Forever Chemicals: PFAS

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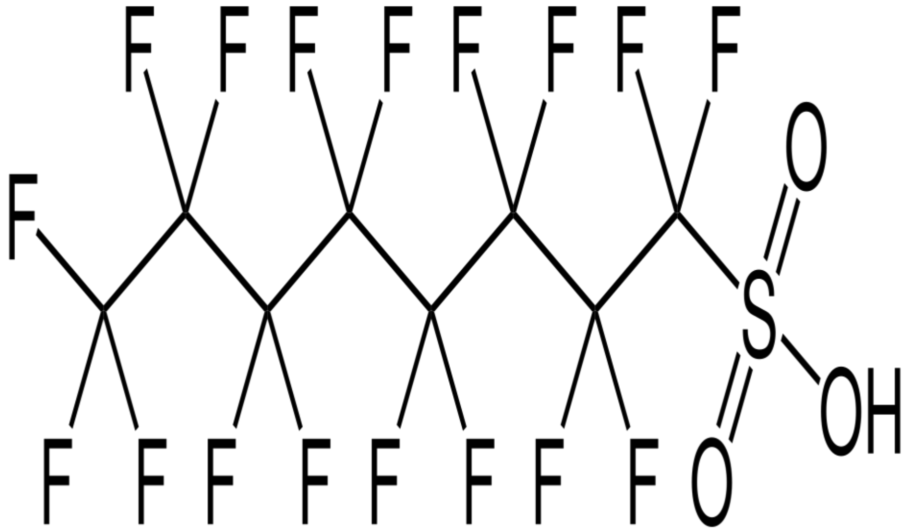
PENNSYLVANIA PUBLIC UTILITY COMMISSION

Key Questions to be Answered

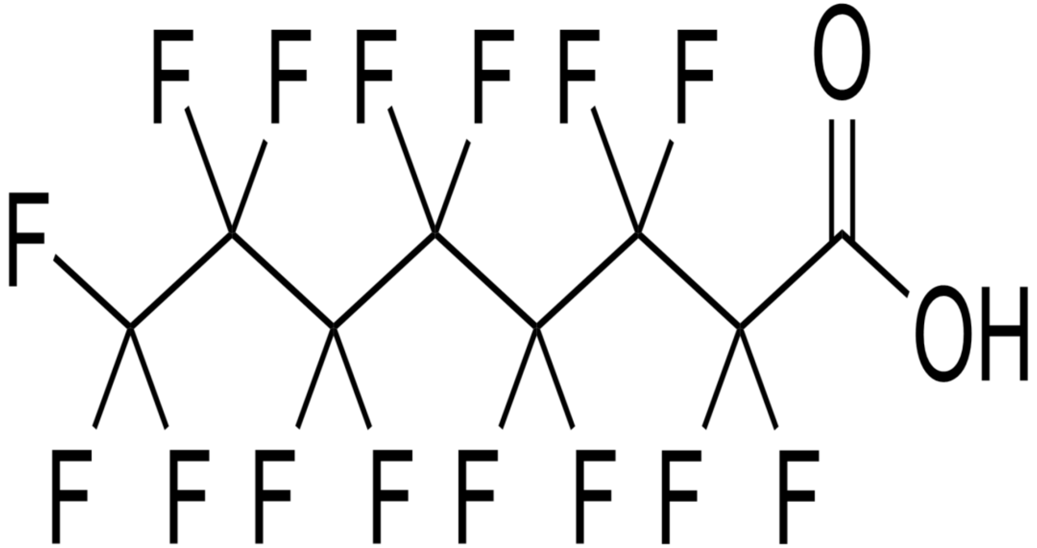
- What are PFAS?
- Why are PFAS dangerous?
- What are the regulations around PFAS in drinking water?
- How do you test for PFAS?
- If needed, how do you treat for PFAS?
- How much does that cost?

What are PFAS?

Per- and Polyfluoroalkyl substances



PFOS



PFOA

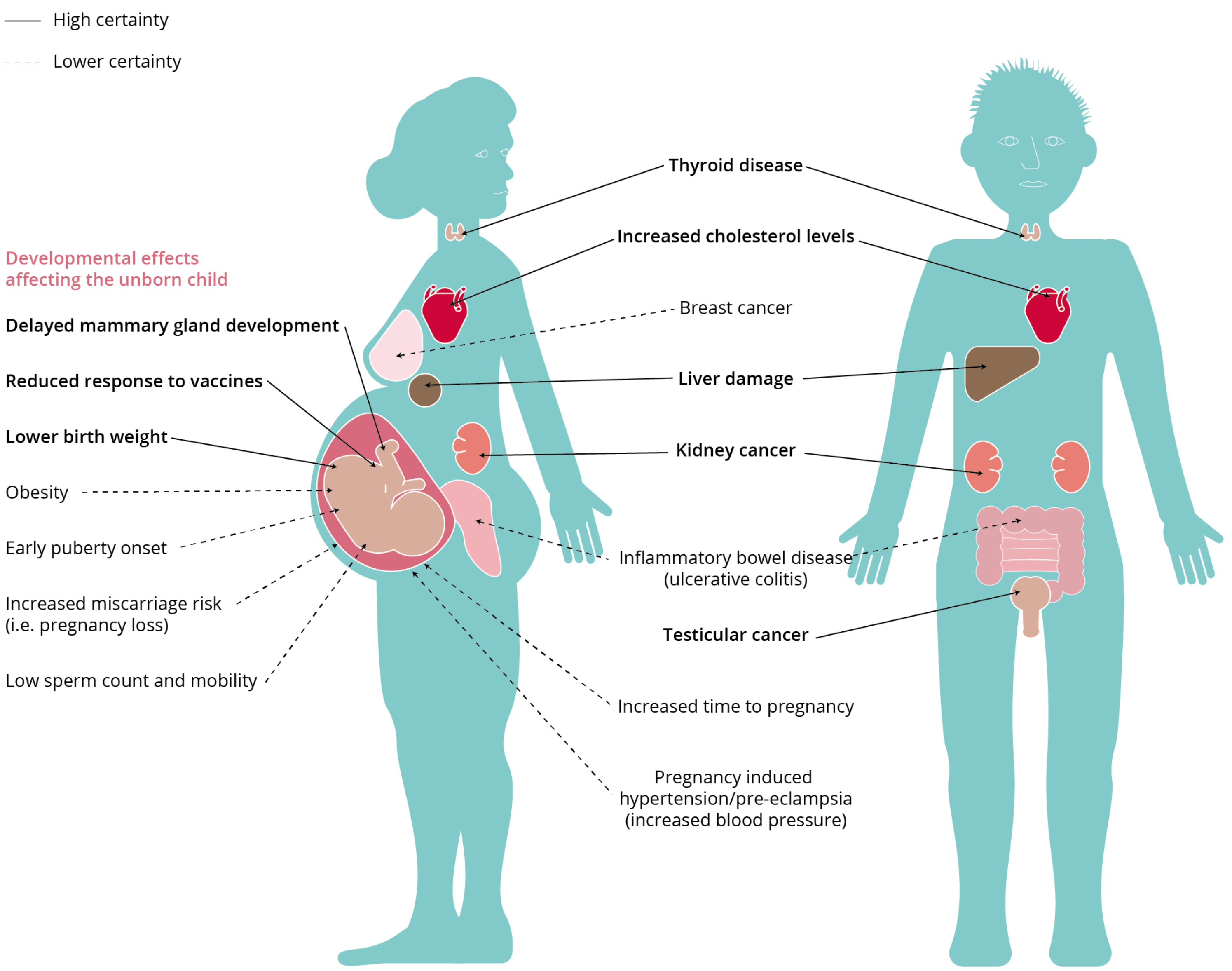
And others: PFHxS, PFNA, GenX Chemicals, PFBS

Why are PFAS in our water?

- In use since the 1940s
- Widely used in a variety of industrial and commercial applications
- Does not break down (forever chemicals)

Why are PFAS bad?

- Carcinogenic
- Liver toxicity
- Cardiovascular effects
- Immune system effects
- Endocrine system effects
- Reproductive system effects
- Developmental effects
- Risk of heart attack and stroke
- Forever chemicals



[Emerging chemical risks in Europe — 'PFAS' — European Environment Agency (europa.eu)]

History of PFAS Usage

1940's
- Early production of PFOA and PFAS
- Production of Teflon

1950's
- Expansion of PFAS production and use

1970's
- Health concerns start to emerge
- PFAS found in the blood of exposed workers

Continued History of PFAS Usage

1990's

- PFAS detection at low concentration becomes possible
- PFAS detected in the general human population

2000's

- Voluntary phaseout of PFOS/PFOA begins

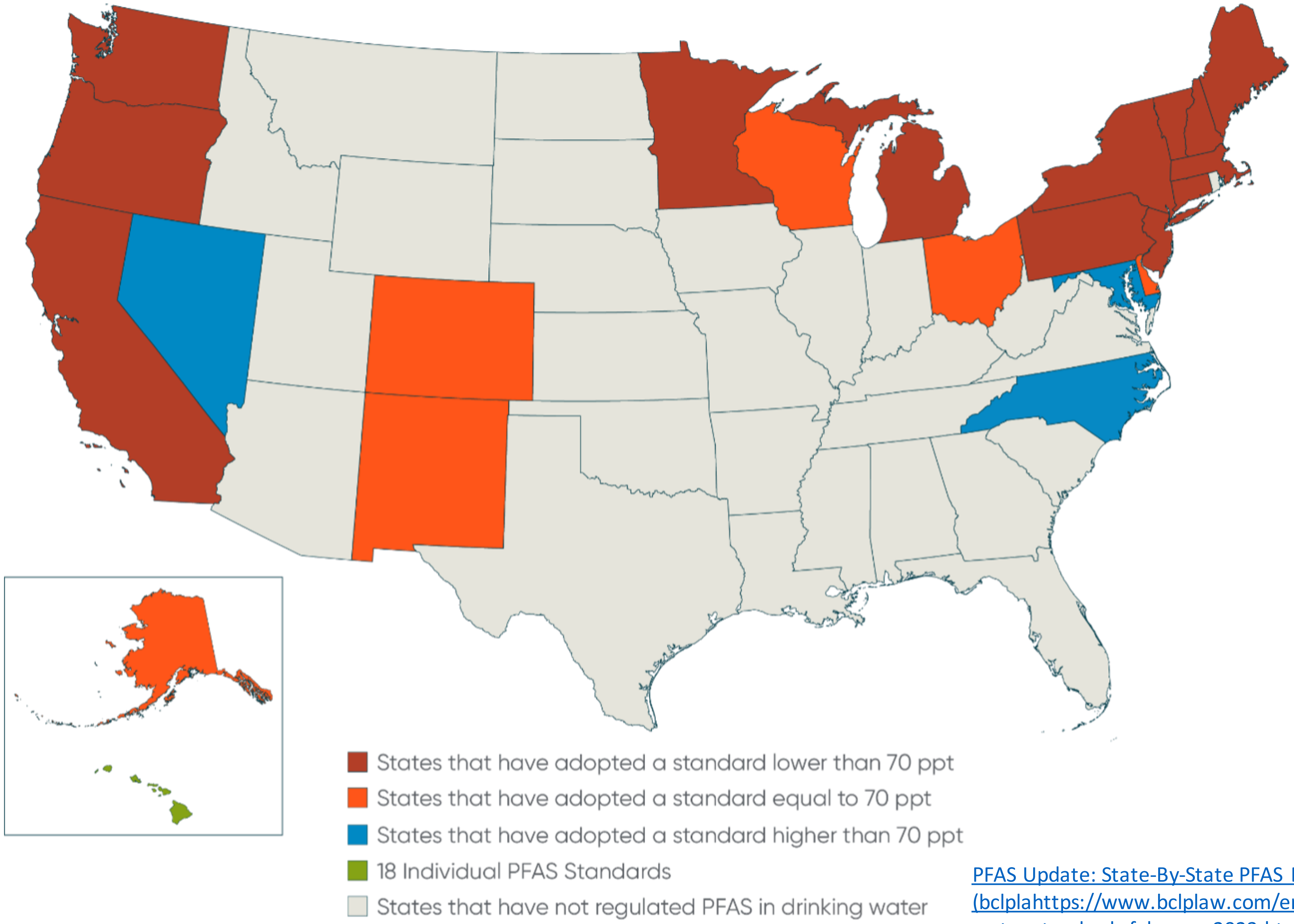
2010's

- EPA lifetime health advisory for PFOS/PFOA
- UCMR3 brings attention to other PFAS

Prior Regulations

- 2016 EPA Health advisory levels, set at 70 ppt (non enforceable)
- 2022 update to EPA health advisories set well below 1 ppt (non enforceable)(0.002 ppt)
- Several states have established their own PFAS regulations

PFAS DRINKING WATER REGULATIONS



[PFAS Update: State-By-State PFAS Drinking Water Standards - February 2023 | Bryan Cave Leighton Paisner (bclplahttps://www.bclplaw.com/en-US/events-insights-news/pfas-update-state-by-state-pfas-drinking-water-standards-february-2023.htmlw.com)](https://www.bclplaw.com/en-US/events-insights-news/pfas-update-state-by-state-pfas-drinking-water-standards-february-2023.html)

The information is current as of February 13, 2023

How are MCLs and MCLGs set?

- Maximum contaminant level vs. maximum contaminant level goal
- MCLG set based on health effects only, with no practicality concerns
- MCL set with practicality in mind

MCLs and MCLGs (in ppt)

Contaminant	EPA MCL	EPA MCLG	DEP MCL	DEP MCLG
PFOS	4	0	18	14
PFOA	4	0	14	8
PFHxS	10	10		
PFNA	10	10		
HFPO-DA (GenX Chemicals)	10	10		

The EPA has also implemented a hazard index for 4 PFAS: PFHxS, PFNA, GenX Chemicals, PFBS

Hazard Index

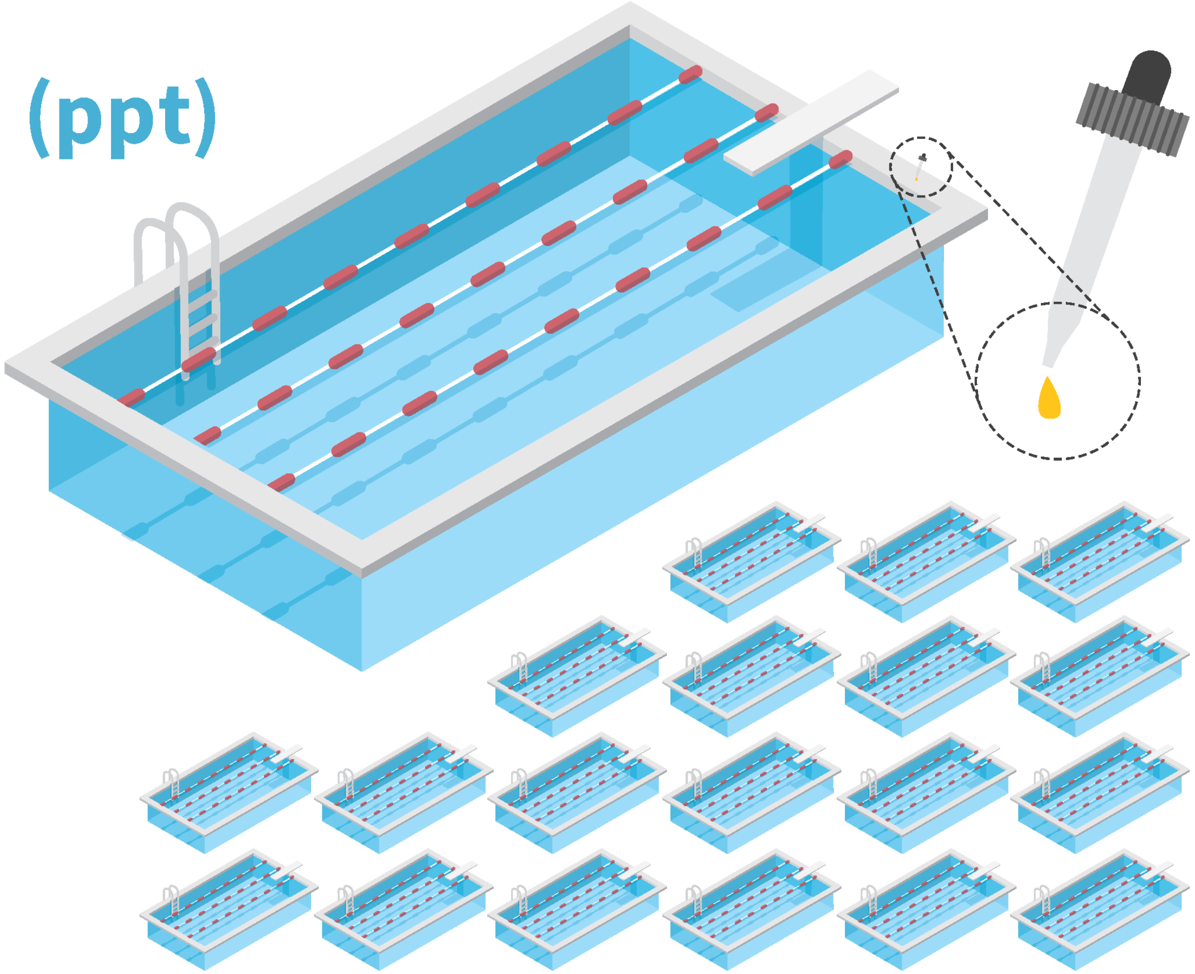
$$HI\ MCL = \left(\frac{[HFPO{-}DA_{water}]}{[10\ ppt]}\right) + \left(\frac{[PFBS_{water}]}{[2000\ ppt]}\right) + \left(\frac{[PFNA_{water}]}{[10\ ppt]}\right) + \left(\frac{[PFHxS_{water}]}{[10\ ppt]}\right) = 1$$

- Used to combine multiple hazards which may share similar or cumulative effects
- Hazard Index must be less than 1 to be compliant with the MCL

1 part per trillion (ppt)

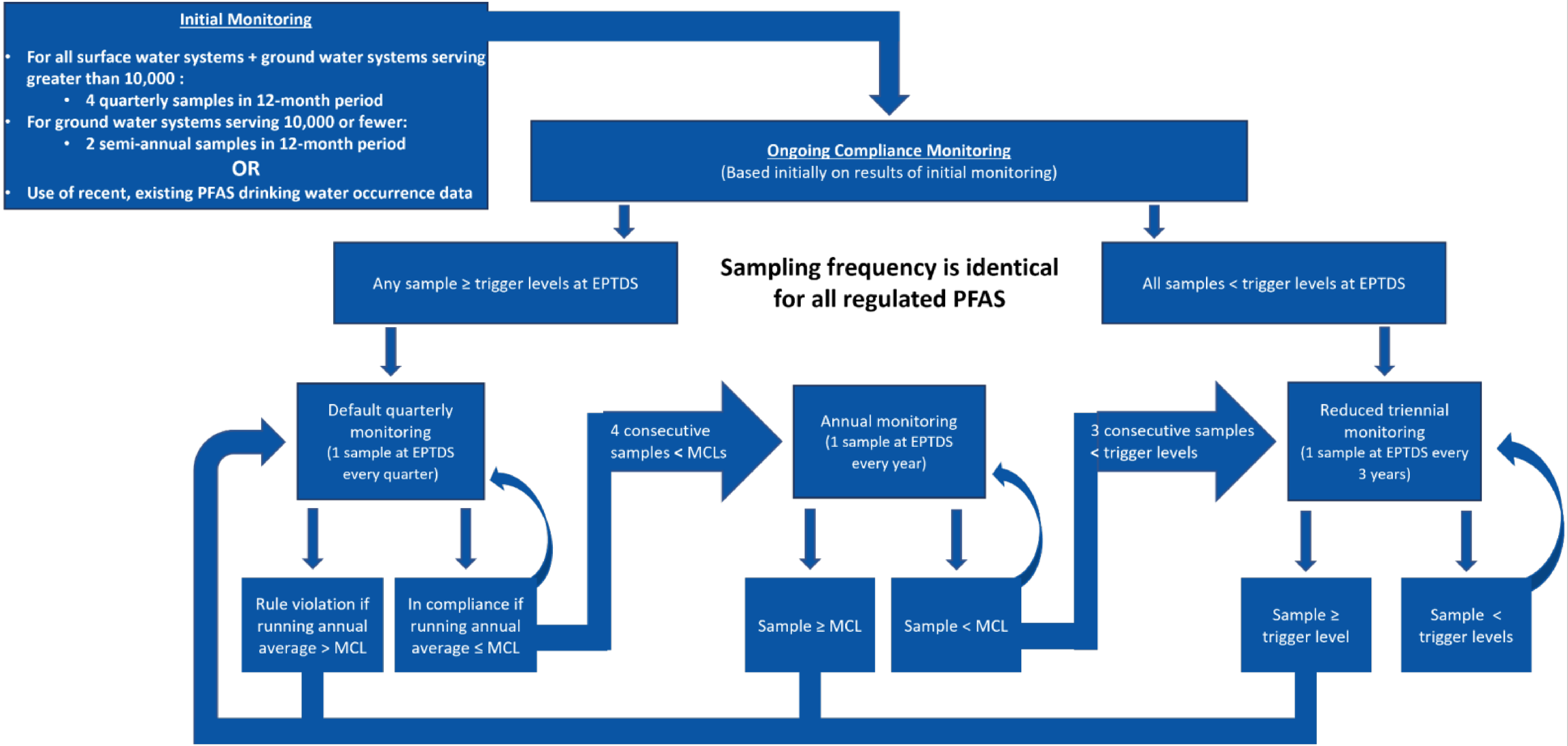
IS EQUIVALENT TO A SINGLE DROP OF WATER IN

20 olympic-sized swimming pools



EPA NPDWR Schedule

- Regulation was finalized on April 10, 2024
- Primacy agencies have 2 years to submit a revised program to the EPA (2026)
- NPDWR initial monitoring requirements must be met within 3 years (2027)
- MCL compliance is required within 5 years, an additional 2 years after testing requirements (2029)



EPTDS: entry point to the distribution system

Trigger Levels and Practical Quantitation Levels

Compound	Trigger Levels (1/2 MCLs)	Practical Quantitation Levels
	Levels (in parts per trillion, ppt)	
PFOA	2.0	4.0
PFOS	2.0	4.0
PFHxS	5	3.0
HFPO-DA	5	5.0
PFNA	5	4.0
PFBS	N/A	3.0
Hazard Index	0.5 (unitless)	N/A

Testing Procedure

Condition

- Run methanol, followed by clean water through the Solid Phase Extraction (SPE) Cartridge

Extract Sample

- Slowly flow the 250ml sample through SDVB SPE Cartridge

Elute Target Analytes

- Pull methanol through sample tubes to extract the PFAS from the SPE

Testing Procedure

Concentrate

- Dry the eluted sample under nitrogen
- Add 1ml of methanol to rehydrate sample

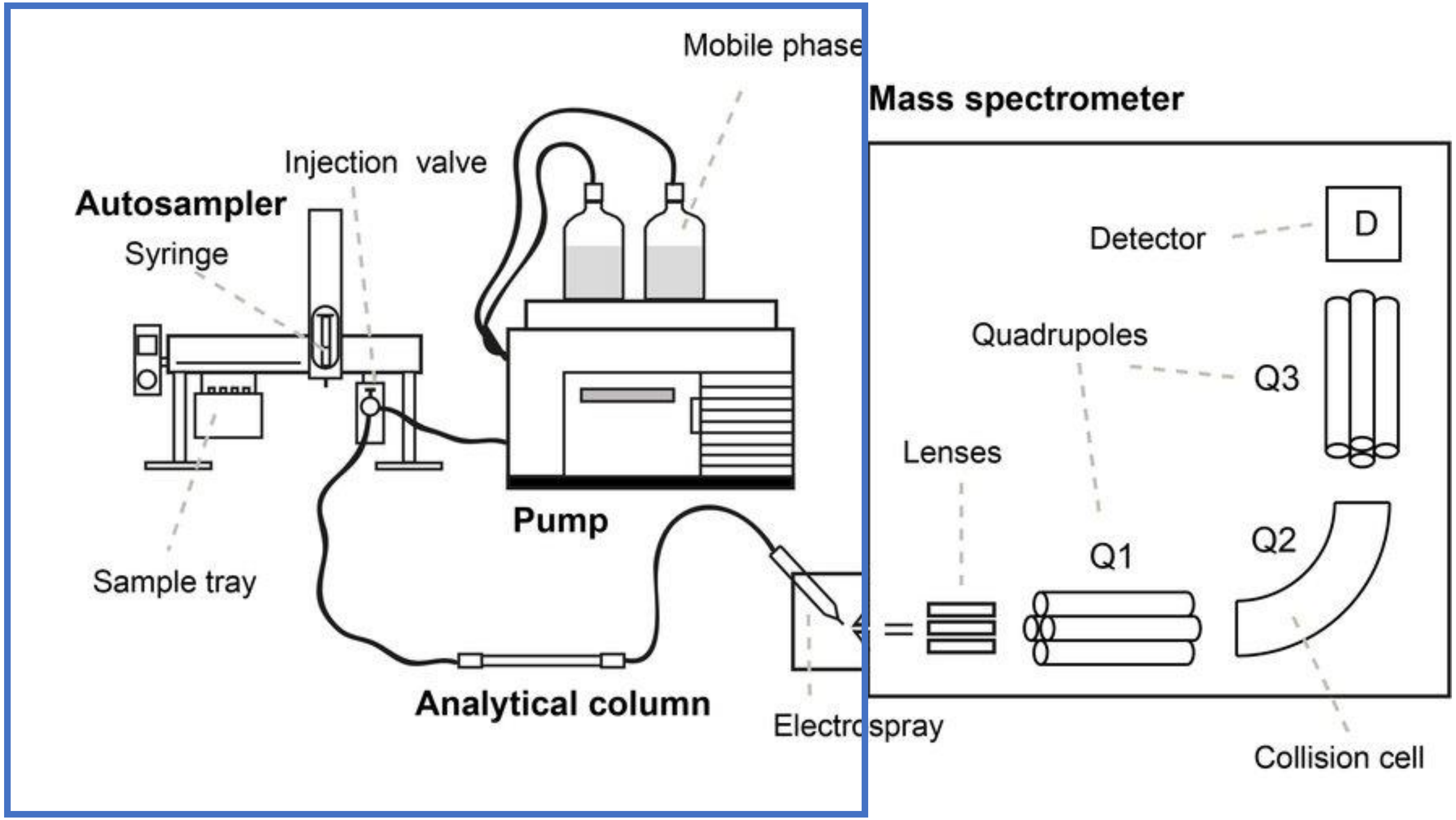
Calibrate

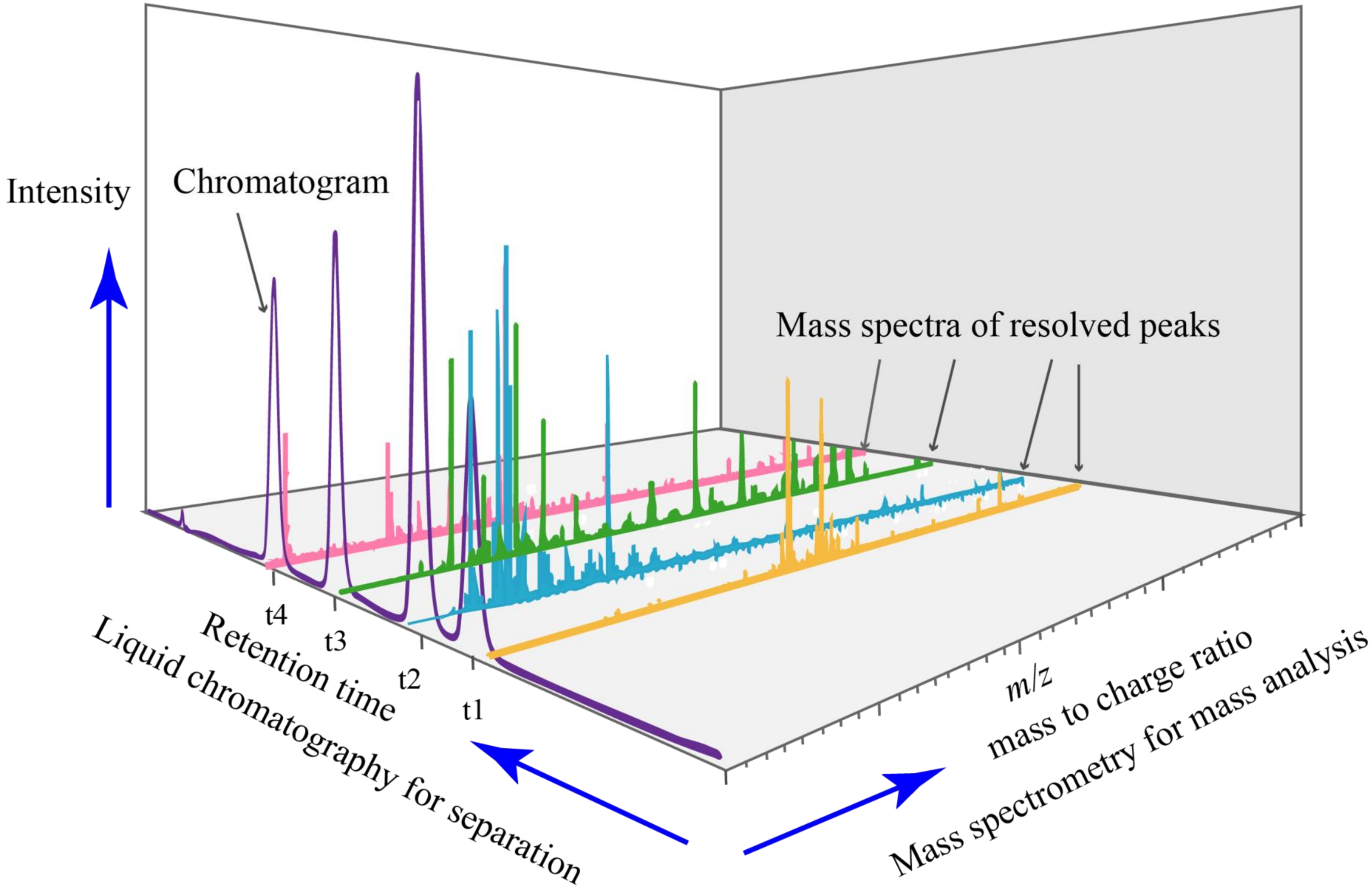
- Calibrate the LC-MS/MS with samples of known composition and concentration

Analyze Sample

- Use the LC-MS/MS to analyze the sample

LC-MS/MS: Liquid Chromatography with Tandem Mass Spectroscopy




Intensity
Chromatogram
Mass spectra of resolved peaks
t4
t3
t2
t1
Retention time
Liquid chromatography for separation
m/z
mass to charge ratio
Mass spectrometry for mass analysis

Testing Procedure Difficulties

- Limited material selections, as some materials interact with PFAS, or may contain PFAS themselves
- Complicated, and requires expensive equipment.
- Requires a high level of precision.

What does all that cost?

$200 to $400 per sample

Sourced from utilities and private labs

What if there's contamination?

What are the chances of contamination?

Compound	DEP Exceedance Rate	EPA Exceedance Rate
PFOS	5.1%	17.7%
PFOA	5.7%	23.0%

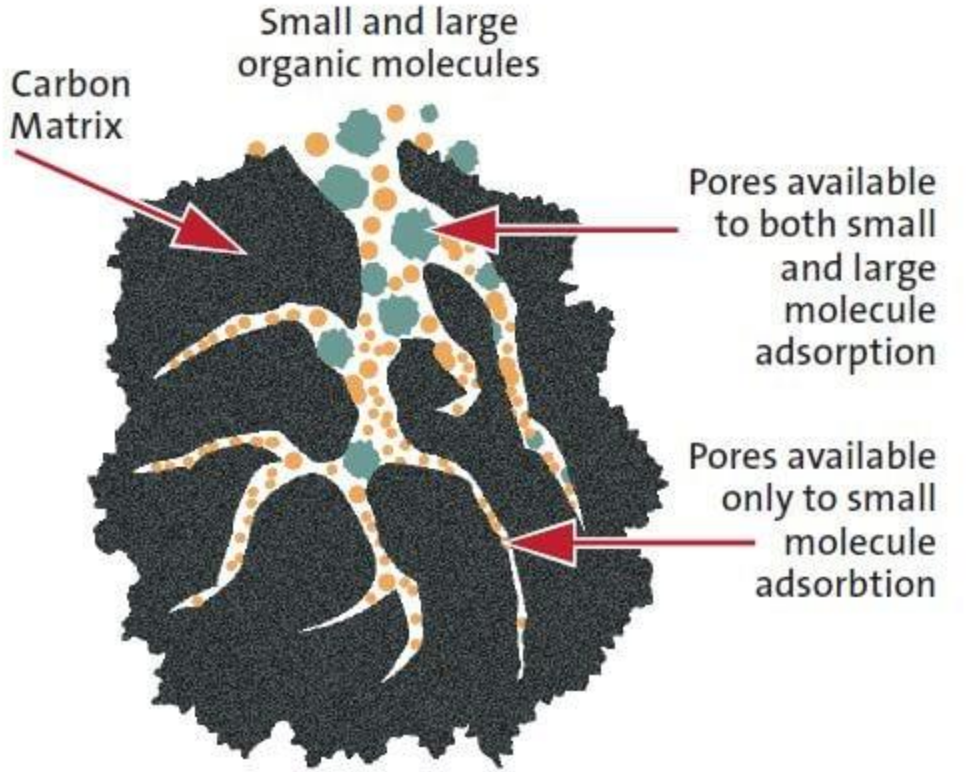
- Based on sampling from locations where PFAS contamination was expected, so actual rates would potentially be lower
- Only one sample was taken per location
- Several sampling locations may be in violation of the Hazard Index for other PFAS
- Sample data includes DEP defined Public Water Systems
- EPA estimates between 6 % and 10% of water systems, out of approximately 66,000 total, will need to treat for PFAS

Treatment Methods

- Granular activated carbon (GAC)
- Anion exchange
- Reverse osmosis

Granular Activated Carbon (GAC)

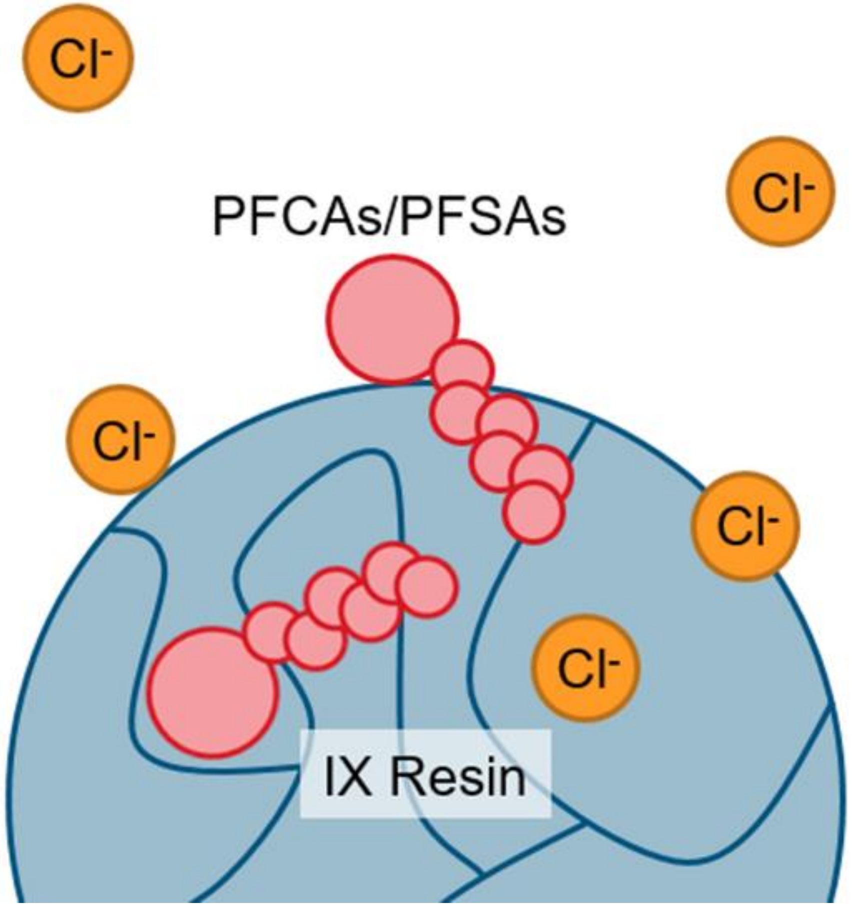
- Highly porous material, captures PFAS physically
- Generally cheaper than other techniques
- More effective for lower concentration of PFAS



https://www.elgalabwater.com/activated-carbon

Anion Exchange

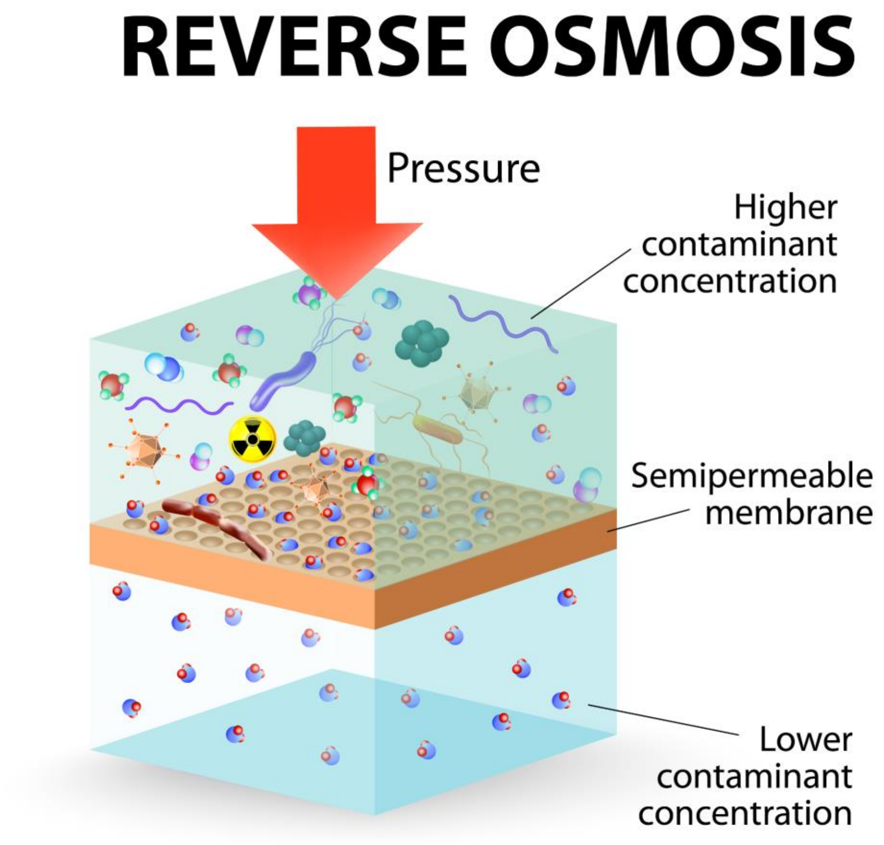
- Captures PFAS based on negatively charged fluorine atoms
- More expensive than GAC
- Smaller footprint in a treatment plant then GAC



https://www.stantec.com/en/ideas/market/water/developing-solutions-to-handle-pfas-aka-forever-chemicals-it-s-an-evolving-science

Reverse Osmosis

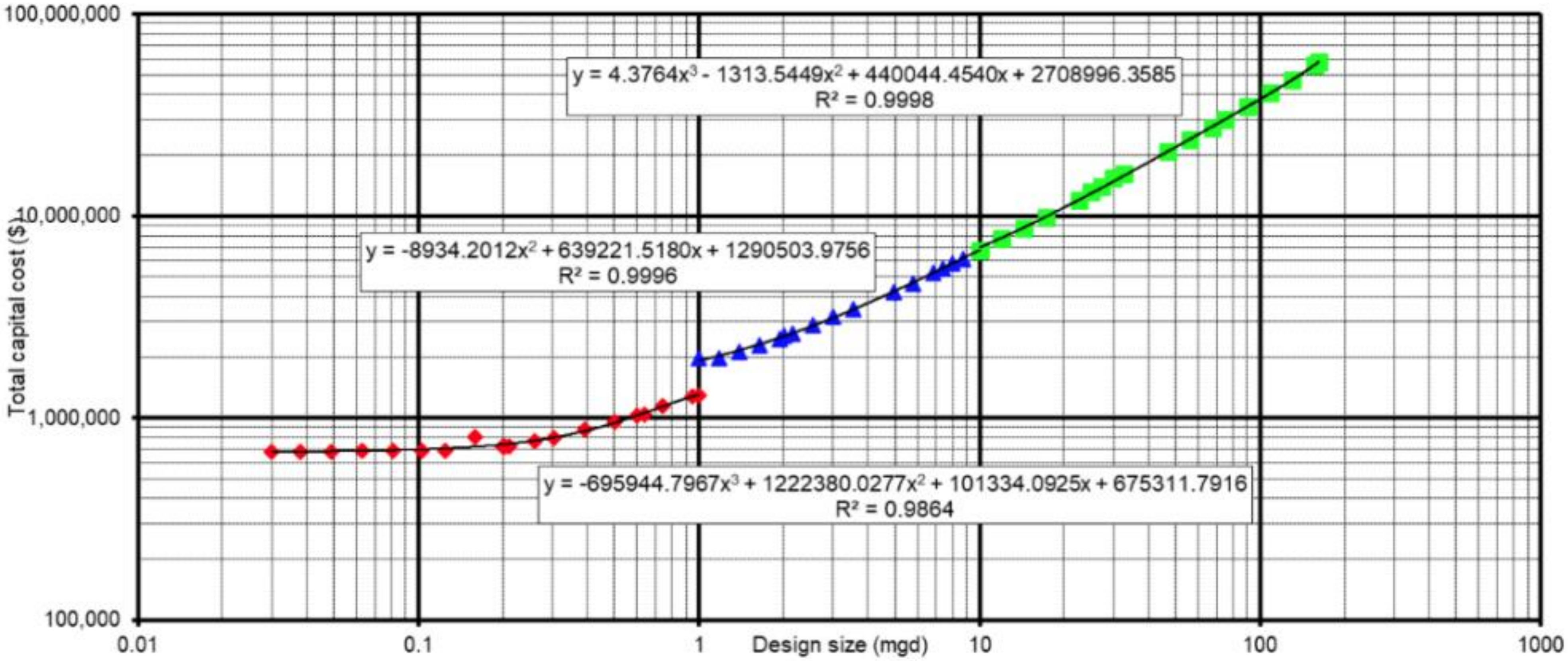
- Pushes water through a membrane that rejects PFAS
- Produces a brine with higher contaminant concentration



https://advancedwaterinc.com/how-reverse-osmosis-works/

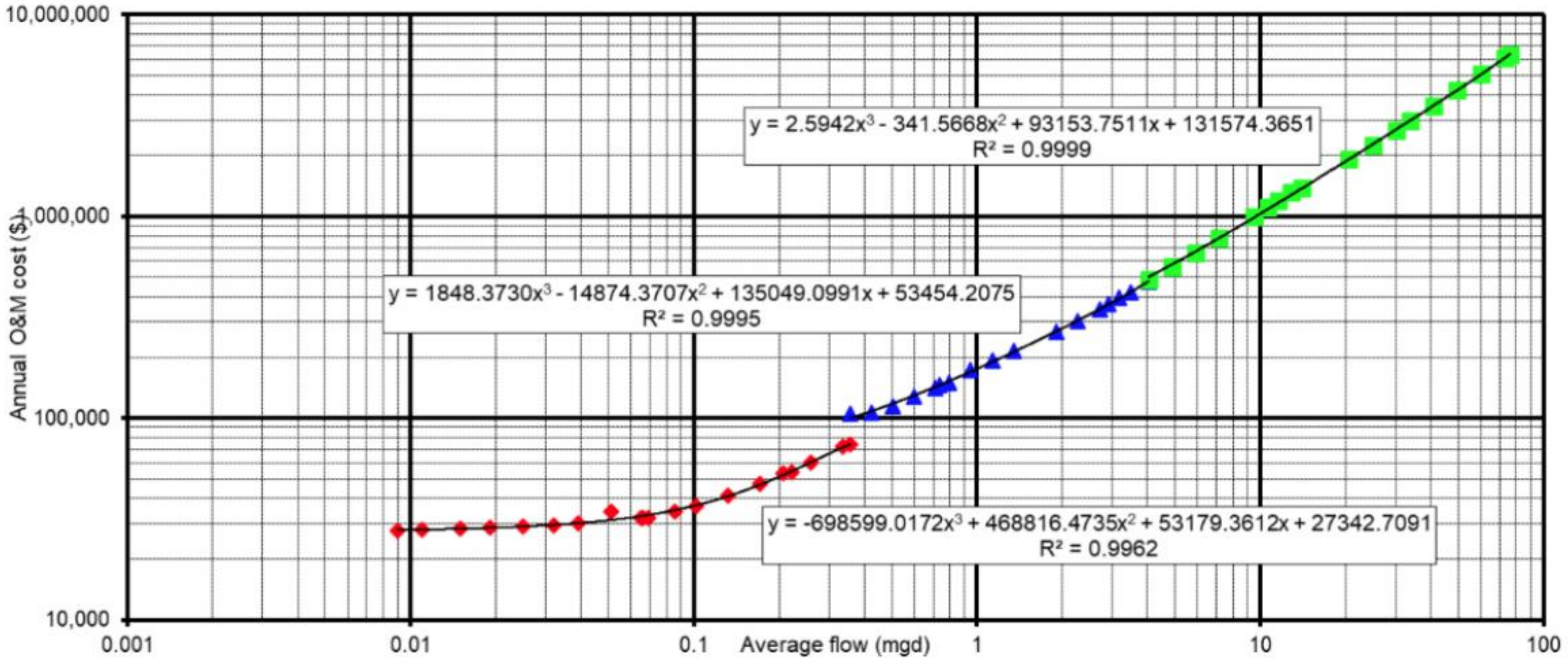
EPA Capital Cost Estimations

- $7 million for a 10 MGD plant
- $700,000 down to .03 MGD



EPA O&M Cost Estimates (2020 Dollars)

- $1 million per year for 10 MGD plant
- $30,000 per year for small systems



Total Costs and Benefits

The Final PFAS NPDWR Will Cost	***Annual Quantified Costs Once Fully Implemented***
Water System Monitoring	$ 36 million
Water System Treatment and Disposal	$ 1,506 million
Water System Administrative	$ 1 million
Primacy Agency Implementation and Administration	$ 5 million

The Final PFAS NPDWR Will Prevent	***Annual Quantified Benefits Once Fully Implemented***	***Number of Avoided Illnesses and Deaths Once Fully Implemented***
Developmental Effects	$209 million	1,300 deaths
Cardiovascular Effects	$607 million	3,700 deaths and 15,600 illnesses
Kidney Cancer	$354 million	2,000 deaths and 7,000 illnesses
Bladder Cancer (resulting from co-removal of disinfection byproducts with PFAS)	$380 million	2,600 deaths and 7,300 illnesses

Total Costs and Benefits

- The EPA estimates that both the costs and the benefits of the NPDWR will total approximately $1.5 billion per year
- The EPA also anticipates non-quantified benefits related to increased ability to fight disease, reductions in thyroid disease, and other non-quantified health benefits
- Non-quantified costs from compliance with the Hazard index are also anticipated.

Other Cost Considerations

- Disposal of PFAS as a hazardous waste would increase costs
- Destruction of PFAS using UV light or oxidizing agents could reduce the cost of PFAS disposal
- Potential supply chain issues for both anion exchange resin and granular activated carbon

Conclusions

- PFAS is dangerous and widespread, and efforts to reduce contamination are ongoing
- PFAS regulations for drinking water on the national level have been finalized
- PFAS testing is complicated, and will be an added expense
- Treatment costs for PFAS, where necessary, will be very expensive

Thank you. Any questions?