



**From the Fire Into the (non-stick) Frying Pan: Some Background Information for PWS on Perfluoroalkyl Substances and the Drinking Water Advisories for PFOA and PFOS.**

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# Perfluoroalkyl substances (PFAS)

- ❑ Group of synthetic, organic chemicals in which all carbon-hydrogen bonds are replaced by carbon-fluorine bonds
- ❑ Generally a carbon backbone of four to 12 carbon atoms
- ❑ Oxygen, nitrogen, sulfur and hydrogen may also be attached
- ❑ Very persistent, with toxic effects
- ❑ Perfluorocarbon (PFC) substances contain carbon and fluorine only: essentially non-toxic, very persistent greenhouse gases

# Physico-chemical properties of PFAS

## ☐ Stability:

- Resistant to photolysis, hydrolysis
- Resistant to reaction with acids, bases, oxidants and reductants
- Non-biodegradable

## ☐ Surfactants

- Hydrophobic: repel water
- Oleophobic: repel oils and greases
- Low friction on surfaces

# Physico-chemical properties of PFAS

- ❑ Water Solubility: Water soluble and generally exist in anionic form at environmentally relevant pH
  - PFOA: 9500 mg/L
  - PFOS: 570 mg/L (potassium salt)
- ❑ Very low volatility
- ❑ Adsorption to particles
- ❑ Mobile in the environment
- ❑ Potential for bioaccumulation
  - Increases with carbon chain length from four to eight carbon atoms
  - Decreases with carbon number > nine
  - PFAS do not sequester in fat
  - PFAS bind to protein albumin in blood, liver, eggs

# Uses of PFAS

- Surface protecting agents
  - Textiles
  - Paper and cardboard
  - Food packaging
- Emulsifiers and wetting agents
- Friction reducers
- Hydrocarbon fire-fighting foams: aqueous film forming foam (AFFF)
- Processing (dispersion) agent for other fluoropolymers, including non-stick cookware, waterproof clothing, electrical wire casing, plumbing thread seal tape

# Exposure to PFAS

## Food ingestion

- Treated utensils and containers

## Hand-to-mouth activity

- Toddlers on treated carpets

## Application of fabric protectants

## Drinking water ingestion

- Treated utensils and containers
- Impacted drinking water
  - Leaching
  - Run-off
  - Deposition

# Human Health Concerns About Exposure to PFAS

- ❑ 2003-2004 National Health and Nutrition Examination Survey (NHANES)
- ❑ Thousand of blood samples collected and analyzed at selected locations across the United States
- ❑ PFAS detected in 98% of blood samples collected and analyzed during the survey

# Health Effects of PFAS

## ☐ Non-cancer Effects

- Elevated cholesterol levels
- Elevated levels of uric acid
- Ulcerative colitis
- Developmental effects to fetuses during pregnancy or breast-fed infancy (e.g., low birth weight)
- Liver effects (e.g., tissue damage, necrosis)
- Immune system effects (e.g., depressed antibody production in response to vaccination)
- Thyroid effects (e.g., decreased T3 and T4 thyroid hormone levels)

## ☐ Cancer effects

- Suggestive evidence of testicular, pancreatic and liver cancers based on animal studies

# Health Effects of PFOA

- ❑ C8 Science Panel (active 2005-2013, DuPont settlement)
- ❑ Found “probable link” between PFOA and several health effects:
  - Elevated blood cholesterol
  - Ulcerative colitis
  - Thyroid disease
  - Testicular cancer
  - Liver cancer
  - Pregnancy-induced hypertension
  
- ❑ Found “no probable link” between PFOA and hypertension and coronary artery disease; chronic kidney disease; liver disease; osteoarthritis; Parkinson’s disease; autoimmune diseases (rheumatoid arthritis, lupus, Type 1 diabetes, Crohn’s disease, multiple sclerosis); common infections; neurodevelopmental disorders in children; asthma or COPD; stroke; birth defect, miscarriage/stillbirth, or low birth weight.

# Long-chain PFAS

- ❑ Greatest concern for health effects
- ❑ Greatest potential for persistence and bioaccumulation
- ❑ Long-chain perfluoroalkyl carboxylic acids with eight or more carbon atoms, including **Perfluorooctanoic acid (PFOA) (C8)**
- ❑ Perfluoroalkane sulfonates with six or more carbons, including **Perfluorooctane sulfonic acid (PFOS)**

# Significant Events Regarding Public Health Concerns Regarding PFAS

- ❑ Voluntary phase-out of PFAS by 3M: 2000-2002.
- ❑ DuPont/Chemours settlement regarding Parkersburg, WV PFOA plant
  - Established C8 Science Panel, 2005
- ❑ US EPA PFOA Stewardship Program, 2006
  - Work toward elimination of PFAS from emissions and products by 2015
  - Participating companies included Arkema, Asahi, BASF (successor to Ciba), Clariant, Daikin, 3M/Dyneon, DuPont, and Solvay Solexis.
  - All companies met stewardship objectives

# Heightened Regulatory Concern About PFAS

- ❑ US EPA “Significant New Use Rule” (SNUR) under Toxic Substances Control Act (TSCA)
  - Requires 90-day notification before manufacture/import of new chemical substance, or new use of an existing chemical
  - Significant New Use Notification (SNUN)
  - EPA has 90 days to act:
    - Request more data;
    - Prohibit or limit use; or
    - Approve use.
  - 2002: Two SNURs regulating 88 PFAS
  - 2007: Amended SNUR for 183 additional PFAS
  - 2013: SNUR regarding all new uses of PFAS in carpets
  - 2015: Proposed SNUR limiting reintroduction of phased-out long-chain PFAS

# PFAO, PFOS and the Safe Drinking Water Act (SDWA)

## ☐ Provisional Short-term Health Advisory, 2009

- PFOA:  $400 \text{ ng/L} = 400 \text{ parts per trillion} = 0.4 \text{ ug/L} = 0.4 \text{ parts per billion}$
- PFOS:  $200 \text{ ng/L} = 200 \text{ parts per trillion} = 0.2 \text{ ug/L} = 0.2 \text{ parts per billion}$

## ☐ Lifetime Health Advisory, 2016

- PFOA:  $70 \text{ ng/L} = 70 \text{ parts per trillion} = 0.07 \text{ ug/L} = 0.07 \text{ parts per billion}$
- PFOS:  $70 \text{ ng/L} = 70 \text{ parts per trillion} = 0.07 \text{ ug/L} = 0.07 \text{ parts per billion}$

# PFAO, PFOS and the Safe Drinking Water Act (SDWA)

## □ Unregulated Contaminant Monitoring Rule (UCMR), 1996

- Mechanism for obtaining data from public water systems regarding concentration of suspected drinking water contaminants for which primary or secondary standards have not yet been established.
- New list developed approximately every five years
- UCMR 3 (2009) required monitoring of 30 contaminant (28 chemicals and two viruses) between 2013-2015 using standard analytical methods
- Monitoring conducted at all large PWS (serving  $\geq 10,000$  people) and a representative sample of small PWS (serving  $< 10,000$  people)
- Monitoring required for six PFAS by Drinking Water Method 537 (Perfluorinated Alkyl Acids in Drinking Water by Solid Phase Extraction and LC/Tandem MS).

# PFAO, PFOS and the Safe Drinking Water Act (SDWA)

- ❑ Unregulated Contaminant Monitoring Rule (UCMR), 1996
- ❑ Six PFAS monitored include:
  - PFOS: perfluorooctane sulfonic acid
  - PFOA: perfluorooctanoic acid
  - PFNA: perfluorononanoic acid
  - PFHxS: perfluorohexanesulfonic acid
  - PFHpS: perfluoroheptanesulfonic acid
  - PFBS: perfluorobutanesulfonic acid
- ❑ 36,972 results reported from 4,920 PWS

# PFAO, PFOS and the Safe Drinking Water Act (SDWA)

□ From the 36,972 results reported from 4,920 PWS

- PFOS: perfluorooctane sulfonic acid
  - Detected above Method Reporting Limit (MRL) in 292 results from 95 PWS (1.9%)
  - Detected above the Reference Concentration (RfC) in 214 result from 46 PWS (0.9%)
- PFOA: perfluorooctanoic acid
  - Detected above MRL in 379 samples from 117 PWS (2.4%)
  - Detected above the RfC in 32 samples from 13 PWS (0.3%).
- PFNA: perfluorononanoic acid: detected > MRL in 14 PWS
- PFHxS: perfluorohexanesulfonic acid: detected > MRL in 55 PWS
- PFHpS: perfluoroheptanesulfonic acid: detected > MRL in 86 PWS
- PFBS: perfluorobutanesulfonic acid: detected > MRL in 8 PWS

# PFAO, PFOS and the Safe Drinking Water Act (SDWA)

- ❑ Contaminant Candidate List (CCL) 4: November 2016
  - Includes 12 microbes and 97 chemicals, including PFOA, PFOS.
  - PFOA and PFOS were also on CCL 3
  
- ❑ Most recent regulatory determination, Final Regulatory Determination on CCL3 (January 2016):
  - Dimethoate; 1,3-dinitrobenzene; terbufos; and terbufos sulfone not regulated
  - Strontium to be regulated
  - did not provide a determination whether or not to regulate PFOA or PFOS
  - PFOA and PFOS regulatory status still pending

# PFAS in the Environment: Fish Consumption

## □ Evaluation of PFAS in fish tissue:

- National Rivers and Streams Assessment (2008-2009)
  - Collected fish tissue samples from over 500 river locations across U.S., including 160 urban locations
  - Fish tissue analyzed for 13 perfluorocarbons
- National Coastal Condition Assessment: Great Lakes Human Health Fish Tissue Study (~ 2010)
  - Fish sampled at 157 location across all five Great Lakes (30 in each lake), including about ten in Western Basin Lake Erie
  - Nearshore and open water fish including trout, bass, walleye, salmon, whitefish and drum
- Fish Consumption Advisory: limit fish consumption to once per week if fish tissue contains > 40 ppb of PFOS
- Great Lake fish tissue concentrations:, mostly PFOS, range up to 100 ppb; most samples non-detected



**From the Fire Into the (non-stick) Frying Pan:  
PFAS by PFAU**

**Questions?**

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