“Unflushables”: Establishing a global agenda for action on everyday practices associated with sewer blockages, water quality, and plastic pollution

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Abstract
The disposal of unflushable products via the toilet is an enduring problem and increasing contributor to environmental and infrastructural challenges such as fatbergs, water quality and plastic pollution. Rising scientific and public interest in “throw-away” cultures, and renewed government pressure for water and sewerage companies to act as custodians of water resources, raises questions about how and why impactful disposal practices occur and what might be done to change them. To date there has been little systematic research on unflushable products, and little is known about the routines and practices through which unflushable products find their way into wastewater systems. This paper reviews social science research including historical, sociological, and anthropological studies of cleanliness and hygiene, as well as sociotechnical approaches to the study of household practices and infrastructures to understand the challenges of unflushables. Based on this research, the paper offers a new conceptualization of the unflushables challenge. We argue that unflushables are a distributed problem, one that is not the direct consequence of either individual behavior, product design or infrastructural decline, but the outcome of myriad social, cultural and material developments in society. These include diversity in “flushing” cultures, gendered expectations in cleanliness practices; the evolution of conventions around cleanliness and hygiene; infrastructural imaginaries and expectations; and political dimensions of infrastructural development and maintenance. We demonstrate how social science research is essential in defining a new global research agenda on unflushables that further aids the design of new intervention and policy pathways.

This article is categorized under:
Engineering Water > Sustainable Engineering of Water
Science of Water > Water Quality

KEYWORDS
everyday practices, plastic pollution, sewer blockages, wastewater, water quality
1 | INTRODUCTION

The disposal of so-called “unflushable” products via toilets is a challenge that is increasingly affecting centralized and decentralized sanitation systems of all levels of technical sophistication, and therefore an important discussion in all sustainable development contexts. “Unflushables” refer to a variety of household products that though possible to dispose of via the toilet are incompatible with most sewerage systems, and consequently contribute to an assortment of environmental problems. The most widely recognized of these products are a variety of wet wipes (e.g., baby, toilet and facial wipes) and menstrual absorbents (e.g., sanitary pads, liners, tampons and applicators). The term also encompasses other products, including incontinence pads, cotton buds, condoms and femidoms, nappies, dental floss, medical wastes (bandages, syringes, needles, and medicines), cigarettes, toilet roll tubes and packaging (Anglian Water, 2018; Ashley, 2004; Ashley et al., 2005; Friedler, Brown, & Butler, 1996).

The term “unflushables” indicates the problematic nature of these materials having entered sanitation systems that were not designed to accommodate the disposal of single-use hygiene products via the toilet. The focus of this paper is on unflushables within centralized sanitation systems such as sewers (although emerging knowledge exists of it as a problematic in decentralized contexts in pit latrines and septic tanks). Unflushables, and the flushing practices that result in their entry to sewer systems, are increasingly recognized as a contributor to infrastructural and environmental challenges. Most notably, once in sewers these products accumulate with other effluences such as fats, oils and greases (FOGs) to contribute to the formation of blockages and fatbergs. In turn, blockages contribute to flooding of wastewater systems that can cause damage to properties, people, animals and the environment. Other challenges include various forms of pollution in aquatic environments, and an unnecessary contribution to rising water demand in the context of increasing water scarcity. These challenges are discussed in more detail in Section 2. Many of the examples given are from the United Kingdom and Europe, however, the disposal of unflushable products via the toilet is a problem world over, affecting sanitation systems in many contexts. This is an understudied, global issue. While the diversity of sanitation systems, hygiene practices and unflushable products need be recognized, there is also a need to further understand how and why impactful disposal practices occur, and what might be done to change them.

Existing research on unflushables is primarily focused on the composition of material flows, interactions of these within wastewater and aquatic systems, and end-of-pipe control and maintenance. Policy action tends to focus on educating consumers to instigate behavior change, rather than intervening in the dynamics of flushing practices in the context of wider sociotechnical systems. To date, the contributions from the social sciences have been poorly applied to the unflushables problem, yet there is a large body of relevant existing research that might aid understandings of how this issue emerges at the intersection of infrastructural design, everyday practices, and rapidly changing consumer and material cultures. Section 3 reviews multidisciplinary social science research including historical, sociological, and anthropological studies of cleanliness and hygiene, as well as sociotechnical approaches to the study of practices and infrastructures.

After reviewing this literature we use a number of guiding questions to structure the rest of the review, namely: How have practices of hygiene product use and disposal emerged and how do they intersect with people’s everyday lives and routines? How do these routines vary, between different individuals and over time? How do these routines intersect with wider sanitation and waste disposal provision inside homes and in other spaces of work, leisure and education where people spend a lot of time? We bring together a range of social science literatures that intersect with these under-explored questions. We present a new conceptualization of the unflushables challenge, illustrating how an orientation toward the dynamics of unflushables from the perspective of everyday practices and sociomaterial systems reveals the distributed and complex nature of the challenge. Our review identifies important empirical questions for further research, establishing an interdisciplinary and transdisciplinary research agenda that will further aid the design of new intervention and policy pathways to reduce sewer blockages, improve water quality and reduce plastic pollution.

2 | BACKGROUND: INFRASTRUCTURAL AND SUSTAINABILITY CHALLENGES ARISING FROM THE INAPPROPRIATE DISPOSAL OF UNFLUSHABLE PRODUCTS

Substantial infrastructural and environmental challenges result from the disposal of unflushable products via the toilet, in this section we outline their contribution to sewer blockages (and fatbergs), pollution in aquatic systems, and their complex relationship to water demand management.
2.1 | Blockages

The formation of blockages and fatbergs (large masses of solid wastes) in sewers is a complex process that typically begins with the accumulation of FOGs and metallic soaps (saponification) on which other solids such as wet wipes found in sewers build up (Ashley et al., 2005; Foden, Browne, Evans, & Sharp, 2018; Mattsson, Hedström, Ashley, & Viklander, 2015). Unflushable products are a substantial component of these accumulations, with recent research showing wet wipes and menstrual absorbents to be principal contributors (Fam, Turner, Latimer, Liu, & Giurco, 2017). According to the UK water industry, the cost of fixing sewer blockages reaches £88 million per year of which around half are caused by disposal of hygiene products via the toilet (WaterUK, 2016).

Sewer blockages are affected by infrastructural dimensions such as the size of sewer pipes and velocity of wastewater flows (Mattsson et al., 2015). Furthermore, the aging of sewers, and insufficient investment in their maintenance plays an important role (Mattsson et al., 2015). For example, the majority of the sewer systems that are in use today in UK metropolitan areas were constructed at the end of the 19th century (before the rise of widespread consumer cultures of disposal hygiene). More recently constructed systems (between the 1970s and 1990s before the rise of widespread consumer cultures of disposal hygiene) were designed to be operational for 25–50 years and have not been adapted to new practices of use or changes in the supply of water (Mattsson et al., 2015). Indeed, most sewage systems have not been designed to accommodate the disposal of products other than human excreta. Design properties of these underground infrastructures connecting smaller home wastewater pipes to larger sewerage infrastructure can be likened to a subterranean maze and the locations of pipes (particularly smaller pipes) are not often mapped. These are infrastructures difficult to know and even more challenging to retrofit despite being essential to public and environmental health policy (Gandy, 2004; Garrett, 2016).

However, it is not infrastructural properties alone that result in blockages (Drinkwater & Moy, 2017). There are many other factors that contribute to the occurrence of blockages. These include the biophysical properties of unflushable products (e.g., their material composition, buoyancy, rate of settlement and disintegration) and the design of spaces in which they are used; social dimensions including cultural and gendered cleanliness practices that incorporate the use and disposal of unflushable products; the historical evolution of conventions around cleanliness and hygiene; infrastructural imaginaries and expectations; and political dimensions of infrastructural development and maintenance. Subsequently, sewer blockages are a distributed sociomaterial problem, one that is not the direct consequence of individual behavior, product design or infrastructural decline, but the outcome of myriad social, cultural and material developments in society.

2.2 | Pollution

The problem of solids discharge was initially characterized as an aesthetic dimension (Ashley et al., 2005; Friedler et al., 1996; Spence et al., 2016), but has now been linked to deepening realization that the hygiene and other products discarded through toilets also contribute to several forms of pollution in aquatic ecosystems (Peberdy, Jones, & Green, 2019). Often hygiene products are not retained by sewage retention systems and consequently end up in water courses and marine environments. Sometimes they are mixed with raw sewage that is discharged by when combined sewer systems overflow (i.e., rainstorms and flooding; Spence et al., 2016). In 2019, the Marine Conservation Society (MCS) reported that sewage related debris contributed approximately 5.9% of the litter found on UK beaches, with wet wipes among the most common items surveyed (MCS, 2019). The visibility of these products, and the tracing of them back to insufficient protocols for retaining hygiene products, has resulted in water and sewerage companies receiving complaints and in some cases fines due to environmental pollution (Blanksby, 2002; Spence et al., 2016; WWF UK, 2017). More recent pollution concerns relate to microplastics found in aquatic environments (Pantoja Munoz, Gonzalez Baez, McKinney, & Garelick, 2018; Peberdy et al., 2019). Products such as nonwoven wipes, menstrual absorbents, or condoms are made of plastic and synthetic materials such as Polyester, Polyethylene and Polypropylene (Drinkwater & Moy, 2017; Pachauri, Shah, Almroth, Sevilla, & Narasimhan, 2019; Pantoja Munoz et al., 2018). Even when these products are retained and decomposed during wastewater treatment, the microscopic synthetic polymers that they contain are released together with wastewater effluents (Pantoja Munoz et al., 2018). Microplastics can also be transferred from sewage sludge into soils when recycled for agricultural uses (Pantoja Munoz et al., 2018). Once in the environment microplastics can enter food chains, including through drinking water, and while the health risks have not yet been
thoroughly studied it is becoming an increasingly a concern for public health (Revel, Châtel, & Mouneryrac, 2018; The Lancet: Planetary Health, 2017).

2.3 Water demand

The disposal of unflushable products down the toilet also has a complex relationship with water demand, an increasingly important agenda given rising population demands and likely consequences of climate change in many regions. Disposing of unflushable products via the toilet requires water use and thereby contributes to domestic water demand, as most modern toilets are flushed with water. In the United Kingdom, each toilet flush uses water that has been treated to drinking standards to transport unflushable products that could instead be disposed following the solid household waste streams potentially with lower environmental and economic costs (Ashley, 2004; Ashley et al., 2005). At the same time, water saving practices and devices (such as low-flow toilets) reduce the input of water into the sewerage and sewer pipe velocities and subsequently impact on the self-cleansing function of sewer systems (Marleni, Gray, Sharma, Burn, & Muttill, 2012; Mattsson et al., 2015). As a result, solids are more likely to settle and accumulate in pipes within “water efficient” systems.

3 RESEARCH SYNTHESIS: EXISTING RESEARCH GAPS AND OPPORTUNITIES

3.1 Moving beyond infrastructures and bad behaviors

The disposal of hygiene products through sanitation systems has been documented as a common practice in many countries across the world (Ashley et al., 2005) and the challenges they produce in infrastructures have been longstanding matters of concern (Mattsson et al., 2015). Yet academic research around unflushables has been very limited (Mitchell, Thamsen, Gunkel, & Waschnewski, 2017; Pantoja Munoz et al., 2018). This contrasts with an increased media attention largely spurred by the increased visibility of “fatbergs” within the UK (e.g., Flushable wipes put to the test as fatbergs clog the nation’s sewers”, 2019; London sewers blocked by record-breaking ‘concreteberg’, 2019; Monster fatberg found blocking Sidmouth sewer, 2019) and emerging concerns about microplastics pollution in aquatic systems (Hurley, Woodward, & Rothwell, 2018).

Existing studies of unflushables are primarily situated within engineering or physical geography literature and focused on characterizing material flows, describing the interactions of these with wastewater infrastructure, and identifying possibilities for end-of-pipe control and maintenance. These are important contributions as they have enabled characterization of the unflushables challenge. For example, the collection of samples from sewers and blockages has furthered understanding of the contents of sewer blockages, an otherwise largely invisible outcome of inappropriate disposal of unflushables (Drinkwater & Moy, 2017; Mitchell et al., 2017; Spence et al., 2016). Estimations on flushed products have also been produced based on collection of waste from beaches and rivers, enabling an understanding of where unflushable products re-emerge from sewerage systems (MCS, 2019; Williams & Simmons, 1999). Fully identifying the contribution of unflushables to blockages and pollution is challenging because the compositions of samples varies greatly depending on time and location of sample collection (Mitchell et al., 2017), and the difficulties to identify the materials when they are partially degraded and mixed with sewage (Drinkwater & Moy, 2017). Yet, this research has yielded important information about what products are most commonly found in sewer systems.

A few studies consider how the disposal of unflushables via the toilet could be reduced. However their recommendations tend to frame solutions in overly simplistic understandings of human behavior (cf. Ashley et al., 2005; Drinkwater & Moy, 2017; Pachauri et al., 2019). For example, studies assume that people flush objects down the toilet because of lack of understanding of sewer systems; lack of awareness about the impact of the practice on infrastructures and the environment; or lack of care about the consequences (Ashley et al., 2005; Drinkwater & Moy, 2017). As a result recommendations tend to focus on raising awareness and educating individuals with the hope that they will take responsibility for their actions and change their damaging behavior (Hawkins, Sharpe, Spence, & Holmes, 2019). This behavioral framing is similar to the way that other interconnected practices, such as the disposal of FOGs down the kitchen sink, are approached in research; however has been subject to substantial critique within the social science literature (Foden et al., 2018).
Exceptions to this behavioral framing is provided by scholars exploration of women's use and disposal of menstrual absorbents (e.g., Alda-Vidal & Browne, 2020; Hawkins et al., 2019). These studies emphasize “the wider societal requirements for discretion and the design, accessibility and availability of bins and bathroom facilities” (Hawkins et al., 2019, p. 11) as the main elements that limit the possibilities women have to dispose of menstrual absorbents differently. This is demonstrative of the value of interpretive social sciences, including social practice theories, in extending our understanding of how and why unflushables are disposed of via toilets. Social practice theories, along with other social science approaches, call for greater attention to the cultural, political and material developments in which disposal practices are entwined; and the wider opportunities and responsibilities for intervention that such recognition opens-up (Evans, Welch, & Swaffield, 2017). Importantly, social science approaches signal a need to reframe the problem of unflushables, rather than being the combined outcome of inappropriate behaviors and infrastructures, as a complex and emergent outcome of mundane practices (cf. Strengers, & Maller, 2015) including around water and sanitation services (Browne, 2015; Hoolohan & Browne, 2020). In the remainder of this review we draw on analytical insights from various social theories to crack open the complexities of the unflushables challenge, identify areas of evidence of how this problem has emerged, and outline topics for an integrated global research agenda that can inform a more nuanced approach to intervention for positive environmental benefit.

3.2 | Hygiene waste on sewers: Sociomaterial practices of disposal in the bathroom

What is missing from existing research is a deeper understanding of the logics, routines and practices through which unflushables find their way into wastewater systems. Research within other spaces of sustainable consumption have increasingly prioritized the importance of understanding how “unsustainable” practices emerge, and how they are sustained, through routine and mundane everyday practices (Shove, Pantzar, & Watson, 2012). Identifying how patterns of unsustainable practice emerge as a co-evolution of infrastructures, everyday practices and social meaning it is argued facilitates a deeper understanding of how systems may be reconfigured and a more diverse set of intervention options that intervene in sociotechnical systems (Geels, McMeekin, Mylan, & Southerton, 2015).

In this section we review different strands of social sciences literature including historical, sociological, and anthropological perspectives of cleanliness, sanitation and hygiene as well as sociotechnical approaches to practices and infrastructures. We suggest how the contributions they offer can be applied to the study of unflushables and outline empirical questions for further research. We argue that engagement with broader contributions from a diversity of social sciences literatures could be fruitful to develop a fuller understanding of the etymology of this problem across society, and to identify a wider set of opportunities for the water and sanitation sectors (and interconnected stakeholders) to intervene in these dynamics.

3.2.1 | Hygiene consumerism and conventions of cleanliness

Social sciences literatures define cleanliness as both a biological and social concept (Campkin & Cox, 2007; Douglas, 1984; Smith, 2007). Historical approaches have shown how hygiene norms, conventions, and standards change over time with developments in water supply and sewerage systems and the commodification of hygiene (Jack, 2018; Shove, 2003; Smith, 2007). In general cleanliness is becoming more resource consuming, not only in terms of water and energy (Shove, 2003), but also the increased commodification and disposability of hygiene practices through the use of single-use products, and increasing rise of industrial chemicals used in its achievement (Wakefield-Rann, Fam, & Stewart, 2019). Hygiene products, and they ways they are used, co-evolve with emergent expectations and conventions, as well as modern lifestyles and rhythms, and flushability (as a marketable characteristic) emerged in the context of increasing commodification of single-use hygiene products. For example, the increasing demand for single-use hygiene products is intertwined with rising anxieties over the elimination of pathogenic germs and with widespread cultures of convenience. When single-use menstrual pads were introduced, educational materials portrayed flushing as the proper disposal technique. Thus, flushability is a characteristic that has been encouraged by products, sanitation systems, conventions of cleanliness and the hygiene industry (Finley, 1998a; Vostral, 2008).

Some of the changes in patterns of hygiene products use and disposal are reflected in the historical data collected about the content of solids in sewers. Data from the late 1990s showed a great number of people disposed menstrual products in the toilet (Friedler et al., 1996), with tampons the most frequently flushed products (Ashley et al., 2005;
Friedler et al., 1996). However, the content of wastewater composition has changed since the 1990s (Mitchell et al., 2017). While menstrual hygiene products, and in particular tampons and applicators, continue to be frequently flushed down the toilet their volume has decreased in relation to other products (Drinkwater & Moy, 2017; Hawkins et al., 2019; Spence et al., 2016). This could be connected to prevailing counter trends in the increased availability of, and interest in, “reusable” menstrual hygiene products in recent years (Jones, 2018). This trend may have potentially reduced the impact of disposable hygiene products on the system also comes with increasing water demand from washing these reusable products which has its own impacts and problems during times of water scarcity or disruption (Alda-Vidal & Browne, 2020).

A recent study conducted in UK sewers showed that wipes are at present the most common element in blockages (Drinkwater & Moy, 2017). Wet wipes made of nonwoven fabrics have gained popularity for an endless variety of uses in and outside the bathroom. This includes among others, baby wipes, wet toilet paper, hand sanitizing wipes, cosmetic and facial wipes, toddler wipes, incontinence wipes, surface cleaning wipes, gardening wipes, lens wipes, pet wipes etc. (Drinkwater & Moy, 2017; INDA/EDANA, 2017; Mitchell et al., 2017). The nonwoven industry has been growing substantially, and production and sales in this sector are estimated to continue increasing in the near future at a very fast rate (Atasağun & Bhat, 2020). From the consumers point of view these types of products fit in “modern lifestyles” and are “cheap and easy to use” (Atasağun & Bhat, 2020, p. 2). Easy disposability is considered as the key feature (Anglian Water, 2011). In many cases these products have been adopted so much into daily routines that even environmentally conscious consumers find difficult to substitute them for more sustainable options.

An important question for future research is how demand for (and practices of use and disposal of) different products such as menstrual hygiene products and wipes evolves in relation to new expectations, conventions, and trends in person and household cleanliness and contemporary lifestyles and rhythms. Research of this kind would be important from a policy and intervention perspective to identify how products (and inappropriate disposal practices) can be reduced or substituted for more sustainable options. In particular the analysis of factors driving the reduction of menstrual waste disposal through sewerage systems could help to identify strategies that could also work for wipes and other single-use products.

### 3.2.2 Cultures of flushing and infrastructural imaginaries

A survey undertaken in 44 countries identified the practice of flushing solids down the toilet “appears to be most prevalent in the UK” (Ashley, 2004, p. 37). More recent studies concur that this practice is more common in the UK than in neighboring European countries (MCS, 2013). As Ashley suggest the prevalence of inappropriate flushing practices is underpinned by different infrastructural expectations that, as we elaborate in this section, could be linked to the historical development and material characteristics of sewers systems.

In the UK, much like other countries in the Global North, a culture of flushing waste into waterways (Benidickson, 2007) has developed since the first water and sewerage systems were designed to “sweep away” difficult, visceral materials related to our bodies (Kaika, 2005; Kaika & Swyngedouw, 2000; Sofoulis, 2005). Over decades these systems have progressively been buried beneath the city disappearing from the sight of users (Kaika & Swyngedouw, 2000) and the services provided by them normalized and taken for granted (Star, 1999). This has contributed to the emergence of a specific infrastructural imaginary and set of consumer expectations which, as Ashley puts it, in the United Kingdom at least creates a perceived “right to put all kinds of solids in sewers” (Ashley, 2004, p. 214).

Yet these infrastructural expectations are not universal and inappropriate flushing practices seem to be less common where infrastructures, or infrastructural failures, are more visible for users. In our networked lives we have lived an infrastructural imaginary that our water and sanitation infrastructures do not need care or maintenance—they are designed to effectively sweep away our waste (Sofoulis, 2005). For many people the infrastructures of sanitation and hygiene are not visible or meaningful within everyday life until they fail such as through localized sewer blockages. For example, users connected to off-grid solutions such as septic tanks that require more level of responsibility and engagement in maintenance are more aware of the challenge produced by unflushables and less likely to dispose this products via the toilet (Hawkins et al., 2019). A similar dynamic has been observed in other locations where users could not rely on the capacity of toilets and sewers to cope with unflushables. In large parts of Greece and most of South America, sewers were not designed to handle toilet paper and normal practice is to dispose of used toilet paper in a bin. As a result, people in these countries are much more likely to use the bin for other sanitary and hygiene products (Ashley, 2004).
In the UK historical infrastructural expectations of flushability are further compounded by privatization, introduced as a means to establish a higher level of service for water and sanitation systems, and further entrenching a sense of the “financial water consumer” with certain demands on the system for a specific level of service (Bakker, 2003; Loftus, March, & Nash, 2019; Trentmann & Taylor, 2005) and delivery of environmental health which is currently in the spotlight from the environmental regulator (cf. Environment Agency, 2018; Ofwat, 2019). While some pollution sources are domestic sewer misconnections (Ellis & Butler, 2015), the UK water sector has been mired by reports, legal action and fines due to inappropriate water pollution through sewage overflows resulting in calls for new legislation to protect and restore waterways (cf. Wainwright & Bradshaw, 2019; WWF UK, 2017). This issue shows the deep sociopolitical nature of the problem of unflushables. For water and sewerage companies operating in this space of trying to reduce the disposal of unflushable products in the sewerage system, there is a need to also address how interventions and engagement also connect with issues of (mis)trust in water companies (cf. Ofwat, 2019, n.d.), and wider discussions about private companies delivering environmental goods (cf. Bakker, 2010). This provides a unique set of political challenges in which cultural practices and infrastructural imaginaries are enmeshed.

Further research to understand the role of infrastructural imaginaries and expectations about sanitation and water infrastructures would valuably contribute to our understanding of unflushables, and should seek to identify how infrastructural imaginaries guide the design and maintenance of urban WASH (water, sanitation, and hygiene) services and flushing cultures in the UK and beyond. Action in this space should also consider developing a deeper understanding of the connections between individual, household and cultural practices in the context of water privatization and ownership models globally, including issues in trust in privatized water sectors, and support strongly voluntary, regulatory and legislative frameworks to reduce sewage pollution and improve environmental health.

3.2.3 The sensory experience of dirt and cultural differences in attitudes toward waste

Anthropological approaches to the social construction of cleanliness, mainly working in majority world contexts, have documented the role of conventions, ideas of morality, sensorial engagements, or visceral reactions as powerful motivations for sanitation and hygiene practices (Akpabio & Takara, 2014; Bloomfield, 2003; Jewitt, 2011; Shove, 2003). Often these subconscious motivations have more importance in shaping our hygiene routines than fears of risks for health prompted by scientific evidence (Rusca, Alda-Vidal, Hordijk, & Kral, 2017). For example literature on unflushables shows that for many people the idea of disposing products “contaminated” with blood or feces in the waste bin is perceived as a threat to human health, even when health professionals assure the health risks that these products actually pose among healthy populations are negligible (Ashley et al., 2005).

In the area of sustainable consumption, research on food waste has explored how modern embodied meanings around “dirt” and “contamination” in homes shape decisions about when food becomes waste and how this is discarded (Martin, Williams, & Clark, 2006; Metcalfe et al., 2012; Waitt & Phillips, 2016; Welch, Swaffield, & Evans, 2018). This includes research revealing how the aversion to smells and appearances of particular food waste (fats, rotten food) marks the preference for getting rid of these as quickly and with as little contact as possible (Foden et al., 2018; Martin et al., 2006); or the association of organic food waste bins with dirt and anxieties about their potential risk for cross-contamination in the kitchen as important elements shaping hesitation to use them (Metcalfe et al., 2012). Research in food waste spaces has also highlighted the interconnection of different routes of food waste disposal. For example, kitchen sink disposers, a technology that was initially introduced to deal with anxieties and aversions over kitchen leftovers has been scrutinized as an alternative to divert waste from landfills (Iacovidou, Ohandja, Gronow, & Voulvoulis, 2012; Iacovidou, Ohandja, & Voulvoulis, 2012; Kim, Song, Song, Kim, & Hwang, 2011).

Embodied experiences toward waste, and human waste in particular, are not universal as attitudes and feelings of disgust vary greatly among cultures and societies (Jewitt, 2011; van der Geest, 2008), and considerations about clean or acceptable routines varies greatly temporarily and geographically (Jewitt, 2011). Sensory reactions and sociocultural differences in relation to flushing practices have little been acknowledged in the literature on unflushables and even then left unexplained. For example, Spence et al. (2016) noted differences in the solids contained in wastewater samples from three different areas in Sheffield, United Kingdom (i.e., high income white population, low income aging population, and low-income 30% Pakistani ethnicity). Considering the sociocultural and sociospatial dynamics of disposal practices also connects with research that has identified the importance of thinking about the multiple and interconnected dynamics of metabolisms of fat from the body to the city level that may influence sewer blockages and their sociospatial distributions across a city (cf. Marvin & Medd, 2006).
These literatures show the importance of understanding the different embodied reactions to everyday hygiene waste and their interconnections to bathroom and other disposal infrastructures within and outside of the home. This includes further investigation into how sensorial and visceral reactions shape disposal practices; particularly for products that have been in contact with bodily fluids (semen, menstrual blood, mucus, urine) and faeces. Problematic practices should be examined in the context of existing sanitation infrastructural designs, and how these relate to different cultural habits. Care should be taken not to assume that practices are determined by sociocultural dynamics, nor to cast responsibility on those whom are performing problematic disposal practices but rather to explore diversity in cultural context and routine as a way to understand the possibilities for more complex intervention and policy to lead to a resolution of the problem (Foden et al., 2018).

An additional question to consider is how these dynamics connect different infrastructures of waste disposal in bathroom inside and outside of the home, with wider metabolisms of sanitation and hygiene waste flows in cities. This includes understanding the diversity of everyday use and disposal of unflushable products in different settings, and critical reflection on how these insights might feature in planning systems to preserve dignity, reduce environmental impacts, and consider other possibilities for discarding products without creating problems somewhere else in the waste system (Alda-Vidal & Browne, 2020). There is a need to situate these reflections within an analysis of how these subterranean flows (Garrett, 2016), are murky examples of the materialities of modern consumer cultures. The accumulation of these consumer products into sewerage systems, alongside the residual fats of our modern diets, connects with wider geographical debates about how sewerage and sanitation infrastructures provide the links between bodies and urban politics particularly capitalist urbanization (Gandy, 2004) and commoditized, disposable hygiene cultures.

### 3.2.4 The gender dimensions of flushing practices

Feminist scholars have shown that personal and household cleanliness is gendered. The burden of home and family cleanliness has traditionally disproportionally fallen on women (Bernier, 1998). Still today women in the UK perform the majority of housework (Barr, 2019). Cleanliness is central to the performance of femininity (Jack, 2018). As such women are subjected to stricter (internal and external) standards and expectations in relation to their own personal cleanliness and that of the household and its members. These gender conventions are often institutionalized by the cleanliness industry that targets women with an always growing number of products and technologies.

Important gender dynamics also play a role in shaping the disposal of menstrual products, which are considered one of the main causes of problems in sewer systems. Around the world there are pervasive menstrual stigmas including shame, beliefs, taboos, which require menstruating people to deal with their periods in privacy and secrecy. These dynamics, intersecting with infrastructural limitations due to a failure of sanitation governance to plan for menstrual hygiene needs, has importantly restricted the possibilities for menstruating people to deal with their periods in a safe and hygienic way across home, public, and work/educational spaces (Alda-Vidal & Browne, 2020; Bobel, 2019). In the United Kingdom and other western countries due to menstrual etiquette “the management of menstruation has remained a highly personal, private act which needs to be concealed at all costs” (Moffat & Pickering, 2019, p. 768) impacting on the everyday experiences of discarding menstrual waste.

A study about the UK’s Bag-It-Bin-It campaign, aimed at reducing inappropriate flushing of menstrual products, pointed to embarrassment as one of the elements for women not wanting to introduce a bathroom bin for disposal in the home (Ashley et al., 2005; Brown, Sharp, & Ashley, 2006). More recent research shows that the situations become more complicated for menstruating people when out of home or using public facilities: women report to feel stressed with the possibility of not finding (functional) disposal facilities (Moffat & Pickering, 2019) or having to use bins located in communal areas where used absorbents are exposed to others (Hawkins et al., 2019). In those situations many women opt for wrapping the used menstrual products and carry them on their person in search of an appropriate facility for disposal (Hawkins et al., 2019; Moffat & Pickering, 2019).

The problem of inappropriate flushing practices has been often framed as a gendered issue in the literature and policy contexts, with studies indicating women are, in the main, responsible for inappropriate disposal practices (Friedler et al., 1996). Men too have perceived “the problem to be entirely related to female behaviour and of little relevance to them, ignoring their own toilet disposal of condoms, razors, and cotton buds” (Ashley et al., 2005, p. 209). Awareness raising campaigns and other interventions have thus mostly been directed to women (examples in Ashley et al., 2005; Harvey, 2018). For example, Sydney Water identified in 2019 that: “We had made an assumption that it would be young mums, with young families, with babies, who would be the primary user...We did quite an extensive survey and it was
quite interesting, the major user group of flushable wipes were young males, 15-29” (Zhou, 2019). In the UK research conducted by a water company shows that men flush baby wipes more than women as they use them as cheap alternatives to moist toilet tissue. Emerging research shows how hygiene standards and conventions are changing in relation to new ways of understanding masculinity (Jack, 2018), in practice meaning an increasing pattern of use and inappropriate disposal of hygiene products by men (Grant, 2013; Harvey, 2018; Keeping it Clear Together Brochure, 2018; Silmalis, 2014; Sofoulis, 2017).

The discussion around gender and flushing hygiene products has two implications. The first is that more research is needed to understand the gendered dynamics of cleanliness expectations, as well as bodily, family, and home labors that shape the use of disposable products such as nonwoven wipes for a variety of other cleanliness tasks (e.g., babies, pets, surfaces etc.). The second implication from this literature is the need to approach the assumptions around the notion that disposable products are a “women’s problem” either associated with their own self-care, or care of other for whom they have responsibility such as young children. Consumer cultures and everyday practices of cleanliness and hygiene are also changing for men, so programs and interventions will need to be careful not to adopt a culture of blame of women. Care needs to be taken not to moralize, responsibilise, or shame the practices of women without understanding the wider gendered dynamics (including menstrual stigma and etiquette) underpinning disposal practices across society. Rather developments in this space need to design interventions, governance and new infrastructures with the needs of gendered users in mind.

3.2.5 | Product design and flushability regulations

Literature on unflushables connects inappropriate flushing practices to skewed perceptions about their flushability. As we elaborate in this section, these perceptions are result of both the material properties of unflushables and the way they are used, and the lack of clear labeling and standards. Current policy and governance conversations are trying to address this challenge.

Hawkins et al. (2019, p. 7) note that “the mechanics of removing used tampons make flushing the ‘easiest’ and most ‘hygienic’ option” for many of the participants in the study. Women perceived tampons to be flushable based on “the compact shape and material composition” and the fact that “the product flushed away easily” in practice. Applicators made of cardboard were also perceived as easily disintegrating (Hawkins et al., 2019). The lack of clarity in the vocabulary used for the commercialization of these products has also contributed to misperceptions. A wipe or a tampon may be made of biodegradable materials but those may not be easily and quickly disintegrated and dispersed in wastewater systems and thus the products should not be treated as flushable. This has been complicated by the history of commercialization of these products. Many hygiene products were for a long time marketed as flushable (Atasagun & Bhat, 2020; Finley, 1998b; Vostral, 2008). Later, producers started including “do-not-flush” symbols in packages (Naismith, 2017). Yet symbols and instructions were not consistent or clear (Naismith, 2017).

In the last years, there have been attempts to standardize the labeling of flushable products through different guidelines and codes of practices (INDA/EDANA, 2017, 2018; WaterUK, 2019). However, these are not as ambitious as some actors would like as they are voluntary; they do not include any obligation for manufacturers to disclose the type of fibers used in production; and they only look at the performance of products in relation to wastewater system but do not address wider environmental challenges such as environmental pollution (Naismith, 2017; Pantoja Munoz et al., 2018). Determining the flushability of products and agreeing on a common standard regarding flushability is an important step to ensuring sustainable manufacturing. However our findings would indicate that labeling alone will be unlikely to prevent inappropriate disposal practices, given that these practices are entangled in wider cultural, material and infrastructural developments.

Research on labeling carried out in 2017 by the UK water industry showed labeling of products as “Do Not Flush” did not prevent the items being flushed (Drinkwater & Moy, 2017). Even with a sophisticated marketing and communication campaign, without underlying primary research to first ascertain people’s attitudes and behaviors around the current different labeling and a behavioral change program approach, a campaign will not be effective in preventing flushing behavior. Wet wipes are only one category of products and there are other products that when flushed cause problems for the sewer system. Relatedly, the promotion of flushable products to consumers sends a confusing normative signal regarding appropriate disposal practices that risks a rebound effect on flushing cultures. In the worst-case scenario this rebound with new “flushable” labeling systems could result in higher volumes of unflushable products.
entering the sewer system. Even if these initiatives were collectively successful in changing behaviors of consumers this may only push the problems elsewhere, increasing the challenge of municipal solid waste management.

An important question for future research is how inappropriate flushing practices are underpinned by customer’s misperceptions of the flushability of different products, how these perceptions are formed, and how they can be changed. Labels are only one indicator of how a product should be disposed of, with the appearance, fabric and use of the product all conveying something regarding the appropriate means of disposal, therefore further research is needed to understand how to design products with characteristics that better convey the appropriate means of disposal. Research is also needed to understand the landscapes of governance and policy development, and what the options are for the advance of new, and more ambitious, environmental regulation in this area.

4 A GLOBAL RESEARCH AGENDA FOR ACTION ON SEWER BLOCKAGES, WATER QUALITY, AND ENVIRONMENTAL POLLUTION

This paper demonstrates that social science research provides substantial contributions to our understanding of how and why impactful disposal practices occur, and what might be done to change them. As our review has shown, though research that reveals the material compositions of unflushables is important to determine which products are contributing to the social and environmental problems caused, this body of research tells us little about how and why unflushables are used, and disposed of, as they are. There have been fewer research projects focused on the social dynamics of the unflushables problem and greater attention is needed in order to unravel the myriad of social, cultural and material developments in society that contribute to unflushables entering, and causing problems within, wastewater systems.

This advanced review illustrates that the diversity in everyday practices (on a personal level, and also along cultural/geographic lines) shape these disposal practices, as do the connections between personal practices and wider cultural and material developments. Furthermore, recognizing that this is a challenge that manifests and is experienced differently in different countries and communities and infrastructural contexts necessitates further efforts to understand the diversity of everyday practices of hygiene product disposal at a personal level, and also along cultural, geographic and infrastructural lines. Throughout this review, recommendations for further research have been identified based on gaps in existing literature. In summary new areas for interdisciplinary and transdisciplinary research which privilege the insights that can be derived from social sciences include:

1. Understanding the demand for disposable hygiene products and how it relates to contemporary life styles, everyday practices, changing cleanliness and hygiene conventions and altering material cultures. This area of research may help to identify how products and practices can be substituted for more sustainable options.
2. Understanding how flushing practices and hygiene disposal practices are shaped by sensory reactions to and cultural variations in attitudes toward everyday bathroom waste and what interconnections to other waste disposal infrastructures are needed to effect positive change.
3. Understanding and planning for the gender dynamics shaping the use and discard of hygiene products. An expansive view of the gendered, cultural and various care dynamics involved in disposal practices is needed to prevent moralizing the behavior of some groups (e.g., women/people that bleed) as responsible for change without understanding gendered waste disposal cultures.
4. Understanding the role of imaginaries and expectations about infrastructures and the provision of urban services in the prevalent flushing and hygiene waste disposal cultures. As well as a focus of these within centralized sewer systems, this research agenda should be extended to connect to related issues in decentralized sewerage infrastructures such as septic tanks, reed bed sanitation systems and pit latrines etc. in minority and majority world contexts.
5. Understanding the governance landscape for unflushables and interconnections with related sectors (waste, water, food, etc.) and identify how regulations and standards can be further developed to promote positive and rapid change to systems of practices, infrastructures and consumer cultures.
6. Finally, this research agenda is complex and interconnected with a wide range of organizations and individuals involved in the challenge of unflushables. This is a distributed problem, requiring a wide range of governmental, nongovernmental organizations (NGOs), manufacturers and businesses (water utilities and companies, manufacturers, marketing, retail, designers, those involved in normalizing certain products), and of course citizens in their everyday lives to reconfigure these systems and initiate action.
For policy practitioners and diverse stakeholders designing solution pathways it is insufficient to only consider how
to design products and infrastructures capable of coping with unflushables. Though design processes and new
manufacturing techniques can help alleviate the problems caused by flushing hygiene products, as long as existing sew-
age system remains in place material design focused solutions may also cause unintended consequences (such as the
replacements with biodegradable plastics that have unknown fates within aquatic systems). We must also consider how
to change the multiple cultural, social, political and material factors that shape how people routinely use and dispose of
unflushable products; alongside other material and infrastructural changes.

5  |  CONCLUSION

Flushing practices are constantly evolving, and any appearance of stability is the result of the repetition, proliferation
and normalization of specific practices. In order to solve the problems associated with unflushables, questions need be asked as to how disposal via the toilet has become normal, how this practice could be unsettled, and what
could be done to introduce and popularize alternative disposal practices. Relatedly, distributed problems require
distributed solutions. Action to reduce unflushables should recognize the many actors that share responsibility for
unflushables entering the sewer system, and who have agency to affect change (for inspiration see a similar discus-
sion within the food waste sector Evans et al., 2017). Reducing unflushables will require not only that water com-
panies and consumers work together, but that their efforts are supported by the many organizations and
businesses that contribute to the social organization of practice, and appropriate governance structures guiding
integrated action. Finally, what people do in their day-to-day lives varies substantially. Acknowledging diversity helps identify different opportunities for intervention, and avoid designing interventions that are at best inef-
cctive, or at worst exposes vulnerable people to unintended consequences, or casts judgment on the actions of partic-
gular groups of people (e.g., women, parents, caregivers).

It has been our intention within this Advanced Review to synthesize the contributions that existing research offers
to the challenges of products being disposed of down the toilet and entering sanitation and water systems. Despite
increasing awareness as to the scale of the problem, there are considerable efforts still needed to develop deeper understandings of how this problem has emerged and how it is maintained, and differences across different geographical
locations. We also call for an increased interdisciplinary and transdisciplinary research and policy agenda to develop to
positively influence existing, and accumulative, environmental pollution from these dynamics. This advanced review
has shown why it is essential to privilege questions derived from the social sciences in the development of research and
policy agendas on unflushables and environmental pollution. Such perspectives provide deeper insights into how to
identify opportunities to intervene to create positive environmental change rather than only relying on end-of-pipe and
technological solutions.

ACKNOWLEDGMENTS

With thanks to the “Change Points” team (Dr Liz Sharp, Dr Matt Watson, Dr Sam Outhwaite (Sheffield), Dr Mike
Foden (Keele), Professor David Evans (Bristol) and colleagues on the RE3 project (including Dr Helen Holmes, Prof
Mike Shaver at University of Manchester, Rachel Gray at WRAP) for wider discussions and debates. This review was
conducted during a consultancy project in 2019–20 funded by Anglian Water and the Anglian Centre for Water Studies
with Dr Vittoria Danino, Rachel Dyson and Clare Pillinger, on which Browne was PI in collaboration with Hoolohan
(Co-PI) and Alda-Vidal (Researcher Co-I). The authors acknowledge funding from several sources that have shaped this
Advanced Review: two ESRC Nexus Network projects between the Universities of Manchester and Sheffield; ESRC
Impact Accelerator Account project “Change Points”; EPSRC funded “RE3 – Rethinking Resources and Recycling” pro-
ject; and funding from the School of Environment, Education and Development, Geography and Sustainable Consump-
tion Institute at the University of Manchester.

CONFLICT OF INTEREST

The authors have declared no conflicts of interest for this article.

AUTHOR CONTRIBUTIONS

Cecilia Alda Vidal: Conceptualization; data curation; formal analysis; funding acquisition; investigation; methodology;
writing-original draft; writing-review and editing. Alison Browne: Conceptualization; data curation; formal analysis;
funding acquisition; investigation; methodology; project administration; supervision; visualization; writing-original draft; writing-review and editing. Claire Hoolohan: Conceptualization; data curation; formal analysis; funding acquisition; investigation; methodology; project administration; supervision; writing-original draft; writing-review & editing.

ENDNOTES
1UK Water Industry Fine to Flush Water Industry Specification defines flushability with nine criteria (a) intended use, (b) safety in the environment, (c) WC bowl clearance, (d) drainline clearance, (e) disintegration in the drainline, (f) snagging in the drainline, (f) continued disintegration in the sewer, (h) settlement in treatment process, and (i) determination of synthetic and nonsynthetic organic components (WaterUK, 2019). Internationally, the International Water Services Flushability Group (IWSFG) defines flushability with five criteria (a) safety in the environment and the composition of materials, (b) toilet and drain line clearance, (c) disintegration, (d) settlement, and (e) biodisintegration (IWSFG, 2018). For a product to be characterized as “flushable” IWSFG describe “it should break into small pieces quickly; not be buoyant; and not contain plastic or regenerated cellulose but only contain materials which will readily degrade in a range of natural environments” (IWSFG, n.d.). This criterion does not guarantee products will not accumulate to produce blockages, but is intended to reduce their contribution.

2While not the focus of this review, in settler colonial contexts, and countries with diverse Indigenous ontologies in regards to lands and waters, deep consideration should also be given as to these (often-but-not-always-invisible) forms of environmental pollution and more-than-human environmental (ill)health caused through sewage, plastic and microbial contamination through on-grid and off-grid sanitation infrastructures that are not fit for purpose. This is particularly important given that the health of lands and waters and more-than-human species is essential to Aboriginal and Indigenous peoples’ health outcomes (cf. Kingsley, Townsend, Philips, & Aldous, 2009). Other forms of local and community knowledges related to land and waters should also be considered within planning and governance contexts where there are links between sanitation practices and health of water ways and marine environments.

RELATED WIREs ARTICLES
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Rethinking water insecurity, inequality and infrastructure through an embodied urban political ecology
Plastic debris in rivers
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A review of the fate of micropollutants in wastewater treatment plants

FURTHER READING
Alda-Vidal, C., Hoolohan, C., Dyson, R., Danino, V., & Browne, A. L. (2020). Unflushables: designing new intervention pathways for sewer blockages and environmental pollution in the Anglian Water region, UK. University of Manchester, Manchester. Available from: https://www.research.manchester.ac.uk/portal/files/161780139/Unflushables_Review_March_2020_FINAL1.1_.pdf
Browne, A. L., Danino, V., Dyson, R., Hoolohan, C., & Pillinger, C. (2020). ‘Unflushables 2030? Mapping Change Points for Intervention for Sewer Blockages’: Workshop Proceedings 27th & 28th January 2020, Manchester, UK. Manchester UK: University of Manchester. Available from: https://www.research.manchester.ac.uk/portal/files/161774404/Unflushables_2030_Workshop_Report_27th_Jan_2020.pdf

REFERENCES
Akpabio, E. M., & Takara, K. (2014). Understanding and confronting cultural complexities characterizing water, sanitation and hygiene in Sub-Saharan Africa. Water International, 39(7), 921–932. https://doi.org/10.1080/02508060.2015.981782
Alda-Vidal, C., & Browne, A. L. (2020). Absorbents, practices, and infrastructures: Changing socio-material landscapes of menstrual waste in Lilongwe. Malawi.
Anglian Water. (2011). A socialmarketing strategy for FOG and un-flushables–domestic audience analysis. Unpublished report.
Anglian Water. (2018). Keeping it clear together. Brochure.
Ashley, (2004). Solids on sewers (Sci. Tech. Rep. Ser.), IWA Publishing.
Ashley, Blackwood, D., Souter, N., Hendry, S., Moir, J., Dunkerley, J., … Goldie, P. (2005). Sustainable disposal of domestic sanitary waste. Journal of Environmental Engineering, 131(2), 206–215. https://doi.org/10.1061/(ASCE)0733-9372(2005)131:2(206)
Atasağın, H. G., & Bhat, G. S. (2020). Advancement in flushable wipes: Modern technologies and characterization. Journal of Industrial Textiles, 49(6), 722–747. https://doi.org/10.1177/1528083718795910
Bakker, K. (2003). An uncooperative commodity privatizing water in England and Wales. Oxford Geographical and Environmental Studies Series.
Rusca, M., Alda-Vidal, C., Hordijk, M., & Kral, N. (2017). Bathing without water: Stories of everyday hygiene practices and risk perception in urban low-income areas. The case of Lilongwe, Malawi. Environment and Urbanization, 29(2), 533–550.

Shove, E. (2003). Converging conventions of comfort, cleanliness and convenience. Journal of Consumer Policy, 26, 395–418. https://doi.org/10.1023/A:1026362829781

Shove, E., Pantzar, M., & Watson, M. (2012). The dynamics of social practice: Everyday life and how it changes. London: Sage.

Silmalis, L. (2014). ‘They pick up excrement and ball into dark nuggets: The fatbergs clogging Sydney sewers. The Guardian. Retrieved from https://www.theguardian.com/australia-news/2019/aug/10/they-pick-up-excrement-and-ball-into-dark-nuggets-the-fatbergs-clogging-sydney-sewers

Smith, V. (2007). Clean: A history of personal hygiene and purity. Oxford, England: Oxford University Press.

Sofoulis, Z. (2005). Big water, everyday water: A sociotechnical perspective (p. 19). Continuum: Journal of Media and Cultural Studies, 19(4), 445–463.

Sofoulis, Z. (2017). Social innovation and drinking water practices: Disrupting the customer focus in a large water utility. In International social innovation research conference. Victoria, Australia: Swinburne University.

Spence, K. J., Digman, C., Balmforth, D., Houldsworth, J., Saul, A., & Meadowcroft, J. (2016). Gross solids from combined sewers in dry weather and storms, elucidating production, storage and social factors. Urban Water Journal, 13(8), 773–789. https://doi.org/10.1080/1573062X.2015.1025081

Star, S. L. (1999). The ethnography of infrastructure. American Behavioral Scientist, 43(3), 377–391.

Strengers, Y., & Maller, C. (Eds.). (2015). Social practices, intervention and sustainability: Beyond behaviour change. London and New York: Routledge.

The Lancet: Planetary Health. (2017). Microplastics and human health—An urgent problem. The Lancet Planetary Health, 1(7), PE254.

Trentmann, F., & Taylor, T. (2005). From users to consumers: Water politics in nineteenth-century London. In F. Trentmann (Ed.), The making of the consumer: Knowledge, power and identity in the modern world (pp. 53–79). Oxford, UK: Berg Publishers.

van der Geest, S. (2008). The social life of faeces: System in the dirt. In R. van Ginkel & A. Strating (Eds.), Wildness and Sensation: Anthropology of Sinister and Sensuous Realms. Makulu: Het Spinnhui (pp. 381–397).

Vostral, S. (2008). Under wraps: A history of menstrual hygiene technology. Plymouth, UK: Lexington Books.

Wainwright, D., & Bradshaw, P. (2019). Rivers used as ‘open sewers’. say WWF charity. Retrieved from https://www.bbc.com/news/uk-england-49131405

Waitt, G. & Phillips, C. (2016). Food waste and domestic refrigeration: A visceral and material approach. Social & Cultural Geography, 17(3), 359–379. https://doi.org/10.1080/14649365.2015.1075580

Wakefield-Rann, R., Fam, D., & Stewart, S. (2019). Microbes, chemicals and the health of homes: Integrating theories to account for more-than-human entanglements. Biosocieties, 1–25. https://doi.org/10.1057/s41292-019-00147-7

WaterUK. (2016). 21st CPB ‘Flushable’ products complaint to trading standards letter.

WaterUK. (2019). WIS 4-02-06. January 2019. Fine to flush: Specification for a testing methodology to determine whether a product is suitable for disposal through a drain or sewer system. Author. Retrieved from https://www.water.org.uk/wp-content/uploads/2019/01/Fine-to-flush-WIS-4-02-06-January-2019.pdf

Welch, D., Swaffield, J., & Evans, D. (2018). Who’s responsible for food waste? Consumers, retailers and the food waste discourse coalition in the United Kingdom. Journal of Consumer Culture. https://doi.org/10.1177/146940518773801

Williams, A. T., & Simmons, S. L. (1999). Sources of riverine litter: The river Taff, South Wales, UK. Water, Air, and Soil Pollution, 112, 197–216.

World Wildlife Foundation UK. (2017). Flushed away: How sewage is still polluting the rivers of England and Wales. Retrieved from https://www.wwf.org.uk/sites/default/files/2017-12/Flushed%20Away__Nov2017.pdf

Zhou, N. (2019). ‘They pick up excrement and ball into dark nuggets’: The fatbergs clogging Sydney sewers. The Guardian. Retrieved from https://www.theguardian.com/australia-news/2019/aug/10/they-pick-up-excrement-and-ball-into-dark-nuggets-the-fatbergs-clogging-sydney-sewers

How to cite this article: Alda-Vidal C, Browne AL, Hoolohan C. “Unflushables”: Establishing a global agenda for action on everyday practices associated with sewer blockages, water quality, and plastic pollution. WIREs Water. 2020;7:e1452. https://doi.org/10.1002/wat2.1452