATK Thiokol (Completed)
- Characterization and Fate of Gun and Rocket Propellant Residues on Testing and Training Ranges (ER-1481), U.S. Army Corps of Engineers, Cold Regions Research and Engineering Laboratory
- Sustainable Range Management of RDX and TNT by Phytoremediation with Engineered Plants (ER-1498), University of York
- Phytoremediation for the Containment and Treatment of Energetic and Propellant Material Releases on Testing and Training Ranges (ER-1499), The University of Iowa
- Rhizosphere Bacterial Degradation of RDX, Understanding and Enhancement (ER-1504), University of Washington

- A Portable Fiberoptic Surface Enhanced Raman Sensor for Real-Time Detection and Monitoring of Perchlorate and Energetics (ER-1602), Oak Ridge National Laboratory
- New Approaches to Evaluate the Biological Degradation of RDX in Groundwater (ER-1607), Shaw Environmental and Infrastructure, Inc.
- The Molecular Microbiology of Nitroamine Degradation in Soils (ER-1608), University of Washington
- Identification of Microbial Gene Biomarkers for In Situ RDX Biodegradation (ER-1609), U.S. Army Corps of Engineers, Engineer Research and Development Center
- Feasibility of New Technology to Comprehensively Characterize Air Emissions (WP-1672), U.S. Army Corps of Engineers, Engineer Research and Development Center
- Fate and Transport of Colloidal Energetic Residues (ER-1689), Shaw Environmental and Infrastructure, Inc.
- Dissolution Rate of Propellant Energetics from Nitrocellulose Matrices (ER-1691), U.S. Army Corps of Engineers, Cold Regions Research and Engineering Laboratory

FY 2010 New Start Projects

- Developing Quantum Chemical and Polyparameter Models for Predicting Environmentally Significant Parameters for New Munition Compounds (ER-1734), University of Delaware
- Fully in Silico Calibration of Empirical Predictive Models for Environmental Fate Properties of Novel Munitions Compounds (ER-1735), Oregon Health and Science University
- Development of an Environmental Fate Simulator for New and Proposed Military-Unique Munition Compounds (ER-1736), U.S. Environmental Protection Agency, Ecosystems Research Division
- Novel, Oxygen Rich Materials as Potential Ammonium Perchlorate Alternatives (WP-1764), U.S. Army, Aviation and Missile Research Development and Engineering Center
- Perchlorate and Halogen-Free High Energy Dense Oxidizers (HEDO) (WP-1765), Ludwig Maximilian University Munich
- Trinitromethyl Ethers and Other Derivatives as Superior Oxidizers (WP-1766), Naval Air Warfare Center Weapons Division

FY 2009 Workshops

DoD Environmentally Sustainable Energetics Workshop, Rockaway, New Jersey – Environmental, safety and occupational health laws and regulations have directly impacted training and production of energetic materials at U.S. military facilities. Examples include complete shut-down of live-fire training at the Massachusetts Military Reservation due to munitions constituents (perchlorate, RDX, etc.) in the groundwater, the inability to use perchlorate-containing simulators at many installations, and cessation of TNT production in the 1980s at Radford Army Ammunition Plant in Virginia. The objective of this workshop was to generate a strategy for the development and implementation of new, environmentally sustainable energetic materials for use in DoD weapons systems. This strategy considers the entire lifecycle of weapons systems that contain energetic materials and will aid in determining requirements for future investment of SERDP research funds. Representatives from the energetics acquisition community discussed program plans and key energetic material requirements for current and future weapons systems, as well as environmental issues specific to energetics. DoD and DOE representatives provided brief overviews of current energetics R&D programs, with an emphasis on the successful technologies developed under these programs and the current plan for energetics investments. Attendees were broken

out into designated groups to develop a coordinated research strategy based on the needs of weapons system program managers to guide future investments.

FY 2011 Initiatives

In the FY 2011 Solicitation, SERDP released two SONs concerning **Energetic Materials.**

Replacement of Hexachloroethane in Handheld Obscurants: The objective of this SEED SON is to develop an effective, safe, low-toxicity obscurant material for handheld applications where high volumes of smoke are required. Replacement materials developed under this SEED SON must demonstrate performance that is at least equivalent to hexachloroethane (HC)-based smokes used as obscurants. HC smoke contains high concentrations of hydrochloric acid, is toxic to humans, and under certain conditions can be an asphyxiant. Although there are alternatives to HC currently developed, these alternatives do not have the same performance as HC. An alternative is needed that can meet the performance of HC, but also is safe and non-toxic.

Environmentally Benign, Insensitive, Castable, High-Performance, Minimum-Smoke Rocket Propellant: The objective of this SON is to develop a new environmentally benign, insensitive, castable, high-performance, minimum-smoke rocket propellant formulation. The new formulation must meet all of the performance requirements associated with the current minimum smoke, double-based propellant. It must not contain lead, ammonium perchlorate or Cyclotrimethylenetrinitramine (RDX). It must also demonstrate a reduction in toxicity and meet insensitive munition (IM) requirements. Exposure to lead has been reported to produce a number of acute and chronic health effects, including damage to the central nervous system, cardiovascular system and immune system, even at very low levels and through multiple exposure routes. RDX is acutely toxic when ingested or inhaled in large doses, impacting the nervous system and causing seizures. Developing alternatives to RDX- and lead-based propellants would reduce the health risk to the soldiers, workers and communities in and around military installations.

vii. Hazardous Materials/Solid Waste

Scope of Problem

The majority of DoD maintenance and repair activities for weapon system components involve the use of toxic or hazardous substances. From the deicing of aircraft and runways to removing coatings from substances, hazardous substances are a DoD-wide problem. In addition to hazardous wastes, DoD must contend with the problem of nonhazardous solid waste. This waste includes the packaging materials needed to sustain personnel both at home and deployed in the field. The areas of hazardous and nonhazardous solid waste are a large environmental problem that DoD must try to resolve.

Figure II-17: Studies of the fundamental mechanisms of how methlyene chloride and phenolic coatings removers function will help aid the design of environmentally benign alternatives.

Overview of Investment

SERDP develops and promotes techniques and technologies that cost-effectively eliminate, reduce, or control hazardous materials and their release to soil, sediments, air, and groundwater. Eliminating hazardous materials from military platforms and weapons systems is the preferable solution; especially if there

will be no net loss of military capability with the alternative material (Figure II-17). In cases where environmentally benign alternatives have not been identified, control technologies, augmented with recycling and reuse methods as well as remedial technologies, need to be developed. SERDP has funded the following initiatives to accomplish the Program's objectives in Hazardous Materials/Solid Waste:

FY 2009 Projects

- PHA Bioplastic Packaging Materials (SI-1478), Metabolix, Inc. (Completed)
- Environmentally Benign Repair of Composites Using High Temperature Cyanate Ester Nanocomposites (WP-1580), Iowa State University (Completed)
- Solids Separation and Concentration of Shipboard Wastewaters and Residuals by a High Shear Rotary Membrane System (HSR-MS) (WP-1671), U.S. Navy, Naval Surface Warfare Center
- Environmentally Benign Aircraft Anti-Icing and De-Icing Fluids Based on Cost-Effective, Bio-Based Ingredients (WP-1678), Battelle Memorial Institute
- New Ionic Liquids from Natural Products for Environmentally Benign Aircraft De-Icing and Anti-Icing (WP-1679), U.S. Navy, Naval Air Warfare Center Weapons Division, China Lake (Completed)
- Understanding the Science Behind How Methylene Chloride/Phenol Chemical Paint Strippers Remove Coatings (WP-1680), University of Dayton
- The Science Underlying Methylene Chloride/Phenolic Paint Stripping (WP-1681), U.S. Navy, Naval Air Warfare Center Weapons Division, China Lake
- Scientific Basis for Paint Stripping Mechanism of Methylene Chloride/Phenol Based Paint Removers (WP-1682), U.S. Navy, Naval Air Systems Command

FY 2010 New Start Projects

- Environmentally Compliant Vinyl Ester Resin (VER) Composite Matrix Resin Derived from Renewable Resources (WP-1755), Foster-Miller, Inc.
- Identification of Important Process Variables for Fiber Spinning of Protein Nanotubes Generated from Waste Materials (WP-1756), U.S. Army Natick Soldier Center
- Directed Biosynthesis of Oriented Crystalline Cellulose for Advanced Composite Fibers (WP-1757), Oak Ridge National Laboratory
- Bio-Based Carbon Fibers and Thermosetting Resins for Use in DoD Composites Applications (WP-1758), U.S. Army Research Laboratory – Aberdeen Proving Ground
- Cyanate Ester Composite Resins Derived from Renewable Polyphenol Sources (WP-1759), Naval Air Warfare Center Weapons Division, China Lake
- Use of Nonthermal Plasma for Cleaning and Decontamination of Weapons Systems and Platforms (WP-1760), Oak Ridge National Laboratory
- Lipophilic Super-Absorbent Swelling Gels as the Cleaners for Use on Weapons Systems and Platforms (WP-1761), U.S. Army Corps of Engineers, Engineer Research and Development Center
- Atmospheric Plasma De-Painting (WP-1762), North Carolina State University
- Shelf Stable Epoxy Repair Adhesive (WP-1763), Infoscitex Corporation

FY 2011 Initiatives

In the FY 2011 Solicitation, SERDP released one SON concerning **Hazardous Materials/Solid Waste**.

Low Observable Coating Removal: The objective of this SON is to develop a large-scale process for removing low-observable (LO) coatings and treatments from Department of Defense (DoD) weapon systems. Coatings of interest include loaded urethane materials such as radar absorbing materials (RAM), loaded gap fillers and fastener filler materials. While the primary weapon systems of interest are current "stealth" aircraft, the coating removal technique should also have potential for use on other DoD weapon systems such as legacy aircraft with stealth treatments and unmanned aerial vehicles. This proposed research effort should greatly reduce the environmental impact of removing LO coatings from DoD weapon system platforms, as well as the total costs and process times. Other costs associated with providing worker protection and collecting and disposing of waste would be greatly reduced. Additionally, since legacy LO coating removal processes are principally manual in nature, they are inherently ergonomically challenging. The proposed effort will greatly reduce long-term impacts and costs associated with worker damage to hands and wrists from repetitive motion injuries.

viii. Emerging Contaminants

Scope of Problem

DoD has defined emerging contaminants as chemicals or materials of interest that are characterized by a perceived or real threat to human health or environment and/or a lack of a published health standards or an evolving standard. A contaminant may also be "emerging" because of the discovery of a new source, a new pathway to humans, or a new detection method or technology. In the past, SERDP has funded research on contaminants such as perchlorate, affording DoD a position at the forefront of characterization and remediation when public awareness increased. SERDP continues today with the process of early identification of emerging contaminants with relevance to DoD needs.

Overview of Investment

DoD has identified three chemicals that fall under the definition of an emerging contaminant. Specific emerging contaminants of interest include 1,4-dioxane, N-nitrosodimethylamine (NDMA) and 1,2,3-trichloropropane (TCP). All three are probable human carcinogens and may have other deleterious health effects as well: exposure to small amounts of 1,4-dioxane may lead to significant adverse health effects. Whereas, the main health effect of TCP in both animals and people is damage to the respiratory system. In general, these chemicals neither sorb to soil particles nor volatilize in groundwater, therefore they can persist and spread as groundwater contaminants.

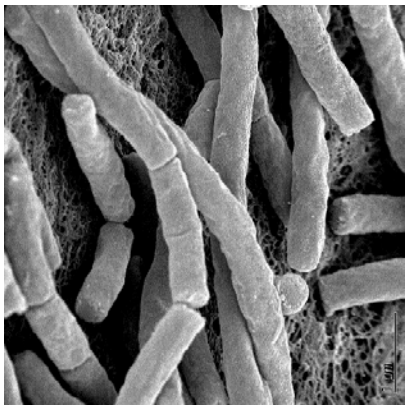


Figure II-18: CB1190 is the first bacterium confirmed to mineralize 1,4-dioxane to CO_2, and to use 1,4-dioxane as a carbon source for cell synthesis.

SERDP's goal for these emerging contaminants is to develop a fundamental understanding of the mechanisms involved in contaminant destruction, either via chemical or microbial means, to develop adequate remedial technologies (Figure II-18). Elucidation of the impact of co-contaminants on degradation processes is another important goal, along with the converse, namely improvement in understanding of the behavior of emerging contaminants under typical remedial technologies for co-contaminants. The goal is that these technologies developed under SERDP can then be transferred to enhance the remediation of these contaminants at DoD sites through further testing and evaluation under the other DoD programs such as

ESTCP. The following projects have been funded by SERDP to accomplish the Program's objectives in the area of Emerging Contaminants:

FY 2009 Projects

- Oxygenase-Catalyzed Biodegradation of Emerging Water Contaminants: 1,4-Dioxane and N-Nitrosodimethylamine (ER-1417), University of California at Berkeley
- Prospects for Remediation of 1,2,3-Trichloropropane by Natural and Engineered Abiotic Degradation Reactions (ER-1457), Oregon Health and Science University (Completed)

FY 2011 Initiatives

In the FY 2011 Solicitation, SERDP released one SON concerning **Emerging Contaminants**.

In Situ Remediation of Perfluoroalkyl Contaminated Groundwater – The objective of this Statement of Need (SON) is to seek fundamental or applied research to develop cost effective in situ treatment technologies for perfluoroalkyl-contaminated groundwater. Research is needed to better understand fate and transport properties of perfluoralkyl contaminants in groundwater, as well as to gain a basic understanding of the mechanisms involved in contaminant destruction, either via chemical, physical, or microbial means, in order to develop cost-effective remedial technologies. Consideration must also be given to common co-contaminants and how these co-contaminants impact degradation, and fate and transport. Proposed research should focus on one or more of the following specific objectives: (1) Improve the fundamental understanding of the mechanisms involved in fate and transport processes in groundwater under varying natural and engineered conditions; (2) Determine the impact of co-contaminants on fate and transport processes; (3) Improve the understanding of the behavior of perfluoroalkyl contaminants under typical remedial technologies for co-contaminants. For example, perfluorooctane sulfonic acid (PFOS) and perfluorooctanoic acid (PFOA) may be present at sites contaminated with petroleum hydrocarbons and possibly chlorinated solvents (e.g., historical fire training sites); therefore, understanding the fate of PFOS and PFOA during monitored natural attenuation or enhanced anaerobic dechlorination is critical; and/or (4) Develop remedial strategies for perfluororalkyl contaminants, including consideration of the necessity for treatment train approaches to facilitate treatment of co-contaminants. Contaminants of interest include perfluoroalkyl sulfonates and perfluoroalkyl carboxylates, such as PFOS and PFOA, contained in historical aqueous film forming foam (AFFF) formulations.

ix. Energy

Scope of Problem

DoD occupies over 620,000 buildings and structures worth $600 billion that are located on more than 400 installations in the United States. DoD spends over $2.5 billion per year on facility energy consumption. DoD is the largest single energy consumer in the Nation representing 78% of the federal sector, and a significant (and sometimes the largest) energy user in many local metropolitan areas. Additionally, deployed forces have special energy needs requiring innovative technology solutions. It is the DoD policy to increase energy conservation, reduce energy demand, and increase the use of renewable energy to improve energy flexibility to not only save financial resources and reduce emissions but to also ensure the uninterrupted operation of installations in the U.S. and enhance personnel capabilities the security of deployed troops in the field.

Overview of Investment

Decreased dependence on fossil fuels and increased energy security are major goals within DoD. Both of these goals suggest that the DoD considers diversifying its current sources of energy by exploring both efficient, energy producing and energy conserving technologies. To achieve these, DoD needs to explore all alternatives, including expanding the use of renewable energy systems such as wind, solar, geothermal, biomass, and biofuels, and other advanced non-polluting distributed energy resource technologies (for example, fuel cells and microturbines). SERDP seeks to develop technologies that can be applied to ranges, installations, and deployed forces (Figure II-19). The following initiatives have been funded by SERDP to accomplish the Program's objectives in the area of Energy.

Figure II-19: Light-weight, small-form factor, soldier-portable advanced thermoelectric power system.

FY 2009 Projects

- Modeling and Simulation of a Distributed Generation-Integrated Intelligent Microgrid (SI-1650), Virginia Polytechnic Institute (Completed)
- Efficient Thermoelectric Power Conversion of Waste Heat for Deployed Forces (SI-1651), RTI International (Completed)
- Advanced Soldier Thermoelectric Power System for Power Generation from Battlefield Heat Sources (SI-1652), Pacific Northwest National Laboratory
- A Systems Approach to Increase DoD Building Energy Efficiency (SI-1709), United Technologies Research Center
- Feasibility and Guidelines for the Development of Microgrids in Campus-Type Facilities (SI-1710), Virginia Polytechnic Institute

D. SERDP Projects of the Year

Each year, SERDP recognizes significant R&D accomplishments with its Project of the Year awards. The awards are presented at the annual Partners in Environmental Technology Technical Symposium & Workshop hosted by SERDP and its sister program, ESTCP. More than 1100 environmental professionals from government agencies, academia, and the private sector participated in the conference, which was held December 1-3, 2009, in Washington, D.C.

SERDP Projects of the Year for Environmental Restoration

Phytoremediation for the Containment and Treatment of Energetic and Propellant Material Releases on Testing and Training Ranges – Dr. Jerald L. Schnoor, The University of Iowa, Department of Civil and Environmental Engineering, Iowa City, Iowa
Sustainable Range Management of RDX and TNT by Phytoremediation with Engineered Plants – Dr. Neil C. Bruce, University of York, Centre for Novel Agricultural Products, York, United Kingdom

Dr. Jerald Schnoor and his team from the Department of Civil and Environmental Engineering at The University of Iowa received a Project-of-the-Year Award for Environmental Restoration for advancing the understanding of how existing, naturally occurring native plants, through the process of phytoremediation, can degrade and contain certain toxic energetic compounds such as RDX that

contaminate subsurface soils on the ranges. The fundamental molecular biology conducted by these researchers has vastly improved scientific understanding of the structure and the mechanisms of the enzymes that have been identified in the microorganisms that degrade the toxic energetic compounds. Their findings provide the knowledge needed to make more effective and efficient use of naturally occurring grasses on ranges to support phytoremediation.

For their work in addressing the challenge posed by TNT, an energetic compound that is toxic to many plants, Dr. Neil Bruce and his team from the University of York Centre for Novel Agricultural Products (United Kingdom), University of Washington, and U.S. Army Engineer Research and Development Center-Cold Regions Research and Engineering Laboratory also received a Project-of-the-Year Award for Environmental Restoration. These researchers succeeded in creating transgenic grasses with unique abilities both to detoxify TNT and degrade RDX. This work is a huge leap forward in developing grasses with specific abilities for use on training ranges. Using genetic engineering techniques in greenhouse settings to develop the transgenic grasses, the researchers modified grasses that naturally grow on DoD ranges, so as to avoid introducing invasive plant species. The findings from this project represent a crucial step in the process that eventually could result in the widespread use of engineered plants to remove toxic energetic compounds from the soil on military training ranges.

SERDP Project of the Year for Munitions Management

Wide Area Detection and Identification of Underwater UXO Using Structural Acoustic Sensors – Dr. Brian H. Houston, Naval Research Laboratory, Washington, D.C.

A significant number of active and former Department of Defense installations have adjacent coastal and inland waters containing military munitions, some partially or completely buried in sediment and some lying on the sediment floor. There is little historical information about the locations or quantities of munitions in the underwater environment so technologies are needed to efficiently assess potentially contaminated areas. Existing underwater search techniques are limited in part because they are unable to see beneath the sediment floor. Dr. Bucaro and his project team have developed an effective technique for wide-area detection and identification of underwater munitions using an innovative structural acoustic sonar system. Instead of using images, structural-acoustics uses the "ringing" that objects make when hit by soundwaves. By analyzing the sound patterns and tone, researchers are able to discern information about the size and nature of the material. This technology holds tremendous potential to provide DoD with a new capability to identify and characterize underwater munitions sites at high coverage rates.

SERDP Project of the Year for Sustainable Infrastructure

Application of Landscape Mosaic Technology to Complement Coral Reef Resource Mapping and Monitoring – Dr. Pamela Reid, University of Miami, School of Marine and Atmospheric Science, Miami, Florida

Coral reefs are threatened and in decline across the globe. To monitor the health of a reef and assess impacts and recovery, DoD needs an accurate depiction of large areas of the reef so as to compare its condition over long periods of time. In the past, divers would be sent down to characterize a reef's condition, but that approach was costly and inefficient and it did not provide a consistent historical record or a quantitative assessment. Dr. Reid and her research team have developed an innovative technology that increases the speed and repeatability with which reef plots can be mapped and inventoried. Remotely operated underwater video is used to create two-dimensional spatially accurate reef mosaics. These mosaics can serve as a tool for monitoring disease, injury, bleaching, and mortality—important indicators of reef health. This technology will provide accurate and defensible inventories of coral reefs under DoD purview.

SERDP Project of the Year for Weapons Systems and Platforms

Alternative for Perchlorates in Incendiary Mix and Pyrotechnic Formulations for Projectiles – Dr. Trevor T. Griffiths, QinetiQ Ltd., Sevenoaks, Kent, United Kingdom

Perchlorate is a contaminant of significant environmental concern throughout the nation. There are many sources of perchlorate including the military, which uses it as a high energy oxidizer in rocket propellants and pyrotechnics. Perchlorate can be released into the environment during manufacture, demilitarization, or when ammunition fails to function correctly. Dr. Griffiths and his colleagues developed environmentally benign, perchlorate-free incendiary and pyrotechnic mix formulations for projectiles such as those used in tanks and howitzers. The ingredients used in these formulations can be obtained readily and their cost is comparable with those presently used for the incendiary compositions. The results of this project demonstrate that perchlorate can be eliminated from these applications without degrading their performance. Perchlorate-free alternatives will enable the Department of Defense to significantly reduce human health and environmental risks while sustaining essential training activities.

III. MANAGEMENT ACTIONS

A. SERDP Council Actions

Multiagency participation is a clear strength of the Program.

Multiagency management and oversight of SERDP continues to be one of the clear strengths of the Program. Active participation by the members of the SERDP Council, their designated representatives on the EWG, and the STCs precludes duplication of effort, ensures quality Program content, and facilitates information transfer. This tripartite arrangement, composed of executive, programmatic, and technical individuals who represent the three primary participating organizations, yields a depth and breadth of knowledge and experience at several levels of management and technical expertise that lend significant credibility to the Program.

On September 29, 2008, the SERDP Council approved the FY 2009 Program Plan and the FY 2010 Investment Plan. For FY 2009, SERDP was appropriated $63.038M.

The Council met one year later on September 29, 2009, to approve the FY 2010 Program. The President's Budget Request for SERDP for FY 2010 was $69.175M, representing a slight increase from the FY 2009 appropriation. The congressional appropriation for FY 2010 is $69.128M. The Council approved the FY 2010 Core program as presented. The Council further granted the Executive Director the authority to execute any congressional interest projects to ensure that they are appropriately focused on defense issues.

B. Executive Director and Program Office

The SERDP Executive Director, Deputy Director, and Program Office staff continued to ensure that the Program focuses on the mission needs of the DoD via refining and implementing an investment strategy that successfully satisfies these mission needs. In FY 2009, the Executive Director and Program Office staff continued the Program's emphasis on (1) research to support the sustainability of range operations and the reduction of current and future liabilities; (2) solicitation and selection of proposals from the broadest possible pool of world class researchers; and (3) promotion of technology transfer to ensure the rapid transition of innovative technologies to the DoD user community.

i. Continued Emphasis on Munitions Response and Range Sustainability and New Initiatives in Energy and Climate Change

SERDP continued to implement its investment strategy that frames research topic areas in terms of DoD priorities. The strategy is based on the premise that the Department's environmental issues fall into two major areas. The first area is **Sustainability of Ranges and Range Operations**, which includes maritime sustainability, TER-S, clearance of UXO on active ranges, toxic air emissions and dust, urban growth and encroachment, and noise. The second area of the SERDP investment strategy is **Reduction of Current and Future Liability**, which addresses (1) contamination from past practices and includes research on munitions response, chlorinated solvents, heavy metals, contaminated sediments, and emerging contaminants such as perchlorate and (2) material substitution and new processes to control life-cycle costs, which includes elimination of hazardous materials to reduce the cost of operation, repair, and demilitarization as well as achieving compliance through pollution prevention.

The continuing SERDP investment in UXO detection and discrimination as well as the emphasis on range sustainability research over the past several years reflects SERDP's focus on priority investment opportunities. According to recent estimates, the cost to cleanup UXO is estimated to be in the tens of billions of dollars. SERDP's belief is that the development of advanced technology can reduce this cost by nearly 70%. Therefore, in FY 2009, SERDP continued to invest heavily in innovative UXO detection and discrimination technologies with an emerging emphasis on UXO in the underwater environment. Furthermore, the UXO Program Plan undergoes a thorough peer review every year to ensure that it properly characterizes the broad problem, establishes clear and logical goals, and identifies specific, relevant, near-term technical objectives.

SERDP also continued to fund research in DoD's SROC key environmental areas related to the sustainability of training and testing ranges, including: MC, TER-S, maritime sustainability, air quality, noise, and urban encroachment. Investments in these areas spanned the Environmental Restoration, Sustainable Installations, and Weapons Systems and Platforms Focus Areas of SERDP. SERDP funded research to provide range managers with techniques to assess the potential for soil or groundwater contamination, to remediate such contamination, and to reduce or eliminate future contamination.

Beginning in FY 2007, SERDP also began to address issues related to energy and climate change and their impacts on DoD facilities. Executive Order 13423 required that all Federal Agencies improve energy efficiency and reduce greenhouse gas emissions via the reduction of energy intensity and the use of renewable energy sources. Both of these goals require that the DoD develop energy conservation and energy efficiency technologies as well as diversify its current sources of energy. SERDP responded by issuing an SON on Scalable Power Grids that Facilitate the Use of Renewable Energy Technologies and another SON on Innovative Technologies for Electricity Production from Waste Heat for Deployed Forces. SERDP continues to seek to develop new energy technologies that can be applied to ranges, installations, and deployed forces. Section II.C.ix-Energy provides an overview of SERDP's investment in energy technologies, including five projects funded in FY 2009.

Climate change in general and sea level rise in particular have potential ramifications for National Security. Legislation in the FY 2008 Defense Authorization Bill was enacted that includes a section entitled: *Department of Defense Consideration of Effect of Climate Change on Department Facilities, Capabilities and Missions*. This legislation directs the Defense Department to provide guidance to military planners to assess the risks of potential climate change and to include an assessment in the next Quadrennial Defense Review of the Armed Forces capabilities to respond to the consequences of climate change. In response to these developments, SERDP issued an SON to fund research beginning in FY 2009 to assess the potential impacts of sea level rise on military infrastructure. Section II.B.x-Sea Level Rise provides an overview of SERDP's investment in this area, including four projects planned that began in FY 2009.

ii. Performance Metrics for SERDP Projects

SERDP uses a number of key metrics to maintain the quality and enhance the success of SERDP projects, beginning with proposal review and continuing throughout project execution and completion.

World class research is considered the cornerstone of SERDP projects. SERDP again solicited proposals from all sources, including the private and academic research sectors. SERDP uses independent external Peer Reviewers and the expertise of the SAB to help review and assess the technical quality of proposals to ensure that the most technically sound efforts performed by world class researchers are selected for funding. Proposal review metrics include scoring criteria that are used to assess the quality of the proposal technical merit, qualifications of the research team, proposed cost and the transition potential.

Timely and thorough financial and technical reporting are keys to ensuring the success of SERDP projects. The SERDP Executive Director has continued to ensure that the Program complies with the DoD fiscal guidance. Effective controls include monthly financial reports and quarterly technical reports that summarize the status of each research project and provide notification of any areas of concern. This reporting and project monitoring is conducted via an online management system in which researchers can upload project information and SERDP staff can conduct real-time assessments of technical and financial progress. SERDP also employs in-progress reviews (IPRs) of projects at which funded researchers at least once per year present the technical and financial status of their research to the SERDP Staff and members of the STCs. Metrics for technical and financial progress used by the SERDP Staff and STC members include the proposed technical project milestones and the proposed financial plan. When appropriate, SERDP requests adjustments to the technical direction of research based on interim results and may implement corrective actions to ensure effective use of limited R&D resources.

iii. Technology Transfer

Since 1991, SERDP has funded more than 850 individual projects. Several avenues are taken to ensure that the successful efforts of the research teams are transitioned to either demonstration and validation programs, such as ESTCP, or implemented directly into field use.

Technology transfer and transition continued to be a primary area of focus during annual project reviews by the SERDP Staff and STCs. All Principal Investigators (PI) are required to prepare Quarterly Progress Reports and Interim Reports that serve as a fundamental baseline of technical progress. At the end of each project, a Final Technical Report is required. These reports are maintained in an online library maintained by SERDP and ESTCP. Additionally, they are entered into the Defense Technical Information Center (DTIC) document system.

SERDP has posted Fact Sheets on its web site for every SERDP funded project, past and present. These Fact Sheets include summaries of the technical objectives, project accomplishments and potential benefits of each project. The SERDP web site also provides links to web sites maintained by SERDP researchers that give additional information about technologies developed under SERDP.

Each year, SERDP, in cooperation with ESTCP, hosts the *Partners in Environmental Technology Technical Symposium & Workshop*. This event has, for the past eleven years, attracted hundreds of researchers, technology developers and users, and regulators to meet in a collegial and informative setting. In December 2009, the annual Symposium once again succeeded in providing an excellent technology transfer and networking forum for researchers, scientists, and engineers from both the federal laboratory system and the nonfederal sector alike. The Symposium focused on “Meeting DoD’s Environmental Challenges” in recognition of the fact that, while significant advances have been made in addressing environmental issues, additional challenges continue. This event brought more than 1100 technology developers and implementers together, as well representatives from the policy, programmatic, regulatory, academic, and industrial sectors. SERDP offered three short courses on environmental restoration technologies and two short courses on munitions response tools to more than 300 attendees during this event to promote technology transfer of SERDP and ESTCP funded research and technologies to the user community. The annual SERDP Project-of-the-Year Awards were given to the best projects in each of the four Focus Areas for FY 2009. These awards have successfully attracted the attention of the scientific and engineering community around the globe and have measurably helped either to transition this technology into higher development programs or to implement its use in field applications. This conference, which has received numerous accolades, will continue to be enhanced to serve as a significant technical, educational, and technology transfer event.

C. Actions of the SERDP Scientific Advisory Board

In accordance with Section 2904, Title 10, U.S.C., the SERDP SAB is required to meet a minimum of four times during the fiscal year. In FY 2009, the SAB met four times. Consistent with the statute, the Board made recommendations to the SERDP Council through the Executive Director regarding the projects reviewed. They also assisted and advised the Council in identifying opportunities and provided advice on other environmental issues within the scope of SERDP.

Figure III-1 provides a list of dates and locations of all SAB meetings held during FY 2009. In accordance with the Federal Advisory Committee Act, all meetings were open to the public and detailed records of events are maintained. Further, all records, reports, working papers, and agendas were made available to the public for review. In FY 2009, no requests were made to review this information.

SAB Meeting Number	Date	Location	Projects Briefed		
			New Start	Continuing	Total
1	October 28-30, 2008	Arlington, VA	18	0	18
2	March 11-12, 2009	Arlington, VA	6	2	8
3	June 9-10, 2009	Durham, NC	0	1	1
4	September 9-11, 2009	Arlington, VA	18	0	18

Figure III-1. Summary of FY 2009 SAB Meetings.

The Board continued its proactive role in identifying and defining environmental research gaps and recommending technology development opportunities. The Board continued to support strongly the concept of focused technical workshops to provide an assessment of the state of the science and identify and prioritize specific research needs in areas of interest to SERDP. Several Board members actively participated in these workshops.

During their review and evaluation of proposals, the SAB conscientiously scrutinized each effort to understand and enhance the research that was proposed. Cooperative research efforts encouraged by the SAB have demonstrated a higher quality of effort by ensuring collaboration and synergies that might not otherwise occur. Where appropriate, the SAB suggested improvements or additions to the research team —from inclusion of a Co-PI having specific disciplinary credentials that would enhance the research effort to offering suggestions of organizations that might shed additional light and enhance the metrics and procedures proposed in the effort. The SAB also strongly encouraged inclusion of graduate students in research teams to promote training and foster development of technical expertise in cutting-edge technologies.

The Board continued its key role to ensure that SERDP-supported projects meet the highest standard of technical and scientific quality. The SAB addressed this issue from three avenues.

- First, the SAB firmly supports SERDP's procedure to have each and every proposal reviewed by at least three Peer Reviewers who are experts in the discipline most closely related to the proposal's technical approach.
- Second, the members encouraged close coordination between projects that address related problems.
- Third, the Board fully supported the yearly In-Progress Review of each project by the SERDP Staff and members of the STCs.

The SAB continued to emphasize technology transfer potential as an important criterion for evaluating proposals. Technology transfer is one of the SERDP Keys to Success, and the Board members continued

their keen interest in the role of the military Services and eventual users of the technologies being developed. Complete technical reporting, including publication in the peer-reviewed literature as well as SERDP-required interim and final technical reports, was a metric used to determine project technical achievement and management acumen.

The SAB continued its participation in the planning and execution of the annual *Partners in Environmental Technology Technical Symposium & Workshop* sponsored by SERDP. During strategy discussions at SAB meetings, the members offered comments on the overall theme of the Symposium and suggestions for technical session topics and plenary and session speakers. The active involvement of the SAB has been a significant contributing factor to the overall success of each Symposium.

In the past the SAB has suggested areas of opportunity for SERDP investment. Often, these areas prove to become the focus of a national or worldwide research effort. An example of research that commenced at the suggestion of the Board is the remediation of groundwater contaminated with perchlorate. Due to their proactive thinking, SERDP was able to get a head start on understanding this phenomenon and initiating research to resolve associated issues.

Consistent with past practice, the Executive Director solicited the advice of the membership regarding his proposed allocation of funds among the four Focus Areas for FY 2010. The Board was fully supportive of the proposed profile and general trends of investment within each of the four Focus Areas. A summary of all projects reviewed by the SAB and the results of their deliberations may be found in Figure III-2. The SAB reviews all new start projects and selected continuing projects upon request.

At the September 2009 SERDP Council meeting, Dr. Ellen Mihaich, Chair of the SAB, noted how the Board strives to ensure that SERDP research is focused on high-priority DoD needs and that technology transfer is fostered to users in the field. Dr. Mihaich expressed her continued support of the Program stating that, during her tenure, SERDP has continued to ensure that only the highest quality research is funded. She noted that the Board members, who represent a diverse group of highly respected experts, truly believe in the value and effectiveness of the program and acknowledge that SERDP research is well published and is recognized worldwide.

D. FY 2010 Program

In FY 2010, SERDP will aggressively respond to the increasing challenges of environmental issues impacting training and testing activities as well as the remediation of groundwater at military installations as well as lands contaminated with UXO. SERDP is also funding efforts to characterize fugitive dust emissions from DoD activities and to understand and restore ecosystems on military installations in the Southwestern United States. SERDP will also fund research to identify environmentally benign substitutes and processes for materials and components used in a variety of weapons systems and platforms Specifically, in response to the President's FY 2010 budget request and subsequent congressional changes, SERDP in FY 2009 issued SONs for projects to begin in FY 2010 in each of the four Focus Areas to address the following issues:

Environmental Restoration

- Predictive Techniques for Assessment of the Environmental Impact of New Munition Compounds
- The Impact of Contaminant Storage in Low-Permeability Zones on Chlorinated Solvent Groundwater Plumes

Project Number	Recommendation				FY09 Meeting Date				New Starts	Continuing Projects
	Funded		Not Funded		1	2	3	4		
	FY09	FY10	FY09	FY10	Oct-08	Mar-09	Jun-09	Sep-09		
MM-1658	$ 369				Y				•	
MM-1669	$ 250				Y				•	
MM-1664	$ 268				Y				•	
MM-1657	$ 500				Y				•	
MM-1662	$ 324				Y				•	
MM-1667	$ 790				Y				•	
MM-1666	$ 386				Y				•	
WP-1673	$ 987				Y				•	
WP-1674	$ 509				Y				•	
WP-1672 (1)					Y					•
WP-1680	$ 249				Y				•	
WP-1681	$ 256				Y				•	
WP-1682	$ 633				Y				•	
SI-1699	$ 501				Y				•	
SI-1697	$ 299				Y				•	
SI-1700	$ 352				Y				•	
ER-1685	$ 503				Y				•	
ER-1704	$ 496				Y				•	
ER-1705	$ 132				Y				•	
SI-1702	$ 449					Y			•	
SI-1703	$ 807					Y			•	
SI-1701	$ 314					Y			•	
SI-1698	$ 278					Y			•	
SI-1547 (1)						Y				•
MM-1533 (1)						Y				•
MM-1708	$ 252					Y			•	
MM-1573	$ 250					Y				•
WP-1672	$ 755					Y			•	
SI-1413		$ 2,767					Y			•
WP-1758		$ 556						Y	•	
WP-1763	$ 300	$ 533						Y		•
MM-1711		$ 496						Y	•	
MM-1712 (2)				$ 274				Y	•	
MM-1713		$ 244						Y	•	
MM-1714 (2)				$ 212				Y	•	
SI-1721 (2)				$ 484				Y	•	
SI-1722		$ 390						Y	•	
SI-1723		$ 326						Y	•	
SI-1727		$ 288						Y	•	
SI-1725		$ 541						Y	•	
SI-1726		$ 279						Y	•	
SI-1724		$ 299						Y	•	
ER-1741		$ 126						Y	•	
ER-1742		$ 534						Y	•	
ER-1743		$ 509						Y	•	
ER-1747		$ 120						Y	•	
ER-1746		$ 335						Y	•	
TOTALS	**$11,209**	**$ 8,343**		**$ 970**						

(1) Project update to Board; no vote on funding required.
(2) Projects presented at the September meeting and were approved at the October 2009 Meeting.

Figure III-2. Summary of Proposals Reviewed by SAB in FY 2009 by Focus Area (Funding in Thousands)

- Mechanisms of Contaminant Interaction with Soil Components and Its Impact on the Bioavailability of Contaminants
- Improved Fundamental Understanding of Contaminant Bioavailability in Aquatic Sediments

Munitions Management

- Advanced Technologies for Detection, Discrimination, and Remediation of Military Munitions
- Improvements in the Detection and Remediation of Military Munitions Underwater
- SEED: Advanced Technologies for Detection, Discrimination, and Remediation of Military Munitions on Land and Underwater

Sustainable Infrastructure

- Southwest Ecological Systems on Department of Defense Lands: Altered Fire Regimes and Non-Native Invasive Plants
- Managing and Restoring Southwest Intermittent and Ephemeral Stream Systems on Department of Defense Lands
- Fugitive Dust Emissions Due to Department of Defense Activities
- SEED: Innovative Control/Eradication Approaches for the Brown Tree Snake (*Boiga irregularis*)

Weapons Systems and Platforms

- Scientific Understanding of the Impact of Lead-Free Electronics
- Environmentally Benign Alternatives to Sulfur Hexafluoride in Department of Defense Applications
- Sustainable Materials and Processes for Resins and Fibers Used in Military Composites
- Environmentally Friendly, Non-Aqueous Cleaners for Use on Weapons Systems and Platforms
- Environmentally Benign, High-Performance Non-Media Paint Strippers
- SEED: Replacement of Ammonium Perchlorate in Tactical Missile Rocket Motors

In developing the FY 2010 program, 17 SONs were prepared, with 3 issued specifically for the SEED program. All SONs were made available to the private sector via a BAA, as well as all federal research centers. The Core solicitation resulted in 276 preproposals submitted by nonfederal participants a large increase from the previous year. Of the 196 full proposals that were received from both federal and nonfederal participants in response to the Core Solicitation, 46 were selected for funding. In the SEED solicitation, of the 39 proposals that were received, 9 were selected for funding. Figures III-3 and III-4 depict the distribution of Core and SEED proposals selected during the FY 2010 program development process.

CORE PROPOSALS					
Thrust Area	Number of Proposals Selected	Source			Approximate Value (in millions)
		Federal	Academia	Private	
Environmental Restoration	17	4	12	1	3.977
Munitions Management	6	2	1	3	1.675
Sustainable Infrastructure	10	1	9	0	3.622
Weapons Systems and Platforms	13	7	2	4	4.606
Total	46	14	24	8	13.880

Figure III-3. FY 2010 Core New Start Proposal Distribution by Focus Area.

SEED PROPOSALS					
Focus Area	Number of Proposals Selected	Source			Approximate Value (in millions)
		Federal	Academia	Private	
Environmental Restoration	0	0	0	0	0
Sustainable Infrastructure	3	2	1	0	0.408
Weapons Systems and Platforms	3	2	1	0	0.450
Munitions Management	3	0	1	2	0.440
Total	9	4	3	2	1.298

Figure III-4. FY 2010 SEED New Start Proposal Distribution by Focus Area.