Briefing to Congress on Best Practices for Cleanup Technologies and Disposal of Soils, Filters, and Aqueous Film Forming Foam Containing Perfluorooctane Sulfonate (PFOS) and Perfluorooctanoic Acid (PFOA), and Required Additional Research

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The estimated cost of this report or study for the Department of Defense is approximately $10,400. This includes $200 in expenses and $10,200 in DoD labor. Cost estimate generated on date, October 17, 2019 RefID: D-2B406C9

Purpose

- **Official Response to House Report 116-120, page 109, accompanying H.R. 2500, the National Defense Authorization Act for Fiscal Year 2020:**

"Accordingly, the committee directs the Under Secretary of Defense for Acquisition and Sustainment to provide a briefing to the House Committee on Armed Services by November 1, 2019, on the Department's understanding of best practices for the cleanup and disposal of PFOS- and PFOA-contaminated soils, and disposal of spent filters and Aqueous Film Forming Foam. The briefing should include a discussion of current research on these chemicals being conducted by the Strategic Environmental Research and Development Program or Environmental Security Technology Certification Program and what areas require additional research."

Overview

- **Developing Best Practices**
  - Cleanup of Waters (Drinking Water and Groundwater)
  - Cleanup of Soils
  - Disposal of Soils, Spent GAC Filters, and Ion Exchange Resin
  - Disposal of Aqueous Film Forming Foam (AFFF)
- **Current Research**
  - Current Strategic Environmental Research and Development Program (SERDP) and Environmental Security Technology Certification Program (ESTCP) Research on Cleanup and Disposal
  - Current SERDP/ESTCP Research on AFFF Replacement
- **Future Research**
  - Future SERDP/ESTCP R&D Focus Areas for Cleanup and Disposal
  - Future SERDP/ESTCP R&D Focus Areas for AFFF Replacement
- **Conclusions**

Best Practices for Cleanup of Waters (Drinking Water and Groundwater)

1. **Granular activated carbon (GAC) (single use or can be regenerated)**
2. **Ion-exchange resins (single use or can be regenerated)**

- **Treatment mechanisms**
  - GAC: PFOS/PFOA adhere to surface of porous carbon particles
  - Ion exchange: positively-charged resin binds negatively-charged PFOS/PFOA
- **Advantages**
  - Commercially available
  - Accepted by regulators
  - Removal of PFOS/PFOA often to the limits of detection (typically in the single-digit parts per trillion [ppt] range)
- **Challenges**
  - Size (ion exchange system smaller than GAC)
  - Cost
  - Single-use spent filters for GAC and spent resin for ion exchange result in increased material requiring disposal
  - Training operators

Examples of PFOS/PFOA Treatment of Waters

- **Willow Grove, PA – GAC/Resin at municipal well head**
  - Installed GAC at five Horsham Water and Sewer Authority (HWSA) public wells (#10, 17, 21, 26, and 40); ion exchange resin also installed on #10 well
  - Filtered water below lifetime health advisory and back to drinking water service

- **Former Pease AFB, NH – GAC/Resin combined injection into groundwater**
  - Installed GAC and ion exchange resin technology to filter PFOS/PFOA
  - Designed to pump and treat up to 700 gallons per minute

- **Picatinny Arsenal, NJ – GAC online system**
  - Installed GAC to remove PFOS/PFOA from existing water supply
  - Two GAC vessels operate in series to remove PFOS/PFOA from drinking water

Cleanup of Soils

1. Excavation

- **Treatment mechanisms**
  - Physical removal: dig up and haul away PFOS/PFOA-containing soils
- **Advantages**
  - Commercially available
  - Accepted by regulators
- **Challenges**
  - Volume and weight of removed soil
  - Soil replacement
  - Cost

Disposal of Soils, Spent GAC Filters, and Ion Exchange Resin

1. **Incineration** [1]
2. **Landfill** [2]

- **Disposal description and mechanism**
  - Incineration: high-temperature decomposition
  - Landfill: containment
- **Advantages**
  - Commercially available
  - Accepted by regulators
- **Challenges**
  - No PFOS/PFOA-specific solid waste regulations
  - Dependent on availability of permitted incinerator and willingness to accept
  - Effectiveness of incineration
  - Limited air emissions data; Environmental Protection Agency (EPA) and Department of Defense (DoD) preparing stack data collection
  - Management of landfill leachate containing PFOS and PFOA

[1] NOTE: Current DoD practice is to only use Resource Conservation and Recovery Act (RCRA)-permitted, hazardous waste incinerators

[2] NOTE: Current DoD practice is to only use RCRA-permitted hazardous waste landfills

Disposal of AFFF

1. Incineration [1]

- **Disposal mechanism**
  - Incineration: high-temperature decomposition
- **Advantages**
  - Commercially available
  - Accepted by regulators (although we use RCRA-permitted hazardous waste incinerators, there is controversy about using them)
- **Challenges**
  - No PFOS/PFOA-specific solid waste regulations
  - Dependent on availability of permitted incinerator and willingness to accept
  - Effectiveness of incineration
  - Limited air emissions data

[1] NOTE: Current DoD practice is to only use RCRA-permitted, hazardous waste incinerators

Current SERDP [1] / ESTCP [2] Research on Cleanup and Disposal

- **In-situ remediation** (7 projects completed; 8 projects ongoing)
  - Treatment trains (combining treatment technologies in series)
  - Technologies and agents to capture and retain PFOS/PFOA
- **Above-ground treatment** (15 projects ongoing)
  - GAC alternatives and improvements
  - New membrane and sorbent systems
  - Innovative regeneration processes to minimize PFOS/PFOA waste
- **Incineration alternatives, on-site technologies** (18 projects ongoing)
  - Hydrothermal, chemical reactors, cold plasma, indirect thermal desorption, smoldering combustion, etc.
  - Four projects passed proof-of-concept gate, continuing efforts
- **Incineration**
  - Mass balance to confirm PFOS/PFOA destruction; joint effort with EPA
- **Characterization, sampling, & analysis** (2 projects completed, 13 ongoing)

[1] Strategic Environmental Research and Development Program (SERDP)
[2] Environmental Security Technology Certification Program (ESTCP)

All current research topics funded for FY20
DoD resources applied: ~$70M to date on research and development
https://www.serdp-estcp.org/Program-Areas/Environmental-Restoration

Current SERDP/ESTCP Research on Cleanup and Disposal, and PFAS [1] Chemicals

- **SERDP statement of need solicitations**
  - Core (3- or 5-year duration research and development [R&D]projects): 15
  - SEED [2] (1-year duration projects): 3
  - Supplemental: 2
  - Projects funded: 55
- **ESTCP solicitations**
  - DoD topics and broad agency announcements (BAAs)
  - Demonstration projects funded: 8
- **SERDP/ESTCP workshops**
  - FY13 two-day forum on research needed to more efficiently deal with long-term management and lengthy restoration of complex groundwater sites
  - FY17 two-day discussion forum to provide strategic guidance for research and demonstrations to improve remediation performance, efficiency, and cost of managing complex groundwater sites

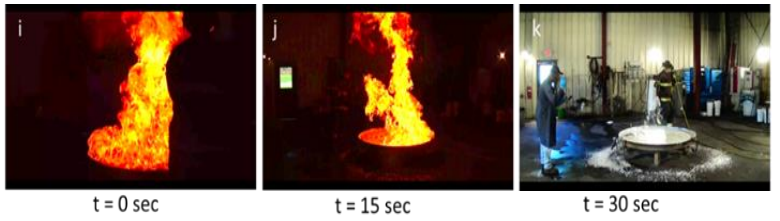
[1] Per- and poly-fluoroalkyl substances (PFAS) (PFOS and PFOA are only 2 of ~5,000 PFAS)
[2] SERDP Exploratory Development (SEED)

Current SERDP/ESTCP Research on AFFF Replacement

- **Partnering with Federal Aviation Administration**
- **Dual track R&D approach**
  - One-year pilot projects and, if promising, full-scale projects
  - More mature projects require toxicology to be assessed
- **Demonstration and validation**
  - Testing currently available fluorine-free foams
  - BAA resulted in 3 projects in FY2019 to investigate fluorine-free AFFF systems and ability to meet stringent military specification requirements

Testing Fluorine Free Foams: Performance improving, but still lagging behind AFFF

Reference AFFF
Ext = 30 seconds



Replacement Formulation
Ext = 51 seconds

DoD resources applied: ~$6M since FY2017 on AFFF replacement R&D
https://www.serdp-estcp.org/Program-Areas/Weapons-Systems-and-Platforms

Future SERDP/ESTCP R&D Focus Areas for Cleanup and Disposal

- **Treatment methods**
  - Cost-effective treatment and disposal technologies
  - Development of on-site technologies for concentrated PFAS waste streams (PFOS and PFOA are only 2 of ~5,000 PFAS)
- **Chemistry**
  - Incineration effected PFOS/PFOA chemical processes
  - Fate and transport properties
  - Bioavailability and biomagnification
  - Toxicity
- **Analysis**
  - Develop and validate PFAS analytical methods with EPA
- **Technology demonstration**
  - Transition high-potential SERDP technologies to ESTCP field trials
- **Commercialization and technology transfer**

All future R&D topics addressed in last FY2017 workshop (description on slide 9)
https://www.serdp-estcp.org/Program-Areas/Weapons-Systems-and-Platforms

Future SERDP/ESTCP Research Focus Areas for AFFF Replacement

- **Chemistry**
  - Unique chemical nature of carbon-fluorine bond (one of shortest and strongest known)
  - Performance requirements currently favor fluorinated compounds
  - Determination of whether engineering and firefighting methodologies can bridge fluorine-free material performance gaps
- **Analysis**
  - Tools to determine with confidence that replacement is fluorine free
  - Determination of alternatives' toxicity and fate and transport
- **Technology demonstration**
  - Transition high-potential SERDP technologies to ESTCP field trials
- **Commercialization and technology transfer**

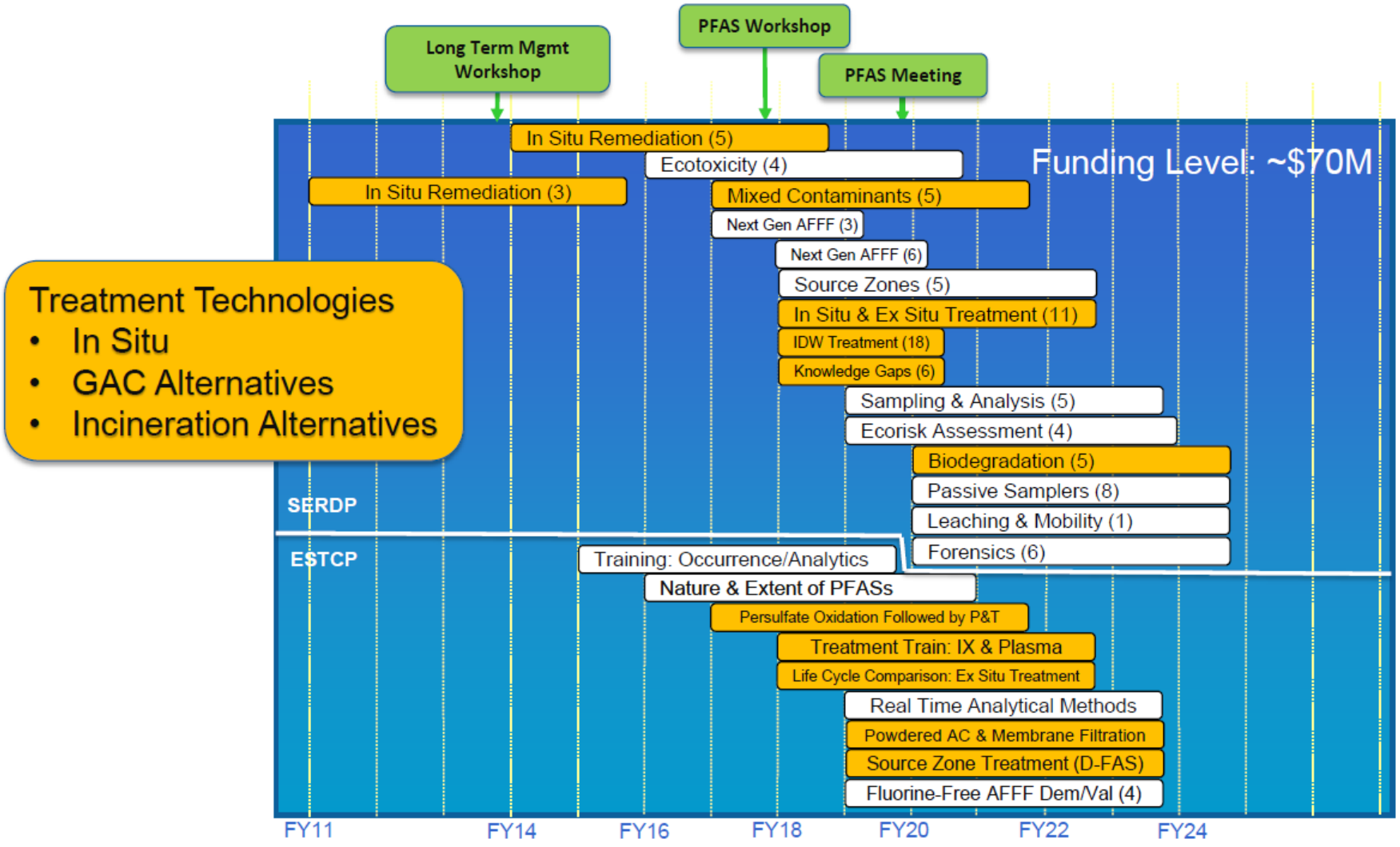
DoD resources planned in FY20: ~$7M on AFFF replacement R&D
https://www.serdp-estcp.org/Program-Areas/Weapons-Systems-and-Platforms

Conclusions

- **GAC and ion exchange are best practices for cleanup of waters containing PFOS/PFOA**
- **Excavation and removal is best practice for cleanup of soils containing PFOS/PFOA**
- **Current practice is incineration and lined landfills for disposal of soil, AFFF containing PFOS/PFOA, spent GAC filters, and ion exchange media containing PFOS/PFOA**
- **Challenges remain for each treatment and disposal best practice, particularly incineration**
- **Current research focuses on aggressive development of treatment and disposal technologies with lower cost and increased effectiveness, and fluorine-free AFFF replacements**
- **Future research will focus on remediation chemistry and analysis; AFFF replacement chemistry, analysis, and toxicology; and technology demonstration, commercialization, and technology transfer**

Backup Slides

SERDP/ESTCP R&D



Treatment Technologies
- In Situ
- GAC Alternatives
- Incineration Alternatives

SERDP/ESTCP R&D