



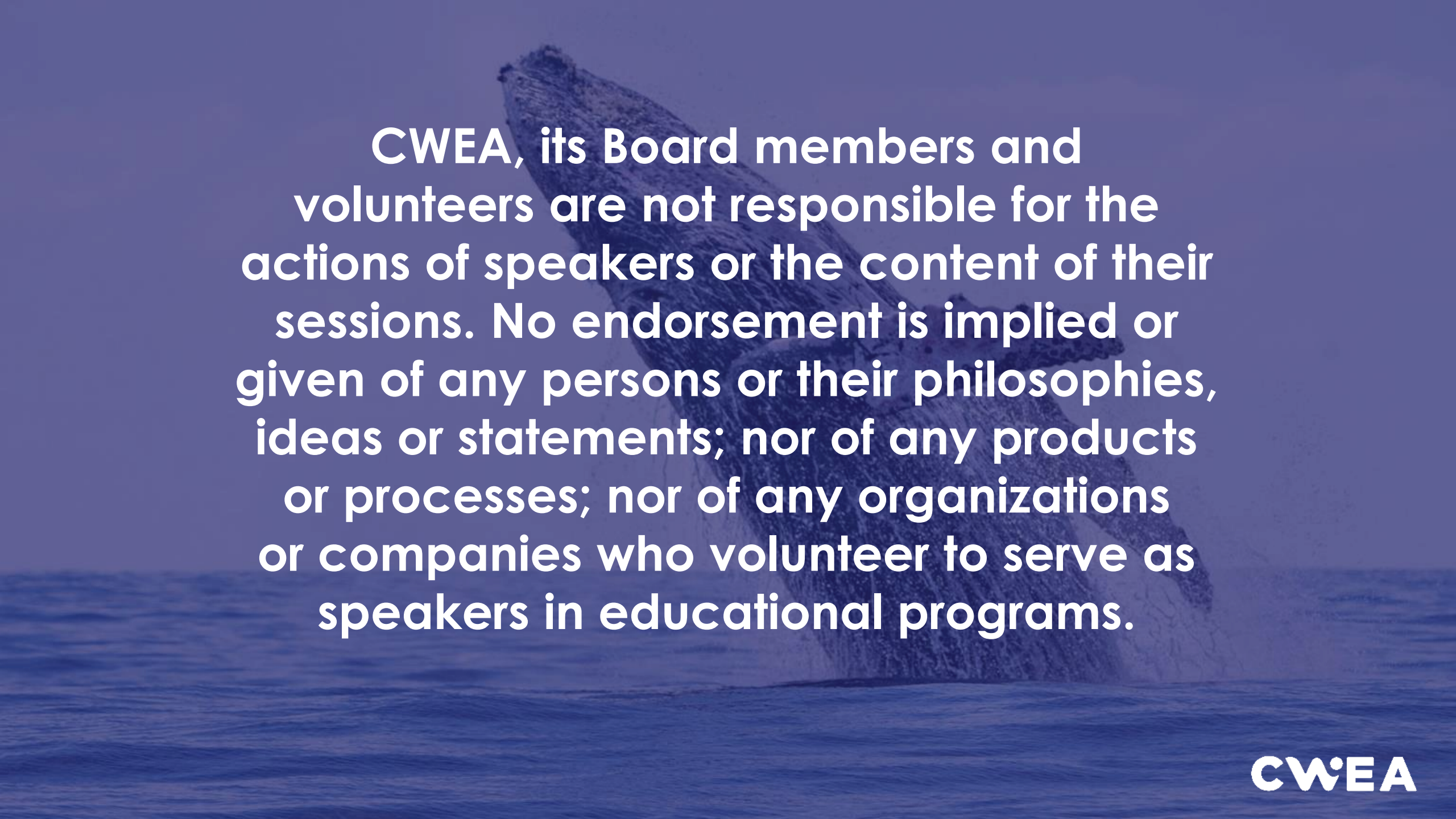
PFAS – The Next Wastewater Utility Challenge

Webinar, November 18, 2020, 11am-12pm

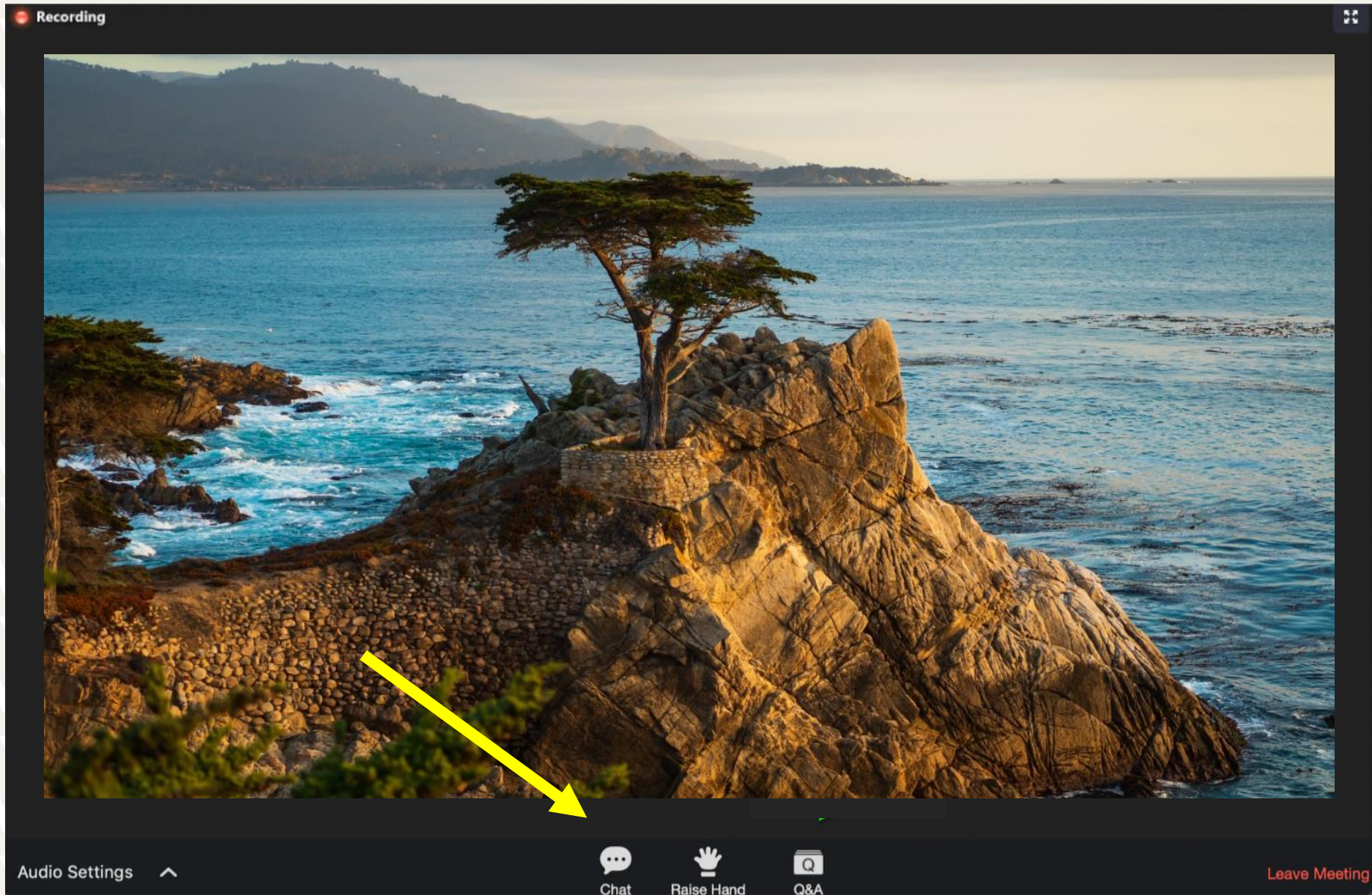


Ryan Sellman
INTRODUCER/MODERATOR

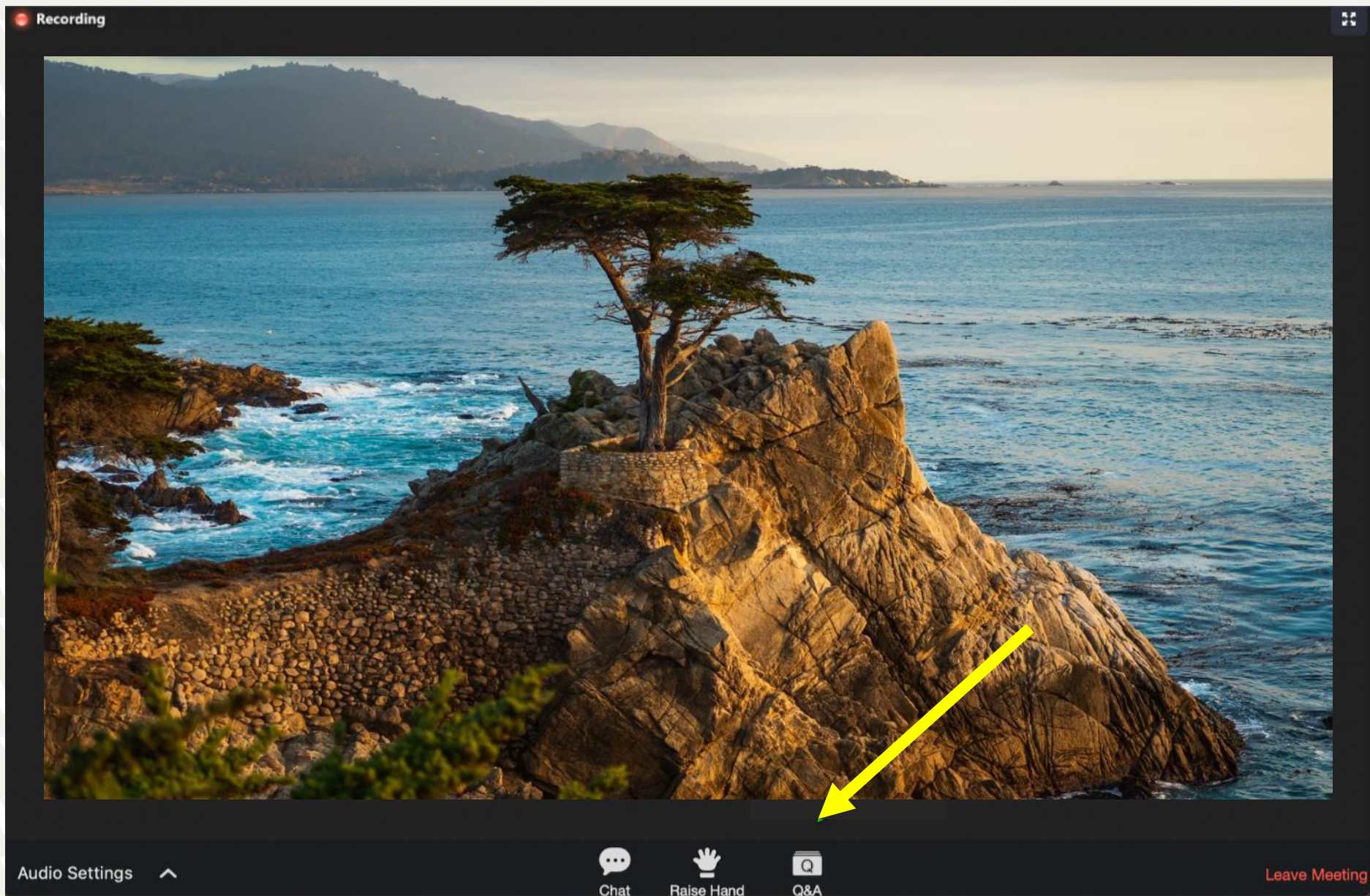
PROJECT MANAGER - CAROLLO ENGINEERS, INC.

The background of the slide is a photograph of a large iceberg floating in the ocean. The iceberg is a massive, dark, and jagged block of ice, with its peak rising sharply from the water. The water is a deep blue, and the sky is a lighter, hazy blue. The overall tone is serene yet powerful.

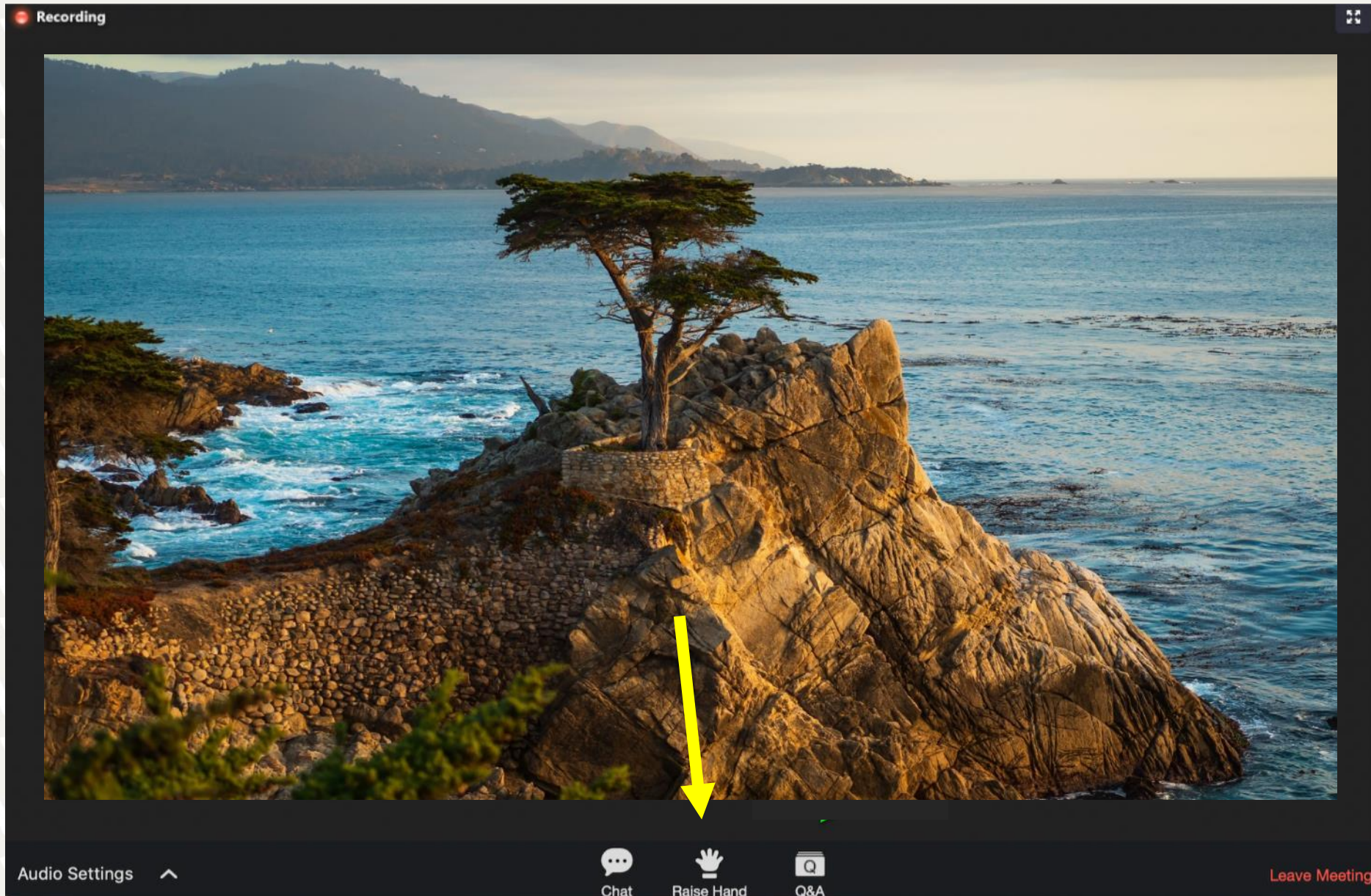
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Zoom Controls: Chat for Comments



Zoom Controls: Q&A for Questions



Zoom Controls: Raise Hand Feature Not Used in Today's Webinar



Eva Steinle-Darling

Speaker

PRINCIPAL TECHNOLOGIST
CAROLLO ENGINEERS, INC.

CW'EA



Rashi Gupta
Speaker

VICE-PRESIDENT/PROJECT MANAGER

CAROLLO ENGINEERS

CWEA



Wendy Linck

Speaker

SENIOR ENGINEERING GEOLOGIST

STATE WATER RESOURCES CONTROL BOARD

// PFAS = Per- and Polyfluoro Alkyl Substances *are Everywhere!*



Unique Properties

- 💧 Stain repellant
- 💧 Flame resistant
- 💧 Non-stick
- 💧 Water resistant
- 💧 Good for coatings

Photos: Charles Hutchins, Yossi Gurvitz, Windell Oskay, Jean-Pierre, White93, Shawn Campbell, Jack W. Reid

// “PFAS” is an umbrella term for a lot of different compounds!

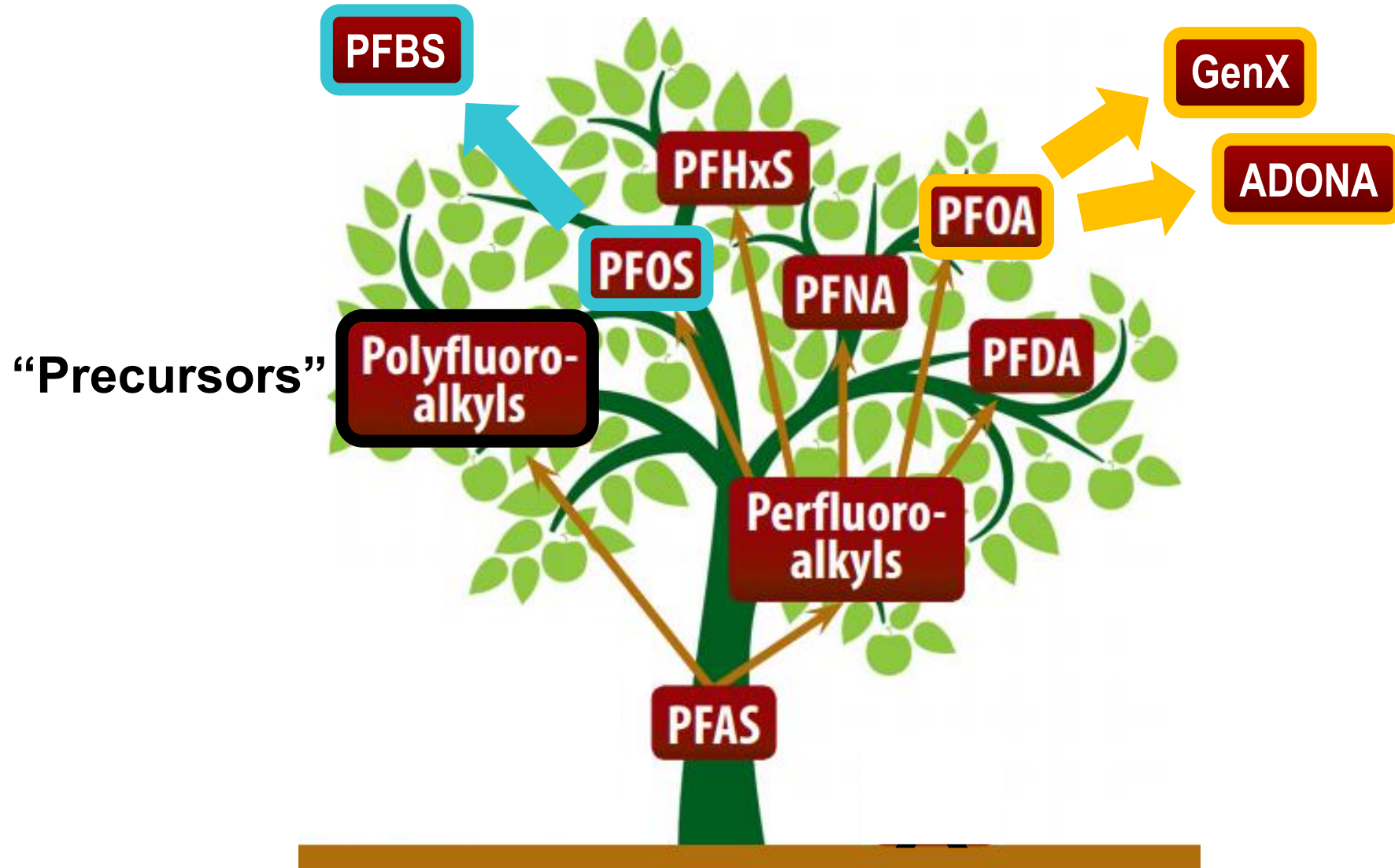


Image Credit: https://www.atsdr.cdc.gov/pfas/docs/PFAS_FamilyTree_EnvHealthPro-508.pdf

// Wide Range of Health Effects associated with PFAS Exposure



PFOA classified by US EPA as
“possibly carcinogenic to humans”

A Brief Note on PFAS in Drinking Water

// Drinking Water Regulations are Evolving Quickly...!

Federal Health Advisory:
PFOA+PFOS < 70 ng/L

Montana –
PFOA +
PFOS ≤ 70
ppt.

Minnesota –
PFOA, PFOS, PFBA, PFBS, and
PFHxS at 35, 15, 7,000, 2,000,
and 47 ppt, respectively.

**Michigan MCLs for PFNA (6-ppt); PFOA (8-ppt);
PFOS (16-ppt); PFHxS (51-ppt); GenX (370-ppt);
PFBS (420-ppt); PFHxA (400,000-ppt) (July '20)**

Colorado –
El Paso County
PFOA + PFOS
≤ 70 ppt.

Nebraska –
PFOA + PFOS ≤ 70 ppt.

Wisconsin –
Groundwater
Advisory levels
for PFAS under
development.

**New York – MCLs for PFOA and
PFOS at 10 ppt each (Aug 2020)**

Maine –
PFOA + PFOS ≤ 70 ppt.

Vermont –
Enforceable: MCL sum of PFOA, PFOS, PFHxS, PFHpA, and PFNA at 20 ppt.
Guidance: Sum of PFOA, PFOS, PFHxS, PFHpA, and PFNA at 10 ppt.

Washington –
MCLs for PFAS
under development.

Oregon –
PFOA, PFOS,
PFNA and
PFHpA at 24,
300, 1 and 300
ppt, respectively.

**California –
Notification Levels:**
PFOA = 5.1 ppt
PFOS = 6.5 ppt
Response Levels:
PFOA = 10 ppt
PFOS = 40 ppt
(February 2020)

Nevada –
PFOA, PFOS,
and PFBS at
667, 667, and
667,000 ppt,
respectively.

Massachusetts – “PFAS6” MCL:
**PFOS+PFOA+PFHxS+PFNA+PFHpA+
PFDA < 20ppt (Sep 2020)**

New Hampshire –
MCL for PFOA, PFOS, PFNA
and PFHxS at 38, 70, 23, and
85 ppt, respectively.

Rhode Island –
PFOA + PFOS ≤ 70 ppt.

Connecticut –
Sum of PFOA, PFOS, PFNA,
PFHxS and PFHpA at 70 ppt.

**New Jersey MCLs for
PFNA at 13 ppt,
PFOA at 14 ppt, and
PFOS at 13 ppt (June 2020)**

Delaware –
PFOA + PFOS ≤ 70 ppt,
PFBS ≤ 40 ppt.

North Carolina –
GenX ≤ 140 ppt.
(PFOA <2000 ppt for GW cleanup)

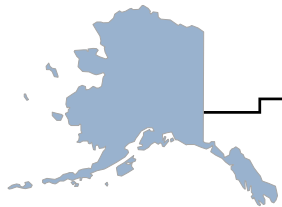
Pennsylvania –
MCL under development
Guidance: PFOA + PFOS ≤ 70 ppt.

Texas –
Groundwater cleanup targets for
PFOA, PFOS, PFNA, PFDA, PFHxS,
PFHxA, PFHpA, PFBS and PFBA at
290, 560, 290, 370, 93, 93, 560,
34,000 and 71,000 ppt, respectively.

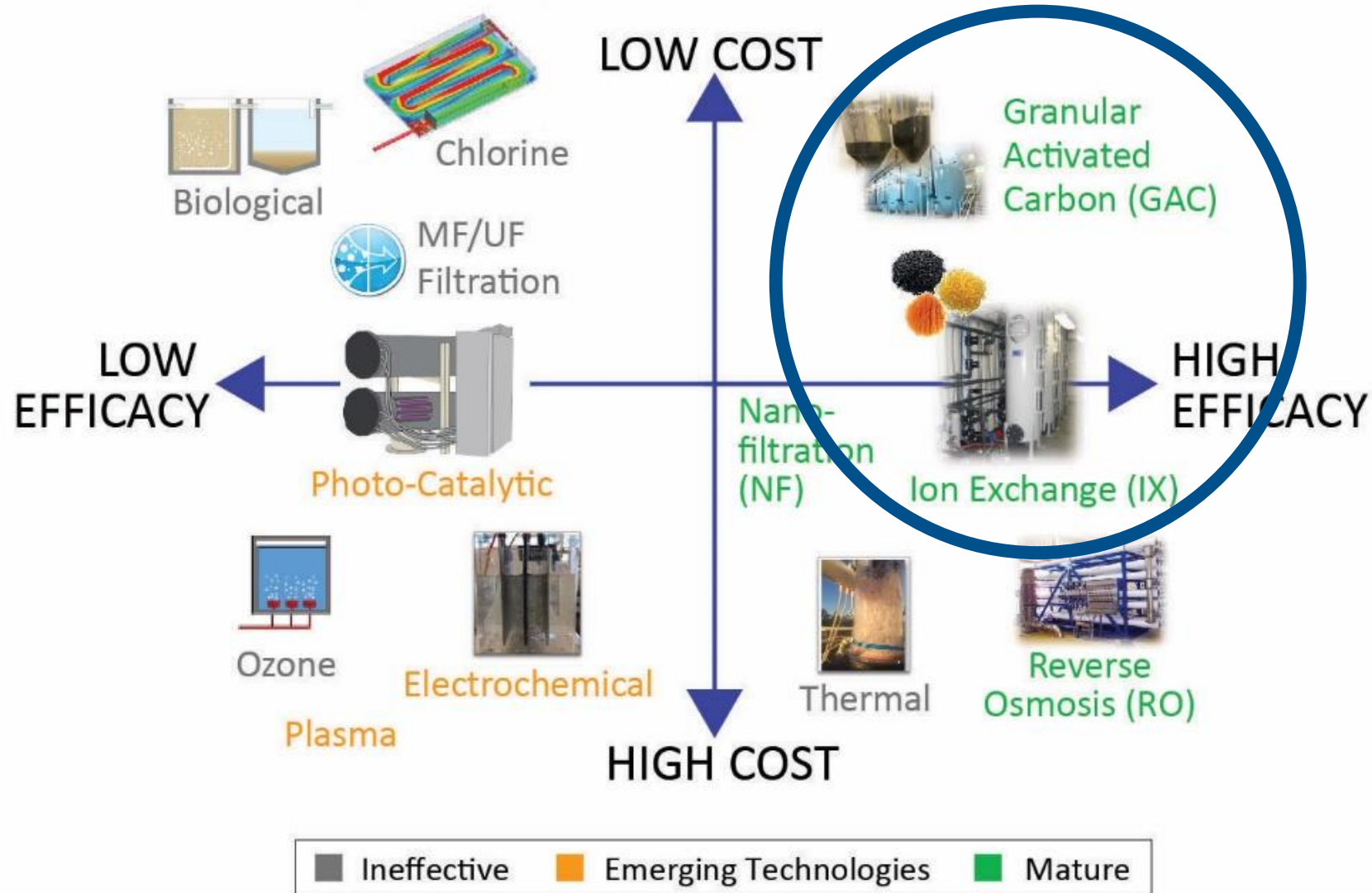
Alaska –
Proposed MCL: Sum of PFOA, PFOS,
PFNA, PFHpA, and PFHxS at 70 ppt, and
PFBS at 400,000 ppt.
DW Guidance: PFOA + PFOS ≤ 70 ppt.
GW Cleanup Target: PFOA + PFOS
=400 ppt

Legend

- DW - Enforceable (& more)
- DW - Enforceable Proposed
- DW - Guidance Only
- No DW but GW cleanup Std

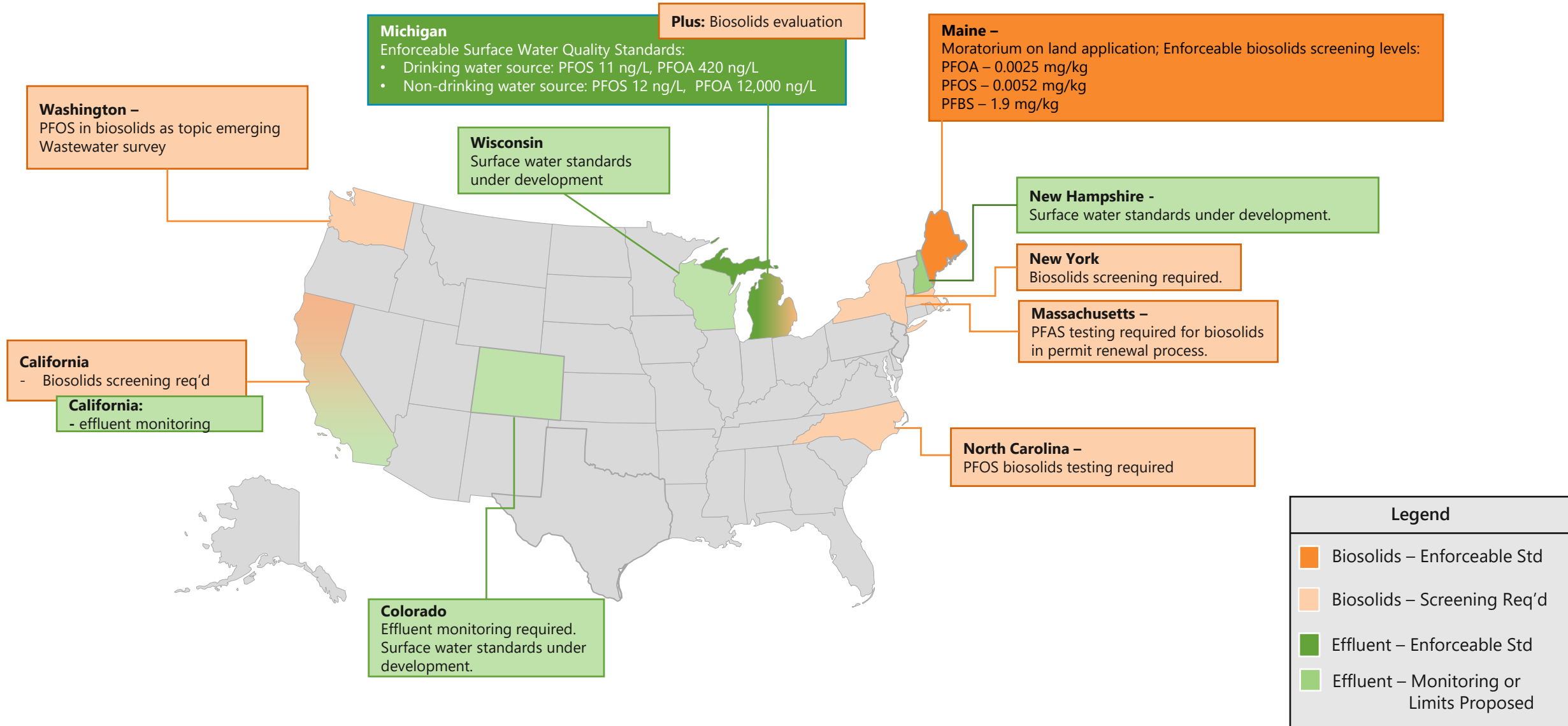


// Effective treatment options are limited




What about PFAS in Wastewater?

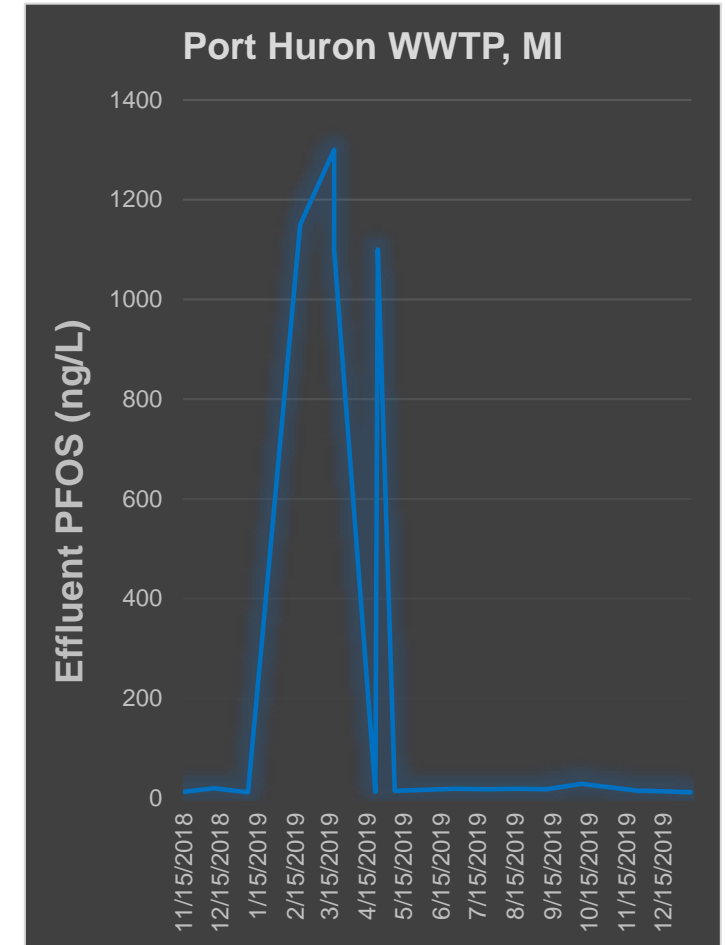
// Regulations for Effluent & Biosolids are coming, too...



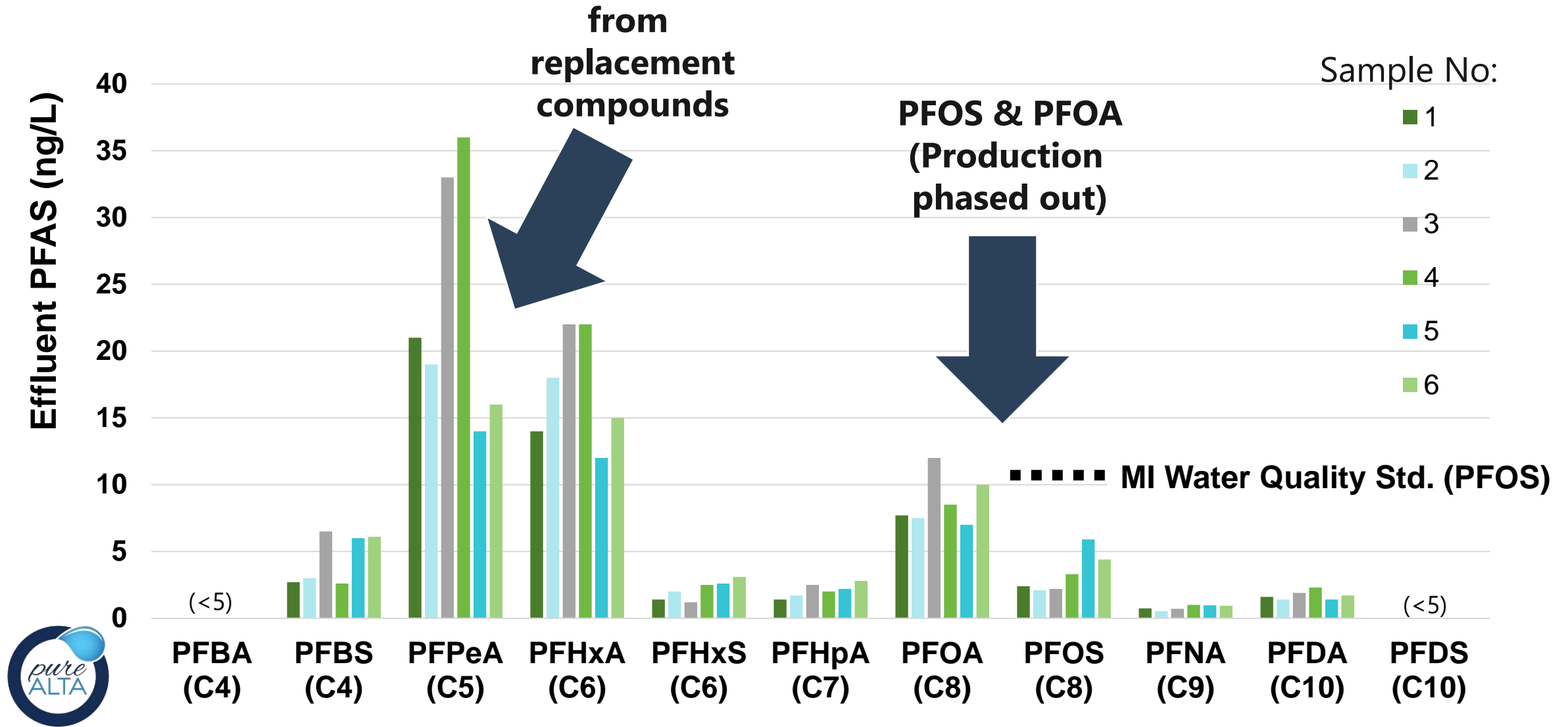
Status as of July 2020

// Effluent Standards: Lessons from Michigan (PFOS Water Quality Standard ≤ 12 ng/L)

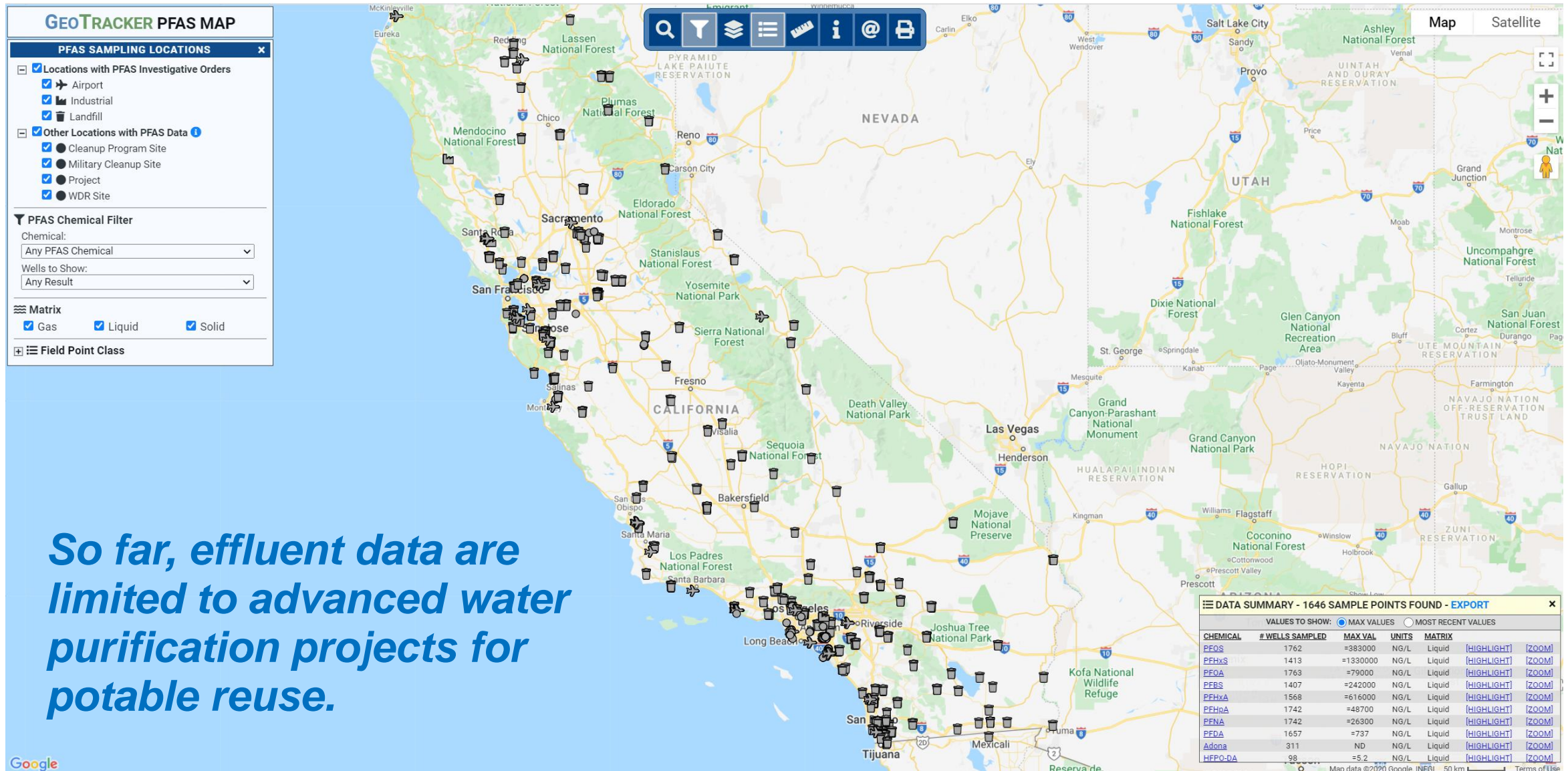
1. “**Background**” PFOS in effluent: 3-7 ng/L
2. Industrial contributions can be **erratic**. 
3. **Source control** is most effective method to control effluent PFOS.



// We're going to have to look beyond PFOS & PFOA



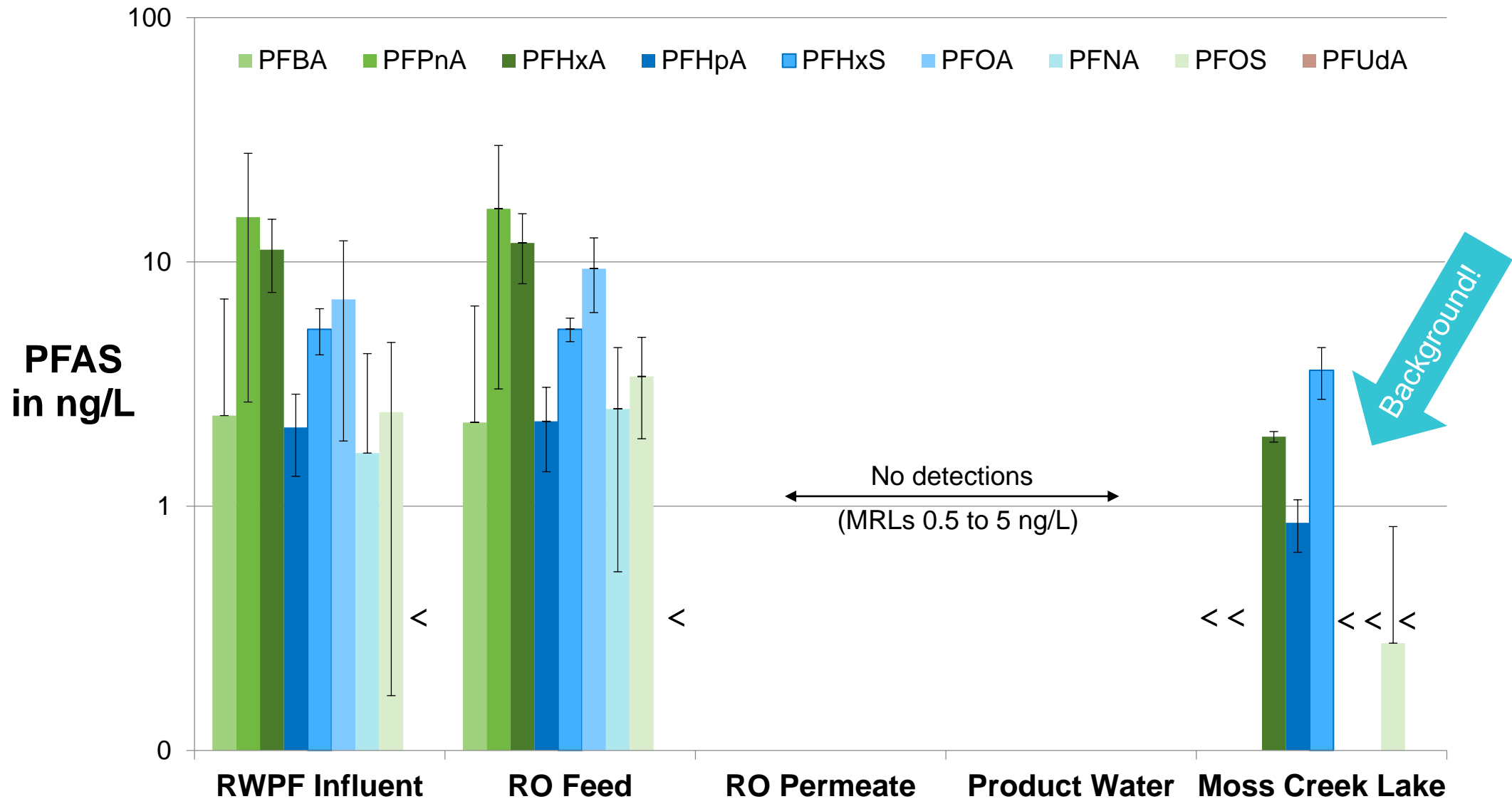
// California has put PFAS data online with GeoTracker



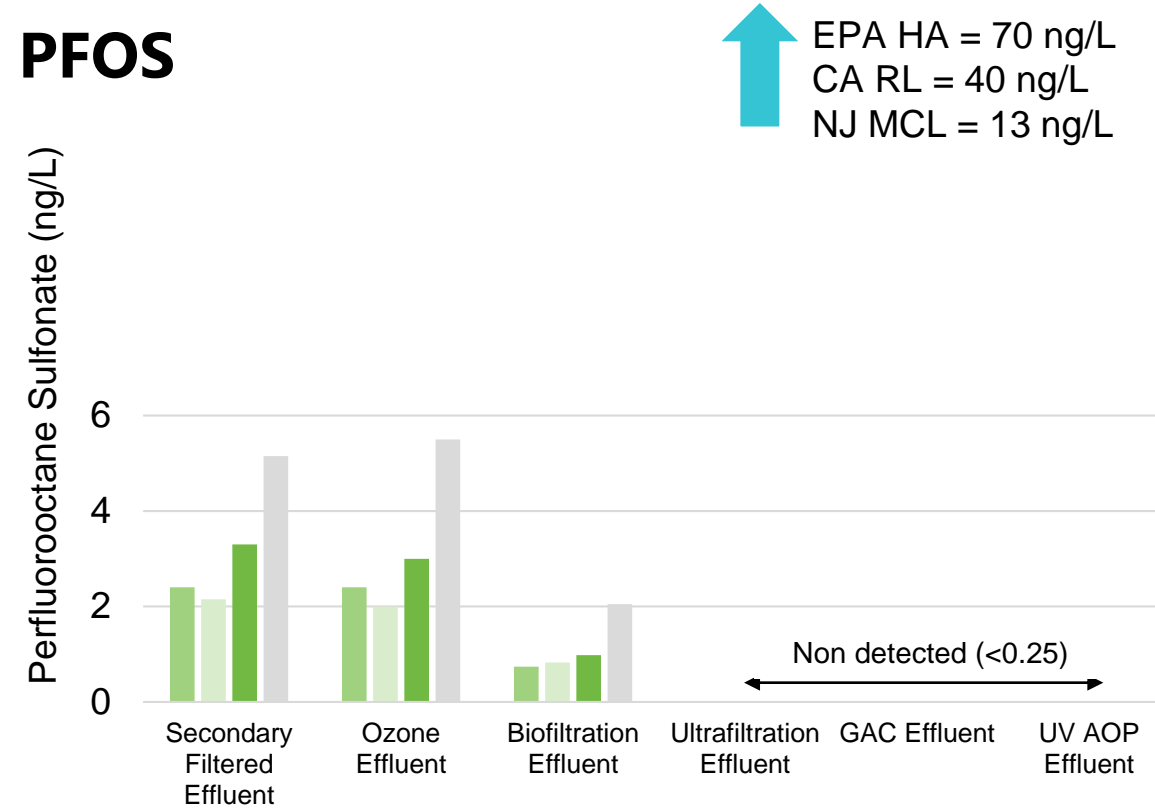
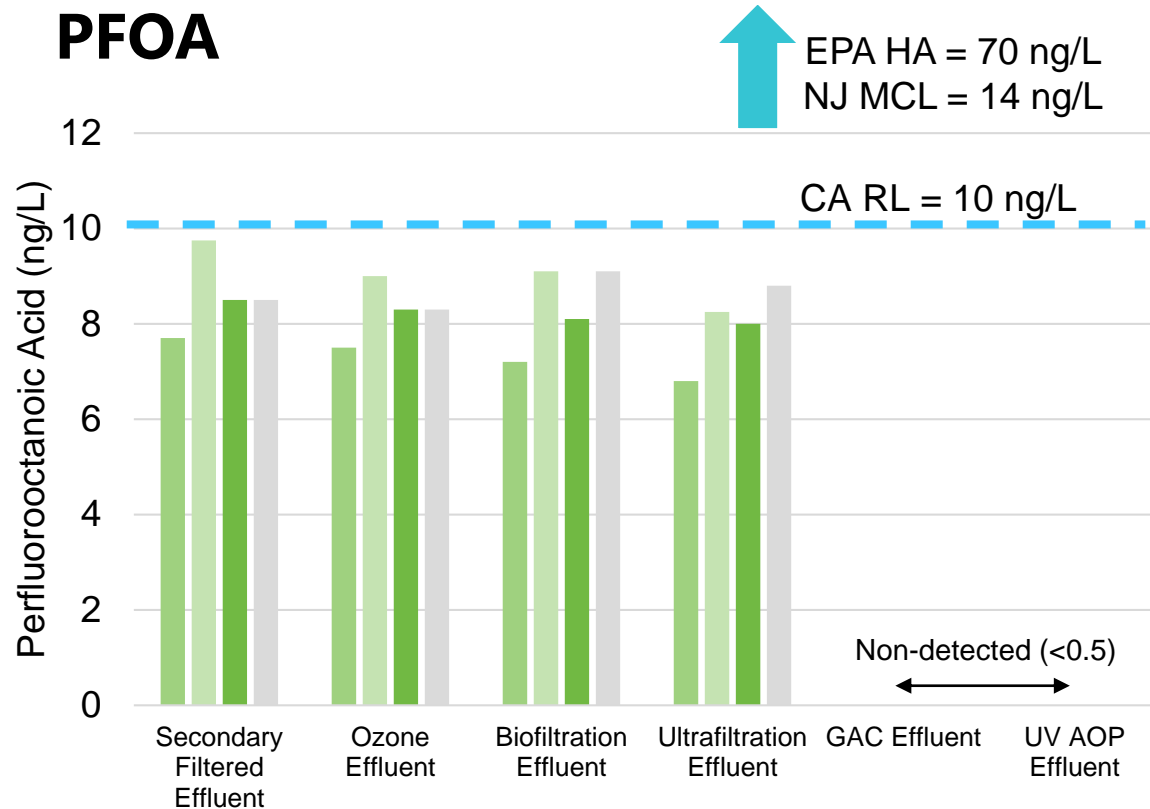
So far, effluent data are limited to advanced water purification projects for potable reuse.

How does advanced treatment stack up?

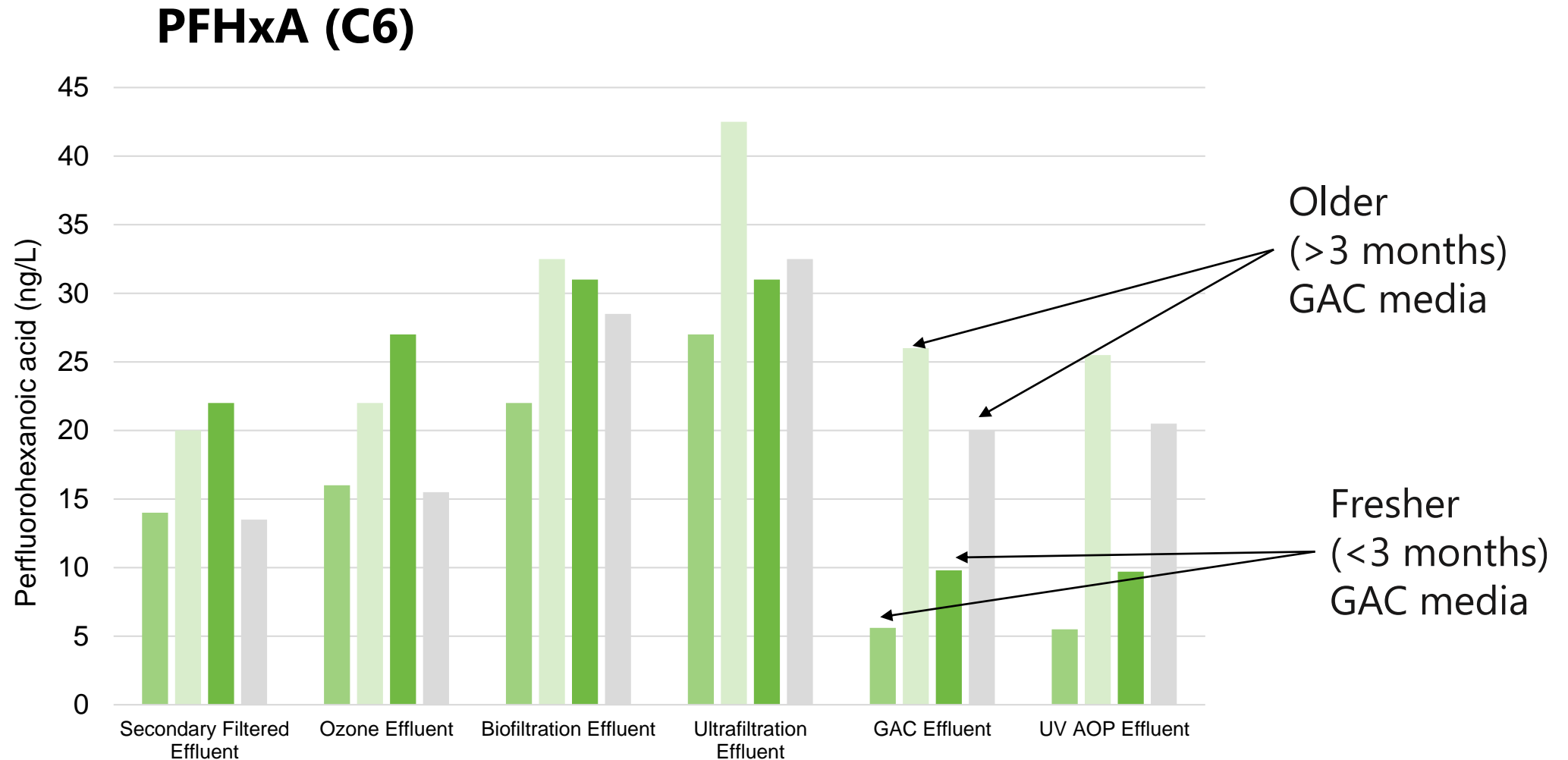
// RO used in potable reuse addresses PFAS compounds



// Ozone/BAF/GAC based advanced treatment also addresses regulated PFAS (PFOS + PFOA)



// Concentrations of some smaller PFAs *increase* through O₃/BAF but GAC is capable of removal



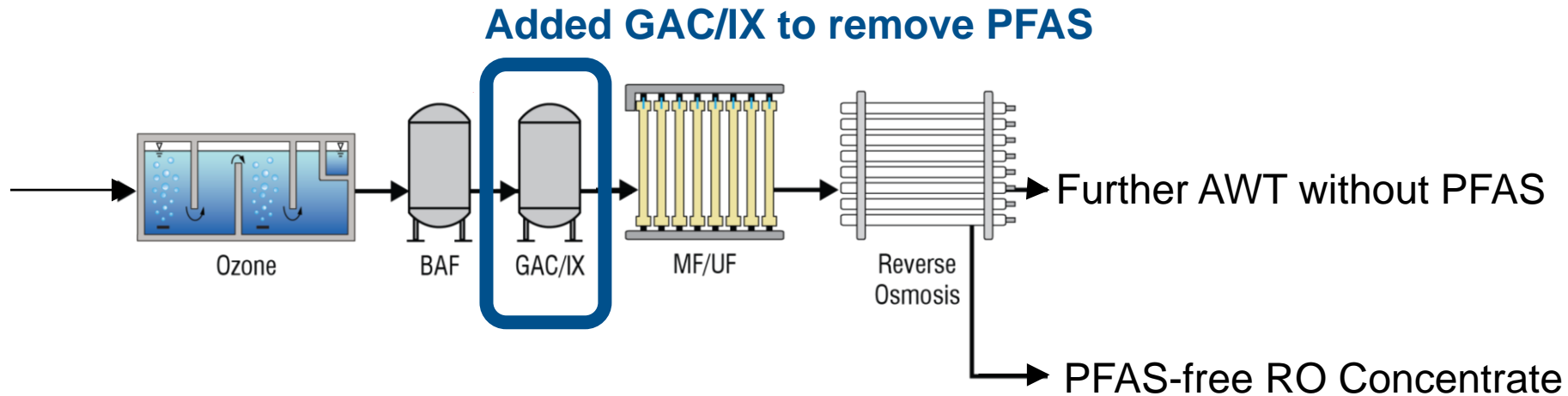
The tail that wags the dog: What about PFAS in RO Concentrate?

// There are only three (practical) alternatives to addressing PFAS in RO Concentrate

1. Remove PFAS before RO

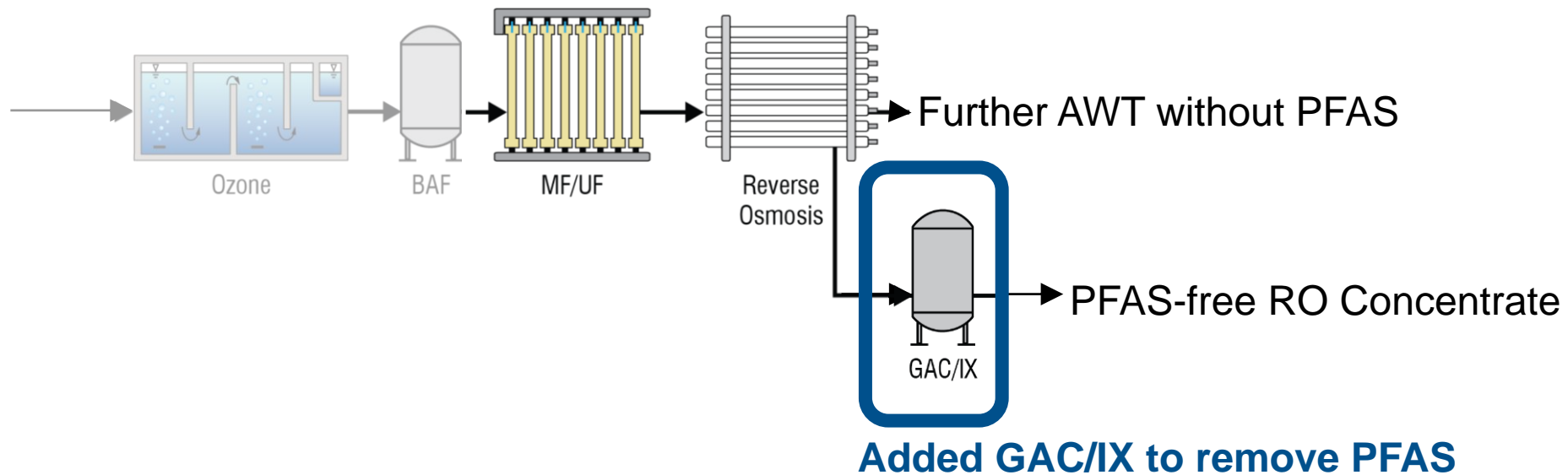
// There are only three (practical) alternatives to addressing PFAS in RO Concentrate

1. Remove PFAS before RO



// There are only three (practical) alternatives to addressing PFAS in RO Concentrate

1. Remove PFAS before RO
2. Remove PFAS from the concentrate



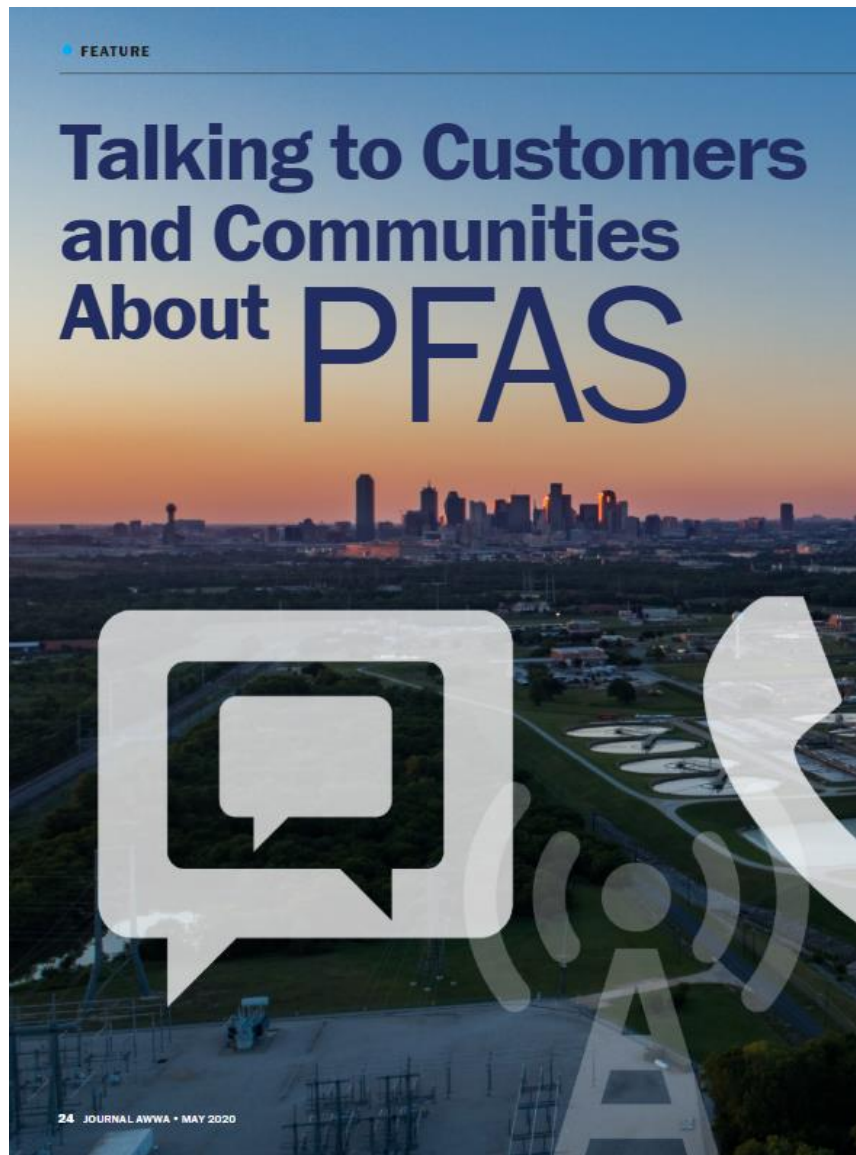
// There are only three (practical) alternatives to addressing PFAS in RO Concentrate

1. Remove PFAS before RO
2. Remove PFAS from the concentrate
3. Ignore PFAS in the concentrate



How can you prepare for PFAS?

Communication Guidance from the Water Research Foundation



Be First:

Crises are time-sensitive. Communicating information quickly is crucial. For members of the public, the first source of information often becomes the preferred source.



Be Right:

Accuracy establishes credibility. Information can include what is known, what is not known, and what is being done to fill in the gaps.



Be Credible:

Honesty and truthfulness should not be compromised during crises.



Express Empathy:

Crises create harm, and the suffering should be acknowledged in words. Addressing what people are feeling, and the challenges they face, builds trust and rapport.



Promote Action:

Giving people meaningful things to do calms anxiety, helps restore order, and promotes some sense of control.



Show Respect:

Respectful communication is particularly important when people feel vulnerable. Respectful communication promotes cooperation and rapport.

THANK YOU!

Eva Steinle-Darling, PhD, P.E.
esd@carollo.com



7677 Oakport Street Suite 600 Oakland CA 94621
510.382.7800 | www.cwea.org



PFAS in Biosolids: Current State of Knowledge

Webinar, November 18, 2020, 11am-12pm

Why do we care about PFAS in biosolids?

Real and Perceived Risk

- Health
- Farming
- Biosolids beneficial use
- Costs

Nationwide, Concerns Grow Over Tainted Sewage Sludge Spread On Croplands

By JOHN FLESHER AND MICHAEL CASEY - THE ASSOCIATED PRESS • SEP 15, 2019

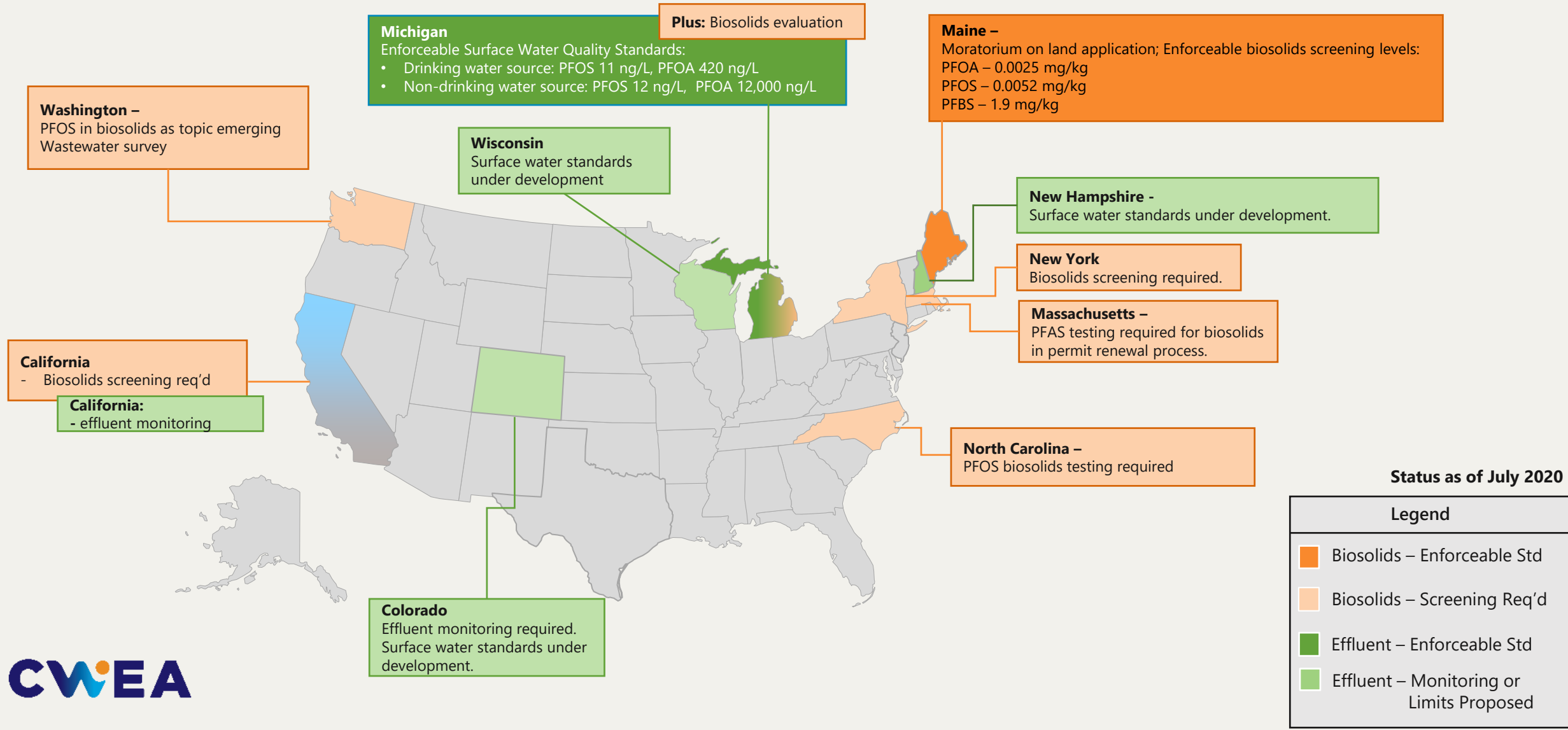


In this Thursday Aug. 15, 2019, photo, dairy farmer Fred Stone pauses while working in the milking room at his farm in Arundel, Maine.

ROBERT F. BUKATY / AP PHOTO

“Studies have documented PFAS absorption by some crops — lettuce, tomatoes and radishes among them — from soils fertilized with sewage byproducts. And the EPA’s inspector general reported last year that the agency was falling short in tracking hundreds of pollutants in sludge, including PFAS.” Maine Public Radio, Sep 15, 2019

WW/Biosolids PFAS Regulatory Snapshot



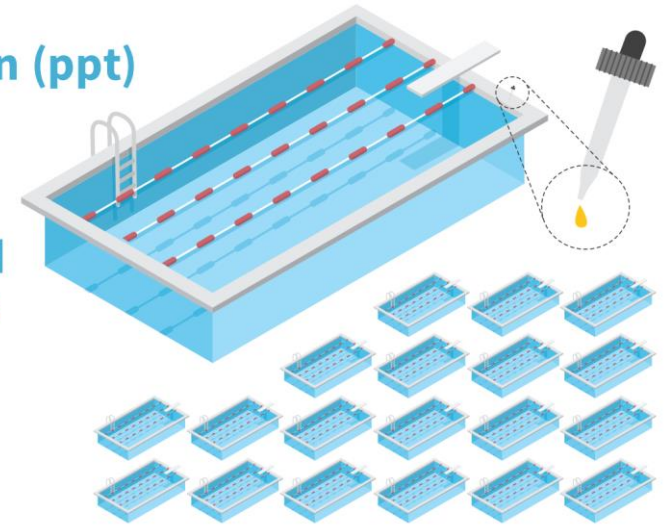
What's in a unit?

ppm	ppb	ppt
mg/kg	µg/kg	ng/kg
mg/L	µg/L	ng/L
µg/g	ng/g	pg/g

1 part per trillion (ppt)

IS EQUIVALENT TO A
SINGLE DROP OF
WATER IN

20 olympic-sized
swimming pools



CA DDW Notification Levels (NL)*

PFOA

5.1 parts-per-trillion (ppt)

PFOS

6.5 parts-per-trillion (ppt)

CA DDW Response Levels (RL)*

PFOA

10 parts-per-trillion (ppt)

PFOS

40 parts-per-trillion (ppt)

A "part-per-trillion" is the equivalent of one drop of water in 20 Olympic-sized swimming pools.

Sources of PFAS in wastewater and biosolids

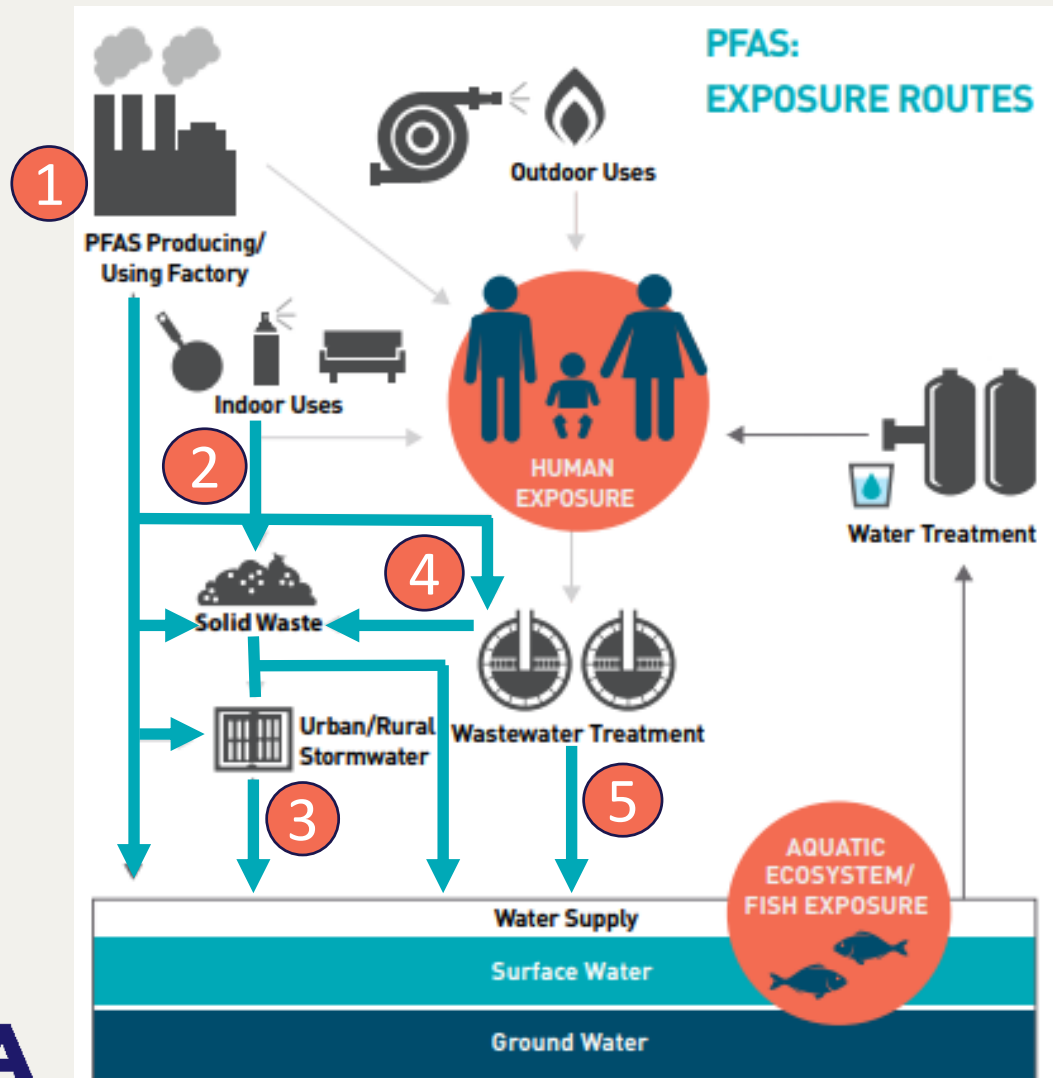


Image Source: Per- and Polyfluoroalkyl Substances, WRF (2020)

1 Industrial WW source concentrations
Semi-conductor: up to 500-1000 mg/L PFOS
Fire-fighting: 5 -120 mg/L PFAS
Textile: 106 ng/L PFAS (median)
Paper: 411 ng/L PFAS (median)
(Various international peer reviewed papers)

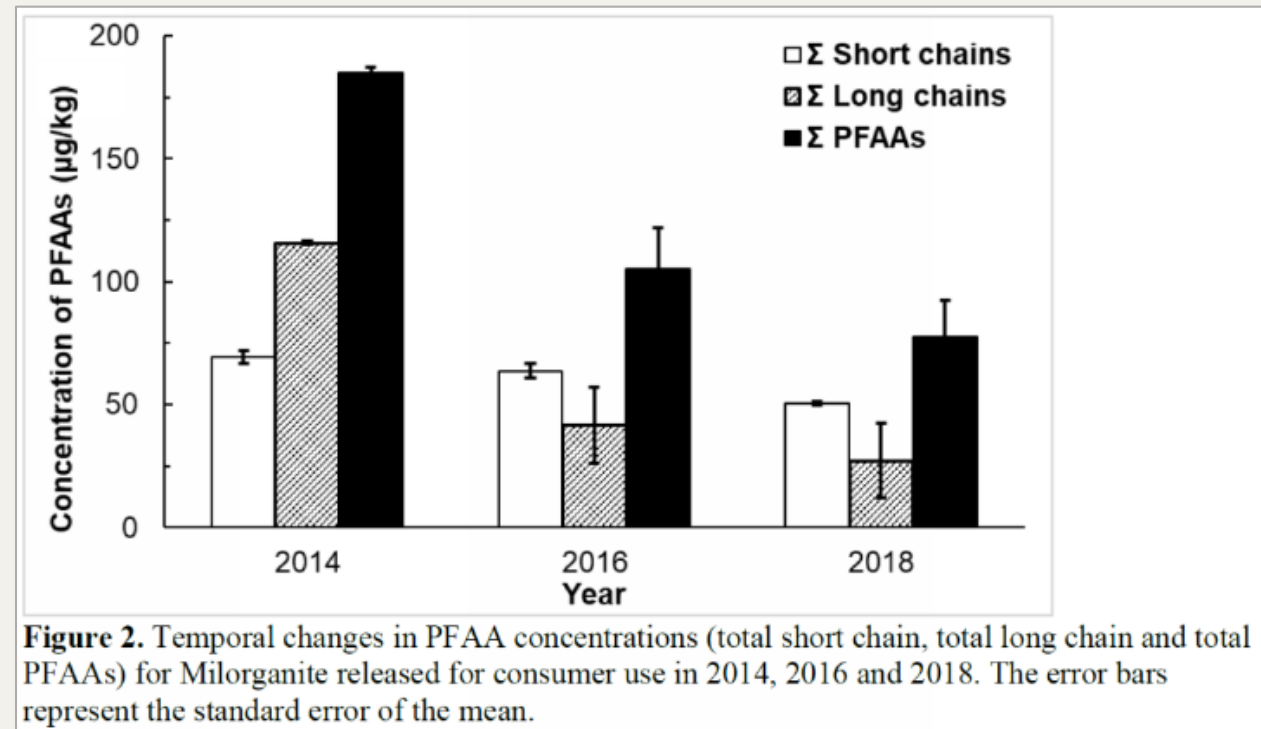
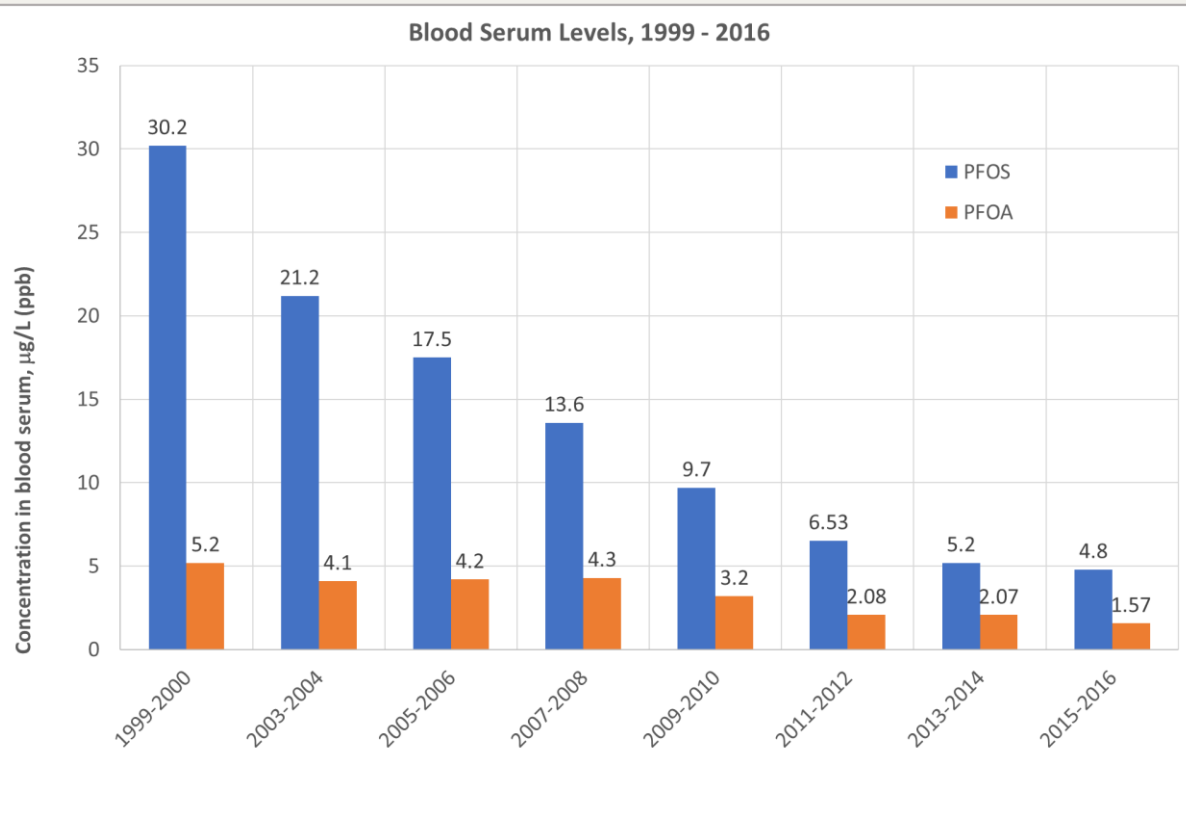
2 Landfill leachate
PFAS: 20-50 µg/L

3 Stormwater
PFOA: 2-30 µg/L
PFOS: 3-42 µg/L
(Page et al. 2019)

4 Biosolids
PFOA: 0-25 µg/kg (ppb)
PFOS: 0-2,000 µg/kg (ppb)
(EGLE, 2020)

5 Domestic Wastewater
PFOA: 0-50 ng/L
PFOS: 0-900 ng/L
(EGLE, 2020)

PFAS/PFOA Levels Have Dropped with Time in Blood Serum and Biosolids Products



Michigan conducted PFAS assessment for wastewater and biosolids

Background for a lot of current data

- 1st Initiative (Feb 2018): Sampling of 95 WWTPs as part of industrial pretreatment program (IPP) to identify industrial sources of PFOA or PFOS to system
- 2nd Initiative (Fall 2018): Evaluate PFAS in influent, effluent, and biosolids at 42 WWTPs

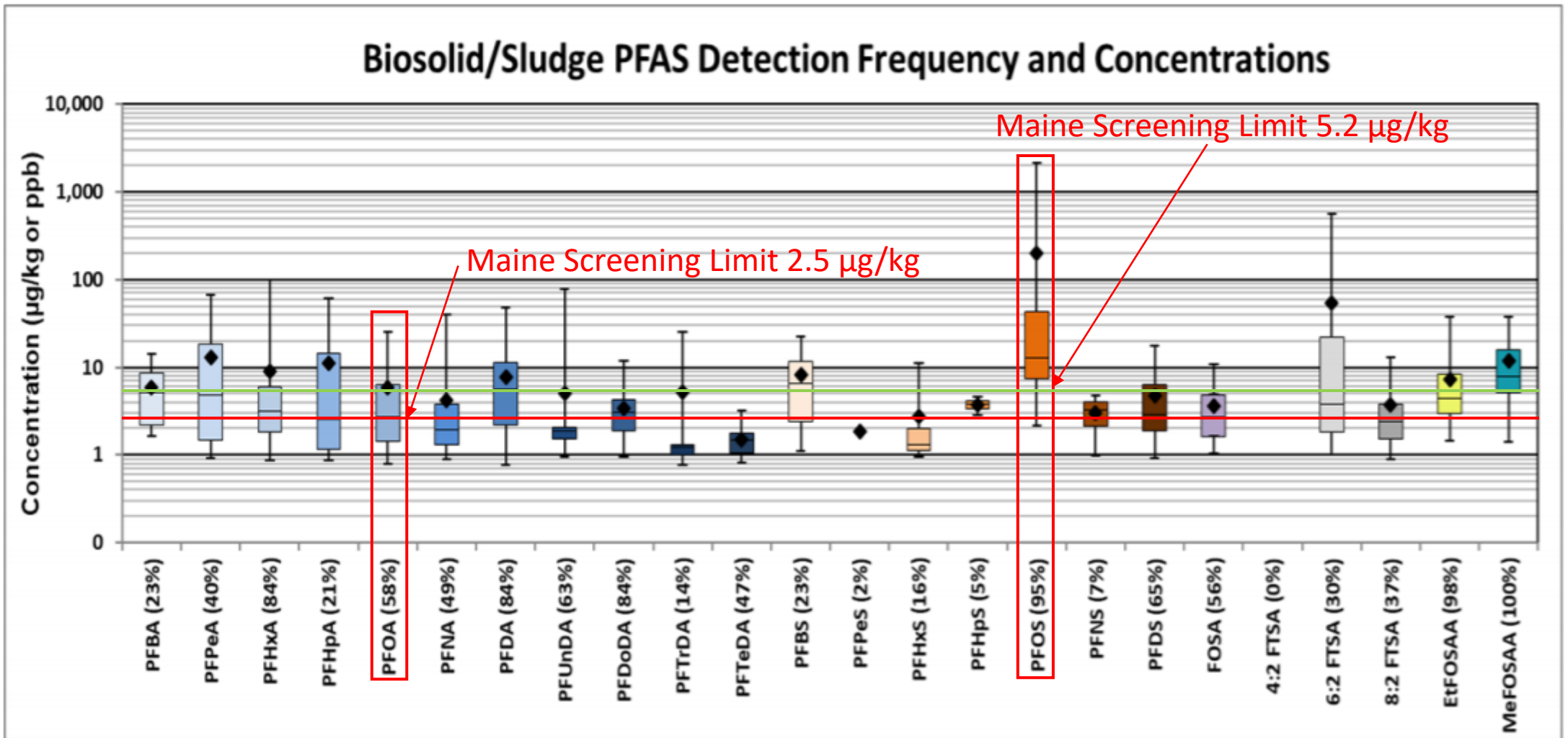
SUMMARY REPORT:

Initiatives to Evaluate the Presence
of PFAS in Municipal Wastewater
and Associated Residuals
(Sludge/Biosolids) in Michigan

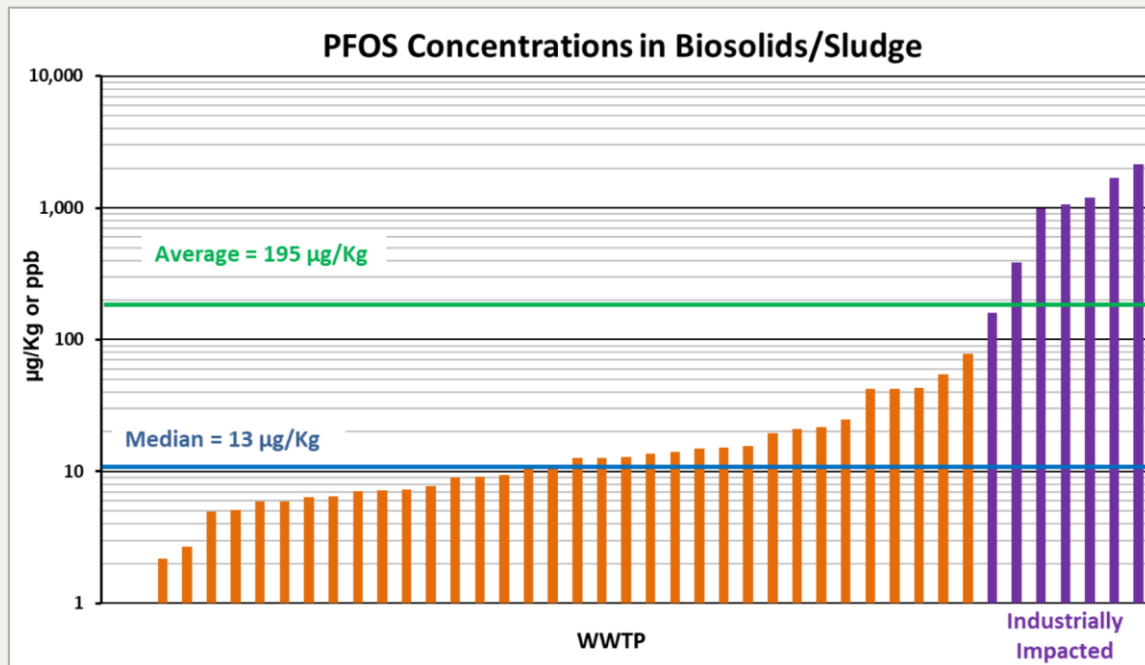
June 2020



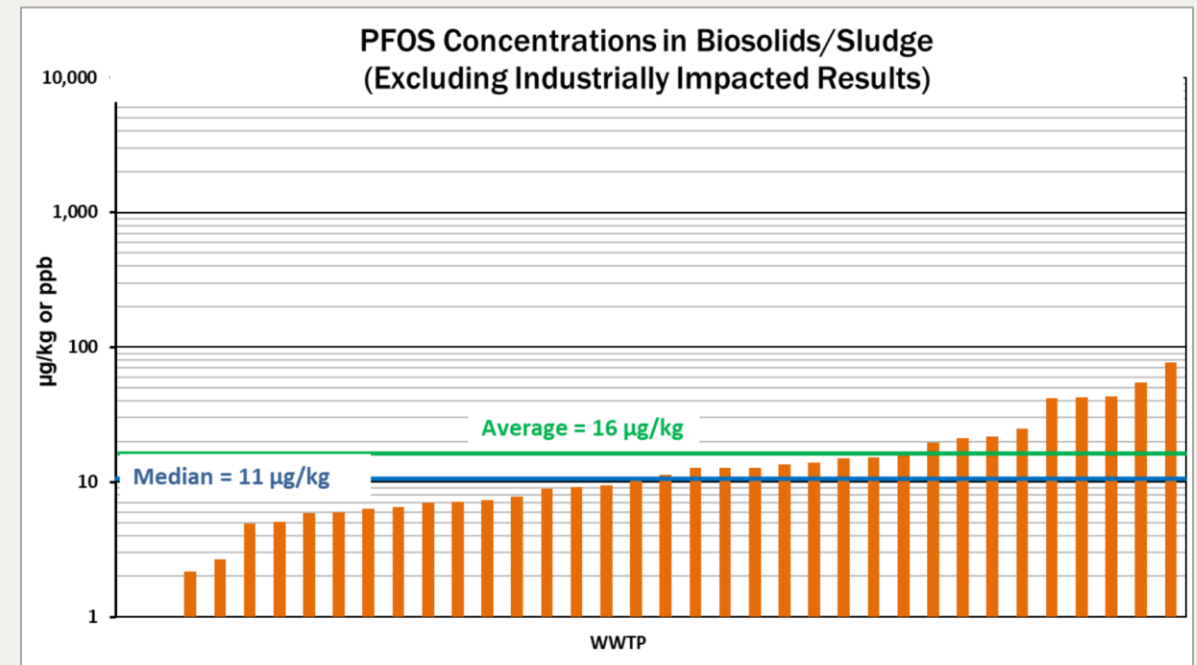
PFAS concentrations in biosolids from Michigan study



Industrial impacts significantly increased PFAS concentrations in biosolids



Source: EGLE, 2020



Source: EGLE, 2020

Higher PFAS levels detected in ag fields with biosolids from highly impacted WWTPs

Environmental Matrix	Total PFAS (Lower Impacted WWTPs)	Total PFAS (Higher Impacted WWTPs)
Effluent, ppt	4-15	300-143,360
Biosolids, ppb	34-124	1,173-2,358
Soil, ppb	ND-15	1-182
Groundwater, ppt	ND-97	ND-541
Surface Water, ppt	ND-52	2.5-2,647
Tile Drain, ppt	ND-58	9-2,495
Ponded Water, ppt	6-346	17-968

Source: EGLE, 2020

Source control and pretreatment in Michigan reduced effluent PFOS significantly

Table 1. Substantial PFOS Reduction at WWTPs with Exceedances (EGLE, 2020)

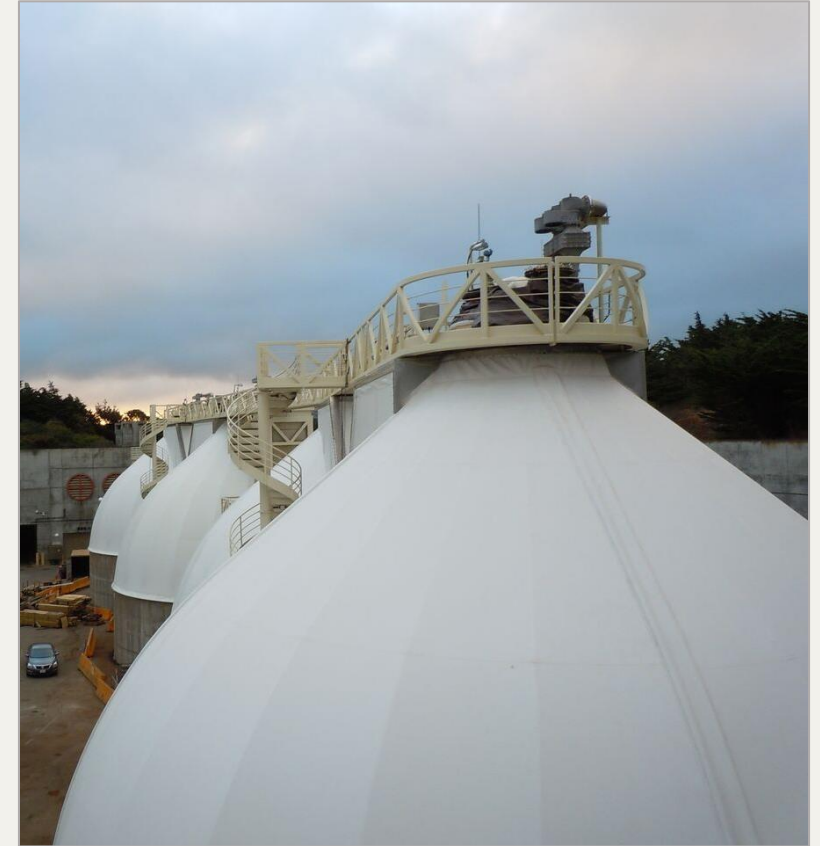
Municipal WWTP	Recent PFOS, Effluent* (ng/L)	PFOS Reduction (highest to most recent)	Actions Taken to Reduce PFOS
Ionia	<7.6	99%	Treatment (GAC) at source (1)
Lapeer	11	99%	Treatment (GAC) at source (1)
Port Huron	13	99%	Eliminated source PFOS (2)
Wixom	18	99%	Treatment (GAC) at source (1)
Howell	3.7	95%	Treatment (GAC/resin) at source (1)
Bronson	13	96%	Treatment (GAC) at source (1)
Kalamazoo	3.1	92%	Treatment (GAC) at source (2), change water supply
K.I. Sawyer	27	89%	Eliminated leak PFOS-containing firefighting foam
GLWA (Detroit)	30	No Value	Treatment (GAC) at sources (8)
Belding	7.2	49%	Restricted landfill leachate quantity accepted

*Data received as of March 26, 2020

- Six facilities achieved >90% reduction in effluent PFOS levels
 - All six: GAC treatment at industrial source(s)
 - Others:
 - Eliminated AFFF leak
 - Restricted acceptance of landfill leachate
- Reduction not necessarily enough to meet MI stream standards at all facilities

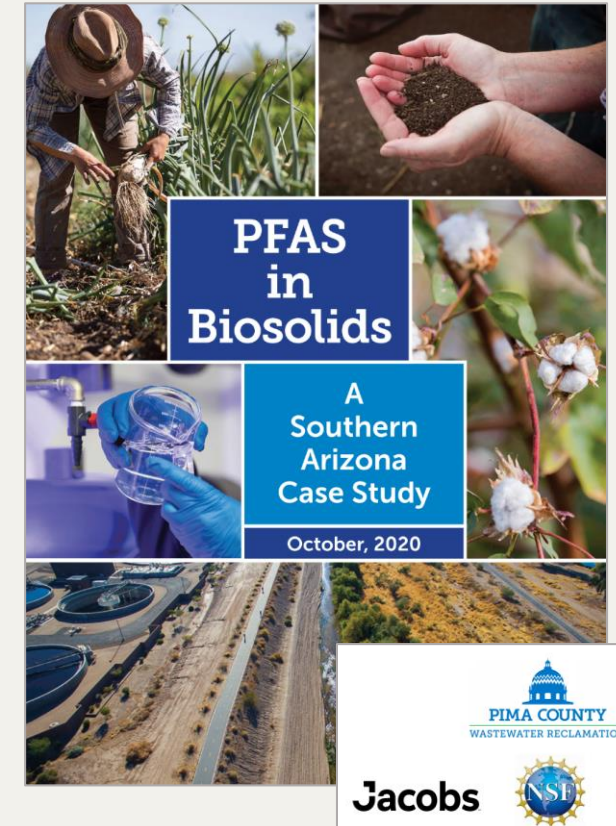
SFPUC found similar PFOA concentrations in biosolids as National Forest soils

- 2018 testing with previous methods
 - PFAS Results <1ppb – 15 ppb
 - PFOA: 0.783 – 1.15 ppb
 - PFOS: 7.99-14.9 ppb
- National Forest soils
 - PFOA: <1ppb – 1+ ppb
- Dust samples from homes/offices
 - PFOA: 296 ppb mean; 142 ppb median
 - PFOS: 761 ppb mean; 201 ppb median



Southern Arizona study focused on long-term land application sites

- Considered biosolids, soil and groundwater (GW) at undisturbed sites, ag land, and 3 sites with varying rates/durations of biosolids land app
- GW ~150' below surface
- Substantial irrigation



Southern Arizona study focused on long-term land application sites

PFAS Contaminant	Ag Sites GW, ppt	Land App Sites GW, ppt	Ag Sites Soil, ppb	Land App Sites Soil, ppb
PFOS	ND-80	ND-15	0.08-3	ND-6
PFOA	ND-20	ND-5	0.06-0.4	ND-4

Notes:

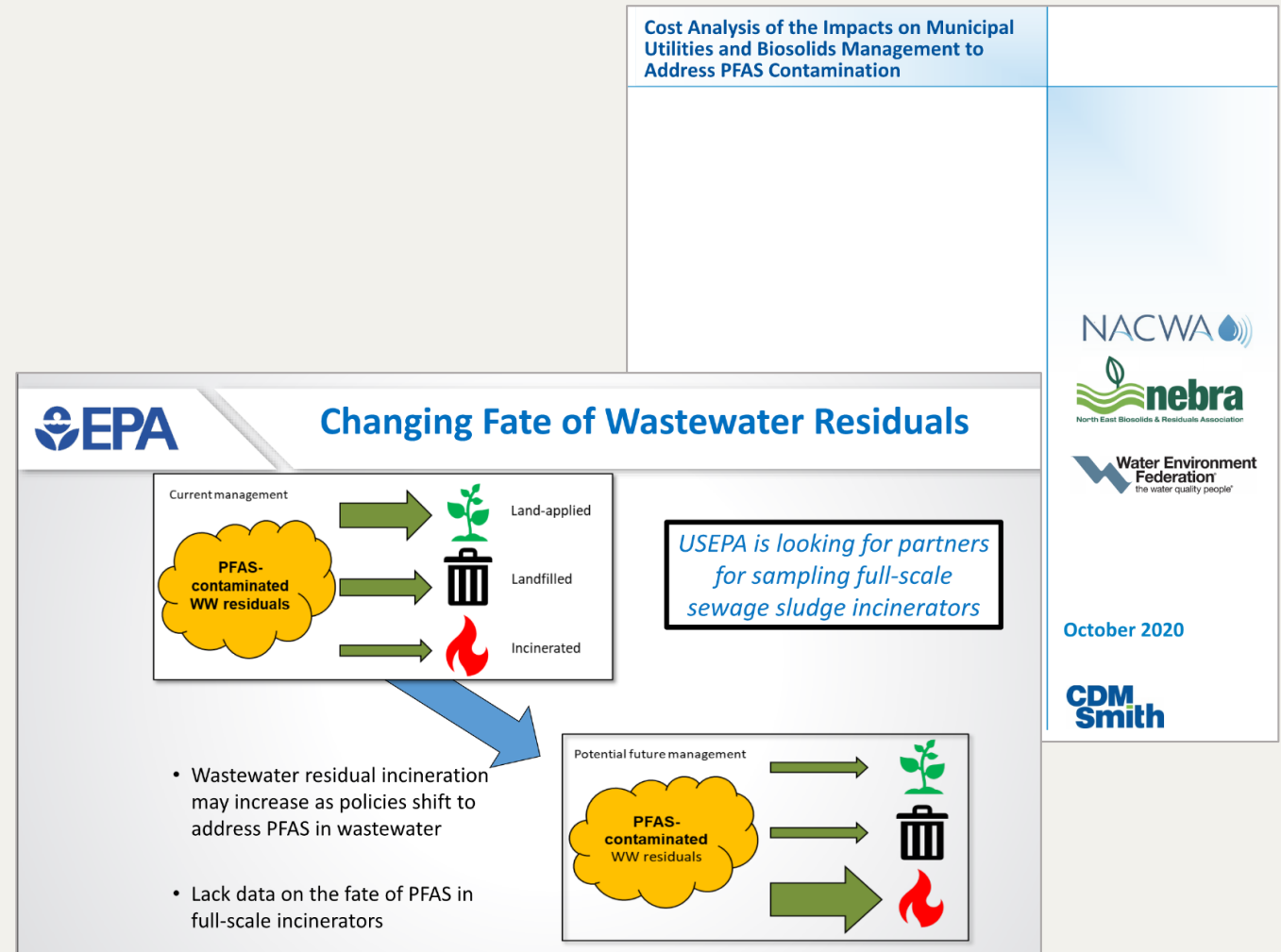
- Only PFOS and PFOA shown here. Analysis included 18 PFAS contaminants.
- Values from report shown with min-max ranges based on reported uncertainties in analytical results.
- Ranges shown combine results from 1', 3', and 6' depth samples. Results indicate 90-97% attenuation, retention in first few feet, and minimal migration below 6'.
- Authors conclude minimal potential for groundwater contamination.
- ND = Not Detected. Below method detection limit.

Recent EPA research provides more data and background

- **RARE Project - EPA/Chris Higgins at Colorado School of Mines:**
 - Found plant uptake into edible portions of certain food crops
 - May have had industrial impacts
- **EPA Land Application of Biosolids Field Study 2:**
 - PFAS precursors at point of application decrease with time but stable PFAS increase with transformation

Will PFAS change biosolids management?

- Source control/prevention preferred
- Public/political pressure now
- Uncertainty about national regulatory changes
- Lack of data recognized
- Biosolids-specific risk assessment and analytical methods still in development



PFAS destruction/fate research in biosolids processing technologies ongoing

Incineration



Gasification



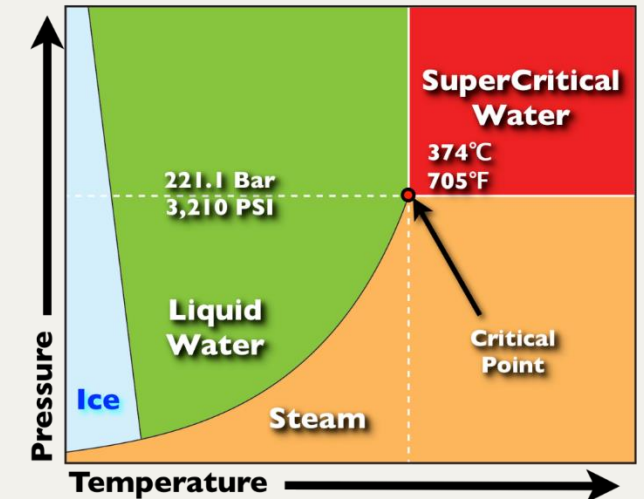
Hydrothermal Liquefaction



Pyrolysis



Supercritical Water Oxidation



Ongoing work related to PFAS in biosolids

- **NEBRA, BioCycle, North West Biosolids, and CASA**
 - Update to first survey report on PFAS in Biosolids in US
 - 2nd National Biosolids Regulation, Quality, End Use & Disposal Survey
 - Estimated Completion Date: March 2021
- **Bay Area Clean Water Agencies (BACWA), San Francisco Estuary Institute (SFEI)**
 - Sampling 10-15 Bay Area WWTPs for 31 PFAS compounds.
 - Influent, effluent, ROC, and biosolids.
 - Work will be started in Q4 2020
 - Results expected in May 2021
- **Bay Area Biosolids Coalition**
 - Finalizing a research study scope to examine plant uptake of 31 PFAS compounds grown in biosolids-amended soil.
 - Work will be done by UC Davis starting in Q4 2020
 - Results are expected in Q4 2021
- **EPA**
 - Risk assessment and modeling
 - Additional research on fate, transport, plant uptake
 - Analytical methods for non-potable, soil, biosolids matrices
 - Incineration studies
 - Ongoing webinar series



U.S. EPA: Biosolids Webinar Series:

Biosolids PFAS Research at the EPA.



Land Application Field Study II

US EPA Biosolids Webinar
October 29, 2020



EPA: Ronald Herrmann, Carolyn Acheson, Larry Zintek, Danielle Kleinmaier
PTSI: Andrea Burkes, Josh Kickish, Bob Grosser, Babina Shrestha

Office of Research and Development

So what now? Suggestions...

- Track your own data
- Identify potential industrial contributors in your service area
- Work with regulators on source control
- Stay on top of research and regulatory changes
- Seek out performance data, including fate of PFAS for biosolids processing technologies (3rd party reviewed info or peer-reviewed journals most reliable)
- Don't hedge yourself in relative to biosolids management – find options that allow for future changes/add-on processes if necessary
- Educate yourself so you are prepared for public questions/outreach

THANK YOU!

Rashi Gupta, P.E.
rgupta@carollo.com



7677 Oakport Street Suite 600 Oakland CA 94621
510.382.7800 | www.cwea.org



**California Water Board's
Per- and Polyfluoroalkyl Substances
(PFAS)
Status of Investigatory Orders**

Webinar, November 18, 2020, 11am-12pm

PFAS Investigatory Actions (2013 to 2020)

February 2019

USEPA –
PFAS Action
Plan

August 2019

Lower notification
levels

- PFOA: 5.1 ppt
- PFOS: 6.5 ppt

January 1, 2020

- California Assembly Bill 756 goes into effect
- Requires notification to consumers for PFAS detected above NL

Aug/Sept 2020

Public Water
System Sampling
Orders (expanded
from 2019)

June 2018

- State Water Board Interim Notification Levels (PFOA: 14 ppt, PFOS: 13 ppt)
- PFOA/PFOS Response level of 70 ppt

March/April 2019

- Water Quality Investigative Orders to Landfills and Airports
- Public Water System Sampling Orders adjacent to the Airports and Landfills

October 2019

Water Quality
Investigative
Orders to Chrome
Plating Facilities

February 2020

Lower response
levels

- PFOA: 10 ppt
- PFOS: 40 ppt

July 2020

Water Quality
Investigative
Orders to
Wastewater
Treatment
Plants

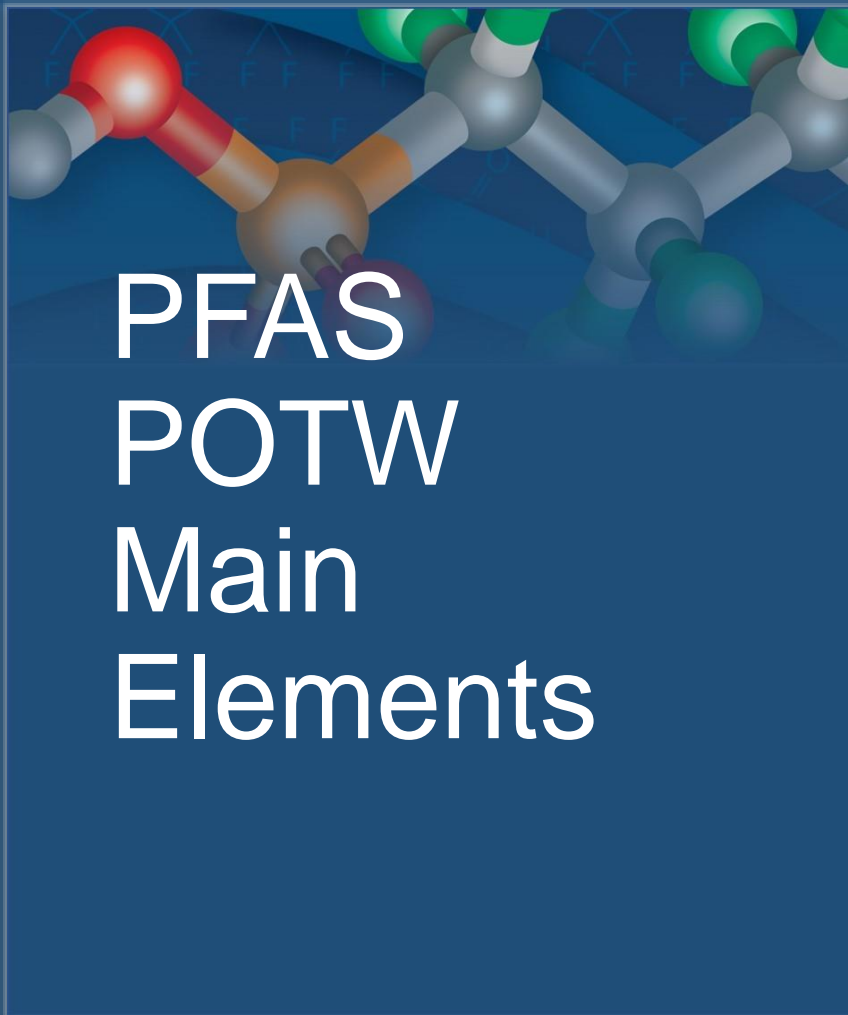
PFOA & PFOS

Health Goals and MCLs by 2024



State-wide PFAS Investigative Orders





TREATMENT
SYSTEM
SAMPLING
AND
REPORTING



GROUND-
WATER
SAMPLING
AND
REPORTING



QUESTIONNAIRE

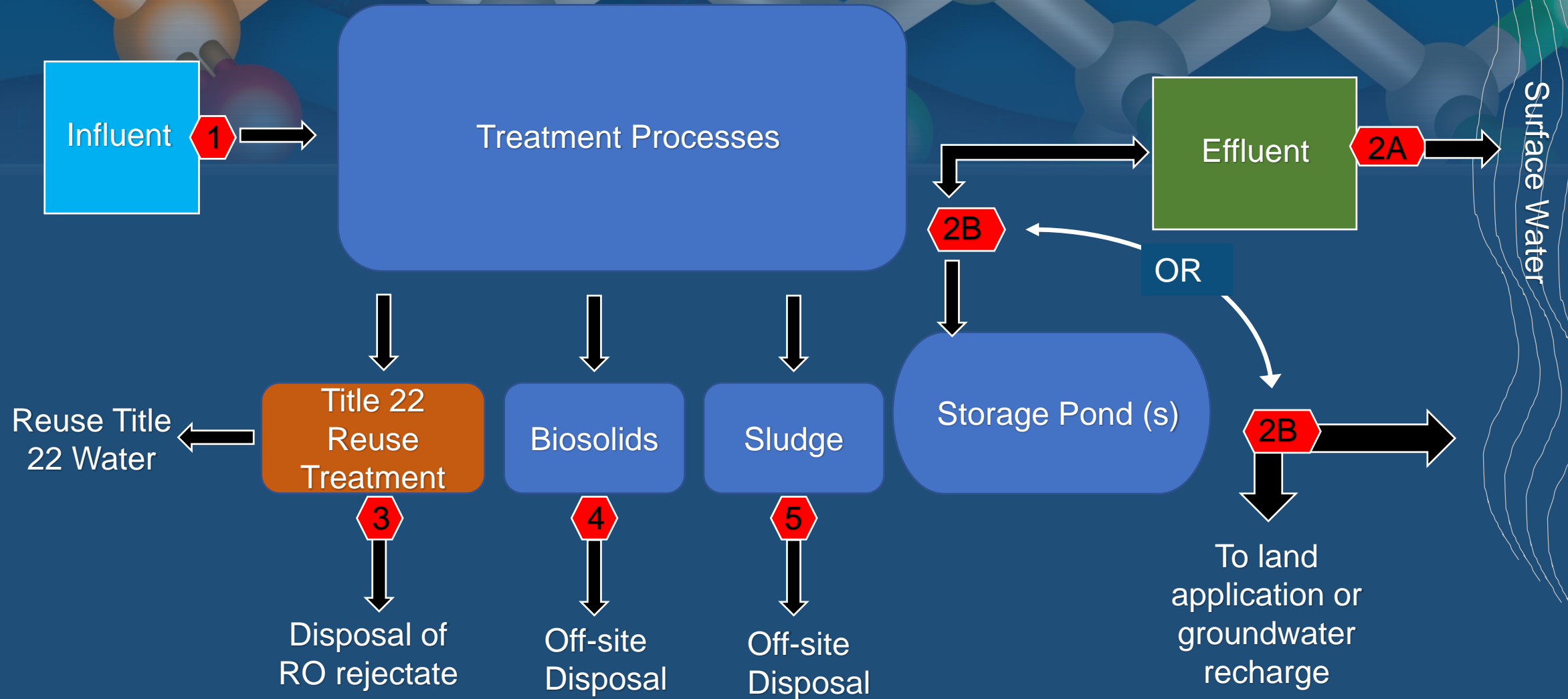
PFAS POTW Order Sampling Summary

	# of POTWs	TREATMENT SYSTEM SAMPLING		REVERSE OSMOSIS CONCENTRATE (ROC)	BIOSOLIDS	GROUNDWATER MONITORING (POTWS with GW MRP)	
Average Dry Weather Design Flow Rate		Locations	Frequency	Frequency	Frequency	Criteria	Frequency
1 to 5 MGD	130	Influent, Effluent	Quarterly for 1 year	Quarterly for 1 year	Once	Provide a min. of 3 well locations on a map and data for Regional Board approval	Once
> 5 MGD	119				Quarterly for 1 year		

PFAS POTW Order Reporting Summary

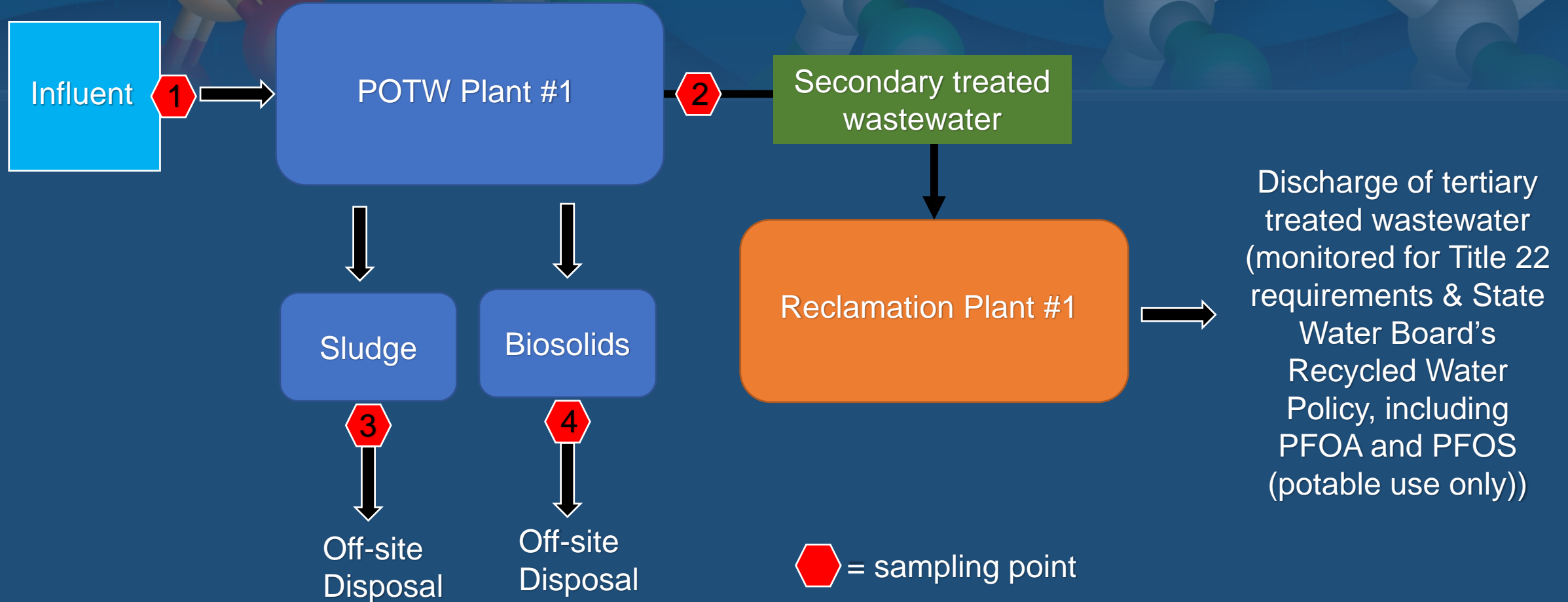
	TREATMENT SYSTEM SAMPLING (influent, effluent, ROC, biosolids)		GROUNDWATER MONITORING (POTWS with GW MRP)	
Average Dry Weather Design Flow Rate	Sampling Starts	Milestones	Sampling Starts	Milestones
1 to 5 MGD	4 th Q 2020	Data uploaded into GeoTracker within 30 days of receiving analytical report	No sooner than 4 th Q 2020	Data uploaded into GeoTracker within 30 days of receiving analytical report
> 5 MGD				
Report	One monitoring report for the treatment system and groundwater monitoring shall be submitted into GeoTracker’s ESI portal no later than 60 days following the receipt of the last analytical laboratory report.			

Sample Locations for POTW PFAS Order



 = sampling point

Sample Locations for POTWs w/secondary treated effluent sent to a Reclamation Plant for further treatment



A background image showing a complex molecular structure with various atoms represented by colored spheres (red, green, grey, orange, purple) and bonds. The structure is set against a dark blue background with faint chemical symbols like 'F', 'O', 'H', 'X', and 'S' scattered throughout.

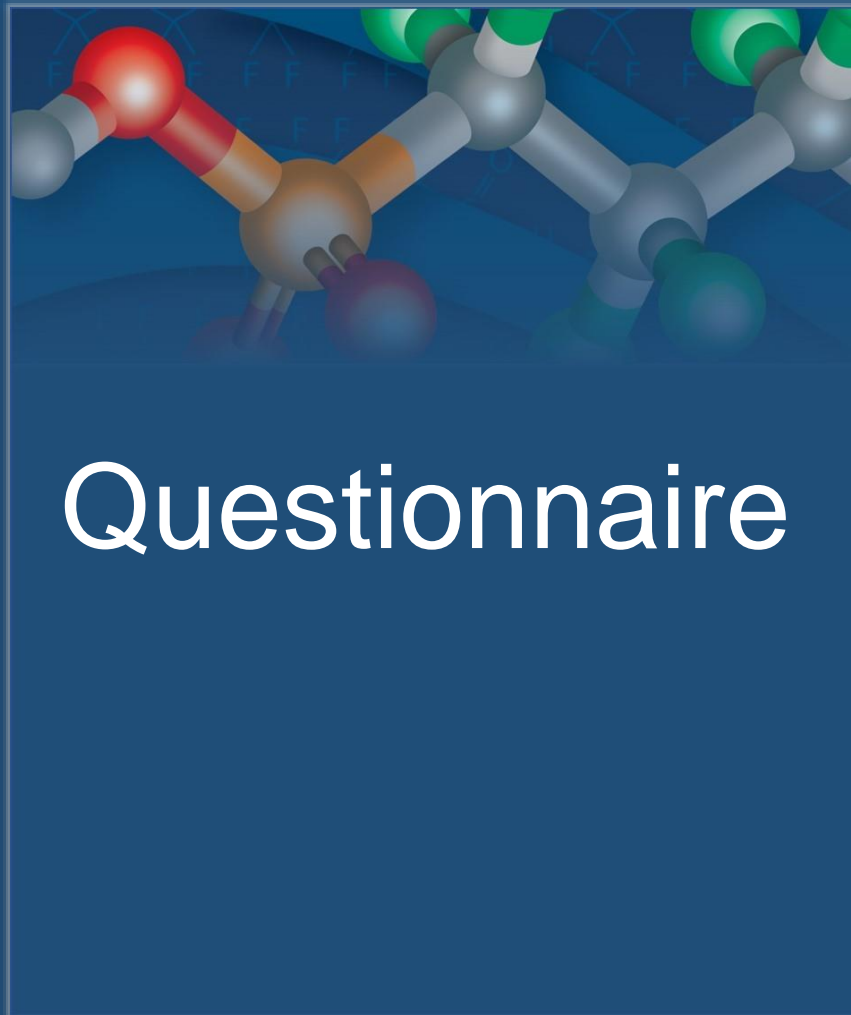
Treatment System Sampling

- Composite vs grab sampling
- Influent samples shall be taken from locations prior to primary settling
- Effluent samples shall be taken following treatment processes and prior to mixing with the receiving waters (before it leaves the facility)
- QAPP is not required in the Order

A background image showing a complex molecular structure with various atoms represented by colored spheres (red, orange, grey, green, blue) and bonds. The structure is set against a dark blue background with faint, repeating chemical symbols like 'F', 'X', 'H', and 'C'.

GW Monitoring Sampling

- Proposal sent w/in 60-days prior to conducting the first groundwater monitoring event:
 - A figure of the groundwater monitoring well network, groundwater flow direction, and monitoring wells proposed to be sampled
 - Rationale for the selection of the groundwater monitoring wells to be used
 - After approval from the Regional Board, monitoring shall commence no sooner than the Fourth Quarter 2020 sampling period (October-December 2020)
- Collection of samples shall comply with SOP for sample collection established in existing MRP

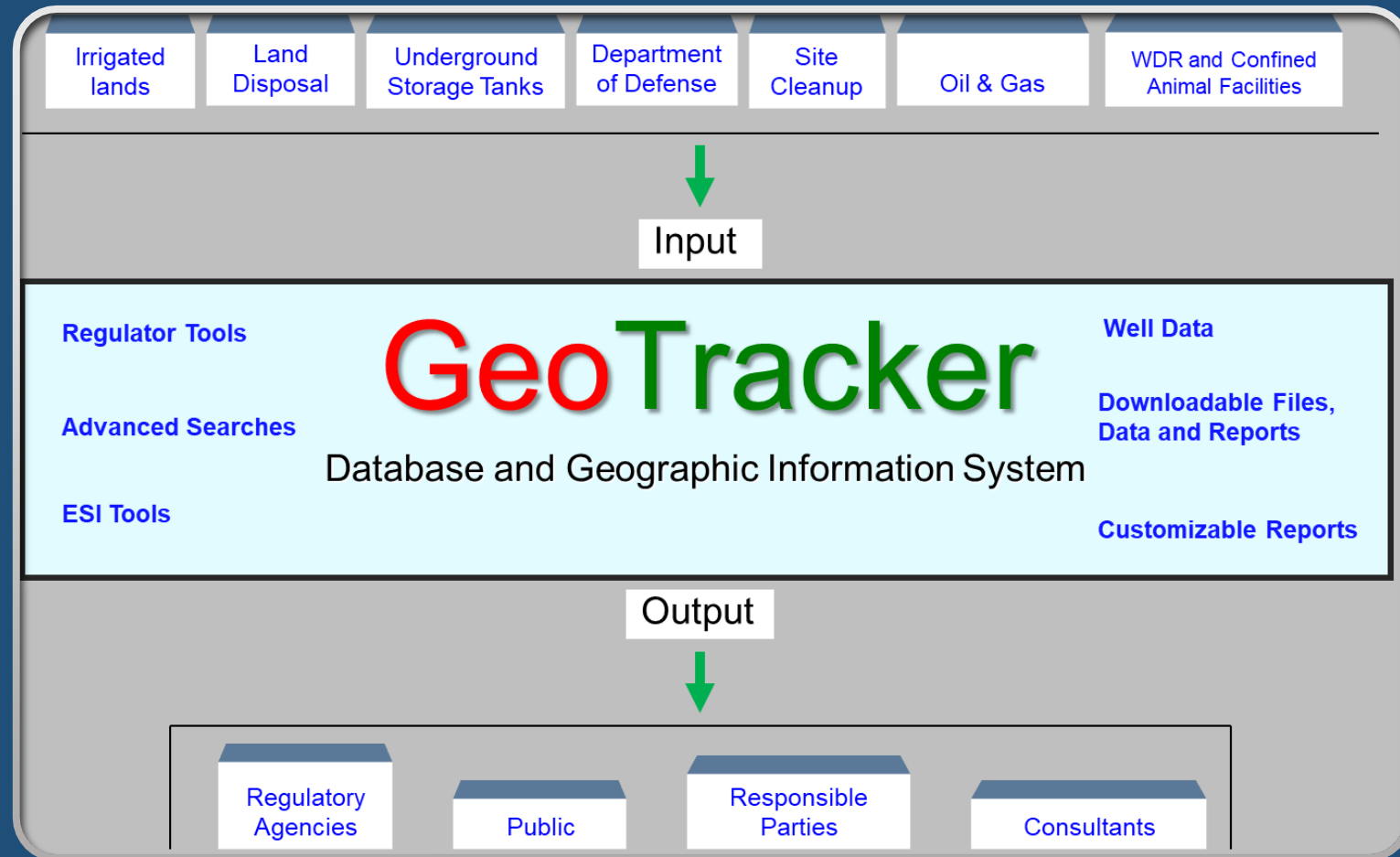
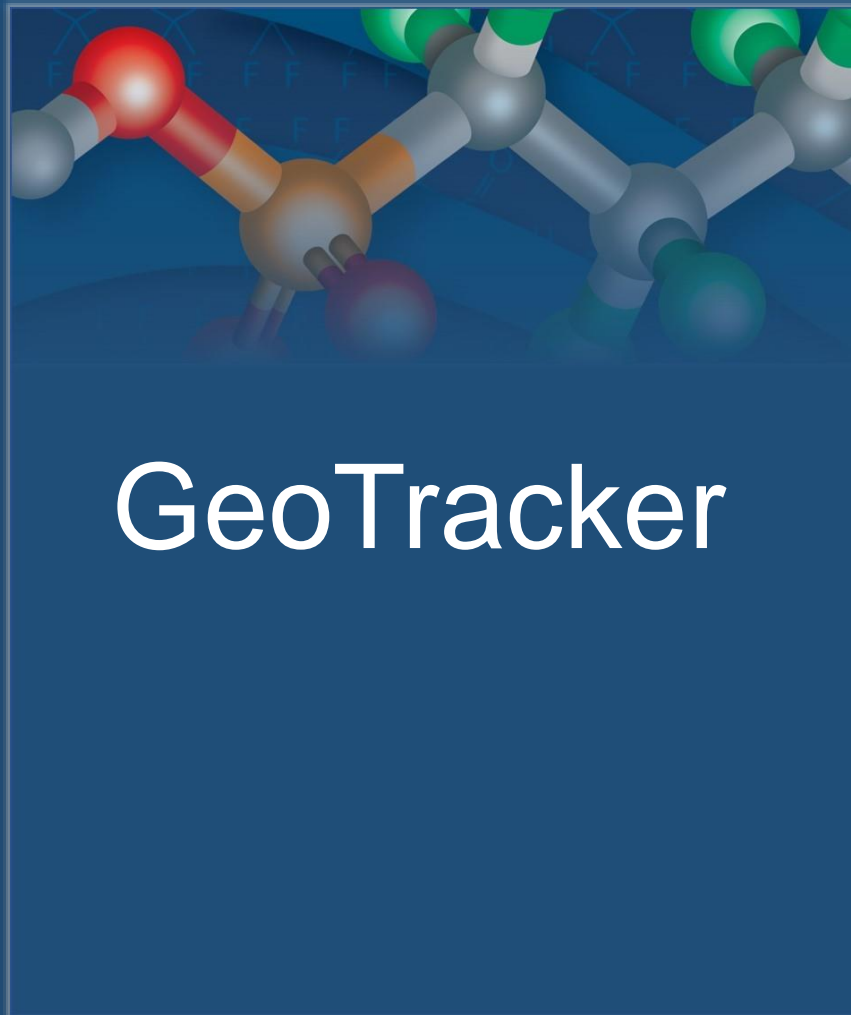


PER- AND POLY-FLUOROALKYL SUBSTANCES (PFAS) – GENERAL INFORMATION	
POTW-specific State Water Board ID #s	
Waste Discharger Identification (WDID) Number:	
GeoTracker Global ID:	
Responsible Agency Information	
Name of Responsible Agency:	
Address of Responsible Agency:	
City:	
County:	
State:	California
Zip:	
POTW Information	
Name of POTW:	
Address of POTW:	
City:	
County:	
State:	California
Zip:	
POTW Mailing Address:	
POTW Point of Contact Name:	
POTW POC Title:	
POTW POC Phone Number:	
POTW POC Email Address:	

A background image showing a complex molecular structure with various atoms represented by colored spheres (red, grey, green, orange) and bonds. The structure is set against a dark blue background with faint chemical symbols like 'F', 'O', 'H', 'X' visible.

Analytical and Data Management

- ELAP accredits labs for analyses compliant with the DoD QSM
 - Labs are being accredited for the additional analytes that are included in the POTW Order that were not included in previous Orders
 - List of labs are provided on PFAS Water Board's website in What's New!
- GeoTracker
 - Order, cover letter, and questionnaire are located each of the POTW's accounts
 - Data repository for analytical data and regulatory correspondence



GeoTracker ESI Webpage

GeoTracker ESI Informational Page:

https://www.waterboards.ca.gov/ust/electronic_submittal/index.html

- How do I upload guide (Getting Started Section)
- Frequently Asked Questions (Getting Started Section)
- EDF Guides (Technical Information on Uploading Data Section)
- GEO XY, Z, and Well Guides and Template (Technical Information on Uploading Data Section)
- Current Valid Value Lists for all electronic uploads (Technical Information on Uploading Data Section)

California Coordinating Agencies



California Air
Resources
Control Board



California
Department of
Pesticides
Regulation



California
Department of
Public Health



CalRecycle



Department of
Toxic
Substances
Control – Safer
Consumer
Products



Office of
Environmental
Health Hazard
Assessment



California
Water Boards

More information available at...



Water Board's PFAS website: <https://www.waterboards.ca.gov/pfas/>



Water Board's Division of Drinking Water PFOA/PFOS website:
https://www.waterboards.ca.gov/drinking_water/certlic/drinkingwater/PFOA_PFOS.html



GeoTracker Help Desk GeoTracker@waterboards.ca.gov 1-866-480-1028



Email: PFAS@waterboards.ca.gov



Subscribe to Receive Notifications:
https://www.waterboards.ca.gov/resources/email_subscriptions/swrcb_subscribe.htm

THANK YOU!

Wendy Linck

Wendy.linck@waterboards.ca.gov



7677 Oakport Street Suite 600 Oakland CA 94621
510.382.7800 | www.cwea.org



Eva Steinle-Darling, PhD, P.E.
esd@carollo.com

Rashi Gupta, P.E.
rgupta@carollo.com

Wendy Linck
Wendy.linck@waterboards.ca.gov

QUESTIONS & ANSWERS

CWEA

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Thank You!

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<https://www.surveymonkey.com/r/PFAS111820>