



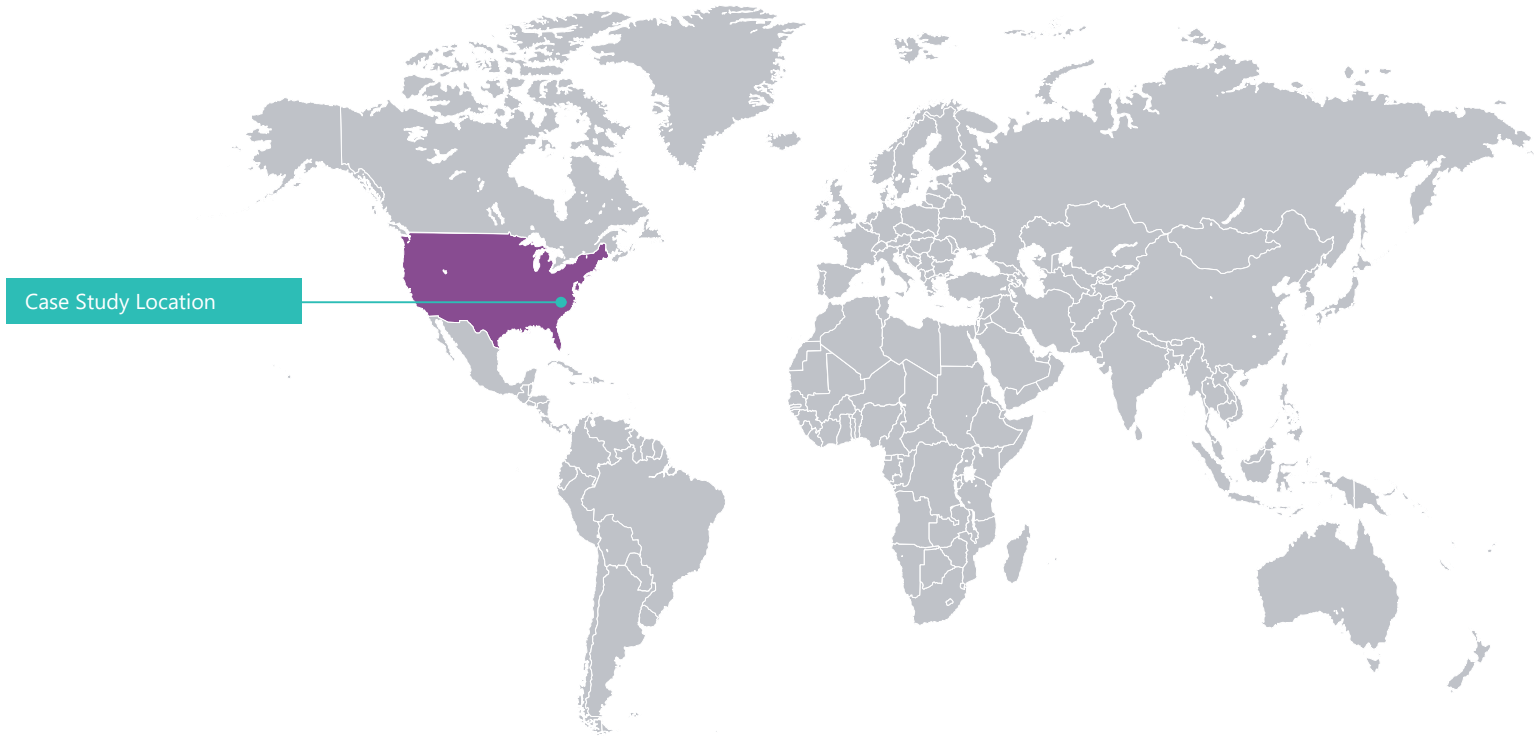
PFAS Site Inspection

A North Carolina Case Study

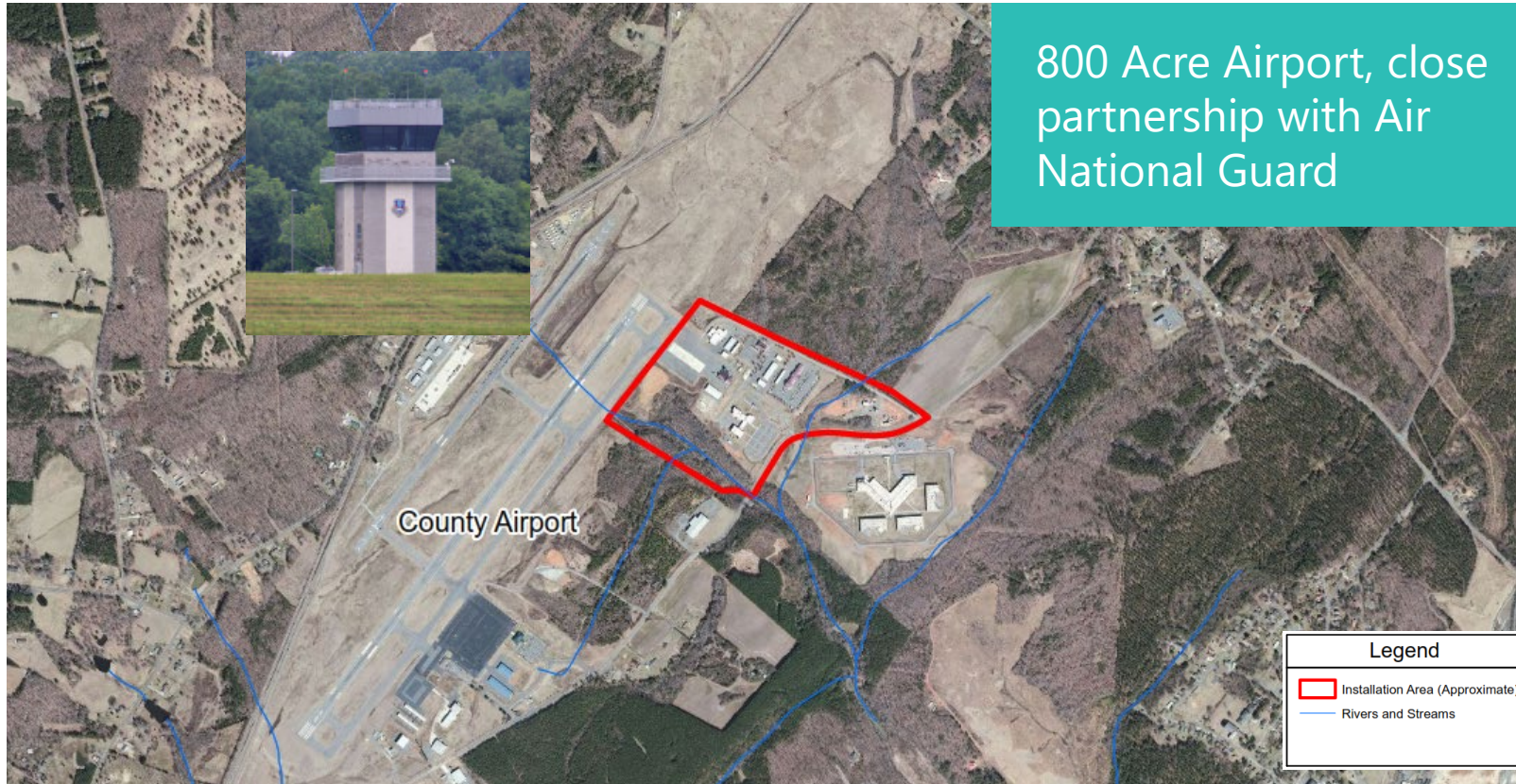
Presented by: Helen Corley
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Site Location





Site Aerial



800 Acre Airport, close partnership with Air National Guard

Legend

-  Installation Area (Approximate)
-  Rivers and Streams



Environmental Protection Agency



1996 Safe Drinking Water Act (SDWA)

- Requires once every five years EPA issue new list of no more than 30 unregulated contaminants to be monitored by public water systems
 - Third Unregulated Contaminant Monitoring Rule (UCMR3)
 - Published May 2, 2012
 - (28 chemicals and two viruses)
 - Included Six Perfluorinated Compounds
- Drinking Water Health Advisory
 - Published May 19, 2016



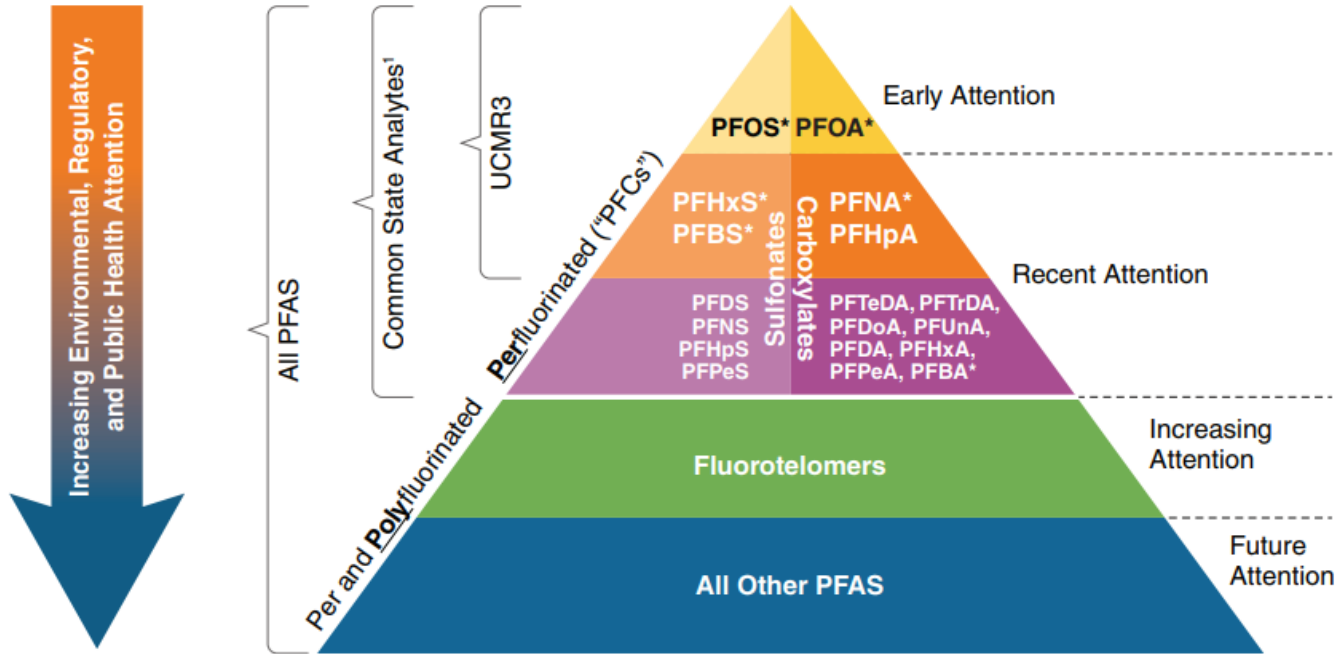
Six Perfluorinated Compounds - UCMR3



Contaminant	MRL* (µg/L)	Use or Source
perfluorooctanesulfonic acid (PFOS)	0.04	Surfactant or emulsifier; used in fire-fighting foam, circuit board etching acids, alkaline cleaners, floor polish, and as a pesticide active ingredient for insect bait traps; U.S. manufacture of PFOS phased out in 2002; however, PFOS still generated incidentally
perfluorooctanoic acid (PFOA)	0.02	Perfluorinated aliphatic carboxylic acid; used for its emulsifier and surfactant properties in or as fluoropolymers (such as Teflon), fire-fighting foams, cleaners, cosmetics, greases and lubricants, paints, polishes, adhesives and photographic films
perfluorononanoic acid (PFNA)	0.02	Manmade chemical; used in products to make them stain, grease, heat and water resistant
perfluorohexanesulfonic acid (PFHxS)	0.03	
perfluoroheptanoic acid (PFHpA)	0.01	
perfluorobutanesulfonic acid (PFBS)	0.09	



PFAS – Increasing Attention



*Common regulatory criteria or health advisories

¹Sum of informal poll (NJ, NH, MN)

Thematic and not proportional.

Bottom of triangle indicates additional number of compounds; not a greater quantity by mass, concentration, or frequency of detection.

Original source: J. Hale, Kleinfelder





PFOA and PFOS Health Effects

U.S. Environmental Protection Agency. Health Effects Support Document for PFOS and Health Effects Support Document for PFOA. EPA Document Numbers 822-R-16-002 and 822-R-16-003; 2016.

- “Human epidemiology data report associations between PFOA exposure and high cholesterol, increased liver enzymes, decreased vaccination response, thyroid disorders, pregnancy-induced hypertension and preeclampsia, and cancer (testicular and kidney).”
- “Epidemiology data report associations between PFOS exposure and high cholesterol and reproductive and developmental parameters.... Data also suggest a correlation between higher PFOS levels and decreases in female fecundity and fertility, in addition to decreased body weights in offspring, and other measures of postnatal growth.”
- “PFOS is not readily eliminated from humans as evidenced by the estimated average half-life values of 4.1–8.67 years.”



Department of Defense – Air National Guard



Installation Restoration Program -> Environmental Restoration Program

Central North Carolina Site



- Site Inspection (2017-2018 Wood)
 - Aqueous Film Forming Foam (AFFF) used at the site since 1993. Used in the Air Force since 1970.
 - Potential Release Locations (PRLs) where AFFF was potentially discharged, stored and where Aircraft Rescue Fire Fighting (ARFF) vehicles were washed



Aqueous Film Forming Foam – A Brief History



The Navy began requiring vessels to carry AFFF in 1967 after 134 sailors died in a fire aboard the USS Forrestal



Charred wreckage on the deck of the USS Forrestal

Photo: Bettmann Archive/Getty Images



Aqueous Film Forming Foam – A Brief History, cont.

- Developed with 3M and patented by the Navy in 1966
- Creates a thin layer over the surface of the fuel that smothers the flames and prevents release of vapor
- Most efficient extinguishing method for petroleum fires and is widely used across the firefighting industry including commercial airports
- Key Ingredient: fluorinated surfactants



Striker – *The most innovative ARFF vehicle in the World*

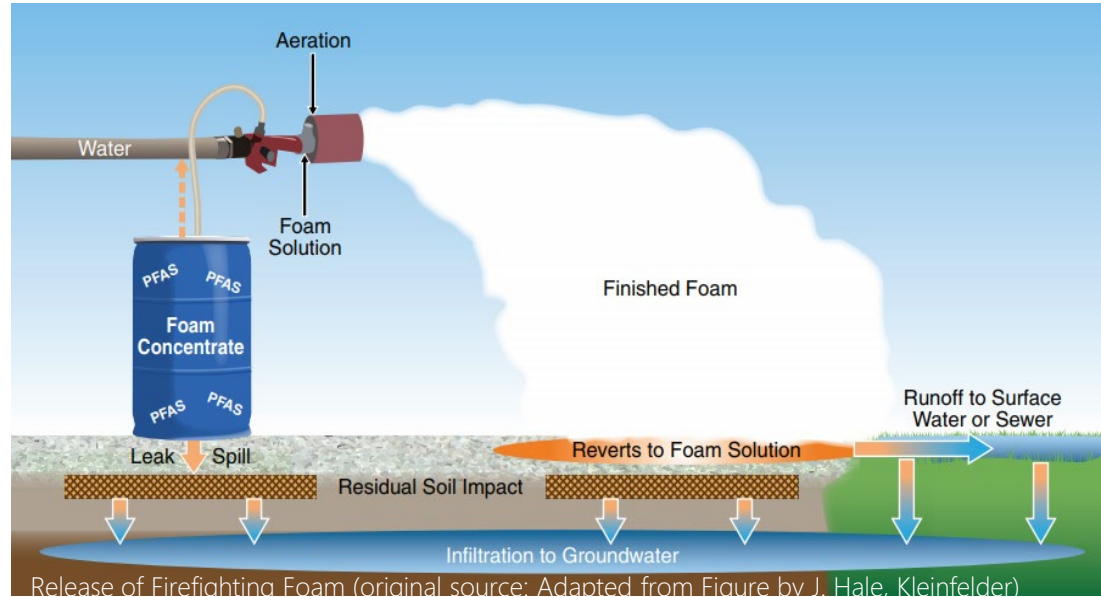


Source: Oshkosh Airport Products



Aqueous Film Forming Foam – Impacts to Soil/Water

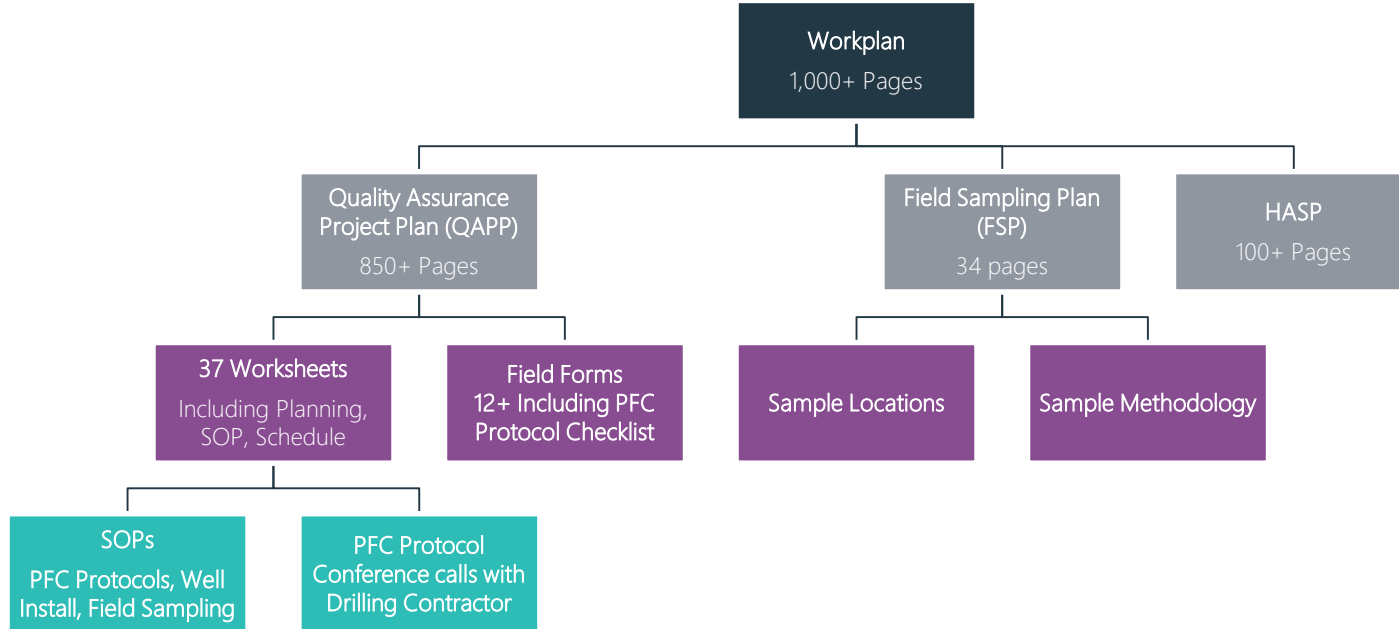
- Complex mixture of unidentified PFAS
- Released through:
 - Low volume releases during storage/transfer or equip. calibration
 - Moderate volume release for apparatus testing
 - Occasional high volume broadcast discharge for fire suppression/prevention
 - Periodic high volume broadcast release for fire training
 - Leaks from foam distribution piping between storage and pumping locations
- Thousands of gallons of foam solution may be applied during a given event



Potential Release Locations of Aqueous Film Forming Foam



Project Preparation



Sampling Considerations

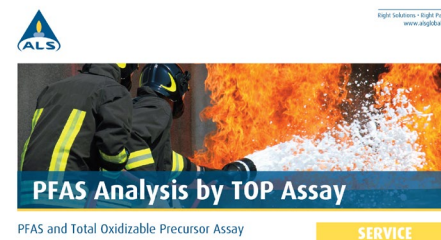
Have SOPs designed to minimize false positive results:

- ✓ No Teflon in sampling pumps, equipment, or sample containers
- ✓ No Gore-Tex, Tyvek, waterproof clothing
- ✓ Natural-based products for sunscreens, bug spray, personal care products
- ✓ Use vegetable oil instead of standard drilling equipment grease
- ✓ Adequate numbers of blanks to monitor contamination
- ✓ Well planned & executed programs can avoid the problems.



Overview of Analytical Methods

- ✓ EPA Method 537
 - ✓ Developed for finished/treated drinking water
- ✓ Modified EPA Method 537
 - ✓ Typically used by commercial laboratories
- ✓ ASTM Method 7979-17
 - ✓ Analysis of environmental solids (soil, sediment, sludge)
- ✓ ASTM Method D7968
 - ✓ Analysis of environmental waters (other than drinking water)
- ✓ Specialty Analyses
 - ✓ Source Fingerprinting
 - ✓ Non-targeted methods to explore unknown compounds
 - ✓ Total Oxidizable Precursors (TOP) Assay



Data Collection



- No plastic clipboards, binders or spiral hard cover notebooks
- No adhesives (Post-it® Notes)
- No waterproof field books other than Rite-in-the-Rain® Products
- Utilize Tablets with specialty coded forms for digital data collection
 - Required additional training



Daily PFC Protocol Checklist - Tailgate Meeting



Field Clothing and PPE (as applicable):

- Field crew in compliance with Tables 1 and 2, SOP AFW-01
- Field crew has not used fabric softener on clothing
- Field crew has not used cosmetics, moisturizers, hand cream, or other related products or exposed body parts this morning
- Field crew has not applied unacceptable sunscreen or insect repellent

Field Equipment:

- No Teflon® containing materials on-site
- All sample materials made from stainless steel, HDPE, acetate, silicon, or polypropylene
- No waterproof field books on-site other than Rite-in-the-Rain® Products
- No plastic clipboards, binders, or spiral hard cover notebooks on-site
- No adhesives (Post-it® Notes) on-site
- Coolers filled with regular ice only. No chemical (blue) ice packs in possession

ATTACHMENT 1 TO SOP AFW-01 DAILY PFC PROTOCOL CHECKLIST		arnec foster wheeler	
Project Name: Phase 1 Regional Site Inspections for Per-Fluorinated Compounds at Multiple Air National Guard Installations	Project Number: 291330006	Contract: W9133L-14-D-0002	Task Order: 0000
Installation:	Weather (temp./precipitation):	Site Name:	Date and Time:
Field Manager:			
Field Clothing and PPE (as applicable):		Sample Containers:	
<input type="checkbox"/> Field crew in compliance with Tables 1 and 2, SOP AFW-01	<input type="checkbox"/> Field crew has not used fabric softener on clothing	<input type="checkbox"/> Field crew has not used cosmetics, moisturizers, hand cream, or other related products or exposed body parts this morning	<input type="checkbox"/> Field crew has not applied unacceptable sunscreen or insect repellent
Field Equipment:		Wet Weather (as applicable):	
<input type="checkbox"/> No Teflon® containing materials on-site	<input type="checkbox"/> All sample materials made from stainless steel, HDPE, acetate, silicon, or polypropylene	For personnel in direct contact with samples and/or sampling equipment, wet weather gear made of Vinyl, polyurethane, PVC, latex or rubber-coated materials only	
<input type="checkbox"/> No waterproof field books on-site other than Rite-in-the-Rain® Products	<input type="checkbox"/> No plastic clipboards, binders, or spiral hard cover notebooks on-site	Equipment Decontamination:	
<input type="checkbox"/> No adhesives (Post-it® Notes) on-site	<input type="checkbox"/> Coolers filled with regular ice only. No chemical (blue) ice packs in possession	<input type="checkbox"/> "PFC-free" water on-site for decontamination of sample equipment	
		<input type="checkbox"/> Alconox and Liquinox to be used as decontamination materials	
		Food Considerations:	
		<input type="checkbox"/> No food or drink on-site with exception of bottled water and/or hydration drinks (i.e., Gatorade and Powerade) that is available for consumption only in the staging area	
QA/QC'd by:		QA/QC Date:	

Food Considerations:

- No food or drink on-site with exception of bottled water and/or hydration drinks (i.e., Gatorade and Powerade) that is available for consumption only in the staging area



Sampling Onsite Water



In order to decontaminate drilling and sampling equipment with “PFC free” water, the on-site domestic water source needed to be sampled for six PFC compounds prior to mobilization



Nitrile Gloves Worn Continuously



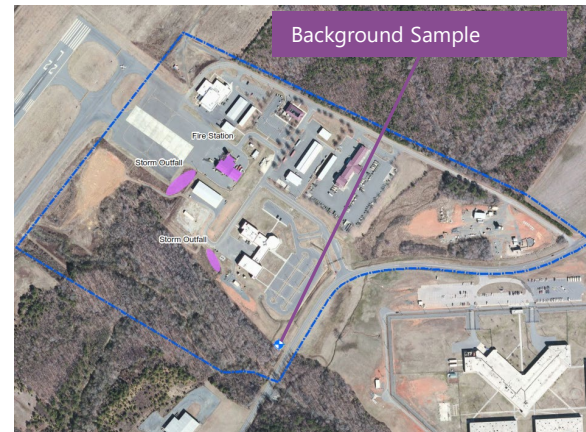
Bring plenty of Gloves!



Sample Locations



Legend	
	Sediment Sample
	Temporary Monitoring Well
	Soil Sample
	Approximate Surface Water Flow
	Potential AFFF PFC PRL (Approximate)



Shallow rock depth required air rotary



Utilities presented challenging sample locations



Surface Water was not present at Outfalls



Standards for 2017-2018 Site Inspections



- Interim Air Force Guidance and USEPA lifetime drinking water Health Advisories
 - PFOS and PFOA
 - 0.07 $\mu\text{g}/\text{L}$ in groundwater/surface water (combined with PFOA)
 - 1,260 $\mu\text{g}/\text{kg}$ in soil
 - 1,260 $\mu\text{g}/\text{kg}$ in sediment
- NCDEQ Interim Maximum Allowable Concentration PFOA
 - 2 $\mu\text{g}/\text{L}$ in groundwater



Screening Criteria



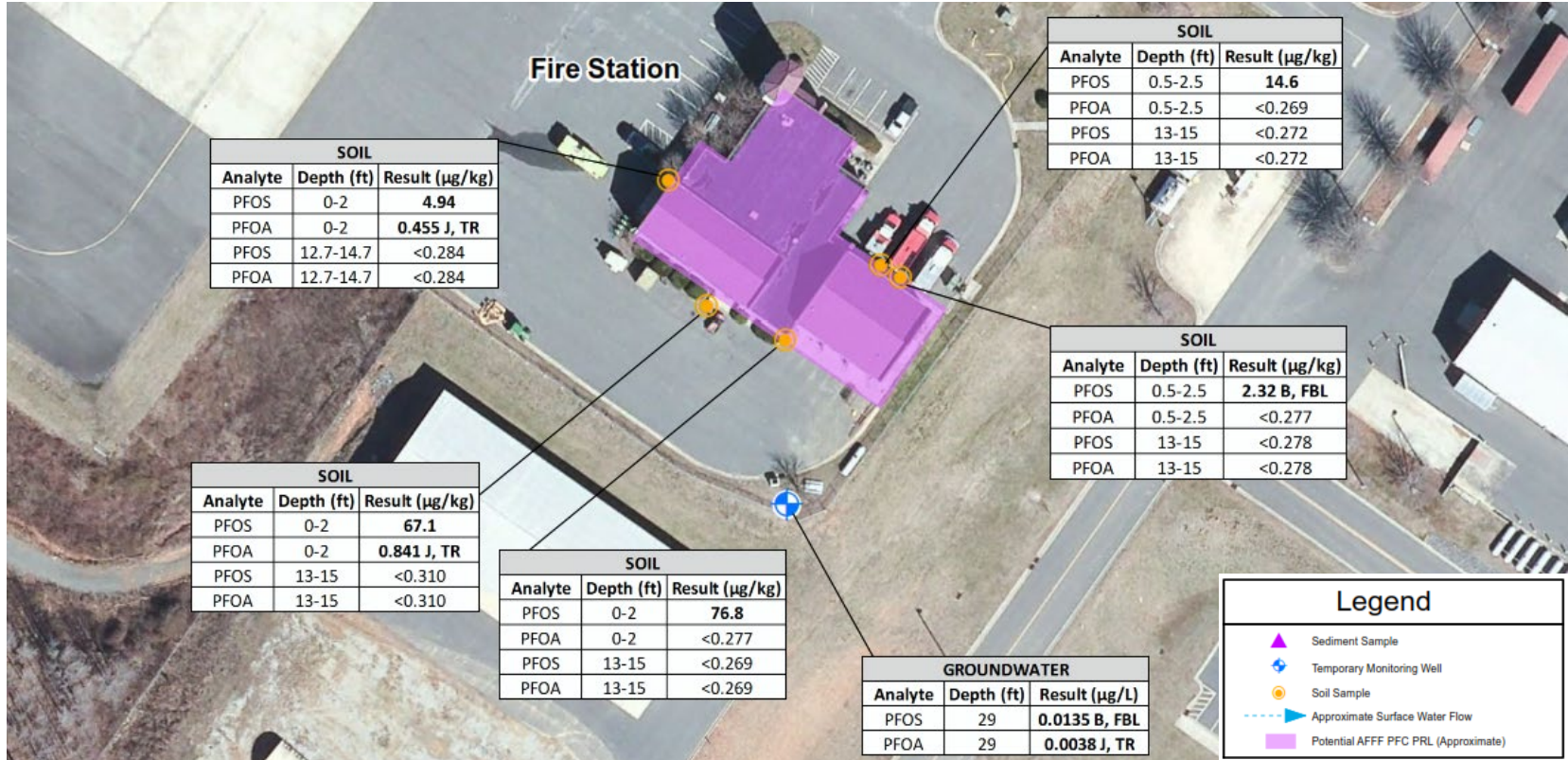
Parameters	Chemical Abstract Number	USEPA Regional Screening Level Table (May 2018) ^a		USAF Guidance for Soils and Sediments ^b (µg/kg)	USEPA Health Advisory Drinking Water (Surface Water or Groundwater) (µg/L) ^c	North Carolina Interim Maximum Allowable Concentration ^g (ug/L)
		Residential Soil (µg/kg)	Tap Water (µg/L)			
Perfluorobutane sulfonate (PFBS)	375-73-5	1,300,000 ^d	400 ^f	NL	NL	NL
Perfluorooctanoic acid (PFOA)	335-67-1	NL	NL	1,260	0.07 ^e	2
Perfluorooctane sulfonate (PFOS)	1763-23-1	NL	NL	1,260		NL



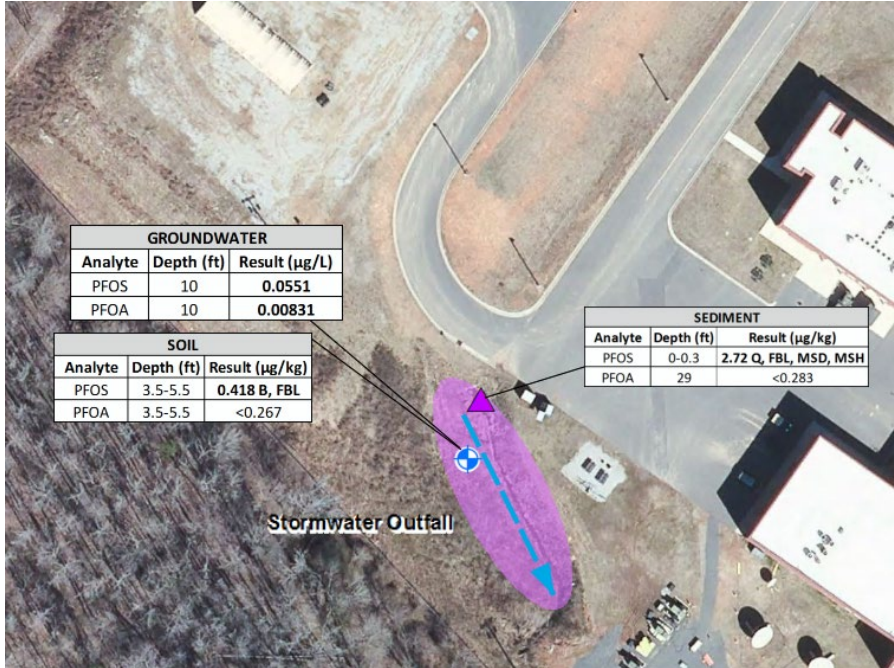
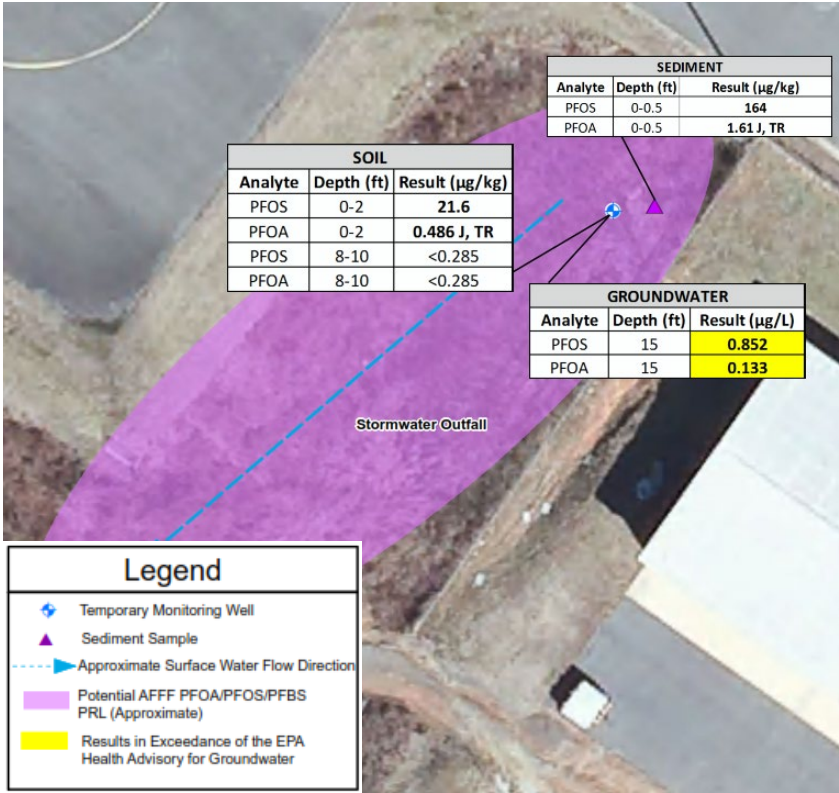
Potential Release Locations of AFFF



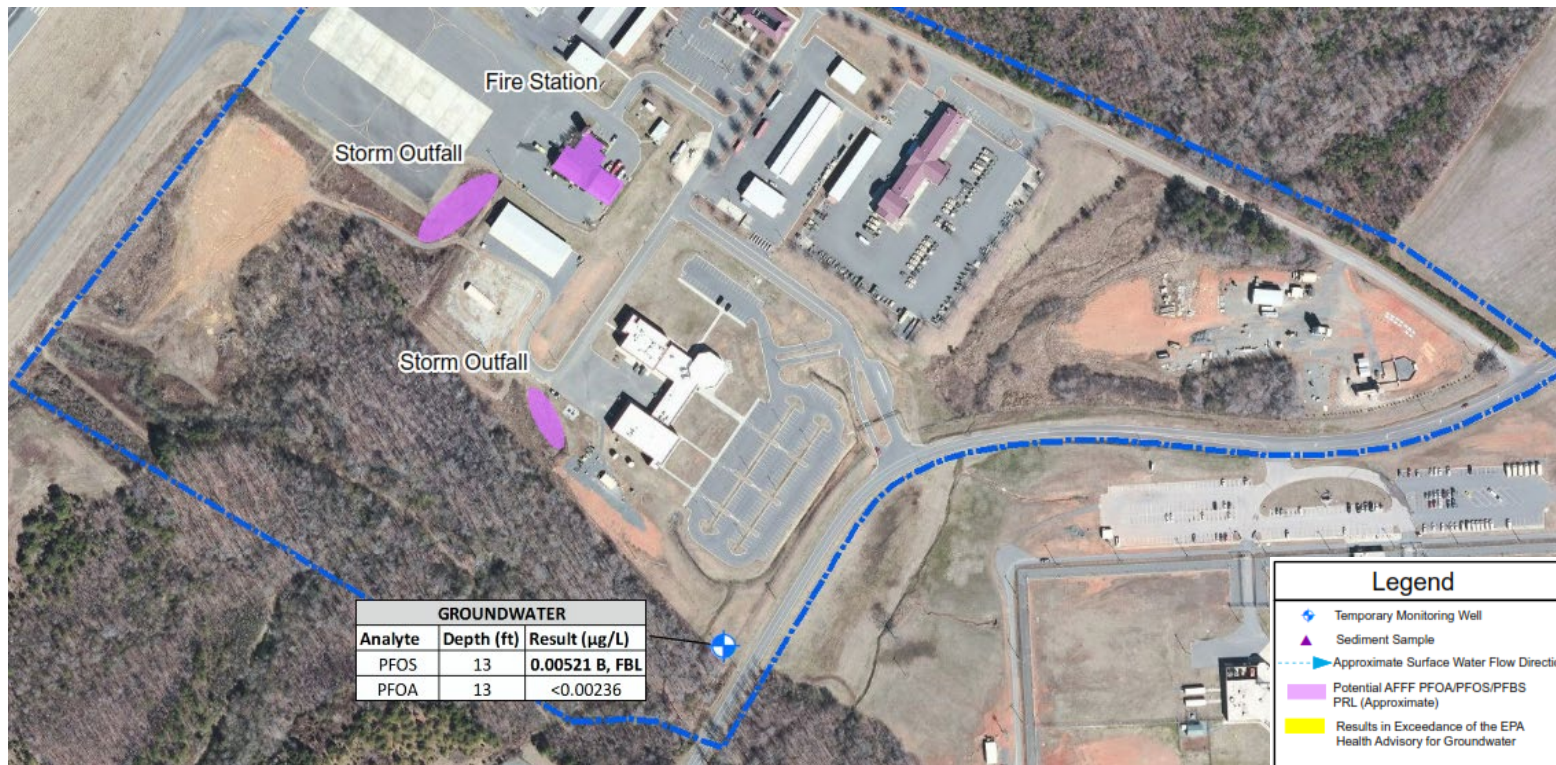
Results – Fire Station



Results – Stormwater Outfalls



Results – Background



Recommendations

- Additional Investigations to further evaluate concentrations of PFCs in groundwater
 - Include source evaluation and delineation to determine nature and extent of release
- Although concentrations of PFCs in soil did not exceed the screening criteria, they may be a source of PFCs to the groundwater
 - Additional soil investigation is recommended where groundwater exceeded the Health Advisory

Wood – The basis for our lessons learned



Evaluating over
130 locations
globally



Canada, US, UK,
Australia,
Germany



Strategic R&D
Partnerships



Policy
development &
review



Author
of Industry BMP
documents



Established Audit
program



New technology
pilot system



Fingerprinting
and source
identification



Design/
constructio
n of
Mitigation
Systems



Litigation
support

wood.

woodplc.com