

# Per- and Polyfluoroalkyl Substances Testing (PFAST) Network Progress Report

Joint Legislative Oversight Committee on  
Agriculture and Natural and Economic Resources



Policy  
Collaboratory

January 10th, 2019

Jeffrey Warren, PhD  
Research Director

# Where We Are

## PFAST Network Team



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

**NC STATE**  
UNIVERSITY



**NORTH CAROLINA  
AGRICULTURAL AND TECHNICAL  
STATE UNIVERSITY**



**ECU**



**Duke**  
UNIVERSITY

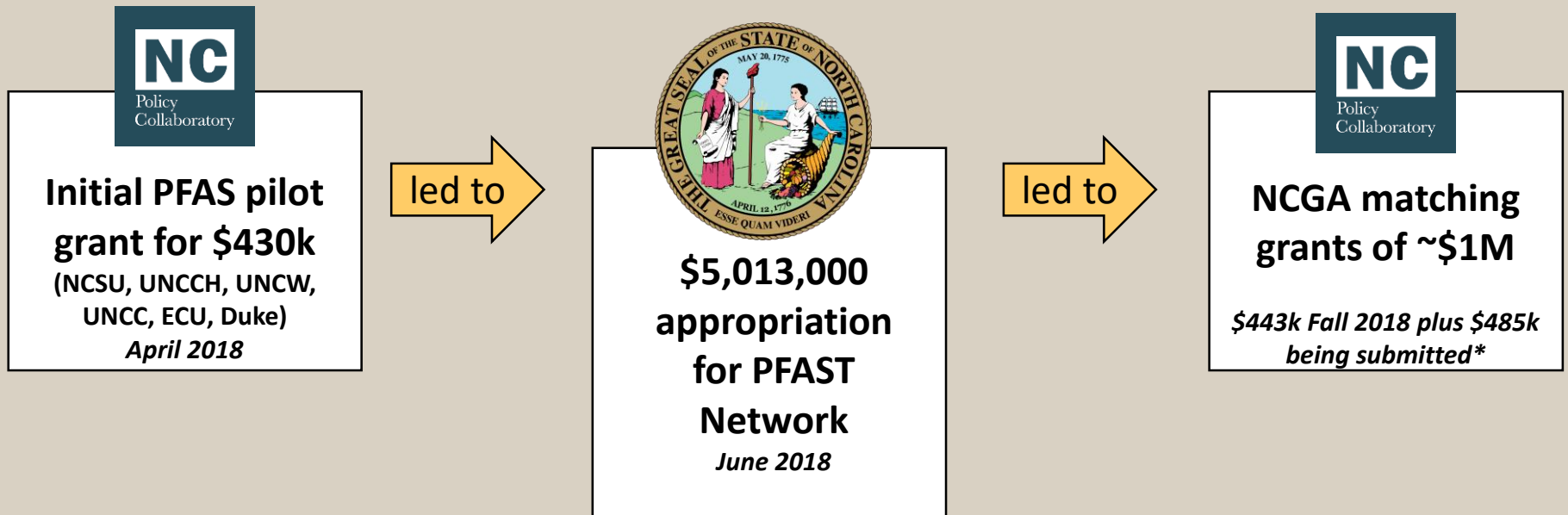
# Challenge Grant funds ~\$1.4M



McDonald Gibson (UNCCH)	\$380,000
Waters/Lockett (UNCCH)	\$50,000
Hoppin (NCSU)	\$168,603.76
Genereux (NCSU)	\$61,597.75
Call (NCSU)	\$75,000
Sun (UNCC)	\$26,858.25
Ferguson (Duke)	\$15,000
Knappe (NCSU)	\$95,625
DeWitt (ECU)	\$77,500*
Knappe (NCSU)	\$407,997*

## Collaboratory leverage with State funds

Collaboratory has made additional investments to supplement the NCGA PFAS appropriation bringing total State investment of **~\$6.4M**



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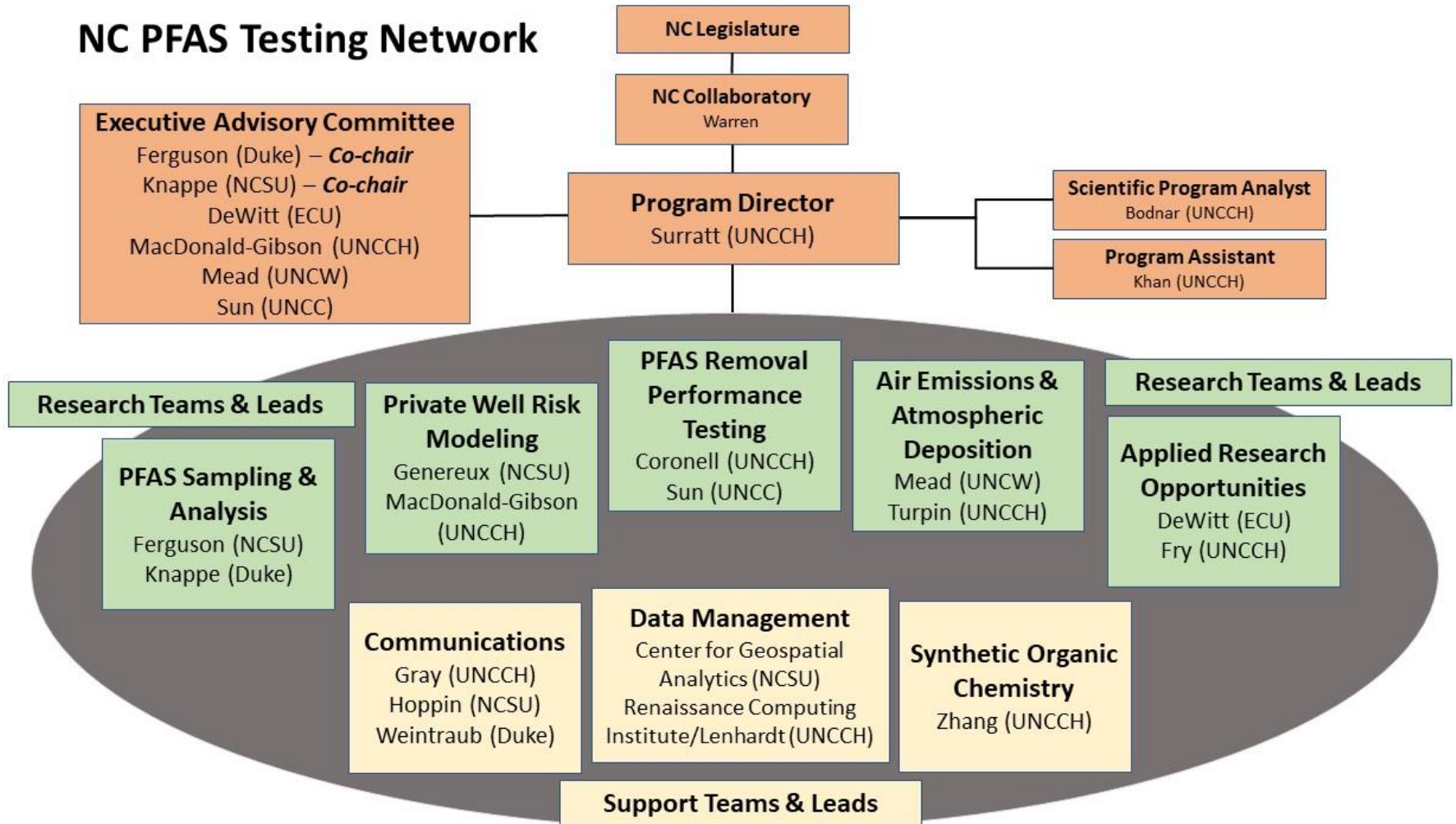
*January 10th, 2019*



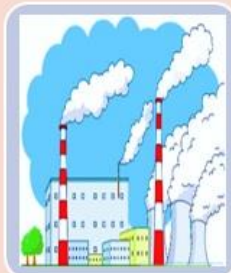
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**Wanda Bodnar, PhD**  
Assistant Professor  
Dept Environmental Science and  
Engineering  
Gillings School of Global Health

# Organizational Structure



# Research and Support Teams



## Team 1:

PFAS Sampling  
and Analysis

## Team 2:

Private Well  
Risk Modeling

## Team 3:

PFAS Removal  
Performance  
Testing

## Team 4:

Air Emissions  
and  
Atmospheric  
Deposition

## Team 5:

Applied  
Research  
*lab experiments*  
*animal studies*  
*human samples*

## Team 6:

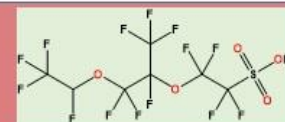
Risk  
Communication

## Team 7:

Data Science  
and  
Management



**Program Management Team & Synthetic Chemist**

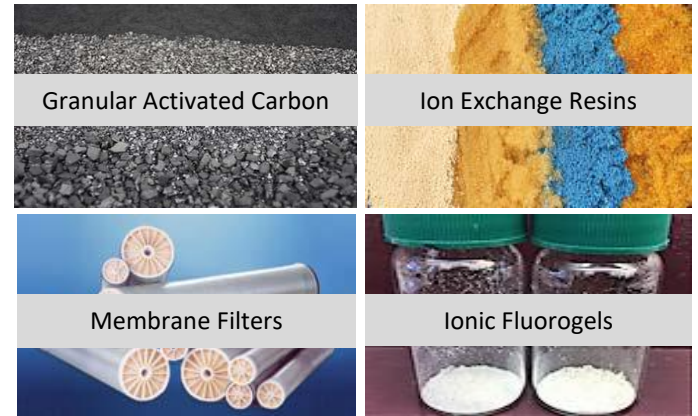


# Research Activities

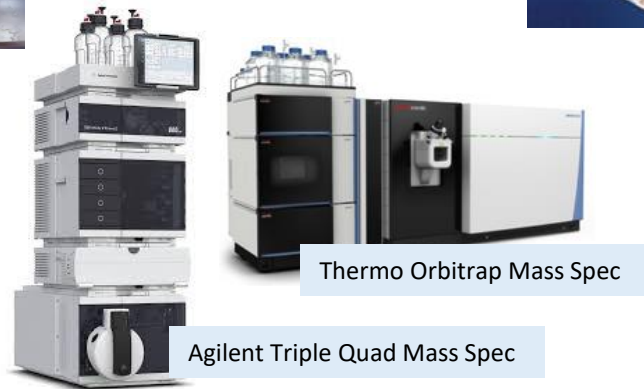
## Sampling



## Removal Performance



## Analysis



## Health Effects



## Predictive Models





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**P. Lee Ferguson, PhD**

Associate Professor

Dept of Civil and Environmental Engineering

Duke University



# PFAST Sample Acquisition and Analysis Plan for PFAS in Water

Team #1: PFAS Testing: Water

P. Lee Ferguson<sup>1</sup>, Detlef Knappe<sup>2</sup>, and Mei Sun<sup>3</sup>

<sup>1</sup>Duke University, <sup>2</sup>NC State University, <sup>3</sup>UNC-Charlotte

NC PFAS Testing (PFAST) Network, a research program funded by the NC Policy Collaboratory

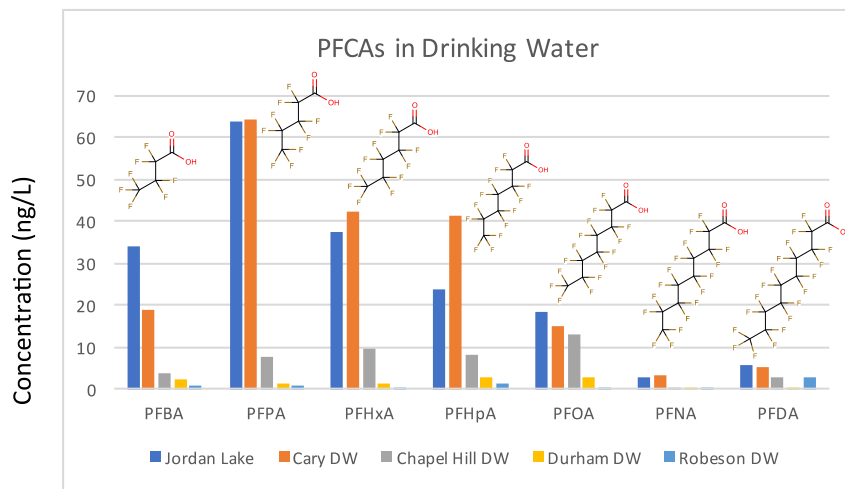
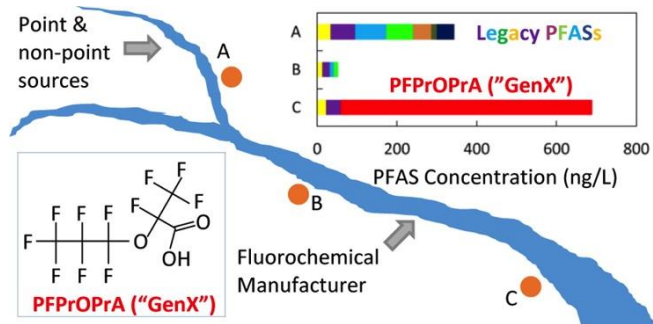
# Research Questions

- What are the concentrations of targeted legacy and emerging PFAS contaminants in North Carolina public drinking water sources?
  - Collect and analyze raw water samples during two consecutive quarters of 2018/2019 at all 191 municipal surface water intakes and all 149 municipal drinking water systems treating groundwater in NC for PFAS measurement
  - Repeat this sampling for systems with detectable PFAS in the third quarter of 2019
- What unanticipated and untargeted PFAS compounds occur in North Carolina public drinking water sources?
  - Apply high-resolution mass spectrometry methods to screen samples collected above for presence of > 5,100 known PFAS compounds as well as for unknown fluorinated organic compounds
- How much of the total organic fluorine in North Carolina public drinking water sources can be accounted for by targeted PFAS quantitation?
  - Utilize adsorbable organic fluorine (AOF) measurements in concert with the quantitative PFAS measurements outlined above to assess fluorine “mass balance” in water samples

# Why is this research needed?

## Legacy and Emerging Perfluoroalkyl Substances Are Important Drinking Water Contaminants in the Cape Fear River Watershed of North Carolina

Mei Sun,<sup>\*,†,‡</sup> Elisa Arevalo,<sup>‡</sup> Mark Strynar,<sup>§</sup> Andrew Lindstrom,<sup>§</sup> Michael Richardson,<sup>||</sup> Ben Kearns,<sup>||</sup> Adam Pickett,<sup>⊥</sup> Chris Smith,<sup>#</sup> and Detlef R. U. Knappe<sup>‡</sup>



Jordan Lake; n=3  
Cary DW; n=4  
Chapel Hill; n=1

Durham; n=2  
Robeson; n=9

Heather M. Stapleton and P. Lee Ferguson, Unpublished

# Sample acquisition strategy

- 191 Municipal surface water sources
- 149 Municipal well water sources

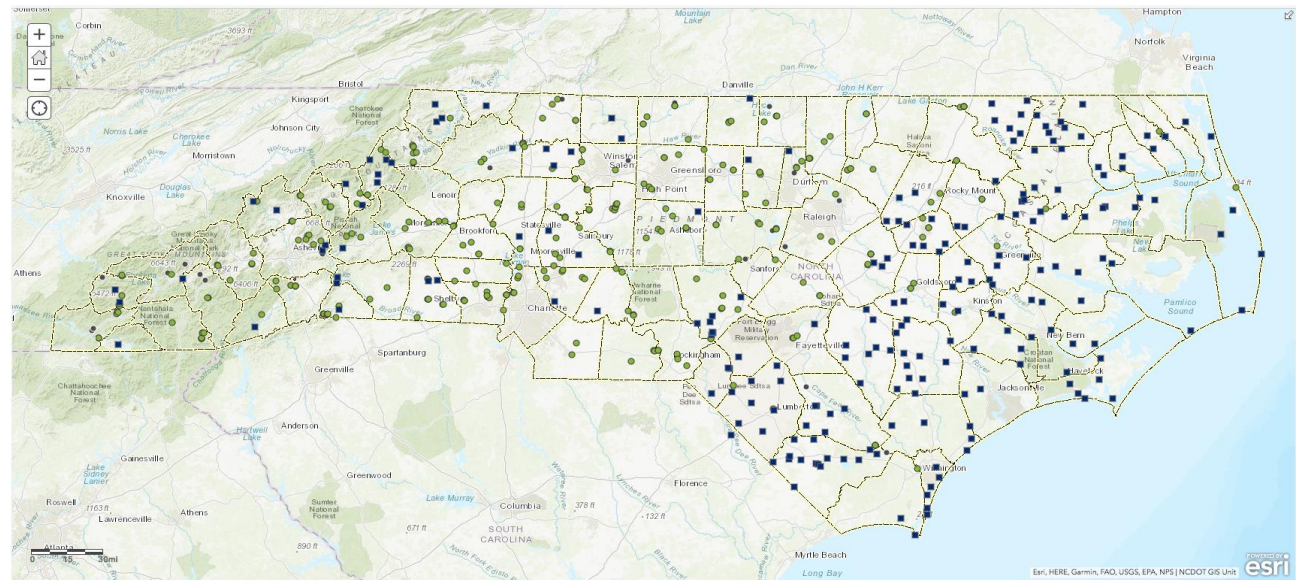
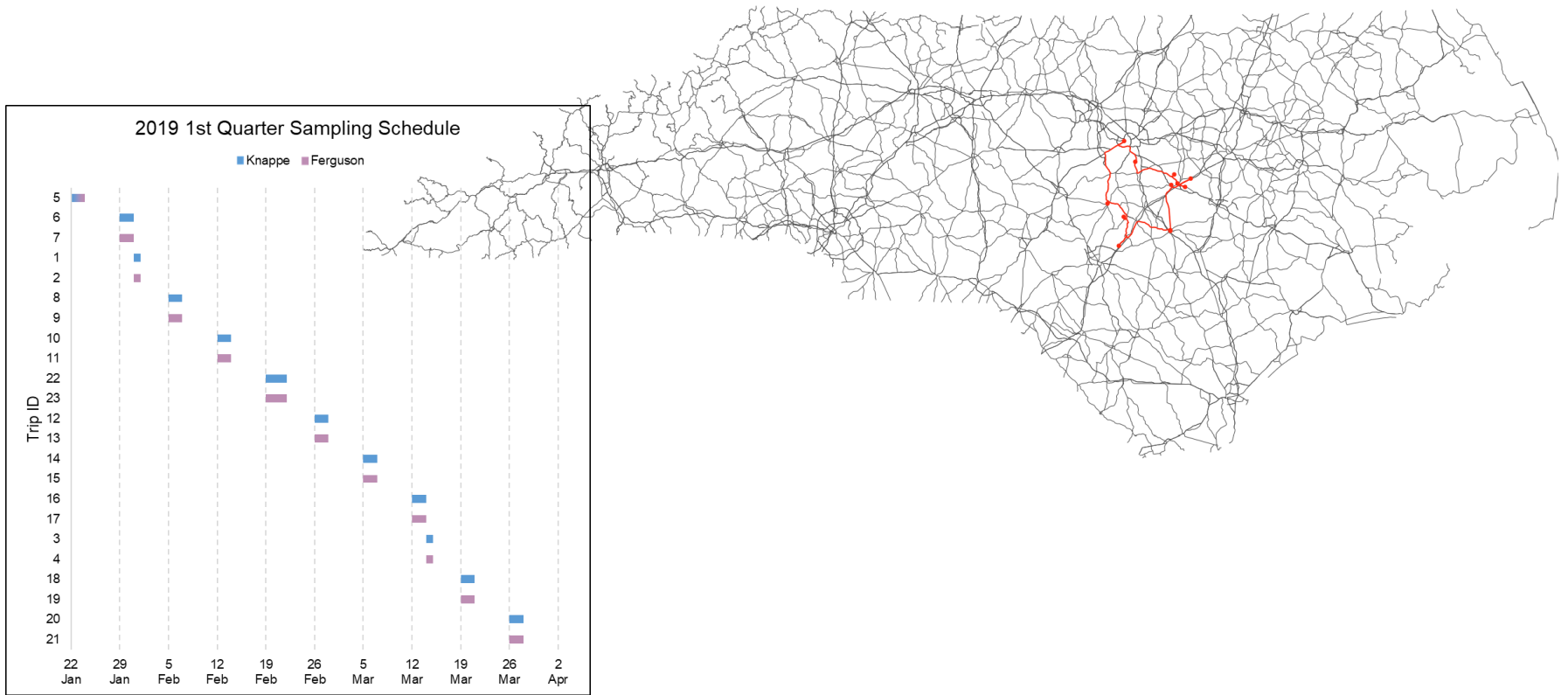


Figure 1. Surface (green circle) and groundwater (blue square) sampling sites for drinking water sources to be analyzed for PFAS compounds.

# Sampling trip design



# PFAS analysis strategy

- Sample collection:
  - Coordinated between NCSU and Duke
  - ~25-30 samples per week, organized in geographic sectors
  - Samples collected in polypropylene bottles and stored on ice during transport
- QA/QC and replication:
  - Trip blanks included with every sampling
  - Trip spikes (50 ng/L analyte addition) included with every sampling
  - Duplicate samples for 10% of sites
  - NCSU & Duke will split sample analyses evenly, with 20% samples analyzed by both labs





# PFAS target compounds (quantitative measurements) – 55 compounds

Analyte	Abbreviation	CAS #
<i>Perfluorocarboxylic Acids</i>		
Perfluorobutanoic acid	PFBA	375-22-4
Perfluoropentanoic acid	PFPeA	2706-90-3
Perfluorohexanoic acid	PFHxA	307-24-4
Perfluoroheptanoic acid	PFHpA	375-85-9
Perfluorooctanoic acid	PFOA	335-67-1
Perfluorononanoic acid	PFNA	375-95-1
Perfluorodecanoic acid	PFDA	335-76-2
Perfluoroundecanoic acid	PFUnA	2058-94-8
Perfluorododecanoic acid	PFDoDA	307-55-1
Perfluorotridecanoic acid	PFTriDA	72629-94-8
Perfluorotetradecanoic acid	PFTeDA	376-06-7
Perfluorohexadecanoic acid	PFHxDA	67905-19-5
<i>Perfluoroalkylsulfonic acids</i>		
Perfluorobutanesulfonic acid	PFBS	375-73-5
Perfluoropentanesulfonic acid	PFPeS	2706-91-4
Perfluorohexanesulfonic acid	PFHxS	355-46-4
Perfluoroheptanesulfonic acid	PFHpS	375-92-8
Perfluorooctanesulfonic acid	PFOS	1763-23-1
Perfluorononanesulfonic acid	PFNS	68259-12-1
Perfluorodecanesulfonic acid	PFDS	335-77-3
Perfluorododecanesulfonic acid	PFDoS	79780-39-5
<i>Perfluoroalkylsulfonamides</i>		
N-ethyl perfluorooctanesulfonamidoacetic acid	NEtFOSAA	2991-50-6
N-methyl perfluorooctanesulfonamidoacetic acid	NMeFOSAA	2355-31-9
Perfluorooctane sulfonamide	PFOSA	754-91-6
N-ethylperfluorooctane sulfamidoethanol	NEtFOSE	1691-99-2
N-methylperfluorooctane sulfamidoethanol	NMeFOSE	24448-09-7
N-ethylperfluorooctane sulfamide	NEtFOSA	4151-50-2
N-methylperfluorooctane sulfamide	NMeFOSA	31506-32-8

Analyte	Abbreviation	CAS #
<i>Fluorotelomer sulfonic acids</i>		
4:2 Fluorotelomer sulfonic acid	4:2 PFS	757124-22-4
6:2 Fluorotelomer sulfonic acid	6:2 PFS	27619-97-2
8:2 Fluorotelomer sulfonic acid	8:2 PFS	39108-34-4
10:2 Fluorotelomer sulfonic acid	10:2 PFS	120226-60-0
<i>Perfluoroalkyl ether carboxylic and sulfonic acids</i>		
Perfluoro-2-propoxypropanoic acid	GenX	13252-13-6
Dodecafluoro-3H-4,8-dioxanonoic acid	ADONA	958445-44-8
9-chlorohexadecafluoro-3-oxanonane-1-sulfonate	F-53B (Major)	73606-19-6
11-chloroeicosafluoro-3-oxanonane-1-sulfonate	F-53B (Minor)	83329-89-9
Perfluoro-2-methoxyacetic acid	PFMOAA	674-13-5
Perfluoro-2-methoxypropanoic acid	PMPA	13140-29-9
Perfluoro-2-ethoxypropanoic acid	PEPA	N/A
Perfluoro(3,5-dioxahexanoic) acid	PFO2HxA	39492-88-1
Perfluoro(3,5,7-trioxaoctanoic) acid	PFO3OA	39492-89-2
Perfluoro(3,5,7,9-tetraoxadecanoic) acid	PFO4DA	39492-90-5
Perfluoro(3,5,7,9,11-pentaoxadodecanoic) acid	PFO5DoDA	39492-91-6
Ethanesulfonic acid, 2-[1-[difluoro(1,2,2-trifluoroethenyl)oxy]methyl]-1,2,2,2-tetrafluoroethoxy]-1,1,2,2-tetrafluoro-	Nafion by-product 1	29311-67-9
Ethanesulfonic acid, 2-[1-[difluoro(1,2,2,2-tetrafluoroethoxy)methyl]-1,2,2,2-tetrafluoroethoxy]-1,1,2,2-tetrafluoro-	Nafion by-product 2	749836-20-2
2,2,3,3,4,4,5,5,5,5-tetrafluoro-2-sulfoethoxy)pentanoic acid	Nafion by-product 4	N/A
Propanoic acid, 3-[1-[difluoro(1,2,2,2-tetrafluoroethoxy)methyl]-1,2,2,2-tetrafluoroethoxy]-2,2,3,3-tetrafluoro-	Hydro-EVE acid	773804-62-9
1,1,2,2-tetrafluoro-2-(1,2,2,2-tetrafluoroethoxy)ethane sulfonic acid	NVHOS	N/A

# “Semi-Targeted” high-resolution MS screening for PFAS

- “Master List” of > 5,000 PFAS compounds
- Data will be non-quantitative (relative abundances among water samples)
- Potential to discover novel PFAS contaminants

The screenshot shows the EPA's PFAS Master List of PFAS Substances webpage. The browser address bar displays the URL: [https://comptox.epa.gov/dashboard/chemical\\_lists/pfasmaster](https://comptox.epa.gov/dashboard/chemical_lists/pfasmaster). The page title is "PFAS Master List of PFAS Substances". Below the title is a search bar labeled "Search PFASMASTER Chemicals" with a search icon. A "Substring search" checkbox is located below the search bar. The "List Details" section provides a description of the master list and lists several source lists with their respective URLs:

- [https://comptox.epa.gov/dashboard/chemical\\_lists/EPAPPFASRL](https://comptox.epa.gov/dashboard/chemical_lists/EPAPPFASRL) is an EPA research list of PFAS compiled from various internal, literature and public sources.
- [https://comptox.epa.gov/dashboard/chemical\\_lists/EPAPPFASINW](https://comptox.epa.gov/dashboard/chemical_lists/EPAPPFASINW) is a complete list of DMSO-solubilized PFAS in EPA's ToxCast inventory.
- [https://comptox.epa.gov/dashboard/chemical\\_lists/EPAPPFAS7S1](https://comptox.epa.gov/dashboard/chemical_lists/EPAPPFAS7S1) list is a prioritized subset of this larger chemical inventory.
- [https://comptox.epa.gov/dashboard/chemical\\_lists/EPAPPFASINSOL](https://comptox.epa.gov/dashboard/chemical_lists/EPAPPFASINSOL) is a list of chemicals procured, but found to be insoluble in DMSO above 5mM.
- [https://comptox.epa.gov/dashboard/chemical\\_lists/PFASOECD](https://comptox.epa.gov/dashboard/chemical_lists/PFASOECD) is a list of PFAS chemicals in the OECD New Comprehensive Global Database.
- [https://comptox.epa.gov/dashboard/chemical\\_lists/PFASKEMI](https://comptox.epa.gov/dashboard/chemical_lists/PFASKEMI) is a list of PFAS chemicals from a KEMI Swedish Chemicals Agency Report (provided by Stellan Fischer).
- [https://comptox.epa.gov/dashboard/chemical\\_lists/PFASTRIER](https://comptox.epa.gov/dashboard/chemical_lists/PFASTRIER) is a list of PFAS compiled by a community effort in 2015.
- [https://comptox.epa.gov/dashboard/chemical\\_lists/EPAPPFASCAT](https://comptox.epa.gov/dashboard/chemical_lists/EPAPPFASCAT) is a list of structure-based Markush PFAS categories (capabilities under development).

The number of chemicals is 5177. The interface includes a "Download / Send" button, a "Sort by" dropdown menu set to "DTXSID", and a "Filter by" dropdown menu set to "Name or CASRN". The "Show info" section is expanded to show "DTXSID", "CASRN", and "TOXCAST" columns, with a "Select all" button and a "Hide" button.

# Data analysis and dissemination

- Data validation/curation
  - Assessment of compound ID confidence (custom non-targeted analysis routines)
  - Cross-validation of suspect screening and quantitative measurements
  - Assessment of PFAS mass balance in samples
- Data analysis and communication
  - PFAST Team 6: Communications – will assess compound identifications and concentrations against known or suspected toxicants for risk assessment based on predicted exposure and hazard
  - PFAST Team 3: Removal Performance Testing – will be provided compound ID lists for testing
  - Data summaries included in reports to GA, stakeholders
  - Curated and georeferenced data will be uploaded regularly to PFAST communications website.



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