Per-and Polyfluoralkyl Substances (PFAS)

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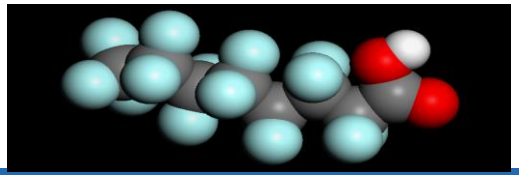
Background-Chemical Characteristics – PFOA/PFOS

Two chemicals in a large group (hundreds) of manmade chemicals called per-and polyfluoroalkyl substances (PFAS) with varying carbon chain lengths

- Uses include surfactants and to make products more resistant to stains, grease, and water.
- PFOS and PFOA both have 8 carbon atoms and are resistant to biodegradation, photolysis and hydrolysis.
- They are the terminal degradation products formed from longer chain commercial, biodegradable precursors.

Both chemicals have similar environmental fate and transport processes.

- Stable in the environment
- Low volatility, but adsorb to airborne particulates and can be transported long-range.
- Mobile in water and soils.
- Bioaccumulate across trophic levels.



PFOA and PFOS Scientific Background

- Most extensively produced and studied of PFAS

- Studies indicate can cause reproductive and developmental, liver and kidney, and immunological effects in laboratory animals

- Both chemicals have caused tumors in animal studies

Background-Physiological Behavior

Both chemicals are very persistent in the human body.

- PFOA half-life in blood serum: 2.3 years (general population)
- PFOS half-life in blood serum: 5.4 years (occupational exposure)

Six CDC National Health and Nutrition Examination Surveys (NHANES) analyzed PFAS in blood serum between 1999 and 2012.

PFOA and PFOS were detected in 99.7% and 99.9% of the U.S. population.

Serum concentrations declined over this period:

- PFOA (geometric mean) concentration from 5.2 µg/L to 2.12 µg/L.
- PFOS (geometric mean) concentration from 30.4 µg/L to 6.31 µg/L.

Previous and Current Uses: Industrial and Consumer Products

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PFOA

Cooking surfaces (Teflon)
Fire fighting foams
Toothpaste, Shampoos, cosmetics
Polishes and waxes
Electronics
Lubricants/surfactants/emulsifiers
Pesticide
Plumbing Tape
Food containers and contact paper
Textiles (Gore-Tex) and Leather
Paints, varnishes, sealants
Cleaning products
And more…

PFOS

Metal plating and finishing
Fire fighting foams
Photograph Development
Semiconductor industry
Aviation Fluids
Flame repellants
Packaging Papers
Oil and Mining
Stain repellants on carpets and upholstery
Cleaning products
Paints, varnishes, sealants
Leathers, textiles
And more…

U.S. Production

PFOS and PFOA are the two PFAS that have been produced in the largest amounts in the U.S since 1950. Both PFOA and PFOS have been phased out of production in the U.S. and replaced by shorter chain PFAS or other compounds.

- Production is still ongoing in other countries, and thus, importation of products containing both compounds is possible.

Environmental Occurrence Examples

- Manufacturing sites
  - DuPont, Diakin, 3M, Ashai, Clarient, etc.
- Industrial use sites
  - Dispersion processors including Saint-Gobain sites (Hoosick Falls)
  - Glass/Cloth Coating
  - Manufacturing and Formulating Coating Products
  - Metal Coating
  - Additives
  - Film and Film Coating Manufacturing
  - Impregnated Felt Cloth
  - Fluoropolymer Fiber Production
- Industrial and municipal waste sites
  - Landfills
  - Waste water treatment plants (Industrial and Municipal)
  - Land application of biosolids
- Fire/crash training areas
  - FAA airports
  - Federal Facilities

Safe Drinking Water Act: Background

- The Contaminant Candidate List (CCL) is a list of contaminants known or anticipated to occur in drinking water that may require regulation.
- EPA included PFOA and PFOS on the third CCL (CCL 3) published in 2009.
- PFOA and PFOS were also included in the fourth CCL (CCL 4) published in 2016.
- Both chemicals will be evaluated for potential regulation under Regulatory Determinations 4.

Safe Drinking Water Act: Background

- To regulate a contaminant under SDWA, EPA must find that it:
  1. may have adverse health effects;
  2. occurs frequently (or there is a substantial likelihood that it occurs frequently) at levels of public health concern; and
  3. there is a meaningful opportunity for health risk reduction for people served by public water systems.

PFAS Monitoring in Drinking Water

- The Unregulated Contaminant Monitoring Rule 3 (UCMR 3) characterized the levels at which particular unregulated contaminants are occurring in drinking water and measured the frequency of that occurrence on a national basis.
- UCMR 3 included **six perflourinated compounds**:
  - perfluorooctanesulfonic acid (PFOS)
  - perfluorooctanoic acid (PFOA)
  - perfluorononanoic acid (PFNA)
  - perfluorohexanesulfonic acid (PFHxS)
  - perfluoroheptanoic acid (PFHpA)
  - perfluorobutanesulfonic acid (PFBS)
- Approximately 5,000 systems total participated in UCMR 3 (monitored from 2013-2015).
- Final data are available online in the National Contaminant Occurrence Database (NCOD).


HEALTH ADVISORY DEVELOPMENT

Lifetime Health Advisories

- In 2016, EPA published final drinking water lifetime health advisories for PFOA and PFOS.
- Lifetime HAs are technical advice and concentrations at which adverse health effects are not expected to occur over an average lifetime.
- The lifetime HA for PFOA and PFOS is based on protecting the public from the adverse developmental and reproductive health effects observed in animal studies.

Summary of Health Effects

PFOA and PFOS health effects information is available from animal studies and human epidemiology studies.

Multiple health effects include: developmental effects, effects on serum lipids and total cholesterol, liver and kidney effects, immune effects, reproductive effects, and cancer.

Animal studies were used quantitatively to develop candidate RfDs. Human epidemiology studies were used as additional supporting lines of evidence.

Under EPA's Cancer Guidelines there is *suggestive* evidence of carcinogenic potential for both PFOA and PFOS.

Support from Human Epidemiology Studies

There is a significant body of epidemiology data for PFOA and PFOS.

PFOA	PFOS
• Increased serum lipids (C8 Panel) • Increased liver enzymes and decreased bilirubin • Low birth weight • Immunological effects (suppressed vaccine response) • Pregnancy induced hypertension (C8 Panel) • Thyroid disorders (C8 Panel) • Ulcerative colitis (C8 Panel) • Cancer (testes, kidney) (C8 Panel)	• Increased serum lipids • Low and mean birth weight • Immunological effects (suppressed vaccine response) • Thyroid effects

Reference Dose (RfD) Selection

EPA modeled average serum values using a peer-reviewed pharmacokinetic model (rat, mouse, and monkey) developed by EPA ORD.

PFOA: EPA modeled data from 6 studies for effects on development (delayed ossification and accelerated puberty, pup body weight; adult body and kidney weight); liver; and immune system.

PFOS: EPA modeled data from 6 studies for effects on development (pup body weight, neurodevelopment, pup survival) and liver.

RfDs are based on multiple adverse effects resulting from short-term and longer-term exposures fall within a narrow range.

EPA selected the most sensitive RfD based on developmental effects to calculate a health advisory protective for the general population and sensitive lifestages.

Critical Studies Selected as Basis for RfDs

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PFOA

- Lau et al., 2006
  - Developmental toxicity study
  - Dosing throughout pregnancy gestational days 1-17; pups sacrificed at weaning (e.g., lactational exposure included)
- Decreased ossification in proximal phalanges and accelerated puberty in male pups
- RfD derived from a LOAEL and a total uncertainty factor of 300

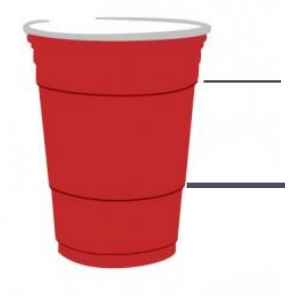
RfD = 0.00002 mg/kg/d

PFOS

- Luebker et al., 2005b
  - 2-generation reproductive toxicity study
  - Dosing premating and throughout pregnancy and lactation for 2 generations
- Decreased body weight and weight gain in pups
- RfD derived from a NOAEL and a total uncertainty factor of 30

RfD = 0.00002 mg/kg/d

Relative Source Contribution (RSC)



RSC of 80%-Exposure is primarily from drinking water; reserve 20% of RfD to account for exposure through other sources (e.g., dust, air, soil, etc.)

RSC of 20%-Exposure is primarily through other sources (e.g., dust, air, soil, etc.); reserve 20% of RfD to account for exposure via drinking water.

- EPA derived an **RSC of 20% for PFOA and PFOS** for the national HA based on available occurrence information and considering the environmental persistence of these compounds

Lifetime HA Calculation for PFOA and PFOS

$$\text{Lifetime HA} = \frac{\text{RfD} \times \text{RSC}}{\text{DWI/BW}}$$

Where:
HA = Health Advisory
RfD = Reference Dose [0.00002 mg/kg/d]
RSC = Relative Source Contribution [20%]
DWI/ BW = DWI adjusted by BW for lactating women [0.054 L/kg]

Lifetime HA = 0.00007 mg/L

= 0.07 µg/L

$$\text{Lifetime HA} = \frac{0.00002 \text{ mg/kg/d} \times 0.2}{0.054 \text{ L/kg}}$$

Lifetime HA and Application

The Lifetime HAs are based on developmental effects resulting from exposures that occur during pregnancy and lactation (nursing) and are protective for all other health effects (non-cancer and cancer) that may occur during a lifetime of exposure to these chemicals in drinking water.

Persistence in the human body and the environment means even a short-term exposure results in a body burden that persists for years and can increase if additional exposure occurs later.

Lifetime Health Advisories

Are based on the agency's assessment of the latest peer-reviewed science to provide information on the health risks of these chemicals, so water systems and states can take the appropriate actions to protect their residents.

Are non-enforceable and non-regulatory

PFAS Regulatory Activity in Other Offices

- Eight companies entered a voluntary agreement through EPA's Office of Pollution Prevention and Toxics (OPPT) PFOA and PFOS Stewardship Programs to phase out production of PFOA, PFOS and chemicals that degrade to PFOA and PFOS by the end of 2015.
- EPA also issued a regulation, or **Significant New Use Rule**, requiring manufacturers and processors of PFAS to notify the Agency of new uses before they are commercialized.

Recommended Actions for Drinking Water Systems

Assess Contamination - If water sampling results confirm that drinking water contains PFOA and PFOS at individual or combined concentrations greater than 70 parts per trillion, water systems should:

Do additional sampling to assess the level, scope and localized source of contamination to inform next steps.

Notify their state drinking water safety agency (or with EPA in jurisdictions for which EPA is the primary drinking water safety agency) and consult with the relevant agency on the best approach to conduct additional sampling.

Inform - Drinking water systems and public health officials should also promptly provide consumers with information about the levels of PFOA and PFOS in their drinking water.

Options to Limit Exposure

Notification to consumers should include actions the water system is taking and identify options that consumers may consider to reduce risk such as seeking an alternative drinking water source, or in the case of parents of formula-fed infants, using formula that does not require adding water.

PWSs can:

- Close contaminated wells or change rates of blending of water sources.
- Treat source water with activated carbon or high pressure membrane systems (e.g., reverse osmosis) to remove PFOA and PFOS.

In some communities, entities have provided bottled water to consumers while steps to reduce or remove PFOA or PFOS from drinking water or to establish a new water supply are completed.

PFAS OCCURRENCE

PFAS Occurrence – UCMR 3 Nationwide Data
PWS Above Method Reporting Limit

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PFAS Name	% PWS > MRL	# PWS > MRL
PFHpA	1.7%	86
PFHxS	1.1%	55
PFBS	0.16%	8

4,920 Public Water Systems sampled for PFAS compounds in UCMR 3

PFAS Occurrence – UCMR 3 Nationwide Data
PWS Above Health Advisory Level

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PFAS Name	% PWS > 70 PPT	# PWS > 70 ppt
PFOA	0.3%	13
PFOS	0.9%	46
PFOA+PFOS	1.3%	63

4,920 Public Water Systems sampled for PFAS compounds in UCMR 3)

AFFF, DOD and Drinking Water

Aqueous Film Forming Foam

- MilSpec formula to put out fuel fires quickly
- Used for decades at military installations, particularly on ships and at air bases
- No hint that its constituents could be toxic

Videos

NASA

https://www.youtube.com/watch?v=WlvYxdG1ovc

California accidental release

https://twitter.com/twitter/statuses/799714552858296320

What does this mean?

A single incident of fighting a fire with foam has resulted in high levels in groundwater for decades

Imagine decades of training with foam at military air bases?

Easton Road PFC HSCA Site
Sampling Results as of 04032018

Legend

Surface/Sediment Sample Location

Well Sample Results

(Combined Concentrations of PFOA & PFOS)

- ≥ 70 ppt
- 41 - 69 ppt

N

0 0.25 0.5 1 Miles

Source: PADEP

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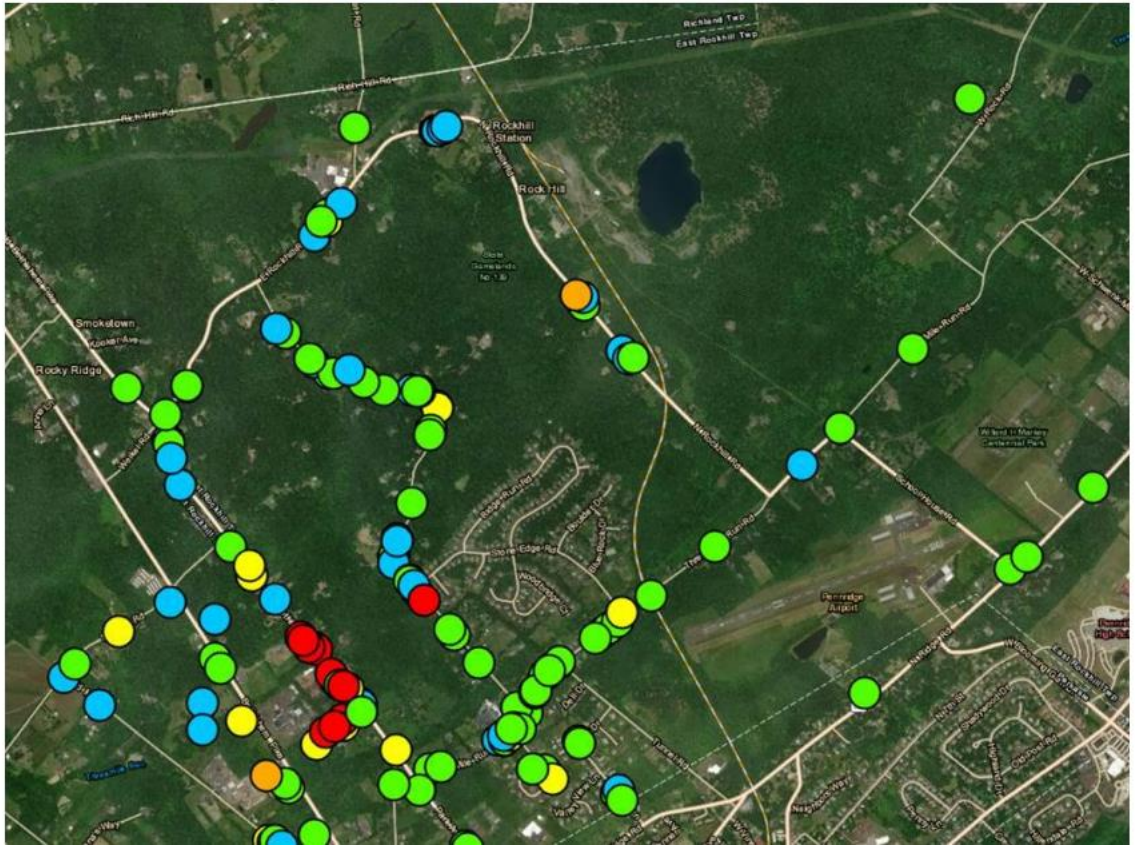
Site Investigation

156 wells sampled total

- > 70 ppt (12 wells)
- 40-69 ppt (2 wells)
- 20 – 39 ppt
- ND – 19 ppt
- No detection of PFAS



Source: PADEP

Legal Authorities

SDWA §1431 Emergency Order Authority
- Assess for and remove exposure through drinking water
- Based on provisional HAL

CERCLA Federal Facility Agreements
- Addresses long term remediation

Legal Authorities

SDWA §1431 Emergency Order Authority

- Region 3 issued orders to:
  - DuPont/Chemours – Parkersburg, WV
  - Navy – former Naval Air Warfare Center Warminster
  - Air National Guard – Horsham Air Guard Station

EPA PFAS Management Plan and Main Goals

Management Plan due out for public comment by 12/31/18

- Four main goals for PFAS
    - Creating Toxicity values for GenX and PFBS
    - Groundwater clean-up goals
    - Determination on regulating PFOA/PFOS
    - Develop analytical methods for additional PFAS and for analyzing other media

GenX, Chemours, and ???

DuPont: GenX is the PFOA replacement – hexafluoropropylene oxide

C-3 Dimer Acid - much shorter half-life in the human body

Known releases:

Fayetteville, NC
Parkersburg, WV
Paulsboro, NJ


QUESTIONS?