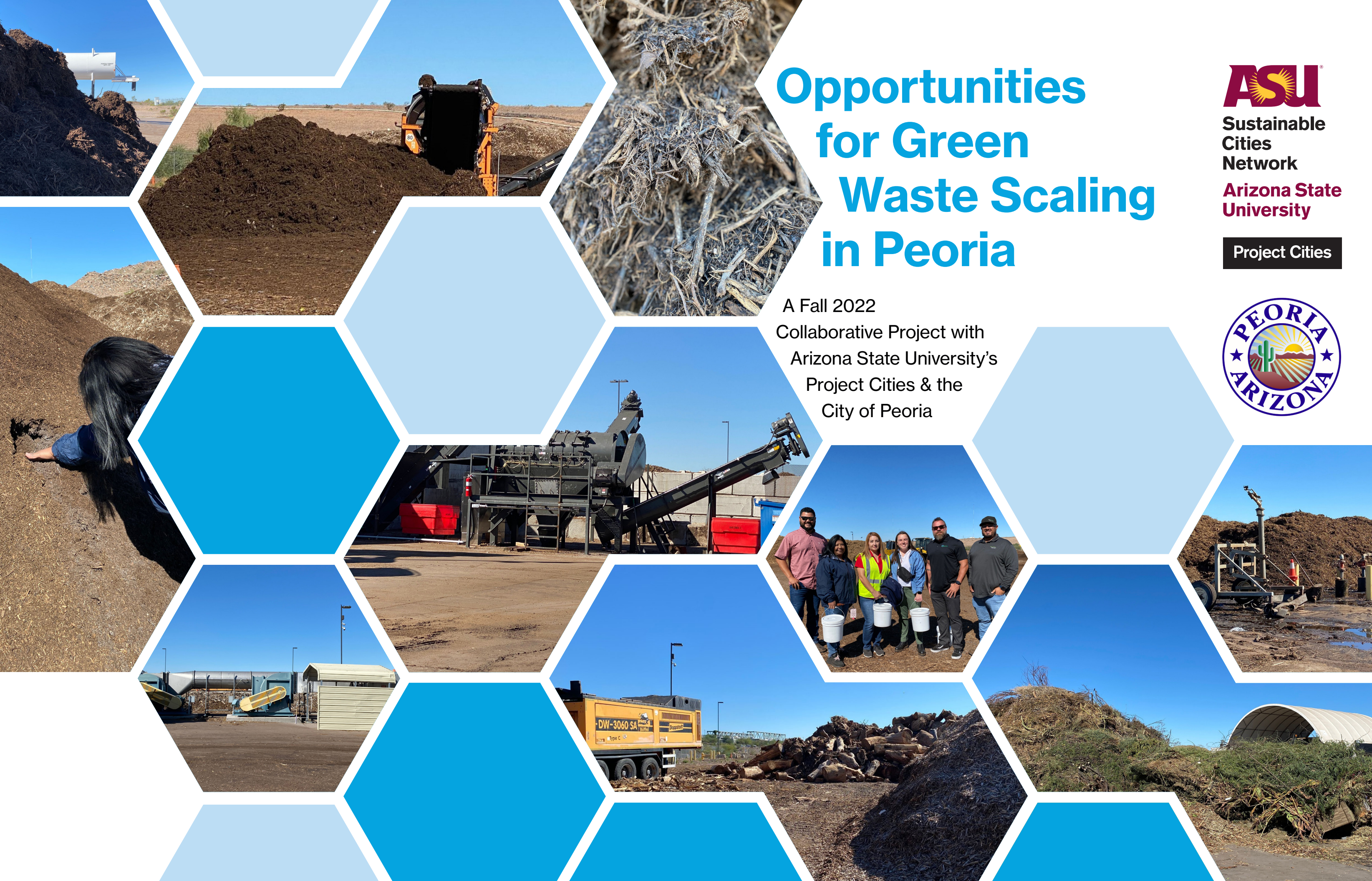


Opportunities for Green Waste Scaling in Peoria

ASU
Sustainable
Cities
Network
Arizona State
University

Project Cities

A Fall 2022
Collaborative Project with
Arizona State University's
Project Cities & the
City of Peoria



PART 1:

Project and Community Introduction

GET TO KNOW THE PROJECT

ABOUT ASU PROJECT CITIES

ABOUT THE CITY OF PEORIA

EXECUTIVE SUMMARY

KEY STUDENT RECOMMENDATIONS

SUSTAINABLE DEVELOPMENT GOALS

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This report represents original work prepared for the City of Peoria 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 Student reports are not peer reviewed for statistical or computational accuracy, or comprehensively fact-checked, in the same fashion as academic journal articles. Editor's notes are provided throughout the report to highlight instances where Project Cities staff, ASU faculty, municipal staff, or any other reviewer felt the need to further clarify information or comment on student conclusions. 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 images:

**Project Cities and
City of Peoria**

ACKNOWLEDGMENTS

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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 Peoria 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 Peoria's future livelihood and community well-being.

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

links.asu.edu/PCPeoriaGreenWaste22F

ABOUT PROJECT CITIES

The ASU Project Cities program uses an innovative 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.

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ASU Sustainable Cities Network
Arizona State University

Project Cities



ABOUT PEORIA

Ranked as the No. 1 place to live in Arizona by Money Magazine, the City of Peoria is currently home to over 190,000 residents. The City enjoys a reputation as a family-oriented, active community with an exceptional quality of life. Peoria entertainment and recreational amenities include attractions such as Lake Pleasant, trails, and community parks.

The City has also demonstrated a strong commitment to sustainability, as evidenced by its incorporation of LEED building design standards, a council-adopted Sustainability Action Plan, and the "Green Team" staff dedicated to managing organization-wide sustainability initiatives.

PEORIA TEAM

Project Cities Community Liaison

Sharon Roberson, Assistant to the City Manager, City Manager's Office

Fall 2022 Peoria Project Leads

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Peoria is the place
World class • Sustainable • Future Ready
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February 28, 2022

Dear Peoria community members,

On behalf of the City of Peoria, we would like to express our appreciation to all who have been involved with Arizona State University's (ASU) Project Cities program. Over the last year, our staff has had the opportunity to collaborate with faculty and students across several academic programs, benefitting from their insights, ingenuity, and diverse perspectives on a number of projects. Many of these entailed public participation, and you may have met some of these engaging students at a community event, or completed a community survey.

Project Cities is one of several partnerships we enjoy with ASU, and part of our ongoing strategy to connect with community partners to leverage our resources as we address the many challenges facing local governments. Working with students at an undergraduate, graduate and capstone project level brings a fresh perspective and resourcefulness to complex issues. This partnership has resulted in extensive research, recommendations, and deliverables that take several key initiatives to the next level. These include our efforts around increasing transit ridership, community engagement strategies, historic preservation and innovative recycling methods. Through this partnership, we have developed an understanding of the feasibility of each initiative much more quickly than we could have without their collaboration.

The results provided on each project position us to serve our community with cost-effective and innovative programs in the interest of continuous improvement. The city has already begun to incorporate the students' deliverables into next steps in advancing these projects. We look forward to continuing this work on additional projects in the coming year with such talented students and faculty.

The City of Peoria appreciates the ongoing and growing relationship with Arizona State University and the many ways in which the alliance provides mutual value.

Sincerely,

A handwritten signature in black ink that reads "Cathy Carlat".

Cathy Carlat, Mayor

A handwritten signature in black ink that reads "Jeff Tyne".

Jeff Tyne, City Manager

Peoria, Arizona



Proud partner of
ASU Sustainable Cities
Network
Arizona State University

Project Cities

Rio Vista Recreation Center

Demographics

total population: **190,985**

median age: **35**

**highly skilled and educated workforce
of 85,252**

11,997 veterans live in Peoria

78% of residents are homeowners

median property value: **\$399,025**

**33% of residents hold a Bachelor's
degree or higher**

median household income: **\$79,700**

Schools

#3 of 131 Best School Districts for Athletes in Arizona

#5 of 40 Best School Districts in Phoenix Metro Area

#7 of 130 Best School Districts in Arizona

The Peoria Unified School District consistently receives high ratings and offers signature programs such as the Career and Technical Education programs. Deer Valley Unified School District has two highly-rated K-8 schools within the city, including an Academy of Arts.

Peoria is also home to Huntington University, a liberal arts college offering digital media education in animation, broadcasting, film, graphic design and other digital media arts.

Leading industries

Peoria, Arizona is not just a scenic suburb of Phoenix, but also a thriving economic development hub with an educated workforce and high-end residential living. There are over 4,000 employers and more than 75,000 people employed within Peoria. Leading industries include health care and social assistance, retail trade, and finance and insurance. Highest-paying industries include utilities, manufacturing and public administration. Beyond these industries, Peoria works actively to attract businesses from aerospace and defense, film and digital media, technology and innovation, hospitality and tourism, and research and development. Peoria is the place for business owners, developers and investors.



Health Care & Social Work

10,905 employees



Retail Trade

10,628 employees



Finance & Insurance

6,574 employees



History

Founded in 1886 by Midwestern settlers, Peoria is nestled in the Salt River Valley and extends North into the foothills around Lake Pleasant. Beginning as a small agricultural town, the economy received a major boost when a railroad spur line was built along Grand Avenue. The construction of the Roosevelt Dam in 1910 secured a reliable water supply, attracting more settlers to the area and business endeavors to the town center. Peoria's economy continued to have an agricultural focus for decades. Continually growing, Peoria assumed city status in 1971 with a population of 4,792. It has since grown into a city with a population over 190,000, and is renowned for its high quality of life and recreational amenities.

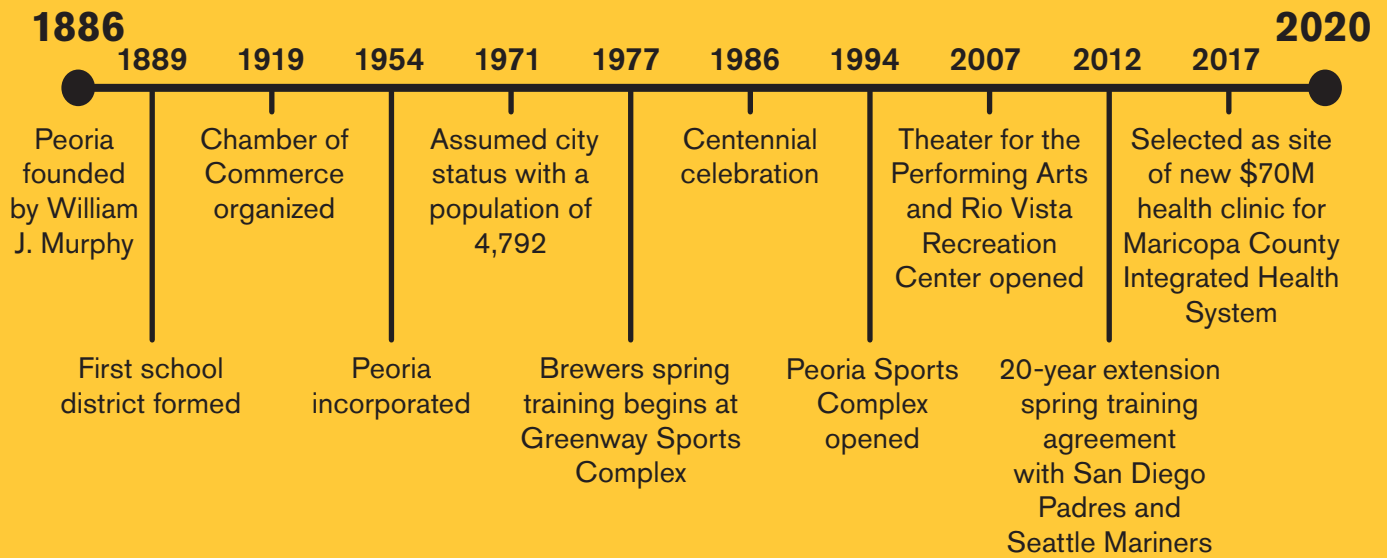
Sustainability

Peoria has demonstrated leadership in municipal sustainability efforts through a wide range of actions. Listed below are some of the City's sustainability accomplishments.

- Incorporation of LEED building design standards
- Appointment of a full-time city staff member who manages and coordinates sustainability initiatives
- Sustainable urban planning practices including open space planning and water management principles
- Sustain and Gain: Facebook page and brochures keep residents up to date on city sustainability efforts and ways to get involved
- Water Conservation Program: free public classes, public outreach at city events, and water rebate incentives for residents
- Council-Adopted Sustainability Action Plan: this strategic planning document, in its second iteration, ensures city departments are developing sustainability-oriented goals, tracking success metrics, and encouraging cross-communication in the preparation of Sustainability Update presentations made to the Peoria City Council on an annual basis
- Sustainable University: courses and workshops to empower residents to make small changes that make Peoria a better place to live; topics covered include residential solar, gardening, composting and recycling

Awards and recognition

- Award of Distinction for Technology Innovation, ROBO Ride Autonomous Vehicle Project, 2022 (*Arizona Forward*)
- Best Neighborhood Program for Social Revitalization/ Neighborliness, 2022 (*Neighborhoods USA*)
- No.1 City to Live, Work and Play in 2021 (*Ranking Arizona*)
- Outstanding Facility Award for Paloma Community Park, 2021 (*Arizona Parks & Recreation Association*)
- Best of the West Excellence in Innovation Award for Pop-up Peoria, 2021 (*Westmarc*)
- Top 15 Safest Cities in the U.S. 2017-2019 (*Wallethub*)
- 10th Best City to Raise a Family in 2018 (*Wallethub*)



Livability

Peoria is renowned as a great place to raise a family and start a career. A plethora of

local amenities and attractions contribute to Peoria's livability. Beyond the tourist attractions of Spring Training and Lake Pleasant, the City offers many community facilities and recreational opportunities for all ages and interests such as an extensive public park system and annual community events. Peoria's dedication toward livability is also evident in the City's latest General Plan which addresses sustainable water use, housing, public services and more.

Ranked as the No. 1 place to live in Arizona and one of the best cities in the United States.

-Money Magazine and Yahoo! Finance

Peoria strives to uphold these six major livability priorities in order to maintain an exceptional quality of life for its citizens:

	Arts, Cultural and Recreational Enrichment		Economic Prosperity
	Smart Growth		Superior Public Services
	Healthy Neighborhoods		Integrated Transportation

Community Facilities

- Peoria Community Center
- Rio Vista Recreation Center
- Peoria Sports Complex
- Peoria Center for the Performing Arts
- 39 neighborhood parks
- 2 libraries
- 3 swimming pools
- 5 golf courses
- 9 lighted multi-purpose ball fields
- 15 tennis courts

Peoria Sports Complex



Lake Pleasant

Urban ecology, ecotourism and recreation

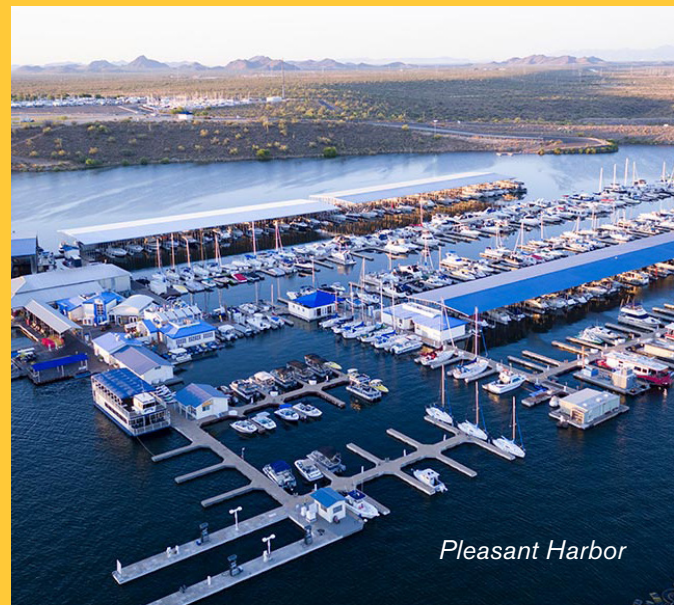
Peoria is surrounded by the natural beauty of the Sonoran Desert and is home to Lake Pleasant, a 23,000-acre park and major recreational asset to the North Valley. The transient Agua Fria River and New River flow through Peoria, as do a multitude of washes and creeks. Most notable perhaps is Skunk Creek — known for the recreational trails running alongside it — which forges a connection between Peoria and Glendale. Northern Peoria is home to beautiful mountains and buttes including Sunrise Mountain, Calderwood Butte and Cholla Mountain.

Boasting over 300 days of sunshine annually, Peoria's ecotourism opportunities are a steady industry for residents and visitors. The City features over 60 miles of trails for walking, biking and horseback riding, as well as 570 total acres of accessible park land.

Lake Pleasant Regional Park contains a full-service marina, providing opportunities for water-oriented recreation such as kayaking, water skiing and even scuba diving. Visitors can also go horseback riding, take gliding lessons, hike, camp and more.

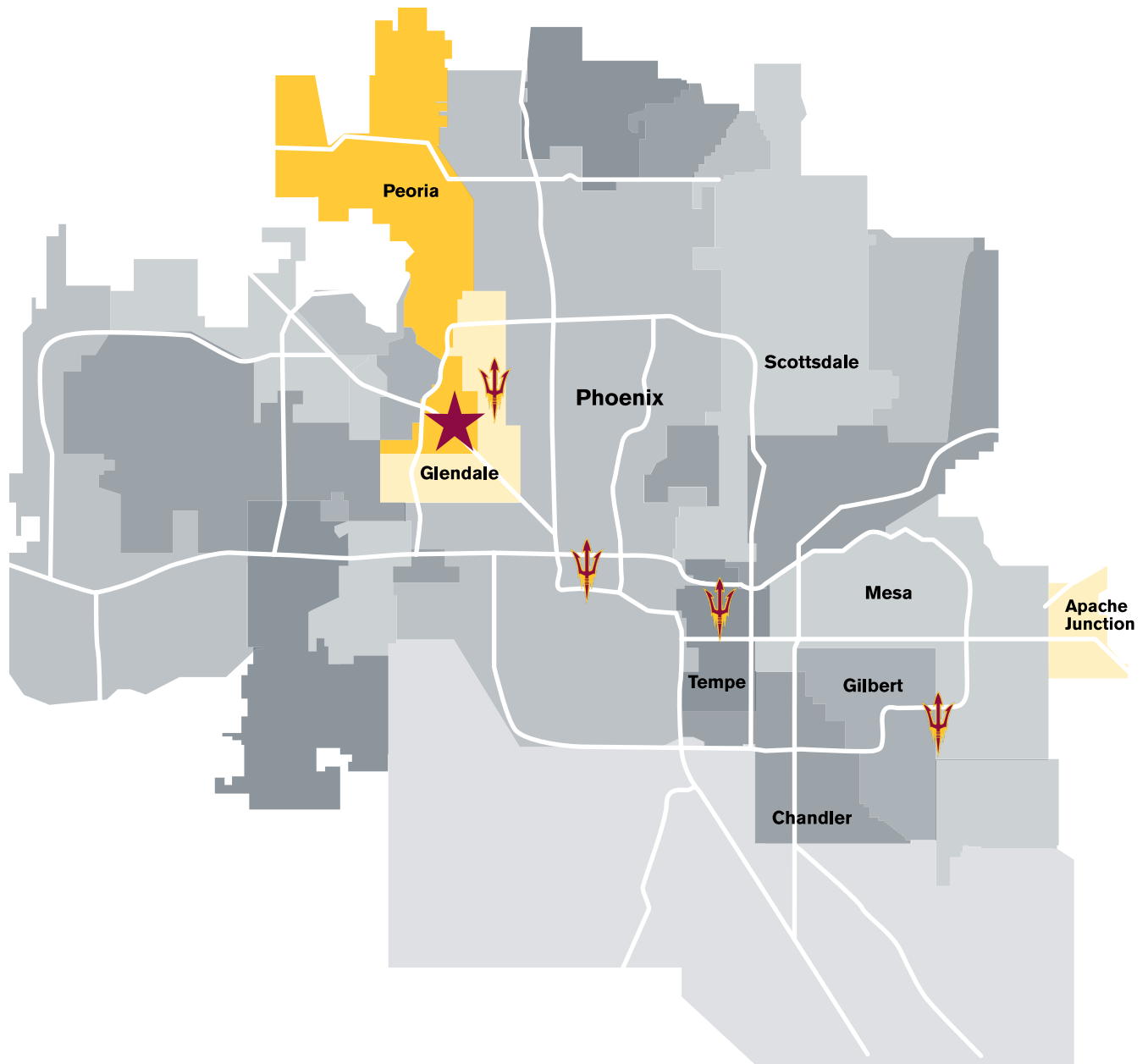


Skunk Creek



Pleasant Harbor

MAP OF PROJECT CITIES PARTNER COMMUNITIES IN THE GREATER PHOENIX METROPOLITAN AREA



 Peoria City Hall

 ASU campus



The following report summarizes and draws highlights from work and research conducted by students in ERM 593: Applied Project for the Fall 2022 partnership between ASU's Project Cities and the City of Peoria.

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

links.asu.edu/PCPeoriaGreenWaste22F

EXECUTIVE SUMMARY

Waste contamination is an increasingly challenging barrier to effective recycling and composting efforts. Green waste contaminants, such as grass clippings and leaves, can release significant amounts of methane and other greenhouse gasses when disposed of in landfills. Green waste is any organic material that can be broken down into compost. Compost is converted into soil, mulch, or natural fertilizer product. Instead of composting green waste, the City of Peoria, Arizona, currently sends green waste to landfills mixed with residential, municipal solid waste. Organic material is degrading in landfills and emitting methane into the atmosphere. The City of Peoria is considering creating a more sustainable solid waste management alternative for green waste through a recycling program.

Master of Science in Environmental and Resource Management graduate student, Annie Grimshaw, from AI Brown's **ERM 593: Applied Project** conducted research to gauge the feasibility of a scaled-up green waste collection program. The research explores possible disposal options for the City of Peoria and the processes and costs associated with a municipal green waste recycling program. The report provides an overview of the benefits and challenges of green waste composting, followed by three case studies of peer community green waste programs. The case studies emphasize the importance of public-private partnerships when implementing a green waste program, largely due to its cost-saving benefits.

Following the case studies, the report details the process of converting green waste into soil to demonstrate to Peoria the composting services companies can provide. A cost-benefit analysis details the net savings of diverting green waste from landfills. While private companies will likely charge more than expected for green waste, there are long-term savings in reducing transportation costs for a municipal collection program. Recommendations are provided to highlight how Peoria can successfully scale a green waste collection program. The goal of this report is for Peoria to use the information provided to identify a trustworthy partnership. The names and information about private green waste processing vendors are provided to the City of Peoria to consider in its green waste efforts. A City-wide green waste recycling program should increase community involvement and create a more sustainable city.

KEY STUDENT RECOMMENDATIONS

Recommendations for Green Waste Recycling

Survey residents and elected officials to find their desires and needs for the program. Discuss with them the disadvantages and advantages of a green waste disposal program. Be transparent with the information provided to the residents.

Contact other municipalities about the green waste programs in their cities to see what advice they can offer. Various cities in Maricopa County are currently running successful green waste programs, so they would be able to provide helpful information.

Contact the subject matter experts identified in this report at WeCare and CTS Green Waste for more information about the services they can provide for Peoria.

Explore the services other local vendors can provide for the City of Peoria. Some examples of these green waste processing facilities are Tempe Solid Waste Compost Yard, Weinberger West Transfer Station, and Salt River Landfill – Green Waste division.

Select a trustworthy and cost-effective vendor to keep prices low and ensure that the green waste is disposed of properly.

Create educational tools for the residents to know which items can be picked up for collection. Community involvement is one of the most important factors when starting a new program like this one. Residents should be provided information about the program using multiple outreach methods, such as:

- Printed and digital flyers explaining the green waste program and what it can provide residents.
- Signs that residents can put next to their trash collection areas at home outlining which items should and should not go to green waste disposal sites.
- Create yard signs to place throughout neighborhoods that detail the pickup times of that area.
- Make posts on apps like Nextdoor and share information through City of Peoria social media accounts.

Keep citizens involved throughout the process by selecting a vendor allowing residents to purchase the final product from the processed green waste. The soil, mulch, and plant additives would be free to residents or sold back to them at a reduced price.

Consider using the soil and mulch products that are created during the recycling process to help with beautification efforts across the city. Reduce the amount of money the city spends on green space maintenance by using recycled soil and mulch.

KEY STUDENT RECOMMENDATIONS

Recommendations for Green Waste Recycling

Create a food waste collection program in addition to the green waste program. Many vendors also accept food waste and encourage food disposal onsite to add more nutrients to the soil.

Use information in this report to educate residents on getting involved in green waste recycling programs.

CITY OF PEORIA PROJECTS: ALIGNMENT WITH THE UNITED NATIONS'

SUSTAINABLE DEVELOPMENT GOALS

As the leading international framework for sustainable decision-making, the 17 Sustainable Development Goals (SDGs) lay out a path for partnerships toward global peace and prosperity. The SDGs provide a set of goals and metrics for project impact to be measured, offering an illustration of the benefits experienced by the cities, towns, and students who participate in a Project Cities partnership. For details on the SDGs, visit sdgs.un.org/goals.



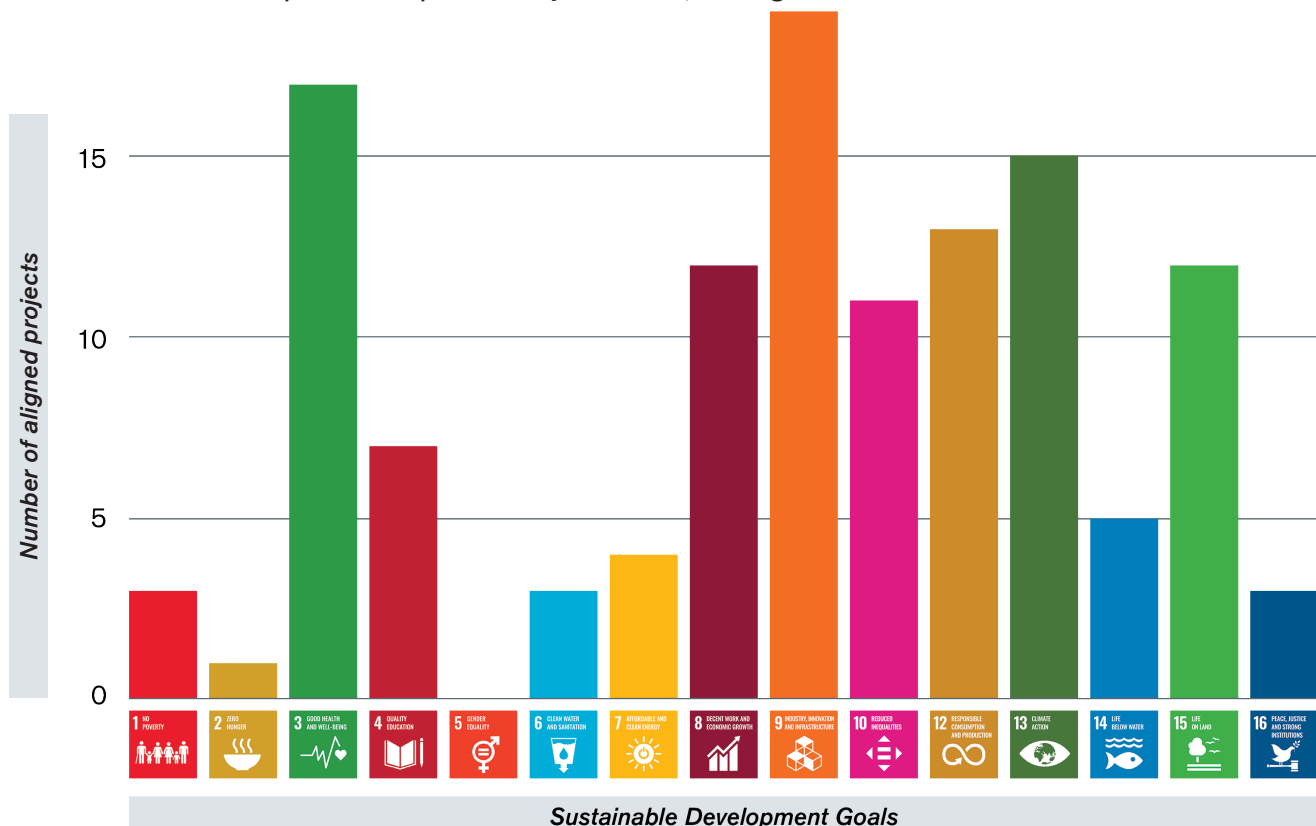
11 SUSTAINABLE CITIES AND COMMUNITIES



17 PARTNERSHIPS FOR THE GOALS

Every project in the PC program aligns with SDGs 11 and 17.

The figure below illustrates SDG project alignment throughout the City of Peoria's partnership with Project Cities, through the Fall 2022 semester.



TOP THREE GOALS ADDRESSED IN THE FOLLOWING REPORT

This project seeks to identify solutions to existing market-based limitations on Peoria's recycling operations. As a result of this student research, Peoria will be better able to divert waste from landfills and further develop a more circular economy. This project contributes to the advancement of several SDGs, including SDG 9, SDG 12, and SDG 15.



Goal 9: Industry, Innovation and Infrastructure

"Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation."

Since green waste a common contaminant in landfills and recycling facilities, it is crucial to consider emerging technologies and programs to recycle green waste appropriately.



Goal 12: Responsible Consumption and Production

"Ensure sustainable consumption and production patterns."

By identifying new opportunities for solid waste management, Peoria can impact community health and resident well-being by providing avenues for responsible recycling.



Goal 15: Life on Land

"Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss."

Diverting green waste from landfills reduces contamination and provides new opportunities for waste to be used in sustainable ways.

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PART 2:

Exploring The Scope for Green Waste Scaling

**RECOMMENDATIONS FOR SUCCESSFUL OPTIMIZATION OF THE
GREEN WASTE RECYCLING PROGRAM**

**ERM 593:
APPLIED PROJECT**

IRA A. FULTON SCHOOLS OF ENGINEERING

**FACULTY
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INTRODUCTION

The City of Peoria is home to approximately 191,000 people living in of 180.5 square miles. Peoria was ranked as the W1 city to live, work, and play in Arizona in 2021 by Ranking Arizona (City of Peoria, n.d.). In years past, it has also been ranked as the first city with booming employment growth and ranked number one for having the best private golf courses by Ranking Arizona in 2022 (City of Peoria, n.d.). These impressive accolades prove that the City is growing and innovating. However, as the population increases, so does the waste generated by the city. As Peoria's innovation, tourism, and beautification efforts improve, the City's waste management system must also improve. The Peoria Solid Waste Division aims to further improve the City's waste services by establishing and scaling a green waste collection program. In 2022, Peoria partnered with the ASU Project Cities program to explore opportunities for green waste disposal and best practices for starting a collection program for their residents.



Figure 1 Denali Composting site visit

The City of Peoria currently does not have a landfill and instead transfers its waste to outside landfills and transfer stations throughout the Valley. Peoria residents are provided with weekly trash and recycling pick up, with the option to schedule a special haul with Peoria Solid Waste. In 2021, the City conducted a six-month pilot program to test the success of a potential green waste collection program in specific areas of Peoria. The City's Solid Waste Division is now identifying the advantages and disadvantages of scaling a green waste collection program city-wide. This report provides background information on green waste, case

studies of successful programs, and information about potential vendors to collaborate with to determine if scaling a green waste program is strategic for the City of Peoria.

Editor's Note

The City of Peoria launched its Blue Lid Pilot as part of a grant from The Recycling Partnership. As part of the study, 2,600 homes were given informational materials about recycling and a blue lid on top of the regular recycling bin. Auditors measured how much contamination occurred, primarily focusing on green waste contamination (yard clippings, food, etc.) in recycling bins.

LITERATURE REVIEW

A literature review was conducted to explore green waste recycling options for the City of Peoria. The research identified environmental hazards associated with improper waste management, innovative green waste technologies, and examples of programs in other cities. Case studies of the selected cities investigated the financial aspects of the programs. Information was collected through communication and interviews with subject matter experts. This group of individuals answered questions such as what their companies can offer and how waste is treated. The subject matter experts provided statistics on the current state of green waste in Arizona and the United States. Additionally, information gathered during a tour of the Denali WeCare Compost Facility in Phoenix, Arizona was used to inform findings and recommendations.

Green waste

Green waste, or "biological waste," is any waste that can be broken down into compost. The type of waste collected is usually composed of waste from gardens and yard work. However, every waste facility typically has a specific list of items that will or will not be accepted. The City of Peoria and many cities across the country dispose of green waste in landfills. A common misconception is that mixing green and household waste helps control landfill odors. However, adding green waste to a landfill causes more harm than good. According to the Environmental Protection Agency (2022), 292.4 million tons of municipal solid waste were generated in 2018. Within that, 12.11% is from yard trimmings, 6.19% is from wood, and 21.59% is from food (U.S. Environmental Protection

Agency, 2022). Most, if not all, of this waste, could be diverted from landfills and composted in a green waste recycling facility in a green waste recycling facility.



Figure 2 Acceptable and unacceptable list of items that can be collected at a green waste facility, by Wiltshire Grab Hire Group

Figure 2 represents an example of acceptable items that a green waste processing facility could take. Most facilities can take in anything that is naturally growing, falling, or being trimmed from lawn and garden maintenance. Certain produce items can also be sent to a green waste processing facility. Partnering with a vendor that can take in produce items could provide opportunities for a food composting program in the future if the City is interested. However, the list of wastes that can be accepted often varies between vendors and geographies. Using diagrams like Figure 2 is a way to advertise the program and educate the public on proper residential waste disposal practices.

Problems involving improper handling of green waste

Disposing of green waste properly is important for various reasons. The main reason municipalities should encourage the proper disposal of green waste is due to the harmful effects of improper disposal. When green waste is put into a municipal solid waste landfill, it breaks down through **anaerobic degradation**. This process emits harmful methane (CH_4) into the atmosphere. Landfills generate 17% of the world's total CH_4 emissions (Meadows, 2014). These methane emissions account for 9% of total greenhouse gas emissions (GHG) nationwide. Despite these striking numbers, many cities are still lacking proper systems to dispose of this type of waste. A study by French scientists estimated that only 7% of municipal wastes are composted, even though 50% are biodegradable organics that can be composted, meaning that many areas of the world

are missing an opportunity to care for green waste properly (Francou et al., 2008).

Advantages of green waste disposal

There are various advantages to creating a green waste disposal collection system, especially when it comes to environmental benefits. The final product that results from green waste recycling can boost soil quality and water retention (Meadows, 2014). Another benefit is that the high quality, nutrient-dense soil helps reduce erosion on land where the topsoil is being depleted. The mulch and soil produced from green waste facilities contain essential nutrients. This results in the reduction of need for chemical fertilizers and pesticides sprayed on the soil. Green waste benefits plant cultivation, especially in urban and suburban areas with small-scale residential and community gardens (Haigh et al., 2020). The product created from composting efforts helps improve the soil by increasing organic matter (Francou et al., 2008). Compost from green waste can also be used in land reclamation efforts to restore soil and natural areas that have been damaged.

Green waste recycling will help the City of Peoria meet its solid waste goals and goals set by the United Nations. Utilizing municipal green waste soil in agricultural efforts can help reach three United Nations Sustainable Development Goals (SDG). These SDGs are 11, 13, and 15 (Haigh et al., 2020). SDG 11 refers to creating Sustainable Cities and Communities by creating a closed-loop system that consistently reuses agricultural products by returning the product to the consumer. SDG 13 refers to Climate Action, which the City of Peoria can advance by reducing methane emissions from landfills and helping lower humans' impact on climate change. The last goal green waste recycling efforts help to advance meets is SDG 15, improving Life on Land. Green waste recycling helps to reach this goal by improving soil quality and providing opportunities for reclamation efforts when compost is used on the land.

Disadvantages of green waste disposal

The benefits of green waste disposal outweigh the financial and environmental costs. However, it is necessary to address some disadvantages of green waste composting. Many of these issues come from improper disposal techniques used by green waste processing facilities. It is important for Peoria to carefully select and audit vendors to prevent nuisance conditions and soil contamination.

One example of a possible disadvantage may be harmful bacteria associated with some plant wastes. According to a study focused on microbiological research, waste-derived composts also may contain a variety of harmful bacteria. Waste-derived composts also may have antibiotic-resistant bacteria (Haigh et al., 2020). Therefore, proper treatment, storage, and disposal of waste are critical to successful city-wide composting efforts. A best practice is having a regular compost sampling program, including lab analysis for microorganisms of concern.

In addition to harmful bacteria, there is a possibility for heavy metals and other chemicals to leach into soil created by compost, thus further providing rationale for a consistent sampling and testing as part of a municipal composting program (Haigh et al., 2020). These contaminants are not acceptable for soil used to grow food crops. If composts are mismanaged, carbon mineralization and carbon dioxide emissions into the atmosphere may occur (Francou et al., 2008). This would mean that instead of the GHG of methane from green waste being emitted into the atmosphere, it would be replaced by the GHG of carbon dioxide. **Immature composts**, compost that has not fully decomposed into a stable product, or composts with high phytotoxicity have led to high ammonium levels in the soil or other high levels of chemicals that cause damage to the soil (Francou et al., 2008). **Phytotoxicity** refers to any adverse effects on plant growth and survival causing chemical damage to the plant. Therefore, improper composting techniques could cause more harm than the disposal of green waste in landfills.

Important takeaways

There are many key takeaways from this research that Peoria should consider when creating its collection program. The first takeaway is that the City should set clear goals to help measure the program's success. A goal of the City of Peoria should be to increase its waste diversion efforts. Waste diversion refers to redirecting recyclable and reused materials away from traditional landfills (Pickering et al., 2020). A series of educational outreach tactics can guide Peoria to a goal of nearly 100% waste diversion. Community outreach and education about new waste recycling programs are among the most important parts of the process. Many studies have suggested that educational messaging is preferred most among governmental entities (Pickering et al., 2020). Peoria must create a communication strategy built on educating citizens on the program's environmental benefits to increase participation. Participating in the green waste program should appeal to the value Peoria residents

enjoy from living in a community with a high standard of living. Messages describing the benefits of green waste recycling should be added to the waste pick-up schedules sent to residents.

Another important factor is that community involvement must be at the forefront of green waste scaling efforts. Public trust is important in a successful waste disposal program because people believe it will be disposed of properly when they put out their green waste (Meadows, 2014). Peoria must ensure its residents that the majority of the green waste being disposed of will not end up in a landfill. There must be full transparency between the City, the vendor, and the residents, and have as much involvement as possible. Previous surveys of residents in other cities indicate that some residents do not view green waste collection programs as beneficial. When the City of Niagara, Canada, started exploring a green waste collection program, the solid waste department sent out a survey to residents to address concerns (Pickering et al., 2020). Figure 2 displays these survey results.

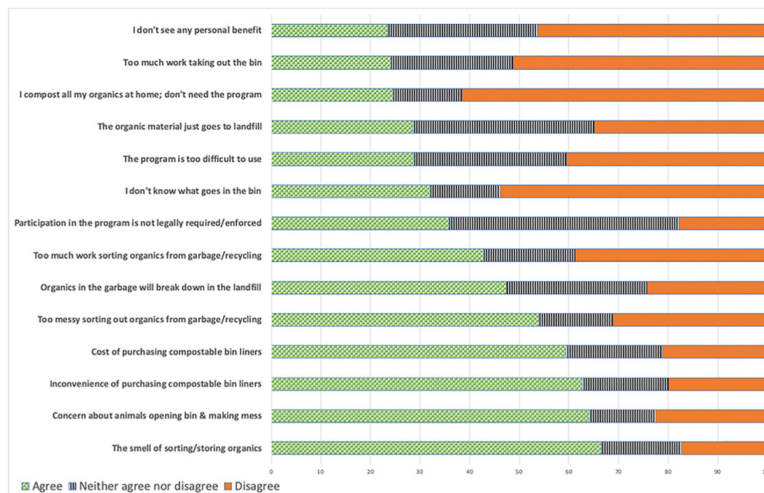


Figure 3 Reasons why residents are hesitant to participate in the green waste disposal program, by Pickering et al., 2020

To help connect the residents with the green waste collection program, outreach and educational tools can be utilized. Some outreach methods may include various types of surveys, social media advertisements, or different incentives to help increase participation (Pickering et al., 2020). Many municipalities have increased participation by providing financial incentives if citizens are involved in the program. This could be done by

slightly decreasing waste collection fees for residents participating in the program. Another incentive is to make participating households eligible for prize drawing contests.

Editor's Note

Editor's note: In Fall 2021, students from the School of Social and Behavioral Sciences worked with the City of Peoria's Solid Waste Division to research best practices for recycling education and messaging.

Read the report at https://links.asu.edu/PCPeoriaCommunicationCampaigns21F_Report

Case study: Atlanta, Georgia

Atlanta has a contract with GreenCycle requiring the company to distribute a percentage of their composted waste to the residents free of charge (Swartz, 1998). Residents place green waste on their curb one day, and then within a few weeks or months, they receive a delivery of nutrient-rich soil and mulch product right at their doorstep. This has proven a successful way to get residents more excited about the program and involve them in each part of the process. This program costs the city about \$5 million annually, which when proportionately compared to the population of Peoria, would equate to approximately \$1.9 million annually.



Figure 4 GreenCycle pickup truck, from Google Images

While Atlanta has been running a successful green waste program for the past 26 years, there have been difficulties along the way (Swartz, 1998). The main obstacles in Atlanta are due to the local laws that waste haulers must follow. Haulers can only collect yard waste in paper bags or marked 32-gallon containers. The paper bags must be marked with "YARD TRIMMINGS" on all four sides. Also, these bags cannot exceed 35 pounds in weight. If Peoria's green waste program requires specific instructions for

residents to collect green waste, the City should leverage strategic educational outreach initiatives to ensure resident waste can be properly collected.

Case study: Eureka, Missouri

One city with a cost-effective green waste collection program is Eureka, Missouri (Eureka, Missouri, n.d.). The City has a partnership with a waste management company called Waste Connections. Eureka sends three types of waste to this facility: residential, recyclables, and yard waste. Waste Connections bills each household directly a total of \$25.05 for collecting all three types of waste (Eureka Missouri, n.d.). Eureka provides a separate waste removal service for non-recyclable wastes intended for landfill disposal. The processing facility for Waste Connections is about 45 minutes away from Eureka in Bridgeton, Missouri. This is an important factor because some of the green waste recycling vendors in Maricopa County may have facilities that are more than ten miles from Peoria. Eureka is a good example of what it is like to work with a vendor that is farther away. Despite the distance, rates for Eureka residents have remained consistent throughout the years and often do not fluctuate due to rising gas prices.



Figure 5 Garbage collection truck, by Waste Collections

Waste Connections collects waste from each household one time per week. Neighborhoods are placed into zones having designated collection days. Three trucks come at different times throughout the morning to pick up the different types of waste. However, residents should have their waste on the curb by 6:00 a.m. on pickup day. Residents may put their yard waste into a 30-gallon brown paper bag or a green waste container that Waste Connections sells. The brown paper bags can be purchased at most grocery stores, home improvement stores, lawn and garden stores, or online for approximately \$2/bag. Figure 3 shows what these brown bags look like and how they are stored curbside. Residents may also use any roll-away bin marked with a "Y," indicating that it is yard waste. Residents can place their green waste on the curb once a week to be picked up by Waste Connections.



Figure 6 Green waste paper bags at a curb, by Bruggers, 2015

Case study: Tempe, Arizona

Tempe, Arizona has a compost resale program and green waste recycling facility. The composting facility at the City of Tempe charges \$32/ton for disposal fees (City of Tempe, n.d.). The compost made from the green waste collected from residents is available for purchase by the City of Tempe residents. This is important because resale programs get citizens involved and excited about green waste programs. The compost is constantly being restocked to be available for all residents. The soil from this process is nutrient-rich and locally made, which means it is compatible with plants grown in the region. The city sells two types of compost that are available to any of the residents. The first type is the fine-texture soil which is sold at \$10 for two-cubic foot bags and at \$30 per cubic yard. This is often used for lawn maintenance and potted plants. Tempe's second product is coarse-mix soil, similar to commercial mulch. This product suits large-scale gardening, city beautification efforts, or recreational areas. It costs \$5 per two-cubic foot bag or \$15 per cubic yard. Figure 7 depicts these two types of products (City of Tempe, n.d.).



Figure 7 Two types of compost, by City of Tempe, AZ (n.d.)

RESEARCH METHODS

A literature review was conducted to explore green waste recycling options for the City of Peoria. The research identified environmental hazards associated with improper waste management, innovative green waste technologies, and examples of programs in other cities. Case studies of the selected cities investigated the financial aspects of the programs. Information was collected through communication and interviews with subject matter experts. This group of individuals answered questions such as what their companies can offer and how waste is treated. The subject matter experts provided statistics on the current state of green waste in Arizona and the United States. Another essential research method utilized during this project was a tour of the WeCare Denali Compost Phoenix location.

FINDINGS & ANALYSIS

Process of green waste composting

This report section describes how green waste becomes a reusable product. The photos in Figure 8 shows how residential waste is transformed into a useful product.



Figure 8 Waste becoming soil and mulch, from original student presentation

The first step in the green waste disposal process is for residents to collect the acceptable green waste allowed by their municipality. The residents then put this waste into a bin or paper bag for collection. Residents can place larger items on the curb for pickup. Green wastes

are transported to the green waste facility to be processed, as seen in Picture 1 of Figure 8.

When delivered to the recycling facility, the waste is sorted to remove unwanted materials, such as plastics and chemical containers, as seen Picture 2. Picture 3 shows how mechanized equipment and vehicles are used to sort unwanted items. Another piece of equipment feeds the sorted waste into a grinder (Picture 4) to reduce the material to a particle size of six inches or smaller.

The material is then piled into rows referred to as **windrows**. These windrows are constantly turned and watered to maintain ideal composting conditions. A specialized piece of equipment turns organic material to promote aerobic degradation. The windrows can get up to 180-190 degrees Fahrenheit or higher if not properly managed (Peralta, 2022). Large and unmaintained piles of organic materials such as compost and cottonseed have been known to begin burning due to unknown causes, including possible spontaneous combustion (A. Brown, personal communication). A supplemental step in the process used by some facilities is to inject air under the piles through pipes to cool or warm the piles. Wastewater called leachate is generated from water applications to the windrows. A best practice is to collect the leachate in a surface impoundment (as seen in Picture 6) and then reapply it to the windrows.

The next step in the process is placing the decomposed material into a tumbler machine, which sifts the product into coarse and fine particle fractions. Examples of these tumblers are seen in both Picture 7 and Picture 8 of Figure 8. The sifted materials age for a few weeks in large piles until deemed acceptable for classification as a final product, as seen in Picture 9. The entire process can take weeks to months, depending on the scope of the facility and seasonal weather conditions. Picture 10 is an example of the final product.

Green waste economics

The assumptions made throughout this section are used to calculate a cost-benefit analysis of creating a green waste recycling program compared to sending green waste to a landfill. The Solid Waste Division of the City of Peoria has stated that the total amount of municipal solid waste in 2021 was estimated to be 67,087 tons, costing \$29/ton

for disposal fees in a landfill (B. Stevenson, personal communication). The City of Peoria could not provide exact tonnage for the amount of green waste generated, but assumptions can be made using EPA data from 2018 municipal solid waste generation values (U.S. Environmental Protection Agency 2022, December 3). The total annual cost of Municipal Solid Waste (MSW) tipping fees for landfill disposal is calculated below. The calculated annual cost of disposal at a landfill is \$1,945,262.

$$\frac{67,087 \text{ tons}}{1 \text{ year}} \times \frac{\$29}{1 \text{ ton}} = \$1,945,262/\text{year}$$

Data from a six-month Pilot Study contracted by Peoria in 2021 was used to calculate the average amount of waste expected to be collected in a year. Figure 9 displays Charts A and B, representing two different outreach methods. Residents in zones in Chart A were notified of the pilot program by placing flyers on their front doors (door tags). Residents in zones in Chart B were notified through the app Nextdoor and door tags.

GREENWASTE BREAKDOWN A					GREENWASTE BREAKDOWN B				
# of HHs w/Green Waste	Green Waste Tons	Average Lbs Green Waste Per/H (c/h)	GW Participation Rate	GW Set Out Rate	# of HHs w/Green Waste	Green Waste Tons	Average Lbs Green Waste Per/H (c/h)	GW Participation Rate	GW Set Out Rate
22	7	636.36	5%	9%	37	4.25	229.73	9%	18%
89	6.31	141.80	8%	13%	117	21.93	374.87	10%	23%
53	29.99	1131.70	7%	12%	93	25.49	548.17	12%	25%
29	14.04	968.28	4%	11%	101	30.32	600.40	15%	39%
74	13.95	377.03	16%	31%	87	24.44	561.84	19%	40%
31	11.79	760.65	17%	20%	77	21.69	563.38	43%	60%
20	3.7	370.00	11%	19%	42	5.57	265.24	24%	40%
31	1.87	120.65	3%	11%	44	4.27	194.09	4%	
62	11.02	355.48	11%	14%	50	12.61	504.4	9%	
411	99.67	540.22	7.63%	16%	648	150.57	426.90	16%	35%

Figure 9 Green Waste Pilot Final Numbers Breakdown, by B.
Borquez, Personal Communication, 2022

The data presented in Figure 9 was used to calculate the number of total zones in the pilot study and the total mass of green waste collected throughout those six months. In the pilot study, 18 zones collected 250.24 tons of green waste in six months. In six months, each zone was visited once.

Figure 10 displays the calculations that resulted from the pilot study. The number of zones in the pilot study was found by adding the number of zones in charts A and B of Figure 9. The Peoria Solid Waste Division team gave the duration of the Pilot Study value. The total mass of green waste collected was found by calculating the summation of green waste tons from charts A and B.

Calculated pilot study figures		
<i>Item</i>	<i>Amount</i>	<i>Units</i>
Number of Zones in Pilot Study	18	Zones
Duration of Pilot Study	6	Months
Total Mass of Green Waste Collected	250.24	Tons

Figure 10 Calculated Pilot Study

Since the City of Peoria was unable to provide data on the total amount of green waste collected each year, an estimation for the entire city was made using the values from the pilot study. The first calculation below describes the average amount of green waste collected in each zone of the pilot study in one month. An average of 13.91 tons/month of green waste was collected in each zone. The second calculation used the average of green waste collected each month to find how much total waste would be collected if the city participated. The entire city comprises 57 zones (B. Borquez, personal communication 2022). The estimated total amount of green waste collected for one month in all zones is 729.87 tons/month. The third calculation describes the estimated total amount of green waste collected in one year. The estimated total amount of green waste collected in one year is 9,514.44 tons/year. Figure 11 displays these findings.

$$\frac{250.24 \frac{\text{tons}}{\text{month}}}{18 \text{ zones}} = 13.91 \text{ tons/month}$$

$$\frac{13.91 \text{ tons/month}}{1 \text{ zone}} \times 57 \text{ zones} = 729.87 \text{ tons/month}$$

$$\frac{729.87 \text{ tons}}{1 \text{ month}} \times 12 \text{ months} = 9,514.44 \frac{\text{tons}}{\text{year}}$$

Total mass of green waste collected per year		
Item	Amount	Units
Number of Zones in Peoria	57	Zones
Duration of Service	12	Months
Average Mass of Green Waste Per Zone	13.1	Tons/Month
Total Mass of Green Waste Each Month	792.87	Tons/Month
Total Mass of Green Waste Each Year	9,514.44	Tons/Year

Figure 11 Total calculated mass of green waste collected per year.

The green waste will be diverted from the landfill and processed at a green waste facility. This diversion of green waste from the landfill will help lower disposal costs at a municipal solid waste landfill. The calculation below describes the amount of municipal solid waste collected once green waste is removed. The total waste without green waste is calculated to be 57,572.56 tons excluding green waste.

$$67,087 \text{ tons of total waste} - 9,514.44 \text{ tons of green waste} = 57,572.56 \text{ tons of waste}$$

The next calculation below describes the new cost for waste disposal at a municipal solid waste landfill where it costs \$29/ton of waste. The new calculated cost of disposal of residential waste is \$1,669,604.24 per year.

$$\frac{57,572.56 \text{ tons of waste}}{1 \text{ year}} \times \frac{\$29}{1 \text{ ton of waste disposed}} = \$1,669,604.24/\text{year}$$

The estimated annual savings is calculated by subtracting the new cost of disposal of residential waste from the original cost of disposal of residential waste. The annual savings for landfill disposal is \$245,657.76/year.

$$\$1,945,262 - \$1,699,604.24 = \$245,657.76/\text{year}$$

According to the calculations above, if Peoria can keep green waste disposal costs close to \$245,657.76/year, the fiscal impact should be relatively neutral. Peoria aims to keep disposal costs for green waste

below \$29/ton. However, Peoria should know that most green waste vendors charge slightly more than \$29/ton for disposal fees.

Green waste vendors will likely charge more than \$29/ton for the City. However, the savings associated with reducing transportation costs for 9,514.44 tons of green waste will offset those additional costs. The City is currently incurring expenses to transport waste to a landfill outside the City, increasing the disposal cost. If the green waste is diverted to a composting facility inside the city, it will reduce the transportation costs of landfill disposal.

Some negotiations could be made with a vendor to help offset the costs further. A possible offset would be to use the compost soil on parcels throughout the City. The soil created at the composting facility could enhance City parks, green spaces, low-impact street medians, and stormwater retention areas. Peoria should consider requiring their contractor to provide 1 ton of compost for every 100 tons of green waste brought to the facility or a ratio deemed fair by both parties. A fair market value can be assigned to the compost to calculate revenue to subtract from the initial cost of green waste disposal.

Potential vendors

This section presents information about potential green waste recycling vendors the City of Peoria may consider as contractors. This report does not provide a complete description of the services provided by the vendors. Costs for the City will vary depending on the specific services requested by the vendor. The companies contacted were responsive and provided general price estimates. The vendors stated there might be additional costs based on specific service requests.

WeCare Denali – City of Phoenix Composting Facility

The first vendor that the City of Peoria could consider partnering with is WeCare Denali, which operates at the City of Phoenix Composting Facility. This is where the pictures from Figure 5 of the green waste process were taken. WeCare Denali is conducting most of its business locally with the City of Phoenix. However, they also have contracts with multiple landscaping companies that bring their green waste directly to the Phoenix facility. They charge approximately \$44/ton of waste for landscaping or private company trucks dropping off green waste (WeCare Compost, n.d.). WeCare charges the City of Phoenix \$32/ton

for disposal at the 27th Avenue Transfer Station location. Currently, they are processing 55,000 tons/year of green waste with a goal of 110,000 tons/year. So, they can partner with an additional city like Peoria. The City of Phoenix owns and operates its green waste collection service. Phoenix uses its vehicles for waste collection. Peoria may use its vehicles to transport the waste to WeCare or contract with an independent waste hauler.

CTS Green Waste Recycling

Another potential vendor for the City of Peoria is CTS Green Waste. Their main facility is in Mesa, Arizona, and CTS reuses 99% of the green waste received. Most of their product is used for commercial agricultural use. They have also worked with the City of Tempe on waste events, conducted a pilot program for the City of Chandler, and worked closely with Maricopa County on creating green waste recycling programs. Therefore, they have the tools and experience to work with Peoria.

CTS has suggested four different services Peoria could use to collect and dispose of green waste. First, Peoria may haul the waste to the Mesa CTS facility site. The disposal rate cost varies depending on the frequency of visits and the amount of waste being dropped off throughout the year. Peoria would need to set up a formal proposal process with CTS to acquire the exact disposal costs. However, the average cost for disposal at the CTS Mesa facility is \$30/ton (M. Battista, personal communication). The next option CTS offers is to set up residential drop-off sites throughout the city where large roll-off bins are placed. A third option is for Peoria vehicles to collect green waste from residences and then place the waste in the roll-off bins. A front-end loader may be needed to load the roll-off bins. Peoria may decide where the roll-off bins are placed and the number of bins. When the roll-off bins are full, CTS will transport them to their Mesa facility. There is a monthly fee for the roll-off bin, and the exact pricing will depend on the number of bins Peoria will have. Figure 9 shows a typical CTS roll-off bin.



Figure 10 CTS green waste roll-off bins, by Melanie Battista via CTS Green Waste, 2022

A fourth service CTS offers is for Peoria to bring green waste collected by their vehicles to a location owned by the city for storage or processing. Peoria may contract with CTS to establish and operate a processing facility. Composted materials may be offered to Peoria residents.

CONCLUSION

The research presented in this report provides the City of Peoria options for scaling its residential green waste program. After a successful six-month pilot program, Peoria is poised to begin the process of expanding its solid waste services to include residential green waste. By diverting green waste from landfills, Peoria can transform residential green waste to nutrient-rich soil while decreasing negative impacts on the environment. Diverting green waste to composting facilities will reduce landfill disposal costs, offsetting new costs associated with composting facility fees. Scaling a residential green waste program will allow the City to continue to demonstrate its commitment to sustainability and livability for the Peoria community.

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