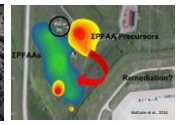


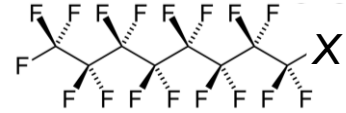


Groundwater and PFAS:
State of Knowledge and Practice
NGWA Press 2017

Seth Kellogg, PG

What Are PFAS?

PFAS: perfluoroalkyl and polyfluoroalkyl substances

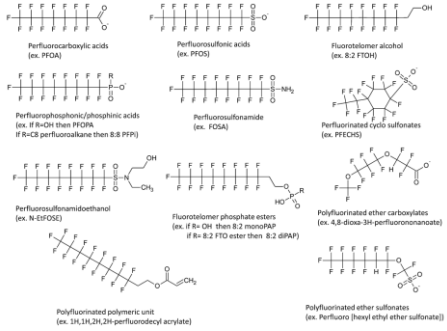


- Strong, stable C-F bonds
- Hydrophobic (water-hating) AND lipophobic (oil-hating)
- Relatively low volatility and high solubility
- Mobile in the environment
- Shorter chains resistant to degradation
- Some highly toxic
- No natural environmental source

2

Buck et al., 2011

Thousands of PFAS compounds exist



3

Lindstrom et. al., 2011

Perfluorinated compounds (PFC)

- PFOS – Perfluorooctane sulfonate
- PFOA – Perfluorooctanoic acid
- PFNA – Perfluorononanoic acid
- PFHxS – Perfluorohexanesulfonic acid
- PFHpA – Perfluoroheptonic acid
- PFBS – Perfluorobutanesulfonic acid

PFOS

PFOA

4

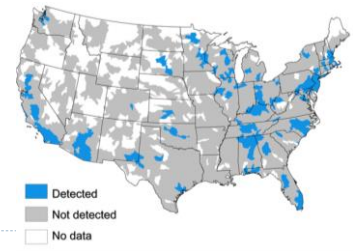
Historical usage of PFAS

- Commercial and consumer since the 1950s.
- Used in products that:
  - Resist heat
  - Resist stains
  - Resist grease
  - Resist water
  - Reduce friction
  - Household and personal products
  - Aqueous Film Forming Foam (AFFF)

5

Why PFAS is an issue now?

- Unregulated Contaminant Monitoring Rule (UCMR) 3 (May 2, 2012) of Safe Drinking Water Act (SDWA)
- May 2016 EPA lifetime health advisory of 70 ppt for PFOS and PFOA



6

Document Purpose

- Produce a technically defensible guide for defining an appropriate path forward for a client, water resource or regulatory action
- Document the known science and knowledge related to PFAS compounds in groundwater and the subsurface
- Identify information that is currently in flux in terms of scientific consensus
- Identify gaps in knowledge

7

Document Outline

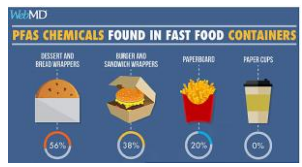
- Section 1: Overview
- Section 2: Abbreviations, Acronyms, Initialisms and Symbols
- Section 3: Human and Ecological Impacts
- Section 4: Fate and Transport
- Section 5: Field Sampling and Analysis
- Section 6: Legal and Regulatory Framework
- Section 7: Risk Communication
- Section 8: Remediation and Treatment

Each section designed to be stand-alone

8

Section 3: Human and Ecological Impacts

- Physical and chemical properties of PFAS
- Human exposure
  - Drinking water
  - Food chain
  - Contaminated soil
  - Ambient air and dust
  - PFAS containing products
  - Occupational exposures
- Ecological exposure
- Toxicokinetics



9

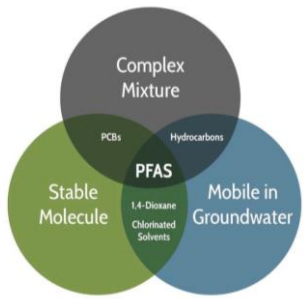
Section 3: Human and Ecological Impacts

- Toxicological effects of PFAS
  - Reproductive and developmental effects
  - Liver and lipoproteins
  - Immune system
  - Carcinogenicy
    - Human – Kidney, testicular
    - Rats – Liver, testicular and pancreatic
- Risk Assessment
  - Toxicity criteria and screening levels
  - Current screening levels for soil, drinking water, sediment, surface water and fish tissue

10

Section 4 Fate and Transport

- Environmental sources
- Mobility
- Mass balance
- Distribution in the subsurface
- Exposure points



11

Section 4: Fate and Transport

- Multiple potential sources
  - Aqueous film forming foam (AFFF)
  - Disposal/land application of municipal biosolids, effluent from WWTP and landfill leachate
  - Releases from commercial and industrial sources
- Detailed discussion of the unique chemistry of PFAS
  - Hydrophobic, lipophobic and surfactant properties
  - Persistence and stability in the environment
- Everything is site specific and chemical specific
  - Minerology
  - Organic carbon
  - Co-contaminants

12

Section 5: Field Sampling and Analysis

- Laboratory Analysis
  - Analytical methods
  - Field screening methods
  - QA/QC and data quality considerations
- Field Sampling Procedures
  - QA/QC and blanks
  - Sources of bias
    - Sampling materials
    - PPE/clothing
    - Field supplies
    - Hygiene products

13

Section 6: Legal and Regulatory Framework

- Multiple layers of federal laws and regulations apply
  - Toxic Substances Control Act (TSCA)
  - Comprehensive Environmental Response, Compensation and Liability Act (CERCLA)
  - Safe Drinking Water Act (SDWA)
- Regional water boards and state environmental agencies may have drinking water and/or groundwater standards, health advisories or guidance levels
- Liability issues and defenses
  - Negligence
  - Product liability

14

Section 7: Risk Communication

- Tools for assisting stakeholders to form scientifically valid perceptions of risk
  - Publicly available materials for communicating PFAS risk
  - Addressing challenges of uncertainty and variability in regulatory criteria
  - Vulnerable sub-populations
  - Managing expectations

15

Section 8: Remediation and Treatment

- Identifies key information to properly select, design, construct, implement and maintain a remedial approach
- Factors that effect remedial efficiency
- Treatment options
  - Groundwater remediation technologies
  - PFAS degradation technologies
  - Developing technologies and areas of additional research
- Treatment by-products

16

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CAPE Environmental	Regenesis
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CDM Smith	SL Environmental Law Group
Dillon Consulting Ltd.	Tetra Tech
Earth Data Northeast	TRC
EnChem	Trihydro
Environmental Law Group	Water Replenishment District of Southern California
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