IC2 Webinar: PFAS: the New Bad Kid on the Block—and getting worst!

2018-06-26

PFAS - the New Bad Kid on the Block - and getting worst!!

IC2 Webinar
26 June 2018

Dr Jimmy Seow

ENVIRON PTY LTD

Adjunct Professor
Murdoch University WA

Adjunct Associate Professor
Curtin University WA

ENVIRON

NEWMOA

Quick Background Relevant to the Talk

Last 5 months PFAS projects

- Review AMSA project firefighting foams used on board ships
- Review of PFAS in Carpets and Rugs for US Green Science Policy Institute
- Technical Advice to WA DFES on 6:2 FTSA in DFES firefighting foams
- Technical advice use of on board ship firefighting foams to RivTowe/BHP
- Technical advice PFAS remediation to Ziltek

- Member PFAS subject matter expert group consisting regulators, policy makers, toxicologists, epidemiologists, research scientists and lawyers from the US, Canada, UK and the EU.
- Publication PFAS papers e.g. Field and Seow 2017 – Review on FTSA
- Co-author and adviser for Queensland DES firefighting foam use policy 2016
- Adjunct Professor Murdoch University – PFAS
- Adjunct Associate Curtin University – Hazmat Response and Management
- Former Manager Pollution Response Manager DWER and member 3 WA emergency management committees and Perth Airport Emergency Group
- PhD UWA – soil science and catchment hydrology

Setting the Scene

1. **PFAS are persistent in the environment and humans**
2. **PFOS and PFOA do not metabolise, oxidize, photooxidise, reduce or undergo abiotic or biotic degradation**
3. **PFOS and PFOS are only part of the PFAS story**
4. **PFAS precursors transform to perfluorocarboxylates (PFCAs, e.g. PFOA, PFNA, PFDA) and perfluoroalkyl sulphonates (PFSAs, e.g., PFOS, PFHxS)**
5. **Fluorotelomer foams may generate PFOA by breakdown**
6. **All AFFF-type firefighting foams contain PerFluoroAlkyl Substances (PFAS) – fluorine-free foams do not**
7. **Recent Policy and Regulation developments are Game Changers**
8. **The Precautionary Principle – part of international and national environmental law**

Anger over Perth Airport toxic testing delays

Nick Butterly | | The West Australian Wednesday, March 7, 2018 02:00AM

SHARE

New Hampshire's chemical reaction

Lawmakers seek to put tighter controls on PFCs

BY LIISA RAJALA

3

Published: March 29, 2018

Two carbon activated filtration tanks were installed at the Pease International Tradeport Water Treatment facility in Portsmouth in 2016. The carbon in one of the filters will soon be replaced.

New Hampshire lawmakers have introduced several bills this legislative session aimed at imposing stricter regulation of perfluorinated chemicals (PFCs) in the environment.

Three of the bills — House Bills 1101 and 485 and Senate Bill 309 — would provide the NH Department of Environmental Services with the authority to regulate groundwater pollution caused by air emissions and instruct the agency to reconsider drinking water standards.

"We currently don't have the ability to

Congress Members Ask for Faster Work to Remove PFAs in Oscoda

April 21, 2018 by Bret Greenacre

Three members of Congress are asking the U.S. Air Force to work faster to remove PFAs around the former Wurtsmith Air Force base in Oscoda.

The chemicals have been linked to cancer, along with thyroid, kidney, liver and reproductive problems.

GenX: Two Studies Show Growth Of Contaminated Water Areas

By VINCE WINKEL • APR 23, 2018

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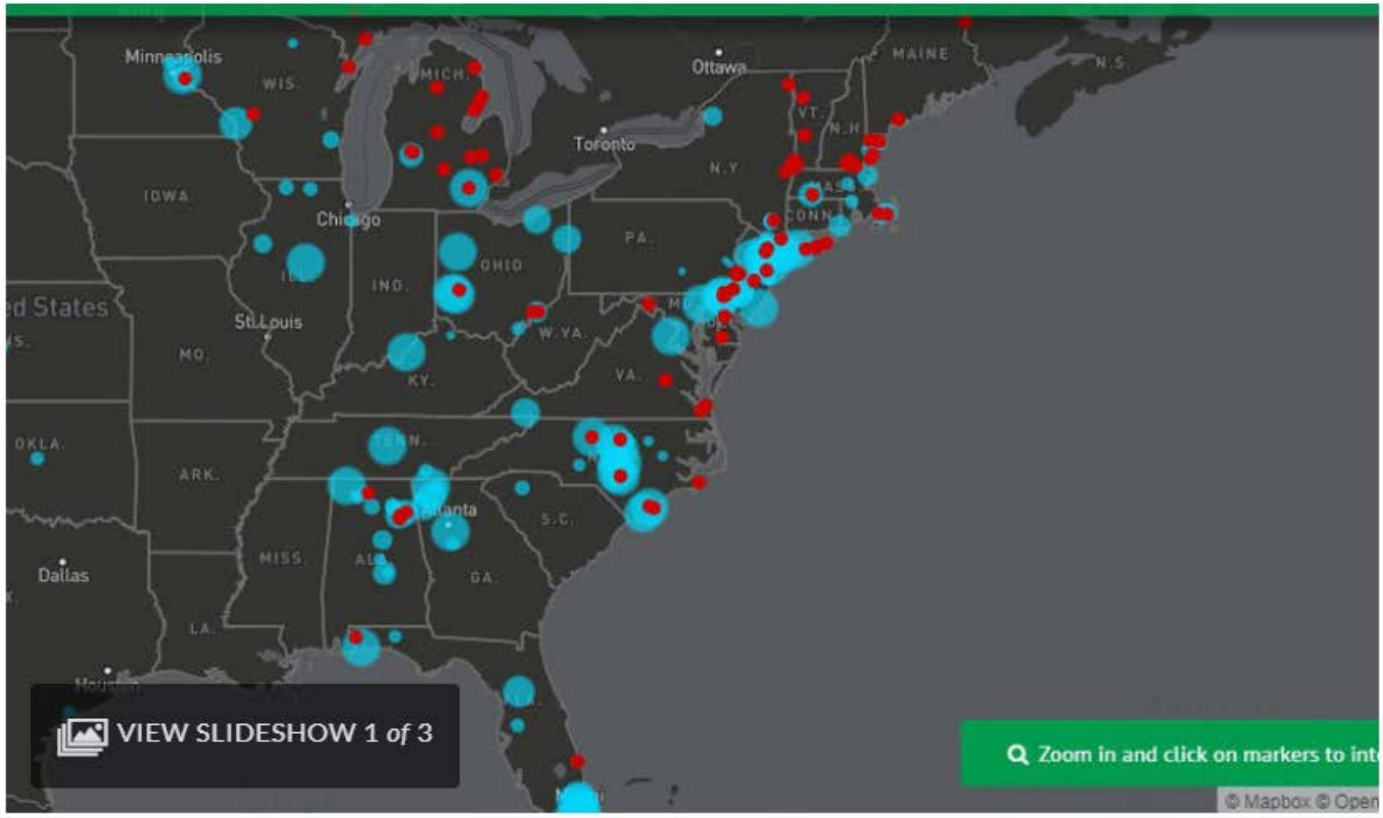

Your Military

DoD: At least 126 bases report water contaminants linked to cancer, birth defects

By: Tara Copp April 26

U.S. Air Force and New Jersey state fire protection specialists from the New Jersey Air National Guard's 177th Fighter Wing battle a simulated aircraft fire at Military Sealift Command Training Center East in Freehold, N.J., on June 12. The foam used to put out aircraft fires has been tied to cancers and childhood development issues, and the military is working on developing a replacement. (Airman 1st Class Amber Powell/Air Force)

The water at or around at least 126 military installations contains potentially harmful levels of perfluorinated compounds, which have been linked to cancers and developmental delays for fetuses and infants, the Pentagon has found.

News Feature | May 1, 2018

Pentagon Releases Contamination Data

By Sara Jerome
@sarmje

The Pentagon provided its most comprehensive report to date on the scope of its role in water contamination in a recent House Armed Services Committee hearing.

"The water at or around 126 military installations contains potentially harmful levels of perfluorinated compounds. The Defense Department identified 401 active and Base Closure and Realignment installations in the United States with at least one area where there was a known or suspected release of


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All news
Proposal to ban 200 highly fluorinated substances
NEWS 12/20/2017
Sweden and Germany propose that about 200 highly fluorinated substances (PFASs) are to be banned in the entire EU. The substances have extremely poor degradability in the environment and accumulate in living organisms. The European Chemicals Agency (ECHA) is now holding a public consultation regarding the proposal.

The Sydney Morning Herald

INVESTIGATION LIFESTYLE HEALTH & WELLNESS HEALTH

Toxic Secrets: Professor 'bragged about burying bad science' on 3M chemicals

By Carrie Fellner
16 June 2018 — 8:37pm

As a leading international authority on toxic chemicals, Professor John P. Giesy is in the top percentile of active authors in the world.

His resume is littered with accolades, from being named in the *Who's Who of the World* to receiving the Einstein Professor Award from the Chinese Academy of Sciences.

Professor Giesy was credited with being the first scientist to discover toxic per- and poly-fluoroalkyl [PFAS] chemicals in the environment, and with helping to persuade chemical giant 3M Company to abandon their manufacture.

Professor John Giesy was allegedly covertly doing 3M's bidding in a widespread campaign to suppress academic research on the dangers of PFAS.

Photo: Supplied

The Game Changers

- **July 2016 – Queensland Department of Environment and Heritage Policy Environmental Management of Firefighting Foam**
- **30 January 2018 - South Australia Environment Protection (Water Quality) Policy 2015 – blanket ban on foams with PFAS – 2 years to comply.**
- **27 March 2018, the US State of Washington Governor Jay Inslee signed a new law restricting the use and sale of firefighting foam containing PFAS class by 1 July 2020.**
- **Short chain, long chain and C6 to be redefined**
- **Germany proposing to ECHA to restrict short-chain PFAS under REACH Article 57 (f)**

30 May 2018 from Australian Government: Parliamentary inquiry into PFAS Contamination

PARLIAMENT of AUSTRALIA
MEDIA RELEASE

PFAS SUB-COMMITTEE
JOINT STANDING COMMITTEE ON FOREIGN AFFAIRS, DEFENCE AND TRADE
Inquiry into the management of PFAS contamination in and around Defence bases

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Issue date: 30 May 2018

Parliamentary inquiry into PFAS contamination

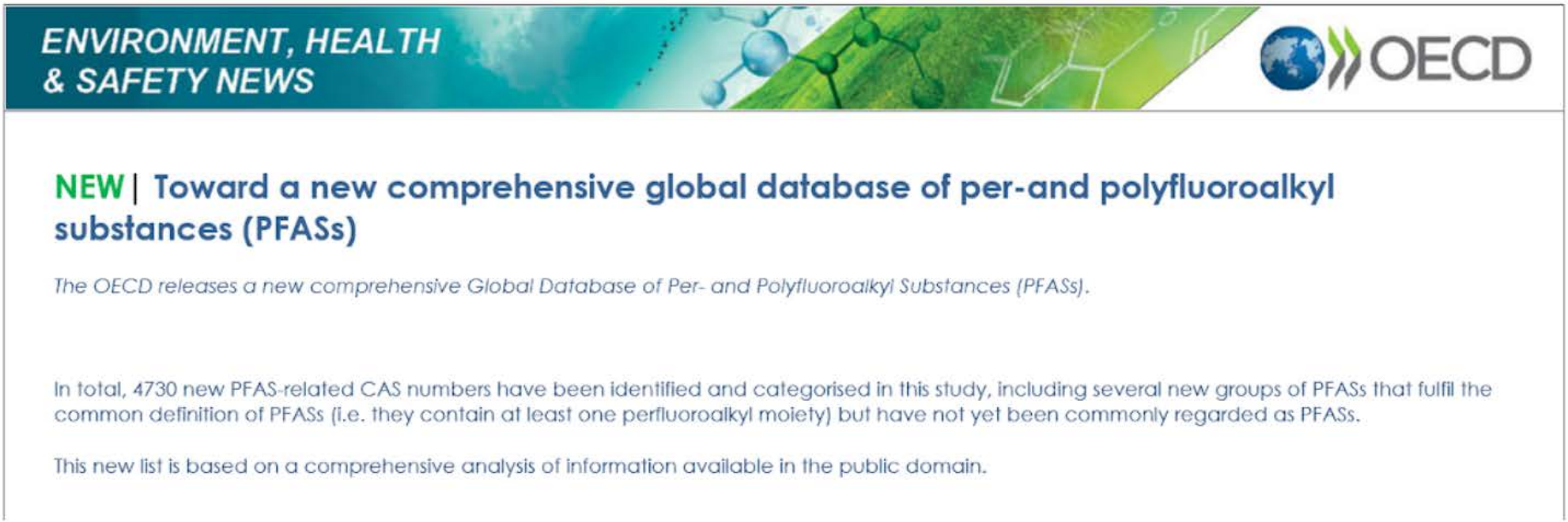
EPA will move to label chemical found in drinking water 'hazardous'

By STEPHANIE EBBS May 22, 2018, 1:13 PM ET

Share Tweet

Environmental Protection Agency chief Scott Pruitt says the agency will move to regulate as "hazardous" a type of harmful chemical found in the drinking water of millions of Americans, calling it a "national priority."

May 2018 from OECD: New global database for PFASs



NEW | Toward a new comprehensive global database of per-and polyfluoroalkyl substances (PFASs)

The OECD releases a new comprehensive Global Database of Per- and Polyfluoroalkyl Substances (PFASs).

In total, 4730 new PFAS-related CAS numbers have been identified and categorised in this study, including several new groups of PFASs that fulfil the common definition of PFASs (i.e. they contain at least one perfluoroalkyl moiety) but have not yet been commonly regarded as PFASs.

This new list is based on a comprehensive analysis of information available in the public domain.

Shown Here:
Placed on Calendar Senate (05/08/2018)

115TH CONGRESS
2D SESSION

H. R. 4

To reauthorize programs of the Federal Aviation Administration, and for other purposes.

IN THE SENATE OF THE UNITED STATES
MAY 7, 2018

Received; read the first time

MAY 8, 2018

Read the second time and placed on the calendar

AN ACT

To reauthorize programs of the Federal Aviation Administration, and for other purposes.

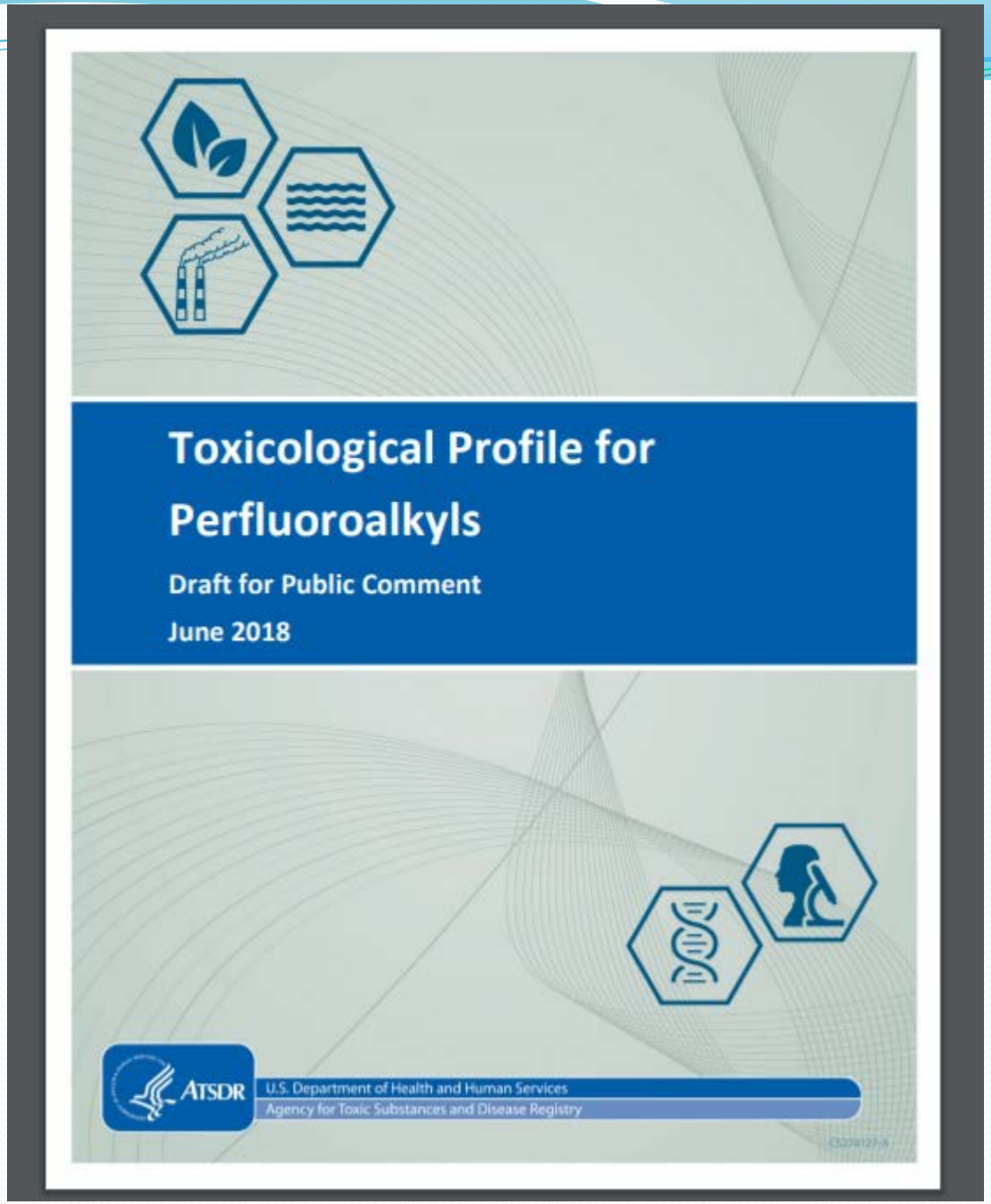
Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled,

Discussions about how to address the HHS study involved EPA Administrator Scott Pruitt's chief of staff and other top aides, including a chemical industry official who now oversees EPA's chemical safety office. | AP Photo

White House, EPA headed off chemical pollution study

The intervention by Scott Pruitt's aides came after one White House official warned the findings would cause a 'public relations nightmare.'

By **ANNIE SNIDER** | 05/14/2018 12:43 PM EDT | Updated 05/14/2018 02:05 PM EDT


Toxicological Profile for
Perfluoroalkyls
Draft for Public Comment
June 2018
ATSDR
U.S. Department of Health and Human Services
Agency for Toxic Substances and Disease Registry

Questions

- Q1 – What are PFAS?
- Q2 – Why is it found worldwide?
- Q3 – How does it affect the environment?
- Q4 – Does it affect me – human health?
- Q5 – How does firefighting foam come into it?
- Q6 – Has there been class actions?
- Q7 – How does it affect my work?

Q 1 - What are PFAS ?

- **PFASs (PerFluoroAlkyl Substances) are man-made chemicals carbon-fluorine (C-F) bonds that impart oil and water repellency**

- **Buck et al 2011 definitions:**
  - **Non polymers - PFAAs, PASFs, PFAIs, PFECAs, PFESAs**
  - **Polymers – FPs, side-chain fluorinated polymers, PFPE**

Key PFAS properties

- **PFAS is persistent in the environment**
  - **PFOS half-life in humans = 2.4 to 21.7 years (Olsen et al. 2007)**
  - **PFOA half-life in humans = 2.3 –3.8 years (Olsen et al., 2007; Bartell et al., 2010; Brede et al., 2010)**
- **PFOS and PFOA do not metabolise, oxidize, photo-oxidise, reduce or undergo abiotic or biotic degradation**
- **PFAS precursors can breakdown to PFCAs (e.g. PFOA, PFNA, PFDA) and PFSAs (e.g., PFOS, PFHxS)**
- **And you have alternatives for PFOS (e.g. F 53 B) and PFOA (Gen-X)**

Q 2 Why is it found everywhere?

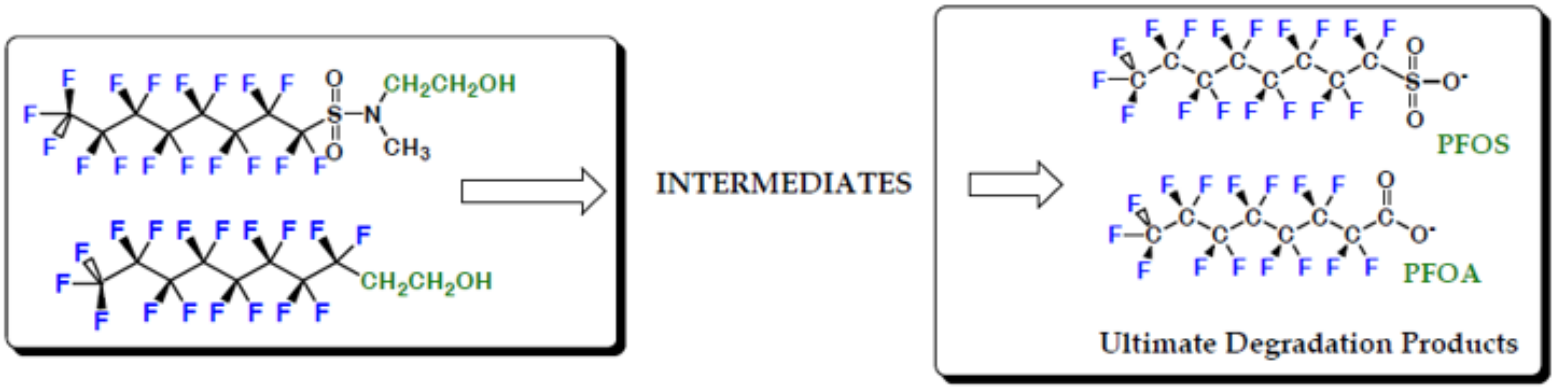
- **PFAS are widely used in many industries besides fire fighting foam, such as textile, fabric and paper treatments, paints, semiconductors, anti-foaming agents, etc., due to their:**
  - **dirt, grease and water resistance properties**
  - **low surface tension**
  - **heat, chemical and abrasion resistance**
  - **low friction and surfactant properties e.g. firefighting foam**
  - **dielectrical properties**
  - **thermal stability, versatility, strength, resilience and durability**

Why is the World Contaminated? Two current hypotheses:

Direct: ***Release of PFOS and PFOA/PFNA from industrial, commercial, or consumer uses has been significant and has resulted in global contamination, including the Arctic and humans.[1,2]***

- *Thousands of tons of PFOA alone emitted from fluoropolymer manufacture*
- *major releases to surface waters (56,000 lbs of PFOA in '99/W.Va);*
- *major fate is to the oceans;*
- *ppm 'residual' in products;*

Indirect: ***Fluorinated precursors (FPs) are degraded atmospherically and metabolically to yield PFCAs. FPs are released from industrial sources and from 'in use' consumer products.*** [3,4,5,6]



2018-06-26

Mabury 2009 Overview of Perfluorinated Chemicals ~ Origin, Fate, and Concern

PFAS sources

- **Firefighting foam usage, e.g., AFFF**
- **Landfill leachates**
- **Waste Water Treatment Plants**
- **Releases and discharges from PFAS manufacturing plants**
- **Releases and discharges from industrial and commercial product manufacturing where PFAS is used**
- **Accidents e.g. Qantas Brisbane Airport, Buncefield**

Q3 – How does it affect the environment?

- **PFAS**
  - **Found everywhere**
  - **Persistent**
  - **Accumulates in the environment and humans due to its persistence – can cause long term pollution and impact**
  - **Soluble and transport over long distances. Its fate and transport is complex because of multiple chain length and charges**
  - **Impact biota, human and the environment**
  - **Uptake in plants and food**
  - **Difficult to remove from the environment**
  - **Potential for "man via environment" exposure**

Many forget to consider this

Dimension of time

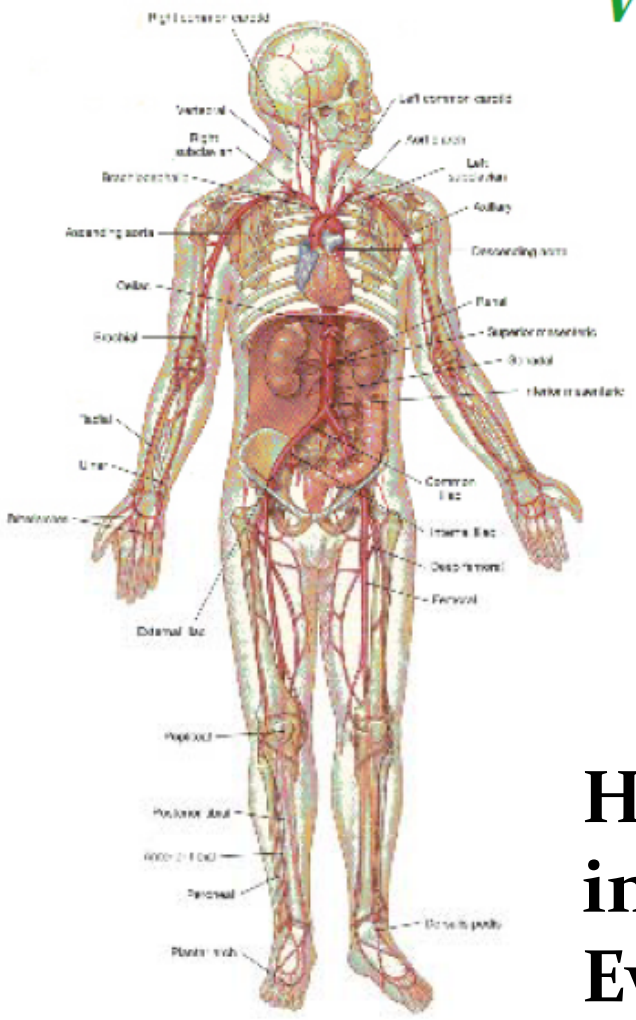
- PFAS soluble and mobile
- PFAS precursors breakdown with time to FTCA, FTUCA, FPCA and PFCA

Different behaviour in different environmental conditions

- Anaerobic, anaerobic and anoxic environmental behaviour

Q4 – Does it affect me? – human health

2018-06-26



Why are People Contaminated?

- direct exposure to PFOS & PFCAs?
- indirect routes of exposure via 'precursors'?
- important as it relates to the problem as one of 'legacy' or is it continuing?
- & if PFAs produced via 'metabolism' then potential issue of reactive intermediates.

Human contamination is mainly by ingestion and inhalation
Evidence so far does not show dermal absorption except rats

PFAS Health Impact

- **Animal studies - hepatotoxicity, immunotoxicity, hormonal effects and carcinogenicity**
- **Human studies – links and association, e.g.**
- **• increased levels of cholesterol in the blood;**
- **• increased levels of uric acid in the blood;**
- **• reduced kidney function;**
- **• alterations in some indicators of immune response;**
- **• altered levels of thyroid hormones and sex hormones;**
- **• later age for starting menstruation (periods) in girls, and earlier menopause; and**
- **• lower birth weight in babies.**
- **More and more studies now being done and in many countries**

PFAS Drinking Water Guidance Values

PFAS Types	Range
PFOS – C8	0.027 µg/L (MDH) to 0.07 µg/L (Australia) to 1 µg/L (UK)
PFOA – C8	0.014 µg/L to 0.56 µg/L (Australia) to 10 µg/L(UK)
PFBA – C4	0.027 µg/L (MDH)
PFBS – C4	0.035 µg/L (MDH)
PFHxS	0.027 µg/L (MDH) to 0.07 µg/L (Australia) to 0.1 µg/L (Denmark)
PFNA	0.013 µg/L (New Jersey)
HFPO Dimer acid (Perfluoro-2-propoxypropanoic acid)	0.14 µg/L (North Carolina)

Fluorotelomers

- A whole range are used in industry
- Persistence and carbon chain-length is a concern
- Found everywhere and also in human blood
- Precursors (e.g. 6:2 to 10:2 FTOH) degrade to PFCAs which have been shown to have acute and chronic toxicity for biological organisms
- 6:2 FTS less toxic and less bioaccumulative than PFOS
- All 8:2 fluorotelomer (FT) derivatives degrade to PFOA
- More and more data emerging of FT environmental impact - early days unlike PFOS and PFOA
- FTSAs (as found in AFFF) are persistent under the anaerobic conditions of landfills and are very poorly removed during municipal waste treatment

The cocktail of concern and there is more

- **PFOS (C8), PFOSA perfluoroctanoic sulfonamide (C8), PFHxS perfluorohexane sulfonic acid (C6)**
- **PFOA (C8) and PFNA perfluorononanoate (C9)**
- **PFHpA Perfluoroheptanoate (C7)**
- **PFDA Perfluorodecanoate (C10)**
- **PFUnA Perfluoroundecanoate (C11)**
- **PFDoA Perfluorododecanoic acid (C12)**
- **PFBA, PFBS (C4)**
- **Long chain fluorotelomers (FTOH etc) and its PFAA derivatives**
- **Many precursors used to make the final products we use**
- **New PFAS of concern e.g. 6:2 chlorinated polyfluorinated ether sulfonate (6:2 Cl-PFAES) F-53B alternative to perfluorooctanesulfonate (PFOS) in electroplating industry in China**
- **HFPO Dimer acid (Perfluoro-2-propoxypropanoic acid)**
- **Mixture effects still largely unknown**

Q5 – How does firefighting foam come into it?

2018-06-26

Q5 – How does firefighting foam come into it?

2018-06-26

The use of firefighting foam represents the environmentally most dispersive of any application involving PFAS

Firefighting foam accounts for large proportion of total fluorochemical global tonnage

AFFF

Firefighting Foam Ingredients: 4 Main Types

Diluent

Water

Surfactants

Fluorosurfactants
Hydrocarbon Surfactants
Protien-Based Surfactants
Synthetic Detergent Mixtures
Fluroalkyl Surfactants
Etc.

Solvents

Butyl Carbitol
Propylene Glycols
Hexylene Glycol
1,2 Propanediol
2-Butoxyethanol
Methyl-1H-Benzotriazole
Propylene Glycol t-Butyl Ether
Tetraethylene Glycol Dimethyl Ether
1H-Benzotriazole
N-Propanol
Triethanolamine
Ethylene Glycol
Etc.

Additives/ Modifiers

Acetic Acid
Biocide
Dichlorophene
EDTA
Ferrous Sulfate
Zinc oxide
Polysacchaaride Gum
Sodium Chloride
Nonylphenol Ethoxylate
2-Biphenylol Sodium Salt
Corrosion Inhibitors
Etc.

Abstract from Hughes Associates Inc, US

Fluorotelomers in foam- Examples:

- 6:2 FTS, 8:2 FTS, 10:2 FTS, 12:2 FTS and other long chain FTS
- 6:2, 8:2, 10:2 and 12:2 fluorotelomer sulfonamide alkylbetaine (FTAB)
- 6:2 fluorotelomer sulfonamide alkylamine (FTAA)
- Perfluoroalkyl betaine (1157)
- Perfluoroalkyl amine oxide (1183)
- 4:2, 6:2, 8:2 fluorotelomer thioamido sulfonate (FTSAS)
- Fluorotelomer thioether amido sulfonate (FtTAoS)

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What is a precursor?

Polyfluroalkyl substances that can undergo transformation to form ***per***fluoroalkyl acids

8:2 FtTAoS (precursor) → 8:2 FtS (intermediate) → PFOA (terminal endpoint)

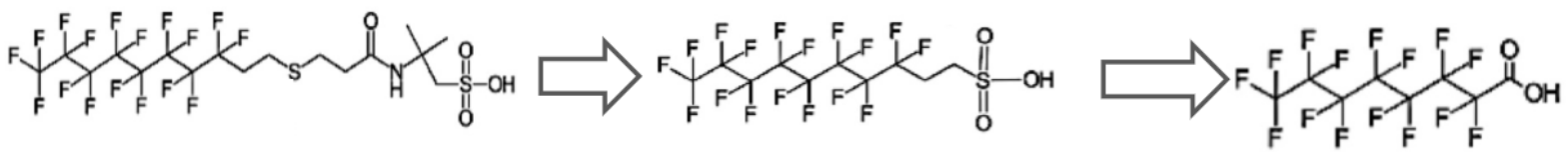


Figure adapted from Ref. 2

2. Harding-Marjanovic, Katie C., et al. "Aerobic biotransformation of fluorotelomer thioether amido sulfonate (Lodyne) in AFFF-amended microcosms." *Environmental science & technology* 49.13 (2015): 7666-7674.

10

Fluorotelomers in foam- Receptors and Precursors

- **Found in river, groundwater, drinking water, soil, sediments, training sites etc –Field and Seow 2017 Table 13**
- **Precursors that transform or degrade to FTSA and to PFAA (perfluoroalkyl acids)**
- **Key papers:**
  - **Field and Seow 2017 (Table 12)**
  - **Favreau et al 2017 (Table 4)**
  - **Barzen-Hanson et al 2017 (Table 1)**
  - **Harding- Marjanovic et al 2015**
  - **D'Agostino and Mabury 2104 (Fig. 1)**
  - **Weiner et al 2013 (Fig. 1 and 2)**
  - **Place, Day and Field 2013 (Table 2)**

2018-06-26

Properties, occurrence, and fate of fluorotelomer sulfonates

Jennifer A. Field [a] and Jimmy Seow[b]

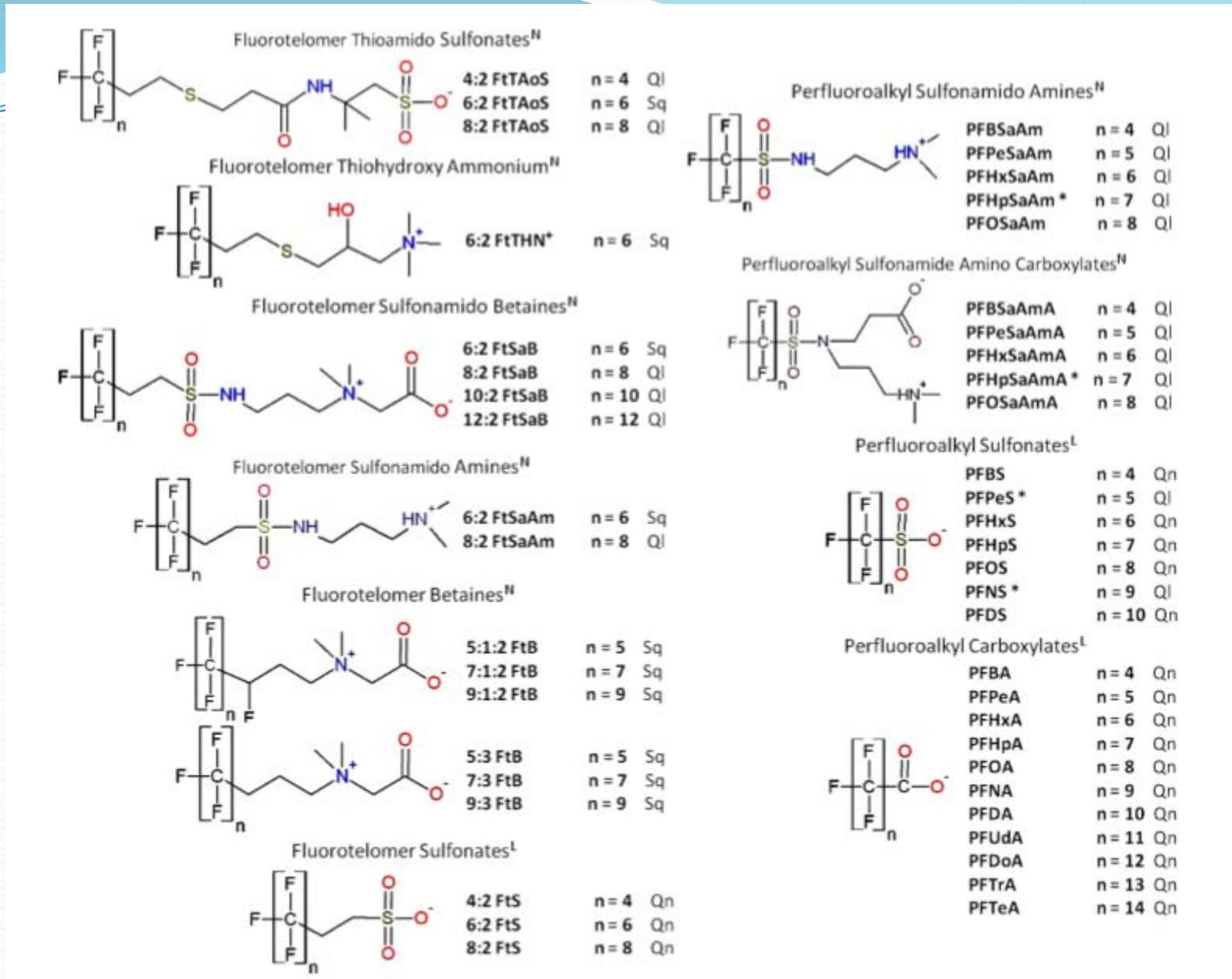
[a]Department of Environmental and Molecular Toxicology, Oregon State University, Corvallis, Oregon, USA; [b]Health Safety and Environment, School of Public Health, Curtin University, Bentley, Western Australia, Australia

ABSTRACT

Fluorotelomer sulfonates (FtSAs) are found in human blood and in environmental media, yet have received relatively little attention compared to the more commonly studied perfluorinated alkyl substances such as perfluorooctane sulfonate and perfluorooctanoate. The FtSA class is overlooked in many reviews on highly fluorinated substances. This review summarizes the state of knowledge on their properties, analytical chemistry, and occurrence of FtSAs in humans and other organisms as well as environmental media. The review also includes their formation as biodegradation intermediates of precursors and current information on their treatment by remediation technologies.

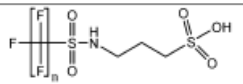
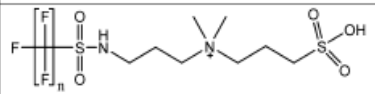
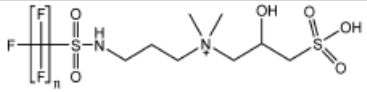
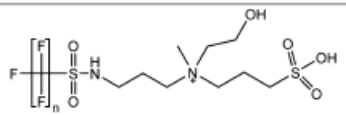
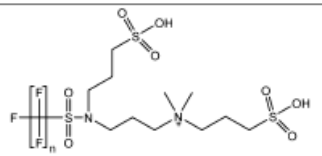
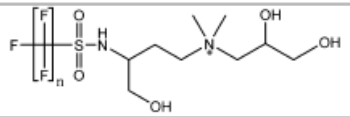
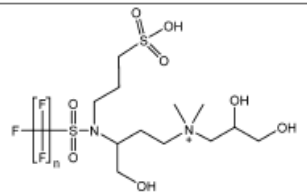
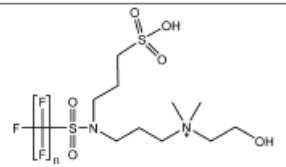
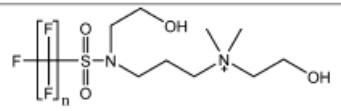
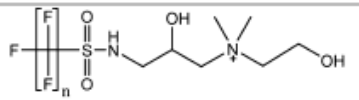
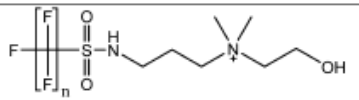
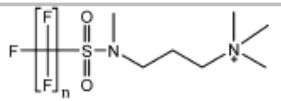
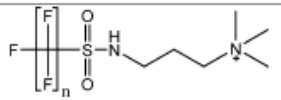
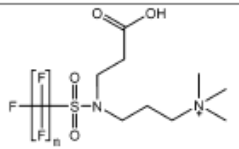
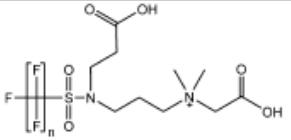
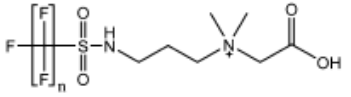
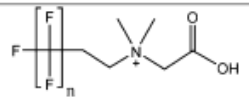
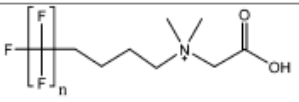
KEYWORDS

Biodegradation; fluorotelomer sulfonates; occurrence; point sources; remediation; treatment



Backe et al 2013 detected various types of PFAS in foams and in groundwater contaminated by AFFF

Table 1. Newly Discovered PFASs Found in AFFFs and CPs

Class Number	Structure	$n^{a,b}$	Acronym[c]	Confidence Level[d,e]	AFFF/CP Found In
1		3-6	N-SP-FASA	2b	B, C
2		3-8	N-SPAmP-FASA	2b	A, B, C, F
3		3-9	N-SHOPAmP-FASA	3[f]	C, D, E, F, G
4		4-6	N-SPHOEAmP-FASA	3	B, C
5		3-8	N-SPAmP-FASAPS	2b	A, B, C
6		3-6	N-diHOPAmHOB-FASA	3	B, C, O
7		2-6	N-diHOPAmHOB-FASAPS	3	A, B, C
8		2-8	N-HOEAmP-FASAPS	2b	A, B, C
9		2-8	N-HOEAmP-FASE	2b	A, B, C, D, E
10		4-6	N-HOEAmHOP-FASA	3	B, C
11		2-8	N-HOEAmP-FASA	2b	A, B, C, D, E
12		4-8	N-TAmP-N-MeFASA	3	B
13		3-8	N-TAmP-FASA	3	A, B, C, D, E, F, G
14		3-6	N-TAmP-FASAP	3	D, E, F, G
15		4-6	N-CMAmP-FASAP	2b	D, E, F, G
16		3-6	N-CMAmP-FASA	2b	D, E, F, G
17		6, 8, 10	CMAmEt-FA	2b	L
18		4, 6, 8	CMAmB-FA	3	L
19	$C_{n+8}H_{16}O_2SN_2F_{2n+1}$	6, 8, 10	Not applicable	4	I, J
20	$C_{n+10}H_{20}O_7SN_2F_{2n+1}$ or $C_{n+10}H_{18}O_4SN_2F_{2n+1}$	Un-known	Not applicable	5	I, J

Barzen-Hanson et al 2017 – Newly discovered PFASs in AFFF

There is no such thing as an environmentally benign firefighting foam

- **Firefighting foams with PFAS are an environmental issue and concern to many**
- **Just because it is a fluorine free foam does not mean it is environmentally acceptable as it may have surfactants and additives which may not be environmentally friendly**
- **Both AFFFs and fluorine-free foams have unacceptable and comparable BOD/COD profiles**

Environmental Acceptability – it is only Science

- **Data! Data! Data!**
  - **What is its chemical make up i.e. composition**
  - **Persistence, e.g., biodegradation**
  - **Bioaccumulation**
  - **Toxicity– acute and chronic**
  - **BOD/COD**
  - **Analytical data – how was it analysed**
  - **Defensible scientific data**
  - **Current data not old data**
  - **Published with peer review**

PFAS analysis

- **Many methods, e.g., HPLC – MS-MS, LC-QTOF, FAB-MS, TOP Assay Total Oxidisable Precursor Assay, Total Organic Fluorine (TOF), Absorbable Organic Fluorine (AOF), Particle Induced Gamma-ray Emission (PIGE)**
- **Standard protocols, e.g., US EPA Method 537, ISO 25101, USEPA LEAF - Leaching Environmental Assessment Framework**

Common Lab PFAS Analysis

- Perfluorobutanesulfonic acid (PFBS)
- Perfluorohexanesulfonic acid (PFHxS)
- Perfluorooctanesulfonic acid (PFOS)
- Perfluorodecanesulfonic acid (PFDS)
- Perfluoro-n-pentanoic acid (PFPeA)
- Perfluorohexanoic acid (PFHxA)
- Perfluoroheptanoic acid (PFHpA)
- Perfluorooctanoic acid (PFOA)
- Perfluorononanoic acid (PFNA)
- Perfluorodecanoic acid (PFDA)
- Perfluoroundecanoic acid (PFUnA)
- Perfluorododecanoic acid (PFDoA)
- Perfluorotridecanoic acid (PFTrDA)
- Perfluorotetradecanoic aicd (PFTeDA)
- Perfluorooctanesulfonamide (PFOSA)

N-ethyl-perfluorooctanesulfonamidoacetic acid (NEtFOSSA)

N-methyl-perfluorooctanesulfonamidoacetic acid (NMEFOSAA)

1H,1H,2H,2H-perfluorohexanesulfonic acid (4:2 FTS)

1H,1H,2H,2H-perfluorooctansulfonic acid (6:2 FTS)

1H,1H,2H,2H-perfluorodecanesulfonic acid (8:2 FTS)

All AFFF have fluorosurfactants

- **All AFFFs (AFFF, FFFP, FP and AR variants) contain fluorosurfactants whether PFOS, PFOA, fluoro-telomers and precursors or various additives depending on:**
  - **Foam formulation**
  - **Brand and type of foam**
  - **Batch of the foam**
  - **Age of the foam – legacy issue**
  - **Type and purity of the PFAS surfactants used to formulate the foam**
  - **Contamination in the foam storage or delivery system**

Key Environmental Issue of Foam

- **Top four PFAS of concern – PFOS, PFOA, PFHxS, PFNA**
- **Persistent foam degradation products (PFAS)**
- **Bioaccumulation and biodegradation issue**
- **Toxicity – varying toxicity depends on foam formulation and how you test – species, temperature and water quality, oxygen saturation**
- **Precursor transformation to intermediates, e.g., FTCA and FTUCA, as well as PFCA and PFSA**
- **BOD/COD issue**
- **SDS incomplete**

Foam SDS incomplete

- **SDS and Technical Information do not say what is the fluorosurfactant**
- **Some SDSs don't even declare it has fluorosurfactants**
- **BOD/COD data at times missing**

Example of poor AFFF SDS statements

- **Foam A - Hydrolysed protein solution containing fluorocarbon surfactants and glycol solvents**
- **Foam B - contains no fluorosurfactants, fluoropolymers, organohalogens, PFCAs, PFOA and no PFOS in accordance with EU Directive 2006/122/EC and mended Council Directive 76/769/EEC.**
- **Foam C - is a fluoroprotein foam concentrate**
- **Foam D - Hydrocarbon surfactants, fluorocarbon surfactants and glycol solvents**
- **Foam E - Amphoteric surfactant. Proprietary**
- **Form F – proprietary mixture consisting of high foaming hydrocarbons surfactants, organic salts and water (>50 %). Not otherwise specified.**

Foam X SDS fluoroadditives not specified

HAZARDOUS COMPONENTS

CAS-No.	Chemical name	Quantity	Classification
107-41-5	2-methylpentane-2, 4-diol	5 - 10 %	Xi R36/38
7646-85-7	Zinc chloride	1 - 5 %	Xn C N R22-34-50-53
64-17-5	Ethanol	1 %	F R11
	Water and other non-hazardous ingredients, including fluroadditives	84 – 94 %	

	FOAM X
	Protein Foam
	µg/L
PFBS	0
PFPeS	0
PFHxS	0
PFHpS	0
PFOS	0
PFDS	0
PFBA	432
PFPeA	37
PFHxA	1042
PFHpA	11
PFOA	18
PFNA	2
PFDA	2
PFUnDA	0
PFDoDA	0
PFTrDA	0
PFTeDA	0
FOSA	0
MeFOSA	0
EtFOSA	0
MeFOSE	0
EtFOSE	0
MeFOSAA	6
EtFOSAA	0
4-2-FtS	370
6-2-FTS	123500
8-2-FTS	146
10-2-FtS	46

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PFOA 18 ppb or 18,000 ppt

Impurity – PFOA, PFNA – the long chain C8

Houtz PhD 2013 (Houtz, Higgins, Field, Sedlak - Persistence of PFAA precursors in AFFF-impacted GW & soil - ES&T 2103, 47, 8187-8195)

2018-06-26

		mmol/L						
	Foam product	**PFBA (C4)**	**PFPeA (C5)**	**PFHxA (C6)**	**PFHpA (C7)**	**PFOA (C8)**	**PFNA (C9)**	**Sum**
Chemguard 2008	A1	6.4	11	3.2	1.1	0.3	0.4	22.4
Chemguard 2010	A2	5.9	11	3.5	1.2	0.3	0.4	22.3
Ansul 1986	B1	5.7	10	5.2	4	1.2	0.6	26.7
Ansul 1987	B2	5.6	10	5.2	3.5	1.2	0.5	26
Ansul 2009	B3	6.5	11	3.9	0.9	0.3	0.1	22.7
Ansul 2010	B4	3.6	6	2.3	0.6	0.1	0.1	12.7
Buckeye 2009	C1	6.9	8.9	7.1	7.3	3.4	1.4	35
National Foam 2005	D1	4.1	8	2.6	1.9	0.7	0.7	18
National Foam 2005	D2	4.2	7.4	2.6	2.2	0.7	0.8	17.9
National Foam 2008	D3	5.9	12	3.5	3.2	0.9	1	26.5

Summary of PFAS Laboratory Data, Sep 2013 to May 2014	PFBS	6:2 FtS	PFHxA	PFHxS	PFHpA	8:2 FtS	PFOS	PFOA	PFOSA	PFNA	PFDA	Total PFCs	
Daniel Hirth ecoforum 2014	C4	C6	C6	C6	C7	C8	C8	C8	C8	C9	C10		
	C4 - PFBS	C6 - 6:2 FtS	C6 - PFHxA	C6 - PFHxS	C7 - PFHpA	C8 - 8:2 FtS	C8 - PFOS	C8 - PFOA	C8 - PFOSA	C9 - PFNA	C10 - PFDA		Sampled
Tyco/Ansul Ansulite ARC 3-6%	0	145	170	0	0	0	**0**	79	0	0	0	**394**	30/01/2014
Angus Fire FP70 Plus	0	244	1.27	0	0	125	0.66	22.1	0	0	0	**393**	30/01/2014
Chemguard T-Storm F-603B		1,166	558		6		4	155		10		**1,899**	2/05/2014
Chemguard T-Storm F787B		931	40.8			20		152		7.8		**1,152**	2/05/2014
Chemguard T-Storm FC-601A		1,811	2,360	6.7	87.6	625		196		17.4	4.4	**5,108**	2/05/2014
Chemguard T-Storm WC103		2,714	188		127	170		190		7.4	21.5	**3,418**	2/05/2014
Sample-N	1390	4240	2800	8900	0	0.53	35,800	1260	0	0	0	**54,391**	27/09/2013
Sample-S	0.01	4520	1160	22.8	0	1280	149,000	330	0	0	0	**156,313**	27/09/2013
Sample-W	0.01	254	0	0	0	0.05	67	22.2	0	0	0	**343**	27/09/2013
	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	ug/L	
EQL	0.02	0.1	0.02	0.02	0.02	0.5	0.02	0.02	0.02	0.02	0.02		

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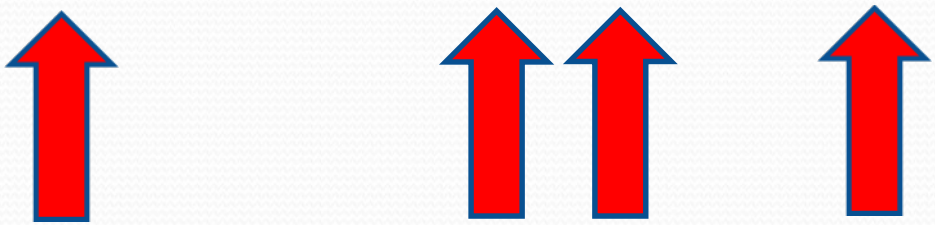

Hirth et al 2014 – look out for the residual PFOS and PFOA and PFNA in the foam with PFAS make up

The Precautionary Principle (Rio 1992)

- **Where there is insufficient scientific evidence upon which to base a decision, i.e.., scientific uncertainty, a conservative or precautionary approach must be taken, especially if there are suspicions, indications or reasonable scientific plausibility of possible adverse effects, especially in the long term.**

Q6 – Has there been class action?

2018-06-26

Bloomberg Markets Tech Pursuits Politics Opinion Businessweek

3M Settles Minnesota Lawsuit for $850 Million

By **Tiffany Kary**

February 21, 2018, 4:53 AM GMT+8 *Updated on* February 21, 2018, 8:02 AM GMT+8

- 2010 suit alleged cancers, colitis linked to Scotchgard toxin
- Chemicals not a health risk at current exposures, 3M said

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DuPont, Chemours to pay $670 million over PFOA suits

Jeff Mordock, The News Journal Published 8:14 a.m. ET Feb. 13, 2017 | Updated 8:08 a.m. ET Feb. 14, 2017

(Photo: DANIEL SATO/THE NEWS JOURNAL)

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The $670.7 million settlement DuPont and Chemours will pay plaintiffs to settle 3,550 lawsuits related to the release of PFOA, a toxic chemical, is good news for the companies and the plaintiffs, at least according to legal experts and Wall Street analysts.

For the Wilmington-based companies, with a combi
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2

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DUPONT PLANT ACCUSED OF RELEASING MORE TOXINS INTO RESIDENTIAL AREA

By Janene Pieters on July 20, 2016 - 08:30

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Oakey residents given final clearance for class action against Department of Defence

By Katherine Gregory

Posted 17 Mar 2017, 5:35pm

Lawyers representing residents in Oakey say they have the final clearance to commence a class action against the Department of Defence.

About 450 residents are demanding financial compensation for their dwindling property prices, because of contaminated groundwater emanating

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Breaking news 90,000 people have added themselves to the electoral roll ahead of same-sex marria

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Williamtown residents angry over revelations Defence delayed information on contamination

PM By Katherine Gregory

Posted 12 May 2017, 5:45pm

Residents of Williamtown in NSW have expressed their anger with the Department of Defence after revelations it delayed informing them about contamination in their water supply.

An independent review into how the NSW Environmental Protection Authority managed the contamination found Defence knew about the problem years before informing residents.

Q7 – How does it affect my work?

To think about

1. Are you doing a point in time only measurement (snap shot) or continuous over a period of time to monitor the contamination
2. Do you know the latest information – science, regulation and policy to act upon or give proper advice
3. Did you provide informed advice to your clients or Board the latest information – science, regulation, policy, thinking
4. Did you forewarn your clients or Board of potential changes in regulation and policy for their decision making or just use the regulation and policy of the day and assume they wont change for some time
5. Did you advice your clients of the risks and consequence of not complying to global best practice let alone legislation and policy and thinking to prevent PFAS impact from their operation
6. Did you consider worst case scenario of class actions and liability for your client or your organisation or even yourself
7. How did you advise your client or Board on closure to reduce risks and liability

Jimmy Seow PhD
Director
ENVIRON PTY LTD

Mobile: +61 432 875 807
Perth Western Australia
Email: jimmyseow@environwa.com.au
www.Linkedin.com/in/jimmyseow
www.environwa.com.au

Adjunct Associate Professor Murdoch University
Adjunct Associate Professor Curtin University

The Training Workgroup continues to plan additional webinars intended to inform and engage. Let us know if you have ideas for future webinar topics or presenters.

Please give us your feedback through the post-webinar survey.

Thank you for attending.