PFAS CAP Overview

Kara J. Steward
August 30, 2017
Chemical Action Plans

• **PBTRule**: criteria, list of chemicals, CAP content and development process

• **Goal**: reduce and phase-out PBT uses, releases, and exposures in Washington

• **CAP**: uses, releases, exposure, recommendations

Chapter 173-333 WAC (2006)
PBTs are a priority because...

• Travel long distances and cross media.
• Span the boundaries of programs, geography and generations.
• Traditional single-media approaches won’t solve the whole problem.
• We need to address PBTs through integrated use of all agency tools and programs.
What’s a CAP?

**DRAFT chapters**
- Chemistry
- Sources, Uses
- Exposure Pathways
  - Human
  - Environmental
- Toxicology
  - Human
  - Wildlife
- Regulations

**Nov/Dec Draft**
Economic analysis
Recommendations

**CAP Focus**
- Washington sources and recommendations
- Comprehensive look at industrial discharges to everyday products
- Collaborative input from Advisory Committee and interested parties
- Fill data gaps
- Look at root causes
Example CAP Actions

• Mercury (2003)
  – Voluntary agreement with dentists to recycle mercury amalgam

• PBDE flame retardants (2006)
  – Ban on some uses after an alternatives assessment

• Lead (2009)
  – Work with Commerce and DOH on assessment and remediation

• PAHs (2012)
  – Continue Ecology programs on wood smoke, creosote, diesel emissions

• PCBs (2015)
  – Work with OSPI to remove PCB light ballasts from schools
Mercury CAP Implementation

- Dentists use a dental amalgam separator to manage waste
- 2003 Mercury Education and Reduction Act (RCW 70.95M) banned some uses
  - Thermometers, novelties, thermostats
- 2010 Mercury lamp product stewardship (RCW 70.275)
  - 1.2 million lights collected in 2016
- Hospital waste best management practices
- Lower detection limit for mercury in water discharge permits
- Auto switch collection
  - 234,500 switches since 2006

Altogether we’ve kept more than 14,000 pounds of mercury out of the environment
PFAS CAP Scope

PFAS: per- and poly-fluorinated alkyl substances

- PBT Rule lists PFOS and salts
- PFAS class CAP (like PBDE, PCB, PAH)
- PFAS CAP Scope: Long chain perfluoroalkyls, precursors, related substances, and intended substitutes

2016/17 Information Collection

Aug 30, 2017 Advisory Committee

Sept/Oct 2017 Update Info/Draft Recommendations

Nov 1, 2017 Advisory Committee

Nov 2017 Research Recommendations

Dec 12, 2017 Advisory Committee

Jan/Feb 2018 Public Review and Comment

May/June 2018 Advisory Committee

June 2018 Interim PFAS CAP

PFAS CAP work continues through 2018
- Implementation of Interim PFAS CAP recommendations
- Final PFAS CAP document and recommendations
PFAS CAP logistics

- CAP Listserv
  https://listserv.wa.gov/cgi-bin/wa?A0=CHEMICAL-ACTION-PLAN

- CAP Website
  https://www.ezview.wa.gov/?alias=1962&pageid=37105

- CAP draft ‘roll-out’
  - Ecological toxicity section
  - Ecological product testing
    http://pubs.acs.org/doi/abs/10.1021/acs.estlett.6b00435
Perfluoroalkyl Substances (PFAS) Occurrence in Drinking Water Supplies

Chemical Action Plan Advisory Committee
August 30, 2017

Scott Torpie
Department of Health
Office of Drinking Water
Office of Drinking Water’s Mission

We work with others to protect the health of the people of Washington State by ensuring safe and reliable drinking water.
Unregulated Contaminant Monitoring Rule (UCMR)

- If a national regulation is needed, we must know if the contaminant occurs in public water systems (PWSs).
- Every five years, the Environmental Protection Agency (EPA) selects up to 30 contaminants to monitor in finished drinking water.
- Who samples?
  - All PWSs serving more than 10,000 people.
  - A representative sample of 800 PWSs serving 10,000 or less.
- EPA uses the results to assess occurrence of the contaminant.
Focusing on Washington State

• Water systems sampled under UCMR3 for six PFAS compounds in 2013–2015.

• Of the water systems that sampled:
  – All 113 systems serve more than 10,000 people.
  – Nineteen small systems serve 10,000 or fewer people.
  – Represents 94 percent of people on public water.
Focusing on Washington State

- PFAS samples results analyzed under UCMR3 in Washington

<table>
<thead>
<tr>
<th>Public Water System</th>
<th>Pop.</th>
<th>PFOA &amp; PFOS (ppt)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Issaquah Water System</td>
<td>26,000</td>
<td>534*</td>
</tr>
<tr>
<td>City of DuPont Water System</td>
<td>11,500</td>
<td>30</td>
</tr>
<tr>
<td>JBLM Lewis</td>
<td>75,000</td>
<td>51</td>
</tr>
</tbody>
</table>

* ~100 parts per trillion (ppt) at entry to distribution (EPTDS); ~70ppt in distribution
Subsequent (Voluntary) Sampling at Military Installations

• Fairchild AFB (Spokane County)
  – PFOA and PFOS sample results from wells within ~five miles of FAFB
    • Ranged from no detection to 2,300 ppt (Σ6 PFAS compounds measured up to > 4,400 ppt)
  – City of Airway Heights issued a 24-day bottled water advisory due to PFOA and PFOS contamination of two wells and its distribution system
    • Contamination as high as 1,250 ppt
Subsequent (Voluntary) Sampling at Military Installations

- NAS Whidbey (Island County)
  - ~210 drinking water wells within 1.5 miles of two naval air station facilities were sampled for PFOA and PFOS.
    - Seven homes have PFOA 130 to 660ppt.
    - One home has PFOS 2,500-3,800ppt.
    - Six homes have PFOA < 70ppt.
- Coupeville sampled its sources: One well in its wellfield has PFOA at 60ppt (blending to 30ppt).
- Twelve other public water systems sampled independently, with no detections.
Subsequent (Voluntary) Sampling at Military Installations

• Fort Lewis and McChord Field operate as a joint base but have separate water systems.

• Fort Lewis:
  – Shut down one well with PFOS and PFOA > 70 ppt.
  – Main water supply sources have PFOS and PFOA at 20ppt.
  – Two other smaller wells have PFOS and PFOA at 45-60ppt.

• McChord Field:
  – Shut down three wells with PFOS at 70 to 240ppt.
  – Two other wells have PFOS below 70 ppt.
Washington PFAS Occurrence in Drinking Water

- Whidbey NAS
- Fairchild AFB
- McChord Field and Fort Lewis
Next Steps for DOH

• Continue to support impacted communities
• Coordinate activities with local health jurisdictions
• Respond to request for rule-making
• Fund up to 500 PFAS samples with grant funds
  – Market sampling program to known at-risk public drinking water supplies
  – Seek greater distribution of sampling data from across the state
Contact

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PFAS from nowhere?

- Sinclair 2006 – 8 analytes


Treatment plant image from: Leonard G. at English Wikipedia
PFASs identified in arctic wildlife, but how?

Physicochemical Properties - PFOS & PFOA

- Low vapor pressure (don’t evaporate)
- Soluble in water (likely to travel by water)
- Not a candidate for “Long-Range Transport"

Biomonitoring ca. 2004-2008

- Evidence of PFAAs and biomagnification in animals of the Arctic
- “The transport pathway for these chemicals to the Arctic remains unclear."
- “Due to low volatility of PFCs, their atmospheric transport to remote regions such as the Arctic had been unexpected.”

Per- and Polyfluorinated Alkyl Substances (PFASs)

• Precursors vs Intermediates vs Final Degradates

\[
\begin{align*}
\text{8:2 Fluorotelomer alcohol (FTOH)} & \rightarrow \text{Intermediate Degradates} \\
\text{(Precursor)} & \rightarrow \text{PFOA} \\
\text{(Stable Degradate)}
\end{align*}
\]

• FTOHs are volatile and travel long distances in the atmosphere
Per- and Polyfluorinated Alkyl Substances (PFASs)

- Varied chain lengths
- Varied functional groups
- Varied chain types

PFBS - basis of 3M chemistry

EtFOSA – abandoned

DiPAP used in paper treatment

6:2 FTOH – current workhorse fluorotelomer

F-53B

ADONA (PFOA replacement)

Or not chains!
Polymer Types Transition over Time

PFAS Transition

Weaker bonds susceptible to attack

EtFOSA

8:2 FTOH

6:2 FTOH

Manufacturing

Example of ECF branched isomer

Percent of Each Isomer Type in Commercial PFOS Samples

1) Electrochemical fluorination (ECF)
2) Telomerization

Isomer profile based on Jiang et al., 2015, Chemosphere 127 (2015) 180–187
Carpet product based on Liu et al. 2012, EPA/ 600/R-12/585, August 2012
Over 100 companies could be involved in production of PFOS and derivative products globally, mostly abroad. Projections of PFOA emissions suggest that PFOA use has not ended, but rather been replaced by use abroad.

Left figure based on 2014 FluoroCouncil submission to POPRC. FluoroCouncil members are not included in these data as they do not manufacture PFOS. Right figure reproduced from “Working towards a Global Emission Inventory of PFASs: Focus on PFCAs - Status Quo and the Way Forward,” © OECD, 2015, p. 39.
How many PFASs are there?
Can we detect & quantify them?

Analytical capability

• Quantitative methods are very limited (1 validated method)
• Qualitative and quantitative methods are developing rapidly, but are hampered by the lack of standards
• The number of environmentally relevant substances far outstrips our analytical capability
• World-class labs quantify ~70 substances

Many environmental samples have a large fraction of precursors not found in standard analytical methods. Oxidation treatment converts unknown precursors to measurable PFAAs. Measure sample twice. Differences are large “unknown” mass converted to PFAAs.
FTP breakdown a long-term source of PFASs

Landfill burial a common end-of-life scenario

Washington & Jenkins, 2015, “Abiotic Hydrolysis of Fluorotelomer-Based Polymers as a Source of Perfluorocarboxylates at the Global Scale,” ES&T, 49, 14129-14135
How does this apply to AFFF?

- Many AFFF concentrates contain precursors that can’t be quantified by standard methods.
- The same is true of AFFF contaminated groundwater, aquifer solids, and soils.
- Cutting-edge techniques have detected a large number of previously unknown classes of PFASs.

Environmental Fate of AFFF

• Forty classes of novel PFASs discovered (both AFFF & GW)
  – Many likely from ECF products that have been abandoned
  – Includes 240 individual compounds (Barzen-Hanson et al., 2017)
• Many shorter-chain PFAS products are more soluble in water, more mobile in soil, & more volatile than the legacy products they replaced
• For some of these, there are no data on environmental fate
  – Xiao: “Knowledge of soil sorption and desorption of cationic and zwitterionic PFASs is critically needed to define soil quality criteria, develop remediation technologies, and establish standards for levels of acceptable contamination after remediation.”

Barzen-Hanson et al., 2017, “Discovery of 40 Classes of Per- and Polyfluoroalkyl Substances in Historical Aqueous Film-Forming Foams (AFFFs) and AFFF-Impacted Groundwater,” ES&T, 51, 2047–2057.
Summary

• There are hundreds or thousands of overlooked PFASs
  – Partly an issue of disclosure and regulatory requirements
• Gaps in knowledge of product nature/composition
  – Product testing an effort to nudge this along
• Vast gap in analytical methods and data on fate properties (not to mention toxicology)
  – Supporting cutting-edge analytical development
• PFASs generate degradates with very high persistence – product impacts will remain long after production ends
  – Ecology program supporting Green Chemistry & safer alternatives
PFAS Production

1940-50
- Nonstick cookware
- Water resistant coating
- Polymer coatings

1960-70
- Fire fighting foams
- Lubricants
- Stain resistant coatings

2000-15
- Reductions
- 2002 PFOS
- 2010-15 PFOA

Slide modified 9/5/17 – trademark names removed

Sources: OECD, DEPA, EPA, ITRC, NWGA, journal articles
## EU PFOS/PFOA Production

<table>
<thead>
<tr>
<th>Substances</th>
<th>Historic Production</th>
<th>EU estimate 2009-11</th>
</tr>
</thead>
<tbody>
<tr>
<td>PFOS and related</td>
<td>96,000 tonnes 1970-2002</td>
<td>10 tonne/yr, 80% used in metal plating</td>
</tr>
<tr>
<td>substances</td>
<td>3,000 tonnes/yr</td>
<td></td>
</tr>
<tr>
<td>PFOA and related</td>
<td>8,000 tonnes 1951-2004</td>
<td>5.5 tonne/yr, PFOA precursor production 20 tonne/yr</td>
</tr>
<tr>
<td>substances</td>
<td>150 tonnes/yr</td>
<td></td>
</tr>
</tbody>
</table>

# PFAS Product Use

<table>
<thead>
<tr>
<th>Consumer Products</th>
<th>Industrial Uses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cookware (nonstick coating)</td>
<td>Photo-Imaging</td>
</tr>
<tr>
<td>Fast food containers</td>
<td>Metal Plating</td>
</tr>
<tr>
<td>Candy wrappers</td>
<td>Semiconductor Coatings</td>
</tr>
<tr>
<td>Microwave popcorn bags</td>
<td>Aviation Hydraulic Fluids</td>
</tr>
<tr>
<td>Personal care products (shampoo, dental floss)</td>
<td>Medical Devices</td>
</tr>
<tr>
<td>Cosmetics (nail polish, eye makeup)</td>
<td>Fire-Fighting Foam</td>
</tr>
<tr>
<td>Paints and varnishes</td>
<td>Insect Baits</td>
</tr>
<tr>
<td>Stain resistant carpet</td>
<td>Printer and Copy Machine Parts</td>
</tr>
<tr>
<td>Stain resistant chemicals</td>
<td>Chemically Driven Oil Production</td>
</tr>
<tr>
<td>Water resistant apparel</td>
<td>Textiles, Upholstery, Apparel and Carpets</td>
</tr>
<tr>
<td>Cleaning products</td>
<td>Paper and Packaging</td>
</tr>
<tr>
<td>Electronics</td>
<td>Rubber and Plastics</td>
</tr>
</tbody>
</table>

*Slide modified 9/5/17 – trademark names removed*
## PFOS Disposal in WA

<table>
<thead>
<tr>
<th>Product</th>
<th>PFOS content</th>
<th>Year</th>
<th>WA Disposal</th>
<th>PFOS disposed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carpet</td>
<td>75 ppm</td>
<td>2009</td>
<td>145,282 tons</td>
<td>10 tons</td>
</tr>
<tr>
<td>Furniture</td>
<td>2.4 ppm</td>
<td>2009</td>
<td>97,620 tons</td>
<td>0.2 tons</td>
</tr>
</tbody>
</table>

Other product categories:
- Paper products, clothing, textiles, electronics, personal care products

2009 disposal = 10.2 tons PFOS


Source: DEPA 2013, Ecology 2017
PFAS Regulations

- EU REACH PFOS/PFOA uses
- Food packaging PFAS restrictions
- EPA – drinking water health advisory, significant new use rules, soil screening guidance, PFOA stewardship, UMCR3
State Actions or Listings

- Effluent
- Fish Tissue
- Ground water
- Product
- Soil
- Surface water
- Waste

Map from - https://mapchart.net/usa.html
## PFAS Drinking Water

<table>
<thead>
<tr>
<th>Agency/year</th>
<th>Health Advisories</th>
<th>PFAS</th>
<th>Health limit (ppb)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minnesota, 2011</td>
<td>Health risk limit for drinking water</td>
<td>PFBA</td>
<td>7.0 ug/L</td>
</tr>
<tr>
<td>Minnesota, 2011</td>
<td>Health risk limit for drinking water</td>
<td>PFBS</td>
<td>7.0 ug/L</td>
</tr>
<tr>
<td>New Jersey, 2017</td>
<td>Proposed state MCL for drinking water</td>
<td>PFNA</td>
<td>0.013 ug/L</td>
</tr>
<tr>
<td>New Jersey, 2017</td>
<td>Recommended by technical committee as a MCL for drinking water</td>
<td>PFOA</td>
<td>0.014 ug/L</td>
</tr>
<tr>
<td>Vermont</td>
<td>Interim Ground Water Enforcement Standard</td>
<td>PFOA</td>
<td>0.02 ug/L</td>
</tr>
<tr>
<td>Minnesota, 2017</td>
<td>Revised Health risk limit for drinking water</td>
<td>PFOA</td>
<td>0.035 µg/L</td>
</tr>
<tr>
<td>Maine, 2014</td>
<td>Drinking water health-based Maximum Exposure Guideline</td>
<td>PFOA</td>
<td>0.1 ug/L</td>
</tr>
<tr>
<td>EPA, 2016</td>
<td>Final Drinking water health advisory – lifetime</td>
<td>PFOA</td>
<td>0.07 ug/L</td>
</tr>
<tr>
<td>Minnesota, 2017</td>
<td>Revised Health risk limit for drinking water</td>
<td>PFOS</td>
<td>0.027 µg/L</td>
</tr>
<tr>
<td>EPA, 2016</td>
<td>Final Drinking water health advisory - lifetime</td>
<td>PFOS</td>
<td>0.07 ug/L</td>
</tr>
</tbody>
</table>
# Products Tested

<table>
<thead>
<tr>
<th>AFFF</th>
<th>Cosmetics</th>
<th>Paint</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carpet</td>
<td>Food packaging</td>
<td>Personal care products</td>
</tr>
<tr>
<td>Carpet care products</td>
<td>Electronics</td>
<td>Sealants</td>
</tr>
<tr>
<td>Cleaners</td>
<td>Lubricants</td>
<td>Ski wax</td>
</tr>
<tr>
<td>Clothing/textiles</td>
<td>Nonstick ware</td>
<td>Sunscreen</td>
</tr>
</tbody>
</table>

Studies vary in product selection and analytical method

- Greenpeace
- Schaider et al 2017
- Herzke et al 2012
- EPA 2009
- Fujii et al 2013
- Kotthoff et al 2015
- Barzen-Hanson et al 2015, 2017
- D’Agostino et al 2014
Ecology 2018 Product Testing

- Product screening
  - AFFF (fire fighting foam)
  - Carpet/care products
  - Cosmetics
  - Food packaging
  - Paints/Lubricants
  - Textiles
PFAS and Human Health

Chemical Action Plan – Advisory Committee meeting
August 30, 2017

Elmer Diaz, Toxicologist
Office of Environmental Public Health Sciences
Health Concerns with Long-Chain PFAS

- Liver and metabolic effects
- Developmental and Reproductive effects
- Immune suppression
Health Concerns with Long-Chain PFAS

• Endocrine effects
• Neurotoxicity
• Cancer
# Most sensitive effects

<table>
<thead>
<tr>
<th>Animals</th>
<th>Humans</th>
</tr>
</thead>
<tbody>
<tr>
<td>↑ Liver weight, and cell damage</td>
<td>↑ Cholesterol</td>
</tr>
<tr>
<td>↓ pup weight and delayed bone formation</td>
<td>↓ Birth weight</td>
</tr>
<tr>
<td>Immune toxicity</td>
<td>Immune toxicity</td>
</tr>
<tr>
<td>Mammary gland development (rats)</td>
<td></td>
</tr>
</tbody>
</table>
Drinking Water Health Advisories

PFOA

New Jersey, 2016
Vermont, 2016
Minnesota, 2017
EPA, 2016
Health Canada, 2016
Australia/NZ, 2017

PFOS

Minnesota, 2017
EPA, 2016
Health Canada, 2016
Australia/NZ, 2017

- **Lifetime health advisory (µg/L)**
- **Reference Dose/Tolerable daily Intake (µg/kg-d)**
PFAS levels in the U.S. population

Trend in median levels of PFAS in serum

Source: CDC, NHANES, 2017
### Long residence time in people
(much shorter in animals)

**Half-life in serum**

<table>
<thead>
<tr>
<th></th>
<th>Female (F)</th>
<th>Male (M)</th>
</tr>
</thead>
<tbody>
<tr>
<td>PFOA</td>
<td>2-4 h</td>
<td>6-7 d</td>
</tr>
<tr>
<td></td>
<td>17-19 d</td>
<td>21-30 d</td>
</tr>
<tr>
<td></td>
<td>236 d</td>
<td>2.3-3.8 years</td>
</tr>
<tr>
<td>PFOS</td>
<td>62-71 d</td>
<td>38-41 d</td>
</tr>
<tr>
<td></td>
<td>31-38 d</td>
<td>36-43 d</td>
</tr>
<tr>
<td></td>
<td>110 d</td>
<td>132 d</td>
</tr>
<tr>
<td></td>
<td>1.7 years</td>
<td>5.8 years</td>
</tr>
</tbody>
</table>

Source: Lau et al. 2015
Typical pathways of exposure

A. 2 yr old child, typical scenario

B. Adult, typical scenario

Source: Egeghy and Lorber, et al. 2010
Developmental exposures

• Concerns
  • PFOS, PFOA, PFHxS, PFNA, PFDA detected in serum of pregnant women
  • Measured amniotic fluid, placenta, umbilical cord blood, breast milk
  • Measured in infants blood serum shortly after birth
PFAS in Drinking Water Contributes...

Median PFAS levels in residents whose water was contaminated by manufacturing disposal sites (2008)

- PFOA: Median levels detected in drinking water
- PFOS: Median levels not detected in water

Source: MDH, 2016

Median PFAS levels in Women in CA Teachers Study (2012)

- PFOA: Median levels detected in drinking water
- PFOS: Median levels not detected in drinking water

PFHxA, PFBS, PFBA - toxicity

- Similar endpoints in rodents, but higher doses required
  - Liver effects (↑weight, cellular changes)
  - Repro/Developmental – PFHxS, PFBA > weight, delayed development, pup mortality. None observed for PFBS
  - Altered thyroid hormones (PFHxA, PFBA)

- Data gaps:
  - Immune effects
  - Hormone disruption
  - Cancer
  - Effects of developmental exposures into adulthood
Are short-chain replacements safer?

Concerns

- Extremely persistent
- Soluble and mobile in soil
- Lack of transparency hinders independent assessment
- Developmental effects of PFAS can emerge across the life course – lack of testing
- Harder to remove from drinking water?
- Migrate more efficiently from treated paper to food?
- More likely to be taken up by plants?

- toxicity, bioaccumulation
DOH Work in Progress

• Map potential PFAS sources to guide further investigation of drinking water
• Develop options for additional water system testing
• Develop evidence-based advice for home gardens, crops with impacted water.
• Develop policy options for addressing other PFAS.
Other problems identified

- Health follow-up on impacted communities
  - Exposure & health effects study
- Detections in WA fish exceed provisional screening values.
- Need data on exposures in consumer products
- Data gaps in toxicology information and exposure potential cause uncertainty.
Questions

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Barbara.Morrissey@doh.wa.gov
References


References


• Minnesota Department of Health (MDH), Toxicological Summary for: Perfluorooctanoic Acid (PFOA), May 2017.

• Minnesota Department of Health (MDH), Toxicological Summary for: Perfluorooctane Sulfonate (PFOS), May 2017.

References

• EPA Office of Water, *Drinking Water Health Advisory for Perfluorooctanoic Acid (PFOA)*, May 2016.

• EPA Office of Water, *Drinking Water Health Advisory of Perfluorooctane Sulfonate (PFOS)*, May 2016.


PFAS in the Environment

Callie Mathieu
August 30, 2017
Environmental Pathways

- Relative importance not characterized in WA
- Discrete product use (AFFF)
- WWTP effluent
- Stormwater
- Atmospheric deposition
- Biosolids, landfill leachate
PFAS Detections in Environment

- Widespread occurrence throughout the globe
- In Washington, detected in:
  - Surface water
  - Groundwater
  - WWTP effluent
  - Marine/freshwater sediments
  - Freshwater fish tissue
  - Osprey eggs
Sediment

- Cores from Urban and WWTP-impacted lakes showed increasing trends 1980s-2010
- Rural lake – no trend

- Marine sediments – detections less frequent, lower concentrations than freshwater cores
Surface Water

- 2008: widespread occurrence
- 2016: fewer detections, most within range of 5 - 50 ng/L
- Highest concentrations in WWTP-impacted waterbodies
- T-PFAA concentrations similar to MI, RI, NY
- 1-2 orders of magnitude lower than U.S. sites impacted by AFFF or manufacturing

Spring T-PFAS: <2 – 153 ng/L

Fall T-PFAS: <2 – 170 ng/L
Surface Water - 2016
WWTP Effluent

- Consistently lower concentrations in 2016 vs 2008
2008 v 2016: shift from PFOA to PFHxA (C6), PFPeA (C5)
Fish Tissue

- No consistent increase/decrease between 2008-2016
- Urban lakes highest concentrations (mostly PFOS)
- Similar levels to other states, lower than AFFF-impacted sites
- Liver concentrations 5x higher, 100% det freq.

T-PFAS: <1.0 – 87.3 ng/g ww
Fish Tissue - 2016

PROVISIONAL Screening Level based on 60 g/day

PROVISIONAL Screening Level based on 175 g/day

[Diagram showing PFAS concentrations in various fish tissues]
Osprey Eggs

• 2008 and 2016: all eggs contained PFAS, no change in concentrations
• 2016: highest concentration in Lake WA (urban)
• Most within range of rural European eggs – 3 exceptions (urban and WWTP-impacted)
Osprey Eggs - 2016

PFAS concentration (ng/g fw)

LOAE – reduced hatchability (Molina et al., 2006)
PNEC – offspring survival (Newsted et al., 2005)
Bioaccumulation

- PFOS and long-chain PFAAs increased up food chain
Bioaccumulation

- PFOA and short-chain PFAAs detected in water, but not biota
Data Gaps in WA?

- Sources to urban waterbodies
- Larger PFOS fish tissue study to meet needs for fish consumption advisories
- Data on larger suite of PFAS compounds
Summary

• Urban and WWTP-impacted waterbodies in WA State have highest concentrations of PFAS
• Replacement PFAS are present in effluent and urban/WWTP-impacted surface water, not biota
• PFOS and long-chain PFAAs are still widespread in fish tissue, osprey eggs
Citations
