PFAS: Evidence from Field Metadata

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25 YEARS OF ESTCP
2019 | Enhancing DoD's Mission Effectiveness

AFCEC Restoration Program's Programmatic Response

- **Preliminary Assessments (PA)**
  - Objective: Identify all potential AFFF releases
  - Status: Complete
- **Site Inspections (SI)**
  - Objective: Confirm AFFF releases (i.e., source-zone sampling)
  - Status: Nearing completion
- **Expanded SIs (ESI)**
  - Objective: Investigate and eliminate off-base drinking water exposure pathways
  - Status: In progress (select installations)
- **Remedial Investigations (RI)**
  - Objective: Delineation, source-strength determination, and baseline risk assessments
  - Status: In progress (select installations)

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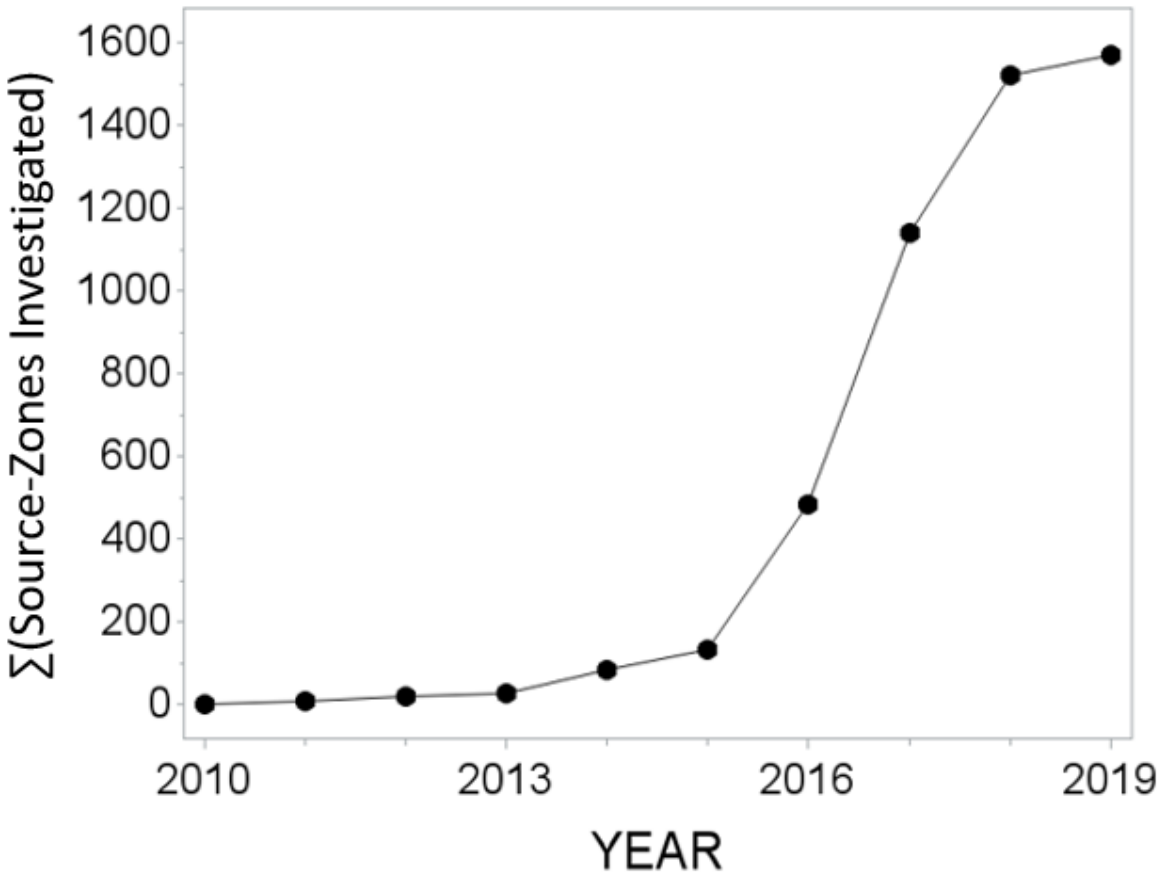
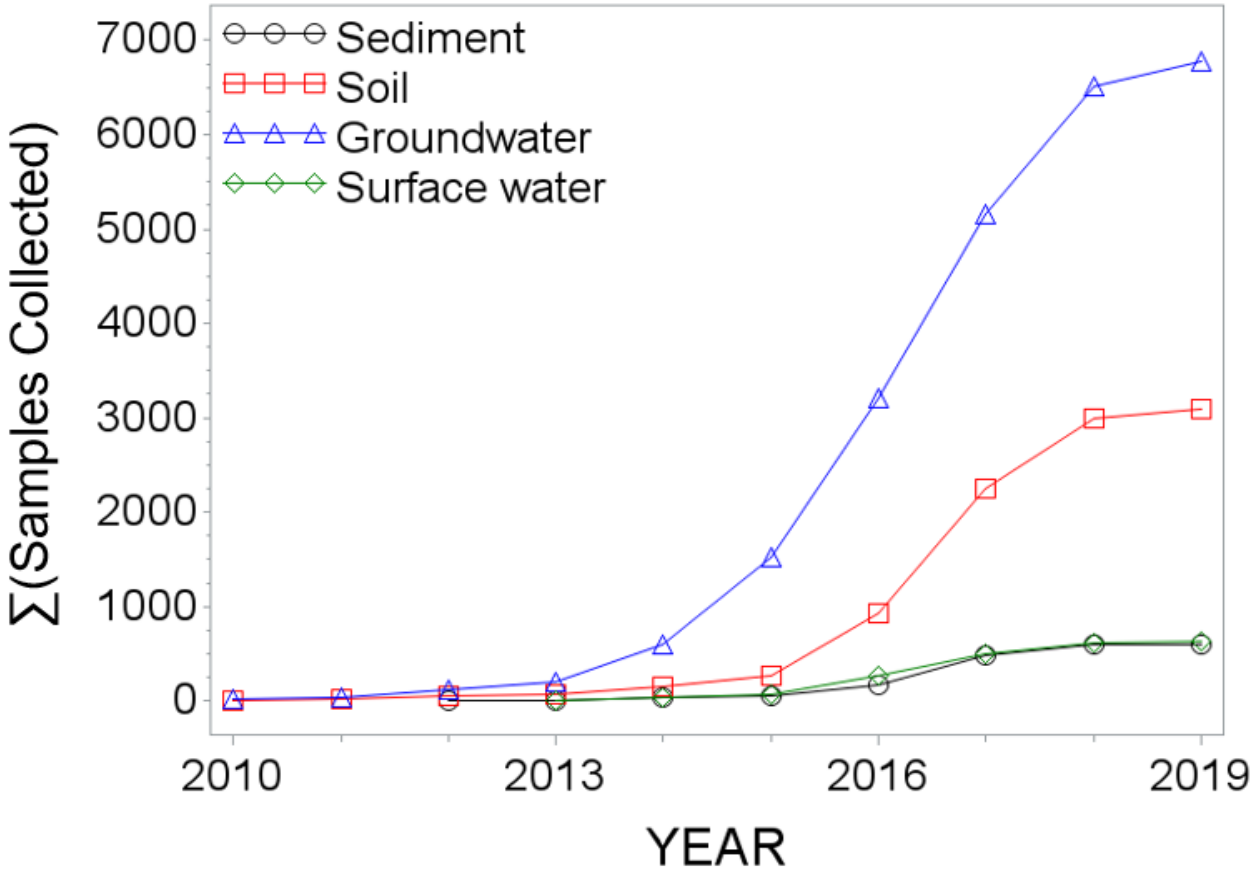
Available Data to Date





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What Do the Data Say?

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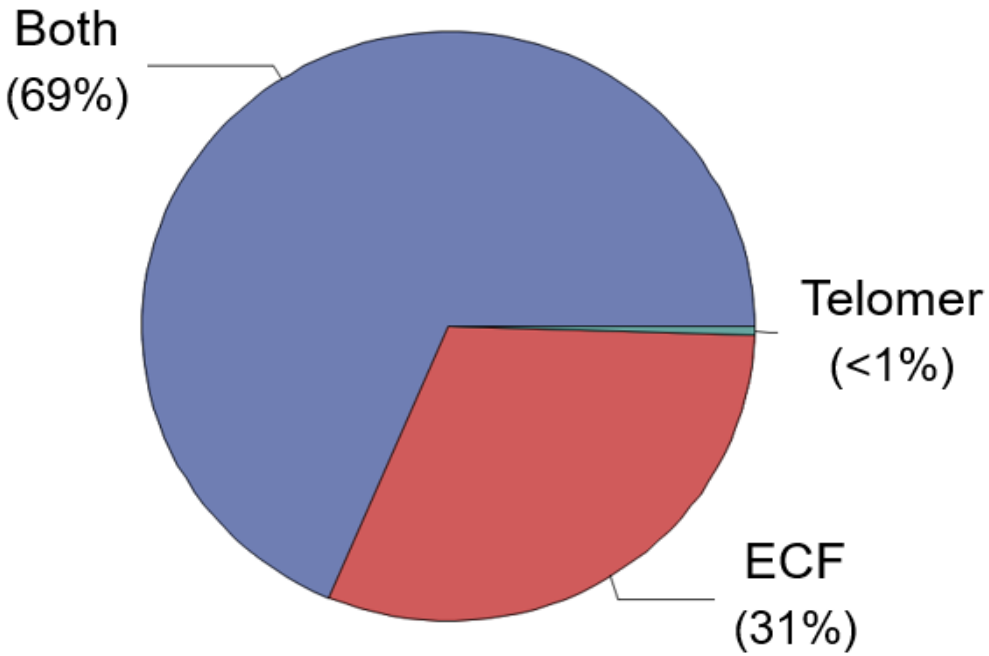
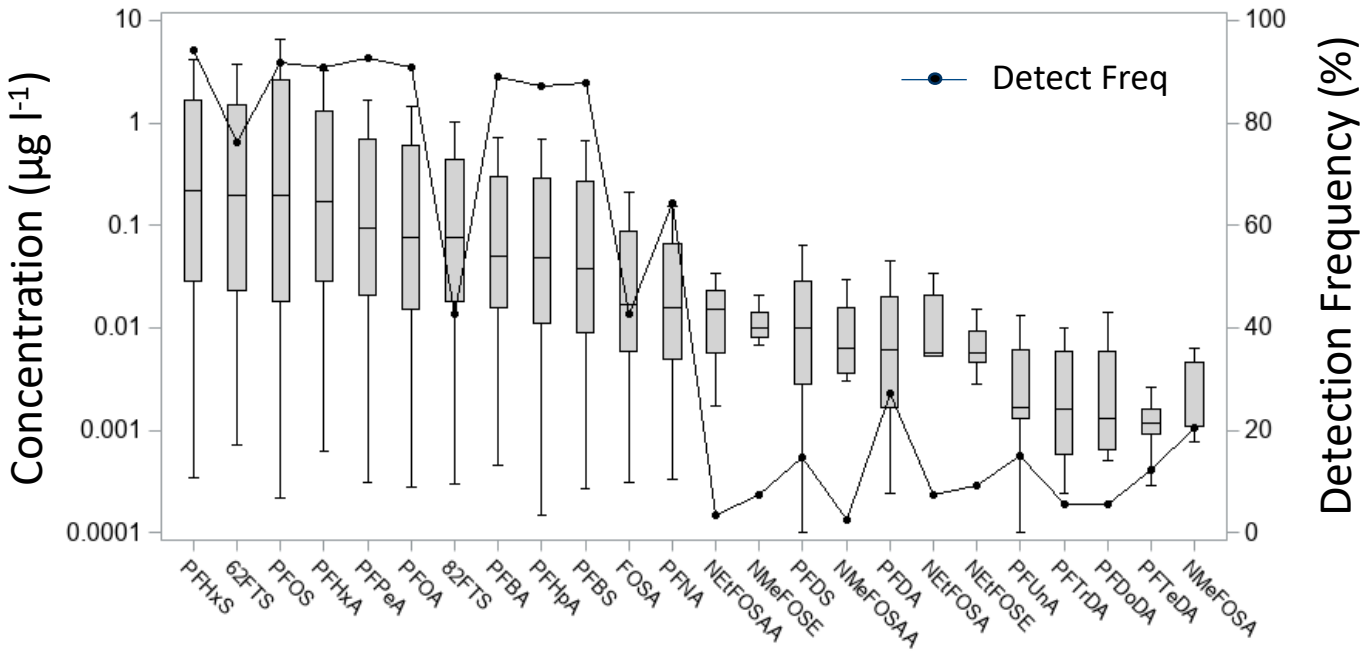
Observed Mixtures in Groundwater Within Source-Zones

- **PFSAs are universally present at AFCEC's AFFF-Impacted Sites**

Distribution of Inferred AFFF Formulations



All Groundwater Data



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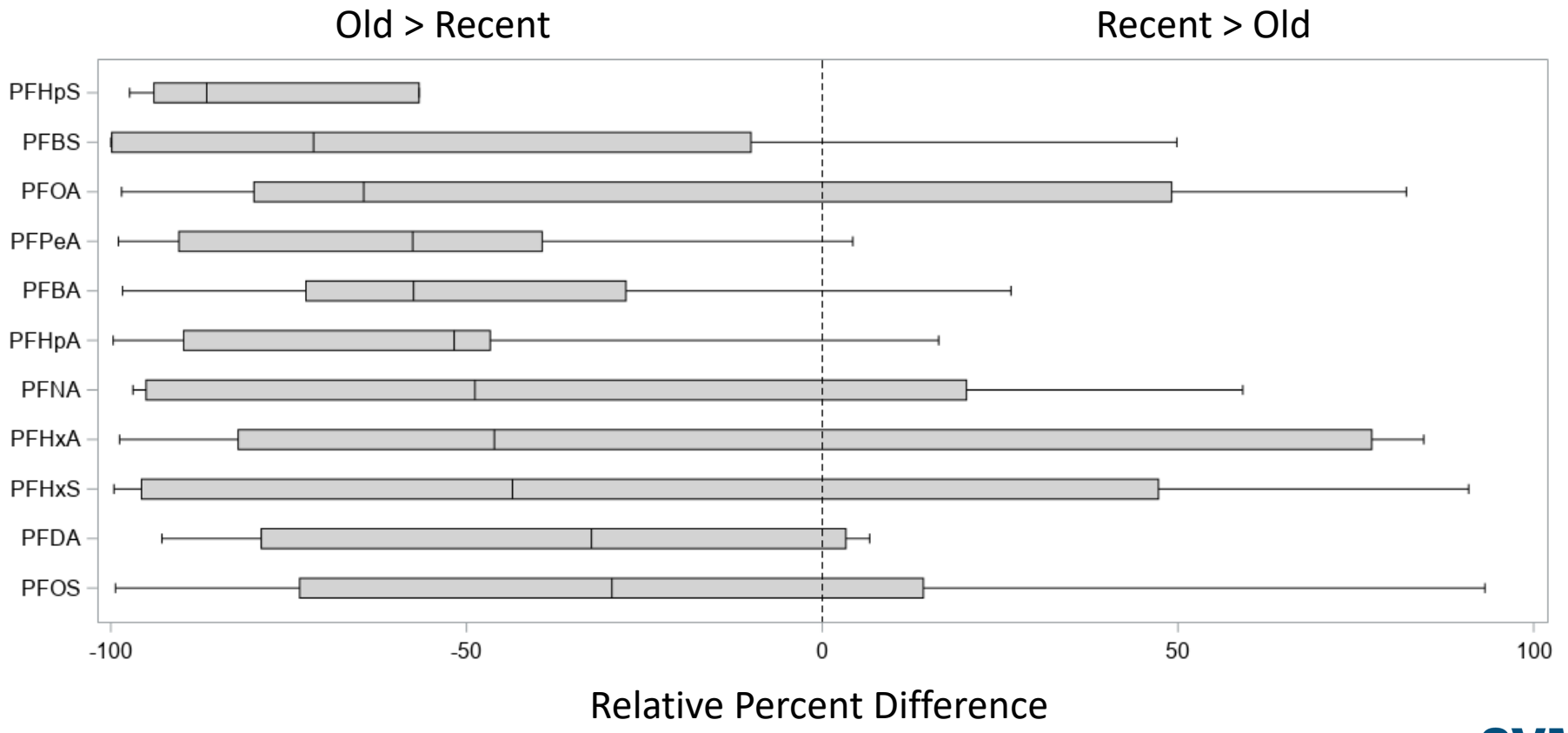
Repeated Measures from Monitoring Wells

- **Concentrations measured in 2010/2011 are systematically greater than from >2015**



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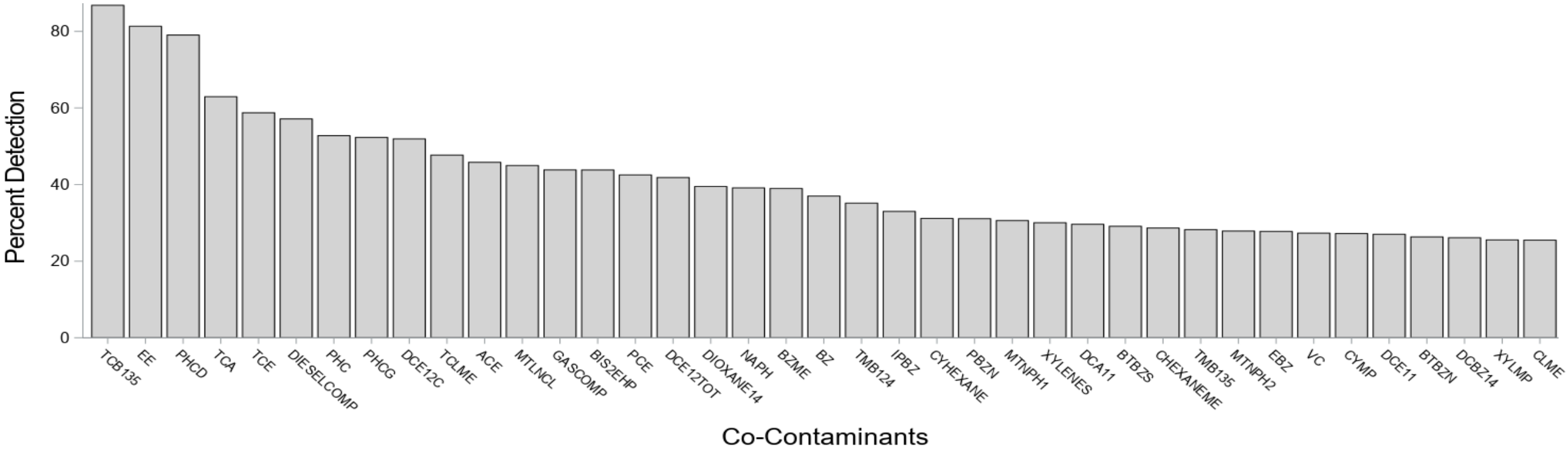
Groundwater Co-Contaminants Within Source-Zones

- **Reflects only 36% of the PFAS dataset**
  - Primarily from former fire-training areas with monitoring wells for legacy contaminants opportunistically sampled during the SI



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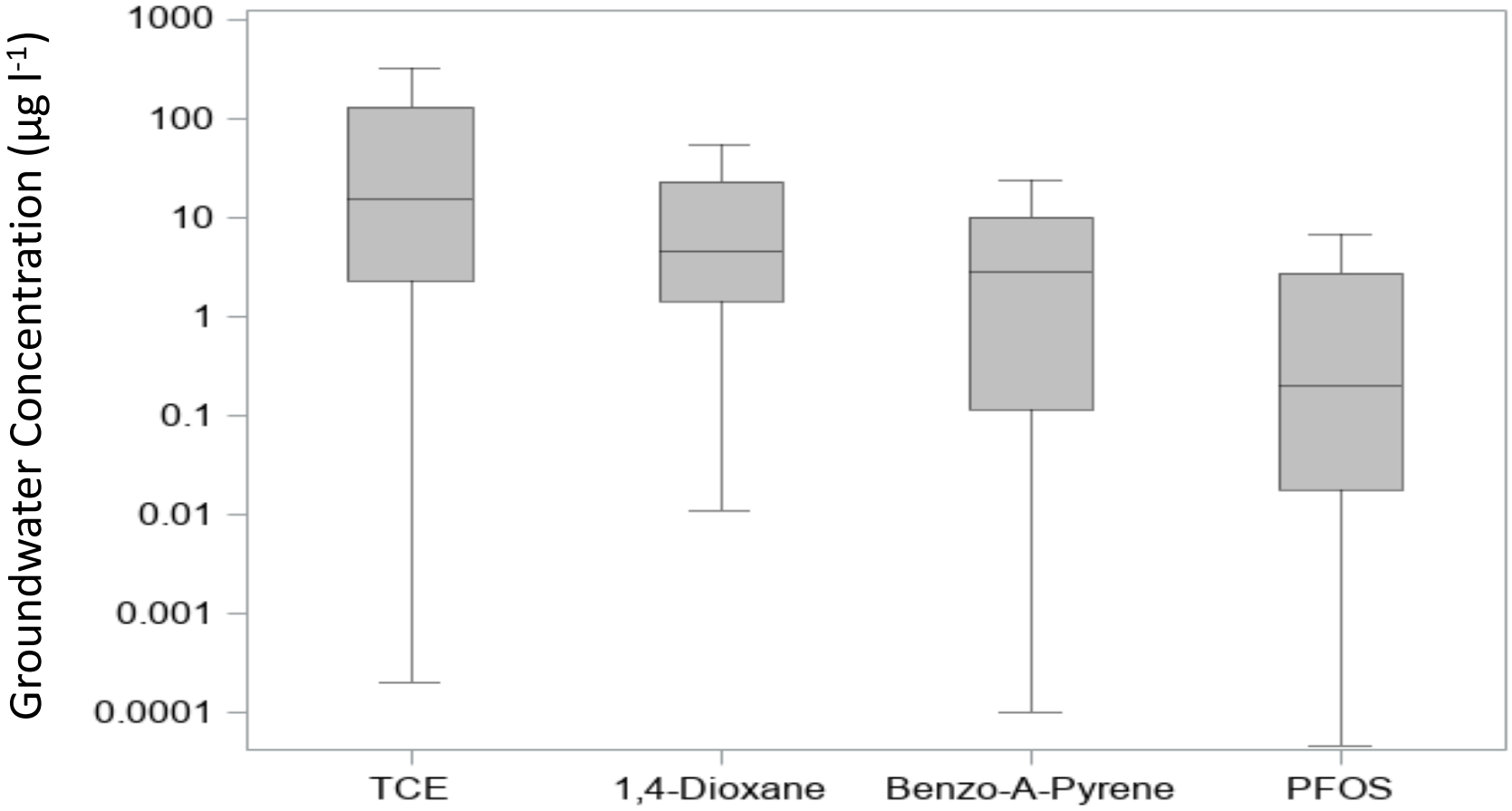
Comparison to Other COCs



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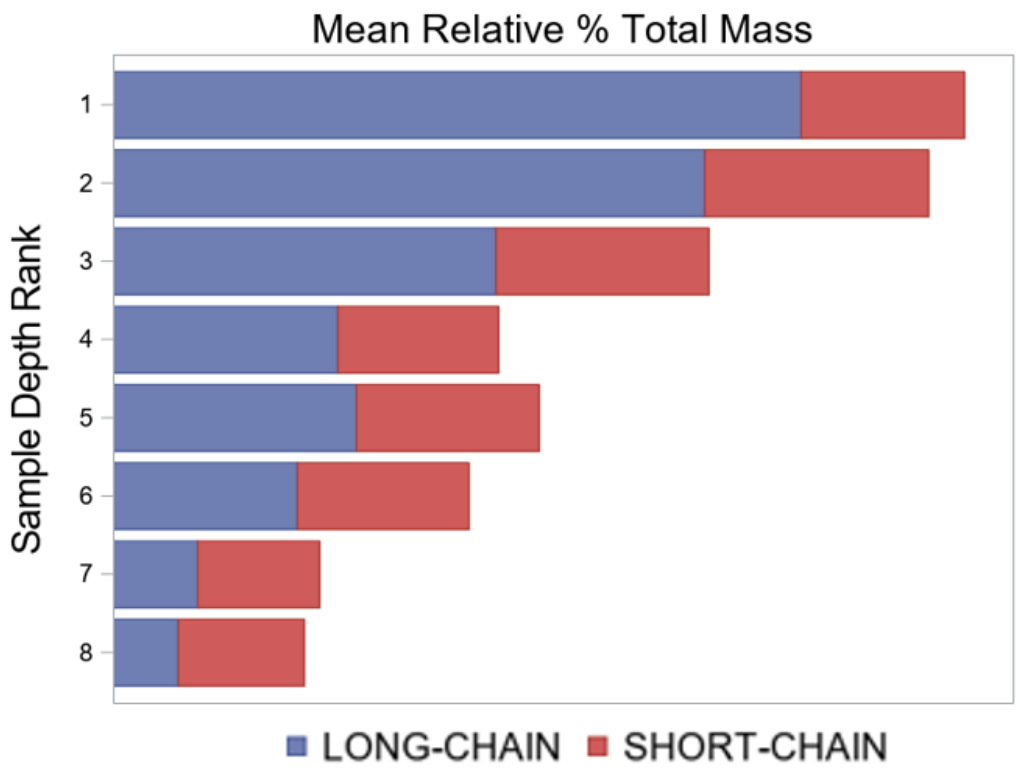
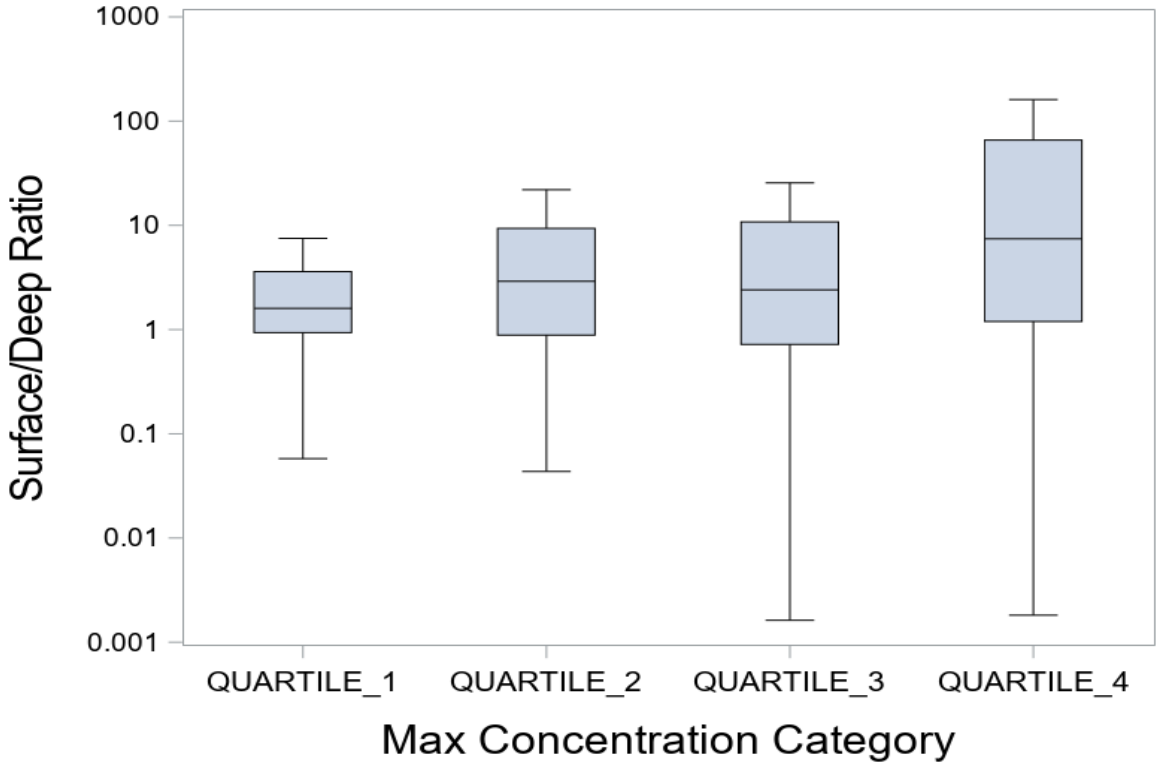
Vadose Zone Retention

- **Soil retention is significant but highly variable**





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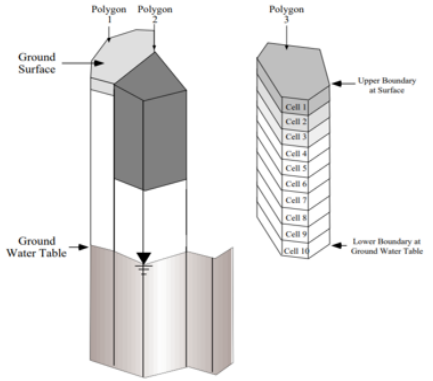
Vadose Zone Retention

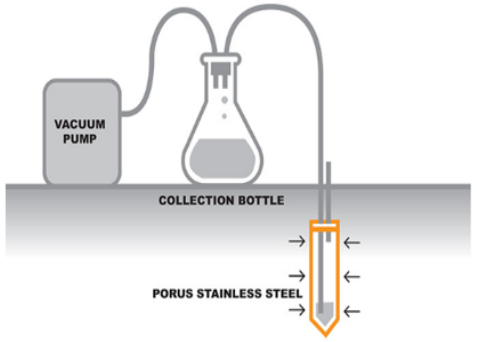
- **Anderson et al. 2019. JCH**
  - Hydrophobic interactions obvious
  - Air-water interfacial sorption implicated
  - Greater retention at poorly flushed sites

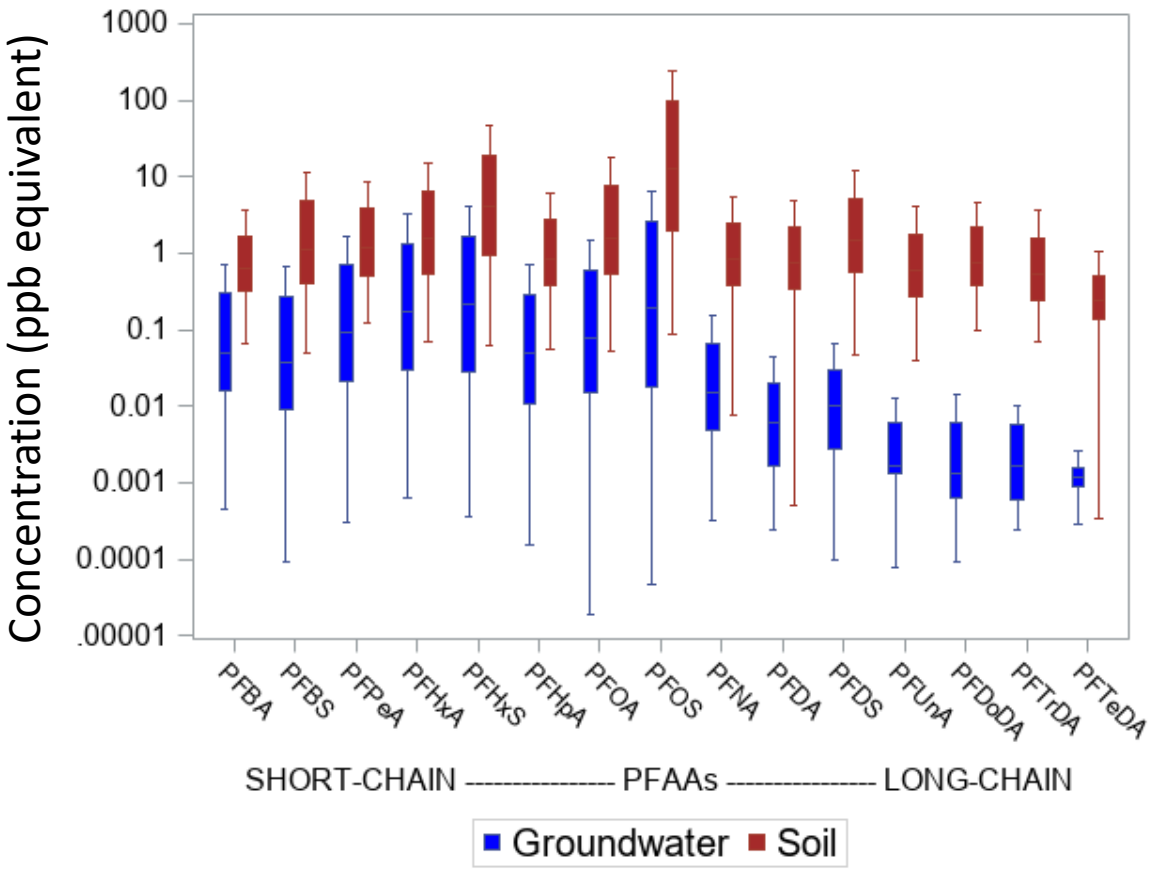
How to Assess Source-Strength?

1D Transport Model



Soil Lysimetry





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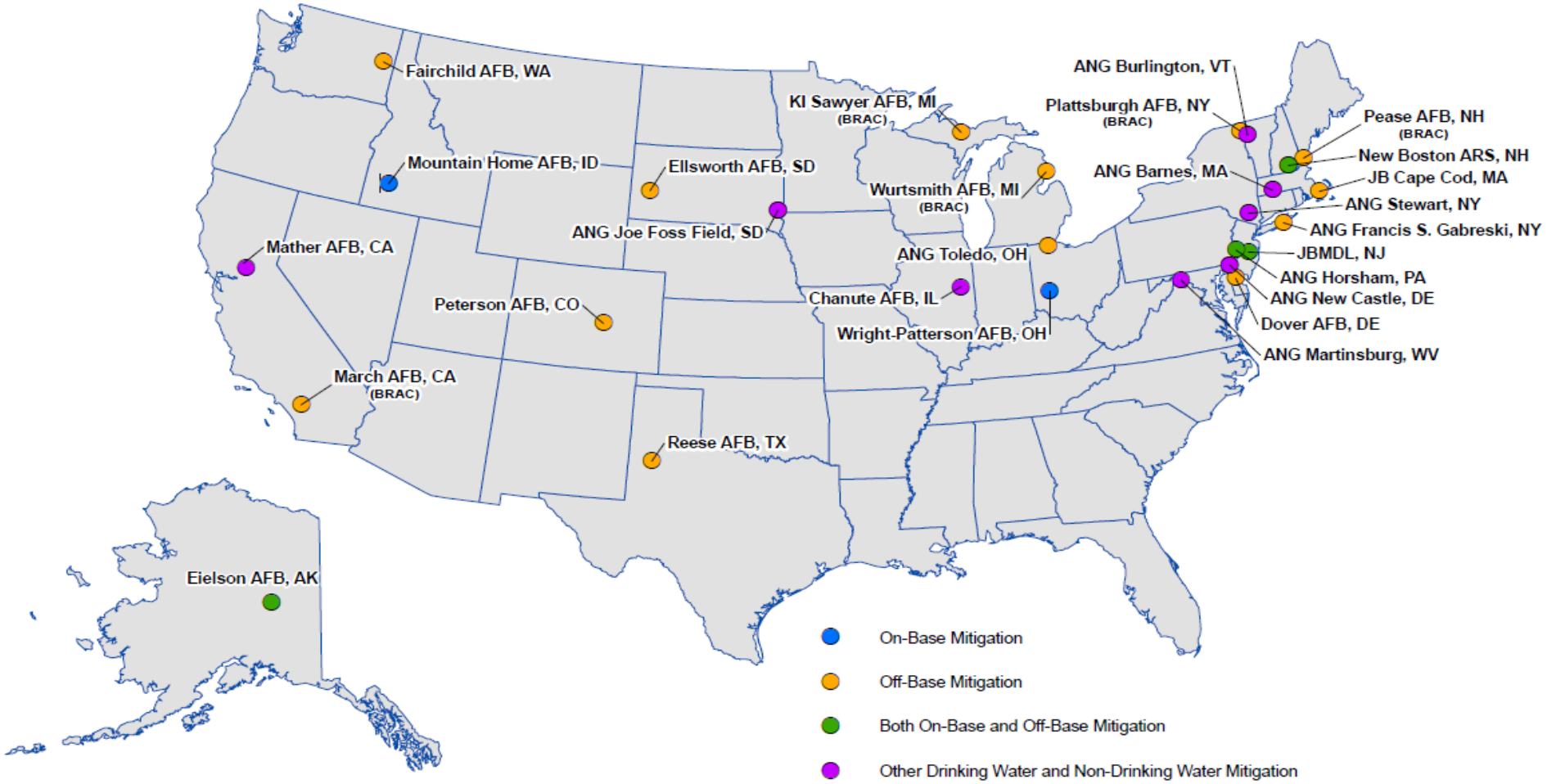
Drinking Water Mitigation Efforts to Date



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Off-Base Drinking Water

- **Potable well surveys conducted during SI out to 4 miles in downgradient direction**
  - Sampled during ESI contingent on the “three P’s”
    1. Probability
    2. Proximity
    3. Pathway
- **Residences with LHA exceedences are provided alternate drinking water or treatment system**
  - Includes municipal production wells in some cases
- **<u>Huge uncertainty between source and receptor wells</u>**

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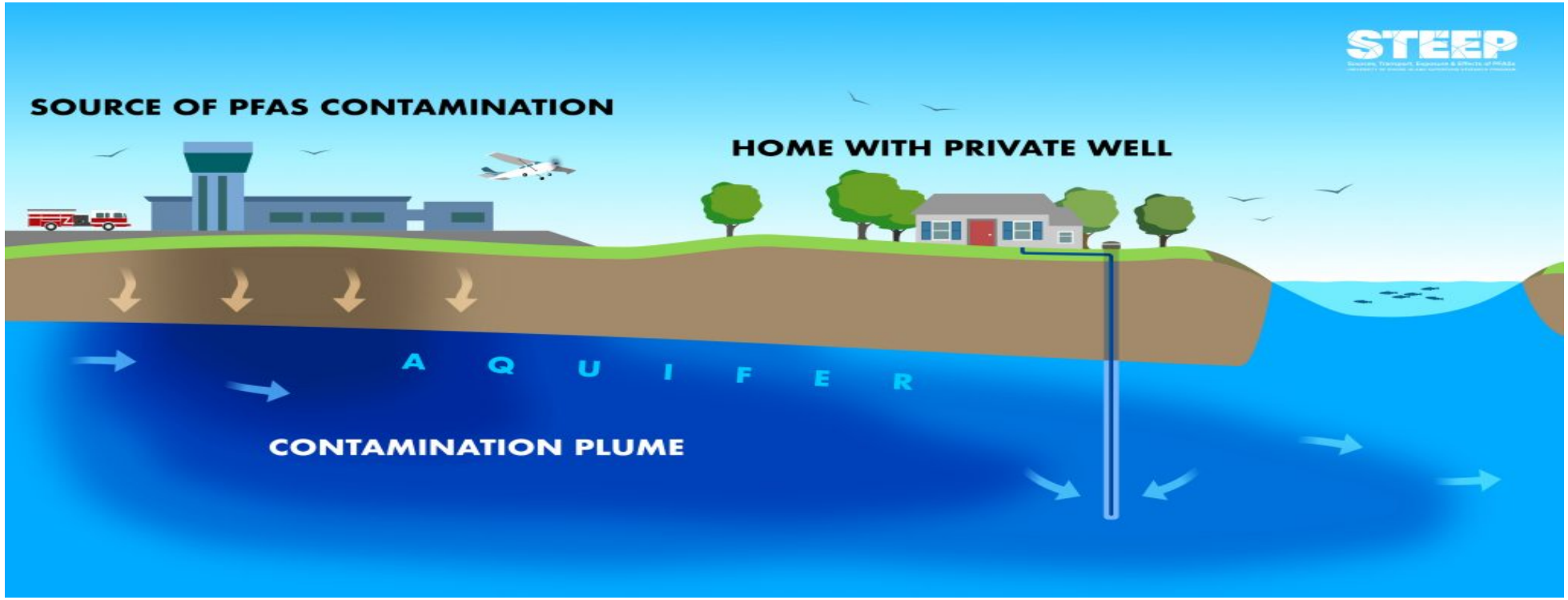
Off-Base Drinking Water

- **Presumed conceptual site model**



https://web.uri.edu/steep/communities/cape-cod/

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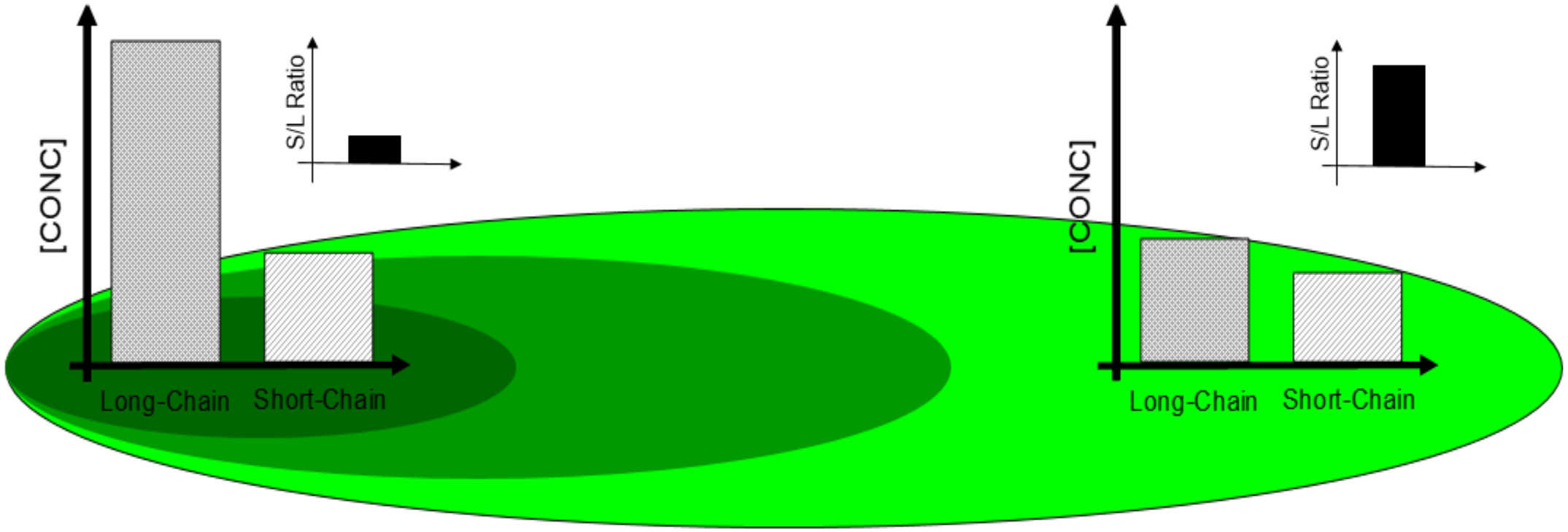
Off-Base Drinking Water

- **Downgradient fractionation should be evident and depends on relative mobility and source-zone concentration**



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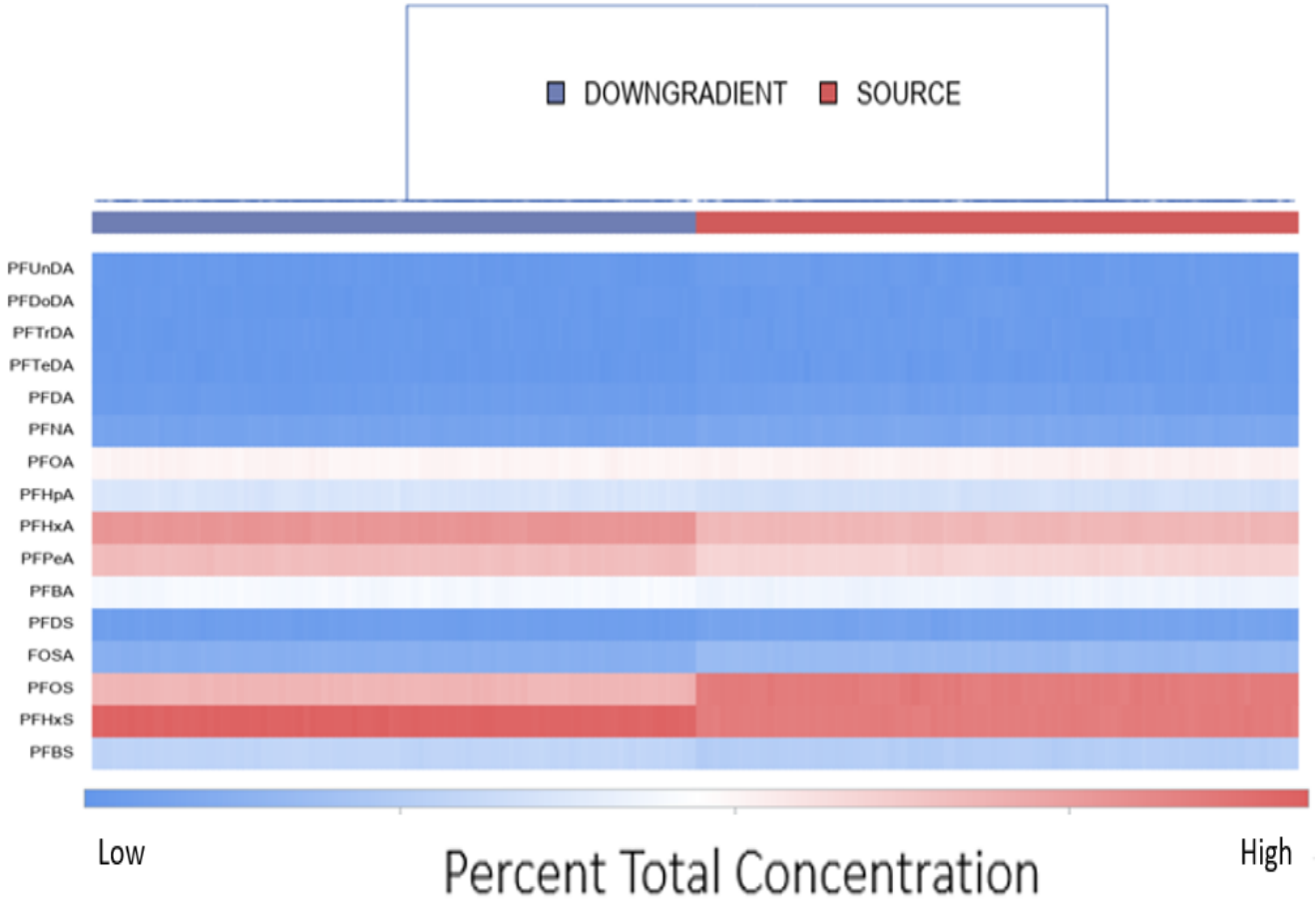
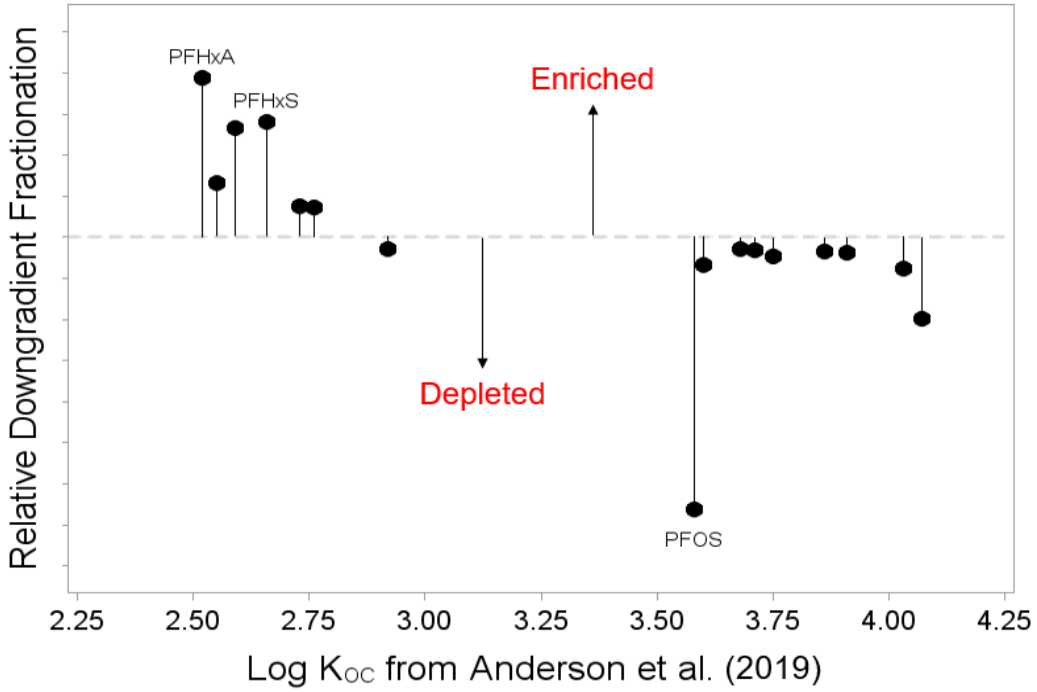
Idealized 1D Simulation of Downgradient Fractionation





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Case Study: Former Wurtsmith AFB

Date: 3/6/2019

Imagery Date: 2010

Base Boundary

Former Wurtsmith Air Force Base

Oscoda, Michigan

Reference: Department of The Air Force, Directorate of Engineering & Services, Washington D.C., Strategic Air Command Comprehensive Plan, Base Layout, Small Scale, Wurtsmith Air Force Base, Oscoda, Micigan, FT. Dates 7-Nov-87, Dates 30-Aug-89, Base Comprehensive PLNG Directive AFR 86-4, Updated 1 May 91.

MDEQ-RRD-SUPERFUND
Geology and Defense
Site Management Unit

1,500 750 0 1,500 3,000 4,500 6,000 Feet

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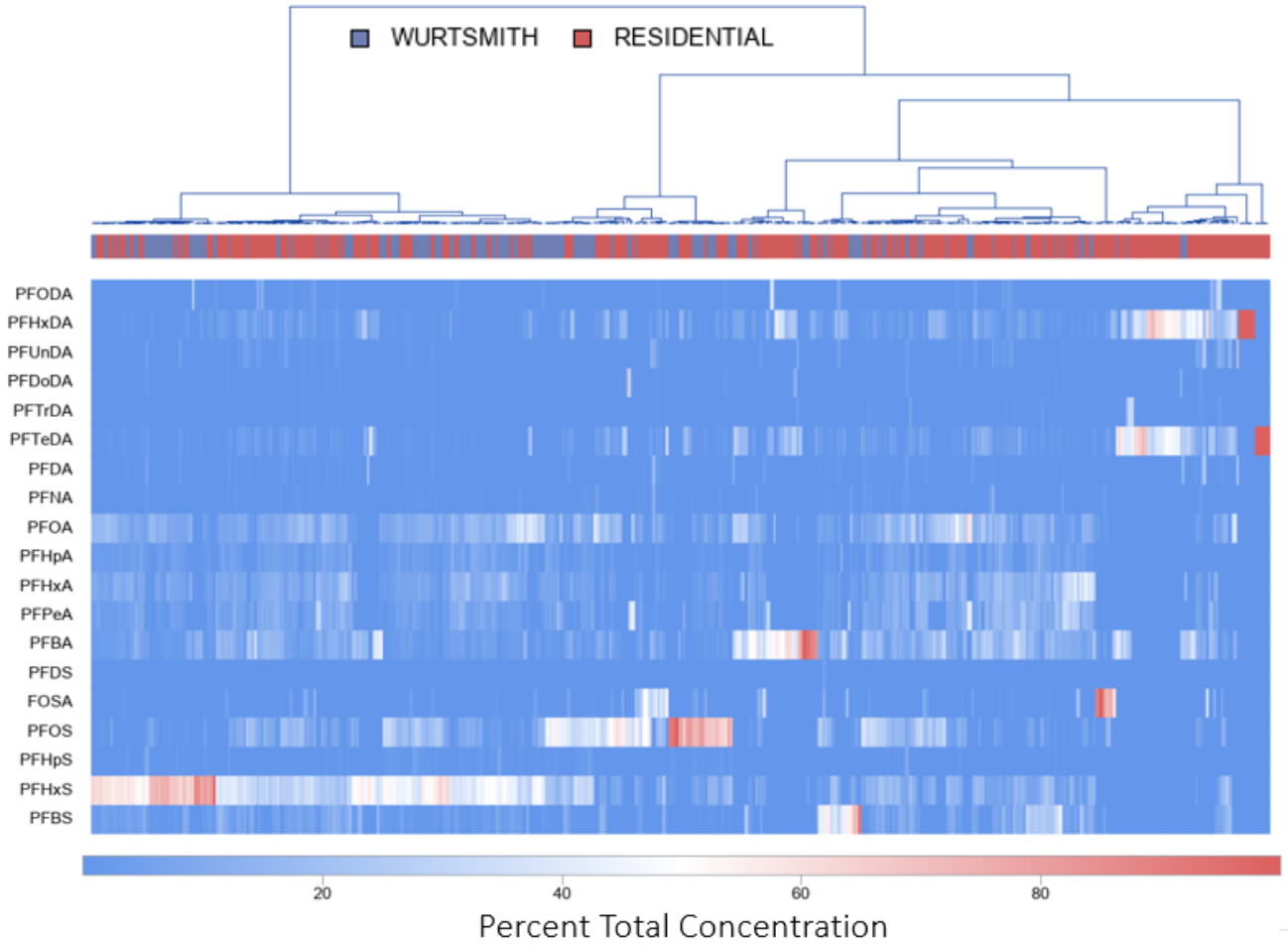
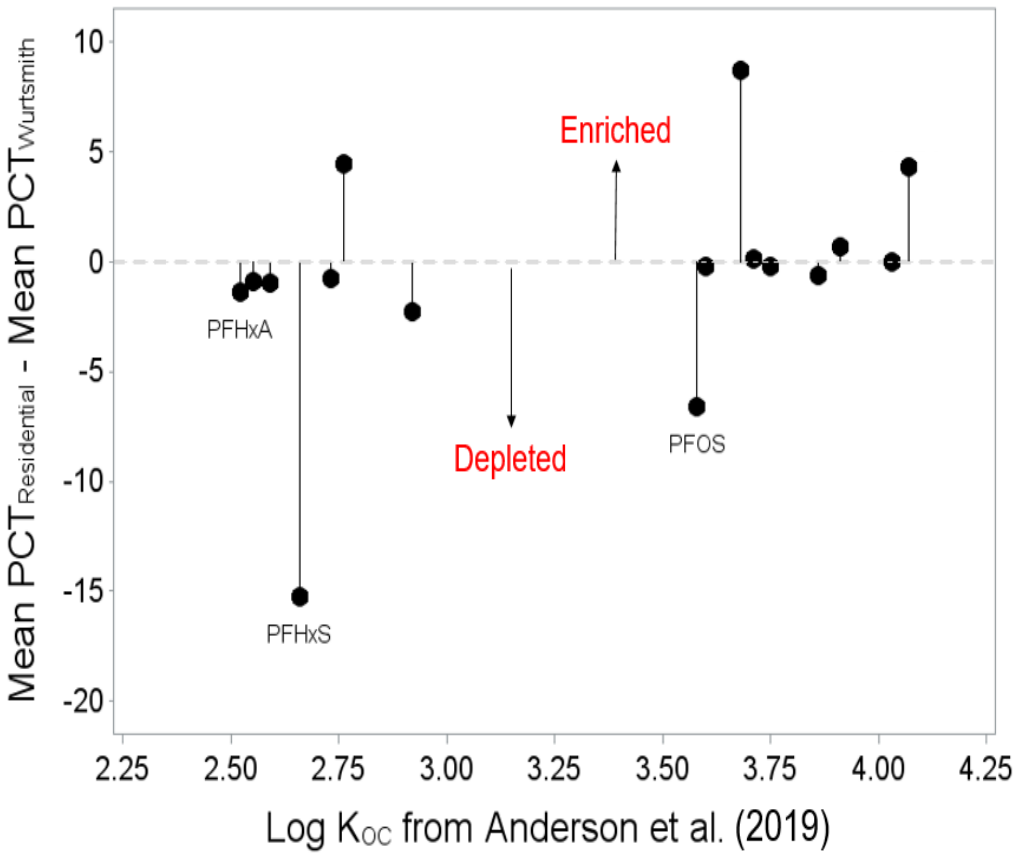
Former Wurtsmith AFB: All Data





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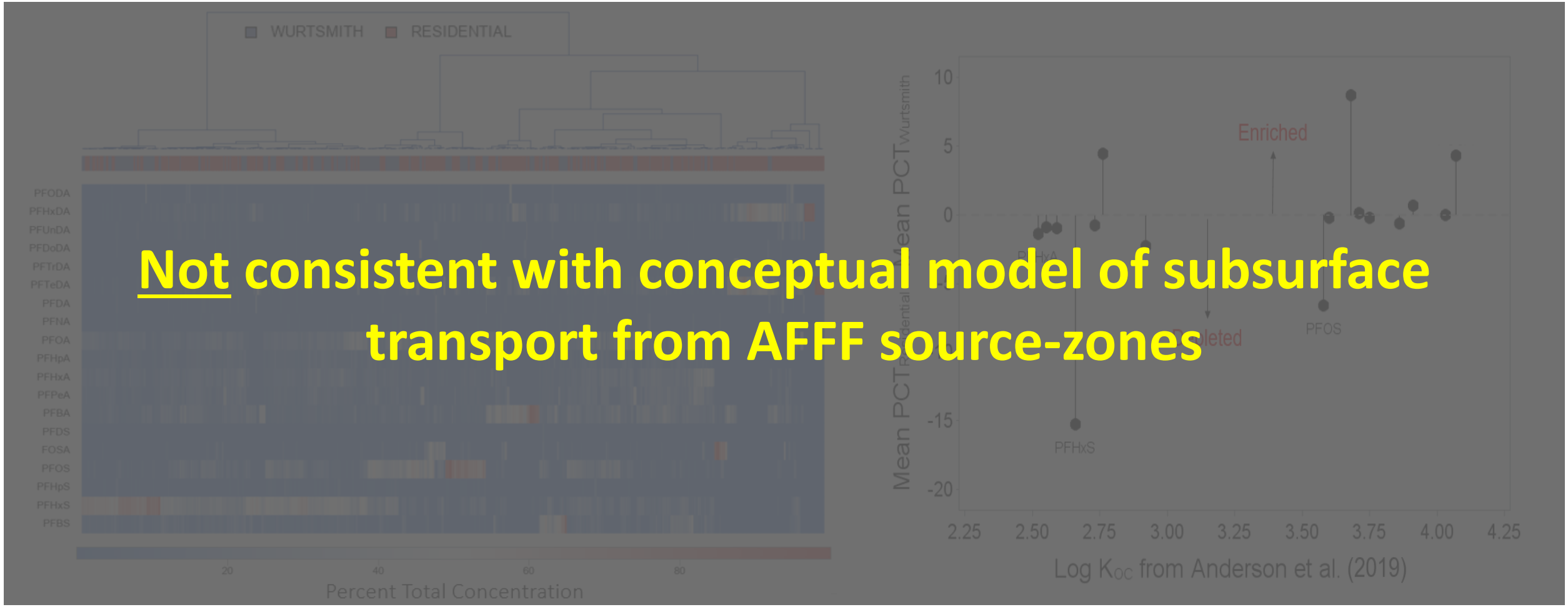

Not consistent with conceptual model of subsurface transport from AFFF source-zones

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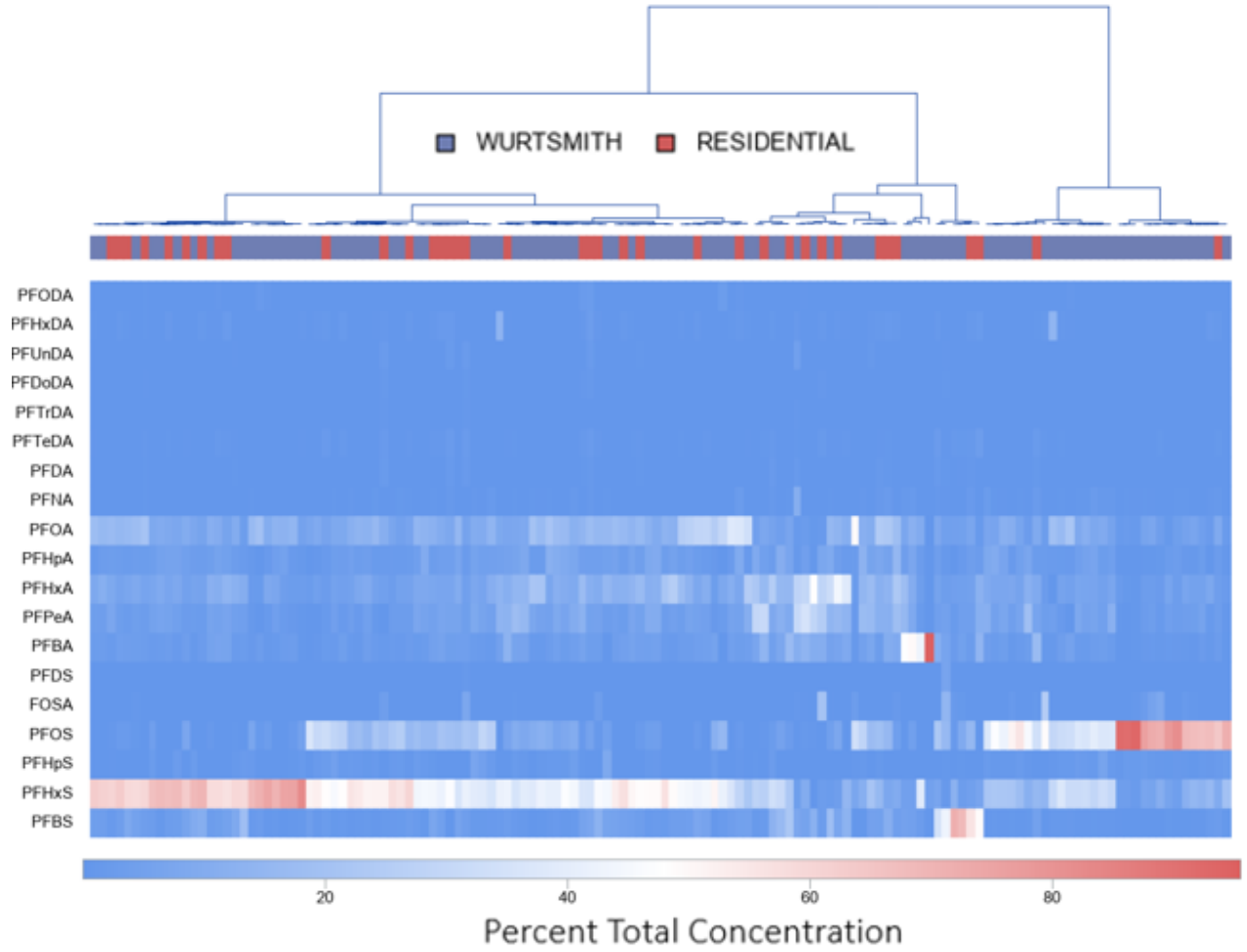
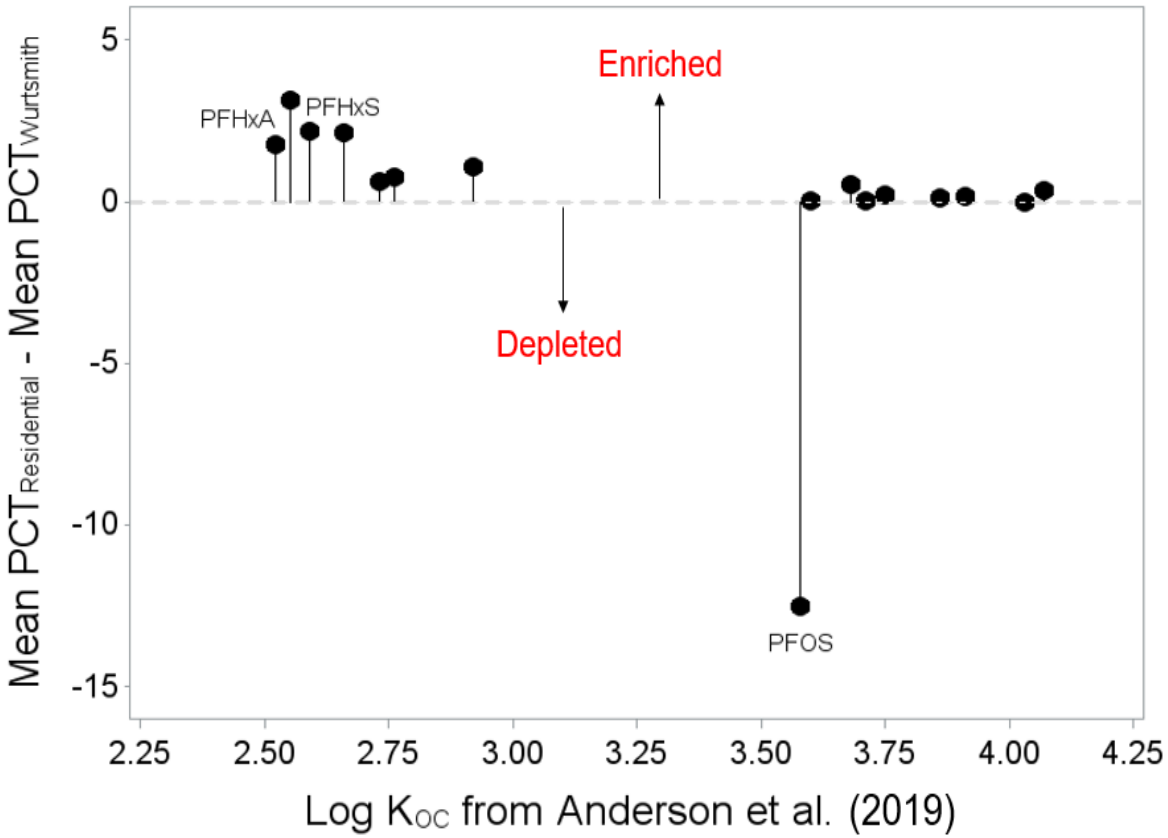
Former Wurtsmith AFB: ∑PFAS > 70 ng l^{-1}





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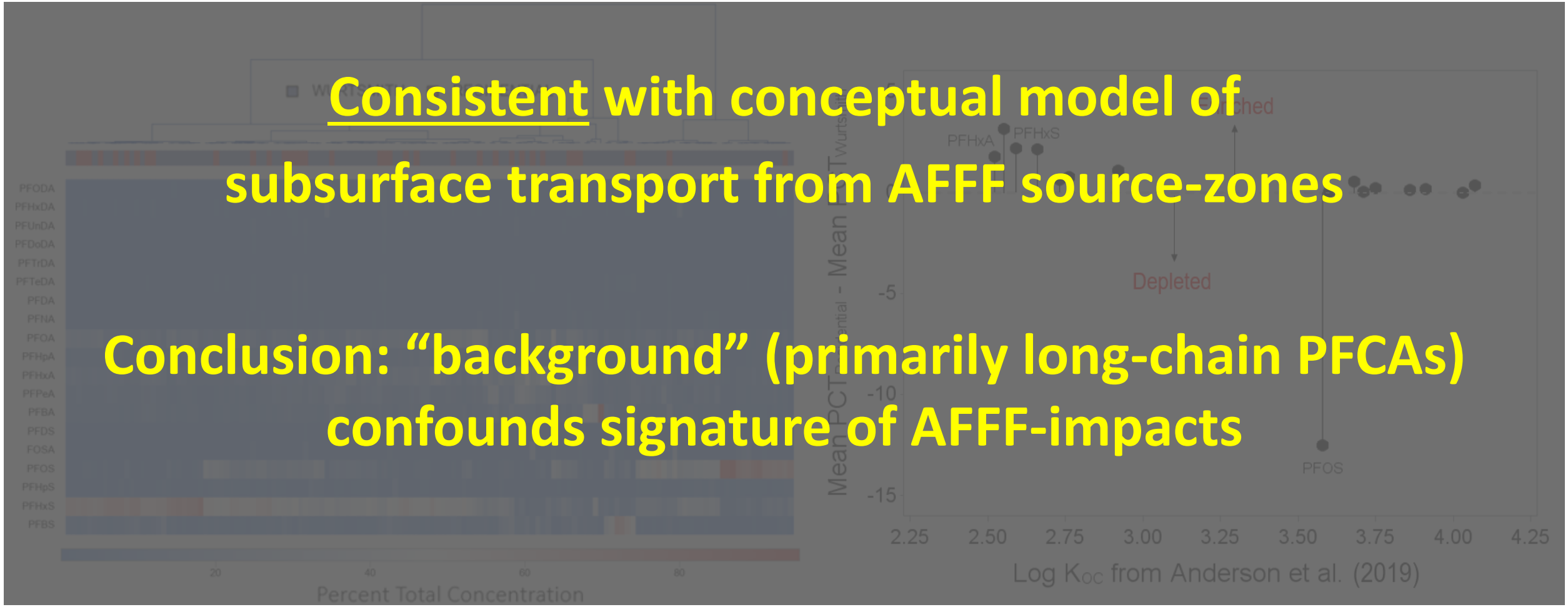

Consistent with conceptual model of subsurface transport from AFFF source-zones

Conclusion: "background" (primarily long-chain PFCAs) confounds signature of AFFF-impacts

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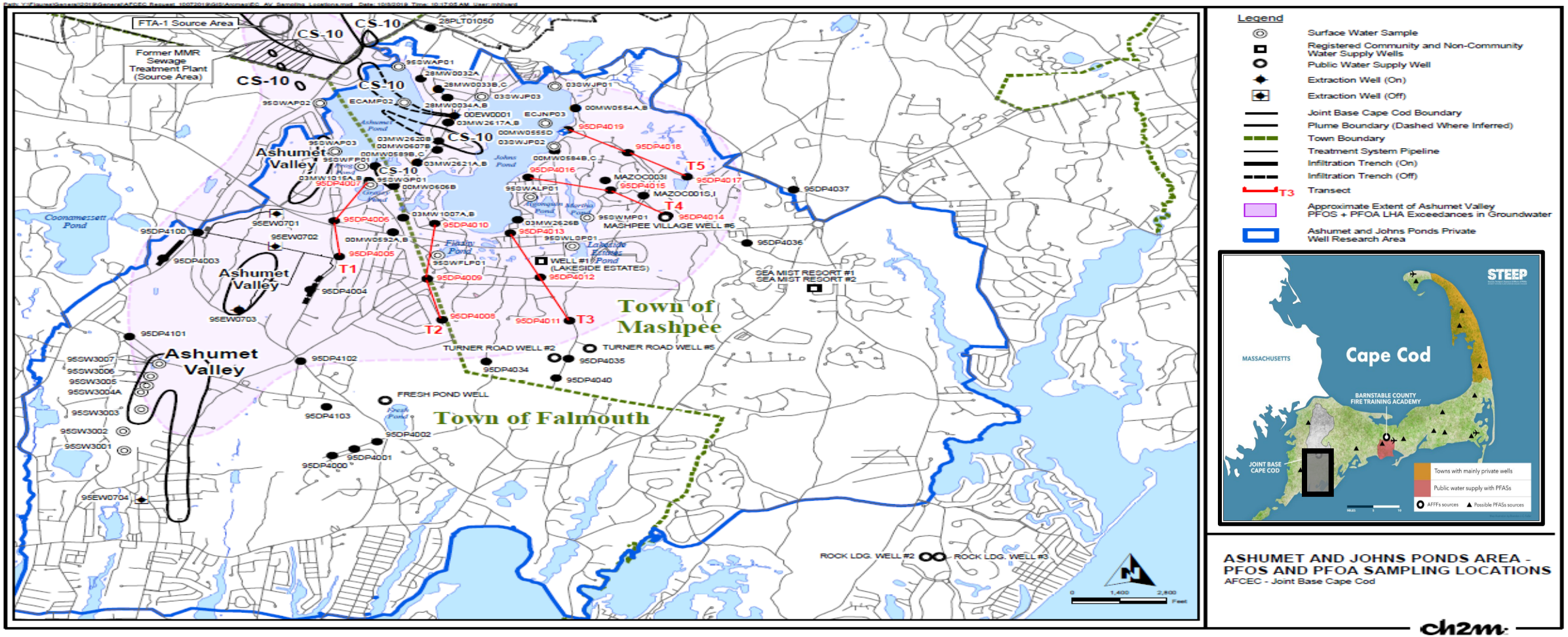
Case Study: Joint Base Cape Cod



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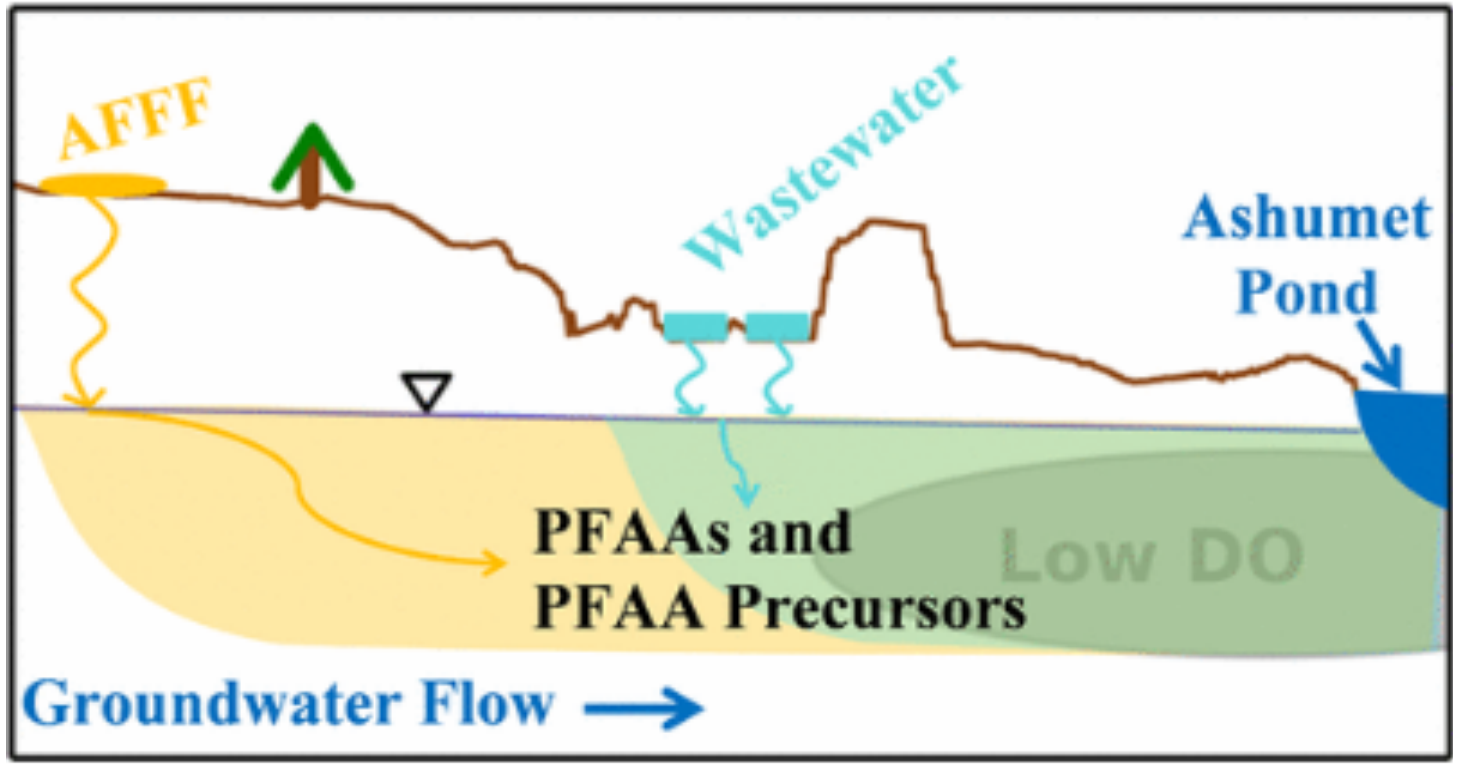
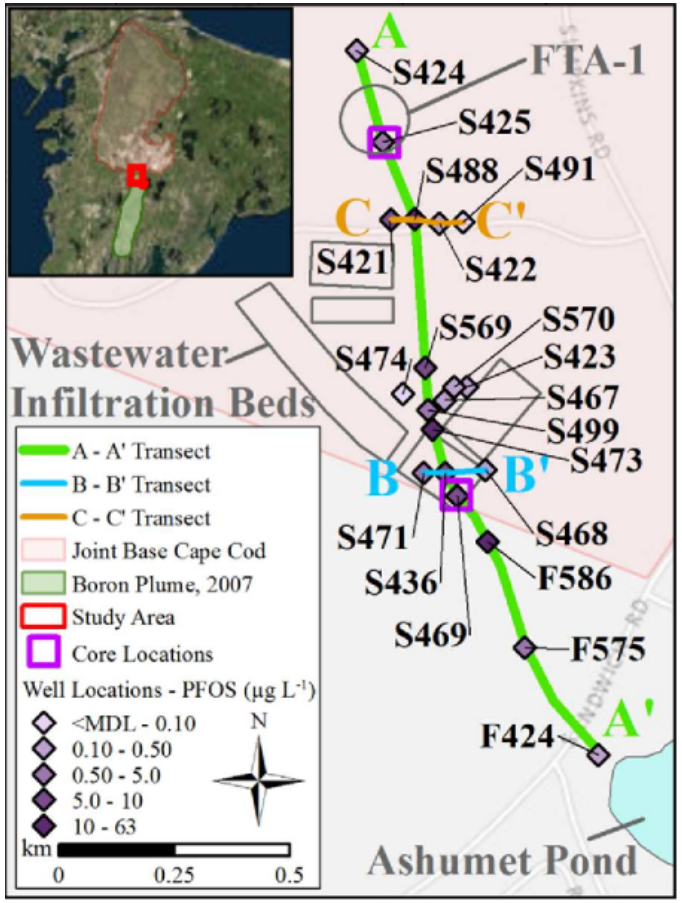
Joint Base Cape Cod: A Positive Control

- Weber et al. 2017. ES&T





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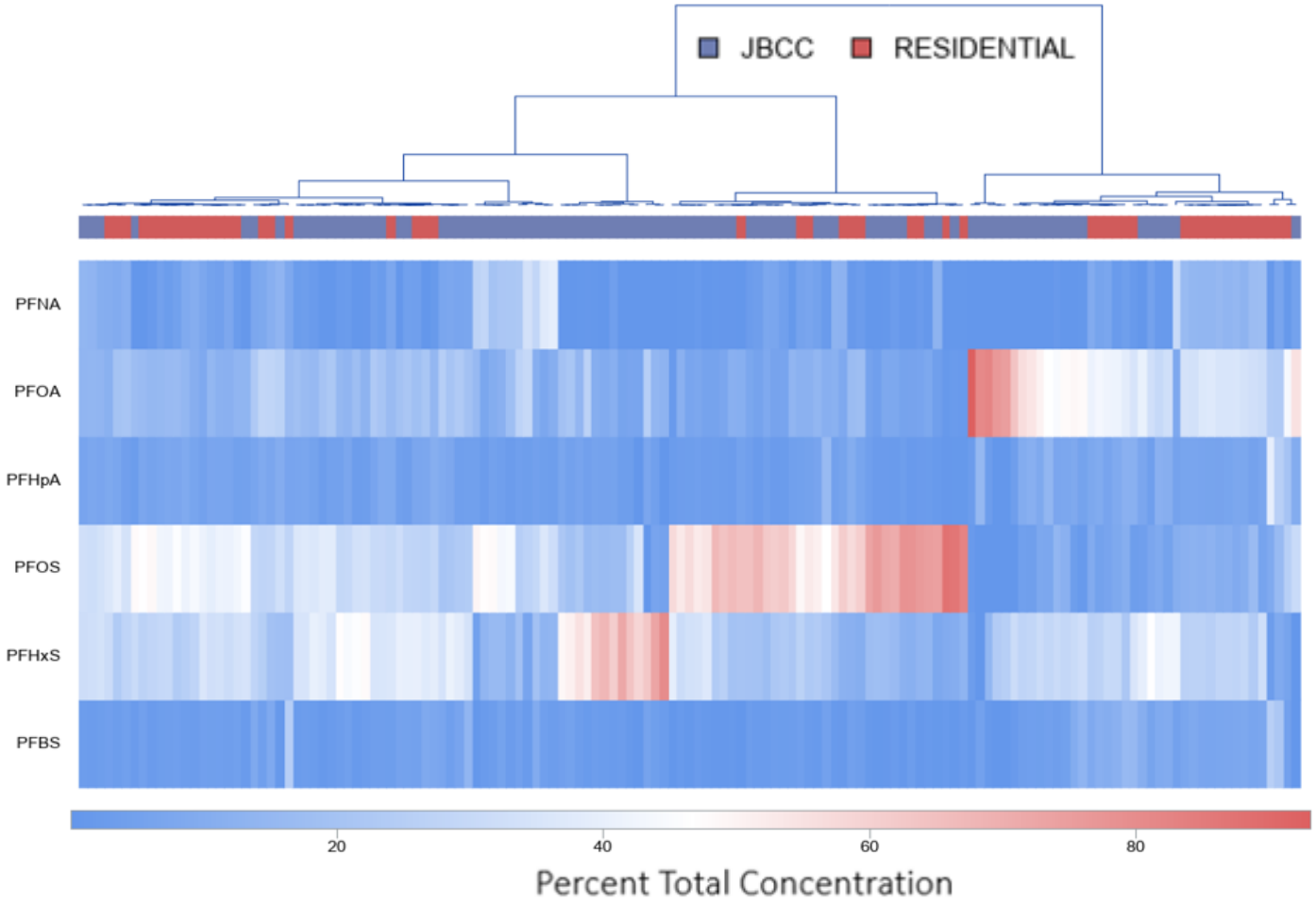
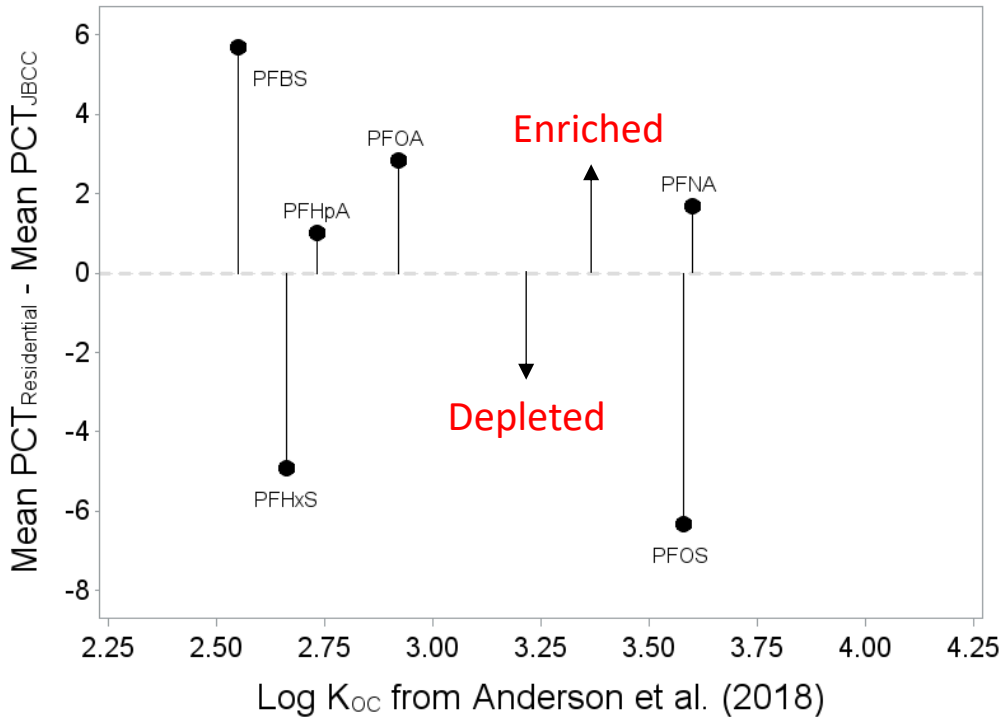
Joint Base Cape Cod: ∑PFAS > 70 ng l^{-1}





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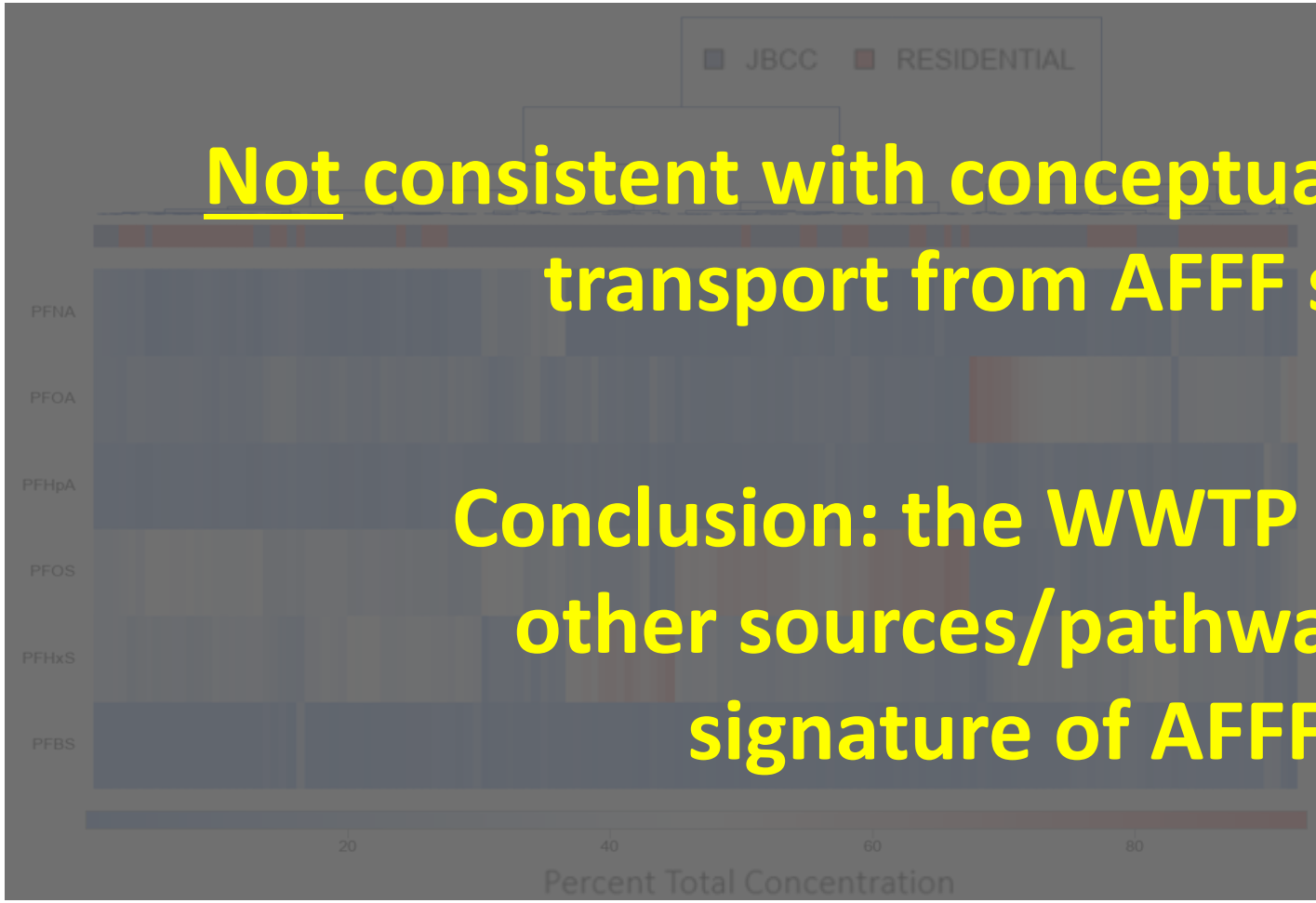

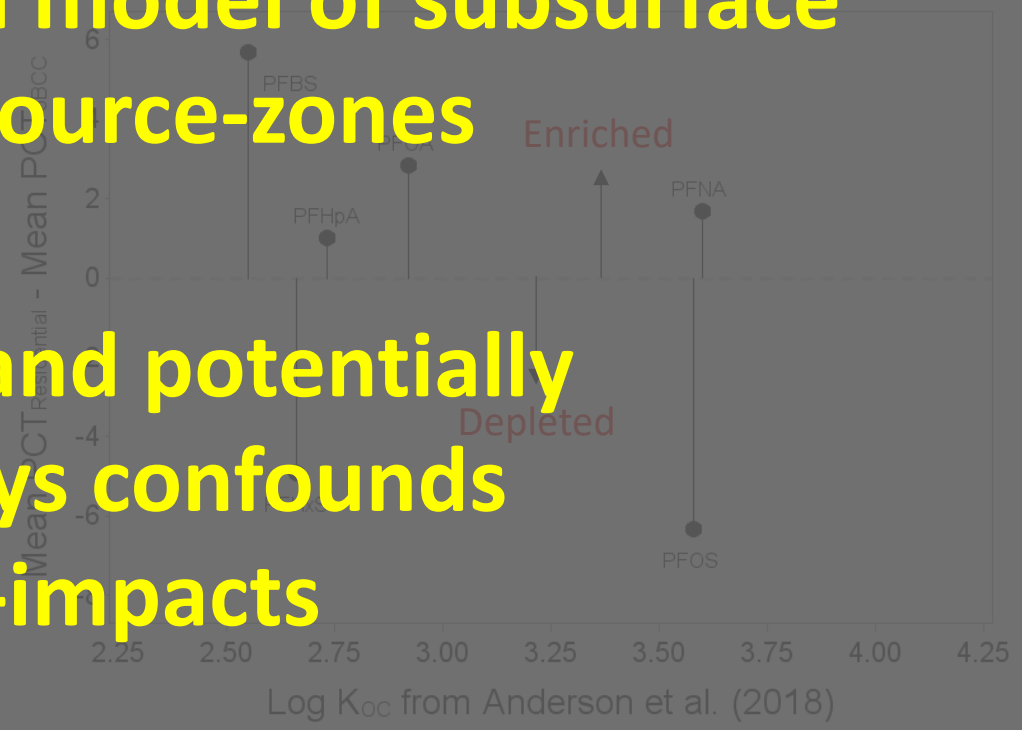

Not consistent with conceptual model of subsurface transport from AFFF source-zones

Conclusion: the WWTP and potentially other sources/pathways confounds signature of AFFF-impacts

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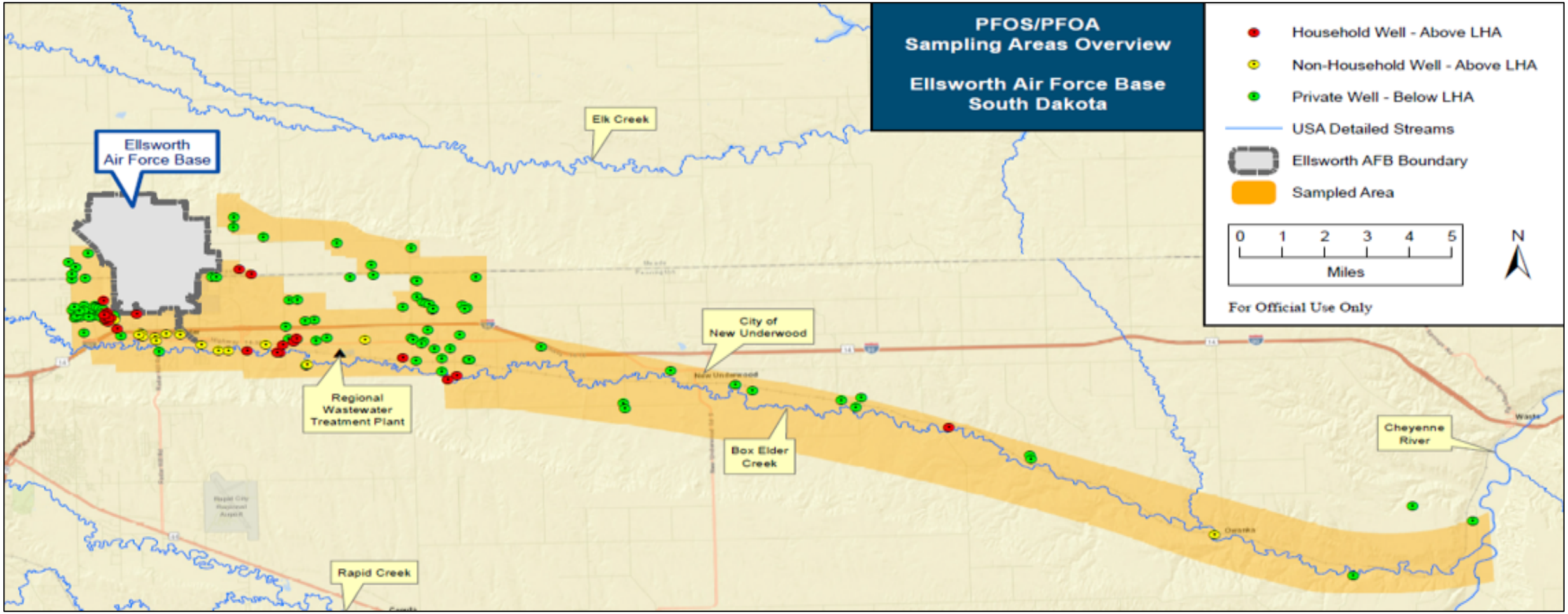
Case Study: Ellsworth AFB



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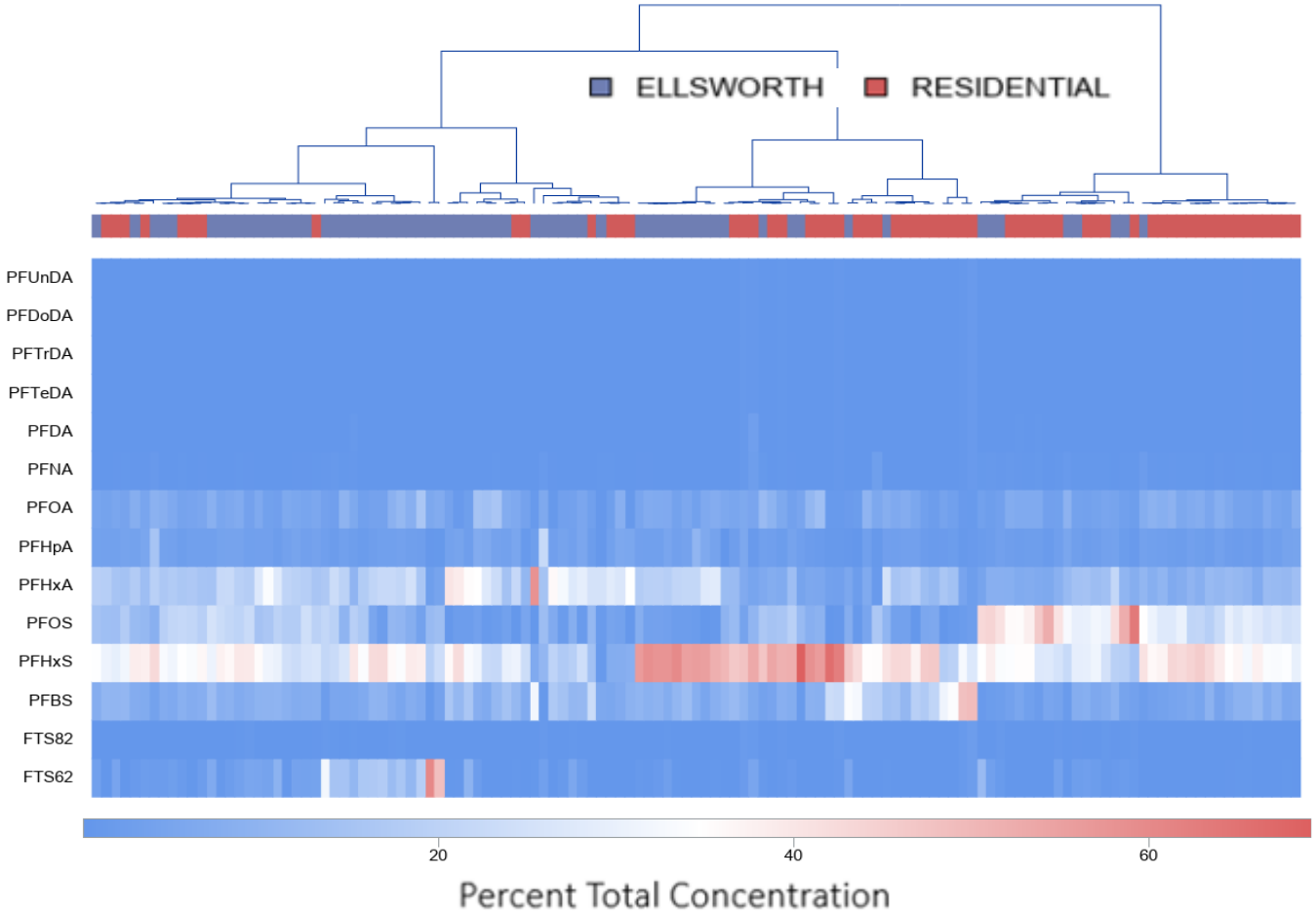

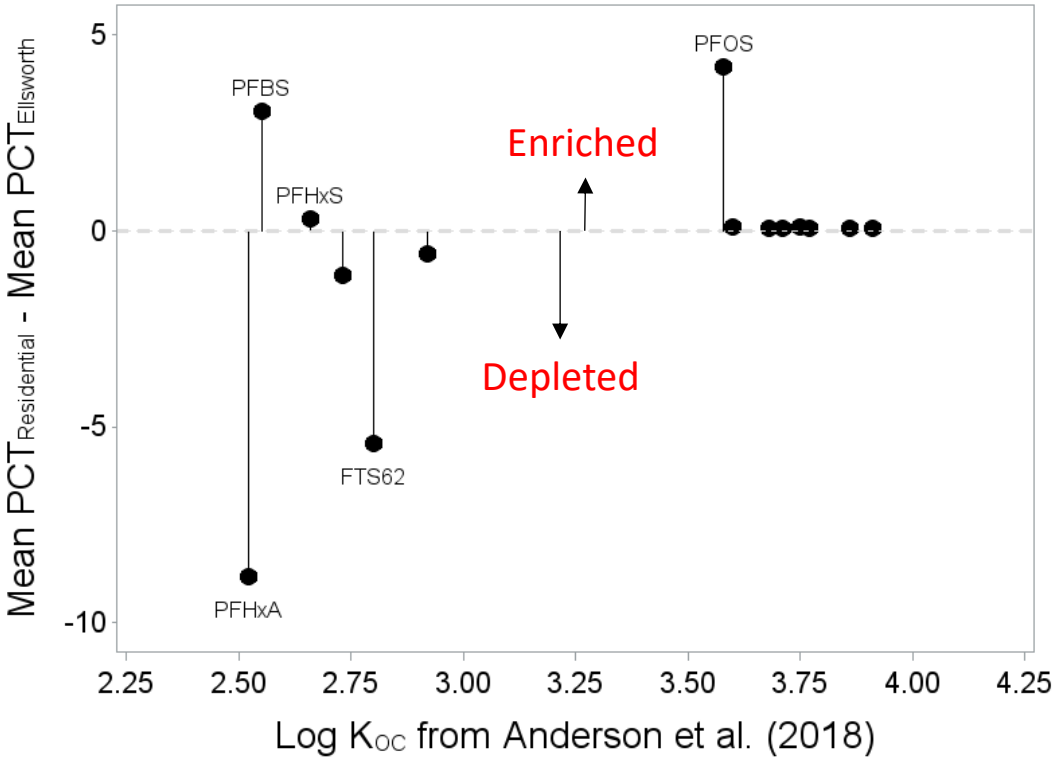

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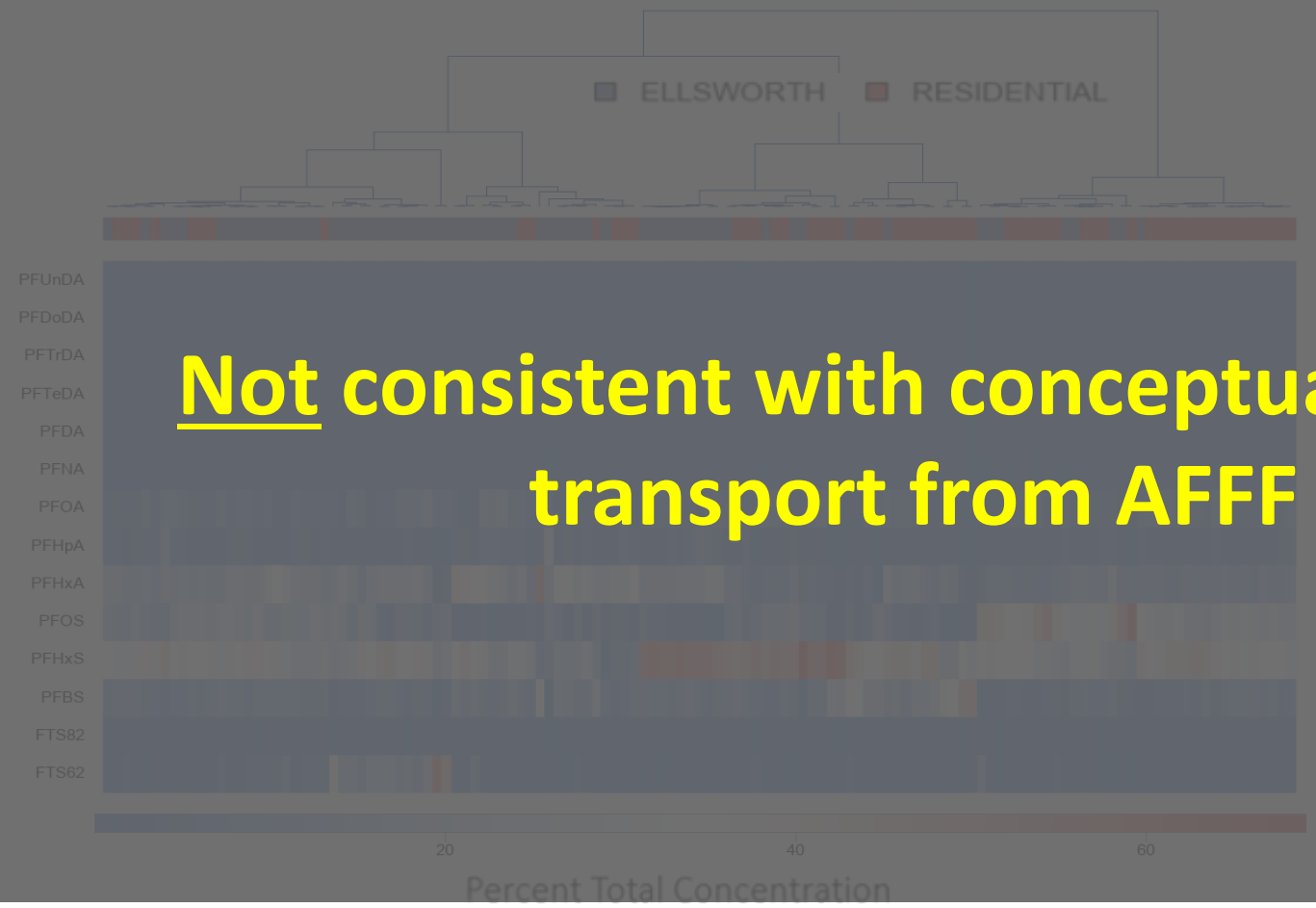

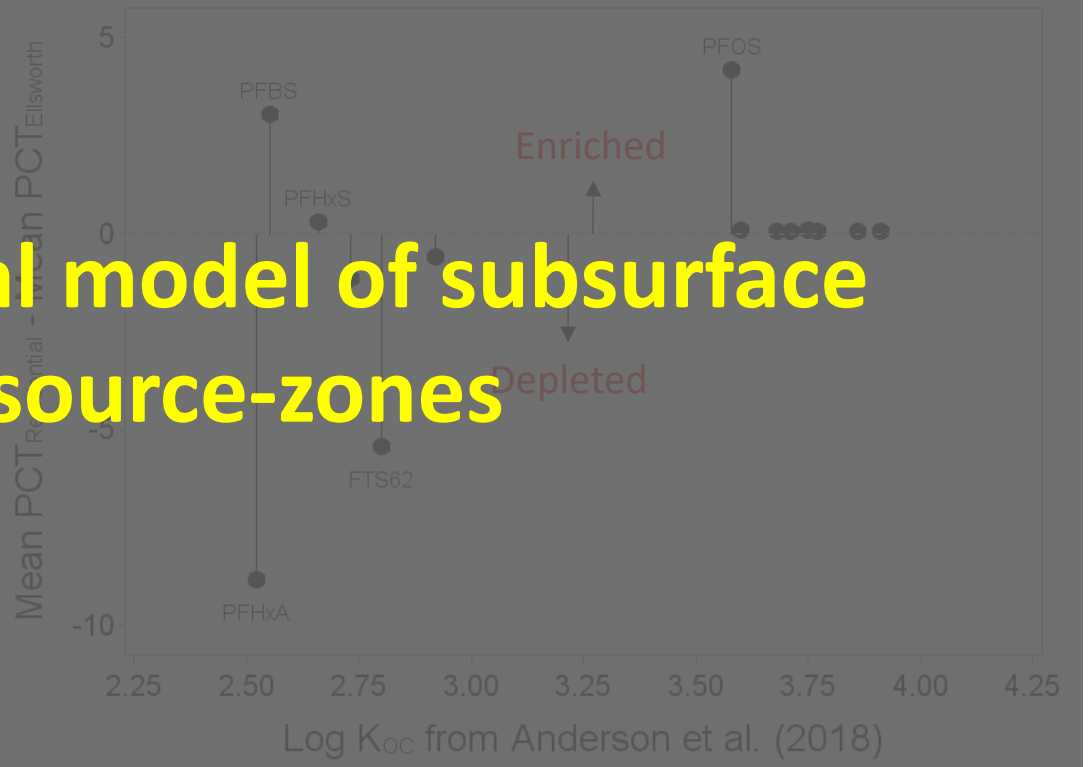

Not consistent with conceptual model of subsurface transport from AFFF source-zones

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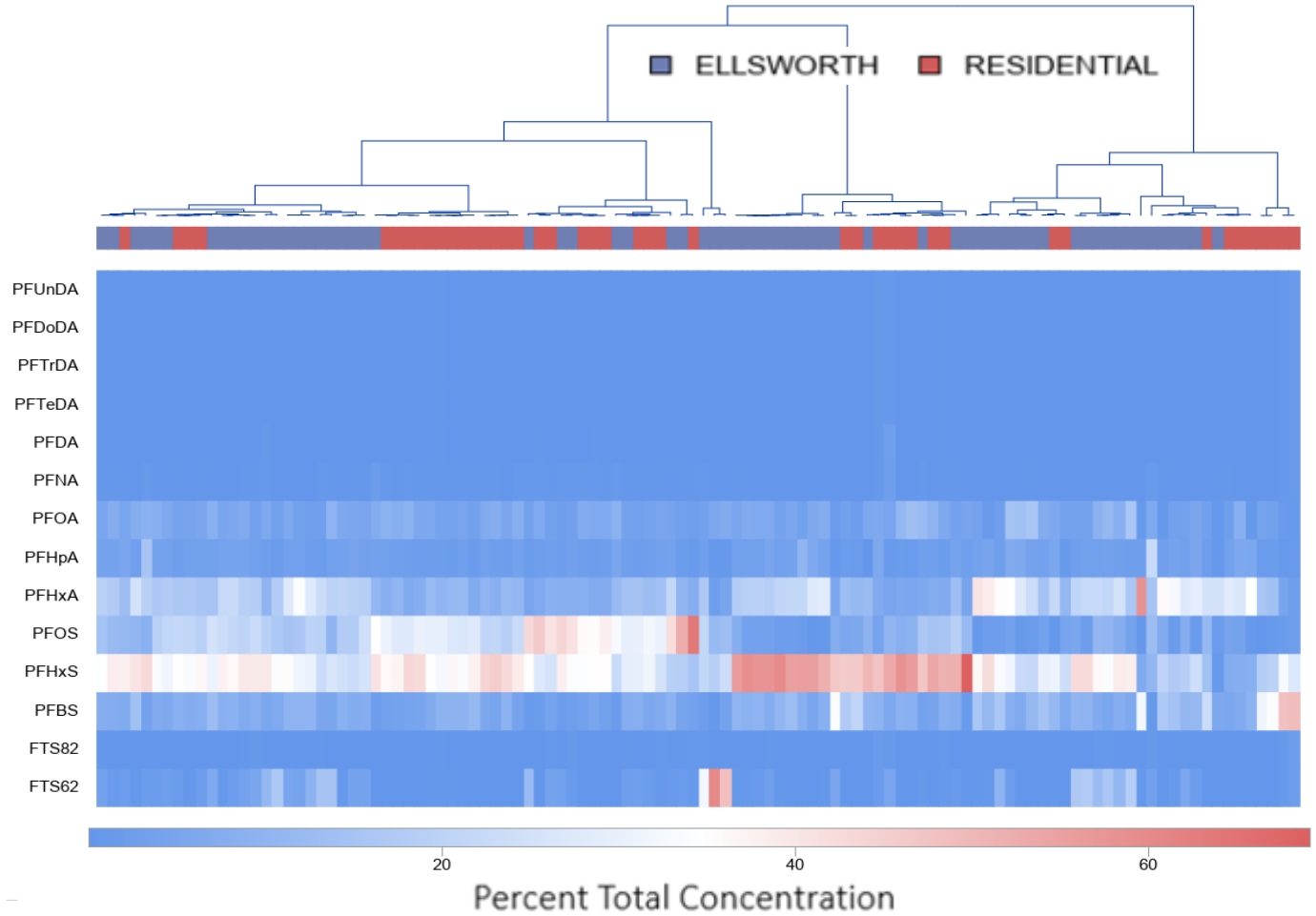
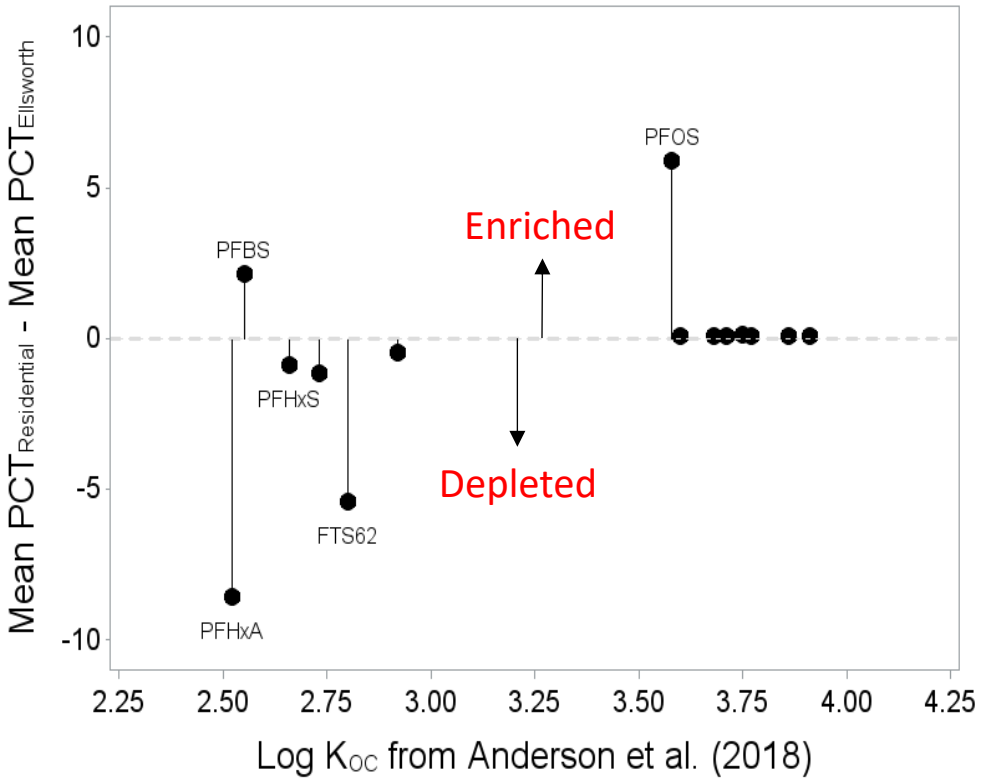
Ellsworth AFB: Upgradient of Off-Base WWTP





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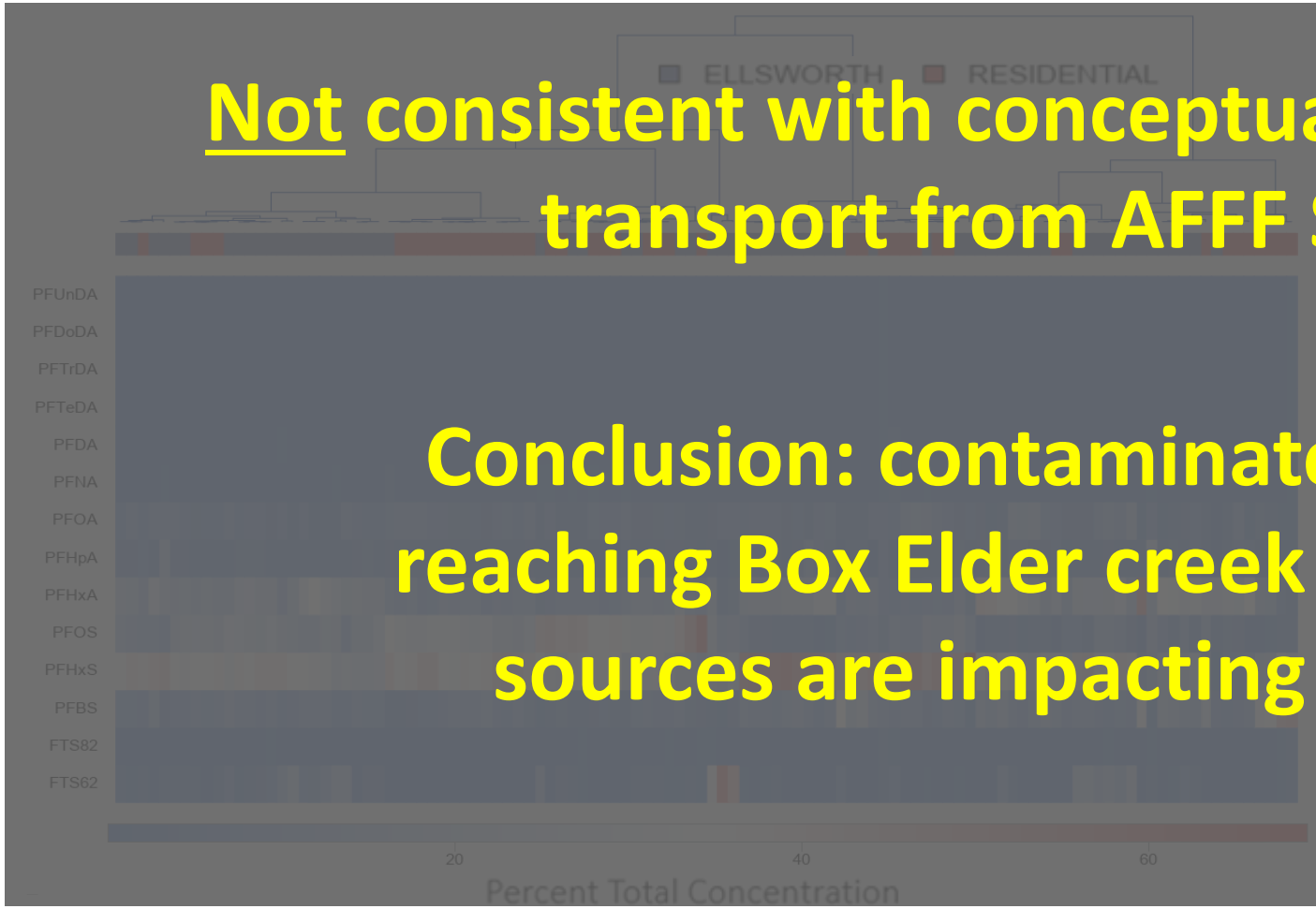
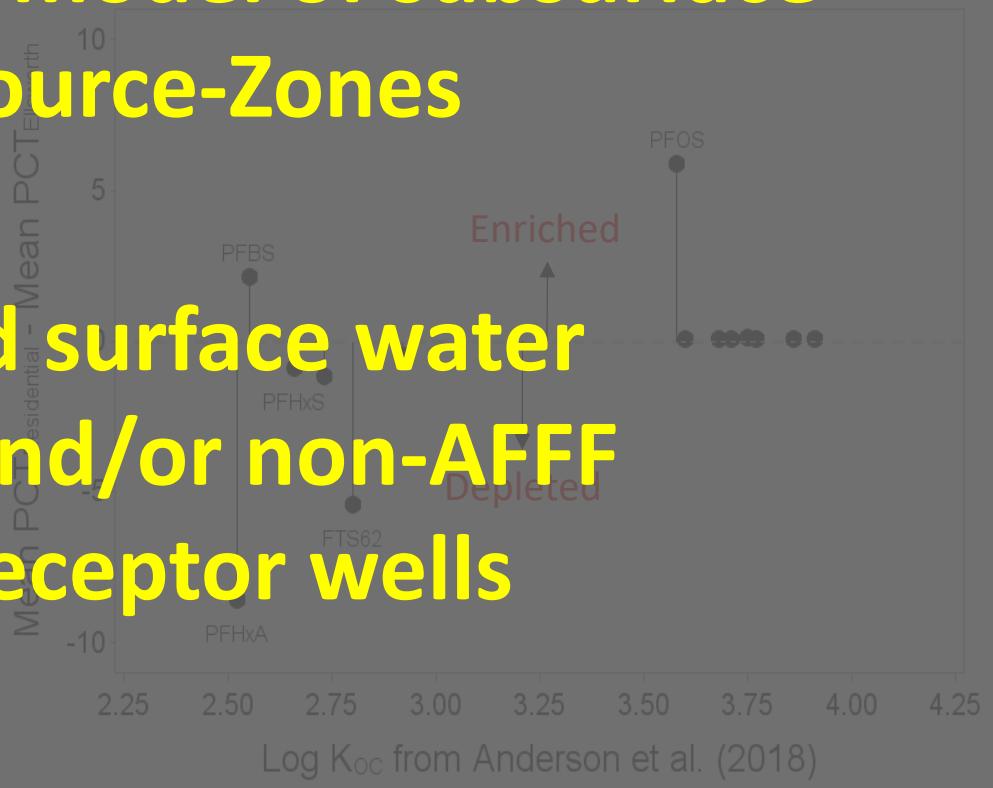
Ellsworth AFB:
Upgradient of Off-Base WWTP





Not consistent with conceptual model of subsurface transport from AFFF Source-Zones

Conclusion: contaminated surface water reaching Box Elder creek and/or non-AFFF sources are impacting receptor wells

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Take Home Conclusions

- **AFCEC currently focused on drinking water exposures in ESI Phase**
  - Off-base potable wells are sampled based on limited information
    - Screening-level transport models could provide some defensibility
    - Cost-effective and sustainable treatment options needed for rapid mitigation
  - Case studies suggest other sources/pathways are highly relevant
    - Forensic methods/tools for definitive source apportionment needed
    - Observed groundwater/surface water interactions emphasize potential for ecological exposures
- **Vadose zone retention at source-zones is significant**
  - PFSAs are universally present
  - Methods for assessing source-strength needed
- **Full-scale RIs will begin within next couple years**
  - Optimized delineation methods needed
  - Risk assessment framework needs worked out ASAP!