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Municipal Composting and Organic Waste Diversion: The Case of Fayetteville, Arkansas

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Municipal Composting and Organic Waste Diversion:
The Case of Fayetteville, Arkansas

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by

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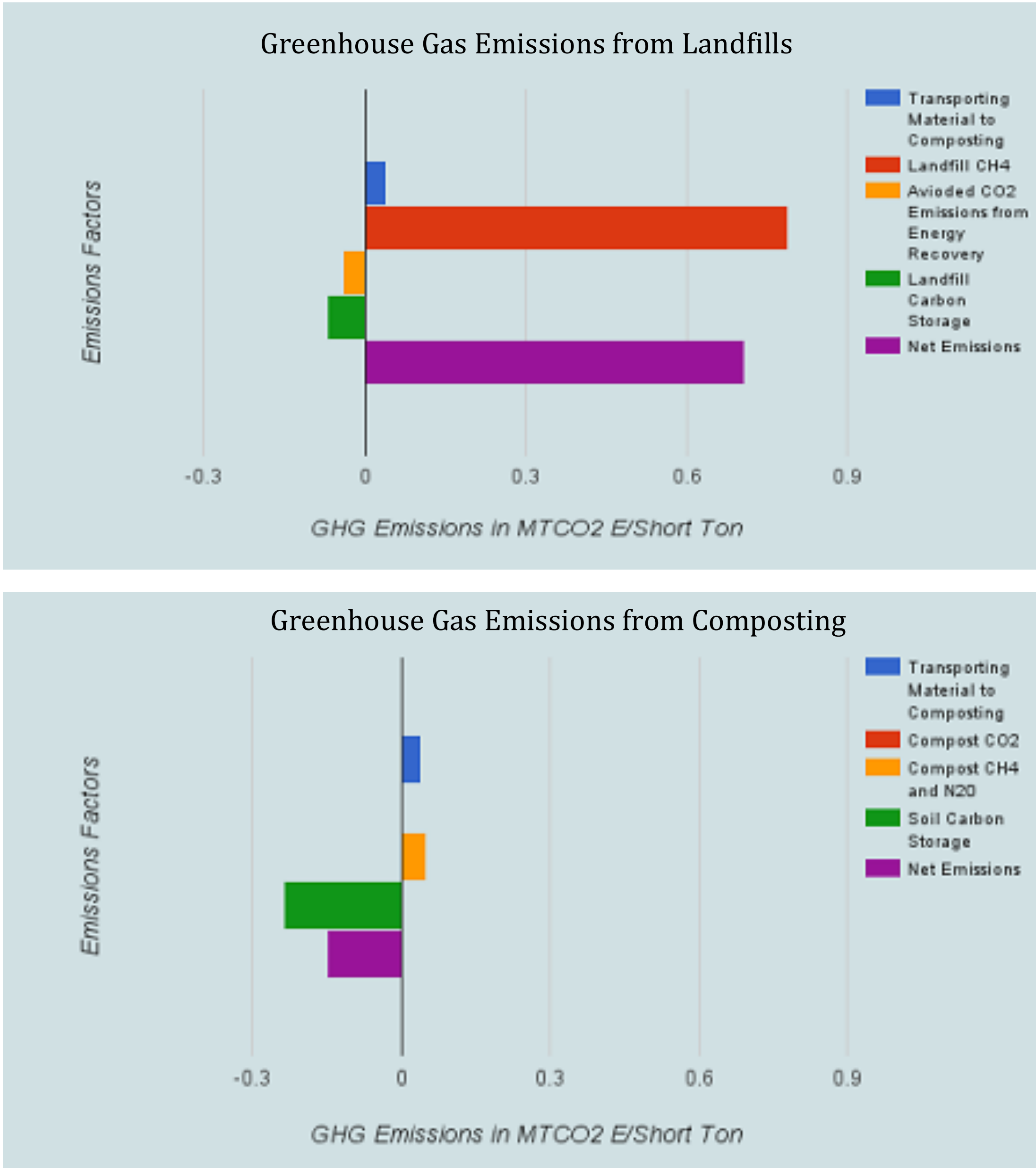
Introduction

It is estimated that nearly 40% of the food produced in the US is wasted somewhere between harvest and consumption. The amount of resources that have been used in producing this wasted food is valued at approximately $165 billion yearly. This wasted food is sent to landfills where is decomposes releasing methane and other decomposition by products. Methane is a greenhouse gas 28 times as potent as carbon dioxide and is the major byproduct of 35 million tons of food decomposing in landfills (Gunders, 2012). In fact this decomposing food is responsible for 23% of US methane emissions yearly (USEPA, 2013). This has serious environmental implication in terms global climate change.

The Environmental Protection Agency (EPA) has set guidelines to promote food recovery and established a hierarchy for food disposal, which is as follows: 1) source reduction, 2) feed hungry people, 3) feed animals, 4) industrial uses, 5) composting, 6) landfill/incineration (USEPA, 2013). This hierarchy was designed to help promote the reduction of the colossal masses of food waste produced in the US on a yearly basis. Implementation of the above-described hierarchy for food disposal implies considerable infrastructure in order to make a serious impact on food waste reduction.

As a country we recycle at rate of 35% when speaking in terms of all recyclable materials and that rate has been relatively static recently when compared to growth in the 1990s (Platt et al., 2014). The most successfully recovered materials as a percent of what is produced are papers, metals, yard trimmings, glass, and biosolids. All of these have recovery rates exceeding 25% and some, such as papers and yard trimmings, exceed 60% (USEPA, 2013). However, when considering the amount of food waste we recover as a percent of what is produced, it is only 5% (Gunder, 2012). This is the lowest recycling rate for materials that the EPA considers recoverable. Examining a survey of composting facilities across the country, it is seen that only a small amount, approximately 7%, of all operating composting facilities compost food scraps (Platt et al., 2014). So, this makes one wonder as to why composting is not a widely adopted practice. Accessibility and ease of composting may prove to be more of an impediment than initially anticipated.

Across the country roughly 350 municipal food-composting facilities are operating, and most of these are near large cities that promote sustainable development and green infrastructure (Platt et al., 2014). The shining example of sustainable waste management is the City of San Francisco and their zero waste by 2020 initiative. The city currently mandates residents to separate recyclables, compostable materials, and landfill trash with the hopes of eventually composting or recycling nearly all waste by 2020 (SFEnvironment, 2016). They currently collect approximately 600 tons of compostable waste per day, contributing to the diversion of 75% of all waste from landfills. A company by the name of Recology partnered with the city of San Francisco to collect and process all of their waste. By recycling and composting as opposed to landfilling, the methane and other green house gases produced in the processing of the waste can be decreased. This is exhibited in the figures below.



Source: United State Environmental Protection Agency (2015)

Figure 1 & 2. Greenhouse Gas Emissions from Landfills and Composting

When ignoring the sequestration properties of composting, it produces 0.11 MTCO2E/short ton compared to 0.46 MTCO2E/short ton in a landfill that uses methane recapturing methods (Allen et al., 2015). The reduction in methane is because recycling and composting do not create the anaerobic conditions preferred by methane producing bacteria (Miyamoto, 1997). Other large cities, such as Seattle, have since followed suit and also set forth a zero waste goal for their city. Policy can be an influential tool in promoting composting throughout communities and cities and is arguably what is needed to truly achieve change in the way people view waste.

Over 20 states have legislation outlawing the disposal of yard waste in landfills, while only a few states have any laws regarding the disposal of food and other compostable waste (Platt et al., 2014). Policy, although influential, walks a fine line between what a community should do, and what people want to do as members of the community. This is a reason why more than just policy change is needed to ensure the success of a municipal composting program. It requires a culmination of planning, logistics, policy, facilities, maintenance, education, and engineering to achieve a system for municipal composting to be effective. Not to mention construction of facilities for composting food waste can be relatively high due to regulations on safety and operation (Platt et al., 2014).

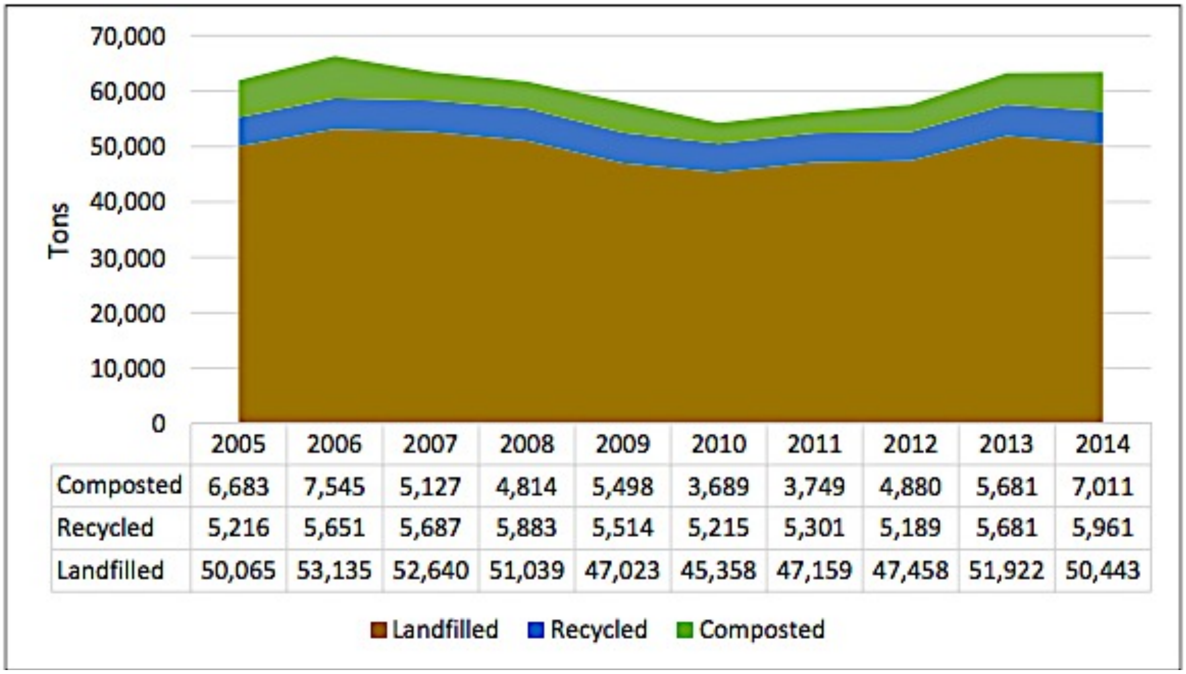
There are a lot of challenges that opening and running a food composting facility pose. Anytime food is being handled in a process, there will be the opportunity for the growth of pathogens; this is combatted in composting by the heating and mixing of composting biomass. Bacteria aerobically decompose the organic matter in turn releasing heat and causing temperatures in compost piles to rise to approximately 55°C which is sufficient to kill pathogens although not spores, if composting is done properly (Trautmann et al., 1997). Contamination must be avoided at all costs. The sell of contaminated compost to agricultural operations could have serious implications in terms of the spreading disease to crops, animals, and humans. The presence of residual herbicides such as aminopyralid, clopyralid, picloram, and aminocyclopyrachlor in compost are also a serious concern of municipal facilities because of the serious repercussions it can have on crops. These types of contamination could cause many millions of dollars worth of damage in a given facility (Platt et al., 2014).

Phosphorous (P) and nitrogen (N) in storm water runoff is another serious concern for facilities that compost food. Because of that, any facility that composts food scraps is required to have a storm water management system that removes contaminants before allowing runoff to exit their property. Building these storm water managements systems in addition to other site preparations can cost hundreds of thousands of dollars per acre to plan and carry out, and this does not include aspects like operating costs and processing costs for the facility (Platt et al., 2014). Another difficult challenge of operating one of these facilities is the need to control the odor of decomposing organic matter, a process that has the potential to produce a wide range of odorous gases given the right conditions. Odor seems to have the most impact with the public and can give the entire facility and program a bad reputation if not handled properly.

A lack of social change is most likely the biggest inhibitor of municipal composting, but that is a difficult metric to quantify. Sustainability has gained a lot of popularity in recent years, as we see many large companies, cities, and universities take on challenges such as reducing energy use and diverting waste from land fills. However, even with large contributors to society making these changes with the hopes of influencing more, we still only see 5% of our food waste being recovered. To give some perspective on how inefficient it is to landfill uneaten food supply: 40% of food that is wasted is responsible for 25% of all fresh water used in the country, 4% of the total oil consumption, and $750 million in disposal fees. Moreover 95% of our food waste represents 35 million tons of waste put into landfills per year (Gunder, 2012). These are staggering numbers when you consider the price of droughts, oil, methane emissions, and the fact that many people still go hungry every day in the US.

Fayetteville Arkansas Current Situation

Fayetteville, Arkansas is a small city when compared to others in the country but it is one of the largest in Arkansas with a population of 80,621 and 54 square miles of land area (USCensus, 2014). In December 2013, the city government put forth and passed Resolution No. 260-13, which set a goal for the city to reach 80% waste diversion by 2025 (City of Fayetteville, 2016). As part of the resolution, the city hired a consulting firm, Kessler Consulting Inc. (KCI) to assess the current system, conduct a waste composition study, and help the city develop a waste diversion master plan. Below is a graph made by KCI that shows the waste generated over the last ten years in Fayetteville, and of that, what is recycled, composted, and landfilled:



	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Composted	6,683	7,545	5,127	4,814	5,498	3,689	3,749	4,880	5,681	7,011
Recycled	5,216	5,651	5,687	5,883	5,514	5,215	5,301	5,189	5,681	5,961
Landfilled	50,065	53,135	52,640	51,039	47,023	45,358	47,159	47,458	51,922	50,443

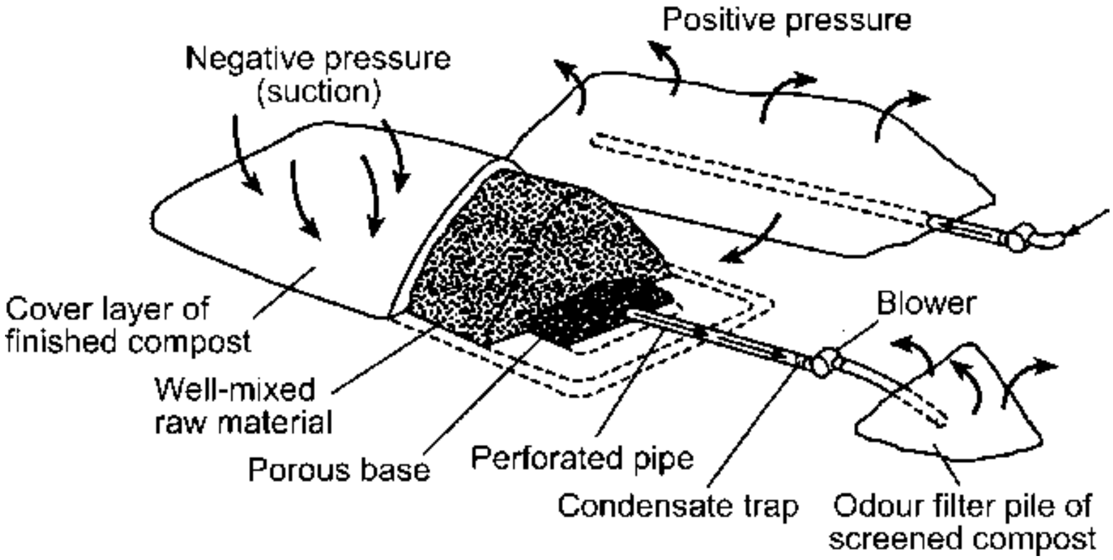
Source: Kessler Consulting Inc. (Mitchell 2015)

Figure 3. Fayetteville Waste Stream

As of 2014, Fayetteville has a diversion rate of 20%, much lower than their goal of 80%. As of now only 9% of total waste generated is recycled and 11% is composted (Mitchell, 2015). The city currently does curbside recycling using 18 gallon green bins that are separated at the curb by city employees into compartmentalized trucks. Residents and businesses are allowed to place papers, cardboards, aluminum and steel cans, plastic bottles, glass bottles, and a few other recyclables in their bins and the city picks them up once a week. Until recently the city of Fayetteville only composted yard waste, as do most municipalities around the country. Roughly half of the states in the country have legislation outlawing the disposal of yard waste in landfills, Arkansas being one of them (Platt et al., 2014).

Starting in 2016, the city of Fayetteville, with the help of KCI, began two pilot projects. In January of 2016 they started a food waste-composting pilot to work as a part of the already existing yard waste composting facility, and in February of 2016 they began a single stream recycling pilot program. KCI chose these two pilot programs based on areas that could make the largest impact on diversion rates. Excluding what is already being composted and recycled, the cities waste stream is comprised of 19% compostable material, and 26% recyclables (Mitchell, 2015).

The composting pilot project collects from a select number of restaurants and local business, and then food waste collected is mixed in the yard waste at the already existing yard composting facility. The facility had to undergo a small amount of retrofitting in order to allow it to accept food scraps. This is in order to make sure the facility stays within the Arkansas Department of Environmental Qualities (ADEQ) standards of operation, which are far stricter on food composting facilities than yard waste facilities. KCI made the decision that it would be best for the city to use modified static aerated pile (MSAP) composting system in their pilot as opposed to the traditional turned windrows the city used when the waste stream was solely yard waste (KCI, 2015). Below is a schematic of a static aerated pile:



Source: FAO NRAES-114 (1999)

Figure 4. Aerated Static Pile Composting Schematic

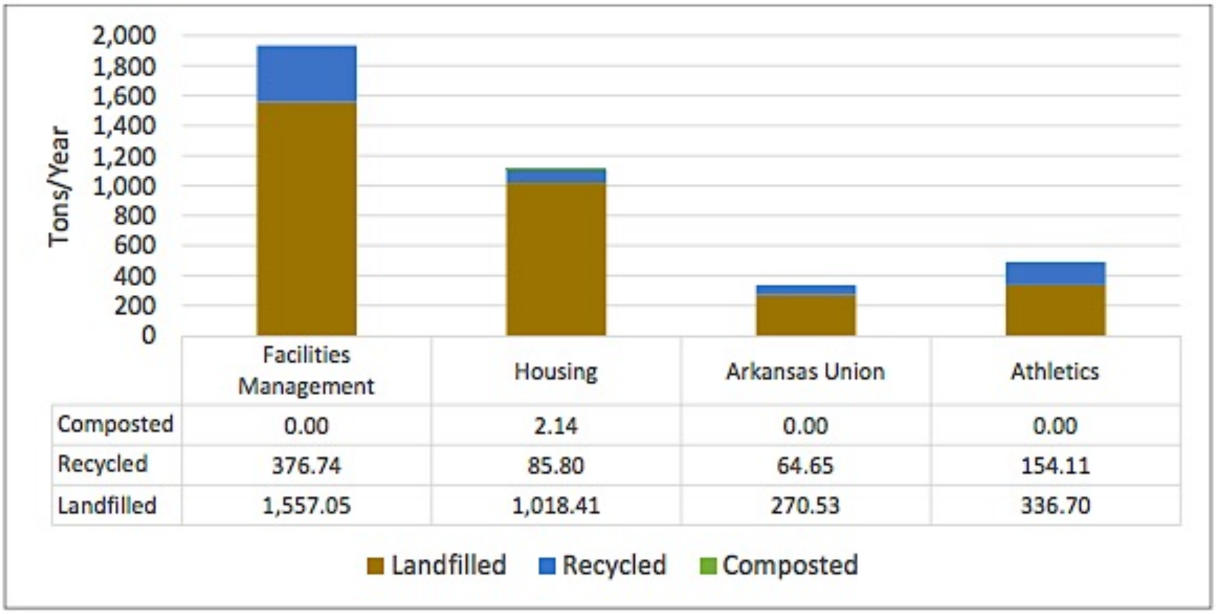
Aerated composting has a few benefits over a turned windrow system, the major one being that it takes only one to two months for a finished compost, while a turned windrow can take 6 months or longer. Other benefits include the reduction of odors, a decrease in required mechanical operation, and ability to maintain aerobic condition, which are necessary for biomolecule breakdown (Mitchell, 2015). The pilot program is underway until July 2016, and at that point KCI will analyze the data they have collected and determine if this system could be a feasible part of Fayetteville's waste diversion master plan. Preliminary suggestions from KCI suggest that they are in consultation with ADEQ to examine if the facility could permanently accept food waste and start collection of commercial compost around the city, with the hopes of adding residential food waste collection within five years (KCI, 2016).

In addition to the composting pilot, the City is also running a single stream-recycling pilot from February to May of 2016 that collects from a small number of neighborhoods and apartments from around Fayetteville. The city already does curbside recycling, however collection is currently conducted by having city employees sort recyclables curbside and place them in their respective bins on the collection truck. KCI believes that by moving to a single stream system, efficiencies in collection will greatly increase and that, if implemented citywide, would also increase community participation. This style of collection would ideally help handle some of the inefficiencies in the drop off the recyclables at the Materials Collection Facility as well (Mitchell, 2015). Through this pilot program the city of Fayetteville hopes to gain useful information on the feasibility of adopting a program like this citywide.

Since 2003, Fayetteville has used a pay-as-you-throw collection program in which residents can choose between a 32, 64, or 95-gallon waste cart that the city picks up once a week. Residents are charged a monthly fee of $9.37, $14.30, $20.31 respectively, for collection, with a one time charge of $20 if a resident would like to move up to a bigger cart. However, there is no charge for downsizing. (City of Fayetteville, 2016) This program is to help provide an incentive for residents to recycle more and send less to the landfills, while also spending less in the process. Programs like this are growing across the country as more municipalities strive towards reducing waste across their cities.

The city of Fayetteville is the only entity allowed to collect waste and recyclables within its limits. The City does have contracts with private companies to aid in some of the waste collection and hauling that require more attention or equipment. Companies such as Allied Waste, Waste Management, and Deffenbaugh Industries have these contracts with the city to handle hazardous wastes, construction waste in large (over 20 cubic yards) roll–off dumpsters, and recyclables not within the area serviced by the residential recycling program, such as the University (Mitchell, 2015).

The University of Arkansas represents a large portion of Fayetteville's population when school is in session. Because the city does not service the University with respect to waste and recycling collection, they are not included as part of Fayetteville's waste diversion master plan. In fact, the University has set its own goal of having 90% diversion by 2021 with the help of the Office for Sustainability (Mitchell, 2015). KCI in conjunction with the City and the University did a waste characterization study for the University at the same time they were conducting one for the rest of the city. The University reimbursed the city for the consulting work, and plans to use the information in their Zero Waste Action Plan (Olson, 2014). Below is a figure produced by KCI showing the waste streams of the University during 2014:



	Facilities Management	Housing	Arkansas Union	Athletics
Composted	0.00	2.14	0.00	0.00
Recycled	376.74	85.80	64.65	154.11
Landfilled	1,557.05	1,018.41	270.53	336.70

Source: Kessler Consulting Inc. (Mitchell 2015)

Figure 5. University of Arkansas Waste Composition

Fayetteville has many steps to take to reach their goal of 80% diversion by 2025. It will require everyone in the city composting and recycling every piece of waste that can be composted or recycled (KCI, 2016). A change in the way people view waste is necessary for a program like this to be successful, and the City realizes that one of the first steps in achieving this is through community outreach and education. They developed a marketing and education program called "Recycle Something." This campaign sponsors numerous events, cleanups, and tours throughout the city. It provides outreach education through school and community presentations in the hopes of cultivating a new way of thinking about waste around the city.

Discussion of Potential Solutions

Problems as immense as waste management will never have a single solution. It takes a calculated combination of solutions, and that is why the City of

Fayetteville has hired a team of engineers from KCI to help develop realistic solutions for waste diversion. The two pilot projects discussed previously are examples of potential solutions that will help Fayetteville move toward their diversion rate goals. The engineers chose these pilot projects because they saw that these areas could have the largest impact on overall diversion.

There can be an infinite amount of inputs when designing a waste diversion master plan for a city, but it is the job of the engineer to determine what aspects of the design are most important, and what has the biggest impact on the outcome. Parameters such as population and waste composition are crucial because they directly impact the amount of each type of waste produced, and therefore impact how much waste must be managed. These parameters also give the ability to predict future situations and allow the engineer to make decisions based on those calculated predictions.

When focusing on the problem of handling all compostable materials in Fayetteville, a certain set of parameters can be defined as most important. These can include but may not be limited to population, total amount of material produced per year (tons), composition in terms of nitrogen and carbon, capital cost of facility and equipment, operating cost, land area available and time to get finished compost. Based on the influx of compostable material in a given year, a facility can be sized to handle this waste and return a finished marketable product that can be sold to residents for gardens and to local farms.

Based on data from 2014, the city collected 63,415 tons of waste throughout the year, of which 19%, 12,049 tons, of compostable material was sent to a landfill (Mitchell, 2015). Considering that the US landfilled 37 million tons of food in 2014, responsible for 23% of approximately 29 millions tons of methane produced yearly (USEPA, 2014). Based on these numbers, Fayetteville released approximately 2200 tons of methane into the atmosphere in 2014 as a result of wasted food decomposing in landfills. Below is a sample calculation showing approximation of Fayetteville's methane production as a result of food waste:

$$\frac{Fayetteville\ Food\ Waste}{US\ Food\ Waste}\times((percent\ of\ total\ methane\ from\ food\ waste)\times(total\ US\ methane))$$

$$\frac{12{,}049\ tons\ food\ waste}{37{,}000{,}000\ tons\ food\ waste}\times(0.23\times29{,}000{,}000\ tons\ methane) = 2172\ tons\ methane$$

This is the equivalent of releasing 55,000 tons of carbon dioxide into the atmosphere, assuming a CO_2 equivalence of 25 used by the US EPA, and that does not include transport or processing, this is only the food sitting in the landfill anaerobically decomposing. This may be small when compared to the impact other cities, such as New York have on the environment, but for Arkansas, Fayetteville is the third largest city, composting this waste could make a serious difference.

Fayetteville's environmental impact was analyzed further using the EPA's waste reduction model (WARM), which allows the user to compare the impact of a city's current waste management system to an alternative system. The model takes into account the complete composition of the cities waste stream, and calculates the environmental impact in the form of MTCO2E based on how the waste is handled. The total impact is calculated separately for each category of waste to see what category has the most impact, and where the largest improvements can be made in regard to reducing green house gas (GHG) emissions. For each category, the model takes the following inputs and assumptions into consideration:

Method of Disposal: Source Reduction, Recycled, landfilled, combusted, composted

Location: State and Region

Landfill Gas Recovery: The model assumes the national average for recovery rate, and assumes gas is captured for energy use

Decay Rate: Assumes national average for decay rate of waste in landfills

Transport Distance: Distance to landfill, combustion, recycling, and composting facilities

Fayetteville: Current Situation					
Material	Tons Recycled	Tons Landfilled	Tons Combusted	Tons Composted	Total MTCO2E
Aluminum Cans	59.0	504.4	-	NA	(518)
Steel Cans	112.0	756.7	-	NA	(174)
Glass	1,365.0	2,370.8	-	NA	(286)
HDPE	129.6	605.3	-	NA	(91)
PET	807.1	194.4	-	NA	(905)
Corrugated Containers	2,134.0	2,320.4	-	NA	(5,619)
Newspaper	722.0	958.4	-	NA	(2,683)
Office Paper	962.0	1,664.6	-	NA	(215)
Dimensional Lumber	-	807.1	-	NA	(794)
Medium-density Fiberboard	144.0	176.6	-	NA	(508)
Yard Trimmings	NA	605.3	-	7,011.0	(977)
Mixed Paper (general)	139.0	4,590.3	-	NA	1,326
Mixed Metals	-	1,109.8	-	NA	43
Food Waste	NA	8,827.5	-	-	6,293
Mixed Organics	NA	5,145.2	-	-	1,475
Mixed MSW	NA	19,208.3	-	NA	8,428
Total					4,796

Fayetteville: Complete Organic Waste Diversion						
Material	Tons Source Reduced	Tons Recycled	Tons Landfilled	Tons Combusted	Tons Composted	Total MTCO2E
Aluminum Cans	-	59.0	504.4	-	NA	(518)
Steel Cans	-	112.0	756.7	-	NA	(174)
Glass	-	1,365.0	2,370.8	-	NA	(286)
HDPE	-	129.6	605.3	-	NA	(91)
PET	-	807.1	194.4	-	NA	(905)
Corrugated Containers	-	2,134.0	2,320.4	-	NA	(5,619)
Newspaper	-	722.0	958.4	-	NA	(2,683)
Office Paper	-	962.0	1,664.6	-	NA	(215)
Dimensional Lumber	-	-	807.1	-	NA	(794)
Medium-density Fiberboard	-	144.0	176.6	-	NA	(508)
Yard Trimmings	NA	NA	-	-	7,616.3	(936)
Mixed Paper (general)	-	139.0	4,590.3	-	NA	1,326
Mixed Metals	-	-	1,109.8	-	NA	43
Food Waste	-	NA	-	-	8,827.5	(1,347)
Mixed Organics	NA	NA	-	-	5,145.2	(711)
Mixed MSW	NA	NA	19,208.3	-	NA	8,428
Total						(4,989)

Table 1 & 2. Results from EPA's WARM

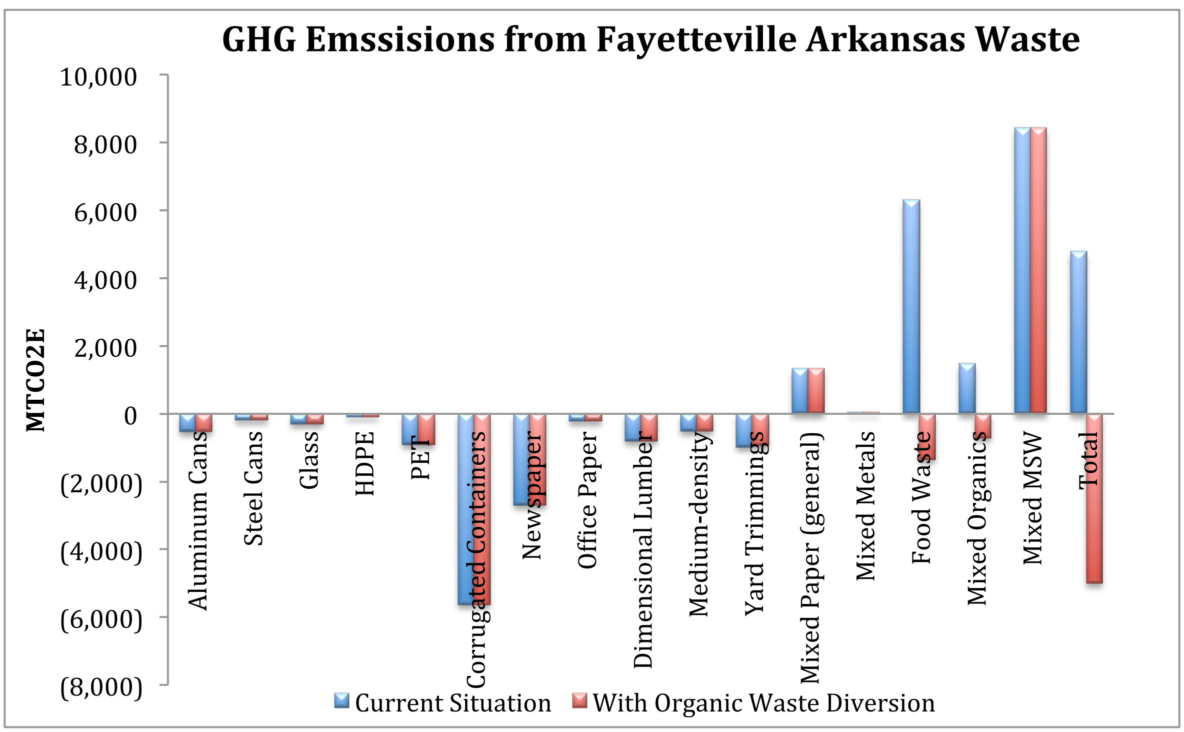


Figure 6. Impacts of Fayetteville's Waste Stream

The results from the WARM model reflect the undeniable impact food and other organic waste has on the release of GHG when it is landfilled. If the city of Fayetteville were able to move away from landfilling organic waste, and towards complete organic waste diversion, their total impact from waste management would go from a net positive impact of 4,796 MTCO2E per year to a net negative impact of 4,989 MTCO2E per year. The results of the analysis reflect Figure 1&2 in which composting and landfilling are compared based on subsequent GHG emission. This helps to solidify that by composting organic waste compared to landfilling it, the results are a vast reduction in environmental impact with regard to GHG emissions.

The size of Fayetteville makes handling its compostable waste much more simple than it would be for a city the size of San Francisco. Fayetteville received approximately 12,000 tons per year in compostable waste, while San Francisco received around 219,000 tons per year. What this means is, unlike San Francisco, Fayetteville could potentially have a single facility with a single style of composting that could easily handle all of the waste produced yearly. Aside from passive static composting, nearly any style of composting has the ability to handle this amount of organic waste in a year (Platt et al., 2014). They range in capacity and time to finished product.

Turned windrows are the simplest system and have a capacity ranging from 3,000 to 150,000 tons per year, but that is largely dependent on land availability (Platt et al., 2014). Windrows cover a lot of ground, so a large land area is needed to carry out the composting. Another downfall of the windrow is even with consistent turning, it takes up to 6 months to get a finished compost product. The City already has a windrow facility that handles yard waste, but it already operates at capacity. With time and land constraints considered, this would not be the best system for Fayetteville to consider for composting additional waste.

Actively aerated static piles are the step up from a turned windrow in terms of process control. They actively push or pull air through the pile and in the process help control temperature, moisture content, and odor. By controlling these parameters, the breakdown of the compost takes only 4-6 weeks, which is significantly shorter than turned windrows and passive static systems and it allows for a more consistent product. Many companies offer proprietary versions of these systems, but these can be costly depending on the system. The current system being implemented in the Fayetteville food-composting pilot is an example of a proprietary system. It is called Harvest Quest Modified Static Aerobic Pile process and as part of the process the company provides a proprietary mix of inoculant that aids in starting the composting process (Ecoverse, 2016). Systems like these are popular choices of cities of all sizes because they have the ability to service a wide range of capacities. They can also have relatively low capital costs as well, depending on the system chosen. This is most likely the best option for Fayetteville based on scalability, capital cost, and time to finished compost. Below is a table put together for *State of Composting in the US* estimating costs of different composting facility equipment and they vary greatly because of variations in size:

Equipment (new)	
Grinders	$100,000 - $500,000+
Slow-speed shredders	$400,000 - $800,000
Mixers	$40,000 - $200,000
Loaders	$85,000 - $400,000
Turners	$30,000 - $900,000+
Moisture addition	$5,000 - $90,000
Screens	$45,000 - $350,000+
Baggers	$30,000 - $500,000+

Source: *State of Composting in the US* (Platt et al. 2014)

Figure 7. Composting Equipment Costs

A Fayetteville facility would be on the low end of the cost spectrum for all of this equipment based on the size the facility needed to handle all of the compostable waste collected in Fayetteville.

The third and final relevant technology to discuss as a solution in Fayetteville is anaerobic digestion. Anaerobic digestion (AD) involves the breakdown of organic materials by methane producing bacteria in an environment that lacks oxygen. Anaerobic digestion produces biogas as a result of the biological breakdown of the organic matter. It is roughly a 60-40 mix of methane and carbon dioxide respectively. Biogas can be used as an energy source as is, or be refined into a cleaner burning gas to be used in natural gas systems. The other byproduct of the digestion process is stable solids that can be mixed in with compost, which creates great potential for hybrid systems. They are generally solid vessels or have a flexible top to allow for expansion during digestion. The major downside to these systems is the steep capital cost to purchase a digester, which is usually in the multi-million dollar range. The cost alone makes this not a feasible option for a town as small as

Fayetteville. However, the University could consider designing a small one for handling food waste on-site. It would serve as a great educational opportunity for both faculty and students.

Conclusion

It is clear that a serious food waste collection program needs to take place in order for Fayetteville to reach its goal of 80% waste diversion by 2025. They are on the right track with the two pilot projects, and the master plan in the works. It is going to take considerably more community education and willingness for that goal to become a reality. KCI believes that the static aerated system in the composting pilot project will be the best fit for handling Fayetteville's waste. The results of the pilot with the MSAP system will come in at the end of July and will help the city decide whether to implement that proprietary system or potentially seek out another similar system.

Regardless of what decision they make, it will ideally be a step made toward a citywide food waste collection infrastructure that handles all compostable waste produced by the city. If the city can do this, they will reduce their carbon footprint from waste management by approximately 200%, and that is only considering if they compost all organics that can be composted. The city can further increase this reduction through other recycling and recovery programs in pursuit of their 80% diversion goal.

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