PennState Behrend   Sustainability

COST BENEFIT ANALYSIS:
REDUCING LANDFILL WASTE THROUGH
FOOD WASTE COMPOSTING & CURBSIDE GLASS RECYCLING

Completed as part of SUST 200 course requirements
FALL 2022

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With Appreciation

to our Project Partners

THE CITY OF ERIE

JOSEPH V. SCHEMBER, MAYOR

PRISM GLASS RECYCLING

CONSERVATION COMPOST

THANK YOU!

For 5-gallon bucket donations

LOWE'S

THE HOME DEPOT

ACE Hardware

Data Accessibility: All raw data will be available, without reservation, by contacting Dr. Sherri A. Mason, Associate Research Professor, Penn State Behrend, sam7201@psu.edu.

EXECUTIVE SUMMARY

Landfills envelop the idea of being '*out of sight and out of mind,*' yet the reality is there is no such place as *'away.'* As landfills take up valuable space and have a variety of known environmental and social impacts, and as the costs of using landfills for the disposal of wastes (much of which can be recycled or composted) is a burden to municipalities, here we engaged in a cost-benefit analysis of waste diversion. We focused on two constituents of municipal waste – food and glass– in part because of their prominence within the waste stream, as well as owing to the availability of local industry to support their diversion out of the landfill.

Both nationally and statewide, food waste is the largest component of landfilled municipal solid waste. As such, accessibility to a food waste composting program can provide a significant means to decrease municipal waste, while simultaneously create a valuable, nutrient-rich soil amendment and supporting local economies. While glass is a much smaller component of landfilled materials, it is infinitely recyclable and given local businesses its curbside collection eases the burden on residents while helping to support local industries.

Data obtained through a summer curbside pilot program, which engaged a hundred residents from two different neighborhoods within the City of Erie, overall compared extremely well with national and regional data, though the distribution within those totals varied notably. While the local food waste data was only about two-thirds the national and regional data, the amount of glass collected curbside was three to nearly ten times higher than these other sources. Given these variabilities the cost-benefit analysis was conducted using these differing (local-to-national) data sources, as well as averaging between them, to account for different possible scenarios.

On average, across all local-to-national data sources, we estimate that diverting food waste from landfilled materials could save the City of Erie over $450,000 annually, while the diversion of glass recycling would save a third of that (~$150,000), yielding a total savings of over $600,000. Based on lessons learned in other communities, we recommend the City of Erie to move to a containerized, mechanized curbside waste and recycling collection process, which would act to save additional monies, as well as improving employee safety, increasing recycling participation rates, and decreasing urban litter. Our cost-benefit analysis indicates that such a program would yield a net return on investment (ROI) within 7 years.

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I. INTRODUCTION

A. TRASH TO TREASURE

Solid waste – also known as garbage, refuse, trash or rubbish – is a fact of life. By simply living, everyone produces waste. As societies evolve, so do the ways people live, and the amount of waste generated. During most of human history, disposing of waste was not a problem (Downs and Medina 2000). Before the industrial revolution, waste was predominantly organic: food and kitchen leftovers (Downs and Medina 2000). These remains would rot and become part of the soil. People used that organic matter to fertilize agricultural fields, thus recycling the nutrients.

Beyond food wastes, wood, ceramics, metals, glass, and textiles represented some of the most discarded materials (Downs and Medina 2000). Yet what is one person's trash is another person's treasure. Scavengers is a term used for those who informally recover waste items for reuse or recycling (Downs and Medina 2000). These individuals have also been referred to 'rag and bone men,' 'waste pickers,' and 'rag pickers' (Strasser 1999). In pre-industrial America, before municipal waste collection existed, scavengers collected and disposed of the waste generated in many towns and villages (Downs and Medina 2000).

Throughout the nineteenth century, largely owed to urbanization and industrialization, scavenging flourished (Downs and Medina 2000). Waste pickers, first equipped with backpacks and then with horse wagons, collected rags, bones, scrap metal and other waste materials from city alleys and municipal dumps (Downs and Medina 2000). They would also barter for a wide array of merchandise, such as pots, pans, washbasins, trays, beeswax, eyeglasses, calico, and medicines, in exchange for rags, bones, and scrap metal (Strasser 1999). Scrap metal was melted and recycled into new products, while bones were used to make glue, and rags to make paper (Downs and Medina 2000). In this way, scavengers would return waste materials back to the manufacturer, who repurposed them into new goods (Strasser 1999). A cyclical relationship developed between the waste and the manufacturer. This relationship was the foundation for early economic growth in America (Strasser 1999). Statistics compiled at the end of the nineteenth century demonstrate that scavengers performed the bulk of refuse collection in many U.S. cities (Downs and Medina 2000).

Though scavenging has always been regulated to the poorest members of society, during the first few decades of the twentieth century, the ability to earn even a meager living through this informal waste collection and associated recycling diminished gradually as industrialization took over (Downs and Medina 2000). Paper manufacturing switched to wood pulp, replacing the need for rags, and more metal became available from domestic and foreign sources (Downs and Medina 2000). Adding to this diminishment in scavenging was the rise in affluence experienced in America, especially as a result of the New Deal and the second World War. The ability to simply throw items away is seen in human society as a luxury for the wealthy, signifying a disposable income (Strasser 1999). The richer a person is, the more garbage they produce (Downs and Medina 2000). People abandon frugality, as reusing and recycling represent the poor and unsanitary.

Instead of items circulating their way back to manufacturers to be reused, landfills and dumping grounds gained popularity as urban life compounded, developing a linear ('take-make-waste') product process (Strasser 1999).

B. LANDFILLS: ISSUES OF REFUSE

Landfills envelop the idea of being '*out of sight and out of mind*', yet their presence is not without complications. A municipal solid waste landfill (MSWLF) is a "discrete area of land or excavation that receives household waste" (EPAa 2022). While landfilling waste materials is one of the oldest forms of waste disposal, MSWLFs are a relatively recent development in the context of human history.

Prior to the urbanization that evolved over the course of the latter half of the twentieth century, most Americans lived in sparsely populated rural farming communities in which solid waste was disposed in open dumps spread over a large area to allow easy access to scavengers (Hickman Jr. 2016). Additionally, pigs were allowed to feed on the refuse (Hickman Jr. 2016). Once thinned, any remaining waste was burned (Hickman Jr. 2016). During the 1940s and 50s, there was a rising awareness and concern among municipal governments, scholars, and the general public as to the impacts of this solid waste management method to both human health and the environment (Hickman Jr. 2016). The first recommended guidelines for refuse collection and disposal practices for a small community were published in 1953, a joint venture of the US Public Health Service (USPHS) and the American Public Works Association (Hickman Jr. 2016).

While these guidelines were updated in 1961 and formed the basis for the first national legislation concerning sanitary landfill practices with the passage of the Solid Waste Disposal Act of 1965, there was no government mandate requiring adoption of these practices for nearly two decades (Hickman Jr. 2016). The solid waste program of the USPHS was moved into the Environmental Protection Agency (EPA), with its creation in 1970, but it was not given regulatory authority over landfills until the 1984 amendment to the Resource Conservation and Recovery Act (RCRA) (Hickman Jr. 2016).

The RCRA Subtitle D contains a series of criteria that govern the design, operating, monitoring, and remediation requirements of MSWLFs (Hickman Jr. 2016). Despite improving the sanitary methods of modern-day landfill construction, landfills still negatively impact their surroundings through such concerns as habitat destruction, groundwater contamination, and contributions to global climate change, among others.

Landfills occupy vast acreage across America (**Figure 1**). The loss of this land can impact wildlife, agriculture, and (simply) desirable places to live. In total, 1.8 million acres of habitat have been lost due to landfill construction within the United States (**Figure 1**; Vasarhelyi 2021). Concerns have been raised (McCarthy 2018) that the United States is slated to run out of space for landfills within twenty years, an issue especially prominent in the Midwest and Northeast (**Figure 1**).

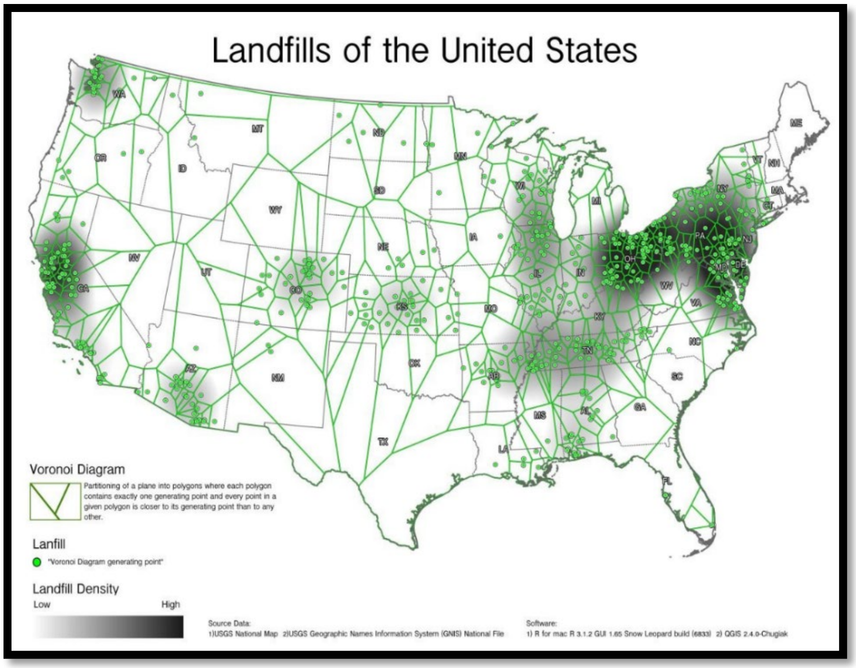

Figure 1. *Landfills of the United States. Each green-filled dot represents a landfill, with shading indicating the density of landfills within a given region.*

Beyond loss of land associated with landfills, MSWLFs are not perfect vessels for waste containment. While landfills contain sophisticated lining systems intended to contain the liquids produced from the waste, the EPA provides that "no liner can keep all liquids out of the ground for all of time. Eventually liners will degrade, tear, or crack, and will allow liquids to migrate out of the unit" (EPAa 2022). This leachate, formed from rainwater percolation, as well as the garbage itself, can contain many toxicants, which can infiltrate surrounding water sources, such as ground and surface water, when they escape the landfill (EPAa 2022). Known as point source pollution, leachate contamination through this water penetration can pollute a vast environment and is hazardous to human and wilderness biota alike.

In addition to the leachate that can escape containment, the (albeit extremely slow) decomposition of organic material within a landfill will lead naturally to gaseous byproducts, known as Landfill Gas (LFG) (EPAb 2022). LFG contains approximately 50% methane and 45% carbon dioxide, with additional trace gasses (EPAb 2022). Unfortunately, both carbon dioxide and methane are known Greenhouse Gasses (GHG), each representing the most significant or the third largest contributor to rising GHG levels, respectively (Lindsey 2022). As GHGs absorb heat, trapping it within the Earth's atmosphere, their increased emission is leading to global climate change (EPAb 2022). MSWLFs represent the third largest source of methane emissions within the United States (**Figure 2**). While LFG can be captured, cleaned, and used as a renewable energy source, as of August 2022, only 538 of the 1,269 MSWLFs in the United States (42%) have operational LFG energy projects (EPAb 2022).

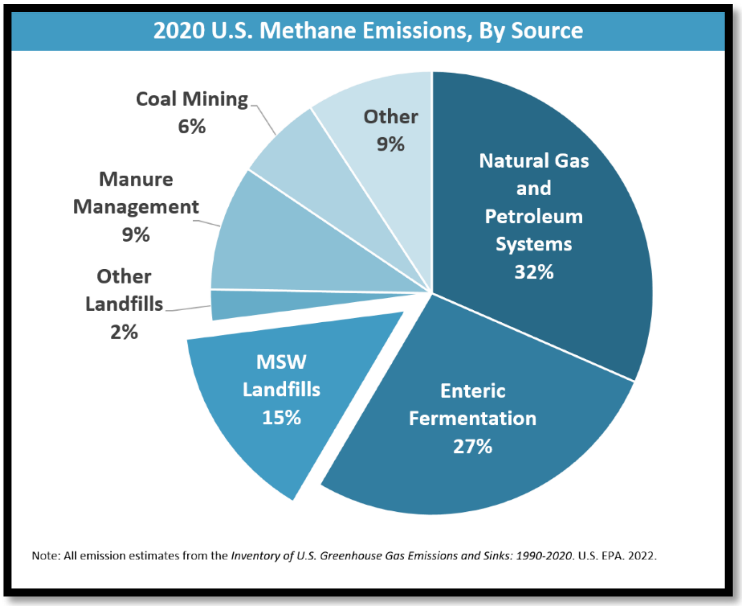

***Figure 2**. United States Methane Emissions (2020), by source.*

Diverting waste away from landfills is the most direct means to reduce the sprawl of landfills and, in turn, leachate and GHG production.

C. THE REMAINS OF AMERICA

There are currently over twelve hundred active landfills responsible for containing all the trash disposed of in the United States (Vasarhelyi 2021). In 2018, the United States generated 292.4 million tons of municipal solid waste (MSW), which is approximately 4.9 pounds per person per day (**Figure 3**). Of all that waste generated, 69 million tons were recycled (23.5%) and 25 million tons were composted (8.5%), with half of the materials, or 149 million tons, being landfilled (EPAc 2022).

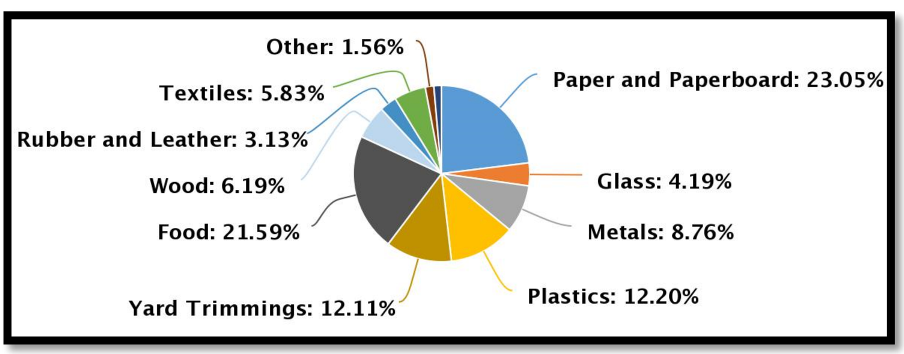

***Figure 3**. Total US Municipal Solid Waste Generated (2018), by material.*

Of the MSW that was landfilled, food represented the largest component (24%), with plastics (18%), and paper and paperboard (12%) rounding out the top three (**Figure 4**) (EPAc 2022). Glass represented 4% of MSW generated and about 5% of what was landfilled (**Figures 3** and **4**).

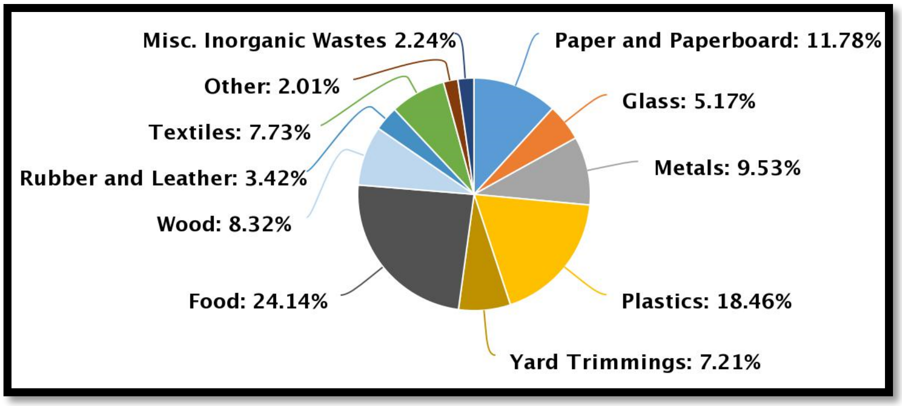

Figure 4*. Total US Municipal Solid Waste Landfilled (2018), by material.*

These numbers reveal that much of what is landfilled could be diverted through composting and recycling (**Figure 4**). For example, only 33% of glass in the United States is recycled, with the remaining (approximately ten million metric tons) of glass ending up in landfills (Jacoby 2019). Compostable organic waste makes up about 30% of the total mass in landfills (EPAc 2022). Based on this, there is potential to actively decrease landfill input by increasing municipal access to composting and recycling programs. This is important as, within the next five years, landfill capacity in the United States is expected to decrease by 15% with the Northeastern United States being most heavily affected (Musulin 2018). Glass recycling and food composting are two viable options to reduce landfill volume.

D. A CLEAR UNDERSTANDING OF GLASS RECYCLING

Glass is a nontoxic product composed primarily of silica, sodium carbonate, and limestone, and it is infinitely recyclable (Freestone 2015). Glass made from raw materials uses sand. To make glass from recyclables, it is broken into small pieces, known as cullet, which is then melted down and remanufactured into new containers at a processing facility. (Jacoby 2019). It can take as little as thirty days for glass to go from waste to a new product (Circular Indiana 2022).

Recycled cullet can replace up to 95% of raw materials used to make glass. Cullet also melts at a much lower temperature than the raw materials, decreasing energy costs, reducing greenhouse gas emissions, and increasing the lifespan of the furnace used (Circular Indiana 2022). Making a bottle from post-consumer glass (recycling) rather than from sand (new, raw material) reduces air pollution by 20% and water pollution by 50% (Glass Packaging Institute 2022). For every six tons of glass recycled, one ton of carbon dioxide is reduced (Glass Packaging Institute 2022). Furthermore, if accomplished at a local level, processing and recycling glass can provide jobs, strengthening regional economies (Circular Indiana 2022).

E. BREAKING DOWN COMPOSTING

Composting is "the natural process of recycling organic matter, such as leaves and food scraps, into a valuable fertilizer" (Hu 2021). Organisms, such as bacteria and worms, work to break down the organic matter, but require oxygen for this process (Hu 2021). Landfills lack the oxygen needed for this process, resulting in anaerobic (rather than aerobic) decomposition and the production of methane, a potent GHG (Vasarhelyi 2021). Landfills represent the third largest source of methane production within the United States (**Figure 2**). Comparatively, composting allows aerobic respiration, decomposition in the presence of oxygen, to occur yielding a nutrient-rich fertilizer for plants (Ashrap and Cathey 2019). Through the creation of compost, organic materials are no longer waste but rather a usable product that can be applied to flower beds, gardens, and fields (Ashrap and Cathey 2019). Through the conversion of organic waste into fertilizer and soil-amendments, composting offers a solution for waste reduction in landfills.

Backyard composting is a trend that has gained popularity in recent years in urban and rural communities (Ashrap and Cathey 2019). Backyard composting is an efficient way for a household to reduce their volume of MSW by removing fruit and vegetable scraps, eggshells, paper products, and yard waste from their waste stream (EPAd 2022). However, many households do not have the space required for this, especially within more urban communities (EPAd 2022). Additionally, largely due to the relatively low temperatures of backyard compost piles, there are many household organic wastes that cannot be included in backyard composting operations (EPAd 2022).

Food waste composting can also be offered by industrial composting facilities. Industrial composting facilities are regulated by USDA and subject to rigorous and frequent testing. Given their scale of operation, leading to much higher internal temperatures, these facilities can accept materials, such as meat, bones, fat, and dairy products, that backyard composters are not equipped to handle.

As food waste represents the largest component within landfilled MSW (**Figure 4**), accessibility to a food waste composting program can provide a significant means to decrease municipal expenditures on the landfilling of MSW. For many communities, the lack of access to industrial composting facilities is often a dominant factor for the landfilling of household organic waste.

F. SAVING ERIE FROM AN EERIE FUTURE

Recycling and waste management in the City of Erie, Pennsylvania, is being impacted by local-to-global circumstances (Nestor Resources 2022). While it is important to recognize the interconnectedness of these issues and the reality that not all are under local control, it is more vital to understand that without changing the local environment, realistic improvements cannot be achieved. Essentially, we must '*think global, but act local*.'

Some of the local systemic issues determined through a 3-year study, which included significant stakeholder input from both the community and municipalities, included (Nestor Resources 2022):

- Government Autonomy and Scattered Control of Commodities
- Lack of Local Processing Capability
- Minimal Competition in the Marketplace
- Prevalence of Vertically Integrated Services
- Dominance of Single Stream Collection
- Location and Logistics

Almost by definition, systemic issues are difficult to tackle, but the burden is eased when a unified group expresses a need for improvement and agrees upon a solution. Solutions exist but do require a change in mindset from current practices and this takes time. Many of the issues noted here are not unique to Erie, meaning the Erie can learn from what others have done.

According to the Recycling Partnership (2022), converting to a cart-based recycling and waste management system can (**Figure 5**):

- save municipalities money,
- improve employee safety,
- increase recycling participation rates, and
- decrease quantities of materials sent to landfills.

Figure 5. Infographic depicting the benefits of a cart-based recycling and waste management system.

Currently, curbside recycling only recovers 32% of the available recyclables in single-family homes (Mouw et al. 2020). The increased recovery of these recyclables could lead to the development of 370,000 jobs, reduce greenhouse gas emissions by 96 million metric tons of carbon dioxide equivalent and conserve the energy equivalent of 154 million barrels of oil (Mouw et al. 2020). In addition to recyclables, food waste represents another ~20% of the total municipal solid waste stream, but only 4% of that food waste is composted (EPAc 2022).

Together recyclables and food compost represent a significant portion of municipal solid waste (MSW) that is typically sent to a landfill. By creating systems in which this material is recovered, municipal waste management costs can be dramatically reduced simply through decreased landfill tipping fees alone (Recycling Partnership 2022; Nestor Resources 2022).

Beyond this, modernizing and mechanizing waste and recycling collection provides additional economic, social, and environmental benefits (Recycling Partnership 2022). Carts keep materials better contained, especially compared to bag-only systems, such as is currently employed in the City of Erie, given the penchant for critters to tear-open bags, releasing their contents into the environment (Karimi and Faghri 2021; Recycling Partnership 2022). Automation and compaction mean more efficient routes as well as requiring less collection staff (Recycling Partnership 2022). Increased employee safety because of mechanized lifting also leads to decreased workers' compensation claims, further reducing costs to municipalities (Recycling Partnership 2022). While the City of Erie is currently only collecting 110 tons of recycling per household, according to the Recycling Partnership data, modernizing and containerizing the current system could more than triple that to 350 tons per household (Mouw et al. 2020).

In this report we explore the idea of re-envisioning waste management within the City of Erie. Our analysis focused on increasing access to glass recycling and food compost collection given both their prominence within the waste stream and the recent emergence of pertinent local businesses (Prism Glass Recycling and Conservation Compost). Additionally, through conversations with the Recycling Partnership – as well as through background research – which lead to a better understanding of the issues, the conversion to a cart-based, mechanized system was included as a foundation of our cost-benefit analysis.

II. METHODS

A. OVERVIEW OF CLASS

Leadership in Sustainability (SUST 200) is a Pennsylvania State University project-based course aimed at engaging students in critical thinking around real-world sustainability-related problems and learning leadership skills through that process. This class perfectly embodies the Open-Lab strategy that is a pillar of Penn State Erie, The Behrend College. The course also serves as the foundational course for the Sustainability Leadership minor.

During the Fall 2022 semester, students within the SUST 200 course were divided roughly in half to form two groups: one focused on a campus-based project, while the other worked on the community-based project, which forms the foundation of this report. Each group had weekly (half class session) meetings with the course instructor during which activities from the prior week were reviewed and work for the next week decided upon and assigned. Overall, the group project represents about half the course grade, with the remaining being devoted to other class readings and activities.

B. PROJECT ACTIVITES

This report reflects the outcome of all project activities, including (1) developing an understanding of the issue and context, through background research, as well as interviews with local officials and pertinent businesses, (2) compiling and obtaining data from local-to-national sources, and (3) pooling this information together to create a cost-benefit analysis for the diversion of glass recycling and food compost from City of Erie landfilled waste.

1. CITY OF ERIE PILOT PROJECT (Summer 2022)

To obtain City of Erie specific (local) data, work on this project began in advance of the academic year. In the summer of 2022, two neighborhoods were selected in consultation with the City of Erie Department of Public Works to be offered the opportunity to participate in a curbside glass recycling and food composting pilot program. The neighborhoods were chosen largely due to their recycling rate, with one representing a high recycling rate and the other a low recycling rate, such that averaging between them would represent an average Erie-ite.

Households were invited to participate in the program through a concerted door-to-door campaign from May through June 2022 (**Table 1**). The canvasing team was able to speak to about 30% of residents, yielding about two-thirds of those that registered to be part of the program (**Table 1**). Flyers describing the program and inviting households to register to be part of the pilot (**Appendix 1**) were left at half of the residences (**Table 1**). No action was taken at about 20% of the households either because they were selling the house, the house was condemned, or it was not considered a single-family household (i.e., a duplex or apartment building) (**Table 1**).

***Table 1**. Numbers of Households within door-to-door campaign who were contacted, as well as those who registered, by neighborhood and type of engagement.*

	CONTACTED						REGISTERED					
	High Recycle		Low Recycle		Total		High Recycle		Low Recycle		Total	
Spoke To	112	34%	139	28%	251	31%	36	67%	34	68%	70	67%
Left Flyer	200	62%	209	43%	409	50%	18	33%	16	32%	34	33%
None	12	4%	144	29%	156	19%	---	---	---	---	---	---
Total	**324**		**492**		**816**		**54**		**50**		**104**	

Of the more than 800 residences visited, a total of 104 households registered to be part of the program. Each of these households were given two 5-gallon buckets: one with a lid and compostable liner for the collection of food waste, and the other without a lid for glass. The 5-gallon buckets were obtained through donations from our local hardware stores, namely: West Erie Lowe's, Home Depot, and Ace Hardware.

As trash, recycling, and yard waste composting is picked-up by the City of Erie personnel between 11pm and 8am, participating households were told to put out their food compost and glass recycling buckets the morning after their normal trash collection (to avoid any confusion with municipal collection staff): Mondays for the high recycling rate neighborhood and Tuesdays for the low recycling rate neighborhood. On these days, the pilot project team would collect the buckets, weigh the net food compost and glass recycling in each, clean the buckets, and return them back to the homes. This process was done once a week for three weeks.

2. INTERVIEWS WITH PROJECT PARTNERS

With the start of the academic year, the project team was expanded to include SUST 200 students. To allow these students to understand the issues and context of the overall waste diversion project, interviews with pertinent businesses and municipal employees were conducted. More specifically, the project team was interested in talking with the City of Erie Department of Public Works, to better understand the current situation, as well as Conservation Compost and Prism Glass, the local businesses to whom diverted materials would be channeled. Prior to all interviews, a list of questions specific to the interviewee was developed and refined (**Appendix 2**). All interviews were recorded to ensure accuracy of information gleaned.

3. DATA COMPILATION AND ANALYSIS

Net weights of glass recycling and food compost obtained in the Summer of 2022 pilot program formed the basis of our local data. To put this data into perspective, additional data was obtained from national (**Figure 4**) and state resources. The United States Environmental Protection Agency (USEPA) provides statistics regarding nationwide data, with the most recent numbers coming from 2018 (EPAc 2022); these numbers form the basis for our national data. In November 2022, the Pennsylvania Department of Environmental Protection (PA DEP) publicly released its 2021 Waste Characterization Study (PA DEP 2022), its first such study in twenty years, with its prior analysis being a 2003 report based on 2001 project effort. The PA Waste Characterization study provides not only Pennsylvania statewide numbers, but also those from within the Northwest Pennsylvania (NWPA) region, with landfilled materials analyzed coming specifically from the Lakeview Landfill that the City of Erie utilizes through its contract with Waste Management (PA DEP 2022). State and regional data were compiled from this report (PA DEP 2022). Thus, local data is framed in comparison to national (USA), statewide (PA), and regional (NWPA) numbers to provide context and perspective.

III. RESULTS

Work started in advance of the academic year to collect City of Erie specific data (curbside pilot study). These numbers were compared to and used in addition to national, state, and regional numbers to provide a variety of potential scenarios.

A. CITY OF ERIE PILOT PROJECT (Summer 2022)

Weekly data obtained as part of the curbside pilot project was averaged across all participating households and within each individual neighborhood (**Table 2**). Given variability in the number of persons per household, weights per person per day provide the most consistent metric for comparison. Not all participating households were able to contribute each week, nor did each contribute to both collections (though the vast majority did) (**Table 2**).

While 54 households from the high recycling rate neighborhood and 50 from the low recycling rate neighborhood registered to be part of the program (**Table 1**), not all participating households were able to contribute each week due to family vacations (**Table 2**). Across both neighborhoods, the amount of food compost collected each week increased across the three weeks of the pilot study (**Table 2; Figure 6**). This is likely owing to the unfamiliarity of the concept, as experience indicates an increase in quantities over time as participants become more aware of what can be included and more accustomed to the process (Conservation Compost, 2022). Glass recycling showed a little more variation, with week 2 being higher in both neighborhoods in comparison to week 1, but week 3 values being lower (**Table 2; Figure 6**). Similar values were obtained across both neighborhoods, though the low recycling rate neighborhood yielded consistently higher numbers (**Table 2; Figure 6**). This consistency across the two neighborhoods that generally have noticeably different recycling rates could be an artifact of the study itself as households had to register to be part of the pilot. Thus, regardless of the neighborhood, those that registered have a similar mindset and hence a consistency in the data.

***Table 2**. Weekly averages for food compost and glass recycling among City of Erie pilot project participants.*

	High Recycle Rate					Low Recycle Rate					Totals				
WEEK 1	**Compost**	**%**	**Glass**	**%**	**Total**	**Compost**	**%**	**Glass**	**%**	**Total**	**Compost**	**%**	**Glass**	**%**	**Total**
Total (kg)	149.84	43%	200.45	57%	350.29	140.95	49%	144.15	51%	285.10	145.40	46%	172.30	54%	317.70
Total (lbs)	330.34		441.92		772.26	310.74		317.80		628.54	320.54		379.86		700.40
# of households	46		45		46	41		38		41	87		83		87
Avg Lbs per HH	7.18	42%	9.82	58%	17.00	7.58	48%	8.36	52%	15.94	3.68	45%	4.58	55%	8.26
Ave kg/p/d	0.13	43%	0.17	57%	0.30	0.15	47%	0.17	53%	0.33	0.14	45%	0.17	55%	0.32
Ave lbs/p/d	0.29	43%	0.38	57%	0.67	0.34	47%	0.38	53%	0.72	0.31	45%	0.38	55%	0.70
WEEK 2	**Compost**	**%**	**Glass**	**%**	**Total**	**Compost**	**%**	**Glass**	**%**	**Total**	**Compost**	**%**	**Glass**	**%**	**Total**
Total (kg)	130.05	53%	115.10	47%	245.15	117.55	33%	233.55	67%	351.10	123.80	42%	174.32	58%	298.13
Total (lbs)	286.72		253.75		540.47	259.15		514.89		774.04	272.94		384.32		657.25
# of households	46		39		46	43		35		43	89		74		89
Avg Lbs per HH	6.23	49%	6.51	51%	12.74	6.03	29%	14.71	71%	20.74	3.07	37%	5.19	63%	8.26
Ave kg/p/d	0.18	50%	0.18	50%	0.36	0.19	40%	0.28	60%	0.47	0.18	44%	0.23	56%	0.42
Ave lbs/p/d	0.39	50%	0.40	50%	0.79	0.42	40%	0.63	60%	1.05	0.41	44%	0.51	56%	0.92
WEEK 3	**Compost**		**Glass**		**Total**	**Compost**		**Glass**		**Total**	**Compost**		**Glass**		**Total**
Total (kg)	149.63	56%	116.83	44%	266.46	116.10	60%	77.60	40%	193.70	132.87	58%	97.21	42%	230.08
Total (lbs)	329.89		257.56		587.45	255.96		171.08		427.04	292.92		214.32		507.24
# of households	46		45		46	41		30		41	87		75		87
Avg Lbs per HH	7.17	56%	5.72	44%	12.90	6.24	52%	5.70	48%	11.95	3.37	54%	2.86	46%	6.22
Ave kg/p/d	0.19	54%	0.16	46%	0.35	0.21	56%	0.16	44%	0.37	0.20	55%	0.16	45%	0.36
Ave lbs/p/d	0.42	54%	0.36	46%	0.77	0.45	56%	0.35	44%	0.81	0.43	55%	0.35	45%	0.79

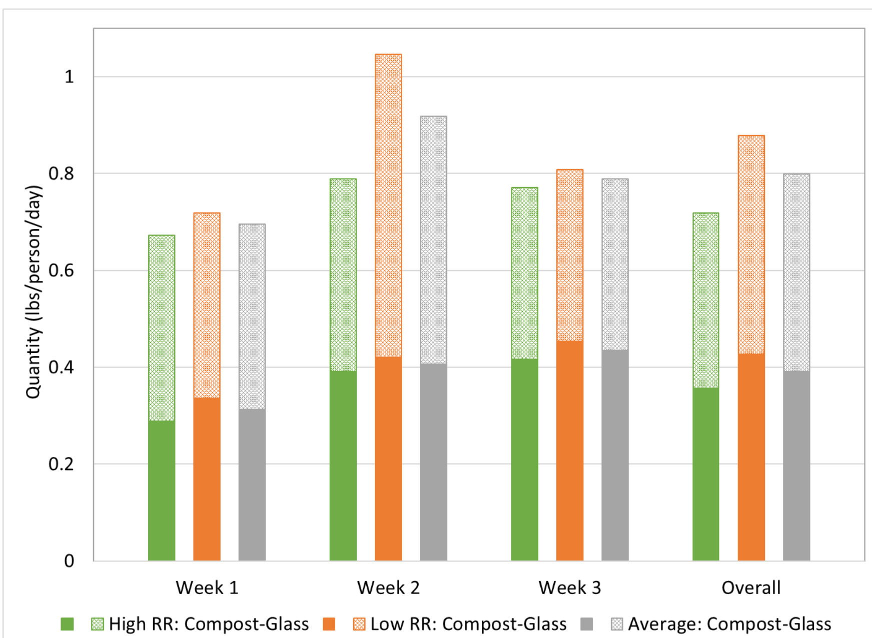

***Figure 6**. Weekly, as well as overall, averages from the City of Erie pilot study data. Solid bars quantify food compost, pattern bars depict glass. Numbers for the "high recycling rate" neighborhood are in green, "low recycling rate neighborhood in orange, and the average between the two in grey.*

Over the course of the three weeks of the project, data were obtained from 99 of the 104 registered households (95%) as some registrants never put out any buckets despite being contacted throughout the process (**Table 3**). Averaging across the three weeks of the pilot project, the data indicate an almost equal quantity of glass recycling and food compost per person per day was obtained regardless of neighborhood (**Table 3; Figure 6**). Averaging across the neighborhoods yielded a net total of 0.80 pounds of both food compost and glass recycling per person per day, roughly equally divided, as the baseline data for an average Erie-ite (**Table 3; Figure 6**).

Table 3. *Average City of Erie food compost and glass recycling data obtained during the summer 2022 pilot project.*

Average	High Recycle Rate					Low Recycle Rate					Average				
	Compost	%	Glass	%	Total	Compost	%	Glass	%	Total	Compost	%	Glass	%	Total
Total (kg)	151.00	47%	173.18	53%	324.18	138.48	41%	196.28	59%	334.75	144.74	44%	184.73	56%	329.47
Total (lbs)	332.89		381.80		714.69	305.29		432.71		738.01	319.09		407.26		726.35
# of households	49		53		53	46		45		46	48		49		99
Avg Lbs per HH	6.79	49%	7.20	51%	14.00	6.64	41%	9.62	59%	16.25	6.72	45%	8.31	55%	15.03
Ave kg/p/d	0.16	50%	0.16	50%	0.33	0.19	49%	0.21	51%	0.40	0.18	49%	0.18	51%	0.36
Ave lbs/p/d	0.36	50%	0.36	50%	0.72	0.43	49%	0.45	51%	0.88	0.39	49%	0.41	51%	0.80

B. COMPARISON TO OTHER DATA

To provide context to the numbers obtained in the City of Erie pilot study, additional data was retrieved from the USEPA (EPAc 2022) and PA DEP (PA DEP 2022). **Table 4** provides this national, state, and regional data in comparison to the local, pilot project data.

Table 4*. Collated national, state, and regional data in comparison to the summer 2022 pilot study (local) data.*

	National Data				Pennsylvania State Data				NW PA Regional Data				City of Erie Data		
Total Persons	327,167,434				12,964,056				989,202				94,831		
Total Households	122,354,219				5,106,601				414,365				36,000		
Avg p/HH	2.67				2.54				2.39				2.70		
MSW Landfilled (Tons/yr)	146,100,000				4,820,573				623,377				---		
													Pilot Study Data		
	%	kg/p/d	lbs/p/d	lbs/hh/wk	%	kg/p/d	lbs/p/d	lbs/hh/wk	%	kg/p/d	lbs/p/d	lbs/hh/wk	kg/p/d	lbs/p/d	lbs/hh/wk
Food Compost	24%	0.27	0.59	11.1	16%	0.15	0.32	5.76	19%	0.29	0.64	10.80	0.18	0.39	6.72
Glass	5.2%	0.06	0.13	2.37	2.6%	0.02	0.05	0.91	2.6%	0.04	0.09	1.45	0.18	0.41	8.31
Total	---	0.33	0.72	13.5	---	0.17	0.37	6.67	---	0.33	0.73	12.25	0.36	0.80	15.03

The pilot project average of 0.80 pounds per person per day of combined glass recycling and food compost compares well with both the national (0.72) and regional (0.73) averages, though all three of these statistics are about twice what was obtained for the state of Pennsylvania (**Table 4**). While the totals are consistent across 3 of the 4 data sources, more variability is seen within the components. The weight per person per day of food compost within the pilot study data (0.39 lbs/p/d) is consistent with the statewide data (0.32) but is only about two-thirds of the regional (0.64) and national (0.59) data (**Table 4**). As noted within the weekly pilot study data (which increased each week), this could be largely owing to unfamiliarity of food composting and likely indicates potential growth within city residents as they become more comfortable with the program. The most significant difference within the local, pilot program data relative to these regional-to-national data sources lies within the glass recycling numbers (**Table 4**). Pilot study numbers for glass (0.41 lbs/p/d) were three to nearly ten times higher than those obtained in these other studies (0.05–0.13 lbs/p/d; **Table 4**). While this could indicate that City of Erie residents utilize more glass packaging, it is more likely an artifact of the pilot study indicating that people had been saving up their glass over a period of time and made use of the study to rid their stores. While this analysis focused on the weights per person per day, similar trends are observed in the weights per household per week (**Table 4**).

C. ESTIMATED WASTE DIVERSION POTENTIAL

The variability in the data collated from national-to-regional sources – and in comparison to the local pilot study numbers – highlights the importance of utilizing multiple data sources to provide a range of potential scenarios. Data collated in **Table 4** was used to extrapolate possible quantities (and associated savings) of food compost and glass recycling that could be diverted from the landfill through city programs. **Table 5** presents the results of these extrapolations, averaged across two calculation methods: the first utilized weight per person per day from the data source and the population of the City of Erie (**Table 4**), while the second utilized weight per household per week and the number of households within the City of Erie (**Table 4**). Given the current City of Erie tipping fee of $55.90 per ton, the weights obtained were converted into estimated savings associated with diverting this food compost and glass recycling from the landfill (**Table 5**).

Table 5. *Estimations of the amount of waste that could be diverted based on national, state, regional, and local data, and City of Erie statistics, as noted.*

		National Data	PA Data	NW PA Data	City of Erie Pilot Data	Average
Food Compost	Tons/Yr	10,300	5,489	10,633	6,531	8,238
	Est. Savings	*$575,762*	*$306,835*	*$594,374*	*$365,085*	*$460,514*
Glass Recycling	Tons/Yr	2,206	873	1,428	7,413	2,980
	Est. Savings	*$123,310*	*$48,775*	*$79,798*	*$414,396*	*$166,570*
Total	Tons/Yr	12,506	6,362	12,060	13,944	11,218
	Est. Savings	*$699,072*	*$355,610*	*$674,172*	*$779,482*	*$627,084*

According to this local-to-national data the City of Erie could divert between ~5500 to over ten thousand tons of food waste each year from the landfill through food compost collection, with an average of about 8000 tons per year (**Table 5**; **Figure 7a**). Diverting this food waste from the landfill would save the City between ~$300,000 and $600,000 each year, with an average of about $450,000 (**Table 5**; **Figure 7a**). As was noted above, the local data obtained in the pilot project is most closely aligned with the Pennsylvania state data, but the similarity of the regional and national data alludes to what might be achievable over time with education and familiarity of the program.

As glass represents a much smaller component of the landfilled waste stream across most data sources – with the exception being the City of Erie pilot project – the diversion of this waste stream would result in much more modest results averaging around three thousand tons per year (**Table 5**; **Figure 7b**). Still the diversion of glass recycling from the landfill could save the City between $50,000 and $400,000 each year, or ~$160,000 per year on average (**Table 5**; **Figure 7b**). The City of Erie pilot project data stands in stark contrast to the other data sources, but the inclusion of the regional-to-national data weights the average considerably (**Table 5**; **Figure 7b**).

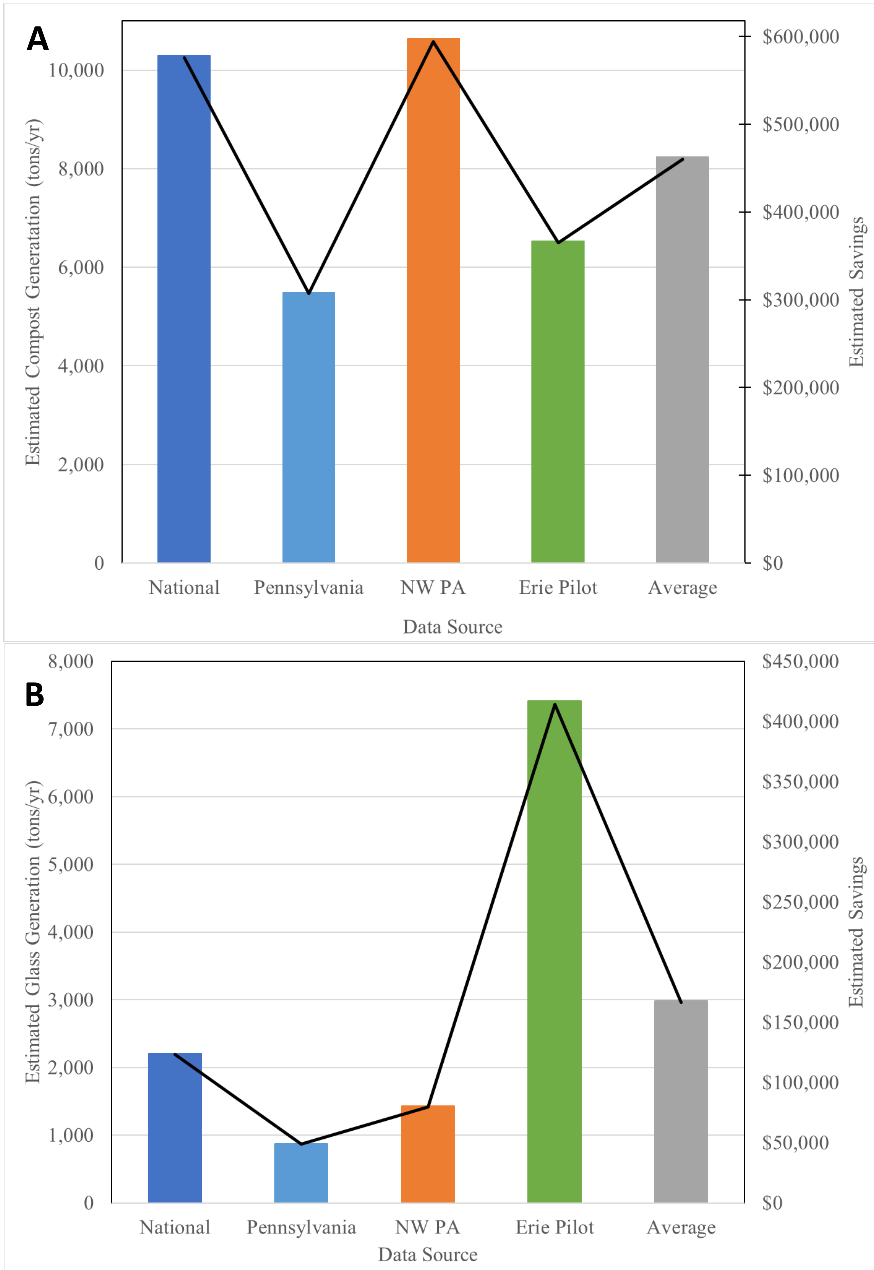

***Figure 7**. Estimated generation (bars) and tipping fee savings (line), depending on data source. A (top) depicts results for food compost; B (bottom) represents data for glass recycling.*

With the exception of the City of Erie pilot project data, food compost represents the majority of the potential waste diversion weight and estimated savings, averaging ~75% of the total (**Table 5**; **Figure 8**). While the City of Erie pilot data yielded an overall higher total estimate, likely resulting from the over production of glass recycling within collected curbside samples, it is still consistent with total estimations from national and regional data (**Table 5**; **Figure 8**). On average, and across both waste streams, data analysis indicates that the City of Erie could save over a half a million dollars annually through the diversion of these materials from the landfilled waste stream (**Table 5**; **Figure 8**).

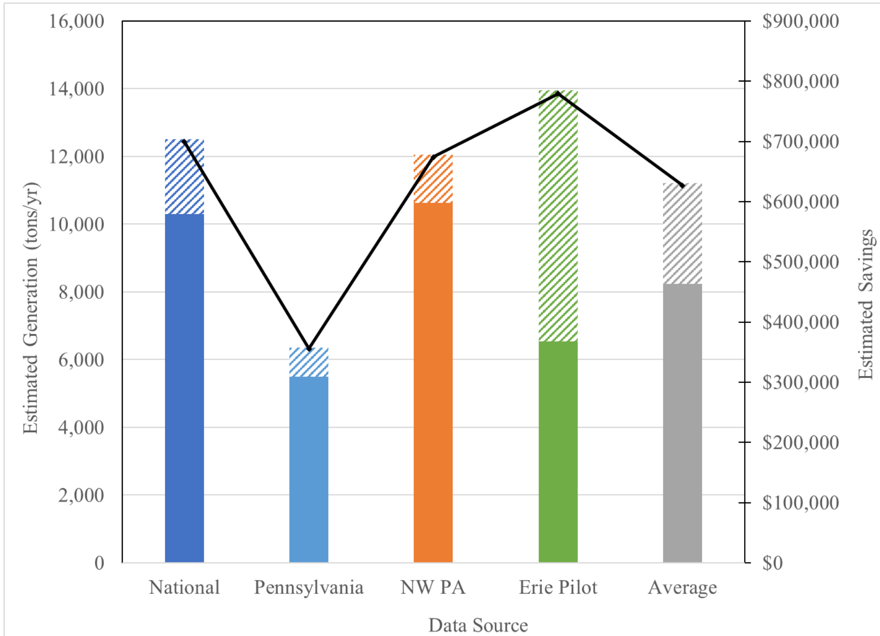

Figure 8. *Estimated waste diversion for food compost (solid bars) and glass recycling (patterned bars) based on different data sources. Total potential savings based on avoiding tipping fees is also shown (line).*

IV. DISCUSSION

A. SUMMARY OF INTERVIEWS WITH PROJECT PARTNERS

The City of Erie manages its own weekly waste, recycling, and yard compost collection through the Department of Public Works. Between 8 and 14 trucks, manned by teams of 3 personnel (one driver and two carriers), are utilized for the collection, which occurs 5 nights a week (Sunday through Thursday) between the hours of 11pm and 8am; more trucks are utilized between March and November when yard waste is collected for composting. Separated yard waste is taken to a City of Erie composting site, while collected waste and recycling are taken by the City owned and managed trucks to a transfer station, owned and operated by the Waste Management; Waste Management owns and operates Lakeview Landfill.

Currently, the City of Erie accepts all grades of paper, all forms of metal, and plastic bottles with screw top lids (lids, themselves, discarded) within the recycling stream. Accepted recyclables are determined by Waste Management, as the City's contracted vendor, but is ultimately a market-driven commodity. Single-stream, or zero-sort, recycling, originally intended to increase recycling rates, have decreased the value of most recyclable materials due to sorting costs. That is, mixed recycling must be transported to sorting facilities (commonly called Material Recover Facilities, or MRFs, for short). MRFs operate largely on a mechanized sorting process. The increased costs of sorting mixed recycling, both through the creation of the MRFs and through the increased transportation costs of bringing materials to the facilities, has decreased the value of most recyclables. As the mechanized process is not perfect, contamination of bailed recyclables (i.e., plastics in with paper, etc.) has also acted to decrease the value of recyclables.

Ostensibly because glass breaks in the collection, transport, and sorting process, several years ago (5-10 years) glass was removed as an allowed component within the City of Erie zero-sort curbside recycling collection. In the shadow of that reality two local start-ups emerged: Bayfront Glass, followed by Prism Glass, as drop-off options for residents. Bayfront Glass requires color separation of collected materials, while Prism Glass does not. Given the logistical barriers of collected color-sorted glass curbside, Prism Glass served as a project partner on this project and study. Prism Glass currently has 47 commercial customers and 19 drop-off locations around Erie. Within their drop-off locations, they collect around ten tons of glass each week, while collecting about sixteen tons of glass each month from local businesses (mostly restaurants and bars). All glass collected is transported to their bunker, which can hold up to 80 tons, before being transferred to CAP Glass in Westmorland County (PA). Prism Glass would accept glass collected curbside for free with the City trucks getting a code to the bunker access gate for drop-off. This process would be similar to the process for other recyclables, which are dropped off at the transfer station. Depending on the quantities received, Prism Glass has even offered a modest revenue share of $2.50 per ton for accumulated weights between five hundred and a thousand tons and $5.00 per ton for weights greater than a thousand.

While the City of Erie collects yard waste curbside for composting from March to November each year, they do not accept any type of food waste into this program for regulatory, as well as aesthetic, reasons. Yard trimmings do represent ~12% of waste generated (**Figure 3**), and about 7% of what is landfilled (**Figure 4**), but this is not even one-third the quantity of food waste that ends up in a landfill (~24%; **Figure 4**). As detailed earlier, food waste represents the largest component of landfilled waste (**Figure 4**). After years of site selection and the permitting process, Conservation Compost open their doors in January 2020 as the regions only industrial composting facility. Residents within Erie and Crawford counties can sign-up at a cost of $10 per month for food composting services. Participants are given a lidded 5-gallon bucket and compostable liner and can drop-off their collected food waste at a number of drop-off locations. Conservation Compost has also partnered with the Mill Creek township to offer the service to all their residents for free. As a relatively new start-up, Conservation Compost is not yet prepared to offer a curbside service but is very interested and willing to work with the City of Erie to provide a convenient drop-off service to all residents.

B. COST-BENEFIT ANALYSIS

Given the potential savings detailed in section III.C., a simplistic cost-benefit analysis for the diversion of food compost and glass recycling out of landfilled waste materials for the City of Erie was conducted. Through conversations with the Recycling Partnership a foundation of this analysis included the containerizing and mechanization of the collection process. The transition to a cart-based system was determined to be integral to this re-envisioning of the waste management process given the lessons learned in other communities, namely that cart-based systems increased recoveries, decreased costs, and decreased the unintentional littering associated with bagged-curbside collection (section I.F.; **Figure 5**).

The cost benefit analysis was conducted for two scenarios: one in which all the costs for the conversion of the entire City to a cart-based system were considered upfront, and a second in which those costs were distributed over the course of time. Common assumptions for both scenarios are detailed here:

- Carts can vary in size from 32-gallon to 96-gallon with the footprint of the container remaining relatively constant but the height changing (Recycling Partnership 2022). There is, of course, a difference in cost depending on the size of cart (Recycling Partnership 2022). For this analysis, a mid-size cart of 64-gallons, at a cost of $50 each, was utilized (Recycling Partnership 2022).
- While nothing is guaranteed, in conversations with the Recycling Partnership they indicated that the City of Erie would be a good candidate for one of their community conversion grants owing to our current poor overall recycling rate and the size of our community. This grant would provide $15 per cart purchased for the containerizing and mechanizing of the waste and recycling collection process. For both scenarios there is a built-in assumption that such a grant (RP grant) is obtained.
- An annual replacement rate of 2% for lost, damaged, or stolen carts is assumed.
- Every two years both the City of Erie and Erie County can apply for state (PA) 902 grants to assist municipalities with improving and supporting their recycling programs. Currently the County has $175,000, and the City has $80,000, in 902 grant funds that are assumed would be put toward this modernization of the waste and recycling process. Additionally, it is assumed (in the phased-in scenario) that the City and County would continue to receive similar state support biannually.
- As glass would need to be kept separate from other recyclables, recycling collections would alternative weeks: one week glass would be collected curbside and the next it would be zero-sort recyclables. There is no additional cost assumed for this program.
- Food compost would not be collected curbside, but rather the City of Erie would work with Conservation Compost to identify convenient drop-off locations throughout the city. Conservation Compost would provide several 96-gallon labeled carts at these locations and be responsible for the collection of these totes from the designated locations on, at least, a weekly basis. There is an assumed annual cost of $250,000 for the entire city to have access to this program, a cost that is offset by the savings in tipping fees.
- As the City of Erie recently purchased two new (non-mechanized) trucks, and as plans already in process for the purchase of additional trucks, to mechanize the fleet we focused on retrofitting these vehicles through the purchase of cart tippers at a cost of ~$10,000 each. There are currently a total of 14 trucks in the fleet, which in the phased-in scenario were mechanized at a rate of 3 trucks every two years.
- No savings in personnel are assumed despite the awareness that the mechanized collection process requires less manpower (1-2 laborers per truck rather than the 3 people currently employed), as well as saving on workers' compensation claims. To be conservative with assumed return-on-investment, these savings were not included in this analysis.

1. ALL-AT-ONCE SCENARIO

The conversion of the entire City of Erie (36,000 households) to a cart-based waste and recycling system would require the acquisition of 72,000 carts (one for waste and one for recycling) at a cost of $50 each, amounting to a total $3.6 million (**Table 6**). This cost would be offset through a presumed Recycling Partnership grant in the amount of $15 per cart or $1.08 million, in addition to the $255,000 in state 902 grant funding to the City and County (**Table 6**). Mechanizing the collection process, requires the purchase of cart tippers at an estimated cost of ~$10,000 each for each of the 14 trucks the City already owns and utilizes in waste collection, totaling $140,000 (**Table 6**). Accounting for all these costs, as well as the grant funding offsets, yields a total upfront cost of $2.4 million (**Table 6**).

***Table 6**. Detailed costs associated with the conversion of the City of Erie to a containerized, mechanized waste and recycling system.*

ALL-AT-ONCE SCENARIO			
Households			36,000
Upfront Costs:			**$2,405,000**
	Carts	$3,600,000	
	Cart Tippers	$140,000	
SUBTOTAL		$3,740,000	
LESS:			
	RP grant	$1,080,000	
	902 grants	$255,000	
Annual Compost Collection Costs			$250,000
Annual Cart Replacement Costs			$36,000

The upfront costs of $2.4 million represent the starting point (year 0) for the cost-benefit analysis presented here (**Figure 9; Appendix 3**). For this analysis, recall that, for each of the national-to-local data sources, (**Table 4**) we were able to estimate an associated cost savings for the diversion of food compost and glass recycling from the landfill given the City of Erie tipping fees of $55.90 per ton (**Table 5**; section III.C.). Savings noted in **Table 5** represent annual estimated cost-savings, which act to diminish the upfront costs, but are slightly offset through the costs of the program, namely the $250,000 for composting services through Conservation Compost and the 2% replacement costs for lost, damaged, or stolen carts (**Table 6**). **Figure 9** details the overall return-on-investment (ROI) given the common upfront and annual costs (**Table 6**), but the differing estimated cost savings for the various data sources in **Table 5**. For three of the four scenarios, the program would pay for itself within ~four- to six- years (**Figure 9**). The average ROI of seven-years is shifted upward given the unusual statewide data in comparison to other data sources, which are much more consistent with each other (**Figure 8**). Given this, and the conservative nature of this (albeit simplistic) cost-benefit analysis, an ROI of 7 years seems quite realistic.

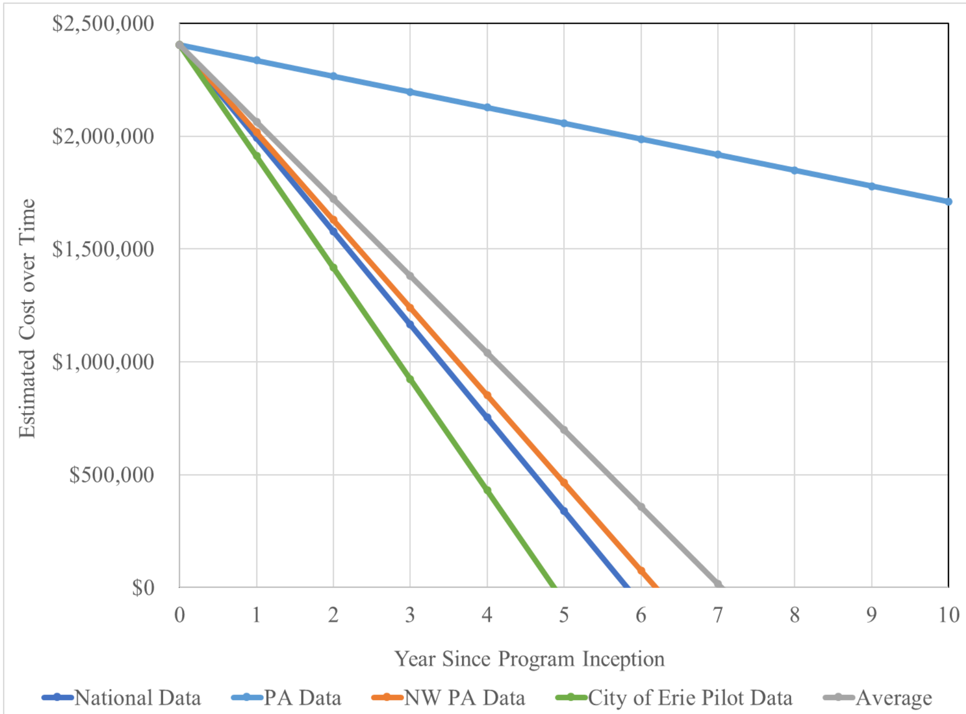

***Figure 9**. Estimated return-on-investment based on estimated savings from waste diversion under a variety of scenarios.*

2. PHASED-IN SCENARIO

Given the significant upfront costs associated with converting the entire City of Erie over to a containerized, mechanized waste and recycling collection process, we also explored the idea of phasing-in this modernization. In this scenario, we envision one-fifth of the city, or 7,200 households, being converted to a containerized system every two years. This dramatically reduces the upfront costs of the program (**Table 7**) as well as allows the City to learn from the process with each phase.

***Table 7**. Detailed costs associated with the phased-in conversion of the City of Erie to a containerized, mechanized waste and recycling system.*

PHASED-IN SCENARIO			
Households			7,200
Upfront Costs:			**$279,000**
	Carts	$720,000	
	Cart Tippers	$30,000	
SUBTOTAL		$750,000	
LESS:			
	RP grant	$216,000	
	902 grants	$255,000	

In a phased-in scenario, the City would need only to purchase ~14,000 carts every other year for a costs of $720,000 (**Table 7**). As with the all-at-once scenario, this cost would be offset through Recycling Partnership ($15 each or $216,000 total), as well as City and County state 902, grant funding (**Table 7**). Rather than purchasing all 14 cart-tippers at once, these would also be phased-in at 3 purchased biannually (**Table 7**). In total the upfront costs would be reduced to ~$280,000 (as compared to the $2.4 million in the all-at-once scenario) (**Table 7**).

These upfront costs represent the starting point (year 0) for the cost-benefit analysis presented here (**Figure 10; Appendix 3**). These upfront costs are associated with one-fifth of the city being converted to a cart-based system, which would be collected through the mechanization of three (of fourteen) city-owned trucks. In this scenario, each odd year since implementation (i.e. years 1, 3, etc.) shows a decrease on the overall estimated costs due to the savings associated with waste diversion from the landfill (**Table 5**), but, in even years, (e.g., 2, 4, 6 and 8) these savings are offset by expanding the program to another fifth of the city (leading to a new round of upfront costs). By year 8, in this scenario, the program has grown to encompass the entire city. The alternating waste-diversion-savings/program-expansion leads to the waviness of the ROI figures (**Figure 10**).

For three of the four data sources, the waste diversion program will pay for itself by the fifth year of the program. This means that the growth of the program to the last two-fifths of the city can be achieved simply through the savings realized by the waste diversion (**Figure 10**). It is only within the statewide data source scenario in which the program does not pay for itself within a ten-year window (**Figure 10**). On average, the program is expected to pay for itself and be cash positive for the City by the seventh year of the program, similar to what was expected in the 'all-at-once-scenario' (**Figure 10**). As we assume that the County and City would continue to obtain state 902 grant funding in an amount similar to what they currently have, the ROI is somewhat faster in this 'phased-in' scenario as compared to the 'all-at-once' scenario above.

While the 'phased-in' scenario does allow the City to learn and adjust through the process of modernizing the waste and recycling collection system, as well as allowing the savings realized through the waste diversion to be used to grow the program, this approach is not without its disadvantages. Converting the city in sections makes the publicity around the program difficult. Additionally, animosity and conspiracy theories are likely to emerge around the selection of which truck routes get phased-in and in what order.

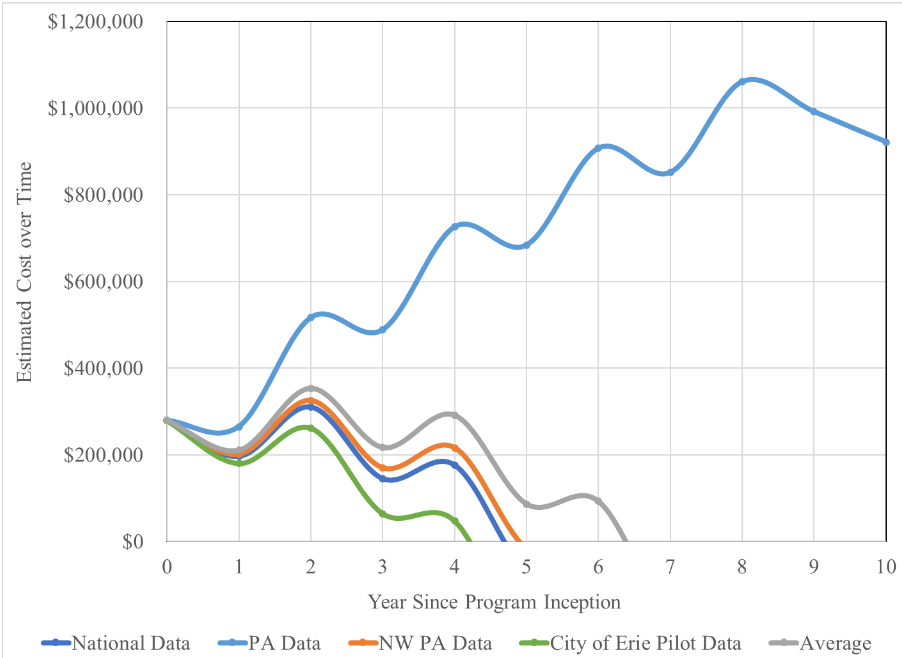

***Figure 10**. Estimated return-on-investment based on estimated savings from a phased-in waste diversion scenario under a variety of data sources.*

A related cost-benefit analysis that only considered the curbside collection of glass recycling (no food compost drop-off) was also conducted (**Appendix 4**). As such a program would not yield a reasonable ROI, it is not presented here (**Appendix 4**).

V. RECOMMENDATIONS

This report reflects the outcome of all project activities, including (1) developing an understanding of the issue and context, through background research, as well as interviews with local officials and pertinent businesses, (2) compiling and obtaining data from local-to-national sources, and (3) pooling this information together to create a cost-benefit analysis for the diversion of glass recycling and food compost from City of Erie landfilled waste.

Based on these activities, the project team unanimously recommends the City of Erie re-envisioning their overall waste & recycling system through:

- Containerizing and mechanizing the collection process;
- Expansion of curbside collection to include glass recycling (alternating weeks); and
- Provision of drop-off food compost locations to divert this waste stream from the landfill.

The preference would be for this vision to be rolled-out citywide, with the possible inclusion of an expanded pilot program in advance of the citywide emergence. The expanded pilot study would aim to encompass more residents and provide a drop-off compost collection site rather than the curbside program offered within the summer 2022 pilot. Such a program would allow additional data collection to be included in the analysis presented here, as well as an opportunity to test some possible marketing messaging.

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APPENDICES

APPENDIX 1

Door-to-Door Advertising Flyer for the Curbside Pilot Program (Summer 2022)

Flyer Front

Flyer Back

APPENDIX 2

Question Lists for Project Partners

<u>City of Erie, Department of Public Works</u>:

<u>Clarification Questions</u>

- What recycling is taken curbside and why?
- What about residential customers who have dumpsters? How do they fit in with your plan?
- How trash and recycling is put out on the curb and why is it that way? Why does it have to be bagged? How is recycling supposed to be out on the curb and why

<u>Questions regarding Truck/Workers</u>

- How many people work on each truck?
- Why do you only have 3 people working per truck?
- Why is your system not mechanized? Why is it thrown in?
- Why does the number of trucks change throughout the year?

<u>Cost</u>

- Breaking down the costs. Ex. How much do you pay your workers? How many workers are required for this task?
- How much are you spending on workers compensation claims
- How much are your tipping costs? Is the cost difference between trash and recycling? Why?

<u>Your ideas</u>

- Do you have any plans on reducing tipping costs?
- Do you have any ideas of different ways to tip into landfills or get around that?
- How to make citizens more aware?

<u>Prism Glass</u>:

<u>Clarification Questions</u>

- How much glass do you recycle on a daily/weekly basis?
- How many drop off locations do you have?
- Where is it currently coming from? Business collaborations, or just drop off?
- What are your means of sorting through different types of glass?
- What are the quantities of glass per household you would expect to get?
- Where is your waste glass going?
- What are your contamination rates?

<u>Your Ideas</u>?

- What are your business plans?
- Are you looking to expand?
- Would you like the city of Erie to adopt a curbside program? How do you see that working?

Conservation Compost:

Clarification Questions

- What is your sorting system to separate compost from other items?
- What do you do with items that don’t belong in the compost pile?
- What characteristics should a location of drop off look like?
- What issues have you run into and how do you deal with them?
- What is the process with the materials you receive and what happens with the compost?
- How often do you pick up compost and why?
- How many communities are you currently working with and how many drop off sites do you have?
- What is your current capacity threshold?
- Why don’t you take Pet Waste?

Cost

- How much are you charging for compost and how much are you spending?
- Travel cost?

Your Ideas

- What are your participation rates? Any ideas on how to increase this?
- Do you plan to grow your company and what are your plans? Looking to hire?
- Concerns about expanding to Erie?
- What would it take to expand? What would you put the money towards?

APPENDIX 3

Detailed Cost-Benefit Analysis Tables

ALL-AT-ONCE SCENARIO					
Year	National Data	PA Data	NW PA Data	City of Erie Pilot Data	Average
0	$2,405,000	$2,405,000	$2,405,000	$2,405,000	$2,405,000
1	$1,991,928	$2,335,390	$2,016,828	$1,911,518	$2,063,916
2	$1,578,856	$2,265,780	$1,628,655	$1,418,037	$1,722,832
3	$1,165,784	$2,196,169	$1,240,483	$924,555	$1,381,748
4	$752,712	$2,126,559	$852,311	$431,074	$1,040,664
5	$339,640	$2,056,949	$464,138	($62,408)	$699,580
6	($73,432)	$1,987,339	$75,966	($555,889)	$358,496
7	($486,504)	$1,917,728	($312,206)	($1,049,371)	$17,412
8	($899,576)	$1,848,118	($700,379)	($1,542,852)	($323,672)
9	($1,312,648)	$1,778,508	($1,088,551)	($2,036,334)	($664,756)
10	($1,725,720)	$1,708,898	($1,476,723)	($2,529,815)	($1,005,840)

PHASED-IN SCENARIO (1/5 of Erie, every 2 years)					
Year	National Data	PA Data	NW PA Data	City of Erie Pilot Data	Average
0	$279,000	$279,000	$279,000	$279,000	$279,000
1	$196,386	$265,078	$201,366	$180,304	$210,783
2	$310,157	$516,234	$325,097	$261,911	$353,350
3	$144,928	$488,390	$169,828	$64,518	$216,916
4	$176,085	$725,624	$215,924	$47,430	$291,266
5	($71,758)	$683,857	($16,979)	($248,659)	$86,615
6	($123,216)	$907,169	($48,517)	($364,445)	$92,748
7	($453,674)	$851,481	($359,055)	($759,230)	($180,119)
8	($587,746)	$1,060,871	($468,227)	($973,711)	($242,203)
9	($1,000,818)	$991,261	($856,400)	($1,467,193)	($583,287)
10	($1,413,890)	$921,650	($1,244,572)	($1,960,674)	($924,371)

APPENDIX 4

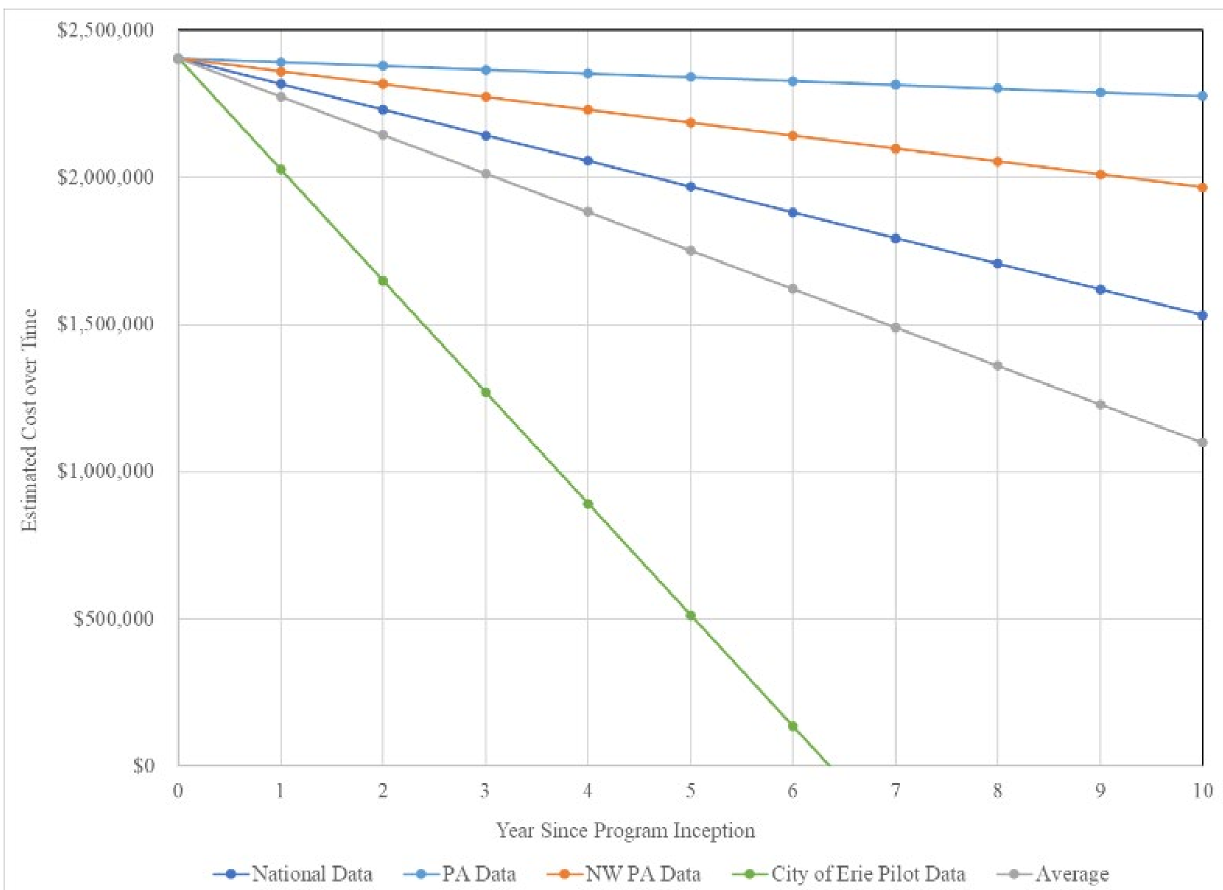
Glass-Only Cost-Benefit Analysis

Following the same assumptions as the cost-benefit analysis in section IV.B., a related analysis was conducted in which only curbside glass recycling was considered, for both scenarios ('all-at-once' and 'phased-in'). Related data tables and figures for this analysis are provided below.

ALL-AT-ONCE

Only for the pilot study data is there a ROI within ten years:

ALL-AT-ONCE SCENARIO: GLASS ONLY					
Year	National Data	PA Data	NW PA Data	City of Erie Pilot Data	Average
0	$2,405,000	$2,405,000	$2,405,000	$2,405,000	$2,405,000
1	$2,317,690	$2,392,225	$2,361,202	$2,026,604	$2,274,430
2	$2,230,381	$2,379,450	$2,317,403	$1,648,207	$2,143,860
3	$2,143,071	$2,366,675	$2,273,605	$1,269,811	$2,013,290
4	$2,055,762	$2,353,899	$2,229,806	$891,414	$1,882,720
5	$1,968,452	$2,341,124	$2,186,008	$513,018	$1,752,151
6	$1,881,143	$2,328,349	$2,142,209	$134,622	$1,621,581
7	$1,793,833	$2,315,574	$2,098,411	($243,775)	$1,491,011
8	$1,706,524	$2,302,799	$2,054,613	($622,171)	$1,360,441
9	$1,619,214	$2,290,024	$2,010,814	($1,000,568)	$1,229,871
10	$1,531,905	$2,277,249	$1,967,016	($1,378,964)	$1,099,301



PHASED-IN

As with the 'All-At-Once' scenario, only given the unusually high data for glass collection as part of the pilot data, is there a ROI within 10 years:

PHASED-IN SCENARIO (1/5 of Erie, every 2 years): GLASS ONLY					
Year	National Data	PA Data	NW PA Data	City of Erie Pilot Data	Average
0	$279,000	$279,000	$279,000	$279,000	$279,000
1	$261,538	$276,445	$270,240	$203,321	$252,886
2	$505,614	$550,335	$531,721	$330,962	$479,658
3	$470,690	$545,225	$514,202	$179,604	$427,430
4	$697,305	$816,560	$766,923	$231,566	$628,088
5	$644,919	$808,895	$740,643	$4,528	$549,746
6	$854,071	$1,077,675	$984,605	($19,189)	$724,290
7	$784,224	$1,067,454	$949,566	($321,906)	$619,834
8	$975,914	$1,333,679	$1,184,768	($421,303)	$768,265
9	$888,605	$1,320,904	$1,140,969	($799,699)	$637,695
10	$801,295	$1,308,129	$1,097,171	($1,178,096)	$507,125