PFAS

John McVeigh, MBA, CHO, RS
Kathleen Lannon, RN, MS
Sean Flaherty UML MPH Graduate Student

Why do we care about PFAS chemicals?

- Starting in 2020 the Massachusetts Department developed regulations for the combined levels of six of these chemicals in public water supplies. The combined levels were not to exceed 20 parts per trillion (ppt) Testing of our six drinking water wells revealed that one of wells exceeded that limit. Because Wells 1 and 2 waters are combined both wells were shut down upon receipt of results. We are now required to remove the six PFAS from the these wells. It will cost us to do so and that process has begun.

- Information concerning how and why the Massachusetts Department of Enviromental Protection developed these regulations can be found at their website. Use the search term PFAS to get to the information. How many Massachusetts communities are impacted to date? The most accessible information is available is from the sierra club website: https://www.sierraclub.org/Massachusetts/pfas-mass-water-part2

Millis H20 Results

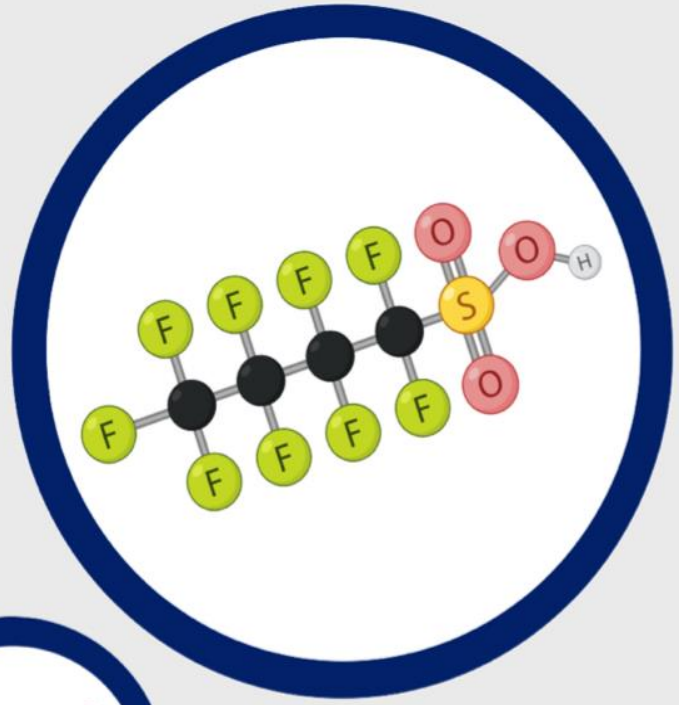
Draft Water Quality Analytical Results
PWS Wells 1, 2 and WTF Millis, MA

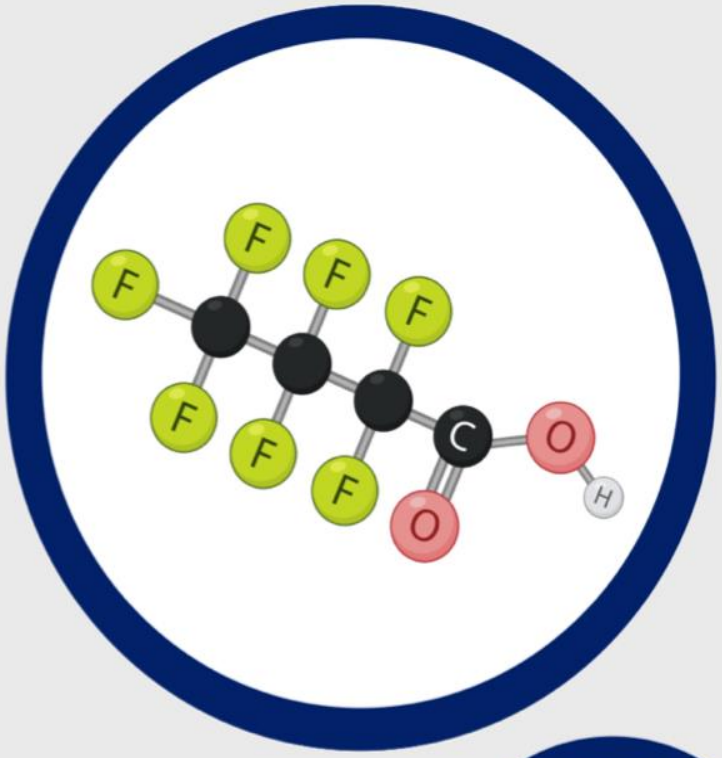
Analyte - PFAS Method 537 Isotope Dilution		Unit	Well 1	Well 2	WTF
Perfluorooctanoic Acid 335-67-1	PFOA	ng/L	**3.62**	**4.36**	**3.85**
Perfluorooctanesulfonic Acid 1763-23-1	PFOS	ng/L	**3.76**	**6.23**	**4.65**
Perfluorononanoic Acid 375-95-1	PFNA	ng/L	**2.14**	**3.36**	**2.54**
Perfluorohexanesulfonic Acid 355-46-4	PFHxS	ng/L	**4.02**	**5.15**	**4.51**
Perfluoroheptanoic Acid 375-85-9	PFHpA	ng/L	**2.10**	**2.31**	**2.07**
Perfluorodecanoic Acid 335-76-2	PFDA	ng/L			
PFAS, Total (6 proposed MA MCL, current ORSG)		**ng/L**	**15.64**	**21.41**	**17.62**
Analyte - PFAS Method 537 Isotope Dilution		**Unit**	**Well 1**	**Well 2**	**WTP**
Perfluorobutanesulfonic Acid	PFBS	ng/L	3.06	2.84	2.98
Perfluorobutanoic Acid	PFBA	ng/L	72-81 ° ATDR		
Perfluorodecanesulfonic Acid	PFDS	ng/L			
Perfluorododecanoic Acid	PFDoA	ng/L			
Perfluoroheptanesulfonic Acid	PFHpS	ng/L			
Perfluorohexanoic Acid	PFHxA	ng/L	4.65	4.25	4.58
Perfluorononanesulfonic Acid	PFNS	ng/L			
Perfluorooctanesulfonamide	FOSA	ng/L			
Perfluoropentanesulfonic Acid	PFPeS	ng/L			
Perfluoropentanoic Acid	PFPeA	ng/L			
Perfluorotetradecanoic Acid	PFTA	ng/L			
Perfluorotridecanoic Acid	PFTrDA	ng/L			
Perfluoroundecanoic Acid	PFUnA	ng/L			
1H,1H,2H,2H-Perfluorodecanesulfonic Acid	8:2 FTS	ng/L			
1H,1H,2H,2H-Perfluorohexanesulfonic Acid	4:2 FTS	ng/L			
1H,1H,2H,2H-Perfluorooctanesulfonic Acid	6:2 FTS	ng/L			
N-Ethyl Perfluorooctanesulfonamidoacetic Acid	NEtFOSAA	ng/L		4.81	1.67
N-Methyl Perfluorooctanesulfonamidoacetic Acid	NMeFOSAA	ng/L		4.29	1.42
11-Chloroeicosafluoro-3-Oxaundecane-1-Sulfonic Acid	11Cl-PF3OUds	Ng/L		0.298(J)	

Notes:
ND – Not detected at or above the laboratory reporting limit shown
Bold – Reported concentration above detection limits

What are PFAS chemicals and why did Massachusetts develop standards for drinking water?

WHAT ARE PFAS?

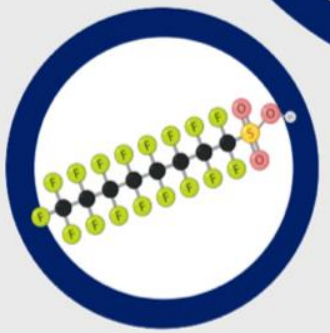


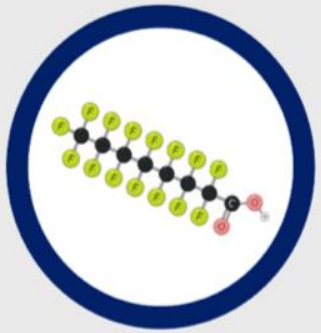


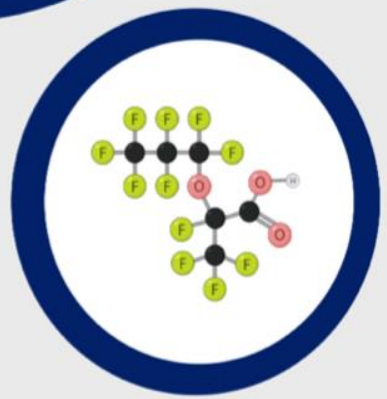
PFAS are "per- and poly-fluoroalkyl substances" and are sometimes called **"forever chemicals"**

There are about 5,000 different PFAS chemicals

These chemicals have chains of **carbon atoms** (the 'alkyl') surrounded by many **fluorine atoms** (the 'fluoro').







Duke
NICHOLAS SCHOOL
of the ENVIRONMENT

PFAS Family Tree

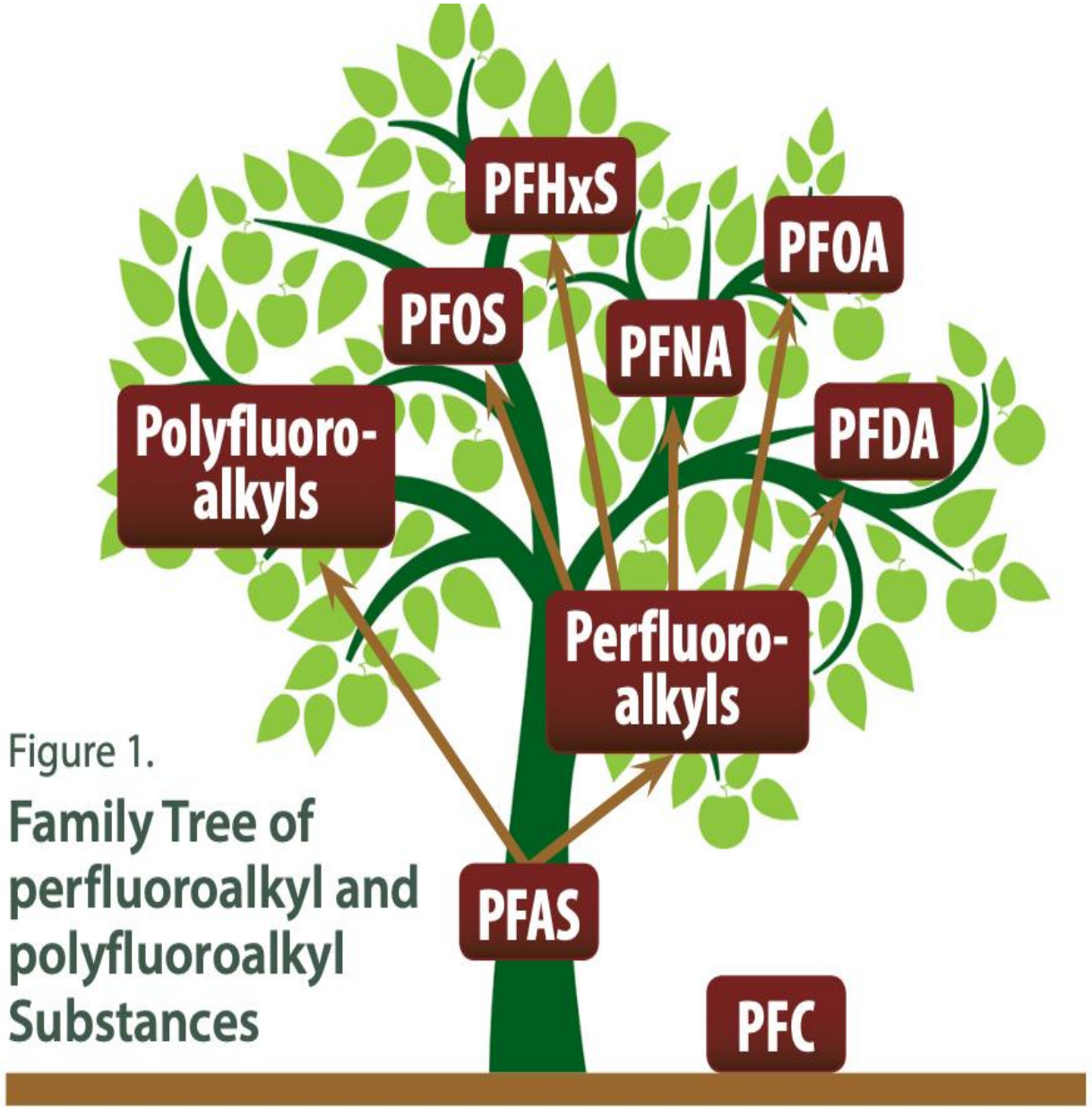


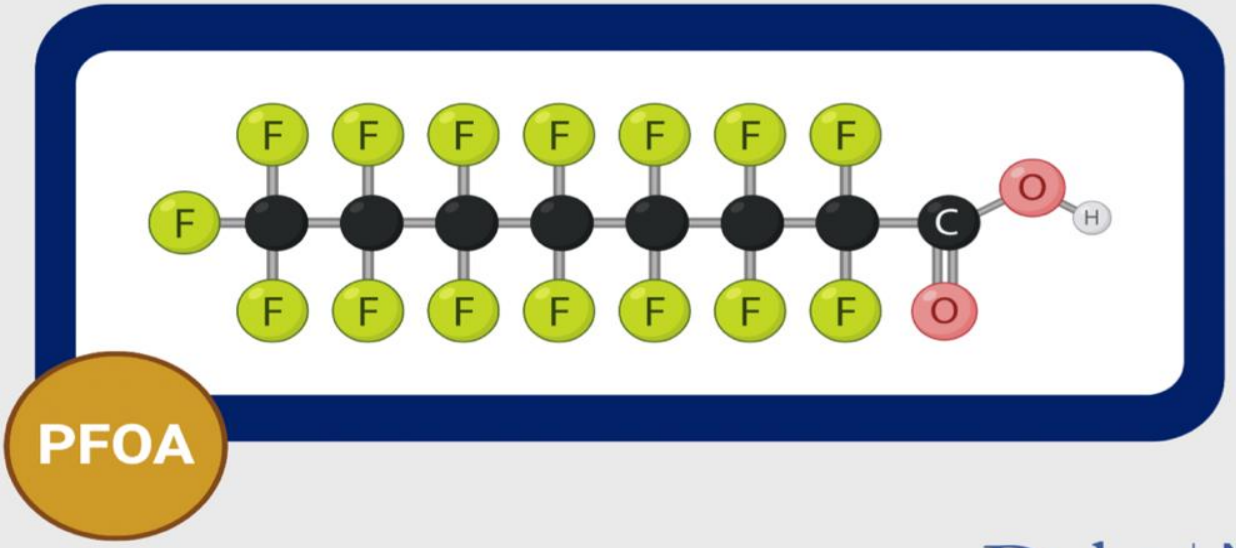
Figure 1.
Family Tree of perfluoroalkyl and polyfluoroalkyl Substances

- PFOS: Perfluorooctane sulfonic acid
- PFOA: Perfluorooctanoic acid
- PFNA: Perfluorononanoic acid
- PFDA: Perfluorodecanoic acid
- PFOSA: Perfluorooctane sulfonamide
- MeFOSA: 2-(N-Methyl-perfluorooctane sulfonamido) acetic acid
- Et-FOSSA: 2-(N-Ethyl-perfluorooctane sulfonamido) acetic acid
- PFHxS: Perfluorohexane sulfonic acid

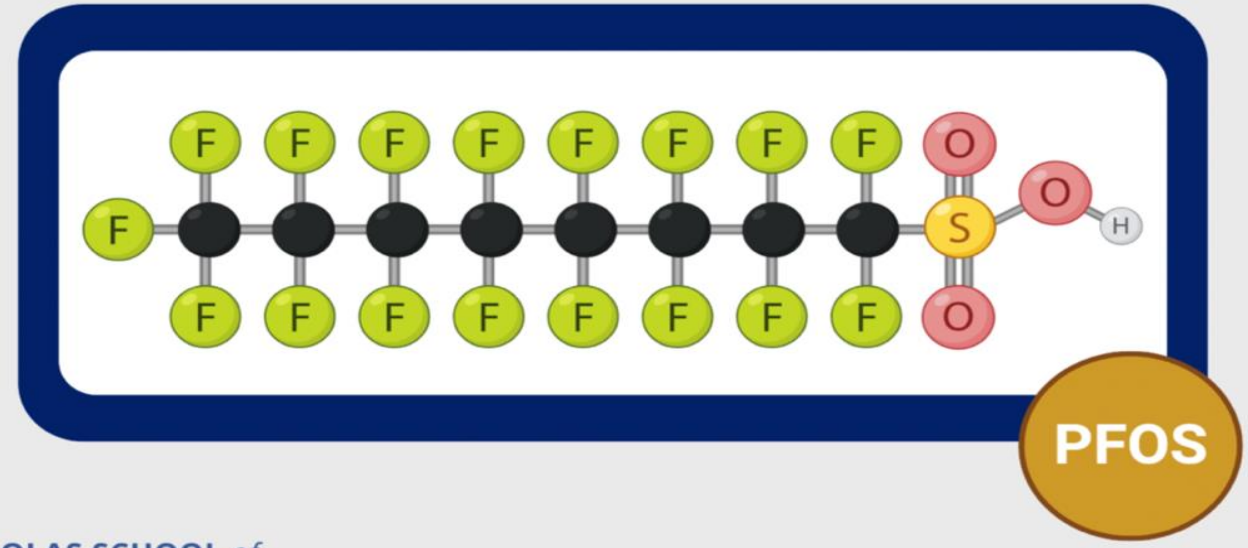
WHAT ARE PFOA & PFOS?

PFOA and PFOS are two kinds of PFAS. They have been used for many years and can be found in drinking water across the US.

The EPA has established a non-enforceable "health advisory" limit for these 2 chemicals at **70 nanograms per liter (ng/L) or 70 parts per trillion (ppt)**



PFOA



PFOS

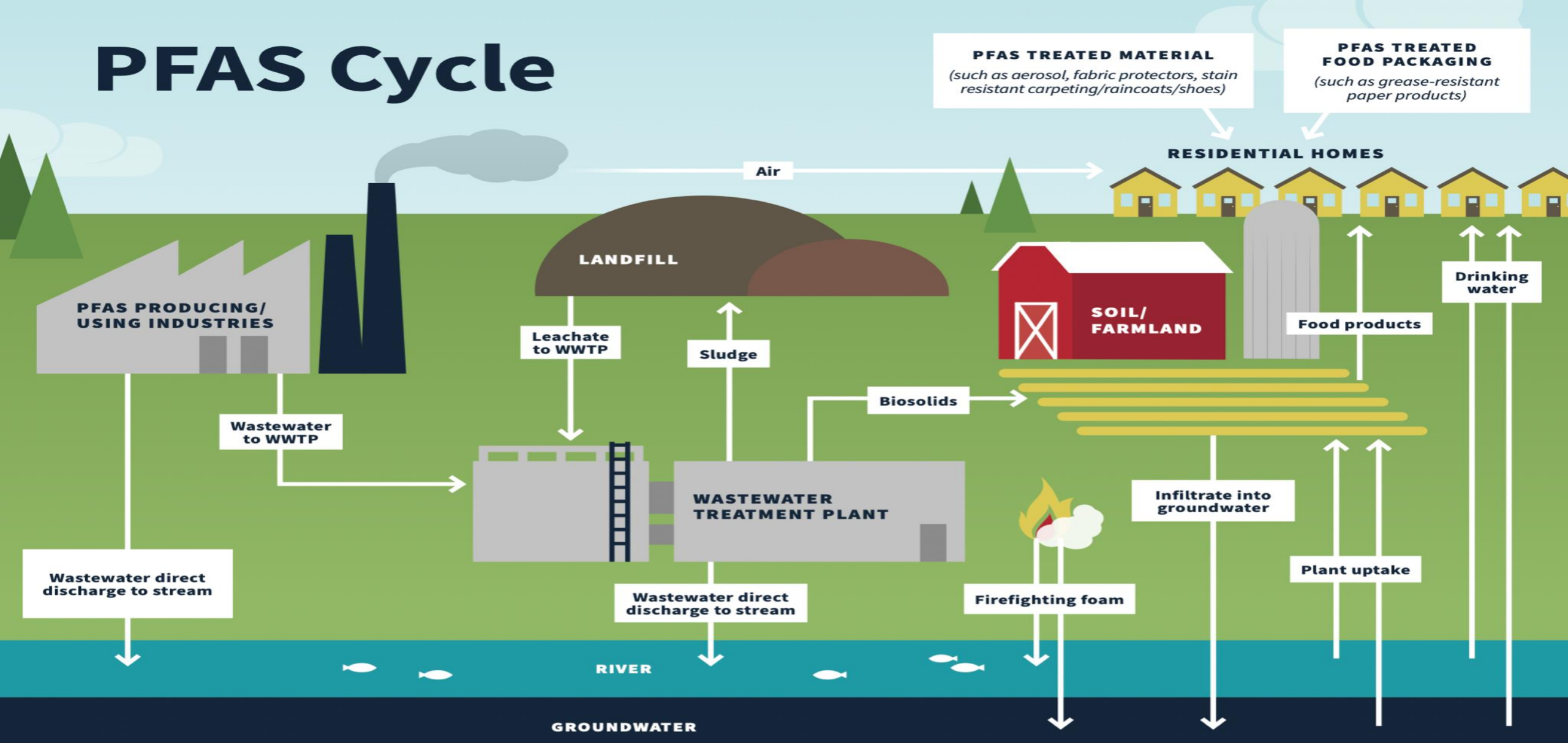
Duke | NICHOLAS SCHOOL of the ENVIRONMENT

INCORPORATED FEB. 24 1885. MILLIS, MASS.

“Forever Chemicals”

- PFAS chemicals are often called forever chemicals because we now know that the carbon-fluoride bonds that define PFAS chemicals are among the strongest known chemical bonds, it is unknown when if ever they completely break down These chemicals are man made, they do no occur naturally In the case of Millis our trash goes to an incinerator in Millbury Mass, the EPA states that incineration does not completely destroy PFAS chemicals so they cycle back to the earth from the emissions (the EPA is currently studying the problem) PFAS chemicals have even been found in the snows of the Artic

PFAS Cycle


PFAS TREATED MATERIAL
(such as aerosol, fabric protectors, stain resistant carpeting/raincoats/shoes)
PFAS TREATED FOOD PACKAGING
(such as grease-resistant paper products)
RESIDENTIAL HOMES
Air
LANDFILL
PFAS PRODUCING/ USING INDUSTRIES
SOIL/ FARMLAND
Drinking water
Food products
Leachate to WWTP
Sludge
Biosolids
Wastewater to WWTP
WASTEWATER TREATMENT PLANT
Infiltrate into groundwater
Plant uptake
Wastewater direct discharge to stream
Wastewater direct discharge to stream
Firefighting foam
RIVER
GROUNDWATER

INCORPORATED FEB. 24 1885.
IN UNITATE VIS
MILLIS, MASS.

PFAS Timeline

- **1938** first PFAS created Dupont chemist working with freon PFOA
- **1946** Dupont introduced non-stick cookware Teflon coating west Virginia plant
- **1952** 3m chemist noted new chemical dropped on tennis shoe kept area stain free PFOS
- Selling it 1956 patented in 1973
- **1963** Navy and 3M developed Aqeous Fire Protection Foam AFPF fight oil and gas fires
- **1960's** FDA allows PFAS in food packaging in 1966 they do not allow Dupont application for PFA as a
- Food additive
- **1970** EPA started
- **1972** Clean Water Act
- **1976** Toxic Substance Control Act 62,000 existing chemicals grandfathered by 2016 only 5 have been banned
- **1998** farmer Wilbur Tennant who sold land to Dupont for non-hazardous landfill (office paper) and lawyer Robert Bilott started case against Dupont lost >100 cows
- **1998** 3M notified EPA with evidence that PFOS accumulates in blood
- **1999** CDC National Health and Nutrition Examintion Survey NHANES started testing for 4 PFAS in human blood
- **2000** judge ruled on Dupont case to release info 110,000 pages sent to Rob Bilott he read them and s summary of info (500 pages) to EPA

PFAS Timeline

- **2001** Tennant case settled 2nd case started 70,000 citizens in area around plant exposed to PFAS in drinking water since PFOA not a regulated contaminent couldn't sue for damages WVirginia law allowed for medical monitoring study 63,000+ eventually participated
- **2002** 3M fined by EPA voluntarily took PFOS off market
- **2003** 3M replaces PFOS with PFBS
- **2005** Dupont fined 16.5 million by EPA for decades long PFOA in house research not being reported <2% of profits PFOA in 2005
- **2006** Dupont and other non US companies agree to stop PFOA production by 2015
- **2009** EPA sets short-term exposure limit to PFOA 400ppt PFOS 200 ppt (advisory)
- **2011** C8 study starts releasing results find probable link to PFOA in class to:
- Kidney and testicular cancer
- Thyroid disease, increased cholesterol, pregnancy induced hypertension and ulcerative colitis
- **2013-2015** first nationwide evaluation of PFOS/PFOA and 4 other PFAS in drinking water (Unregulated Contaminent Monitoring Rule – part of Safe Drinking Water Act)
- **2016** EPA sets long-term exposure limit to PFOS/PFOA combined at 70 ppt (advisory) considered a technical guidance for water utilities Catch 22 for them as it is subject to change (Hoosick Falls NY –
- Saint-Goban manufacture of Teflon coated materials /Honeywell member of Hoosick village council tested water 150-540 ppt state wouldn't pay for GAC not a regulated contaminent 2014 by 2015 s-g agreed to pay for GAC/bottled water 2 milllion 2017 EPA applied for Superfund 130,000 ppt found at site NY one of first to develop any state standard for PFAS/drinking water
- **2016** FDA stops use of long chain (8 carbon) PFAS in food packaging
-
- **2018** Agency for Toxic Substances and Disease Registry (Health and Human Services) releases information re ex PFOA/PFOS in drinking water could be harmful at levels 7-10 times lower than advisory EPA standard after Fre Information Act applicaton by Union of Concerned Scientists
- **2019** EPA develops PFAS Action Plan
- **2020** Mass DEP develops standard 20 ppt 6 PFAS
- **2020** FDA starts voluntary 3 year phase out of 6:2 PTOH (short chain PFAS) starting 1/21

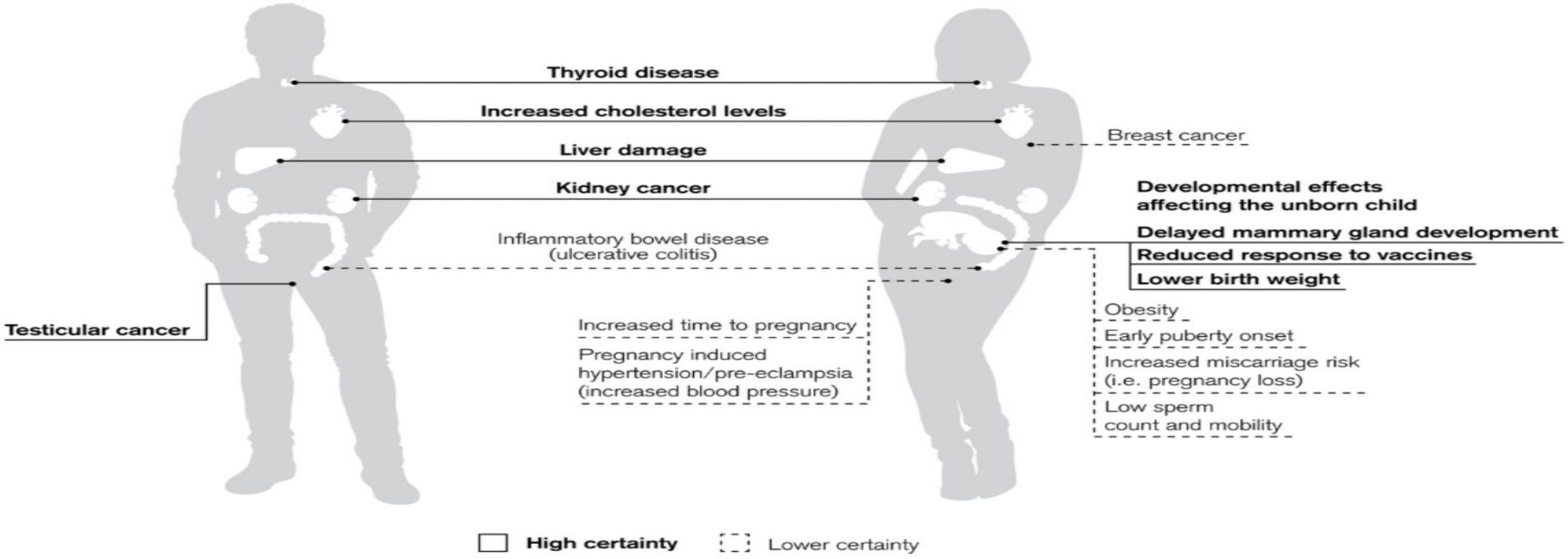
INCORPORATED FEB. 24 1885.
IN UNITATE VIS
MILLIS, MASS.

How did we begin to learn about potential PFAS health effects?

- It started with a farmer who cared about his cows and a lawyer with environmental law experience who was willing to do a favor for his grandmother and it resulted in law suits against a PFAS production plant in West Virginia that contaminated groundwater with PFAS chemicals for a large area around the plant. It resulted in the largest epidemiology study of a human chemical exposure (the PFAS chemical known as PFOA and was a major ingredient in the nonstick cookware material that was brand named Teflon)

- The study of more than 60,000 people living around the plant is commonly know as the C8 study (PFOA has 8 carbon molecules)
- Full study results can be found by searching for C8 study
- The CDC has a video reviewing the study as well search PFAS to find, other information at the CDC site can be found by this as well
- A summary of the findings is presented in the next slide

Emerging Chemical Risk

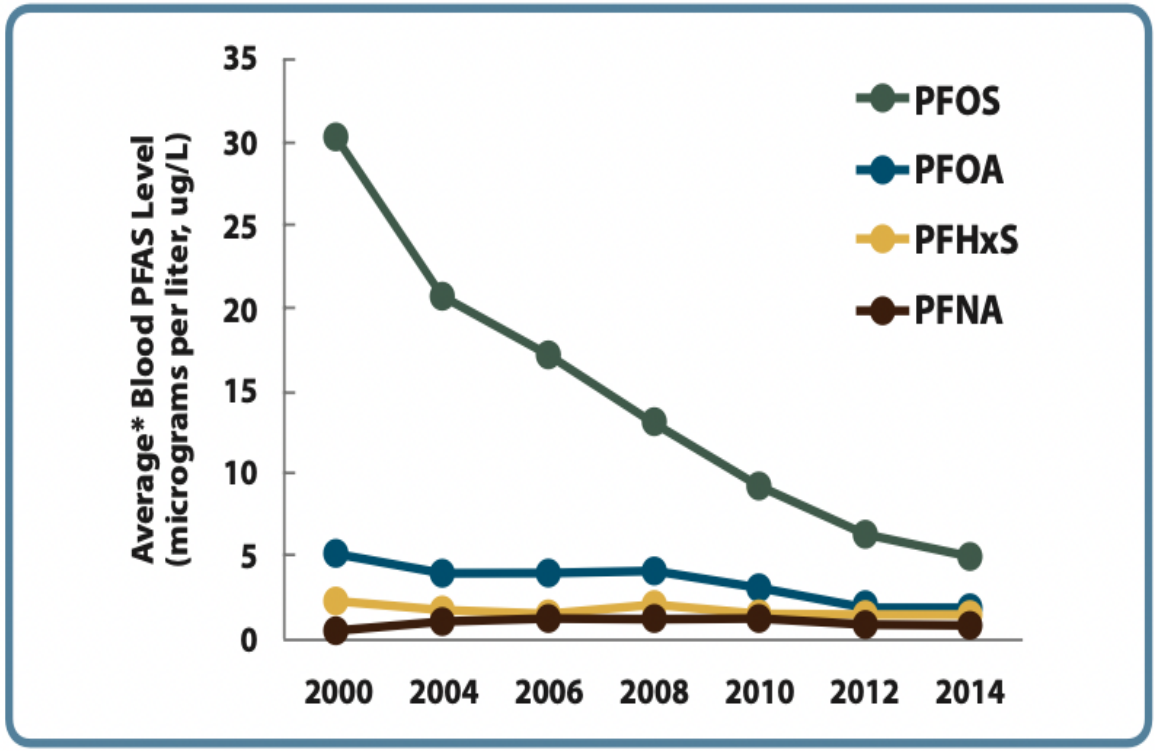


PFAS levels in human blood

- As information was provided as part of “discovery” materials in the West Virginia lawsuit another producer of a PFAS know as PFOS (was branded as Scotchguard at the time) informed the EPA that levels of PFOS was found in the blood of plant workers
- Starting in 1999 testing for four PFAS chemicals was included in the surveillance testing done by the National Health and Nutrition Examination Survey (NHANES) more than 95% of the people tested had levels of the PFAS tested in their blood

PFAS in People

Blood Levels of the Most Common PFAS in People in the United States from 2000-2014



* Average = geometric mean

Data Source: Centers for Disease Control and Prevention. Fourth Report on Human Exposure to Environmental Chemicals, Updated Tables, (January 2017). Atlanta, GA: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention.

- Production and use of PFOS and PFOA have declined in the U.S. since 2002.
- Blood PFOS levels have declined more than 80% from 1994-2014.
- Blood PFOA levels have declined more than 60% from 1994-2014.
- Even with PFOS/PFAS chemicals getting phased out and replaced, people may be exposed to other PFAS.

MassDEP Public Drinking Water Standard

- MassDEP PFAS public drinking water standard is set at 20 nanograms per liter (ng/L) (or parts per trillion (ppt)).
- This public drinking water standard is set for individual PFAS chemicals or for the sum of the concentrations of six specific PFAS.
- These six specific PFAS are PFOS, PFOA, PFHxS, PFNA, PFHpA, and PFDA.
- The public drinking water standard is set to protect the public from adverse health effects.
- **One part per trillion is equivalent of 4 grains of sugar in an Olympic sized swimming pool.**

Time for a little math

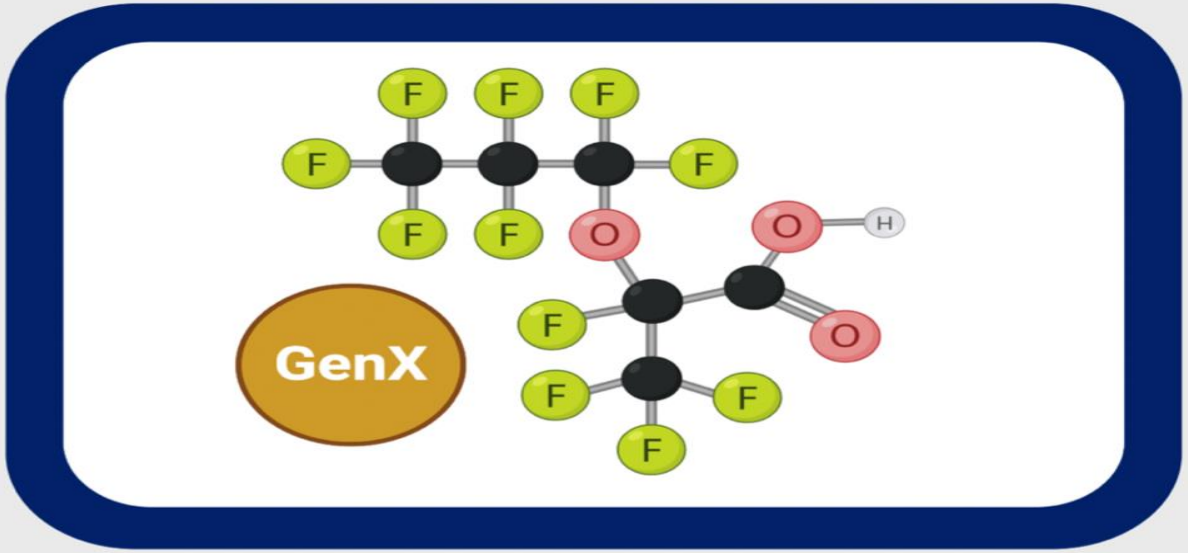
- The drinking water standard is measured in parts per trillion(ppt)
- PPT is also reported as ng/l (nanograms per liter)
- The amounts of PFAS chemicals in human blood is measure in parts per billion (ppb) PPB is also reported as ug/l (micrograms per liter)

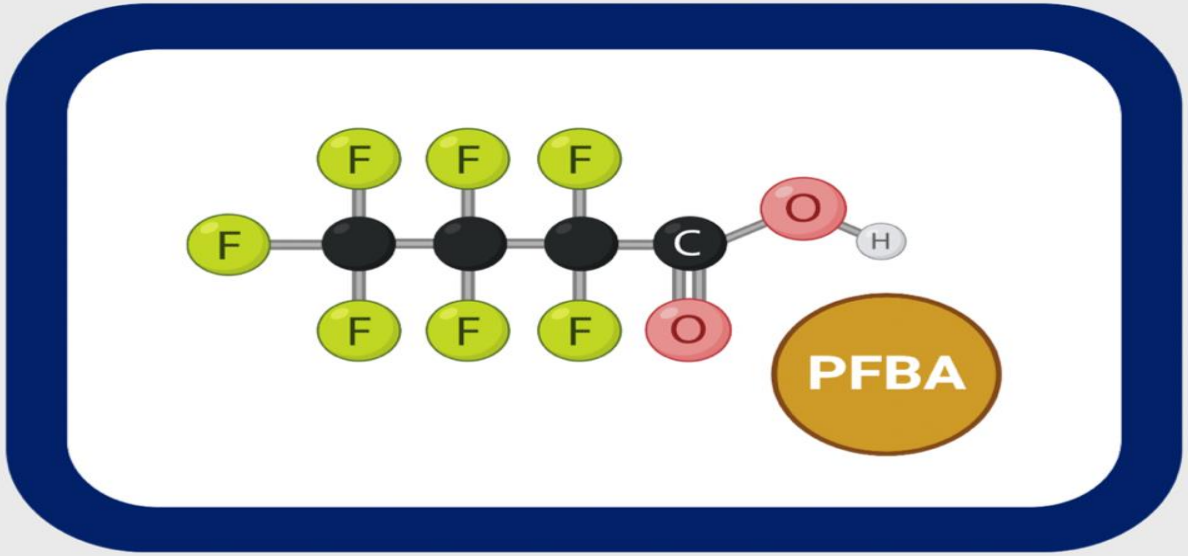
- The takehome is 1 part per billion = 1,000 parts per trillion
- The initial NHANES results showed an average of 5 parts per billion of PFAS tested in the blood of study participants

Newer PFAS

WHAT ABOUT GEN-X? WHAT ABOUT NEWER PFAS?

Some newer, emerging PFAS are replacing older PFAS chemicals. GenX is one of these emerging PFAS that was detected in the Cape Fear River. Other shorter-chain PFAS like PFBA are also emerging PFAS and have been found in the Haw River. We know even less about the health effects of these newer PFAS.





Newer PFAS

- PFOA and PFOS are no longer produced
- They were replaced by “shorter chain” PFAS chemicals – they had less carbons that the 8 in PFOA and PFOS
- Gen-X a brand name of the “replacement” for PFOA is being used to make non-stick cookware in a plant in North Carolina, the above slide is from a presentation of the Duke School of Public Health concerning PFAS contaminants found in the surface and ground water around the plant (the entire slide deck can found by searching PFAS and North Carolina)
- Information concerning potential health effects of Gen-X and other “short chain” PFAS can be found at the Agency of Toxic Substances and Disease Registry (ATDSR) website by using search term PFAS

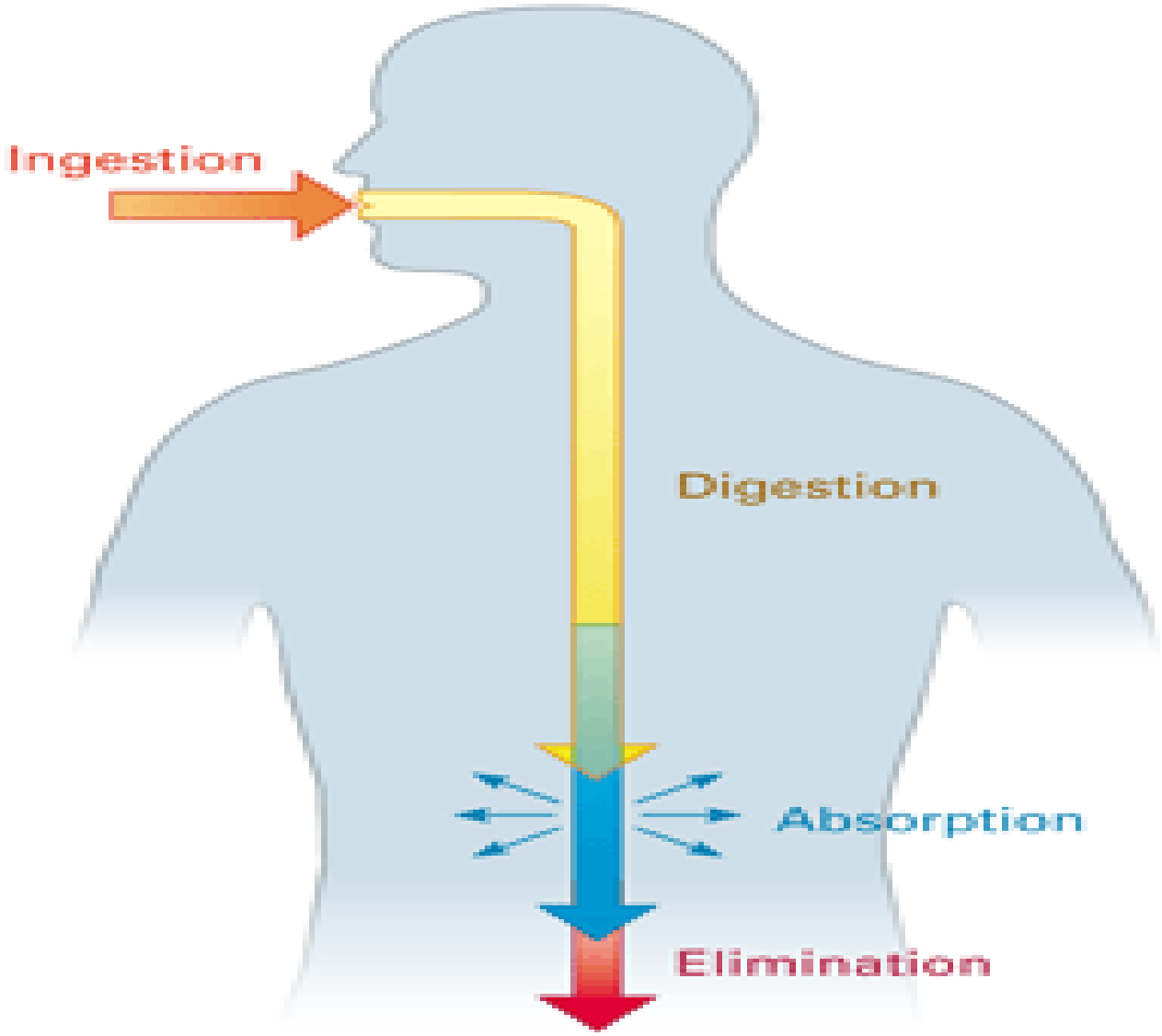
PFAS in our Homes: What do we know/need to Learn to Minimize our Exposures Today

PFAS in Common Items

PFAS in the home

- Because these chemicals are water-resistant, stain-resistant, and “slippery” (non-stick) they have been used in the last 70+ years in the manufacture of a multitude of products
- The early PFAS chemicals were invented prior to the EPA, PFAS chemicals were “grandfathered” at the time and were not seen as chemicals of concern
- This makes it difficult for the consumer to know if there is PFAS in the items they purchase from food containers to clothes, shoes, furniture fabrics, cleaning products like polishes, indoor paints and personal products to name a few, there are no requirements to add them to ingredient labels

Ingestion



Ingestion is the primary method of exposure

- Mass DEP has now regulated our “lifetime” safe exposure in drinking water

- The Food and Drug Administration is responsible for regulation of exposure from food, leaching of PFAS into food from containers, exposure from products such as cosmetics, personal care products

- The chocolate cake is pictured as in a check of certain foodstuffs it was found to have high levels of PFAS (it was purchased from a supermarket)

- The FDA website has information concerning the testing of food stuffs they have done to date and the limits of certain PFAS levels allowed in different food products
- They allow some PFAS in food containers and have stopped the use of others
- The information can be found by searching the term PFAS at the FDA website
- The NHANES data shows that blood levels of the two PFAS that are no longer produced (PFOA and PFOS) are decreasing in study participants Where is it going? Remember the previous slide of the PFAS cycle in the environment? The Mass DEP PFAS website has information on PFAS levels in downstream water from wastewater treatment plants including that of the Medway plant available for your perusal

CHOICE
PREMIUM QUALITY
FOOD SERVICE
CLING FILM
2000 FT
18" x 2000'

Where Can You Find Information on PFAS in Food Wrappers/Containers?

Bad News – PFAS chemicals are used in many products Good News – Consumer groups have already begun to identify and encourage products without PFAS

- Below are some of sites that address this issue

PFAS Food Wrappers/Containers Alternative Resources

Safer Chemicals, Healthy Families

GET INVOLVED OUR WORK GET THE FACTS ABOUT DONATE

MEDIA RELEASE / JULY 21, 2021

House Passes PFAS Action Act of 2021

The United States House of Representatives today passed a bipartisan bill that would begin to address the country's PFAS crisis, H.R. 2467. The PFAS Action Act of 2021 will restrict PFAS air and water pollution and help to jumpstart cleanup at polluted sites across the country.

MEDIA RELEASE / JUNE 16, 2021

Burger King leadership addresses PFAS "forever chemicals" in food packaging for first time ever

Restaurant Brands International CEO announces that alternatives to toxic PFAS are being tested and more details will be shared "in the next few months"

Safer Chemicals, Healthy Family-https://saferchemicals.org

INCORPORATED FEB. 24 1885. MILLIS, MASS.

PFAS Food Wrappers/Containers Alternative Resources Continued

Retailer Report Card-https://retailerreportcard.com

PFAS Food Wrappers/Containers Alternative Resources Continued

TOXIC-FREE FUTURE
SCIENCE • ADVOCACY • RESULTS

resource for restaurants and

Who We Are | Key Issues | Research | Healthy Living | Take Action | News

ACT NOW • DONATE • SIGN UP

Science

We conduct our own research to solve real-world problems.

Advocacy

We work to protect health and environment from toxic chemicals.

Results

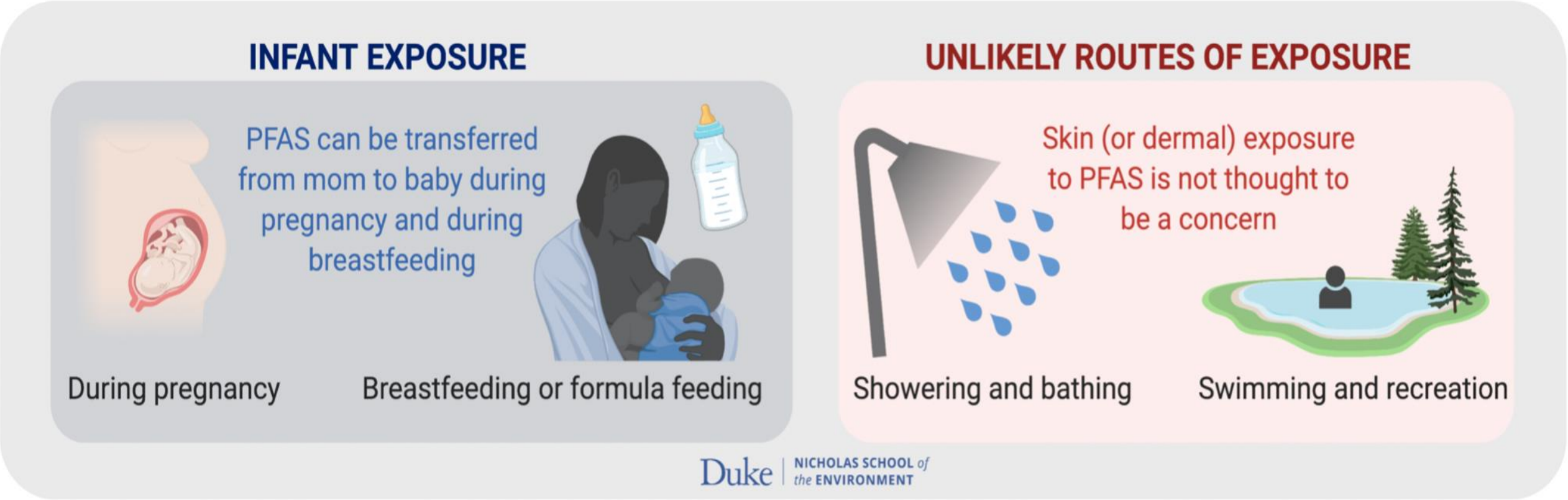
We win stronger protections from toxic chemicals.

Toxic Free Future- PFAS free paper/food packaging alternative: A resource for restaurants and retailers-https://toxicfreefuture.org

INCORPORATED FEB. 24 1885. MILLIS, MASS.

PFAS Exposures Ingestion and Skin

PFAS Skin Exposure



PFAS Skin Exposure Continued

Resources for PFAS Skin Exposure Continued

PERSONAL CARE PRODUCTS | COSMETICS

Skin Deep®

Since 2004, EWG's Skin Deep® cosmetic database has helped people protect themselves from potentially toxic chemicals in personal care and beauty products.

EWG - Skin Deep Made Safe- https://www.ewg.org

Potential PFAS Inhalation/Ingestion

Potential PFAS Inhalation/Ingestion Continued

Environmental Working Group- https://www.ewg.org

Teflon can't stand the heat...

Chemical Releases

1,202° CF_4 (carbon tetrafluoride): Global warming gas; affects heart, lungs, and nervous system [1].

1,112° CF_3COF (trifluoroacetic acid fluoride): degrades to HF & TFA
OFCB (octafluorocyclobutane): Linked to heart palpitations
PFB (perfluorobutane): Global warming gas [1].

932° COF_2 (carbonyl fluoride): fluorinated version of chemical warfare agent
HF (hydrogen fluoride): Corrosive gas. Kills tissue on contact [2].

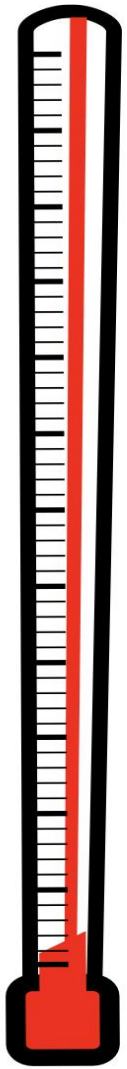
887° PFIB (perfluoroisobutene): Chemical warfare agent [3].

878° SiF_4 (silica tetrafluoride): highly toxic by inhalation and ingestion [1].

680° Toxic gasses released:
TFE (tetrafluoroethylene): animal carcinogen
HFP (hexafluoropropene): worker toxicant
TFA (trifluoroacetic acid): poisonous to plants
DFA (difluoroacetic acid): Animal kidney toxicant
MFA (monofluoroacetic acid): lethal to humans at low doses
PFOA (perfluorooctanoic acid): animal carcinogen [4].

554° Ultrafine particulates released (oxidized Teflon particles) [5].

464° Lowest temperature at which Teflon particles have been measured [6].



Common cooking temperatures

1,500° Broiling temperature for high-end ovens [7].

1,000° Drip pans in stovetop burner
Gas flame on range top [8].

800° Electric coil on range top [8].

750° Surface temperature of PTFE-coated pan after heating for 8 minutes on conventional stove [9].

700° Preheated grill [10].

536° Birds killed in DuPont lab experiments [5].

500° Searing temperature for meat in oven or grill
Maximum temperature for many ovens

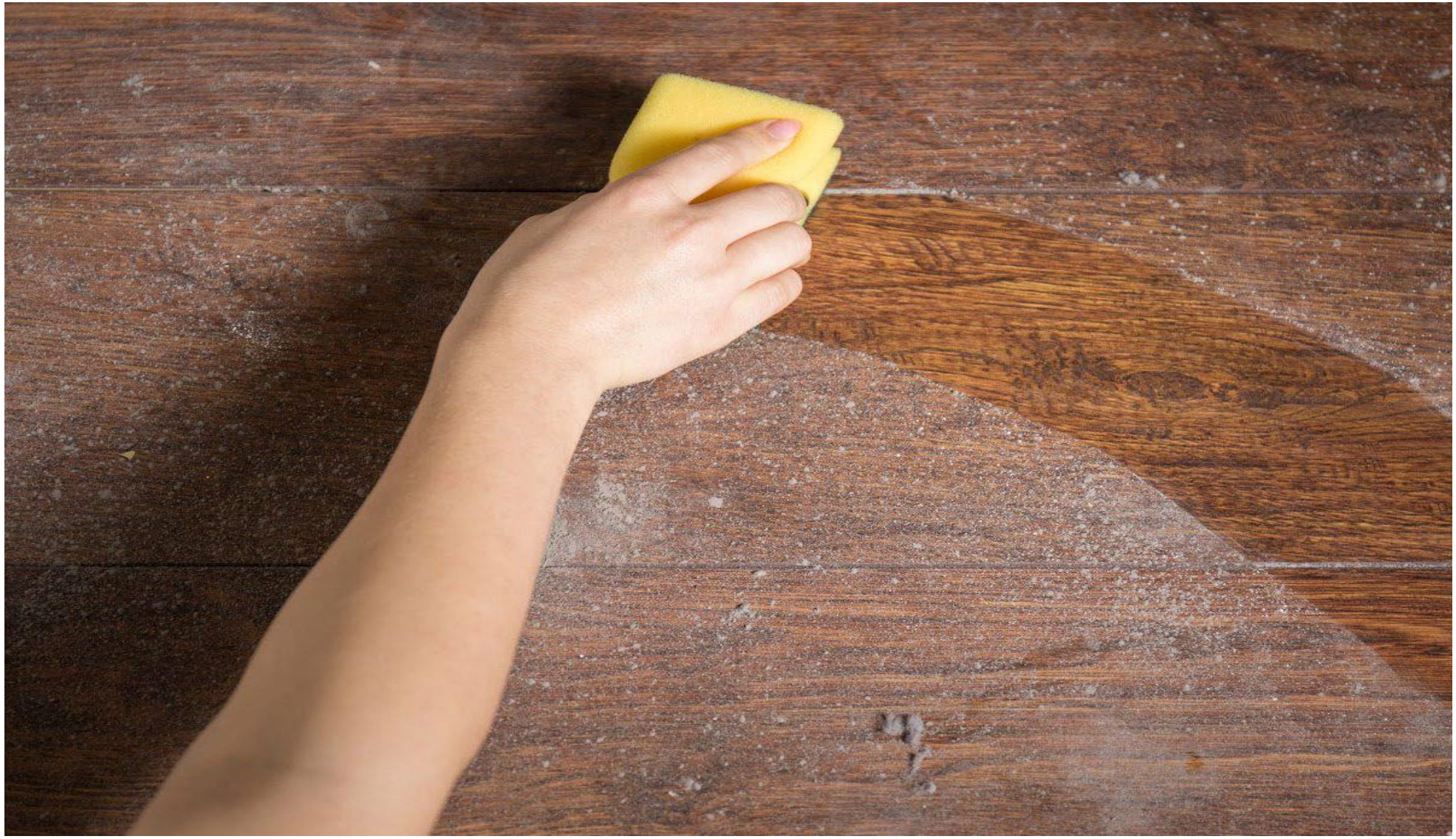
396° Temperature of PTFE-coated light bulbs under which Missouri birds died [11].

350° Common baking temperature

325° Birds died from preheated oven [12].

All temperatures are in degrees Fahrenheit.

Potential PFAS Inhalation/Ingestion Continued



PFAS in the home

- Studies have shown that the mean concentration of one PFAS-PFOA in household dust was found to be between 10,000 and 50,000 parts per trillion (ppt) Trudel et al.Risk Analysis Vol 28 No. 2, 2008

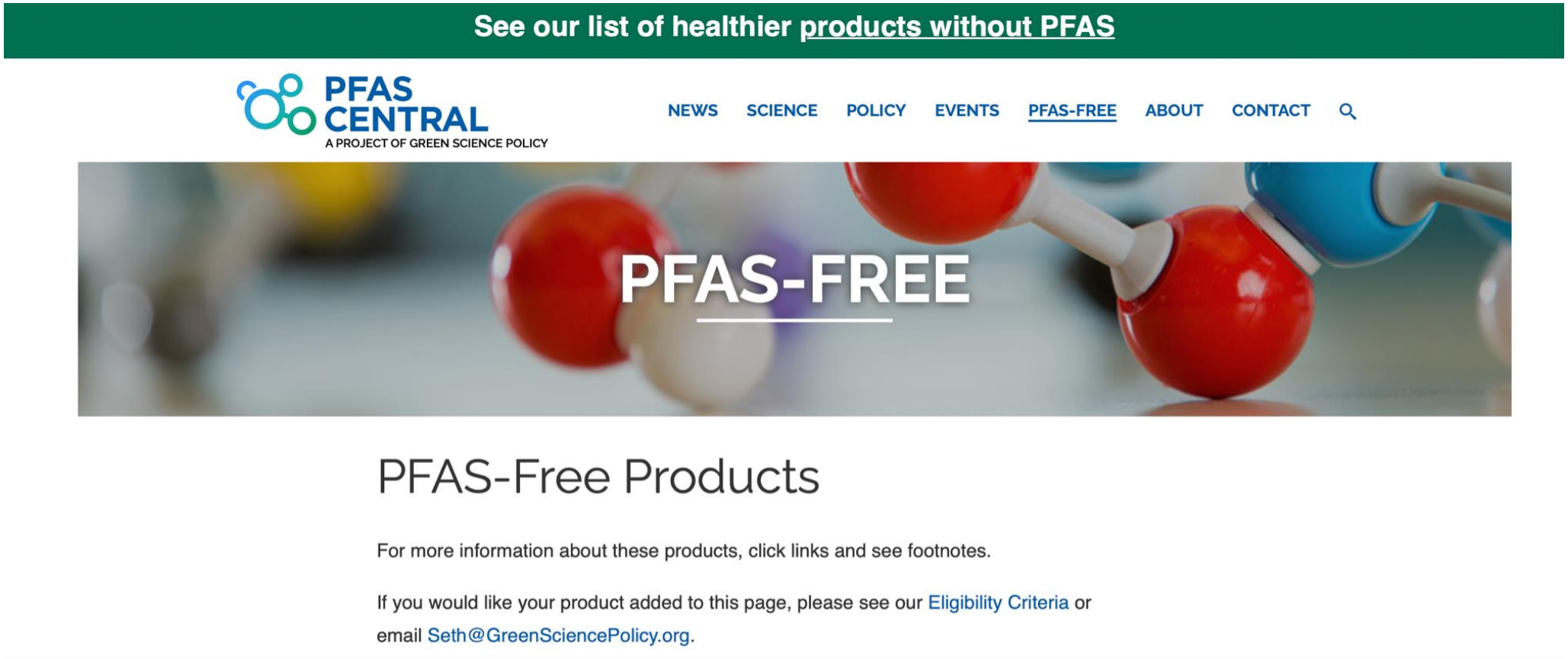
What about Pets?

- Not much is know about PFAS in pet products

- They are closer to exposures from rugs, floor cleaning products, upholstery
- A resident near the North Carolina plant had his blood and his cats blood level tested for some PFAS chemicals, the cats levels were higher than the owners level
- Some external flea/tick long term products tested by individuals were found to have PFAS

Potential PFAS Inhalation/Ingestion Continued

PFAS-Free Products



PFAS-Free Products - PFAS Central- https://pfascentral.org/pfas-free-products/

What Can be Done?

10 Ways You Can Take Action on PFAS

We are buying products containing PFAS and now we will be paying to remove PFAS chemicals from our water

More and more research is finding health effects from exposure to some of these chemicals

As consumers we can demand PFAS free products especially when we purchase new home products

1. Avoid non-stick cookware if you can, if using it avoid surface damage and be careful not to use with high heats (remember PFOS or PFOA free labeling does not mean it's PFAS free)
2. Avoid food containers/packaging that contain PFAS (consumer websites have info on PFAS- free packaging)
3. When making purchases of home fabrics, rugs, curtains, uphosterly ask for PFAS free products
4. When buying clothes, shoes, home linens do the same (if it's water, stain, wrinkle resistant be sure it's PFAS-free)
5. When buying personal products, avoid products with PFAS (check consumer websites)
6. The FDA has done some testing of some PFAS chemicals in food stuffs (on the FDA website) with results below the minimum detection limit for each PFAS, review what those limits are for each chemical!
7. Avoid dry dusting at home, use vacuuming and wet mopping
8. Avoid cleaning products with PFAS
9. Encourage legislation to identify PFAS chemicals in use, assess as a group not individually as was done with PFOA and PFOS
10. Information concerning potential health effects of PFAS are emerging try to keep abreast of new information

Legislative Information Regarding PFAS

Legislative PFAS

safer states

OUR VISION STATES IN THE LEAD TOXIC CHEMICALS

Home > Toxic Chemicals > PFAS in Food and Water

PFAS

Safer States is at the forefront of a state-driven national movement to combat exposures to PFAS chemicals. We coordinate a large and diverse coalition of advocates, policymakers, scientists, and representatives from the most impacted communities to influence public policy, corporate practices, and end-of-life management decisions on products containing these deadly chemicals. Our goal is to turn off the tap on over 3,000 chemicals in this class and ensure safe drinking water for all. For information intended for a legislative audience, please visit our PFAS Candidate Engagement Guide.

Massachusetts

S 1494: Prohibits the manufacture, distribution and use of food packaging containing PFAS chemicals.

PFAS in Food and Water-Safer States-
https://www.saferstates.com/toxic-chemicals/pfas/

Legislative PFAS

We go to court for the future of our planet.

Legislative PFAS

WHAT SHOULD THE FEDERAL GOVERNMENT DO?

- **Prohibit the manufacture of any new PFAS, or the significant new use of any existing PFAS, immediately.**
- **Regulate PFAS as a class of compounds.**
- **Change military specifications and FAA regulations to permit the use of PFAS-free firefighting foams.**
- **Prioritize development of methods to detect and analyze PFAS in water and soil;**
  - immediately adding all PFAS that can be detected to the Unregulated Contaminant Monitoring Rule (UCMR) of the Safe Drinking Water Act (SDWA); and,
  - developing a National Primary Drinking Water Regulation for PFAS in accordance with safe levels of exposure as established by independent scientists.
- **Ensure that communities and local governments are aware of the release of PFAS in their communities by:**
  - adding PFAS to the Toxics Release Inventory (TRI) of the Emergency Planning and Community Right to Know Act (EPCRA), § 313 so that facilities must report to EPA and the public when PFAS are released into the environment;
  - designating the class of PFAS as toxic pollutants under Clean Water Act § 307;
  - designating the class of PFAS as hazardous substances under Clean Water Act § 311;
  - revising the Toxic Substances Control Act (TSCA) Chemical Data Reporting Rule to require reporting of PFAS with no threshold.
- **Ensure clean-up of PFAS contamination and accountability of polluters by:**
  - listing PFAS as hazardous substances under:
    - Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) § 101
    - the Solid Waste Disposal Act (SWDA) § 1002;
  - significantly increasing Defense Environmental Restoration Program budget and target for PFAS clean up;
  - providing money to states to clean up PFAS in water and soil;
  - permitting civil suits against PFAS polluters where an imminent and substantial endangerment to health or environment may exist and/or for payment of medical monitoring to exposed persons with or without present injury or disease; and,
  - establish rules requiring manufacturers of products intentionally containing PFAS to accept such PFAS products from customers and destroy and dispose of them in a health-protective manner.

There is no scientific, legal, or public health basis for failing to take all of these necessary actions.

Earthjustice- Congress must protect families from dangerous chemicals in drinking water- https://earthjustice.org/sites/default/files/files/PFAS-Factsheet_2019-01.pdf

Centers for Disease Control and Prevention. (2022, February 2). *Per- and polyfluorinated substances (PFAS) factsheet*. Centers for Disease Control and Prevention. Retrieved April 18, 2022, from https://www.cdc.gov/biomonitoring/PFAS_FactSheet.html

Environmental Working Group – know your choices: Environmental working group. EWG. (2021, January 20). Retrieved April 18, 2022, from https://www.ewg.org/

MassDEP. (2022). *Per- and polyfluoroalkyl substances (PFAS)*. Mass.gov. Retrieved April 18, 2022, from https://www.mass.gov/info-details/per-and-polyfluoroalkyl-substances-pfas

Pfas (per- and polyfluoroalkyl substances). Safer Chemicals Healthy Families. (2022, March 31). Retrieved April 18, 2022, from https://saferchemicals.org/get-the-facts/toxic-chemicals/pfas-per-and-polyfluoroalkyl-substances/

PFAS-Free Products. PFAS. (2022). Retrieved April 18, 2022, from https://pfascentral.org/pfas-free-products/

Pfas. Earthjustice. (2022, April 15). Retrieved April 18, 2022, from https://earthjustice.org/tags/pfas

Pfas. Safer States. (2022). Retrieved April 18, 2022, from https://www.saferstates.com/toxic-chemicals/pfas/

Retailer Report Card. (2021, March 11). *Who's minding the store? ranking retailers on Toxic Chemicals*. Ranking retailers on toxic chemicals. Retrieved April 18, 2022, from https://retailerreportcard.com/

Toxic Free Future. (2022). *Free future: Science, advocacy, results*. Toxic. Retrieved April 18, 2022, from https://toxicfreefuture.org/