Circularity Assessment Protocol
Blytheville, Arkansas

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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New Materials Institute
University of Georgia
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US 30602
www.circularityinformatics.org

Contact:
Dr. Jenna Jambeck
jjambeck@uga.edu

Authors:
Jill Blackmon (CIL), Madison Werner (CIL), Jenna Jambeck (CIL)

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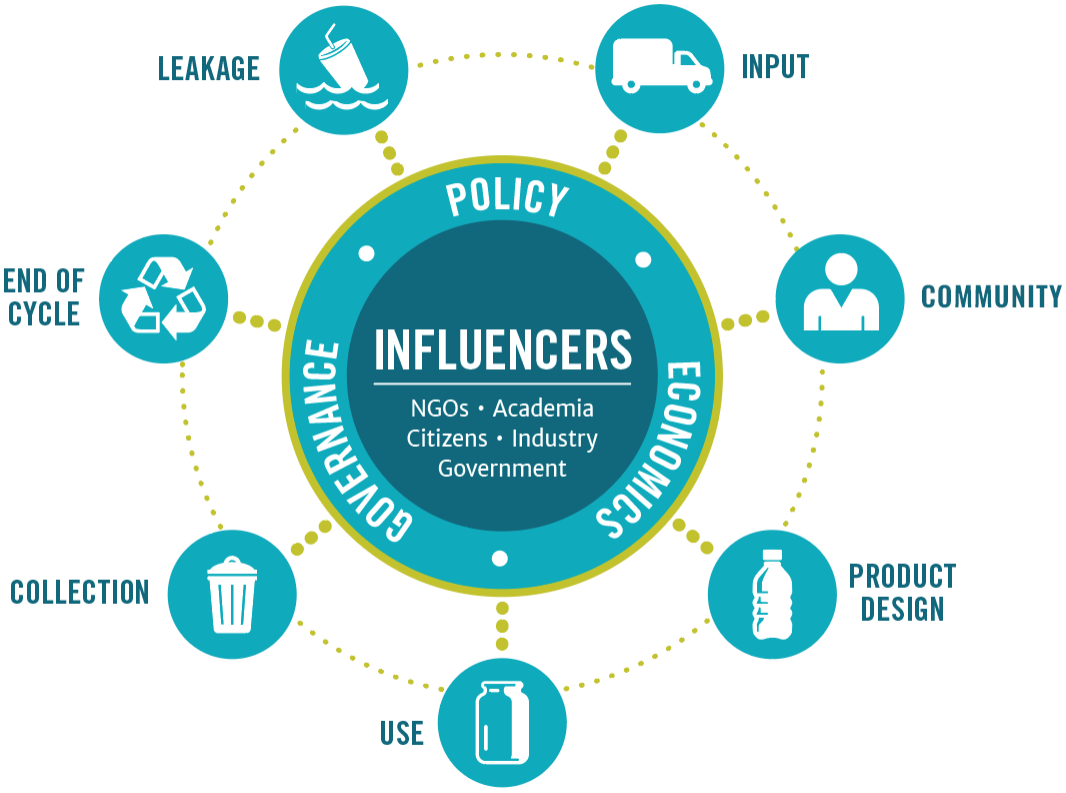
Executive Summary

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 March 2023, a team from CIL conducted fieldwork in Blytheville, Arkansas. The CAP was conducted with support from the Mississippi Rivers Cities and Towns Initiative (MRCTI). This report was made possible through funding by the Walmart Foundation. Fieldwork included product and packaging assessments in stores across the city; key stakeholder interviews with government officials; 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 following table.

Key Findings

INPUT

Findings: While several producers and manufacturers of common convenience items found in Blytheville were sourced from countries in Asia and Europe, the bulk of companies were sourced in the US, with many located proximally to Blytheville in Tennessee, Pennsylvania, Illinois, and Texas. Candy packaging tended to travel the most distance to be sold in Blytheville, while chips and beverages were typically procured from domestic sources.

Opportunities:

- There may be opportunities to partner with packaging manufacturers and production companies that are proximal to Blytheville on EPR schemes, product design innovation, and alternative delivery systems.
- Encouraging domestic candy products as opposed to those that come from abroad may reduce the overall footprint that is required to bring products to Blytheville from overseas.
- Although no EPR schemes exist in Arkansas, Blytheville could lead an exploratory initiative to examine what EPR policies may be appropriate and cost-effective in the community for both residents and businesses.

COMMUNITY

Findings: Key issues mentioned by interviewees included the recycling center being closed, as well as weather complicating waste management efforts. It was clear that the ethos of cooperation among government officials has enabled resilience when navigating existing barriers and challenges.

Opportunities:

- Although the recycling center's closing presented some setbacks for Blytheville, the cooperative ethos of the town provides a great framework

for problem-solving. Moving forward, there may be an opportunity for private investment to fund the town's recycling needs.

PRODUCT DESIGN

Findings: Multilayer film and other forms of film were common among typical plastic items sold at convenience and grocery stores, primarily among chip and candy packaging. Candy items were found to often have multiple forms of packaging for more items compared to chips and beverages. PET was the most common plastic packaging for the beverage category. Similarly, 77% of food vendor packaging was made of either styrofoam or hard plastic such as Polypropelene.

Opportunities:

- The candy packaging in Blytheville was found to have a higher ratio of plastic packaging to product than other cities in the US studied through CAP. There is opportunity here to reduce the amount of plastic packaging sold in the community by shifting to selling products with less plastic packaging overall.
- Many of the restaurants in Blytheville currently use styrofoam for to-go food containers and cups. Given the community's desire to re-establish a recycling facility, a shift towards easier to recycle materials that food vendors give out may be a smart step to take.

USE

Findings: Currently few businesses offer alternatives to plastic retail bags, which typically consist of paper or other reusable plastic options. Notably, local businesses were the least likely to offer alternatives, with many opting to use traditional plastic retail bags. Additionally, stores who sold alternatives were more likely to sell compostable items as opposed to reusable items despite there being no current system to compost these items citywide.

Opportunities:

- There may be opportunities for local businesses to explore alternative cost-effective options or systems that encourage customers to bring their own bags by providing a discount to their purchase.
- To support and encourage local businesses, the city could highlight those that choose to switch to alternative modes of product delivery systems and designs or encourage customers to reuse or bring their own. Doing so may increase buy-in from local community members and businesses that could ultimately encourage positive policy outcomes.

COLLECTION

Findings: The city of Blytheville is responsible for curbside municipal waste collection while the private hauler WastePro is used to pick up commercial and industrial waste. There are no current recycling or composting operations running in the city. Yard waste is currently collected curbside separately from garbage collection.

Opportunities:

- There is large need for a recycling facility in the city as all plastic waste and other recyclables are currently going straight to the landfill. There would be opportunity to create a composting program at the same time as re-instating a recycling program.
- 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

Findings: Landfilling is the only form of waste management in Blytheville at the moment. All the waste in the city of Blytheville is taken to the Mississippi County Landfill which runs a Class IV and Class I landfill.

Opportunities:

- There are ample opportunities to explore diversion strategies through other end-of-cycle outlets like recycling and composting as well as upstream efforts like waste reduction. The most accessible model for sustainable waste management may be through sustainable material management approaches that prioritize net reduction in environmental, social, and economic impacts of waste, as opposed to ambitious circular economy and zero waste scenarios that may be more appropriate later on as Blytheville develops its own comprehensive approach to improving plastic waste management.
- 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.

Findings: The largest percentages of litter by number of items found were plastic (25.9%) fragments and food plastic (23.1%). Overall, the average is 0.768 pieces of litter per square meter at the sample locations in Blytheville. However, there was significant variation between transects in the same population class.

LEAKAGE

Opportunities:

- Reinstating recycling infrastructure with the help of private investment could ensure that less recyclable materials end up as litter.
- 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, the city may be able to identify innovative ways to prevent and abate litter in the community.

Strengths

- Most products in Blytheville sampled as part of this project originate from manufacturers and production companies located in the USA, showing that there is a large market in the city for domestic products that can be leveraged for innovation and collaboration with producers and manufacturers.
- The small population and location of Blytheville mean that communication and education campaigns may be easily communicated across households as well as businesses. Additionally, this supports the opportunity for efficient coordination between the public, the business community, and the local government to collaborate on efforts to manage plastic materials.

Table of Contents

Introduction

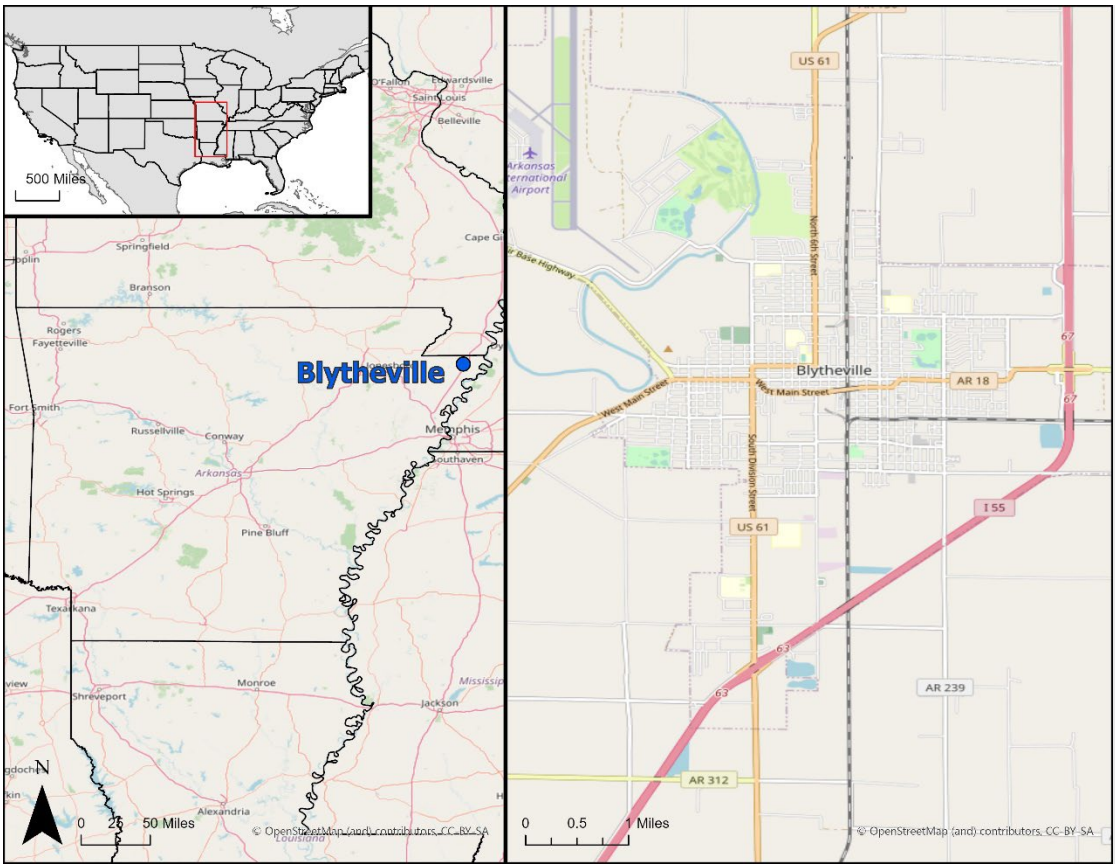
With a population of 13,406 in 2020, Blytheville is the largest city in Mississippi County, Arkansas. The largest census group is Black or African American, who make up about sixty percent of the town's population, followed by Caucasian at thirty percent. The median household income is around $43,000, and about 23.7% of residents live below the federal poverty line. More than ninety-five percent of Blytheville's residents speak English at home. Most of the remaining 5% speak Spanish [1].

Although the land was inhabited for much longer by Native American groups, who were forcibly displaced to Oklahoma in the mid-1800s, Blytheville was formally incorporated around 1890. Over the past century and a quarter, the key industry has transitioned from lumber to farming. Then, during the second world war, Blytheville became a military town with an Air Force base. After the Air Force base closed in 1992, the town's population decreased and the economy transitioned to manufacturing, particularly steel production at the Nucor-Yamato mills. Other industries include steel associates, including tool and pipe companies, as well as aviation repair facilities at the Arkansas International Airport. However, agriculture remains an important sector within city limits as well as in the broader county [2]. The primary crops grown in Mississippi County are cotton, grain, oilseeds, and beans [3].

Blytheville demonstrates the complex way land and water are tied together. The city is situated in the Mississippi Delta in northeastern Arkansas. To support the cultivation of water-intensive crops like cotton and keep the delta's natural wetlands drained, Blytheville is networked with drainage ditches, as well as natural creeks [4]. These waterways connect to the Big Lake Wildlife Management Area ten miles west of Blytheville, where the Little River widens into Big Lake. Further downstream, it meets the St. Francis River, a tributary of the Mississippi [5]. On the other side of Blytheville, ten miles east, is the Mississippi River itself. The Mississippi River drains all or part of thirty-two US states and two Canadian territories into the Gulf of Mexico and is a vital artery of regional transportation. Because of the natural levees and engineered river control structures, there is no direct link between Blytheville waterways and the Mississippi [6], Figure 1 contains a map of the study area for this project.

Waste management for residents of Blytheville is done by door-to-door collection through the Department of Public Works [7]. Commercial contractor Waste Pro provides dumpsters for other waste producers [8]. Waste is deposited in the landfill run by Mississippi County [9]. By weight through industry, Blytheville is an immense recycler--due to the steel plants' use of 90 percent recycled scrap in their production [10]. Ordinary residents have very limited access to recycling services though. The nearest recycling facility is Marck's facility in Jonesboro, AR, fifty miles away [11].

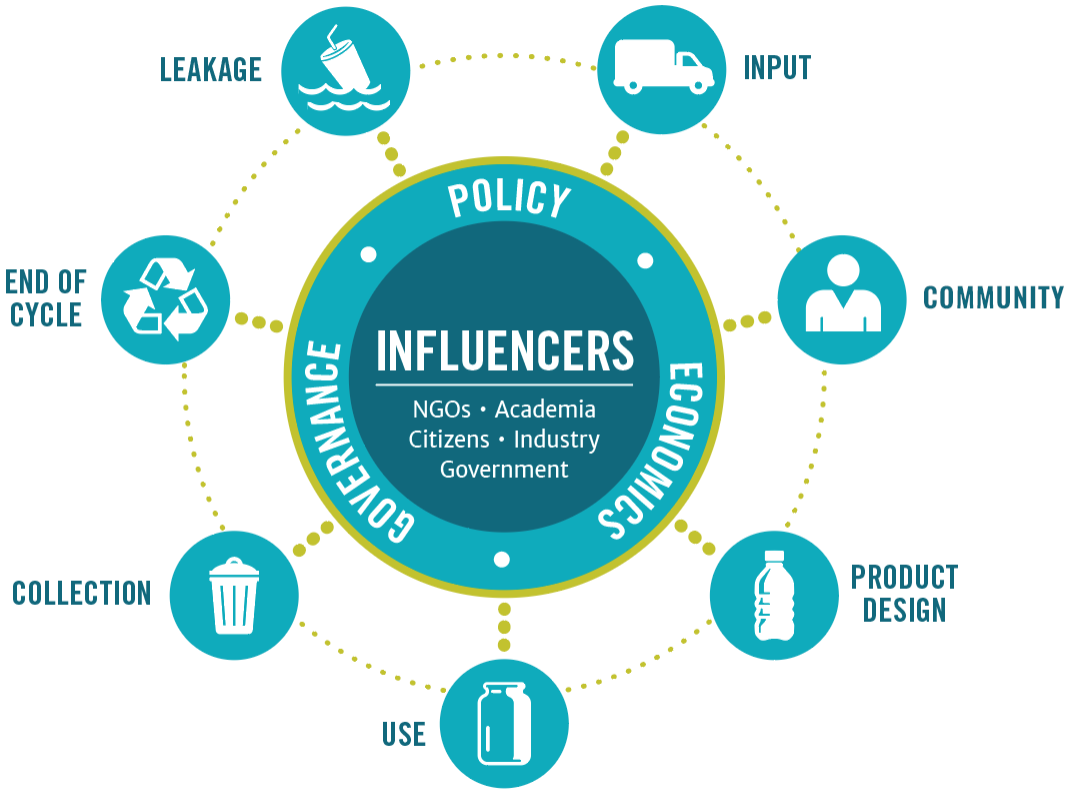
Figure 1: Overview map of survey area



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.

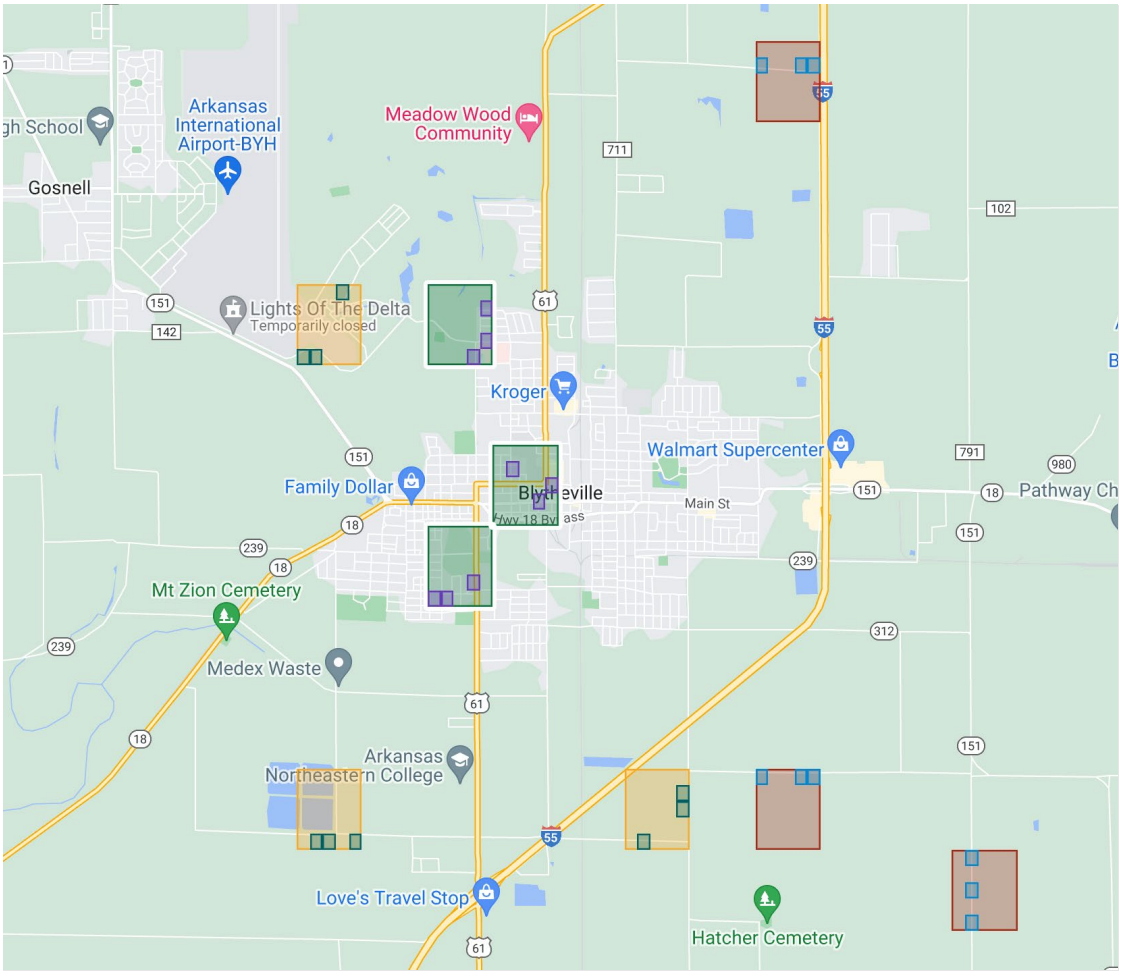


In March of 2023, a team from the Circularity Informatics Lab conducted fieldwork in the city of Blytheville, Arkansas with the support from the Mississippi River Cities and Towns Initiative (MRCTI) and the city's local government. This CAP was conducted with funding support from the Walmart Foundation. 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 solutions to strengthen the circular economy and waste management in Blytheville, AR.

Sampling Strategy

In order to randomly sample various locations in a city, the CAP typically identifies a 10 x 10km 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 tertiles (three groups) (Figure 3). Ambient population count can be described as "where people go" and "societal activity" — it is not population density of where people live. These three areas typically form samples of different land uses, etc.

Figure 3: Population tertiles and survey sites in Blytheville.



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. In total, 9 sites were surveyed, across low, medium, and high ambient population tertiles.

Input

The US and its partner countries in the North American Free Trade Agreement (NAFTA) contributed to 19% of the world's plastic production, having produced about 70 million metric tons of plastic products in 2020. According to the Plastics Industry Association, nearly 380,000 people (or about 13% of the 2020 state population) in Arkansas are employed in the plastics industry including processors, marketing, and support activities as well as plastic-dependent industries[12]. Within the Arkansas plastics industry, 8,590 people are employed specifically in plastic production, which consists of businesses involved in plastics processing, marketing, support and captive activities.

To get a snapshot of the characterization, scope, and source of common plastic packaged items that are entering Blytheville, samples of fast-moving consumer goods (FMCG) in four popular categories were taken within the nine 1 km^2 transects in Blytheville. The team selected three convenience or grocery shops to sample within each 1km2 transect area, where shops were present and open at the time of surveying. In the case of Blytheville, only 7 stores were surveyed total due to the size of the town and availability of open stores. In total, 511 unique brands of convenience products were collected and sampled, including 228 candies, 63 chips, and 220 beverages (Figure 3). Samples of identical brands were not collected multiple times, even when present in multiple stores. Common brands of tobacco products were also visually assessed in stores, although samples were not purchased; 7 brands of cigarettes are included in the input analysis for top brands.

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). It should be noted that manufacturing locations for products in US are often difficult to find as companies are not required to provide this information online; therefore, if we were unable to find the manufacturing location of a product, we have used the parent company location as the manufacturing location for the estimations in this study. Manufacturer and parent company distances (Table 1) are intended to estimate the distance in kilometers between the city and the origin of each product.

Top brands of each category, based on a visual assessment of shelf space in a store, conversations with shopkeepers, and repeated occurrence across stores, included the following:

- **Beverages**: Mountain Dew, Powerade, Pepsi
- **Candy**: Reese's, M&Ms, Hershey's
- **Chips**: Cheetos, Doritos, Lays
- **Tobacco Products**: Marlboro, Newport, Pall Mall

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

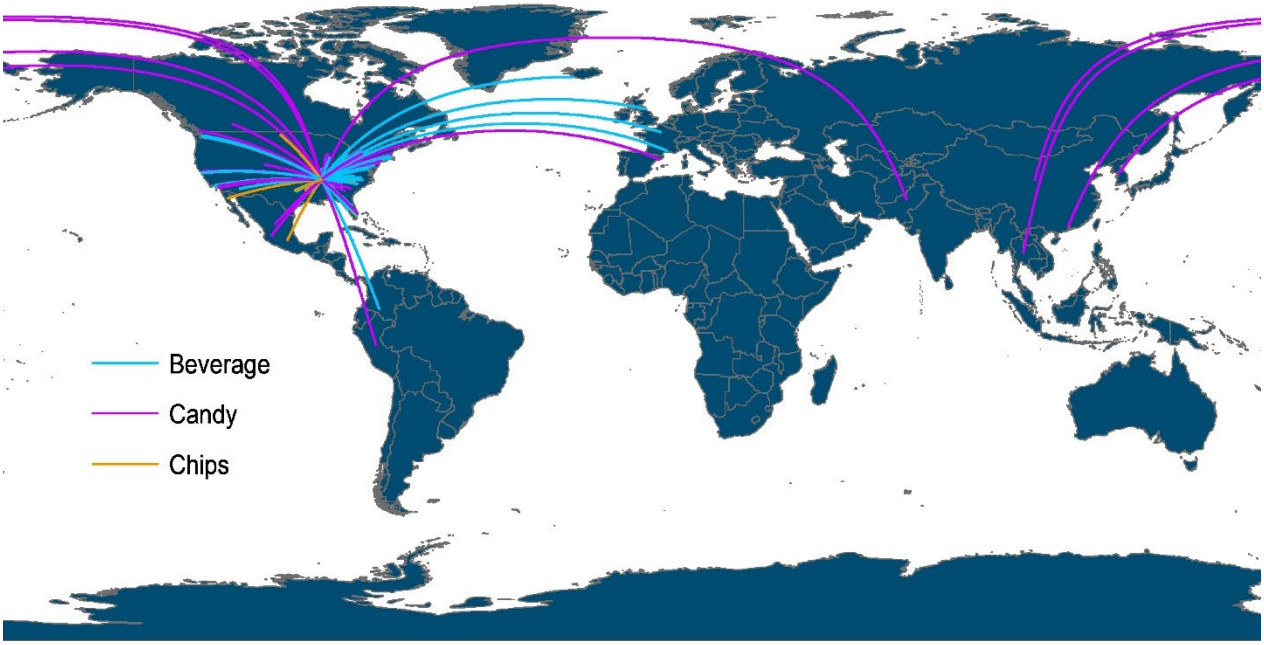
	Length Store to Parent Company (km)			Length Store to Manufacturer (km)		
	Minimum	*Maximum*	*Average*	*Minimum*	*Maximum*	*Average*
Beverages	285	22,388	1,761	285	20,573	1,986
Candy	548	22,388	3,028	67	25,114	5,159
Chips	137	4,606	1,624	113	3,126	1,018

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

The average distances for each product were similar for product manufacturers and parent companies. Candy had the highest average distance from manufacturers due to the maximum distance being located over 25,000 km away. Candy also had the highest average distance from parent companies, although candy and beverages both shared the highest maximum distance of 22,388 km. In contrast, Chips had the lowest average distance, the lowest minimum distance, and the lowest maximum distance to parent companies, with the nearest parent company being 137 km away from Blytheville (Table 1). For manufacturing locations, candy had the highest maximum and lowest minimum distance from Blytheville, with the nearest manufacturing location being in Covington, TN. Chips also had a low minimum distance to a manufacturer with the nearest source manufacturer in Jackson, TN, only 113 km away from Blytheville (Table 1).

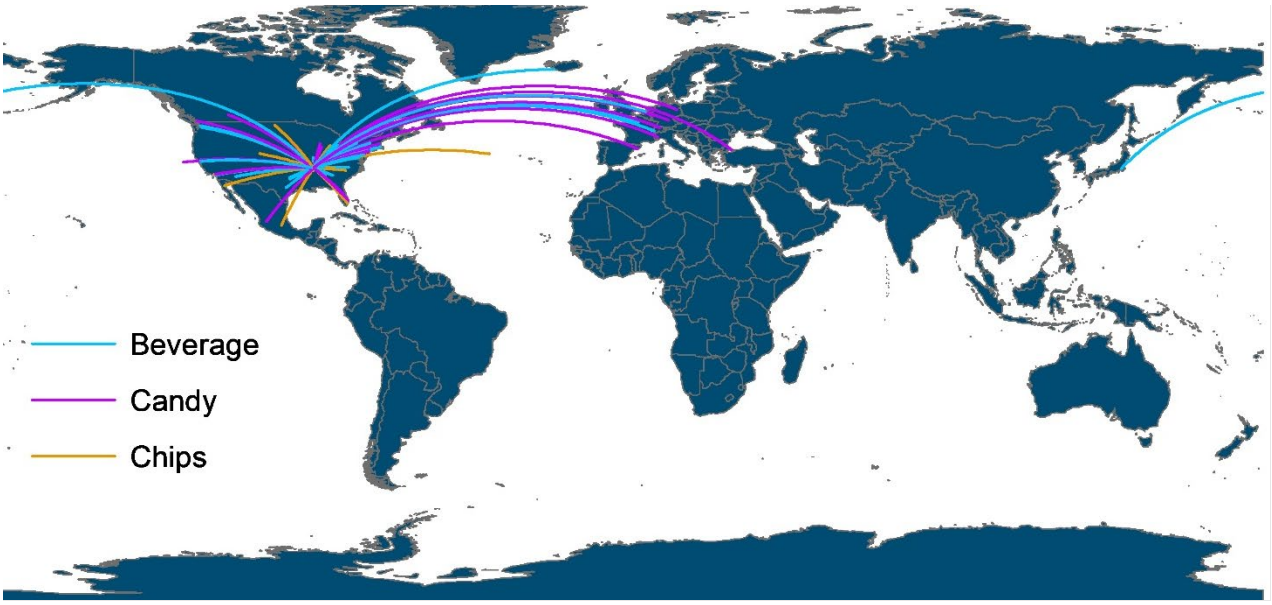
Based on the origins of the convenience categories, regional distribution of products in the United States was common among both manufacturers and producers. Most of the chip brands were manufactured in the US; only one brand of chips was manufactured outside of the U.S.. In contrast, 95% of beverages were manufactured in the U.S., 2% in the UK, 1.5% in France, 0.5% in Canada, and 0.5% in Iceland. Candy had the largest percentage of products manufactured outside the US; 80% of the candy products were manufactured in the US, while 14% were manufactured in China, 1% in Canada, 1% in Thailand, 1% in Mexico, as well as in Pakistan, South Korea, Spain, and Peru (Figure 4). The most common states for manufacturing were Georgia (16% of beverages), Pennsylvania (21% of candy), New Jersey (14% of candy), Texas (37% of chips), and Illinois (9% of beverages and 8% of candy). Marketside, the beverage brand owned by Walmart, was the only manufacturer of the surveyed products that were based in Arkansas, while 13% of the convenience products were manufactured in states neighboring Arkansas (Table 2.)

Figure 4: World Map displaying manufacturing locations for top convenience items in Blytheville



Like manufacturer locations, parent company locations were heavily concentrated in the US. By product category, several candy items and some beverages had parent companies based in Europe, specifically Italy and Switzerland. Chips similarly tended to emerge from parent companies located in the US, with a few located in Mexico (Figure 5). Of all parent company locations, 85% were in the USA, followed by 6.3% in Italy, and 2% in Mexico. Additionally, Pennsylvania had the highest proportion (16%) of parent companies for Blytheville products followed by New York (15.9%), California, (8.2%), and Virginia (7.7%). Like manufacturers, there was only one parent company located in Arkansas. However, 7% of parent companies were located in neighboring states like Missouri, Tennessee, Kansas, and Texas.

Figure 5: World Map displaying parent company locations for top convenience items in Blytheville



A handful of states in the US have implemented Extended Producer Responsibility (EPR) policy legislation that encourages producers of products to bear some responsibility for their end-of-life management. At current, Arkansas 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 [13]. EPR can take many forms, but common approaches throughout the world and the U.S. include product-take back and deposit-refund schemes as well as waste collection and take back guarantees [14]. The plastics industry in the US tends to oppose EPR schemes arguing that waste management relies on consumer practices and behaviors [15], and that the schemes can lead to increased costs, food waste, and life cycle impacts [16]. EPR schemes are typically supported by state-level governance, suggesting that Blytheville state-level representatives could advocate for legislation targeting EPR efforts or engagement with packaging producers. Based on the CIL surveys, Walmart is the only manufacturer located in Arkansas that would be able to participate at the state level, and there is still opportunity for partnership with companies in neighboring states as shown in Table 2, or beyond that geography. EPR can be a requirement of the companies doing business in a state no matter where products are manufactured, or where companies are located. A full list of parent companies and manufacturers documented across the Blytheville product surveys is available in Table A2 and Table A3 in the Appendix.

Table 2: Domestic products and materials produced or manufactured in states neighboring Blytheville, AK

Neighboring State ***Company Name***	**Product Category**	**Packaging Types**
Kansas		
Associated Wholesale Grocers	Beverage	PETE; hard plastic; film
Missouri		
Russel Stover	Beverage	PETE; hard plastic; film

Tennessee		
Brim's Snack Foods	Chips	Single layer plastic film; multilayer film
Charms LLC	Candy	Single layer plastic film; multilayer film
Defiance Fuel	Beverage	PETE; hard plastic; film
Dollar General Corporation	Beverage	PETE; hard plastic; film
The Double Cola Company	Beverage	PETE; hard plastic; film
Pepsico	Beverage	PETE; hard plastic; film
Pringles Manufacturing Co.	Chips	Cardboard; aluminum film; hard plastic
Texas		
Barcel	Chips	Multilayer film
Bai Brands, LLC.	Beverage	PETE; hard plastic; film
Keurig Dr. Pepper	Beverage	PETE; hard plastic; film
Frito-Lay	Chips	Multilayer film
Kim's Snacks LLC.	Chips	Single layer plastic film
Ozarka Water	Beverage	PETE; hard plastic; film

Community

To understand current attitudes and perceptions of plastic waste, semi-structured interviews were conducted with three key government officials in Blytheville, Arkansas. Due to Blytheville being a small, rural town, officials across departments work together on city-level issues. Thus, waste management in Blytheville is inherently connected to public works and wastewater. Key issues mentioned by the officials included the recycling center being closed, as well as weather complicating waste management efforts. It was clear that the ethos of cooperation among government officials has enabled resilience when navigating existing barriers and challenges.

A prominent issue mentioned by the government officials was the closing of Blytheville's recycling center in 2020 due to the excess of cardboard that was viewed as a conduit to the COVID-19 virus, as well as labor shortages:

> **"For a consumer or an average citizen, we no longer have a recycling center. At one time we had a position assigned to public works, and that position was responsible for going around and picking up the recycled bags and taking them to the recycling center. But in 2020, they closed our local recycling center down, and it has not reopened. So we do not have anywhere for citizen recycling to go. So now we are mixing our recyclables with our regular trash and it goes to the landfill, through our public works department."**

One government official shared how community members felt about the recycling center's closure:

> **"People really want [the recycling center] back. I think 85% of the calls that I got in 2021 and 2022 was "when are y'all going to start back recycling?" [Interest] was really hot -- it has died down since then. You know, once something big like that closes, it is like a shock. It sends a shock wave through the community."**

Another government official mentioned how the closure of the recycling center influenced landfill tipping fees:

> **"[I saw an] increase in tipping fees -- I can see a difference. You would not believe the cardboard that comes in this little town. Cardboard is the number one factor, and it is heavy."**

Weather was frequently brought up as a factor that influences solid waste management pickup:

> **"We were down for a whole week around the week before Christmas. We basically had a White Christmas! But it was all ice -- with that ice you can't do anything with it. We tried and tried…And then the streets are narrow, and we are really residential within the incorporated city. And so people park their cars on the streets so you don't want to take the chance of putting the big trash truck coming up and down the street. So we suspended operations for about a week…A lot of people don't think those big trucks can't move or slide. But that ice has no friends."**

> **"We have an ordinance that every resident should use black bags, and we just can't get people on track. They just dump anything and everything inside the can. Whew, lord help us. But it's not too bad. In the winter time everything gets frozen to the bottom of the can and we can't get anything out, and in the summers coming on, the stench. You go up to a green can and instead of a green can, it's white with all the maggots."**

> **"Especially last week, we had all that rain. Every can in town had water in it. They were very heavy. When you dump that in the back of the truck, you have to bob and weave. That water will shoot out. But other than that, it's alright."**

Recent weather events also showed how the community comes together to address challenges related to waste, highlighting the cooperative and resilient spirit of Blytheville:

> **"There was a huge state tournament this past weekend, and trash collection generally does not happen on the weekend. We probably had about 6-70k people who are not normally here. So I called [them] on a Saturday morning, and said, 'We have trash everywhere. Can you help me?' It is so unsightly. Out of the kindness of his heart, he got his team and they were able to get some of the trash out and get it to a holding place until Monday. So we are a very tight knit community, we do whatever we have to do at all cost."**

> **"So yeah, we had an insurmountable amount of trash last week, but we made it through!"**

> **"We had a torrential storm overnight. Thursday, everything was okay. Friday morning when we wake up, we have a sewer backup…I put 10 million gallons of storm drain water through 2 lagoons and a band spanking new treatment plant in 48 hours. Unheard of."**

Regardless of the challenges presented by the COVID-19 pandemic and weather-related issues, the cooperative ethos of the town provides a great framework for problem-solving. Moving forward, government officials shared their interest in bringing in private investment to fund the town's recycling needs.

Product Design

To characterize material types used in common consumer products, samples of common convenience were obtained as described in the Input section. The CIL team sampled stores in most of the nine 1km2 transect areas where stores were available; a total of 7 convenience and grocery stores were surveyed. Three of the stores were larger grocery chains comprising of Walmart, Kroger, and Dollar General. The other four stores surveyed were smaller convenience stores and local grocery stores including Dodge's, Hay's, Larry's, and Shell. A total of 415 items were sampled and at least thirty unique forms and brands were purchased to obtain packaging weights. The average weight of both the packaging and the product itself was collected for all samples (Table 3). Beverages had both the highest product mass and packaging mass (Table 3), largely due to the high density of liquid product as well as the higher density quality polyethylene terephthalate (PET) commonly used in plastic bottles. Candy had a high product mass and high packaging mass compared to other CIL assessments. In Vicksburg, Mississippi, the average packaging mass of candy was 4.2 grams compared to 9.14 grams found in Blytheville. Packaging for both candy and chip products consisted largely of multilayer film, but there were some instances of PP, paper, HDPE, coated paperboard, and cardboard among candy packaging. Multilayer film is arduous and costly to recycle due to the varying characteristics that give it a low mass, which makes it difficult to capture in recycling machinery and provide less material value [19]. Its food preservation capabilities are also reflected in the multiple layers, which make it challenging to isolate individual materials within the packaging for recycling.

Table 3: Average weight of products and their plastic packaging for common convenience items.

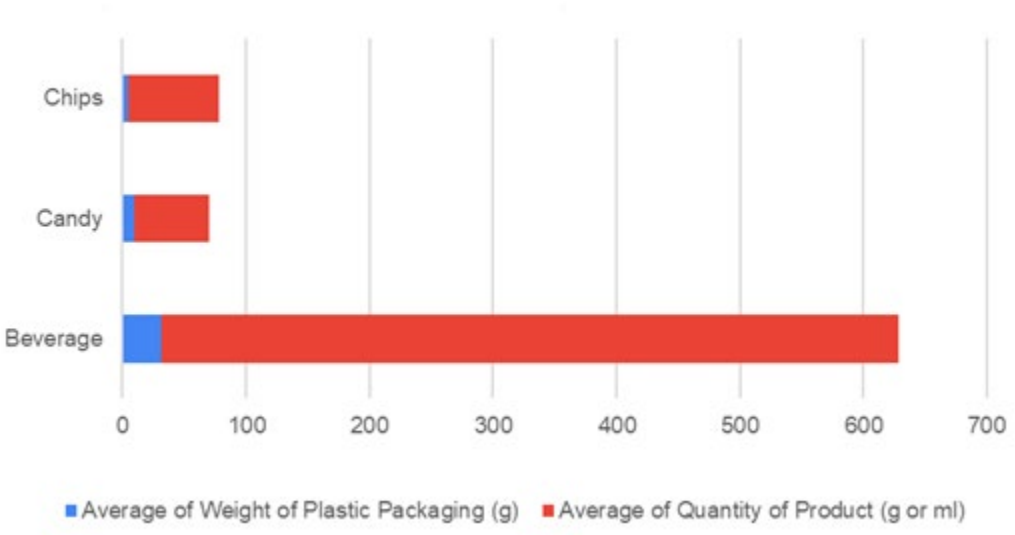
Product Type	Number of Samples	Average Weight of Plastic Packaging (g)	Average Quantity of Product (g or mL)
Beverages	128	31.34	596.73
Candy	225	9.14	60.57
Chips	62	4.43	73.87

Compared to data collected by CIL in Atlanta, Blytheville has a much higher average weight of plastic packaging for candy with 9.14g, the average in Atlanta for candy was 3.7g. Additionally, Atlanta had a higher average quantity of product of 85.9 g whereas Blytheville only had an average of 60.57g for candy. This suggests the candy products available in Blytheville have a higher ratio of plastic packaging to product than other cities CIL has captured data in. Samples taken in several cities in India showed that the

average product weight for candy items was around 3.8g and the average packaging weight was around 0.15g — those found in Santiago were around 10 times larger for both product and packaging weight. Smaller product sizes may lead to more frequent, less individually expensive purchases compared to larger product sizes, although there is often a "poverty tax" associated with these small packets compared to the price per quantity in larger sizes, in addition to the generation of more packaging weight in summation.

Together, beverage products and packaging had the greatest mass by far of the three product types (Figure 20). However, when considering the ratio of packaging to product, candy was more substantial with 0.15 g of packaging for every gram of product, compared to chips and beverages which both had a ratio of about 0.06 g/g. As such, candy wrappers generate the most packaging waste per unit of product delivery of the three categories. Reducing the ratio of plastic packaging to product through minimal packaging design and/or increasing quantities of products can make product delivery more efficient [17].

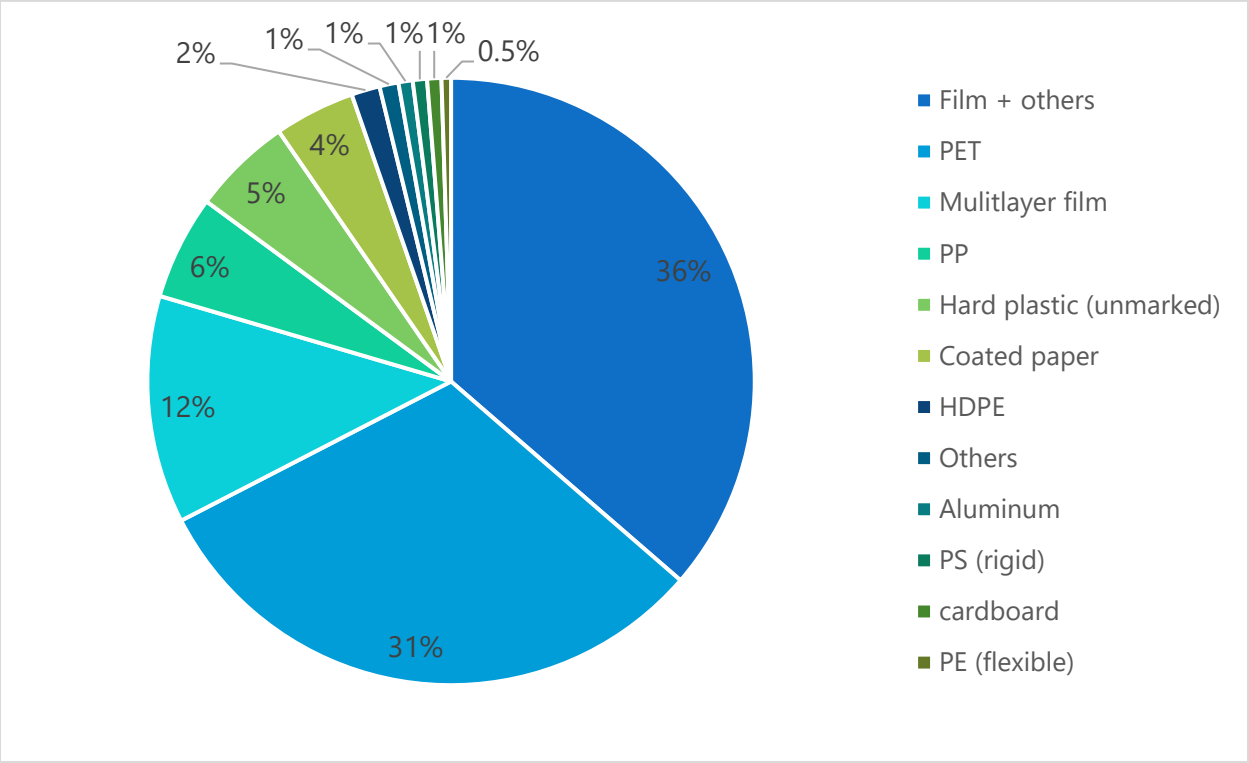
Figure 20: Convenience store plastic to product ratios, shown in grams (not including unknown products or tobacco as there is no weight data for tobacco)



Cigarettes were excluded from our purchase of samples. They are typically a standard size and we have previously found an average of about 10 g of plastic packaging to about 15 g of product. This relatively high plastic packaging to product ratio means cigarettes generate larger amounts of plastic waste per unit of product, which is likely driven by the cellulose acetate filters in cigarette butts, which typically weigh about a gram each.

For each convenience item surveyed, the CIL team documented the polymer type (Figure 21).

Figure 21: Material breakdown of top convenience items in Blythville; include pie charts or bar graphs for each item category (beverages, chips, candy) based on averages of visual surveys.



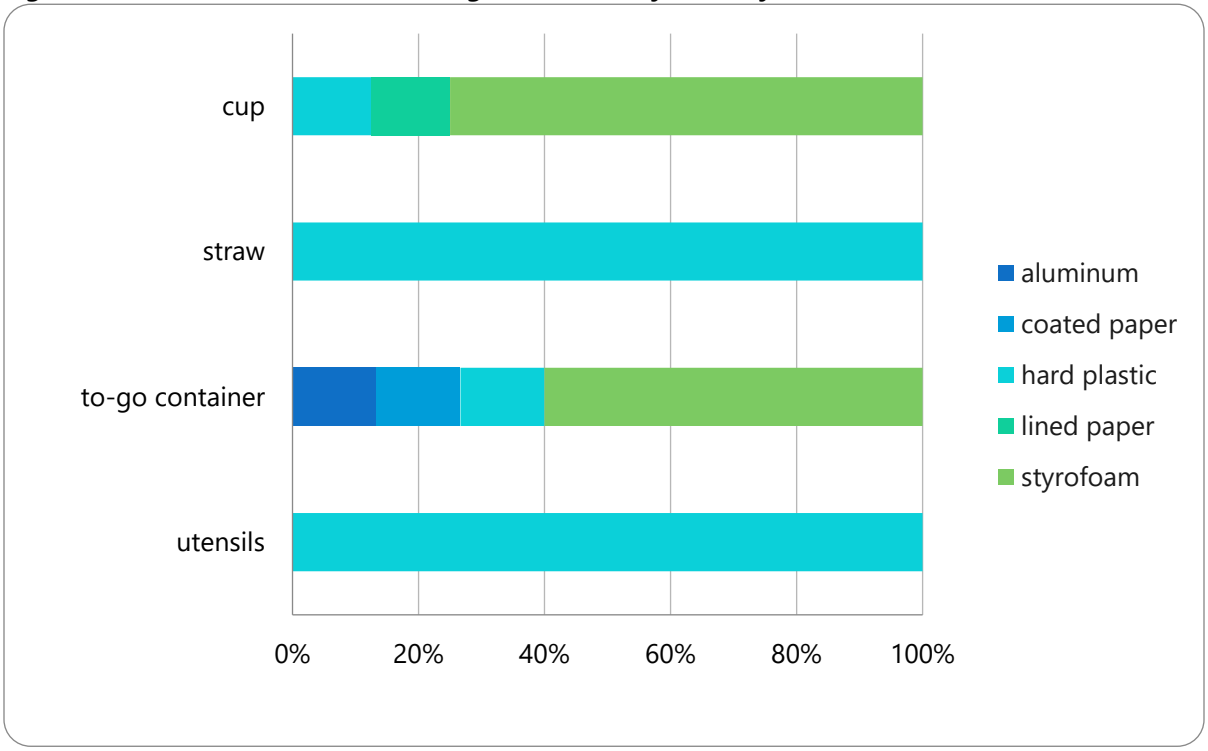
In addition to surveying convenience and grocery stores, the CIL team surveyed restaurants in each of the nine 1 km^2 transects areas. Through visual assessments and discussions with restaurant owners, we assessed the material type for to-go food items like containers (including their lids), cups, utensils, and straws. In total, we characterized 88 items in 14 restaurants (Figure 22). Fourteen food vendors were sampled across the transects, of which one was a national fast-food chain, eight were full service sit-down restaurants, one was American fast casual chains, two were local counter service and fast-food spots, and two were grocery store delis. Across these vendors, 88 takeout items were collected such as cups, straws, utensils, food containers, etc. The most common items acquired were food containers and cups, both of which varied by material type. Most of the other items were generally comprised of one or two material types. For example, all seven straws obtained were made of polypropylene, while all 14 bags were made of either HDPE or paper. By material type, 77% of the items were made of plastic, with the most common type being polypropylene items including utensils, lids, cups, and straws. Paper was the second most common material for food vendor take-out items including food containers, cups, and bags. Table 4 summarizes the items by product type and material.

Figure 22: Example to-go materials surveyed in Blytheville

Table 4: Products and material types surveyed in restaurants and food vendors.

Product	Material Type	Number of Observations
To-Go Containers (including lids if applicable)	Hard plastic	2
	Foam	9
	Paper	1
	Aluminum	1
	Coated Paper	1
	Aluminum-lined paper	2
Cups	Coated Paper	1
	Hard Plastic	1
	Foam	6
Straws	Paper	0
	Hard Plastic	7
Utensils	Hard Plastic	4
	Wood	0

Figure 23: Material breakdown of to-go items surveyed in Blytheville.



Use

To understand patterns of use and reuse for plastic products in Blytheville, 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 to establish economic accessibility to these types of products. With the exception of liquid dish soap refills, a majority of alternatives in Blytheville were compostable, including compostable bowls, plates, straws, platters, and kitchen bags. 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. Compostable items were generally much more expensive than disposable items. For example, compostable cutlery were $0.14 each compared to single-use plastic cutlery that cost $0.07 each. A full list of the alternatives found can be seen in Table 5.

It is worth noting that misleading nomenclature and public information can cause confusion due to confusing labeling on different types of plastic, particularly when it comes to 'compostable' items. Based on the CAP survey, plastic items labeled as compostable were typically designated as made of natural and organic material like bamboo, plant material, fiber, and sugar cane. Plastics marketed as biodegradable do not necessarily degrade in the natural environment as they do in laboratory conditions, with many biodegradable items requiring specific conditions provided in industrial composting facilities. Bio-based plastics can be chemically identical to fossil-fuel-based plastics but can be confused for compostable or biodegradable. These items can also be mistaken as recyclable [19]. These subtleties can lead to consumer

confusion due to uncertainty around material types and categories as well as ambiguity around appropriate management. Recent studies highlight the challenges associated with bio-based and biodegradable plastics driven by the combination of inadequate legal provisions for effective collection and treatment, unharmonized waste collection infrastructure, and social attitudes and awareness around consuming, sorting, and managing these materials [20].

Table 5: Cost of plastic items compared to reusable and refillable alternatives available in Blytheville

Product	Alternative Type	Cost of Alternative (currency)	Cost in Single-Use Plastic Packaging (currency)	Cost Difference for Alternative
liquid dish soap	refill	$ 0.01	NA	NA
plates	compostable	$ 0.17	$ 0.19	-6.45%
bowls	compostable	$ 0.17	$ 0.10	69.92%
plates	made from renewable materials	$ 0.07	NA	NA
bowls	made from renewable materials	$ 0.07	NA	NA
plates	made from renewable materials	$ 0.14	NA	NA
plates	made from renewable materials	$ 0.06	NA	NA
plates	compostable	$ 0.22	$ 0.19	18.27%
plates	compostable	$ 0.12	$ 0.18	-33.76%
bowls	compostable	$ 0.16	$ 0.10	51.56%
straws	compostable	$ 0.08	$ 0.01	740.81%
plates	made from renewable materials	$ -	NA	NA

cutlery	compostable	$ 0.14	$ 0.07	83.79%
cups&lids	compostable	$ 0.50	$ 0.33	49.94%
platters	compostable	$ 0.25	$ 0.40	-36.90%
large plates	compostable	$ 0.16	$ 0.15	1.78%
small plates	compostable	$ 0.09	$ 0.08	20.20%
bowls	compostable	$ 0.17	$ 0.15	11.19%
paper cups&lids	made from renewable materials	$ 0.31	$ 0.33	-7.91%
ultra small plates	made from renewable materials	$ 0.20	$ 0.08	159.51%
ultra large plates	made from renewable materials	$ 0.16	$ 0.08	106.65%
ultra extra large plates	made from renewable materials	$ 0.15	$ 0.06	130.97%
ultra bowls	made from renewable materials	$ 0.15	$ 0.16	-2.82%
large plates	made from renewable materials	$ 0.08	$ 0.08	1.02%
bowls	made from renewable materials	$ 0.11	$ 0.15	-25.90%
bowls	compostable	$ 0.15	$ 0.16	-5.23%
plates	compostable	$ 0.10	$ 0.08	14.42%
kitchen bags	compostable	$ 0.28	$ 0.17	69.45%
kitchen bags	compostable	$ 0.58	$ 0.26	120.22%
large plates	made from renewable materials	$ 0.11	$ 0.17	-35.71%

extra plates	made from renewable materials	$ 0.17	$ 0.14	16.66%
small plates	made from renewable materials	$ 0.09	$ 0.13	-25%
bowls	made from renewable materials	$ 0.13	$ 0.16	-22.72%
ultra bowls	made from renewable materials	$ 0.15	$ 0.16	-4.89%
ultra large plates	made from renewable materials	$ 0.16	$ 0.12	29.31%
plates	compostable	$ 0.10	$ 0.17	-40.62%
platters	compostable	$ 0.30	$ 0.10	196.87%
bowls	compostable	$ 0.17	$ 0.07	150%

Throughout the transects, the CIL team surveyed what types of bags businesses provided at check-out. All the seven stores surveyed provided plastic HDPE bags for free, while two of those stores also provided paper bags for free. Three of the stores had reusable bags available for purchase ranging between the price of $.99 to $4.99. Of the fourteen restaurants surveyed, 57.14% of the bags distributed were made of plastic, while 21.43% were unlined paper, and 21.43% were lined paper.

Figure 24: Reusable bag options in Blytheville

A couple of the stores surveyed had areas designated for materials recycling collection for the products they sold. One store had a plastic bag recycling receptacle, while another had an area for water jug recycling (Figure 25.)

Figure 25: Water Jug Deposit at Local Store

One common approach to reducing plastic consumption is through policy efforts that disincentivize their use such as plastic bans or fees. The city of Fayetteville, AR had unanimously passed a ban on EPS foam as a form of to-go containers due to their large litter problem with the material; as of 2021, the state of Arkansas singed into law Act 751 which prohibits cities from regulating what kind of to-go containers businesses can use. (https://www.nwahomepage.com/news/arkansas-state-law-may-invalidate-fayettevilles-styrofoam-ban/) In terms of upstream management of plastic waste, this law undermines opportunities for material to become waste in the first place, which can be accomplished through reducing consumption of plastic products that in many instances can be easily replaced or avoided entirely like straws, bags, and many food containers. Despite being limited through governance, the implementation of product bans or fees could still be carried out by private businesses in Vicksburg. Alternatively, businesses could explore cost-effective alternatives to bags or simply ask their customers to bring their own for a small discount on their purchase.

Collection

In 2017, the state of Arkansas landfilled 3,337,392 tons of waste and recycled 2,780,660 tons of recyclables; [21]. By applying the population of Arkansas from 2020 of 3,011,524 (US Census) to these numbers, Arkansas citizens generate an estimated 5.05 kg of waste per capita daily. In comparison to the national average of waste generation of 2.2 kg per capita [22], Arkansas had a considerably higher waste generation in 2017. Of the 2,780,660 tons of material recycled in 2017, there were 2,245,791 tons metals, 130,786 tons yard waste, 131,973 tons plastics (6,910 tons HDPE, 47,388 tons LDPE, 2,262 tons PET, 59,555 tons PP, and 15,858 tons other plastic), 196,103 tons paper, 21,156 tons glass, 20,711 tons oil, 15,416 tons tires & rubber, 9,724 tons textiles & leather, 1,979 tons mixed recyclables, 6,283 tons batteries, 8,555 tons e-waste, and 1,183 tons household hazardous waste [21]. These numbers reflect the amount of material that was successfully recycled; however, by applying the US national average plastic waste composition rate of 12% to the total amount of waste landfilled and recycled in Arkansas in 2017 [18], an estimated 734,166 tons of plastic waste were generated in the state in 2017, leaving and estimated 602,193 tons of plastic waste going to the landfill instead of being recycled.

Nearly 100% of waste is collected in the USA, with many cities mandating the provision of household waste collection. Typically, waste is collected via curbside bins, dumpsters, or drop off points. Trucks then transport waste to their final disposal site or to transfer stations or sorting facilities that temporarily store waste for further transport over longer distances. Effective plastic waste management at the city level requires not just efforts toward waste reduction, but also consistent collection services. At present, successful collection of plastic waste relies heavily on behaviors at the household and individual level. As such, efforts toward education and incentivization strategies can help encourage behavior that helps waste infrastructure run smoothly. In the city limits of Blytheville, AK, residential curbside pickup is operated by the City of Blytheville Sanitation Department. The cost of pickup for the city is $22.08/month as of March 2023. Residential waste is collected once a week via 90-gallon curbside containers that must be purchased by every resident or apartment complex; the garbage cans can be purchased through the City Collector’s office or independently (City of Blytheville 2023). The municipality does not pick up commercial or industrial waste, all waste falling within these categories must be picked up by a private hauler (e.g., WastePro). Private haulers typically do pick-ups four days a week.

Figure 26: Commercial Dumpster at a Local Business

There is no longer a recycling facility in Blytheville, so recyclables are not collected, nor are there drop-off sites for recyclables. With the onset of COVID-19 in 2020 came the closure of the recycling facility. As one city official mentions, COVID-19 brought a labor shortage, forcing the city to shut down. Previously, the city worked with the county to provide recycling services to the citizens of Blytheville. The county would provide the trucks, fuel, and dumpsters to recycle, and the city oversaw processing the materials. The CIL team documented one plastic bag collection bin located at a Kroger for residents to drop off their plastic film waste for recycling.

There may be grant opportunities that Blytheville can tap into to target improvement of waste collection throughout the community. There are also several state-assisted opportunities; for example, through the Arkansas Department of Environmental Quality (ADEQ), cities, counties, and regional solid waste authorities, private companies, and research institutions can apply to grants ranging from assistance with cost to building and running a computer and electronic waste recycling program, supporting collection of scrap electronic equipment, and aiding the funding of regional solid waste management districts. In addition, Blytheville is currently working with MRCTI and Replenysh to explore drop-off collection, storage, densification and recycling opportunities that the city could operate themselves.

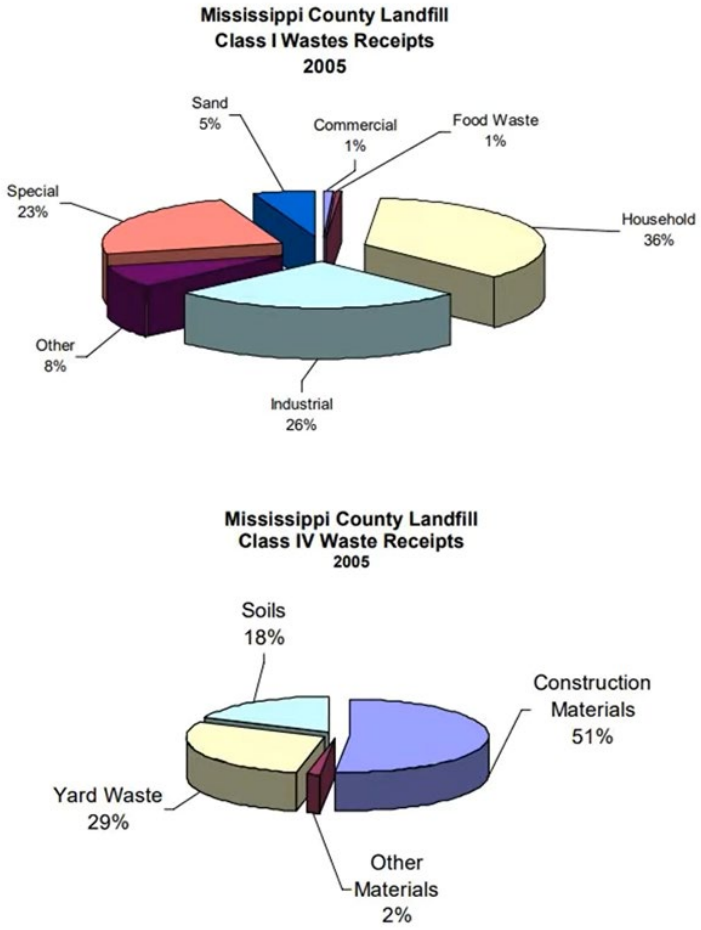
End of Cycle

All solid waste from the City of Blytheville goes to the Mississippi County, Arkansas Landfill. As of 2020, the landfill was averaging annual collections of 90,000 tons per year. The Mississippi County landfill provides disposal for all county generated waste, as well as some waste coming from outside the county. Waste characterization data from 2005 of the landfill can be seen in Figure 27. The landfill is located outside of Luxora, AR, about 13 miles from the center of Blytheville. The Mississippi County Regional Solid Waste Management District is responsible for ensuring lawful disposal of solid waste throughout the county. Funding for the landfill comes from federal grant money, the Arkansas Department of Environmental Quality (ADEQ), and the Mississippi County General Fund. Additionally, residents of the county pay a fee that goes towards curbside collection for residents and disposal fees at the landfill.

Mississippi County owns and operates a Class I and Class IV landfill. A Class I landfill can accept household wastes, non-hazardous commercial wastes, and non-hazardous industrial wastes, while a Class IV landfill can accept construction and demolition wastes, tree wastes, minor amounts of yard waste, inert commercial and manufacturing materials, auto and truck bodies and parts, shredded or cut tires, shipping waste, and furniture and appliances. In 2018, the disposal rate in Class I was $40.50 per ton and $32.00 per ton in Class IV. While this landfill accepts Class I and Class IV materials, asbestos must be disposed of separately at the landfill and costs $63.00 per ton. Two times a year, the Mississippi County landfill offers free disposal to individuals and a 50% discount to businesses and municipalities to clean up the community.

The Mississippi County landfill is regulated by the Arkansas Department of Environmental Quality (ADEQ), who conduct quarterly and annual inspections of the landfill. The landfill pays $250K in permits and fees annually to ADEQ. In addition to these fees, the landfill must pay for $125- $150K in annual leachate disposal, $150K to FTN Associates for consulting services on landfill expansion, $340K for a bond payment obligation that will last six years, $375K in annual equipment leasing, $125K in annual equipment repair, and $1.5 million in post closure liability for an inactive Phase I, Class I cell. In addition to these obligations, the landfill must set aside $500K a year to have funds to open a new cell every 4 to 5 years. Each new cell costs approximately $2-2.5 million dollars. The ability to continue funding the opening of a new cell every 4 to 5 years continues to be a priority for city officials. As the population declines in the area and economic circumstances change, there has been no growth in revenue to offset the annual increases in operating expenses. To reduce costs, the landfill purchased the equipment necessary to test the water quality of the stormwater ponds and trained their staff to prevent the need to hire consultants travelling from Little Rock, AK. Another measure the landfill has taken to increase the longevity of active cells is to use a plastic layer (described as biodegradable) to cover the landfill daily instead of a six inch layer of dirt. Before, the landfill would cover the landfill with six inches of dirt daily in between work days; now the landfill will use a 2 ml thick plastic covering instead every day except Friday. This will save the landfill approximately 2 ft of air space weekly, increasing the longevity of the active cells in the landfill (Mississippi County 2023, https://www.mississippicountyar.org/services.)

Figure 27: Waste characterization data of the Mississippi County Landfill (https://www.mississippicountyar.org/services**)**



Composting

With the lack of access to a municipal or commercial composting program in Mississippi County, Arkansas, with an infusion of resources, the county and the city of Blytheville could explore creating a 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 proposed 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 (Table 6). 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.

Yard trimmings and waste are currently collected separately from municipal garbage. For the estimation of the program, it is assumed that yard waste will continue to be collected separately and that the yard waste that is not currently collected separately will be accepted in the new curbside and drop-off composting programs.

Table 6: 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

Blytheville and Mississippi County				
	Households Covered	**Mass (Tons)**	**GHG Reduction (MTCO2E)**	**Area Required (Acres) ****
County-Curbside* (50-100%)	19,250	4,720 - 9,440	1,875 - 3,750	1.71 - 3.42
City Curbside* (50-100%)	7,111	1,742 - 3,483	692 - 1,384	0.63 - 1.26
City Drop-off (25-50%)	7,111	1,161 - 2,323	461 - 922	0.42 - 0.84

*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 Table 7.

Table 7: 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
Total Refuse for County Calculations: 43,552 tons/year
Total Refuse for City Calculations: 16,071 tons/year
Using West South Central region for electricity grid mix emission factor
Using National Average for LFG recovery in 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%

Using the Residential Source Separated Organics Collection Performance Model by SAIC Energy, Environment & Infrastructure, LLC, we were also able to create a cost estimation for a residential curbside composting collection with 70% Participation. Those costs and the associated assumptions made to calculate the costs can be found in Table 8 and Table 9.

Table 8: Cost Estimation of a City Curbside Composting Program with 70% Participation using the Residential Source Separated Organics Collection Performance Model by SAIC Energy, Environment & Infrastructure, LLC

Cost Estimation for City Curbside with 70% Participation	
Summary of Annual Costs of Residential SSO Collection Program:	
Personnel Costs	$225,000
Equipment Costs	$748,216
O&M Costs	$30,000
Fuel Costs	$0
Processing Costs	$12,192
Other Costs	$0
Total	$1,015,408
Summary of Annual Revenues/Savings of Residential SSO Collection Program:	
Fuel Savings*	$0
Mulch/Compost Revenues**	$0
Mulch/Compost Savings	$24,000
Disposal Cost Avoidance	$78,028
Other Revenues and Savings	$0

Total	$102,028
Estimated Monthly Net Costs per Household	
Monthly Cost per Household (Includes all Households in Community)	$10.70
Monthly Cost per Household with Access to Residential SSO Collection Program	$10.70
Monthly Cost per Participating Household	$15.29

* Did not estimate fuel savings for difference in routes because the location of potential composting facility is unknown

** Did not anticipate selling the mulch/compost in this cost estimation

Table 9: Assumptions made for Cost Estimation of a City Curbside Composting Program with 70% Participation using the Residential Source Separated Organics Collection Performance Model by SAIC Energy, Environment & Infrastructure, LLC

Assumptions for Cost Estimation of Municipal City Curbside with 70% Participation	
Vehicle type used for collection	Rear Loader (Manual)
Frequency of Pick-up	Every Week
Is yard waste included in program	Yes (not including amount currently collected separately)
Composition of Refuse Materials Targeted by Program Disposed by Community:*	
Fruits, Vegetables, and Bakery	7.50%
Other Food Scraps	5.90%
Non-Recyclable Paper	10.70%
Yard Trimmings	2.10%
Wood (non-C&D)	1.40%
Other Organics	1.30%
Capture Rate	75%
Number of households served on single route	700
Routes per week	7
Number of vehicles	2
Carts, estimated number assumes purchase of an extra 10% of carts for replacements	7,822
Cost per vehicle (average between new and used automated side-loader)	$200,000

Interest rate for vehicle	5%
Payment Term or Depreciation term (years)	7
Cost per cart	$55
Interest rate for cart	5%
Payment Term or Depreciation term (years)	7
Annual Operation and Maintenance of Vehicles	$30,000
Jobs created:	
One Crew Leader	$65,000
Two Truck Drivers	$55,000 (each)
One Public Education Officer	$50,000
Processing cost per ton of organic waste excluding personnel, equipment, and fuel impacts	$5
Estimated amount of mulch/compost needed by city that is currently purchased (cubic yards) **	800
Cost per cubic yard of mulch/compost	$30
Disposal Cost Avoidance per ton***	$32.00
Will the city sell the mulch/compost created	No

* Composition Assumption is based on the Georgia Statewide Waste Characterization study located: http://www.dca.state.ga.us/gasolidwaste/GADCAWebCalc/Report/GA%20WCS%20Final%20Report%2020050726.pdf
** Estimated using current number of public buildings/land in Blytheville, AR
*** Based on tipping fee for the Mississippi County Landfill

Leakage

In total, 2,074 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.

The largest percentages of litter by number of items found were plastic fragments and food plastic. These two categories accounted for almost fifty percent of waste items found. Tobacco products were also high at 19%. Metal, and glass composed significant minorities (Figure 28 and Figure 29).

Figure 28: Litter Material Breakdown

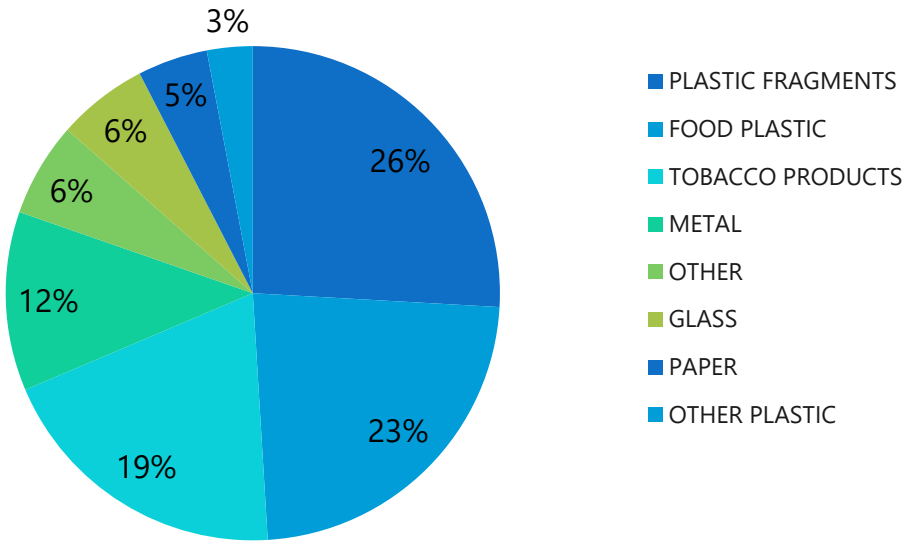
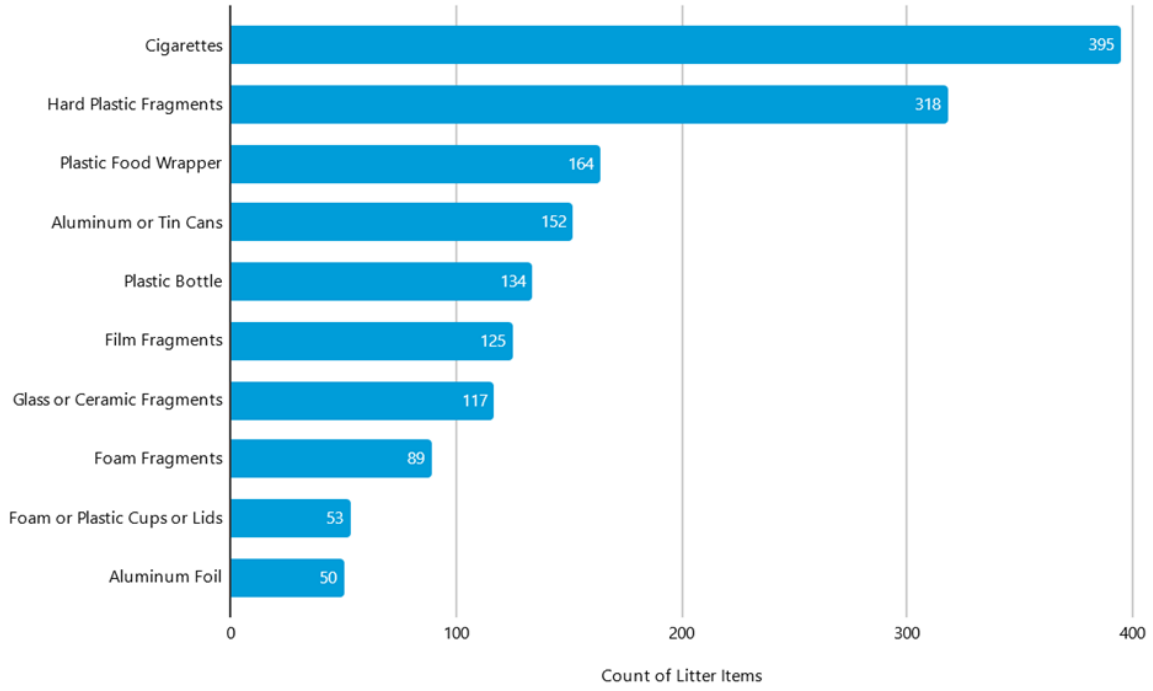


Figure 29: Example Litter Photos from Blytheville

Of the top ten overall items found, some would have likely been recyclable, if the infrastructure was available, such as foil, cans, glass, and plastic bottles. However, the majority, including the overall number one item cigarette butts, would typically be sent to a landfill (Figure 30). Interestingly, most of the plastic came from food or beverage products: bottles, foam cups, food wrappers, bottle caps, etc.

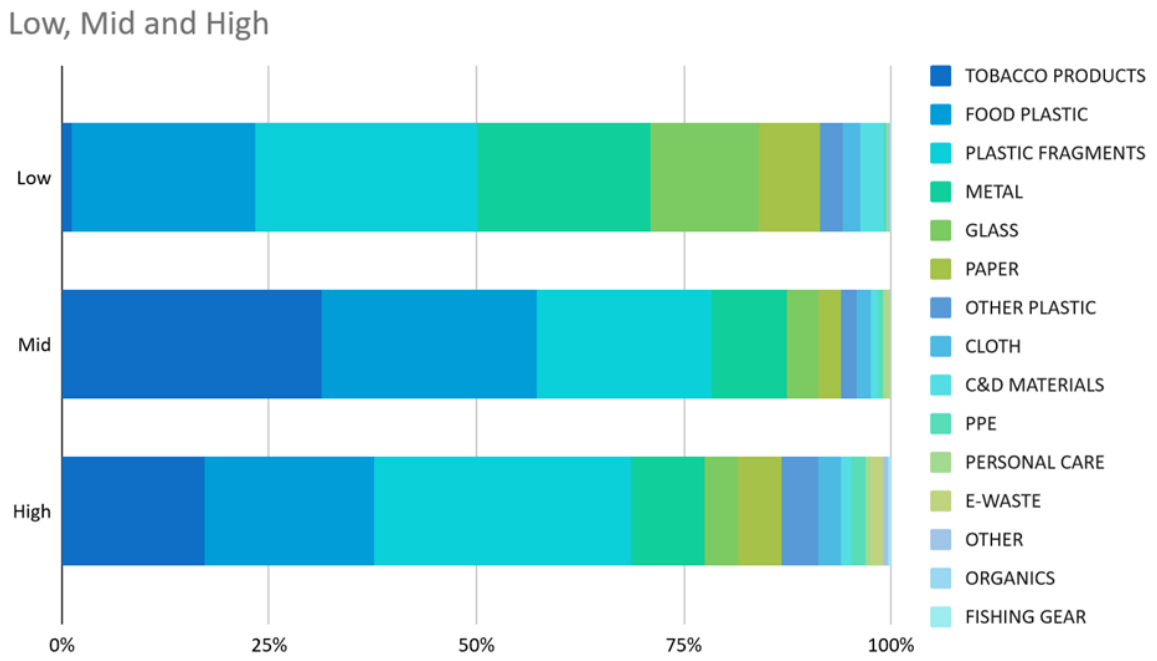
Figure 30: Overall Count of Litter Items



The prevalence of plastic fragments, the most common category of waste, may suggest that these items remained in the environment long enough to be broken down. In contrast, the intact presence of more easily degradable materials like paper implies that they had been exposed to the elements more recently.

As might be expected, cigarettes and other tobacco products were least apparent at the low population density sites. At those sites, there was significantly more metal and glass debris than at the more populated sites. There was also more paper and construction and demolition materials as a percentage of total litter. All three categories of site had similar and significant fractions of food-related waste. The medium and high population areas had higher percentages of personal care items, e-waste, cloth, and personal protective equipment. (Figure 31).

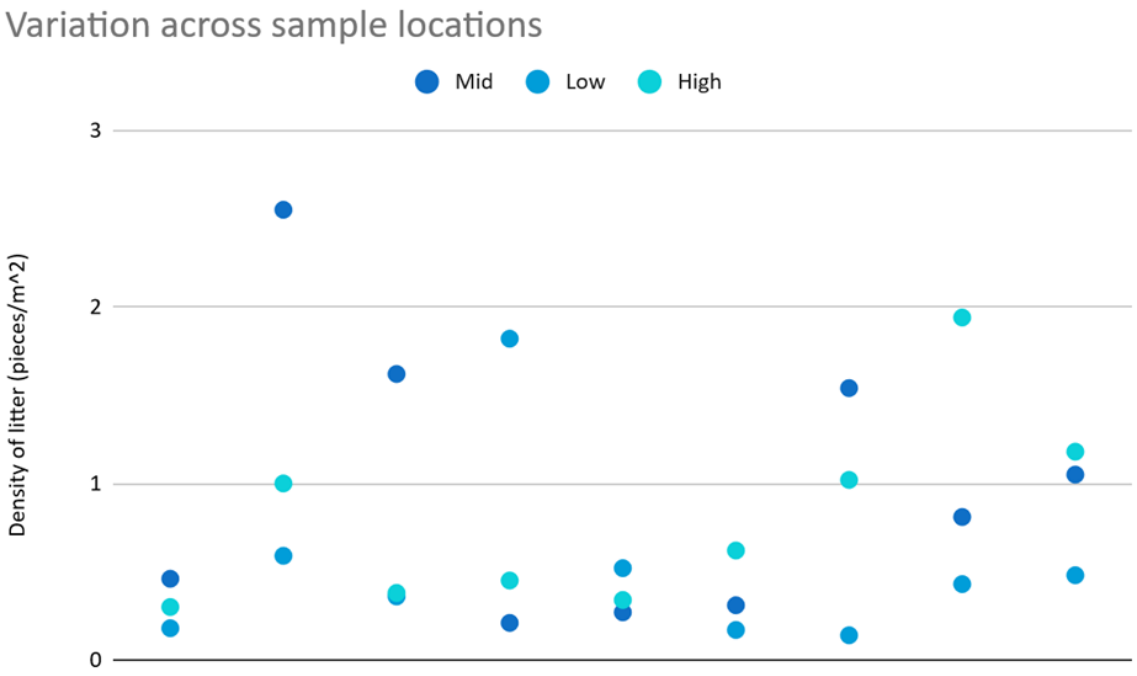
Figure 31: Litter Breakdown According to Ambient Population Density



The average density of litter pieces was significantly less at the low-density sites, averaging 0.52 items per square meter. It was also slightly higher at the medium than high density sites, with average densities of 0.98 and 0.80 items per square meter, respectively.

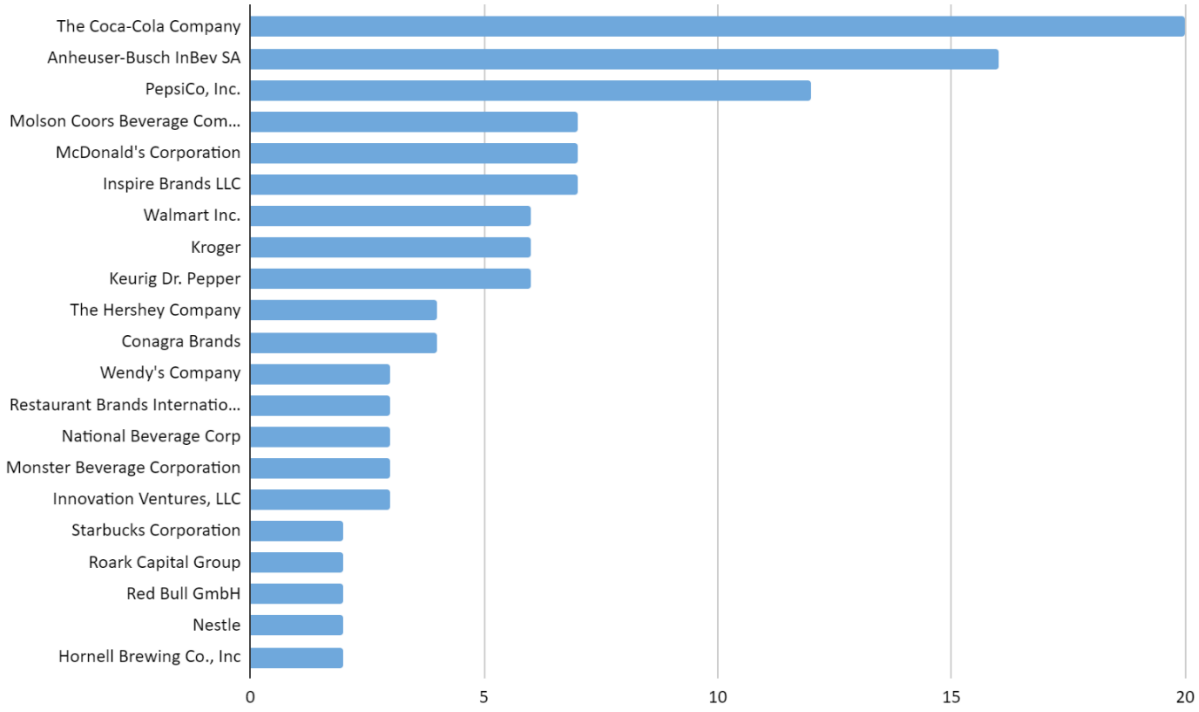
Overall, the average is 0.768 pieces of litter per square meter at the sample locations in Blytheville. However, there was significant variation between transects in the same population class. For example, the locations with the highest (1.54 pc/m^2) and lowest (0.26 pc/m^2) average density were both sites with moderate population. This suggests that other characteristics of each individual site besides population density contribute substantially to litter distribution. (Figure 32).

Figure 32: Litter Variation across Ambient Population Density Locations



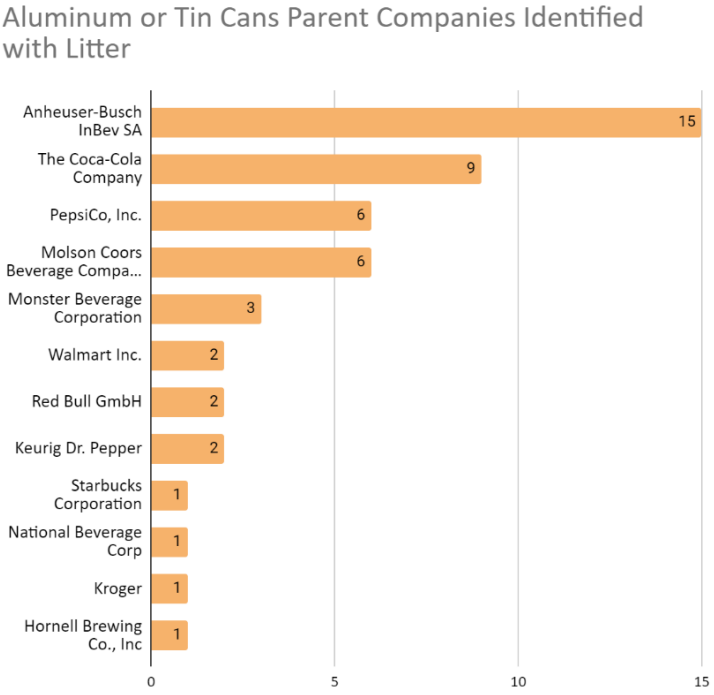
Considering the items whose manufacturer or distributor was able to be identified, there were many items that almost certainly trace back to fast food restaurants in the community, including McDonalds, Wendy's, Burger King, and Sonic. Identifiable food items included chips, gum, and candy, while alcoholic beverages and energy drinks comprised a significant percentage of drinks. Interestingly, water bottles demonstrate the full range of products available: Dasani, Fiji, Great Value, Kroger, SmartWater, and local brand Ozarka were all represented. Brands were identified on 144 total litter items, with 73 unique brand names. Brand names were mapped back to 44 associated parent companies. The top parent companies were The Coca-Cola Company (20 items) Anheuser-Busch InBev SA (16 items), and PepsiCo, Inc. (12 items) (Figure 33). Most of the litter items for the top three parent companies are aluminum cans, plastic bottles, or glass bottles for beverages, only three of items for these companies are related to plastic food packaging. To identify more specific opportunities for engagement, top parent companies were also mapped to specific items of concern in the litter dataset (Figure 34). Of particular note are beverage bottles and aluminum can parent companies; these highly recyclable items present a clear opportunity for corporate engagement around litter reduction and extended producer responsibility.

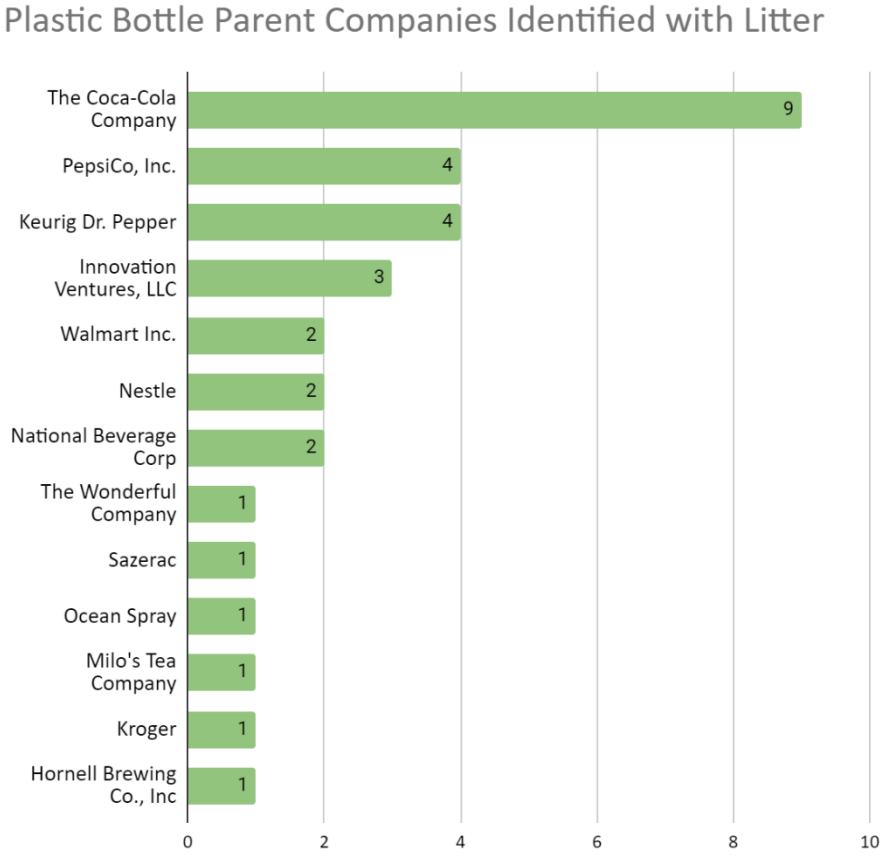
Figure 33: Parent companies of the brand identified in litter (parent companies with n≥2)

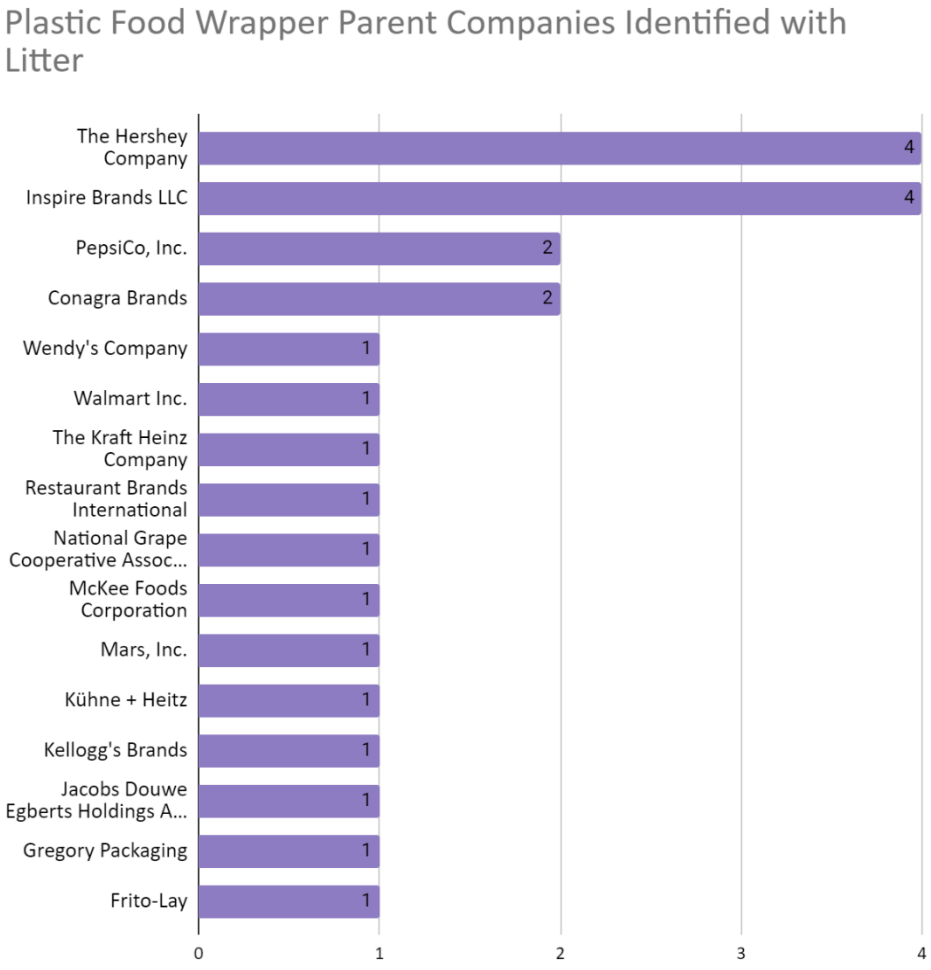


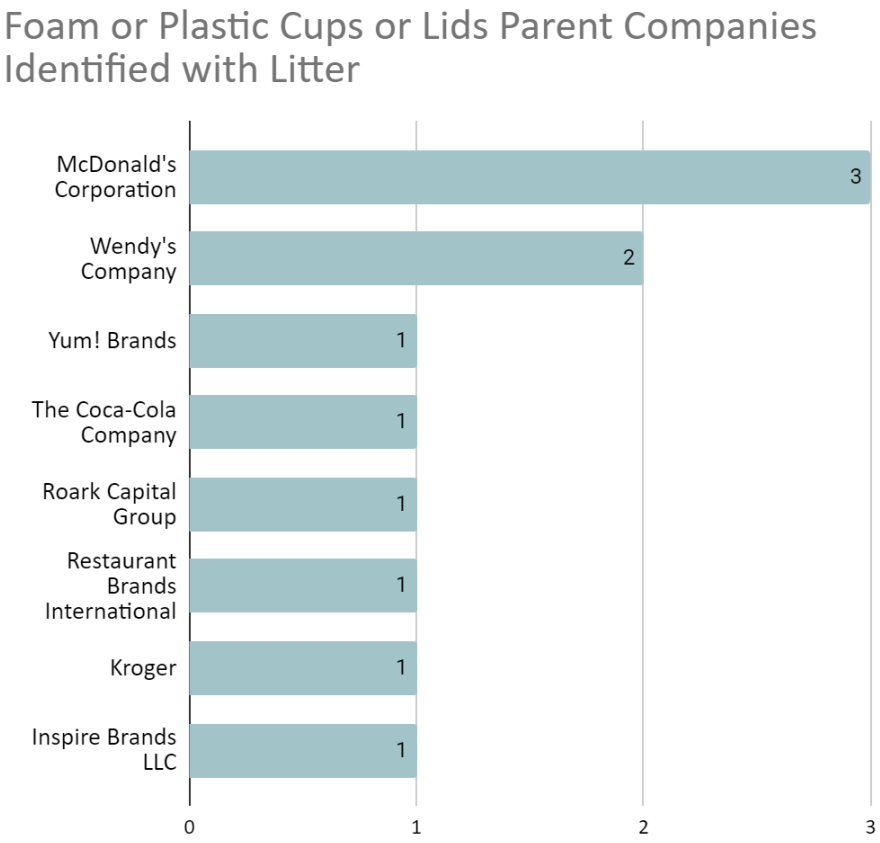
Compared to the amount of litter items logged, the number of branded items and unique brand names identified is small. With this small sample size, caution should be taken when referring to this data. Despite the sample size, presenting brands here can initiate discussions for brand engagement.

Figure 34: Parent Companies ID's with aluminum cans, plastic beverage bottles, food wrappers and plastic cups


Aluminum or Tin Cans Parent Companies Identified with Litter
Anheuser-Busch InBev SA
15
The Coca-Cola Company
9
PepsiCo, Inc.
6
Molson Coors Beverage Compa...
6
Monster Beverage Corporation
3
Walmart Inc.
2
Red Bull GmbH
2
Keurig Dr. Pepper
2
Starbucks Corporation
1
National Beverage Corp
1
Kroger
1
Hornell Brewing Co., Inc
1
0
5
10
15


Plastic Bottle Parent Companies Identified with Litter
The Coca-Cola Company
9
PepsiCo, Inc.
4
Keurig Dr. Pepper
4
Innovation Ventures, LLC
3
Walmart Inc.
2
Nestle
2
National Beverage Corp
2
The Wonderful Company
1
Sazerac
1
Ocean Spray
1
Milo's Tea Company
1
Kroger
1
Hornell Brewing Co., Inc
1
0
2
4
6
8
10


Plastic Food Wrapper Parent Companies Identified with Litter
The Hershey Company
4
Inspire Brands LLC
4
PepsiCo, Inc.
2
Conagra Brands
2
Wendy's Company
1
Walmart Inc.
1
The Kraft Heinz Company
1
Restaurant Brands International
1
National Grape Cooperative Assoc...
1
McKee Foods Corporation
1
Mars, Inc.
1
Kühne + Heitz
1
Kellogg's Brands
1
Jacobs Douwe Egberts Holdings A...
1
Gregory Packaging
1
Frito-Lay
1
0
1
2
3
4



Opportunities

CIL found the following opportunities to expand and enhance circularity in Blytheville 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

- The large percentage of domestic parent companies and manufacturers for top convenience items lend themselves to engaging companies on end-of-life management, product design, alternative materials and alternative product delivery systems. Blytheville could lead community initiatives toward working with top local brands and producers that operate locations proximal to the community and Arkansas, with a particular focus on beverage and chip packaging.

- Explore resources and potential local industry partnerships that may be available for effective development, implementation, and enforcement of EPR Guidelines and rules that result from those guidelines. In addition, the city should be involved to the extent possible in crafting EPR Guidelines at the city and national level to ensure that they can be effectively implemented at the local level.

Community

- Although the recycling center's closing presented some setbacks for Blytheville, the cooperative ethos of the town provides a great framework for problem-solving. Moving forward, there may be an opportunity for private investment to fund the town's recycling needs.

Product Design

- The candy packaging in Blytheville was found to have a higher ratio of plastic packaging to product than other cities in the US studied through CAP. There is opportunity here to reduce the amount of plastic packaging sold in the community by shifting to selling products with less plastic packaging overall.
- Many of the restaurants in Blytheville currently use styrofoam for to-go food containers and cups. Given the community's desire to re-establish a recycling facility, a shift towards easier to recycle materials that food vendors give out may be a smart step to take.

Use

- Currently few businesses offer alternatives to plastic retail bags, which typically consist of paper or other reusable plastic options. Notably, local businesses were the least likely to offer alternatives, with many opting to use traditional plastic retail bags. There may be opportunities for local businesses to explore alternative cost-effective options or systems that encourage customers to bring their own bags by providing a discount to their purchase.
- To support and encourage local businesses, the city could highlight those that choose to switch to alternative modes of product delivery systems and designs or encourage customers to reuse or bring their own. Doing so may increase buy-in from local community members and businesses that could ultimately encourage positive policy outcomes.

Collection

- There is large need for a recycling facility in the city as all plastic waste and other recyclables are currently going straight to the landfill. There would be opportunity to create a composting program at the same time as re-instating a recycling program.
- 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

- Landfilling is the only form of waste management in Blytheville at the moment. There are ample opportunities to explore diversion strategies through other end-of-cycle outlets like recycling and composting as well as upstream efforts like waste reduction. The most accessible model for sustainable waste management may be through sustainable material management approaches that prioritize net reduction in environmental, social, and economic impacts of waste, as opposed to ambitious circular economy and zero waste scenarios that may be more appropriate later on as Blytheville develops its own comprehensive approach to improving plastic waste management.
- 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.

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

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

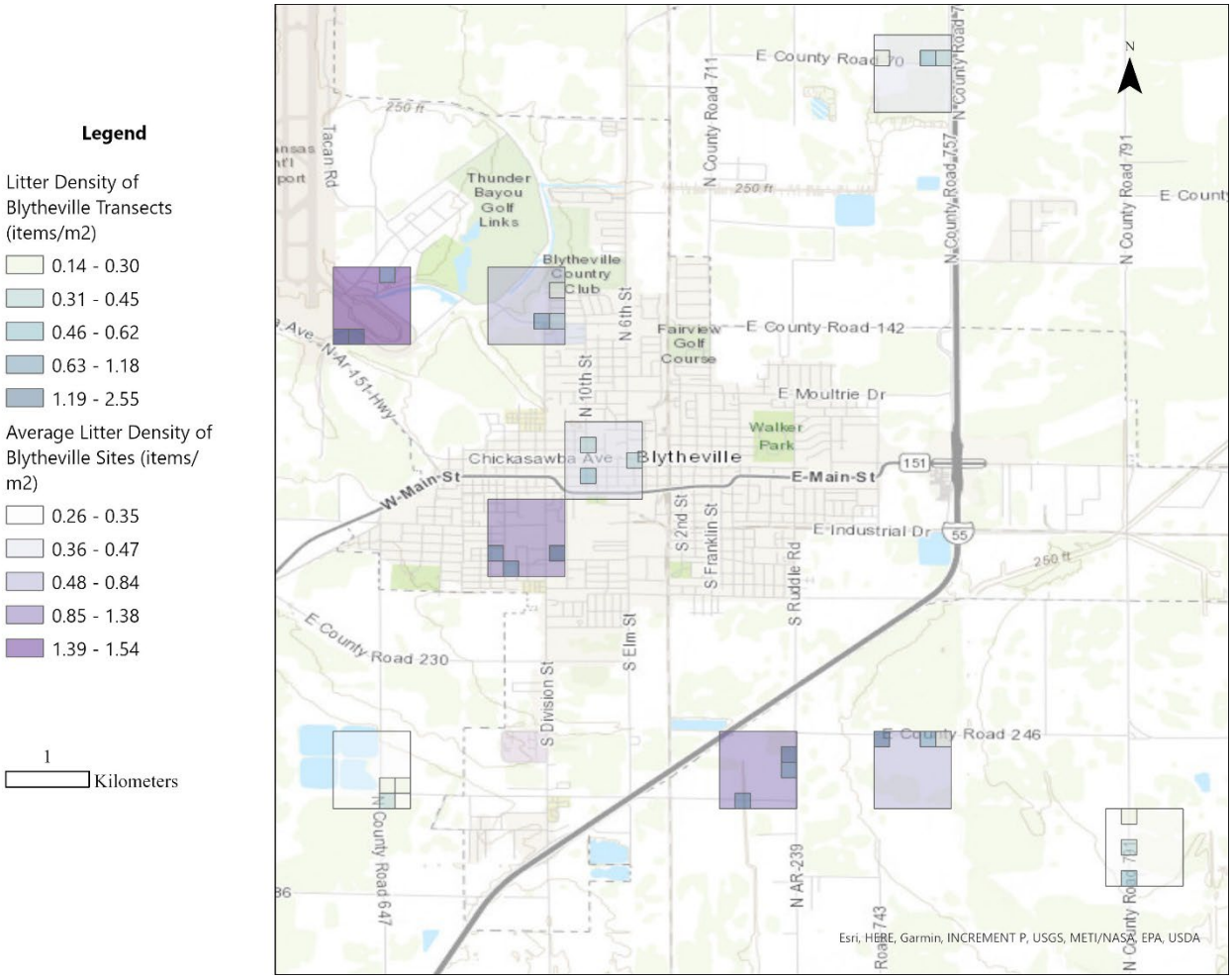
Material	Items
C&D Materials	Aggregate & Brick Bolts, Nails, and Screws Building Materials Lumber Other C&D
Cloth	Clothing Towels or rags Fabric Pieces Other Cloth
E-Waste	Batteries E-Waste Fragments Wire Other E-Waste
Fishing Gear	Buoys and Floats Fishing Line Other Fishing Gear Plastic Net or Net Pieces 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

Figure A1: Litter densities in transects and sites surveyed in Blytheville.



An interactive web map version of this map is available at:

https://usg.maps.arcgis.com/apps/mapviewer/index.html?webmap=4433e24840394228beb803a4a01f8fff

Table A2: Full table of manufacturers of top convenience products

Manufacturer	Manufacturing City Location	Manufacturing Country Location
Adams & Brooks	San Bernardino, CA	USA
Alani Nutrition	Louisville, KY	USA
Alkaline Water Company inc	Scottsdale, AZ	USA
Aloevine	Neward, NJ	USA
Andes Candy LLC	Delevan, WI	USA
Associated Wholesale Grocers	Kansas City, KS	USA
August Storck USA	Chicago, IL	USA

BA Sports Nutriton LLC	New York City, NY	USA
Bai Brands, LLC	Plano, TX	USA
Barcel	Coppell, TX	USA
Bazooka Candy Brands	New York City, NY	USA
Bevpax	Wilmington, DE	USA
Bottling Company LLC	Wytheville, VA	USA
Boyer candy CO.	Altoona, PA	USA
Brim's Snack Foods	Memphis, TN	USA
Brooklyn Bottling	Milton, NC	USA
Bug Juice International, Inc	Brighton, MI	USA
Candy Dynamics Inc.	Lahore	Pakistan
CandyRific	Louisville, KY	USA
Charms LLC	Convington, TN	USA
Chipoys	Baja California	USA
Chocolat Frey	Buffalo, NY	USA
ConAgra Foods	Chicago, IL	USA
Concord Confections	Concord	Canada
Congo Brands	Louisville, KY	USA
Cott Beverages	San Bernardino, CA	USA
Crown Candy Corporation	Macon, GA	USA
Danone	Paris	France
Deer Park	Chesterfield County, SC	USA
Defiance Fuel	Nashville, TN	USA
Dole Food Company	Thousand Oaks, CA	USA
Dollar General Corporation	Goodlettsville, TN	USA
Dorval Trading Co.	Nanuet, NY	USA
Dot's Pretzels	Velva, ND	USA
Keurig Dr. Pepper	Plano, TX	USA
Dulces de la Rosa	Guadalajara	Mexico
Essentia Water LLC	Bothell, WA	USA
Eternal Beverages, Inc.	Walnut Creek, CA	USA
Evans Food Group Ltd.	Chicago, IL	USA
Facetwister	Hales Corners, WI	USA

fairlife, LLC	Chicago, IL	USA
Faygo Beverages, Inc.	Detroit, MI	USA
Feastables		Peru
Ferrara Candy Company	Chicago, IL	USA
Ferraro USA	Parsippany, NJ	USA
Florida's Natural Growers, Inc	Lake Wales, FL	USA
Flow Beverage Corp	Toronta	Canada
Ford Gum and Machine Company	Guangdong	China
Frankford Candy LLC	Philadelphia, PA	USA
Frito-Lay	Plano, TX	USA
Fun Sweets LLC	West Palm Beach, FL	USA
Galerie, Inc		China
Gatorade	Chicago, IL	USA
Glaceau	Morpeth, Northumberland	UK
Glow Beverages	Rancho Cucamonga, CA	USA
Goetze Candy Co	Baltimore, MD	USA
Golden Flake Snack Foods	Birmingham, AL	USA
good2grow, LLC	Atlanta, GA	USA
Haribo of America	Rosemont, IL	USA
Hilco LLC	Louisville, KY	USA
Hint, Inc	San Francisco, CA	USA
Hoist	Cincinnati, OH	USA
Icelandic Water Holdings hf	Hlidarendi, Olfus	Iceland
Imaginings 3, Inc Flix Candy	Niles, IL	USA
Innovative Candy Concepts	Atlanta, GA	USA
Intrastate Distributors Inc.	Detroit, MI	USA
Jays Foods Inc	Chicago, IL	USA
Jelly Belly Candy Company	Fairfield, CA	USA
Junior Mints	Cambridge, MA	USA
Just Born Inc.	Bethlehem, PA	USA
Karma Culture LLC	Pittsford, NY	USA
Kellogg Company (Sunshine Biscuits)	Elmhurst, IL	USA
KidsMania	Guangdong	China

Kidz World	Barcelona	Spain
Kim's Snacks LLC	Atlanta, TX	USA
Koko's Confectionery	China	China
Kraft Heinz Company	Chicago, IL	USA
Lilys Sweets LLC	Boulder, CO	USA
Lindt & Sprungli USA	Stratham, NH	USA
Lipton	New York City, NY	USA
Mars Wrigley Confectionery US, LLC	Hackettstown, NJ	USA
Mederer USA	Des Plaines, IL	USA
Milo's Tea Company, Inc	Bessemer, AL	USA
Mondelez Global LLC	East Hanover, NJ	USA
Morinaga America, Inc	Irvine, CA	USA
Naked Juice Co	Irvine, CA	USA
Nestle USA, Inc.	Rossyln, Arlington, VA	USA
New Century Beverage Company	San Francisco, CA	USA
Niagara Bottling	Diamond Bar, CA	USA
Ocean Spray Cranberries Inc	Lakeville-Middleborough, MA	USA
Old Tyme Holdings Group, LLC	New York City, NY	USA
Oliver's Candies	Calgary, AB	Canada
Original Gourmet Food Company	Salem, NH	USA
Ozarka Water	El Campo, TX	USA
Pepsi Midamerica	Marion, IL	USA
Pepsico	Knoxville, TN	USA
Perfetti Van Melle USA	Erlanger, KY	USA
Perrier Vittel SA	Vergeze	France
Popcorners	Middletown, NY	USA
Prairie Farms Inc.	Edwardsville, IL	USA
Pringles Manufacturing Co	Jackson, TN	USA
Protein2o	Chicago, IL	USA
Push Beverages	Succasunna, NJ	USA
R.L. Albert & Son, Inc.	Stamford, CT	USA
RAP SNACKS Inc	Miami, FL	USA
Red Diamond Inc	Moody, AL	USA

Royal Crown Bottling Company	Winchester, VA	USA
Russel Stover Chocolates LLC	Kansas City, MO	USA
Sabritas	Mexico City	Mexico
Sensible Portions	Boulder, CO	USA
Shamrock Farms Dairy	Phoenix, AZ	USA
Shearer's Foods, LLC	Massillon, OH	USA
Simple Truth (Kroger)	Cincinnati, OH	USA
Simply Orange Juice Company	Apoka, FL	USA
Smart Sweets Inc.	Vancouver	Canada
Smarties Candy Company	Union, NJ	USA
Snak-King Corp.	Los Angeles, CA	USA
Snapple Beverage Corp.	Frisco, TX	USA
Snyder's Lance, Inc	Charlotte, NC	USA
Spangler Candy Company	Bryan, OH	USA
Splash Beverage Group	Fort Lauderdale, FL	USA
Star Brands North America	White Plains, NY	USA
Sundance Beverage Co	Warren, MI	USA
Sunkist Growers Inc	Valencia, CA	USA
Sweet Bandit, Inc.	St Irwindale, CA	USA
Talking Rain Beverage Company	Preston, WA	USA
The Coca-Cola Company	Atlanta, GA	USA
The Double Cola Company	Chattanooga, TN	USA
The Foreign Candy Company, Inc		Thailand
The Gatorade Company	Chicago, IL	USA
The Hershey Company	Hershey, PA	USA
The Pepsi Bottling Group	Athens, GA	USA
The Pickle Juice Company	Mesquite, TX	USA
The Topps Company, Inc	New York City, NY	USA
The Wonderful Company	Los Angeles, CA	USA
Tootsie Roll Industries, LLC	Chicago, IL	USA
Topps	Scranton, PA	USA
Tropicana Manufacturing, INC	Bradenton, FL	USA
Tum-e Yummies	Atlanta, GA	USA

Turkey Hill Dairy	Lancaster County, PA	USA
Uncle Ray's, LLC	Detroit, MI	USA
Unique Beverage	Everett, WA	USA
Utz	Hanover, PA	USA
Venture Food & Beverage LLC	Raleigh, NC	USA
Walmart, Inc.	Bentonville, AK	USA
Weeny Beeny	Seoul	South Korea
Welch's	Concord, MA	USA
Yolo Candy	Mahwah, NJ	USA
Zapp's Potato Chips	Hanover, PA	USA
ZenWTR Inc	Long Beach, CA	USA

Table A3: Full table of parent companies of top convenience products

Parent Company	Parent Company City Location	Parent Company Country Location
A&A Global Industries	Orlando, Fl	USA
Adams & Brooks	San Bernardino, CA	USA
Alani Nutrition	Louisville, KY	USA
Alkaline Water Company inc	Scottsdale, AZ	USA
Aloevine	Neward, NJ	USA
August Storck KG	Berlin	Germany
Benestar Brands	Chicago, IL	USA
Best Choice Brands	Kansas City, KS	USA
Bevpax	Wilmington, DE	USA
Bimbo	Mexico City	Mexico
BlueTriton Brands	Stamford, CT	USA
Boyer candy CO.	Altoona, PA	USA
Brimhall Foods Company, Inc.	Memphis, TN	USA
Brooklyn Bottling	Milton, NY	USA
Bug Juice International, Inc	Brighton, MI	USA
Campbell's Soup Company	Camden, NJ	USA
Candy Dynamics	Indianapolis, IN	USA
CandyRific	Louisville, KY	USA

CandyRific LLC	Louisville, KY	USA
Chipoys	Baja California	Mexico
Citrus World, Inc.	Lake Wales, FL	USA
ConAgra Foods	Chicago, IL	USA
Congo Brands	Louisville, KY	USA
Crown Candy Corporation	Atlanta, GA	USA
Danone	Paris	France
Defiance Fuel	Nashville, TN	USA
Dorval Trading Co.	Nanuet, NY	USA
Dot's Pretzels	Velva, ND	USA
Dulces de la Rosa	Tlaquepaque	Mexico
Eternal Beverages, Inc.	Walnut Creek, CA	USA
Fanatics Inc	New York City, NY	USA
Feastables	Chicago, IL	USA
Ferraro SpA	Alba	Italy
Flow Beverage Corp	Toronta	Canada
Ford Gum and Machine Company	Akron, NY	USA
Frankford Candy	Frankford. PA	USA
Fun Sweets LLC	West Palm Beach, FL	USA
Galerie, Inc	Hebron, KY	USA
Glow Beverages	Rancho Cucamonga, CA	USA
Goetze Candy Co	Baltimore, MD	USA
good2grow, LLC	Atlanta, GA	USA
Grupo Bimbo	Mexico City	Mexico
Hain Celestial Group	Boulder, CO	USA
Haribo	Bonn	Germany
Hint, INC	San Francisco, CA	USA
Hoist	Cincinnati, OH	USA
Icelandic Water Holdings hf	Hlidarendi, Olfus	Iceland
Imaginings 3, Inc	Chicago, IL	USA
Innovative Candy Concepts	Atlanta, GA	USA
Intrastate Distributors Inc.	Detroit, MI	USA
Jelly Belly Candy Company	Fairfield, CA	USA

Just Born Inc.	Bethlehem, PA	USA
K.J. International, Inc.	Chino, CA	USA
Karma Culture LLC	Pittsford, NY	USA
Kellogg Company	Battle Creek, MI	USA
Keurig Dr. Pepper	Frisco, TX	USA
KidsMania	Irwindale, CA	USA
Kidz World	Barcelona	Spain
Kim's Snacks LLC	Atlanta, TX	USA
Kohlberg Kravis Roberts & Co. L.P.	New York City, NY	USA
Kraft Heinz Company	Chicago, IL	USA
Kroger	Cincinnati, OH	USA
Lindt & Sprungli	Kilchberg	Switzerland
Mars Inc	McLean, VA	USA
Matel	El Segundo, CA	USA
Mederer Group	Furth	Germany
Migros	Zürich	Switzerland
Milo's Tea Company, Inc	Bessemer, AL	USA
Mondelez International Group	Chicago, IL	USA
Morinaga & Co	Tokyo	Japan
National Beverage Company	Fort Lauderdale, FL	USA
National Grape Cooperative Association, Inc. - NCFC	Washington, DC	USA
Nestle Inc.	Vevey	Switzerland
Niagara Bottling	Diamond Bar, CA	USA
Ocean Spray Cranberries Inc	Lakeville-Middleborough, MA	USA
Old Tyme Holdings Group, LLC	New York City, NY	USA
Oliver's Candies	Calgary, AB	Canada
Original Gourmet Food Company	Salem, NH	USA
Peak Rock Capital LLC	Austin, TX	USA
Pepsi Midamerica	Marion, IL	USA
PepsiCo	Purchase, NY	USA
Perfetti Van Melle	Breda	Netherlands
Prairie Farms Inc.	Edwardsville, IL	USA

Protein2o	Chicago, IL	USA
Push Beverages	Succasunna, NJ	USA
R.L. Albert & Son, Inc.	Stamford, CT	USA
Rap Snacks INC	Miami, FL	USA
Red Diamond Inc	Moody, AL	USA
Refresco	Rotterdam	Netherlands
Russel Stover Chocolates LLC	Kansas City, MO	USA
Schuster Products LLC	Hales Corners, WI	USA
Shamrock Foods Company	Phoenix, AZ	USA
Smart Sweets Inc.	Vancouver	Canada
Smarties Candy Company	Union, NJ	USA
Snak-King Corp.	Los Angeles, CA	USA
Snyder's-Lance, Inc.	Charlotte, NC	USA
Spangler Candy Company	Bryan, OH	USA
Suntory	Tokyo	Japan
Sweet Bandit, Inc.	St Irwindale, CA	USA
Talking Rain Beverage Company	Preston, WA	USA
The Coca-Cola Company	Atlanta, GA	USA
The Foreign Candy Company, Inc	Hull, IA	USA
The H. T. Hackney Company	Knoxville, TN	USA
The Hain Celestial Group Inc	Lake Sucess, NY	USA
The Hershey Company	Hershey, PA	USA
The Pickle Juice Company	Mesquite, TX	USA
The Topps Company	New York City, NY	USA
The Wonderful Company	Los Angeles, CA	USA
Tootsie Roll Industries, LLC	Chicago, IL	USA
Topps	New York City, NY	USA
Unique Beverage	Everett, WA	USA
Utz Quality Foods, LLC	Hanover, PA	USA
Viacom International Inc	New York City, NY	USA
Walton Enterprises	Bentonville, AK	USA
Weeny Beeny	Seoul	South Korea
Wind Point Partners	Chicago, IL	USA

Yildiz Holding	Istanbul	Turkey
Yolo Candy	Mahwah, NJ	USA
ZenWTR Inc	Long Beach, CA	USA