streamlined
ENVIRONMENTAL

Literature assessment of emerging contaminants in wastewater: Recommendations for monitoring

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Author background

- PhD in Chemistry
- 9 years as organic NP chemist
- Last 9 years as Environmental Chemist (previously NIWA)
  - Legacy contaminants
  - Emerging contaminants
  - Advice and reviews for RCs
  - Research
  - Chemical ecology

- PhD in Environmental Science
- Experienced aquatic Ecologist/Ecotoxicologist (27 years)
- Human impacts on freshwater and estuarine ecosystems
- Science communication and education

Project Background

- As part of re-consenting of Omaha WWTP, Watercare Services Ltd (WSL) are preparing an Assessment of Environmental Effects
  - Multiple workstreams
- Lack of information on Emerging Contaminants (ECs) in WWTP effluent or the marine receiving environment
- WSL commissioned review of ECs
  - Tremblay and Northcott (2015) recommendations
    - Measuring ECs in WWTP effluent, environmental soils and groundwater
    - Determining risk of ECs to Whangateau Harbour
- WSL commissioned Streamlined Environmental to proceed with phase 2

Phase 2 – Initial scope

1. Assess the literature available on ECs[1] and confirm a list that will be relevant, detectable and potentially an issue for the receiving environment of the Whangateau Harbour
2. Present the outcomes of task 1 above to the Omaha WWTP Consultative Group

[1] Primarily Tremblay and Northcott (2015) and Stewart et al. (2009, 2013, 2014)

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What are Emerging Contaminants?

- Emerging contaminants (ECs) are chemical or microbial agents that are not regulated against
  - Industrial chemicals, Pharmaceuticals and Personal Care Products, Pesticides, (microbes, nanoparticles…)
  - ECs can be manmade or natural
  - ECs can be diffuse or point source
    - Major diffuse sources are agriculture
    - Major point sources are WWTPs & septic tanks
  - Highly diverse effects, uses, chemical properties, stability and production
    - Effects are generally more long-term or inter-generational than acute
    - Uses include industrial, medicines, personal care products, agriculture & horticulture
    - Vast numbers and properties
  - Many knowledge gaps

Approach

- Assess report of Tremblay and Northcott (2015)
  - Confirm recommended list of ECs (“T&N List”)
- Perform risk-based assessment
  - Confirm high-risk priority list (“Focused List”)
- Combine and validate lists (“Initial List”)
- Provide recommended list for analysis (“Final List”)

T&N list

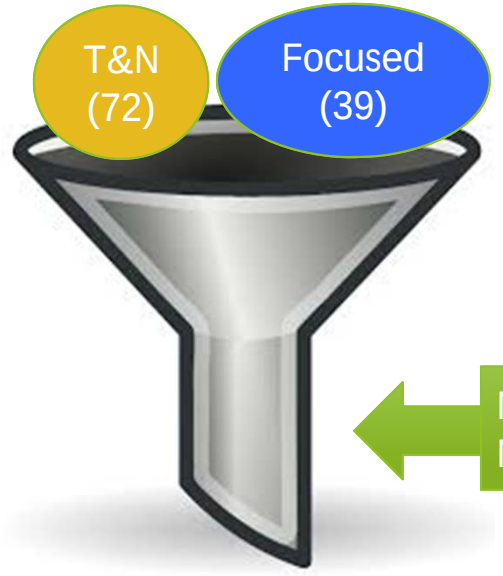
- Tremblay and Northcott (2015) (T&N) recommended the inclusion of **72** ECs for WW monitoring;
  - Based on a current study in Gisborne, for which very limited data are currently available
  - The choice of ECs to include was based *primarily* on evidence for their *presence* in New Zealand or international wastewaters
  - However, mere presence does not necessarily equate to ecological or human risk
  - Some ECs that are shown to be present in the NZ receiving environment are not included in this list, e.g. BDE flame retardants and glyphosate
- Our view is that the T&N list is too large and not representative enough
  - Consolidation and validation is required
- We believe that a risk-based approach is a more scientifically robust way of selecting a subset of ECs for monitoring wastewaters

Risk-based method

- Two recent US studies* used a *conservative* risk-based approach to prioritise a large number of ECs for wastewater monitoring
- Both studies used a panel of experts
  - Anderson: 1000s ECs ➔ 15 high risk ECs
  - Diamond: 516 ECs ➔ 24 high risk ECs
- Anderson also provided recommendations for receiving environment monitoring

*Anderson et al., 2012 and Diamond et al., 2010

Initial List



NZ relevance: HSNO/PHARMAC
NZ Literature

Initial list
(41)

Final List

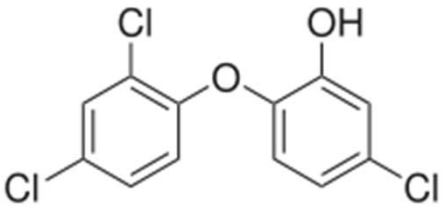
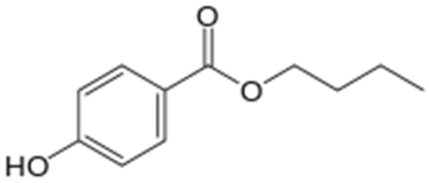
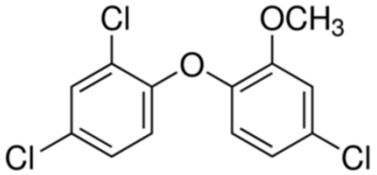
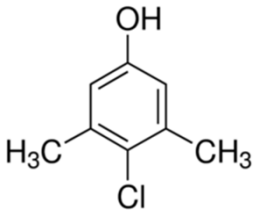
Maximum 2 ECs per class
Highest use and/or reported concentration

Final list
(26)

Final List

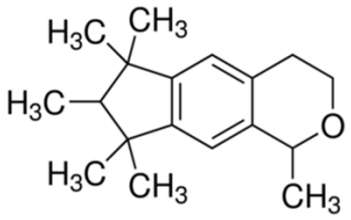
Analyte	Class
Triclosan	Anti-microbial
Paraben (TBC)	Anti-microbial
Paraben (TBC)	Anti-microbial
Methyl triclosan/chloroxylenol (TBC)	Anti-microbial
Galaxolide	Deodorizer/Fragrance
Tonalide	Deodorizer/Fragrance
Tamoxifen	Estrogen receptor antagonist
BDE47	Pentabrominated DPE flame retardant
BDE99	Pentabrominated DPE flame retardant
BDE209	Decabrominated DPE flame retardant
Alkylphosphate flame retardant (TBC)	Alkylphosphate flame retardant
Alkylphosphate flame retardant (TBC)	Alkylphosphate flame retardant
Glyphosate	High use herbicide
Estrone	Steroid hormone
17β-estradiol	Steroid hormone
17α-ethinyl estradiol	Synthetic steroid hormone
Diclofenac	NSAID
Ibuprofen	NSAID
Acetaminophen (provisional)	NSAID
Chlorpyrifos	Organophosphate Insecticide
Bifenthrin	Pyrethroid Insecticide
Permethrin	Pyrethroid Insecticide
4-Nonylphenol	Surfactant
Bisphenol A	Plasticizer
DEHP	Plasticizer
BBP	Plasticizer

Anti-Microbials

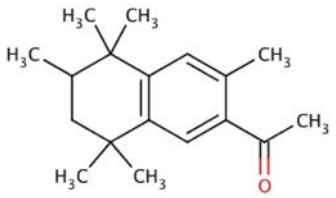
 **Triclosan** Widely used in consumer products, including soaps, detergents, toys and, surgical cleaning treatments	 **Parabens (x2)** Widely used preservatives in cosmetic and pharmaceutical products
 **Methyl Triclosan*** Environmental transformation product of triclosan	 **Chloroxylenol*** Used in hospitals and households for disinfection and sanitation

* One of methyl triclosan/chloroxylenol

Fragrances

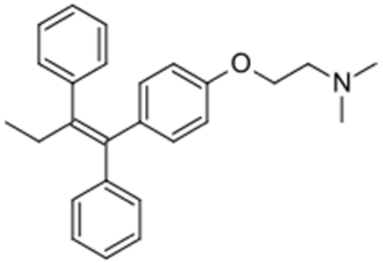
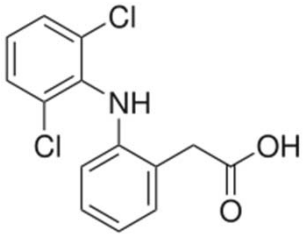
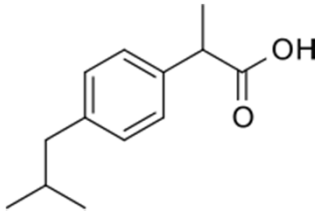
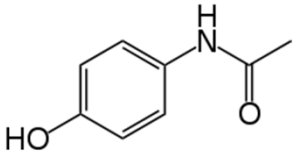


Galaxolide
Perfume with broad use in cosmetics and detergents

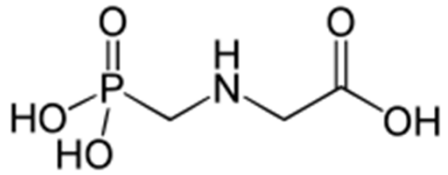
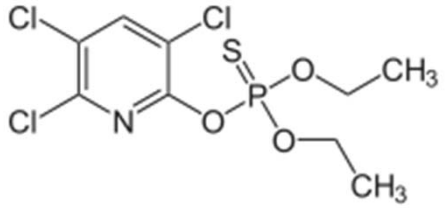
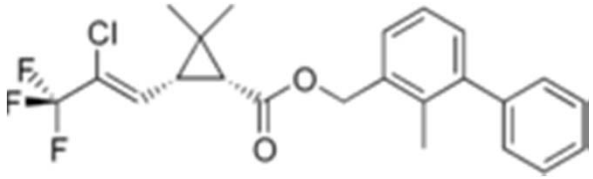
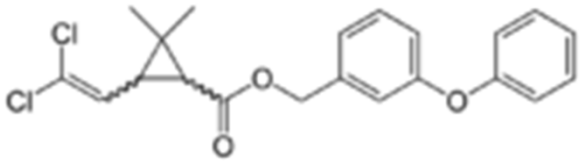


Tonalide
Perfume with broad use in cosmetics and detergents

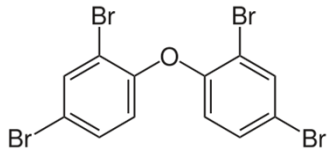
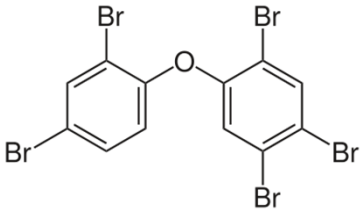
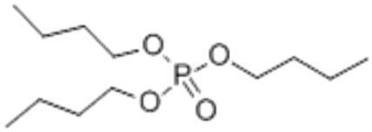
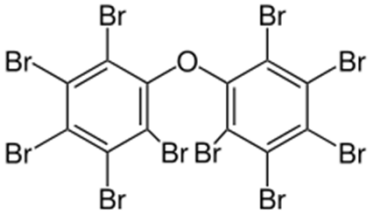
Pharmaceuticals

 **Tamoxifen** Multiple medical uses	 **Diclofenac (Voltaren)** NSAID (pain, inflammation) 17th most prescribed drug in NZ plus OTC
 **Ibuprofen (Nurofen)** NSAID (pain, inflammation) 7th most prescribed drug in NZ plus OTC	 **Acetaminophen (Paracetamol)** NSAID (pain, inflammation) Most prescribed drug in NZ plus OTC

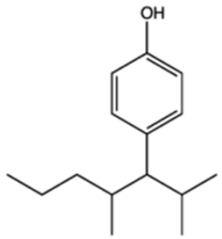
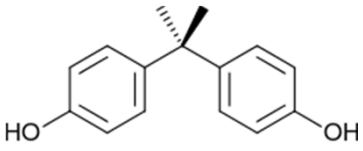
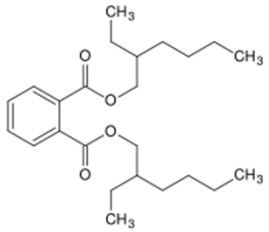
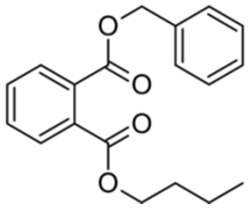
Pesticides

 **Glyphosate** Most widely used herbicide in the world. WWTPs contribute to glyphosate (and AMPA breakdown product) in the environment	 **Chlorpyrifos** Organophosphate pesticide mainly used in agriculture but is controversial pesticide
 **Bifenthrin** Pyrethroid used in the household, agriculture and horticulture	 **Permethrin** Pyrethroid used in the household, agriculture and horticulture

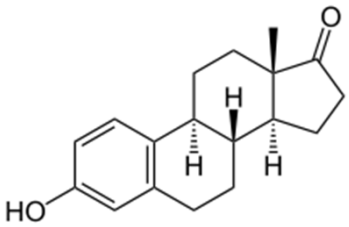
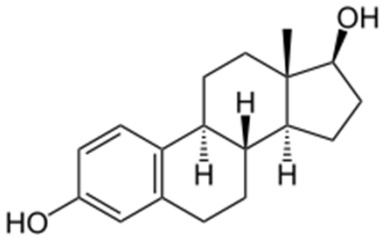
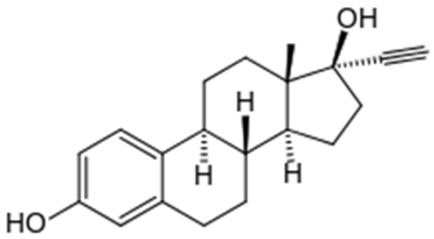
Flame retardants

 **BDE-47** Used primarily in polyurethane foam used for furniture Listed as POP in Annex A of Stockholm Convention	 **BDE-99** Used primarily in polyurethane foam used for furniture Listed as POP in Annex A of Stockholm Convention
 **Phosphate flame retardants (x2)** Widely used in standard and engineering plastics, polyurethane foams, thermosets, coatings, and textiles	 **BDE-209** Used commonly in rigid plastics, resins and coatings 90% of total BDEs Undergoes debromination

Surfactants and Plasticisers

 **4-Nonylphenol** Main breakdown product of large volume nonylphenol ethoxylate surfactants	 **Bisphenol A** Widely used plasticiser
 **DEHP** Widely used phthalate plasticiser	 **BBP** Phthalate plasticizer in vinyl foams, often used as floor tiles

Steroid estrogens

 **Estrone** Natural estrogenic steroid Also used in pharmaceuticals	 **17ß-estradiol** Primary female sex hormone Also used in pharmaceuticals
 **17α-ethinyl estradiol** Synthetic oral contraceptive	

Next Steps

1. Finalise analytical laboratory capability for recommended list
   - In progress
   - Likely AsureQuality and Plant & Food/Northcott Consultants
2. Measure ECs in Omaha WWTP effluent
3. Assess potential risks to receiving environment
4. Decide on pragmatic way forward based on results of points 2 and 3