NC DEQ and NC PFAST Network Summit 2025

January 29, 2025

Summit Proceedings

DEQ and NC PFAST Network Summit 2025

January 29, 2025

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DEQ PFAS Interest Areas and Needs

DEQ PFAST Summit
January 29, 2025

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Topics to Cover for Each Division

1. PFAS work performed

2. Current PFAS challenges

3. Needs related to external partners and topics

4. Specific ideas on projects to carryout with PFAST researchers

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Division of Waste Management (DWM)

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DWM Discussion Topics

- DWM Recent PFAS Activities
- PFAS Challenges DWM is Facing
- DWM Needs Related to External Partners and Topics
- Ideas or Projects for PFAS Researchers

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DWM Recent Activities

- PFAS 02L Standards Development
- Sites with PFAS Work:
  - Sampson County Landfill
  - Alamance County
  - Randolph County
- Expansion of Bernard Allen Program
- Chemours Barrier Wall and Expanded Well Sampling

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PFAS 02L Standards Development

- Environmental Management Commission (EMC) Rules
  - DWM assisted DWR with proposing revisions to 15A NCAC 02L .0202 for groundwater standards for PFOA, PFOS, and GenX.
  - 60-Day public comment period November 1 – December 31, 2024.
  - Three public hearings held across the state:
    - November 21 – Charlotte
    - December 2 – Wilmington
    - December 3 – Raleigh

Department of Environmental Quality - Waste Management

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Sampson County Landfill PFAS Sampling

- In July of 2023 DEQ asked NC landfills to test for PFAS
- DEQ split PFAS samples with the GFL landfill
- Groundwater, surface water, soil and leachate were sampled

Inferred GW Flow Direction

Approximate Drainage Divide

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Sampson County Landfill PFAS Data

- Continued Assessment work to determine source of PFAS and remedial options

	Average Total PFAS (ng/L)
82-01 Groundwater Wells	3,628
82-02 Groundwater Wells	6,477

ng/L = ppt

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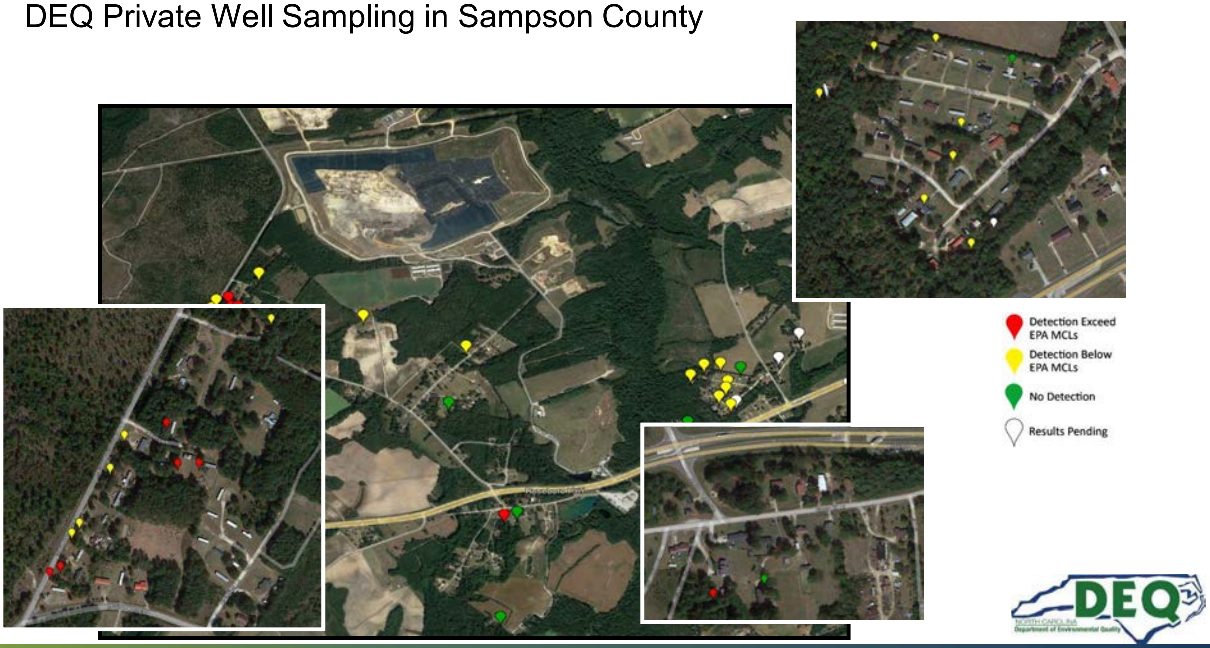
DEQ Private Well Sampling in Sampson County



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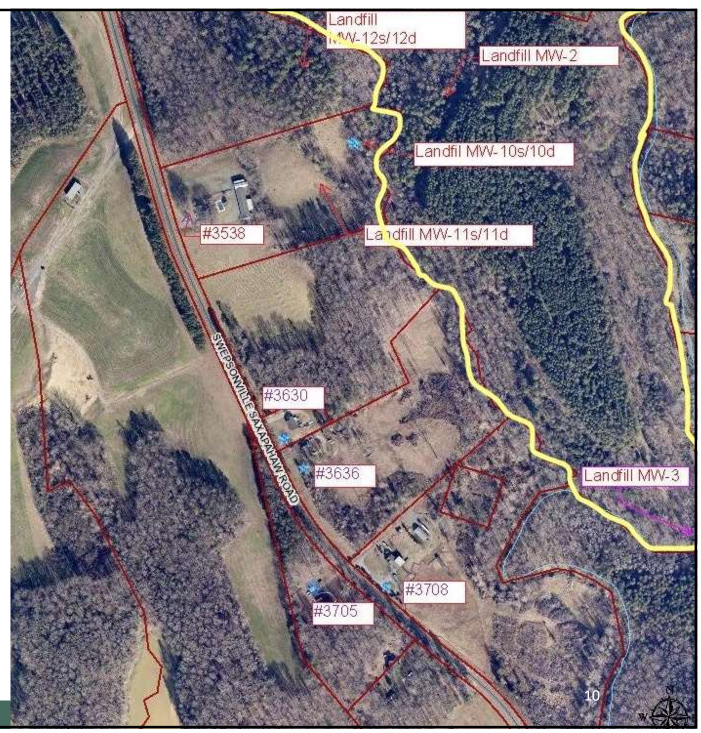
Alamance County PFAS Detections

- Residential wells by road impacted by PFAS, 305 to 2,261 ng/L
- Highest: 1,648 ng/L (#3538) and 2,261 ng/L (#3705)
- Multiple Potential Sources:
  - Closed, unlined Municipal Solid Waste Landfill (Yellow)
  - Residual Biosolids Application Fields (left side)
  - Home Septic Tank Systems?



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Alamance County (Continued)

PFAS found in monitoring wells downgradient of Landfill in both Groundwater and Surface Water. Homes mostly downhill of the application fields.

Residential well depths largely unknown.

Nitrate identified in wells closest to the application fields. Two homes >10 mg/L (2L Standard).

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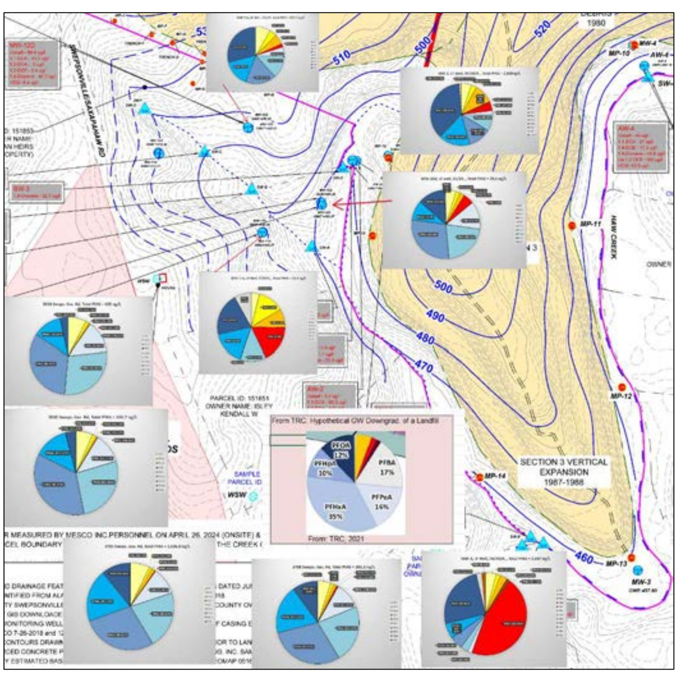

Alamance Co PFAS Signatures

- Top 3 charts: Monitoring Wells located downgradient of landfill. Most screened fractured bedrock.
- Residential wells (left 3 and bottom center) have similar signatures. Mostly PFHxA, PFPeA, PFHpA, PFBA, PFBS.
- Middle Chart (MW-11d) and landfill wells have PFOS (red), especially southern-most (MW-3, lower right chart).
- Signatures similar to typical signature for PFAS in groundwater downgradient of landfill (TRC, 2021)
- *Source: Upgradient application fields?*
  - Greater PFOA & PFOS, bottom charts
  - Nitrate detected in Private wells (two exceed 10 mg/L)

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Source Identification Gaps, Possible Partnerships

- Little published information on PFAS signatures in groundwater downgradient of biosolid application fields. Planning is underway to install monitoring wells near biosolids fields.
- Pollution investigation tool: Stable Isotope analyses for Nitrogen and Oxygen. Isotopes of Nitrogen helpful for contamination situations involving nutrients.
- DWM ISO additional "typical" PFAS Signatures for Comparison. EPA, Other States, Federal, Academia, Priv. Sources. Signature evaluation is a "tool", multiple lines of evidence is very important.
- Additional Site Characterization: Depth of residential wells. Location of fractures (downhole camera, geophysical testing).

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Randolph County PFAS Area

- Impacted water supply wells at Elementary School
- Flexographic printing company in the area. Major focus is printing and adhering labels.
- Water-based and alcohol-based inks. Formerly solvent-based.
- 3 Septic Tanks, only 2 permitted by County. Waste from "inksplitter" device to third tank, installed mid-1990s.

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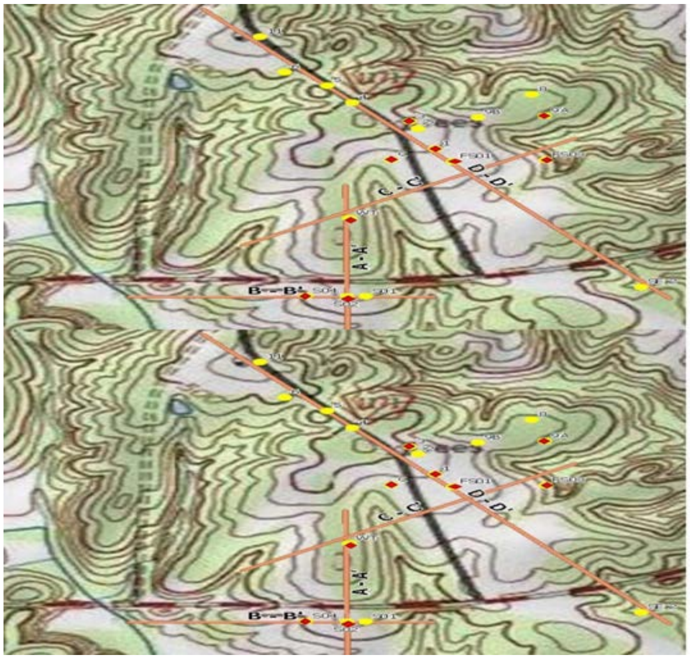

Randolph Co. PFAS Area

- Yellow dots (private wells). Ones with red diamonds are contaminated with PFAS.
- School wells are FS-01 (7,078 ng/L) and FS-03 (15 ng/L).
- Adjacent property well 3,450 ng/L.
- DWM evaluated Well Depths, Geology and PFAS signatures.

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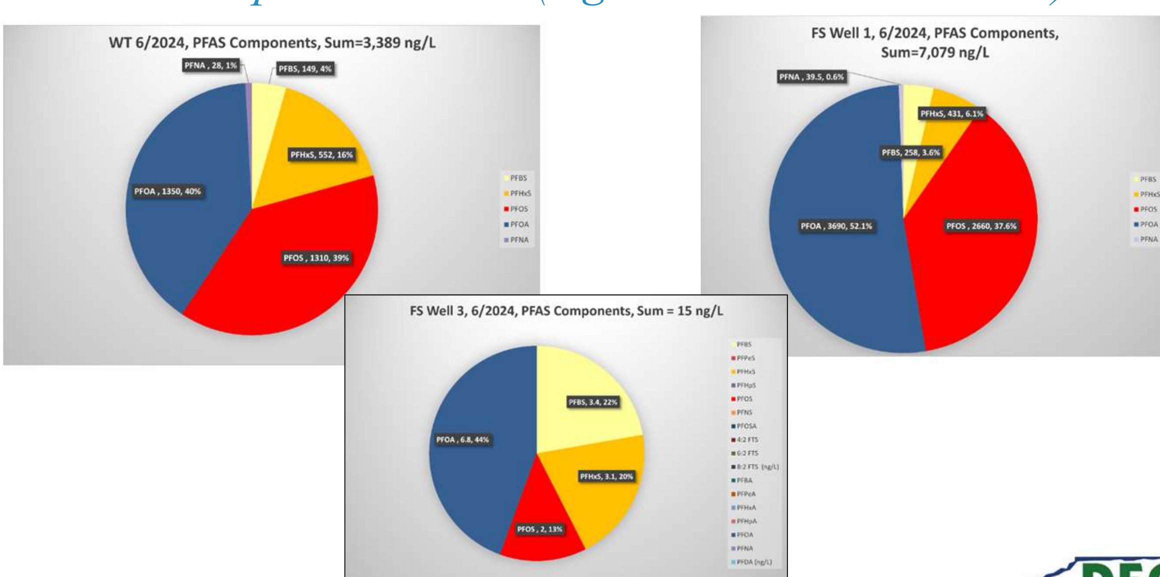
Randolph PFAS Area (signatures – Groundwater)



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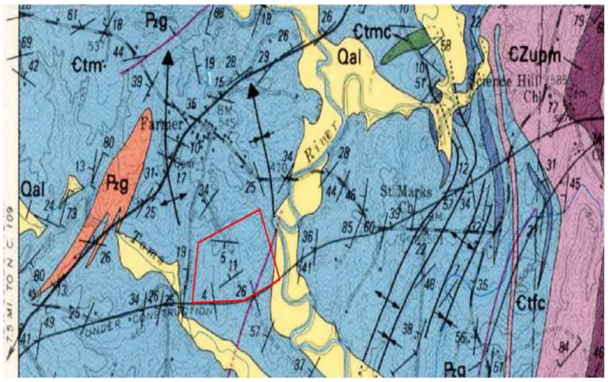
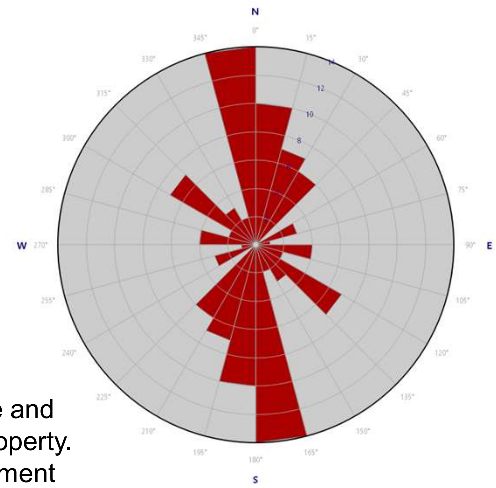
Site Evaluation Work





- Randolph Co. - Some Well Construction Information.
- Asheboro Geologic Map (Seiders, 1991) shows strike and dips. Red outline = combined school and adjacent property.
- Potential fractures in bedrock inferred based on lineament analysis (right). Stream segments within 2 miles of site. Directions: Primary N 0-15° W, Secondary N 0-15° E.

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Bernard Allen Memorial Emergency Drinking Water Fund

- Administered by the N.C. Division of Waste Management, was created in 2006 by the General Assembly in G.S. 87-98 to improve the state's response to water supply well contamination and provide low-income households with a safe drinking water supply.

- The fund has three authorized uses:
  - 1) pay for notice to persons whose wells were at risk from groundwater contamination
  - 2) pay for the costs of testing private wells.
  - 3) provide an alternate drinking water supply to well owners affected by the contamination.

- To Date 530 wells have been sampled for PFAS. 145 residences have been provided alternate water through the BAF. An additional 33 have been referred to Chemours.

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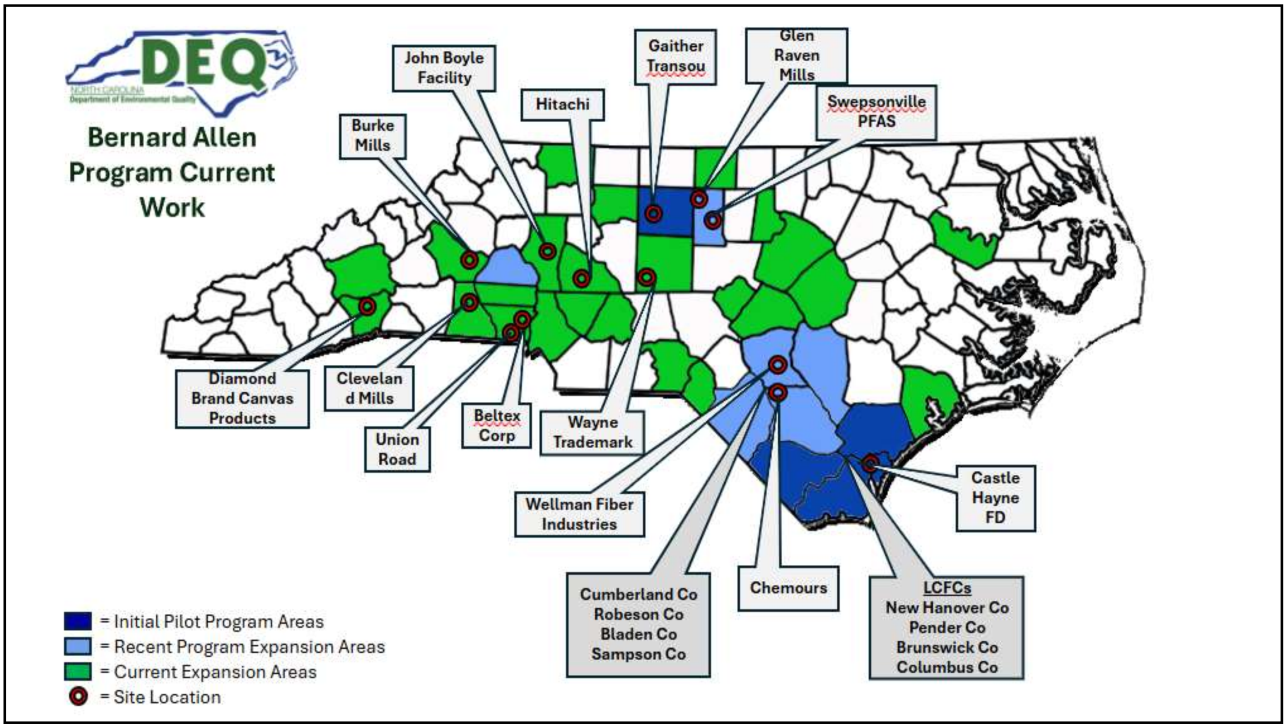
Bernard Allen Program Current Work
John Boyle Facility
Gaither Transou
Glen Raven Mills
Hitachi
Swepsonville PFAS
Burke Mills
Diamond Brand Canvas Products
Clevelan d Mills
Union Road
Beltex Corp
Wayne Trademark
Wellman Fiber Industries
Castle Hayne FD
Cumberland Co Robeson Co Bladen Co Sampson Co
Chemours
LCFCs New Hanover Co Pender Co Brunswick Co Columbus Co
= Initial Pilot Program Areas
= Recent Program Expansion Areas
= Current Expansion Areas
= Site Location

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Community Engagement
NC Dept of Environmental Quality
Inquire About PFAS Well Testing
Call: 910-678-1101
Call: 910-678-1100
GenX Investigation | NC DEQ
Democracy Green
Residents of Bladen, Cumberland, Robeson, Sampson Counties
Why should you have your well sampled?
Chemours is required to sample private drinking water wells to find GenX/PFAS contamination coming from their facility and provide replacement drinking water supplies. DEQ urges eligible residents to have their wells tested to find and reduce exposure to PFAS contamination.
Call Chemours (910) 678-1101
Learn More: bit.ly/FayWells
Well Sampling Information for Lower Cape Fear Area Residents | NC DEQ
Conozca las PFAS
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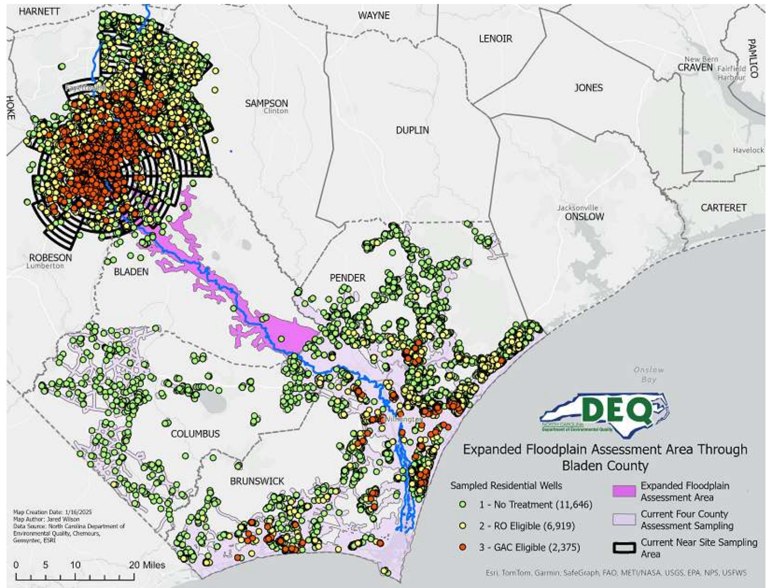
Expanded Private Well Sampling Work Related to Chemours



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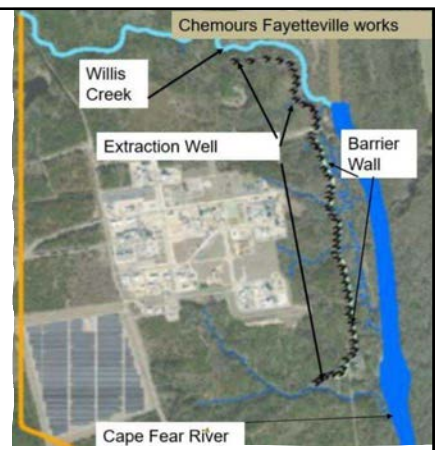
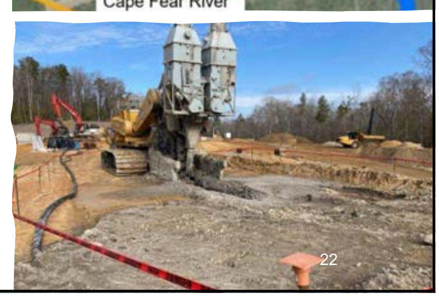
Chemours Barrier wall and groundwater extraction system

- Barrier Wall Design
  - 6,050 feet long and 70-80 feet deep. Keyed into Upper Cape Fear Confining Unit
  - Wall is approx. ½ meter thick
  - One-pass installation mixes soil and bentonite/cement mix continuously during construction





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Challenges DWM is Facing

- Landfill PFAS Dataset and Assessment
- Increasing numbers of PFOA / PFOS detections in private wells
- Increasing geographical area impacted by Chemours
- Additional work on source identification

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DWM Needs Related to External Partners and Topics

- AFFF Work with the NC Collaboratory on private wells at fire stations and surrounding properties
- Groundwater modeling partnership

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Ideas or Projects for PFAST Researchers

- Move forward with the Collaboratory on the AFFF fire station receptor work and glean information from them on PFAS destruction technologies

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PFAS Update and Investigations at DEQ Division of Water Resources

Julie Grzyb, Deputy Director

January 29, 2025

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Public Water System Sampling in NC

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NC Public Drinking Water Systems Impacted by the PFAS Rule

All NC Community Water Systems (CWSs) and Non-Transient Non-Community Water Systems (NTNCWSs) with their own source will be affected by the new SDWA PFAS rule.

Category	Number of Systems
Total Number of Water Systems Affected	1,958
CWSs	1,648
NTNCWSs	310
Groundwater (GW) Systems	1,789
Surface Water (SW) Systems*	169

*Includes surface water purchase systems with their own source and Groundwater Under the Direct Influence of Surface Water (GWUDI) systems.

NC is proceeding through the rulemaking process to adopt the federal drinking water regulation by reference (April 26, 2029 compliance date).

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NC PWS PFAS Sampling Overview

Sampling Event	Number of Systems	Notes
The NC Collaboratory	376	Raw water. 47 analytes. Municipal systems.
Public Water Supply Section 2022	50	Raw and treated water. One sample/month for three months. 57 analytes.
Public Water Supply Section 2023	534	Treated water. One sample at one entry point per system. 57 analytes.
Public Water Supply Section 2024	255	Treated water. One sample at one entry point per system. 57 analytes.
UCMR5	298	Treated water. Multiple samples per system/per entry point. 29 analytes. 177 systems sampled as of May 31, 2024.
Aqua North Carolina, Inc.	707	Treated water samples only. Data available for six analytes. Received results in April 2024.
Carolina Water Service, Inc. of NC	96	18 analytes. Received results in April 2024.

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North Carolina Compliance Projections

- Based on sampling efforts thus far, it is currently projected that approximately 355 (21.7%) of systems sampled could exceed one or more of the PFAS MCLs or the HI.
- All systems that were sampled by the PWS Section have been notified of their PFAS results and if PFAS was found above an MCL, those notifications included language about the availability of funding for studies and treatment through the Division of Water Infrastructure.
- Currently moving through the rule-making process to adopt the federal SDWA PFAS regulations by reference. (Public Comment period is open).

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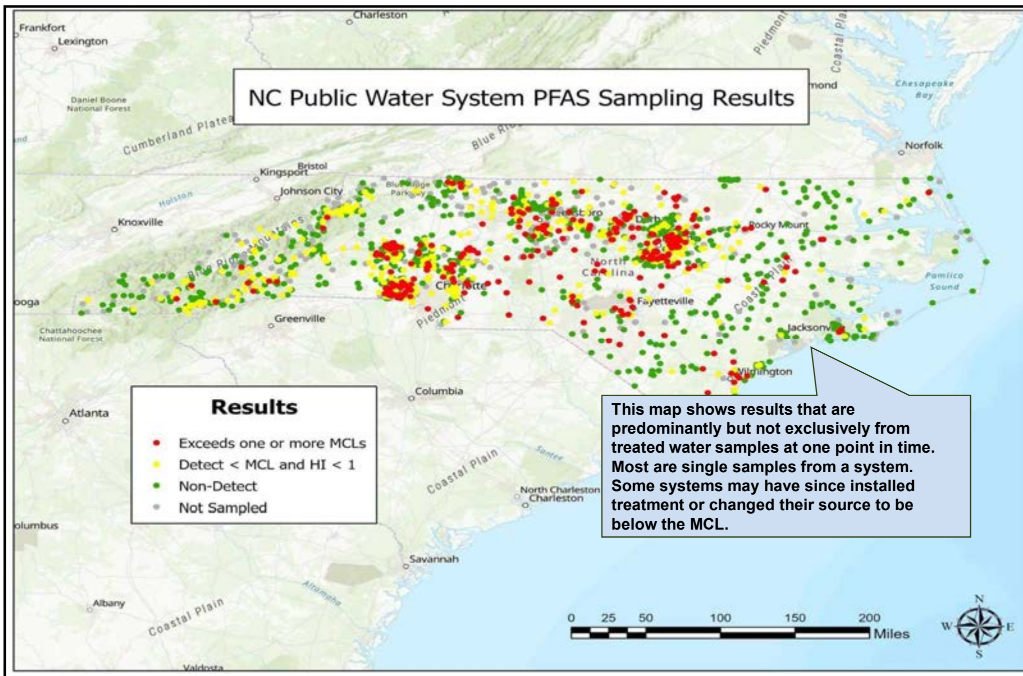

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General Summary of PWS Data

- PFOS and PFOA most prominent contaminants > MCL
- ≈1 % systems initially sampled with HI >1
- ≈1 % systems initially sampled PFHxS exceedances
- No systems initially sampled with PFBS exceedances
- ≈ 0 – 0.5% systems initially sampled* with GenX exceedances
- No systems initially sampled with PFNA exceedances
- We are finding PFAS other than the six compounds in the final regulation

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Groundwater Sampling in NC

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Statewide Ambient Groundwater Monitoring using the DWR Groundwater Monitoring Well Network

- DWR is assessing PFAS in groundwater utilizing the DWR ambient groundwater monitoring well network to better understand the nature and extent of PFAS contamination in North Carolina's aquifers. The network consists of ~700 wells at 240 locations statewide.

- As of January 2025,
  - > 600 groundwater PFAS samples collected
  - ~ 400 individual monitoring wells sampled in 64 counties
  - ~ 170 monitoring stations sampled

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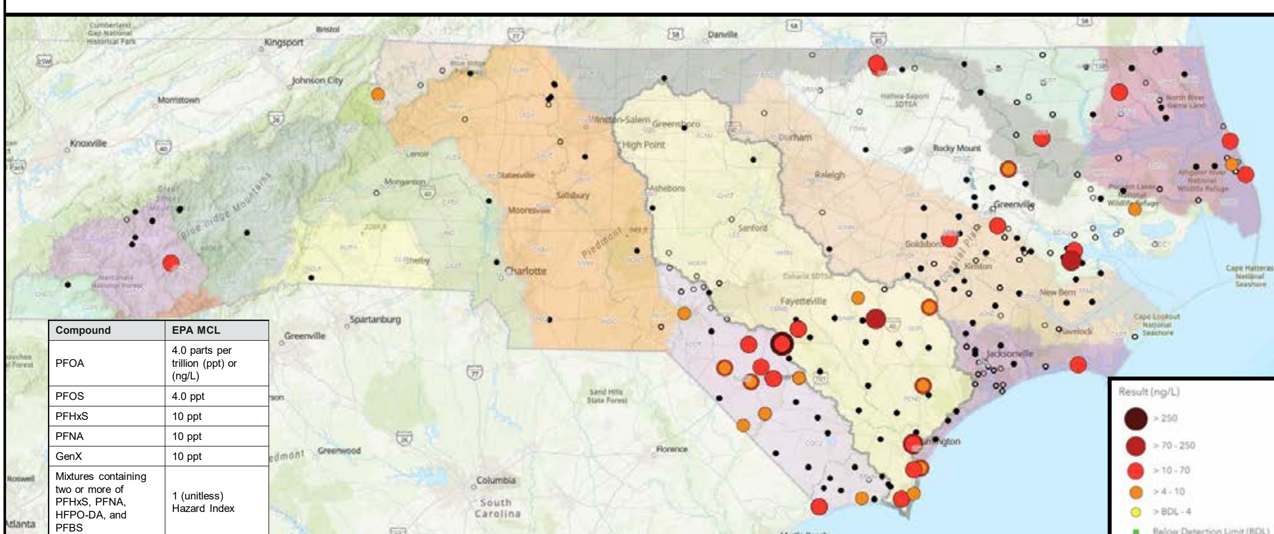
PFAS Exceedances of any EPA MCLs in DWR Groundwater Monitoring Well Network



Compound	EPA MCL
PFOA	4.0 parts per trillion (ppt) or (ng/L)
PFOS	4.0 ppt
PFHxS	10 ppt
PFNA	10 ppt
GenX	10 ppt
Mixtures containing two or more of PFHxS, PFNA, HFPO-DA, and PFBS	1 (unitless) Hazard Index

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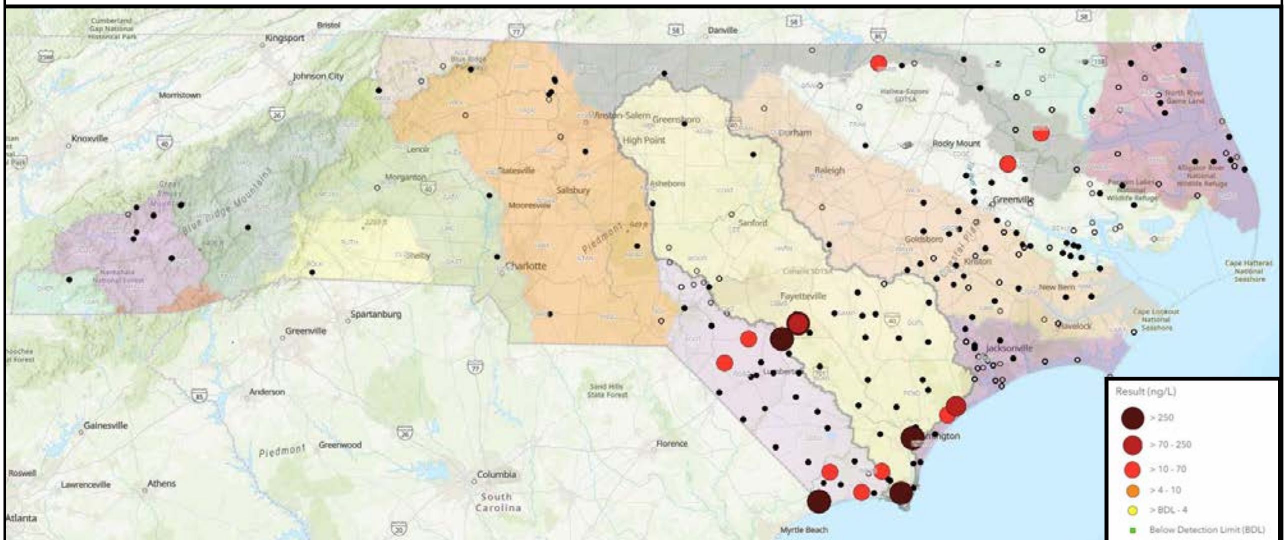
Any Attachment C PFAS > 10 ng/L or Σ{Attachment C PFAS} > 70 ng/L in Groundwater at DWR Groundwater Monitoring Well Network



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Summary of PFAS Detections by Aquifer in DWR Groundwater Monitoring Well Network

			Number of Wells…			…exceeding EPA MCLs					…with Chemours Compounds > 10 ng/L									
Aquifer	Well Depth range (ft)	Average Well Depth (ft)	Sample Set	at least one criterion exceeded	Below MCL	PFOA >4	PFOS >4	PFHxS >10	H.I. >1	GenX >10	PFMOAA	PFO2HxA	PFO3OA	PFO4DA	PMPA	PEPA	PFESA BP2	PFHpA	Total Att. C PFAS >70 ng/L	Total PFAS >70 ng/L
Basement Saprolite	17-48	31	7	2	5	2	1											1		1
Surficial	9-225	41	120	32	88	22	25	3	8	4	11	7	4	4	4	2	2	2	6	13
Yorktown	40-266	112	32	5	27	5	3		1									2		1
Upper Black Creek	45-280	136	7	1	6						1				1	1			1	1
Peedee	36-640	199	40	2	38	1	2	2	2											1
Black Creek	30-619	217	50	3	47	3	1											1		1
Castle Hayne	60-510	235	32	2	30	1	1		1	1	1	1	1	1					1	1
Basement Rock	50-550	249	34	2	32	2	2													1
Beaufort	105-529	291	11	1	10	1														1
Upper Cape Fear	85-588	342	46	5	41	5	1													
Lower Cape Fear	380-870	571	13	0	13															
Lower Cretaceous	600-1001	801	2	0	2															
Totals			394	55	339	42	36	5	12	5	13	8	5	5	5	3	2	6	8	21

- 110 (28%) wells with **at least one PFAS detection**
- 55 (14%) wells with a result **exceeding EPA MCL or NC IMAC**
- 42 (11%) wells with a **PFOA result > 4 ng/L**
- 36 (9%) wells with a **PFOS result > 4 ng/L**
- 12 (3%) wells with a **HI >1**
- PFBA, PFOA, PFOS, and PFPeA are the **most detected analytes**

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Summary

- Groundwater samples collected across the statewide DWR groundwater monitoring well network indicate ***detections of PFAS are widespread***, particularly in the coastal plain, but generally in lower concentrations.

- ***Surficial aquifer impacts*** are usually more significant than in deeper aquifers. Most significant impacts appear to be in the ***southeast portion of the state***.

- Latest data from repeated samples show relatively little change for most compounds in most wells. However, some wells show an increase while other wells show decreases in specific PFAS concentrations.

- 2025: Continue sampling NC DWR monitoring well network, focusing on monitoring shallower wells, which are more likely to be impacted by surficial processes than deeper wells.

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Surface Water

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Emerging Compounds Strategy: Surface Water

- In 2019, NPDES Permitting required 28 POTWs with Significant Industrial Users and 20 Industry within the Cape Fear River Basin to test for PFAS during a three-month period - influent and effluent.
- PFAS monitoring is added to NPDES industrial permittees known or suspected of discharging PFAS.
- As part of the Biosolids PFAS source identification study, influent, effluent, and biosolids were tested for PFAS at 39 wastewater treatment plants
- Currently, NPDES Permitting is working with POTWs to add PFAS monitoring at Significant Industrial Users known or suspected of having PFAS in their wastewaters.
- The EMC's WQ Committee has requested that DEQ work on a PFAS Minimization Plan for Industrial Permittees and Significant Industrial Users
- NPDES is adding a requirement for Industrial NPDES facilities to development and implement PFAS Best Management Practices for Industrial Permittees and SIUs discharging (creating) PFAS

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Biosolids Investigation Study

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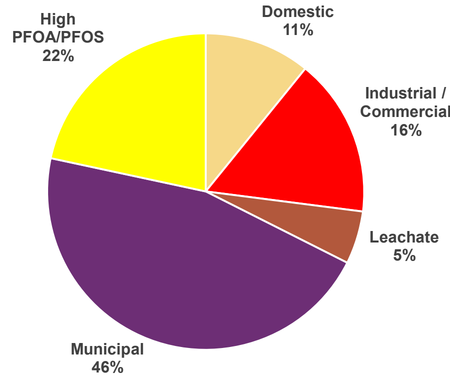
DWR Biosolids Investigation

Criteria for Selection of Facilities

1. Facilities previously identified with **high PFOA + PFOS** based on influent sampling.
2. Facilities that receive **landfill leachate** suspected to contain high PFOA + PFOS.
3. Facilities that treat **100 % domestic wastewater** which are among the top 10 largest (by permitted flow).
   - *Two within Cape Fear River Basin; one outside the basin.*
4. **Large municipal wastewater treatment plants** (by permitted flow).
5. **Large industrial process & commercial wastewater treatment plants** (by permitted flow).



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DWR Biosolids Investigation
2023 Biosolids Sampling

1. Investigation of **influent, effluent, and biosolids** generated at 39 wastewater treatment plants.
   - Two grab samples obtained from source facilities to capture variability in the waste stream.
2. Investigation of a subset (28) of **land application fields** (**soil**) with long history of usage.
   - Composite soil samples were collected from representative acre within each field.
3. Investigation of **groundwater** at 1 land application site.
   - 1 upgradient and 1 downgradient groundwater sample collected from Pasour Mountain Groundwater Monitoring and Research Station monitoring wells.

All samples were sent to GEL Laboratories for analysis via EPA Modified Method 537.1

➢ Analysis of 45 compounds, including expanded PFAS list (GenX and Consent Order Attachment C PFAS)

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DWR Biosolids Investigation 2024 Data Analysis

- In 2024, DWR reviewed the data collected and used the data to assess the levels of PFAS at the 39 source facilities and 28 land application fields.
- This included:
  - statistical analyses
  - evaluation of most common PFAS observed
  - comparison to other published studies, including Michigan EGLE's work
  - determination of a "threshold" PFOS concentration denoting industrially impacted biosolids (same approach as Michigan)
  - comparison of observed soil PFAS to Preliminary Soil Remediation Guidelines (PSRGs)
  - PFAS mass balance calculations for the load received at the WWTP
  - review of EPA's Risk Assessment of PFOA and PFOS in biosolids (published 1/14/25)

- A final report, summarizing the findings of this investigation will be published soon, along with the data.

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PFAS Projects/Needs

- Can we develop source-specific fingerprints for PFAS contamination in different regions of North Carolina to identify the most significant contributors?
- How are emerging sources of PFAS, such as consumer products and biosolids, contributing to water contamination in North Carolina?
- How do the unique hydrological and hydrogeological characteristics of North Carolina (e.g., coastal plains, Piedmont, mountains) influence the fate and transport of PFAS in surface and groundwater systems?
- What are the most effective and cost-efficient treatment technologies for removing PFAS from drinking water sources in North Carolina, considering the specific characteristics of the water sources and the types of PFAS present?

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Specific ideas or projects to carry out with PFAST researchers

PWS

- Technical assistance to assist the smaller PWSs with turn-key engineering services (application for funding, evaluation of contamination, evaluation of mitigation alternatives, implementation of selected mitigation strategy.)
- Collect the remaining initial monitoring samples for all of the PWS serving <10,000 population using EPA's certified test method 537.1

Biosolids

- Collection of "background" soil samples from buffer zones within land application fields
- Additional groundwater sampling in land application areas
- Collection of surface water samples near land application fields

Groundwater

- Establish a portal where university and state certified PFAS data can be consolidated in a consistent and accessible web format

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Division of Air Quality (DAQ)

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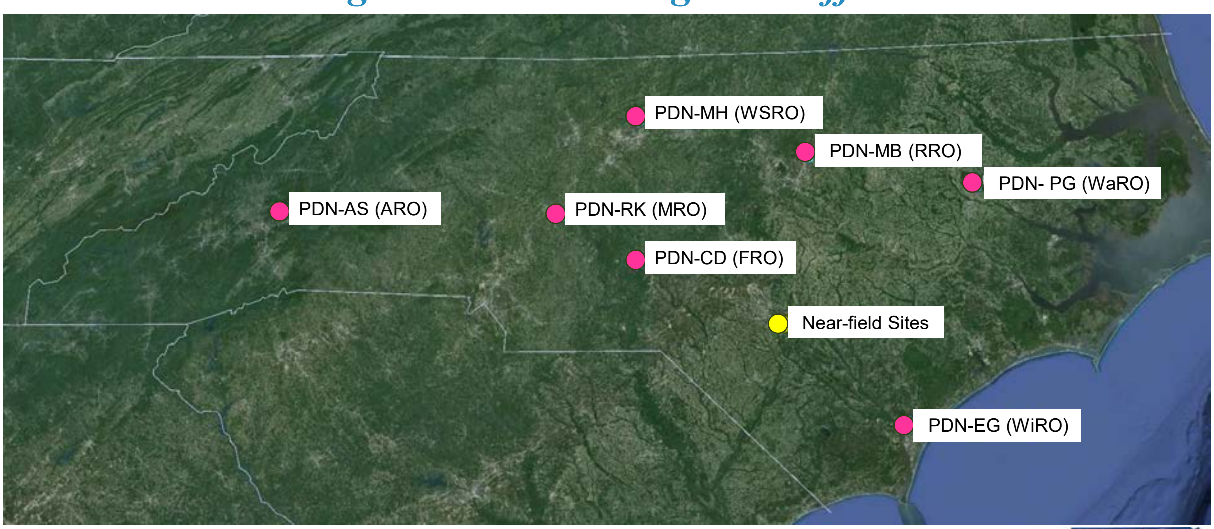
PFAS Deposition Network (PDN)
Background Sites at Regional Offices



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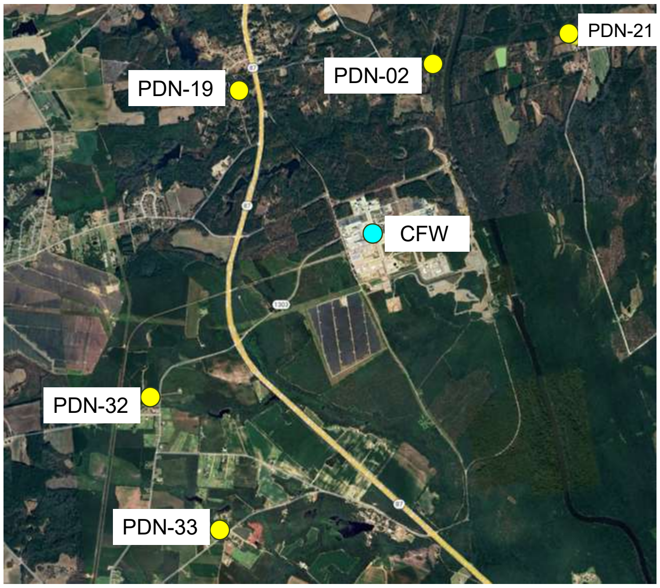
PDN Sites Near-field to Chemours Fayetteville Works



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Sites Near-field to Chemours Fayetteville Works

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Sites Near-field to Chemours Fayetteville Works

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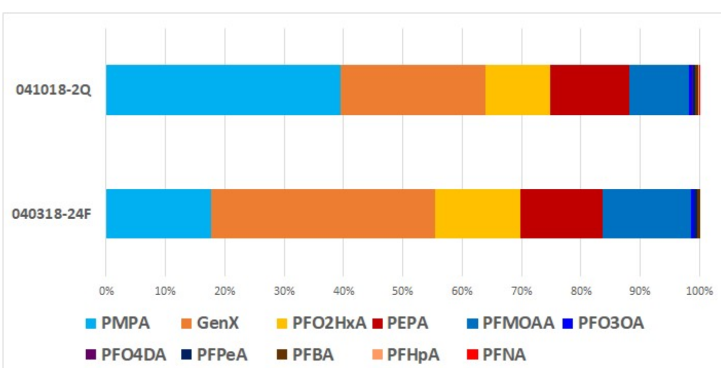
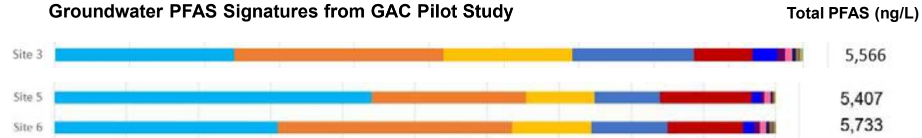
PFAS Signatures in April 2018 Wet/Dry Deposition Sample



Total (GenX)PFAS (ng/L)	Deposition (ng/m2) = (Concentration * sample volume) / Bucket opening
1,254 (307)	26,200 (6,420)
532 (200)	11,100 (4,180)

Groundwater PFAS Signatures from GAC Pilot Study



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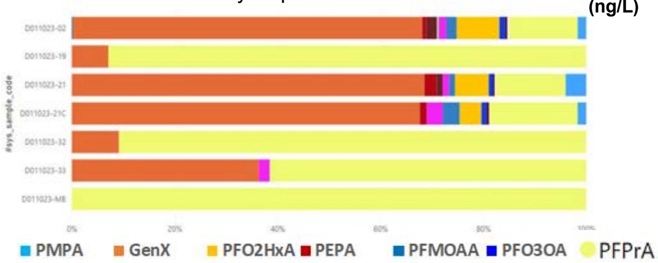
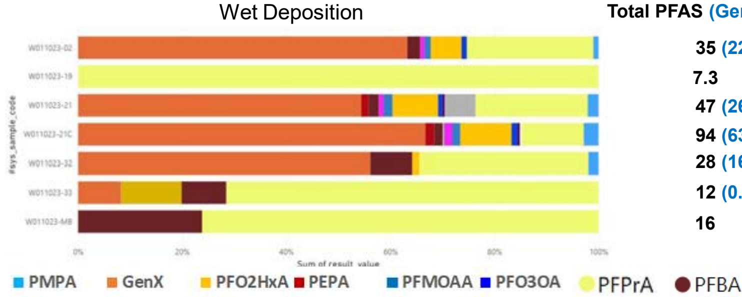
Deposition in 2023 Samples

Dry Deposition



Total PFAS (GenX) Conc (ng/L)	Total PFAS (GenX) Dry Deposition (ng/m2)
107 (73)	1,000 (670)
9.1 (0.647)	80 (6)
95 (65.3)	880 (600)
38 (25.8)	350 (240)
7.5 (0.687)	70 (6)
14 (5.09)	130 (47)
8	0.007

Wet Deposition



Total PFAS (GenX) Conc (ng/L)	Total PFAS (GenX) Wet Deposition (ng/m2)
35 (22)	320 (200)
7.3	70
47 (26)	430 (240)
94 (63)	880 (590)
28 (16)	260 (150)
12 (0.96)	110 (90)
16	190

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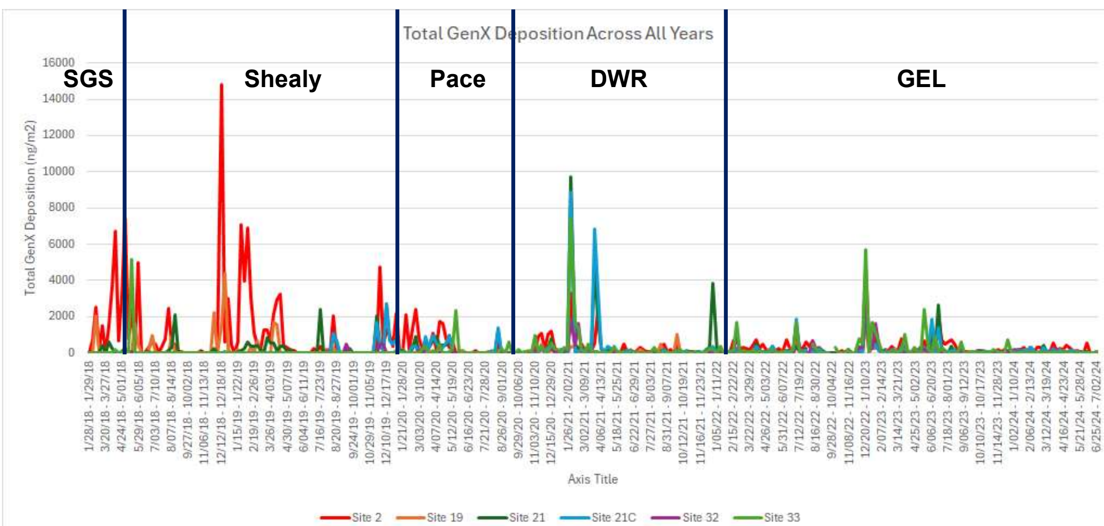
Near-field Site GenX Total Deposition



Department of Environmental Quality Note: Frequency of detection increases with time due to lower quantitation limits

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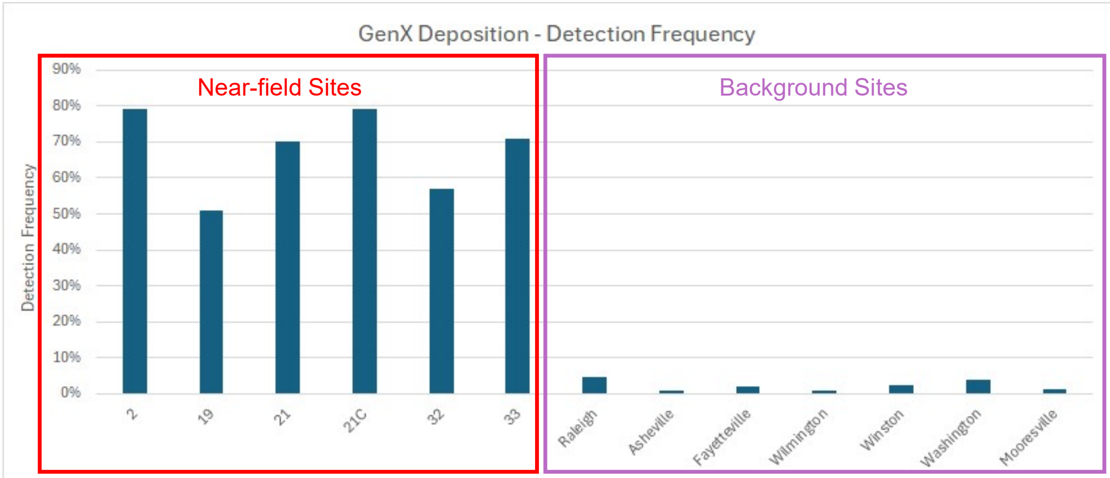
GenX Detection Frequency Since 2018



Notes: GenX detection frequency now greater
PFOA, PFOS, PFNA found in 0% to 2% of samples at all locations

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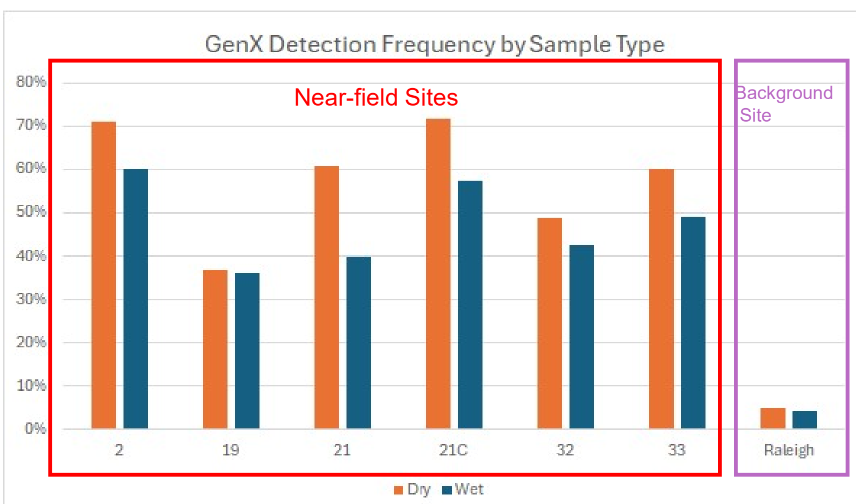
GenX in Detection Frequency in Dry vs. Wet Samples



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Typical pattern for most PFAS with the following exceptions: PFMOAA, PFPrA, PFBA

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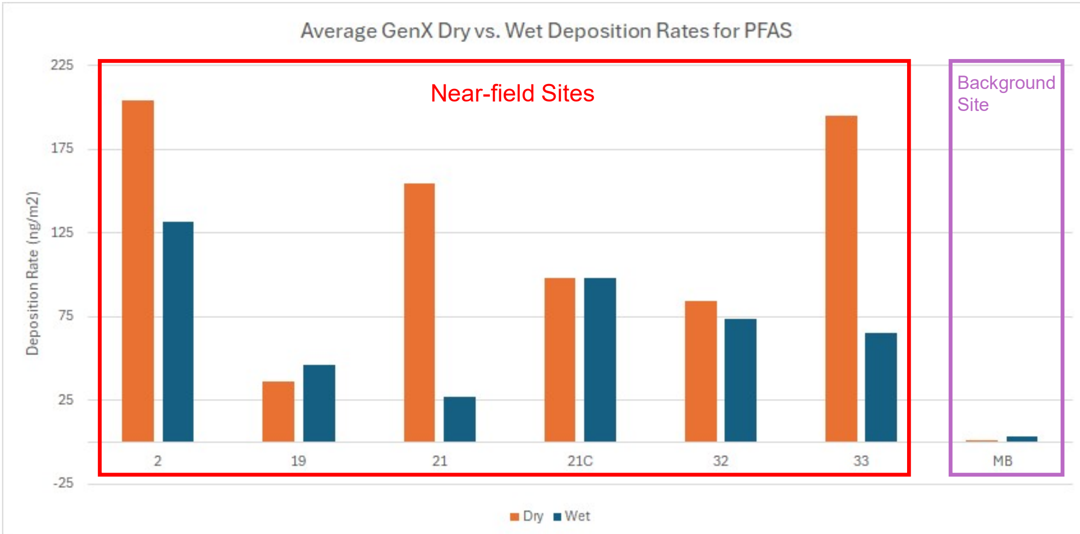
GenX Deposition Rates in Dry vs. Wet Samples



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Data beginning in 2022

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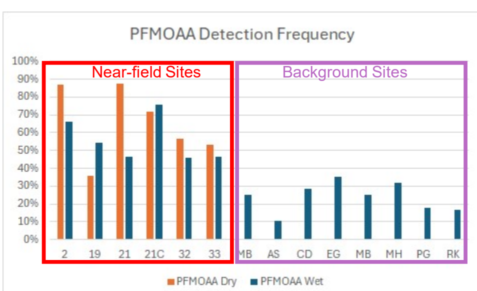
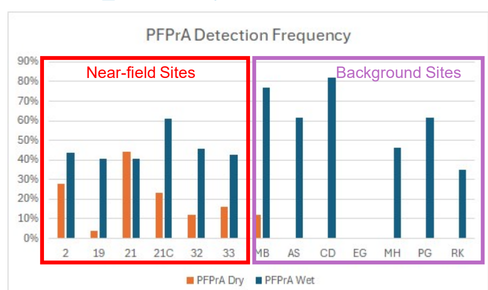
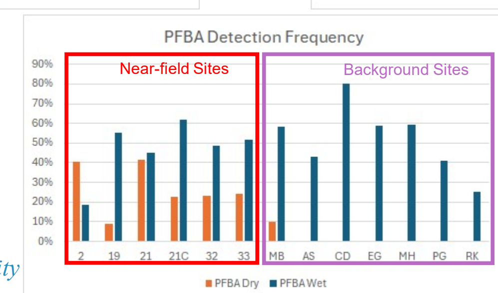
PFAS Detection Frequency







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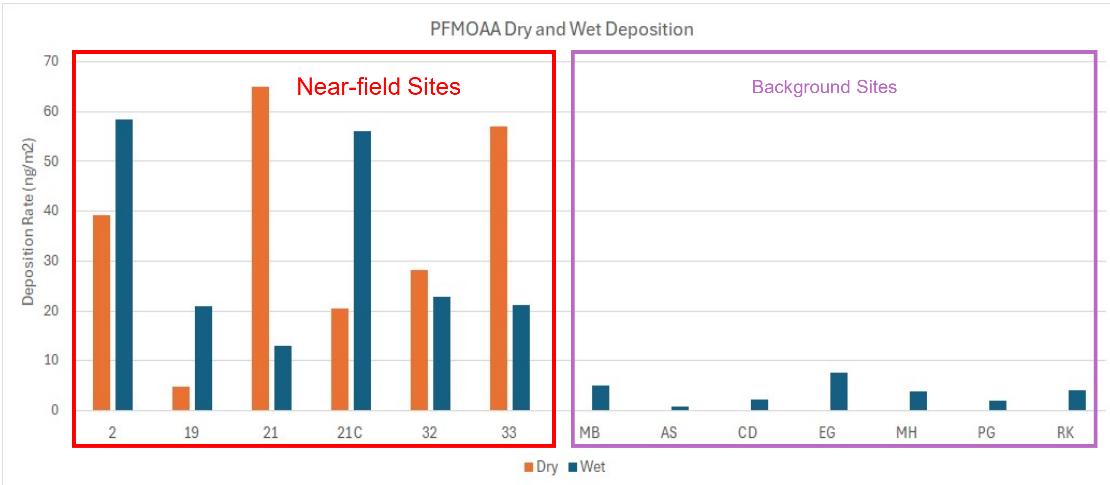
PFMOAA Deposition Rates in Dry vs. Wet Samples



Some results calculated with values that are BQL and are estimates

Data beginning in 2022

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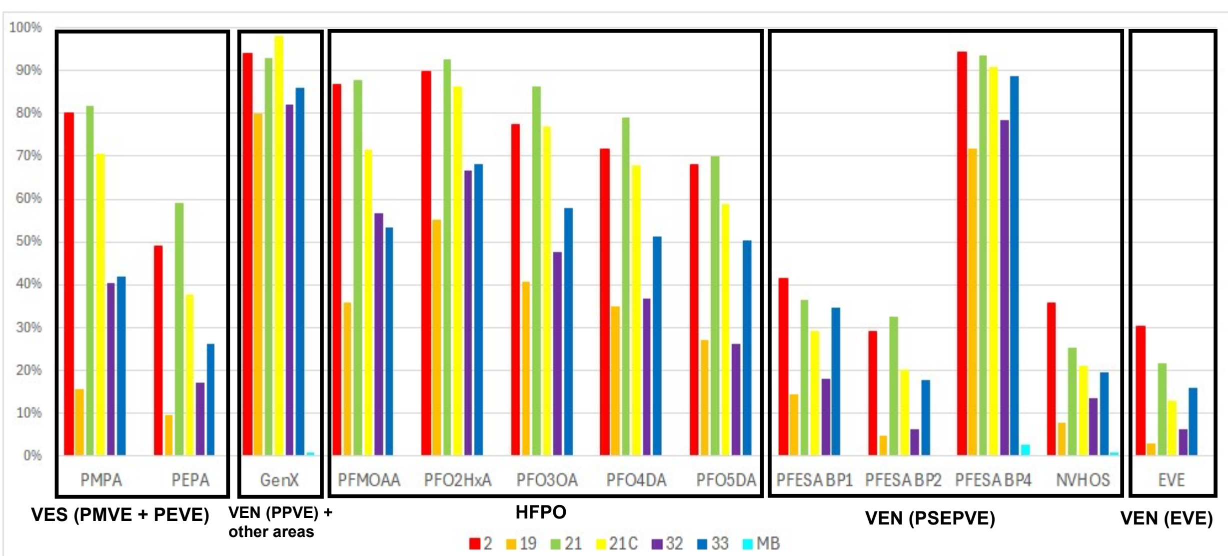
Near-field Site Dry Deposition Detection Frequency



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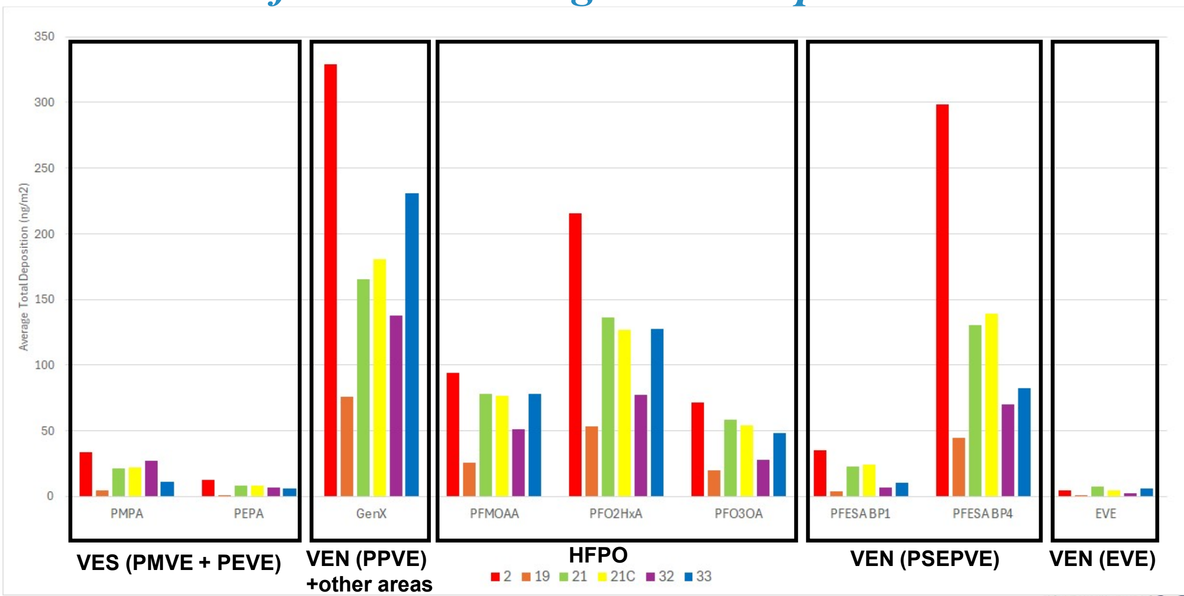
Near-field Site Average Total Deposition Rates



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PFAS Challenges

- Requests for PFAS destruction project trials in NC – inadequate data on transfer of PFAS to air
- Stack test data needed from the following companies:
  - Supercritical Water Oxidation Technology (374Water)
  - Plasma synthesis reformer (HelioStorm) (Heartland Water Technology)
  - Thermal Desorption (Clean Earth)
- Need for faster development of stack test methods at EPA

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Needs Related to External Partners

- Review of PFAS destruction techniques and potential for phase transfer to air
- Reliable analytical methods to complement existing targeted methods
  - Non-targeted analysis
  - TOF (extractable organic fluorine method)
  - TOP assay (to include short-chain PFAS, especially TFA and PFPrA)
  - Methods for compounds in air samples not amenable to LC/MS/MS analysis

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Ideas for Projects with PFAST Network

- Further study on the complex air/surface/groundwater interactions. How much of what is deposited through atmospheric deposition reaches groundwater?
- Further study of potential atmospheric transformations is needed.

(Plan for research on two points above has been drafted and discussed with PFAST researchers)

- Analysis of samples with complementary analytical methods
  - Determine mass balance
  - Investigate whether PFAS have transferred from solid/liquid to air
- Further study of surface microlayer of Cape Fear River and Atlantic Ocean

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Office of the Secretary

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PFAS Work Performed

- Work completed by the Office of the Secretary supports PFAS across all divisions.
- Main Areas of Focus include
  - PFAS in Fish
  - Developing tools to optimize workflows when working with multiple databases and data sources
  - Health impacts of PFAS
  - Technical Review and Development of PFAS Toxicological Summary Information
  - Fiscal Analysis of the Removal of PFAS from NPDES Facilities
  - Database of Industry's Utilizing PFAS
  - Benefits Analysis of Reducing PFAS Discharges to Surface Water

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Current PFAS Challenges

- Source identification information and tools
- PFAS in fish across all of NC
- Presence of PFAS in surface waters across NC
- Understanding and applying non-targeted results
- Toxicological data for legacy and emerging PFAS
- PFAS exposure for North Carolinians
- PFAS residuals management
- Multi-media understanding of managing PFAS in different waste streams

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Needs related to external partners and topics

- Identification of Dominant PFAS by industry type
- Characterization of PFAS in fish in NC (expanding on existing work)
- Non-targeted analysis
- Generations of toxicological data for legacy and emerging PFAS
- Evaluation of PFAS residuals management options
- Characterization of background PFAS levels from domestic sources

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Specific ideas on projects to carryout with PFAST researchers

- Multi-media evaluation of PFAS emissions from the management of PFAS-laden residuals
- Determination of the food web incorporation of PFAS in the food web of the Cape Fear freshwater-marine continuum
- Impacts of PFAS in surface water on groundwater quality
- Technology based effluent limits for targeted industries generating PFAS

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PFAST Researcher Panel:
Air and Land

Dr. Brent McKee, Dr. Chad Lane, and Dr. Jason Surratt

1

Brent McKee
Mary and Watts Hill Distinguished Professor
Department of Earth, Marine and Environmental Sciences
The University of North Carolina Chapel Hill

Geochemist, Radiochemist

Research focus: Using naturally-occurring radioisotopes to understand the fate, pathways and timescales of particulates and their associated geochemical constituents in inland and coastal waters.

2

PFAS project (in collaboration with Dr. Detlef Knappe and graduate student Nadia Sheppard at NCSU)

Research Objective: **To examine the concentration, pathways and fates of particle-bound PFAS compounds in natural environments.**

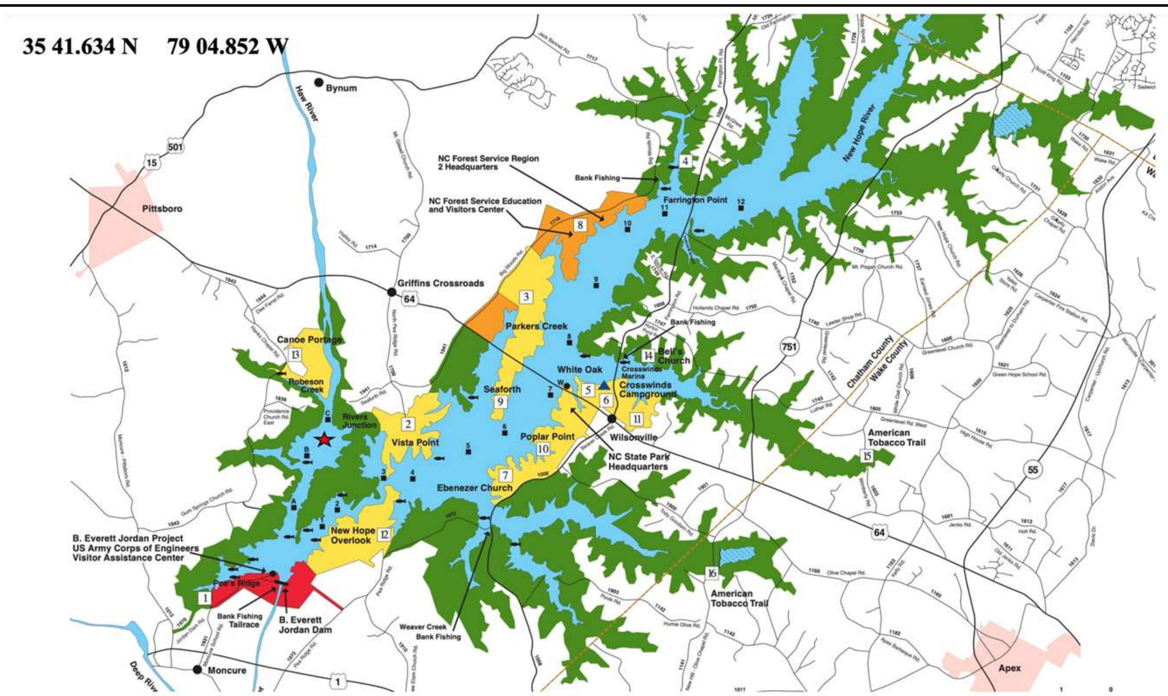
Approaches:

(1) To quantify PFAS concentrations of surface sediments in Jordan Lake

(2) To reconstruct a sediment history of particle-bound PFAS inputs to Jordan Lake from the Haw River

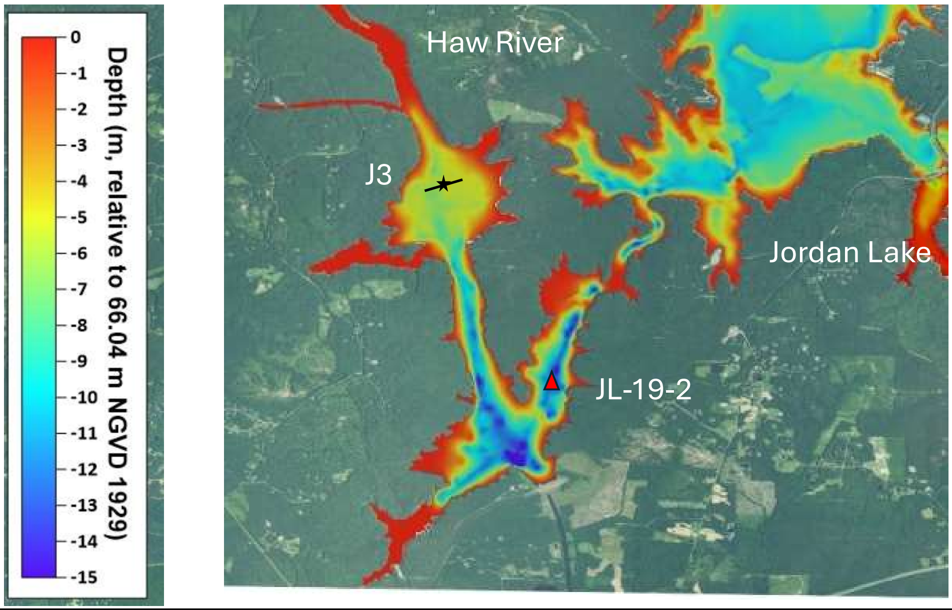
(3) To examine the sorption/desorption behavior of particle-bound PFAS under environmental conditions

3



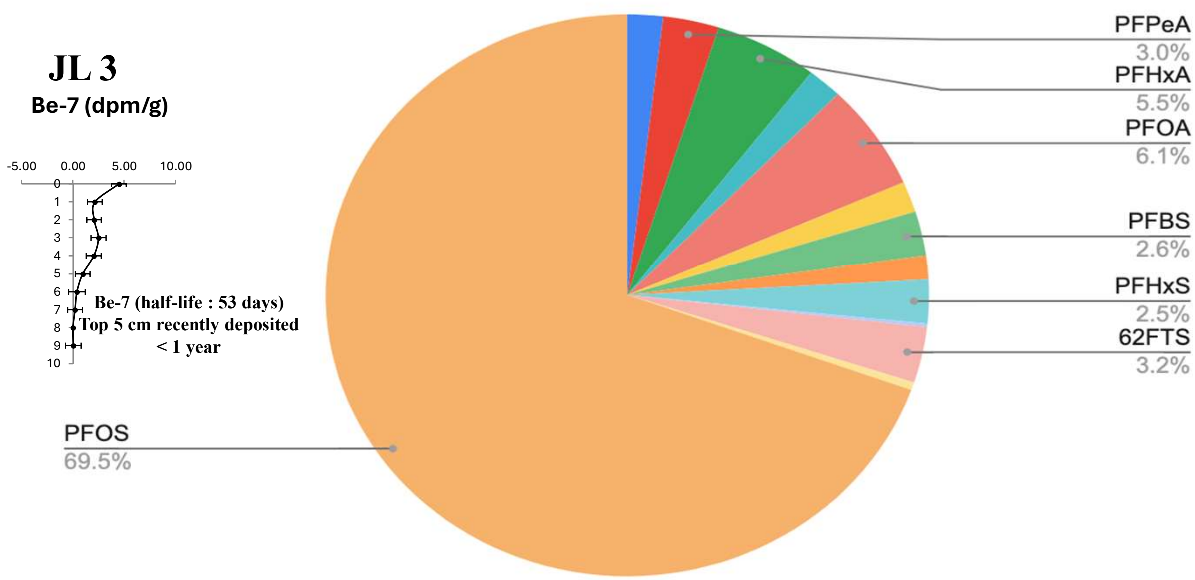
4

We collected surface sediments in Jordan Lake at J3 and a 50 cm core at JL-19-2



5

JL 3 0-5 cm 3489.9 ng/kg dried) ∑ PFAS 3.4 (ng g^{-1})



6

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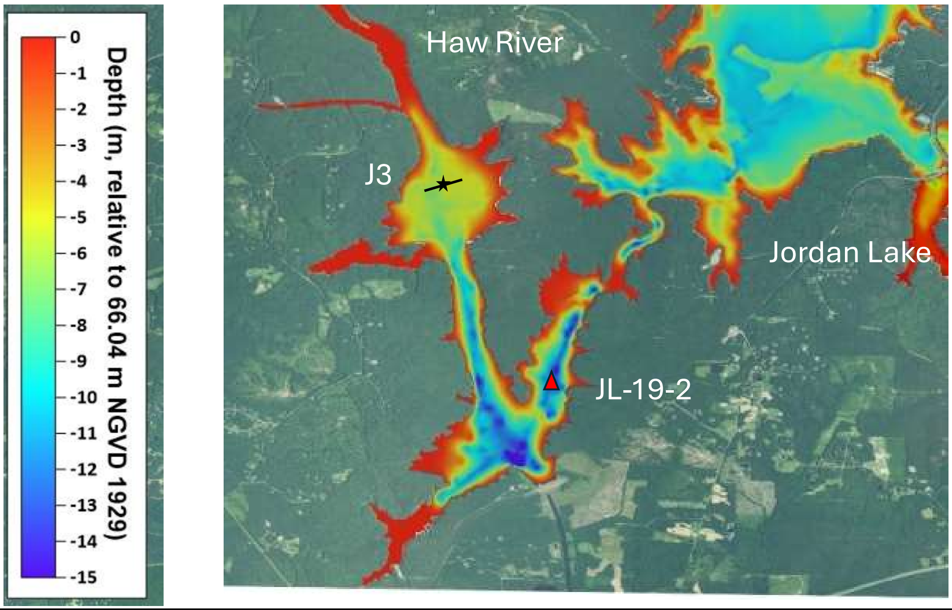
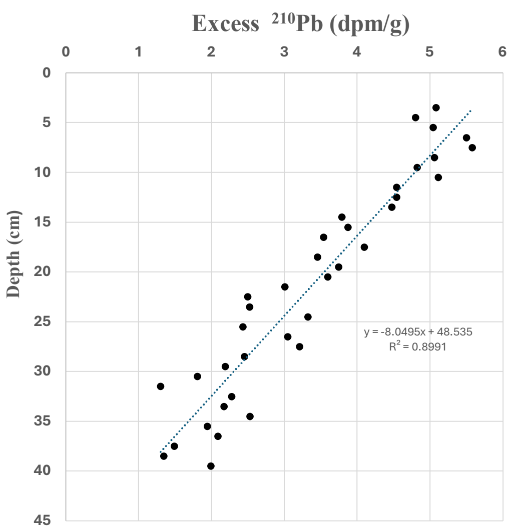
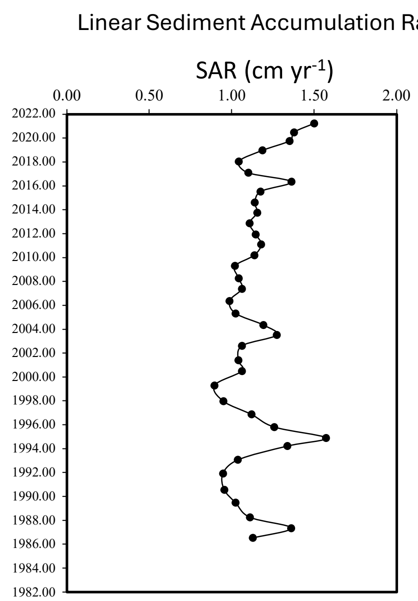


7

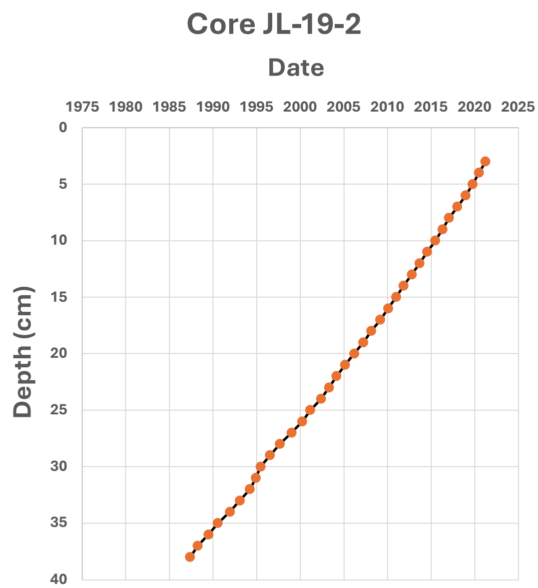
Established a sediment geochronology for JL-19-2 using Pb-210 (22.3-year half life).





8

Each cm downcore represents 1.15 years; Bottom of the core was deposited 1986 just after the Jordan Lake Dam was constructed



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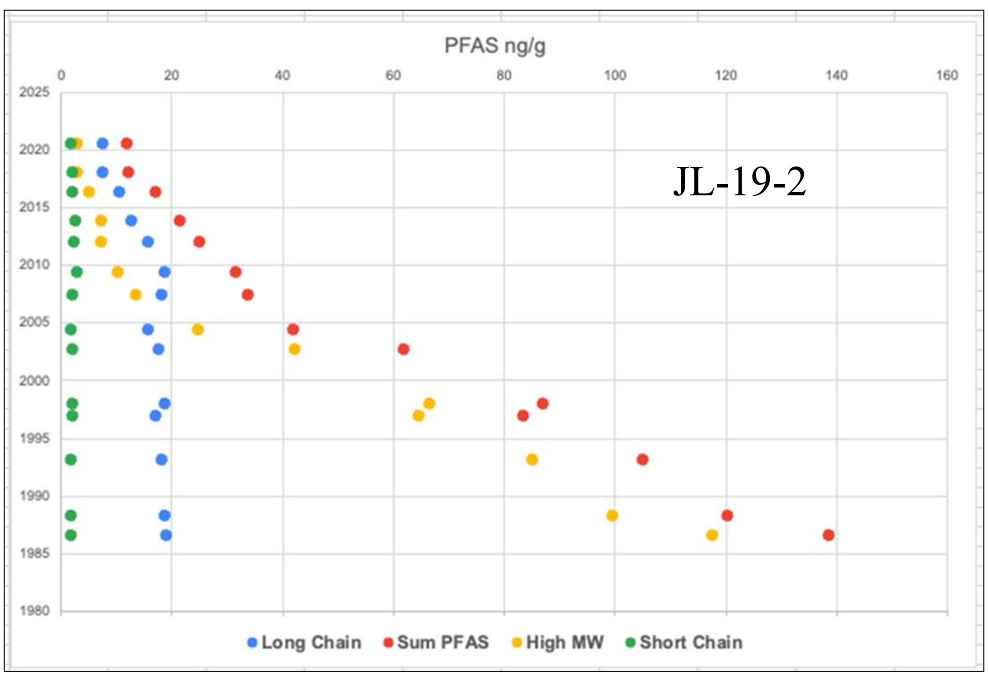


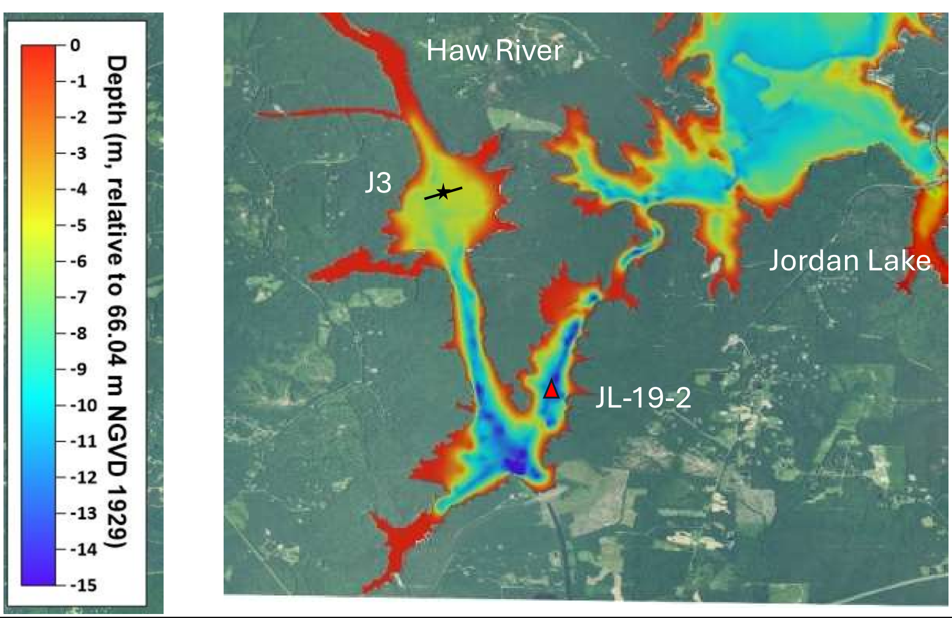
10

Presently we are performing the following desorption experiments on sediments from JL-19-2

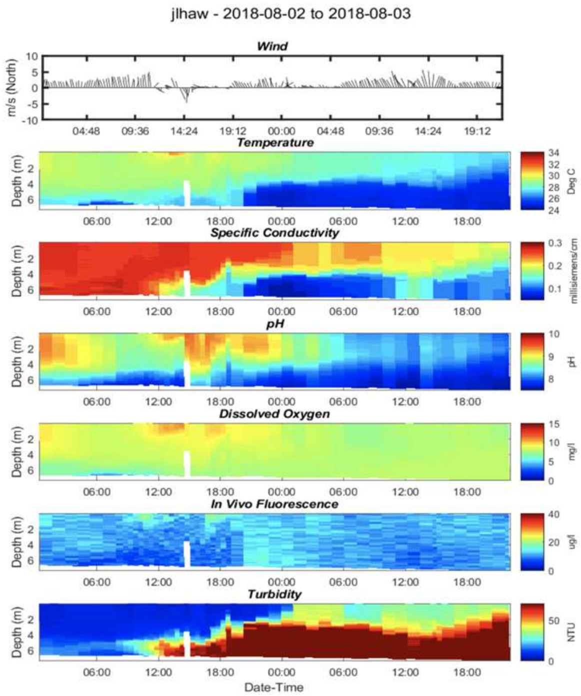
A range of pH conditions from **6 to 10** (the annual historical range measured at the Jordan Lake site)

11

We collected surface sediments in Jordan Lake at J3 and a 50 cm core at JL-19-2

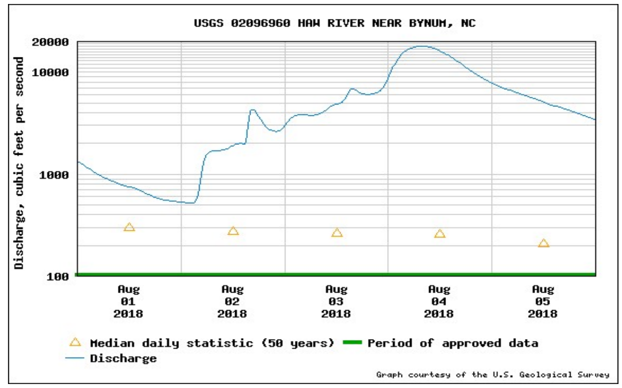


12

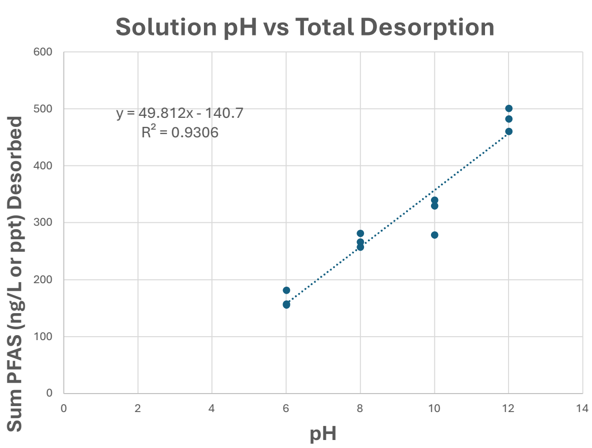


An example from Jordan Lake Profiler

Jordan Lake Observatory (R. Luettich, IMS)



13



130 ng/g Sum PFAS in interval 37-38 cm of JL-19-2

0.2 g add to each 50 ml tubes = 26 ng

pH	percent	Sum PFAS Desorbed (ng/L)
6	0.6349	161
8	1.0314	260
10	1.2149	305
12	1.8509	477

Increase in desorption as pH increases from 6 to 12

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Next:
Desorption experiment on surface and mid-core intervals of JL-19-2

Desorption Experiments: A range of oxygen concentration from **0.1 to 14.0 mg l^{-1}** (the annual historical range measured at the Jordan Lake site)

Collect cores to examine sediment PFAS concentrations in Falls Lake, Lock and Dam #2, Lower Cape Fear, other selected reservoirs

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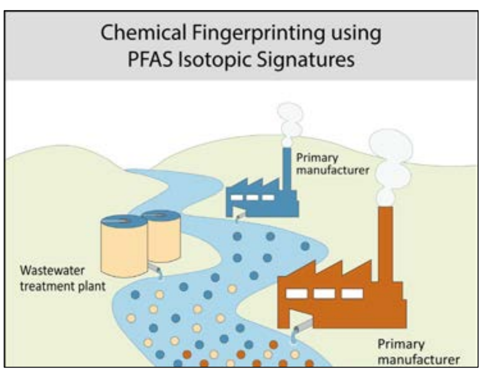
Assessment of Light Stable Isotope Ratios as Forensic Data to Monitor Source to Sink Dynamics of PFAS



Chad Lane, Allison Dombrowski, Paul Wojtal, Hai Pan, and Ralph Mead
University of North Carolina Wilmington
Department of Earth and Ocean Sciences
Center for Marine Science

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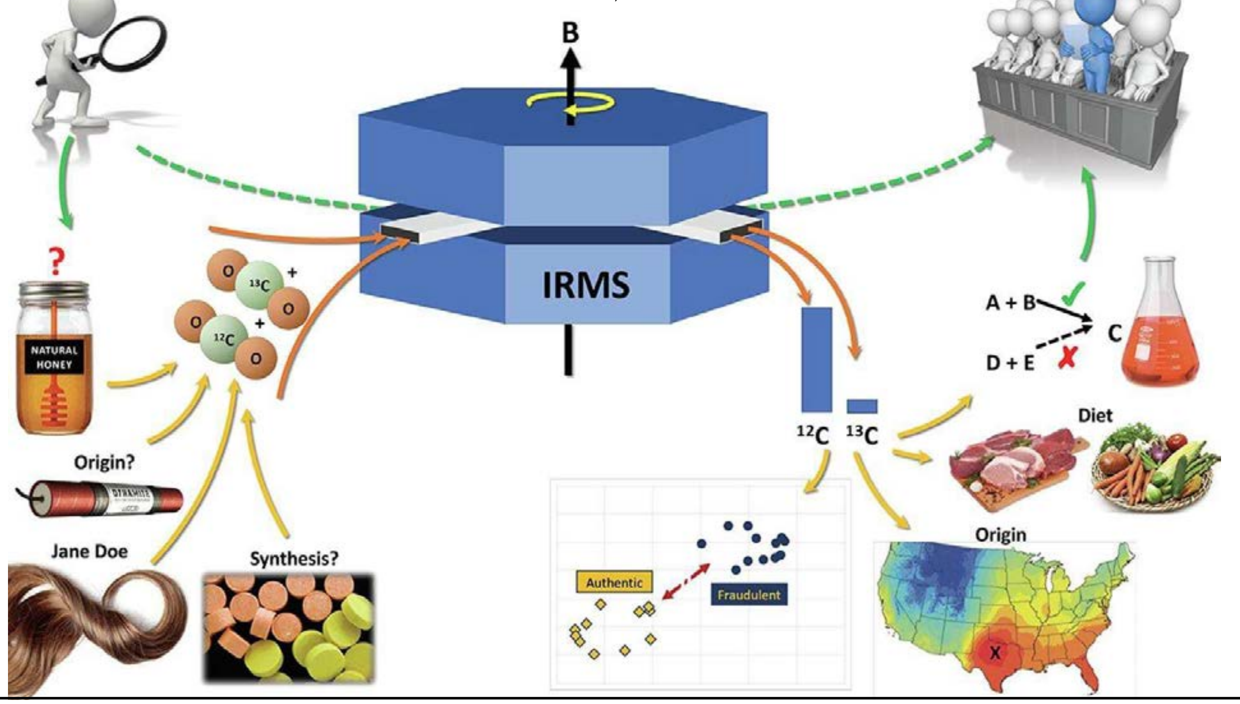
Matos and Jackson, 2019



17

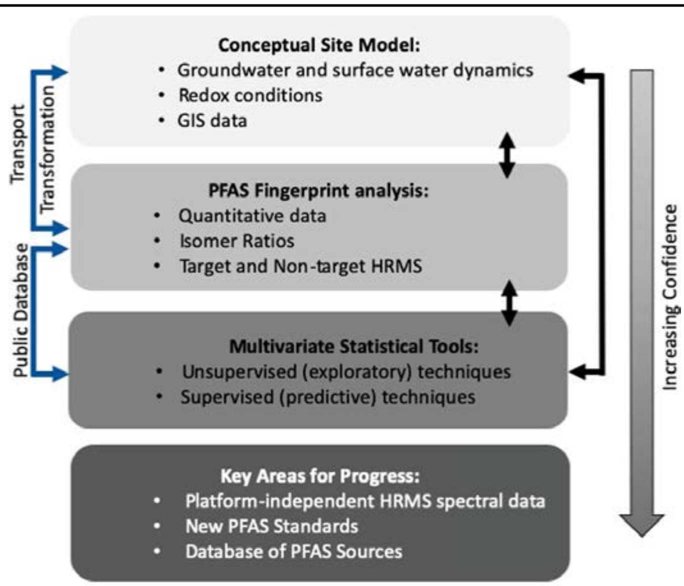


Figure 1. PFAS source tracking tools and opportunities. Black arrows depict the integration of individual tools into a forensics approach, and blue arrows represent two-way information exchange between categories.

Charbonnet et al. 2021

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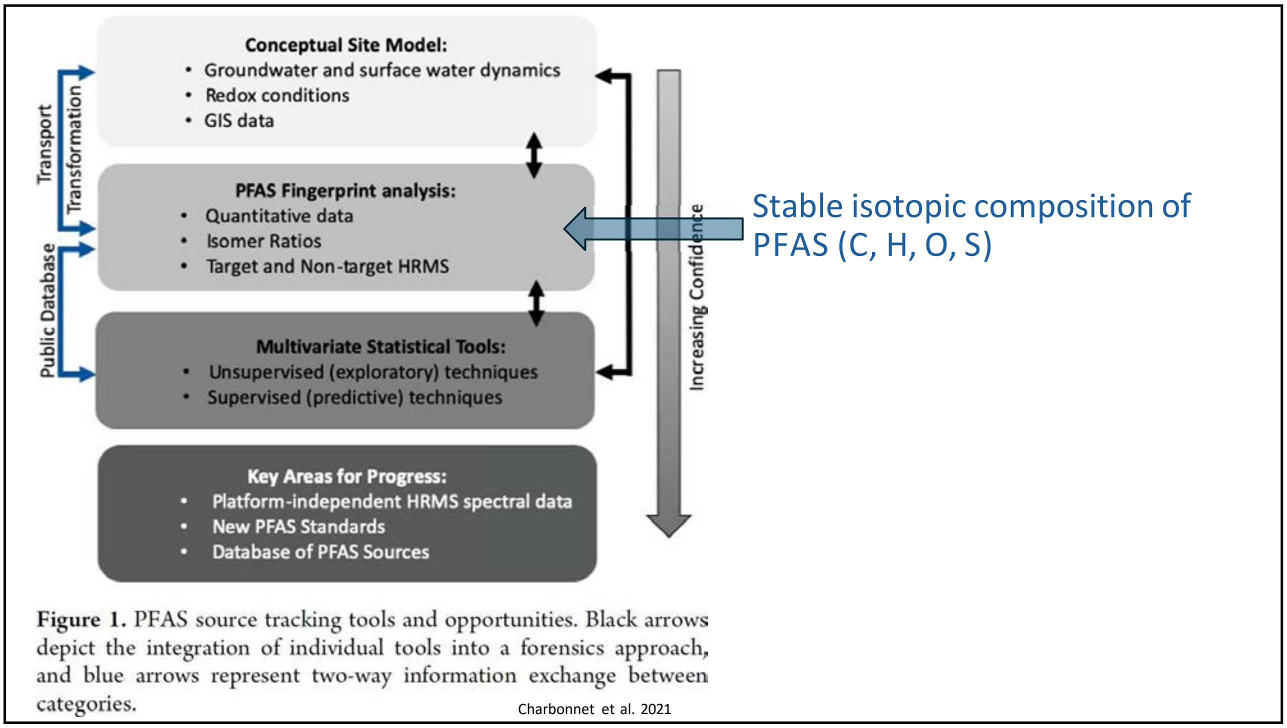
Conceptual Site Model:
• Groundwater and surface water dynamics
• Redox conditions
• GIS data
PFAS Fingerprint analysis:
• Quantitative data
• Isomer Ratios
• Target and Non-target HRMS
Multivariate Statistical Tools:
• Unsupervised (exploratory) techniques
• Supervised (predictive) techniques
Key Areas for Progress:
• Platform-independent HRMS spectral data
• New PFAS Standards
• Database of PFAS Sources
Transport
Transformation
Public Database
Increasing Confidence
Stable isotopic composition of PFAS (C, H, O, S)
Figure 1. PFAS source tracking tools and opportunities. Black arrows depict the integration of individual tools into a forensics approach, and blue arrows represent two-way information exchange between categories.
Charbonnet et al. 2021

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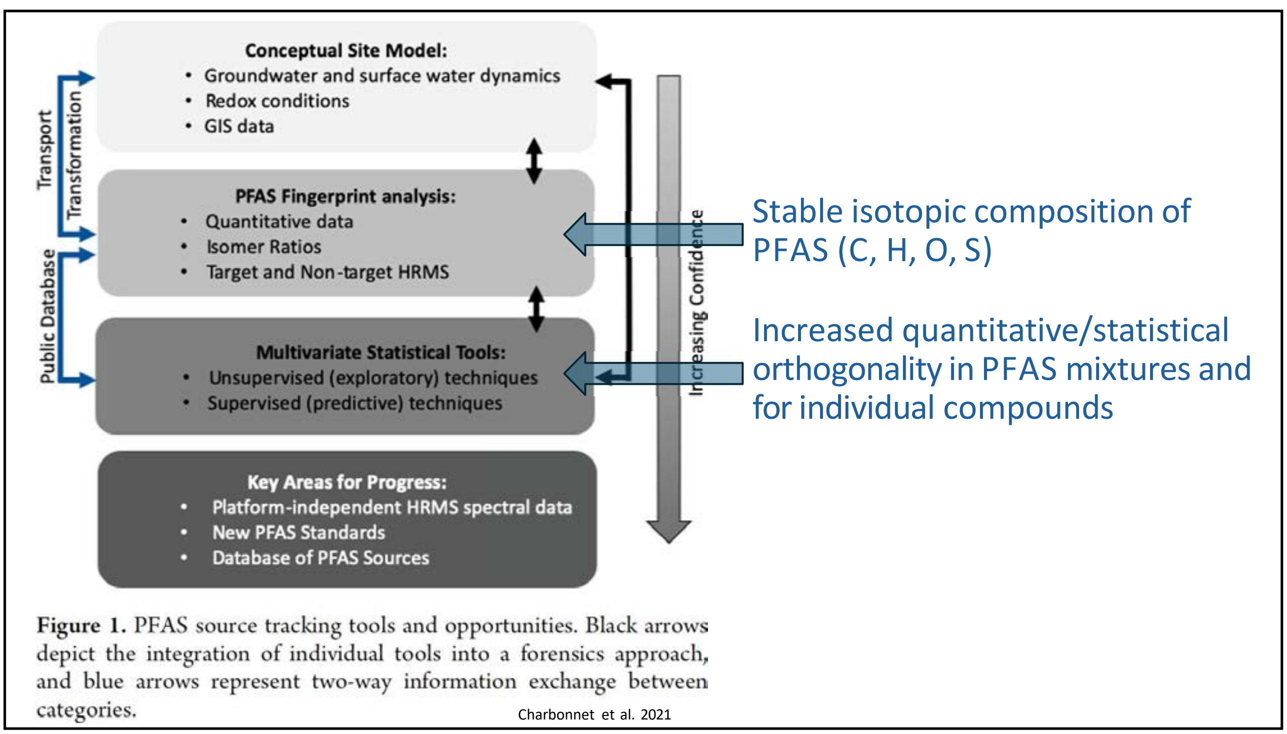
Conceptual Site Model:
• Groundwater and surface water dynamics
• Redox conditions
• GIS data
PFAS Fingerprint analysis:
• Quantitative data
• Isomer Ratios
• Target and Non-target HRMS
Multivariate Statistical Tools:
• Unsupervised (exploratory) techniques
• Supervised (predictive) techniques
Key Areas for Progress:
• Platform-independent HRMS spectral data
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• Database of PFAS Sources
Transport
Transformation
Public Database
Increasing Confidence
Stable isotopic composition of PFAS (C, H, O, S)
Increased quantitative/statistical orthogonality in PFAS mixtures and for individual compounds
Figure 1. PFAS source tracking tools and opportunities. Black arrows depict the integration of individual tools into a forensics approach, and blue arrows represent two-way information exchange between categories.
Charbonnet et al. 2021

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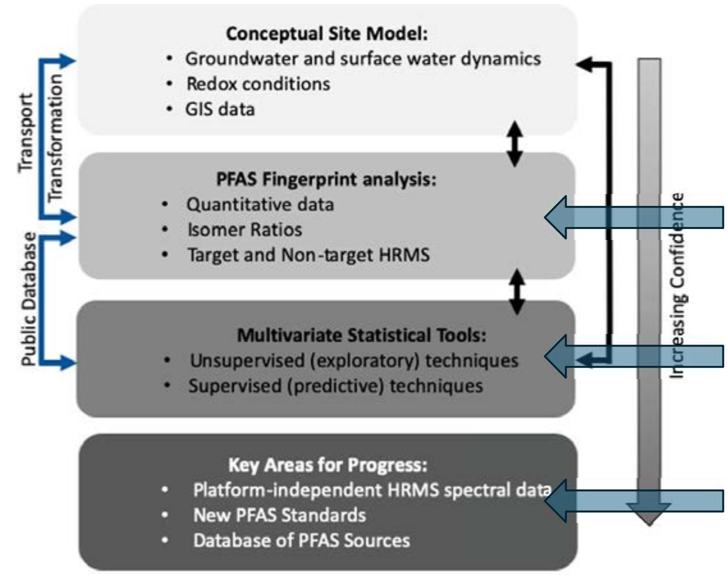

Figure 1. PFAS source tracking tools and opportunities. Black arrows depict the integration of individual tools into a forensics approach, and blue arrows represent two-way information exchange between categories.

Charbonnet et al. 2021

Stable isotopic composition of PFAS (C, H, O, S)

Increased quantitative/statistical orthogonality in PFAS mixtures and for individual compounds

Initial collection of PFAS source isotopic variations and PFAS isotope standard development

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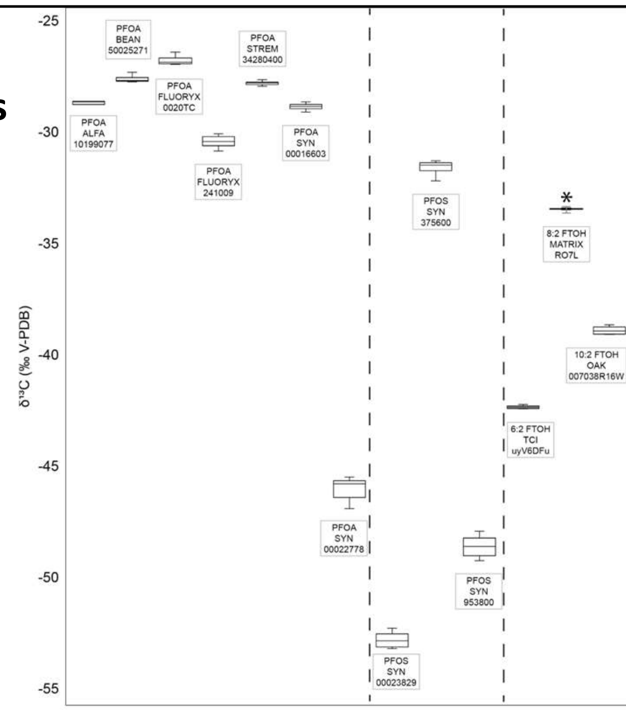
Stable Carbon Isotopic Composition of PFAS from Vendors

(Dombrowski et al., *in press*)

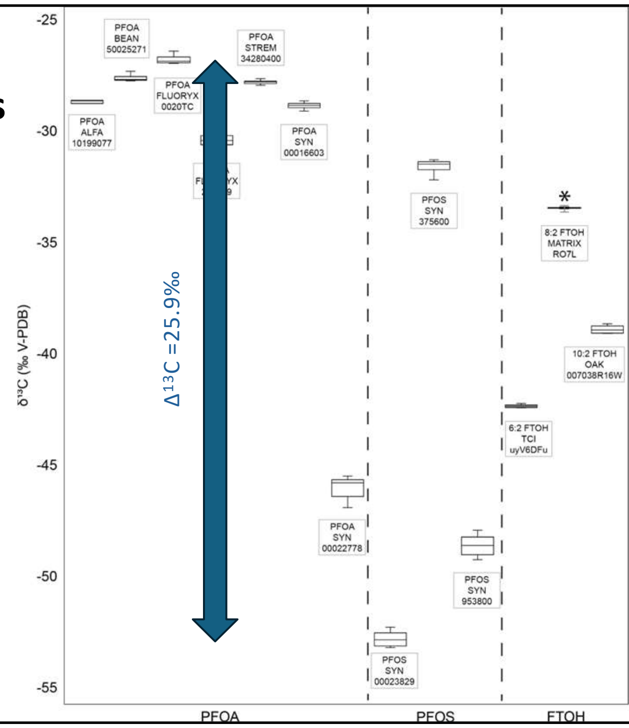


22

Stable Carbon Isotopic Composition of PFAS from Vendors

(Dombrowski et al., *in press*)

- Very large carbon isotope variations amongst PFAS compounds

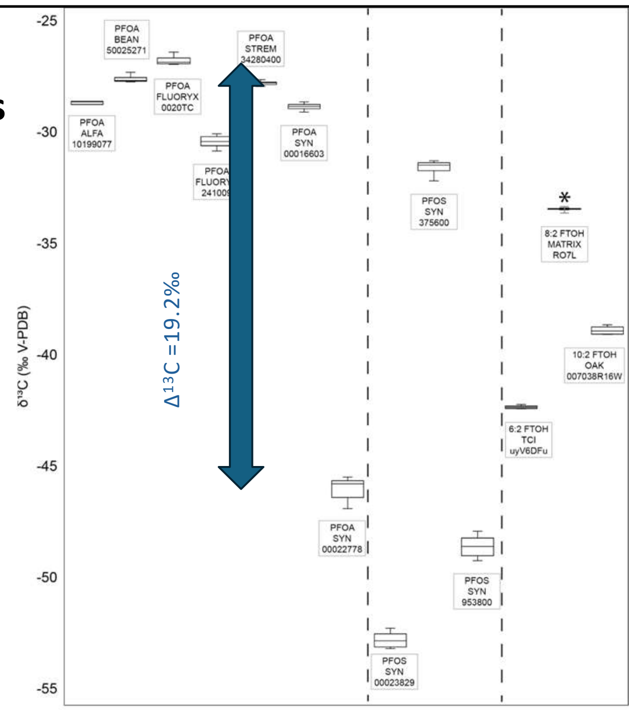


23

Stable Carbon Isotopic Composition of PFAS from Vendors

(Dombrowski et al., *in press*)

- Very large carbon isotope variations amongst PFAS compounds
- Large carbon isotope variations amongst vendors



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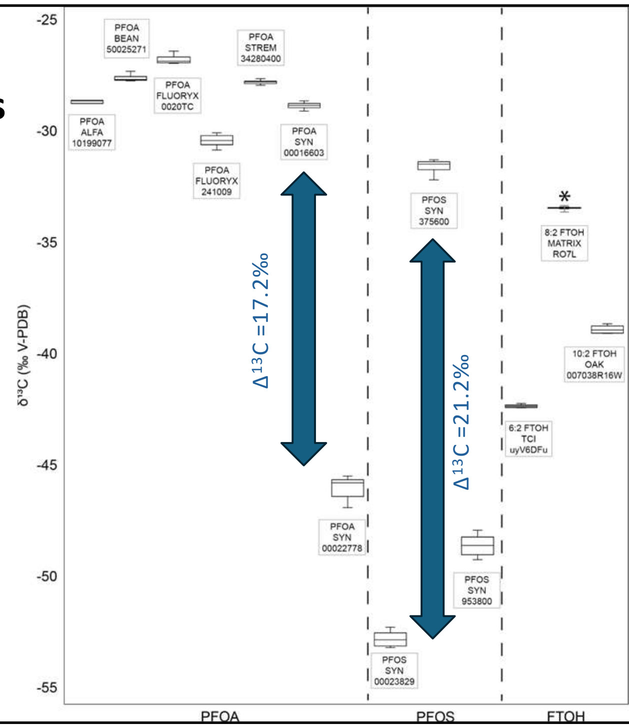
Stable Carbon Isotopic Composition of PFAS from Vendors

(Dombrowski et al., *in press*)

- Very large carbon isotope variations amongst PFAS compounds
- Large carbon isotope variations amongst vendors
- Large carbon isotope variations amongst different lots of the same PFAS from the same vendor



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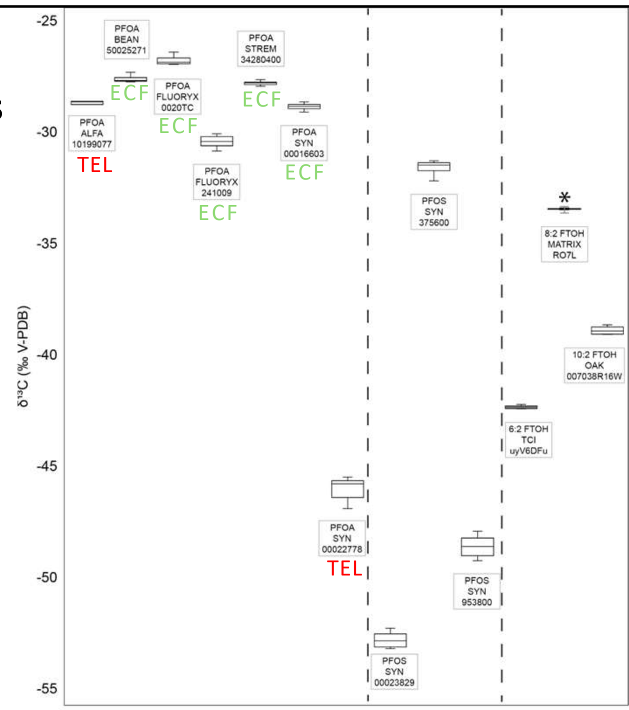
Stable Carbon Isotopic Composition of PFAS from Vendors

(Dombrowski et al., *in press*)

- Very large carbon isotope variations amongst PFAS compounds
- Large carbon isotope variations amongst vendors
- Large carbon isotope variations amongst different lots of the same PFAS from the same vendor
- Causes of isotopic variation? Feedstock materials? Synthesis methodology? Other?



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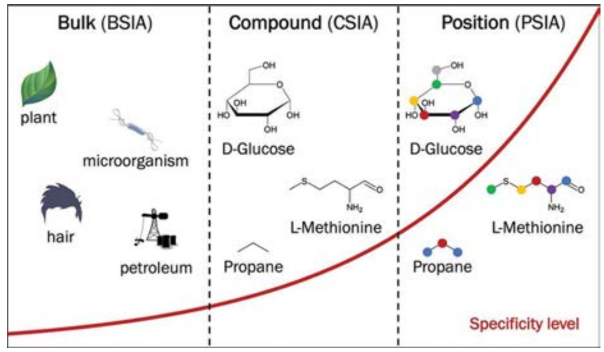
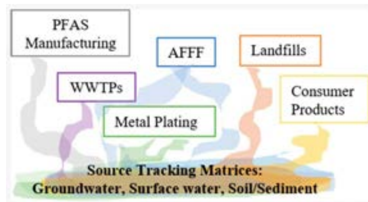
Next Steps

- Methodological development and analysis of environmental PFAS samples using an Orbitrap mass spectrometer
- Experiments to assess potential variables controlling isotopic fractionation
- *Ultimately, this research will provide a tool to assist regulators in identifying and mitigating PFAS discharge to the environment thus reducing human exposure*



Neubauer et al. 2023



Charbonnet et al. 2021

Thermofisher.com

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Real-Time Air Measurements of PFAS (RAMP) 2025 Campaign

Jason D. Surratt
UNC-Chapel Hill
Professor
Department of Environmental Sciences & Engineering
Department of Chemistry

FAYETTEVILLE, NC 2025

RAMP

THE UNIVERSITY of NORTH CAROLINA at CHAPEL HILL

TEXAS A&M UNIVERSITY Atmospheric Sciences

Aerodyne Research

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Research Team and Acknowledgements

TAMU Mobile Research Van

Co-Lead PIs

Barbara Turpin (UNC)
Yue Zhang (TAMU)

PhD Students

Michael Davern (UNC)
Yufan Hu (UNC)
Yoonsub Kim (UNC)
Sahir Gagan (TAMU)

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U.S. EPA - Science To Achieve Results (STAR) Program
Grant # R840431

collaboratory
science. policy. solutions.

Vocus HR-CIMS

"Theran"

DEQ Colleagues
Michael Abraczinkas
Frances Nilsen

PFAST Network Office
Ralph Mead (UNCW)
Rachylle Hart (UNCW)

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Chemical Ionization Mass Spectrometry (CIMS): Real-Time Detection of Airborne PFAS

- Multiple reagent chemistries can detect a wide array of analytes
- TOF-MS allows for determination of elemental compositions
- Large linear dynamic range (sub-ppt to 10s of ppb)
- Real-time sampling gives 1-second time resolution
- Suitable for mobile deployment

[Riedel et al., 2019, *ES&TL*; Bowers et al., 2023, *ESPI*; Young et al., 2024, *ES&TL*; Davern et al., 2024, *Analyst*]

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Iodide (I^-)-CIMS Detection Limits of Gas-Phase PFAS

Michael Davern (UNC)

3-second LODs Listed

Compound	Limit of Detection (ppt)	Compound	Limit of Detection (ppt)
4:2 FTOH	3.1	PFHpA	1.3
6:2 FTOH	1.5	PFOA	0.7
8:2 FTOH	2.0	HFPO-DA	0.7
10:2 FTOH	1.7	N-MeFOSE	0.2
TFA	3.0	N-EtFOSE	0.3
PFPrA	9.1	N-EtFOSA	0.2
PFBA	1.3	HFPO	1700
PFPeA	2.0	E2	1700
PFHxA	2.0	PFMOAA	No authentic standard, but detectable with I-CIMS

[Davern et al., *Analyst*] – describes our liquid calibration system

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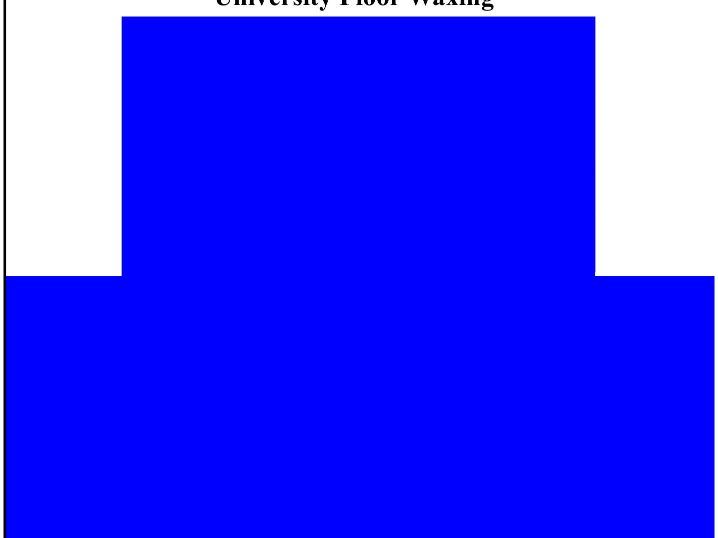
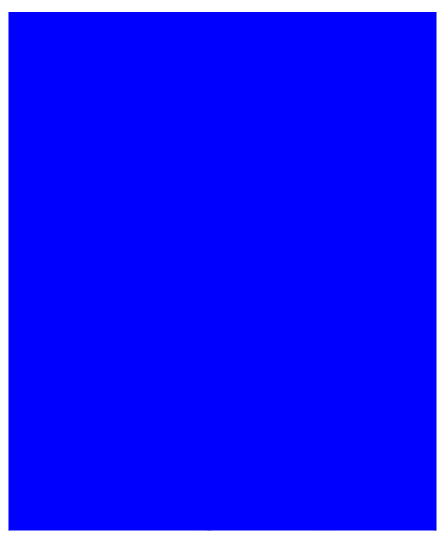
I-CIMS Real-Time Detection of Gas-Phase PFAS in Indoor Air

University Floor Waxing



[Davern et al., 2025, *to be submitted*]

Cooking Microwave Popcorn



[Davern et al., 2024, *Analyst*]

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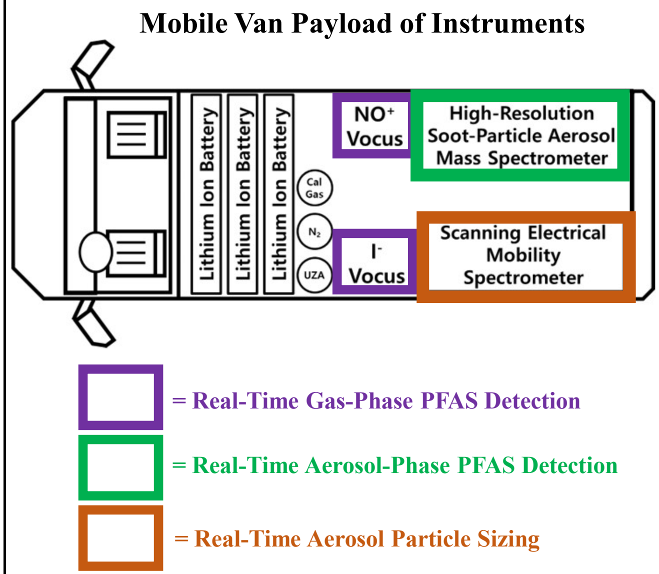
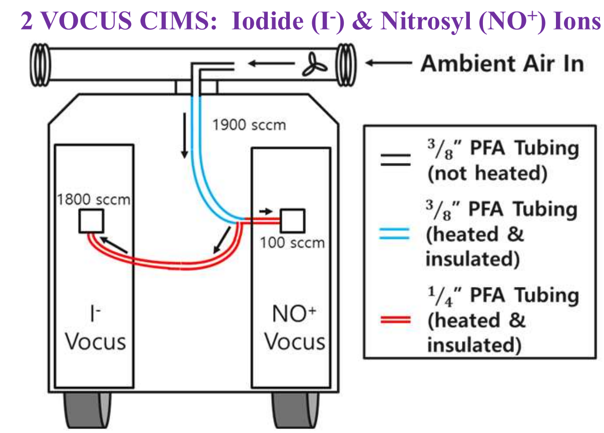
Mobile Van Payload for Gas- and Particle-Phase Detection of PFAS





Tubing is heated to 40 °C and insulated

Time-integrated samplers also onboard, including PUF-XAD

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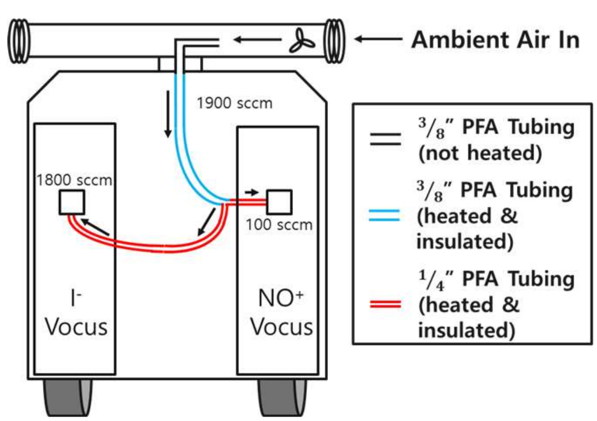
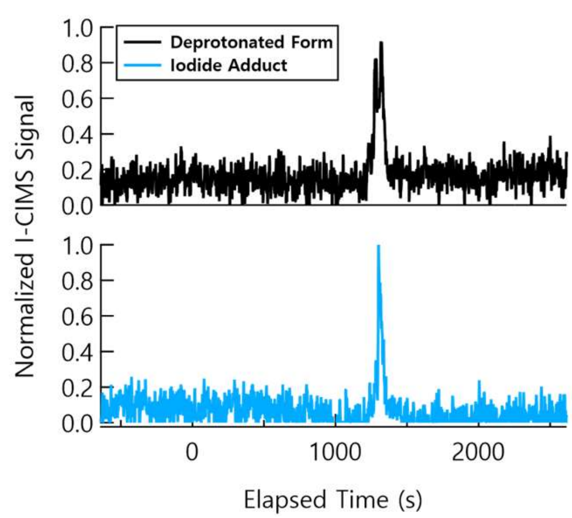
Sniff Testing Near Ambient Air Inlet Shows PFAS Make it to CIMS





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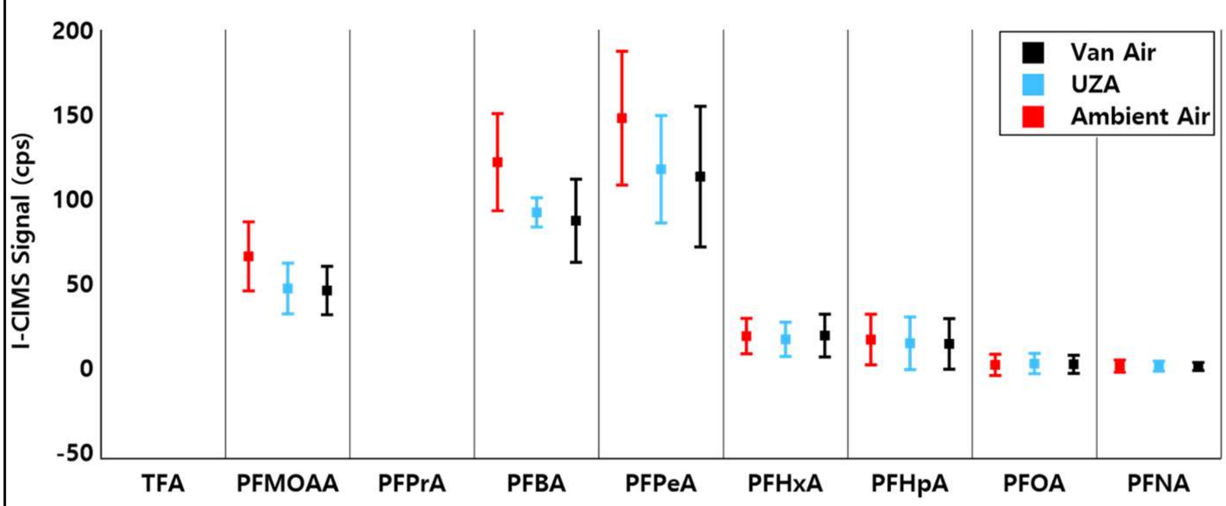
I-CIMS Data from Fayetteville Suggest that PFCAs and PFECAs Not Above LODs



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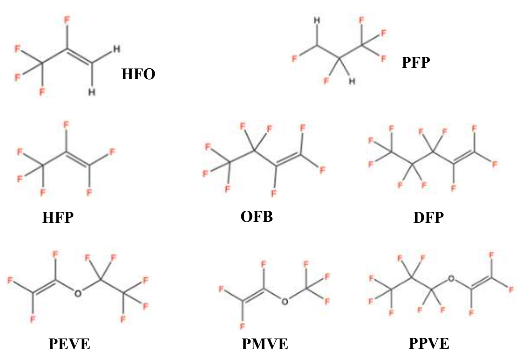
PFAS Compounds Characterized in Positive Ion Mode

Sahir Gagan (TAMU)



Name	Abbreviation	Emissions (kg yr^{-1})	NO$^+$ (NO 1%) Current Study	
			LOD (10s) pptv	LOQ (10s) pptv
Hexafluoropropylene	HFP	22018.3	3.79	12.5
Perfluoropropyl vinyl ether	PPVE	1290.7	9.28	30.6
Perfluoromethyl vinyl ether	PMVE	1215.0	22.8	75.2
Perfluoroethyl vinyl ether	PEVE	696.9	6.22	20.5
Octafluorobutene	OFB	446.8	3.86	12.7
Decafluoropentene	DFP	8.2	70.3	232
2,3,3,3-tetrafluoropropene	HFO	-	5.81	19.2
1,1,1,2,3-pentafluoropropane	PFP	-	101.04	333.4

- D'Ambro et al. (2021) modeled high emissions of fluorinated olefins and vinyl ethers near the source
- Developing a technique for real-time measurement is essential to accurately assess the chemical evolution, potential health, and climate impacts of these compounds

*D'Ambro et al. ES&T, **2021** 55 (2), 862-870*

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PFAS Characterization – Positive Ion Mode

Poly/per-fluoro olefin in PTR mode

$C_nF_mH_x \xrightarrow[\text{Fragmentation}]{\text{Fluorine}} [C_nF_{m-1}H_x]^+$

Hydrofluoro olefin (HFO)

$C_nF_{2n} \xrightarrow[\text{Fragmentation}]{\text{Fluorine}} [C_nF_{2n-1}]^+$

Perfluoro olefin (PFO)

Poly/per-fluoro olefin in NO$^+$/O$_2^+$ mode

$C_nF_mH_x \xrightarrow[\text{and Hydride Abstraction}]{\text{Charge Transfer}} [C_nF_mH_x]^+$ and $C_nF_mH_{x-1}$

$C_nF_{2n} \xrightarrow[\text{and Charge Transfer}]{\text{Fluoride abstraction}} [C_nF_{2n-1}]^+$ and $[C_nF_{2n}]^+$

Per-fluoro vinyl ethers in PTR mode

$C_nF_{2n}O \longrightarrow [C_nF_{2n-3}O]^+$

Perfluoro vinyl ether

n = number of carbon atoms

m = number of fluorine atoms

x = number of hydrogen atoms

Per-fluoro vinyl ethers in NO$^+$/O$_2^+$ mode

$C_nF_{2n}O \longrightarrow [C_nF_{2n}O]^+$

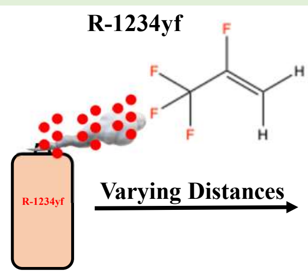
Fluorinated-olefin undergoes **fluoride atom fragmentation** in PTR mode to form a charged ion

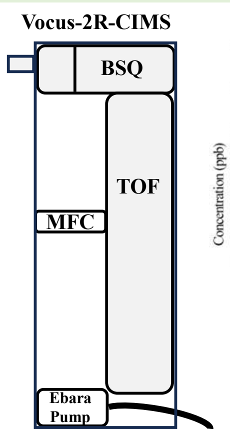
NO$^+$/O$_2^+$ reagent ion forms charged ion through **hydride/fluoride abstraction** (R-H$^-$ or R-F$^-$) or via **charged transfer**

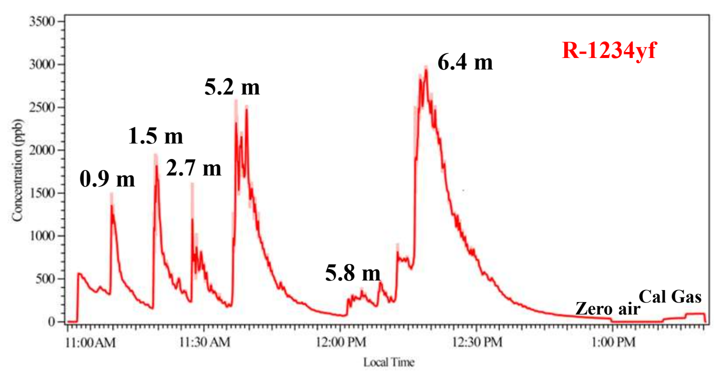
[Gagan et al. 2025, *to be submitted*]

37

Realtime measurement – R-1234yf commercial refrigerant







[Gagan et al. 2025, *to be submitted*]

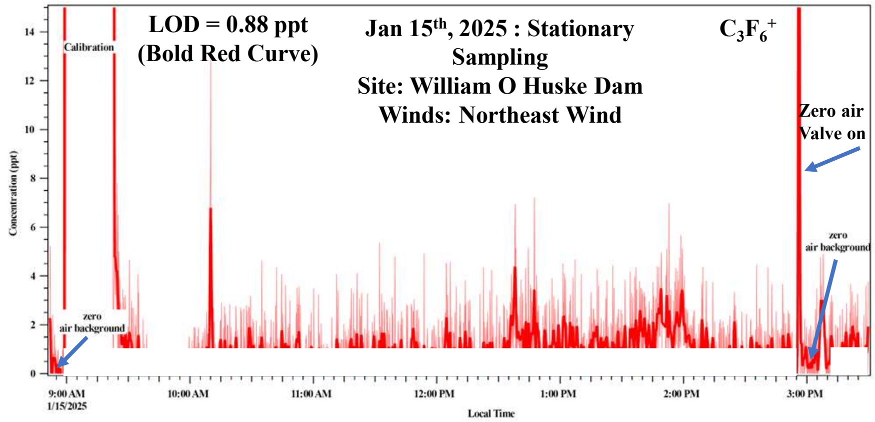
R-1234yf
✓ Commercial name for 2,3,3,3-tetrafluoropropene

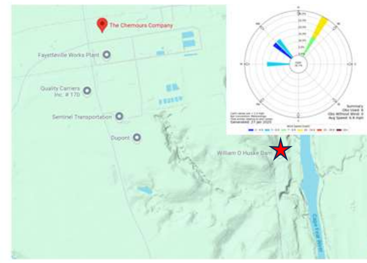
- First real-time characterization and quantification of R-1234yf, a commercial refrigerant commonly used in air conditioners for automobiles
- R-1234yf oxidizes in the atmosphere, forming trifluoroacetic acid (TF) linked to increased glycemic biomarkers.
- Measurement suggests that fugitive emission while handling R-1234yf might be high, indicating potential occupational hazard

Hurley et al. Chem. Phys. Lett., 450 (2008) 263–267
Duan et al. Environ. Int., 134 (2020) 105295

38

Field Measurement – RAMP 2025 North Carolina





Stationary Site

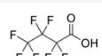
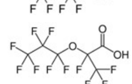
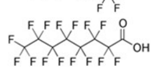
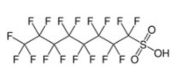
- Time series show signals for $C_3F_6^+$, a tracer ion for Hexafluoropropylene remains above LOD during the stationary sampling
- Zero air background time is 10 minutes

39

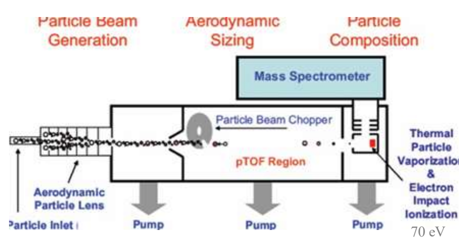
Real-Time High-Resolution Aerosol Mass Spectrometry (HR-AMS) Detection of PFAS Aerosols

Dr. Meng, Xiangxinyue

- **Standards**

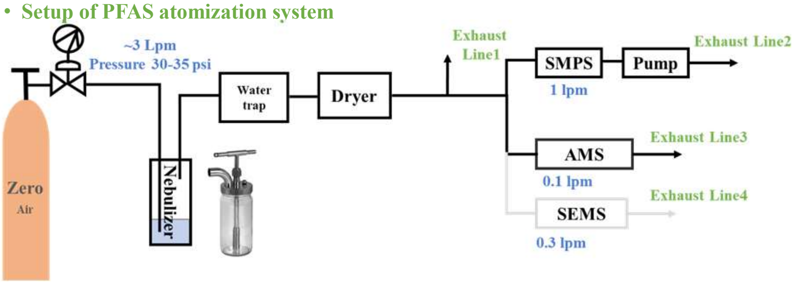
Acronym	Name	Formula	Structure
PFBA	Perfluoro-n-butanoic acid	$C_4HF_7O_2$	
GenX	Hexafluoropropylene oxide-dimer acid, (HFPO-DA), parent acid of "GenX"	$C_6HF_{11}O_3$	
PFOA	Perfluoro-n-octanoic acid	$C_8HF_{15}O_2$	
PFOS	Perfluorooctane sulfonic acid	$C_8HF_{17}O_3S$	

- **Setup of HR-AMS**



The vaporizer temperature is at 600 °C to ensure higher ionization efficiency.

- **Setup of PFAS atomization system**



Procedures:
- Test background of water and methanol, then test four PFAS standards
- Measure size distributions of PFAS-generated aerosol and measure by HR-AMS
- Extract high-resolution mass spectrum and determine tracer ions of PFAS
- Adjust concentration of standard solution to get calibration curve of PFAS

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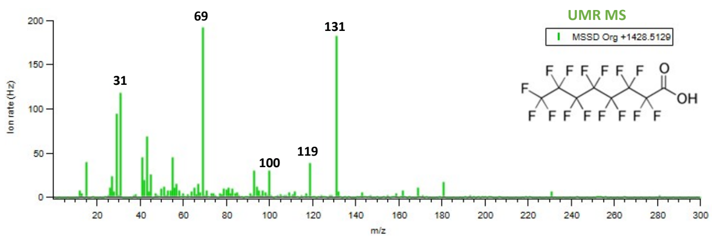
Preliminary Results for Particulate PFAS in HR-AMS

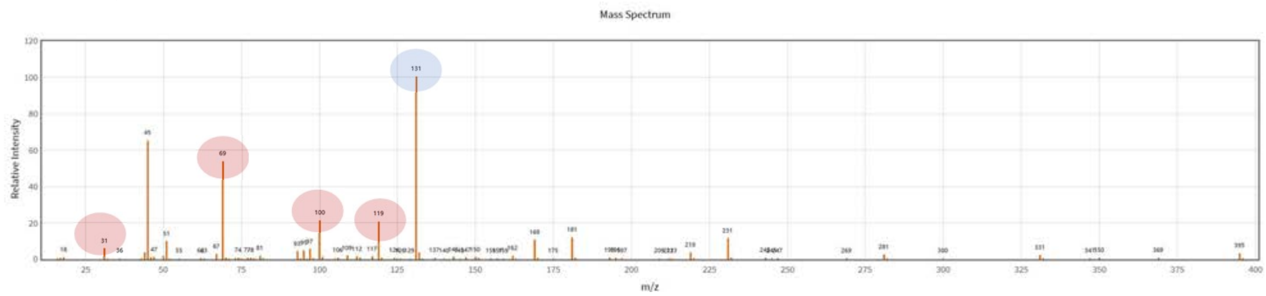
- PFOA



Possible Tracer Ion for PFOA Group:

- *m/z* 31 - CF
- *m/z* 69 - CF_3
- *m/z* 100 - C_2F_4
- *m/z* 119 - C_2F_5

- Compare with NIST database-PFBA



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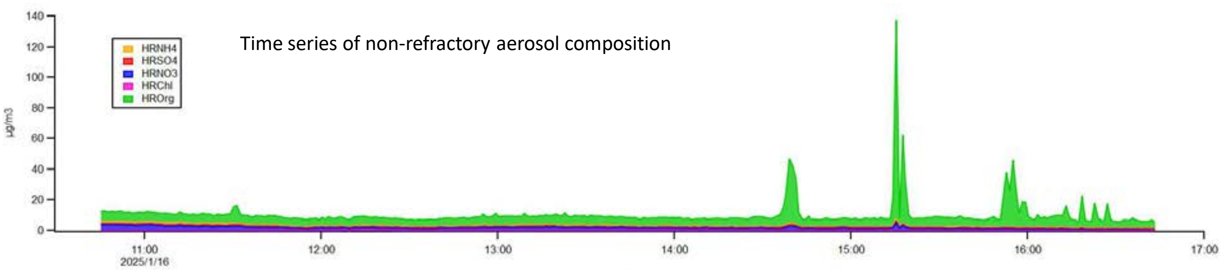
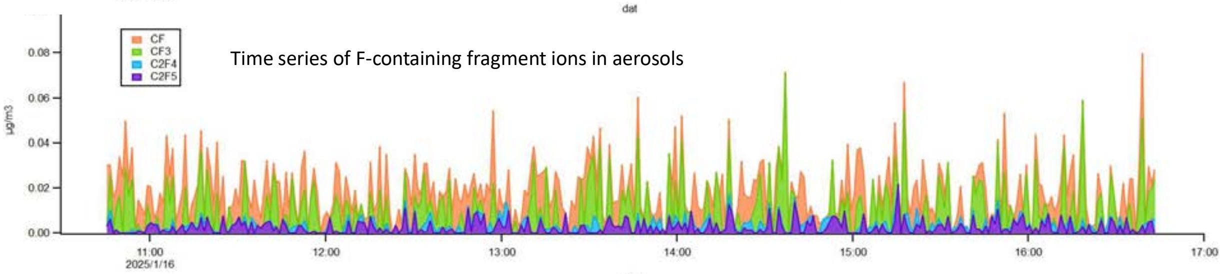
Preliminary AMS Results for Mobile Air Measurement in NC field Campaign





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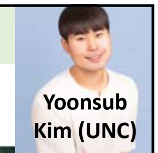
Particle- & Gas-Phase PFAS Sampling Being Conducted at 2 stationary Sites



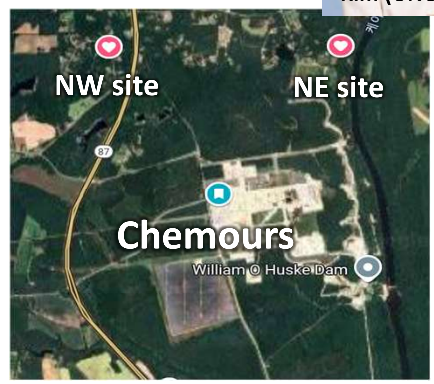
▲ Integrated samplers at the stationary site

Particle-phase PFAS

- HiVol sampler with QFF (w/ PM_{10} impactor)
- LoVol sampler with QFF (w/ $PM_{2.5}$ impactor)

Gas-phase PFAS

- LoVol sampler with PUF-XAD2-PUF cartridge



▲ Locations of the stationary sampling sites.

▼ Brief information for sampling

	NW site	NE site
HiVol QFF(Every six days)	1000 LPM	1000 LPM
LoVol PUF-XAD2-PUF	5 LPM	5 LPM
LoVol QFF	10 LPM	10 LPM

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DEQ and NC PFAST Network Summit 2025
Air and Land Panel Q&A

Question	Answer (respondent)
Does salinity have an impact on the partitioning of PFAS in sediment cores? Perhaps background samples taken in saline water would be helpful?	We have only looked at freshwater so far, but one of our future goals is to take some cores out in Bogue sound near some sea grass beds and see if salinity makes any difference at all. We don't think so, but perhaps (McKee)
Could the PFAS treatment plant directly above lock 3 contribute to aerosol particles that were detected?	I don't think we know enough yet with our time-resolved data to say anything about that but that is something we are very much interested in knowing as well. (Surratt)
You have a question about the comingling forces and diversity of what you could see in a sample. How do you deal with that from an isotope perspective?	So that will likely be a large challenge to the environmental sampling. That's where we hope to use the Orbitrap with multiple isotope systems, but also position specific work to be able to disentangle really at the finest possible scale isotopically, where those sources might. Then use well-established mixing models in isotope world to try and disentangle at least rough percentages of what's coming from where in those systems. (Lane)
How will you validate that [profiling]? Do we have enough information on the contributors to that mixture to be able to trace them? How would one prove? How can you get the information or does the information exist that they would have contributed? For the Haw River, where you have potentially lots of smaller contributors that gets a little trickier, right?	There are already in play, quantitative fingerprints that are being used for things with distinctive compounds being produced at a plant. We are going to share with easy point source sorts of locations, so landfill effluent is an easy point source, where we know where that's coming from. We know what's coming out. You can measure it and then compare to other landfills or other point sources that might be available. Once you do the mixture, it becomes challenging of course, because you have so many, its everywhere part of the problem. So point sources will be the first step, looking at the variability of point sources and then moving on from there as we build this library of information. (Lane) We haven't really explored that yet. (Lane) We'll have to defer your question to keep up on time, but that sounds like a good discussion point for subsequent sessions. (DEQ)

Fellow Program Past and Present Perspectives

Dr. Lee Ferguson, Dr. Jamie Dewitt, Dr. Ralph Mead,
Dr. Detlef Knappe

1

2

DEQ-PFAST Fellow Program

Jamie DeWitt, PhD, DABT
Oregon State University
Director, Pacific Northwest Center for Translational Environmental Health Research
Professor, Department of Environmental and Molecular Toxicology
jamie.dewitt@oregonstate.edu

A toxicologist's perspective

3

Toxicological goals of fellowship program

- Keep DEQ leadership team updated on emerging PFAS toxicological data.
- Collaborate with DEQ Toxicologist, as needed, on PFAS toxicity study design and interpretation.
- Assist DEQ Toxicologist, as needed, on toxicology-related plans and projects.
- Lean about types of toxicological data needed for DEQ-centered decision-making.

What I learned from the fellowship program

What I think DEQ gained from my fellowship experience

Future collaborative opportunities

- PFAS toxicological research/study design priority setting and data acceleration.
- Working collaboratively to ensure PFAS toxicological data are fit for DEQ purposes.
- Expansion of PFAS toxicological research questions to meet DEQ needs and priorities for NC PFAS.
- Bringing in other toxicological researchers to address DEQ research needs for NC PFAS.

4

Expected Fellow Fall 2025 – Dr. David Genereux

NC STATE Department of Marine, Earth, and Atmospheric Sciences

919-515-6017

genereux@ncsu.edu

- Education
  - BS in Geology/Chemistry, University of Delaware, 1984
  - MS in Environmental Engineering, MIT, 1988
  - PhD in Hydrology, MIT, 1991
- Selected research
  - Use of GW age dating (tritium, e.g.) and measured flux at GW-stream interfaces to predict past and future PFAS in GW discharge to streams
  - Use of GW age dating and numerical particle tracking at selected wells to predict PFAS at different screen depths
  - PFAS and flux measurement techniques in GW-stream settings

Department of Environmental Quality

1

1

Expected Fellow F25/Sp26 – Dr. Jason Surratt

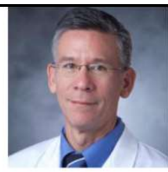
THE UNIVERSITY *of* NORTH CAROLINA *at* CHAPEL HILL

- Professor at UNC in the following Departments
  - Environmental Sciences and Engineering
  - Chemistry
- Specialty: Atmospheric chemistry fundamentals
- DEQ Project: to help monitor and understand PFAS in ambient air, especially near sources
- Will work with Amy Delinsky in DAQ

Department of Environmental Quality

2

2



PRINCIPAL INVESTIGATOR

Herbert Kim Lyerly

George Barth Geller Distinguished Professor of Immunology
Professor of Surgery
Professor in Immunology
Professor of Pathology
Core Faculty Member, Duke-Margolis Institute for Health Policy
Affiliate of the Duke Regeneration Center
Affiliate, Duke Global Health Institute
Member of the Duke Cancer Institute

CONTACT INFORMATION

Office: 203 Research Drive, Rm 433B, Box 2606, Durham, NC 27710

Campus Mail: DUMC Box 2606 Med Ctr, Durham, NC 27710

Overview

Duke ENVIRONMENTAL HEALTH SCHOLARS PROGRAM

Home to multiple high-power universities, agencies, corporations, and non-profit organizations, the Triangle Area presents an ideal environment for stimulating productive, synergistic, activity exploring environmental aspects of health. Members of the Duke School of Medicine (DSOM) together with investigators at the Duke Nicholas School of the Environment (NSOE), the Duke Law of School, the Duke Margolis Center for Health Policy, and other Duke institutes and centers have a history of involvement in both basic and population research arenas.

Environmental health research explores the impacts of our natural and man-made environment on human health. Yet, the environment is not limited to our air, water, soil and food. It also encompasses our sociocultural environment, economic environment, work environment and family environment. The phrase "applied environmental health" means translating the results of environmental health research into positive actions and public health interventions that are appropriate in the context of our total sociocultural and economic environment at local, national, and global levels.

1

Human Drug Metabolism in Humanized Mice

Mouse	Mouse & Human	Mostly Human
		
Not Humanized Mouse Inbred (C57B6, 129S, etc.) Outbred strains	**Conventional Humanized** FRG (2007) uPA (2001) TK-NOG (2008)	**Next Generation Humanized** PIRF mouse (2017) (Barzi et al. *Nat Comm* 2017)

2

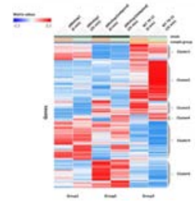
GenX Exposure of Next Gen Humanized Mice

GenX PFAS

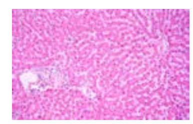
Humanized PIRF mouse

- Highly humanized
- No murine cytochrome metabolism
- Limited phase II metabolism

MS based analysis



RNA sequencing



Body distribution & histology

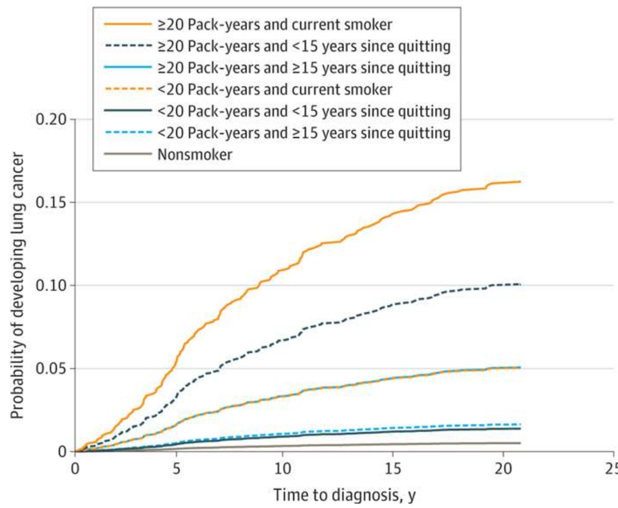
3

Preliminary study “Health impacts of PFAS in the U.S. public water system”

- Populations exposed to the higher levels of PFAS in public water systems (vs. the levels at the MCL standards of 4.0 ppt for PFOS and PFOA, and 10 ppt for PFHxS) have higher risks of developing non-cancer thyroid disease, diabetes, Alzheimer’s disease, among others.
- There are race-specific differences in disease risks in populations exposed to PFAS.

4

Lung cancer risk and smoking



JAMA Oncol. 2022;8(10):1428–1437. doi:10.1001/jamaoncol.2022.2952

5

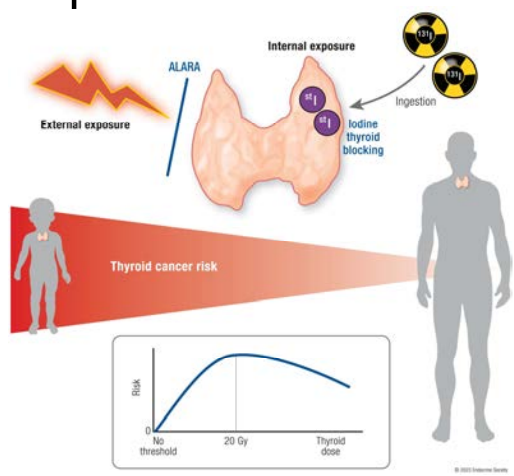
Hazard Ratios (HRs) of disease incidence risk for residential populations exposed to PFAS levels exceeding the EPA MCL standards in the U.S. public water system (vs. the levels below the EPA standards); populations aged 65+, 5% Medicare data.

Disease	PFOS		PFOA		PFHxS	
	HR	95% CI	HR	95% CI	HR	95% CI
Diabetes	**1.10**	**1.09-1.12**	**1.06**	**1.05-1.06**	**1.02**	**1.01-1.03**
Dementia	1.02	1.00-1.03	**1.03**	**1.02-1.04**	1.00	1.00-1.01
Alzheimer's disease	**1.08**	**1.06-1.10**	**1.03**	**1.02-1.05**	**1.02**	**1.01-1.03**
Kidney disease	**1.05**	**1.04-1.06**	**1.02**	**1.01-1.02**	1.00	1.00-1.01
Cerebrovascular disease	**1.09**	**1.08-1.10**	**1.05**	**1.04-1.06**	1.00	1.00-1.00
Non-cancer thyroid disease	**1.10**	**1.09-1.11**	**1.05**	**1.04-1.06**	**1.02**	**1.02-1.02**

6

Thyroid cancer risk related to environmental exposures

ENDOCRINE SOCIETY



Endocr Rev, Volume 45, Issue 1, February 2024, Pages 1–29, https://doi.org/10.1210/endrev/bnad022

OXFORD UNIVERSITY PRESS

7

Data Sources

- The most recent updates of the following data on PFAS in NC (from the NC DEQ) will be used:
  - the Chemours data on PFAS in residential wells, the NC DEQ);
  - the Bernard Allen Fund data on PFAS in residential wells;
  - data on PFAS in the public water supply;
  - data on atmospheric PFAS components.
- The above listed datasets will be linked to the health data to investigate the impacts of PFAS on disease risk, ED visits, hospital admissions, and cause-specific mortality:
  - mortality data from the NC State Center for Health Statistics;
  - the NC Cancer Incidence Statistics data;
  - the NC State Inpatient Database (SID) and NC State Emergency Department Database (SEDD) HCUP data.

8

Race-specific HRs of disease incidence risk in populations exposed to the PFAS in the U.S. public water system, Medicare beneficiaries.

Race	Disease	PFOS	PFOA	PFHxS
American-Indian	Alzheimer's disease	1.38, p=0.0017	1.42, p=0.0014	1.47, p=0.0005
	Dementia	1.20, p=0.0208	1.21, p=0.0242	1.29, p=0.0028
	Prostate cancer	1.71, p=0.0002	1.43, p=0.028	1.50, p=0.0092
White	Thyroid cancer	1.16, p<0.0001	1.16, p<0.0001	1.12, p=0.0024
	Brain cancer	1.14, p<0.0001	1.20, p<0.0001	1.09, p=0.0059
	Ulcerative colitis	1.12, p<0.0001	1.16, p<0.0001	1.07, p=0.0022
	Crohn's disease	1.07, p=0.0019	1.12, p<0.0001	1.03, p=0.2635
	Non-cancer thyroid disease	1.08, p<0.0001	1.07, p<0.0001	1.08, p<0.0001
Black	Thyroid cancer	1.21, p=0.0513	1.17, p=0.1194	1.13, p=0.3762
	Non-cancer thyroid disease	1.03, p=0.0134	1.05, p=0.0003	1.08, p<0.0001
	Systemic lupus erythematosus	1.03, p=0.7105	1.06, p=0.8849	1.20, p=0.0404

9

- The list of diseases shown to have a higher incidence risk in populations exposed to PFAS in public water systems across the U.S. was further confirmed in NC population.

Preliminary study "Health impacts of PFAS in NC public water system"

PFAS in NC public water system: HRs of disease incidence risk in populations exposed to PFAS levels exceeding the detection threshold vs. the levels below the detection threshold, Medicare beneficiaries

Disease	PFOS	PFOA	GenX	PFDA	PFHxS	PFBS	PFNA
Thyroid non-cancer	1.04 p=0.026	1.03 p=0.0761	1.05 p=0.0009	1.08 p<0.0001	n/s*	n/s	n/s
Thyroid cancer	1.29 p=0.0737	1.51 p=0.0125	n/s	1.29 p=0.0282	1.35 p=0.0438	n/s	n/s
Alzheimer's disease	1.07 p=0.0095	1.09 p=0.007	n/s	n/s	1.08 p=0.0013	1.09 p=0.0007	n/s
Systemic lupus erythematosus	n/s	n/s	1.38 p=0.0018	1.24 p=0.0339	n/s	n/s	1.24 p=0.0322

Note: n/s* - non-significant (based on p-value).

10

1

DEQ Interest Areas

DEQ Divisions provide descriptions of interest areas for potential Fellows

Include:
- Priority of deliverable,
- Project time-frame,
- Skillset required, etc.

Combined DEQ projects are grouped into Topic Areas and published on the website that can be shared with researchers.

Researchers use topic areas to submit a simple application to DEQ.

Fellowship Project Topic Areas

Toxicology

1- Toxicology knowledge transfer between DEQ and Fellow to understand where the knowledge gaps are and how the academic sector can help fill those needs to support regulations.
   a. The Fellow could serve as a point of contact for their network in guiding studies to fill the knowledge gaps and highlighting the importance of their publications.
2- Toxicology studies investigating the toxic effects of Chemours Signature PFAS Compounds.
   a. DEQ needs assistance in understanding the toxic effects of Chemours PFAS to develop regulations. Laboratory-based studies investigating the toxic effects of these chemicals are needed as there is a paucity of information in the literature. This type of fellowship would end in a publication.

Fate & Transport

1- Atmospheric Transport and Transformation of PFAS compounds
   a. Transport and transformation of Chemours PFAS in the atmosphere, photon-induced transformation, and degradation, etc.
      i. Ongoing Fellowship comparing near-field atmospheric deposition to stack testing reports from point source facility.
2- Hydrogeological Transport of PFAS compounds
   a. Groundwater modeling of PFAS through the different hydrogeologic regions of NC.
      i. Project with NCSU modeling Chemours contamination through groundwater.
3- Environmental Transport of PFAS compounds
   a. Transformation and transport in surface water, soil, sediment, biota.

More to come in the Break-Out sessions…

2

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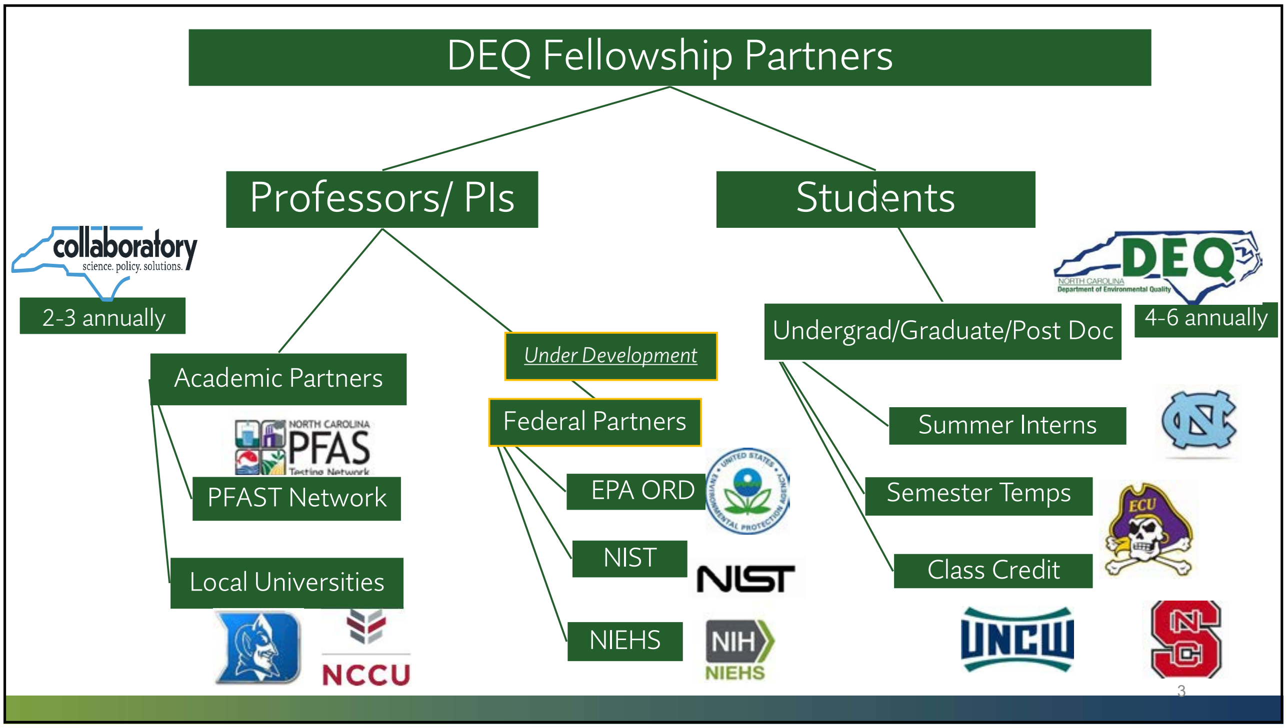
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ECU
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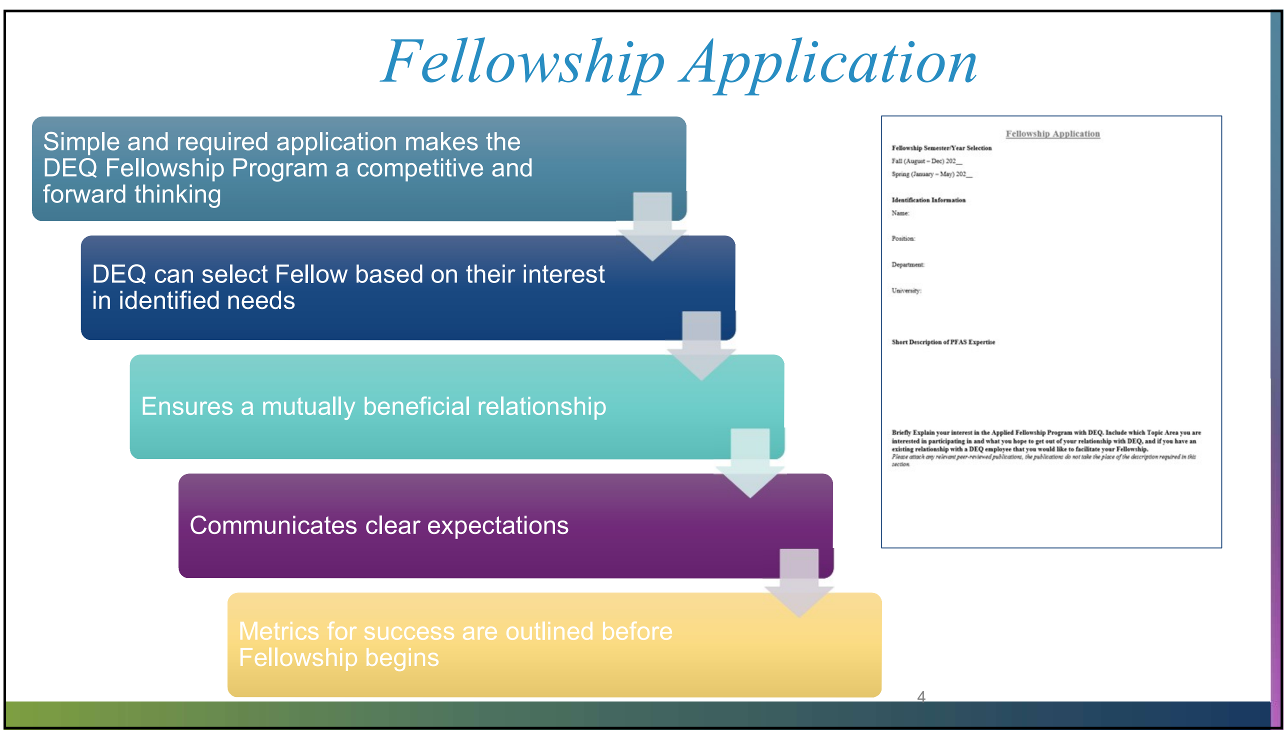
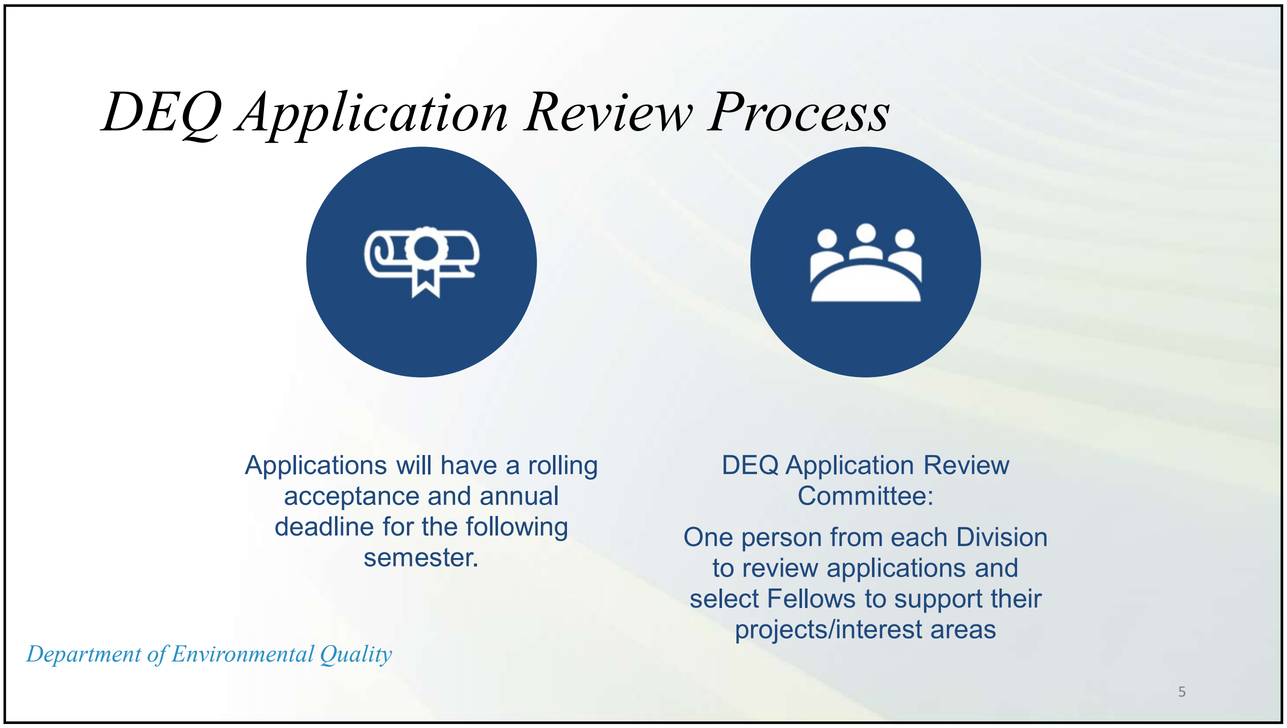
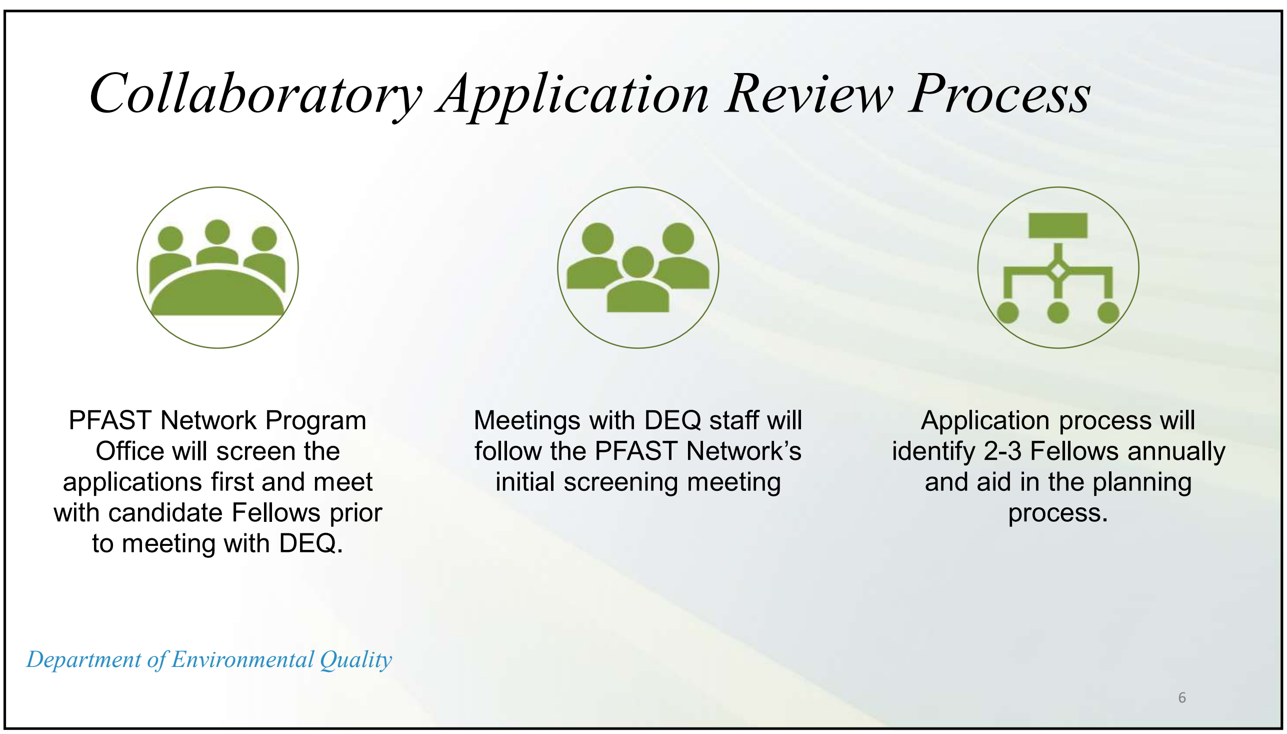

Fellowship Application
Simple and required application makes the DEQ Fellowship Program a competitive and forward thinking
DEQ can select Fellow based on their interest in identified needs
Ensures a mutually beneficial relationship
Communicates clear expectations
Metrics for success are outlined before Fellowship begins
Fellowship Application
Fellowship Semester/Year Selection
Fall (August – Dec) 202__
Spring (January – May) 202__
Identification Information
Name:
Position:
Department:
University:
Short Description of PFAS Expertise
Briefly Explain your interest in the Applied Fellowship Program with DEQ. Include which Topic Area you are interested in participating in and what you hope to get out of your relationship with DEQ, and if you have an existing relationship with a DEQ employee that you would like to facilitate your Fellowship.
Please attach any relevant peer-reviewed publications, the publications do not take the place of the description required in this section.
4

4


DEQ Application Review Process
Applications will have a rolling acceptance and annual deadline for the following semester.
DEQ Application Review Committee:
One person from each Division to review applications and select Fellows to support their projects/interest areas
Department of Environmental Quality
5

5


Collaboratory Application Review Process
PFAST Network Program Office will screen the applications first and meet with candidate Fellows prior to meeting with DEQ.
Meetings with DEQ staff will follow the PFAST Network's initial screening meeting
Application process will identify 2-3 Fellows annually and aid in the planning process.
Department of Environmental Quality
6

6

Upcoming Steps

Website launch

Application period formally opens

7

7

Program Contacts

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gkarthur@unc.edu

Frannie Nilsen

Frannie.nilsen@deq.nc.gov

Rachylle Hart

hartr@uncw.edu

Department of Environmental Quality

8

8

PFAST Researcher Panel: Drinking Water and Wastewater

Dr. Pingping Meng, Dr. David Genereux,
and Dr. Madan Maharjan

1

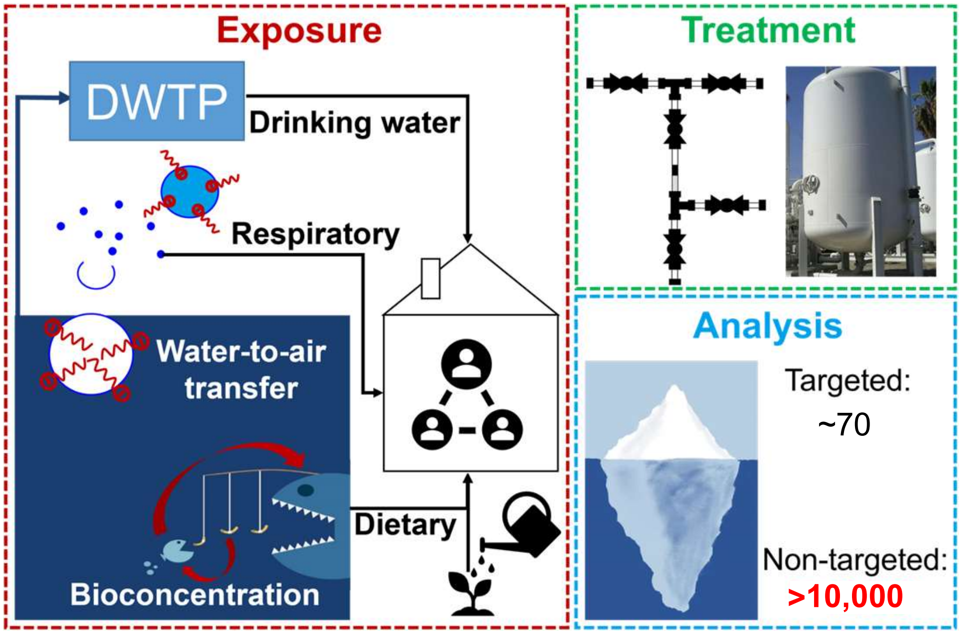
PFAS in North Carolina: Identification and Remediation

Pingping Meng
Department of Chemistry, East Carolina University

DEQ/NC PFAST Collaboratory Meeting
January 29, 2025

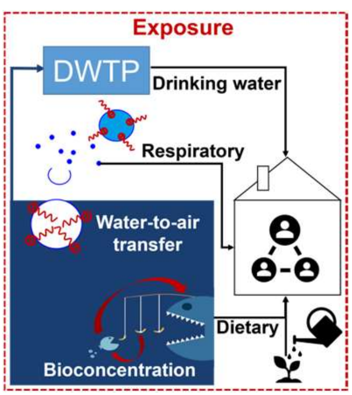
2

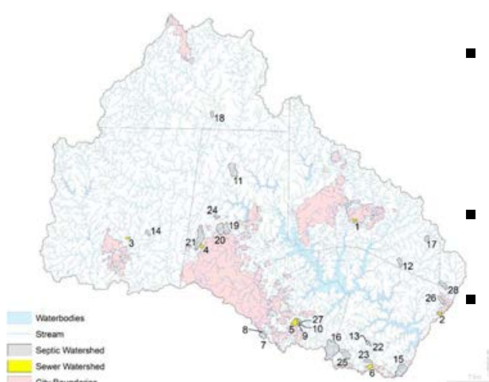
Ongoing and planned research



3

Water



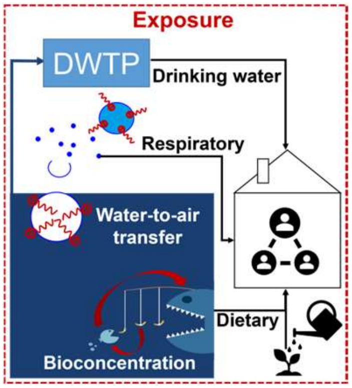


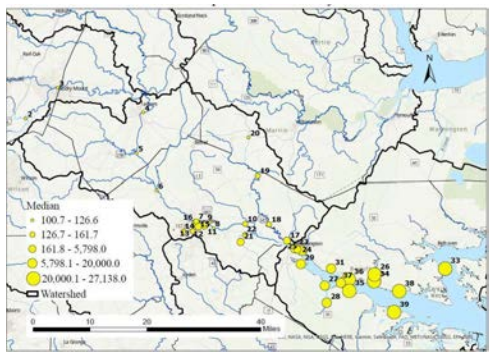
- Water samples from tributary streams of the Falls Lake reservoir (upstream) were analyzed
- Monthly sampled from 28 sites (2020/09 to 2021/08)
- Elevated PFAS levels were observed (up to >100 ng/L)

- ❑ To evaluate the influence of onsite wastewater treatment systems on PFAS loading in the Falls Lake watershed
- ❑ The samples were obtained from a completed DEQ project led by Dr. Michael O’Driscoll at ECU

4

Water





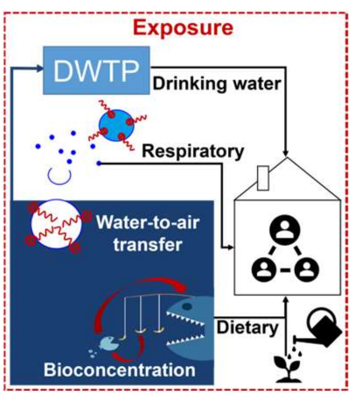
- Water samples along the Tar-Pamlico River
- Monthly sampled from 36 sites (starting Jan 2022)
- Frequent detection of PFAS (e.g., PFOA) above the EPA MCL

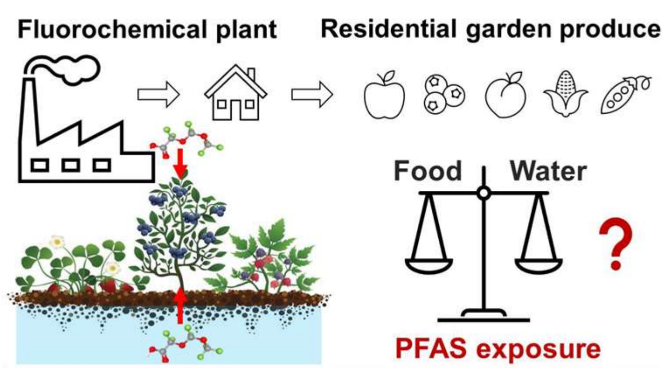
❑ To evaluate the temporal and spatial trends of PFAS levels in the Tar-Pamlico River basin

❑ The samples were obtained from the NSF: Coastlines and People (CoPe) project led by Dr. Stephen Moysey at ECU

5

Food



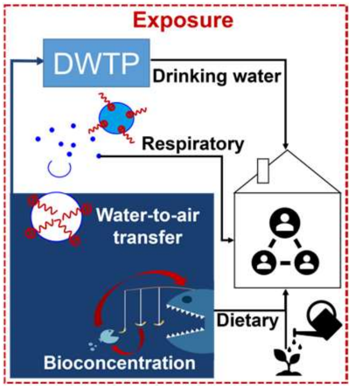


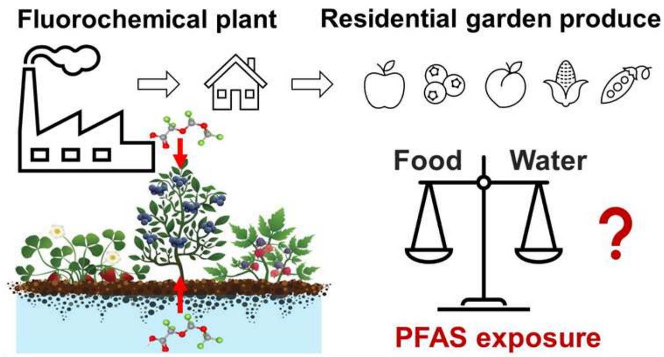
J. Agric. Food Chem. 2024, 72, 48, 26874–26883

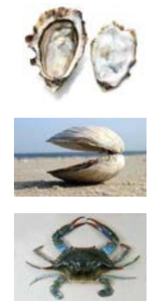
❑ Garden produce grown near a fluorochemical plant contains GenX and other PFAS, which can be an important exposure pathway

6

Food





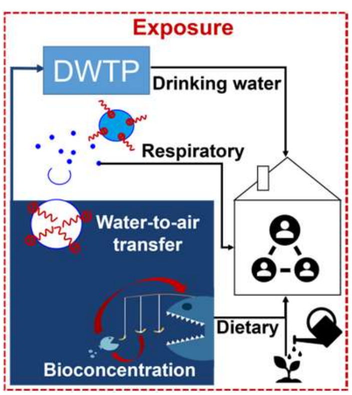


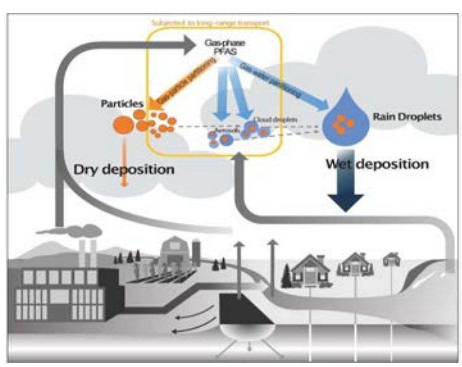
J. Agric. Food Chem. 2024, 72, 48, 26874–26883

- ❑ Garden produce grown near a fluorochemical plant contains GenX and other PFAS, which can be an important exposure pathway
- ❑ **Planned research**: Pilot samples were obtained from local seafood markets in Wilmington, NC to evaluate PFAS levels in shellfish (local and out-of-state)

7

Air





Shimizu et al 2021

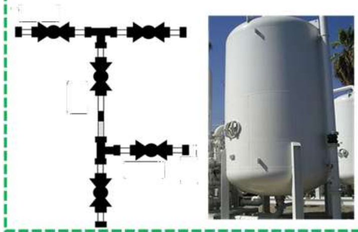
Dekati® Low Pressure Impactor

14 stages
16 nm – 10 µm

- ❑ **Planned research**: To investigate the occurrence, deposition and atmospheric transformation of unique PFAS near the Fayetteville Works facility

8

Treatment

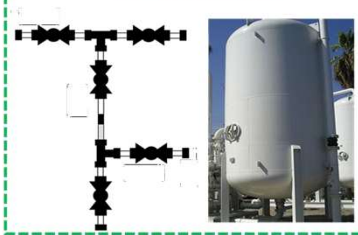


Sorption

Batch & column tests:
- ❑ Water matrix
- ❑ PFAS structure
- ❑ Sorbent characteristics

9

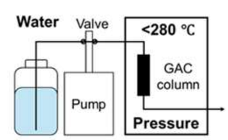
Treatment



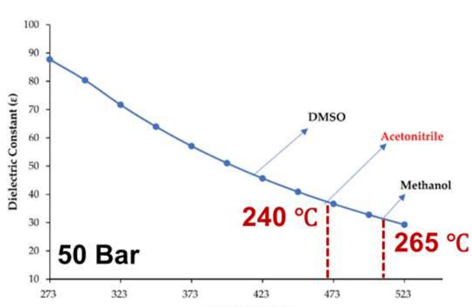
Sorption

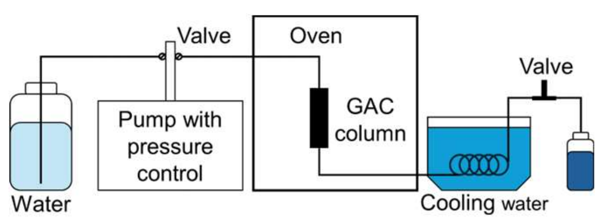
Batch & column tests:
- ❑ Water matrix
- ❑ PFAS structure
- ❑ Sorbent characteristics

Regeneration



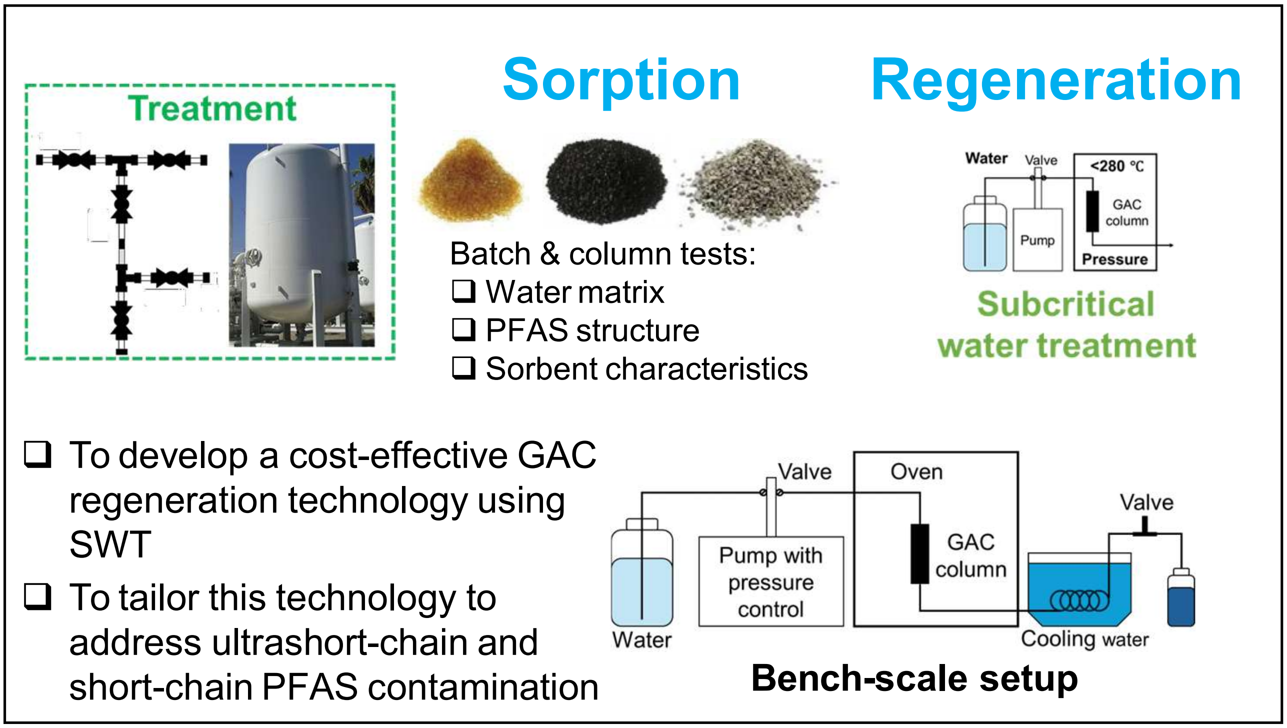
Subcritical water treatment



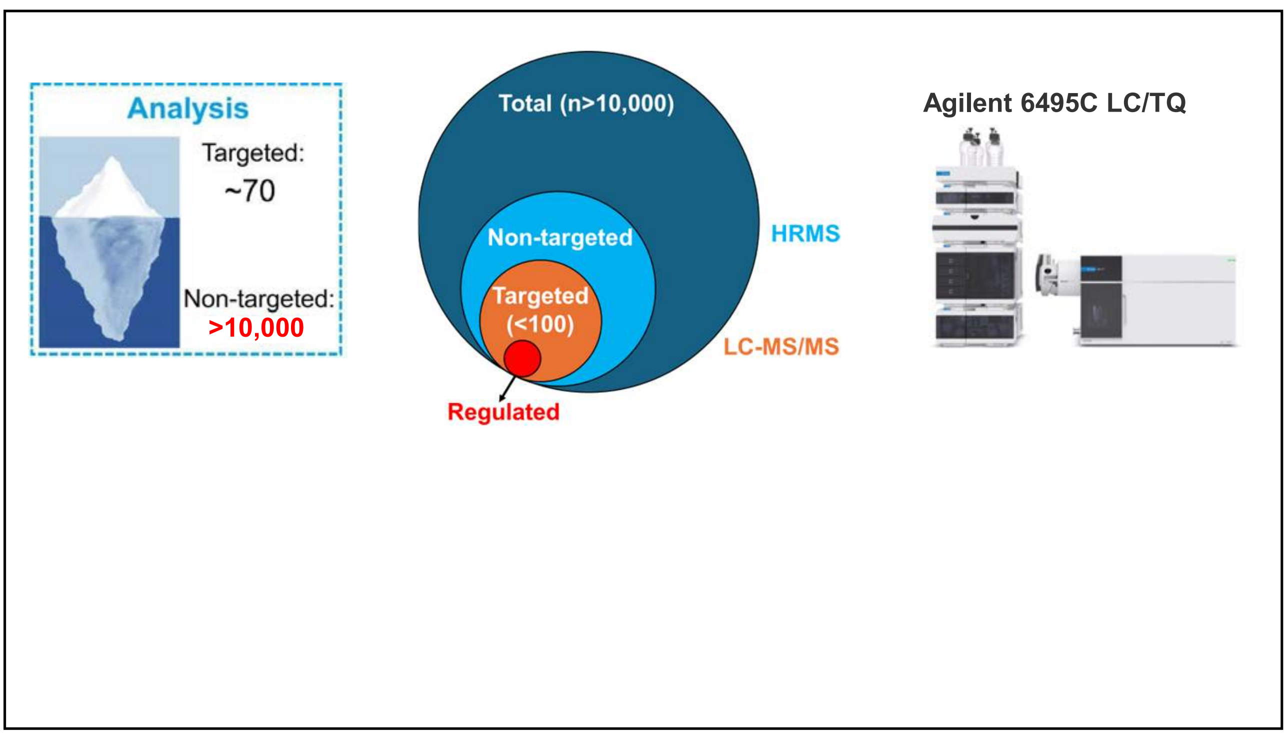


Bench-scale setup

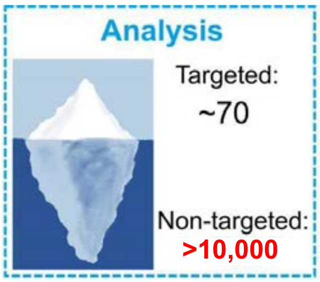
10

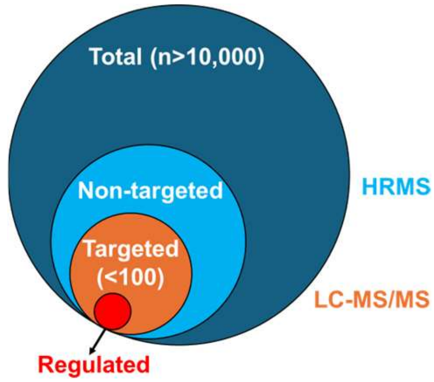

Treatment
Sorption
Regeneration
Batch & column tests:
❑ Water matrix
❑ PFAS structure
❑ Sorbent characteristics
Water
Valve
<280 ℃
GAC column
Pump
Pressure
Subcritical water treatment
❑ To develop a cost-effective GAC regeneration technology using SWT
❑ To tailor this technology to address ultrashort-chain and short-chain PFAS contamination
Valve
Oven
Valve
GAC column
Pump with pressure control
Water
Cooling water
Bench-scale setup

11


Analysis
Targeted: ~70
Non-targeted: >10,000
Total (n>10,000)
Non-targeted
Targeted (<100)
Regulated
HRMS
LC-MS/MS
Agilent 6495C LC/TQ

12

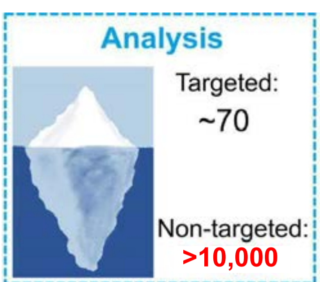


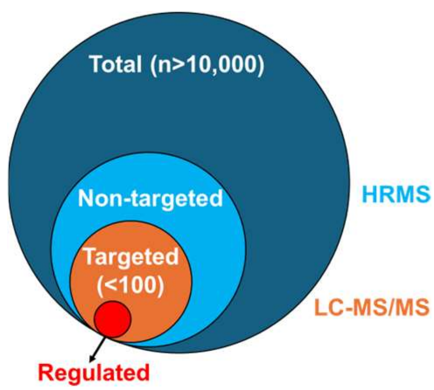


Agilent 6495C LC/TQ

Is there a method to target "total" PFAS?

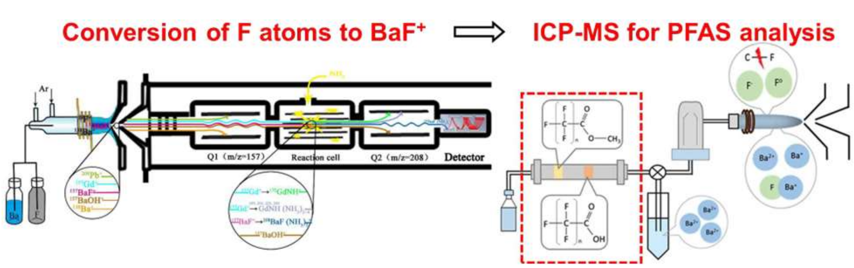
13





Agilent 6495C LC/TQ

Thermo iCAP TQ iMR TQ ICP-MS



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Existing TOF/EOF method cannot separate organic and inorganic fluorine

EPA Method 1621 (CIC)

Cleanup required to remove F^-

Sample (PFAS, F^-) → Combustion furnace → Absorption solution → IC system

Combined peak

15

Existing TOF/EOF method cannot separate organic and inorganic fluorine

EPA Method 1621 (CIC)

Cleanup required to remove F^-

Sample (PFAS, F^-) → Combustion furnace → Absorption solution → IC system

Combined peak

HPLC-ICP-MS
HPLC-ICP-MS/MS

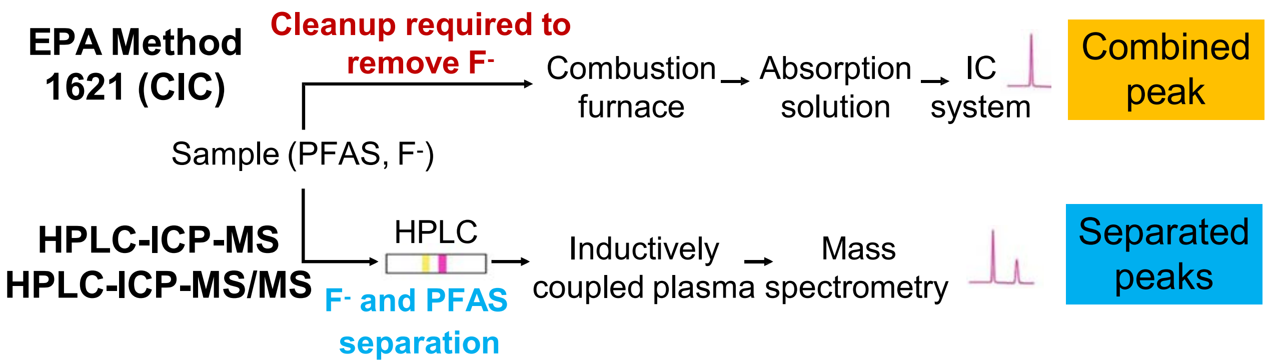
Sample (PFAS, F^-) → HPLC → Inductively coupled plasma → Mass spectrometry

F^- and PFAS separation

Separated peaks

16

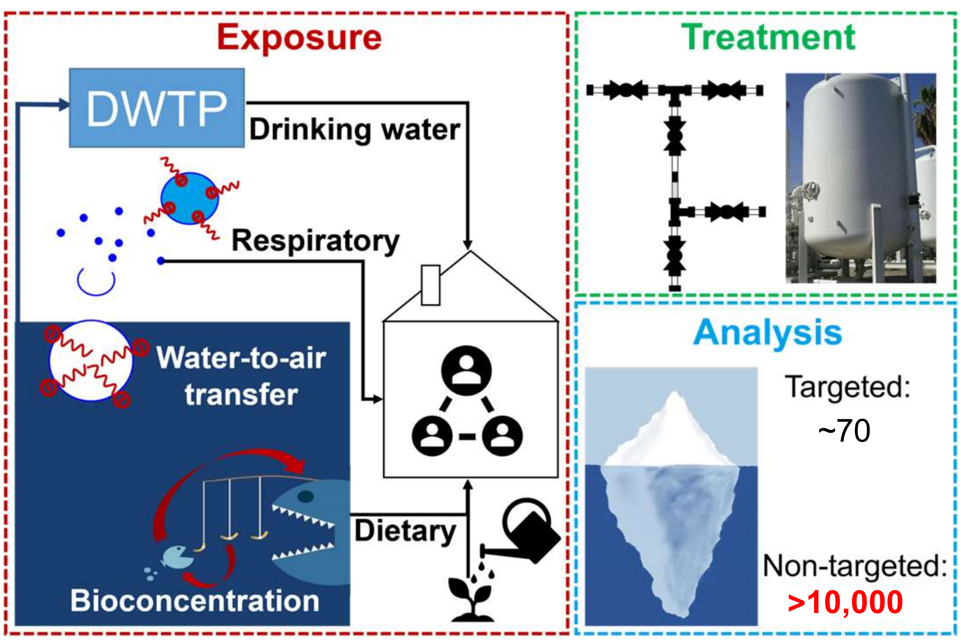
Existing TOF/EOF method cannot separate organic and inorganic fluorine



- ❑ **Planned research**: To develop a cost-effective method using HPLC-ICP-MS(/MS) to measure TOF/EOF levels in **wastewater and biosolids**

17

Ongoing and planned research



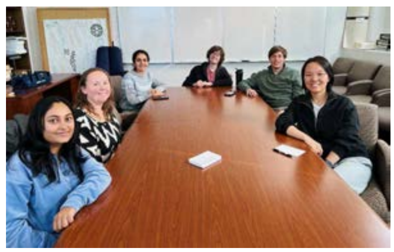
18

ECU

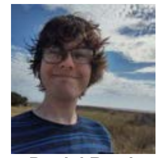
Thank you!
mengp22@ecu.edu

collaboratory
science. policy. solutions.

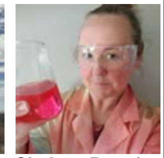
NORTH CAROLINA
PFAS
Testing Network



PhD students:



Daniel Reed



Chelsea Dennis

Master student:

William Bauer

Undergraduates:

Greyson Sanchez

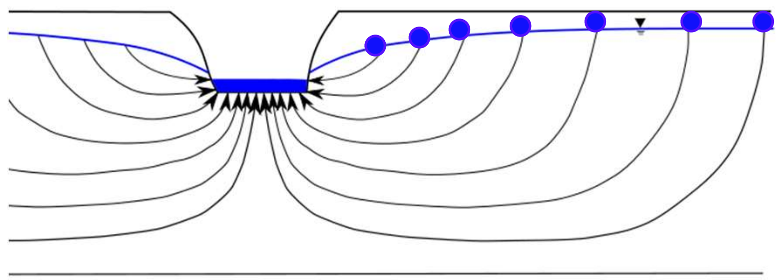
Chris East

19

Dr. David Genereux

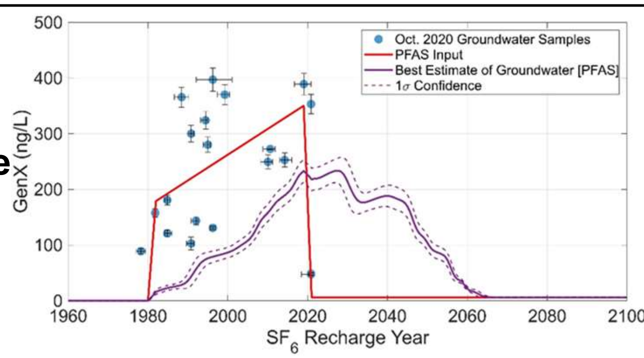
20

Non-point-source chemical reaching the water table and moving through groundwater to a stream



21

Convolution model of GenX in groundwater discharge to Cape Fear tributaries near Fayetteville Works (Jensen et al. 2024, *ES&T*)



GenX output to streams = GenX input at water table ➡ routed through groundwater transit time distribution (TTD)

$$[GenX]_{out}(t) = \int_{-\infty}^{t} [GenX]_{in}(t')TTD(t-t')dt'$$

t = output time, t' = input time, t – t' = groundwater age

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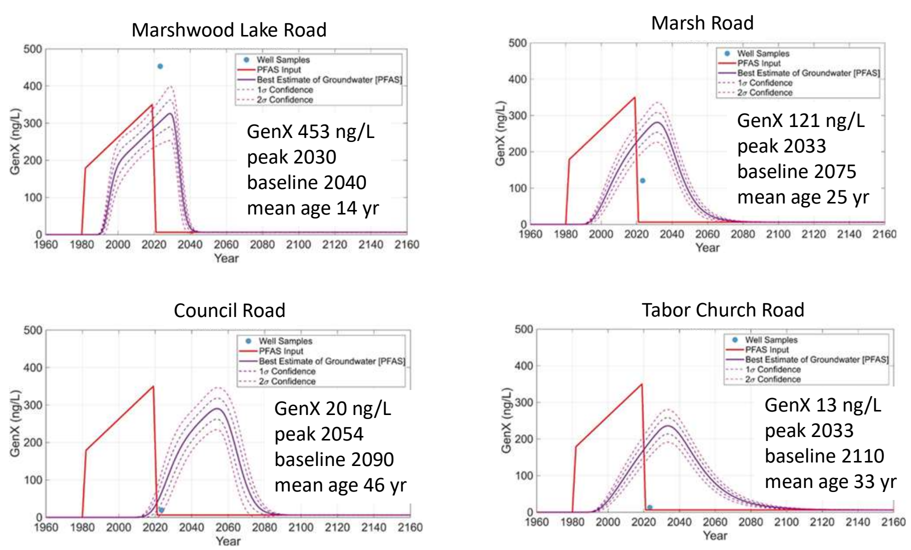
What about individual drinking water wells rather than bulk groundwater discharge to streams?

It's been done for nitrate and hypothetical model contaminants (not PFAS), with good agreement between convolution and spatially-distributed numerical models

More challenging: concentration at a point rather than bulk integrated groundwater discharge

Current project on 6 private drinking water wells, with numerical modeling from Kumar Mahinthakumar at NC State (prof. in CCEE)

23



low GenX but much more on the way?

low GenX, lower input function called for?

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Spatial variations of PFAS concentration in groundwater around the Chemours facility

Madan Maharjan

UNC Pembroke

DEQ and NC PFAST Network Summit 2025

January 29, 2025

Drinking Water and Wastewater Panel

NORTH CAROLINA Department of Environmental Quality

NORTH CAROLINA PFAS Testing Network

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Overview

Current Situation	Scopes	Ideas	Future work	Challenges	Goals
Groundwater is a vital resource	Gather comprehensive data	Predict PFAS concentration in new untested wells	verification of the implied methods	Non uniformity in data	Maximize sample size
PFAS contamination in GW is a growing concern	Identify impacting factors for PFAS-contaminated wells	Improve weekly testing strategy	Implement this method to newer areas	Limited access to acquiring data	Improve models
The level of contamination is heterogeneous					

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Current Situation

Groundwater wells

Need a permit and maintain the records by NCDHHS

No regulations for the residential wells

Groundwater usage

Primary source of drinking water for more than 4 million North Carolinians.

520 mgd of freshwater in NC alone is consumed for domestic, industrial, agricultural, mining etc.

PFAS crisis

PFAS is in water, soil, air, even in living beings

Chemours is one of PFAS emitters in NC and is required to test residential water wells around its facility

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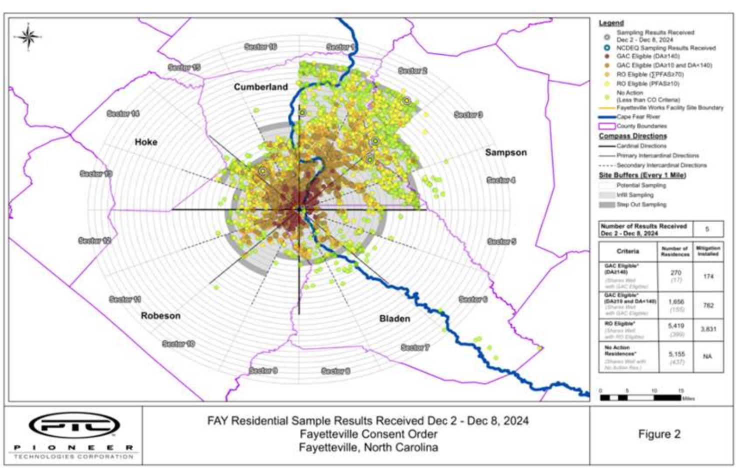
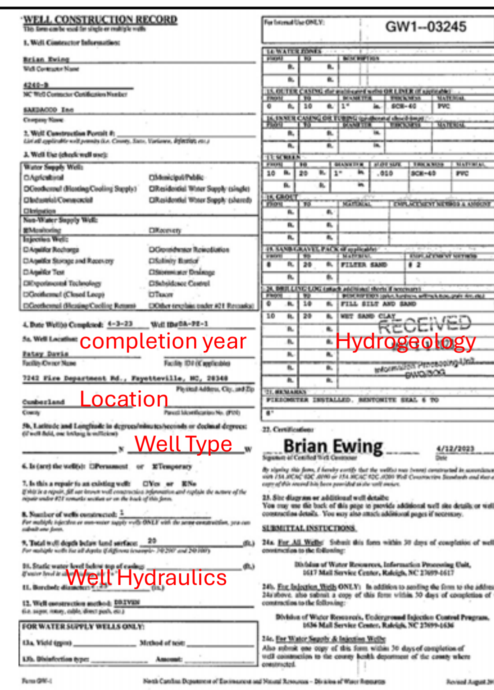
Idea

Sharon Martin (DEQ) provided well sampling results for more than 12,000 residential wells from the Chemours



https://edocs.deq.nc.gov/WasteManagement/DocView.aspx?id=1916674&dbid=0&repo=WasteManagement



https://edocs.deq.nc.gov/WaterResources/Browse.aspx?id=2625285&dbid=0&repo=WaterResources

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Future work

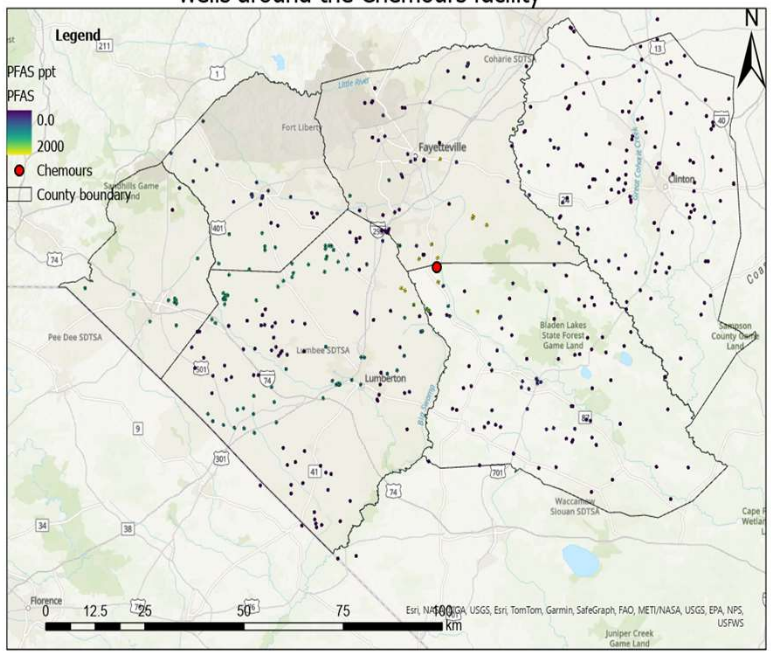
We compiled nearly 600 data points for six counties surrounding to the Chemours company from two different data sources.

Limitation of data are mainly due to inaccessibility of complete data for wells constructed prior to year 2021.

Model predicts PFAS concentrations in the area be grouped into three classes.

Validation of model with ground truthing.

PFAS concentration (truncated) in residential water wells around the Chemours facility



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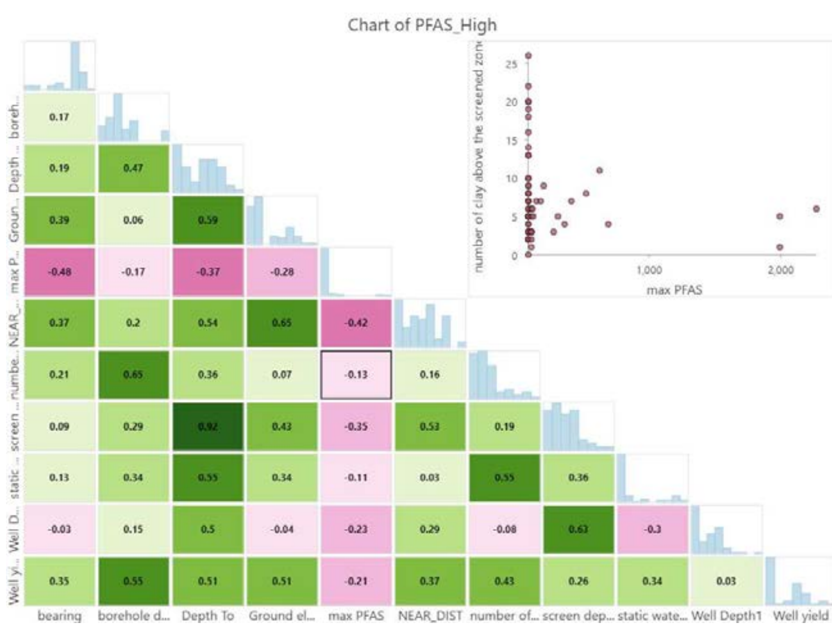
Challenges

Non conclusive and weaker connections but it indicates that the higher PFAS levels are in connection with
- Low ground elevation
- Lower well yield
- Shallow wells
- Closer to the Chemours facility
- a few numbers of clay layers in the well



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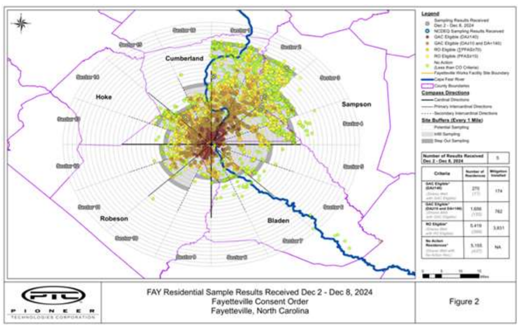
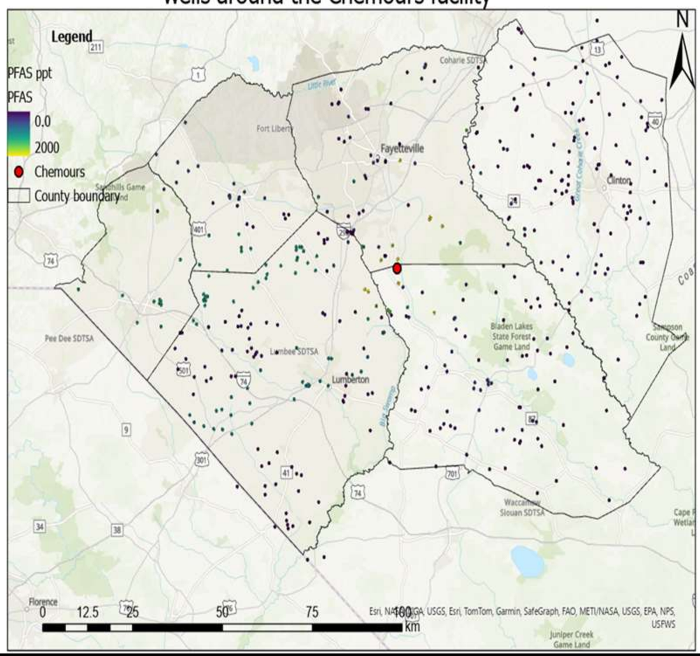
Goals

- Access more data
- Refine the model
- Testing water quality form untested wells that the model predicted for higher PFAS concentrations
- Run the tested model for different areas



PFAS concentration (truncated) in residential water wells around the Chemours facility



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DEQ and NC PFAST Network Summit 2025
Drinking Water and Wastewater Panel Q&A

Question	Answer (respondent)
How well do water levels around a site correlate with levels of PFAS from sites associated with food sources? Does direct treatment of resorption result in less of more amount in the food?	In total, we have five household that provided us with garden produce. We also have groundwater taken; however, we do not find a direct connection between the water and produce overall. Generally, if you see higher levels in the water, there is higher levels in the produce. However, this doesn't necessarily mean it's a linear correlation or a direct correlation. I think there are multiple factors that need to be taken into consideration because if you compare the PFAS signature in the groundwater and produce, they do not match perfectly (Meng)
How might the molecular weight or functional groups, not only functional groups, but carbon chain length might affect what you see?	Those traditionally studied, legacy PFAS, we find that chain lengths do have an impact on PFAS uptake by plants because the shorter chain PFAS are more likely to be uptake to produce, and especially into the edible parts. The same this as the carboxylic and sulfonic acids. For the ether PFAS we also see the same thing, which is the smaller ether PFAS are more likely to be taken into the produce (Meng)
Are there any factors that change the transient water flows? Just wondering what else you would need to account for when measuring flush through for PFAS?	We're counting on the tracer data to tell the story of everything that has happened to the water on its way there. It is a completely different approach than a distributed numerical model, which is going to be data hungry, like porosity, hydraulic conductivity, a recharge rate at the top, a storage parameter if there's an unsteady component. The convolution results I showed are based on the story of all that history of heterogeneity. Whatever that water encountered on its way to the measurement point is embedded in that tracer information. It's not transient analysis, but its assuming a steady hydrology (Genereux)
Your figure showed groundwater affecting surface water, what about when conditions are optimal for surface water to impact groundwater?	That is not very common in the Eastern US, but you can have flood waves come down a river. It is a transient phenomenon too and you get bank storage and that can reverse after a flood wave passes. We are not studying that sort of transient phenomenon. The basic condition is here deeply incised tributaries, that basically function as groundwater drains into the landscape. (Genereux)

DEQ and NC PFAST Network Summit 2025
Break Out Topic: Air Emission Testing

Who participated in this discussion? What organizations were they from?

UNC CH (*Jason Surratt, Barbara Turpin, Ralph Mead*), UNCW researchers, DAQ *(Taylor Hartsfield, Gary Saunders, Heather Carter)*

1. **What are the knowledge gaps and/or unknowns related to this topic?**
   - PFAS destruction technologies – effect of transfer to air medium
   - TFO as an analytical method
   - Limited set of compounds form test method
   - OTC methods slow to develop – additional compounds
   - Partitioning – K_{OC} for these organic compounds

2. **How can your organization help resolve these gaps in knowledge?**
   - Reactive uptake / kinetics for these compounds
   - PFAS in consumer products
   - Know what source signatures exist
   - Pathways – air / water / soil / plant interface

3. **What is an example project that we could collaborate on to resolve the knowledge gaps/unknowns?**
   - Experiments to define reaction kinetics
   - Experiments to define motion kinetics
   - Testing of emerging PFAS removal technologies for air emissions
   - Lab based experiments to determine atmospheric reactions
   - Identifying total Fluorine budget
     - Fluorine NMR issue with having enough mass
     - Mass balance attempt
   - Testing of thermal controls and determine PFAS emission profiles – how heat variations impact chain length

DEQ and NC PFAST Network Summit 2025
Break Out Topic: AFFF

Who participated in this discussion? What organizations were they from?

NCDEQ DWM (*Adam Ulishney, Rebecca Funderburg, Lori Mitchell, Logan Smith*), DEMLR (*Mitchell Lawyer*), Dep Secretary (*Sushma Masemore*)

1. **What are the knowledge gaps and/or unknowns related to this topic?**
   - Number of facilities that use AFFF in training activities
   - How are we communicating with residences that are on private wells near fire fighting training facilities that have PFAS contamination (AFFF)
   - Fire stations or training areas with AFFF with private wells?
     - Are these onsite wells or surrounding wells impacted
   - Which airports use AFFF and are there PFAS discharges in stormwater?

2. **How can your organization help resolve these gaps in knowledge?**
   - Determine if there is AFFF at NC airports (find out if permitted)
   - Identify the homes near a fire training facility that may be potentially impacted and determine if there is a private well to sample
     - Send letters offering testing
     - Follow results with HRE letter from DEQ

3. **What is an example project that we could collaborate on to resolve the knowledge gaps/unknowns?**
   - Create a Tracking system for AFFF at NC airports (find out if permitted)
   - Create a map layer that includes the fire training facilities to compare to DEQ's ambient GW well monitoring network to aid in the identification of potentially impacted areas.
   - Facilitate sampling through the responsible party, or no-fault sampling through Bernard Allen
   - Joint sampling / screening, mapping assessment for receptors, site characterization using DEQs protocol
   - Fingerprinting AFFF from various sources/sites (military, fire training, airports)
   - Should we (DEQ) develop an AFFF specific state policy for the disposal /destruction of AFFF to provide regulatory discretion for emergency use of AFFF

DEQ and NC PFAST Network Summit 2025
Break Out Topic: Bio-sludge Land Management Options

Who participated in this discussion? What organizations were they from?

DEQ DWR/DWM/ADM, EPA, NCSU, DEMLR, Baylor U, NCAT

1. **What are the knowledge gaps and/or unknowns related to this topic?**

- F/T – transfer from biosolids to soil to groundwater, plants, surface water; inactive sites
- Percent solids or liquid content and differences in anaerobic digestion and aerobic.
    - How does this affect PFAS?
- How does PFAS degraded/transformed during the wastewater treatment process?
    - Hydraulic time in wastewater treatment, solids, and liquid time
- Source of biosolids and how to access samples
- What is a safe level to apply to apply to fields
    - Are heavy metals an indicator? What is an allowable level?

2. **How can your organization help resolve these gaps in knowledge?**

- Sample land application fields and compared to buffer zones soil, groundwater, etc. (note PFAS signatures)
- Agents to apply in soil to bind them with PFAS (Purdue university research)
- Studying gaining and losing streams for PFAS (groundwater, surface water interface)
- Research wastewater treatment technologies to mitigate

3. **What is an example project that we could collaborate on to resolve the knowledge gaps/unknowns?**

- Design probes for surface water stream sampling near land app sites or groundwater
    - Researchers revisiting biosolid sites previously sampled – special sample probes to catch groundwater before discharge in streams
- Conduct leachate studies: Run PFAS leach tests through various soil types and media
- Study industry biosolid providers and research PFAS signature and treatment techniques
    - Biosolids data related to each industry
    - Are there other indicators of industrial impacts biosolids?
    - Find other indicator PFAS through data mining – use non-legacy PFAS more representative of current industries impact
- F/T - Sampling buffer zones, surface water, groundwater monitoring wells,
    - Soil – design sampling procedure (depths, edges), what effects movements (buffer zones)
    - Analysis of soil – what kind tends to hold onto PFAS
    - Leaching tests (biosolids) on different soil types for targeted PFAS

- Researching binding materials that could be used to reduce migration of PFAS from biosolids
    - How do polymers for flocculation affect PFAS – remove or retain

DEQ and NC PFAST Network Summit 2025
Break Out Topic: Communication

Who participated in this discussion? What organizations were they from?

UNCW (*Rachel Hart, Dylan Lipscomb*), DEQ (*Hanna, Davy Conners, Collin Yate*s), Duke (*Kim Lyerly*), NCSU (Jane Hoppin)

1. What are the knowledge gaps and/or unknowns related to this topic?

- Research – if PFAS is found by researchers, what is next?
- Level of public trust and how to approach difficult conversations
  - What are trusted sources? Community / individual/ Industry / communication
  - Transparency in potential health impacts; How direct should organizations be?
  - Where is the best source to obtain information and how to express folks personal risk level
- How can local communities use their very limited bandwidth to do outreach and inform people that are already dealing with issues?

2. **How can your organization help resolve these gaps in knowledge?**

- Community meetings: Different ways of communicating to reach a wider audience
  - Private meetings at the local level
  - DHHS PSAs with spontaneous reminders; Targeted messaging
  - Have more 2-way conversations instead of one-way release of information
- Give context for data given to individuals and communities surveyed
  - PFAST Network developing encyclopedia and common terms page
  - Create consistent language on how to discuss PFAS and find the information,
  - Revisit jargon for clarity
- Communities might have very little money / resources or have undocumented community members that don't want to talk to regulators, so having a third party to help facilitate communication

3. What is an example project that we could collaborate on to resolve the knowledge gaps/unknowns?

- Conduct a study to evaluate the effectiveness of communications and meeting your audience
- Create communication strategy and using the PFAST Network Encyclopedia
- Create K-12 youth engagement / education opportunities; including more foundational knowledge (where does my water come from?)
- Create a community of practice that will facilitate a mechanism for a variety of sources (Universities, agencies, NGOs, all with varying levels of complexity and jargon) to condense the information for the public

DEQ and NC PFAST Network Summit 2025
Break Out Topic: Land Application Exposure – Crops, Food, etc.

Who participated in this discussion? What organizations were they from?

EPA (*Mark Strynar, Manyiel Mel*), Duke (*Kallie Davis, Beatrice Bissig*), ECU (*Pingping Meng*), DEQ (*Logan Smith, Crystal Smith, Vince Antrilli*)

1. **What are the knowledge gaps and/or unknowns related to this topic?**
   - What PFAS are present following pesticide application?
   - There are no analytical standards for PFAS in food.
   - Continue developing methods for testing PFAS in commodities, standard methods are not sufficient to fully analyze media– need NTA methods / screening also
   - What are the other options for disposal of biosolids in lieu of land application?
   - How to remediate land contaminated with PFAS from biosolids?
   - What is a safe level of PFAS in food, milk, etc. for human consumption / health?

2. **How can your organization help resolve these gaps in knowledge?**
   - Collaborate across organizations; Dept of Ag. for foods, milk, fertilizer
   - Engage public, share data, be transparent, engage intermediaries (counties, river keepers, locals).
   - Develop methods for crops, milk, food (need to request)
   - Develop innovative and novel disposal options
   - Develop methods, standards
   - ECU - did pilot / screening of seafood (oysters, etc.) for PFAS, can share results

3. **What is an example project that we could collaborate on to resolve the knowledge gaps/unknowns?**
   - Study surface water runoff (ambient) compared to map of biosolids application after rain (flushing)
   - Sample locations of repeated biosolid application to determine if PFAS are concentrated at that location
   - What is the cost impact on industry to move away from land application of biosolids?
   - Surface water sampling near biosolid applied fields
   - Investigate if mixing biosolids with activated carbon is a method for limiting exposure

DEQ and NC PFAST Network Summit 2025
Break Out Topic: PFAS Destruction Techniques

Who participated in this discussion? What organizations were they from?

Duke, NCA&T, UNCC

1. **What are the knowledge gaps and/or unknowns related to this topic?**

- Interference from other compounds
  - Field contaminants could impact destruction efficiency compared to laboratory performance
  - Processes for destruction still interfered with by other contaminants / compound (slowing implementation ability)
  - What are the plans for handling byproducts?
- How do we completely break down the PFAS instead of shorter chain PFAS
  - capturing, destroying, re-releasing the PFAS?
- Costs of these technologies
  - Supercritical water oxidation (CO_2, H_2O, fluorine gas compound)
  - Smaller scale technologies for lower-level concentration sites

2. **How can your organization help resolve these gaps in knowledge?**

- Use the combination of methods and instrumentation available to the universities to investigate the effectiveness of destruction methods.

3. **What is an example project that we could collaborate on to resolve the knowledge gaps/unknowns?**

- Design and test the effectiveness of smaller, more accessible destruction technologies that could be used at homes or landfills.
- Determine what industries have the highest concentrations and the biggest needs for PFAS destruction
- Opportunities to test efficiency of different waste types during destruction (don’t know how the destruction tech works with a range of matrices
  - Concentrating material then determining destruction efficacy

DEQ and NC PFAST Network Summit 2025
Break Out Topic: PFAS Disposal Techniques

Who participated in this discussion? What organizations were they from?

NC Collaboratory (*Alex Gorzalksi*), DEQ (*Michael Pjetroj, Jessica Fay, Michael Lawyer, Trisha Tucker, Toby Vinson*), NCSU (*Dr. Knappe*), ECU (*Pingping Meng*)

1. **What are the knowledge gaps and/or unknowns related to this topic?**
   - What can be disposed of in different classes of landfills?
   - Characterization of facilities; SIU designation for PFAS?
   - Deep well injection – is it viable for long term PFAS disposal – what are the effects?
   - Regeneration – what is fate of PFAS being removed; Recycling / regeneration (GAC, leachates, ion exchange resins, etc)

2. **How can your organization help resolve these gaps in knowledge?**

- Focus on biosolids, characterization, consider what field being used in
- Work and collaborate with Texas regarding deep well storage

3. **What is an example project that we could collaborate on to resolve the knowledge gaps/unknowns?**

- PFAS Fate and transport – biosolids
  - ground v. surface deposition.
  - traditional v nontraditional analytes.
  - consider TOF
- Sampling aquifers and deep well injections
- Set standards for biosolids application and what can be disposed of in different types of landfills
- Baseline sampling and impact assessment of semiconductors fabs and battery plants
  - Air / water /solid waste / biosolids
  - Explore disposal options for waste stream
- Characterization of drinking water treatment residuals
  - Coagulation residuals with or without PAC
  - Spent GAC and IX sorbents
  - Fate of the above in simulated landfill conditions (may have been done)

DEQ and NC PFAST Network Summit 2025
Break Out Topic: Fate & Transport - Groundwater

Who participated in this discussion? What organizations were they from?

DWR (*T Campbell*), DHHS (*Kennedy Holt*), GIS ambient monitoring network (*Andy Neal*), UNCP (*Madan Maharjan*), NCCU (Z *Afzel*), NCSU (*Dave Genereux*)

1. What are the knowledge gaps and/or unknowns related to this topic?

- Private drinking water well depths: Pre-2008 -no permits required, standardized well records don't exist
  - Digitized since 2021 by DEQ because this was a barrier to DEQ progress
    - GW-1 records from electronic DEQ form include well depth and construction information
    - Other information since 2008 is house locally at health departments
- Matrix diffusion characteristics in various soil types are unknown
- Bedrock monitoring wells - are deeper wells are sufficient protection from PFAS?
- The county health programs are mandated (yet not funded) to house well permits, resources are lacking to enable sharing of records

2. How can your organization help resolve these gaps in knowledge?

- Private drinking water well depths:
  - DEQ- mobilize regional office staff to locate records at local health departments; hire summer students to transcribe scanned records
- NCSU Pilot studies on matrix diffusion and bedrock well monitoring via grad students

3. What is an example project that we could collaborate on to resolve the knowledge gaps/unknowns?

- Examine the role of matrix diffusion in and out of clay soils using well depth to answer complex fate and transport questions.

DEQ and NC PFAST Network Summit 2025
Break Out Topic: Fate & Transport – Wet/Dry Deposition

Who participated in this discussion? What organizations were they from?

DAQ (*Amy Delinski, Taijah Hamil, Emily Supple*), DEQ (*Keirah-Lee Garry*), NCSU (*Craig Jensen)*

1. **What are the knowledge gaps and/or unknowns related to this topic?**

- PFAS in the gas phase, how to quantify and how it behaves in the environment
- Models for dispersion in environment, how rain events effect groundwater concentrations
- Models and input information for groundwater sampling may be inconsistent with the information collected. For further wells near Chemours)
- How rain events effect groundwater samples

2. **How can your organization help resolve these gaps in knowledge?**

- Collaboration with organizations that have the ability / equipment to collect data
- Develop trends in PFAS deposition sampling, share knowledge / data
- Spatial trends / PFAS deposition can be helpful for groundwater deposition

3. **What is an example project that we could collaborate on to resolve the knowledge gaps/unknowns?**

- Compare ambient monitoring data with live (LCMS/GCMS)
- Find ways to summarize, organize, and share collected data between organizations
- Finding ways to summarize and access data that DEQ has (PFAS sampling related)

DEQ and NC PFAST Network Summit 2025
Break Out Topic: Lab Related

Who participated in this discussion? What organizations were they from?

DWR (*Allen Martin, Jim Felelhaus*), DAQ, EPA-ORD (*Jackie Bangma*), UNCC (*Mei Sun)*, ECU (*Tracy woodlet*), NCSU (*Dr. Knappe*)

1. **What are the knowledge gaps and/or unknowns related to this topic?**

- Nontarget analyses EPA/ORD – can only give ranges based on other compounds, not measured values
- Certified methods – labs need b/c validated, but only able to for few
- Modified method – any modified lab method is not certified
- Certified standards – need for commercial availability
- Protocol – time 5-8 ears to certify method, need more people, not AI
- Companies stopped making standards because they got sued by company being investigated
- TOF – detection limit (WNCC), some compounds are PFAS by European definitions, but not by the EPA. Takes a long time.
- Chemists in lab trying to make pharmaceutical software work for the environment

2. **How can your organization help resolve these gaps in knowledge?**

- Post doc Heather Whitehead at ORD has helped development nontargeted analyses
- Fluoromatch – database, not spectral library of fluorine, in R
- NCSU has mass spec and will let DWR use them
- Collaboration with BP4NTA.org, Flroromatch (NTA Database)
- Non Extractable side chain polymers

3. **What is an example project that we could collaborate on to resolve the knowledge gaps/unknowns?**

- NTA – improving quantifying nontargeted analyses EPA is improving ranges (Another group of EPA) may take a decade or more. Have published 8,000 word paper. In water only, now working on other matrices.
- Non extractable precursors to PFAS recovered from oxidized sediments (NCSU) , some ideas of methods for oxidation protocol important for biosolids
- Alamance County, textiles; high performance textiles, like military / firefighter gear
- Methods for semi conductors and Li batteries

DEQ and NC PFAST Network Summit 2025
Break Out Topic: Toxicity Testing

Who participated in this discussion? What organizations were they from?

EPA / ORD, DEQ, NCSU, Duke, Oregon State, NCCU

1. What are the knowledge gaps and/or unknowns related to this topic?

- Depth and knowledge of wildlife toxicity information
  - Many compounds still don't have wildlife endpoints
  - Fish behavioral impacts
- Mechanistic impacts in humans
  - Pathways / transformations in the body need elucidation, as well as DAF extrapolation from test species to humans
  - Accounting got human clearance rate for determination human protective values from dose response data
- Usability of research in recreation activities
  - Validate NAMS method to show comparability to traditional methods (LC_{50}, REDS, CSFs)

2. How can your organization help resolve these gaps in knowledge?

- Wildlife data gaps- work together to get contact information of researchers with tissue archives for PFAS analysis
- Collaboratory and DEQ –
  - Start discussions to coordinate work being done in mitochondrial impacts;
  - Mitochondrial testing could be a way to link the existing studies that are underway from all collaborators
  - Collaboration with data exchange to mine information from mitochondrial studies and look for new opportunities
- Additional studies, collaborations across organizations to conduct similar studies with larger compounds

3. What is an example project that we could collaborate on to resolve the knowledge gaps/unknowns?

- Evaluation / analyses of existing tissue sample from other organizations
- Mixture testing with waste stream samples; expanding DWR Aquatic Tox lab to conduct PFAS testing to fill in data gaps
- Coordinated Toxicity testing studies
  - Human health; Aquatic life; Wildlife
- Create a PFAS Toxicity database that is accessible to collaborators
- Laboratory Chemical Synthesis of PFAS (Chemicals needed for toxicity studies) at EPA Labs
- New approaches (computational) and compare, potentially link with standard OECD tox study results

Directory of NC PFAS Testing Network Researchers

NC DEQ and NC PFAST Collaboratory Summit 2025

NC COLLABORATORY

The North Carolina Collaboratory is a research funding agency that partners with academic institutions and government entities to transform research into practical information and technologies for use by the State and local governments and the communities they serve.

Since its authorization in 2016 by the General Assembly (see 31A N.C.G.S. Sec. 116-255) the Collaboratory has stewarded approximately $225 million in appropriations from the legislature, investing in over 600 research projects that have the potential to develop innovative, evidence-based solutions that benefit our State and its residents. Initially focused on environmental and natural resources research, the scope of the Collaboratory's portfolio has expanded to include projects focused on public health, education, technology, and infrastructure.

Given the Collaboratory's history, our mission has always been clear: To serve the State.

Collaboratory Attendees

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science. policy. solutions.

NC PFAS TESTING NETWORK

The NC PFAS Testing Network (NC PFAST) is a collaborative group of multi-disciplinary academic researchers from higher education institutions across North Carolina. We conduct fundamental and applied research on per- and polyfluoroalkyl substances (PFAS), including occurrence in drinking water, environmental fate and transport, exposure and toxicology, and mitigation technologies.

This program is part of the North Carolina Collaboratory, established through a legislative mandate and funded by the North Carolina General Assembly.

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NORTH CAROLINA PFAS Testing Network

Air and Land Panelist

Brent McKee

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Research Focus and Expertise

Primary Areas of Research: Transformation and fate of particulate materials, marsh accretion rates in coastal North Carolina and the response of coastal wetlands to sea-level rise, Response of bay-head deltas to sea-level rise (Roanoke and Newport Rivers, NC)

Research Overview: The overarching focus of my research is on land-ocean interactions and global change. I am interested in the role of Major Rivers (Amazon, Changjiang, Huanghe, Orinoco, Danube, Columbia, Mississippi) in global biogeochemical cycles and global change. Rivers are the primary interface between continental and oceanic environments and play a critical role in global cycles such as carbon.

Current Projects

The Fate and Geochronology of PFAS in Sediments

This project assesses the relationship between PFAS compounds and sediments in North Carolina. In a previous project, high concentrations of PFAS compounds were found to be associated with lake bottom sediments collected close to the input from the Haw River. Using naturally occurring radioisotopes to determine sedimentation rates for lake bottom sediments, we were also able to create a sediment history of PFAS inputs to the reservoir over the 40 years since it was formed.

In this project we will make the same measurements in other environments to see how they compare with the Jordan Lake results. We will also perform experiments to understand the environmental conditions (variability in oxygen concentrations, pH and resuspension activity) under which PFAS compounds are released from sediments. The results of this project will provide valuable insights regarding the prevalence of sediment bound PFAS and the permanence of that association.

Key Collaborators: Detlef Knappe (NC State)

Air and Land Panelist

Chad Lane

Professor and Chair

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Publications and Engagements

- Dombrowski, A., C.S. Lane, R.N. Mead, P.K. Wojtal, and H. Pan. In Review.Stable carbon and sulfur isotopic compositions of per- and polyfluoroalkyl substances. Submitted to Environmental Science and Technology Letters.
- Wojtal, P.K., B. Davidheiser, C.S. Lane, and R.N. Mead, 2025. Stabile isotopic analysis of per- and polyfluoroalkyl substances (PFAS) by nanoflow-HPLC-Orbitrap-MS. Presented at the 2025 American Geophysical Union Annual Meeting, Washington, DC.

Research Focus and Expertise

Primary Areas of Research: Stable isotope geochemistry

Key PFAS-Related Questions: Can stable isotope compositions of PFAS be a useful environmental forensics tool?

Current Projects

Development of a Forensic Model to Trace PFAS in Atmospheric Deposition

We are assessing variation in the stable isotopic compositions of PFAS to gauge their utility in forensic tracing of PFAS from source to sink.

Key Collaborators: Ralph Mead (UNCW), Paul Wojtal (UNCW), Allison Dombrowski, Hai Pan (UNCW)

Key Findings

Developed analytical methodologies to measure the stable carbon and sulfur isotope composition of PFAS. Documented large variations in PFAS carbon isotope compositions. Now beginning method development for these measurements on environmental samples (atmospheric and aqueous).

Collaboration Opportunities

While we are only in the very earliest stages of assessment of stable isotopes as a potential forensics tool for tracing the source and fate of PFAS, if successful, the methodology has clear ramifications for regulatory enforcement, remediation, and overall improved understanding of the transport of PFAS through the environment.

Air and Land Panelist

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Publications and Engagements

- Davern, M. J.; West, G. V.; Eichler, C. M. A.; Turpin, B. J.; Zhang, Y.*; Surratt, J. D.* (2024) External Liquid Calibration Method for Iodide Chemical Ionization Mass Spectrometry Enables Quantification of Gas-Phase Per- and Polyfluoroalkyl Substances (PFAS) Dynamics in Indoor Air. Analyst, 149 (12), 3405–3415.

- Zhou, J.; Baumann, K.; Surratt, J. D.*; Turpin, B. J.* (2022) Legacy and Emerging Airborne Per- and Polyfluoroalkyl Substances (PFAS) Collected on PM2.5 Filters in Close Proximity to a Fluoropolymer Manufacturing Facility, Environmental Science: Processes and Impacts, 24 (12), 2272–2283.

Research Focus and Expertise

Primary Areas of Research: Environmental and Air Chemistry, Analytical Chemistry, & and Measuring Airborne PFAS

Key PFAS-Related Questions: Can HR-ToF-CIMS methods using reagent ions like iodide (I-), oxygen anion (O2-), nitrate (NO3-), nitrosyl (NO+), hydronium (H3O+) and oxygen cation (O2+) measure airborne PFAS in real-time from known point sources? What are the transformations and fates of airborne PFAS?

Current Projects

Development of High-Resolution Chemical Ionization Mass Spectrometry Methods for Real-Time Measurement of Emerging Airborne Per- and Polyfluoroalkyl Substances (PFASs)

Our overarching hypothesis is that CIMS methods using iodide (I-), oxygen anion (O2-), nitrate (NO3-), hydronium (H3O+), oxygen cation (O2+) or nitrosyl (NO+) reagent ions can efficiently measure airborne PFASs in real-time down to parts per trillion (ppt) or sub-ppt levels, with 3 objectives addressing this: (1) Determine HR-ToF-CIMS and Vocus 2R CI-ToF calibration curves and detection limits for atmospherically-relevant PFASs by using commercially-available and synthesized standards; (2) Oxidize these PFAS standards with hydroxyl radicals (OH)/ozone (O3) in controlled laboratory settings to generate commercially-unavailable PFASs and to also gain insights into their atmospheric transformations/fates; and (3) Deploy a mobile laboratory with these newly developed/lab-validated CIMS methods and other air- and particle-phase sampling techniques at a stationary point source to study fugitive PFAS emissions and their near-source downwind chemistry.

Key Collaborators: US DAQ and homeowners around the Chemours Facility

Improved Online Quantification of Airborne PFAS in NC by a Field-Deployable GC-CIMS Method

We propose to interface a real-time liquid calibration system, pre-concentrator, and gas chromatograph to an existing HR-ToF-CIMS (i.e., GC-CIMS) at UNC to expand our capabilities in measuring airborne PFAS concentration dynamics (even for low-level backgrounds), and resolve unique PFAS linked to specific sources. Our new GC-CIMS method (in collaboration with Aerodyne, Inc.) will systematically examine atmospheric PFAS transformations in the lab, and measure airborne PFAS emissions from inside NCSU's textile manufacturing plant in collaboration with Drs. Turpin (UNC) and Ormond (NCSU).

Key Collaborators: NC State University (Bryan Ormond) and Aerodyne, Inc. (Chenyang Bi)

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Key Findings

We can measure airborne PFAS in real-time with CIMS during indoor perturbations, including from clothing, microwave popcorn, and university floor waxing activities.Furthermore, we have integrated two CIMS (one with I- and one with O2+) into a research van to sample airborne PFAS near the Chemours facility in Corpus Christi, TX. We are now preparing to use this van near Chemours in Fayetteville , NC, during Jan-Feb 2025. O2+ CIMS can measure vinyl ethers (i.e., PPVE, PMVE, and PEVE), HFP, OFB, and DFP with LODs of single pptv levels. I- CIMS can measure PFCAs, PFECAs, and FTOHs with LODs at or below 1 pptv levels.

Collaboration Opportunities

We have integrated two CIMS into a research van to sample airborne PFAS near the Chemours facility in Corpus Christi, TX. We are now preparing to use this van near Chemours in Fayetteville during Jan-Feb 2025.

Continued.

Fellow Program Panelist

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Publications and Engagements

- Lithium-ion battery components are at the nexus of sustainable energy and environmental release of per- and polyfluoroalkyl substances Guelfo, Jennifer L.; Ferguson, Lee; Beck, Jonathan; Chernick, Melissa; Doria-Manzur, Alonso; Faught, Patrick W.; Flug, Thomas; Gray, Evan P.; Jayasundara, Nishad; Knappe, Detlef; Joyce, Abigail S.; Meng, Pingping; Shojaei, Marzieh
  Published 2024 in Nature Communications

- Characterizing azobenzene disperse dyes and related compounds in house dust and their correlations with other organic contaminant classes Overdahl, Kirsten E.; Kassotis, Christopher D.; Hoffman, Kate; Getzinger, Gordon J.; Phillips, Allison; Hammel, Stephanie; Stapleton, Heather; Ferguson, Lee
  Published 2023 in Environmental Pollution

Research Focus and Expertise

Primary Areas of Research: Development of methods using high-resolution mass spectrometry for targeted and non-targeted analysis of emerging pollutants in the aquatic environment

Current Projects

PFAS sources and fate in public drinking waters of North Carolina impacted by firefighting and textile operations

The research addresses the occurrence, sources and fate of PFAS in public drinking water supplies. Specifically, this project has two main focuses:

1. Understanding the scope of aqueous film forming foam (AFFF)- related contamination in public water supply wells near fire stations
2. Comprehensively assess sources, fate and exposure to textile-derived PFAS precursors in the Cape Fear River watershed of North Carolina.

Key Collaborators: Detlef Knappe (NC State), Mei Sun (Charlotte)

Remote Attendee

Fellow Program Panelist

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Research Focus and Expertise

Primary Areas of Research: PFAS toxicology/immunotoxicology

Key PFAS-Related Questions: (1) Does exposure to understudied PFAS affect antibody responses to vaccinations similar to PFOA? (2) Does exposure to any PFAS affect how B cells (cells of the immune system that make antibodies) use energy as they transition to antibody-secreting cells?

Current Projects

The North Carolina Firefighter Cancer Cohort Study (NC-FCCS): Investigating PFAS & Chemical Exposures as Cancer Risks (PI: Heather Stapleton, Duke University)

One goal of my contributions to this project is to evaluate in vivo and in vitro immunotoxicity of understudied PFAS identified as relevant to firefighters. Another goal is to develop an immune-based in vitro assay to better screen understudied PFAS for potential immunotoxicity.

Key Collaborators: Duke University and the firefighting community

Key Findings

We just started work on this project, so no key findings as of yet, but we are hopeful that the screening assay could help the DEQ prioritize PFAS for potential regulatory oversight.

Collaboration Opportunities

It is probable that some of the understudied PFAS identified as relevant to firefighter health may also exist in the natural environment. This overlap in PFAS presence means that data from this project can potentially inform DEQ decision-making or perhaps guide them in prioritizing PFAS for decision-making.

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Publications and Engagements

- Dombrowski, A., C.S. Lane, R.N. Mead, P.K. Wojtal, and H. Pan. In Review. Stable carbon and sulfur isotopic compositions of per- and polyfluoroalkyl substances. In-press Environmental Science and Technology Letters.
- Wojtal, P.K., B. Davidheiser, C.S. Lane, and R.N. Mead, 2025. Stabile isotopic analysis of per- and polyfluoroalkyl substances (PFAS) by nanoflow-HPLC-Orbitrap-MS. Presented at the 2025 American Geophysical Union Annual Meeting, Washington, DC.

Fellow Program Panelist

Research Focus and Expertise

Primary Areas of Research: Marine and environmental chemistry

Key PFAS-Related Questions: (1) Can stable isotope compositions of PFAS be a useful environmental forensics tool? (2) What are the temporal and spatial atmospheric depositional fluxes of PFAS near-field and distal to a fluorochemical facility?

Current Projects

Development of a Forensic Model to Trace PFAS in Atmospheric Deposition

We are assessing variation in the stable isotopic compositions of PFAS to gauge their utility in forensic tracing of PFAS from source to sink.

Key Collaborators: PFAST Collaboratory, Dr. Chad Lane, Dr. Paul Wojtal, Ms. Allison Dombrowski, Dr. Hai Pan

Key Findings

Developed analytical methodologies to measure the stable carbon and sulfur isotope composition of PFAS. Documented large variations in PFAS carbon isotope compositions. Now beginning method development for these measurements on environmental samples (atmospheric and aqueous).

Applied total oxidizable precursor methodology to atmospheric wet deposition samples and have detected various unknown precursors that have the potential to transform to PFBA, PFHxA and PFOA.

Collaboration Opportunities

While we are only in the very earliest stages of assessment of stable isotopes as a potential forensics tool for tracing the source and fate of PFAS, if successful, the methodology has clear ramifications for regulatory enforcement, remediation, and overall improved understanding of the transport of PFAS through the environment.

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Publications and Engagements

- Residential Garden Produce Harvested Near a Fluorochemical Manufacturer in North Carolina Can Be An Important Fluoroether Exposure Pathway (https://pubs.acs.org/doi/full/10.1021/acs.jafc.4c06177)
- Removal of Per- and Polyfluoroalkyl Substances (PFAS) in fixed bed anion exchange reactors: Factors determining PFAS uptake capacity and models predicting PFAS breakthrough (https://www.sciencedirect.com/science/article/pii/S0043135424015288)
- Per- and polyfluoroalkyl ether acids in well water and blood serum from private well users residing by a fluorochemical facility near Fayetteville, North Carolina (https://www.nature.com/articles/s41370-023-00626-x)

Fellow Program Panelist

Research Focus and Expertise

Primary Areas of Research: PFAS remediation, PFAS analysis

Key PFAS-Related Questions: How are we exposed to PFAS? What interventions can effectively reduce exposure to PFAS and other contaminants?

Current Projects

PFAST Team 1: PFAS sources and fate in public drinking waters of North Carolina impacted by firefighting and textile operations

The goals of this research are to understand (1) firefighting foam-related PFAS contamination in public water supply wells located near fire stations and (2) textile-derived PFAS precursors in public water supplies in the Cape Fear River watershed of North Carolina. In our lab, we are especially interested in assessing the occurrence of ultrashort-chain PFAS.

Key Collaborators: Lee Ferguson (Duke), Mei Sun (Charlotte)

Sorptive treatment of PFAS and geochronology of PFAS in sediments

The goals of this research are to understand (1) mechanisms of PFAS removal by novel sorbents with the goal of developing predictive models and (2) the presence of PFAS and PFAS precursors, such as fluorinated side-chain polymers, in sediment of important NC drinking water sources.

Key Collaborators: Brent McKee (UNC-CH)

Key Findings

- Trifluoroacetic acid occurs at high concentrations (~700-1600 ng/L based on our analyses of 2024 samples) in NC drinking water supplies
- Side-chain fluorinated polymers are important perfluoroalkyl acid precursors that have accumulated in Jordan Lake sediments

Collaboration Opportunities

We are looking for opportunities to collaborate on sample collection and splitting of samples NC DEQ is collecting as part of their PFAS reconnaissance efforts

Drinking Water and Wastewater Panelist

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Publications and Engagements

- Meng, P., Sheppard, N., Joseph, S., Duckworth, O.W., Higgins, C.P. and Knappe, D.R.U.2024. Residential Garden Produce Harvested Near a Fluorochemical Manufacturer in North Carolina Can Be An Important Fluoroether Exposure Pathway. J Agr Food Chem 72(48), 26874-26883.
- Cheng, L., Meng, P., Knappe, D.R.U. 2025. Removal of Per- and Polyfluoroalkyl Substances (PFAS) in fixed bed anion exchange reactors: Factors determining PFAS uptake capacity and models predicting PFAS breakthrough. Water Res 268, 122629

Research Focus and Expertise

Primary Areas of Research: Water quality and treatment, Analytical chemistry, Human exposure

Key PFAS-Related Questions: What are reliable methods for screening a wide range of PFAS in different environmental matrices, and what analytes are the most important to target? What are the major exposure pathways for PFAS and how can exposure be effectively minimized?

Current Projects

Development of improved analytical methods for the determination of total organic fluorine in water, wastewater and biosolids

This project is to develop cost-effective TOF methods using high performance liquid chromatography-inductively coupled plasma mass spectrometry (HPLC-ICP-MS) and tandem HPLC-ICP-MS (HPLC-ICP-MS/MS) to measure TOF levels in water, wastewater, and biosolids for large-scale testing efforts in North Carolina.

Key Collaborators: The Urban Water Consortium (UWC)

Key Findings

Found human exposure through consuming residential garden produce in an impacted community close to a fluorochemical manufacturer in North Carolina

Collaboration Opportunities

1. Develop advanced TOF/EOF methods to evaluate the total PFAS levels in samples
2. Assess PFAS dietary exposure in impacted communities
3. Develop efficient GAC regeneration strategies

David Genereux

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Publications and Engagements

- Jensen, C.R., D.P. Genereux, D.K. Solomon, D.R.U. Knappe, and T.E. Gilmore. 2024. Forecasting and hindcasting PFAS concentrations in groundwater discharging to streams near a PFAS production facility. Environmental Science & Technology, 58(40), 17926-17936.

- VanDerwerker, T.J., D.R.U. Knappe, D.P. Genereux. 2024. Adapting to PFAS contamination of private drinking water wells near a PFAS production facility in the US Atlantic Coastal Plain of North Carolina. Water Environment Research, 96(8), e11091.

Drinking Water and Wastewater Panelist

Research Focus and Expertise

Primary Areas of Research: PFAS in groundwater, discharge from groundwater to surface water.

Key PFAS-Related Questions: (1) What types of PFAS are in groundwater? (2) At what rate do they discharge from groundwater to surface water? (3) What future PFAS concentrations are expected in groundwater at wells and at areas of discharge to surface water?

Current Projects

PFAS in Groundwater: New Insights On Inputs and Outputs

This project uses a variety of data and analyses to provide new insights on PFAS inputs to and outputs from groundwater near the Fayetteville Works, with the goal of improving understanding and models of future PFAS persistence in groundwater.

Key Collaborators: Detlef Knappe, NC State (PFAS analysis in water); Kip Solomon, University of Utah (analysis of groundwater age-dating tracers); Kumar Mahinthakumar, NC State (groundwater modeling); DEQ (we have utilized DEQ data on atmospheric deposition of PFAS)

Key Findings

PFAS discharge from groundwater to Cape Fear tributaries near Fayetteville Works is expected to drop slowly for about 20 years and then more quickly, reaching baseline by about 2060. Baseline does not mean zero, as PFAS deposition and input to groundwater has continued at a lower but non-zero, nontrivial rate since 2019 (based on data through 2022). The timescale for reaching baseline could be much longer if PFAS diffusion into and out of clay strata is significant

Collaboration Opportunities

The timescale for persistence of PFAS and magnitude of future PFAS concentrations and loading are of interest to water users and suppliers/managers in the Cape Fear basin. DEQ data on atmospheric deposition of PFAS are important in understanding PFAS inputs to the land surface and groundwater, post-thermal-oxidizer (after 2019).

Drinking Water and Wastewater Panelist

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Research Focus and Expertise

Primary Areas of Research: Water quality

Key PFAS-Related Questions: Are the spatial variations in PFAS concentrations in private residential wells near the Chemours facility influenced by underlying geology, hydrogeology, geomorphology, or weather-related factors?

Current Projects

Spatiotemporal variations of PFAS concentration in groundwater around the Chemours facility

This ongoing project, which began last year, aims to gather geological and hydrogeological data from well construction records of private wells in six counties. There has been different factors slowing down the collection of data from the NCDEQ web portal (GW-1) and the scanned pdf files. As of now, 580 private-well construction records were collected. The preliminary results indicate spatial variations in PFAS concentrations.

Key Collaborators: In the later phase of the research, I will collaborate with Lee Ferguson, a member of the NC PFAS Testing Network, to analyze water samples from the selected wells on at least three occasions.

Key Findings

This research is still in progress, making it premature to discuss findings at this stage. However, it is worth noting that the quality of the data varies, as the construction reports are prepared by drillers rather than geologists. Instances of duplicate data have been identified, and in some cases, the same well has been recorded in different locations.

Access to the construction records of all private wells in the six counties surrounding the Chemours facility would greatly enhance the reliability of this study outcomes.

Collaboration Opportunities

Our data collection efforts would support the DEQ's initiatives to maintain a comprehensive digital record of all residential wells, although the current DEQ digital record remains incomplete. This research aligns with the DEQ's goals of safeguarding the quality of the State's surface water and groundwater and ensuring safe drinking water for its residents.

Zainab Afzal

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Publications and Engagements

- Participated in discussions with community members about the impacts of PFAS and strategies to raise awareness of its toxicity through the “Toxic Trip” community outreach initiative and lunch roundtables at the PFAS National Conference, Ann Arbor, MI – June 2024.
- Presented a poster titled "Forever Impacts: How Chemicals like PFAS Disrupt Gene Regulatory Programs During Development" at the Society for Developmental Biology Annual Conference, Atlanta, GA – July 2024.

Research Focus and Expertise

Primary Areas of Research: PFAS toxicology, developmental biology

Key PFAS-Related Questions: How PFAS impacts early vertebrate development? How PFAS impacts maternal-zygotic transition during early development?

Current Projects

Forever consequences: How chemical like PFAS impact early vertebrate development

Exposure to PFAS has been linked to developmental delays in children, with studies indicating associations between maternal PFAS exposure and an increased risk of childhood leukemia, as well as reduced language and motor skills in toddlers. In our project, we utilize zebrafish as our research organism to investigate how PFAS exposure—either directly to embryos or indirectly through parental exposure—affects early development. Zebrafish have approximately 70% of their genome conserved compared to humans, making them a valuable system for investigating the impacts of environmental toxins like PFAS on molecular processes and behavioral changes during early development.

Key Collaborators: NC State University, National Institute of Environmental Health Sciences

Key Findings

One of the common types of PFAS, PFOA, in our study appears to impact neuro-muscular development, evidenced by the differential expression of genes active in neurons and muscles during early embryogenesis as revealed by single nuclei RNA sequencing experiments. Notably, we have also observed that low doses of PFOA exposure during different stages of the maternal-zygotic transition, a critical period when the embryo shifts from relying on maternal RNA transcripts to activating its own zygotic genome, seems to disrupt normal tail-twitch responses in exposed zebrafish embryos, indicating potential interference with early neuromuscular coordination.

Collaboration Opportunities

The primary route of exposure to PFAS is through drinking water, and it has been observed that there is a higher rate of PFAS present in the drinking water for communities of color. Understanding how PFAS exposure affects, for example, neuro-muscular development, could help identify ways to mitigate negative effects of exposure in communities with higher exposure levels, especially focusing on vulnerable populations such as infants and children whose development may be most affected. Informed by this research, we could create community outreach programs to educate the public about PFAS risks and potential developmental effects, empowering communities to take proactive steps in reducing their exposure.

Luming Chen

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**Attending on Behalf of NC PFAST Member Marc Deshusses*

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Research Focus and Expertise

Primary Areas of Research: Novel PFAS Destruction Technologies (Supercritical water oxidation)

Key PFAS-Related Questions: (1) Closing the mass balance of fluoride. (2) Potential degradation pathways and reaction kinetics. (3) Understanding PIDs (products of incomplete destruction), specifically volatile fluorinated compounds (VFCs) during treatment.

Current Projects

Closing the fluorine mass balance of supercritical water oxidation of PFAS in a continuous flow reactor

A huge fluorine mass deficit is found in previous research, where only mineralized inorganic fluoride and organic fluorine in the liquid phase (through LC-MS/MS analysis) are accounted for. In this research, we describe a continuous flow SCWO reactor with gas sampling technique that is in accordance with the standard protocols of OTM-50 method, which identifies volatile fluorinated compounds (VFCs) of incomplete thermal destruction.

Key Collaborators: EPA (Dr. Stephen Jackson), Ferguson Lab at Duke, Knappe Lab at NC state, 374Water

Key Findings

Analysis of gaseous products shows the presence of significant amounts of volatile fluorinated compounds at temperatures below 550 ℃, with the dominant gaseous intermediates in the form of $C_nF_{2n+1}H$.
An average of 95% of the total fluorine mass is accounted for in this study, which is a significant improvement in fluorine mass balance compared to previous results.

Collaboration Opportunities

Closing the mass balance of fluoride, particularly by understanding the various pathways through which fluorine species are generated during PFAS degradation, is crucial for assessing the efficiency and feasibility of novel treatment technologies.

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Publications and Engagements

- Hydrolytically Stable Ionic Fluorogels for High-Performance Remediation of Per- and Polyfluoroalkyl Substances (PFAS) from Natural Water Manning, Irene M.; Guan Pin Chew, Nick; Macdonald, Haley P.; Miller, Kelsey E.; Strynar, Mark J.; Coronell, Orlando; Leibfarth, Frank
  Published 2022 in Angewandte Chemie International Edition

- Ionic Fluorogels for Remediation of Per- and Polyfluorinated Alkyl Substances from Water Kumarasamy, Elango; Manning, Irene M.; Collins, Leonard B.; Coronell, Orlando; Leibfarth, Frank
  Published 2020 in ACS Central Science

Research Focus and Expertise

Primary Areas of Research: Water purification and Membrane-based and sorption processes

Current Projects

The NC Pure Project

The North Carolina PFAS University Research Alliance (NC Pure) aims to evaluate commercial and emerging technologies for PFAS remediation from North Carolina waters at sequentially larger scales, up to pilot scale. NC Pure will deploy pilot-scale PFAS remediation systems to at least three locations throughout NC:

- Water treatment plant that provides drinking water from the Cape Fear River
- Wastewater treatment plant that discharges into the Cape Fear River (or source water tributary)
- Drinking water source in either the Castle Hayne or PeeDee Aquifer

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Publications and Engagements

- Nanofibrous Materials for Remediation of Poly- and Perfluoroalkyl Substances and Methods of Use Thereof Zhang, Lifeng; Mantripragada, Shobha; Dong, Ming; Deng, Dongyang
  Published 2024 in United States

- Algae-Enhanced Electrospun Polyacrylonitrile Nanofibrous Membrane for High-Performance Short-Chain PFAS Remediation from Water Mantripragada, Shobha; Deng, Dongyang; Zhang, Lifeng
  Published 2023 in NANOMATERIALS

Research Focus and Expertise

Primary Areas of Research:

- Trace level contaminants removal from aqueous phase
- Physical, chemical and biological wastewater treatment technology development
- Shale gas fracturing flow back water remediation and reuse
- Advanced surface characterization and analysis
- Chemical spill and fate in the environment
- Environmental microbiology
- Sustainable resource and energy development

Current Projects

Photo-Catalyst and Soil Microbiome Synergy: Targeting GenX Degradation Using Soil from Nearby PFAS-Affected Sites

This project introduces an innovative approach to tackling the persistent issue of GenX contamination by leveraging environmental remediation. Dr. Deng's team is not only targeting GenX but also investigating the diverse functional microbial groups thriving in various PFAS-contaminated sites across North Carolina.

From industrial regions like Greensboro's Piedmont Triad International Airport and the Fayetteville area to the urban areas near Charlotte Douglas Airport, the researchers are collecting soil samples to uncover the unique microbial dynamics at each site. Their goal is to compare how various microbial communities, adapt and respond to different levels and types of PFAS contamination.

The project employs a two-pronged strategy: first, the initial breakdown of GenX through photocatalysis; second, the subsequent biodegradation using the most effective local microbial consortia. This method aims not only to degrade GenX more efficiently but also to understand and harness the inherent resilience and diversity of microbial communities in contaminated environments.

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Publications and Engagements

- In Fall 2024, we shared PFAS blood levels with community members throughout the Basin in webinars and in person meetings.
- Our dust paper has been resubmitted to Environmental Science and Technology and may be accepted by the time we meet.

Research Focus and Expertise

Primary Areas of Research: PFAS epidemiology, biomonitoring, public health impacts, report back and data sharing

Key PFAS-Related Questions: (1) Exposure Characterization: What PFAS are in the blood of people in the Cape Fear River Basin and how are these changing over time? (2) Health Effects Assessment: What are the health effects of PFAS in people living in the Cape Fear River Basin?

Current Projects

GenX Exposure Study

This is a prospective epidemiologic study of >1000 people ages 6 and older living in three regions of the Cape Fear River Basin: Town of Pittsboro, Fayetteville Private Well Community, and Brunswick and New Hanover Counties. People have provided 1-3 blood samples for PFAS and clinical analytes. In 2019, samples from well and tap water, house dust, and wristbands were collected in the Fayetteville Private Well Community.

Key Collaborators: Heather Stapleton (Duke), Detlef Knappe (NC State), Nadine Kotlarz (NC State), David Collier (ECU), Suzanne Lea (ECU), Cape Fear River Watch, Haw River Assembly, Sustainable Sandhills, local health departments

Key Findings

Found that PFAS blood levels were lower in 2023 than in 2020-21 throughout the region, probably due to improvement in water quality.
House dust samples near the Chemours facility had high levels of low molecular weight PFAS unique to the Chemours facility; levels were higher in homes closer to the facility.

Collaboration Opportunities

Reduction in PFAS blood levels shows that remediation of drinking water does reduce body burden.
The gradient of low molecular weight PFAS in dust argues that future dust monitoring is appropriate to identify whether homes are still impacted by these chemicals not found in blood.
Happy to include DEQ in our public engagement activities.

Deepak Kumar

Principal Investigator

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Publications and Engagements

- Per- and polyfluoroalkyl substances activate UPR pathway, induce steatosis and fibrosis in liver cells. DOI: 10.1002/tox.23680
- Postdoc presented a poster titled "Forever Impacts: How Chemicals like PFAS Disrupt Gene Regulatory Programs During Development" at the Society for Developmental Biology Annual Conference, Atlanta, GA – July 2024.

Research Focus and Expertise

Primary Areas of Research: PFAS toxicology, Non-alcoholic fatty liver disease, developmental biology

Key PFAS-Related Questions: How PFAS enhances liver cell steatosis and fibrosis? How PFAS impacts early vertebrate development? How PFAS impacts maternal-zygotic transition during early development?

Current Projects

How PFAS exposure impacts adult liver physiology and early vertebrate development.

Exposure to PFAS has been linked to the development of fatty liver disease in adults and developmental delays in children. Studies have shown associations PFAS and cancer, and between maternal PFAS exposure and an increased risk of childhood leukemia, as well as reduced language and motor skills in toddlers. In our research, we use liver cell lines to investigate the effects of PFAS exposure on liver cells and zebrafish as a model organism to study its impact on early vertebrate development.

Key Collaborators: NIEHS, NC State, RTI

Key Findings

PFAS has been shown to increase the expression of inflammatory markers, elevate endogenous reactive oxygen species (ROS) production, and activate the unfolded protein response (UPR), as demonstrated through comprehensive analyses in multiple liver cell lines.
In our study, one of the most common PFAS compounds, PFOA, appears to disrupt neuro-muscular development and normal tail-twitch responses in zebrafish embryos. This is supported by differential gene expression identified through single-cell RNA sequencing and behavioral observations of the embryos.

Collaboration Opportunities

The primary route of PFAS exposure is through drinking water, with studies showing higher concentrations of PFAS in the drinking water of communities of color. Understanding how PFAS exposure affects vulnerable populations, such as infants and older adults, can guide the development of community outreach programs to educate the public about PFAS risks and potential developmental effects. Such initiatives can empower communities to take proactive steps to reduce their exposure.

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Publications and Engagements

- Hoxie, T., Zhang, S., Herkert, N.J., Bauer, R., Guo, Y., Bhattacharya, A., Carignan, C., Hoffman, K., Higgins, C., Stapleton, H.M. 2024. Silicone Wristbands as a Personal Passive Sampler to Evaluate Indoor Exposure to Volatile and Non-Volatile PFASs". Environ. Sci. Technol., 58: 16316-16326.

- Hall, S.M., Zhang, S., Tait, G.H., Hoffman, K., Collier, D.N., Hoppin, J.A., Stapleton, H.M. 2023. PFAS Levels in Paired Drinking Water and Serum Samples Collected from an Exposed Community in Central North Carolina. Science of the Total Environment: 895, 165091.

Research Focus and Expertise

Primary Areas of Research: Human exposure to PFAS; measurement of PFAS in blood, indoor air, dust, soil and silicone wristbands (wearable exposure tool); environmental epidemiology

Key PFAS-Related Questions: (1) Do firefighters in North Carolina have similar or higher exposure to PFAS compared to the general population? (2) What are the primary PFAS exposure source among firefighters in NC?

Current Projects

The North Carolina Firefighter Cancer Cohort Study (NC FFCCS)

The North Carolina Firefighter Cancer Cohort Study (NC FFCCS) is a research study that is affiliated with the National Firefighter Cancer Cohort Study. This project seeks to identify specific chemicals that may contribute to cancer risk.PFAS (per- and polyfluoroalkyl substances) found in aqueous film-forming foam (AFFF) is a particular focus; however, we are also investigating other potential sources of exposure, including turnout gear, vehicles, and air emission in fire stations.

Key Collaborators: Firefighters, FFCCS, Office of the State Fire Marshal

Key Findings

- Providing information on levels of PFAS in firefighter blood and how it varies geographically across the state
- Assessing indoor air levels of PFAS in fire station based on how turnout gear is stored

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Publications and Engagements

- Cyclic removal and destruction of per- and polyfluoroalkyl substances from water using ion exchange, resin regeneration, and UV/sulfite reduction. B Liu, J Chen, Y You, M Sun. Water Research 2025. 272, 122915

- Remove legacy perfluoroalkyl acids and emerging per- and polyfluoroalkyl ether acids by single-use and regenerable anion exchange resins: Rapid small-scale column tests and model fits. B Liu, YL Liu, M Sun. Water Research 2024. 257, 121661

Research Focus and Expertise

Primary Areas of Research: Water quality, PFAS detection in various environmental media, environmental chemistry, remediation strategies

Key PFAS-Related Questions: (1) What PFAS are in different environment media/ consumer products or generated from different treatment processes? (2)How to completely remove PFAS from the environment?

Current Projects

Passive Samplers for Per- and Polyfluoroalkyl Substances with Innovative Sorbents

Develop new sorbents with high PFAS affinity and use them to build passive samplers to monitor time-averaged PFAS concentrations in surface water and groundwater

Key Collaborators: Researchers from other universities

Key Findings

Synthesized a new ion exchange resin that can capture PFAS better than current commercial resins, and it can be used for PFAS monitoring (passive samplers) and treatment.

Collaboration Opportunities

- Capacity for PFAS monitoring and analysis in multiple media for community protection
- Treatment methods for drinking water protection and contamination remediation

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Publications and Engagements

- Chang et al. (2025) Exposure to Per- and Polyfluoroalkyl Substances (PFAS) in North Carolina Homes: Results from the Indoor PFAS Assessment (IPA) Campaign, ESPI, https://doi.org/10.1039/D4EM00525B.
- Chang et al. (2025) Indoor Air Concentrations of Quartz Fiber Filter-Collected Ionic PFAS and Emissions to Outdoor Air: Findings from the IPA Campaign, Environ. Sci. Processes Impacts, DOI: 10.1039/d4em00359d.
- Eichler et al. (2024) Fluorotelomer Alcohol (FTOH) Emission Rates from New and Old Rain Jackets to Air Determined by Iodide High-Resolution Chemical Ionization Mass Spectrometry, Indoor Environments, 1, 4, 100055, https://doi.org/10.1016/j.indenv.2024.100055.

Research Focus and Expertise

Primary Areas of Research: Outdoor and indoor air chemistry; organic aerosol formation; water-soluble gases and aqueous/multiphase atmospheric chemistry; exposure science

Key PFAS-Related Questions: What are the main routes and pathways for exposure to PFAS? How can PFAS exposure to the general public and those occupationally exposed be effectively mitigated? Can we use advanced real-time air measurements to identify and quantify sources, leaks from storage tanks, fugitive and point sources to the atmosphere, as well as understand the cloud, multiphase and gas phase transformations and fate?

Current Projects

Toward an Improved Understanding of Airborne Per- and Polyfluoroalkyl Substances (PFAS): Advancing Measurements of Air Concentrations and Emissions and Application to a North Carolina Occupational Setting. NC Collaboratory funding

Optimize methods and measure PFAS air emission rates from textiles/materials, expand integrated air measurement capabilities, contribute to textile manufacturing field campaign

Key Collaborators: Bryan Ormond (NCSU)

Chemical Characterization and Variability of Per- and Polyfluoroalkyl Substances (PFAS) in Indoor and Outdoor Air Environments in North Carolina

Measurements of PFAS in air, dust, surfaces, cloth in firehouses to understand indoor reservoirs and levels compared to more typical indoor environments

Key Collaborators: Chapel Hill and Chatham Fire Departments; Bryan Ormond (NCSU)

Development of High-Resolution Chemical Ionization Mass Spectrometry Methods for RealTime Measurement of Emerging Airborne Per and Polyfluoroalkyl Substances (PFASs) – funded by EPA

Laboratory optimization and field measurements of PFAS in air in real time near a major point source.

Key Collaborators: NC DEQ

Residential Indoor PFAS Assessment Campaign

Sloan-funded (completed) project measuring PFAS in air, dust, water, surfaces, clothing over a time period of 6-9 months in each of 10 homes in North Carolina, to understand reservoirs and partitioning of PFAS in homes, emissions from homes, partitioning, and the contributions of air and clothing to residential indoor exposure for residents not living near a major point source.

Key Collaborators: EPA

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Publications and Engagements (cont.)

- Eichler et al. (2024) Partitioning of neutral PFAS in homes and release to the outdoor environment: Results from the IPA Campaign, Environ. Sci. Technol., 58, 18870-18880, DOI: 10.1021/acs.est.4c05286.

- Davern et al. (2024) External Liquid Calibration Method for Iodide Chemical Ionization Mass Spectrometry Enables Quantification of Gas-Phase Per- and Polyfluoroalkyl Substances (PFAS) Dynamics in Indoor Air, Analyst, 149, 3405-3415.

- Eichler et al. (2023) Cloth-Air Partitioning of Neutral Per- and Polyfluoroalkyl Substances (PFAS) in North Carolina Homes during the Indoor PFAS Assessment (IPA) Campaign. Environ. Sci. Technol., 57, 15173-15183, 10.1021/acs.est.3c04770.

Key Findings

1. Found that inhalation is a major contributor to non-dietary residential PFAS exposures. Fabrics/textiles (e.g., rain jackets) constitute an important source.
2. Determined that PFAS can be quantitatively measured in real-time with chemical ionization mass spectrometry and identify/locate sources (or leaks) indoors (e.g., floor waxing) and sometimes outdoors.

Collaboration Opportunities

Collaboration for field deployment; interaction to facilitate more relevant research questions; public engagement; we value the interactions and are happy to help

Continued.

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Publications and Engagements

- Outreach: Continuing Medical Education Lecture: Craven County Medical Society: Effects of water pollution on human health and disease.

Research Focus and Expertise

Primary Areas of Research: Immunotoxicology, PFAS toxicology, Public Health Impacts

Key PFAS-Related Questions: How do the impacts of new and emerging PFAS, with limited toxicological data, compare to the well-established effects of PFOA and PFOS on immune cell populations and vaccine response outcomes, such as T-cell dependent antibody response?

Current Projects

Immunotoxicological testing of per- and polyfluoroalkyl substances (PFAS) in North Carolina

The research focuses on conducting immunotoxicological studies using animal models to assess the potential health risks of lesser-known PFAS, many of which lack established health-based exposure limits. These studies aim to generate critical toxicological data to develop reference doses (RfDs) for these compounds.

Key Findings

Immunotoxic and hepatotoxic potential of new and emerging PFAS with little to publicly available data.

Collaboration Opportunities

A key beneficiary of this research would be the North Carolina Department of Environmental Quality, which has formulated an action strategy for PFAS. The agency relies on scientific literature and toxicological methods to assess and monitor PFAS levels and their impacts within the state.

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Publications and Engagements

- Patel, Harsh V., Myles Greer, Brian Brazil, Wenzheng Yu, Sameer Hamoush, Lifeng Zhang, and Renzun Zhao. "Adsorption capacity and mechanism of modified coal fly ash (CFA) for per-and polyfluoroalkyl substances (PFAS) in landfill leachate." *Journal of Hazardous Materials* 484 (2025): 136763.

Research Focus and Expertise

Primary Areas of Research: PFAS in solid waste management and wastewater treatment, Low-cost remediation approaches for PFAS concentrates, Quick testing of PFAS in environmental media.

Key PFAS-Related Questions: What are the alternative mechanisms for PFAS adsorption? What are the alternative mechanisms for PFAS degradation? What are the alternative mechanisms for PFAS detection?

Current Projects

Advancing techniques to assess the fate, transportation, and detection of PFAS

The projects are developing coal fly ash based low-cost PFAS remediation technology, quick testing with Raman spectrometry and fate/transport prediction with machine learning.

Key Collaborators: Electrical Power Research Institute (EPRI)

Key Findings

Coal fly ash is feasible to remove PFAS from concentrated waste streams.

Collaboration Opportunities

- Mitigating the PFAS and coal fly ash issues in North Carolina
- Quick testing of PFAS in environmental media with Raman Spectrometry
- Prediction of fate and transport of PFAS with data science tools

2025 NC DEQ and NC PFAST Collaboratory Summit Attendee Contact List			
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