

PFAS- WHAT PUMBERS SHOULD KNOW ABOUT THE IMPACTS OF PFAS ON SEPTIC SYSTEM EFFLUENT AND SEPTAGE



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TradeMutt



Workwear company in Australia

Social enterprise workwear company by tradies for tradies (primarily high viz and medical scrubs)

They make funky, eye-catching workwear designed to start conversations about mental health

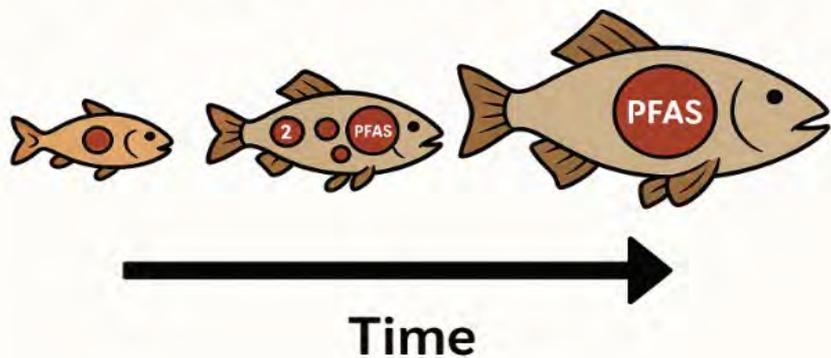
50% of profits from sales goes to the mental health charity TIACS - <https://www.tiacs.org/>

Male suicide continues to be the leading killer of Australian men under the age of 55, most work in blue collar industries

Outline

- What are PFAS?
- Where do they come from?
- What do we know about PFAS in relation to onsite wastewater treatment systems (OWTS)?
- What work needs to be done?

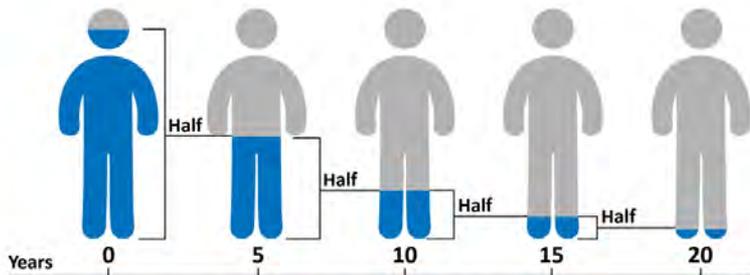
BIOACCUMULATION IN FISH



What are PFAS?

Per - and Polyfluoroalkyl Substances

- Invented in the 1938 but peak usage in the 1990 – early 2000s
- Over 4700 versions/chemicals
- Called “forever chemicals” because they do not break down in the environment



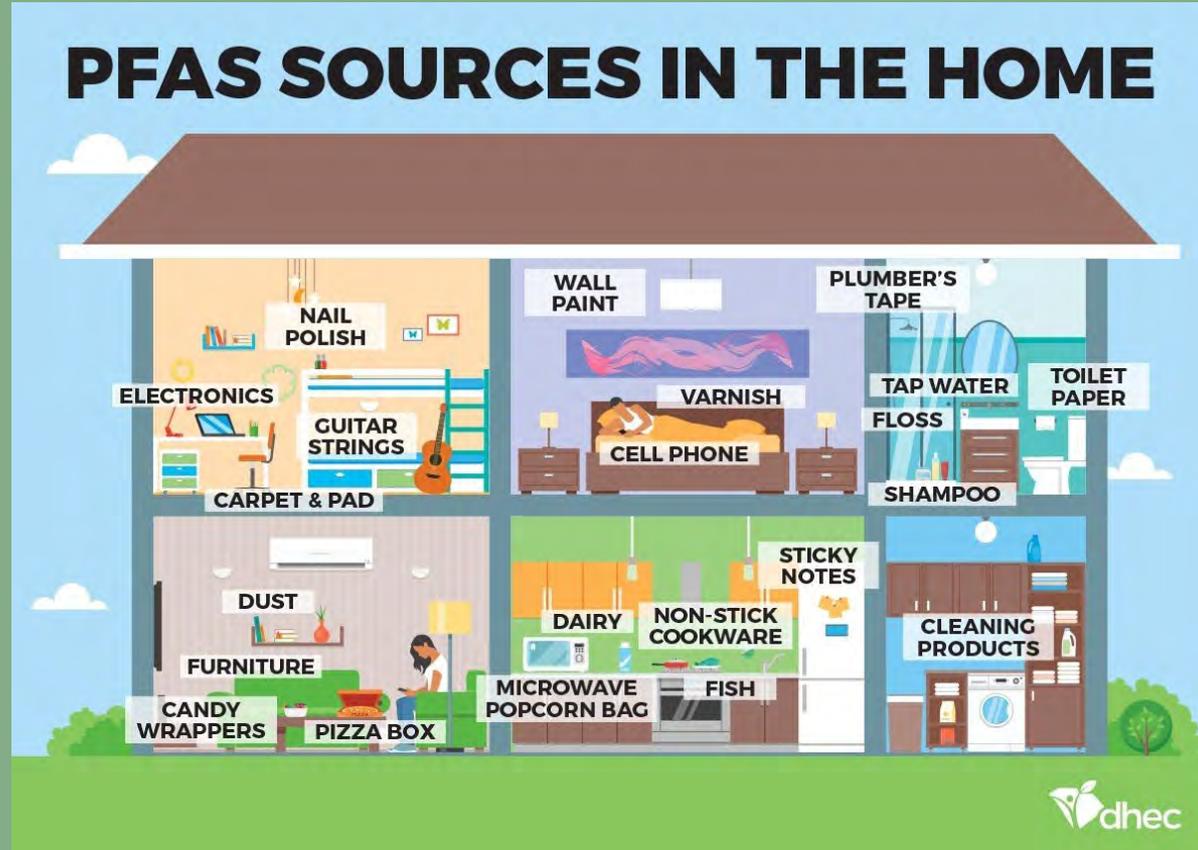
This picture shows how the amount of a chemical with a five-year half-life changes over time. The blue shading on the right shows how much of the chemical remains in the body 20 years after exposure ended.

PFAS

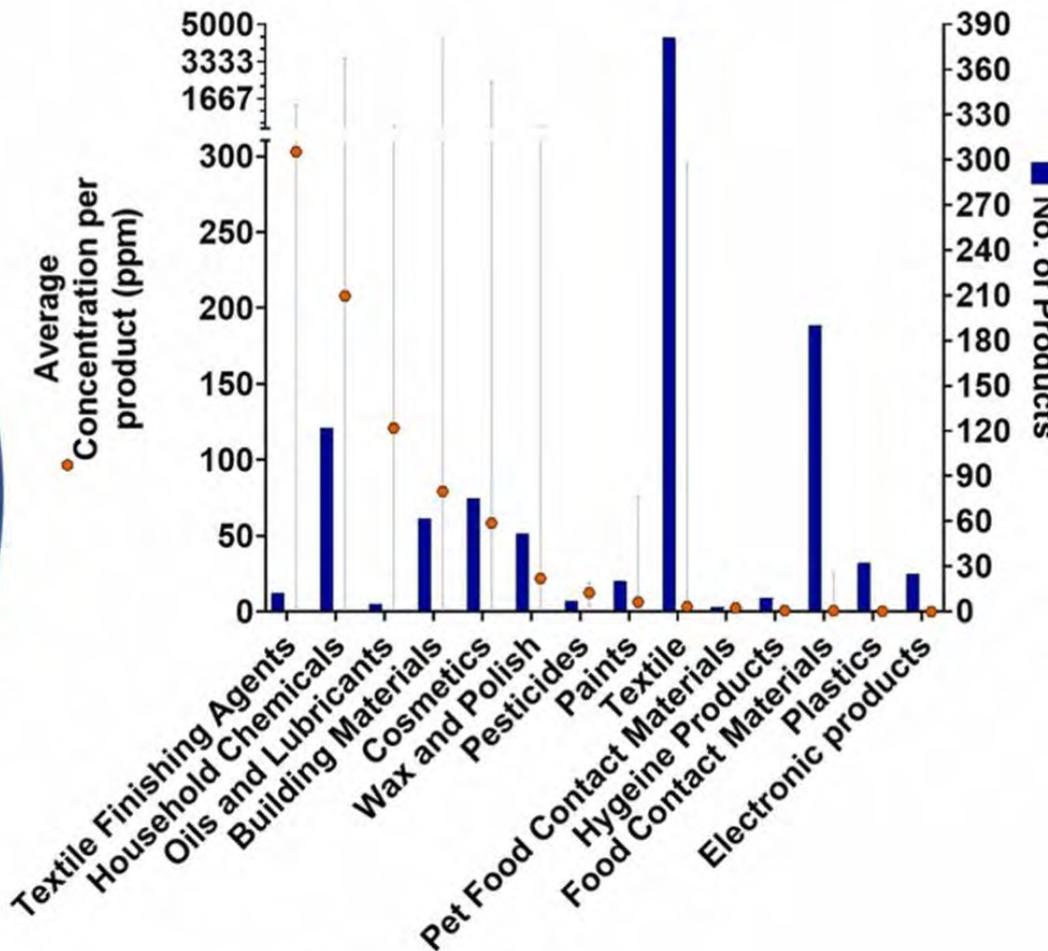
- They share the characteristic of having carbon atoms linked to fluorine atoms
- Some PFAS are made of long-chains of carbon-fluorine groups (longchain PFAS), others of shorter-chains (short-chain PFAS)
- The carbon-fluorine bond is one of the strongest bonds known in nature
- The half-lives of some PFAS polymers is >1,000 years in soil while others are lower at 40 years

Where does PFAS come from?

- Food packaging
- Household products
- Personal care products
- Electronics
- Firefighting foams
- Medical equipment
- Industrial equipment
- Food



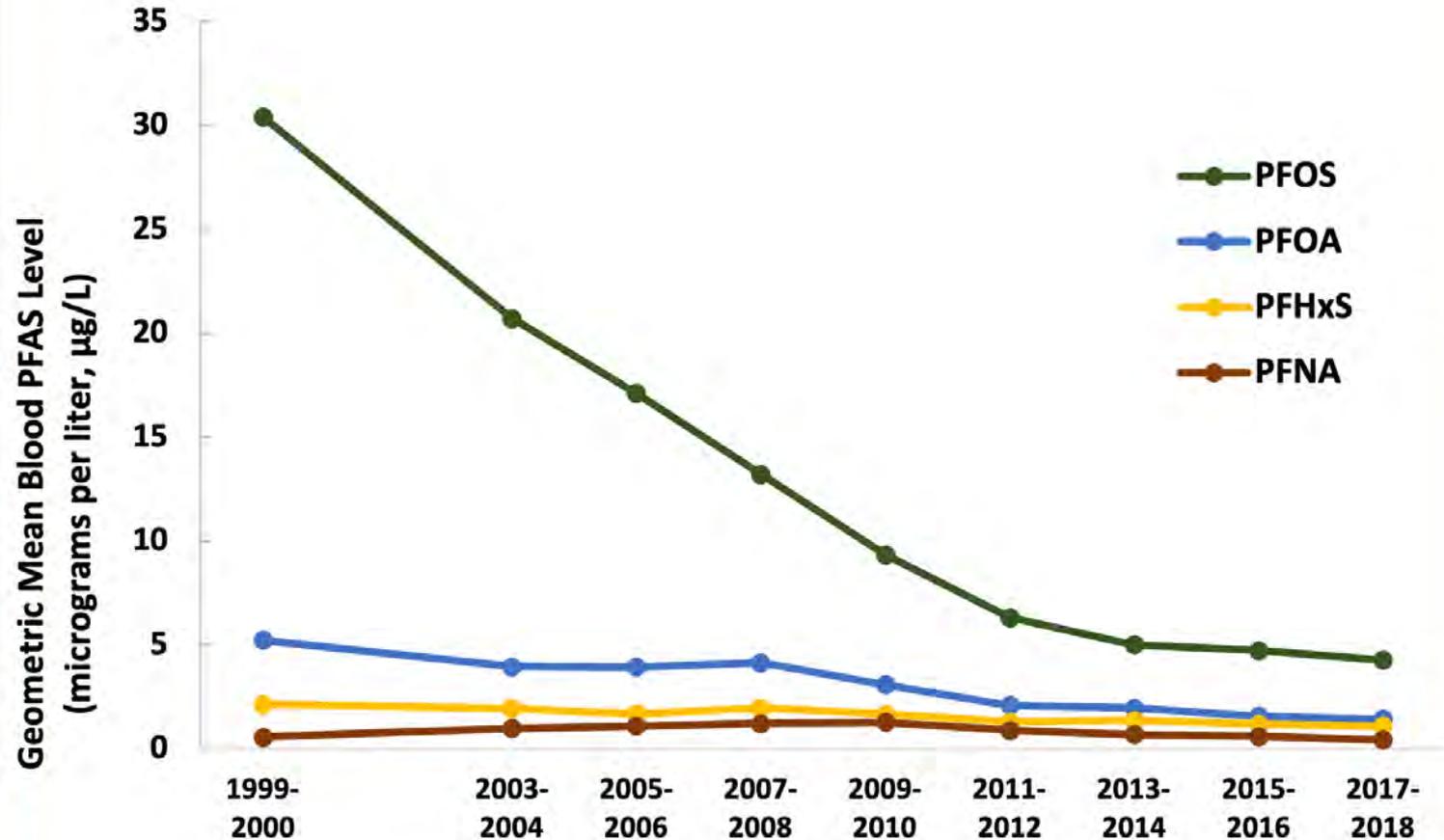
PFAS in Household Products



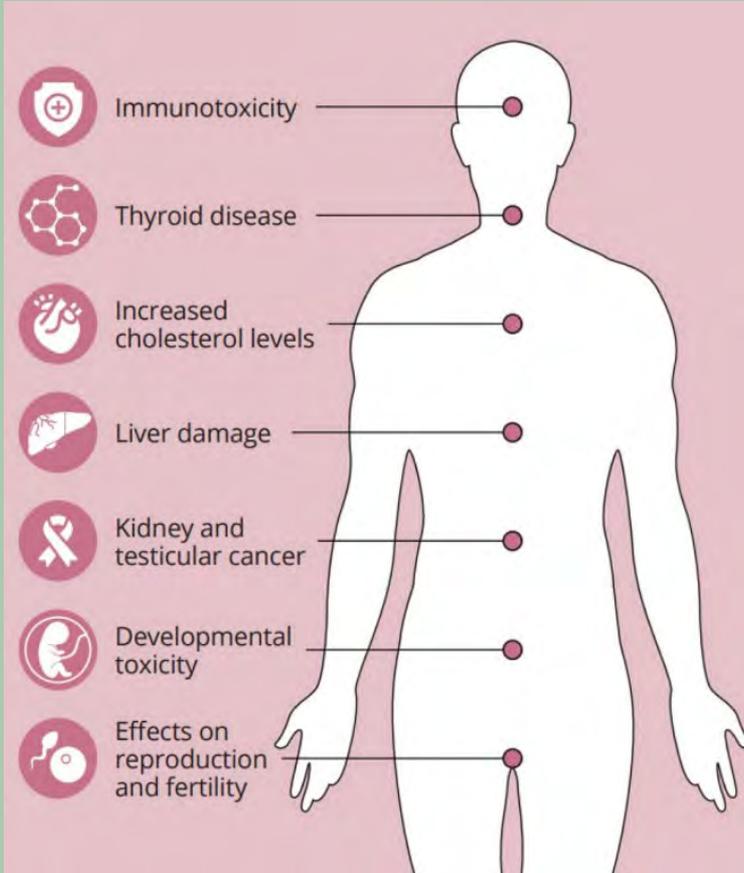
EPA Regulations on PFAS in Drinking Water (April 2024)

- Specific to 6 most common PFAS compounds
- PFOA and PFOS have maximum contaminant level (MCL) of 4 parts per trillion (same as micrograms/liter ($\mu\text{g/L}$))
 - *4 drop of food coloring in 18 million gallons*
 - Commonly used as heat and water resistant additives
- PFHxS, GenX, and PFNA have MCL of 10 ppt
- Compliance with standards is from annual average
- So new that changes are likely as new research becomes available

Blood PFAS levels in the US

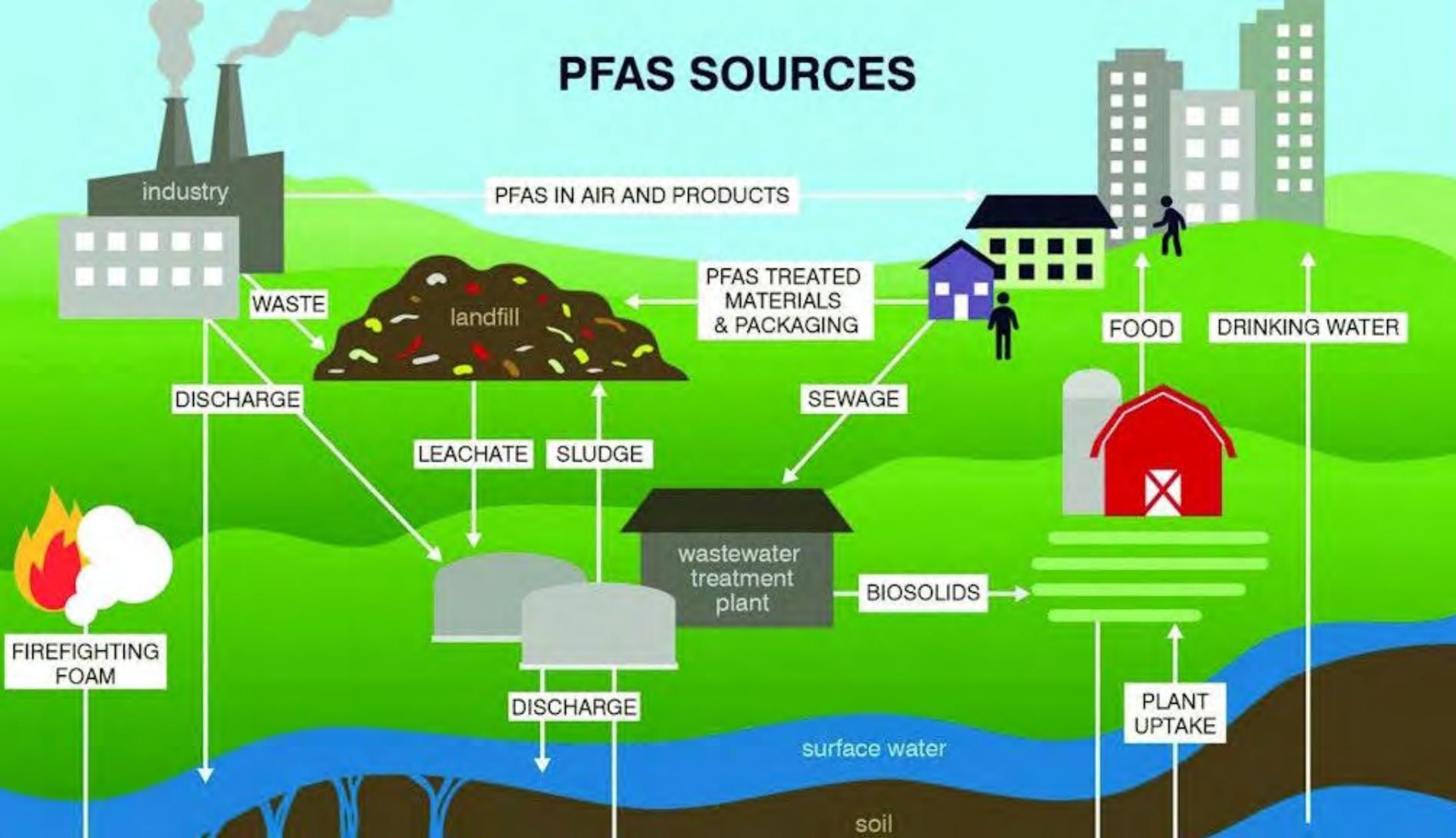


Human Health Impacts of PFAS



- Impaired immunological function
- Chronic autoimmune diseases
- Hepatotoxicity (liver damage)
- Cancer
- Decreased fertility
- Toxic developmental effects

PFAS SOURCES





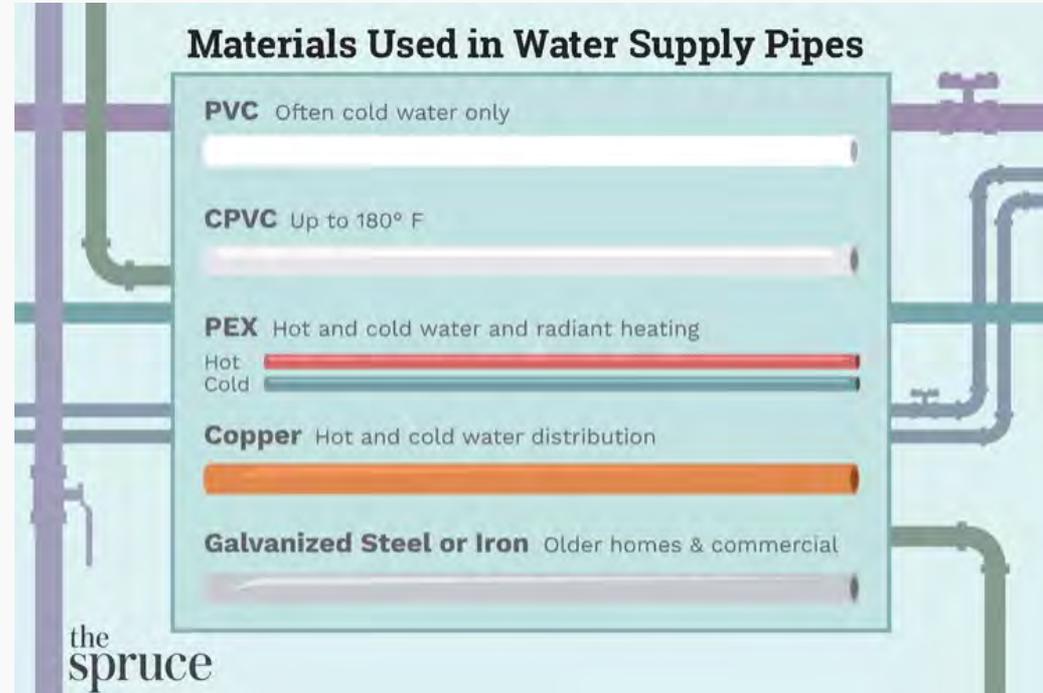
Available Research

- New Hampshire OWTS
- Wisconsin groundwater study
- New York groundwater and wastewater
- Ohio septage and pump stations
- Minnesota septage
- Florida biosolids

Can PFAS come from wastewater infrastructure?

OWTS Materials:

- Concrete
- Fiberglass reinforced plastic
- Steel
- Plastic (High density polyethylene)



New Hampshire OWTS Evaluation



Objectives:

- Evaluate isolated waste streams – carpet cleaning and floor stripping waste from a school
- Evaluate supermarket and school OWTS with monitoring wells
- Evaluate residential community OWTS wastewater

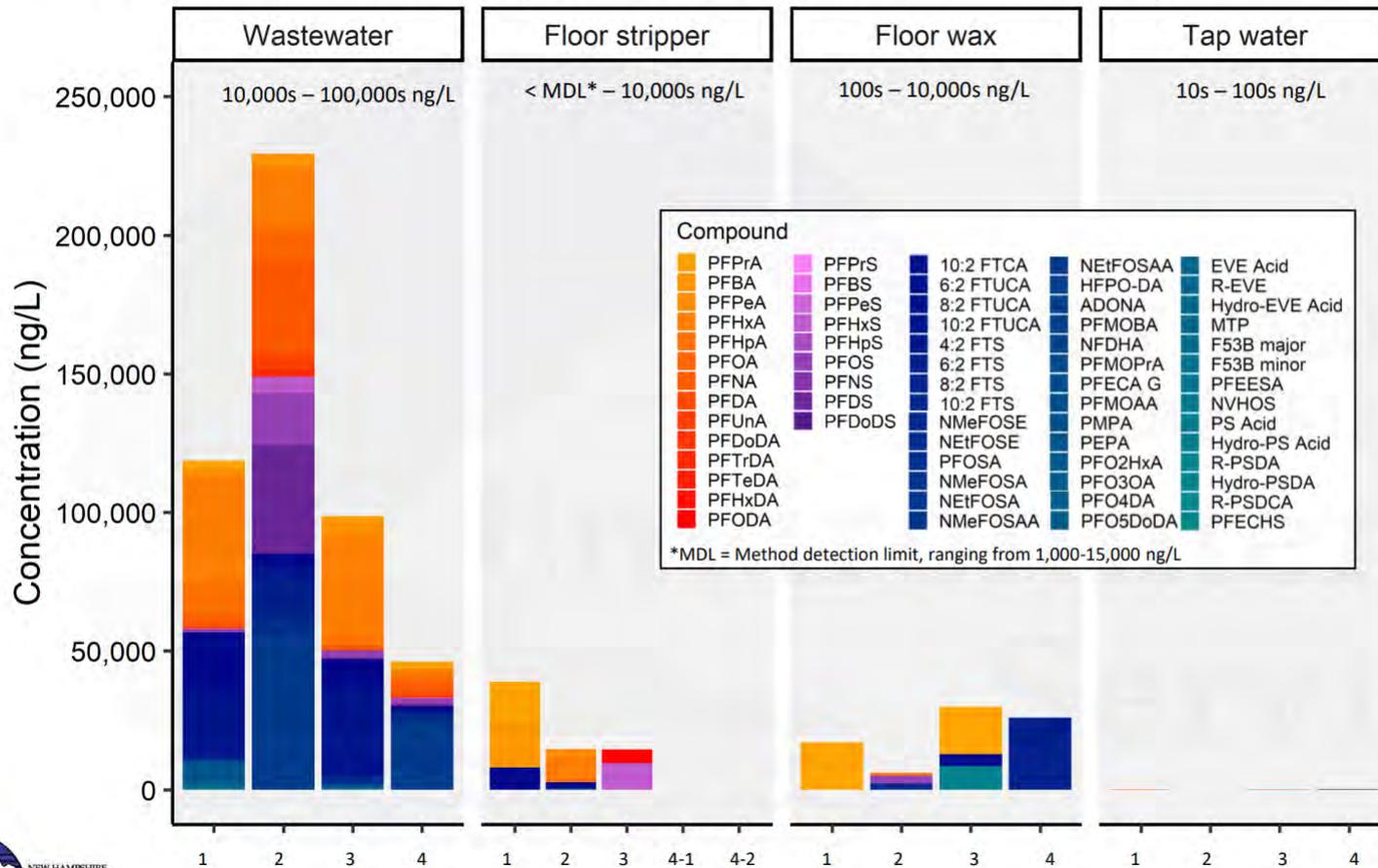
Results Isolated Waste Streams

- Wastewater generated from floor stripping and carpet cleaning is highly concentrated with PFAS from products used and surfaces being cleaned
- Commercial cleaning wastewater is a likely source of PFAS to septic systems



PFAS results for schools: floor stripping & refinishing

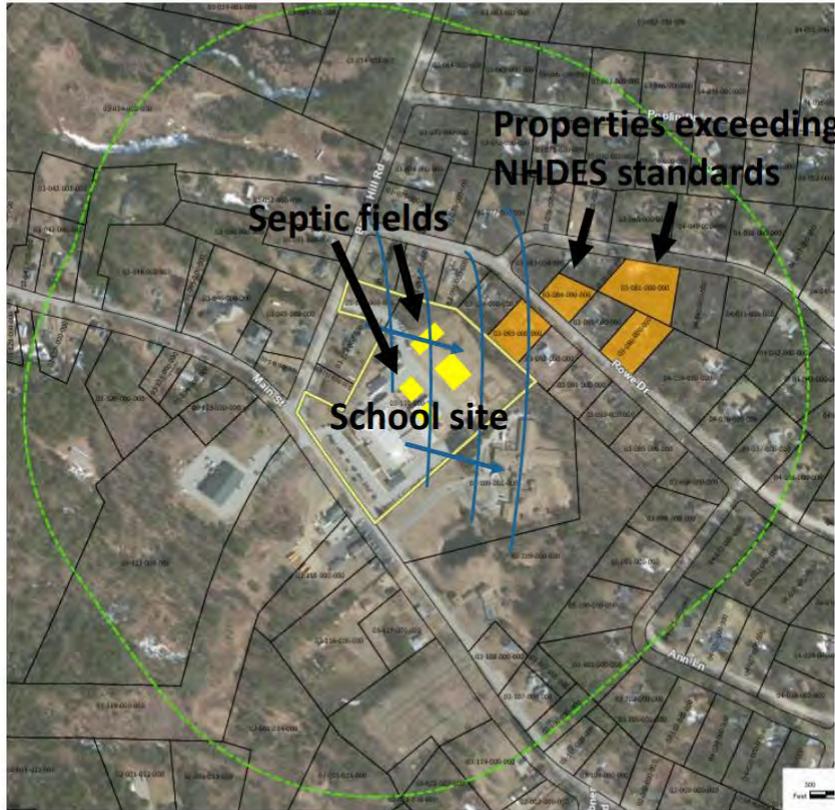
Non-domestic



For more details, see <https://www.pfas.des.nh.gov/groundwater>

Case study: School contaminates neighboring water supply wells

Non-domestic



NHDES Waste Management Division
29 Hazen Drive; PO Box 95
Concord, NH 03302-0095



SUPPLEMENTAL SITE INVESTIGATION

“Drinking water sampling of residential wells in the vicinity of the Subject Property has identified PFAS compounds in excess of AGQs...”

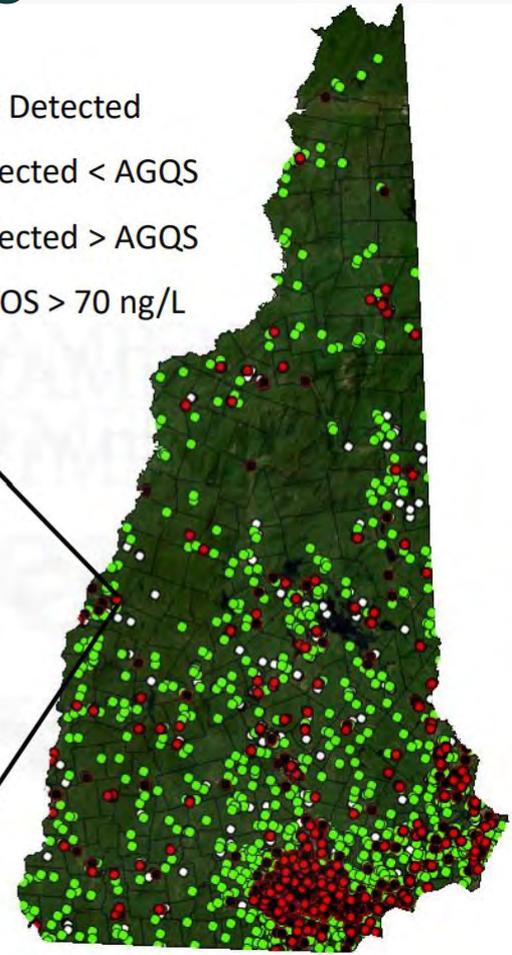
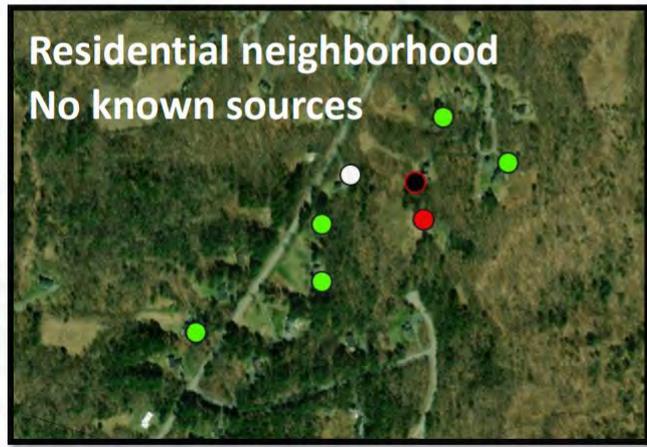
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“...the school’s wax contained PFAS and may have contributed to the historical PFAS presence in the neighborhood.”

Groundwater Testing Results

NH Ambient Groundwater Quality Standards (AGQS)
PFOA: 12 ng/L
PFOS: 15 ng/L
PFNA: 11 ng/L
PFHxS: 18 ng/L

- PFAS Not Detected
- PFAS Detected < AGQS
- PFAS Detected > AGQS
- PFOA+PFOS > 70 ng/L



Summary of 4 Community System Results

Two systems were conventional and 2 had advanced treatment

Two systems were residential and two were senior living

PFAS mass loadings from effluent range from 1 – 14 $\mu\text{g}/\text{person}/\text{day}$

Minnesota Septage Study



Objectives:

- Characterize rest area septage
- Measure a large variety of characteristics from many sites
- Find how common PFAS contamination is in septage and identify possible sources

Minnesota PFAS research methods

- 5 rest areas (RA), septic tanks sampled during tank cleaning
- Mixed septage/wastewater from the “dirtiest” load
- Compared to EPA standards for all other test criteria



Minnesota PFAS research results

- PFAS concentrations were detectable at 3 of the 5 sites sampled
 - 13 different PFAS compounds were detected at St Croix (contaminated groundwater)
 - 14 at Grand Portage
 - 12 at Goose Creek.
- The three showed varying concentrations of different compounds, but St Croix showed a considerably larger total of 746.6 ng/L compared to Goose Creek with 240.7 ng/L and Grand Portage with 91.2 ng/L

OSTP PFAS research results

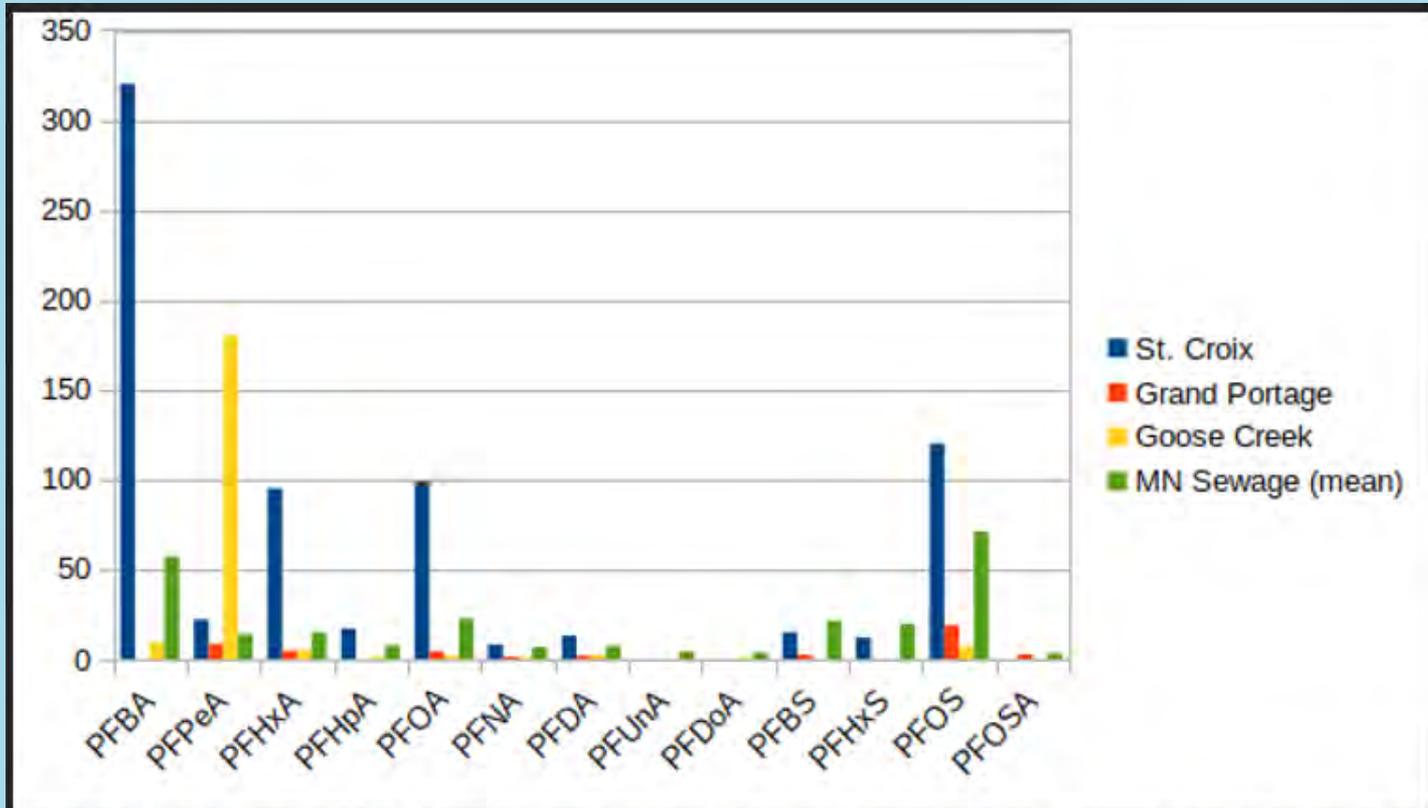


Figure 13: Concentrations of PFAS [ng/L] from this study and Minnesota sewage [4]. Note that there is no data available for PFOSA at St. Croix.

Florida Biosolids Study



Objectives:

- Characterize movement of PFAS in biosolids during different treatment methods
- Identify how PFAS will move in land application and what treatments are best to prevent leaching

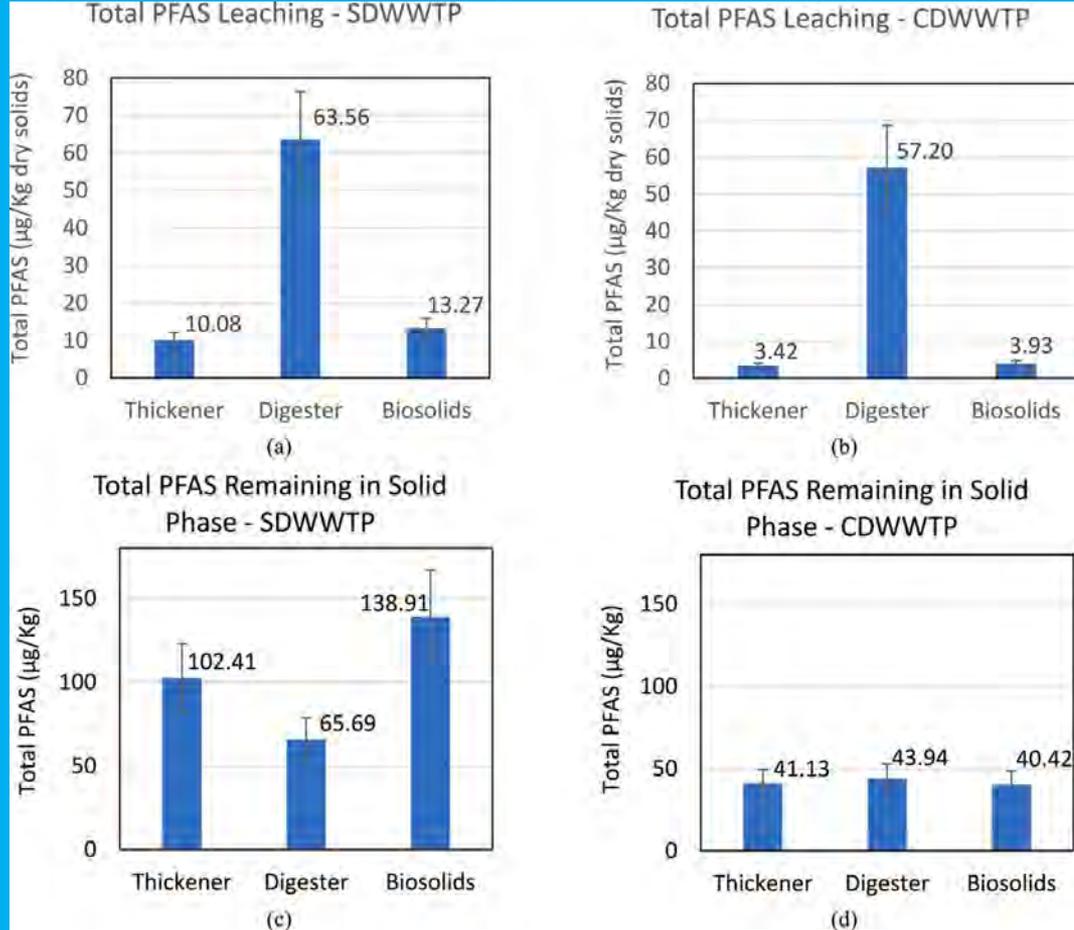
PFAS septage research methods Florida

- Sludge samples collected from two treatment plants with similar treatment processes: waste activated sludge mixed with polymer and sent to gravity thickeners and stabilized by anaerobic digestion, then dewatered via centrifugation
- Sludge samples were collected after thickening, digestion, and dewatering and tested for total, fixed, and volatile solids
- Sludge samples were rewatered with deionized water, mixed for 30 days and centrifuged then analyzed for 40 PFAS compounds

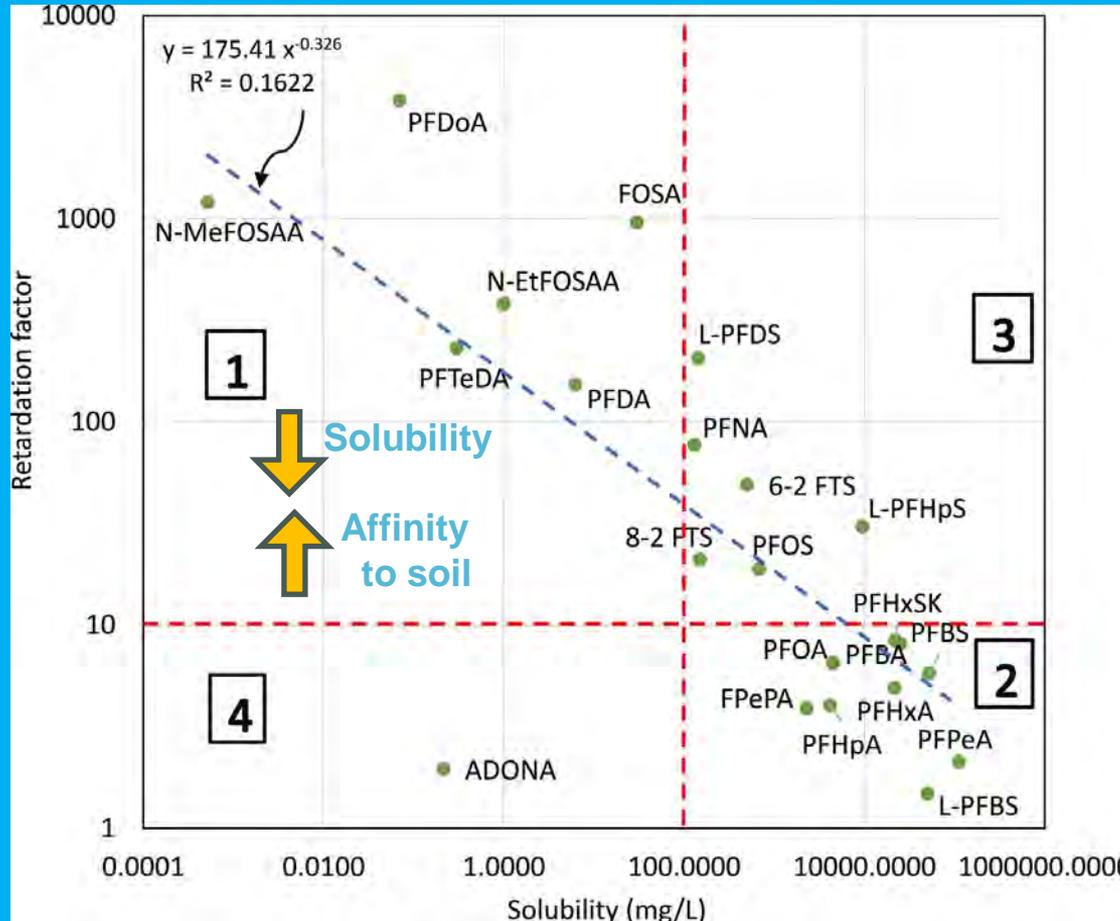
PFAS septage research results Florida

- PFAS movement after biosolid land application was dependent on the type of PFAS compound and how it behaves, with solubility and affinity for soil organic matter being the deciding factors
- PFAS levels in dewatered biosolids are lower compared to the samples from thickener and anaerobic digestion
- Based on comparison of different treatment methods, 24 of the 40 measured PFAS compounds are highly mobile and soluble
- PFAS made soluble did not get reabsorbed in digested sludge and in dewatered sludge

PFAS septage research results



PFAS septage research results



3 - High solubility and high affinity = re-absorb in soil

2- High solubility and low affinity = mobilized through soil

1- high solubility and high affinity = accumulate in soil

4 - low solubility and low affinity = accumulate in soil

PFAS research methods Wisconsin



Study of 450 homes with shallow private wells

Groundwater wells no deeper than 40 ft in Wisconsin

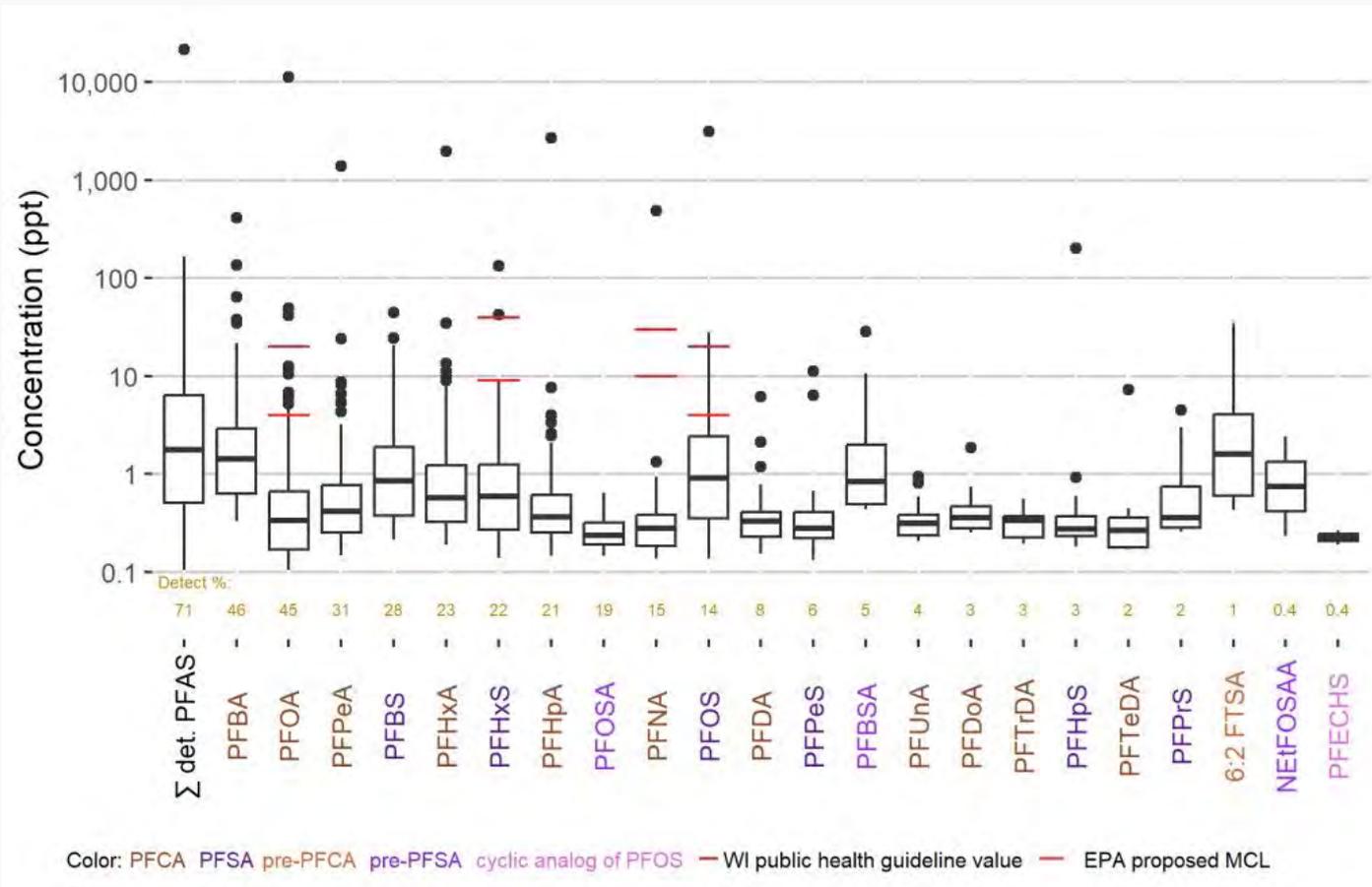
Tested tap water from home well water for 44 PFAS compounds and other organic and inorganic compounds

The additional compounds were primarily indicators of septic or agricultural influence

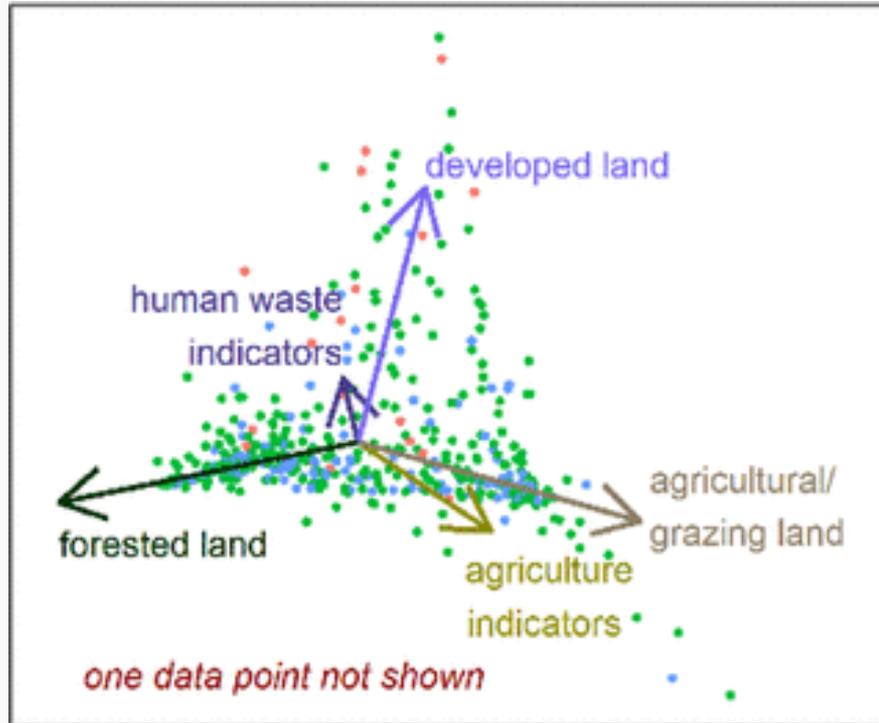
PFAS research results Wisconsin

- At least one of 44 PFAS chemicals tested was found in 71% of homes
- 3.7% of homes had levels exceeding maximum contaminant guidelines
 - Several showed signs of human waste indicators
- PFAS found commonly in all land use types, but most common in developed, forested, grassland, and agricultural areas in that order

PFAS research results WI



OWTS linkage?



450 samples from shallow private wells

- PFOA ≥ 4 ng/L,
PFOS ≥ 4 ng/L and/or
PFHxS $\geq \sim 9$ ng/L
- PFAS detected
- no PFAS detected

North Carolina Study



Objectives:

- Quantify the amount of PFAS contamination in private wells and septic systems in Bladen County
- Test for E. coli and total coliform in wellwater
- Compare with EPA standards

PFAS research methods North Carolina

- North Carolina study of septic effluent and private wells from 18 homes chosen along the Cape Fear River or near it, at varying locations from the Chemours industrial plant
- Field tested pH, oxidation reduction potential, turbidity, temperature, and specific conductance
- Lab tested PFAS, PFOA, GenX, TDN, TSS, NO₃, TKN, DOC, Chloride, E. coli, and total coliform

PFAS research results North Carolina

Results showed detectable levels of one type of PFAS in 61% of wells and another type in 39% of wells

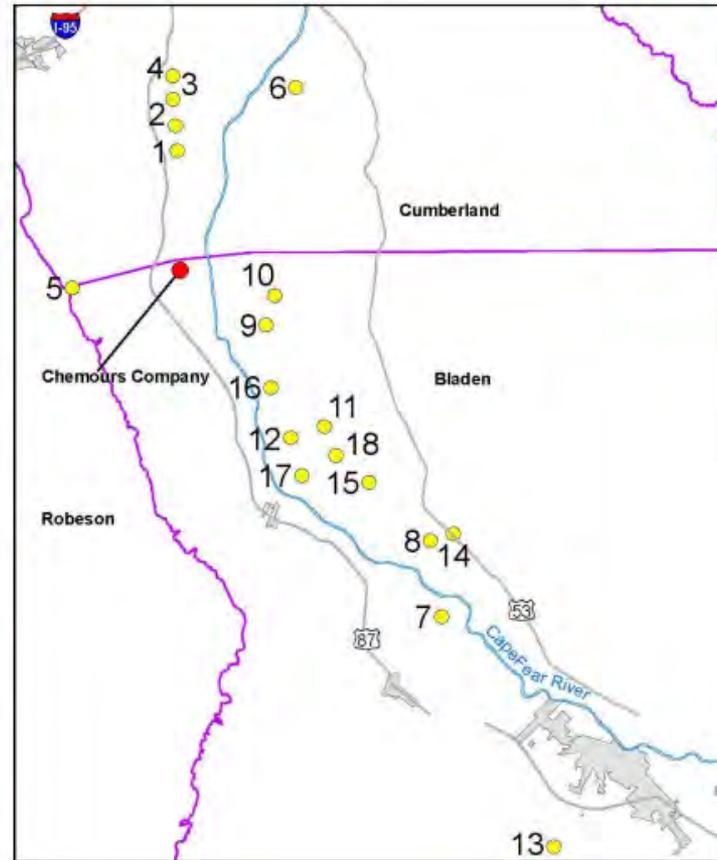
50% of these private wells exceeded EPA's regulation levels for PFAS

No clear correlation between PFAS levels in septic effluent and the levels in that home's well

The wells nearest to the Industrial Plant saw increased levels of PFAS compounds in varying ways

PFAS research results NC

Location	PFOA (ppt)	PFOS (ppt)	GenX (ppt)
Site 1- Well	0	0	0.35
Site 2 -Well	0	0	2
Site 3 - Well	15.6	0.15	0
Site 4- Well	0	0	0
Site 5 -Well	1.1	0	31.7
Site 6 - Well	2.3	0.13	29.6
Site 7- Well	0	0	0
Site 8 -Well	11.6	0	0
Site 9 - Well	19.3	15.4	44
Site 10- Well	10.9	8.8	43
Site 11 -Well	0	0	0
Site 12 - Well	0	0	0
Site 13- Well	2.7	0	0
Site 14- Well	0.93	0	0
Site 15- Well	22.8	0.15	6.2
Site 16- Well	0	0	0
Site 17- Well	72.4	0.64	0
Site 18- Well	4.9	78.2	0



Ohio Study



Objectives:

- Compare PFAS levels in septage and pump stations by sampling both in several areas
- Identify needs for reduction of PFAS contamination

PFAS research methods Ohio



Study conducted by researchers from Ohio on pump stations compared to septic tanks when measuring 70 PFAS compounds



Grab samples taken over 4 week period in Spring at 12 total pump stations sampled twice each

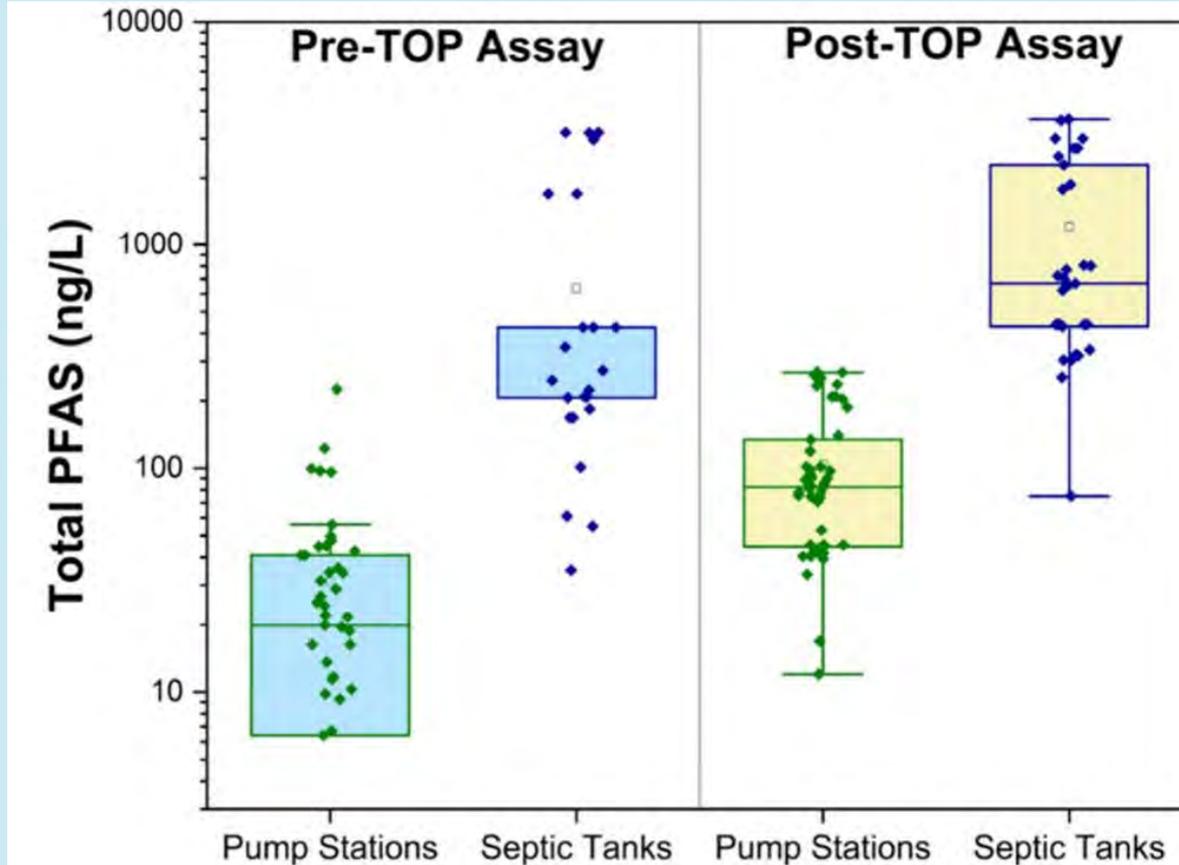


Samples tested using isotope dilutions and extracted internal standard calibrations then treated using TOP assay technique

PFAS research results Ohio

- Out of the 70 PFAS compounds measured for, 27 total were detected
- Septic tanks retain wastewater over long periods of time, allowing for the accumulation of PFAS
- Pump stations rapidly transport wastewater to centralized facilities, meaning lower overall PFAS concentrations
- Contamination of the environment from septic systems depends on the depth of the aquifer and the permeability of the soil
- Pump stations lead to periodic PFAS contamination spikes

PFAS research results OH



New York Study



Objectives:

- Characterize PFAS contamination in area of shallow fractured bedrock, with shallow groundwater as primary water source
- Test private bedrock wells, soil, groundwater, surface water and sediment samples from lakes and wastewater discharge outfalls

PFAS research methods New York

- New York Study of 306 private bedrock wells, soil, groundwater, surface water and sediment samples from lakes and wastewater discharge outfalls
- 7 private water supply wells and 2 temporary overburden monitoring wells were sampled for septic tracer analysis
- Sampling via soil borings, temporary monitoring wells, groundwater sampling via pumps, PFAS free scoops for sampling lakes and wastewater discharge outfalls.
- Private water supply samples collected from faucets
- Tested for 6 PFAS compounds using USEPA methods

PFAS research results New York

- PFAS was detectable and often exceeding comparison limits in all water samples, but notably higher in ground and well water rather than surface
- Soil samples showed little trace of PFAS contamination except adjacent to the fire station and sludge tank at the wastewater treatment plant

PFAS research results New York

- Septic tracer levels follow PFAS levels, indicating that PFAS contamination can be connected to septic effluent
- PFAS contamination in groundwater are similar to that in the nearby lake surface water, indicating contamination by septic system discharges from properties near lake edge

PFAS research results NY

Media	Groundwater (Overburden)	Surface water (WWDO)	Lake surface water	Private water supply well water
No. of samples	24^a	2	11^a	218
<i>PFOA Criteria^b</i>	<i>6.7 ppt</i>	<i>6.7 ppt</i>	<i>6.7 ppt</i>	<i>10 ppt</i>
Number of PFOA > Criteria	21	2	11	194
PFOA maximum detection	140 ppt	16 ppt	8.4 ppt	47 ppt
<i>PFOS criteria^b</i>	<i>2.7 ppt</i>	<i>2.7 ppt</i>	<i>2.7 ppt</i>	<i>10 ppt</i>
Number of PFOS > Criteria	22	2	11	183
PFOS maximum detection	81 ppt	25 ppt	3.8 ppt	190 ppt

PFAS research results NY

AceK ppb	Sucralose ppb	Nitrite ppm	Nitrate ppm	PFOA ppt	PFOS ppt
0.26	0.13	< 0.040	3.67	46	14
0.30	2.9	< 0.010	6.13	21	22
0.58	24	< 0.040	19.5	35	85
0.32	10	< 0.020	15.3	23	32
0.31	20	0.013	12.8	20	29
0.82	1.4	< 0.010	2.81	25	37
0.24	3.2	< 0.004	3.67	25	11

How do we remove it?

- Stop it at the source
- Removal/separation can capture PFAS for later destruction:
 - Activated carbon
 - Ion exchange
 - Reverse osmosis/nanofiltration
- Treatment: oxidation, advanced oxidation, photocatalysis, incineration, and bioremediation that breaks the strong carbon-fluorine bond

What work still needs to be done?

- New products without PFAS
- Research on biosolids vs septage and PFAS
- Research on drinking water filtration for PFAS
 - Reverse osmosis
 - Ion exchange resins
 - Charcoal
- Research on PFAS in water from non-potable sources and soils
- Deeper understanding of transport of PFAS in septic systems
- Research on PFAS filtration from effluent to prevent leaching

Regulatory changes?

- Connecticut, Maine, and New Hampshire have banned land application of biosolids
- 12 other states are considering
- More discussion is needed on septage vs biosolids

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