# Penn State PFAS in Agroecosystems Research & Extension Network

**Heather Preisendanz**

Professor, Department of Agricultural & Biological Engineering

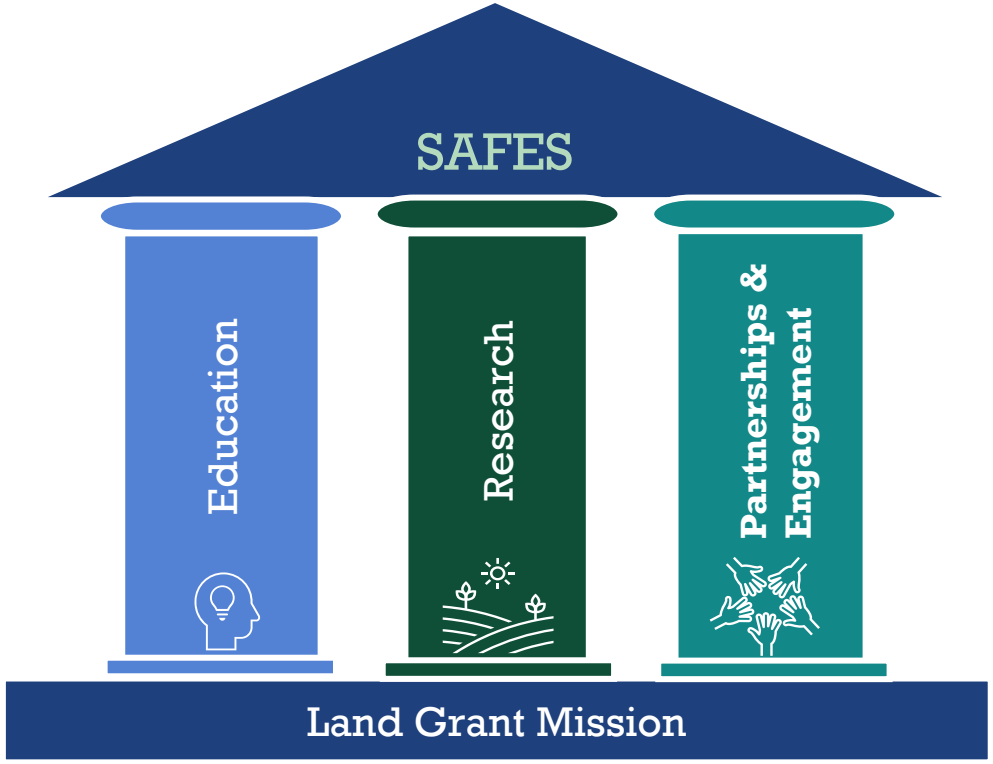
Director, Institute for Sustainable Agricultural, Food, and Environmental Science (SAFES)

PennState College of Agricultural Sciences

SAFES
Institute for Sustainable Agricultural, Food, and Environmental Science
agsci.psu.edu/safes

- Conceptualized in Fall 2019
- Established in May 2020
  - Founding Director: Dr. Karen Fisher Vanden (2020-2023)
  - Current Director: Dr. Heather Preisendanz (March 2024 – Present)

- Unique Approach:
  - SAFES is based on a science-to-practice model where a transdisciplinary network of investigators, students, and stakeholders engage in an iterative co-production of knowledge – "shared discovery."
  - The **only** Institute at Penn State that contains and integrates across all three components of the Land Grant Mission



# Critical Issue Initiatives (CIIs)

PennState College of Agricultural Sciences

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Agricultural Sustainability in Urbanized Landscapes

Managing Earth's Critical Zone

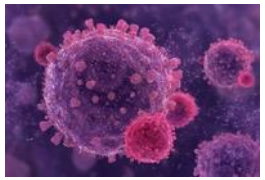
Bioeconomy Solutions

Precision Biodiversity

Stakeholder Engagement Science and Practice

Transformative Water Quality Strategies

Contaminants of Emerging Concern



Vector-Borne Disease

Food Choice and Health

# PFAS in Agroecosystems Research & Extension Network: People

**Daniela Carrijo, Ph.D.**
Assistant Professor & Extension Specialist

Department of Plant Science

**Enrique Gomez, Ph.D.**
Professor of Chemical Engineering and Materials Science and Engineering

Interim Associate Dean for Equity and Inclusion for the College of Engineering

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Professor and H. Thomas and Dorothy Willits Hallowell Chair in Agricultural Sciences

Department of Veterinary and Biomedical Sciences

**Cheryl Thompson, Ph.D.**
Professor at Penn State College of Medicine

Associate Director, Population Science, Cancer Institute
Associate Director, Social Sciences Research Institute

**Alyssa Collins, Ph.D.**
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Distinguished Professor of Molecular Toxicology & Carcinogenesis

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Deputy Director, Cancer Institute

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**Patrick Drohan, Ph.D.**
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Department of Ecosystem Science & Management

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Managing Director, Energy and Environmental Sustainability Laboratories

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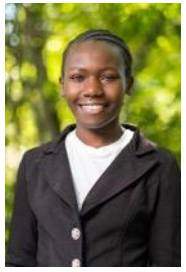
Director, SAFES Institute

**Juliana Vasco-Correa, Ph.D.**
Assistant Professor of Agricultural and Biological Engineering

Department of Agricultural and Biological Engineering



**Faith Kibuye, Ph.D.**
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Department of Ecosystem Science & Management

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Assistant Research Professor

Environmental Contaminants Analytical Laboratory

**Jon Sweetman, Ph.D.**
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Department of Ecosystem Science and Management

**Stephanie Velegol, Ph.D.**
Associate Department Head and Teaching Professor

Department of Chemical Engineering

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## PFAS Fate & Transport in Agroecosystems

*Evaluating PFAS Occurrence and Fate in Rural Water Supplies and Agricultural Operations to Inform Management Practices.*
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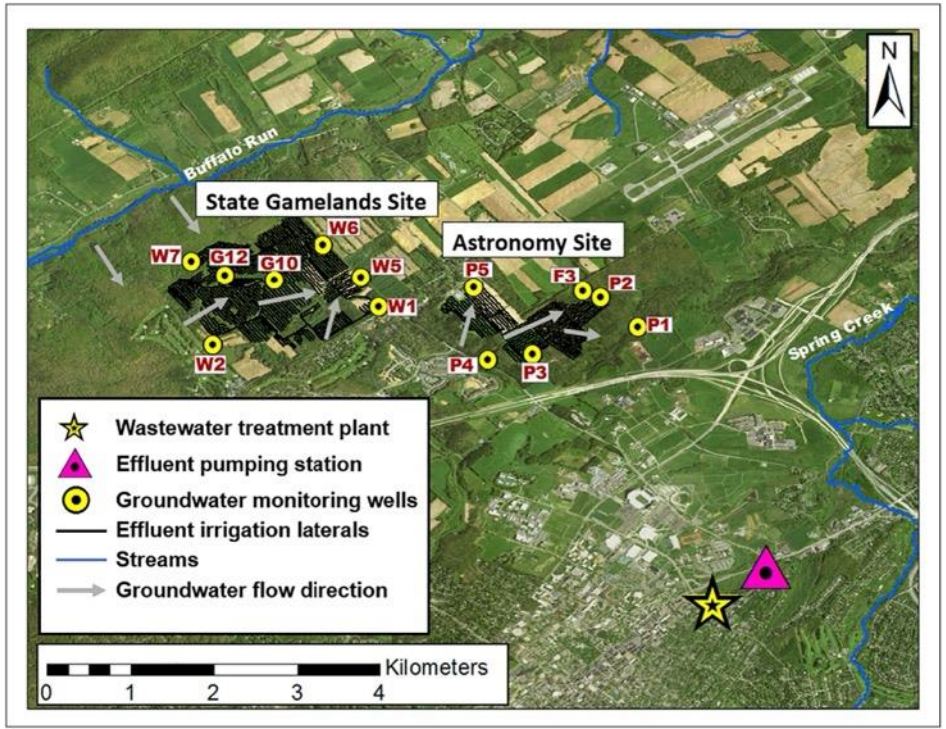
# Penn State's "Living Filter": Beneficial Reuse Site


- Living Filter Area:
  - ~240 ha of forested & agricultural fields split across two sites (State Game Lands Site & Astronomy Site)
  - More than 175 laterals and 3000 spray heads
- 40+ Year Irrigation History:
  - Full-scale irrigation since the 1980s
  - Irrigation occurs daily (12 hour period)
  - Permitted irrigation rate of ~ 5 cm/ha/week
- Site Characteristics:
  - Soils are deep (> 30 m)
  - Predominantly Hagerstown silt loam
- Permit:
  - Operating permit from the PA DEP
  - Maintain groundwater concentrations less than 10 mg-N/L (nitrate drinking water standard)
  - No off-site generation of surface runoff
- Monitoring:
  - 13 groundwater monitoring wells
  - Sampled quarterly for nitrate since the 1980s
  - Pharmaceuticals monitored from 2016-2017
  - PFAS monitored from 2019-2023



# PFAS at the Penn State Living Filter Site


PFAS Sources

Penn State Living Filter Wastewater Beneficial Reuse Site

Livestock & Human Health Implications

Wastewater Influent

Wastewater Effluent

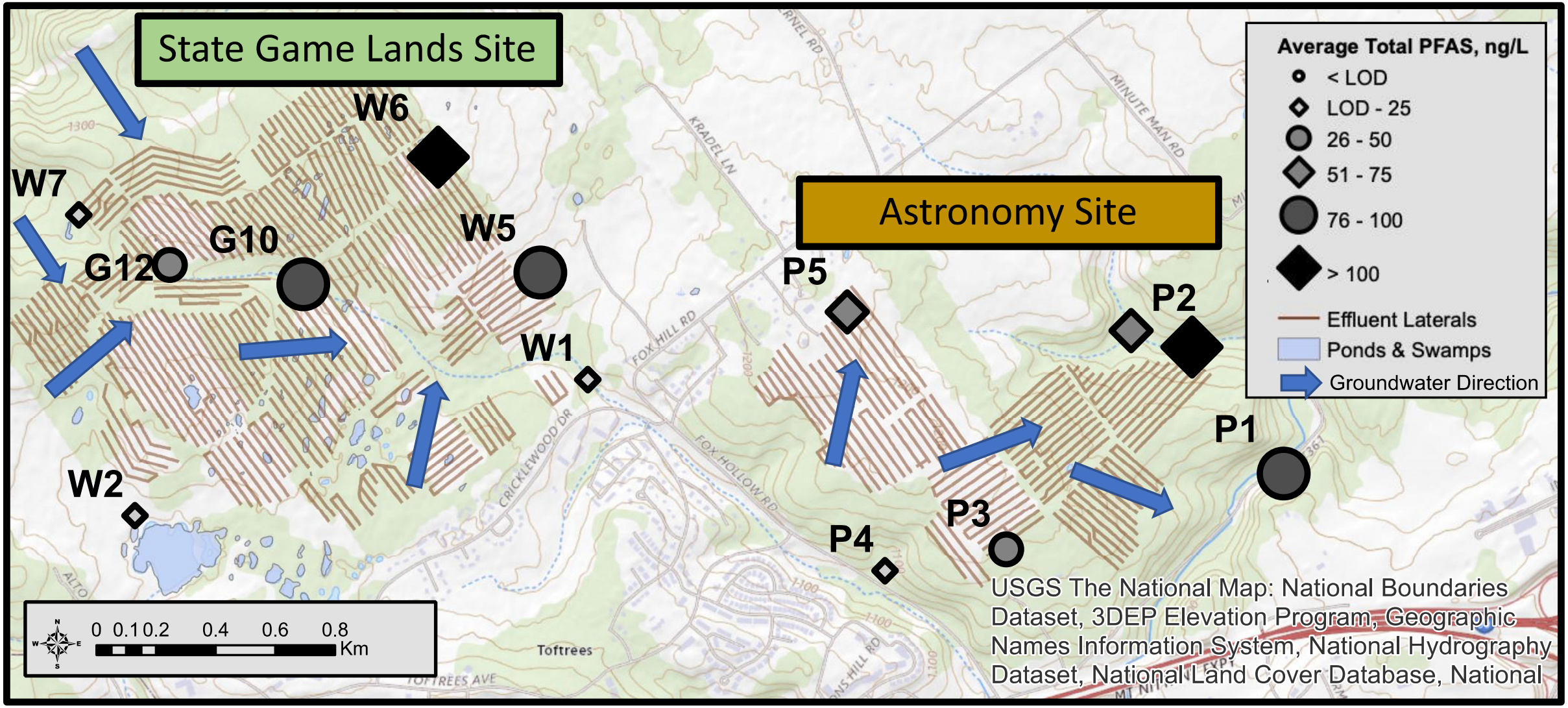
Groundwater

Crop Tissue

Livestock Feed

Drinking Water Standards

# Spatial Patterns at the Living Filter (2019-2023)


**Publication:** Mroczko et al., 2022. Journal of Environmental Quality. DOI: 10.1002/jeq2.20408

# Fate, Transport, and Mitigation at Biosolids-Amended Fields

**Research Question:** How effective are best management practices that are implemented to reach nutrient and sediment reduction goals at mitigating PFAS from biosolids-amended fields?

**Project Partner Facility:** Carlisle Wastewater Treatment Plant

**Partner Farms:** 3 farms that receive biosolids 1-3 times per year and have a riparian buffer on their property

NRCS

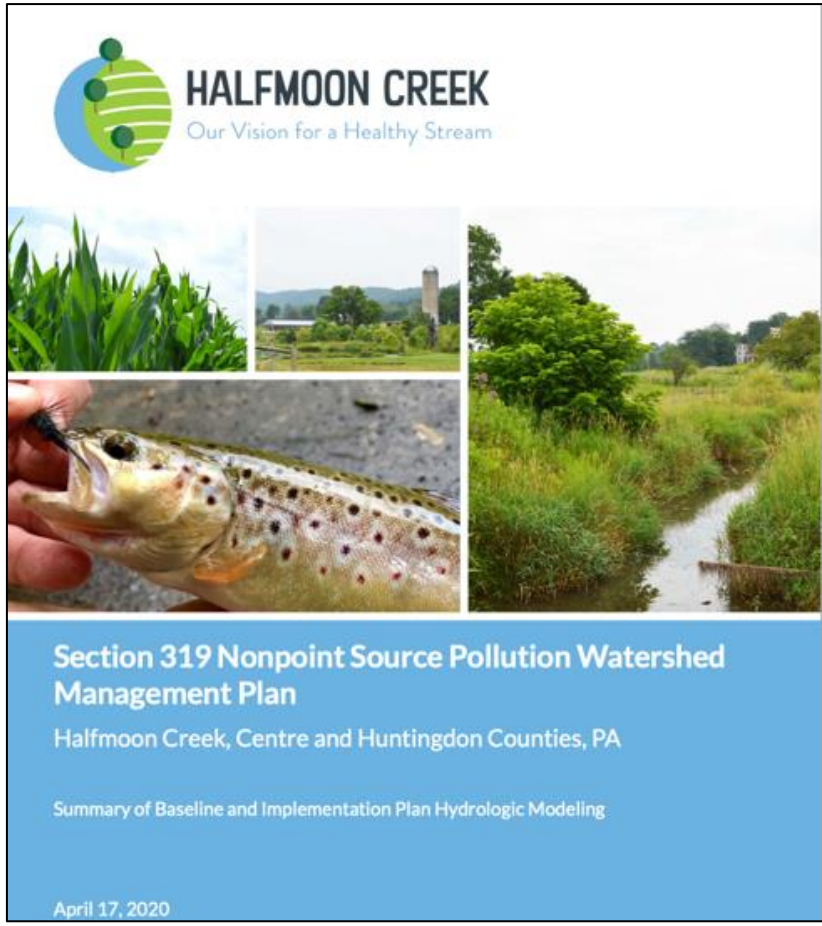
# Fate and Transport in a Headwater Catchment: Halfmoon Creek

**Why Halfmoon Creek watershed?**

- Impaired for sediment from agricultural land use
- High-quality, cold-water fishery; renowned for flyfishing.
- In Tier 2 ( & small portion of Tier 3) of the PA portion of the Chesapeake Bay Watershed Implementation Plan for reducing nutrient & sediment loads.
- Approved watershed management plan & $1M to implement new conservation practices.
- History of partnerships in the watershed since 2015

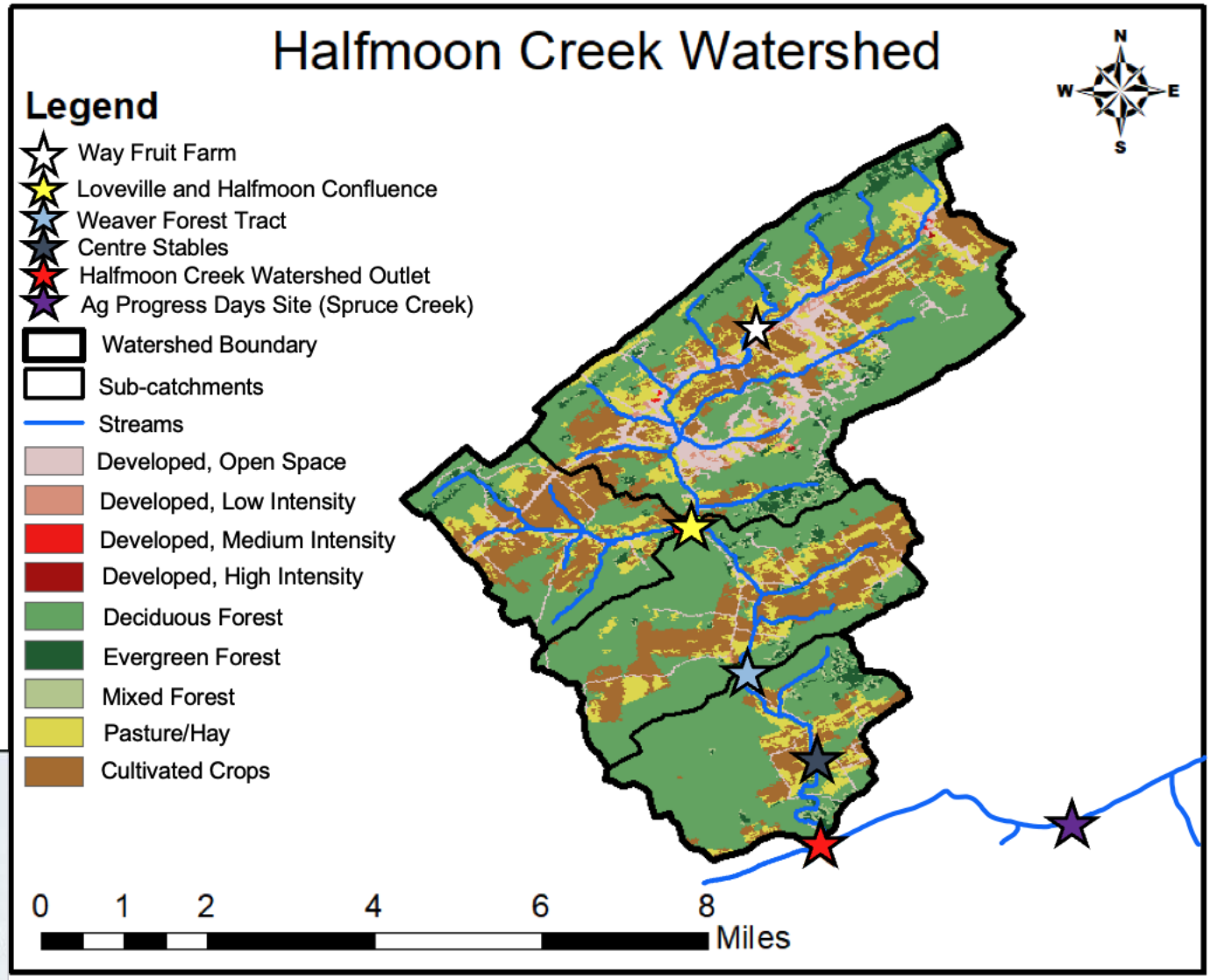
| Tier 1 – First 25% of Reductions | Tier 2 - Second 25% of Reductions | Tier 3 - Third 25% of Reductions | | Tier 4 - Last 25% of Reductions | |
|---|---|---|---|---|---|
| Lancaster | Franklin | Adams | Schuylkill | Union | Potter |
| York | Lebanon | Northumberland | Bradford | Chester | Somerset |
| | Cumberland | Perry | Juniata | Dauphin | Wyoming |
| | Centre | Snyder | Clinton | Berks | Elk |
| | Bedford | Huntingdon | Tioga | Blair | Indiana |
| | | Columbia | Susquehanna | Lackawanna | Cameron |
| | | Mifflin | Clearfield | Luzerne | Wayne |
| | | Lycoming | Fulton | Montour | McKean |
| | | | | Cambria | Jefferson |
| | | | | Sullivan | Carbon |

Source: PA DEP, 2019

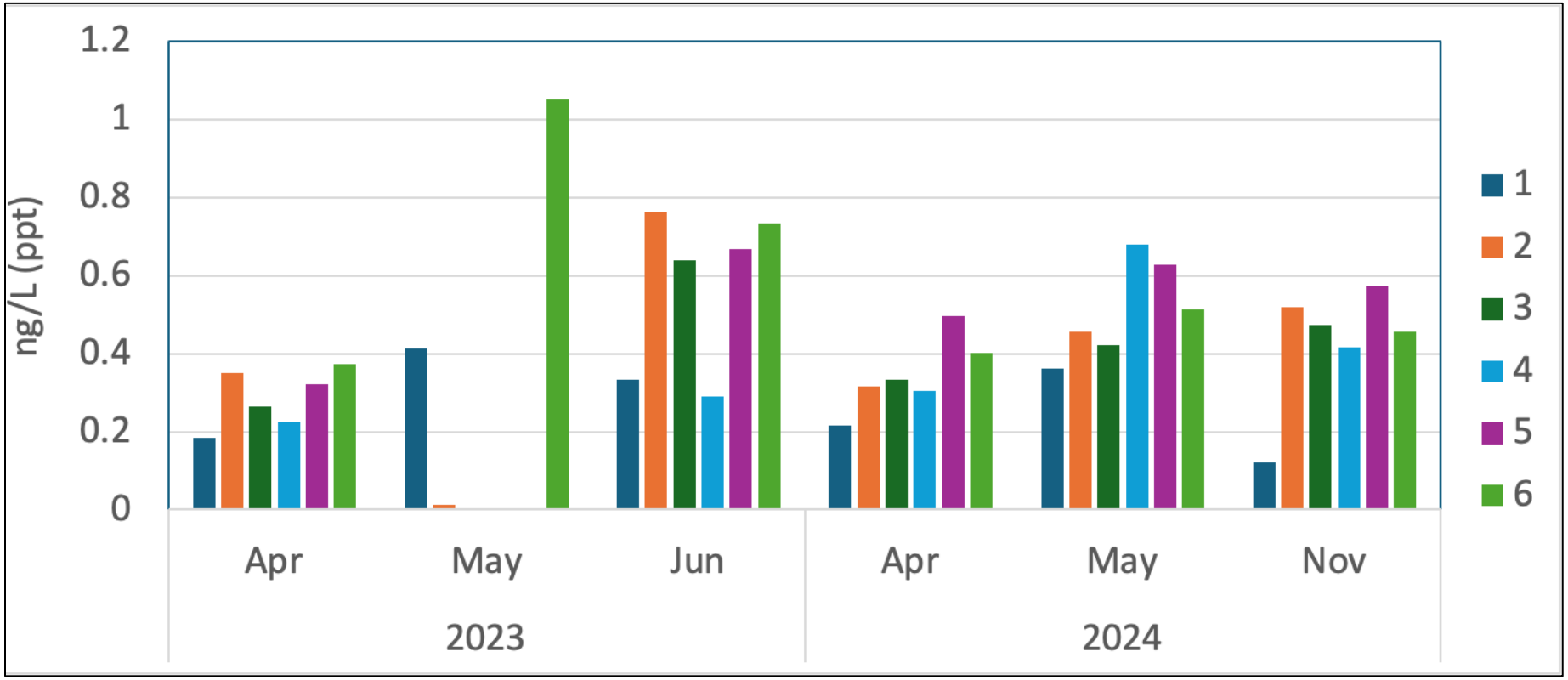


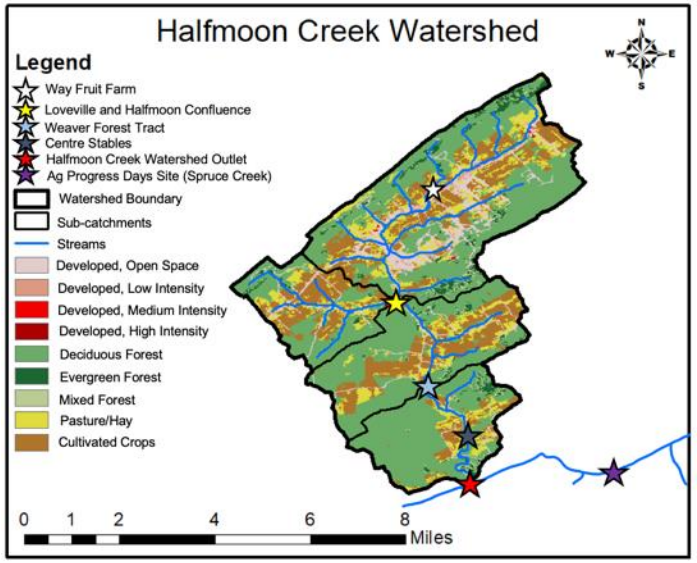
# Water Quality Monitoring in Halfmoon Creek Watershed

- **Six monitoring sites:**
  - Continuous hydrology monitoring
  - Continuous DO and temperature
  - Samples collected every two weeks (since 2021)
- **Grab samples**
  - Sediments
  - Nutrients
  - PFAS *(since 2023)*
  - Pesticides
  - PPCPs
- **Passive Samples**
  (Polar organic chemical integrative samplers)
  - PFAS
  - Pesticides
  - PPCPs



# PFOA Occurrence in Halfmoon Creek Watershed

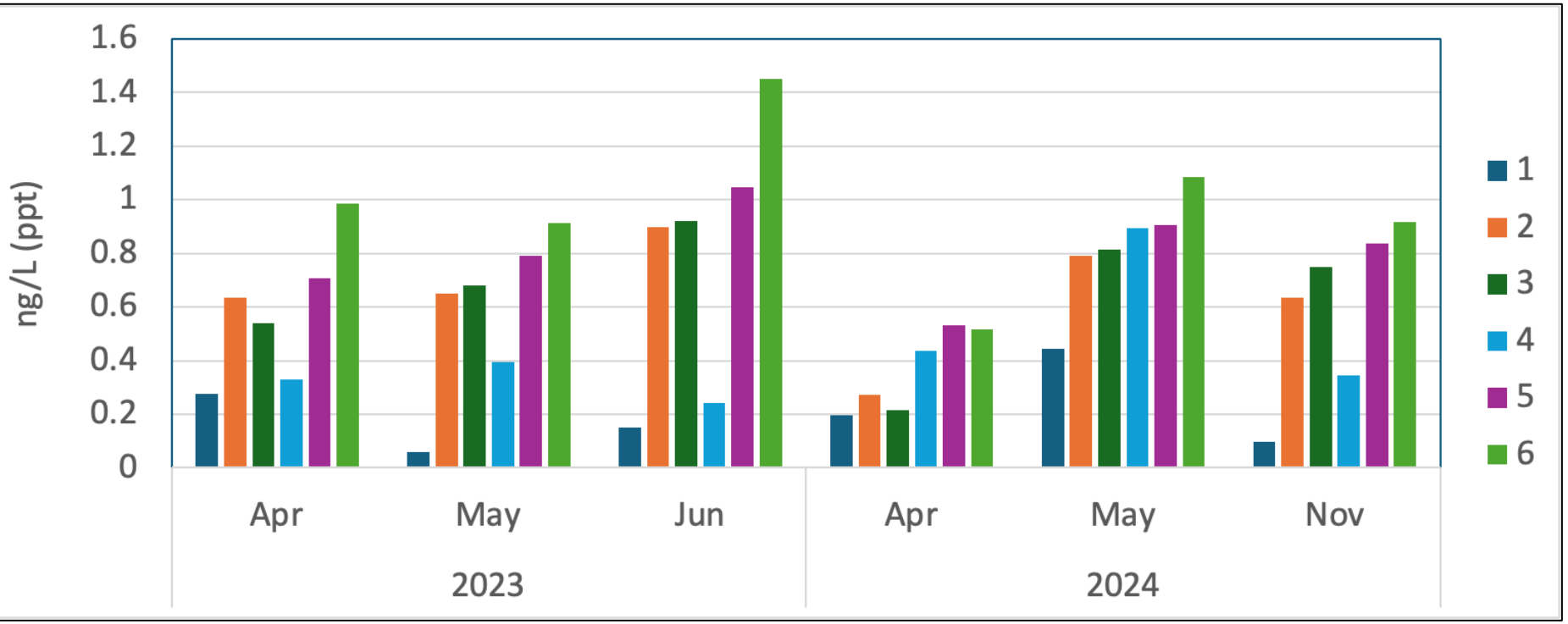


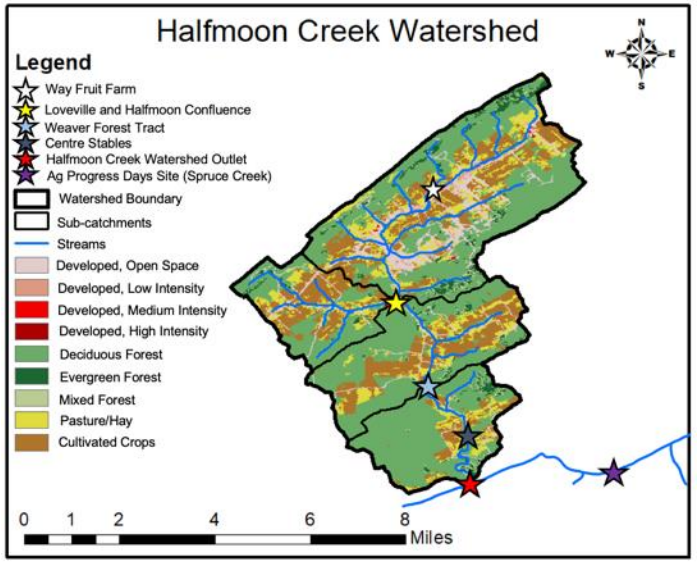




monthly average (grab samples)

Unpublished results. Veith, T. 2024, USDA-ARS.

# PFOS Occurrence in Halfmoon Creek Watershed

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# PFAS Occurrence in Private Wells

- **Assess PFAS occurrence in private groundwater wells across PA**

**Motivation:**

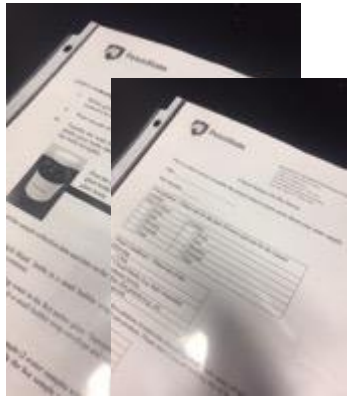
- More than 1 million private wells across Pennsylvania, serving as a drinking water source to ~3.5 million people
- PA does not have statewide construction standards for private wells
- The majority of private wells in PA fail to meet at least one primary or secondary drinking water standards
- Rural homeowners are more vulnerable to lower quality drinking water than people on public water supplies

**Goal:** Assess the occurrence of PFAS in private groundwater wells to help residents understand their risk to elevated PFAS exposure from their drinking water.

**Objectives:**

- Conduct a community-science based study to quantify PFAS levels in private wells used as a potable water supply;
- Investigate potential links between PFAS levels and proximity to potential sources (initial focus: biosolids application sites);
- Assess potential relationships between PFAS levels and well physical data (age, depth).

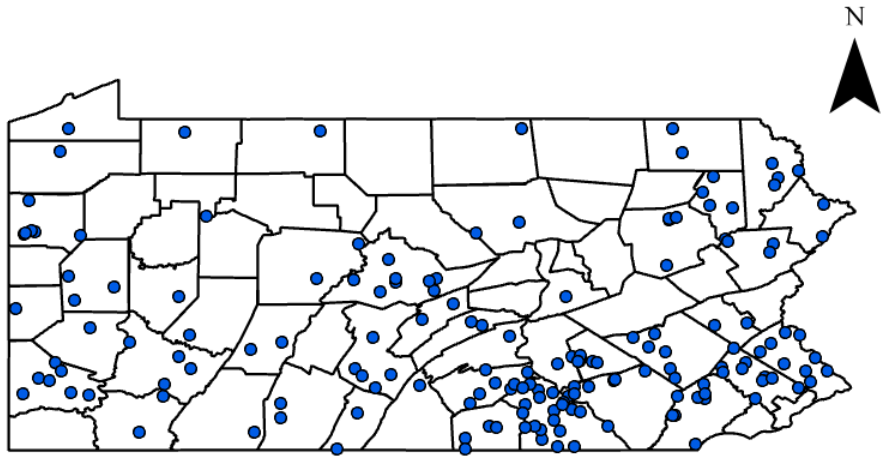
# Community Science – Sampling Kits

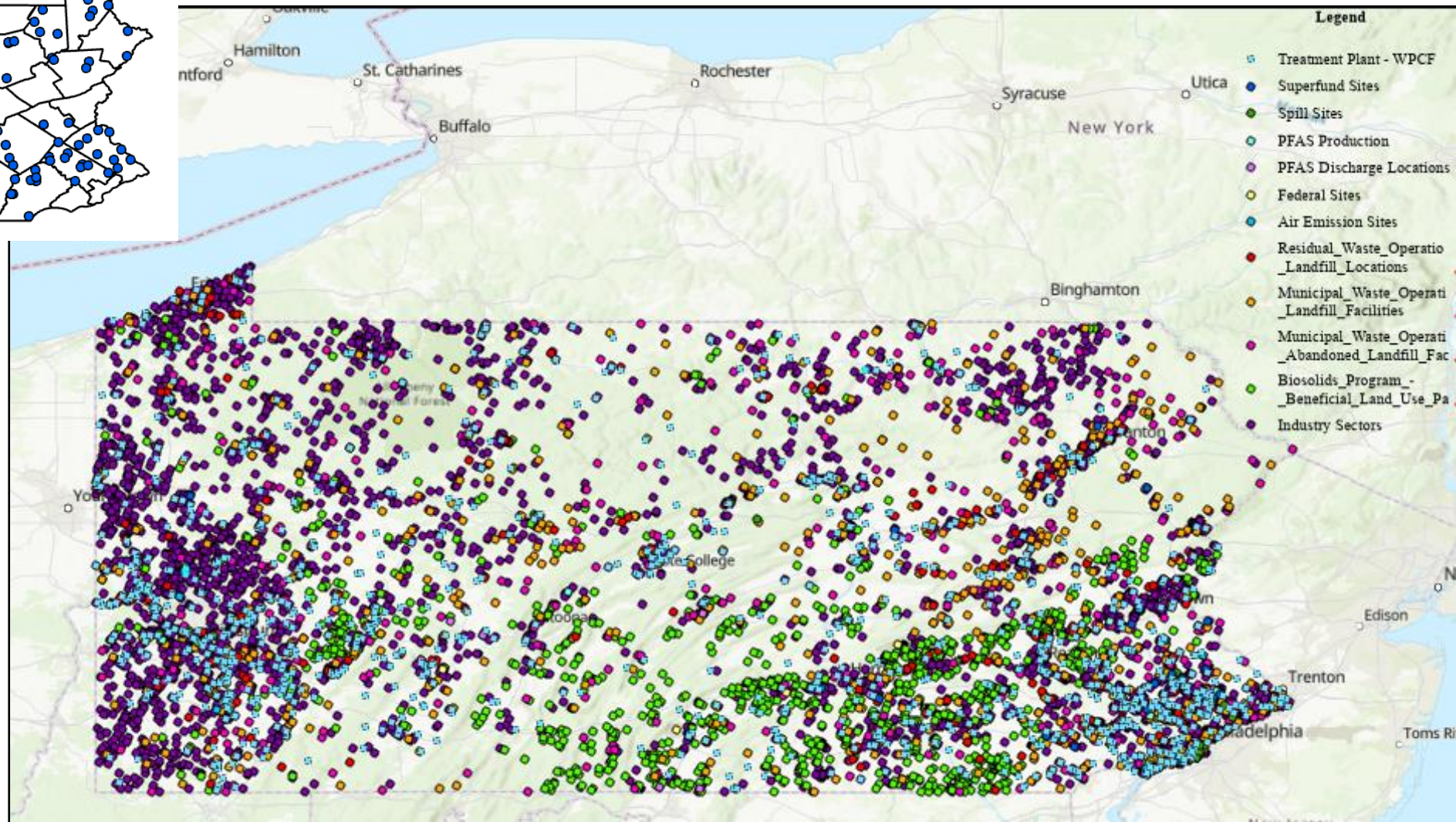




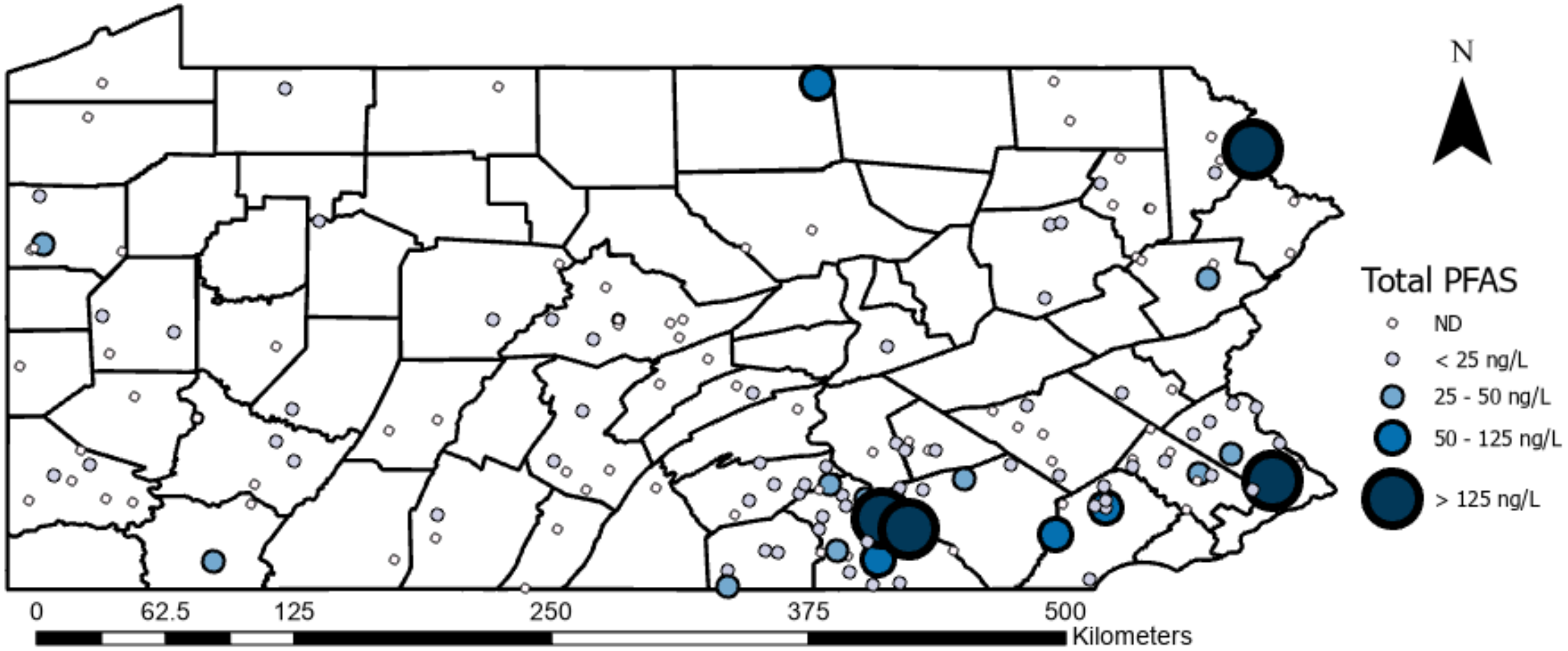
- Sample collection procedure
- Sample submission form
- 2 pairs of latex gloves
- 2 reusable ice packs
- 1 plastic bottle filled with water labeled ‘Field blank water’ in a bubble wrap bag
- 2 empty plastic bottles wrapped in bubble wrap
  - 1 plastic bottle labeled ‘Well/Spring Water Sample’
  - 1 plastic bottle labeled ‘Field Blank Sample’
- A prepaid UPS shipping label for overnight shipping
- Foam cooler
- Cardboard shipping box

# Map of Participant Locations (n = 185) and PFAS Sources



# Summary of PFAS Data: Total PFAS*



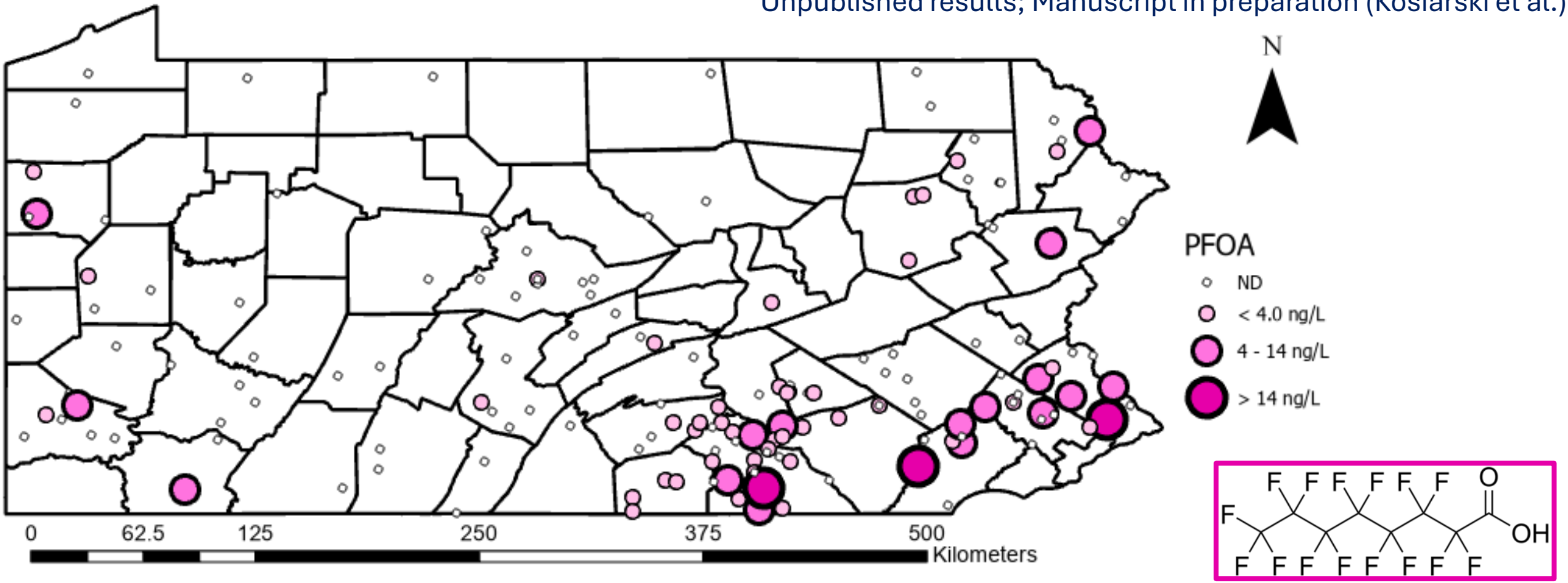

*Analyzed using EPA method 537.1: 20 PFAS compounds

| % Detected | 56% |
|---|---|
| Maximum | 224.3 ng/L |

Unpublished results; Manuscript in preparation (Kosiarski et al.)

# Summary of PFOA Data: Perfluorooctanoic acid

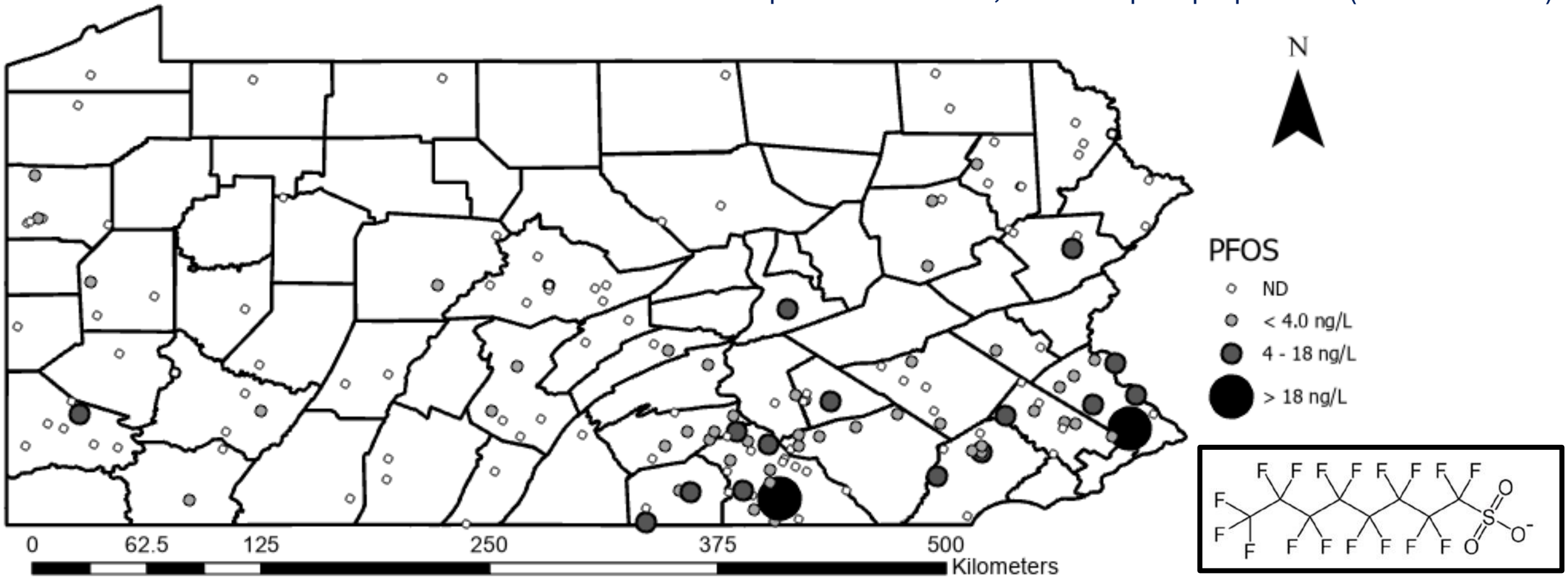
Unpublished results; Manuscript in preparation (Kosiarski et al.)




| PFOA Detected (> 0.4 ng/L) | Maximum Concentration | Above PA DEP MCL (14 ng/L) | Above EPA MCL (4 ng/L) |
|---|---|---|---|
| 39% | 34 ng/L | 2.2% | 12.5% |

# Summary of PFOS Data: Perfluorooctane sulfonic acid

Unpublished results; Manuscript in preparation (Kosiarski et al.)




| PFOS Detected (> 0.4 ng/L) | Maximum Concentration | Above PA DEP MCL (18 ng/L) | Above EPA MCL (4 ng/L) |
|---|---|---|---|
| 39% | 62 ng/L | 1.6% | 10% |

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# Understanding occurrence of PFAS in wastewater-irrigated crops


**Research Question:** What is the relative contribution of PFAS in forage crops (corn and orchardgrass) from foliar sorption from wastewater irrigation vs. root uptake?

**TABLE 1** Description of treatments for corn and orchard grass in the greenhouse study. Treatments were designed to assess the contribution of foliar sorption and root uptake to per- and polyfluoroalkyl substances (PFAS) occurrence in the crop at the time of harvest.

| Treatment name | Treatment description | Uptake pathway(s) assessed |
|---|---|---|
| C: Control | Crops grown in control soil and watered with tap water | None |
| F: Foliar spray | Crops grown in control soil, watered with tap water, and irrigated with treated wastewater sprayed on foliage | Foliar sorption |
| S: Living Filter soil | Crops grown in Living Filter soil and watered with tap water | Root uptake from soil |
| S + F: Living Filter soil + foliar spray | Crops grown in Living Filter soil, watered with treated wastewater, and irrigated with treated wastewater sprayed on foliage | Foliar sorption and root uptake from soil |

Major Findings:

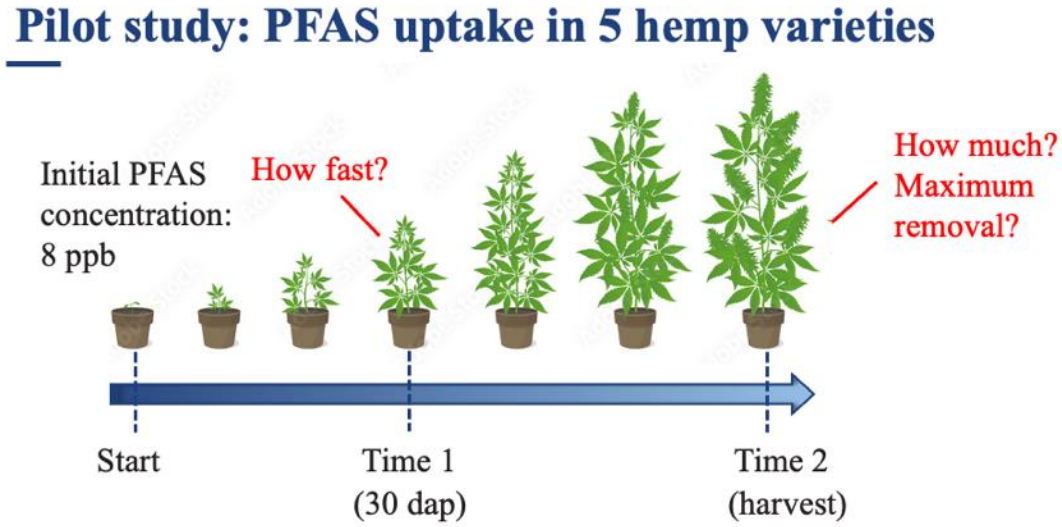
- Grass uptake > corn uptake;
- Foliar sorption is an unlikely contributor to PFAS concentrations in corn and grass;
- Root uptake by grass was primarily short-chain compounds (although, they are more likely to transfer to milk products)

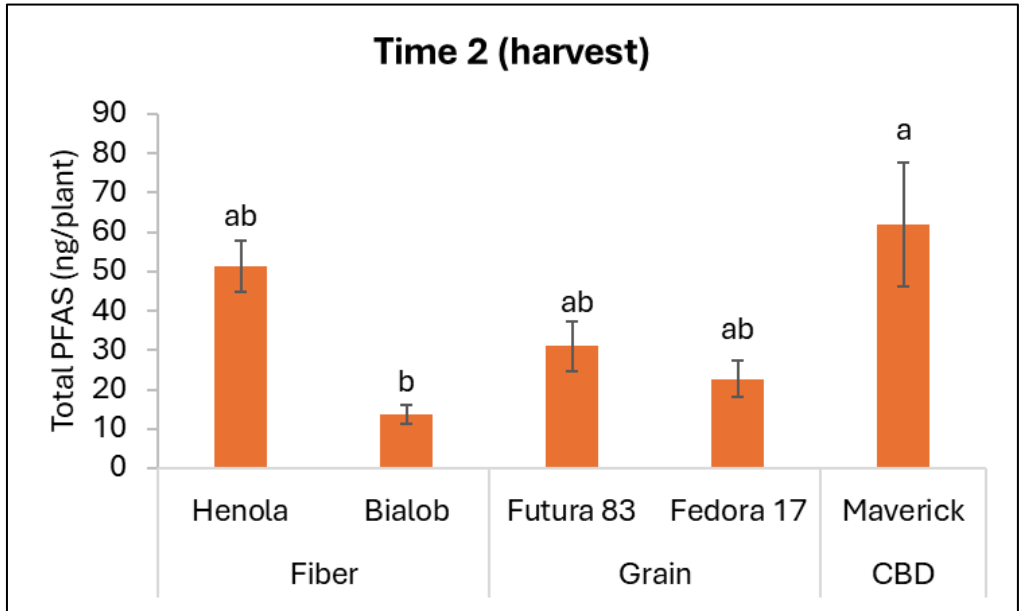
**Publication:** Kosiarski et al., 2024. Journal of Environmental Quality. DOI: 10.1002/jeq2.20630

# Can hemp help remove PFAS from soils?

**Preliminary findings from seed grant:**

- Hemp PFAS uptake differs across varieties.
- Variety effect does not seem to be solely driven by growing period.
- Hemp was not a good accumulator of the 5 PFAS chemicals currently regulated in drinking water.
- Uptake was < 1% of the PFAS in the soil (from the Living Filter site)
- Hemp does show potential to be a good accumulator of PFPeA and PFBA
- Results suggest that hemp can likely be grown safely in biosolids-amended fields, given the low uptake.




Unpublished results. Carrijo, D. 2024, College of Ag Sciences, Penn State

# Acknowledgements


- **Graduate Student:**
  - Kelly Kosiarski

- **Collaborators:**
  - Jenn Fetter
  - Daniela Carrijo
  - Susan Boser
  - Faith Kibuye
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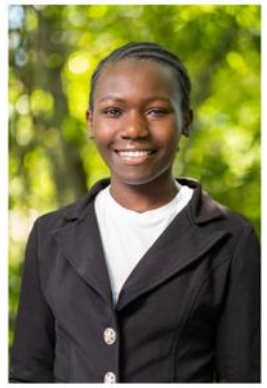
  - Kurt Pennell (Brown)
  - Tamie Veith (USDA-ARS)

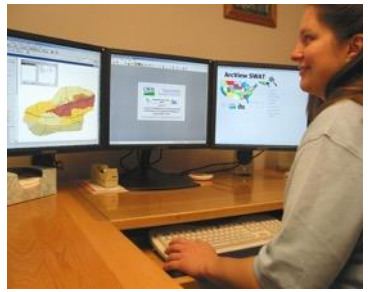













- **Funding**:
  - United States Environmental Protection Agency, Grant #R84008201
  - USDA-NIFA Project PEN04870 and Accession number 7005711
  - USDA-NIFA Project PEN04726 and Accession number 7000254
  - Penn State Cancer Institute
  - Penn State College of Agricultural Sciences


EPA United States Environmental Protection Agency

USDA NIFA

# Thank you!

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https://agsci.psu.edu/safes/research/initiatives-projects/pfas-in-agroecosystems-research-and-extension-network

**Email:** hpreisen@psu.edu