Water policy and governance for demand management: The case of Tucson, AZ

Presented by:

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October 27, 2022

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I work with stakeholders and community partners to answer questions related to water security, urban resilience, and environmental justice, by focusing on greenspace/green infrastructure.

I am originally from Monterrey, Mexico. I did my undergraduate studies on architecture at ITESM in Monterrey.

I hold two advanced degrees from the UArizona:

- a master of architecture degree with a concentration in design and energy conservation
- a doctoral degree in arid lands resource sciences with a minor in global change.

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Overview of the seminar

First day – Water management in Tucson

- Introduction – why Tucson?
- Tucson before water pumping
- Institutional context
- Action at the local level
- Water policy at the state level
- Water policy at the county level
- Water policy at the city level
- Education and outreach
- Conclusion

Second Day – From a hazard to a resource

- Reframing water from a hazard to a resource
- Green infrastructure and urban design
- Challenges for mainstreaming green infrastructure in Tucson
- Justice issues
- Institutionalization of green infrastructure
- Conclusions

Water management in Tucson

Study sponsored by the National University of Singapore and the International Water Security Network

- **A literature review was conducted to examine water policies in Tucson, AZ, as an example of a city located in an arid environment, and their effectiveness in reducing water demand.**

Resilient Water Services and Systems

The Foundation of Well-Being

Chapter 13

Tucson Arizona – a story of "water resilience" through diversifying water sources, demand management, and ecosystem restoration

A. Zuniga-Teran and C. Staddon

EWRA *Water Utility Journal* 28: 1-17, 2021.

Water policies and their effects on water usage: The case of Tucson, Arizona

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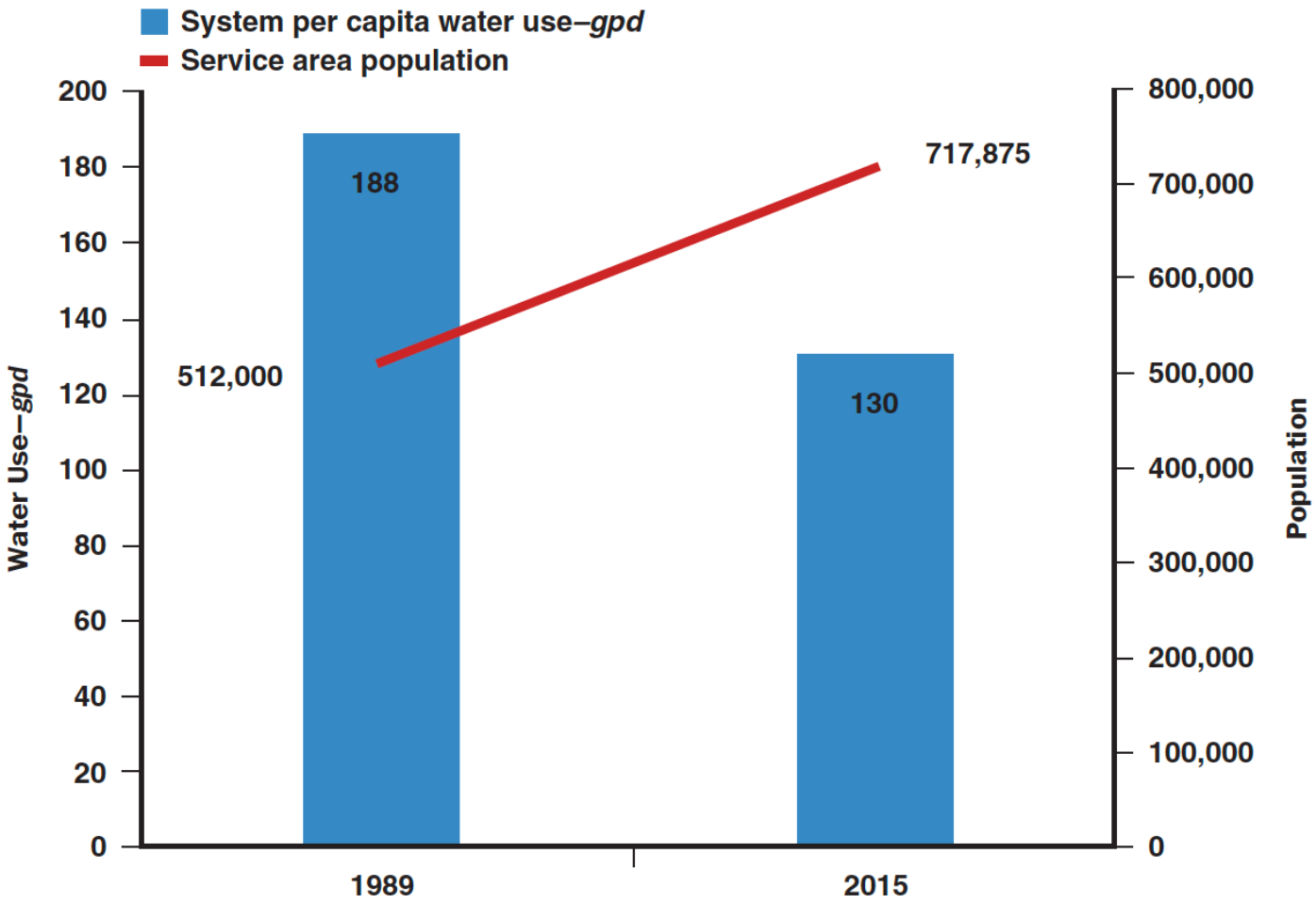
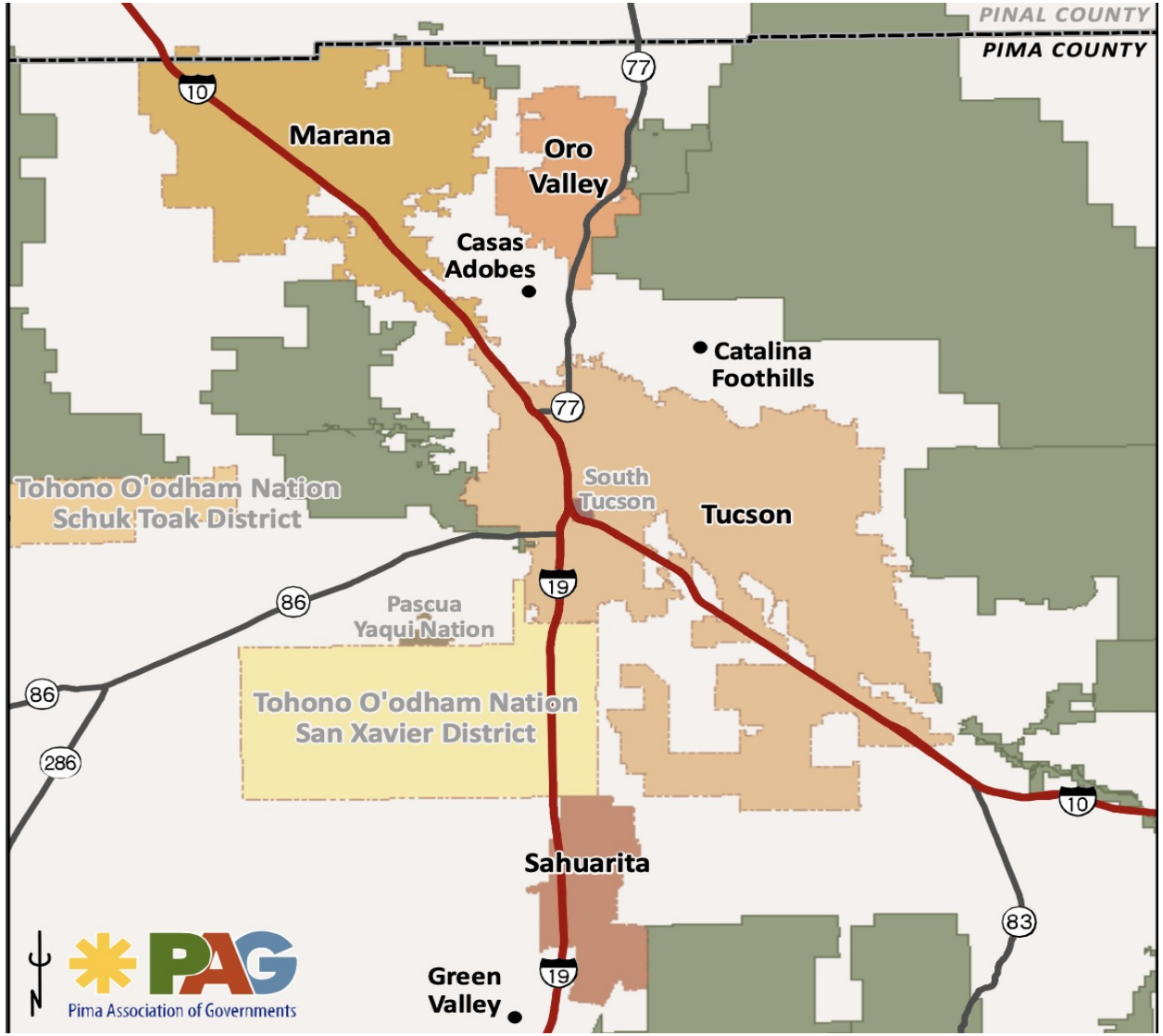
Introduction – why Tucson?

- Tucson is located in a desert environment with a growing population, yet the city has managed to reduce not just per-capita, but *overall* water consumption over time.
- In 2015, Tucson's per-capita water use was only 80 gallons per capita per day (gpcd) (below the state of Arizona's water usage of 146 gpcd, and the U.S.' water usage rate of 83 gpcd).
- They have lowered their system per capita water use by 58 gpcd, with respect to 1989.



Comparison of per capita water use and service area between 1989 and 2015 in Tucson (Rupprecht et al. 2020)

Introduction - Tucson Metropolitan Area



Tucson is located in a hot and semiarid region (300mm ave annual precip) in Southern Arizona that extends through 400 sqmi and is home to about 1 million people.

Tucson encompasses several jurisdictions:

- the City of Tucson,
- the City of South Tucson,
- Oro Valley, Sahuarita,
- Marana,
- Tohono O'odham district
- Pascua Yaqui district,
- the rest is unincorporated area in Pima County.

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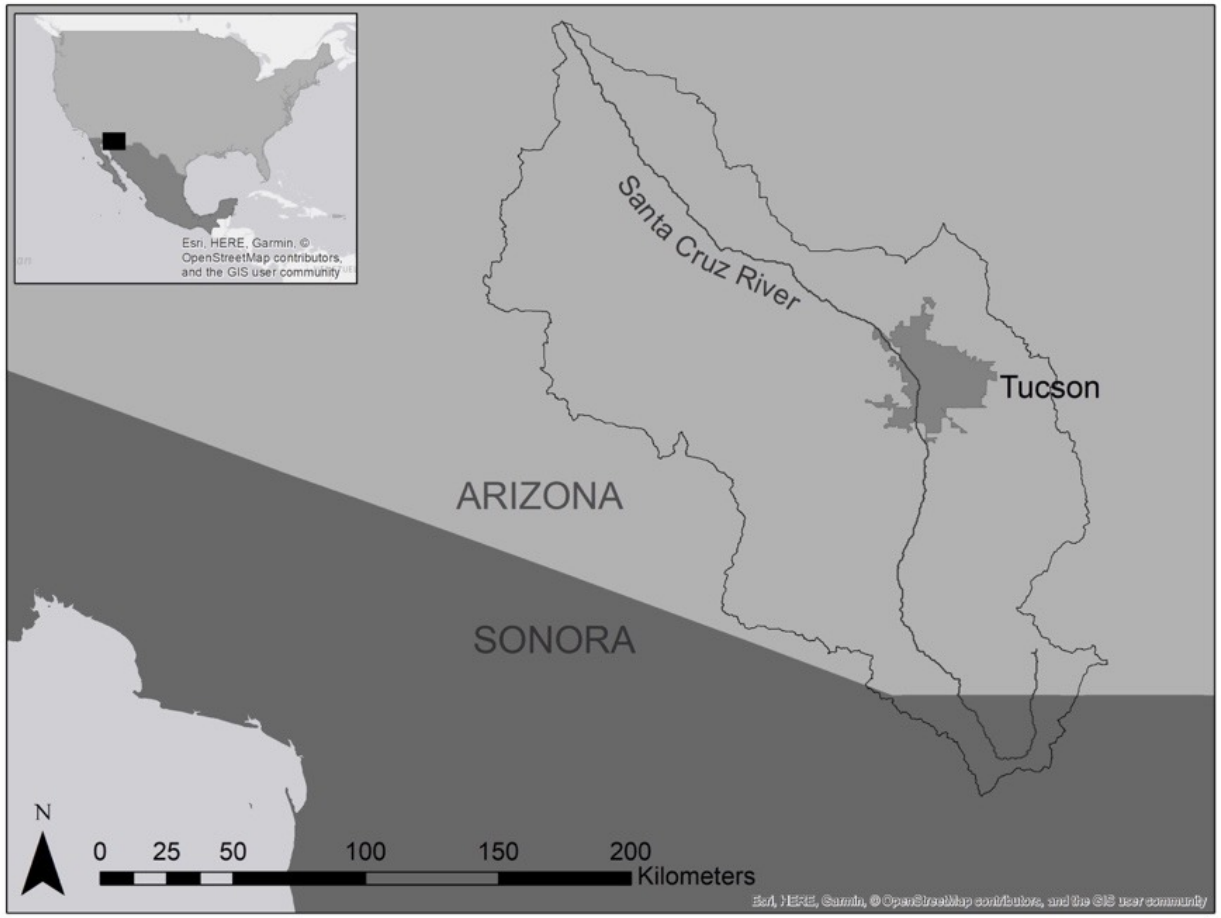
Tucson before water pumping

The original water source for Tucson was surface water from the **Santa Cruz River** – a binational river shared between the U.S. and Mexico – that provided water to established communities throughout history:

- Hohokams,
- Pimas,
- Tohono O'odhams,
- Pascua Yaquis,
- Spaniards,
- Mexicans, and
- Americans.



The Santa Cruz River Basin – a binational river that provided water to Tucsonans and other communities in Southern Arizona and Northern Mexico

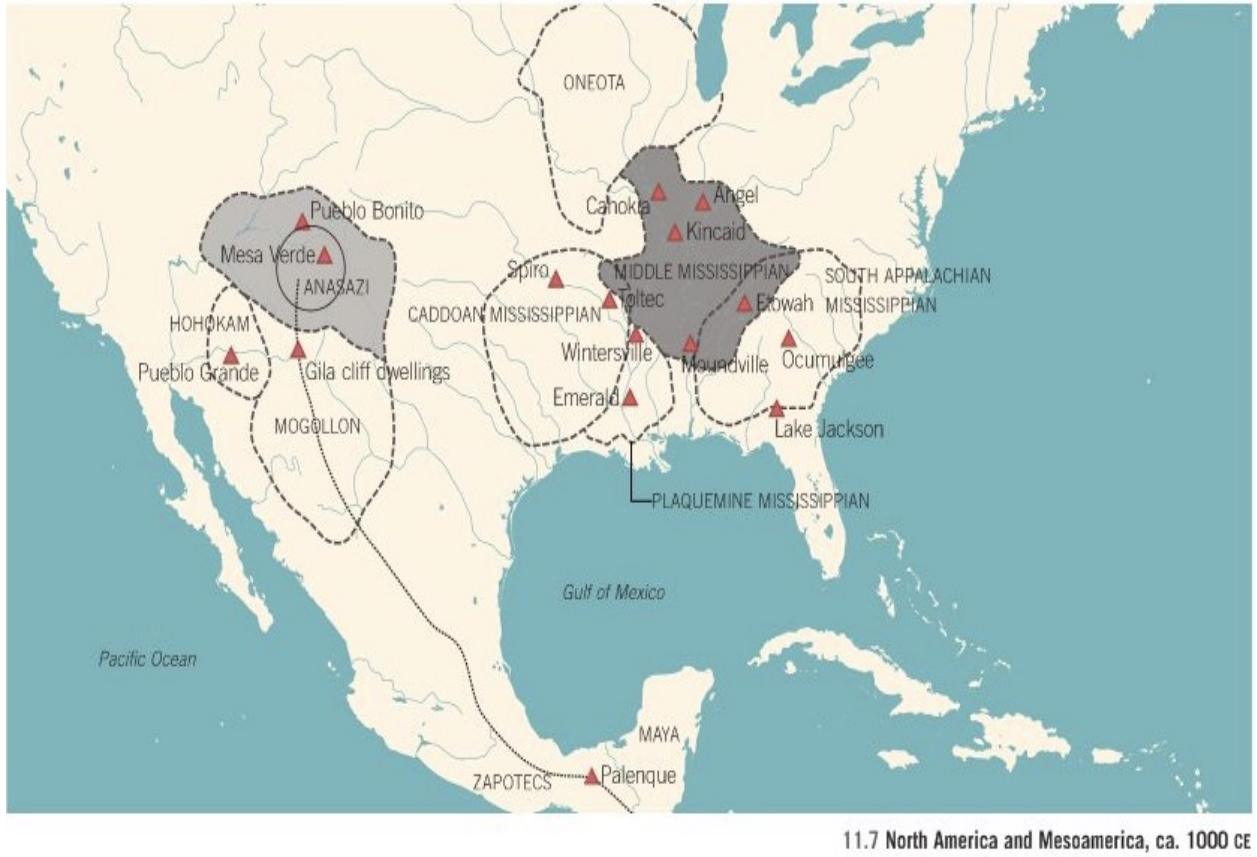
Hohokams

The Hohokams are considered the “Masters of the desert,” who lived in this region from the first years of CE to 1450 CE, just 95 before the Spaniards arrived.[1]

They are admired for the irrigation canals – the most complex in the New World north of Peru.

Their villages were located along the canals and hosted several hundred people.

Hohokam archaeological site in Casa Grande, AZ



11.7 North America and Mesoamerica, ca. 1000 CE

Hohokams and Puebloans inhabited this region in 1000 CE.

1: National Park Service. Hohokam Culture.

Hohokams

Hohokam farmers figured out a way to successfully grow crops in the same location for hundreds of years, and create a large, prospering society.

Their descendants are the Pima and Tohono O'odham people of Southern Arizona.[1]

Map of Hohokam irrigation canals in the Salt River (Phoenix). Map by Turney in 1929.

Canals in Mesa, AZ 1200-1450. Mural in the AZ Museum of Natural History by Ann and Jerry Schutte

1: National Park Service. Hohokam Culture.

The Santa Cruz River

In 1870, as a U.S. Territory, communities in Tucson still received water from this river through a distribution system based on gravity.

Historic photos of the Santa Cruz River. AZ Daily Star. Arizona Historic Society.

Electric wells

In 1808, mechanical drilling of wells was invented in the US.

In 1830a deeper wells were drilled, and since then, the technology advanced rapidly.

Groundwater = hidden resource. It provides good water quality and does not require massive infrastructure.

In 1889, Tucson Water Company – the main water utility in Tucson – started drilling wells and pumping groundwater to meet water demand for the municipality, and for other uses including farming and mining.

Pima cotton grown in Marana

Electric water well

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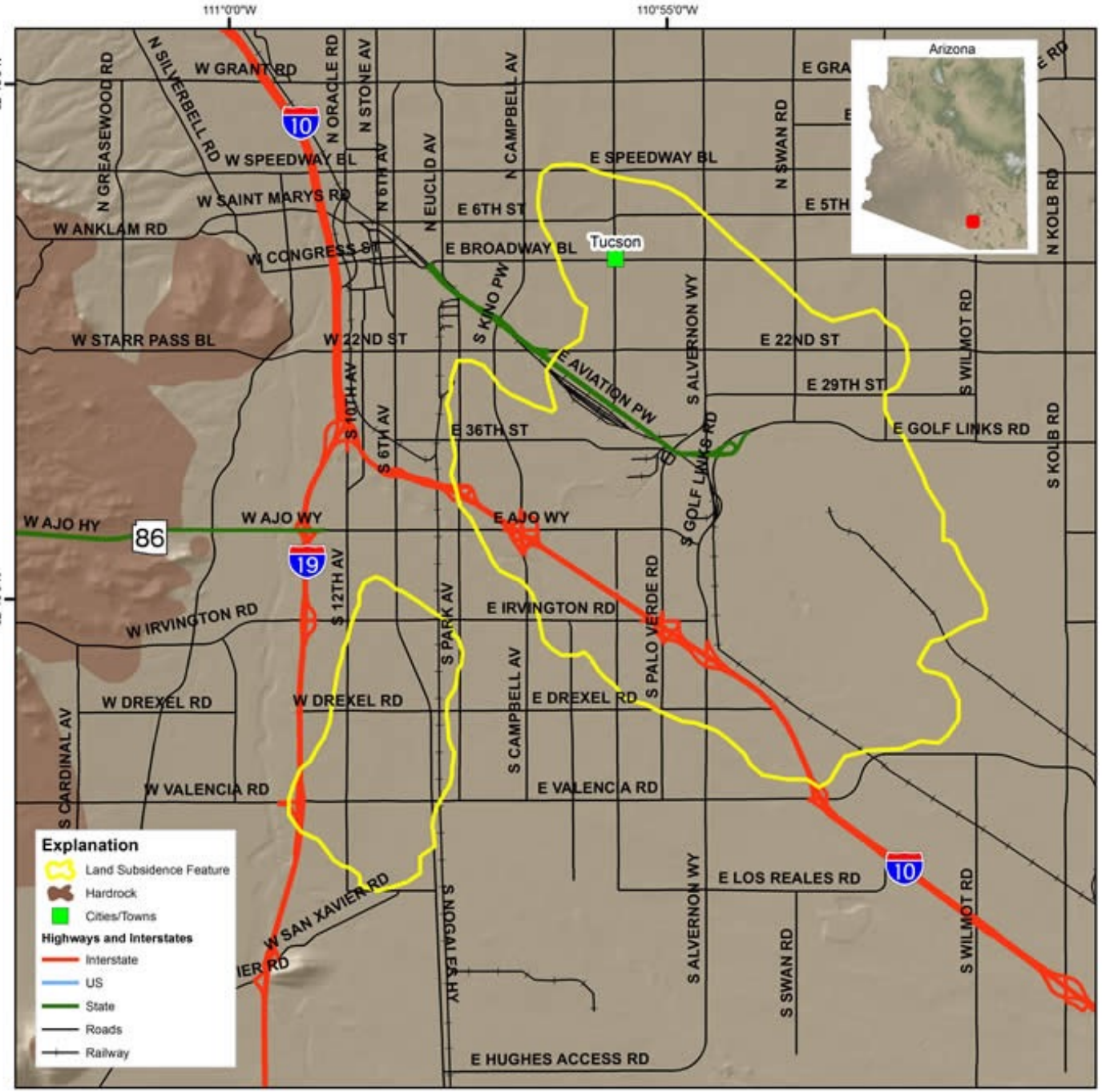
Groundwater depletion

As population continued to grew, groundwater pumping increased and became unsustainable – Tucson faced aquifer depletion and experienced land subsidence.

Something needed to change…

Land subsidence



Institutional context

Early legislation for groundwater in Arizona dates to 1948 with the enactment of the **Critical Groundwater Code.**

The Code delineated areas where groundwater was not sufficient for irrigation - Critical Groundwater Areas – prohibiting the constructions of more wells,

However, they failed to monitor the withdrawals of existing wells or place restrictions for non-irrigation uses.

After 1948, the **Rule for Reasonable Use** was passed allowing landowners the use of groundwater in their property for reasonable and beneficial uses only.

Despite the enactment of the Code and the passing of the Rule, groundwater overdraft persisted in Arizona.

The Groundwater Management Act

Facing imminent aquifer depletion and land subsidence, the state of Arizona developed three policy instruments to prevent groundwater depletion:

1. a state-wide groundwater conservation policy,
2. enforcement of such policy, and
3. the retirement of groundwater rights.

The first policy (conservation) is supported by the other two (enforcement and rights retirement) and was exercised by the state legislature through the enactment of **the Groundwater Management Act (GMA)** in 1980.

Signing of the GMA by Gov. Bruce Babbitt in 1980

Institutional context - institutions

Arizona water policy is recognized as innovative groundwater policy around the world.

Arizona became a leader in groundwater management legislation with the passing of the Groundwater Management Act (GMA) in 1980.

Also established in 1980, the Arizona Department of Water Resources (ADWR) became the institution in charge of executing the GMA and administering 2.8 acre feet of Colorado River Water (40% of the state water use).

ADWR administers water laws at the state level, except for water quality.

Institutional context – water quality

In 1987, the Arizona Department of Environmental Quality (ADEQ) was created to regulate water quality issues across the state.

ADEQ oversees compliance of the Clean Water Act (federal law that regulates all users discharging water into water bodies).

Water management at the state level is distributed into several institutions that many times work in siloes.

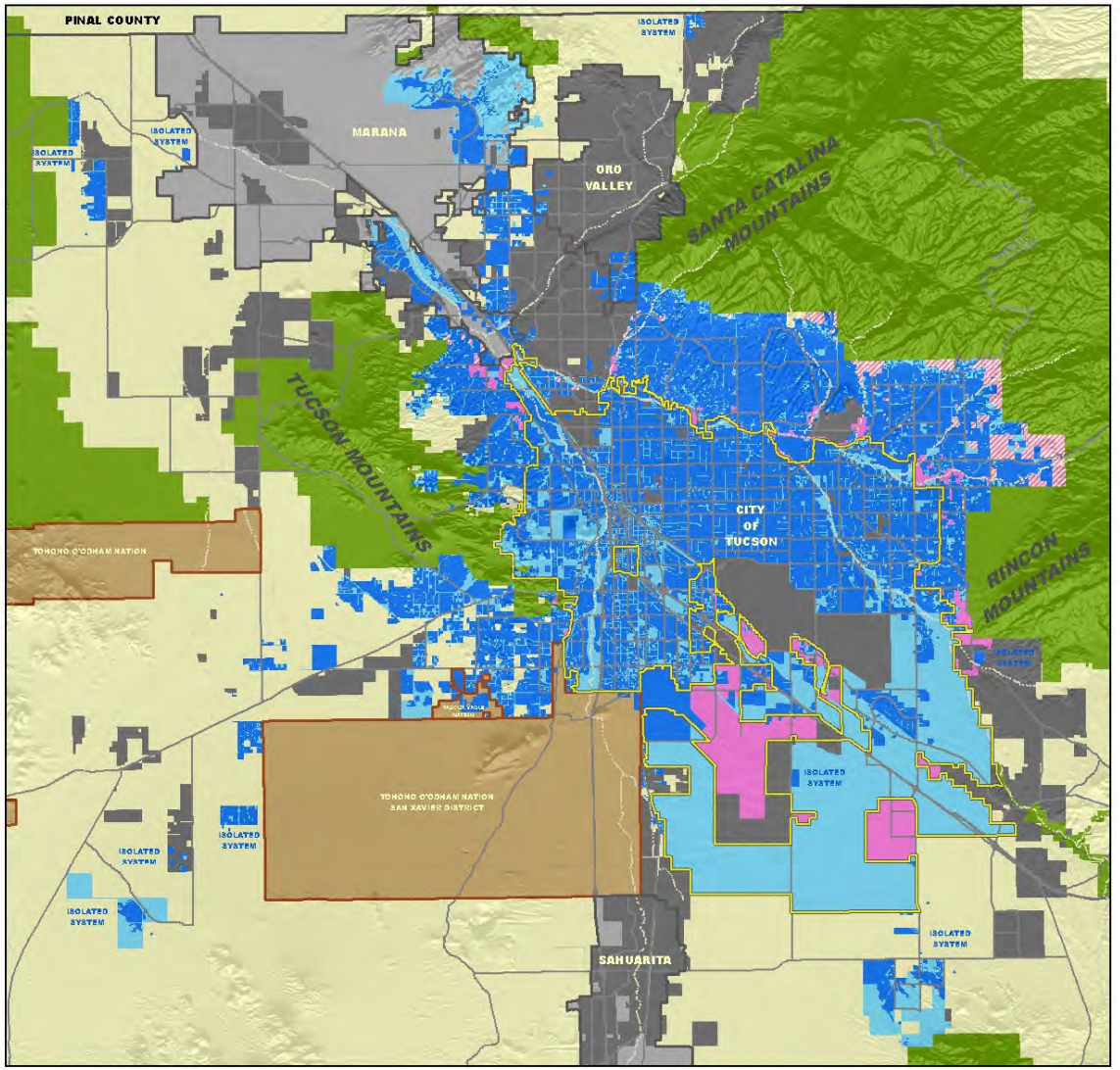
Tucson Water service area

Tucson Water provides potable and reclaimed water to about 736,500 people or 75% of Tucson's population – 1/4 of which live in unincorporated Pima County or in another jurisdiction (other than the City of Tucson).

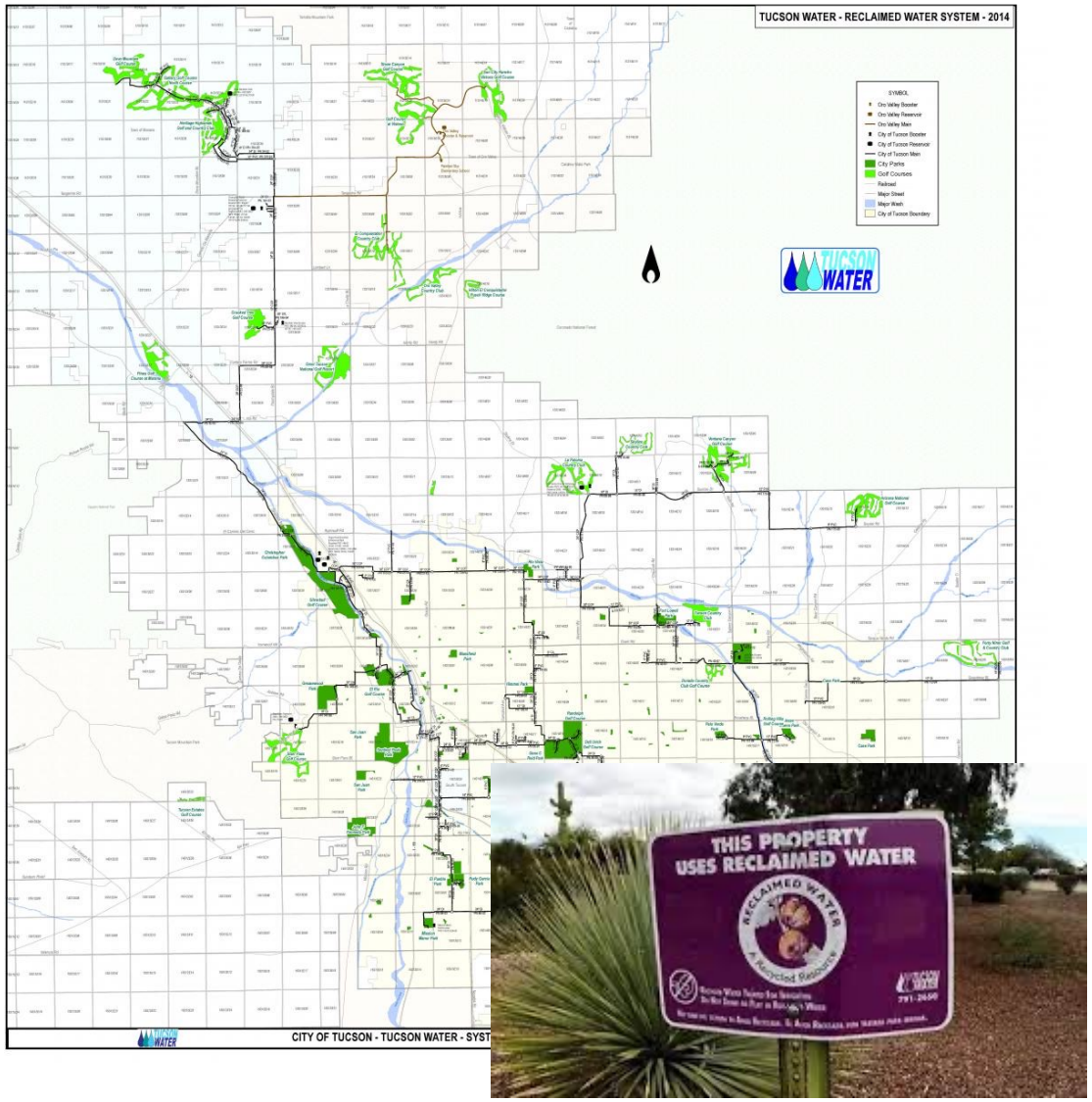
The other water utilities that serve the rest of the population (about 245,000 people) include:

- Tucson Metro Water District,
- Oro Valley Water and Sewer,
- Marana Water Utility, and
- Vail Water Company.

Wastewater treatment, most of the service (75%) is provided by the Pima County Regional Wastewater Reclamation Department through two main treatment facilities.



Reclaimed water



Although the use of reclaimed water can save potable water and costs (because of the proximity of treatment plants to potential end users), there are still some health risks associated with this water that can influence public opinion.

Reclaimed water can still present toxic industrial chemicals organic materials, and endocrine substances, but experts still consider this type of water suitable for recharge and irrigation of non-edible products, such as parks and golf courses.

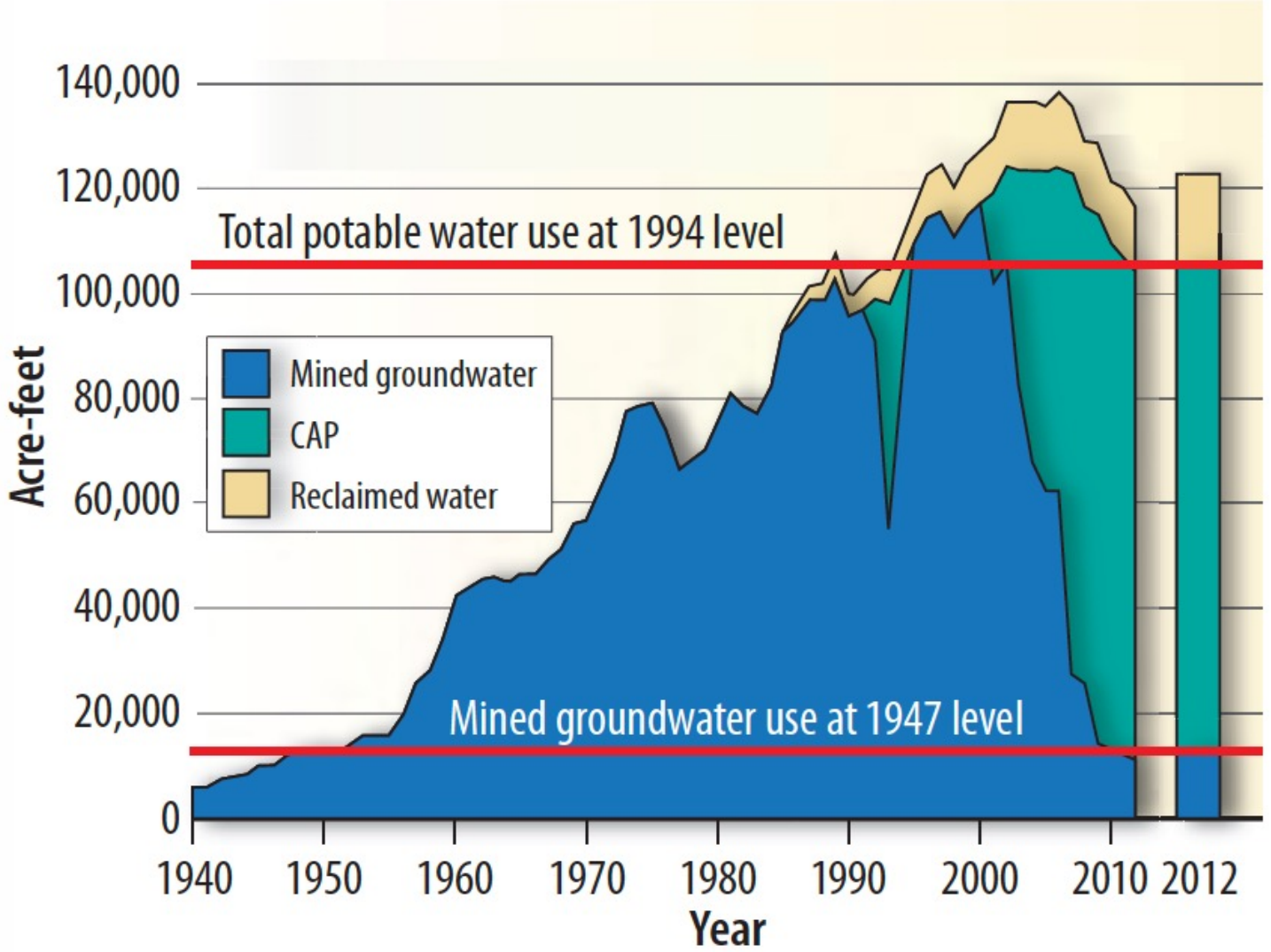
Tucson's main use for reclaimed water is the irrigation of golf courses and other landscapes through a network of purple-colored pipes.

Tucson Water's portfolio

There are five water sources in Tucson:

1. groundwater
2. CAP water
3. effluent (reclaimed water)
4. graywater (at the household level)
5. rainwater (at the household level)

However, sustained drought conditions still pose a threat to water security in Tucson.



Water use in Tucson over time (City of Tucson 2003)

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Action at the local level

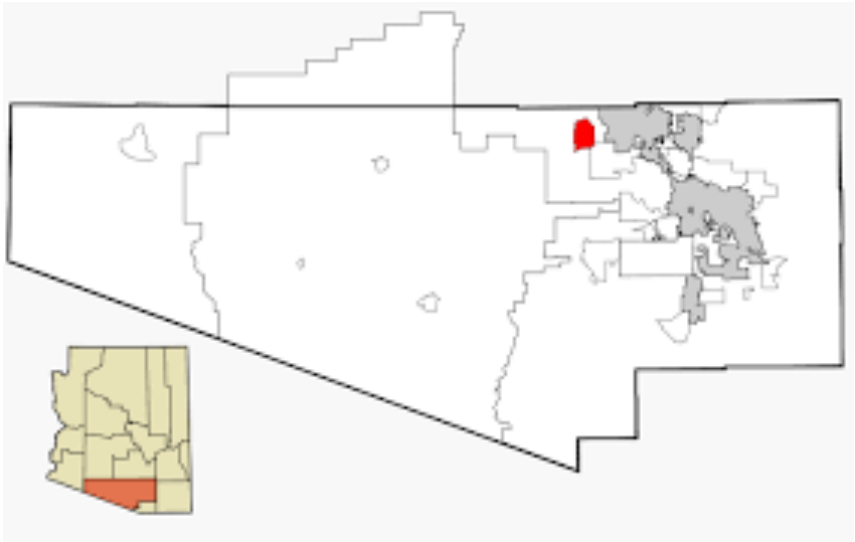
Tucson Water – 1970s – changing water uses

Policy changes at the state level were parallel to action at the local level.

In the 1970s, 1980s, and 1990s, Tucson dramatically shifted their water management approach.

In the 1970s, Tucson Water (now owned by the City of Tucson) started purchasing agricultural land (Avra Valley) and along with the land, their water rights to be used for municipal uses.

By changing water uses (from agriculture to municipal), Tucson Water was able to fulfill the demand of a growing population.



Location of Avra Valley.

Hard path approaches – inter basin transfers

Tucson Water – 1980s – Large-scale infrastructure

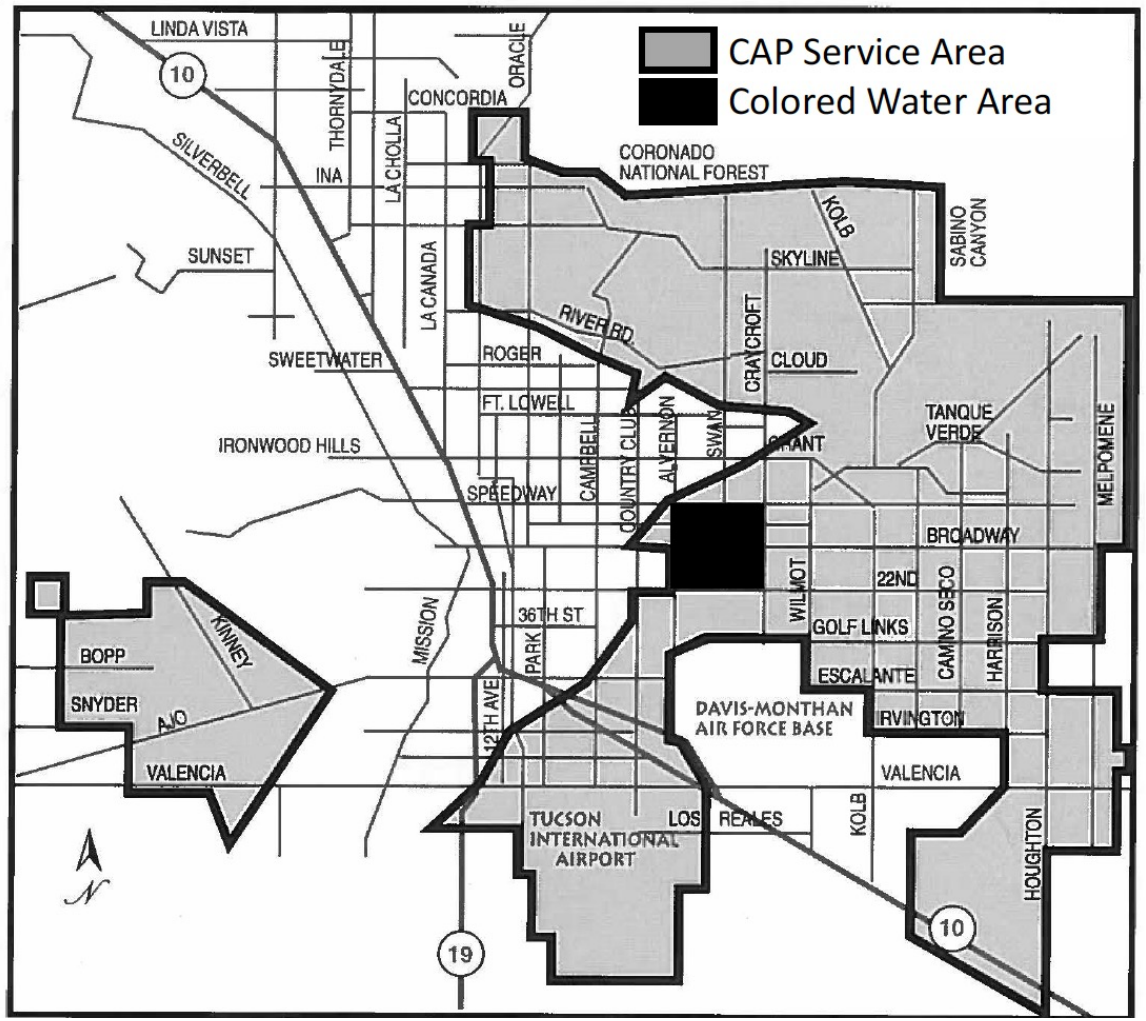
Central Arizona Project.

In the 1980s, Tucson turned to a large-scale federally funded infrastructure to achieve water security - the Central Arizona Project (CAP).

CAP is a conveyance system and replenishment facilities that conveys Colorado River water to the main cities in the state of Arizona – Phoenix and Tucson – some 540 km away and 730 m above its point of origin - Lake Havasu.

But deliveries of CAP water did not go as planned…

Tucson Water – 1990s – water quality issues



In the early 1990s, after numerous complaints from customers (colored water came out of taps because of chemical reactions linked to pH levels and the old pipes), Tucson's Mayor and Council prohibited its direct use.

CAP water treated in a new-built treatment plant could no longer be piped directly to the customers, who were used to groundwater.

Water quality issues angered Tucson residents.

Hard path approaches – aquifer recharge

Tucson Water – 1990s – aquifer recharge

Colorado River water is conveyed via CAP to the Avra Valley recharge facilities for infiltration.

In the 1990s, in an innovative approach, the land purchased in the 70s (the Avra Valley farms) was used as recharge facilities.

The farm was rehabilitated with large ponds used to infiltrate CAP water and mix it with groundwater.

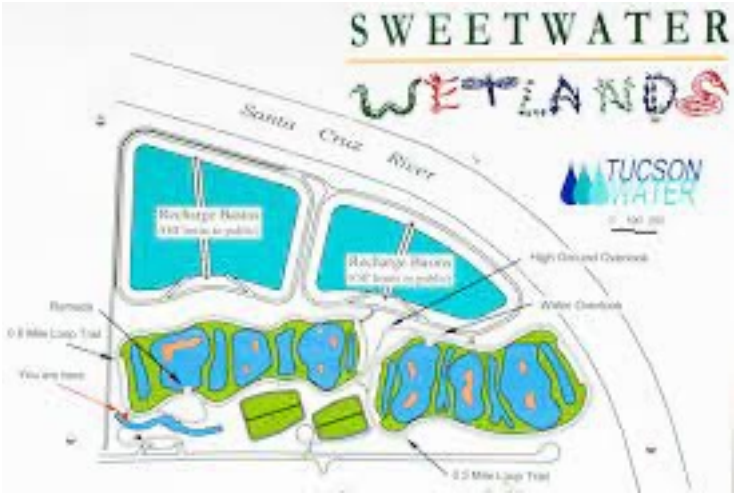
Mixed water was then pumped and delivered to the customers or store it in the aquifer for future use (water banking).

Tucson Water started reclaiming wastewater for landscape irrigation, diversifying their water source portfolio

Tucson Water's Clearwater Program

Tucson Water manages their allocation of Colorado River Water (or CAP water) through the **Clearwater Program** that consists of five facilities:

1. **The Central Avra Valley Storage and Recovery Project** (recharge capacity of 100K acre-feet per year)
2. **the Southern Avra Valley Storage and Recovery Project** (recharge capacity of 60K acre-feet per year)
3. the Pima Mine Road Recharge Project (recharge capacity of 30K acre-feet per year)
4. **the Sweetwater Wetlands Recharge Facility** that also serves as a recreation, education, and wildlife habitat
5. **the South Houghton Area Recharge Project,** which recharges effluent (about 4K acre-feet per year) and serves as a park.



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Active Management Areas

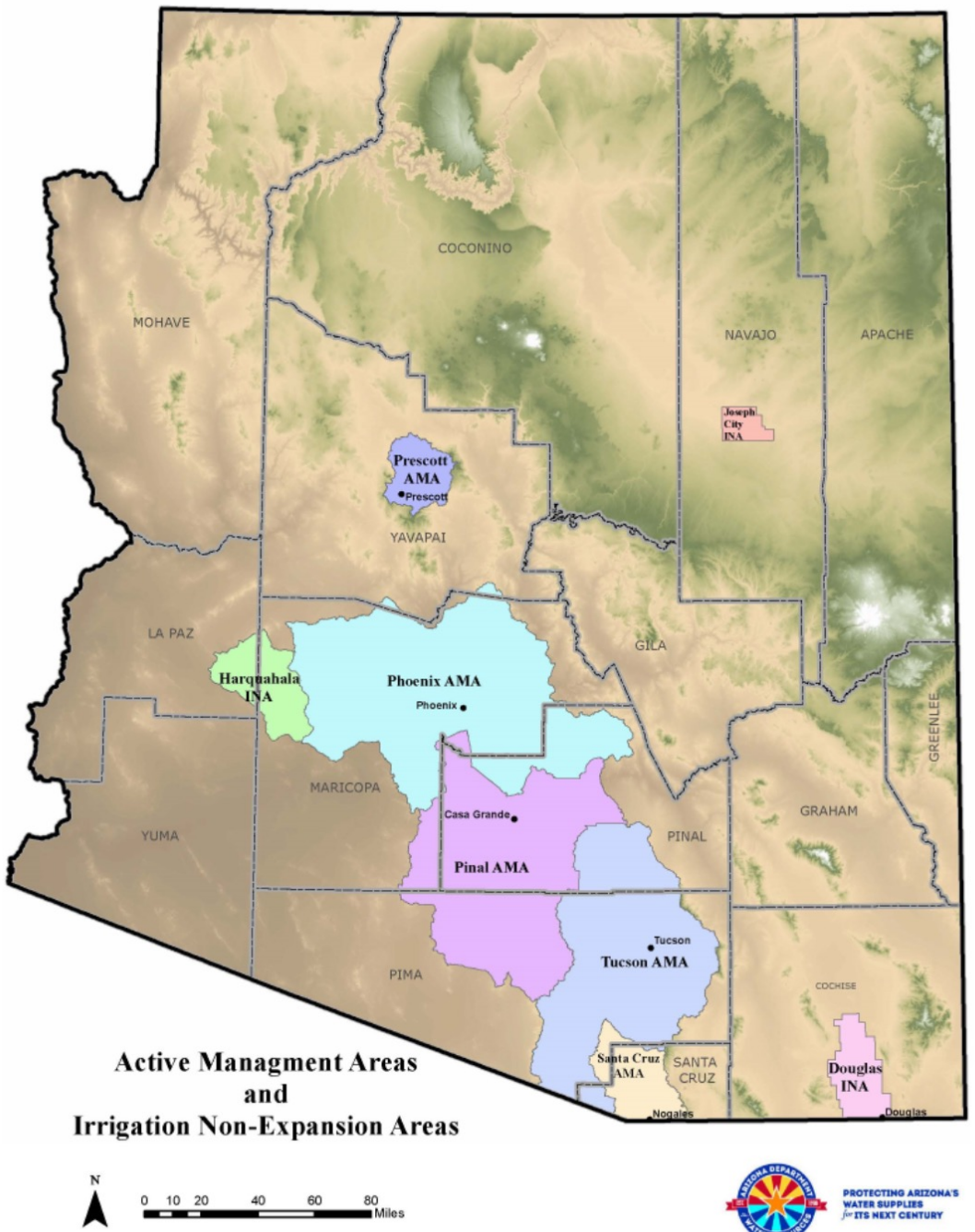
The GMA designated five Active Management Areas (AMAs) include:

- Prescott
- Phoenix
- Pinal
- Tucson
- Santa Cruz.

And three Irrigation Non-expansion Areas (INAs) include:

- Joseph City,
- Harquahala, and
- Douglas

Areas are delineated based on the geology of the aquifers and not according to political boundaries



The Groundwater Management Act

The GMA's overarching goal is to prevent groundwater depletion through long-term reduction plans, which include present and future withdrawals.

- **Current withdrawals** - the GMA outlines five-year conservation plans with stringent conservation measures along with a pumping tax.

- **Future withdrawals** - the GMA requires new subdivision development to demonstrate 100 years of assured water supply.

New development within an Active Management Area must demonstrate 100 years of assured water supply.

Threats to water security

Dropping water levels at Lake Mead

CAP water is not assured since Arizona has junior rights to the Colorado River Water – in case of extreme drought and shortage, Arizona could potentially lose this water, or a portion of their allocation.

Because of climate change, water supply from the Colorado River is expected to decrease between 6 - 20% by 2050.

Effluent volume production is linked to water use, which is expected to decline during a drought as a response of regulations

Potable water sources may not be available in the same amounts as a backup for reclaimed water production.

This vulnerable situation has driven water managers to seek water conservation strategies.

Water policy at the state level

Water policy	Description	Caveats	Effect on water conservation
Groundwater Management Act	A 1980 law that aims to manage groundwater use sustainably. It identifies 5 Active Management Areas (AMAs) and 3 Irrigation Non-expansion Areas (INAs)	There is a considerable area in the state outside these AMAs and INAs that is not managed by the law. Also, environmental uses are not considered.	These policies have significantly improved the condition of the aquifers of AMAs
Groundwater Management Code	Everyone within an AMA who withdraws groundwater from a nonexempt well (with a capacity > 35 gall/min), must report their annual water use and pay a withdrawal fee. Enforcement action = a civil penalty of $10K per day of violation	This is a "goal" not a mandatory requirement. There is a significant number of exempted wells withdrawing groundwater without control	
Underground Water Storage, Savings, and Replenishment Program	Promotes the savings, storage, and replenishment of water in the aquifers to prevent groundwater overdraft. The program allows recharge in one area and the recovery of the same amount elsewhere. The program allows users to accommodate seasonal water demand by storing water and using it later on.	There is a hydrologic disconnect between the storage and the recovery.	

Water policy at the state level

Water policy	Description	Caveats	Effect on water conservation
Assured and Adequate Water Supply Program	Developers within an AMA must demonstrate assured water supply for the next 100 years from renewable sources - surface, CAP, or effluent.	This safe yield is not required outside the AMAs, so overall, Arizona may face aquifer depletion in some areas	These policies have significantly improved the condition of the aquifers of AMAs
ADWR's Conservation Program	Provides information about conservation regulations and resources through outreach, conservation assistance, and education; collaborating with other organizations at the reg. and nat. level	No caveat found	
Reclaimed Water Program	The use of reclaimed water for beneficial use with stringent treatment and quality standards regulated and managed by ADEQ.	No caveat found	83% of reclaimed water is recharged or used, decreasing potable water demand
Graywater reuse "soft permitting"	Regulations to address the potential health risks associated with the use of graywater for landscape irrigation and allowing small scale graywater reuse without a permit.	No caveat found.	Graywater reuse reduces water demand

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Water policy at the county level

Pima County is a progressive county in the state of Arizona that has promoted and supported water conservation policies through the ongoing collaboration between different organizations and across several jurisdictions.

Location of Pima County.

Soft path approaches - Drought Response Plan and Water Wasting

Stages	Status	Actions
Stage 1	Alert	• Restaurants provide water on request • Hotels conserve water • Water conservation campaign is launches
Stage 2	Warning	• Landscapes can only be irrigated from 7pm- 7am • Outdoor misters and public fountains are not allowed • Household car wash restricted to bucket of shut-off nozzle • Only commercial car wash that recirculate water are allowed • Turf areas cannot be overseeded – except when using reclaimed water
Stage 3	Emergency	• No filling of new pools • Pools cannot be refilled, only top-off to maintain water levels
Stage 4	Crisis	• Landscape irrigation restricted to trees and shrubs • Potable water cannot be used for construction projects • Water cannot be used to clean parking lots and streets

Drought Response Plan and Water Wasting

Enforcement

Violators get an infraction and are subject for discontinuation of water service.

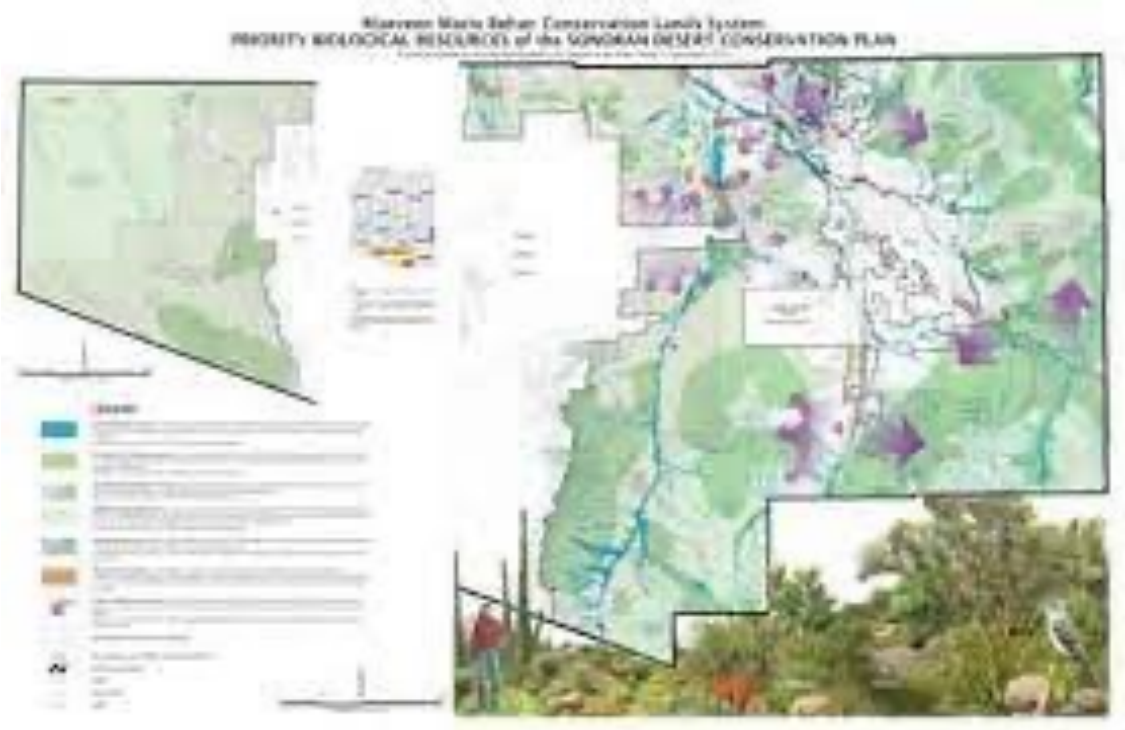
Infractions vary according to the drought stage. For example, violations under stage 2 are $250, while violations under stage 3 are no less than $400, and violations under stage 4 are no less than $600.

Each violation is associated with an infraction and every day constitutes a separate infraction.

The Sonoran Desert Conservation Plan

Pima County is a leader in environmental land use planning, which protects riparian ecosystems.

The Sonoran Desert Conservation Plan is an award-winning land use plan that guides the growth of Tucson that sets aside and protects habitat from development.



Although the goal is to comply with the Endangered Species Act, it also helps protect riparian habitat from development, and this way, supports the hydrological processes that affect aquifer health.

It also reduces sediment build up from flooding in the built environment.

Water policy at the county level

Water policy	Description	Caveats	Effect on water conservation
Drought Response Plan	A four-stage plan drought monitoring system	After years of declared Drought Stage 1 (since 2006), this condition is the new normal	Decline in gallons per capita per day (gpcd) among Tucson Water's customers
Water Wasting Ordinance	Regulation that is linked to different stages outlined in the Drought Response Plan to avoid water wasting	Very difficult to enforce at the household level	Unknown
GI Action Plan for Pima County	Set of policies designed to support the wide implementation of green infrastructure (GI)	Voluntary policies	Unknown
Sonoran Desert Conservation Plan	Land use plan that protects riparian habitat from development	None	Unknown

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Factors affecting water demand

Retirees are likely to use more water.

Water demand can be explained by:

- level of education,
- income,
- number of household members,
- Age,
- cultural background.

E.g., in Tucson, people older than 65 are more likely to consumer more water – as they are more time at home and engage in gardening and other water-use activities.

people in their pre-retirement years (55-64) are more likely to focus on work, spend less time at home engaging less time in domestic activities, and consequently using less water.

Factors affecting water demand - housing

Housing type affects water use.

Housing type also affects water use

Size of the house (square footage) plays a role in water consumption.

Lot size is related to outdoor water use, particularly in arid regions

Presence of a pool and size of the pool are related to water consumption, as is the greenness in vegetation.

Weather is related to outdoor water use – Including temperature, precipitation, and wind speed.

Soft path approach - Water policy at the city level

Xeriscape Landscaping and Screening Ordinance 7522

- One of the earliest policies aimed to reduce water demand for irrigation, effective in 1991.
- Mandates that all new (after 1991) multifamily, commercial, and industrial development in Tucson use desert plants in their landscape design.

- This land use code is part of Tucson City Code and is designed to reduce water demand for irrigation, allowing only 2.5% of turf in commercial facilities, and 5% in multifamily facilities.

- This regulation also requires the introduction of trees in yards and street frontages, in parking lots (one for every 15 spaces) and requires dust control through ground cover.

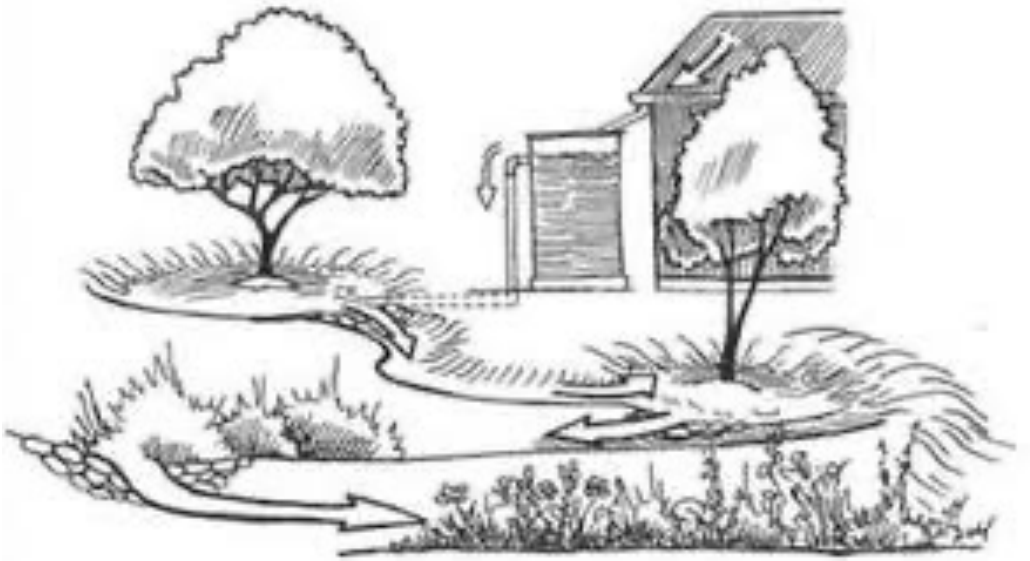
- Result = reduction of potable water used for irrigation and has played a major role in the overall reduction of water consumption at the city level.

Xeriscape landscaping

Water policy at the city level

Commercial Rainwater Harvesting Ordinance 10597

- Mandates commercial development to meet 50% of irrigation demand with rainwater.
- This regulation took effect on June 1, 2010, regulating new commercial construction to use passive rainwater harvesting systems, and use irrigation controls that measure soil moisture.
- This ordinance has likely resulted in 50% of water savings in commercial development.



Passive rainwater harvesting system

Water policy at the city level

Rainwater Harvesting Rebate Program

- Launched by Pima County Cooperative Extension/ Smartscape Program in collaboration with Tucson Water.
- The rebate program aims to reduce water consumption by using rainwater and stormwater for landscape irrigation (60% of domestic water uses in AZ. – 40% in Tucson).
- An internal evaluation of the program (Radonic, 2018), however, shows that water consumption did not decrease, instead it increased.
- This study identifies the **creation of a desert oasis** as the main motivation for program participation, which resulted in an extension of vegetation cover.

Rainwater harvesting system

Water policy at the city level

Rainwater Harvesting Rebate Program

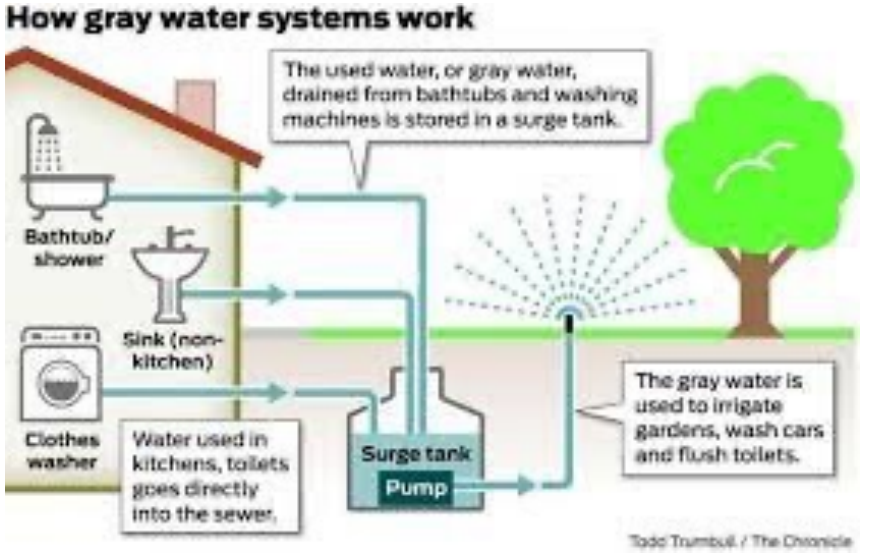
- 75% of people interviewed declared that they added more vegetation as a result of the program (Radonic, 2018).
- Water consumption was not correlated to increase in vegetation. Instead, it was related to irrigation management (how long and how often to irrigate the plants), and to people's understanding (or not) of plants' water needs.
- People were frustrated – there is an increased cost and expertise required to connect the new system to their existing irrigation system.
- An increase in water bill was not acknowledged by many participants (most are affluent and the water cost in Tucson is very low).

Rainwater harvesting system

Water policy at the city level

Residential Graywater Ordinance

- Using graywater for landscape irrigation can save up to 40% of water.
- Retrofitting existing homes entails a large cost, but new homes can easily be designed with dual plumbing systems that include laundry-to-landscape and using gravity at a low cost.
- This practice can save up to 19,000 gallons (72,000 lt or 19,000 gallons) of water per household (2.5 people) per year.
- Graywater reuse consists of a plumbing fixture that allows water from the clothes washer, bathtub, shower, and sink to be directed to the landscape, using a cistern or not.
- Blackwater (toilet, kitchen sink, and dishwasher) cannot be used for this purpose and should be directed to the sewage system directly.



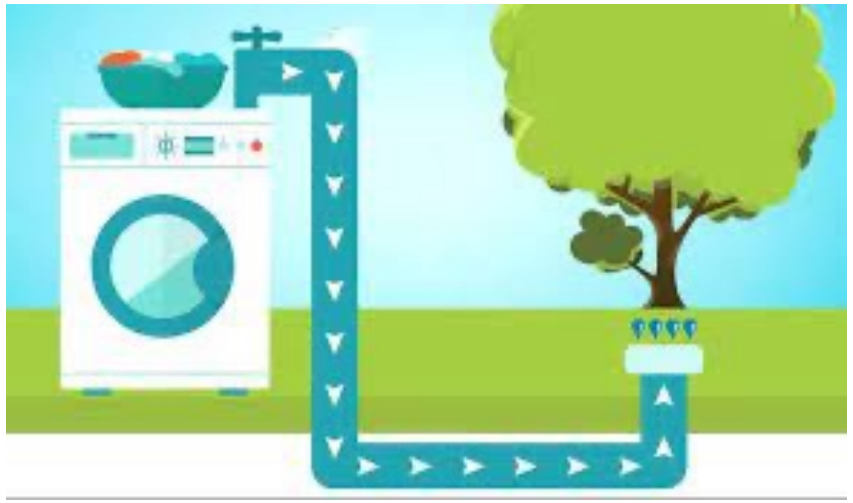
Graywater system

Water policy at the city level

Residential Graywater Ordinance

- Even though new constructed homes have the plumbing for graywater reuse in place, most residents do not use it. An assessment study by Bell (2018) indicates that only 10.5% of the sample population use graywater.

- Barriers:
  - **Policy** - a lack of educational outreach.
  - If residential users use their graywater, then there is less water for large-scale city-run water reclamation programs.
  - **Community** - lack of neighborhood scale planning to utilize graywater collectively.
  - **Organizational** - lack of information for property owners on how to use the system.
  - **Incentive** - only a fraction of workshops participants applied for the $1,000 rebate. Directing water from the washer to the landscape was easy and affordable to do on their own.
  - **Interpersonal** - participants could not find a plumber who knew how to install the system.



Graywater reuse

Water policy at the city level

Water policy	Description	Caveats	Effect on water conservation
Xeriscape Landscaping and Screening Ordinance 7522	Mandates the use of drought-tolerant plants in landscape design	Only applicable to multifamily, commercial, and industrial development	Water used for landscape irrigation has been reduced
Commercial Rainwater Harvesting Ordinance 10597	Commercial development must use passive rainwater systems to irrigate landscapes	None	50% of water savings for outdoor uses in commercial development
Rainwater Harvesting Rebate Program	Applicants get reimbursed for installing rainwater harvesting systems in their homes	This program has shown equity issues	Average saving of 748 gallons per month (Weiser, 2018)
Residential Graywater Ordinance 10597	New homes are built with a plumbing dual system that allows users to use graywater for landscape irrigation	The ordinance does not require the installation of the system, only the possibility of installing the system	potential water savings of 40%. But, only about 10.5% of the new homeowners use the system, saving some 72,000 lt (or 19,000 gallons) per household per year
Stormwater Management Program	Promotes the use of GI along the rights-of-way and boulevards in the transportation network	Difficult to get curb cut permits for GI	Unknown

Water policy at the city level

Water policy	Description	Caveats	Effect on water conservation
Stormwater quality Ordinance 10209	Ensures that non-point source pollutants do not enter the drainage system	None found	Unknown
Conserve to Enhance	Funding opportunity for GI at the neighborhood scale	May result in equity issues	Unknown
Low-Income Rainwater Harvesting Program	Provides financial support (grants and loans) to low-income families to implement residential rainwater harvesting	Only funds active systems that require space and maintenance	Unknown
Land Use Code	Land use regulation body that requires stormwater harvesting to be used for irrigation	None	Unknown

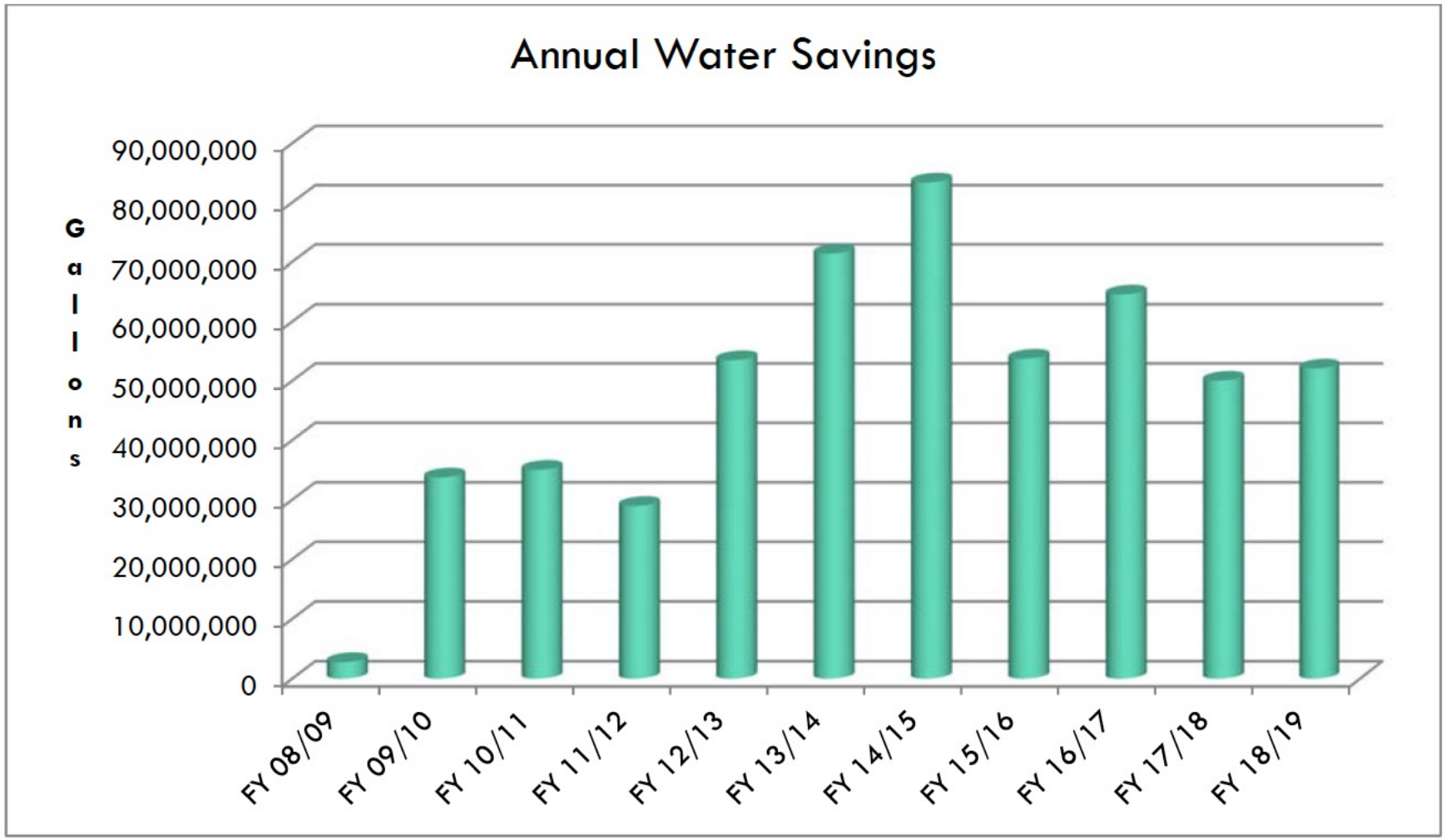
Tucson Water policies

Water policy	Description	Caveats	Effect on water conservation
Water Waste and Theft Ordinance (6096)	Customers who waste water are penalized with fees	Difficult to identify all water waste cases	Unknown
Emergency Water Conservation Ordinance (8461)	Prohibits non-essential water uses during emergency situations	None	Unknown
Conservation fee	All Tucson Water customers are charged a fee for conservation programs in their water bills	Everyone pays the fees but not everyone benefits from programs - inequities	52.1 million gallons of water saved in FY2018-2019
Increasing Block Rate Structure	Customers who consume more water pay a higher unit price	Wealthy people may not react to this incentive	Varied by household
Water Conservation Rebates	Rebates for multiple water conservation features	Low-income families may not be able to apply to most programs	2,611 million gallons of water saved from 2008-2019
Green Stormwater Infrastructure Fund	$1 fee is charged to every Tucson Water customer to fund the 1 Million Tree campaign	Potential equity issues if greening does not happen in low-income neighborhoods	Unknown

Tucson Water policies

Water policy	Description	Caveats	Effect on water conservation
Tucson Audit Program	On-site examinations of water features and water use data from billing records	Residential customers are not included in the program	115 million gallons of water saved in 2015, or 26% of water savings per audit
Zanjero Program	Free individualized survey (audit) for residential customers to help them lower water bill	None found	Varies by household
Water Conservation Kits	Free water conservation materials or water fixtures	None found	Varies by household

Water savings from conservation programs



Water savings from Tucson Water incentive programs over time (Rupprecht, 2020).

Overview of the seminar

First day – Water management in Tucson

- Introduction – why Tucson?
- Tucson before water pumping
- Institutional context
- Action at the local level
- Water policy at the state level
- Water policy at the county level
- Water policy at the city level
- **Education and outreach**
- Conclusion

Education and outreach

- Educational programs and communication are the most important tools to reduce water demand because they influence the behavior of current users, and future users.

- Programs target school-aged children, teachers, homeowners, landscape professionals, property managers, business owners, and the general public .

- Trainings ensure that key actors are educated in water conservation, including Green Plumbers, Irrigation Installers, Irrigation Auditors, Certified Water Auditors, Landscape Architects, etc.

- Education is generally achieved through workshops, lectures, printouts, websites, etc. These need to include how to save water and why (e.g., to save costs, energy, environmental resources).

Rainwater harvesting workshop

Education and outreach

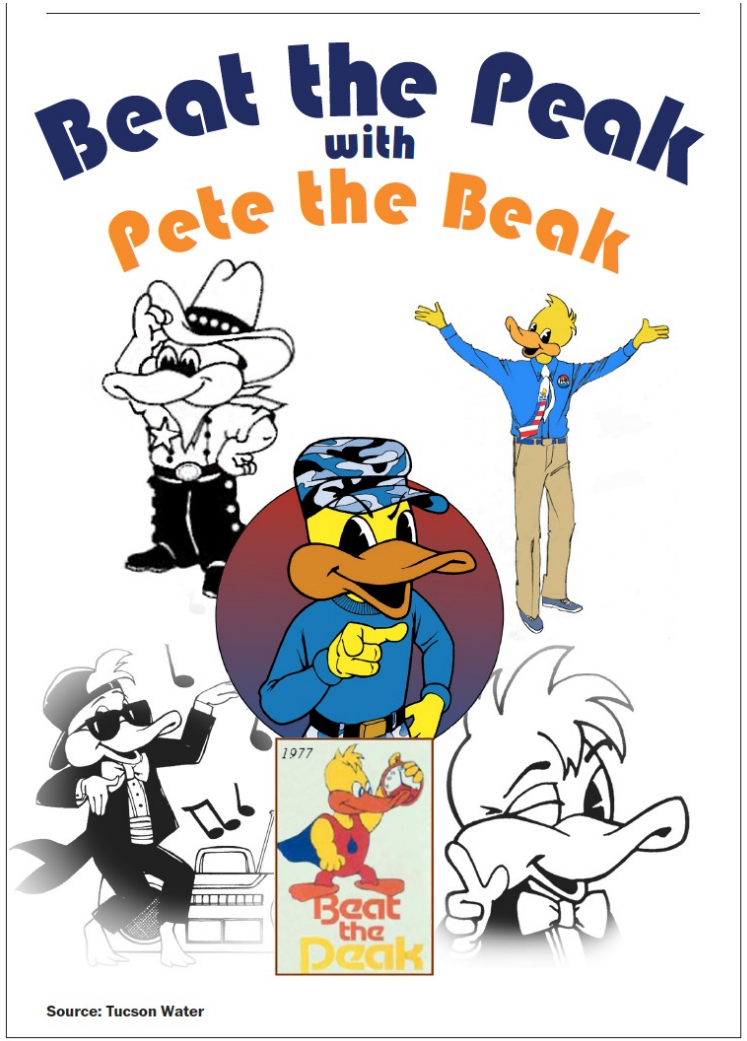
- Tucson Water relies on other organizations for some of their education and outreach programs. Examples:
  - Youth Educations Programs (Da Drops, Our Water Our Future, Tucson Toolkit),
  - Science Technology Engineering Mathematics (STEM) Academy,
  - SmartScape Program (in cooperation with UArizona Cooperative Extension), that offers workshops to landscapers and residents, now also in Spanish,
  - Water Waste Enforcement,
  - Water Harvesting Demonstration Sites,
  - Education Outreach (Sweetwater Wetlands, Project Wet).
  - Arizona Project Wet,
  - Environmental Education Exchange.

Smartscape Program

To date the educational programs (for the last 11 years) have reached 289,000 students, 11,500 teachers, and 54,000 adults (Rupprecht, 2020).

Education and outreach

- In the 1970s, Tucson Water launched an intense water conservation campaign named *Beat the Peak* that focused on reducing water consumption during the peak summer months.
- They created the character *Pete the Beak* and the public embraced water conservation practices and exceeded the expected results.
- Tucson residents are now very proud of their long-time water conservation ethic.



Evolution of Pete the Beak

Education and outreach

- Communicating a positive story about the impact of collective action that is relevant to ratepayers has been instrumental for conservation.

- Public awareness is a key tool for water demand management - through campaigns in the form of television, radio announcements, newspaper articles, and interviews.

- But it is very hard to assess communication effectiveness and social learning.

Outreach at schools

Conclusions

- Tucson has been testing water management policies for decades, so they have had time to learn from their mistakes (groundwater depletion, subsidence lack of enforcement).
- Dire situations can be opportunities for innovation – GMA, the creation of ADWR, ADEQ, AMAs – INAs.
- Hard path approaches have allowed growth, but soft path approaches have made it possible to control water demand.
- Policies without enforcement capacity are not effective.
- Education and communication are critical for the success of water demand management.

Thank you!

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