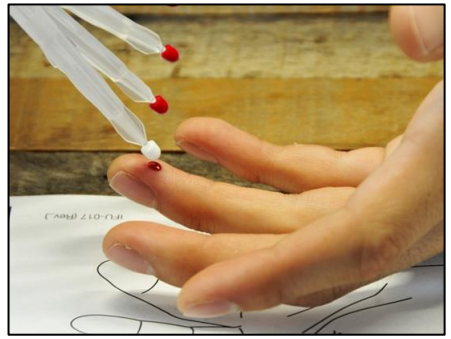
PFAS 'Forever Chemicals' in Michigan: Actionable Information for Healthcare Providers





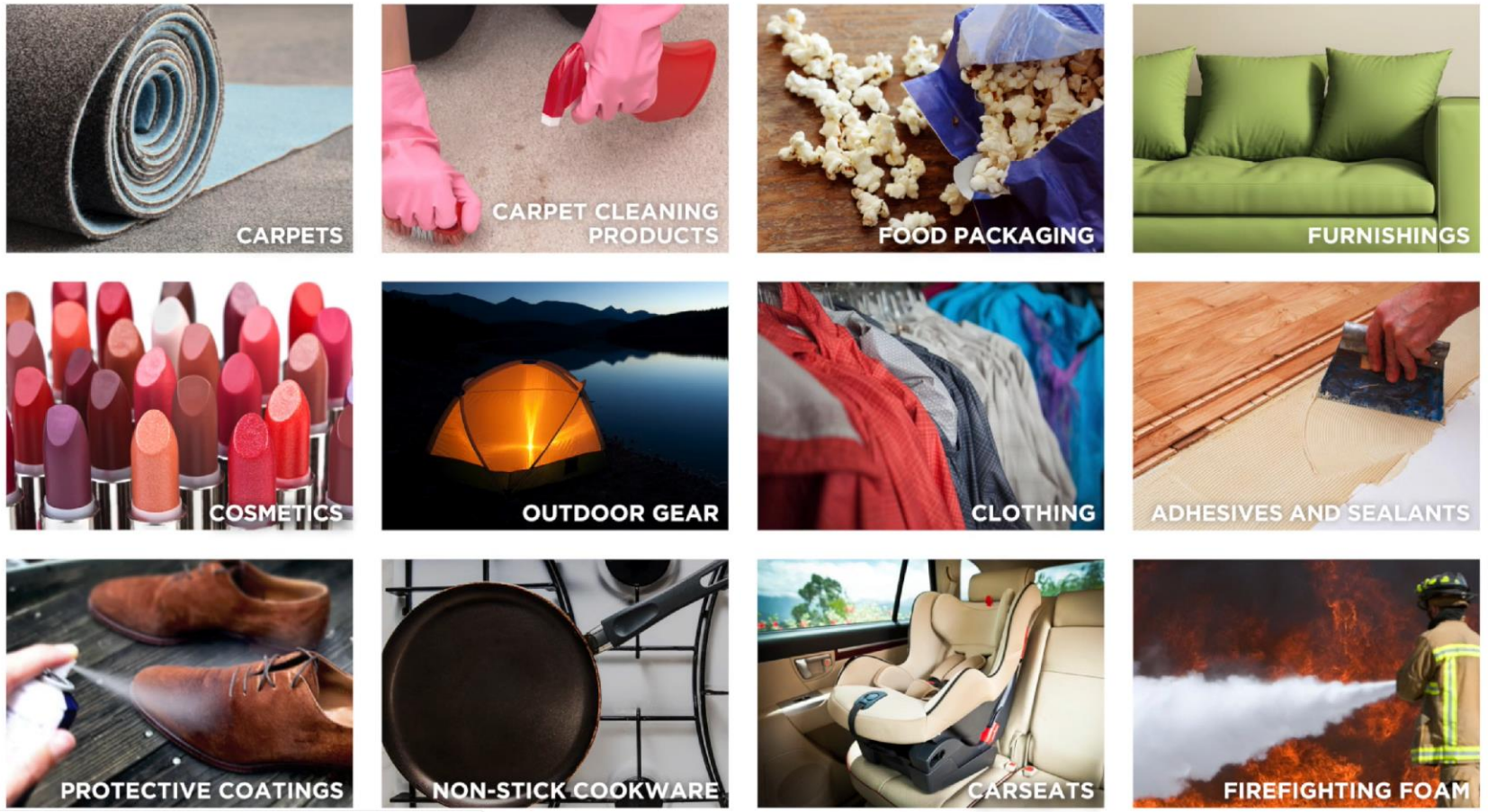
Courtney Carignan, Ph.D.
Michigan State University

Alliance of Nurses for Healthy Environments
September 18, 2024

Outline

1. PFAS 101
2. Community Perspectives
3. PFAS Exchange & Continuing Medical Education
4. National Academies Clinician Guidance

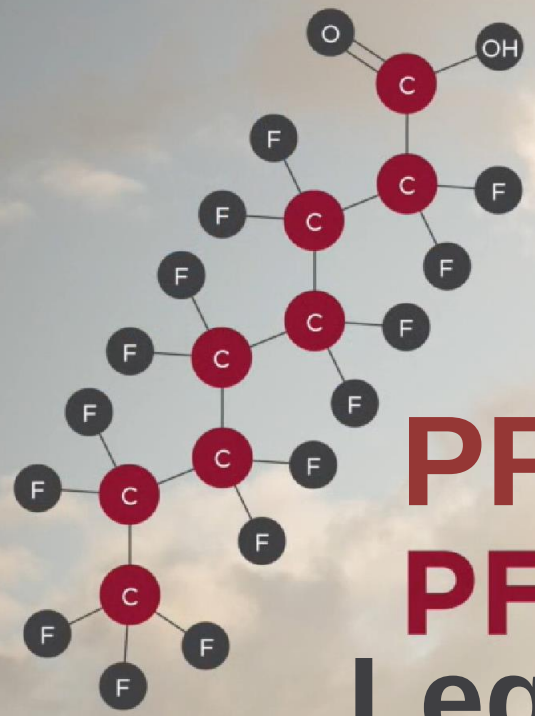
Provide Stain, Grease, Water and Fire Resistance



https://www.voutube.com/watch?v=imZUJJ8keBE

SIXCLASSES.ORG
GREEN SCIENCE POLICY INSTITUTE

Also:
Stain and water-resistant sprays
Medical devices (& stent coating)
Home barrier insulation
Specialty paints (e.g., outdoor)
Paper coatings
Ski wax, bike & auto lube
Semiconductor manufacturing
Solar panels
Cleaners (auto, chain, gun, piano)
Hydraulic fracturing lubricant
Chrome plating fume suppressant
Shaving, ‘gliding’ floss, Band aids



Per- and Polyfluoroalkyl Substances (PFAS)

Class of over 12,000 fluorinated chemicals
'Forever Chemicals'

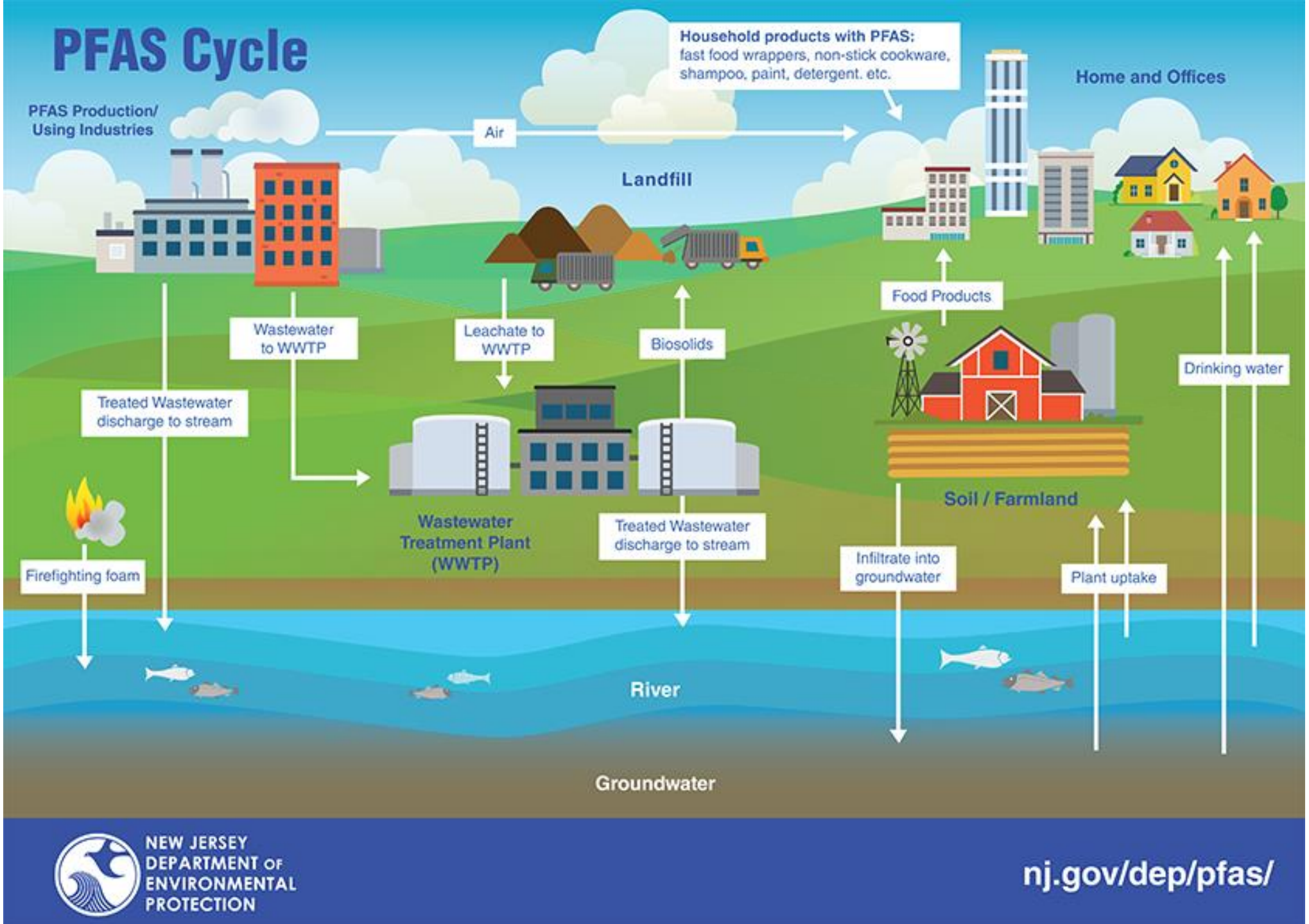
C8

PFOS
PFOA
Legacy

C6 | C4 | C3

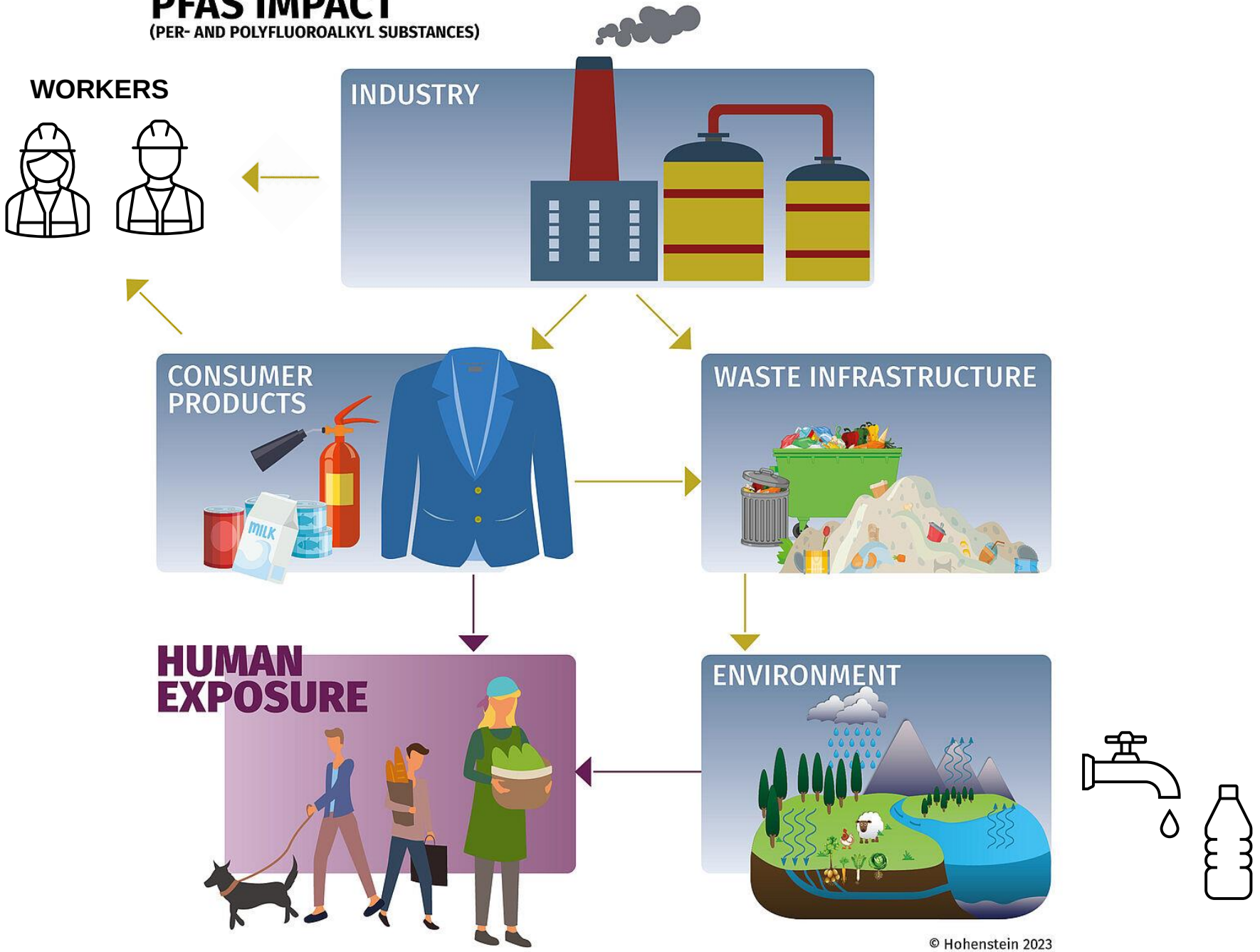
Current Use

https://www.youtube.com/watch?v=jmZUJJ8keBE

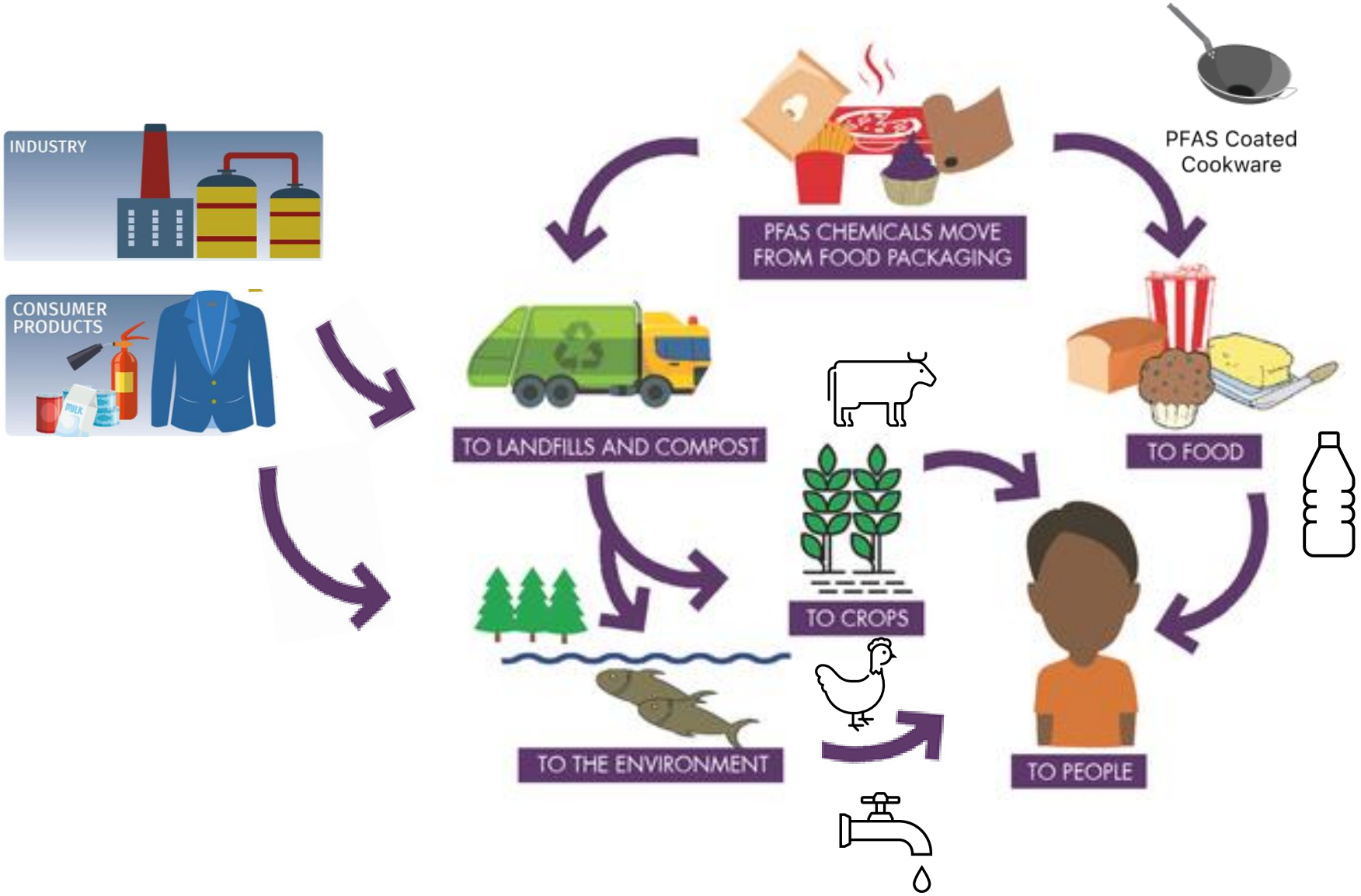

PFAS Cycle
Household products with PFAS:
fast food wrappers, non-stick cookware, shampoo, paint, detergent. etc.
Home and Offices
PFAS Production/
Using Industries
Air
Landfill
Food Products
Wastewater
to WWTP
Leachate to
WWTP
Biosolids
Drinking water
Treated Wastewater
discharge to stream
Wastewater
Treatment Plant
(WWTP)
Soil / Farmland
Firefighting foam
Treated Wastewater
discharge to stream
Infiltrate into
groundwater
Plant uptake
River
Groundwater
NEW JERSEY
DEPARTMENT OF
ENVIRONMENTAL
PROTECTION
nj.gov/dep/pfas/

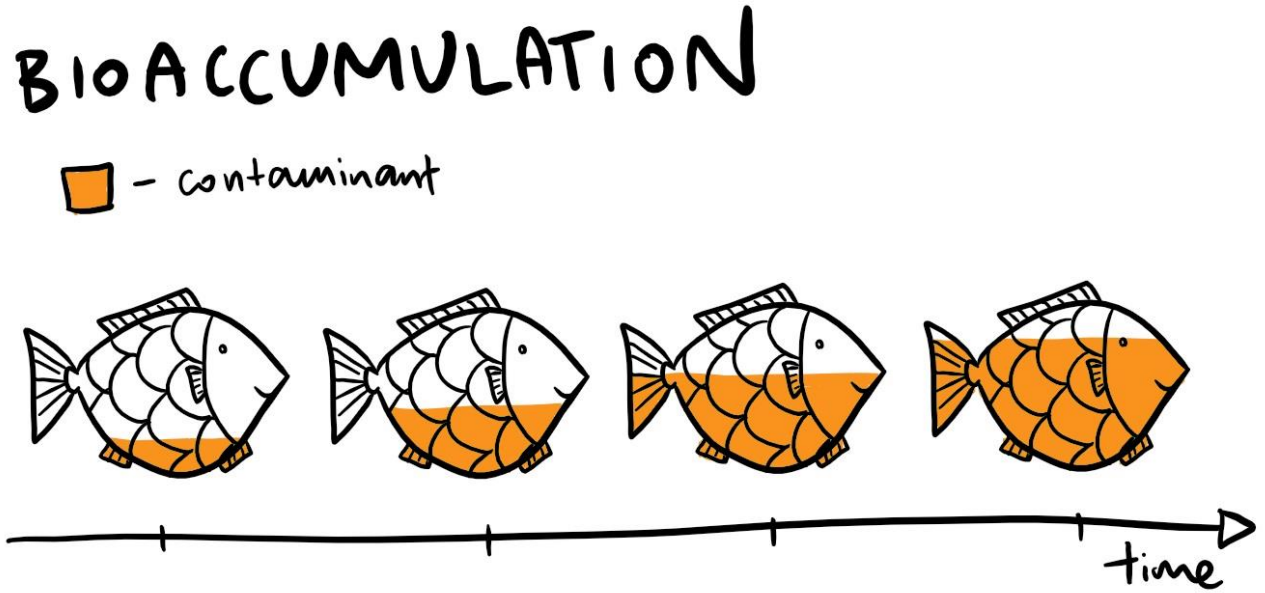
PFAS IMPACT

(PER- AND POLYFLUOROALKYL SUBSTANCES)

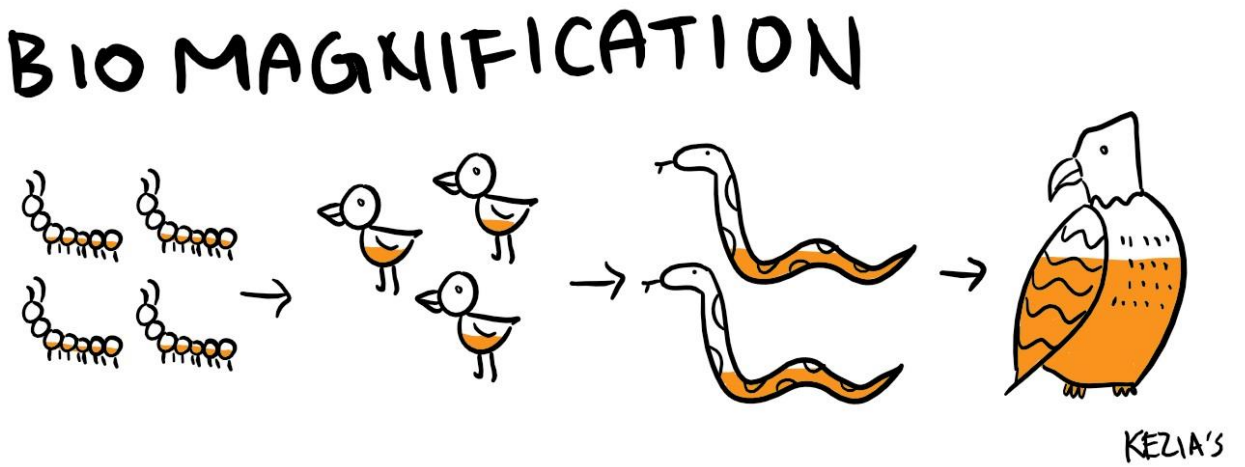


© Hohenstein 2023


INDUSTRY
CONSUMER PRODUCTS
PFAS CHEMICALS MOVE FROM FOOD PACKAGING
PFAS Coated Cookware
TO LANDFILLS AND COMPOST
TO FOOD
TO CROPS
TO THE ENVIRONMENT
TO PEOPLE

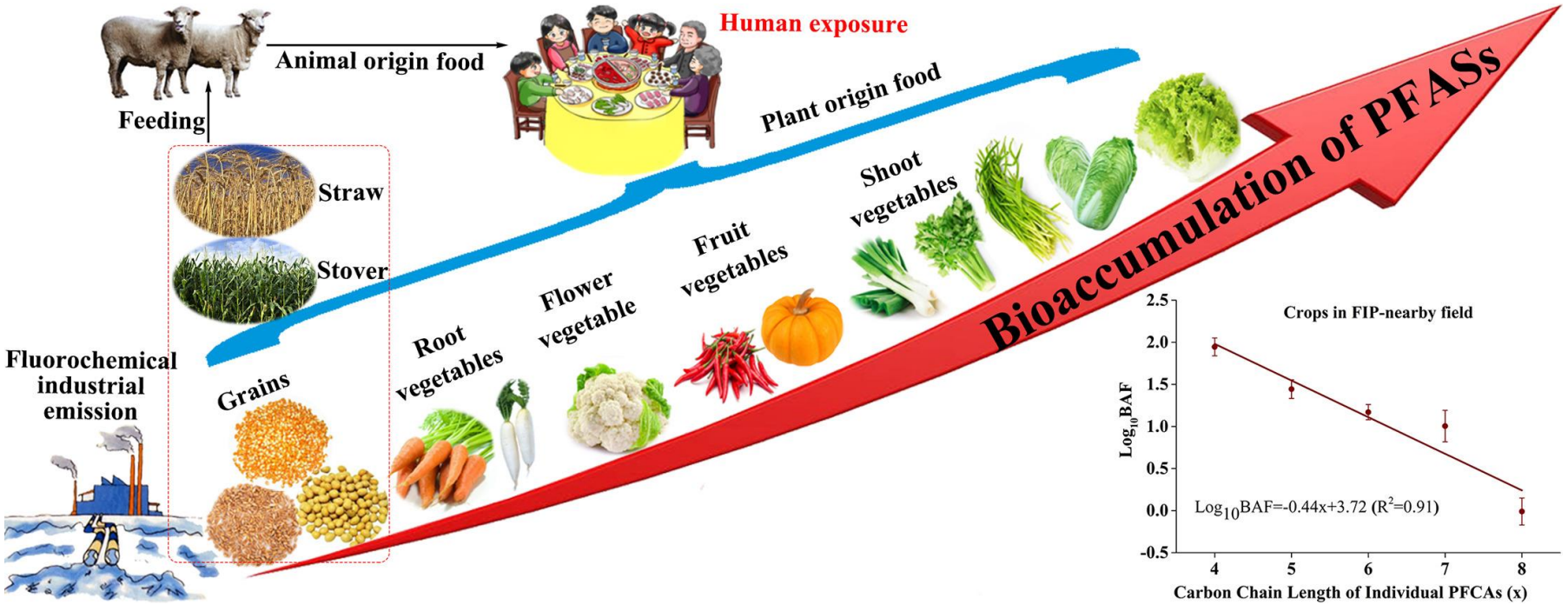


Bioaccumulate in animals over time



Biomagnify up the food chain

Legacy (long-chain) PFAS bioaccumulate in animals

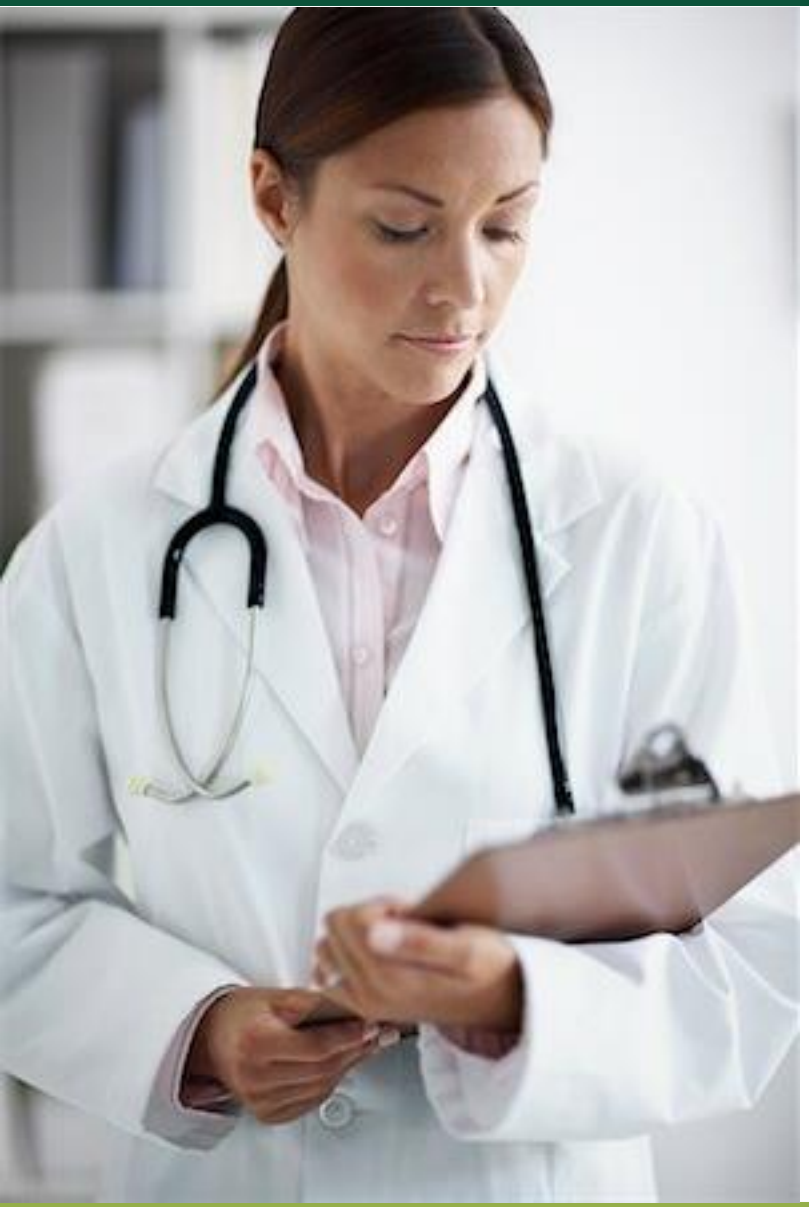


Current use (short-chain) PFAS are taken up into produce

Liu et al 2019

Found in the bodies of most Americans

Born exposed



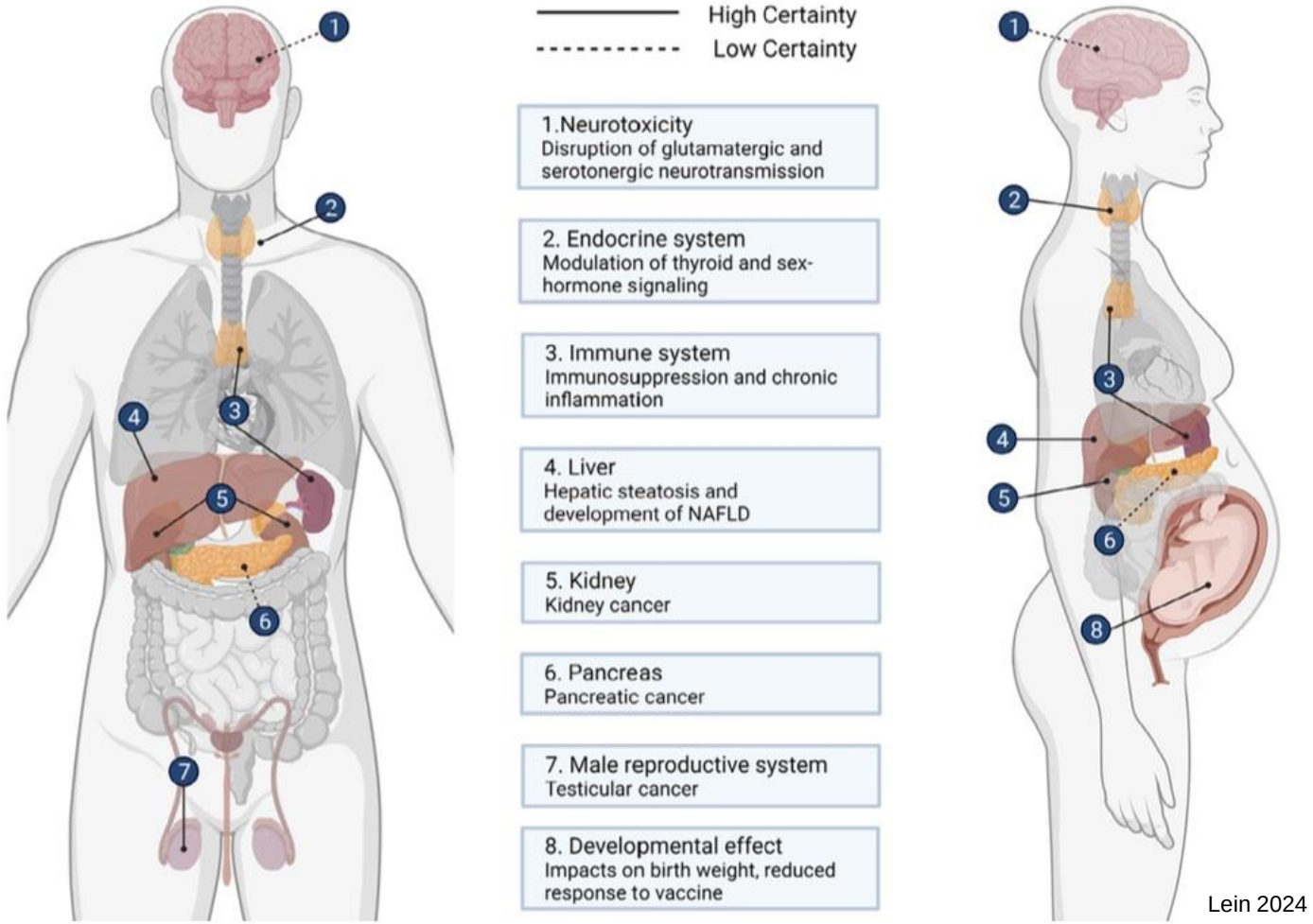
Health Concerns:

- High cholesterol
- Decreased infant and fetal growth
- Certain cancers (kidney, testicular)
- Pregnancy induced hypertension
- Thyroid disease and dysfunction
- Ulcerative colitis

C8 Health Study

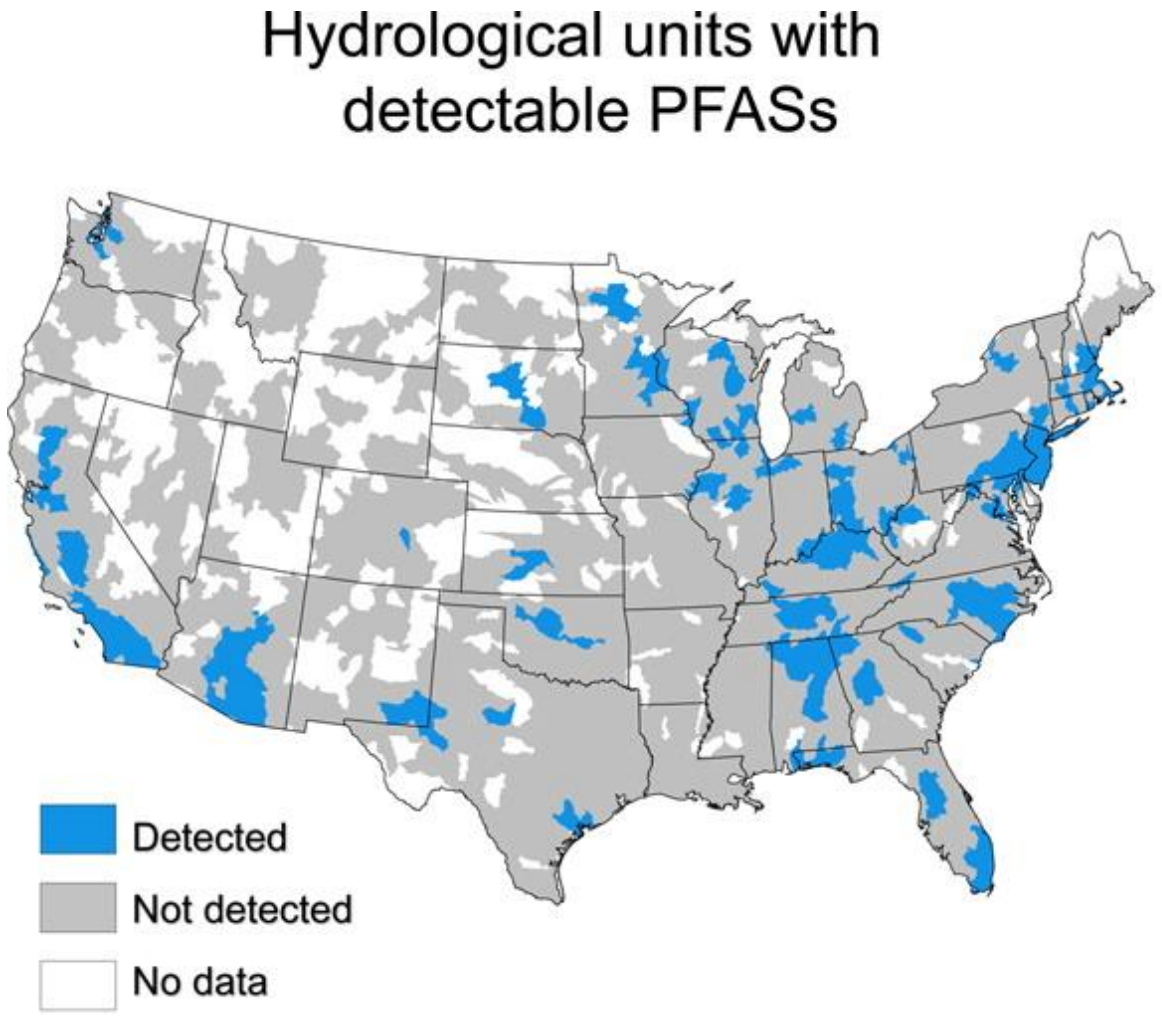
Figure 2: *Toxicological effects of PFAS on human biology. Solid lines indicate biological effects for which there is strong evidence; dashed lines, biological effects for which there is more limited evidence.*

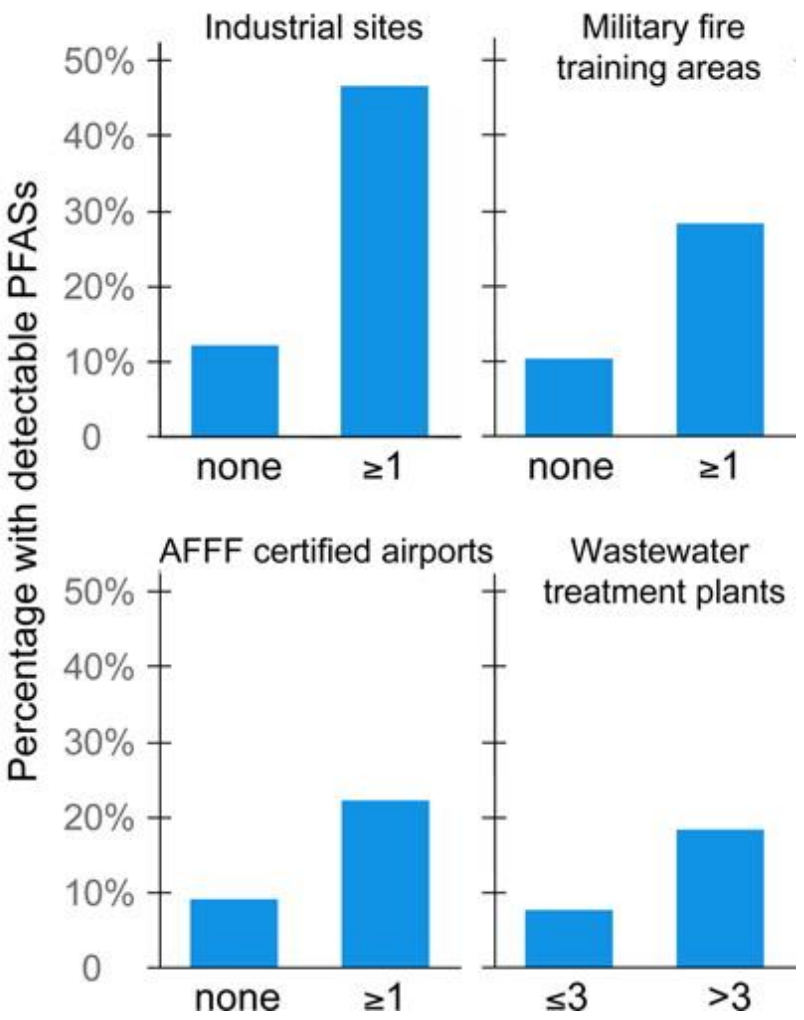
Updated list includes immune, liver, reproductive, and other effects.



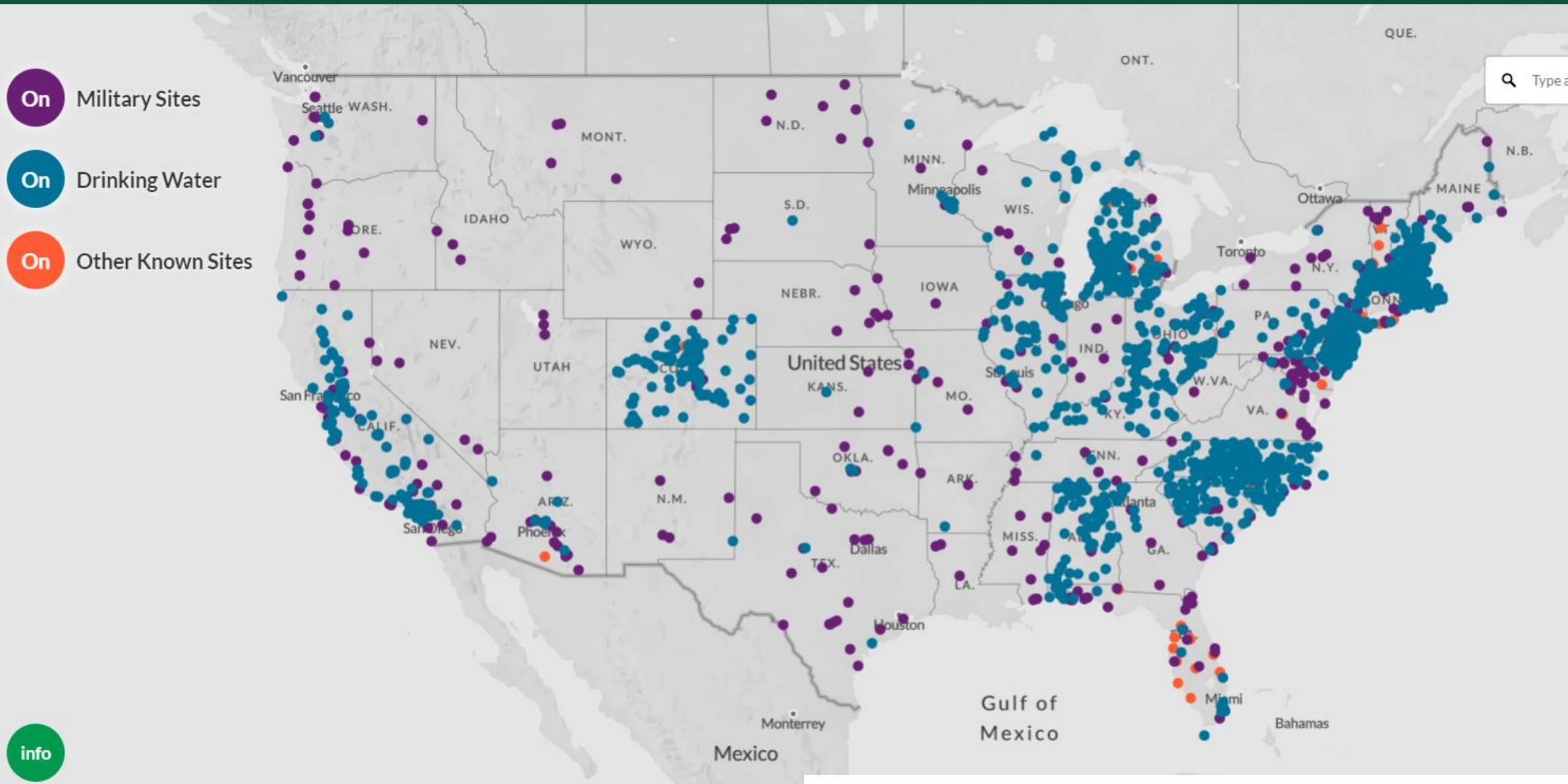
Lein 2024

Estimated 6 Million Americans with Impacted Water

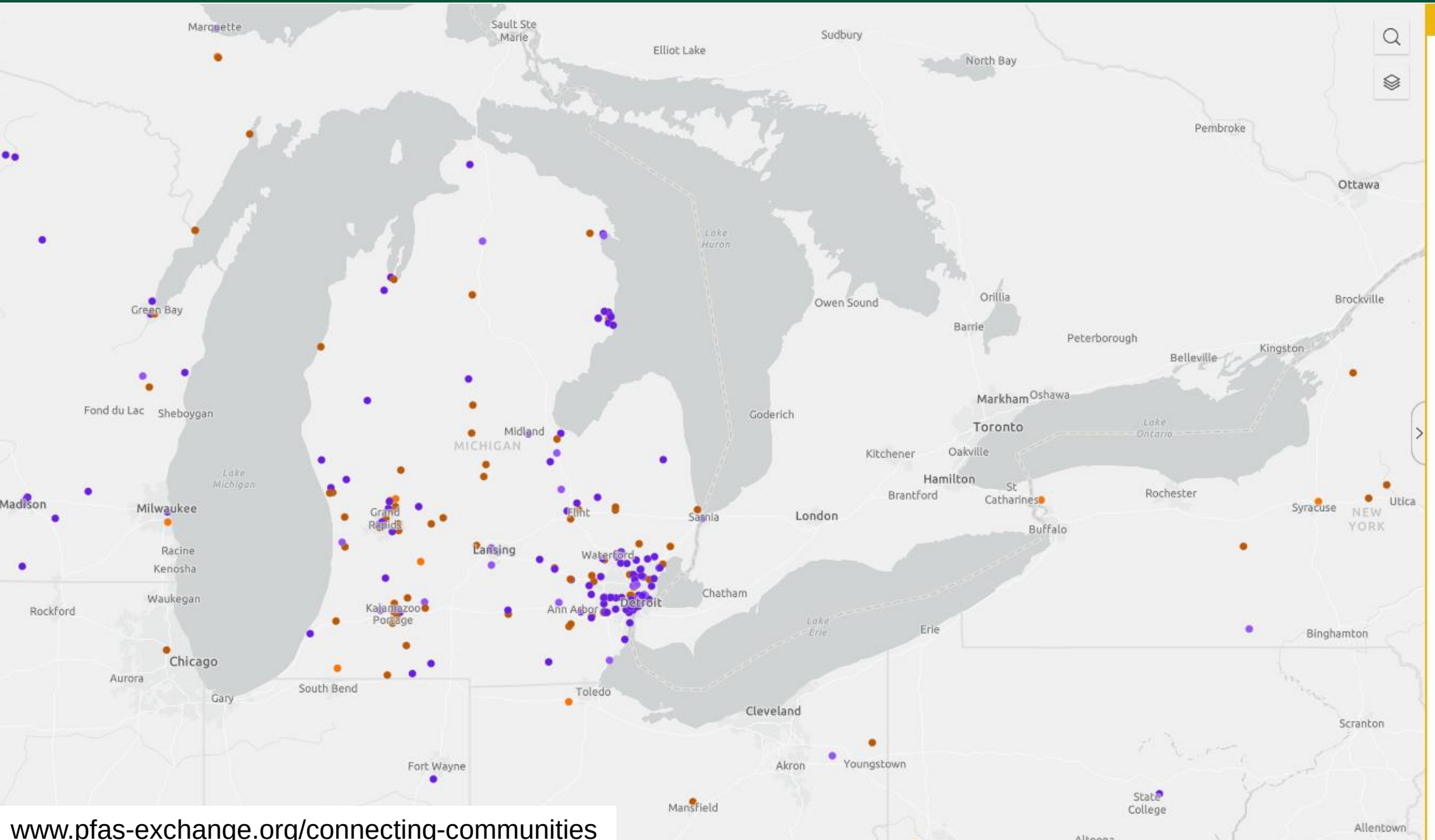




Hu et al. ES&T Letters 2016

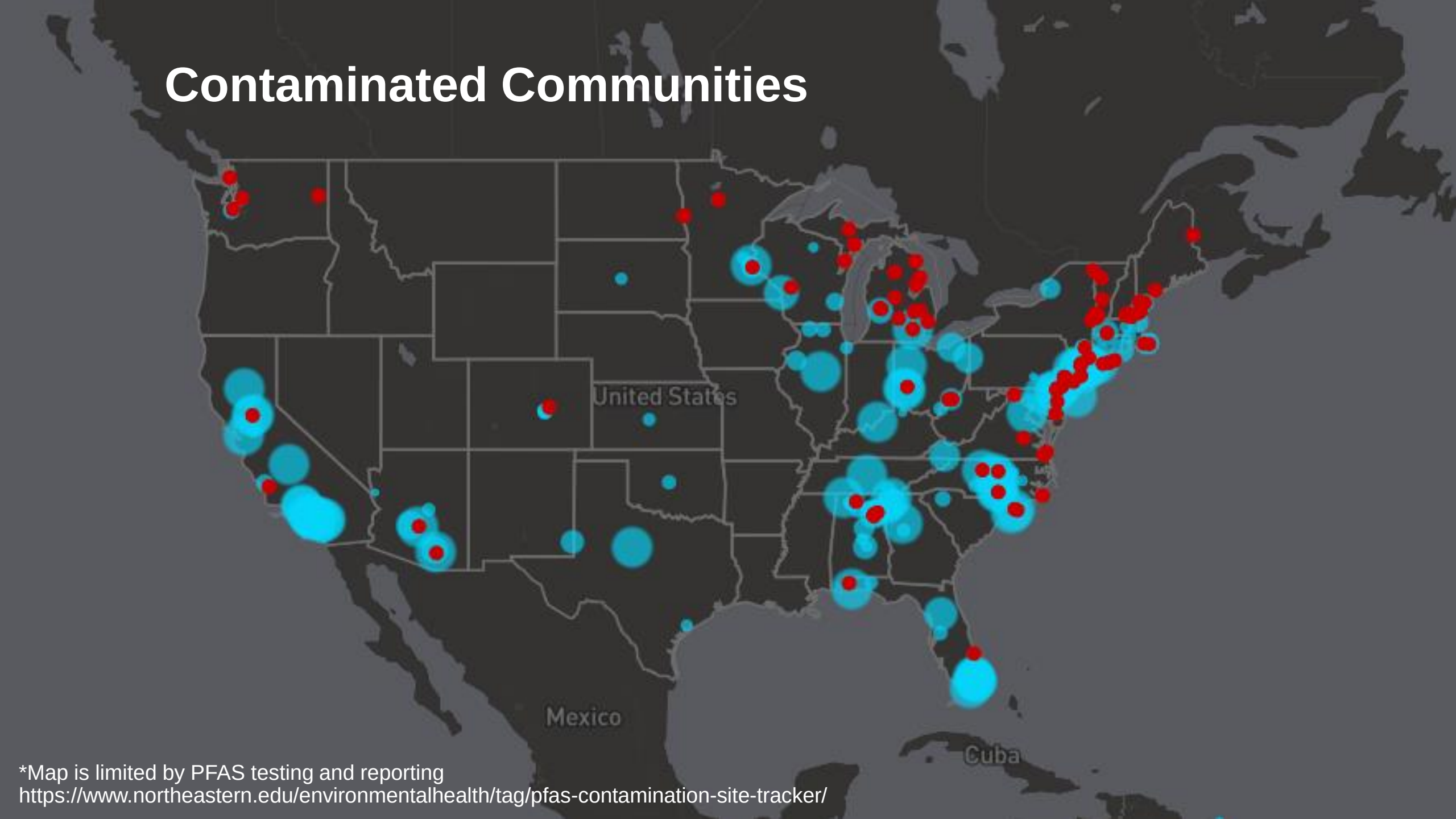


https://www.ewg.org/interactive-maps/pfas_contamination/map/



www.pfas-exchange.org/connecting-communities

Contaminated Communities



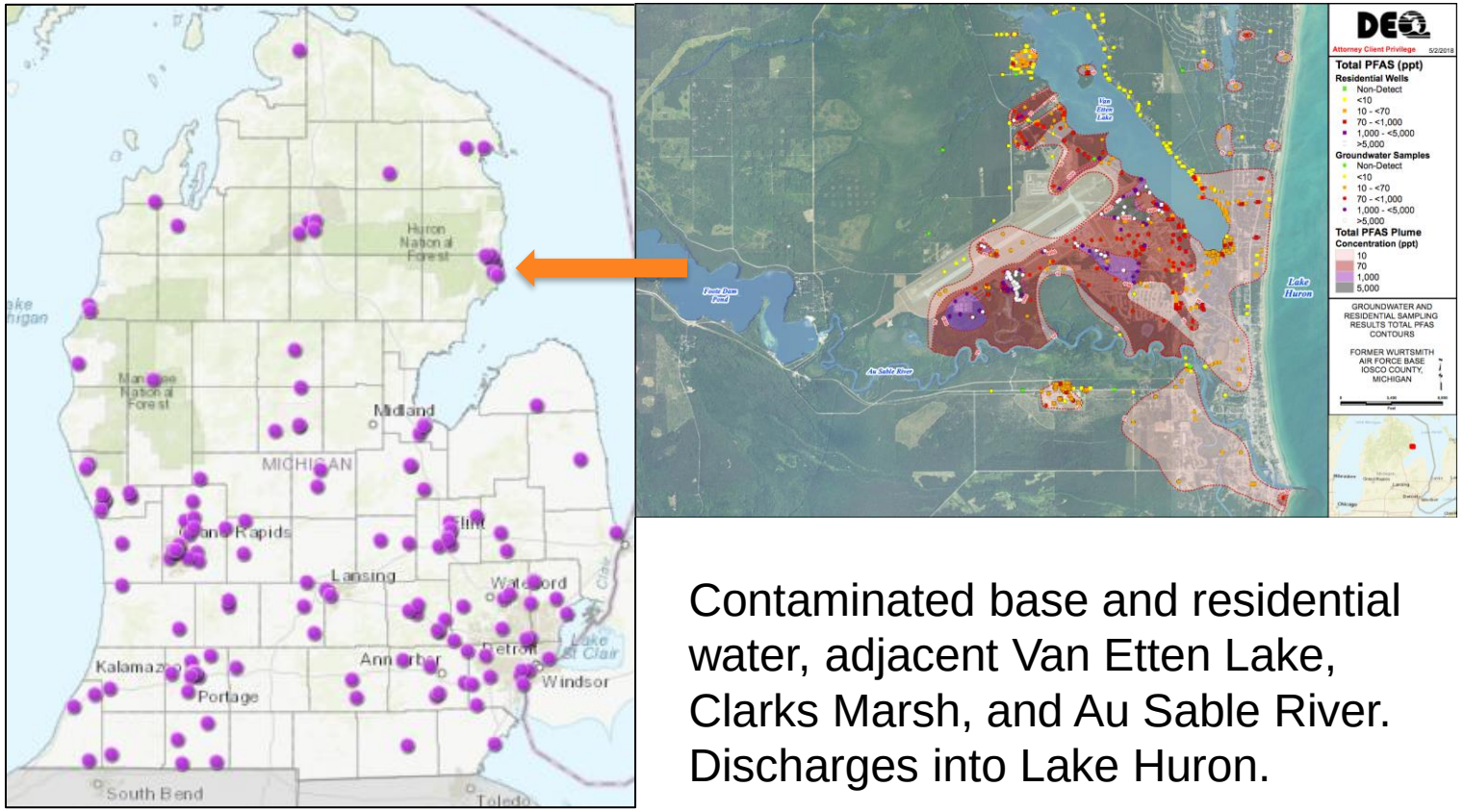
*Map is limited by PFAS testing and reporting
https://www.northeastern.edu/environmentalhealth/tag/pfas-contamination-site-tracker/

Former Wurtsmith Air Force Base
Oscoda, MI

PFAS contamination discovered over 15 years ago

Specialized fire fighting foam

Hangar suppression systems



Contaminated base and residential water, adjacent Van Etten Lake, Clarks Marsh, and Au Sable River. Discharges into Lake Huron.

Aqueous Film Forming Foam (AFFF)

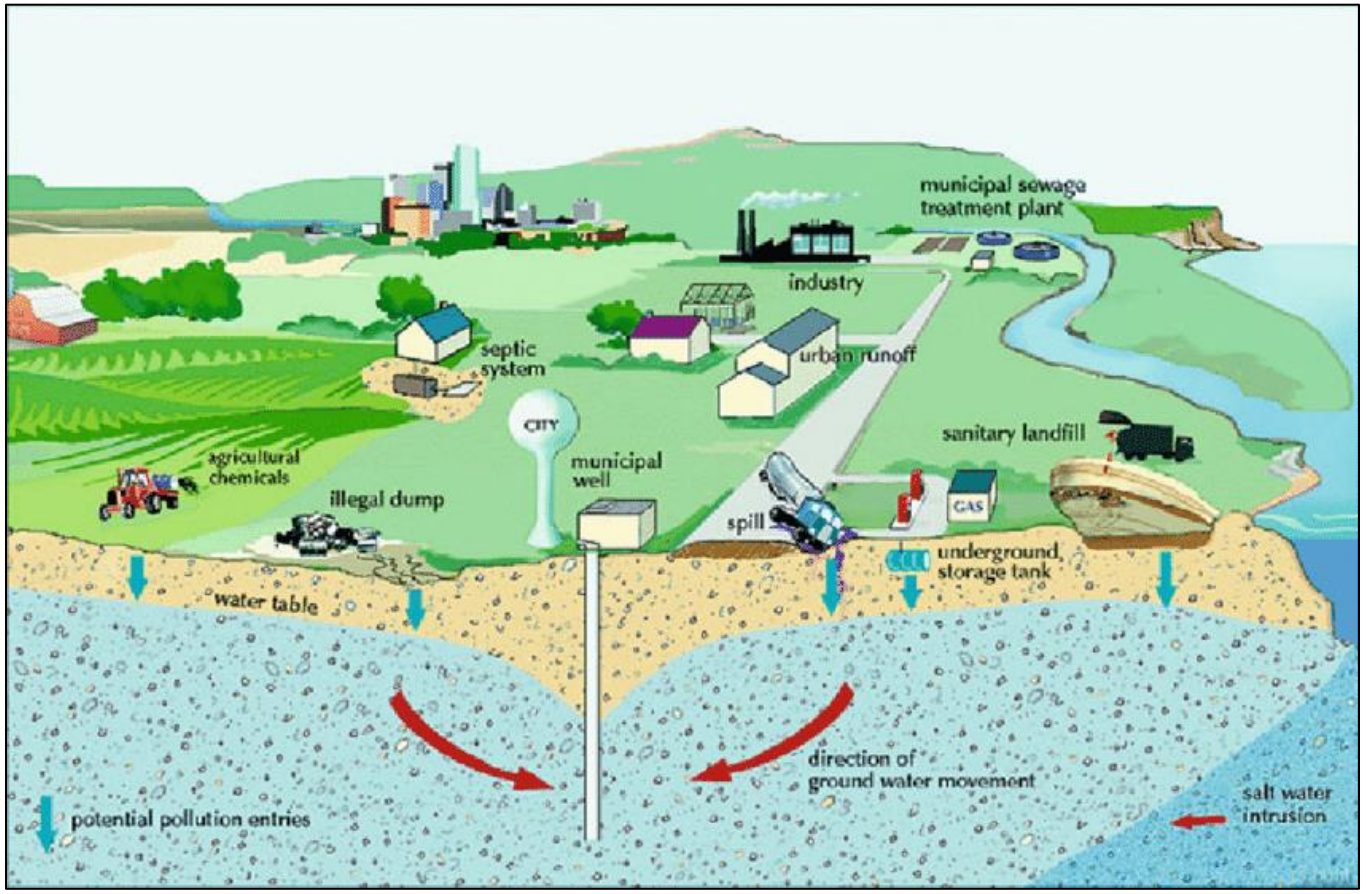
Firefighter Training

Vehicle Fires

Firefighters were told it was as
‘safe as soap and water’


TASMANIA FIRE SERVICE
ESSA

PFAS Easily Migrate into Groundwater



Zeidan et al. 2016

Groundwater is commonly used for **drinking water** by cities, towns and individual homes

Do Not Eat Advisories

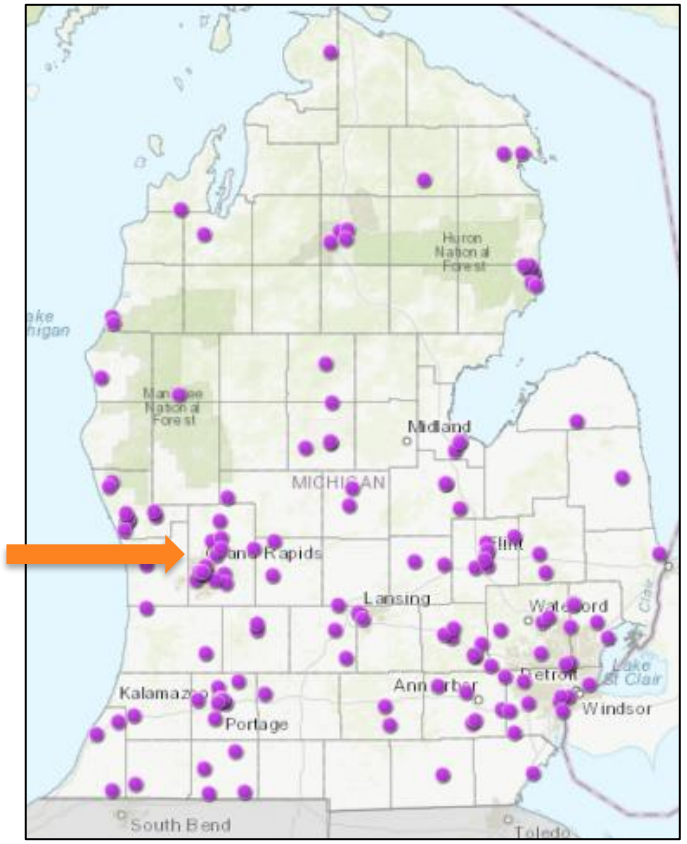
PFAS and Dissolved Organic Carbon Enrichment in Surface Water Foams on a Northern U.S. Freshwater Lake

Trever Schwichtenberg, Dorin Bogdan, Courtney C. Carignan, Patrick Reardon, Justin Rewerts, Thomas Wanzek, and Jennifer A. Field*

Cite This: *Environ. Sci. Technol.* 2020, 54, 14455–14464

Wolverine Worldwide former Tannery Rockford, MI

Poor disposal of tannery waste at dumping sites across town



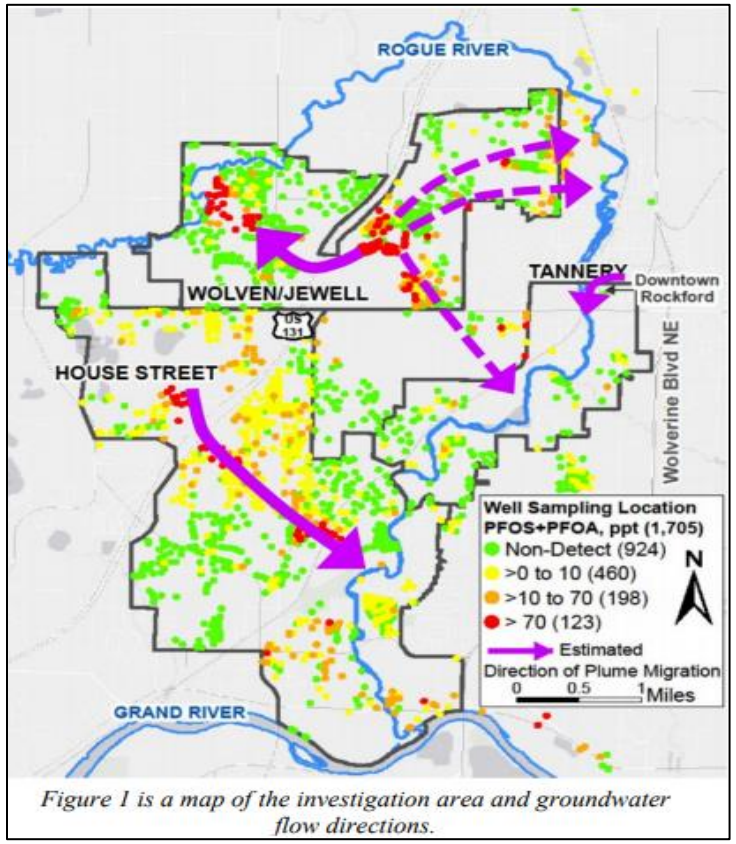
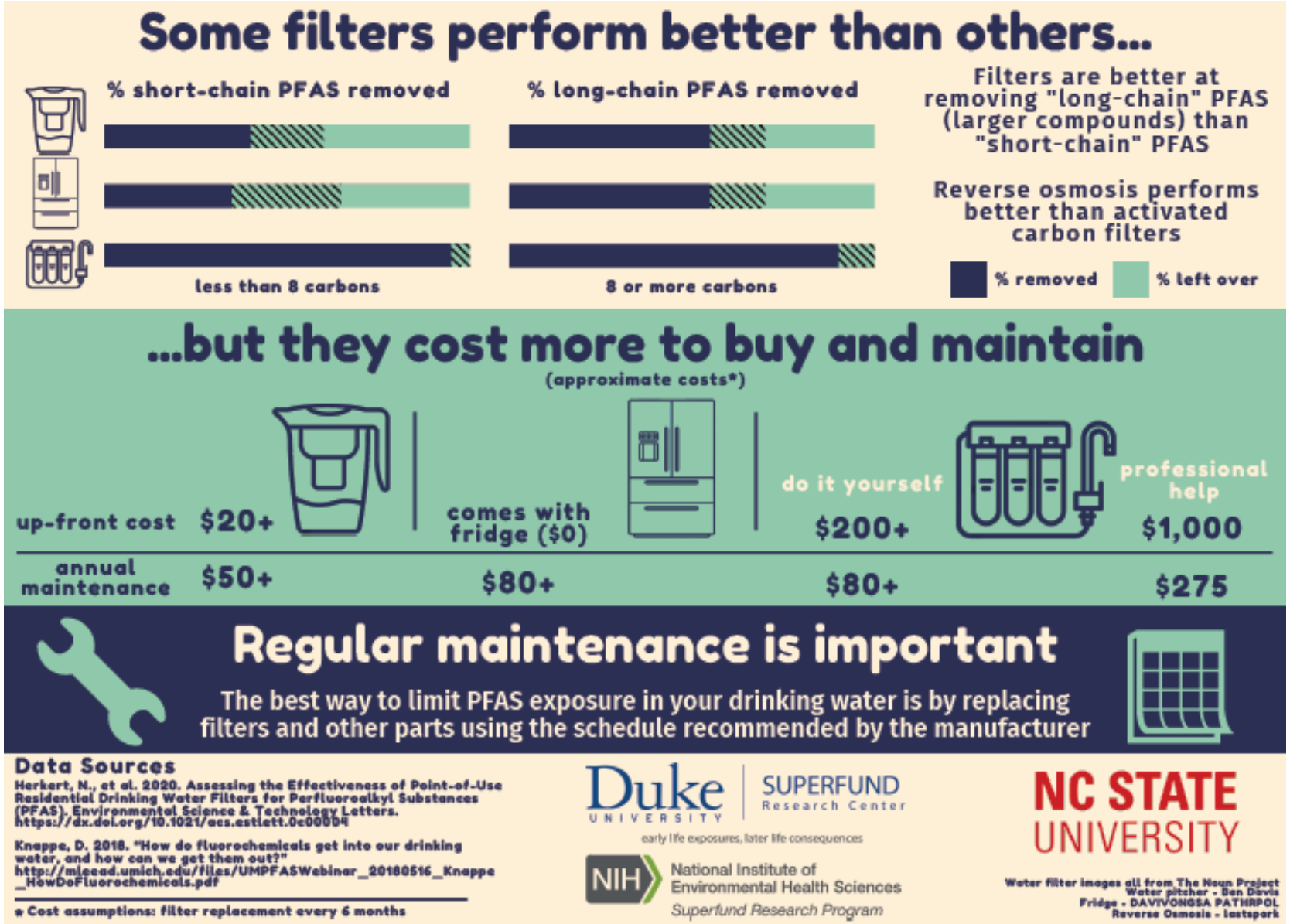


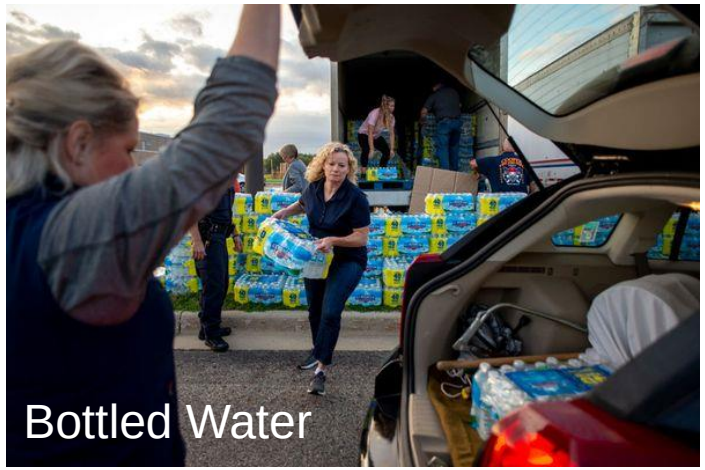
Figure 1 is a map of the investigation area and groundwater flow directions.

Some Private Wells Highly Contaminated

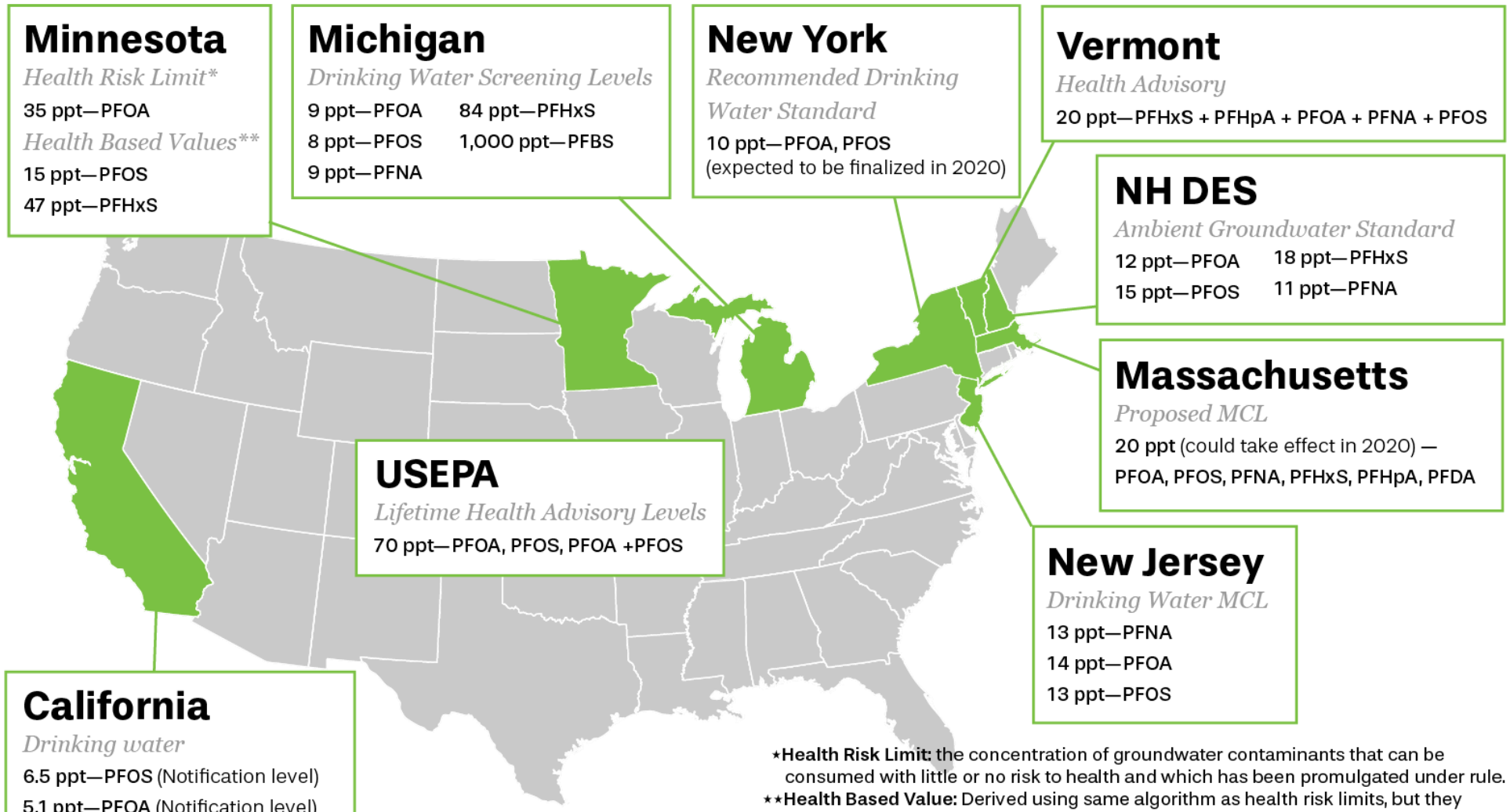


https://sites.nicholas.duke.edu/pfas/files/2020/09/PFAS-and-Water-Filtering-fact-sheet.pdf

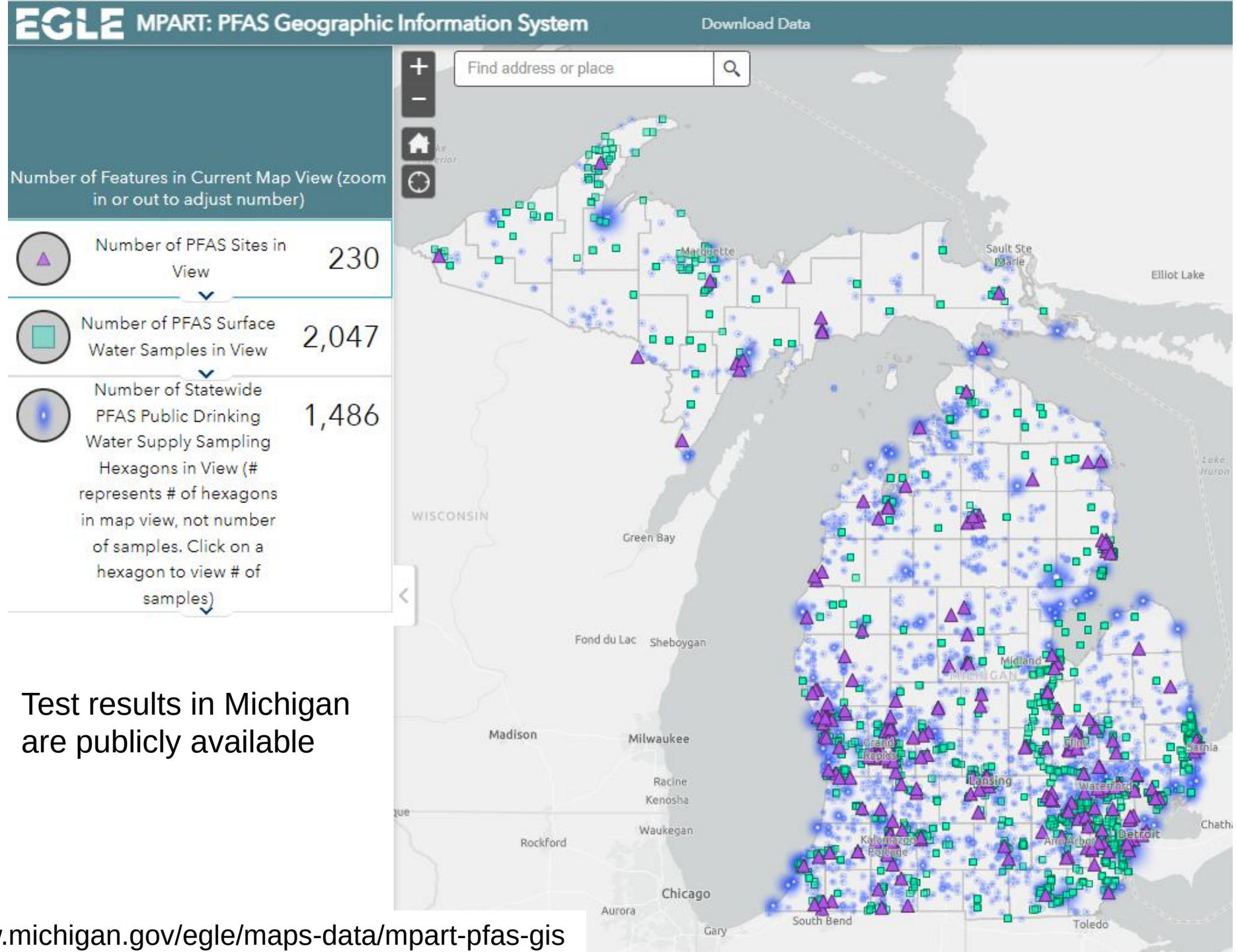
Drinking Water Interventions



Enforceable Standards: Maximum Contaminant Levels (MCLs)



CDM Smith (2020)



Test results in Michigan are publicly available

https://www.michigan.gov/egle/maps-data/mpart-pfas-gis

ABC NEWS

EPA announces first-ever national standard limiting 'forever chemicals' in drinking water

The agency says the move will protect 100 million people from PFAS exposure.

By Kelly Livingston
April 10, 2024, 4:04 PM

"One hundred million people will be healthier and safer because of this action," Regan said. "This action will prevent thousands of deaths and tens of thousands of serious illnesses."

PFAS exposure has been linked to increases in cholesterol, changes in liver enzymes and pregnancy complications like preeclampsia, among other issues, according to the Centers for Disease Control and Prevention.

"Every single person in the United States is walking around with PFAS in their bodies," Olson said. "The risks are very real. These EPA rules will start the process of controlling the risks from tap water."

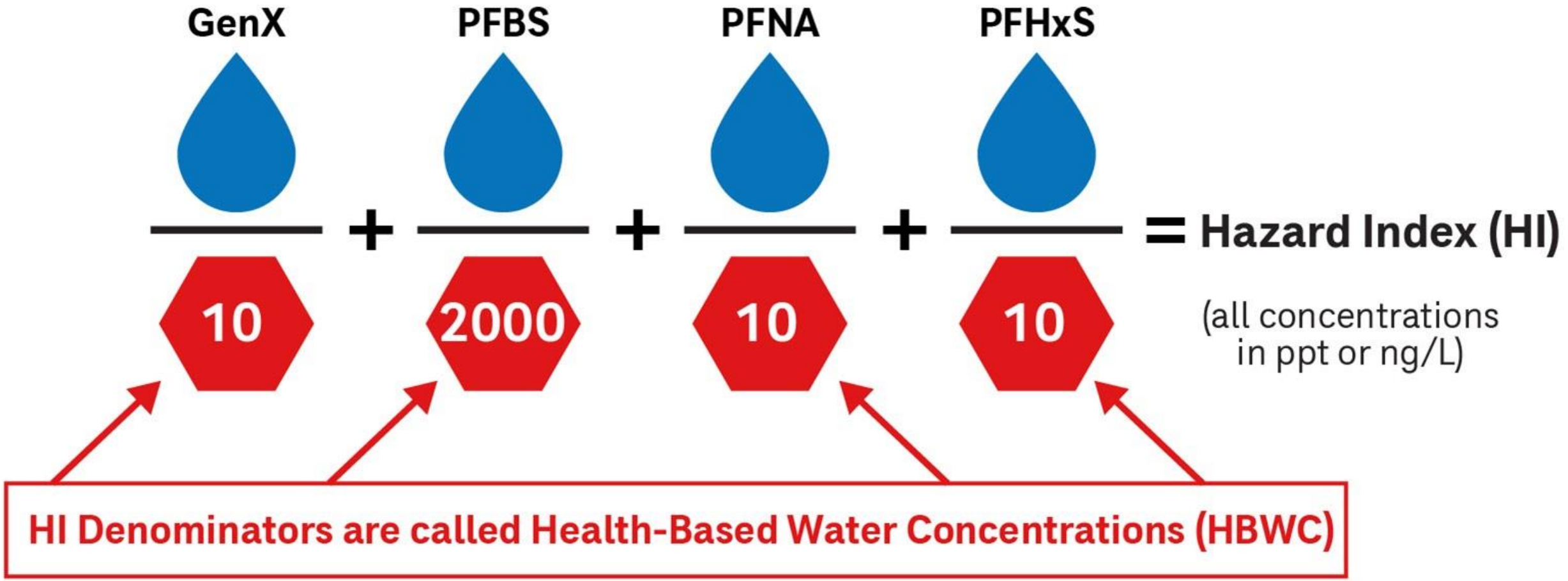
U.S. EPA Federal Drinking Water Standards

PFAS Compound	Maximum Contaminant Level Goal (MCLG)	Enforceable Maximum Contaminant Level (MCL)
PFOA	0	4.0 parts per trillion (ppt)
PFOS	0	4.0 ppt
PFNA	10	10.0 ppt
PFHxS	10	10.0 ppt
HFPO-DA (GenX Chemicals)	10	10.0 ppt
Mixture of two or more: PFHxS, PFNA, HFPO-DA (GenX), and PFBS	Hazard Index of 1	Hazard Index of 1

Historic enforceable MCLs for PFAS

Goal (MCLG) is no detectable PFOA or PFOS.

MCL is based on feasible detection limit for most labs.


GenX
PFBS
PFNA
PFHxS
10
2000
10
10
= Hazard Index (HI)
(all concentrations in ppt or ng/L)
HI Denominators are called Health-Based Water Concentrations (HBWC)

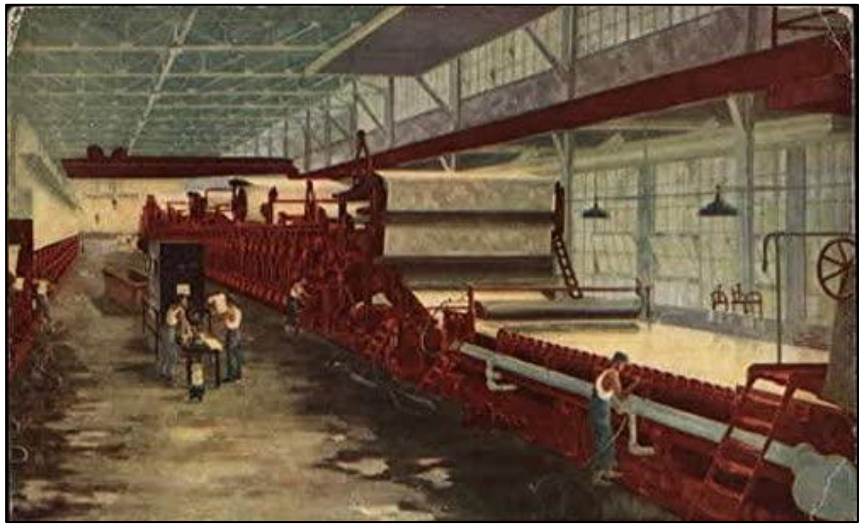
10% of Public Water Systems Exceed PFAS MCL

Table 4. Comparison of UCMR 5 Average Results and the MCLs for Regulated PFAS

Regulated PFAS	MCL (µg/L)[1]	Total number of locations with a full set of results[2]	Number of locations with an average greater than MCL	% of locations with an average greater than MCL	Total number of PWSs with location(s) with a full set of results	Number of PWSs with average(s) greater than MCL	% of PWSs with average(s) greater than MCL
PFOS	0.0040	6,935	369	5.3%	2,875	226	7.9%
PFOA	0.0040	6,939	330	4.8%	2,878	184	6.4%
HFPO-DA (GenX chemicals)	0.01	6,946	1	0.0%	2,882	1	0.0%
PFHxS	0.01	6,936	20	0.3%	2,878	16	0.6%
PFNA	0.01	6,947	3	0.0%	2,882	3	0.1%
Hazard Index (HFPO-DA, PFHxS, PFNA, PFBS)	1 (unitless)	6,928	24	0.3%	2,873	20	0.7%
Total number of unique PWSs with one or more averages greater than MCL = 293 of 2,883 (10%)							

EPA Office of Water: https://www.epa.gov/system/files/documents/2023-08/ucmr5-data-summary_0.pdf
Report through 4th set of data collected and is only 35% of total results expected by 2026.
25% of systems exceed EPA's health reference level for screening lithium
Searchable data: https://www.epa.gov/dwucmr/fifth-unregulated-contaminant-monitoring-rule-data-finder

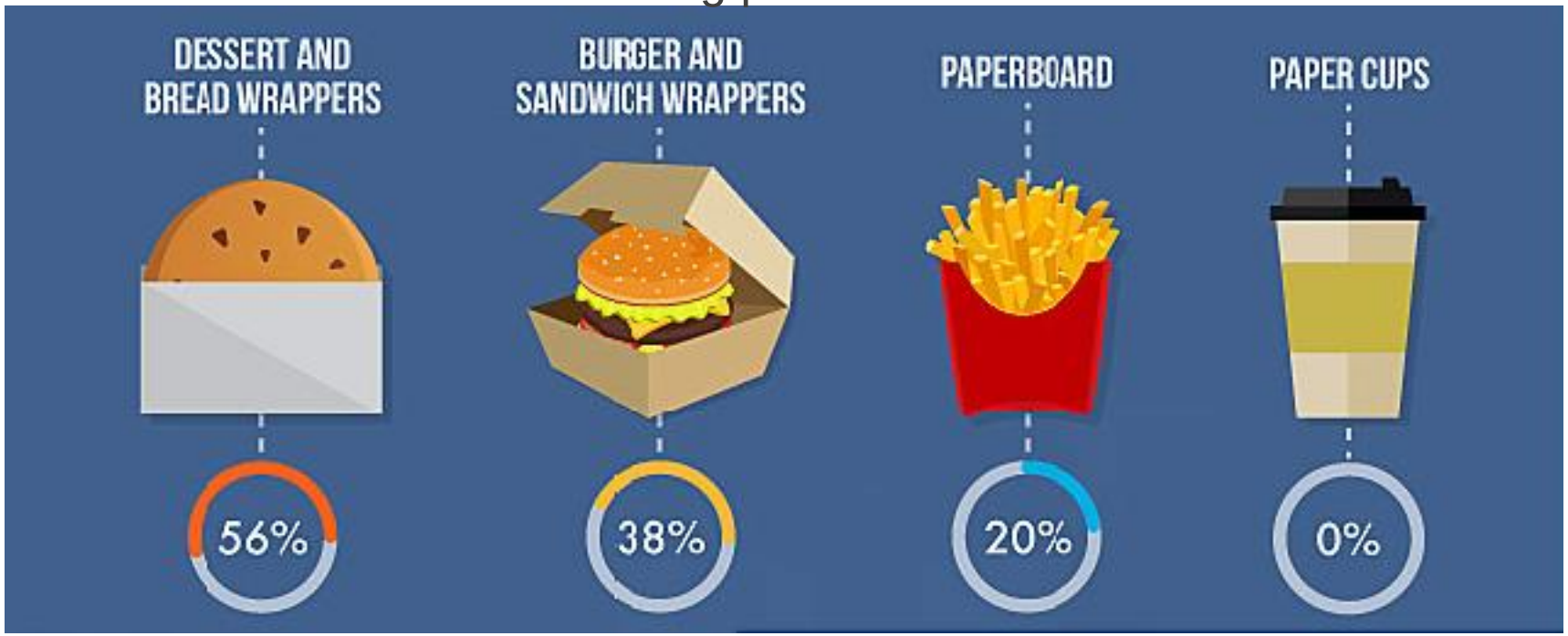
Former Crown Vantage Paper Mill
Parchment, MI



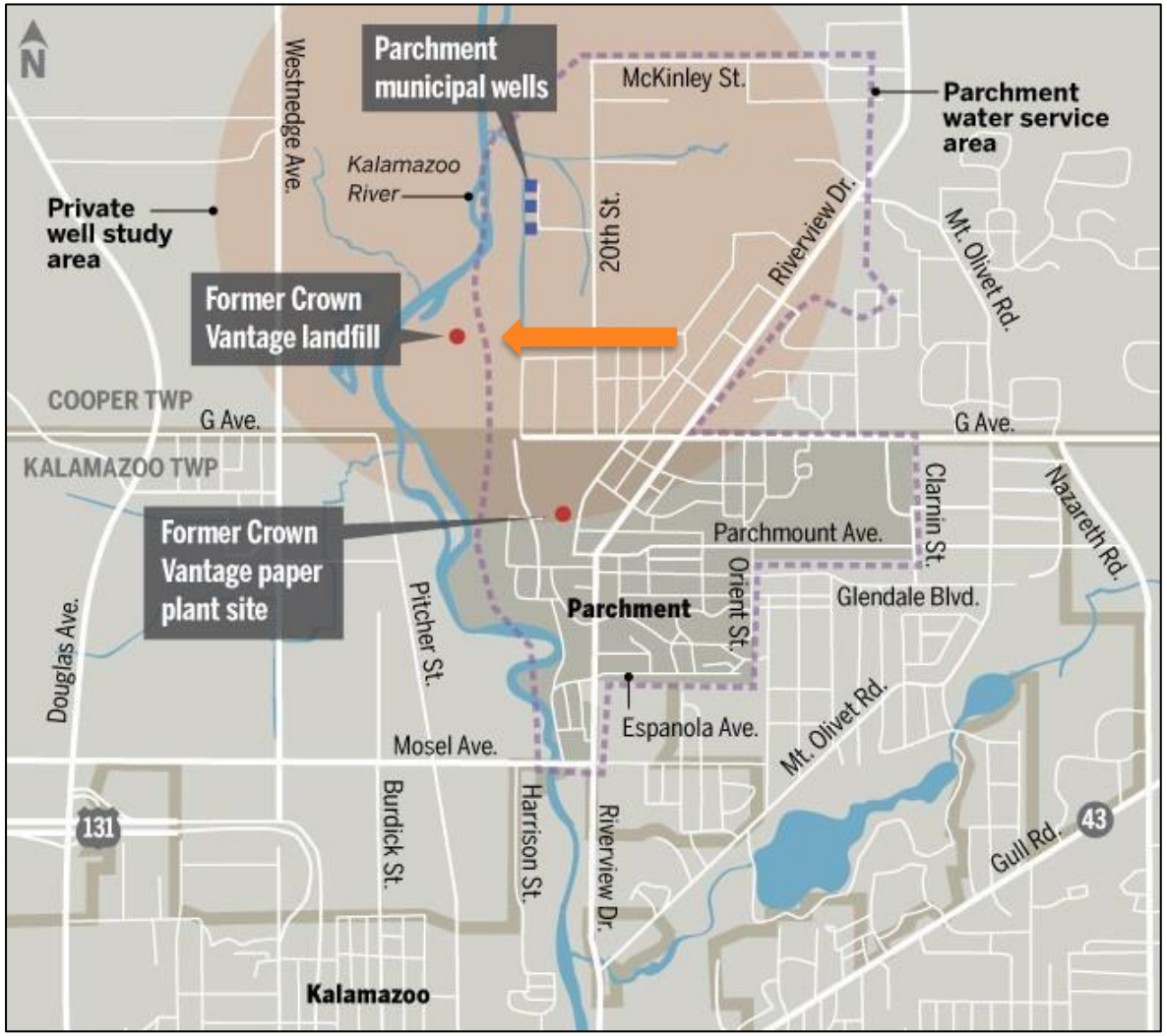
Used in grease resistant paper food packaging

Paper making waste disposed in nearby landfill

Being phased out



PFAS from the landfill contaminated the groundwater and the nearby municipal wells

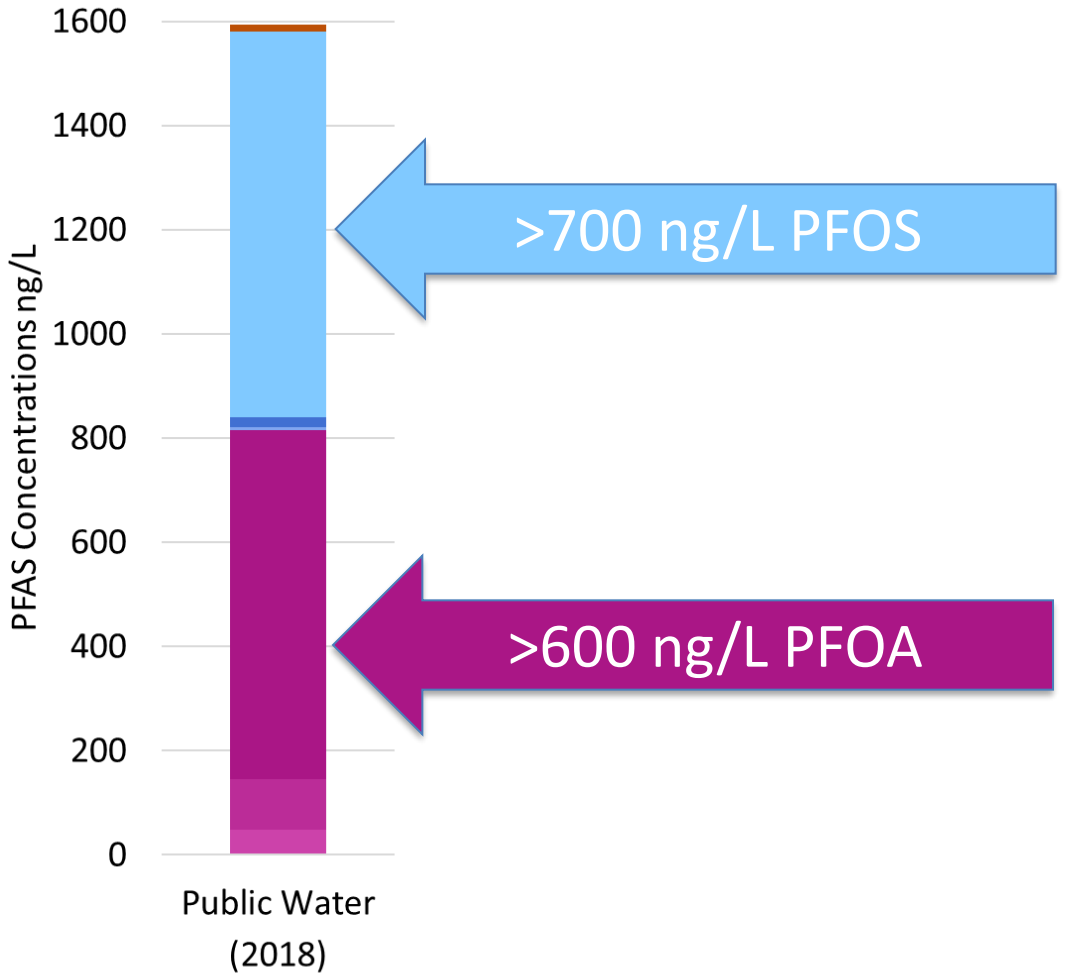


PFAS Concentration (ng/L)

Milt Klingensmith | MLive.com

High PFAS Concentrations in Municipal Water

1600 ng/L (parts per trillion)



>700 ng/L PFOS

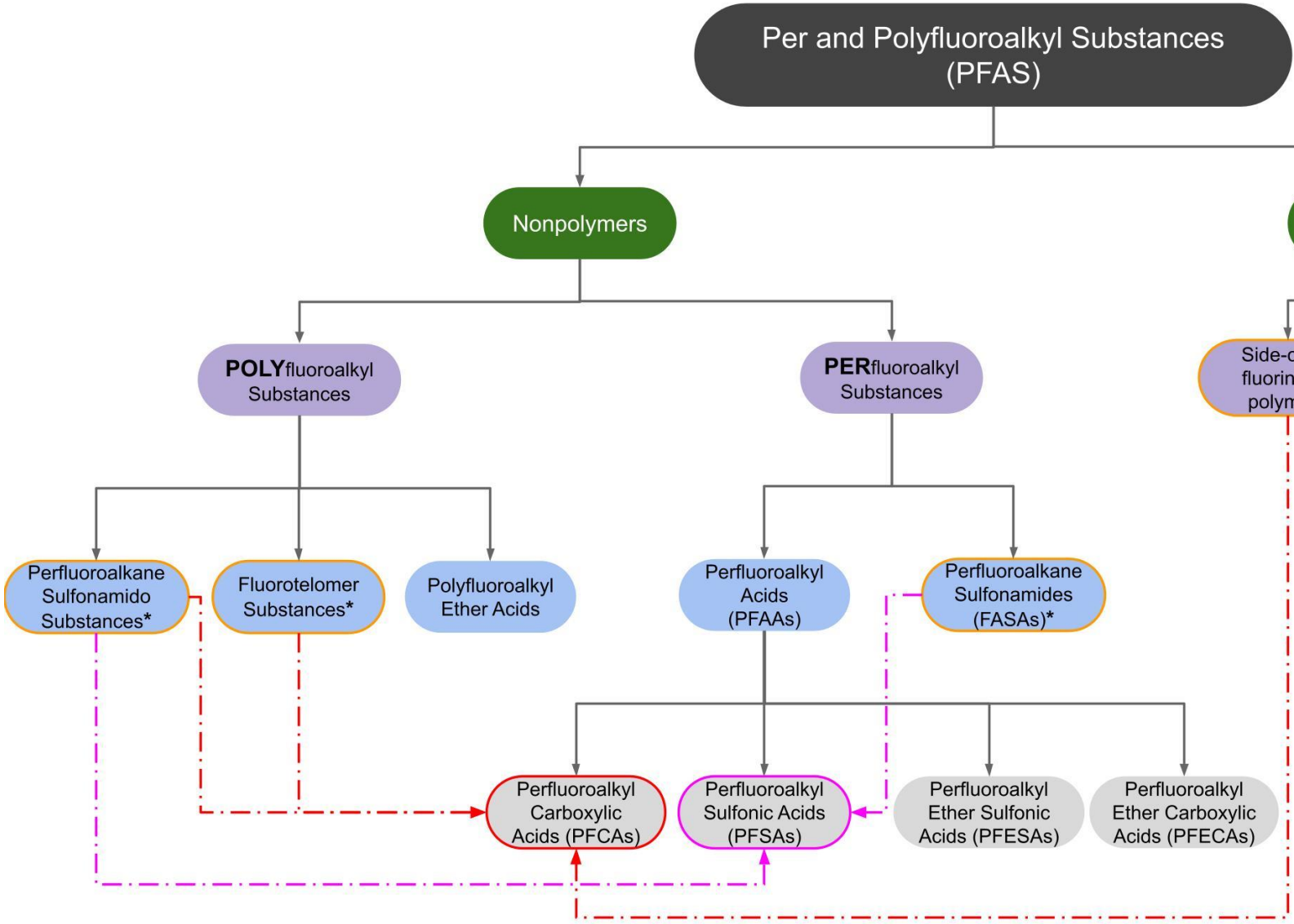
>600 ng/L PFOA

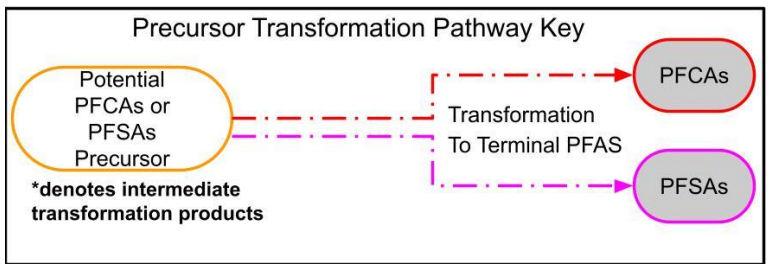
4 ng/L for PFOS

Maximum Contaminant Levels (MCLs)

4 ng/L for PFOA

Bauer et al. *in review*





POLYfluoroalkyl substances contain a carbon alkyl backbone, attached to a functional group(s), with *at least* one hydrogen bonded to carbon replaced with fluorine

PERfluoroalkyl substances have a carbon alkyl backbone, attached to a functional group(s), with *only* fluorine atoms replacing *all* hydrogens

Adapted from Interstate Technology & Regulatory Council (2022)

Family tree of PFAS sub-groups

Large class of over 20,000 chemicals

Include many ‘precursors’ that transform to PFCAs and PFSAs in the environment and our bodies

Total organic fluorine tests can help identify how much PFAS is not identify by standard method

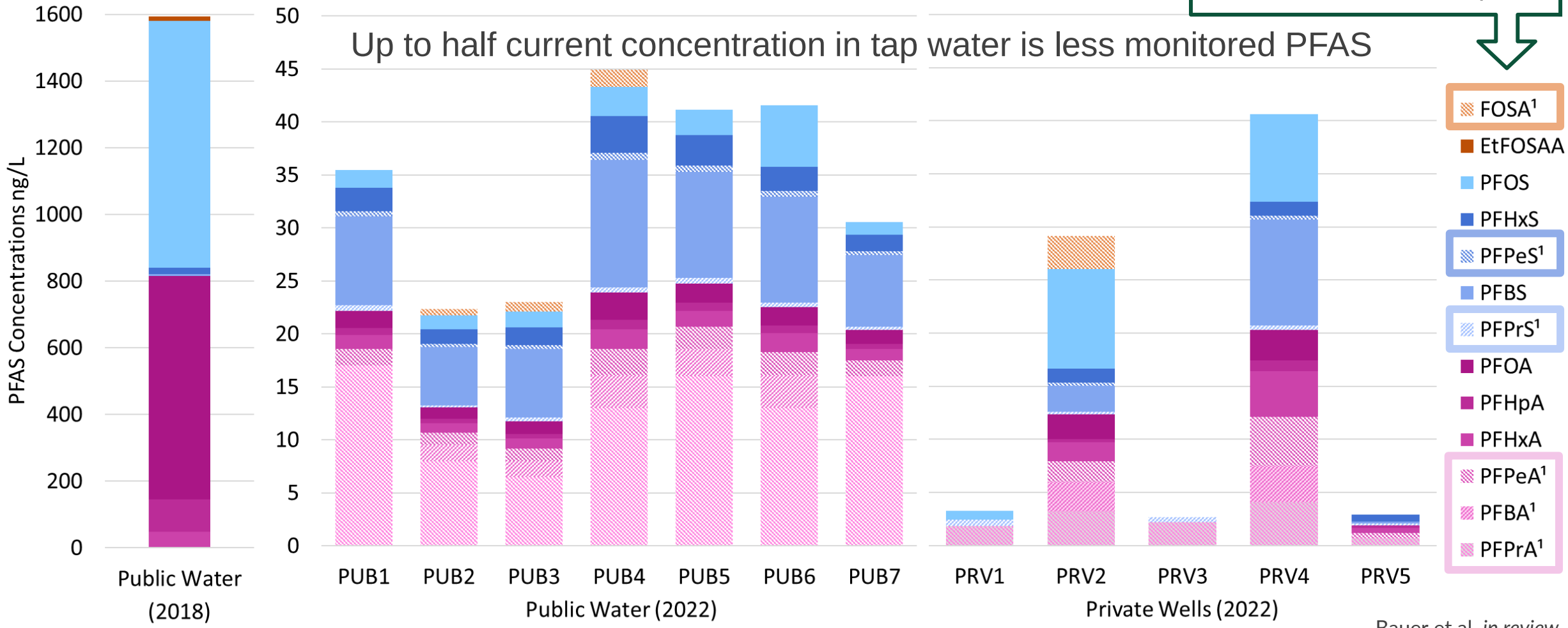
https://www.sfei.org/projects/pfas

Lower PFAS Concentrations in Current Tap Water

<40 ng/L (parts per trillion)

[1]PFAS not in standard panel

Up to half current concentration in tap water is less monitored PFAS



Bauer et al. *in review*

Local and Home Produced Foods

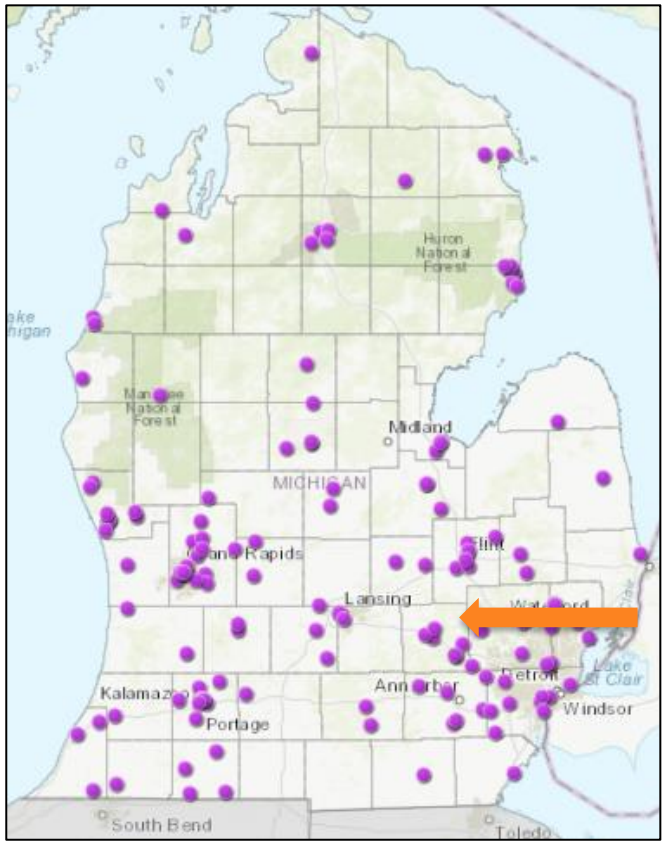
Local Fish


Home Grown Produce


Home Produced Eggs

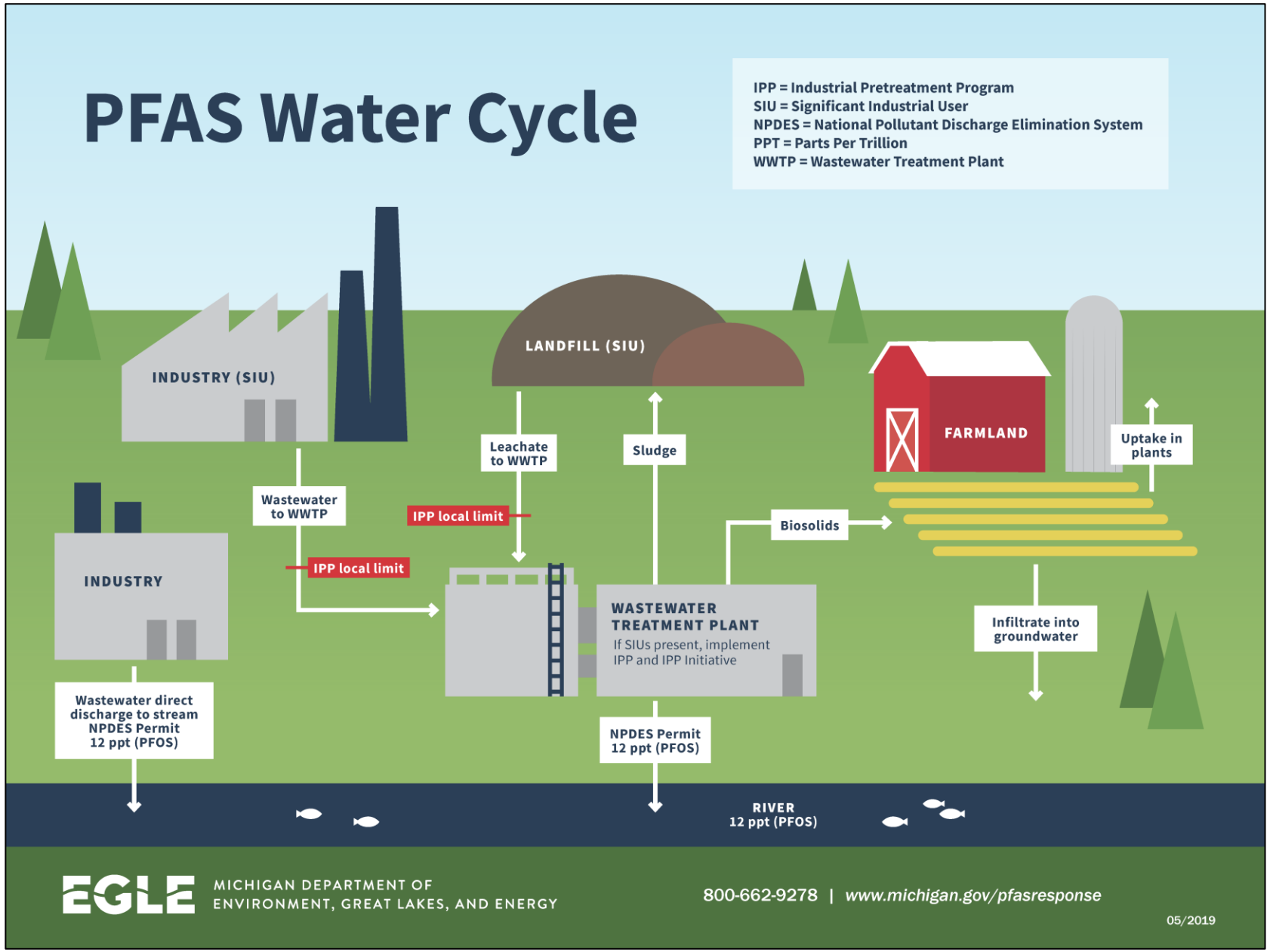

Local Venison

Chrome Plating
Huron River



https://finishingandcoating.com/index.php/plating/224-epa-michigan-find-that-pfos-suppresants-work

PFAS used as fume suppressant in chrome plating



PFAS passes through the waste-water treatment plant into the Huron River and into biosolids.

Biosolids are often applied to agricultural fields for nutrients, landfilled or incinerated.

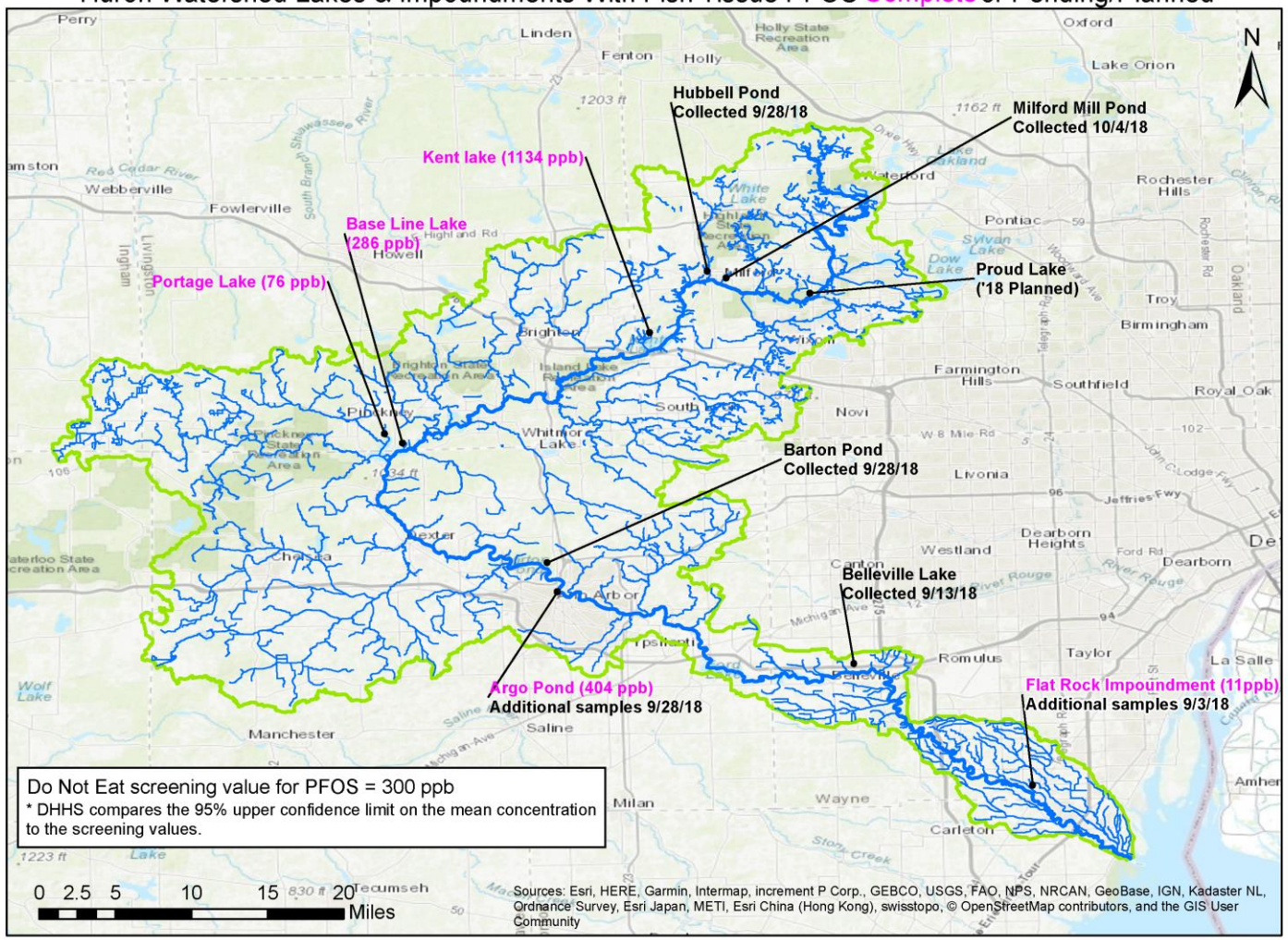
Michigan's pre-treatment program now helps limit PFOA and PFOS influent.

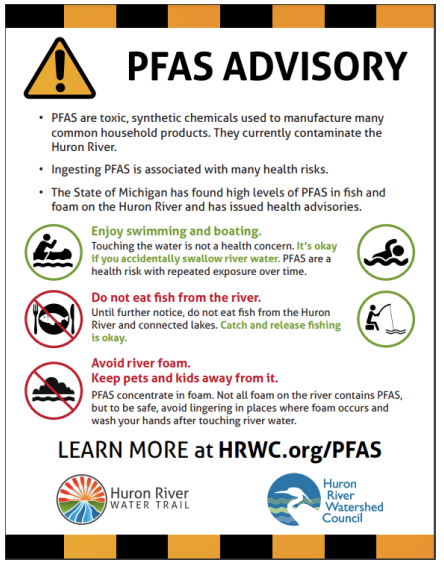

0 10 0 10
Miles Kilometers
Red Cedar River
LIVINGSTON COUNTY
OAKLAND COUNTY
MACOMB COUNTY
INGHAM COUNTY
Howell
Milford
Pontiac
Clinton River
Mt. Clemens
Wolverine Lake
Walled Lake
Brighton
Wixom
Novi
Lake St. Clair
South Lyon
Pinckney
Stockbridge
Huron River
River Rouge
U.S.
CANADA
Detroit
Windsor
Detroit River
Dexter
Chelsea
JACKSON COUNTY
WAYNE COUNTY
Ann Arbor
Ypsilanti
Belleville
Romulus
WASHTENAW COUNTY
Huron River
Woodhaven
Flat Rock
Gibraltar
Rockwood
South Rockwood
LENAWEE COUNTY
MONROE COUNTY
River Raisin
Monroe
Michigan
Ohio
Ontario
Lake Erie

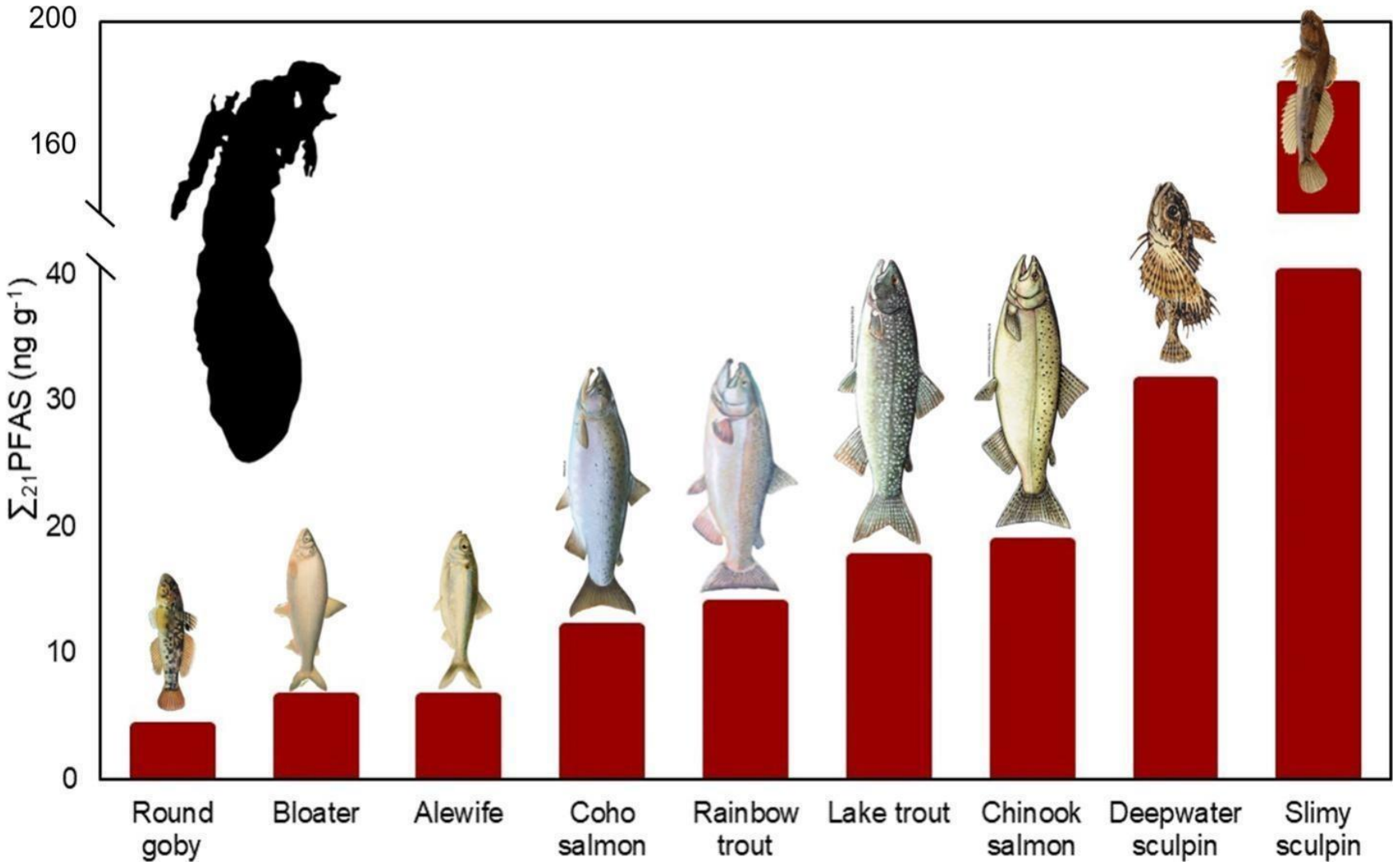

FISH ADVISORY
DO NOT EAT ANY FISH
For information on the Fish Advisory call the Indiana State Department of Health
(317) 233-7808
Sign posted by:
MONROE COUNTY HEALTH DEPARTMENT
(812) 349-2542

PFAS discharge from chrome plating facilities to waste-water treatment plants

Huron Watershed Lakes & Impoundments With Fish Tissue PFOS Complete or Pending/Planned



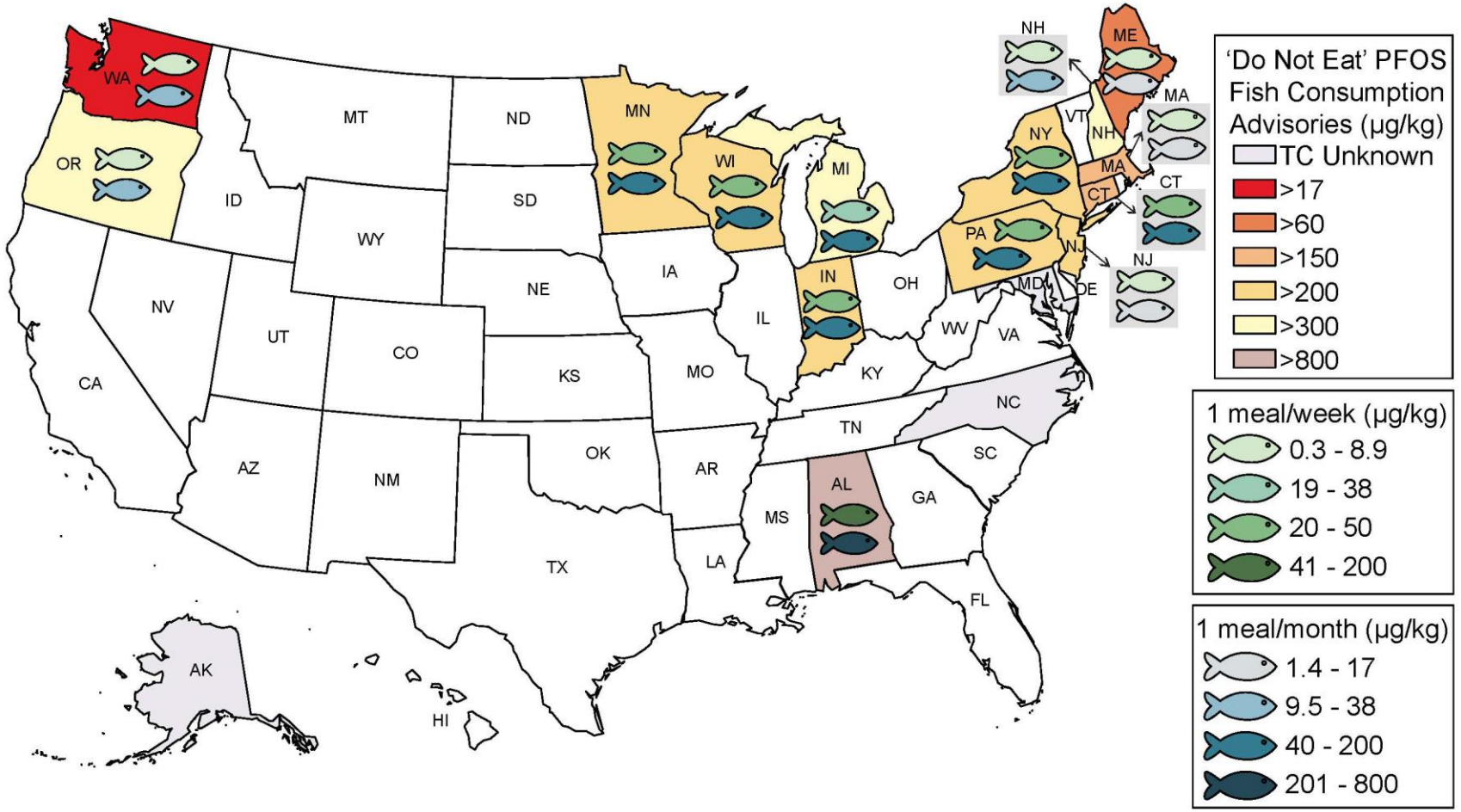




Miranda et al. 2023

Fish can be a notable source of PFAS exposure

PFOS Consumption Advisories Vary by State



Petali et al 2024

PFAS in Biosolids ⇨ Soil ⇨ Crop ⇨ Livestock/People

Concerns grow over PFAS-tainted sewage sludge spread on croplands

Source: MI sewage sludge application

Michigan beef found to contain dangerous levels of 'forever chemicals'

Contamination at a small farm discovered after sewage sludge was tested for PFAS, but officials downplayed incident as 'isolated'

Source: MI cattle farm news

Discoveries over past decade include WV, AL, CO, NM, ME, MI. Need to be able to discover and act.
National support is urgently needed for farmers and regulators.

PFAS in Compost ⇨ Soil ⇨ Crop ⇨ Livestock/People

Maine PFAS Screening Levels

Fish Tissue Action Level (ng/g wet weight)	
Compound	Action Level
PFOS	3.5

Milk[4] (ng/l or ppt)	
Compound	Action Level
PFOS	210

Beef[5] (ng/g)	
Compound	Action Level
PFOS	3.4

Dairy[6] - PFOS Crop-Specific Soil Screening Levels (ng/g dry weight)			
	Soil to Hay to Milk Screening Level	Soil to Corn-Silage to Milk Screening Level	Soil to Hay and Corn-Silage to Milk Screening Level
Grass-Based Farm	6.8	120.0	6.4
Average Maine Farm	13.8	54.8	11.0

Maine DEP (2023)

Maine has helpful guidance and has been more proactive than most states.

MAINE PFAS SCREENING LEVELS

December 2023

Soil Remedial Action Guidelines[1] (mg/kg dry weight)						
Compound	Leaching to Groundwater	Residential	Commercial Worker	Park User	Recreator Sediment	Construction Worker
PFBS	0.11	26	340	74	85	230
PFBA	0.36	110	1,600	300	350	2,000
PFHxS	0.00047	1.7	22	4.9	5.7	5.1
PFHxA	0.13	43	560	120	140	130
PFNA	0.0046	0.26	3.4	0.74	0.85	0.77
PFOS	0.001	0.17	2.2	0.49	0.57	0.51
PFOA	0.017	0.26	3.4	0.74	0.85	0.77

Soil Beneficial Use[2] (ng/g dry weight)	
Compound	Beneficial Use
PFBS	1,900
PFOS	5.2
PFOA	2.5

Interim Drinking Water Standard[3] (ng/l or ppt)	
Compound	Residential
PFOS + PFOA + PFHpA + PFNA + PFHxS + PFDA	20

Maine DEP (2023)

Protections for Food

- Reducing/eliminating production, use and disposal of PFAS will reduce migration pathways to food
- Many states have fish advisories
- PFAS added to FDA's Total Diet Study
- Michigan implemented a pre-treatment program to reduce the biosolids pathway
- Maine has guidance for irrigation water, soils and foods – and has banned application of biosolids or sludge on agricultural fields

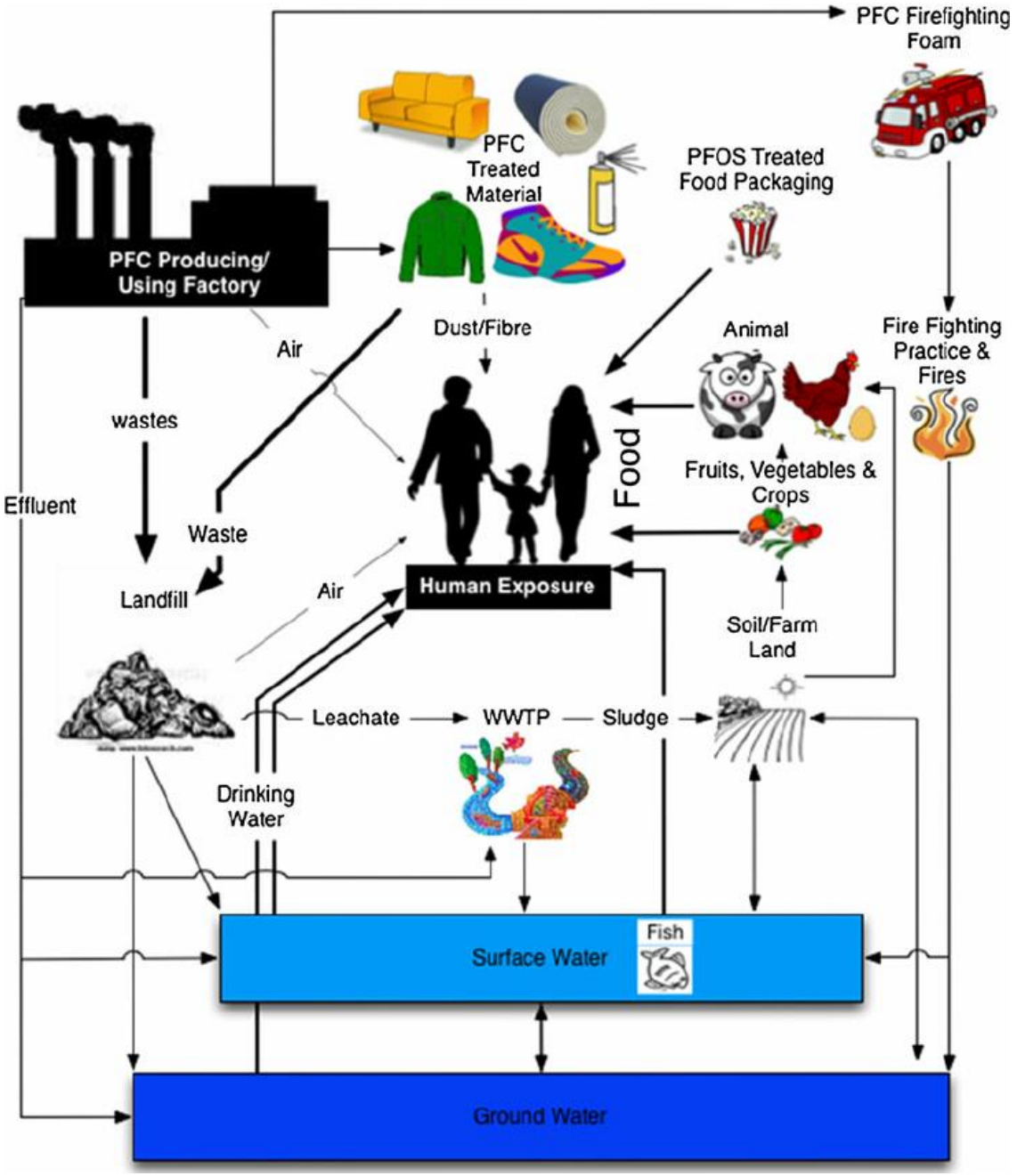
Primary Exposure Pathways

Impacted Communities:

- Occupational
- Drinking water
- Fish
- Venison
- Home eggs
- Breast milk & Formula (water)

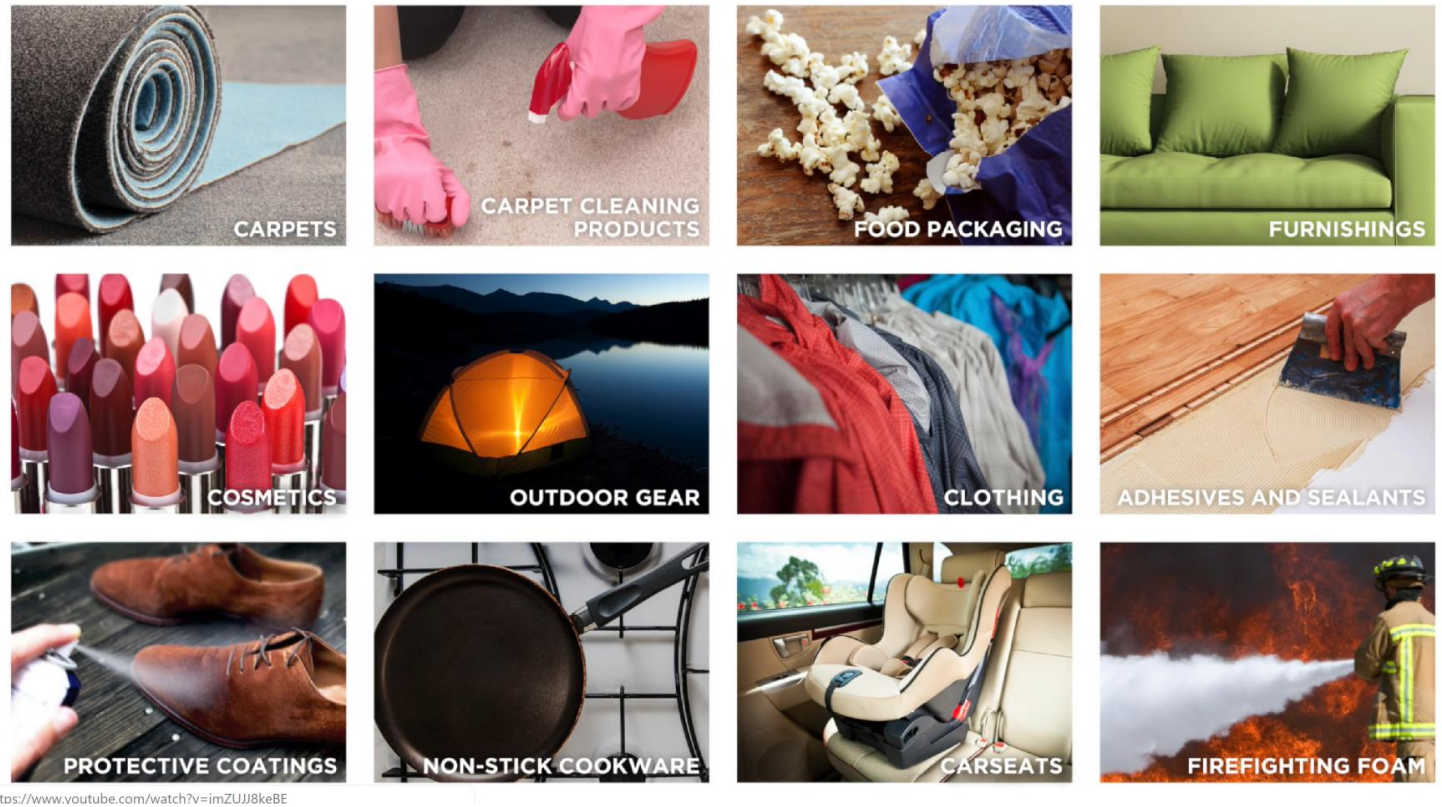
General population:

- Water resistant sprays
- Stain resistant carpeting
- Microwave popcorn
- Fish
- Grease resistant packaging
- Non-stick cookware (Teflon)
- Make-up (lipstick, foundation)



Oliaei et al. 2012

Occupational Exposures



*Blood tests may not test/work for PFAS used over past decade

Examples:

PFAS chemical manufacturing
Tannery, leather workers
Carpet and upholstery manufacturing
Specialty textile manufacturing
Medical device manufacturing
Manufacturing home barrier insulation
Manufacturing and using specialty paints
Specialty paper manufacturing
Ski, bike & auto makers and technicians
Semiconductor manufacturing
Solar panel manufacturing and installation
Auto, bike, gun, and piano maintenance
Plumbing (Teflon tape)
Auto wash (‘Teflon’ treatment)
Hydraulic fracturing (used as lubricant)
Chrome plating (fume suppressant)
Firefighters (esp. military & airport: AFFF)

Contaminated Communities often Support:

- Improved drinking water treatment technologies
- Safe disposal of PFAS containing waste
- Restrict manufacture and use of PFAS that are not essential
- Enforceable federal drinking water standards (MCLs)
- Expanded and equitable drinking water testing
- Research and especially health studies
- Access to PFAS blood testing and medical monitoring
- Clinician education and support

Expert Blog

PFAS Blood Tests: Needed but Denied

Guest blog by Andrea Amico, a PFAS community leader from Portsmouth, NH. She is passionate about advocating for answers and action on behalf of PFAS impacted communities nationwide.

February 18, 2020

Dr. Anna Reade
Director, PFAS Advocacy, Environmental Health

SHARE THIS PAGE

Andrea Amico is a PFAS community leader from Portsmouth, NH. She is passionate about advocating for answers and action on behalf of PFAS impacted communities nationwide. | *TEDx Talks https://www.youtube.com/watch?v=-3wspAVJ6Ps*

Community Perspectives

"When I would go to the doctor's and tell them about some of the exposures of over 50 chemicals that I was exposed to, the doctors would laugh and say no. Clearly they didn't have any information about environmental components [of disease]. They made me feel small, they made me feel stupid and embarrassed even just asking the question." *Hope Grosse*

NASEM 2022 Appendix B: Summary of the Committee's Town Halls

Jun 29, 2021

Improved medical screening in PFAS-impacted communities to identify early disease

People highly exposed to PFAS often face significant hurdles in getting screened for potential health effects from the exposure. That needs to change.

Isabella Raponi , Phil Brown and Alissa Cordner

PFAS Exchange

WHAT'S MY EXPOSURE | RESOURCES | CONNECTING COMMUNITIES | CHILDREN'S HEALTH STUDY

Resources

Because PFAS are so ubiquitous in the environment and exposures are so widespread, it's important for people to be informed. Below are resources to help you make decisions to protect your health.

Fact Sheets

Health Monitoring

- Medical Screening Guidance – for people in PFAS-impacted communities
- Medical Screening Guidance – for clinicians
- Vaccine Response and PFAS Exposure – for people in PFAS-impacted communities
- PFAS Blood Testing: What You Need to Know
- Information About Blood Testing Laboratories – for individuals

pfas-exchange.org

How do I get a PFAS blood test?

Your doctor may be able to order a PFAS blood test. Providers should use ICD-10 diagnosis code Z13.88, and if ordering a test through Quest, they should use Test Code 39307 and CPT code 82542. Let your provider know you prefer a lab that measures both linear and branched isomers and a comprehensive panel that includes many compounds (see explanation on next page). Blood testing fact sheet has codes for doctor

If your doctor cannot order the test, ask if they can help with a blood draw. Either way, you can contact a lab directly to request the test.

How do I find a lab?

Several labs in North America currently offer PFAS blood testing to individuals: AXYS Analytical, EmpowerDX, and Eurofins. AXYS and Eurofins measure PFAS in blood serum, and EmpowerDX offers a home finger-prick test. NMS Labs does not offer tests to directly to individuals, but does provide blood testing to other entities, including Quest and LabCorp that do offer testing to individuals through clinicians.

For information about price, specific chemicals tested, and lab requirements, see our online guide (**bit.ly/pfas-blood-test**).

Blood draw vs. finger-prick tool

- Most labs require a **blood draw** by a phlebotomist so they can test a large amount of your blood. This has been preferred for many years, is well studied, and may have legal benefits.
- EmpowerDX (part of Eurofins) offers a **finger-prick tool** that allows you to collect a sample at home and will test your whole blood. Note that if PFAS levels in your blood are low, this test may be less likely to detect the PFAS.

Limitations you may encounter

- Health insurance may not cover costs.
- The maximum number of PFAS that can be tested is around 40. This is a small number compared to the thousands of PFAS that exist.

A note about litigation

If you are considering legal action, consult a lawyer before testing your blood. Discovery of PFAS in blood may start the clock on a statute of limitations that could prevent you from litigating in the future. Note that certain documentation may be required in legal settings, so you may need a blood draw (rather than a finger-prick) by a phlebotomist who can serve as a documented witness.

PFAS Exchange

WHAT'S MY EXPOSURE | RESOURCES | CONNECTING COMMUNITIES | CHILDREN'S HEALTH STUDY

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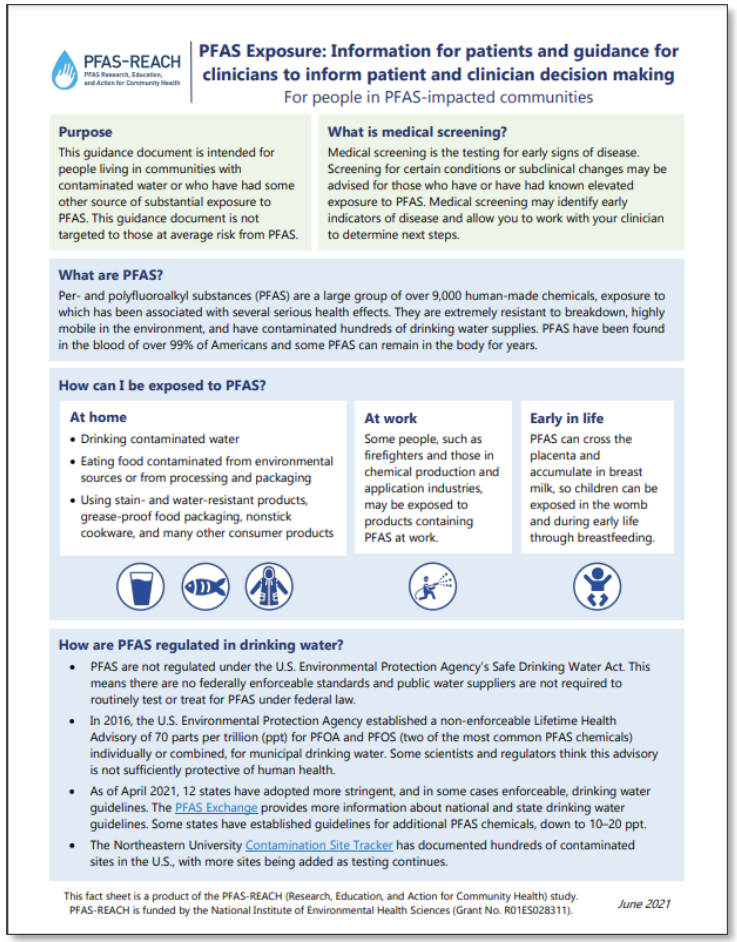
- Information About Blood Testing Laboratories – for individuals

pfas-exchange.org

Medical Screening Guidance

PFAS-Impacted People



PFAS-REACH
PFAS Research, Education, and Action for Community Health

PFAS Exposure: Information for patients and guidance for clinicians to inform patient and clinician decision making

For people in PFAS-impacted communities

Purpose

This guidance document is intended for people living in communities with contaminated water or who have had some other source of substantial exposure to PFAS. This guidance document is not targeted to those at average risk from PFAS.

What is medical screening?

Medical screening is the testing for early signs of disease. Screening for certain conditions or subclinical changes may be advised for those who have or have had known elevated exposure to PFAS. Medical screening may identify early indicators of disease and allow you to work with your clinician to determine next steps.

What are PFAS?

Per- and polyfluoroalkyl substances (PFAS) are a large group of over 9,000 human-made chemicals, exposure to which has been associated with several serious health effects. They are extremely resistant to breakdown, highly mobile in the environment, and have contaminated hundreds of drinking water supplies. PFAS have been found in the blood of over 99% of Americans and some PFAS can remain in the body for years.

How can I be exposed to PFAS?

At home

- Drinking contaminated water
- Eating food contaminated from environmental sources or from processing and packaging
- Using stain- and water-resistant products, grease-proof food packaging, nonstick cookware, and many other consumer products

At work

Some people, such as firefighters and those in chemical production and application industries, may be exposed to products containing PFAS at work.

Early in life

PFAS can cross the placenta and accumulate in breast milk, so children can be exposed in the womb and during early life through breastfeeding.

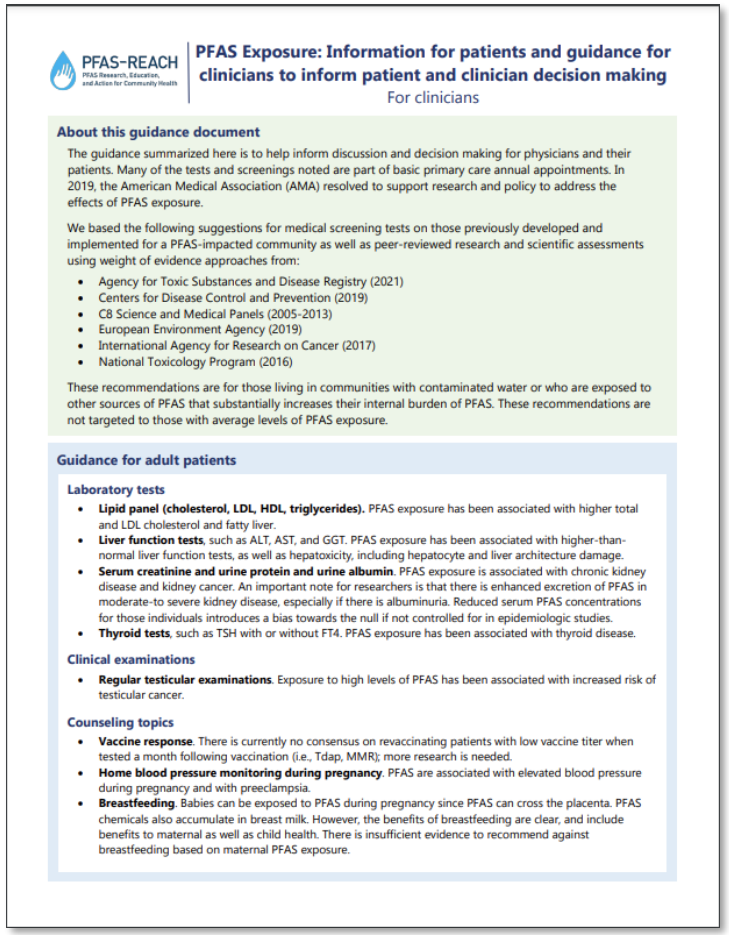
How are PFAS regulated in drinking water?

- PFAS are not regulated under the U.S. Environmental Protection Agency's Safe Drinking Water Act. This means there are no federally enforceable standards and public water suppliers are not required to routinely test or treat for PFAS under federal law.
- In 2016, the U.S. Environmental Protection Agency established a non-enforceable Lifetime Health Advisory of 70 parts per trillion (ppt) for PFOA and PFOS (two of the most common PFAS chemicals) individually or combined, for municipal drinking water. Some scientists and regulators think this advisory is not sufficiently protective of human health.
- As of April 2021, 12 states have adopted more stringent, and in some cases enforceable, drinking water guidelines. The PFAS Exchange provides more information about national and state drinking water guidelines. Some states have established guidelines for additional PFAS chemicals, down to 10–20 ppt.
- The Northeastern University Contamination Site Tracker has documented hundreds of contaminated sites in the U.S., with more sites being added as testing continues.

This fact sheet is a product of the PFAS-REACH (Research, Education, and Action for Community Health) study. PFAS-REACH is funded by the National Institute of Environmental Health Sciences (Grant No. R01ES028311).

June 2021

Their Clinicians



PFAS-REACH
PFAS Research, Education, and Action for Community Health

PFAS Exposure: Information for patients and guidance for clinicians to inform patient and clinician decision making

For clinicians

About this guidance document

The guidance summarized here is to help inform discussion and decision making for physicians and their patients. Many of the tests and screenings noted are part of basic primary care annual appointments. In 2019, the American Medical Association (AMA) resolved to support research and policy to address the effects of PFAS exposure.

We based the following suggestions for medical screening tests on those previously developed and implemented for a PFAS-impacted community as well as peer-reviewed research and scientific assessments using weight of evidence approaches from:

- Agency for Toxic Substances and Disease Registry (2021)
- Centers for Disease Control and Prevention (2019)
- C8 Science and Medical Panels (2005-2013)
- European Environment Agency (2019)
- International Agency for Research on Cancer (2017)
- National Toxicology Program (2016)

These recommendations are for those living in communities with contaminated water or who are exposed to other sources of PFAS that substantially increases their internal burden of PFAS. These recommendations are not targeted to those with average levels of PFAS exposure.

Guidance for adult patients

Laboratory tests

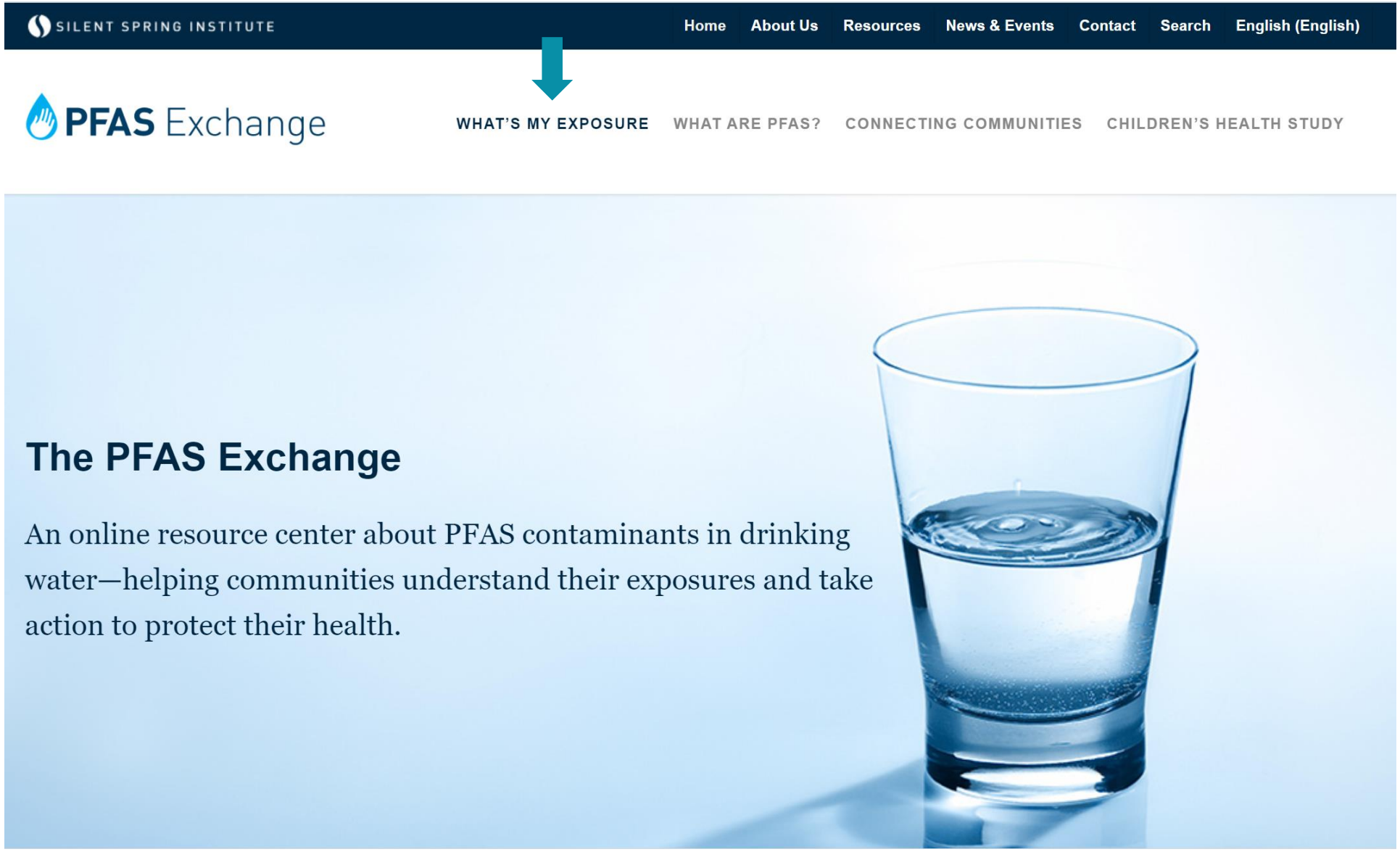
- **Lipid panel (cholesterol, LDL, HDL, triglycerides).** PFAS exposure has been associated with higher total and LDL cholesterol and fatty liver.
- **Liver function tests**, such as ALT, AST, and GGT. PFAS exposure has been associated with higher-than-normal liver function tests, as well as hepatoxicity, including hepatocyte and liver architecture damage.
- **Serum creatinine and urine protein and urine albumin**. PFAS exposure is associated with chronic kidney disease and kidney cancer. An important note for researchers is that there is enhanced excretion of PFAS in moderate-to severe kidney disease, especially if there is albuminuria. Reduced serum PFAS concentrations for those individuals introduces a bias towards the null if not controlled for in epidemiologic studies.
- **Thyroid tests**, such as TSH with or without FT4. PFAS exposure has been associated with thyroid disease.

Clinical examinations

- **Regular testicular examinations**. Exposure to high levels of PFAS has been associated with increased risk of testicular cancer.

Counseling topics

- **Vaccine response**. There is currently no consensus on revaccinating patients with low vaccine titer when tested a month following vaccination (i.e., Tdap, MMR); more research is needed.
- **Home blood pressure monitoring during pregnancy**. PFAS are associated with elevated blood pressure during pregnancy and with preeclampsia.
- **Breastfeeding**. Babies can be exposed to PFAS during pregnancy since PFAS can cross the placenta. PFAS chemicals also accumulate in breast milk. However, the benefits of breastfeeding are clear, and include benefits to maternal as well as child health. There is insufficient evidence to recommend against breastfeeding based on maternal PFAS exposure.



pfas-exchange.org

What's My Exposure?

This online tool can help interpret PFAS levels in water and blood.

Information from your blood report (or water)

	Value	Unit
PFOA (in blood) -- Perfluorooctanoic acid	0.85	ng/mL
PFOS (in blood) -- Perfluorooctane sulfonic acid	7.6	ng/mL
PFHxS (in blood) -- Perfluorohexane sulfonic acid	2.7	ng/mL
PFNA (in blood) -- Perfluorononanoic acid	0.84	ng/mL

Generate report

PFAS Exchange
www.pfas-exchange.org

PFOS (Perfluorooctane sulfonic acid)

Your result: 7.6 µg/L (You entered this as: 7.6 ng/mL)

Your result was **below** the U.S. 95th percentile of 18.3 ng/mL (18.3 µg/L)

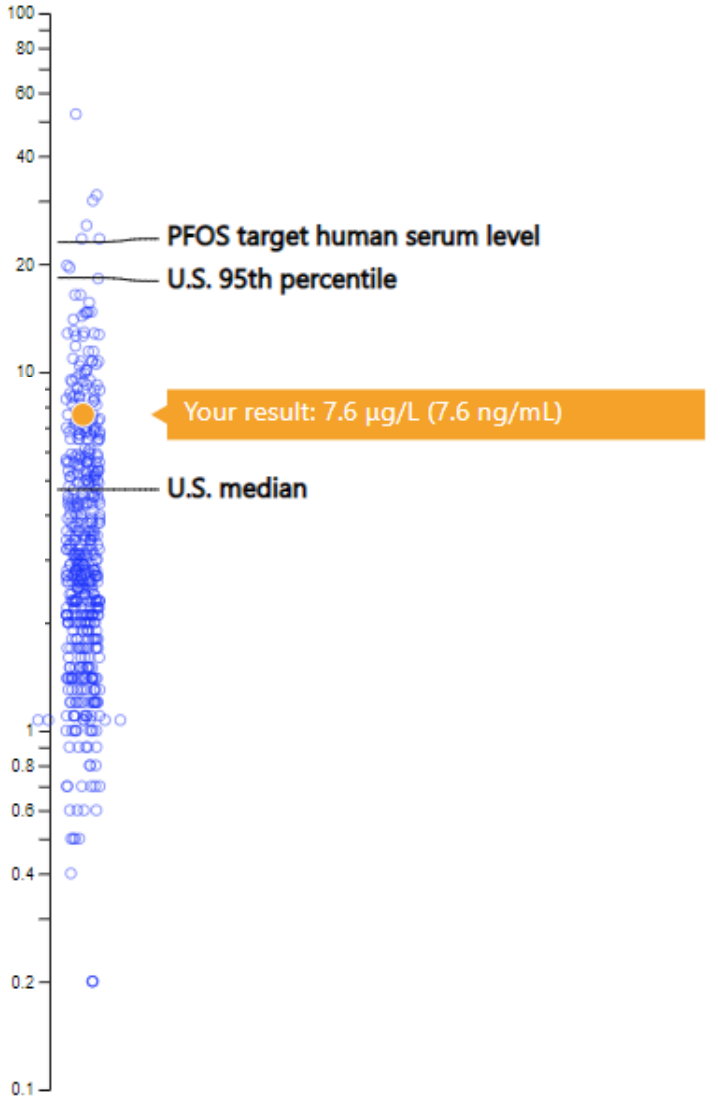
Your result was **above** the U.S. median of 4.7 ng/mL (4.7 µg/L)

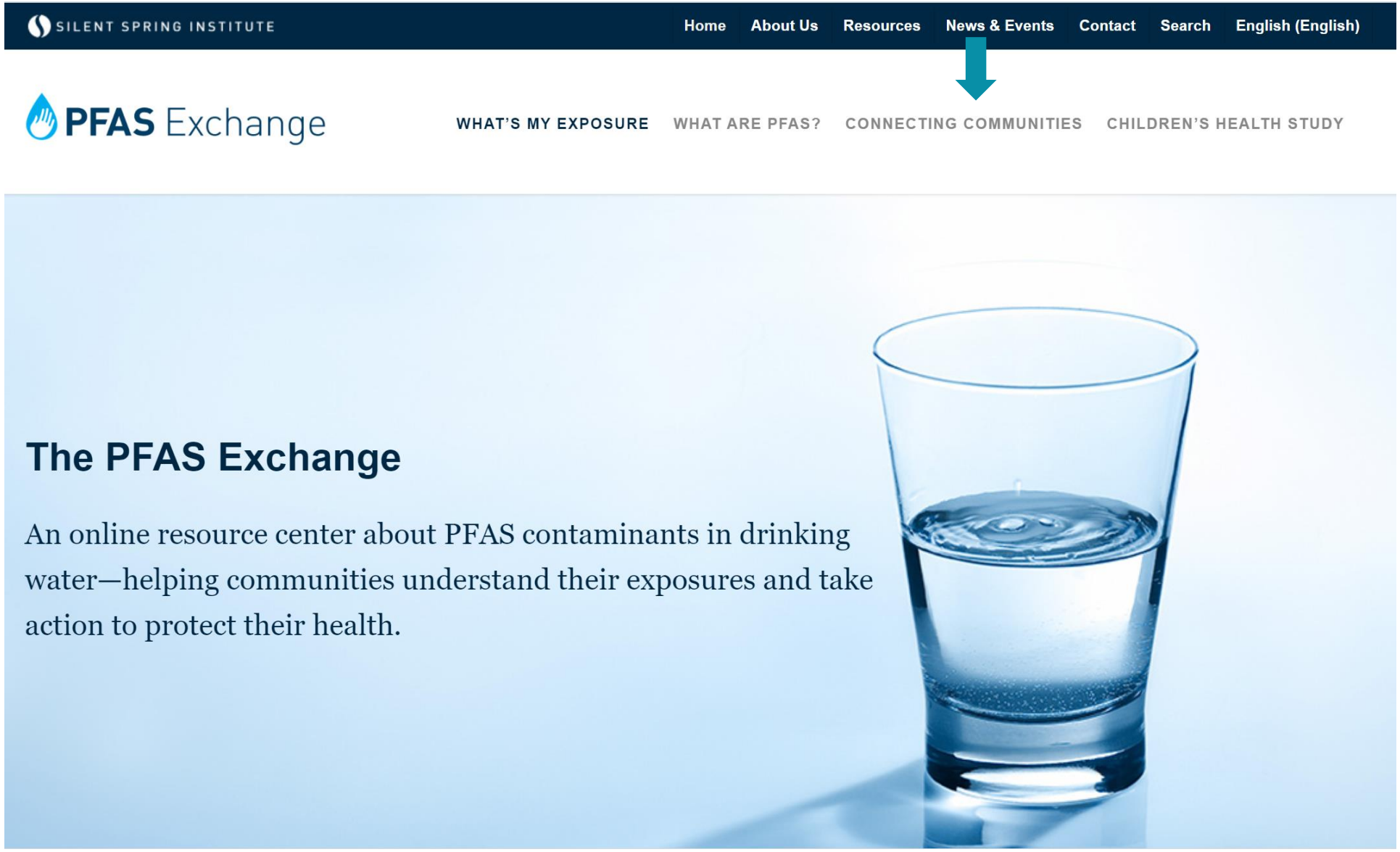
Graph legend

People in a representative sampling of Americans

PFOS level in my blood

Benchmarks from a representative sampling of Americans and from other PFAS exposure studies

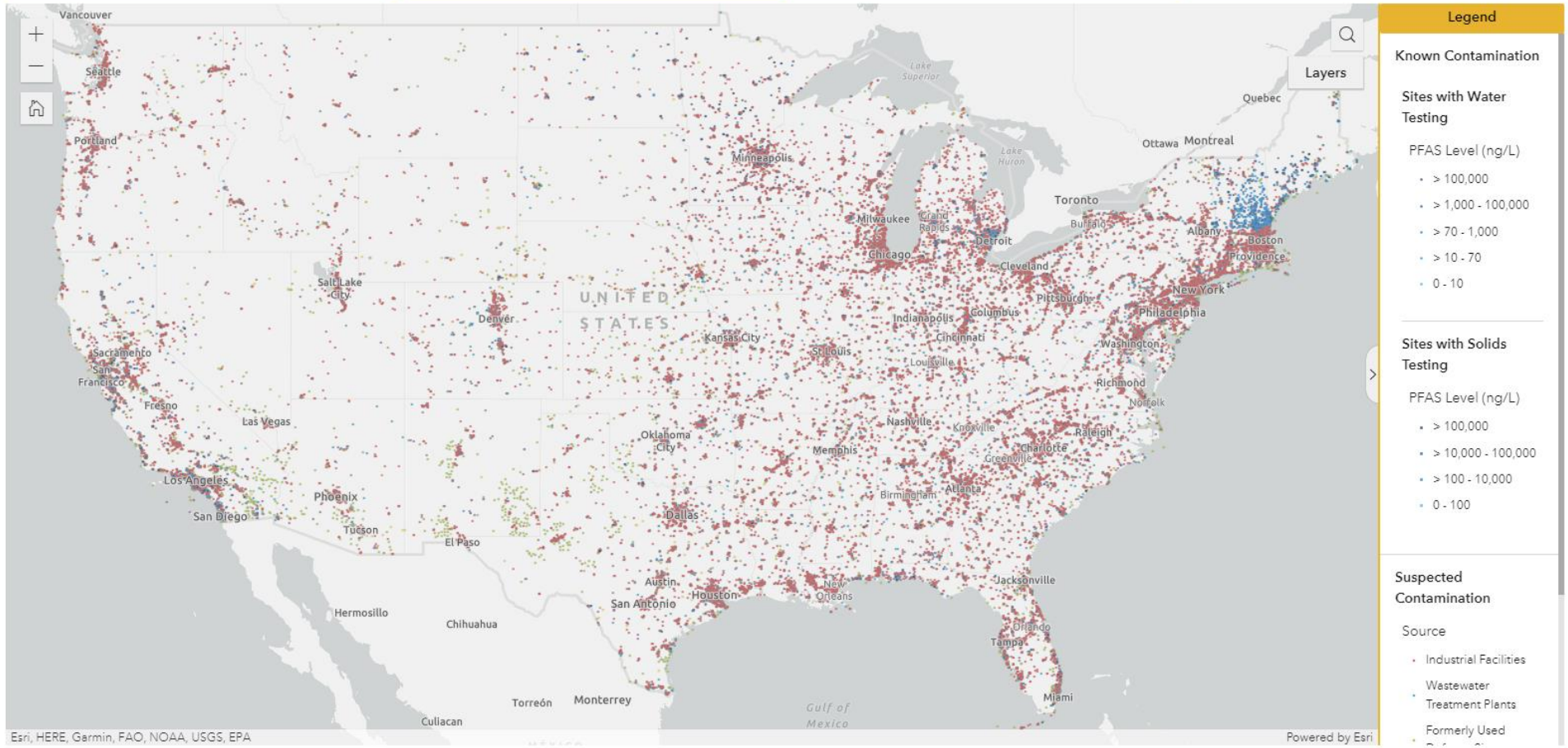




www.pfas-exchange.org

PFAS Exchange

Known Contamination | Suspected Contamination | Community Resources | State Action



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PFAS Exchange

WHAT'S MY EXPOSURE | RESOURCES | CONNECTING COMMUNITIES | CHILDREN'S HEALTH STUDY

Resources

Because PFAS are so ubiquitous in the environment and exposures are so widespread, it's important for people to be informed. Below are resources to help you make decisions to protect your health.

Scroll Down

Resources for Clinicians

A comprehensive set of resources for medical and health professionals, including our 2022 Continuing Medical Education Course.

Resources for Clinicians

Because PFAS are so ubiquitous in the environment and exposures are so widespread, it's important for clinicians to be informed. Below are resources to help guide you in your practice.

Video: Health Education and Guidance on PFAS Exposure

This presentation highlights the importance of increasing clinical knowledge and understanding among healthcare providers for patients with potential risk factors and/or concerns about PFAS exposure. The presentation discusses individual risk factors and teaches the audience current federal recommendations for screening, as well as other protocols for assessing PFAS exposure and prevention and follow up approaches where research and research findings may be involved and/or unclear. The presentation promotes knowledge and competence for understanding and recognizing likely PFAS environmental exposures and preventing further exposure.

https://cmetracker.net/MSU/Publisher?page=pubOpenSub#/event/94092/

MICHIGAN STATE UNIVERSITY

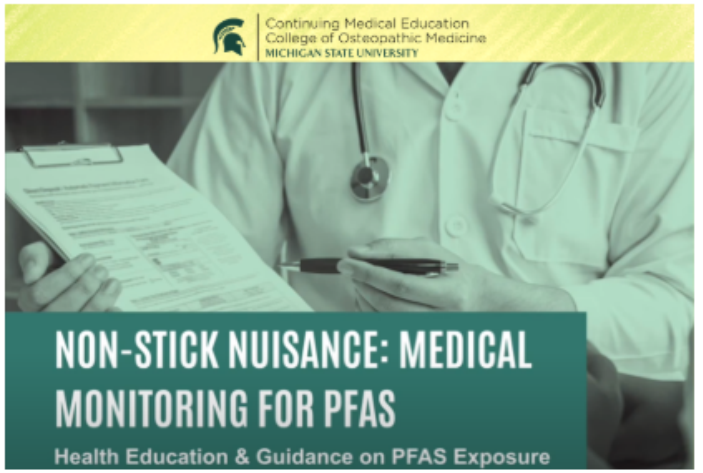
Sign In All Activities

Nonstick Nuisance: Medical Monitoring for PFAS

You will be asked to complete a pre-test prior to the video starting. There will then be a post-test and CME evaluation following the video. Please do not make the YouTube window full screen, it will breakt the CME flow and you will not be able to claim your certificate at the end. This video is an hour long and must be completed in one sitting. Thank you!

Sign In to Register

Free CME



Activity Type

On-Demand

CME Credit Available

AMA PRA Category 1

Credits Offered:

Participant - 1.00
AMA PRA Category 1 Credit™ - 1.00

New Clinician Training CME

Developed by our PFAS REACH team in collaboration with project partners. Features leading experts in PFAS toxicology, occupational medicine and pediatric environmental medicine.

Linda Birnbaum

National Institute of Environmental Health Sciences

Alan Ducatman

West Virginia University

Elizabeth Friedman

Children's Mercy Kansas City

PEHSU Pediatric Environmental Health Specialty Units

Courtney Carignan

Michigan State University

Phil Brown

Northeastern

Laurel Schaider

Silent Spring Institute
Researching the Environment and Women's Health

New Clinician Training CME

Includes presentations by project partners and personal stories from people impacted by PFAS contamination. Produced by communication professionals.

Andrea Amico

TESTING *for* PEASE

Sandy Wynn-Stelt

GREAT LAKES PFAS ACTION NETWORK

Ayesha Khan

nantucket PFAS ACTION GROUP

Jamie Honkawa

nantucket PFAS ACTION GROUP

Full report is free online.

Guidance on PFAS Testing and Health Outcomes

Per- and polyfluoroalkyl substances (PFAS) are chemicals that contaminate many communities in the United States. Our expert committee will examine the health outcomes associated with the most widely studied PFAS and make recommendations to the CDC on who, when, how, and what to test, as well as the risks of testing.

Provide feedback on this project

SUBSCRIBE FOR UPDATES FROM BEST

https://nap.nationalacademies.org/catalog/26156/guidance-on-pfas-exposure-testing-and-clinical-follow-up

Foundational Principles: Proportionality, Justice, Autonomy, Feasibility, Adaptability

PFAS Health Effects

- Literature review of studies on effects of PFAS in humans
- Synthesized available evidence, including previous decisions from other authoritative bodies and more recent human studies.
- Because most people are exposed to mixtures of PFAS, making it difficult to disentangle the specific effects of each PFAS, the Committee provided one strength of evidence determination for all PFAS for each health effect.
- Categories of “strength of evidence”: (1) Sufficient evidence of an association; (2) Limited suggestive evidence of an association; (3) Inadequate or insufficient evidence of an association; and (4) Limited suggestive evidence of no association.

CATEGORY OF ASSOCIATION	HEALTH OUTCOMES WITH INCREASED RISK ASSOCIATE WITH PFAS EXPOSURE
Sufficient evidence of an association Based on strong evidence, there is high confidence that there is an association between exposure to PFAS and the health outcome. It is unlikely that the association is due to chance or bias.	• Decreased antibody response (in adults and children) • Dyslipidemia (in adults and children) (high cholesterol) • Decreased infant and fetal growth • Increased risk of kidney cancer (in adults)
Limited suggestive evidence of an association Based on limited evidence, there is moderate confidence that there is an association between exposure to PFAS and the health outcome. It is possible that the association is due to chance or bias.	• Increased risk of breast cancer (in adults) • Liver enzyme alterations (in adults and children) • Increased risk of pregnancy-induced hypertension (gestational hypertension and preeclampsia) • Increased risk of testicular cancer (in adults) • Thyroid disease and dysfunction (in adults) • Increased risk of ulcerative colitis (in adults)
Inadequate or Insufficient Evidence to Determine an Association Based on inconsistent evidence, a lack of evidence, or evidence of insufficient quality, there is moderate confidence that there is an association between exposure to PFAS and the health outcome. No conclusion can be made about a potential association.	• Immune effects other than reduced antibody response, and ulcerative colitis; Cardiovascular outcomes other than dyslipidemia; • Developmental outcomes other than small reductions in birthweight • Cancers other than kidney, breast, and testicular; Reproductive effects other than hypertensive disorders of pregnancy; Endocrine disorders other than thyroid hormone levels; Hepatic effects other than liver enzyme levels; Respiratory effects; Hematological effects • Musculoskeletal effects, such as effects on bone mineral density; Renal effects, such as renal disease; Neurological effects
Limited Suggestive Evidence of No Association Based on at least limited evidence, there is at least moderate confidence that there is NO association between PFAS and the health outcome.	• No outcomes were identified.

https://nap.nationalacademies.org/resource/26156/PFAS%20Guidance%20Highlights.pdf NASEM 2022

Advising Patients Seeking Exposure Reduction

1. Talk with patient to determine if and how they may be exposed;
2. Advise those with:
   - Occupational exposures to consult with occupational health clinician;
   - Elevated PFAS in drinking water to use and maintain filters;
   - Living in areas of known PFAS contamination that PFAS can be present in fish, wildlife, meat and dairy.
3. For infants: discuss steps that can lower sources of exposure (e.g., mix formula with safe water).

PFAS Testing and Levels that can Inform Clinical Care

Testing should be offered to patients with elevated PFAS exposure

Benefits:

- Helps people to better understand and mitigate their exposure
- Exposure levels can inform clinical follow-up

Limitations

- Do not predict likelihood of a health effect as individual risks vary
- Levels in blood decrease over time and that decline varies by PFAS
- May increase stress or health concerns (although may also decrease them)

Whether to test requires shared, informed decision making

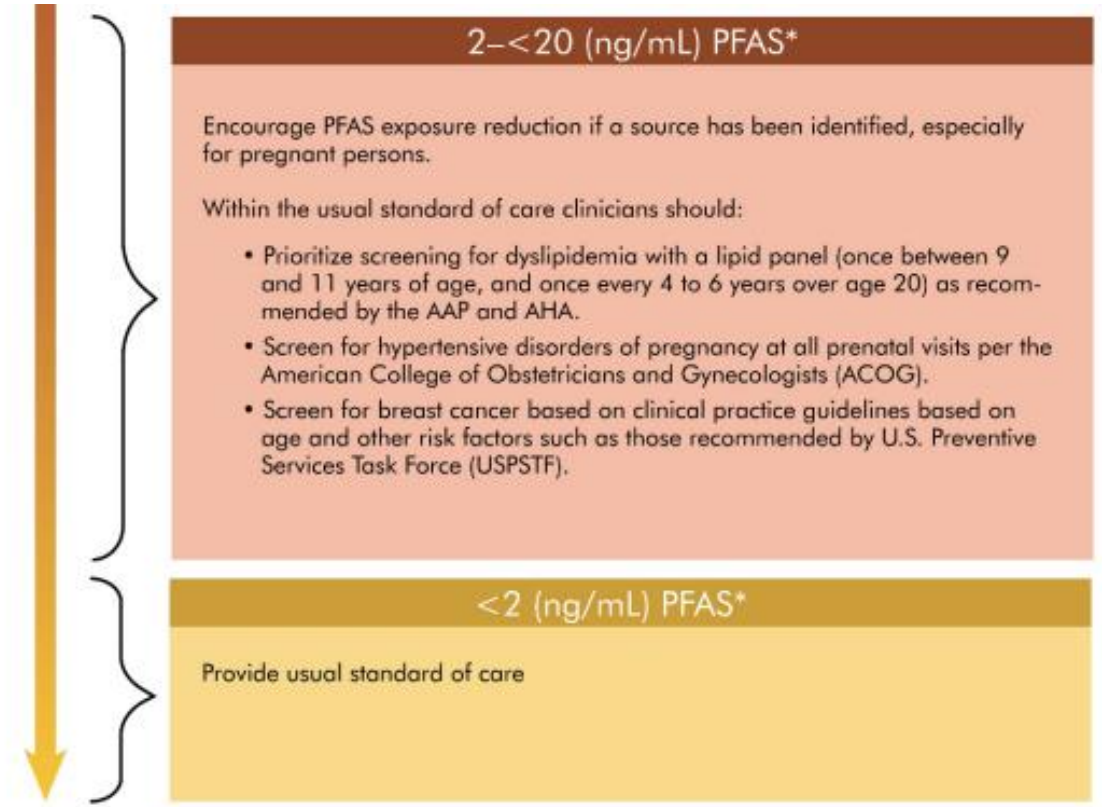
PFAS Testing and Levels that can Inform Clinical Care

Human Biomonitoring Commission in Germany and the European Food Safety Authority determined guidance values for:

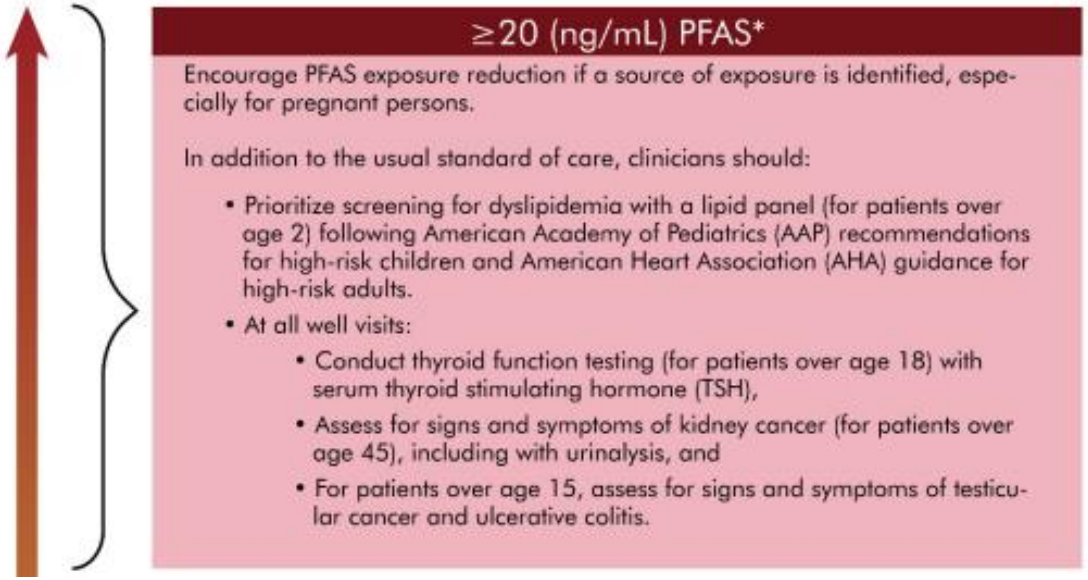
- Levels below which health effects are unlikely to be observed, and
- Levels above which effects have been observed in the general population and more sensitive groups such as pregnant persons.

Using these risk-based values and assumptions of dose additivity, the committee determined that:

Clinical Guidance for Follow-up with Patients after PFAS Testing



* Simple additive sum of MeFOSAA, PFHxS, PFOA (linear and branched isomers), PFDA, PFUnDA, PFOS (linear and branched isomers), and PFNA in serum or plasma



National Academies of Sciences, Engineering, and Medicine. 2022. Guidance on PFAS Exposure, Testing, and Clinical Follow-Up. Washington, DC: The National Academies Press. https://doi.org/10.17226/26156

National Academies Medical Screening Guidance

Advises tests in typical physical plus a little more

≥20 (ng/mL) PFAS*

Encourage PFAS exposure reduction if a source of exposure is identified, especially for pregnant persons.

In addition to the usual standard of care, clinicians should:

- Prioritize screening for dyslipidemia with a lipid panel (for patients over age 2) following American Academy of Pediatrics (AAP) recommendations for high-risk children and American Heart Association (AHA) guidance for high-risk adults.
- At all well visits:
  - Conduct thyroid function testing (for patients over age 18) with serum thyroid stimulating hormone (TSH),
  - Assess for signs and symptoms of kidney cancer (for patients over age 45), including with urinalysis, and
  - For patients over age 15, assess for signs and symptoms of testicular cancer and ulcerative colitis.

* Simple additive sum of MeFOSAA, PFHxS, PFOA (linear and branched isomers), PFDA, PFUnDA, PFOS (linear and branched isomers), and PFNA in serum or plasma

Population Inference of Risk

Contextualizing possible increases in population risk can be useful. Kidney cancer example:

- Odds Ratio = 2 among those with elevated PFAS in drinking water.
- If general population odds is 1 in 64 then a doubling of odds is 1 in 32.
- May expect this 2-fold higher incidence in populations with comparatively elevated exposures. This inference uses population risk.
- However, an individual person's risk will vary as each person has different risk factors and most diseases have multiple risk factors.

Workflow Review

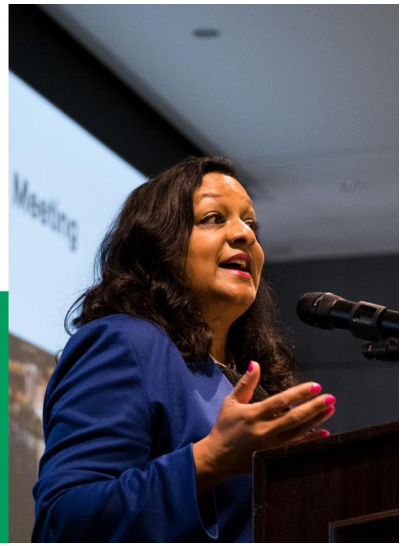
- Exposed patient (suspected or known based on water levels, occupation, etc) requests blood testing.
- Can order a blood test using ICD-10 diagnosis code Z13.88, Test Code 39307 and CPT code 82542 (see Blood Testing Fact Sheet).
- Share medical screening guidance (on PFAS Exchange).
- Contextualize results using Exposure tool (PFAS Exchange).
- Offer medical screening based on NASEM guidance.
- Those with notably high PFOS: might consider 6 week course of cholystyramine (see our guidance and results of clinical trial).

NATIONAL PFAS CONFERENCE

June 10 -12

Ann Arbor, MI

nationalpfasconference.org



3 DAYS OF POWERFUL TALKS

WHERE SCIENCE MEETS COMMUNITY

This conference series is uniquely designed to exchange information, provide support to PFAS-affected communities, and facilitate engagement across diverse sectors involved with PFAS to accelerate the protection of health and the environment.

Supporting Impacted Communities

Protecting Environmental Public Health

Visit the Conference Website

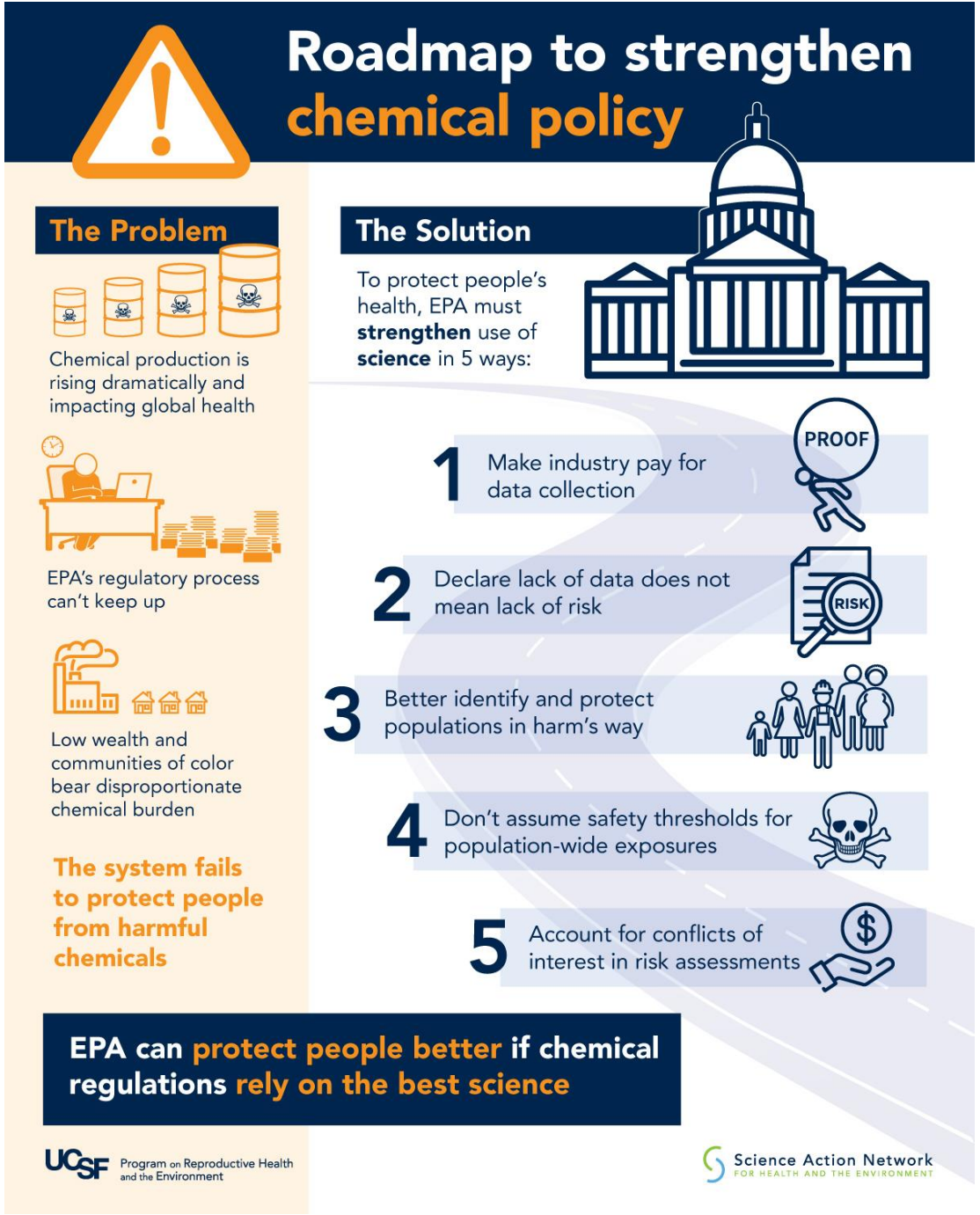
nationalpfasconference.org

2024 Conference: Recordings of sessions on the Michigan Story, Human Rights, etc.

nationalpfasconference.org

Dark Waters Motion Picture

Dramatization of the true story of PFAS discovery



https://prhe.ucsf.edu/strengthening-chemical-regulatory-process

Acknowledgements: PFAS Exchange

PFAS-REACH
PFAS Research, Education, and Action for Community Health

Northeastern University
Phil Brown
Martha Powers
Kim Garrett
Kira Mok

Silent Spring Institute
Laurel Schaider
Maia Fitzstevens

Testing for Pease
Andrea Amico

Massachusetts Breast Cancer Coalition
Cheryl Osimo

Slingshot Community Action
Sylvia Broude
Shaina Kasper
Dana Colihan

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NIH NIEHS

PFAS-REACH is a partnership of Silent Spring Institute, Northeastern University, and Michigan State University, funded under grant R01ES028311.

Declarations

I serve/have served as an external peer-reviewer for agency PFAS documents.

I have served as a plaintiff's expert witness for two PFAS cases.

I currently am funded to investigate PFAS exposure pathways and effects on reproductive and child health (sources of funding: NIH, EPA, USDA, IAFF).

Disclaimer: The views expressed do not necessary reflect those of funders.

Thank You!

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