

‘Emerging Contaminants’ in Biosolids – Impact and Solutions



Dr Bradley Clarke

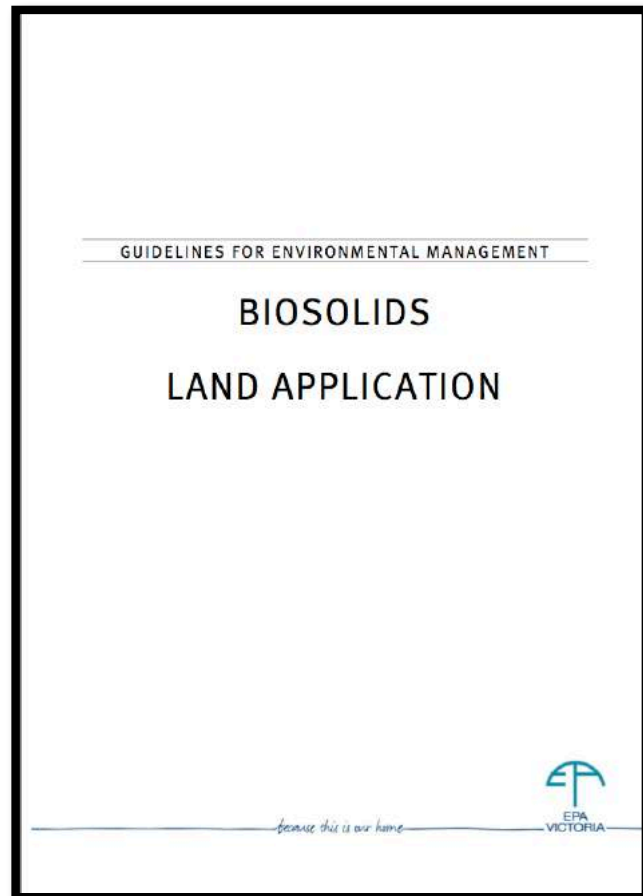
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Bradley Clarke



State

- Environment Protection Act 1970
- Agricultural and Veterinary Chemicals (Control of use) Act
- Food Act 1984

Compound	Minimum					Maximum					NEPC
	Nat	Vic	WA	SA	NSW	Nat	Vic	WA	SA	NSW & Qld	
ΣDDT	0.5	0.5	0.5	-	0.5	1	1	1	-	1	200
Aldrin	-	-	0.02	0.02	0.02	-	-	0.5	-	1	10
Chlordane	-	-	0.02	0.02	0.02	-	-	0.5	0.5	1	50
Dieldrin	-	-	0.02	0.02	-	-	-	0.5	0.5	1	10
Hepachlor	-	-	0.02	-	-	-	-	0.5	-	1	10
HCB	-	-	0.02	-	0.02	-	-	0.5	-	1	-
Lindane	-	-	-	-	-	-	-	-	-	-	-
ΣOCPs	0.05	0.05	-	-	-	0.5	1	-	-	-	-
PCBs	0.05-0.3	0.2	0.3	-	0.3	0.5	1	0.5	-	1	10

Federal

- Australian New Zealand Food Authority (ANZFA) Food Standards Code

- National Environment Protection (Assessment of site contamination) Measures



Environment

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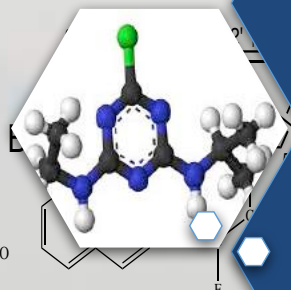
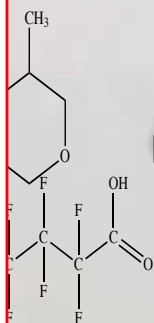
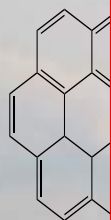
environment wherever practicable;

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d serious
e

Assessing Risk

Exposure Pathways

1. Direct Exposure
2. Plant Uptake
3. Grazing Animals
4. Groundwater



Toxicology



Occurrence

Exposure Pathways



Relying on natural attenuation processes



Example 1

PFAS

**Poly and perfluoroalkyl
substances**

An international contaminant of emerging concern

NEWS

Oakey residents fear contaminated groundwater from aviation base may have impacted town water supply

By Isobel Roe

Updated Thu 2 Jun 2016, 12:51pm

There are growing fears in the southern Queensland Darling Downs community of Oakey that chemicals in the town's groundwater have also affected the town water supply.



Williamstown chemical contamination fallout

Coverage of the Williamstown RAAF chemical contamination from ABC Newcastle.

TOXIC FALLOUT

NEWS

Fiskville report: Firefighters deserve 'justice' over toxic CFA training facility, report finds

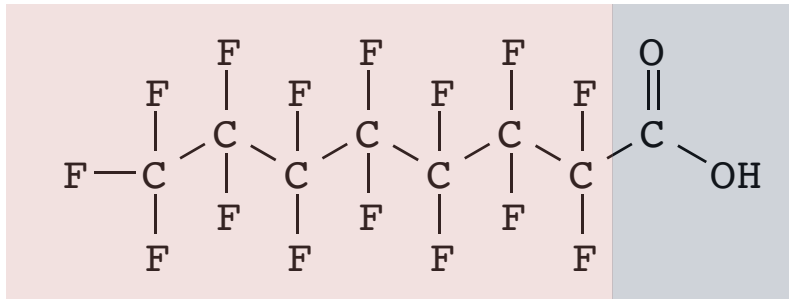
Updated Tue 24 May 2016, 5:09pm

Department of Defence recommends not drinking groundwater in investigation area (Department of Defence, 2014)

NSW government adds recommendation for limited consumption of home grown produce in contaminated area (NSW EPA, 2016)

What are PFAS?

PFOA



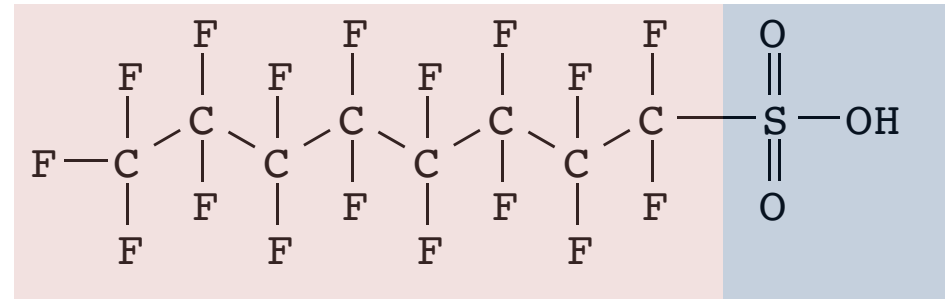
Half-life Water >92 years

(USEPA, 2014)

- Persistent (UNEP, 2009)
- Mobile (Munoz et al., 2015)



PFOS



Half-life Water >42 years

(USEPA, 2014)

- Bioaccumulative (Conder et al., 2008)
- PFOS - Stockholm convention (OECD, 2009)



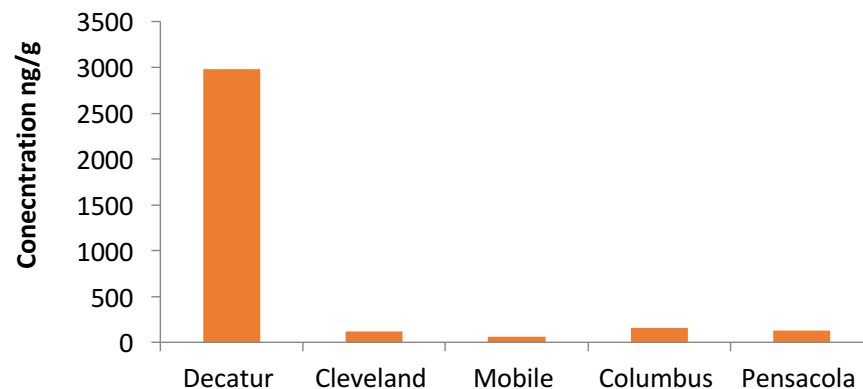
Incident 1:

Decatur, Alabama



- In 2009 EPA found elevated levels in soil (Renner, 2009)
- Accepted waste from fluorinated chemicals manufacturer (3M, Daikin), one user (Toray Fluorofibers, metal platers and landfill leachate (Renner, 2009)

PFOS in Biosolids (3M, 2001)



- Applied fluorinated contaminated biosolids >10yrs
- Contaminated local drinking water wells (Renner, 2009)
- 25% exceeded the USEPA provisional health advisory limit (USEPA, 2009)

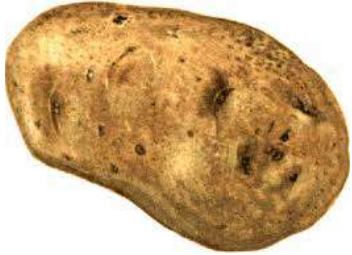

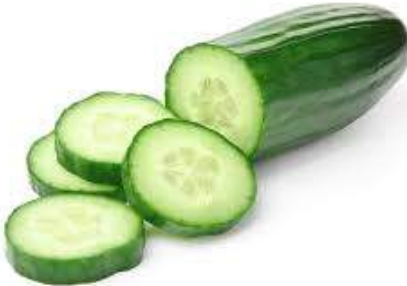
Incident 2: Sauerland, Germany

- Industrial waste with high concentrations of PFC was manufactured into a soil improver by a recycling company and spread by farmers on agricultural land of the rural area Sauerland, and led to substantial environmental pollution (Wilhelm, 2008)
- In parts of the affected area, perfluorooctanoic acid (PFOA) concentrations in drinking water were $> 500 \text{ ng/L}$ (Wilhelm, 2008)



**50,000 to 5 million
people exposed to
elevated PFOA for
years**

Plant Uptake (Lechner, 2011)

	Potato	Carrot	Cucumber
			
Transfer Factors [Plant]/[Soil]	↓	↓	↓
	PFOS 0.36 PFOA 0.40	PFOS 0.38 PFOA 0.58	PFOS 0.17 PFOA 0.88

Transfer from “soil to crops” provides a possible explanation for the presence of PFCs in foodstuffs and human body (Stahl, 2009).



Example 2

Brominated Fire Retardants (BFRs)

[illegible]

Schedule B7

Health Investigation Level

PBDEs in Soil

2013

- Ingestion of soil
- Ingestion of home-grown produce
- Dermal adsorption

ubs/actionplans/deccadbe.html
d on Wednesday, April 28, 2010

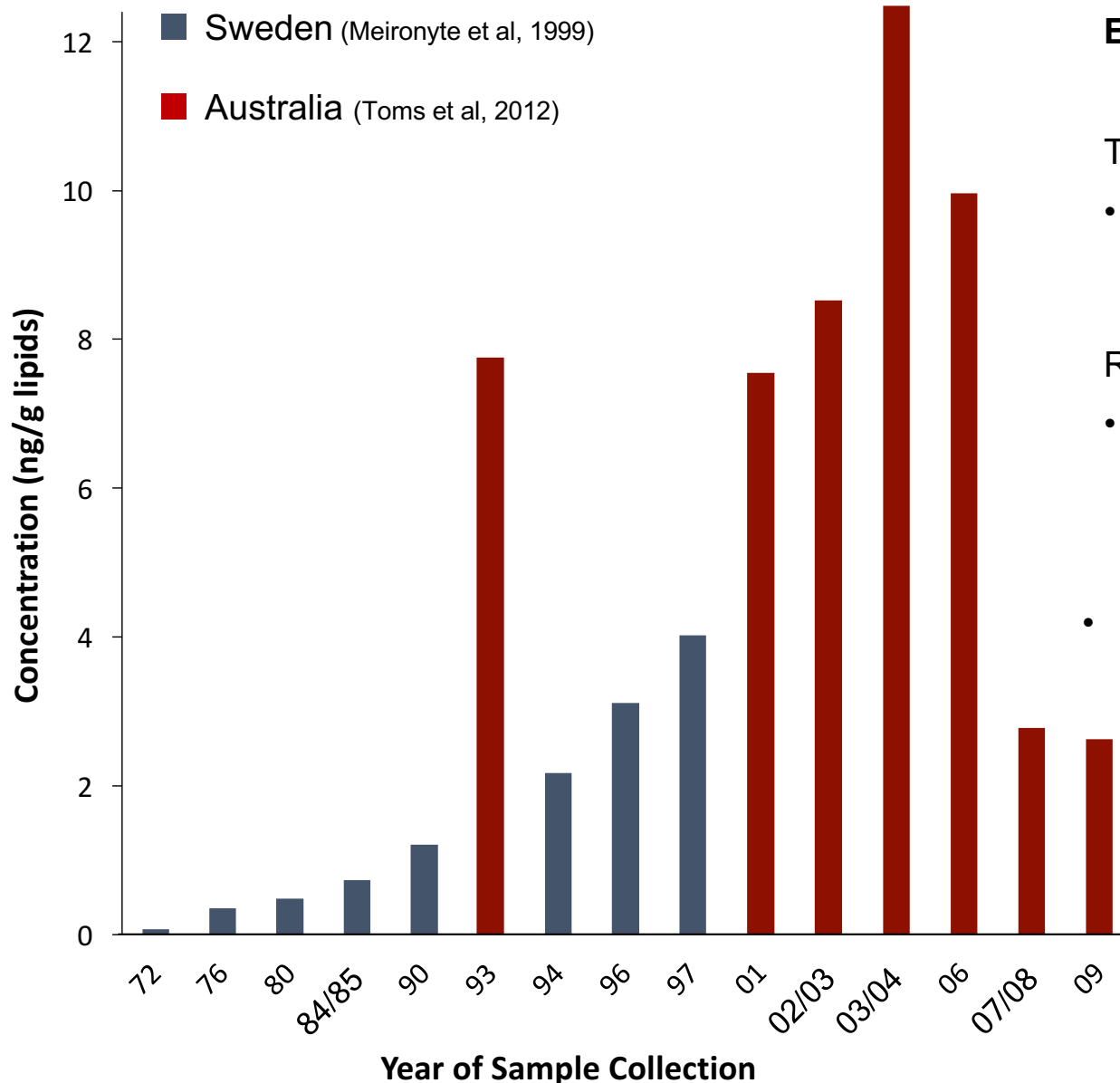
APPENDIX A5

The Derivation of HILs for PCBs and PBDEs

m Convention

Organic Pollutants (POPs)

Bioaccumulation and Toxicity



Mean Σ PBDE concentrations in human milk from Australia and Sweden

Endocrine Disruption:

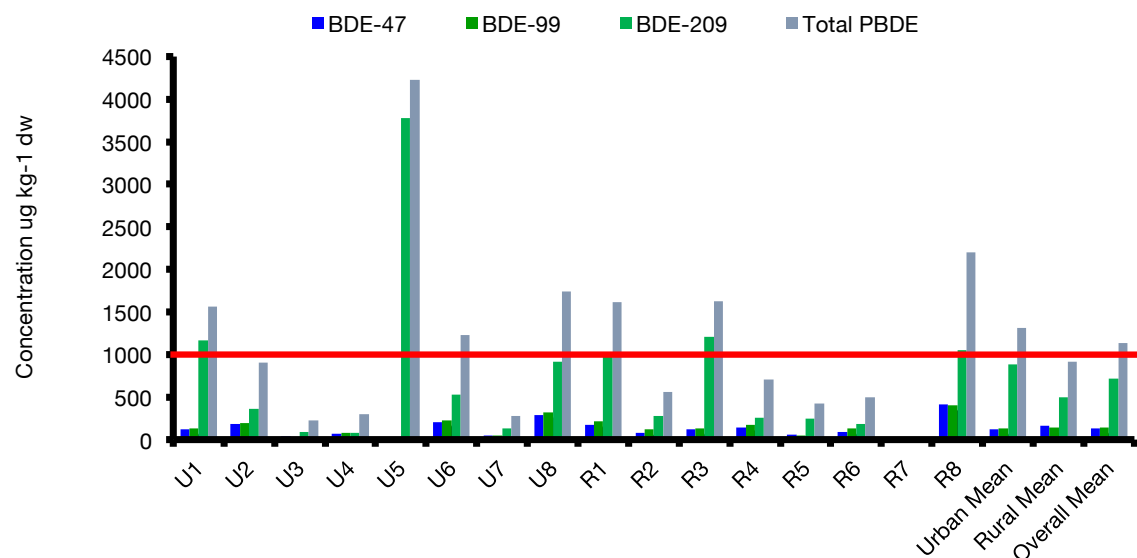
Thyroid hormones (Johnson et al 2013)

- Significant in growth and development

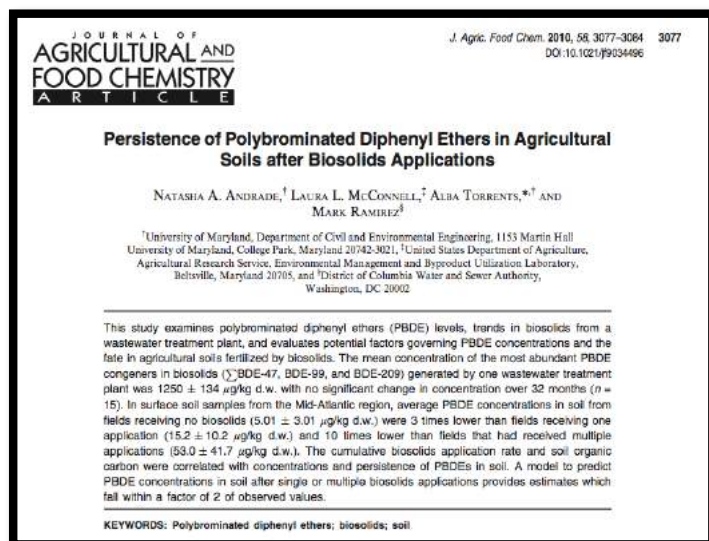
Reproductive hormones (Liu et al, 2011)

- Effects to testosterone and estrogen regulation
- Hepatic and neurodevelopmental effects (ATSDR, 2004)

Present in Biosolids



Persistent in Soil



- Actual half-life unknown
- Elevated levels 20 years after last known application

What are the legal implications of applying biosolids that contain PBDEs to land?

Capable of Transfer to Grazing Animals

Fate of Higher Brominated PBDEs in Lactating Cows

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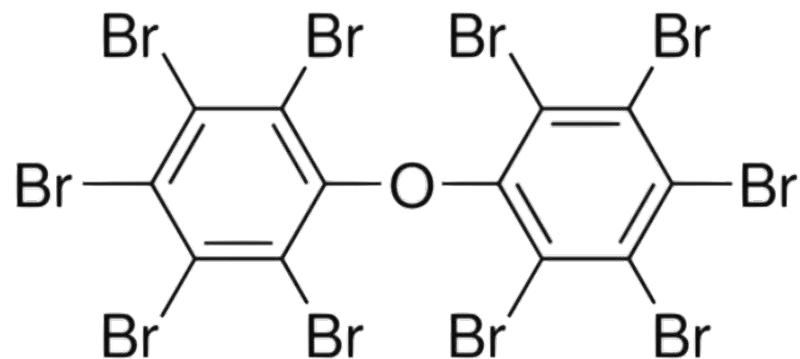
Department of Environmental Science, and Centre for Chemicals Management, Lancaster Environment Centre, Lancaster University, Lancaster LA1 4YQ, U.K.

Environment Protection Act

- At what point is there serious or irreversible damage?

BDE209

Source of
breakdown
compounds





Example 3 microplastics

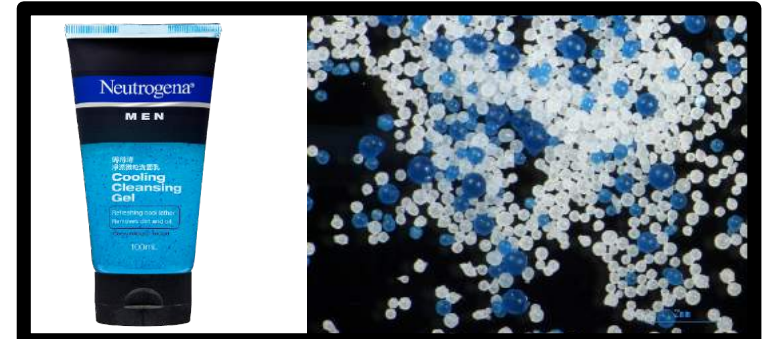
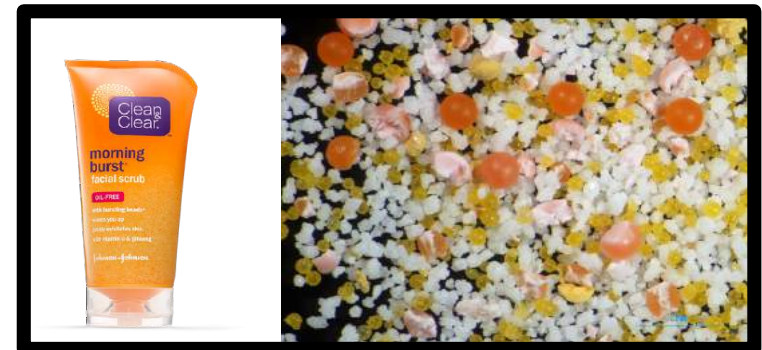
What's entering the WWTP system?



There are thousands of consumer products that microplastics particles are incorporated and this is a worldwide issue.



- **Per capita daily emissions (USA, 2009)**
 - 2.4 mg/person/day
 - 180 particles/person/day
- **Annual emissions (USA, 2009)**
 - 267 tonnes
 - 2.0×10^{13} particles (20,000 billion particles) (Goiun, 2011; 5Gyres, 2013)





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Persistent Organic Pollutants Research Group



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Acknowledgements



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Australian Contaminated
Land Consultants Association

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