



GREEN SCIENCE
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PFAS: Chemistry, Sources & Policy

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Green Science Policy Institute

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BRJ BUILDING RESEARCH & INFORMATION (2012) 40(6), 738-755

INFORMATION PAPER

Fit for building insulation: ... codes

ENVIRONMENTAL Science & Technology LETTERS

Novel and High Volume Use Flame Retardants in US Couches
Heather M. Thomas F., P. Lee Ferguson, Michelle Gabriel

Fluorine in U.S. Fast Food Packaging
Laurel A. Schaidler, Philippe Grandjean, Rainer Lohmann, Courtney C. Carignan, Arlene Blum, Simona A. Balan, Christopher P. Higgins, and Elsie M. Sunderland

Detection of Poly- and Perfluoroalkyl Substances (PFASs) in U.S. Drinking Water Linked to Industrial Sites, Military Fire Training Areas, and Wastewater Treatment Plants
Xindi C. Hu, David Q. Andrews, Andrew B. Lindstrom, Thomas A. Bruton, Laurel A. Schaidler, Philippe Grandjean, Rainer Lohmann, Courtney C. Carignan, Arlene Blum, Simona A. Balan, Christopher P. Higgins, and Elsie M. Sunderland

Supporting Information

ABSTRACT: Drinking water contamination with poly- and perfluoroalkyl substances (PFASs) poses risks to the developmental, immune, metabolic, and endocrine health of consumers. We present a spatial analysis of 2013–2015 national drinking water PFAS concentrations from the U.S. Environmental Protection Agency's (US EPA) third Unregulated Contaminant Monitoring Rule (UCMR3) program. The number of industrial sites that manufacture or use these compounds, the number of military fire training areas, and the number of wastewater treatment plants are all significant




Education



Retreats

Research

Policy & Purchasing Change

A large, dense pile of multi-colored jelly beans in various colors including red, orange, yellow, green, blue, purple, and pink. The text is overlaid on the center of the image.

**EVALUATING TENS OF THOUSANDS OF
INDIVIDUAL CHEMICALS IS UNWORKABLE**



BUT ADDRESSING **SIX GROUPS** OF
CHEMICALS OF CONCERN IS MANAGEABLE



1

Highly
Fluorinated

2

Antimicrobials

3

Flame
Retardants

4

Bisphenols
+ Phthalates

5

Some
Solvents

6

Certain Metals



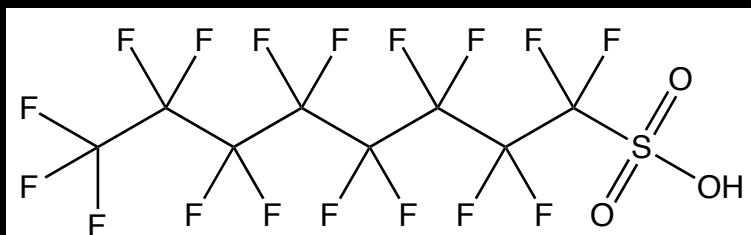
1

Highly
Fluorinated

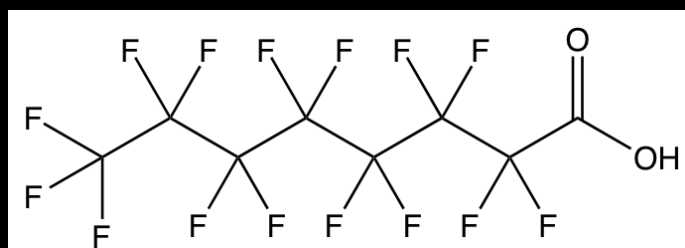


Highly Fluorinated Chemicals

PFOS

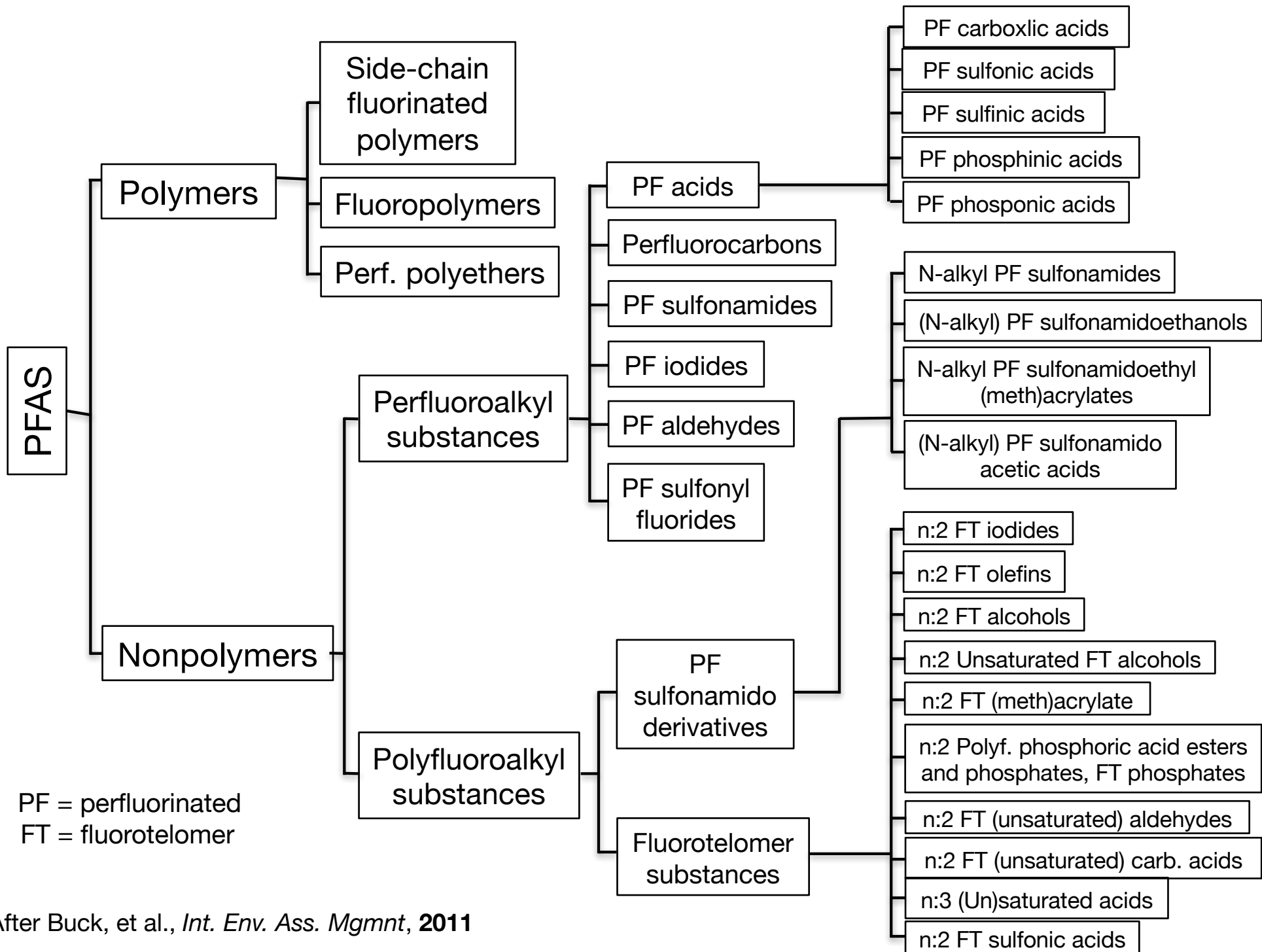


PFOA

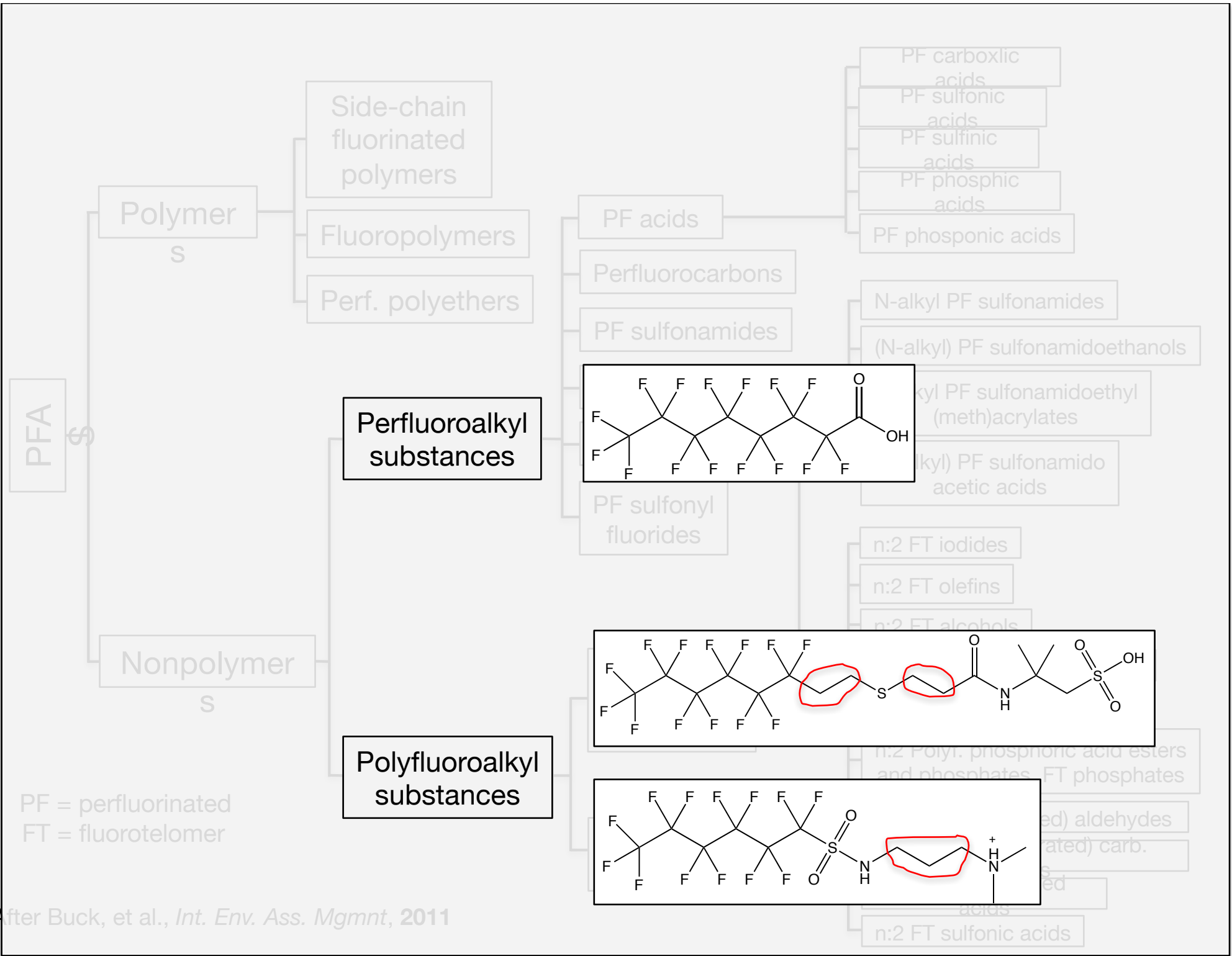


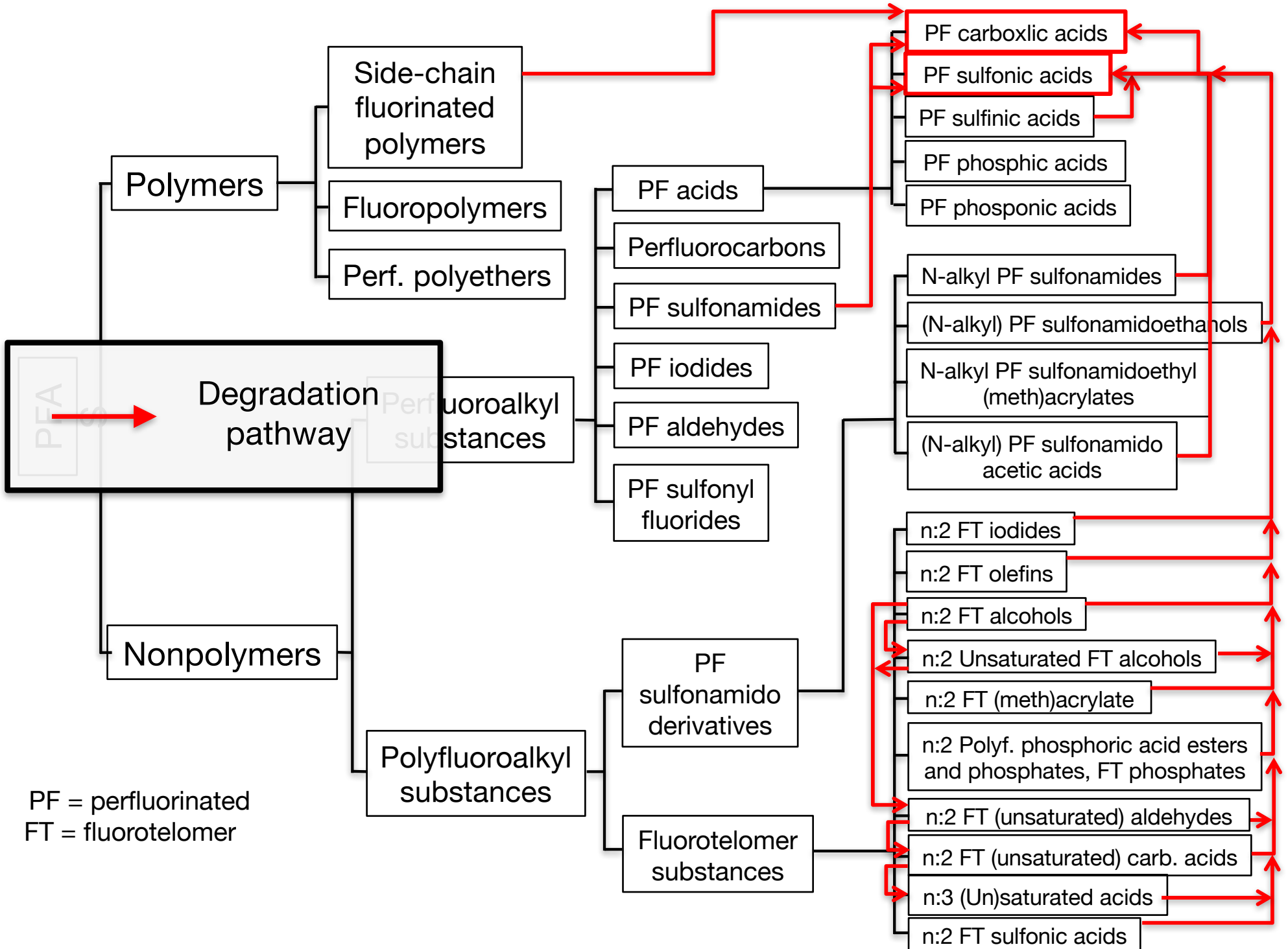
Carbon-Fluorine bond strength:

- Leads to oil and water repellency
- “Forever chemicals” -- last for geologic time!



After Buck, et al., *Int. Env. Ass. Mgmnt*, 2011





Common Uses



CARPETS



CARPET CLEANING PRODUCTS



FOOD PACKAGING



FURNISHINGS



COSMETICS



OUTDOOR GEAR



CLOTHING



ADHESIVES AND SEALANTS



PROTECTIVE COATINGS



NON-STICK COOKWARE



CARSEATS



FIREFIGHTING FOAM

PFASs exposure is a health concern



Exposure linked to health risks:

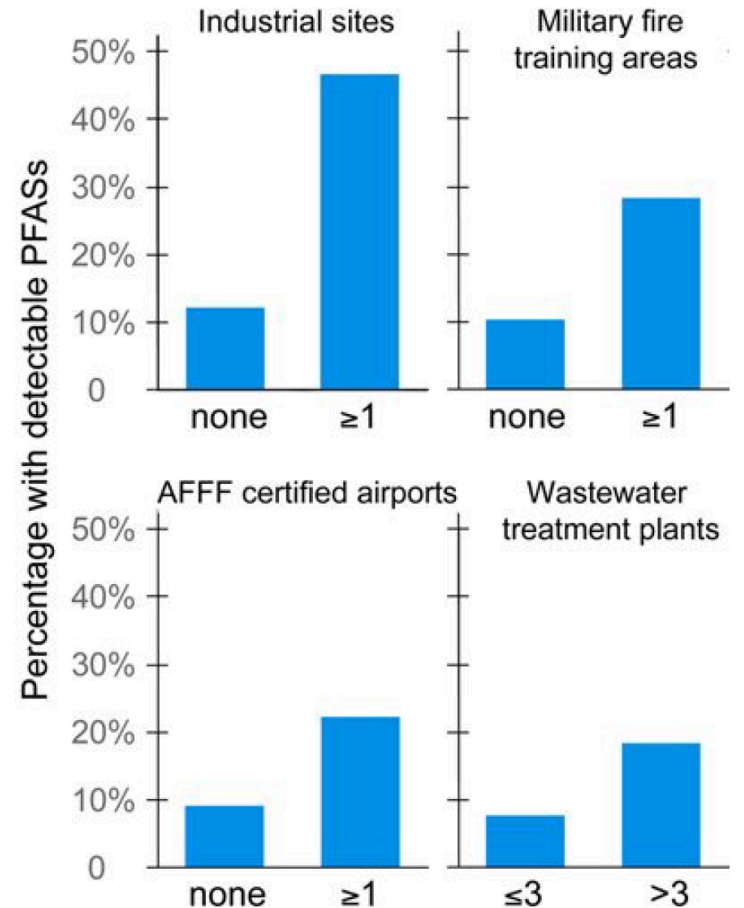
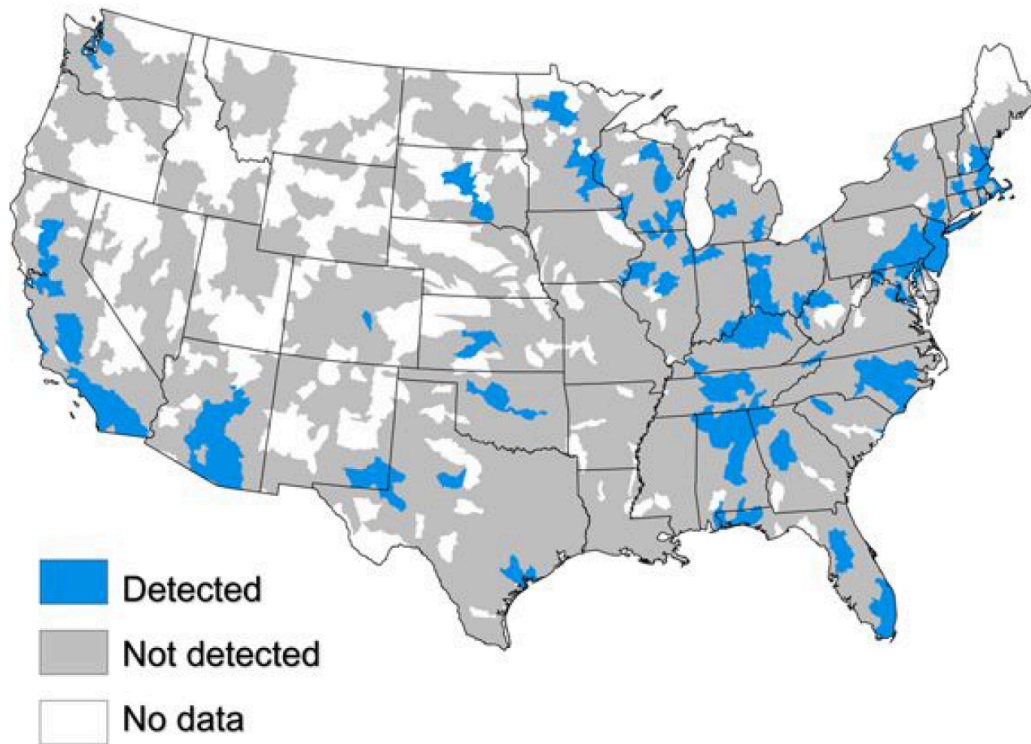
Cancer, elevated cholesterol, obesity, immune suppression, and endocrine disruption

Courtesy, Cindy Hu, Harvard University

(Ref: Lewis et al., 2015; Grandjean et al., 2012; Braun et al., 2016; Barry et al., 2013)

EPA Lifetime Health Advisory Level of 70 ng/L PFOA + PFOS

Hydrological units with detectable PFASs



Hu et al., Environ. Sci. Technol. Lett. 2016

Drinking Water Health Guidelines

DuPont
PFOA: 5000

DuPont
PFOA: 1000

U.S. EPA
PFOA: 400

U.S. EPA
PFOA: 70

New
Jersey
PFOA: 14

New York
PFOA: 10

1987

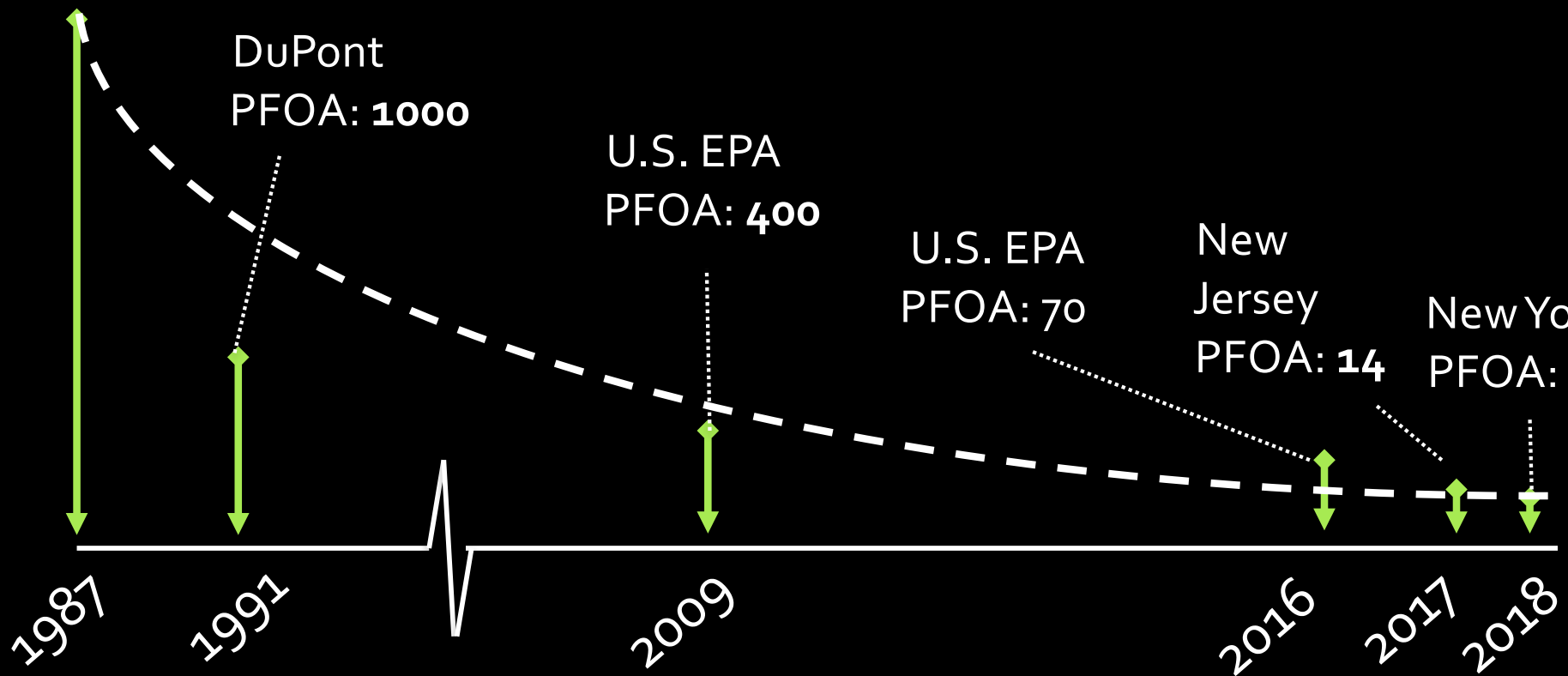
1991

2009

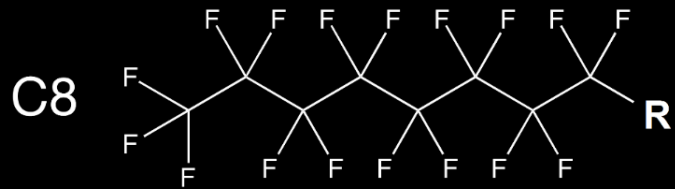
2016

2017

2018



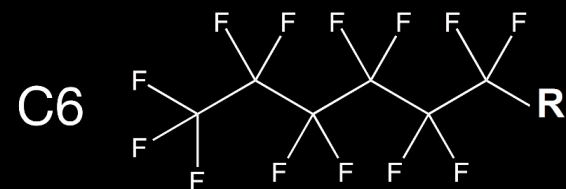
Industrial Transition



Long-chain PFAS

Concerns:

- Extreme persistence
- **Bioaccumulation**
- Toxicity



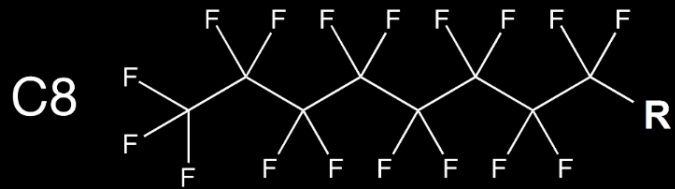
Short-chain PFAS

- "Favorable toxicological profile"¹
- "Safe for intended use"²

1. https://www.chemours.com/Industrial_Bakery_Solutions/en_GB/sustainability/dibs_genx.html

2. <https://fluorocouncil.com/fluorotechnology/terminology/>

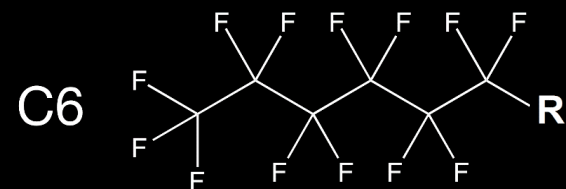
Is C6 a safer substitute for C8?



Long-chain PFAS

Concerns:

- Extreme persistence
- **Bioaccumulation**
- Toxicity

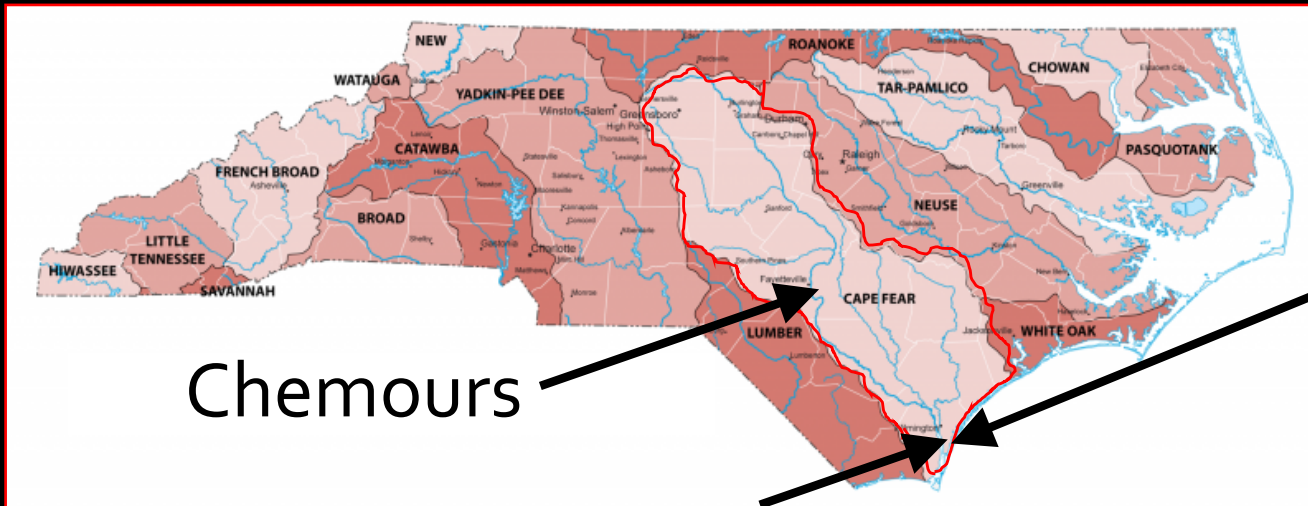


Short-chain PFAS

Concerns:

- Extreme persistence
- Build up in plants
- Suspected toxicity
- More mobile
- Remediation more difficult

Water Treatment Costs: North Carolina



Chemours

Brunswick County:
reverse osmosis
filtration:

- \$99M to build
- \$2.9M to operate

Cape Fear Public Utility Authority
activated carbon filtration:

- \$46M to build
- \$2.7M to operate each year

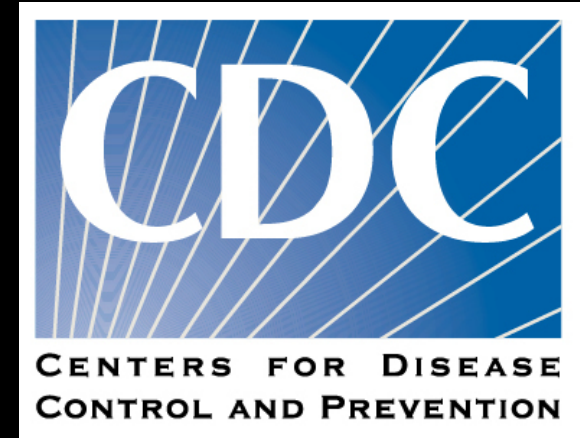
Wilmington Star News,
May 9th and 10th, 2018

Recent comments from CDC

Patrick Breysse, Director of the CDC's National Center for Environmental Health:

The presence of perfluorinated chemicals in U.S. drinking water is "one of the most seminal public health challenges for the next decades."

"...it won't be too long before we think hundreds of millions of Americans will be drinking water with levels of these chemicals above levels of concern."



- BNA News, Oct. 17, 2017

Congressional PFAS Task Force

- Launched 1/24/19
- Goals
 - Educate
 - Legislate
 - Elevate
 - Appropriate



- **Members:**

Lujan (NM-03)

King (NY-03)

McGovern (MA-02)

Upton (MI-06)

Huizenga (MI-02)

Dingell (MI-12)

Turner (OH-10)

Boyle (PA-02)

Walberg (MI-07)

Lawrence (MI-14)

Bergman (MI-01)

Dean (PA-04)

Delgado (NY-19)

Levin (MI-09)

Stevens (MI-11)

Slotkin (MI-08)

Tlaib (MI-13)

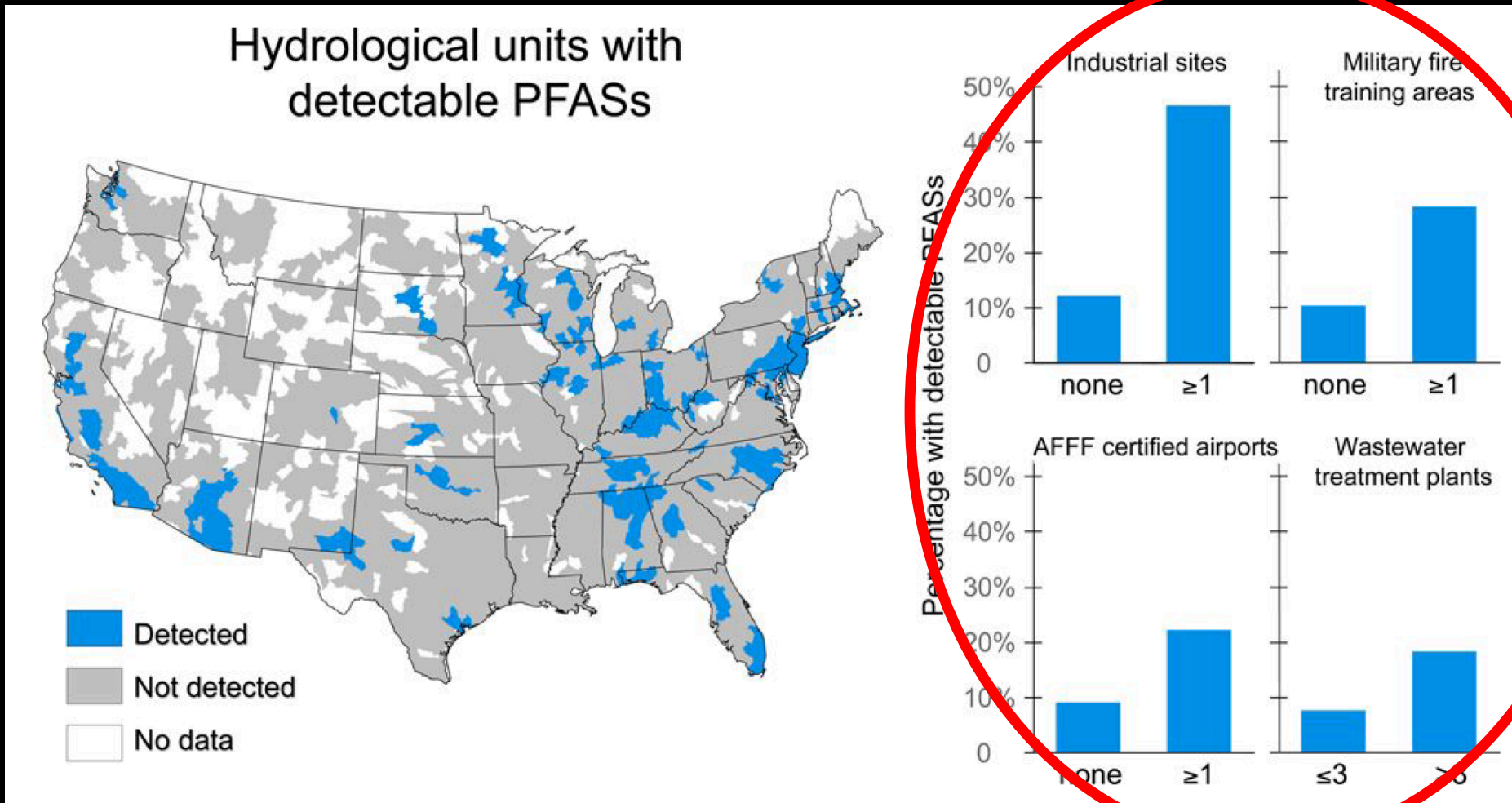
Maloney (NY-18)

Pappas (NH-04)

PFAS are Problematic
& Difficult to Clean Up

Prevention is Preferable!

EPA Lifetime Health Advisory Level of 70 ng/L PFOA + PFOS



Hu et al., Environ. Sci. Technol. Lett. 2016

Industrial facilities

- Primary manufacturing
 - Where PFAS are made
 - Relatively few
 - Responsible for massive amounts of emissions
- Secondary manufacturing
 - Where PFAS are used
 - More common



Primary Manufacturing: WV Fluorochemical plant

- PFOA used to manufacture fluoropolymers
- Releases to air, groundwater, surface water
- 70,000 + residents with contaminated drinking water
- C8 Health Study + class action suit



Secondary Manufacturing: Michigan leather tannery

- Wolverine treated leather with Scotchguard (PFOS)
 - Leather scrap dumped
 - Sludge applied to fields



- PFOA + PFOS level up to 58,000 ppt
842 times EPA health advisory level!

Secondary Manufacturing: other examples

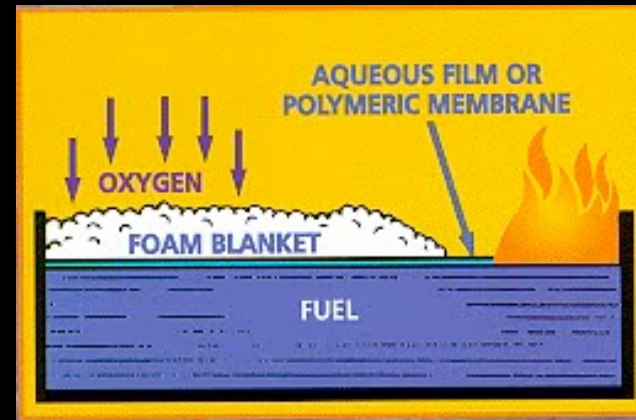
- Hoosick Falls, NY
 - Bennington, VT
 - Merrimack, NH
 - Parchment, MI
- } PFAS-coated fabrics/plastics
- Paper mill
- Likely many others

Firefighting foam



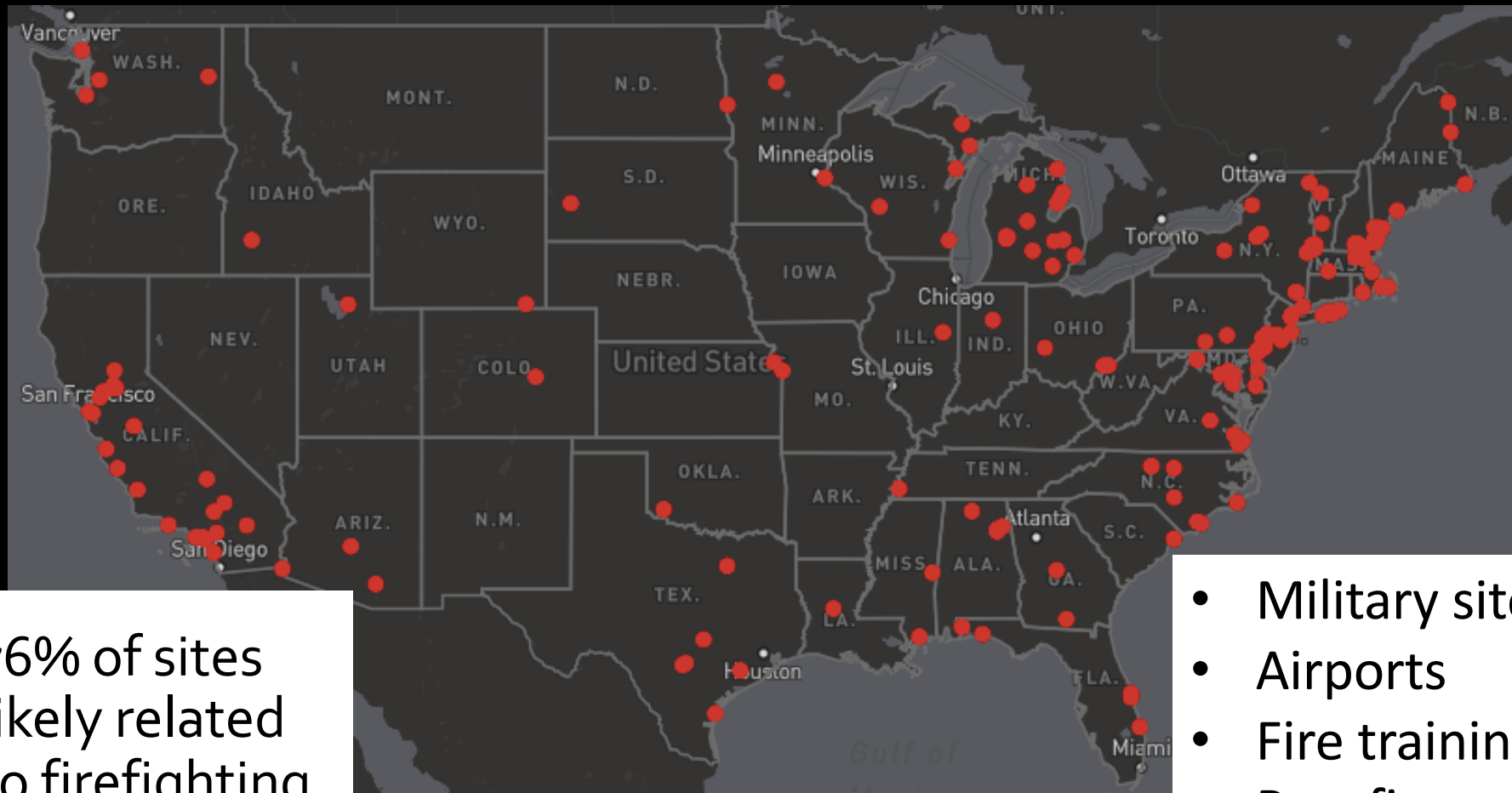
Aqueous Film-Forming Foams (AFFF)

- For fighting Class B (petroleum) fires
- Contains PFAS
- Used by military, airports, municipal firefighters, oil & gas industry
- High concentrations of PFAS now found in soil and groundwater at training sites



Foam as a Source of Water Contamination

Northeastern U. and EWG Site Tracker, 10/4/18



76% of sites likely related to firefighting foam use

- Military sites
- Airports
- Fire training
- Past fires

New Mexico

- Cannon Air Force Base
 - Firefighting foam entered groundwater
 - PFAS migrated from base to dairy wells to cows to milk
 - Farmer: "I can't sell the milk. I can't sell beef. I can't sell the cows. I can't sell crops on my property."
 - **PFOS level up to 12,000 ppt**
171 times EPA health advisory level!



Government policy is a major driver of AFFF use

- Class B firefighting foams used by the U.S. military are required to contain PFAS.
 - MILSpec: “Concentrates shall consist of fluorinated surfactants...”
- U.S. civilian airports are also required to use PFAS-containing foam
 - FAA policy refers to MILSpec

Fluorine-Free Foams

“Current fluorine-free ... firefighting foams are now viable operational alternatives to fluorinated AFFF.”



“Unlike fluorinated AFFFs, fluorine-free foams do not give rise to environmentally persistent, toxic, or bio-accumulative chemically stable end-products.”

<https://ipen.org/documents/fluorine-free-firefighting-foams>

Washington State's Ban on PFAS in Firefighting Foam

(HB 2793/SB 6413)



- Signed into law on March 27, 2018
- Bans sale of firefighting foam containing any PFAS beginning July 1, 2020
- **The states of CT, GA, KY, MA, MN, NY have similar bills this year**

More info <https://toxicfreefuture.org/key-issues/legislative-priorities-2018/>

Congress to FAA: allow the use of fluorine-free foams

2018 FAA Reauthorization

- Directs FAA to allow airports to use PFAS-free Class B firefighting foams (within 3 years)
- Signed into law Oct. 5
- Response from FAA?



Congress to DoD: allow the use of fluorine-free foams

U.S. Senate Armed Services Committee, in its report
on the defense authorization bill:

- *“the committee strongly encourages the Department of the Navy to amend MILSPEC F-24385 to no longer require fluorine in [firefighting foam], as appropriate.*

WWTPs



WWTPs

- Source of PFAS loading
 - Industrial – electroplating, firefighting foam, other?
 - Consumer – carpets, apparel, food packaging, cosmetics, other
- Conventional treatment trains not effective for PFAS removal
 - Effluent > influent!
- Partitioning to biosolids
 - Long-chains > short-chains

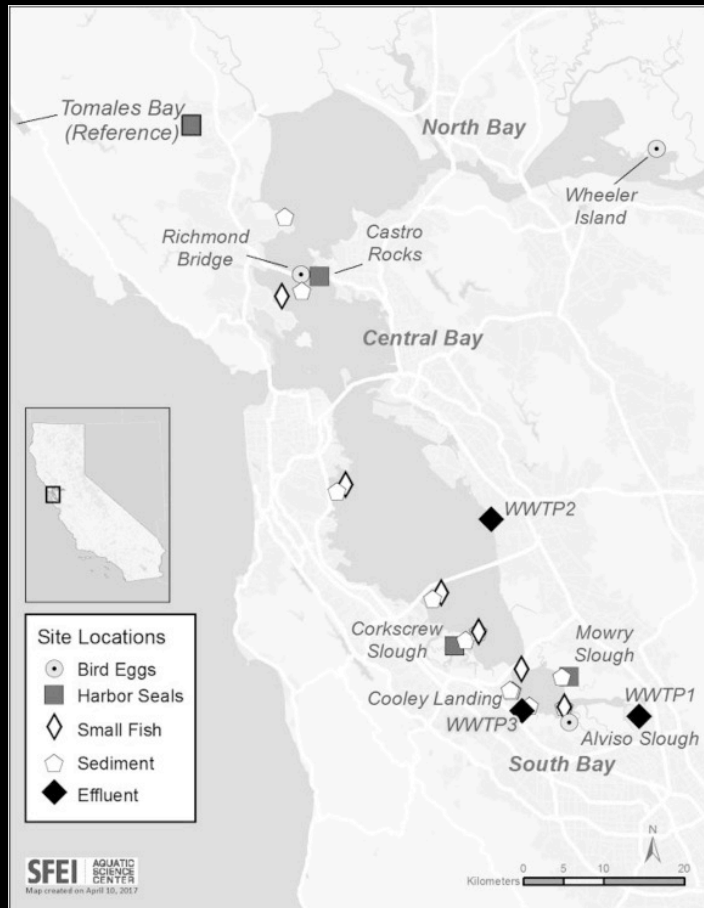
Maine

- Biosolids spreading leads to contamination of
 - Milk at dairy
 - Local municipal supply well



- Maine DEP response:
 - All biosolids must now be tested for PFAS prior to use

SFEI Regional Monitoring Program



Concentrations of PFOS in SF Bay cormorant and seals are some of the highest observed worldwide.

Moving away from PFAS



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CARPET CLEANING PRODUCTS



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FURNISHINGS



COSMETICS



OUTDOOR GEAR



CLOTHING



ADHESIVES AND SEALANTS



PROTECTIVE COATINGS



NON-STICK COOKWARE



CARSEATS



FIREFIGHTING FOAM



By reducing use of Six Classes

We can have a healthier world.

**For more information
Green Science Policy Institute
www.greensciencepolicy.org**