KNOWING YOUR RISKS

PFAS Identification and Exposure Assessment

SEPTEMBER 23, 2025

MEET YOUR PRESENTERS

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AGENDA

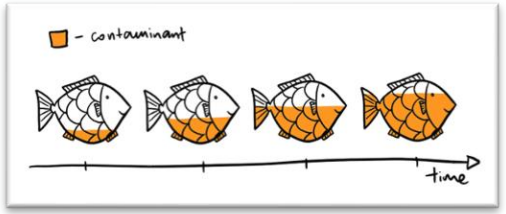
- What are PFAS?
- Regulatory landscape
- Where are they found?
- Assessing PFAS in the environment
- PFAS remediation technologies
- Assessing and controlling PFAS in the workplace

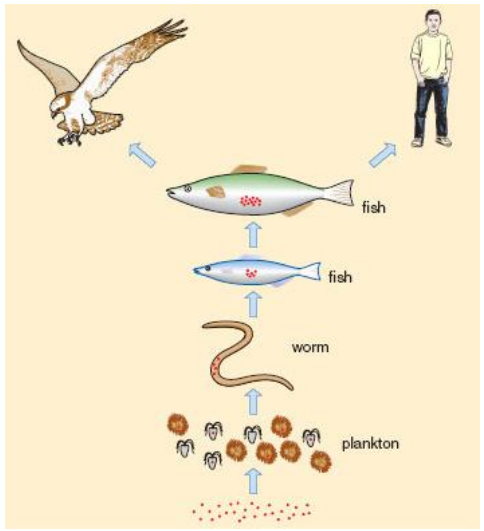

PFAS

PER- AND POLYFLUOROALKYL SUBSTANCES (PFAS)

Concerns about the public health impact of PFAS have arisen for the following reasons:

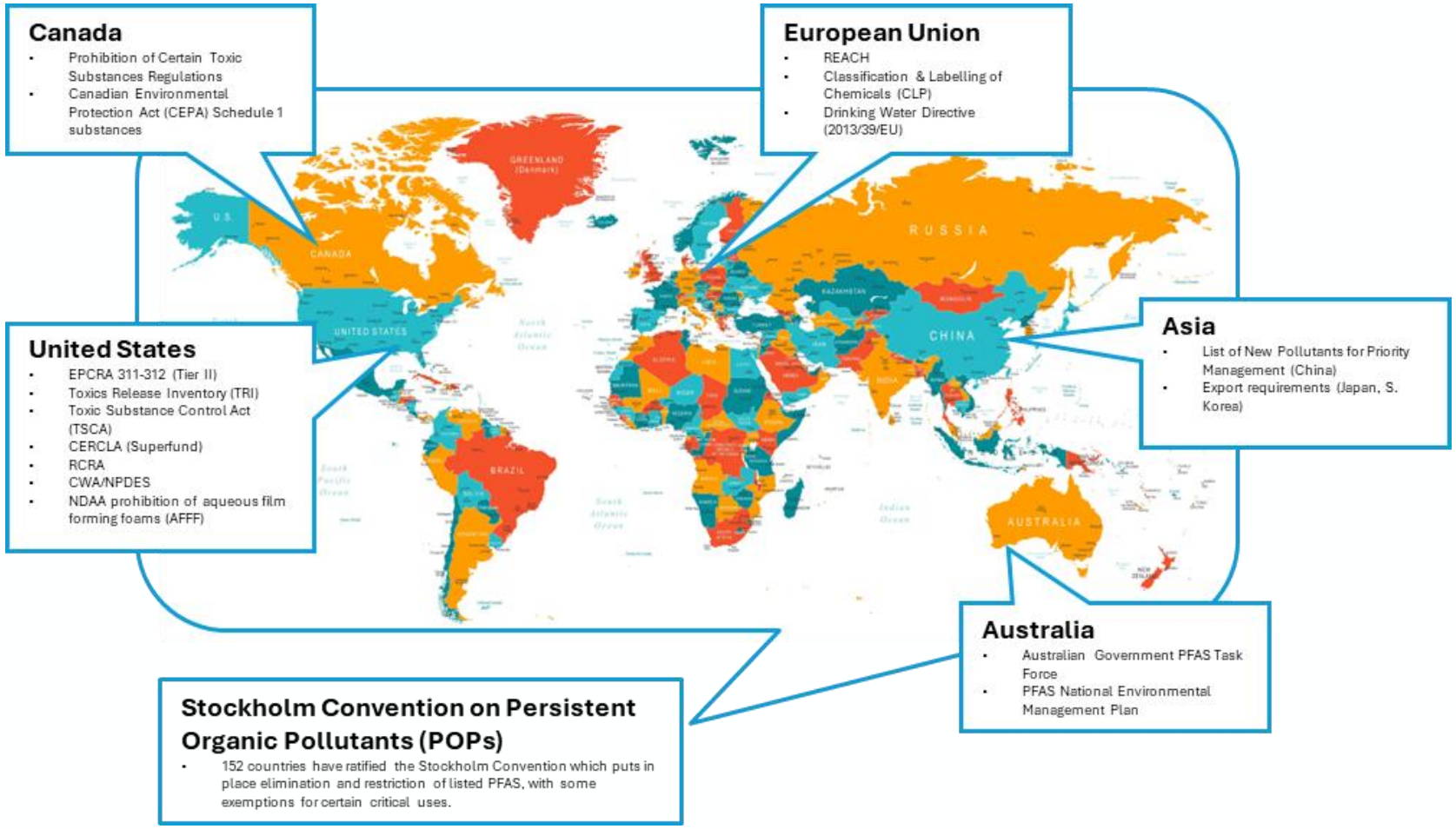
- Widespread occurrence
- Numerous exposures
- Growing numbers of PFAS
- “Forever chemicals”
  - Persistent, Mobile
- Bioaccumulation:





Source: niehs.nih.gov/health/topics/agents/pfc, faypwc.com/pfas-facts/, zeropm.eu/what-is-a-persistent-and-mobile-substance/

EVER CHANGING GLOBAL REGULATORY LANDSCAPE



EXPANDING FROM COMPLIANCE TO UPHOLDING DUTY OF CARE

$10-12.5B
Estimated civil liability for the largest PFAS contamination lawsuit to-date (2023)[1]

8,430
The number of active lawsuits against manufacturers of PFAS and PFAS-containing products as of March 2025[3]

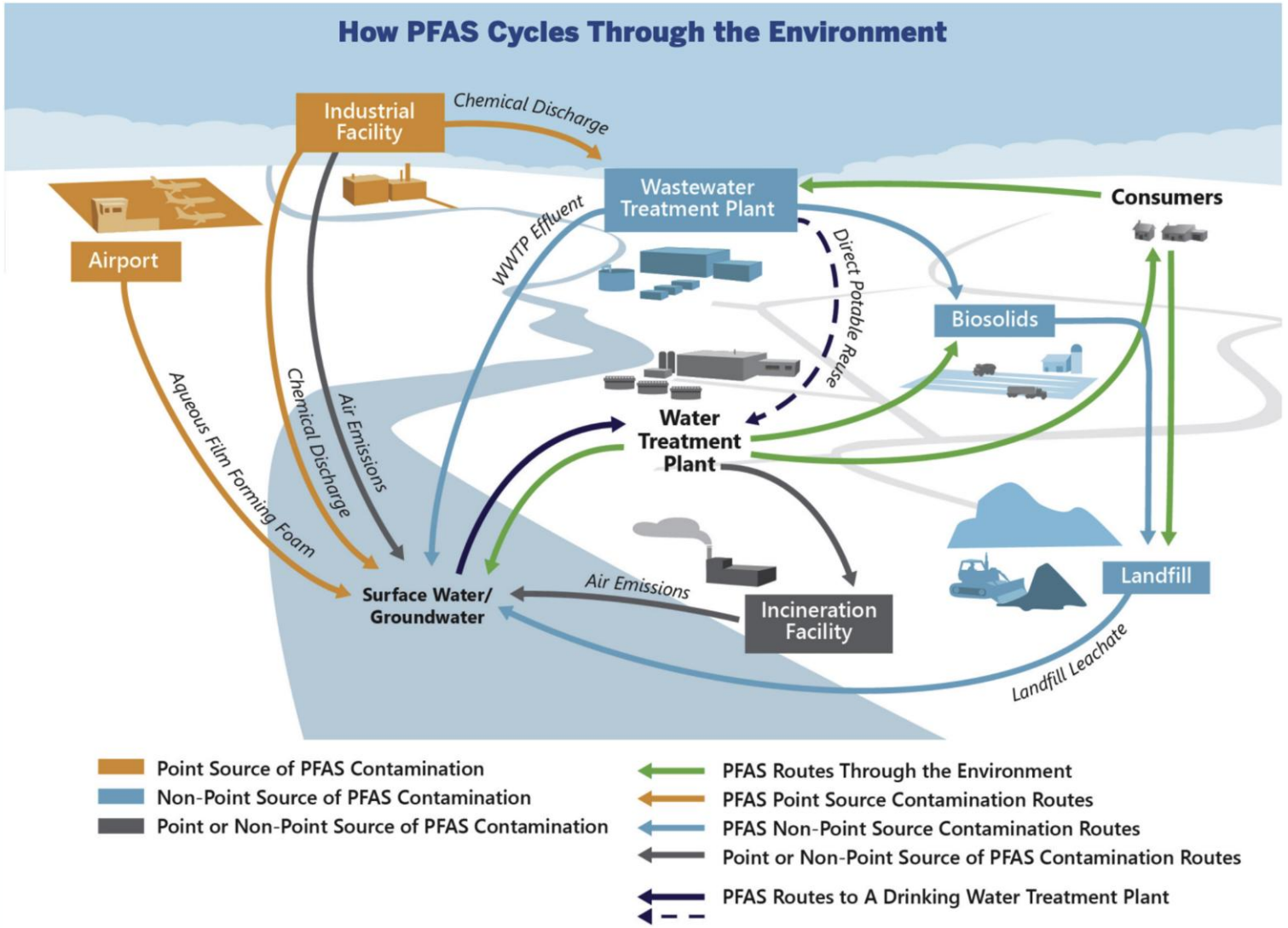
6,864
Estimated annual number of US cancer diagnoses due to PFAS drinking water contamination[2]

$3.2-5.7B
The estimated annual cost of PFAS drinking water clean-up in the US[4]

$75,000-$375,000
Average settlement amount per single PFAS water contamination lawsuit/claimant[2]

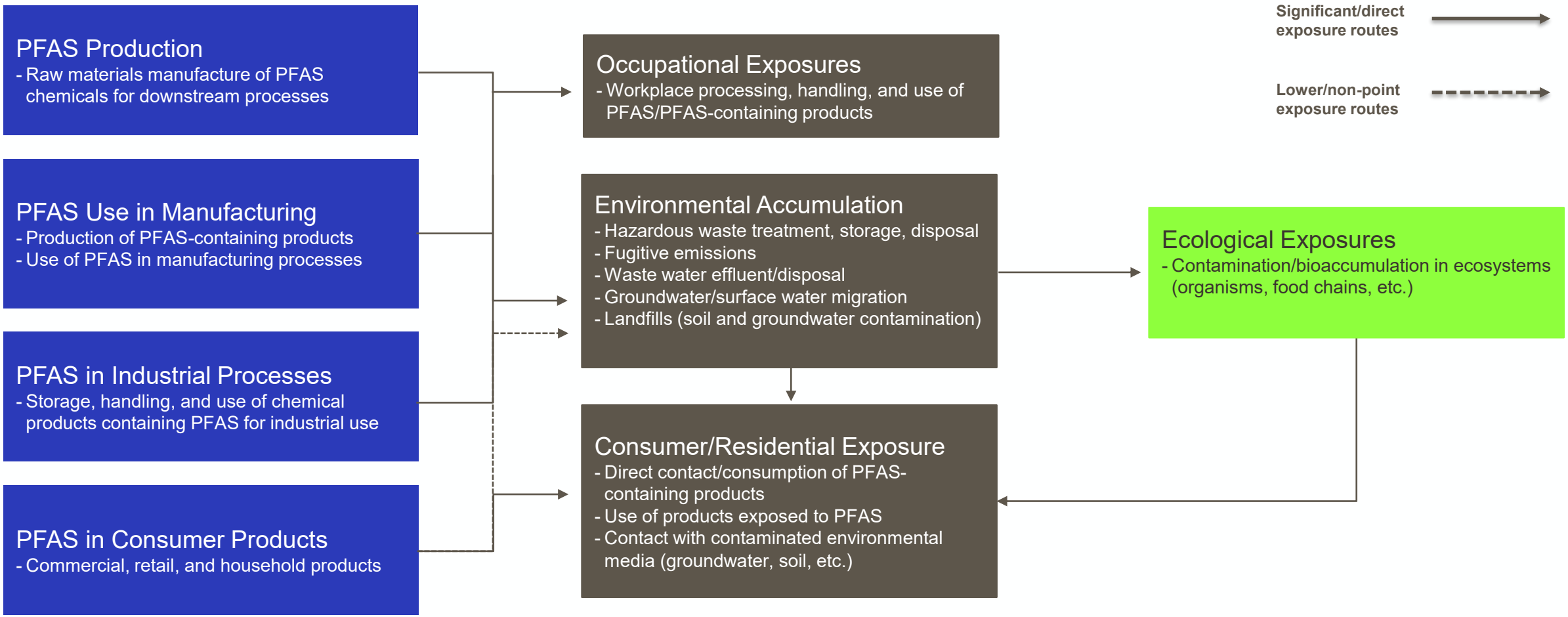
1. https://www.enr.com/articles/56574-dupont-spinoffs-to-pay-119b-in-largest-yet-pfas-in-drinking-water-settlement
2. https://www.lawsuit-information-center.com/pfas-water-contamination-lawsuit.html
3. https://www.robertkinglawfirm.com/personal-injury/pfas-class-action-lawsuit/

PFAS SOURCES, ROUTES, AND EXPOSURES: FROM PLACES OF WORK…



Source: dri.org/docs/default-source/paper-uploads/2021/4_itrc_history-and-use-of-pfas-found-in-the-environment.pdf?sfvrsn=4
cell.com/one-earth/fulltext/S2590-3322%2822%2900493-6?_returnURL=https%3A%2F%2Flinkinghub.elsevier.com%2Fretrieve%2Fpii%2FS2590332222004936%3Fshowall%3Dtrue

Generalized PFAS uses, relative exposure, and environmental impact potential.



…IN OUR HOMES AND INTO OUR BODIES

[Everything in Your Home That May Have PFAS Forever Chemicals | TIME]

FINDING AND REMOVING PFAS

Immune system effects

High blood pressure and pre-eclampsia

Low infant birth weights

Elevated cholesterol levels

Disruption of thyroid hormones

Linked to cancer:
- *Testicle cancer*
- *Ovarian cancer*
- *Prostate cancer*
- *Kidney cancer*
- *Non-Hodgkin lymphoma*

Reduced vaccine response

Developmental delays

Bioaccumulation in animals

Liver damage

Contamination of water resources

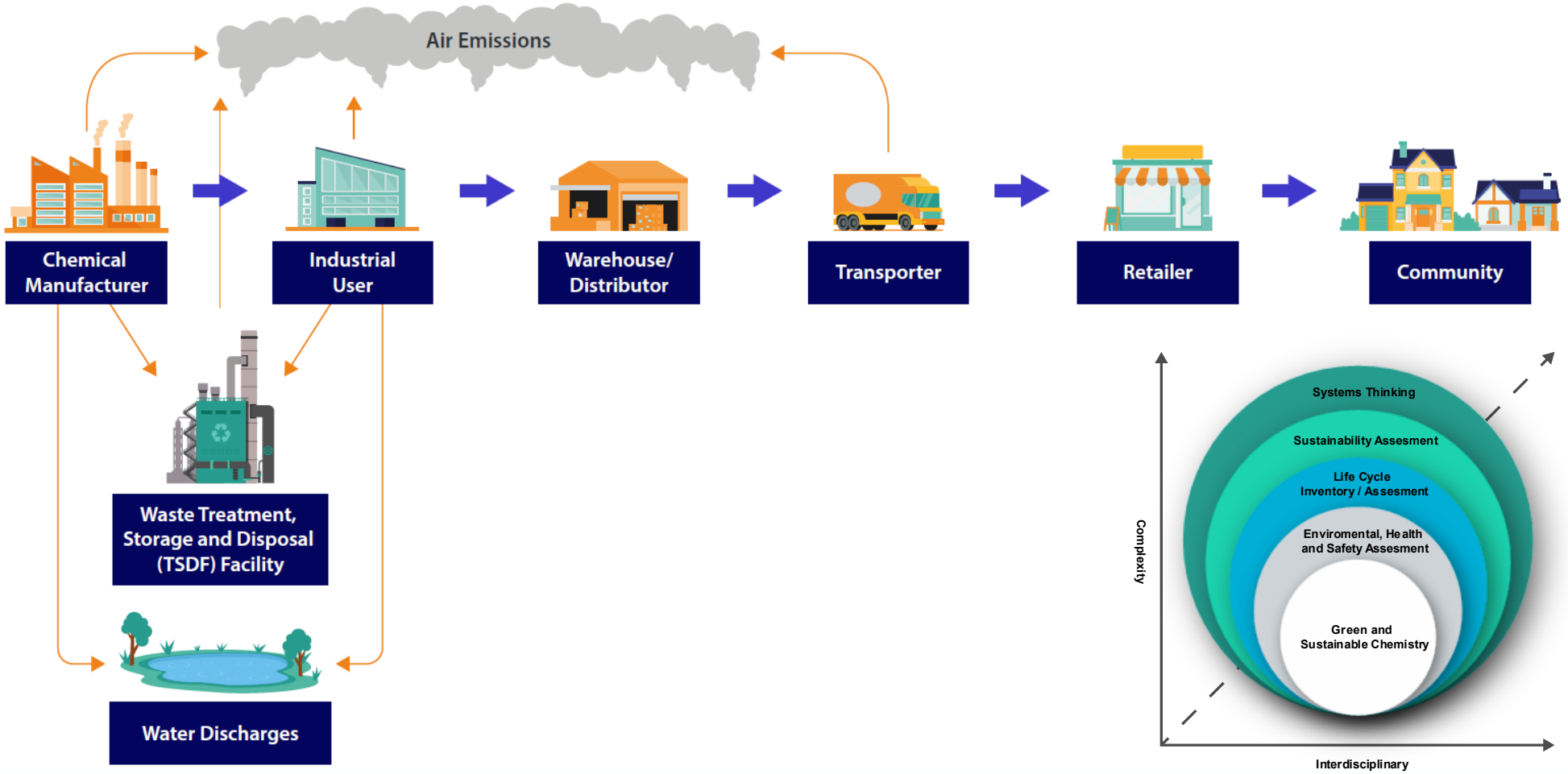
Persistence in environment

Soil contamination

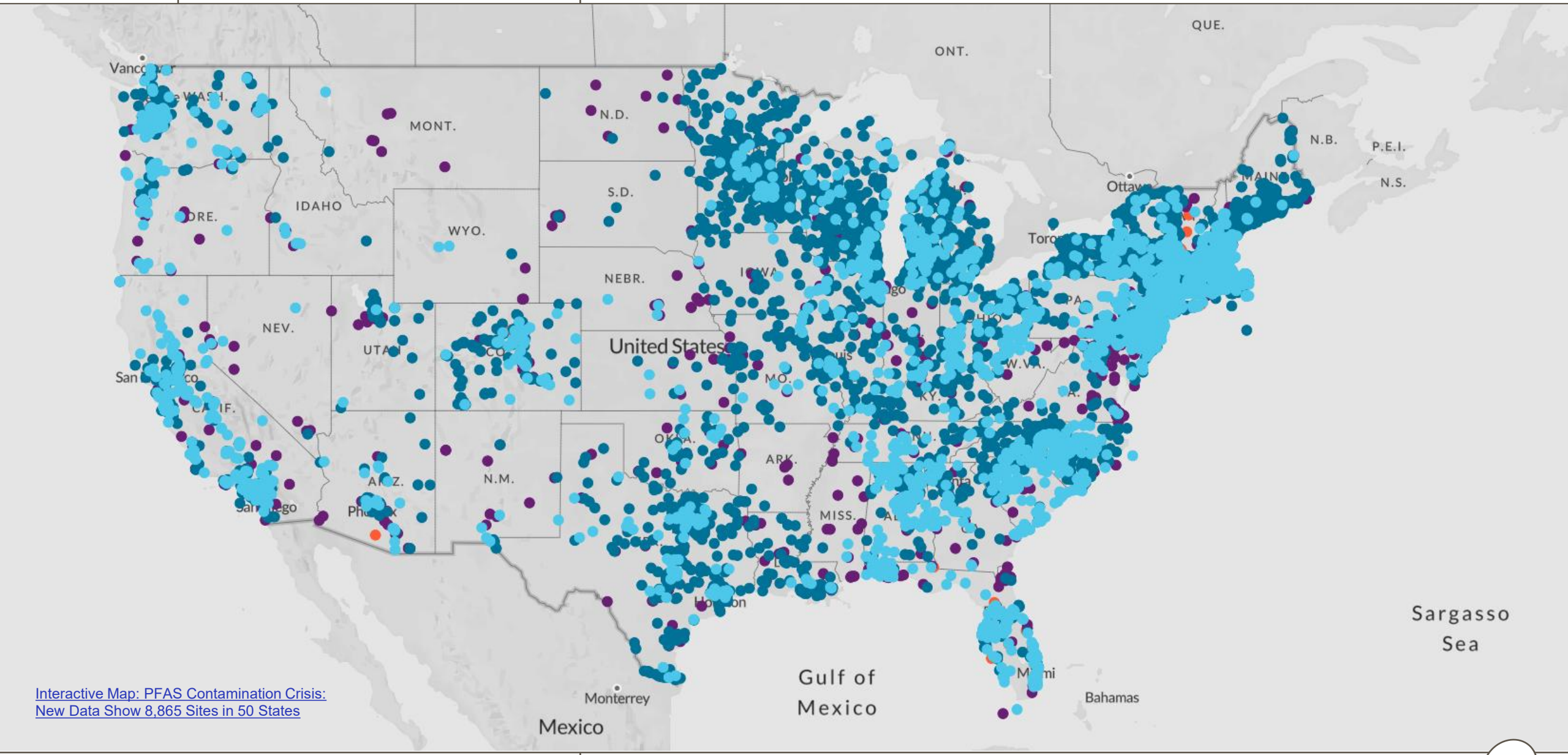
….

….IS CHALLENGING, YET CRUCIAL FOR ALL OF HUMANITY!

CHEMICAL MANAGEMENT IS EVERYONE'S RESPONSIBILITY



ASSESSING PFAS IN THE ENVIRONMENT



[Interactive Map: PFAS Contamination Crisis: New Data Show 8,865 Sites in 50 States]

ENVIRONMENTAL MONITORING OF PFAS: A SNAPSHOT

Sampling Goals

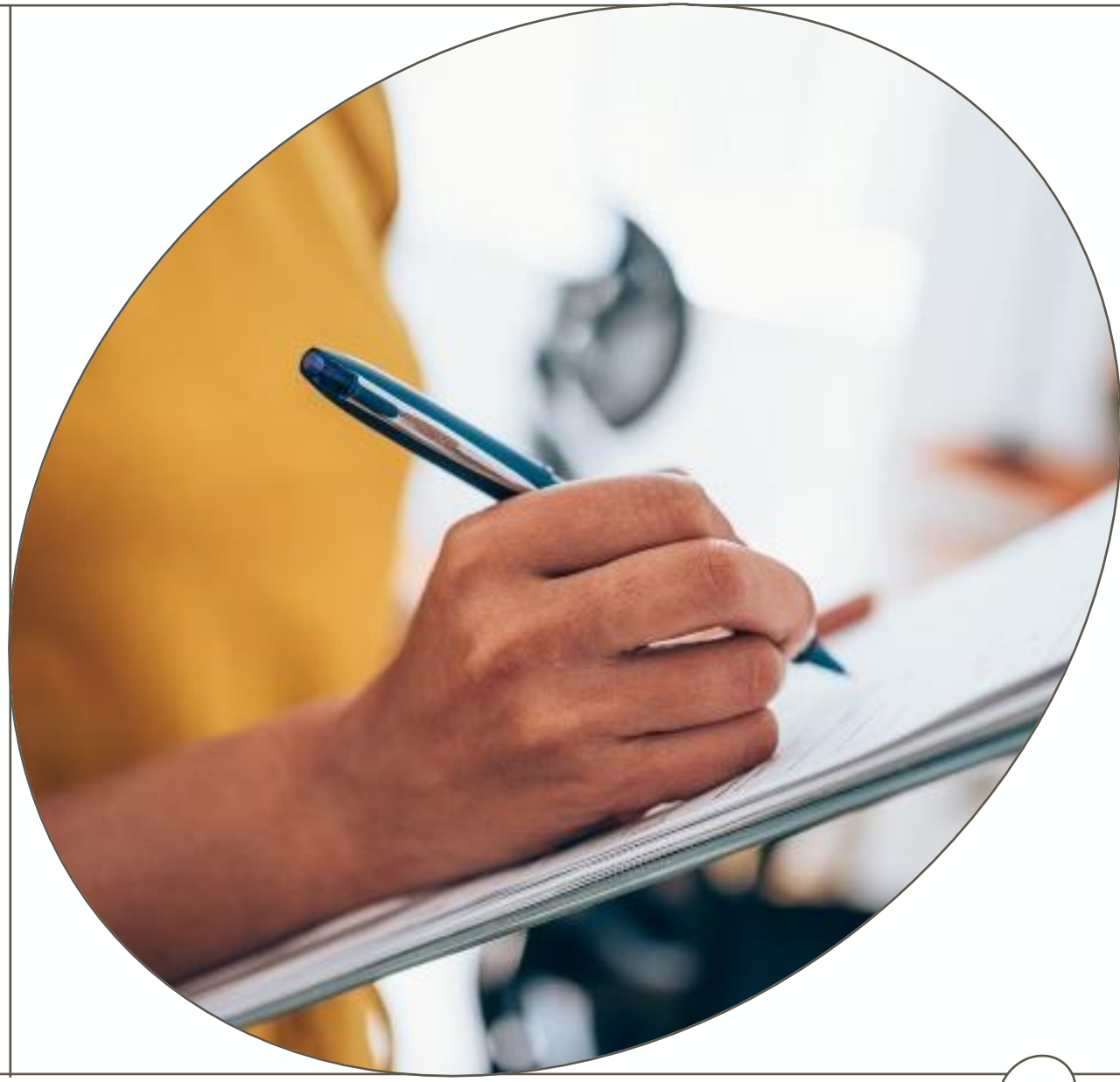
- Track contamination spread
- Support human & ecological exposure assessment
- Inform remediation strategies

Common Matrices

- Surface water
- Groundwater
- Sediment
- Ambient air
- Rainwater
- Fish tissue

SITE CHARACTERIZATION

- Site history
- Known PFAS usage
- Consideration of PFAS behavior
  - + Hydrophobicity
  - + Chain length
  - + Protein binding



ENVIRONMENTAL WATER SAMPLING

MEDIA	METHOD	DESCRIPTION
Drinking (Potable) Water	EPA 537.1	Measures 18 PFAS in drinking water (Updated from EPA 537)
Drinking (Potable) Water	EPA 533	Measures 25 PFAS in drinking water
Non-Potable Water & Other Media	EPA 8327	Measures 24 PFAS in non-drinking water aqueous samples
Non-Potable Water & Other Media	EPA 1633	Measures 40 PFAS in non-drinking water and other media samples

https://www.epa.gov/water-research/pfas-analytical-methods-development-and-sampling-research

ENVIRONMENTAL AIR SAMPLING: EPA OTM-45

- Measures 50 polar semi-volatile and particulate-bound PFAS in air emissions from stationary sources

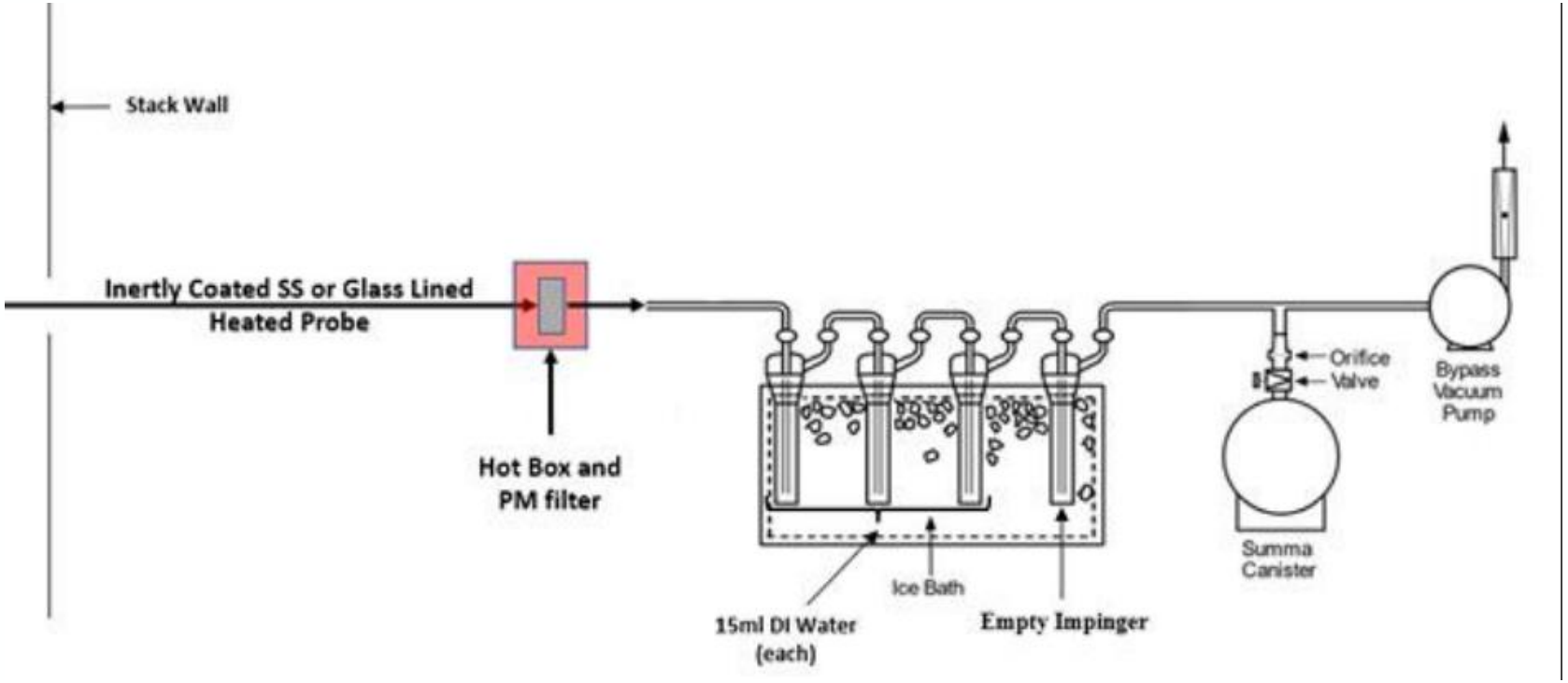
  EXAMPLES:
  - PFOA
  - PFOS
- Supports annual Toxic Release Inventory Reporting (TRI)

https://www.epa.gov/system/files/documents/2024-11/508-compliant-pfas-tr-webinar.pdf

ENVIRONMENTAL AIR SAMPLING: EPA OTM-50

Measures 30 nonpolar volatile PFAS in air emissions from stationary sources

- Compounds released during incomplete combustion of PFAS



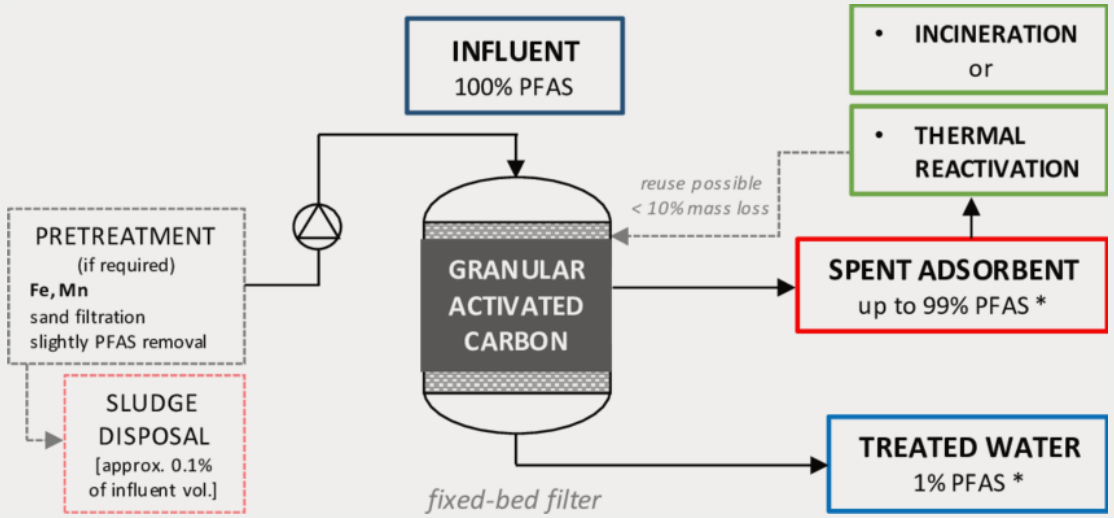
https://www.epa.gov/system/files/documents/2024-11/508-compliant-pfas-tr-webinar.pdf

PFAS REMEDIATION TECHNOLOGIES

FROM UNKNOWN TO KNOWN – AND THEN WHAT?

Remediation is complex due to PFAS chemical stability and diversity.

- Three main categories of remediation:
  - Immobilization (e.g., Activated Carbon)
  - Mobilization + Separation (e.g., Soil Washing)
  - Destruction (e.g., Thermal, Catalytic, Oxidative methods)
- Biological methods (e.g., Phytoremediation) are emerging but limited in scope.



IMMOBILIZATION TECHNOLOGIES

- **Techniques:** Granular Activated Carbon, Biochar, Inactivated Carbon, Composite Soil Amendments, etc
- **Application**: Used to immobilize PFAS in soils, reducing leachability.

Photo Credit: Riegel, Marcel & Egner, S. & Sacher, Frank & Beuthe, B. & Bonte, Matthijs & Hjort, Markus. (2020). Review of water treatment systems for PFAS removal.

MOBILIZATION AND SEPARATION TECHNOLOGIES

- **Techniques:** Soil Washing, Membrane Filtration, etc.
- **Application**: Involves extracting PFAS from soil using washing solutions.

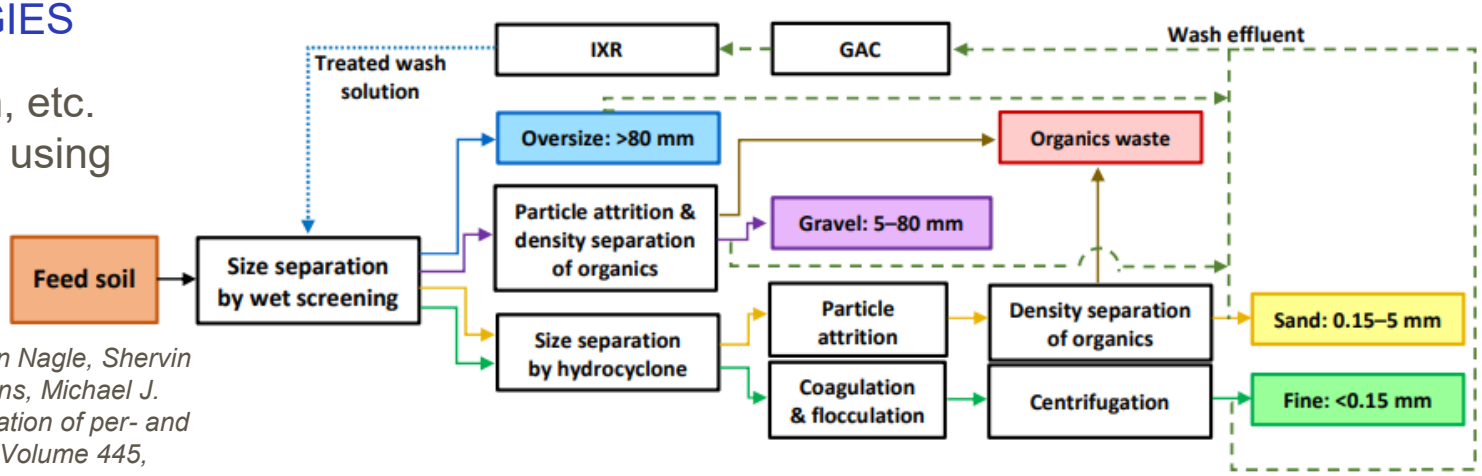
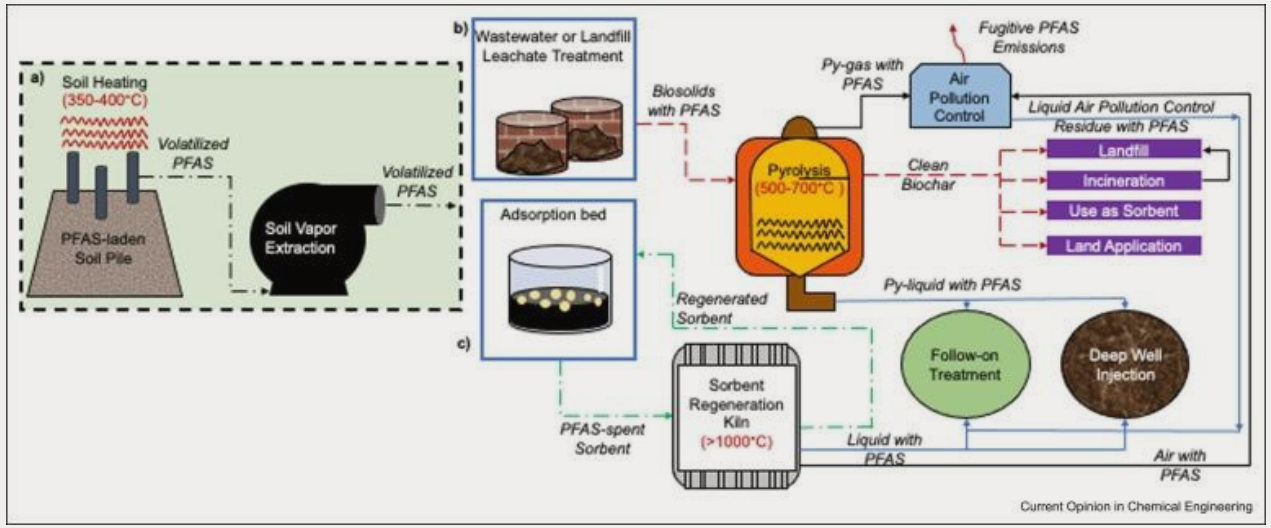


Photo Credit: Charles Grimison, Emma R. Knight, Thi Minh Hong Nguyen, Nathan Nagle, Shervin Kabiri, Jennifer Bräunig, Divina A. Navarro, Rai S. Kookana, Christopher P. Higgins, Michael J. McLaughlin, Jochen F. Mueller (2023) The efficacy of soil washing for the remediation of per- and poly-fluoroalkyl substances (PFASs) in the field, Journal of Hazardous Materials, Volume 445, 2023, 130441, ISSN 0304-3894



DESTRUCTION TECHNOLOGIES

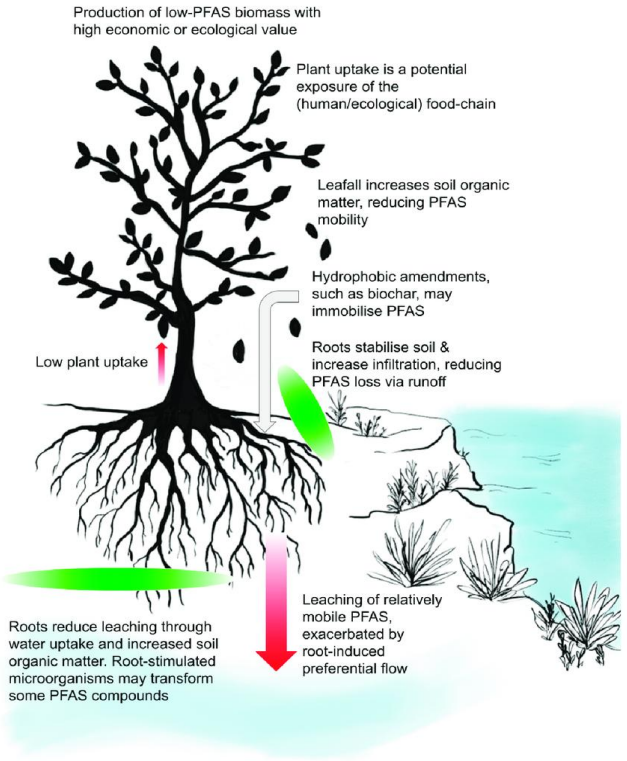
- **Techniques:** Direct Thermal Destruction, High-frequency heating (HFH), catalytic degradation, etc.
- **Application**: High-temperature treatment to decompose PFAS in soils; targeting complete breakdown of PFAS

Photo credit: David Zgonc, Pia Ramos, Yifan Gao, Eric M V Hoek, Jens Blotevogel, Anthony K Rappé, Shaily Mahendra,Hot topic: thermal treatment of per- and polyfluoroalkyl substances,Current Opinion in Chemical Engineering, Volume 42, 2023, 100976, ISSN 2211-3398,

BIOLOGICAL AND PLANT-BASED TECHNIQUES

- **Techniques:** Phytoremediation, bioelectrochemical systems, etc.
- **Application**: Utilizes plants to uptake PFAS from soil.

Photo credit: Evangelou, M.W.H.; Robinson, B.H. The Phytomanagement of PFAS-Contaminated Land. Int. J. Environ. Res. Public Health 2022, 19, 6817



PFAS REMEDIATION TECHNOLOGY OVERVIEW

TECHNOLOGY	TYPE	BEST USED FOR	KEY ATTRIBUTES	PROS	CONS	SUCCESS / LIMITATIONS
Activated Carbon (AC) Sorption [1], [7]	Immobilization	Soils with moderate to high PFAS; long-term containment	High surface area; PAC/GAC; long-term stability	Effective on long-chain PFAS; durable (>95% reduction over 4 years)	Limited removal of short-chain PFAS; non-destructive	Field-tested, proven in Australia and Canada; reduced leaching by 95%+
Soil Washing [2], [7]	Mobilization + Separation	Coarse soils; ex-situ PFAS removal	Physical-chemical separation; water recycling	Removes up to 97% PFAS; soil reused as backfill	Limited for high-clay soils; needs liquid PFAS treatment	Full-scale 2200-ton project achieved >90% mass removal
High-Frequency Heating (HFH) [3]	Destruction	Sites needing rapid, complete removal of PFAS	Electromagnetic field heating; sub-2 min treatment	Destroys 99.9% of PFAS; effective for all types	Emerging tech; cost and scale factors unknown	Lab-verified destruction of short/long-chain and precursors
Catalytic Oxidation (UV/electro/photo) [4], [5], [7]	Destruction	Concentrated PFAS waste streams; water	Advanced oxidation with UV, catalyst, or electrolysis	Degrades many PFAS; field-adaptable to water	Not field-proven in soil; energy-intensive	Effective in water trials; limited in real soil
Phytoremediation with Hemp [6]	Phytoextraction + Biodegradation	Low-level PFAS soil; community-engaged remediation	PFAS uptake in biomass; HTL destroys PFAS in plant	Low-cost; targets short-chain PFAS; biomass treatable	≤2% soil PFAS removed/season; not viable alone	Pilot project removed 1.4 mg PFAS; HTL effective post-processing

1. Navarro et al., 2023. Stabilisation of PFAS in Soils. Environmental Pollution.
2. Grimison et al., 2023. Soil Washing for PFAS Remediation. J. Hazard. Mater.
3. Sun et al., 2024. High-Frequency Heating for PFAS Soils. J. Hazard. Mater.
4. Restivo et al., 2024. Catalytic Routes for PFAS Water. J. Environ. Chem. Eng.
5. Rhakho et al., 2024. PFAS Water Treatment Survey. J. Environ. Chem. Eng.
6. Nason et al., 2024. Hemp Phytoremediation Field Study. Environ. Sci. Advances.
7. Bolan et al., 2023. Comprehensive Review of PFAS Soil Remediation. J. Hazard. Mater.

PFAS REMEDIATION TECHNOLOGIES: BENEFITS, DRAWBACKS AND LIMITATIONS

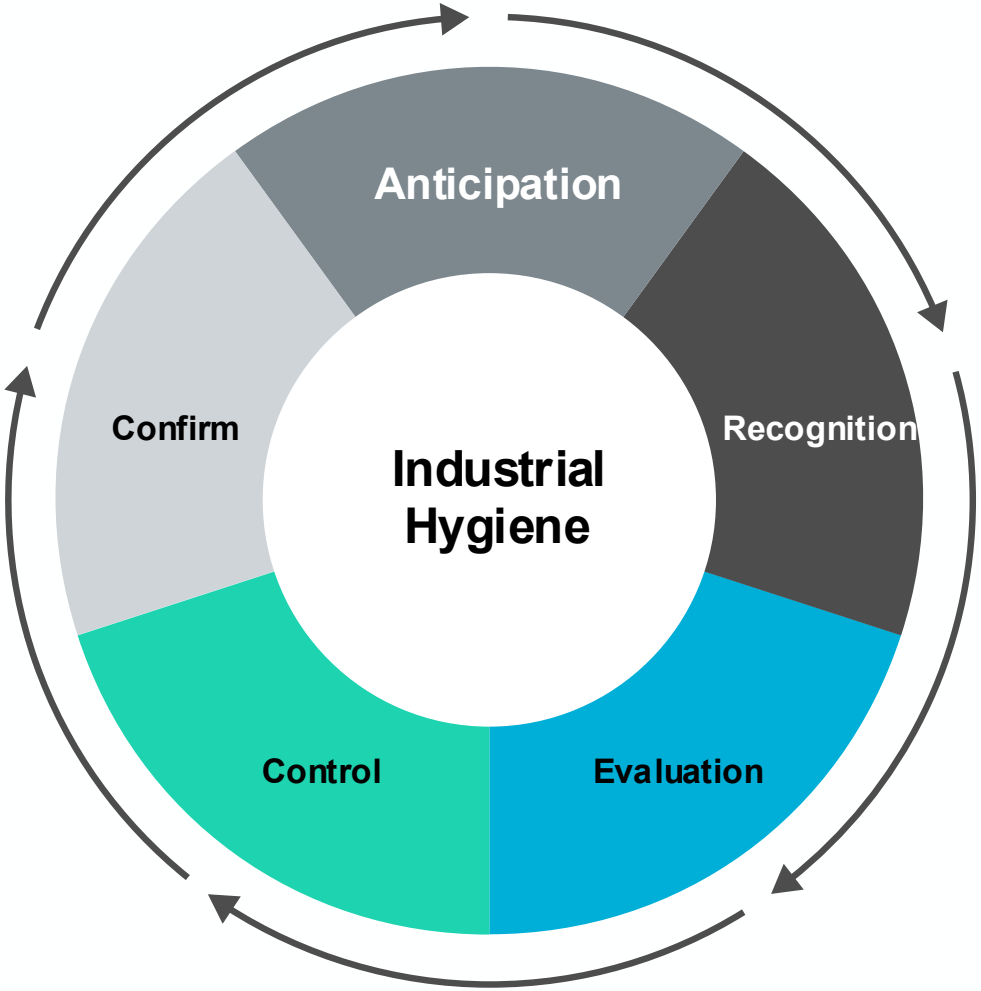
No single technology fits all scenarios — site- and contaminant-specific!

- **Immobilization:** Field-proven for long-chain PFAS but does not destroy compounds.
- **Mobilization:** Effective for source removal but generates secondary waste.
- **Destruction:** Enables permanent PFAS removal; often costly or infrastructure-heavy.
- **Phytoremediation:** Low-cost and community-friendly; slower and less effective for long-chain PFAS.

DECISION-MAKING MUST WEIGH EFFECTIVENESS, COST, SCALE, SUSTAINABILITY, AND REGULATORY CONTEXT.

ASSESSING PFAS IN THE WORKPLACE

TRADITIONAL IH PROCESS



PFAS AIR SAMPLING TRAIN: EPA OTM-45

OTM-45 Sample Train

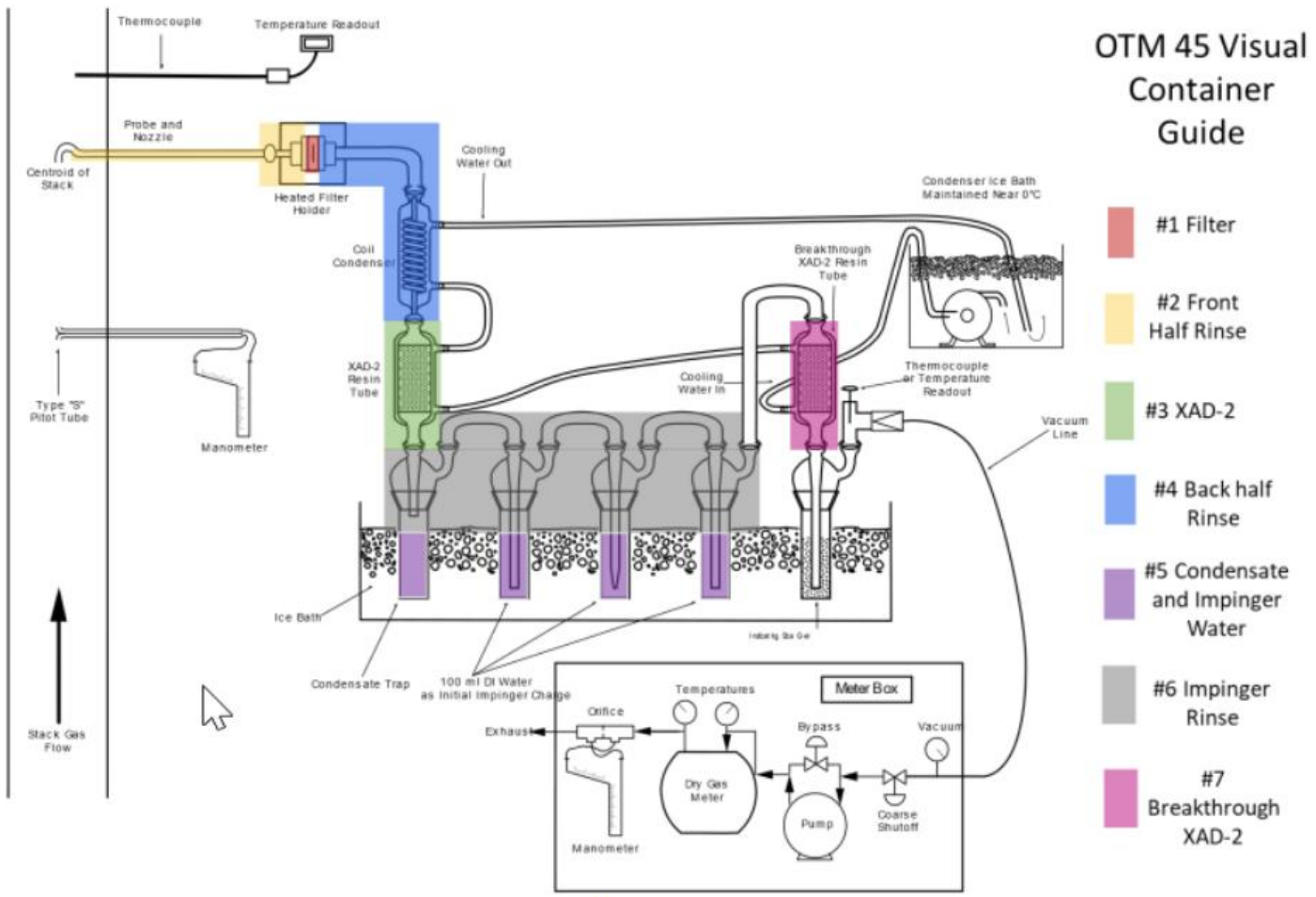
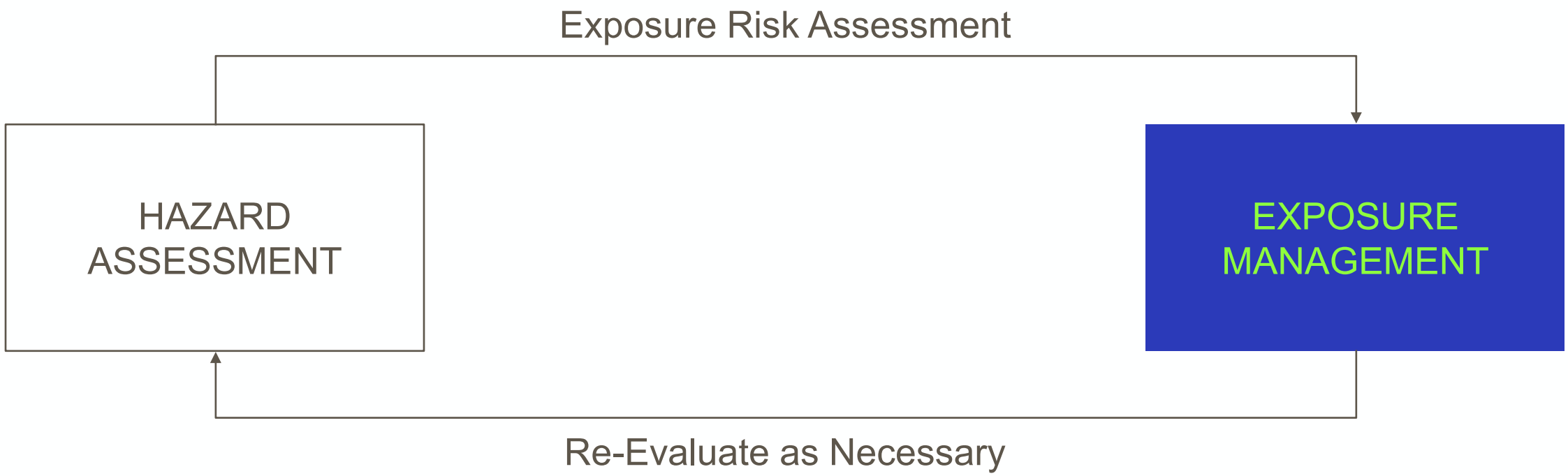


Figure OTM-45-1. Sampling Train

https://montrose-env.com/blog/how-to-use-otm-45-for-pfas-air-testing/

EXPOSURE ASSESSMENT APPROACH

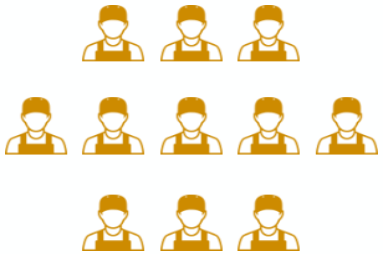


SIMILAR EXPOSURE GROUPS

DEPARTMENT: Maintenance
JOB: Maintenance Tech

DEPARTMENT: Production
JOB: Operator

DEPARTMENT: QA Lab
JOB: Lab Technician



HAZARD ASSESSMENT: EXPOSURE BANDING

- Chemicals without OELs or IH sampling methods
- Qualitative chemical risk assessment
- Hazard profile based on:
  - + GHS hazard classifications
  - + Published studies
  - + Toxicological information
- Assign into exposure bands (A-E)
- Science-based method to characterize risk and support decision making

EXPOSURE BANDING

BAND A	BAND B	BAND C	BAND D	BAND E
• Minimal toxicity effects • High exposure concentrations	• Reversible or mild health effects • Moderate exposure concentrations	• Serious or irreversible health effects • Lower exposure concentrations	• Highly toxic, severe health effects • Very low exposure concentrations	• Extremely toxic, life-threatening effects • Lowest exposure concentrations

CONTROL BANDING: LINKING HAZARD TO PRACTICAL CONTROLS

BAND A	BAND B	BAND C	BAND D	BAND E
• General ventilation • Basic hygiene practices • Minimal PPE	• Local ventilation • Routine PPE • Training	• Local ventilation • Administrative controls • Air-purifying respirators	• Closed or isolated systems • Advanced PPE • Medical surveillance	• Full containment • Supplied Air, PAPR • Chemical-resistant suits

PUTTING IT ALL TOGETHER: PERFLUORODECANOIC ACID (PFDA)

EXPOSURE BANDING

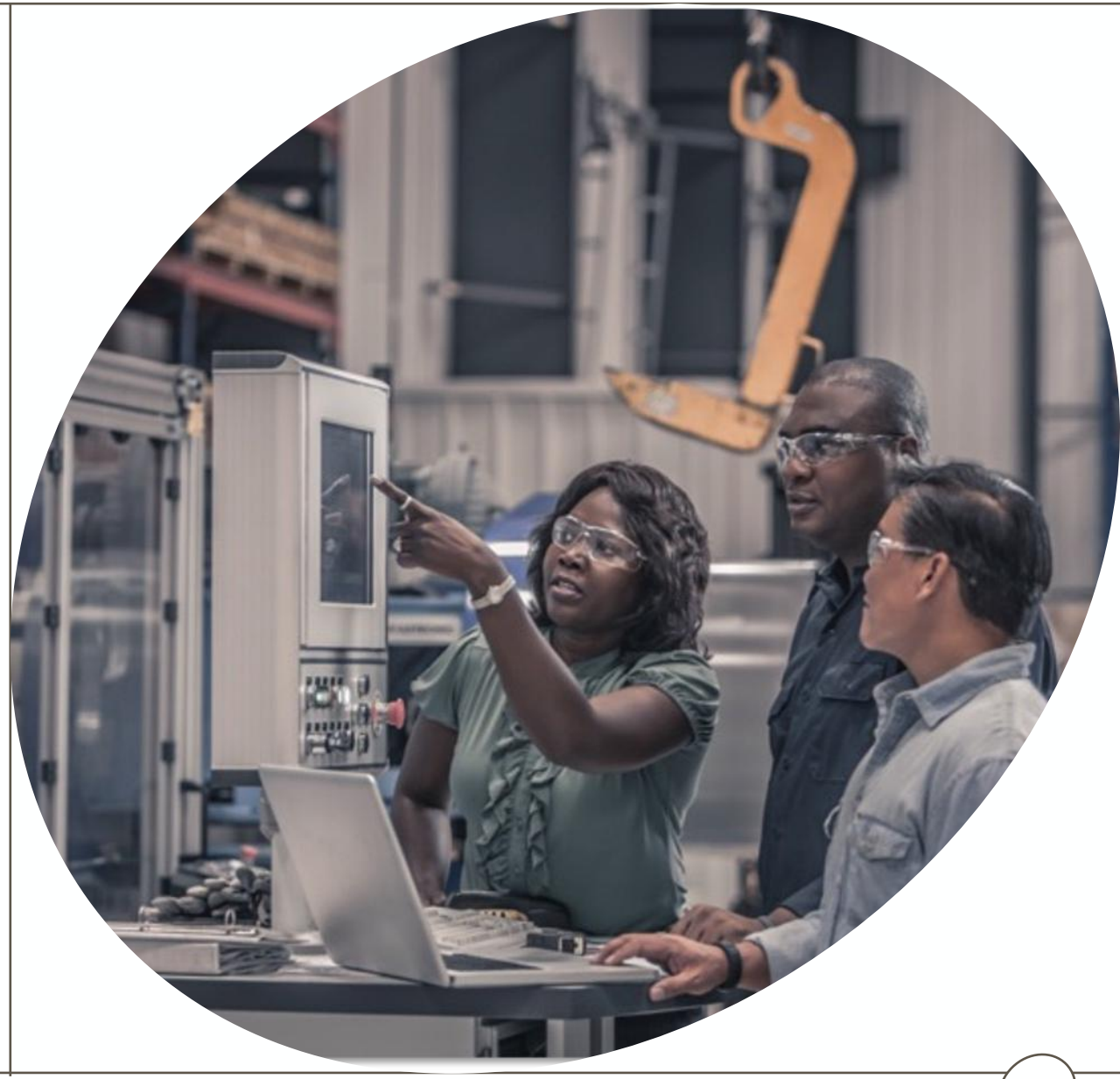
- No OEL
- Hazard Profile
  - + **GHS**: Skin & eye damage, suspect carcinogen, target organ toxicity
  - + **Studies**: Thyroid tox, liver tox, reproductive toxicity, endocrine disruptor
  - + **Tox Data**: Low NOAEL values
- **Band E or D – High/Very High Hazard**

CONTROL BANDING

- **Band E Controls**:
  - + Evaluate **Substitution** options
  - + **Engineering**: Closed handling system, fume hoods/glove boxes
  - + **PPE**: Chemical-resistant gloves and suits, PAPR
  - + **Administrative**: Restricted access, SOPs, training, medical surveillance

ADVANTAGES OF EXPOSURE BANDING FOR PFAS RISK MANAGEMENT

- Addresses data gaps
- Proactive risk assessment
- Supports consistent, transparent decision making
- Informs control strategies
- Flexible and scalable
- Strengthens chemical inventory management



IN SUMMARY

- PFAS are prevalent and biopersistent
- Ever-changing global regulatory landscape
- PFAS cycles through the environment – surface and ground water impacts
- Software can help identify PFAS in your chemical portfolio
- Continuous improvement of Environmental monitoring and remediation technologies
- Proactive need to assess and mitigate PFAS exposure risks
  + Exposure Banding
  + Control Banding for risk management

QUESTIONS?

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