SERDP & ESTCP Announce 2017 Projects of the Year

Notable Efforts Include Research on Management of Fluorochemical Contamination & Unexploded Ordnance in the Underwater Environment

THE STRATEGIC ENVIRONMENTAL Research and Development Program (SERDP) and the Environmental Security Technology Certification Program (ESTCP) have selected nine "Projects of the Year" in recognition of outstanding research and technology developments that will benefit the Department of Defense (DoD). These efforts are helping DoD enhance its mission capabilities, improve its environmental performance and reduce costs. The following are recipients of this honor and descriptions of their award-winning projects.

Environmental Restoration
SERDP Project-of-the-Year Award

Characterization of the Fate and Biotransformation of Fluorochemicals in AFFF-Contaminated Groundwater at Fire/Crash Testing Military Sites

Professor Jennifer A. Field,
Oregon State University

Per- and polyfluoroalkyl substances (PFAS) are common contaminants at sites where aqueous film forming foam (AFFF) was used. Up until 2011, the understanding of the composition of individual PFASs and their precursors in AFFF formulations and their impact on priority pollutant biotransformation was limited

Professor Jennifer Field from Oregon State University and her team led a project that aimed to fully delineate the PFASs that persist in AFFF-contaminated groundwater, sediment and soil and evaluate their impact on priority pollutant biotransformation. The study developed analytical tools and provided analytical advances for a more complete characterization of AFFF-contaminated media. Over the course of the project, over 50 classes of PFASs comprised of several individual homologs were identified.

A complete characterization of AFFF-impacted sites leads to a better understanding of the effectiveness of treatment technologies. Biotransformation pathways of these

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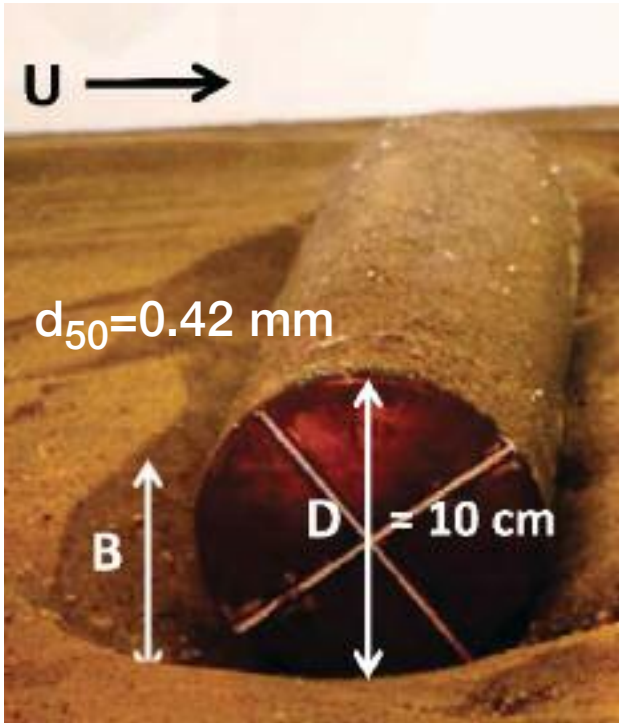
Characterization of AFFF-impacted sites will lead to more effective remediation strategies.



Parametrized models help predict the behavior of munitions underwater.

These models provide an improved and unified understanding of fundamental parameters in the interactions of munitions-sized objects with sediments.

compounds also provide a framework for understanding the fate of the precursors and insight into the conditions that leads to high concentrations of persistent fluorotelomer sulfonates.

Munitions Response SERDP Project-of-the-Year Award

Simple Parameterized Models for Predicting Mobility, Burial and Re-exposure of Underwater Munitions

Dr. Carl Friedrichs
Virginia Institute of Marine Science

SERDP has been sponsoring development of a simple, engineering model of mobility, burial and re-exposure of unexploded ordnance (UXO) and UXO-like objects for a number of years. An essential first step in construction of the model was the compilation of existing measurements on items ranging from UXO and UXO-like objects to river cobbles from across the DoD, engineering and scientific community and development of a simple framework to reconcile and understand the totality of the prior work. This framework would have the added benefit of guiding the measurements to be made via SERDP.

Dr. Carl Friedrichs from the Virginia Institute of Marine Science and his team developed simple, parameterized models for predicting munitions' behavior underwater. These models provide an improved and unified understanding of fundamental parameters in the interactions of munitions-sized objects with sediments. The parameterized model relations have been incorporated into more complex tools designed to guide DoD installation personnel in the management of underwater UXO sites.

Resource Conservation and Resiliency SERDP Project-of-the-Year Award

Assessing Climate Change Impacts for DoD Installations in the Southwest United States during the Warm Season

Dr. Christopher L. Castro
University of Arizona

Over the past sixty years, there have been important long-term changes in atmospheric conditions during the annual monsoon period in the southwestern United States. Given the potential impact of these changes and the risk they pose to infrastructural limits and operational capabilities of the many DoD facilities in the region, the DoD requested an evaluation of the changes in extreme weather during the late summer. As a result, this research directly supports DoD's requirement to manage installation assets to sustain the national defense mission (DoD Directive 4715.1).

Dr. Christopher Castro from the University of Arizona and his team evaluated how warm season extreme weather events in the Southwest will change with respect to occurrence and intensity. The project addressed several key questions including the consideration of existing operational protocols for weather and climate related decision making, creation of climate change projection information at an appropriate spatial scale and consideration of extreme weather and climate events. The data was gathered and then used to inform adaptation strategies.

This project resulted in a physically robust and computationally efficient methodological approach to the projection of extreme event weather in the Southwest that could be easily adapted for other regions of the United States and the world. A convective permitting modeling approach adds substantial value to the projection of extreme weather by pinpointing the spatial locations within the Southwest with a high degree of accuracy where precipitation is becoming more intense.

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A better understanding of the changes in extreme weather events will help DoD manage infrastructure and operations in the Southwest.

Weapons Systems and Platforms SERDP Project-of-the-Year Award

MEMS-Enabled Reliable Submunition

Mr. Charles H. Robinson & Mr. Jeffrey R. Smyth
U.S. Army Armament Research, Development and Engineering Center

Contamination of military ranges from low order detonation and unexploded submunitions is a significant environmental and personnel safety concern for DoD. Even the acceptable failure rate of submunitions results in a significant number of items that must be removed from DoD training ranges.

Mr. Charles Robinson, Mr. Jeffrey Smyth and their team from the U.S. Army Armament Research, Development and Engineering Center (ARDEC) addressed this issue by focusing on the development of microelectro-mechanical system (MEMS) enabled safety and arming submunition fuze-technology. Research into this technology stems

MEMS-enabled reliable submunitions reduce the instances of UXO and low order detonations on DoD ranges.

from an updated DoD policy on reducing the rate of UXO for all submunitions to less than one percent by 2018. The technology eliminates causes of submunition unreliability and also contributes to alternative concepts to comply with DoD policies to reduce or eliminate lead energetic materials from fuze components. Physical dimensions of MEMS devices can vary in size between several millimeters to smaller than one-micron. An improved detonation propagation mechanism was demonstrated in MEMS-scale fuzing devices. This provides an improvement over legacy lead-based initiator technologies with less-reliable direct-contact initiation mechanisms that may require unreliable mechanical air gaps.

Development was aided through leveraging efforts by the Joint Services Small Arms Program, the Small Arms Grenade Munition Program and the Cluster Munition Replacement Program. The MEMS-enabled reliable submunition program and output-technology provides a transferrable solution for improved munition-fuze reliability, reduced UXO and improved safety that can lead to submunition designs that comply with DoD policy.

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Energy and Water ESTCP Project-of-the-Year Award

Geothermal Heat Pumps with Underground Thermal Energy Storage

Mr. Charles Hammock
Andrews, Hammock & Powell, Inc.

Conventional geothermal heat pumps (GHP) heating, ventilating and air conditioning (HVAC) systems are considered one of the most efficient active HVAC systems. GHPs use 25 to 50 percent less electricity and offer energy savings of up to 40 percent compared to the conventional heating or cooling systems. They are quieter, last longer, need little maintenance and do not depend on the temperature of the outside air. However, conventional GHP ground-source designs are susceptible to performance deterioration in applications where annual heating and cooling loads are imbalanced. In facilities that are cooling dominant, which applies to most DoD installations, this load imbalance can lead to higher supply water temperatures over time and cause the operating efficiencies of the water-cooled GHP to decrease.

Mr. Charles Hammock from Andrews, Hammock & Powell, Inc. and his team demonstrated the performance and savings of an innovative system design, which couples a GHP system with underground thermal energy

By combining a GHP with underground thermal energy storage, DoD is able to realize significant reductions in energy and water use for the heating and cooling of buildings.

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storage (UTES). This system demonstrates higher energy savings not only by capturing the waste heat of cooling systems and the waste cool of heating systems, but also by capturing out-of-season winter's "cold" or summer's "heat," if needed, in cooling-dominated or heating-dominated buildings respectively. The demonstration of this project included installation of two types of GHP-UTES HVAC systems installed at two different locations—Borehole Thermal Energy Storage (BTES) System, installed at the Marine Corps Logistic Base (MCLB) in Albany, Georgia and the Aquifer Thermal Energy Storage (ATES) installed at Fort Benning, Georgia.

The technology demonstration was successful resulting in the reduction of HVAC energy by nearly 50 percent and the elimination of cooling tower water use—a reduction of 4.2 million gallons a year. Impressed by these results, MCLB's (Albany, Georgia) Installation & Environment Division funded three new BTES systems to serve an additional 10 buildings at MCLB. In addition to the improved energy and water performance of the new BTES systems, the bid for these projects came in under the budget for the traditional GHP system designs.

Environmental Restoration ESTCP Project-of-the-Year Award

1,4-Dioxane Remediation by Extreme Soil Vapor Extraction

Dr. Rob Hinchee,
Integrated Science & Technology, Inc.

1,4-Dioxane, a cyclic diether used as an additive in chlorinated solvents, is a common and persistent groundwater contaminant. While conventional soil vapor extraction (SVE) can remove some 1,4-dioxane, a substantial residual source is left behind causing long-term groundwater contamination. Due to the compound's complete miscibility in water, 1,4-dioxane becomes sequestered in the vadose zone pore water, which serves as a long-term source of groundwater contamination.

Dr. Rob Hinchee from Integrated Science & Technology, Inc. and his team led a project that aimed to evaluate and demonstrate the efficacy of enhanced or extreme soil vapor extraction (XSVE) designed specifically to remove 1,4-dioxane from the vadose zone by incorporating enhancements such as increased air flow, increased temperature and focused vapor extraction. (Note: The vadose zone is the Earth's terrestrial subsurface that extends from the surface to the groundwater table.)

A screening-level mass and energy balance model, HypeVent XSVE, was developed to simulate the remediation of 1,4-dioxane by XSVE.

The study results indicate that 1,4-dioxane concentrations in the treatment zone decreased about 95 percent and soil moisture decreased about 45 percent. Downward migration of 1,4-dioxane due to condensation was not observed. HypeVent XSVE adequately simulated 1,4-dioxane removal, soil moisture and soil temperatures observed during the demonstration. Sensitivity analyses showed that 1,4-dioxane removal benefited considerably from heated air injection.

XSVE has been demonstrated to be a cost-effective remediation approach for 1,4-dioxane in the vadose zone,

XSVE was demonstrated as an effective remediation approach for 1,4-dioxane contaminated groundwater.

The study results indicate that 1,4-dioxane concentrations in the treatment zone decreased about 95 percent and soil moisture decreased about 45 percent.

which may reduce the need for long-term groundwater remediation. HypeVent XSVE has been demonstrated to be a useful feasibility assessment and design tool for XSVE of 1,4-dioxane.

Munitions Response ESTCP Project-of-the-Year Award

Development of Blast-Barge Technology for Underwater Munitions Demolition

Mr. Timothy W. Shelton
U.S. Army Corps of Engineers
Engineer Research and Development Center

Disposal of underwater UXO encountered during a munitions response is commonly conducted using two primary methods—tow-to-shore and blow in place. Tow-to-shore operations require transporting UXO from an underwater site to the shore for disposal. This process requires evacuating the surrounding area and endangers DoD personnel who handle and transport UXO. In many places, shore access is not available. Blow in place or in situ remediation of underwater UXO present challenges as well. Blow in place operations expose the marine environment to potential damage and are not allowed at many remediation sites.

Blast barge technology has been demonstrated as a safe and sustainable solution for disposal of underwater UXO.

Mr. Timothy W. Shelton with the U.S. Army Corps of Engineers, Engineer Research and Development Center (ERDC) and his team developed and demonstrated a mobile blast barge system to provide improved remediation options to DoD personnel. The system consists of a blast box that can withstand the blast environment created during UXO disposal fitted to a standard barge. The blast barge system can be constructed using commercially available parts, is reusable and is easily transportable to various locations.

Mr. Shelton and his team used a combination of numerical modeling, scaled simulations, subscale experiments and field demonstrations to mature a robust platform. Fifty-five experiments were conducted from 2016 to 2017, during which time the blast box has not shown any signs of damage and scaled explosive weights used during testing have far exceeded anticipated prototype weapon sizes.

In addition to developing a robust platform, hydrophone data has been collected from every explosive event during experiments and testing. Data collected from these events will be used to quantify sound wave propagation from an explosive detonation occurring above the water and determine the potential impacts of these disruptions to marine mammals. Data collected will also help researchers determine the path for continued development of the blast barge technology. These data sets will be used to validate numerical models that will predict sound impacts beyond the limits of the explosive masses tested during the demonstrations.

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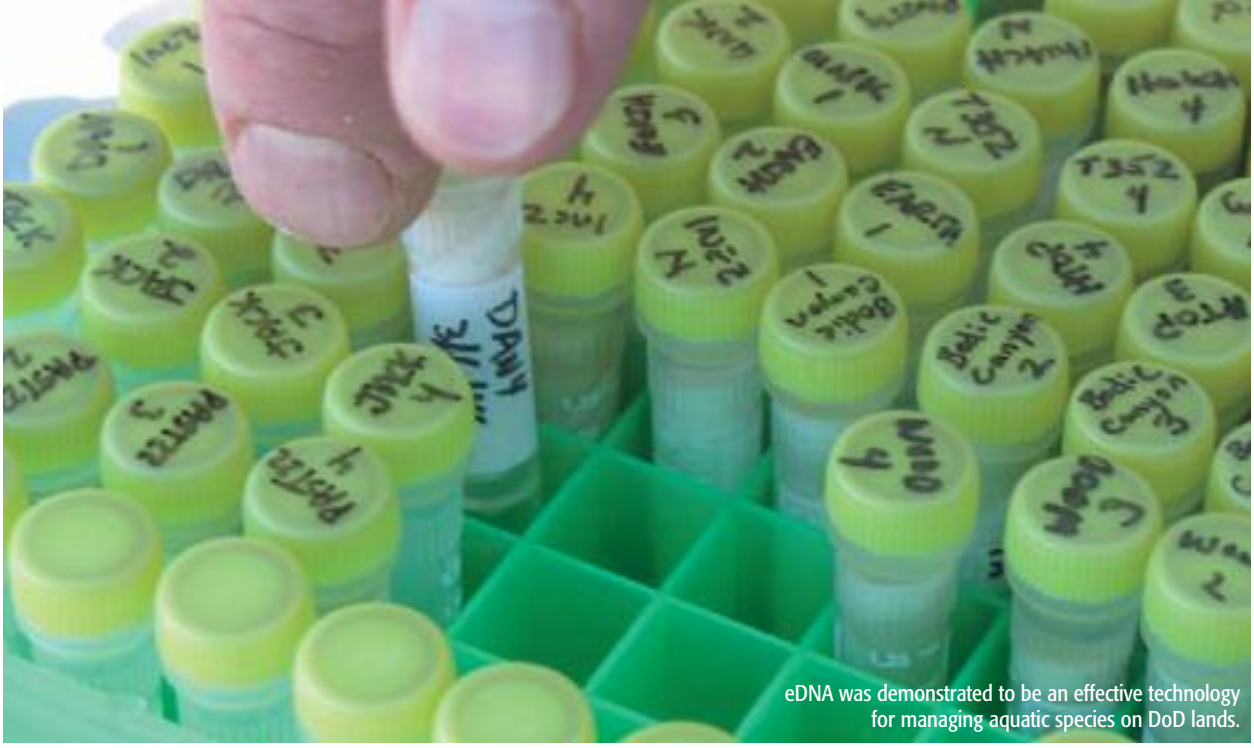

eDNA was demonstrated to be an effective technology for managing aquatic species on DoD lands.

Resource Conservation and Resiliency ESTCP Project-of-the-Year Award

Environmental DNA as a Tool for Inventory and Monitoring of Aquatic Vertebrates

Dr. Alexander Fremier &
Dr. Caren Goldberg
Washington State University

Detection of amphibian and fish species using conventional survey methods is not always possible. At least 22 at-risk amphibian species and over 40 at-risk fish species are known to occur on DoD lands. For elusive species, such as many amphibians and fishes, lack of reliable monitoring data can lead to an underestimate of the species' distribution. An efficient alternative to traditional field surveys is the use of environmental deoxyribonucleic acid (eDNA) to detect species presence. Animals shed cells with their DNA into the environment regularly through the shedding of skin, mucous and excrement. By sampling this shed DNA, researchers can infer a species' presence in the sampled environment using existing genetic methods.

Dr. Alexander Fremier, Dr. Caren Goldberg and their team from Washington State University led an ESTCP-funded project that demonstrated the effectiveness of environmental DNA techniques for monitoring sensitive aquatic vertebrate species and their invasive threats at three DoD installations. The team developed and validated eDNA sampling protocols for a variety of aquatic species, including frogs, salamanders, fish and disease-causing pathogens. In addition, the eDNA protocol results were compared to traditional field sampling with respect to sensitivity, detection probabilities and cost efficiency.

This demonstration showed that eDNA can be a sensitive and cost-effective technology for monitoring aquatic species under a range of conditions that included factors expected to limit eDNA detection. Techniques used during this demonstration are helping inform ongoing natural resource management activities including development of species-specific endangered species management plans, Section 7 consultations with the U.S. Fish and Wildlife Service and early detection and control of invasive aquatic species that may prey on or hybridize with native species.

Weapons Systems and Platforms ESTCP Project-of-the-Year Award

Zirconium Oxide Pretreatment for Military Coating Systems

Mr. Fred L. Lafferman
U.S. Army Research Laboratory

Finishing systems for military vehicles require pretreatments that enhance adhesion and provide resistance to corrosion. These treatments either

The use of zirconium oxide pretreatments will result in a significant reduction in DoD's usage of hexavalent chromium and other hazardous materials.

About SERDP & ESTCP

SERDP AND ESTCP are DoD's environmental research programs, harnessing the latest science and technology to improve DoD's environmental performance, reduce costs and enhance and sustain mission capabilities. SERDP and ESTCP respond to environmental technology requirements common to all of the military Services, complementing the Services own research programs. The programs promote partnerships and collaboration among academia, industry, the military Services and other Federal agencies. Investments are managed in five program areas:

1. Energy and Water
2. Environmental Restoration
3. Munitions Response
4. Resource Conservation and Resiliency
5. Weapons Systems and Platforms

SERDP and ESTCP are independent programs managed from a joint office to coordinate the full spectrum of efforts, from basic and applied research to field demonstration and validation.

SERDP is DoD's environmental science and technology program, planned and executed in partnership with the Department of Energy and the U.S. Environmental Protection Agency, with participation by numerous other federal and non-federal organizations. The program focuses on cross-service requirements and pursues solutions to the Department's environmental challenges while enhancing and sustaining military readiness.

ESTCP is DoD's environmental technology demonstration and validation program. Project researchers conduct formal demonstrations at DoD facilities and sites in operational settings to document and validate improved performance and cost savings. Demonstration results are subject to rigorous technical reviews to ensure that the conclusions are accurate and well supported by data.

For more information, visit www.serdp-estcp.org.

This study provides an alternative to both zinc-phosphate with chromate post-rinse for ferrous substrates or hexavalent- and trivalent-chromium containing etch-primers and conversion coatings for aluminum substrates.

directly contain toxic metals or require a sealer or other rinse products that do.

To address this issue, Mr. Fred Lafferman and his team at the U.S. Army Research Laboratory demonstrated a zirconium-pretreatment technology as a replacement for existing aluminum and steel pretreatments at military depots. This provides an alternative to both zinc-phosphate with chromate post-rinse for ferrous substrates or hexavalent- and trivalent-chromium containing etch-primers and conversion coatings for aluminum substrates. Demonstrations were conducted at the Anniston Army Depot, Letterkenny Army Depot and Marine Depot Maintenance Command-Production Plant, Albany.

Performance testing of the demonstration parts and panels from the three demonstrations, including laboratory accelerated corrosion testing and seacoast environmental testing, have confirmed that the zirconium technology provides performance that is equal to both zinc phosphate and the aluminum conversion coatings. Due to the performance of this technology, it is anticipated that it will be qualified to a number of military specifications. This qualification will allow this technology to be transitioned into DoD facilities. This advancement increases the sustainability of DoD platforms and reduces risk of exposures to the warfighter and maintenance personnel. ⚓

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