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

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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

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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.

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

- **Point sources**: industrial facilities, airports, military bases
- **Non-point sources**: 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)
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
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

- AFFF Discharge
- Industry Facilities
- PFAS – Related Waste

Operationalization
Presumptive PFAS Contamination

**Conceptual Model:**

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

- **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)

- **Sites Related to PFAS-Containing Waste**
  - Wastewater Treatment Plans (Clean Watershed Needs Survey)

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

**Expected: Types of Sites Not Included in Map**

- Other AFFF discharge sites, including airplane crash sites, firefighting training site, petroleum refinery fires, and others
- Facilities with FRS geolocation scores ≥1,000
- Facilities using or emitting PFAS whose NAICS code is not included in our model
- 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 Newprint) 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)           |
| 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                                         |
| 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

Known PFAS Contamination Sites

Presumptive PFAS Contamination Sites
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
Predictive Power

NH Known

NH Presumptive

TN Known

TN Presumptive

NH Validation = 52 - 61% accuracy

TN Validation = 100%
| State          | Known contamination sites, n | Consolidated county known contamination<sup>b</sup> | Known contamination sites, n | Observed matches<sup>c</sup>, n (%) | Expected matches (not observed)<sup>d</sup>, n (%) | Total matches<sup>e</sup>, 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%*)                    |                                 |
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 data⁶¹ |
|-------------------|----------------|----------------|----------------|
| **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 |
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)
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
Improving governance of “forever chemicals” in the US and beyond

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Figure 2. An intersecting system of PFAS management

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