Emerging Per- and Polyfluoroalkyl Substances (PFAS)

Andrew B. Lindstrom[1], Jason E. Galloway[2], Mark J. Strynar[1], Detlef Knappe[3], Mei Sun[4], Seth Newton[1], Linda K. Weavers[2]

[1]U.S. Environmental Protection Agency, [2]The Ohio State University, [3]North Carolina State University, [4]University of North Carolina Charlotte

Northeastern University
Social Science Environmental Health Research Institute

Highly Fluorinated Compounds
Social and Scientific Discovery
Northeastern University Social Science Environmental Health Research Institute
June 14 – 15, 2017

Overview

- Sources and exposure pathways of legacy PFAS (PFOS & PFOA) somewhat known

- USEPA's Stewardship Program has reduced legacy PFAS but has also resulted in the development of many new "emerging" PFAS

- New analytical capabilities (high resolution mass spectrometry) allow detection of many new PFAS

- Emerging PFAS almost completely uncharacterized with regard to sources, environmental fate, human exposure implications

- Discussion of some recent research on sources of emerging PFAS, human exposure pathways, overall implications

US Environmental Protection Agency
PFOA Stewardship Program

- In January 2006, USEPA started this program to help minimize impact of PFOA in the environment

- Eight major international companies have agreed to participate (including 3M, DuPont, Asahi Glass, Daikin)

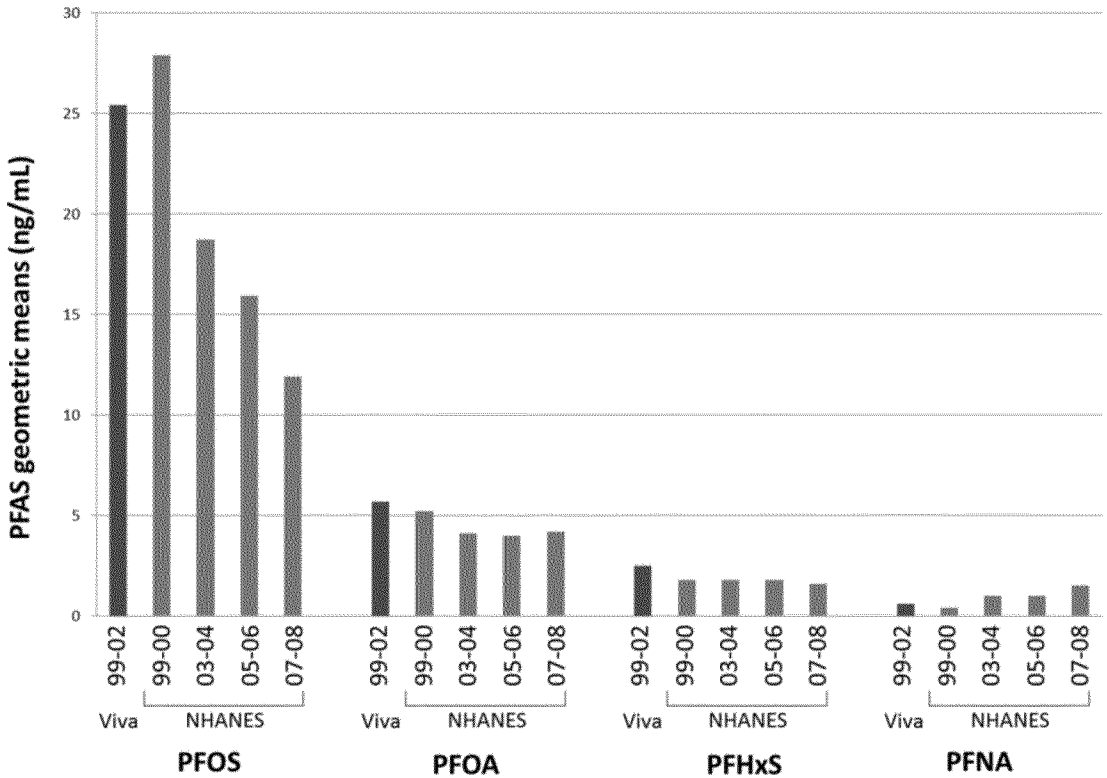
- Agreement to voluntarily reduce factory emissions and product content of PFOA and related compounds* on a global basis by 95% no later than 2010

- Agreement to work toward total elimination of emissions and product content of these compounds by 2015

- Based on emissions and content determinations made for 2006

* Includes PFOA, precursor chemicals that can break down to PFOA, higher homologues (C9 and larger)

Trends in PFAS Serum Levels in US



Sagiv et al. *Environmental Science & Technology* 2015, 49, 11849−11858

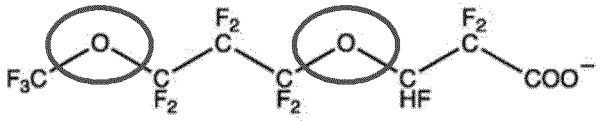
Table 2. Geometric mean and 95% confidence interval and selected percentiles of PFOS, PFOA, PFHxS, and PFNA serum concentrations (ng/mL) for the U.S. population 12 years of age and older: Data from NHANES 2011-2012 [a]

	Geometric Mean (95% Confidence Interval)		Selected Percentiles			
			50th	75th	90th	95th
PFHxS	1.28	1.15-1.43	1.27	2.26	3.81	5.43
PFOS	6.31	5.83-6.82	6.51	10.48	15.62	21.68
PFOA	2.08	1.95-2.22	2.08	3.02	4.35	5.67
PFNA	0.88	0.80-0.97	0.86	1.30	1.95	2.54

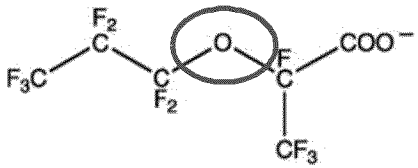
[a] CDC (2015)

Fluoropolymer manufacture

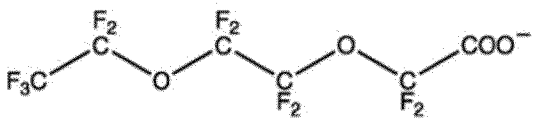
ADONA (CAS No. 958445-44-8)



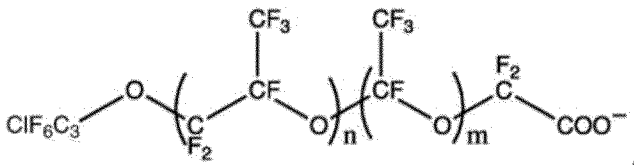
GenX (CAS No. 62037-80-3)



Asahi's product (CAS No. 908020-52-0)

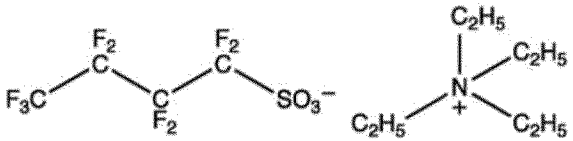


Solvay's product (CAS No. 329238-24-6)

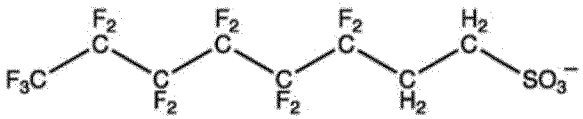


Metal plating

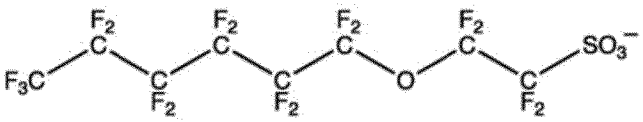
$N(Et)_4$-PFBS (CAS No. 25628-08-4)



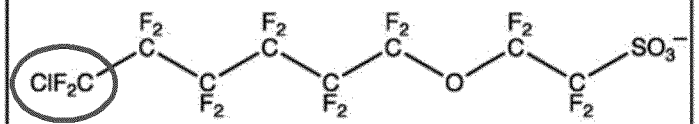
6:2 FTSA (CAS No. 27619-97-2)



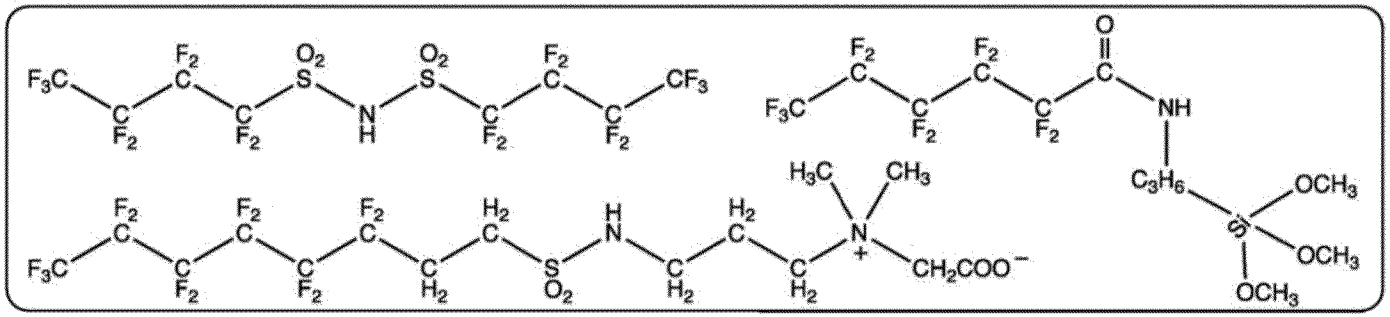
F-53 (CAS No. 754925-54-7)



F-53B (CAS No. 73606-19-6)



Fire fighting foams and miscellaneous



Unknown Characteristics of “Emerging” Fluorinated Compounds

- Actual identities of alternatives unknown in industrial sectors and geographical regions that are not well regulated

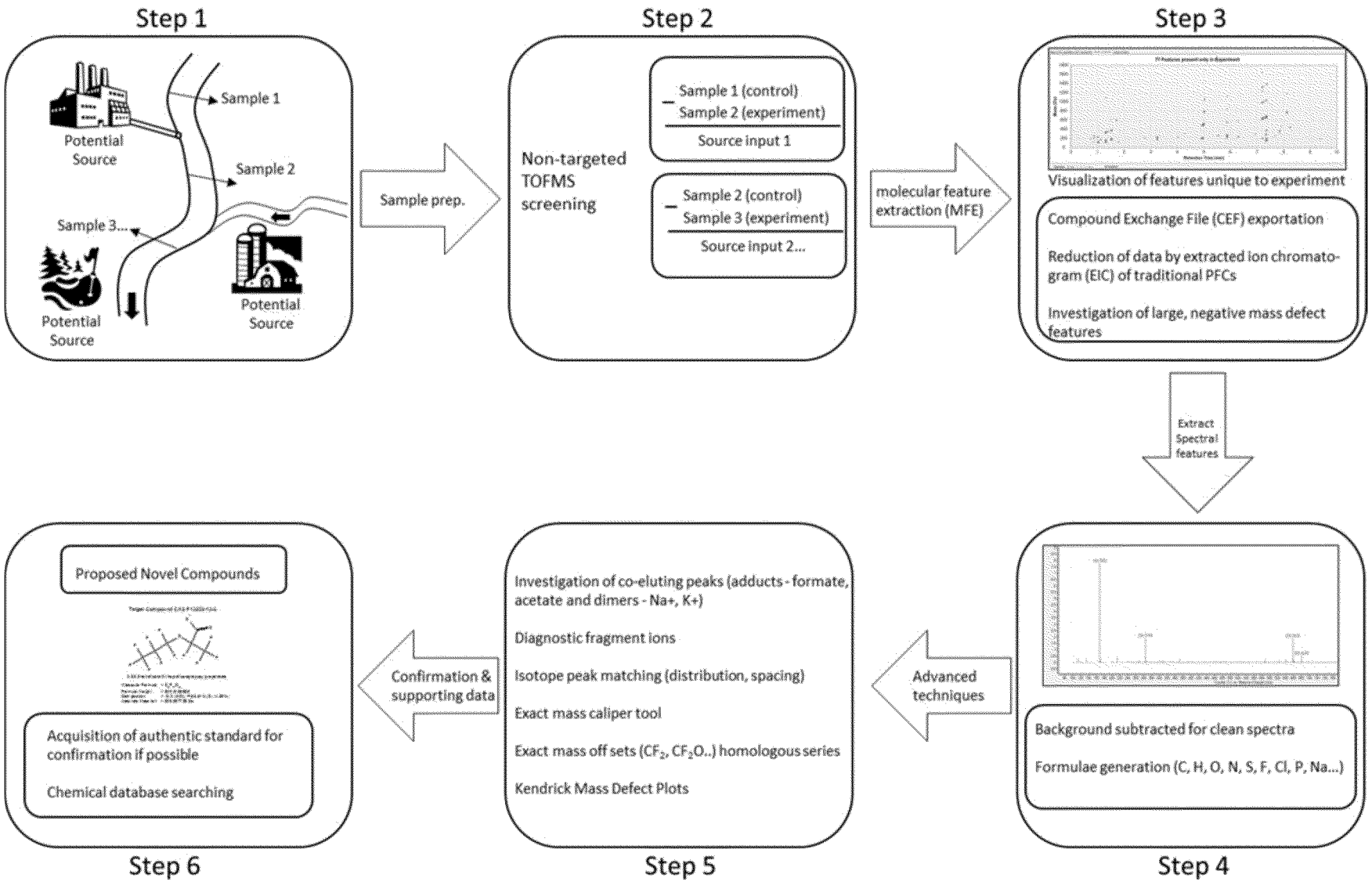
- Data on environmental and human health effects are incomplete (at best) and more often nonexistent

- Data on degradability, bioaccumulation, and toxicity (environmental and human) are incomplete (at best) or completely lacking

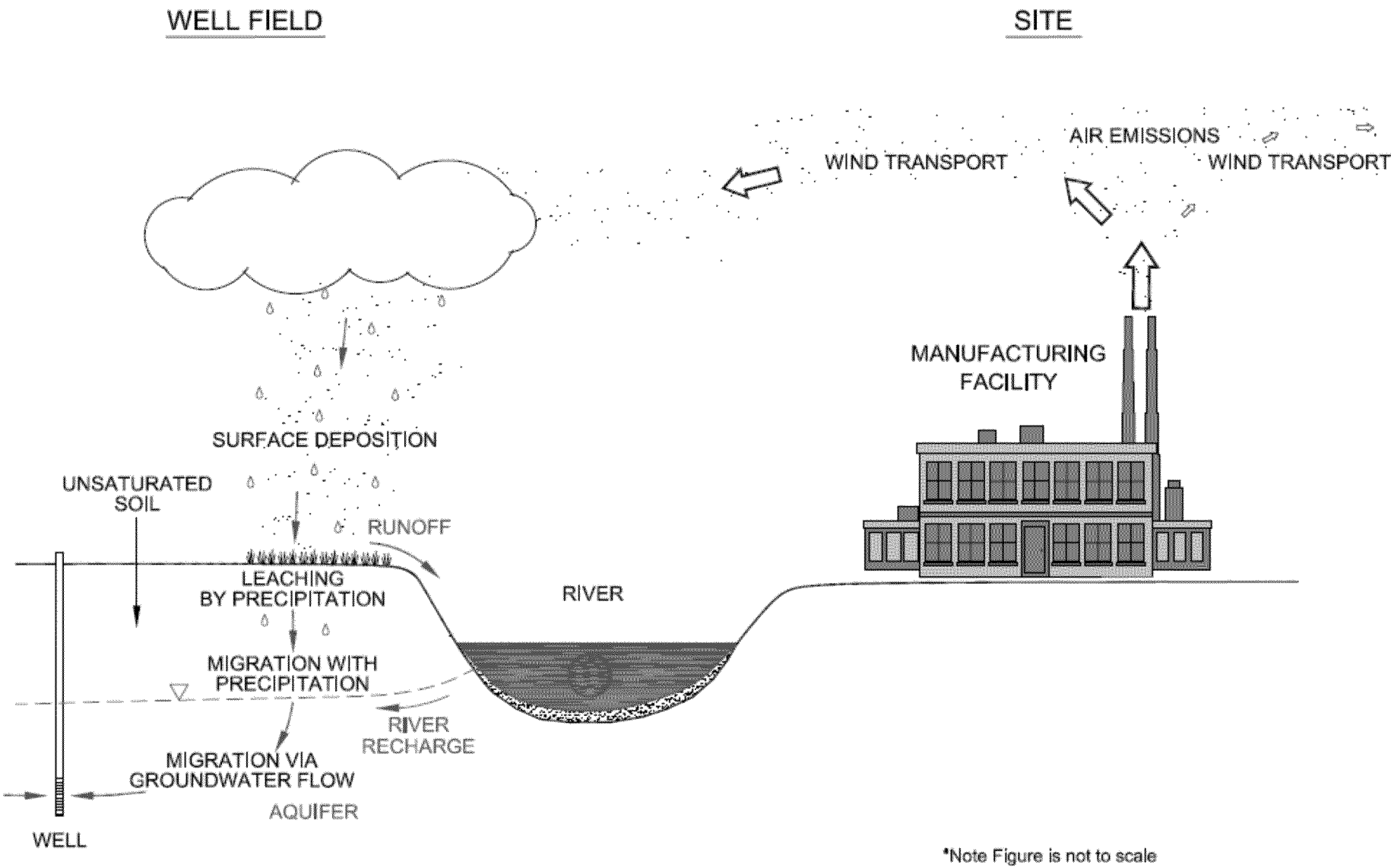
- Information on production volume and environmental emissions not available

Wang et al. *Environment International* 2013, 60, 242−248

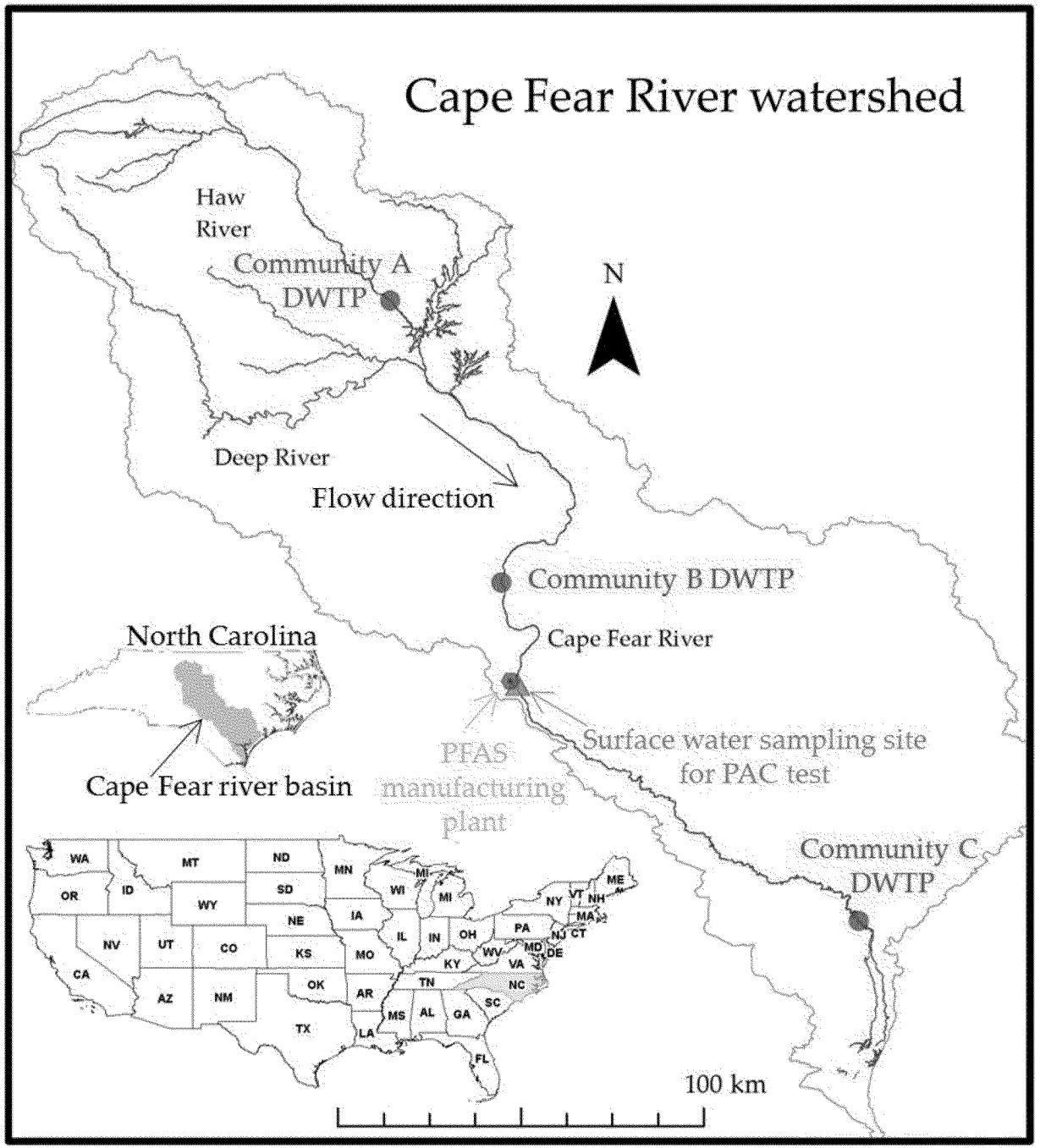
High Resolution Mass Spectrometry to Find “Emerging” PFAS



Strynar et al. *Environmental Science & Technology* 2015, 49, 11622−11630

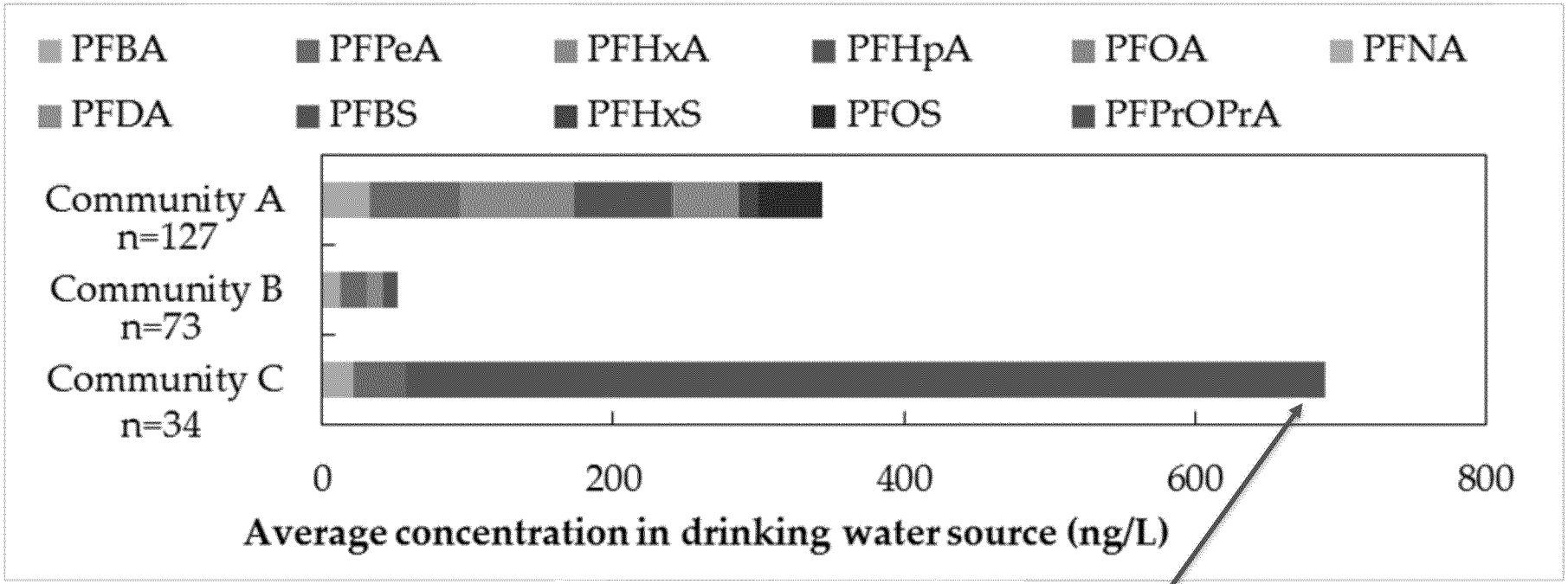


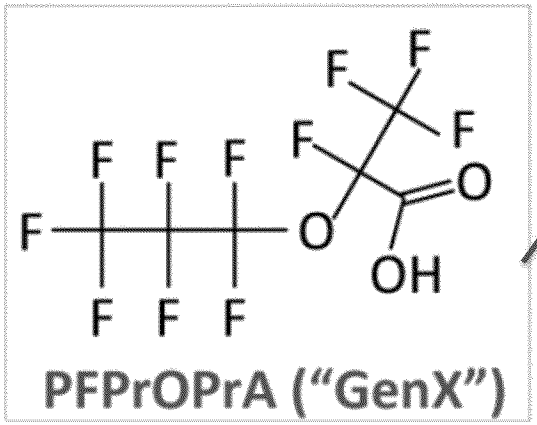
Davis et al. *Chemosphere* 2007, 67, 2011–2019



Sun et al. *Environmental Science & Technology Letters* 2016, 3, 415−419

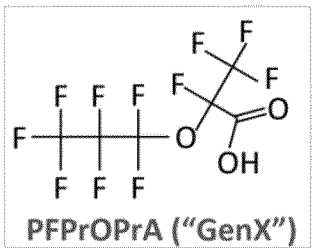
Legacy PFAS with GenX in Cape Fear River Basin

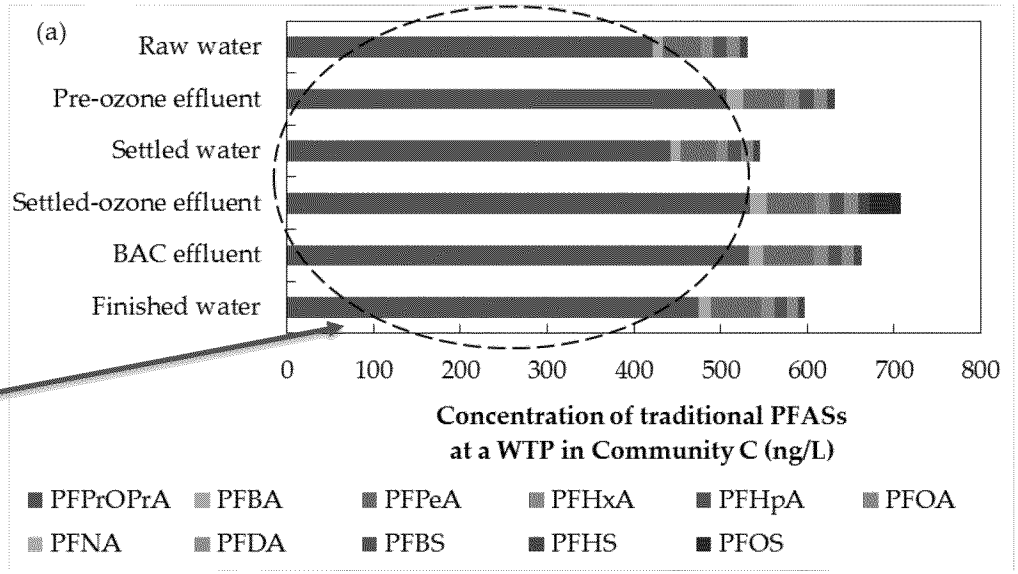


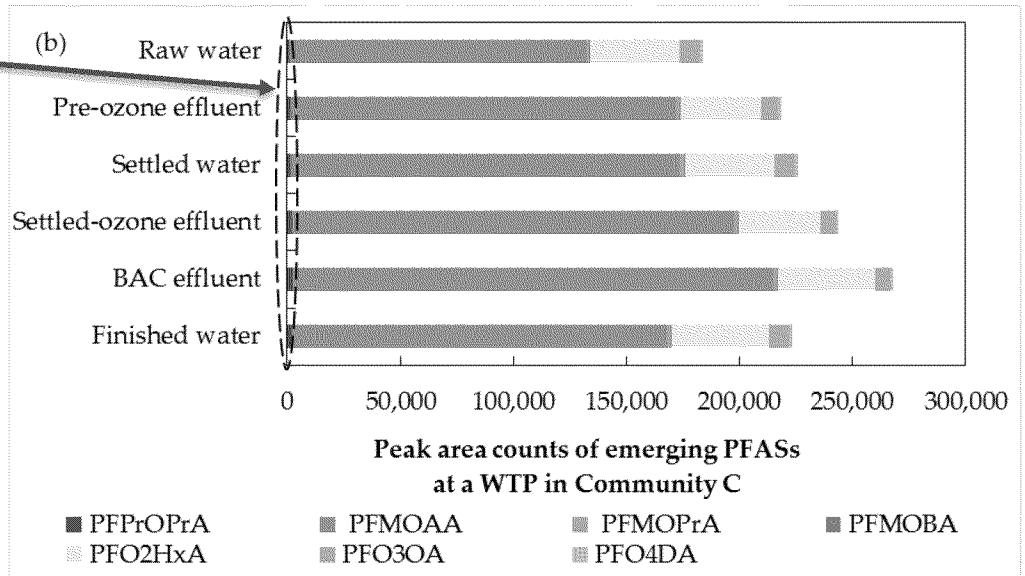


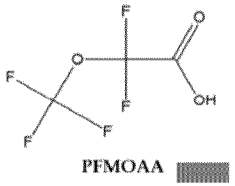
Sun et al. *Environmental Science & Technology Letters* 2016, 3, 415−419

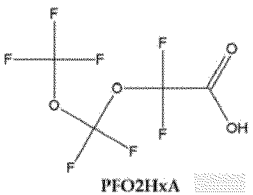
Emerging PFAS in Cape Fear River Basin

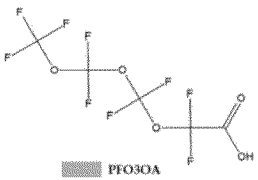




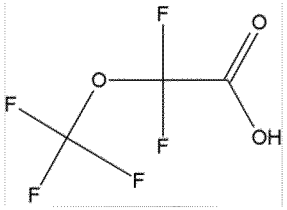




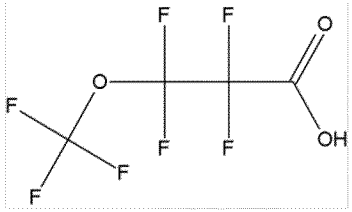




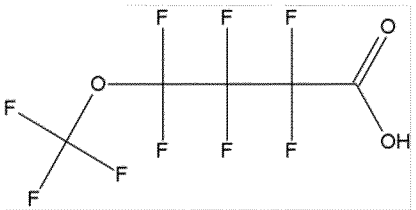
Sun et al. *Environmental Science & Technology Letters* 2016, 3, 415−419



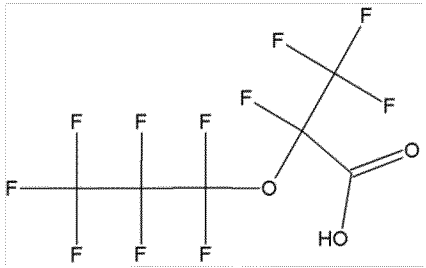
PFMOAA



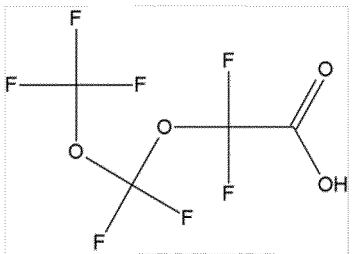
PFMOPrA



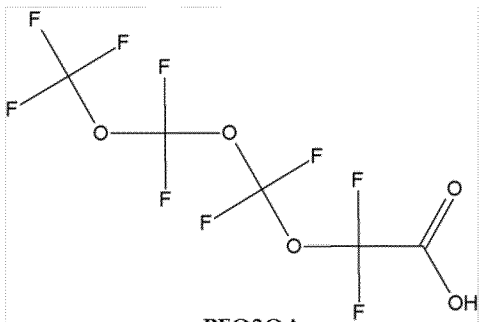
PFMOBA



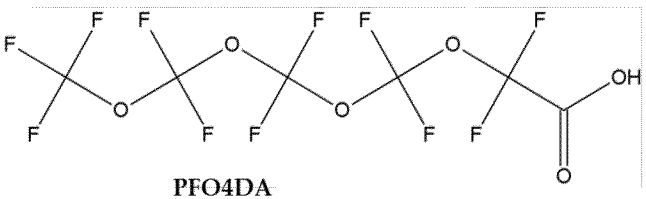
PFPrOPrA



PFO2HxA



PFO3OA



PFO4DA

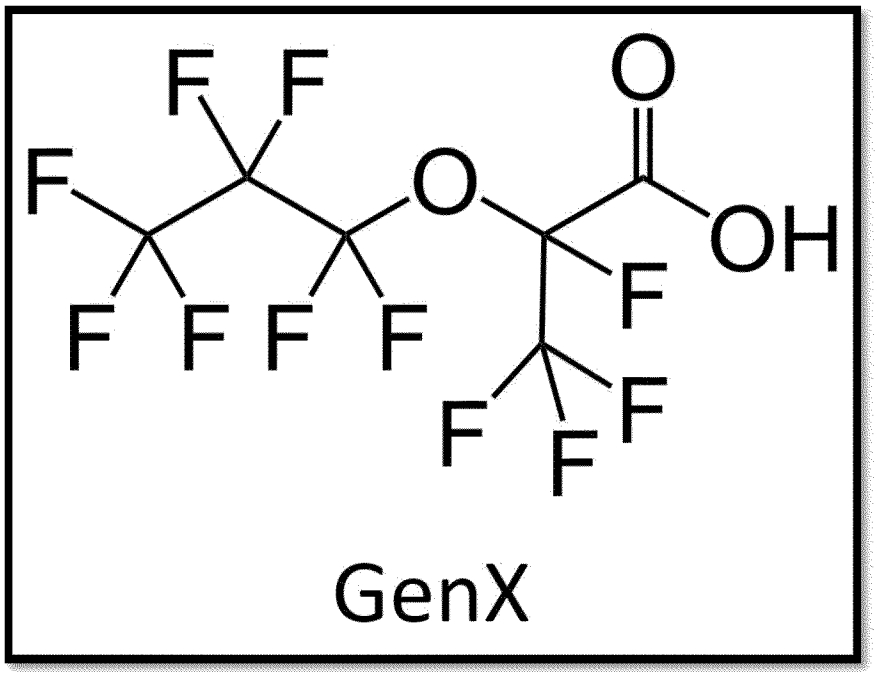
Sun et al. *Environmental Science & Technology Letters* 2016, 3, 415−419

GenX

- Identity originally protected as Confidential Business Information (CBI)

- Still persistent, still toxic, but less bioaccumulative than C8

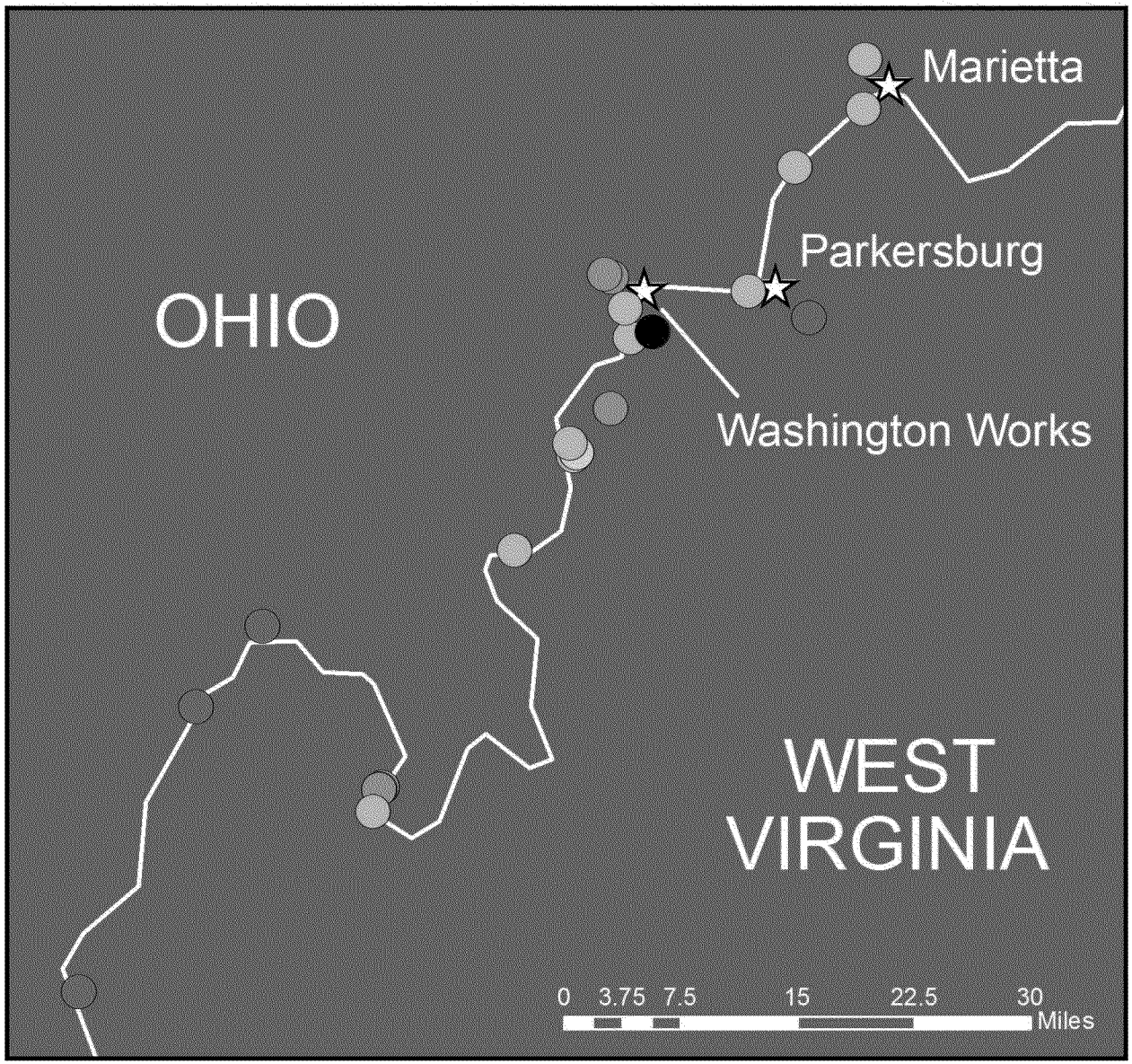
- DuPont studies found effects on rats similar to C8, including possible endocrine/immune disruption, enlarged livers and kidneys, and cancer



- Approved by the EPA, no further testing required

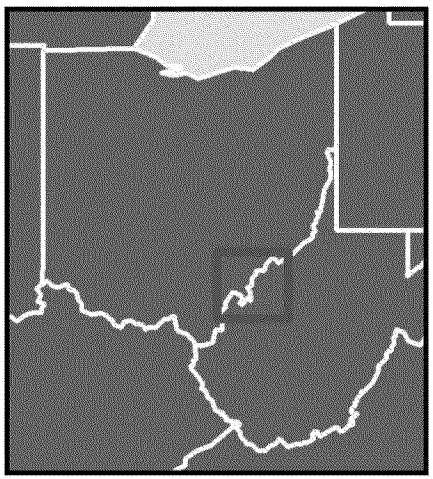
Trip #1 – Ohio River

Ohio River Results

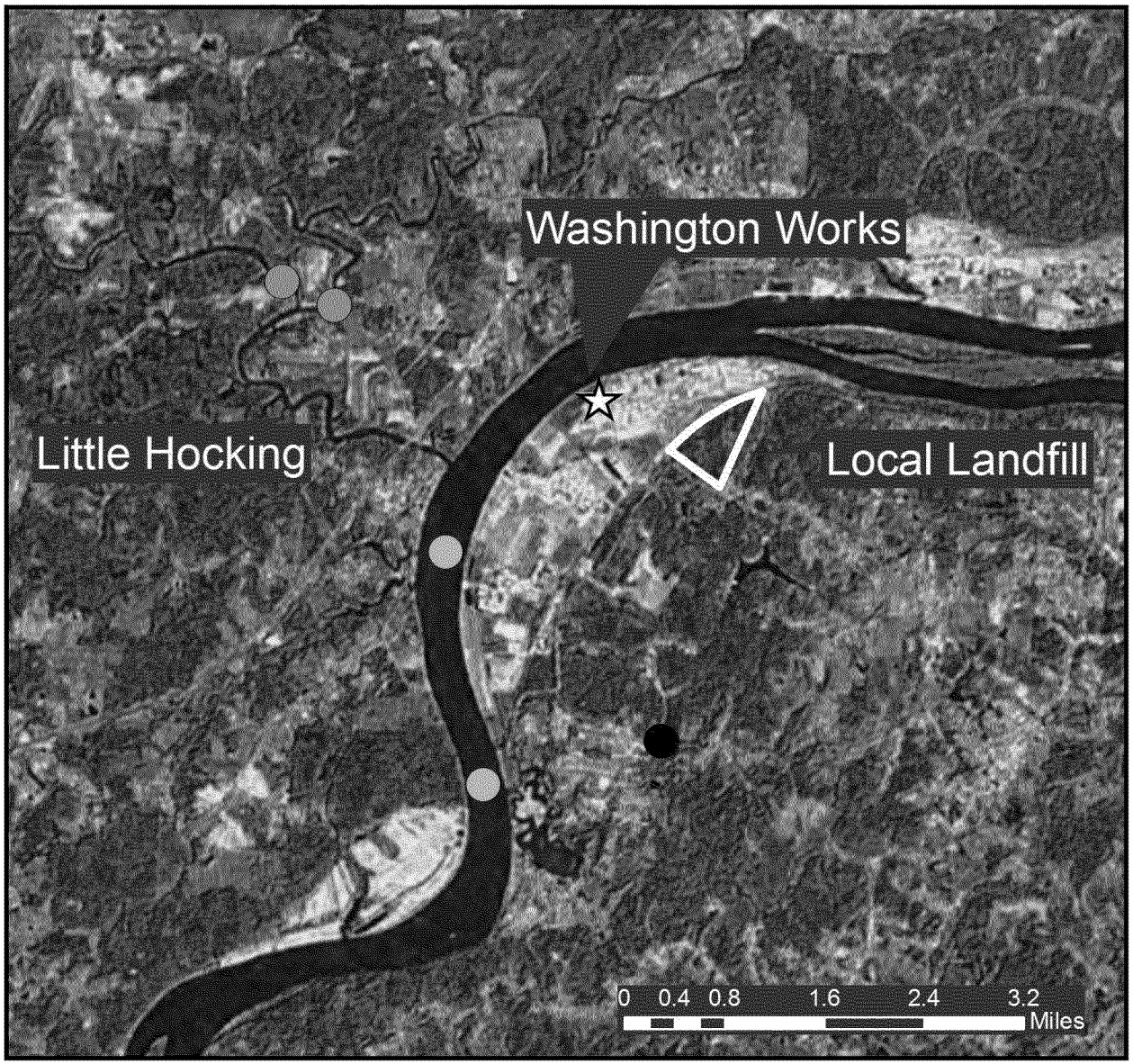


PFOA

- 0 - 10 ng/L
- 10 - 50 ng/L
- 50 - 100 ng/L
- 100 - 500 ng/L
- 500 - 1000 ng/L
- >1000 ng/L

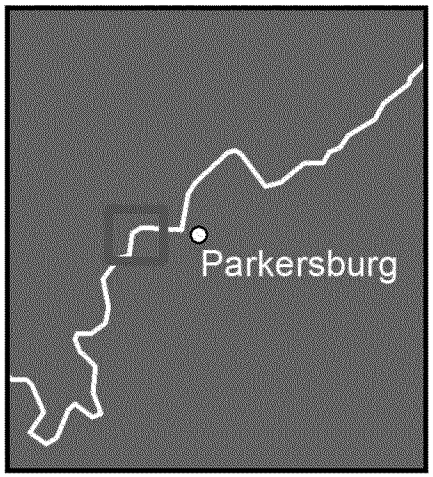


Ohio River Results (Detail)

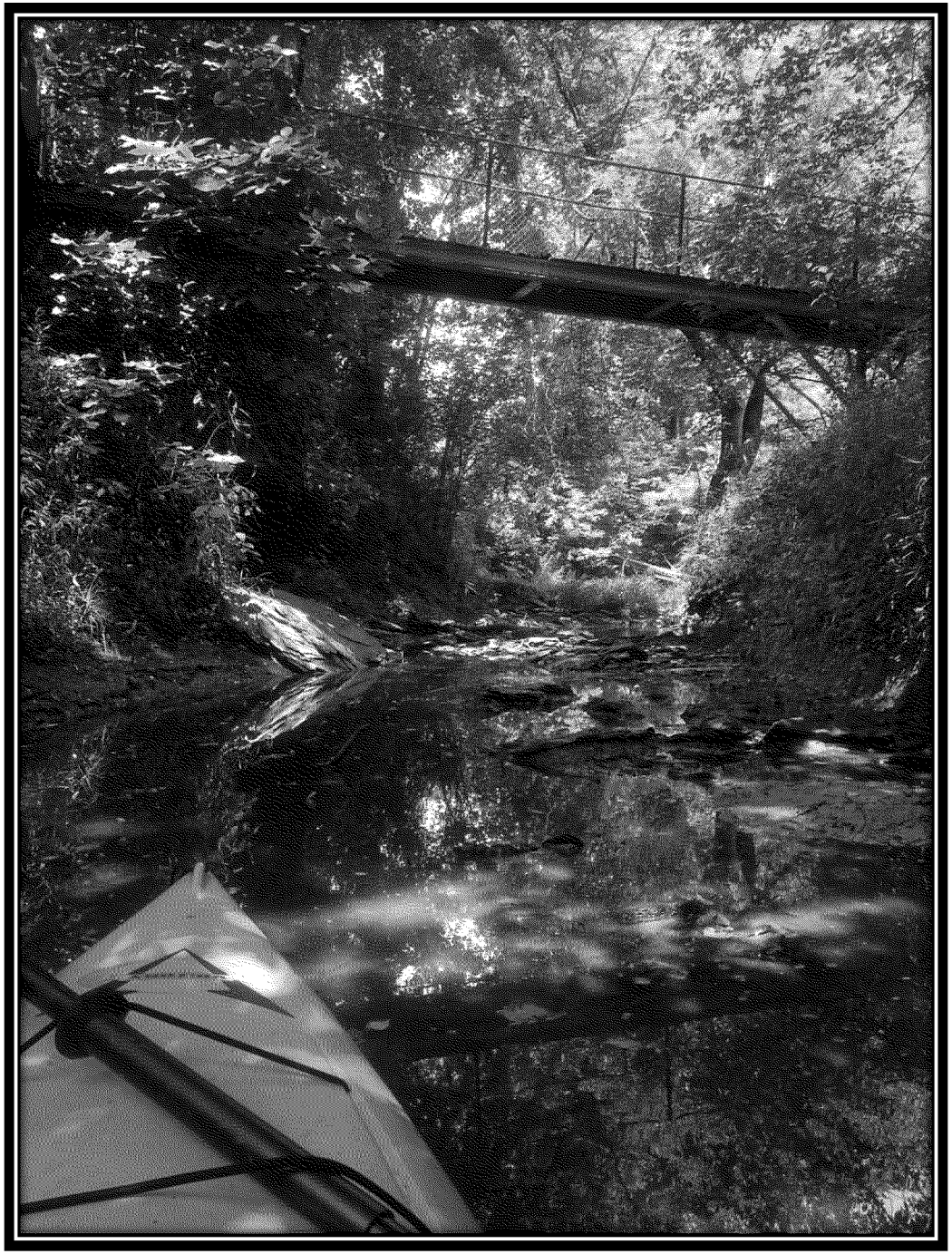


PFOA

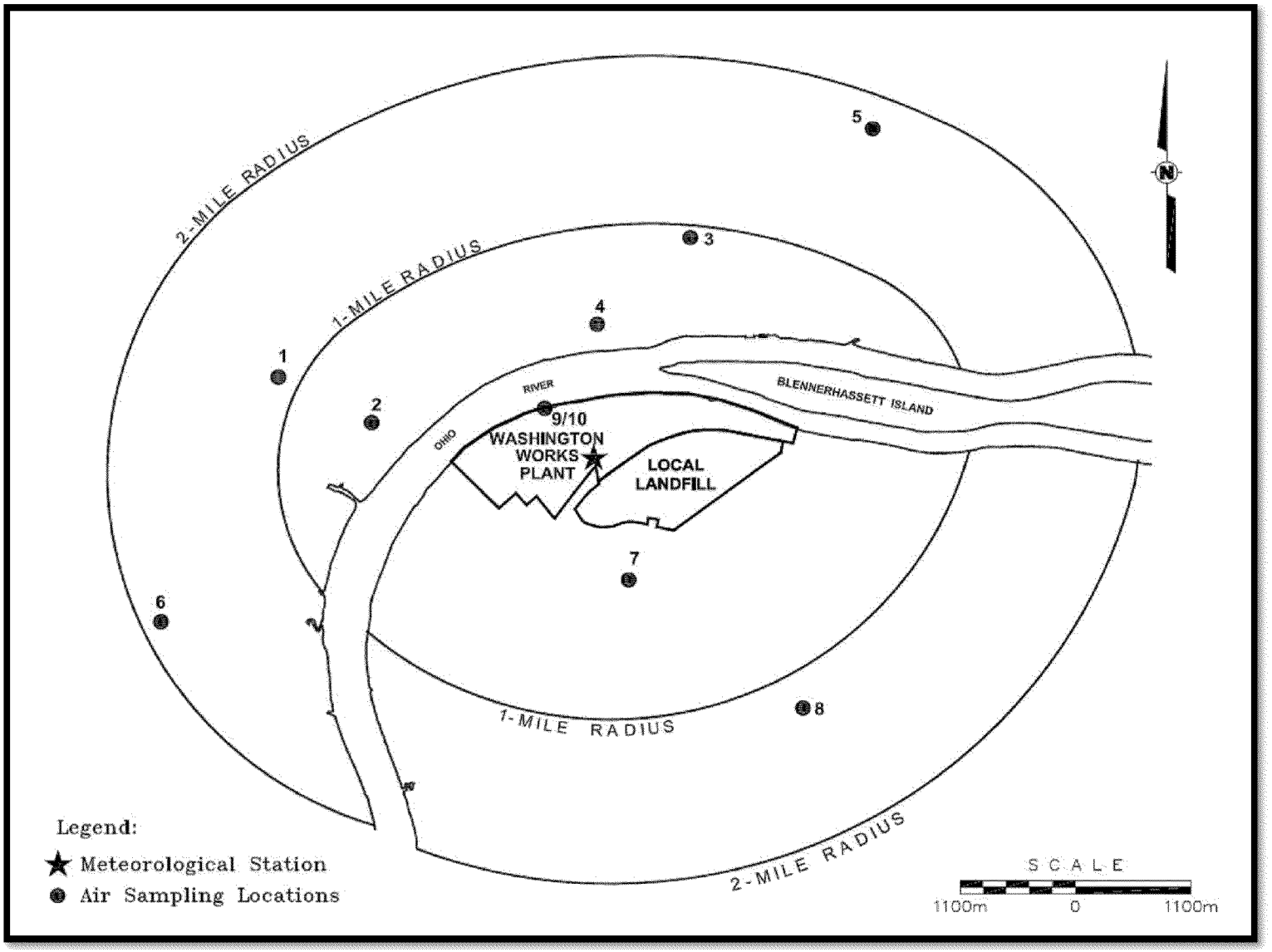
- 0 - 10 ng/L
- 10 - 50 ng/L
- 50 - 100 ng/L
- 100 - 500 ng/L
- 500 - 1000 ng/L
- >1000 ng/L



Trip #2 – Little Hocking River

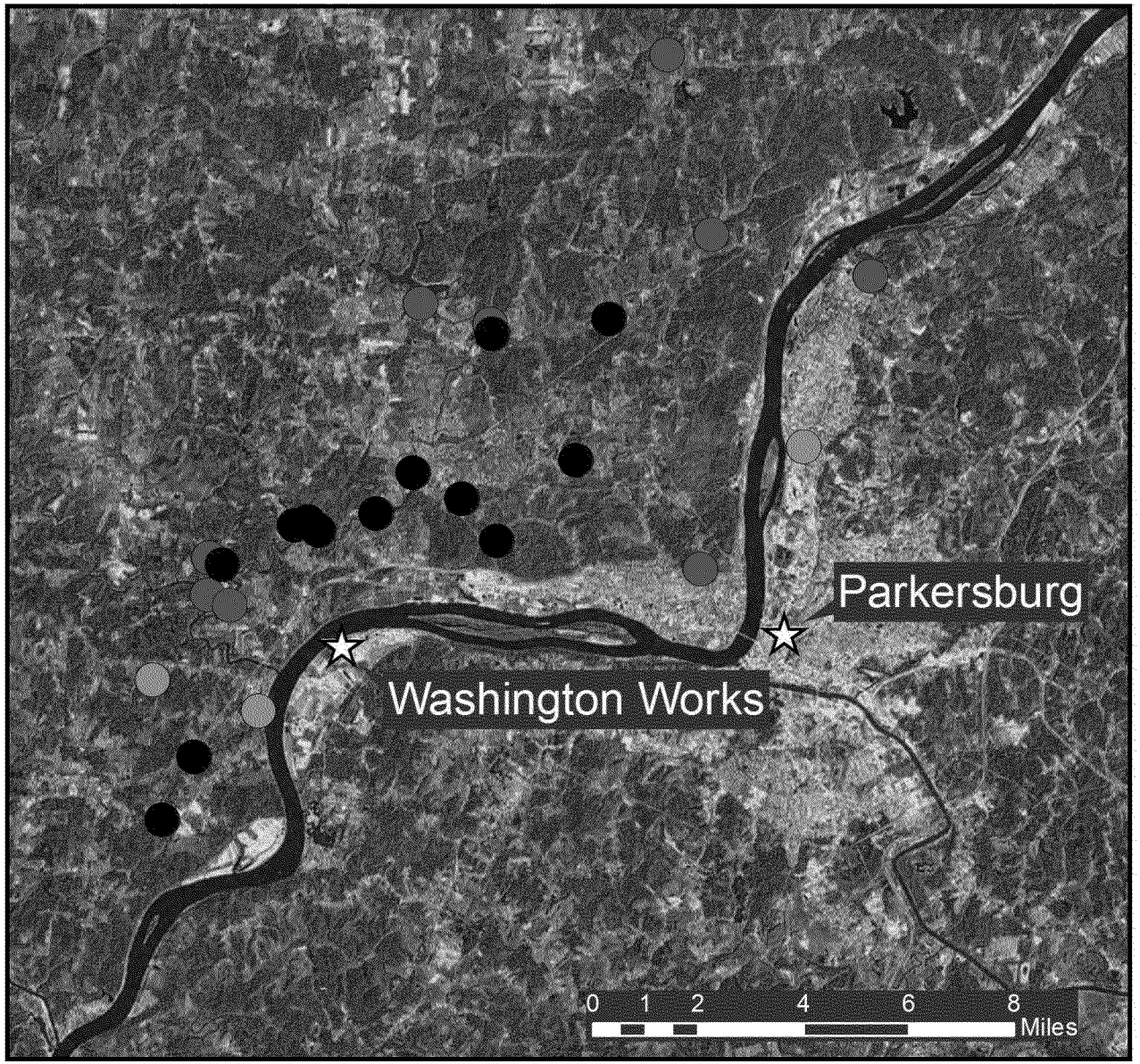


Air Monitoring Around Washington Works



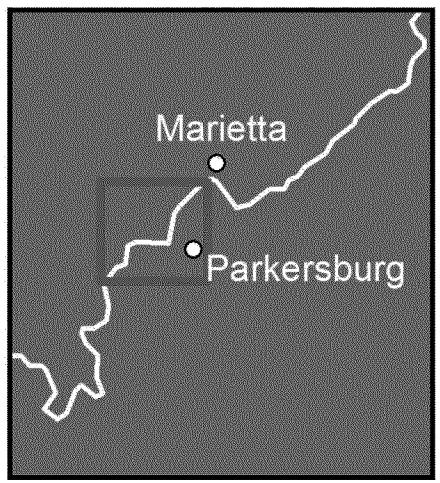
Barton et al. *Journal of the Air & Waste Management Association* 2010, 60, 402–411

Little Hocking Results



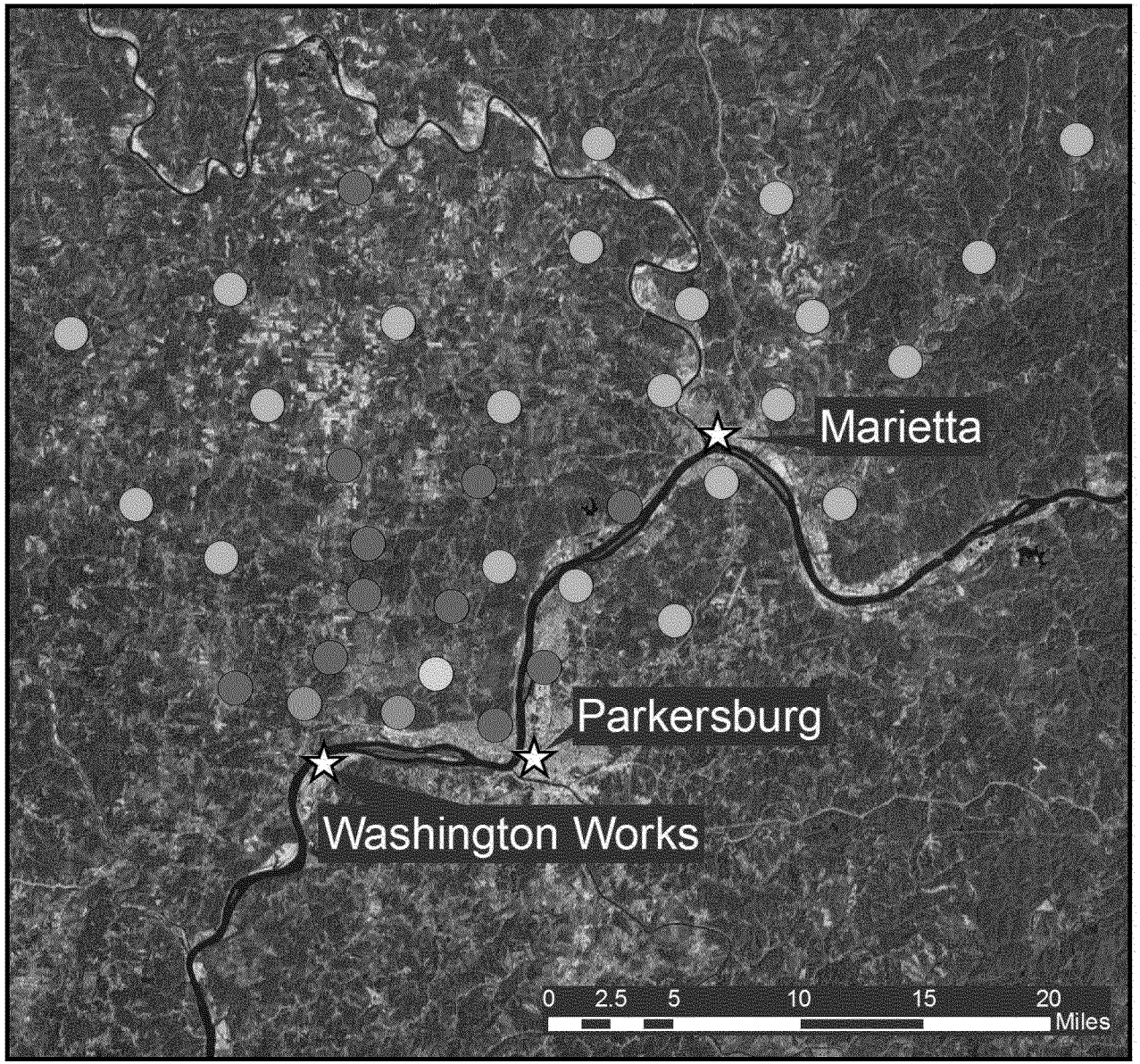
PFOA

- 0 - 10 ng/L
- 10 - 50 ng/L
- 50 - 100 ng/L
- 100 - 500 ng/L
- 500 - 1000 ng/L
- >1000 ng/L



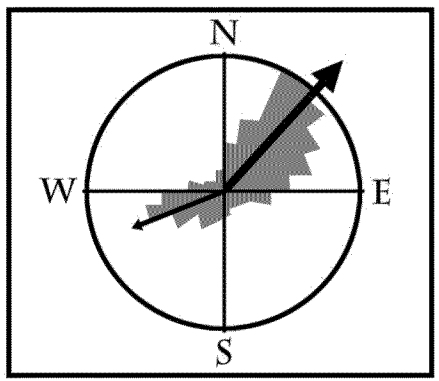
Trip #3 – Little Hocking and Beyond

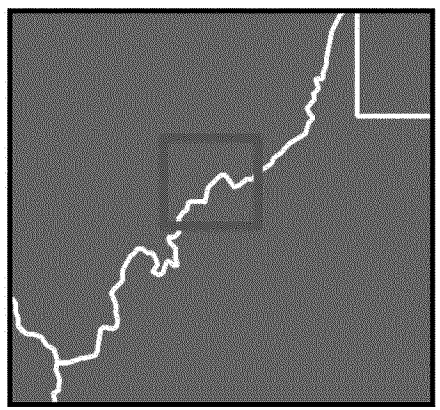
Extended Sampling Results



GenX

- 0 - 10 ng/L
- 10 - 50 ng/L
- 50 - 100 ng/L
- 100 - 500 ng/L
- 500 - 1000 ng/L
- >1000 ng/L





Conclusions

- The presence of significant levels of PFOA (>100 ng/L) in surface water more than 15 miles from the facility and quantifiable levels (>10 ng/L) more than 25 miles away suggest local contamination may be more extensive than originally thought

- The discovery of GenX at many of the collection sites suggests the replacement PFAS is contaminating the local environment via air deposition as well

- More testing is needed – especially private well water between the boundaries of the Little Hocking Public Water district and the Muskingum River

Questions?

Email: lindstrom.andrew@epa.gov
galloway.18@osu.edu