

Attachment 3: Summary of sediment and biota accumulation by EOCs and PPCPs

Question 8 from Auckland Council's S92 response for the application by Watercare to consent Beachlands WWTP is provided below.

"Sediment bioaccumulation risks of emerging organic contaminants (EOCs): Based on the authors' knowledge about sediment bioaccumulation of EOCs and available data, please provide an assessment as to the risk / potential of analysed personal care products and pharmaceuticals (PCPPs) (and other EOCs, where applicable) in the Beachlands WWTP discharge to sediment bioaccumulation in the downstream receiving environment, both at the Bridge Site (Site 15) and estuary."

This attachment provides the response to this question.

PPCPs were not measured in the sediment from the receiving environment sites (we note sediment was collected from upstream farm pond (A), farm pond (B), and Bridge (15) sites once on 10 November 2023). Further, the literature data used for EOCs was as a water concentration. Our understanding is that this is primarily unfiltered so will be total rather than dissolved concentrations.

As we have no measured sediment concentrations, we can't compare these concentrations with sediment effects thresholds such as predicted no effects concentrations (PNECs). Accurate derivation of a predicted effects concentration (PEC) for each chemical is complex (European Centre for Ecotoxicology and Toxicology of Chemicals, 2004) and requires detailed knowledge of the local conditions. Therefore, a high level assessment is provided here.

As EOCs/PPCPs are a large range of chemicals they will encompass a wide range of physico-chemical properties, ranging from highly water soluble to very low water solubility. However, predictions on how an individual chemical may partition between sediment and water can be made based on organic carbon normalised sorption coefficient (Koc) acknowledging that for most chemicals sorption is driven primarily by organic carbon content of the sediment. Further, although not specifically mentioned by Council, bioaccumulation in biota for most



chemicals occurs through a similar process. We have included a bioaccumulation concentration factor (BCF) for each. A summary of results is provided in **Table 1**, with discussion in the following sections.

Sediment accumulation

Koc provides the organic-carbon normalised distribution coefficient potential of a chemical. This is effectively the affinity of that chemical to sediment. The higher the affinity the less mobile the chemical is in the water phase. The FAO mobility classification¹ based on Koc is:

- <10 Highly mobile
- 10-100 Mobile
- 100-1,000 Moderately mobile
- 1,000-10,000 Slightly mobile
- 10,000-100,000 Hardly mobile
- >100,000 Immobile

Bioaccumulation potential

Bioconcentration factors (BCF) may be used to estimate potential bioaccumulation of EOCs in biota. Although the bioaccumulation factor (BAF) is more ecologically relevant than BCF because it includes dietary, respiratory, and dermal exposures, it is calculated from field-caught fish, so requires EOC measurements (Costanza et al., 2012). Costanza et al. (2012) also showed that for the majority (86%) of high and medium production volume chemicals there was no difference between BCF and BAF. The US EPA define a chemical with a BCF <1000 as having a low bioconcentration potential (US EPA, 2012), while ECHA define a chemical as fulfilling the bioconcentration criterion when BCF >2000 (European Chemicals Agency, 2017).

Discussion

This high level assessment shows that 8 out of 54 EOCs have high soil/sediment affinity and potential for bioaccumulation in biota: the surfactant nonylphenol; the antimicrobials chlorophene and triclosan; the fragrances galaxolide and tonalide; and the plasticisers BBP, DPB, and DEHP. All 8 were assessed in the effects assessment report as low ecological risk in water.

As stated previously EOCs were not measured in the receiving environment sediment so a direct assessment cannot be made of those concentrations with sediment PNECs. The 15% (8

¹ https://www.epa.gov/pesticide-science-and-assessing-pesticide-risks/guidance-reporting-environmental-fate-and-transport#II_C



out of 54) of the EOCs included in the effects assessment report that have the physico-chemical properties required to bind strongly to sediment are also bioaccumulative so are likely to be the highest risk in terms of accumulation in sediment and biota. However, toxicity (PNEC) to sediment dwelling organisms and higher trophic level biota would also need to be considered. For many EOCs these are provided by the NORMAN database for sediment, plus fish and mollusc (marine and freshwater) biota.

A complication of assessing bioaccumulation of EOCs in biota is that there is even less known about distribution of EOCs in biota than water and sediment. This would need to be a watching brief through a consent condition for monitoring (see below).

A more detailed assessment should be included as a consent condition, which specifically measures EOCs in receiving environment sediment (upstream, farm pond, site 15 and the estuary).

We note that the upgrade to MBR will reduced total suspended sediment in the WWTP discharge which will reduce the concentrations of EOCs with strong affinity to particulate matter, and more likely to bioaccumulate in biota, in the discharge and hence risk to sediment dwelling organisms and higher trophic level biota in the receiving environment.



Table 1. Summary of soil adsorption and mobility classification and potential for bioaccumulation of EOCs in biota. Koc and BCF were extracted from the Chemspider database² and are pH dependent for some chemicals. Chemicals which have the highest affinity for sediment and potential for bioaccumulation in biota are bolded red.

Class	Analyte	CAS#	Koc (pH 5.5/7.4)	FAO mobility classification	BCF (pH 5.5/7.4)	Potential for bioaccumulation in Biota?
Akylphosphate flame retardant	TBEP	78-51-3	1,814	Slightly	250	No
	TBP	126-73-8	2,565	Slightly	406	No
	TCEP	115-96-8	141	Moderately	7	No
	TCPP	13674-84-5	433	Moderately	34	No
	TDCP	13674-87-8	1,410	Slightly	176	No
	TiBP	126-71-6	2,458	Slightly	383	No
	TPP	115-86-6	4,135	Slightly	792	No
Alkylphenol	Tech-NP-equivalents	84852-15-3	51,196/51,148	Hardly	26,628/26,603	Yes/Yes
Antimicrobial	Chlorophene	120-32-1	5,300/5,280	Slightly	1,120/1,116	Yes/Yes
	Chloroxlenol	88-04-0	1,495/1,489	Slightly	191/190	No/No
Insecticide	DEET	134-62-3	392	Moderately	29	No
Nitro and polycyclic musk fragrance	Cashmeran	33704-61-9	3,863	Slightly	720	No
	Galaxolide	1222-05-5	40,212	Hardly	19,002	Yes
	Tonalide	21145-77-7	32,039	Hardly	13,834	Yes
Pharmaceutical	Acetaminophen	103-90-2	39	Mobile	1	No
	Carbamazepine	298-46-4	415	Moderately	32	No
	Diclofenac	15307-86-5	298/5	Moderately/Mobile	68/1	No/No
	Ibuprofen	15687-27-1	122/2	Moderately/Mobile	16/1	No/No
	Naproxen	22204-53-1	181/3	Moderately/Mobile	20/1	No/No
	Salicylic acid	69-72-7	1	Mobile	1	No/No
Plasticiser	BBP	85-68-7	8,300	Slightly	2,096	Yes
	Bisphenol A	80-05-7	2,242/2,240	Slightly/Slightly	337/336	No/No
	DBP	84-74-2	8,404	Slightly	2,133	Yes
	DEHP	117-81-7	480,322	Immobile	607,695	Yes
	DEP	84-66-2	715	Moderately	68	No

² <http://www.chemspider.com/>

Class	Analyte	CAS#	Koc (pH 5.5/7.4)	FAO mobility classification	BCF (pH 5.5/7.4)	Potential for bioaccumulation in Biota?
	DMP	131-11-3	252	Moderately	16	No
Plasticiser metabolite	MBP	131-70-4	7/1	Highly/Highly	1	No
	MEHP	4376-20-9	88/9	Mobile/Highly	25/2	No/No
	Monomethyl-PAE	4376-18-5	1	Highly	1	No
PFAS	PFOS	1763-23-1	1	Highly	1	No
	PFHxA	307-24-4	1	Highly	1	No
	PFHpA	375-85-9	2	Highly	1	No
	PFOA	335-67-1	5	Highly	2	No
	PFNA	375-95-1	17/16	Mobile/Mobile	11	No
	PFDA	335-76-2	46/43	Mobile/Mobile	44/42	No/No
PPCP	Acesulfame	33665-90-6	1	Highly	1	No
	Atenolol	29122-68-7	1	Highly	1	No
	Bupropion	34911-55-2	25/718	Mobile/Mobile	3/82	No/No
	Caffeine	58-08-2	34	Mobile	1	No
	Cotinine	486-56-6	25/29	Mobile/Mobile	1	No
	Diltiazem	34933-06-7	2/74	Highly/Mobile	1/10	No/No
	Diphenhydramine	58-73-1	3/106	Highly/Moderately	1/17	No/No
	Fluoxetine	54910-89-3	4/15	Highly/Mobile	1/3	No/No
	Gabapentin	60142-96-3	1	Highly	1	No
	Gemfibrozil	25812-30-0	690/11	Moderately/Mobile	137/2	No/No
	Lamotrigine	84057-84-1	111/194	Moderately/Moderately	6/11	No/No
	Metoprolol	37350-58-6	1/2	Highly/Highly	1	No
	Norcotinine	17114-40-8	13/15	Mobile/Mobile	1	No
	Sucralose	56038-13-2	19	Mobile	1	No
	Sulfamethoxazole	723-46-6	44/3	Mobile/Highly	1	No
	Triclocarban	101-20-2	45	Mobile	11	No
	Triclosan	3380-34-5	17,458/12,559	Hardly/Hardly	5,935/4,270	Yes/Yes
	Trimethoprim	738-70-5	1	Highly	1	No
	Venlafaxine	93413-69-5	1/24	Highly/Mobile	1/3	No/No

References

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