EBC Rhode Island
Emerging Contaminants Program: Understanding the Science and Toxicity of PFAS – A Deeper Dive
EBC Committees & Chapters

Climate Change and Air Committee
Dam Management Committee
Energy Resources Committee
Infrastructure Committee
Ocean and Coastal Resources Committee
Site Remediation and Redevelopment Committee
Solid Waste Management Committee
Water Resources Committee
Ascending Professionals Committee

Connecticut Chapter
New Hampshire Chapter
Rhode Island Chapter
Welcome

Rick Mandile

Principal
Sage Environmental
Introduction and What You Will Learn

Robert May Jr.  Program Co-Chair
Senior Vice President, Fuss & O’Neill, Inc.

Steve LaRosa  Program Co-Chair
Senior Project Manager, Weston & Sampson

Environmental Business Council of New England
Energy Environment Economy
UNDERSTANDING THE SCIENCE AND TOXICITY OF PFAS

October 22, 2019
What are PFAS?

• PFAS are partial to fully fluorinated, organic compounds that have been produced in the largest amounts within the United States.

• PFAS are the family of synthetic chemicals that include long chains of carbon and fluorine.

• Have unique lipid- and water-repellent characteristics, and are used as surface-active agents in various high-temperature applications and as a coating on surfaces that contact with strong acids or bases.
PFAS Background

- Environmental Persistence
  - Resistant to:
    - Oil and Grease
    - Staining
    - Water
    - Heat

- Bioaccumulation
  - <1 week to 10 years
  - “Long” chain vs “short” chain
Structural Makeup

- Anionic Perfluorinated Alkyl Acids (Terminal, NO BREAKDOWN)
  - Negatively charged
  - Low vapor pressure
  - Water soluble

PFAAs generally act as surfactants with tail in the air and head in water.

Perfluorinated TAIL  Anionic HEAD

PFOA - perfluorooctanoic acid

PFOS - perfluorooctanesulfonic acid
Historic Uses

- Used in fire fighting and odor control foams, Aqueous Film-Forming Foam (AFFF)
- Also used in industrial and commercial products including:
  - Textiles and leather products (Gore-Tex, Polartec)
  - Metal plating
  - Stain-resistant fabric
  - Photographic industry/photolithography
  - Semi-conductors
  - Paper and packaging (fast food wrappers)
  - Coating additives (Teflon)
  - Cleaning products
  - Pesticides
So where is it? (In high concentrations)

- Airports
- Air Force Bases
- Naval Facilities
- Fire Fighting Academies
- Manufacturing Facilities
So where is it?  (In lower concentrations)

• Car washes
• Biosolids
• Septic systems
• Landfills
• Food
Questions?
Considerations for Analysis of PFAS in Non-Drinking Water Samples

David R. Blye

Principal Chemist

Environmental Standards, Inc.
Considerations for Analysis of PFAS in Non-drinking Water Samples

David R. Blye, CEAC
Principal Chemist/President

October 22, 2019

EBC Rhode Island Emerging Contaminants Program
Providence, Rhode Island

www.envstd.com
Foam fun — Justin Gilday, 3, (left) and his brother Shaun, 4, both of Newark, romp through the residue of “The Blob” in Vilone Park, Elsmere. Firefighters spread the foam as part of the opening-day events at the park. More photos, B1.
PFA$
About Environmental Standards

What we do:
- Consulting Chemistry
- Environmental Forensics
- Consulting Geosciences
- Data Management and Information Technologies
- Health and Safety (PSM/RMP) Auditing

What we do NOT do:
- We are NOT a laboratory
- We do NOT work for agencies performing enforcement.
- We do NOT own/sell data management software

Our independence in providing QA support means we act in the best interest of the project
PFAS Issues – The Big Picture – Just Go Sample!

- Industries and agencies are under pressure to JUST GO SAMPLE!!
- Industries are being directed to sample/analyze PFAS in solids/sediments with no approved US EPA methodologies.
  - US EPA has been slow to develop/validate methods for anything but DW.
- Why is the lack of US EPA methods a problem for Industries?
  - Significant differences in procedures equals poor data comparability.
  - Laboratory accreditation/oversight by the States is severely lacking.
  - Most laboratory analysts experience with PFAS is < 2 years
  - Decisions made using data of unknown quality by “modified” methods.
  - Interpreting PFAS data without toxicity benchmarks for many PFAS?
Emerging Contaminants in the National Media
Scientists Try Dealing with the Analytical Hurdles

- PFAS analytes have garnered a ton of media attention.
  - Be ready for the PFAS discussion – no industry is immune

- The need for analytical data cannot be reliably accomplished solely on current methodologies available from US EPA.

- Laboratories are being requested to analyze for PFAS in matrices that have no approved US EPA methodology.

- Laboratories have developed their own procedures which may or may not be reliable.

- Planning and Communication are **Critical**.
PFAS Monitoring and Data Quality Concerns

- US EPA has been slow to develop/validate methods
  - Laboratory accreditation/oversight is lacking.

- Modifications of PFAS procedures have lead to chaos.
  - These modifications lead to notable data comparability issues (to be kind).

- Industries and agencies are under pressure
  - Just GO collect samples!

- Decisions are being made using data of unknown quality without toxicity benchmarks.
Great Resource

Interstate Technology Regulatory Council (ITRC)

▪ ITRC Fact Sheets:
  ▪ [https://pfas-1.itrcweb.org/fact-sheets/](https://pfas-1.itrcweb.org/fact-sheets/)
Uses of PFAS Compounds

PFAS are synthetic compounds that have been used for decades

- Carpeting, upholstery, and garments (Scotchgard™)
- Apparels (GORE-TEX®)
- Paper food wrappings (popcorn bags)
- Aqueous Film Forming Foams (AFFF)
- Electroplating mist suppressants
- Semiconductor manufacturing
- Aerospace and electronics applications
- Metal plating
- Teflon®
- Paints
- Polishes
- Cookware
- Lubricants
- Even pizza boxes!
Available PFAS Methodologies

- ASTM Methods D7979-16 and D7979-17 for water and sludge
- ASTM Method D7968-17a for solids
- DoD QSM 5.3 has PFAS criteria
  - WHICH IS NOT A METHOD
- Laboratories modify drinking water methods for solids and cleverly call them “537 Modified”
  - Laboratories make up their own calibration/QC acceptance criteria (Really?)
  - See our comments to the Docket - LINK HERE
- Soon to Come? SW-846 Method 8328 – Maybe there is hope?
Sediment Extraction/Analytical Overview

Variations impact data comparability and increase chaos

- Availability of Standards
- Calibration
- Sample Performance Monitoring
- Extraction
- Analysis
- Reporting
Variability So Far

- How the samples is extracted (shake, sonicate, concentrate, etc.)
- What is calibrated (branched and linear, or just linear)
- How the target is calibrated (external, internal, or by isotope dilution)
- Frequency of calibration checks
- Sample extraction/analysis performance monitoring
- Acceptance limits for QC items
- And now this ...
Analyte List Variability

- US EPA Method 537.1 has a list of 14 PFAS analytes

- Various state and federal agencies have inconsistent analyte lists.

- Laboratories will report fewer or more PFAS analytes than included in Method 537 (e.g., include 6:2 fluorotelomersulfonic acid, PFBA, PFPA, etc.).

- The variability in PFAS lists between facilities makes data comparisons more difficult.

- CAS Number use has been variable (e.g., sulfonic acid, sulfate, or salt) and many times wrong.
Draft SW-846 Method 8327

- Docket ID: EPA-HQ-OLEM-2018-0846
  - Published for public comment June 21, 2019
  - 30 day comment period extended to 60 days; August 23, 2019
  - Draft Method, Multi-lab Validation Report, Statistical Report


- Direct Aqueous Injection (DI) for non-drinking water aqueous matrices.

- Numerous issues with the method and validation study.

- 24 PFAS analyte list.

- 11 of 24 compounds indicated in the draft method as “significant analytical challenges.” Flagged footnote “#”

- No use of isotope dilution; yet labelled compounds spiked pre-extraction as surrogates.
Draft SW-846 Method 8327

- Lacks definitive performance metrics (acceptance criteria).
- No chromatographic resolution and separation criteria for branched and linear PFAS.
- We recommended reporting peaks integrated as branched and linear compounds separately.
- No cleanup procedures to remove interferences.
- Study showed high variability and bias for many PFAS.
- Most materials provided to labs (analytical columns and calibration standards, etc..) – robustness not tested. And explicit instructions.
- No attempt to mimic real world samples.

- NOT A GOOD ATTEMPT AT A METHOD FOR US EPA’s FIRST EFFORT!!
Formulations

- Synthesis by Electrochemical Fluorination (historic)
  - Mix of branched and linear isomers
  - Manufacturer - 3M

- Synthesis by Telomerization (current)
  - Results in an “Isomerically pure” product
    - Retains starting material linearity
    - Major product C₈ or C₉
    - Some impurities in chain length
    - Manufacturer - DuPont
Branched/Linear Configurations

PFOS anion (C₈F₁₇O₃S)

- There are 89 possible structural isomers
- There are 11 isomers in most standards
- Technical-grade standard
  - 68.3% linear
  - 30.1% methyl isomers
  - 1.6% dimethyl isomers
- Quantitation-grade standard
  - 78.8% linear
  - 20.4% methyl isomers
  - 0.7% dimethyl isomers

http://dx.doi.org/10.1071/EN10145
Quantitative vs Technical Grade PFOS Standards
Branched/Linear Configurations

PFOS anion (\(\text{C}_{8}\text{F}_{17}\text{O}_{3}\text{S})\)

- Technical-grade standard
  - 68.3% linear
  - 30.1% methyl isomers
  - 1.6% dimethyl isomers
- Quantitation-grade standard
  - 78.8% linear
  - 20.4% methyl isomers
  - 0.7% dimethyl isomers
- Dimethyl isomers often not included for quantitation
Example of Linear and Branched PFAS

- Calibration and quantitation with linear only.
- Technical grade standard used for RT window.
Example of Linear and Branched PFAS

- PFOS with branched elements quantitated, and only linear isomer calibration.

Sample quantitated with suspected branched peaks.
Linear isomer was the only calibration standard.
Example of Chromatographic Interference

<table>
<thead>
<tr>
<th>Analyte: PFHxA</th>
<th>Extraction Standard: 13C5-PFHxA</th>
</tr>
</thead>
<tbody>
<tr>
<td>313.0 / 269.0</td>
<td>318.0 / 273.0</td>
</tr>
</tbody>
</table>

**Calibration Standard**

- Intensity: 1.0e5
- Time, min: 5.56

**Sample**

- Intensity: 5000
- Time, min: 5.57

**Environmental Standards**
Example of Identification Issue

<table>
<thead>
<tr>
<th>Analyte: PFOS</th>
<th>Extraction Standard: 13C8-PFOS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calibration Standard</td>
<td></td>
</tr>
<tr>
<td>499.0 / 80.0</td>
<td></td>
</tr>
<tr>
<td>6.85</td>
<td></td>
</tr>
<tr>
<td>Sample</td>
<td></td>
</tr>
<tr>
<td>499.0 / 80.0</td>
<td></td>
</tr>
<tr>
<td>6.60</td>
<td></td>
</tr>
</tbody>
</table>

Intensity vs. Time, min

<table>
<thead>
<tr>
<th>Analyte: PFOS</th>
<th>Extraction Standard: 13C8-PFOS</th>
</tr>
</thead>
<tbody>
<tr>
<td>507.0 / 80.0</td>
<td></td>
</tr>
<tr>
<td>6.85</td>
<td></td>
</tr>
</tbody>
</table>

Intensity vs. Time, min
Branched Isomers without Standards

10 Perfluoroheptanoic acid
F4:m/z 362.9 > 318.8:Moving5PtAverage_x2

19 Perfluorononanoic acid (M)
F6:m/z 462.8 > 418.8:Moving5PtAverage_x2
Quantitative PFOS at Various Laboratories
PFOS in Samples

![Graphs showing PFOS in samples with time in minutes and pH levels.](image)
PFOA in Samples

![Graphs showing PFOA in samples with peaks at various values.]
PFOA in Samples – Same 2 Wells, Same Laboratory, 2 Different Collection Events
Conclusion

- PFAS determination has few EPA published methods.
- Method modifications can take many forms.
- Extraction and analytical techniques impact sensitivity.
- How PFAS are integrated can vary.
- Comparability between laboratories can be complicated.
- Planning and communication with the Lab is critical.
Recommendations

- Critically review sampling procedures
- Critically review analytical requirements
- Identify quality laboratories with LC/MS/MS experience
- Audit field teams and laboratories in early phases
- Perform data validation as data are reported
- Troubleshoot/correct suspicious data
  - Critical review - laboratories RE-ISSUE rescind/reissue data
- Centralize the data management for larger scale programs
Thanks

- Meg Michell, MS – Environmental Standards, Inc.
- Steve Zeiner, CEAC – Environmental Standards, Inc.
- All the clients that provided projects
- All the laboratories that supported the projects and answered questions
Thank You

QUESTIONS?

David R. Blye, CEAC
Principal Chemist/President
610.935.5577 x401
dblye@envstd.com
1140 Valley Forge Road
P.O. Box 810
Valley Forge, PA 19482
PFOA and PFOS: Explaining the EPA and ATSDR Drinking Water Guidance and Concerns for Exposure

Laura Kerper
Senior Toxicologist
Gradient Corp.

Julie C. Lemay
Senior Environmental Health Scientist
Gradient Corp.

Environmental Business Council of New England
Energy Environment Economy
PFOA and PFOS: Explaining the Drinking Water Guidance and Concerns for Exposure

Laura E. Kerper, Ph.D.
Julie C. Lemay, M.P.H.

EBC Rhode Island Emerging Contaminants Program October 22, 2019
Agenda

**Part 1: PFOA and PFOS Guidance Values**
- Introduction
- Half-lives: Animals vs. Humans
- US EPA Guidance
- ATSDR Draft Guidance

**Part 2: Exposure Concerns**
- Common Sites with PFAS
- Potential Human Exposure Pathways
- State and US EPA Screening Values
- PFAS Risk Assessment
What Are the Agency Guidance Values?

Guidance Values for Drinking Water and Acceptable Daily Intake

<table>
<thead>
<tr>
<th>Chemical</th>
<th>US EPA Health Advisory for Drinking Water (ng/L or ppt)</th>
<th>US EPA Reference Dose (mg/kg-day)</th>
<th>ATSDR Draft Minimum Risk Level (mg/kg-day)</th>
</tr>
</thead>
<tbody>
<tr>
<td>PFOA</td>
<td>70</td>
<td>$2 \times 10^{-5}$</td>
<td>$3 \times 10^{-6}$</td>
</tr>
<tr>
<td>PFOS</td>
<td>70</td>
<td>$2 \times 10^{-5}$</td>
<td>$2 \times 10^{-6}$</td>
</tr>
</tbody>
</table>
### Half-lives of PFOA and PFOS in Humans and Animals

<table>
<thead>
<tr>
<th>Species</th>
<th>Sex</th>
<th>PFOA</th>
<th>PFOS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mouse</td>
<td>Female</td>
<td>18 days</td>
<td>38 days</td>
</tr>
<tr>
<td></td>
<td>Male</td>
<td>17 days</td>
<td>43 days</td>
</tr>
<tr>
<td>Rat</td>
<td>Female</td>
<td>3.4 hours</td>
<td>18 days</td>
</tr>
<tr>
<td></td>
<td>Male</td>
<td>6.5 days</td>
<td>54 days</td>
</tr>
<tr>
<td>Monkey</td>
<td>Female</td>
<td>33 days</td>
<td>155 days</td>
</tr>
<tr>
<td></td>
<td>Male</td>
<td>20 days</td>
<td>166 days</td>
</tr>
<tr>
<td>Human</td>
<td>Both</td>
<td>2.3 years</td>
<td>3.3 years</td>
</tr>
</tbody>
</table>

Notes: (a) All values are approximations based on reported ranges. (b) A half-life is the time it takes for half of a chemical to leave the body.
Human Equivalent Dose (HED)

- HED is the dose to humans that results in the serum concentration that is associated with health effects in animals.

$$\text{HED} = \text{Animal Serum Concentration} \times \text{Clearance}$$
Basis of US EPA's PFOA Health Advisory


- Species: Mouse
- Exposure: 1, 3, 5, 10, 20, or 40 mg PFOA/kg-day to pregnant mice from gestation days 1-17
- Study type: one generation
- Endpoints evaluated include fetal survival; bone formation; structural defects; time to puberty
Typical Dose-response Curve
Bone Formation and Sexual Maturity in Pups After PFOA Exposure

Dose-response for Reduced Bone Formation

Dose-response for Accelerated Sexual Maturity
Derivation of US EPA Reference Dose for PFOA

- Lowest Observed Adverse Effect Level (LOAEL) = 1 mg/kg-day
- Mouse serum concentration at LOAEL = 0.38 mg/mL
- HED = 0.0053 mg/kg-day
- Uncertainty factors total = 300
  - 10 for interspecies differences
  - 3 for intraspecies differences
  - 10 for use of LOAEL dose
- Reference dose = 2 × 10⁻⁵ mg/kg-day

- Species: Rat
- Exposure: 0, 0.1, 0.4, 1.6, or 3.2 mg/kg-day to males and females for 6 weeks prior to mating, during mating, and for females, through gestation and lactation, across two generations
- Evaluated reproductive and developmental parameters across both generations
Pup Body Weight Reduction After PFOS Exposure

Days of Study

Days of Study

- 1-4 (pre-culling)
- 4 (post-culling) - 7
- 7-14
- 14-21

Weight Change/Litter (g)

- 0 mg/kg-d
- 0.1 mg/kg-d
- 0.4 mg/kg-d

* denotes statistical significance.
Derivation of US EPA Reference Dose for PFOS

- No Observed Adverse Effect Level (NOAEL) = 0.1 mg/kg-day
- Rat serum concentration at NOAEL = 0.00626 mg/mL
- HED = 0.00051 mg/kg-day
- Uncertainty factors total = 30
  - 10 for interspecies differences
  - 3 for intraspecies differences
- Reference dose = $2 \times 10^{-5}$ mg/kg-day
Derivation of US EPA Drinking Water Health Advisories for PFOA and PFOS

• Target population is lactating women
• Drinking water intake for lactating women = 54 mL/kg-day (90th percentile)
• Assumes 20% of total daily exposure comes from drinking water
• Lifetime Health Advisory = 70 ng/L
Derivation of ATSDR Minimal Risk Level (MRL) for PFOA

• Based on mouse neurodevelopment and skeletal development (Koskela et al., 2016; Onishchenko et al., 2011)
  • LOAEL = 0.3 mg/kg-day (only dose tested)
  • HED = 0.000821 mg/kg-day
• Uncertainty factors total = 300
  • 10 for interspecies
  • 3 for intraspecies
  • 10 for use of LOAEL
• MRL = 3 \times 10^{-6} \text{ mg/kg-day} (7-fold lower than US EPA RfD)
• Difference from US EPA's value is due to a different starting dose (LOAEL) and HED
Derivation of ATSDR Minimal Risk Level (MRL) for PFOS

- Similar to US EPA Health Advisory (same basis) except:
  - ATSDR added an extra modifying factor of 10 for concern about immunotoxicity
  - MRL = $2 \times 10^{-6}$ mg/kg-day (10-fold lower than US EPA RfD)
General Risk Assessment Process

Hazard Identification → Dose-response Assessment → Exposure Assessment

Risk Characterization

General Risk Assessment Process

Hazard Identification $\rightarrow$ Dose-response Assessment $\rightarrow$ Risk Characterization

Exposure Assessment
Sites that Commonly Contain PFAS Compounds

Aqueous Film-forming Foam (AFFF) Sites
- Fire Training Academies
- Airports
- Gas Stations
- Military Bases

Industrial Production of PFAS or PFAS-coated Products
- Coated textiles
- Carpet

Paper Mills
- Production of coated paper and cardboard

Biosolids
How Might People be Exposed to PFAS Compounds at Sites?

- **Soil/Sediment**: Ingestion/Skin Contact
- **Fish**: Ingestion
- **Surface Water**: Ingestion
- **Drinking Water**: Ingestion
### Applicable State Screening Values: Drinking Water

<table>
<thead>
<tr>
<th>State</th>
<th>PFOA (µg/L)</th>
<th>PFOS (µg/L)</th>
<th>PFNA (µg/L)</th>
<th>PFHxS (µg/L)</th>
<th>PFHpA (µg/L)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>CAS Number</strong></td>
<td>335-67-1</td>
<td>1763-23-1</td>
<td>375-95-1</td>
<td>355-46-4</td>
<td>375-85-9</td>
</tr>
<tr>
<td>Massachusettsa</td>
<td>0.07</td>
<td>0.07</td>
<td>0.07</td>
<td>0.07</td>
<td>0.07</td>
</tr>
<tr>
<td>Connecticuta</td>
<td>0.07</td>
<td>0.07</td>
<td>0.07</td>
<td>0.07</td>
<td>0.07</td>
</tr>
<tr>
<td>Rhode Islandb</td>
<td>0.07</td>
<td>0.07</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Maineb</td>
<td>0.07</td>
<td>0.07</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>New Hampshirec</td>
<td>0.012</td>
<td>0.015</td>
<td>0.011</td>
<td>0.018</td>
<td>NA</td>
</tr>
<tr>
<td>Vermonta</td>
<td>0.02</td>
<td>0.02</td>
<td>0.02</td>
<td>0.02</td>
<td>0.02</td>
</tr>
</tbody>
</table>

Notes:  
- NA = Not Available  
- PFNA = Perfluorononanoic acid  
- PFHxS = Perfluorohexane sulfonic acid  
- PFHpA = Perfluoroheptanoic acid  

(a) Sum of the 5 PFAS compounds should not exceed the listed value. Also note that Massachusetts has proposed groundwater values of 0.02 µg/L.  
(b) Sum of PFOA and PFOS should not exceed 0.07 µg/L.  
(c) NH values are enforceable standards effective October 2019.
## Applicable US EPA Residential Screening Level Values\textsuperscript{a}

<table>
<thead>
<tr>
<th>Environmental Medium</th>
<th>PFOA</th>
<th>PFOS</th>
<th>PFBS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soil (mg/kg)\textsuperscript{b}</td>
<td>1.3</td>
<td>1.3</td>
<td>1,300</td>
</tr>
<tr>
<td>Tap Water (µg/L)\textsuperscript{c}</td>
<td>0.4</td>
<td>0.4</td>
<td>400</td>
</tr>
<tr>
<td>Fish (mg/kg)\textsuperscript{d}</td>
<td>0.056</td>
<td>0.056</td>
<td>56</td>
</tr>
<tr>
<td>Air (µg/m\textsuperscript{3})</td>
<td>Not Volatile</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Notes: PFBS = Perfluorobutane sulfonate. (a) Calculated with US EPA default assumptions in RSL Calculator with target cancer risk of 10\textsuperscript{-6} and target HQ = 1. (b) Additional values available in the calculator for workers. (c) Tap water only includes ingestion. (d) Fish Ingestion requires site-specific input – the above value uses 30 g/day.
General Risk Assessment Process

- **Hazard Identification**
- **Dose-response Assessment**
- **Exposure Assessment**

Risk Characterization

# Toxicity Values for Risk Assessments

<table>
<thead>
<tr>
<th>Chemical</th>
<th>Oral Cancer Slope Factor (mg/kg-day)$^{-1}$</th>
<th>US EPA Reference Dose (mg/kg-day)</th>
<th>ATSDR Draft Minimum Risk Level (mg/kg-day)</th>
<th>In EPD</th>
</tr>
</thead>
<tbody>
<tr>
<td>PFOA</td>
<td>$7 \times 10^{-2}$</td>
<td>$2 \times 10^{-5}$</td>
<td>$3 \times 10^{-6}$</td>
<td>No</td>
</tr>
<tr>
<td>PFOS</td>
<td>NA</td>
<td>$2 \times 10^{-5}$</td>
<td>$2 \times 10^{-6}$</td>
<td>No</td>
</tr>
<tr>
<td>PFBS</td>
<td>NA</td>
<td>$2 \times 10^{-2}$</td>
<td>NA</td>
<td>Yes</td>
</tr>
</tbody>
</table>

Notes: NA = Not Available; PFBS = Perfluorobutane Sulfonate.
Questions?

Laura E. Kerper, Ph.D.
Sr. Toxicologist
lkerper@gradientcorp.com
(617) 395-5508

Julie C. Lemay, M.P.H.
Sr. Environmental Health Scientist
jlemay@gradientcorp.com
(617) 395-5593
Investigation for PFAS and PFAS Case Studies

Bob Bowden
Associate
Fuss & O’Neill, Inc.
Investigation for Per- and Polyfluoroalkyl Substances (PFAS) and PFAS Case Studies

Bob Bowden, LEP
Fuss & O’Neill, Inc.

October 22, 2019
Agenda

• PFAS use
• Sites and/or areas with potential for release
• Routes of PFAS release to the environment
• PFAS cleanup criteria
• Environmental sampling for PFAS
• F&O PFAS case studies in New England
• Remediation of PFAS
• PFAS concerns for environmental professionals and property owners/stakeholders
PFAS Use in Industrial Applications and Consumer Products

- PFAS include thousands of fluorine-containing chemicals
- Resistant to heat, water, and petroleum products (carbon-fluorine bond, one of the strongest in nature)
- Typically used to make products stain resistant, waterproof and/or fire retardant
- Industrial applications:
  - Chemical manufacturing
  - Surface finishing and treatment of metals, paper, textiles or durable goods (e.g., leather)
  - Mist suppressant for metal plating baths, especially chromium plating processes
  - Wire coating
  - Fire suppression
PFAS Use in Industrial Applications and Consumer Products

- Consumer products:
  - Paints and adhesives
  - Waterproof clothing (e.g., GORE-TEX®)
  - Stain/water repellent for textiles (e.g., Scotchgard™)
  - Surfactants (detergents and waxes)
  - Coated paper and cardboard
  - Food-grade non-stick coatings (e.g., Teflon™)
  - Personal care products (e.g., cosmetics, soaps, shampoos, sunscreens)
  - Fluorocarbon-based synthetic rubber (e.g., gaskets, O-rings, hoses)
Sites and Areas with the Potential for PFAS Use/Release

- Chemical manufacturers, including paints/coatings
- Paper/box manufacturers
- Aerospace manufacturers
- Fire-suppressant foam use areas (e.g., aqueous Class B, film-forming foam (AFFF))
  - Airports
  - Fire stations
  - Industrial facilities
- Landfills
- Car washes (wax)
- Gas stations (fire suppression)
- DoD facilities (more than 2,000 tested to date)
- Dry cleaners/laundromats
- Artificial turf fields?
Routes of PFAS Release to the Environment

- Spills/application to the ground
- Floor drains
- Septic systems
- Drum leakage
- Tank leakage
- Landfill leachate
- Storm water runoff
- Air emissions
- Disposal/land application of biosolid wastes from wastewater treatment plants
PFAS Characteristics in the Environment

• Carbon-fluorine bonds very strong
• Oil and water repellent
• Stable in the environment
• Resistant to degradation
• Can bioaccumulate (small amounts build up over time in blood and organs)
• Long half-lives in humans (years) – easy to build up high levels in the body - one reason cleanup criteria are low
PFAS Cleanup Criteria

- Ingestion primary means of human exposure
- EPA set a lifetime health advisory (LTHA) for two PFAS in drinking water
- LHTA is level below which no harm is expected
- 70 nanograms per liter (ng/L) (ppt) for sum of perfluorooctanoic acid (PFOA) and perfluorooctanesulfonic acid (PFOS)
- Extremely low action level – reflects:
  - The human body's inability to excrete these chemicals
  - Uncertainty associated with their toxicity
## PFAS Cleanup Criteria in New England – October 2019

<table>
<thead>
<tr>
<th>State</th>
<th>Drinking Water Action Level</th>
<th>Soil Action Level(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Connecticut</td>
<td>70 ng/L (sum of 5 PFAS*) Also APS Groundwater Protection Criterion (GWPC)</td>
<td>• APS Residential Direct Exposure Criterion (sum of 5): 1.35 mg/kg</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• APS Indust/Comm DEC: 41 mg/kg</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• APS GA Pollutant Mobility Criterion (sum of 5): 1.4 ug/kg</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• APS GB PMC: 14 ug/kg</td>
</tr>
<tr>
<td>Massachusetts</td>
<td>70 ng/L (sum of 5)</td>
<td>None yet</td>
</tr>
</tbody>
</table>
| New Hampshire| PFOA 12 ng/L  
PFOS 15 ng/L  
PFHxS 18 ng/L  
PFNA 11 ng/L  
Also Ambient Groundwater Quality Criterion (AGQC) | None yet                                                                           |
| Vermont     | 20 ng/L (sum of 5)                                                                             | None yet                                                                           |
| Rhode Island| 70 ng/L (sum of 2)                                                                             | None yet                                                                           |
| Maine       | 70 ng/L (sum of 2)                                                                             | None yet                                                                           |

* PFOA, PFOS, PFHxS, PFHpA and PFNA
Environmental Sampling for PFAS

- Very low action levels require extremely sensitive analysis using modified drinking water analysis
- Laboratory reporting limits down to single-digit ppt
- Low-level field or laboratory cross-contamination can invalidate data sets
- PFAS are present in consumer products, clothing, and many other applications – high potential for cross-contamination
- Special care needs to be taken during sampling to address this challenge – SOPs prescribe materials that can and can’t be used/worn
F&O PFAS Case Studies in New England: Types of Sites/Potential PFAS Release Areas

- CT - Fire Training School
- CT - Specialty Paint and Coating Manufacturer
- CT - Paper/Box Manufacturer
- CT - Car Wash
- NH - Landfill
- CT - Aerospace Manufacturer – Fire Training Area
F&O PFAS Case Studies in New England: Results to Date

• CT - Fire Training School
  o Aqueous film forming foam (AFFF) applied to the ground over a large area for many years during training exercises
  o 5 groundwater samples:
    – PFAS detected in all samples
    – PFOS primary PFAS detected
    – Total PFAS concentrations up to 48,100 ng/L
    – All samples exceeded the CT APS GWPC for the 5 PFAS
F&O PFAS Case Studies in New England:

Results to Date

- **CT - Fire Training School**
  - 23 soil samples:
    - Collected from historical foam application and storage areas
    - PFAS detected in all samples
    - PFOS primary PFAS detected
    - Total PFAS concentrations up to 424 ug/kg
    - 16 of 23 samples exceeded the CT APS GB PMC for the 5 PFAS
  - 3 off-site drinking water well samples, located in vicinity of fire school:
    - 2 private wells and 1 public well
    - PFAS detected in 1 private well, not detected in the other 2 wells
    - (Perfluorobutanesulfonic acid (PFBS) primary PFAS detected
    - Sample exceeded the CT DWAL for the 5 PFAS
    - Resampling confirmed result
    - Total PFAS concentrations ranged from 168 to 208 ng/L
    - Residence connected to public water supply
F&O PFAS Case Studies in New England

Results to Date

• CT - Specialty Paint and Coating Manufacturer
  
  o 57 soil samples:
    - PFAS detected in 12 samples (Note: Can collect samples free of cross-contamination)
    - All 17 PFAS analytes detected in at least 1 sample
    - PFOS primary PFAS detected
    - Total PFAS concentrations up to 37 ug/kg
    - No samples exceeded the applicable CT APS DEC or PMC
    - Locations where PFAS detected in soil include:
      - Former drum storage area
      - Landfills
      - Former lagoon/setting pond
      - Dumpsters
      - Loading docks
      - USTs/possible septic area
      - Beneath manufacturing building
      - Upgradient property boundary
F&O PFAS Case Studies in New England

Results to Date

• CT - Specialty Paint and Coating Manufacturer

  o 23 groundwater samples:
  - PFAS detected in 22 samples, including all 3 upgradient (background) monitoring locations
  - 12 of 17 PFAS analytes detected in at least 1 sample
  - PFOS and PFOA primary PFAS detected
  - Total PFAS concentrations up to 1,011 ng/L
  - GB area, CT APS GWPC does not apply
  - 1 sample exceeded 70 ng/L for the 5 PFAS
  - Background concentrations ranged from 9.9 to 33 ng/L
F&O PFAS Case Studies in New England

Results to Date

• CT - Paper/Box Manufacturer
  - 7 groundwater samples:
    - PFAS detected in all samples, including background monitoring location
    - PFOS and PFOA primary PFAS detected
    - Total PFAS concentrations up to 57 ng/L
    - Background concentration 55 ng/L – exceeded 4 site wells
    - No samples exceeded the CT APS GWPC
F&O PFAS Case Studies in New England

Results to Date

• CT - Car Wash
  o 6 wash water samples:
    - Collected from wash-water oil-water separator
    - PFAS detected in all samples
    - PFOS primary PFAS detected
    - Total PFAS concentrations up to 4,220 ng/L
  o 3 groundwater samples:
    - PFAS detected in all samples
    - Total PFAS concentrations up to 1,603 ng/L
    - 2 samples exceeded the CT APS GWPC
F&O PFAS Case Studies in New England

Results to Date

• NH - Landfill
  o 3 groundwater samples:
    - PFAS detected in 1 sample
    - PFOA only PFAS detected
    - Total PFAS concentration 14 ng/L
    - No samples exceeded the NH DWAL
F&O PFAS Case Studies in New England

- CT – Aerospace Manufacturer – Fire Training Area
  - Many aerospace manufacturers and other industries historically had a fire training area in the “back 40”
  - Flammable liquids would be poured into a metal pan or onto the ground, and training would be performed, often using AFFF
  - 10/19 - Geoprobe groundwater investigation, installation of monitoring wells
  - Pending results, additional groundwater and/or soil investigation may follow
Remediation of PFAS

• Groundwater: Pump and treat using:
  o Granular activated carbon (GAC) filtration (may not filter out all PFAS – pilot test)
  o Chemically-engineered ion-exchange resin filtration (more efficient)
  o Oxidation may be considered, but may create byproducts that are more difficult to treat
  o In-situ (injection) remediation – emerging technology, liquid activated carbon has shown promise

• Soil or solid media from filter systems:
  o Incineration (expensive)
  o Landfill (RCRA Subtitle C type, with liner and leachate collection)
PFAS Concerns for Environmental Professionals

- Determining when PFAS should be investigated as a COC – new/evolving info on uses/settings
- Lack of consensus regarding sampling considerations
- Lack of EPA-approved, validated analytical methods for media other than drinking water
- Evolving PFAS analyte lists - did we analyze for enough/the right compounds?
- Variability between laboratory procedures, analyte lists and reporting limits
- Lengthy laboratory turnaround times
PFAS Concerns for Environmental Professionals

• Regulatory limits/standards:
  o Variability in toxicity assumptions used for calculating limits
  o Evolving limits as studies are completed
  o Extremely low regulatory limits vs. ubiquitous nature of PFAS

• Uncertain and evolving regulatory drivers:
  o What will drive investigation and remediation for PFAS?
  o Drivers may include:
    – State and Federal cleanup programs
    – Identification of contamination at high-priority sites like landfills, fire training facilities, etc.
    – Contaminated supply wells
    – Permitting (discharge permits, new public water supply)

• Lack of proven in-situ soil treatment options and uncertainty regarding the effectiveness of thermal treatment, sorption and stabilization, and capping

• Should soil and wastewater to be disposed be tested for PFAS?
Should I Sample for PFAS?

- Municipal facilities such as fire stations may want to look into how PFAS is being managed, possible release mechanisms and sample on-site well, if present.

- If a requirement to sample for PFAS does not exist and you are conducting environmental investigations and find one of the known uses of PFAS, sampling would be prudent if:
  - Potential for impact to a nearby private or public water supply.
  - Investigation results will support future regulatory program closure - regulators will likely require it to close out a site in the future.
  - A complete understanding of site conditions is required as part of investigations supporting a transfer in ownership of a property.

- Be sure to collect background samples – PFAS may be ubiquitous in the area.
What Can I Do Now?

- Organizations should review their current processes to determine the potential for PFAS use/release.
- If identified, prepare an Operations & Maintenance program to develop best management practices and/or engineered solutions to reduce risk of PFAS exposure.
Bob Bowden, LEP
Fuss & O’Neill, Inc.
860.646.2469 x5515
bbowden@fando.com
www.fando.com
PFAS Implications in Wastewater and Bio-Solids

Ned Beecher

Executive Director

North East Biosolids & Residuals Association
PFAS: Implications in Wastewater & Biosolids

Ned Beecher • NEBRA

October 22, 2019

Presentation to EBC Rhode Island Emerging Contaminants Program

Save the Bay, Providence, RI
NEBRA... www.nebiosolids.org

- Founded in 1997 following example of NBMA
- Non-profit, tax-exempt membership organization
- New England and Eastern Canada
- Mission - *Promoting the environmentally sound recycling of biosolids and other residuals in the greater New England region.*
- Funding from public wastewater agencies, private biosolids management companies, environmental engineers, end users of biosolids, project grants.
- Provides networking information hub (website, newsletters), public education, fosters research
PFAS in Biosolids ("sludge") and Residuals

Recycling organic "wastes" benefits society and the environment.

Throughout the U. S. and Canada, biosolids (treated and tested sewage sludge), septage, paper mill residuals, composts, and other organic residuals are commonly recycled to soils. This recycling does amazing things:

- enhances soil health
- recycles nutrients

New! CASA PFAS Fact Sheet - Oct 2019
New! BioCycle PFAS Update & articles
Updated! PFAS Regulatory Limits in Drinking Water & Other Media, v. 4, September 2019
Maine Farm PFAS Concern - Information Update - March 26, 2019
Michigan’s public costs for addressing PFAS. How much will society spend reducing risks by how much? - March 21, 2019
NEBRA has joined as a “friend of the court” (amicus) in support of the plaintiffs. Proper process is important.

10/1/19

Municipal Interests Sue New Hampshire for Wrongful PFAS Rule Adoption

On September 30th, the day new water quality regulations for PFAS were to take effect in New Hampshire, a coalition of municipal, farm, and company interests sued to halt their implementation. PFAS is a family of commonly-used chemicals that have been linked to potential negative health impacts and are being aggressively regulated by a few states, including New Hampshire. Plaintiffs in the suit are Plymouth Village Water & Sewer District, Resource Management Inc., Charles Hanson, and 3M Company.

This **legal action** “is narrow,” according to a statement from Resource Management Inc., a company that manages biosolids and other recyclable organic residuals for municipalities throughout the state and region. It argues that the NH Department of Environmental Services (NH DES):
Biosolids Recycling
Organics GENERATED in 10 NERC Region States

- 31% Other Organic
- 27% Biosolids
- 42% Food Waste

% of the 24,514,000 wet tons/year organics GENERATED
Options for Organic Waste Management

Slide courtesy of D. Perry, formerly of CDM Smith
Managing biosolids & organic residuals: What’s ideal for sustainability?

MAXIMIZE BENEFICIAL USES OF RESOURCES

<table>
<thead>
<tr>
<th>Constituent</th>
<th>Benefits</th>
<th>Concerns</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water</td>
<td>valuable in agriculture in dry times</td>
<td>cost of transport</td>
</tr>
<tr>
<td>Organic matter</td>
<td>vital to soils</td>
<td>putrescible, odor</td>
</tr>
<tr>
<td>Nutrients</td>
<td>plant &amp; animal food</td>
<td>impacts to water</td>
</tr>
<tr>
<td>Energy</td>
<td>renewable, displaces oil/gas air emissions, no use of nutrients &amp; organic matter if incinerated</td>
<td></td>
</tr>
</tbody>
</table>

MANAGE TO MINIMIZE POTENTIAL RISKS

Reduce/control/mitigate trace elements (e.g. metals), pathogens, synthetic and natural organic chemical compounds, odors, nuisances
Biosolids improve soils.
Numerous studies demonstrate the benefits derived from adding organic matter, such as biosolids, to soils: higher carbon content (carbon sequestration), increased microbial activity, increased water-holding capacity, and lower bulk density (which means easier tillage & handling).

– Dr. Sally Brown, Univ. of WA, 2011 research
Findings:
Lower GHG emissions from use on soils

"Methane avoidance"

- Energy recovery
- Cold wet climate
- 800°C
- 25% solids
- No recovery

- 900°C
- 30% solids
- Energy recovery
- Using virgin lime
  **if recycled lime → total to -211**

- Anaerobic dig.
- Land ap

Findings:
Lower GHG emissions from use on soils
Biosolids use: Agriculture

- Bulk material markets: animal feed crops (corn, hay), grains (wheat, hops), soy, other commodity crops

- Prices:
  - Class B - $0 - $30 / wet ton
  - Class A – up to $60 / ton

- Trend: increasing demand; waiting lists in some areas

Moorhead, MN: Feed corn grown with liquid injected, Class B, anaerobically-digested biosolids, July 2012
Farmers Love Biosolids

Net Profit Increase = $250 – $500 per acre

Slide courtesy Lakhwinder Hundal, MWRDG Chicago
Early growth of corn on control (left) and compost amended (right) plots on Woodstown silt loam soil (Epstein and Chaney, 1974).

Research has been ongoing since the 1970s...
Reclamation of Disturbed Sites

Spectacle Island in Boston Harbor was reclaimed with biosolids compost and other recycled organics, 2004.

- Bulk material market
- Used to restore healthy soil ecosystem and either native vegetation or cropland
- Prices: vary, often $0
  - Uses a lot of biosolids
- Trend: increasing use, because of huge benefits – biosolids use is best practice for this kind of reclamation
Revegetated coal mine spoil at Frostburg, MD, treated with composted biosolids (Armiger et al., 1975).
Reclamation of Disturbed Sites

Pennsylvania mine before

Same Pennsylvania mine after

Photos courtesy Bill Toffey, MABA
Reclamation is still in demand
Biosolids use: Forestry

Photos courtesy of King County, WA
http://dnr.metrokc.gov/WT/D/biosolids/

- Only in some areas
- Speeds up harvest cycle in actively managed stands
- Price:
  - Class B $0 - minimal

nebiosolids.org
Biosolids use:
Horticulture / Landscaping / Turf

- Class A bulk material markets: potting mixes (e.g. Tagro), golf courses (e.g. Milorganite), parks, lawns, growing turfgrass (e.g. in RI), sports fields (hi-spec turf)

- Prices:
  - Class A bulk – up to $60 / ton
  - Class A bagged/retail – up to $450 / ton

- Trend: increasing demand for quality, consistent products

Biosolids compost use on my home garden – raspberries, May 2014
A biosolids treatment process that results in biosolids to be used or discarded.

Trend: Huge interest & activity now, across the continent.
General biosolids resources

http://www.endless-films.com/site/?portfolio=biosolids

http://www.loopforyoursoil.com

Land Application and Composting of Biosolids

What are biosolids?
Every day, wastewater treatment facilities across the country treat billions of gallons of wastewater generated by homes and businesses. The treatment process produces liquid effluent that is discharged to water bodies or reused as well as a byproduct of solid residuals (sewage sludge) that must be managed in an environmentally sound manner. The sludge contains substantial amounts of nutrients, such as nitrogen, phosphorus, calcium, iron, magnesium, and zinc. Biosolids can be beneficially used to improve soil quality and to enhance agricultural productivity.

What are some of the benefits of biosolids land application?
Biosolids provide plant nutrients (nitrogen, phosphorus, and potassium) and secondary nutrients (calcium, iron, magnesium, and zinc). They also help to cycle carbon into the soil and fertilizing vegetation, which can improve soil health and productivity.
Biosolids & soils: Remarkable media for managing CECs!
Concentrations of CECs in biosolids

Clark and Smith, 2010

Fig. 1. Typical concentrations of selected ‘emerging’ organic contaminants in sewage sludge (mg kg\(^{-1}\) dw).
CECs / Microconstituents - Not Our First Rodeo

• Dioxins/Furans
• PPCPs
  ▪ Medicine - hormones, drugs for disease & pain management, homeopathic drugs, vitamins & other health supplements, etc.
  ▪ Hygiene - soaps, detergents, hand sanitizers, etc.
• Microbeads
• And now PFAS
  ▪ With over 85,000 known chemical compounds in commerce, unlikely to be our last
The presence of a contaminant in biosolids does not mean there is risk; its fate and impact on humans and the environment must be evaluated.
Biosolids: Understanding the risk

Putting it into perspective - how does using biosolids or compost made with biosolids compare to chemical exposures in everyday life?
Number of years of contact = 1 dose

Legend:
- Gardener
- Child
- Hiker

What is a Risk Analysis?
A risk analysis estimates the risk to human health by examining how harmful a chemical is (toxicity) and the amount of contact with that chemical (exposure).
Risk = Toxicity x Exposure
Chemicals with high toxicity and high exposure have higher risk, while chemicals with low toxicity and low exposure have lower risk.

What About Food?
For this analysis, wheat fertilized with biosolids was tested for over 80 compounds in pharmaceuticals.
Q: Where do we want to put CECs? (We can’t remove every bit from wastewater.)

A: Get them into the solids…and into soils… …because healthy soils (e.g. enriched with biosolids and/or other organic amendments) are the best media for degrading most CECs.

“These terrestrial systems have orders of magnitude greater microbial capability and residence time to achieve decomposition and assimilation compared with aquatic systems.”

– Overcash, Sims, Sims, and Neiman, 2005
PFAS

an extreme, worst-case CEC
the only common trace contaminant of drinking water regulated in low ppts

perfluorinated:

polyfluorinated:
There are 2 major sources of PFAS in the environment:

- industrial discharges
- fire-fighting (including training, e.g. at military sites)
Major sources of PFAS in the environment:

Cottage Grove, MN

Parkersburg, WV

EPA reaches new C8 deal with DuPont
Major source of PFAS in the environment: AFFF, Pease AFB, NH

All the white is AFFF (PFAS-containing foam)

https://www.youtube.com/watch?v=8W_zJfJGhSI&feature=youtu.be
*Data: PFAS contamination at industrial sites*

**EXAMPLE:** Wolverine Worldwide Kent County tannery dump sites, Rockford, MI

Date of discovery: 2017

Results (PFOS/ PFOA) or Range above EPA LHAs: House Street Area Testing Results as of 12/20/18 as reported by Wolverine:
- Wolverine has sampled 689 homes
- 38 homes over 70 PPT (PFOA+PFOS)
- 392 had detection of PFOA/PFOS
- Highest concentration is **76,000 PPT** (PFOA+PFOS)

**Suspected source:** This area consists of a former licensed disposal facility owned and operated by Wolverine... and several unregulated dump sites across three townships in northern Kent County.

*Data: PFAS at firefighting & training sites*

**EXAMPLE:** Battle Creek Air National Guard Base, MI
Date of discovery: 2018
Results (PFOS/ PFOA) or Range above EPA LHAs: On-base groundwater:
  - PFOA: 21,500 ppt
  - PFOS: 55,000 ppt
  - PFHxS: 38,400 ppt
Two contaminated private wells (drinking water): -PFOS+PFOA: high of 411 ppt
Other Results PFAS or Range above EPA LHAs: On-Base water wells show presence of 13 PFAS compounds - Highest results: PFHxS=38,400 ppt
Suspected source: Firefighting foam used at Battle Creek ANGB

**EXAMPLE:** Travis Air Force Base, CA
Date of discovery: 2018
Results (PFOS/ PFOA) or Range above EPA LHAs:
  - PFOA + PFOS = 712,000 ppt
  - PFOA = 88,000 ppt
  - PFOS = 690,000 ppt
Other Results PFAS or Range above EPA LHAs: PFBS = 140,000 ppt
Suspected source: Firefighting foam

PFAS ambient background:

includes most wastewater & biosolids and other residuals (e.g. compost, paper mill residuals), septic (onsite) systems, solid waste management activities
Typical biosolids are part of “ambient background” levels of PFAS.
There are a few cases of large industrial inputs to WWTFs & biosolids; those are industry point sources - not typical.

| Source: Dr. Bradley Clarke, RMIT, Per- and polyfluoroalkyl substances (PFAS) in Australia, Dec. 2017 slide presentation to Water Research Australia |
PFAS are in wastewater of course. Wastewater & biosolids mirror modern life.

- Even small-town, purely domestic wastewater has typical PFAS levels.
- We are aware because of advances in analytical chemistry.
Why worry about PFAS in wastewater & biosolids?

1) PFAS leach in soil some.

Sepulvado et al; *Environ. Sci. Technol.* 2011, 45, 8106-8112

Concentrations of PFOA and PFOS with depth in the long-term plots at various loading rates. Control = 0 Mg/ha, LR 1 = 553 Mg/ha, LR 2 = 1109 Mg/ha, and LR 3 and LR 3 dup = 2218 Mg/ha (on dry weight basis).
Why worry about PFAS in wastewater & biosolids?

2) We’re regulating at background levels.

NH MCLs & ambient groundwater quality standards:

- PFOA 12 ppt
- PFOS 15 ppt
- PFHxS 18 ppt
- PFNA 11 ppt

Effective September 30, 2019.

Estimated cost for 2 years: $267 million; no funding provided for municipalities & utilities (an underestimate).
Cape Cod groundwater & drinking water impacted by septic systems

Data...

PFAS are showing up in various waters & soils:

- drinking water
- groundwater
- surface water
- wastewater

DATA following are ng/L (ppt)

Compare to 70 ppt for PFOA + PFOS (EPA PHA)

PFOA
Data...
PFAS are showing up in various waters:

- drinking water
- groundwater
- surface water
- wastewater

![PFOA structure](image)
Monitoring well testing at sludge monofill

- Monofill used in 1980s. Since ~1996, all biosolids from WWTP (11.5 MGD) have been land applied, some on farm field shown.
- Likely a worst-case scenario? But nothing like a firefighting site!
Ottawa AD biosolids


- Relatively low levels of PFOA & PFOS
- Applied at 22 Mg dw / ha (~10 tons dw/ac)
- Incorporated to 20 cm

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Concentration or value</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH</td>
<td>7.9</td>
</tr>
<tr>
<td>Moisture (%)</td>
<td>74.8</td>
</tr>
<tr>
<td>Electrical conductivity (mS cm(^{-1}))</td>
<td>4.4</td>
</tr>
<tr>
<td>Organic carbon (%)</td>
<td>23.5</td>
</tr>
<tr>
<td><strong>Polybrominated diphenyl ethers (PBDEs) (ng g(^{-1}) dw)</strong></td>
<td></td>
</tr>
<tr>
<td>BDE-47</td>
<td>358 (24)</td>
</tr>
<tr>
<td>BDE-99</td>
<td>393 (84)</td>
</tr>
<tr>
<td>BDE-100</td>
<td>101 (36)</td>
</tr>
<tr>
<td>BDE-153</td>
<td>39 (3)</td>
</tr>
<tr>
<td>BDE-154</td>
<td>29 (3)</td>
</tr>
<tr>
<td>BDE-183</td>
<td>9 (1.3)</td>
</tr>
<tr>
<td>BDE-209</td>
<td>819 (83)</td>
</tr>
<tr>
<td><strong>Additional brominated flame retardants (BFRs) (ng g(^{-1}) dw)</strong></td>
<td></td>
</tr>
<tr>
<td>Decabromodiphenyl ethane (DBDPE)</td>
<td>17</td>
</tr>
<tr>
<td>1,2-Bis(2,4,6-tribromophenoxy)ethane (BTBPE)</td>
<td>23</td>
</tr>
<tr>
<td>Pentabromoethylbenzene (PBEB)</td>
<td>0.096</td>
</tr>
<tr>
<td>Hexabromobenzene (HBB)</td>
<td>0.124</td>
</tr>
<tr>
<td><strong>Perfluoroalkyl acids (PFFAs) (ng g(^{-1}) dw)</strong></td>
<td></td>
</tr>
<tr>
<td>Perfluorobutanoic acid (PFBA)</td>
<td>&lt;0.4</td>
</tr>
<tr>
<td>Perfluoropentanoic acid (PFPeA)</td>
<td>1.2</td>
</tr>
<tr>
<td>Perfluorohexanoic acid (PFHxA)</td>
<td>1.5</td>
</tr>
<tr>
<td>Perfluorohexanoic acid (PFHxA)</td>
<td>&lt;0.4</td>
</tr>
<tr>
<td>Perfluoroctanoic acid (PFOA)</td>
<td>1.6</td>
</tr>
<tr>
<td>Perfluorodecanoic acid (PFDA)</td>
<td>19</td>
</tr>
<tr>
<td>Perfluorodecanoic acid (PFDA)</td>
<td>7.2</td>
</tr>
<tr>
<td>Perfluoroundecanoic acid (PFDuN)</td>
<td>2.7</td>
</tr>
<tr>
<td>Perfluorodecanoic acid (PFDoA)</td>
<td>3.6</td>
</tr>
<tr>
<td>Perfluorobutane sulfonate (PFBS)</td>
<td>22</td>
</tr>
<tr>
<td>Perfluorohexane sulfonate (PFHxS)</td>
<td>&lt;0.7</td>
</tr>
<tr>
<td>Perfluorooctane sulfonate (PFOS)</td>
<td>7.2</td>
</tr>
<tr>
<td>Perfluorooctane sulfonamide (PFOSA)</td>
<td>0.5</td>
</tr>
</tbody>
</table>
Concentrations of PFAAs in 2m groundwater [left hand panels] and tile discharge [right hand panels]

Treated area = open circle
Control = closed circle

Compare to:
EPA health advisory: 70 ppt
NH groundwater: teens ppt
Groundwater at NH septage facilities
Summer 2019, NH DES completed testing of groundwater monitoring wells at septage lagoons:

13 lagoons / septage treatment facilities
PFAS detected at all but 2 (forest, remote sites)
PFAS exceeded Sept. 30 groundwater standards at 8 (62% of facilities)

Next steps: DES requires testing of neighbor wells within 1000 feet. If contamination found, septage facility will likely be required to pay for investigation, installation & maintenance of water treatment system for each well impacted. Will DES require groundwater cleanup? What unexpected costs will hit facilities?
PFAS are showing up in various waters:

- drinking water
- groundwater
- surface water
- wastewater

![PFOA molecule](image-url)
Landfill / Surface water
Hoosic River, NY
2016

Legend
- Surface Water
- Landfill Monitoring Well

- Sample from pond.
- Landfill seep/leachate sample.
- Hoosic River sample located downstream of treatment plant.
PFAS are showing up in various waters:

- drinking water
- groundwater
- surface water
- wastewater

PFOA
Wastewater Assessments

NH DES data & slide
### PFAS in wastewater - ppt
(presence further confirmed, 2017 NH DES data)

<table>
<thead>
<tr>
<th></th>
<th>PFBA</th>
<th>PFHXA</th>
<th>PFHXS</th>
<th>PFHXA</th>
<th>PFNA</th>
<th>PFOA</th>
<th>PFOS</th>
<th>PFPEA</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>C4</td>
<td>C6</td>
<td>C6-S</td>
<td>C6</td>
<td>C9</td>
<td>C8</td>
<td>C8</td>
<td>C5</td>
</tr>
<tr>
<td>Small City Influent</td>
<td>13</td>
<td>&lt;4</td>
<td>&lt;4</td>
<td>7</td>
<td>&lt;4</td>
<td>6</td>
<td>6</td>
<td>5</td>
</tr>
<tr>
<td>Small City Effluent</td>
<td>7</td>
<td>&lt;4</td>
<td>&lt;4</td>
<td>46</td>
<td>&lt;4</td>
<td>6</td>
<td>7</td>
<td>21</td>
</tr>
<tr>
<td>Mid-size City Influent</td>
<td>&lt;9.6</td>
<td>7</td>
<td>7</td>
<td>10</td>
<td>&lt;4.8</td>
<td>15</td>
<td>22</td>
<td>29</td>
</tr>
<tr>
<td>Mid-size City Effluent</td>
<td>&lt;9.6</td>
<td>5</td>
<td>8</td>
<td>20</td>
<td>&lt;4.8</td>
<td>15</td>
<td>14</td>
<td>9</td>
</tr>
<tr>
<td>Municipality with industrial impacts Influent</td>
<td>56</td>
<td>8</td>
<td>&lt;4</td>
<td>49</td>
<td>&lt;4</td>
<td>50</td>
<td>4</td>
<td>36</td>
</tr>
<tr>
<td>Municipality with industrial impacts Effluent</td>
<td>73</td>
<td>19</td>
<td>&lt;4</td>
<td>195</td>
<td>&lt;4</td>
<td>49</td>
<td>&lt;4</td>
<td>101</td>
</tr>
<tr>
<td>Region</td>
<td>PFOA (ppt)</td>
<td>PFOS (ppt)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-----------------</td>
<td>-------------</td>
<td>-------------</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Michigan*</td>
<td>16 to 3,200</td>
<td>9 to 960</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>United States</td>
<td>30 to 5,000</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Europe</td>
<td>ND</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Australia</td>
<td>17</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>China</td>
<td>281 to 1,971</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Worldwide Range</td>
<td>ND to 214,000</td>
<td>ND to 6,020</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Based on leachate analyses from 32 MWRA-member landfills participating in this statewide study and leachate data obtained on MiWaters.com.

MI & VT concluded: leachate not a big problem because its amounts are relatively small in a WRRF.
Data...
PFAS are present in all biosolids, some residuals, & soils...

DATA following are ng/g (ppb) dry weight

Compare to:
~72 ppb a NY DEC screening value
2.5 ppb ME PFOA limit
5.2 ppb ME PFOS limit
<table>
<thead>
<tr>
<th>Location</th>
<th>PFOA</th>
<th>PFOS</th>
<th>PFBS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gorham, ME grab sample, July 2019</td>
<td>&lt;16</td>
<td>24</td>
<td>8.6</td>
</tr>
<tr>
<td>Lewiston-Auburn, ME septage, Aug. 2019</td>
<td>&lt;33</td>
<td>20</td>
<td>&lt;10</td>
</tr>
<tr>
<td>Sanford, ME, Sept. 2019</td>
<td>&lt;50</td>
<td>121</td>
<td>&lt;50</td>
</tr>
<tr>
<td>Kennebunk, ME dewatered septage May, 2019</td>
<td>39</td>
<td>82</td>
<td></td>
</tr>
<tr>
<td>Presque Isle, ME dewatered septage, April 2019</td>
<td>16</td>
<td>62</td>
<td></td>
</tr>
<tr>
<td>Belgrade dewatered septage, April 2019</td>
<td>60</td>
<td>46</td>
<td></td>
</tr>
</tbody>
</table>
Biosolids & SPF* Assessments

*SPF = short paper fiber (paper mill residuals)

NH DES data & slide

- PFBS
- PFBA
- PFHSA
- PFHS
- PFNA
- PFOA
- PFOS
- PFPEA

ppb
# Maine biosolids/compost results

<table>
<thead>
<tr>
<th></th>
<th>PFOA (ug/kg (ppb) dry wt. basis)</th>
<th>PFOS (ug/kg (ppb) dry wt. basis)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Maine Data - Biosolids and Biosolids-Based Soil Amendments - Sample number = 49</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Median</td>
<td>2.8</td>
<td>15</td>
</tr>
<tr>
<td>Maximum</td>
<td>35</td>
<td>120</td>
</tr>
<tr>
<td>Minimum</td>
<td>0.6*</td>
<td>2.1</td>
</tr>
<tr>
<td><strong>Maine Screening Std.</strong></td>
<td>2.5</td>
<td>5.2</td>
</tr>
<tr>
<td><strong>NEBRA data compilation</strong></td>
<td>Avg. 5</td>
<td>14</td>
</tr>
<tr>
<td><strong>2001 US biosolids</strong> **</td>
<td>Avg. 34</td>
<td>403</td>
</tr>
</tbody>
</table>

- Six samples were below the LOD for PFOA.

No clear trends in types of processing/size of plant v. PFAS concentrations.

Voluntary phase out of PFOA and PFOS use in US → lower levels in the environment.

Note that the PFOA level in several of these non-biosolids composts would be higher than the Maine screening standard of 2.5 ppb.

Figure 1. PFAA concentrations quantified (micrograms per kilogram oven-dried, <2 mm) in the compost (left) and the relative contribution (percent) of each PFAA to the total PFAAs quantified for composts 1–10 (right).
### Context: Biosolids levels vs. other sources

<table>
<thead>
<tr>
<th>Biosolids</th>
<th>PFOA (ppb)</th>
<th>PFOS (ppb)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Higgins et al., 2005</td>
<td>5 – 152 (total perfluorocarboxylates, not just PFOA)</td>
<td>55 – 3370 (total perfluoroalk sulfonates, not just PFOS)</td>
</tr>
<tr>
<td>Sepulvado et al., 2011</td>
<td></td>
<td>80 – 219 (range)</td>
</tr>
<tr>
<td>Tests of EPA samples from 32 states &amp; DC from 2001 (Venkatesan and Halden, 2013)</td>
<td>34 (average)</td>
<td>403 (average)</td>
</tr>
<tr>
<td></td>
<td>11.8 - 70.3 (range)</td>
<td>308 – 618 (range)</td>
</tr>
<tr>
<td>a northern New England biosolids compost, 2016</td>
<td>8.3</td>
<td>11</td>
</tr>
<tr>
<td>a northeast paper mill residual (recycle pulp), 2017</td>
<td>1.6</td>
<td>25</td>
</tr>
<tr>
<td>lowest state soil screening level (for dermal, inhalation) – VT</td>
<td></td>
<td>300</td>
</tr>
</tbody>
</table>

### Other sources

<table>
<thead>
<tr>
<th>Other sources</th>
<th>PFOA (ppb)</th>
<th>PFOS (ppb)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Household organic waste compost (Brandli et al.)</td>
<td>Combined PFAS: 3.4 – 35 (6 = median)</td>
<td></td>
</tr>
<tr>
<td>Dust in U.S. daycare centers, median values (Strynar and Lindstrom, 2008)</td>
<td>142</td>
<td>201</td>
</tr>
<tr>
<td>25 MGD New England WWTF (May 2017)</td>
<td>influent: 0.015</td>
<td>0.022</td>
</tr>
<tr>
<td></td>
<td>effluent: 0.015</td>
<td>0.014</td>
</tr>
<tr>
<td></td>
<td>raw solids: ND</td>
<td>17</td>
</tr>
<tr>
<td>Garden control soils (MN Dept. of Health, 2005, median, n = 6)</td>
<td>0.36</td>
<td>1.4</td>
</tr>
<tr>
<td>Human blood, U. S. population 1999 average (CDC NHANES)</td>
<td>5</td>
<td>30</td>
</tr>
<tr>
<td>Human blood, U. S. population 2012 average (CDC NHANES)</td>
<td>2</td>
<td>6</td>
</tr>
</tbody>
</table>
A few biosolids are impacted at levels of some concern - when an industry discharges large amounts of PFAS to a sewer:

- Decatur, AL (2000s) – 3M manufacturing facility
- Lapeer, MI (2017) - metal plating industry
- Maine farm (2019) - issue is not municipal biosolids; PFOS is the only concern; paper industry sludge/ash; max soil: 878 ppb PFOS (see NEBRA fact sheet: https://www.nebiosolids.org/pfas-biosolids

Solution:
Apply pretreatment & source control.
Soils Study for VT DEC 2018

ΣPFAS (n=66)
- 8 locations >5,000 ng/kg
- 23 locations 2,000-5,000 ng/kg
- 25 locations 1,000-2,000 ng/kg
- 10 locations <1,000 ng/kg
Summary of Biosolids-Amended Soil Sampling Data

Maine, 2019
29 fields, 1 sample each
ng/g (ppb)
at farms that have used biosolids annually for 20+ years

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>Maximum</th>
<th>Minimum</th>
<th>Screening</th>
</tr>
</thead>
<tbody>
<tr>
<td>PFBS</td>
<td>ND</td>
<td></td>
<td></td>
<td>1900</td>
</tr>
<tr>
<td>PFOA</td>
<td>3.06</td>
<td>12.90</td>
<td>1.05</td>
<td>2.5</td>
</tr>
<tr>
<td>PFOS</td>
<td>8.76</td>
<td>20.90</td>
<td>2.13</td>
<td>5.2</td>
</tr>
</tbody>
</table>
Assessing leaching (PFAS in soil)

Limited research shows:

- PFAS soil concentrations can be correlated to biosolids loading rate.
- Correlation is especially strong for longer chain (>C8) PFCA.
- For short chain PFCA, soil concentration may correlate better with time from last application.
- PFAS concentrations in well water and surface water seem to be correlated to loading rate of short chain PFAS.
- Soil PFAS concentrations at depth may increase over time (slow leaching? degradation of precursors?)
- Soil PFAS concentration can change as a result of precursor degradation.
Demonstration of an Agricultural Chemical Fate and Transport Model to Determine Biosolids PFAS Screening Level Concentrations Required for Groundwater Protection

August 2nd, 2019 (with minor corrections August 20, 2019)
Michael Winchell, Marco Propato

Stone Environmental, Inc.

Separate complete set of slides available at https://www.nebiosolids.org/pfas-residuals. Contact NEBRA for access.
Biosolids Application Rate and Concentration Limits: Balancing Mass Loads to Protect Groundwater

The annual and long-term loading rate of PFOA/PFOS from land applied biosolids will determine the potential concentrations in groundwater. This requires management of both:

- Biosolids application rates (tons/acre)
- PFAS concentrations in biosolids

Given a high (20 ton/acre) rate, PFOA+PFOS concentrations below 19 – 29 ppb would limit peak groundwater concentrations to 70 ppt.

PFAS Concentrations and Biosolids Application Rates Required to Keep Peak PFOA+PFOS groundwater conc. below 70 ppt.

Worst case sorption scenarios:
- Low biosolids rate
- High biosolids rate
Policy, legal, & regulatory developments...

...affecting biosolids/residuals and wastewater management in a few states today

Current focus on long-chain... some on replacements.
Maine’s biosolids programs severely disrupted by March 22, 2019 moratorium.

...an unfortunate reaction driven by a strategic news conference on a farm...
New Hampshire’s biosolids recycling harmed by strictest-in-the-nation drinking water & groundwater standards effective 9/30/19.

Is it possible to regulate at near background levels?
Pushing back on flawed regulatory processes in NH:

• Septage management company goes bankrupt in response to responsible party designation & requirement to pay for neighbors’ well impacts; NH DES takes on responsibility for orphaned wells.

• Plymouth Water & Sewer District et al. v. NH DES; in court:

THE STATE OF NEW HAMPSHIRE

MERRIMACK, SS

SUPERIOR COURT

DOCKET NO.

THE PLYMOUTH VILLAGE WATER & SEWER DISTRICT, RESOURCE MANAGEMENT, INC., CHARLES G. HANSON, and 3M COMPANY

Plaintiffs

v.

ROBERT R. SCOTT, AS COMMISSIONER OF THE NEW HAMPSHIRE DEPARTMENT OF ENVIRONMENTAL SERVICES

Defendant
State actions pending:

- **AK** - further action on clean-up standards, etc. were put on hold, pending EPA action
- **CA** - Set drinking water notification levels in single parts per trillion (e.g. 6.5)
- **FL** - Provisional target clean-up levels for PFOA & PFOS; considering surface water screening values
- **MA** - proposed site soil & groundwater clean-up values in the 20 ppt range for residential groundwater; comments taken. MCLs being developed.
- **MI** - drinking water MCLs being proposed now, finalized in spring 2020
- **NJ** - has had recommended MCLs and groundwater standards for 2+ years: PFOA = 13 ppt, PFOS = 14 ppt
- **NY** - Comments were due by Sept. 24 re drinking water MCLs: PFOA = 10 ppt, PFOS = 10 ppt
- **VT** - May 2019 state law requires DEC to set MCLs for 5 PFAS by Feb. 1, 2020 and later adopt surface water standards
- **WI** - recommended groundwater standards & preventive actions

BUT... most states are not rushing ahead... watching for EPA lead & learning
Impacts on municipalities & utilities today in ME & NH:

• Price increase: $70 to $138 per wet ton for two NH WWTF solids management programs
• Transport to Quebec & other out-of-region
• ~60% fewer Maine farm fields receiving Class B biosolids - loss of fertilizer
• One Maine farmer’s costs increased > $10,000 in 2019 for fertilizer replacing biosolids
Will there be impacts for wastewater effluent in the future?

- Drinking water levels → groundwater levels
- Influence surface water standards
  - Example in MI: 11 ppt PFOS!
- Water standards influence effluent standards
  - Example MI is using 11 ppt for screening effluent... very low.... Already disrupting wastewater & solids management in MI....
Key points:

- Relatively minor amounts of PFAS are conveyed to the environment by typical municipal wastewater (singles to tens of parts per trillion) & biosolids (singles to tens of parts per billion). This is part of ambient background cycling of these persistent, widely used chemicals.

- PFOA & PFOS - the most concerning - have been phased out and are down in human blood >70% and are down in wastewater & biosolids too. Phasing out use of concerning PFAS is the most efficient way to address potential concerns from such ambient background levels. PFOA & PFOS are becoming legacy issues.

- Recycling municipal biosolids to soils has not caused known impacts to food products and has only impacted groundwater above EPA’s health screening value of 70 ppt in a very few rare cases - and only where there have been large industrial inputs to the sewer.

- Receivers of PFAS - municipalities and utilities - cannot carry the major burden of addressing PFAS at the end of the pipe. If stringent water quality standards (<70 ppt) are set, funding has to be provided and society will be paying large sums to reduce PFAS to such low levels in all waters.

- WRRFs can proactively follow & update best practices to cost-effectively reduce potential risks & liability related to PFAS: upstream source control, BMPs.

- Regulatory agencies should be aware of unintended impacts on WRRF programs when setting site cleanup and water quality standards for PFAS.
What works:
US Environmental Protection Agency
PFOA Stewardship Program

In January 2006, USEPA started this program to help minimize impact of PFOA in the environment

Eight major international companies agreed to participate (including 3M, DuPont, Asahi Glass, Daikin)

Agreement to voluntarily reduce factory emissions and product content of PFOA and related compounds* on a global basis by 95% no later than 2010

Worked toward total elimination of emissions and product content of these compounds by 2015

Based on emissions and content determinations made for 2006

* Includes PFOA, precursor chemicals that can break down to PFOA, higher homologues (C9 and larger)

Slide by A. Lindstrom, U. S. EPA, March 2018
What works: Blood serum levels declining

Median concentration of selected per- and polyfluoroalkyl substances (PFAS) in blood serum (1999-2014) in the United States

https://www.atsdr.cdc.gov/pfas/pfas-blood-testing.html
Thanks for…
your invitation, your attention, & your feedback.

ned.beecher@nebiosolids.org

603-323-7654
Networking Break
RIDEM PFAS Initiatives and Case Studies

Nick Noons
Sanitary Engineer
RIDEM
Rhode Island PFAS Initiatives and Case Studies

Rhode Island Department of Environmental Management

Nicholas Noons, PE
Statewide Sampling

- 2017 and 2019 RIDOH Studies
  - 97% of Rhode Islanders who get drinking water from public water systems
  - 49% of all community water systems
  - 100% of schools supplying their own drinking water

- DEM sampled over 100 private wells in the vicinity of PWS with detections of PFAS, more follow-up studies planned.
Results

- Total of 87 water systems have been sampled to date.
  - 44% of systems with PFAS detections*
  - 15% of systems exceeding 20 ng/L (ppt) for five PFAS (PFOA, PFOS, PFNA, PFHpA, and PFHxS)*
  - Only one PWS exceeded EPA Health Advisory (Oakland Water Association)

*System results may be related to a single well or multiple wells and are not indicative of the point of entry concentrations.
State MCL for PFAS

- RIDOH has began the process of evaluating a State MCL for PFAS.

- Convened a PFAS technical advisory group to solicit input from stakeholders, including public water systems, industry experts, and academia to help inform decision-making process.
  - Two of four planned meetings complete, two more before the end of the year.

- Decision on how to proceed with regulation of PFAS in drinking water anticipated in early 2020.
Legacy AFFF Take-Back Program

- Emergency Response coordinating with fire departments and other entities statewide.
- Over 2,000 gallons committed to date.
- Targeting pre-2003 Class B AFFF formulations.
Statewide Landfill Sampling

- Waste Facilities Management Program will (tentatively) require a minimum of two rounds of PFAS in groundwater at all actively monitoring landfills.
Naval Station Newport

- Newport Naval Education and Training Center (NETC) Superfund Site.

- Naval Station Newport had a capacity of over 110,000,000 gallons (2,645,000 barrels) during operation.

- PFAS was sampled for as early as 2015.

- Presence of PFAS has significantly impacted remediation efforts.
Site 7 (Tank Farm 1)

- Defense Logistics Agency (DLA) responsible for remediating petroleum impacts from former ASTs.

- Selected remedy called for on-site treatment of approximately 90,000 cubic yards soil over 5 acres using thermal desorption technology.

- Presence of PFAS made thermal desorption unfeasible/uneconomical.

- Alternative remedy using evaporative desorption technology was unable to treat petroleum impacts effectively.
Site 24 (Melville DFSP)

- Site was in the process of being transfer to surrounding boatbuilding operations.

- Boatbuilders had approved work plan to remediate petroleum impacts at the site using a combination of air sparge/SVE and soil excavation.

- Sampling for PFAS conducted when land transfer was imminent.

- Highest concentrations of PFAS in groundwater in Rhode Island.
Bradford Dyeing Association

- Historic textile finishing plant located on the Pawcatuck River.

- Over 500,000 square feet of manufacturing space.

- Until operations were scaled down circa 2007, BDA was the largest producer of battle dress uniform fabrics to the Department of Defense and the sole provider of JSLIST chemical suit fabrics.

- The operating company filed for bankruptcy in 2012 and the property was later placed in receivership.
TOXICS ACTION CENTER
& DIRTY DOZEN AWARD 2004 &

This certificate is awarded to
Bradford Dyeing Association
for threatening the health and safety of Bradford residents.

December 1st, 2004

CAUTION! Combustible
May Cause Irritation
Keep away from heat and open flames.
Avoid contact with eyes, skin and clothing.
Keep out of reach of children.
Wash thoroughly after handling.
Use with adequate ventilation.

FIRST AID:
In case of contact, seek medical assistance immediately. Call your Poison Control Center for information before you move product.

FIRE: Do not use water. Use dry chemical or CO2.

SPILL: Clean up with absorbent material.

PERISHABLE IF FROZEN
Moderated Discussion

Moderator: Robert May, Fuss & O’Neill, Inc.

Panelists:
- David R. Blye, *Environmental Standards, Inc.*
- Laura Kerper, *Gradient Corp.*
- Julie C. Lemay, *Gradient Corp.*
- Steve LaRosa, *Weston & Sampson*
- Ned Beecher, *North East Biosolids & Residuals Association*
- Nick Noons, *RIDEM*
Emerging Contaminants Program: Understanding the Science and Toxicity of PFAS – A Deeper Dive