Resilient Recycling and Adapting to a Changing Market

A Fall 2019 Collaborative Report
with Arizona State University's
Project Cities & the City of Glendale

Sustainable Cities Network
Arizona State University

Project Cities

Glendale
ARIZONA

This report represents original work prepared for the City of Glendale by students participating in courses aligned with Arizona State University's Project Cities program. Findings, information, and recommendations are those of students and are not necessarily of Arizona State University. Student reports are not peer reviewed for statistical or computational accuracy, or comprehensively fact-checked, in the same fashion as academic journal articles. Project partners should use care when using student reports as justification for future actions. Text and images contained in this report may not be used without permission from Project Cities.

Cover image:

Steven Russell

Project Cities

ACKNOWLEDGMENTS

City of Glendale

Jerry Weiers, Mayor

Ray Malnar, Vice Mayor

Bart Turner, City Councilmember

Ian Hugh, City Councilmember

Joyce Clark, City Councilmember

Lauren Tolmachoff, City Councilmember

Jamie Aldama, City Councilmember

Kevin Phelps, City Manager

Monica Rabb, Environmental Program Manager

Megan Sheldon, Deputy Director of Water Services

Amanda McKeever, Department Support Services Administrator

Jean Moreno, Executive Officer Strategic Initiatives & Special Projects

Arizona State University (ASU)

Julie Ann Wrigley Global Futures Laboratory

Peter Schlosser, Vice President, Global Futures Laboratory

Christopher Boone, Dean, School of Sustainability

Patricia Reiter, Director of Strategic Initiatives, Global Futures Laboratory

Meredith Simpson, Director of Operations, Global Futures Laboratory

On behalf of the Julie Ann Wrigley Global Futures Laboratory, the Global Institute of Sustainability and Innovation, and the School of Sustainability, we extend a heartfelt thank you to the City of Glendale for enthusiastically engaging with students and faculty throughout the semester. These projects provide valuable real-world experience for our students and we hope that their perspectives shine light on opportunities to continuously improve Glendale's future livelihood and community well-being.

TABLE OF CONTENTS

PART 1
GET ACQUAINTED WITH THE PROJECT

PART 2
SUSTAINABLE WASTE MANAGEMENT PRACTICES

To access the original student reports, additional materials, and resources, visit:
links.asu.edu/PCGlendaleRecycling19F

ABOUT PROJECT CITIES

The ASU Project Cities program uses an innovative, new approach to traditional university-community partnerships. Through a curated relationship over the course of an academic year, selected Community Partners work with Project Cities faculty and students to co-create strategies for better environmental, economic, and social balance in the places we call home. Students from multiple disciplines research difficult challenges chosen by the city and propose innovative sustainable solutions in consultation with city staff. This is a win-win partnership, which also allows students to reinforce classroom learning and practice professional skills in a real-world client-based project. Project Cities is a member of Educational Partnerships for Innovation in Communities Network (EPIC-N), a growing coalition of more than 35 educational institutions partnering with local government agencies across the United States and around the world.

ABOUT SUSTAINABLE CITIES NETWORK

Project Cities is a program of ASU's Sustainable Cities Network. This network was founded in 2008 to support communities in sharing knowledge and coordinating efforts to understand and solve sustainability problems. It is designed to foster partnerships, identify best practices, provide training and information, and connect ASU's research to front-line challenges facing local communities. Network members come from Arizona cities, towns, counties, and Native American communities, and cover a broad range of professional disciplines. Together, these members work to create a more sustainable region and state. In 2012, the network was awarded the Pacific Southwest Region's 2012 Green Government Award by the U.S. EPA for its efforts. For more information, visit *sustainablecities.asu.edu.*

PROJECT CITIES TEAM

Director

Anne Reichman
anne.reichman@asu.edu
480-965-2168

Program Manager

Steven Russell
steven.russell@asu.edu
480-727-2698

Program Assistant

Jordan Sene, Bachelor of Science in Sustainability

Program Assistant

Lindsey Sikorski, Master of Landscape Architecture

ASU Sustainable Cities Network
Arizona State University

Project Cities

Sustainability Through Local Action

projectcities.asu.edu

ABOUT GLENDALE

The City of Glendale is located in Maricopa County, roughly nine miles northwest of Downtown Phoenix. Glendale's population is about 250,000, comprised of diverse communities, including large Hispanic populations, retirement communities, local businesses, and event-goers. Glendale is home to attractions such as the State Farm Stadium, Westgate Entertainment District, the Gila River Arena, Glendale Community College, and the ASU West Campus. With abundant attractions and temperate climate, Glendale has something to offer for its residents and tourists all year round. In August 2016, 71% of voters supported Envision Glendale 2040, a plan that signaled the City's commitment to sustainability. Glendale has chosen to pair up with Project Cities to find new ways to promote sustainability and engage with their communities to better serve their diverse needs.

GLENDALE TEAM

Project Cities Community Liaison

Amanda McKeever, Department Support Services Administrator

Glendale Project Leads

Brent Stoddard, Deputy City Manager

Jean Moreno, Executive Officer Strategic Initiatives & Special Projects

Michelle Woytenko, Director of Field Operations

Amy Moreno, Solid Waste Superintendent

Vern Baker, Facilities Management Superintendent

Jenna Goad, Intergovernmental & Council Services Manager

Glendale
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We improve the lives of the people we serve every day

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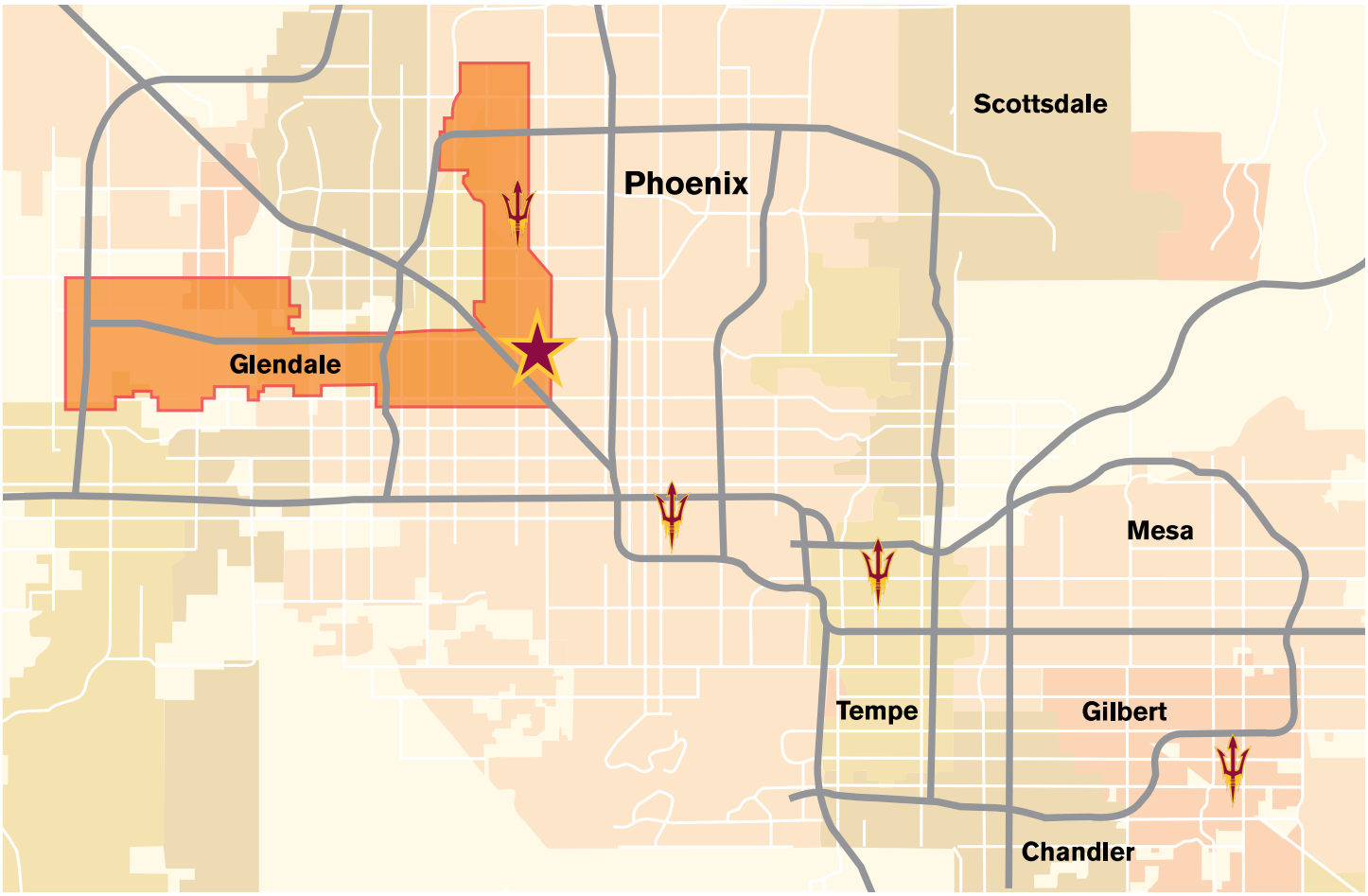
MAP OF GLENDALE & GREATER PHOENIX, ARIZONA



A Message from the City Manager

In 2018, the City of Glendale entered into a partnership with Arizona State University to participate in the Project Cities Program. The goal of this program is to deliver sustainability research, education, and solutions with practical, measurable and meaningful impact to local government. It is a university-community partnership in which ASU students work on research projects that will inform programs or services related to the city's strategic objectives and which have a sustainability component. These projects may include co-creating implementation frameworks or solution pathways for environmental, economic, or social improvement projects all of which will help Glendale prepare for the future.

The leadership team and I can proudly say that ASU's Project Cities program has provided a value-added experience for our staff and fulfilled the need for research on key organizational issues. We have been extremely impressed with the professionalism and relationships our city has developed with the students and ASU's Project Cities staff. They have brought a fresh and unique perspective to challenges that affect our city.

The projects chosen are aligned to the City of Glendale's mission and values and are intended to help advance several of our strategic objectives, initiatives, and existing programs. We specifically sought to gain insights around communication to include social media management and multi-generational engagement, as well as sustainable asset management for the city fleet, facility master plan, and above ground chemical storage tanks.

This valuable experience has been a tremendous learning opportunity for our city as well as for the dedicated students who exhibited their unique skill set. One of the surprising benefits has been for our staff liaisons who were refreshed and invigorated through their interactions with the next generation of leaders, and found the students to be very thoughtful, intelligent, and inquisitive. The opportunity to expose students to potential careers in local government also aids in developing a pipeline of future talent in local government.

In closing, we truly strive to improve the lives of the people we serve every day and these projects have provided us with insights that will help guide actions and future recommendations for our City Council. We are excited about the strategic direction for Glendale and have set the bar high for success. We feel extremely fortunate to have experienced a great partnership through the ASU Project Cities program which will play an integral role in achieving our goals.

Sincerely,

Kevin R. Phelps
City Manager
5850 W. Glendale Avenue, Glendale, AZ 85301
623.930.2870

The following report summarizes and draws highlights from work and research conducted by students in ERM 432/532 Sustainable Solid Waste Management, for the Fall 2019 partnership between ASU's Project Cities and the City of Glendale.

To access the original student reports, additional materials, and resources, visit:

links.asu.edu/PCGlendaleRecycling19F

ASU Sustainable Cities Network
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Project Cities

Sustainability through local action

EXECUTIVE SUMMARY

The global, national, and local recycling industries are continuously shifting and changing alongside new technologies and policies. Municipal recycling services depend on a wide range of factors to run efficiently, including resident participation, facility maintenance, and the market for processed materials. Without strong support, recycling programs can suffer, and in some cases, stop altogether.

For many years, China purchased much of the United States' processed recyclable materials. However, when Operation National Sword was passed by China in January 2018, significant restrictions were placed on imported recyclables. Because most raw recycled materials exported by America were highly contaminated and did not meet China's new import standards, it suddenly became near impossible for American municipalities to continue exporting their material to China, without making significant changes. These circumstances caused a significant global market shift that communities must respond to in order to maintain their recycling services and continue to provide healthy, eco-conscious solid waste management systems for their residents.

The City of Glendale has partnered with ASU to conduct a review of community responses to this global market change and determine potential courses of action for the City and its 250,000 residents. Students in ERM 432/532 Sustainable Solid Waste Management spent the Fall 2019 semester conducting literature reviews on community responses, holding interviews with industry professionals, and identifying the most feasible recommendations for the City to implement within its recycling program. The 26 students divided into four groups, each addressing the project with a specific goal.

Community Responses: To benchmark what other communities have achieved in the wake of Operation National Sword, multiple municipal recycling programs were analyzed, including local Arizona communities and the highly successful recycling program in San Francisco, California. Students in this group conducted interviews with city staff and researched responses to the global market shift to distill recommendations proven successful in other communities.

Public Outreach: A recycling program's success ultimately starts at the source, that is to say with the resident. As a community learns more about what is recyclable within the city's program, it is presumed contamination rates will decrease while collection rates will rise. This group of students focused on identifying effective public outreach methods to better educate Glendale's residents on its recycling program requirements.

Closed Loop Fund and Intergovernmental Agreements: Closed Loop Partners is an investment firm focused on providing municipalities with funds to repair or establish sustainable solid waste management. Intergovernmental agreements are mutually beneficial partnerships that can be established between various entities to address mutual issues. Students researched these two large-scale interventions and outlined potential scenarios that could prove beneficial to Glendale.

Cost-Benefit Analysis: Certain recommendations made by other student groups were analyzed to determine their cost-benefit ratio, an economic tool providing insight on the viability of a project or investment. This group focused on the feasibility of distinct public outreach methods, utilization of the Closed Loop Fund, and a hypothetical Intergovernmental agreement scenario.

GOALS & RECOMMENDATIONS

The goal of this report is to provide feasible recommendations for the City of Glendale's Materials Recovery Facility (MRF) in response to the effects of the global market change surrounding solid waste management. Student research and subsequent recommendations for the City of Glendale focus on existing community responses, public outreach, Intergovernmental agreements, and utilization of the Closed Loop Fund.

Figure 1 *Students visit the Glendale Materials Recovery Facility for a first-hand experience in the recycling management process.*

Figure 2 *ASU students and faculty throw 'forks up at the Glendale Materials Recovery Facility site visit.*

RECOMMENDATIONS FOR SUSTAINABLE RECYCLING MANAGEMENT

Community response benchmarking

Produce and distribute educational outreach flyers or promotional items to inform residents about how to reduce recycling contamination (Real Bird et al., p.24).

Encourage recycling among children by creating a fun character like Peoria's "Javi the Javelina" (Real Bird et al., p.24).

Host recycling competitions at local schools to further involve the youth community in recycling programs (Real Bird et al., p.24).

Develop pilot programs similar to Tempe Zero Waste Days to divert more waste from the Glendale MRF and landfill, or pilot programs that help residents better sort their curbside pickup recyclables to reduce the amount of sorting needed at the Glendale MRF (Real Bird et al., p.24).

Develop an online tool or mobile application to help residents quickly determine if a material is recyclable through their program (Real Bird et al., p.24).

Create a dedicated website to educate the public on recycling issues, similar to Recology, Inc. (Real Bird et al., p.24).

Partner with a company like Renewology, that buys plastics 3-7 to convert to diesel fuel, could generate revenue and divert waste from landfills (Real Bird et al., p.24).

Conduct a recycling rate study to gather information on program changes Glendale residents would like to see (Real Bird et al., p.25).

Provide a rate outline for residents to maintain transparency on rate changes and active services (Real Bird et al., p.25).

Closed Loop Fund and intergovernmental agreements

Procure a zero-interest loan from the Closed Loop Fund, a social impact investment fund, to upgrade the existing Glendale MRF. A partial or full facility upgrade would increase efficiency and, subsequently, commodity sales (Layne et al., p.20 and Bhore et al., p.17).

Utilize the Closed Loop Fund to invest in community education programs, increasing public knowledge on recycling to reduce contamination rates and raise collection rates (Layne et al., p.19).

Arrange an intergovernmental agreement (IGA) between Glendale and several local municipalities for a mutually beneficial program. Specific IGA examples and their respective benefits are provided on pages 80-83 of this report (Layne et al., p.19 and Bhore et al., p.14).

RECOMMENDATIONS FOR SUSTAINABLE RECYCLING MANAGEMENT (CONT'D)

Public outreach
Demonstrate product transformations in recycling advertisements to reiterate the purpose of recycling and instigate a public conversation about the potential behind recycled materials (Foster et al., p.17).
Use advertisements to educate the public on what materials are recyclable through the City's program, such as online videos, bus wraps, postcards, and other marketing channels (Foster et al., p.17).
Replace recycling receptacle lids with blue lids to reduce confusion between the current similar-looking recycling and garbage bins, subsequently reducing contamination (Foster et al., p.18).
Include updated instruction labels on new receptacle lids to reflect currently accepted recyclables in both English and Spanish (Foster et al., p.18).
Provide free recycling magnets to Glendale citizens that educate the public on accepted and unaccepted recyclable materials in both English and Spanish. Provide a simple way for the public to order these magnets, such as a request form on the City of Glendale's website homepage (Foster et al., p.19-20).
Engage with the Glendale School District to provide recycling education to students. School-wide assemblies allow presenters to make an impact on many students at one time and to distribute promotional materials (Foster et al., p.21).
Encourage family volunteers to be present at recycling school assemblies or other outreach events to increase the impact of the presentation, and potentially decreasing the necessity for city employees to run all outreach events as more volunteers become familiar with the content (Foster et al., p.22).
Host classroom workshops to spread information about recycling on a more personal level, providing the opportunity for Glendale employees to encourage and inspire the students to recycle (Foster et al., p.21-22).
Increase the use of recycling advertisements in Spanish, through a variety of channels, including print, radio, social media, and websites (Foster et al., p.23).
Improve the already existing relationships between Glendale solid waste management and local event venues. Larger signage for recycling bins, short infomercials played during events, and venue employee education can all help reduce contamination and raise collection rates of recyclables at local venues (Foster et al., p.25)

RECOMMENDATIONS FOR SUSTAINABLE RECYCLING MANAGEMENT (CONT'D)

Cost-benefit analysis of select recommendations

For comparison, the "business as usual" (BAU) cost-benefit analysis (CBA) for Glendale's current recycling program is 0.21. Programs that raise this number are considered more beneficial than programs that lower this number (Bhore et al., p.4).

A school outreach campaign involving assemblies and distribution of selected promotional materials would cost the City approximately $11,572.78, and potentially generate an estimated revenue of $194,125.73 through high-quality commodity sales, resulting in a CBA of 0.2754. This option raises the BAU CBA and requires minimum investment while reaching a broad audience (Bhore et al., p.6-7, and p.16).

Participating in the two IGAs outlined on pages 80-83 in this report (glass and plastic) could generate revenue for Glendale and extend the life of the city landfill. If Glendale enters into both agreements as detailed later in this report, the resulting CBA equals 0.207, which lowers the BAU CBA (Bhore et al., p.15).

Conduct a case specific economic analysis before proceeding with a Closed Loop Fund (CLF) loan. A $2.5 million investment from the CLF could assist Glendale with a partial Materials Recovery Facility (MRF) upgrade; however due to the below market cost of funds offered by the CLF, it would result in a lower CBA of 0.1723 (Bhore et al., p.11).

Seek potential support through IGAs with outside municipalities before attempting to acquire a significant loan from the Closed Loop Fund, as IGAs have the potential to immediately increase revenue and subsequently raise the CBA (Bhore et al., p.13).

Implement the Blue Lid Initiative by replacing the current recycling bin lids with blue, in-mold labeled lids, at a cost of approximately $841,500. Switching to these lids saves $48 per customer in replacement costs when compared to buying all new blue receptacles (Bhore et al., p.7-8 and p.16).

Pursue public outreach efforts first, to decrease contamination rates at the source via advertising, school outreach, and the Blue Lid Initiative. If these programs prove effective, recycling revenue may increase and can be put toward future facility upgrades (Bhore et al., p.12-13).

FACULTY
AL BROWN

ERM 432/532: SUSTAINABLE SOLID WASTE MANAGEMENT
IRA A. FULTON SCHOOLS OF ENGINEERING
THE POLYTECHNIC SCHOOL

Sustainable Waste Management Practices

Recycling program enhancement planning to adapt to the rapidly evolving recycling market

ACKNOWLEDGMENTS

Faculty

Albert Brown

Teaching Assistant

Sydney Wills

Students

Group 1

Isabella Foster
Damaris Domingo
Hannah Cherry
Mauricio Gonzalez
Zach Grootegoed
Kyle Benson

Group 2

Elias Layne
Jason Potts
Nuipong Penn Sharon
Sarah Lorenzen
Skyler Lee-Eason

Group 3

Grant Real Bird
Catherine Fox
Emilie Smith
Clint Steiner
Kayla Tyre
Bharat Venkatesh
Cameron Wright

Group 4

Safya Bhore
Alonso Haros
Nikhil Patel
Varun Choudhary
Srikanth Baskar
Tim Jones
Adam Rangel

Editors

Lindsey Sikorski
Jordan Sene
Steven Russell
Anne Reichman
Kayla Frost

Glendale Staff Team

Amy Moreno
Amanda McKeever

FOREWORD FROM FACULTY

The 2018 Operation National Sword policy decision by China rejects waste imports that do not meet China's criteria for acceptance. One major criterion is a new, very low tolerance of contamination in the waste that is exported to China. Most existing U.S. material recycling facilities are unable to reduce the level of contamination that was set by China. This policy enactment has caused Glendale, and other cities across the country and globe, to find alternative markets for existing waste streams. Unfortunately, some previously recycled materials (e.g., glass), are now being landfilled by some cities due to lack of buyers.

Each of us must continue to seek useful and environmentally beneficial alternatives to landfilling our solid waste. Each person in the U.S. generates solid waste at a staggering rate approaching 4.5 pounds per day. Much of the waste we generate is potentially recyclable; however, it is often contaminated by food and other residues, which ends up in the landfill after being sorted, even if residents disposed of it in the recycling containers provided by cities. Residents can also contaminate their recyclables by comingling them with non-recyclable items, like tissue paper, at the household level. These pervasive behaviors lower the quality of the potentially recyclable materials each city wishes to divert from their landfills.

In addition to being a local issue, waste diversion from landfills is also a much larger national issue. The recycling industry should ideally be working with cities, counties, and municipalities to develop domestic markets for our U.S. generated recyclables, subsequently lessening the nation's reliance on other countries for material processing. The U.S. should be as independent and responsible as possible for all the wastes we generate, and should not assume other countries will take our wastes, for any reason. The federal government could play an important role in this system transformation by setting new national policy. In the absence of changes to federal solid waste policy, municipalities, product manufacturers, waste generators, and the recycling industry should continue active efforts to divert waste from our landfills. The economic disruption of U.S. recycling systems has created an opportunity for the waste generators and recycling industry to proceed rapidly towards finding solutions that are sustainable and protective of the local and global environment.

INTRODUCTION

For the past 25 years, nearly half the world's recycling was consistently bought and processed by China (Foster et al., p.3). In January of 2018, Operation National Sword was enacted by the Chinese government, which placed heavy restrictions on imported recyclables, changing the global market surrounding solid waste management (Foster et al., p.3). The new policy reduced the permissible recycling contamination level to 0.5%, excluded plastics 3-7, and subsequently decreased China's imports of recyclables by 99% (Real Bird et al., p.3; Foster et al., p.4). This caused a ripple effect, sending most municipalities in the United States scrambling to locate additional recycling markets and to develop a new plan to handle their recycling programs at a reasonable cost.

In this report, student researchers explore the impact of these recycling restrictions with specific reference to Glendale, Arizona. Currently, the City of Glendale's Materials Recovery Facility (MRF) collects about 15,000 tons of material each year and sells processed materials to offset costs (Foster et al., p.4). The Glendale MRF can sort plastics 1-7, but due to lack of buyers, the MRF has eliminated acceptance of plastics 3-7 (Real Bird et al., p.3). The global market change catalyzed by Operation National Sword has resulted in a $1.4 million deficit per year for the City of Glendale (Foster et al., p.4).

Glendale's dedication to maintaining and improving its recycling program in the wake of these restrictions illustrates the City's leadership and commitment to serving its residents. Glendale partnered with ASU Project Cities and students in ERM 432/532: Sustainable Solid Waste Management to identify feasible methods to support and improve the recycling component of the City's solid waste management.

Figure 3 *Students receive a private tour of the Glendale Materials Recovery Facility in October, 2019.*

RESEARCH METHODS

Students began their research with a guided tour of the Glendale Materials Recovery Facility (MRF), in October 2019. During the site visit, students first participated in a workshop delivered by the city's tank management contractor. The students then had a private tour of the facility to get a firmer grasp on the scale of operations. The day ended with a panel discussion of frontline staff and a bus tour into and around the landfill area. This firsthand experience helped frame the students' subsequent research and analysis by providing an enriched understanding of the industry.

Students spent the remainder of the semester conducting literature reviews; interviewing community stakeholders including local municipal employees; and conducting benchmark case studies of community recycling initiatives across the country. Subsequently, student researchers compiled a list of recommendations for Glendale's consideration. Students then performed cost-benefit analyses of select recommendations to determine the financial feasibility of each for the city.

Figure 4 *Students and Glendale city staff on the bus tour of the landfill area.*

BENCHMARKING COMMUNITY RESPONSES

Topic overview

The following benchmark case studies identify a variety of community responses to the impact of Operation National Sword and the subsequent global market shift. This group of students conducted literature reviews, stakeholder interviews, and examined financial principles to distill best practices from existing community standards and responses (Real Bird et al., p.2). Seven local Arizona communities were studied, and a sampling of adaptation success stories was identified based on their recycling program relevance. From this sampling, students inferred a combination of education and community-based recommendations that aim to offset the costs and maintenance of Glendale's recycling program (Real Bird et al., p.2).

Research findings and analysis

Peoria, Arizona (population ~172,259)

According to the Environmental Coordinator for the City of Peoria, **the global recycling market shift has not affected the City of Peoria in recent years**, nor has it taken full effect on neighboring communities (Real Bird et al., p.4). The Environmental Coordinator attributed the lack of impact to the contract Peoria has with the City of Phoenix, who previously bought and continues to purchase recyclables from Peoria despite the new export restrictions (Real Bird et al., p.4).

The City of Peoria cited the following recent actions as successes in improving its recycling program:

1. Educating the public about contamination and proper recycling through flyers (see Figures 5-7), apps, and videos (Real Bird et al., p.4).
2. Hosting recycling competitions in local schools (Real Bird et al., p.4).
3. Having city inspectors leave thank you notes on recycling cans as a form of positive reinforcement (Real Bird et al., p.4).
4. Citing residential misuse of recycling cans, followed by reinspection of the container (Real Bird et al., p.4).

Figure 5 *Top 10 in the Bin flyer, helping educate Peoria residents on acceptable recycling materials with Javi the Javelina, by the City of Peoria.*

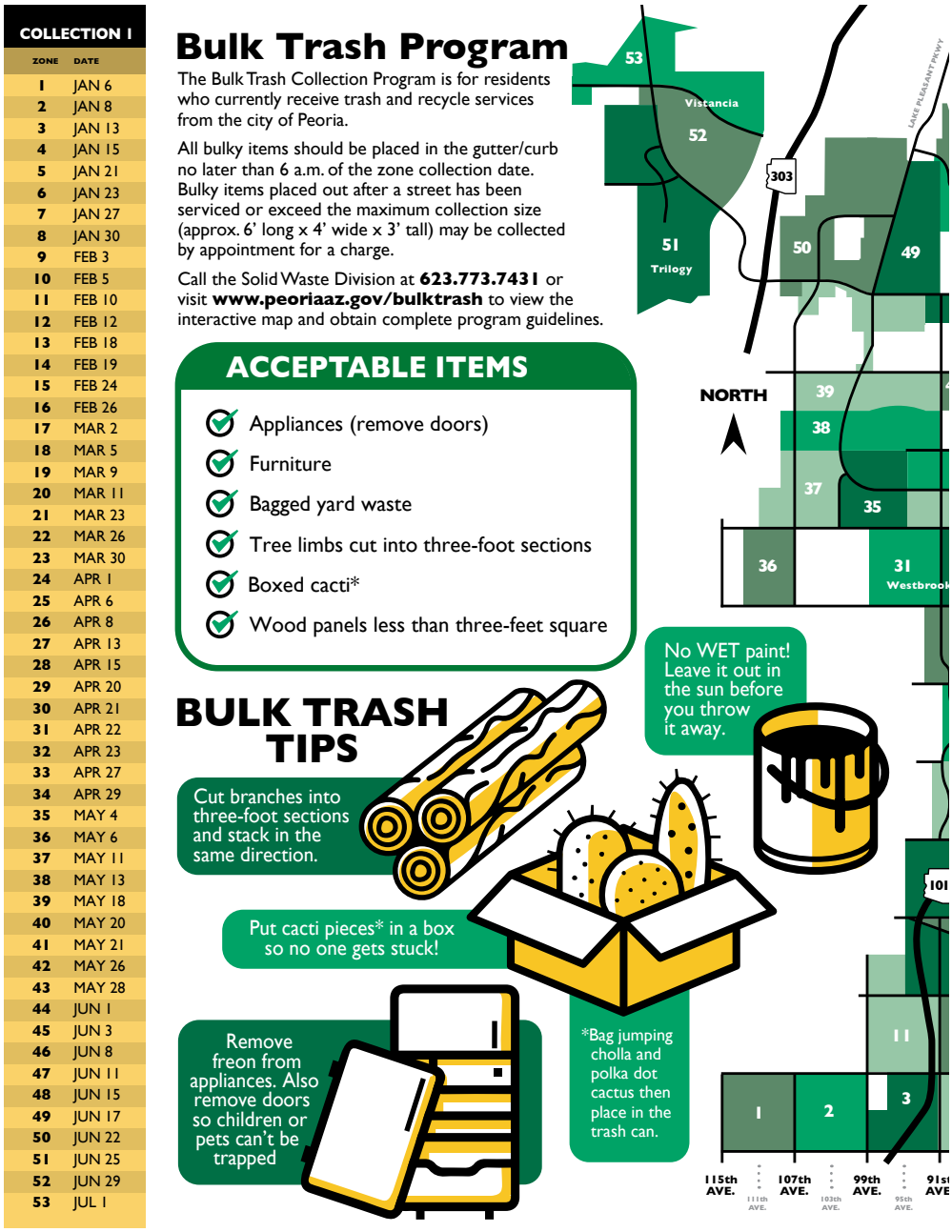


Figure 6 *Helpful page from Peoria's Sustain and Gain 2020 brochure, informing residents on how to handle specific waste needs, by City of Peoria.*

Placement Guidelines (How to Trash Like a Pro)

Place containers out by 6 a.m. Your actual pickup time may change as there is not a scheduled time for each stop due to traffic, weather, road conditions, route changes and truckload capacity.

Containers must be placed behind the residence setback (front of house) by the end of collection day.

Bag and tie all trash, including yard clippings (grass, leaves, etc.) and pet waste.

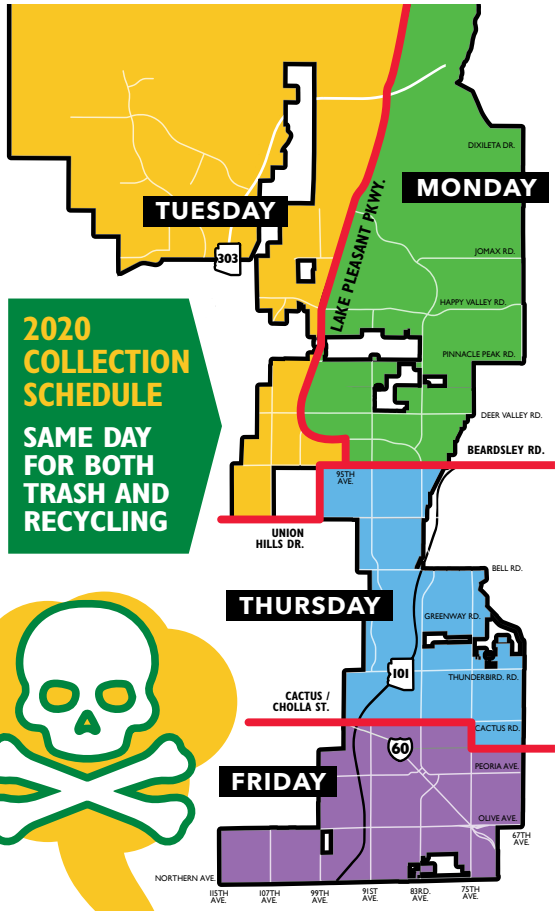
Place containers four feet apart with the rear wheels in the curb area. Make sure containers are not too close to vehicles or other obstacles. If you live on a major street (such as 83rd Avenue), place the containers on the property close to the street or sidewalk.

Grocery bags, bread bags, case overwrap and produce bags can be dropped off at your local grocery store.

Do not put paint or oil in the trash container. Schedule a Household Hazardous Waste pickup (See below).

Do not overfill your containers. The lids should be closed when placed out for collection.

Contact the Solid Waste Division at **623.773.7431** to order an additional trash container or schedule a special haul, if needed.



Household Hazardous Waste (HHW) Pick up by Appointment Only!

The city of Peoria will pick up household hazardous waste from your home. Have a list of your waste items ready before scheduling an appointment by phone at 623.773.7836 or online at **www.peoriaaz.gov/hhw.**

- Put all items in cardboard box clearly marked "HHW."
- Place out by 6 a.m. in front of garage door or carport on your scheduled HHW day.
- Electronics and latex paint are **NOT** acceptable HHW items.

Upcoming HHW Schedule

Scheduling Opens	Collection Dates
Jan. 13	Feb. 4 - 22
Apr. 13	Apr. 22 - May 10
Sept. 14	Sept. 30 - Oct. 17

Figure 7 *Helpful page from Peoria's Sustain and Gain 2020 brochure, informing residents on how to handle specific waste needs, by City of Peoria.*

Editor's Note
The City of Mesa temporarily halted its recycling services in April of 2020, citing financial concerns due to the Coronavirus pandemic.

Mesa, Arizona (population ~500,000)

The City of Mesa is in its fifth year of a ten-year contract with Waste Management, where Mesa is charged a processing fee for recyclables and receives a percentage of revenue generated from its commodity sales (Real Bird et al., p.5). Despite this contract, Mesa has decided to close its recycling drop-off centers due to high costs, falling commodity values, and persistent contamination issues (Real Bird et al., p.5). These challenges put a substantial burden on the City's curbside pickup services.

To reduce contamination rates, Mesa reconfigured its recycling program and now only accepts specific, easy-to-clean items, including beverage containers, glass, metal food cans, paper, and cardboard. Figure 8 shows an informational flyer distributed to Mesa residents, illustrating these changes to accepted recyclables. **By no longer taking difficult-to-clean containers, the City hopes to see a decrease in contamination and an increase in the value of sold commodities** (Real Bird et al., p.5).

Figure 8 *Informational flyer displaying the City of Mesa's accepted recyclables, by City of Mesa.*

Gilbert, Arizona (population ~248,279)

The Town of Gilbert previously sent all recyclables to the Salt River Pima-Maricopa Indian Community (SRP-MIC) Materials Recovery Facility (MRF). However, since a fire destroyed the landfill and damaged adjacent recycling structures in October 2019, the SRP-MIC MRF has been unable to accept Gilbert's recyclables, subsequently suspending the town's program. When Gilbert's recycling program was previously available, the Town **used its website as a primary method of communicating proper recycling behaviors to citizens** (Real Bird et al., p.6). An example of this communication can be seen in Figure 9, an infographic explaining what citizens were able to recycle in Gilbert. Before the enactment of Operation National Sword, the Town's recycling program generated revenue. However, since the global market shift in 2018, the additional costs associated with the recycling program have exceeded the revenue generated from material sales (Real Bird et al., p.6).

Editor's Note
In fiscal year 2018, Gilbert earned $342,000 to sustain the recycling program but in fiscal year 2019, the program cost the town $271,000 (Gilbert Sun News, 2019).

Figure 9 *"Recycling Is Easy...Stick With It!" infographic by Town of Gilbert.*

Phoenix, Arizona (population 1,660,272)

The Phoenix Public Works Department handles solid waste collection and disposal for over 350,000 households, as well as maintenance of city properties and vehicles (Real Bird et al., p.7). Phoenix offers residential curbside pickup of trash, green organics, and recyclables. The City also allows residents to schedule curbside pickup of bulk items, as well as the scheduled pickup of used clothing, shoes, and linens through Goodwill (Real Bird et al., p.8).

Phoenix has two solid waste transfer stations that temporarily stores collected waste before disposal at the State Route 85 Landfill in Buckeye (Real Bird et al., p.8). The North Gateway Transfer Station has an adjoining MRF (Figure 10) where collected materials are hand- and machine- sorted into separate bales depending on the material. **The 27th Avenue Transfer Station features an adjoining composting facility that processes collected organic material into quality compost** (Real Bird et al., p.8).

Figure 10 *Phoenix North Gateway Transfer Station which includes an adjoining MRF.*

The City of Phoenix has a very active solid waste management program that connects with businesses and residents. Some of the program's significant accomplishments include:

- **Reimagine Phoenix**: A comprehensive waste diversion program started in 2013. Reimagine Phoenix has the goal of diverting 40% of waste from the landfill by 2020, and an initiative to reach zero waste by 2050 (Real Bird et al., p.7).
- **Phoenix Green Business Program**: A collaborative effort with businesses that provides employee training and rewards businesses for sustainability initiatives through various benefits and an exclusive recognition event (Real Bird et al., p.7-8).
- **City Outreach Program**: A robust and extensive solid waste education and outreach program featuring school presentations, waste transfer station tours, community meetings, and booths at community events (Real Bird et al., p.8).

Editor's Note
As of 2020, Reimagine Phoenix has reached half of its goal, diverting 20% of waste from the municipal landfill. Visit **www.phoenix.gov/sustainability/goal** for more information.

Due to the minimal number of state-wide recycling grant programs in Arizona, cities are most often responsible for the cost of solid waste management, especially when it comes to recycling programs. Phoenix has been impacted by Operation National Sword, particularly in the area of contamination rates (Real Bird et al., p.9). **Phoenix transfer stations experience a 25% contamination rate of recyclables**, a figure far higher than Mesa's contamination rate of 11% (Real Bird et al., p.9). To decrease the city's contamination rate, Phoenix provides public educational outreach explaining what materials are recyclable through its recycling services. Figure 11 shows an informational graphic used by the City in this outreach campaign.

Figure 11 *Graphic depicting accepted recyclable materials, by City of Phoenix.*

Even though Phoenix has a robust recycling program and multiple processing facilities, it continues to be affected by the global market shift, experiencing increased costs to run its programs and decreased revenue from processed materials (Real Bird et al., p.9). In response, North Gateway Transfer Station recently underwent a $4.5 million facility upgrade (Real Bird et al., p.9). The City of Peoria, a significant partner that sells its materials to Phoenix, contributed $1 million to Phoenix's upgrade program (Real Bird et al., p.9). Closed Loop Partners, a private equity fund that sources money from large corporations like Walmart, invested $3 million in the city's project (Real Bird et al., p.10). **Facility upgrades included advanced screens and plastic sorters, a refurbished pre-sort area, and a system to increase the flow of recyclables for sorting** (Real Bird et al., p.10).

Editor's Note
See the Resource Innovation Campus brochure in the online student content at **links.asu.edu/PCGlendaleRecycling19F.**

Phoenix also partnered with Renewology, a company that buys plastics 3-7 (see Table 1) and converts them into diesel fuels. A proposed site for a Renewlogy location is the Resource Innovation Campus at the 27th Avenue Transfer Station (Real Bird et al., p.24). The amount of targeted plastics diverted from Phoenix annually through this partnership is approximately 6 million pounds (Real Bird et al., p.25). This cooperative effort is another step toward reaching the City's goal of 40% diversion by 2020 (Real Bird et al., p.25).

Editor's Note
While Renewology recycles plastics, the diesel fuel produced still contributes to increased greenhouse gas emissions. This is one example of the complexities of recycling management systems

Recycling status of plastics #3-7		
#3	PVC	Not currently recyclable
#4	LDPE	Not currently recyclable
#5	PP	Rigid containers sized one gallon or larger are currently recyclable
#6	PS	Not currently recyclable
#7	Other	Not currently recyclable

Table 1 *Current recycling status of plastics #3-7, by lessismore.org: Santa Barbara County's Recycling Resource.*

Chandler, Arizona (population ~257,165)

Chandler's Solid Waste Services, part of the Public Works and Utilities Department, maintains several safe and cost-effective programs for recycling, including curbside collection and scheduled bulk collection. The City also features the Recycling-Solid Waste Collection Center (RSWCC), a self-haul, self-unload residential drop-off facility for recycling and trash disposal (Real Bird et al., p.11). The Public Works and Utilities Department operates the RSWCC which is available for use by Chandler residents who pay for the City's solid waste services (Real Bird et al., p.11).

Chandler also keeps its residents informed about recycling services via an extensive public outreach program, including an online blog, which heightens community awareness around the importance of recycling (Real Bird et al., p.12).

Despite their well-established system, the City of Chandler experienced severe ripple effects from Operation National Sword. In 2017, the City received $543,075 for 19,500 tons of recyclables at $25.50 per ton. Chandler expected to earn a profit again in 2018 by selling to United Fibers. The City's plans changed in the wake of the global market shift, and the agreement with United Fibers was voided. Chandler eventually had to pay United Fibers $450,000, or $61 per ton, to handle recyclables that previously generated revenue for the City (Real Bird et al., p.12).

Chandler's recycling program also faces the challenge of contamination issues. During the week of September 8, 2019, the Public Works and Utilities Department reported **22% of materials deposited in residential recycling bins consisted of non-recyclable contaminants**, including plastic wrap, grocery bags, Styrofoam, and padded envelopes. This percentage is considered high by Solid Waste Division Standards (Real Bird et al., p.13). According to Chandler's Communications and Public Affairs office, it is of the utmost importance that residents take care to "recycle right" for the City to continue its collection services (Real Bird et al., p.12). "Recycling right" means the community must understand what items are recyclable or a contaminant, and consistently abide by these guidelines (Real Bird et al., p.12-13). Figure 12 is an example of recycling education information accessible on the City of Chandler's website.

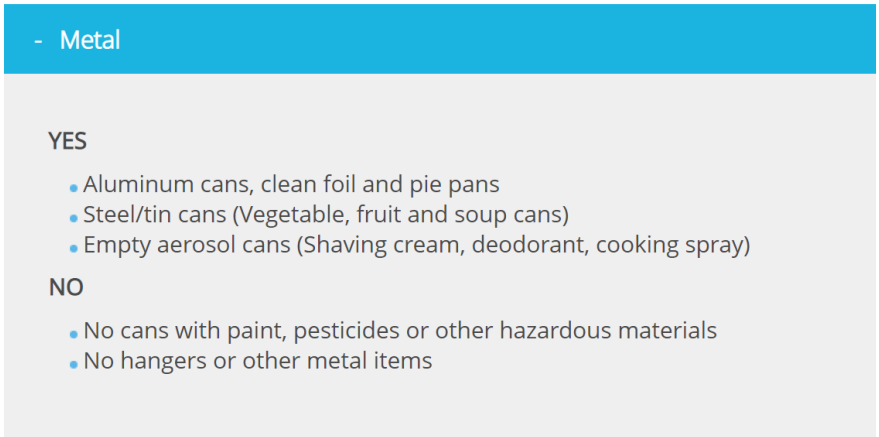


Figure 12 *Online recycling information available on the City of Chandler website, by City of Chandler.*

Tempe, Arizona (population 192,364)

The City of Tempe boasts a robust solid waste management and recycling program. According to the City website, all types of plastic are accepted as recyclables except for thin plastic bags and wraps, due to their ability to damage recycling equipment. Tempe's city website lists the top ten items for curbside recycling pickup as (Real Bird et al., p.15):

- cardboard
- paper
- food boxes
- mail
- beverage cans
- food cans
- glass bottles
- plastic and glass jars
- jugs
- plastic bottles and caps

As a city initiative, Tempe has an overall recycling goal of 25% by 2020 (Real Bird et al., p.15). Tempe gives residents the option to participate in the Save Money and Recycle Tempe (SMART) Initiative. SMART incentivizes residents to save money on their solid waste collection fees by right-sizing their recycling bins to fit their personal needs. This initiative is considered a critical part of reducing waste in Tempe (Real Bird et al., p.16).

Zero Waste Days

Tempe hosts Zero Waste Days in January, April, and November. During these events, residents can drop off a myriad of items and materials for recycling, that would otherwise end up in a landfill. Materials accepted include (Real Bird et al., p.15):

- styrofoam
- electronics
- textiles
- plastic bags and wraps
- paper to be shredded
- building materials
- tires
- clothing
- furniture
- household hazardous waste
- appliances
- scrap metal
- bicycles
- bike repair stands
- bike parts

The wide variety of collected materials is then distributed to entities that recycle or reuse the items or materials. For example, the Trex company in Nevada receives the collected plastic bags, which are recycled into decking, birdhouses, benches, and other products (Real Bird et al., p.15). Stardust Building Supplies, a local nonprofit organization, receives collected building materials to sell at its two valley thrift stores (Real Bird et al., p.15). **These special collection days allow the City of Tempe to increase the types and amount of materials collected while reducing the amount of sorting needed for regular curbside recycling** (Real Bird et al., p.15).

Pilot Programs

Through pilot programs, Tempe works directly with its residents to identify solid waste and recycling solutions that will improve residential services (Real Bird et al., p.16). To get involved, City staff first evaluate neighborhoods where residents are expressing interest in participating in additional solid waste pickup programs. The decision to include an area in a pilot project is based on several factors, including the number of homes seeking participation and the feasibility of subsequent route changes to include said homes (Real Bird et al., p.16). There are currently several pilot programs available for neighborhoods interested in exploring new solid waste management practices and providing feedback to city staff. Green Organics Curbside Collection is one such pilot program that provides residents with a 96-gallon container for organic materials such as tree trimmings or manure (Real Bird et al., p.16). Optional pilot programs such as these allow the City to focus resources on residents interested in improving their community's waste systems (Real Bird et al., p.16).

Solid Waste Study

The City of Tempe practices transparency with its citizens by maintaining the costs of solid waste management, and potential increases, as public knowledge available on the city website at **https://www.tempe.gov/government/municipal-utilities/solid-waste-and-recycling/solid-waste-rate-study** (Figure 13) (Real Bird et al., p.16).

Class	Container Size	JAN FY 2020 Calculated Rate	JAN FY 2020 Current Rates	JAN FY 2020 $ Change	JAN FY 2021 Calculated Rate	JAN FY 2021 $ Change
Residential	48GAL	$ 21.94	$ 20.10	$ 1.84	$ 23.47	$ 1.53
Residential	65GAL	$ 23.96	$ 22.05	$ 1.91	$ 25.63	$ 1.67
Residential	300/96 GAL	$ 27.64	$ 25.60	$ 2.04	$ 29.57	$ 1.93
Residential - Addt'l Can	96GAL	$ 17.08	$ 17.08	$ -	$ 18.28	$ 1.20
Residential Green Organics	96GAL	$ 5.55	$ -	$ 5.55	$ 5.93	$ 0.38

Figure 13 *Tempe public solid waste rate, available online, by City of Tempe, retrieved fall 2019.*

Solid Waste Studies are a critical aspect of this transparency. With the help of a third-party service, Tempe conducts rate adjustment studies to balance City operations and services in an informed manner (Real Bird et al., p.16). The rate adjustment studies provide insight on factors such as changing collection days to improve route efficiency, targeting neighborhoods with more recycling bins, and increasing residential recycling rates to offset costs (Real Bird et al., p.16). **These public studies, in conjunction with other city programs described above, help Tempe extend the life of its landfill and reach the targeted goal of 40% diversion by the end of 2020** (Real Bird et al., p.16).

Figure 14 *Announcement for the 2019 Solid Waste Rate Study, by City of Tempe.*

Scottsdale, Arizona (population ~300,000)

Similar to the Town of Gilbert, the City of Scottsdale previously sent their recycling and solid waste to the now-defunct Salt River Pima Maricopa Indian Community (SRP-MIC) Materials Recovery Facility (MRF) and landfill (Real Bird et al., p.17). The City's contract with the SRP-MIC MRF was set to expire in 2032; however, since services were rendered unavailable in 2019 due to the previously mentioned fire damage, Scottsdale's solid waste management and collection services may need to change (Real Bird et al., p.17). While it was running, the Salt River Landfill and MRF reported no operational changes ordered by their governing corporation, Republic Services, in response to Operation National Sword and the consequent global market change.

Phoenix Waste Management Open

Setting a standard for sustainability in sporting events, The Phoenix Open, hosted in Scottsdale, has earned the title of "The Greenest Show on Grass" (Real Bird et al., p.20). Waste Management became the title sponsor for the Phoenix Open in 2009 and enacted the Zero Waste Challenge, a promise that zero waste from the Open would be sent to a landfill (Real Bird et al., p.20). Seemingly impossible, the challenge has been repeatedly achieved since 2013 by diverting 100% of waste generated by over 655,000 fans, players, and sponsors (Real Bird et al., p.20). **Waste Management worked with The Thunderbirds, sponsors, and vendors to ensure all event materials used are compostable, recyclable, reusable, or recoverable for energy** (Real Bird et al., p.20). The waste diversion was calculated by measuring the different streams of waste exiting the venue. Table 2 illustrates a breakdown of the waste from the 2017 Waste Management Phoenix Open (WMPO).

2017 Phoenix Waste Management Open waste stream diversion rates

Percent of waste stream	*Method of diversion*
50%	Recycled
34%	Composted
14%	Converted to energy
2%	Donated

Table 2 *2017 WMPO waste stream diversions.*

These diversion rate claims are validated by Laboratories Environment Inc., who has been working with the WMPO since 2013 (Real Bird et al., p.21). In 2017, 100% of WMPO waste was diverted from landfill operations with 13.9% incineration energy recovery (Real Bird et al., p.21).

San Francisco, California (population ~885,000)

Recology Inc.

Editor's Note
Recology Inc.'s website offers valuable inspiration for Glendale, providing a robust model of how to display municipal waste management tools to the public. By incorporating easy to navigate online information like Recology, Glendale could spread recycling awareness to its residents and potentially reduce recycling contamination rates.

San Francisco's recycling infrastructure and processes have fared well based on its response to the global market shift (Real Bird et al., p.18). Solid waste management in San Francisco is reliant on Recology Inc., the exclusive waste collector and processor in the Bay Area (Real Bird et al., p.18). A long-term contract exists between the City and Recology Inc., where San Francisco sets and approves collection rates, provides research, oversight, and outreach. At the same time, Recology Inc. develops waste management infrastructure, collects, and processes waste (Real Bird et al., p.18). A useful facet of Recology Inc. is its robust, online educational tools and public outreach programs. These resources help San Francisco residents make informed decisions about solid waste and recycling that is specific to their city by listing accepted materials, instructions on how to properly clean recyclables and answering common recycling program questions (Real Bird et al., p.18). The website also features information geared toward becoming a more responsible consumer, like paying attention to the amount of packaging waste associated with a product (Real Bird et al., p.18). Figure 15 is an example of one of these educational tools. In this case, an online application called "WhatBin," helps users determine the correct collection bin for a specific material (Real Bird et al., p.18).

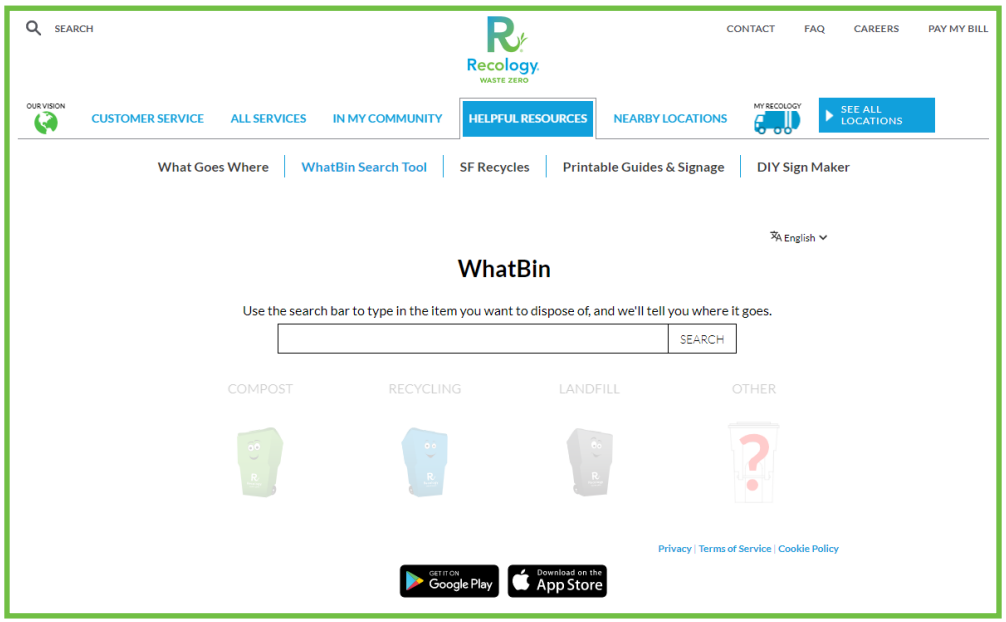


Figure 15 *Recology's online "WhatBin" application on Recology.com.*

Each day in San Francisco, 500-600 tons of recyclables are collected by Recology Inc., with a 4-5% contamination rate of its processed bales (Real Bird et al., p.19). While dramatically lower than the reported 25% contamination rate in nearby Sacramento, California, this level of contamination is still too high to export materials to China after the enactment of Operation National Sword (Real Bird et al., p.19). **To continue lowering contamination rates, it is imperative to focus on improving recycling practices of City residents** (Real Bird et al., p.19).

California Refuse and Recycling Council

The California Refuse and Recycling Council (CRRC) is an organization that encourages ethical business practices in the waste management industry and coordinates with all agencies of government from city to federal levels to sustain waste management standards. The CRRC website may prove exceptionally useful to the City of Glendale. A plethora of resources and materials are available under the Media Response to Recycling Market Crisis section (Real Bird et al., p.19). These materials can be used to educate residents about the financial impacts of the recycling global market change and the likelihood of necessary rate increases. Local government employees may also find the materials useful to help explain the need to incentivize domestic recycling infrastructure development (Real Bird et al., p.20).

The CRRC website is updated almost daily with new developments on the global recycling market (Real Bird et al., p.21). Some of the latest news is particularly applicable to the City of Glendale and could benefit the City's MRF. For example, a story on the Media Response page talks about a recently introduced industry-backed bill pushing recycling grant programs from resource-recycling.com (Real Bird et al., p.21). The article also mentions the RECOVER Act, a program that provides funds for recycling infrastructure, outreach programs, and education (Real Bird et al., p.21). The legislation before Congress could provide up to $500 million in matching grants to state and local governments for recycling support (Real Bird et al., p.21). Figure 16, shared by the Plastics Industry Association, explains the details on the RECOVER Act's funding and support (Real Bird et al., p.21).

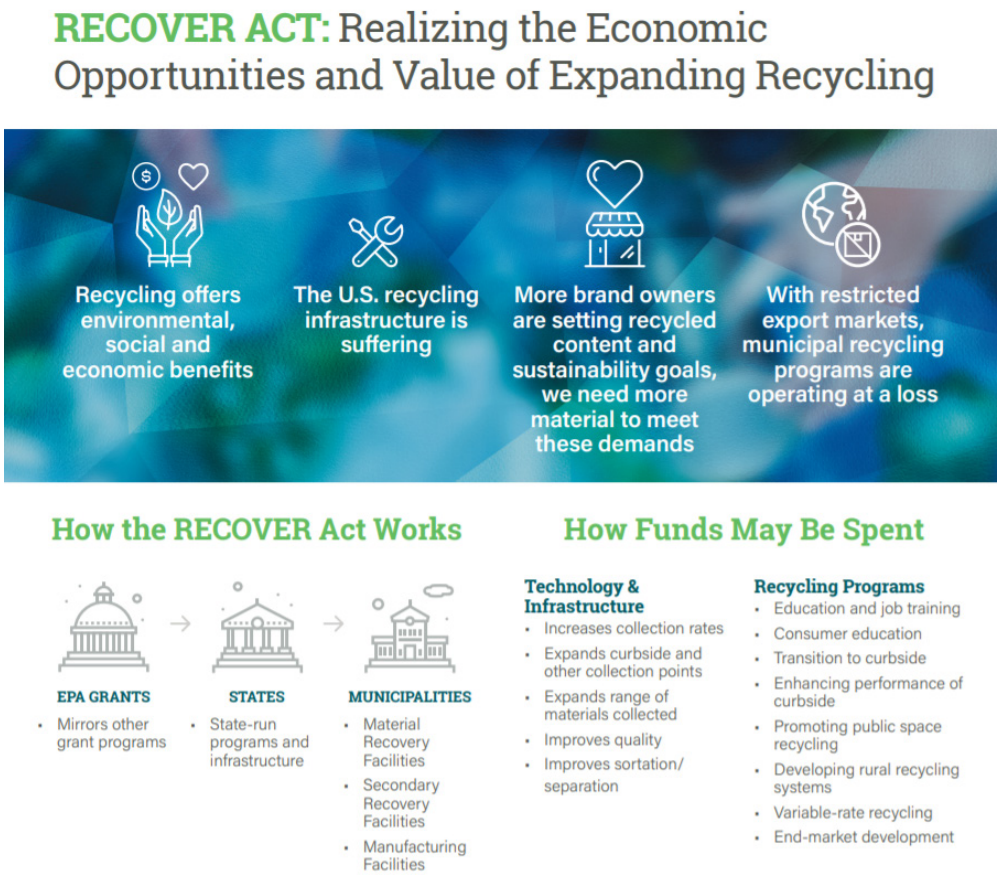


Figure 16 *Information shared in support of the RECOVER Act, by The Plastics Industry Association.*

Key findings from community response benchmarking

- Communities that took the initiative to reduce contamination rates in recycling processes appeared to have fared the best in the aftermath of the global market shift (Real Bird et al., p.22).
- Notably impactful responses include Phoenix's community partnerships, Tempe's Zero Waste Days and Pilot Programs, San Francisco's online resources and collaboration with Recology Inc., and the Waste Management Phoenix Open's complete waste diversion method (Real Bird et al., p.22).
- Educating the public about recycling, even with methods as simple as promotional flyers, appear to be a driving force for increased collections and decreased contamination rates (Real Bird et al., p.23).

Recommendations from community response benchmarking

- Produce and distribute educational outreach flyers or promotional items to inform residents about how to reduce recycling contamination (Real Bird et al., p.24).
- Develop an online tool or mobile application to help residents quickly determine if a material is recyclable through their program (Real Bird et al., p.24).
- Create a dedicated website to educate the public on recycling issues, similar to Recology, Inc. (Real Bird et al., p.24).
- Encourage recycling among children by creating a fun character to use in promotional items and advertisements like Peoria's "Javi the Javelina", seen on page 23 (Real Bird et al., p.24).
- Host recycling competitions at local schools to further involve the youth community in recycling programs and familiarize them with recycling principles (Real Bird et al., p.24).
- Develop pilot programs similar to Tempe Zero Waste Days to divert more waste from the Glendale MRF and landfill (Real Bird et al., p.24).
- Develop pilot programs that help residents better sort their curbside pickup recyclables to reduce the amount of sorting necessary at the Glendale MRF. For example, the City could provide multiple recycling bins for residents to keep plastics separate from paper, automatically reducing sortation needs at the pickup source. If a pilot program proves successful, the City may consider implementing additional pickup routes (Real Bird et al., p.24).
- Partner with a company like Renewology, that buys plastics 3-7 to convert to diesel fuel, which could generate revenue and divert waste from landfills (Real Bird et al., p.24).
- Conduct a recycling rate study to gather information on program changes Glendale residents would like to see. Consider including questions such as, "Would you use a website to determine what bin to place certain materials in?" or "Would you approve a rate increase for your recycling?" (Real Bird et al., p.25).
- Provide a public residential rate outline to maintain transparency on rate changes and active services (Real Bird et al., p.25).

PUBLIC OUTREACH

Topic overview

This section of the report summarizes methods aimed at increasing public participation in recycling and landfill diversion, and improvement of the quality of recovered materials (Foster et al., p.3). Overarching topics to be reviewed include marketing, online outreach, school system outreach, the Blue Lid Initiative, bilingual outreach, and event venue collaboration. Students investigated these topics through relevant case studies and other supporting materials. Student researchers focused on public outreach methods and examples that could be feasibly implemented by the City of Glendale.

Editor's Note

Given that many schools are practicing distance learning due to COVID-19 at the time of this report's release, this recommendation could also be accomplished through online informational webinars and social media outreach.

Research findings and analysis

Marketing and advertising

Product Transformation Salience Study

A six-part study conducted by researchers at Pennsylvania State University (Penn State) and Boston College found that **utilizing product transformation salience in advertisements and marketing could increase recycling participation rates** (Foster et al., p.4).

Editor's Note

Product transformation salience refers to the knowledge of how recyclables can be turned into new products, such as Rothy's footwear using recycled water bottles in their product materials.

Perhaps most notably, **the first study in the series showed a 30% increase in recycling rates** after participants were exposed to advertisements for products made from recycled plastic (Foster et al., p.4). This increase was present regardless of whether the final transformed products were shown visually or simply explained in the form of an advertisement (Foster et al., p.4). These same findings were also supported in later parts of the study.

Part five of the study consisted of a field test conducted at Penn State during a home football game and tailgate event. Certain areas of the event displayed transformed recyclable materials near a recycling bin.

These receptacles yielded a 40% increase in recycling rates over control areas that did not display product transformation messaging (Foster et al., p.5). The study results provide evidence to support the importance of educating people on the transformation process of recyclable materials and why it is important to recycle materials correctly (Foster et al., p.5).

Recycle This, Not That! Awareness Campaign

In 2016 the "Recycle This, Not That!" awareness campaign from the City of Miami won the Solid Waste Association of North America's (SWANA) Award of Excellence, which recognizes excellence in solid waste programs and facilities across the country. Focusing on residential areas of Miami, Florida, the campaign had a goal of achieving a 5% reduction in recycling contamination, followed by an effort to continue lowering the percentage once it was achieved (Foster et al., p.5). The City started by educating their residents on recycling issues (Foster et al., p.5).

Figure 17 *"Recycle This, Not That!" advertisement, by Miami-Dade County.*

A prevalent recycling problem in Miami was contamination by non-recyclable materials (Foster et al., p.5). Throughout the education campaign, public outreach was prioritized via online videos and social media, with the intent that the information would be further shared by viewers (Foster et al., p.5). This tactic was deemed successful, with many people expressing appreciation for the information. The main video on the City of Miami's website received 200,000 clicks each month, and videos shared to Facebook had 187,000 views at the time of this report (Foster et al., p.5).

Miami-Dade County achieved its goal of a 5% decrease in recycling contamination after just one year of the campaign's release. It mainly credited the campaign's success to the extensive online outreach (Foster et al., p.5).

Miami-Dade County had a promotional campaign budget of $248,000 throughout 2016, equating to a cost of $0.78 per household (Foster et al., p.11). This budget served a much larger population than Glendale's, implying that a similar campaign may cost less if implemented in the City of Glendale. An awareness campaign similar to "Recycle This, Not That!" could provide a better cost to benefit ratio than replacing machinery at the current Glendale MRF (Foster et al., p.12).

"Education is a much easier solution than adding new processing equipment to the City's MRF, costing less and still yielding noticeable results" (Foster et al., p.17).

Recycling infographic magnets

Displaying vital information such as pickup schedules, contact info, and recycling material specifications on a common household product like a refrigerator magnet could consistently help residents "recycle right". The Glendale MRF has reported demand from its residents for informational recycling magnets (Foster et al., p.12). **Most contamination at the Glendale MRF stems from a lack of public knowledge of what materials are currently accepted for recycling at their facility** (Foster et al., p.12).

Easily accessible educational materials like printed magnets could prove highly useful in amplifying the city's recyclables list and message. According to a study conducted by the Austin Resource Recovery in Austin, Texas, residents can be categorized into five types of recyclers based on their recycling abilities, knowledge, and motivation, displayed in Table 3 on the following page.

Editor's Note
View the original Austin Resource Recovery report in the online student content, at **links.asu.edu/PCGlendaleRecycling19F**.

The Analyst recycler lacks an understanding of why their contributions to the city's recycling program matter, and The Well-Intentioned recycler needs additional information on what are the accepted recycling materials (Foster et al., p.12). Educational materials would be an effective way to cater to these different "types" of residential recyclers. (Foster et al., p.13).

Austin Resource Recovery types of recyclers	
Name	***Description***
The Analyst	Not recycling at home, but will recycle if: (1) social pressure is applied and a clear system is present or (2) if they are convinced by the personal impact, environmental impact, or impact on their city.
The Enthusiast	Recycles consistently at home and likely to make trips to Recycle Reuse Drop Off center or auxiliary locations. Considers themselves a good steward of the environment. Has high potential to teach and inspire others to recycle.
Under Pressure	In general doesn't contribute to single stream recycling but will donate old items or collect cans to help others. If basic needs are met, has potential to recycle given education and tools.
Lone Recycler	If on their own, would recycle really well, but living with other housemates who do not recycle, they feel alone in the fight. They struggle to set up or maintain recycling systems from lack of support.
The Well-Intentioned	Not recycling at their full potential due to gaps in knowledge and systems. Motivated by visions of a better future and goals of fitting into a progressive society.

Table 3 *Types of recyclers, by Austin Resource Recovery.*

Another study in Massachusetts demonstrated recycling contamination rates shrank after residents received educational materials including magnets in the mail explaining what materials are recyclable through their program (Foster et al., p.13).

Custom magnets can be a low-cost educational tool. Prices will vary based on the manufacturer. For example, 1,000 postcard-sized magnets ordered from Vistaprint cost only $263.99 (Foster et al., p.13). There would also be costs incurred to distribute magnets to residents by mail, or volunteers could hand-deliver them, or they can be shared by city staff at public outreach events to avoid additional costs (Foster et al., p.13). Figures 18 and 19 shows some examples of informational magnets given out by other counties.

Figure 18 *Monroe County, New York recycling magnet, from Monroe County's Recycle Right Campaign.*

Figure 19 *Pierce County, Washington recycling magnet/poster from Pierce County Recycling Resources.*

Web and social media

The use of smartphones and social media are ubiquitous in today's culture and have paved the way for increased, fast communication. Utilizing this technology could prove beneficial for municipal solid waste management and local recycling programs (Foster et al., p.9). Social media platforms such as Facebook and Twitter are prime tools for communicating ideas across a broad audience and could act as a more efficient and cost-effective means of communication (Foster et al., p.9). For example, instead of passing out informational flyers or hosting a town hall meeting, a city could promote recycling events and share real-time data with the public via social media to widely spread knowledge around waste management and recycling programs (Foster et al., p.9). By using social media platforms to promote events and real-time data for the public, the City of Glendale could bridge the gap between residents, city staff, and policymakers, providing the community with an active voice in the recycling program (Foster et al., p.9).

The increased use of social media channels could result in higher participation rates from younger community members; however, to ensure the ongoing attention of this group, these channels must remain updated and accurate. If an account falls out of date or reports inaccuracies, it could lead to public distrust and loss of engagement (Foster et al., p.9). For example the District of Columbia's Public Works Department instituted its "Waste Less, Recycling More" campaign and successfully used social media platforms to support and increase its marketing efforts. As a result, DC noticed a significant decrease in recycling contamination rates and an increase in viable collected materials by 200 tons (Foster et al., p.10). This social media presence bolsters the department's other digital marketing efforts, public advertisements, and informational flyers, all of which utilize a standardized messaging system to prevent confusion (Foster et al., p.10).

Editor's Note
The 200 ton increase in viable collected materials stems from a notable 8% drop in contamination and 9.5% increase in collected recycling.

Blue Lid Initiative

As seen in Figure 20, Glendale's residential recycling and trash bins are very similar in color and style, making it difficult to distinguish between the containers, potentially leading to higher contamination rates (Foster et al., p.6). Making the designated recycling bin more distinct could help to increase recycling participation and decrease contamination rates (Foster et al., p.6).

Figure 20 *City of Glendale recycling and trash receptacles.*

Purchasing a new colored recycle bin for all residents would be costly; however, replacing only the lid with a bright, identifiable blue colored lid would be less than half the cost of replacing the entire bin and still accomplish the goal of changing its appearance (Foster et al., p.12). Imprinting recycling instructions on the new lids is also more cost-effective than purchasing an entirely new bin (Foster et al., p.12). Providing new lids like the Town of Fountain Hills did (see Figure 21) would also require less production time than a complete bin replacement (Foster et al., p.19).

Figure 21 *The Town of Fountain Hills, AZ trash and recycling receptacles, featuring a distinctly noticeable blue lid on the recycling bin.*

According to a study conducted by the University of California, Los Angeles, a two-sided waste receptacle successfully increased community recycling habits (Foster et al., p.6). These findings support the idea that changing the appearance of Glendale's recycling bins could spur residents to recycle correctly, increasing the amount of materials recycled (Foster et al., p.6).

"BinBisa created the two-sided container to keep solid waste on one side, and recyclables on the other. The result was an increase in recycling specific items ranging from 23% to 258% higher depending on the material, and 88% of the community reporting their recycling habits had changed" (Foster et al., p.6).

Figure 22 *One available style of BinBisa receptacle, by BinBisa via Earth911.*

School system outreach

Educational programs could prove to be a great benefit to the City of Glendale (Foster et al., p.6). In a survey of 2,000 people across the United States, Covanta Waste Management reported the following statistics about the public and their understanding of recycling:

- 53% of respondents believed greasy pizza boxes are recyclable
- 68% of respondents believed plastic utensils are recyclable
- 22% reported they did not have enough information about recycling
- 18% reported not understanding what can and cannot be recycled (Layne et al., p.7)

These staggering survey results help illustrate how vital public outreach is to a successful recycling program. A study conducted in Snohomish County, Washington, tested the effectiveness of recycling awareness in their public-school system. Through a partnership with Waste Management, Snohomish County integrated programs into their elementary and middle schools to improve the understanding of recycling in their community. The program utilized school assemblies, workshops in classrooms, action projects, and outreach to student families (Foster et al., p.7).

The results of the Snohomish County study were promising, indicating:

- 95% of students reported learning something new
- 82% of teachers reported recycling in their classrooms improved
- 99% of teachers reported the program encouraged students to share their new recycling knowledge with others
- 95% of students reported they planned to recycle more in the future (Foster et al., p.7).

This study demonstrates the positive influence recycling education can have throughout a school system and the community overall.

"Teaching sustainable practices to students at a young age creates sustainable habits now that can continue throughout their future" (Foster et al., p.7).

School system outreach could be approached in a variety of ways, depending on budget and resources. The Snohomish County program utilized multiple outreach methods, including assemblies, classroom workshops, facilitating family outreach, technical assistance, and action projects (Foster et al., p.13). This robust program was spread throughout the county's 130,000 residents, reaching a final cost of $1.61 per household (Foster et al., p.13). While this extensive effort resulted in promising results, similar outcomes could be achieved with more straightforward, less expensive projects. A significant portion of the cost of educational outreach is attributed to time spent by city employees visiting classrooms and the associated travel costs (Foster et al., p.13). An alternative option to reduce costs would be to recruit volunteers, such as parents or school staff, to conduct classroom presentations and projects, effectively reducing the number of city staff needed for school activities (Foster et al., p.13).

Editor's Note

Partnering with local nonprofits that provide recycling education, such as Keep America Beautiful programs, could also accomplish educational outreach goals. For Glendale specifically, Keep Phoenix Beautiful **(https://keepphxbeautiful.org/)** may be a possible partner.

Material costs for educational supplies could be reduced to reach a lower final budget. When city staff visits a school, a myriad of teaching methods can be utilized, such as educational videos, games, awarding prizes, or distributing informational materials like flyers, brochures, and magnets (Foster et al., p.14). Many of these items are low-cost items. For example, providing a classroom of 30 students with an informational flyer would only be about $3.75 (Foster et al., p.14). Material costs could also be eliminated if visiting city staff focused their outreach on presentations and videos (Foster et al., p.14). Furthermore, using ready-made public materials like those available on Waste Management's website would reduce the preparation time of city employees (Foster et al., p.14).

Bilingual recycling materials

At the time of this report, Glendale's population was 37.3% Hispanic, and Spanish is the most common non-English spoken language in the City (Foster et al., p.8). According to a 2014 study conducted by Cone Communications, the strongest proponents of recycling are children and the Hispanic community (Foster et al., p.8). The survey reported the following highlights:

- 53% of the Hispanic population recycles at home, higher than the average of 46% (Foster et al., p.8).
- The Hispanic community was more likely (26% vs 20% U.S. average) to seek further information about their recycling programs to ensure items were disposed of in the appropriate containers (Foster et al., p.8).
- The Hispanic community was less likely (20% vs 26% U.S. average) to dispose of items in a recycling bin if there was any uncertainty regarding its recyclability (Foster et al., p.8).
- The combination of these factors contributed to reduced recycling contamination rates (Foster et al., p.8).

This study emphasizes the importance of communicating recycling information with the Hispanic community in Glendale. For bilingual outreach to be successful, information needs to be available in Spanish, but also for it to be culturally relevant and present in multiple media outlets like radio, television, print, websites, and social media (Foster et al., p.8). An example of this framework in action is the "Recicla Mas" campaign from King County, Washington's Solid Waste Division Program. The campaign established Spanish-language media partnerships, language tools, and materials for their Spanish speaking residents (Foster et al., p.8). In 2013 King County, in a partnership with Snohomish County, also developed a targeted pilot program focused on outreach to Hispanic multi-family housing, which ultimately increased recycling participation by 24%, and collected materials by volume by 80% (Foster et al., p.8). During a follow-up, residents responded positively upon receiving bilingual informational materials (Foster et al., p.24). Considering Glendale's large Hispanic population, these case studies demonstrate the potential for a high return on investment in bilingual recycling outreach programs (Foster et al., p.9).

The cost of printing bilingual materials is generally inexpensive and accessible (Foster et al., p.14). Professional translation costs vary from $0.13 to $0.21 per word and can be used to "transcreate" rather than translate (Foster et al., p.14).

"Transcreation goes beyond word-for-word translation, where context and meaning can be lost, and instead focuses on conveying the same message while maintaining the intent, tone, and context of the original language. It is regarded as a cost-effective means for cities to effectively reach a wider audience with their public information" (Foster et al., p.15).

Incorporating these translations on recycling bin lids could be an inexpensive and effective way to enhance bilingual outreach (Foster et al., p.15). Providing translated educational materials for use in schools may be more difficult. However, it would still provide an effective means of outreach as students take their materials home and share with their families, increasing recycling information throughout the bilingual community (Foster et al., p.15). Figure 23 lists "Seven steps to effective multicultural outreach", including transcreation, which was referenced by King County, Washington when developing their recycling program.

Sidebar – Seven steps to effective multicultural outreach

Developing an inclusive and effective program for a multicultural audience requires approaching the work in new ways. Here are seven steps for taking a more culturally competent approach in project development:

1) Choose your audience groups

- Look at demographic data about the group(s) that will be engaged: culture, language, race and housing type.
- Analyze, with community members' involvement, which communities live in your city, county or region and ask why these groups have or have not yet been served by programs.
- Identify the barriers and motivators for the audience group you wish to engage so messages can be tailored to effectively reach them. Tackle one barrier and motivator at a time.

2) Build a stakeholder group

- Invite community members or community-owned consulting firms to assist. Involve audience group members in the planning and design of the program.
- Create representative stakeholder groups to advise, plan and implement the program. Investing in this manner, creates ownership of the program, resulting in deeper, more resonant behavior change.
- Invite community or faith-based organizations to collaborate and together find ways to effectively engage the community in recycling education.
- Hire community members, influencers and staff to be part of the team.
- Include technical experts, city, county or hauler partners.

3) "Transcreate"

- Find out what resonates in the audience group you are trying to reach. Consider imagery, content and format. "Transcreate," not just translate, messaging. Understanding the context of your message, both visually and with content, is essential for effective communication and engagement.
- Incorporate community feedback, in all messages, images, content and communication formats you intend to use.

4) Test assumptions

- Test assumptions about what strategies or messages will be effective through a "usability test" to get feedback from members of the intended audience.
- Build time into planning to take a step back and ask questions. Be prepared to make changes to approaches based on input from stakeholder groups or findings from usability testing. This will save money and make outreach more successful.

5) Staff with intention

- Make sure that your team reflects the community in a culturally appropriate way. Your team reflects the community through race, ethnicity, language and culture.
- Look for staff who know the community. This will help staff learn how to build trust for the program as they know the community and the community, in turn, trusts them.

6) Evaluate progress

- Establish clear goals and objectives that are measurable from the beginning.
- Have an evaluation plan before diving in.
- Learn from the results. Unexpected results are not necessarily a bad thing. Those types of outcomes are essential indicators that can help pivot a program towards success.
- Learn from failures as a group. Why did it not work? How can these tactics be improved or should they be eliminated?

7) Circle back

- Continue to engage stakeholder team members by going back and acknowledging those who contributed to successes.
- Share successes, failures and learning lessons with the community. This will help build trust within the community.
- Be consistent, don't over-promise and listen genuinely to what community team members offer.

Figure 23 *Guide to effective multicultural outreach, referenced by King County, Washington.*

Event venue collaboration

The City of Glendale's waste management department already partners with the Westgate Entertainment District and local sports venues. In the wake of the global market change, recycling protocols at these locations will need to adjust (Foster et al., p.10), specifically educating event attendees on what items are now accepted as recyclables by the City (Foster et al., p.10). A 2017 University of Missouri study found that home football events could achieve zero waste standards by providing better recycling receptacles and sorting options (Foster et al., p.10). During the home season, an estimated 47.3 metric tons of waste were generated. Of this waste, 29.6 metric tons consisted of off-site food waste, with 96% of it being unsold food (Foster et al., p.10). The remaining 17.7 metric tons originated at the stadium, 43% of which was recyclables (Foster et al., p.10). Improving the design of recycling receptacles at Glendale's event venues could similarly increase the percentage of waste that ends up recycled rather than landfilled (Foster et al., p.11). Other possible improvements include:

- Incorporating receptacles at events that display easy to understand sorting options (Foster et al., p.11).
- Design receptacles to be more noticeable by using signage or colors that stand out (Foster et al., p.11).
- Provide announcements via speakers and/or large screens, reminding guests to recycle properly (Foster et al., p.11).

Changes like these could be implemented not only at sporting venues in the Westgate District but also in smaller venues like concert halls or local festivals (Foster et al., p.11). **For these efforts to be successful, employees at the sites would first need to be educated on the City's accepted recyclables**, which could be accomplished via paid employee training (Foster et al., p.16).

CenturyLink Field in Seattle provides a good example to follow for improving recycling behaviors at event venues. CenturyLink Field partnered with Waste Management and achieved a diversion rate of 90% by providing an on-site recycling center, staff training, consistent signage, and receptacles throughout the stadium (Foster et al., p.16). The U.S. Bank Stadium, home of the Minnesota Vikings, also has effective venue recycling practices. The stadium features 375 single- and triple-compartment receptacles, which cost $1,500 each (Foster et al., p.16). These bins, along with informational signage, aim to improve the quality of recycled materials collected from the venue (Foster et al., p.16).

Key findings for public outreach

- Marketing and advertising are vital to public awareness and understanding of municipal programs such as recycling. Advertising can have a dramatic impact on public recycling habits by introducing people to the possibility of a material's new use after being recycled or explaining the effects of recycling contamination (Foster et al., p.11).
- Outreach within local schools provides education to a broad audience of students and their families in a relatively short timeframe with minimal investment (Foster et al., p.26).
- Social media and online outreach is an effective means of mass, rapid communication between the City and its residents and can bridge the gap between older and younger generations (Foster et al., p.26).
- It is critical to consider the City's demographics when developing outreach programs. In Glendale's case, bilingual outreach should be a high priority (Foster et al., p.26).
- Recycling infographic magnets are in demand by Glendale citizens and can be a cost-effective method to reduce contamination rates by providing accessible information to residents (Foster et al., p.26).
- Event venue partnerships are useful. Strategic improvements to venue recycling practices, such as implementing employee training and adding clearly marked receptacles, can dramatically increase landfill diversion (Foster et al., p.26).

Recommendations for public outreach

- Demonstrate product transformations in recycling advertisements to reiterate the purpose of recycling and instigate a public conversation about the potential behind recycled materials (Foster et al., p.17).
- Use advertisements to educate the public on what materials are recyclable through the City's program, which could include online videos, bus wraps, postcards, and beyond (Foster et al., p.17).
- Replace recycling receptacle lids with blue lids to reduce confusion between the current similar-looking recycling bin and the garbage bin, subsequently decreasing the likelihood of contamination. The new lids should have updated instruction labels on them to reflect accepted recyclables in both English and Spanish (Foster et al., p.18).

- Provide free recycling magnets in both English and Spanish to Glendale citizens that educate the public on accepted and unaccepted recyclable materials. Provide a simple way for the public to order these magnets, such as a request form on the City of Glendale's website homepage (Foster et al., p.19-20).
- Engage with the Glendale School District to provide recycling education to students. School-wide assemblies are time- and cost-effective means of engagement, allowing presenters to make an impact on many students at one time and can also be an opportunity to distribute promotional materials such as flyers, magnets, or posters (Foster et al., p.21).
- Encourage family volunteers to be present at recycling school assemblies or other outreach events. Community leader participation increases the impact of the presentation and could also result in a decreased necessity for City employees to run outreach events as more volunteers become familiar with the content (Foster et al., p.22).
- Engage with students via classroom workshops to spread information about recycling on a more personal level, providing the opportunity for the Glendale employees to encourage and inspire the students to recycle (Foster et al., p.21-22).
- Increase the amount of Spanish-language recycling advertisements and promotions through multiple advertising channels, such as print, radio, social media, and websites (Foster et al., p.23).
- Support and improve the already existing relationships between Glendale solid waste management and local event venues. Larger signage for recycling bins, short infomercials played during events, and venue employee education can all help reduce contamination and raise collection rates of recyclables at local venues (Foster et al., p.25).
- Develop a mobile application focused on municipal waste services, such as detailing recycling events, and keeping users updated on current services (Foster et al., p.24).

CLOSED LOOP FUNDS AND INTERGOVERNMENTAL AGREEMENTS

Topic overview

This section will explore recommendations aimed at increasing recyclable material commodity sales. The two recommendations analyzed for consideration are the Closed Loop Fund (CLF), and intergovernmental agreements (IGAs) and findings highlight current experimentation and successes in the United States.

Due to the fallout of the global market shift in solid waste management following Operation National Sword, the United States recognized its outdated, inefficient infrastructure for handling the nation's recycling directly (Layne et al., p.8). Cities must work cooperatively to update the ubiquitous cradle-to-grave waste management system to a more sustainable cradle-to-cradle system (Layne et al., p.8).

Editor's Note

Cradle-to-grave systems suggest a finite life to a product, where it is disposed of somehow at the end of its use. Cradle-to-cradle systems challenge this notion by utilizing regenerative design where materials are continually circulated through the system being truly recycled.

Research findings and analysis

A multitude of factors affects Glendale's recycling commodity sales, including financial responsibilities and city demographics (Layne et al., p.8). Glendale's population is projected to increase 9.7% from 2018 to 277,194 by 2023. The Glendale Materials Recovery Facility (MRF) only accepts residential recycling, meaning the City's most valuable commodities are derived from its single-stream households (Layne et al., p.9). The power and maintenance costs of the Glendale MRF, roughly $163,285 annually, also affect the profitability of the City's recycled commodities (Layne et al., p.9). Entering an IGA with other municipalities or utilizing the CLF for facility upgrades, could help Glendale increase its collection rates of single-stream recyclables and subsequently increase profits. The CLF could also help bring down operating costs of the MRF by providing funds for equipment upgrades, resulting in increased efficiency to the point of being capable of processing other municipalities' materials brought in by an IGA (Layne et al., p.9).

Closed Loop Fund

The Closed Loop Fund (CLF) is provided by Closed Loop Partners, an investment firm with the primary goal of transitioning the current linear supply chain (cradle-to-grave) into a circular supply chain (cradle-to-cradle). CLF's mission statement is to be:

"A hub for collaboration, advisory services, and innovation to advance the transition from a take-make-waste economy to a circular economy in which materials are shared, reused and continuously cycled" (Layne et al., p.4).

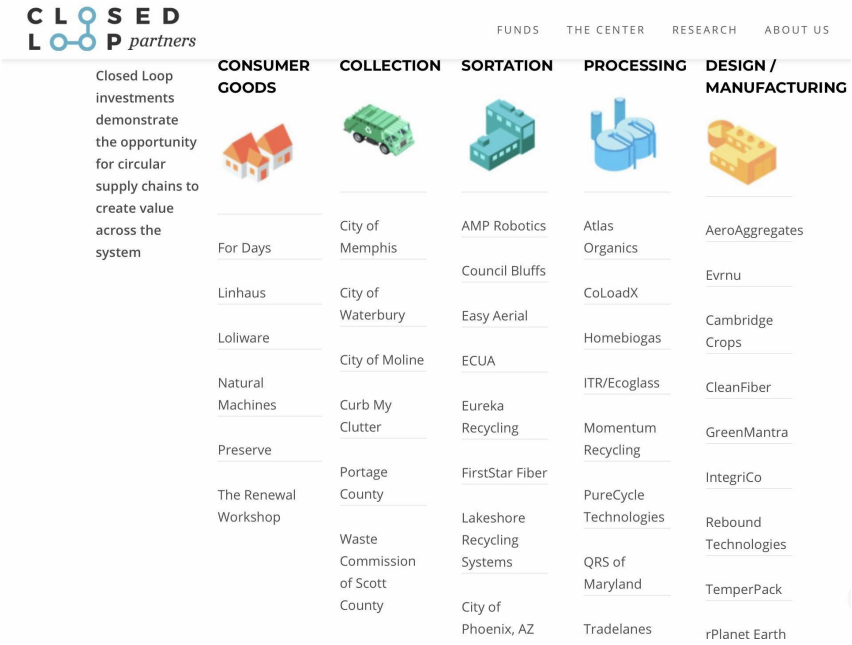


Figure 24 *Closed Loop Partners participants listed on the Closed Loop Partners website.*

The firm offers zero-interest loans to municipalities from $1-7 million and secured by collateral (Layne et al., p.4). Major industry leaders such as 3M, Amazon, Walmart, and P&G have invested in the program. (Layne et al., p.3). Funds from Closed Loop Partners have been used for MRF equipment upgrades, with loans typically reimbursed between 1 and 10 years (Layne et al., p.4). These upgrades can lead to higher efficiency throughout the facility, and improvement of quality and quantity of materials to be collected and sold (Layne et al., p.4). When a municipality files for the CLF, many criteria are evaluated to determine its eligibility for a loan. Reviewed criteria include municipal reduction and avoidance of greenhouse gases, landfill diversion, scalability of the project and increase of participation in recycling (Layne et al., p.5).

Applicable services offered by Closed Loop Partners include advisory services and project finance (Layne et al., p.5). Figure 25 illustrates the five investment categories where funds are applied in the envisioned circular recycling system: Consumer Goods, Collection, Sortation, Processing, and Design/Manufacturing.

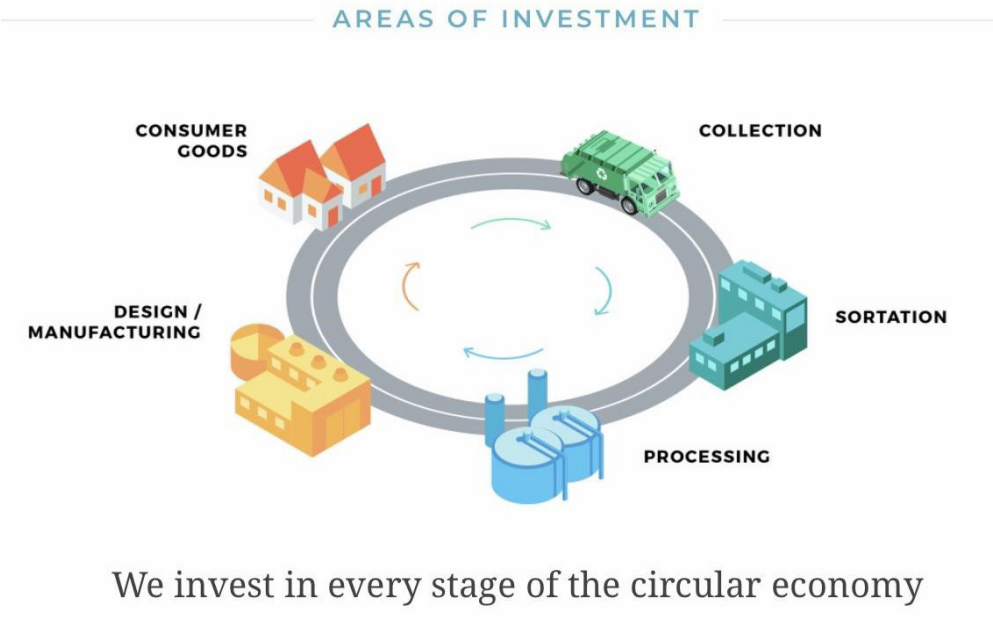


Figure 25 *Closed Loop Partners areas of investment, from the Closed Loop Partners website.*

In Glendale's case, two of the five categories, Collection and Sortation, require the most focus by the City (Layne et al., p.5). Sortation refers to the implementation and/or upgrades to a recycling facility so that it can more efficiently sort collected materials. Collection refers to the City's equipment and pickup needs, such as trucks, bins, and personnel.

Case study: Waterbury, Connecticut

The City of Waterbury, Connecticut, utilized the CLF to purchase new trucks and 95-gallon recycling bins for every household in 2017 (Layne et al., p.5). Following these new elements, Waterbury made a goal to increase its 6% recycling rate to 25% (Layne et al., p.5). Follow up returns showed Waterbury's recycling rate doubled within the first month of implementing its new program (Layne et al., p.6). The Waterbury partnership was a major turning point for the Closed Loop Partners as its first formal partnership with a state where funds were used to help deploy below market rate capital to improve the recycling system (Layne et al., p.6).

In the following sections, multiple case studies illustrate the successful construction and upgrades of various recycling facilities and their subsequent benefits stemming from the utilization of the CLF (Layne et al., p.6). While procuring this type of loan can be difficult, the resulting benefits often greatly outweigh the costs (Layne et al., p.21). CLP funds could be applied to a wide range of programs, including facility upgrades and school system outreach (Layne et al., p.21).

Intergovernmental agreements

An intergovernmental agreement (IGA) is a collaborative partnership between governmental or quasi-governmental entities to provide mutually beneficial services. For example, a joint MRF between two or more cities has the potential to decrease energy costs, increase efficiency, and satisfy many recycling needs that may not be fulfilled by one MRF alone (Layne et al., p.6). Other entities can also participate in IGAs, including school systems, counties, and universities (Bhore et al., p.13). For example, a school system could partner with a recycling facility to provide educational programming around recycling. Programs could inform students and their families how to properly identify and clean recyclables , and what recycled-content products the recycled materials can become after they are processed (Layne et al., p.6). IGAs are often completed in two steps, first determining if a partnership would be beneficial, and then deciding where to allocate potential funds (Layne et al., p.6).

Many cities in the United States, including in Arizona, actively use IGAs to provide better services to their residents. For example, Hall County, Georgia, and the City of Lumpkin, Georgia, have an arrangement where Lumpkin brings all its recyclables except glass to the Hall Recycling Center, and Lumpkin is paid for providing materials (Layne et al., p.7). Similar to this scenario, if Glendale were to enter an IGA with the City of Phoenix, where Glendale would give Phoenix their glass recyclables, certain Glendale recycling expenditures could potentially decrease (Layne et al., p.7). This type of partnership could also allow Glendale to begin collecting glass recyclables for Phoenix to purchase (Layne et al., p.7). If an IGA with Phoenix proves unattainable, other nearby municipalities also have the capability to recycle glass, including Peoria, Tolleson, Goodyear, and Avondale (Layne et al., p.7).

Partnering with Goodyear and Avondale could provide even more benefits since they also recycle plastics 1-7, whereas Glendale only recycles plastics 1 and 2 (Layne et al., p.7). This scenario could increase the life of Glendale's landfill by diverting more 3-7 plastics and benefit Goodyear and Avondale by transferring some of their non-recyclable waste to the Glendale landfill (Layne et al., p.7).

Case study: Emerald Coast Utilities Authority

The Emerald Coast Utilities Authority (ECUA) in Florida suffered financially for a long time due to its reliance on private haulers, transportation and tipping fees, and lack of a local MRF. ECUA's status quo was to send recyclables to a facility in Montgomery, Alabama. When this facility shut down, ECUA had nowhere to send its 22,000 tons per year of collected materials. With public support, the decision was made to build a new MRF with the capacity to handle its own region's 300,000 households, as well as serve additional municipalities nearby (Layne et al., p.10). Due to a lack of experience in the design and operation of a MRF, the city outsourced this work to experienced partners, Bulk Handling Systems and Zero Waste Energy (Layne et al., p.11).

The establishment of the new MRF allowed for a dramatic increase in waste diversion. The capability to partner with other municipalities dramatically increased the amount of material collected annually from 22,000 tons to 68,000 tons in just under two years. Average monthly processing rates increased over 25% in that same period, as shown in Figure 26 (Layne et al., p.11).

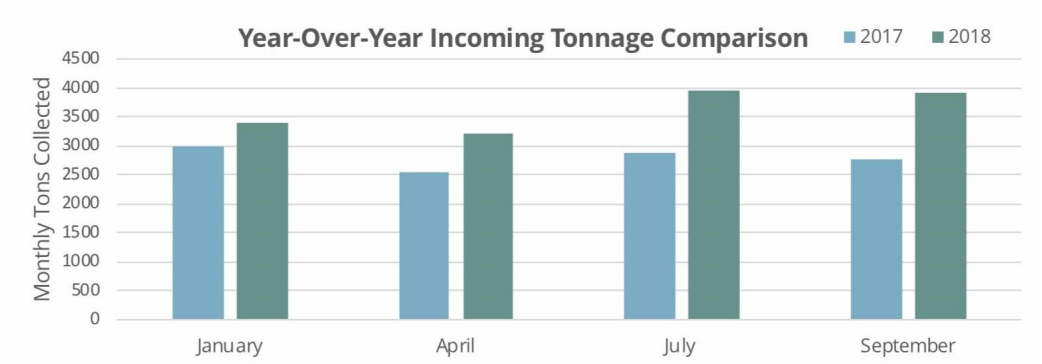


Figure 26 *Monthly material tonnage processed by the ECUA in the first two years of its new MRF operation, by Closed Loop Partners.*

The establishment of the new ECUA MRF impacted more than just collection rates. At the release of the case study, the MRF had avoided $2.3 million in tipping fees and generated $1.9 million in revenue to date, allowing the facility to operate at an average monthly profit margin of 16%, which equates to a total economic benefit of $96 per ton (Layne et al., p.12). Table 4 on the following page lists several economic benefits of the new MRF.

Economic benefits of the new Emerald Coast Utilities Authority Materials Recovery Facility	
Progress (January 2017-September 2018)	***Projected by 2026***
50,968 tons diverted	400,000 tons diverted
143,984 million metric tons of greenhouse gases avoided	1.1 million metric tons of greenhouse gases avoided
257,000 households	257,000 households
30 jobs created	30 jobs created
$4.2 million in economic benefits to municipalities	Minimum $20 million in economic benefits to municipalities (projected)

Table 4 *Current and projected economic benefits of the new ECUA MRF.*

The new ECUA MRF is a 53,000 square foot metal and fabric facility built with a limited commitment for the county in mind (Layne et al., p.13). It is capable of accepting glass, metal, paper, and plastics, and features equipment such as glass cleaning systems and bag ripping machines used to quickly release materials collected in non-recyclable plastic bags (Layne et al., p.13).

Figure 27 *Inside view of the Emerald Coast Utilities Authority Materials Recovery Facility, by Closed Loop Partners.*

The ECUA MRF is a useful example of the potential impact of IGAs. Neighboring municipalities such as Oskaloosa County have partnered with ECUA to improve its solid waste programs. Since the start of the partnership, the County added 32,000 residential carts to its recycling program, increasing collection rates and diverting more waste from landfills. ECUA intends to continue partnering with other municipalities, maximizing capacity at the MRF, streamlining processes within the plant, and reducing contamination to maximize the amount of viable materials. While the global market shift in solid waste management has not yet shown its impact on the ECUA, the benefits to upgrading facilities have proven positive thus far (Layne et al., p.13).

Case Study: Lakeshore Recycling Systems Heartland MRF

Lakeshore Recycling Systems (LRS), a Chicago area waste management company, was in dire need of facility upgrades. The Chicago area was increasing in population, contributing a significant increase in collected single-stream recyclables. This resulted in substantial backups at the company's six aging MRFs, each only capable of processing 20 tons of material per day. Due to this backup, LRS had no other option than to dump unprocessed materials into neighboring landfills at a rate of $50 per ton (Layne et al., p.13). These circumstances catalyzed the decision to build a new MRF at the pre-existing Construction & Demolition recycling facility. **The new MRF, called the Heartland Facility, was intended to increase throughput from 20 tons per day to 20 tons per hour.** LRS determined the project budget to be $8.5 million (Layne et al., p.14). $1.5 million was procured through the CLF and $7 million was loaned from Comerica Bank (Layne et al., p.14).

Once Heartland MRF became operational, it quickly reached its processing rate goal of 20 tons per hour. The state-of-the-art facility is capable of processing materials that many MRFs do not accept, including glass and plastics 3-7. Its central location also plays a part in its success, as 56% of collected materials come from its contract with the City of Chicago, and the remaining 44% from third party haulers. Most households served by the facility are within a 20-mile radius, which keeps transportation costs low. The sheer speed of Heartland MRF's processing rate, and acceptance of many materials, has allowed the facility to maintain an average revenue of approximately $100 per ton on outbound sales of commodities, with 92% of inbound material being single stream. The result is the MRF operates at a profit of $50 per ton after tipping fees and operational costs, and has a processing capacity of over 300 tons of material each day.

"The success of the Heartland MRF has also provided 100 jobs to the greater Chicago area, diverted 110,000 tons of waste from landfills, and is on track to divert over 1 million tons by 2025" (Layne et al., p.14).

Case study: Waste Commission of Scott County, Iowa

Scott County, Iowa, was aware of inefficiencies in its recycling program but did not have the budget available to make proper updates (Layne et al., p.15). The County was practicing dual-stream recycling, where residents separated their recyclables into different material bins to minimize contamination. A 2011 study, however, revealed residents were throwing just as many recyclables in the trash as into the recycling bins. To remedy the situation, Scott County moved to a single-stream recycling program, the success of which resulted in a higher than 250% increase of collected materials. This increase in materials warranted a need for new, advanced sortation machinery to handle the increased tonnage. Scott County secured a $2.7 million loan from CLF to install new sortation machinery to their existing facilities, which resulted in a 61% increase in collected materials at their central MRF and increased quality of sorted material (Layne et al., p.15 and p.26).

Figure 28 *Ribbon cutting at the updated Scott County, Iowa Materials Recovery Facility.*

Case study: Denver recycling and public school systems

As previously mentioned, IGAs can occur between a wide range of governmental and quasi-governmental entities. The City of Denver is an excellent example of this, implementing a variety of IGA programs with the end goal of improving diversion rates and increasing residential recycling participation (Layne et al., p.16).

Some of these programs include:

- Hosting free Learn to Compost classes for residents (Layne et al., p.16).
- Distributing recycling newsletters for approximately 176,000 eligible residents (Layne et al., p.16).
- Establishing a partnership between Denver Recycles and local fire stations to improve their recycling and compost rate, which rose from 12% to 70% (Layne et al., p.16).
- Partnering with 166 school campuses and administrative offices to increase collection rates and improve community education on recycling (Layne et al., p.16).

These IGA programs resulted in over 49,000 tons of material being diverted from landfills, and increased residential participation to 85% (Layne et al., p.16).

Case Study: Milwaukee and Waukesha County

The City of Milwaukee and Waukesha County are a prime example of a well-functioning joint MRF facility operating under an IGA (Layne et al., p.18). Multiple studies were conducted, indicating a shared recyclables processing facility would be the most cost-effective method for the City and County (Layne et al., p.18). The Request for Proposal was developed and issued on behalf of the City of Milwaukee and Waukesha County after an authorizing IGA adopted by the Common Council in March 2013 (Layne et al., p.18). Following the establishment of the IGA, Milwaukee and Waukesha County avoided nearly $940,000 in landfill disposal costs and earned over $1.77 million in revenue for 2013 alone (Layne et al., p.17). **Overall, the MRF provided savings of approximately $57 per ton of collected materials** (Layne et al., p.17).

Recycling Resource Systems assisted the City and County by developing their financial model and establishing educational community outreach programs. One such program featured an event offering free compost and rain barrels for residents at a discounted price. These combined efforts helped contribute to the dramatic reduction of operating costs at the joint MRF (Layne et al., p.17).

Table 5 displays the 2012-2013 increase in residential recycling rate alongside the decrease in net costs for the City of Milwaukee. Table 6 demonstrates the financial impact on the City and County after implementing the IGA. While this table shows revenue decreasing, this is due to lower recyclable commodity prices at that time (Layne et al., p.18).

Residential program metrics: Waukesha County and Milwaukee, Wisconsin			
Effectiveness measures	***2012***	***2013***	***Change***
Household material recycling rate*	9.9%	10.3%	0.4%
Yard waste recycling rate	13.4%	12.4%	-1.1%
Other materials recycling rate**	1.0%	1.1%	0.1%
Total recycling rate	24.3%	23.8%	-0.5%
Household materials recycling pounds per household	262.11 lbs.	277.90 lbs.	15.79 lbs. or 6.0%
Efficiency measures - household recycling only	***2012***	***2013***	***Change***
Residential recycling program costs (reported to State)	$9,561,852	$9.187.019	$(374,833)
State cost sharing/grant revenue	$2,324,896	$2,325,945	$1,048
Recyclable commodity sales revenue	$1,912,279	$1,774,648	$(137,631)
Avoided landfill disposal costs	$899,442	$939,772	$40,329
Subtotal of offsets	$5,136,618	$5,040,365	$(96,253)
Net costs - residential recycling program	$4,425,234	$4,146,654	$(278,580)
Net costs per ton - residential recycling program	$183.26	$165.52	$(17.74)
*The Comptroller's Office method of computing Household Solid Waste Tons includes garbage tons from the City's >4 unit multi-family dwelling customers, a sector not serviced by the City with recycling collection. Since the City does not have recycling tonnage figures for these customers serviced with recycling by the private sector, the resulting recycling rate is artificially low. **Does not include 5,601 tons of concrete and asphalt shingles recycled in 2013 through the Self Help Centers. The State of Wisconsin does not include these categories as residential in annual reporting.			

Table 5 *Waukesha County and Milwaukee, Wisconsin Residential Program Metrics 2012-2013.*

Recyclables processing financial comparisons: Waukesha County and Milwaukee, Wisconsin				
	2012	***2013***	***Change***	***% Change***
Commodity sales revenue				
Revenue/ton (market value)	$97.77	$87.59	$(10.18)	-10.4%
City's share (revenue/ton received from contractor)	$78.22	$70.07	$(8.15)	-10.4%
Total revenue to City	$1,912,279	$1,774,648	$(137,631)	-7.2%
Processing costs				
Processing per ton rate	$50.45	$51.29	$0.84	1.7%
Processing tons	24,207.42	25,089.21	881.79	3.6%
Processing costs	$1,221,243	$1,286,812	$65,569	5.4%
Net revenue				
Net revenue (received)	$691,036	$487,836	$(203,200)	-29.4%
Net revenue per ton	$28.55	$19.44	$(9.11)	-31.9%
Avoided disposal costs				
Landfill costs per ton	$37.16	$37.46	$0.30	0.8%
Landfill costs avoided	$899,442	$939,772	$40,329	4.5%
Total benefit				
Total net benefit	$1,590,479	$1,427,608	$(162,871)	-10.2%
Total net benefit per ton	$65.70	$56.90	$(8.80)	-13.4%
This table relates to processing of residential recyclables after collection. It does not include collection costs or recycling grant revenues. The net benefit figure compares total processing costs with recyclables revenue and avoided landfill disposal costs. In 2013, despite an increase in recycling bins, revenue declined due to lower recyclable commodity prices overall combined with a changing recyclable stream composition reflecting a growing proportion by weight of glass, a low value material.				

Table 6 *Waukesha County and Milwaukee, Wisconsin Recyclables Processing Financial Comparisons 2012-2013.*

Key findings

- Utilizing the Closed Loop Fund (CLF) 0% interest loans can be an accessible means to upgrade municipal recycling facilities, build infrastructure, or start new educational programs (Layne et al., p.18).
- According to the Glendale MRF Operations Supervisor, a partial upgrade to the existing MRF would cost $2-5 million, and includes upgrades to conveyor systems, screening devices, a metering drum, and a magnetic trommel for metal can sortation (Layne et al., p.20).
- A full upgrade to the Glendale MRF could cost between $6-8 million and would include the implementation of optical sorters throughout the materials stream to increase efficiency. Optical sorters themselves can range between $800,000 and $1.5 million (Layne et al., p.20).
- IGAs could pose multiple benefits to Glendale, depending on if they take place with smaller or larger municipalities. Generally, IGAs result in higher collection rates, higher processing rates, and higher commodity sales (Layne et al., p.19).

Recommendations to City for Closed Loop Funds and intergovernmental agreements

- Procure a zero-interest loan from the Closed Loop Fund (CLF) to help upgrade the existing Glendale MRF. A partial or full facility upgrade would increase efficiency and subsequently increase commodity sales (Layne et al., p.20 and Bhore et al., p.17).
- Utilize the CLF to invest in community education programs, increasing public knowledge on recycling to reduce contamination rates and raise collection rates (Layne et al., p.19).
- Arrange an intergovernmental agreement (IGA) between Glendale and local municipalities for a mutually beneficial program. For example:
    - An IGA between Glendale and the Cities of Phoenix and Tolleson would divert glass from the Glendale landfill and generate additional revenue.
    - Similarly, an IGA between Glendale and the cities of Avondale, Peoria, and Goodyear could divert plastics from the Glendale landfill, and generate additional revenue. (Layne et al., p.19 and Bhore et al., p.14).
- An alternative to the CLF or an IGA is exploring federal grant programs which could help facilitate updates to municipal recycling facilities like the Glendale MRF (Layne et al., p.8).

Editor's Note
The EPA periodically opens $100,000 Sustainable Materials Management grants, and also has recurring environmental education grants and Brownfield grants that Glendale may find helpful.

COST-BENEFIT ANALYSES

Topic overview

This section of the report will systematically estimate the advantages and weaknesses of select previously suggested strategies for improving the Glendale MRF by analyzing their respective benefit to cost ratio (Bhore et al., p.1). Analyzed strategies are compared against a business as usual (BAU) scenario, which evaluates the Glendale MRF's existing operations. This BAU Cost-Benefit Analysis (CBA) will provide a contextual baseline to then compare against the CBAs of select recommendations from previous sections of this report (Bhore et al., p.1). Recommendations analyzed include:

- Increasing public outreach
- Procuring a Closed Loop Fund loan
- Creating an intergovernmental agreement

The following analyses aim to provide further understanding of the economic effect these strategies could have on existing solid waste management operations within the City of Glendale (Bhore et al., p.1).

$$\text{Cost-Benefit Analysis (CBA)} = \frac{\text{Total Project Revenue}}{\text{Total Project Expense}}$$

A CBA is an economic measurement tool that aids in project assessment. CBAs determine if the project would be profitable and are commonly used to assist investors in making informed decisions (Bhore et al., p.2). Table 7 lists the implications of calculated benefit to cost ratios.

CBA ratio implications	
Ratio	***Implication***
>1 A ratio greater than 1	Project is economically satisfactory, achieving greater benefits than costs.
=1 A ratio equivalent to 1	Project is an economic breakeven, achieving equal benefits and costs.
<1 A ratio of less than 1	Project is potentially a loss, with benefits not justifying the costs.

Table 7 *Cost-benefit analysis ratio implications.*

Research findings and analysis

Scenario 1: Business as Usual

The Business As Usual (BAU) scenario assumes the Glendale MRF will continue existing operations without incorporating any of the recommendations provided in this report. In 2018, the MRF and recycling program's operational expenses exceeded just over $3 million (Bhore et al., p.2). Tables 8 and 9 on page 68 detail MRF operation expense data, and the recycling program's operation expense data. These two categories total a 2018 expenditure of **$3,093,341.76**.

Expenses are summarized in the following graphs, Figures 29 and 30. There are currently no outstanding loans associated with either program, implying costs included in the initial benefit to cost ratio were solely operations and maintenance costs (Bhore et al., p.2).

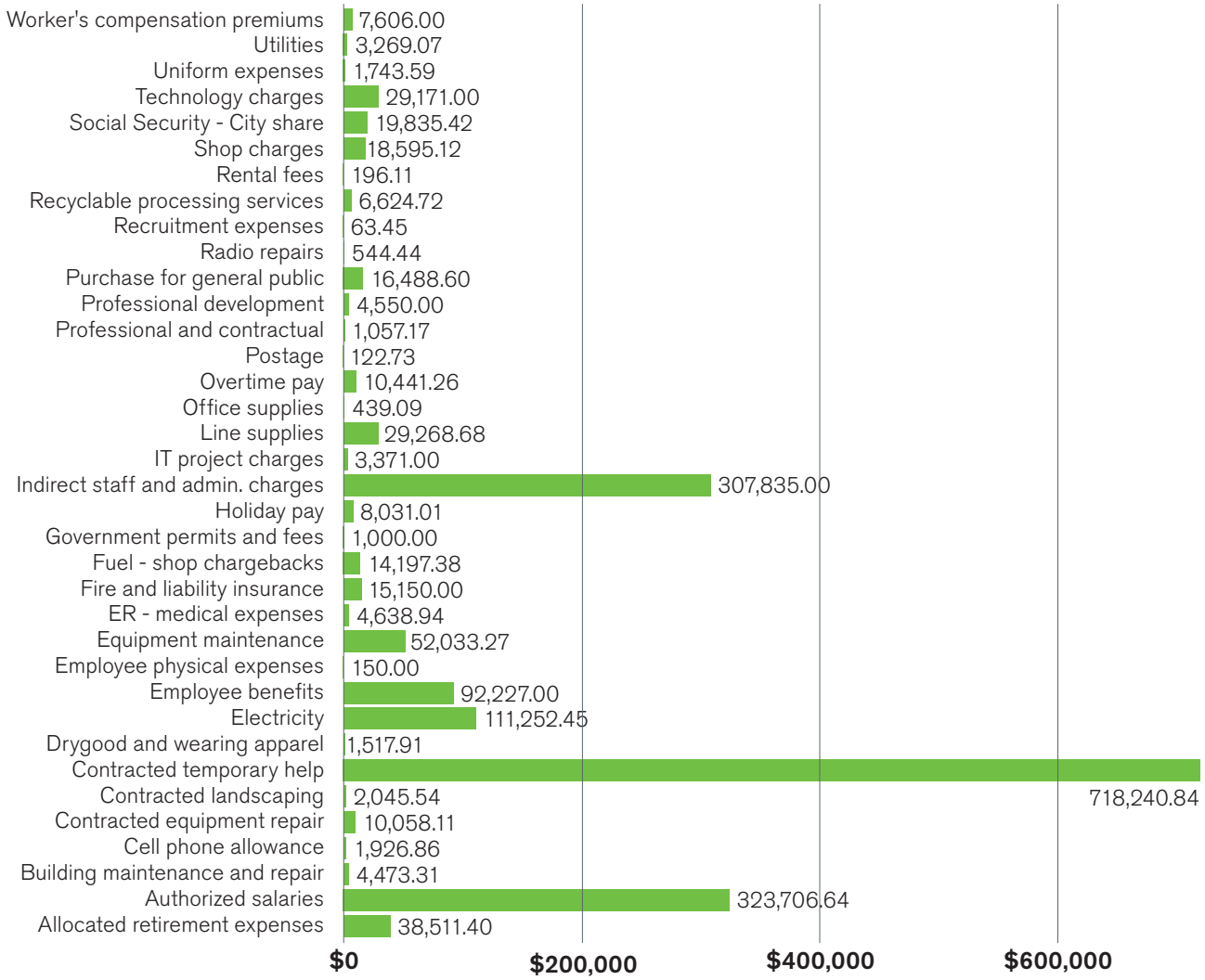


Figure 29 *Cost for operation and maintenance of the Glendale MRF (2018).*

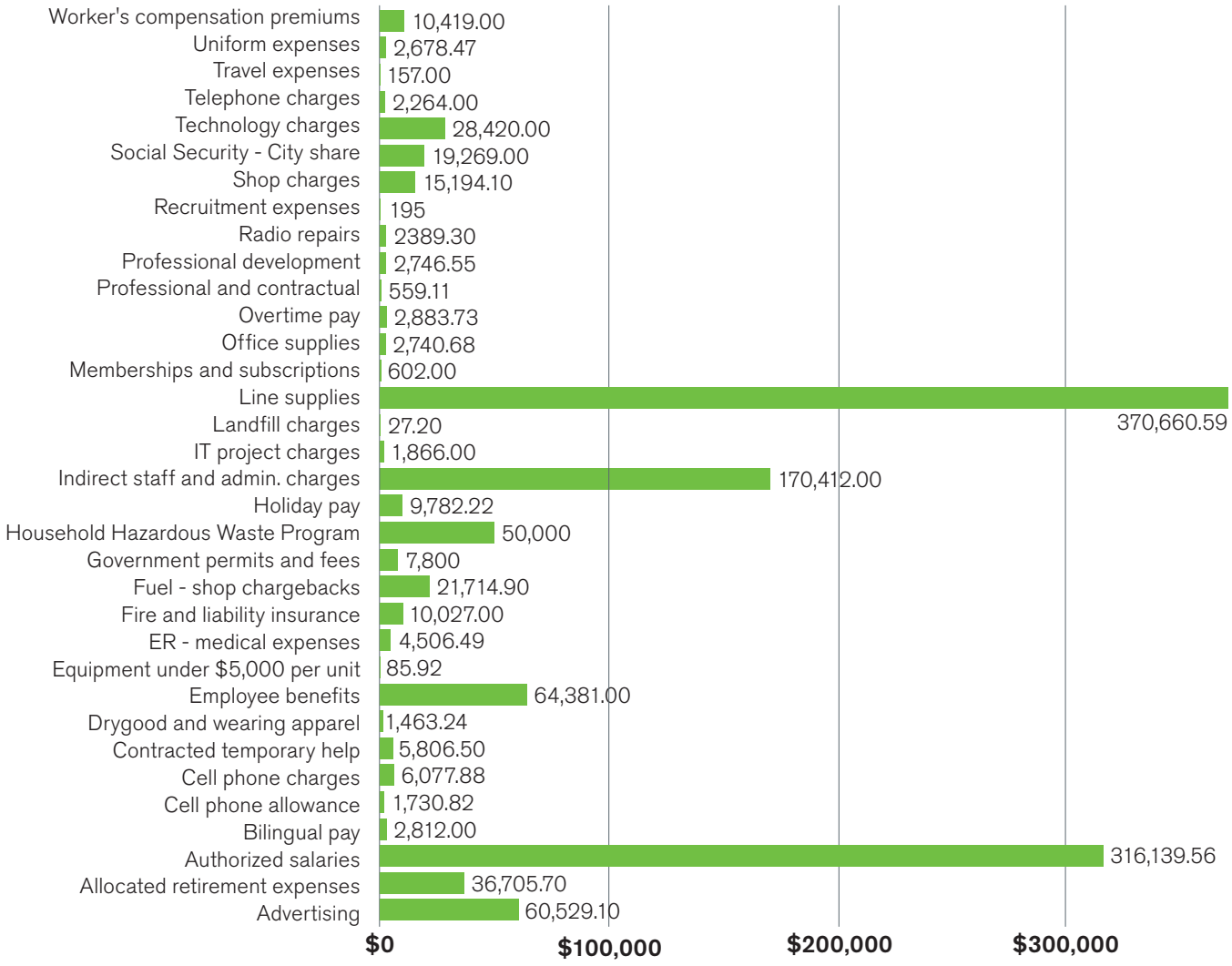


Figure 30 *Cost for operation and maintenance of the recycling program at the Glendale MRF (2018).*

City of Glendale 2018 MRF expenditures	
Account expenses	***Amount ($)***
Allocated retirement expenses	38,5111.40
Authorized salaries	323,706.64
Building maintenance & repair	4,473.31
Cell phone allowance	1,926.86
Contracted maintenance &repair	10,058.11
Contracted landscape maintenance	2,045.54
Contracted temporary help	718,240.84
Dry goods and wearing apparel	1,517.91
Electricity	111,252.45
Employee benefits	92,227.00
Employee physical expense	150.00
Equipment maintenance	52,033.27
ER-Medicare expenses	4,638.94
Fire and liability insurance	15,150.00
Fuel - shop chargebacks	14,197.38
Government permits and fees	1,000.00
Holiday pay	8,031.01
Indirect staff & admin charges	307,835.00
IT project charges	3,371.00
Line supplies	29,268.68
Office supplies	439.09
Overtime pay	10,441.26
Postage	122.73
Professional and contractual	1,057.17
Professional development	4,550.00
Purchase for general public	16,488.60
Radio repairs	544.44
Recruitment expenses	63.45
Recyclable processing services	6,624.72
Rental fees	196.11
Shop charges	18,595.12
Social Security - City share	19,835.42
Technology charges	29,171.00
Uniform expenses	1,743.59
Utilities	3,269.07
Worker's compensation premiums	7,606.00
Total	**1,860,383.10**

Table 8 *City of Glendale MRF expenditures.*

City of Glendale 2018 recycling program expenditures	
Account expenses	***Amount ($)***
Advertising	60,529.11
Allocated retirement expenses	36,705.73
Authorized salaries	316,139.56
Bilingual pay	2,812.00
Cell phone allowance	1,730.82
Cell phone charges	6,077.88
Contracted temporary help	5,806.50
Drygoods and wearing apparel	1,463.24
Employee benefits	64,381.00
Equipment <$5,000 per unit	85.92
ER-Medicare expenses	4,506.49
Fire and liability insurance	10,027.00
Fuel - shop chargebacks	21,714.99
Government permits and fees	7,800.00
HHW program	50,000.00
Holiday pay	9,782.22
Indirect staff & admin charges	170,412.00
IT project charges	1,866.00
Landfill charges	27.20
Line supplies	370,660.59
Memberships and subscriptions	602.00
Office supplies	2,740.68
Overtime pay	2,883.73
Professional and contractual	559.11
Professional development	2,746.55
Radio repairs	2,389.30
Recruitment expenses	195.00
Risk mgmt. ins. reimbursement	-87.63
Shop charges	15,194.11
Social Security - City share	19,269.09
Technology charges	28,420.00
Telephone charges	2,264.00
Travel expenses	157.00
Uniform expense	2,678.47
Worker's compensation premiums	10,419.00
Total	**1,232,958.66**

Table 9 *City of Glendale recycling expenditures.*

The revenue generated from 2018 commodity sales was $643,998.56, resulting in a cost to benefit ratio of 0.21 (Bhore et al., p.4). Table 10 provides a detailed calculation for reaching this ratio. This BAU CBA of 0.21 will provide a contextual baseline to compare against the CBAs of selected recommendations, where recommendations that raise the BAU CBA are considered beneficial, and recommendations that lower the BAU CBA are considered disadvantageous.

Glendale MRF "business as usual" cost to benefit ratio	
Total 2018 revenues generated by Glendale MRF through the sale of recyclable commodities	$643,998.56
Total 2018 expenses incurred by the Glendale MRF	$3,093,341.76
Business as Usual Benefit to Cost Ratio (revenue / expense)	**0.21**

Table 10 *Calculation of Glendale's MRF "business as usual" cost to benefit ratio.*

Scenario 2: Implementing Report Recommendations at the Glendale MRF

Public outreach programs aim to increase recycling knowledge among the City's residents through a variety of channels (Bhore et al., p.4). This section of the report subdivides public outreach into three separate categories:

1. School campaigns
2. The Blue Lid Initiative
3. Event venue advertising

Increasing public awareness via school campaigns

Public education programs were analyzed in the previous "Public Outreach" section of this report. The Snohomish County case study details a recycling program partnership between Waste Management and the County school district. The study provided promising results, as 95% of students reportedly learned something new from the program, and 99% of teachers reported the program encouraged students to share their newfound knowledge with others (Bhore et al., p.4). This section of the report establishes school system outreach as a beneficial intervention with the potential to promulgate recycling knowledge beyond the classroom (Bhore et al., p.4).

Outreach programs in schools have the potential to reach a broad audience, including students, teachers, staff, and families of the students (Bhore et al., p.4). Certain material costs are associated with this type of outreach, such as promotional flyers, stickers, and magnets, and payroll costs for City staff to organize and participate in the outreach (Bhore et al., p.5). The primary focus for the following CBA will be the Glendale Elementary School District (GESD), serving kindergarten through eighth grade, totaling over 11,000 students and 1,500 employees across 17 schools (Bhore et al., p.5).

This type of outreach may be conducted in an individual classroom format, or through school-wide assemblies. The assembly method is potentially more convenient and cost-effective for staff conducting the outreach campaign as they reach a larger audience in a shorter time, resulting in efficient use of time and resources (Bhore et al., p.5). Approximate costs listed in Table 11 (on the following page) are related to the assembly method of school outreach.

Case study: Ward Traditional Academy in Tempe, Arizona

Ward Traditional Academy in Tempe, AZ, a public school comprised of kindergarten through eighth grade, hosted a "Water Safety" outreach campaign on their campus via assemblies. The school had to conduct three separate assemblies to accommodate their 461 students. The campaign also provided students with coloring books as part of the program. The cost per assembly was approximately $150, resulting in a $450 total cost for the "Water Safety" outreach campaign (Bhore et al., p.5).

School campaign cost calculation

In the GESD, 12,500 combined students and staff are reachable through an assembly outreach campaign (Bhore et al., p.5). Considering there is an average of two people per household; the campaign audience is doubled to almost 25,000 people. In addition to the assembly, sharable materials like flyers, magnets, and stickers can also help spread the campaign message (Bhore et al., p.5). Table 11 on the following page summarizes the approximate total cost of a school assembly outreach campaign, including distribution of promotional materials, **totaling $11,572.78 to reach all 17 schools in the GESD** (Bhore et al., p.6).

Cost estimation: School outreach campaign		
Content	***Quantity***	***Total cost for Glendale based on visiting 17 schools***
Outreach campaign through assemblies ($150 ea.)	$450 total (targeted 3 assemblies per school)	$7,650
Fridge magnets ($0.11 ea.)	13,000 total	$1,320
Brochures/ Flyers ($0.02 ea.)	13,000 total	$308.75
Stickers/ Displays ($0.02 ea.)	15,000 total	$294.03
Miscellaneous costs (Overtime pay, Transportation costs, etc.)	1	$2,000
Total cost of a campaign		**$11,572.78**
Detailed descriptions of these costs are available in the original student content at **links.asu.edu/PCGlendaleRecycling19F**.		

Table 11 *Estimated cost for assembly format school outreach campaign by the City of Glendale.*

This estimated campaign cost is dramatically less than the current advertisement costs budgeted by the Glendale MRF of $60,529.11. In an ideal scenario, the estimated potential revenue from recyclable materials based on estimated exposure from the school outreach campaigns could totals $194,125.73 (Bhore et al., p.6). Calculations for determining this revenue are detailed in Table 12 on the following page.

Estimated potential revenue correlated to school assemblies	
Glendale per capita recyclable waste generation calculation	
Total quantity of recyclable waste received at Glendale MRF during the year 2016-2019	42,970.4 MT*
Average quantity of recyclable waste received per year	14,323.46 MT*
Population of Glendale	250,702**
Therefore, per capita recyclable waste generation for the city = quantity of recyclable waste received per year / population	14,323.46 MT / 250,702 = **57.1 kg per year** or **0.0571 MT per year**
School outreach impact of per capita recyclable waste generation	
Considering an average of 2 people per family or household = estimated total recipients of the school public outreach program	2 x 12,500 (estimated school outreach audience) = **25,000 people**
Therefore, estimated recyclable waste generated by 25,000 people = Per capita waste generation x recipients of public outreach program =	0.057MT x 25,000 = **1,427.5 MT*****
*Net average value of commodities of recycled waste =	$135.99 per MT
Therefore, the impact of the public outreach program on the commodity sales for the City of Glendale = Per capita waste generation x average commodity value	1,427.5MT x $135.99 = **$194,125.73**
MT = Metric Ton (2,204.62 pounds) **Source: 2018 Commodity Sales Report provided by City of Glendale* ***Source: US Census 2018* ****This quantity of recyclable waste will be well-segregated waste and would serve as a commodity for the city of Glendale*	

Table 12 *Estimated potential revenues related to assembly format outreach programs run by the City of Glendale in GESD.*

The benefit to cost ratio for this public outreach scenario is **0.2754** (Bhore et al., p.6). Calculations to determine this ratio are shown in Table 13 below.

Scenario 2: Public outreach cost to benefit ratio		
Total expenses that would be incurred by eliminating original cost budgeted for advertising and increasing outreach via campaigns at schools	$3,093,341.76 - $60,000 + $11,572.78 =	$3,042,915.54
Total revenues generated by Glendale MRF	$194,125.73+ $643,998.56 =	$838,124.29
Benefit to Cost Ratio (revenue / expense)	**838,124.29 / 3,042,915.54 =**	**0.2754**

Table 13 *Calculations for school outreach programs benefit to cost ratio.*

Increasing public outreach via Blue Lid Initiative

Detailed in the "Public Outreach" section of this report, the Blue Lid Initiative is a potentially cost-effective way to increase collection rates and decrease contamination rates by making the recycling bins more distinguishable from trash bins, and including recycling information on the new lids themselves. Figure 31 shows the City of Tempe's "In-Mold" labeling used on various residential bins, which embeds the label to the container (Bhore et al., p.7). This method of labeling receptacles is more durable and stays legible for a longer period of time, even in Arizona's harsh conditions. Tempe contracted with Otto Environmental Systems NA for this labeling service (Bhore et al., p.7).

Figure 31 *A three-year-old Tempe residential bin featuring "In-Mold" labeling.*

Replacing the lids of residential recycling bins is dramatically more cost-effective than replacing the entire container. The cost of one bin with an embedded label is currently $63.30, and when provided for each of Glendale's 55,000 residential customers results in a total cost of $3,481,500 (Bhore et al., p.7). **Alternatively, the cost of replacing only the current bin lids with blue "In-Mold" labeled lids totals approximately $841,500, saving the City $2,640,000 in replacement costs or $48 per customer** (Bhore et al., p.7).

Increasing public outreach via advertising at event venues

Advertising at event venues provides a unique opportunity to reach a large and diverse audiences in a short timeframe (Bhore et al., p.7). Advertising formats, however, vary greatly in cost, making it difficult to determine their feasibility. For example, displaying advertisements at a professional stadium can cost anywhere from $4,500 to $15,000 per game (Bhore et al., p.7). In this setting, celebrity endorsements for local waste management campaigns may impact a wider audience (Bhore et al., p.8). These types of endorsements are frequently used in conservation marketing, and in some cases, celebrities may provide their endorsements for free, leaving just production costs to be considered (Bhore et al., p.8).

Advertising at high school sports venues can be more affordable, ranging from $350 for a banner to $3,000 for a 30-second video advertisement (Bhore et al., p.7). If only varsity baseball and football games are considered, there are 26 total games each year (Bhore et al., p.16). An estimated total of 60,000 impressions would be made for an entire playing season at one high school (Bhore et al., p.16). For a 30-second video advertisement, and a banner advertisement in 11 schools, the investment total is $36,850 (Bhore et al., p.16). It is not recommended to advertise at every one of Glendale's high school sporting facilities as costs would quickly add up (Bhore et al., p.7). Revenue from these types of advertisements can not be anticipated, making the return on investment disproportionate to expenses incurred (Bhore et al., p.7). Due to this uncertainty, advertisement costs are excluded from the total expenses budgeted for public outreach programs (Bhore et al., p.7).

Procuring a loan from the Closed Loop Fund

The Closed Loop Fund (CLF) can be applied to multiple areas such as sortation, processing, and facility design. The most useful allocation of Closed Loop Funds at the Glendale MRF would be sortation (Bhore et al., p.9). Constructed in 2000, the Glendale MRF is relatively outdated and uses less efficient equipment than is currently available (Bhore et al., p.9). The facility's equipment maintenance costs exceeded $52,000 in 2018, further indicating the need for upgrades (Bhore et al., p.9).

A partial upgrade would cost between $2-5 million and include the replacement and addition of multiple pieces of equipment while still maintaining the existing supporting framework within the MRF (Bhore et al., p.9). Possible equipment additions include:

- **Metering Drum:** Controls the "flow rate" of collected materials through different processes
- **Screening devices** for two-dimensional (paper) and three-dimensional (plastic) materials
- **Metal Trommel:** Sifts lighter materials like dirt from the metal materials stream

A complete upgrade could cost between $6-8 million and would still include a Metering Drum, but would additionally require Optical Sorters (Bhore et al., p.9). A single Optical Sorter can cost between $800,000 and $1.5 million, and multiple sorters are generally needed to accommodate for different material streams (Bhore et al., p.9). The addition of Optical Sorters would also require an overhaul of the Glendale MRF's existing framework (Bhore et al., p.9). Figure 32 illustrates how an Optical Sorter would function in the Glendale MRF.

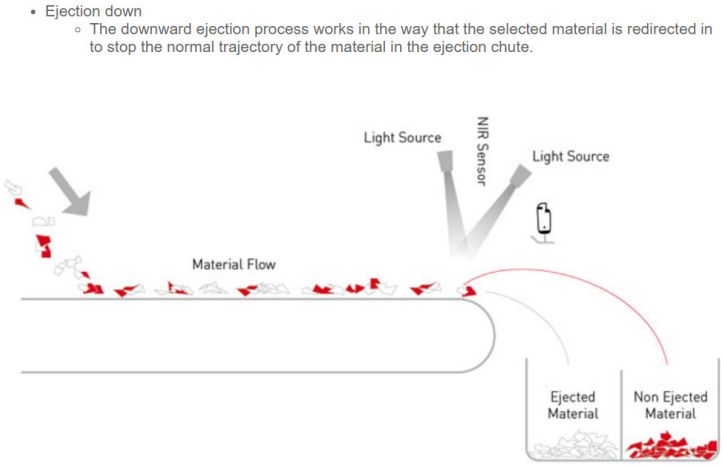


Figure 32 *Example of an Optical Sorter from Eagle Vizion.*

Partial and complete upgrades differ significantly in cost, however a greater investment implies the ability to collect and process more materials with less contamination. This would ideally result in higher revenue from commodity sales (Bhore et al., p.9).

A zero-interest loan acquired from CLF can range from one to ten years. The following CBA includes a five-year loan from CLF for a partial upgrade. In this scenario, Glendale would be responsible for an annual payment of $500,000 (Bhore et al., p.10). CBAs involving loans require a Net Present Value (NPV), which is used in Capital budgeting to analyze the profitability of a project or investment (Bhore et al., p.10). NPV is calculated by taking the difference between the present value of cash inflows and the present value of cash outflows over a certain period, after discounting the flows at an inflation rate (Bhore et al., p.10). Figure 33 details the NPV formula.

$$NPV = \sum \frac{Cash\ inflow}{(1+R)^t} - Cash\ outflow$$

Cash inflow = Revenue generated
Cash outflow = Expenses incurred or investment
R = Discount rate/inflation rate
t = time period

Figure 33 *Equation for calculating Net Present Value (NPV)*

The 2018 expenses for the Glendale MRF totaled $3,093,341.76. A $2.5 million loan over a payback period of 5 years would incur an additional $500,000 to this set of expenses (Bhore et al., p.11). The total revenue generated by the City of Glendale in 2018 was $643,998.56 (Bhore et al., p.11). At this rate, and accounting for inflation, revenue generated over the next five years would total $3,051,909.15 (Bhore et al., p.11). **This brings the overall NPV for the $2.5 million CLF investment to $551,909.15** (Bhore et al., p.11). Detailed calculations for determining this NPV are provided in Table 14 on the following page.

Editor's Note

The CBA calculated by students in Table 14 was based on the solid waste program budget materials provided by the City of Glendale using data from 2018. Economic conditions, and subsequently the current CBA, have most likely changed since this report was written.

Net Present Value calculations for a $2.5 million Closed Loop Fund investment	
The total investment of CLF	$2.5 million
Total expenses incurred to Glendale MRF if a CLF of $2.5 million over a 5-year payback period is procured for partial upgrade =	$3,093,341.76 + ($2,500,000/5) = $3,593,341.76
After removing the operation and maintenance cost of $52,000, the expenses incurred =	$3,593,341.76 - $52,000 = $3,541,341.76
According to the US Labor Department, the annual inflation rate for the US for 12 months ending in October 2019 is	1.8%
The revenue generated per year by the City of Glendale according to the 2018 commodity sales report	$643,998.56
Inflation adjusted revenue	$_{i=1}\sum$(Revenue generated/$(1+R)^{I}$)
Inflation adjusted revenue for year 1	643,998.56/(1+0.018)1 = $632,406.58 for 1st year
Inflation adjusted revenue for year 2	643,998.56/(1+0.018)2 = $621,458.61 for 2nd year
Inflation adjusted revenue for year 3	643,998.56/(1+0.018)3 = $609,866.63 for 3rd year
Inflation adjusted revenue for year 4	643,998.56/(1+0.018)4 = $599,562.65 for 4th year
Inflation adjusted revenue for year 5	643,998.56/(1+0.018)5 = $588,614.68 for 5th year
Total revenue generated over **5 years**	$3,051,909.15
Average revenue generated **per year**	$610,381.83
Therefore, Benefits/Costs =	610,381.83/ 3,541,341.76 = **0.1723**
NPV value (=$_{i=1}\sum$(Revenue generated/$(1+R)^{I}$) – Expenses incurred)	$551,909.154

Table 14 *Calculations of expenses to determine Net Present Value of a $2.5 million loan procured from the Closed Loop Fund.*

A $2.5 million investment would accomplish a partial upgrade to the Glendale MRF. These upgrades would carry significant impacts on the annual operation and maintenance costs of the facility, with maintenance costs dropping dramatically in the first five years (Bhore et al., p.11). Because of this expected drop, it is acceptable to remove the established annual maintenance costs of $52,000 when calculating the CBA for partial upgrades. However, due to the small portion of annual maintenance plays in the annual expenses as a whole, students included the maintenance costs in their calculations. Revenues from the recycling program were not included in the calculation of this CBA as the only revenues were through the MRF and would contribute to an inaccurate CBA if included (Bhore et al., p.11).

As shown in Table 14, the final CBA for a partial upgrade to the Glendale MRF, funded by a $2.5 million loan from the Closed Loop Fund, is **0.1723** (Bhore et al., p.11). The goal of these interventions is to have a CBA greater than the Business as Usual (BAU) CBA of 0.21, but this recommendation results in a lower ratio, implying a disadvantageous project. An exact CBA was not calculated for a full upgrade, as the higher capital costs and subsequent annual payments would be dramatically higher, resulting in an even lower CBA (Bhore et al., p.11).

Students recommend making the increase of proper curbside participation a priority in Glendale (Bhore et al., p.12). This method decreases contamination at the source and can be accomplished via the aforementioned public outreach strategies (Bhore et al., p.12). If these methods prove effective, facility upgrades could serve as a future possibility (Bhore et al., p.12). Students also recommend seeking further support through an IGA before acquiring a loan from the CLF, detailed in the following section.

Case Study: Scott County, Iowa Recycling Center

In 2016, the Scott County Recycling Center was in need of repair and replacement of its aging equipment. The County's curbside recycling program served 48,000 residents, similar to Glendale's 55,000. The Recycling Center underwent a full upgrade in 2016, totaling $10.75 million. $2.7 million was loaned from the CLF, and the County was responsible for the remaining $8 million. One year after the renovations, the Recycling Center experienced a 61% increase in volume of processed material, and the County pays its CLF loan with revenue returns from their improved MRF (Bhore et al., p.11). Results following the MRF upgrade were immediately promising. However, it should be noted that revenues were comparatively higher at the time the case study was conducted than they are today. This indicates payback periods will be considerably longer under today's market conditions (Bhore et al., p.12).

Strategy 3: Intergovernmental agreement

Intergovernmental agreements (IGAs) are outlined in the previous "Closed Loop Funds, and IGAs" section of this report, and are generally made between two or more governmental or quasi-governmental entities to address problems of mutual concern (Bhore et al., p.13). These agreements can be challenging to form and sometimes difficult to sustain; however, there are many successful and relevant examples of IGAs within the United States.

Case study: Colorado five-party IGA

Larimer County, the City of Fort Collins, the City of Loveland, and the Town of Estes Park, formed a five-party IGA in February of 2019. The agreement established responsibilities of planning, education, water prevention, recycling, collection, composting, transportation, and disposal amongst the five municipalities. The overarching objectives of this agreement were to increase commercial revenue while developing and modernizing infrastructure. The five parties were generally obligated to services in solid waste management and funding obligations where the funds committed after 2019 are subject to and conditioned per appropriations of the governing bodies (Bhore et al., p.13).

Case study: Denver Solid Waste Management and Denver Public Schools IGA

Aimed at increasing landfill diversion and active participation in the City's recycling program, this IGA included the implementation of a composting education program, newsletter communications, and partnering with 166 schools to increase outreach and awareness around recycling. After this IGA was established, over 49,000 tons of plastic were successfully diverted from landfills (Bhore et al., p.14).

Based on these successful IGAs, students developed suitable suggestions to be explored by the City of Glendale. Detailed calculations for each IGA are presented in the tables following each description.

IGA 1: City of Glendale with the City of Phoenix and City of Tolleson (Bhore et al., p.14)

Signer: City of Glendale

Signee: City of Phoenix and City of Tolleson

Objective: To divert glass from the City of Glendale landfill as it is not being recycled under Glendale's current program.

Benefits for all partners:

- Glass received at the Glendale MRF can be sent to facilities handled by the partner cities, Phoenix and Tolleson, diverting glass from the Glendale landfill and generating revenue through commodity sales for the partner cities.
- Revenue generated from collected glass can then be shared amongst the cities on a 40-60 basis, where 60% of the profits are awarded to Phoenix and Tolleson, and 40% are awarded to Glendale. Specific revenue amounts for each city are calculated in Table 15.
- The Glendale landfill can accept yard waste and compostable waste from Phoenix and Tolleson if needed.

Benefits for the City of Glendale:

- Diverting glass from the Glendale landfill will extend the life of the landfill and generate revenue.
- Yard waste or compostable waste received from Phoenix and Tolleson would decompose faster than regular trash, and subsequently take up less space, having a minimal effect on the Glendale landfill. Added organic waste; however, could result in additional methane and carbon dioxide emissions, potentially requiring modifications to the landfill's existing air pollution control permit.
- If Glendale sends 15 tons of glass to Phoenix and Tolleson annually, Glendale would incur a transportation cost of $300, and gain $150 according to the terms of IGA.

Calculations: Intergovernmental agreement 1	
Total quantity of glass waste	15 tons per year
Tons of glass that can be sent to other cities based on handling capacity.	10 tons to Phoenix 5 tons to Tolleson
Transportation cost per ton	$20 per ton, per 50 miles
Total transportation cost	15 tons x $20 = $300
Selling cost of recycled glass	$75
Revenue	15 tons x $75 = $1,125
Revenue for Glendale	$450
Revenue for Phoenix	$450
Revenue for Tolleson	$225
Profit for Glendale (revenue – transportation cost)	$450 – $300 = **$150**

Table 15 *Calculations for IGA 1 between the City of Glendale and the Cities of Phoenix and Tolleson.*

IGA 2: City of Glendale with City of Avondale, City of Peoria, and City of Goodyear (Bhore et al., p.15)

Signer: City of Glendale

Signee: City of Avondale, City of Peoria, and City of Goodyear

Objective: Recycle plastics 3-7

Benefits for Partner Cities:

- Additional plastics would be recycled at partner facilities and could reenter the market, resulting in revenue.
- Profits can be shared on a 40-60 basis, where 60% is awarded to the Cities of Avondale, Peoria, and Goodyear. 40% is awarded to Glendale.
- The Glendale landfill can accept yard waste and compostable waste from the Cities of Avondale, Peoria, and Goodyear, which do not currently have municipal organic waste pickup programs outside of intermittent bulk yard waste collection.

Benefits for the City of Glendale:

- Divert plastics from the Glendale landfill, subsequently extending the landfill's life.
- Additional yard waste would decompose quickly, though it could result in additional methane and carbon dioxide emissions, potentially requiring modifications to the landfill's existing air pollution control permit.
- The amount of plastic diverted from the Glendale landfill is estimated at 140 tons, and if sold could generate a profit of $560.

Editor's Note

If Glendale acquired yard waste from other cities the ideal arrangement would be to partner with another entity that can process it, like the City of Phoenix, rather than adding it to the Glendale landfill. Theoretically, entities looking to form partnerships should identify amongst themselves, who can process which different waste streams, then identify the best regional alternative for each type of waste stream.

The idea that yard waste would decompose quickly in the landfill is also not necessarily true for the Phoenix valley's climate, rather it is more true for areas that receive higher levels of precipitation. Therefore, acquiring additional yard waste is not necessarily recommended for the City of Glendale, though it appears in the original student content.

Calculations: Intergovernmental agreement 2	
Total quantity of non-recyclable plastic	140 tons
Tons of plastic that can be sent to other cities based on handling capacity	80 tons to Peoria 40 tons to Avondale 20 tons to Goodyear
Transportation cost per ton	$10/ton/50 miles
Total transportation cost	140 tons x $10 = $1,400
Selling cost of recycled plastic (3-7)	$4,900
Revenue for Glendale	$1,960
Revenue for Peoria	$1,680
Revenue for Avondale	$1,400
Revenue for Goodyear	$700
Profit for Glendale (revenue – transportation cost)	$1,960 – $1,400 = **$560**

Table 16 *Calculations for IGA 2 between the Cities of Glendale, Avondale, Peoria, and Goodyear.*

When using the above calculations, it can be determined that Glendale would earn additional revenue if entering into IGA 1 and IGA 2, as previously outlined (Bhore et al., p.15). It should be noted this plan also increases investment costs by $1,400, which brings the final benefit to cost ratio to 0.207 (Bhore et al., p.15). Table 17 below details the calculations used to determine this ratio.

Cost-benefit ratio calculations for IGA 1 and IGA 2	
Expenses incurred in IGA 1	$300
Revenues obtained in IGA 1	$450
Expenses incurred in IGA 2	$1,400
Revenues obtained in IGA 2	$1,960
Total Expenses through IGA 1 and IGA 2	$1,700
Total Revenues through IGA 1 and IGA 2	$2,410
Total expenses for CBA	$(1,700 + 3,093,341.76) = **$3,095,041.76**
Total Revenues for CBA	$(2,410 + 643,998.56) = **$646,408.56**
Benefit to Cost Ratio (revenue / expense)	$3,095,041.76 / $646,408.56 = **0.209**

Table 17 *Cost-benefit ratio calculations for IGA1 and IGA 2.*

Key findings for cost-benefit analyses

- Campaigning throughout the Glendale Elementary School District requires a minimum amount of investment while reaching a broad audience, with an approximate total cost of execution of $11,000. The CBA for school outreach is 0.2754 (Bhore et al., p.16).
- A zero-interest loan could be procured to fund upgrades to the Glendale MRF. Partial upgrades, however, could still result in expenses higher than initial revenues, which drops the benefit to cost ratio to 0.1723 (Bhore et al., p.17).
- Previously outlined IGA 1 and IGA 2 are beneficial arrangements for each party involved, generating revenue for multiple cities, extending the life of the Glendale landfill, and providing an eco-friendly alternative for partner cities' yard waste. The only expenses come from transportation. The IGA arrangements do, however, reduce the overall benefit to cost ratio from the BAU 0.21 to 0.209 (Bhore et al., p.17).
- The Blue Lid Initiative requires an $84,100 investment but is overall less expensive than replacing entire recycling bins. New lids could decrease contamination rates by better distinguishing the receptacles from trash bins, and by providing new informational, bilingual labels on the lids (Bhore et al., p.16).
- Advertising through local high school sports venues is one potential investment opportunity. However, returns on these efforts are difficult to calculate and are therefore not included in the CBA calculations (Bhore et al., p.7). Due to the uncertainty associated with such a high investment, students do not recommend advertising at school sporting events (Bhore et al., p.18).

Recommendations based on cost-benefit analyses

- As public school outreach programs and the Blue Lid Initiative would theoretically improve recycling rates over time, it is suggested that these efforts are given precedence and adopted before the IGA and CLF recommendations are pursued (Bhore et al., p.19).
- If residential recycling quantity and quality increase, revenue for the recycling program will also increase. Future upgrades to the Glendale MRF could be made with said revenue (Bhore et al., p.13).
- Before acquiring a significant loan from the CLF, further support through an IGA with outside municipalities could provide additional recycling material to be processed and result in additional revenue for the City of Glendale. Furthermore, if IGAs are arranged as previously outlined, the life of Glendale's landfill will be extended (Bhore et al., p.13).
- Despite the financial burden, long-term benefits can be predicted following an upgrade to Glendale's MRF, potentially with funds procured from the CLF. Due to the significant investment level of $2.5 million, it is recommended that Glendale first attempt to establish savings from material revenue to be put toward facility upgrades (Bhore et al., p.19).

CONCLUSION

The ripple effects of Operation National Sword and the significant restrictions it placed on the export of recyclable materials has an ongoing global and local impact on the solid waste management market. The City of Glendale, like many other municipalities, must react in a timely fashion to preserve and improve on its existing recycling programs. Student researchers in ERM 432/532 investigated a wide range of methods to facilitate this process, including case studies, public outreach, the CLF and IGAs. A cost-benefit analysis was performed for select recommendations with the goal of providing the City with a means of evaluating their current recycling program and addressing issues to continually improve their recycling services for residents and potential partner communities. Ultimately, these recommendations aim to provide a framework for Glendale to react and adjust to the global market shift in an informed fashion.

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Image credits

Figure 5 *Top 10 in the Bin flyer, helping educate Peoria residents on acceptable recycling materials with Javi the Javelina, by the City of Peoria.*
https://www.peoriaaz.gov/home/showdocument?id=14753

Figures 6 and 7 *Helpful pages from Peoria's Sustain and Gain 2020 brochure, by City of Peoria.*
https://www.peoriaaz.gov/home/showdocument?id=20256

Figure 18 *Monroe County, New York recycling magnet, from Monroe County's Recycle Right Campaign.*
https://nyfederation.org/wp-content/uploads/2019/pdf2019/41%20Meyer%20L--Garland%20M.pdf

Figure 19 *Pierce County, Washington recycling magnet/poster from Pierce County Recycling Resources.*
https://www.piercecountywa.gov/3615/Multifamily-Recycling

Figure 22 *An available style of BinBisa receptacle, by BinBisa via Earth911.*
https://earth911.com/living-well-being/recycling-bin-binbisa/

Figure 24 and 25 *Closed Loop Partners participants and Closed Loop Partners areas of investment listed on the Closed Loop Partners website.*
https://www.closedlooppartners.com/

Figure 26 and 27 *Monthly material tonnage processed by the ECUA in the first two years of its new MRF operation, and inside view of the ECUA MRF, by Closed Loop Partners.*

https://www.closedlooppartners.com/wp-content/uploads/2020/01/Closed-Loop-Partners-Case_Study_ECUA.pdf

Figure 32 *Example of an Optical Sorter from Eagle Vizion.*
http://www.eaglevizion.com/optical_sorting