Wisconsin
Department of Natural Resources

PFAS Technical Advisory Group

Waste Management Subgroup
November 7, 2019

Welcome!

- Reminder to please mute while on Skype

- Agenda and presentation can be found online at https://dnr.wi.gov/topic/Contaminants/PFASGroup.html under Subgroups

Purpose and Scope

WASTE MANAGEMENT TAG SUBGROUP

- Work with stakeholders to develop best management practices for handling and disposing of PFAS-containing waste
- Information gathering
- Scope of this group: PFAS going to, at, and from waste sites
  - Other groups working on testing parameters, surface water, etc.

11/7/19 Agenda

- Status of DNR Efforts – Joe Van Rossum
- 1:20 PFAS and Landfill Leachate – Mark Peters
- 1:40 Water Quality and Wastewater Treatment – Nate Willis
- 2:00 PFAS Health Standards Development – Sarah Yang, DHS Toxicologist
- 2:25 DNR's Effective Disposal Workgroup
- 2:40 Effects on Waste Industry – Roxanne Wienkes, SWANA

Assess time for questions throughout

DNR PFAS Updates

- Staff meetings weekly
  - Site specific updates
  - Team accomplishments and next steps
- Responding to foam events
- Sampling surface water and fish tissue
- Requested data from municipal WWTPs
- Defining research needs

DNR PFAS Updates

- Rulemaking:
  - Surface water quality criteria (WY-23-19)
  - Drinking water max contaminant levels (DG-24-19)
  - Groundwater standards (DG-15-19)

- AFFF Survey to fire departments

- Contract for analysis of potential source locations and type in WI

Wisconsin Department of Natural Resources

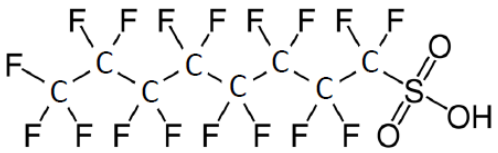
PFAS in Leachate

Summary from Environmental Research & Education Foundation Summit August 2019

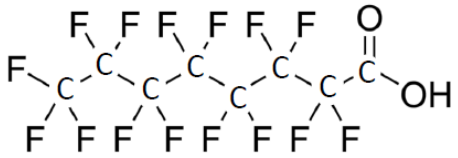
Mark Peters, Hydrogeologist
Waste & Materials Management Program

PFAS Overview

- Brief Intro to PFAS
  - Chemistry
  - Timeline



PFOS – perfluorooctanesulfonic acid



PFOA – perfluorooctanoic acid

- 4,600 CAS Registry Numbers
- PFAS precursors (Non-Regulated)
  - Currently hard to detect analytically
  - Constitute the majority of all fluorinated chemicals at many sites
- End Products- PFOA and PFOS

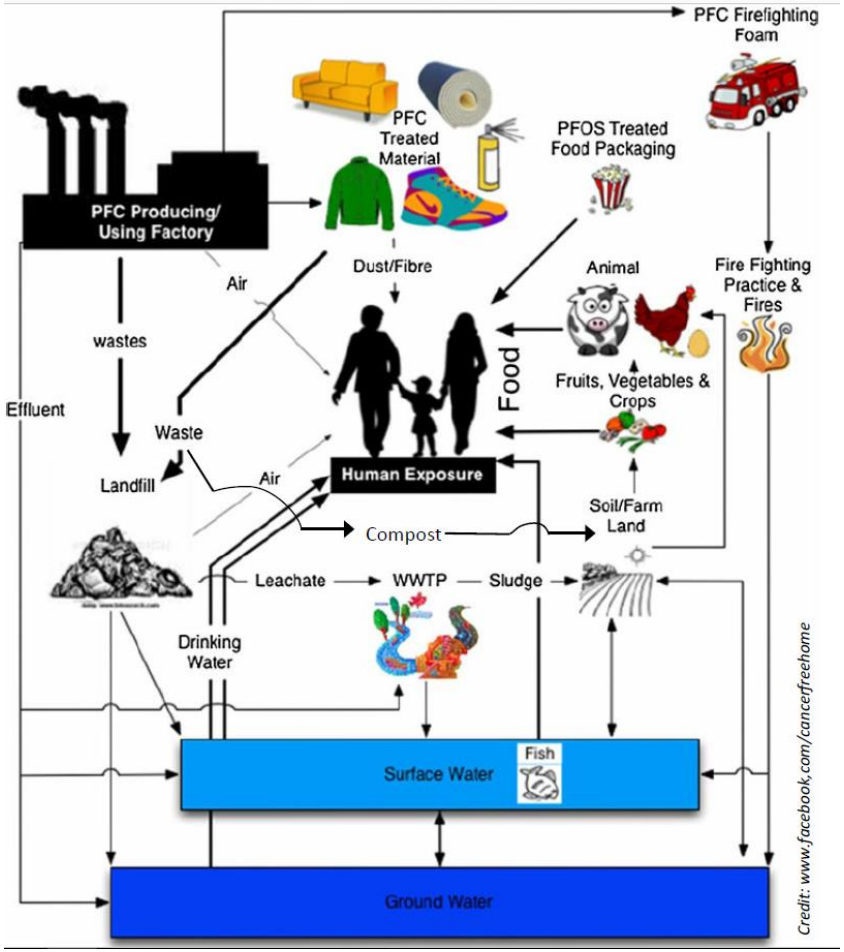
Source: Bolyard, S.C. and Staley, B. *Brief History of PFAS: What are they? Why are they used? What are they in?*

PFAS Exposure

- PFAS in blood
  - Half-life (time for 50% concentration reduction in blood) increases with carbon chain length
    - 3-28 days for 4-chain PFAS
    - 2-5 years for PFOA/PFOS
- Primary human exposure dust/food
- Environmental Pathways
  - Air, compost, wastewater, solid waste
  - PFAS accumulation in recyclables unknown

Source: Staley, B. *Health/Environmental Implications of PFAS & Exposure Pathways: A summary of Current Research*

Exposure Pathways



Source: Staley, B. *Health/Environmental Implications of PFAS & Exposure Pathways: A summary of Current Research*

PFAS Analysis Methods

- Total fluorine tests
  - Ion Selective Electrode (ISE)-destructive
  - Particle Induced Gamma Emission (PIGE)-surface scan
  - Non-detect fluorine indicates no PFAS
  - Fluorine detection does NOT definitively indicate PFAS.
  - If positive fluorine test, can do total organic precursor (TOP) assay test (LC/MS)

PFAS Analysis Methods

- LC-QTOF MS
  - Unlimited PFAS compounds
  - Expensive
  - Limited US availability
  - Method 537 LC MS more common
- Fluorotelomer Acids
  - PFAS precursors
  - Prevalent in leachate
  - ASTM D7979

PFAS Sampling Challenges

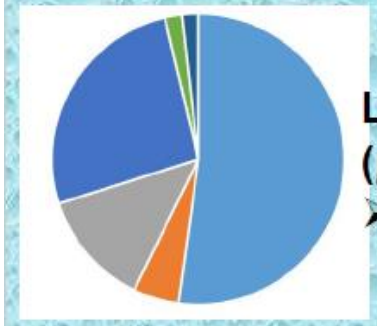
- Leachate- High TOC/SpC Liquid
- Sampling practices
  - Eliminate PTFE (Teflon) Equipment
    - Both lab and field
  - Field Material Tests
    - Positive for PFAS- Non-stick Al foil (minor)
    - Negative for PFAS- **Ice packs, Rite-In-The-Rain logs, post-it notes,** tape, labels**, markers, plastic binders**
      - Bold items above restricted by Navy interim guidance

PFAS In Leachate

- Shorter chain PFAS predominant
  - Some evidence PFOS/PFOA may be sequestered in LF
  - Synthetic Precipitaion Leaching Procedure (SPLP) samples also majority short chain
- PFOA/PFOS Consistent in US LFs
  - China LF concs. higher
  - China did not participate in ban
- PFOA/PFOS loading from LFs to WWTPs dependent on total flow
  - WWTP discharge in MI exceeds LF influent loading (LF Study)

PFAS Comparison

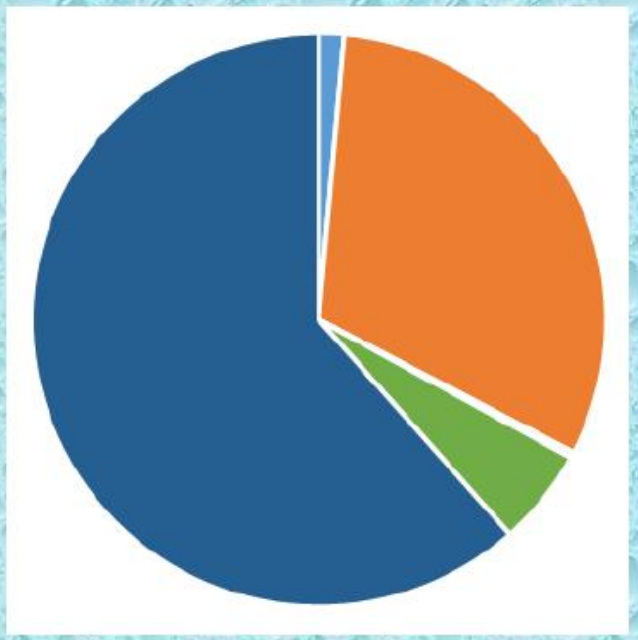
- Municipal WWTP effluent, landfill leachate, and AFFF-contaminated groundwater



Landfill leachate (µg/L)

- **short-chain** dominant in classes

Municipal WWTP (ng/L)

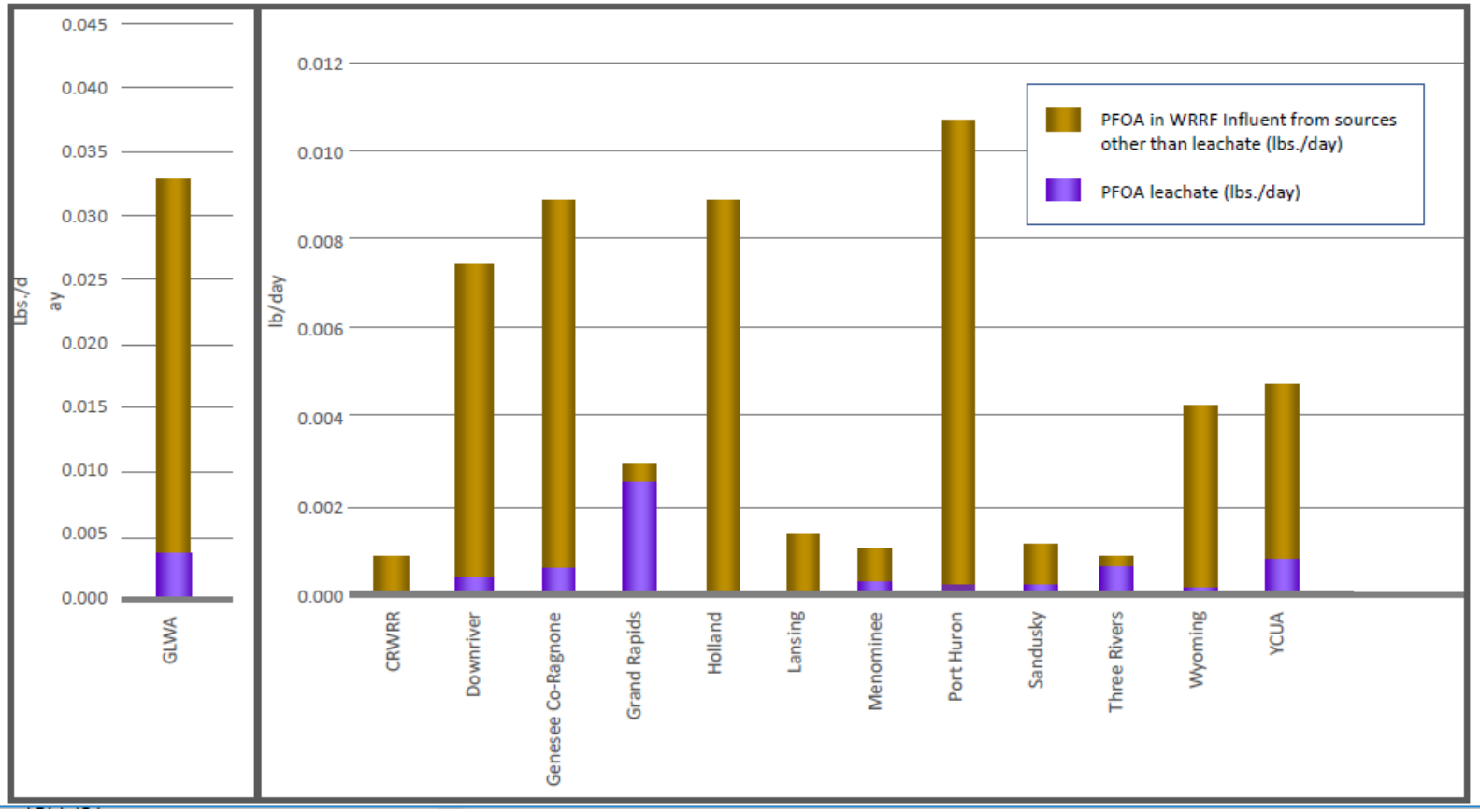


Groundwater (AFFF) (mg/L

PFCAs PFSA Me-AA Amides FTCA FTSA Other

Source: Field, J.A. *PFASs in Leachate and Wastewater: Sampling Considerations and Analytical Challenges*

PFOA Mass: Influent Leachate vs. Overall WRRF Influent



Source: Burns, B. *Statewide Study on Landfill Leachate PFOA and PFOS: Impact on Water Resource Recovery Facility Influent*

PFAS in Landfills

- Clothing/carpeting in model LFs
  - Lag period >100 days before PFAS release
  - Variable results
- Many precursors volatile
  - Could be in LF gas
  - USEPA funding to evaluate PFAS in LF gas

PFAS Leachate/WW Treatment

- Primarily transfer/separation technologies right now
  - Most technologies RO focused
  - GACs/Membranes LF'd or Incinerated
- Deep Injection Wells
  - Disposal method, no destruct/transfer
  - Not occurring in Wisconsin
- Destruction of PFAS compounds
  - Early research phase - no specific technologies

Crow Wing Co. MN Treatment

- 22.5 Acre LF- 50,000 tons/yr.
- Aerated Ponds
- Land Application of Leachate
  - Struggling to deal with treatment
- Recirculation
- Haul to WWTP if needed

Crow Wing Co. MN Treatment

- RO Treatment after Pond Aeration
  - What to do with Concentrate/residual
  - Solidification not effective

PFAS (ng/L)	Standards	Raw	Permeate	Concentrate
PFBS	7,000 (MN HRL) 2,000 (MN HBV)	714	<16.7	1,150
PFBA	7,000 (MN HRL)	1,460	<16.7	2,020
PFOA	70 (EPA HAL) 35 (MN HRL)	1,050	<16.7	3,360
PFOS	70 (EPA HAL) 300 (MN HRL) 15 (MN HBV)	130	<25.1	413
PFDA		<18.2	<16.7	<31.0
PFHpA		625	<25.1	1,960
PFHxS	47 (MN HBV)	446	<25.1	1,420
PFHxA		2,230	18.1	8,310
PFNA		55.6	<33.5	173
PFPeA		1,180	<25.1	697

Source: Doran, F. *Demonstrations for Treating PFAS in Leachate*

Regulatory Responses

- Risk-based models in US
  - Similar to other contaminant groups
- Leachate/WW cycling
  - Where to break chain in PFAS cycle
- Recognize LF/WWTP operators concerned
- PFAS in Leachate/WW Ubiquitous
- AFFF Inventories- 37K gal MI, 2K CT

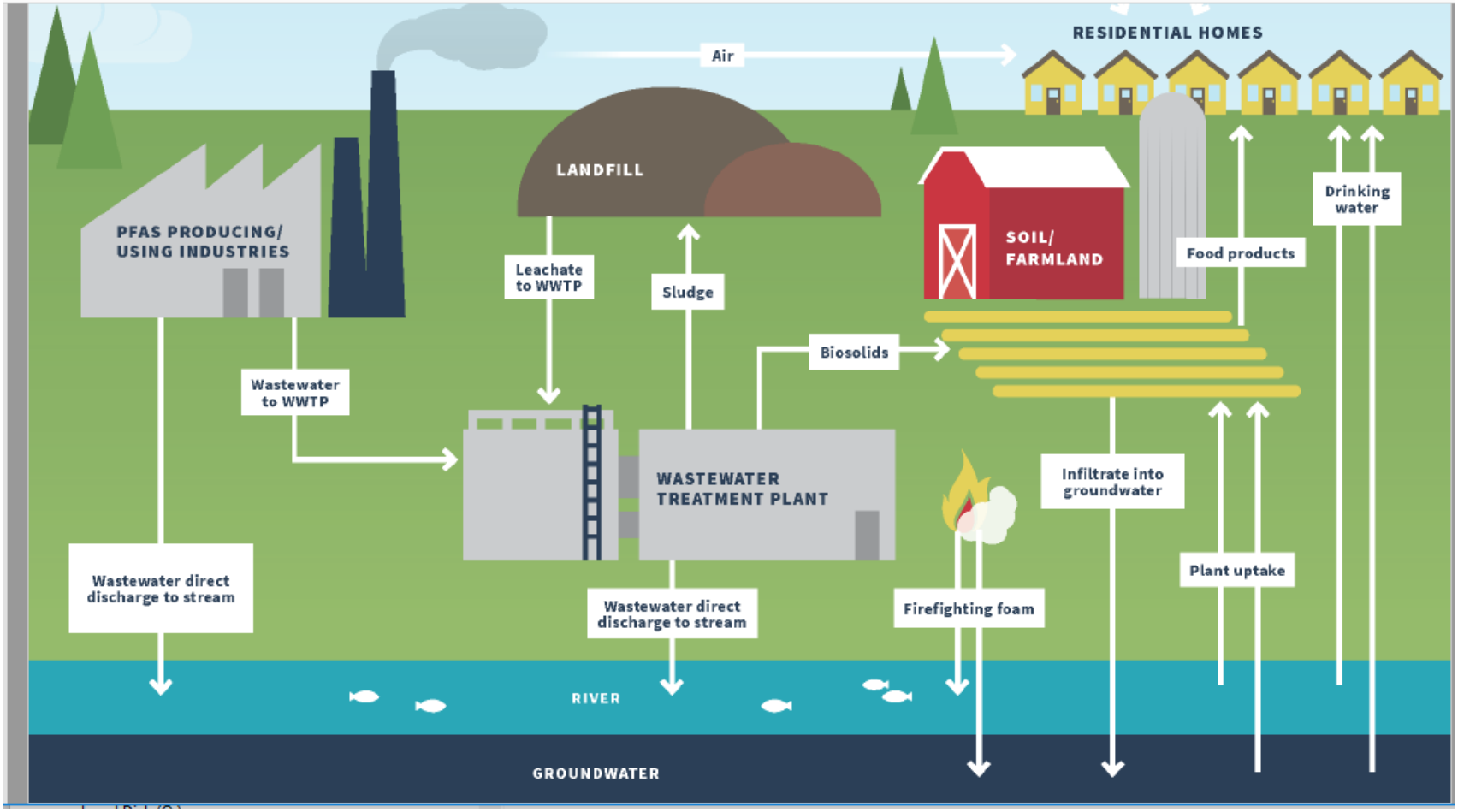
Receiving Facilities

- Landfill acceptance of PFAS waste variable across the US
- Leachate reduction efforts (existing technology)
- Michigan WWTPs responding to State directives
  - Source reduction/declining trends
- PFAS in Fresh Water
- Fate of Biosolids

What do WWTPs/LFs need?

- Standardized Analytical Methods
- Baseline Data in Environment
- How Significant is Significant?
  - Waste Receipt
- Surface Water Standards
- Mass Balance/Sequestration in LFs
- Federal MCL
  - Confirm # of compounds
  - Economics

Questions



Source: Silver, S. *Michigan Taking Action on PFAS*

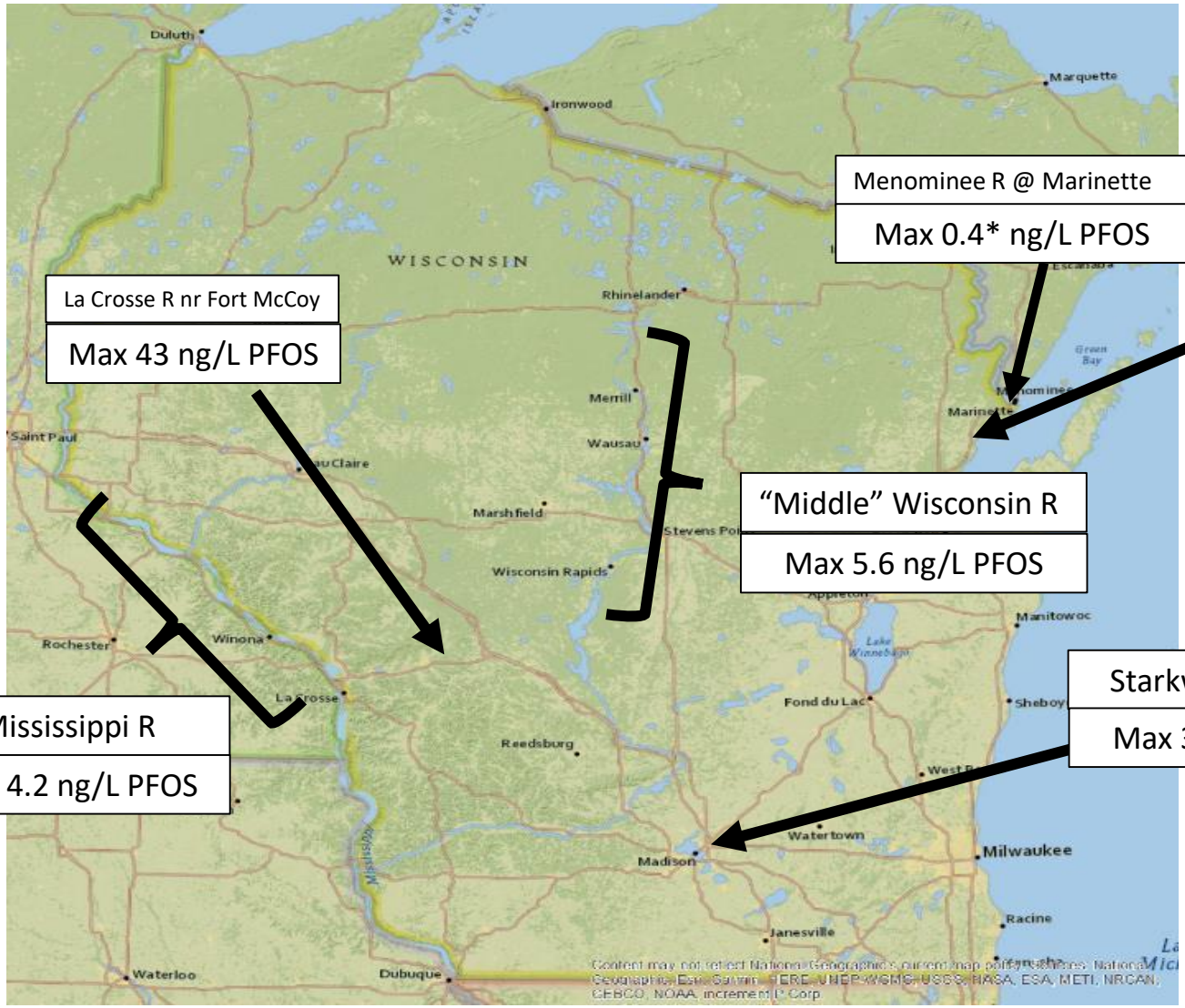
Water Quality Program Update

Nate Willis
Wastewater Engineer
Water Quality Bureau

Topics

- PFAS Monitoring efforts
- PFAS wastewater treatment options
  - How does this impact landfills?

2019 WR Surface Water and Fish Tissue Monitoring Plans

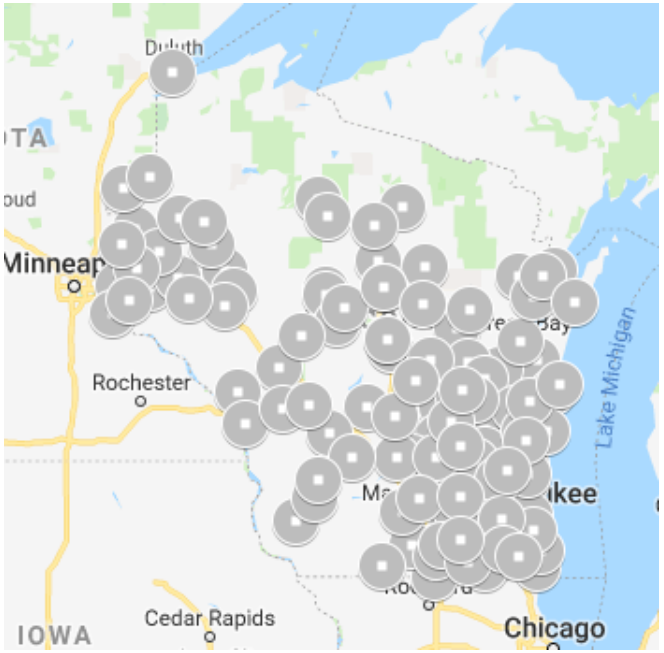


Letter Sent to 125 POTWs

- PFAS Background
- Known Industrial Sources
- Statement that POTWs are not original sources of PFAS, but PFAS pass through them
- Requested Actions
- Invitation to participate in the State Lab of Hygiene Study
- Statement of Department's Intent in sending letter
- Additional Resources

Recipients

- 125 POTWs
  - 27 Authorized Pretreatment Programs
  - 91 Other POTWs with SIUs
  - 6 found by query of permit fact sheets
  - 1 community with PFAS in water supply



Requested Actions

- Voluntary sampling of influent and effluent
  - 36 PFAS compounds
  - Please use isotope dilution method
  - Within 90 days of receipt of letter

- Source Identification and Reduction
  - If PFOA+PFOS > 20 ng/L
  - Invitation to work with DNR to develop plan to sample potential sources
  - Invitation to work with DNR and sources to eliminate PFAS
    - Product substitution
    - Operational Controls
    - Cleanup of historical contamination
    - Pretreatment

Intended Outcomes

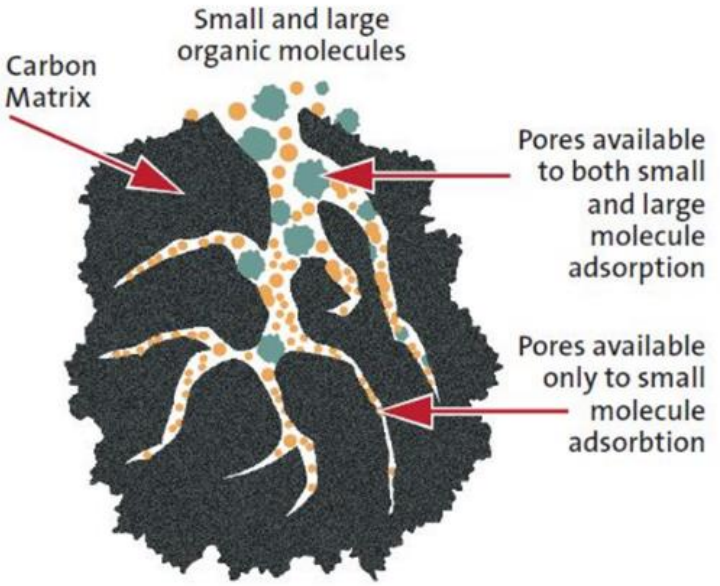
- Primary Goal: Avoid effluent limitations at POTWs
  - Address sources before standards take affect
  - Avoid back-end treatment at POTWs
- Parallel Michigan's demonstrated approach
- Scope extent of PFAS contamination in Wisconsin
- Inform Economic Impact Analysis for standards rulemaking
  - Make informed decisions based upon data

Actual Outcomes

- 2 POTWs completed sampling
- 4 POTWs signed on for participation in WSLH study
  - Initial sampling of influent and effluent performed in October, final participants will be chosen based on those results
- Several POTWs have indicated they will sample once labs have been certified
  - Labs can be certified for PFAS testing of wastewater as of 10/29/2019
- POTWs have indicated they will look to work with pretreatment industries to reduce PFAS in effluent

PFAS Wastewater Treatment

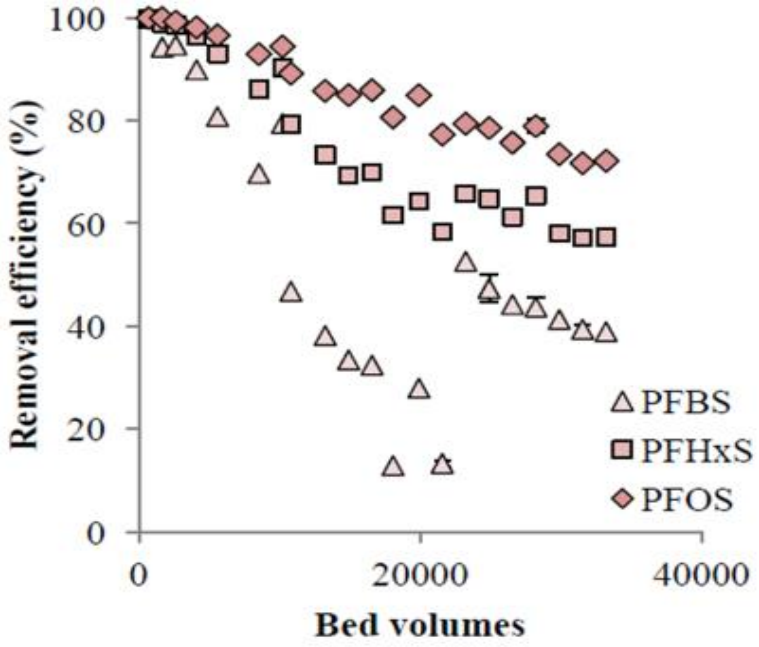
- GAC (Granular Activated Carbon)
  - Pollutants adsorb to surface of activated carbon
  - Carbon material (wood, coconut shells, coal, etc.,…)
    - Diameter = 0.5 to 3mm
    - Surface Area = 1000 – 1500 m^2/gram
  - Once adsorption capacity reached, carbon is either regenerated or replaced



(https://www.elgalabwater.com/technologies/activated-carbon)

PFAS Wastewater Treatment

- GAC Column Experiment Example



$$\text{Bed Volume} = \frac{\text{Volume of treated water}}{\text{Volume of the adsorbent (carbon)}}$$

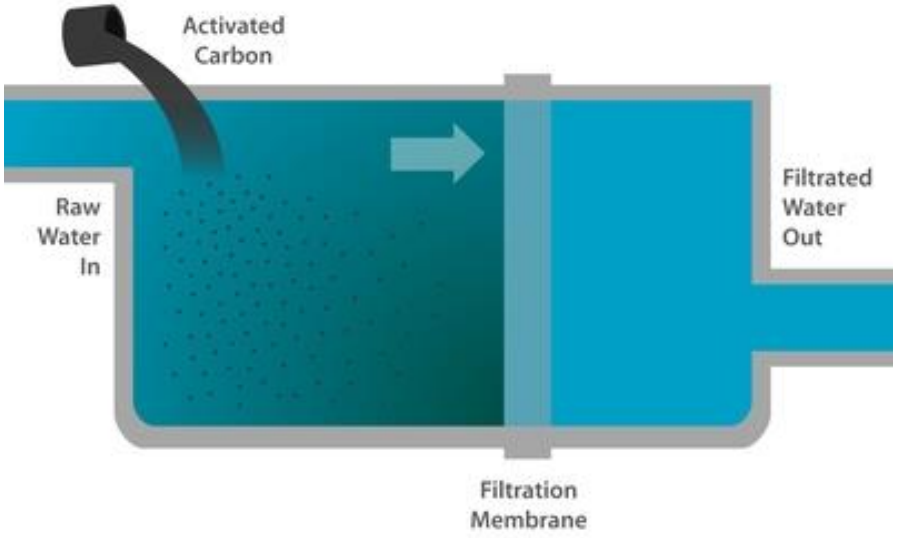
Source: (https://stud.epsilon.slu.se/8158/13/ostlund_a_150709.pdf) Ostlund, Anna; *Evaluation of granular activated carbon and anion exchange using column tests, and the effect of dissolved organic carbon*, Swedish University of Agricultural Sciences

PFAS Wastewater Treatment

- GAC
  - Most widely-used/studied treatment for PFAS
  - High removal efficiency (89 - 99%) of long-chained PFAS (≥C8; PFOA, PFOS)
  - **Poor removal of smaller-chained PFAS (<C6; PFBS)**
  - Background organics negatively impact efficiency
  - What to do with spent carbon?
    - Landfills
    - Incineration
      - Little information on created byproducts

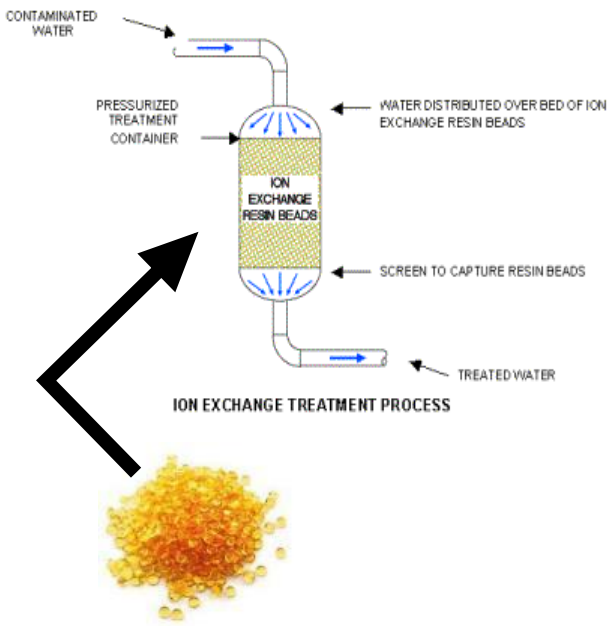
PFAS Wastewater Treatment

- PAC (Powdered Activated Carbon)
  - Same principle as with GAC, pollutants adsorb to carbon surface
    - Same issues with removal efficiencies affected by organics
  - Solids filtered out
  - Disposal of media
    - Landfill
    - Incineration



PFAS Wastewater Treatment

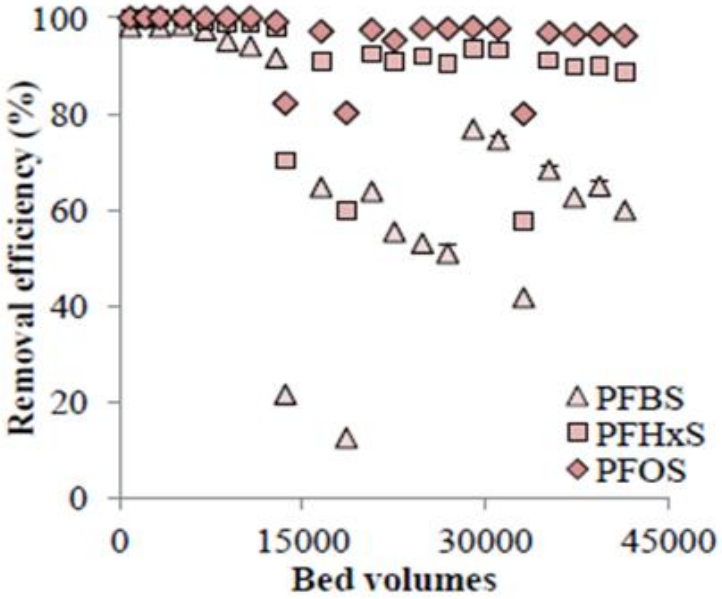
- Anion-Exchange Resins
  - Anions in resin exchange with PFAS anions
  - Binds PFAS with resin
  - Operated in series or individually
  - Like GAC, must be regenerated or disposed



Resin Image: (https://www.indiamart.com/proddetail/ion-exchange-resin-7318500655.html) Ion-Exchange Process Image: (http://onlineresize.club/news-club.html)

PFAS Wastewater Treatment

- Anion-Exchange Resin Column Experiment Example



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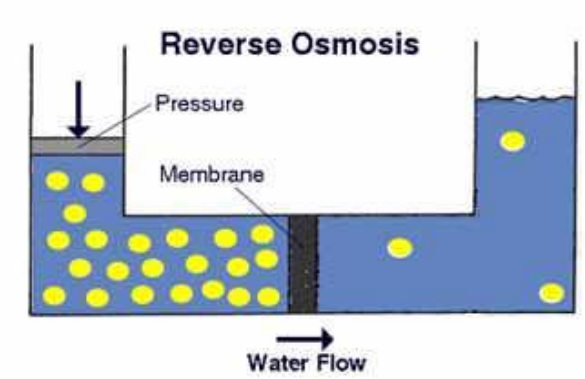
PFAS Wastewater Treatment

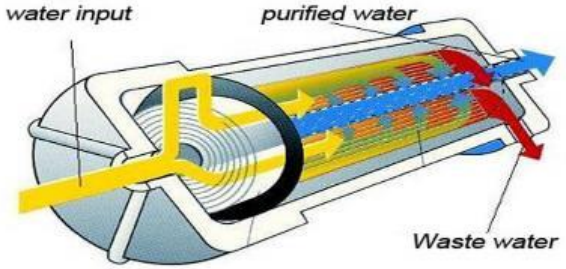
- Anion-Exchange Resin
  - Higher removal rates of longer-chained PFAS at higher Bed Volumes than GAC
  - Same issues as GAC:
    - Breakthrough of smaller-chained PFAS
    - Organic matter reduces efficiency
  - Disposal of spent resin
    - Landfills
    - Incineration

PFAS Wastewater Treatment

- Reverse Osmosis Filters
  - Water is pushed through a spiralized semipermeable membrane under pressures that exceed the osmotic pressure
  - 93-99% Removal efficiencies
  - Contaminants are captured by the membrane and contained in a more **concentrated solution**
    - Concentrated Volume: Typically 10-20% of original
  - More initial capital costs than GAC
  - Shown to be effective for treating landfill leachate, but not widely used



Source: (http://www.csun.edu/~vchsc006/356b/ro.html)



Source: (http://www.ionicsystems.com/us/reverse-osmosis/)

Health Standards Development

Sarah Yang, Ph.D.
Toxicologist
WI Department of Health Services

Effective Disposal Workgroup

- Internal (so far) DNR group
  - Members from Solid Waste, Hazardous Waste, Remediation, Wastewater, Air

- Gathering information from other states, research, sites in WI

Dealing With Waste

VISION: protecting and managing natural resources while supporting the economy and the well-being of our citizenry

- Identify best management practices for where and how to dispose
- Identify management practices for dealing with waste that has already been disposed, such as ways to detect, track, manage, and potentially remove PFAS
- Develop outreach materials to guide the management of PFAS containing waste

Treatment of PFAS Waste

- Not considered a hazardous waste by federal or state rules

- Treatment options: (info from CleanHarbors)
  - Granular Activated Carbon sorption and stabilization
  - Isolation and containment
  - Reverse osmosis
  - Additives/stabilization
  - Incineration – destructive? – best available control?



Incineration Concerns

- Effective incineration or thermal treatment is difficult to achieve (and expensive) – C-F bonds are very strong, requiring extreme heat and long residence time
- Incineration test burns and full-scale incineration happening worldwide – but limited in scope and/or scale
- Input compounds and breakdown products are difficult to measure and account
- Unsure of products resulting from incomplete combustion
- Currently, there is no EPA-approved stack testing methodology for PFAS
  - Dispersion and deposition?

Disposal of PFAS Waste

- Review of known sites in WI with PFAS contamination
  - identify all environmental media contaminated with PFAS
  - list PFAS compounds analyzed
  - current waste management practices (disposal or treatment)

- Remedial and spill-related work, known impacts
- Number of analytes varies widely from site to site, most often includes both PFOA and PFOS

Disposal of PFAS Waste

- Groundwater has been managed by sending it out of state for deep well injection (Ohio, Texas) or treated using GAC systems

- Surface and storm water have been treated using GAC systems

- Soil has been transported out of state for disposal at a number of landfills
  - US Ecology accepts soil impacted with PFAS at varying levels, at a variety of out of state locations including Michigan, Texas, Nevada, Idaho and Oregon

Disposal of PFAS Waste

- No information so far on managing sediments
- Biosolids are managed using a filter press. The filtrate is treated using a GAC system, and the filter cake is landfilled out of state (Oregon)
- Spent carbon from GAC treatment systems is regenerated or landfilled out of state

Disposal of PFAS Waste

? Best technology so far is containment in RCRA Subtitle C landfill triple lined with leachate capture and destruction?

- Need informal survey of consultants and site owners re: disposal best management
- Need BMPs and outreach development

- EPA research grant awards

Effects on Waste Industry

Roxanne Wienkes,
SWANA Representative

PFAS Technical Advisory Group

Questions?

Thank you!

Next PFAS Technical Advisory Group meeting:

December 13, 2019

10:00 am – 2:00 pm

DNR GEF2 Building, Madison

101 S. Webster St.