Summary of Projects & Activities under SERDP & ESTCP Addressing Issues Associated with Per- and Polyfluorinated Alkyl Substances (PFASs)

The first two links below provide a summary as of April 2016 of the research and demonstrations funded by SERDP & ESTCP addressing issues associated with perfluoroalkyl compounds. Following this, a summary of upcoming key events, a summary of two FY18 SERDP Statement of Needs, and a summary of each funded project is provided. Funded projects are grouped by (1) fate, transport and characterization, (2) treatment, (3) ecological effects, and (4) development of alternatives to PFOS and PFOA in AFFF.

- Summary of PFOS/PFOA Efforts under Environmental Restoration Program Area (April 2016)
  https://www.serdp-estcp.org/News-and-Events/Blog/Advances-in-Perfluoroalkyl-Chemicals-PFCs-Characterization-and-Remediation
- Webinar held on 28 January 2016: Per- and Polyfluoroalkyl Substances (PFASs): Analytical and Characterization Frontiers
  https://www.serdp-estcp.org/Tools-and-Training/Webinar-Series/01-28-2016

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Key Events

February 14, 2017: In Progress Review Presentations for projects addressing ecotoxicity of PFASs as well as ER-201633.

May 2-3, 2017: Strategic Workshop to discuss research and demonstration needs for addressing issues associated with PFASs within the context of occurrence, fate, transport, and remediation. To be held at the Navy Yard, Washington, D.C.

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FY18 SERDP Statement of Need: Improved Understanding of Per- and Polyfluoroalkyl Substance Source Zones

Goal

- To improve our understanding of PFASs in source zones resulting from the use of Aqueous Film Forming Foam (AFFF) formulations by the DoD.
- Better understand the fate of precursor compounds and the role they play in sustaining perfluoroalkyl acid (PFAA) groundwater plumes, as well as the contribution to groundwater contamination of residual PFAS mass in near surface soils.

Progress: Proposals are currently under review. Selections will be made in July 2017, with Scientific Advisory Board evaluation in Fall 2017. Project initiation will be in early 2018.

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FY18 SERDP Statement of Need: In Situ and Ex Situ Remediation of Per- and Polyfluoroalkyl Substance Contaminated Groundwater

Goal: To develop cost-effective in situ or ex situ remedial technologies for groundwater contaminated with PFASs resulting from the use of AFFF formulations
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Progress: Proposals are currently under review. Selections will be made in July 2017, with Scientific Advisory Board evaluation in Fall 2017. Project initiation will be in early 2018.

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Fate, Transport and Characterization Projects

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

Goal: To fully delineate the fluorochemicals that persist in AFFF-contaminated groundwater, sediment, and soil and evaluate their impact on priority pollutant transport and bioremediation so that we can understand which breakdown products are of most concern.

Progress: Have identified the PFASs in the different AFFF formulations, determined the potential for biotransformation, and characterized sorption of PFASs to soils and sediments under conditions representative of military sites.

Final Products: Final Report due September 2016; numerous journal articles; follow on effort under ESTCP (described below; ER-201574)

Lead Investigator: Jennifer Field (Oregon State University)

Web Site: https://www.serdp-estcp.org/Program-Areas/Environmental-Restoration/Contaminated-Groundwater/Emerging-Issues/ER-2128/ER-2128

Behavior of Perfluoroalkyl Chemicals in Contaminated Groundwater (SERDP)

Goal: Evaluate the relative importance of key physicochemical and biological parameters in determining the fate and transport of PFCs in groundwater, both in the presence of common co-contaminants and during remediation of co-contaminants.

Progress: Traditional in situ chemical oxidation (ISCO), as commonly applied to groundwater, is unlikely to degrade perfluoroalkyl acids (PFAAs), but will strongly affect their transport in the subsurface. In addition, research showed that PFAAs recalcitrance could have adverse impacts on microbial processes used for bioremediation of co-mingled chlorinated solvents such as trichloroethene (TCE).

Final Products: Final Report submitted and to be posted in May 2016

Lead Investigator: Christopher Higgins (Colorado School of Mines)

Web Site: https://www.serdp-estcp.org/Program-Areas/Environmental-Restoration/Contaminated-Groundwater/Emerging-Issues/ER-2126/ER-2126

Catalyzing Rapid Information Transfer among Key Stakeholder on Per- and Polyfluoroalkyl Substances (PFASs) at contaminated Military Sites (ESTCP)

Goal: To expedite the transfer of a base of knowledge of both the types of PFASs that occur at military sites as well as how they can be reliably measured in environmental media to the target audiences.

Progress: On site analytical workshops have been held and will be complete within the next few months. The remaining tech transfer products will be completed by May 2017.

Final Products: An extended Reference Document and a succinct Frequently Asked Questions (FAQ) sheet, videos, on-line workshops for RPMs, and on-site “hands-on” workshops for vendor (commercial) laboratories.

Lead Investigator: Jennifer Field (Oregon State University)

Web Site: https://serdp-estcp.org/Program-Areas/Environmental-Restoration/Contaminated-Groundwater/Emerging-Issues/ER-201574-T2

Characterization of the Nature and Extent of Per-and Polyfluoroalkyl Substance (PFASs) in Environmental Media at DoD Sites for Informed Decision-Making (ESTCP)
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Goal: To characterize the total footprint of PFAS contamination at field sites to enable fingerprinting of AFFF-based sources as compared to non-AFFF sources as well as to determine the nature and extent of PFAS source areas at Navy and other DoD sites.

Progress: Only recently initiated work in 2016. This project will provide results of recent efforts to the ER Technical Committee in July 2016.

Final Products: Final report due in 2018. The team also plans tech transfer efforts through micro-lectures and a one- to two-page summary of results.

Lead Investigator: John Kornuc (NAVFAC EXWC)

Web Site: https://www.serdp-estcp.org/Program-Areas/Environmental-Restoration/Contaminated-Groundwater/Emerging-Issues/ER-201633/ER-201633

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Treatment Projects

Field Demonstration to Enhance PFAS Degradation and Mass Removal Using Thermally-Enhanced Persulfate Oxidation Followed by Pump-and-Treat (ESTCP)

Goal: To demonstrate a cost-effective in situ treatment train approach to destroy and capture PFAS, thereby reducing contaminant mass and the overall duration and cost of remediation. Our approach utilizes a combination of thermally-enhanced persulfate oxidation and ex situ GAC sorption.

Progress: FY17 new start project. Project will be initiated in early 2017.

Final Products: Final Report due March 2020.

Lead Investigator: John Kornuc (NAVFAC EXWC)

Web Site: Not yet available.

Development of Coupled Physicochemical and Biological Systems for In Situ Remediation of Perfluorinated Chemical and Chlorinated Solvent Groundwater Plumes (SERDP)

Goal: To develop and test highly reactive materials capable of degrading and/or sequestering PFAS and chlorinated ethenes and to develop biological systems to treat chlorinated ethenes and PFAS reaction byproducts following sorptive and reactive treatment. The treatment performance of the combined physicochemical and biological systems will then be evaluated.

Progress: FY17 new start project. Project will be initiated in early 2017.

Final Products: Final Report due 2020.

Lead Investigator: Kurt Pennell (Tufts University)

Web Site: Not yet available.

In Situ Remediation of Aqueous Film Forming Foams and Common Co-Contaminants with the Dual Approach of Chemical Oxidation and Bioremediation (SERDP)

Goal: To develop knowledge leading to an in situ groundwater remediation strategy for mixtures of perfluorinated compounds persistent in AFFF with chlorinated compounds and 1,4-dioxane as co-contaminants. Overall goal is to establish optimal combinations of ISCO and bioremediation processes to clean up multiple contaminants.

Progress: FY17 new start project. Project will be initiated in early 2017.

Final Products: Final Report due 2020.

Lead Investigator: Lisa Alvarez-Cohen (University of California, Berkeley)

Web Site: Not yet available.

A Novel Reactive Electrochemical Membrane System for Treatment of Mixed Contaminants (SERDP)
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Goal: Develop novel reactive electrochemical membrane (REM) system to treat mixed contaminants of concern (COCs) that are commonly present in groundwater at DoD sites, including perfluoroalkyl acids (PFAAs).
Progress: FY17 new start project. Project will be initiated in early 2017.
Final Products: Final Report due 2018.
Lead Investigator: Qingguo Huang (University of Georgia)
Web Site: Not yet available.

Synergistic Treatment of Mixed 1,4-Dioxane and Polyfluorinated Chemical Contaminations by Combining Electrolytic Degradation with Electrobiostimulation (SERDP)
Goal: To determine the efficacy of electrolytic water treatment for the remediation of groundwater contaminated by mixed COCs, including PFASs and 1,4-dioxane in the presence of chlorinated solvents.
Progress: FY17 new start project. Project will be initiated in early 2017.
Final Products: Final Report due 2020.
Lead Investigator: Jens Blotevogel (Colorado State University)
Web Site: Not yet available.

Key Fate and Transport Processes Impacting the Mass Discharge, Attenuation, and Treatment of Poly- and Perfluoroalkyl Substances and Comingled Chlorinated Solvents or Aromatic Hydrocarbons (SERDP)
Goal: To better understand fundamental fate and transport processes in mixed contaminant systems that include PFASs to facilitate the development and optimization of treatment strategies for management of PFAS sites comingled with co-contaminants.
Progress: FY17 new start project. Project will be initiated in early 2017.
Final Products: Final Report due 2020.
Lead Investigator: Chris Higgins (Colorado School of Mines)
Web Site: Not yet available.

In Situ Treatment Train for Remediation of Perfluoroalkyl Contaminated Groundwater: In Situ Chemical Oxidation of Sorbed Contaminants (ISCO-SC) (SERDP)
Goal: To develop a predictable and low cost in situ treatment train for remediating perfluoroalkyl contaminated groundwater toward expedited closure of DoD sites. The approach takes advantage of the key features of two current best practices for treatment of perfluoroalkyl contaminated water, sorption onto granular activated carbon (GAC) and destruction using activated persulfate oxidation, while overcoming key limitations of each.
Progress: Researchers have shown rapid and extensive sorption onto GAC; activated persulfate then breaks down PFOS & PFOA into smaller compounds. ***This project will provide results of recent research to the ER Technical Committee on May 16, 2016.***
Final Products: Final Report due March 2017.
Lead Investigator: Michelle Crimi (Clarkson University)
Web Site: https://www.serdp-estcp.org/Program-Areas/Environmental-Restoration/Contaminated-Groundwater/Emerging-Issues/ER-2423/ER-2423

Development of a Novel Approach for In Situ Remediation of PFC Contaminated Groundwater Systems (SERDP)
Goal: To develop a cost-effective, in situ method using coagulants to sequester six PFASs in groundwater systems to prevent their migration to drinking water supplies. The central hypothesis is that the addition of chemical coagulants used in the drinking water industry will enhance PFAS sorption to

the soil, preventing mobility. Also, the effect, if any, of co-contaminants (e.g., fuels) on PFAS enhanced sorption and retardation will be assessed.

Progress: A select coagulant has been shown to successfully reduce PFOS concentrations to below 0.3 µg/L. Studies will continue with this coagulant at larger scales. ***This project will provide results of recent research to the ER Technical Committee on May 16, 2016.***

Final Products: Final Report due July 2017

Lead Investigator: Matt Simcik (University of Minnesota)

Web Site: https://www.serdp-estcp.org/Program-Areas/Environmental-Restoration/Contaminated-Groundwater/Emerging-Issues/ER-2425/ER-2425

Quantification of In Situ Chemical Reductive Defluorination (ISCRD) of Perfluoroalkyl Acids in Groundwater Impacted by AFFFs (SERDP)

Goal: To develop reductive technologies as a first step in remediating PFOS as a representative PFAS. Researchers will determine optimal conditions and the effectiveness of a subset of reductive technologies and couple the most successful reductive approaches to oxidative technologies to obtain highly effective destruction in a cost-effective in situ treatment train.

Progress: Have improved analytical extraction and detection of PFCs, a key challenge. Have identified a catalyst that appears to be successful in degrading PFOS. ***This project will provide results of recent research to the ER Technical Committee on May 16, 2016.***

Final Products: Final Report due February 2017

Lead Investigator: Linda Lee (Purdue University)

Web Site: https://www.serdp-estcp.org/Program-Areas/Environmental-Restoration/Contaminated-Groundwater/Emerging-Issues/ER-2426/ER-2426

Bioaugmentation with Vaults: Novel In Situ Remediation Strategy for Transformation of Perfluoroalkyl Compounds (One-year proof of concept study) (SERDP)

Goal: To develop an in situ remediation technology using enzymes packaged into vaults that will facilitate biodegradation of difficult-to-treat chemicals such as poly- and perfluoroalkyl compounds (PFCs). Vaults are naturally-occurring particles found in a wide range of organisms that can house nearly 100 enzymes.

Progress: The project has been successful at constructing vaults and using them to package and deliver enzymes. The researchers have not yet been successful at demonstrating significant degradation of target chemicals.

Final Products: Final Report submitted and to be posted in May 2016

Lead Investigator: Shaily Mahendra (UCLA)

Web Site: https://www.serdp-estcp.org/Program-Areas/Environmental-Restoration/Contaminated-Groundwater/Emerging-Issues/ER-2422/ER-2422

Investigating Electrocatalytic and Catalytic Approaches for In Situ Treatment of Perfluoroalkyl Contaminants in Groundwater (SERDP)

Goal: To develop and assess the use of electrocatalytic and catalytic approaches for in situ treatment of PFASs in groundwater.

Progress: The project has been successful at identifying substances capable of defluorinating PFOS. Additional studies are being conducted at larger scale.

Final Products: Final Report due May 2017.

Lead Investigator: Charles Schaefer (CDM Smith)

Web Site: https://www.serdp-estcp.org/Program-Areas/Environmental-Restoration/Contaminated-Groundwater/Emerging-Issues/ER-2424/ER-2424

Ecological Effects Projects

Development of Toxicity Reference Values (TRVs) for Birds Exposed to PFOS, PFOA and Associated Mixtures of Fluorinated Compounds (SERDP)
Goal: Development of toxicity reference values for birds.
Progress: Approved by the Scientific Advisory Board in October 2015. Not yet on contract.
Final Products: Final Report due 2019.
Lead Investigator: Matt Simcik (University of Minnesota)
Web Site: https://serdp-estcp.org/Program-Areas/Environmental-Restoration/Contaminated-Groundwater/Emerging-Issues/ER-2624

Development of Toxicity Data to Support Toxicity Reference Values for Perfluorinated Compounds (SERDP)
Goal: Development of toxicity data for mammalian species.
Progress: Presenting before the Scientific Advisory Board in June 2016; not yet approved.
Final Products: Final Report due 2019.
Lead Investigator: Michael J Quinn (U.S. Army Public Health Command)

Development of Amphibian Poly- and Perfluoroalkyl Substances Toxicity Reference Values for Use in Ecological Risk Assessment at Aqueous Film Forming Foam Sites (SERDP)
Goal: Development of toxicity reference values for amphibians.
Progress: Approved by the Scientific Advisory Board in October 2015. Not yet on contract.
Final Products: Final Report due 2019.
Lead Investigator: Maria Sepulveda (Purdue University)
Web Site: https://serdp-estcp.org/Program-Areas/Environmental-Restoration/Contaminated-Groundwater/Emerging-Issues/ER-2626

Advancing the Understanding of the Ecological Risk of Per- and Polyfluoroalkyl Substances (SERDP)
Goal: Development of toxicity data for fish, reptiles and invertebrates. Also, to develop and validate a low-cost, prioritization protocol for evaluating other PFASs that may drive risks at DoD sites. This improved understanding of the ecotoxicity of perfluorinated compounds and evaluation protocol can help guide site-specific risk assessment needs.
Progress: Approved by the Scientific Advisory Board in October 2015. Not yet on contract.
Final Products: Final Report and Prioritization Protocol due 2019.
Lead Investigator: Christopher Salice (Towson State University)
Web Site: https://www.serdp-estcp.org/Program-Areas/Environmental-Restoration/Risk-Assessment/ER-2627/ER-2627

Development of Fluorine Free AFFF

The link below provides a summary of the need statement and of two research and development projects recently approved and funded by SERDP for development of fluorine free AFFF. Following this, a summary of each funded project is provided.

- SERDP Statement of Need published for FY17 new starts

https://serdp.org/content/download/35979/344522/version/3/file/WPSON-17-01_Fluorine-Free+AFFF.pdf

- Two core projects were selected and ultimately approved by the SERDP Scientific Advisory Board, the Executive Working Group and the SERDP Council.
- One limited scope effort focused on the synthesis of alternative surfactants will be initiated shortly.

Fluorine-free Foams with Oleophobic Surfactants and Additives for Effective Pool Fire Suppression (Development of Fluorine Free AFFF)(SERDP)

Goal: The objective of this project is to develop a fluorine-free, firefighting surfactant formulation that meets the performance requirements of MIL-F-24385F and is an environmentally friendly drop-in replacement for the current environmentally hazardous AFFF.

Progress: Approved by the Scientific Advisory Board in September 2016. Funds distributed.

Final Products: Final Report due 2020.

Lead Investigator: Ramogopal Ananth (Naval Research Laboratory)

Web Site: https://serdp.org/Program-Areas/Weapons-Systems-and-Platforms/Waste-Reduction-and-Treatment-in-DoD-Operations/WP-2739/WP-2739

Fluorine-Free Aqueous Film Forming Foam

Goal: The objective of this project is to use scientific methods to increase understanding of the physical and chemical processes that underlie fire-fighting foams, and how the components of a foam formulation can deliver the properties required for good fire performance whilst minimizing environmental burdens. Statistical methods will be employed to develop a fluorine-free surfactant formulation that meets the performance requirements defined in MIL-F 24385

Progress: Approved by the Scientific Advisory Board in September 2016. Contract expected to be in place shortly.

Final Products: Final Report due 2020.

Lead Investigator: John Payne (National Foam)

Web Site: https://serdp.org/Program-Areas/Weapons-Systems-and-Platforms/Waste-Reduction-and-Treatment-in-DoD-Operations/WP-2738/WP-2738