

# The History, Euphemisms & Caveats of PFAS Analysis



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# Thank You

## Environmental Federation of Oklahoma

- **Howard (Bud) Ground**
- **Jody Reinhart**
- **Paula Hofford**



**Environmental Federation of Oklahoma**

**Working for Oklahoma's Economic and Environmental Future**

# Thank You

- **Oklahoma State University-Tulsa**
- **Dr. Sheryl Tucker**
- **Vice Provost**
- **Dean of the Graduate College**





# MY LENS: A CHEMIST

- **I am not a lawyer**
- **Or politician!**
- **I am a Chemist**
- **These are just my views, my opinions....**
- **I have studied Chemistry for the past five decades**
- **PFAS is the most complex chemical issue I have ever studied!!**

*Regs. per Ken Ede”*

*“Regs. per Ken Ede”*

- These are my recommendations!
- These are not law nor regulations!!
- But they are just my recommendations to you.....

# AGENDA: PFAS

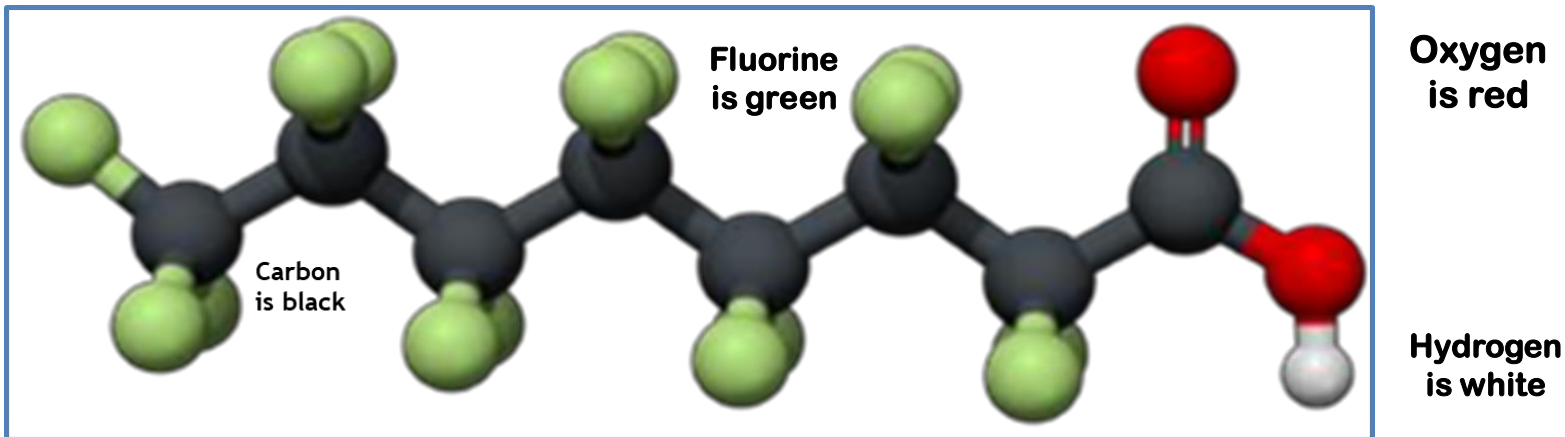
- **Studied Chemistry on the east coast**
- **Had two Chemistry professors who worked on the Manhattan Project during World War II (1943)**
- **My introduction to PFAS was in 1970**
- **27 years after WWII, these Professors still talking about fluorocarbon chemistry (PFAS)**



# PFAS

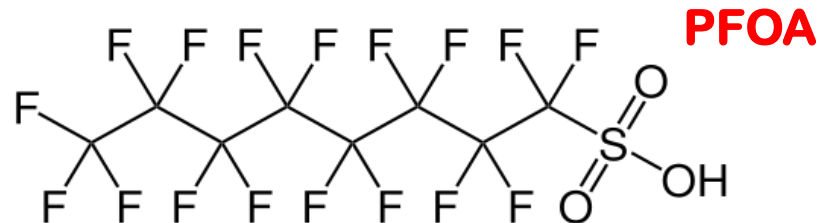
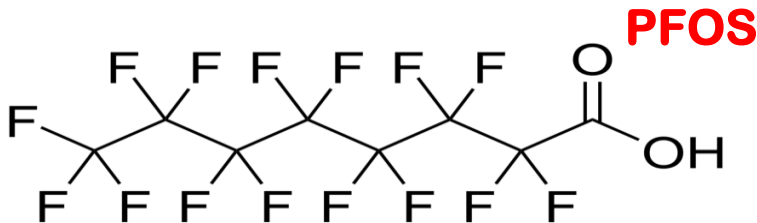
## Per- & Poly-Fluoro-AlkySubstances (PFAS)

- Per- or Poly: All or more than one
- Fluoro: contains fluorine
- Alkyl: Contains carbon



# PER- AND POLYFLUOROALKYL SUBSTANCES (PFAS)

- **PFAS: Umbrella term**
- **PFAS are family of > 10 000 manmade chemicals**
- **PFOS, PFOA, etc..... X 10 000**
- **Most common names: Teflon (PTFE), Kynar, Gore-Tex, Scotchgard, AFFF, etc.**



# How did we get here?

- **PFAS is found in every blood bank**
- **Almost every human on this planet**
- **Polar bears**
- **North Pole**
- **South Pole**
- **Eagles**
- **Most aquatic life**

# ‘Forever Chemicals’ Are Building Up in the Arctic—and Likely Worldwide

• June 12, 2020





# PFAS found on Mt. Everest

Science

## 'Forever chemicals,' other pollutants found around the summit of Everest



A long queue of mountain climbers find a path on Mount Everest in Nepal. Snow samples around the summit showed traces of toxic chemicals known as PFAS. (Rizsa Alsz/AP)

By Murray Carpenter

April 17, 2021 | Updated April 17, 2021 at 9:34 a.m. EDT

From an elevation of 27,600 feet, just below the summit of Everest, researcher Mariusz Potocki could see one of the planet's most dramatic scenes — the snow-capped Himalayas against a deep blue sky. He was on a mission to gather snow and ice samples at the summit, but just above him was another startling sight: a line of climbers so dense that a photo of it went viral.

### [Everest's massive climber traffic jam](#)

His team had stopped at a resting spot climbers call "The Balcony," and the snow there was littered with feces, oxygen bottles and other trash. But he wanted to gather what samples he could, so he ascended a short distance to find some cleaner snow off to the side of the trail. "I just pulled out the bottles and took samples," he said.

Is automation

## CLIMBING

SKILLS

NEWS

GEAR

PLACES

PEOPLE

PHOTOS

VIDEOS

OLYMPICS

PODCAST

**Tents, clothing, boots, ropes, food packaging**



**Why Are There Harmful Chemicals on Mount Everest?**



# The \$60,000 Question



**\$60,000 Lab Report**



**\$60,000 Corvette**

# **The \$60,000 Question**

- **Lab Report: Paper and numbers**
- **Today, electronic reports, just numbers**
- **If the numbers are not correct or**
- **Not admissible in a court of law**
- **You have just wasted \$60,000**

# My Goal

- To ensure you receive good, reliable data, .....
- You must understand how to both:
  1. How to sample for PFAS
  2. Interpret the laboratory analysis

# ***“\$10,000 per Mass Spec”***

- **The cost of the instrumentation to analyze PFAS substances is extremely expensive**
- **\$400K to \$600K per mass spec**
- **Due to this expense, lab directors are placing more and more pressure on their Chemists to generate revenue**
- **One lab director specifically stated that he expects \$10,000 per day per mass spec**

# \$10,000 per Mass Spec

- Most laboratory errors today are caused by the very fast pace of PFAS analysis
- Many consulting companies have QA/QC software that are not written by Chemists
- Their software fails to catch many of these problems



# Chemistry Euphemisms for PFAS

- **Euphemisms: The substitution of an agreeable expression for one that may be unpleasant**
- ***Euphemism* derives from the Greek word *euphēmos*, which means "*sounding good*"**
- **Every occupation has their own euphemisms**
- **Instead of the word "*Died*"**
- ***"Passed on"* or *"passed away"***

Legal

acted

United States District Court  
For the Northern District of California

1 [REDACTED]  
2 [REDACTED]  
3 [REDACTED]  
4 [REDACTED]  
5 [REDACTED]  
6 Moreover, [REDACTED]  
7 [REDACTED]  
8 [REDACTED]  
9 [REDACTED]  
10 [REDACTED]  
11 [REDACTED]  
12 [REDACTED]  
13 [REDACTED]  
14 [REDACTED]  
15 [REDACTED]  
16 In that same vein, [REDACTED]  
17 [REDACTED]  
18 [REDACTED]  
19 [REDACTED]  
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27 [REDACTED]  
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# **Chemical Euphemisms**

- 1. Unexpected Results**
- 2. Recalcitrant**
- 3. Treatment of PFAS**

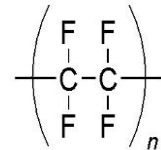


# Historical Perspective: 1938

- Yesteryear: Failed Experiment
- ~~➤ 1938: “Two Failed Experiments”~~
- Today: “Two Experiments with *Unexpected Results*”
- 1938: Both experiments changed the world forever!

# History of PFAS

- 1938: Dr. Roy J. Plunkett with DuPont was trying to develop a gaseous refrigerator coolant
- The experiment failed!
- Instead, he accidentally developed the first solid fluorinated-hydrocarbon
- The waxy solid (not gas or liquid) that proved to be the most slippery, inert material in existence
- Polytetrafluoroethylene (**PTFE - Teflon**)



# History of PFAS

Reenactment of the 1938 discovery of Teflon

- However, Dupont could not find a use for a substance that would not stick to anything.....
- It was shelved!

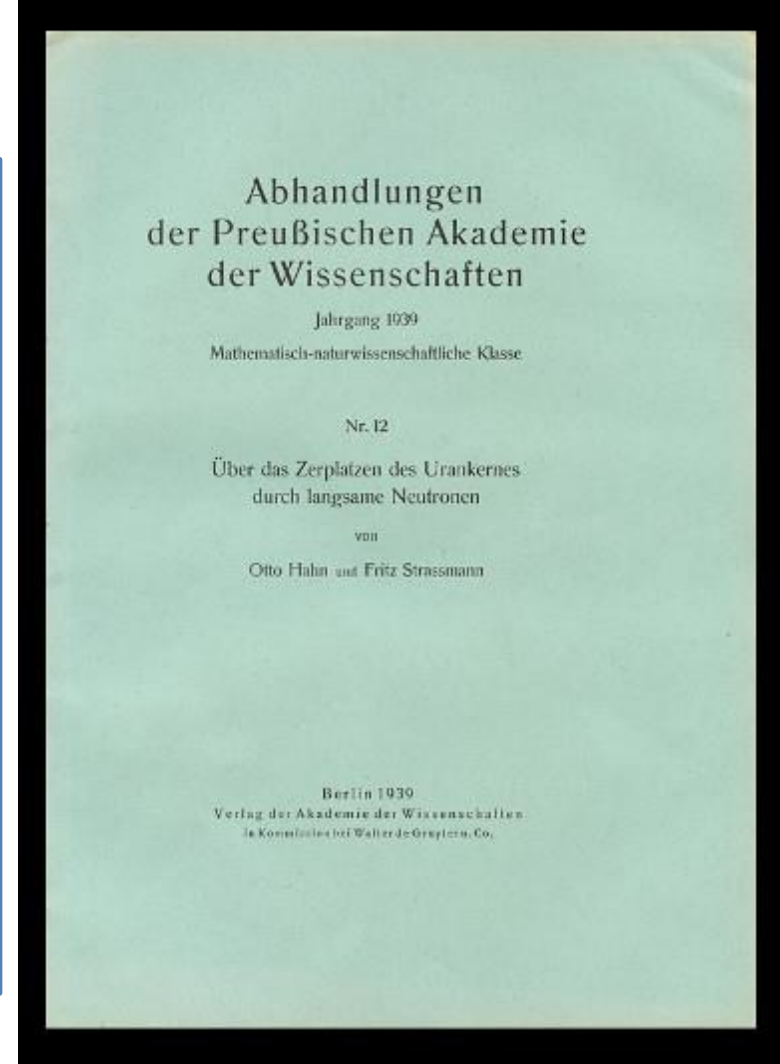
This should have been a gas!



Note: This is a white powder!

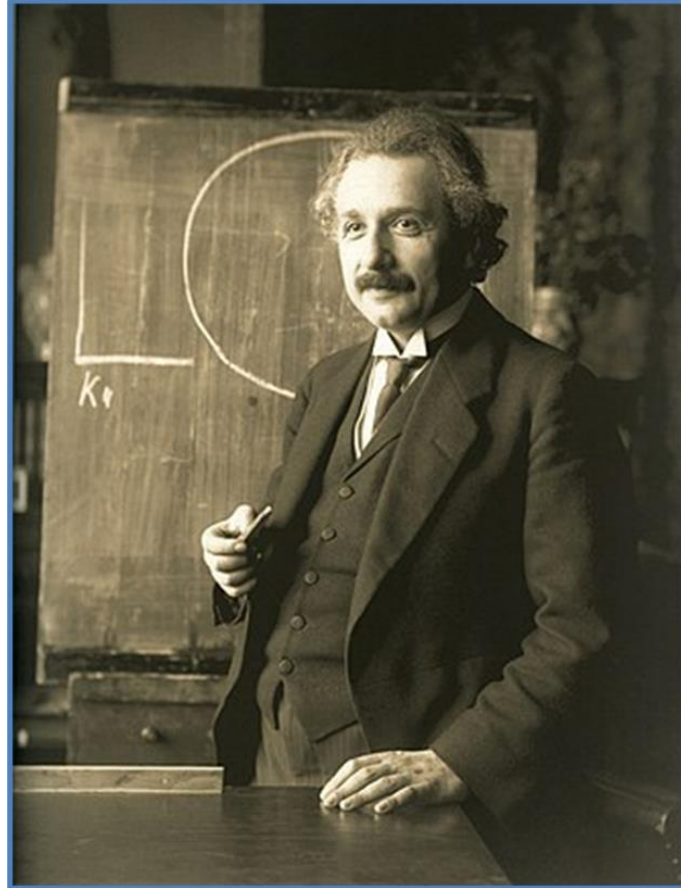
## 1938: 2nd Unexpected Results

- **Two German scientists, Otto Hahn & Fritz Strassmann, successfully split the uranium atom into two or more parts (fission)**
- ***“Über das Zerplatzen des Urankernes durch langsame Neutronen”***



# Recalcitrant PFAS

- **January 1933: Hitler becomes Chancellor of Germany**
- **May 1933: Albert Einstein escapes Germany to USA**
- **1938: Albert Einstein is made aware of discovery of fission**
- **Einstein writes a warning letter to President Roosevelt regarding Germany developing the atomic bomb**



Albert Einstein  
Old Grove Rd.  
Massau Point  
Peconic, Long Island

August 2nd, 1939

F.D. Roosevelt,  
President of the United States,  
White House  
Washington, D.C.

Sir:

Some recent work by E. Fermi and L. Szilard, which has been communicated to me in manuscript, leads me to expect that the element uranium may be turned into a new and important source of energy in the immediate future. Certain aspects of the situation which has arisen seem to call for watchfulness and, if necessary, quick action on the part of the Administration. I believe therefore that it is my duty to bring to your attention the following facts and recommendations:

In the course of the last four months it has been made probable - through the work of Joliot in France as well as Fermi and Szilard in America - that it may become possible to set up a nuclear chain reaction in a large mass of uranium, by which vast amounts of power and large quantities of new radium-like elements would be generated. Now it appears almost certain that this could be achieved in the immediate future.

This new phenomenon would also lead to the construction of bombs, and it is conceivable - though much less certain - that extremely powerful bombs of a new type may thus be constructed. A single bomb of this type, carried by boat and exploded in a port, might very well destroy the whole port together with some of the surrounding territory. However, such bombs might very well prove to be too heavy for transportation by air.

-2-

The United States has only very poor ores of uranium in moderate quantities. There is some good ore in Canada and the former Czechoslovakia, while the most important source of uranium is Belgian Congo.

In view of this situation you may think it desirable to have some permanent contact maintained between the Administration and the group of physicists working on chain reactions in America. One possible way of achieving this might be for you to entrust with this task a person who has your confidence and who could perhaps serve in an unofficial capacity. His task might comprise the following:

a) to approach Government Departments, keep them informed of the further development, and put forward recommendations for Government action, giving particular attention to the problem of securing a supply of uranium ore for the United States;

b) to speed up the experimental work, which is at present being carried on within the limits of the budgets of University laboratories, by providing funds, if such funds be required, through his contacts with private persons who are willing to make contributions for this cause, and perhaps also by obtaining the co-operation of industrial laboratories which have the necessary equipment.

I understand that Germany has actually stopped the sale of uranium from the Czechoslovakian mines which she has taken over. That she should have taken such early action might perhaps be understood on the ground that the son of the German Under-Secretary of State, von Weizsäcker, is attached to the Kaiser-Wilhelm-Institut in Berlin where some of the American work on uranium is now being repeated.

Yours very truly,  
*A. Einstein*  
(Albert Einstein)

# Recalcitrant PFAS

- **Einstein was correct**
- **April 1939, Hitler starts the “*Uranverein*”**
- **April 1939, Hitler under “*Wehrmacht*” “*recruits*” all of the top theoretical physicists in Germany for one task.....**
- **Goal: Build the first atomic bomb!**



# German Physicists: Uranverein



Horst Korsching



Karl Wirtz



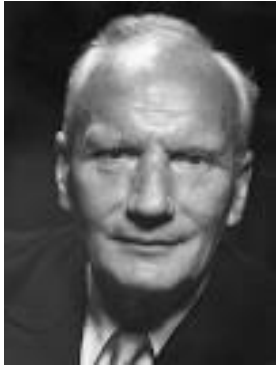
Walther Gerlach



Erich Bagge



Kurt Diebner



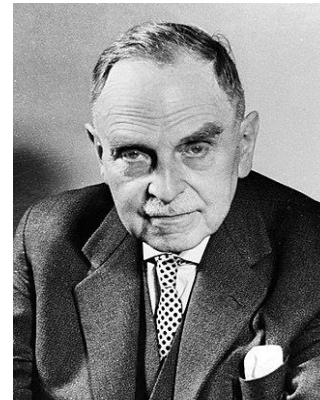
Walther Gerlach



**Werner Heisenberg**



Paul Harteck



Otto Hahn



Abraham Esau



# German Physicists: Uranverein



Siegfried Flügge



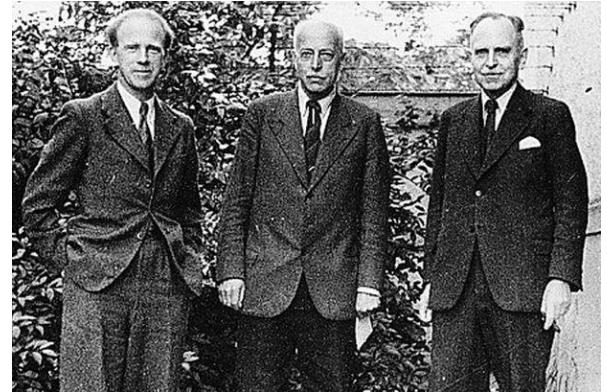
Hans Wilhelm Geiger

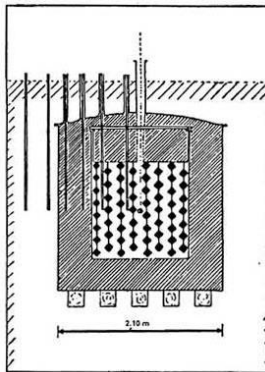
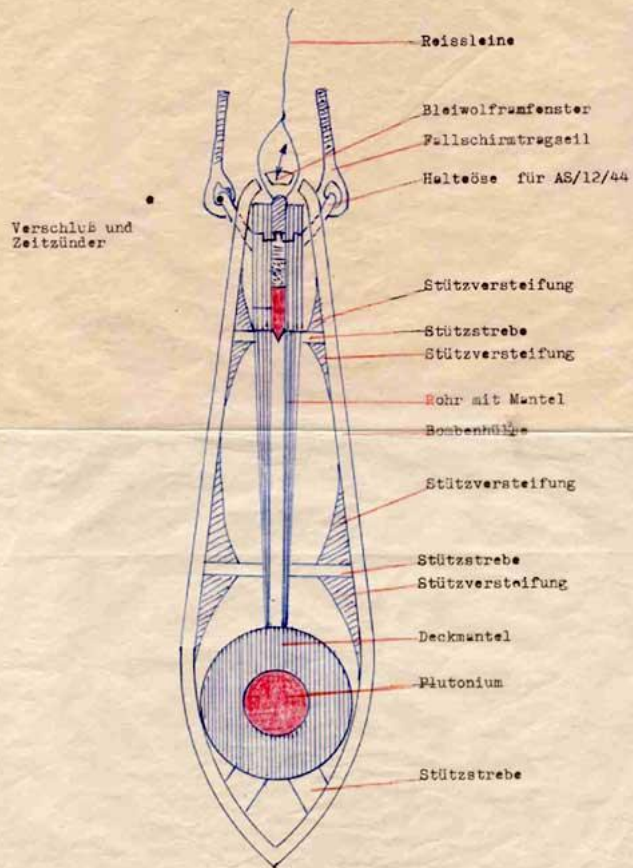


Max von Laue



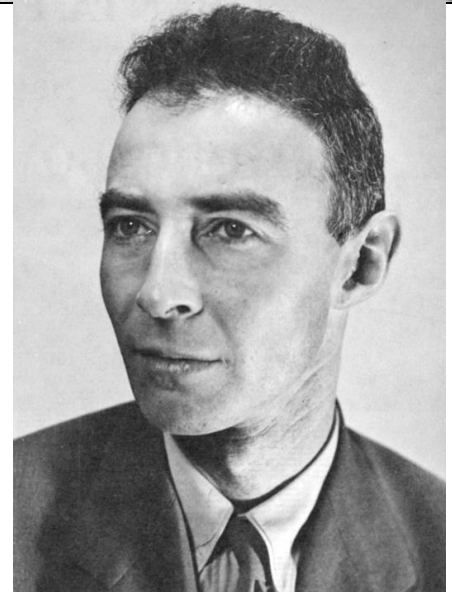
Carl von Weizsäcker





# History of PFAS

- **December 7, 1941: Japanese attack Pearl Harbor**
- **December 8, 1941: US enters World War II**
- **December 28, 1942: President Roosevelt authorized the formation of the Manhattan Project under Dr. Oppenheimer**
- **Germany had a three-year head start!**



Dr. J. Robert Oppenheimer<sub>31</sub>



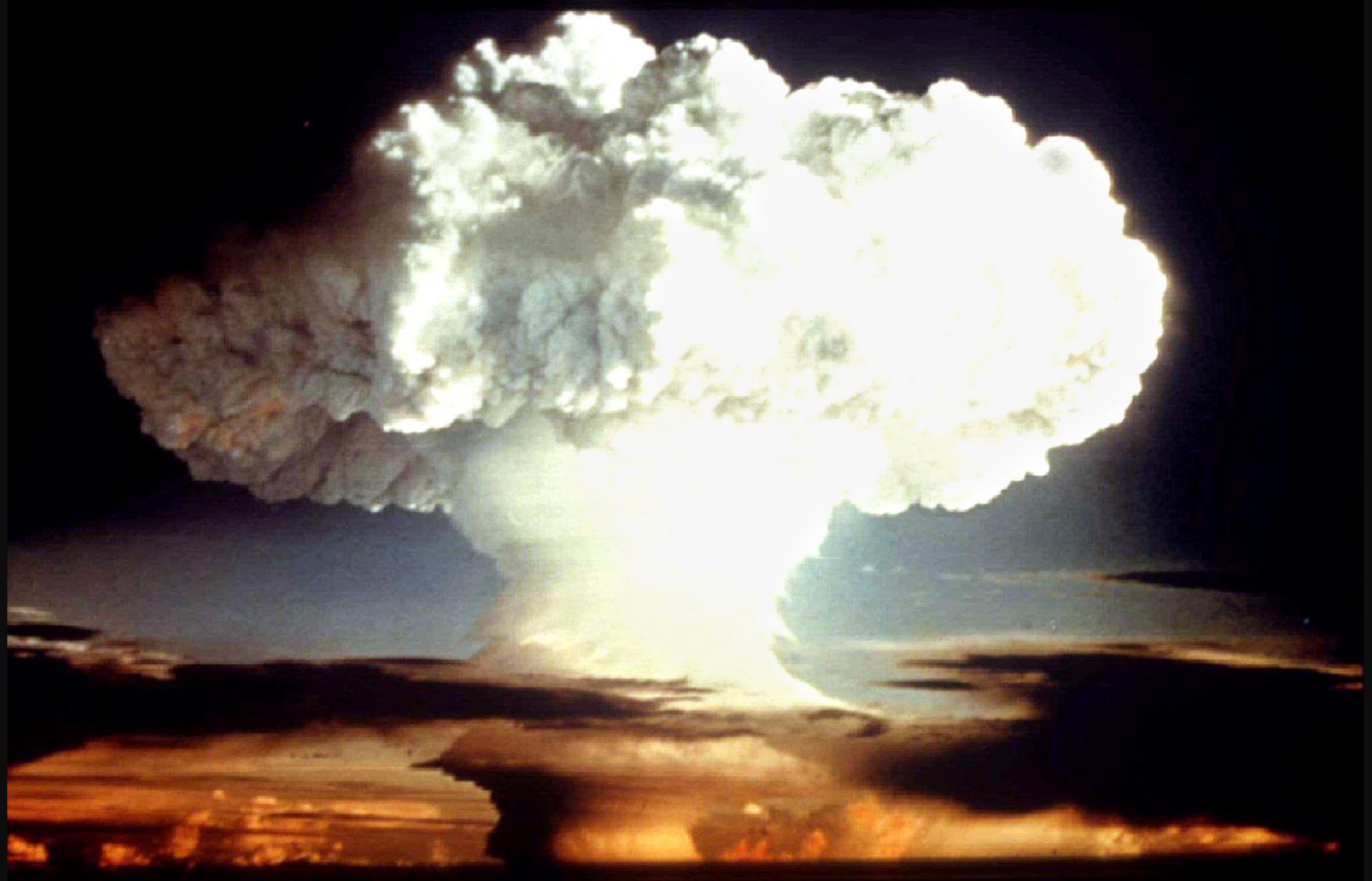
# Manhattan Project: August 13, 1942

- Again, three years later
- Finally, America starts the Manhattan project in 1942



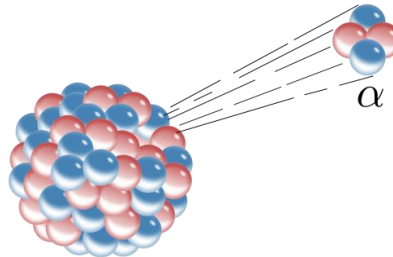
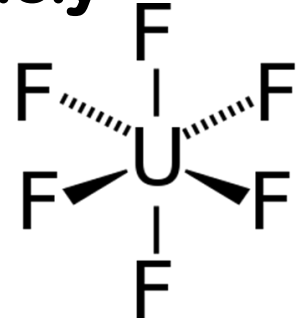
# Recalcitrant PFAS

- Germany, Japan & America had the same problem:
- When uranium is mined, it consists of approximately
- 99.3% Uranium-238 ( $\text{U}^{238}$ ): 92 protons + 146 neutrons
- $\text{U}^{238}$  Cannot support a chain reaction (non-fissile)
- 0.7% Uranium-235 ( $\text{U}^{235}$ ): 92 protons + 143 neutrons
- $\text{U}^{235}$  **Can support a chain reaction (fissile)**
- Needed: 64 kilograms (141 lbs) of highly-enriched uranium ( $\text{U}^{235}$ )
- Just 141 lbs of  $\text{U}^{235}$  you get this....



# Recalcitrant PFAS

- Both Germany, Japan & USA needed a needed a way to separate  $U^{235}$  from  $U^{238}$  (Enrichment)
- They needed a substance that could withstand:
  1. Gaseous uranium hexafluoride  $UF_6$  (extremely corrosive)
  2. HF gas (extremely corrosive)  $H-\ddot{F}:$
  3. High pressures
  4. High temperatures &
  5. Alpha radiation!

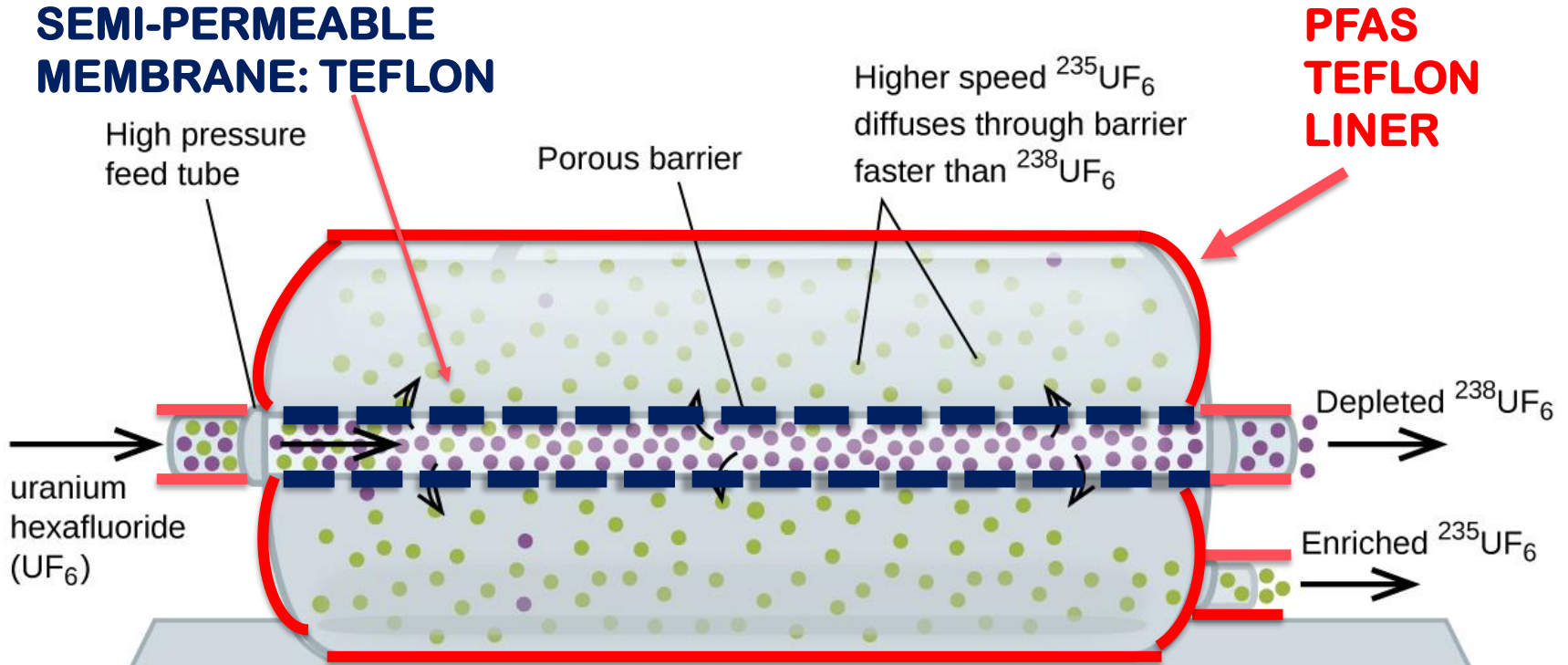


# Recalcitrant PFAS

- All three countries used Gaseous Diffusion Stage to enrich uranium with a Semi-permeable membrane
- Manhattan Project: One former DuPont Chemist recalled Teflon (PFAS) properties
- USA: Teflon (PFAS) was used for the first time
- They applied a Teflon coating to:
- The lining of each Gaseous Diffusion Stage
- Every valve, every seal, every gasket was either lined or manufactured using **Teflon** (PFAS)
- **Semi-permeable membrane made from Teflon**



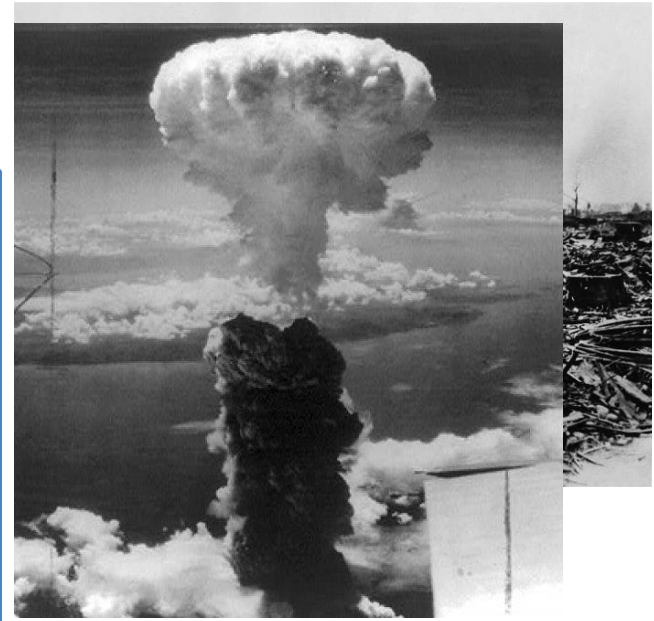
# Gaseous Diffusion Stage



In addition, every valve, every seal, every gasket was either lined or manufactured using Teflon (PFAS)!

# History of PFAS

- **Three years later**
- **August 06, 1945: The United States drops the Atomic Bomb on Hiroshima, Japan**
- **August 09, 1945: Another atomic bomb is dropped on Nagasaki, Japan**
- **September 02, 1945 - Japan surrenders**



# History of the Atomic Bomb

- **Historians (especially German) will give you 100 reasons why Germany did not develop the first atomic bomb, save one!**
- **PFAS!**
- **Remember, Germany developed the first uranium fusion reaction**
- **Germany had a three-year head start**
- **Germany had the most brilliant theoretical physicists**

# “Recalcitrant”

## TEACHING MOMENT: WORLD WAR II

The PFAS **Carbon – Fluorine** bond is very resistant (**recalcitrant**) to:

- Any biological attack (micro-organism)
- Any chemical attack (strong acids or bases)
- Any thermal attack
- Unaffected by convention wastewater treatment system

# Recalcitrant PFAS

➤ Simultaneously, Teflon (PFAS) was exposed to:

1. Gaseous **URANIUM HEXAFLUORIDE** ( $\text{UF}_6$ )

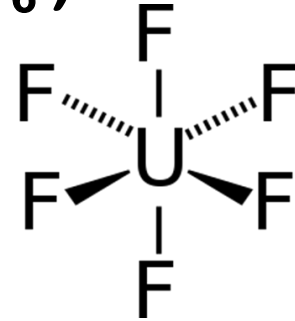
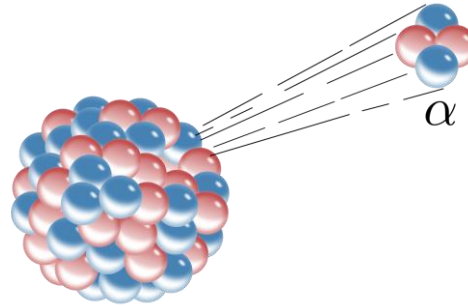
(extremely corrosive)

2. **HF** gas (extremely corrosive)  $\text{H}-\ddot{\text{F}}:$

3. High pressures

4. High temperatures &

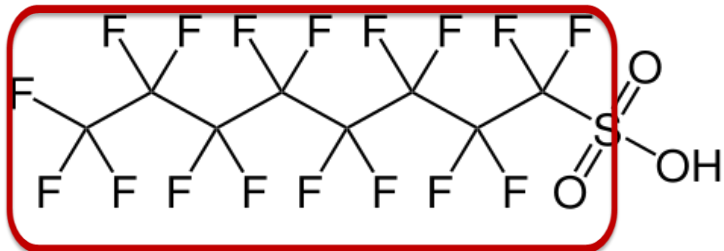
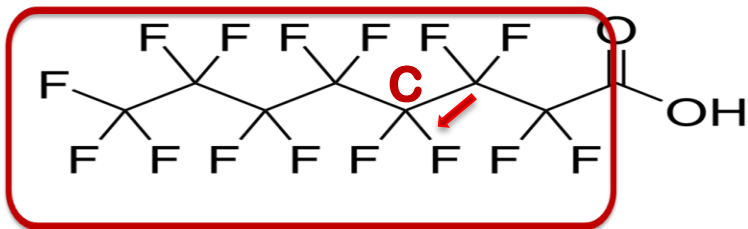
5. Alpha radiation!



➤ Without breaking down!

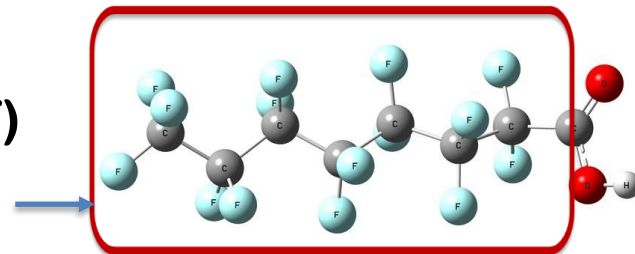
# 2018: PFAS: Why so stable?

➤ Like an armored vehicle, no place to react



**Melting Point of Carbon Steel:  $1425^{\circ}\text{C}$  ( $2600^{\circ}\text{F}$ )**

**Destruction temperature:  $1000^{\circ}\text{C}$  ( $1832^{\circ}\text{F}$ )**





**\$5000 REWARD**

Reward for the capture, dead or alive,  
of one Wm. Bonney, better known as

**BILLY THE KID**



★ **DEAD OR ALIVE** ★

# \$50,000 Reward: Non-Incineration Methods

News Releases from Headquarters > Office of the Administrator (AO)

## EPA, U.S. Department of Defense, and State Partners Launch Technical Challenge Seeking Innovative Ways to Destroy PFAS in Firefighting Foam

*Trump Administration continues its commitment to support state, tribal, and local communities in addressing PFAS*

08/25/2020

Contact Information:

EPA Press Office ([press@epa.gov](mailto:press@epa.gov))

**Fayetteville, N.C.** (August 25, 2020) — At a per- and polyfluoroalkyl substances (PFAS) roundtable hosted by U.S. Congressman Richard Hudson (NC-08) today in Fayetteville, N.C., U.S. Environmental Protection Agency (EPA) Administrator Andrew Wheeler launched an innovation challenge to identify solutions to destroy PFAS. The *Innovative Ways to Destroy PFAS Challenge* is a partnership between federal and states agencies seeking detailed plans for a non-thermal technologies to destroy PFAS in concentrated aqueous film forming foam (AFFF), a type of firefighting foam. This challenge is part of the significant progress the Trump EPA has made in implementing the [PFAS Action Plan](#)—the most comprehensive cross-agency plan ever to address an emerging chemical of concern.

“EPA researchers and staff are harnessing the power of crowdsourcing to identify ways to destroy PFAS through non-incineration methods,” said **EPA Administrator Andrew Wheeler**. “The Trump Administration has offered major assistance to more than 30 states across the U.S. to protect human health regarding PFAS, and the agency is offering up to \$50,000 for the best design concept to safely destroy the chemical.”





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Innovation

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EPA Innovation Home

Innovative Ways to Destroy PFAS

## Prize

EPA is awarding \$60,000 in prize money to the winning concepts. Challenge winners also will have the opportunity to submit their winning design concepts to DoD's SERDP/ESTCP programs for further testing.

### Top of page

Clean Air Excellence Awards
Green Power Leadership Awards
National Award for Smart Growth Achievement
President's Environmental Youth Award
Presidential Green Chemistry Challenge
Presidential Innovation

Background

Per- and polyfluoroalkyl substances (PFAS) are a group of synthetic chemicals that have been widely used for more than 60 years to make plastics, firefighting foams, and lubricants, and to help make products stain-resistant, waterproof, and nonstick. Newer forms of PFAS have been adopted over the past few years to replace older forms of PFAS compounds that were discontinued. Addressing and managing PFAS in the environment is one of the most pressing issues facing EPA, states and regions. This issue is particularly challenging because PFAS chemicals have a very strong carbon-fluorine chemical bond that leads to persistence in the environment and makes their complete destruction difficult. PFAS can be found at different concentrations in various waste streams including

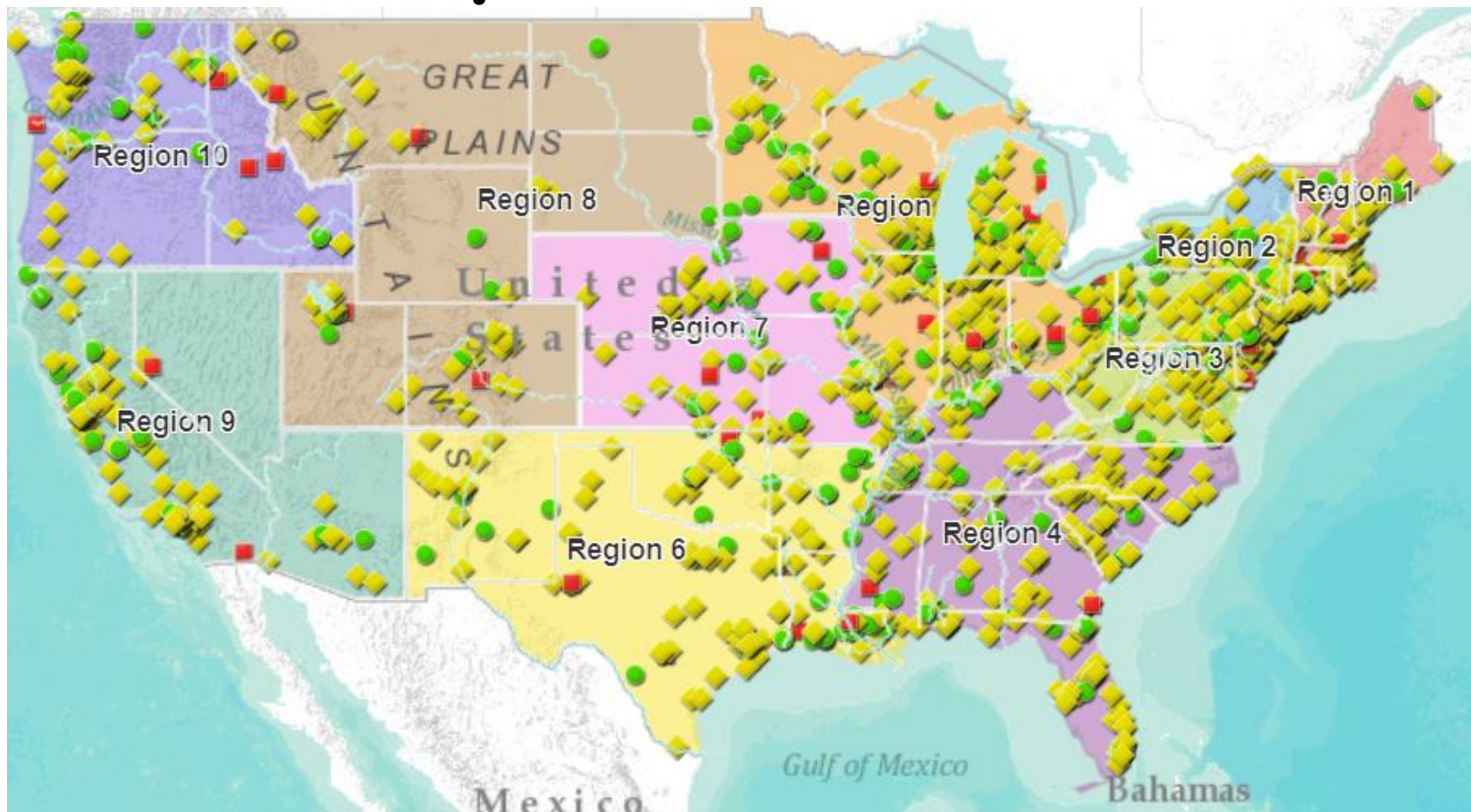
to Destroy PFAS

PER- AND POLYFLUOROALKYL SUBSTANCES

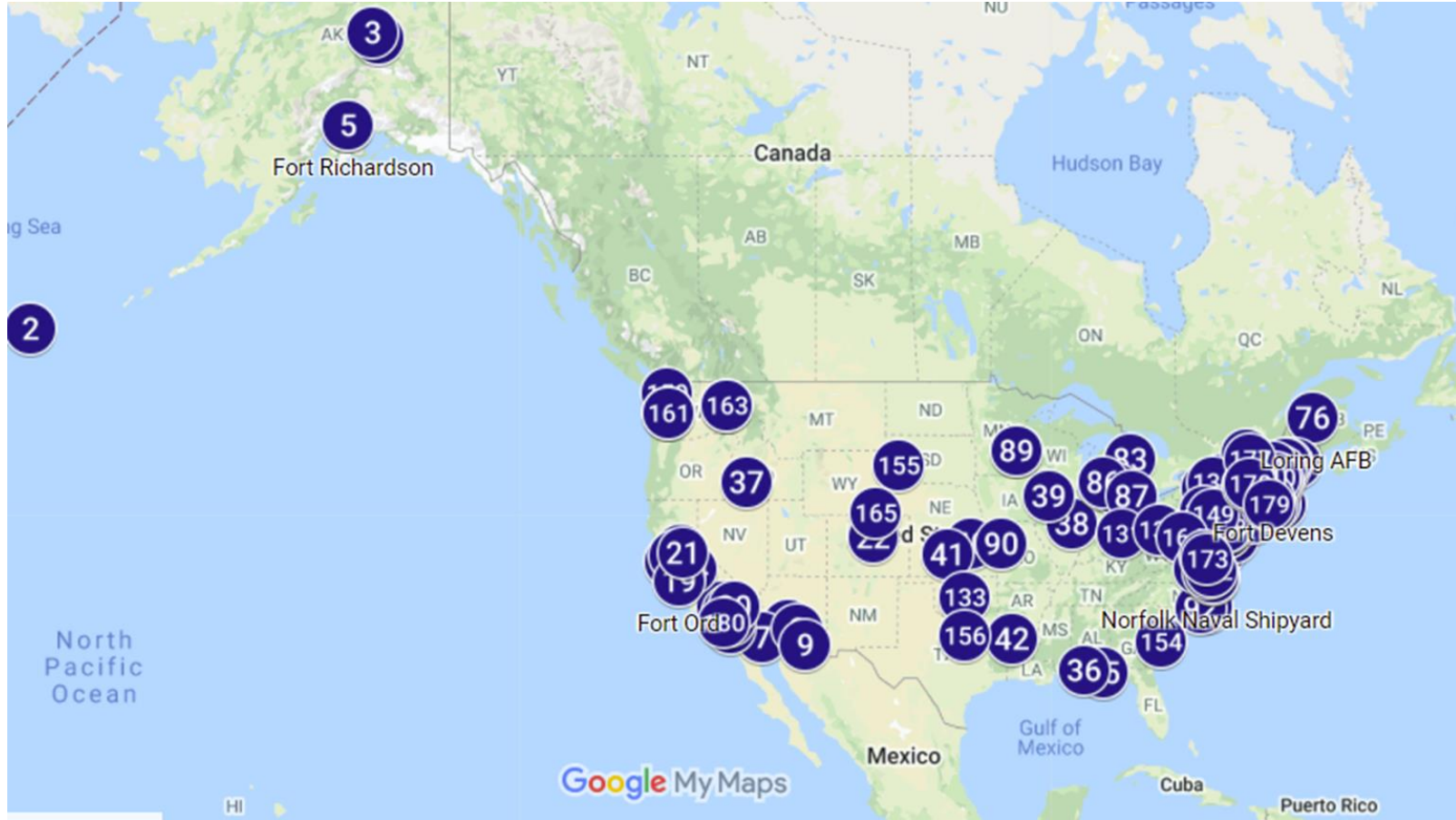
# Question...

➤ **How recalcitrant is PFAS to microbial breakdown?**

# 1335 Superfunds Sites in USA



To date, EPA has found **180 Superfund Sites** with **PFAS contamination**



# Minnesota Pollution Control Agency

## MPCA: 'Almost Every Closed Landfill It Oversees' Has PFAS Groundwater Contamination

59 Closed Landfills In 41 Counties Have Contamination That Exceeds State's Health Guidance

March 18,  
2021

### Landfills are leaking PFAS 'forever chemicals' in 41 Minnesota counties

Magnitude of the PFAS, groundwater problem is unknown, the state said.

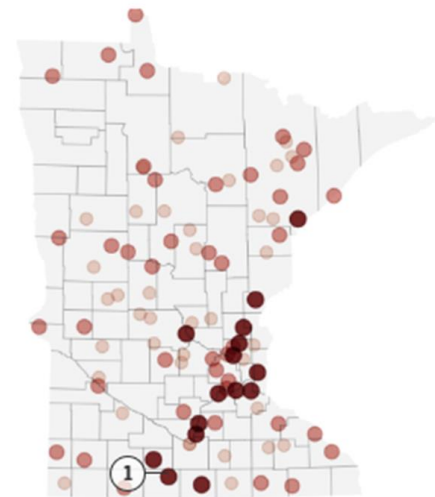
By Jennifer Bjorhus Star Tribune | MARCH 18, 2021 — 3:17PM



Groundwater at the old Gofer Landfill in Martin County near the Iowa border contains PFAS levels more than 1,000 times the state drinking water safety standard. No nearby drinking water wells have been contaminated, the MPCA said.

**PFAS levels > 1000  
times the state  
drinking water  
safety standard**

PFAS detected PFAS exceed state standards PFAS exceed at least 10 times the standards



1 Gofer Landfill



# Landfills are leaking PFAS 'forever chemicals' in 41 Minnesota counties

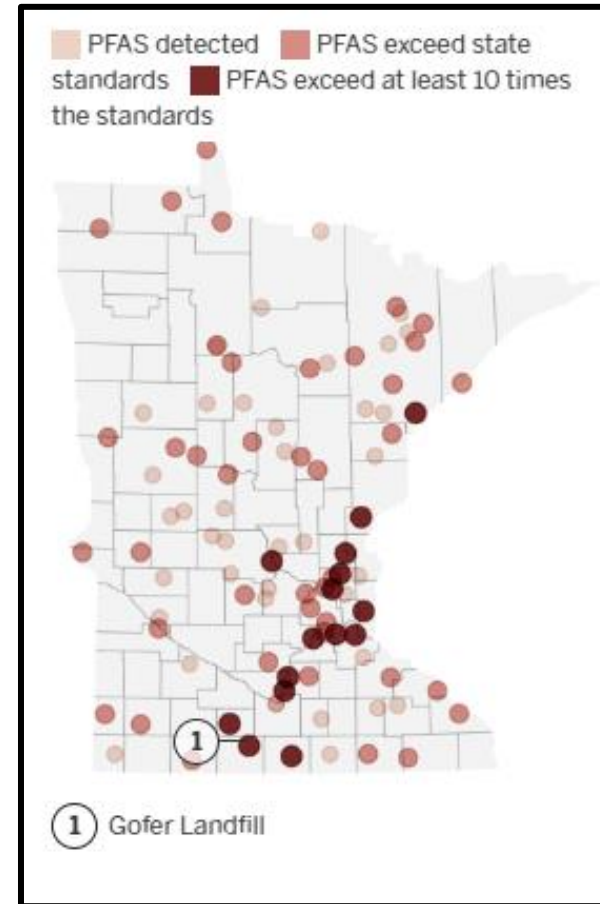
Magnitude of the PFAS, groundwater problem is unknown, the state said.

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SUBMITTED PHOTO

Groundwater at the old Gofer Landfill in Martin County near the Iowa border contains PFAS levels more than 1,000 times the state drinking water safety standard. No nearby drinking water wells have been contaminated, the MPCA said.



**PFAS levels > 1000 times the state drinking water safety standard**



## 704 Military Sites With Known and Suspected Discharges of PFAS



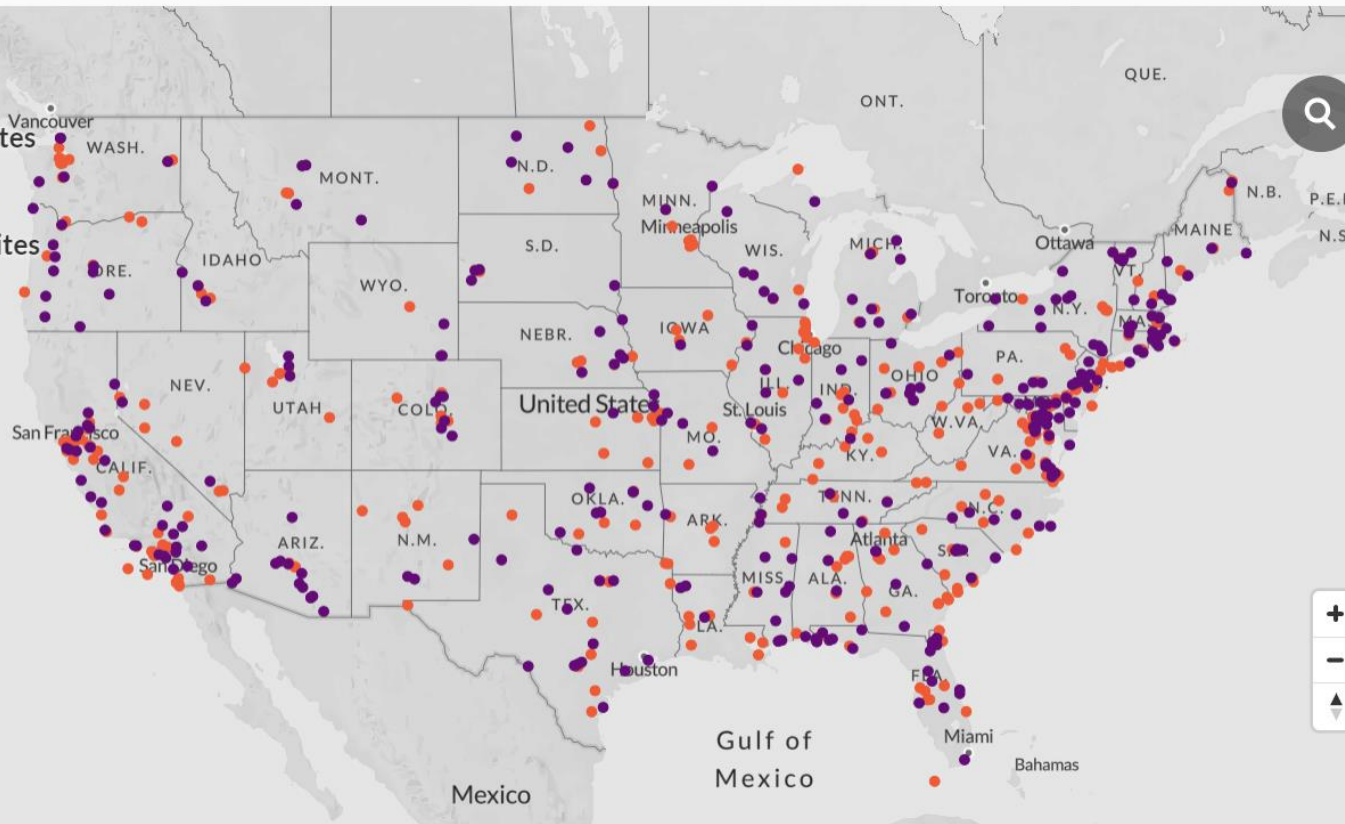
On

Suspected Military Sites

On

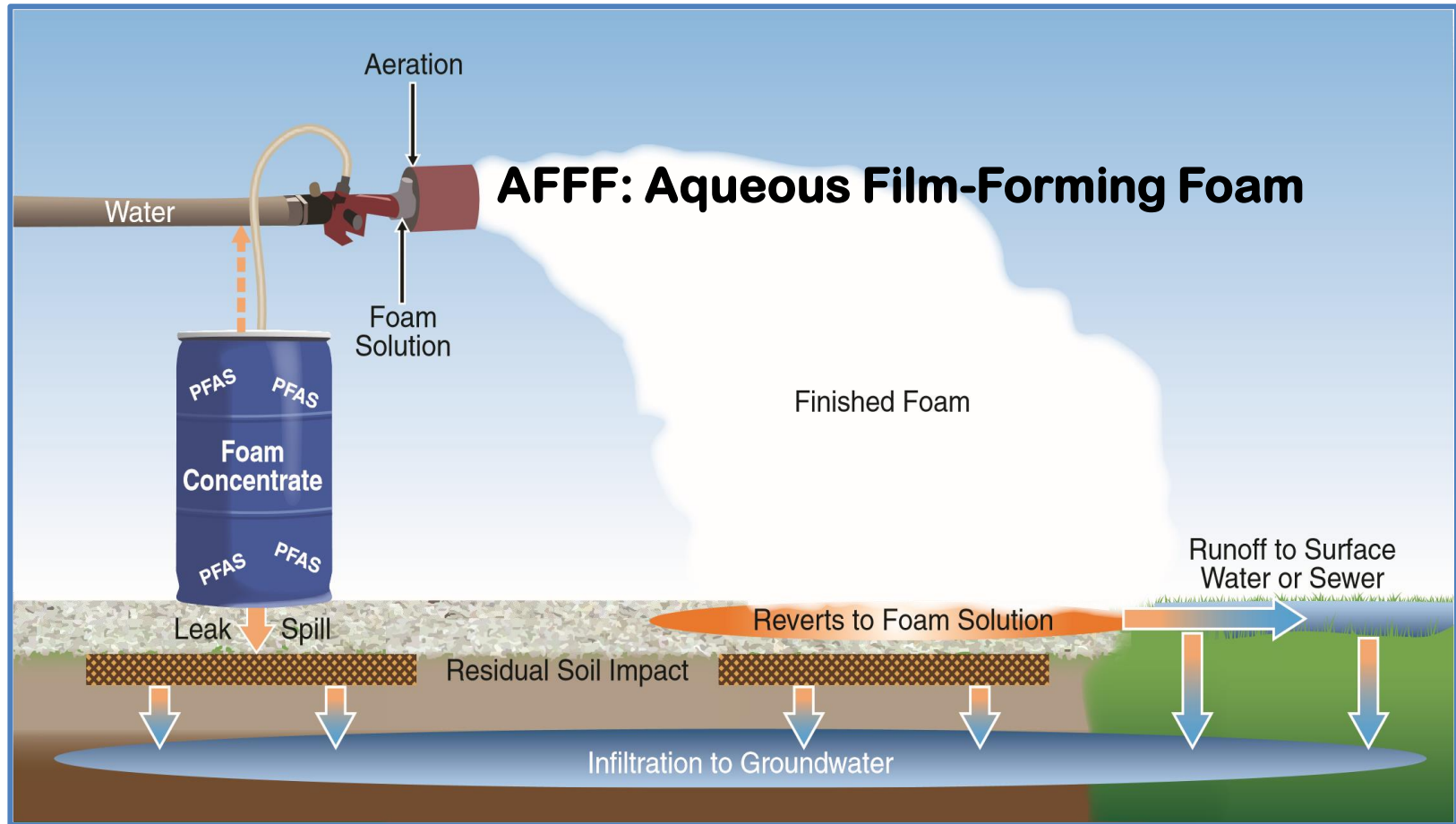
Confirmed Military Sites

info





# Fire Fighting Foam with Deluge System



# AFFF: Foam Concentrate

- EPA has established a lifetime health advisory level for PFOA & PFOS **70 parts per trillion**
- If just one drop of a 1% solution of PFAS was spilled into 1 liter of water, the concentration of PFAS would be about
- **500 000 000 parts per trillion!**









This is not snow!

















Test Ellsworth AFB POL

**AFFF**





























# Euphemism “Treatment” of PFAS

- Chemistry perspective
- Treatment of PFAS equates to breaking the bond



- During incineration or using GAC or ion exchange or reverse osmosis, if you are not breaking this bond
- You are removing PFAS, not treating the PFAS

# Clean Harbors incineration facility cited in lawsuit against DOD

by Caitlan Butler | February 22, 2020 at 8:01 p.m.



Incinerator: In this December 2016 file photo, an employee walks across the Clean Harbors' complex in El Dorado with the new technologically advanced incinerator shown in the background. The company unveiled the new incinerator four years ago. Clean Harbors was recently named in a lawsuit against the U.S. Department of Defense.

Clean Harbors' El Dorado Incineration Facility has been named in a lawsuit against the United States Department of Defense, which alleges that the DoD has approved the incineration of toxic chemicals in violation of several federal laws.

# Hearing set in East Liverpool incinerator lawsuit

BUSINESS

AUG 29, 2020

STEPHANIE UJHELYI

Staff writer



SHARE



TWEET



HEADING TO COURT — Heritage Thermal Services, which operates this incinerator in East Liverpool, is a co-defendant in a hearing that will be held Sept. 9 in federal court in California. (File photo)

# **PFAS test at Covanta-operated incinerator scrapped following public outcry**

The New Jersey DEP expressed disappointment, while the U.S. EPA said it will continue partnering with states and local governments as it seeks ways to destroy the toxic chemicals.



# PFAS incineration in New York spurs legislation, loss of federal contracts



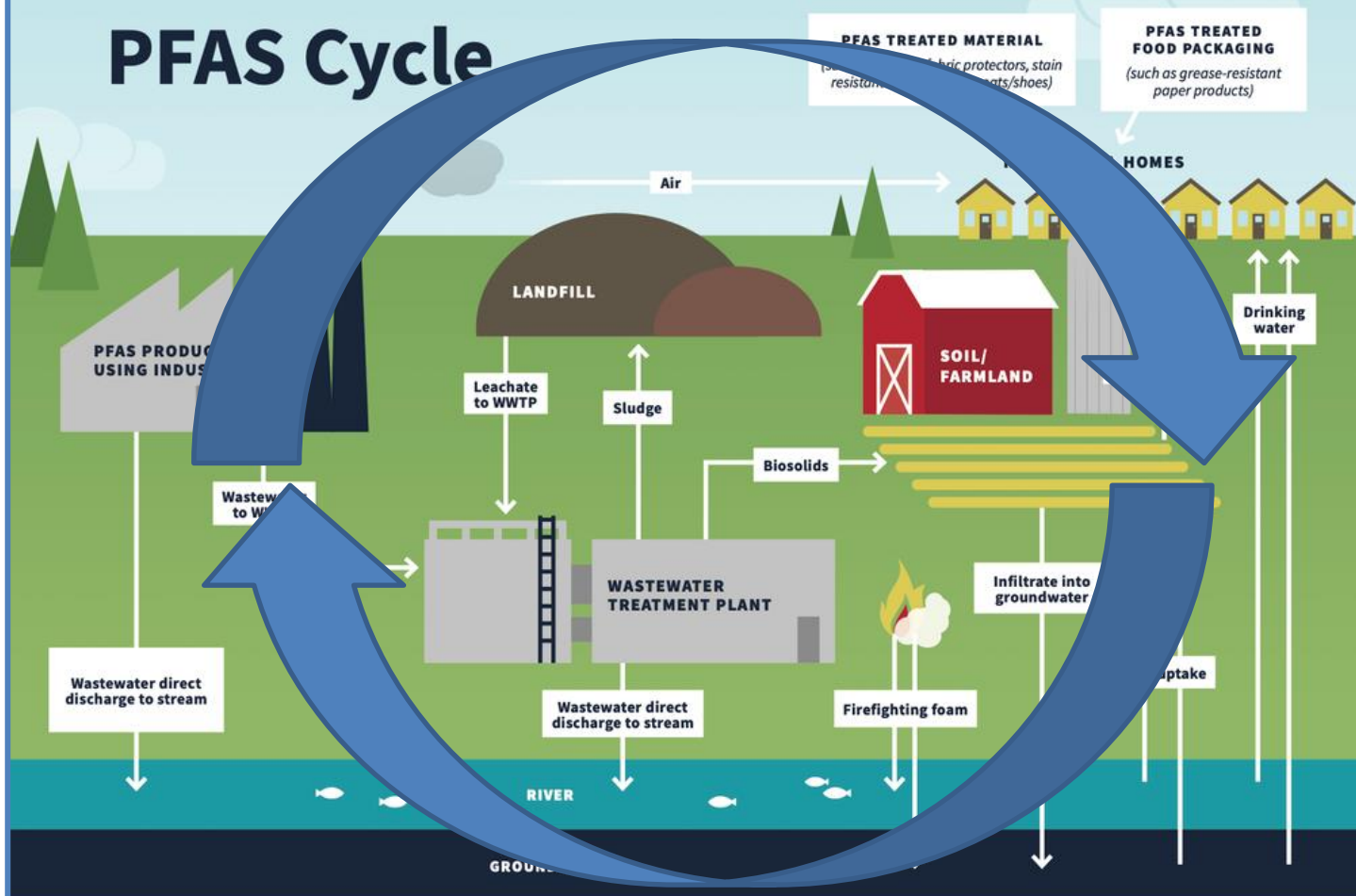
*The image by Яіскў Шнояє is licensed under CC BY 2.0*

# Euphemism “Treatment” of PFAS

- As of today.....
- There is **NO treatment of PFAS!**
- Regs. Per Ken Ede
- Solid PFAS waste: “Store” your PFAS waste in a hazardous waste landfill (Subtitle C)
- Liquid PFAS wastes: “Store” your PFAS waste in a hazardous waste injection well (Subtitle C)



# PFAS Cycle



# **Sampling Protocols for PFAS**

- **Oklahoma State University is writing the first sampling protocols for the State of Oklahoma**
- **Should be completed by Thanksgiving, 2021**
- **We have spent months reviewing the other 49 states PFAS protocols**
- **In addition, we have reviewed many other countries sampling PFAS protocols**
- **We have found a common tread!**



## Per- and Polyfluoroalkyl Substances (PFAS) Sample Collection Guidance

The purpose of this document is to provide guidance on groundwater sampling protocols when collecting sample(s) for analysis for PFAS. Detection of these compounds at very low levels can be influenced by materials that are present at the sampling site, materials used by the sampling agent, or sample container handling practices. For more detailed information, please refer to Standard Operating Procedure (SOP) No. HWRB-21 in the NHDES HWRB Master Quality Assurance Project Plan, prepared for sites investigated through contracts administered by the HWRB.

Because of the potential presence of PFAS in common consumer products and in equipment often used to collect groundwater samples, special handling and care must be taken when collecting PFAS samples. Accordingly, NHDES strongly recommends that protocols specific to sampling groundwater for the presence of PFAS be used for all well purging and groundwater sampling collection and handling methods, and that the sampling be performed by a consultant familiar with these protocols.

NHDES recognizes that studies are ongoing to identify the potential for cross-contamination from PFAS-containing items during sampling, and that some studies have found that the referenced guidance may be conservative. NHDES recognizes that studies are ongoing to identify the potential for cross-contamination from PFAS-containing items during sampling, and that some studies have found that the referenced guidance may be conservative. NHDES recommends appropriate quality assurance and quality control sampling be implemented if sampling protocols are modified. Please contact your project manager for further information.

Other information is available from:

- ITRC Fact Sheet "Site Characterization Considerations, Sampling Precautions, and Laboratory Analytical Methods for PFAS" ([https://pfas-1.itrcweb.org/wp-content/uploads/2018/03/pfas\\_fact\\_sheet\\_site\\_characterization\\_3\\_15\\_18.pdf](https://pfas-1.itrcweb.org/wp-content/uploads/2018/03/pfas_fact_sheet_site_characterization_3_15_18.pdf))
- Michigan PFAS Sampling Guidance ([https://www.michigan.gov/pfasresponse/0,9038,7-365-86510\\_87154-469832--,00.html](https://www.michigan.gov/pfasresponse/0,9038,7-365-86510_87154-469832--,00.html)), with a quick reference guide available at: [https://www.michigan.gov/documents/pfasresponse/PFAS\\_Sampling\\_Quick\\_Reference\\_Field\\_Guide\\_634603\\_7.pdf](https://www.michigan.gov/documents/pfasresponse/PFAS_Sampling_Quick_Reference_Field_Guide_634603_7.pdf)

Revised May 2019

Page 1 of 3

## GENERAL PFAS SAMPLING GUIDANCE

This document contains an introduction to PFAS, biosecurity recommendations, and general recommendations to decrease the possibility of cross-contamination.

Revised 10/16/2018

Michigan  
Department of  
Environmental  
Quality

## Per- and Polyfluoroalkyl Substances (PFAS) Sampling Guidelines for Non-Drinking Water

CALIFORNIA STATE WATER QUALITY CONTROL BOARD  
DIVISION OF WATER QUALITY

SWRCB PFAS Website: <https://www.waterboards.ca.gov/pfas/>  
DDW PFAS Website: [https://www.waterboards.ca.gov/drinking\\_water/cert/drinkingwater/PFAS\\_PQI.html](https://www.waterboards.ca.gov/drinking_water/cert/drinkingwater/PFAS_PQI.html)



September 2020

New Hampshire

Michigan

California

## Field Sampling Guidelines for PFAS

### Using EPA Method 537 or 537.1

Please read entire instruction sheet prior to sampling.

Also, view the MassDEP video on how to conduct PFAS sampling at: <https://youtu.be/crwahGL9SM>

Sampling for per- and polyfluoroalkyl substances (PFAS) using EPA method 537 or 537.1 can be challenging due to the prevalence of PFAS compounds in consumer products. Many materials normally used in field and laboratory operations contain PFAS and cannot be used in sampling for PFAS: e.g., tubing, sample containers, and sampling tools. In addition, many consumer goods, such as water-resistant jackets or fast food wrappers brought to a sampling site may contain PFAS that can also contaminate samples.

#### Field Clothing and Personal Protective Equipment

- Do not wear clothing or boots containing Gore-Tex®.
- Wear new nitrile gloves.
- Wet weather gear should be made of polyurethane and polyvinylchloride (PVC) only.
- Wear safety boots made from polyurethane and PVC.
- Do not use materials containing Tyvek® or polytetrafluoroethylene (PTFE), also known as Teflon®.
- Do not use fabric softener on clothing to be worn in field.
- Do not use cosmetics, moisturizers, hand cream, or other related products the morning of sampling.
- Do not use prohibited sunscreen or insect repellent. See Do's and Don'ts table below for more information.

#### Food Considerations

No food or drink allowed on-site with exception of bottled water.

#### Field Equipment

- Must not contain Teflon® (aka PTFE) or low-density polyethylene (LDPE) materials.
- All sampling materials must be made from stainless steel, high-density polyethylene (HDPE), acetate, silicone, or polypropylene.
- No waterproof field books can be used.
- No plastic clipboards, binders, or spiral hard cover notebooks can be used.
- Sharpies® and permanent markers not allowed; regular ball point pens are acceptable.
- Keep PFAS samples in separate cooler, away from sampling containers that may contain PFAS.
- Coolers filled with regular ice only - Do not use chemical (blue) ice packs.

# Massachusetts

## PFNA/PFAS Sampling Information For Water Systems Performing Sample Collection

### 1. Choosing a Laboratory

The analytical laboratory selected for perfluorononanoic acid (PFNA) analysis must be certified by the New Jersey Department of Environmental Protection (NJDEP) Office of Quality Assurance (OQA). The methods allowed for the analysis of PFNA and other selected per- and polyfluorinated alkyl substances (PFAS) in drinking water are EPA 537 Revision 1.1 and EPA 537.1. The list of laboratories certified for EPA 537 or 537.1 in a drinking water matrix can be found by going to the NJDEP webpage at [www.nj.gov/dep](http://www.nj.gov/dep). Go to **Data Miner** found under **Information Tools** and choose the Category **Certified Laboratories**.<sup>1</sup>

#### Ensure that the laboratory:

- has a detection limit (DL) less than or equal to 2 ng/L and a minimum reporting level (MRL) less than or equal to 5 ng/L for PFNA,
- can electronically submit the results to the NJDEP through E2,
- will provide a laboratory report that includes at a minimum:
  - qualified results (J-flagged) if PFNA is detected between the DL and the MRL;
  - a sample results report listing both the DL and MRL;
  - Field Reagent Blank (FRB) results if analyzed; and
  - documentation of any analytical issues that did not meet the method specifications.
- if requested, can provide quality control (QC) information that includes calibration check recoveries, surrogate recoveries, laboratory fortified blank (LFB) recoveries, internal standard responses and matrix spike information (Level 2 data package).
- can meet the required timeframe of submitting the data using E2 to the NJDEP within 10 days of the following quarter,
- for every quarter, can accommodate the analysis of your treatment plant samples and any possible FRB analyses.

### 2. Planning for the sampling

#### Minimize potential of background contamination:

Due to the ubiquitous nature of these PFAS, there is a higher than usual potential for sample contamination. To minimize this potential, careful preparation for this sampling event is strongly recommended. The clothing worn, personal care products used, and objects brought to the sampling site should be considered.

#### Clothing NOT to be worn includes:

- Tyvek suits

<sup>1</sup> Or follow this link:  
<https://www13.state.nj.us/DataMiner/Search/SearchByCategory?InExternal=y&GetCategory=y&catName=CertifiedLaboratories>

# New Jersey



Department of  
Environmental  
Conservation

## SAMPLING, ANALYSIS, AND ASSESSMENT OF PER- AND POLYFLUOROALKYL SUBSTANCES (PFAS)

Under NYSDEC's Part 375 Remedial Programs

January 2021



[www.dec.ny.gov](http://www.dec.ny.gov)

# New York

## Per- und polyfluorierte Alkylverbindungen (PFAS)

Organische Verbindungen, die vollständig (per-) oder teilweise (poly-) fluoriert sind

### Verwendung

Schon seit siebzig Jahren produzieren Unternehmen per- und polyfluorierte Alkylverbindungen (PFAS) in großen Mengen, um ganz unterschiedliche Materialien hitze-, wasser- und fettabweisend zu machen. Meist steht die Oberflächenbehandlung im Vordergrund, beispielsweise von Textilien, Haushaltsgegenständen und Baustoffen, in der Papierveredelung und in chemischen Spezialitäten. PFAS finden sich aber auch in Reinigungsmitteln, Löschschäumen, Kabelummantelungen, hydraulischen Flüssigkeiten und werden auch in der Metallurgie, Elektronik und Medizintechnik verwendet. Dabei können sie sowohl bei der Herstellung als auch bei der Verwendung und der Entsorgung in die Umwelt gelangen und den Menschen belasten.

Nach OECD Schätzungen gibt es über 4000 PFAS, die teilweise oder vollständig fluoriert sind. Grundsätzlich wird zwischen Polymeren und Nicht-Polymeren unterschieden. Alle PFAS sind menschengemacht, sie kommen nicht natürlich in der Umwelt vor. Zu den Polymeren gehören Perfluorpolyether, Polymere mit fluorierten Seitenketten sowie Fluorpolymere wie das Polytetrafluorethylen (PTFE), das in unterschiedlichen Produkten unter den Handelsnamen Teflon®, Scotchgard™ und Goretex® bekannt ist.

Nicht-Polymere können sowohl perfluorierte als auch polyfluorierte Alkylverbindungen sein. Aus den polyfluorierten Stoffen können perfluorierte Verbindungen entstehen, beispielsweise durch Stoffwechselprozesse im Menschen, Tieren, Pflanzen und Mikroorganismen oder durch nicht-biologische Abbauprozesse in der Umwelt.

### Daten der Umweltprobenbank

PFAS Untersuchungen sind einer der Schwerpunkte in der Umweltprobenbank. Es gibt viele Daten für perfluorierte sowie für einige polyfluorierte Alkylsubstanzen, die von jungen Erwachsenen sowie Pflanzen, Tieren und nicht-biologischen Proben der Binnengewässer, Küsten und terrestrischen Ökosysteme stammen. Für die meisten Probenarten gibt es auch Zeitreihen. Hierbei wurden sowohl regulierte als auch nicht regulierte PFAS untersucht.

### Gefahren für Mensch und Umwelt

Perfluorierte Verbindungen sind in der Umwelt und im Menschen sehr langlebig. Je nach Stoffeigenschaft verteilen sie sich in den Umweltmedien, einige Verbindungen reichern sich auch in den Nahrungsnetzen an. Mit den Weltmeeren und über den Luftpfad können sie sich über die Erde verteilen und so auch die entlegenen Polarregionen erreichen. Einige der perfluorierten Verbindungen sind als toxisch bekannt.

Germany

HEPA

## PFAS National Environmental Management Plan

Version 2.0 – January 2020

National Chemicals Working Group of the Heads of EPAs  
Australia and New Zealand

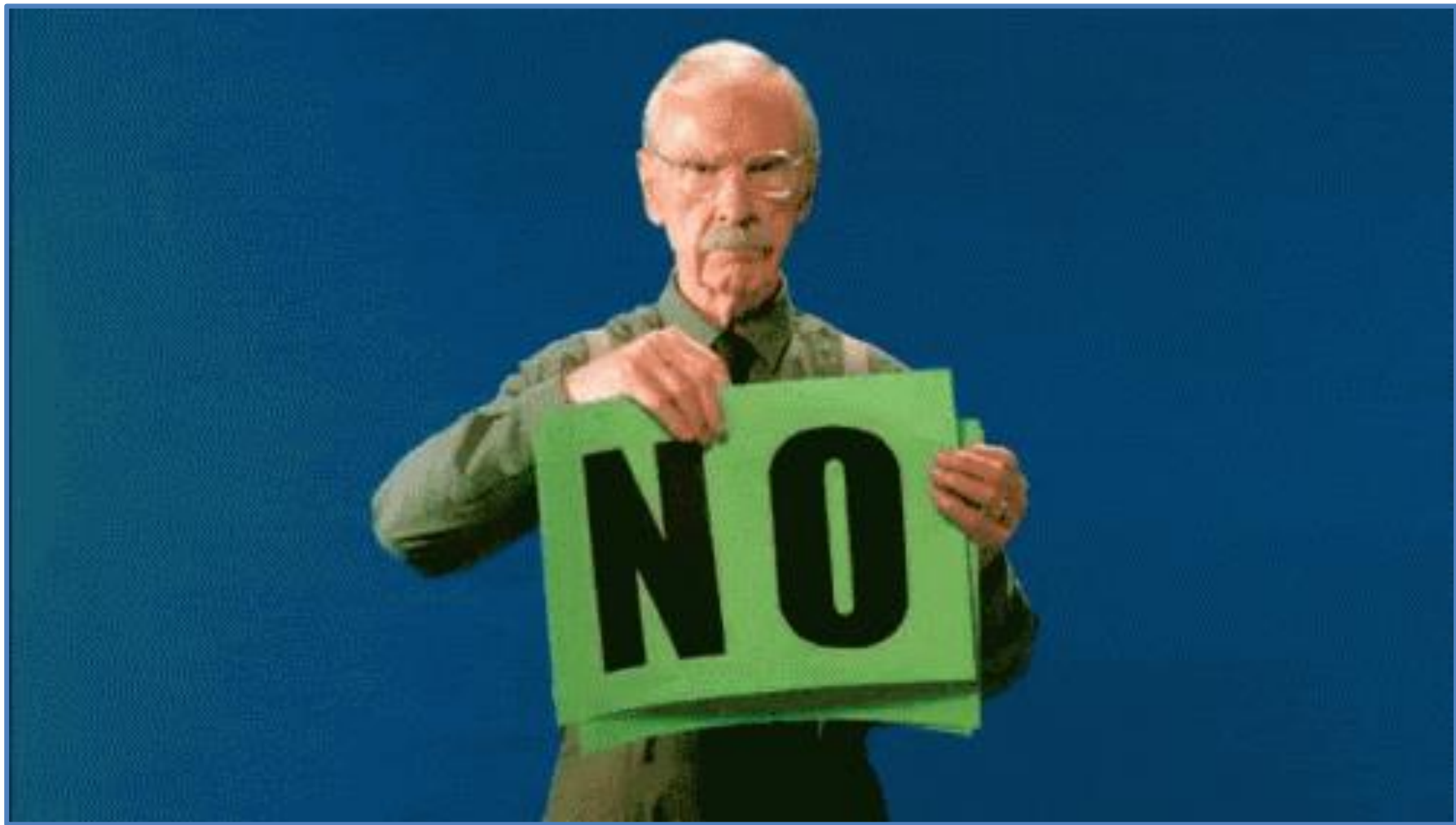


Australia & New Zealand



# Sampling Protocols

- **Regs. Per Ken Ede**
- **Assume that every site you visit will be investigated one day for PFAS**
- **Use your PFAS sampling plan for every site you visit**
- **Why, because all PFAS protocols are based on the “land of NOs”**



# Land of NOs

- **NO** Gore-Tex clothing      nylon clothing or
  - **NO** Gore-Tex boots      hats
  - **NO** Gore-Tex hats, gloves, etc.
  - **NO** Tyvek
  - **NO** new clothing
  - **100% Cotton** only
  - **NO** Polyester or
- All clothing must be washed at least **7** times without fabric softener

# Land of NOs

- **NO** clothing chemically treated for insect repellence
- **NO** clothing that has been treated for ultraviolet protection
- **NO** clothing that has been treated for stain resistance
- **NO** clothing that has ever been washed with clothing that contains any treated for insect resistance, ultraviolet protection water, dirt, and/or stain resistant chemicals
- **NO** Post-It or any other adhesive paper products

# Personal Care Products: Land of NOs

- **NO** Eyeshadow
- **NO** Bronzer or highlighter
- **NO** Facial powder
- **NO** Foundation
- **NO** Sunscreen
- **NO** Mascara
- **NO** Eye cream
- **NO** Hand cream
- **NO** Blush
- **NO** Shaving cream
- **NO** Facial moisturizer
- **NO** Brow liner
- **NO** Hair Spray
- **NO** Fragrances (perfume or aftershave)



# Land of NOs

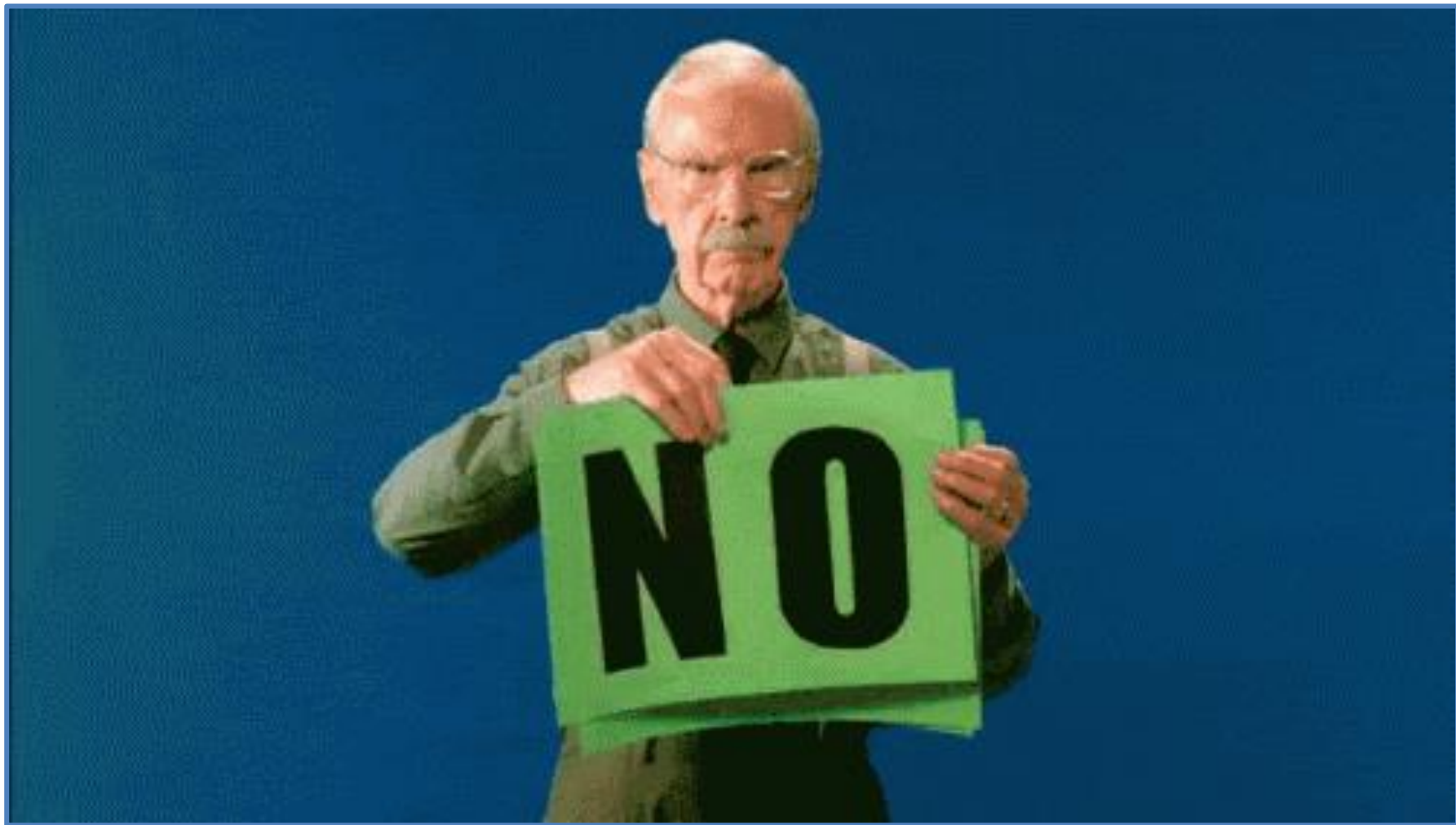
- **NO** Pre-wrapped food or snacks (such as candy bars, energy bars)
- **NO** Popcorn made in a microwave
- **NO:** Low-density Polyethylene (LDPE) in containers and bottles, plastic bags, and tubing
- **NO** Blue Ice
- **NO** Waterproof field books
- **NO** Treated paper
- **NO** plastic clipboards
- **NO** plastic binders
- **NO** waterproof markers (Sharpie)

# The Sampling Land of “NOs”

- **NO TEFLON (PTFE):**  
Hoses, tubing, wiring, gears, valves, etc.
- **NO Neoflon (PCTFE):**  
Valves, seals, gaskets & **food packaging**
- **NO Kynar (PVDF):**  
Tubing, films/coatings on **aluminum**, galvanized, aluminized steel, wire insulators, and **lithium-ion batteries**
- **NO Tefzel (ETFE):**  
Wire and cable insulation and covers, films for roofing and siding, liners in pipes, **cable tie wraps**

# Only Two Exceptions

- **When you compile all of these documents into one document there are only two exceptions!**



**Parts per Million  
(ppm) 1E-6**

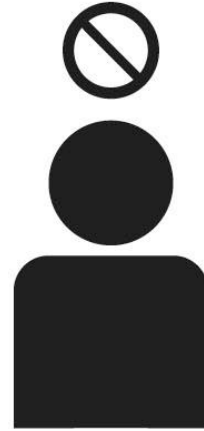
**1 milligram per  
kilogram  
(mg/kg) = 1 ppm**

**1 milligram per  
liter (mg/l)  
= 1 ppm**

**1 microgram per  
gram ( $\mu\text{g/g}$ )  
= 1 ppm**



# OUR GOAL.....



**No**

# Our Goal

- **Our goal is to write the most “sampler-friendly” document in the United States**
- **One example: No Gore-Tex**
- **Problem: Gore-Tex is found everywhere you see the words “waterproof or water-resistant”**

# One Solution

- **Go old school**
- **Before WWII clothing was “waterproofed” with beeswax and other natural products**
- **Advantage: NO PFAS and do not cause health issues to your workers**
- **Examples:**

## Waxed-Cotton



QUICK VIEW



Men's Double L Waxed-Cotton Upland Coat  
\$249-\$269

★★★★★ 28



QUICK VIEW



Men's L.L.Bean Upcountry Waxed-Cotton Down Jacket  
\$199-\$209

★★★★★ 81



QUICK VIEW



Women's L.L.Bean Upcountry Waxed-Cotton Down Jacket  
\$199

★★★★★ 47

Viewing 1 - 3 of 3

### Adults' Wool-Lined Waxed-Cotton Fowler's Cap

Item #: TA271100 | ★★★★★ 122 Reviews | [Write a Review](#)



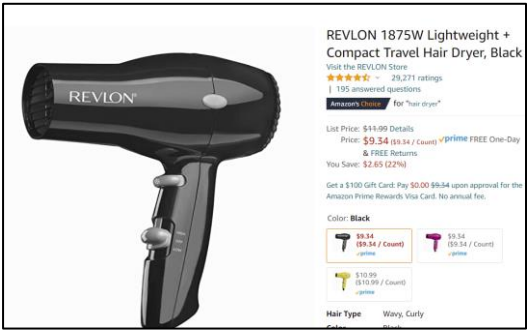
### Men's Waxed-Canvas Maine Hunting Shoes, 10"

Item #: TA20205 | ★★★★★ 162 Reviews | [Write a Review](#)



# Non-PFAS Substitutes

Purchased leather gloves  
and then applied bee's wax



L.L.Bean > Footwear > Men's > Boots > Hunting > Black

Men's Arctic Sport Muck Boots, High-Cut

Item #: TA280532 | ★★★★★ | 83 Reviews | Write a Review



## SECTION 2 – COMPOSITON/INFORMATION ON INGREDIENTS

PRODUCT NAME

Beeswax

CAS NUMBER

8012-89-3

PURITY

100%

WATER PROOFING

**Table 6: Allowed/Approved Sunscreens**

- Banana Boat® for Men Triple Defense Continuous Spray Sunscreen SPF 30
- Banana Boat® Sport Performance Coolzone Broad Spectrum SPF 30
- Banana Boat® Sport Performance Sunscreen Lotion Broad Spectrum SPF 30
- Banana Boat® Sport Performance Sunscreen Stick SPF 50
- Coppertone® Sunscreen Lotion Ultra Guard Broad Spectrum SPF 50
- Coppertone® Sport High Performance AccuSpray Sunscreen SPF 30
- Coppertone® Sunscreen Stick Kids SPF 55
- L'Oréal® Silky Sheer Face Lotion 50
- Meijer® Clear Zinc Sunscreen Lotion Broad Spectrum SPF 50
- Meijer® Sunscreen Continuous Spray Broad Spectrum SPF 30
- Meijer® Clear Zinc Sunscreen Lotion Broad Spectrum SPF 15, 30 and 50
- Meijer® Wet Skin Kids Sunscreen Continuous Spray Broad Spectrum SPF 70
- Neutrogena® Beach Defense Water+Sun Barrier Lotion SPF 70
- Neutrogena® Beach Defense Water+Sun Barrier Spray Broad Spectrum SPF 30
- Neutrogena® Pure & Free Baby Sunscreen Broad Spectrum SPF 60+
- Neutrogena® UltraSheer Dry-Touch Sunscreen Broad Spectrum SPF 30



# Chemistry Euphemisms

- **Matrix Interference**
- **“qualifiers” on laboratory reports**
- **M**
- **J**
- **B**
- **Memory**
- **Lack of linearity**

# Matrix Interference











# PFAS Matrix Interference

- **The term “Matrix” includes water, soil, solids, sludges, boots, cake, etc.**
- **However, water is rarely a problem**
- **Therefore, generally matrix interference refers to everything other than water**
- **Problem: Matrix Interferences can cause either:**
  - **False Positives or**
  - **False Negatives**



# Leaked FDA Documents Reveal Dangerous 'Forever Chemicals' in Meat, Poultry, Milk, and Chocolate Cake

The amount of PFAS found in chocolate cake was more than 250 times higher than the federal guidelines for PFAS in drinking water.



**FDA: Total PFAS**  
**Chocolate Cake: 17,640 PPT**  
**Seafood 865 PPT**  
**Meat 765 PPT**  
**Leafy Greens 813 PPT**

▲ The FDA report found much higher levels in the chocolate cake, the Associated Press reported, with PFAS levels

# PFAS in food

## FDA Makes Available Testing Method for PFAS in Foods and Final Results from Recent Surveys

[Subscribe to Email Updates](#)

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[in LinkedIn](#)

[✉ Email](#)

[🖨 Print](#)

### Constituent Update

October 31, 2019

# PFAS Matrix Interference

- **If you believe you have matrix interference, either change:**
  - 1. The analytical procedure**
  - 2. The solvent used for extraction**

# Mercury in Oklahoma Soil

- I have tested many Oklahoma soil samples Mercury using the cold vapor technique
- Average concentration  $\approx 0.02 \rightarrow 0.04$  mg/kg
- Professor contacted me regarding a large grant he received for the sampling and testing for mercury in remote parts of Oklahoma
- He found very high concentrations of Hg?

# Mercury in Soil

Location	Mercury Concentration (mg/kg)
Surface	0.2

**Remember: Average Hg conc. in OK is about 0.03 mg/kg**

# Mercury in Oklahoma Soil





# Matrix Interference

## 4.0 INTERFERENCES

4.1 Solvents, reagents, glassware, and other sample processing hardware may yield artifacts and/or interferences to sample analysis. All of these materials must be demonstrated to be free from interferences under the conditions of the analysis by analyzing method blanks. Specific selection of reagents and purification of solvents by distillation in all-glass systems may be necessary. Refer to each method to be used for specific guidance on quality control procedures and to Chapter Three for general guidance on the cleaning of glassware. Also refer to Method 7000 for a discussion of interferences. le)

4.2 Potassium permanganate is added to eliminate possible interference from sulfide. Concentrations as high as 20 mg/Kg of sulfide, as sodium sulfide, do not interfere with the recovery of added inorganic mercury in reagent water.

4.3 Copper has also been reported to interfere; however, copper concentrations as high as 10 mg/Kg had no effect on recovery of mercury from spiked samples.

4.4 Samples high in chlorides require additional permanganate (as much as 25 mL) because, during the oxidation step, chlorides are converted to free chlorine, which also absorbs radiation of 254 nm. Care must therefore be taken to ensure that free chlorine is absent before the mercury is reduced and swept into the cell. This may be accomplished by using an excess of hydroxylamine sulfate reagent (25 mL). In addition, the dead air space in the BOD bottle must be purged before adding stannous sulfate. Alternatively, the sample may be allowed to stand for at least an hour under a hood (without active purging) to remove the chlorine.

# Mercury Analysis

## 4.0 INTERFERENCES

- 4.1 Interferences have been reported for waters containing sulfide, chloride, copper and tellurium. Organic compounds which have broad band UV absorbance (around 253.7 nm) are confirmed interferences. The concentration levels for interferants are difficult to define. This suggests that quality control procedures (Section 9.0) must be strictly followed.



**TUESDAY | 7:43 a.m.**

Deer Park, Texas, Incident Date:  
March 17, 2019

# PFAS Matrix Interference

- **Again, other than water, the matrix may cause either false positives or false negatives for PFAS**
- **If your results do not seem correct, work with your lab to either:**
  - **Change the analytical procedure or**
  - **The extraction solvent**

# Qualifiers

- A qualifier on a laboratory report tells the client additional information regarding the integrity of the data

Sample Location	Sample Description	Sample Date	Sample Method	Qualifiers	Total PFAS
MW-1 ng/L	Water	10/1/2021	537.1	J, B	4,500
MW-2 ng/L	Water	10/1/2021	537.1	B	550
Soil Sample #1 ng/kg	Soil	10/1/2021	537-m	J, M, B	600
Trip Blank ng/L	Water	10/1/2021	537.1	B	478
Field Blank ng/L	Water	10/1/2021	537.1	J & B	400
Equipment Blank ng/L	Water	10/1/2021	537.1	B	25



# Laboratory Qualifiers

➤ **M = modified**

3. Per Federal & State regs (SDWA) requires you to use their chemical analytical procedures (533, 537.1)

4. Laboratory is certified for that analysis in your State

# PFAS Analyses Potable Water

2. Chain of Custody (COC) form

1. Sampled properly ODEQ guidelines

# PFAS Analysis

- At the present time, all PFAS analysis was designed for finished potable water ONLY
- There are no final regulations as to how to analyze for PFAS in soils, sludges, non-potable groundwater, finished products (boots)



**5. NO Laboratory is certified  
for PFAS in solids**

**4. NO Federal or State  
regulations as to how to analyze  
PFAS in soils or groundwater**

# **PFAS Analyses Soils**

**3. NO Federal or State  
regulations as to how to extract  
the PFAS from soils or non-  
potable groundwater**

**1. Sampled properly  
ODEQ guidelines**

**2. Chain of  
Custody (COC)  
form**

# M = modified

- Any time you see a “M” next to a test procedure, this means the laboratory has modified a drinking water analytical test protocol to test non-drinking water
- 537-M or 533-M, etc.
- Remember M = modified or made-up
- Why? Because at the present time .....



# m = modified

- No Federal or State regulations as to how to extract the PFAS from soils or non-potable groundwater
- Shandy Extraction Protocol
- No Federal or State regulations as to how to analyze PFAS in soils or groundwater
- No Laboratory is certified for PFAS in solids, soils, groundwater only drinking water





# “B” Laboratory Qualifiers



# Laboratory Qualifiers

- **B = Compound was found in the laboratory method blank and the sample**
- **How did PFAS contaminate both the method blank and the sample?**
- **The answer: The labs water purification's system!**

# **“B” Laboratory Qualifiers**

- **Every laboratory has a water purification system**
- **However, the valves, tubing, gaskets are all made out of Teflon (PFAS)**
- **This Teflon leaches from the water purification system into your samples**
- **Before each shift, the Chemist should “waste” one to two gallons of purified water into the sink**
- **Next, the Chemist should run the equipment blanks**

Sample Location	Sample Description	Sample Date	Sample Method	Qualifiers	Total PFAS
Trip Blank ng/L	Water	10/1/2021	537.1	B	478
Field Blank ng/L	Water	10/1/2021	537.1	J & B	450
Equipment Blank ng/L	Water	10/1/2021	537.1	B	25



## Per- and Polyfluoroalkyl Substances (PFAS) Report

**“B” qualifier — means the chemical was found in both the sample and a “blank”.**

When chemicals are found in both the blank and the test sample, the reported value is qualified with a “B” to show the uncertainty in the source of the contamination. Such samples must be recollected and reanalyzed. In the example above,

# Chemistry Euphemisms

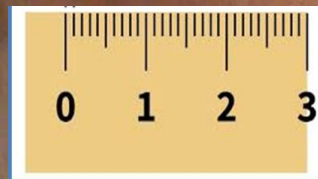
➤ ***“Lack of linearity”***



# Lack of Range of Linearity

- At the present time, all analytical procedures for PFAS were designed for finished drinking water
- Goal: Report very low Parts per Trillion (1 to 5 PPT)
- However, most soils (and some groundwater) that was contaminated with fire fighting foam (AFFF), you will detect Parts per Million
- The difference between a PPT ( $1\text{E}-12$ ) and PPM ( $1\text{E}-6$ ) = 1 million
- To give a perspective

**Diamond 1/5 carat**



**3.8 mm (0.149 inches)**

$$3.8 \text{ mm} \times 1\,000\,000 = 3800 \text{ meters}$$



**3.8 mm**



**3.8 mm**



**3.8 mm**



**3.8 mm**



**3.8 mm**



**3.8 mm**



**3.8 mm**



**3.8 mm**



**3.8 mm**

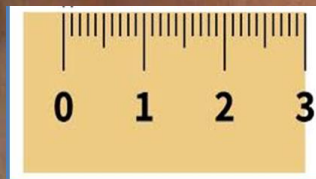
Elevation 3800 m





diamond  
store TV

**Diamond 1/5 carat**



**3.8 mm**

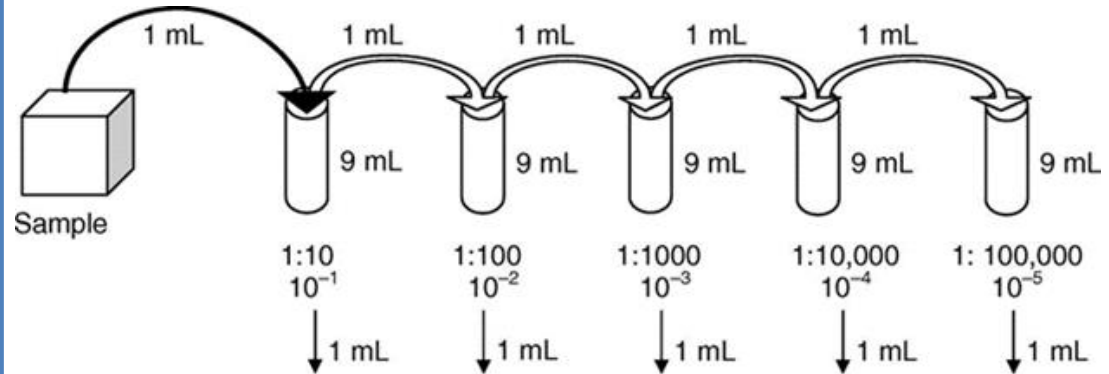
Elevation 3800 m





# Serial Dilution

- Every time a Chemist pipettes one solution into another there are always small errors
- Every error is then multiplied by x100,000 or x1,000,000



# Analytical Caveats of PFAS

## 1. Lack of range of linearity

- Again, today's analytical techniques were designed for finished potable water
- LC/MS/MS only has a range of accurate reliability between:
  - 5 PPT → 1000 PPT
- Any value below 5 PPT or above 1000 PPT is an estimate (J-flag)

# Actual samples: Split Labs

SAMPLE ID	Matrix	Lab A PPT	Lab B PPT
1	Brackish Water	1035	
2	Liquid	996	
3	Solid	30 700 000	
4	Solid	90 900 000	
5	Solid	15 000 000	

PFAS range of accurate reliability between:

**5 PPT → 1000 PPT**

# PFAS Chemist's Euphemisms

**“Research Gaps”**

# PFAS Chemist's Euphemisms

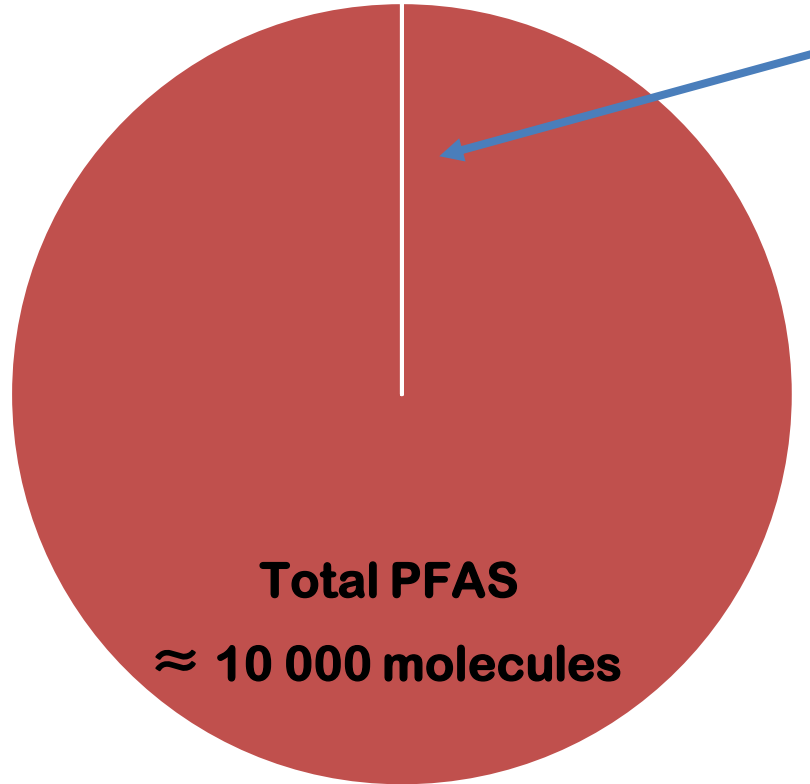
**The analytical results have “Research Gaps”**

- **Very polite expression to tell the reader that the PFAS family has about 10 000 different molecules**
- **Presently we can detect about 36 molecules**
- **Therefore this “research gap” means the Chemist cannot identify 9964 of the 10 000 molecules!**

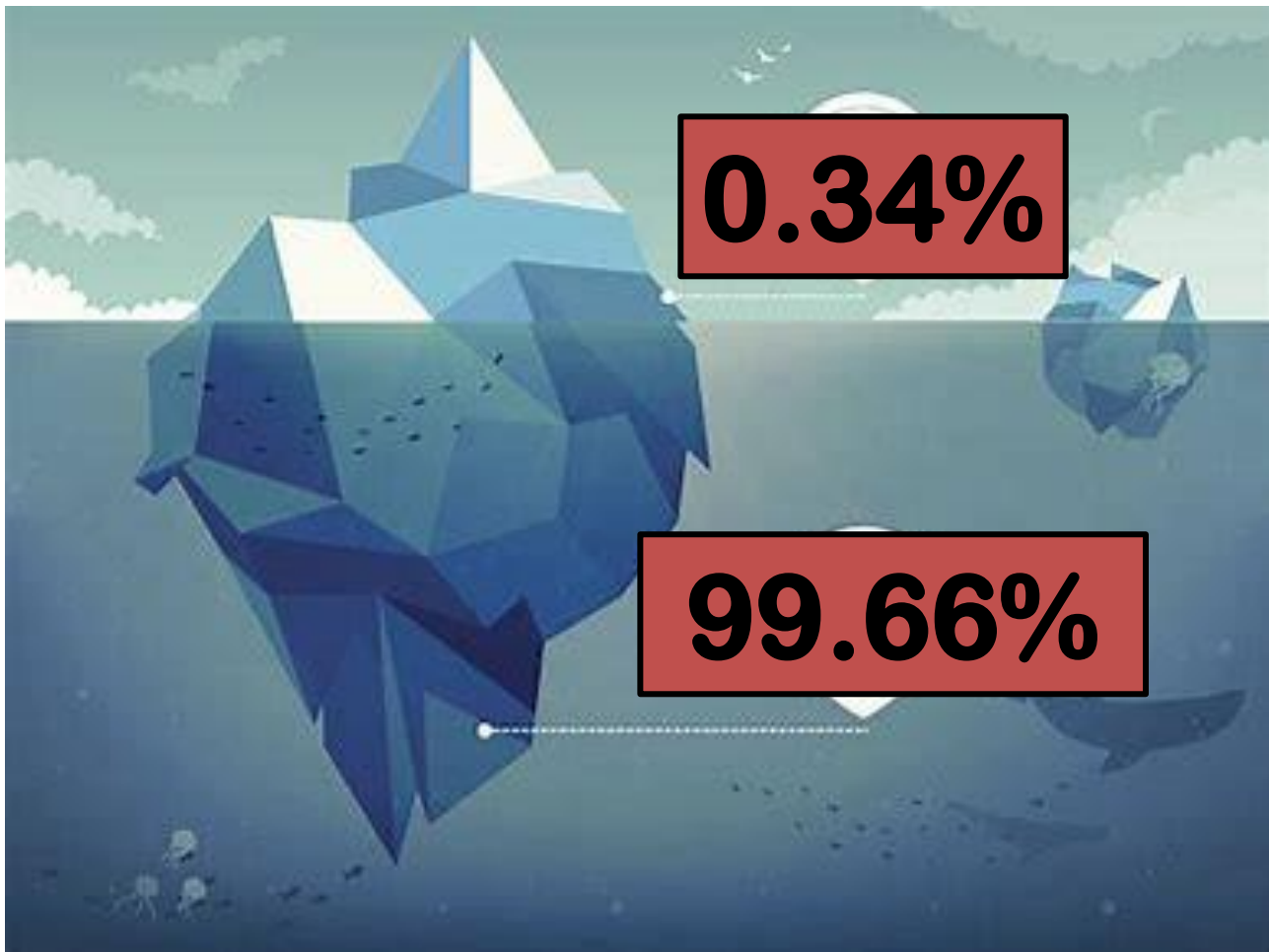
# Research Gaps

**$\Sigma 533, 537 = 36$  PFAS**

**CY 2021  
0.36 %**







# Chemistry Euphemisms

➤ **Memory**

# Chemist's Euphemisms

**“The mass spectrometer has...**

***“carry over”***

**or**

***“ghost peaks”***

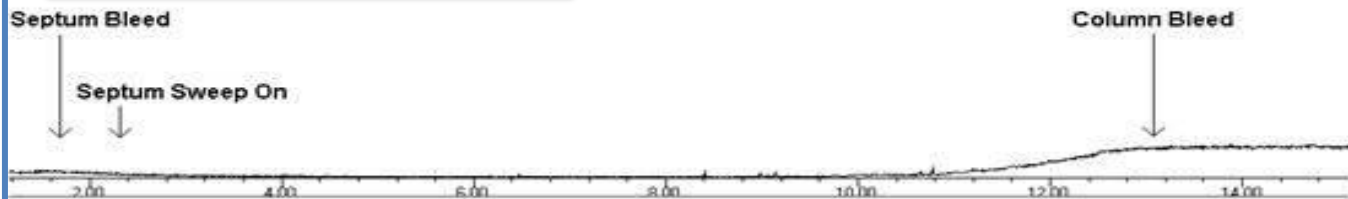
***or***

***“memory”***

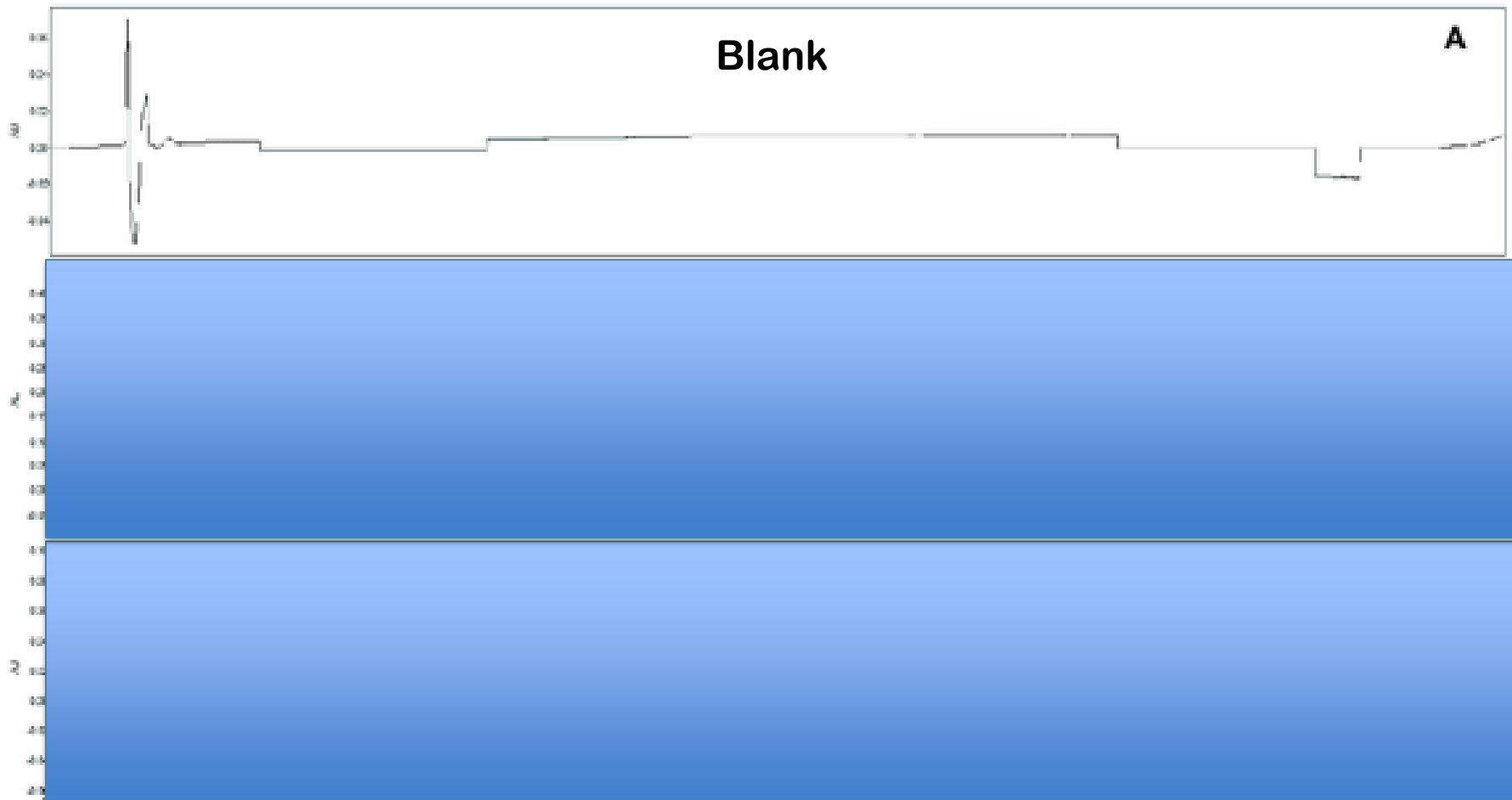
# Chemist's Euphemisms

- **Memory Euphemism:**
- **Polite expression to tell the reader that the Chemist forgot to run a blank sample between your sample and the previous one**
- **Therefore, if the previous sample is contaminated, your sample will also show contamination!**

# Blank



Courtesy of Accurate Labs





# Memory

SAMPLE ID	Matrix	Lab A PPT
1	Brackish Water	
2	Groundwater	
3	Trip Blank	
4	Field Blank	
5	Equipment Blank	

# Blanks

- ❖ **Because PFAS is ubiquitous and chemical instruments have “memory,” blanks should be run first**
- ❖ **If any parameter is above BDL (Below Detection Limit), the Lab must call you!**
- ❖ **You may want to resample**
- ❖ **You cannot subtract the blank values from the sample values**

# Thank You



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QUESTIONS?



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