Poly-and Perfluoroalkyl Substances: What, When, and Why to Analyze and Remediate – Challenges Encountered from >100 Projects

Erik Ribeli
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Background - Nomenclature

- **Poly-and Perfluoroalkyl Substances (PFASs)** – includes thousands of completely and incompletely fluorinated compounds

- **Perfluorinated Compounds (PFCs)** – Subset of PFASs - completely fluorinated compounds (e.g. PFOS/PFOA - no hydrogen atoms)

- **Perfluoroalkyl Acids (PFAAs)** – Subset of PFCs including PFOA and PFOS

- **Aqueous Film Forming Foam (AFFF)** – foams used to fight Class B Hydrocarbon fires and containing PFASs

- **C-F Bond strongest there is!**
Background – PFASs

PFASs – What, When and Why?
Background - Manufacturing and Uses

– Synthetic chemicals used in manufacturing fluoro-polymers
  • PFOA – perfluorooctanoic acid and it’s principle salts
  • PFOS – perfluorooctane sulfonate

– Typically only a fraction of final product/not an end product

– Used in making surface treatments
  • Non-stick cookware (Teflon®)
  • Breathable, all weather clothing (Gore-tex®)
  • Fluoro-elastomers (gaskets, O-rings, Hoses)
  • Paper and packaging protectors

– Used in making performance chemicals
  • Aqueous Film Forming Foam (AFFF) used for fire fighting
  • Mining and oil surfactants
  • Metal plating baths (chromium)
  • Insecticides
AECOM Portfolio of PFAS Project Sites

Formal evaluation on 85 sites, portfolio now >150
AECOM Portfolio - Site List/Dataset

- Sites are principally AFFF related but also involve:
  - Landfills
  - Plating operations
  - PFAS manufacturing facilities
  - Biosolids application
- Project size, complexity, and degree of characterization vary significantly
  - Largest site involved collection of >14,000 samples and sampling along 58 mile segment of a major river
- Sampling has included:
  - Groundwater, surface water, soil, sediment, air
  - Human and Livestock blood serum
  - Crops/Produce
  - Fish tissue
  - Site infrastructure/facilities (e.g. concrete, piping, etc.)
  - Method development/validation for new media
PFAS Site Evaluation – Life Cycle Stages for 85 Sites

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<th>Project Activities (# of Sites)</th>
<th>Investigation</th>
<th>Remedial Design</th>
<th>Risk Assessment</th>
<th>Remediation</th>
<th>Feasibility Study</th>
<th>Management planning</th>
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PFASs – What, When and Why?
What PFASs to Analyze?– Sources influence the List!

– PFASs widely used in manufacturing
  • Biosolids land application
  • Municipal & Industrial WWTP discharges to surface water

– AFFF – Aqueous Film Forming Foam
  • DOD Sites
  • Refineries
  • Large Rail Yards
  • Chem/Pharma Facilities
  • Commercial and some private airports
  • Landfills
  • Fire Stations
  • Municipal Fire Training Areas
  • Plating Facilities
What PFASs to Analyze?

- PFOA and/or PFOS Only
- U.S. EPA UCMR-3 List six PFASs only
- Livsmedelsverket Sum of PFAS-11
  - PFBS, PFHxS, PFOS, PFPeA, PFHxA, PFHpA and PFOA + 6:2 FTS, PFBA, PFNA, PFDA
- Full commercial lab suite in U.S. (12 to 23 compounds)
- Expanded University lab suite (90 up to 200 compounds)
- All compounds associated with AFFF – impossible!
- Special care must be given to potential introduction of PFASs during sampling
When and Why to analyze PFASs?

– When screening level criteria are available?
– When remediation cleanup standards are available?
– When impacts to human health receptors are suspected? Confirmed?
– When impacts to ecological receptors are suspected? Confirmed?
– When there are litigation risks?
– When there are public relations or perception risks?
– Extraordinary analytes may be warranted!
What? To do with Data - Quality/Sampling Lessons Learned

– When Toxicity data is not available
  • Exposure is ubiquitous but are PFCs really that toxic?
  • How do we differentiate from background?
  • What are we trying to protect?

– Data Quality Issues
  • Results vary significantly lab to lab
  • Blanks and QA/QC samples very important
  • Avoid cross contamination, false positives, sources may include:
    – Water proof field notebooks
    – Teflon® bottle liner, pump o-rings, bailers or wells
    – Decon 90 decon solution, possibly others
    – Fast food wrappers
    – Tyvek® suits
    – New/water resistant clothing
    – Fabric protection on auto seats
    – Many others
What PFASs to Remediate? And Treat?

– Regulated compounds only
– All detected compounds
– What about drinking water detections
  • Managing community outrage
  • What about other sources
– What about treatment of discharges?
  • To sewer
    • Biosolids liabilities
  • To surface water
    • Unanalyzed and untreated PFASs may still result in long term impacts (e.g. short chain compounds untreated by GAC)
  • Beneficial reuse
    • Spray Irrigation
    • Biosolids application
    • New groundwater plumes created, uptake by crops
When and Why to remediate and treat PFASs?

– When screening level criteria are available?
– When remediation cleanup standards are available?
– When impacts to human health receptors are suspected? Confirmed?
– When impacts to ecological receptors are suspected? Confirmed?
– When there are litigation risks?
– When there are public relations or perception risks?

– Extraordinary remediation/treatment may be warranted!
When and Why? - Is it too early for PFAS remediation?

- PFOA and PFOS are not just parent compounds
- We don’t know how much we don’t know
- No long-term data to verify plume behavior over time
- Only energy-intensive or cost prohibitive ex-situ technologies proven effective
- Criteria for treatment performance
- Assumptions/Contingency
- There is no right or wrong answer!
Challenges

– PFASs highly soluble, mobile, don’t attenuate, bioaccumulate

– Large potential analyte list, analytical limitations, lacking tox and regulatory thresholds

– Many sources, background impacts, potential introduction during sampling

– Limited but extremely low water action values

– Migration pathways via surface water, groundwater, sewers, and drainage systems

– Limited commercially available Treatment options, ex situ water treatment likely
Challenges - Redefining our View of Large Dilute Plumes

PFASs – What, When and Why?
Lessons Learned

• Primary sources include AFFF, plating facilities, and landfills

• Sources influence analyte list, discuss and evaluate extensively before conducting any sampling – know how you will react to data!

• Significant potential for background contamination, other sources, and introduction of PFASs during sampling – follow rigorous sampling protocols with extraordinary QA/QC

• THINK BIG in terms of potential impacted areas and receptors - very soluble, recalcitrant and persistent PFASs = VERY LARGE plumes

• Extraordinary analysis and remediation may be warranted!

• There is no right answer to What? When? Why?, many different site specific factors should influence actions.

• PFASs appear to be unlike anything we’ve dealt with before and represent a significant challenge to us all.
Thank You

erik.ribeli@aecom.com

Co-authors:
Rachael Casson - rachael.casson@aecom.com
Dave Woodward - dave.woodward@aecom.com