



The Role of MDH in Addressing PFAS

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Agency Roles and Responsibilities

Environmental agencies:

- Protect health and the environment
- Identify contamination at hazardous waste sites
- Characterize risk of exposure for decision-makers
- Clean up contamination

Public Health agencies:

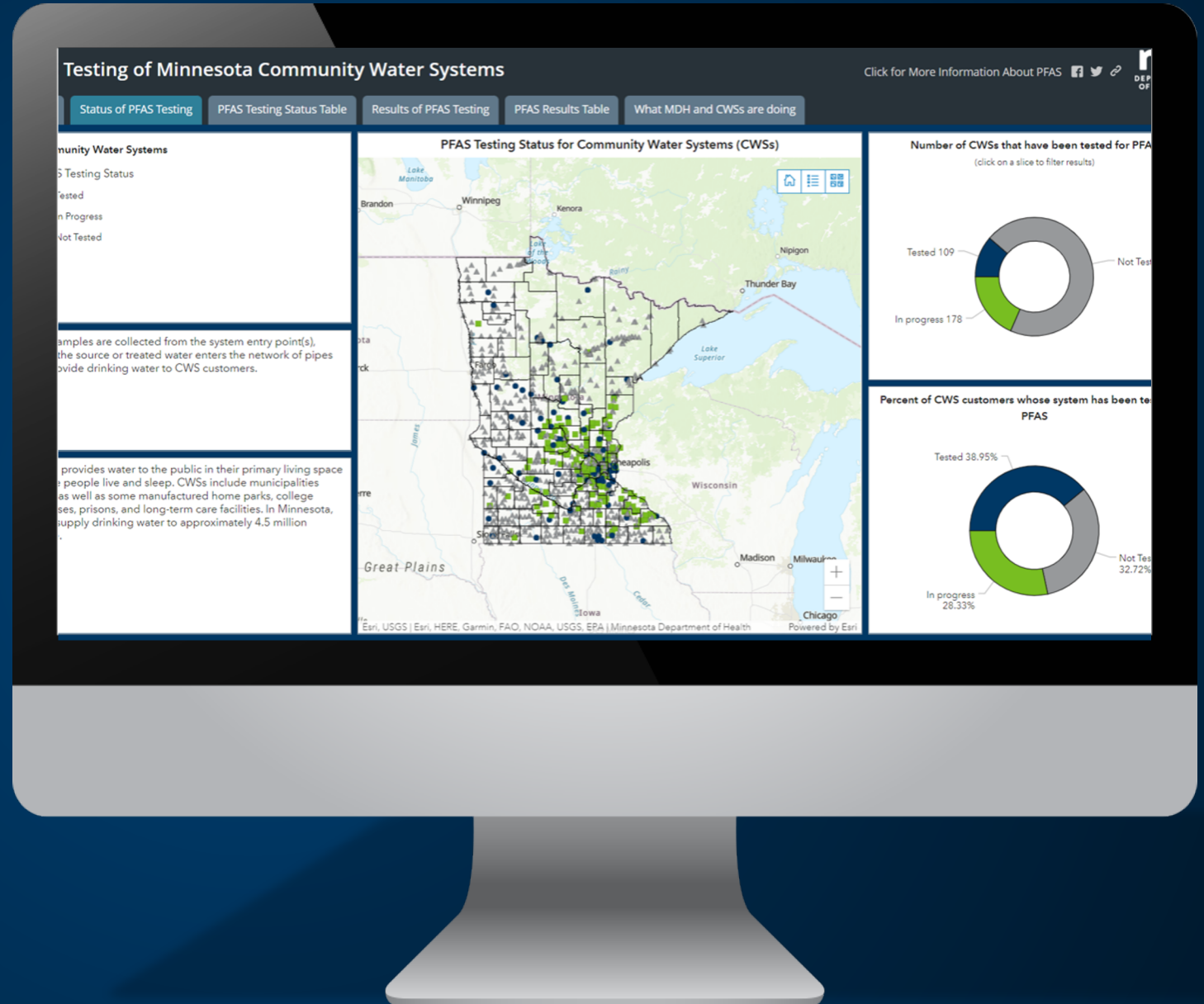
- Provide assistance to environmental agencies
- Develop assessments to identify needed actions/fill data gaps
- Provide public health advice to communities/reduce exposures
- Public health intervention – education, surveillance, etc.

Environmental Health Division Sections with PFAS Roles

- Drinking Water Protection:
 - Regulates and samples community and non-community public water supplies
 - Works with water operators to address contamination issues
- Environmental Surveillance and Assessment
 - Groundwater guidance values, toxicology support (Risk Assessment)
 - Health Risk Assessment at contaminated sites
 - Environmental public health tracking & biomonitoring
 - Fish advisory
- Well Management:
 - Enforces of state well code
 - Establishes Special Well Construction Areas

Interactive web dashboard

- Status of PFAS testing in drinking water
- PFAS testing results
- Health guidance
- Actions MDH and systems are taking

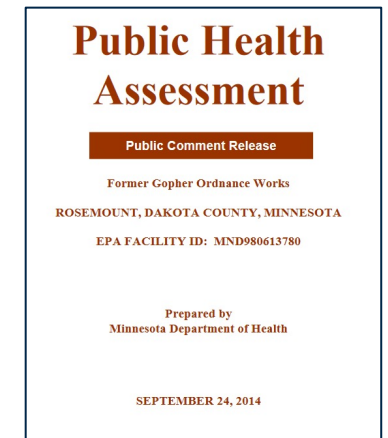
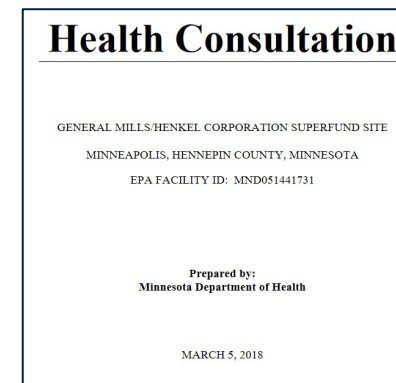
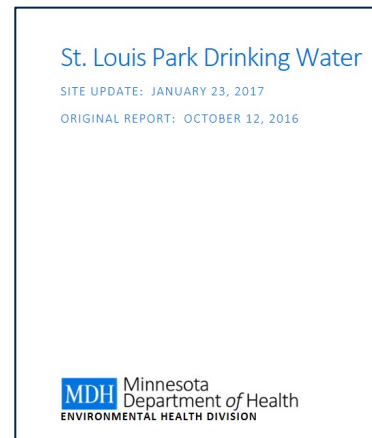


Risk Assessment vs. Health Assessment

Risk Assessment
is a predictive estimate of
potential health impacts
(quantitative)

Screening
values

Health Assessment
focuses on the measurement
of **actual** health impacts
and addressing **perceived**
health impacts
(quantitative and qualitative)



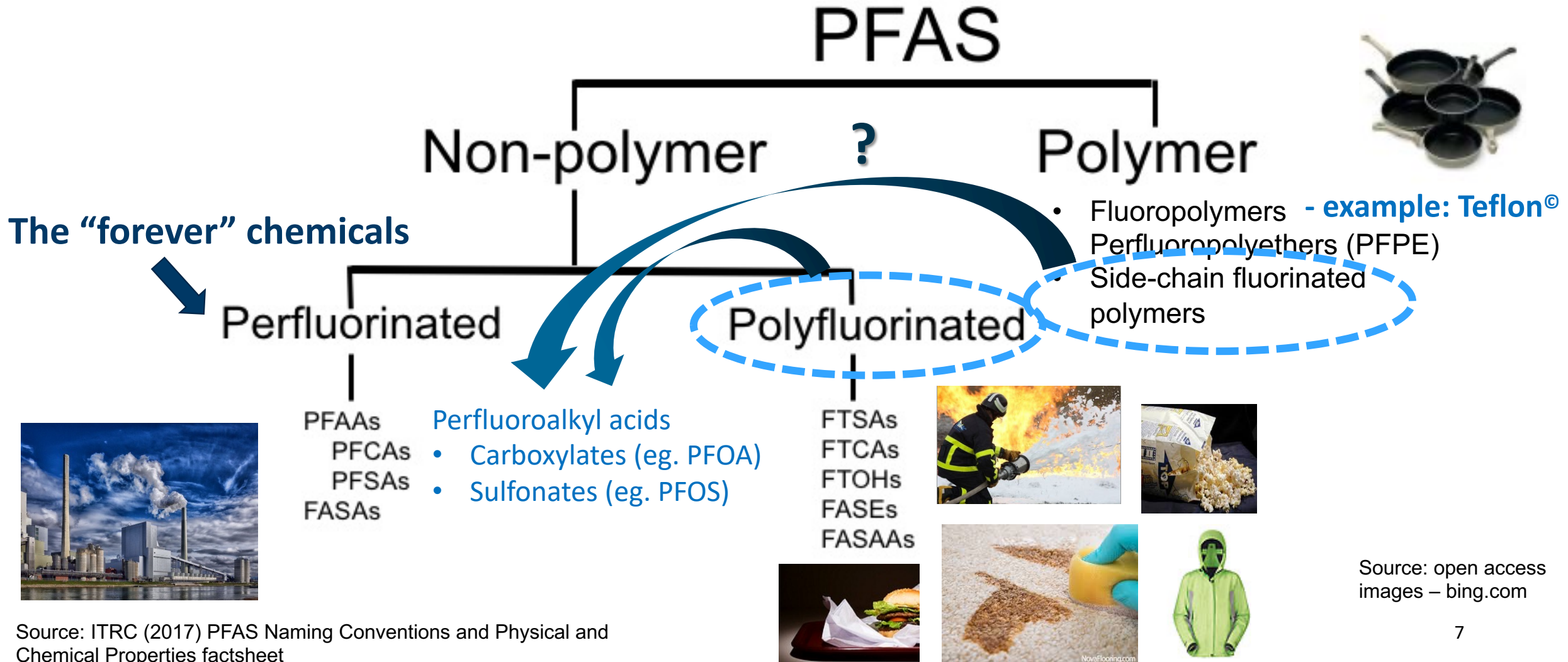
SAC Health Assessment

- Look at site-specific ways people may be exposed to environmental contaminants
- Fill data gaps
- Consider past exposures in addition to present and future
- Review health outcome data
- Identify whether exposures are likely to be harmful

Provide recommendations
to protect health

Address community
concerns/educate
community

The PFAS “Family Tree”

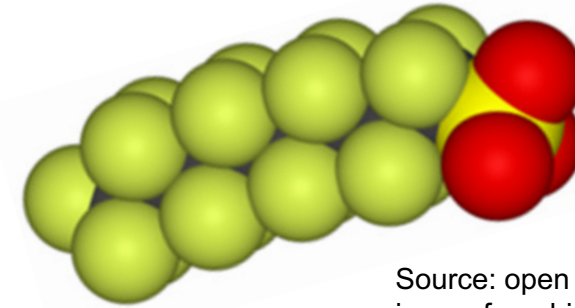


Source: ITRC (2017) PFAS Naming Conventions and Physical and Chemical Properties factsheet

Source: open access images – bing.com

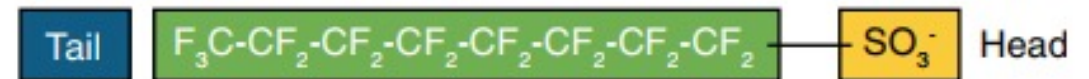
ABCs of PFAAs

- **Perfluoroalkyl Acids (PFAAs) – the basic PFAS**
 - Fully fluorinated carbon chain or “tail”
 - Carboxylate (COO^-) or sulfonate (SO_3^-) “head”
- **Perfluorinated = fully fluorinated**
 - Won't degrade in the environment
- **Polyfluorinated = partially fluorinated**
 - May degrade in the environment
- **C-F bond unbreakable in the environment**
 - Destruction only at high temperatures and/or high pressure

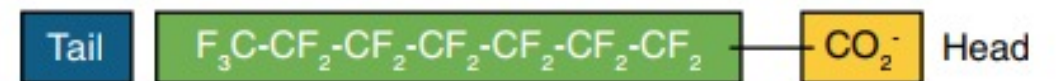


Source: open access image from bing.com

Perfluorooctane sulfonate (PFOS)



Perfluorooctane carboxylate (PFOA)



Source: ITRC (2017) PFAS Naming Conventions and Physical and Chemical Properties factsheet

PFAS in the Environment

- Chain length and functional group help predict where PFAAs are most likely to be found

Little or no bioaccumulation (?)

Bioaccumulate

Short-chain PFCAs				Long-chain PFCAs				
PFBA	PFPeA	PFHxA	PFHpA	PFOA	PFNA	PFDA	PFUnA	PFDoA
PFBS	PFPeS	PFHxS	PFHpS	PFOS	PFNS	PFDS	PFUnS	PFDoS
Short-chain PFSA				Long-chain PFSA				

Source: ITRC (2017)
PFAS Naming
Conventions and
Physical and Chemical
Properties factsheet

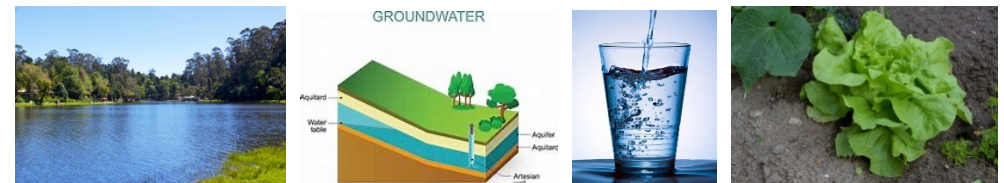
- Longer chain and/or sulfonate: relatively less water soluble & more bioaccumulative

- Soils & sediments
- Animals & humans



- Shorter chain and/or carboxylate: relatively more water soluble & less bioaccumulative

- Surface water, groundwater, drinking water
- Plants



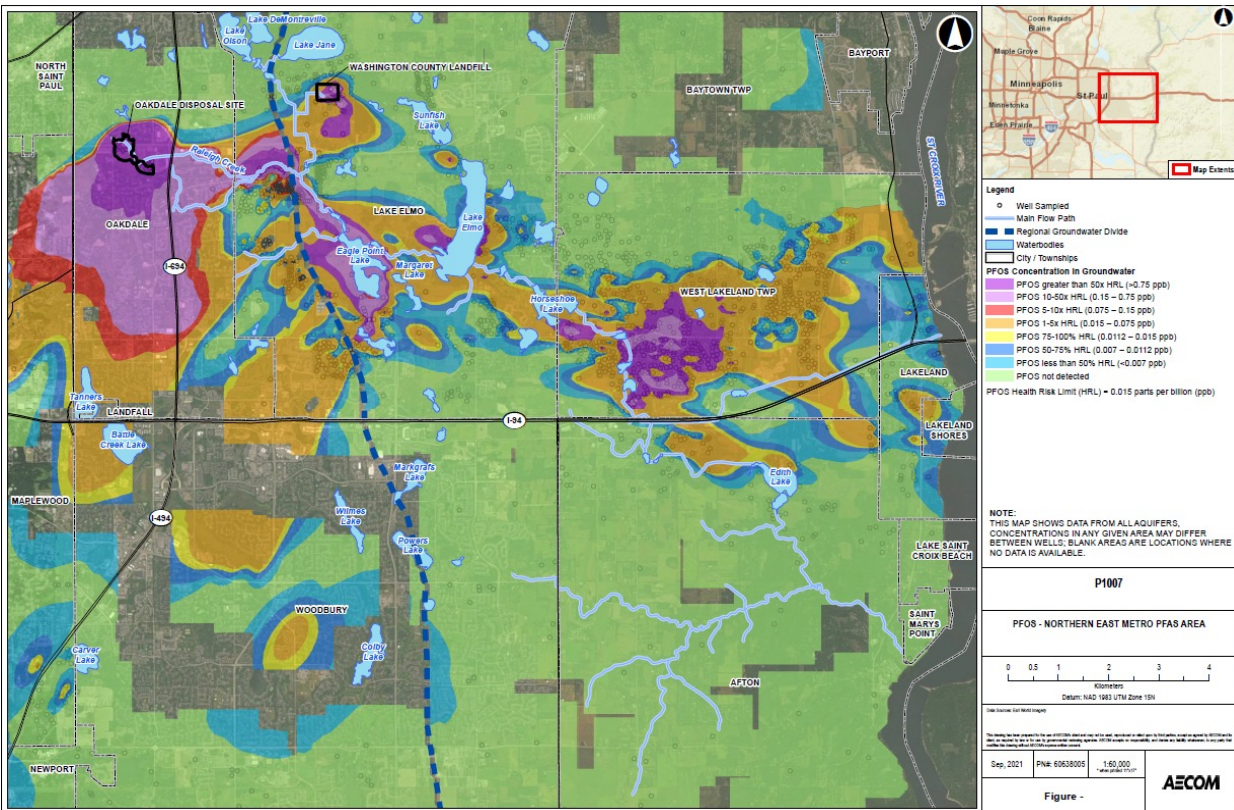
- BUT: once in water all PFAAs are mobile to some extent

“What’s So Special About PFAAs?”

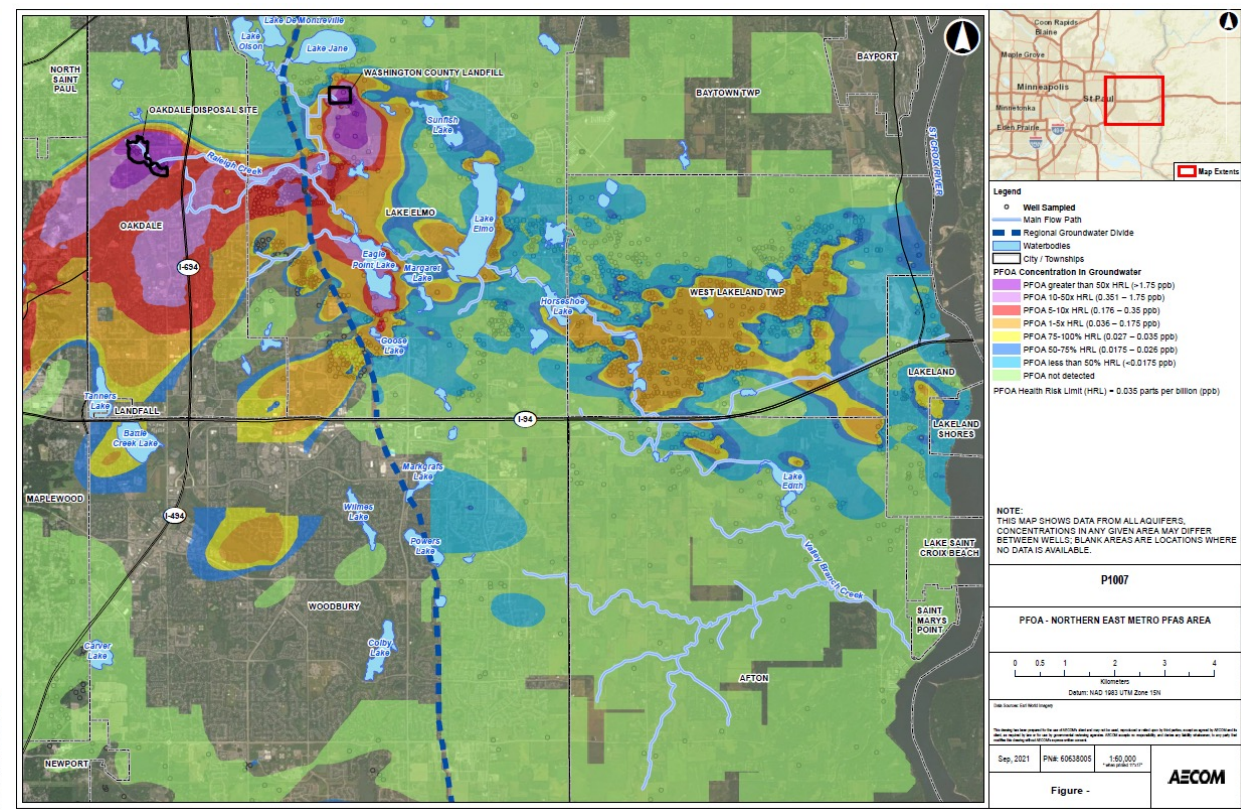
Table modified from Ducatman, 2018

		PFAAs	Dioxins & PCBs
Highly water soluble	Can travel miles in surface water & create very large groundwater plumes	Yes	No
Bind well to soil & sediments		No	Yes
Degrades to some extent in the environment		No	Yes
Bioaccumulate in fish	* True for PFAAs with 8 or more fluorinated carbons (PFOS, PFNA, and longer-chain)	Yes*	Yes
Bioaccumulate in lipids		No	Yes
“Proteinphilic”	ppt in water ↓ ppb in serum	Yes	No
Drinking water is major exposure route		Yes	No
Removed by conventional wastewater treatment		No	Maybe (TSS)

PFOS/PFOA Extents Known To-Date - 2021



PFOS



PFOA

Other PFAS Sites - AFFF

- **Statewide**

- 2008-2009: MPCA and MDH evaluated fire-training areas and nearby drinking water (detects mainly of low level PFBA)

- **Bemidji Airport**

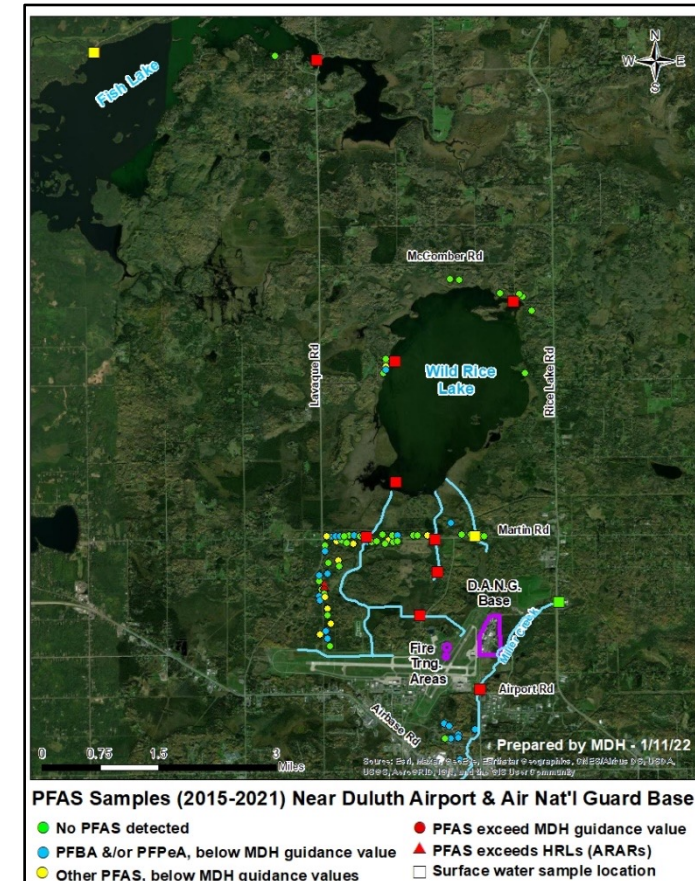
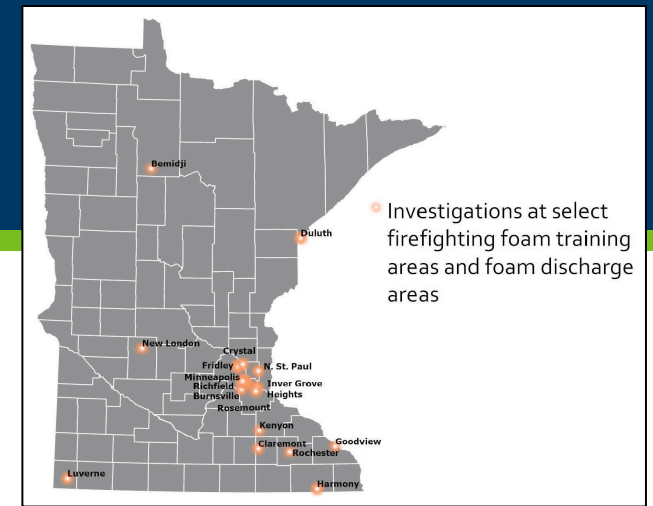
- 2014: UCMR3 – PFOS exceeded EPA LHA of 0.07 ppb in 2 wells
- 2015 – present: Increasing concentrations and lower MN values for PFOS & PFHxS – all wells exceed
- 2021 – GAC treatment system installed

- **Duluth Airport / Air National Guard Base**

- 2 drinking water advisories issued
- Surface water transport – exceeds guidance values 10 miles from source

- **Army National Guard Bases**

- Evaluations begun (delayed by pandemic)



How Are People Exposed to PFAS?

RISK =

EXPOSURE

- Pathway (how people are exposed)
- Amount of chemical
- How often
- How long

X

HAZARD

- What are the chemical's health effects?
- How does the exposure pathway affect the health effects?

Human Exposure Pathways

• Major

- Diet (bioaccumulation)
 - Fish & seafood
 - Homegrown produce
- Drinking water
- Incidental soil/dust ingestion

• Minor

- Skin absorption
- Inhalation

Primary exposure pathways for people living near contaminated sites

Health Effects of PFOA and/or PFOS

➤ Animal (lab studies)

- ❑ Liver effects
- ❑ Immunological effects
- ❑ Developmental effects
- ❑ Endocrine effects (thyroid)
- ❑ Reproductive effects
- ❑ Hematological (blood) effects
- ❑ Neurobehavioral effects
- ❑ Tumors (liver, testicular*, pancreatic*)

Sensitive endpoints – effects seen at lowest doses

➤ Human (possible links)

- ❑ Liver effects (serum enzymes/bilirubin, cholesterol)
- ❑ Immunological effects (decreased vaccination response, asthma)
- ❑ Developmental effects (birth weight)
- ❑ Endocrine effects (thyroid disease)
- ❑ Reproductive effects (decreased fertility)
- ❑ Cardiovascular effects (pregnancy induced hypertension)
- ❑ Cancer* (testicular, kidney)

* PFOA Only

Minnesota Water Guidance

- MDH health-based guidance values evolve as new research becomes available
- Protects the most vulnerable - developing fetuses & breast-fed infants born to mothers exposed 10+ yrs.
 - Provides even greater protection for the general population
 - More than protective for cancer and other less sensitive endpoints



PFAS Guidance Values Evolving Rapidly

Long-chain

Short-chain

	PFOA	PFOS	PFHxS	PFHxA	PFBA	PFBS
2002	7	1				
2006	1	0.6			1	
2007	0.5	0.3			7	
2009	0.3	0.3			7	7
2013	0.3	0.3	0.3		7	7
2016	0.07	0.07	0.07		7	7
2017	0.035	0.027	0.027		7	2
2019	0.035	0.015	0.047		7	2
2021	0.035	0.015	0.047	0.2	7	2
2022	0.035	0.015	0.047	0.2	7	0.1

Values in ppb

Blue = Health Risk Limit
(promulgated by rule-making)

Red = Health Based Value

Green = Surrogate Value

EPA LHA:

PFOA + PFOS < 0.07 ppb

How MDH Evaluates Health Risk of Mixtures

- For mixtures of chemicals that affect the same organ or bodily system, MDH calculates the Health Risk Index (HI)
- PFAS nearly always occur as mixtures
- HI calculation can include chemicals other than PFAS, if they affect the same organs or systems (example: chlorinated solvents, like TCE)

$$\text{HI} = \frac{\text{PFOA}_{[\text{conc}]}}{0.035} + \frac{\text{PFOS}_{[\text{conc}]}}{0.015} + \frac{\text{PFHxS}_{[\text{conc}]}}{0.047} + \frac{\text{PFHxA}_{[\text{conc}]}}{0.2} + \frac{\text{PFBA}_{[\text{conc}]}}{7} + \frac{\text{PFBS}_{[\text{conc}]}}{0.1}$$

HI > 1 is an exceedance

Remediation – Still Only Limited Options

- Soil & Sediment

- Excavation / dredging
- Containment vaults / capping
- Incineration
- Stabilization / Binding
- Soil washing



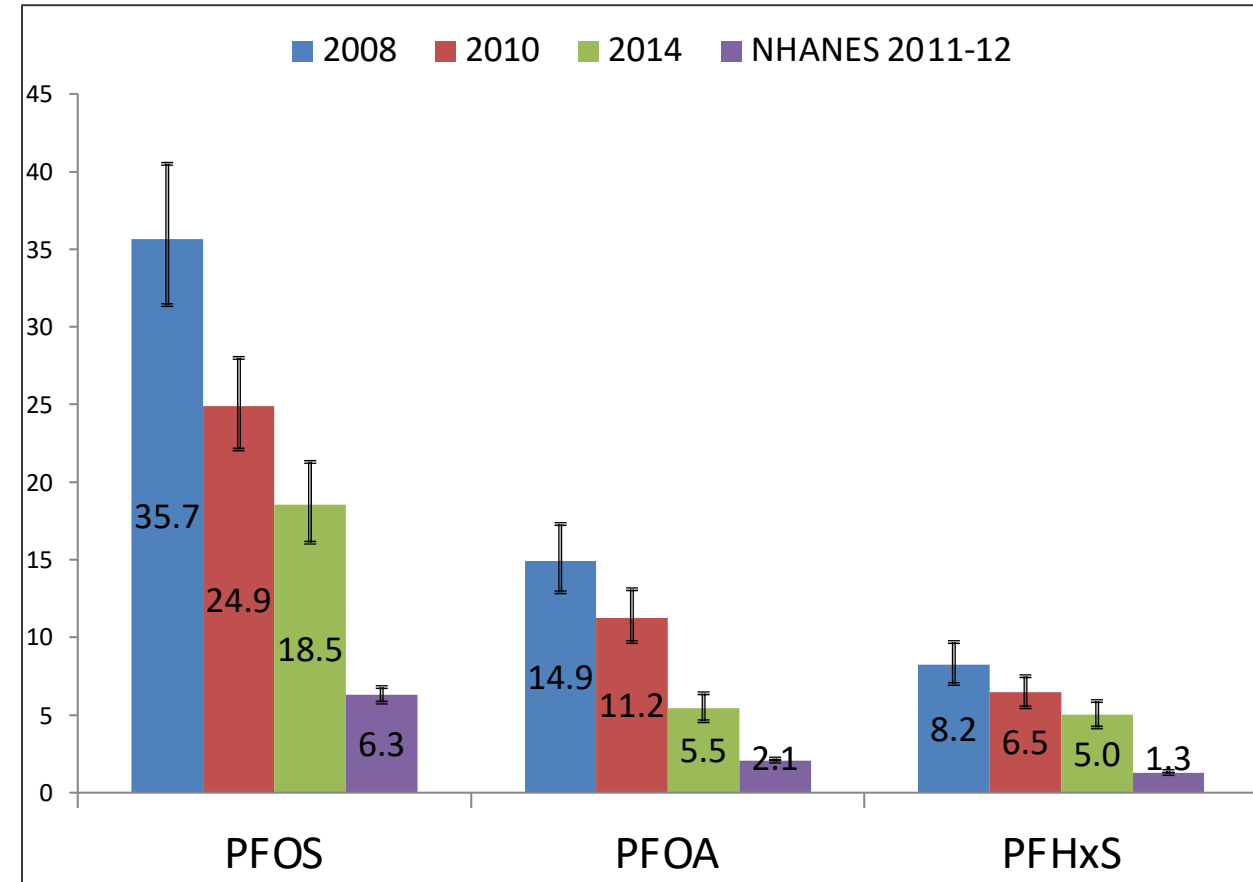
- Groundwater

- Pump & treat
 - GAC (and other carbon)
 - Ion Exchange
 - Reverse osmosis
 - Foam fractionation
- Injection / barrier walls
 - Colloidal carbon



Biomonitoring

- Exposed adults in affected East Metro communities:
 - 3 rounds: 2008, 2010, 2014
 - 196 initial participants (164 completed all 3 rounds)
- PFOS, PFOA, and PFHxS detected in 100%
- PFAS serum levels decreased for residents drinking treated water, but...
- Mean concentrations > national means
- Conclusion: removing drinking water pathway key to reducing exposure



Acknowledgements

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- AECOM
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The opinions expressed are those of the author and do not necessarily reflect the official views of ATSDR, the CDC, the Department of Health and Human Services, or the Minnesota Department of Health.

Questions?

