# On-Site Demonstration of Thermal Desorption Coupled with Thermal Oxidation Technology to Treat Solid PFAS-Impacted Soil IDW

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# Agenda

Technology Description

Thermal Projects at EA

Analytical testing methods

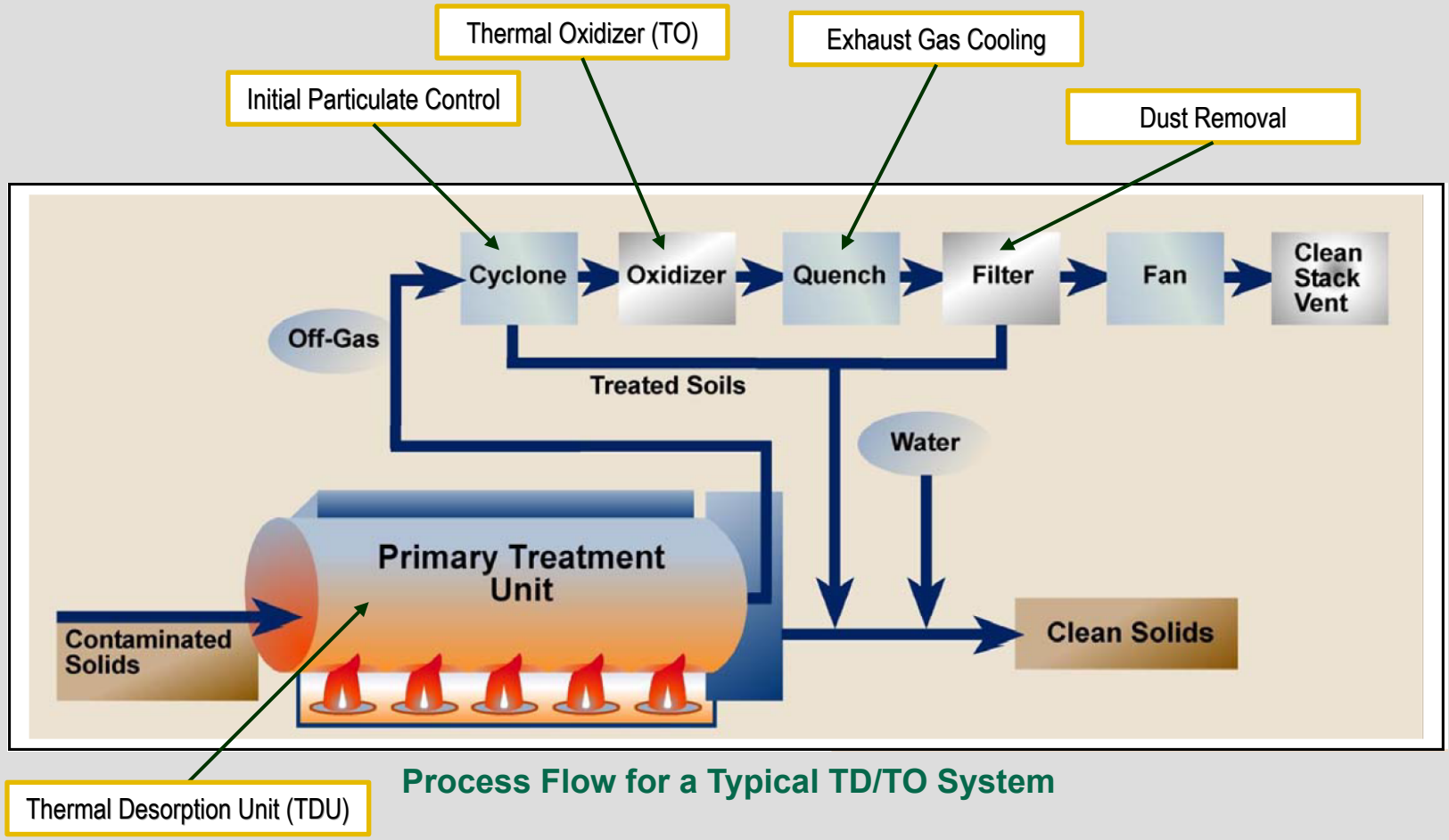
Lessons learned

# Technology Description

Widely applied for contaminated soils

Application to PFAS-impacted soil is relatively novel

***NOT*** incineration




**Process Flow for a Typical TD/TO System**

# Thermal Desorption is Not Incineration

- **Incineration (as per 40 CFR Part 260.10)** – A process that uses "controlled flame combustion in an enclosed device" to treat or dispose a hazardous waste that has been designated under RCRA.
  - The heating of PFAS contaminated material in a thermal desorption process does not meet the definition of incineration.
- Gases separated from the soils are "uncontained gases" and are excluded from the definition of solid waste (40 CFR Part 258.2).
  - Emissions control of these gases in a thermal oxidizer is not considered incineration because they are regulated under the Clean Air Act.
- **Thermal desorption of PFAS contaminated soil does not fall under the definition of incineration.** PFAS is removed from the soil in a primary dryer and then completely destroyed for air emission control in a separate, permitted thermal oxidizer.

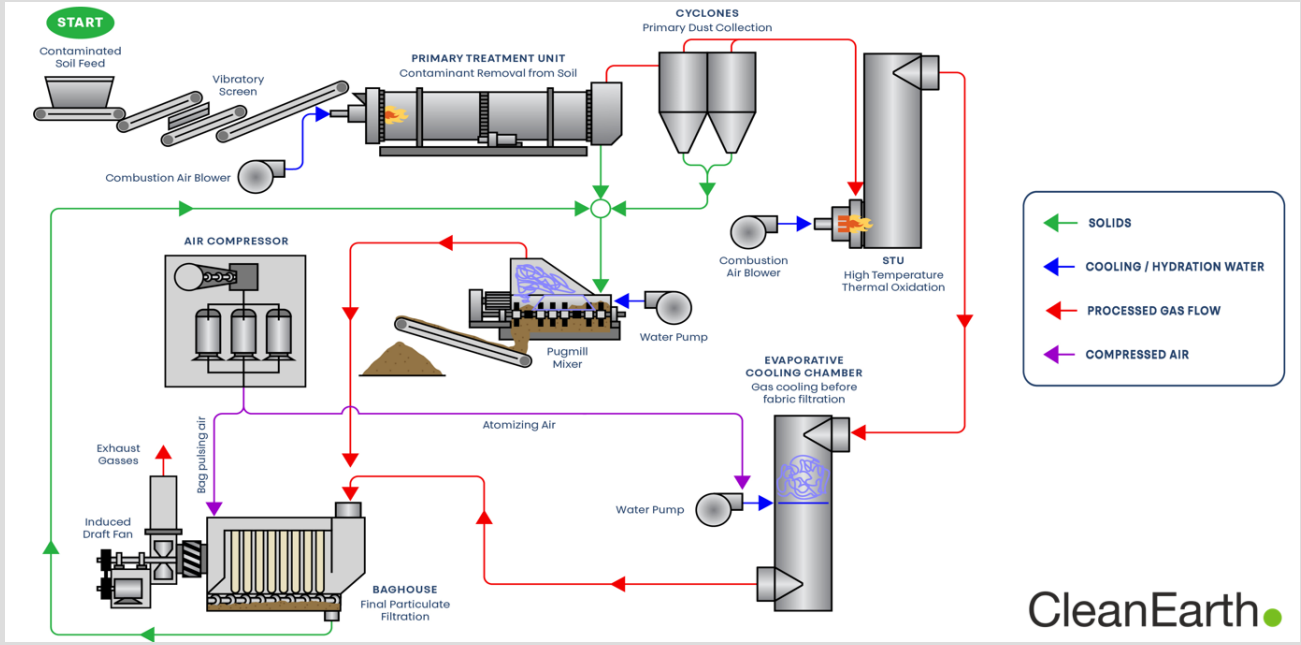
# PFAS Thermal Treatment Projects at EA

## SERDP ER18-1572 - Evaluation of Indirect Thermal Desorption Coupled with Thermal Oxidation (ITD/TO) Technology to Treat Solid PFAS-impacted Investigation-derived Waste (IDW)

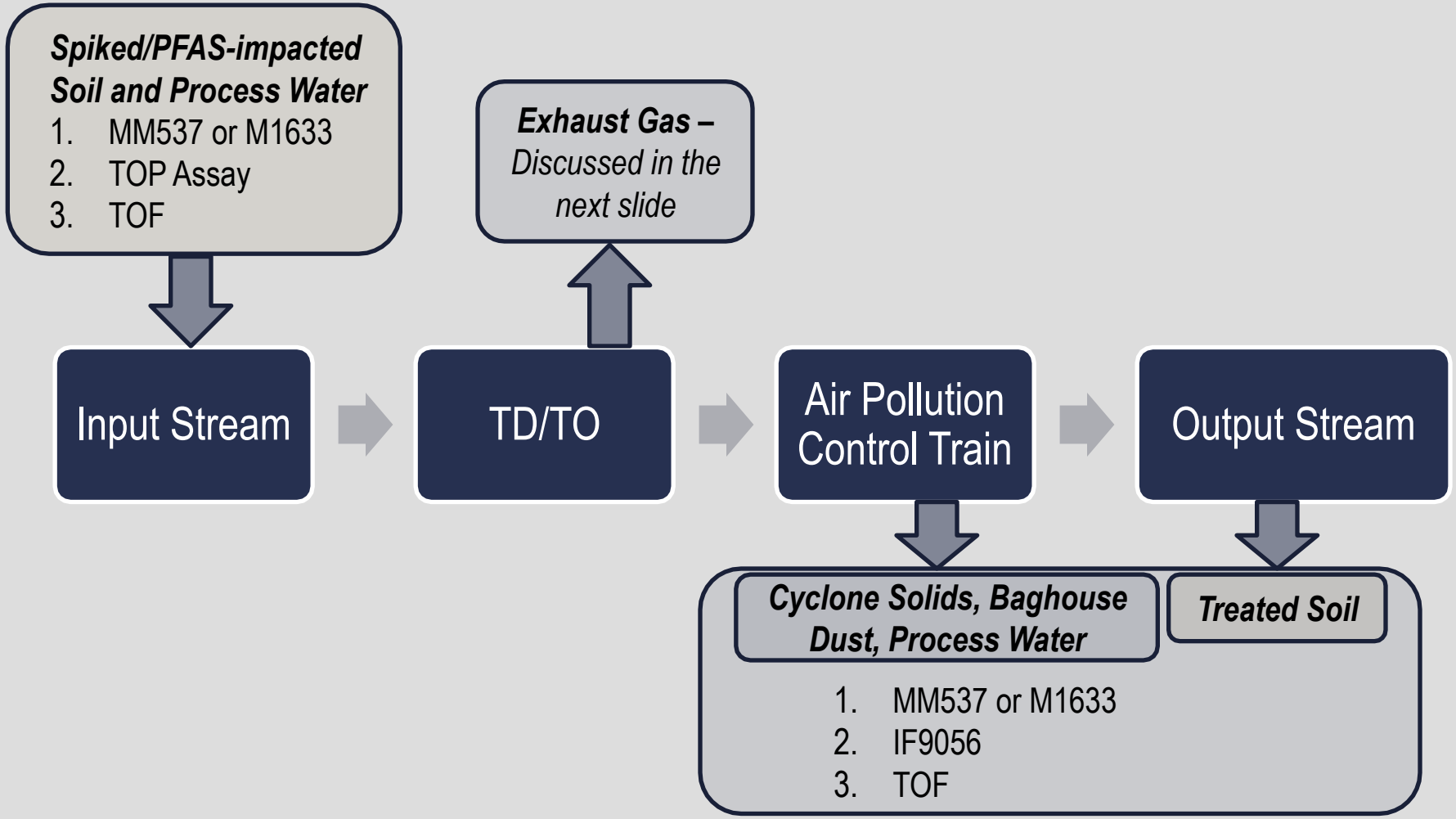
- ✓ Completed - *2020*
- ✓ Pilot-scale study
- ✓ Effectiveness of TD/TO to treat and destroy PFAS
- ✓ Developed emissions sampling train using EPA Method 0010
- ✓ **Analytical Methods**

## ESTCP ER21-5119 - On-Site Demonstration of Thermal Desorption Coupled with Thermal Oxidation Technology to Treat Solid PFAS-Impacted Soil Investigation Derived Waste

- ❑ Ongoing



# Sampling Trains and Analytical Methods



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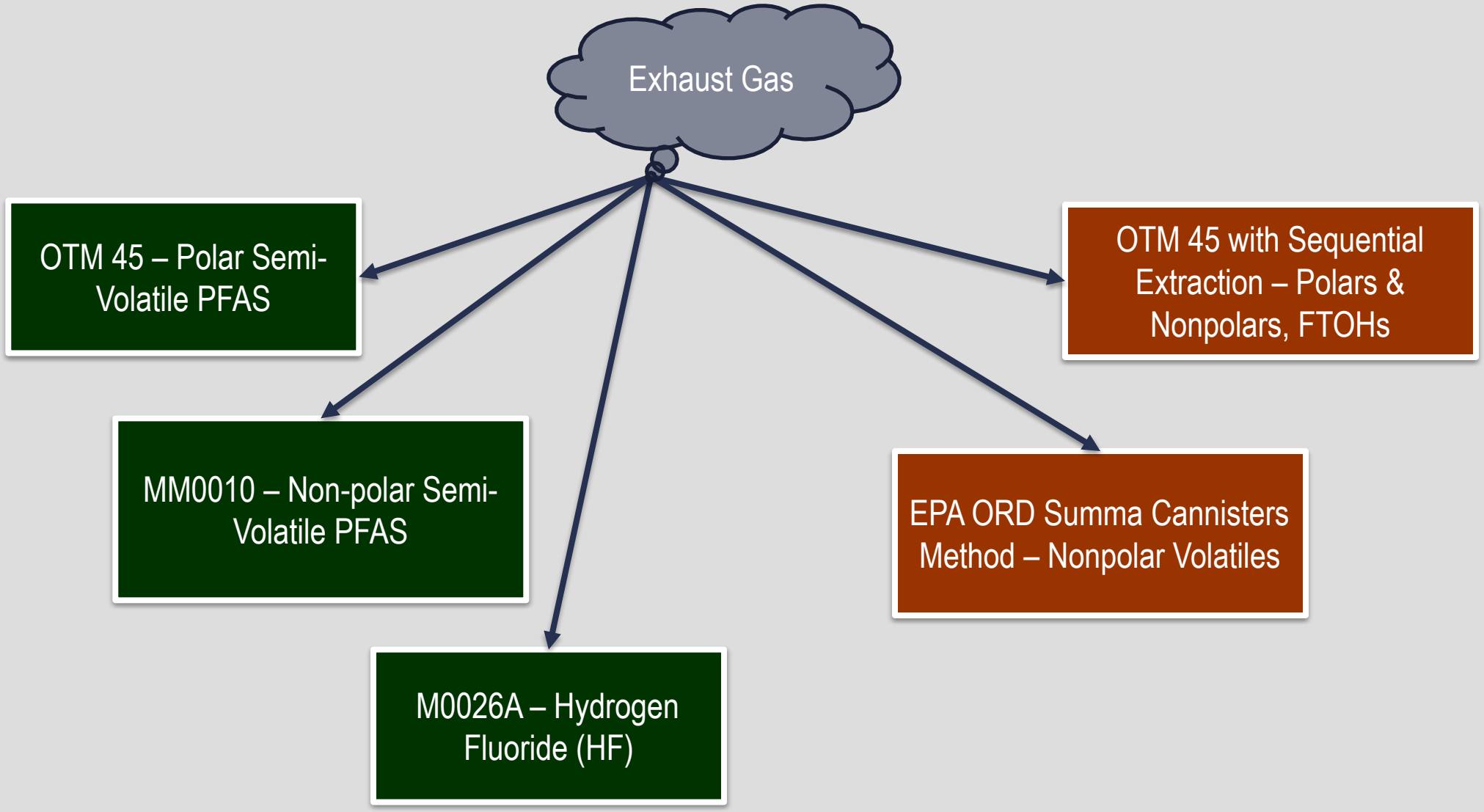
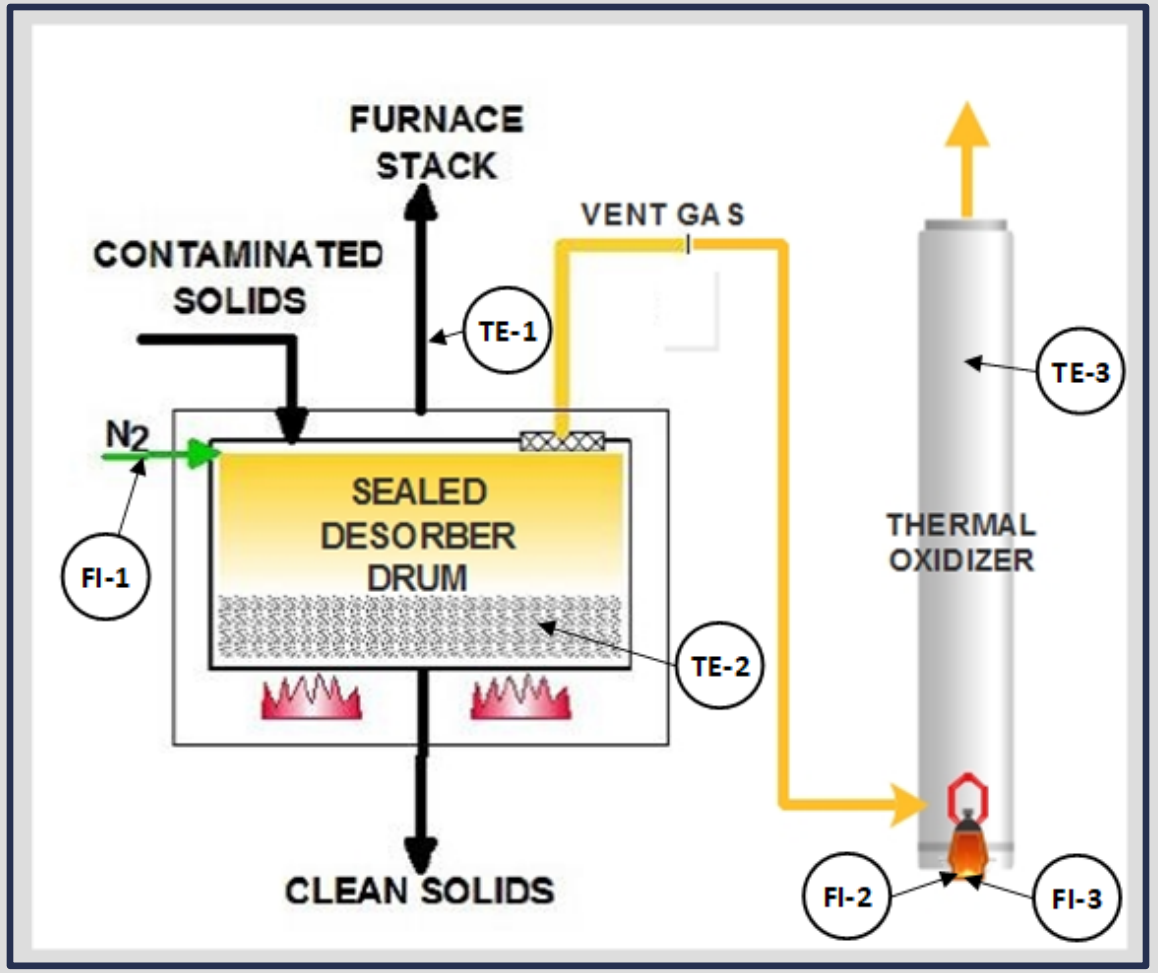


# Overview of Completed SERDP Pilot Study

## SERDP ER18-1572

- **Principal Investigator:** Frank Barranco
- **Period of Performance:** 2018 to 2020
- **Overview:** Conduct Pilot study to evaluate the effectiveness of Indirect Thermal Desorption (ITD) followed by Thermal Oxidation (TO) to remove and destroy PFAS
- **Research Objectives:** Determine if ITD/TO effectively removes and destroys PFAS (and any precursors in soil) to low ppb levels and verify the Destruction or Removal Efficiency (DRE)

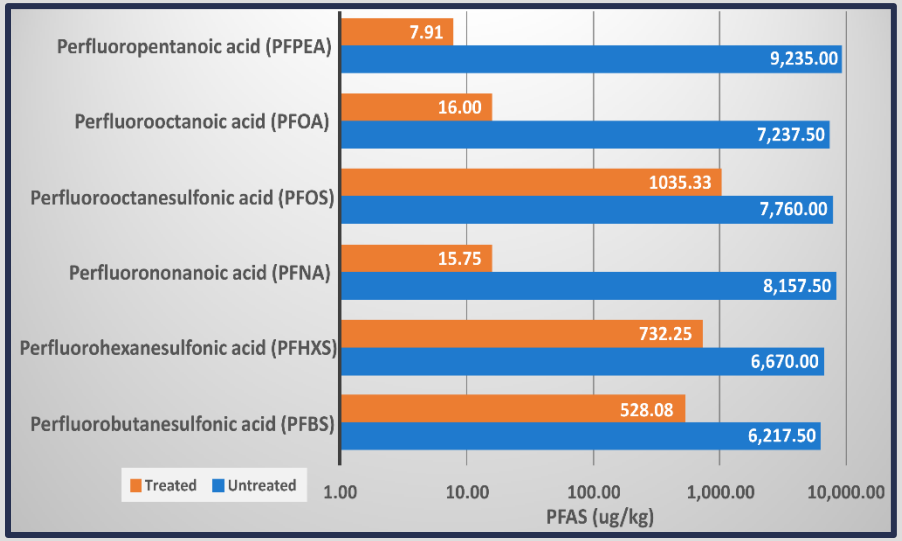


# Results – ITD of PFAS-Spiked Soils

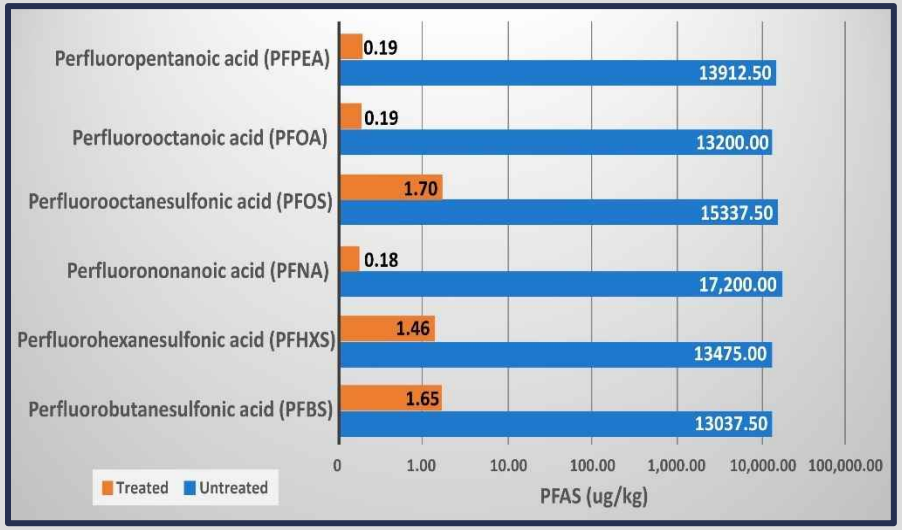
## Results

- PFSAs required higher temperatures compared to PFCAs
- PFAS removal efficiency of 97.0% @ 500 °C
- PFAS removal efficiency of 99.7% @ 650 °C
- Result at 650 °C reflect treatment to low ppb levels, which are sufficiently low to meet different states treatment criteria

**500°C**



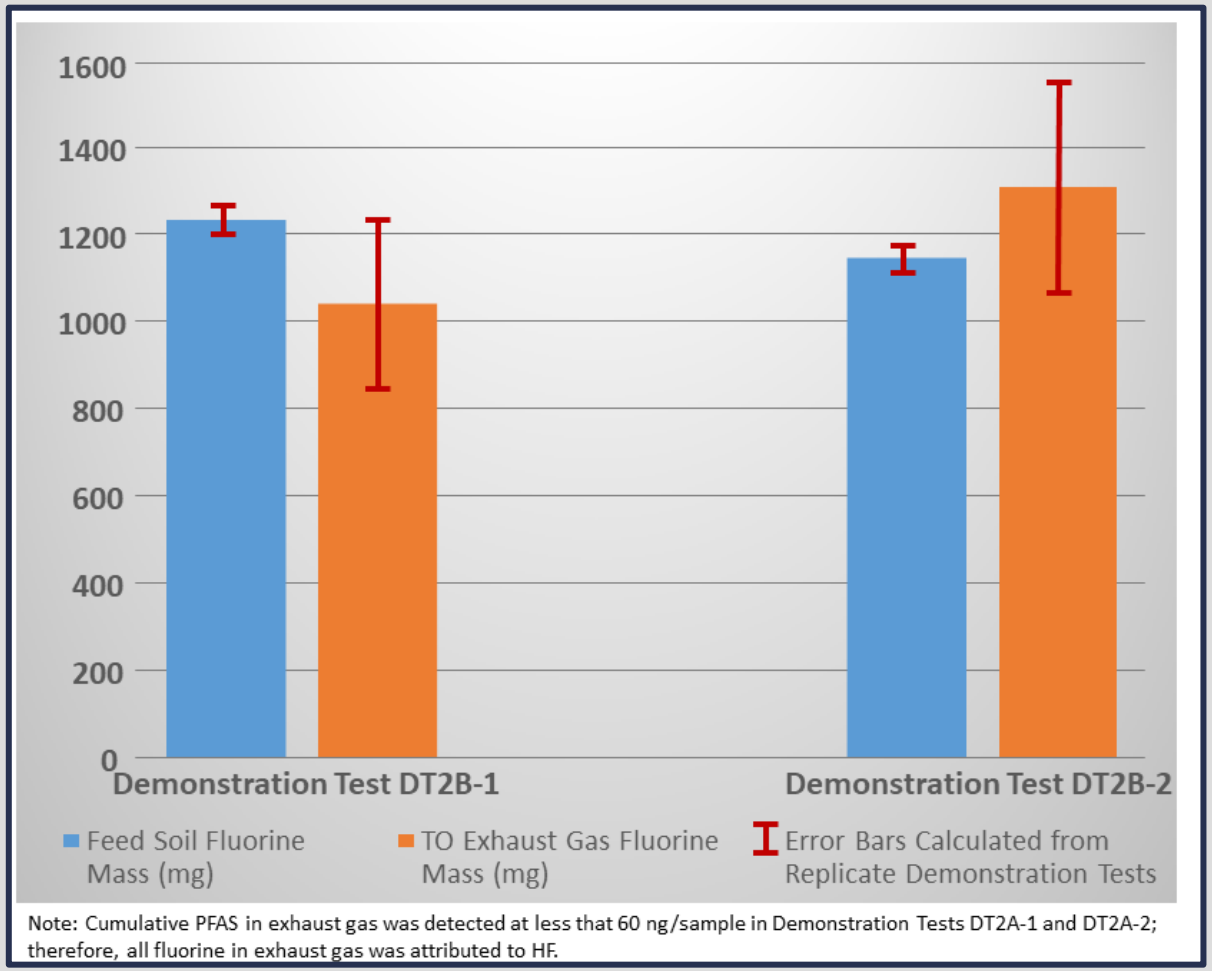

**650°C**



# Results – Fluorine Mass Balance

## Results

- PFAS removal efficiency of 97.0% @ 500 °C
- PFAS removal efficiency of 99.7% @ 650 °C
- Result at 650 °C reflect treatment to low ppb levels, which are sufficiently low to meet different states treatment criteria
- Completed fluorine mass balance (fluorine mass recovery of 84% and 114%, respectively, for two trial tests conducted with 6 PFAS-spiked soil runs)




Note: Cumulative PFAS in exhaust gas was detected at less that 60 ng/sample in Demonstration Tests DT2A-1 and DT2A-2; therefore, all fluorine in exhaust gas was attributed to HF.

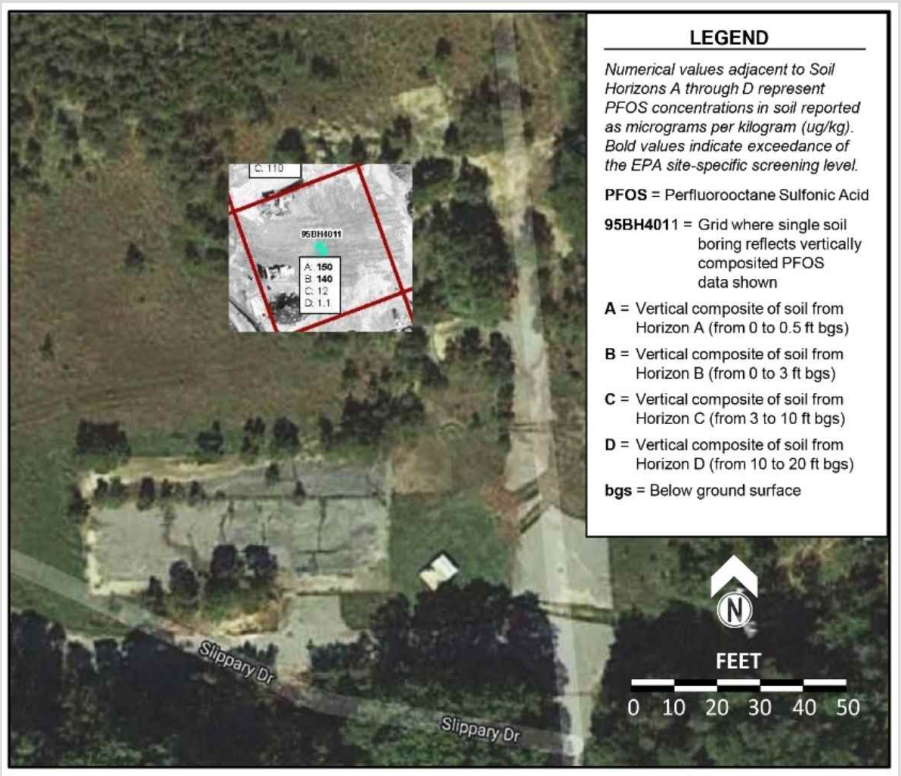
# ESTCP ER21-5119 – Full Scale Demonstration Test

## Demonstration Test of Direct Thermal Desorption (DTD) Coupled with Thermal Oxidation (TO) to Treat PFAS-Impacted Soil

- **Phase I –** Permitting, Equipment Fabrication, Planning, ***Site Selection***, Soil and TO Exhaust Sampling/Analytical Program
- **Phase II –** Mobilization and Continuous Operation of DTD/TO Demonstration Test
  - Onsite <30 days (roughly 20 days of operation)
  - Day-time operation (10-20 hrs/day)
  - Periodically excavate and stockpile feed soil
  - DTD treatment rate of 10 to 20 tons/hr
  - Approximately 2500 to 5000 tons treated
  - Return soil to excavation after lab confirmation
- **Phase III –** Data Evaluation, Cost Feasibility Analyses, and Reporting

# ESTCP – Full Scale Demonstration Test - Status

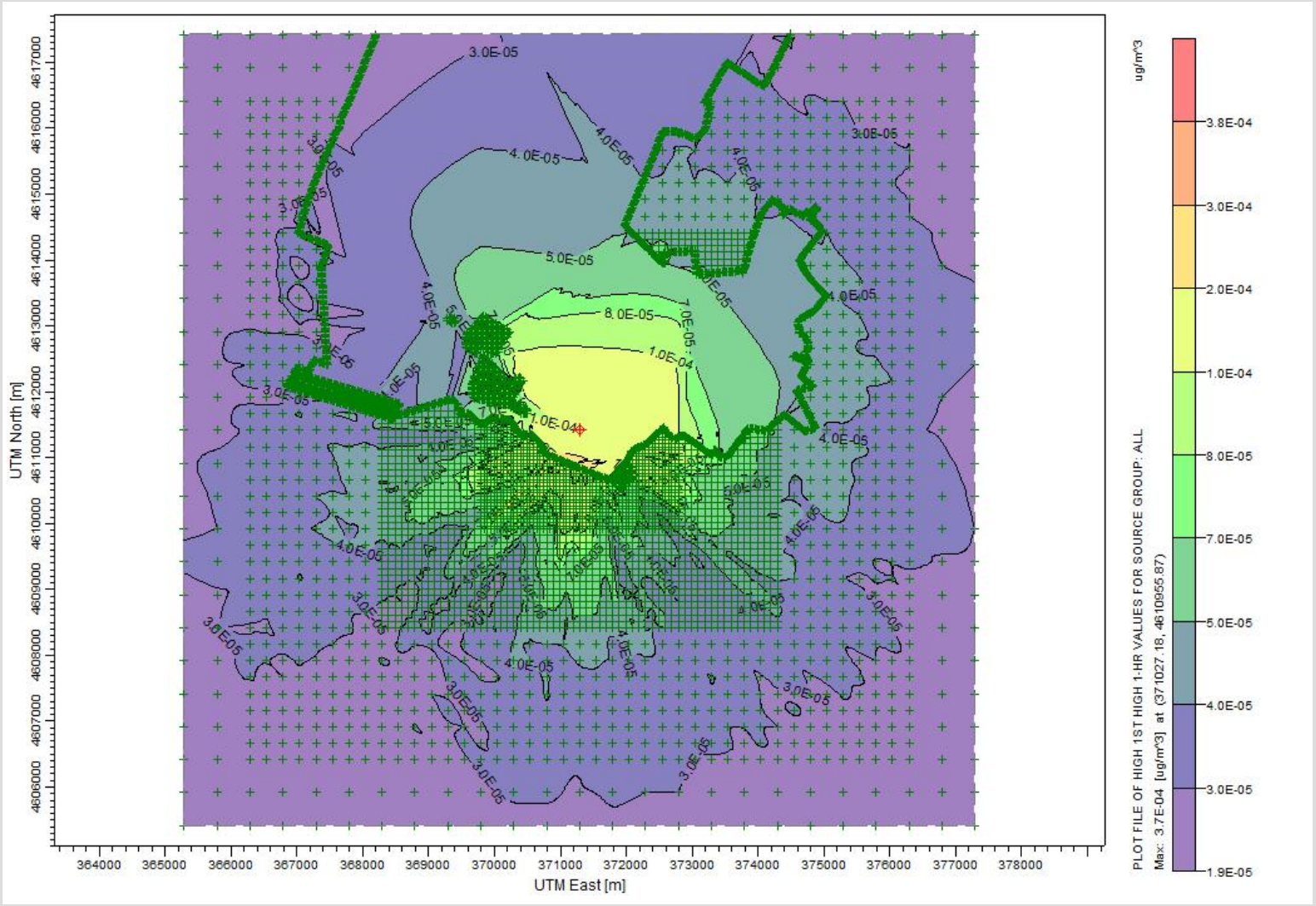
- **Phase I - Ongoing**
  - **Initial Site Location –** Joint Base Cape Cod (JBCC)
  - **Air Emissions Permitting**
    - Comprehensive Plan Application (CPA) for Non-Major Source – **on hold** by MassDEP Air
    - Awaiting EPA-approved air emissions test methods and more definitive information on potential risks to human health, ecological receptors and environmental media.
  - **Site Selection**
    - Reviewing potential DOD and non-DOD sites
  - Work is anticipated to commence in 2023-2024




Originally Proposed Site:
FTA-1 Area at JBCC

# Air Emissions Modeling

| Risk-Based Air Toxics Regulations | PFOA (µg/m³) |
|---|---|
| Michigan 24-Hr Average | 0.07 |
| Minnesota 24-Hr Average | 0.063 |
| Texas 1-Hr Average | 0.05 |
| New Hampshire 24-Hr Average | 0.05 |
| New York Annual | 0.0053 |




AERMOD Plot of 1-hr Highest 1-Hr Ground-Level Ambient Air Concentrations (ug/m³) of PFOA (Maximum: 3.7E-04 ug/m³)

# ESTCP – Full Scale Demonstration Test

- **Phase II**
  - Site Mobilization, Set-Up, and Shakedown Testing
  - Trial Burn Performance Test
  - Normal Operation of TD/TO Treatment
- **Phase III**
  - Detailed Data Evaluation
    - Includes soil and exhaust gas analysis
  - Feasibility Evaluation and Cost Analyses of Scalable TD/TO Design
  - Final Reporting and Technology Transition

Photo of TDU to be Utilized

# Lesson Learned

- **Analytical Developments**
  - **Soil –** Evolution of PFAS analysis from M537 to Draft M1633
  - **Targeted Air Emissions –** Change out of M0010 to OTM-45 for PFAS
  - **Nontargeted Air Emissions -** Development of sequential extraction methods
- **Air permitting**
  - Proceed cautiously in states that haven't considered PFAS air emissions standards
  - PFAS air emissions will be *de minimus* in most settings
  - Employ electrical power where possible to avoid generator related criteria pollutant emissions or the toxics
  - Wet scrubber will be necessary to address HF

# Summary

- TD/TO technology to treat PFAS-contaminated soil
- Thermal desorption is ***NOT*** incineration
- Developments in the PFAS exhaust gas sampling and analysis
- Full Scale Demonstration test is ongoing
- Proceed cautiously in states that haven't considered PFAS air emissions standards
- PFAS air emissions will be *de minimus*

*Thank You!*

**Questions?**