Concentrations of Per- and Polyfluoroalkyl Substances (PFAS) in Selected Brooks and Rivers in Massachusetts, 2020

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New England Water Science Center
What are PFAS compounds?

- Man-made (synthetic), mostly carbon and fluoride long-chained compounds
- Produced since the 1940’s
- Consumer products
  - Food packaging
  - Nonstick, water repelling, stain resistant
  - Ski wax
- Fire-fighting foams
- Very persistent in the environment
- Adverse human and animal effects

Tokranov and others, 2021
Project Objectives

1. Characterize PFAS near WWTFs that discharge upstream of public water supply intakes.
   • 48 Sites: upstream/downstream of 24 WWTFs.

2. Characterize PFAS downstream of possible non-point or industrial sources (non WWTF).
   • 9 Sites

3. Characterize background PFAS at locations with no known PFAS sources.
   • 7 sites
Project Sampling Locations
WWTF-Vicinity
Sampling Locations

Legend
- WWTF Sample Site
- Other Sample Site
- Wastewater Treatment Facility
- Rivers Sampled for PFAS
- Major Streams & Ponds
Quality Assurance Project Plan (QAPP):

- 3 rounds of samples – August to November 2020
- Monitor streamflow to optimize low-flow (baseflow) sample collection
- Deionized water blanks (6), replicates (22), and equipment blanks (23) (over 25% of the environmental samples)
Sampling Methods:

Samples were collected by wading or from bridges (except for the Taunton - boat)

- Rivers <30 feet wide – centroid sample
- 30 to 60 ft wide – left, center, right composite sample
- >60 ft wide – Equal-width depth integrated sample (EWI)

Sawmill Brook
(upstream MCI Bridgewater)
Sample Collection:

- HDPE sampling equipment used (no Teflon)
- 250 ml HDPE bottles provided by Alpha Analytical
- Samples were unfiltered, no preservative added, and chilled
- Sampling equipment was rinsed with sample water prior to sample collection
- Lab Evaluation Procedure used by USGS to ensure lab proficiency
Handheld DH-81 suspended-sediment/water-quality sampler

Brendan Crowley - Assabet River (downstream Westborough WWTF)
Suspended DH-95 sampler

(weighs 29 lbs)

Lower and raise by hand or using bridgeboard

Guy Holzer
Chicopee River
Bridge board

Alex Bissell

Alex Bissell and Casey Beaudoin

Kyle Fronte
Merrimack River
Equal-width incremental sample

D-95 with crane
(64 lbs)
Samples were analyzed for 24 PFAS compounds by Alpha Analytical in Mansfield, MA

<table>
<thead>
<tr>
<th>PFOA*</th>
<th>N-MeFOSAA</th>
<th>PFBA</th>
<th>PFOSA (FOSA)</th>
</tr>
</thead>
<tbody>
<tr>
<td>PFOS*</td>
<td>N-EtFOSAA</td>
<td>PFDS</td>
<td>PFPeS</td>
</tr>
<tr>
<td>PFHxS*</td>
<td>8:2 FTS</td>
<td>PFDsA</td>
<td>PFPeA</td>
</tr>
<tr>
<td>PFHpA*</td>
<td>6:2 FTS</td>
<td>PFHpS</td>
<td>PFTA</td>
</tr>
<tr>
<td>PFDA*</td>
<td>4:2 FTS</td>
<td>PFHxA</td>
<td>PRTrDA</td>
</tr>
<tr>
<td>PFNA*</td>
<td>PFBS</td>
<td>PFNS</td>
<td>PFUnA</td>
</tr>
</tbody>
</table>

* compounds currently regulated in MassDEP drinking water standard

MassDEP drinking water standard for PFAS6 is 20 ng/L (Individually or the sum of the concentrations of the PFAS6)
Alpha Analytical

• Alpha Analytical analyzed PFAS using a modified version of EPA Method 537.1 with isotope dilution

• Analysis method included extraction of dissolved (liquid phase) and sediment-bound PFAS compounds

• Liquid chromatography – tandem mass spectrometry (LC-MS-MS)

* The use of brand names is for identification purposes only and does not imply endorsement by the United States Government
Observations: Data Quality Evaluation

- No apparent red flags with respect to data validity.
- DIW and equipment blanks showed little/no detects, except for one common contaminant - Perfluorohexanoic acid (PFHxA).
- Sufficient duplicates were collected in each round and show good agreement.
- Most of the data qualifiers are “E” denoting an “estimated value” (MDL < result < RL) and not a technical data quality issue.
Results of Per- and Polyfluoroalkyl Substances (PFAS) in Selected Brooks and Rivers in Massachusetts, 2020

Richard Chase, MassDEP
Observations: Environmental Data Results

• PFAS detected in all 27 rivers sampled

• Number of PFAS analytes detected at each location (of 24 tested):
  • Average: 10 compounds
  • Range: 2 - 16 compounds
  • Max # of detections: Shawsheen River (16 PFAS)
  • Concentration range for individual PFAS analytes ND - 109 ng/L

• Highest individual compound values observed:
  • North Nashua River (East Fitchburg) – PFBS concentration 109 ng/L
  • Sawmill Brook (MCI Bridgewater) – PFPeA concentration 106 ng/L
<table>
<thead>
<tr>
<th>Analyte short name</th>
<th>Percent of samples with results &gt; MDL</th>
<th>Number of detections</th>
<th>Minimum (ng/L)</th>
<th>Median (ng/L)</th>
<th>Mean (ng/L)</th>
<th>Maximum (ng/L)</th>
</tr>
</thead>
<tbody>
<tr>
<td>PFHxA</td>
<td>100</td>
<td>192</td>
<td>0.34</td>
<td>9.3</td>
<td>13</td>
<td>91</td>
</tr>
<tr>
<td>PFOA *</td>
<td>99</td>
<td>191</td>
<td>0.24</td>
<td>7.5</td>
<td>8.7</td>
<td>42</td>
</tr>
<tr>
<td>PFOS *</td>
<td>95</td>
<td>183</td>
<td>0.52</td>
<td>6.3</td>
<td>6.9</td>
<td>55</td>
</tr>
<tr>
<td>PFHApA *</td>
<td>95</td>
<td>182</td>
<td>0.24</td>
<td>3.3</td>
<td>4.1</td>
<td>19</td>
</tr>
<tr>
<td>PFPeA</td>
<td>95</td>
<td>182</td>
<td>0.44</td>
<td>10.8</td>
<td>14.4</td>
<td>106</td>
</tr>
<tr>
<td>PFBA</td>
<td>94</td>
<td>180</td>
<td>0.43</td>
<td>4.9</td>
<td>6.7</td>
<td>54</td>
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<tr>
<td>PFBS</td>
<td>90</td>
<td>173</td>
<td>0.33</td>
<td>4.0</td>
<td>8.0</td>
<td>109</td>
</tr>
<tr>
<td>PFHxS *</td>
<td>88</td>
<td>169</td>
<td>0.4</td>
<td>2.5</td>
<td>3.1</td>
<td>26</td>
</tr>
<tr>
<td>PFNA *</td>
<td>87</td>
<td>167</td>
<td>0.29</td>
<td>1.3</td>
<td>1.6</td>
<td>10</td>
</tr>
<tr>
<td>PFDA *</td>
<td>65</td>
<td>124</td>
<td>0.28</td>
<td>0.64</td>
<td>0.86</td>
<td>4.7</td>
</tr>
<tr>
<td>PFPeS</td>
<td>64</td>
<td>123</td>
<td>0.24</td>
<td>0.43</td>
<td>0.53</td>
<td>2.9</td>
</tr>
<tr>
<td>PFUnA</td>
<td>21</td>
<td>40</td>
<td>0.24</td>
<td>0.36</td>
<td>0.53</td>
<td>1.8</td>
</tr>
<tr>
<td>6:2 FTS</td>
<td>13</td>
<td>25</td>
<td>1.3</td>
<td>3.0</td>
<td>4.61</td>
<td>18</td>
</tr>
<tr>
<td>N-MeFOSAA</td>
<td>5</td>
<td>10</td>
<td>0.68</td>
<td>0.74</td>
<td>0.87</td>
<td>1.5</td>
</tr>
<tr>
<td>PFTA</td>
<td>5</td>
<td>10</td>
<td>0.23</td>
<td>0.26</td>
<td>0.28</td>
<td>0.37</td>
</tr>
<tr>
<td>N-EtFOSAA</td>
<td>5</td>
<td>9</td>
<td>0.82</td>
<td>0.95</td>
<td>1.17</td>
<td>2.3</td>
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<tr>
<td>PFTrDA</td>
<td>2</td>
<td>3</td>
<td>0.31</td>
<td>0.35</td>
<td>1.01</td>
<td>2.3</td>
</tr>
<tr>
<td>PFDoA</td>
<td>1</td>
<td>1</td>
<td>0.56</td>
<td>0.56</td>
<td>0.56</td>
<td>0.56</td>
</tr>
<tr>
<td>PFHpS</td>
<td>1</td>
<td>1</td>
<td>1.6</td>
<td>1.6</td>
<td>1.6</td>
<td>1.6</td>
</tr>
</tbody>
</table>

1) Not detected in any of the samples: 8:2FTS, 4:2FTS, PFDS, PFNS, and PFOSA  
2) *=PFAS6
Observations: PFAS6 Results

- Concentration range for individual PFAS6 analytes only (all sites): **ND-55 ng/l (PFOS was max in the Shawsheen)**
- Concentration range for [sumPFAS6] (all sites): **ND-108 ng/l**
- # of sites (of 64 total) with [sumPFAS6] concentrations greater than 20 ng/l: **43 sites**

PFAS6 = PFOA + PFOS + PFHpA + PFHxS + PFNA + PFDA
PFAS6: US/DS of WWTF
Example:

Changes in % composition of PFAS6 for each sampling round from Upstream (UP) to Downstream (DS) of a Wastewater Treatment Facility
Observations: PFAS24 Results

- Concentration range for [sum of 24 compounds] (all sites): **0.3-399 ng/l**
- Of the 64 sites, PFAS24 concentrations greater than 50 ng/L detected at 41 of the 64 sites sampled
- Waterbodies generally showing higher PFAS total [sum24] concentrations (>~50 ng/l):
  - Assabet River
  - Sewage Brook
  - Concord River
  - Nashua River (maximum [sum24] observed= 399 ng/l, DS of E. Fitchburg)
  - Blackstone River
  - Charles River
  - Three Mile River
  - Sawmill Brook
  - Nemasket River
  - Salisbury Plain River
  - Town River
  - Taunton River
  - Millers River
  - Shawsheen River (maximum [PFAS6] observed= 108 ng/l)
  - Westfield River
PFAS24: US/DS of WWTF
Examples:

Relatively low upstream PFAS24 concentrations compared to downstream of discharge.
Examples: Significant increases in [PFAS24] from upstream to downstream of discharge
Examples:

Similar and elevated upstream and downstream [PFAS24]
Examples:

Possible dilution of UPS [PFAS24] resulting in lower levels DNS (inconclusive)
Summary & MA PFAS Standards and Requirements:

- **Surface Water** (including primary contact, fish consumption, aquatic life):
  - none
- **Drinking Water:**
  - PFAS6 < 20 ng/L (Individually or the sum of the concentrations of the PFAS6)
  - PFAS testing for PWS required
  - STORY MAP: PFAS in drinking water supplies in Massachusetts
- **Wastewater Discharge Permits:**
  - no numerical limits; quarterly monitoring of influent, effluent and sludge required
- **Biosolids:**
  - No numerical limits; quarterly monitoring of residuals that have an Approval of Suitability (AOS) is required
- **Contaminated Sites (MCP):**
  - Reportable Concentrations (RCs) and Reportable Quantities (RQs) under the MCP for groundwater and soils
## PFAS6 Results: Drinking Water from Concord, Merrimack & Taunton Rivers

<table>
<thead>
<tr>
<th>Public Water Supply</th>
<th>River</th>
<th>Population</th>
<th>Raw Water PFAS6 (ppt)</th>
<th>Finished Water PFAS6 (ppt)</th>
<th>Closest Upstream WWTF</th>
<th>Range of Upstream River PFAS6 (ppt)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Billerica</td>
<td>Concord</td>
<td>40,243</td>
<td>NA</td>
<td>3.04 on 4/1/21 (QC pending) 7.46 on 4/22/21 (QC pending)</td>
<td>Concord (Concord River)</td>
<td>21.0 – 23.4</td>
</tr>
<tr>
<td>Tewksbury</td>
<td>Merrimack</td>
<td>31,044</td>
<td>8.31 on 11/14/19 6.65 on 1/28/20</td>
<td>3.36 on 11/14/19 3.34 on 1/28/20</td>
<td>Lowell (Merrimack River)</td>
<td>7.1 – 34.6</td>
</tr>
<tr>
<td>Methuen</td>
<td>Merrimack</td>
<td>50,706</td>
<td>Not needed</td>
<td>ND on 11/25/19</td>
<td>Lowell (Merrimack River)</td>
<td>7.1 – 34.6</td>
</tr>
<tr>
<td>Lawrence</td>
<td>Merrimack</td>
<td>80,162</td>
<td>5.95 on 11/18/19 6.11 on 1/2/20 6.95 on 2/18/20</td>
<td>6.01 on 11/18/19 2.99 on 1/2/20 6.88 on 2/18/20</td>
<td>Lowell (Merrimack River)</td>
<td>7.1 – 34.6</td>
</tr>
<tr>
<td>Andover</td>
<td>Merrimack</td>
<td>33,201</td>
<td>11.7 on 11/4/19</td>
<td>3.68 on 11/4/19</td>
<td>Lowell (Merrimack River)</td>
<td>7.1 – 34.6</td>
</tr>
<tr>
<td>Lowell</td>
<td>Merrimack</td>
<td>106,519</td>
<td>11.5 (PFOS/PFOA) on 8/13/19 5.6 on 11/13/19 2.5 on 3/3/20</td>
<td>7.4 (PFOS/PFOA) on 8/13/19 2.9 on 11/13/19 Est. detects only on 3/3/20</td>
<td>Pepperell (Nashua River)</td>
<td>40.8 – 61.8</td>
</tr>
<tr>
<td>Aquarion</td>
<td>Taunton</td>
<td>93,810</td>
<td>NA</td>
<td>ND on 11/24/20</td>
<td>Taunton (Taunton River)</td>
<td>21.8 – 23.0</td>
</tr>
</tbody>
</table>
Next Steps

- USGS data publication (NWIS): 6/22
- Presentation to facilities: 6/23
- Presentation to selected watershed groups: 6/30
- USGS data report & release: Fall 2021
- DEP Planning for additional studies and actions: On-going
  - PFAS in Fish tissue
  - Additional surface water quality sampling
  - Source control and treatment
Data available USGS National Water Information System (NWIS)
waterdata.usgs.gov/nwis
Tutorials
USGS Data Report and Data Release

- Describes sampling methods
- Results publicly accessible
- Includes field QAQC data (replicates, blanks)
- Includes all Alpha Analytical lab QAQC data
Thank you!

Questions?

Project-Related:
• Richard Carey, richard.carey@mass.gov
• Richard Chase, richard.f.chase@mass.gov

PFAS, NWIS and Other USGS Work:
• Jennifer Savoie, jsavoie@usgs.gov
• Denise Argue, dmargue@usgs.gov