

Reducing Household Contributions to Marine Plastic Pollution

Report for Friends of the Earth

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Executive Summary

Globally, millions of tonnes of plastic waste are thought to enter the marine environment *every year*. This plastic can float on the ocean surface, be washed up on beaches or sink to the ocean floor. Along the way to and from any one of these places it can interact with wildlife in different ways, through ingestion, toxicological effects and habitat impacts.

The world is waking up to the marine plastic problem. There is no doubt over the impact of the wildlife documentary series, *Blue Planet II*, on the UK and international psyche. In China alone 80 million viewers tuned in, and in Britain it topped the 2017 TV ratings with an audience of more than 14 million.^{1,2} The effect that this has had on raising awareness of the marine plastic pollution problem among the general population is immense, building momentum behind a powerful desire to prevent this from continuing.

One of the more recent concerns about plastics in the marine environment comes from so-called microplastics which are generally recognised as particles of plastic below 5mm in size – these have often previously been limited to a lower size of <1 µm (0.001mm – 5 to ten times thinner than a human hair), in part due to the limitations in sampling such small particles in the marine environment. However, ‘nanoplastics’ of down to 1nm (1,000,000 times smaller than a mm) are beginning to be studied, with similar and potentially more serious concerns beginning to be expressed.³

Microplastics can result from the fragmenting of larger plastic items such as bottles, plastic bags and fishing nets as they are subjected to UV radiation and physical abrasion. They can also be manufactured as microplastics from the outset, such as the ‘microbeads’ used in cosmetics. They can also be generated through the use of a product during its life – examples of this are the wearing away of tyres and the fibres released from synthetic clothing during washing.

Larger plastic items – often known as ‘macroplastics’ – include anything larger than 5mm but can range from bottles and bags to drift nets and buoys. These are often recognisable and large enough to remove from beaches, which is why the best source of information for their relative prevalence is beach cleans which usually include some form of item counting.

Determining the amount of larger plastic waste entering the sea each year is not an easy task. It is difficult to make an accurate estimate of the how much there is based solely on, for example, beach litter counts, and very carefully designed, extensive research

¹ <https://www.thetimes.co.uk/article/china-quick-to-soak-up-blue-planet-3nh8h9zfl> Accessed 31/05/18

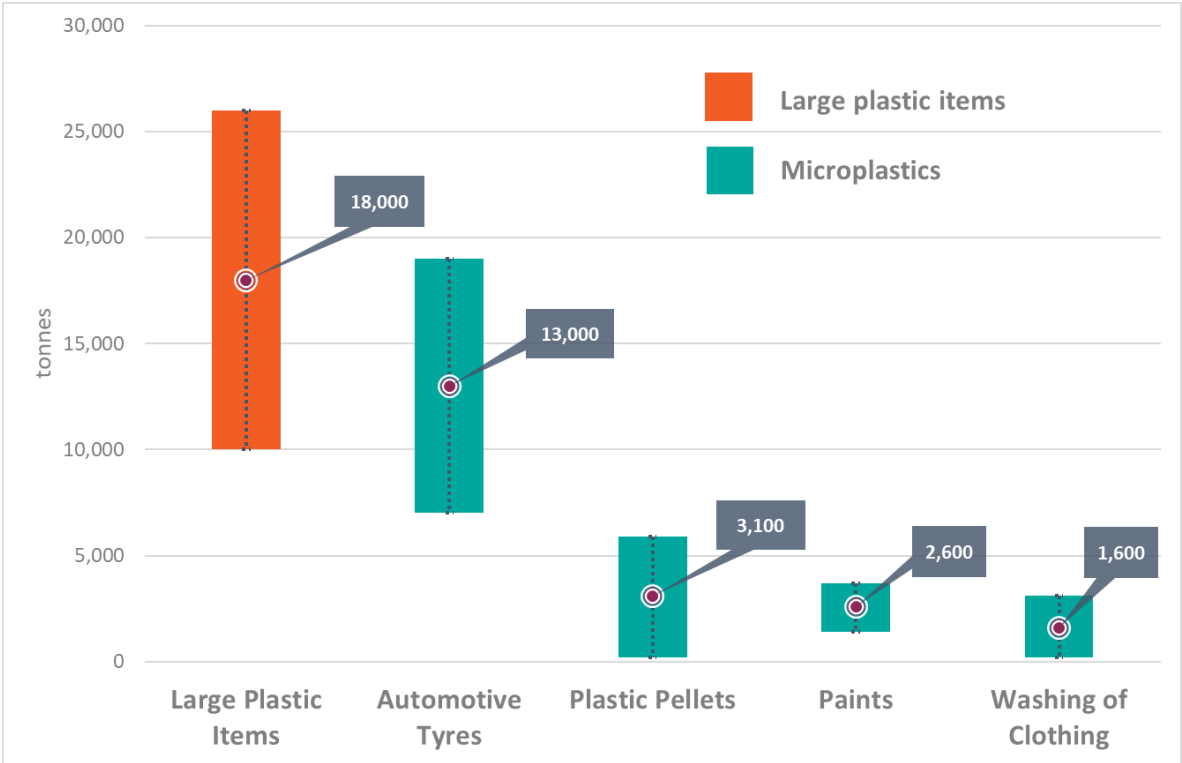
² <http://www.bbc.co.uk/news/entertainment-arts-42641146> Accessed 31/05/18

³ Rios Mendoza, L.M., Karapanagioti, H., and Álvarez, N.R. (2018) Micro(nanoplastics) in the marine environment: Current knowledge and gaps, *Current Opinion in Environmental Science & Health*, Vol.1, pp.47–51

would be required to distinguish how much is in the environment already from how much is added over a particular time period. For these reasons, there is not yet a robust, commonly accepted method for determining marine litter inputs across a range of different types of larger plastic items.

Looking at the scale of this issue from a UK perspective we can, however, combine the various estimates for large and microplastic waste to help to determine the priority products to focus on. Large items from municipal waste (which includes waste from households) are estimated to account for somewhere between 10,000 and 26,000 tonnes to surface waters annually in the UK. This is additional to the microplastics from the key sources identified for the UK. Figure 1 shows all of these key land-based sources that have been quantified to date. To put these figures into perspective, for the large plastic items this is the equivalent of between **600 million and 1.6 billion** (16g) plastic bottles ending up in the ocean from the UK every year. Although fibres from clothes washing is the smallest source in terms of tonnage, it has the most direct route to the marine environment and 1,600 tonnes is the equivalent of almost **4 trillion individual fibres** each year.

Figure 1 – Estimates for Key Sources of Plastic Pollution to Surface Waters from the UK from land-based sources



Note: The upper estimates of microplastic sources represent the largest estimate of emissions at source combined with the lowest level of capture e.g. least effective wastewater treatment. The lower estimates represent the smallest source emissions combined with the highest level of capture before reaching waterways. The likelihood of either scenario is not currently known therefore a midpoint is provided for comparative purposes. For large plastic items, the estimate relates to plastics from municipal waste.

E.1.0 The Top Ten

Based on the preceding research a 'top ten' list of items of concern has been developed for householders worried about the impact of the plastics they use on the marine environment. These are a combination of some of the most prevalent items found on beaches such as bottles, packets and cutlery as well as some of the items that we know often enter the sewers from households – and consequently rivers and estuaries. We also include significant sources of microplastics that the public should be aware of in their daily lives.

Options for Action	Definition	Time Horizon	Products
Significant immediate action possible	Actions can achieve positive results immediately; there are good alternatives for consumers to easily switch to and/or significant scope (and perhaps existing precedent) for swift governmental action to eliminate the problem for good.	<2 years	Wet wipes Sanitary Products On the go utensils Cotton Buds Drinks Bottles (water)
Limited action possible Immediately, but significant action possible within 5 years	More resource needed to understand and identify the best course of action, but no significant barriers exist for positive results to be obtained within 5 years. Some options available for consumers, but may be more difficult; government action is needed to make good progress.	2 – 5 years	Drinks Bottles (flavoured/ carbonated) Take away food containers Cosmetics
Action dependant on further research and/or government regulation	Further interventions and innovation required and, in some cases, international level collaboration is needed; basic consumer advice is available, but governmental, business and scientific collaboration may be required to solve these complex issues.	5 years+	Crisp Packets Automotive Tyres Synthetic Clothing

E.1.1 In the Household

Firstly, we look at some of the key sources of plastic pollution that come directly from the household through the daily use of products. The common thread with all of these is that they enter the marine environment via our wastewater system, either being inappropriately flushed down the toilet, or being released through washing activities (both washing ourselves, and the washing of clothing).

Wet Wipes

Summary: Significant immediate action possible

Evidence suggests that wipes cause problems for wastewater systems and can find their way into the sea if they are flushed. Whilst alternatives to plastic exist for wet wipes there are still question marks over whether it should be acceptable to flush these as they may still pollute the marine environment. Better messaging on wipes may prevent them from being flushed, but consumer habit is hard to change and with reusable alternatives available a ban on the marketing of any single use wipes as flushable is likely to be the most effective way to reduce their impact. Furthermore, manufacturers of wipes that do not conform to the forthcoming agreed 'flushability' standard should also be required to contribute to the cost of unblocking sewers (relative to their contribution to the problem).

Sanitary Towels and Tampons (Sanpro)

Summary: Significant immediate action possible

There are several options that allow the avoidance of single use plastic. Reusables are becoming more accepted and they have the benefit of reducing overall waste and show significant life-time cost savings. There are also single-use alternatives made of organic cotton. Based on this, there is a clear opportunity for governmental intervention to drive the move away from single use products containing plastic.

Cotton Buds

Summary: Significant immediate action possible

There are many alternatives, both reusable and single use, that do not use plastic. The key is to make these more available, but this will only happen on a limited basis without the introduction of a ban on the single use plastic sticks. The UK government is looking into this with a ban mooted for as early as 2019. This will provide a level playing field for all manufacturers and retailers to provide alternatives.

Skin-care Including Make-Up and Sunscreen

Summary: Limited action possible immediately, but significant action possible within 5 years

The lack of transparency as to the ingredients used in cosmetics makes it difficult for consumers to identify those they might wish to avoid, and suitable alternatives. Cosmetics with only natural ingredients are available, but these could still contain bio-polymers. The UK's ban on microplastics in cosmetics only covers 'rinse-off' products and should be expanded to encompass all cosmetic products, with the burden of proof on manufacturers to show that their products (and ingredients) are not harmful in the marine environment.

Synthetic Clothes Washing

Summary: Action dependant on further research and/or government regulation

Whilst there are several small changes to behaviour and clothing choices available to consumers to make a difference to fibre pollution, the ubiquity of synthetic clothing (both existing and new) means that the ultimate solution – a shift away from the fibres /fabric constructions that emit the most fibres and effective upstream capture – needs to come from manufacturers and retailers with the support of national and international legislation.

E.1.2 On the go

In this section we look at some of the key sources of plastic pollution that may be produced 'on the go' throughout the day. These are plastics – usually packaging – that are most often disposed of outside of the home and therefore have a greater chance of being littered or at least not being recycled. Such plastic items placed in litter bins, even those designated as 'Recycling on the Go' bins, are very unlikely to be recycled. Items that are littered have a chance of being blown into nearby rivers or coastlines. In this section we also include microplastics generated from the wear of vehicle tyres.

Drinks Bottles and Tops

Summary: Significant Immediate action possible for water bottles; limited action possible immediately, but significant action possible within 5 years for other bottles.

The key way in which consumers can avoid single use plastic bottles is to carry a reusable bottle which can be refilled with tap water. For occasions where single-use beverage containers are purchased – flavoured soft drinks for example – the proposed introduction of a deposit return scheme in the UK would be likely to increase recycling rates to 90% or more. By placing a value on the used bottle, it is also less likely to be littered and if it is, others would be more likely to pick it up for the value of the deposit.

Take-away Food Containers

Summary: Limited action possible immediately, but significant action possible within 5 years

Whilst reusable alternatives are available, they are not widespread in their use and it often requires individuals to proactively use their own containers. Greater social acceptance of this practice is important, but the introduction of a tax on single use take away items and the wider implementation of reusable schemes is the main way to reduce consumption and littering.

On-the-go Utensils

Summary: Significant immediate action possible

With non-plastic alternatives readily available and the government already suggesting a ban on single use plastic straws there is a strong case to expand this to all utensils at the same time.

Crisp Packets

Summary: Action dependant on further research and/or government regulation

Crisp packets are problematic. They can't be recycled, they are bought in their millions and they are easily dropped and transported by wind. No alternatives exist that provide the same service to contain and preserve the product and therefore it is a particularly problematic item of packaging. Whilst innovation in packaging and materials should be ongoing (in partnership with recyclers), ways to incentivise the return of the packets so they do not become litter should be the immediate, short term focus.

Automotive Tyre Wear

Summary: Action dependant on further research and/or government regulation

Choosing walking, cycling and public transport over private car journeys should be the first option. Where a journey by private car is unavoidable, there are several small things that drivers can do to reduce tyre wear which generally coincide with behaviours that are encouraged for eco-driving. The main action, however, needs to be undertaken by the manufacturers, with regulatory oversight in order to design tyres that exhibit lower rates of tread wear per mile driven.

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1.0 The Plastic Pollution Problem

1.1 What is the Problem?

Globally, millions of tonnes of plastic waste are thought to enter the marine environment *every year*. This plastic can float on the ocean surface, be washed up on beaches or sink to the ocean floor. Along the way to and from any one of these places it can interact with wildlife in different ways, through:

- **Ingestion** - marine animals ingest plastic both intentionally and accidentally. Intentional ingestion occurs when marine animals mistake plastic litter for their prey. A 2015 study found that seven turtle species had ingested marine plastic, as had 164 seabird species and 47 whale species.⁴ This blocks nutritious food from being absorbed and causes damage to the digestive system.
- **Entanglement** - the most common way by which marine organisms are entangled is via 'ghost fishing', when they are caught in fishing nets that have been lost or intentionally discarded by fishermen. At the species level 100% of marine turtles, 67% of seals, 31% of whales and 25% of seabirds have been recorded as entangled.⁵ Entanglement causes wounds, and restricted movement. Entangled organisms may no longer be able to acquire food and avoid predators, or become so exhausted that they starve or drown.⁶
- **Toxicological effects** - plastics can contain a variety of potentially toxic chemicals incorporated during manufacture, and plastic debris can adsorb persistent organic pollutants (POPs) that are present in the oceans from other sources. These substances can become highly concentrated on the surface of the plastic. If ingested, these toxic chemicals in plastics could be transferred to marine organisms and cause serious harm.^{7,8}

⁴ Kühn, S., Rebolledo, E.L.B., and Van Franeker, J.A. (2015) Deleterious Effects of Litter on Marine Life, in Melanie Bergmann, Lars Gutow, and Michael Klages, (eds.), *Marine Anthropogenic Litter* (2015) Springer International Publishing

⁵ Kühn, S., Rebolledo, E.L.B., and Van Franeker, J.A. (2015) Deleterious Effects of Litter on Marine Life, in Melanie Bergmann, Lars Gutow, and Michael Klages, (eds.), *Marine Anthropogenic Litter* (2015) Springer International Publishing

⁶ Laist, D.W. (1997) Impacts of Marine Debris: Entanglement of Marine Life in Marine Debris Including a Comprehensive List of Species with Entanglement and Ingestion Records, *Marine Debris: Sources, Impacts and Solutions* (1997) pp.99–139

⁷ Teuten, E.L., Saquing, J.M., Knappe, D.R.U., et al. (2009) Transport and release of chemicals from plastics to the environment and to wildlife, *Philosophical Transactions of the Royal Society of London B: Biological Sciences*, Vol.364, No.1526, pp.2027–2045

⁸ Hirai, H., Takada, H., Ogata, Y., et al. (2011) Organic micropollutants in marine plastics debris from the open ocean and remote and urban beaches, *Marine Pollution Bulletin*, Vol.62, No.8, pp.1683–1692

- **Habitat impacts** - plastics create a floating habitat for bacterial colonisation and rafting insects, aiding the movement of invasive species.^{9,10} Among other impacts they can also affect the temperature and oxygen concentration of marine sediments, increase disease in coral and sea grass, and block light necessary for photosynthesis in these organisms.^{11,12,13}

1.2 Recent Public Interest

The world is waking up to the marine plastic problem, in no small part due to the effect on viewers of the wildlife documentary series, Blue Planet II. In China alone 80 million viewers tuned in, and in Britain it topped the 2017 TV ratings with an audience of more than 14 million.^{14,15} The effect that this has had on raising awareness of the marine plastic pollution problem among the general public is immense, building momentum behind a powerful desire to prevent this from continuing.

Prime Minister Theresa May has declared ‘war on plastic’, vowing to eliminate the UK’s ‘avoidable’ plastic waste by 2042 and encouraging Commonwealth countries to participate. Meanwhile Environment Secretary Michael Gove is pushing for a Deposit Return Scheme for plastic bottles, as well as suggesting a ban on sales of plastic straws and drink stirrers.¹⁶ The European Commission also released its Plastic Strategy at the start of 2018 and has proposed a new Directive to target single-use plastic products.^{17,18}

As well as government initiatives, companies are getting involved. For example, over 40 major companies have signed the UK Plastics Pact to reduce plastic pollution by 2025. These include Coca-Cola, Asda, Procter & Gamble and M&S, with signatories accounting for over 80% of plastic packaging in UK supermarkets, which of course largely ends up as household plastic waste.¹⁹

⁹ Goldstein, M. (2012) *Abundance and ecological implications of microplastic debris in the North Pacific Subtropical Gyre*, 2012

¹⁰ Carson, H.S., Nerheim, M.S., Carroll, K.A., and Eriksen, M. (2013) The plastic-associated microorganisms of the North Pacific Gyre, *Marine Pollution Bulletin*, Vol.75, No.1–2, pp.126–132

¹¹ Carson, H.S., Colbert, S.L., Kaylor, M.J., and McDermid, K.J. (2011) Small plastic debris changes water movement and heat transfer through beach sediments, *Marine Pollution Bulletin*, Vol.62, No.8, pp.1708–1713

¹² Lamb, J. B. et al. (2017) Plastic Waste Associated with Disease on Coral Reefs, *Science*, Vol 359, Issue 6374, pp. 460-462

¹³ <https://www.blastic.eu/knowledge-bank/impacts/smothering/> ; Fitzpatrick, J., & Kirkman, H. (1995). Effects of prolonged shading stress on growth and survival of seagrass *Posidonia australis* in Jervis Bay, New South Wales, Australia. *Marine Ecology Progress Series*, 127, 279–289.

¹⁴ <https://www.thetimes.co.uk/article/china-quick-to-soak-up-blue-planet-3nh8h9zfl> Accessed 31/05/18

¹⁵ <http://www.bbc.co.uk/news/entertainment-arts-42641146> Accessed 31/05/18

¹⁶ <https://www.independent.co.uk/news/uk/politics/plastic-straws-ban-stirrers-gove-commonwealth-a8311301.html> Accessed 31/05/18

¹⁷ http://europa.eu/rapid/press-release_IP-18-5_en.htm

¹⁸ <https://eur-lex.europa.eu/legal-content/en/ALL/?uri=CELEX%3A52018PC0340>

¹⁹ <http://www.bbc.co.uk/news/business-43901328> Accessed 31/05/18

With such a clamour to address issues relating to plastics, it is important to focus on pragmatic solutions that not only address plastic waste, but avoid generating problems of their own. We must be mindful that materials other than plastic also have environmental consequences and that any 'war on plastics' should result in real environmental gain and not simply substitute one environmental problem such as marine pollution with another such as greater emissions of greenhouse gases.

In some cases, this may mean that it is preferable to continue using plastics until better alternatives become available as using other materials would cause a significant increase in environmental or social harm. In such cases every effort should be made to ensure that none of that plastic escapes to pollute the environment. There should also be a drive to innovate to provide alternative ways of performing the same service, ideally without the need for any material or, failing that, with a more sustainable alternative to plastics.

1.3 Where Does the Plastic Come from?

Sources of marine plastic pollution can be split into two broad categories:

- 1) **Land based** - litter, run-off from roads and urban areas containing tyre wear and paints, and synthetic clothing fibres and cosmetics through sewers.
- 2) **At sea** – fishing gear, boat paint, plastic pellet spillages, litter from boats.

Globally, land-based plastic contributes the majority of inputs, releasing 10.5 million tonnes per annum (Mtpa) to the marine environment, while plastic from at-sea sources totals 1.75 Mtpa.²⁰

In the EU, the total demand for plastic increased from 47.5 million tonnes in 2005 to 52.5 million tonnes in 2007.^{21,22} Over the subsequent two years, the impacts of the financial crisis led to a reduction in demand to 45 million tonnes in 2009. Since this time, demand levels have fluctuated but are on a general upwards trend, and the most recent data (2015) reports demand of 49 million tonnes. Total plastics production was 58 million tonnes in 2015, suggesting that 16% (9 million tonnes) of plastics produced in the EU28 is exported outside the EU. Around half of all the plastics consumed in the EU in 2014 – the latest year for which waste data is available – became household waste with 20% becoming industrial waste and the remaining 30% in use within the various products, buildings and vehicles we own.

²⁰ <http://www.eunomia.co.uk/reports-tools/plastics-in-the-marine-environment/>

²¹ Plastics Europe (2016) *Plastics – the Facts 2016: An analysis of European plastics production, demand and waste data*, October 2016

²² These figures do not include plastics in imported products or packaging, and nor do they take account of the use of recycled plastics. Hence they are (i) an underestimate, and (ii) the proportions may differ once imports are taken into account.

1.4 Microplastics

One of the more recent concerns about plastics in the marine environment comes from so-called microplastics which are generally recognised as particles of plastic below 5mm in size. Research on microplastics has until recently been limited to a lower size of <1 µm (0.001mm – one fifth to one-tenth of the width of a human hair), in part due to the limitations in sampling such small particles in the marine environment. However, ‘nanoplastics’ of down to 1nm (1,000,000 times smaller than a mm) are beginning to be studied, with similar and potentially more worrying concerns beginning to be expressed.²³

Microplastics can result from the fragmenting of larger plastic items such as bottles, plastic bags and fishing nets as they are subjected to UV radiation and physical abrasion. They can also be manufactured as microplastics, such as the ‘microbeads’ used in cosmetics. Microplastics can also be generated through the use of a product during its life – examples of this include abrasion of particles from vehicle tyres and the fibres released from synthetic clothing during washing.

Microplastics are understood to pose a particular threat to the health of the marine environment and wildlife as their small size enables them to interact with a diverse range of marine organisms and thus potentially enter the food chain. As well as the physical harm they can cause, their ability (as for larger plastic items) to adsorb and concentrate chemicals present in the environment, or release some of their chemical additives, is also a concern.

Microplastics have been found in surface water, shallow waters, beaches and sediment in many different areas of the world, including otherwise pristine environments such as the Arctic and most recently the Antarctic.^{24,25,26,27,28}

Although many sources of microplastic have been identified, the pathways these plastics take to reach the marine environment are less well understood. Some emissions of microplastics, such as tyre wear, have been highlighted as a significant contributor to

²³ Rios Mendoza, L.M., Karapanagioti, H., and Álvarez, N.R. (2018) Micro(nanoplastics) in the marine environment: Current knowledge and gaps, *Current Opinion in Environmental Science & Health*, Vol.1, pp.47–51

²⁴ Barnes, D.K.A., Galgani, F., Thompson, R.C., and Barlaz, M. (2009) Accumulation and fragmentation of plastic debris in global environments, *Philosophical Transactions of the Royal Society B: Biological Sciences*, Vol.364, No.1526, pp.1985–1998

²⁵ Song, Y.K., Hong, S.H., Jang, M., Kang, J.-H., Kwon, O.Y., Han, G.M., and Shim, W.J. (2014) Large Accumulation of Micro-sized Synthetic Polymer Particles in the Sea Surface Microlayer, *Environmental Science & Technology*, Vol.48, No.16, pp.9014–9021

²⁶ Obbard, R.W., Sadri, S., Wong, Y.Q., Khitun, A.A., Baker, I., and Thompson, R.C. (2014) Global warming releases microplastic legacy frozen in Arctic Sea ice, *Earth's Future*, Vol.2, No.6, p.2014EF000240

²⁷ Waller, C.L., Griffiths, H.J., Waluda, C.M., et al. (2017) Microplastics in the Antarctic marine system: An emerging area of research, *Science of The Total Environment*, Vol.598, pp.220–227

²⁸ Greenpeace (2018) *Microplastics and persistent fluorinated chemicals in the Antarctic*, June 2018

microplastics in the environment; however, as yet no clear pathway has been identified that allows accurate estimates to be made of how much of this ends up in the marine environment. By contrast, microplastics included in rinse-off cosmetic applications are by design typically ejected directly into household wastewater effluent and therefore reasonable assumptions can be made as to the path they take to reach the ocean, and the proportion that may be captured in sewage sludge at wastewater treatment works (and potentially then applied to land).

A 2018 study for the European Commission sought to quantify the releases of microplastics from land-based sources into surface waters.²⁹ The authors noted that, in general, there is far greater certainty as to the estimates of the amounts of microplastics released at source, than the amounts that reach the aquatic environment, as the latter is based on a number of assumptions, backed up by available evidence, relating to pathways. Figure 2 shows the results of the study, with automotive tyres thought to be responsible for the greatest proportion of microplastics entering surface waters. From a total of 500,000 tonnes of tyre wear produced every year the study estimated that around 20% will enter surface waters.

Applying UK traffic statistics to the tyre wear data in the study suggests that the UK accounts for the generation of 68,000 tonnes of microplastics from tyre tread abrasion every year with around 7,000 – 19,000 tonnes entering surface waters. Research, involving direct measurement, is currently ongoing in the UK to improve the scientific understanding of tyre microplastics pathways.³⁰

Plastic pellets – the feedstock that is used to manufacture plastic items – also contribute a significant amount of (very visible when washed up on beaches) microplastic pollution when the pellets are accidentally lost during transport and handling. The plastics industry is attempting to reduce this by encouraging manufacturers to sign up to Operation Clean Sweep.³¹ However if even a fraction of one per cent – in this case 0.01% – is lost due to spills or poor controls this can lead to thousands of tonnes cumulatively. The UK makes up 7.5% of the EU plastics demand, and it is therefore estimated that 1,300 – 12,600 tonnes are spilt every year in the UK with 200 – 5,900 tonnes of this lost to surface waters.³² Unfortunately, consumers are not in a position to influence this through their purchasing decisions at the moment.

Paints on buildings and road markings are also thought to be a source of microplastic pollution as the paints weather away and flake off. Taking the EU figures and converting on a per capita basis suggests that the UK generation of microplastics from these sources

²⁹ Eunomia Research & Consulting (2018) *Investigating options for reducing releases in the aquatic environment of microplastics emitted by (but not intentionally added in) products*, Report for European Commission, February 2018

³⁰ <https://www.gov.uk/government/news/government-launches-microplastics-research-to-protect-oceans>

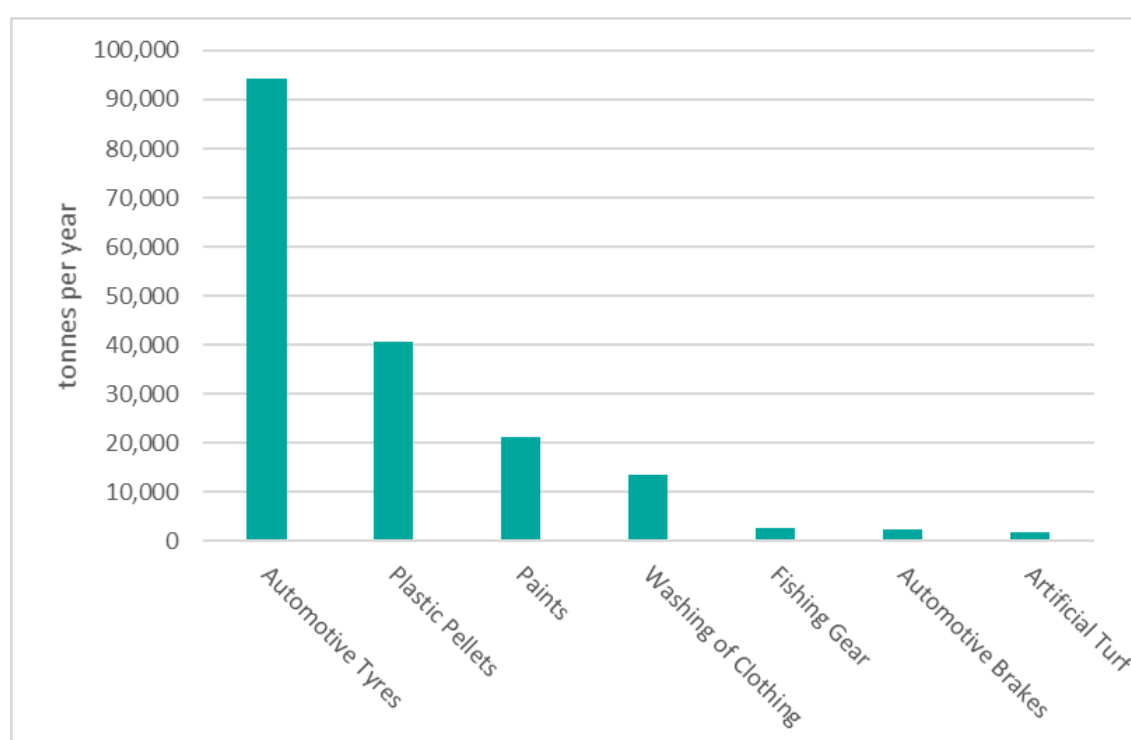
³¹ <http://www.opcleansweep.eu/>

³² Plastics Europe (2016) *Plastics – the Facts 2016: An analysis of European plastics production, demand and waste data*, October 2016

may be around 14,400 – 16,100 tonnes with 1,400 – 3,700 tonnes of this ending up in surface water per year.

The final large source of microplastics is from the washing of synthetic clothing. The average UK household is thought to run around 165 washing machine cycles per year. With the assumption that 90% of homes have a washing machine (the remainder using commercial services), this is around 4.2 billion wash cycles per year. Applying these UK specific figures to the calculation method used for the EU estimates from the European Commission results in the generation of 2,300 – 5,900 tonnes of fibres annually in the UK. Somewhere between 150 and 2,900 tonnes of this could be passing through wastewater treatment into rivers and estuaries.

Figure 2 – Midpoint Estimates of Annual Emission of Microplastics Created Through Wear or Accidental Loss into Surface Waters in the European Union



Source: Eunomia on behalf of the European Commission (2018)

1.5 Large Plastic Waste

Larger plastic items – often known as ‘macroplastics’ – include anything larger than 5mm but can range from bottles and bags to drift nets and buoys. These are often recognisable and large enough to be removed from beaches which is why the best source of information for their prevalence is beach cleans which usually include some form of item counting. The 2016 results for the OSPAR beach surveys show the following items are the most commonly found under the category of “identifiable, general (i.e. non-fishing related) plastic items” (Table 1). It is difficult to compare items by their total weight as this information is often not collected due to contamination from being in the

sea and on the beach. Equally there are also many items and fragments that are not identifiable for the same reason. Some items may not appear higher on the list for the simple reason that they are smaller, more prone to breaking up or just difficult to categorise effectively. However, we can estimate the original mass of some of the more generic single use items to determine which ones are likely to contribute more to marine pollution when they break down. This shows that despite drinks bottles accounting for 5% by count, they account for a much larger proportion by the mass of the single use items (where it was practicable to estimate a mass for the item).

Table 1: Most commonly found identifiable household plastic items on UK Beaches

Item	Item count ²	% by item	Estimated Weight (g)	% by weight ¹
Caps/lids	2,541	13%	2	13%
Crisp/sweet packets and lolly sticks	2,216	11%	2	12%
Cotton bud sticks	2,121	11%	0.16	1%
Drinks bottles	1,016	5%	16	42%
Cutlery/trays/straws	735	4%	5	10%
Cigarette ends	683	3%	1	1%
Foam sponge	636	3%		
Sanitary towels/panty liners/backing strips	635	3%	7	12%
Bags (e.g. shopping)	499	2%	5	6%
Small plastic bags (e.g. freezer bags)	412	2%	2	2%
Toys and party poppers	306	2%		
Food containers incl. fast food containers	257	1%		
Shotgun cartridges	238	1%		
Industrial packaging, plastic sheeting	173	1%		
Plastic cups	165	1%		
Balloons, valves, ribbons, strings	160	1%	2	1%
Pens	131	1%		
Tampons and tampon applicators	121	1%	2	1%
Cigarette lighters	117	1%		
Cosmetics bottles and containers (e.g. sunscreen, shampoo)	109	1%	2	13%

Notes:

1. Proportion by weight is based on items where a reasonable estimate for item weight was possible. Item categories that encompass more varied items (e.g. toys) were not estimated.

2. Source: OSPAR

Determining the amount of larger plastic waste entering the sea each year is not an easy task. It is difficult to make an accurate estimate of how much there is based solely on, for example, beach litter counts, and very carefully designed, extensive research would be required to distinguish how much is in the environment already from how much is added

over a particular time period. For these reasons, there is not yet a robust, commonly accepted method for determining marine litter input from a particular place.

An alternative approach used by several groups of researchers, the most well-known of which was carried out by researchers from the University of Georgia, relies on estimating the total amount of waste generated, how much of it is plastic, how much waste is littered, and how much of it gets into the sea.³³ Each part of the puzzle can be obtained in different ways, leading to big differences in the current estimates. However, working up these estimates is still of value to get a general picture of what the answer might look like.

The approach was recently used by the OSPAR Commission to estimate marine litter input from countries in the catchment of the sea in OSPAR's jurisdiction, which includes the UK.^{34,35}

The study took the population of the individual countries and multiplied this by the average waste production per capita. This was then multiplied by the percentage of waste estimated to be plastic, based on local authority waste composition data. The proportion of waste estimated to be littered was applied (2%). To obtain a low-end estimate, 15% of the litter was assumed to enter the sea. To obtain a high-end estimate, 40% of the litter was assumed to enter the sea. The assumptions made about the proportion of waste littered and the proportion of waste entering the sea were taken from the previous study by the University of Georgia researchers.³⁶

Applying this method to UK data on municipal waste (household waste and other similar waste), results in an estimated 10,000 – 26,000 tonnes of plastic entering the marine environment every year from the UK.

Most of this variation is owing to the uncertainty around what proportion of plastic waste becomes litter and what proportion of that ends up getting washed into drains, rivers and the sea – there is very little evidence from the UK to be certain of the extent to which this takes place, therefore these figures are very much indicative at present.

³³ Jambeck, J.R., Geyer, R., Wilcox, C., et al. (2015) Plastic waste inputs from land into the ocean, *Science*, Vol.347, No.6223, pp.768–771

³⁴ OSPAR is the mechanism by which 15 Governments & the EU cooperate to protect the marine environment of the North-East Atlantic. The fifteen Governments are Belgium, Denmark, Finland, France, Germany, Iceland, Ireland, Luxembourg, the Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and United Kingdom.

³⁵ OSPAR Commission (2017) *Assessment document of land-based inputs of microplastics in the marine environment*, November 2017

³⁶ Jambeck, J.R., Geyer, R., Wilcox, C., et al. (2015) Plastic waste inputs from land into the ocean, *Science*, Vol.347, No.6223, pp.768–771

1.6 The Scale of the Problem

Although little is known about the scale, and the rate, at which larger items are reduced to microplastics there are numerous activities taking place across the world, in all types of marine environments to sample and quantify the amounts of all sizes of plastics. Whilst it is difficult – if not impossible – to create a fully joined-up picture of the entire scale of the problem we can look to some of the latest research to provide an indicator of what is known to date.

The most recent and comprehensive study by Lebreton et al., which looks at the occurrence of plastics floating in the North Pacific – often referred to as the ‘Great Pacific Garbage Patch’ – comes as a result of the Ocean Cleanup initiative which began as a crowdfunded project to remove plastics from the oceans.³⁷ It has attracted some of the most active scientists in the field to first determine the extent of the problem.

The North Pacific has seen the most direct sampling as it has become an accumulation zone for plastics that come from Asia and the US. Obviously, it is unlikely that the UK will contribute directly to plastic pollution in the Pacific, although many of the products we buy are manufactured in Asia and therefore there may be an indirect contribution linked to our own consumption. A summary of Le Breton et al.’s results can be found in Figure 3 indicating that around 80,000 tonnes of plastic are floating in the North Pacific – around twice the amount found in the North Atlantic. Although less than 10 per cent of this is microplastic this equates to 1.7 trillion particles each with the ability to be ingested by marine life.

It is also often particularly difficult to identify the source of the plastic once it has been in the marine environment for long enough to partially break down. However, the study still attempted to characterise plastic items and found that around half of all items were related to commercial fishing activity.

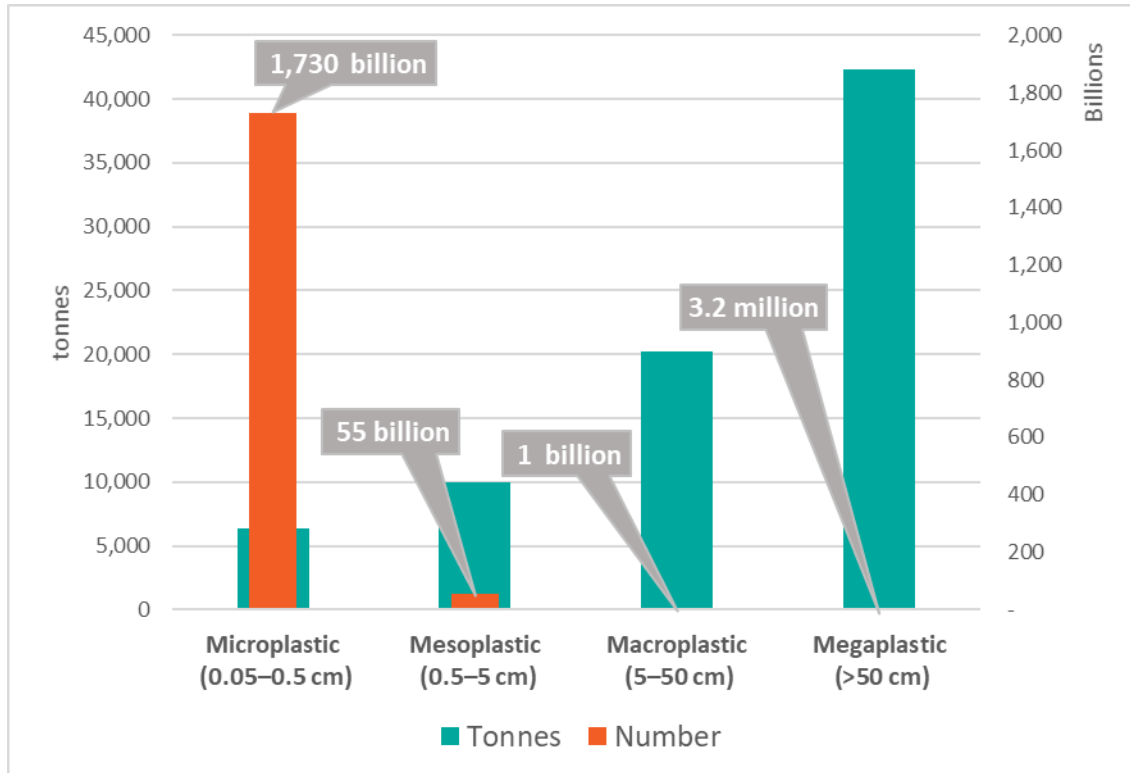
Despite these large amounts of plastic being found floating in the oceans, this is far from the millions of tonnes predicted to enter the oceans *each year*.³⁸ There is a large disconnect between what is observed and what is expected. For example, there should be a far larger tonnage of microplastics compared with larger items, the reasoning being that plastic items in the sea only ever get smaller as they are broken down. We may not be able to accurately detect or easily sample the smallest particles (<0.5mm), but we would expect an increase in the mass of particles found as the size decreases; in fact, the opposite is true. Although negatively buoyant plastics represent around half of the overall global plastics demand – and will therefore sink quickly – the remainder must be accumulating in other places. These can include beaches, ingestion by marine life and -

³⁷ Lebreton, L., Slat, B., Ferrari, F., et al. (2018) Evidence that the Great Pacific Garbage Patch is rapidly accumulating plastic, *Scientific Reports*, Vol.8, No.1, p.4666

³⁸ Jambeck, J.R., Geyer, R., Wilcox, C., et al. (2015) Plastic waste inputs from land into the ocean, *Science*, Vol.347, No.6223, pp.768–771

most likely in the greatest quantities - the ocean floor as they lose buoyancy through biofouling (the attaching of organisms such as barnacles and algae). Unfortunately, the sea bed, and more specifically the deep sea, is the least studied habitat on earth and therefore the true scale of the problem is yet to be fully understood.³⁹

Figure 3 – North Pacific Floating Plastic



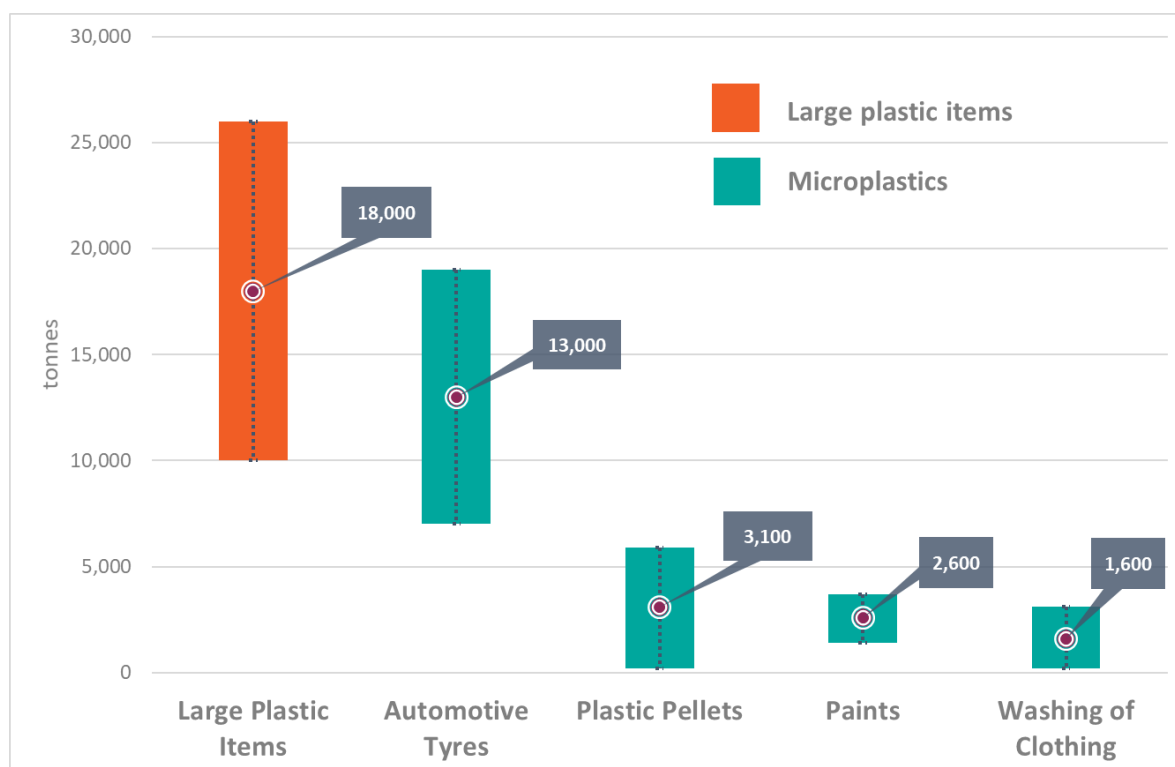
Source: Results from Lebreton et al (2018)

Looking at the scale of this issue from a UK perspective we can combine the estimates for large and microplastic waste to help to determine the priority products to focus on.

Figure 4 shows estimates for the main sources of microplastics alongside the estimate for large plastic items from the municipal waste stream (which includes waste from households). To put these figures into perspective, for the large plastic items this is the equivalent of between **600 million and 1.6 billion** (16g) plastic bottles ending up in the ocean from the UK every year. Although fibres from clothes washing is the smallest quantity, it has the most direct route to the marine environment and 1,600 tonnes is the equivalent of almost **4 trillion individual fibres** each year.

³⁹ Webb, T.J., Berghe, E.V., and O’Dor, R. (2010) Biodiversity’s Big Wet Secret: The Global Distribution of Marine Biological Records Reveals Chronic Under-Exploration of the Deep Pelagic Ocean, *PLOS ONE*, Vol.5, No.8, p.e10223

Figure 4 – Estimates for Key Sources of Plastic Pollution to Surface Waters from the UK from land-based sources



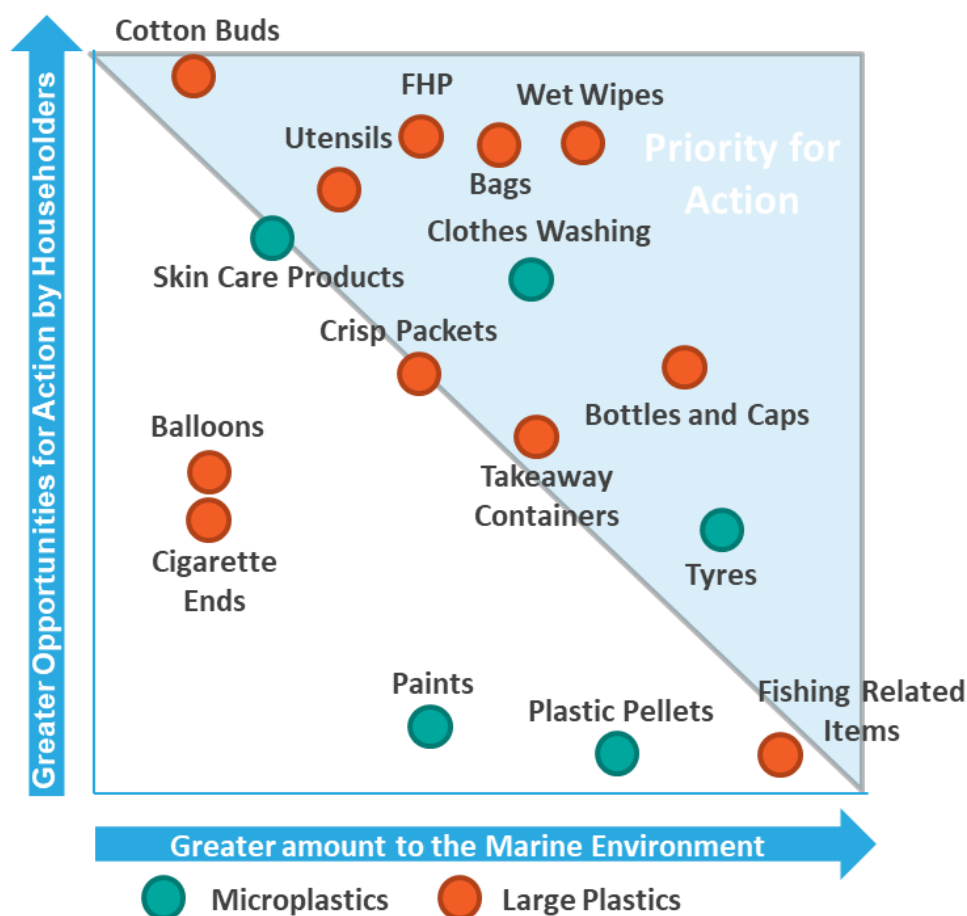
Note: The upper estimates of microplastic sources represent the largest estimate of emissions at source combined with the lowest level of capture e.g. least effective wastewater treatment. The lower estimates represent the smallest source emissions combined with the highest level of capture before reaching waterways. The likelihood of either scenario is not currently known therefore a midpoint is provided for comparative purposes. For large plastic items, the estimate relates to plastics from municipal waste.

1.7 The Top Ten

Based on the preceding research, a 'top ten' list of items of concern has been developed for householders worried about the impact of the plastics they use on the marine environment. These are a combination of some of the most prevalent litter found on beaches such as bottles, crisp packets and cutlery as well as some of the items that we know often enter the sewers from households – and consequently rivers and estuaries. We also include significant sources of microplastics that the public should be aware of in their daily lives.

Figure 5 shows how the top ten have been selected based upon the known or suspected amounts entering the marine environment and the opportunities for householders to make a direct difference to this. Whilst some items such as fishing-related waste, plastic pellets and microplastics from paints are thought to be relatively large contributors, there is less that the householder can do directly to influence these losses. The Priority for Action area shows the large number of products that are used regularly for which actions can more readily be taken. Plastic bags are not included in the top ten as there has been recent concerted effort to reduce these with the introduction of a charge alongside the associated significant increase in consumer awareness and engagement.

Figure 5 – Top Ten Prioritisation



In Table 2 we also categorise the top ten by the way in which plastic is used and becomes pollution in these products. Whilst most are wholly made of plastic and it is *the product itself* that is problematic, there are also others where plastic is just a part of the product or gets worn away to become the problem.

Table 2: Classification of Top Ten Items

Classification	Definition	Products
Single-Use Plastic Items	The single-use product or packaging itself is plastic and it's the whole product/packaging that is the problem.	Plastic cotton bud sticks Take-away food packaging On-the-go utensils (plastic straws, stirrers and cutlery) Plastic drinks bottles Crisp packets Wet wipes Sanitary Products
Plastic Ingredients	The plastic is an ingredient within an item and it's the ingredient that's the problem.	Cosmetics
Microplastic Loss During Use	The product is largely or wholly plastic and it's the loss of microplastics during the useful life of the product that's the problem.	Synthetic Clothing Vehicle Tyres

The following are summaries of the items in no particular order:

1.7.1 Tyre Wear

The wearing away of vehicle tyres is known to generate particles that enter the environment. The tread wear layer is primarily comprised of a variety of natural and synthetic rubber compounds (rubber is a polymer that is believed to persist and behave in the marine environment in the same way as plastics) as well as various additives – all of which are a closely guarded secret for each tyre manufacturer.⁴⁰ The particles can vary in size and composition, and therefore it is very difficult to identify and track exactly where they go as they can be widely dispersed around roads and washed away during rain. Their buoyancy in water varies and a great deal of the particles are likely to settle into river and estuary sediments – where they may still interact with river wildlife. Nevertheless, the sheer volume of these particles thought to be entering waterways is still a cause for concern and their occurrence and effects in the environment is a subject of ongoing research.⁴¹

There are also concerns around the finer particles that are generated (known as PM₁₀) which become airborne and form part of the on-going problem of air pollution in UK cities which is linked to various respiratory illnesses. It is estimated that up to 10% of tyre wear is generated as airborne particles.⁴² These can also settle in the surrounding areas where their impact is not known.

1.7.2 Synthetic Fibres from Washing Clothing

A relatively recent discovery is that synthetic clothing can shed fibres during washing which consequently wash into domestic drains and into waste water treatment (WWT) plants. These plants are not designed to filter such small fibres and therefore a large number of them can be released into waterways and ultimately the oceans. Laboratory sampling of the influent and effluent from UK WWT plants estimates that up to 98% of microplastics can be retained, but this varies depending upon the treatment type and technology installed.⁴³ In this best-case scenario around 150 tonnes of fibres would still be released into waterways every year in the UK – the equivalent of 200 billion individual fibres that can never be recovered.

⁴⁰ <http://www.wrap.org.uk/sites/files/wrap/2%20-%20Composition%20of%20a%20Tyre%20-%20May%202006.pdf>

⁴¹ <https://www.plymouth.ac.uk/news/university-receives-government-funding-to-analyse-impact-of-tyres-and-textiles-on-the-marine-environment>

⁴² <http://publications.jrc.ec.europa.eu/repository/bitstream/JRC89231/jrc89231-online%20final%20version%202.pdf>

⁴³ Murphy, F., Ewins, C., Carbonnier, F., and Quinn, B. (2016) Wastewater Treatment Works (WwTW) as a Source of Microplastics in the Aquatic Environment, *Environmental Science & Technology*, Vol.50, No.11, pp.5800–5808

It is also particularly difficult to sample and count fibres in any sort of natural environment due to the ease of contamination – full forensic procedures need to be used to make sure that samples are not contaminated by the researcher. Research in this field is ongoing worldwide and processes are being developed and trialled that aim to remove microplastics from sewage.⁴⁴

Fibres that are retained in WWT plants are captured in the sludge – the agglomeration of the organic solid material that is filtered out of the water. In the UK 80% of this sludge is used for agricultural purposes as a soil fertiliser (commonly known as muck spreading) with around 20% burned to recover energy.⁴⁵ This means that most of the captured fibres are subsequently applied to the land where they can accumulate and potentially be ingested by soil dwelling creatures. These fibres are known to persist and have been detected in soils 15 years after the last sludge application.⁴⁶ There is also significant potential for these to run off into streams and rivers over time due to soil erosion.⁴⁷

The fibres are known to be ingested by ocean organisms both in the lab and field and have even been detected in mussels and fish destined for the dinner table. The fibres have also been detected in the deepest oceans and locked up in the ice in the Arctic. Whilst it is also speculated that fibres can permeate the environment when they become airborne during abrasion in the course of being worn, the current best explanation for the pervasiveness of these fibres is their release during washing. A great deal of research has been focused on attempting to measure these releases and to identify the key factors that influence this.

One of the less well understood pathways for fibres into waterways is via combined sewage overflows (CSOs). These are gates that bypass wastewater treatment, which are opened to prevent the plants being overloaded after heavy rain. There are tens of thousands in the UK and they are known to be a significant source of river pollution as untreated sewage is released directly into rivers along with any other plastics present.^{48,49} The majority of these CSOs are unmonitored and therefore the extent to which this is a problem is not fully understood, however a report by WWF found that for one unnamed water company 50% of their CSOs discharged more than once per month; the

⁴⁴ <http://www.wasserdreinull.de/en/news/newsreader/finally-clean-water-wasser-3-0-presents-itself-as-an-exhibitor-at-the-ifat-2018.html>

⁴⁵ Hann, S., Sherrington, C., Jamieson, O., Hickman, M., Kershaw, P., Bapasola, A., and Cole, G. Investigating options for reducing releases in the aquatic environment of microplastics emitted by (but not intentionally added in) products Final Report, p.335

⁴⁶ Zubris, K.A.V., and Richards, B.K. (2005) Synthetic fibers as an indicator of land application of sludge, *Environmental Pollution*, Vol.138, No.2, pp.201–211

⁴⁷ http://wwf.panda.org/our_work/food/agriculture/impacts/soil_erosion/

⁴⁸ Water UK (2009) Combined Sewer Overflow Position Paper - Draft

⁴⁹ Marine Conservation Society (2011) Combined Sewage Overflow Position Paper

implication being that due to the lack of reporting and regulation, the CSOs are being used to make up for under capacity in the treatment system.⁵⁰

1.7.3 Skin-care Including Make-Up and Sunscreen

The discovery that microplastics – often called microbeads – have been included in many cosmetic products for a number of years has arguably led to much of the further investigation into how other microplastics can enter the oceans. A number of countries across the world have either implemented a ban or are looking to do so. This includes the UK as of 2018. Despite this, the issue is not fully dealt with. Most if not all of the bans have been framed in the context of ‘rinse-off’ products which has been defined by the cosmetics industry. This includes shower gels, hand washes and hair shampoos.

However, it is also true that plastic polymers of varying types are ubiquitous in a large number of cosmetic products. Microplastics have also been found in sunscreens, makeups, face and hand creams and even deodorants.⁵¹ However, these are often too small to see. Sunscreens can contain particles of 0.0003 mm with between 10 and 100 trillion particles in one single product. This is just above the size limit for so-called ‘nanomaterials’ which are subject to stricter ingredient regulations under EU law and have unanswered questions around their health risks.⁵² They are also of concern for the marine environment as smaller particles are known to be just as harmful if not more so than microplastics in the visual range as they can be ingested more easily and absorbed directly through the outer tissue of ocean organisms.

Polytetrafluoroethylene (PTFE) is another plastic known to be sold in powder form for use in face powders, blushes, mascara, eye shadow, make-up bases, sunscreens, foundations, shaving gels, creams and lotions in sizes of 0.005 – 0.013 mm – thinner than a human hair.⁵³ These are used to provide a more luxurious feel and to bulk out the product. The limited information that the cosmetics industry is legally required to put on cosmetics packaging makes it almost impossible at present to determine the exact contents – the naming is very generic and not presented in a way which consumers are expected to comprehend. It is therefore difficult to fully determine the extent of microplastics in cosmetics.

Polyethylene Glycol (PEG) is also a ubiquitous ingredient in many cosmetic products, to provide a soft feel and aid absorption into the skin. Although these come in waxy form

⁵⁰ WWF UK (2017) *Flushed Away: How sewage is still polluting the rivers of England and Wales*, November 2017

⁵¹ Eunomia Research & Consulting (2016) *Study to support the development of measures to combat a range of marine litter sources*, Report for European Commission DG Environment, 2016

⁵² <http://www.safecosmetics.org/get-the-facts/chemicals-of-concern/engineered-nanomaterialsnanotechnology/>

⁵³ <http://www.mpipersonalcare.com/ProductDetail.aspx?id=251>

rather than as a solid plastic there are concerns that some forms will not fully dissolve in water but instead can persist in the marine environment.⁵⁴

These products are included in the top ten as, despite not being well understood from a marine pollution perspective at present, they are used daily in most households in the UK. The cosmetics industry often argues that these sorts of microplastics are 'not found' in the marine environment. Whilst it may be true that they have not yet been identified, it is very difficult to sample some of the smaller sizes (<0.1mm) and almost impossible thereafter to identify the exact origin with high certainty. This is also the case with a lot of microplastic pollution but is no justification for dismissal at this stage.

1.7.4 Wet Wipes

Despite looking and feeling like paper, wet wipes are a form of 'non-woven' synthetic plastic usually made from polyester fibres mixed with wood fibres. The wipes are then impregnated with various types of moisturisers, fragrances or cleaning agents. They are often marketed as baby wipes, for personal care use or for domestic cleaning.

It is reported by Water UK - the trade body representing all of the main water and sewerage companies in the United Kingdom - that there are approximately 300,000 sewer blockages every year costing £100 million to clear. It is further noted that wipes made up around 93% of the material causing the sewer blockages which the study investigated.^{55,56}

From the perspective of the marine environment it is also known that waste water treatment plants are not capable of capturing all of the wipes that end up there. Many simply pass straight through or directly bypass via CSOs.

1.7.5 Sanitary Towels and Tampons

Disposable sanitary products (sanpro) are flushed down toilets from where they can end up in the marine environment. Items flushed include tampon applicators that are made entirely of plastic, sanitary towels that are plastic backed (and said to contain as much plastic as 4 plastic bags⁵⁷) and tampons which can include a mix of plastic microfibers of polyester, polypropylene and polyethylene.⁵⁸ Although it is estimated that 4.3 billion

⁵⁴ Bernhard, M., Eubeler, J.P., Zok, S., and Knepper, T.P. (2008) Aerobic biodegradation of polyethylene glycols of different molecular weights in wastewater and seawater, *Water Research*, Vol.42, No.19, pp.4791–4801

⁵⁵ Water UK (2017) Press release: New proof that flushing wipes is a major cause of sewer blockages, available at <https://www.water.org.uk/news-water-uk/latest-news/new-proof-flushing-wipes-major-cause-sewer-blockages>

⁵⁶ Water UK (2017) Wipes in Sewer Blockage Study

⁵⁷ https://www.huffingtonpost.com/dr-mercola/feminine-hygiene-products_b_3359581.html?guccounter=1

⁵⁸ <https://tampax.co.uk/en-gb/tampax-articles/women-s-health/what-are-tampax-tampons-made-of>

items are used annually in the UK, this is a particularly difficult waste stream to quantify as people are often uncomfortable talking about what for many continues to be a taboo subject.⁵⁹ Most sanitary products weigh between 5-10g so this creates between 21,500 and 43,000 tonnes of waste each year in the UK.

Disposable sanitary products which are flushed down the toilet can make their way into the marine environment in a similar way to wet wipes. The Marine Conservation Society, through its annual beach litter monitoring, notes that 'sewage related debris' (flushed plastics) makes up approximately 8.5% of beach litter in the UK, a figure that has been rising each year.⁶⁰ It is not clear how much of this sewage related debris is composed of menstrual products.

In the UK it is estimated that about 700,000 panty liners, 2.5 million tampons and 1.4 million sanitary towels are flushed down the toilet every day.⁶¹ Other estimates are as high as 1.5 – 2 billion items flushed which all adds to the £100 million bill for unblocking drains.^{62,63}

1.7.6 Cotton Buds

Although cotton bud stems used to be made of wood or, more commonly, paper, in recent decades they have predominantly been made out of plastic. This, combined with the fact that many householders are unaware of the consequences of flushing these items down the toilet, has led to them being consistently one of the most commonly identified items on beaches. So how do they get there? Firstly, we know that quite a lot of people flush these kinds of things down the loo. For example, a survey conducted for the Think Before You Flush campaign reported that 3 out of ten admitted flushing bathroom items down the toilet, with 26% of those naming cotton bud sticks as one of the item types flushed – i.e. 8% of respondents. 52% of people who flushed items did not realise that there were negative consequences to the environment from doing so.⁶⁴

Plastic cotton bud stems float, and so are not amenable to the sedimentation processes commonly used in waste water treatment. Because they float, they are also likely, especially in times of capacity overload (when too much water is travelling through the system), to simply flow over the top of screens in waste water treatment facilities. They are also another product that is released when CSOs discharge. Because of their shape and propensity to float orientated with their small cross-section facing in the direction of

⁵⁹ <http://www.ahpma.co.uk/docs/Menstruation%20Facts%20and%20Figs.pdf>

⁶⁰ https://www.mcsuk.org/media/GBBC_2017_Report.pdf

⁶¹ https://www.the-ies.org/sites/default/files/journals/water_security_oct_14.pdf

⁶² <https://www.mcsuk.org/downloads/pollution/PPPS%20Marine%20Plastics.pdf>

⁶³ <https://www.water.org.uk/policy/environment/waste-and-wastewater/what-not-flush>

⁶⁴ <http://thinkbeforeyouflush.org/the-nations-flushing-behaviour/>

travel, at other times, many cotton bud stems pass straight through these screens, which are not fine enough to catch the cotton buds consistently.

Many brands and retailers have recently switched to paper stems in place of plastic, and thus it is likely that consumption of plastic stemmed cotton buds has fallen in recent years. A recent report for Defra estimated annual consumption of 1.8 billion.⁶⁵

1.7.7 Drinks Bottles and Tops

Market data indicates that approximately 10 billion plastic drinks bottles are consumed in the UK every year.⁶⁶ Although many will be consumed in the home, where collection for recycling (or at least within residual waste) is almost guaranteed, bottles and their caps are still responsible for a large proportion of marine litter, both by count and to an even greater extent when considering their weight or volume. In this case we look at the issue of the use of plastic bottles outside of the home and how to prevent littering.

1.7.8 Take-Away Food Containers

There is a wide variety of types of take-away food containers and situations in which they're used, with market data suggesting billions are used in the UK each year.⁶⁷ They're commonly found ranking high in beach litter clean-ups. Some are used in eat-in catering, others for take-away scenarios, where food is either eaten at home or on-the-go. Eat-in catering (where it's outdoor) and on-the-go situations are those that carry most risk of littering. Finding a set of alternatives to cover all food types and scenarios requires consideration of a wide range of different products and approaches.

1.7.9 On-the-go Utensils

On-the-go utensils are implements used for eating and drinking, such as straws, stirrers and cutlery. They are commonly used outside the home, associated with take-away food, and so are at high risk of being littered. There are many billions of each of these items sold in the UK every year.⁶⁸

⁶⁵ Defra (2018) Government launches plan to ban plastic straws, drinks stirrers and cotton buds. Press release – available at <https://www.gov.uk/government/news/government-launches-plan-to-ban-plastic-straws-cotton-buds-and-stirrers>

⁶⁶ Eunomia Research & Consulting (2018) *Plastics: Reuse, recycling and marine litter – Impact assessment of measures to reduce litter from single use plastics*, Report for DG Environment, 2018, http://ec.europa.eu/environment/waste/pdf/Study_sups.pdf, In Press

⁶⁷ Eunomia Research & Consulting (2018) *Plastics: Reuse, recycling and marine litter – Impact assessment of measures to reduce litter from single use plastics*, Report for DG Environment, 2018, http://ec.europa.eu/environment/waste/pdf/Study_sups.pdf, In Press

⁶⁸ Eunomia Research & Consulting (2018) *Plastics: Reuse, recycling and marine litter – Impact assessment of measures to reduce litter from single use plastics*, Report for DG Environment, 2018, http://ec.europa.eu/environment/waste/pdf/Study_sups.pdf, In Press

1.7.10 Crisp Packets

Packaging for crisps is most commonly made from metallised plastic film, usually PET or PP.⁶⁹ At present, these packets are not widely recycled, and are not recyclable via household collections.^{70,71}

This metallised film is lightweight, which allows for a low cost of shipping, enables graphics to be printed onto it allowing branding and information to be placed on the packaging, and the packet is grease-proof and gas proof to maintain freshness. However, the lightweight nature of the material means that each individual used crisp packet is of low value and thus does not incentivise separate collection. Furthermore, being of low weight and with a high surface area, crisp packets are prone to being dispersed by wind, increasing their likelihood of leakage to the marine environment. Finally, their composite nature makes them particularly challenging – both financially and technically – to recycle. An additional problem linked to consumption of crisp packets is their contamination of metal recycling streams as a result of consumer confusion and inclusion with foil packaging.⁷²

Annual consumption of crisps in the UK is reportedly high relative to elsewhere in Europe, and around 20% of consumption occurs outside the home.⁷³ Market data suggests current annual consumption of 8.3 billion packets of crisps and other savoury snacks in the UK.⁷⁴

⁶⁹ Some crisp packets may be made of plastic film only, however these are less common

⁷⁰ Terracycle provide a private recycling service for crisp packets, however the recycling process itself is costly.

⁷¹ *Plastic film & carrier bags* | *Recycle Now*, accessed 1 March 2018, <https://www.recyclenow.com/what-to-do-with/plastic-film>

⁷² *Rubbish: why your recycling isn't working. Remember to reduce, and re-use as well as recycle, and 'pick it up'.* | *West Wales Rivers Trust*, accessed 12 June 2018, <http://westwalesriverstrust.org/rubbish-why-your-recycling-isnt-working-remember-to-reduce-and-re-use-as-well-as-recycle-and-pick-it-up/>

⁷³ Statista – *Crisps- Out of home snacking* <https://www.statista.com/statistics/311498/crisps-out-of-home-snacking-occasions-united-kingdom-uk-ireland-by-location/> Date accessed: 12/06/2018

⁷⁴ Global Data Plc. (2017), Market Report – Packaging (Flexible Food Packaging), 2017, available for purchase at <https://www.globaldata.com/consumer/research-areas/industry/packaging/>

2.0 How do we Tackle the Problem?

In this section we take each of the top ten plastic products in turn and look at what we as individuals can do to eliminate or reduce their use or lessen their impact. Importantly, we also look at what manufacturers, retailers, local and national governments should be doing to help as there is only so much that members of the public can do on their own.

As part of this we include a categorisation system which helps to characterise the issues and nature of the solutions associated with plastic products on which this report focuses. The categorisation takes account of the difficulty and complexity of the solutions available (if any exist), and the timescales over which action can be taken.

Options for Action	Definition	Time Horizon	Products
Significant immediate action possible	Actions can achieve positive results immediately; there are good alternatives for consumers to easily switch to and/or significant scope (and perhaps existing precedent) for swift governmental action to eliminate the problem for good.	<2 years	Wet wipes Sanitary Products On the go utensils Cotton Buds Drinks Bottles (water)
Limited action possible Immediately, but significant action possible within 5 years	More resource needed to understand and identify the best course of action, but no significant barriers exist for positive results to be obtained within 5 years. Some options available for consumers, but may be more difficult; government action is needed to make good progress.	2 – 5 years	Drinks Bottles (flavoured/ carbonated) Take away food containers Cosmetics
Action dependant on further research and/or government regulation	Further interventions and innovation required and, in some cases, international level collaboration is needed; basic consumer advice is available, but governmental, business and scientific collaboration may be required to solve these complex issues.	5 years+	Crisp Packets Automotive Tyres Synthetic Clothing

2.1 General Guidance

For many single use plastic items – including ones not specifically addressed in this guide – it is useful to apply a hierarchy of best practice. This is a thought process that can be run through when considering buying a single-use plastic item.

1) Can the single-use item be avoided?

We have a multitude of convenience products in our lives, but first and foremost we should think to ourselves, “is it really necessary?”. If we can stop using these single-use items altogether this would be preferable from an environmental perspective. An example of this would be to refuse drinking straws - of all types - in restaurants and bars. There is an argument that these sorts of products, when made of plastics, should not be permitted due to their short life span and problematic impacts in the marine environment. Indeed, the European Commission has recently proposed that single-use plastic drinking straws – along with stirrers, cutlery and cotton bud sticks - be banned.⁷⁵

2) Are there environmentally preferable alternatives?

If the product can't be avoided, can it be substituted? There are usually two ways of looking at this:

- a. Are there reusable alternatives to the single-use item?
- b. Is there a single-use alternative made from a material that is preferable from an environmental perspective?

For members of the public, it can be very difficult to know whether single-use items made from alternative materials are better for the environment. This isn't helped by the numerous products whose environmental claims may be unverified or potentially misleading. The issue of biodegradable plastics – a clear example of consumers receiving confusing messages – is discussed in greater detail in Section 2.1.1, but it often pays to do some research into a manufacturer's claims rather than taking them at face value.

If in doubt, a simple rule of thumb is that it is almost always better to opt for a reusable product regardless of its material – as long as it will, indeed, be reused in reality. For example, there are many types of reusable coffee cups on the market, from bamboo to metal to glass and plastic. Any one of these would be preferable to using a disposable cup every day.

⁷⁵ http://ec.europa.eu/environment/circular-economy/pdf/single-use_plastics_proposal.pdf

2.1.1 Biodegradable Plastic Alternatives

One option that is frequently put forward as a solution to many of the problems associated with plastic packaging, is to make the items from 'biodegradable' or 'compostable' plastic. Firstly, it is worth explaining the distinction. Compostable means that it will break down relatively quickly in aerobic conditions to form a compost material and there is an EU standard for this in terms of industrial composting EN 13432.

Biodegradable is a more general term that on its own means very little, as it describes neither the specific environmental conditions in which the item will biodegrade, nor the timescales over which biodegradation will take place in such conditions. Given enough time, most materials biodegrade!

Due to the lack of any coherent legislation or guidance as to how it should be measured or applied the term has been widely used (and arguably misused). Importantly, a material's ability to biodegrade (to decay naturally and in a way that is not harmful) is as much dependant on the environment it ends up in as it is on the nature of the material.

There is a general hierarchy of 'aggressiveness' for environments, with industrial composting being the most aggressive and the oceans being one of the least aggressive – see Figure 6. The rate of decomposition is affected by the presence of bacteria and fungi and can happen both aerobically (with oxygen) and anaerobically (without oxygen). It therefore stands to reason that many 'biodegradable' materials may decompose in industrial composting, but not (or at a considerably slower rate) on land or in the marine environment.

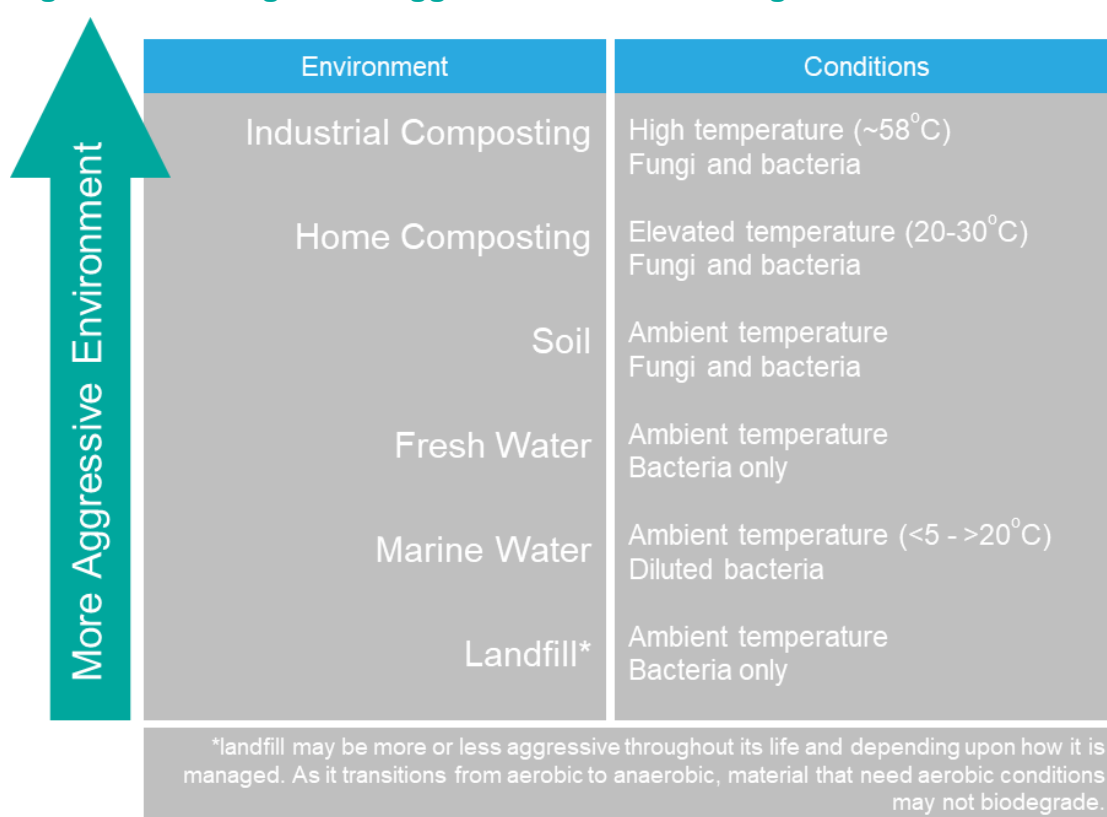
These differences are generally not communicated effectively and therefore may lead to consumers discarding the product incorrectly because they believe it will 'disappear' without causing harm. Similarly, biodegradable plastics look like regular plastics and hence can easily get mixed with recycling collections, resulting in the potential for contamination of materials where quality is of great importance. It is also worth noting that there is a clear distinction between the conditions present in home composting and industrial composting. Home composting operates at a lower temperature and hence most of the biodegradable materials that meet EN 13432 will not home compost, although there are certain polymers (to different standards) that will.

Equally, the situation around biodegradable/compostable plastics in UK organic household waste collections is complicated and potentially confusing for the householder. Many local authorities have introduced separate food waste collections – and this will only increase in the future – alongside a collection for garden waste. These two organic waste streams typically go to very different treatment processes and in the case of food waste the general UK practice is to screen out plastics (biodegradable or otherwise) at the beginning of the process to prevent the fouling of pumping systems and contamination of the final compost. Garden waste would therefore be the main conduit for biodegradable plastic packaging, but the communication of this distinction to householders will be a difficult task especially given the need to maximise regular plastics recycling through their household plastics recycling collections. From the point of view of businesses there is also the issue of the lack of communication from

wholesalers with regard to the correct disposal method of compostable plastic products especially within the catering sector – as businesses have to arrange their own sorting/collection of waste there is more chance of the wrong services being procured for this.

Ultimately, like a lot of the issues we have with plastics in the UK, the issue is systemic and arises from the waste industry having to react to products placed on the market rather than being invited to work with manufacturers and designers to produce products that take into account their full lifecycle impacts. Doing so would mean that products should be designed with a commonly utilised recycling process in mind rather than expecting the waste industry to independently design a process to accommodate the new product or packaging type once it's on the market.

Figure 6- Ranking of the Aggressiveness of Biodegradation Environments



Environment	Conditions
Industrial Composting	High temperature (~58°C) Fungi and bacteria
Home Composting	Elevated temperature (20-30°C) Fungi and bacteria
Soil	Ambient temperature Fungi and bacteria
Fresh Water	Ambient temperature Bacteria only
Marine Water	Ambient temperature (<5 - >20°C) Diluted bacteria
Landfill*	Ambient temperature Bacteria only

*landfill may be more or less aggressive throughout its life and depending upon how it is managed. As it transitions from aerobic to anaerobic, material that need aerobic conditions may not biodegrade.

2.1.1.1 Biodegradation in the Marine Environment

Where further difficulty arises is in an uncontrolled open environment. In particular, no current international standard exists for biodegradation in the marine environment. The American ASTM standard specification for biodegradable plastic in the marine

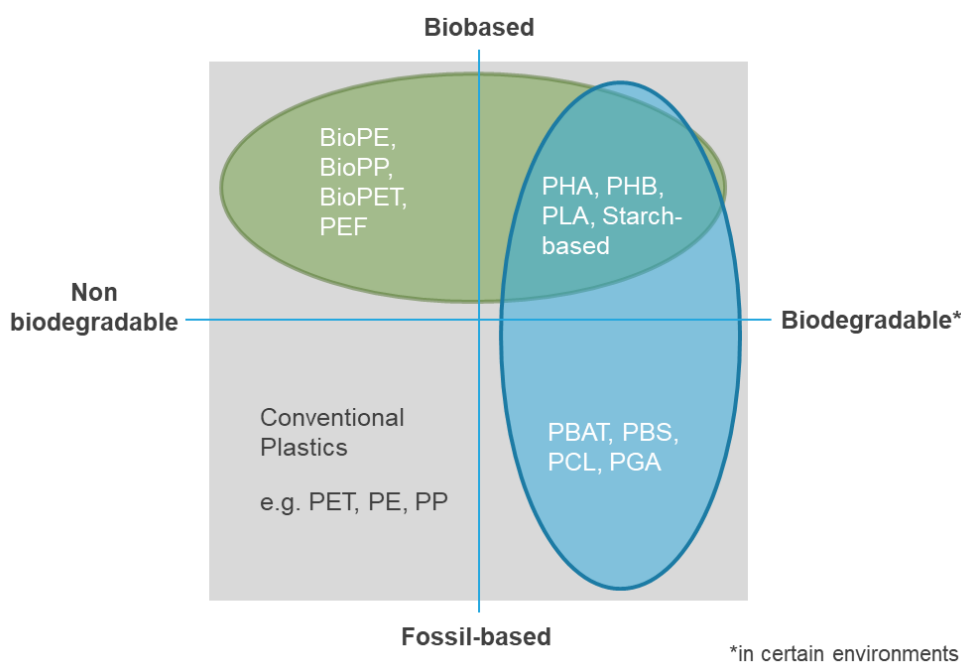
environment – ASTM D7081⁷⁶ – was withdrawn in 2014 and has yet to be replaced and although work has been ongoing for a number of years to develop a new standard there are significant challenges in doing so. For example, the marine environment is actually a whole host of environments with varying temperatures and organic life – to categorically state that a particular plastic will biodegrade in all these environments is, perhaps, an impossible task.

The challenge of deciding what is an acceptable period of time for a plastic to reside in the ocean has yet to be overcome. Most of this research is focused on the time to biodegrade in different marine environments, but much less is known about whether the risk posed to wildlife from entanglement or ingestion is directly linked to this timescale, i.e. does the risk reduce as biodegradation time reduces? This is unlikely to be resolved soon.

2.1.1.2 Bio-based Plastics

There is also confusion around the nature of **bio-based** plastics. Consumers may – quite understandably – believe that bioplastics will biodegrade. Whilst this may be true of some it is not true of all as the plant-based feedstock can also be used to make conventional plastic. Makers of these often do little to allay this common misapprehension. Figure 7 shows some of the common types of plastic and whether their feedstock is fossil or bio-based. Only a few are both derived from natural materials and known to biodegrade under certain conditions.

Figure 7 – Examples of Plastics



⁷⁶ <https://www.astm.org/DATABASE.CART/WITHDRAWN/D7081.htm>

2.1.1.3 Other Claims

There are also other kinds of material which claim to be biodegradable, but the reality of such assertions is questionable. They are known as 'oxo-degradable' or 'oxo-biodegradable' plastics and should not be confused with the biodegradable plastics already discussed. These are conventional plastics such as polyethylene (PE) which include an additive that is designed to help them break down and fragment. The manufacturers often claim that once littered the plastic will fragment and quickly biodegrade. There is little evidence for full biodegradation in practice but the plastic will fragment with the pieces becoming microplastics more rapidly than would be the case for conventional plastics.⁷⁷ The European Commission has also come to the same conclusion and is currently investigating a ban.⁷⁸ The manufacturers themselves agree that their products will not break down in compost⁷⁹ and plastics recyclers are concerned about oxo-degradables contaminating and reducing the quality and value of their material.⁸⁰ Therefore for the householder the best approach is to put them into the refuse bin in order to avoid contaminating plastic recycling streams. They are frequently marketed in a similar way to other biodegradable plastics and therefore the consumer is likely to find this confusing; or worse still be encouraged to litter these items if they think they will harmlessly degrade.

One place to have addressed the issue of consumer communication of biodegradability claims is California with their 'plastics labelling law' which states that:⁸¹

It is the intent of the Legislature to ensure that environmental marketing claims, including claims of biodegradation, do not lead to an increase in environmental harm associated with plastic litter by providing consumers with a false belief that certain plastic products are less harmful to the environment if littered.

Essentially it is illegal to use the term 'biodegradable' or imply it unless it is supported with scientific proof. Walmart has already fallen foul of this with a fine of US\$1 million for making unsubstantiated claims.⁸² This progressive law recognises that whilst there may be a place for biodegradable plastics, the increasing consumer appetite for better environmental options should not be exploited through misleading claims about products. Introducing similar requirements in the UK would therefore go a long way to helping consumers make the best decisions and begin to standardise communications and recycling activities.

⁷⁷ <https://publications.europa.eu/en/publication-detail/-/publication/bb3ec82e-9a9f-11e6-9bca-01aa75ed71a1>

⁷⁸ <https://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1516986702401&uri=CELEX:52018DC0035>

⁷⁹ <https://www.symphonyenvironmental.com/frequently-asked-questions/>

⁸⁰ http://randd.defra.gov.uk/Document.aspx?Document=11110_AnnexResearchers%27ReplytoIndustry.pdf

⁸¹ http://leginfo.ca.gov/faces/codes_displayText.xhtml?lawCode=PRC&division=30.&title=&part=3.&chapter=5.7.&article=

⁸² <https://www.lexology.com/library/detail.aspx?g=f85ab77f-a43d-412c-a10f-dd5e918aa877>

In the following sections we look at some of the key sources of plastic pollution that may be coming directly from within the household or 'on the go' through the daily use and disposal of plastic products.

2.2 In the Household

Firstly, we look at some of the key sources of plastic pollution that come directly from the household through the daily use of products. The common thread with all of these is that they enter the marine environment via our wastewater system, either being inappropriately flushed down the toilet, or being released through washing activities (both washing ourselves, and the washing of clothing).

2.2.1 Wet Wipes

Summary: Significant immediate action possible

Evidence suggests that wipes cause problems for wastewater systems and can find their way into the sea if they are flushed. Whilst alternatives to plastic exist for wet wipes there are still question marks over whether it should be acceptable to flush these as they may still pollute the marine environment. Better messaging on wipes may prevent them from being flushed, but consumer habit is hard to change and with reusable alternatives available a ban on the marketing of any single use wipes as *flushable* is likely to be the most effective way to reduce their impact. Furthermore, manufacturers of wipes that do not conform to the forthcoming agreed 'flushability' standard should also be required to contribute to the cost of unblocking sewers (relative to their contribution to the problem).

Can we do without wet wipes?

Single use wet wipes are a fairly modern invention that have replaced other reusable products over the years for reasons of convenience. There are therefore a number of options that can replace them. Cotton washable baby wipes⁸³ are available which are washed after use. They can be stored moist in their own container and can even be infused with essential oils. Similar products are also available to use as facial wipes. Natural alternatives such as coconut oil can be used to moisten the wipes to remove make-up. Like most reusable products, the greater the number of times they are reused, the lower their 'per use' environmental impact.

An option for those who prefer wet wipes to toilet paper is the 'toilet paper spray'. Various products are available which moisten toilet paper with a moisturiser to make it feel similar to a wet wipe, but without the problems associated with wet wipes.

⁸³ <http://www.cheekywipes.com/cloth-baby-wipes/cotton-terry-cloth-baby-wipes.html>

Is there a non-plastic alternative readily available that does not bring greater environmental challenges?

There are non-plastic single-use alternatives to synthetic wipes which are available on the market for those who do not want to deal with reusables. These are mostly made from cotton⁸⁴, which has its own negative impacts on the production side (explained in more detail in Section 2.2.5 on synthetic clothing). These perform exactly the same function as a synthetic wipe but are more likely to break down if disposed of incorrectly. Nevertheless, these should still not be flushed away as they will take time to biodegrade and still cause blockages in sewage systems. ***In small quantities*** it would be acceptable to place these in a household food or garden waste collection. However, if used frequently they should be placed in the refuse bin. In either case there is no route for recycling of these and therefore they are not recommended above reusable items.

An alternative that is being explored is a wet wipe made from viscose (also known as rayon or lyocell). Viscose is usually made from wood pulp which is dissolved and treated chemically to form cellulose fibres. These fibres are increasingly being used in wipes described as 'flushable' with producers claiming that they are biodegradable in the marine environment. It is unclear at this stage whether this is the case – as discussed in the biodegradable alternatives section - due to the lack of standards in this area.

The non-woven textiles industry⁸⁵ and the UK Water industry⁸⁶ have separately developed their own standards for what is considered flushable, and UK Water Industry Research (UKWIR) has produced its own with stakeholders from both sides – this test is considered to be the more rigorous test currently.⁸⁷ Importantly, none of the tests focus on biodegradability, but rather whether the wipe breaks apart and does not cause blockages. It is perfectly feasible that a certified wipe – or fragments of it – could still end up in the marine environment. This is why the water industry (as Water UK) is working with wipe manufacturers to define a better standard that would ensure that wipes would degrade in the wastewater treatment plant itself and this is likely to include a recommendation that synthetic fibres should not be included in any product labelled as flushable.

⁸⁴ <http://www.natracare.com/products/wipes/>

⁸⁵ <https://www.edana.org/industry-initiatives/flushability>

⁸⁶ <https://www.water.org.uk/policy/environment/waste-and-wastewater/sewer-misuse/snap>

⁸⁷ <https://www.ukwir.org/reports/12-WM-07-16/66917/Test-Protocol-to-Determine-the-Flushability-of-Disposable-Products>

An international group of wastewater organizations⁸⁸ have suggested that the following requirements should be mandatory for 'flushable wipes' by suggesting that they:

- 1) Break into small pieces quickly;
- 2) Not be buoyant; and
- 3) Not contain plastic or regenerated cellulose (viscose) and only contain materials which will readily degrade in a range of natural environments.

The viscose industry disputes the final point. However, to conclusively determine that no harmful marine impacts can result from this is not possible currently; therefore, flushing any such product is still not recommended. Water industries and the non-woven manufacturers are yet to fully agree on this subject. The UK government has also voiced its lack of appetite for regulation, instead encouraging the water and wipe industries to jointly develop their own code of practice⁸⁹.

How should it be treated at end of life?

If wet wipes have to be used then the best way to dispose of them is through the refuse bin at home. As there is no agreed standard for 'flushable wipes' even these should not be flushed away as there is no guarantee that they will not cause problems in sewers or become marine pollution.

What should product manufacturers do?

Manufacturers of synthetic wet wipes should make it clear on the packaging that these should not be flushed. A clear and **prominent** 'do not flush' logo should appear on all such products on or adjacent to where the wipes are dispensed. Ideally this should be standardised so that consumers can instantly recognise it such as the logo recommended by EDANA.



What should retailers do?

Retailers should only stock products that contain a prominent 'do not flush' logo as non-flushable wipes account for 90% of those available in the UK retailers⁹⁰. They should also work to include information at the point of sale to help advise their customers about the correct disposal procedures. The larger retailers (i.e.

⁸⁸ <http://www.nacwa.org/docs/default-source/resources---public/2017-03-15mdemtest.pdf?sfvrsn=4>

⁸⁹ Defra (2018) Blog: Defra in the Media, Tuesday 8th May, available at

<https://deframedia.blog.gov.uk/2018/05/08/monday-8-may-global-ivory-trade-and-wet-wipes/>

⁹⁰ <https://www.edana.org/newsroom/news-announcements/2016/10/26/making-all-wet-wipes-do-not-flush-isn-t-the-answer>

supermarkets) should be a part of the conversation between wipe manufacturers and the water companies to make sure best practice and communication is consistent throughout.

As retailers are usually advocates of consumer choice, they should look to sell reusables and toilet paper spray in the same area so consumers are able to make the choice without proactively searching them out.

What can and should government do?

Although the water and wipe industries are engaged in creation of a voluntary flushability standard it may be argued that this become mandatory once developed. It is also recommended that this be re-framed as an environmental standard rather than a flushability standard in light of the fact that the issue is more than just prevention of sewer blocking.

However, due to the uncertainty around any alternative flushable wipes in the marine environment (and whether it can truly be proven that there will be no harm caused by them) it is recommended that the government go further to enact a ban on the sale of any kind of wipes described as flushable. This means that wipes could still exist, but they can no longer be marketed as flushable. Relying on effective communication to help the consumer differentiate between flushable and non-flushable is highly unlikely to eliminate the issue entirely, and thus should not be a selected course of action.

The government could also look to impose a legislative requirement on the sale of single use wet wipes that includes the following criteria:

- synthetic fibres should not be included in any single use wet wipe
- mandatory labelling of single use wet wipe with a 'do not flush' logo
- mandatory labelling of all single use wipes with the material composition

If the 'flushability' standard is not mandatory it could be further backed up by calling for the manufacturers of wipes that do not conform to the standard to contribute to the cost of unblocking sewers (relative to their contribution to the problem) which would also add extra cost to the product and make it less attractive for consumers.

2.2.2 Sanitary Towels and Tampons (Sanpro)

Summary: Significant immediate action possible

There are several options that allow the avoidance of single use plastic. Reusables are becoming more accepted and they have the benefit of reducing overall waste and show significant life-time cost savings. There are also single use alternatives made of organic cotton. Based on this, there is a clear opportunity for governmental intervention to drive the move away from single use products containing plastic.

Can we do without sanpro?

A product is definitely needed; menstruation is a fact of life. However, there are reusable alternatives available:

- Menstrual cups/discs – these are worn internally to collect menstrual fluid which is then emptied into the toilet. They can be rinsed in the sink prior to reinsertion, which is advantageous as it means not getting ‘caught out’ without a sanitary protection, a well-known issue with disposables. They do need to be fully sterilised (with boiling water or sterilising agent) every month. A further advantage of cups/discs over tampons is that they can be worn for up to 12 hours (pretty much double time) and have no links to toxic shock syndrome.
- Reusable cloth towels – these contain a waterproof inner layer and are made with popper buttons to attach them to underwear. They can then be put in the washing machine as with other laundry items. Pre-soaking is recommended, which is a disadvantage over the convenience of disposables, but is not essential. The popper buttons mean that they can be folded up neatly once used if you’re on the go.
- Period panties are very similar to cloth towels, except the absorbent layer is a part of the pants itself instead of separate. They can also go in the washing machine. These are great as back-up for women who worry about leaks (which can be an issue for both disposable and reusable products) or can be used on their own.

Cups are made of medical grade silicone and discs are the same polymer used to make surgical tools. However, whether this material should be considered to be a plastic from a marine pollution perspective is open to debate although these products are much less likely to end up in the sea. Reusable towels and period pants include a waterproof layer which is usually made of polyurethane, so do contain plastic. However, both have a long life-span of 5-10 years so result in a significant reduction in terms of total waste quantities relative to single-use. However, as a relatively new product, it is not clear how best to dispose of old reusable menstrual products and this has not yet been thoroughly investigated.

Other alternatives include a reusable tampon applicator, which reduces plastic by removing the need for applicators but doesn’t help the issue of tampons themselves being flushed.⁹¹

One of the biggest advantages of reusables over disposables is the cost savings to be made due to the longevity of the items. On average, a woman uses around 11,000 disposable sanpro items during her lifetime which costs around £1,800. Menstrual

⁹¹ <https://www.dezeen.com/2018/03/05/reusable-sustainable-tampon-applicator-dame-design-periods/>

cups cost about £20 each so even if four or five were bought over a lifetime this is still a maximum of £100, or just over 5% of the cost of disposables.

More women switching to these more innovative methods could significantly reduce the quantity of disposables used but it requires a cultural shift that includes being able to discuss periods more openly in general. There is a lot of online content regarding reusable menstrual products, including vlogs and community forums⁹². Mainstream media is slowly beginning to discuss it too.

The best way to bring about change is to engage teenage girls who have just started menstruating and get them comfortable with using reusables from the beginning, before the use of disposables becomes a habit. The NGO City to Sea has started a schools programme⁹³ that includes discussion of the benefits of reusables, which is a significant step forward as currently big manufacturers of disposables like Always and Tampax (who only sell disposables) are at the forefront of girls' education on menstruation. This includes giving out free samples of disposable menstrual products to girls in a classroom environment in a bid to gain life-long customer loyalty.

Is there a non-plastic alternative readily available that does not bring greater environmental challenges?

For those that are not comfortable changing to new or markedly different products there are single use organic cotton tampons available which are free of plastics⁹⁴. The applicator is usually cardboard and the tampon and string are cotton. They are designed to be a direct replacement for ordinary tampons. Whilst these are less widely available than plastic versions (most of the large supermarkets don't stock them) they can be purchased online and there are subscriptions services available.⁹⁵ They are currently around two to three times the price (20 – 30 pence each) of the most popular brands of tampon.

How should it be treated at end of life?

As is the case for wipes, they should be disposed of in general refuse. Although some Local Authorities are beginning to introduce household nappy collections for parents (usually on request), they often do not collect other sanitary products alongside. Trials of separate collection of sanitary products are limited and there are no mainstream recycling routes at present.

⁹² <https://www.wen.org.uk/periodsinthepress/>

⁹³ <https://www.citytosea.org.uk/plasticfreeperiods/>

⁹⁴ <http://www.natracare.com/products/tampons/>

⁹⁵ <https://www.totm.com/>

What should product manufacturers do?

Whilst it is unlikely that large manufacturers will voluntarily move towards reusables due to the loss in sales, they should expand their product offering to include organic cotton (or other non-plastic) versions to provide more choice for their customers. As a minimum they should look to revert back to cardboard applicators and paper wrappers that were common until plastics took over.

For plastic versions they should ensure better labelling on the product to make it clear that it should not be flushed. Currently, this is usually in a small font size, in an inconspicuous part of the packaging where it can easily be missed. It should be in a prominent place on the front of the box and on each individually wrapped item. The wet wipes industry is beginning to use a standard logo (see the example in that section) – adoption of the same or similar graphic would help to standardise the message across all non-flushables.

Manufacturers must also take responsibility to ensure the ‘do not flush’ message is communicated via advertising and online platforms.

What should retailers do?

Some major retailers, such as Boots and Superdrug, have started selling reusables and organic cotton versions, which is a positive step. Other retailers could also sell these with campaigns and discounts to encourage the switch. Retailers should ensure that their staff are aware of reusable menstrual products so that they can advise customers when asked about them. A customer may come across them in a store but not have heard of them before so may request more information. If this cannot be supplied by the retailer they are less likely to try something new, particularly as the initial cost of a reusable is higher than a disposable.

What can and should local authorities do?

Some local authorities are currently drafting motions with regard to the issue of period poverty, whereby a lack of affordable sanitary products prevents girls from going to school. The plan is to provide those from such backgrounds with free sanitary products. This is an important issue that needs to be addressed but should be done in tandem with promoting reusables, which would help local authorities to achieve waste prevention.

Access to schools within the control of local authorities by the large disposable sanpro manufacturers should be re-evaluated. Other options such as inviting NGOs (City to Sea for example) may be a better option for impartial advice with no particular product affiliations.

What can and should government do?

The key issue for government is to help prevent sanpro being flushed and becoming marine pollution. In the first instance the onus should be placed upon the manufacturers of these to find effective ways to prevent this from happening. This could be through any number of communication activities. If after a defined duration the industry has not managed to effectively reduce this (measured by reduced occurrence in sewer blockages, and beach cleans) they should be subject to legislation. This could be as strict as an outright ban on plastic-based non-reusables or to place a levy on these products – obviously what would be seen as a ‘tax’ by consumers is a controversial issue for these products and can only be implemented if the access to single-use alternatives is just as easy and with no cost increases.

As the move to cotton disposables potentially has its own environmental consequences (from cotton production) there should be a concerted effort to encourage reusables. Funding of a national program for awareness of reusables in schools would help to bring about the cultural shift necessary to make these products a more acceptable alternative.

2.2.3 Cotton Buds

Summary: Significant immediate action possible

There are many alternatives both reusable and single use that do not use plastic. The key is to make these more available, but this will only happen on a limited basis without the introduction of a ban on the single use plastic sticks. The UK government is looking into this with a ban mooted for as early as 2019. This will provide a level playing field for all manufacturers and retailers to provide alternatives.

Can we do without cotton buds?

Cotton buds are used for a variety of health and cosmetic purposes, from cleaning ears, eyes and noses, cleaning and dressing wounds, to applying makeup. They also find uses in household cleaning and hobbies.

Most people would consider their main use to be for cleaning the inner areas of the ear, although there is emerging medical advice that they should not be inserted into the ear canal on the grounds that the ear canal cleans itself naturally, and that there is a risk of pushing earwax further into the ear canal and exacerbating any problems.

The advice given is that:

“the only cleaning needed is to gently wipe the conch of the external ear with a damp flannel over a finger in order to clean earwax away from the entrance to the ear canal.”⁹⁶

Is there a non-plastic alternative readily available that does not bring greater environmental challenges?

Paper- and wood-stemmed cotton buds are well-established alternatives to plastic single-use cotton buds. The original ‘Q-tips’, produced in the US, were wood-stemmed.⁹⁷ Now major manufacturers such as Johnson and Johnson have switched to paper sticks in some markets, and major supermarkets in the UK have followed suit. There are also several countries including England (and Italy, France and Scotland) who have proposed or are implementing plastic cotton bud stick bans and a ban is also proposed at the EU level. It should therefore become easier for consumers to avoid plastic cotton bud sticks in the future.

For make-up application, a wide variety of almost entirely plastic-free brushes can be found that have the added benefit of being re-usable, however animal fibres such as sable, mink, goat, squirrel or horse hair may be inappropriate for vegans and others concerned about animal welfare. Additionally, the epoxy resin adhesive used to attach the bristles to the brush is itself a synthetic polymer, with similarities to plastic.⁹⁸ Silicone sponges and sponge-tipped brushes are also available. There is very little understanding of whether silicone is a ‘better’ material to use than plastic when it comes to downsides like persistence in the environment or additives used in their manufacture, albeit the major advantage here is provided by their re-usable nature.

For cleaning wounds, cotton balls and pads would also provide a plastic-free alternative, though switching may lead to the use of more cotton per use – a resource-intensive raw material. A paper or wood-stemmed cotton bud is thus likely to be preferable for treating very small areas, while for larger areas paper tissue or toilet tissue might be less resource-intensive. These items would have the added benefit of potentially being able to be manufactured from recycled or Forest Stewardship Council (FSC) certified paper/wood.

⁹⁶ National Institute for Health and Care Excellence (2017) *Hearing loss in adults: assessment and management. Draft for consultation.*, 2017, <https://www.nice.org.uk/guidance/gid-cgwave0833/documents/draft-guideline>

⁹⁷ <https://www.independent.co.uk/life-style/health-and-families/features/the-dangers-of-putting-cotton-buds-in-your-ear-why-cant-we-resist-the-temptation-despite-warnings-on-a6840251.html>

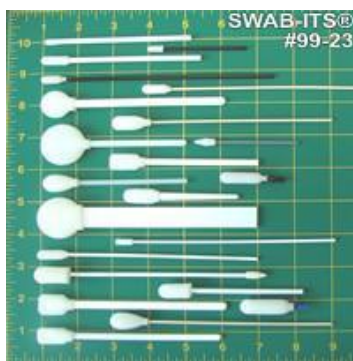
⁹⁸ <http://hair-and-makeup-artist.com/makeup-brush-construction/>

If we still use plastic for cotton buds how can we minimise plastic pollution?

A variety of re-usable plastic products could be used/adapted to undertake all of the functions of cotton buds. They include: U-tips, a cotton bud-like tool made of plastic that can be washed under the tap,⁹⁹ other types of make-up tools such as sponge-tipped applicators and synthetic bristle brushes,¹⁰⁰ and craft and cleaning tools (e.g. technical cleaning swabs made of plastic and foam),¹⁰¹ all of which can be cleaned and washed time and time again.



A U-tip



A selection of re-useable foam swabs

How should it be treated at end of life?

Single-use items, whether they are plastic or not, should never be flushed, unless they are literally just a piece of toilet tissue. They may still contribute to marine litter, even though non-plastic items may last less time in the environment. The right way to deal with this kind of plastic bathroom item is to put it in the bin. Many people have a bin in the bathroom for convenience for these kinds of items. Paper and wood-stemmed tips, tissues and cotton pads should be composted at home or put in the food waste or garden waste for collection.

What should product manufacturers do?

Given the availability of a very close like-for-like product with a non-controversial material substitution, product manufacturers should switch from plastic to paper or wood. This will incur some costs for modifying production lines but given how feasible the switch is, it is entirely reasonable to expect companies to change their practices in this way, instead of leaving others to pick up the cost of dealing with the consequences.

⁹⁹ <https://utilitytip.com/>

¹⁰⁰ <https://www.wilko.com/en-uk/health-beauty/make-up/face-brushes-applicators/c/839>

¹⁰¹ <https://www.techspray.com/swabs>

Regardless of material, manufacturers should also label their products with much more prominent 'do not flush' signage, as outlined for menstrual products and wet-wipes. This is important as the move to natural materials might suggest it is fine to flush these, but they may cause problems in sewer systems if they do not break down as readily as toilet paper.

What should retailers do?

Retailers should buy from manufacturers that have 'switched the stick' and not stock plastic-stemmed cotton buds.

Paper-stemmed buds are now sold in the UK by one of the major cotton bud manufacturers, Johnson and Johnson. Several UK supermarkets, such as Sainsbury's and Tesco, have pledged to only sell paper-stemmed cotton buds in their stores.¹⁰² This is a good start and is likely to prompt other retailers to follow suit.

What can and should local authorities do?

Local authorities could support water companies to get the 3P's message across – only pee, paper and poo down the loo.

Local authorities can let residents know the best place to dispose of single-use non-plastic alternatives like paper- or wood-stemmed sticks, given local recycling facilities. This could be in online 'accepted items' lists or recycling apps.

What can and should government do?

The governments of the UK and devolved nations should carry through their proposals to implement and enforce a ban on plastic-stemmed cotton buds. The Scottish Government conducted an eight-week consultation on the proposal ending on June 22. The UK government consultation will start later in 2018. Individuals should respond to the consultation voicing their support for the proposal.

¹⁰² <https://www.about.sainsburys.co.uk/news/latest-news/2017/22-02-2017>

2.2.4 Skin-care Including Make-Up and Sunscreen

Summary: Limited action possible Immediately, but significant action possible within 5 years

The lack of transparency as to the ingredients used in cosmetics makes it difficult for consumers to identify those they might wish to avoid, and suitable alternatives. Cosmetics with only natural ingredients are available, but these could still contain bio-polymers. The UK's ban on microplastics in cosmetics only covers 'rinse-off' products and should be expanded to encompass all cosmetic products, with the burden of proof on manufacturers to show that their products (and ingredients) are not harmful in the marine environment.

Can we do without cosmetics?

While many of us choose to wear make-up or use skin care products, most of us do so without knowing these products can potentially cause harm in the environment. One option is to not wear make-up and reduce the amount of cosmetic products we use in general. Sunscreens are perhaps one of the exceptions to this and it is highly recommended that they are used as required.

Is there a non-plastic alternative readily available that does not bring greater environmental challenges?

The difficulty is in identifying which cosmetics products may or may not contain ingredients that are of concern in terms of marine plastic pollution. However, similar to 'rinse-off' cosmetic products for which a ban on microplastics is now in place, we can look to the label for some of the commonly used plastic ingredients:

- **polyethylene**
- **polypropylene**
- **polyethylene terephthalate (PET)**
- **polymethyl methacrylate (PMMA)**
- **polytetrafluoroethylene (PTFE)**
- **nylon**

If any of these ingredients are present there could be microplastics in the product. Sunscreens that contain **styrene/Acrylates Copolymer** or **acrylates copolymer** or **polyethylene copolymer** on the label may also contain microplastics although these names can cover a whole host of ingredients which makes it very difficult to establish for certain.

As a minimum, consumers can buy cosmetics with the 'look for zero' logo which is produced by the Beat the Microbead campaign¹⁰³. The certification does not limit itself to rinse-off products and the website has a list of manufacturers and products which comply.



Alternative natural products have also been available for many years from many different suppliers. Most still contain a large number of different chemicals and preservatives but are derived from a 'natural origin'. The use of plastics or polymers is usually less likely in these types of products, but they can still contain polymers from bio-based sources which still behave like plastic in the marine environment.

If plastic remains as an ingredient how can plastic pollution be minimised?

If there is no change to cosmetic product use, the single most important action is to make sure that the likelihood of them entering the sewer system is minimised. This means that any make-up removal wipes/pads etc. are not flushed away after use. They should be disposed of in the general waste. This deals with products that are manually removed, but other so called 'leave on' products that are not routinely removed that will either wear off onto clothing or be washed off during bathing. Either way there is a route to the marine environment through the sewers which cannot be prevented.

What should product manufacturers do?

Cosmetics manufacturers have a responsibility to be more transparent about what their products contain. Whilst they comply with the letter of the law it is clear that the ambiguity in product labelling of ingredients can create consumer confusion.

Manufacturers should remove microplastics from all of their products and support the 'look for zero' logo on their products – at this time none of the large global manufacturers (which dominate the market) are doing so.

What should retailers do?

Retailers can require manufacturers to declare whether their products contain microplastics using a broader definition than used in the current ban i.e. not restricted to rinse off products. They can use this as the basis for whether these products are stocked. A number of the supermarkets also have their own branded products which are under their control and for these they can therefore commit to a wider ban.

¹⁰³ <http://www.beatthemicrobead.org/look-for-the-zero/>

What can and should government do?

The UK government has already taken the step to ban microplastics in 'rinse-off' cosmetic products. However, this was certainly seen as a 'quick win' with little opposition from the cosmetics industry at the time. 'Leave on' products such as sunscreens should also be included in the ban and there should be no lower size limit to this – essentially plastic should be banned from all cosmetic products. If seeking an exemption from the ban, the burden of proof should be upon the manufacturers to prove that their products cannot be reformulated, are necessary and do not cause problems in the marine environment.

Addressing wider concerns with cosmetic ingredients is more difficult especially as there is little publicly available research into this particular field. Determining whether polymer ingredients in cosmetics that are not solid plastic particles are a persistent pollutant in the marine environment should be a priority research focus.

The way in which ingredients are communicated on cosmetics packaging is controlled by EU law at present. The UK could potentially, after leaving the EU, introduce more stringent rules to provide more accessible information around what is contained in cosmetic products. This would also facilitate the identification and elimination of plastic-containing products.

2.2.5 Synthetic Clothes Washing

Summary: Action dependant on further research and/or government regulation

Whilst there are several small changes to behaviour and clothing choices available to consumers to make a difference to fibre pollution, the ubiquity of synthetic clothing (both existing and new) means that the ultimate solution – a shift away from the fibres /fabric constructions that emit the most fibres and an effective upstream capture – needs to come from manufacturers and retailers with the support of national and international legislation.

Can we do without synthetic clothing?

In this case it is not the product itself (i.e. clothing) that is the issue, but the fabrics they are made from and how they behave during washing. There are several niche services that have cropped up^{104,105, 106} in recent years that attempt to change the business model of the fashion industry to one of rental or subscription service rather

¹⁰⁴ <https://www.renttherunway.com/>

¹⁰⁵ <https://girlmeetsdress.com/>

¹⁰⁶ <https://fordays.com/>

than purchase and ownership. Whilst none of these aims to tackle microplastic pollution, this sort of business model may be the key to more sustainable fashion and could be used to reduce microplastics by keeping to a closed-loop supply chain in the future. In the rental model the (usually high value) clothing is returned from dry cleaning at the distribution warehouse. There are significant opportunities to incorporate filters for wet or dry cleaning to prevent fibres from being released into the sewers.

‘Fast fashion’ with the focus on speed of change and low cost has wider negative environmental consequences, but this may also be exacerbating the microplastic problem. In general terms low quality, less well made clothing is thought to release more fibres than higher quality, more durable clothing, and as new clothing fibre release peaks during the first few washes, frequently buying short lived clothing would seem likely to lead to greater release of microfibres than holding onto a higher quality garment for a longer period of time.

Synthetics have specific properties that are particularly useful in the sports apparel market; wicking of sweat, water proofing, insulation and stretching are all useful properties for sports fabrics. Some or all of these properties can be achieved with natural alternatives to a greater or lesser extent, but sometimes with trade-offs – for example duck down is a superior insulator, but there are serious questions around the ethical supply of down¹⁰⁷ and unless it is treated with chemicals it absorbs water when wet and becomes useless. The immediate elimination of synthetic clothing is not practical, and further research and innovation into more environmentally preferable alternatives is needed to make this a possibility. Currently the production of most natural fibres requires significant improvements to make these ‘environmentally friendly’.

Is there a non-plastic alternative readily available that does not bring greater environmental challenges?

Synthetic clothing makes up approximately 34% of the European clothing market¹⁰⁸. Natural fibres such as cotton and wool accounts for 56% and the remaining 10% are made from viscose (derived from wood cellulose).

The current understanding is that natural fibres do not behave in the same way as synthetic fibres in the marine environment. They are therefore likely to have less of an impact on the marine environment. However, cotton fibres entering the marine environment may release any chemicals that were used throughout its farming and

¹⁰⁷ <https://www.theguardian.com/world/2016/jan/14/winter-coat-ethically-produced-down-geese-feathers>

¹⁰⁸ JRC (2014) *Environmental Improvement Potential of Textiles (IMPRO-Textiles)*, Report for European Commission, January 2014

processing. Farming of cotton is also highly water and energy intensive and therefore a wholesale move from synthetic to natural fibres for clothing may have considerable negative impacts. A recent report by Changing Markets¹⁰⁹ found that the Better Cotton Initiative (BCI) – once lauded as the scheme that would clean up the cotton industry – is promoting unsustainable activities as best practice.

In this case, the best alternative is likely to be a garment made from certified organic cotton with one of the two international standards shown below. Hemp is also a promising alternative with significant benefits over cotton in terms of the biodiversity impacts during farming.



From a clothing performance point of view cotton is often dismissed for sporting applications as it retains sweat which is uncomfortable. The sweat wicking properties of some synthetics are thought to be superior – although the effects may mostly be psychological.¹¹⁰ Nevertheless, there is at least one¹¹¹ wicking fabric on the market made from cotton although it appears to achieve this partly through the use of chemicals.

The other alternative is clothing made from viscose (variations included, lyocell, cupro and modal). As discussed in the section on wet wipes, it is currently unclear whether or not these fibres cause impacts similar to synthetic microfibres in the marine environment. There is also a variation known as cellulose acetate which is also sometimes used in clothing and is usually labelled as 'acetate' or 'triacetate'. This has been found to have varying biodegradability¹¹² but this is the same material used in cigarette filters which are a prominent beach litter source.

¹⁰⁹ <https://changingmarkets.org/portfolio/dirty-fashion/>

¹¹⁰ Abdallah, S.J., Krug, R., and Jensen, D. (2015) Does wearing clothing made of a synthetic "cooling" fabric improve indoor cycle exercise endurance in trained athletes?, *Physiological Reports*, Vol.3, No.8

¹¹¹ <https://www.cottoninc.com/quality-products/performance-technologies/transdry/transdry-technology/>

¹¹² Puls, J., Wilson, S.A., and Höltzer, D. (2011) Degradation of Cellulose Acetate-Based Materials: A Review, *Journal of Polymers and the Environment*, Vol.19, No.1, pp.152–165

For clothing there is also some question over the manufacturing practices of some of the market leaders which suggests the fibres are not being produced in a sustainable way.¹¹³ This is largely due to the harmful chemicals that are used during production which are sometimes allowed to run into nearby rivers. Closed-loop chemical processes exist which are much less harmful, but from the consumer perspective there is no way to discern this (assuming they are even aware of the issue). This makes it very difficult for them to choose garments that they know will not be contributing negatively in other ways.

If we still use synthetic fibres how can plastic pollution be minimised?

As there is a considerable industry built up around synthetic clothing and a large proportion of existing clothing will also be synthetic it is also important to look at what we can do to reduce the impact of the synthetic clothing we already have (or intend to buy).

In recent years there have been many studies that have attempted to gain more understanding of just why and how fibres are released during washing. We still do not know enough to be able to identify whether specific fibre types are more susceptible to this with any degree of certainty. We do, however, know that there are aggravating factors which can increase fibre release during washing. These mostly relate to actions which can reduce how aggressive the washing process is. The following are some of the small changes that can be made to reduce fibre release during machine washing:

- **Wash at low temperatures (typically ~30°C)** – a lower temperature wash is less aggressive, so therefore less likely to stimulate fibre release, and also saves energy
- **Use Liquid detergent** – Liquid detergent is less abrasive than powdered detergent and is more than adequate for cleaning unless the clothing is heavily stained.
- **Use fabric softener** – This is thought to reduce the friction when washing and therefore helps to prevent fibres from breaking and releasing.
- **Fill the washing machine** – a full washing machine means less friction between items and fewer fibres released.
- **Reduce spin speeds** - whilst faster spin speeds dry clothes quicker it also agitates them more. However, it is important not to offset this with increased time in a tumble drier.
- **Air dry rather than tumble dry** – fibres can be released when tumble drying. If the condenser is connected to a waste water pipe this can also release microfibres. If the fibre is captured in the lint filter, empty it into the bin and not into the sink.

¹¹³ <https://changingmarkets.org/portfolio/dirty-fashion/>

- **Use a front-loading washing machine** – although top loading machines are not common in the UK, tests have shown that they are likely to result in more fibres being released.

There are also some buying decisions that may also reduce the contribution of fibres released-

- **Buy fewer fleeces** – polyester fleece is thought to be one of the biggest emitters of microfibres due to its construction. An alternative is woollen fleece.
- **Keep your clothing for longer** – fibre release often peaks in the first few washes and therefore frequently buying lots of new clothing is likely to be worse overall. It is often also suggested that ‘high quality’ clothing will shed fewer fibres. This is difficult to prove and define in practice and the product quality price may not always be linked to price.

To capture fibres after they are released there are also some emerging products which claim to reduce the number of fibres reaching the marine environment. The Cora Ball¹¹⁴ and the Guppy Friend¹¹⁵ are two such products. The effectiveness of these has yet to be proven but they are expected to capture around 10 – 20% of fibres.

What should product manufacturers do?

Very few large consumer-facing brands have acknowledged the issue so far. There appears to have been even less engagement further up the supply chain with the large mills throughout Asia which produce the majority of our clothing. A number of European textiles trade associations committed to a ‘cross industry agreement’ in early 2018.¹¹⁶ They have committed to define common measurement methods for fibre release, sharing knowledge and supporting industrial research. The common measurement method is the pivotal and most controversial part of this as it will allow garments/fabrics/fibre types and weave/knit types to be rated against each other with the expectation that the worst performers could then be phased out – although this latter step (and any commitment to firm action) is conspicuously absent in the cross-industry agreement at present.

A common measurement method will likely involve a standard wash procedure that measures the number of fibres being released. This can be used for different fibre types (polyester, acrylic etc.), fabric constructions (woven or knitted) and garment construction (the way edges are finished). The results can then direct the best methods to reduce fibre release.

¹¹⁴ <https://coraball.com/>

¹¹⁵ <http://guppyfriend.com/en/>

¹¹⁶ <https://www.aise.eu/newsroom/newsroom/aise-joins-cross-industry-agreement-on-prevention-of-microplastic-release-from-the-washing-of-synthetic-textiles.aspx>

What should retailers do?

Retailers are often also brand leaders who source and/or produce their own clothing lines. These have a unique role to play alongside the manufacturers. As the link between consumers and manufacturers it is important that they engage directly with those who are buying their products to understand and educate the consumer on this issue. They should also investigate what proportion of their sales are from synthetic clothing and whether switching to natural alternatives is feasible and assess the wider environmental impacts of doing so. As data becomes available on the relative extent to which different types of synthetic clothing by fibre type and construction (e.g. knit/weave) shed microfibres, retailers should move towards the best performing options that exhibit the lowest rates of loss.

If and when products (filters) are available that are proven to mitigate the loss of fibres during washing, these can be made available in store and/or given away depending upon the cost.

Retailers also play a large role in educating the consumer and helping to provide good information for their choices. This also requires that the retailers educate themselves on the impacts of their supply chain as a whole so that they are acting in the most responsible manner.

What can and should government do?

National and international research into various aspects of this issue continues. This is largely focused on two areas:

- Testing fabrics and garments to identify what causes fibre release; and
- Discovering to what extent the fibres are present and can be captured in waste water treatment plants.

It remains to be seen whether the latter will be a good and cost-effective solution and therefore it is important to prevent fibre release before it reaches sewers. The development and mandatory installation of a washing machine filter is one such way. The challenge here is for it to be a cost-effective addition and it is problematic if the cost is passed to the washing machine manufacturers and/or the consumer.

Alternatively, this could be funded by the synthetic clothing industry as a form of producer responsibility with payments relative to how many fibres their product releases (which obviously depends on a reliable testing regime for microfibre release).

Supporting research both independently and collaboratively with the textiles industry is important to help solve this issue. The textiles industry is looking to develop voluntary standards, but this is unlikely to be sufficient due to the complexity of the textile supply chains. It may therefore be necessary to develop supporting legislation to create a level playing field. This should be at European or global level with relevant EN/ISO test standards and regulations on maximum fibre release (with escalating targets to push towards better products).

2.3 On the go

In this section we look at some of the key sources of plastic pollution that may be produced 'on-the-go' throughout the day. These are plastics – usually packaging – that are most often disposed of outside of the home and therefore have a greater chance of being littered or at least not being recycled. Such plastic items placed in litter bins, even those designated as 'Recycling On The Go' bins, are very unlikely to be recycled.

Items that are littered have a chance of being blown into nearby rivers or coastlines. In this section we also include microplastics generated from the wear of vehicle tyres.

2.3.1 Drinks Bottles and Tops

Summary: Significant Immediate action possible for water bottles; limited action possible immediately, but significant action possible within 5 years for other bottles.

The key way in which consumers can avoid single use plastic bottles is to carry a reusable bottle which can be refilled with tap water.

For occasions where single-use beverage containers are purchased – flavoured soft drinks for example – the proposed introduction of a deposit return scheme (DRS) in the UK would be likely to increase recycling rates to 90% or more. By placing a value on the used bottle, it is also less likely to be littered and if it is, others would be more likely to pick it up for the value of the deposit.

Is the product really needed and/or can the service it provides be delivered in a different way?

In a country with widely available, safe drinking water like the UK, two different models for making sure people have access to water to drink are relatively easy to implement. One is to reinstate and improve a network of public drinking fountains. The second is to encourage businesses to sign up to a Refill network scheme, undertaking to give members of the public free access to tap water as requested.

The UK charity City to Sea launched Refill Bristol in 2015 as part of Bristol's 2015 European Green Capital year. Refill has now expanded the project to tens of other towns and cities in the UK and is in the process of launching nationwide.

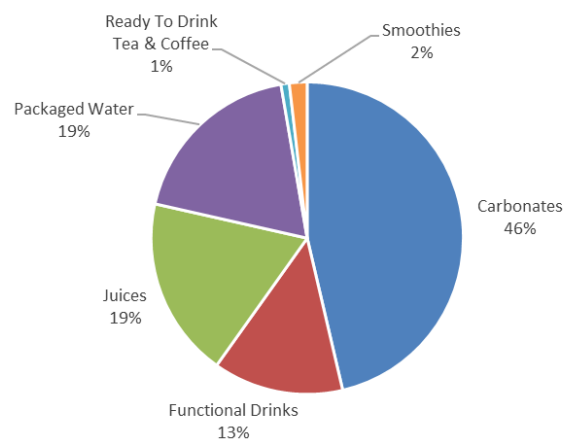
Cafes, bars, restaurants, and any other business or public venue (such as a museum or tourist information centre) can register with Refill as a Refill Station, indicating that consumers are welcome to refill their reusable water bottles for free. Refill has developed an app so that consumers can easily locate a refill station on the go, and participating businesses also display a sticker in their window.

On a smaller scale, an example has been set by ZSL London, which no longer stocks single-use plastic bottles, as part of the One Less campaign.¹¹⁷ Visitors and staff can buy refillable bottles or bring their own and refill them at any of the catering outlets or fountains on-site. Similarly, Selfridges in London, working in partnership with the One Less Campaign, has stopped selling plastic water bottles and instead provides a fountain for customers to fill their bottles at no charge.¹¹⁸ Pret has also been trialling refill stations and different refillable container options.



Water accounts for approximately 19% of the soft drink beverage containers sold in the UK. For other soft drinks, producers or retailers could install soda or beverage machines for use with refillable bottles, rather than selling single-use plastic bottles. Consumers would then bring refillable bottles to the outlet and purchase the volume of beverage they require for their bottle.

Soft beverages by number of units sold, UK



Eunomia Research & Consulting (2018) Reuse, recycling and marine litter – Impact assessment of measures to reduce litter from single use plastics, Report for DG Environment, 2018, In Press

¹¹⁷ <https://www.zsl.org/news/zsl-london-zoo-ditches-plastic-water-bottles>

¹¹⁸ <http://data.parliament.uk/writtenevidence/committeeevidence.svc/evidencedocument/environmental-audit-committee/packaging/oral/71506.pdf>

Cordials, squashes and syrups, as well as powdered flavours, represent yet another way of delivering flavoured drinks that can be combined easily with refillable service models, and save on the transport emissions of hauling around large volumes of liquid.

Is there a non-plastic alternative readily available that does not bring greater environmental challenges?

There are a variety of other single-use beverage containers that are not predominantly made of plastic, though few are truly 'plastic free'. For example, cans are manufactured with various polymeric coatings,¹¹⁹ and glass bottle caps frequently contain plastics to help provide a seal.

Generally speaking, item for item, single-use alternatives to plastic are heavier and will generate more carbon emissions during haulage prior to consumption. Glass and aluminium also consume more energy (and therefore create more greenhouse gas emissions) in their primary manufacture. However, in terms of their impacts as marine litter and leaching of additives, other materials do have advantages. Because of these advantages and disadvantages, there is no clear frontrunner regarding which material is best for single-use applications. Therefore seeking to avoid waste in the first place through carrying your own refillable bottle is the priority.

In terms of re-usable alternatives, the same issue around the difficulty of finding 'plastic-free' items applies: stainless steel or glass bottles usually have plastic components, generally the entire cap or a seal inside it. Again, the prime advantage of these items lies in their re-usability rather than the fact that they don't contain plastic.

If we still use plastic for drinks bottles and tops how can we minimise plastic pollution?

There is a huge range of re-useable plastic and *almost* plastic-free bottles available today. Re-use is a really effective way to reduce the generation of plastic waste and therefore minimise plastic pollution.

In terms of single-use plastic bottles that continue to be used, the imperative is to reduce littering and achieve a very high level of high quality (bottle to bottle) recycling. Deposit return schemes for beverage containers can do both – they can lead to recycling rates in excess of 90% and reduce littering of deposit-bearing containers by 90%.

How should it be treated at end of life?

Beverage containers of any kind are all readily recyclable and plastic ones are usually made of PET which is easy for recyclers to identify and sort. The best option would be

¹¹⁹ <https://www.wired.com/2015/03/secret-life-aluminum-can-true-modern-marvel/>

for the beverage container to be collected via a DRS, as this ensures a clean source of material for recycling. While plastic drinks bottles are already collected via household recycling, recycling rates are much lower than they would be under a DRS, and the quality of the material collected in this way isn't as good, meaning it's less likely that environmentally preferable closed loop recycling (into new bottles) will take place.

What should product manufacturers do?

Drinks producers should work to maximise the use of refill at point of sale as a model for the delivery of their products. They should also commit to high targets for recycled content in the plastic bottles that they use, in order to 'close the loop' by further increasing demand for recycled material.

The packaging industry's efforts to prevent plastic waste to date have been focused on lightweighting – i.e. designing packaging with the minimum amount of raw materials possible – as another form of waste prevention. However, although lightweighting leads to less weight of material being wasted, the number of items, with all their potential for littering, is not changed by this approach. Additionally, re-use can prevent more waste in the long run than lightweighting.

Therefore, designing highly functional, durable and appealing re-usable items, and getting involved in their production, is another way that manufacturers can get involved in reducing plastic emissions to the environment.

There is also room for innovation in creating alternative materials for transporting liquids that are both lightweight – like plastic – don't take a lot of energy to produce – unlike metal – easily recyclable – unlike tetrapaks – but that are not as harmful to the marine environment. For example, research into producing bottles made with alternative materials such as wood fibre,¹²⁰ algae¹²¹ and chitin¹²² are being explored.

Given that plastic bottle caps are frequently found on beaches, and in greater numbers than plastic bottles themselves, designing items in such a way that they have reduced littering potential (such as cap-tethering, or resealable packaging), while still readily permitting recycling is a way that manufacturers can help minimise littering.

What should retailers do?

Retailers can sign up to refill schemes, fund the installation of public drinking water fountains (either individually or in partnership with other businesses, such as via Business Improvement Districts), and sell their own re-usable (and potentially returnable) bottles alongside offering and promoting refills.

¹²⁰ E.g. Carlsberg green fibre bottle

¹²¹ E.g. Ooho! water capsules

¹²² E.g. CuanTec bottle

What can and should local authorities do?

Local authorities can help reinstate and install new public drinking fountain networks. The requirement to install, maintain and promote the use of a network of water fountains should be a requirement within their waste management and street scene contracts, given that it should reduce waste and litter. They could also increase participation in Refill schemes by including it as a licensing requirement. They could further ensure that single-use plastic bottles are not procured and/or sold on public land or in public organisations.

What can and should government do?

Government should introduce a Norway-style beverage container tax that places a tax (at a very high level) on each beverage container sold, with the tax reducing as the recycling rates for those types of beverage containers increases. In Norway this led to industry very quickly deciding to implement a (very effective) DRS.

Such a tax could also be modified in such a way as to incentivise high levels of recycled content alongside high recycling rates.

Central government could also help support local authorities to reinstate public drinking fountain networks, either financially, or by setting a clear expectation or target. It can also lead by example through green public procurement at a central or a local level, and also by not selling bottled water in its own buildings and departments.

2.3.2 Take-away Food Containers

Summary: Limited action possible immediately, but significant action possible within 5 years

Whilst reusable alternatives are available, they are not widespread in their use and it often requires individuals to proactively use their own container. Greater social acceptance of this practice is important, but the introduction of a tax on single use take away items and the wider implementation of reusable schemes is the main way to reduce consumption and littering.

Is the product really needed and/or can the service it provides be delivered in a different way?

The principle unique selling points of take-away food are speed, versatility and spontaneity – the provision of single-use containers contributes to maximising these advantages. However, there are situations in which take-away food containers are not really necessary. For example, some retailers offer food in takeaway containers even where there is space to sit and eat on the premises. Furthermore, not every kind of takeaway food needs a container. And there are quite a few contexts in which re-useable crockery could be provided as a hireable service – in the same way that

glasses can be hired for parties, cutlery and crockery could be hired, for example, for street markets and public events. In each of these circumstances, the product in question is not really needed, and the service could and should be provided in a different way. This has already been implemented at public events in Vienna and Munich for example.¹²³ In 2011, Vienna introduced an obligation to use reusable items at events with more than 1,000 people, where more than 500 people are attending in venues recognised as “permanent” by the Viennese Government, or which are held on property owned by the Viennese Government.¹²⁴

Is there a non-plastic alternative readily available that does not bring greater environmental challenges?

There are many types of food trays and containers available that are made of organic materials – from paper and card to bagasse¹²⁵, compressed wheat straw and banana leaves. However, they are generally less suitable for more liquid food because at present they tend not to be as easily sealable, or resistant to hot liquids for a long time period. A commonly used non-plastic alternative that is suitable for more liquid food is the aluminium foil container with a cardboard lid.

In terms of the environmental implications of the use of these different materials, they all have different advantages and disadvantages depending on what you’re looking at – for example whether it’s the achievable recycling rate, greenhouse gas emissions, or litter impact. Again, heavier materials will typically be associated with more energy expenditure (and plastics are usually the lightest option), but organic materials will not be associated with marine impacts years or decades into the future.

Food containers can also be made out of plastic termed “biodegradable”. They are portrayed as an eco-friendly alternative to plastic, but in reality they share many features of plastic as previously discussed. This includes boxes that are lined with “biodegradable” plastic film.

Re-use schemes based on tiffin boxes are operated by some independent retailers. These are traditionally a set of metal tins that can be strapped together by a band, as commonly used in India to deliver thousands of meals throughout cities every day.¹²⁶ Typically, a retailer might sell a tiffin box and return customers will use it each time they buy a takeaway. Alternatively, the boxes can be ‘owned’ by the retailer who hands it to the consumer for a deposit large enough to incentivise its return.

¹²³ http://www.prewaste.eu/index.php?option=com_k2&view=item&task=download&id=415&Itemid=94

¹²⁴ Eunomia (2012) A Feasibility Study on a Legal Obligation Aimed at the Systematic Use of Reusable Containers for Drinks and Food Served at Events Held in Public Places in the Brussels-Capital Region, Final Report to Bruxelles Environnement, August 2012.

¹²⁵ https://www.vegware.com/catalogue/bagasse-tableware/cat_9.html

¹²⁶ <https://www.bbc.co.uk/news/world-asia-india-26128597>

Currently, retailers can be resistant to accepting re-usable containers brought by the customer, on the grounds that portions and pricing may be determined incorrectly. Selling by weight, by slice, or determining correct serving quantities by using standard volume serving implements, are all ways retailers can support re-useable container use. Alternatively, developing standard volumes for re-usable containers could help.

If we still use plastic for take away food containers how can we minimise plastic pollution?

Re-useable schemes are being developed that would reduce the generation of plastic waste, whether the items are made out of plastic or not. For example, the design chosen for the 'Bring Back Box', trialled in the Swiss city of Bern, was a plastic container.¹²⁷ This scheme was based around a system of participating restaurants stocking Bring Back Boxes, a robust, durable box that was paid for with a deposit (10 francs – around £8), returned to any participating restaurant, where the boxes were washed or picked up and washed at a central facility, and redistributed to participating restaurants.



Another example is provided by Go Box in San Francisco.¹²⁸ The company offers an app based reusable box service for take-away and street vendors. Each box can be used up to 300 times before it is eventually recycled.

Another way of encouraging re-use is for businesses to provide discounts for people bringing their own containers, whatever material they are made from – the more re-use in the system, the more this reduces the number of containers in circulation that can be littered.

For single-use plastic items, the most important thing, with regards to preventing marine impacts, is that they should not end up as litter.

How should it be treated at end of life?

¹²⁷ <http://www.gruenetatze.ch/waschen-und-geliefert>

¹²⁸ <https://challenges.openideo.com/challenge/circular-design/ideas/go-box-the-service-for-reusable-and-returnable-to-go-container>

For single-use plastic items, recycling bins at home are preferable to general refuse. The right waste stream is likely to be mixed dry recyclables, but specifics should be obtained from your local authority. They should definitely end up in a bin.

For single-use items made of PLA lined paper and PLA items, whether they end up being recycled depends on the facilities of local authorities for recycling food and green waste. The best home for them might be green waste, where they stand more chance of getting composted. If they are put with food waste, they might or might not be screened out before entering the recycling process, depending on the plant and its set-up.

Oxo-degradables do not have a home anywhere and should be put in the general refuse. This is also true of plastic-lined card.

For genuinely compostable items, such as bagasse, paper, wheatstraw or banana leaves, the best place for these sorts of items is with food or green waste. This includes the greasy bits of pizza boxes, which otherwise contaminate the paper and card material recycling stream.

What should product manufacturers do?

Product manufacturers can look into designing the most appealing, durable, safe and resource-efficient re-useable containers possible to take advantage of the public's increased interest in taking responsibility for their waste and their consumer habits. Determining suitable standard volumes that retailers will accept can help resolve the reported issue of portions and pricing which is said by some to deter retailers from accepting re-usable containers; having various 'volume levels' as a scale on the inside of a container could provide extra flexibility and standardisation at the same time.

Reducing the numbers of types of plastics used for containers and lids would also be useful to increase the recycling rate, if single-use plastic items remain in use. For example, PET and PP are the only items for which there is a market at the moment, while everything else tends to go to incineration. Producers and reprocessors should work together to streamline the number of materials used as much as possible.

What should retailers do?

As well as being receptive to customers bringing their own containers and communicating this, businesses can encourage re-use by providing discounts for customers bringing their own containers (although Government implementing a tax on single-use takeaway containers at the point of sale would be preferable). Making sure portioning can be carried out by other methods (weighing, graded serving spoons, slices) than using the end container is also a way of facilitating the utilization of re-usable containers.

Businesses should not be offering single-use containers where they have in-house seating and the customer will be consuming the food on the premises – i.e. where the food is not being taken away.

If single-use items are used, choosing those with the least plastic content possible for the application desired will help minimize the duration of any subsequent littering impacts.

Where plastic containers are used, choosing plastic types where recycling is more likely at present such as PET and PP, helps to increase the recycling rate of the materials once collected.

What can and should local authorities do?

Local authorities could participate in launching and running re-usable container schemes. They can also require the use of re-usable items on public land or at public events, or as part of the licencing conditions of markets or local businesses. They can also use their procurement powers to ensure single-use plastic containers are not used in the catering paid for by the public purse.

What can and should government do?

Government should implement a tax (of perhaps 25p) to be paid by consumers at the point of sale for each single-use takeaway container provided (of any material type) to encourage the uptake of reusable alternatives.

It can also ensure that on its own premises, re-usable cutlery and crockery are used wherever there is seating for eating and drinking. There are many ways the government can support design for better capture and recycling.

Government should make packaging producers financially responsible for dealing with packaging that is not recycled, including the costs of clearing up littered packaging.

2.3.3 On-the-go Utensils

Summary: Significant immediate action possible

With non-plastic alternatives readily available and the government already suggesting a ban on single use plastic straws there is a strong case to expand this to all utensils at the same time.

Is the product really needed and/or can the service it provides be delivered in a different way?

On-the-go utensils include cutlery, straws and stirrers. Cutlery is a necessity depending on the nature of the on-the-go meal (e.g. sandwiches vs. pasta salad). Stirrers of some

kind are necessary for mixing milk and sugar into beverages. Straws are only really needed by people with certain disabilities and children learning to drink from a cup, however dentists do recommend them to protect teeth when drinking sugary drinks due to its potential to cause cavities or staining. More and more retailers are committing to eliminate plastic straws from their operations.

Is there a non-plastic alternative readily available that does not bring greater environmental challenges?

A well-established alternative to single-use plastic cutlery is conventional washable and reusable metal cutlery which is eventually recycled at end of life. This requires the user to carry their own – easy enough to do with normal cutlery used in the home, or there are several options designed for camping and picnics.¹²⁹ Re-use and return schemes are possible but have not yet been trialled for utensils.

Many takeaway food retailers, e.g. LEON¹³⁰, are making the switch to compostable cutlery made of wood or bamboo. There are also some options available for edible cutlery, e.g. the Indian company Bakeys¹³¹ that makes spoons, forks and chop sticks from rice, wheat and sorghum with three flavour options (savoury, sweet and plain). These can be eaten with, and then eaten themselves, or will decompose in a few days if not eaten.

Most beverages are prepared and personalised (e.g. with the addition of milk or sugar) at the point of purchase, with stirrers disposed of immediately and not carried away with the cup. This means replacing single-use stirrers with teaspoons is a relatively easy alternative for the drinks retailer, although this requires a washing system. Some companies, e.g. Network Rail, have decided to only supply biodegradable wooden stirrers¹³².

Reusable straws in a variety of materials (silicone, glass, acrylic, bamboo, metal) are becoming increasingly common, and personal ones often come with an accompanying cleaning brush.

Single-use paper straws, wheatstraws, algae-based straws and even pasta straws are also a biodegradable alternative, though of course reuse is still generally preferable.

If it needs to be plastic how can plastic pollution be minimised?

¹²⁹ <https://www.thekitchn.com/green-on-the-go-10-reusable-ut-94914> Accessed 14/06/18

¹³⁰ <http://www.retailtimes.co.uk/network-rail-to-ban-retailers-from-supplying-plastic-cutlery-and-cups-in-managed-stations/> Accessed 14/06/18

¹³¹ <http://www.bakeys.com/> Accessed 14/06/18

¹³² <http://www.retailtimes.co.uk/network-rail-to-ban-retailers-from-supplying-plastic-cutlery-and-cups-in-managed-stations/> Accessed 14/06/18

The only kind of plastic on the go utensils that should be used are reusable ones, which can then ultimately be recycled at end of life.

How should it be treated at end of life?

Single-use plastic cutlery, straws and stirrers are generally made from one type of plastic which is technically recyclable, but in practice this is unlikely due to the market for the sorts of materials often used. Disposal in household or street recycling bins is still likely to be the best option, however. Thereafter any general waste bin is preferable to utensils simply being lost to the environment as litter since their small and lightweight nature means they are easily transported to waterways and thereafter the sea.

What should product manufacturers do?

In light of a potential ban, current manufacturers of single use plastic cutlery should look towards diversifying to other materials or reusables. Making reusable alternatives attractive and durable can help to encourage the consumer to stop using single-use plastic utensils in the run up to a ban, or if a ban is not enacted.

What should retailers do?

Many retailers are already taking steps to eliminate single-use plastic utensils from their supply chains by replacing them with non-plastic compostable/biodegradable alternatives. This is a good step to reduce plastic waste, however the carbon emissions associated with deforestation required to supply raw material (paper and wood) for these compostable alternatives, as well as the methane released during their decomposition, have negative environmental effects.

In light of this it is important to try to reduce the number of single use utensils in circulation, whether they are plastic or another material. Some steps to help retailers do this include:

- Ask whether consumers actually want/need the utensils when buying their food or drink – they may not if they have access to their own reusable alternatives. One way of giving away fewer utensils is to place them behind the counter, and possibly out of sight.
- Provide incentives for customers to use their own reusable utensils, like discounts and charges (for single-use items).
- Return schemes for retailer-owned and supplied utensils could be developed. Such a scheme is being piloted for coffee cups by CupClub.¹³³ Centralised washing facilities could be provided for businesses within a certain radius in a

¹³³ <https://cupclub.com/>

closed system, such as at events, on campuses, or using reverse vending machines in which consumers can purchase food with reusable cutlery at one location, and drop off at another after use. Alternatively, city-wide refill schemes, which may remove the necessity for on-site washing, with reusable containers being collected by logistics and washing operators, are another option. It is worth saying that this is easier for bigger items like coffee cups, easily branded and tracked using a chip, compared to smaller utensils with a much lower perceived and actual value.

What can and should local authorities do?

Local authorities can help to raise awareness around consumer choice by advocating the benefits of reusable utensils and educating citizens about what materials are recyclable. They could also work with local manufacturers and retailers to provide recycling options and organise advertising campaigns to educate consumers. And as well as for food containers they can also require the use of re-usable utensils on public land or at public events, or as part of the licencing conditions of markets or local businesses.

What can and should government do?

The UK Government should ban single-use plastic utensils, but also tax the non-plastic alternatives in order to reduce consumption across the board. It's worth noting that in May the EU proposed a ban on plastic cutlery and straws in order to reduce marine litter¹³⁴.

In the interim, the government could make sure that all government building and procurement practices eliminate the use of single use plastic utensils (and indeed all single use plastic items).

2.3.4 Crisp Packets

Summary: Action dependant on further research and/or government regulation

Crisp packets are problematic. They can't be recycled, they are bought in their millions and they are easily dropped and transported by wind. No alternatives exist that provide the same service to contain and preserve the product and therefore it is a particularly problematic item of packaging. Whilst innovation in packaging and materials should be ongoing (in partnership with recyclers), ways to incentivise the

¹³⁴ <https://www.independent.co.uk/news/world/europe/plastic-ban-straws-eu-cutlery-cotton-buds-single-use-uk-environment-a8373351.html> Accessed 14/06/18

return of the packets so they do not become litter should be the immediate, short term focus.

Can we do without crisp packets?

At present, there is no non-plastic alternative to crisps which come in bags. In this sense, the product – the crisp packet – is needed. Crisps however, can be packaged in plastic/foil composite packets or packets which are plastic only, with the latter preferable from a recycling perspective. The main alternative is the cardboard tube, popularised by Pringles. Whilst the constituent parts are recyclable (card body, metal bottom, plastic lid), its composite nature means that it is also effectively unrecyclable and has been highlighted as one of the ‘worst packaging offenders for recyclability’ by the Recycling Association.¹³⁵ As such, as far as the consumer is concerned, the majority of crisp brands are only available in a non-recyclable plastic packaging.

Manufacturers defend the plastic/foil composite packet on the basis of maintaining the freshness and crispiness of the product, as well as needing a greaseproof and gas proof material. Additionally, there is a benefit of using an opaque plastic/foil composite in terms of branding and creating a product which is aesthetically attractive. However, crisp packets can be made from plastic film only and the potential for switching to such packaging should be explored by manufacturers, albeit this helps only with recycling and does not prevent it being littered.

Is there a non-plastic alternative readily available that does not bring greater environmental challenges?

Potential alternatives to the metallised film of crisp packets have been investigated but none have been sufficiently successful. 100% compostable crisp bags were trialled by Frito Lay for their Sun Chip range in 2010, but were removed from the market within the year due to falling sales, linked to consumer complaints about how “noisy” the packet was.¹³⁶ The compostable bags were made from poly-lactic acid (PLA), a corn based bio-polymer which can biodegrade at varying speeds in different environments.

Other attempts have been made to package crisps in alternative formats such as the Boxerchips range which created recyclable cardboard boxes for crisps but still used a foil/plastic based outer for freshness. The main selling point of the box format was fewer broken crisps rather than recyclability.¹³⁷ Finally, the Stax range developed by

¹³⁵ <http://www.therecyclingassociation.com/latest-news/ceo-simon-ellin-picks-out-worst-packaging-offenders-for-recyclability-for-the-bbc>

¹³⁶ Sutcliffe, H. (2010) Eco crisp packet is too noisy for consumers, *The Guardian*

¹³⁷ *Chips and Crisps- Boxerchips* <https://www.chipsandcrisps.com/boxerchips.html> Date accessed: 12/06/2018

Walkers/Lays used a rigid plastic-only or coated cardboard-only tube, with a plastic lid, in place of the metal/plastic cardboard composite used by Pringles.¹³⁸ However, the recyclability of these alternatives has been questioned and none have achieved wide market presence.¹³⁹

With no viable alternatives how can we minimise plastic pollution from crisp packets?

Given the current lack of widespread recyclable alternatives to the foil/plastic composite the key challenge is to reduce the number of items in the litter stream, with stimulation of innovation towards recyclable alternatives as a secondary aim.

This could be achieved through the measures listed below, and through consumer choice shifting away from non-recyclable packaging or reducing consumption of crisps as a whole.

How should it be treated at end of life?

At present, composite crisp packets must be included with residual waste for treatment, with the exclusion of the few examples in recyclable packaging. As such, best practice for end of life would be ensuring that crisp packets are collected through household waste collection systems and are not littered. However, there is innovation within the recycling sector towards end-of-life treatment for crisp packets.

Schemes exist run by private organisations looking at “non-recyclable” packaging. TerraCycle are an example who reward participants of their schemes with charitable donations for sending them certain pieces of non-recyclable packaging. In the USA and Canada this applies to crisp bags, and to similar but non-foil lined biscuit packaging in the UK.^{140,141,142} TerraCycle collects this waste in a single-stream through asking consumers to send their collected waste via post. TerraCycle also offers recycling of

¹³⁸ Allen, R., Billings, D., and Leitz, K. (2012) *Texture comparison in chips in various environments through mechanical property estimation*, 2012, <https://web.wpi.edu/Pubs/E-project/Available/E-project-031312-125309/unrestricted/FinalReport.pdf>

¹³⁹ While no apparent alternatives appear to be currently available for crisp packaging, some items of confectionary are packaged in paper wrappers with grease barrier properties.

¹⁴⁰ *Snack Bag Recycling Program*, accessed 1 March 2018, <https://www.terracycle.com/en-US/brigades/haincelestial>

¹⁴¹ *Terra®, Sensible Portions® and Garden of Eatin’® Recycling Program*, accessed 1 March 2018, <https://www.terracycle.ca/en-CA/brigades/terra-sensible-portions-and-garden-of-eatin>

¹⁴² *McVitie’s® Biscuit Wrapper Recycling Programme · TerraCycle*, accessed 1 March 2018, <https://www.terracycle.co.uk/en-GB/brigades/mcvities-biscuit-wrapper-brigade>

crisp packets and snack wrappers in the UK via a paid service, through one of their “Zero Waste Boxes”.¹⁴³

Processing of such waste is expensive, but possible. Using different processing options it is possible to generate an output of Polypropylene (PP) or Polyethylene terephthalate (PET) plastic pellets containing flakes of aluminium, aluminium and an oil, or plastic pellets of PP or PET and aluminium separately.

What should product manufacturers do?

Manufacturers should continue to look into alternatives and switch away from non-recyclable packets. Some crisp manufacturers at present use a plastic film-only packet, which has a grease-proof lining and the same is used for some sweet on-the-go snacks. The counter argument to such alternatives is that they are inferior at preserving the ‘freshness’ of the crisps- and therefore reducing the shelf life. Crisp brands using such packaging at present include Santitas in the USA. Cardboard tube packaging is another alternative, as mentioned with respect to the Stax crisps.

Some crisp manufacturers have already stated intentions in this respect with Walkers having pledged to make the packaging across their product portfolio 100% recyclable, compostable or biodegradable by 2025.¹⁴⁴ These pledges are welcome but should not be fulfilled in isolation. The term ‘recyclable’ is subjective and requires that they work with the Local Authorities and recyclers to determine what this means in reality. Involving all the supply and disposal chain in this process is key to more joined-up thinking. Equally, if they are biodegradable it should be in a range of natural environments that they are likely to end up (e.g. soil, marine environment).

It is understood that many manufacturers are responding to the supermarket’s requirement for increased shelf life (up to a year). This is to make stock control and bulk purchasing easier with no evidence of any specific consumer demand for this length of shelf life.

What should retailers do?

Retailers can help by working with companies providing a recycling service, such as TerraCycle, and providing recycling collection points in store. This could be done in a similar way as is presently done with used carrier bags and plastic films.¹⁴⁵

¹⁴³ TerraCycle: *Crisps Bags, Snack Packaging and Sweet Wrappers Zero Waste Box* https://www.terracycle.co.uk/en-GB/zero_waste_boxes/candy-and-snack-wrappers Date accessed: 12/06/2018

¹⁴⁴ Country Living: *Crisp packets contain even more plastic than you thought, so sign this petition to get them changed* <https://www.countryliving.com/uk/wildlife/countryside/a19826273/petition-walkers-plastic-crisp-packets/> Date accessed: 12/06/2018

¹⁴⁵ *Plastic film & carrier bags | Recycle Now*, accessed 1 March 2018, <https://www.recyclenow.com/what-to-do-with/plastic-film>

They should also re-evaluate whether their long shelf life requirements are creating the demand for non-recyclable packaging. They should work directly with the manufacturers to determine whether this sort of packaging is entirely necessary.

What can and should local authorities do?

Local authorities can help encourage consumer choice, by contributing to increased consumer awareness around what's recyclable, and by advocating the benefits of choosing an item with recyclable packaging over one without recyclable packaging.

Ensure that they are taking litter prevention measures – measures that address littering in general will also reduce the quantity of crisp packets littered. Such measures could include information campaigns, provision and maintenance of litter-bins to ensure they are not overfilled and leaking, and additional provision of waste management services around public events.

Local authorities could also work directly with manufacturers and retailers to provide recycling options as well as clear and consistent communication to consumers.

What can and should government do?

Awareness can be raised around reducing consumption of non-recyclable items and incentivising consumer options for recyclable packaging.

Government should also ensure that under extended producer responsibility for packaging, producers are financially responsible for their packaging that isn't recycled, including the full costs of clearing up packaging that is littered. For producers of crisps, this would provide a further stimulus to redesign the packaging or put in place mechanisms to reduce littering (and possibly increase recycling, if financially preferable) of their packaging.

2.3.5 Automotive Tyre Wear

Summary: Action dependant on further research and/or government regulation

Choosing walking, cycling and public transport over private car journeys should be the first option. Where a journey by private car is unavoidable, there are several small things that drivers can do to reduce tyre wear which generally coincide with behaviours that are encouraged for eco-driving. The main action, however, needs to be undertaken by the manufacturers, with regulatory oversight in order to design tyres that exhibit lower rates of tread wear per mile driven.

Can we do without tyres?

Automotive tyres are currently the only mainstream method used to provide an effective interface between vehicle and road surface. The friction that creates tyre particles is a necessary element to provide grip and increase safety. The main alternatives are therefore a modal switch to active travel or public transport systems.

Is there a non-plastic alternative readily available that does not bring greater environmental challenges?

Conversations with the tyre industry suggest that ‘biodegradable polymers’ have been the focus of trials for many years although there is yet to be such a product commercially available. Obviously, such a product suffers from the same issues as highlighted in the general guidance on biodegradable alternatives. There would also be challenges such as preventing them from biodegrading during use that need to be overcome.

If such a product can be effectively developed it may be the best solution to reducing the impact of the particles as they disperse throughout the environment. It may take an innovative leap to make this happen as demonstrated by a concept tyre from Michelin. They propose an airless tyre that can be 3D printed from organic material and is fully biodegradable. The car industry is well known for challenging convention with outlandish concept designs and it is unlikely that this will be commercially available for some time yet.



Source: Michelin

If tyres continue to be made from rubber, how can we minimise plastic pollution?

There are several ways in which microplastic pollution can be minimised by drivers on a *per mile* basis. Most of these have parallels with more efficient (and safe) driving

practices with the focus on driving smoothly and avoiding aggressive manoeuvring. There are definite synergies to be had between these campaigns.

These include:

- Accelerating gently and not taking corners aggressively;
- Driving with the correct tyre pressure;
- Removing unnecessary weight from the vehicle;
- Choosing to drive smaller, lower weight vehicles;
- Sharing journeys rather than running cars with single passengers; and
- Choosing to use public transport.

What should product manufacturers do?

At present there is no meaningful incentive for tyre manufacturers to prolong the life of their tyres, i.e. reduce the wear rate of the rubber tread. The European Tyre Manufacturers' Association (ETRMA) position¹⁴⁶ is that driver behaviour has the most effect on tyre wear. Even if this is true it does not preclude introducing better wear characteristics in the tyre design which will undoubtedly reduce microplastics overall.

It is sometimes suggested that by increasing the wear rate, the grip and therefore the safety is reduced, but there is no clear trend between these two for tyres on the EU market¹⁴⁷ – suggesting that manufacturers can and do make tyres that grip well and have reduced wear.

Manufacturers should therefore prioritise the development of tyres that maintain (and even enhance) performance in terms of rolling resistance, wet grip and external noise, while reducing the rate at which the tyre tread wears.

What can and should government do?

The UK Government should work with other EU Governments to speed the introduction of a standard test to measure tyre tread abrasion rate, potentially combined with a more comprehensive test for wet grip, rolling resistance and external noise over the typical lifetime of a tyre. Once the test is developed, the test should be integrated into the EU Tyre Label, so that consumers can see which tyres exhibit the lowest rates of tread abrasion. Such labels could also be used in Green Public Procurement. The test method could also be used as the basis for banning the sale of tyres with the highest rates of tread abrasion.

¹⁴⁶ http://www.etrma.org/uploads/Modules/Documentsmanager/20171003_etrma_trwp-position-paper.pdf

¹⁴⁷ FUNDACIÓN CIDAUT *Type approval requirements for the general safety of motor vehicles*, Report for European Parliament

Furthermore, as tyre wear is a key microplastic pollution source, and one where complete elimination at source looks unlikely, the government should require the tyre industry to significantly contribute towards mitigation as well as research and innovation. Funding of better infrastructure to capture microplastics at roadside can be raised by a levy per tyre placed on the market. The levy could be varied based upon the wear rate of the tyre.

What should retailers do?

Tyre retailers both in person and online have a large influence on the tyres a consumer buys. This is an infrequent purchase that often relies upon the apparent expertise of the retailer. Retailers should be more active in their support of the tyre labelling scheme to provide effective information to consumers. If tyre wear rate does become part of the tyre labelling this needs to be communicated effectively at the point of purchase. In a review of the current tyre label it was found that consumers find the concept of 'mileage', i.e. how many miles the tyre will last, to be equally as important as the tyre's effect on fuel efficiency.

What can and should local authorities do?

If a local authority is concerned about this issue there are actually several actions they can take to mitigate it for the area they control;

- **Increase provision and support for walking and cycling** – Reducing the use of private vehicles and increasing the proportion of journeys made by active travel leads to a wide range of benefits relating to air quality, noise, health and reduced tyre wear.
- **More regular gully emptying** – directly below the drains at the side of the road are often traps – known as gully pots – which are designed to capture solid particles before they are washed into the sewers. These are up to 80% effective in capturing particles such as tyre wear microplastics if they are emptied regularly, but unfortunately, they are often allowed to overfill.
- **Increased road sweeping/cleaning** – Road sweeping can be used to sweep up the tyre particles which have landed on the roads or adjacent paths. An increase in the frequency of this can reduce the amount of microplastics that are washed into sewers. This requires a more sophisticated scheduling as the best time to do so is just before rain. This is the point in time where the most accumulation will occur before being washed away. The UK also has very detailed traffic data which a local authority can use to target the busiest roads in the most effective way.
- **Using porous asphalt** – this is used extensively in the Netherlands as a way of managing surface water drainage, however it may also help to trap microplastics. The particles can become trapped in the pores of the asphalt until they are cleaned out. This means that less frequent road cleaning can be used that is not contingent on scheduling before rain events. This is combined

with the known benefits of improved safety through reduction of standing water and spray although it is costlier than traditional asphalt.