Reallocating Food Waste

Evaluating Food Waste Management Options for Atlanta

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Abstract

This paper recommends efficient ways for city officials to mitigate Atlanta's food waste. Redirecting food waste will provide the city with three significant benefits: (1) Equity – The reallocation of excess, edible food will improve food security amongst thousands of Atlanta residents now classified as food insecure, (2) Environment – Redirecting food waste away from disposal reduces the need for landfills and mitigates greenhouse gas emissions, and (3) Economy – The reuse of food waste provides a valuable resource for the provision of food, the production of biofuels, and the generation of electricy, amongst other uses. Therefore, an evaluation of Atlanta's food waste management options is necessary for city officials to fully define and explore the problem, set priorities, leverage strengths, build coalition groups, attract private investment, and begin to implement a plan, which will reduce the amount of food going to landfills and redirect food towards its best uses.

This paper will present the case for an improved food waste management plan in eight sections. In sections 1 through 5, the paper explores why food waste diversion is important, examines food reallocation currently in Atlanta, sets up a process for evaluating Atlanta's need for reducing food waste and presents data to that effect, and presents a series of recommendations for improving Atlanta's food reallocation. Section 6 provides a deeper analysis of Anaerobic Digestion, a particularly promising option. Finally, in Sections 7 and 8, the report presents concluding remarks and References.

I. Why is Food Waste Diversion Important?

A. Negative Consequences of Food Waste

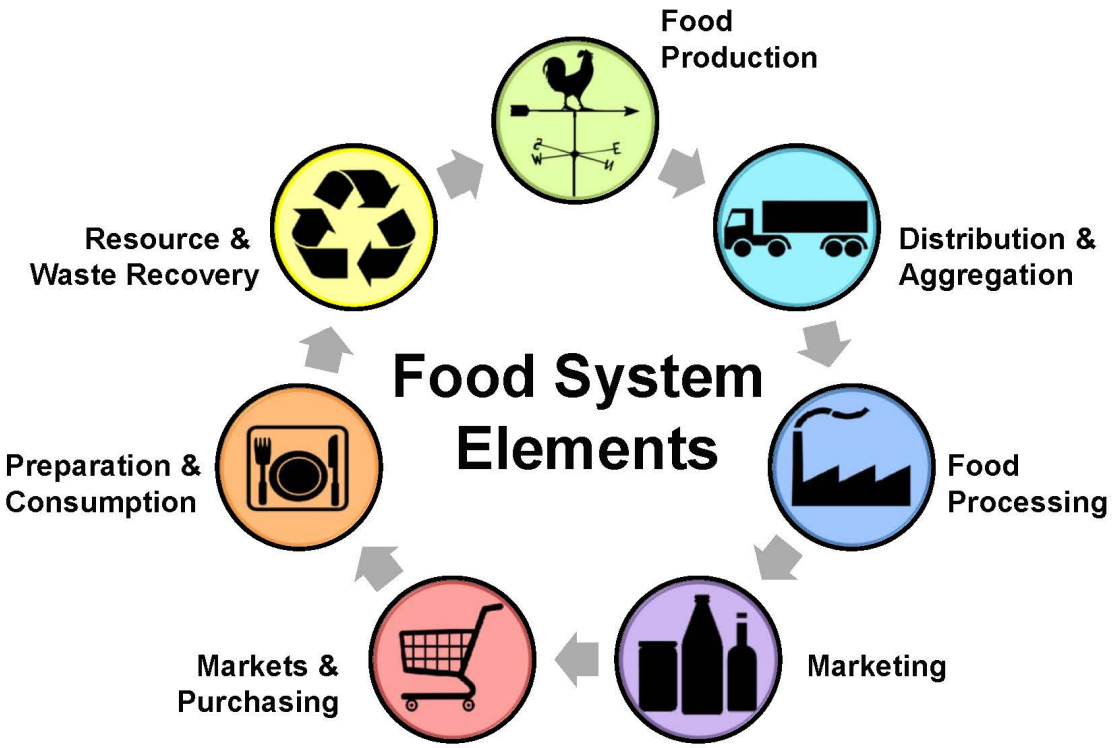
The negative consequences of food waste primarily fall under the categories of economic loss, environmental damage, or equity issues. Regarding economic losses, the United States Department of Agriculture (USDA) estimates that in 2010 approximately 30% to 40% of the food supply in the United States was never consumed.[1] Substantial amounts of farmland, water, energy, fertilizers, pesticides, and other resources are being used to produce billions of pounds of food, which will be buried in landfills.

The EPA's most recent report on the generation and disposal of solid waste estimates that food accounted for approximately 15% of the United States' landfill deposits in 2015, presenting serious environmental issues.[2] Additionally, as food waste decomposes underground, it produces methane (CH4), a greenhouse gas that is significantly more potent at trapping heat in Earth's atmosphere than carbon dioxide (CO2). This problem began to attract more attention after the Food and Agriculture Organization (FAO) of the United Nations released an official statement in 2011, estimating that food waste was responsible for approximately 8% of humanity's global greenhouse gas emissions.[3]

In addition to the environmental problems associated with sending billions of pounds of food to landfills every year, food waste is also an issue of equity. In 2017, approximately one in eight Americans (40 million people) were classified as food insecure, meaning that they did not have consistent access to enough food for an active, healthy life.[4] Although the United States has more than enough food to feed these hungry people, redistributing perishable foods before they expire is a difficult task that involves significant oversight, but it is a task that Americans are fully equipped to handle.

One of the aspects of food waste that makes it such a difficult problem is that food is wasted at

every step of the food system. This high level of decentralization makes food waste a complex problem, requiring multiple solutions. A concept map of the food system developed by Michigan State University can be seen in the following figure.[5]



Adapted by Christy Shi, Center for Environmental Farming Systems.
From: Wilkins, J. and Eames-Sheavly, M. Discovering the Food System; An experiential learning program for young and inquiring minds. Cornell University, Departments of Nutritional Science and Horticulture. http://www.discoverfoodsys.cornell.edu/

B. Food Waste by Sector

In addition to being spread across the food system, food waste occurs in multiple sectors of the economy, including agriculture, transportation, processing, retail, food service, and residential consumption. Due to their differences, each sector wastes food differently. Some examples include: "ugly" food on farms that is left to rot, unused scraps from food processing, improperly stored food that expires during transport, meat and produce that expires at supermarkets, uneaten food at

restaurants, and uneaten food in households. It is important to reduce food waste in each of these sectors, but the most important sectors for a city to consider when creating a food waste management plan are residential consumption, retail, and food service.

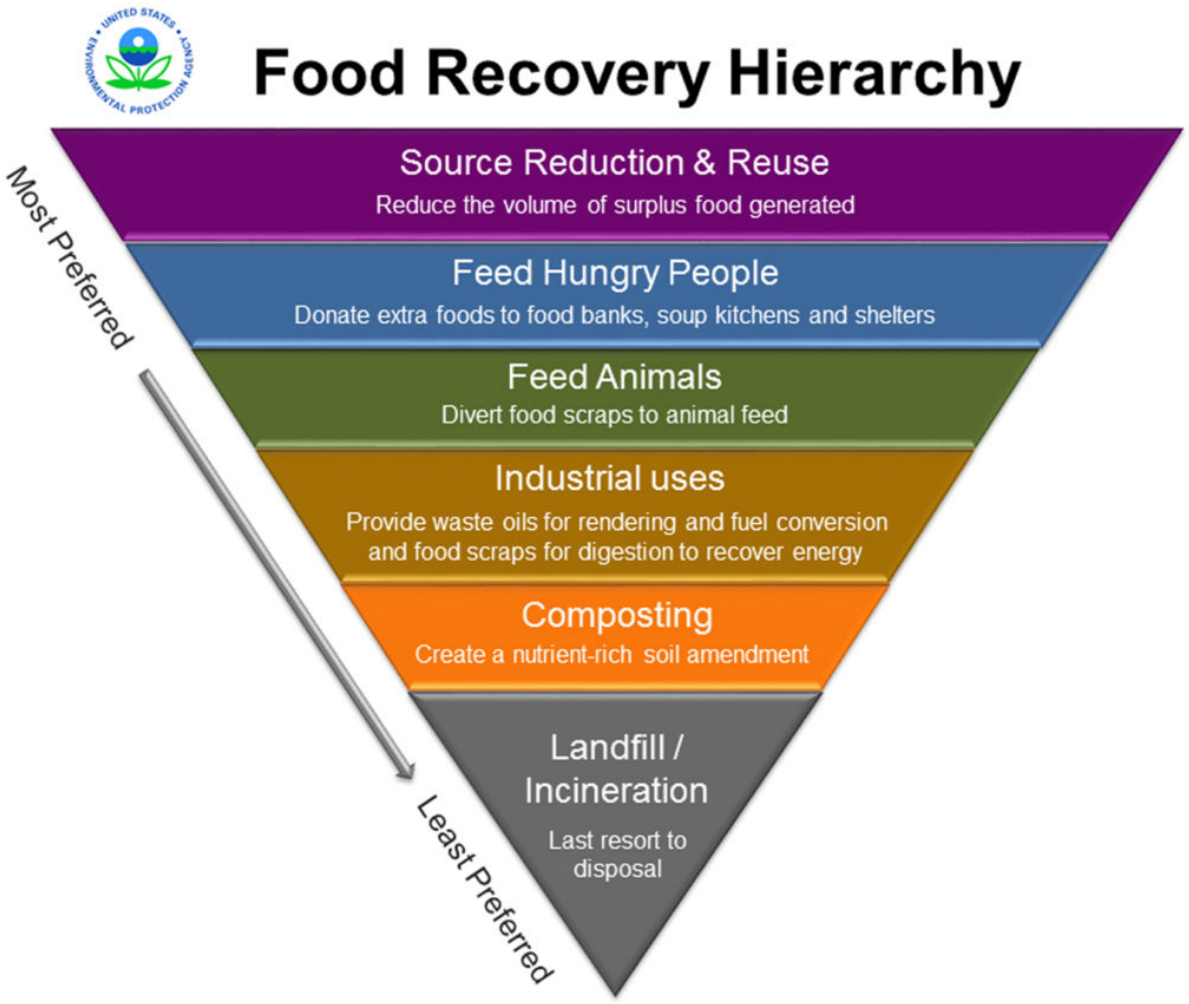
Numerous groups have tried to estimate which sectors waste the most food in the United States, and although their studies have produced slightly different results based on criteria measured, they all estimate residential consumption to generate approximately half of all food waste in the United States.[6,7] This presents numerous challenges, because residential areas are often highly decentralized, and individual homes produce relatively small amounts of food waste. Additionally, a city's homes can fall under a variety of public and private waste disposal services, making coordination difficult.

In comparison to residential food waste, grocery stores are highly centralized and send billions of pounds of food to landfills every year, making them a prime opportunity for public-private partnerships. Some companies like Kroger have used these partnerships to donate millions of pounds of food to hungry families, and there are opportunities for these partnerships to be replicated with other grocery stores and in other cities around the United States.[8]

American food service venues, including restaurants, hotels, schools, hospitals, and many others, send millions of pounds of food to landfills every day. This food waste includes: (1) excess, uneaten food that can be delivered to food insecure families and (2) leftovers from served meals, which can be diverted from landfills towards a higher valued use. Providing business with the means to capture a portion of the lost economic value of food waste will provide the proper incentives for private and public corporations to individually divert their food waste from landfills.

C. Solutions to Mitigating Food Waste

Food waste is inevitable. People are bound to forget about food in the back of the fridge for too long and can't realistically eat apple cores or banana peels. No matter what humans do, there will always be food waste, but there are better ways to use this resource than sending it to a landfill. To help city administrators decide how to prioritize food waste allocation, the EPA created the Food Recovery Hierarchy, which is shown in the following figure.[9]



1. Source Reduction & Reuse

The Food Recovery Hierarchy categorizes the different ways that food waste can be allocated towards its best uses, but the EPA asserts that the best way to solve the food waste problem is by

reducing the volume of food waste generated entirely. This process can be accomplished within homes, businesses, and anywhere else that food is purchased. Due to the large amount of food wasted in residential areas, one of the best ways to reduce this type of food waste is to encourage consumers to make more frequent visits to the grocery store, buying less perishable food per trip than they were before.

2. Feed Hungry People

If a city does have excess food, it should prioritize feeding hungry people, which is more economically efficient than paying for food to be buried in a landfill. Companies like Goodr and Second Helpings have discovered that this inefficiency is a business opportunity and have worked to connect businesses with too much food with people who need food.[10,11] These businesses are primarily restaurants and food vendors, like the ones at sports games, who are incentivized through tax deductions to donate their excess food. In addition to increasing their profitability, these companies mitigate food from going to landfills, while also providing food insecure families with fresh food.

When companies are considering donating their excess food, one of the most prevalent concerns is liability. These corporations worry that if someone eats their donated food and gets sick, the company will be responsible for reparations. However, the Federal Bill Emerson Good Samaritan Food Donation Act of 1996 protects corporations from any liability associated with food donation, provided that the corporations use the appropriate donation channels.[12]

3. Feed Animals

For thousands of years, humans have been feeding food waste to cows and pigs to turn food that is no longer edible for humans into meat. This allows for food waste to be reallocated towards a

more valuable use than being buried in a landfill. Although keeping a concentrated number of farm animals in a city presents numerous problems, food waste can be shipped to local farms, which helps to foster relationships between urban residents and rural farmers. Rutgers University and Pinter Farms, which is only 15 miles away, have formed this kind of partnership, resulting in the reallocation of over a ton of food scraps to the farm per day.[13]

4. Industrial Uses

Food waste, such as coffee grounds or cooking grease, can be economically valuable if processed. Examples of food waste industrial processing include: (1) rending, which converts food waste into animal food, cosmetics, soap, and other products, (2) biodiesel, which is an environmentally-friendly fuel, and (3) anaerobic digestion, which generates methane and soil amendment.[14]

Anaerobic digestion of food waste provides exciting opportunities for cities to use their food waste and create a multitude of environmental benefits. The process of digestion takes place in massive, steel drums, which provide a controlled environment for the decomposition of food waste. In this process, bacteria are deprived of oxygen so that they will produce methane as they decompose the food. While landfills release their produced methane into the atmosphere, the digestion process traps and stores this flammable gas, which cities can use as a source of green energy.[15] After the digestion is finished, the processed food waste can also be composted. This multi-stage process of digestion and decomposition is still a relatively new technology and has not yet been widely adopted.

Several American cities have already adopted anaerobic digestion of food waste and are often partnering with water treatment facilities that have already been using this technology for municipal

waste. For example the Des Moines' (Iowa) Metropolitan Wastewater Reclamation Authority operates six, 2.7 million-gallon anaerobic digesters.[14] This facility accepts approximately 60 truckloads of organic waste per day, which is digested with municipal sludge to produce over 2.1 million cubic feet of methane per day. This biogas provides enough energy to heat the facility's boilers, run two, 1.4-megawatt engine generators, and provide energy for a neighboring facility's boilers. Numerous other cities like New York have proposed to add digesters and composting facilities to their waste disposal, a process that would redirect millions of pounds of food away from landfills towards more efficient uses.[16] If cities around the United States adopt this technology, the massive food waste of urban areas could be harnessed as a substantial source of energy and organic fertilizer. Anaerobic digestion will be evaluated further in the paper's analysis.

5. Composting

After food waste has been processed through anaerobic digestion, it can also be composted, which farther increases the economic and environmental benefits of food waste reallocation. Composting is the process of breaking down yard trimmings and food waste into nutrient-rich, organic soil through the utilization of bacteria and earthworms.[17] This "black gold" is considered highly valuable, because organic farmers use compost as a soil amendment instead of synthetic fertilizers. This process allows farmers to grow healthy crops and return essential nutrients back to the soil. Some American cities have gone so far as to make composting mandatory. Examples include Seattle, Portland, and San Francisco.[18,19,20] These cities have found that mandatory composting and recycling can divert as much as 75% of single-family residential waste away from landfills.[21]

II. Food Reallocation in Atlanta

A. Historic Context of Food Reallocation in Atlanta

In 2016, Atlanta joined the Rockefeller Foundation's 100 Resilient Cities network, giving the city funds to hire a Chief Resiliency Officer and technical support to develop a Resiliency Strategy.[22] Atlanta's Resiliency Strategy, completed in 2017, specifies targets that included, "Develop a resilient local food system by 2025" and "Ensure every Atlantan lives within one-half mile of fresh food by 2025".[23] One of the ways that Atlanta can meet these goals is by reallocating food waste to food insecure households.

Although Atlanta likely has more than enough food to feed its hungry people, connecting perishable foods to food insecure households is a difficult task that involves direct oversight and a significant amount of information. For Atlanta to reallocate its food waste in an efficient manner, it needs resources and data. Several important aspects of Atlanta's food waste are unknown: How much of Atlanta's food is sent to landfills each year? Where is food being thrown away? Why types of food are sent to landfills? Which sectors throw away the most edible food? By answering these questions, Atlanta can become more fully equipped to handle food waste reallocation.

In 2017, the NRDC began to estimate urban food waste with its report, Estimating Quantities and Types of Food Waste at the City Level. This report used the internationally supported Food Loss and Waste Accounting and Reporting Standard (FLW Standard) to estimate the food waste of Denver, Nashville, and New York.[24,25] The NRDC collected extensive details for each city: food waste by sector, types of foods wasted, "edibility" of wasted food, citizen recommendations for food waste reduction, and various other types of data. By collecting this extensive information, each of the cities is more

equipped to create a unique plan that maximizes its limited resources and introduces specialized food waste reduction efforts that are tailored to the city's needs.

One of the ways that Atlanta is approaching its Resilient Strategy goals is by working with the NRDC to create a detailed estimation of Atlanta's food waste, similar to the estimations performed in Denver, Nashville, and New York. Using data that is specific to Atlanta, the city can create a Food Waste Management Plan that is tailored with strategies that account for Atlanta's specific strengths and weaknesses.

B. Atlanta's Food Waste Mitigation Strengths

When deciding which food waste management options will be effective in Atlanta, it is important to consider Atlanta's specific strengths and weaknesses around food waste mitigation. Atlanta's food waste mitigation strengths include: (1) The Atlanta Community Food Bank, (2) Goodr & Second Helpings, (3) Kroger, Sprouts, and Other Grocers, (4) F. Wayne Hill Water Resources Center, (5) Local Urban Farms & Community Gardens, (6) Compost Now, and (7) Southern Waste and Recycling. Each of these strengths will be explored in more detail below.

1. The Atlanta Community Food Bank

The Atlanta Community Food Bank is one of Atlanta's greatest strengths to repurpose food waste. This massive organization works with more than 600 nonprofit agencies to distribute approximately 70 million pounds of food and grocery products to families across north Georgia each year.[26] This organization already partners with Second Helpings and food industry representatives to redistribute excess food from grocery stores, food service industries, and other food businesses in Atlanta to hungry people in need.[27,28] This organization will be a vital asset for any food waste management strategies focused on redistribution.

2. Goodr & Second Helpings

Companies like Goodr and Second Helpings are helping to mitigate food waste by providing a service, transporting excess food from local businesses to hungry families.[10,11] Goodr and Second Helpings are an important piece of the food waste mitigation solution, because they help to solve the connectivity problem - Atlanta has enough food to feed all of its hungry citizens, but connecting excess food resources to the families that need food requires a significant amount of coordination and resources. By utilizing these nascent companies, Atlanta can mitigate food waste from landfills while providing good food for hungry residents.

3. Kroger, Sprouts, & Other Supermarkets

Grocery stores send billions of pounds of food to landfills every year, making them a prime opportunity for food waste reallocation. Although many food retail stores do not pay food waste much attention, some companies like Kroger and Sprouts have begun to see the opportunities associated with food waste mitigation. Kroger has set a goal to eliminate food waste across the entire company by 2025 and has donated millions of pounds food to hungry families through its Zero Hunger | Zero Waste Food Rescue program, which utilizes partnerships with NGOs such as Feeding America and the World Wildlife Foundation.[29] This program benefits the company by turning food waste into tax deductions, helps to improve food security for the community, and creates public-private partnerships, which foster trust in the community.

Sprouts has also created a "Zero Waste" goal – to achieve a 90% food waste diversion rate by 2020.[30] In 2017, Sprouts successfully diverted 55% of its food waste by feeding hungry people through donations to NGOs such as Feeding America, feeding livestock by donating food to local cattle ranches and dairy farms, and revitalizing farmland by composting spoiled food.

Although Sprouts and Kroger have made significant progress towards reducing their food waste, the companies are still far from their goal of zero food waste. By working with these companies to discover creative solutions, Atlanta can help Sprouts, Kroger, and other food retailers to mitigate food waste while also increasing their bottom lines.

While working with the food retailers that have already initiated food waste diversion programs is important, even more opportunity exists for encouraging grocers that currently lack such programs. These companies can more easily reallocate food waste away from landfills, towards better uses, by adopting pre-existing food waste mitigation strategies and policies that have already proven to be effective. The city can promote food diversion by clarifying and facilitating these opportunities, including financial incentives through tax deductions associated with food donations.

The Center for Biological Diversity's 2018 report, "Checked Out: How U.S. Supermarkets Fail to Make the Grade in Reducing Food Waste" gave grades to different food retailers on their efforts to reduce food waste. These grades can be seen in the following figure.[31] Given how many of these food retailers have multiple stores in Atlanta, numerous opportunities exist for city officials to work with food retailers to mitigate food waste.

How U.S. Supermarkets Fail to Make the Grade in Reducing Food Waste

Company	Grade	Accountability	Prevention	Recovery & Recycling
Walmart	B	7	16	9
Ahold Delhaize U.S.	C	16	5	5
Kroger	C	8	7	9
Albertsons Companies	C	7	9	6
Target Stores	D	6	5	6
Trader Joe's	D	2	8	6
Whole Foods Market	D	0	9	5
Costco U.S.	D	3	4	7
Publix	D	3	2	6
ALDI U.S.	F	2	2	3

Accountability (19 points possible); Prevention (20 points possible); Recovery & Recycling (11 points possible)

Full report available at: www.GroceryWaste.com

A project of the Center for Biological Diversity's Population and Sustainability Program and the Ugly Fruit & Veg Campaign.

4. F. Wayne Hill Water Resources Center & Other Anaerobic Digesters

One of the ways that cities are mitigating their food waste is by sending the waste to their pre-existing wastewater treatment facilities, which are already outfitted with anaerobic digesters, capable of processing food waste to create natural gas and material for compost. Although Atlanta's wastewater treatment facilities predate anaerobic digesters, the recently built F. Wayne Hill Water Resources Center in the city of Buford has several digesters and is designed to process 60 million

gallons per day.[32] This facility already has a Fats, Oils, and Grease (FOG) and High Strength Waste (HSW) Receiving Station, which uses anaerobic digestion to convert waste products into methane. Additionally, the facility converts excess methane into energy, offsetting the energy needs of the entire water resources center.

When the digesters are not running at capacity, this existing infrastructure provides an opportunity to process local food waste, which results in more economic value than burying it in a landfill. By utilizing this pre-existing infrastructure, the city can prove the effectiveness of anaerobic digesters at mitigating food waste and advocating for the other wastewater treatment facilities to receive their own digesters. Even without the added incentive of mitigating food waste, the Atlanta RM Clayton Water Reclamation Center was accepting private bids in October of 2018 to design and build anaerobic digesters on site.[33] By advocating for more of these digesters, Atlanta can improve the efficiency of its wastewater treatment facilities and capture the energy potential of its food waste.

5. Truly Living Well & Other Local Urban Farms and Community Gardens

The Truly Living Well Center for Natural Urban Agriculture is an urban farm in the heart of Atlanta, where a team of locals grow healthy food for the community, especially those who could not afford it otherwise.[34] Like most urban farms, Truly Living Well (TLW) composts food scraps and yard waste to create its own fertilizer, in a process that decreases its overall expenses and reallocates food waste to a more efficient use. Atlanta's urban farms and community gardens provide an opportunity for the city to reallocate some of its inedible food waste, by allowing urban growers to transform food waste into tasty and nutritious food. Additionally, these urban growers can help to educate Atlanta's residents on how to compost their food scraps and yard waste at home, farther decreasing the food waste of the city.

6. Compost Now

One of Atlanta's greatest strengths for food waste reallocation is Compost Now. This company collects food waste from offices, restaurants, and homes in Atlanta, transforms the waste into soil, and sells this soil to local farmers as an organic fertilizer.[35] Compost Now represents an opportunity for public-private partnership, which could allow Atlanta to redirect some of the city's food waste towards the company's existing infrastructure and resources. By creating stronger partnerships between the city and Compost Now, Atlanta can advocate for the company, encouraging residents to subscribe to Compost Now's services, potentially offering a tax deduction for residents who do.

7. Southern Waste and Recycling

Southern Waste and Recycling is a waste and recycling management company with an Organics Recovery Program that offers Atlanta's companies sustainable food recycling solutions.[36] Southern Waste and Recycling transports this food waste offsite and uses environmentally approved food processing and recovery management practices in partnership with local farms to create soil amendment and animal nutrients. Like Compost Now, Southern Waste and Recycling offers an opportunity for Atlanta to pursue public-private partnerships for the reallocation of food waste.

8. The City of Atlanta Department of Public Works

Atlanta's Department of Public Works collects commercial and residential solid waste from locations within the city of Atlanta.[37] Given that this department is already collecting solid waste from around the city, it is possible that the department could collect organic wastes, including food waste. Having one, centralized organization collecting all this waste makes the process of educating employees and building infrastructure much easier to implement. However, the metro Atlanta area

sprawls numerous different public and private waste collection organizations, making a widespread, concerted collection of food waste across the entire metro Atlanta area very difficult.

9. The City of Atlanta Mayor's Office of Sustainability

Formerly the Mayor's Office of Resilience, the Mayor's Office of Sustainability is filled with Atlanta professionals who are committed to helping Atlanta become a more sustainable city.[38] These individuals can help to facilitate coalition building, pilot projects, and other methods of making Atlanta a more sustainable city.

10. The Atlanta Local Food Initiative (ALFI)

ALFI is a group of diverse stakeholders that are involved in various different sections of Atlanta's food system, with individuals representing local communities, non-profit organizations, government agencies, businesses, and concerned individuals. ALFI has numerous goals, but overall the group seeks to improve Atlanta's local food system by ensuring that Atlanta residents have access to fresh, healthy food and local farmers are supported and treated fairly.[39]

11. Georgia Organics

Georgia Organics is a non-profit organization in Atlanta that enables Georgia residents to eat more organic food and Georgia farmers to produce more organic food.[40] Given the organizations connections, previous work, and knowledge of the local food system, the organization will be a valuable partner for city officials seeking to mitigate Atlanta's food waste.

12. Food Well Alliance

Food Well Alliance is an organization that primarily focuses on enabling Atlanta's local food system, especially through urban agriculture.[41] Food Well Alliance has facilitated food system

stakeholder collaboration throughout Atlanta and can also be a valuable partner in mitigating Atlanta's food waste.

III. Evaluating Atlanta's Need to Reduce Food Waste

A. Benefits of Evaluating Atlanta's Food Waste Mitigation Options

We have seen that redirection of food waste affords many opportunities for Atlanta, and that the city already has significant strengths to achieve this goal. We are now left with the central question raised by this report, namely, **What are the most economically, environmentally, and equitably efficient ways to redirect Atlanta's food waste away from landfills?**

Atlanta is a hub of business, with the 10th highest GDP by Metropolitan Area in the United States, according to the U.S. Department of Commerce's Bureau of Economic Analysis.[42] In addition to being a hub for business, approximately 480,000 people live in Atlanta.[43] All of these residents and businesses are bound to produce substantial amounts of food waste, and for Atlanta to reallocate this food waste towards better uses than being buried in a landfill, the city must develop a plan. Therefore, this paper will investigate different ways that Atlanta could mitigate its food waste in ways that are economically, environmentally, and equitably efficient.

By evaluating Atlanta's food waste mitigation options, Atlanta can utilize its resources to maximize its pounds of food reallocated per dollar. This evaluation will provide recommendations for food recovery methods, which can provide food for Atlanta's food insecure population, including Fulton County, where Feeding America estimates that 18% of residents are food insecure.[44] Over time, food waste reallocation will also reduce the number of landfills that Atlanta requires, due to food accounting for approximately 15% of the United States' landfill deposits in 2015.[2] Atlanta can also reduce its carbon footprint as food waste is responsible for approximately 8% of humanity's global

greenhouse gas emissions.[3] In addition to these other incentives to reduce food waste, recycling food waste provides numerous economic benefits for the city and a strengthened relationship between Atlanta and local farmers.

B. Developing Recommendations for a Food Waste Management Plan

Food waste management plans typically use three types of policies: (1) Prevention -These policies focus on reducing the total amount of food waste through methods such as date labeling regulations, (2) Recovery – These policies focus on redirecting surplus edible food away from landfills and towards residents that do not have enough food. This is often accomplished through liability protections and tax incentives, and (3) Recycling – These policies incentivize using inedible food waste to feed animals, compost, and other industrial uses that provide a higher return than sending the waste to a landfill.

One of the best ways for Atlanta to evaluate its food waste mitigation options is by studying what other cities have done through case studies. By looking at the experiences of cities with similar food waste patterns, Atlanta can determine the best practices to allocate its food waste in ways that have already been proven to work effectively under similar conditions.

C. Methods Used to Investigate Atlanta's Food Waste Mitigation Options

The research design of this paper will begin by investigating the available data from the NRDC's initial report on Atlanta's food waste and proceed to evaluate collections of case studies from other cities that have made progress on reducing their food waste. These data sources will include: (1) The NRDC's Initial Report Estimating Quantities and Types of Food Waste at the City Level in Atlanta, (2) The United Nation's Food and Agriculture Organization's City Region Food Systems and Food Waste Management Report, (3) The World Biogas Association's Global Food Waste Management: An Implementation Guide for Cities Full Report, and (4) NRDC Estimating Quantities and Types of Food Waste at the City Level - Denver, Nashville, New York City. When deciding which food waste management options will be effective for Atlanta, it will be important to consider Atlanta's strengths and which sectors produce the most food waste. With this knowledge, these case studies can be dissected to discover which food waste mitigation strategies have been successful for other cities and which food waste mitigation strategies would be likely to be successful in Atlanta.

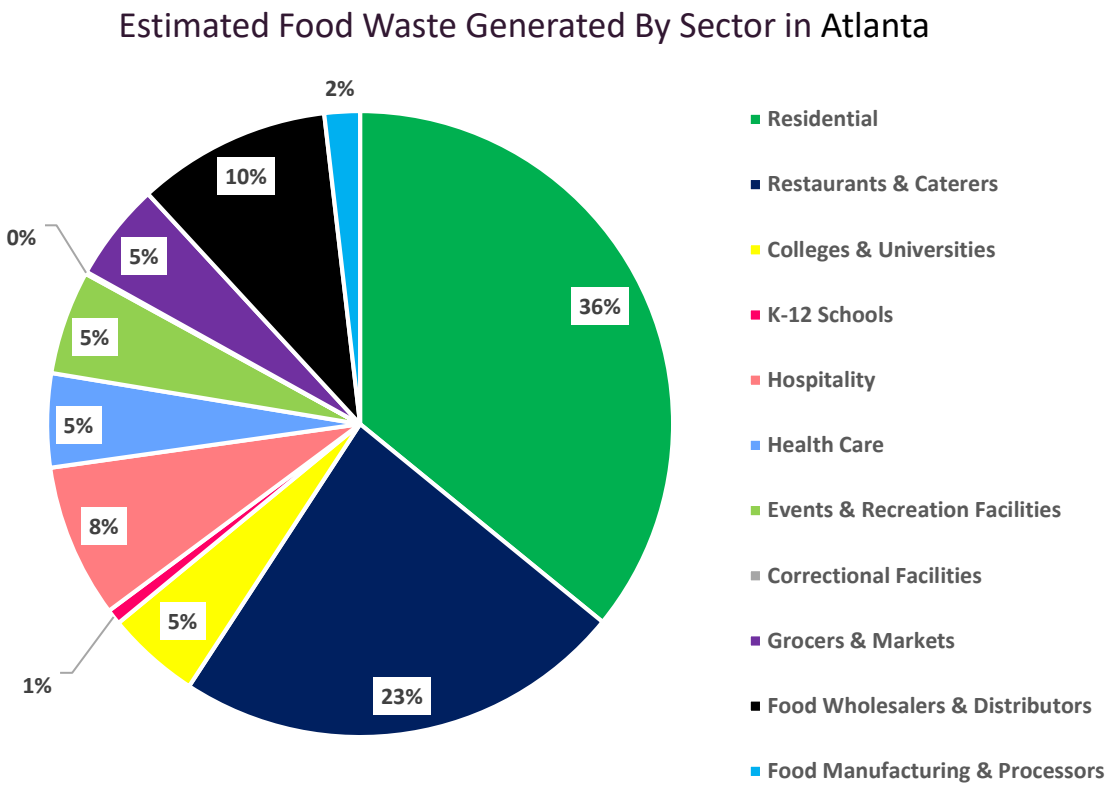
After analyzing the available data, the report will proceed to give recommendations for Atlanta to build a food waste management plan using ReFED's 27 solutions to reduce American food waste as a framework. After investigating Atlanta's potential role in these 27 solutions, this report will give a further analysis of the potential role of anaerobic digestion in Atlanta.

IV. Food Waste in Atlanta: Current Condition

A. NRDC Initial Report on Estimating Quantities and Types of Food Waste in Atlanta

Atlanta has been working with the NRDC to create a detailed estimation of Atlanta's food waste. This data is specific to Atlanta and will therefore be valuable for creating a Food Waste Management Plan that is tailored to Atlanta. The initial results from this project can be found in the following figure.

These results are not yet published, but they have been shared with me for this analysis by city officials working in the City of Atlanta Mayor's Office of Sustainability.[45]



These results suggest that the greatest opportunities for reducing Atlanta's food waste include: (1) Residential, 26%, (2) Restaurants & Caterers, 23%, (3) Food Wholesalers & Distributors, 10%, (4) Hospitality, 8%, (5) Colleges & Universities, 5%, (6) Health Care, 5%, (7) Events & Recreation Facilities, 5%, and (8) Grocers & Markets, 5%. Similar to Nashville, Denver, and New York City, the largest sources of food waste by sector in Atlanta are Residential and Restaurants & Caterers, which are responsible for approximately 59% of Atlanta's total food waste. This data is extremely useful for determining how to build a Food Waste Management Plan for Atlanta, because it shows which sectors should be given the most attention and resources.

B. The United Nation's Food and Agriculture Organization's City Region Food Systems and Food Waste Management Report

The United Nation's Food and Agriculture Organization's City Region Food Systems and Food Waste Management Report is a collection of case studies from cities that have tried to reduce their food waste.[46] By looking at the experiences of cities with similar food waste patterns, Atlanta can determine the best practices to allocate its food waste in ways that have already been proven to work effectively under similar conditions. In total, the FAO's study goes into great deal on 13 different case studies from all over the world, but not all of them apply to the city of Atlanta.

The four case studies that apply to the city of Atlanta include: (1) Île-de-France Region, France: Recovery and Redistribution of Safe and Nutritious Food through Social Supermarkets, (2) York, Canada: The Ontario Food Collaborative – A City Region Initiative For Preventing and Reducing Food Waste, (3) Curitiba, Brazil: Reduction and Recycling of Urban Waste in Support of Adequate Urban Diets and Prevention of On-farm Food Waste, and (4) Linköping, Sweden: Linking Rural and Urban Areas through Agricultural and Urban Waste Recycling. A brief description of each of these case studies can be found below:

1. FAO Case Study: Île-de-France Region, France: Recovery and Redistribution of Safe and Nutritious Food through Social Supermarkets

This case study documents the region around Paris, France, which simultaneously experienced high rates of social inequality and food waste. As a result of this imbalance, "social supermarkets" emerged. These supermarkets are non-profit organizations that sell produce at a lower price than other supermarkets, and only sell to customers that are below a specific level of income. The French Social Supermarket Network provides two programs for social supermarkets to receive fresh produce, the Potager de Marianne Programme and the UNITERRES Programme. The Potager de Marianne

Programme collects fresh fruits and vegetables that were likely to be discarded by different entities within the food system, including food wholesalers, food industries, and other organizations. These fruits and vegetables are often discarded due to cosmetic requirements by food industries. The UNITERRES Programme works to connect local farmers with local urban residents, allowing the urban residents to buy fresh food directly from the farmers, which provides substantial benefits for both parties, and reduces food waste directly at the farm. These programs also hire vulnerable workers, providing social benefits to the local communities. In 2015, these programs recovered 690 tonnes of food, reducing food waste from the involved entities by approximately 45%.

Although Atlanta already have several programs to help lower income residents with food security, introducing social supermarkets to the city could help to reduce the waste from Food Wholesalers & Distributors, which accounts for approximately 10% of the city's food waste. If Atlanta saw a similar reduction of food waste by 45% for these entities, Atlanta could reduce its overall food waste by approximately 4.5%.

2. FAO Case Study: York, Canada: The Ontario Food Collaborative – A City Region Initiative for Preventing and Reducing Food Waste

The Ontario Food Collaborative (OFC) is collaborative effort to reduce food waste in the Ontario region. The OFC is comprised of diverse stakeholders from different sectors of the food system, including, (1) Government (all levels), (2) Non-Government Organizations, (3) Farmers, (4) Food Processors and Manufacturers, (5) Food Retailers, and (6) Restaurants. Through the OFC's collaboration, these diverse stakeholders were able to build a strategic food waste management plan, with representation from members across the food system. In addition to creating these diverse stakeholder partnerships, the OFC has sought to (1) increase public education regarding food waste

through various events and campaigns, (2) integrate food waste problems and solutions into relevant policies and programs, (3) reduce food waste at every step of the food system, from farm to fork, and (4) measure and track food waste so that progress can be measured.

The OFC has made some progress towards reducing residential food waste. Although the OFC has increased rates of food waste recycling using composting and anaerobic digestion, the OFC has also worked to educate residents on ways of preventing food waste before it happens, which is the most preferred solution on the EPA's Food Recovery Hierarchy. If Atlanta pursued similar programs, it could also reduce residential food waste, which is by far the biggest source of food waste in Atlanta and also the most scattered. Atlanta is already facilitating cooperation between stakeholders from different sectors of the local food system through the Atlanta Local Food Initiative (ALFI). By continuing to support ALFI and other groups encouraging cooperation between food system stakeholders, Atlanta can continue to make a concerted effort towards reducing its food waste, by helping residents, businesses, and government officials to work together to reduce food waste, rather than reducing food waste in spite of each other.

3. FAO Case Study: Curitiba, Brazil: Reduction and Recycling of Urban Waste in Support of Adequate Urban Diets and Prevention of On-farm Food Waste

Although the city of Curitiba, Brazil faces a different set of problems than Atlanta, their work in this case study can still provide useful ideas for Atlanta to pursue in its efforts to reduce food waste and provide healthy food to Atlanta residents. Curitiba, Brazil has created a program, which allows local residents to trade their recyclables and plant or animal-based oils for locally-grown food. For every four kilograms of recyclables or two liters of oil that the residents bring, they receive one kilogram of fruits and vegetables. A non-profit organization, the Instituto Pro Cidadania Curitiba, packages and transports

the recyclables and oil, where they are sold to companies who use these materials to make various goods. The income from this program is used to compensate the costs of buying fresh fruits and vegetables from local farmers, but Curitiba City Hall provides the financial resources to fund all of the infrastructure and various other resources needed.

This program helps farmers to have a stable demand for their produce, which offers significant opportunities for these farmers to reduce their waste, increase their income, and plan for the future. This program primarily helps farmers to reduce their food waste. However, a similar program could be implemented in Atlanta, with partnership from local farms. This program could similarly accept recyclables and oil, but also accept food waste, utilizing the food waste for composting and anaerobic digestion operations. Under such a program, Atlanta could reduce food waste from the residential sector, reduce food waste at local farmers, increase rates of recycling, and help Atlanta residents to have better access to fresh, locally-grown, healthy foods.

4. FAO Case Study: Linköping, Sweden: Linking Rural and Urban Areas through Agricultural and Urban Waste Recycling

The Linköping Waste-to-Energy plant works to collect organic wastes from the city and farms in the surrounding, rural areas and transform this waste into energy using anaerobic digestion. This program collects organic wastes from food industries, local farms, school canteens, and restaurants. After the waste has been collected and digested, the digestate is shipped back to farmers for use as a bio-fertilizers, and the captured methane is distributed to twelve public refueling stations, which are used to refuel buses, private cars, taxis, and company distribution vehicles.

This program has been considered a major success for the city, because it lowers the city's reliance on fossil fuels, lowers transportation related CO2 emissions, lowers levels of local air pollution,

decreases farmers' reliance on artificial fertilizers, lowers the amount of waste sent to landfills each year, and bolsters the local economy. If Atlanta were to similarly build anaerobic digesters throughout the city, Atlanta could transform its organic wastes, including sewage, food waste, and animal manure from pets or livestock, into valuable fertilizers and methane, which could be used as an alternative fuel source for local buses. A program like this could utilize food waste from any sector, allowing Atlanta to reduce its food waste across the board. With proper pasteurization of the organic wastes to destroy any unwanted bacteria, this waste could be used as a valuable resource to produce organic fertilizers and a green, alternative fuel source.

C. The World Biogas Association's Global Food Waste Management: An Implementation Guide for Cities Full Report

The World Biogas Association's Global Food Waste Management: An Implementation Guide for Cities Full Report investigates different ways that cities have been mitigating their food waste.[47] The list of cities includes: (1) Auckland, New Zealand, (2) Cajica, Colombia, (3) Copenhagen, Denmark, (4) Hartberg, Austria, (5) Milan, Italy, (6) Minneapolis, United States, (7) New York City, United States, (8) Oslo, Norway, and (9) Seoul, South Korea. Overall the major findings of this report included, (1) Programs that started with pilot projects before gradually expanding were more effective, (2) Food waste can be effectively reused as feedstock for composting, anaerobic digestion, or animal feed, (3) Providing residents with compostable bags can significantly help to reduce the contamination of food waste, and (4) Collecting food waste separately from yard waste is necessary for most operations. A brief exploration of the most applicable case studies to Atlanta can be found below.

1. World Biogas Association Case Study: Auckland, New Zealand

The city of Auckland used a pilot project to introduce 2000 households to a new method of separating food waste from other trash. City officials used this pilot project to estimate participation rates, volume of collection, expected contamination, household satisfaction, and other metrics. Households chosen for the pilot project were sent a postcard with basic information on the program, which was followed up by home visits from city waste advisors. This pilot project ran for four months, and residents were asked to separate their food waste using a few provided items: (1) a 6 liter container, designed to be kept in the kitchen, (2) a 23 liter container, designed to be placed at the curbside weekly, (3) compostable bags for both containers, and (4) materials explaining which waste should be placed in the containers. After collecting data from this pilot project, the city has been progressively updating its program to be easier for residents to understand and increasing the number of homes whose food waste is collected.

Compost Now, a private corporation, already performs a similar service in Atlanta. However, Compost Now charges households approximately $360 per year for this service, whereas Auckland's service is expected to cost approximately $44 per year. This massive difference can largely be attributed to economies of scale and proximity of homes being serviced. Households choose to opt in to Compost Now, which can result in the serviced homes being relatively spread out, significantly increasing costs for the company. If Atlanta were to implement a similar pilot project, it could begin to collect food waste from select neighborhoods, collect data on how such a program would be implemented and received, and begin to move food waste collection into the responsibilities of the City of Atlanta's Department of Public Works.

2. World Biogas Association Case Study: Minneapolis, United States

The city of Minneapolis has introduced the separation of organic waste from other trash through a progressive series of programs that have helped the city to dramatically decrease its residential food waste. When the program began, Minneapolis households were encouraged to sign up to participate in a program, where they would bring their food waste to one of several drop-off locations throughout the city. The organic waste was then shipped to a commercial composting facility. This initial program was then expanded into a much larger program, wherein Minneapolis Solid Waste & Recycling services began to collect organic wastes from residents who chose to participate at no extra charge. By the most recent estimations, approximately 43% of eligible single-family households and small apartment buildings have enrolled in this program, helping to substantially reduce Minneapolis' residential food waste.

Given that residential food waste is the largest sector of food waste in Atlanta and arguably the most difficult to collect, a similar program in Atlanta could dramatically lower the city's residential food waste. By making the program voluntary and introducing it in stages, the city could gauge interest, gain support from households and stakeholders, and expand the program as funds became available. By encouraging local residents to bring their food waste to one of several locations throughout Atlanta, Atlanta can begin the process of collecting residential food waste at a very low cost, which would be an ideal pilot project for the city.

3. World Biogas Association Case Study: New York City, United States

While New York has similar methods of collecting residential food waste to Minneapolis, the city's program goes a step farther by creating regulations for local restaurants and food retail stores, regarding their food waste. These regulations have made segregation of food waste mandatory for (1)

Food service establishments with a floor area of at least 15,000 square feet, (2) Food service establishments that are part of a chain of 100 or more locations in the city of New York, and (3) Retail food stores with a floor area of at least 25,000 square feet. These businesses can either hire a company to haul their food waste to an approved processing facility, transport the food waste to one of these facilities themselves, or process the food waste on site.

Although regulation is always unpopular, the results are effective. A similar regulation in Atlanta could dramatically reduce food waste from Restaurants & Caterers, Food Wholesalers & Distributors, and Grocers & Markets, which produce a combined total of approximately 38% of Atlanta's food waste. By implementing regulation, Atlanta could dramatically reduce this source of food waste. However, to avoid conflict between government officials and local business owners, it would be best to encourage stakeholder collaboration and begin to approach regulation through voluntary programs first.

4. World Biogas Association Case Study: Oslo, Norway

When cities begin attempting to collect food waste, many government officials worry about how the city will pay for the program, and budget constraints can prevent city officials from pursuing the collection of food waste. The city of Oslo, Norway found a slightly different way of collecting food waste that has worked very well and kept costs relatively low. The program is very simple. Oslo residents can pick up government-provided green and blue bags from local supermarkets. Residents are encouraged to place their recyclable waste in the blue bags and food waste in the compostable green bags. Both bags are placed in the same waste container, which is collected by the city once per week. Once these bags have been taken to a processing facility, the bags are separated by color. The green bags are taken to an anaerobic digester, and the blue bags are taken to recycling centers.

By placing food waste and recyclables in the same container, Oslo has found a way to dramatically increase food waste collection without buying more trucks, increasing the number of waste collection days, or placing significant financial strains on the city. The City of Atlanta's Department of Public Works could attempt a relatively inexpensive pilot project based on this idea to see if a similar system could work for Atlanta. By running a pilot project with this system, city officials could determine contamination rates, expected quantities of food waste, and other important metrics for determining if this program could work in Atlanta. This program would run smoothly with residents are already recycling, and so this program would work best in Atlanta neighborhoods that already have high rates of recycling.

D. NRDC Estimating Quantities and Types of Food Waste at the City Level - Denver, Nashville, New York City

The NRDC's 2017 report, Estimating Quantities and Types of Food Waste at the City Level, estimates the food waste of Denver, Nashville, and New York.[48] The NRDC collected extensive details for each city: food waste by sector, types of foods wasted, "edibility" of wasted food, residents' recommendations for food waste reduction, residents' knowledge of food waste, and various other types of data. By collecting this extensive information, each of the cities is more equipped to create a unique plan that maximizes its limited resources and introduces food waste reduction efforts that are tailored to the city's needs. The report's final recommendations include, (1) Recommendations for Cities Regarding Outreach to Residential Sector, (2) Recommendations for Cities Regarding Working with ICI Sector, and (3) Recommendations for Cities from Residential Study Participants. These recommendations are explained in more detail below.

1. NRDC Recommendations for Cities Regarding Outreach to Residential Sector

The NRDC's surveys of Denver, Nashville, and New York residents found that most residents were relatively uninformed about food waste. The results of the surveys suggest that most residents underestimate their contributions to their city's food waste, underestimate food waste from the residential sector, overestimate food waste from restaurants and food retailers, underestimate the environmental consequences of food waste, and are not fully informed on numerous other food waste facts. The NRDC report suggests that education campaigns are needed to inform city residents about food labels, how to reduce wastage of edible food, how to recover edible food for human consumption rather than composting, and other general facts about food waste.

Education is one of the best ways to prevent food waste before it happens. Preventing food from being wasted is much more difficult than recycling food waste, because prevention requires a significant cultural shift in the way Americans buy, prepare, and consume food, and preventing food waste will require a massive educational campaign and significant efforts by the public.

2. NRDC Recommendations for Cities Regarding Working with ICI Sector

This report suggests several ways that cities can encourage food waste reductions in the Industrial, Commercial, and Institutional (ICI) sector. These suggestions include (1) providing aid to food banks to help divert and/or depackage non-usable food away from landfills, (2) spreading information to businesses on the social and financial benefits of donating excess food and how to donate food safely, (3) training health inspectors to encourage businesses to donate their extra food, (4) providing food recovery infrastructure, and (5) measuring local food waste to track progress and attain goals.

Similar to the recommendations for the residential sector, these recommendations encourage cities to pursue education campaigns. Many Atlanta food businesses are likely choosing not to donate their excess food or divert their food waste from landfills, because they are unaware of the potential benefits of these activities, or they might not know how to go about recovering or recycling excess food. Increasing awareness of the ICI sector and providing food recovery infrastructure can help to dramatically reduce food waste in Atlanta.

3. NRDC Recommendations for Cities from Residential Study Participants

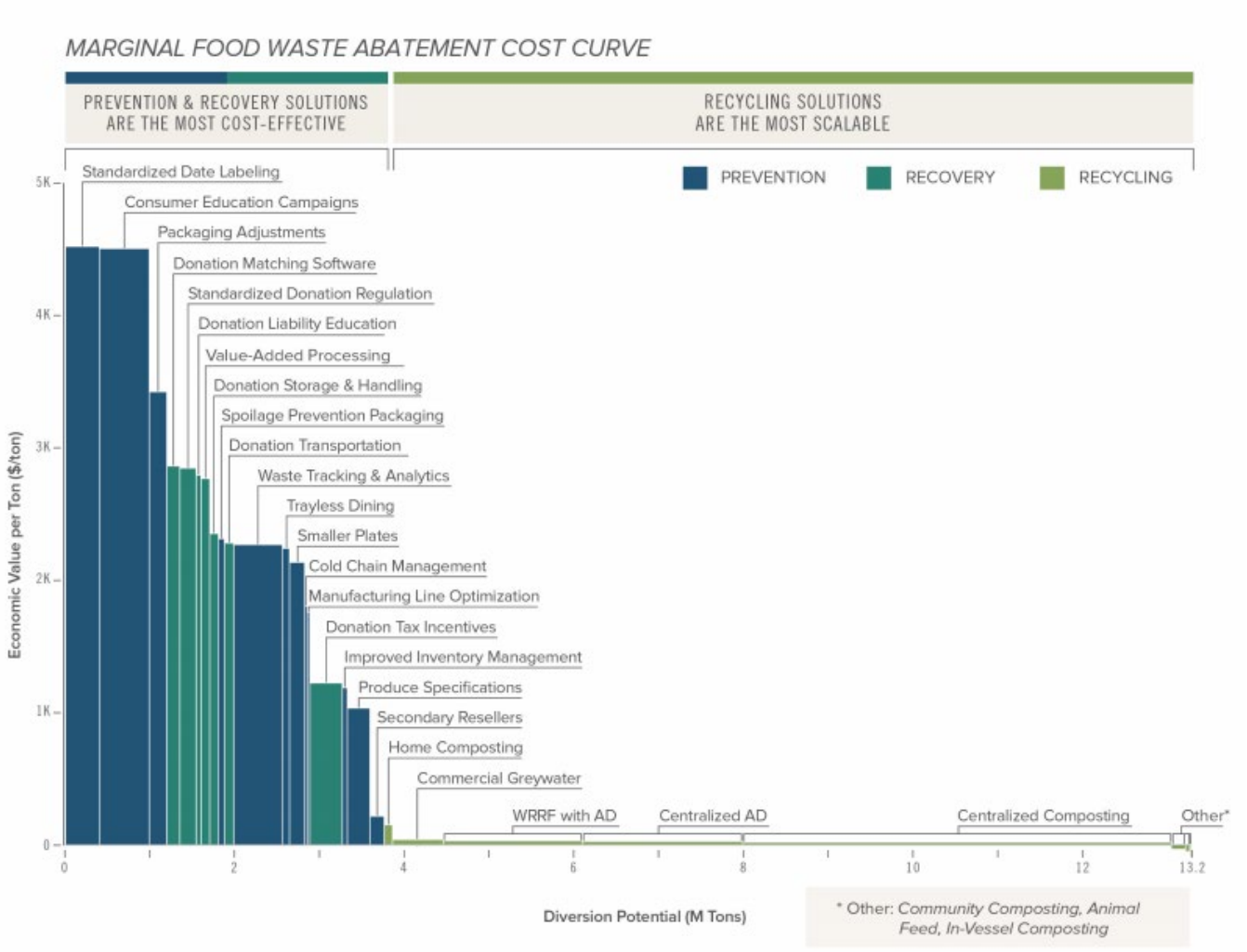
This section of the report documents responses from residents in Denver, Nashville, and New York when they were asked "What do you think Denver/Nashville/New York can do to help residents waste less food?" The most common answers included, (1) provide urban residents with more information on food waste, especially in schools, (2) provide tips on how individuals can reduce their food waste, (3) make composting and anaerobic digestion cheaper and more available, (4) encourage restaurants and supermarkets to increase the availability of smaller proportions of food, (5) continue to run studies on food waste, and (6) focus on restaurants and supermarkets to reduce food waste.

Although the NRDC has not yet surveyed Atlanta on this issue, the results are likely to be fairly similar for Atlanta. Similar to the other sections of the NRDC's report, these recommendations heavily emphasize the value of education in reducing residential food waste. If the city of Atlanta begins to implement education programs regarding food waste into Atlanta public schools, the information could begin to disseminate, helping young Atlanta residents and their families to begin reducing their food waste patterns.

V. Recommendations for Atlanta's Food Waste Management Plan: ReFED Framework

This section of the paper will apply the previously explored data and case studies to the City of Atlanta using a framework for eliminating food waste that was developed by ReFED in their 2016 report, ReFED: A Roadmap to Reduce U.S. Food Waste by 20 Percent.[49]

ReFED is a nonprofit organization, filled with stakeholders from every sector of the food system who are dedicated to reducing American food waste with a data-driven approach. Through this multi-stakeholder, data-driven approach to reducing food, ReFED has created 27 solutions to reduce American food waste that are separated into three categories: (A) Prevention; 12 solutions, (B) Recovery; 7 solutions, and (C) Recycling; 8 solutions. These solutions are explored in farther detail below, with recommendations for how Atlanta can implement and support these solutions. The following figure shows the estimated economic value and diversion potential of ReFED's 27 solutions to reducing food waste.[50]



A. ReFED Prevention Solutions – Stopping Waste from Occurring in the First Place

Many of the methods of preventing food waste require information campaigns to educate households, food retailers, and other food businesses about the numerous economic and environmental benefits of reducing food waste. Although ReFED's food waste prevention solutions usually require action from food manufacturers, retailers, or consumers, the city of Atlanta can include information on these solutions into its food waste information campaigns and implement these food waste prevention solutions in Atlanta schools, hospitals, and other local government buildings. By educating Atlanta residents and businesses about the benefits of preventing food waste and

implementing these prevention methods in local government buildings, city officials can facilitate knowledge diffusion of these solutions throughout Atlanta.

ReFED's food waste prevention solutions include, (1) Standardized Date Labeling, (2) Packaging Adjustments, (3) Spoilage Prevention Packaging, (4) Produce Specifications (Imperfect Produce), (5) Smaller Plates, (6) Trayless Dining, (7) Waste Tracking & Analytics, (8) Cold Chain Management, (9) Improved Inventory Management, (10) Secondary Resellers, (11) Manufacturing Line Optimization, and (12) Consumer Education Campaigns. These are briefly explored below.

1. Prevention Solution: Standardized Date Labeling

Date labels on foods include, best before, best if used by, sell by, use by, expires on, packaged on, and many others. These labels can create confusion for consumers, causing households to throw out food before it has actually expired. Packaged foods are not required to have date labels, and companies that decide to add date labels are given full discretion over deciding which date and label to use, because date labels are not standardized. Some estimations suggest that approximately 20% of residential food waste is a result of consumer uncertainty around date labels.[51] For this reason, the FDA has recently shown support for standardizing the date label, "Best if used by" to help eliminate consumer confusion as part of the White House initiative, Winning on Reducing Food Waste. This label is preferred to other labels, because it communicates when the food will be freshest, but also communicates that the food is still good to eat after the specified date.

Atlanta Recommendation: While standardizing date labels would require federal regulation, the city of Atlanta can have a role to play in this issue. First, the city of Atlanta can include information on date labels in any future food waste information campaigns that the city pursues, helping Atlanta

residents to be more informed on date labels and waste less food. Second, city officials can show their support for the Winning on Reducing Food Waste initiative, showing that Atlanta is committed to reducing food waste, which will help pressure Congress to adopt federal regulation for date labels. Third, city officials can work with local supermarkets to educate employees about date labeling and encourage local supermarkets to adopt the "Best if used by" label for foods that the supermarket prepares in-house.

2. Prevention Solution: Packaging Adjustments

Many households buy foods such as bread or fresh, leafy greens in bulk, due to the household's potential for economic savings. However, these bulk, packaged foods can result in significant levels of food waste if the entire package is not consumed. Additionally, smaller households may have difficulty finishing an entire packaged food, when the smallest packaged size for that food is relatively large, such as a loaf of bread. Packaging size issue have led some food manufacturers to begin selling a wider range of sizes of packaged foods, allowing households to pick the size that fits their specific needs, offering economic savings for the household and lower levels of food waste. If food is being sold in smaller packages, this could increase the amounts of single-use plastic in the food system. To prevent this problem, food manufacturers should seek out more sustainable packaging materials, which could include compostable packaging materials or other, reusable packaging materials.

Atlanta Recommendation: This issue primarily requires food manufacturers to make modifications to their methods of packaging and selling foods. However, the City of Atlanta can educate Atlanta residents on the potential economic savings and food waste mitigation of buying food packages that are a better fit for their household. Additionally, city officials can encourage local

supermarkets to offer a wider range of food package sizes for the foods prepared in-house, which will encourage food manufacturers to offer a wider range of package sizes to stay competitive.

3. Prevention Solution: Spoilage Prevention Packaging

Some fruits, vegetables, and meats could stay fresher for a longer period of time by updating the ways that these foods are packaged. By using more intelligent packaging designs, food manufacturers can reduce food waste by keeping their products fresh for a longer period of time. This will also help to decrease the possibility of spoilage during transport and save households money, because they have a larger period of time to consume the food before it expires. Similar to the packaging adjustments solution, there are environmental concerns about single-use plastics in spoilage prevention packaging. Manufacturers will need to use creative designs to solve the spoilage prevention packaging problem without simply transforming this problem into a single-use plastics problem.

Atlanta Recommendation: Similar to the packaging adjustments solution, this solution primarily requires active participation by food manufacturers to make changes that keep food fresher longer and prevent unnecessary food waste. However, Atlanta city officials can educate local residents on better ways to store their fruits, vegetables, and meats to maximize their freshness for as long as possible. Recommendations to residents can include methods of utilizing reusable food containers, freezing foods without sacrificing their flavor, vacuum sealing foods, and other methods of preserving freshness. City officials can also begin to implement these methods of food preservation in Atlanta schools, hospitals, and other local government buildings.

4. Prevention Solution: Produce Specifications (Imperfect Produce)

This ReFED prevention solution discusses "ugly" food. Ugly food is food has the same nutritional content as other food, but does not meet certain cosmetic standards. One example of an ugly food is a carrot with two taproots, rather than one. As a result of these cosmetic standards, ugly food usually doesn't ever reach food wholesalers, supermarkets, restaurants, or homes. However, supermarkets that sell ugly food usually offer the ugly food at a discount, which can help households to save money on their grocery bills. Of all of the reasons why food is wasted, this one is one of the most unnecessary.

Atlanta Recommendation: Educating Atlanta residents on the benefits of eating ugly food would be a beneficial addition to a food waste information campaign. Additionally, Atlanta city officials can contact food wholesalers about selling ugly food for use in food preparation in Atlanta schools, hospitals, and other local government buildings. In addition to helping ugly food to get eaten, using ugly food in government buildings will begin to diffuse knowledge about ugly food, including its financial and food waste mitigation benefits.

5. Prevention Solution: Smaller Plates and Trayless Dining

Using smaller plates and eliminating trays in all-you-can-eat dining restaurants has been proven to reduce food waste. When customers get less food per trip to the buffet and make more trips, they are more likely to stop when they are comfortably satisfied, which can significantly reduce waste in these styles of restaurants.

Atlanta Recommendation: This method of food waste can be implemented immediately in Atlanta schools, hospitals, and other local government buildings to reduce food waste at these

locations. Additionally, city officials can also encourage local all-you-can-eat dining restaurants to transition to smaller plates and eliminate trays.

6. **Prevention Solution: Waste Tracking & Analytics**

There are numerous different online resources to help food businesses to track their waste. By using these resources, managers can learn more about their waste, allowing them to take steps to reduce this waste, which can offer significant financial benefits for the company. It is likely that many restaurants and other food businesses are not already using data analytics to track their food waste, because they overestimate how difficult it is and underestimate the potential benefits.

Atlanta Recommendation: Like several of the previous solutions, Atlanta can begin to implement data analytics in Atlanta schools, hospitals, and other local government buildings. By adopting this method of food waste reduction in local government buildings, the method will diffuse to other local businesses. Additionally, city officials can create online resources that help local food businesses understand the benefits of food waste data analytics and teach these businesses how to begin tracking and analyzing their food waste.

7. **Prevention Solution: Cold Chain Management**

By updating the way food is transported to be more efficient, the amount of food that is spoiled during transport can be decreased. Updating food transport methods can be accomplished by making food shipments from suppliers to supermarkets more direct or by using cold-chain-certified carriers. As a result of this increase in efficiency and reduction in food waste, businesses can save money, and grocery shoppers can get a few more days of freshness from their food, giving them a longer time period to consume the food before it expires.

Atlanta Recommendation: Atlanta city officials can encourage Atlanta schools, hospitals, and other local government buildings to buy food through cold-chain-certified carriers, which will help to standardize the practice. Additionally, city officials can encourage local supermarkets to buy food that is shipped directly from suppliers to supermarkets or food that is transported by cold-chain-certified carriers.

8. Prevention Solution: Improved Inventory Management

This ReFED solution considers how more sophisticated, data-driven inventory management methods can help supermarkets to reduce their waste by predicting consumer purchasing patterns. These methods help supermarkets to make better stocking decision, which will reduce the number of items that go unsold. Although many large retailers already implement data-driven inventory management methods, smaller retailers are less likely to have implemented these methods due to concerns that these methods will not be cost-effective.

Atlanta Recommendation: To help implement this solution in Atlanta, city officials can create online resources that help smaller food retailers understand the benefits of data-driven inventory management methods and teach these businesses how to begin using data-driven inventory management.

9. Prevention Solution: Secondary Resellers

Secondary resellers are businesses that buy unwanted foods, including ugly foods, and sell this food at a discount to customers. These businesses also purchase food that is nearing its expiration, prepare this food for consumption, and sell the prepared food to customers for relatively little cost.

Atlanta Recommendation: These types of stores are currently relatively uncommon in Atlanta. However, city officials can encourage Atlanta residents to support these stores and encourage employees at Atlanta schools, hospitals, and other local government buildings to source their food from stores like these.

10. Prevention Solution: Manufacturing Line Optimization

Optimizing manufacturing lines to reduce food waste in food manufacturing could systematically reduce food waste in these types of facilities. However, there is little Atlanta can do to support this solution except support companies who pursue manufacturing line optimization.

11. Prevention Solution: Consumer Education Campaigns

Practically every ReFED solution benefits from an information campaign. By educating households, retailers, restaurants, and other food businesses about the problems and solutions of food waste, food waste could be significantly reduced across the country. Of all of the ReFED prevention solutions, consumer education campaigns have the highest estimated diversion potential and economic value.

Atlanta Recommendation: Atlanta has already begun to pursue information campaigns to educate local residents about the benefits of mitigating food waste. One example of an Atlanta event with information on food waste mitigation is the Soil Festival at Truly Living Well.[52] By diffusing information throughout the city about methods to prevent food waste from ever happening, Atlanta can become more efficient and progressive as a city, serve as an example for other cities in the southeast, lower its carbon footprint, extend the lifespan of its landfills, save local residents and businesses millions of dollars per year, and capture the other, numerous benefits of preventing food waste.

B. ReFED Recovery Solutions – Redistributing Food to People

No matter how many ReFED prevention solutions Atlanta adopts or encourages, there will always be a certain amount of edible food waste. However, collecting edible food that would be otherwise destined for landfills and distributing this food to food insecure Atlanta households can help Atlanta to achieve its goal of ensuring every Atlanta resident has access to fresh, healthy food.

ReFED's food waste recovery solutions include, (1) Donation Matching Software, (2) Donation Storage & Handling, (3) Donation Transportation, (4) Value-Added Processing, (5) Donation Liability Education, (6) Standardized Donation Regulation, and (7) Donation Tax Incentives. These are briefly explored below.

1. Recovery Solution: Donation Matching Software

When food businesses have extra food to donate, smaller donations might not seem cost effective for food donation centers to recover. Donation matching software helps food donation centers to connect multiple locations with small donations into one efficient collection route, which significantly reduces the costs of recovering small donations, preventing smaller donations from being wasted. This method of reducing food waste is relatively new and utilizes apps, data, and machine learning to collect food donations more efficiently than has ever been possible before.

Atlanta Recommendation: The best way for Atlanta to help implement this recovery solution is to create online resources that can facilitate connections between local food recovery organizations and donation matching software companies.

2. Recovery Solution: Donation Storage & Handling

If extra food is transported to a food donation center, but the donation center lacks the infrastructure or necessary labor to recover this food, the food will likely be wasted. By ensuring that food recovery organizations and donation centers have the resources they need, food waste can be mitigated and meals can be delivered to food insecure residents.

Atlanta Recommendation: The City of Atlanta can maximize its ability to support local food recovery organizations and donation centers by offering grants or low-cost loans. By using grants and loans to support these non-profits, city officials can which project to support from a list of applications. This will help city officials to maximize the number of meals recovered with the city's investment.

3. Recovery Solution: Donation Transportation

Edible food is often wasted, because a method to transport the food from its location to a food donation center was not available. Transporting food can be costly, and different barriers exist for both short and long distances of transportation. In order to prevent this edible food from being wasted, infrastructure for short and long-distance transportation is needed.

Atlanta Recommendation: Similar to Donation Storage & Handling, city officials can assist with donation transportation through grants and low-cost loans for food recovery organizations. Additionally, city officials can connect local organizations with excess transportation infrastructure to organizations with a shortage of transportation infrastructure. Organizations with excess transportation infrastructure could include food retailers and other food businesses. These organizations could lend their trucks and other equipment to food recovery organizations during off-peak time periods when the equipment would otherwise go unused.

4. Recovery Solution: Value-Added Processing

The lifespan of fruits, vegetables, and other foods can be extended by processing this food into soups, sauces, pickles, jellies, and other value-added foods. Processing food into ready-to-eat meals and dispersing these meals to food insecure populations can help to significantly reduce food waste and food insecurity simultaneously. Additionally, sauces, pickles, jellies, and other preserved foods have a long shelf-life, giving Atlanta residents more opportunities to consume these foods before they expire.

Atlanta Recommendation: Redirecting food away from landfills towards value-added processing can provide substantial economic benefits, but the problem is connecting individuals with excess food with individuals who have the ability to process this food. Atlanta city officials can facilitate these connections by creating online forums and other resources for local Atlanta businesses to advertise their excess food availability. Additionally, city officials can educate local food recovery organizations and other non-profits on the benefits of value-added processing to prevent food waste.

5. Recovery Solution: Donation Liability Education

As mentioned in the literature review, many food businesses are unaware of the Good Samaritan Food Donation Act, which protects corporations from any liability associated with food donation, provided that the corporations use the appropriate donation channels. However, the Good Samaritan Food Donation Act has never been tested in court, leaving some individuals suspicious of its ability to protect donors.

Atlanta Recommendation: To encourage more Atlanta businesses to donate food business owners, managers, and employees must be educated on the Good Samaritan Food Donation Act, which

city officials can facilitate through information campaigns and online resources. Additionally, city officials can educate food donors on the minimum standards suggested by the Good Samaritan Food Donation Act as well as some examples of best practices that city officials recommend for extra protection against liability.

6. Recovery Solution: Standardized Donation Regulation

This recovery solution brings attention to how bureaucratic roadblocks can prevent food from being donated, especially when different states and cities have different regulations regarding the donation of food. In "home rule" states, where cities have the ability to pass more extensive laws on food donation if politicians see fit, restaurants and other food business could be subject to different food donation regulations based on their zip code. These differences in regulation based on location can be especially confusing for fast food chains and other food businesses with multiple locations. ReFED recommends cities and states across the country work together to standardize food donation regulations, which would minimize confusion and encourage more businesses to donate food.

Atlanta Recommendation: Given that Georgia is a home rule state, each Georgia county and city could have different regulations for food waste, if they so choose. To mitigate bureaucratic roadblocks from preventing food donations, Atlanta city officials must work together with state and municipal policymakers to ensure that any future state or municipal food donation regulations do not overly complicate the food donation process and unnecessarily prevent food donations. Additionally, Atlanta city officials can show their support for the development of a more fully comprehensive, standardized federal regulation for the food donating process.

7. Recovery Solution: Donation Tax Incentives

ReFED's research suggests that the current federal tax benefits for food donation are approximately equivalent to the costs for food businesses to donate. If these tax incentives were increased, farms, retailers, restaurants, and other food businesses would have a stronger financial incentive to donate their excess food, which would help to cover any transportation costs associated with donation. Of all of the recovery solutions, ReFED calculated that this recovery solution has the highest potential to reallocate food from landfills to food insecure homes. Additionally, businesses could save millions of dollars per year, while reducing their carbon footprint.

Atlanta Recommendation: Increasing the food donation tax incentives would require federal regulation. However, Atlanta city officials can show their official support for increasing these tax incentives, showing that Atlanta is committed to eliminating food insecurity and food waste in the most equitable, efficient ways possible.

C. ReFED Recycling Solutions – Repurposing Waste

Some types of food waste cannot be prevented or recovered. Banana peels are a perfect example. Additionally, even the most well-informed households are going to occasionally generate food waste by not eating something before it expires. For these types of situations, the best way to use this food waste is to recycle it. Although many of ReFED's prevention and recovery solutions depend on active participation from food manufacturers, retailers, consumers, and federal policymakers, recycling solutions are significantly more dependent on participation from city officials. Therefore, recycling solutions offer Atlanta city officials the greatest opportunity to get directly involved in mitigating Atlanta's food waste in a way that other actors in the food system cannot.

ReFED's food waste recycling solutions include, (1) Centralized Anaerobic Digestion (AD), Water Resource Recovery Facility (WRRF) with AD, and Commercial Greywater, (2) Centralized Composting, (3) Community Composting, In-Vessel Composting, and Home Composting, and (4) Animal Feed. These are briefly explored below.

1. Recycling Solution: Centralized Anaerobic Digestion (AD), Water Resource Recovery Facility (WRRF) with AD, and Recycling Solution: Commercial Greywater

Anaerobic digestion is an excellent way to recycle food waste. Commercial Greywater anaerobic digesters are digesters that process waste on site at homes, businesses, or other locations before flushing the partially processed waste into the sewage system. In addition to redirecting food waste away from landfills and significantly lowering the carbon footprint of food waste, anaerobic digestion produces energy-rich biogas and digestate, which can be used as an organic fertilizer. Anaerobic digesters are usually built on farms to process animal waste, at food processing plants to process food scraps, at WRRFs to process sewage, or as a stand-alone digesters, which receive organic waste from another location. Although stand-alone digesters provide ample room for food waste, it is likely more efficient to build digesters at other, more stable sources of organic waste, such as WRRFs. Local food waste can be added to the digesters at these locations in a process called co-digestion.

Atlanta Recommendation: Anaerobic digestion could provide a substantial opportunity for Atlanta to reduce its carbon footprint, both by redirecting food waste from landfills and expanding Atlanta's renewable energy portfolio. Additionally, Atlanta can use anaerobic digestion to provide organic fertilizers to farmers all over Georgia. Although city officials could send Atlanta food waste to the F. Wayne Hill Water Resources Center in Buford, Atlanta city officials should advocate for building anaerobic digesters within Atlanta. If city officials increase the number of anaerobic digesters in

Atlanta, the city could utilize this waste-to-energy technology to reduce the city's food waste and lower its carbon footprint. Additionally, Atlanta can begin to implement pilot projects like the ones in Auckland, Minneapolis, New York, and Oslo to collect residential food waste and bring the waste to the digesters. Given that residential food waste is the most significant source of food waste in Atlanta, fully utilizing anaerobic digestion could provide opportunities for city officials to redirect thousands of tons of food waste away from landfills each year. Anaerobic digestion will be discussed in further detail later.

2. Recycling Solution: Centralized Composting

Similar to anaerobic digestion, composting is a great way to recycle yard waste and food waste into organic fertilizers and lower a city's carbon footprint. Centralized Composting describes massive composting operations that can process thousands of tons of food waste per year. These Centralized Composting operations can either exist as an alternative to anaerobic digestion, or Centralized Composting can provide a way to more fully process solid digestate from digesters into fertilizers.

Atlanta Recommendation: Although Atlanta could build its own centralized composting operation to process thousands of tons of food waste per year, it could partner with a commercial composting operation to process food waste instead. Given that Compost Now has been slowly scaling up in Atlanta over the past few years, city officials could collaborate with Compost Now to begin processing Atlanta's food waste on a large scale. Although city officials could use pilot programs to test different methods of collecting food waste from across the city for treatment in a centralized composting operation, it would be more beneficial to extract the energy from this food waste through anaerobic digestion first. After the food waste has been processed into solid and liquid digestate, the solid digestate could be transferred to a centralized composting operation.

3. Recycling Solution: In-Vessel Composting, Community Composting, and Home Composting

These three ReFED composting solutions each describe community members composting their own food waste at different scales. The Community Composting solution refers to composting operations that can process a neighborhood's food waste. The In-Vessel Composting solution refers to composting devices that utilize mechanical or heat energy to quickly compost organic waste from businesses, institutions, or other entities that create substantial yard and food waste. The Home Composting Solution simply refers to backyard composting, which households can use to compost their own food and yard waste into an organic fertilizer for their yard.

Atlanta Recommendation: Each scale of composting has its own challenges, but by supporting all of them, Atlanta city officials can enable neighborhoods, businesses, households, and other interested Atlanta residents to compost their food waste into an organic fertilizer. Information on composting will be vital for Atlanta food waste information campaigns and online resources.

City officials can facilitate neighborhood composting operations by providing online resources for neighborhoods that are interested and streamlining the process to get a composting permit. City officials can include information on home composting in a food waste information campaign and make public demonstrations of how to maintain a compost pile to enable interested households to begin composting their own food waste. For In-Vessel composting, city officials can educate local food businesses about the benefits of composting food waste and offer grants or low-cost loans for businesses that are interested in composting their own waste.

4. Recycling Solution: Animal Feed

ReFED discusses converting food waste into animal feed as a way to reduce food waste. However, this process is primarily recommended for food waste generators that are already located near farms. Using food waste as animal feed is a potential option for Atlanta's food waste. However, the process of treating and transporting the food waste is relatively expensive.

Atlanta Recommendation: Using food waste as animal feed would be a good option for rural areas that have nearby farms, but it is likely too expensive for urban areas. Therefore, this is not recommended for Atlanta.

VI. Anaerobic Digestion: Further Analysis

This section of the paper will examine anaerobic digestion in further detail in order to predict if building more anaerobic digesters in Atlanta would be a good use of resources. This analysis will be accomplished by calculating the Levelized Cost of Electricity (LCOE) of an anaerobic digester, and performing a site suitability analysis to determine which locations in Atlanta would likely receive the greatest benefit from building an anaerobic digester.

A. Typical Locations of Anaerobic Digesters

The most efficient place to build an anaerobic digester is right next to a source of organic waste, which is why most anaerobic digesters are built at sites that produce significant amounts of organic waste. Additionally, anaerobic digesters are typically categorized by where they are built, which includes: (1) Farms, (2) Water Resource Recovery Facilities (WRRFs), (3) Food Processing Plants, or (4) Stand-Alone Digesters.

1. Farms

Given the significant quantities of manure that livestock farms produce, many farms have started building anaerobic digesters on site to manage waste, reduce waste odors, generate electricity, and produce fertilizers.[53]

2. Water Resource Recovery Facilities (WRRFS)

Similar to farms, WRRFs around the United States have been building anaerobic digesters on site to process sewage, and some WRRFs have begun to accept food waste from the community, and these WRRFs are digesting that food waste with their sewage in a process that is called co-digestion.[54] There are three WRRFs already accepting food waste into their digesters in Georgia: (1) The F. Wayne Hill Water Resources Center in Buford, Georgia, (2) The South Columbus Water Treatment Facility in Columbus, Georgia, and (3) The Lower Poplar Street WRF in Macon, Georgia.[55]

3. Food Processing Plants

In the process of converting fresh, raw food from a farm into a packaged food that can go on a shelf in a grocery store, there will inevitably be food waste created along the way. By locating anaerobic digesters at food processing plants, these plants can lower their waste output, produce some of their own electricity, and sell fertilizers to local farmers. In this analysis, we will be using data from Napoleon Biogas, an anaerobic digestion facility located across the street from a Campbell's Soup plant in Harrison Township, Ohio.[56] Data on anaerobic digesters is difficult to acquire due to how recently the technology has developed. As a result, this site was primarily selected due to the availability of its data. As more data becomes available, it would be valuable to compare the LCOE of different digesters based on their feedstock.

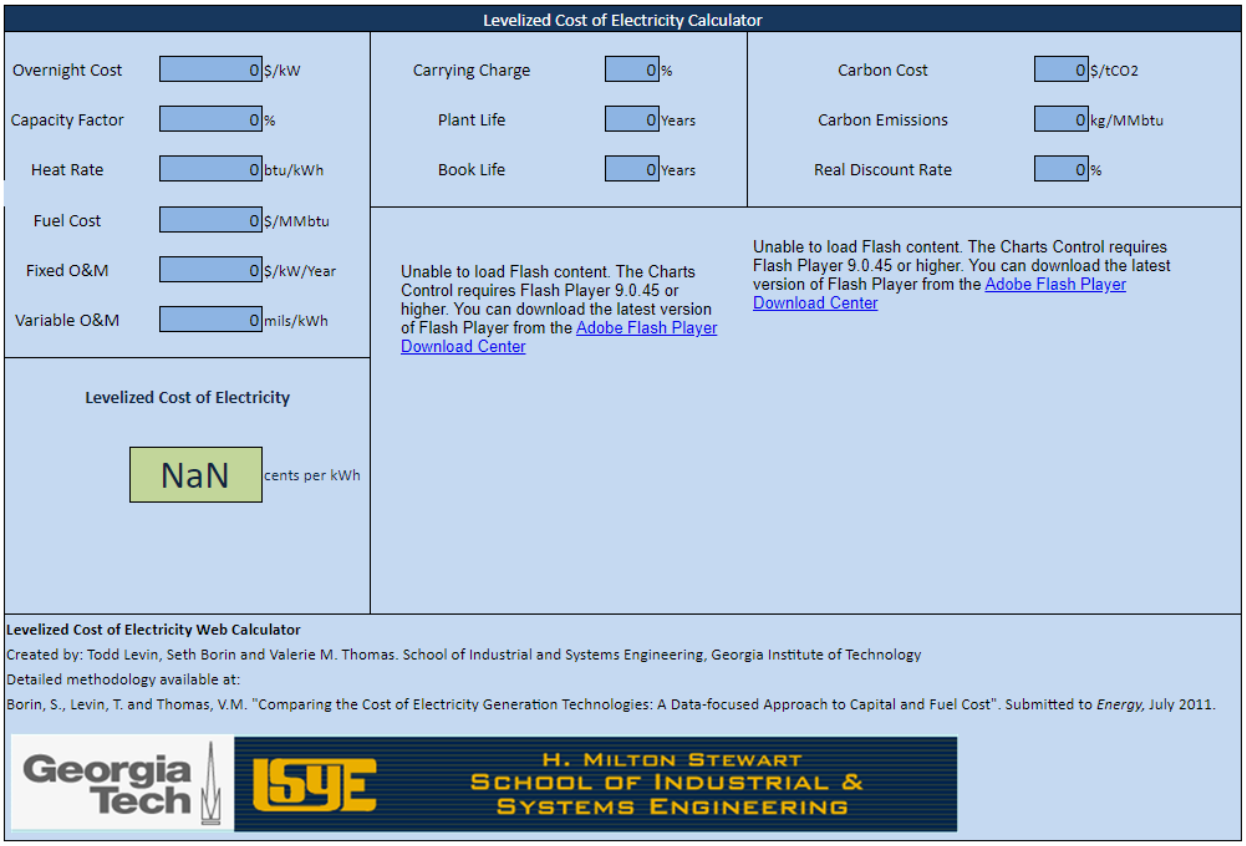
4. Stand-Alone Digesters

Stand-alone digesters are relatively rare, but many are being built in urban areas to process municipal food waste. There is one stand-alone digester that is accepting food waste in Georgia, and it is located in Cartersville.[55]

B. Calculating the Levelized Cost of Electricity (LCOE) of an Anaerobic Digester

1. Levelized Cost of Electricity (LCOE)

LCOE is usually given in the form of ¢/kWh. LCOE is a calculated metric that allows for utility regulators and policymakers to compare different methods of generating electricity against each other to determine the most economically competitive method of generating electricity.[57] Most LCOE calculations consider numerous different aspects of electricity generation, including: (1) The cost to build a power plant, (2) the percent of time that the power plant is running, (3) the power plant's efficiency, (4) the cost of fuel, (5) the power plant's fixed costs that it must pay per kW of electricity generated, (6) the power plant's variable costs, (7) the expected life cycle of the power plant, (8) the discount rate, and (9) sometimes the cost of carbon is added to the power plant's costs.[58] This analysis will be use an LCOE calculator that was developed by Dr. Valerie Thomas from Georgia Tech. A picture of the calculator can be seen in the following figure.[58]



2. Napoleon Biogas

This analysis will calculate the LCOE of Napoleon Biogas, an anaerobic digester facility located across the street from a Campbell's Soup plant in Township, Ohio. This facility has the capacity to digest 450 tons of organic waste per day and generate up to 2.8 MWh of electricity.[56] Additionally, Napoleon Biogas is estimated to reduce the Campbell's Soup plant's carbon emissions from energy use by approximately 16,000 tons of CO2e per year. In addition to digesting the Campbell's plant's food scraps, Napoleon Biogas also digests organic waste from local food processors, waste recyclers, and dairy farms. Due to the high tipping fees of landfills, these local businesses are happy to bring their organic waste to Napoleon Biogas, giving the facility its fuel for free. Specific information regarding Napoleon Biogas' energy efficiency, operating costs, and project costs were retrieved from the S&P Global Market Intelligence online database.[59]

3. Data: LCOE Metrics

The following metrics were used in the LCOE calculation of Napoleon Biogas. Most of the data comes from the S&P online database. The rest of the data was pulled from reputable sources, regarding the typical metrics of anaerobic digesters.

1. Overnight Cost: $3571/kW
    a. Source: S&P Global
2. Capacity Factor: 90%
    a. Source: University of California at Davis and Onsite Power Systems, Inc.[60]
3. Heat Rate: 6842 btu/kWh
    a. Source: S&P Global
4. Fuel Cost: $0/MMbtu
    a. Source: Napoleon Biogas
    b. Napoleon Biogas has a fuel cost of $0, because the food scraps from the Campbell's plant are free and would otherwise be destined for a landfill. However, if the operators of a stand-alone facility wanted to invest into collecting food waste from local businesses and households, could it do so profitably? To answer this question, I will also be running a version of the model where the power plant is spending $5/ton, $10/ton, and $20/ton on food waste, which will serve as an indicator of the costs of bringing external sources of food waste to an anaerobic digester. Using the estimated 280kWh of electricity produced per ton of food waste, this comes out to approximately $5.2375/MMbtu, $10.475/MMbtu, and $20.95/MMbtu.[61]
5. Fixed O&M: $0.048/kW/Year

    a. Source: S&P Global

6. Variable O&M: 10 mils/kWh
    a. Source: There was no source available for the typical variable O&M costs of an anaerobic digester so 10 mils/kWh has been used as a very conservative estimate.
7. Discount Rate/Carrying Charge: 7%
    a. Source: This is a typical discount rate for these types of projects.
8. Plant Life/BookLife: 15 Years
    a. Source: S&P Global
9. Carbon Reduction: 523.7 kgCO2e/MMbtu
    a. Source: The EPA estimates that the average greenhouse gas emissions of food waste sent to landfills is .54 metric tons of CO2e (mtCO2e) per ton of food waste, and the average greenhouse gas emissions of food waste sent to anaerobic digesters is .04 mtCO2e per ton of food waste.[62] This means that for every ton of food waste diverted from landfills to digesters, .5 mtCO2e are not released into the atmosphere. Using the estimated 280kWh of electricity produced per ton of food waste, this translates to a reduction of approximately 523.7 kgCO2e/MMbtu. I will be calculating the LCOE if the digester was compensated $0, $5, or $10 per mtCO2e.
10. Selling the Solid and Liquid Fertilizers
    a. Unfortunately, not enough data is publicly available to determine the potential profitability of the fertilizers. As more data becomes publically available, this data will be factored into future calculations of LCOE, and the calculated LCOE of anaerobic digesters will become even more cost competitive.

4. Results

LCOE (¢/kWh)				
	Fuel Cost			
Carbon Credit	$0/ton	$5/ton	$10/ton	$20/ton
$0/MTCO2E	4.17	7.74	11.31	18.44
$5/MTCO2E	2.39	5.96	9.52	16.66
$10/MTCO2E	0.6	4.17	7.74	14.87

5. Conclusions

The results of the LCOE show that anaerobic digestion can be very competitive with other sources of electricity if fuel costs are low or if the digester is compensated for its carbon emissions reduction. In fact, if fuel costs are low, anaerobic digestion has a comparable LCOE to coal, solar, wind, and other methods of generating electricity. The LCOE of these technologies are typically 3 to 12 ¢/kWh.[63] Anaerobic digestion's LCOE falls into this range in the majority of the projected scenarios.

Given how new anaerobic digestion is to electricity generation, it is likely that these numbers will only continue to improve as the technology develops. As more digesters are built and more data becomes available, it will also be possible to compare the LCOE of different models of anaerobic digesters and fully examine the viability of stand-alone digesters in urban centers. For now, these calculations show that the fuel costs of anaerobic digesters are extremely important if digesters are going to be competitive generators of electricity, and a carbon credit would allow anaerobic digesters to become extremely competitive.

To keep fuel costs low, anaerobic digesters should first be built on sites that are as close as possible to organic waste sources, such as farms, WRRFs, and food processing plants. Although stand-alone digesters are a valuable way to divert municipal waste from landfills, these digesters will have higher fuel costs and therefore a less cost competitive LCOE than other digesters. Therefore, at least for now, stand-alone digesters should primarily be seen as a way to divert waste from landfills, rather than competitive sources of electricity, but this could change with a carbon credit or high costs of fertilizers.

C. Anaerobic Digester Site Suitability Analysis

1. Objective

The objective is to perform a site suitability analysis of the metro Atlanta area to determine optimal locations to build a new anaerobic digester. Given the LCOE advantages of building an anaerobic digester at a WRRF, this site suitability analysis will focus on helping city planners and policy makers to determine if any existing Atlanta Water Resource Recovery Facilities (WRRFs) are in a location of high suitability.

2. The Study Area

This project will be analyzing data from these ten counties in the metro Atlanta area: (1) Cherokee, (2) Clayton, (3) Cobb, (4) DeKalb, (5) Douglas, (6) Fayette, (7) Fulton, (8) Gwinnett, (9) Henry, and (10) Rockdale. Within these 10 counties, there are 738 census tracts.

3. Data

This table contains detailed information regarding the data used in this site suitability analysis.

Variable	Description	Data Source	Data type
Population Density	This variable was derived from 2010 census information, which is made publically available by the Atlanta Regional Commission. This variable gives the number of people per square km. Given that the residential sectors produces substantial amounts of food waste, building an anaerobic digester closer to concentrated sources of residential food waste will help to divert more food waste away from landfills.	The Research & Analytics Division of the Atlanta Regional Commission; https://www.arcgis.com/home/item.html?id=2e73cc4a02a441ba968e6a63a8b526f5	Vector
Major Grocery Store Locations	This variable was originally created by an ESRI employee named Jim Herries. He collected a substantial amount of data on the locations of grocery stores and made it publically available for use in research.	ESRI's Online GIS database; https://www.arcgis.com/home/item.html?id=b249a736eac04487b345d3dafb765e20	Vector
Landfill Locations	This variable contains the locations of all of the municipal solid waste landfills in the metro Atlanta area. The closer an anaerobic digester is built to an exisiting landfill, the more convenient it will be for people to divert their organic waste from that landfill to the anaerobic digester.	Georgia Environmental Protection Division; https://epd.georgia.gov/land-protection-branch/solid-waste/permitted-solid-waste-facilities	Vector
Water Resource Recovery Facilities (WRRFs)	This variable contains the locations of the major WRRFs in the 10 county, metro Atlanta area. This data was not available so I gathered the data myself. As most of the addresses were unrecognized roads, I converted all of these locations to latitude and longitude coordinates.	Various sources including; County websites, EPA public records, Google Maps, and Google Maps satellite Imagery	Vector

4. Methodology

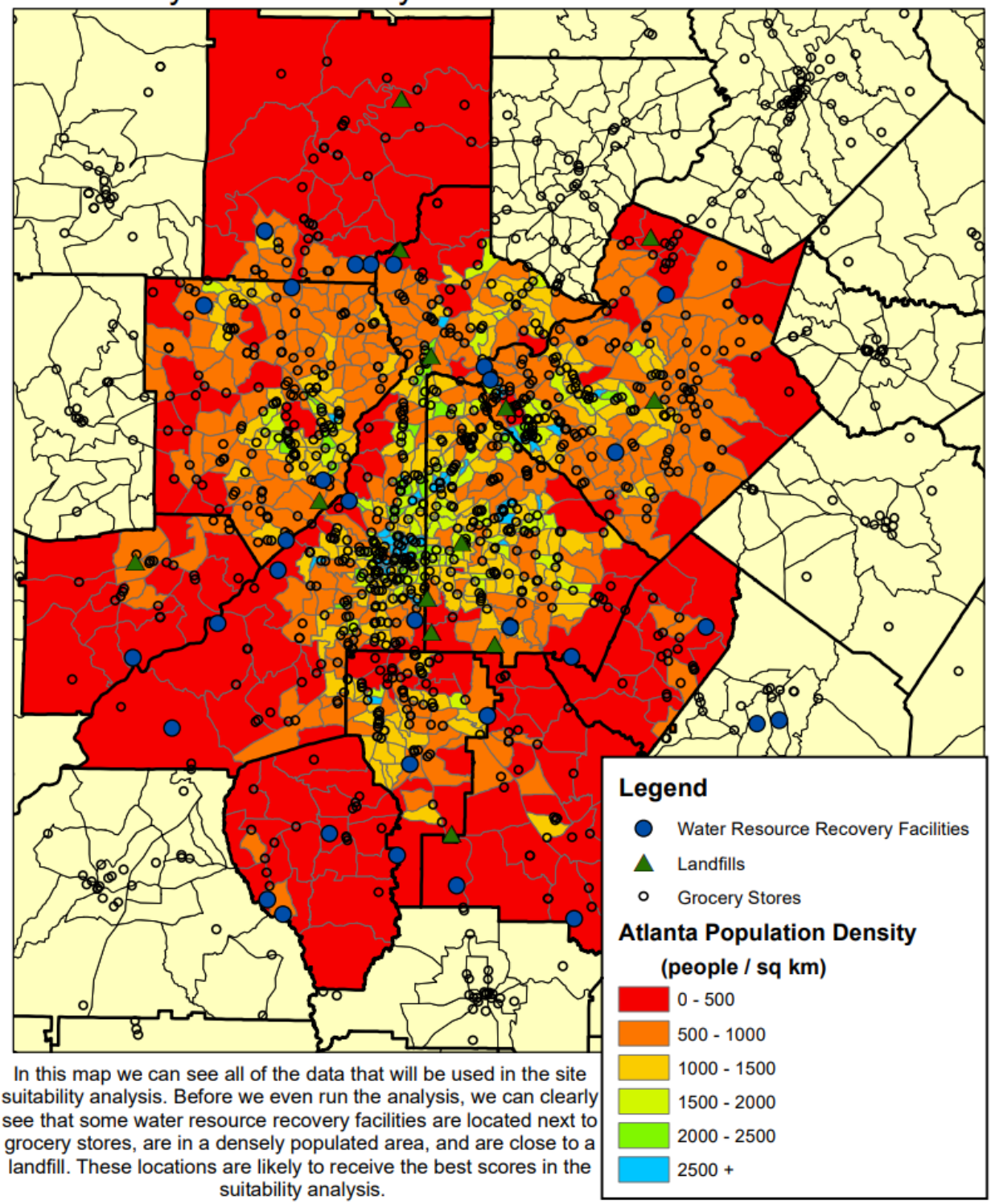
Given that each of these variables are currently in vector format, the first step is to convert the data to raster. The conversion from vector to raster will include weighting the different variables. These variables will be analyzed using a weighted linear combination and will be weighted according to the rating schedule found below. After each of the variables have been weighted and converted to a raster, they will be combined via summation into one, single raster. Higher scores will indicate a preferable location for building an anaerobic digester. The minimum possible score is 0, and the maximum possible score is 23.

Ratings Schedule		
Variable	**Input**	**Output**
Population Density (people / sq km)	0 - 500	0
	500 - 1000	2
	1000 - 1500	4
	1500 - 2000	6
	2000 - 2500	8
	2500 or more	10
Grocery Stores	The grocery stores were evaluated using a spatial analyst, point density analysis tool to determine the locations that had the densest concentrations of grocery stores. The resulting values ranged from 0 to 8 based on the density of of grocery stores.	0 - 8
Landfills	The landfills were evaluated using a buffer. All points within 10 km of a landfill were given a 5. Any points outside of that range were given a 0.	0 or 5

5. Results

Data for Site Suitability Analysis

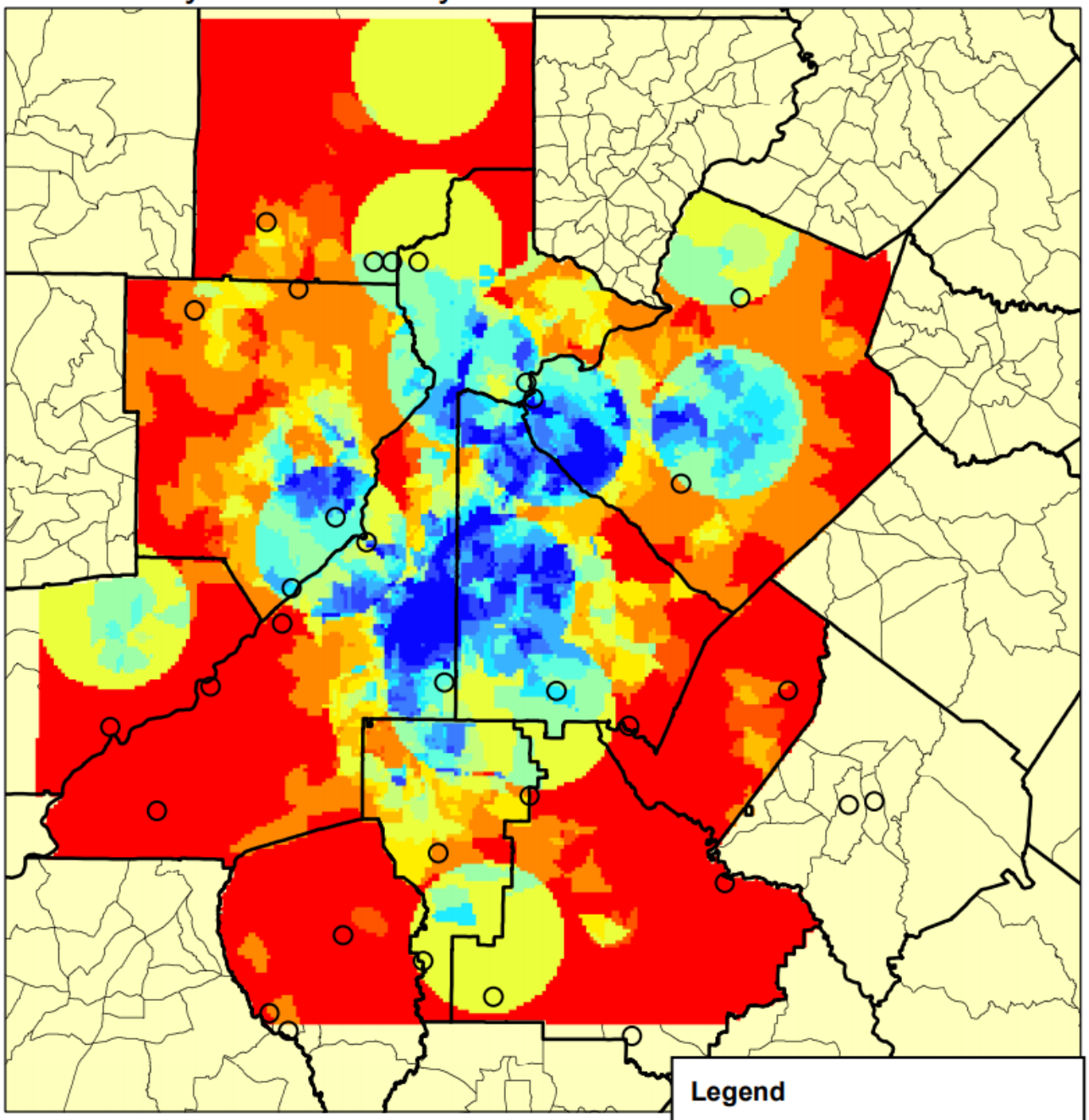
Created by Trevor McCoy



In this map we can see all of the data that will be used in the site suitability analysis. Before we even run the analysis, we can clearly see that some water resource recovery facilities are located next to grocery stores, are in a densely populated area, and are close to a landfill. These locations are likely to receive the best scores in the suitability analysis.

Anaerobic Digester Site Suitability Analysis

Created by Trevor McCoy



In this map, we can see a suitability analysis for building an anaerobic digester, based on population density, distance to grocery stores, and distance to landfills. The bluer values indicate a better suitability. You can also see Atlanta's water resource recovery facilities (WRRFs) as the dots on the map. Building an anaerobic digester at one of these WRRFs with a high suitability score would maximize the digester's efficiency. As you can see in the map, we have several different options to choose from.

6. Conclusions

After running the site suitability analysis, it is clear that seven of the WRRFs have relatively high suitability scores, meaning that any of these locations could be a suitable WRRF to build an anaerobic digester. However, the Crooked Creak Water Reclamation Facility had the highest total score. More WRRFs received high scores than expected, meaning that these WRRFs could be further compared to determine which of the seven WRRFs would be the best to receive a digester. Some of the other factors that could be considered in future analyses include the WRRF's load capacity, space on the WRRF's property, distance from major roads, and numerous other variables.

VII. Concluding Remarks

From this analysis, it is clear that Atlanta city officials have numerous opportunities to mitigate Atlanta's food waste in a way that is economically, equitably, and environmentally efficient. This analysis suggests that city officials should primarily focus on implementing these methods of mitigating food waste: (1) Information campaigns, (2) Facilitating stakeholder collaboration, (3) Creating online resources for Atlanta residents, food retailers, restaurants, food recovery organizations, food donation centers, and other food organizations, (4) Supporting progressive federal food waste and food donation policies, (5) Providing infrastructure, grants, and low-cost loans to local food organizations interested in mitigating food waste, (6) Expanding anaerobic digestion in Atlanta, (7) Implementing food waste solutions in Atlanta schools, hospitals, and other local government buildings, and (8) Using pilot projects to test different scalable methods of collecting residential food waste.

Although the process of mitigating Atlanta's food waste will take significant time, energy, and resources, the economic, environmental, and equitable benefits will significantly outweigh the costs. By becoming a more progressive, sustainable city, Atlanta can serve as a leader for the southeast, and other cities can learn from Atlanta's example, enabling the southeast to become more sustainable as a region.

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