Water Policy Strategies for a Sustainable Peoria

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

Sustainable Cities Network

Arizona State University

Project Cities

PEORIA ARIZONA

PART 1:

Project and Community Introduction

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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 Student reports are not peer reviewed for statistical or computational accuracy, or comprehensively fact-checked, in the same fashion as academic journal articles.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:

City of Peoria, Babbitt Center and Project Cities

ACKNOWLEDGMENTS

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Jon Edwards, Vice Mayor

Bill Patena, Mayor Pro Tem

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Vicki Hunt, City Councilmember

Bridget Binsbacher, City Councilmember (2015-2022)

Brad Shafer, City Councilmember (2022-Present)

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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/PCPeoriaWaterPolicy22S

links.asu.edu/PCPeoriaWaterRates22S

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.*

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ASU Sustainable Cities Network
Arizona State University

Project Cities

Sustainability through local action

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.

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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,

Cathy Carlat, Mayor

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)*

Lake Pleasant

1886 — **2020**

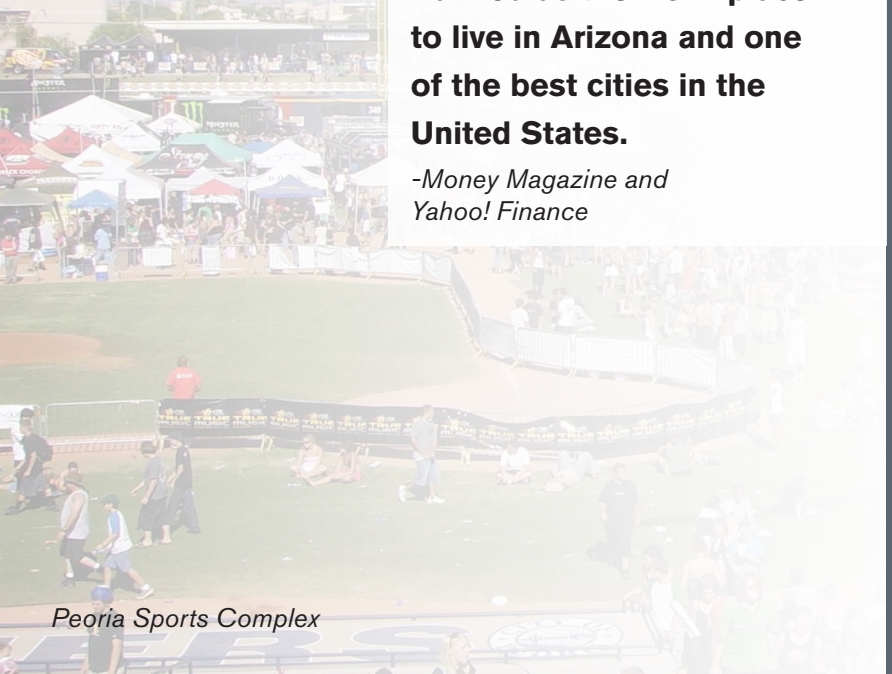
- **1889** — Peoria founded by William J. Murphy
- **1889** — First school district formed
- **1919** — Chamber of Commerce organized
- **1954** — Assumed city status with a population of 4,792
- **1954** — Peoria incorporated
- **1971** — Centennial celebration
- **1977** — Brewers spring training begins at Greenway Sports Complex
- **1986** — Theater for the Performing Arts and Rio Vista Recreation Center opened
- **1994** — Peoria Sports Complex opened
- **2007** — 20-year extension spring training agreement with San Diego Padres and Seattle Mariners
- **2012** — Selected as site of new $70M health clinic for Maricopa County Integrated Health System
- **2017**

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 Sports Complex

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

Lake Pleasant

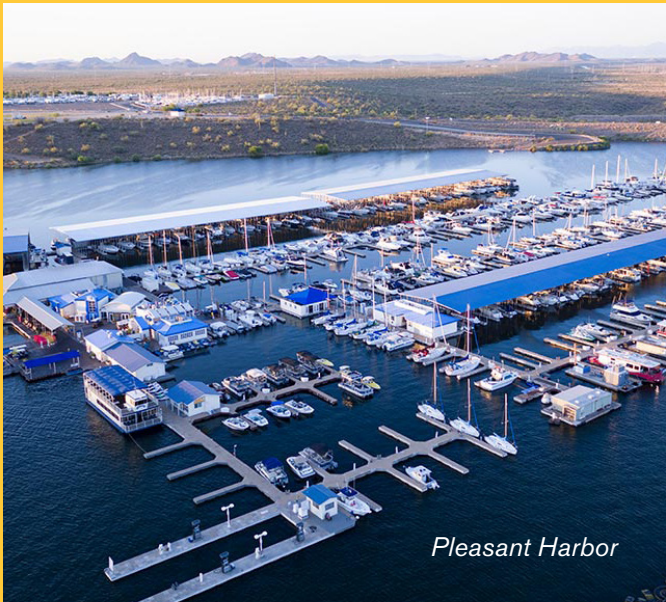
Urban ecology, ecotourism and recreation

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.

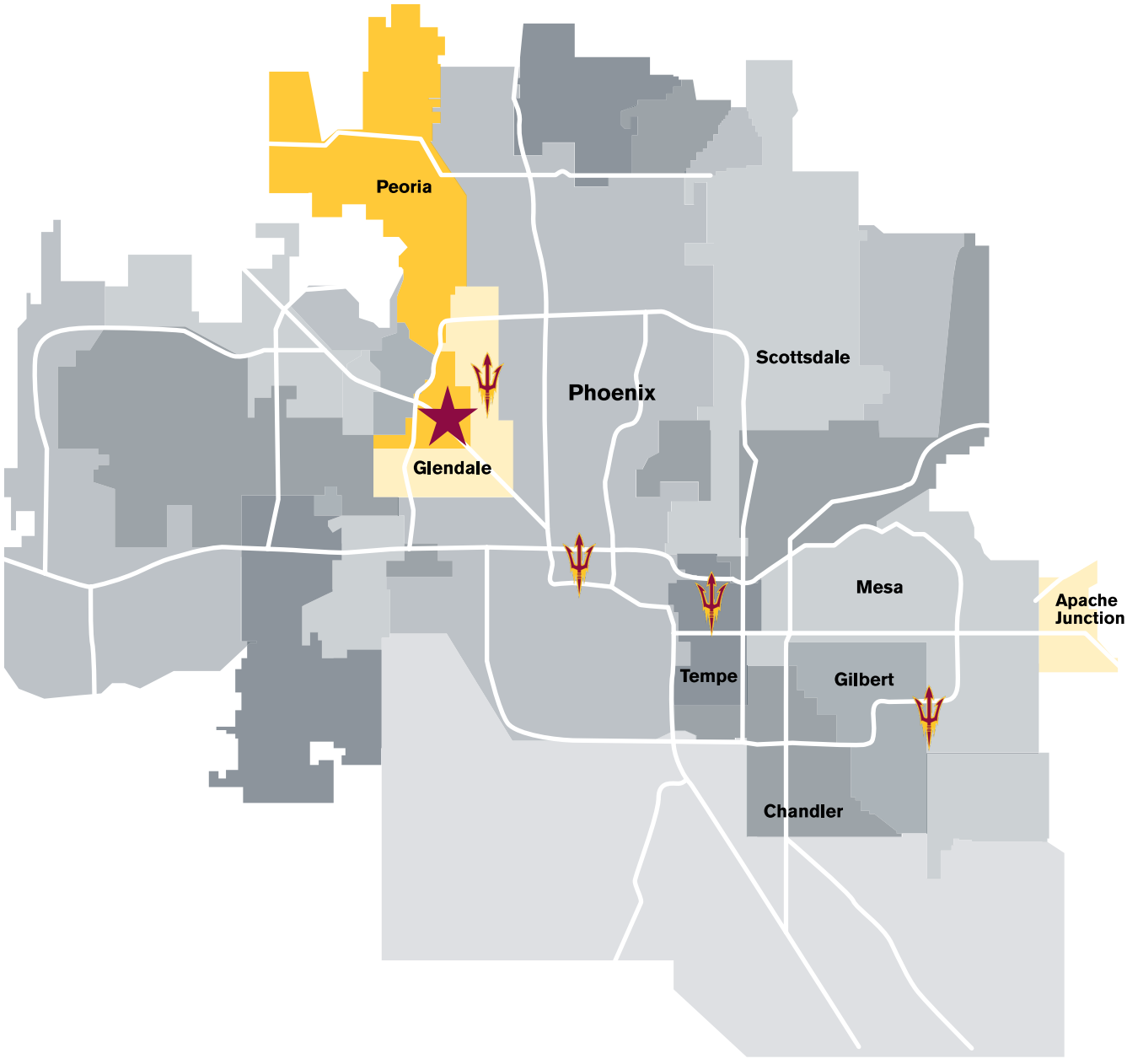
Lake Pleasant Regional Park contains a full-service marina, providing opportunities for water-oriented recreation such as kayaking, water skiing and even scuba diving. Visitors can also go horseback riding, take gliding lessons, hike, camp and more.

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 SOS 321 Policy & Governance in Sustainable Systems and by graduate student Jade Bravo in PAF 509 Public Affairs Capstone for the Spring 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/PCPeoriaWaterPolicy22S

links.asu.edu/PCPeoriaWaterRates22S

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Sustainability through local action

EXECUTIVE SUMMARY

As a desert community, water is a precious resource for the City of Peoria. The City has consistently shown it is a forward-thinking community through its sustainability planning efforts. Peoria's general planning document, PlanPeoriaAZ 2040, outlines the City's commitment to ensuring the best quality of living for Peoria residents through the Livability Initiatives. As part of its priorities, the City prioritizes "Smart Growth," emphasizing sustainable development, particularly conserving water resources in anticipation of future growth.

Figure 1 *Peoria Municipal Complex, by City of Peoria*

In the Spring 2022 semester, the City of Peoria engaged with two ASU classes to research water conservation strategies and advise on improvements to the City's existing water policies. The City's Water Services department has previously engaged with students through the ASU Project Cities program to research best practices for its drought planning efforts. However, as Peoria's population grows, and thus its residential and commercial developments, the Water Services and Planning departments seek to better integrate water and land use planning into its general plan, codes, and ordinances.

Candice Carr Kelman's **SOS 321 Policy and Governance in Sustainable Systems** students engaged with Peoria's Water Services to review Peoria's existing water planning documents, codes, and ordinances. Students were split into six teams to review peer community plans for six policy areas, including General Drought and Water Management, Growth, Service Extension and Annexation, Building and

Plumbing, Landscaping and Outdoor Irrigation, Land Conservation and Open Space, and Water Conservation. Students reviewed peer community general plans, drought management documents, policies, and ordinances related to their respective topics to identify key themes and develop recommendations for the City of Peoria to implement in their water and land use planning.

One graduate student from Malcolm Goggin and LaDawn Lingard's **PAF 509 Public Affairs Capstone** collaborated with Peoria's Water Services Director as part of the culminating experience for her Master of Public Policy (MPP). The City currently uses block tier pricing to incentivize residents to conserve water use but would like additional guidance on restructuring its tiered rating system. The student conducted a peer community analysis of Arizona and other communities to identify an ideal tier pricing structure.

The City of Peoria has demonstrated its commitment to water conservation efforts, including considering integrating water and land-use methods. While the City offers a variety of rebates and incentives for water use, the student research revealed that the City could benefit from better communicating its water conservation efforts and opportunities to its residents through the City website and social media. Additionally, the City can consider alternative methods for water-saving incentives, including consumption-based fixed rates. The following project summary report details a review of peer community policies and strategies related to water conservation. The student recommendations aim to provide the City of Peoria with tools and best practices to better inform Peoria's water planning efforts.

KEY STUDENT RECOMMENDATIONS

Recommendations for city planning	Read more
Expand the utilization of reclaimed water for non-potable use for other public landscapes, such as cemeteries, hotels, and golf courses.	pp.31, 37
Collaborate with other municipalities in the region to expand on a water reclamation program.	pp.31, 37
Expand the existing water conservation programs such as a water audit and fixture retrofit program.	pp.32, 36-37
Further develop public information and education programming to inform Peoria residents about municipal water conservation programs, inspiring residents to take advantage of City resources.	pp.32, 37

Recommendations for growth, service, and annexation	Read more
Develop water for annexation agreements ensuring full control over new developments or communities that wish to utilize Peoria water supply. These agreements empower local governments to control exactly where growth happens and at what cost.	pp.39-42
Develop internal and interlocal agreements to establish uniform standards for growth and establish a consistent and frequently revisited water service area policy that lays out where services can and should be extended. This policy should be formed through the concerted efforts of water, urban, and environmental planning staff with a focus on economic, social, and environmental considerations.	pp.39, 40, 43
Establish acceptable usage of water that allows water users to maintain current or even reduced pricing, while raising rates for any users in excess of acceptable water usage.	pp.38, 41-43

KEY STUDENT RECOMMENDATIONS

Recommendations for building and plumbing codes	Read more
Incorporate aspects of the LEED indoor water use scoring sheet into the plumbing code. Such as requiring new buildings to apply fixtures with a minimum efficiency that meets LEED standards. This could be done for established buildings as well, though it would be more reasonable to have reduced LEED requirements.	pp.48-50
Implement additional rebate offers for high efficiency fixtures and appliances for established buildings outside of what is already offered.	pp.46-47, 50
Improve public education on plumbing problems and solutions, including damages, leaks, blockages, and calcium deposition, and alternative pipe structures that can reduce the risk of these issues. After a period of time, deemed sufficient, leakage fines could be implemented for preventable leakages to deter water waste/contamination and to provide city revenue.	pp.44, 49-50
Limit water sprinklers use during set hours and only allow the use of drip irrigation in its place to conserve water during peak usage times.	pp.45, 50
Offer water efficiency checks through a service charge and provide more public direction towards water saving strategies.	pp.44, 49, 51
Incentivize the use of grease traps to prevent system damage.	pp.46-48, 51
Consider the implementation of low-flow plumbing fixtures in municipal buildings.	pp.48, 51

Recommendations for water conservation	Read more
Consider widely advertising the existing free residential homeowner water efficiency water audit program.	pp.52, 53, 56
Advertise the free residential homeowner water efficiency water audit program with online educational tools to detect leaks and construct personalized water conservation strategies.	pp.53, 56
Publicize drought contingency plans for residents.	pp.52, 55
Create more specific protocols for each stage of severity in Peoria's drought contingency plans.	pp.52, 55
Design a communication campaign for the City's water tiered rating system in order to communicate how tiered rates impact conservation and save residents' money.	pp.93-94, 97
Consider Consumption-Based Fixed Rating as an alternative to tiered water pricing, which considers additional factors that impact water use such as the season and household size.	pp.95-97

KEY STUDENT RECOMMENDATIONS

Recommendations for landscaping and irrigation	Read more
Expand the Non-Residential Landscape Water Budget Program to residential developments.	pp.59, 63
Conduct a comprehensive assessment of Peoria's landscaping water use to determine where excess water is being used and how much is being used.	pp.62, 63
Set limits for total percentage of water intensive landscaping in landscaped areas, while providing exceptions for schools and parks. A recommended maximum of 10% water intensive landscaping, with 30% using reclaimed water.	pp.58, 63
Prohibit the creation of new covenants, conditions, and restrictions that require the use of water intensive landscaping in residential developments.	pp.58, 63
Publicize the programs, incentives, and policies Peoria has developed so they are more accessible to the general public.	pp.62, 63
Provide an educational program for residents with lawns to learn about their rights as homeowners and their HOA.	pp.58, 63

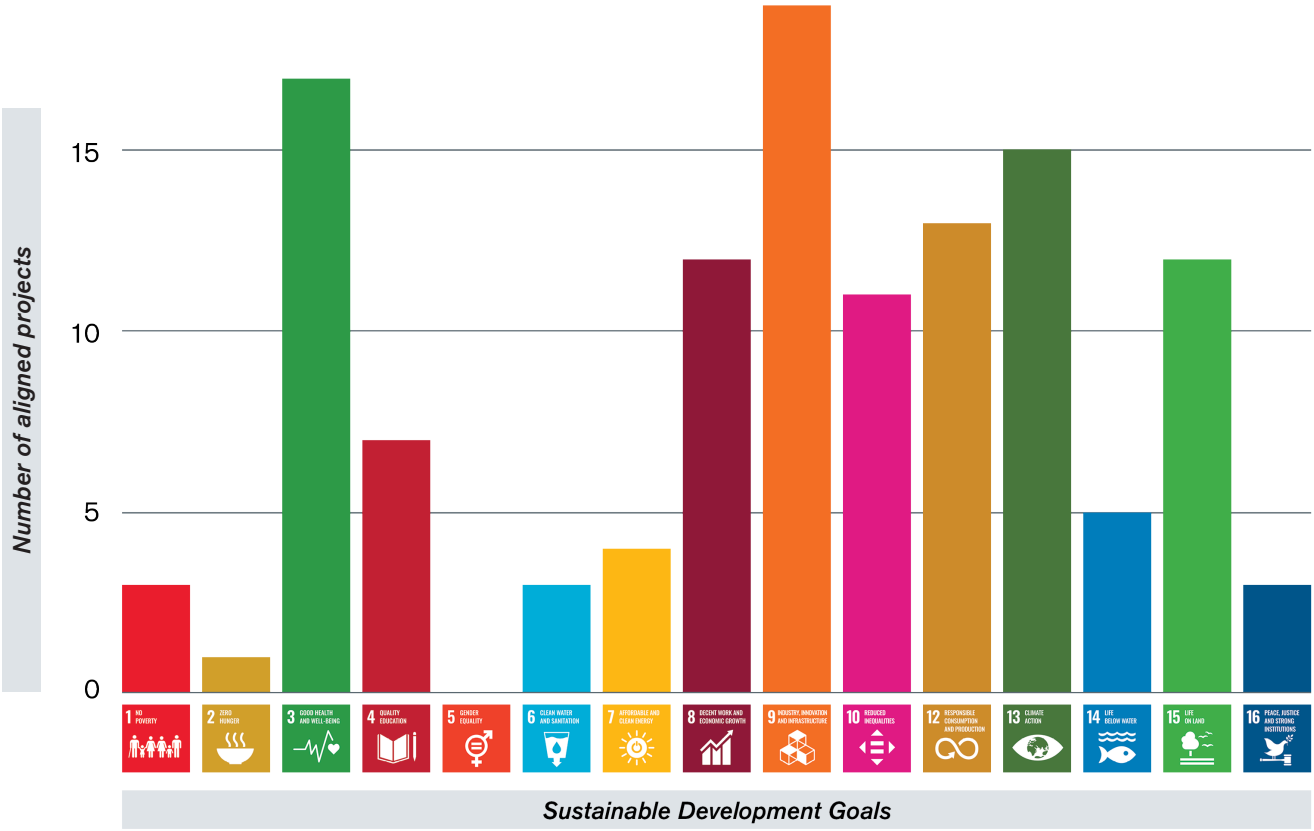
Recommendations for land conservation and open space	Read more
Utilize existing trails, such as the Skunk Creek Trail, to develop wildlife corridors in an effort to reduce development and preserve open space.	pp.65-66, 68
Incorporate land preservation efforts in city planning to preserve existing undeveloped land.	pp.64, 66-68

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.**

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 spring 2022 semester.



TOP THREE GOALS ADDRESSED IN THE FOLLOWING REPORT

This project seeks to identify solutions regarding sustainable use of the water. By analyzing peer communities policies, the student work aims to provide Peoria recommendations to continue growing as a regional leader in sustainability. This project contributes to the advancement of several SDGs, including SDG 11, SDG 12, and SDG 13.

Goal 3: Clean Water and Sanitation

"Ensure availability and sustainable management of water and sanitation for all."

Managing water quantity and quality through policies as well as community engagement efforts is important for the health and wellbeing of residents in Peoria.

Goal 13: Climate Action

" Take urgent action to combat climate change and its impacts."

As water and climate are connected, developing water policy strategies to serve Peoria, its residents, and the local environment now and into the future is a key step towards sustainable development.

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."

Incorporating development policies focusing on sustainable land use management will support Peoria now and into the future.

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PART 2:

Water and Land Use Planning Strategies

RECOMMENDATIONS FOR INTEGRATED LAND AND WATER USE PLANNING AND MANAGEMENT

SOS 321:
POLICY AND GOVERNANCE IN SUSTAINABLE SYSTEMS

SCHOOL OF SUSTAINABILIY

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ACKNOWLEDGMENTS

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INTRODUCTION

Before the City of Peoria was booming with residential areas, Peoria was known as a modest agricultural community. With more than 190,000 residents, Peoria strives to maintain its reputation as a friendly and safe place to establish and grow (City of Peoria, n.d.a). In doing so, Peoria dedicates itself to becoming more sustainable in land use and development while maintaining the City's social, economic, and aesthetic values. The City of Peoria prioritizes goals, policies, and implementation programs to ensure sustainable growth in the face of future development. The City prioritizes water conservation, which is reflected in its *Sustainability Action Plan 2.0* and Livability Initiatives (City of Peoria, 2017a; City of Peoria, n.d.a). Through this, Peoria has committed to aquifer recharge, direct reuse of reclaimed water, and planning and building reliable water infrastructure.

Editor's Note
The Livability Initiatives are six overarching goals outlined in its recent General Plan, Plan Peoria AZ 2040. The six goals provide an overarching framework for the City to consider in its work.

Figure 1 *The six Livability Initiatives focusing on sustainable development*

Peoria has shown that sustainable development is important to the community through its Smart Growth program. As part of the City's general planning document, Peoria's planning favors compact developments with improved walkability and multi-modal transportation

while using less land (City of Peoria, n.d.a). In its general plan, Peoria takes the next step of incorporating guidelines on where and how its future growth will occur. Peoria aims to preserve land and water and enhance the quality of life of its residents.

Figure 2a *Water Treatment Facility in Peoria*

Figure 2b *Reclaimed water sign, by City of Peoria*

Editor's Note
As of June 2022, several Arizona cities including the City of Mesa and the City of Tempe have started to implement water shortage measures.

Peoria anticipates substantive population growth, and in light of recent drought planning measures imposed in Arizona, the City hopes to learn from other communities about land use planning measures and policies. Typically, land use planning and water use planning are situated in different municipal departments, but as water challenges continue to persist, the City is interested in further developing its planning to better integrate land use and water planning in order to mitigate the challenges posed by increased land development. In order to identify best practices in land and water use planning, the Peoria Water Services Department collaborated with undergraduate students from the ASU School of Sustainability to research and provide recommendations for the City of Peoria.

To achieve these ends, students met with the Sustainability Coordinator of Peoria, Victoria Caster, to learn about the City's vision, goals, and pressing sustainability issues. Students also met with staff from the Babbitt Center for Land and Water Policy to understand the context of Peoria's water issues from a water policy perspective. Through these engagement opportunities, students learned how water policy fits into the greater picture of the other communities that share geographic or water supply sourcing commonalities.

Editor's Note

The Babbitt Center for Land and Water Policy is a unit of the Lincoln Institute for Land Policy. The Babbitt Center works to advance the integration of land and water management in order to meet the needs of the Colorado Water Basin. Its programs include the Colorado River Basin Map, Storymap of the Colorado River, and the Growing Water Smart workshop series.

Additional information about the Growing Water Smart program can be found at: **https://www.lincolninst.edu/babbitt-center-land-water-policy/growing-water-smart**

Under the suggestions of a Program Manager from the Babbitt Center, the students began their research into best practices for water policy in four case studies targeting the cities of Boulder, Colorado; Moab, Utah; Tucson, Arizona; and Gilbert, Arizona. While most of the recommendations in this report originate from practices in these four locations, students incorporated a few additional areas from Texas and Colorado to highlight best practices and findings.

Editor's Note

Babbitt Center Program Manager, Erin Rugland, as well as Senior Program Manager, Zach Snugg met with the students virtually during the semester to workshop the policy focus areas.

The following report details the insights, findings, and recommendations discovered by the students separated into six distinct policy groups recommended by the Babbit Center, including general drought and water management; growth, service extension, and annexation policies; building and plumbing codes; water conservation policies and rates; landscaping/outdoor irrigation policies, requirements, and standards; and finally land conservation and open space policies. Ultimately, these outcomes intend to aid Peoria's governing and planning bodies in their efforts to create both a sustainable and water-smart community for its residents.

RESEARCH METHODS

Based on the recommendations of the Babbitt Center, students were divided into six groups, with each group focusing on a relevant policy area. The groups researched the relevant codes and policy areas based on the following policy areas:

1. General Drought and Water Management
2. Growth, Service Extension, and Annexation
3. Building and Plumbing
4. Water Conservation
5. Landscaping and Outdoor Irrigation
6. Land Conservation and Open Space

As water policy in Arizona is a complex field, staff from the Babbitt Center and a doctoral student studying resource economics in the ASU School of Sustainability presented to the students during the semester to help inform the project methods and findings. These presentations included information on the history of water resource management, the current state of water policy, and future recommendations based on research and best practices in the field.

The Growing Water Smart workshop series stems from a collaboration between the Lincoln Institute and the Sonoran Institute to provide community workshops for land use and water planning. By engaging with community teams through a series of sessions, the Growing Water Smart workshop provides policy tools and expert resources to identify community water resilience goals and design an action plan to achieve those goals.

In 2021, the City of Peoria participated in the Growing Water Smart workshop to better integrate land use and water planning in its planning.

More information about the workshop series can be found at: **https://www.lincolninst.edu/babbitt-center-land-water-policy/growing-water-smart**

Based on recommendations from Peoria staff and the Babbitt Center, students identified peer communities to review their general planning

documents to recommend best practices for land and water conservation practices. Students primarily studied Arizona communities, such as Tucson and Gilbert, but also looked into communities in Colorado and Utah due to their similarities in climate, growth, and population demographics. The peer communities included:

- Tucson, Arizona
- Gilbert, Arizona
- Boulder, Colorado
- Moab, Utah
- Westminster, Colorado
- Colorado Springs, Colorado

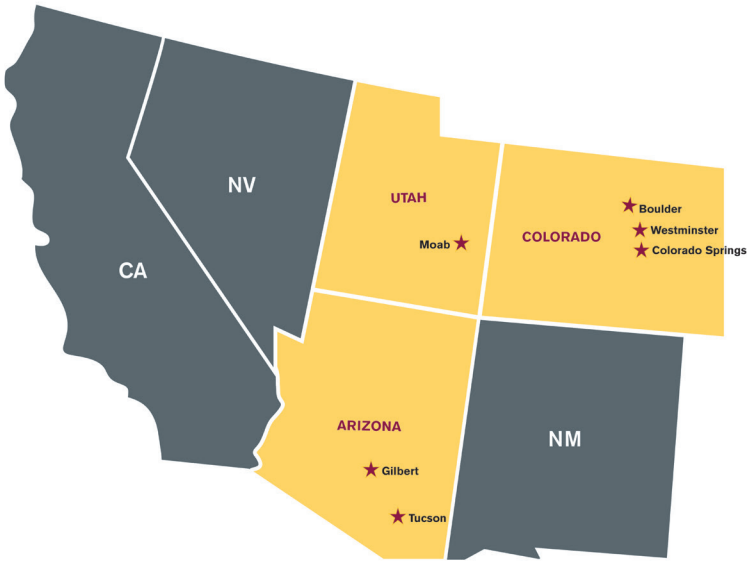


Figure 3 *Map representating peer communities considered for the purpose of this report*

Students identified consistent themes in the planning documents of the peer communities to provide policy and code recommendations for the City of Peoria. Following an analysis and discussion of the key themes, students developed recommendations for their respective policy areas and supporting resources for the City to consider as they continue developing their water strategy.

FINDINGS & ANALYSIS

General Drought and Water Management

Given the strain on water resources in Arizona and the Southwest, it is crucial to observe the actions of other similarly situated municipalities to coordinate the best methods for confronting this imminent challenge.

Green Infrastructure and Low Impact Development

Low impact development (LID) is a design approach that is comprised of tools, strategies, and principles that redirect and manage stormwater runoff. LID practices seek to utilize natural landscape features, as well as mimic natural process, in order to mitigate the effects of stormwater runoff on water quality and natural habitats (Environmental Protection Agency, n.d.).

Green infrastructure (GI) practices capture and reuse stormwater to restore natural habitats. LID and GI are typically used interchangeably. Implementing LID/GI practices has numerous benefits, including the reduction of runoff and associated pollutants, increased reuse of stormwater for landscape irrigation, and urban heat reduction (Sustainable Cities Network, 2019).

Common LID/GI practices include:

- Permeable pavements
- Curb openings
- Stormwater harvesting basins
- Vegetated or rock bioswales
- Bioretention systems
- Curb extensions
- Bioretention planters

The ASU Sustainable Cities Network released the Greater Phoenix Metro Green Infrastructure and LID Handbook, which includes resources for LID approaches. The handbook is available at **sustainability-innovation.asu.edu/sustainable-cities/resources/lid-handbook/**

Students sampled and reviewed Peoria's general, comprehensive, sustainability, and resource management plans. After reviewing Peoria's plans, students compared findings to those belonging to other cities in the United States. These individual case studies allowed students to develop recommendations based on successes in other regions and may prove to be successful in Peoria.

Peer community case studies

Tucson, Arizona

Students chose Tucson, Arizona due to its comparable population growth and similar challenges regarding conscious, sustainable development. Tucson is comparable to Peoria since it lies in a similar, arid climate to Peoria, which must reflect in its water management and sustainability planning. Tucson's water plans are heavily influenced by the community's needs and the myriad of challenges that will soon need to be addressed regarding Tucson's water supply and management. Tucson's water plan is designed to take place from 2000 to 2050 and includes 10 goals and plan recommendations to be implemented in the City (City of Tucson, 2004).

The recommendations include emphasizing physical water management strategies, utilizing renewable groundwater, reassessing the water-quality target for Colorado River water, fully utilizing Colorado River water, fully utilizing reclaimed water, utilizing reclaimed water as a wet-water resource, acquisition of additional water supply, managing water demand, implementing a water-resource impact fee, and expanding regional cooperation (City of Tucson, 2004). Peoria can also utilize reclaimed water for non-potable use and cooperate with other cities in Maricopa County.

Gilbert, Arizona

Gilbert is also situated in the same climate as Peoria, although it lies in the East Valley of the Phoenix Metropolitan Area. The two municipalities also share similar demographics, along with comparable population sizes. Therefore, the expectation was that Gilbert and Peoria's sustainability and water plans would share various similarities. Both municipalities emphasize water conservation and how necessary it is to promote urban resilience. Gilbert has built two surface water treatment plants, two wastewater treatment plants, several wells, and groundwater recharge facilities (Town of Gilbert, n.d.b).

Figure 4 *Theodore Roosevelt Dam on the Salt River located northeast of Phoenix, by Peoria Times*

Gilbert's current planning area spans an estimated 45,000 acre-feet, with the Salt River Project (SRP) claiming 11,600 of those acres and 20,185 acres to the Roosevelt Water Conservation District. The water claimed by these rights ensures that the claimed water cannot be used outside of their allocated areas. Therefore, Gilbert's water resources depend directly on land that has been urbanized for development. Gilbert has implemented measures such as the water audit and fixture retrofit program, an ordinance for model homes in new residential developments, and public information and education (Town of Gilbert, n.d.b). The final measure listed shares Peoria's interest in keeping the public well informed and aware of water supply and conservation efforts.

Boulder, Colorado

Boulder, Colorado is unlike the cities previously discussed because it has a relatively large sum of resources from which to draw water, including the Barker, Boulder, Lakewood, and Silver Lake reservoirs (City of Boulder, n.d.b). Therefore, water scarcity is not discussed in the Boulder water use plans at the lengths mentioned in those belonging to Peoria. However, both cities emphasize stakeholder engagement in their water use services (City of Boulder, n.d.b). Boulder has employed several different methods to manage and regulate water resources, including a water quality monitoring program, an efficiency plan, and a water source impact assessment. These methods are intended to utilize chemical, hydrological, and biological data to assess the overall quality of available

water, implement conservation programs in Boulder neighborhoods, and provide up-to-date recommendations on water use based on these facts (City of Boulder, n.d.b). Research revealed that Boulder placed less emphasis on dealing with water scarcity and more on water quality and management practices (City of Boulder, n.d.b). This approach may be adapted to fit Peoria's needs, as there is less of an emphasis on the water quality management in Peoria's city plans.

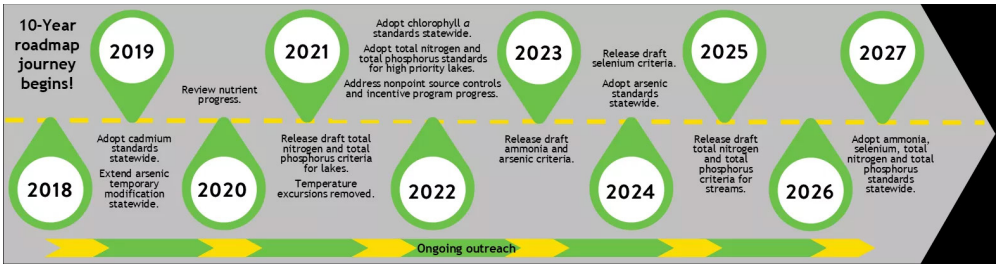


Figure 5 *Water quality 10-year roadmap journey, by Colorado Department of Public Health and Environment*

Analysis & discussion

Water stress

Tucson, Gilbert, and Boulder have faced water stress and developed policies to mitigate this challenge. For Tucson, the City has managed to stay near safe yield because of its long-term strategies involving the Colorado River water and groundwater, which began in 2001 (City of Tucson, 2004). Residents within Tucson are reportedly very good at conserving their water, as the per capita water usage has dropped since the 1970s (City of Tucson, 2004). Tucson residents embrace the desert landscape they live in, seeing less need to have high water use amenities like green lawns. The biggest concern is that because Tucson is dependent on the Colorado River, its long-term success is almost completely tied to it (Davis, Presnell, Project, & Wiley, 2021). And while population growth is worrying, the City is confident that it will be able to keep up with demand while using the same amount of water they have been using otherwise. Lastly, Tucson has been exploring alternative water sources, such as rainwater (Jackson, 2021).

Editor's Note

The City of Tucson, Arizona offers a Rainwater Harvesting Rebate Program, which incentivizes rainwater collection and reuse for Tucson residents. As part of the program, residents must apply with a project plan, as well as attend a free workshop in order to qualify for the program.

More information about the program can be found at: **https://www.tucsonaz.gov/water/rainwater-harvesting-rebate**

Figure 6 *Colorado River Basin and nearby water bodies, by Kyl Center for Water Policy at Morrison Institute*

The Town of Gilbert has contracts with the Colorado, Salt, and Verde Rivers, and has included them in their water plan for the next 100 years. Due to this diverse water supply, the Town has assured residents that because they possess high delivery priority with the Colorado River, there will be no need to worry about the immediate impacts of water shortages (Town of Gilbert, 2019b). In 2018, Gilbert residents, staff, homeowner associations (HOA's), businesses, and churches saved 375 million gallons of water through free water conservation programs, which helped keep the water rates low (Town of Gilbert, 2019b). Additionally, they mention that water usage has seen a decline of 29% since 1997 and include a useful chart that lists a variety of roles that citizens can fulfill to do their part in conserving water, as well as useful links to workshops, calculators, checkups, and more (Town of Gilbert, 2019a).

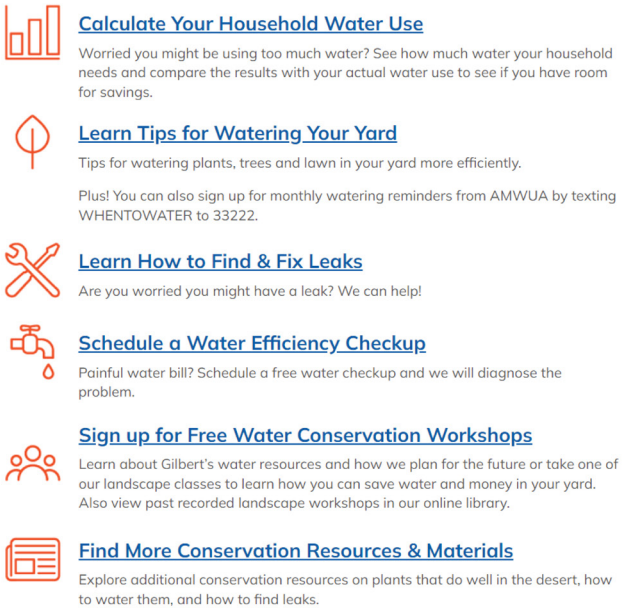


Figure 7 *Programs offered online to help residents conserve water, by Town of Gilbert*

Editor's Note

The ASU Kyl Center for Water Policy at Morrison Institute conducts extensive research on the Colorado River.

The Center developed a story map of the Colorado River shortages and its policy implications, which can be viewed at **https://storymaps.arcgis.com/stories/a1a782ce054d4ad28a0d7d0845e6c03d**

Unlike the municipalities in Arizona, Boulder's large pool of water resources allows it to be less concerned with water stresses or shortages. For example, the City of Boulder faced a drought in 2002, one of the City's notable extreme droughts of the past century. During the drought, the lowest streamflow faced by the Colorado River since the mid-1800s was recorded (Kennedy, 2011). Due to the diversity of water resources, including reservoirs and pipelines that capture water runoff from the City's primary water source, Boulder Creek. The City's water resources coordinator attributes Boulder's ability to withstand the 2002 drought to the City's diversity in water resources and voluntary conservation efforts (Kennedy, 2011).

Long-term water plans

Gilbert's Reasonable Conservation Measures (RCM's) and eight water quality rules map how Gilbert's future will look concerning its water conservation efforts (Town of Gilbert, 2012). All the municipalities mentioned have some sort of water plan currently in place for the long term and are planning for potential disasters in the future, like droughts or floods, depending on the place. Tucson's water plan was written to help bridge the gap between Tucson Water and the community to properly tackle water supply challenges that may arise and develop decisions that need to be made at specific points in the future (City of Tucson, 2004). Boulder's long-term plans involve the Stormwater Master Plan, which aims to better manage stormwater to protect communities, property, and ecosystems (City of Boulder, n.d.a).

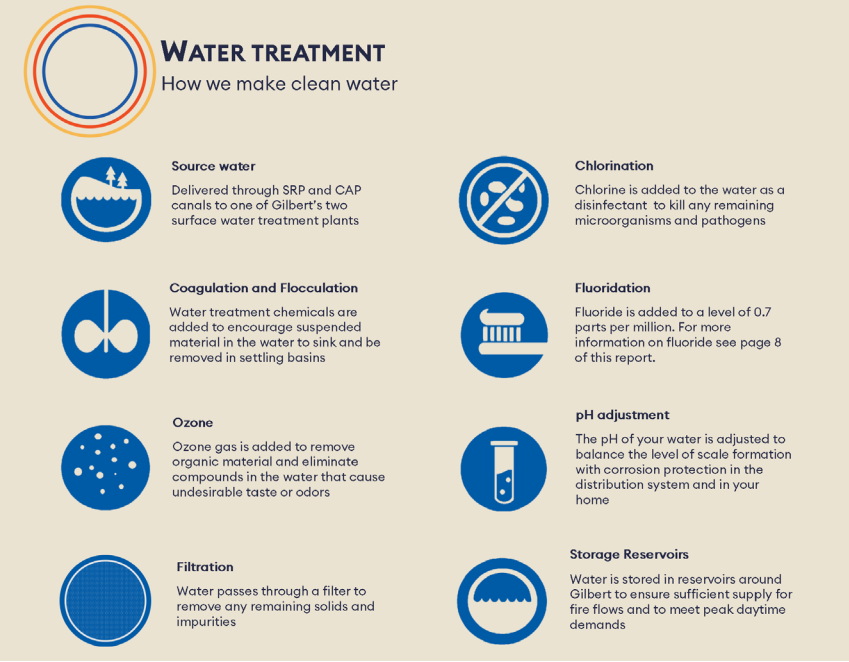


Figure 8 *Town of Gilbert's eight-step water purification plan to maintain water quality, by Town of Gilbert*

Editor's Note

The Town of Gilbert participates in the Arizona Department of Water Resources (ADWR) Non Per Capita Conservation Program (NPCCP) to consult a list of water conservation best practices, known as the Reasonable Conservation Measures (RCM's). The rules are targeted toward residential and non-residential water uses and include practices such as a water auditing program, water conservation ordinances, landscaping guidelines, and more.

Reflections

The potential impacts on Peoria's land and water use planning will have consequences for the City itself and similar municipalities that may look to Peoria for water and land management guidance. Given the Southwest's precarious position with water access, water and land conservation is one of the most important methods to consider in Peoria's water planning. Otherwise, the region may see unsettling and destabilizing effects of water insecurity. Ensuring that the City has enough sources to draw potable and non-potable water secures the wellbeing of Peoria residents, businesses, agricultural producers, and the overall municipality. Efficient water and land use planning may also act as a catalyst for other such municipalities in Arizona and the Southwest to implement similar policies, lessening the strain on already stressed water sources such as the Lake Mead reservoir. Peoria's water policy will prevent future water shortage disasters and make the City more resilient against future water scarcity and sustainability challenges.

Recommendations

Recommendations for General City Planning	
Recommendation	**Resources**
Expand the utilization of reclaimed water for non-potable use for other public landscapes, such as cemeteries, hotels, and golf courses.	City of Peoria - Reclaimed Water **https://www.peoriaaz.gov/government/departments/water-services/reclaimed-water**
Collaborate with other cities in the region to expand on a water reclamation program.	Town of Gilbert - Water Conservation **https://www.gilbertaz.gov/departments/public-works/water-conservation**
Utilize additional water conservation programs such as a water audit and fixture retrofit program.	City of Peoria - Conservation **https://www.peoriaaz.gov/government/departments/water-services/sustainability-water-conservation/conservation**
Further develop public information and education programming to inform Peoria residents about municipal water conservation programs, inspiring residents to take advantage of City resources.	City of Peoria - Conservation **https://www.peoriaaz.gov/government/departments/water-services/sustainability-water-conservation/conservation**

Growth, Service Extension, and Annexation

Peoria has a comprehensive plan on how they wish to expand for future development. As part of its General Plan, Peoria commits to the concept of "Smart Growth" to promote efficient and sustainable development while consuming less land. Its ultimate goal is to ensure its communities' social, economic, and aesthetic values (City of Peoria, 2020). Peoria's strengths remain in its forward thinking planning for the City; however, Peoria could improve by adding legally binding agreements to its plans. Agreements regarding annexation for service extension eligibility and uniform growth standards will secure development most sustainably. Peoria, historically and currently, has been a primarily residential community. While 62% of its water consumption is attributed to residential uses, 22% is attributed to landscaping (City of Peoria, 2020). Due to these factors, future water planning should primarily address the demands of these two categories.

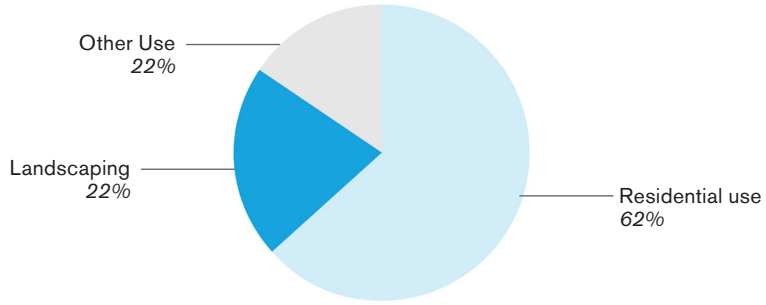


Figure 9 *Water Consumption in City of Peoria*

Peer community case studies

Tucson, Arizona

Tucson, Arizona is located in the Sonoran Desert and shares many of the same challenges that Peoria faces with water management policy. Extremely high summer temperatures and dependency on Colorado River water to augment their existing water supply are two of the water challenges shared by the cities. Tucson has experienced a marked decrease in water use over the last 25 years, dropping from 121 gallons per capita per day (GCPD) in 1996 to 89 gallons per capita per day in 2020. This change dropped Tucson below the U.S. average, while the rest of Arizona hovers around 146 GCPD (MAP AZ Dashboard, 2020). Tucson has accomplished this feat through various policies to reduce demand through conservation practices manifesting in rebate

and incentive programs, community education and outreach, plumbing efficiency code updates, and perhaps most importantly, increased block pricing.

Editor's Note

Increased block pricing, or tiered pricing, is a water conservation practice that prices water per unit of water depending on the amount of water used. Currently, the City of Peoria uses an increased block structure based on consumption categories, including residential, multi-residential, commercial/industrial, residential care, and landscape.

Moab, Utah

Moab has created an Interlocal Agreement (ILA), an agreement between the City of Moab and Grand County. The intent is to establish uniform standards for growth around the city, especially in areas that can be annexed in the future. Moab ensures agreements with nearby areas to confirm compatible development as the community grows. Currently, Peoria has a Future Land Use Map (FLUM) and a Municipal Planning Area (MPA), including city limits and adjacent areas intended to be annexed. Like Moab, Peoria would benefit from having a solidified agreement with these nearby counties to make certain that the growth is consistent with the plans of Peoria and non-conflicting. Additionally, an interlocal agreement would save future time and money regarding the annexation process.

Figure 10 *Moab city center and historic buildings*

Analysis & discussion

Integration of annexation and service extension

Editor's Note
A county island is a portion of land that is not incorporated into the jurisdiction of a county or municipality. County islands are typically surrounded by incorporated municipalities.

The City of Tucson has fully embraced integrating land and water use planning. The City can properly steward its water supply and ensure that any future growth is manageable and sustainable through this integration. They have been employing a policy of mandatory pre-annexation agreements to receive new water service extensions (City of Tucson, 2004). Through this policy, their government has ensured that they will have adequate time and control to plan for current and future growth while also allowing themselves another planning tool to eliminate county islands and unincorporated land within the city limits. Combining these two aspects of growth into one agreement process may remove some of the negotiation process needed between developers and city governments and place the power firmly in the hands of the government and planning officials.

Standardized guidelines for future growth

Better guidelines for growth in cities may create more sustainable development (Kennedy, 2011). The incorporation of interlocal agreements will ensure planned growth. The City can also plan its policies around agreements with counties. Political and jurisdictional constraints can be found in areas, so policies favoring development will impact growth and mitigate urban sprawl (City of Moab, 2017b).

Tucson's Water Service Area Policy is another interpretation of establishing standardized guidelines for growth. Established in 2010, this policy centers around creating a Water Service Area Map that outlines general guidelines for water service in terms of where water is provided, should be provided, should not be provided, and unknown area. An appeals process accompanies this map before a seven-member planning committee from multiple city departments can overrule the map in particular circumstances (City of Tucson, 2019). Considering similar strategies would enable the City of Peoria to continue pursuing its stated goals of sustainable growth. By developing an updatable consistent set of rules for said growth, the City can tailor its policies to align with the goals and vision of the people and government of Peoria.

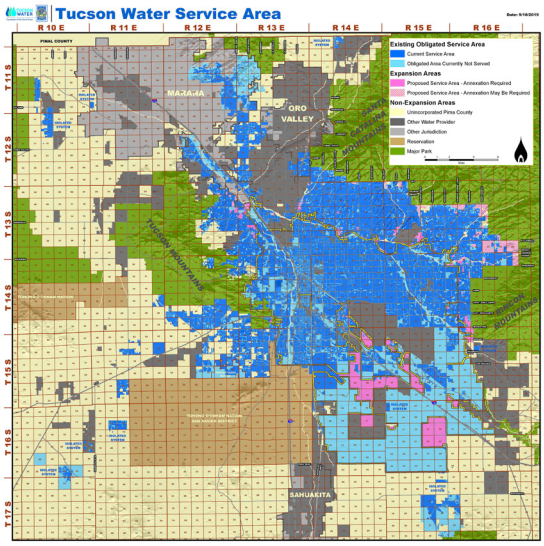


Figure 11a *Tucson Water Service Area, by City of Tucson*

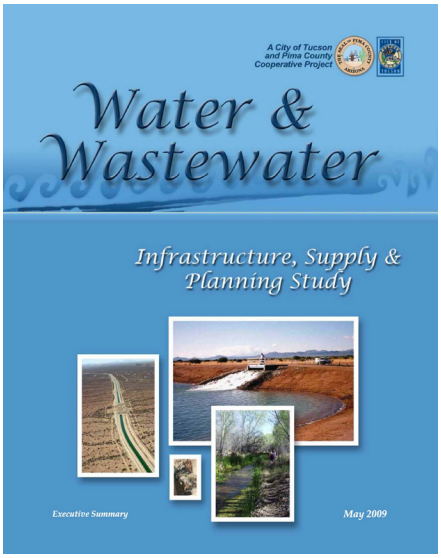


Figure 11b *Water and Wastewater report cover, by Pima County*

Demand-side management

Another interesting strategy employed by Tucson is the use of block increased pricing, which is becoming more popular in many communities, including Peoria. Additionally, block increasing pricing is a tool that aims at internalizing externalities through demand-side management. This effect is achieved by significantly raising the high water use rates while ensuring that lower water use still pays a reasonable price.

As the City of Peoria, like most of our case studies, has gone to great lengths to create an adequate supply and buffer of available water stocks, the next feasible area of focus to enable growth is to reduce and manage the water demand. As any additional water supply acquisition is often costly and complicated, continued expansion of demand-side strategies seems to have greater potential for ensuring sustainable growth. This could manifest in the continued development of rebate and incentive programs that reward the adoption of conservation strategies or disincentivize wasteful practices of water use.

Reflections

Peoria desires continued expansion over the coming years. A development strategy that ensures water-smart growth will require a new type of collaboration that brings together multiple facets of government in a departure from "business as usual" planning approaches. By using

co-management strategies among government departments, Peoria will be able to handle its anticipated influx of residents over the coming years. The Maricopa Association of Governments (MAG) projects a 30% population increase in Peoria over the next decade (Maricopa Association of Governments, n.d.). As the City learns more about how these policies work for them, they will hopefully continue to refine their guidelines through various feedback until it becomes a true adaptive co-management policy.

Additional management strategies, including block tier pricing, can incentivize residents to practice mindful water use by rewarding water conservation practices. Also, policies that enforce the City's vision of growth and expansion through pre-annexation development agreements should provide the government with additional tools to house legally legitimate policy strategies for sustainable growth in Peoria.

There is a distinct possibility that adapting to this new management style will have initial challenges. However, this will yield dramatic benefits by enabling Peoria's planning and water departments to collaborate to create more informed strategies for growth. Through collaboration, Peoria can continue its commitment to smart growth while supporting the integration of water and land use governance.

Recommendations

Recommendations for Growth, Service Extension, and Annexation	
Recommendation	**Resources**
Develop water for annexation agreements ensuring full control over new developments or communities that wish to utilize Peoria water supply. These agreements empower local governments to control exactly where growth happens and at what cost.	City of Tucson - Water Annexation **https://tucson.com/news/local/tucson-may-tighten-water-for-annexation-rules/article_23ccab7f-728f-5d14-aad6-1e05657bb832.html** City of Tucson - Pre-annexation Development Agreement **https://www.tucsonaz.gov/water/PADA-fees**

Develop both internal and interlocal agreements to establish uniform standards for growth and establish a consistent and frequently revisited, water service area policy that lays out where services can and should be extended. This policy should be formed through the concerted efforts of water, urban, and environmental planning staff with a focus on economic, social, and environmental considerations.	Moab General Plan - Urban Service Area Plan **https://moabcity.org/DocumentCenter/View/1528/General-Plan-Final-071117?bidId=** Peoria General Plan - Future Land Use Map (FLUM) **https://www.peoriaaz.gov/home/showpublisheddocument/23960/637503574566470000**
Establish acceptable usage of water that allows water users to maintain current or even reduced pricing, while raising rates for any users in excess of acceptable water usage.	Tucson - Residential Water Rates **https://www.tucsonaz.gov/water/residential-rates-and-monthly-charges** Peoria - FY22 Utility Rates and Charges **https://www.peoriaaz.gov/home/showpublisheddocument/26972/637727594714500000**

Building and Plumbing Codes

When it comes to conservation, buildings' plumbing fixtures can prevent the overuse of water. They can also improve, or provide the capability, to repurpose grey and effluent waters to maintain the freshwater supply. Each municipality studied is located in the West where their state, as a whole, relies on the Colorado River as a water source. With Peoria being in the same situation, it is helpful to look at the strategies implemented by these municipalities regarding their plumbing and building codes to see what could be adapted to Peoria.

Peer community case studies

Gilbert, Arizona

The Town of Gilbert primarily utilizes the 2018 International Plumbing Code supplemented by amendments and ordinances. These additions generally entail Town-specific plumbing uniformity and saving water. More specifically, the Town has instituted many requirements to prevent contamination of clean water by requiring full backflow protections,

plumbing design that prevents cross-contamination, and restricting connections between separate water systems. Additionally, any form of non-essential plumbing installation requires a permit and inspection. Then there are the simple piping and flow rate standards that all systems are expected to adhere to. The Town itself has also provided resources to the public to improve water conservation regarding plumbing. Gilbert offers free efficiency checks for private plumbing systems and provides information on managing damaged or leaking systems (Town of Gilbert, n.d.a).

Figure 12 *International plumbing code manual cover, by International Code Council*

Tucson, Arizona

Like most municipalities in the United States, Tucson also uses the 2018 International Plumbing Code (IPC), as well as its own policy additions. Like Gilbert, Tucson ensures water sources are not contaminated but is also more concerned about maintaining its plumbing systems. In commercial spaces, grease traps must be installed in drains that are likely to receive grease intake to prevent blockages and damage to the system. New developments are required to include greywater systems for irrigation to conserve water. The City also provides public resources for plumbing water conservation and advertises free efficiency checks. Presently, they offer several rebates for different installations like high water-efficient appliances and fixtures and the installation of greywater systems. Individuals can also be fined for failures to fix controllable plumbing leaks (City of Tucson, 2014).

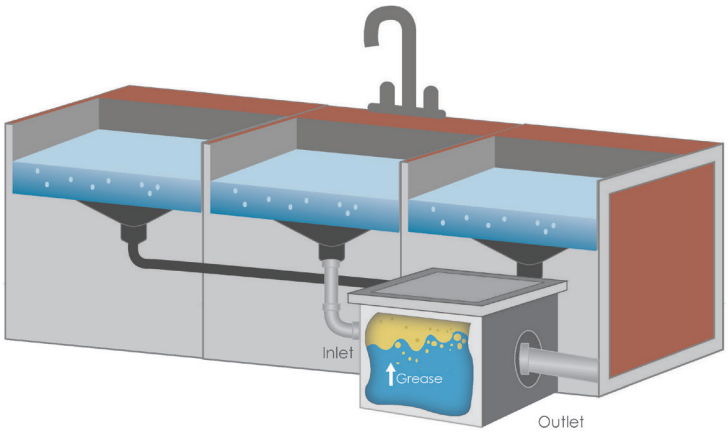


Figure 13 *Illustration of Grease Trap, by City of Scottsdale*

Boulder, Colorado

While Gilbert and Tucson are located in Arizona, Boulder is nestled right at the foot of the Colorado Rockies. With pristine views of the mountains and lush forests, Boulder is one of the premier tourist destinations in the state. As with most cities across the United States, the City of Boulder has also adopted the 2018 International Plumbing Code for use in the municipality. In an act to preserve this, the City of Boulder has water conservation practices to alleviate the strain on the amount of available water. One such conservation effort made by the City has been banning water sprinklers during set hours and only allowing the use of drip irrigation in its place. Presently, the City of Boulder offers free irrigation consultations to homeowners wishing to lessen their water usage and the amount of water needed to irrigate outside.

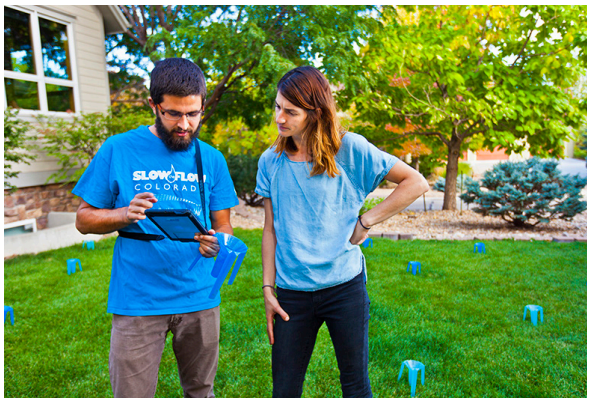


Figure 14 *Irrigation consultation offered by a nonprofit organization in Boulder County, by Resource Central*

Moab, Utah

Moab is also an adopter of the 2018 International Plumbing Code, but has not issued any amendments. Instead, the City follows the amendments set by the State of Utah and its existing city ordinances. Presently, Moab intends on adopting an ordinance in 2022 that would require new developments to incorporate greywater systems with landscape irrigation to conserve water. Combined with this, the City plans on requiring the use of WaterSense appliances and fixtures in all connections to greywater systems. Any new plumbing connections to wastewater treatment facilities must fit various requirements to prevent water contamination, such as installing grease traps for food service establishments and restricting the materials legal to be dumped into connected drainage. Any such connection to wastewater treatment is also subject to inspection at any time to ensure the enforcement of the policy. Moab itself offers no rebates for improved efficiency. Still, the State of Utah does offer a statewide rebate program, Utah Water Services. As one of the programs, the State will offer up to $100 for residents that replace older toilets with a WaterSense-labeled toilet. The program currently covers toilets in residences built before 1994 and for toilets that currently use more than 1.6 gallons of water per flush (Utah Water Services, 2022).

Figure 15 *WaterSense faucet and sprinkler, by WaterSense*

Editor's Note

WaterSense labeled products are products that are water efficient. In order to be labeled as a WaterSense product, the product must meet criteria set by the Environmental Protection Agency (EPA).

More information about the WaterSense label can be found at **https://www.epa.gov/watersense/watersense-products**

Analysis & discussion

Greywater systems

Greywater systems provide additional uses for what would typically be wastewater (Arizona Department of Environmental Quality, n.d.). Greywater systems allow water to be reintroduced into the natural environment, rather than relying solely on sewage treatment facilities. Peoria could encourage the use of greywater systems to reduce overall water consumption in conjunction with its expansion of reclaimed water usage.

Editor's Note
Greywater, or gray water, is wastewater that often originates from clothes washers, bathtubs, showers, and sinks. Greywater is differentiated from other wastewater sources in that it is collected from an entirely different sewage system.

High-efficiency fixtures and appliances

High-efficiency fixtures and appliances reduce user-end water usage in their daily activities to help preserve overall water resources. Peoria could require the installation of high-efficiency fixtures and appliances in new buildings and residences while expanding their rebate program past that of just toilets, irrigation, and faucet heads for existing buildings.

Editor's Note

The City of Peoria offers several water rebate programs for its residents, including rebates for high-efficiency toilets, smart irrigation, xeriscaping, and tree planting.

More information about the rebate programs can be found at: **https://www.peoriaaz.gov/government/departments/water-services/water-conservation/rebate-programs**

Contamination protection

Preventing the contamination of greywater effluent ensures the efficiency of the water. Contamination prevention measures, such as grease traps, can reduce water usage and effluent waste while saving costs down the line to prevent grease damage. Peoria could require grease trap installation and restrictions on what may enter indoor drainage, especially if it is connected to a greywater system or water treatment. Installing a grease trap for a business costs $250-$8,500, depending on the installation (Easton Utilities, 2021). This preventative measure costs little compared to the cost of addressing grease damage, which has cost nearly $500,000 over three years (City of Minneapolis, n.d.). Then there are also the individual variable costs to businesses in cases of local grease damage.

Editor's Note
According to Peoria's Water Conservation Coordinator, Arizona has such hard water that the calcium buildup can make it difficult to maintain a constant water stream with some models of high-efficiency faucets.

LEED certifications

Editor's Note
Cooling towers are a structure that brings air and water in direct contact to reduce the water's temperature. Cooling towers are typically used for heating, ventilation, and air conditioning.

The LEED certification program includes various areas of interest where building design provides points towards getting certified. Established buildings could be required to reach any form of LEED certification instead of only Silver and higher. With Peoria requiring new buildings to acquire LEED Silver certifications, they could provide greater specifications as to the points that need to be earned when getting LEED-certified that would benefit water conservation (City of Peoria, 2017a). By pursuing LEED certifications for its municipal buildings, the City of Peoria has opportunities for additional water saving tools and techniques, such as high-efficiency faucet heads and plumbing fixtures. Requirements could also be implemented for cooling towers and evaporative towers by requiring water meters and efficient drift eliminators. This could be applied to new buildings as well. Depending on the building, the more that needs to be replaced, the more expensive it will be.

Editor's Note
Drift eliminators are used with cooling towers to prevent large water droplets from escaping the air stream.

Figure 16a *Cooling Towers, by Evapco*

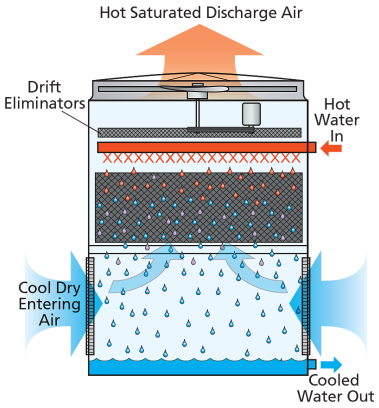


Figure 16b *Illustration of a Cooling Tower, by Evapco*

Editor's Note

Since 2012, the City of Peoria has enforced LEED certification for its new building projects and major municipal renovations. The City has received LEED Gold for its Municipal Courts Building, Community Center, and Sports Complex.

Residences and evaluation

Individuals' homes are generally held under far less scrutiny when it comes to maintenance, as long as any failures do not prove any danger or affect neighbors. Thus, the condition and efficiency of one's plumbing system is generally not a major point of their concern. Many leaks may go unnoticed without specifically checking the changes in household water consumption (United States General Service Administration, 2016). Given that water is a concern for the entirety of the City, it would be beneficial to provide homeowners with a professional means of assessing the condition and efficiency of their current plumbing system and possibly fine any serious negligence to maintenance. This way, there is incentive and resources for the improvement or maintenance of personal water systems.

Editor's Note

The City of Peoria does offer individual consultations for homeowners interested in evaluating their water use. Though Peoria staff may not enter the homes of residents, advertising this opportunity more widely to homeowners may be helpful to garner interest in incorporating water conservation practices into residential areas.

Reflections

The presented recommendations would increase the requirements for new construction projects, potentially increasing their fixed cost by a minimum of $500. Still, the requirements can decrease the costs associated with water use and maintenance depending on the age of the plumbing system and water rates at the time, saving the average individual about $380 per year. This would also apply to public plumbing, decreasing the risk of fatbergs and other plumbing maintenance issues that can cost a city around $170,000 per year, and keeping reclaimed water fit for reuse. Cost for the average resident could be reduced by implementing efficiency checks to determine what could be done to improve their system, alongside promoting high-efficiency fixtures and appliances.

Recommendations

Recommendations for Building & Plumbing Codes	
Recommendation	**Resources**
Incorporate aspects of the LEED indoor water use scoring sheet into the plumbing code, such as requiring new buildings to apply fixtures with a minimum efficiency that meets LEED standards. This could be done for established buildings as well, though it may be more reasonable to have reduced LEED requirements.	LEED - Indoor Water Use Reduction Guide **https://www.usgbc.org/credits/new-construction-core-and-shell-data-centers-new-construction-warehouse-and-distribution-0**
Implement additional rebate offers for high-efficiency fixtures and appliances for established buildings outside of existing offerings.	City of Tucson - Conservation Programs **https://www.tucsonaz.gov/water/residential-and-commercial-conservation** Utah Water Savers - **https://utahwatersavers.com/**
Improve public education on plumbing problems and solutions, including damages, leaks, blockages, and calcium deposition, and alternative pipe structures that can reduce the risk of these issues. After a period of time, deemed sufficient, leakage fines could be implemented for preventable leakages to deter water waste/contamination and to provide city revenue.	City of Tucson - Water Waste Ordinance **https://www.tucsonaz.gov/files/water/docs/Water_Waste_Ordinance.pdf**
Limit water sprinklers use during set hours and only allow the use of drip irrigation in its place to conserve water during peak usage times.	Arizona Municipal Water Users Association - Watering Schedules **https://www.amwua.org/landscaping-with-style/maintain/watering-schedules**

Advertise efficiency checks for free or a small service charge and provide more public direction towards water saving strategies.	City of Tucson - Residential and Commercial Conservation **https://www.tucsonaz.gov/water/residential-and-commercial-conservation** Town of Gilbert - Water Conservation **https://www.gilbertaz.gov/departments/public-works/water-conservation**
Incentivize the use of grease traps to prevent system damage.	City of Tucson - IPC Amendments **https://www.tucsonaz.gov/files/integrated-planning/2018_-_IPC_Amendments.PDF** City of Minneapolis - Grease Handout **https://www2.minneapolismn.gov/media/content-assets/www2-documents/residents/FOG-Handouts-English.pdf**
Consider the implementation of dual-flush toilet systems and low-flow urinals into adaptation of plumbing code 604.6.	U.S. General Services Administration - **https://www.gsa.gov/cdnstatic/Indoor_Water_Conservation_December_2016_508_compliant.pdf**
International plumbing code 606.4 'Faucets' consider controls for faucets shall be automatic at a 0.35-0.5 gpm aerator.	California State University, Scaramento - **https://www.csus.edu/experience/innovation-creativity/sustainability/_internal/_documents/ir-faucet.pdf**

Water Conservation

Being in a desert climate with increasing water shortages, effectively using and monitoring the limited water resources is more important than ever. Successfully implementing policies that enforce the sustainable usage of water, such as regulating recreational water use or allocating different resources, is necessary to ensure that the entire population has adequate access to water. A comprehensive management strategy includes planning for the future—whether it be stocking water resources for future use, obtaining new water resources, or any other plan that guarantees water supplies.

Peer community case studies

Gilbert, AZ

A Town with exceptional efforts in managing its water supply is Gilbert, Arizona. The Town has established an assured water supply, effective conservation strategies, and other protocols that ensure responsible water use and consumption. Specifically referring to drought management practices, Gilbert has a proactive and aggressive approach to conserving water in the event of a water supply challenge. Peoria could consider Gilbert's strategies in modifying its drought plan. Both municipalities have four-stage drought plans that progress from least to most severe, but Gilbert's public contingency plan includes more comprehensive details. With each stage, Gilbert specifically identifies the measures to be taken and the policies that will be enforced to reduce water usage (Town of Gilbert, n.d.). One key point that can be pulled from their planning documentation is that it is essential for the community to have understandable and specific information on how the Town will handle water shortages. The specific steps provided in the Gilbert drought contingency plan provide this information effectively to community members. Additionally, the plan is publicly available, so residents have the option to read and research.

Editor's Note
The Town of Gilbert has its "Water Supply Reduction Management Plan," which details an action plan for the Town in response to water shortages.

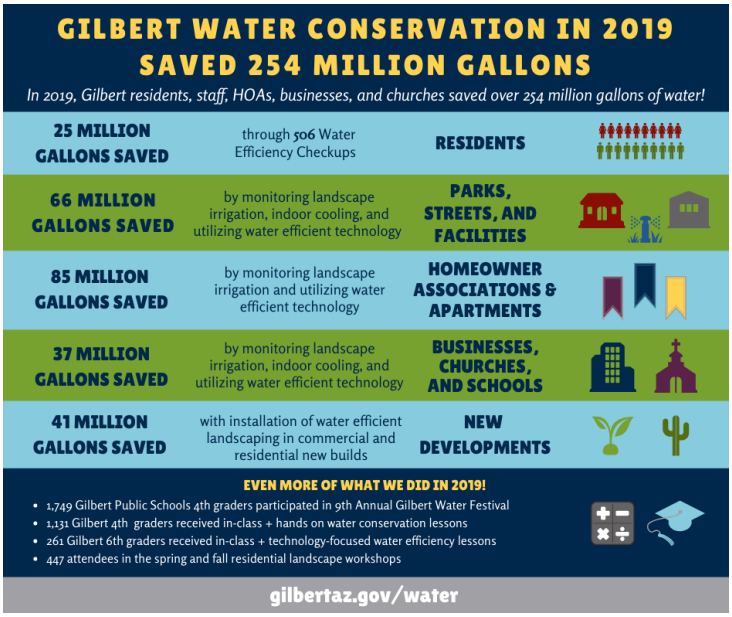


Figure 17 *Infographic representating the amount of water saved in Gilbert, by Town of Gilbert*

In an effort to conserve residential water use, the Town of Gilbert offers and advertises to residents a Water Efficiency Checkup program to residents. The program offers education and free water audits to residential homeowners. There are two types of water audit checkups- the first is an onsite audit with a water conservation specialist. The residents and the expert will have an in-depth walk-through of the house and property to detect leaks or water conservation strategies. The second option is for the resident to have a virtual appointment with a water conservation specialist who will teach the resident how to do their water audit and help them with specialized water conservation techniques (Town of Gilbert, n.d.a). Online educational video resources walk through personal leak detection and water efficiency opportunities. The program also provides educational links on repairing or getting help to fix leaks. The links for Water Efficiency Checkup appointments are easily found on the Town website and a phone number and email.

Editor's Note
The City of Peoria is currently expanding its web and mobile presence for residents. The City can consider further developing its presence to communicate its water services programs.

Figure 18 *Onsite Water Efficiency Checkup offered by a water conservation specialist, by Town of Gilbert*

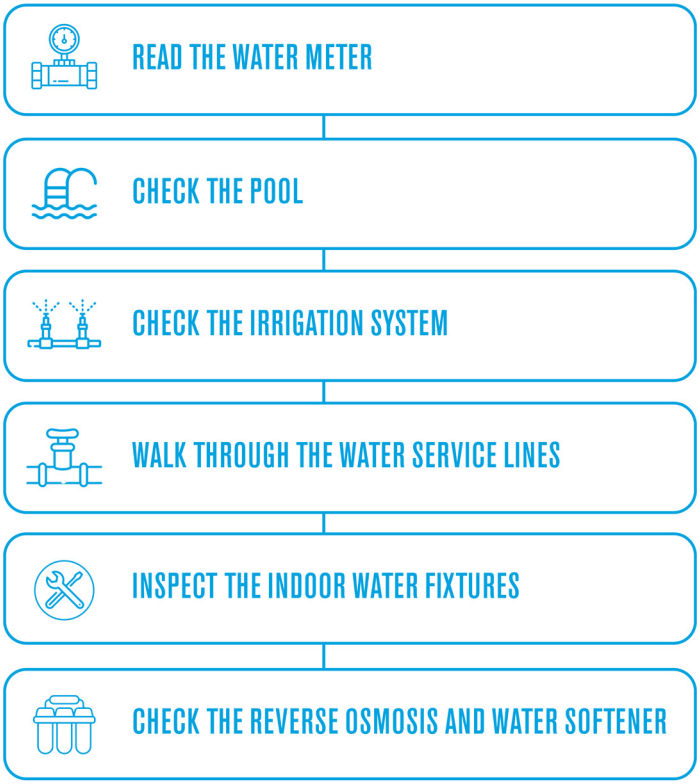


Figure 19 *Step-by-step process for preventing water leakes and promoting water conservation, by Town of Gilbert*

Gilbert has found success in its Water Efficiency Checkup program since it was first established in 2011 through decreasing residential water consumption and achieving cost-effective savings. In 2019, Gilbert's Water Efficiency Program provided 506 water audit appointments and saved about 25 million gallons of water (Town of Gilbert, n.d.b). Using 2011 Gilbert Water Efficiency Checkup program data, the program's cost to provide water checkups and customizable plans for the year was $32,705. Still, without the program, the amount of lost and newly bought water would have cost $176,170 (Town of Gilbert, 2021a).

This case study is relevant to Peoria, whose main population owns single-family residences. The Gilbert Residential Water Efficiency program is adaptable and proven to reduce water consumption. One key point from this case study is the ability of the homeowner who has a high water bill to take action in multiple ways. There are educational videos and virtual and in-person opportunities that are easily accessible and free of charge.

Analysis & discussion

Drought plan recommendations

The primary theme gathered from observing Gilbert's drought plan is the specificity of the management protocols and how the Town has established detailed measures for each stage of severity. Peoria's current publicly available drought management plan would benefit from more specificity, since it currently states that strategies will be identified when necessary (City of Peoria, 2017b). Enforcing more specific drought management protocols would likely encourage more proactive strategies when encountering these water shortages rather than addressing them as it occurs. This may prevent the further shortage and lessen the impacts of the drought and encourage more sustainable water usage in general. Based on this, the recommendations for Peoria's drought contingency plan would be to make the strategies more public and to have a set protocol for each stage of severity. Publicizing these strategies can encourage sustainable water usage among its residents. Allowing this knowledge to be accessible to everyone is important for when these drought stages are announced, people are prepared and know what to expect.

Editor's Note

In the Spring 2020 Project Cities cohort, students analyzed Peoria's existing drought management plan to recommend additional water conservation efforts, such as stormwater management and xeriscaping strategies.

Additional insights can be found at: **https://links.asu.edu/PCPeoriaWaterConservation20S_Report**

Residential water efficiency program

The Town of Gilbert's Residential Water Efficiency Program was designed to be easy to use by its customers. The central theme drawn from this case study is the importance of accessibility and adaptability in water conservation programs to foster participation. The City of Peoria offers a variety of educational tools and programs for water conservation on its website. There is an opportunity for the City to expand its web and social media presence to reach a larger audience about its water conservation programming, especially its water efficiency checkups. Residents should be provided with multiple options to have water efficiency checkups through in-person appointments, virtual appointments, and videos for personal water audits. Water conservation

experts should be readily available to help educate residents to engage the larger public. By taking advantage of the City's cost-saving programs, residents can be incentivized to engage in water-conscious practices. Free water audits and educational information on setting up long-term water savings and routines must be communicated to the public. It is important to improve public awareness on the importance and rewards of water conservation at the home level, which can be done by promoting information on social media, public meetings, flyers, events, websites, and water bill mailers.

Peoria residents have different lifestyles and water consumption needs. For residents of Peoria to conserve water at a personal level, the programs available should be adaptable and configurable. Peoria's water conservation goals recognize the importance of saving water for present and future residents. Water customers play an important part in water consumption and conservation, especially when 74.2% of the housing in Peoria is owner-occupied (U.S. Census Bureau, 2021).

It is recommended for Peoria to create a free residential water efficiency and audit program to work with homeowners to prevent leaks and excessive water consumption. However, programs can be expensive, but educational water conservation strategies graphics and step-by-step leak detection instructional videos published on the Peoria water conservation website are a cost-effective step toward an effective water audit program.

Reflections

Peoria's comprehensive management strategy includes planning for the future through water conservation, providing a 100-year assured water supply, drought management, a diverse water portfolio, and lowering water consumption rates. Residents of Peoria play an important role in ensuring water conservation, and related programs that encourage participation and education are needed. Also, multifamily housing, commercial, and industry should be considered in future water conservation policies or programs. Peoria is ahead of the curve in regards to its water conservation policies and strategies and is a remarkable representation of how a desert city should manage its water supply and resources. As a leader in the Valley, students aim to provide insights on additional areas of improvement so Peoria can continue to be a leader in sustainability.

Recommendations

Recommendations for Water Conservation	
Recommendation	**Resources**
Consider widely advertising the existing free residential homeowner water efficiency water audit program.	Gilbert's Water Efficiency Water Checkup - **https://www.gilbertaz.gov/departments/public-works/water-conservation/water-checkup**
Develop online educational tools for Peoria residents to detect leaks and construct personalized water conservation strategies.	Gilbert's Water Efficiency Water Checkup - **https://www.gilbertaz.gov/departments/public-works/water-conservation/water-checkup**
Publicize drought contingency plans for residents. Information about drought planning should be clearly communicated to residents.	Gilbert Drought Plan - **https://library.municode.com/az/gilbert/codes/code_of_ordinances?nodeId=CO_CH66UTOP_ARTVIIIWACO_DIV2REDE**
Create more specific protocols for each stage of severity in Peoria's drought contingency plans.	Gilbert Drought Plan - **https://library.municode.com/az/gilbert/codes/code_of_ordinances?nodeId=CO_CH66UTOP_ARTVIIIWACO_DIV2REDE**

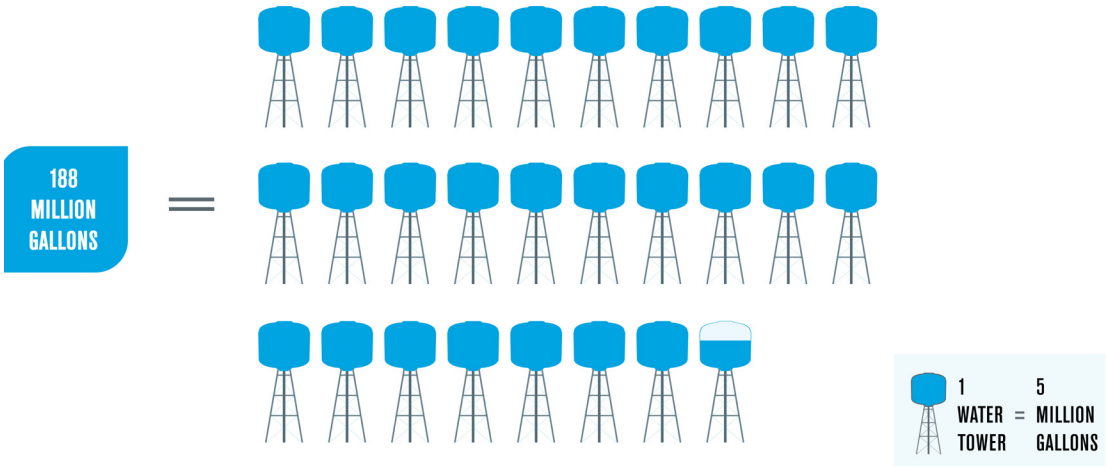
Landscaping and Irrigation

A common theme in many parts of the Phoenix Metropolitan area is the use of water-intensive landscapes to make areas more green and beautified. In the Sonoran Desert, where the climate is arid and water is a limited resource, landscaping and irrigation can easily strain municipal water supplies without the right policies, programs, and education. Improving irrigation systems and controllers while embracing the natural beauty of native desert plants can make a big difference in the water used for landscaping in Peoria.

Peer community case studies

Gilbert, Arizona

Gilbert faces the same obstacles as the City of Peoria since it is located in the arid Sonoran Desert and has a low-density design with spread-out suburban areas. Like Peoria, the Town of Gilbert receives most of its water supply from the Central Arizona Project (CAP) and the Salt River Project. The Town of Gilbert has put in place many policies and programs to limit the use of water-intensive landscaping, including requiring efficient irrigation controllers, and facilitating programs to educate and support those who wish to use less water in their landscaping and irrigation practices. A program that has made the Town of Gilbert stand out when it comes to conserving water used for landscaping is its Landscape Water Budgeting Program. The program provides a free customized water budget for participating HOAs, multifamily communities, churches, schools, and businesses. Each month, updates are provided to keep participants on track with managing their landscape water use. Gilbert's Landscape Water Budget Program is credited with saving hundreds of millions of gallons of water a year. In 2019, the 290 program participants saved over 188 million gallons of water, equating to $381,000 in avoided excess water costs (n.d.e.).



Gilbert also has a policy limiting the percentage of water-intensive landscaping planted in a landscaped area. There can only be water-intensive landscaping in common areas of a new single-family and multifamily development, up to 10% of the total area, or up to 30% if the landscaping is watered using reclaimed water. The remaining area must be only drought-tolerant plants. Turf is also prohibited in all rights-of-way

in residential areas of the Town (Town of Gilbert, 2021b). Further, Gilbert prohibits the creation of new covenants, conditions, and restrictions (CC&R's) in new residential developments that require water-intensive landscaping or prohibit low water use landscaping (City of Gilbert, 2021b).

Tucson, Arizona

Like Peoria and Gilbert, Tucson receives a large portion of its water supply from the Colorado River via the Central Arizona Project and from groundwater and effluent water. Tucson's relevance to Peoria becomes apparent when considering the two cities' different approaches to water-conserving landscaping and irrigation policies. Tucson has taken advantage of water conservation opportunities, including implementing xeriscape landscape policies, water harvesting systems, and the requirement of water-conserving irrigation systems, to name a few. Due to their strict approach, Tucson has been banking around half of its yearly allocated water supply of 144,000-acre-feet from the Colorado River in their aquifer every year (Jackson, 2021). This shows how having water-conserving policies can build resilience in the face of the threat of possible water shortages in the future. Analyzing Tucson's practices can shed light on the types of policies Peoria may consider adopting and reveal how opportunities for the City of Peoria to consider in its landscaping and irrigation policies. In Tucson's Land Use Code, their landscaping standards state that drought-tolerant plants are required, and plants that are not drought-tolerant are restricted to "oasis" areas (City of Tucson, n.d.b.). For multifamily developments, oasis areas are limited to 5% of a site, and for all other development, the maximum oasis area is only 2.5%. Notable exceptions to this limitation include public parks, botanical gardens, outdoor recreation facilities, and golf courses.

Editor's Note
According to the City of Tucson's Landscape Standards, an oasis area is where non-drought tolerant plants and landscape designs are allowed.

Tucson requires water-conserving irrigation systems for all new landscaping, reclaimed water, stormwater, and runoff harvesting to supplement drip irrigation. In addition, landscaping plans must be designed with water conservation in mind. This means considering factors such as microclimates, grouping plants with similar water needs, grading, hydrology, and structural plans to maximize water recapture (City of Tucson, 2004). Tucson also recommends a "water by the weather" guide to irrigation for their residents, which considers seasonal weather changes. Tucson uses strict xeriscape landscaping policies and efficient irrigation systems to conserve water. Tucson takes it one step further by requiring the use of reclaimed water and water harvesting systems built into their landscaping. So, the City is conserving water, but they are

taking advantage of utilizing other water sources that do not affect their allocated water supply from CAP.

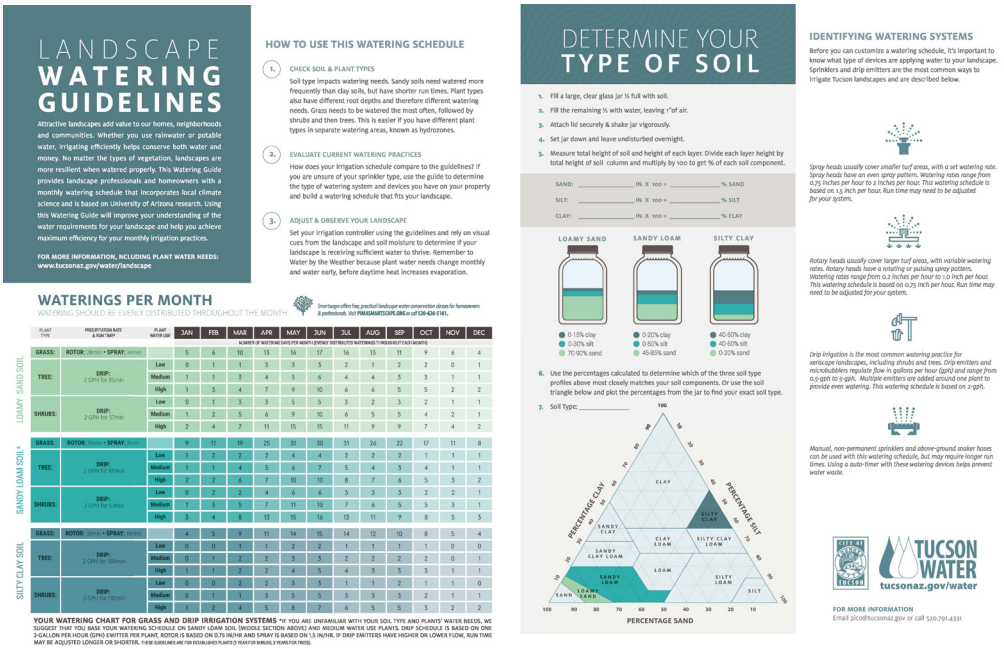


Figure 20 *"Water by the weather - Landscape Watering guidelines" guide for water conservation, by City of Tucson*

Westminster, Colorado

Westminster's Water Conservation & Efficiency Plan was established in 2020 to maximize water conservation. The City found that bluegrass landscaping has resulted in significantly increased water use for the community. Westminster also found that household leaks in older buildings contribute to higher water use. To help reduce the amount of water used in the City, Westminster created a list of the programs and policies Peoria can reference to maximize its water conservation called Water Efficient Activities (City of Westminster, n.d.).

Editor's Note

Bluegrass is the largest genus in the grass family, comprising over 500 species. Originally brought over from Europe, bluegrass is water-intensive grass primarily used for lawn grass.

Landscape and irrigation incentive programs	
Low-income leak repairs	Leaks in low-income homes are fixed so they can participate in other water efficiency activities.
City-facility turf replacement	Replaces turf that is non-functional or installed for aesthetics. It is being replaced by a biodiverse landscape that uses less water.
"Slow the Flow" irrigation system efficiency consultations	Offered to those with the largest over-irrigation groups. A free consultation for a more sustainable irrigation system is regularly offered to residents.
Water education events	Free water conservation events teach youth about water efficiency, water law, and other water related topics.
Water-wise landscapes and HOA regulations	Educates homeowners about their rights and what the HOA can enforce. Westminster also has a 2040 Comprehensive Plan that is working on a landscape design that encourages native plant use and puts thought into the placement of green spaces and parks.

Figure 21 *Example water conservation programs offered by the City of Westminster, Colorado*

Analysis & discussion

Drought-tolerant landscaping

One common theme shared amongst these three case studies is limiting the use of water-intensive plants and requiring or encouraging the use of drought-tolerant and native plant species. This approach is called xeriscaping when landscapes are designed to decrease or eliminate the need for irrigation. While the upkeep of water-intensive landscaping like a traditional lawn uses large amounts of water, as it does not occur naturally in the desert, xeriscaping allows you to work with the natural ecosystem. Xeriscaped landscapes need very little to no supplemental watering and rely solely on the natural water from the environment. In hot, arid climates such as Peoria and the case studies, this means utilizing drought-tolerant native plants (City of Tucson, 2004). Gilbert and Tucson share similar policies in which areas containing water-intensive plants are limited to only 5-10% of the total landscaped site for new development (Town of Gilbert, 2021b; City of Tucson, n.d.b). Requiring new developments to implement water-conserving landscaping can greatly reduce the amount of water needed for irrigation, thus contributing to the communities overall water conservation efforts.

Figure 22 *Xeriscape landscaping in Tucson, by Arizona Daily Star*

Incentives

Peoria uses incentives like rebates to promote water conservation with its residents, but can also benefit from enforceable policies. Offering rebates can be more effective if they are more publicly advertised to residents. The City of Westminster includes information about its rebates programming in its general plan, in addition to educational programs about landscaping. Currently, the City of Peoria does not provide this information in its general plan, but information about water saving tips and other programming is included on its website. The City does advertise a free kit, though the documentation may not always be easily accessible by residents. The City of Peoria can strengthen its incentive efforts by expanding its information-sharing efforts and better communicating policies and ordinances to residents.

Reflections

As droughts and water shortages have become a harsh reality in Arizona, Peoria can strengthen its rules and regulations around landscaping and water use. While Peoria has impactful programs and educational materials available to make the City's landscaping and irrigation more efficient and sustainable, there are still many areas that could continue to be improved. Outdoor water use like landscaping accounts for approximately 55% of the daily water use in Peoria (City of Peoria, 2022). Peoria can improve the Non-Residential Landscape Water Budget Program by expanding it to residential areas and making information about the program more available and accessible to the public. Programs similar to this have saved the Town of Gilbert hundreds of millions of gallons of water (Town of Gilbert, 2019a).

Recommendations

Recommendations for Landscaping & Irrigation	
Recommendation	**Resources**
Expand the Non-Residential Landscape Water Budget Program to residential developments.	Town of Gilbert - Nonresidential Water Conservation **https://www.gilbertaz.gov/departments/public-works/water-conservation/commercial**
Conduct a comprehensive assessment of Peoria's landscaping water use to determine where excess water is being used and how much is being used.	City of Boulder - Landscaping **https://bouldercolorado.gov/services/landscaping**
Set limits for total percentage of water intensive landscaping in landscapable areas, while providing exceptions for schools and parks. A recommended maximum of 10% water intensive landscaping, with 30% using reclaimed water.	City of Tucson - Xersicape Landscaping and Screening **https://www.tucsonaz.gov/water/ord-7522**
Prohibit the creation of new covenants, conditions, and restrictions that require the use of water intensive landscaping in residential developments.	City of Westminster - Water Efficiency Plan **https://www.cityofwestminster.us/Residents/Water/Conservation/WaterEfficiencyPlan**
Publicize the programs, incentives, and policies Peoria has developed so they are more known to the general public.	City of Westminster - Water Efficiency Plan **https://www.cityofwestminster.us/Residents/Water/Conservation/WaterEfficiencyPlan**
Provide an educational program for residents with lawns to learn about their rights as homeowners and their HOA.	City of Westminster - Water Efficiency Plan **https://www.cityofwestminster.us/Residents/Water/Conservation/WaterEfficiencyPlan**

Land Conservation and Open Space

As a desert community, water conservation in the Phoenix Metro is already of utmost importance. Land conservation and open policies affect water conservation and efficiency since open space development leads to increased water use (U.S. EPA, n.d.). The impacts of land conservation on Peoria's water conservation are substantial. Developments require a considerable amount of water, especially residential housing, Peoria's most popular development type. Peoria can drastically improve water conservation by implementing strategic land conservation policies to maintain the natural beauty its residents enjoy.

Peer community case studies

Boulder, Colorado

Due to the large influx of people moving into the City of Boulder in the mid-1900s, in 1967 the City voted into law the first locally-funded greenbelt in the United States. With a 1 cent increase in sales tax over 31 years, the City of Boulder generated $116 million and conserved 33,000 acres of land. The creation of this greenbelt has directly resulted in Boulder becoming one of the largest tourist cities in Colorado (About Boulder, 2022). Boulder maintained its identity by limiting the City's growth and focusing on restoring older buildings using the money from the sales tax increase. The City of Peoria has various sites with natural beauty and popular destinations, such as Lake Pleasant, posing an opportunity for the City to consider open space conservation efforts.

Tucson, Arizona

Pima County enacted its open space preservation plan in 1998, the Sonoran Desert Conservation Plan. Open space is a vast spread of land connected by local jurisdictions and includes the appropriate open space in private developments. Since the start, the Coalition for Sonoran Desert Protection has been an advocate for the preservation of the open space and successfully was approved for over $174 million in bond funds to recommend the Habitat Protection Priorities. The priorities identify lands in need of protection, outline land preservation efforts, and designs for a project for land preservation (Pima County, 2010, p. 36).

Editor's Note
The Central Arizona Conservation Alliance (CAZCA) has developed the Regional Open Space Strategy (ROSS) to strategize open space conservation in Maricopa County.

Along with the conservation plan, Pima County is engaging private development in land and water conservation efforts. The County encourages prospective home-buyers and private property owners to incorporate open space into the projects to preserve the area for wildlife and increase the quality of life. Communities can see the benefit of

preserving land and incorporating that into already developed land; thus, encouraging preservation over development can incorporate the safety of keeping as much open space as possible for wildlife.

Editor's Note

The Coalition for Sonoran Desert Protection comprises over 30,000 members that work on grassroots efforts for the preservation of the Sonoran Desert. The Coalition has aided in developing three Habitat Conservation Plans: Pima County's Multi-Species Conservation Plan, Town of Marana's Habitat Conservation Plan, and the City of Tucson's Greater Southlands and Avra Valley Habitat Conservation Plans.

Analysis & discussion

Land preservation

A primary theme of this case study is the value of thoughtful development. Boulder has created a community with stunning natural beauty for residents and tourists. This has increased the City's property value and has fostered a tourism economy while allowing the city to maintain its identity (City of Boulder, 2020). Peoria can take on a similar approach to conserving land around popular landmarks like Lake Pleasant.

Community engagement

A second theme within this case study is how it is possible to protect land throughout a county and how to bring people together by preserving land rather than developing it. Pima County has made significant strides in its land preservation efforts through collaborative work with the Coalition for Sonoran Desert Protection (Coalition for Sonoran Desert Protection, n.d.). Due to its size and available land, Peoria could encourage the increase of open space by preserving as much natural space as possible when planning for development. Preserving land and open space while planning for development will be largely beneficial not only for wildlife but would also benefit Peoria citizens' quality of life.

Editor's Note

Wildlife corridors are set areas, or habitats, that connect wildlife populations that would be otherwise separated by human activities.

Reflections

Due to Peoria's existing trails, such as the New River Trail, Agua Fria River Trail, and the Skunk Creek Trail, the City has an opportunity to include wildlife preservation and wildlife corridors in its trail planning efforts. A main area of focus could be the Skunk Creek Trail, a paved

trail used commonly for biking and gives access to the Arizona Canal Diversion Channel. This channel is a far-reaching path that provides access through Glendale, Phoenix, and Scottsdale. While preserving the Skunk Creek Trail should remain a priority, the New River Trail is a less developed paved trail that still interconnects with other trails but offers unique opportunities as a wildlife corridor in Peoria. As freeways continue to expand, more trails like Skunk Creek and New River should also be expanded. Developments place a significant strain on the land, so land preservation efforts can potentially reduce water usage typically associated with developments. The current undeveloped land consists of primarily desert-adapted and low water-use plants, so additional water would not be needed to maintain the areas as open space.

Figure 23 *New River Trail*

Recommendations

Recommendations for Land Conservation and Open Space Preservation	
Recommendation	**Resources**
Utilize existing trails, such as the Skunk Creek Trail, to develop wildlife corridors in an effort to reduce development and preserve open space.	City of Peoria - Lake Pleasant Area Plan **https://www.peoriaaz.gov/home/showpublisheddocument/637194548939800000**
Incorporate land preservation efforts in city planning to preserve existing undeveloped land.	City of Peoria - Integrated Transportation **https://www.peoriaaz.gov/home/showpublisheddocument/23962/637484745805930000**

CONCLUSION

As Arizona communities continue to face threats and challenges to water supplies, it is paramount to consider integrating land use and water planning into the City's general planning, codes, and ordinances. The pressing challenge of water scarcity and drought has become the forefront for many communities. The City of Peoria has consistently stressed the importance of sustainability in its community, and its Livability Initiatives seek to provide the best quality of living for its residents. Through its forward-thinking approach to water-related issues, the City of Peoria engaged with students from the School of Sustainability to research best practices for water conservation to inform recommendations for future planning efforts.

The primary goal of this peer community case study analysis was to provide the City of Peoria with a variety of municipal policy recommendations to encourage integrated land and water use planning and management. With Peoria already being a city that sets sustainability precedents statewide, further developing current plans will benefit the City itself and set an example for other areas to follow. This summary report presents general planning, water policy, plumbing codes, and landscaping suggestions that will strengthen current water management, conservation and awareness, efficiency, and water-intensive landscape management. Concerning land planning, the students provide recommendations for growth and annexation policies and land conservation management to prepare for future growth and protect undeveloped land.

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PART 3:

Leveraging Tiered Water Rates as a Conservation Tool

DETERMINING THE IDEAL TIERED WATER RATE STRUCTURE FOR SUSTAINABLE WATER MANAGEMENT

PAF 509:
PUBLIC AFFAIRS CAPSTONE

SCHOOL OF PUBLIC AFFAIRS

FACULTY
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INTRODUCTION

Ensuring the availability of a freshwater supply is a global concern, especially in arid and semi-arid climates like Arizona (O'Neill & Boyer, 2020). While Arizona has implemented some of the most progressive water conservation policies and supply strategies, like the Central Arizona Project (CAP) and Groundwater Management Act (GMA), a serious water deficit still exists but is masked by unsustainable pumping of underground aquifers and the quick draining of Lakes Powell and Mead (45% and 37% capacity, respectively, in 2016) (Hirt et al., 2016, p. 265). The chronic dry conditions in the Southwest have led to allocation cut-backs for the first time, indicating that the 2021 monsoon season, and any more like it in the future, will not be enough to mitigate the previous years of drought (Arizona Department of Water Resources, 2022). As one of the fastest growing states in the country, there is a clear urgency for cities in Arizona to implement sustainable water strategies (U.S. Census Bureau, 2021).

Figure 1 *Lake Powell, by Mark Henle/The Republic*

Project scope

Committing to sustainability is a massive task for any city, but the City of Peoria continues to undertake this challenge and emphasize the importance of water conservation in its policies and practices. By implementing a diverse set of non-pricing strategies such as reclamation projects, rebates for water conservation, educational programs, landscape demonstrations and home water conservation kits, Peoria has demonstrated that water management is a priority.

However, the City is looking to implement improved tiered water rates, a strategy used by many municipalities already to achieve conservation goals. Currently, Peoria structures most of its water services in an inclining block structure, otherwise called tiered rates, which is differentiated by consumption categories: residential, multi-residential, commercial/industrial, residential care, and landscape. Tiered or inclining block rates are "characterized by an increasing unit price of water," meaning the more water a customer consumes, the more expensive water becomes (Hildebrand et al., 2009, p. 86). As a conservation strategy, tiered rate structures increase and are intended to incentivize water conservation through the price increases.

According to research on allocation-based water rates by the Irvine Ranch Water District in California, average per acre water use decreased by 61% and water demand in the Eastern Municipal Water District in southern California declined by 10-15% (Mukherjee, Mika & Gold, 2016). Cities like Tucson and Scottsdale in Arizona have already implemented tiered water rate systems and provide in-state examples of the potential for Peoria. Along with other water sustainability policies, tiered water rates represent another opportunity to further conservation goals. However, there are a number of concerns and uncertainties when setting tier rates which include equity, economic feasibility, and actual ability to increase conservation while lowering demand.

Figure 2 *General meeting at Tucson Water, by City of Tucson*

Research questions

The aim of this study is to recommend tier level rates that will encourage water conservation and also achieve Peoria's conservation goals without being punitive or having adverse impacts on consumers. Therefore, the research questions of this project are:

1. How are tiered rates structured in other communities?
2. What impact do the tiered rates have on water consumption, or in other words, which tier costs actually encourage long-term conservation?
3. How do higher tiers, and the subsequent higher reliance in variable revenue, drive the need for higher levels of financial reserves?

Literature review

Due to a combination of factors, including climate change, interstate appropriation agreements, and growing populations, states as early as the 1980s have explored strategies to encourage conservation. The literature on urban water pricing, demand, and conservation is extensive, with much of the research on its effectiveness coming from studies in California. Research in Arizona shows that the current rates of water consumption are unsustainable with the demand from an increasing population. As such, a study of tiered watered rate literature is beneficial for Peoria to recommend strategies to encourage water conservation.

Water conservation and demand reduction water policy has been implemented across the nation in a variety of ways, including water pricing structures by water utilities. The literature suggests that while tiered water structures can be effective in increasing conservation by lowering demand, determining effective price structures relies on price elasticities of water demand which are also responsive to a variety of factors (Howe, 2005). Additionally, questions of equity across consumers are a major concern in implementing effective rate structures. The purpose of the following literature review is to explain the overarching economic concepts behind water pricing, the effectiveness of tiered water pricing and issues associated with the strategy of water conservation.

Economic context of tiered water rates

To understand the rationale for tiered water rates, the underlying economic theories are most often analyzed by researchers. While previous research has been concerned with the application of frameworks and analysis methods to estimate demand, more recent empirical research focuses on consumer response to changes in price (Baerenklau et al., 2014a). Water pricing is considered an economically efficient way of increasing conservation and included as a primary factor in municipal water rate design (Howe, 2005; Hall, 2007).

Elasticity

Price increases have been found to have a significant effect on demand, however, the elasticity of water demand is thought to be counterintuitive. Previous studies suggest that water demand is inelastic, and often they assume a uniform rate structure. Olmstead (2007) finds that uniform water rate "elasticity estimates were biased" and do not account for several confounding factors that impact elasticity (p. 184). Goetz (2013) describes the elasticity of water demand as complicated because while water is necessary for life, thus inelastic, it is also a luxury if used for activities like lawn upkeep or swimming pools making it "considerably more elastic by definition" (p. 65). Unlike purchasing an item and understanding the financial impact right away, there is a delay "between the time of water consumption and … the billing statement" (Goetz, 2013, p. 65). For consumers, budgeting water use can be difficult.

Water pricing

Understanding the elasticity of water demand is critical to water utilities because water pricing affects revenue generation. In the development of water pricing, Gaur (2007) states that revenue must cover the cost associated with providing water services such as operation and maintenance, capital and reserves five to ten years into the future (p. 112).

Editor's Note
In 1996, California voters approved Proposition 218, which subjected all taxes and some property-related fees to voter approval.

Literature on California's water pricing history offers insight into the conflict of revenue sufficiency and water conservation. The implementation of stronger water conservation goals and the growing costs of infrastructure caused local governments to turn to utility fees as revenue (Hildebrand et al., 2009; Mukerjee et al. 2016). However, due to Proposition 218 which limits the ability of local governments to raise rates, tiered water rates that had been implemented in several cities were challenged; tiered rates do not meet the revenue-neutral and cost

of service standard of Prop 218 (Hildebrand et al., 2009). Justifying rate increases proves to be difficult under the assumption that water demand is inelastic.

Potential revenue loss concerns

Water utilities also fear losing revenue. The literature on price elasticity of residential and industrial water demands suggests that elastic rates, which previous studies mentioned argue for, will decrease revenues at higher price rates (Foster & Beattie, 1979; Billings & Agthe, 1980; Howe, 1982; Boland et al., 1984; Schneider & Whitlatch, 1989; Nieswiadomy, 1990; Tate, 1990; Renzetti, 1992; as cited in Howe, 2007). However, studies on tiered water rate structures have shown that while demand may decrease using a tiered water rate structure, the upper tiers can cover costs especially with the usage of additional cost related charges (Hildebrand et al. 2009; Goetz, 2013; Baerenklau et al. 2014a).

Effectiveness of tiered water rates

The effectiveness of tiered water rates is determined by its ability to reduce water demand and increase water conservation. Theoretically, tiered water rates increase conservation behaviors and water demand in consumers while providing sufficient revenue, as shown previously. In an empirical study by Olmstead et al. (2007), it was found that increasing the marginal price of water lowered the demand in residential water by 3 to 4% compared to flat rates. Baerenklua et al. (2014b, as cited in Mukherjee et al. 2016) found that demand in Southern California's Eastern Municipal Water District was reduced 10 to 15% after switching from a "uniform rate structure with the same average price level" (p. 3). In addition, efficient users reduced their demand by 5%, but inefficient user demand dropped 25%.

An earlier study of the same area and data by Baerenklua et al. (2014), showed real average prices of water under a tiered structure rose by less than 4% with an 18% reduction in demand over years, whereas a flat rate structure would require a 48% real price yearly increase to achieve the same demand reduction. The findings further suggest that "households with higher water prices… learn how to be more water efficient" even if prices decrease in the future (Baerenklua et al., 2014, p. 12).

Benefits of education

Education plays another key role in the success of tiered rates. Research by Goetz (2013) shows that one of the biggest issues with tiered water pricing is the lack of information and explanation for the pricing structure. Citing a study by Oberlin College (2006), a clear explanation of the unit prices on a household's water bill can result in the same level of water conservation as other utilities with a "30% to 40% lower rate increase" (Goetz, 2013, p. 66). Essentially, the elasticity of water demand increases through simple consumer education. Baerenklua et al. (2013) also found similar results in their analysis; there appeared to be a positive relationship between water use and education. Given enough time to re-learn consumption beliefs, attaining conservation goals faster may be possible. The lack of studies outside of California does raise questions about the effectiveness and applicability of tier rates in different regions.

Equity

One of the primary considerations in water pricing is fairness or equity among consumers. A common perception about raising water prices is that the poor will be most negatively impacted. Hildebrand et al. (2009) raises equity concerns over imposing a general inclining tier rate structure "across a diverse pool of customers" because larger households have "greater inherent needs for water than small households" (p. 86). Howe (2005) and others argue that equity can be handled through very low first tier rate prices to fulfill essential uses of water instead of lowering prices for all users (Mayer et al., 2008; Baerenklua et al., 2013).

Individualized approach

As cited in Hall (2009), Boland and Whittington critique tier rate structures, finding that the variability of prices across a large number of customers is not equal to the marginal cost, leaving the large consumers with a greater incentive to increase their water efficiency to reach lower tier levels. To address this, Hall (2009) argues for the creation of "more homogenous customer classes" based on factors like location and family size, and threshold amounts with equal average prices for water (p. 551). Hildebrand (2009) also argues for a similar structure called "water budget rate structures" that take an individualized approach to inclining block rates which are based on "specific customer characteristics" (p. 87). Addressing equity in water pricing can be achieved through effective water tier rates, however, water utilities will need to conduct customer analyses to design rate structures that consider individual factors.

To summarize, the literature has focused on proving the economic viability, effectiveness, and equity of tiered water rates in the context of conservation potential. Water demand elasticity accounts for most of the empirical work conducted in this field and has concluded that demand becomes more elastic with the implementation of tiered rate pricing. This structure has proven to be effective in reducing demand in a number of California's cities, although, more studies in a variety of regions in the United States would help to strengthen those empirical findings. Finally, reaching equity across a diverse customer base may be achieved through the implementation of individualized tiered water rates as shown in a number of studies.

RESEARCH METHODS

The following research questions, as determined in conjunction with the City of Peoria, will be examined:

1. How are tiered rates structured in other communities?
2. What impact do the tiered rates have on water consumption, or in other words, which tier costs actually encourage long-term conservation?
3. How do higher tiers, and the subsequent higher reliance in variable revenue, drive the need for higher levels of financial reserves?

This project will rely on an in-depth academic literature review, industry publications, media sources, and other appropriate sources to gain a better understanding of the issue at hand, as directed by the client-partner. Following the completion of the literature research phase, the highlights of the research will be compiled and reported. In addition to literature research, expert interviews will be conducted with key stakeholders in the community and industry to seek insights and answer questions related to the results of literature review. City staff facilitated connections to data, personnel, external stakeholders, and resources at the Department of Water Resources. Data collected from the research and interviews informed answers to the research questions and water tier rate recommendations.

FINDINGS & ANALYSIS

Arizona ranks eighth in highest average water bill per month, both because of and in spite of the arid, dry climate and diverse water resources (Phillips, 2022). Cities in Arizona, however, vary in their water rate structure and in water prices. The cities that will be compared are shown in Figure 3. The following cities were chosen due to data being made available through Peoria's finance department that uses the data to create its rate structures.

City	Number of tiers	Lowest tier cost	Highest tier cost	Base charge for 3/4" metre	Population	Cost of service
Chandler	4	1.60	3.27	10.35	273,102	302.00
Gilbert	4	1.20	2.06	16.30	266,714	394.00
Tempe	5	1.90	5.58	15.30	207,982	427.00
Peoria	4	1.22	5.12	16.91	187,055	483.00
Scottsdale	5	1.50	6.75	18.75	268,839	485.00
Glendale	4	2.83	6.89	15.60	259,659	496.00
Mesa	4	3.24	6.56	28.52	548,213	703.00
Avondale	3	1.93	4.83	9.00	94,579	
Buckeye	5	3.93	9.59	32.94	95,463	
Goodyear	4	2.21	10.62	19.10	98,741	
Queen Creek	3	1.77	2.96	18.33	62,191	
Surprise	3	2.37	5.44	28.82	153,505	

Figure 3 *Residential water rate structures*
Note: Data compiled from "Rates effective January 1, 2022" dataset from Peoria's Financial office and city government's websites

No city water tier structure exceeds five tiers or drops below three tiers. While tier rate structures have no universal standard, there is a clear effort to include a conservation and a wasteful consumption tier. The city with the lowest first tier rate is Peoria at $1.26 and the highest is Buckeye at $3.93. Buckeye also has the highest meter base charge. At the other end, Goodyear claims the highest top tier rate at nearly $11 while the lowest top tier rate is Gilbert and just over $2. On average, the lowest first tier is $2.15, and the highest top tier rate is $5.81, which puts Peoria below the average in both categories.

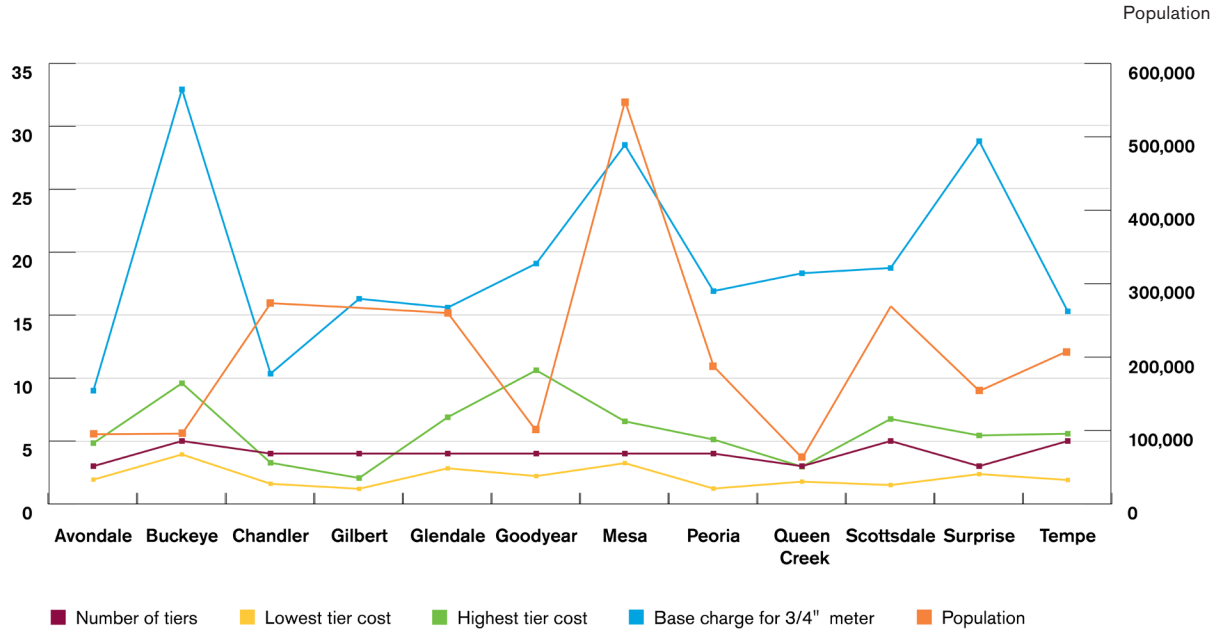

Figure 4 *Residential tier water structure by city*
Note: Right axis corresponds to population, the left axis corresponds to the rest of the variables

The graph above illustrates the information from Figure 3. There is no clear correlation between the cost of the lowest and highest tiers with any of the variables shown above as most cities have very similar rate prices and tiers despite differences in population and base rate charge. The cost of service for providing water services, however, is a primary factor in the determination of water rates as the revenue from those rates pays for the water expenditures. A study conducted by the City of Tempe which compares the estimated annual household cost of providing water services reveals that generally, the cost of service does not highly correspond with the cost of the tiers but actually the base rate charge (City of Tempe, 2021). While the highest tier cost does slightly increase as the cost of service does, the lowest tier rates across the cities compared in the study stay at about the same level.

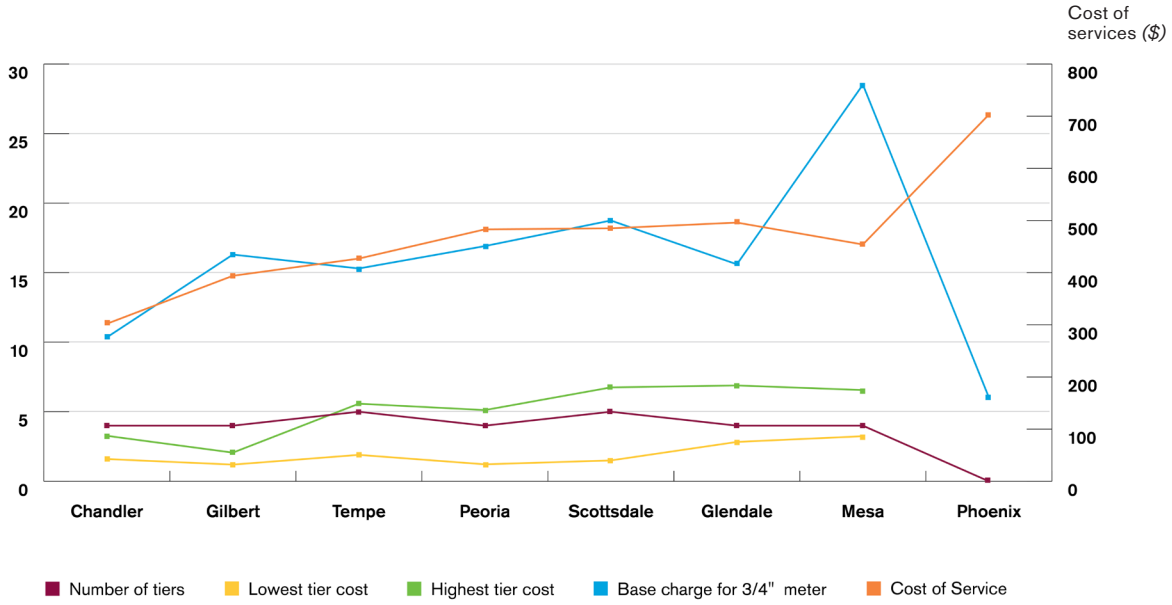

Figure 5 *Comparison of eight cities' cost of service (City of Tempe, 2021)*
Note: Right axis corresponds to cost of service($), the left axis corresponds to the rest of the variables

According to City of Scottsdale, which has a five-tier structure and more expensive highest tier than two thirds of cities, the higher costs are due to its heavy reliance on CAP surface water, larger impacts of arsenic regulations on the groundwater supplies, and significant elevation changes in the distribution system (City of Scottsdale, 2022). This is reflected in the high cost of service in Figure 5. Chandler on the other hand, has the lowest water service cost thus having a correspondingly low pricing structure: the fourth cheapest first tier rate, and third cheapest highest tier rate. Officials attribute the low costs to workforce efficiency and regular review of the largest cities in the Valley (City of Chandler, 2020).

U.S. city comparison

According to an examination of water prices from 2015, although water rates are steadily increasing (41% average rise since 2010 in 30 major cities), Phoenix is one of many cities where "total water use is dropping," indicating that conservation efforts may be working (Walton, 2015). However, rates between states vary greatly depending on a number of factors. The Great Lakes Region, for example, is close in proximity to abundant water which lowers the energy cost of transporting water but, decreasing consumption has also caused rates to increase (Walton, 2010). The City of Milwaukee has experienced a concerning decline

of consumption and instead had to raise its rates, thus conservation is not a major goal. Boston, who experiences significant rainfall and low consumption, also maintains higher water rates compared to Phoenix where rainfall is very low, but consumption is high (See Figure 6). Santa Fe, despite being a Southwestern arid state with little precipitation, unlike Las Vegas and Phoenix whose average monthly water bills are very low compared to use, has much more expensive water bills and less per capita consumption.

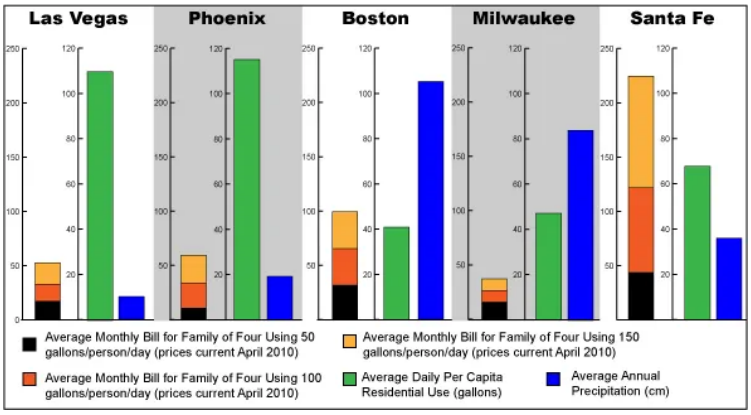

Figure 6 *Water use comparison of five U.S. cities (2010), Trevor Seela, by Circle of Blue*

While Santa Fe's per capita use had dropped 42% since 1995, Phoenix consumers actually used the same amount of water (per capita) that they did 10 years prior despite a population increase of around 400,000 (Walton, 2010).

To further compare the differences between various U.S. cities to Peoria, Figure 7 summarizes the tier rate structures of seven cities including Peoria. While Moreno Valley in California boasts the least expensive lowest tier rate, its highest tier rate ranks second in highest cost. Unsurprisingly, based on the information in Figure 6, Santa Fe holds the highest cost high tier and second highest low tier. Similar to the Arizona city comparison, most cities have a similar tier structure except for Boston which utilizes a six-tier structure paired with expensive costs. Compared to the average low and high tier of the Arizona cities, four of the seven cities exceed the low tier average and five out of seven exceed the high tier average.

City	Number of tiers	Lowest tier cost	Highest tier cost	Base charge for 3/4" metre	Population	Precip.(in)
Las Vegas	4	1.40	5.51	13.92	623,747	4.20
Peoria	4	1.26	5.26	17.38	259,659	7.20
Santa Fe	2	6.06	21.72	18.42	86,099	14.17
Moreno valley	4	1.14	12.30	14.40	204,198	14.30
Seattle	3	5.71	11.80	18.45	684,451	39.40
Boston	6	7.97	10.83	N/A	667,137	43.60
Atlanta (Fulton County)	3	3.90	7.79	9.25	463,878	50.40

Figure 7 *Comparison of seven cities' water tier rates*
Note: Data compiled from city government utilities websites, water district websites, and U.S. National Centers for Environmental Information

Interestingly, the average base charge rate for Arizona cities is almost $4 higher than the cities in Figure 7 which may suggest that the selected cities rely on their volumetric water revenue more than the revenue from their fixed costs. The data from Figure 7 is visualized below to further reveal the differences between the cities. While cost of service is not included in the data, precipitation averages are added. The graph shows that as precipitation increases, the tier rates do not necessarily increase. Based on the data examined thus far, there does not seem to be one ideal pricing structure that is based on a predictable variable, however, a combination of factors which include the cost of service, water projects and consumption may have the strongest impacts.

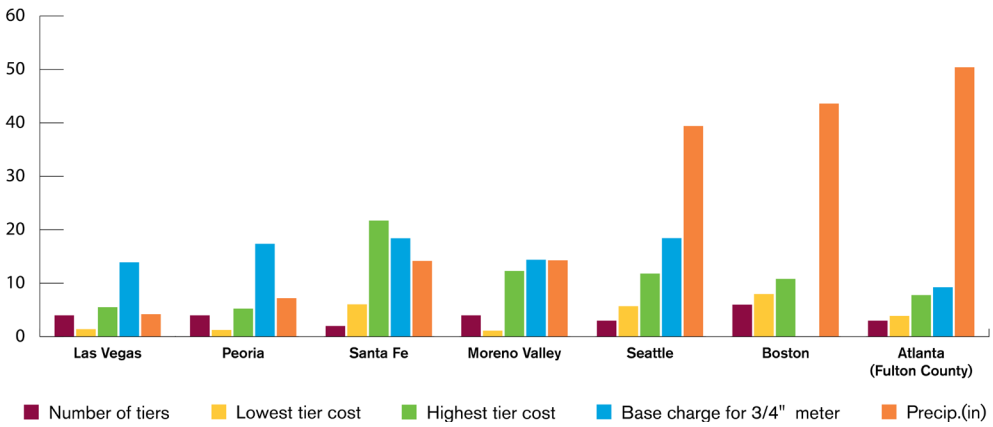

Figure 8 *Comparison of seven cities' water tier rates*
Note: Data comes from Figure 7

Discussion

The data reviewed above reveal the variety of water pricing within Arizona and around the country. Few of the variables correlate to pricing structures despite intuition suggesting that factors such as population size, precipitation, and cost should play roles in their determination. According to the literature research on increasing block rates, revenue recovery does play a major role in determining the price of utilities and water is no exception. To answer why cities with less rainfall are able to charge less for water than those with high rainfall, Walton (2010) found that major water infrastructure projects are often federally funded, especially in the West. With capital costs not included in the price of infrastructure projects, cities do not need to recover the costs using water service revenue. The Central Arizona Project (CAP) was one such project that utilized federal support and residents are paying less than half of the project's total cost ($3.6 billion), thus the cost of water services is lower than they could have been (Walton, 2010). For cities without such funding for water infrastructure, the cost must be built into the pricing of water. Santa Fe, for example, has the highest overall water rates which are likely due to $217 million Buckman Direct Diversion, a non-federal project jointly paid by the county and city, that was necessary because of scarce and unsustainable groundwater use.

In addition to the financing of water infrastructure projects, the general decline of water occurring in many states, forces utilities to price services higher. Block increasing rate structures favor water conservation but usually not revenue stability (Williams, 2019, p. 62). During times of high-water conservation or reduced demand, consumers are punished for using less water by a higher bill. Approximately 80% of utility costs are fixed and must be covered by revenues, but many cities, nearly 52%, utilize increasing block rate structures and that accounts for up to 80-90% of revenue (Walton, 2015; Spang et al., 2015, p. 2015). It stands to reason that cities like Seattle and Atlanta, where precipitation is high, water demand is lower than in dry, Western cities, thus rate structures must be as high to recover the costs of providing water.

Peoria

Understanding each cities' unique combination of variables that contribute to the design of the rate structure, the following discussion will describe the current water rate plans in the location of interest. In the City of Peoria, water tier rates are determined by the financial office whose focus is generating revenue to support the cost of service. The most recent financial Water and Wastewater Rate Study conducted in

2021 recommended an annual 2.75% increase in rates every year from FY 2022 to FY 2026 to cover all costs and fiscal targets (FCS Group, 2021). In 2015, the previous rate adjustment period found that like many Arizona cities, Peoria was experiencing a declining per customer water usage that resulted from higher rainfall, customer efforts to reduce household expenses and low flow fixtures and appliances (Davis, 2015, p. 16). As a result, the rate structure reflected the need to recover revenue by charging wasteful users more through the tier structure, as do most utilities.

Tiered rates impact on water consumption

As stated previously, the water tiers will need to increase 2.75% yearly because the cost of service will increase by a similar rate assuming demand changes are negligible. While studies in the literature review state that increasing block rate structures do increase conservation behaviors, there is little information suggesting that increasing the rates solely to increase conservation are justified. Considering cities with higher rate structures are the ones with more abundant water, the factors that contribute to water tier pricing are not straightforward. In Williams' (2019) study of different water rate structures and their ability to increase conservation and impact on revenue during different periods of water availability, she found that tiered rate structures were able to maintain water agency revenue during the drought period, "but the rate increases likely do nothing to encourage conservation behavior" (p. iv). This may be due to increased water rates or additional fees and increased fees to make up for the loss in revenue generated by less consumption. It is further suggested that the increase in consumers' water bills may have negative impacts on long-term behavior and utility management (Williams et al., 68).

RECOMMENDATIONS

The purpose of this study was determining if there is an ideal tier rate structure that both increases conservation and adequately generates revenue to cover the cost of service. As explained in the literature review, a one-size-fits all rate structure applied to a diverse consumer base makes it difficult for water utilities to equitably charge customers for water use. Peoria, Arizona utilizes a tiered rate structure, and has determined a rate at which to increase the price of tiers to sufficiently cover water operations for the next four years; however, the increase of water insecurity and drought have made the City question if more can be done from a conservation perspective. In comparison to other cities around the

U.S., Peoria's cheaper tier structure may seem counterintuitive. However, as the research shows, the factors that influence water pricing likely have less to do with conservation goals and more to do with the costs of water services and demand for water in relation to precipitation. Cities with tiered rate structures still have to generate sufficient revenue and if customers do not need to buy as much water from utilities, then the costs for water need to be high to cover expenses.

Figure 9 *Lake Mead near Hoover Dam*

Arizona cities' high demand for water ensures water agencies will be able to generate sufficient revenue, even if they need to raise prices. However, drought and water availability concerns will only continue to build as cities continue to grow and put pressure on water supplies. If there is not an ideal rate structure based on conservation and revenue stability due variations in a variety of factors that impact water pricing, what can cities do instead?

Stakeholder education

Critiques of tiered water rate structure's effectiveness often cite the lack of awareness and education among customers and suggest for rates to be successful; thus, utilities should include outreach and communication as part of conservation goals (Goetz, 2013; Baerenklua et al., 2014; Hildebrand et al., 2009; Williams, 2019). Providing information on the billing statements about how tiered rates work, what they are designed to achieve, and how consumers can monitor their

water use will be important if tiered rates are to be continued. Inserting bill mailers explaining why tiered rates are being implemented and adding easy-to-understand information to the utility's website such as a water calculator, videos, or graphics can also be great ways to spread awareness, according to Goetz (2013). These strategies have already been implemented by water utilities across the nation. In a study of the differences in informational content of bills in 383 utilities in the United States, bills with pricing information did have a significant impact on water demand (Gaudin, 2007).

Instituting a new water pricing structure may likely prove to be difficult and receive resistance form the community that relies on the water provided by the water agency. The City of Peoria has changed its rates in the past and will in the future, but those changes align with historical water pricing structure and do not differ greatly from other Valley cities. In order to institute a new rate structure, the leaders of Peoria's water services will need to communicate and educate the community, as it has done in past water related projects and campaigns. For example, Davis, California was set to institute a completely different pricing system and promoted the new structure with an informational flyer that explained the change and a clear equation for an example customer bill (see Appendix A). However, the City of Davis's educational campaign, to occur 20 months before the rate structure implementation, faced "several shortcomings in messaging and public education" (Spang et al., 2015b). Strategic and clear customer education will play a significant role in the success of rate structures and sustainability in Peoria as it builds a community where people feel like they are part of the change.

Data collection

Since users are so diverse and locations vary in a number of ways, data collection provides a great tool for managers and high leadership to make better decisions about water management. In addition, continuous and location specific data collection and analysis will be key for determining if alternative pricing structures or structure changes are suitable for Peoria's conservation goals and maintaining equitable pricing. Sterle & Singletary (2017) argue that continuous data collection can contribute to greater collaboration among water managers, as well as understand human behaviors during drought conditions and build capacity to adapt to drought conditions. Science-based data information can be used to "inform and support changes to" rate structures that "enhance revenue stability and conservation practices" (Williams, 2019, p. 73).

Consumption based fixed rates

The results of the study recommend the exploration of a new water pricing structure that reimagines conservation-focused rate structures: consumption-based fixed rates (CBFR). Spanger et al. (2015a) states that any pricing structure that decouples fixed (operation & maintenance, cost of service) and variable costs (volumetric use) from fixed and variable revenues in the way that conservation focused structures do, these structures will lead to revenue instability (p. E165). Compared to the most common pricing structures, CBFR divides costs into three categories so that actual fixed costs only represent a small portion of costs and fixed costs that actually depend on volumetric use like operation cost and maintenance can be recovered with fixed volumetric revenue (see Figure 10). True variable costs, delivery of water, also represent a smaller portion and are recovered with a corresponding revenue source. There is a stronger conservation incentive since two charges are intrinsically tied to volumetric consumption.

Fixed-Fixed	Fixed-Volumetric	Variable
▪ Water meter installation and reading ▪ Fire protection services ▪ Administrative/billing costs	▪ Purchasing water rights ▪ Planning and environmental costs ▪ Water mains, pipelines, tanks, and wells ▪ Building/maintaining water treatment facility	▪ All costs that vary with water use ▪ Examples: Wholesale water purchases, pumping costs, water treatment (including chemical) costs

Figure 10 *Example of utilities costs under CBFR, by Spang et al., 2015a*

One of the key aspects of consumption-based fixed rates is that the base costs to the customer is allocated towards the utility's fixed costs; similarly variable costs are proportional to demand and thus give customers greater control over their water bill. In cases where the fixed base rate still does not fully cover the costs, the CBFR model includes a "supply fee as part of the rate calculation" based on the consumer's use during peak summer periods so that higher users pay a proportional fee for their great use (Williams, 2019, p. 69). In this way, equitability is increased across the system. The CBFR may actually give

consumers greater control over their water bill than the current structure and could easily support the cost of service through revenue. Table 4 offers a comparison of the most common rate structures and CBFR to further illustrate the differences in cost differentiation and conversation incentives.

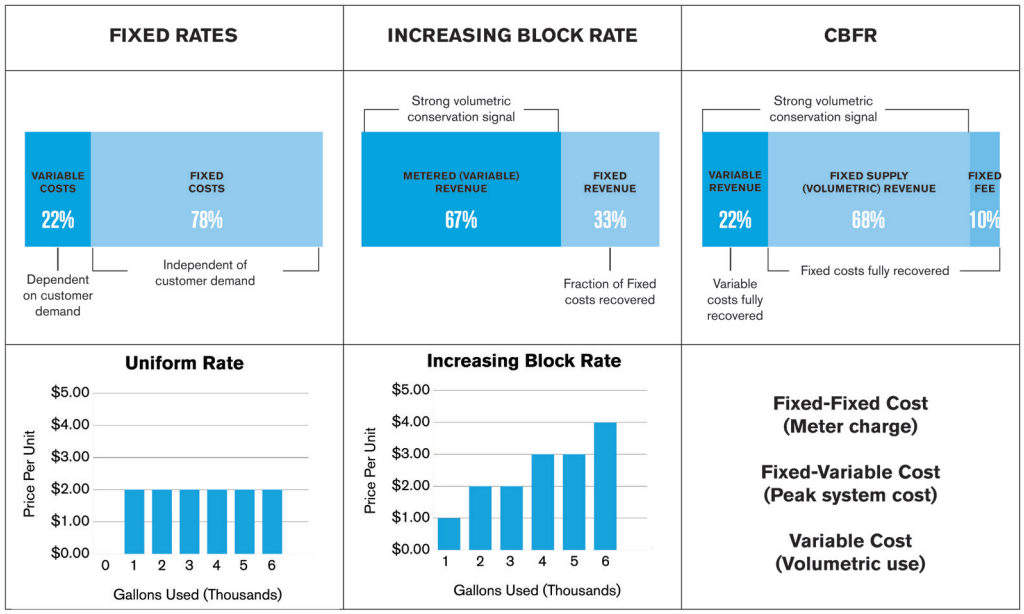

Figure 11 *Comparison of water rate models*
Note: Displays theoretical and conceptual design and impact of different rates

The implementation of CBFR has only been attempted in Davis, California and despite the theoretical foundation of CBFR, is compelling; it is no surprise that the rate structure underwent modifications and compromises. In practice, water managers and utilities must take into account the "pragmatic, legal and political demands" of its community and city, which means that each city will have to navigate unique circumstances and realities regarding water pricing (Spang et al., 2015a, p. E384). Ultimately, the City of Davis's City Council voted on a five-year plan that compromised and gave the city time to prepare for CBFR: first, an inclining block rate will be implemented for two-year period then modified CBFR rates would go into effect for the remainder of the five years (Spang et al. 2015a, p. E385). While studies have yet to show the results of the CBFR rates in Davis, the process has shown the resilience and flexibility of the structure; data from the experiment could prove CBFR's worth as an effective conservation tool that can maintain revenue stability.

CONCLUSION

The City of Peoria is a leader in sustainability and sustainable practices in the Phoenix Metro Area. While already offering and promoting a number of water conservation practices, the City believes that more can be done as a community to conserve. Cities across the nation face similar challenges as water scarcity and climate change induced weather pattern changes impact water availability. Conservation does not have to result in revenue instability and cause financial deficits in order to provide water services. The evaluation of a city's diverse customer-base and the application of an equity rate structure that encourages conservation while utilizing high-use consumers to pay their portion can reconcile the complexities of water rate pricing. As Peoria continues to grow and develop as it hopes to, it is inevitable that the cost of providing and distributing water will increase, and it will be even more essential for the city to plan for future challenges. However, any changes to the current tiered rate system will require a significant public education and communication campaign to communicate the goals and benefits of the changes. The success of a new pricing structure that strives for equitability and sustainability will depend on the water services department's ability to collect data regularly and account for a variety of factors and their complexity. Finally, exploration into the feasibility of CBFR for Peoria may reveal potential positive outcomes in conservation and revenue goals.

Figure 12 *Lake Pleasant, by City of Peoria*

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links.asu.edu/PCPeoriaWaterRates22S

APPENDIX A

Davis, California - CBFR Informational Flyer

Water Rate Methodology Change

New Consumption-Based Fixed Rate

Water use May-October 2014 will affect water rates beginning January 1, 2015

Beginning January 1, 2015, the City's water service fees will be based on a new, innovative rate structure referred to as the Consumption-Based Fixed Rate (CBFR) structure. The CBFR structure is comprised of three components - a distribution charge, a variable charge, and a supply charge.

1. Distribution Charge

A fixed charge based on the size of the water meter serving your property and comprises approximately 13% of the average monthly water bill.

2. Variable Charge

This variable charge consists of a uniform rate per unit of water for all user classes. One unit of water is equal to 100 cubic feet (ccf) of water (which is equal to 748 gallons). The variable charge will comprise approximately 20% of the average monthly water bill.

3. Supply Charge

The supply charge is calculated by using the projected annual revenue requirement related to water supply and treatment and dividing it by the total projected 6-month peak period (May through October) water use to produce a per ccf rate. The individual fee per customer is then calculated by taking the per ccf rate and multiplying it by the individual customer's prior year's 6-month peak period water use. The supply charge will comprise approximately 67% of an average monthly water bill.

Each year, the supply charge amount is recalculated based on an individual's actual water use during the prior 6-month May through October peak consumption period. So for January 1, 2015, the May-October of 2014 total volume will be used. The supply charge for each property remains the same each month until the next January 1 adjustment date.

This new rate structure and Supply Charge ensures that property owners will have increased control over their utility bills by employing conservation techniques (the Variable Charge and the Supply Charge). Property owners will be able to determinate approximately 80% of their water service fees in a given year in advance and can budget accordingly (the Distribution Fee and the Supply Charge).

Together, the rates for the three components of the City's water service fees are structured in such a way as to recover the proportionate costs of providing water service to each property receiving water service.

For new accounts, the CBFR charge will be based on estimated consumption until actual peak period (May-Oct) usage is established at which time a true-up will be accomplished.

The City has partnered with WaterSmart to provide property owners and residents with water saving tips and feedback on individual water usage. Visit your personalized water use website at *Water.CityofDavis.org/WaterSmart*

Bill Estimation Tool for 2015 (CBFR Structure)

Type of Charge	**Distribution Fee** (based on meter size)	+	**Variable Charge** (based on current month's consumption)	+	**Supply Fee** (based on summer consumption)	=	**Total Bill** for the Month
Charge Equation	_____ (Fee for Your Meter)	+	_____ x $0.86 (Monthly Volume)	+	_____ x $0.32 (6 Month Peak Use)	=	Total Bill for the Month
Example Calculation (typical home)	$ 10.21 (3/4" meter)	+	(11 ccf* x $0.86) Monthly volume (ccf) x $/ccf	+	$0.32 x 102 ccf	=	Total Bill for the Month
Example Figures (typical home)	$ 10.21	+	$9.46	+	$32.64	=	$52.31