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Thermal Desorption to Treat PFAS-Contaminated Soil

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Background

Occurrence, Regulation

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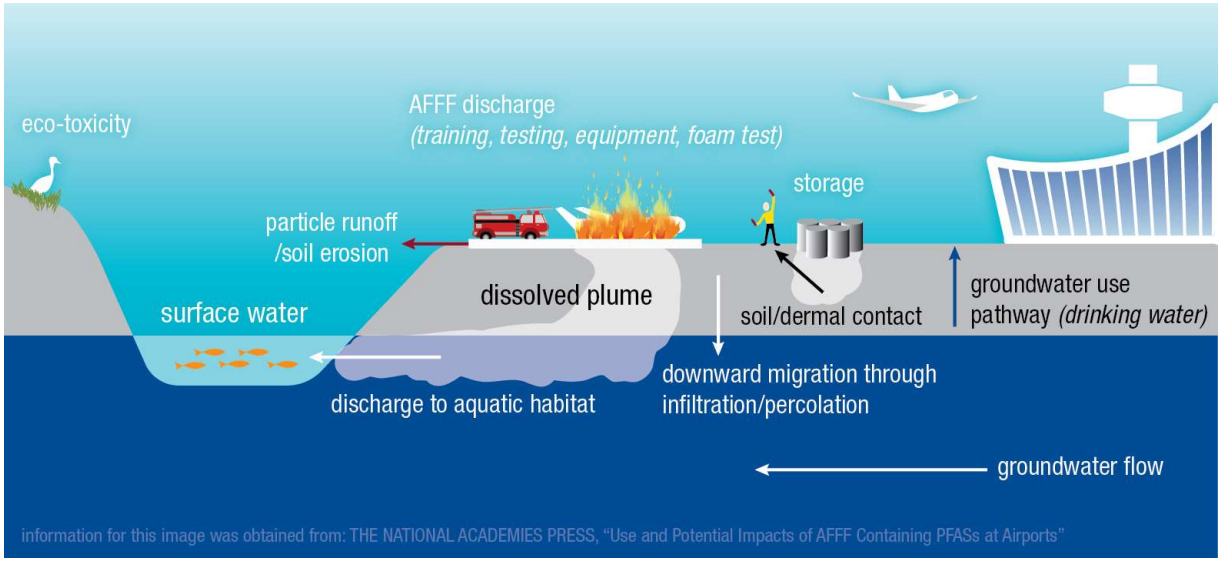
PFAS occurrence in soil



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Soil regulations and screening levels

- Quickly evolving
- US EPA Regional Screening Levels (RSLs)
  - Published RSLs for PFBS
  - RSLs can be calculated for PFOA and PFOS
- State/provincial regulations and screening values
  - **Alaska**, **British Columbia**, Michigan, North Carolina, Texas
  - Human health values
    - *PFOS/PFOA at mg/kg levels*
  - Protection of groundwater
    - *PFOS/PFOA at µg/kg levels*

Protective of GW	PFOA (µg/kg)	PFOS (µg/kg)
British Columbia	---	350
Alaska	3	1.7

HQ = hazard quotient

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Soil Treatment Options

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Excavation and disposal

- Only well-developed option
- Disposal options
  - Landfill
  - Incineration
- Goal: develop more sustainable options

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Developing soil treatment options

- Stabilization/sorption – addition of PFAS sorbing amendments
- Soil washing
- Soil sorting / size segregation

Size Fraction	% Total PFAS
-1" to +1/4" (-25.4 to +6.3 mm)	1.1
-1/4" to +#4 (-6.3 to +4.75 mm)	0.2
-#4 to +#30 (-4.75 to +0.6 mm)	8.9
-#30 to +#200 (-0.6 to +0.076 mm)	38.5
-#200 (-0.076 mm)	51.2

70% of soil mass
98.7% of PFAS mass

- Thermal desorption

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Thermal desorption

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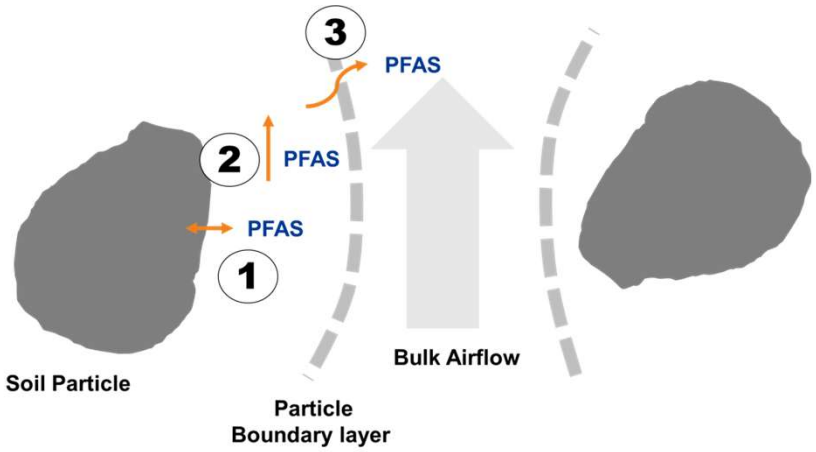
Conceptual model for desorption

1. Desorption
2. Sublimation
3. Diffusion



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Thermal desorption temperature approaches

Low temperature (100 – 300 °C)

- Historically use for conventional VOCs/SVOCs
- In situ and ex situ

Medium temperature (300 – 600 °C)

- Not typically used
- In situ (up to 400 °C) and ex situ

High temperature (600 – 1,000 °C)

- Historical use for remediation via rotary kilns
- Ex situ applications only
- Higher energy cost

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Bench-scale testing: Methods

- Infrared thermal treatment
  - 1 cubic foot bench test chamber
  - Soil heated to 300 °C and 350 °C
- Soil samples collected over 8 days
- Samples analyzed for 24 PFAS compounds by SGS AXYS

Parameter	PFAS	PFCA	PFOA	PFSA	PFOS
Initial Conc. (µg/kg)	151	24.7	5.52	118	96

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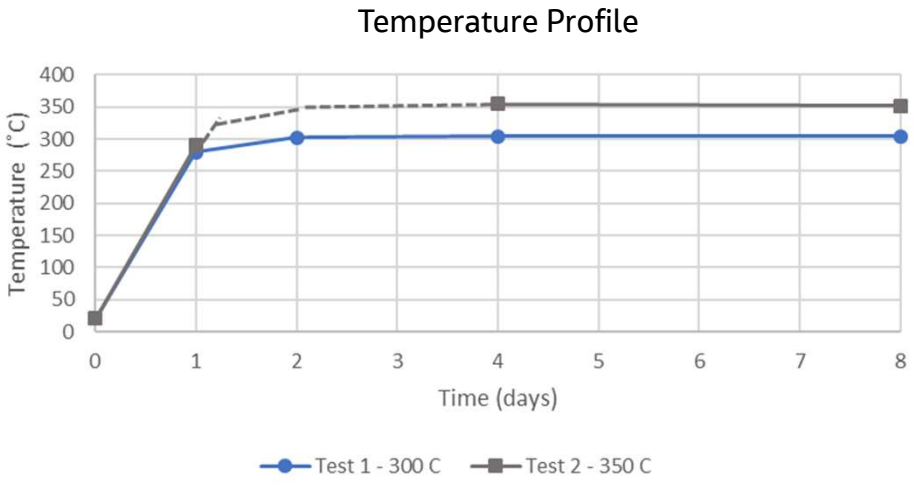
Bench-scale testing: Results



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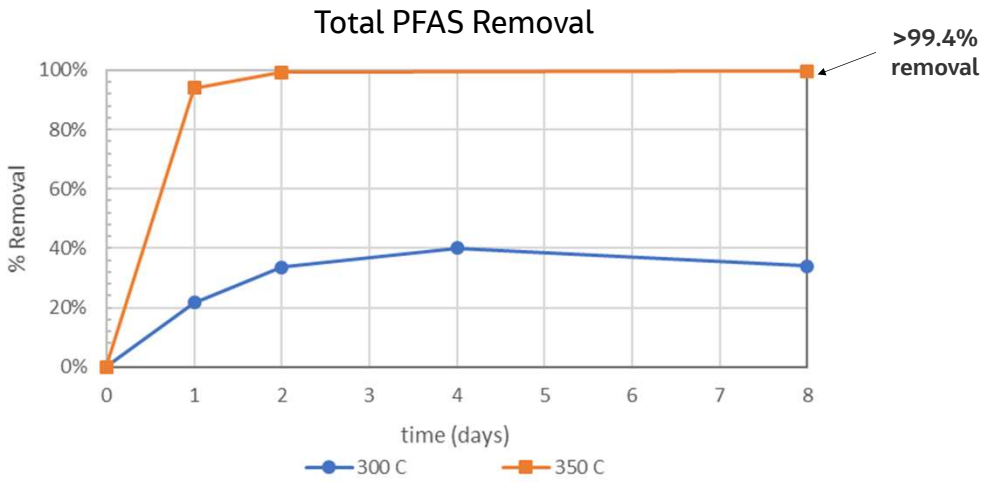
Bench-scale testing: Results



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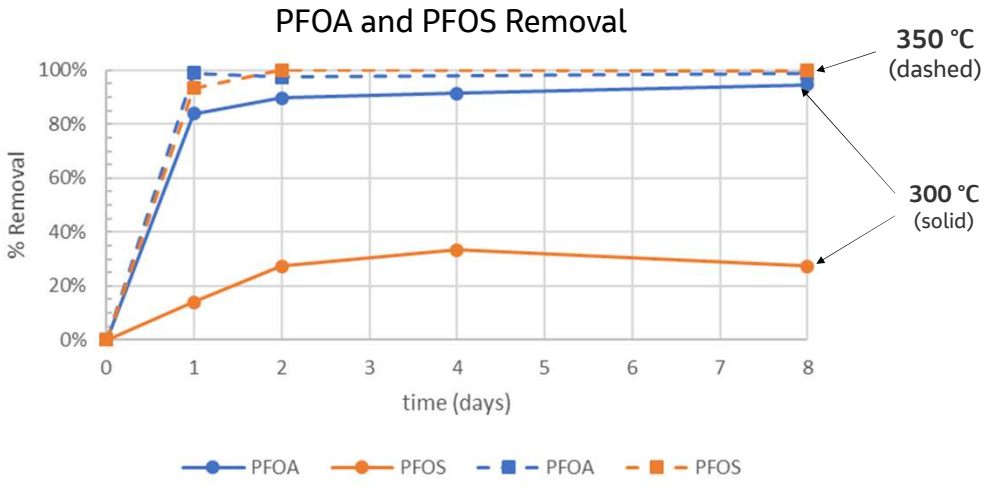
Bench-scale testing: Results



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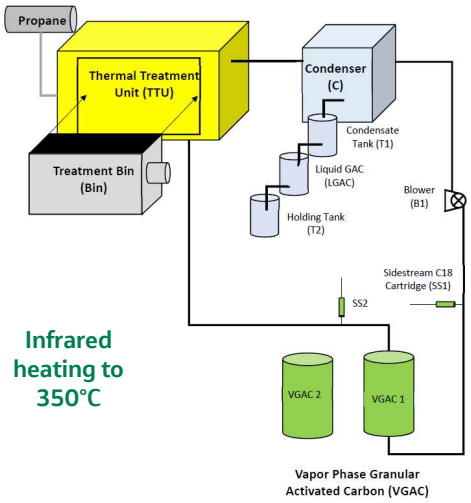
Pilot-scale testing for IDW treatment



Infrared heating to 350°C

SERDP DOD • EPA • DOE

ER18-1603
Field Demonstration of Infrared Thermal Treatment of Per and Polyfluoroalkyl Substances (PFAS)-contaminated Soil from Subsurface Investigations

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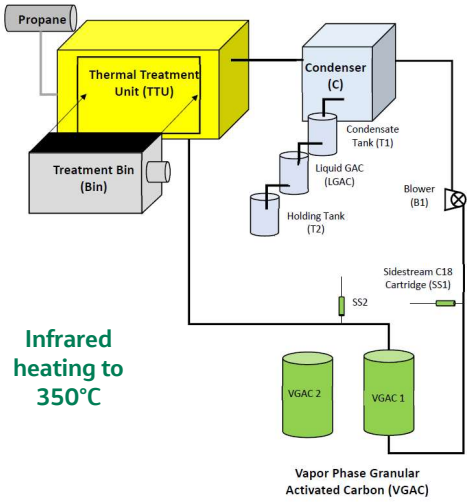
Pilot-scale testing for IDW treatment



Infrared heating to 350°C

DEPARTMENT OF

ENVIRONMENTAL CONSERVATION

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Oil and Other Hazardous Substances Pollution Control

As amended through October 27, 2018

Cleanup goals:
PFOA = 1.7 µg/kg
PFOS = 3.0 µg/kg

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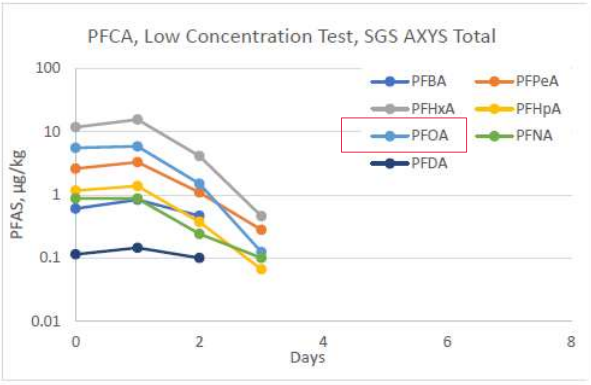
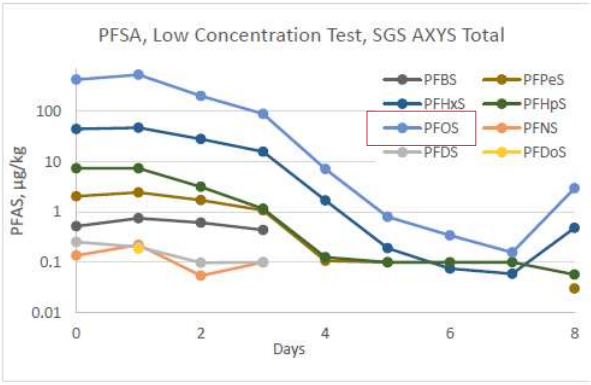
Pilot-scale testing: Results



PFCA = perfluoroalkyl carboxylates $-COO^-$

PFOA removal: non detect (>97.4%) (below cleanup goal)



PFSA = perfluoroalkane sulfonates $-SO_3^-$

PFOS removal: 99.6% (below cleanup goal)

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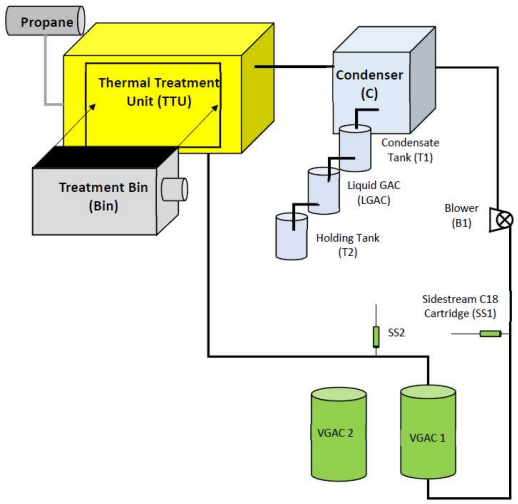
Conclusions and next steps

- Good agreement between bench and pilot
- Treatment successful at temps. >350 °C
  - PFOA, PFOS
- Treatment time related to ability to dry soil, achieve temperature
- Next steps
  - Close mass balance
  - Vapor treatment refinement (e.g., wet scrubber)
- "Medium temperature" thermal desorption promising technology
  - Low end of temperature range
  - Cost savings for lower energy input
  - Ex situ and in situ
- Upcoming ESTCP project: in situ thermal



Vapor Phase Granular Activated Carbon (VGAC)

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