

APPENDIX B3

A Review of Policy Options to Address Tobacco Product Waste

Kyra Hill, J.D.¹, Colin Welker², Hudson Kingston³, Thomas E. Novotny⁴

¹ Public Health Law Center, Mitchell Hamline School of Law, St. Paul, MN 55105, USA (Corresponding author, Kyra.Hill@mitchellhamline.edu).

² Public Health Law Center, Mitchell Hamline School of Law, St. Paul, MN 55105, USA

³ Public Health Law Center, Mitchell Hamline School of Law, St. Paul, MN 55105, USA

⁴ School of Public Health, San Diego State University, San Diego, CA 92182, USA

1. Introduction

In addition to their well-documented public health impacts, commercial⁵ tobacco product manufacturing, distribution, and post-consumption disposal may have devastating environmental consequences.⁶ Cigarette butts have been shown to leach toxic chemicals, including (1,2) metals and heavy metals, (3–6) polycyclic aromatic hydrocarbons (PAHs), phthalates, volatile organic compounds (VOCs), and other pollutants. (7). In addition, each individual discarded commercial cigarette filter (attached to more than 90% of cigarettes sold globally) is composed of more than 15,000 individual strands of cellulose acetate that break apart into plastic microfibers.(8–10). This toxic plastic and chemical waste can contaminate waterways, aquatic biomes, and drinking water sources. (8,11) It has been shown to be harmful to freshwater aquatic species, (1) marine species, (12–14) and even entire ecosystems. (5,9,10,14–16)

In fact, globally an estimated 4.5 trillion toxic cigarette butts are discarded irresponsibly (e.g., outside of waste receptacles) each year, meaning that cigarette butt waste is a problem of international and extraordinary scale (15,17). Further, other types of tobacco product waste (TPW) have gained the attention of researchers, given that

⁵ The Public Health Law Center recognizes that traditional and commercial tobacco are different in the ways they are planted, grown, harvested, and used. Traditional tobacco is and has been used in sacred ways by Indigenous communities and tribes for centuries. Comparatively, commercial tobacco is manufactured with chemical additives for recreational use and profit, resulting in disease and death. For more information, visit: <http://www.keepitsacred.itcml.org>. When the word “tobacco” is used throughout this document, a commercial context is implied and intended.

⁶ All aspects of the tobacco life cycle have devastating impacts on the environment. (World Health Org. (WHO), 2017; Novotny et al., 2015, Araujo and Costa, 2019; Public Health Law Center, 2019). For example, the production of tobacco products results in the release of liquid, solid, and airborne waste products, including wastes that are classified as hazardous (Novotny and Zhao, 2011; WHO 2017; Public Health Law Center 2019). While commercial tobacco cultivation and manufacturing-related pollution is tremendously concerning from an environmental standpoint, this literature review focuses on those policy solutions that seek to address the waste that occurs as a result of product use and consumption, rather than their production and manufacture.

discarded electronic cigarettes can also leach nicotine (18) and heavy metals, (4,19) and many of these products contain plastics and lithium batteries that may be considered toxic waste; in fact, the nicotine contained in these products is classified as acute hazardous waste under federal law. (19–21) The disposal of new heated tobacco products such as IQOS, a tobacco product that heats tobacco using a heating coil and emits chemicals in the form of aerosol, also may contaminate surface water and impact terrestrial and aquatic species. (22) Other TPW, such as the wastewater from waterpipe smoking, has also been shown to contain hazardous, toxic chemicals that can potentially put water sources at risk of contamination when the waste from waterpipe use is discarded down drains. (23) Finally, TPW is an environmental justice issue because it is concentrated around businesses that sell tobacco products, (24,25) which are disproportionately located in low-income communities and communities of color. (26) Policies aimed at remedying TPW should also aim to eliminate those disparities. (15,27)

The goal of this review is to describe the physical and environmental justice impacts of TPW in communities as well as the current landscape of policy approaches to address TPW.

2. Methods

This review utilized searches of Google Scholar, PubMed.gov, Westlaw, and LexisNexis for keywords and combinations thereof. Material type keywords were “tobacco product waste,” “environmental justice,” “hazardous waste law,” “tobacco retailer density” “healthy neighborhoods,” “plastic pollution,” “water pollution,”

“microplastics,” “cigarette butts,” “product toxicity,” and “social justice.” Additionally, selected articles’ references and appropriate related unpublished reports were reviewed. A total of 97 reports were identified and analyzed. Websites of the U.S. Food & Drug Administration (FDA), the Environmental Protection Agency (EPA), and the online United States Code (USC), Code of Federal Regulations (CFR) were accessed. The California Constitution, California Public Resources Code, California Health and Safety Code, California Revenue and Taxation Code, California Penal Code, the California Code of Regulations, and previous analyses of laws and resources by the Public Health Law Center on this topic were reviewed.

3. Results

Several themes emerge in the literature addressing TPW policy applications and the environmental justice impacts of waste and litter. The policy approaches that were identified differ in terms of where they target the commercial tobacco product supply and consumption chain. Some reports describe solutions seeking to fundamentally shift consumption and use patterns, thereby reducing the number of products sold, used, and then discarded; these would be considered *upstream* policy solutions. Some reports describe policy solutions that would impose additional costs or regulatory requirements on the consumption of the products; these might then be considered *midstream* policy solutions. Other reports suggest methods of mitigating, managing, or paying for the costs for cleanup imposed on the public by TPW; these would be considered *downstream* policy solutions. The next section will discuss the current

policy applications of these three categories, recognizing, of course, that there are conceptual and practical overlaps among them.

3.1 Upstream Policy Solutions

Upstream policy solutions to address TPW are those that prevent either the sale or use of a product in a way that effectively reduces sales, and ultimately, consumption, prior to the product ending up as post-consumption waste (17,28). Upstream policy solutions can include sales restrictions, some hazardous waste or materials laws, comprehensive smoking restrictions, and certain educational campaigns. Such solutions (which may also be thought of as “source reduction”) aim to address the source of the problem, namely the normalization of smoking, the availability of the products themselves, and the patterns of use of the products, rather than attempting to address the presence of TPW only after it has been discarded.

3.1.1 Sales restrictions

Several reports discuss the possibility of a restriction on the sale of cigarettes with filters as an efficient and effective means of controlling TPW due to discarded cigarettes. (15,17,28–31) A ban on the sale of cigarettes with filters could effectively minimize their presence, use, and resulting environmental impact as plastic waste (almost all filters are made of cellulose acetate, a poorly degradable plant-based plastic). State legislators in California and New York have proposed legislation to prohibit the sale of single-use cigarette filters; however, to date, no such legislation has been enacted. Further, depending on how filters or single-use tobacco products are

defined in these restrictions, these types of policies could have limited efficacy and could be manipulated by the tobacco industry (29,30) Further, many new tobacco products contain plastics that would not be classified as filters: e-cigarettes, cigar tips, packaging, and scores of additional tobacco-related items that either are made of or are contained in plastics that end up being discarded. Electronic cigarette cartridges (e.g., JUUL pods) contain plastic, metal heating coils, and nicotine, and these materials are often discarded around school grounds. (32) Current efforts to ban the sale and provision of single-use plastic products,⁷ including those targeting specific products such as plastic bags⁸ and straws⁹ could apply to cellulose acetate cigarette filters and the myriad other tobacco product-related plastic waste. (29) Importantly, we found no articles discussing the penalty or enforcement provisions contained in these policies that currently apply specifically to tobacco products. Sales restrictions not specifically aimed at targeting or mitigating the presence of TPW (for example, sales restrictions limiting the sale of flavored tobacco products or prohibiting the sale of tobacco products generally) were not identified in the literature, though such policies—particularly if adopted on a wide scale—could result in a decrease in the amount of TPW simply due to the fact that tobacco sales are correlated with tobacco use and thus the creation of waste.

⁷ In 2019, the European Union issued a directive that aims to reduce single-use plastic waste, which includes food containers, plastic bags, straws, water bottles, and other plastic items intended for one-time use and subsequent disposal. (33) The Directive encourages Member States to set national consumption reduction targets that consider life cycle impacts as well as prohibit the sale of products where more sustainable alternatives are already available. In the context of tobacco products, the Directive merely encourages the development of alternatives and post-consumption waste reduction.

⁸ Several jurisdictions have enacted bans, imposed fees, or otherwise regulated the provision of plastic bags to customers, including California, Connecticut, District of Columbia, Oregon, and others. (34)

⁹ Several jurisdictions in California and Seattle have banned the use of straws, while the State of California prohibits restaurants from automatically disseminating them to customers. (35)

It is possible that a law restricting the sale of certain tobacco products based on the presence of filters or plastic, and thus their likelihood to cause environmental harm, would be challenged in court by the tobacco industry as “tobacco product standard.” States and localities are largely preempted by the Family Smoking Prevention and Tobacco Control Act from issuing their own tobacco product standards. However, the ability of a locality to impose limitations on the sale (rather than the manufacture or formulation) of a product is expressly preserved by the Tobacco Control Act¹⁰ and would likely not be preempted. (29) Numerous federal courts have affirmed that local jurisdictions can prohibit the sale of tobacco products with a particular characteristic without creating a “product standard” under federal law.¹¹

3.1.2 Hazardous waste or materials-based sales restrictions

There is also growing realization that various aspects of hazardous waste and hazardous materials law could be used to regulate TPW as a hazardous waste. (6,21,36) One report provided evidence that cigarette butts that include a filter and smoked tobacco are acutely toxic to freshwater fish species and therefore could meet California’s aquatic toxicity threshold for hazardous waste. (1) The U.S. Environmental Protection Agency has similarly stated that discarded unused tobacco products containing processed leaf tobacco could be considered hazardous waste due to their

¹⁰ See 21 U.S.C. § 387p (expressly preserving the ability of state and local governments to “enact, adopt, promulgate, and enforce any law, rule, regulation, or other measure with respect to tobacco products that is in addition to, or more stringent than, requirements....relating to or prohibiting the sale, distribution, possession, exposure to, access to, advertising or promotion of, or use of tobacco products by individuals of any age....”).

¹¹ See Nat’l Ass’n of Tobacco Outlets, Inc. v. City of Providence, 731 F.3d 71 (1st Cir. 2013); Independents Gas & Serv. Stations Ass’n v. Chicago, 112 F. Supp. 3d 749 (N.D. Ill., 2015); R.J. Reynolds Tobacco Co. v. Cty. of Los Angeles, 2020 WL 4390375 (C.D. Cal. July 13, 2020); U.S. Smokeless Tobacco Mfg. Co. LLC v. City of New York, 708 F.3d 428 (2d Cir. 2013); R.J. Reynolds Tobacco Co. v. City of Edina, 2020 WL 5106853 (D. Minn. Aug. 31, 2020)).

toxicity. (37) Further, a recent study by Venugopal et al., 2021, found that thirty percent of the chemicals identified in an analysis of leachates from cigarette butts are listed in the FDA's established or proposed Harmful and Potentially Harmful Constituents in Tobacco Products and Tobacco Smoke list published pursuant to the Tobacco Control Act in 2012.¹² (7) Nicotine is also listed as an acute hazardous waste—the most toxic category—under the federal Resource Conservation and Recovery Act, meaning that when it is discarded in certain quantities, it must be handled, transported, and disposed of according to specific regulatory requirements. (20,37) Krause and Townsend, 2015, also demonstrated that some e-cigarettes meet the threshold for hazardous waste toxicity due to their metal content. (19) Many new commercial tobacco products contain batteries that are themselves treated as hazardous waste in some states,(20) including in California.¹³ Limitations on the sale of hazardous materials and products that become hazardous waste when discarded could be an effective way of also preventing the sale of tobacco products at the outset. For example, the State of California recently became the first state in the nation to ban the manufacture or sale of cosmetics containing twenty-four particularly toxic substances,¹⁴ while the federal government prohibits the sale of certain particularly hazardous substances.¹⁵ Sales restrictions based on a product's status as hazardous waste (as well as sales restrictions based on the toxicity of the filter) would also reflect the "precautionary principle,"¹⁶ which Novotny

¹² 77 Fed. Reg. 20034-20037 (Apr. 3, 2012).

¹³ 22 Calif. Code Regs. § 66273.2.

¹⁴ Calif. Health & Safety Code § 108980.

¹⁵ 16 C.F.R. § 1500.17.

¹⁶ The precautionary principle is a tenant of environmental protection that provides that an action should not be taken where there are threats of serious or irreversible damage or scientific uncertainty surrounding the action's potential impacts. (38) In the context of regulated industries, any uncertainty about potential impacts stemming from industry or governmental action should be resolved in favor of prevention. (39)

and Slaughter, 2014, argue could be applied to the regulation of TPW even though there is not yet an established human health outcome for this waste. (17)

3.1.3 Limiting Retailer Density

Restrictions on the density of retailers in a specific geographic area could impact both the number and the proximity of retailers in a given area, thereby reducing the sale and consumption of tobacco products in that community (40–43). Research shows that increased exposure to point-of-sale marketing increases smoking initiation and decreases the probability of smoking cessation. (44) Because point-of-sale marketing is concentrated where tobacco products are sold, and tobacco retailers are disproportionately located in low-income communities, individuals with lower socioeconomic status are exposed to environments that increase likelihood of initiation and decrease likelihood of cessation. This suggests that limiting exposure to tobacco sales and marketing could reduce existing tobacco-use disparities in communities disproportionately exposed to tobacco advertisements and marketing. While we found no articles that discuss tobacco retailer density restrictions as a potential policy solution to address the presence of TPW, several studies discuss using density-based restrictions to address inequities in tobacco and other substance use disorders. (27,42,44) In the context of a study of the racial and socioeconomic disparities in the density of alcohol retailers, for example, Romley et al., 2007, note that the widely accepted definition of “toxic environment” includes environmental factors that encourage tobacco use and consumption.(27) This suggests that a retailer density restriction could be an environmental justice intervention by considering inequity in policy design, for

example, by focusing on density per roadway mile rather than on a per capita basis. Similarly, Mennis et al., 2016, state that “one of the fundamental aims of environmental justice is to investigate if, how, and why environmental risks are distributed inequitably with regards to race and socioeconomic status.”(42) With respect to TPW, multiple studies note that TPW accumulates around locations where tobacco is used and sold. (15,24) Further, Zhang et al., 2019, found that the presence of litter has a statistically significant relationship to worse mental health, which is itself correlated with physical and social health. Other studies have similarly recognized this impact on industry-targeted communities, (21) along with the broader recognition that the burden of exposure to environmental pollution contributes significantly to disparities in health for low-income communities and communities of color. (45) In addition, recent studies indicate that retailers of newer tobacco products such as vape shops appear to be following the predatory tactics of other tobacco retailers by locating in low-income, Asian, Black or African-American communities, and Hispanic or Latino communities. (26,46) Farley et al., 2019, found a positive association between neighborhood poverty levels, tobacco retailer density, and smoking prevalence, potentially reflecting the predatory history of the tobacco industry in siting retail locations. (47) Similarly, Leas et al., 2019, found a higher prevalence of smoking in areas with more tobacco retailers, lower median household income, and fewer non-Hispanic white residents. (48) Finally, Gonzalez et al., 2019, found a significant inverse correlation between tobacco retailer density and social capital (i.e., community-level trust, reciprocity, social control, and civic engagement). (49) This finding supports the adoption of density-reducing tobacco

policies in conjunction with policies that help foster social capital as an integrated approach to reducing tobacco-use disparities.

3.1.4 Comprehensive educational campaigns

Certain educational campaigns could qualify as upstream policy solutions, provided they have a denormalizing effect on smoking and tobacco product use. Novotny and Slaughter, 2014, suggest that alliances with and mobilization of coalitions of public health advocates and environmental groups to raise awareness about the toxicity and other environmental impacts of TPW could help reduce the social acceptability of smoking. (17) Novotny et al., 2009, also note that behavior changes are likely only if there is a comprehensive approach taken to public information campaigns that involve all stakeholders. (28) Barnes, 2011, underscores the importance of an educational campaign as an element of any regulatory approach to controlling TPW. (50) Hoek et al., 2019, similarly suggest an “integrated” strategy that begins with educational efforts in order to reinforce behavior patterns, with a longer-term goal of reducing the number of tobacco product users. (51) Further, there is unquestionably an information gap in both smokers’ and non-smokers’ understanding of the harm that filters pose to both human health and the environment. (15,16,31,51–53) This information gap underscores the need for comprehensive policy interventions that include a robust educational component. Educational campaigns could also help identify the economic costs associated with TPW, including the costs of treating

smoking-related diseases, and the potential damage to ecosystem services¹⁷ associated with the life cycle of tobacco product cultivation, production, and use. (15)

3.2 Midstream Policy Solutions

Some policy solutions would impose additional costs or regulatory requirements on tobacco products or tobacco product users to address TPW. While some of these proposed policy solutions could ultimately have upstream effects by increasing the cost of tobacco products to consumers, leading to decreased consumption or denormalization, (28) we include them in a “midstream” policy solution category. Their immediate impact is to impose additional costs or burdens on either the consumer or the regulated industry, rather than to entirely shift the regulatory paradigm of sale and consumption on to the producer. That said, there is some fluidity between these categories, and their ultimate impact on TPW in the environment might depend on implementation and enforcement.

3.2.1 Mitigation fees and/or taxes

Taxes or fees imposed on cigarettes or other tobacco products at the point of sale could help fund the costs of proper disposal and cleanup of TPW, as well as any administrative costs associated with such programs. (28,55,56) Further, research suggests there would be widespread, national public support for a \$0.75/pack tax to pay

¹⁷ Ecosystem services include the services that ecosystems provide, which include food supply, public sanitation services such as water and waste purification, and cultural and aesthetic services including tourism and recreation. (54)

for cleaning up cigarette butt litter (31), even absent a general understanding that filters contain plastic.

The costs associated with TPW cleanup are significant; early estimates ranged from \$500,000 to \$6 million for a city the size of San Francisco, excluding costs resulting from the products' toxicity or impacts on tourism. (56) More recent research, taking into account such indirect costs, suggests that the costs associated with TPW (as represented by cigarette butt litter, excluding electronic cigarettes from the analysis) are likely much higher, ranging from \$4.7 million to \$90 million for the 30 largest cities in the United States. (21) In fact, San Francisco imposed a twenty-cent litter abatement fee in 2009 on packs of cigarettes to help offset the multi-million-dollar cost of cleaning up cigarette butts in the city. (29,56) Unfortunately, due to a successful tobacco industry-led California ballot initiative in response—Prop 26—such fees are now considered “taxes” in California and a local government cannot impose a tax or fee without approval of two-thirds of the local electorate.¹⁸ (29) Further, California law also prohibits the imposition of local tobacco taxes,¹⁹ meaning that localities cannot impose additional taxes on tobacco products above and beyond what is required at the state level. That said, a California court concluded that when a fee (i.e., on paper bags) is retained by the retailer who collected it and is not paid to the government, it is not a “tax” under Prop 26.²⁰ This potentially leaves the door open to fees structured differently from that in San Francisco. At the same time, researchers argue it is important to ensure that any additional cost imposed on products do not result in financial windfalls to manufacturers

¹⁸ Calif. Const. art. 13C, § 2.

¹⁹ Calif. Revenue and Taxation Code § 30111.

²⁰ Schmeer et al. v. County of Los Angeles, 213 Cal.App.4th 1310 (2013).

or retailers. (55) Therefore, any increased income for the retailer should be accompanied by regulatory requirements to use the funds for particular programs or tasks (e.g., TPW collection, neighborhood cleanup, etc.).

3.2.2 Deposit/return schemes

Multiple studies suggest imposition of a deposit/return scheme that would require manufacturers to take back cigarette butts or other TPW. (9,17,28,50,55,57) Several reports discussed a proposed bill in Maine that would have created a deposit and return scheme that involved a one-dollar fee on every pack of cigarettes, with a five-cent refund applied to every cigarette butt returned to a redemption center. (29,50,58) It is possible that requiring a large deposit for each tobacco product sold could effectively reduce use and consumption, as higher prices have been shown to result in a reduction in use. (59) Metcalfe et al., 2017, proposes including a cigarette-butt collection bag with packs of cigarettes sold that consumers then return to a redemption site. (55) However, such bags could also lead to more litter if they are not used as intended. While the deposit system has been successful in other consumer product contexts,(29) it runs the risk of, similar to recycling, putting the returned item out of sight and out of mind, thus encouraging continued consumption and use. (60) As with any other potential policy solution that requires infrastructure and costs to handle toxic waste, a deposit return scheme may also be impractical for the odorous, unsanitary TPW. (61) E-cigarettes with batteries may be the best candidates for a deposit and return system, given the potential technological complications of a cigarette butt-return program. (29) However, the high cost and complications of disposing of e-cigarettes that contain several

different hazardous wastes in a small and difficult to disassemble package makes such a return system potentially difficult to administer. Although battery return requirements exist for certain rechargeable batteries in California,²¹ the law's impact is rather limited as there is no associated deposit data. (56) Compliance reporting is subject to the discretion of the California Department of Toxic Substances Control,²² and the program exempts large categories of products, such as batteries that are "contained in a package with a battery-operated device", which is the case with many e-cigarettes.²³ California does have a fee-based program applicable to certain electronic products with screens, which requires the consumer to pay a small fee upon purchase of the electronic device.²⁴ Unlike a deposit and return system, however, the retailers do not return the deposit fee to the consumer; rather, the fees help to fund a program that offsets the cost of recovery, processing, and recycling activities for certain electronic products. (62) That program similarly appears to have had minimal impact on actual recycling and recovery rates of covered electronic products. (62)

3.2.3 Hazardous waste or hazardous materials laws

As discussed above, federal environmental law places strict requirements on the handling of certain types and quantities of hazardous waste. (20) Additional requirements could be imposed on the handling of e-cigarettes, their batteries, and potentially large quantities of cigarette butts or other TPW, particularly if additional

²¹ Calif. Public Res. Code §42454.

²² Calif. Public Res. Code §42456.

²³ Calif. Public Res. Code §42453.

²⁴ The fees range from \$6 for a device with a screen of less than 15 inches measured diagonally to \$10 for a device with a screen measuring greater than or equal to 35 inches diagonally. See Calif. Pub. Res. Code § 42464 (2019).

research establishes their toxicity under the federal EPA and California EPA standards. The handling, storage, transportation, and disposal of TPW could be regulated through either hazardous waste or hazardous materials laws at the state or local level, depending on the regulatory regime of the jurisdiction. (36) For example, businesses and schools may be required to prepare and implement a hazardous waste management plan for storage and handling of hazardous waste, including designing a plan for accidental releases.²⁵(36) We found no information that specifically evaluated how this type of requirement would apply to tobacco retailers; therefore, additional research is needed to better understand how existing hazardous waste management programs could be expanded to include TPW.

3.2.4 Tobacco Product Use Restrictions

Numerous reports discuss the need for increased restrictions on where tobacco products can be used, thereby affecting the amount of discarded TPW. (9,11,15,16) This type of restriction, if comprehensive and applicable in many places throughout a jurisdiction, could be considered an upstream policy approach because it could lead to denormalization of product use and fewer smokers, assuming the policies are enforced. (15) However, many of the reports discuss place-based restrictions on the use of cigarettes (e.g., on beaches, in parks), meaning that, even if effective, they may only impact the presence of TPW in specific areas rather than reducing overall tobacco use. Further, because cigarette butts travel to oceans through drains, rivers, and streams, specific beach-focused smoke-free laws will not eliminate cigarette butts from beaches

²⁵ See also Calif. Health and Safety Code § 25508.

or other environments close to water sources (28) Thus, place-based policies may have limited effects. Valiente et al., 2020, also found a high concentration of cigarette butt litter in many different urban environments, including where smoking is prohibited by law, suggesting that broader, more integrated interventions are necessary to have a meaningful positive environmental impact on TPW. (63) Additionally, some research supports the imposition of fines or strict punishments for violating use restrictions or existing litter laws. (9,28,50) Such enforcement structures should be considered in light of the previous discussion on social justice, as they could result in an inequitable financial burden imposed on low-income individuals if fines and financial penalties are imposed, and any enforcement that has the potential to increase interactions between individuals and law enforcement should be avoided. Further, strict punishments for littering, without comprehensive education and other controls to denormalize tobacco use, have had limited effectiveness.

3.2.5 Extended Producer Responsibility (EPR) and Product Stewardship (PS)

A number of reports describe policy solutions to place responsibility for the costs of managing TPW onto the manufacturers through a structure that exists with other consumer products. This concept is known as Extended Producer Responsibility (EPR) or Product Stewardship (PS). (14,17,21,36,50,52,55,58,61,64) Policies adopting an EPR model exist for products such as batteries, electronics, pharmaceuticals, mattresses, paint, and other products. (17,61) Rather than constituting one specific solution, EPR/PS could underlie the structure for several different policy solutions, including several of the ones discussed above, such as deposit/takeback schemes,

hazardous waste management requirements, recycling, and clean-ups, (61) depending on how involved the manufacturer or retailers are in the management of waste. A true EPR structure would place responsibility for running and operating those programs onto the manufacturers or retailers themselves. (50) While the ultimate goals of an EPR/PS scheme include denormalizing product use, increasing the cost of tobacco products, and bridging alliances among environmental groups and tobacco control advocates, the main thrust of any EPR/PS structure is that it would place responsibility for paying for TPW mitigation onto the manufacturers. In the case of PS, this would extend to all responsible parties involved in the life cycle of the product (17,50,61) The degree of industry involvement in an EPR-based structure could be extensive, and this could include financing systems for collecting and transporting waste, developing performance standards, and even creating educational programs. (50,61) This has not yet been implemented in any form for TPW. For this reason, EPR/PS schemes should be approached cautiously in the context of the tobacco industry. This industry has been found guilty of violating federal racketeering laws and has intentionally lied to consumers for decades. It has intentionally manipulated scientific information on tobacco and health, and despite recent corporate social responsibility campaigns, it continues to sell the world's deadliest consumer product (compared to, for example, paint or mattresses).²⁶ (65) The industry already has a history of co-opting campaigns related to cigarette butt waste, (30,65) suggesting any potential industry involvement should be avoided. Finally, requiring certain product alterations, such as eliminating filters, could also be considered to some extent an EPR structure. However, it is

²⁶ See also *United States v. Philip Morris USA Inc.*, 449 F. Supp. 2d 1 (D.D.C. 2006).

important that those types of restrictions are done in the context of sales restrictions (discussed above), rather than manufacturing requirements, unless they are standards adopted by Tribes or the U.S. Food and Drug Administration or promulgated by Congress.²⁷ (29)

3.2.6 Labeling

Some articles discuss the possibility of having educational/informational labels on the front of cigarette packages as a potential intervention. (17,28) Like graphic warning labels that warn of the health implications of smoking, an environmental hazard label would provide some information about the environmental impact of smoking, including the environmental toxicity of TPW, as well as information about proper disposal. (17,28) A potential problem with this intervention is that it may be preempted by the Federal Cigarette Labeling and Advertising Act (FCLAA) and Tobacco Control Act. Therefore, it would only be possible through legislative action at the federal level.²⁸ Other countries that do not have similar preemptive laws could theoretically consider such labeling schemes at a local or state level, though additional research about their potential efficacy would be necessary.

3.3 Downstream Policy Solutions

Downstream policy solutions focus on cleaning up or eliminating litter once it's been discarded and are the least likely to result in either denormalization or a substantial reduction in the number of products discarded. In fact, it is perhaps telling

²⁷ 21 U.S.C. § 387p.

²⁸ 21 U.S.C. §387p(a)(2); 15 U.S.C. §1334(b-c).

that the tobacco industry has spearheaded anti-litter campaigns, funded distribution of hand-held ashtrays or ashcans for smokers, researched biodegradable filters, and funded clean-ups in order to shift blame away from itself and onto individuals or communities. (58,64,65) These policies address tobacco products only once they become waste and do nothing to address the source of the waste. (15,52)

3.3.1 Cleanups

Resident-driven cleanups in neighborhoods burdened by litter have had a positive impact on community mental health and behavior, particularly paired with reimbursement of residents for their cleanup services and increased civic participation. (66) While cleanup campaigns have been undertaken by legitimate organizations and can serve the purposes of educating participants about the environmental impact of TPW, it is physically not possible to have a measurable impact on TPW through cleanups alone. (52) For example, Ocean Conservancy reports that as of 2016, approximately 52 million butts had been picked up in 27 years of cleanups—this is out of the roughly 4.5 trillion that are discarded every year. (61) In other words, for every cigarette butt that has *ever* been picked up over those 27 years, 86,538 more butts are littered *every year*. Further, as reflected by the tobacco industry's historic funding of organizations that lead clean-up efforts, (28,52,58,64) they tend to limit attention to the industry's role in creating TPW. Given the industry's historic involvement in clean-up efforts, it is reasonable to anticipate industry infiltration to community or government efforts to address TPW. (30,64)

3.3.2 Waste receptacles

Waste receptacles have also been provided or funded by the tobacco industry through partnerships with organizations such as Keep America Beautiful and its affiliates, (28,52,58,64) but there are limited data on their efficacy. (11,61) For example, Castaldi et al., 2020, studied two interventions on Italian beaches and found a small but statistically significant drop in littered butts on beaches where portable ashtrays were provided (10-12% reduction). (67) However, the researchers found that the pairing of the ashtrays with informational signs did not have a significant impact compared with the ashtrays alone. Given the volume of cigarette butts, and the fact that the study found a relatively small reduction in the occurrence of TPW, portable ashtrays on beaches are not a meaningful policy intervention. (15) Moreover, a 2014 study by Bruton and Floyd assessing socioeconomic and racial/ethnic disparities in public park amenities suggests that interventions such as waste receptacles do not alone determine a reduction in litter. (68) This is perhaps in part because the presence of receptacles themselves can have the counterproductive effect of normalizing tobacco use, and necessarily they only cover small geographic areas—they cannot cover large areas of land. Finally, it is also the case that portable ashtrays may be plastic and discarded as waste themselves, or at least inappropriately emptied, sending TPW down storm drains or onto streets.

3.3.3 Biodegradable filters

As with the other downstream policy approaches, the tobacco industry itself has researched the development of biodegradable filters, (28,51,52,65) In fact, the

industry's international research foundation, CORESTA, formed a "Cigarette Butt Degradability Task Force" in the 1990s comprised primarily of representatives from cigarette, chemical, paper, adhesive, and other industries that would have benefitted financially from the development of a marketable cigarette filter that would degrade more quickly. (69) The commission ultimately determined that the interest was not sufficient to justify the time and amount of data collection needed to adequately study the issue of filter degradability. (28,69) Thus, for these companies, the issue of marketability took precedence over environmental responsibility.

Furthermore, it has been noted that biodegradable filter requirements could theoretically "preempt environmental legislation" and might allow a smoker to "litter without guilt." (65) While biodegradable filters have been posed as a potential solution to the specific problem caused by cellulose acetate filters as plastic waste, (9,29) others have concluded that biodegradable filters could lead to even more butt littering. (61) and enable industry exploitation and greenwashing. (30) Even if they were commercially viable, however, biodegradable filters would still contain and release toxic chemicals into the environment. (9,28,30,52)

3.3.4 Litigation

Several articles discuss the potential utility of different types of legal theories that could help recover the costs imposed by TPW on the public. (17,28,29,36,52) For example, the legal doctrine of public nuisance has been successfully used in the context of other toxic consumer products (e.g., lead-based paint) and could be used to hold tobacco product manufacturers accountable for interfering with common rights, which

include damage to water, parks, or air. (36) Further, local jurisdictions can define what constitutes a public nuisance, making the lawsuits somewhat easier to prove. (36) Recent litigation against the pharmaceutical industry and lead paint manufacturers suggests that manufacturers can be held responsible for some public nuisance impacts of products they put into the stream of commerce.²⁹ However, those cases are extremely costly, complex, and can take years or even decades to resolve. We found no reports discussing holding retailers, as opposed to manufacturers, responsible for TPW under a public nuisance theory, which could be another potential avenue for intervention. Additional legal theories discussed in the literature include negligence and product liability, (28,36) though due to the potential preemptive effect of the federal Tobacco Control Act, state law, and the limited availability of such claims to municipalities, these avenues were not identified as the strongest potential legal claims. (36) Witkowski, 2014, does identify the potential, though limited, utility of using enforcement mechanisms of hazardous waste law, (36) particularly in California where cigarette butt leachate has been shown to meet certain aquatic toxicity thresholds. (1) That said, because hazardous waste laws generally take effect once material becomes “waste” (i.e., are discarded, see 22 Calif. Code of Regs. § 66261.2), they could also have the perverse result of placing liability on public institutions where waste accumulates while sparing entities that produce the toxic TPW in the first place.

3.3.5 Litter-focused educational campaigns

²⁹ State of Oklahoma v. Purdue Pharma L.P., No. CJ-2017-816, 2019 WL 9241510, at *1 (Okl. Dist. Nov. 15, 2019) and People v. ConAgra Grocery Prod. Co., 17 Cal. App. 5th 51 (2017).

Anti-littering campaigns differ from more comprehensive anti-TPW educational campaigns because they focus solely on encouraging individual smokers not to litter, rather than providing information about the role played by the industry in promoting the fraudulent health “benefits” of filters. (30,70) In fact, Smith and McDaniel (2010) argue that the word “litter” itself should be replaced with “waste,” which refocuses attention on the producer of the waste, rather than on the person throwing the object on the ground. (58) Indeed, tobacco product users tend to believe that cigarettes are biodegradable or do not constitute “trash”, as evidenced by the fact that the littering rate for cigarette butts is 65% compared to a 17% littering rate of other products. (51,53,61) There is clearly an information gap when it comes to understanding the environmentally damaging nature of these products—smokers and non-smokers alike generally do not know that cigarette butts are made of plastic and never biodegrade. Further, “anti-littering” campaigns have been a favorite industry tool precisely because they aim to shift responsibility for TPW to individual product users and communities, away from the industry itself. (58,61,64,65,71) As discussed above, certain comprehensive, non-industry-funded campaigns focused on providing accurate information about the extent of TPW’s environmental risks could have a meaningful impact on tobacco product use. (11) However, educational campaigns with a limited focus on anti-littering have not been shown to have a significant impact on the amount of cigarette butts that are discarded. (67)

3.3.6 Recycling

Recycling programs were proposed in New York and implemented in Vancouver, British Columbia, and have been proposed as potential solutions by some researchers. (9,55) However, recycling programs may be complicated and costly to administer, and the products to be recycled contain harmful chemicals, meaning that they could pose harm even in recycled form (29,61,72) or may simply be unrecyclable. (15) There are also examples of industry-supported cigarette butt recycling programs, (61) and the e-cigarette industry has also made regular attempts to demonstrate an interest in recycling. (73) As with the ineffectiveness of other efforts that rely on the personal actions of individual smokers, recycling is likely not a viable solution for reduction of TPW. (72) Further, recycling of plastic products is more generally a concern from an environmental justice standpoint. For example, Barnes, 2019, found that the exportation of plastic waste places the burden of that waste on low-income communities and countries and may contribute to an *increase* in plastic consumption due to an “out-of-sight, out of mind” mentality. (60)

4. Conclusions

This review of the legal and scientific literature relating to policy approaches to address TPW, as well as the physical and environmental justice impacts of TPW, aims to support consideration of environmental policies to reduce tobacco use. The review suggests that there are a number of policy approaches that have already been considered, though they vary in their likely efficacy and ultimate impact on the accumulation and environmental impacts of TPW. Upstream solutions to address TPW are, as compared with midstream and downstream, likely to be the most efficient, most

economical, and most likely to actually reduce the amount of TPW being produced. Yet, due to many decades of information suppression and political influence by the tobacco industry, upstream solutions, particularly sales restrictions, may still be politically difficult in many jurisdictions. Thus, an integrated approach that uses multiple tools to address consumption patterns through density, pricing, imposing regulatory costs on the industry where feasible, and addressing waste accumulation could optimize the management of TPW in the near-term and strengthen state and local tobacco control efforts. Current research supports policy approaches that disseminate comprehensive and accurate information about TPW and the cellulose acetate filter, changing norms about smoking overall and about discarding butts, and eliminating disparities in where tobacco products are sold, consumed, and discarded. Further research could identify additional avenues to shift costs of TPW onto manufacturers and retailers of tobacco products and away from vulnerable communities, voluntary groups, and governments, thereby increasing the costs of tobacco products to the consumer. As with all tobacco control policies, multi-component strategies are likely to be more effective than single, secular approaches.

Conflicts of Interest

The authors declare no conflicts of interest.

Funding

This work was supported by the California Tobacco Control Program of the California Department of Public Health, Contract No. 20-10206, through the San Diego State University Research Foundation.

References

1. Slaughter E, Gersberg RM, Watanabe K, Rudolph J, Stransky C, Novotny TE. Toxicity of cigarette butts, and their chemical components, to marine and freshwater fish. *Tob Control*. 2011 May 1;20(Suppl 1):i25–9.
2. Micevska T, Warne MStJ, Pablo F, Patra R. Variation in, and Causes of, Toxicity of Cigarette Butts to a Cladoceran and Microtox. *Arch Environ Contam Toxicol*. 2006 Feb 1;50(2):205–12.
3. Moerman JW, Potts GE. Analysis of metals leached from smoked cigarette litter. *Tob Control*. 2011 May 1;20(Suppl 1):i30–5.
4. Koutela N, Fernández E, Saru M-L, Psillakis E. A comprehensive study on the leaching of metals from heated tobacco sticks and cigarettes in water and natural waters. *Sci Total Environ*. 2020 Apr 20;714:136700.
5. Santos-Echeandía J, Zéler A, Gago J, Lacroix C. The role of cigarette butts as vectors of metals in the marine environment: Could it cause bioaccumulation in oysters? *J Hazard Mater*. 2021 Aug 15;416:125816.
6. Qamar W, Abdelgalil AA, Aljarboa S, Alhuzani M, Altamimi MA. Cigarette waste: Assessment of hazard to the environment and health in Riyadh city. *Saudi J Biol Sci*. 2020 May 1;27(5):1380–3.
7. Venugopal PD, Hanna SK, Gagliano GG, Chang HW. No Butts on the Beach: Aquatic Toxicity of Cigarette Butt Leachate Chemicals. *Tob Regul Sci*. 2021;7(1):17–30.
8. Novotny TE, Lum K, Smith E, Wang V, Barnes R. Cigarettes Butts and the Case for an Environmental Policy on Hazardous Cigarette Waste. *Int J Environ Res Public Health*. 2009 May;6(5):1691–705.
9. Shen M, Li Y, Song B, Zhou C, Gong J, Zeng G. Smoked cigarette butts: Unignorable source for environmental microplastic. *Sci Total Environ*. 2021;791:148384.
10. Belzagui F, Buscio V, Gutiérrez-Bouzán C, Vilaseca M. Cigarette butts as a microfiber source with a microplastic level of concern. *Sci Total Environ*. 2021 Mar 25;762:144165.
11. Roder Green AL, Putschew A, Nehls T. Littered cigarette butts as a source of nicotine in urban waters. *J Hydrol*. 2014 Nov 27;519:3466–74.
12. Booth DJ, Gribben P, Parkinson K. Impact of cigarette butt leachate on tidepool snails. *Mar Pollut Bull*. 2015 Jun 15;95(1):362–4.

13. Wright SL, Rowe D, Reid MJ, Thomas KV, Galloway TS. Bioaccumulation and biological effects of cigarette litter in marine worms. *Sci Rep.* 2015 Sep 15;5(1):14119.
14. Green DS, Kregting L, Boots B. Effects of cigarette butts on marine keystone species (*Ulva lactuca* L. and *Mytilus edulis* L.) and sediment microphytobenthos. *Mar Pollut Bull.* 2021 Apr 1;165:112152.
15. Araújo M, Costa M. A critical review of the issue of cigarette butt pollution in coastal environments. *Environ Res.* 2019 Feb 1;172.
16. Freire Lima C, Amaral dos Santos Pinto M, Brasil Choueri R, Buruaem Moreira L, Braga Castro Í. Occurrence, characterization, partition, and toxicity of cigarette butts in a highly urbanized coastal area. *Waste Manag.* 2021 Jul 15;131:10–9.
17. Novotny TE, Slaughter E. Tobacco Product Waste: An Environmental Approach to Reduce Tobacco Consumption. *Curr Environ Health Rep.* 2014 Sep 1;1(3):208–16.
18. Alberti S, Sotiropoulou M, Fernández E, Solomou N, Ferretti M, Psillakis E. UV-254 degradation of nicotine in natural waters and leachates produced from cigarette butts and heat-not-burn tobacco products. *Environ Res.* 2021 Mar 1;194:110695.
19. Krause MJ, Townsend TG. Hazardous waste status of discarded electronic cigarettes. *Waste Manag.* 2015 May;39:57–62.
20. Public Health Law Center. Disposing of E-Cigarette Waste: FAQ for Schools and Others [Internet]. 2019 [cited 2021 Aug 25]. Available from: <https://www.publichealthlawcenter.org/sites/default/files/resources/Disposing-of-E-Cigarette-Waste-FAQ-for-Schools-and-Others.pdf>
21. Schneider JE, Scheibling CM, Peterson NA, Stigler Granados P, Fulton L, Novotny TE. Online Simulation Model to Estimate the Total Costs of Tobacco Product Waste in Large U.S. Cities. *Int J Environ Res Public Health.* 2020 Jan;17(13):4705.
22. U.S. Food and Drug Administration, Center for Tobacco Products. Programmatic Environmental Assessment: Marketing Orders for Marlboro HeatSticks, Marlboro Smooth Menthol Heatsticks, Marlboro Fresh Menthol Heatsticks, and the IQOS System Holder and Charger by Philip Morris Products, S.A. [Internet]. 2019 [cited 2021 Aug 31]. Available from: <https://www.fda.gov/media/134458/download>
23. Edwards RL, Venugopal PD, Hsieh JR. Aquatic toxicity of waterpipe wastewater chemicals. *Environ Res.* 2021 Jun 1;197:111206.
24. Marah M, Novotny TE. Geographic patterns of cigarette butt waste in the urban environment. *Tob Control.* 2011 May 1;20(Suppl 1):i42–4.

25. Araújo MCB, Costa MF. From Plant to Waste: The Long and Diverse Impact Chain Caused by Tobacco Smoking. *Int J Environ Res Public Health*. 2019 Jan;16(15):2690.
26. Berg CJ, Schleicher NC, Johnson TO, Barker DC, Getachew B, Weber A, et al. Vape shop identification, density and place characteristics in six metropolitan areas across the US. *Prev Med Rep*. 2020 Sep 1;19:101137.
27. Romley JA, Cohen D, Ringel J, Sturm R. Alcohol and environmental justice: the density of liquor stores and bars in urban neighborhoods in the United States *. *J Stud Alcohol Drugs*. 2007 Jan 1;68(1):48–56.
28. Novotny TE, Lum K, Smith E, Wang V, Barnes R. Cigarettes Butts and the Case for an Environmental Policy on Hazardous Cigarette Waste. *Int J Environ Res Public Health*. 2009 May;6(5):1691–705.
29. Freiberg M. (DON'T) SEE MORE BUTTS: PREEMPTION AND LOCAL REGULATION OF CIGARETTE LITTER |. *Hamline Law Review*. 2014;37(1):205–28.
30. Evans-Reeves K, Lauber K, Hiscock R. The 'filter fraud' persists: the tobacco industry is still using filters to suggest lower health risks while destroying the environment. *Tob Control* [Internet]. 2021 Apr 25 [cited 2021 Aug 28]; Available from: <https://tobaccocontrol.bmj.com/content/early/2021/04/26/tobaccocontrol-2020-056245>
31. Patel M, Cuccia AF, Folger S, Benson AF, Vallone D, Novotny TE. Support for cigarette filter waste policies among US adults. *Tob Control* [Internet]. 2021 Jun 7 [cited 2021 Aug 17]; Available from: <https://tobaccocontrol.bmj.com/content/early/2021/06/08/tobaccocontrol-2020-056451>
32. Mock J. Notes from the Field: Environmental Contamination from E-cigarette, Cigarette, Cigar, and Cannabis Products at 12 High Schools — San Francisco Bay Area, 2018–2019. *MMWR Morb Mortal Wkly Rep* [Internet]. 2019 [cited 2021 Aug 25];68. Available from: <https://www.cdc.gov/mmwr/volumes/68/wr/mm6840a4.htm>
33. European Parliament and the Council of the European Union. Directive (EU) 2019/904 of the European Parliament and of the Council of 5 June 2019 on the reduction of the impact of certain plastic products on the environment. *Off J Eur Union* [Internet]. 2019 [cited 2021 Sep 27]; Available from: <https://eur-lex.europa.eu/eli/dir/2019/904/oj>
34. National Conference on State Legislatures. State Plastic Bag Legislation [Internet]. 2021 [cited 2021 Sep 26]. Available from: <https://www.ncsl.org/research/environment-and-natural-resources/plastic-bag-legislation.aspx>

35. Andrew Johnson. Del Mar Passes Total Plastic Straw Ban, Follows in Seattle, San Francisco's Footsteps. NBC 7 San Diego [Internet]. 2019 Mar 6 [cited 2021 Sep 26]; Available from: <https://www.nbcsandiego.com/news/local/del-mar-city-council-plastic-straws-ban-paper-alternatives-reusable-environment/3358/>
36. Witkowski J. Holding Cigarette Manufacturers and Smokers Liable for Toxic Butts: Potential Litigation-Related Causes of Action for Environmental Injuries/Harm and Waste Cleanup. *Tulane Environ Law J*. 2014;28(1):1–36.
37. U.S. Environmental Protection Agency, Office of Resource Conservation and Recovery. Letter from Barnes Johnson to AnnMarie Beattie [Internet]. 2017 [cited 2021 Aug 31]. Available from: <https://rcrapublic.epa.gov/files/14894.pdf>
38. United Nations Conference on Environment and Development. Rio Declaration on Environment and Development [Internet]. 1992 [cited 2021 Sep 26]. Available from: https://www.un.org/en/development/desa/population/migration/generalassembly/docs/globalcompact/A_CONF.151_26_Vol.I_Declaration.pdf
39. Goldstein BD. The Precautionary Principle Also Applies to Public Health Actions. *Am J Public Health*. 2001 Sep;91(9):1358–61.
40. Travis N, Levy DT, McDaniel PA, Henriksen L. Tobacco retail availability and cigarette and e-cigarette use among youth and adults: a scoping review. *Tob Control* [Internet]. 2021 Jul 22 [cited 2021 Aug 28]; Available from: <https://tobaccocontrol.bmj.com/content/early/2021/07/22/tobaccocontrol-2020-056376>
41. Marsh L, Ajmal A, McGee R, Robertson L, Cameron C, Doscher C. Tobacco retail outlet density and risk of youth smoking in New Zealand. *Tob Control*. 2016 Dec 1;25(e2):e71–4.
42. Mennis J, Stahler GJ, Mason MJ. Risky Substance Use Environments and Addiction: A New Frontier for Environmental Justice Research. *Int J Environ Res Public Health*. 2016 Jun;13(6):607.
43. Lee JGL, Landrine H, Torres E, Gregory KR. Inequities in tobacco retailer sales to minors by neighbourhood racial/ethnic composition, poverty and segregation, USA, 2015. *Tob Control*. 2016 Dec 1;25(e2):e142–5.
44. Siahpush M, Jones PR, Singh GK, Timsina LR, Martin J. The association of tobacco marketing with median income and racial/ethnic characteristics of neighbourhoods in Omaha, Nebraska. *Tob Control*. 2010 Jun 1;19(3):256–8.
45. Landrigan PJ, Rauh VA, Galvez MP. Environmental Justice and the Health of Children. *Mt Sinai J Med*. 2010 Apr 3;77(2):178–87.

46. Venugopal PD, Morse AL, Tworek C, Chang HW. Socioeconomic Disparities in Vape Shop Density and Proximity to Public Schools in the Conterminous United States, 2018. *Health Promot Pract*. 2020 Jan 1;21(1_suppl):9S-17S.
47. Farley SM, Maroko AR, Suglia SF, Thorpe LE. The Influence of Tobacco Retailer Density and Poverty on Tobacco Use in a Densely Populated Urban Environment. *Public Health Rep*. 2019 Mar 1;134(2):164–71.
48. Leas EC, Schleicher NC, Prochaska JJ, Henriksen L. Place-Based Inequity in Smoking Prevalence in the Largest Cities in the United States. *JAMA Intern Med*. 2019 Mar 1;179(3):442–4.
49. Gonzalez M, Sanders-Jackson A, Henriksen L. Social Capital and Tobacco Retail Outlet Density: An Empirical Test of the Relationship. *Am J Health Promot*. 2019 Sep 1;33(7):1020–7.
50. Barnes RL. Regulating the disposal of cigarette butts as toxic hazardous waste. *Tob Control*. 2011 May 1;20(Suppl 1):i45–8.
51. Hoek J, Gendall P, Blank M-L, Robertson L, Marsh L. Butting out: An analysis of support for measures to address tobacco product waste. *Tobacco Control*. 2020;29(2):131–7.
52. Novotny TE. Environmental accountability for tobacco product waste. *Tob Control*. 2020;29:138–9.
53. Rath JM, Rubenstein RA, Curry LE, Shank SE, Cartwright JC. Cigarette Litter: Smokers' Attitudes and Behaviors. *Int J Environ Res Public Health*. 2012 Jun;9(6):2189–203.
54. Newman S, Watkins E, Farmer A, Brink P ten, Schweitzer J-P. The Economics of Marine Litter. In: Bergmann M, Gutow L, Klages M, editors. *Marine Anthropogenic Litter* [Internet]. Cham: Springer International Publishing; 2015 [cited 2021 Sep 25]. p. 367–94. Available from: https://doi.org/10.1007/978-3-319-16510-3_14
55. Metcalfe S, Murray P, Schousboe C. A kick in the butt: time to address tobacco waste in New Zealand. *N Z Med J* [Internet]. 2017 [cited 2021 Aug 17];130(1456). Available from: <https://www.nzma.org.nz/journal-articles/a-kick-in-the-butt-time-to-address-tobacco-waste-in-new-zealand>
56. Schneider JE, Peterson NA, Kiss N, Ebeid O, Doyle AS. Tobacco litter costs and public policy: a framework and methodology for considering the use of fees to offset abatement costs. *Tob Control*. 2011 May 1;20(Suppl 1):i36–41.
57. Heulton CG, Cummings KM, O'Connor RJ, Novotny TE. Butt really? The environmental impact of cigarettes. *Tob Control*. 2011 May 1;20(Suppl 1):i1–i1.

58. Smith E, McDaniel PA. Covering their butts: responses to the cigarette litter problem | Tobacco Control [Internet]. [cited 2021 Aug 26]. Available from: <https://tobaccocontrol.bmj.com/content/20/2/100>
59. Jha P, Chaloupka FJ. The economics of global tobacco control. *BMJ*. 2000 Aug 5;321(7257):358–61.
60. Barnes SJ. Out of sight, out of mind: Plastic waste exports, psychological distance and consumer plastic purchasing. *Glob Environ Change*. 2019 Sep 1;58:101943.
61. Curtis C, Novotny TE, Lee K, Freiberg M, McLaughlin I. Tobacco industry responsibility for butts: a Model Tobacco Waste Act. *Tob Control*. 2017 Jan 1;26(1):113–7.
62. CalRecycle. Covered Electronic Waste Recycling Program [Internet]. 2021 [cited 2021 Aug 31]. Available from: <https://www.calrecycle.ca.gov/electronics/cew>
63. Valiente R, Escobar F, Pearce J, Bilal U, Franco M, Sureda X. Estimating and mapping cigarette butt littering in urban environments: A GIS approach. *Environ Res*. 2020 Apr 1;183:109142.
64. Wallbank LA, MacKenzie R, Beggs PJ. Environmental impacts of tobacco product waste: International and Australian policy responses. *Ambio*. 2017;46(3):361–70.
65. Smith EA, Novotny TE. Whose butt is it? tobacco industry research about smokers and cigarette butt waste. *Tob Control*. 2011 May 1;20(Suppl 1):i2–9.
66. Kaiser ML, Hand MD, Pence EK. Individual and Community Engagement in Response to Environmental Challenges Experienced in Four Low-Income Urban Neighborhoods. *Int J Environ Res Public Health*. 2020 Jan;17(6):1831.
67. Castaldi G, Cecere G, Zoli M. “Smoke on the beach”: on the use of economic vs behavioral policies to reduce environmental pollution by cigarette littering. *Econ Polit* [Internet]. 2020 Nov 16 [cited 2021 Aug 17]; Available from: <https://doi.org/10.1007/s40888-020-00205-5>
68. Bruton CM, Floyd MF. Disparities in Built and Natural Features of Urban Parks: Comparisons by Neighborhood Level Race/Ethnicity and Income. *J Urban Health Bull N Y Acad Med*. 2014 Oct;91(5):894–907.
69. Deutsch LJ. Cigarette Butt Degradability Task Force: Final Report [Internet]. 2000 [cited 2021 Sep 25]. Available from: <http://legacy.library.ucsf.edu/tid/qtg33a00>
70. van Schalkwyk MCI, Novotny TE, McKee M. No more butts. *BMJ*. 2019 Oct 23;367:l5890.
71. Chapman S. Butt clean up campaigns: wolves in sheep’s clothing? *Tob Control*. 2006 Aug 1;15(4):273–273.

72. Geueke B, Groh K, Muncke J. Food packaging in the circular economy: Overview of chemical safety aspects for commonly used materials. *J Clean Prod.* 2018 Aug 20;193:491–505.
73. Paul K. Vaping's other problem: are e-cigarettes creating a recycling disaster? *The Guardian* [Internet]. 2019 Aug 27 [cited 2021 Aug 31]; Available from: <http://www.theguardian.com/society/2019/aug/26/vapings-other-problem-are-e-cigarettes-creating-a-recycling-disaster>