PERRIN CONFERENCES

ENVIRONMENTAL RISK & PFAS LITIGATION CONFERENCE

The New York City Bar Association | June 17-18, 2025

The Future of PFAS: Zero-discharge Facilities

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THE FUTURE OF PFAS

ZERO-DISCHARGE FACILITIES

By: Verónica Vázquez, ESQ.

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AGENDA

- Introduction
  - Overview of PFAS
  - Challenges of Zero-Discharge
- Continued Use of PFAS and Emerging Policies
  - Military Phase-Out of PFAS-Based Foams
  - Essential Use Concept
  - Impact of PFAS Bans on Industry
- Regulatory Difficulties
  - Proposed Maximum Contaminant Levels (MCLs)
  - CERCLA Designation
  - Gaps in Discharge and Biosolids Regulation
- Burden on Public Water Systems (PWS)
  - Compliance Costs and Treatment Upgrades
  - Ongoing Contamination through Biosolids and Industrial Discharges
- Conclusion

OVERVIEW OF PFAS

- Introduction to PFAS
  - Large family of synthetic chemicals
  - Used in industry and consumer products since mid-20th century
- Unique Properties of PFAS
  - Resistance to heat, water, and oil
  - Applications in non-stick cookware, stain-resistant textiles, firefighting foams, and semiconductor manufacturing
- Environmental Persistence
  - Break down extremely slowly
  - Bioaccumulate in people and environment over time
  - Nicknamed “forever chemicals”
- Global Contamination
- Health Effects

CHALLENGES OF ZERO-DISCHARGE

- Persistence and Toxicity of PFAS
  - Regulators and communities aim to eliminate or reduce PFAS pollution
- Zero-Discharge Goal
  - Phasing out all non-essential uses of PFAS
  - Preventing essential uses from entering waste streams
- Significant Hurdles
  - Ongoing essential uses of PFAS
  - Regulatory efforts
  - Technical and legal obstacles
  - Burdens on public water systems

MILITARY PHASE-OUT OF PFAS-BASED FOAMS

- Continued Use of PFAS in Industry and Consumer Products
  - Despite awareness of risks, PFAS use persists
  - Requires careful policy considerations
- U.S. Military Phasing Out PFAS-Based Foams
  - Due to contamination concerns
  - Mandated by law to phase out AFFF by October 1, 2024
  - Limited waivers allowed up to 2026
- Development of PFAS-Free Replacement Foams
  - Driven by National Defense Authorization Act
  - Challenges in meeting performance needs
- Civilian Airports and State Bans
  - Adoption of PFAS-free foams

ESSENTIAL USE CONCEPT

- Essential Use Concept
  - Critical for health or safety
  - Lack safer alternatives
- Examples of Essential Uses
  - Medical devices
  - Specialized safety gear
- Non-Essential Uses
  - Consumer products
  - Targeted for phase-out
- U.S. Legislation
  - State-level laws prohibiting or limiting use of PFAS

IMPACT OF PFAS BANS ON INDUSTRY

- Role of PFAS in High-Tech and Manufacturing
  - Essential in at least seven major industries
  - Semiconductor industry uses PFAS for photolithography and etching
  - Aerospace manufacturers use PFAS for high-performance coatings
  - Energy sector uses PFAS in battery components
  - Medical field uses PFAS in implants, medical wires, and ventilators
- Economic Impact of PFAS Bans
  - Potential loss of millions of jobs
  - Trillions of dollars in economic output at risk
  - Disruption of supply chains
- Regulatory Approach
  - Balancing public health protection and industrial needs

MAXIMUM CONTAMINANT LEVELS (MCLS)

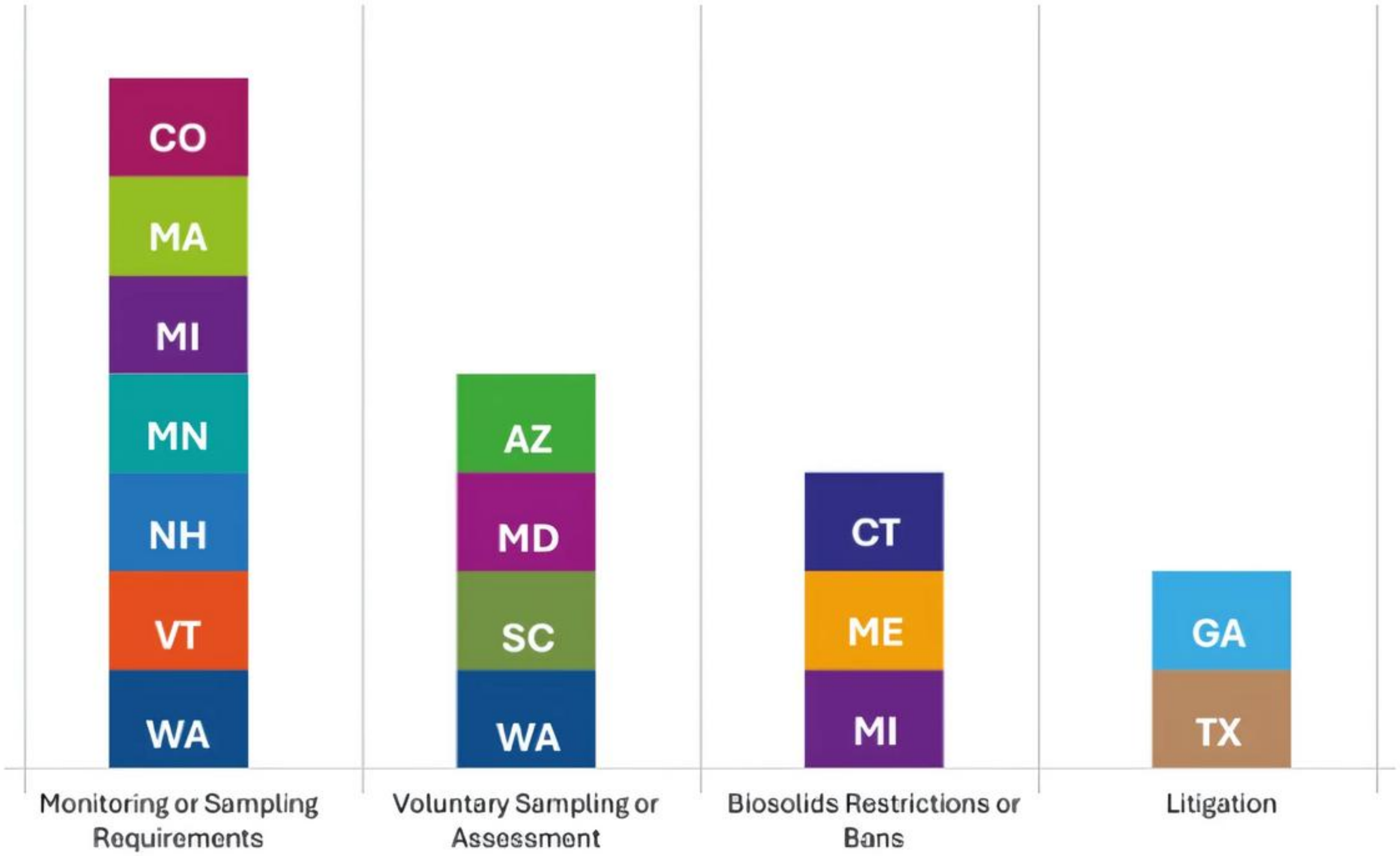
- EPA's Maximum Contaminant Level for PFAS
  - Proposed in March 2023
  - Final rule issued in April 2024
- Established MCLs for PFAS
  - 4.0 ppt for PFOA and PFOS
  - 10 ppt for PFNA, PFHxS, PFBS, and GenX HFPO-DA
- Impact on Water Systems
  - 66,000 water systems affected
  - Monitoring required
- Compliance Costs
- State Regulations vs. Federal Rule
  - Having a Federal rule offers a uniform baseline
  - When only states regulate, there is no uniformity

CERCLA DESIGNATION

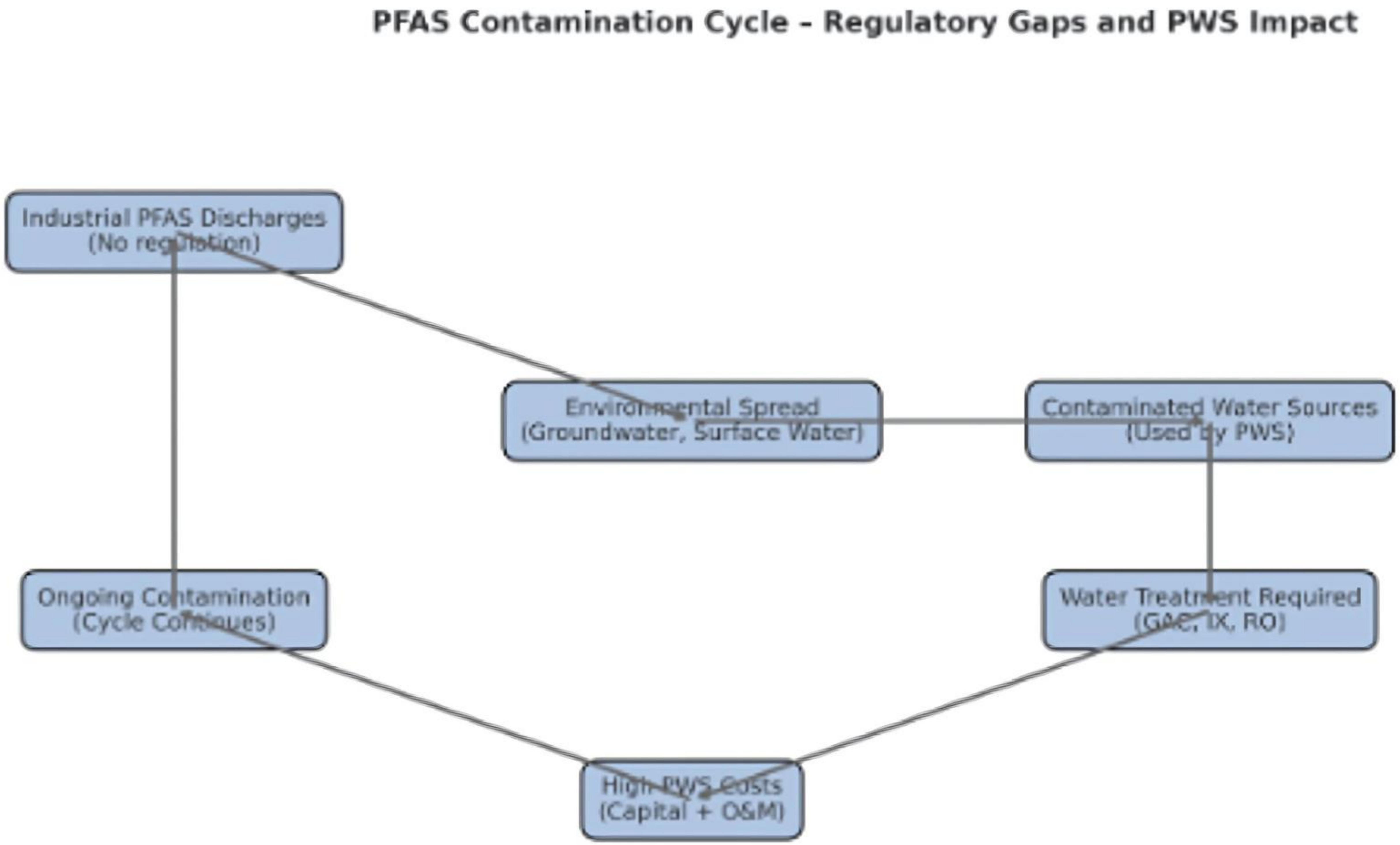
- EPA's Regulatory Development
  - Designated certain PFAS as hazardous substances
  - Finalized rule listing PFOA and PFOS under CERCLA
- Impact of CERCLA Designation
  - Triggers CERCLA’s remediation and liability provisions
  - EPA can compel or undertake cleanup actions
  - PRPs can be held liable for cleanup costs
- Motivation for Companies
  - Encourages prevention of PFAS pollution
- Opposition and Concerns
- EPA's Enforcement Discretion Memo
- Financial and Legal Implications

GAPS IN DISCHARGE AND BIOSOLIDS REGULATION

- Regulatory Gaps in PFAS Control
  - No comprehensive federal limits on PFAS in industrial wastewater discharges
  - Clean Water Act's NPDES program lacks PFAS limits for most industries
- Withdrawn EPA Rule
  - Previously considered rule for technology-based PFAS discharge limits was withdrawn
  - Resulted in a void in federal discharge standards
- State Authority
  - States can impose PFAS limits or monitoring requirements
  - PFAS can still be legally discharged into waterways without state action
- Biosolids Regulation
  - No federal regulation for PFAS content in biosolids
  - EPA issued guidance recommending states monitor biosolids



Activity in the States:
PFAS in Wastewater and Biosolids



SUMMARY OF PFAS CONTAMINATION CYCLE

ONGOING CONTAMINATION THROUGH BIOSOLIDS AND INDUSTRIAL DISCHARGES

- Continuous Invasion of PFAS
  - Complicates operations for wastewater management
- Conventional Wastewater Treatment
  - Does not destroy PFAS
  - Filters may not prevent PFAS from re-entering the environment
- Increased Calls for Upstream Source Control
  - Programs requiring industries to remove PFAS before wastewater is sent to municipal plants
  - Bans to keep PFAS out of consumer waste streams
- Responsibility of Water Utilities
  - Not solely responsible for managing PFAS at the end of the line

CONCLUSION

- Potential Negative Impact of PFAS Bans
  - Key industries may be adversely affected
- Path Forward for Continued PFAS Use
  - Exploring possible solutions and alternatives
- Technological and Regulatory Hurdles
  - Necessary implementations for future use

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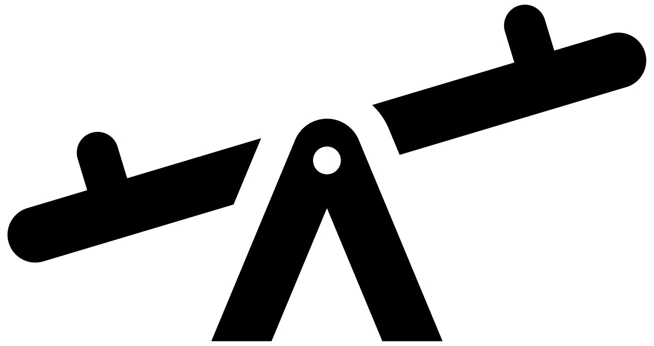
How does PFAS enter a facility?

1. Facility manufactures PFAS
2. Facility uses or historically used PFAS in manufacturing process
3. Contaminated incoming water supply
4. Packaging and other elements of supply chain
5. Historic uses by others and deposition from adjacent sites

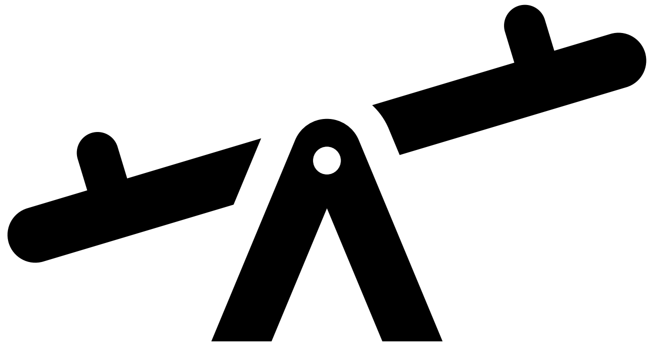
Considerations to Assess Vulnerability

PFAS USE



PFAS PROCESS

PFAS-FREE DEFINITION



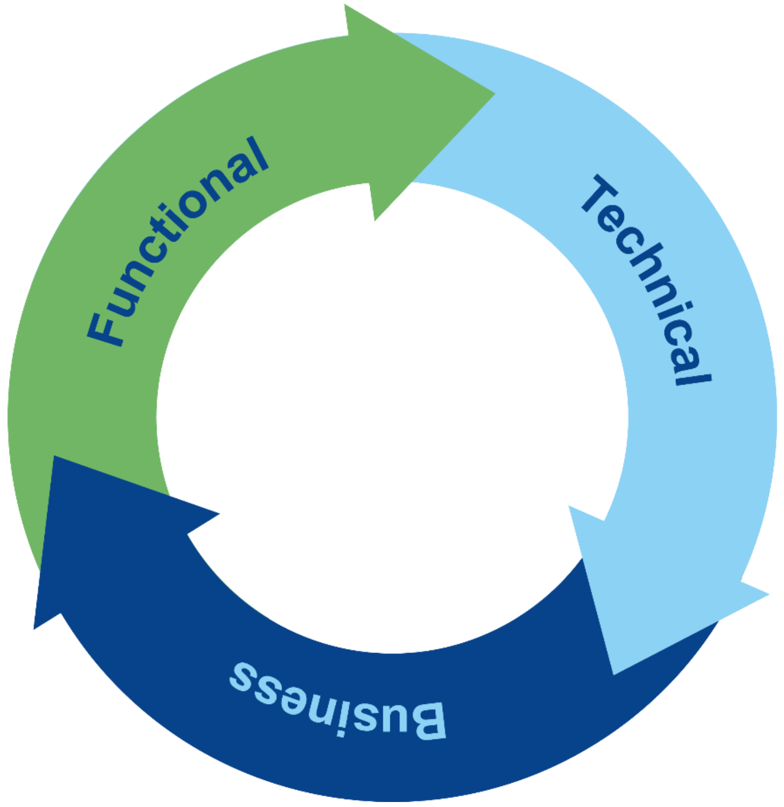
Vulnerability Assessment

Functional

- Alternative Assessment
- Supply Chain Evaluation

Technical

- Hazard Assessment
- Lifecycle Assessment



Business

- Strategy, Risk Management

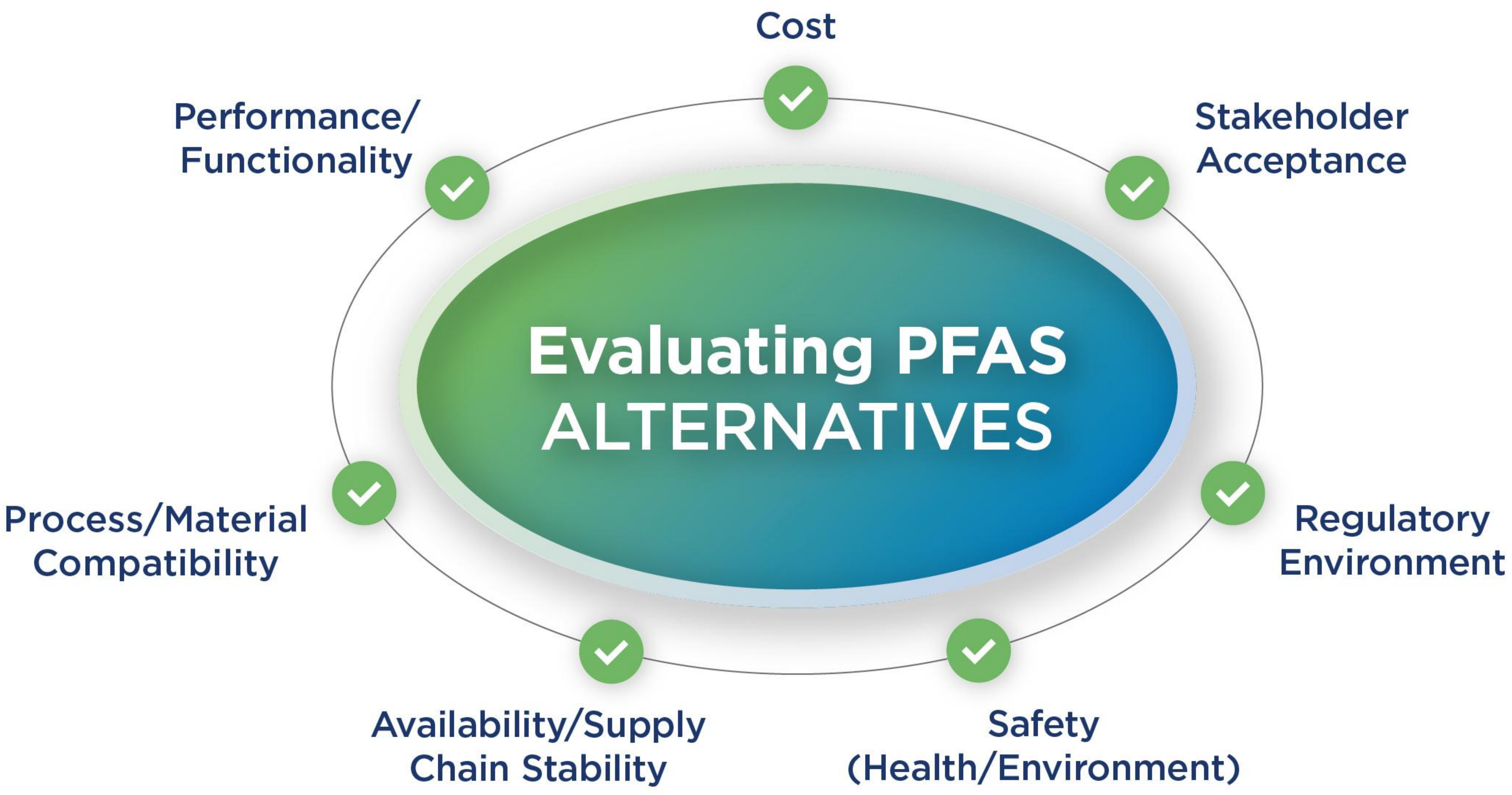
Business

- Cost/Liability Management

Desktop Review

Functional Assessment	Technical Assessment	Cost/Liability Management	Strategy/Risk Management
• Where is PFAS used in product formulations or processes? Across the supply chain? • How necessary is the function provided by PFAS in the product or process? • Are there suitable alternatives to support the function?	• Are PFAS chemicals documented in formulations/ Safety Data Sheets (SDS)? If not, is analytical testing required? • What are the specific PFAS present, and are they persistent, bioaccumulative, toxic, or mobile? • Are the chemicals being or have they been released to the environment? Have there been human exposures? • What is the environmental impact across the lifecycle?	• What PFAS-related regulations apply in the areas in which the company operates or sells products? • What additional regulations are anticipated in these areas? • What types of permitting and regulatory compliance actions are required? • Have environmental reserves been calculated to address liabilities?	• Based on functional, technical, and cost assessment, what are the highest priorities? • Establish and rank high-, medium- and low-risk priority by operations/ geography. • Develop management and mitigation plan to address current risks and plan for future potential risks.

Material Alternatives Assessment



Analytical Evaluation

Questions	Methods	Matrices
• Screening Test (Is PFAS present? Yes/No) • PFAS Characterization (Which PFAS chemical(s) are present?) • Total Concentration (How much PFAS is present?) • Environmental Passive Sampling (What kinds/how much PFAS are present in an environment?) • Fingerprinting (What type of PFAS is present in the environment? What is the likely source?)	• Liquid Chromatography Tandem Mass Spectrometry (LC-MS/MS) • Gas Chromatography-Mass Spectrometry (GC-MS) • High-Resolution Mass Spectrometry (HRMS)	• Water • Soil/sediment • Air • Biological tissue (plant, animal, fungal) • Firefighting foams • Materials (polymers, coatings, electronic components, mold release agents, lubricants, etc.) • Finished products (textiles, plastics, personal care products, home goods, industrial products, etc.) • Packaging (paper/corrugate, coatings, linings)

Risk Assessment and Ranking

Likelihood Assessment

Probability of a risk occurring based on historical data, trends and expert analysis

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Impact Assessment

Potential severity of consequences including operational, legal, financial and reputational

→ **Composite Risk Score**

Considerations for Site Remediation

Site Characterization	Fate and Transport Modeling	Remediation and Deconstruction
Where does PFAS exist in the environment? How much and what kind? • Passive sampling methods (water, air) • Sample collection and analysis (water, soil, sediment) • Source attribution/ fingerprinting	How does PFAS move in the environment? Where will it end up? • Hydrological (surface/groundwater) • Soil/sediment • Air dispersion • Bioaccumulation	What is the best way to get rid of PFAS in the environment? • Adsorption (granular activated carbon (GAC) and ion exchange) • Reverse osmosis • Incineration • Supercritical water oxidation and other oxidation processes • Landfilling • Deep well injection

INOGEN® ALLIANCE

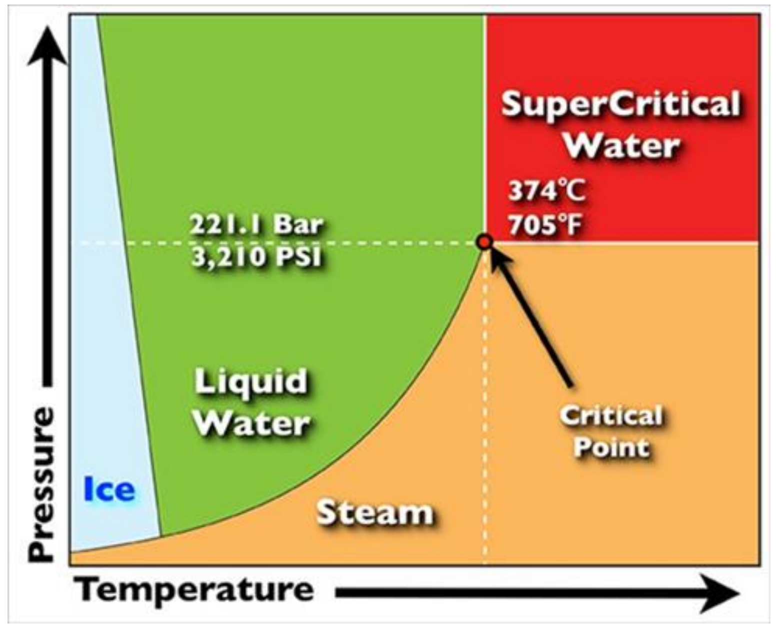
Zero PFAS Discharge Facilities – Is it Possible?

Zero Discharge Facility / What does it mean?

- Focus is on Industrial & Municipal Wastewater Treatment Plants (WWTPs)
  - ❖Difference is largely scale (treatment volume)
- *PFAS enters WWTPs as influent & exits via treated water, air emissions and biosolids*
- *Zero Discharge would require removal/destruction of PFAS in all waste streams (solids & liquids)*
- *Regulatory focus is on identify upstream point sources & eliminate/minimize PFAS contribution to WWTP*
- *Options to achieve zero discharge via regulatory action or remediation/Destruction include:*
  - ❖*Pre-Treatment Programs, NPDES Permitting Requirements (PFAS sampling)*
  - ❖*Destruction of waste streams onsite*

PFAS Remediation - What's new?

- Historical focus has been on the following PFAS treatment methodologies:
  - Adsorption (i.e., GAC, IX resin)
  - Separation & Concentration (i.e., RO, Foam Fractionation)
- *Both approaches have significant waste challenges.*
- *Stand alone destruction technologies are currently best suited for higher concentration, low volume waste streams.*



New Trend is to look at a "treatment train" that combines a separation/concentration process with an onsite destruction technology that results in a minimal/no waste outcome. Commercial application of Foam Fractionation & SCWO (Super Critical Water Oxidation) is already in the market where landfill leachate is being treated with no PFAS waste to manage.

Remediation Approaches for Liquids

- **Incineration** (prohibited ?)
- **Adsorption**
  - ❖ GAC, IX Resin, Polymeric Adsorbents and other Polymer products and media
- **Separation & Concentration**
  - ❖ Filtration (RO, NF/UF)
  - ❖ Fractionation (Air, Ozone, DAF)

Waste Media

- Spent Media (GAC/Resin/other adsorbents) - *Solid Waste*
- Regeneration fluids (for select IX resins)
- Reject Water (RO/UF/NF)
- Concentrate/Super Concentrate (Fractionation)

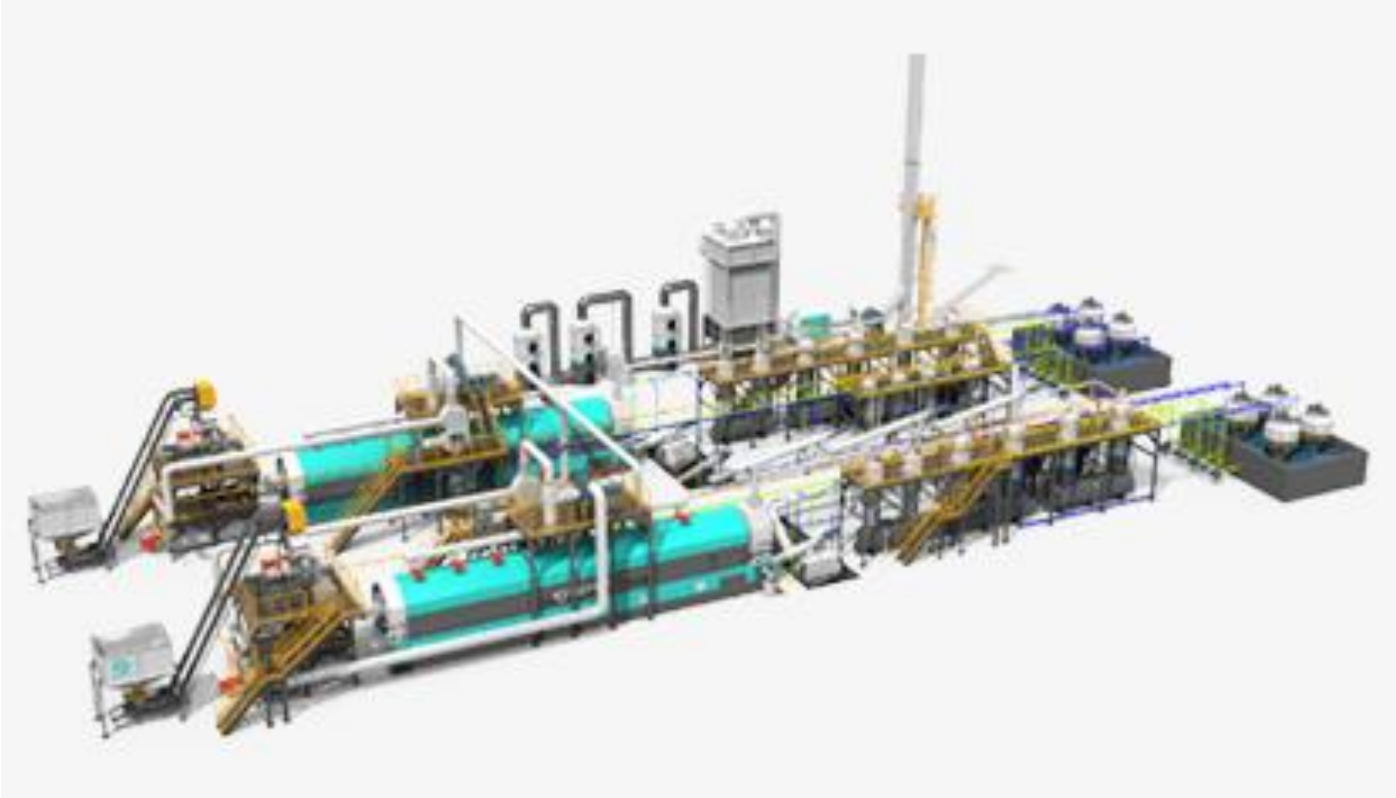
Note:

Soil Washing produces a liquid waste stream that is likely treated by one of these approaches.

Remediation Approaches for Solids

Pyrolysis is a treatment process that decomposes impacted solids including biosolids at moderately high temperatures in an oxygen-free environment. **Gasification** is similar but introduces small quantities of oxygen. Gasification leverages the partial combustion process to provide additional heat to operate the process.

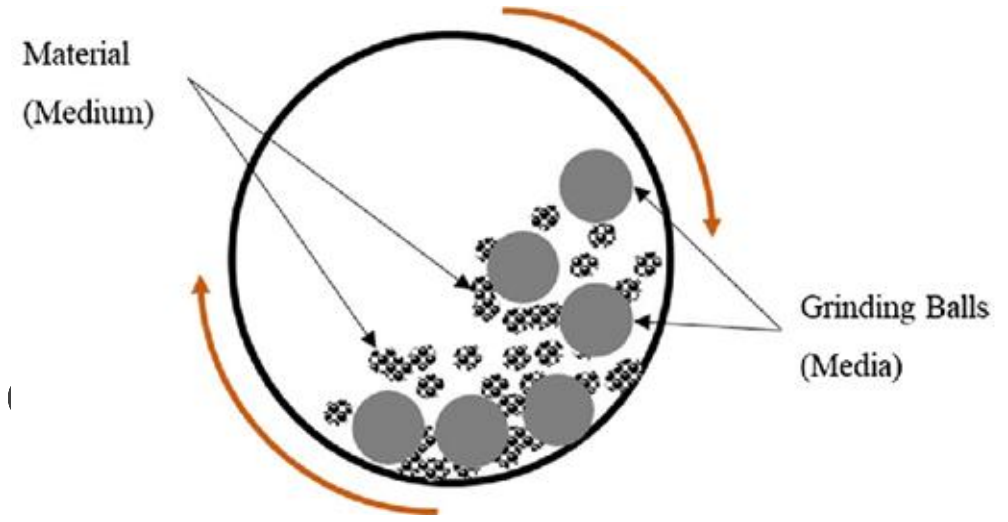
- Pyrolysis (no oxygen) and gasification (limited oxygen) makes the technologies differ from incineration.
- Potential application for biosolids
- Can be used to create biochar/soil amendment and syngas (alternate fuel source)
- Solids reduction of over 90%
- Emissions and incomplete destruction of PFAS needs additional evaluation.



Emerging Remediation Approach for Solids

Mechanochemical Degradation (MCD)

- High energy ball-milling
- MCD doesn't require solvents or heat
- Soils/solids application (potential biosolids?)
- Co-milling reagents (silica, potassium hydroxide, calcium oxide maybe added to react with fluorine
- Milling process produces radicals, electrons, heat and plasma that rea with PFAS to produce inorganic fluoride compounds and graphite
- Proven technology at both bench and pilot scale with some POPs (PCBs) that achieved 99% destruction at a 6t/hr rate
- Evaluation of technology for treating PFAS is still in the preliminary stages
- Technology may produce gaseous PFAS emission that may require separate treatment step



Waste Management Challenge

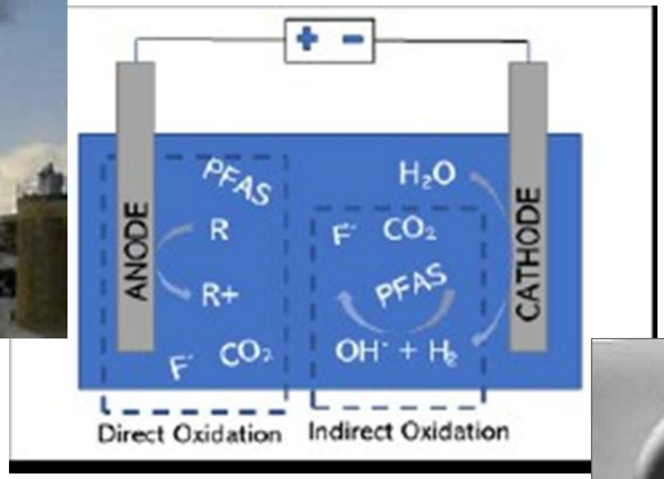
- PFAS compounds are recalcitrant by nature and today's remediation technologies don't destroy/degrade PFAS, so waste is likely relocated to offsite treatment/disposal facilities where is may re-enter the environment.

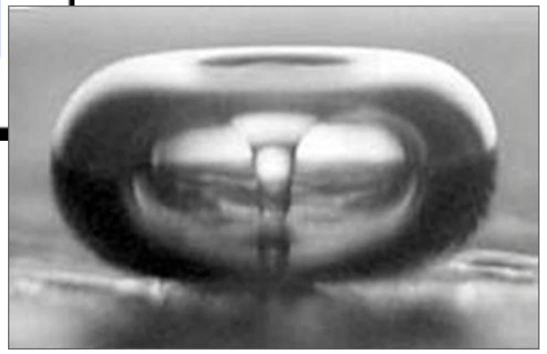
- The Good News is that it is possible to break this cycle via new and emerging technologies that at bench and pilot scale have successfully achieved the destruction of PFAS!

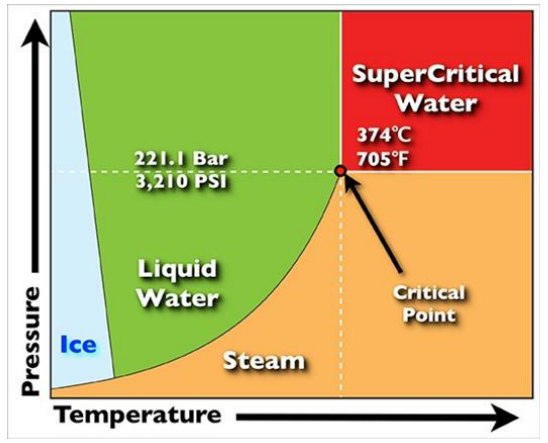
- The Challenge is that current destruction technologies are best applies for low volume, higher concentration media (i.e. SCWO approx. <500 gpd (1900 lpd) per treatment unit).

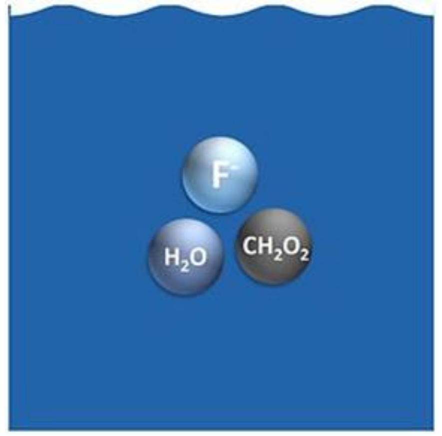
PFAS Removal/Destruction Technologies

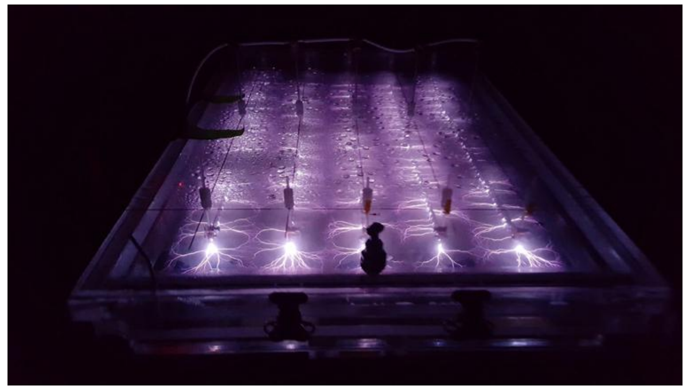
- Incineration/Thermal Treatment
- Electrochemical Oxidation (EC)
- Super Critical Water Oxidation (SCWO)
- Sonolysis
- Electrical Discharge Plasma
- Hydrothermal Alkaline Treatment (HALT)
- Photo Activated Reductive Defluorination (PRD)
- Biological approaches (early days)











PFAS Remediation/Removal Considerations

- Remediation/Removal life Cycle Cost
- Treatment cost likely driven by energy consumption and consumable (reagents, electrodes, etc.) prices
- Treatment rates (typically low) and unwanted byproducts
- Batch verses continual flow considerations
- Air Emissions?
- Scalability (Pilot, Bench, Full Scale)
- Commercialization ($, $$, $$$ /unit)
- Stakeholder Acceptance (Client, Public, Regulator)

Legal Claims by WWTP Attempting to Achieve Compliance with Zero Discharge of PFAS.

MM.

Common Legal Claims Against Upstream Dischargers

Legal Theory	Basis for Claim	Tech Upgrade Cost Recovery?	Practical Considerations
Public Nuisance	Unreasonable interference	Yes, as abatement	Strong when PFAS affect public utility function
Negligence	Failure to exercise care	Yes, as damages	Requires showing duty and breach
Trespass	Unauthorized intrusion	Yes, in equitable relief	Stronger when discharger lacks permit
Strict Liability	Inherently dangerous activity	Yes	May require expert testimony on hazard
Equitable Contribution	Fair cost apportionment	Yes, shared upgrades	Common in negotiated settlements
Permit Violation	Breach of pretreatment terms	Yes, as part of remedy	Regulatory enforcement + civil claims

Common Defense Theories for Upstream Dischargers

Defense Consideration	Brief Description
Fate & Transport Complexity	PFAS persistence and behavior complicate tracing
Lack of Fingerprinting	No unique markers to link PFAS to discharger
Multiple Sources / Co-mingling	Hard to isolate one source in a complex system
Insufficient Historical Data	No monitoring data from key periods
Legal Defenses (Foreseeability, Permits)	Dischargers claim legal compliance or ignorance
Causation & Damages Proof	Must show PFAS reached WWTP and caused specific harm
Scientific Uncertainty	Definitions and standards still evolving

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THANK YOU

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Thank you

If you have more questions…

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