

Enabling State Adoption of Non-Targeted Analysis (NTA) to Address Pressing Public Health Needs: Maryland, Minnesota, and California Leading the Way

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ORD

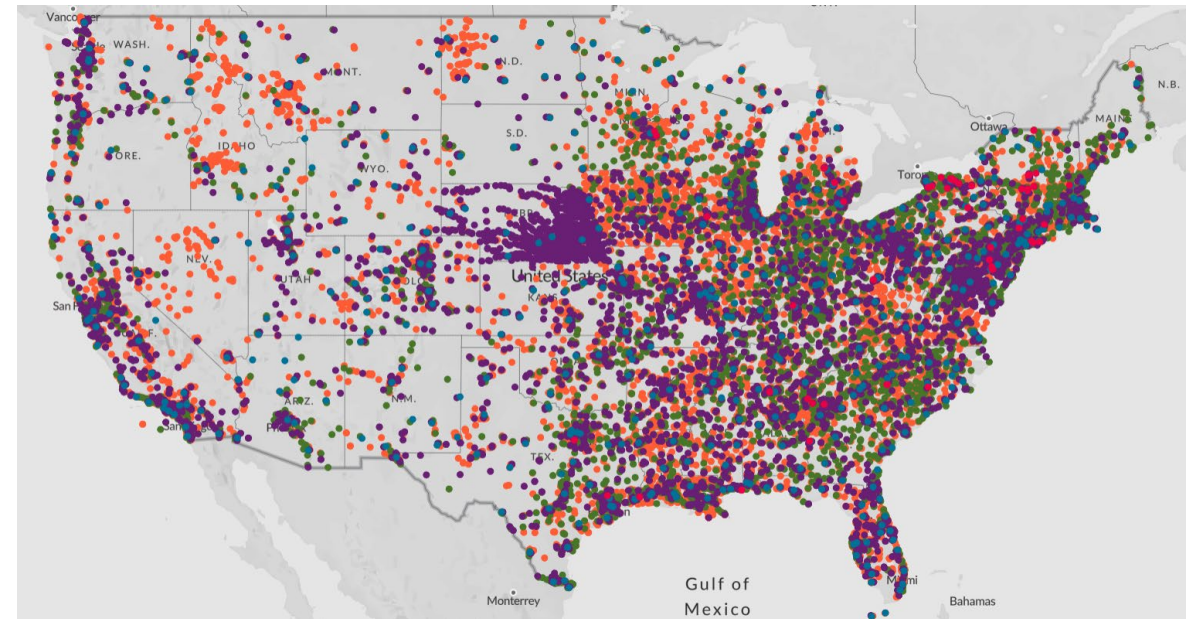
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Rationale: Scientific

- PFAS environmental contamination impacting every state in the U.S.
 - PFOS associated mortality >6M deaths 1999 -2018 (Wen et al. 2023)
 - >200 M U.S. residents have PFOS/PFOA in drinking water > 1 ng/L (Andrews and Naidenko, 2020)
- Number of PFAS in commerce vastly greater than monitoring capability
 - 1400 PFAS across 200 use categories (Kluge et al. 2020)
 - Thousands PFAS exist (n=12,034 CompTox Chemical Dashboard (<https://comptox.epa.gov/dashboard/chemical-lists/PFASMASTER>))
 - Targeted methods n~40
- **Need exposure tools that keep pace with chemicals in commerce and that are dynamic with manufacturing, use, and behavior** (Vandenberg et al. 2023)

**Sites known or suspected of making, using or releasing PFAS
(n=41,828)**

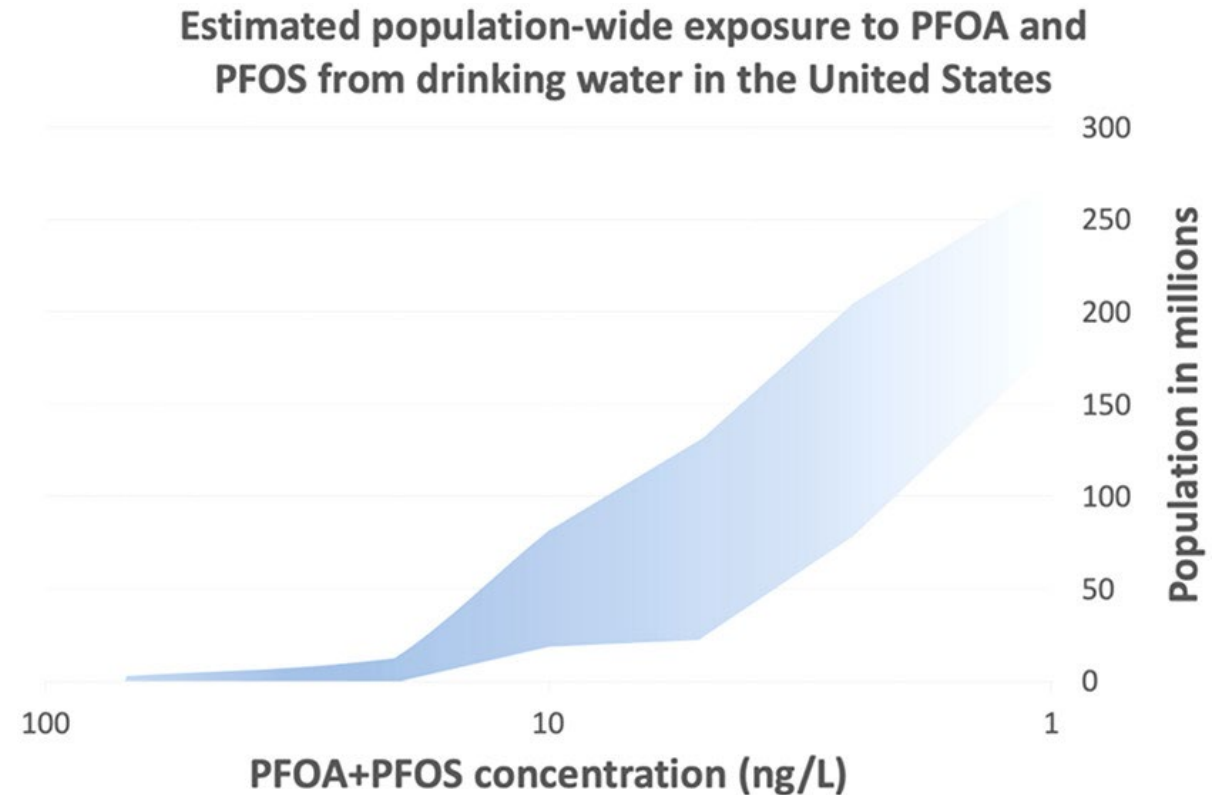


Different colored points represent PFAS known users; suspected users; airports previously required to use AFFF; landfills and waste disposal facilities; and sewage and waste treatment plants.

Source: https://www.ewg.org/interactive-maps/2021_suspected_industrial_discharges_of_pfas/map/

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Source: Andrews and Naidenko, ES&T2020

NEWS

Minnesota, 3M reach settlement ending \$5 billion lawsuit

By **BOB SHAW** | Pioneer Press

PUBLISHED: February 20, 2018 at 3:41 p.m. | UPDATED: February 20, 2018 at 10:58 p.m.

Minnesota Reformer

Outspoken PFAS critic Amara Strande dies from cancer

‘We are not OK,’ former Tartan High School student says of Amara Strande’s death

By: [Deena Winter](#) - May 3, 2023 6:01 am

Maryland investigating ‘forever chemicals’ near industrial plant in Cecil County https://www.bayjournal.com/news/pollution/maryland-investigating-forever-chemicals-near-industrial-plant-in-cecil-county/article_f0c3195c-1ce7-11ee-937d-6b7e9ab39a5d.html

Timothy B. Wheeler

Jul 19, 2023



Norma Calabro of Elkton, MD, learned that her residential well, located in this springhouse, is contaminated with PFAS or “forever chemicals.”



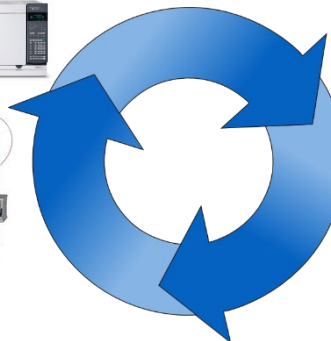
CLIMATE & ENVIRONMENT
Los Angeles Times

‘This is taking too long’: California community awaits cleanup of PFAS-contaminated wells

NTA is a Transformative Environmental Health Technological Advance

NTA is a measurement technique that relies on high-resolution mass spectrometry and a set of data resources and workflows that are capable of characterizing a **large chemical space** of complex samples identifying **unknown and understudied chemicals** without prior knowledge of chemical content of the sample.

Analytical Instruments



Computational Tools / Workflows



Chemical Database



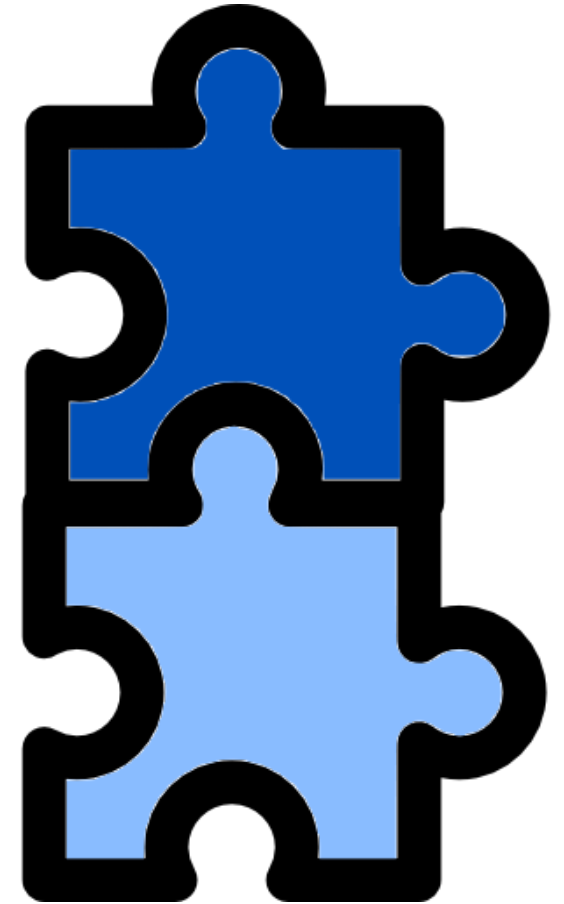
NTA: Right Place/Right Time

Advances in measurement technology

- > Detection of emerging PFAS using HRMS platforms to perform NTA, including PFAS not measured in targeted analysis techniques

Heightened awareness of public health threats

- > State concerns over public health threats from PFAS contamination in water resources



Technology Adoption Curve

Research applications

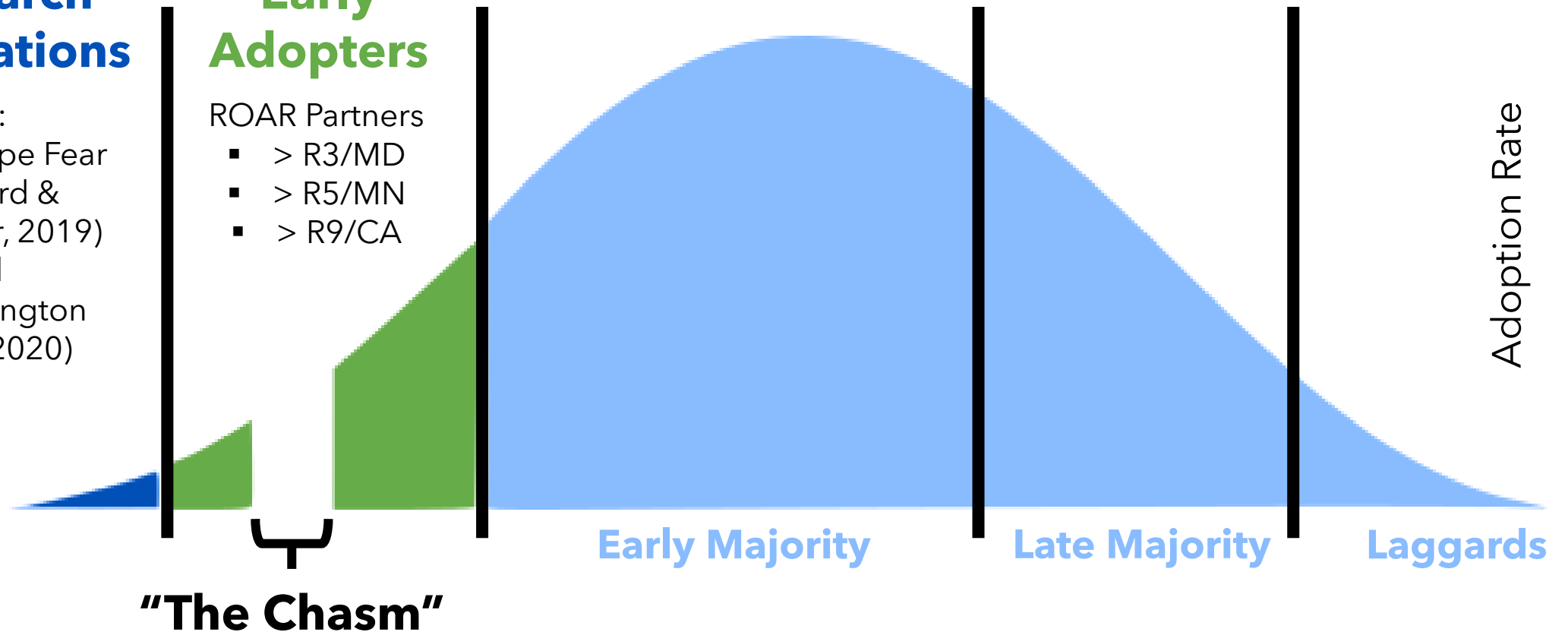
Examples:

- NC Cape Fear (McCord & Strynar, 2019)
- NJ Soil (Washington et al. (2020))

Early Adopters

ROAR Partners

- > R3/MD
- > R5/MN
- > R9/CA



ROAR Objective

Among early adopter states:



To build capacity and empower states/regions to access high resolution mass spectrometry NTA knowledge and tools **to independently apply NTA** in their management of PFAS and other contaminants of emerging concern

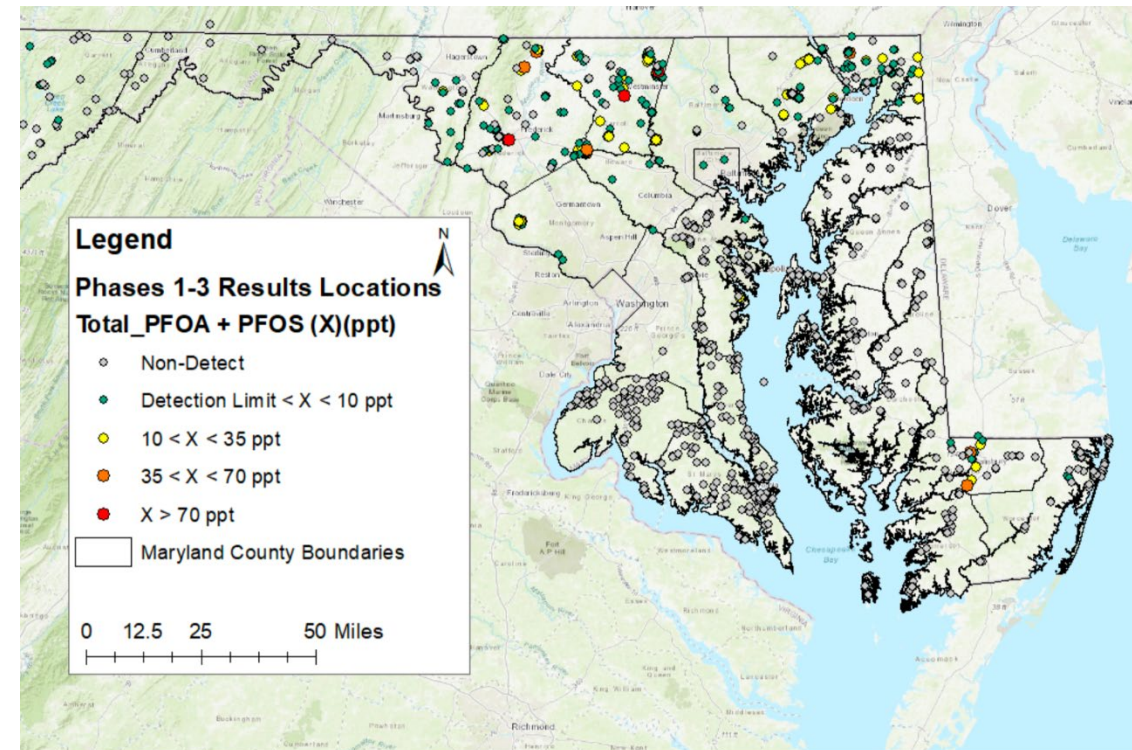
Partnership with R3/Maryland

- Existing drinking water surveillance program to understand presence of PFAS in finished drinking water
 - ~1000 samples collected and analyzed on targeted analysis for 18 PFAS (537.1)
 - 500 analyzed using HRMS (Sciex UPLC-X500R-QTOF) for NTA

Retrospective: workflows and data resources to analyze existing data for 500 samples

Active: optimize study design, sampling, and instrument acquisition to assess accidental industrial release

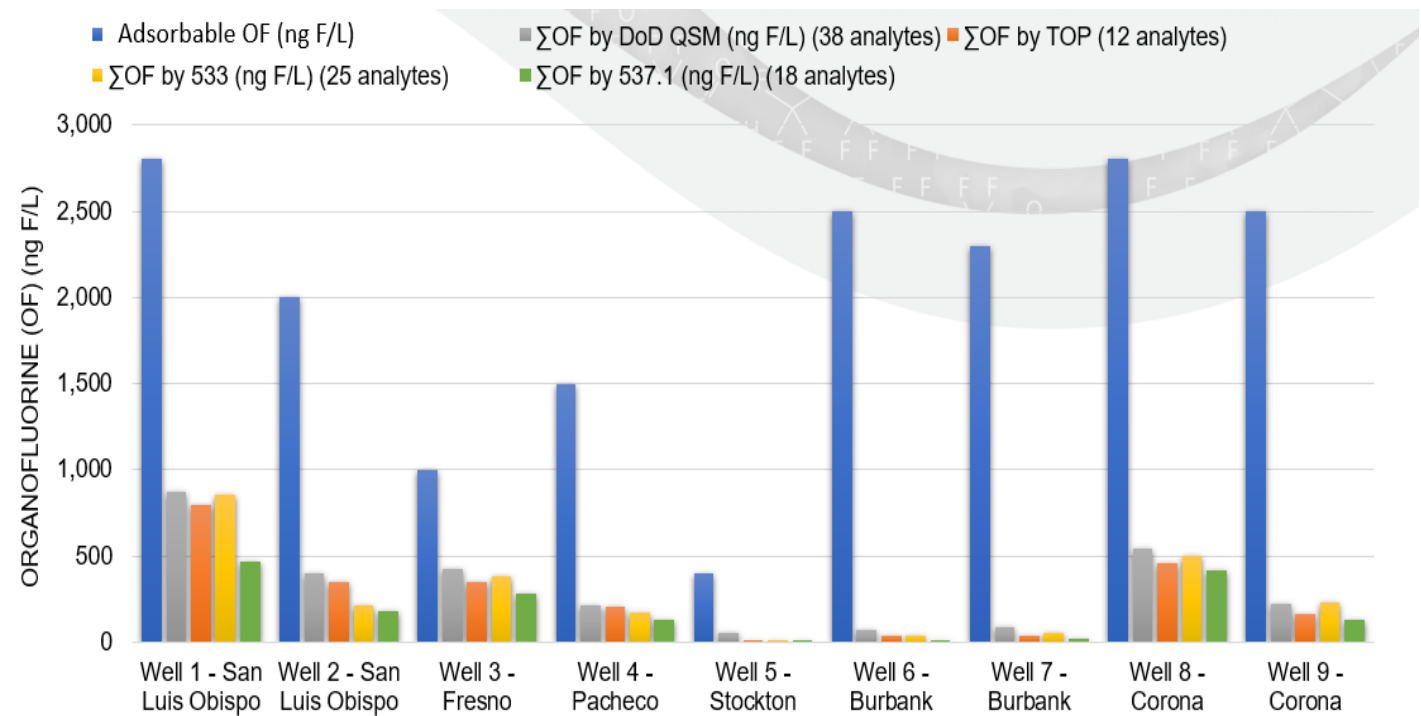
- 50 drinking water samples collected & analyzed for NTA related to PFAS accidental industrial release
- Data analysis underway; QA results encouraging



Source: <https://mde.maryland.gov/PublicHealth/Pages/PFAS-Landing-Page.aspx>

Partnership with R9/California

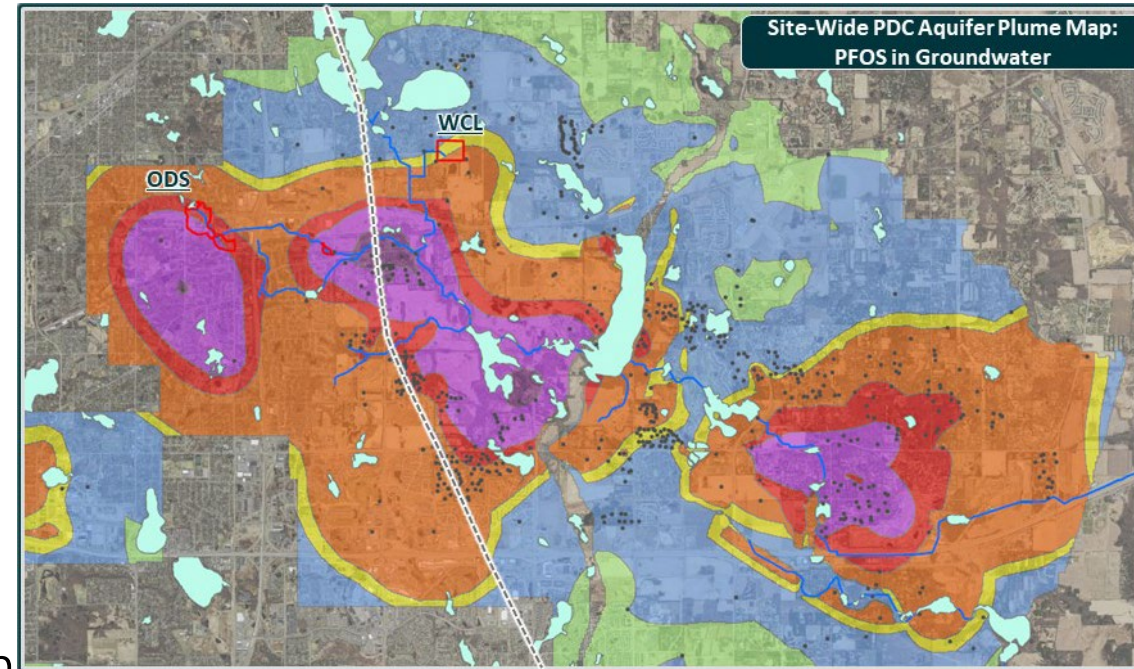
- Results of a pilot study that compared measurements of PFAS using various analytical techniques
 - Pilot study: 5 methods applied to 9 samples
- ROAR will support large \$15M study considering EJ and sampling a total of 4,000 wells, using a tiered analytical methods: targeted > total organic fluorine > NTA
- NTA to be applied to ~1000 samples
- Sampling to begin early 2024



Partnership with R5/Minnesota

- DOH laboratory has HRMS capability / experience primarily dedicated to detecting illicit drugs
- “Project 1007” is a well-studied surface and groundwater contamination zone in the eastern suburbs of Minneapolis impacted by 3M dump site (~70 years old)
 - Characterization to date has been limited to 40 analyte targeted PFAS methods
- Samples collected and analyzed up and down stream of disposal sites (n~20; spring/summer 2023) & SAFF pilot system
 - Analysis conducted on two HRMS platforms: Sciex QTOF & Thermo Orbitrap (7/2023)
 - Data being analyzed; QA analysis encouraging

m1 MINNESOTA POLLUTION
CONTROL AGENCY



Closing the “Chasm” (11 months in)

Learning of State Challenges

- Development of an NTA QAPP
- Need for a generic and more comprehensive HRMS PFAS reference library
- NTA paradigm shift in approach
 - Study design
 - Data-dependent analysis
 - Rare skill set: analytical chemistry & HRMS & cheminformatics & data processing/statistical analysis
- Computational resources
- Interpreting / communicating results

Developing Strategies to Overcome

- Example QAPPs (project & state-specific)
- Generic HRMS PFAS reference library
- Tools and workflows to standardize analysis
 - CompTox Chemicals Dashboard
 - BP4NTA Study Reporting Tool
 - ORD NTA WebApp
 - NTA R code
 - Innovative Omics: FluoroMatch
- Desk Statement providing NTA context, description, caveats
- Community of practice: BP4NTA International Workgroup



Summary

- There is great scientific & public health rationale for **expanding NTA** to address the gap between the number of chemicals that threaten human health & environment and the number of chemicals that we measure
 - PFAS is a case-in-point
 - State public health agencies are motivated to adopt; MD, MN, and CA are early adopters
- EPA has partnered with MD, MN, and CA to **identify and overcome barriers** to NTA implementation
- All three states are positioned **to evaluate, report, and act on novel PFAS** in water resources; first time environmental characterization beyond targeted analysis

References

- Andrews DQ and Naidenko OV (2020): Population-Wide Exposure to Per- and Polyfluoroalkyl Substances from Drinking Water in the United States. *Environ. Sci. Technol. Lett.* 2020, 7, 12, 931–936
- Glüge J , Scheringer M , Cousins IT , DeWitt JC , Goldenman G , Herzke D , Lohmann R , Ng CA , Trier X , Wang Z . An overview of the uses of per- and polyfluoroalkyl substances (PFAS). *Environ Sci Process Impacts*. 2020 Dec 1;22(12):2345-2373. doi: 10.1039/d0em00291g. Epub 2020 Oct 30. PMID: 33125022; PMCID: PMC7784712.
- McCord J, Strynar M. Identifying Per- and Polyfluorinated Chemical Species with a Combined Targeted and Non-Targeted-Screening High-Resolution Mass Spectrometry Workflow. *J Vis Exp*. 2019 Apr 18;(146):10.3791/59142. doi: 10.3791/59142. PMID: 31058907; PMCID: PMC8801205.
- Vandenberg LN, Rayasam SDG, Axelrad DA, Bennett DH, Brown P, Carignan CC, Chartres N, Diamond ML, Joglekar R, Shamasunder B, Shrader-Frechette K, Subra WA, Zarker K, Woodruff TJ. Addressing systemic problems with exposure assessments to protect the public's health. *Environ Health*. 2023 Jan 12;21(Suppl 1):121. doi: 10.1186/s12940-022-00917-0. PMID: 36635700; PMCID: PMC9835264
- Washington JW, Rosal CG, McCord JP, Strynar MJ, Lindstrom AB, Bergman EL, Goodrow SM, Tadesse HK, Pilant AN, Washington BJ, Davis MJ, Stuart BG, Jenkins TM. Nontargeted mass-spectral detection of chloroperfluoropolyether carboxylates in New Jersey soils. *Science*. 2020 Jun 5;368(6495):1103-1107. doi: 10.1126/science.aba7127. PMID: 32499438; PMCID: PMC7814412
- Wen X, Wang M, Xu X, Li T. Exposure to Per- and Polyfluoroalkyl Substances and Mortality in U.S. Adults: A Population-Based Cohort Study. *Environ Health Perspect*. 2022 Jun;130(6):67007. doi: 10.1289/EHP10393. Epub 2022 Jun 22. PMID: 35731224; PMCID: PMC9215707