Circularity Assessment Protocol
Atlanta, Georgia, USA

University of Georgia
Circularity Informatics Lab
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The Circularity Informatics Lab at the University of Georgia is committed to information sharing, data analytics, empowering communities, and systems change related to circular materials management.

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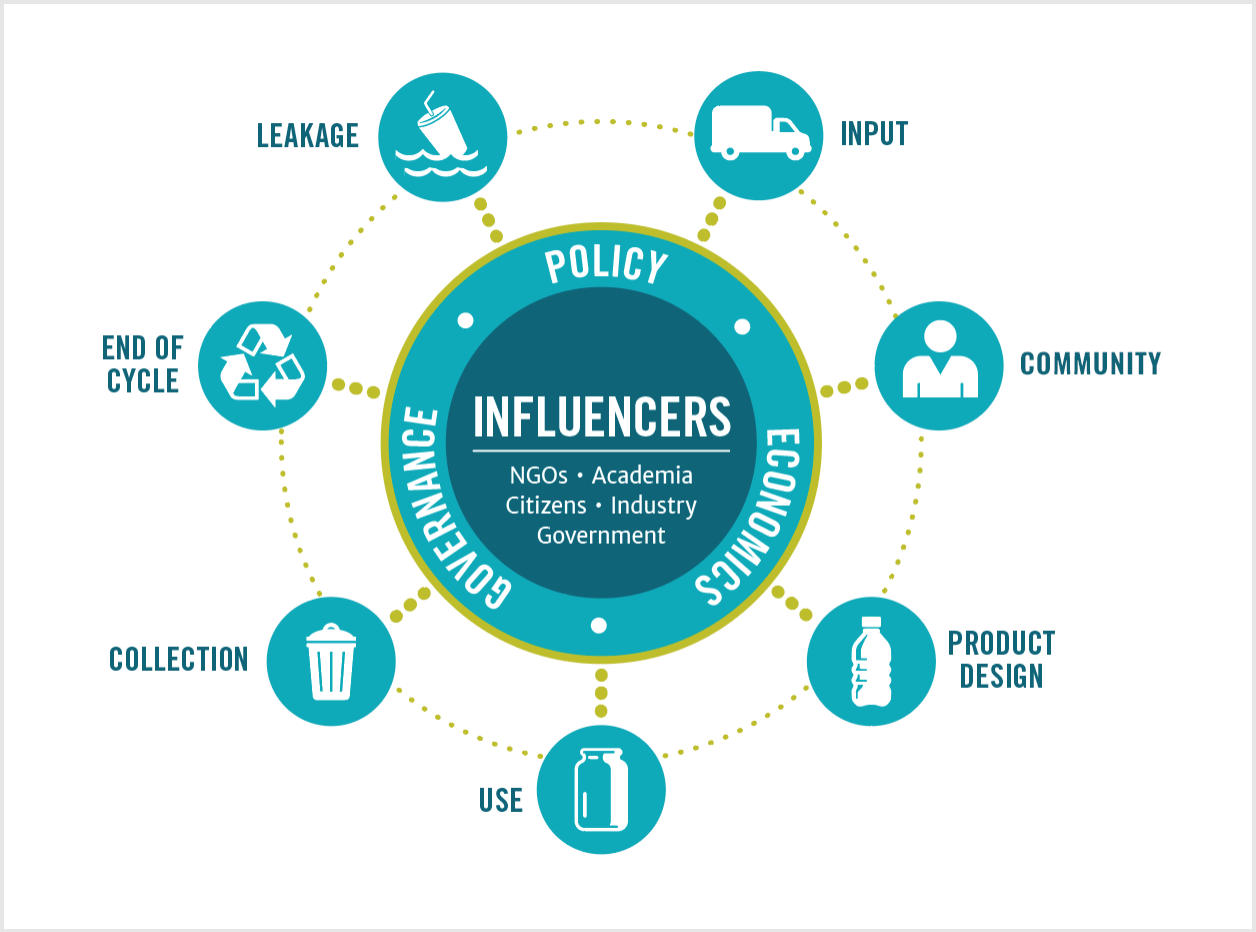
Executive Summary

Developed by the Circularity Informatics Lab at the University of Georgia, the Circularity Assessment Protocol (CAP) is a standardized assessment protocol to inform decision-makers through collecting community-level data on plastic usage. Grounded in materials flow and systems thinking concepts, the CAP uses a hub-and-spoke model to holistically characterize how consumer plastic flows into a community, is consumed, and flows out, either through waste management systems or leakage into the environment. The model, shown below, is comprised of seven spokes: input, community, material and product design, use, collection, end of cycle, and leakage. At the center, the system is driven by policy, economics and governance with key influencers including non-governmental organizations, industry, and government.



In June and July of 2022, a team from the Circularity Informatics Lab conducted fieldwork in the city of Atlanta, Georgia. This report was made possible through funding by the Walmart Foundation and from the National Science Foundation under Grant No. 2236080. Fieldwork included product and packaging assessments in stores across the city; key stakeholder interviews with government, industry, and non-profit organizations; material type characterizations for consumer plastic items; cost analysis of reusable products and alternatives to plastic available in the city; visual audits of recycling contamination; identification of public waste and recycling collection bins; and litter transects in three categories of population. Key findings from each spoke are summarized in the table below.

Key Findings

INPUT

Findings: From our sampling, roughly 30% of beverage parent companies and 20% of beverage manufacturing is found in Atlanta, while candy had the highest average distance for both parent companies and manufacturers.

Opportunities:

- The prevalence of beverage parent companies and beverage manufacturing presents a unique opportunity for conversations with these local companies about extended producer responsibility (EPR).
- Encouraging domestic candy products as opposed to those that come from abroad may reduce the overall footprint that is required to bring products to Atlanta from overseas.

Findings: Interviewees tended to mention how education, infrastructure, and economic issues all played into peoples' abilities to participate in circular activities. These themes also related to interviewees' suggestions of creating better signage, more transparent information, and increased infrastructure (particularly in the realm of composting). Keeping environmental justice at the forefront of any effort is pivotal. For example, through field observations, the team noticed that low-income areas of Atlanta are the most exposed to plastics and EPS products in both the stores and restaurants through takeout containers and disposable tableware.

COMMUNITY

Opportunities:

- The need to send a clearer message to people through education campaigns, information transparency, and better signage could clarify confusion about recycling, waste management, and composting in Atlanta.
- For some communities, it has not been easy to get involved in sustainable solid waste behavior, either because of allocation of resources or exposure to specific materials that make it easier or faster to landfill everything in the best-case scenario.
- Circularity in Atlanta could benefit from a multifaceted, community-based equity approach that recognizes these inequalities in resources. For example, low-income areas of Atlanta are the most exposed to plastics and EPS products in both the store and restaurants through takeout containers and disposable tableware.
- The current popularity of Live Thrive's CHaRM center proves the general public's interest in having spaces dedicated to hard to recycle materials; further data collection on where people may want similar services, what their barriers to participation may be, etc. could be necessary to expand infrastructure in Atlanta.

PRODUCT DESIGN

Findings: The most popular product materials in most stores are commonly multilayer film and PET. While major grocery stores currently offer compostable alternatives to disposables, there is significantly less availability of plastic alternatives in gas stations, convenience and small grocery stores. Based on store sampling, the most common products in the categories of Candy, Chips, and Drinks were M&Ms, Hersheys, and Reese's; Lays, Doritos, and Cheetos; and Coca-Cola, Pepsi, and Gatorade; respectively. Top tobacco items consisted of Marlboro, Newport, Camel, Cheyenne, L&M, and Pall Mall.

Opportunities:

- Specialized stores carry environmentally conscious brands that use more sustainable packaging.

- Sustainable packaging consists of plastic alternatives and some compostable materials - there is an opportunity to make these options and alternatives more equitably distributed throughout Atlanta.
- Some of the emergent snack brands already portray sustainability as part of their company goals making them more prone to changing packaging practices.
- Repackaged snacks, wildly popular on gas stations and small convenience stores, could represent another opportunity for sustainable packaging.

USE

Findings: In general, while compostable food bags (quart size), bowls, and plates were more expensive, they were still within comparable ranges of similar products sold in plastic packaging. In contrast, compostable utensils, trash bags, straws, and cups were significantly more expensive on a per unit basis when compared with traditional plastic alternatives. Reusable products also tend to have a bigger price tag, with the most popular reusable materials being plastic, silicone, and aluminum.

Opportunities:

- Reusable alternatives are available in some areas of Atlanta, but these could be expanded, and equity should be at the forefront of this opportunity to expand.
- To encourage leadership and innovation among businesses, the city could highlight efforts by local businesses to reduce plastic use.
- As more complex plastic alternatives are introduced to the waste stream, more education efforts will be needed to combat misleading product labels and encourage understanding and appropriate management by individuals and households.
- While there is a considerable amount of compostables already being used and sold in Atlanta, it may be pertinent to expand composting infrastructure to meet this interest, in addition to developing education and outreach programs.

COLLECTION

Findings: From interviews, we learned that standardization of collection and recycling ordinance enforcement has been a challenge, leaving multi-family residences of more than six units and commercial buildings to make their own arrangements for trash collection and recycling. The city is focusing on zero waste goals through partnerships with other intermediaries such as CHaRM and Goodr, to reduce waste (especially food waste); partnerships such as these provide a great opportunity to address contamination at the source.

Opportunities:

- While plastics #1 - #5 have some infrastructure for collection and management, there may be possibilities for expanding collection of film plastics led by private businesses (mainly grocery retailers).
- Mapping out existing receptacles and drop-off locations would provide an opportunity to examine collection gaps and disparities in access across the community.

Findings: The City of Atlanta recycles plastics number 1-5, although contamination and high recycling tipping rates make recycling challenging, with the most cost-effective plastics being #1 and #2. Composting has become one of the most talked about topics in the Atlanta solid waste scene; stakeholders recognize the importance of access to centralized industrial composting to process the amount of organic waste produced in the city.

END OF CYCLE

Opportunities:

- With landfill tipping fees being cheaper than recycling tipping fees ($45/ton to landfill and $75/ton recycling), there is a need to brainstorm how local and regional recycling can be incentivized.
- Given the lack of compost facilities paired with the growing use of compostable and biodegradable items in the waste stream, there is a growing need to educate consumers about what these product designations mean, what product labels entail, and how to appropriately manage different materials based on their disposal designations.
- There is an opportunity to expand composting in Atlanta as compostable materials use and waste streams continue to grow.
- The most recent study on waste characterization in Atlanta was in 2005; getting more updated data could help inform solutions in the city.

LEAKAGE

Findings: Across all surveyed transects, plastic fragments and food plastic were the most prevalent litter item by item type, followed by glass, paper, tobacco products, metal, other plastics, and construction and demolition materials. The top five litter items among the low, mid, and high population count areas are glass, plastic fragments, food plastic, paper, and tobacco products.

Opportunities:

- Collecting data and monitoring trends over time can provide insight into waste patterns, community needs, and effectiveness of waste management programs. With continued litter monitoring in selected locations, the city may be able to identify innovative ways to prevent and abate litter in the community.
- Plastic fragments are the most common item, which makes it difficult to identify intervention points. However, the other most common litter item, food plastics, can be addressed with a community-wide food reuse system and alternatives to plastic from compostables (with proper composting infrastructure) or biodegradable materials.

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Introduction

As of 2023, the United States (US) is home to a population of 331 million people (US Census Bureau 2020) and has an average waste generation rate of 2.24 kilograms per person per day, more than twice that of the global rate of 0.74 kilograms per person per day (Kaza et al. 2018). As a high-income nation, waste management in the US is considered advanced due to its well-designed and regulated waste management infrastructure providing high coverage of the country's growing population waste needs. These advanced waste management capabilities are met with some of the highest rates of consumption in the world, with the US generating the largest mass of plastic waste (42 million metric tons in 2016) in the world (Law 2020). The waste in the US is 12% plastic, although the largest percentage of the waste stream is paper/paperboard (23%) and organic materials, like food waste, make up 21.6%. And while nearly 100% of waste is collected in the USA, plastic waste is generally disposed of via landfill (76% by mass), combustion (12%), or recycling (8.7%) (US EPA 2020). However, the US has gained attention in recent years for exporting some of the highest quantities of plastic scrap out of the country for management elsewhere, often to developing countries (Brooks et al. 2018, Law 2020). Further, an estimated 0.28 million metric tons of plastic waste are mismanaged in the USA, with an estimated 0.51–1.45 million metric tons lost to the coastal environments from US waste around the world (Law 2020). The focus of the CAP for this project was to look at both plastics and organic materials in the waste stream that could be managed through composting, compostable products, biodegradable products, and plastic packaging.

As one of the largest countries in the world, both in terms of population and land coverage, the US is known for substantial variation in infrastructure and development across regions, states, and cities. For example, the city of Seattle generates 0.95 kilograms per capita per day (Kaza et al. 2018) compared to 3.6 kilograms per person per day in Miami (Circularity Informatics Lab 2021). Substantial focus has been given to large cities and states with progressive waste management strategies, however, there is a lack of focus on regions that are in need of assessment in order to develop appropriate, context-sensitive solutions.

Atlanta is the capital of Georgia and spans both Fulton and Dekalb counties. Atlanta currently has a population of roughly 500,000 people, with a racial makeup of roughly 48% Black people, 41% white people, and 5% for Asian and Latino people, respectively (U.S. Census 2022). Major industries include professional, scientific, and technical services, health care and social assistance, and educational services. Additionally, Atlanta receives millions of tourists per year, with 57 million people (about twice the population of Texas) visiting Atlanta in 2019 alone (Discover Atlanta 2023). Residents in Atlanta generate about 814 lbs. of trash per capita (City of Atlanta, 2009). To better understand how various materials move through Atlanta, it is important to recognize how intertwined the production of materials is to histories of racial violence.

Racial history of Materials in Atlanta

Racial discrimination has influenced the development of Atlanta from the exploitation of the workers who built it to the material structure of the city that perpetuates inequality every day. Before and after the 1821 Indian Springs Treaty with representatives of the Creek nation, a few white settlers moved into the area that would later become Atlanta. The city itself was founded as "Terminus," the end of a railway connection to the Midwest, in 1837 (Georgia Writers Program 1942) Over the next two decades, Atlanta grew into a very small city, mostly known for being a convenient railroad junction connecting cities across the South. Most railroads in the pre-Civil War South were built using enslaved Black labor, and those in Atlanta were no exception (Blackmon 2008).

After the Civil War began, Atlanta quickly grew into a manufacturing city, to process goods such as iron and cloth for the blockaded Confederacy (Vanatta & Du 2010). Because a large percentage of white men served in the Confederate Army, the bulk of labor was done by women and enslaved African Americans (Logue 1993). During this time, the system of industrial slavery that had emerged in the pre-war years became more formalized. General Sherman targeted Atlanta in 1864 during his March to the Sea because of Atlanta's economic importance. After evacuating the population, he burned the city to the ground in 1837 (Georgia Writers Program 1942). Although the city and its nascent industry were shattered, refugees from across the South fled to Atlanta. Newly free Blacks hoped that federal occupation would provide a measure of protection from vindictive former confederates and the demands of their former slaveholders. As the population of the city skyrocketed, Black residents were forced to move into less desirable areas to the east, west and south of downtown, "near railroad tracks, in industrial sections, [and] on cheap land" (Bayor 1996).

Rebuilding Atlanta's commercial infrastructure would be a difficult task, however. By 1868, the first labor contract for Georgia prisoners was used to build the Georgia and Alabama railroad (Blackmon 2008). As the state's convict labor system expanded, these railways brought raw materials from the mines and quarries in North Georgia, frequently also run by convict labor, to build the city. Within city limits, companies like the Chattahoochee Brick Company used forced labor to compensate for the lack of capital to invest in production (Blackmon 2008). Most of the prisoners who worked under this system were Black, convicted of racialized offenses such as vagrancy and sentenced to long prison terms to pay off their fine and the debt they incurred from court costs (Blackmon 2008). The Thirteenth Amendment banned slavery, except as punishment for those who had been convicted of a crime, but the convict system provided a loophole for prominent white Atlantans to continue to profit from slave labor (Blackmon 2008). By 1908, the exploitation of convict labor was clear to Georgia's legislature. They banned the lease system but required prisoners to work on state and local government projects (Blackmon 2008). Many of the roads in Georgia have been built using convict labor, and raw materials from quarries worked by prisoners continued to pour into Atlanta for building and distribution along rail lines (Serafini "State Run Chain Gangs").

Two strikes during the late nineteenth century, the 1881 washerwomen's strike and the 1897 Fulton Bag and Cotton Mill Strike, show the racial hierarchy present in Atlanta's industries. First, the 1881 washerwomen's strike began due to the low wage paid for laundry work. The mostly Black women in this industry refused to wash clothes until their pay was improved, despite pressure from the city government. The strike's success demonstrated the importance of service work and Black labor to the daily functioning of the city (Bentley 2019). Black women especially found economic opportunity in Atlanta, because wage labor didn't require land or capital to start (Hickey 2003). In 1897, white textile workers at the Fulton Bag and Cotton Mill also went on strike. The white strikers' goal was to prevent Black women from being allowed jobs that had previously only been given to white women (Hickey 2003). Black workers were typically only allowed access to unskilled and domestic labor and were poorly paid. The situation demonstrates a common tactic of industrialists in the South, who used forced labor and depressed Black wages to control union activity and

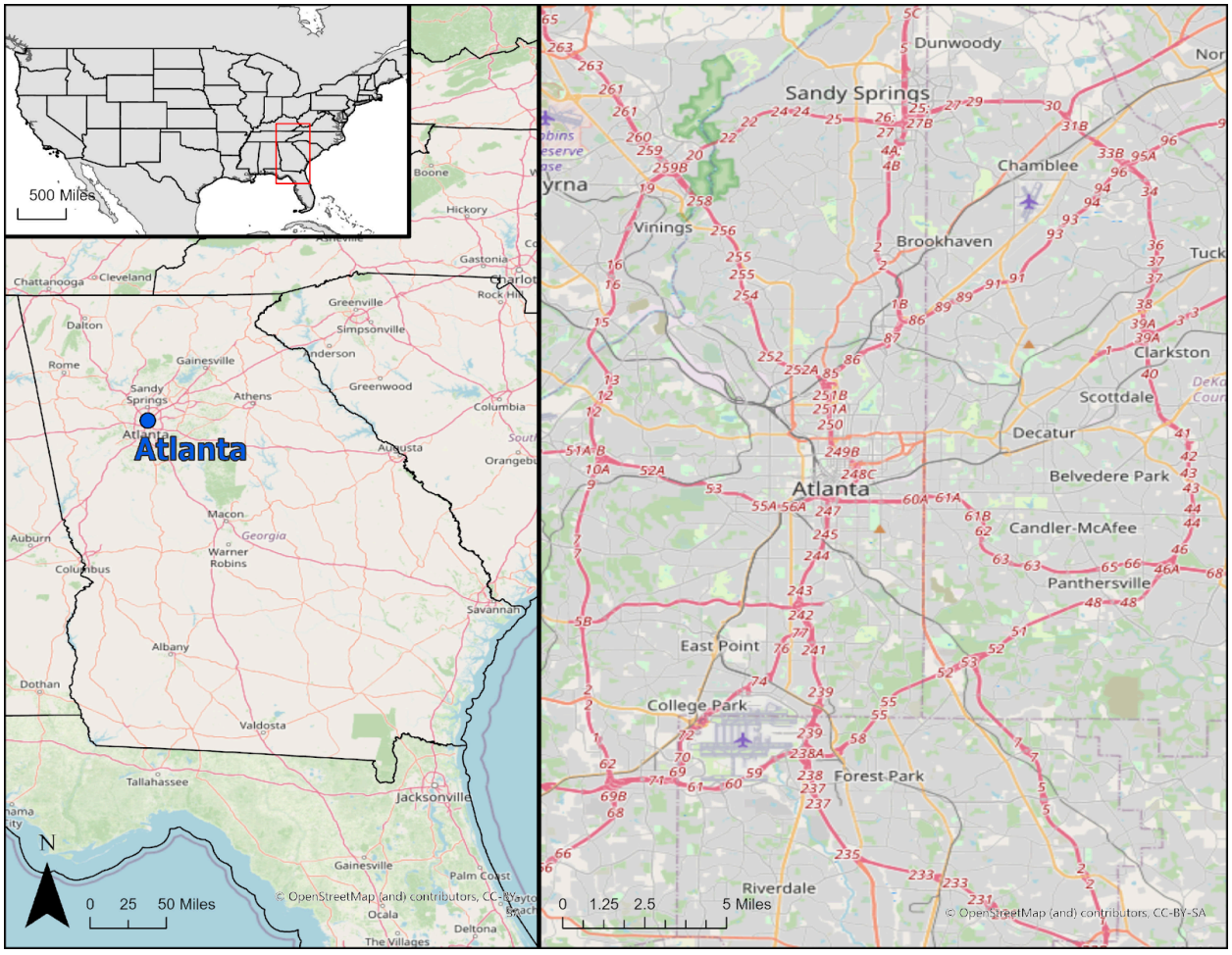
keep labor costs low (Blackmon 2008). The contrast between these two successful labor actions highlights the opportunities and injustices of Black life in Atlanta.

Atlanta's Auburn Avenue was one of the most prosperous Black communities in America. Graduates of Atlanta's Black colleges worked in professional jobs and founded businesses such as Standard Life Insurance Company and Citizens Trust Bank (Bayor 1996). However, as for poorer Blacks, the prospective industrialists of Auburn Avenue lacked opportunities in land and capital to establish manufacturing facilities. Additionally, governmental neglect of Black communities meant that community members had to contribute to the mutual aid networks that actually supported them in addition to their taxes. For example, Black communities often had inferior physical infrastructure, which could be improved by community members (Bayor 1996). Programs like the Works Progress Administration (WPA) prioritized white workers for economic relief, again leaving Black communities to take care of themselves and subsidize white workers with their taxes (Bayor 1996).

In Atlanta, the economic power of segregation was clear to residents. During the 1895 Atlanta Cotton Exposition, which promoted the growth of the Atlanta cotton industry, Booker T. Washington urged Black Atlantans to focus on economic matters, rather than civil or social equality (Alridge 2004). Pushed into less valuable jobs and mistreated without legal recourse, Black Atlantans had very little choice but to accept his plan. By the time of the Civil Rights Movement, Atlanta prided itself on being a "city too busy to hate" (Bayor 1996). It is true that schools were desegregated earlier than in the rest of the South in 1961, and desegregation was not accompanied by the violent protests seen in other cities like Birmingham. However, white Atlantans began to move to the suburbs, taking jobs and opportunities with them (Keating 2001). Atlanta was economically important as "the heart of the South," but because of advances in transportation and energy, factories did not have to be located within city limits to take advantage of Atlanta's transportation facilities (Keating 2001). Additionally, the service sector became a larger part of Atlanta's economy, replacing blue-collar manufacturing jobs (Stacker "Industries in Atlanta" 2021). To deal with these problems, the Southern Christian Leadership Conference's main initiative in Atlanta-- "Operation Breadbasket" --worked to get Blacks better access to city jobs, as well as move toward equal pay for equal work (Bayor 1996).

The legacy of Atlanta's racial history is still obvious in the physical infrastructure of the city. The sprawling metropolitan area is poorly connected, with the highway system cutting through the city. It was meant to be a barrier between majority white and majority Black neighborhoods, but now it prevents Atlantans from easily accessing city resources, like the single CHaRM recycling center (Bayor 1996; Stokes 2018). Additionally, as jobs are created in the suburbs, out of reach of the MARTA transit system, lower-income Atlantans, who are still disproportionately Black, have access to fewer economic opportunities than the metropolis generates (Stokes 2018). Historically Black neighborhoods are mostly still majority Black neighborhoods, where home values are lower than in comparable white neighborhoods (U.S. Census 2020). Because these homes were built among the industrial sections south and west of downtown, they are more likely to be contaminated by industrial waste (U.S.EPA 2023). Atlanta's Superfund sites (including a highly contaminated lead site that is Atlanta's only National Priority List site) are concentrated in Black communities.

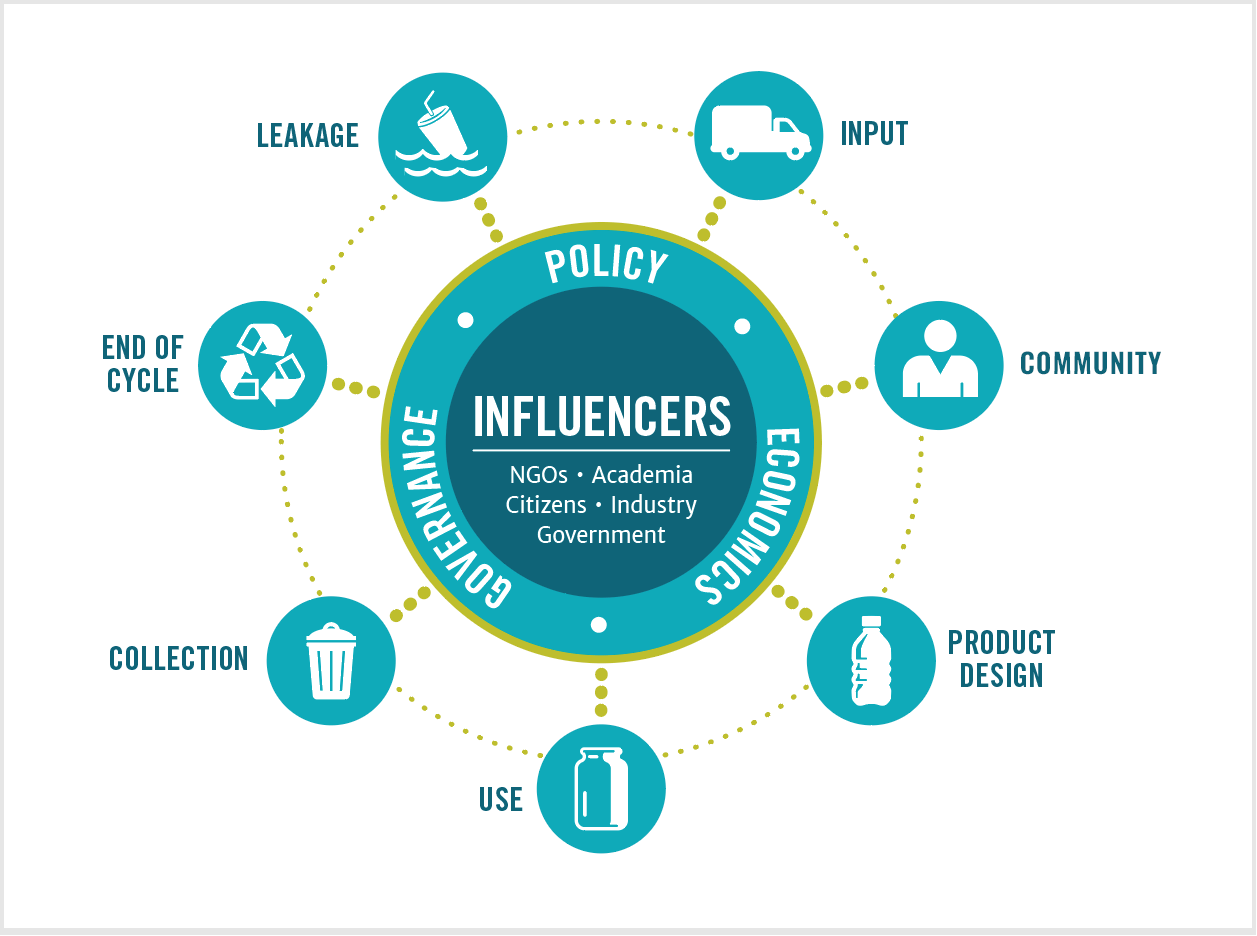
Figure 1: Overview map of survey area



The Circularity Informatics Lab (CIL) at the University of Georgia (UGA) developed the Circularity Assessment Protocol (CAP) in 2018, which is a standardized assessment protocol used to collect community-level data to inform decision-makers (Figure 2). The CAP characterizes seven community components:

1. **Inputs** – What products are sold in the community and where do they originate?
2. **Community** - What conversations are happening and what are the stakeholders' attitudes and perceptions?
3. **Product design** - What materials, formats, and innovations are found in products, particularly packaging?
4. **Use** – What are the community trends around use and reuse of product types?
5. **Collection** – How much and what types of waste are generated? How much is collected and what infrastructure exists?
6. **End-of-cycle** – How is waste disposed? What is the fate of waste once it is properly discarded? How is it treated?
7. **Leakage** - What waste ends up in the environment? How and why is it getting there?

Figure 2: Circularity Assessment Protocol (CAP) hub-and-spoke model.

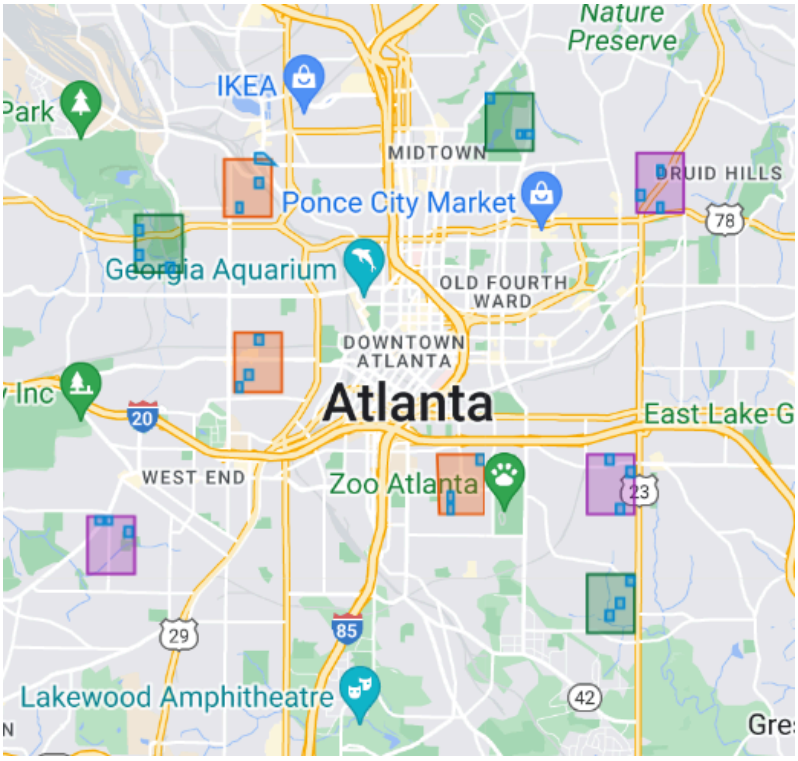


In June and July of 2022, a team from the Circularity Informatics Lab conducted fieldwork in the city of Atlanta, Georgia with support from the city's local government. This CAP was conducted with funding support from the Walmart Foundation and from the National Science Foundation under Grant No. 2236080. The CAP report is split into the following sections, which include results and discussion of each: Input, Community, Product Design, Use, Collection, End of Cycle, and Leakage, followed by Opportunities. The intent is for the data in this report to inform ongoing stakeholder engagement around optimizing circularity in Atlanta, GA.

Sampling Strategy

To randomly sample various locations in a city, the CAP typically identifies a 10 x 10 km (about 6.21 mi) area over the city (with the center of the city in the center of the area). In this area, the ambient population is sectioned into three groups, or 'tertiles' (Figure 3). Ambient population count can be described as "where people go" and "societal activity" – it is not population density of where people live. Typically, three 1 x 1 km areas for surveying are randomly selected within each population tertile using NOAA's Sampling Design Tool, resulting in a total of nine 1km2 areas for surveying, three in each of the high, mid and low population count tertiles. These nine areas typically form samples of different land uses, etc.

Figure 3: Population tertiles and survey sites in Atlanta


Nature
Preserve
IKEA
Park
MIDTOWN
Ponce City Market
78
Georgia Aquarium
OLD FOURTH
WARD
DOWNTOWN
ATLANTA
Atlanta
East Lake G
20
WEST END
Zoo Atlanta
23
29
85
Lakewood Amphitheatre
42

Input

To get a snapshot of the characterization, scope, and source of common plastic packaged items that are entering Atlanta, the CIL team sampled common convenience items in three common product categories: candy, chips, and drinks. These items were recorded during transects held across nine 1 km2 survey areas in Atlanta - three within each tertile of the population count (Figure 3).

The team selected three convenience or grocery shops to sample within each 1 km2 transect area. In total, 155 convenience products were collected and sampled, including 58 candy products, 47 chips, 50 beverages. Samples of identical brands were not collected multiple times, even when present in multiple stores. For each of the top products documented, the team noted the type of packaging (including polymer, if possible), the brand, and the parent company. From there, the team was able to determine the manufacturing location, which was determined from manufacturing locations listed on product packaging or desktop research, as well as the headquarters location for the parent company of the brand (largely determined by desktop research). For tobacco, top brands only were identified, and they consisted of: Marlboro, Newport, Camel, Cheyenne, L&M, and Pall Mall.

Candy had the highest average distance for both parent companies and manufacturers. In contrast, beverage items had the lowest median distance to parent companies and manufacturers, which is because Coca Cola's headquarters located in Atlanta. Regardless, the average parent company and manufacturer distances for beverages ended up being higher than the average distances for chips; this suggests that regardless of Coca Cola's headquarters, beverages are still being shipped in from other places.

Based on the origins of the convenience categories, regional distribution of products in the United States was common among both manufacturers and producers. A majority of chip parent companies are located in the continental U.S. or in South America. Although some beverage and candy parent companies are located in the U.S., a majority of them are located in Asia or Europe (Figure 4). Domestically, Georgia, Texas, Pennsylvania, New Jersey, and New York had the highest quantity of parent companies for products found in Atlanta. Similarly, chip manufacturing primarily takes place in the U.S. or South America. While a majority of candy and beverages were manufactured in the U.S., some beverages came from Colombia, France, and the United Kingdom (Figure 5). Within the U.S., Georgia, Texas, Pennsylvania, and New Jersey had the highest proportion of manufacturers.

Table 1: Distances between Atlanta and manufacturer and parent company locations for top FMCG convenience items

	Length Store to Parent Company (km)*			Length Store to Manufacturer (km)		
	Minimum	*Maximum*	*Avg.*	*Minimum*	*Maximum*	*Avg*
Beverages	0	22,539	2,610	0	8,252	1,799
Candy	885	22,370	4,916	881	9,385	1,875
Chips	418	8,981	2,530	0	7,289	1,651

*Note: Distances were projected using an Azimuthal Equidistant projection. Values have been rounded to the nearest km.

Figure 4: World map displaying parent company locations for top convenience items in Atlanta

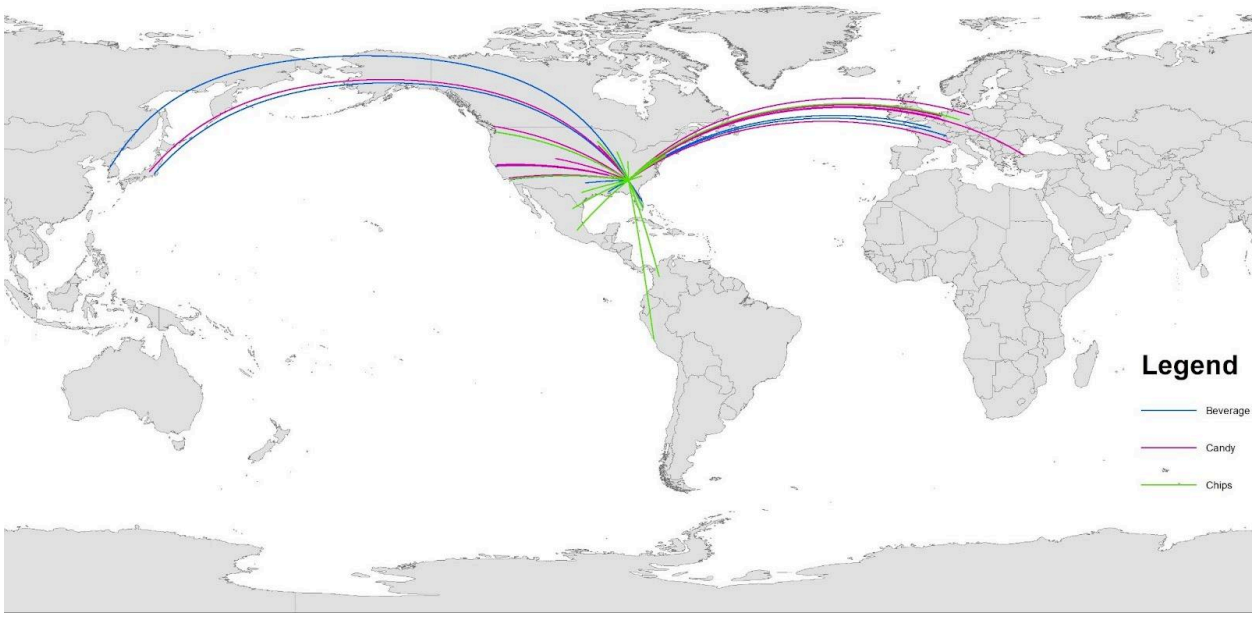
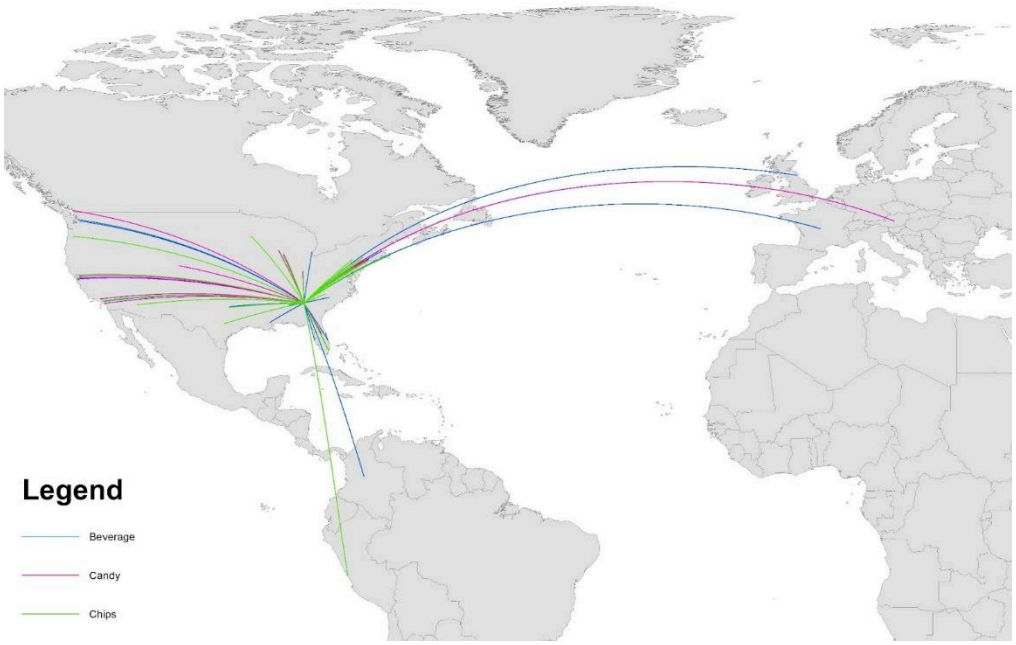


Figure 5: World map displaying manufacturing locations for top convenience items in Atlanta



Based on our sampling, roughly 30% of beverage parent companies and 20% of beverage manufacturing are located in Atlanta, presenting an excellent opportunity for conversations with these closer companies about extended producer responsibility (EPR). A handful of states in the US have implemented EPR policy legislation that encourages producers of products to bear some responsibility for their end-of-life management. At current, Georgia does not have any EPR legislation, which generally requires packaging producers to join a producer responsibility organization (PRO), or stakeholder organization, to develop a plan and manage the program (Sustainable Packaging Coalition 2022). EPR can take many forms, but common approaches throughout the world and the US include product-take-back and deposit-refund schemes as well as waste collection and take-back guarantees (UNEP 2018). They can also supply resources for current state or city-wide management systems as they currently are. The plastics industry in the US tends to oppose EPR schemes arguing that waste management relies on consumer practices and behaviors (Nash and Bosso 2013), and that the schemes can lead to increased costs, food waste, and life cycle impacts (ACC 2021). EPR schemes are typically supported by state-level governance, suggesting that Atlanta state-level representatives could advocate for legislation targeting EPR efforts or engagement with packaging producers. There is immense opportunity for partnerships with producers and manufacturers located in Atlanta. EPR can be a requirement of the companies doing business in a state no matter where products are manufactured, or companies are located.

Community

Information transparency and education seem to be key components in making environmentally responsible decisions at the consumer level, which in turn makes for more efficient approaches to recycling and composting in the city of Atlanta. Accomplishments include:

- 30% reduction on recycling contamination thanks to targeted education
- 35% increase on composting drop-off participation within the last year
- Circularity solutions have helped divert 4 million pounds of organic waste from landfills
- Better signage in goods and packaging would curve contamination in both composting and recycling streams

Dedicated drop-off composting facilities could potentially improve organic waste diversion and engage the community with the circularity of the solid waste process. The allocation of resources seems to be another factor that strongly determines who has access to various recycling and composting resources, as well as the frequency of participation and overall effectiveness.

Recycling markets have great limitations for the plastics currently circulating. Fluctuating demand and the variety of plastics make successful recycling a consciously uphill battle for many of the stakeholders in the system. This is represented in the system struggles from the consumers' confusion about materials, prerequisites, and rules around recycling, to the complicated market relationships needed to maintain a constant flow of the supply-demand chain of recycled plastics.

Although third-party companies have entered the system providing valuable intermediary steps that allow for more efficient systems of solid waste diversion, there are still plenty of opportunities to improve the system and see through those important goals of solid waste reduction. These opportunities span themes like the importance of education and information sharing, the need for dedicated infrastructure for waste diversion, and the crucial sustainability reverberation of economic needs.

For this section, the CIL team used field observations, semi-structured interviews, and document collection to establish patterns and support potential opportunities in the community element of the protocol. Stakeholders from different fields, from government officials to non-profits, gave their opinions on the current situation and future approaches to circular waste management directly, while other aspects of the study were analyzed from a researcher perspective through field observations and backed by document analysis. Based on these interviews, the themes of education, infrastructure, and economics.

Education

The importance of education and information sharing has already been established in some of the most popular successes on solid waste diversion and contamination reduction in the city. Thanks to a small grant and a carts audit campaign, the city of Atlanta has seen a reduction of 30% in recycling contaminants during the new administration. Additionally, the existence of the non-profit Live Thrive's Center for Hard to Recycle Materials (CHaRM) in Atlanta has provided an alternative to the constraints of curbside recycling as well as organic materials diversion, with an increase of 35% participation in composting drop-off within the last year and a jump of people served from 5,000 in 2015 to 63,000 in 2021 (Nord, 2022). This increasing popularity of Live Thrive's CHaRM is easy to understand in its website list of accepted materials given that it explicitly states what kind of items they accept, where to put them, and how much if anything would be charged for the visit. In this sense, information transparency about the process and destination of recovered materials may create a sense of trust that would boost waste diversion rates and people's understanding of circularity. In other words,

> **" [t]he bottle of [soda] you had this afternoon, goes on to become carpet, then, when that carpet is done, it can become more carpet, or something else [inside the state of Georgia]... and showing that economic impact of recycling... really drives the impact of what a circular economy can be."**

Inside the common theme of the importance of information transparency and education, stakeholders worry about appropriate signage on products in order to make recycling as well as composting more effective and efficient. As one of the biggest challenges in both the recycling and composting streams, the confusion around compostable plastics has been one of the biggest issues. From determining the difference between a recyclable and a compostable container, to the highly specialized distinction between industrial and backyard composting, the introduction of alternatives to plastics has created a crucial layer of misinformation that would need to be addressed to take maximum advantage of such alternatives. As an example, Live Thrive's CHaRM was accepting compostable plastics until the plastic contamination became such that they were forced to stop accepting them. In a similar way, another player on the organic materials diversion game, Goodr, advises potential clients on specific brands of compostable tableware that they would be able to collect and process.

The need to send a clearer message to people through education campaigns, information transparency, and better signage would have a ripple effect to other parts of the system including infrastructure and economics.

Infrastructure

On infrastructure, we have learned that although composting facilities sometimes have mechanical means of sorting out contamination, it is not cost effective for them to do so at all levels (Michal, 2022). That means that it is of vital importance for these facilities to rely on people's understanding of what it is that they can and cannot process.

With the increase in compostable products in the market, "compostable" labels have become a new hope for sustainable plastics management. However, a successful implementation of widespread compostable plastics would have to include clear instructions for the user. In this sense, Alter Eco candies as well as other companies have managed to tell consumers exactly where their product's packaging should go (Figure 6). This would clearly become more challenging when addressing take-out containers that, with rare exceptions, do not have instructions in each individual container.

Figure 6: Examples of Disposal Instructions in Packaging for Compostable Items

The other step in the chain of appropriate signage and information transparency comes in the form of compostables collection or lack thereof. In Figure 5, some brands are forthcoming in telling consumers about the industrial composting requirement and the possibility that a facility does not exist around them. However, at least one of these compostable items is trash bags, which normally would be expected to end up in the landfill instead of their appropriate disposal facility. Therefore, it would be more transparent to either work towards a landfill friendly alternative or rebranding the bags (e.g. composting waste bags), so that its use would potentially send them to the correct industrial composting facility if the users had access to collection. However, either through transportation or a drop-off site, consumers' involvement in composting collection is currently minimal.

Aside from the currently singular compost processing company in Atlanta, CompostNow, there are not many alternatives for residents of the city to dispose of their compostables outside of landfilling them through the standard curbside collection. Although, big events and organizations, including multifamily housing, have the possibility to hire private haulers to transport compostable waste to drop-off facilities like Live Thrive's CHaRM, or they address their food waste through organizations like Goodr, the average Atlanta resident would need to purposefully plan their organic waste collection to survive the drive to CHaRM or contact CompostNow to have weekly or biweekly pickups for a much higher monthly fee. There is a drop-off fee for businesses and some specific materials in facilities like CHaRM, but it is a fee that universities, churches, and other organizations who want to compost and recycle, but have no other resources to do so, are willing to pay. In the words of stakeholders,

> **"I think the problem here in the city is that there are not many [composting] options that are cost effective."**

Stakeholders, however, are also recognizing a way to circumvent all the hassles that consumers would encounter through the main suggestion of building more or centralized composting facilities, as exemplified by this quote:

> **"Build it, they will come."**

Some stakeholders are convinced that if there were a large composting facility that is regulated and dedicated for collecting compostables from residents and organizations, composting would be more popular in the city (See End of Life Section).

Although this approach would be consistent with the growing popularity of Live Thrive's CHaRM as a recycling facility, there are quite a few technical issues to be addressed in such a composting facility that the recycling side of CHaRM has had to learn to manage. Contamination and economic support come to mind as big issues that need to be addressed, which could potentially be mitigated if education and information transparency are adopted throughout the system. However, with the strong relationships that the center has with both organizations and companies that use hard-to-recycle materials that have been developed over time, the center has a continuous materials flow that allows for circularity to flourish. Companies like Nexus Circular which converts plastic into fuel, for instance, take the materials that CHaRM and other facilities provide, while the facilities have less contamination in the recycling stream that instead they can commercialize (Huddleston, 2022). In the same way, there are 120 manufacturers in Georgia who depend on recycling materials.

Collection, transportation, and processing of compostable materials is currently very limited in Atlanta, due in part to the lack of composting infrastructure and again to the lack of information transparency that obscures the few current options. While more or specialized composting facilities would make a difference mostly for organizations and residents with the option to haul compostable materials, not all residents would have the chance to compost their organic waste. Moreover, having widespread educational and information transparency opportunities would make current and future processes of composting more efficient and cost-effective. It would be vital as well to highlight the importance of composting in such educational efforts so that the impact to a circular economy from the composting perspective can be attractive to residents, even if there are communities that currently need more support than the educational side.

Economics

In Atlanta, like many other places, there are different communities who benefit from circularity in different ways. Besides organizations like Goodr, who work to end food waste by both feeding the hungry and diverting organic waste, key stakeholders like Live Thrive's CHaRM also contribute to the circular economy by both connecting with recycling-dependent manufacturers and encouraging the average citizen to divert waste from the landfills. However, it is the social representatives of our culture that usually get the accolades for demonstrating circularity in our daily activities. For instance, the sports community in Atlanta has made significant strides towards their zero waste goals and circularity, demonstrating how proceeds from sustainable sporting events translate to economic development for the city (McCormick, 2022). With their involvement with Habitat for Humanity and organizations like Goodr and CHaRM, the State Farm Arena and Mercedes-Benz Stadium have managed to reach communities that would otherwise be less engaged in sustainable solid waste behavior. For some communities it has not been easy to get involved in sustainable solid waste behavior, either because of allocation of resources or exposure to specific materials that make it easier or faster to landfill everything in the best-case scenario.

For instance, through field observations the team noticed that low-income areas of Atlanta are the most exposed to plastics and EPS products in both the store and restaurants through takeout containers and disposable tableware. EPS is the most common material used in takeout containers to the West of I-75 and South of I-20. In the stores, Figure 7, shows the Disposable Tableware aisle in two Walmart locations - one in

Midtown and another in Downtown Atlanta - highlighting a significant percentage difference of materials between the two communities.

Figure 7: Disposable Containers Availability in a Walmart Downtown (Top) and a Walmart Midtown (Bottom)

In the stores, the Downtown Walmart had many EPS and plastic tableware with a small section of lined-paper plates, while the Midtown Walmart had a small percentage of EPS and plastic with most of the paper and even some compostable alternatives in its Disposable Tableware section. EPS containers are especially popular in restaurants that appeal to minorities (e.g. Latin American food staples) and low income populations (i.e. The higher the tag price, the better packaging) as seen in Figure 8, depicting standard entrees from vendors with a online registered price of $-inexpensive (EPS, Plastic, paper, LDPE bag) and $$-moderately expensive (Compostable fiber, PLA, paper bag). In the same way, convenience stores and gas stations with specific demographics had products with extra plastic packaging or simply made of the less expensive EPS materials with no reusable or alternative options.

Figure 8: Takeout Containers from a $$ Vendor (Left) and a $ Vendor (Left)

In higher income areas, the matter of plastic use in to-go containers was mentioned in a mournful way, including remarks of economic reasons being the main obstacle towards more sustainable alternatives with vendors perhaps open to cost-effective alternatives. The stores in these higher income areas were also populated with on-aisle plastics alternatives for a lot of their disposable products. From reusable options to compostable disposables, these stores had plenty of options for the environmentally conscious shopper.

Product Design

Although the most popular product materials in a majority of stores are commonly multilayer film and PET, there are some points of opportunity when it comes to materials and product design.

- Specialized stores carry environmentally conscious brands that use more sustainable packaging.
- Some of the emergent snack brands already portray sustainability as part of their company goals making them more prone to changing packaging practices.
- Repackaged snacks, wildly popular at gas stations and small convenience stores, could represent another opportunity for sustainable packaging.

Major grocery stores currently offer compostable alternatives to disposables, although there is still a limited presence of the latter in stores and local alternative shopping (e.g., gas stations, convenience, and small grocery stores). To characterize material types used in common consumer products, samples of a variety of convenience and to-go items were obtained as described in the Input section. The CIL team sampled stores and vendors in each of the nine 1 km^2 transect areas. With a distribution of three stores and vendors per transect area, we analyzed a total of 27 stores and 27 vendors.

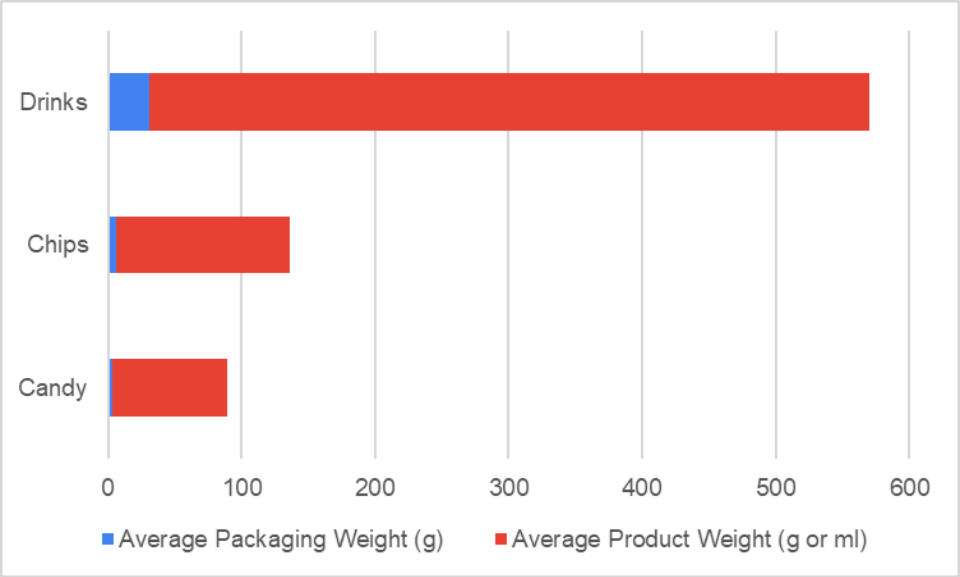
Store Product Analysis

Throughout the stores the most common products in the categories of Candy, Chips, and Drinks were M&Ms, Hershey's, and Reese's; Lays, Doritos, and Cheetos; and Coca-Cola, Pepsi, and Gatorade; respectively. Although the team did ask about the most popular Tobacco brand, Newport, we decided early on not to obtain samples of these products since the packaging is very standard for them and their environmental impact is already known. For the product samples collected, the average weight of both the packaging and the product itself is shown in Table 2. Additionally, Figure 9 shows a comparison between both weights to establish the packaging-to-product ratio with the highest to lowest being Drinks, Chips, and Candy.

Table 2: Average weight of products and their plastic packaging for common convenience items.

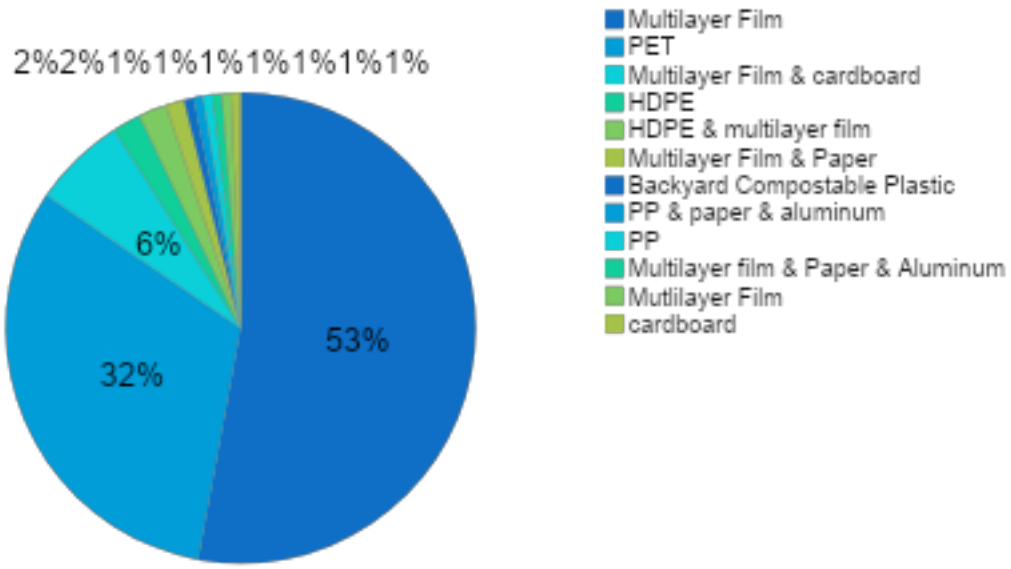
Product Type	Number of Samples	Average Weight of Plastic Packaging (g)	Average Quantity of Product (g or mL)
Beverages	50	30.8	439.5
Candy	58	3.7	85.9
Chips	47	6.3	129.6

Figure 9: Packaging to product weight ratio



The team also decided to sample a variety of products to include potential plastic alternatives in product packaging, besides the standard materials found in stores' common brands. In that sense, we had a wide variety of products, some with sustainably invested parent companies that already used compostable materials or who are interested in diminishing their negative environmental impact. Because of these, besides the more common PET and multilayer film packaging, we collected some samples that included cardboard, paper, and even backyard-compostable plastic (Figure 10).

Figure 10: Material breakdown of sampled convenience items in Atlanta



Although there were only eight main materials present in the samples, 65% of the samples contained multi-material or multiple polymers packaging. For the most common brands in stores, 100% of the packaging for chips was Multilayer Film as was 60% of the candy packaging. The drinks had 98% PET

packaging. It is important to highlight that we found lower-environment-impact containers for some of the same brands of popular candy and drinks in some of the major grocery stores and even some of the smallest convenience stores. However, we also found distributors who offer more affordable sized candy packages in gas stations, convenience stores, and even pharmacies with their own branding on packaging usually made of plastic and coated paper.

Food Vendor Container Analysis

The team also kept track of the type of materials used for take-out in the restaurants around the studied areas, noting the presence of compostable materials and plastic alternatives when available (Table 3). Out of the 170 to-go items analyzed from the 27 restaurants, only 17% are considered to be made of compostable or biodegradable materials, but they are present (under different brands) in every to-go item category.

Table 3: Types of Materials of common packaging items from food vendors

Product	Material Type	Number of Observations
Bag	LDPE	19
	Paper	10
Cup	Coated paper	6
	EPS	11
	PET	7
	PLA	2
Lids	PET	7
	PLA	3
	Undetermined Plastic	16
To-go Container	Aluminum	1
	Cardboard	8
	Coated Paper	3
	EPS	10
	Fiber	5
	PET	2
	PP	6
Sauce Containers	PLA	2
	Plastic Film	1
	PP	2
	Undetermined Plastic	2
Straw	PHA	1
	PLA	3
	PP	19
Utensils	CPLA	3
	PP	23
	Wood	1

Although there is a representation for compostable take-out materials and plastic alternatives in the restaurants sampled in Atlanta, the most common material for containers and cups is EPS; for utensils, straws, and sauce containers was PP; LDPE for bags; and lids from undetermined plastic. Therefore, the majority of materials used by vendors in the sampled areas of Atlanta are plastics (50%), as shown in Figure 10, and even EPS (12.2%), which some markets in the US have banned. Also, unmarked plastics (10.5%) make it extremely challenging for community members to know what to do when it comes to disposal, creating the need for information transparency discussed in the Community section.

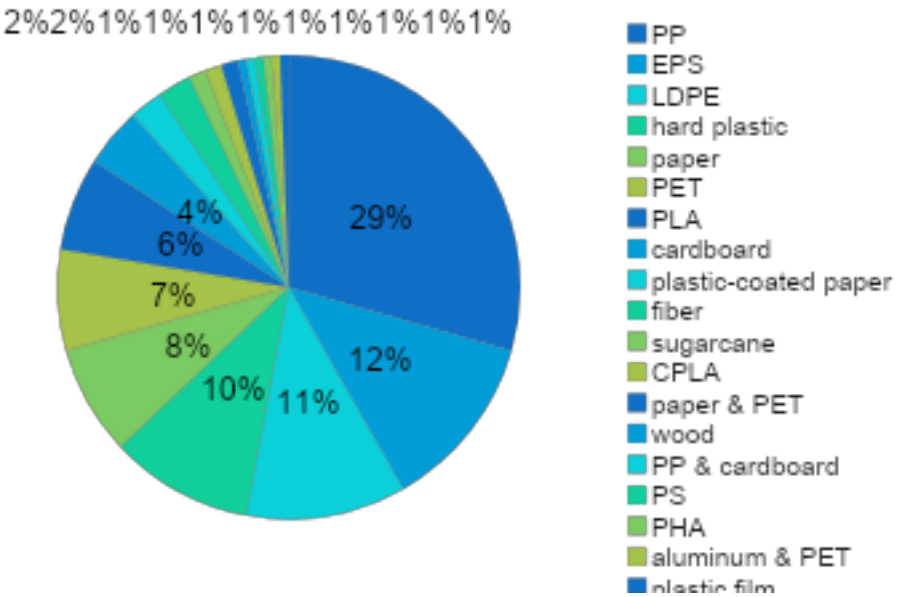
Restaurant sampling consisted of 170 total to-go items from 27 restaurants, including 37 food containers, 29 bags, 27 utensils, 25 cups, 23 straws, 22 cup lids, and 7 sauce containers. The most common food containers are listed below:

- Food container: EPS
- Bags: LDPE

- Utensils: PP
- Cups: EPS
- Straws: PP
- Cup lids: hard plastic (polymer unknown/undesignated)
- Sauce containers: PP

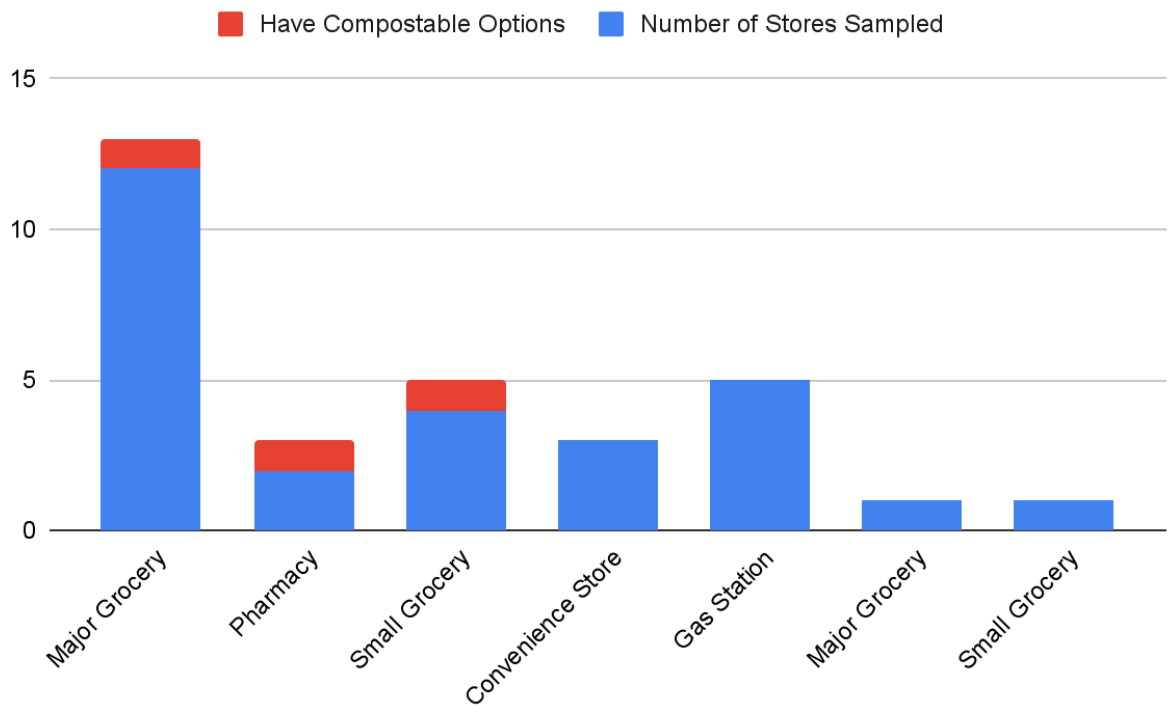
Roughly 19% of the restaurants sampled offered compostable plastic to-go items. Among all to-go products, 9% were labeled compostable and 2% were labeled biodegradable, a majority being food containers. In total, there were 19 different material types offered for restaurant packaging (Figure 11 shown below):

Figure 11: Material breakdown of to-go items sampled in Atlanta



Despite more environmentally conscious options appearing in the food markets every day, like compostable and biodegradable to-go containers, as well as people refusing single-use straws and utensils in certain circumstances, the presence of plastics, even in the face of vendors and consumers' discomfort (see Community section), points to a different issue than consciousness. In that aspect, we should consider information transparency, availability, and costs as some of the biggest obstacles that a better product design could potentially address. In terms of information transparency, for instance, proper signage on individual to-go containers could avoid recycling and composting streams contamination due to confusion. Availability would mean having more options for vendors to choose from when it comes to to-go containers in their neighborhood. Such options are again becoming popular in the stores with almost all major grocery store chains (except one) and pharmacies in the studied area having compostable alternatives to plastic (see Figure 12). Convenience stores and gas stations, on the other hand, only had EPS and plastic when packaging was available (except for sustainability geared small stores, which presented themselves as miniature health/grocery stores). As for costs, the following section analyzes the differences that make usage of a certain material possible under the current circumstances in Atlanta.

Figure 12: Compostable to-go items availability per store type and sample size



To understand patterns of use and reuse for plastic products in Atlanta, alternatives to plastic and their respective prices were documented where available in the study areas. Similar products in plastic packaging were recorded at the stores where alternatives were found in order to establish economic accessibility to these types of products. In the following table, the team established average prices for the products as well as an alternative minimum and plastic minimum within each of the three areas of study in the city. Where available, we also recorded prices for reusables as plastic alternatives and compared those prices to plastics.

Table 4: Cost of plastic items compared to reusable and refillable alternatives available in Atlanta

Product	Plastic Alternative	Avg. Cost of Alternative	Avg. Cost of Plastic or Similar	Min. Cost of Alternative	Min. Cost of Plastic or Similar	Avg. Cost Difference for Alternative
Bowls	Compostable	$0.28 /bowl	$0.20	$0.14	$0.10	38%
Cups	Compostable	$0.54 /cup	$0.06	$0.52	$0.05	88%
	Reusable	$1.29 /cup				220%
Food Bags	Compostable	$0.13 /qt bag	$0.05	$0.10	$0.02	16%
	Reusable	$5.58 /qt bag				1114%

Plates	Compostable	$0.20 /L-Plate	$0.12	$0.15	$0.03	67%
Straws	Compostable	$0.07 /Straw	$0.04	$0.05	$0.03	96%
Trash Bags	Compostable	$0.54 /13-gal bag	$0.23	$0.46	$0.19	139%
Utensils	Compostable	$0.16 /unit	$0.07	$0.13	$0.05	122%

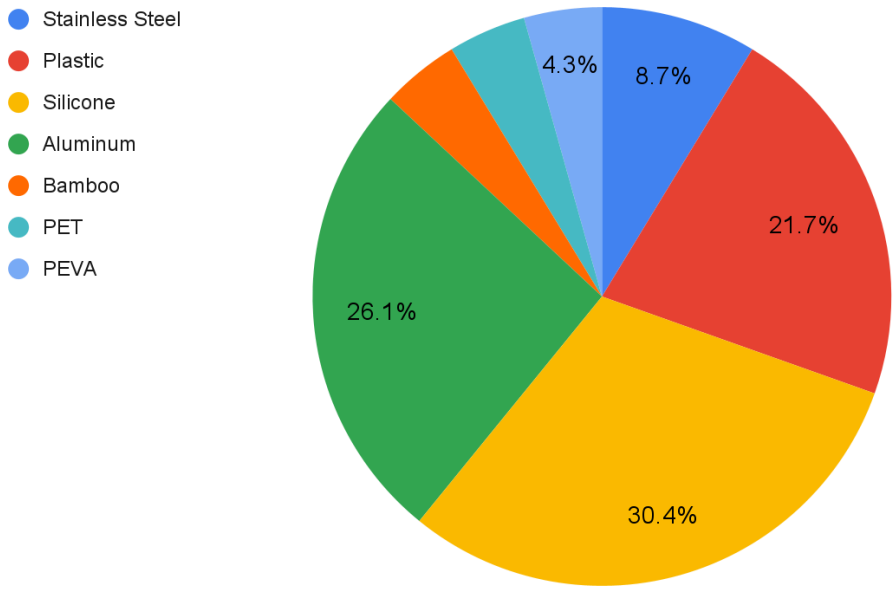
There were a significant number of stores surveyed in Atlanta that sold exclusively disposable tableware products that were alternatives to plastic in at least one of the products analyzed. Unfortunately, this pattern mostly applied to major grocery stores and pharmacies, while on the other hand there were little to no plastic alternatives in small grocery, convenience stores, and gas stations. In the stores where a majority of disposable products had plastic alternatives, other products had plastic-free alternative packaging such as carton and paper personal care products and bulk options (one of which was recorded as the most popular brand at the store.)

Reusable products usually have a bigger price tag that makes them harder to compare to the type of products that we analyzed. As seen in Table 4, reusable products often require a higher monetary investment, and can also require considerable time and effort to use/maintain, which limits their accessibility to everyone. Community members that are already committed to environmental sustainability are the ones who usually purchase these items. Reusable materials vary with the most popular being plastic (21.7%), silicone (30.4%), and aluminum (26.1%), in different brands that appear across different stores (Figure 13).

Figure 13: Carton and Paper Personal Care Products

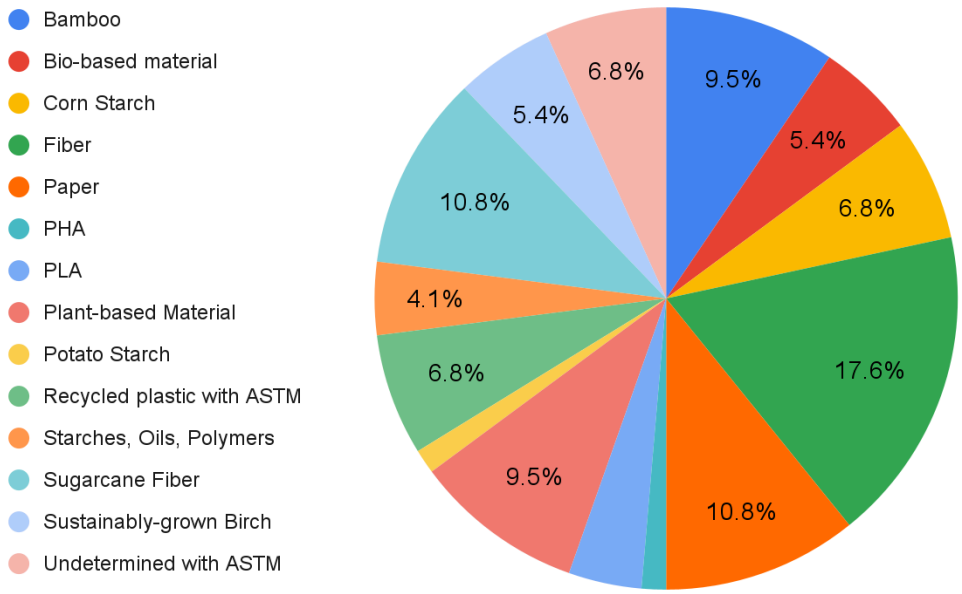

Hi
nice to meet you.
We're on a mission to rid the world of unnecessary plastic. But we want to look fabulous doing it. Is that so wrong?
How: Rub the angled side of HiBAR on wet hair. Be patient - HiBAR doesn't drown your hair like liquid conditioners. Gently work through your hair for a light, thorough coating. Wait a few minutes. Rinse.
Store HiBAR hi, dry and upright.
Ingredients:
For external use only.
No parabens, sulfates, silicone, phthalates or cruelty.
Made with love by
HiBAR
HiBAR.
SOLID
CONDITIONER
MAINTAIN
Look, no plastic bottle! Just a color-safe conditioner that maintains the health of your hair, leaving it fresh and clean, with shea butter and honeyquat to add a bit of shine.
Goodbye plastic, hello HiBAR.
Coastal Breeze
Avocado
Lavender
Cedarwood

Figure 14: Reusable products by material type



Compostable and biodegradable options in stores are also made from a wide variety of materials with the most popular being fibers (28.4%), paper (10.8%), and bamboo (9.5%), and the majority specifying the need for industrial composting (Figure 15). Some sampled biodegradable products presented that they would break down in 1-5 years under standard landfill conditions; however, this seems questionable given that traditional plastics do not biodegrade.

Figure 15: Plastic alternatives by material type



In general, while compostable food bags (quart size), bowls, and plates were more expensive, they were still within comparable ranges to these products sold in plastic packaging. Alternatively, utensils, trash bags,

straws, and cups were significantly more expensive on a per unit basis when compared with traditional plastic alternatives. The impact of these prices transfers to food vendors who potentially want to use those alternatives. A promising cost reduction option to navigate this price discrepancy, besides cups without straws, is the "Do not include utensils" option in online orders; however, it has been the case that vendors still send utensils even when the option is chosen. It is important to highlight that products like alternative-plastic straws were more easily adapted by food vendors in Atlanta, who tend to choose alternative options to plastic according to their target audience (see Community, Economics).

Food vendors also offer the option to use paper, plastic, or no bags in their to-go orders, the latter being easier to get when consumers are picking up their own orders. For the majority of online or multi-entree orders, however, they use either paper or plastic bags, LDPE being almost twice as popular than paper. This trend is also consistent with the bags offered at the 27 sampled stores, who offered 89% plastic bags (96% LDPE, 1 HDPE2 bag), with no option of paper bags in 85% of stores, no reusable fabric bags in 96% of them (one store sold 4 waxed cotton food bags for $9.99), and only one store with a reusable plastic bag option for $0.98 and a $0.10 discount if you brought your own reusable bag.

Since there is a considerable amount of compostables already being used and sold in Atlanta, it is important to educate the public on proper disposal of them and other options in the city. If it is true that there is some industrial composting in the city, the infrastructure around it and public outreach for its use is very limited and sometimes confusing. Potential partnerships with the strongest stakeholders in order to provide this education could be a way to reach neighborhoods from different economic levels. Composting infrastructure also needs streamlining to be able to provide a path for all these plastic alternatives now and in the future.

In Atlanta, 27 stores were sampled. Of these stores, 89% had plastic as the most common bag type. Roughly 96% of those plastic bags were LDPE, with 1 bag type being labeled as "HDPE2 - 49.28% Biodegradation in 900 days under Landfill Conditions." This likely means that this HDPE product contains oxo-degradable additives, and the bag does not actually biodegrade. 85% of stores sampled did not offer paper bags, while 96% did not offer fabric bags. The only store that did offer fabric bags had them priced at $9.99 for a 4 pack of waxed cotton food bags. One store sold reusable plastic bags for $0.98, and another offered a $0.10 discount if you brought your own reusable bag

A total of 10 grocery/pharmacy stores were sampled for compostables, reusables, and recyclables, culminating in 122 total sampled products. A price breakdown of these alternatives is shown below:

- Average unit cost of reusable items: $7.05
- Average unit cost of single-use products: $0.34
- Average unit cost for biodegradable items: $0.14
- Average unit cost of compostable items: $0.26
- Average unit cost of regular plastic or plastic coated single-use items: $0.13

The most common brands for compostable items were Simple Truth, Total Home, and Repurpose. 16 total brands were documented for compostables, while two more brands were labeled as biodegradable. The most common biodegradable material types were fiber (15% of compostables), plant-based material, corn starch, bamboo, and sugarcane. There were a total of 21 different material types or combinations of materials identified for items labeled as compostable. There were 7 material types identified for reusables, which tended to consist of silicone (37%) and aluminum (32%). By product, reusable options were only seen for cups, bags, straws and utensils. Compostables were found in all item categories (plates, trash bags, utensils, straws, bags, cups, and bowls), with the most compostable options found in plates and bowls.

Collection

In 2019, the City of Atlanta's Department of Public Works committed to a series of solid waste enhancements related to collection and pick-up for residential areas, vacant lots, multi-family units, and the commercial sector (City of Atlanta Department of Public Works, 2019). These proposed enhancements are shown in Figure 16 below:

Figure 16: City of Atlanta Proposed Solid Waste Enhancements, 2019

The City of Atlanta Solid Waste Services provides residents with cans for single-stream recycling and waste disposal for weekly collection, with residents paying fees for this service. Once waste is collected in Atlanta, it goes to a Waste Management transfer station, where it is then distributed to various landfills in Fulton County (Wheatley, 2019). While the City of Atlanta does not have a program for handling household hazardous waste, it partners with Live Thrive's CHaRM (Center for Hard to Recycle Materials) to properly manage and dispose of household hazardous materials. Commercial, non-residential waste, including construction and demolition debris, is collected by private haulers. High-traffic areas where there is likely to be more waste generated include Atlanta Hartsfield-Jackson International Airport, The Battery (Braves Stadium), Mercedes-Benz Stadium, and Centennial Olympic Park -- including the Georgia Aquarium and the World of Coca-Cola.

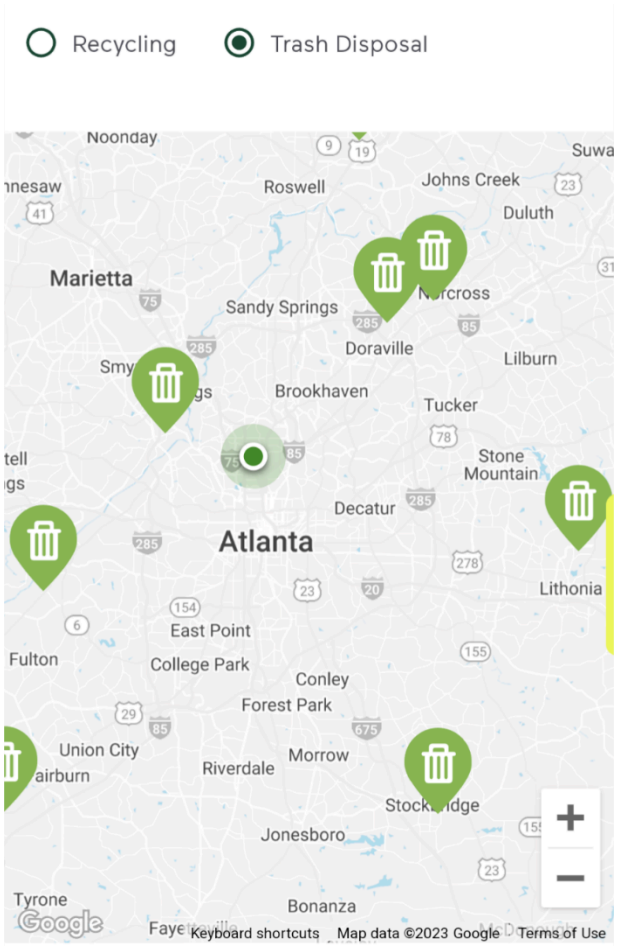
From interviews, we learned that standardization of collection and recycling ordinance enforcement has been a challenge. The Curbside pickup service currently covers most of single-family and under six-unit multi-family residences in the city, leaving out almost 95% of people living in multi-family residences. Therefore, multi-family residences of more than six units and commercial buildings make their own arrangements for trash collection and recycling, in which the latter is not always up to standards and rarely enforced. Currently, the city utilizes rear-loading collection trucks for curbside pickup, with most trucks colored blue with the City of Atlanta logo (Figure 17) as observed in a residential part of a high ambient population zone. The observed recycling trucks were white with no logos (Figure 17), although both trash and recycling trucks had similar characteristics with at least a partial autoloader. This is contrary to some private recycling haulers of multi-family residences who load recycling manually. With close to fifty collection

entities currently operating in the city, there are understandable challenges to standardizing collection services (EPD, 2023). However, among their future strategies, the city hopes to acquire eleven Automated Side Loaders (ASLs) within the next few years to increase their collection efficiency.

Figure 17: Curbside Pickup of Trash (Left) and Recycling (Right) in Atlanta

The last step in the collection process involves a stop at a Transfer Station, where the waste is transferred to go to surrounding landfills (for waste), and another Transfer Station where recyclables are transferred to a Materials Recovery Facility (MRF). Some of these transfer stations also are drop-off spots for Atlanta residents (Figure 18), but at least half of the twenty-five active transfer stations in Fulton and Dekalb counties are outside of the City of Atlanta. Although there is a possibility that at least in one case, recycling contamination can be addressed in this in-between station of the process, the most critical step in addressing recycling contamination happens at the source. Reducing contamination at the source helps Material Recovery Facilities (MRFs) to avoid the typical problems of contamination at the facility. There are currently two such facilities operating in Atlanta, with another two in Fulton County, from which the most profitable recovered materials are plastics #1 and #2. The city is focusing on zero waste goals through partnerships with other intermediaries such as CHaRM and Goodr, to reduce waste, especially food related. These intermediaries are another in-between station before recycling markets, and the one operating composting facility (Collegetown Farm / Community Composting Lab) and one operating landfill (Seminole Road Landfill) currently within the city of Atlanta that are the end-of-life station for Atlanta waste.

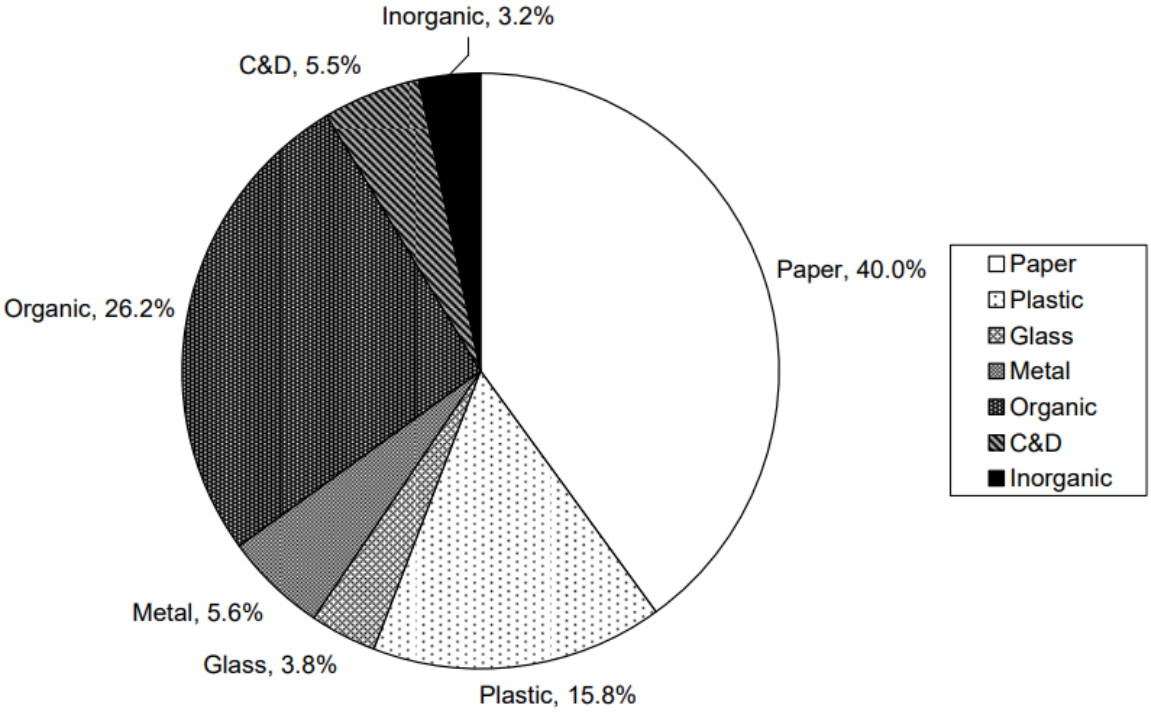
Figure 18: Trash Drop-off/ Waste Management Transfer Stations


Recycling
Trash Disposal
Noonday
Roswell
Johns Creek
Duluth
Suwa
Marietta
Sandy Springs
Doraville
Lilburn
Brookhaven
Tucker
Stone Mountain
Decatur
Atlanta
Lithonia
East Point
College Park
Fulton
Conley
Forest Park
Union City
Riverdale
Morrow
Jonesboro
Tyrone
Bonanza
Keyboard shortcuts
Map data ©2023 Google
Terms of Use

End of Cycle

On average, households in Atlanta produce 814 pounds of waste (including bulky items) per person each year (City of Atlanta, 2009). The most recent study on waste characterization in the state of Georgia determined that the Atlanta Regional Commission Regional Development Center (consisting of Cherokee, Clayton, Cobb, Dekalb, Douglas, Fayette, Fulton, Gwinnett, Henry, and Rockdale counties) had MSW composition consisting of: paper 40%, plastic 15.8%, glass 3.8%, metal 5.6%, organic 26.2%, C&D 5.5%, inorganic 3.2% (Georgia Department of Community Affairs, 2005). An example figure from that report is shown in Figure 19.

Figure 19: Atlanta Regional Commission RDC Disposed MSW Composition



The city of Atlanta recycles plastics number 1-5, although contamination and high recycling tipping rates make recycling challenging, with the most cost-effective plastics being #1 and #2. The current system costs the city $45/ton to landfill and $75/ton to recycle solid waste, since the latter is taken to private MRFs. On the other hand, a resident dropoff center for Live Thrive's CHaRM only charges based on type of waste and business status. Residents are allowed, for the most part, to dispose, without fees, of materials, such as cartons, plastics, tires, textiles, compost, cooking oil, glass and metals, among others.

Composting has become one of the most talked about topics in the Atlanta solid waste scene (Wheatley, 2022; Pepalis, 2022). Stakeholders recognize the importance of access to central composting facilities that offer industrial composting in order to process the amount of organic waste produced in the city. Although there are currently private entities offering pickup services for compostable waste, they are limited in the amount and scope of materials they collect. Out of all compostable products in the surveyed stores, a majority are designed for commercial composting, although there are some that advertise backyard composting. According to their website, CompostNow is one option for curbside pickup and composting of alternative plastics, however, some facilities have decided to stop accepting compostable plastics because of traditional plastics contamination, which has reduced the opportunities for processing industrial compostable materials. During interviews, some stakeholders mentioned having plans to build their own composting facilities or believe there should be a place for residents to drop off their compost or even

recyclables, but they also believe that big organizations, with the capability for it, should incorporate on-site composting. However, for a smaller communal facility (not industrial scale) to be able to operate properly, there needs to be education and signage on the various kinds of plastic and biodegradable containers to avoid contamination (including PLA plastics).

Composting

With the lack of access to a municipal or commercial composting program in Atlanta, the city has an opportunity to create a residential composting program for their residents. Using the Residential Source Separated Organics Collection Performance Model by SAIC Energy, Environment & Infrastructure, LLC and the WARM Model from the EPA, we have calculated the estimated households covered in the program, mass of organic waste to be collected, GHG Reduction from the program, and area required to create a composting facility for the organic waste. The calculations will vary based on the range of estimated participation between 50-100% for the curbside collection and 25-50% for the drop-off collection.

Table 5: Estimated Mass of organic waste, GHG Reduction, and Area Required for introducing a residential compost program based on the Residential Source Separated Organics Collection Performance Model by SAIC Energy, Environment & Infrastructure, LLC

Atlanta				
	Households Covered	**Mass (Tons)**	**GHG Reduction (MTCO2E)**	**Area Required (Acres) ****
City Curbside* (50-100%)	253,355	21,898 - 43,795	8,698 - 17,396	7.94 - 15.9
City Drop-off (25-50%)	253,355	14,598 - 29,197	1,675 - 3,351	5.29 - 10.6

*Assumed capture rate of 75% for all curbside calculations, range of percentage applies to participation rate
**Calculated conversion rate of 2,757.58 tons/acre from https://www.biocycle.net/calculating-a-composting-facility-footprint/
To calculate the GHG Reduction that would come with the introduction of a residential composting program, several assumptions needed to be made using the WARM Model from the EPA. Those assumptions can be found in the following table:

Table 6: Assumptions made for calculating the GHG Reduction using the WARM Model from the EPA

Assumptions for GHG Reduction
Using only net change in materials diverted from landfill to composting facility in GHG Reduction model
Waste Generation Per Capita in Atlanta: 2.23 lbs/person/day*
Total Refuse for City Calculations: 202,054.90 tons
Using South Atlantic region for electricity grid mix emission factor
Using National Average for LFG recovery in landfills since waste from Atlanta could go to one of three different landfills
For Landfill gas collection efficiency, assuming Typical operation suggested by WARM model of:
Years 0-1: 0%
Years 2-4: 50%
Years 5-14: 75%

Years 15 to 1 year before final cover: 82.5%
Final Cover: 90%
Moisture conditions and associated bulk MSW decay rate is national average according to WARM model: weighted average based on the share of waste received at each landfill type
Emissions that occur during transport of materials to the management facility are default according to WARM Model
Percentages of Materials used for WARM model:
Fruits and Vegetables: 3.75%
Bread: 3.75% (in place of bakery)
Mixed Organics: 13.4% (in place of non-recyclable paper, wood, and other organics)
Food Waste: 5.9% (in place of Other Food Scraps)
Yard Trimmings: 2.1%

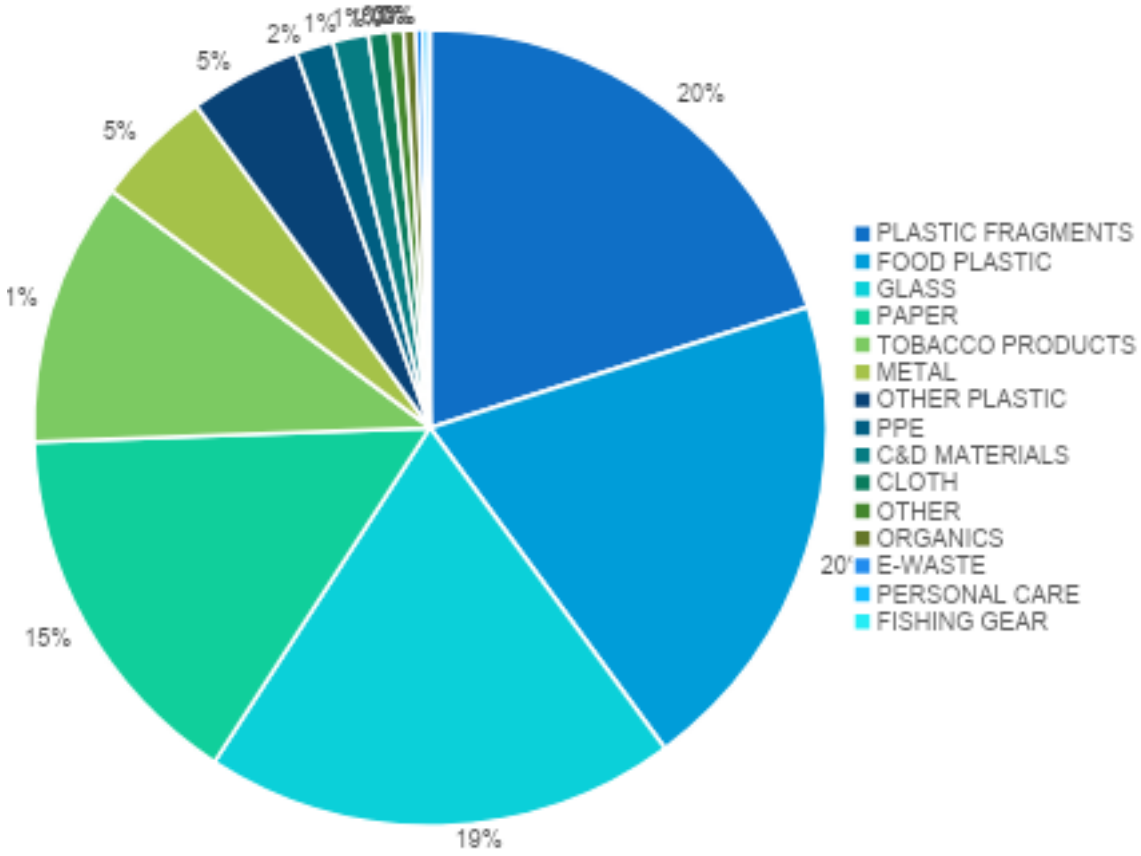
*Waste generation rate based on this study:
https://dca.ga.gov/sites/default/files/atlanta_ci_cdp_community_assessment_community_participation_community_agenda_2011_part_ii.pdf

Leakage

A spatially stratified random sampling method generated survey areas for conducting transects, which were selected within nine 1-square kilometer areas and were distributed across three groups of population count (upper, middle, lower) across Atlanta. These population counts were based on the Oak Ridge National Laboratory's LandScan global ambient population data for 2021 (Sims et al. 2022). Litter items were recorded using the open-source Debris Tracker mobile application ('app') (Jambeck and Johnsen 2015). A full list of items available in the app and their associated material categories can be found in the Appendix. Litter was examined based on abundance, proportion of material and product types, and product densities across all transects and aggregated across the three population groupings.

In total, 1,661 litter items were recorded across twenty-seven 100 m^2 transects in nine different square kilometer areas sampled in June and July 2022. Across all surveyed transects, plastic fragments and food plastic were the most prevalent litter item by item type, together representing 40% of all items recorded. The second largest category was glass (19%) followed by paper (15%), tobacco products (11%), metal (5%), other plastics (5%), and construction and demolition materials (2%). The remaining categories represented 3% or less of all litter items (Figure 20).

Figure 20: Litter Material Breakdown for Atlanta



In total, 1,661 items were logged in 27 transects (each 100m^2) characterizing 9 different square kilometer areas. Transect locations were selected using a stratified random sampling method, in which transects were randomly selected in ten square kilometers which were distributed across three groups of population count (upper, middle, lower) based on LandScan ambient population data. Litter items were recorded using the

open-source Marine Debris Tracker app. A full list of items available in the app and their associated material categories as well as a map of sample sites and their surveyed litter densities can be found in the Appendix.

By individual product types, hard plastic fragments, cigarettes, and plastic food wrappers were the most recorded items (Table 5). Common food packaging like candy and chip wrappers, have low packaging-to-product ratios, which are generally less valuable for recycling compared to plastic bottles made of PET. The presence of paper (15%) in litter transects suggests that it may not be fully captured in the current system.

Table 5: Total transect count of top 20 debris items by item type

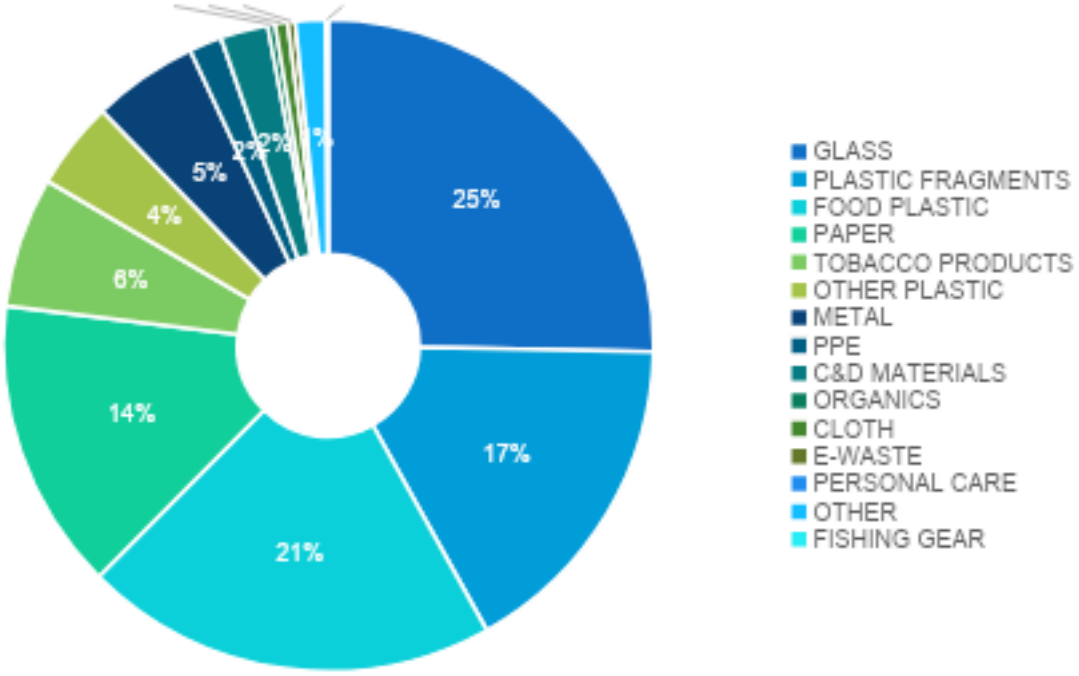
Item Type	Count	Percent of Total
Hard Plastic Fragments	350	21.1%
Cigarettes	292	17.6%
Plastic Food Wrapper	277	16.7%
Paper	249	15.0%
Foam or Plastic Cups or Lids	70	4.2%
Plastic Bottle Cap	54	3.3%
Plastic Bottle	47	2.8%
Other Plastic Bag	40	2.4%
Aluminum or Tin Cans	39	2.3%
Straws	32	1.9%
Metal Bottle Caps or Tabs	32	1.9%
Plastic Grocery Bag	29	1.7%
Non-coated Paper Food Wrapper	26	1.6%
Plastic Utensils	20	1.2%
Other	17	1.0%
Other Tobacco Packaging	13	0.8%
Cigarette Packaging	13	0.8%
Glass Bottle	11	0.7%
Disposable Gloves	10	0.6%
Corrugated Cardboard	9	0.5%
Total (Top 20)	**1630**	**98%**

When examining the litter characterization based on the population count, some similarities and distinctions can be seen between the three groups. The top five litter items among the low, mid, and high population count areas are glass, plastic fragments, food plastic, paper, and tobacco products. The large proportion of plastic fragments in all three areas is notable given the challenges related to collecting, managing, sorting, recycling or disposing of plastics, it also indicates they have been in the environment for some time to have

weathered and fragmented. Also, notable is the large proportion of food plastics, which are difficult to recycle, and in the case of food wrappers, not recyclable.

The variation in proportions of litter types across the population tertiles can provide insight into material use and leakage across the areas. For example, glass is the most prevalent material type found among low (25%) and high (24%) population areas, whereas food plastics (24%) were the most common material found in mid population areas. Tobacco products were most prevalent in the mid population tier (18%), which could suggest that more people in mid population areas smoke, or that there is less opportunity for disposal in those areas (Figure 21).

Figure 21: Proportion of most common plastic items in low (inner), mid (middle), and high (outer) population count areas in Atlanta



When aggregated across all surveys, Atlanta has an average litter density of 1.14 items per square meter. However, like the variation seen in litter composition, litter density also differed between the three population count areas. Litter density was highest in high population areas, while litter density was also lowest in low population areas. This trend is observed in cities where other influencing variables are equal, so that sheer numbers of people influence leakage. However, other variables that have been observed to influence leakage include income (Schuyler et al., 2021).

Table 6: Litter Densities of Population Tertiles (Societal Activity) in Atlanta

Population Tertile	Top 5 Litter Items	Litter Density (count/m^2)

High	1) Glass or Ceramic Fragments, 2) Hard Plastic Fragments, 3) Paper, 4) Plastic Food Wrappers, 5) Cigarettes	1.46
Mid	1) Cigarettes, 2) Hard Plastic Fragments, 3) Plastic Food Wrappers, 4) Glass or Ceramic Fragments, 5) Paper	1.08
Low	1) Glass or Ceramic Fragments, 2) Plastic Food Wrappers, 3) Paper, 4) Hard Plastic Fragments, 5) Cigarettes	0.89

Opportunities

CIL found the following opportunities to expand and enhance circularity in Atlanta based on the findings of this report. These opportunities are categorized based on the seven spokes of the CAP model. Stakeholder engagement with the partners of this project should take place to further expand, refine and prioritize these opportunities based on local context, impact, feasibility, and cost. It is important to note that the opportunities listed below are individualized based on the findings, but solutions cannot happen in a vacuum and are most impactful when strategically combined within a holistic system framework.

Input

- From our sampling, roughly 30% of beverage parent companies and 20% of beverage manufacturing is found in Atlanta, presenting a unique opportunity for conversations with these local companies about extended producer responsibility (EPR).
- Encouraging domestic candy products as opposed to those that come from abroad may reduce the overall footprint that is required to bring products to Atlanta from overseas.

Community

- The need to send a clearer message to people through education campaigns, information transparency, and better signage could clarify confusion about recycling, waste management, and composting in Atlanta.
- For some communities, it has not been easy to get involved in sustainable solid waste behavior, either because of allocation of resources or exposure to specific materials that make it easier or faster to landfill everything in the best-case scenario.
- Circularity in Atlanta could benefit from a multifaceted, community-based equity approach that recognizes these inequalities in resources. For example, low-income areas of Atlanta are the most exposed to plastics and EPS products in both the store and restaurants through takeout containers and disposable tableware.
- The current popularity of Live Thrive's CHaRM center proves the general public's interest in having spaces dedicated to hard to recycle materials; further data collection on where people may want similar services, what their barriers to participation may be, etc. could be necessary to expand infrastructure in Atlanta.

Product Design

- Specialized stores carry environmentally conscious brands that use more sustainable packaging.
- Sustainable packaging consists of plastic alternatives and some compostable materials - there is an opportunity to make these options and alternatives more equitably distributed throughout Atlanta.
- Some of the emergent snack brands already portray sustainability as part of their company goals making them more prone to changing packaging practices.
- Repackaged snacks, wildly popular in gas stations and small convenience stores, could represent another opportunity for sustainable packaging.

Use

- Reusable alternatives are available in some areas of Atlanta, but these could be expanded and equity should be at the forefront of this opportunity to expand.
- To encourage leadership and innovation among businesses, the city could highlight efforts by local businesses to reduce plastic use.
- As more complex plastic alternatives are introduced to the waste stream, more education efforts will be needed to combat misleading product labels and encourage understanding and appropriate management by individuals and households.

Collection

- While plastics #1 - #5 have some infrastructure for collection and management, there may be possibilities at expanding collection of film plastics led by private businesses (mainly grocery retailers).
- Mapping out existing receptacles and drop-off locations would provide an opportunity to examine collection gaps and disparities in access across the community.

End of Cycle

- With landfill tipping fees being cheaper than recycling tipping fees ($45/ton to landfill and $75/ton recycling), there is a need to brainstorm how local and regional recycling can be incentivized.
- Given the lack of compost facilities paired with the growing use of compostable and biodegradable items in the waste stream, there is a growing need to educate consumers about what these product designations mean, what product labels entail, and how to appropriately manage different materials based on their disposal designations.
- There is an opportunity to expand composting in Atlanta as compostable materials use and waste stream continue to grow.
- The most recent study on waste characterization in Atlanta was in 2005; getting more updated data could help inform solutions in the city.

Leakage

- Collecting data and monitoring trends over time can provide insight into waste patterns, community needs, and effectiveness of waste management programs. With continued litter monitoring in selected locations, the city may be able to identify innovative ways to prevent and abate litter in the community.
- Plastic fragments are the most common item, which makes it difficult to identify intervention points. However, the other most common litter item, food plastics, can be addressed with a community-wide food reuse system and alternatives to plastic from compostables (with proper composting infrastructure) or biodegradable materials.

Glossary

CAP: Circularity Assessment Protocol

CIL: Circularity Informatics Lab

EPR: Extended Producer Responsibility

EPS: Expanded polystyrene

FMCG: Fast moving consumer goods

HDPE: high density polyethylene

MSW: municipal solid waste

PET: polyethylene terephthalate

PLA: polylactic acid

PP: polypropylene

SUP: single-use plastic

UGA: University of Georgia

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Appendix

Table A1: Full List of Debris Tracker Litter Items and Associated Material Categories

Material	Items
C&D Materials	Aggregate & Brick Bolts, Nails, and Screws Building Materials Lumber Other C&D
Cloth	Clothing Towels or rags Fabric Pieces Other Cloth

E-Waste	Batteries E-Waste Fragments Wire Other E-Waste
Fishing Gear	Buoys and Floats Fishing Line Other Fishing Gear Plastic Net or Net Pieces Plastic Rope
Glass	Glass Bottle Glass or Ceramic Fragments Other Glass
Metal	Aluminum Foil Aluminum or Tin Cans Foil to-go container Metal Bottle Caps or Tabs Metal Fragments Other Metal
Organic Waste	Food Waste Other Organic Waste
Other	Other Popsicle or lollipop Stick
Other Plastic Products	Bulk Bags Flip Flops or shoes Plastic String, Tape, or Packing Straps Rubber Bands Trash bag Tires Balloons Plastic toys or balls Car Parts Hard plastic jugs or containers

	Other Plastic
Food-Related Paper	Paper cups Paper food box or container Paper plates or bowls Compostable paper cups Paper food wrapper Compostable food box or container Napkins Other Food-Related paper
Paper	Office paper and newspaper Tags, tickets, and receipts Corrugated Cardboard Paper fragments Other Paper
Personal Care Products	Blister Pack or other pill packaging Cotton Buds Ear plugs Personal Care Product Sachet or packet Toothbrushes Toothpaste or Other Product Tube Flossers Feminine products Needles and syringes Other Personal Care Product
Food-related plastic	Foam cups Plastic cups Compostable plastic cups Cup Lids Plastic Bottle Aseptic cartons Mini alcohol bottles Plastic Bottle Cap

	Plastic Food Wrapper Condiment packet or container Plastic Grocery Bag Sandwich or snack bags Plastic Utensils Straws Foam to-go container or clamshell Plastic to-go container or clamshell Compostable plastic container or clamshell Other Food-Related Plastic
Plastic Fragments	Film Fragments Foam Fragments Hard Plastic Fragments Rubber/ tire fragments Other Fragments
PPE	Disinfectant Wipes Disposable Gloves Face Masks Other PPE
Tobacco Products	Cigarette Packaging Cigarettes Tobacco Sachets or packets E-cigarettes and vaping Plastic cigar/cigarillo tips Lighters Cannabis-related waste Other Tobacco Product

Social Media Analysis

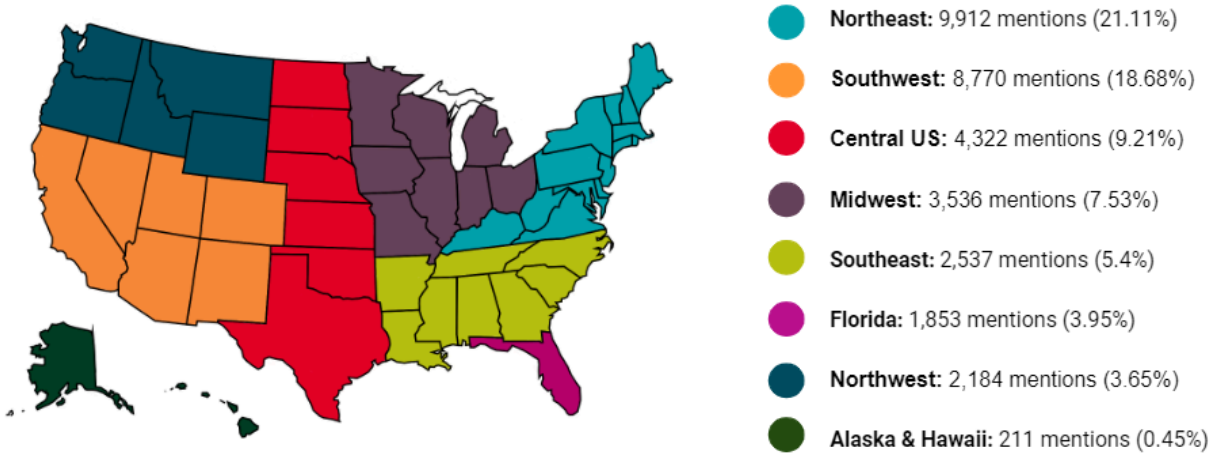
Education, infrastructure, and information transparency once again make an appearance in the community through our social media analysis. Through the data found in this analysis it is important to remark that information transparency plays a significant role in negative posts, those that usually include the criticism of a product, brand, or company. In this sense, people have negative feelings about the confusion around compostable and biodegradable items, the latter of which is sometimes used for greenwashing. Moreover, greenwashing creates a lot of distrust in potentially eco-friendly alternatives, making clearer labels and information transparency about the end-of-cycle of materials a crucial component of education. Education in the form of social media outreach has been present for a while, however, despite the clarifying bits of information in platforms, it's not always easy for users to refer to Twitter or Instagram to find information unless they already follow a specific educational account. These educational posts along with hopeful posts on infrastructure and composting count towards the positive or uplifting feelings demonstrated by the social media community. Some other posts give instructions on what to do with small and big contaminants of composting (from fruit stickers to sauce cups), or address the confusion about what is appropriate for what type of composting (home or industrial) and guide people on what what type of composting should be used for a certain product and what to do with it in the case of lack of infrastructure. In general, positive feelings posts highlight education initiatives or infrastructure/materials development while negative posts focus on the lack of information transparency that creates confusion and distrust, which is consistent with interviews and the general themes of stakeholders' concerns. Overall, between the lack of industrial composting facilities and citizens' confusion in how to dispose of plastic alternatives, the widespread introduction and use of compostables needs a responsible approach that includes addressing education, infrastructure, information transparency, and economics.

From July 1st, 2021, to August 31st, 2021, the Social Media Engagement and Evaluation (SEE Suite) group at University of Georgia's Grady College of Journalism and Mass Communication conducted a Compostable Plastics & Bioplastics Social Media Analysis using Bandwatch to aid in our understanding of consumer access and awareness of compostable and biodegradable plastics. SEE Suite sought to address three questions:

8. Are people aware of and purchasing biodegradable plastic alternatives?
9. Do people have access to compostable/biodegradable plastics in their community?
10. What types of composting systems would people like to see in their communities?

A geographic analysis of responses is shown below:

Figure A2: Geographic Analysis by Region



Twitter Conversations & Mentions

Conversations related to the awareness of and purchasing of biodegradable plastic alternatives that were analyzed on Twitter varied by region. 3.7% of the conversations related to biodegradable plastics were from the Southeast, while 7.5% of these conversations were from the Midwest. In contrast, 31% of biodegradable plastic conversations came from the Northeast and the Southwest, which indicates the regional awareness of plastic alternatives is higher in these areas than in the Southeast and Midwest. Tweets based on terms such as buy, own, purchase, use etc. captured 13.36% of the dataset, yet these conversations mostly discussed purchasing straws made from bioplastics, biodegradable/compostable straws, and reusable bags. Overall, purchasing patterns were difficult to gauge based on Twitter conversations.

Compostable/biodegradable plastics are widely available at grocery stores such as Walmart, Food Lion, Save A Lot, Kroger, Publix, etc., as well as at online retailers such as Amazon. However, compostable and biodegradable products are more expensive on average when compared to plastic, which can limit accessibility.

SEE Suite's search for specific methods of composting, ("warm composting," "hot composting," "vermicomposting,"etc.), only pulled ~6 mentions, which is very low compared to the almost 700 mentions from the total query. Data suggested that people are more focused on if composting is happening, as opposed to what type of composting. When using broader terms such as "composting infrastructure" and "composting systems," they found that industrial composting centers were desired among a niche group of people.

Industrial Composting

About half of those concerned with industrial composting came mostly from individuals with related professional experience, while the other half originated from nonprofits and professional/trade organizations such as Closed Loop Partners, Industrial Packaging, Nature Works, and the Plastics Industry Association. Most of these conversations revolved around the heat differences between home composting and industrial composting. Other conversations consisted of consumers purchasing biodegradable plastics with the intention of home composting, only to realize that the purchased items had to be sent to industrial

composting, while other Tweets were from companies highlighting biodegradable plastics that can be home composted.

Home Composting

Home composting Twitter conversations tended to be broader, and had roughly equal representation from individuals, nonprofits, and companies. 25% of these conversations yielded no insights relating to how to live a more sustainable life or what activities to do to celebrate Earth Day. In contrast, insightful conversations tended to revolve around what items should and should not be added to home composts. A significant number of conversations were about how biodegradable plastics and stickers should not go into one's home compost. Overlapping conversations between Tweets about industrial composting and Tweets about home composting tended to share that industrial facilities are much hotter and that biodegradable plastic products must be sent to an industrial facility. Again, Tweets from companies highlighted products that can be home composted.

Greenwashing

About half of the Twitter conversations on greenwashing within the compostable/biodegradable plastics space came from individual users, while the other half came from media outlets, companies, nonprofits, and trade/professional organizations. Most of these Tweets focused on how biodegradable/compostable plastics/bioplastics are greenwashing, yet they rarely are explicit about sharing why. Conversations also focused on buzzwords that are typically used to convince consumers that a product is more environmentally friendly than it actually is, such as "plant-based," "biodegradable," "all natural," and "compostable." Although less common, conversations about how to avoid greenwashing typically bring up product labeling and certification, such as the USDA Certified Biobased label. Interestingly, there were a few instances where brands such as Exxon, Coca Cola Company, Unilever, and EcoTools were called out for explicit greenwashing.

Aside from the major themes related to industrial composting, home composting, and greenwashing, additional themes that emerged related to Packaging & Products, the Environment, Circular Economy, Purchasing Compostable/Biodegradable Plastics, and Research, Innovation, & Design.

- Packaging & Products: related to the materials used in packaging, as well as consumer products
    - Total Mentions: 9,997; 21.31% of all mentions
- The Environment: mentioned ecological systems from which bioplastics primarily benefit, such as oceans and plants
    - Total Mentions: 9,480; 20.19% of all mentions
- Circular Economy: primarily mentioned topics of recycling, composting, and reusing plastics
    - Total Mentions: 6,618; 14.11% of all mentions
- Purchasing Compostable/Biodegradable Plastics: related to the purchasing of biodegradable plastics instead of other plastic that is more environmentally harmful
    - Total Mentions: 6,266; 13.36% of all mentions
- Research, Innovation, & Design: focused mainly on research related to bioplastics and the market, as well as new forms of compostable and biodegradable technology
    - Total Mentions: 5,025; 11.1% of all mentions

Individual conversations related to these themes are shown on a timeline below:

Figure A3: Timeline of Conversations, July 1, 2021 – September 30, 2021

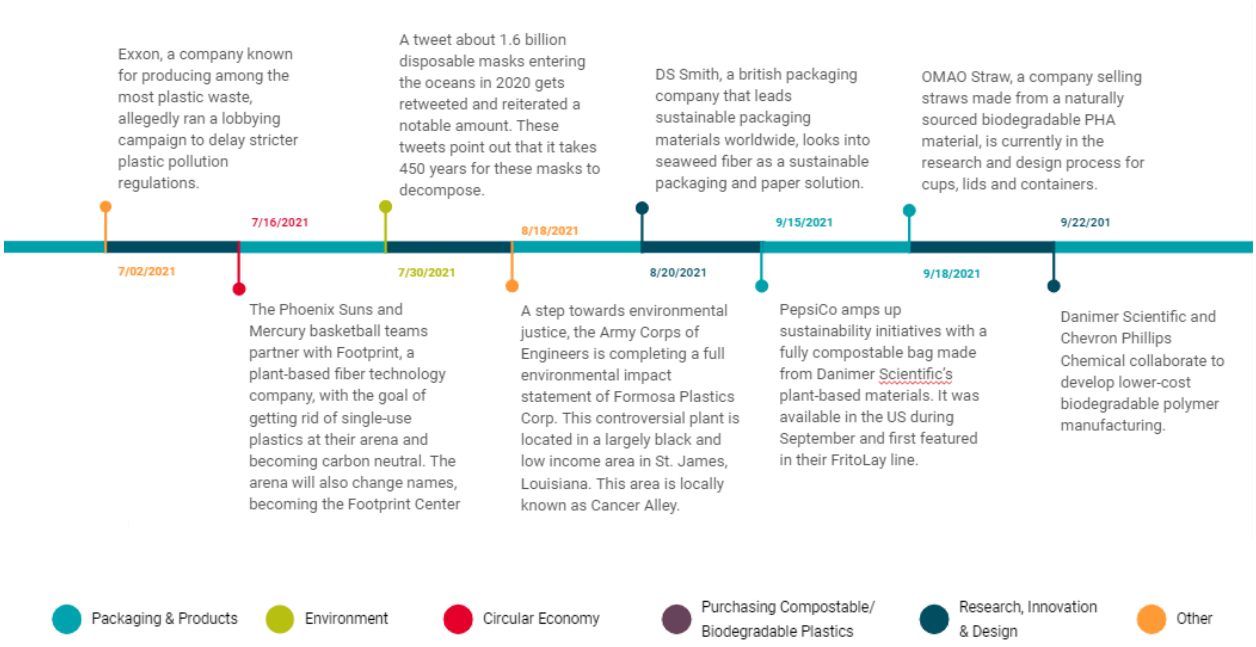

Exxon, a company known for producing among the most plastic waste, allegedly ran a lobbying campaign to delay stricter plastic pollution regulations.
7/02/2021
7/16/2021
The Phoenix Suns and Mercury basketball teams partner with Footprint, a plant-based fiber technology company, with the goal of getting rid of single-use plastics at their arena and becoming carbon neutral. The arena will also change names, becoming the Footprint Center
A tweet about 1.6 billion disposable masks entering the oceans in 2020 gets retweeted and reiterated a notable amount. These tweets point out that it takes 450 years for these masks to decompose.
7/30/2021
8/18/2021
A step towards environmental justice, the Army Corps of Engineers is completing a full environmental impact statement of Formosa Plastics Corp. This controversial plant is located in a largely black and low income area in St. James, Louisiana. This area is locally known as Cancer Alley.
DS Smith, a british packaging company that leads sustainable packaging materials worldwide, looks into seaweed fiber as a sustainable packaging and paper solution.
8/20/2021
9/15/2021
PepsiCo amps up sustainability initiatives with a fully compostable bag made from Danimer Scientific's plant-based materials. It was available in the US during September and first featured in their FritoLay line.
OMAO Straw, a company selling straws made from a naturally sourced biodegradable PHA material, is currently in the research and design process for cups, lids and containers.
9/18/2021
9/22/201
Danimer Scientific and Chevron Phillips Chemical collaborate to develop lower-cost biodegradable polymer manufacturing.
Packaging & Products
Environment
Circular Economy
Purchasing Compostable/ Biodegradable Plastics
Research, Innovation & Design
Other

Figure A4: Timeline of Conversations, October 1, 2021 - December 31, 2021

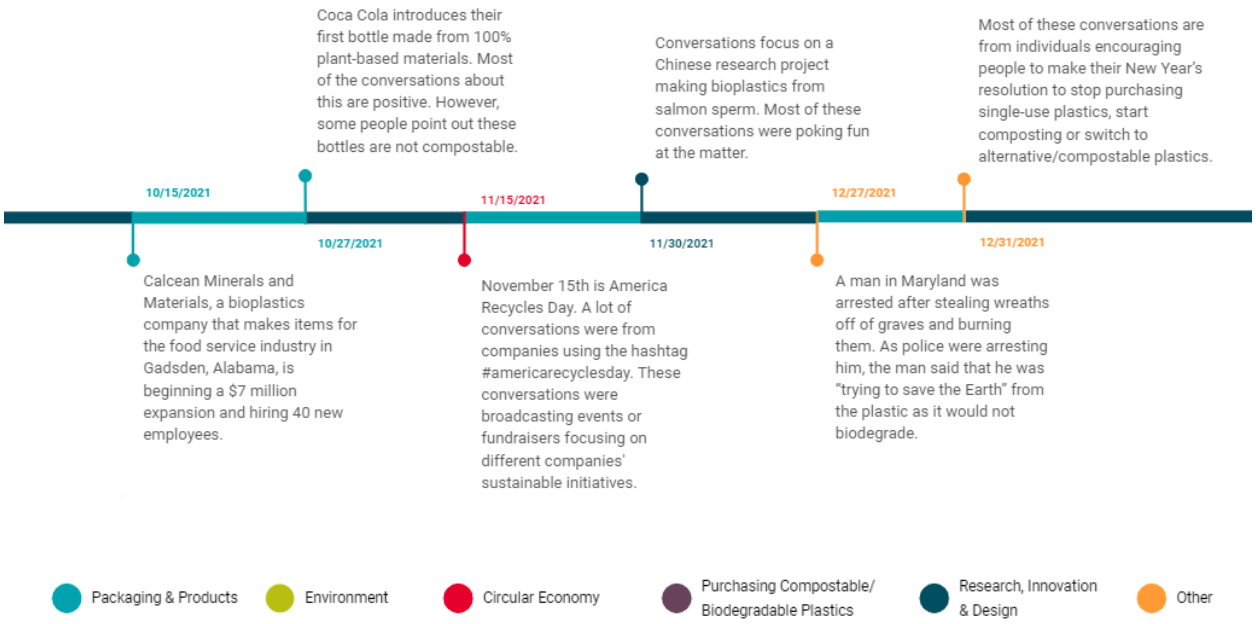


Figure A5: Timeline of Conversations, January 1, 2022 - March 31, 2022

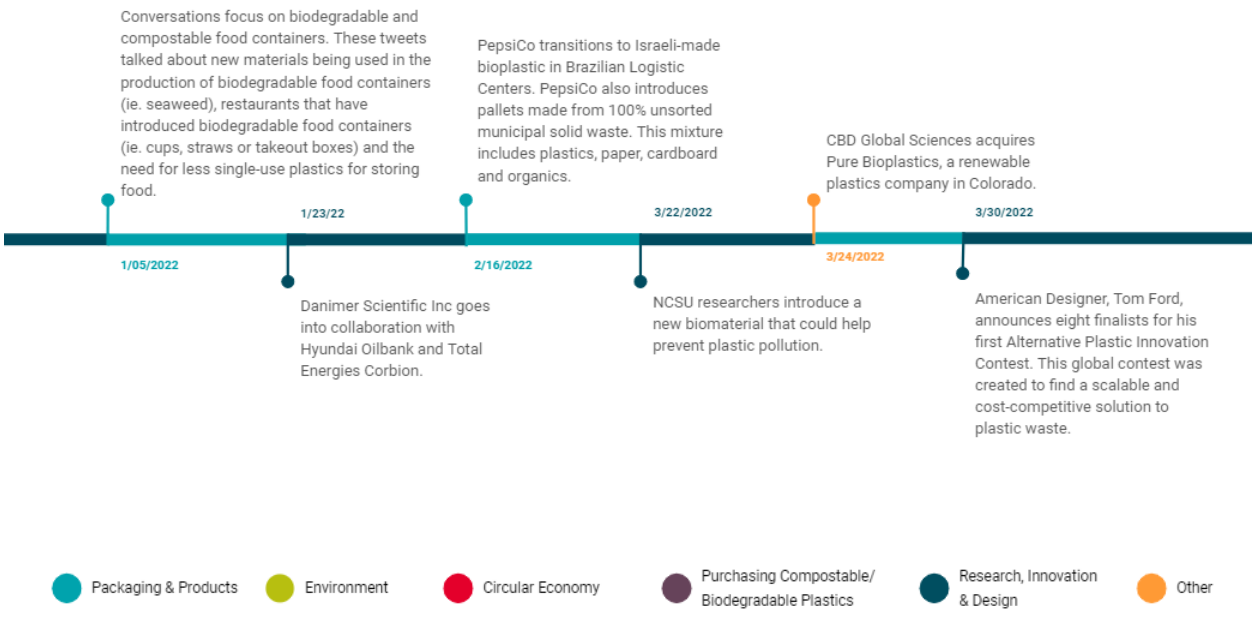


Figure A6: Timeline of Conversations, April 1, 2022 - June 30, 2022

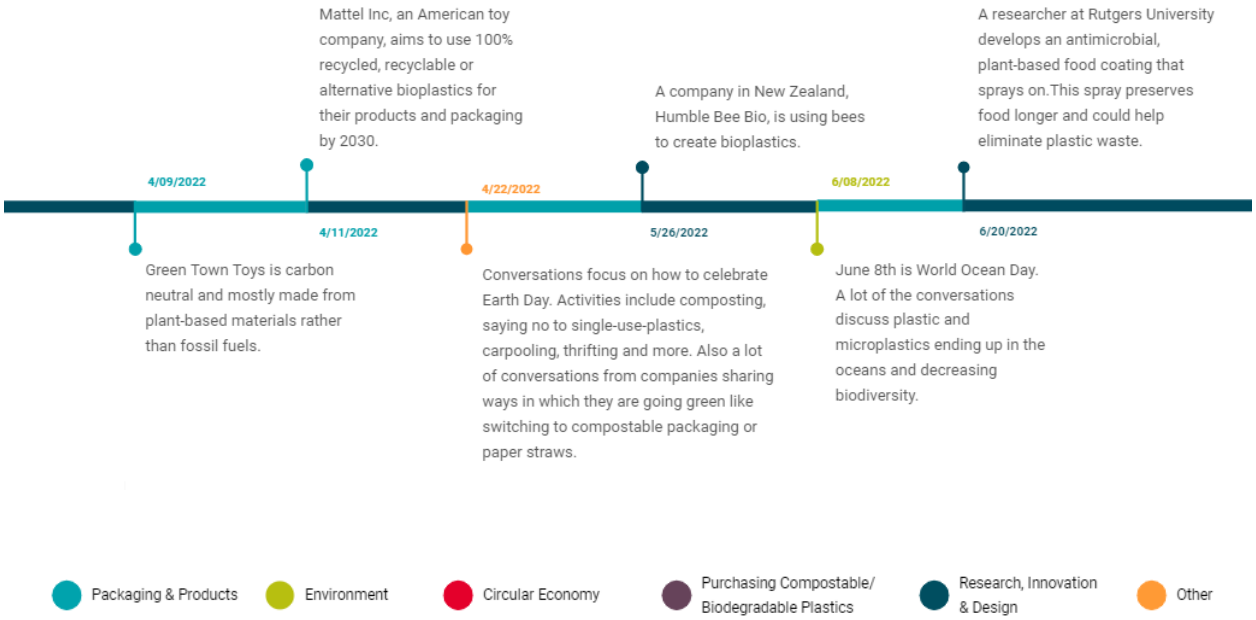
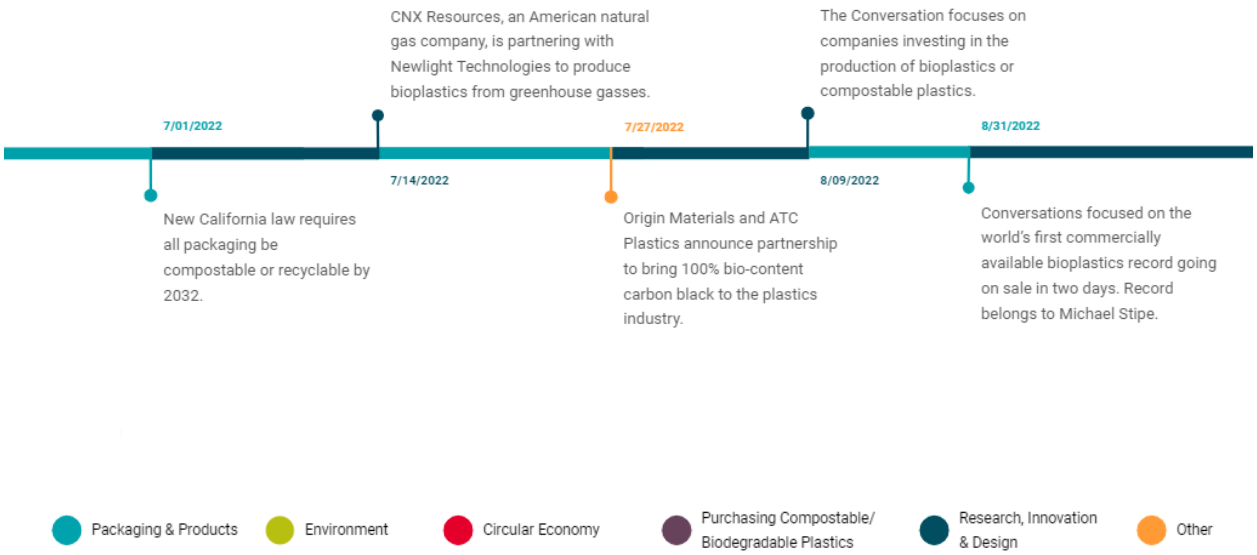


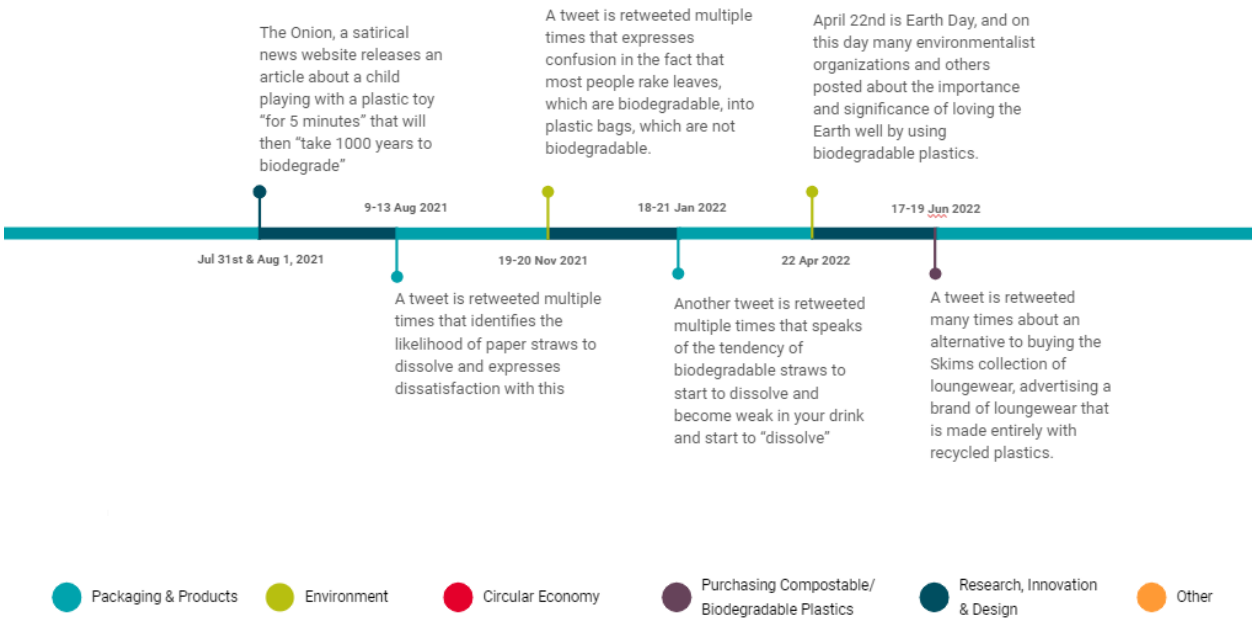
Figure A7: Timeline of Conversations, July 1, 2022 - August 31, 2022



Insights from the Southeast

Insights from the Southeast include both Tweets from the Southeast, and Tweets about the Southeast. Unique trending topics include "plastic pollution" (2,374 mentions) and "ban single use plastics" (104 mentions). "Plastic pollution" Tweets mostly described the environmental harm that plastics cause, as well as ways to combat this problem. Although a more narrow topic, "ban single-use plastics" examined the idea of single-use plastic bans in the South, which is increasingly gaining traction in the region.

Figure A8: Conversations from the Southeast; June, 2021 - July 31, 2022



Instagram Conversations & Mentions

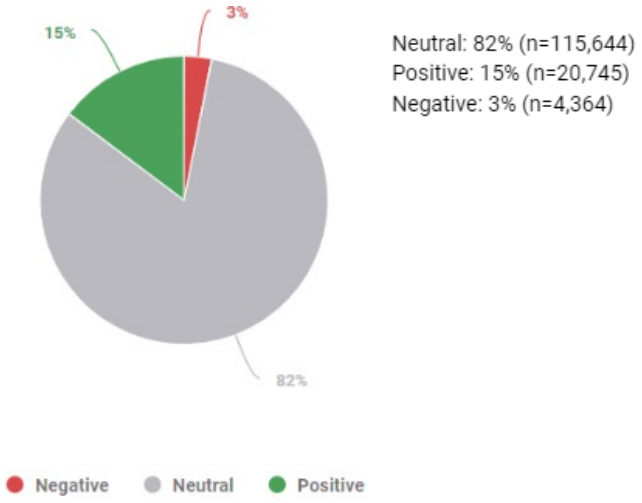
While conversations about plastics, biodegradable and compostable materials, and related topics did happen on Instagram, Instagram's platform is mostly used as a way to sell alternative products. From Instagram, three main topics emerged, with total mentions of 140,753 and a total reach of 206,270,463. These topics are listed below:

- "Plastic Free July": @plasticfreejuly creates most of the posts mentioning this topic. Plastic Free July encourages people to stop consuming single-use plastics as part of their larger goal of ending plastic pollution globally. The nonprofit Let's Be Plastic Free mentioned the Plastic Free July Campaign in their popular yearly campaigns, while other nonprofits mentioned it when talking about actions to curb plastic pollution, such as composting. Companies mention Plastic Free July when promoting products that are packaged in compostable or biodegradable materials.
    - 6,657 mentions; 9,888,269 reach
- "Plastic Pollution": most of the mentions of plastic pollution come from nonprofits and companies. Nonprofits primarily mention plastic pollution when talking about community events such as beach cleanups, as well as other actions that curb plastic pollution. Companies tend to mention plastic pollution when discussing sustainability initiatives that resulted in less plastic pollution (such as turning waste into a bioplastic) or when discussing biodegradable packaging. Other posts related to environmental degradation, primarily in aquatic ecosystems. About 25% of these posts also mention Plastic Free July.
    - 4,629 mentions; 29,817,854 reach
- "Plant Based": here, "plant based" was used in multiple contexts, as this is the broadest topic. Food and restaurants described as being organic or plant forward consisted of the most common usage for the phrase; these conversations tended to mention biodegradable or compostable packaging. There were also many cleaning products and beauty products that were plant based. Posts from the two topics above -- "Plastic Free July" and "Plastic Pollution" -- tended to be evenly split between companies and nonprofits, with a few individuals chiming in. However, this topic mostly consisted of companies displaying and promoting different products.
    - 13,585 mentions; 19,868,364 reach

Beauty and household products were a theme that was more specific to Instagram, consisting of 15.8% of the conversation, with 22,181 mentions and a total reach of 21,746,642. The eco-friendliness of everyday household and beauty products has been a prevalent topic of discussion in recent years. Conversations within this theme tend to be brands advertising their eco-friendly products on Instagram, due to Instagram's large marketplace and advertising platform. Other discussions urged consumers to not choose the "wrong products" by describing how those products are resulting in environmental harm.

Although posts sometimes had to mention the negative to promote positives, sentiment in Instagram posts tended to be neutral (82%), while positive posts (15%) outweighed the negative posts (3%).

Figure A9: Overview of Sentiment



While positive conversations were broad, they tended to come from companies and nonprofits. Companies had positive conversations when promoting new products, new partnerships, or anniversaries of important innovation milestones. Nonprofits were a part of many positive conversations when highlighting increasingly sustainable companies or successful events. Other posts from nonprofits and influencers relate to the impact that composting has on health and the environment. The top positive post in this dataset combined innovation and plastic is 4ocean's plastic guitar, shown below.

Figure A10: Top Positive Post - 4ocean Plastic Guitar

4ocean A guitar made from recovered ocean plastic

Last year, our good friend @Burlsart joined us for a day on the water cleaning up trash in Boca Raton, FL. The goal? Collect ocean plastic that Burls can turn into an epic guitar!

Due to its durability, Burls chose to use recovered HDPE and polypropylene plastic for the body of the guitar. And if you take a close look at the neck, you'll notice it's made up of plastic straws

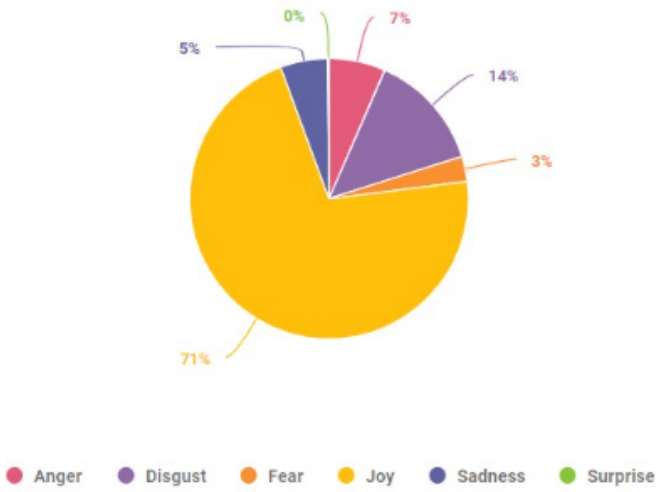
To check out a YouTube video on how Burls made this rad guitar, visit the link in our bio!

Negative conversations were also broad, but tended to bring up topics related to environmental harm, plastic pollution, and waste, as well as how these topics related to environmental justice issues and human health outcome. Some posts mention a lack of industrial composting facilities or people not sorting items correctly in waste or recycling bins. The top negative post was @get.waste.ed's post where they used a picture of Colgate's biodegradable packaging wrapped in plastic to promote their own line of bamboo toothbrushes.

Figure A11: Top Negative Post – Get.waste.ed and Colgate

While Brandwatch only categorized 61.12% of our dataset based on emotion, the emotions shown in Instagram posts tended to be overwhelmingly positive.

Figure A12: Overview of Emotions



Joy: 71% (n=61,465)
Disgust: 14% (n=11,700)
Anger: 7% (n=5,644)
Sadness: 5% (n=4,723)
Fear: 3% (n=2,494)
Surprise: 0% (0 mentions)

Conversations portraying joy were mostly from nonprofits expressing excitement about upcoming events and celebrations. Other conversations from individuals, companies, and nonprofits invoked discussions on

the beauty of nature while homing in on the importance of limiting plastic waste by purchasing products in compostable packaging or by composting. Other companies shared excitement about new compostable packaging or bioplastic products. Conversations portraying disgust tend to focus on fossil fuel, petroleum, and fishing industries, as well as pollution and plastic waste. Conversations that portray anger tend to be from individuals who express their irritation with a lack of global environmental policies, detailing how arduous legal and legislative processes are and how big companies should take more accountability by participating in sustainability initiatives, changing their packaging, etc.

Overall, interest in biodegradable and compostable materials, concern over plastics, and other related materials seems to be growing on platforms like Twitter and Instagram. While individuals do participate in these interrelated conversations on both Twitter and Instagram, nonprofits, companies, and even some professionals in this space seem to be leading the discourse. While Twitter conversations tended to be more closely related to discourse about these topics, Instagram's visual nature provided more of an opportunity to promote alternative products.