IMPACT OF PFAS REMOVAL ON WATER TREATMENT RESIDUALS DISPOSAL OPTIONS

Eric Kelley, PE and Liz Garvey, PE
NEWWA WTP Residuals Committee

Contaminants of Emerging Concern and Plant Operations
September 2023 Specialty Conference

Agenda

- NEWWA WTP Residuals Committee Background
- Overview of PFAS Treatment Residuals
- Regulatory Considerations
- O&M and Disposal Considerations
- What to Expect
- Questions

NEWWA WTP Residuals Committee

- Mission: “To study and report on areas related to drinking water treatment plant (WTP) residuals management. To make recommendations to the NEWWA board on processing, disposal, and beneficial reuse of WTP residuals, related water works practice issues/technology, regulatory permitting requirements, and technology transfer.”

- Committee Members include representatives from Public Water Systems, Consultants, and State Regulators

Where could PFAS treatment residuals be produced?

- Pre-Treatment – Fe/Mn Removal, Sedimentation, Clarification, Filter Backwash Waste
- PFAS Treatment – GAC/IX Backwash Waste, Membrane Reject, CIP Waste
- PFAS Removal Media – Disposal or Reuse
- System Commissioning – Media washwater
- Process waste – sample and analyzer waste

SOURCE: HTTP://WWW.WESTECH-INC.COM/

SOURCE: HTTP://WWW.CALGONCARBON.COM/

PFAS Treatment Residuals – Lessons Learned

- GAC Commissioning Waste
  - pH, suspended solids, Fe, Mn, and As
- IX Commissioning Waste
  - pH, Chlorides and Sulfates
- Where to Discharge
  - On-site/Sewer/Portable Tanks
  - Existing WTP permits may not allow commissioning waste
- Design Considerations
  - Backwash water source
  - Dechlorination
  - Site Access/Laydown areas

Residuals Regulations and PFAS

- Evolving Regulations
- Water Quality Standards
- Analytical Methods
- Monitoring Requirements
- Reuse Limitations
- Land Application
- Environmental Risk

PFAS Compound	Proposed MCLG	Proposed MCL
PFOA	0 ppt	4.0 ppt
PFOS	0 ppt	4.0 ppt
PFNA	1.0 (unitless Hazard Index)	1.0 (unitless Hazard Index)
PFHxS		
PFBS		
HFPO-DA (GenX)		

CERCLA Update

- CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act
  - Also known as Superfund
- Two efforts by EPA for Hazardous Designation
  - Proposed designation of PFOA and PFOS
    - Final rule anticipated February 2024
  - Preparing to request input on additional PFAS compound's designations

Implications of CERCLA Update

- All entities releasing hazardous substances to environment are potentially liable
- Liability allocation results:
  - Increase waste management costs
  - Reduce available options
  - Create uncertainty on future operations
- EPA tools to allocate liability
  - Issuance of new policy documents
    - Water Systems PFAS Liability Protection Act
  - Settlement agreements with Potentially Responsible Parties
  - Site-specific resolutions

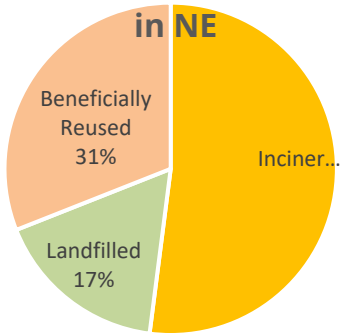
PFAS Impacts on Biosolids Management in New England

- Large % of biosolids generated in NE are beneficially reused, especially in northern states
  ME *(79%)*, VT *(70%)*, NH *(68%)*
- None of the 3 biosolids management methods address PFAS (incineration has potential)
- PFAS regulations/concerns impacting costs of beneficial reuse programs the most
- Important benefits being lost!

nebra
North East Biosolids & Residuals Association
www.nebiosolids.org

Country's closed folks; Moose outside shoulda told you that.

End Uses for Wastewater Solids in NE



SOURCE: NEBRA (2007)

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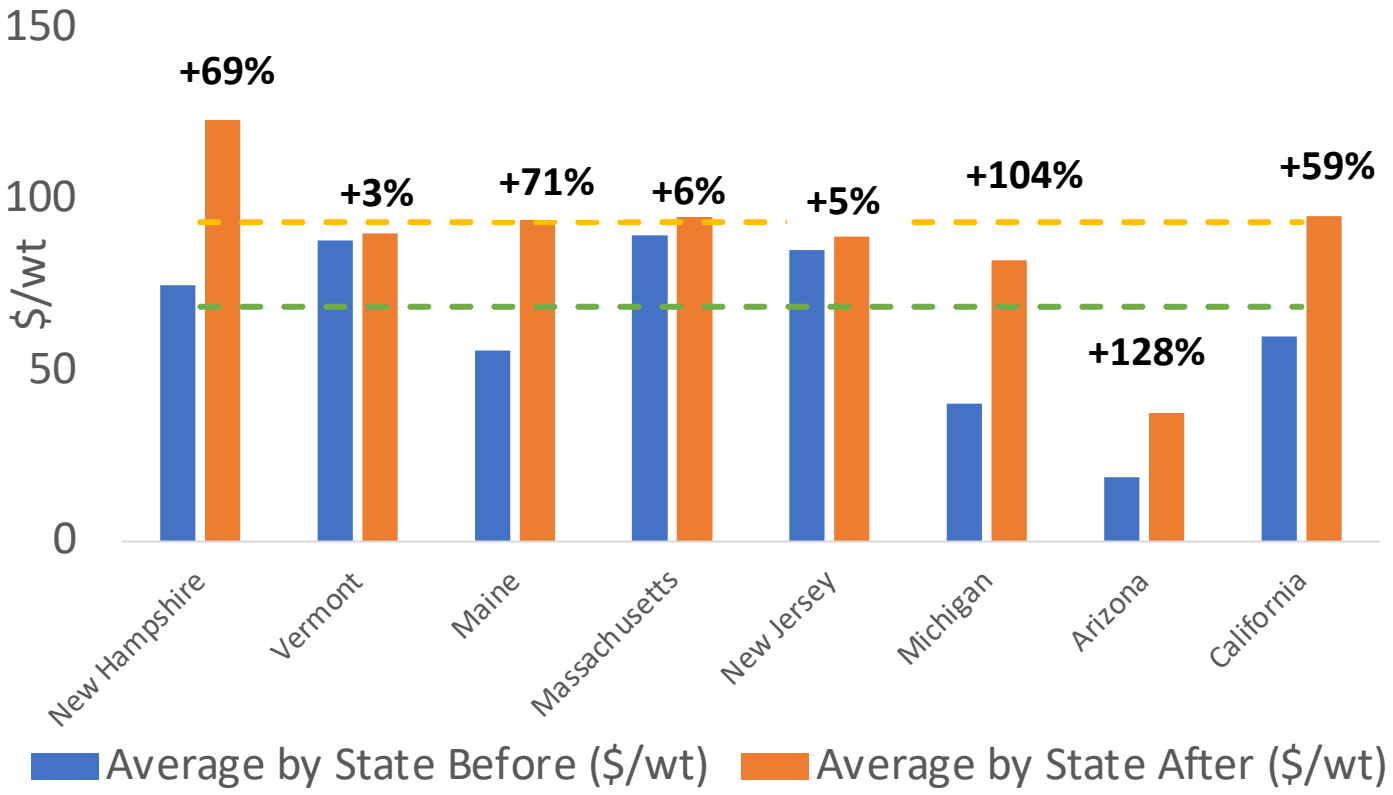
PFAS Impacts on Biosolids Management in New England

NEBRA Predictions

- More investment in volume reduction (drying and digestion)
- More PFAS testing
- Less land application
- Capacity pinches at incinerators & landfills
- Solids handling cost increases (guaranteed)



SOURCE: CDM SMITH (2020)

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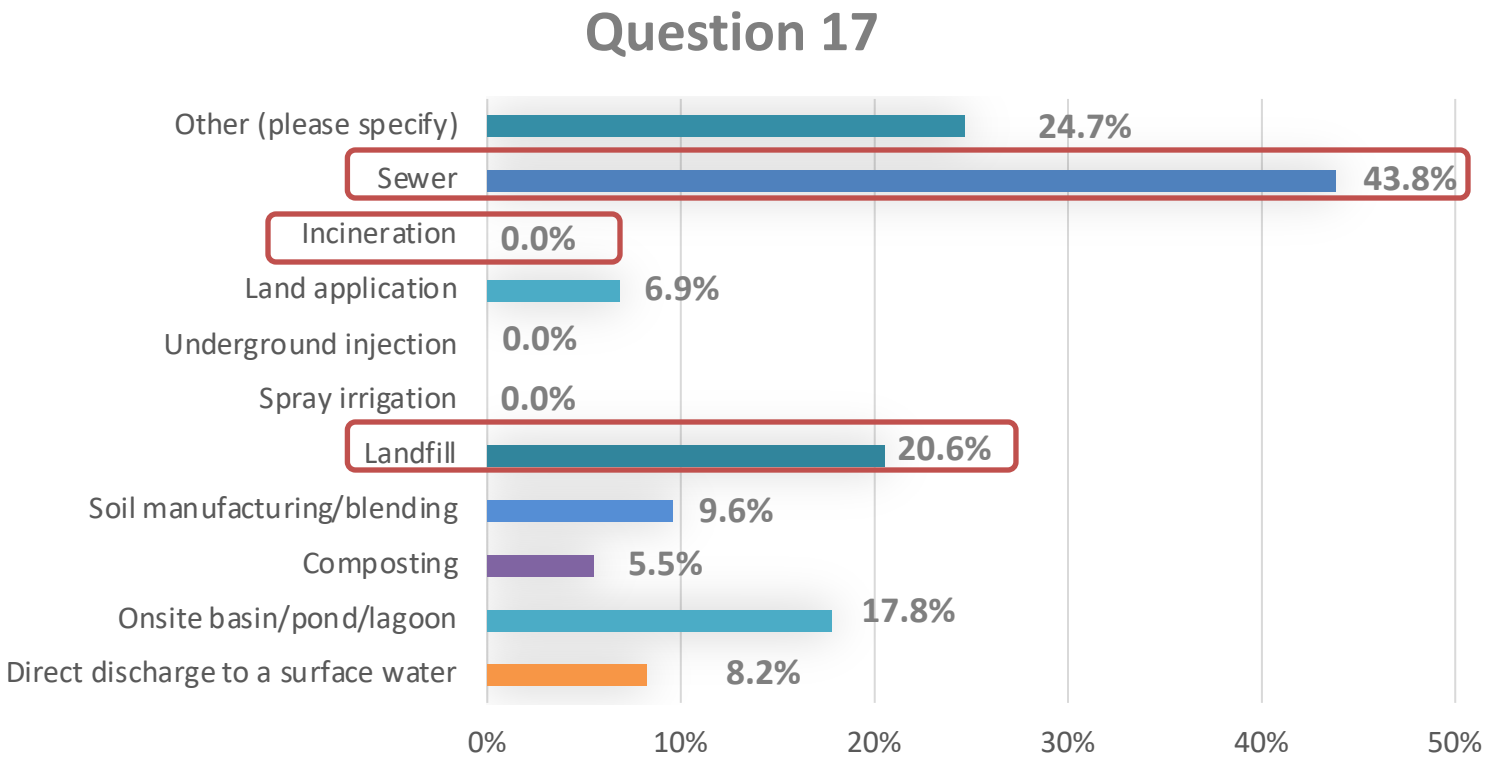
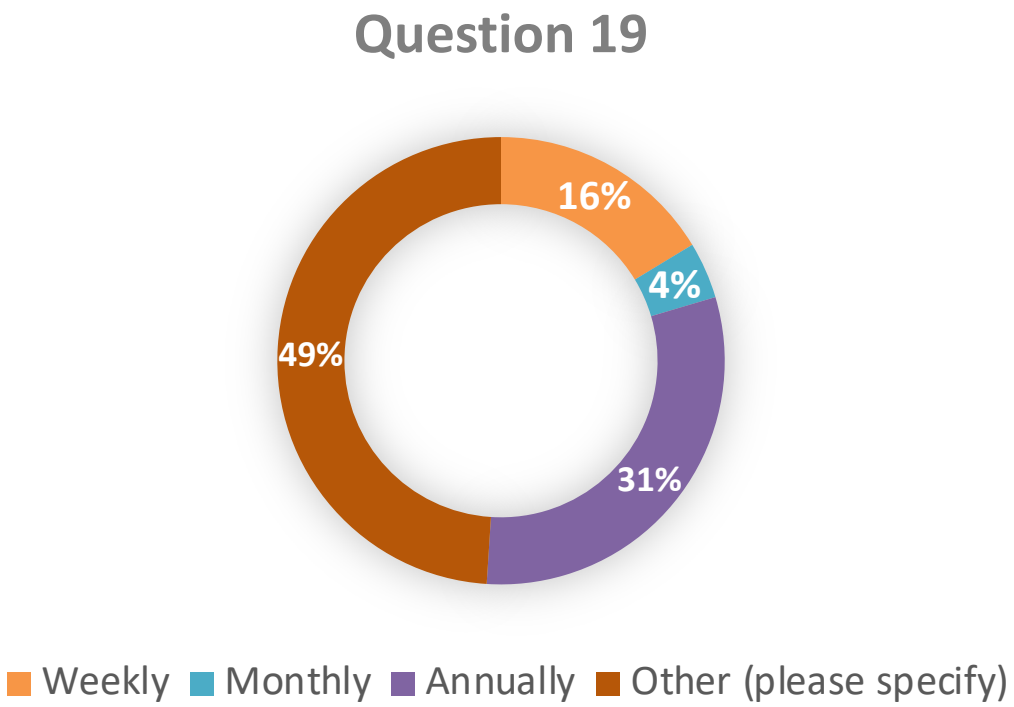
What are the methods of final WTP residuals disposal?



How often are you disposing of residuals?



How much do you spend annually for residuals disposal?

- 49 Respondents
- Ranged from $0 to $1.6M
- 31 responded with costs greater than $5,000/yr
- 11 responded unknown
- Median cost was $75,000/yr
- Average cost was $165,000/yr

NPDES and Residuals

- Final Permit Published – July 24, 2023
- Permit Effective – October 1, 2023
- NOI for WTPs – Due within 60-days of permit effective date (November 29, 2023)

- Aluminum Limits and Monitoring
- Whole Effluent Toxicity Testing
- PFAS Monitoring
- Phosphorous Monitoring

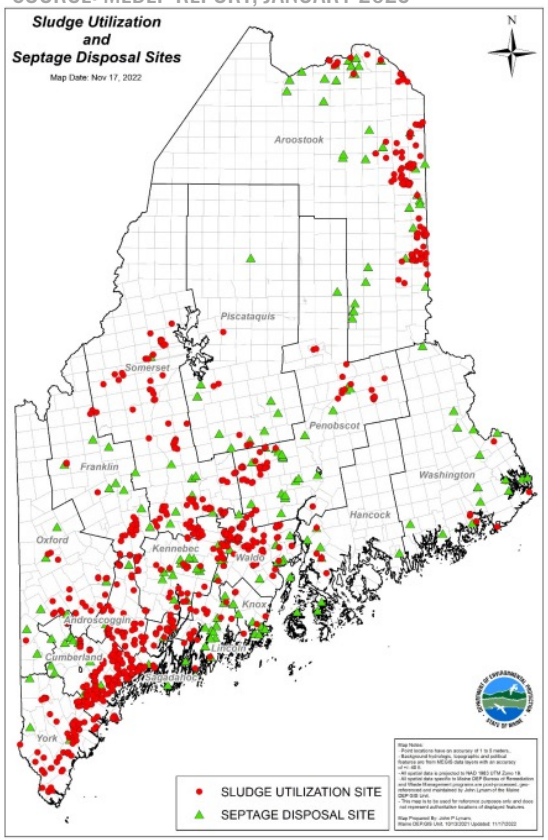
Regulatory Contacts

- CT – Patricia Bisacky, DPH
  DPH.EmergingContaminants@ct.gov, (860) 509-7356
- MA – Jennifer Wood, MADEP
  jennifer.wood@mass.gov, (617) 654-6536
- ME – Susanne Miller, MEDEP
  Susanne.miller@maine.gov, (207)-557-2700
- NH – Anthony Drouin, NHDES
  anthony.drouin@des.nh.gov, (603) 271-3571
- VT – Eamon Twohig, VTDEC
  eamon.twohig@vermont.gov, (802) 490-6189
- RI – Ann Battersby, RIDOH
  Ann.Battersby@health.ri.gov, 401-222-7771

Maine – Regulatory Requirements for Residuals Management

- PFAS Task Force created in 2019
- DEP Chapter 418 Rule requires screening for PFOA, PFOS, and PFBS in WWTF residuals intended for Beneficial Use.
- 2019 DEP required testing of WWTF and papermill residuals prior to spreading and finished compost produced:
  - 65% residuals exceeded PFOA screening level
  - 93% residuals exceeded PFOS screening level
  - 89% compost exceeded PFOA screening level
  - 74% compost exceeded PFOS screening level
  - No PFBS exceedances
  - No papermill residuals exceeded any PFAS screening level
- https://www.maine.gov/dep/spills/topics/pfas/index.html

SOURCE: MEDEP REPORT, JANUARY 2023



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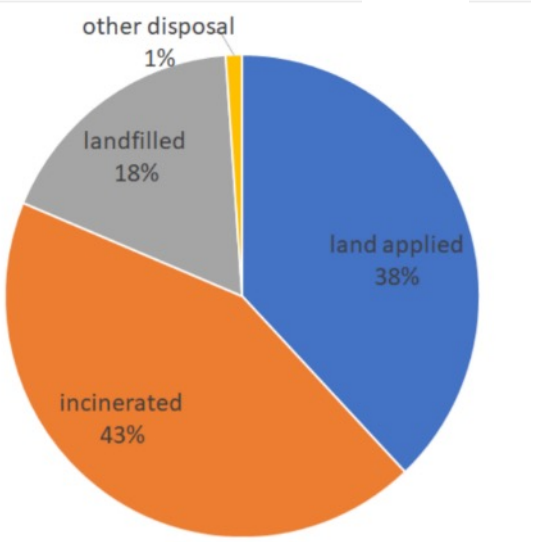
Massachusetts Residuals Regulations

- 310 CMR 32 – Regulations governing residuals
  - Blending Policy , 87-01
- MassDEP reviews/approves AOS for residuals use, sale or distribution within Massachusetts
- MassDEP reviews PFAS in residuals data and previously reviewed lab SOPs on Method 533.
- Use of Method 1633 expected once multi-lab validation completed

Residual reuse and disposal in Massachusetts[1]

- 122 Sources
- 180, 800 dry tons

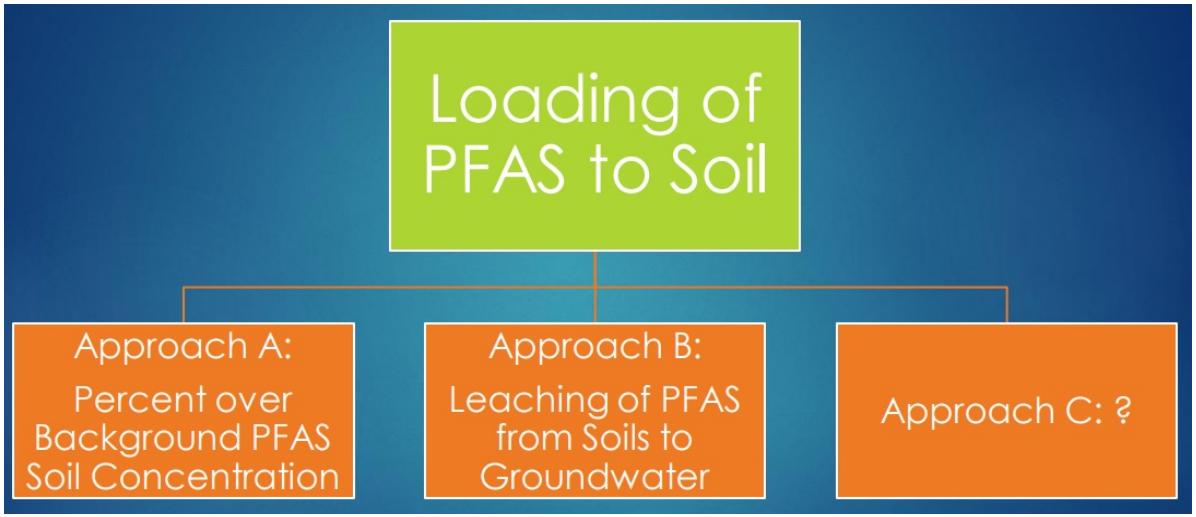
[1]The Mass Sludge Survey 2018 Wastewater Solids Generation and Management in Massachusetts



Residuals Specific Email
massdep.residuals@mass.gov

Massachusetts Residuals Regulations

- Approval of Suitability (AOS) – requires quarterly PFAS monitoring to better characterize PFAS levels in residuals products
- Stakeholder Group – Data collection and sharing, advise on strategy for PFAS in residuals
- MassDEP is evaluating background levels in soils, leaching potential, and environmental/human health risk to derive PFAS Screening Values



No residuals standard or guideline … YET!

New Hampshire
Applicable State Rules for Residuals Management

- Land Application - Env-Wq 800/Env-Wq 1600/RSA 485-A
- Solid Waste - Env-Sw 100 through 2100, RSA 149-M
- Incineration - Env-A 600, 40 CFR Part 60, Subpart O
- Federal Regulations - 40 CFR Part 503

New Hampshire
PFAS Action Items since 2017

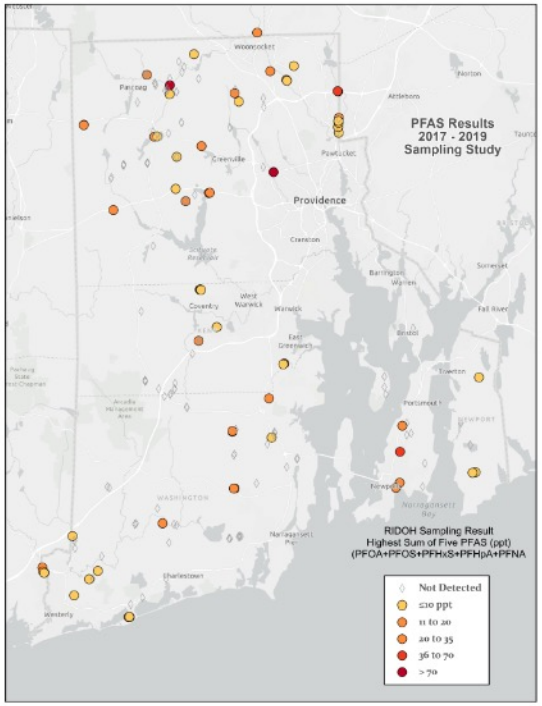
- Spring of 2019 – Implemented Sampling and Reporting requirements for Sludge Quality Certificate holders
- Ongoing PFAS investigation with biosolids program, sludge and septage lagoon facilities, and septage hauled in the state since 2017
- PFAS sampling training following NEBRA guidance
- Created and have been running the Northeast Biosolids Improvement Program since November of 2019
- Coordination in conjunction with the 2021 NEIWPCC Regional Sludge Study collecting 2018 data across New Hampshire with all permitted POTW's
- USGS NH Soil and Sludge Leaching Study is in process and slated for completion in 2022

Vermont Regulatory Update

- 2019 - Legislative act establishing a 20 ppt MCL for total of PFOA, PFOS, PFHxS, PFHpA and PFNA.
- 2019 – Routine PFAS monitoring begins – CMWS/NTNCs
- 2020 - PFAS MCL and sampling requirements incorporated into Water Supply Rule
- Challenges – Lots of TNCs (e.g. Killington condominium associations) and NTNCs (schools/daycares)
- Researching land application of biosolids near water supply wells

Rhode Island PFAS Regulatory Status

- RIDOH screening PWS in 2017 – 83 Community and NTNCs screened with priority on those within proximity of potential PFAS source
- RI State Law passed in June 2022: Sum of 6 (PFOA, PFOS, PFHxS, PFNA, PFHpA, and PFDA)
  - Detection of >20ppt – QT sampling
  - Detection < 20ppt – annual MN
  - No Detections – biennial
- PWS must sample by July 1, 2023 and provide potable water if exceeding by July 1, 2023
- As of start of May, 52 PWS have submitted PFAS data



SOURCE: RIDOH

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Connecticut PFAS Regulatory Status

CASRN	Analyte	CT Drinking Water Action Level (nanograms per liter; ng/L)^
756426-58-1	6:2 chloropolyfluoroether sulfonic acid (6:2 Cl-PFESA, 9Cl-PF3ONS,* F-53B major)	2
763051-92-9	8:2 chloropolyfluoroether sulfonic acid (8:2 Cl-PFESA, 11Cl-PF3OUdS,** F-53B minor)	5
1763-23-1	Perfluorooctane sulfonic acid (PFOS)	10
375-95-1	Perfluorononanoic acid (PFNA)	12
335-67-1	Perfluorooctanoic acid (PFOA)	16
13252-13-6	Hexafluoropropylene oxide dimer acid (HFPO-DA; GenX)	19
355-46-4	Perfluorohexane sulfonic acid (PFHxS)	49
307-24-4	Perfluorohexanoic acid (PFHxA)	240
375-73-5	Perfluorobutane sulfonic acid (PFBS)	760
375-22-4	Perfluorobutanoic acid (PFBA)	1,800

* EPA Methods 533 & 537.1 use9Cl-PF3ONS (9-chlorohexadecafluoro-3-oxanonane-1-sulfonic acid) for this PFAS.
** EPA Methods 533 & 537.1 use11Cl-PF3OUdS (11-chloroeicosafluoro-3-oxaundecane-1-sulfonic acid) for this PFAS.

- 2016 action level of 70 ppt for sum of 5 PFAS
- 2019 PFAS Action Plan
- June 2022 and June 2023 – Revised individual action levels
- As of August 2023 – only 8 PWS with exceedances above EPA's draft PFOA/PFOS MCLs

Disposal Considerations

- PFAS is Likely to Impact…Everything
  - Sampling and Analysis
  - Sewer Discharge
  - Landfill Disposal
  - Incineration
  - Media Reactivation/Regeneration
  - Beneficial Reuse
  - Environmental Risk and Liability

Sampling and Analysis

EGLE Michigan Department of Environment, Great Lakes, and Energy

BIOSOLIDS AND SLUDGE PFAS SAMPLING
Guidance

Introduction

This guidance document contains the processes, decontamination procedures, and acceptable materials for sampling biosolids and sludge for Per- and Polyfluoroalkyl Substances (PFAS). In addition, this guidance will be used to support the sampling objectives and procedures based on the Quality Assurance Project Plan (QAPP) developed prior to sampling activities.

NOTE: Sections 1-4 of the **General PFAS Sampling Guidance** should be reviewed prior to reviewing this guidance document.

The Michigan Department of Environment, Great Lakes, and Energy (EGLE) intends to update the information contained within this PFAS sampling guidance document as new information becomes available. Users of this guidance are encouraged to visit the Michigan PFAS Response website (Michigan.gov/PFASResponse) to access the current version of this document.

In Michigan, the term "biosolids" is commonly used to describe the residuals created in a Wastewater Treatment Plant (WWTP) and land applied in accordance with the Part 24 Rules, Land Application of Biosolids, promulgated pursuant to Part 31, Water Resources Protection, of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended. The term "sludge" is typically used to describe the solids that have been disposed through methods other than land application.

Any Michigan WWTP that land applies biosolids in Michigan must have an approved Residuals Management Program that includes a sampling plan describing the methodology representative of the biosolids samples to be collected. The individual responsible for overseeing the collection of the biosolids for PFAS sampling should use this guidance document in conjunction with their facility's approved Residuals Management Program to obtain a representative biosolids sample. Special considerations should be followed as described in the project QAPP based on project objectives.

Wastewater flows through two treatment processes at a WWTP, a liquid stream and a solid stream. The liquid stream is treated by primary and secondary treatment processes at a minimum and sometimes with a tertiary treatment process. Sampling for the liquid stream of the wastewater is covered in EGLE's Wastewater PFAS Sampling Guidance. This sampling guidance will address the analysis of biosolids and sludge, the solids portion of the wastewater that is treated through the solid stream. The solids content of the sludge from the primary, secondary, and possibly tertiary treatment is highly aqueous and is sometimes thickened/dewatered prior to storage for eventual land application or landfilling. Biosolids and sludge samples can be obtained from many points along the WWTP's solids stream.

Additional information about Michigan's Biosolids Program, including program staff map, can be found at: Michigan.gov/Biosolids.

Michigan.gov/PFASResponse 800-662-9278 10/2019

- Sampling and Analytical Requirements specified by State Agencies
- Treatment/Disposal facilities may have specific pre-characterization requirements
- Method 537.1 - Drinking Water
- SW846 Method 8327 – groundwater, surface water, and wastewater
- CWA Method 1600 – non-drinking water, fish tissues, biosolids, soils and sediments
- Sampling protocols and guidance readily available

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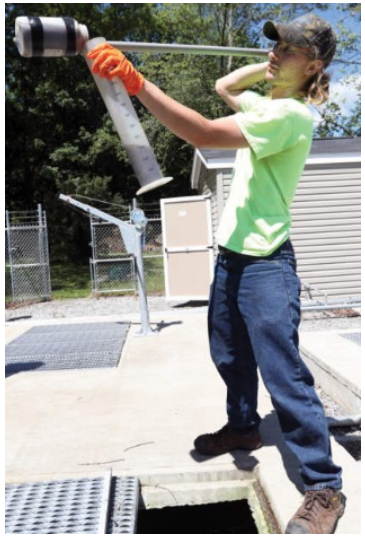
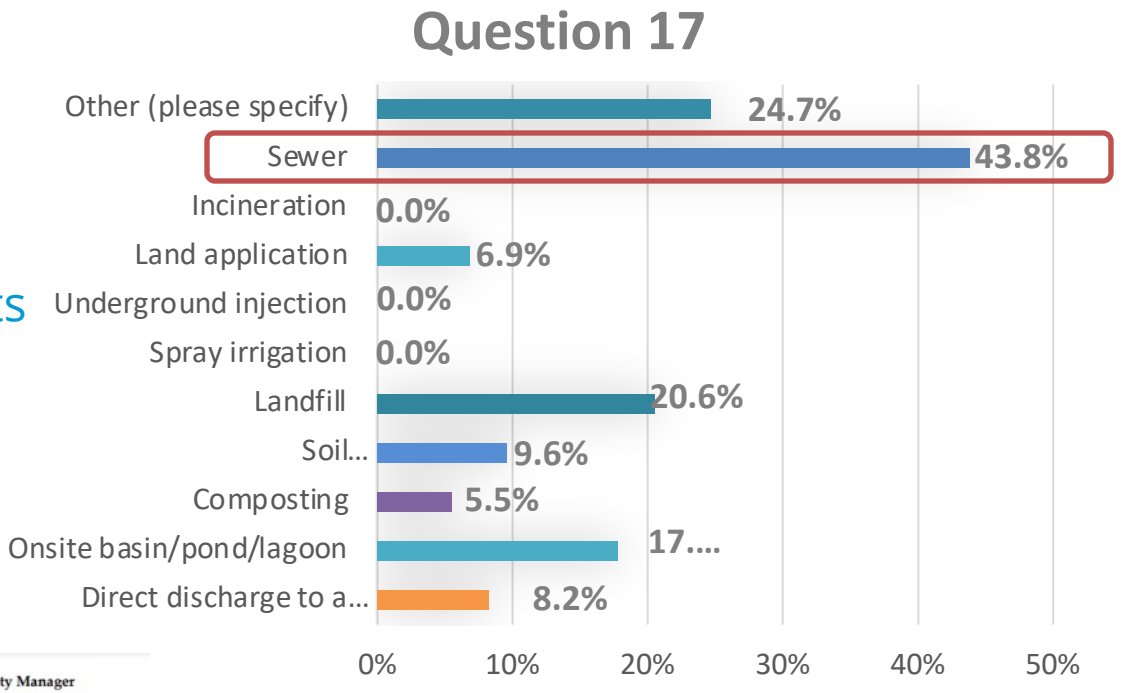
We Anticipate:
New Testing Requirements – More States

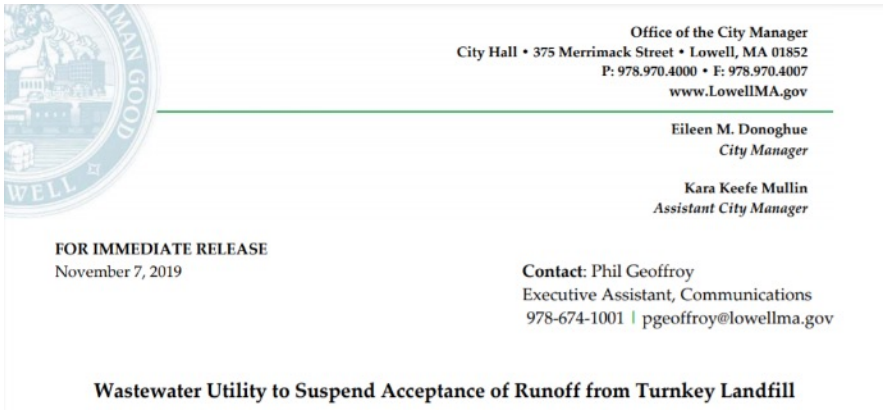
- Connecticut
  - Requires testing at sites where PFAS are "likely to have been released" including "at and around landfills"
- Massachusetts
  - Requiring testing of residuals in all new or renewed Approval of Suitability for Land Application of Sludge and Septage
- New Hampshire
  - DES biosolids program initiated compliance assistance & source control efforts for treatment facilities
- Vermont
  - DEC conducted testing of effluent & sludge from all treatment facilities – report coming
  - Requiring treatment facilities to conduct sampling (soils & GW at Class B land application sites)



Sewer Discharge

- WTP waste stream inventory, pre-treatment, screening and reporting requirements
- POTW NPDES requirements
- Contingency Plans





Office of the City Manager
City Hall • 375 Merrimack Street • Lowell, MA 01852
P: 978.970.4000 • F: 978.970.4007
www.LowellMA.gov

Eileen M. Donoghue
City Manager

Kara Keefe Mullin
Assistant City Manager

FOR IMMEDIATE RELEASE
November 7, 2019

Contact: Phil Geoffroy
Executive Assistant, Communications
978-674-1001 | pgeoffroy@lowellma.gov

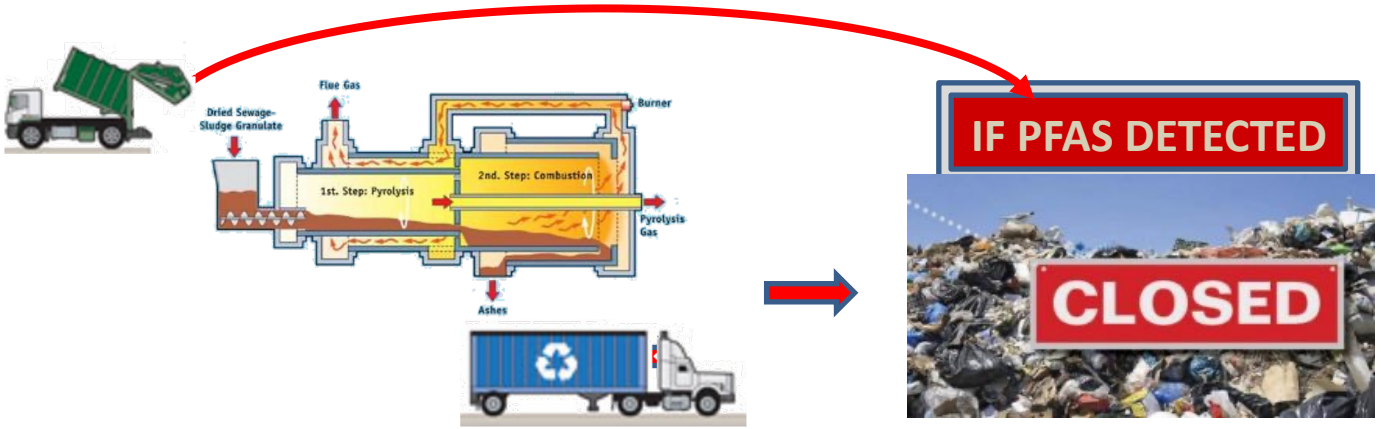
Wastewater Utility to Suspend Acceptance of Runoff from Turnkey Landfill

Landfill / Incineration

- Total Cost = Transportation + Disposal
- Scenario assumptions
  - Per 1 MGD
  - 8 tons of media for 1 filter vessel
  - $10/mile transport via truck cost
  - Media transported 2,000 miles
  - $140/ton for landfill
  - $760/ton for incineration
- Hazardous Waste Landfill
  - ($10/mile x 2,000 miles) + ($140/ton x 8 tons) = **$21,120**
- Hazardous Waste Incinerator
  - ($10/mile x 2,000 miles) + ($760/ton x 8 tons) = **$26,080**

We Anticipate: Capacity Limitations & Air Emissions Concerns

- A New England SSI has said: "If sludge tests positive for PFAS, we can no longer take it…"
  - Possible response: BUT you have to take my sludge!
    - During outages, some landfills are required to find homes for material under contract. PFAS may restrict backup options in these cases



- "There are too many data gaps to argue that burning is safe," said Jen Duggan, a lawyer at the Conservation Law Foundation in Vermont. "Even if we did know what conditions are required to destroy PFAS, we don't have monitoring at the stacks to make sure it's being done properly,"

PFAS Media Reactivation / Regeneration

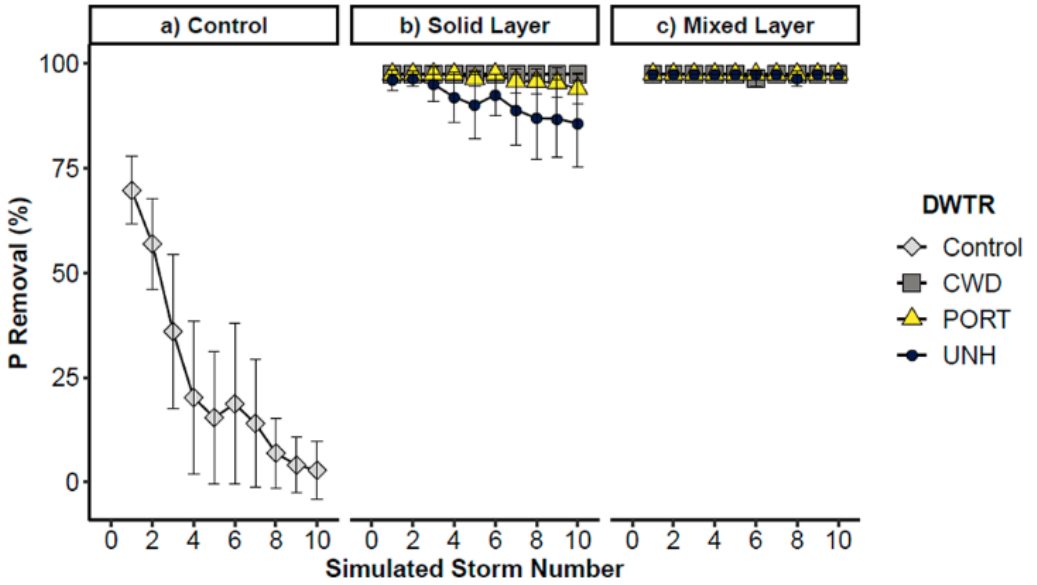
- Granular Activated Carbon (GAC) or Ion Exchange Resin (IX)
- Adsorption Capacity and Breakthrough
- Reactivation vs. Regeneration
- GAC reactivation – thermal treatment to remove PFAS, add supplemental virgin GAC and reinstall
- Regeneration – research in progress on GAC and IX

SOURCE: HTTP://WWW.CALGONCARBON.COM/

SOURCE: HTTPS://WWW.RESINTECH.COM/

Beneficial Reuse

- Limited Options to begin with
- Challenges with:
  - Quantity produced
  - Frequency
  - Aluminum toxicity
- Environmental liability
  - Long-term land application to soils
  - Leaching potential to groundwater



SOURCE: AMENT ETAL, 2021

We Anticipate:
Increased Transportation & Disposal Costs

- Transportation
  - Hauling further & to different sites (out-of-state & if all states are limited → out-of-country?)
- Compliance
  - Anticipated future regulations
- Technology upgrades
  - Utilities may install driers or other energy intensive processes
- Disposal costs
  - Incinerators may have to install new systems (burn hotter)
  - Landfills may have to install new treatment systems for leachate

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PFAS – A New Driver in Treatment Tech

Proven / Mature	Emerging / Experimental

• Pump and Treat
  • Granular Activated Carbon (GAC)
  • Ion Exchange (IX)
  • Nanofiltration (NF) / Reverse Osmosis (RO)
• Incineration (not for water)
  • Excavation
  • On or off site
  • Requires extremely high temperatures (>1,000 deg.C)
	• Novel Medias
	• Flocculation / Electrocoagulation
	• Foam Fractionation
	• Ozofractionation
	• Polymeric Adsorbents
	• Electrochemical Oxidation
	• Sonolysis
	• Advanced Oxidation / Reduction Processes
	• Pyrolysis
	• Photolysis
	• Fungal Enzymes
	• Monitored Natural Attenuation (MNA)
	• Ball Milling
	• Hydrothermal Liquefaction (HTL)
	• Hydrothermal Alkaline Treatment

Blue denotes adsorption / separation
Red denotes Destruction

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Summary of Anticipated Outcomes

1. Less land application
   - More landfill disposal – hazardous facilities
   - More volume reduction (drying)
2. Additional testing requirements
   - Need for an EPA-accepted methodology in solid media
3. Capacity pinches at incinerators (especially when residuals are tested)
   - Need to better understand PFAS through incineration
   - Can tweaks/additions to processes remove/destroy PFAS?

More Anticipated Outcomes

3. New technologies (some may work)
   - Higher treatment/processing costs
   - Residuals production/treatment

4. New transportation needs (Canada and/or overseas)
   - Disposal sites more remote. More trucking & trains and maybe some barges

5. Rising disposal costs (GUARANTEED)
   - User rate increases by utilities will be needed

Markets Always Adjust

"The markets are the same now as they were five or ten years ago because they keep changing - just like they did then." - Ed Seykota

- ...Prices will initially accelerate upward
- Utilities will shift to accepted disposal options
- New players & options will appear
- The market & prices will stabilize...

What Can We Do???

- Stay active & informed!
- Talk to the associations (NEWWA, NEBRA…)
- Talk to your regulators
- Educate the public & your local officials
- Advocate to your State politicians
- Study & understand PFAS thru the incineration process
- Consider that rate increase you have been putting off…

Light at the End of the Tunnel

- Destructive Technologies
- Regenerative Medias
- Source Reduction
- Increased R&D

Acknowledgements

Residuals Committee:

- Anthony Drouin
- Chris Countie
- David Miller
- Jim Cray
- Jim Finegan
- Marc Morin
- Sean Griffin
- Todd Melanson
- Bryan Sadowski
- Don Bunker
- Rob Little
- Darline Tenney

Contributors:

- NEBRA
- NHDES
- MADEP
- RIDOH
- MEDEP
- Clean Harbors
- Calgon Carbon
- Waste Management
- Evoqua

Questions

Eric Kelley, PE
Principal
eak@envpartners.com
Environmental Partners

Liz Garvey, PE
Project Engineer
elizabeth.garvey@stantec.com
Stantec