DON'T WASTE DURHAM
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The Cost of Single-Use Plastic Bags

in Durham, North Carolina

Prepared by the Duke Environmental Law and Policy Clinic
for Don't Waste Durham

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Background

The Duke Environmental Law and Policy Clinic prepared this report on behalf of Don't Waste Durham. Its purpose is to provide greater context to Durham City Councilmembers, Durham County Commissioners, staff, and residents for the need to implement a policy that reduces the consumption of single-use bags. The report summarizes the national and global problems associated with single-use bags but also emphasizes the local environmental and economic costs they impose right here in Durham. The report also provides an overview of the policy strategies that Durham could employ to reduce single-use bag consumption and mitigate these costs. The attached appendices provide a more detailed analysis of some of the information provided in this report.

Don't Waste Durham is a local 501(c)3 nonprofit which creates solutions that prevent trash. For more information on Don't Waste Durham, its mission, and its programs, visit its website at http://www.dontwastedurham.org/.

The Duke Environmental Law and Policy Clinic is a joint enterprise of Duke University's Law School and Nicholas School of the Environment. The Clinic trains the next generation of environmental leaders while providing support to nonprofit organizations and clients involved in environmental conflicts. To learn more, visit https://law.duke.edu/envlawpolicy/.

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1. Executive Summary

Retailers in Durham, North Carolina, typically provide plastic and/or paper single-use bags to customers at the check-out counter free of charge. However, these bags have very real costs for our community: they contribute to litter on streets and in waterways, clog storm drains, take up limited landfill space, and wreak havoc on recycling infrastructure. Overall, these costs amount to $2,686,943/year in the City of Durham. These costs, broken down by sector, amount to:

1. City Government: $86,538
2. Businesses (Retailers & Sonoco Recycling): $2,595,904
3. Nonprofits: $4,501

Single-use plastics pose challenges to communities throughout the country, but many communities have implemented solutions to minimize these harms. Baltimore, Washington D.C., Los Angeles, and New York are just a few of the places that regulate trash as a pollutant, which requires them to capture and remove trash from their stormwater system using various controls. This is a path Durham could take, but it does nothing to prevent pollution in the first place. Other communities have opted to reduce single-use bags at the point-of-sale by prohibiting retailers from providing them altogether or by requiring retailers to charge customers a small fee for a bag. For this report, we explored six policy instruments to reduce single-use bags:

1. Plans or Commitments
2. Bans
3. Fees or Taxes
4. Retailer Take-Back Programs
5. Circular System for Reusable Bags
6. Combination of Policy Instruments

Don't Waste Durham, in conjunction with the Duke Environmental Law and Policy Clinic, concludes that imposing a bag ban or fee to reduce single-use bags at the point-of-sale would be the most appropriate strategy for Durham. Studies examining the effectiveness of bag bans and fees have shown measurable decreases in bag usage. Additionally, our legal analyses indicate that, while Durham has the authority to implement any of the discussed policy instruments, a ban or fee more closely aligns with the State's solid waste management goals. These goals are set forth in North Carolina's Solid Waste Management Act, which articulates the State's policy to reduce waste at the source above all other forms of solid waste management.

Specifically, we recommend that Durham take the following measures:

- **Adopt an ordinance that requires businesses to place a fee of at least $0.10 on all single-use bags, no matter their material, at the point of sale.**

- **The Solid Waste Management Departments should develop metrics and assign responsibility for evaluation of the effectiveness of the bag-fee ordinance.** Local organizations that conduct litter clean-ups could harmonize data collection tools so that measurements include single-use bags collected during litter clean-up events before and after the ordinance goes into effect. Expenditure on recycling machinery repairs and other measures could be included.

- **Establish reuse as a line item in the Solid Waste Management Departments' annual budgets to receive the collected $.10 fees.** This line item would support new positions within the Departments of Solid Waste Management to collect data, develop and circulate educational and outreach materials, and expand circular reuse systems like Bull City Boomerang Bags to additional locations across Durham and provide convenient drop-off receptacles for reusable bags. The fees could also support other interventions that offer practical and sustainable alternatives to single-use plastics.

It will be vitally important that a bag-fee policy is designed to mitigate the environmental injustices of plastic production and plastic pollution while minimizing disproportionate harms to disadvantaged community members. Evidence from the academic literature and examples of policies implemented in other municipalities demonstrate that there are solutions that can minimize potential inequities associated with bag fees. The following recommendations will ensure that Durham implements the proposed bag fee policy in the most fair and equitable manner possible:

1. Exempt customers using SNAP, WIC, Medicaid, and other assistance programs from paying the fee.

2. Support efforts to provide free reusable bags and recirculating bag programs to Durham residents.

3. Implement complementary waste reduction programs to maximize the environmental and social benefits of the policy.

4. Use culturally appropriate messaging and communication.

2. The Problems with Plastic and Plastic Bags

Despite their ubiquity, plastic bags are a relatively recent fad. In the U.S., a handful of grocery stores first provided customers with plastic bags – in place of paper – in 1979. The switch was met with significant public opposition. By 1984, plastic bags comprised only 20% of the bags provided by grocery stores in the U.S., as many customers still preferred the sturdier and roomier paper bags.[1] By the end of the decade, however, plastic bags dominated the market largely due to heavy lobbying and marketing by the industries that profit from them, especially Mobil Chemical Company (now ExxonMobil). Today, U.S. residents use an alarming 100 billion plastic bags every year.[2] At the same time, we now understand that the effects of this product will be with us for generations to come.

While consumers typically receive plastic bags for "free" at the checkout counter, plastics and plastic bags impose significant costs on communities, costs that begin during the manufacturing process and continue long after the end of a bag's short lifespan. When we consider those who shoulder the greatest environmental health and justice burdens from plastic production and disposal, it is increasingly clear that we cannot continue to justify reliance on plastic bags and single-use plastics merely because of their convenience.

2.1 Production

If you feel like there is more single-use plastic than ever before, you're on to something. The amount of single-use plastic in our daily lives has increased substantially in recent years. Carry-out lunch typically comes in a Styrofoam clamshell container, wrapped in a plastic bag, and accompanied by disposable plastic utensils. Even a coffee "for here" is often prepared in a paper cup with a plastic lid and sometimes a plastic straw or splash stick. Half of all plastic ever made was produced between 2003 and 2017,[3] and production is expected to continue to rise 3.5% to 3.8% every year until 2050 (from 311 million tons produced globally per year in 2014 to 1,124 million tons in 2050).[4]

Plastics are produced from non-renewable fossil hydrocarbons, oil and natural gas and their byproduct, ethylene. In the United States, the advent of hydraulic fracturing technology (or

[1] Belkin, L., Battle of the Grocery Bags: Plastic Versus Paper, published in *The New York Times* (November 17, 1984), *available at* https://www.nytimes.com/1984/11/17/style/battle-of-the-grocery-bags-plastic-versus-paper.html (accessed June 30, 2020); Altman, R., American Beauties, published in *Topic*, Issue No. 14 (August 2018), *available at* https://www.topic.com/american-beauties (accessed May 4, 2021).
[2] United States International Trade Commission, *Polyethylene retail carrier bags from China, Malaysia, and Thailand* (2016).
[3] Geyer, R., *et al*., Production, use, and fate of all plastics ever made, *Science Advances,* Vol. 3 (2017).
[4] The World Economic Forum and the Ellen Macarthur Foundation, *The New Plastics Economy: Rethinking the Future of Plastics* (2016).

"fracking") over the last decade has allowed fossil fuel companies to exploit previously untapped sources of oil and natural gas from reservoirs primarily in Texas, California, North Dakota, West Virginia, and Pennsylvania. This boom in fossil fuel production has provided the incentive for companies like Shell and ExxonMobil to invest hundreds of billions of dollars in their petrochemical infrastructure in a tail-wagging-the-dog scenario. That is, consumer demand for plastic has not spurred a rise in production of hydraulically fracked fossil fuels. Instead, the oil and gas industry is able to produce fossil fuels rapidly and cheaply and needs an outlet for their use. While hydraulic fracturing dramatically increased production of fossil fuels, demand for these fuels decreased substantially due to more fuel-efficient cars and transitions to cleaner and renewable energy sources.

Hydraulic fracturing has intensified oil and gas production and moved the infrastructure closer to people. Numerous studies have linked these activities to soil, water, and air contamination. For example, in North Dakota between 2007 and 2019, there were more than 14,000 oil and gas related spills – due to predictable failures like pipeline leaks, storage container leaks, and well pad explosions[5] – which contaminated the surface water and soil with heavy metals and radioactivity.[6] Researchers have also found that hydraulic fracturing can contribute to elevated levels of air pollutants in the vicinity of wells, including diesel emissions, silica, hydrogen sulfide, and toxic organic pollutants such as benzene and toluene.[7] The West Virginia Department of Environmental Protection measured benzene concentrations in air at levels that exceeded the Centers for Disease Control's threshold for "the minimum risk level for no health effects" even beyond the 625-foot setback distance for well pads.[8]

Communities of color and low-wealth communities bear the greatest burdens from the extraction of oil and natural gas through hydraulic fracturing. Several studies have shown that these communities are more likely to live in close vicinity to hydraulic fracturing infrastructure and to be exposed to hydraulic fracturing contamination, particularly air pollution.[9] Further, studies show that communities that live in close proximity to hydraulic fracturing infrastructure have relatively

[5] Data from the North Dakota Oil and Gas Division, *available at* https://www.dmr.nd.gov/oilgas/ (accessed October 7, 2020).
[6] Lauer *et al*., Brine spills associated with unconventional oil development in North Dakota, *Environmental Science and Technology*, Vol. 50 (p. 5389-5397); Cozzarelli *et al*., Environmental signatures and effects of an oil and gas wastewater spill in the Williston Basin, North Dakota, *Science of the Total Environment*, Vol. 579, p. 1781-1793 (2017).
[7] Natural Resource Defense Council*, Fracking Fumes: Air Pollution from Hydraulic Fracturing Threatens Public Health and Communities* (2014).
[8] West Virginia Department of Environmental Protection, Division of Air Quality, *Air, Noise and Light Monitoring Results for Assessing Environmental Impacts of Horizontal Gas Well Drilling Operation*s (2013).
[9] Ogneva-Himmelberger and Huang, Spatial distribution of unconventional gas wells and human populations in the Marcellus Shale in the United States: Vulnerability analysis, *Applied Geography*, Vol. 60, p. 165-174 (2015); Silva, *et al.*, Spatial modeling to identify sociodemographic predictors of hydraulic fracturing wastewater injection wells in Ohio census block groups, *Environmental Health Perspectives*, Vol. 126 (2018); Johnston *et al.*, Wastewater disposal wells, fracking, and environmental injustice in Southern Texas, American Journal of Public Health, Vol. 106, p. 550-556 (2016).

higher incidences of negative birth outcomes, including low-birth weight babies,[10] preterm birth,[11] and congenital heart defects.[12] In addition to negative health consequences, hydraulic fracturing also brings a number of other stressors to these communities, including increased truck traffic and noise, increased incidence of crime and substance abuse, and increased rental housing prices.[13]

The environmental injustices of plastics production do not end once the natural gas has been extracted. Following extraction, oil and gas are often transported long distances via pipelines to refineries, many of which are concentrated in the Gulf Coast region. An 85-mile stretch along the Mississippi River, between Baton Rouge and New Orleans, Louisiana, is frightfully known as "Cancer Alley." This area is home to a Black community living with some of the highest air pollution levels and cancer rates in the U.S. as a result of the nearly 150 oil and petrochemical refineries that have moved into this area since the 1980s. Despite significant opposition from local community members,[14] the number of petrochemical plants in "Cancer Alley" and the Gulf Coast region continues to grow as oil and gas companies invest billions of dollars into plastics manufacturing. For example, the state of Louisiana recently permitted Formosa Plastics to build a $9.4 billion facility that will be one of the largest plastics manufacturing facilities in the world, spanning 2,300 acres.

Plastics have become the oil and gas industry's lifeline in a world that is grappling with climate change and the detrimental effects of increasing greenhouse gas emissions. While climate change policies and advancing technologies aim to reduce human-caused greenhouse gas emissions, the emissions from plastics production are projected to rise. If current plastic production trends continue, plastics will be responsible for 15% of the global greenhouse gas budget by 2050 (this refers to the greenhouse gas emissions budget necessary to keep the planet below 2 degrees Celsius warming by 2100), up from only 1% in 2014.[15] It is increasingly clear that solving the global climate crisis cannot be done without reducing our reliance on plastic, starting with single-use plastics that require the continued extraction of fossil hydrocarbon resources.

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[10] Currie *et al.*, Hydraulic fracturing and infant health: New evidence from Pennsylvania, *Science Advances*, Vol. 3 (2017).
[11] Casey *et al*., Unconventional natural gas development and birth outcomes in Pennsylvania, USA, *Epidemiology*, Vol. 27, p. 163-172 (2016).
[12] McKenzie *et al*., Congenital heart defects and intensity of oil and gas well site activities in early pregnancy, Environment International, Vol. 132 (2019).
[13] Adgate *et al*., Potential public health hazards, exposures and health effects from unconventional natural gas development, *Environmental Science and Technology*, Vol. 48, p. 8307-8320 (2014).
[14] Laughland and Holden, In the most polluted part of America, residents now battle the US's biggest plastic plant, *The Guardian* (April 1, 2020), *available at* https://www.theguardian.com/us-news/2020/apr/01/cancer-town-chemical-plant-plastics-louisiana-toxic-pollution-greenhouse-gas (accessed May 4, 2021).
[15] The World Economic Forum and the Ellen Macarthur Foundation, *The New Plastics Economy: Rethinking the Future of Plastics* (2016); McKenzie, *et al*., Human health risk assessment of air emissions from development of unconventional natural gas resources, *Science of the Total Environment*, Vol. 424, p. 79-87 (2012).

2.2 Disposal

Recycling

Unlike rigid plastics that are widely accepted by city recycling programs, plastic bags and film have remarkably limited options for recycling. The U.S. Environmental Protection Agency estimates that only 10% of plastic bags, sacks, and wraps were recycled in 2018.[16] Most city recycling programs do not accept plastic film commingled with other materials because it is often too contaminated to turn into another product, and it causes clogs and jams when moving through the sorting machinery. Even clean, dry plastic bags have limited utility, as there are only a handful of companies that recycle them into a new product. When successfully recycled, plastic bags and film are primarily incorporated into composite decking/lumber, which accounted for 46% of recycled plastic film in 2018. Following composite decking/lumber, 34% of recycled plastic film is turned into other films, and 12% of recycled plastic film is turned into injection molding.[17] It is also important to note that the quality of all plastic degrades when it goes through the recycling process, and so recycled plastics – rigid and film – often can only be recycled once or twice.

For years, recycling programs in the U.S. and other high-income countries relied heavily on selling their recyclables, primarily plastics, to China. From 1988 to 2016, China imported an estimated 45% of global plastic waste.[18] This market crashed in 2018 when China enacted a new policy, known as the National Sword policy, banning imports of most plastic waste due to the high contamination rate from materials like plastic film. As a result, it is expected that an estimated 111 million metric tons of plastic waste will be displaced by 2030.[19]

China's ban on plastic waste imports has forced recycling programs across the U.S. and the globe to find new end-markets for plastic waste. Some recycling companies have terminated their contracts with municipalities altogether, while others have raised the price of service contracts.[20] Many municipalities in North Carolina are also facing these challenges since China's ban. For example:

[16] United States Environmental Protection Agency, *Advancing Sustainable Materials Management: 2018 Tables and Figures* (December 2020).
[17] More Recycling, *2018 National Post-Consumer Plastic Bag & Film Recycling Report* (August 2020).
[18] Brooks, *et al*., The Chinese import ban and its impact on plastic waste trade, *Science Advances*, Vol. 4 (2018).
[19] *Ibid.*
[20] Semuels, A., Is This the End of Recycling, published in *The Atlantic (*March 5, 2019), *available at* https://www.theatlantic.com/technology/archive/2019/03/china-has-stopped-accepting-our-trash/584131/ (accessed May 4, 2021).

- **Raleigh, North Carolina,** went from paying Sonoco Recycling $1 per ton to $105 per ton to take its recycling.[21] **Davidson County** went from paying Waste Management $29 per ton to $85 per ton.[22]

- **Greensboro, North Carolina,** stopped accepting glass in its residential recycling program in July 2019 to offset the rising costs of recycling.[23] The cities of **Clinton, Mooresville, and Statesville** have also recently stopped glass recycling.[24]

- **China Grove, North Carolina,** ended its curbside recycling program altogether in 2019, citing that it would be too costly to continue their services with GFL Environmental.[25] Since 2019, **Pinebluff, Gastonia, Kings Mountain, Leland, Nags Head, Shelby, and Trinity** have also ended their curbside recycling programs due to cost.[26]

Since China's ban on recycled plastic imports, there have been reports of the use of incineration as a short-term way to deal with plastic waste. For example, Philadelphia reportedly burned the recovered materials from half its residents in a waste-to-energy incinerator, located in the majority-Black city of Chester, Pennsylvania, following the ban.[27] The use of incinerators to dispose of plastic waste is concerning. Most of the U.S.'s incinerators are aging, leading to greater releases of air pollutants such as particulate matter, nitrous oxides, sulfur dioxides, and volatilized metals such as lead and mercury. Additionally, 79% of incinerators are located in low-income communities and communities of color.[28]

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[21] Brown, T., Why Raleigh is going to pay $1.5 million for recycling (And it's not all China's fault), published in *The News and Observer*, *available at* https://www.newsobserver.com/news/local/counties/wake-county/article236821623.html (accessed March 30, 2021).
[22] Coley, B., Davidson County facing higher recycling fees, published in *The Dispatch* (March 26, 2019), *available at* https://www.the-dispatch.com/news/20190326/davidson-county-facing-higher-recycling-fees (accessed March 30, 2021).
[23] Friend, E., *Greensboro Votes To Scrap Glass Recycling, Citing Rising Costs*, published online at *WUNC* (May 23, 2019), *available at* https://www.wunc.org/environment/2019-05-23/greensboro-votes-to-scrap-glass-recycling-citing-rising-costs (accessed March 30, 2021).
[24] Suggs, M., Glass no longer accepted in recycling, published in *Mooresville Tribune* (January 5, 2020), *available at* https://mooresvilletribune.com/news/local/glass-no-longer-accepted-in-recycling/article_df17f0bf-4271-5dfe-a2a6-cbe97c5fdbc3.html (accessed March 30, 2021); City's curbside recycling program makes changes, published in *The Sampson Independent* (June 7, 2019), *available at* https://www.clintonnc.com/news/40111/citys-curbside-recycle-program-makes-changes (accessed March 30, 2021).
[25] Jefferies, T., China Grove Town Council votes to discontinue recycling services, published in Salisbury Post (November 15, 2019), *available at* https://www.salisburypost.com/2019/11/05/china-grove-town-council-votes-to-discontinue-recycling-services/ (accessed March 30, 2021).
[26] Waste Dive, *Where curbside recycling programs have stopped in the US*, available at https://www.wastedive.com/news/curbside-recycling-cancellation-tracker/569250/ (accessed March 30, 2021).
[27] Corkery, M., As Costs Skyrocket, More U.S. Cities Stop Recycling, published in *The New York Times* (2018), *available at* https://www.nytimes.com/2019/03/16/business/local-recycling-costs.html.
[28] The New School: Tishman Environment and Design Center, *U.S. Municipal Solid Waste Incinerators: An Industry in Decline* (May 2019).

The U.S. also figured out another way to dispose of its difficult-to-recycle plastic waste following China's ban: diverting it to other countries in Southeast Asia, many of which lack adequate infrastructure to properly manage the waste. In 2018, the U.S. increased its plastic waste exports to Thailand, Malaysia, Vietnam, and other countries.[29] Due to a lack of infrastructure, these countries have historically mismanaged much of their waste, meaning it often ends up as litter or is disposed of in uncontrolled landfills or the ocean.[30] In 2010, Thailand mismanaged 75% of its waste, Malaysia mismanaged 57%, and Vietnam mismanaged 88%.[31] While these countries are often blamed for being the highest contributors of debris to the oceans,[32] we must not ignore the pivotal role the U.S. plays in inundating these countries with a waste stream they are not equipped to handle.

Landfilling

Ultimately, the commingling of recyclables and the lack of end markets makes recycling plastic quite difficult. As a result, many plastics and plastic bags are destined for landfills, where they degrade on incredibly slow time scales, up to thousands of years. It is estimated that 79% of all plastic waste ever generated has been discarded in a landfill or in the natural environment.[33] In 2018, the Environmental Protection Agency estimated that plastics accounted for over 18% of landfilled municipal solid waste by weight, which is the second largest waste category after food (24%).[34]

Waste trends over the last few decades are alarming. Solid waste generation has increased substantially, from 88.1 million tons in 1960 to 292.4 million tons in 2018. Per capita waste generation also increased, from 2.68 pounds per person per day in 1960 to 4.9 pounds in 2018.[35] Over the same time period that waste generation has been increasing, the number of solid waste landfills has decreased. Small landfills servicing individual cities have been replaced with fewer, larger landfills, often located in low income, rural communities. In North Carolina, there are currently 42 permitted and active municipal solid waste landfills.[36] Landfills in North Carolina are

[29] Clarke, J.S. and Howard, E., US plastic waste is causing environmental problems at home and abroad, published in *Unearthed* (May 10, 2019), *available at* https://unearthed.greenpeace.org/2018/10/05/plastic-waste-china-ban-united-states-america/ (accessed May 19, 2021).
[30] Jambeck *et al*., Plastic waste inputs from land into the ocean, *Science*, Vol.347, p. 768-771 (2015).
[31] *Ibid.*
[32] *Remarks by President Trump of America's Environmental Leadership* (July 8, 2019), *available at* https://trumpwhitehouse.archives.gov/briefings-statements/remarks-president-trump-americas-environmental-leadership/ (accessed May 19, 2020).
[33] Geyer, R., *et al*., Production, use, and fate of all plastics ever made, *Science Advances,* Vol. 3 (2017).
[34] The Environmental Protection Agency, *National Overview: Facts and Figures on Materials, Wastes and Recycling*, *available at* https://www.epa.gov/facts-and-figures-about-materials-waste-and-recycling/national-overview-facts-and-figures-materials (accessed May 19 2021).
[35] *Ibid*.
[36] North Carolina Department of Environmental Quality Online GIS, *Permitted Solid Waste Landfills (Open and Closed)*, *available at* https://data-ncdenr.opendata.arcgis.com/datasets/5a1df7c1c27246c9897901ca33285433_0 (accessed 4 November 2020).

disproportionately located in low wealth and minority communities. One study found that the probability of a landfill was 2.8 times greater in census block groups with more than 50% people of color compared to block groups with less than 10% people of color, and 1.5 times greater in block groups with median house values of less than $60,000 compared to block groups with median house values of more than $100,000.[37] New facilities were found to be 2.7 times more likely to be permitted in a block group with more than 50% people of color compared to block groups with less than 10% people of color.[38]

These communities are burdened with trash that they did not produce. They face groundwater contamination,[39] truck traffic, foul odors, and exposure to gases such as methane and volatile organic compounds which are hazardous to human health.[40] Durham's trash is taken to the Durham Waste Disposal and Recycling Center and then transferred to a 1,300-acre landfill in Sampson County, 96 miles from downtown Durham. Between July 2019 and June 2020, the Sampson County Landfill received 1.6 million tons of municipal solid waste, over double the amount received by any other landfill in the state,[41] 344,000 tons of which came from Durham County.[42]

The Sampson County Landfill is located in the town of Snow Hill, a historically Black community, many of whom oppose the landfill.[43] According the 2010 U.S. Census data, the landfill lies entirely in two census blocks that are 72% and 82% Black, compared to the City of Durham which is 39% Black[44] and the state of North Carolina which is 22% Black (**Figure 1**).[45] Snow Hill residents report that after the landfill's arrival in 1973, their community became plagued with foul odors, buzzards, pollution, and lowered property values.[46]

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[37] Norton, J.M., *et al.,* Race, Wealth, and Solid Waste Facilities in North Carolina, *Environmental Health Perspectives*, Vol. 115, p. 1344-1350 (2007).
[38] *Ibid.*
[39] Abiriga, D., *et al*., Groundwater contamination from a municipal landfill: Effect of age, landfill closure, and season on groundwater chemistry*, Science of the Total Environment*, Vol. 737 (2020).
[40] Vrijheid, M., Health effects of residence near hazardous waste landfill sites: a review of epidemiologic literature, *Environmental Health Perspectives*, Vol. 108, p. 101-112 (2000).
[41]North Carolina Department of Environmental Quality, Division of Waste Management, *Municipal Solid Waste and Construction and Demolition Disposal, FY 2019-2020*, *available at*https://deq.nc.gov/about/divisions/waste-management/solid-waste-section/solid-waste-facility-lists-presentations-and (accessed May 13, 2021).
[42]North Carolina Department of Environmental Quality, Division of Waste Management, *N.C. County Waste Disposal Report FY 2019-2020, available at* https://deq.nc.gov/about/divisions/waste-management/solid-waste-section/solid-waste-facility-lists-presentations-and (accessed May 13, 2021).
[43] Horan, J., 'We all feel targeted': Rural N.C. community pushes back against landfill, hog farms, Southerly Magazine (3 February 2021), *available at* https://southerlymag.org/2021/02/03/we-all-feel-targeted-rural-n-c-community-pushes-back-against-landfill-hog-farms/ (accessed 8 February 2021).
[44] United States Census Bureau, Profile for Durham city, North Carolina, *available at* https://data.census.gov/cedsci/profile?g=1600000US3719000 (accessed March 30, 2021).
[45] United States Census Bureau, Profile for North Carolina, *available at* https://data.census.gov/cedsci/profile?g=0400000US37 (accessed March 30, 2021).
[46] Horan, J., 'We all feel targeted': Rural N.C. community pushes back against landfill, hog farms, Southerly Magazine (3 February 2021), *available at* https://southerlymag.org/2021/02/03/we-all-feel-targeted-rural-n-c-community-pushes-back-against-landfill-hog-farms/ (accessed 8 February 2021); Personal correspondence with Danielle Koonce, Sampson County Resident (November 17, 2020).

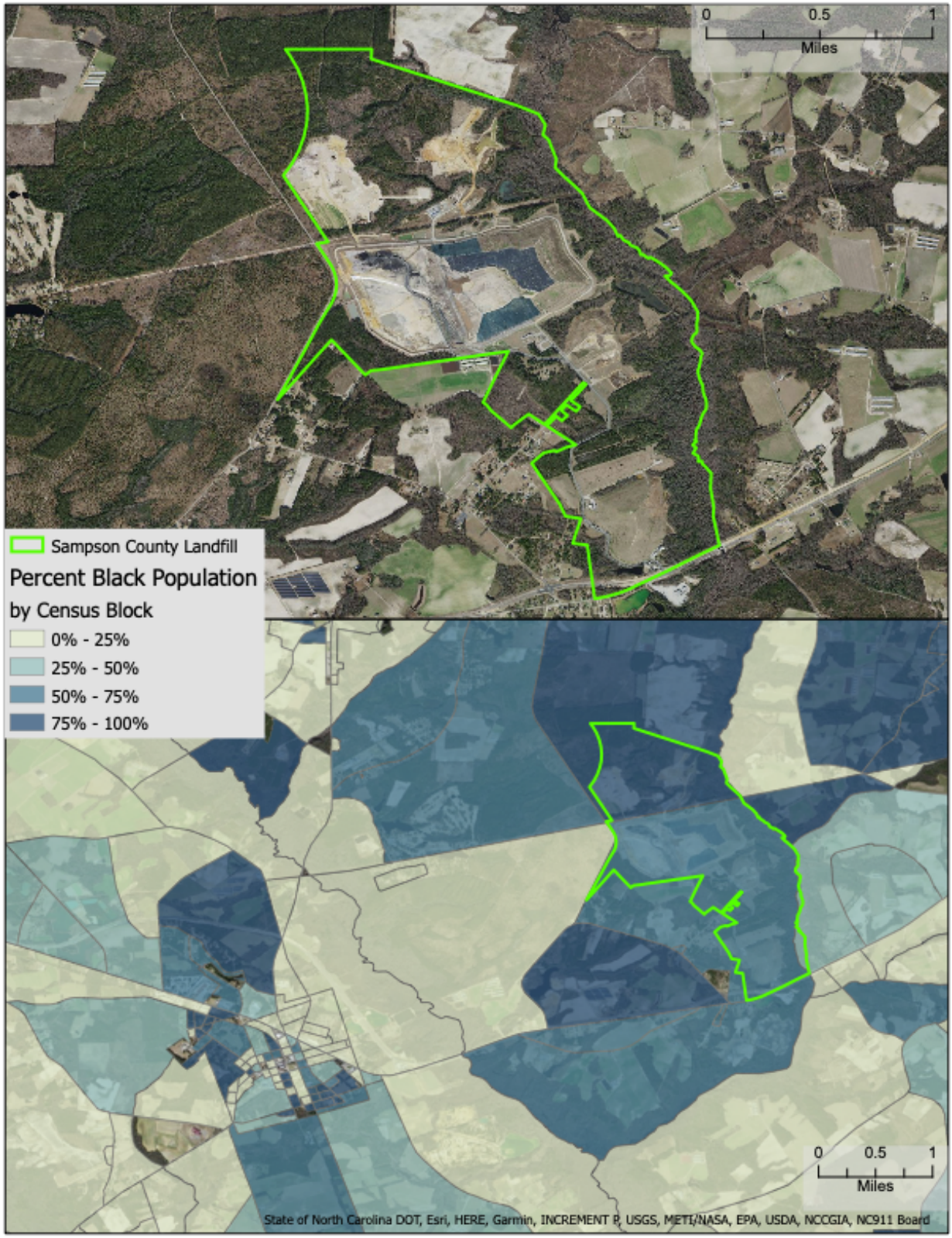

Figure 1. Aerial imagery of the Sampson County Landfill (*Top*). Census blocks shaded by percent Black population in the area of the Sampson County Landfill (*Bottom*).

2.3 Environmental Contamination

Plastic bags are a highly visible and problematic component of litter. Because of their aerodynamic shape and light weight, they are easily dispersed by wind and water and deposited across great distances. They can contribute to litter either through intentional discard or by escaping the waste collection process, such as by blowing off dumpsters, curbside bins, or the landfill itself (**Figure 2**). While most litter is produced on land, it ultimately makes its way downstream – often via stormwater discharge – and accumulates in the oceans. Coastal countries add an estimated 8 million tons of mismanaged plastic waste to the oceans every year,[47] and plastic grocery bags are consistently listed in the top-ten items found during beach clean-ups.[48]

Figure 2. A photograph of plastic bags at the South Wake Landfill in Apex, North Carolina.[49]

Plastic in the environment is worrisome because it can persist for hundreds to thousands of years before it biodegrades. In the meantime, it poses choking and entanglement hazards to wildlife, especially marine animals. Studies have found that at least 690 unique species have encountered

[47] Jambeck, J.R., *et al*., Plastic waste inputs from land into the ocean, *Science*, Vol. 347, p. 768-771 (2015).
[48] Ocean Conservancy International Coastal Cleanup, *Together for Our Ocean: International Coastal Cleanup Report* (2017); Surfrider, Beach Cleanups Data Tool: Results, *available at* https://cleanups.surfrider.org/results/ (accessed October 8, 2020).
[49] Photograph provided by Sara Davarbakhsh, Environmental Education Program Coordinator with Wake County Solid Waste Management Services.

marine debris (i.e., ingested, became entangled in, etc.) and that 92% of encounters involve plastic.[50] Plastic bags, in particular, resemble jellyfish when submerged in water, and sea turtles have trouble distinguishing the two when in search of food.[51] Since the 1980s, the ingestion of plastic has been documented in six out of the seven species of sea turtles, all of which are listed by the International Union for Conservation of Nature (IUCN) as globally "vulnerable," "endangered," or "critically endangered."[52] Recent research finds that sea turtles face a 50% chance of dying after ingesting just 14 pieces of plastic.[53]

The North Carolina coast is a particularly important habitat for sea turtles and other coastal and marine species due to its location. The Gulf Stream and the Labrador currents meet off the shores of Cape Hatteras, which is home to a particularly rich, productive, and biodiverse ecosystem. Littered plastics threaten many of these species, including sea turtles and seabirds. One study conducted over the course of 14 years (1975-1989) found plastic in the guts of 21 out of 38 seabird species on the North Carolina coast.[54] The North Carolina Wildlife Resources Commission has also observed birds entangled in plastic and nests contaminated with plastic bags on the North Carolina coast (**Figure 3**).[55]

Figure 3. Photos of birds' nests contaminated with plastic bags on a North Carolina beach.

[50] Gall and Thompson, The impact of debris on marine life, *Marine Pollution Bulletin*, Vol. 92, p. 170-179 (2015).
[51] Schuyler *et al*., Mistaken identity? Visual similarities of marine debris to natural prey items of sea turtles, *BMC Ecology*, Vol. 14 (2014).
[52] International Union for Conservation of Nature, The IUCN Redlist of Threatened Species, *available at* https://www.iucnredlist.org/ (accessed October 8, 2020).
[53] Wilcox, *et al.,* A quantitative analysis linking sea turtle mortality and plastic debris ingestion, *Scientific Reports*, Vol. 8 (2018).
[54] Moser, M.L. and Lee, D.S., A fourteen-year survey of plastic ingestion by western North Atlantic seabirds, *Colonial Waterbirds*, Vol. 15, p. 83-94 (1992).
[55] Personal communication with Carmen Johnson, North Carolina Wildlife Resources Commission Wildlife Diversity Biologist (October 16, 2020).

Well before plastics biodegrade in the environment, they fragment into exponentially smaller pieces known as "microplastics," which measure between one micrometer and five millimeters in diameter. Microplastics have become ubiquitous in our bodies and our environment. One study estimates that, through consumption and inhalation, U.S. residents take in 74,000-113,000 microplastic particles every year.[56] To date, microplastics have been found almost everywhere that researchers have looked for them, including in the air,[57] tap water,[58] remote water bodies,[59] the guts and tissues of commercial fish,[60] and the guts of sea turtles.[61] The Engineering Department at Duke University has identified microplastics in the sediments of Ellerbe Creek in Durham[62] and the Haw Riverkeeper has identified them in the surface waters of Haw River Watershed, including Jordan Lake, a drinking water source for the City of Raleigh (**Figure 4**). Despite the ubiquity of microplastics in surface waters and drinking water sources, municipal drinking water plants do not monitor or test for them because it is not mandated by the U.S. Environmental Protection Agency.

Both macro- and microplastics in the environment have elicited concerns over toxic leaching of the chemical additives. As discussed in Section 2.1, plastics are produced from a hydrocarbon byproduct known as polyethylene. To improve the durability and flexibility of plastics, several chemicals are added to the polyethylene, including plasticizers, flame retardants, antioxidants, acid scavengers, light/heat stabilizers, lubricants, dyes, and antistatic agents.[63] Most of these additives are not chemically bound to the plastic but are applied to the surface, which allows them to easily migrate into food and into the environment. The leaching of these chemicals into food depends on the amount of the chemical in the plastic to begin with, as well as the length of interaction, storage conditions (e.g., temperature), and the nature of the food it is interacting with (e.g., fat content).[64] The leaching of these chemicals into the environment is more difficult to assess but is recognized as a global problem that is quickly gaining attention. Plastic additives have been detected across

[56] Cox, *et al*., Human consumption of microplastics, *Environmental Science and Technology*, Vol. 53, p. 7068-7074 (2019).
[57] Dris, *et al.,* Microplastic contamination in an urban area: a case study in Greater Paris, *Environmental Chemistry*, Vol. 12, p. 591-599 (2015).
[58] Kosuth *et al.,* Anthropogenic contamination of tap water, beer, and sea salt, *PLoS One* (2018).
[59] Free *et al*., High-levels of microplastic pollution in a large, remote, mountain lake, *Marine Pollution Bulliten*, Vol. 85, p. 156-163 (2014).
[60] Bachler *et al*., Microplastic occurrence and effects in commercially harvested North American finfish and shellfish: Current knowledge and future directions, *Limnology and Oceanography Letters*, Vol. 5, p. 113-136 (2020); Zitouni *et al*., First report on the presence of small microplastics (<3 μm) in tissue of the commercial fish Seannus Scriba from Tunisian coasts and associated cellular alternations, *Environmental Pollution,* Vol. 263 (2020).
[61] Duncan *et al*., Microplastic Ingestion Ubiquitous in Marine Turtles, *Global Change Biology,* Vol. 25, p. 744-752 (2018).
[62] Personal communication with Anna Lewis, PhD Candidate in Environmental Engineering at Duke University.
[63] Hahladakis *et al*., An overview of chemical additives present in plastics: Migration, release, fate and environmental impact during their use, disposal and recycling, *Journal of Hazardous Materials*, Vol. 344, p. 179-1999 (2018).
[64] *Ibid.*

the globe in estuarine and marine waters and sediments,[65] with increasing evidence that plastic litter and microplastics are a source of the chemicals.[66]

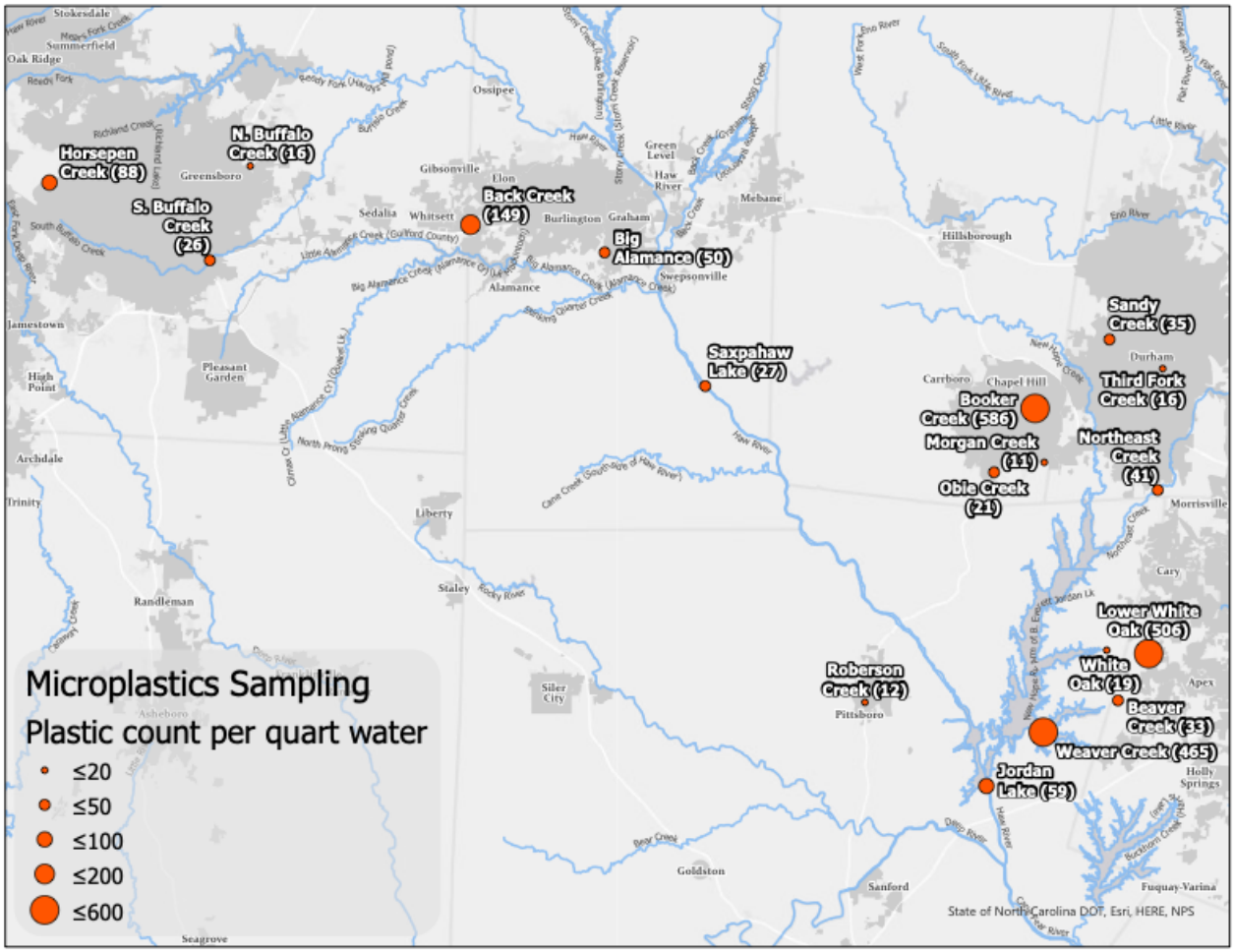

Figure 4. Map of Haw River Assembly microplastic sampling locations and results. The number in parentheses following the stream name is the microplastic count per quart of surface water.

[65] Hermabessiere, *et al*., Occurrence and effects of plastic additives on marine environments and organisms: A review, *Chemosphere*, Vol. 182, p. 781-793 (2017).
[66] Al-Odaini, *et al*., Enrichment of hexabromocyclododecanes in coastal sediments near aquaculture areas and a wastewater treatment plant in a semi-enclosed bay in South Korea, *Science of the Total Environment*, Vol. 505, p. 290-298 (2015).

3. The Costs of Single-Use Bags

3.1 Overview of the Costs of Single-use Bags

The problems with plastic bags translate into significant tangible costs for Durham government, businesses, and the public. Businesses pay an initial cost to purchase plastic bags to provide to customers, but many of the costs of single-use bags in Durham are from managing the bags once they leave the store. These include, among others, the costs to remove litter, untangle the bags from recycling equipment, and transport and dispose of the bags at the Sampson County landfill.

Table 1 presents an overview of the costs associated directly with single-use plastic bags to government, businesses, and nonprofits in Durham. These costs were derived from City and nonprofit budgets, where available, for the calendar year 2019 (January 1-December 31). Where appropriate, we calculated the portion of the budget that can be attributed directly to plastic bags. When budget information could not be provided, such as for private retail businesses, we estimated the costs using information from peer-reviewed literature and government reports. Detailed information on how these costs were calculated is provided in Sections 3.1-3.4. The estimated annual costs associated with single-use plastic bags to the City of Durham is $86,538, while businesses pay a price of $2,595,904 and nonprofit organizations pay $4,501.

It is important to note that the cost of plastic bags provided in this section is a conservative estimate, as there are additional costs that are not accounted for or can only be described qualitatively. The limitations of this analysis are also described in Sections 3.1-3.4.

Table 1. Summary of costs of single-use, plastic bags to government, business, and the public.

Entity	Division/Activity	Cost ($/year) from Plastic Bags	Notes
City Government			
Public Works	Street Sweeping & Litter/Bus Routes Clean-up	$52,773	Includes personnel and operating expenses
General Services	Litter Removal from Roadsides	$5,078	Does not include unclogging of stormwater drains
General Services	Keep Durham Beautiful	$387	Includes supplies and 50% AmeriCorps staff
Solid Waste Management	Tipping Fees	$28,300	
Businesses			
Sonoco Material Recovery Facility	Removing Bags from Sorting Equipment	$24,000	Includes employee time only and does not include wear on machinery parts, loss of productivity, or transportation of waste to landfill
Grocery, Convenience, and Retail Stores	Purchasing Bags	$2,571,904	Cost to purchase plastic bags to meet demand of City residents
Nonprofits			
Ellerbe Creek Watershed Association	Volunteer Litter Clean-ups	$260	Includes staff and volunteer time, and supplies
Haw River Assembly	Volunteer Litter Clean-ups	$991	Includes staff and volunteer time, and supplies
Keep Durham Beautiful	Volunteer Litter Clean-ups	$3,250	Includes volunteer time
Total		**$2,686,943**	

3.2 Purchasing Plastic Bags

Grocery, convenience, and other retail stores in Durham typically provide plastic and paper bags free of charge to customers at the point of sale. However, these businesses incur costs to purchase the bags from the manufacturers. Plastic bags cost a retailer approximately $0.02 to $0.03 each, while paper bags are more expensive, ranging in price from $0.10 to $0.20 each.[67]

We calculated the cost of plastic bags to all businesses in Durham by estimating the number of bags that Durham residents consume annually. Obtaining data on per capita bag use is difficult because many businesses do not track this information or treat it as proprietary information. However, The United States International Trade Commission estimated that the average American uses 320 plastic bags per year, which are provided by grocery, drug, convenience, department, specialty retail, and discount stores, as well as restaurants.[68] Studies that measured bag-use in individual cities, prior to any single-use bag restrictions, had similar, although slightly higher, estimates ranging from 335 to 600 plastic bags per person per year.[69]

As of 2019, 321,488 people live in Durham County, which includes the City population.[70] Assuming the average Durham resident uses 320 plastic bags per year, we estimate that Durham businesses must provide at least 103 million plastic bags each year to meet customer demand. If each plastic bag costs, on average, $0.025, then all the businesses in Durham combined spend $2.6 million on plastic bags each year. To put these costs into perspective, one study's survey of businesses found that store owners listed disposable bags as their fourth highest operating cost, after electricity, payroll, and credit card fees.[71]

Given these costs, it is not surprising that many Durham businesses are supportive of charging customers a fee for the plastic and paper bags that they provide. Between June and December of 2019, the Duke Environmental Law and Policy Clinic surveyed 60 businesses in Durham in zip codes 27701, 27703, 27704, 27705, and 27707 (**Appendix A**). When asked whether they would support a fee on single-use plastic bags, 80% of businesses indicated that they were either in favor of or neutral to the fee. When a subset of these businesses (21) was asked whether they would

[67] Bag cost estimates come from interviews with local Durham businesses as well as from: Taylor and Villas-Boas, Bans vs. Fees: Disposable Carryout Bag Policies and Bag Usage, *Applied Economic Perspectives and Policy,* Vol. 38, p. 351–372 (2016).
[68] US International Trade Commission, *Polyethylene retail carrier bags from China, Malaysia, and Thailand* (2016).
[69] Wagner, T. P., Reducing single-use plastic shopping bags in the USA, *Waste Management*, Vol. 70, p. 3-12 (2017).
[70] U.S. Census Bureau, *Population and Housing Unit Estimate Tables*, *available at* https://www.census.gov/programs-surveys/popest/data/tables.2019.html (accessed September 20, 2021).
[71] Taylor and Villas-Boas, Bans vs. Fees: Disposable Carryout Bag Policies and Bag Usage, *Applied Economic Perspectives and Policy,* Vol. 38, p. 351–372 (2016).

support a fee on *all* single-use bags, 76% of businesses indicated that they were either in favor of or neutral to the fee. Offsetting the costs of plastic and paper bags by charging a small fee is advantageous from a business perspective, as it allows businesses to either increase their revenue or lower the costs of food or merchandise for shoppers.

3.3 Managing Plastic-Bag Waste

Improper Recycling

Once a plastic bag fulfills its purpose of carrying items from a store to one's home, there are two proper ways to dispose of it. Currently, the best option is to return the clean, dry bag to a plastic film take-back receptacle, which some retail stores provide (although, as discussed below, it is unclear whether those bags actually are recycled). The second option is to place it in a garbage bin for landfill disposal. Sonoco Recycling in Raleigh, North Carolina, the company contracted to accept Durham's mixed residential recyclable materials, does not accept plastic bags due to their tendency to jam the sorting machinery and the lack of a recycling market for recycled plastic film. In Sonoco's past efforts to recycle plastic bags, it found that guaranteeing the film's quality and cleanliness was difficult when commingled with other materials. Also, accumulating enough film for processing took a long time.

However, a significant number of plastic bags and film are still placed in curbside recycling bins and taken to Sonoco's Materials Recovery Facility. An estimated 2.1% of recycled materials (by weight) in Durham is composed of plastic film that should not be there.[72] This improperly recycled film results in significant costs and manual labor for Sonoco. At the Raleigh facility, two to six employees continuously work to remove plastic film materials from conveyor belts in the sorting process (**Figure 5**). They are not, however, able to remove all of them. Plastic bags and film that do not get cleared clog the machinery, requiring employees to shut down the machinery and remove tangled material multiple times per day. The clearing of plastic bags and film from the machinery is physically demanding and dangerous, as it requires workers to be harnessed and crawl through the sorters to manually cut the tangled plastic film from the machinery.

Employees shut down the machines and clear trapped plastic film from the screens three or four times a day. These breaks can take 10 to 15 minutes for a quick cleaning during the middle of a shift or up to 30 minutes at the end of a shift for a more thorough cleaning.[73] The Sonoco Recycling facility in Raleigh estimates that lost employee time associated with machinery downtime due to "tanglers," such as plastic bags, costs $24,000 annually.[74]

[72] City of Durham Solid Waste Management, *Waste Characterization Study* (2016), Prepared by Kessler Consulting, Inc.; "Plastic film" includes loose and bagged plastic bags, garbage bags, shrink wrap, resealable bags, and other films.
[73] Personal correspondence with Patrick MacDonald, Sonoco Plant Manager (November 20, 2019).
[74] Personal correspondence with Patrick MacDonald, Sonoco Plant Manager (August 19, 2019).

Figure 5. Plastic bag contamination on a conveyor belt at the Sonoco Materials Recovery Facility in Raleigh, North Carolina (*Left*). Plastic bags, film, and other contaminants that have been removed from the conveyor belts to be landfilled (*Right*).

The Sonoco Recycling facility in Raleigh is by no means the only recycling facility to report costs associated specifically with plastic bags and film. The Recycling Director at Waste Management Recycling Center in Chicago, Illinois, estimated that machinery downtime due to plastic bags costs them $9,500 per month, or $114,000 annually, in labor.[75] Interestingly, Materials Recycling Facilities in San Jose, California, and New York State reported much higher annual costs from plastic bags, ranging from $300,000 to $1.0 million dollars.[76] These estimates included costs associated with screen cleaning, employee time spent fixing jams, and wear on machinery parts.

The annual $24,000 cost to Sonoco Raleigh is for labor alone and does not include the losses to production associated with machinery downtime, wear on parts, or the landfilling of plastic bags and film material. All these pose additional costs. For example, Sonoco is responsible for all trucking costs and tipping fees associated with sending contaminants to the landfill. Sonoco estimates that in a typical month, it will spend roughly $90,000 on transportation and tipping fees for all the waste materials it receives that are not recyclable. Sonoco does not keep track of the portion of this cost that can be attributed to plastic bags.

[75] Elejalde-Ruiz, A., Plastic bags a headache for recyclers, published in *Chicago Tribune* (July 30, 2015).
[76] New York State Department of Environmental Conservation, *New York State Plastic Bag Task Force Report: An Analysis of the Impact of Single-Use Plastic Bags, Options for New York State Plastic Bag Legislation* (2018).

Landfilling

The City of Durham advises that if residents are not going to take their plastic bags to a proper recycling receptacle, they should simply discard the plastic bags in their curbside garbage bins.[77] City sanitation crews collect residential waste and bring it to the transfer station located at the Waste Disposal and Recycling Center at 2115 East Club Boulevard prior to being taken to the Sampson County Landfill, which is located approximately 96 miles from downtown Durham. Durham County sent 344,000 tons of waste to the Sampson County Landfill in fiscal year 2019-2020.[78]

We can estimate the portion of waste comprised of plastic film using data from waste characterization studies. In 2015, the City of Durham's Solid Waste Department commissioned a waste and recyclables characterization study of the Durham transfer station. The ultimate goal of the characterization study was to identify opportunities for Durham to divert at least 65% of the waste material delivered to the Waste Disposal and Recycling Center by 2025. The study found that, depending on the category (e.g., single-family residential waste, multi-family residential waste, or commercial waste), 6.2% to 7.6% of landfill waste by weight was non-rigid plastic film, a category that includes grocery bags, garbage bags, plastic sheeting, plastic wrap, and other films.[79]

Unfortunately, Durham's waste characterization study does not specify the percent of waste that is composed of plastic grocery and retail bags in the broader category of plastic film. Waste characterization studies from other cities provide more granular categories that can inform our estimate for Durham. For instance, Orange County, North Carolina, also conducted a waste composition study in 2017, finding that "Retail Bags & Stretch Film" comprised 1.5% of their municipal solid waste by weight (still likely an overestimate due to the inclusion of stretch film).[80] Fortunately, some waste characterization studies have specifically categorized "Plastic Grocery and Merchandise Bags." These studies found that plastic bags tend to make up 0.3% to 0.9% by weight of a city's or state's solid waste profile (**Table 2**). 0.3% to 0.9% is quite substantial for such a low-density material to make up a measurable portion of the waste stream by weight. This equates to 500 to 1,500 plastic grocery and merchandise bags per ton of trash, or 10,000 to 30,000 bags in each 20-ton garbage truck load.

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[77] City of Durham, *Recycling*, *available at* https://durhamnc.gov/862/Recycling (accessed March 9, 2020).
[78] North Carolina Department of Environmental Quality, Division of Waste Management, *N.C. County Waste Disposal Report FY 2019-2020, available at* https://deq.nc.gov/about/divisions/waste-management/solid-waste-section/solid-waste-facility-lists-presentations-and (accessed May 13, 2021).
[79] City of Durham Solid Waste Management, *Waste Characterization Study* (2016), Prepared by Kessler Consulting, Inc.
[80] Orange County Solid Waste Management, *Waste Composition Study* (2017), Prepared by Kessler Consulting, Inc.

Table 2. Plastic bag component of municipal solid waste compiled from waste characterization studies.

State or Municipality	Category Definition	% of MSW (By Weight)	Year
Chicago, IL[81]	Grocery and Merchandise Bags	0.8%	2007-2009
Iowa[82]	Retail Shopping Bags	0.9%	2017
California[83]	Plastic Grocery and Other Merchandise Bags	0.3%	2008
Wisconsin[84]	Plastic Shopping Bags	0.3%	2009
Vermont[85]	Retail Bags	0.57%	2013
Oregon[86]	Plastic Grocery/Merchandise Bags	0.35%	2016-2017
Orange County, NC	Retail Bags and Stretch Film	1.5%	2017

Although Durham's Waste Characterization Study does not specifically measure the plastic bag component of its municipal solid waste stream, we can estimate it. In Section 3.2, we estimated that Durham uses 103 million single-use plastic bags each year. With each bag weighing an average of 5.5 grams, Durham needs to dispose of an estimated 620 tons of plastic bags each year. This comprises approximately 0.2% of its landfilled waste by weight (620 tons out of 344,000 total tons), which is similar to, although slightly lower than, the results of the waste characterization studies discussed above. This slightly lower estimate is not surprising. We may be underestimating the weight of Durham's landfilled plastic bag waste because our calculation does not account for the extra weight that plastic bags take on due to moisture and contamination once thrown away.

Durham incurs a cost known as a "tipping fee" for disposing trash at the Sampson County Landfill. A tipping fee is the cost per ton for a truck to tip its bed and unload municipal solid waste. Once

[81] Chicago Department of Environment, *Waste Characterization Study* (2010), Prepared by CDM.
[82] Iowa Department of Natural Resources, *Iowa Statewide Waste Characterization Study* (2017), prepared by SCS Engineers.
[83] California Integrated Waste Management Board, *Contractor's Report to the Board: California 2008 Statewide Waste Characterization Study*, prepared by Cascadia Consulting Group (2008).
[84] Wisconsin Department of Natural Resources, *2009 State-Wide Waste Characterization Study* (2010), prepared by MSW Consultants.
[85] Vermont Department of Environmental Conservation, Solid Waste Program, *2018 Vermont Waste Characterization* (2018), prepared by DSM Environmental Service, Inc.
[86] Oregon Solid Waste*, Characterization and Composition Study,* (2016/2017), *available at* https://www.oregon.gov/deq/mm/Pages/Waste-Composition-Study.aspx (accessed October 14, 2020).

the municipal solid waste has been unloaded at the Durham transfer station, Waste Industries, the contractor that manages the transfer station, charges Durham the tipping fee of $45.69 per ton to transport municipal solid waste to the Sampson County Landfill.[87] Ultimately, tipping fees associated with disposing of an estimated 620 tons of plastic bags each year at the Sampson County Landfill costs Durham an estimated $28,300.

3.4 Removing Plastic-Bag Litter

Plastic bags that are not recycled or disposed of in a landfill end up as litter. Litter not only degrades the aesthetic value of a landscape, but it is also costly to clean up. For example, a 2012 study by the Natural Resources Defense Council concluded that litter cost the state of California $428 million each year, mostly attributed to street sweeping and storm drain management.[88] In 2018, the North Carolina Department of Transportation reportedly spent $18 million to remove litter from roadsides,[89] $1.4 million of which was spent on trash pickup in the Triangle area alone.[90] In addition to the direct costs associated with removing litter, there are additional costs such as loss of property value and reduction in tourism, as the public prefers for the environment to be clean.[91] Although these costs are difficult to quantify, estimates suggest that they can be significant.[92]

Litter is also costly for the City of Durham. In 2019, Durham City Public Works spent $1,759,130 on street sweeping and bus route cleaning, and the General Services department spent $169,275 for contractors to remove litter while mowing along roadsides. The General Services department also partially funds Keep Durham Beautiful, a cost of $12,911 in 2019. There are also several other City services focused on litter clean-up, but the costs are not itemized in the City budget. For instance, the Landscape Services Division collects litter along City streets, but those costs are not

[87] North Carolina Department of Environmental Quality, Division of Waste Management, *Public and Private Tipping Fees FY 2019-2020* (February 4, 2021), *available at* https://files.nc.gov/ncdeq/Waste%20Management/DWM/SW/Annual%20Reports/FY-19-20-Tipping-Fees.pdf (accessed September 20, 2021).
[88] National Resource Defense Council, *Waste In our Water: The Annual Cost to California Communities of Reducing Litter that Pollutes Our Waterways* (August 2013).
[89] North Carolina Department of Transportation, *2018 North Carolina Interagency Report: Litter Cleanup, Education/Prevention and Enforcement* (2019), *available at* https://www.ncdot.gov/initiatives-policies/environmental/litter-management/Documents/2018-year-end-litter-report.pdf (accessed May 18, 2021).
[90] Julia Wilson, *NCDOT Spent More Than $1M on Triangle Trash Pickup in 2018, Officials Say,* published online at ABC 11 News (April 8, 2019), *available at* https://abc11.com/community-events/ncdot-spent-more-than-$1m-on-trash-pickup-in-2018-officials-say-/5237350/ (accessed May 18, 2021).
[91] Eunomia, *Exploring the Indirect Costs of Litter in Scotland* (2013), *available at* https://www.eunomia.co.uk/reports-tools/exploring-indirect-costs-litter/ (accessed March 10, 2020).
[92] Beach closures, decreases in beach use, and decreased sportfishing due to marine pollution and debris wash up in New Jersey resulted in an economic loss of $867 million (in 2020 USD). *See* Ofiara, D.D. and Brown, B., Assessment of Economic Losses to Recreational Activities from 1988 Marine Pollution Events and Assessment of Economic Losses from Long-Term Contamination of Fish within the New York Bight to New Jersey, *Marine Pollution Bulletin* Vol. 38, p. 990-1004 (1999).

reported. In 2019, the City also spent $173,768 to flush clogged stormwater pipes. Litter certainly contributes to this cost, but it is impossible to know how much.

In addition to costs borne by the City of Durham for litter removal, many local nonprofit organizations conduct litter clean-ups. Nonprofit organizations and the volunteers they rely on dedicate time and resources each year to litter. For example, in 2019, Keep Durham Beautiful deployed 3,515 volunteers to collect 1,143 bags of garbage and 367 bags of recyclable material littered in Durham's parks, neighborhoods, and streams.[93] In total in 2019, Keep Durham Beautiful, the Ellerbe Creek Watershed Association, and the Haw River Assembly organized litter clean-ups that utilized 11,098 volunteer hours. The opportunity cost of the volunteer time from these three organizations alone amounts to $144,274 per year, assuming an hourly wage for unskilled workers of $13/hour.[94] In addition to this opportunity cost, these organizations also incur costs associated with staff time and supplies.

Table 3 presents the total costs of litter in Durham, which we calculated from the opportunity cost of volunteers as well as the direct expenses (staff time, supplies, equipment etc.) reported by the nonprofit organization or City department. This is a conservative estimate, as several other government divisions, nonprofit organizations, and individuals participate in litter clean-ups around the community that are not accounted for in this calculation.

We cannot attribute all litter costs in **Table 3** to plastic bags. Various other items – many of which are also single-use plastics (e.g., straws, food wrappers) – comprise the litter profile in Durham. However, litter survey data demonstrate that plastic bags make up a significant portion – between 3% and 8% – of the litter in Durham and in North Carolina. The Ocean Conservancy compiles citizen science litter survey data in its Trash Information and Data for Education and Solution (TIDES) database.[95] In the last five years (2016-2020) citizen scientists in North Carolina logged 530,845 pieces of litter in the database. These data indicate that plastic grocery bags were the 7th most found litter item and made up 2.88% of litter by number **(Table 4).** The Duke Environmental Law and Policy Clinic also conducted litter surveys from 2016-2019 and documented that plastic bags comprised 8.4% of litter by number in streams in Durham.[96] Other data sets show similar results. For example, 29 years of data collected on California Coastal Cleanup Day show that plastic and paper bags made up 7.7% of litter.[97]

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[93] Personal correspondence with Emma Jablonski, AmeriCorps Environmental Outreach & Volunteer Coordinator with Keep Durham Beautiful (March 2, 2020).
[94] Bureau of Labor Statistics, *Occupational Employment and Wages in Durham-Chapel Hill* (May 2018), *available at* https://www.bls.gov/regions/southeast/news-release/occupationalemploymentandwages_durham.htm (accessed March 10, 2020).
[95] Ocean Conservancy, *TIDES*, available at https://www.coastalcleanupdata.org/reports (accessed May 17, 2021).
[96] For a more detailed description of the Duke Environmental Law and Policy Clinic's litter survey methods and results see **Appendix B.**
[97] California Coastal Commission, *California Coastal Cleanup Day History*, *available at* https://www.coastal.ca.gov/publiced/ccd/history.html#top10 (accessed March 10, 2020).

Table 3. Summary of total costs of cleaning up litter in Durham.

Entity	Activity	Cost ($/year) from Litter	Cost ($/year) from Plastic Bag Litter	Notes
Government				
Public Works	Street Sweeping & Litter/Bus Routes Clean-up	$1,759,130	$52,773	Includes personnel and operating expenses
General Services	Litter Removal from Roadsides	$169,275	$5078	
General Services	Keep Durham Beautiful	$12,911	$387	Includes supplies and 50% AmeriCorps staff
Public/Nonprofit				
Ellerbe Creek Watershed Association	Volunteer Litter Clean-ups	$8,650	$260	Includes staff time, supplies, and volunteer time
Haw River Assembly	Volunteer Litter Clean-ups	$33,038	$991	Includes staff time, supplies, and volunteer time
Keep Durham Beautiful	Volunteer Litter Clean-ups	$108,355	$3,250	Includes volunteer time
Total		**$2,091,359**	**$62,740**	

Table 4. Top 10 litter items in North Carolina (2016-2020).

Rank	Item	Total (#)	Percent
1	Cigarette Butts	168,722	38.41%
2	Food Wrappers (candy, chips, etc.)	39,099	8.90%
3	Beverage Bottles (Plastic)	30,344	6.91%
4	Bottle Caps (Plastic)	22,574	5.14%
5	Beverage Cans	21,168	4.82%
6	Other Trash (Clean Swell)	17,560	4.00%
7	**Grocery Bags (Plastic)**	**12,636**	**2.88%**
8	Straws, Stirrers	12,052	2.74%
9	Beverage Bottles (Glass)	9,744	2.22%
10	Lids (Plastic)	8,783	2.00%

If we conservatively assume that 3% of litter by number in Durham is composed of plastic bags, then we can estimate that litter costs attributed directly to plastic bag litter amount to $62,740 dollars each year. Despite this hefty investment, litter clean-ups unfortunately address only a

fraction of the problem with single-use plastic pollution. It is impossible for clean-ups to remove all of the litter, especially if the source of the pollution remains.

4. Plastic Bag Alternatives

There are several alternatives to single-use plastic bags, including paper bags, biodegradable plastic bags, compostable plastic bags, and reusable bags made from cotton, woven polypropylene, and other materials – as well as using no bag at all. It is important to explore the environmental implications of these plastic bag replacements to ensure that plastic bags are not simply replaced with a regrettable alternative that has an equal or even greater footprint. In this case, limiting the footprint of plastic bag alternatives falls in line with the "reduce, reuse, recycle" hierarchy. The best "replacement" for plastic bags is to simply use no bag at all as often as one can. However, in some instances, it is inconvenient or impossible to go without a bag. When considering the economic, environmental, and societal costs of alternative bags, we find that reusable bags, especially those made of reused or recycled materials, are a considerably better alternative to plastic bags than single-use paper or compostable bags.

4.1 Paper Bags

Paper bags are often regarded as a more sustainable alternative to single-use plastic bags because they can decompose in a landfill or the natural environment and are more widely recyclable. However, for several reasons, we do not recommend paper bags as an alternative to plastic bags. Although paper bags are made from trees, a renewable resource, they require significantly more energy to manufacture compared to plastic bags, and high carbon emissions are associated with their production and distribution.[98] In fact, studies suggest a paper bag would have to be reused three times for its impact on global warming to equal that of a plastic bag used only once.[99]

4.2 Compostable and Biodegradable Bags

"Compostable" and "biodegradable" plastic bags are also often marketed as an environmentally friendly alternative to typical plastic film bags made from polyethylene. However, they are similarly problematic. "Compostable" plastic bags must be taken to a commercial composting facility; they do not break down in the soil, a backyard composter, or a landfill. Without curbside composting, it is inevitable that compostable plastic bags will be improperly disposed of in curbside trash and recycling bins. Additionally, neither compostable nor biodegradable plastic bags reliably break down in the environment. In one study, researchers placed compostable and biodegradable bags in three natural environments for three years: the open air, buried in soil, and

[98] Muthu, *et al*., Carbon footprint of shopping (grocery) bags in China, Hong Kong and India, *Atmospheric Environment*, Vol. 45, p. 469-475 (2011).
[99] Environment Agency, *Life cycle assessment of supermarket carrier bags: a review of the bags available in 2006* (2011).

submerged in seawater.[100] The study found that none of the bags would reliably break down in all three of these environments. After nine months in the open air, both compostable bags and biodegradable bags had simply shredded into smaller pieces. After three years submerged in seawater, the biodegradable plastic bag was still completely intact and able to hold a full load of groceries. After 27 months in soil, the compostable bag was still present.

4.3 Reusable Bags

Reusable bags can be a suitable alternative to single-use plastic bags. However, not all reusable bags are created equal. The materials that make up reusable bags determine their environmental and social costs. Reusable bags made either from already-existing materials or recycled materials will have the smallest footprint, as they do not require the manufacturing of new materials and they provide a purpose for materials that were otherwise destined for the landfill. On the other end of the spectrum, reusable bags made from virgin materials, such as cotton, have an especially large footprint.

[100] Napper, I.E. and Thompson, R.C., Environmental Deterioration of Biodegradable, Oxo-biodegradable, Compostable, and Conventional Plastic Barrier Bags in the Sea, Soil, and Open-Air Over a 3-Year Period, *Environmental Science & Technology*, Vol. 53, p. 4775-4783 (2019).

5. Policy Solutions

Since the early 1990s, when the environmental harms associated with plastic bags first became a topic of broad public concern, municipalities across the world have adopted various measures to reduce the harms associated with plastic bags.[101] Generally, these policy instruments fall into six categories: plans or commitments, bans, fees, retailer take-back programs (also known as "recycling laws"), circular programs for reusable bags, and a combination of policy instruments.

To understand the effectiveness, successes, and challenges of each of these policies, we analyzed the scientific and policy literature as well as case studies of municipalities from across the U.S. that use one or more of these approaches. The findings of our analyses are summarized in **Table 5** and are presented in more detail in Sections 5.1-5.7. We urge Durham to review and consider these policy options as it determines the most appropriate strategy to reduce its single-use bag consumption. Durham should consider that the most effective strategy could employ a combination of the discussed policy tools.

We have also examined the legal authority for Durham to implement each of the following strategies. The Solid Waste Management Act grants Durham authority to impose a fee or a ban on single-use bags. Specifically, NCGS § 130A-309.09A(a) states in part, "Each unit of local government shall implement programs and take other actions that it determines are necessary to address deficiencies in [collection] service or [disposal] capacity required to meet local needs and to protect human health and the environment." This directive, read in conjunction with the Solid Waste Management Act's primary goal of waste reduction at the source, authorizes a plastic-waste-reducing initiative such as a bag fee or ban. See **Appendix C** for more details.

[101] Karasik, *et al*., *20 Years of Government Responses to the Global Plastic Pollution Problem: The Plastics Policy Inventory* (2020), *available at* https://nicholasinstitute.duke.edu/events/20-years-government-responses-global-plastic-pollution-problem (accessed October 5, 2020).

Table 5. Summary of pros and cons for policy tools to reduce single-use plastic bags.

Policy Tool	Brief Description	Pros	Cons
Plans and Commitments	Durham develops measurable goals to reduce plastic bags and evaluates programs or policies to meet those goals.	Provides a framework for Durham to collect data and make informed choices regarding the most appropriate policy or program.	Not likely to have appreciable impact on consumer behavior or bag use when implemented without other policy tools or programs.
Bans	Durham prohibits retailers from providing plastic bags.	Assuming compliance, bags subject to the ban are completely eliminated in the community.	Increased consumption of other single-use bags can occur unless there is a ban or fee on the alternatives. Bans eliminate consumer choice and potentially lead to increased use of non-regulated bags.
Fees	Durham requires retailers to charge customers a small fee ($0.05-$0.25) on plastic bags. Fees can be retained by the retailer, by the City/County, or both.	Bags subject to the fee are substantially reduced in the community. Fees kept by retailers can compensate for compliance costs. Fees kept by the City/County can fund anti-litter programs, reusable bags, and/or program staffing needs. Protects consumer choice.	Increased consumption of other single-use bags can occur unless there is a ban, restriction, or fee on the alternatives. Requires additional accounting by businesses and government. Fees can be an additional economic burden for low-income members of the community.
Retailer Take-back Program	Retailers that supply plastic bags must provide consumers with the opportunity to return used plastic bags for recycling.	Extends retailer responsibility for single-use plastic bags. Offers a convenient option to residents to recycle bags.	Increased cost to retailers that would be especially burdensome on small businesses. Severely limited market for recycled plastic bags.
Circular System for Reusable Bags	Durham government and/or nonprofit organizations invest in infrastructure and services to provide and recirculate reusable bags.	Low or no direct cost for consumers. Provides reusable bags to residents who may not otherwise be able to afford them.	Can be difficult to keep enough bags in stock to meet customer demand, especially without financial support.

5.1 Policy Option 1: Plans and Commitments

Overview

The creation of a plan or commitment would require the City/County of Durham to set goals related to reducing single-use bags, plastics, or waste; develop a detailed program of action to meet those goals; and periodically evaluate the effectiveness of the chosen program. Durham could do this under an already existing plan, such as *The City of Durham Sustainability Roadmap, The Durham Comprehensive Plan*, or the *Strategic Plan*, or develop a new plan solely focused on reducing single-use bags, plastics, and/or waste.

Case Studies

A number of municipalities across the U.S. and the globe have made commitments to achieve zero waste, leading to the adoption of policies to reduce plastic bags. Examples of municipalities include:

- **San Francisco** established a "zero waste" commitment in 2002, with the goal to divert 75% of its waste from landfills by 2010 and to divert 100% of its waste by 2020. To help achieve these goals, San Francisco adopted the first ban on plastic bags in the U.S. in 2007.

- **New York City's** *One New York* outlines its commitment to become "the most sustainable big city in the world," in part by sending zero waste to landfills by 2030.[102] Under this goal, New York City made plans to ban expanded polystyrene foam food-service containers in 2015 and to "work with the City Council to reduce the overall impact of [single-use bags] on our local environment." To meet this goal, New York City adopted a ban on plastic bags and a five-cent fee on paper bags in 2020.

Considerations

A plan or commitment will not be successful on its own in addressing the problems with plastic bags and single-use plastics. The main advantage of a plan is that it will encourage Durham to set measurable targets and evaluate the policies or programs that are best suited to meeting those targets. However, such policies or programs would need to be implemented for there to be meaningful reductions in plastic bag usage. This could still require funding, staff time, additional committee(s), or outsourcing to carry out the plan and the adoption of an ordinance. Another advantage of a plan is that it can provide the City and County with a framework and a timeline to 1) collect meaningful data such as bag usage and consumer attitudes, 2) evaluate the most effective

[102] The City of New York, *One New York: The Plan for a Strong and Just City* (2015), *available at* https://onenyc.cityofnewyork.us/wp-content/uploads/2019/04/OneNYC-Strategic-Plan-2015.pdf (accessed May 18, 2021).

policy or program for Durham based on this data, and 3) determine the most equitable way to implement the chosen policy or program.

5.2 Policy Option 2: Ban on Plastic and/or Paper Bags

Overview

Adopting an ordinance that bans single-use plastic bags would prohibit retailers from providing these bags to customers altogether, requiring customers to bring their own bag, purchase a reusable bag at the store, or use no bag at all. Some municipalities allow retailers to provide an alternative bag, such as a paper, compostable, or biodegradable bag; others extend the ban to all single-use bags. Often bans apply only to bags supplied at check-out and do not include, for example, bags used to package loose items such as fruit and vegetables, bags used to wrap frozen foods, fish or meat, and bags provided by pharmacists for prescription medicines.

Case Studies

Bans are by far the most common policy tool used by U.S. municipalities to reduce plastic bags. In states without a statewide policy, there are at least 200 cities and counties that have banned plastic bags.[103] Examples of municipalities that have implemented a ban on plastic bags include:

- **Charleston, South Carolina,** has prohibited businesses and food establishments from providing plastic bags less than four mils thick since January 2020. The ordinance also places restrictions on other single-use plastics, such as disposable food service ware and polystyrene. Prior to implementing the policy, the City of Charleston organized a Plastic Bag Minimization Committee, made up of government officials, concerned citizens, conservation groups, and business groups. The coalition worked to review bag-reduction policies and survey business owners and citizens.[104]

- **Orange Village, Ohio,** has banned plastic bags less than 2.25 mils thick since 2019. Retailers are explicitly allowed to provide customers with reusable bags (i.e., cloth and fiber bags) or thick plastic bags, as well as paper bags manufactured with at least 40% recycled content.

- **Dare, Currituck, and Hyde Counties in North Carolina** had a ban on plastic bags from 2009 to 2017. This ban was enacted through state law, rather than a local ordinance. In 2009, the North Carolina General Assembly enacted Senate Bill 1018, which aimed to protect the critical ecosystems located on the North Carolina coast. Businesses were

[103] Don't Waste Durham, *U.S. Bag Policies Map*, *available at* https://arcg.is/1y0DbL (accessed May 3, 2021).
[104] Charleston, South Carolina, *Minimizing Plastic Bags*, *available at* https://www.charleston-sc.gov/1454/Minimizing-Plastic-Bags (accessed October 14, 2020).

prohibited from providing plastic bags but could provide paper bags that contained at least 40% recycled material. In 2017, the ban was repealed following opposition from the North Carolina Retail Merchant Association.

Considerations

A ban, if fully complied with, has the potential to completely eliminate single-use plastic bags in Durham. Bans are also appealing because they do not require record-keeping, and so the cost of monitoring and enforcement is often cheaper for bag bans compared to bag fees (see Section 5.3).[105] However, by preventing the sale and use of some bags, bans reduce consumer choice.

There is also a major loophole that is important to avoid when implementing a ban on plastic bags. We have identified several ordinances that ban plastic bags of a certain thickness (e.g., plastic bags less than 2.25 mils thick). This provision results in businesses simply supplying customers with thicker plastic bags that are more expensive and that have an even greater environmental footprint. Similarly, if the policy bans only plastic bags, businesses may simply switch to paper bags, which are more expensive for the business to purchase and still have a significant environmental footprint. In order to avoid this loophole, it is vital that the ban extends to all single-use bags or that a fee is placed on non-banned bags to discourage their use. If the ban does not extend to all single-use bags, then the ordinance should provide a carefully curated list of the types of bags that a retailer may provide.

Bag bans also raise an important question: Will the benefits of limiting access to thin-filmed plastic bags at the checkout be offset by more consumers purchasing thicker plastic bags to line their trash bins and pick up pet waste? One study on consumer behavior in California found that this offset does happen to some degree but does not fully negate the benefit of the bag-ban policy. The study found that the elimination of 40 million pounds of plastic carryout bags was met with a 12-million-pound increase in trash bag purchases.[106] These purchases were primarily small and medium-sized trash bags, whose sales increased by 120% and 64%, respectively, after the bans were put in place.

5.3 Policy Option 3: Fee on Plastic and/or Paper Bags

Overview

A bag fee requires retailers to place a small fee, typically ranging from $0.05 to $0.25, on single-use bags at the point of sale in an effort to encourage customers to bring their own bag or use no bag. In some municipalities, retailers charge a fee only for single-use plastic bags and may provide

[105] Taylor and Villas-Boas, Bans vs. Fees: Disposable Carryout Bag Policies and Bag Usage, *Applied Economic Perspectives and Policy,* Vol. 38, p. 351–372 (2016).
[106] Taylor, R., Bag leakage: The effect of disposable carryout bag regulations on unregulated bags, *Journal of Environmental Economics and Management*, Vol. 93, p. 254-271 (2019).

any alternative bags, such as a paper, compostable, or biodegradable bag free of charge. Still, other cities require retailers to charge a fee for all single-use bags or even all bags, including reusable bags. These fees typically apply only to bags supplied at check-out and do not include bags used to package loose items such as fruit and vegetables, bags used to wrap frozen foods, fish or meat, or bags provided by pharmacists for prescription medicines. The fee is typically charged directly to the consumer and listed on the receipt separately from the products purchased. The fee could be 1) kept entirely by the municipality and used for related purposes, such as enforcement, single-use prevention programs, and community outreach and education, 2) kept entirely by the business, or 3) split between the two entities.

Case Studies

Bag fees, while less common than bans, are another policy tool often implemented at the local level to reduce single-use bags. Examples of municipalities with bag fees include:

- **Minneapolis, Minnesota,** has required retailers to charge at least $0.05 for single-use plastic bags, compostable plastic bags, paper bags, and reusable bags since 2017. Recipients of supplemental nutritional programs are exempt from paying the fee. The fee is retained entirely by the retailer.

- **Edwardsville, Illinois,** has required retailers to charge consumers $0.10 for each single-use plastic or paper bag since April 2020. Recipients of supplemental nutritional programs are exempt from paying the fee. The fee is retained entirely by the retailer.

- **Boulder, Colorado,** has required food stores to charge consumers $0.10 for each disposable bag, which includes plastic bags less than 2.25 mils thick and paper bags, since 2013. The food store retains $0.04 of the fee, while the City of Boulder collects the remaining $0.06.

Considerations

Bag fees are one of the best-studied bag-reduction policy tools, which provides context for how successful a bag fee might be at reducing single-use bag consumption in Durham. Studies in Chicago, Illinois; Montgomery County, Maryland; Suffolk County, New York; and Washington, D.C., all found measurable decreases in either the number of single-use bags consumers were using, the number of single-use bags retailers were buying, or the number of littered single-use bags.

In Chicago, Illinois and Montgomery County, Maryland, studies[107] found that implementing a fee on bags is an effective strategy to reduce consumption of disposable bags. Following the fee, the studies found (1) fewer customers used disposable bags, (2) customers who still used disposable bags used fewer, (3) more customers used reusable bags, and (4) more customers used no bag at all (**Figure 6**).

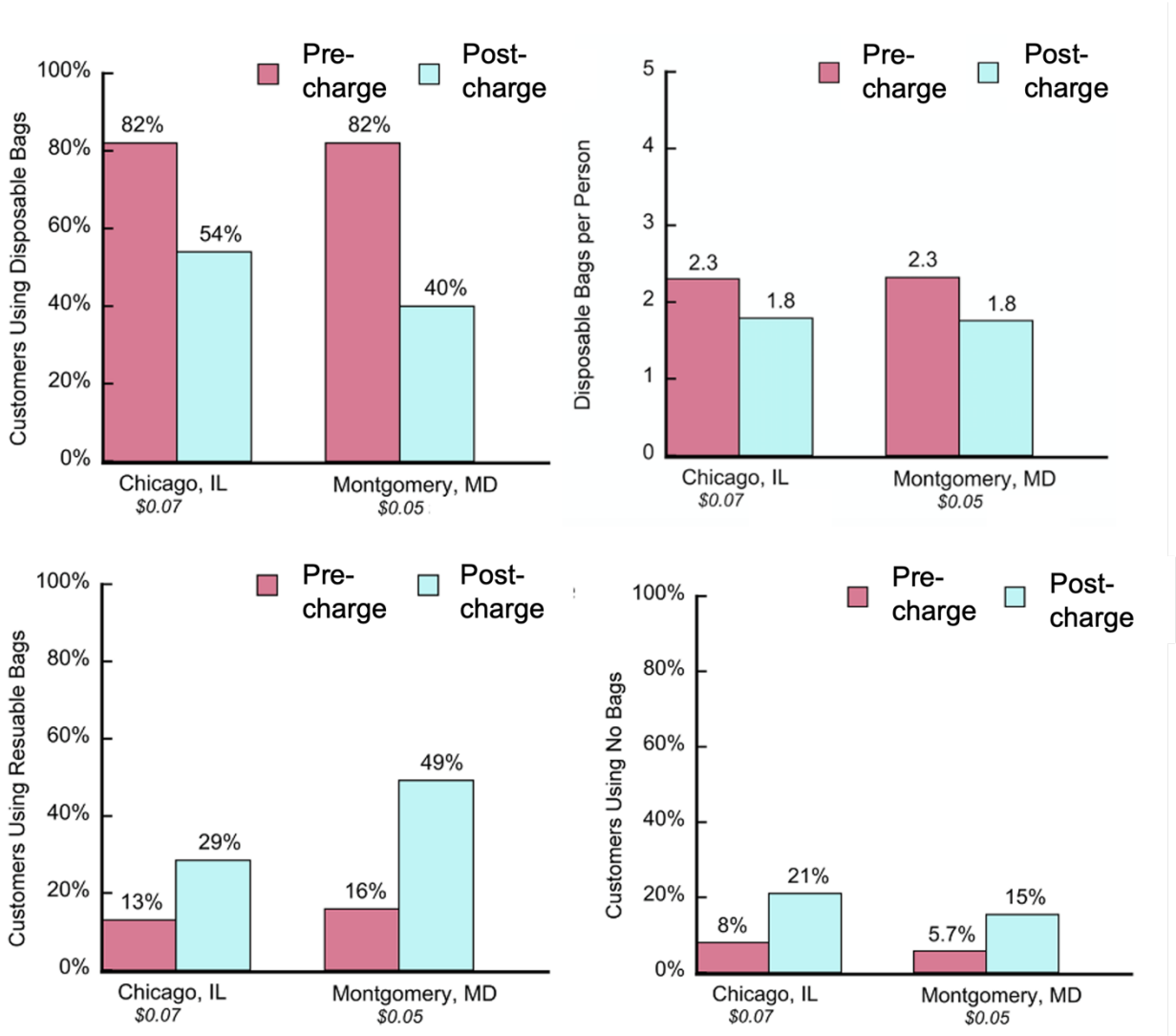

Figure 6. Consumer bag-use trends before and after the implementation of bag fees in Chicago, Illinois, and Montgomery County, Maryland.

[107] Homonoff *et al.*, *Skipping the Bag: Assessing the impact of Chicago's tax on disposable bags* (September 2018); Homonoff, Can Small Incentives Have Large Effects? The Impact of Taxes versus Bonuses on Disposable Bag Use, *American Economic Journal: Economic Policy*, Vol. 10, 177-210 (2018).

A study in Suffolk County, New York,[108] where retail stores were required[109] to charge customers a minimum of five cents for each bag provided at the point of sale, found similar trends to those in Chicago and Montgomery County. The study observed both consumer behavior and retailer purchases before and after the implementation of the bag-fee policy. Compared to 2017, retailers reported purchasing 82% fewer plastic bags and 79% fewer paper bags in 2018, after the implementation of the ordinance. The study also found that the percentage of people using reusable bags or no bag at all increased from 28% prior to the ordinance to 60% following the ordinance.

Bag fees also decrease the amount of bag litter in a community. When comparing volunteer clean-up data from 2017 to 2018, the American Littoral Society Northeast Chapter found that plastic-bag litter decreased 42% and paper bag litter decreased 41% along Suffolk County shorelines.[110] The American Littoral Society also noted that this decrease in bag litter was observed despite the fact that the number of volunteers and the amount of debris collected increased from 2017 to 2018. In Washington, D.C., data from Potomac River watershed clean-ups from 2007 to 2014 indicate that, since the implementation of D.C.'s $0.05 bag charge, there has been a 41% reduction overall in the number of plastic bags collected and a 71% reduction in the average number of plastic bags per clean-up.[111]

A major advantage a bag fee has over a bag ban is that it provides a source of revenue for businesses and/or the City and County, although this does require additional record-keeping by both. The fee could be used to offset the costs to businesses of implementing the policy, or go to the City/County to fund personnel, enforcement costs, solid waste management/litter programs, or free reusable bags for Durham residents. Finally, a fee provides customers with more consumer choice than a ban. Customers who regularly reuse plastic bags to pick up pet waste or line trash cans can pay the small fee and continue to have access to plastic bags. Alternatively, customers can avoid the fee altogether simply by bringing their own bag or not using a bag at all.

An important consideration with bag fee policies is the "rebound effect" – the phenomenon where consumers become accustomed to a fee and, over time, revert to single-use bags. As such, the fee

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[108] Christopher Sortino, *Annual Recycling Report, Progress of Single-Use Carryout Bag Reduction*, Memorandum prepared for James L. Tomarken (March 2019), *available at* https://www.suffolkcountyny.gov/portals/0/formsdocs/health/administration/Annual%20Report%20Final.pdf (accessed October 8, 2021).

[109] The New York State Bag Waste Reduction Act went into effect on March 1, 2020. The Act prohibits the distribution of plastic carryout bags by retailers in New York state. As a result, Suffolk County now bans plastic bags, but charges a 5-cent fee for paper bags. *See* https://www.suffolkcountyny.gov/Departments/Health-Services/Public-Health-Protection/Plastic-Bag-Law (accessed May 3, 2021).

[110] Christopher Sortino, *Annual Recycling Report, Progress of Single-Use Carryout Bag Reduction*, Memoradum prepared for James L. Tomarken (March 2019), *available at* https://www.suffolkcountyny.gov/portals/0/formsdocs/health/administration/Annual%20Report%20Final.pdf (accessed October 8, 2021).

[111] Alice Ferguson Foundation, *Bag Fees at Work: An Analysis of Reductions in Plastic Bags from Potomac River Watershed Cleanups 2007-2014*, *available at* https://fergusonfoundation.org/wp-content/uploads/2015/05/DC_Plastic-Bag-reduction_OnePager_5-11-15-Final.pdf (accessed May 18, 2021).

may need to be increased over time to maintain the desired effect. The rebound effect has been observed in South Africa[112] as well as Ireland.[113] If data suggest that the effectiveness of a bag-fee policy is waning, one option to counteract the "rebound effect" is to raise the fee. For example, Ireland raised its 15 euro-cent charge to 22 euro-cents five years after its initial implementation.

Another important consideration with a bag fee is that it could place an additional economic burden on low-wealth communities. Any bag fee should have the goal of proactively addressing concerns regarding equity and disproportionate impact. Possible ways to lessen the economic burdens of a bag fee include 1) providing free, reusable bags to consumers, 2) exempting Supplemental Nutritional Assistance Program (SNAP), Women, Infant, & Children (WIC), and Medicaid recipients from paying the fee, 3) implementing complementary waste reduction programs, 4) practicing culturally appropriate messaging and communication, and 5) implementing Durham's *Equitable Community Engagement Blueprint* to solicit feedback (**See Appendix D**).

Finally, bag-fee policies have a similar loophole to bag-ban policies if the fee applies only to thin-film plastic bags. Implementing a fee only on thin-film plastic bags, and no other materials, would likely result in an increase in disposable paper bags or thicker, unregulated plastic bags, thereby decreasing net environmental benefit. If a fee were to be placed on paper or other single-use bags as well, the fee must be high enough to change consumer behavior. In three neighboring cities in California, paper-bag fees of $0.10 per bag were more effective at reducing paper bag use compared to fees of $0.05 per bag.[114]

5.4 Policy Option 4: Retailer Take-back Programs

Overview

Retailer take-back programs (also known as "recycling laws") require retailers who supply plastic bags to also provide consumers with a proper receptacle to return used plastic bags for recycling and to contract with a company to pick up and process the material. In one version of this policy, retailers could avoid the requirement to provide a receptacle only if they stop providing customers with free plastic bags.

In Durham, the correct way to recycle a thin-film plastic bag is to return the clean, dry bag to a take-back receptacle at the retail store. To our knowledge, only 37 retail stores in Durham currently provide a bin for customers returning their plastic bags for recycling. Moreover, it is not clear whether plastic bags returned to these bins actually are being recycled. A mandated retailer take-

[112] Dikgang, J., Leiman, A., and Visser, M., Analysis of the plastic-bag levy in South Africa, *Resources, Conservation and Recycling*, Vol. 66, p. 59–65 (2012).
[113] Convery *et al*., The most popular tax in Europe? Lessons from the Irish plastic bags levy, *Environmental and Resource Economics*, Vol. 38, p. 1-11 (2007).
[114] Taylor and Villas-Boas, Bans vs. fees: Disposable carryout bag policies and bag usage, *Applied Economic Perspectives and Policy,* Vol. 38, p. 351–372 (2016).

back program would serve to increase this number of recycling bins in hopes of increasing plastic-bag recycling rates.

Case Studies

A handful of states, including Maine, California, Delaware, New York, Rhode Island, along with Washington, D.C., have enacted recycling laws for plastic bags over the last 30 years. Interestingly, all of these states now have a statewide ban or fee on plastic bags, with the exception of Rhode Island.

- **Maine** passed the first plastic bag recycling law in 1991, prohibiting retailers from providing customers with plastic bags unless the retailer also provided a receptacle to collect the plastic bags at the entrance of the store. Effective 2021, Maine amended its strategy by requiring retailers to stop providing plastic bags less than four mils thick and to charge a $0.05 fee for paper and reusable bags.

- **New York** passed the Plastic Bag Reduction, Reuse and Recycling Act in 2008, which required retailers to provide receptacles for customers to return plastic bags for recycling. The Act also required that plastic bags be labelled with the words "Please Return to a Participating Store for Recycling." Effective 2020, New York now bans single-use plastic bags altogether.

- **North Carolina** has participated in a plastic bag recycling campaign known as "A Bag's Life" since 2011. The campaign is supported by the American Chemistry Council, the North Carolina Retail Merchants Association, Keep North Carolina Beautiful, as well as some private companies such as Trex, Food Lion, and Harris Teeter.[115] While the campaign is purely educational and not mandated by law, its purpose is to encourage North Carolina residents to recycle plastic bags and to provide educational materials on plastic bag recycling.

Considerations

Retailer take-back programs are quite different from bag bans and bag fees in that they intend to increase plastic bag recycling as opposed to reducing plastic bags at the point-of-sale. As a result, these policies do not necessarily reduce the environmental injustice associated with the production of plastics but could potentially help divert mismanaged plastic bags (i.e., those that are improperly recycled or littered) to their proper recycling stream.

[115] A Bag's Life, *available at* http://www.abagslife.com/ (accessed October 7, 2021).

This policy would result in an increased cost to retailers and could be prohibitively expensive for small, local businesses that do not have the infrastructure to economically recycle plastic bags. Large retail stores, such as grocery stores, have the greatest capacity to properly recycle plastic bags and film. For large retail stores, the process of recycling plastic bags and film is relatively efficient because they can collect more stock and they use already established pathways and infrastructure to store and transport the film they collect. In contrast to large retail stores, smaller stores do not have the space and infrastructure to store materials in a large enough quantity to sell at a competitive rate. For these businesses, paying to contract with a pickup service could cost $1,000 annually.[116]

Indeed, nearly all of the plastic film receptacles currently located in Durham are located in large retail stores, as would be expected based on the expenditure and infrastructure needed to offer this service. We identified only 37 businesses in Durham that currently offer plastic-bag recycling.[117] Twenty-four of these 37 businesses (84%) are chain grocery stores such as Harris Teeter, Whole Foods, and Food Lion; seven are big box merchandise stores such as Target, Walmart, and Lowes Hardware; and the last six are locally franchised dry cleaners.

While this policy would increase costs for businesses, it would come at low or no direct cost for the consumer, since it relies on their voluntary actions to return the bags to take-back receptacles. However, based on current film recycling trends, it is unclear whether increasing access to take-back receptacles would actually result in an increased rate of recycling. A 2012 Moore Recycling report found that over 90% of the U.S. population already has access to (i.e., lives within 10 miles of) plastic-bag recycling, but that this access is not being used to its full potential.[118] Moreover, there is a limited market for end-of-life plastic bags, and increasing the number of recycled plastic bags does not necessarily mean that there is a useful product they can be recycled into.[119] As described in Section 2, few manufacturers are interested in purchasing used plastic bags due to costly collection and sorting, poor quality and cleanliness of collected materials, and the limited type of products that can be produced from recycled plastic film.[120] Accordingly, it may be that any increased collection of "recyclable" single-use bags would ultimately be diverted to landfills. We contacted several retailers to ask about the recycling of the plastic bags they collect, but none were able to provide us with any information.

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[116] Personal communication with Tonya Randell, Project Manager, Moore Recycling Associates (March 26, 2020).
[117] A Bag's Life, *Find a Recycling Center*, *available at* http://abagslife.com/find-a-recycle-center/ (accessed April 12, 2020).
[118] Moore Recycling, *Plastic Film and Bag Recycling Collection: National Reach Study* (April 2012).
[119] *Ibid*.
[120] Eureka Recycling, *Recycling Plastic: Complications & Limitations* (April 2009), *available at* https://static1.squarespace.com/static/59bd5150e45a7caf6bee56f8/59bd52cc7e2a5fb4e246e309/59bd52ab7e2a5fb4e246dc48/1505579691425/industry_Eureka-Recycling-newsletter-re-plastic-recycling.pdf?format=original (accessed May 4, 2021).

5.5 Policy Option 5: Circular System for Reusable Bags

Overview

A circular economy is one in which a community relies on products that are designed to be used repeatedly, for as long as possible. As a result, the community decouples itself from its reliance on finite resources and the generation of waste. Some communities have applied circular economy principles to shopping bags by providing residents with reusable bags and a system for those bags to be returned, washed, and redistributed. These programs are often given names that convey this system, such as "Share a Bag," "Boomerang Bags," or "Take a Bag, Leave a Bag."

Case Studies

Many of the municipalities that have a circular system for reusable bags created the program to provide residents access to reusable bags after the implementation of a bag ban or fee. Local government sustainability offices, nonprofits, businesses, and volunteers all play a role in making these programs successful.

- **Durham, North Carolina:** Thanks to the efforts of Don't Waste Durham,[121] in 2021, Durham joined the 1,145 communities worldwide that have a Boomerang Bag program.[122] In the Bull City Boomerang Bag program, volunteers sew reusable bags out of rescued scrap fabric that would have otherwise gone to the landfill and fabric donated by the community. Bags will be made available at the checkout counters of grocery and retail stores for any customer to use for free. Customers may choose to keep and continue to use the bag or bring it to a return receptacle where it is then washed and sanitized before being returned to the store. The volunteer-driven program is currently in its pilot phase at Save-A-Lot. Prior to the onset of the COVID-19 pandemic in the U.S., the Durham Farmers Market also provided a reusable bag "tree," where shoppers could freely take or leave reusable bags while at the market.

- **Santa Monica, California:** Santa Monica has the "Share a Bag" program, which encourages residents to leave reusable bags in designated bins around the City for anyone to use.[123] The program aims to meet the increased customer demand for reusable bags following Santa Monica's ban on plastic bags. The program has also partnered with GreenVetsLA, a Los Angeles sewing company that works with the Veterans Administration Hospital, to manufacture reusable bags.

[121] Don't Waste Durham, *Our Programs*, *available at* http://www.dontwastedurham.org/programs (accessed March 30, 2021).
[122] Boomerang Bags, *available at* https://boomerangbags.org/ (accessed March 30, 2021).
[123] City of Santa Monica Office of Sustainability and the Environment, *Business: Share a Bag Program*, *available at* https://www.smgov.net/Departments/OSE/Business/Share_a_Bag_Program.aspx (accessed May 18, 2020).

- **Jersey City, New Jersey:** The nonprofit GreenerJC operates Jersey City's "Take a Bag, Leave a Bag" program to complement Jersey City's ban on single-use plastic bags.[124] Participating businesses provide bins with reusable bags for people to borrow and bring back, donate to, or take from.

Considerations

In Durham, the Bull City Boomerang Bags pilot program, implemented at the Save-A-Lot on Liberty Street in East Durham, has been well received. Customers who walk to the store find that the cloth bags are much sturdier than plastic bags, making it easier to transport groceries home.[125] The manager of Save-A-Lot also indicated that some customers do indeed bring the Boomerang Bags back for future shopping trips.

The major challenge with the Bull City Boomerang Bags program is keeping enough bags in stock to meet customer demand. The manager of Durham's Save-A-Lot estimated that the store goes through approximately 2,000 bags per week, while Don't Waste Durham can only provide about 50 Boomerang Bags per week. A Bull City Boomerang Bags volunteer indicated that until there is additional funding for the program to pay a project manager or volunteer coordinator, it will be difficult to scale up the program.[126]

For many of the circular bag programs we identified, including Durham's, nonprofit staff and volunteers are the ones tasked with supporting and running circular bag programs. Investing city/county funds, such as those generated by a bag fee, in a circular bag program is one way to extend the program's reach and lessen the burden of a bag policy on low-wealth residents.

It is important to note here that the COVID-19 pandemic has raised questions about the safety of reusables. At the onset of the pandemic in the U.S. in March 2020, several municipalities limited the use of reusable bags due to concerns that they could be a source of virus transmission. However, public health experts have reached a consensus that the primary route of COVID-19 transmission is air-borne transmission via close contact with an infected person, and contaminated surfaces do not pose a substantial risk. Public health experts are also concluding that reusable bags do not pose a transmission risk that is any greater than single-use bags when common hygiene practices are implemented.[127] Reusable bags can be disinfected by washing them with soap for five

[124] GreenerJC, JC Bag Share Program, *available at* https://greenerjc.org/jc-bag-share (accessed July 12, 2021).
[125] Personal communication with Madeline James, Volunteer, Don't Waste Durham (July 22, 2021).
[126] *Ibid*.
[127] Greenpeace, *Health Expert Statement Addressing Safety of Reusables and COVID-19* (2020), *available at* https://www.greenpeace.org/usa/wp-content/uploads/2020/06/Health-Expert-Statement_125-experts.pdf (accessed October 13, 2020).

minutes.[128] Other hygiene practices, such as bagging your own groceries and washing your hands before handling your bags, can also reduce any potential risks associated with transmission via reusable bags. In sum, reusable bags may be safely used during the COVID-19 pandemic.

5.6 Policy Option 6: Combination of Policy Instruments

Overview

To fully address the wide range of problems and costs with single-use bags, a combination of the previously discussed policy instruments may be most appropriate. For example, combining a ban on plastic bags with a fee on paper or other alternative bags has been shown to combat the unintended consequence of consumers simply switching from plastic to paper. Or, combining a city/county-wide commitment to reduce the amount of waste sent to the landfill with a bag fee can be an effective way to evaluate the success of the fee in meeting established waste-reduction benchmarks.

Case Studies

Many of the municipalities provided as case studies in the previous sections, such as New York City, Santa Monica, and San Francisco, have combined multiple policy tools to increase effectiveness. Other examples include:

- **Los Angeles County, California,** banned single-use plastic bags and charges customers $0.10 per recyclable paper bag. The County also conducted public outreach by giving an ordinance packet to stores and setting up a public website that answered common questions about the ordinance. Prior to the policy's implementation, 7,000 reusable bags were distributed at stores and libraries. Los Angeles County reported that they eliminated single-use plastic bags and decreased paper-bag usage by 25%.[129] Businesses in Los Angeles County reported that customers adapted quickly to the ban and that the revenue from the paper-bag fee offset the additional costs of buying paper bags.[130]

- **San Jose, California,** banned single-use plastic bags and charges customers 10 cents per paper bag, which must be made of 40% post-consumer recycled material. This charge is kept by the business. Since implementing the policy, the City of San Jose has measured a

[128] Chin, *et al*., Stability of SARS-CoV-2 in Different Environmental Conditions, *The Lancet Microbe,* Vol. 1, (2020).
[129] LA County, *Implementation of the County of Los Angeles Plastic and Paper Carryout Bag Ordinance, LA County* (2012).
[130] *Ibid*.

91% reduction in single-use bag use.[131] San Jose has also seen a reduction in plastic bag litter in streams from 9.2% of total litter pre-ban to 2.0% of total litter post ban, as well as 69% fewer single-use bags in stormwater.[132]

[131] City of San Jose, *Bring Your Own Bag Ordinance, available at* https://www.sanjoseca.gov/your-government/environment/recycling-garbage/waste-prevention/bring-your-own-bag-ordinance (accessed September 30, 2021).
[132] *Ibid.*

6. Conclusion and Recommendations

Durham can be a leader in North Carolina by addressing the problems with single-use bags through meaningful, evidence-based policy change. We urge the City and County of Durham to give careful thought to all the policy tools discussed in this report and to include City/County staff and Durham residents in the policy-making process through Durham's *Equitable Community Engagement Blueprint*. Waste prevention and reduction should be considered as much a part of "waste management" as landfilling, incinerating, and recycling. To meaningfully address the related crises of climate change and plastic pollution, solid waste management strategies must evolve to embrace reuse as a means to manage our municipal waste stream beyond disposal and recycling.

Our own analysis leads us to recommend that the City and County adopt an ordinance that would require a minimum 10-cent fee on *all* bags, including paper and plastic, at the point of sale. Case studies and research show that this policy would likely lead to significant reductions in single-use bag consumption in Durham. This, in turn, would reduce many of the associated problems, such as pollution, litter, recycling contamination, unnecessary machinery repair and labor costs, and the amount of trash needlessly deposited in the Sampson County Landfill. It would also help Durham businesses save money, as they would not need to purchase as many single-use bags.

In addition, combining a bag fee with other policy tools could increase its effectiveness and acceptance by the community. Drawing from policy options one, three and five in the report, we recommend the following combination of measures:

- **Adopt an ordinance that requires businesses to place a fee of at least $0.10 on all single-use bags, no matter their material, at the point of sale.**

- **The Solid Waste Management Departments should develop metrics and assign responsibility for evaluation of the effectiveness of the bag-fee ordinance.** Local organizations that conduct litter clean-ups could harmonize data collection tools so that measurements include single-use bags collected during litter clean-up events before and after the ordinance goes into effect. Expenditure on recycling machinery repairs and other measures could be included.

- **Establish reuse as a line item in the Solid Waste Management Departments' annual budgets to receive the collected $.10 fees.** This line item would support new positions within the Departments of Solid Waste Management to collect data, develop and circulate educational and outreach materials, and expand circular reuse systems like Bull City Boomerang Bags to additional locations across Durham and provide convenient drop-off

receptacles for reusable bags. The fees could also support other interventions that offer practical and sustainable alternatives to single-use plastics.

This combination of policy tools would effectively reduce all single-use bags – including plastic and paper – at the point of sale through a bag fee, track the ordinance's effectiveness, and provide the community with free reusable bags. A bag fee, as opposed to a bag ban, is advantageous because it can provide sustainable financial support for infrastructure improvements that prevent waste and lessen the burdens on disadvantaged communities.