

Per and Polyfluoroalkyl Substances (PFAS) in landfill leachate: inconvenience or crisis?

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presentation outline

- what are PFAS?
- health risks/properties
- regulatory round up
- sources (focus on wastes)
- taking action – sampling, assessment, leachate pretreatment

PFAS and Barr Engineering

- engineering and environmental consultants
- 9 offices, primarily in Midwest
- PFAS manufactured in the Twin Cities area from the 1940s to 2002
- began working on PFAS sites in MN in the early 2000s, have worked on PFAS sites nationally and internationally since then
- Barr long-term clients include manufacturers, platers, refineries, paper mills, landfills, and city WWTPs
- exponential increase in projects over last two years



what the per- or poly fluoro alkasulfawhatsit?

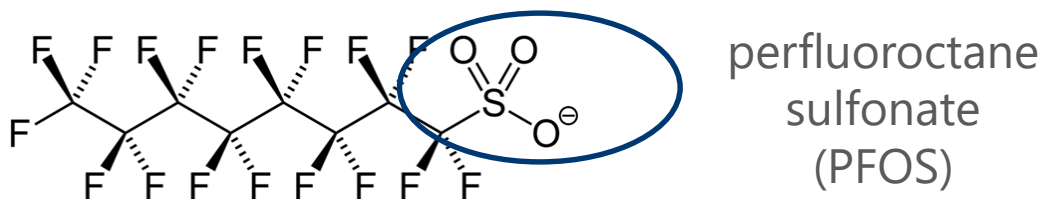
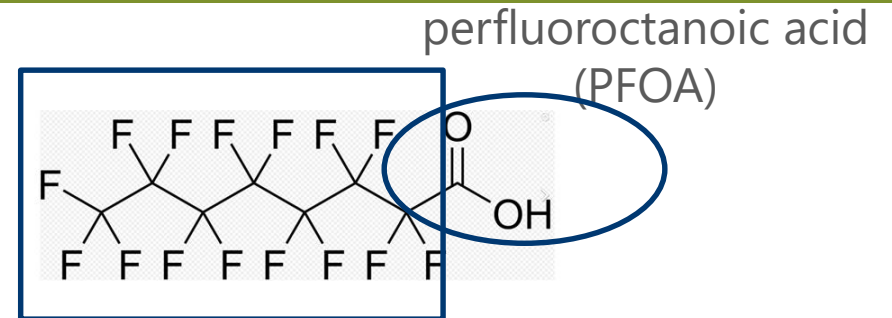
- PFAS

- over 3000 separate compounds
- used in Teflon™ non-stick processes
- useful chemical in reducing surface tension

- phased out in US by 2013

- production continues internationally; persistent but decreasing

- PFOA and PFOS replaced with shorter chain PFAS



health risks

- persistent in humans (5-7 years)
- national average human blood level – 2 parts per billion
- December 2011: EPA found there was a “probable link” between PFOA and
 - kidney cancer
 - testicular cancer
 - thyroid disease
 - high cholesterol
 - ulcerative colitis

chemistry - properties

- carbon-fluorine bond among strongest
- do not easily breakdown past C8; do not biodegrade
- surfactant (mobile in environment)
- semi-volatile (can get into air, but don't volatilize)
- miscible in water at ppb/ppm but concern at ppt concentrations
- some affinity for organic carbon – primary method of treatment and pretreatment (removing carbon)



regulatory round up – very small concentrations

- 2016 EPA releases Health Advisories (HAs) for total PFOA/PFOS at 70 ppt for combined PFOA and PFOS at **part per trillion levels** (1 second in 31,000 years)
- states taking action, some enforcing at very low ppt levels
 - dump sites
 - defense sites (fire fighting foam)
 - recently landfills and WWTP's
- ATSDR 2018 draft report on PFAS: listed additional effects for PFOA and PFOS and also added health concerns for PFNA, PFHxS and PFHpA- relies primarily on mice studies
- industry viewpoint: significant concerns over methodology

regulatory framework

- approximately 20 States are using EPA criteria or released/revised criteria and many have created guidance documents or taken other action
- several states have added PFNA, PFHxS, and PFHpA limits

| | EPA drinking water (PPT) | MDH Health Based Value (PPT) | VT drinking water (PPT) | NJDEP drinking water (PPT) | MIDEQ drinking water (ppt) | TX drinking water (ppt) |
|---------------|-----------------------------------|--|----------------------------------|-------------------------------------|-------------------------------------|----------------------------------|
| PFOS | 70 | 27 | 20 | 11 | 70 | 560 |
| PFOA | 70 | 35 | 20 | 14 | 70 | 290 |
| PFOA +PFOS | 70 | | 20 | | 70 | |

what are the main drivers?

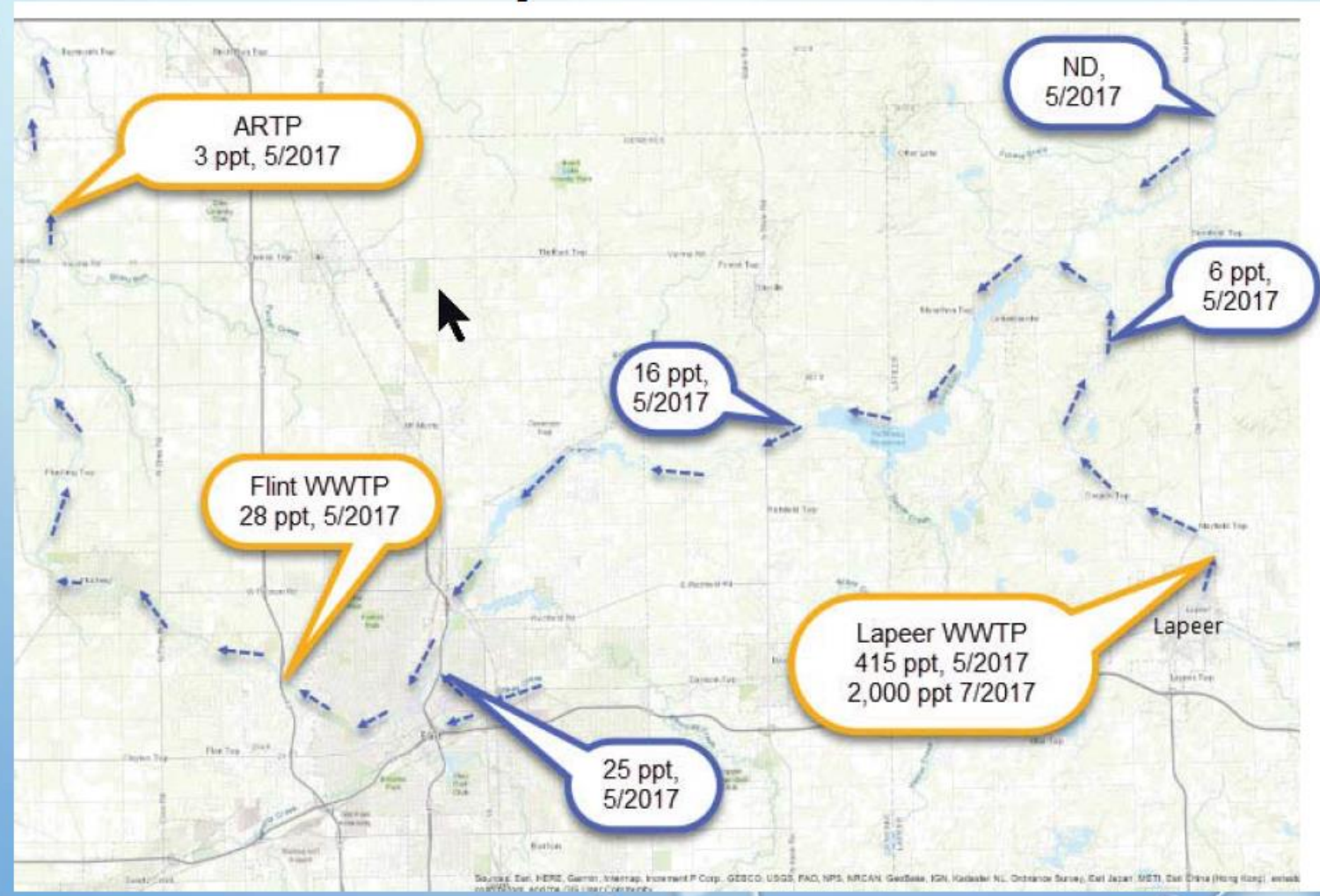
- public sensitivity increasing
- some states are getting proactive
 - class action lawsuits
 - pressure on WWTPs
 - pressure on landfills and other industries
- MI has been sampling water systems
- ND has started sampling program
- USEPA PFAS Summit – “4 Point Plan”
- toxicity values for GenX, new chemicals, MCLs etc.



Michigan PFAS enforcement

- with a Flint crisis as a backdrop....
- Michigan started with WWTPs
- identify potential sources and demonstrate below thresholds
- pre-treatment where concentrations above standards

Case Study: Flint River PFOs



sources: potential waste types

- outdoor fabrics/glass
fabric/cookware



- food packaging



- carpet/shoes/furniture
fabrics



- fire-fighting foam/burned
debris, wire, mill sludge

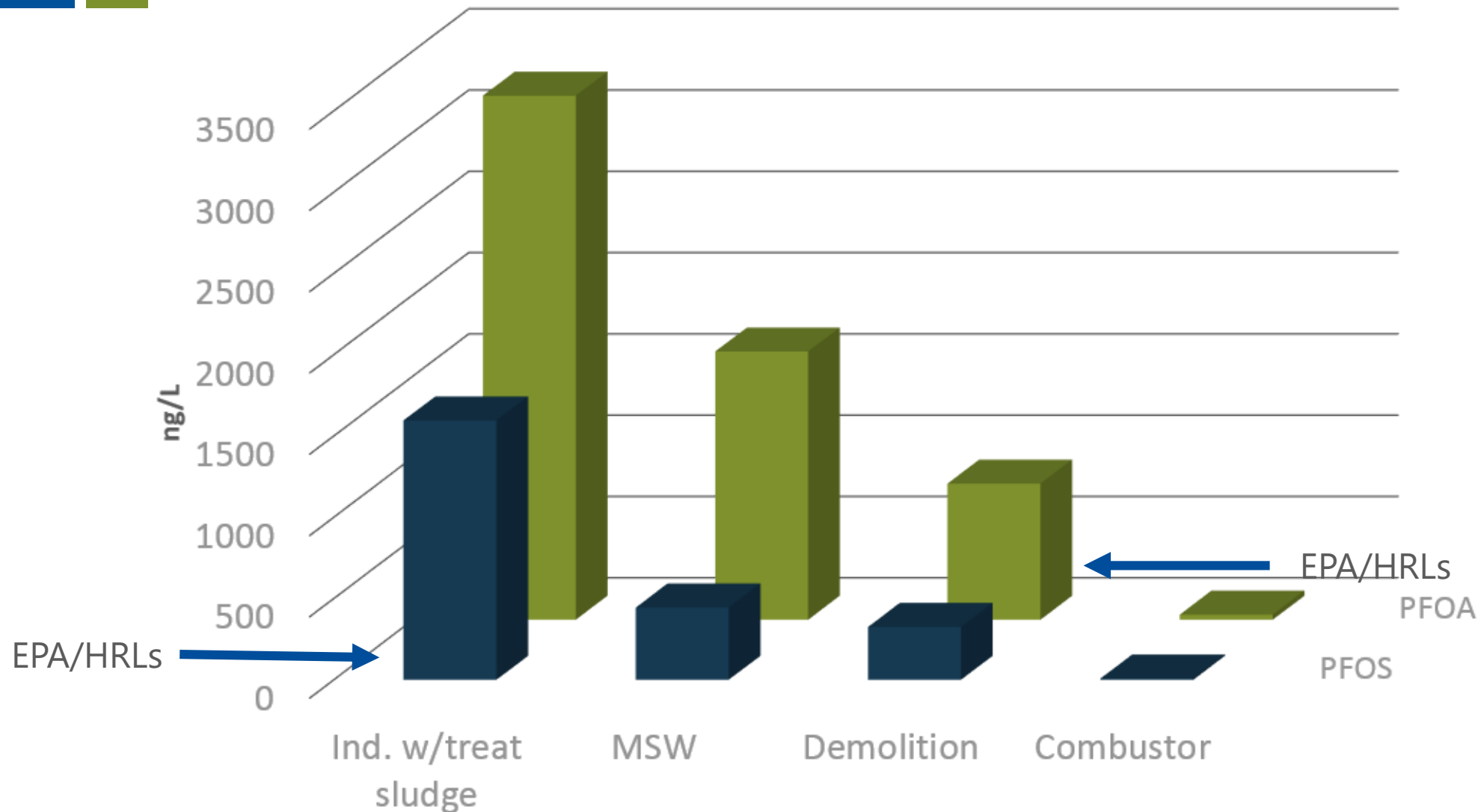


sources: accumulation of PFAS at landfills

- landfill leachate
- landfill gas condensate
- sumps/tanks/manholes
- land application areas
- evaporation ponds (where allowed)



average PFOA/PFOS in leachate (MPCA, 2006)

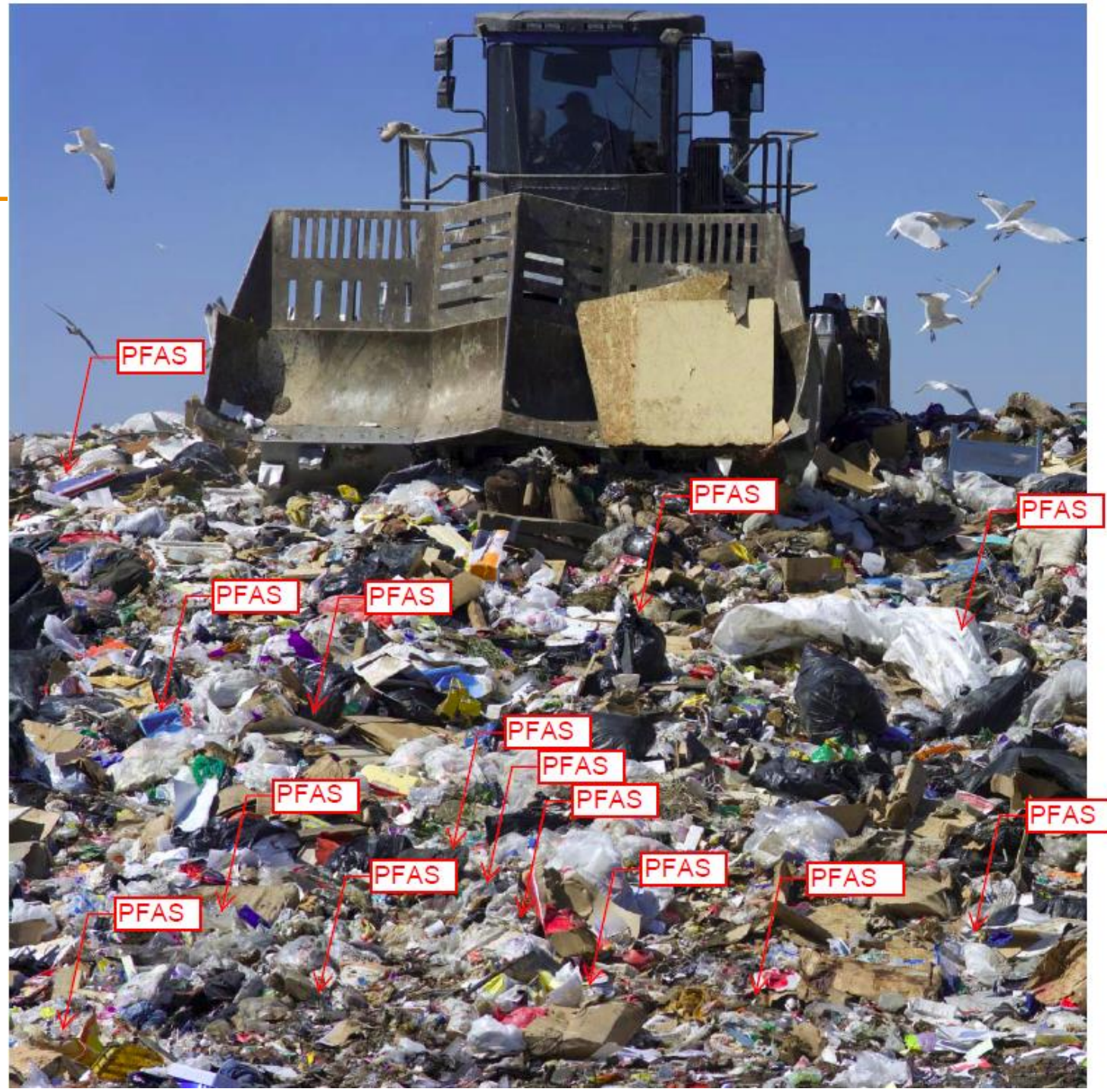


taking action – how to get ahead of the PFAS curve?

- step 1: seek advice from a qualified consultant (who has sampled and knows PFAS), conduct “Comprehensive Media Evaluation”
- step 2: to consider waste types, leachate collection, handling and management
- step 3: sample leachate (groundwater if unlined) for PFAS, consider focus on different cells or landfill areas; must have proper QA/QC
- step 4: develop BMPs to reduce or minimize PFAS footprint

CME: visual waste survey

- work with client (landfill operators)
- gain general sense for the types of wastes present
- focus on volumes of types of PFAS wastes ("buckets")
- discuss how active face managed, covered, and capped
- can major types be segregated



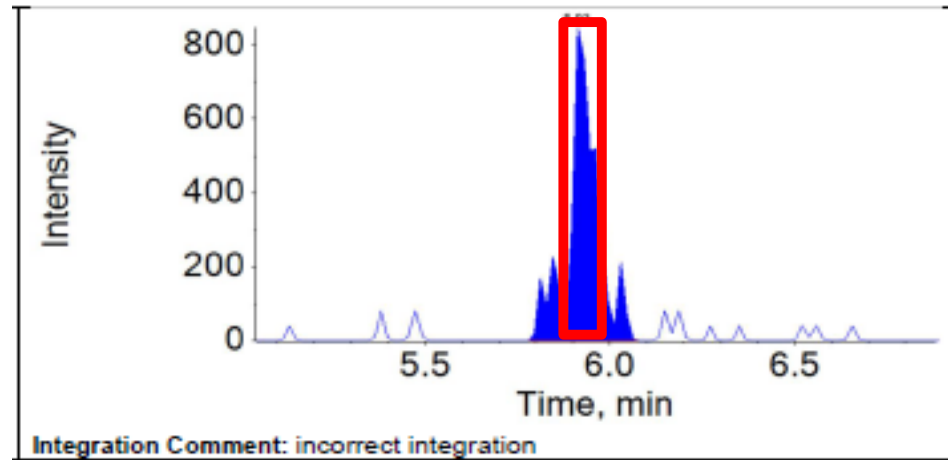
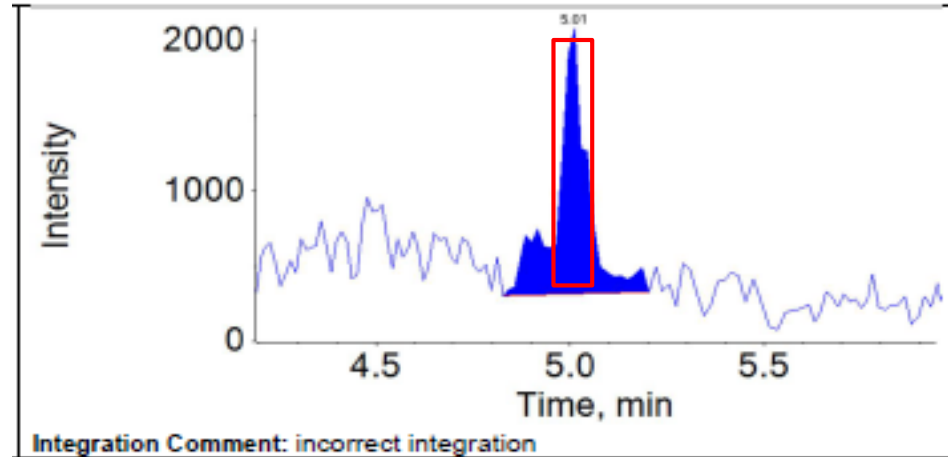
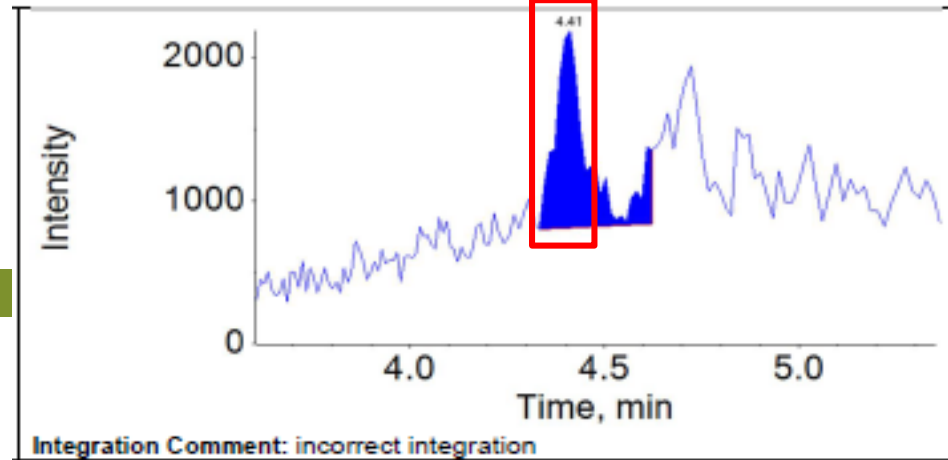
CME: sampling/cross contamination

- reminder: ppt is a small number
- rinsate blanks/equipment blanks necessary
 - sampling devices and containers
- materials should be checked
 - Barr studies indicate over **100** potential sources in sampling/lab equipment
 - bentonite, lube oil for drilling tools, pipe dope
 - Teflon™ bailers, tape
 - Tyvek® Nomex®
 - blue ice packs
 - field books
 - performance fabrics and rain gear



CME: QA/QC your data

- QA/QC on lab data – is it really there?
- how concentrations calculated
- utilizes significant judgment
- need to make sure there is clarity with lab on standards used
- discuss uncertainty around “shoulders”
- adding 30% to 50 ppt=75 ppt



taking action: are we talking treatment?

- standard treatment for drinking water: GAC or Ion Exchange
- portable skid rigs and POET-type systems can be effective for small volume
- cleaning up suspended organic carbon and removing solids from media is key to effective pre-treatment
- adsorption increases in organic soils/leaching remobilizes

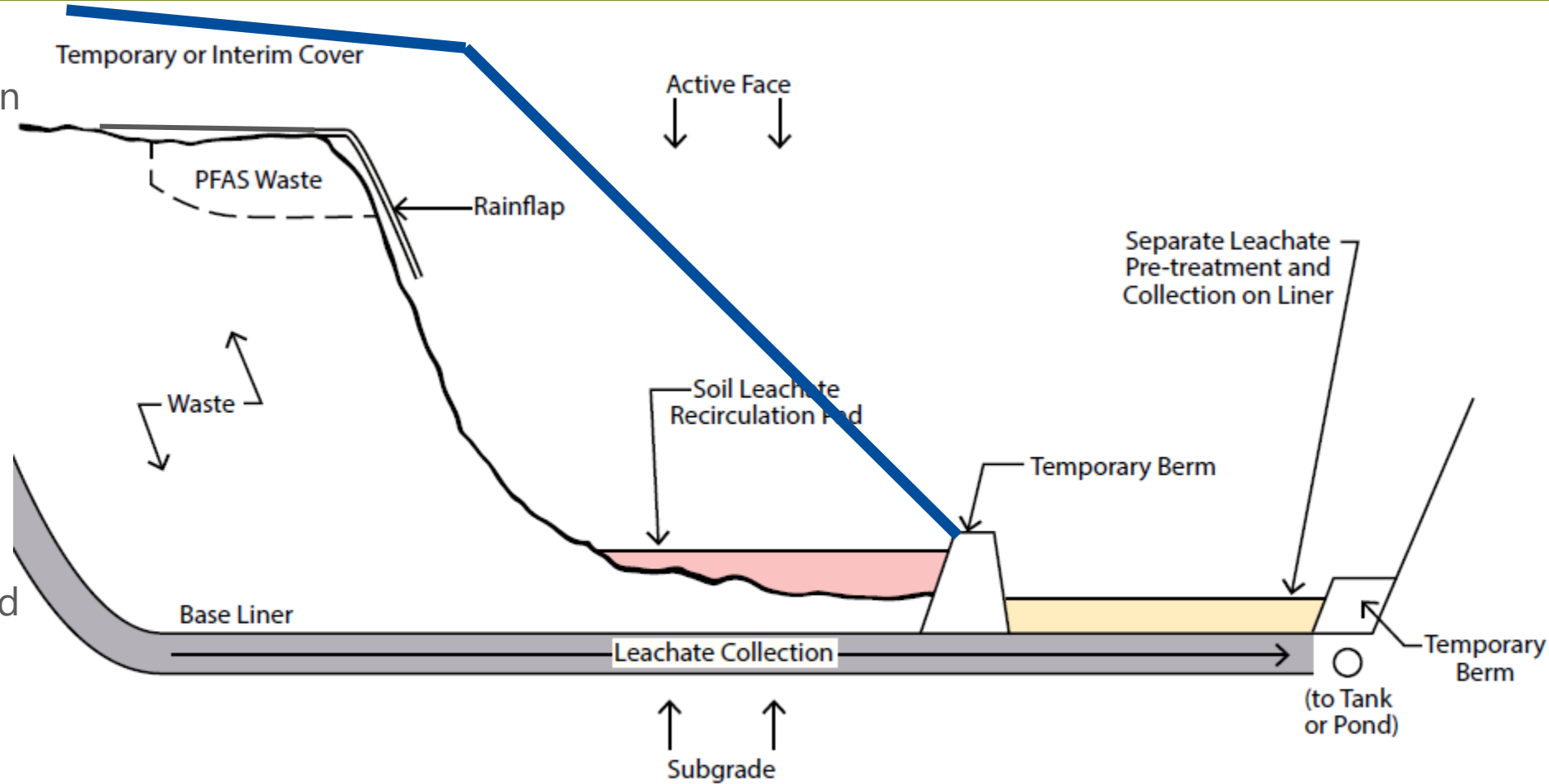


chemistry – fate, transport, and treatment

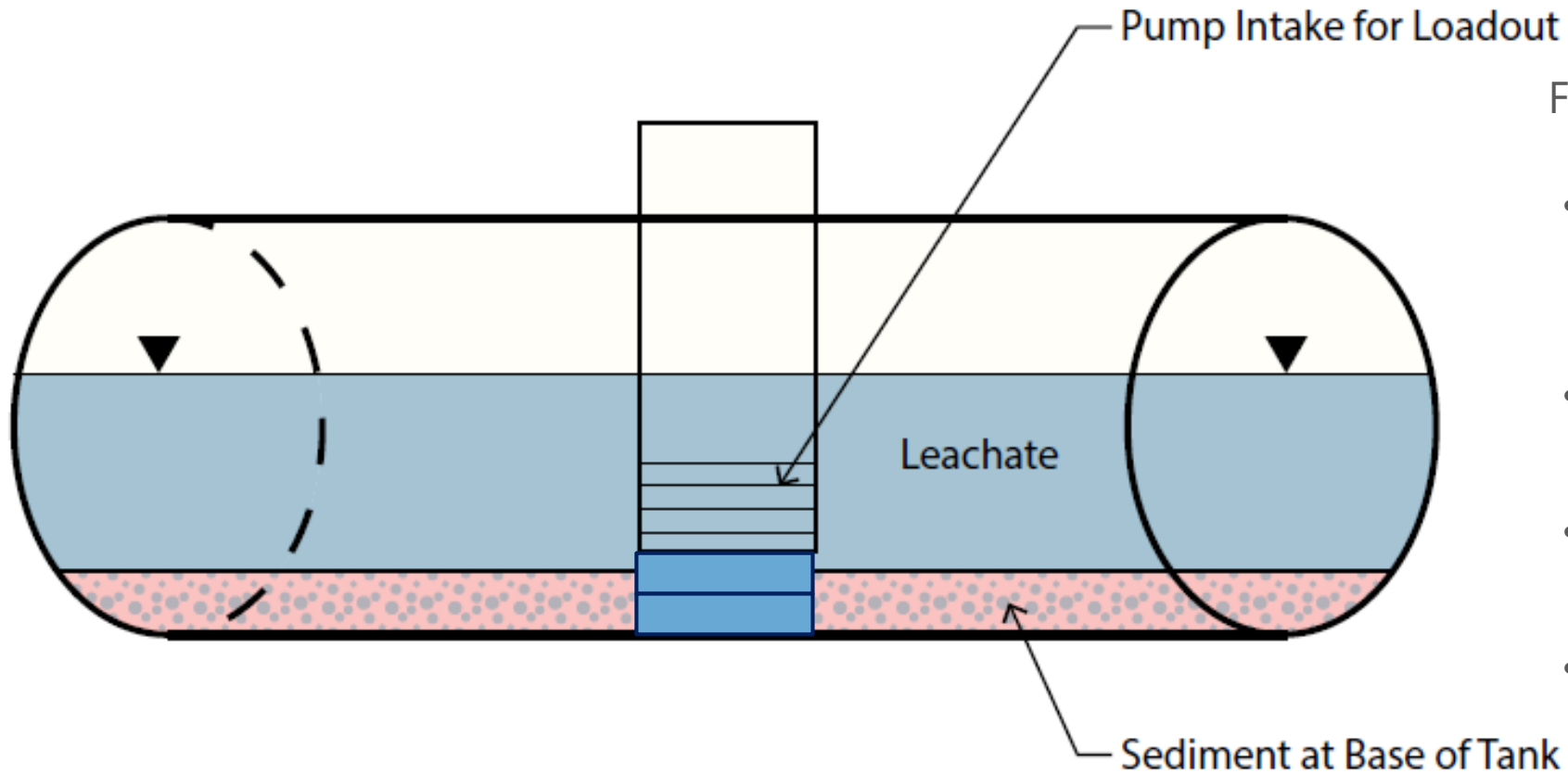
- PFAS are generally hydrophobic: adsorbs to carbon
- Barr calibrated models/monitoring data support a Koc of 550 L/kg (PFOA). For reference, benzene is 165 L/kg
- removing suspended particles likely removes PFAS
- sequestering or precipitating dissolved solids to clean up media
- leachate land application: highly dependent on site specific conditions; modeling fate and transport useful to showing no impact

taking action: conceptual model for PFAS management

- basic idea is to keep PFAS in the landfill until final cover
- prevent leaching of PFAS material and exposure to precipitation
- utilize available materials that may be suitable for binding PFAS (e.g. soil wastes)
- work with regulators toward innovative solutions
- return precipitates and solids to landfill



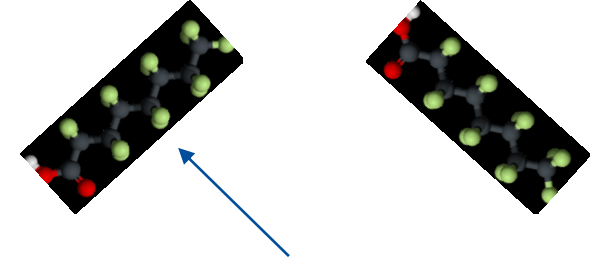
taking action – leachate tank or pond



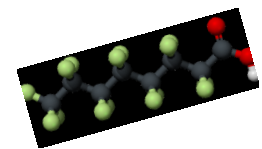
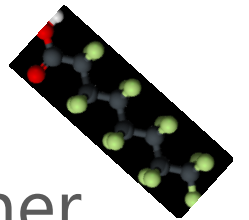
For PFAS in Leachate >3.8 s.u.

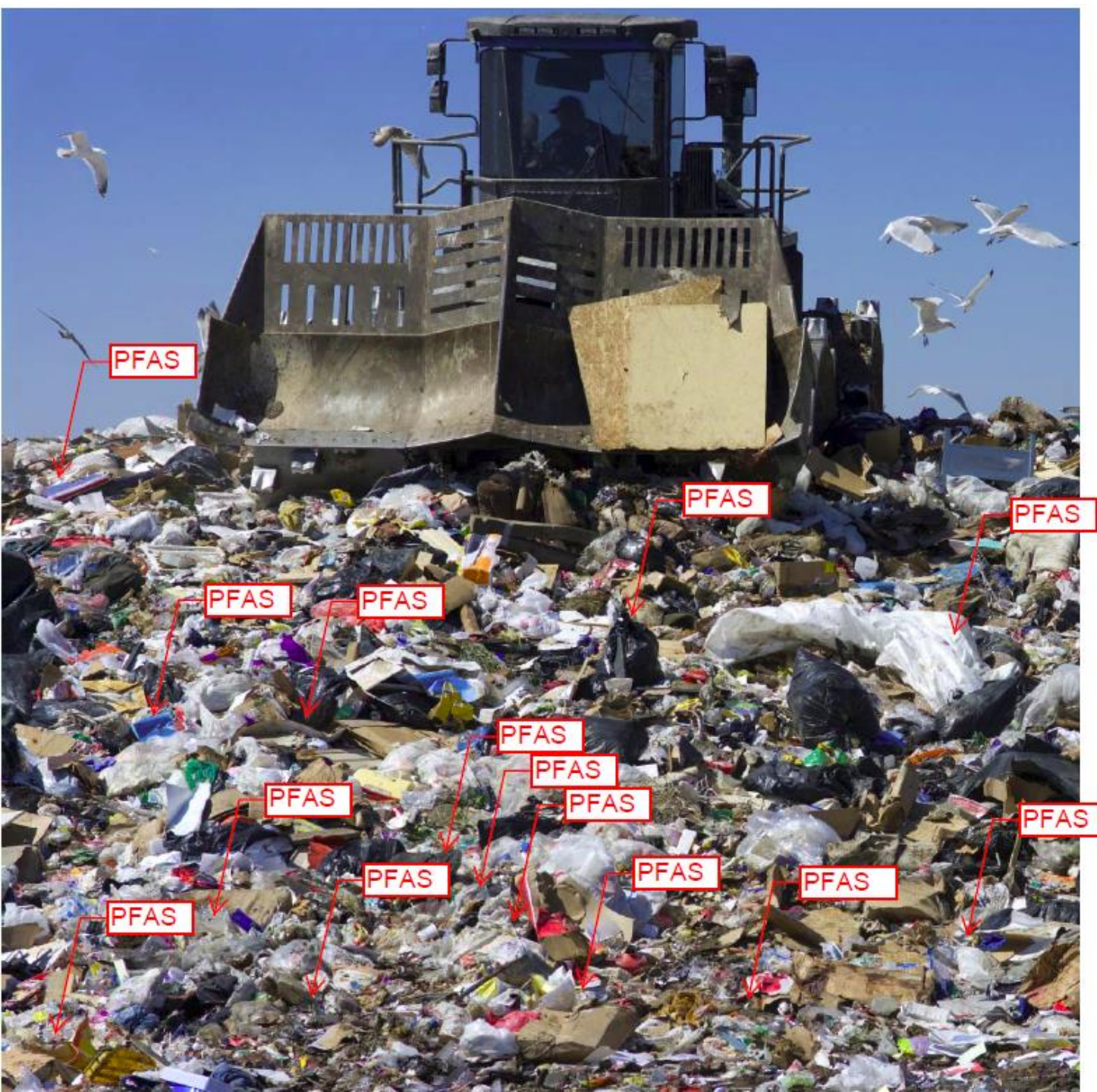
- precipitation and settling of solids occurs where leachate stops moving
- redox reactions can occur in presence of oxygen
- PFAS are moderately sorbed to organic carbon particles
- organo-metallic complexes

the takeaway:



- PFAS are persistent and accumulate: regulatory trend toward more protective due to risk to sensitive populations
- PFAS are becoming a serious compliance issue for landfills (and waste water treatment plants)
- what to do: understand your risk and take prudent actions
- having knowledge and a plan can make the difference whether they become a crisis or inconvenience for your facility





Questions?

more information at:

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avoiding treatment: the basics of pretreatment

- inexpensive options first
- minimize active face
- limit infiltration and run-on
- eliminate stagnant water
- segregate problem wastes
 - do not allow PFAS prone wastes to remain water logged
 - blend leachate down where possible
 - avoid mixing solids on leachate tank bottoms



taking action: comprehensive media evaluation (CME)

- **description:** intended to be low cost relative to potential PFAS treatment and/or other regulatory action
- **purpose:** to assess whether PFAS are significant concern at the landfill and if necessary, develop ways to avoid, minimize, or mitigate (pre-treat) leachate to avoid transfer off site
- **scope:** site visit, sampling (if needed), QA/QC on data, evaluate sources of PFAS and determine potential for minimizing leachate production, reduce concentrations, keep PFAS on the liner

Minnesota PFAS enforcement

- Minnesota MPCA and MDH taking a prudent approach
- additional requirements expected for permits with leachate land application (e.g. if PFAS in groundwater > ILs)
- recent settlement/grant likely to fund more research
- different groups within MPCA meeting to address surface water and other issues
- closed landfill group-has funding to review sites

average PFHxA/PFHxS in leachate (MPCA 2006)

