Presumptive Contamination: A New Approach to PFAS Contamination Based on Likely Sources

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Photo: Members of the PFAS Project Team at the 2022 Third National PFAS Conference

The PFAS Project Lab studies social, scientific, and political factors related to Per- and Polyfluoroalkyl substances (PFAS).

We produce rigorous, accessible research about the PFAS contamination crisis through collaborations with impacted communities, leading interdisciplinary researchers, and nonprofits.

We share this PFAS research with impacted communities and a broad range of other stakeholders.

Presumptive Contamination: A New Approach to PFAS Contamination Based on Likely Sources

Derrick Salvatore, Kira Mok, Kimberly K. Garrett, Grace Poudrier, Phil Brown, Linda S. Birnbaum, Gretta Goldenman, Mark F. Miller, Sharyle Patton, Maddy Poehlein, Julia Varshavsky, and Alissa Cordner*

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ABSTRACT: While research and regulatory attention to per- and polyfluoroalkyl substances (PFAS) has increased exponentially in recent years, data are uneven and incomplete about the scale, scope, and severity of PFAS releases and resulting contamination in the United States. This paper argues that in the absence of high-quality testing data, *PFAS contamination can be presumed* around three types of facilities: (1) fluorinated aqueous film-forming foam (AFFF) discharge sites, (2) certain industrial facilities, and (3) sites related to PFAS-containing waste. While data are incomplete on all three types of presumptive PFAS contamination sites, we integrate available geocoded, nationwide data sets into a single map of presumptive contamination sites in the United States, identifying 57,412 sites of presumptive PFAS contamination: 49,145 industrial facilities, 4,255 wastewater treatment plants, 3,493 current or former military sites, and 519 major airports. This conceptual approach allows governments, industries, and communities to rapidly and systematically identify potential exposure sources.
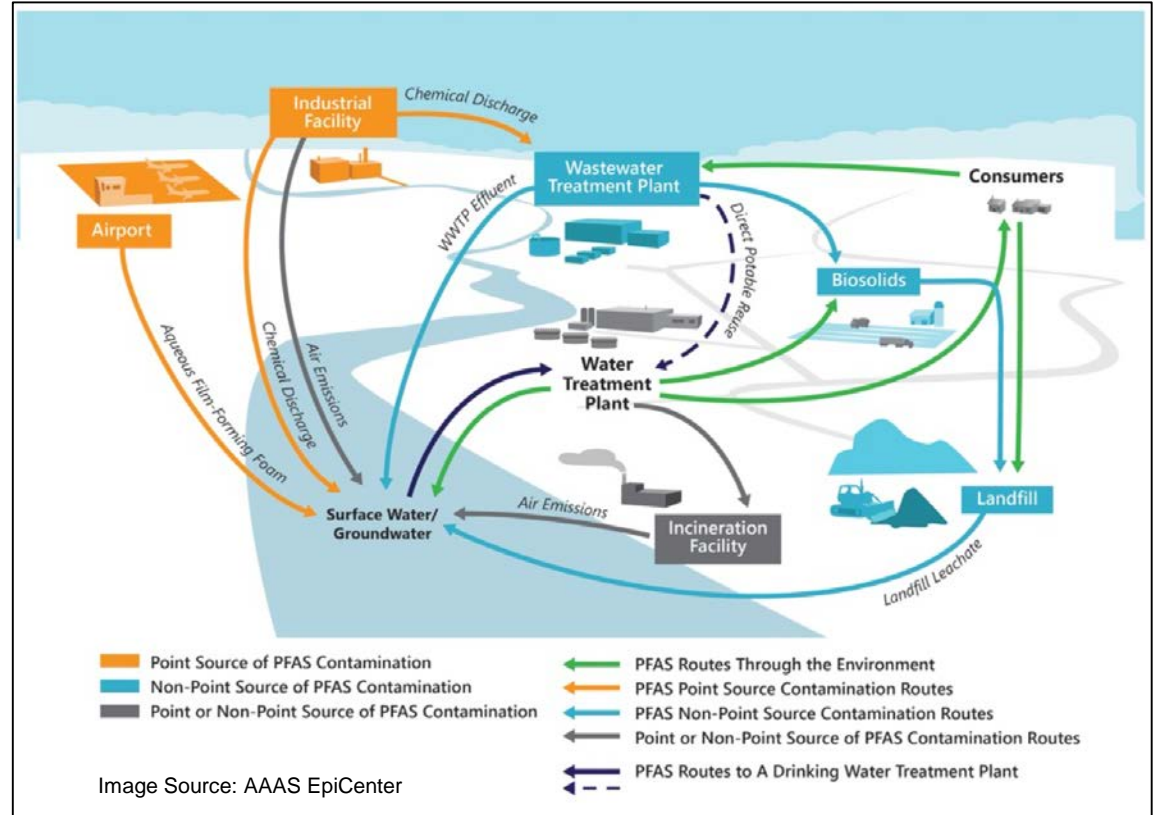
Presumptive Contamination Sites (n=57,412)

Military Sites
Major Airports (FAA Part 139)
Wastewater Treatment Plants
Industrial Facilities

KEYWORDS: per- and polyfluoroalkyl substances (PFAS), presumptive contamination, PFAS testing and investigation, AFFF, PFAS waste and disposal

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PFAS in the Environment

- <u>Point sources</u>: industrial facilities, airports, military bases
- <u>Non-point sources</u>: Landfills, wastewater treatment plants (WWTPs)
- Not removed by standard WWTP methods
- Environmentally persistent
- Mobile through water cycle
- Globally ubiquitous in rainwater

Image Source: AAAS EpiCenter

PFAS and Environmental Justice

- Tribal water systems and populations underrepresented in federal testing, and many Tribal lands are close to presumptive PFAS contamination sites (Mok et al. conditional acceptance, *Environmental Health Perspectives*)

- BIPOC, low income, and limited English populations disproportionately exposed to PFAS in New Jersey (Mueller et al. in preparation)

- Approximately ½ of U.S. carceral facilities are proximate to a presumptive PFAS contamination site (Poirier et al. under review)

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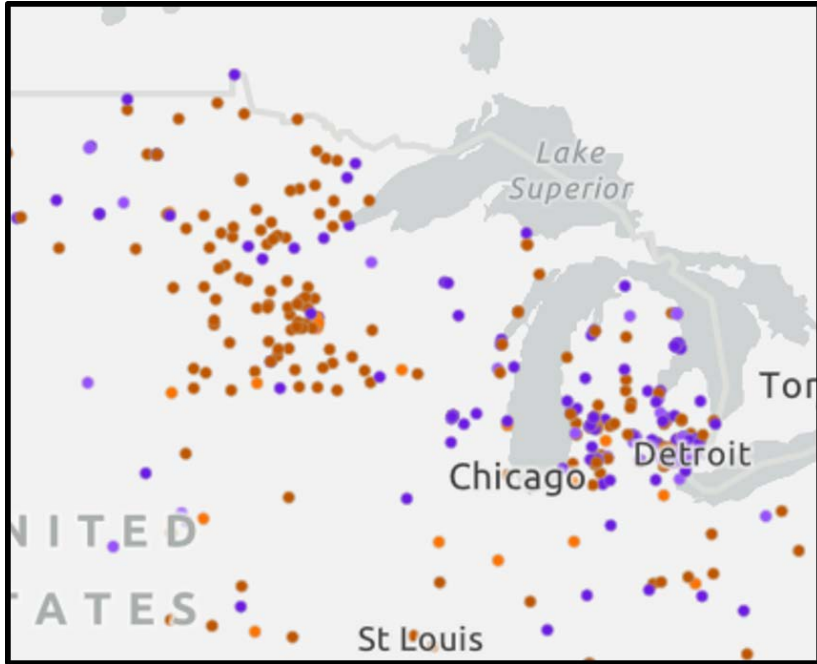
What we know:

- Currently no enforceable federal standards (MCLs) for PFAS, so no systematic federal testing and treatment
  - UCMR3 (2013-15) - small number of PFAS, high reporting levels, large water systems
  - UCMR5 (2023-25) requires public water systems serving >10,000 people to test for 29 PFAS
- Environmental PFAS testing occurs on a state-by-state basis
  - Some states have implemented enforceable drinking water limits for certain PFAS

PFAS Contamination Site Tracker

www.pfasproject.com/pfas-sites-and-community-resources

Where are PFAS?

Where are PFAS?
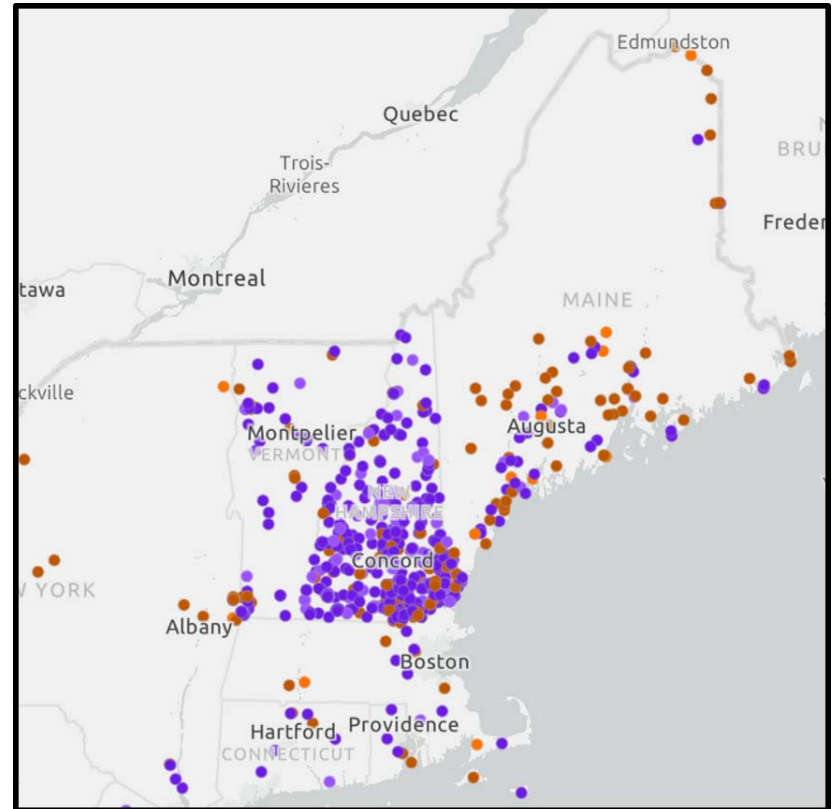
Filling the gaps: a *presumptive PFAS Contamination* model

- Increasing public and scientific interest in PFAS means more interest in PFAS testing
- EPA regulatory action and funding for PFAS research and remediation

- Where should states start their testing?
- Are certain industries more likely to emit PFAS than others?
- Could a presumptive contamination model reveal environmental justice concerns?

Presumptive PFAS Contamination Model
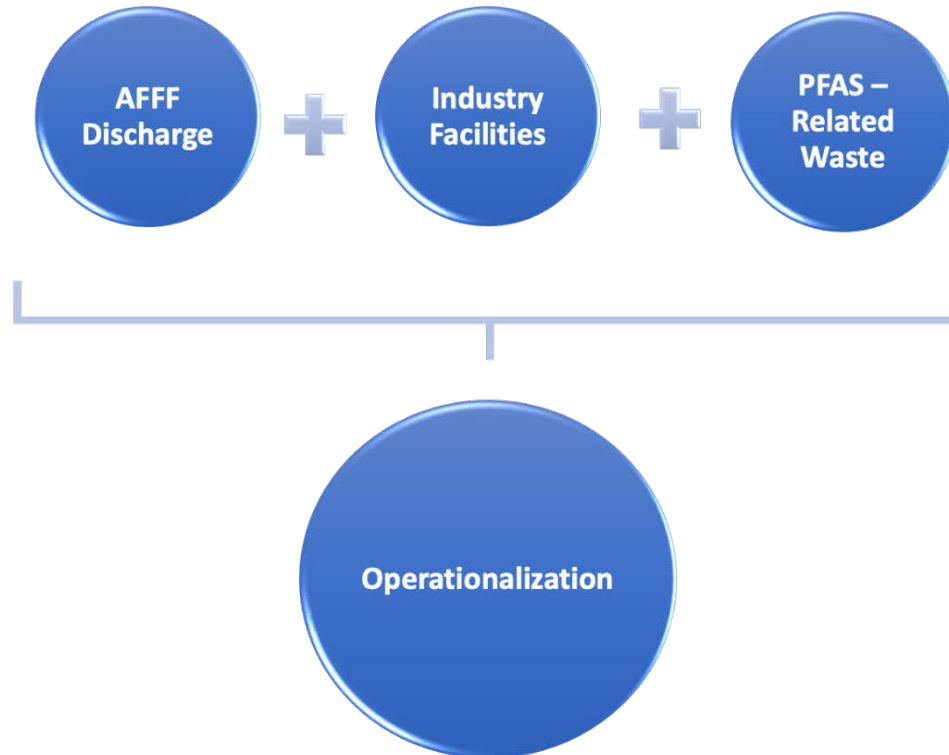
Presumptive PFAS Contamination

Conceptual Model:

Observable: Nationwide, Publicly Available Data *Included in Map*

Expected: Types of Sites *Not Included in Map*

AFFF Discharge Sites

AFFF-Certified Airports (FAA Dataset of Part 139 Airports)
Military Sites (MIRTA and FUDS datasets)

Other AFFF discharge sites, including airplane crash sites, firefighting training site, petroleum refinery fires, and others

Industrial Facilities that Produce and/or Use PFAS

38 NAICS codes used by at least four regulatory agencies and/or academic researchers to identify and/or verify PFAS contamination sites (facility list downloaded from EPA Facility Registry Service by primary NAICS code, with geolocation accuracy <1,000 meters)

Facilities with FRS geolocation scores ≥1,000
Facilities using or emitting PFAS whose NAICS code is not included in our model

Sites Related to PFAS-Containing Waste

Wastewater Treatment Plans (Clean Watershed Needs Survey)

Sludge land application sites
PFAS-burning incinerators

Industry facilities?

| NAICS code	title
313320	Fabric Coating Mills
325510	Paint and Coating Manufacturing
322220	Paper Bag and Coated and Treated Paper Manufacturing
313210	Broadwoven Fabric Mills
322121	Paper (except Newsprint) Mills
332813	Electroplating, Plating, Polishing, Anodizing, and Coloring
324110	Petroleum Refineries
325612	Polish and Other Sanitation Good Manufacturing
334413	Semiconductor and Related Device Manufacturing
326113	Unlaminated Plastics Film and Sheet (except Packaging) Manufacturing
332812	Metal Coating, Engraving (except Jewelry and Silverware), and Allied Services to Manufacturers
333318	Other Commercial and Service Industry Machinery Manufacturing
334419	Other Electronic Component Manufacturing
562212	Solid Waste Landfill
325199	All Other Basic Organic Chemical Manufacturing
323111	Commercial Printing (except Screen and Books)

NAICS code	title
313110	Fiber, Yarn, and Thread Mills
314110	Carpet and Rug Mills
316110	Leather and Hide Tanning and Finishing
325211	Plastics Material and Resin Manufacturing
324191	Petroleum Lubricating Oil and Grease Manufacturing
325998	All Other Miscellaneous Chemical Product and Preparation Manufacturing
562211	Hazardous Waste Treatment and Disposal
562213	Solid Waste Combustors and Incinerators
313310	Textile and Fabric Finishing Mills
322219	Other Paperboard Container Manufacturing
323120	Support Activities for Printing
313220	Narrow Fabric Mills and Schiffli Machine Embroidery
313230	Nonwoven Fabric Mills
322130	Paperboard Mills

NAICS code	title	
332999	All Other Miscellaneous Fabricated Metal Product Manufacturing	
424690	Other Chemical and Allied Products Merchant Wholesalers	
314910	Textile Bag and Canvas Mills	
326112	Plastics Packaging Film and Sheet (including Laminated) Manufacturing	
335999	All Other Miscellaneous Electrical Equipment and Component Manufacturing	
562112	Hazardous Waste Collection	
562219	Other Nonhazardous Waste Treatment and Disposal	
325611	Soap and Other Detergent Manufacturing	

Connecting Knowns to Unknowns

<u>Known PFAS Contamination Sites</u>

<u>Presumptive PFAS Contamination Sites</u>

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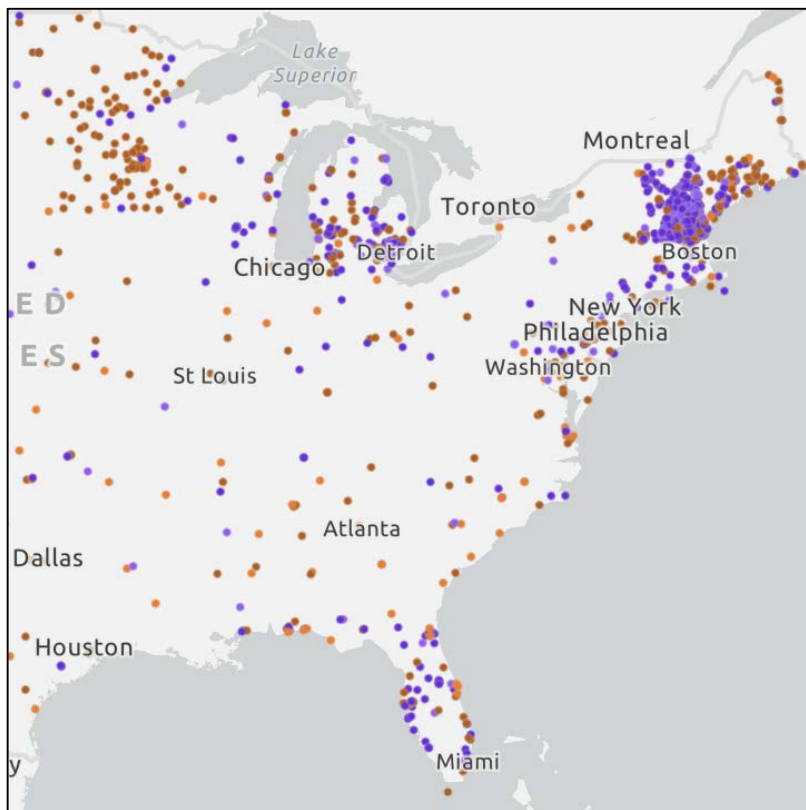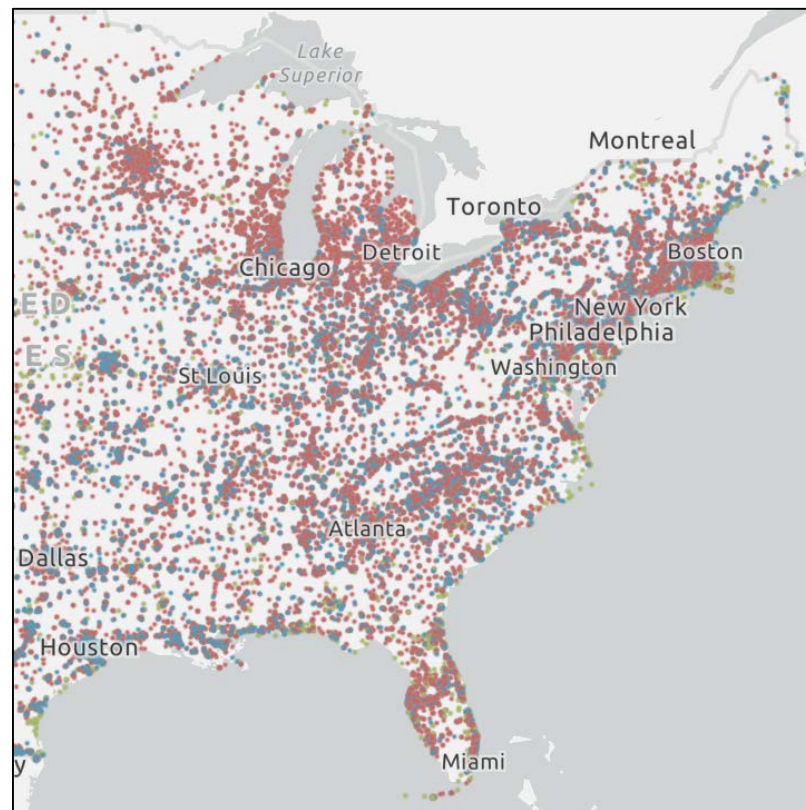
Model Validation

- 5 states with *highest* number of known PFAS contamination sites
- 5 states with *median* number of known PFAS contamination sites
- 4 *counties within each* state; two with highest and two with median known sites
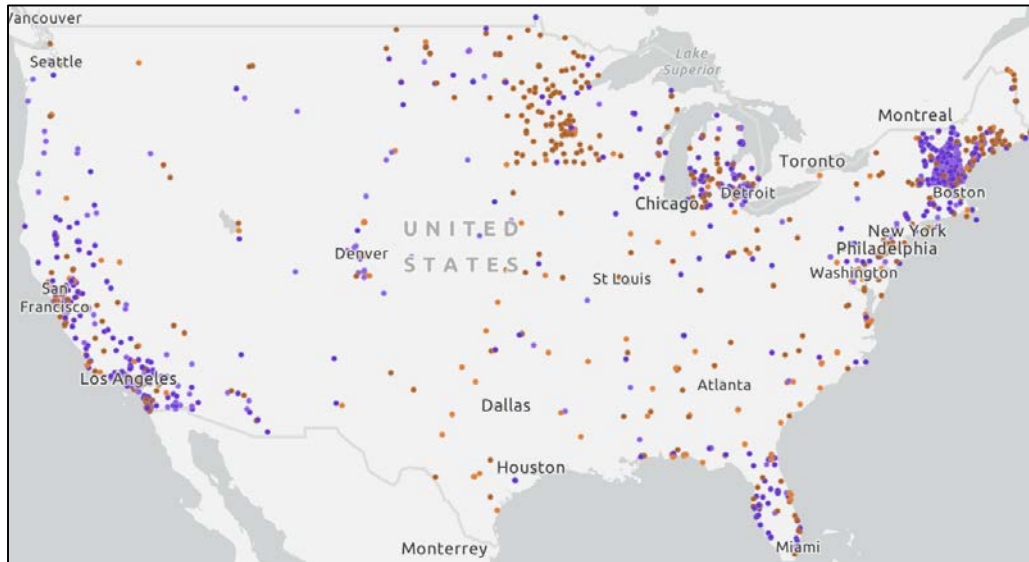
State	Known contamination sites, n	Consolidated county known contamination[b]
New Hampshire	469	2 Highest
		2 Median
California	253	2 Highest
		2 Median
Michigan	188	2 Highest
		2 Median
Minnesota	101	2 Highest
		2 Median
Maine	99	2 Highest
		2 Median
Vermont	62	2 Highest
		2 Median
Mississippi	9	2 Highest
		2 Median
Rhode Island	8	2 Highest
		2 Median
Washington	8	2 Highest
		2 Median
Tennessee	6	2 Highest
		2 Median

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Predictive Power

NH Known   NH Presumptive
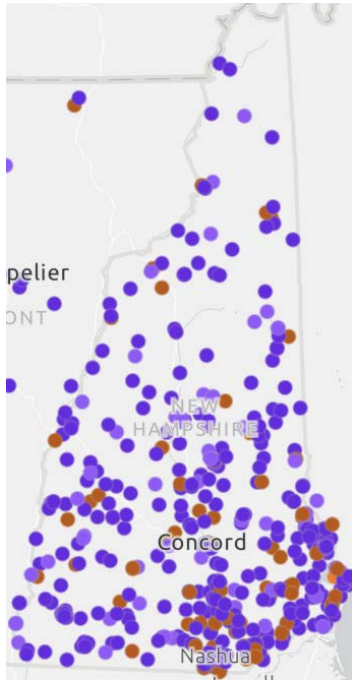
TN Known
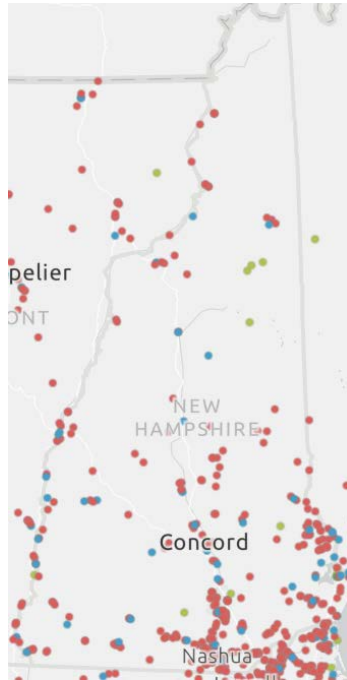
TN Presumptive

NH Validation = 52 - 61% accuracy

TN Validation = 100%

Table 1. Presumptive Contamination Model Validation by Selected States[a,f]

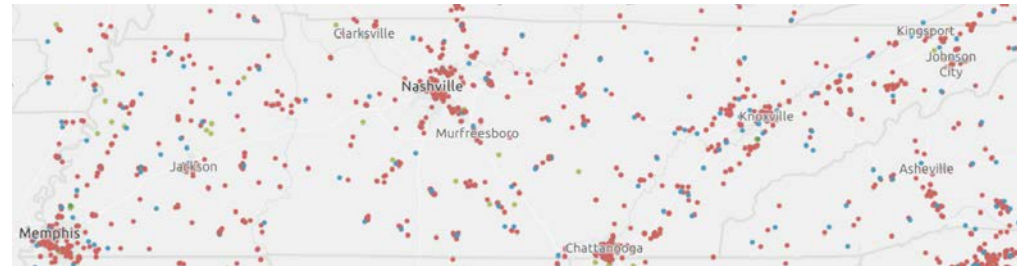| State	Known contamination sites, n	Consolidated county known contamination[b]	Known contamination sites, n	Observed matches[c], n (%)	Expected matches (not observed)[d], n (%)	Total matches[e], n (%)
New Hampshire	469	2 Highest	189	30 (16%)	69 (37%)	99 (52%)
		2 Median	76	14 (18%)	32 (42%)	46 (61%)
California	253	2 Highest	52	39 (75%)	11 (21%)	50 (96%)
		2 Median	8	6 (75%)	2 (25%)	8 (100%)
Michigan	188	2 Highest	57	30 (53%)	22 (39%)	52 (91%)
		2 Median	2	0 (0%)	2 (100%)	2 (100%)
Minnesota	101	2 Highest	17	9 (53%)	6 (35%)	15 (88%)
		2 Median	2	2 (100%)	0 (0%)	2 (100%)
Maine	99	2 Highest	28	9 (32%)	11 (39%)	20 (71%)
		2 Median	11	2 (18%)	7 (64%)	9 (82%)
Vermont	62	2 Highest	30	15 (50%)	15 (50%)	30 (100%)
		2 Median	7	2 (29%)	5 (71%)	7 (100%)
Mississippi	9	2 Highest	5	5 (100%)	0 (0%)	5 (100%)
		2 Median	2	2 (100%)	0 (0%)	2 (100%)
Rhode Island	8	2 Highest	5	1 (20%)	3 (60%)	4 (80%)
		2 Median	3	2 (67%)	1 (33%)	3 (100%)
Washington	8	2 Highest	2	2 (100%)	0 (0%)	2 (100%)
		2 Median	2	1 (50%)	1 (50%)	2 (100%)
Tennessee	6	2 Highest	3	3 (100%)	0 (0%)	3 (100%)
		2 Median	2	2 (100%)	0 (0%)	2 (100%)
Total			503	176 (35%)	187 (37%)	363 (72%)

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Missed Connections

Our model is conservative and *underestimates the number of PFAS-contaminated sites*

- Sites with very possible PFAS contamination outside of our presumptive criteria (septic ponds, dry cleaners)

Accuracy of conceptual model is higher than observed in the map; *the map is an underestimation*

- Geolocation issues
- Land use & ownership changes
- Lack of high-quality and nationwide datasets

Table S-6. Presumptive contamination model validation – known contamination data[61]

State	County	Site name	Source	Observed match, presumptive site name(s)	Expected match, Type
ME	Kennebec	Oakland Landfill	Landfill	No	Yes, Landfill
ME	Kennebec	Pat Jackson Septic Compost Facility	WWTP	No	No

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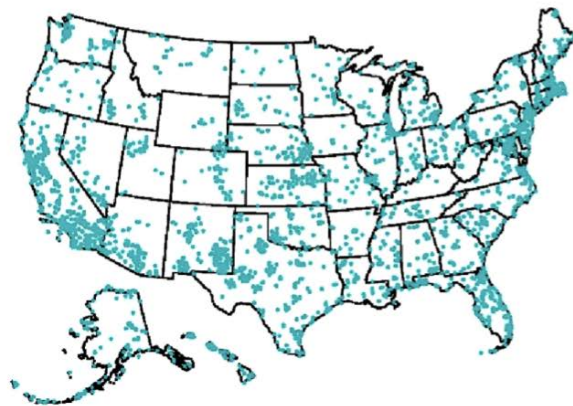# Presumptive Contamination Sites (n=57,412)

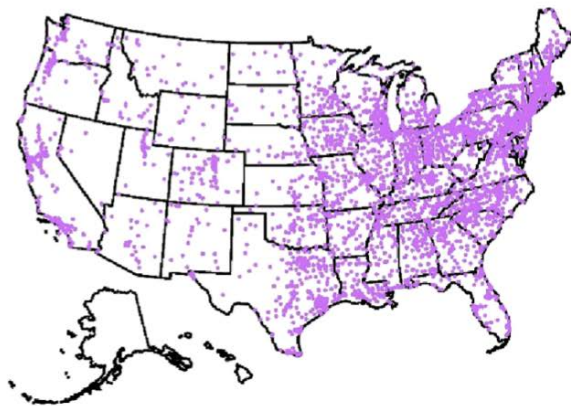

Industrial Facilities (n=49,145)
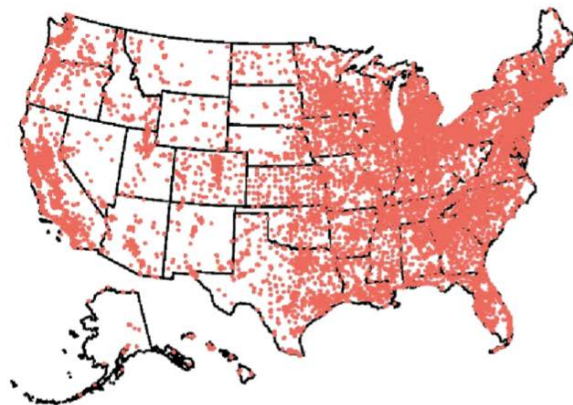
Major Airports (n=519)

Military Sites (n=3,493)

Wastewater Treatment Plants (n=4,255)

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Applications and Next Steps

- Allows regulators, researchers, residents, and other decision-makers to identify presumptive PFAS contamination locations
- Identify and prioritize locations for monitoring, regulation, and remediation

Possible future work:

- Adding more data at smaller geographic scales
- Hazard- or risk-based weighting
- Proximity to other types of locations, such as water supplies, Tribal lands, EJ communities, public parks, or population-dense areas
- Extend to exposure pathways (hydrologic flows, airborne emissions)
- Extend to presumptive PFAS *exposure* based on occupation, residential location, and consumer products

Ongoing work at the PFAS Project Lab, including…

- PFAS Sites and Community Resources Map
- Environmental justice and unequal exposure to PFAS
- PFAS effects on children's immune response (PFAS REACH)
- Health professionals information
- PFAS Advertising and a focus on DuPont's history
- Social costs of PFAS contamination
- PFAS on Indigenous Lands (collaboration with Tribal PFAS Working Group)
- Studying PFAS advocacy and activism
- Studying PFAS governance
- PFAS and regrettable substitution
- PFAS definitions in legislation and regulation

Commentary

Improving governance of "forever chemicals" in the US and beyond

Kimberly K. Garrett [1, 3], Phil Brown [1, 3, 4], Julia Varshavsky [1, 4, 5], Alissa Cordner [1, 2]
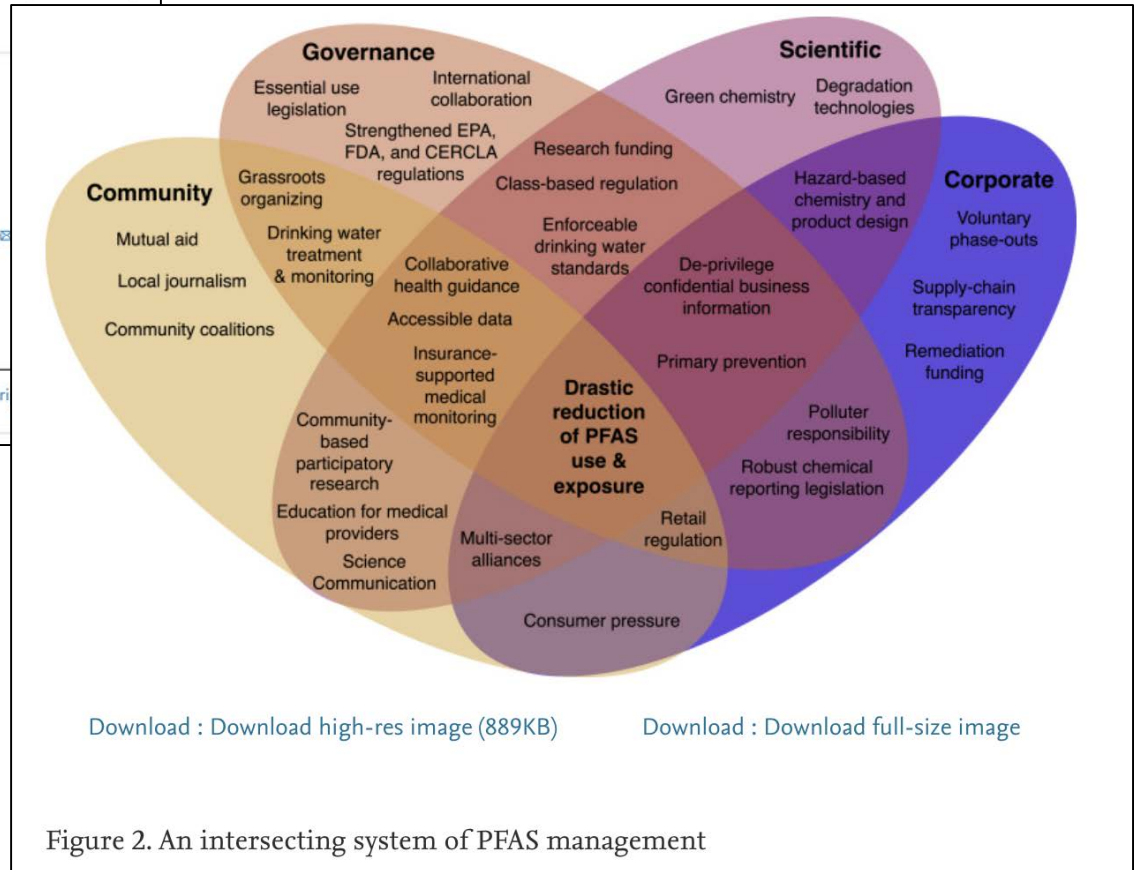
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Figure 2. An intersecting system of PFAS management

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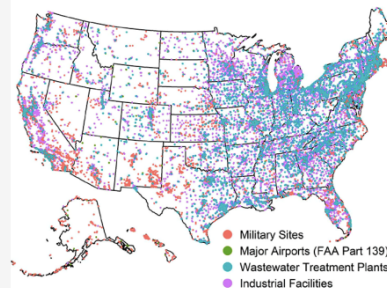
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Presumptive Contamination Sites (n=57,412)

Military Sites
Major Airports (FAA Part 139)
Wastewater Treatment Plants
Industrial Facilities

It's open-access!

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Community and Organizational Collaborators

Testing for Pease

Massachusetts Breast Cancer Coalition

Slingshot

Environmental Working Group

Green Science Policy Institute

Sitting Bull College and the Standing Rock Sioux Tribe

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