



# Managing the risks of microplastics when they don't reach the ocean

Dr Mike Williams | 6<sup>th</sup> August 2024

Australia's National Science Agency





I would like to begin by acknowledging the Wurundjeri people as the Traditional Owners of the land that we're meeting on today, and pay my respect to their Elders past and present.





# Plastics in the terrestrial environment

## Direct discharge

- Plastic products in the environment (tyre dust, artificial turf, pavements etc.)
- Micro- and nanoplastic (up to 150,000 t/yr land and ocean)

## Mismanaged waste “leakage”

- Litter, uncontained industrial sites
- Macro- and mesoplastics (up to 10,000 t/yr)

## Managed waste “leakage”

- Organic wastes, wastewater
- Microplastics (up to 1000 t/yr)



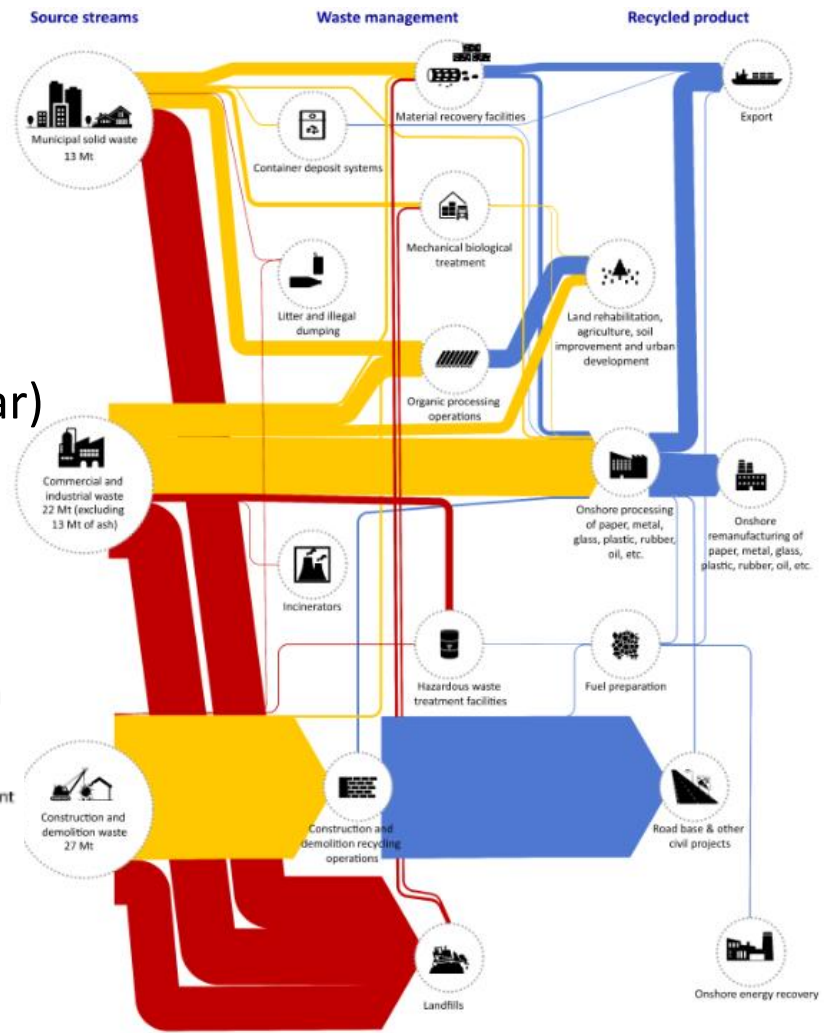
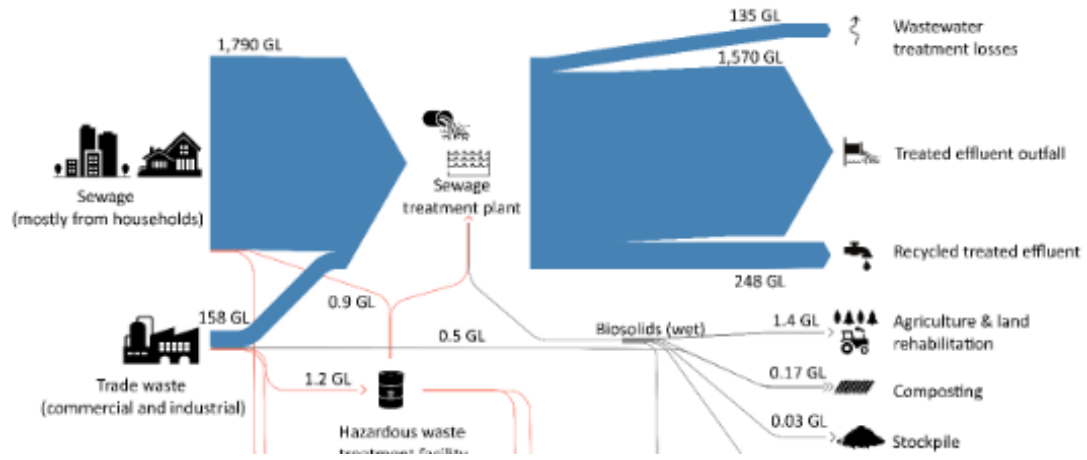
# Managed waste sources

Biosolids (~1.7 Mt/year)

Composts (~5.6 Mt/year)

Construction, industrial waste etc. (>30 Mt/year)

Wastewater (~1500 GL/year)



Based on 2019 data: <https://environment.gov.au/protection/waste/national-waste-reports/2020>



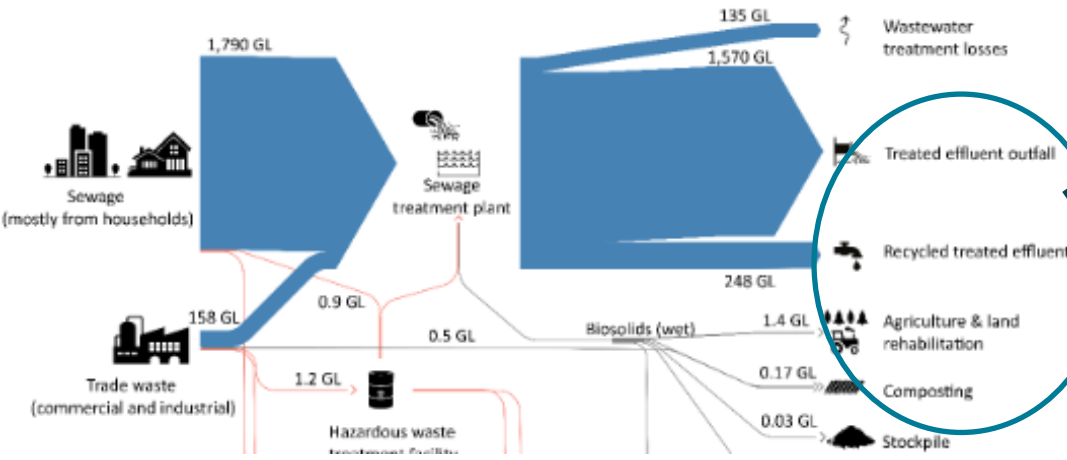
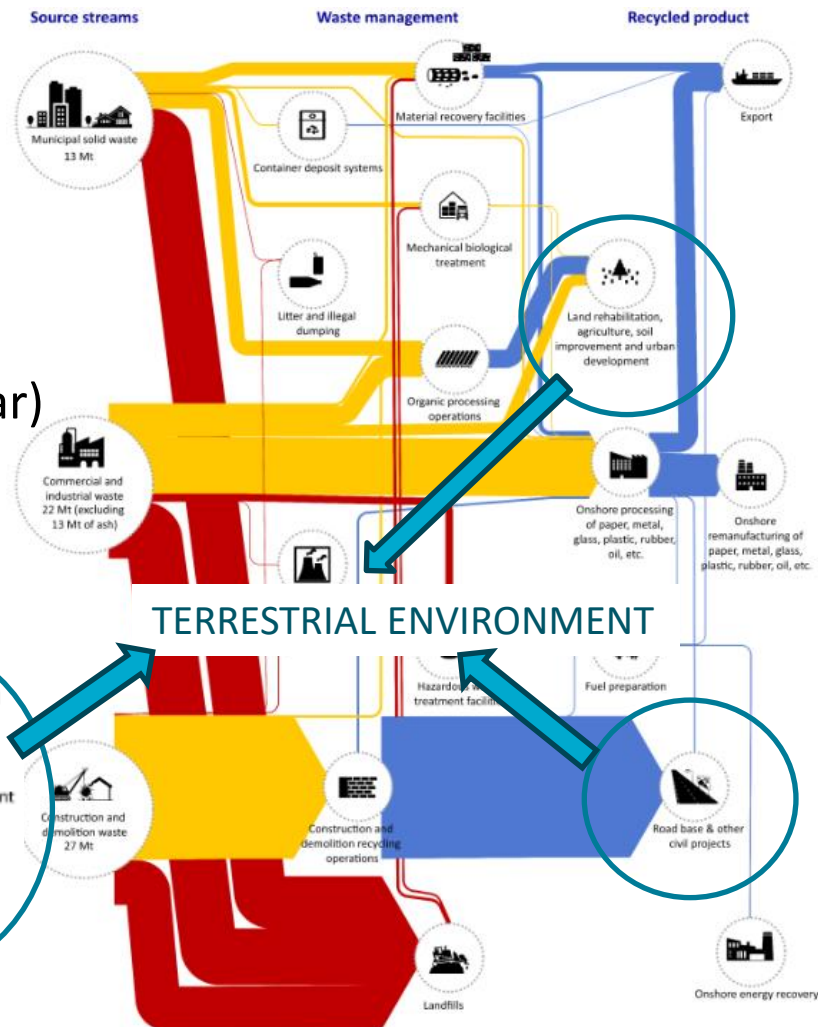
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TERRESTRIAL ENVIRONMENT

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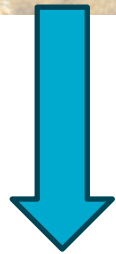
# Microplastics in organic wastes

## Biosolids

- ~1.4 Mt/yr to agricultural land
- Estimated up to 1000 t/yr MPs
- Measured 140-8000 t/yr<sup>#</sup> OR  $2 \times 10^{10}$ - $4 \times 10^{12}$  MPs/yr<sup>\*</sup>

## Other organic waste?

- Compost (~5.6 Mt/yr)
- Construction/industrial wastes (>30 Mt/yr)



<sup>#</sup>Okoffo et al. (2020) *ES&T* 54, 15132-15141; <sup>\*</sup>Ziajahromi et al. (2024) *Water Research* 250, 121071



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# Managing risks

How many?

Impacts?

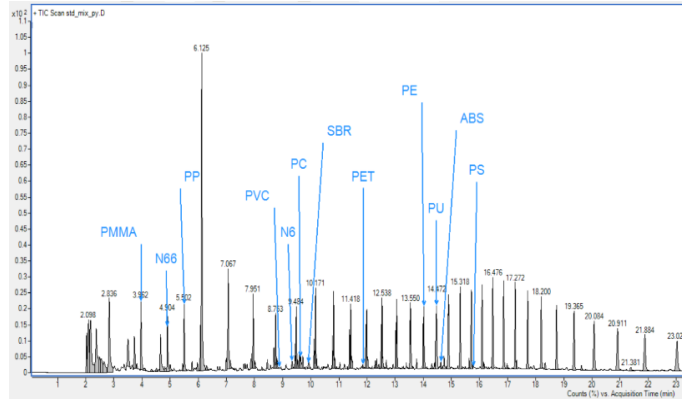
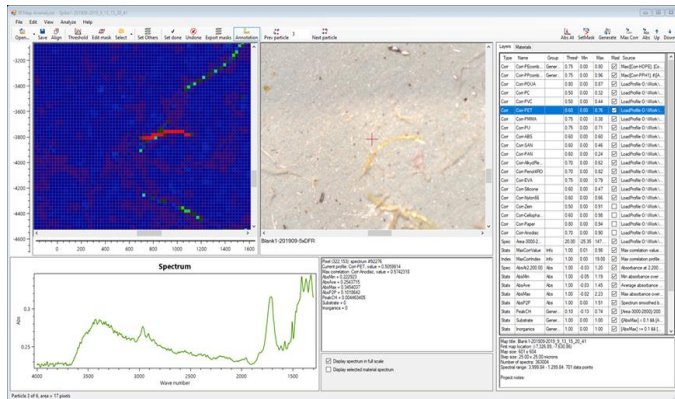
Risk reduction





# Managing risks

## How many?



What	IR Spectroscopy	Mass Spectrometry
Polymer	++	+
Number/Morphology	+	-
Mass	-	+
Sensitivity	+++	+
Time	+	++
Cost	+++	++



# Managing risks

How many?

Standardisation

- Sample collection, preparation, analysis



## Managing risks

How many?

Standardisation

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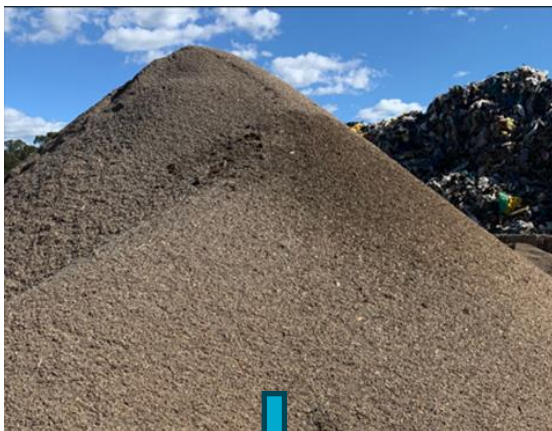


# Managing risks

How many?

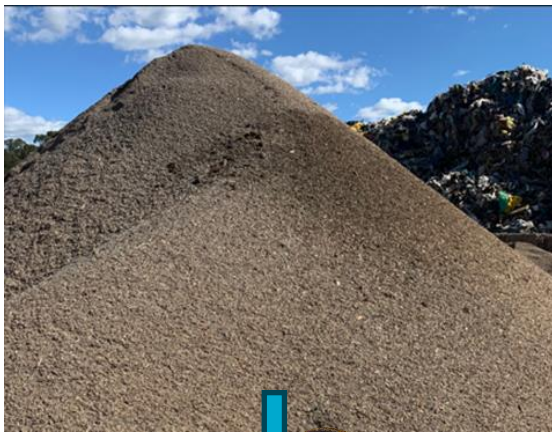
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## Managing risks



How many?

Standardisation

- Sample collection, preparation, analysis



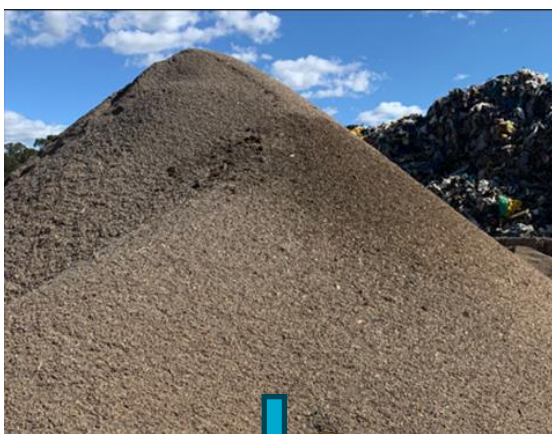


# Managing risks

How many?

## Standardisation

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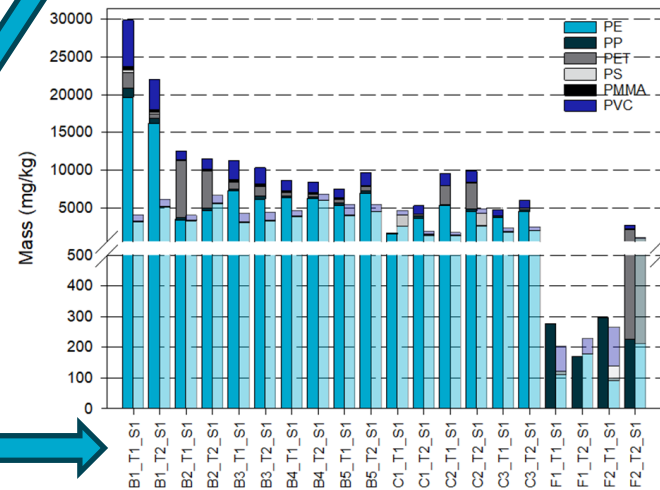
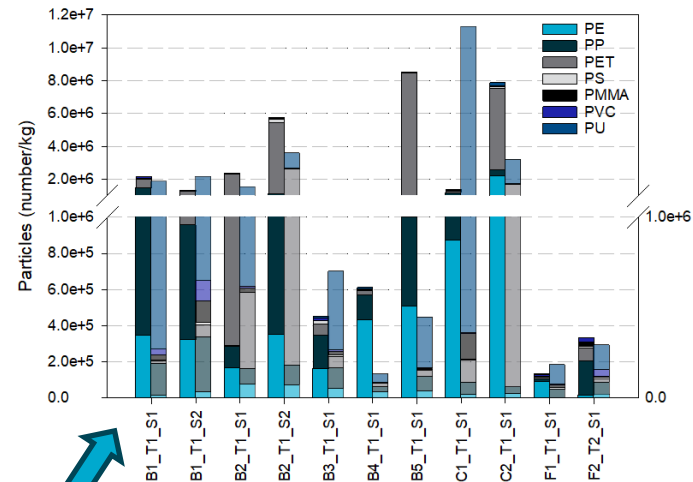
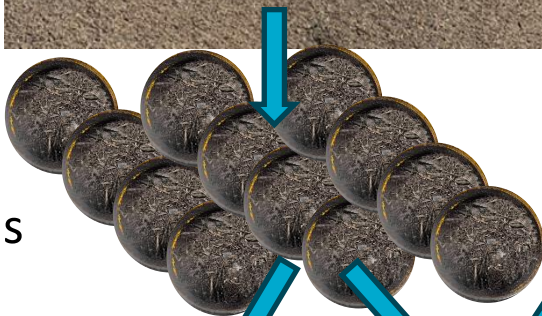
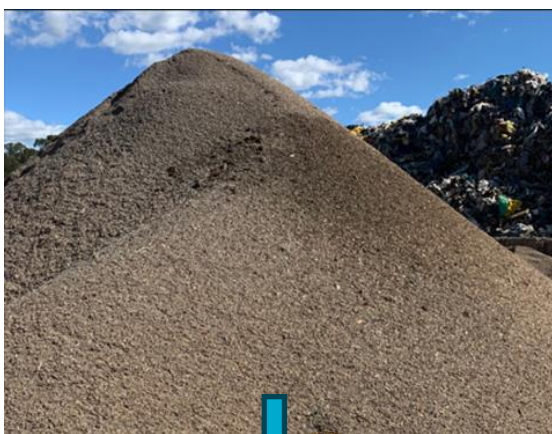


# Managing risks

How many?

Standardisation

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# Managing risks

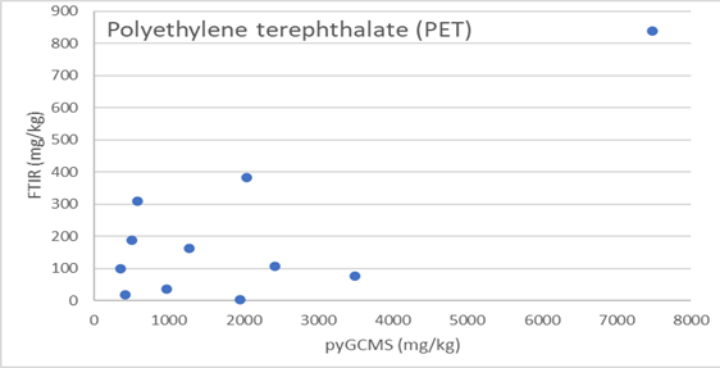
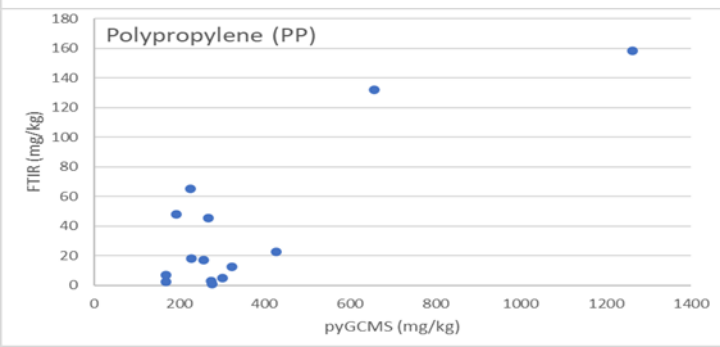
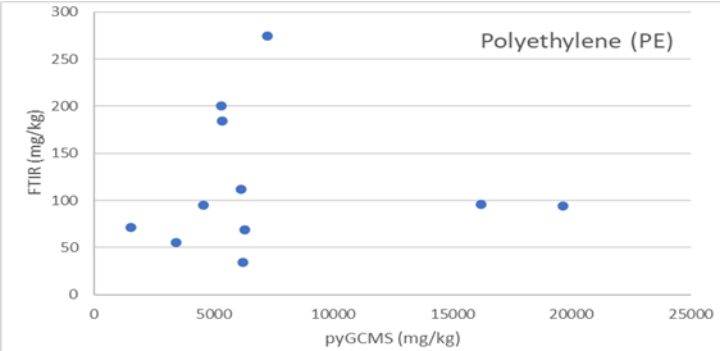
How many?

Standardisation

- Sample collection, preparation, analysis

Mass estimation?

- Polymer shape/density







# Managing risks

## How many?

## Standardisation

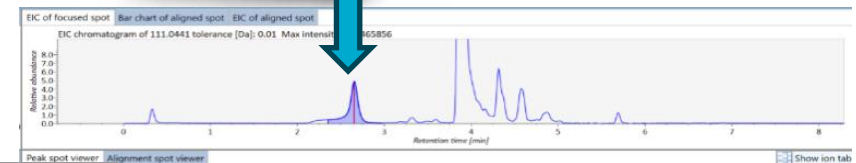
- Sample collection, preparation, analysis

## Mass estimation?

- Polymer shape/density

## Chemical additives?

- Plasticisers, flame retardants, lubricants etc.?



Identifiers		Substance Type		Confidence assignment	
Address	Chemical Name	Address	Chemical Name	Confidence	Assignment
0712	12607-76-0	Phenyl Ethanolamine	C271	0	1 0 0 0 0
0713	12189-89-0	1,2-Dimethoxyethane	IC81	0	1 0 0 0 0
0714	2425-29-3	2,6,5,3,5,5-Hexachloro-2,2,4,4-tetrahydrophthalic anhydride	BCF(CCC)CO3	0	1 0 0 0 0
0715	3074-40-0	Acetic acid, ethyl ester	IC20	0	1 0 0 0 0
0716	8190-59-3	Lead n-dodecylsulfate	MAZ(D)-Ma, L	100	0 1 0 0 0
0717	2406-01-0	Phosphoric acid, butyl ester	SP(CCC)CC	0	1 0 0 0 0
0718	2542-36-7	Stearic acid, dibutyl ester	SB(CCC)CC	0	1 0 0 0 0
0719	1031-70-8	Boric acid, magnesium salt	PAZ(Mg)CH	0	1 1 0 0 0
0720	10371-09-6	Magnesium bis(2-ethylhexylphosphine oxide)	PH(CH)	0	1 1 0 0 0
0721	16408-64-4	Stannous chloride, monohydrate	GB(CS)CH	100	0 1 0 0 0
0722	10324-05-0	Dodecanoic acid, ethyl ester	IC22	0	1 1 0 0 0
0723	2487-02-5	Phenolic acid, 2-ethylhexyl ester	IC18	0	1 1 0 0 0
0724	14786-35-1	Dodecanoic acid, ethyl ester	DYME(C)CC	0	1 1 0 0 0
0725	10291-42-6	Phenyl morpho-ethyl ester	MG(D)CH	0	1 1 0 0 0
0726	10521-01-6	Stearic acid, n-dodecyl ester	IC18	0	1 1 0 0 0
0727	10848-32-0	1,2-Epoxyoctadecane	Unsp	1	1 0 0 0 0
0728	103881-09-0	Phosphoric acid, triethyl ester	CC(C)CC	100	0 1 0 0 0
0729	1031-23-3	Acetic acid, 2-(2-ethylhexyl) ester	IC18	0	1 0 0 0 0
0730	1184-61-4	Benzene, 1,2-dibutyl ether	DYME(C)CH	0	1 0 0 0 0
0731	1802-43-9	Diethyl 2-(4-ethylphenyl)acetate	DEG(C)CH	0	1 0 0 0 0
0732	1091-73-8	Benzene, 2-(2-ethylhexyl) ether	DYME(C)CH	0	1 0 0 0 0
0733	1031-23-3	Acetic acid, 2-(2-ethylhexyl) ester	IC18	0	1 0 0 0 0
0734	1031-23-3	Acetic acid, 2-(2-ethylhexyl) ester	IC18	0	1 0 0 0 0
0735	1031-23-3	Acetic acid, 2-(2-ethylhexyl) ester	IC18	0	1 0 0 0 0
0736	1031-23-3	Acetic acid, 2-(2-ethylhexyl) ester	IC18	0	1 0 0 0 0
0737	1031-23-3	Acetic acid, 2-(2-ethylhexyl) ester	IC18	0	1 0 0 0 0
0738	1031-23-3	Acetic acid, 2-(2-ethylhexyl) ester	IC18	0	1 0 0 0 0
0739	1031-23-3	Acetic acid, 2-(2-ethylhexyl) ester	IC18	0	1 0 0 0 0
0740	1031-23-3	Acetic acid, 2-(2-ethylhexyl) ester	IC18	0	1 0 0 0 0
0741	1031-23-3	Acetic acid, 2-(2-ethylhexyl) ester	IC18	0	1 0 0 0 0
0742	1031-23-3	Acetic acid, 2-(2-ethylhexyl) ester	IC18	0	1 0 0 0 0
0743	1031-23-3	Acetic acid, 2-(2-ethylhexyl) ester	IC18	0	1 0 0 0 0
0744	1031-23-3	Acetic acid, 2-(2-ethylhexyl) ester	IC18	0	1 0 0 0 0
0745	1031-23-3	Acetic acid, 2-(2-ethylhexyl) ester	IC18	0	1 0 0 0 0
0746	1031-23-3	Acetic acid, 2-(2-ethylhexyl) ester	IC18	0	1 0 0 0 0
0747	1031-23-3	Acetic acid, 2-(2-ethylhexyl) ester	IC18	0	1 0 0 0 0
0748	1031-23-3	Acetic acid, 2-(2-ethylhexyl) ester	IC18	0	1 0 0 0 0
0749	1031-23-3	Acetic acid, 2-(2-ethylhexyl) ester	IC18	0	1 0 0 0 0
0750	1031-23-3	Acetic acid, 2-(2-ethylhexyl) ester	IC18	0	1 0 0 0 0
0751	1031-23-3	Acetic acid, 2-(2-ethylhexyl) ester	IC18	0	1 0 0 0 0
0752	1031-23-3	Acetic acid, 2-(2-ethylhexyl) ester	IC18	0	1 0 0 0 0
0753	1031-23-3	Acetic acid, 2-(2-ethylhexyl) ester	IC18	0	1 0 0 0 0
0754	1031-23-3	Acetic acid, 2-(2-ethylhexyl) ester	IC18	0	1 0 0 0 0
0755	1031-23-3	Acetic acid, 2-(2-ethylhexyl) ester	IC18	0	1 0 0 0 0
0756	1031-23-3	Acetic acid, 2-(2-ethylhexyl) ester	IC18	0	1 0 0 0 0
0757	1031-23-3	Acetic acid, 2-(2-ethylhexyl) ester	IC18	0	1 0 0 0 0
0758	1031-23-3	Acetic acid, 2-(2-ethylhexyl) ester	IC18	0	1 0 0 0 0
0759	1031-23-3	Acetic acid, 2-(2-ethylhexyl) ester	IC18	0	1 0 0 0 0
0760	1031-23-3	Acetic acid, 2-(2-ethylhexyl) ester	IC18	0	1 0 0 0 0
0761	1031-23-3	Acetic acid, 2-(2-ethylhexyl) ester	IC18	0	1 0 0 0 0
0762	1031-23-3	Acetic acid, 2-(2-ethylhexyl) ester	IC18	0	1 0 0 0 0
0763	1031-23-3	Acetic acid, 2-(2-ethylhexyl) ester	IC18	0	1 0 0 0 0





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How many?

Standardisation

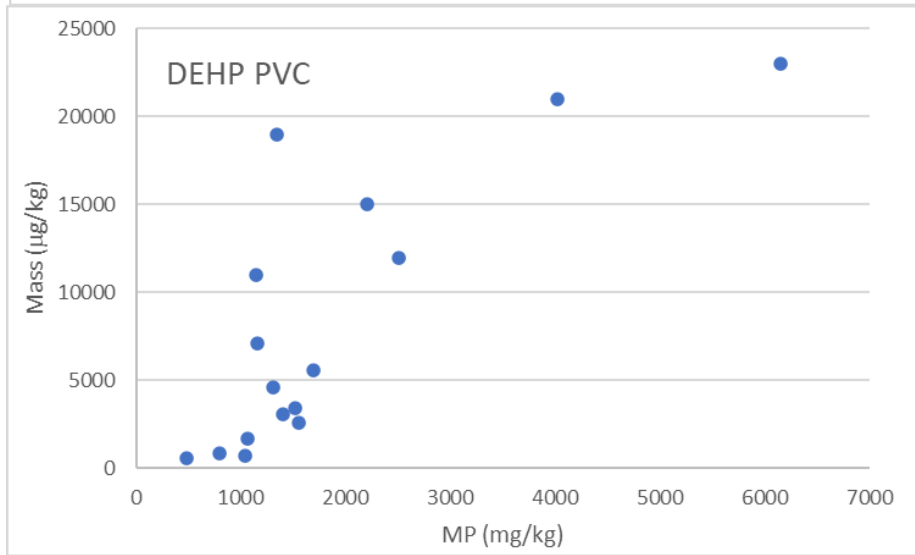
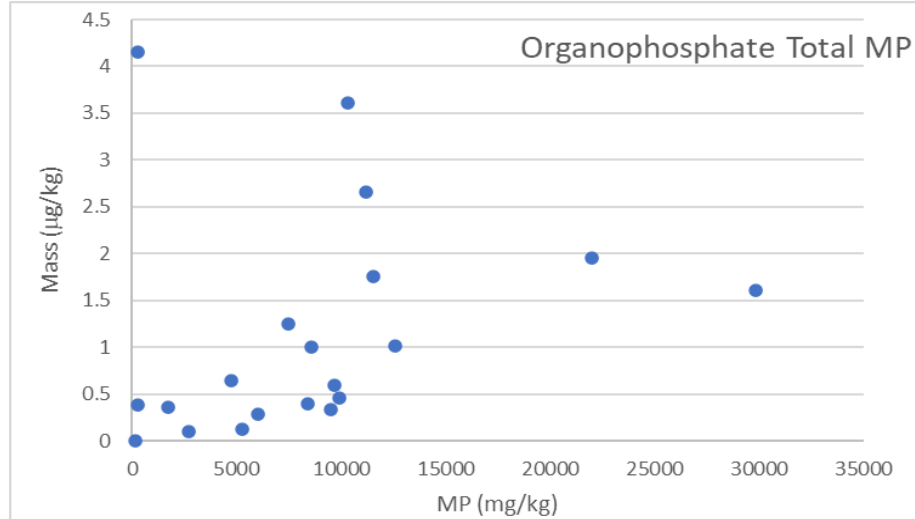
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Mass estimation?

- Polymer shape/density

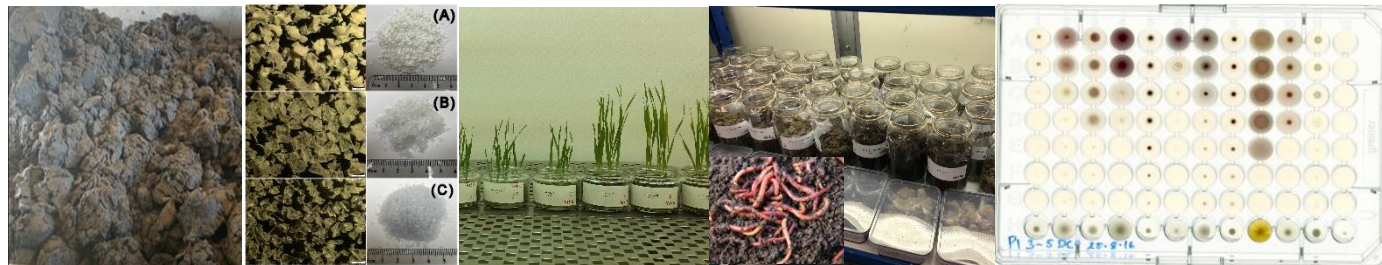
Chemical additives?

- Plasticisers, flame retardants, lubricants etc.?



# Managing risks

How many?  
Impacts?



- ~1% in soil may<sup>§</sup> or may not<sup>#</sup> have an effect on terrestrial organisms
- Toxicity from microplastic or from chemicals released from microplastic?
- Weathering, polymer type, particle size shape affect interaction with organisms, transport, release of chemicals...

<sup>§</sup>Huerta-Lwanga et al. (2016) *ES&T* 50, 2685-2691,

<sup>§</sup>Qi et al. (2018) *STOTEN* 645, 1048;

<sup>#</sup>Judy et al. (2019) *Env. Pollut.* 252, 522-531



## Managing risks

How many?

Impacts?

Risk reduction

- Standardised, cost-effective tools for baseline load/impacts
- Evidence-based
- Minimising loads = \$\$
- Source control?





## Summary

### How many?

- Standardisation for baseline
- What (MP number/shape/mass, chemical additives)?
- How often (cost)?

### Impacts?

- What is being impacted (organisms, crops etc.)?
- Effect of ageing/fragmentation (nanoplastics)?
- MPs or chemical additives?

### Evidence-based risk reduction

**Environmental sustainability of circular economy**



# Thank you

**CSIRO Environment**

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