Water Conservation Planning and Forecasting

November 18, 2022

This program is made possible under a cooperative agreement with US EPA.

Erik Porse
Environmental Finance Center at Sacramento State &
UCLA Institute of the Environment and Sustainability

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About Us

The Environmental Finance Center Network (EFCN) is a university-based organization promoting innovative and sustainable environmental solutions while bolstering efforts to manage costs.

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Building TMF Capacity for Small Water Systems

Our Building Technical, Managerial, and Financial Capacity Programs for Small Water and Wastewater Systems provide free training and technical assistance across every state, territory, and tribal nations. Technical assistance is available on a first-come, first-served basis.

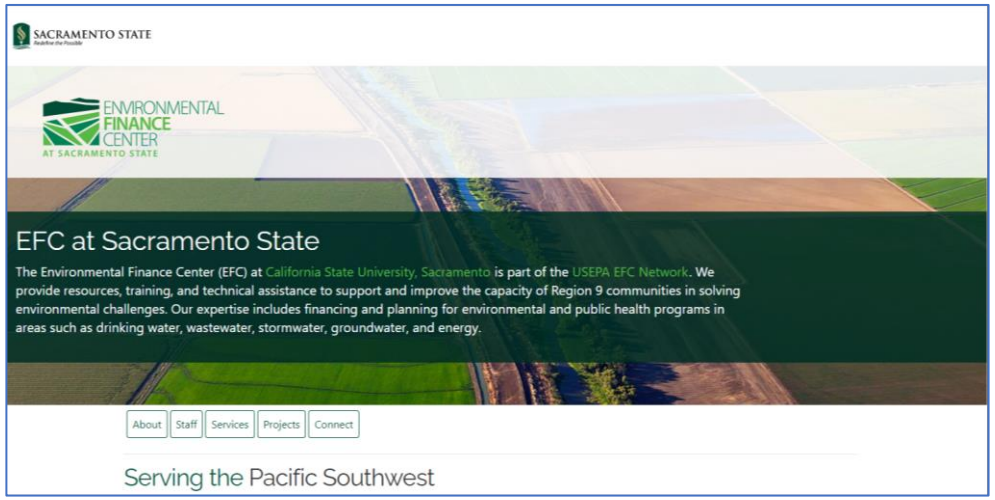
Smart Management for Small Water Systems

Smart Management for Small Water S… …am

The Small Systems Water and Wastewater Teams

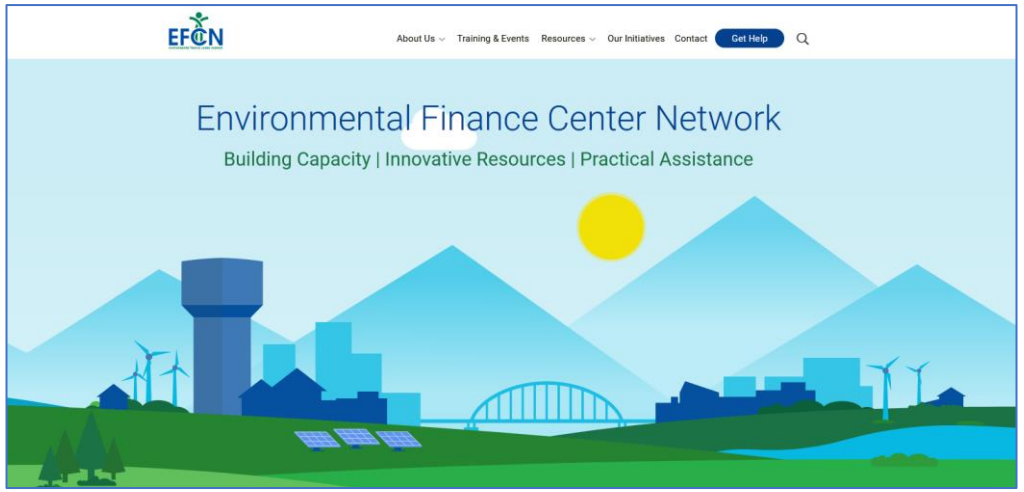
- Southwest Environmental Finance Center at the University of New Mexico
- Syracuse University Environmental Finance Center
- Environmental Finance Center at The University of North Carolina at Chapel Hill
- Environmental Finance Center at Wichita State University
- **Environmental Finance Center at Sacramento State**
- New England Environmental Finance Center at the University of Southern Maine
- Environmental Finance Center at the University of Maryland
- Government Finance Officers Association (GFOA)
- National Association of Development Organizations (NADO)
- Mississippi State University Extension
- Environmental Finance Center West
- Great Lakes Environmental Infrastructure Center at MTU

EFCN Links

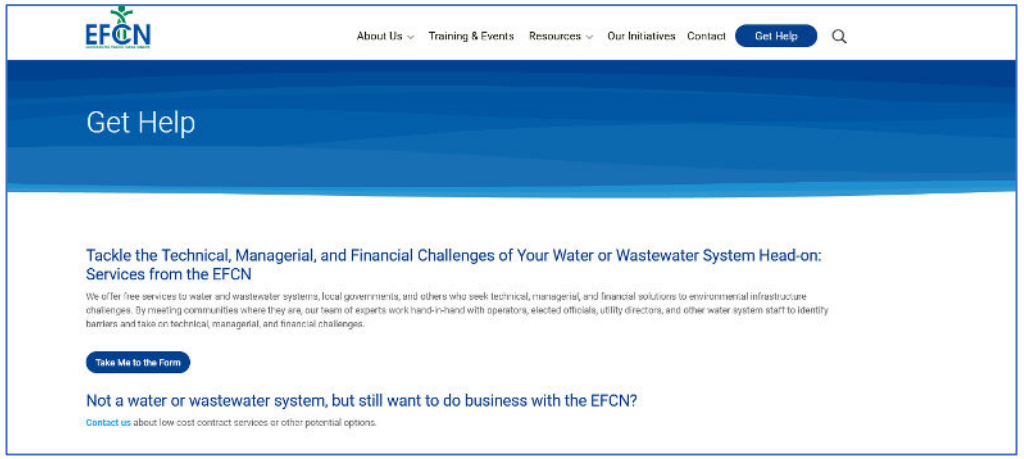


https://www.efc.csus.edu/

ENVIRONMENTAL FINANCE CENTER AT SACRAMENTO STATE



https://efcnetwork.org/



https://efcnetwork.org/assistance/request-assistance/

EFCN environmental finance center network

Services

Asset Management

Rate Setting and Fiscal Planning

Leadership Through Decision-making and Communication

Water Loss Reduction

Energy Management Planning

Accessing Infrastructure Financing Programs

Workforce Development

Water Conservation Finance and Management

Collaborating with Other Water Systems

Resiliency Planning

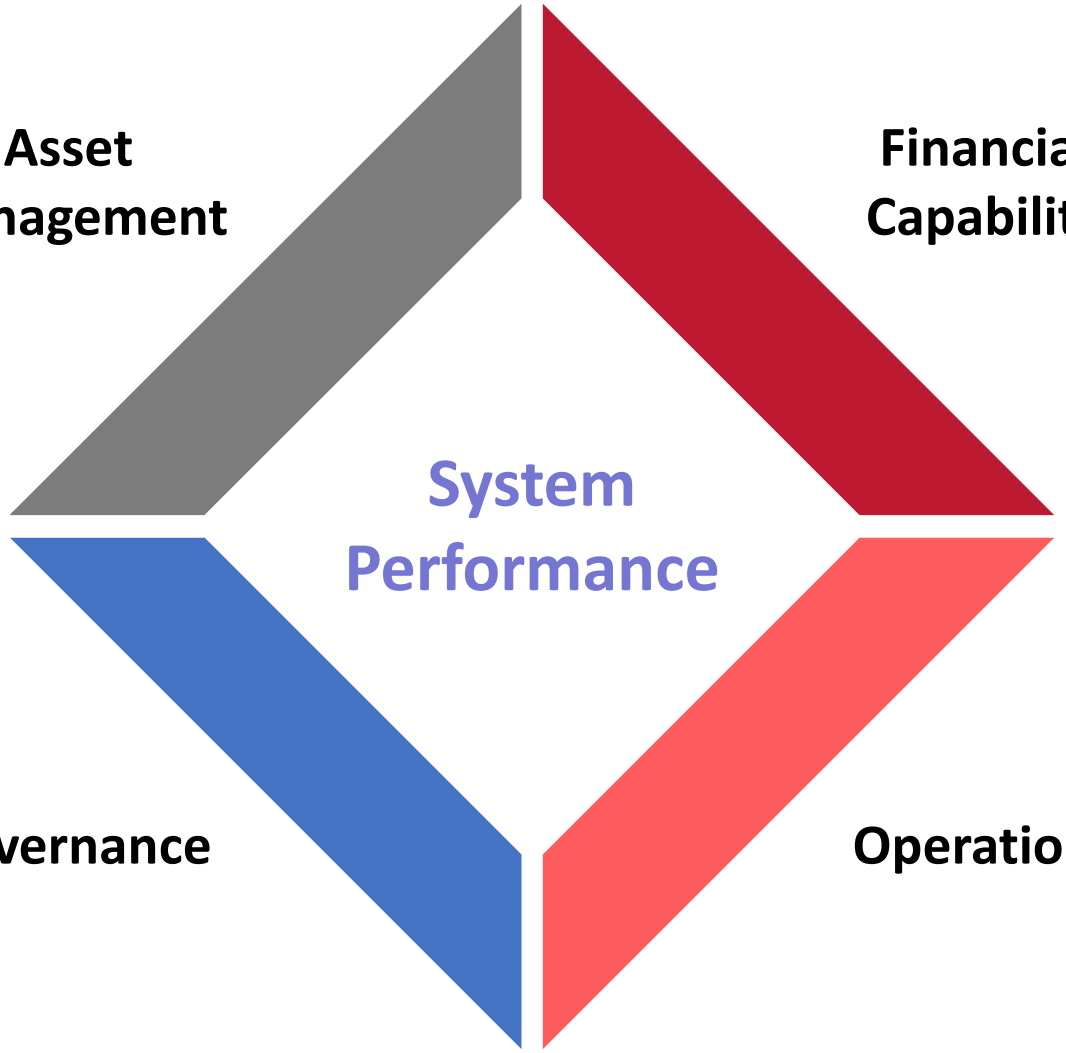
Managing Drought

Agenda

- Background: water use efficiency and conservation
- Components of a water conservation program
- Demand planning and forecasting
- Setting water rates for conservation
- Resources and links

Background: Water Use Efficiency and Conservation

Key Factors in Water System Performance



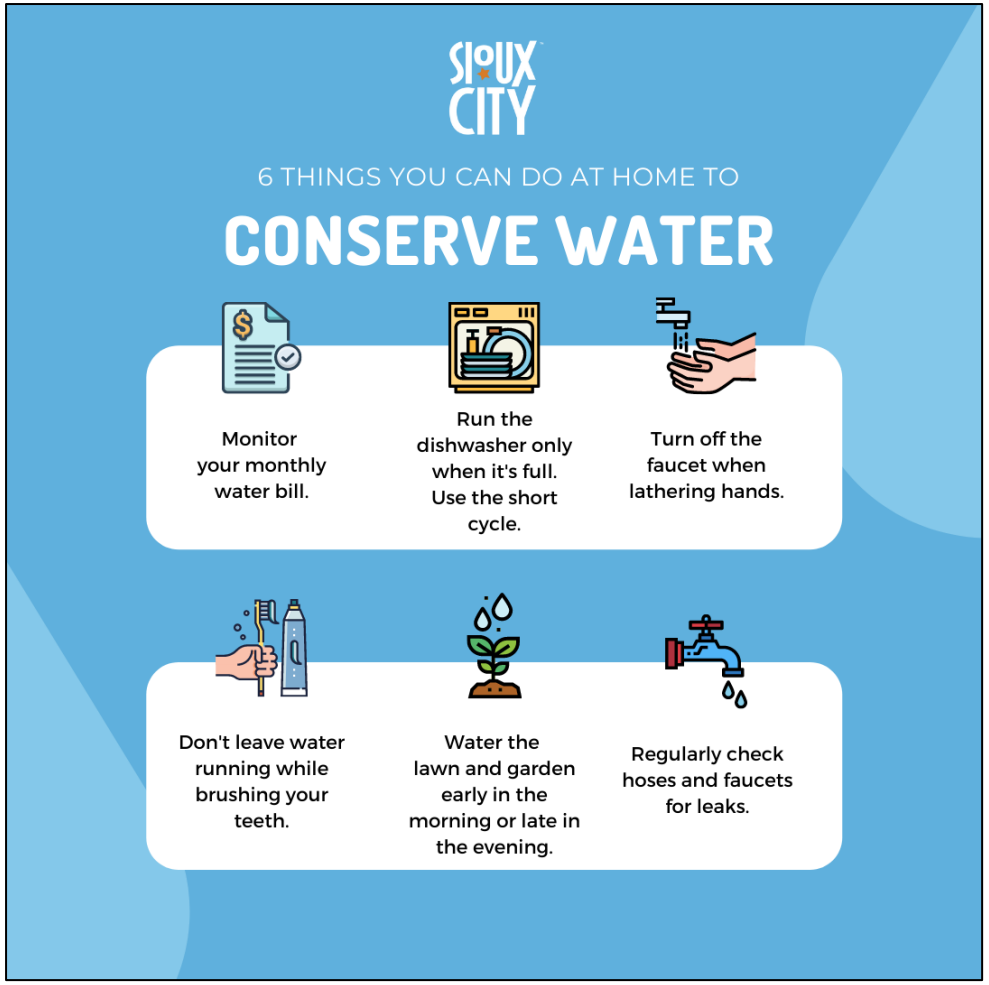
How can water use efficiency & conservation contribute to these goals?

Where Does Water Conservation Happen?

We can all conserve:

- Cities
- Suburbs
- Farms and rural areas

For this webinar, we will focus on urban and suburban water conservation



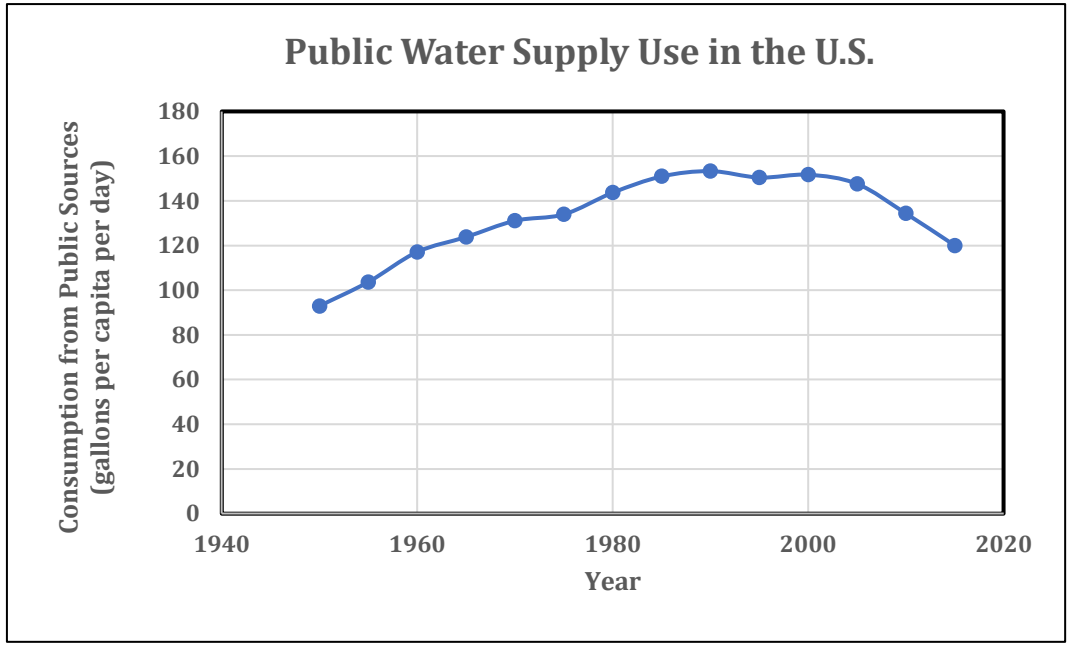
Source: *Sioux-city.org*

Water Conservation: National Trends

Public per capita water use in the U.S. is trending downward

- Population is increasing, but water is being used more efficiently
  - We need better data in the U.S.

In many communities, water agencies already incentivize water conservation



***Source**: USGS, "Water Use in the U.S." 2015 based on data for Public Supply*

Water Conservation: National Trends

Total & per capita demand is decreasing, but regional differences persist

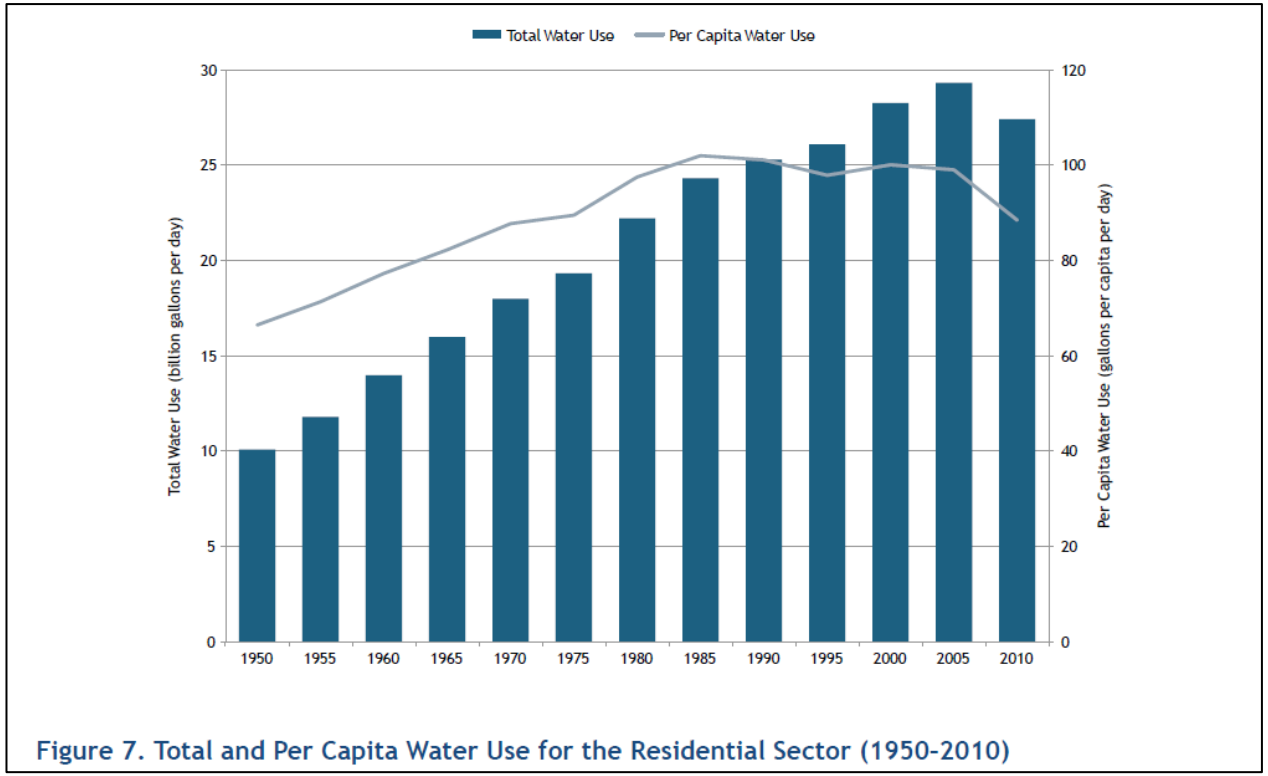
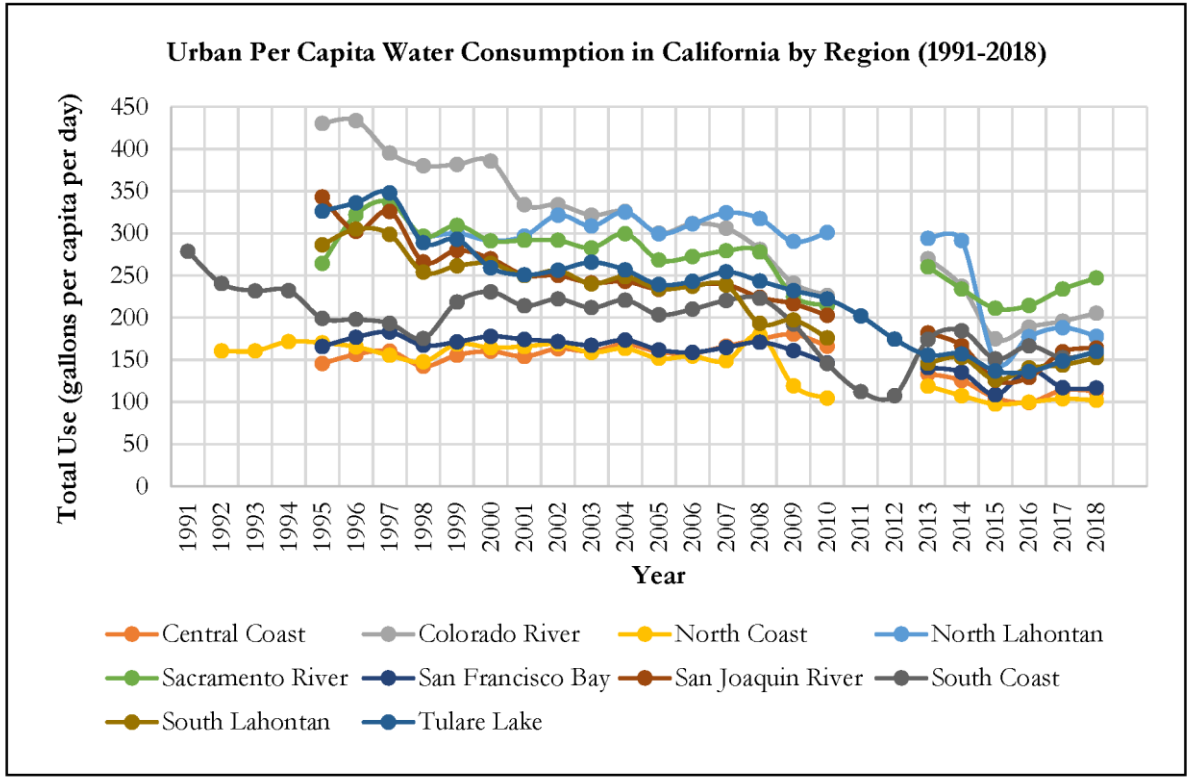


Figure 7. Total and Per Capita Water Use for the Residential Sector (1950-2010)



***Sources**: Pacific Institute (left) and OWP at Sacramento State (right)*
Data from USGS and California Department of Water Resources & State Water Resources Control Board

Water Conservation: National Trends

CITY OF LEWISVILLE

City of Lewisville Water Restrictions Remain in

By Jacob Reyes • Published July 3, 2022 • Updated on July 3, 2022 at 10:38 pm

Surface level view of backyard sprinkler spraying in an undated file photo.

The City of Lewisville is contin
on May 1 and will continue to

LATEST HEADLINES

Kingston Water Department issues drought alert, urges users to conserve

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North Georgia Water Utilities Continue Conservation Winning Streaks, Recognized with EPA 2022 WaterSense® Sustained Excellence Awards

Metro Atlanta, GA — The U.S. Environmental Protection Agency (EPA) has once again recognized three north Georgia water agencies with a 2022 WaterSense Sustained Excellence Award for helping people save water. The Metropolitan North Georgia Water Planning District, Athens-Clarke County Public Utilities Department, and Cobb County Water System were honored on Thursday, Oct. 6 during the WaterSmart Innovations (WSI) Conference and Exposition in Las Vegas.

Organizations from across the U.S. were recognized for their commitment to promoting WaterSense and water efficiency in 2021. Notably, this is Athens-Clarke County's sixth year to receive the Sustained Excellence Award and the fifth years for the Metropolitan North Georgia Water District and Cobb County Water to be recognized. Award recipients include utilities, manufacturers, builders, retailers, and other organizations that partner with WaterSense to promote water-efficient products, homes, and programs.

California just declared a drought emergency. What does that mean and how will it affect your life?

Jefferson Public Radio | By Manola Secaira/CapRadio

Published October 21, 2021 at 6:13 AM PDT

***Sources**: NBC5 (Dallas-Fort Worth, Texas), Daily Freeman (New York) Jefferson Public Radio (California), North Georgia Water*

Water Conservation: National Trends

Lawns are still popular, but growing interest in native landscaping

ENVIRONMENT

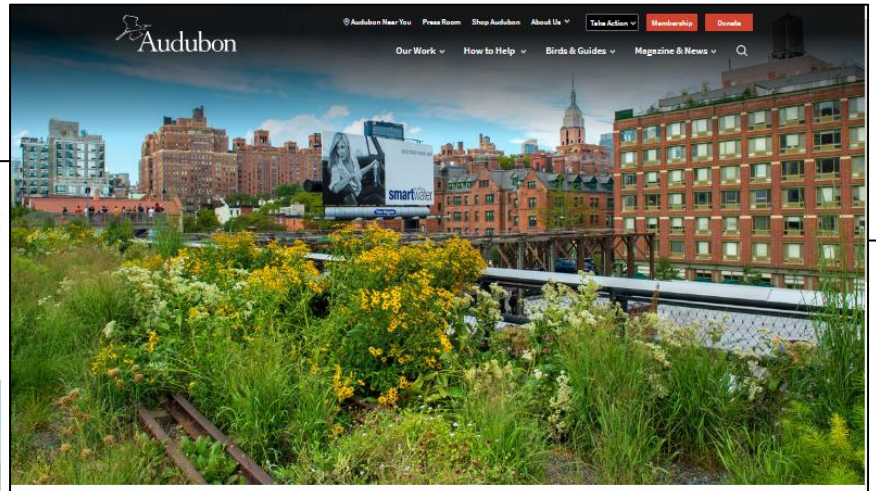
Lawns are the No. 1 irrigated 'crop' in America. They need to die.

Eric Holthaus Grist.org

Published 2:21 p.m. MT May 2, 2019 | **Updated 2:56 p.m. MT May 2, 2019**

View Comments

A sprinkler head pops up from the ground to water a lawn. *EMMANUEL LOZANO/The Republic*



Native Plants

How Urban Landscapers Use Native Plants to Create Habitats for Wildlife

Increasingly, popular public spaces are using a conservation-oriented gardening philosophy that can also transform communities.

By Paul Spencer

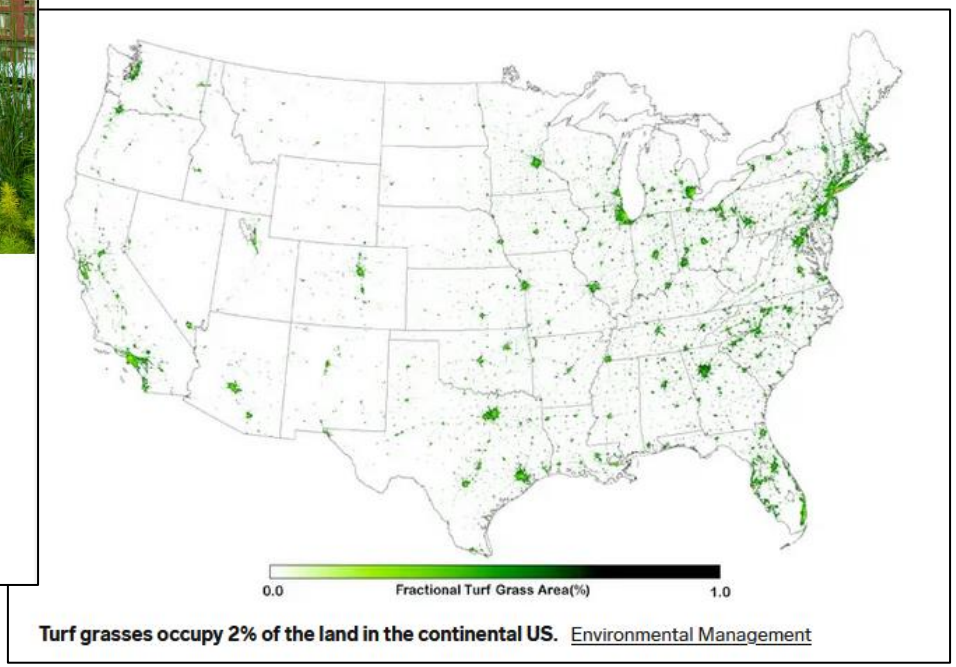
After New York City's High Line park opened in June 2009, it quickly became a trendy model for urban landscapers who wanted to innovate common green spaces. The captivating mix of flowers and foliage, juxtaposed with the rail line's industrial features, also made it an instant hit with tourists. So much so, in fact, that it is one of the top 10 most-Instagrammed places in the world. But what most of those people snapping selfies don't realize is that the High Line embodies its own ecological philosophy, one that many other projects have been inspired to follow. Call it a reconciliation of

Popular Stories

Find Your Bird-Friendly Plants

Native plants provide birds with the food they need. Use our database to discover the best plants for birds in your area.

Search the Database



Turf grasses occupy 2% of the land in the continental US. Environmental Management

***Sources**: grist.org, audubon.org, Milesi et al (2005)*

Are Efficiency and Conservation the Same?

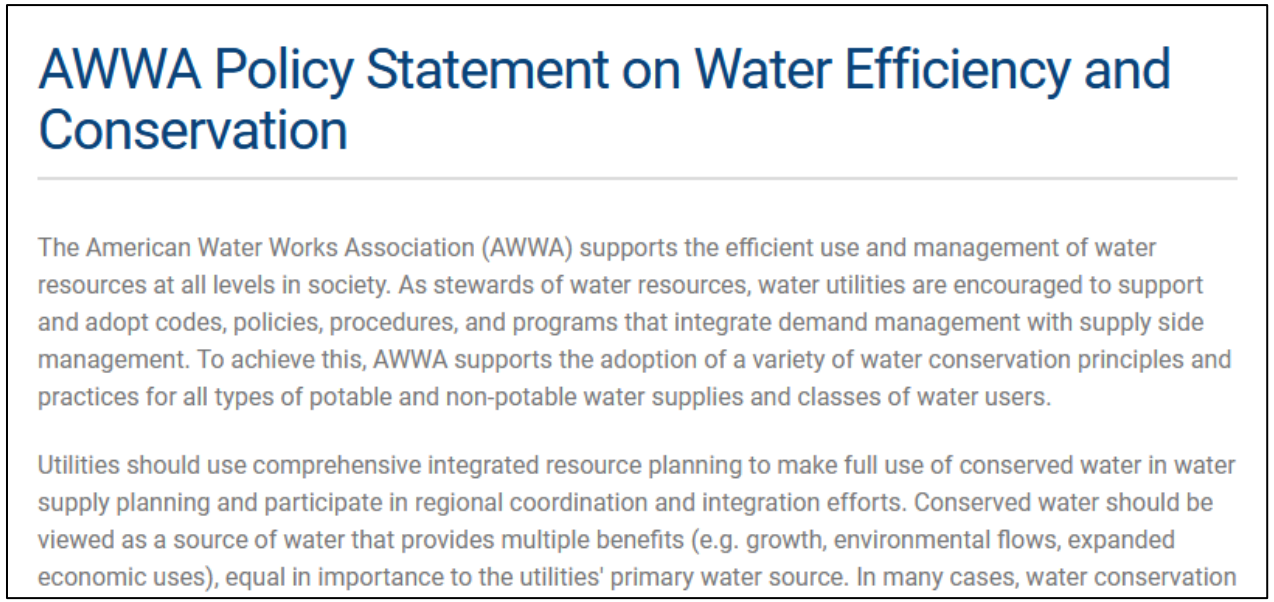
Water Use Efficiency

- Adopting technology and promoting behavioral change to better use available water resources
  - "Get more per drop"

Water conservation

- Aggregate water reductions

Water use efficiency does not always result in conservation



AWWA Policy Statement on Water Efficiency and Conservation

The American Water Works Association (AWWA) supports the efficient use and management of water resources at all levels in society. As stewards of water resources, water utilities are encouraged to support and adopt codes, policies, procedures, and programs that integrate demand management with supply side management. To achieve this, AWWA supports the adoption of a variety of water conservation principles and practices for all types of potable and non-potable water supplies and classes of water users.

Utilities should use comprehensive integrated resource planning to make full use of conserved water in water supply planning and participate in regional coordination and integration efforts. Conserved water should be viewed as a source of water that provides multiple benefits (e.g. growth, environmental flows, expanded economic uses), equal in importance to the utilities' primary water source. In many cases, water conservation

***Source**: awwa.org*

What Drives Water Conservation?

Depends on who you ask:

- Economist >> prices & rates
- Engineer >> technology (fixtures, leak detection)
- Hydrologist >> climate
- Landscape Architect >> design
- Sociologist >> networks & information sharing, population changes
- Anthropologist >> Rights, access, & power
- Policy-maker >> policies & regulations
- Ecologist >> plants

- Water conservation manager:
  "I'm not picky, just gonna do what works…"

Source: *mercurynews.com*

Is Drought the Only Reason to Conserve Water?

- **Drought is a regular event that affects water use and can be planned for:**
  - Mitigation & preparation
  - Forecasting
  - Shortage response
  - Recovery & relief

- **But, water conservation is not just a response to disasters**

Source: Small Water Systems and Rural Communities Drought and Water Shortage Contingency Planning and Risk Assessment: Part 1 – Recommendations for Drought and Water Shortage Contingency Plans (DWR 2021).

Figure 1. Disaster Risk Management Framework

Why Invest in Water Conservation Programs?

U.S. homes & businesses are saving water through efficiency

- EPA WaterSense
- State and local requirements
  - Codes and behavior changes
- Drought

If water agencies do not incorporate efficiency & conservation into demand planning, there is a risk of "over-building"

A new home built to EPA WaterSense standards could use 35 gallons per person per day or less

***Source**: www.epa.gov/watersense/homes*

Benefits of Water Conservation Planning

Save residents and businesses money on water bills

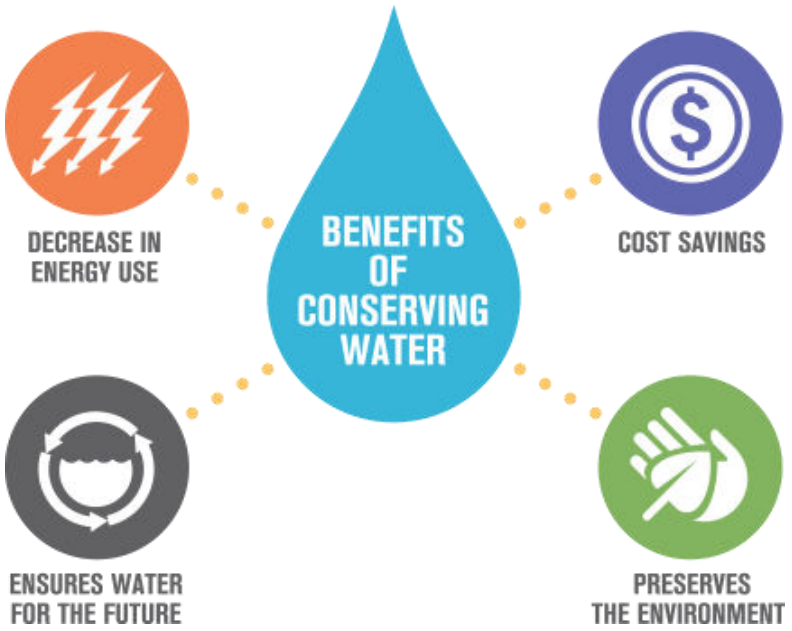
Avoid unnecessary new infrastructure

"OneWater" planning

- Link water supply with wastewater and stormwater improvements

Keep water in aquatic ecosystems

Reduce energy use and greenhouse gas emissions

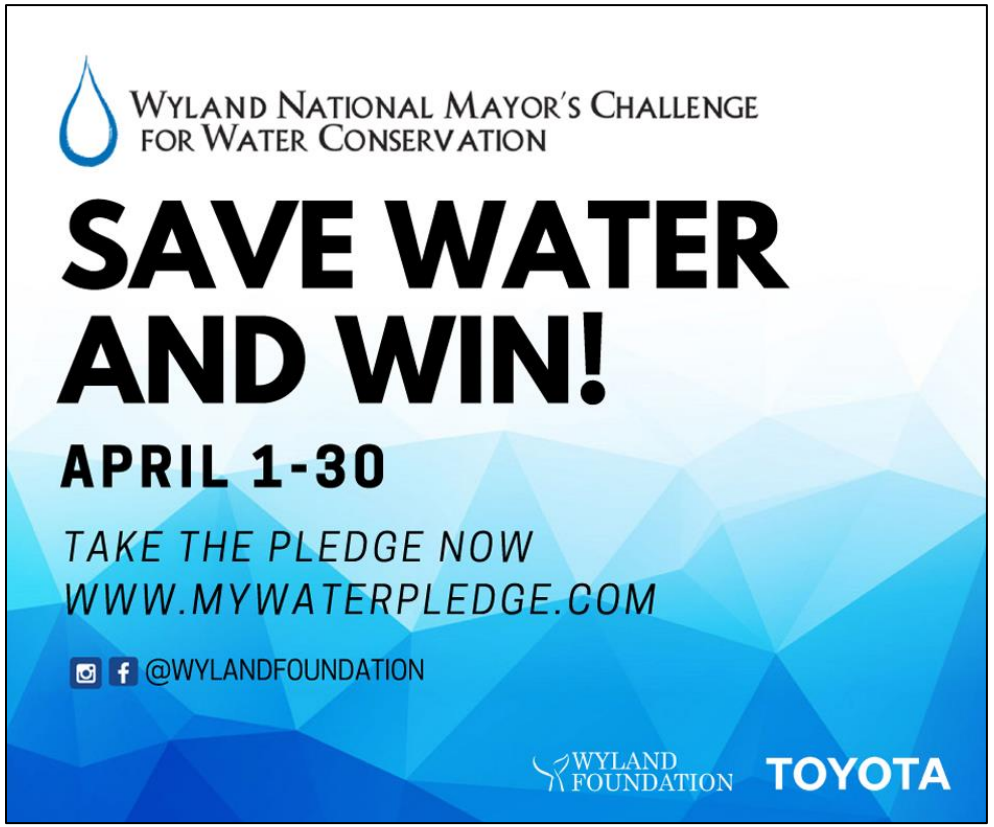


***Source**: Arizona Department of Water Resources*

Challenges in Water Conservation Planning

Water conservation programs can face many challenges

- Funding
- Technical expertise
- Public participation
  - Changing behavior and expectations is difficult
- Acceptance by Boards/Councils
- Effects of conservation on existing infrastructure & operations



***Source**: edenprairie.org*

Components of Water Use Efficiency and Conservation Programs

Components of Water Conservation Programs

Public education and outreach programs

- Websites, SWAG, advertising, social media, public relations, outreach to schools & community groups

Incentives and rebates

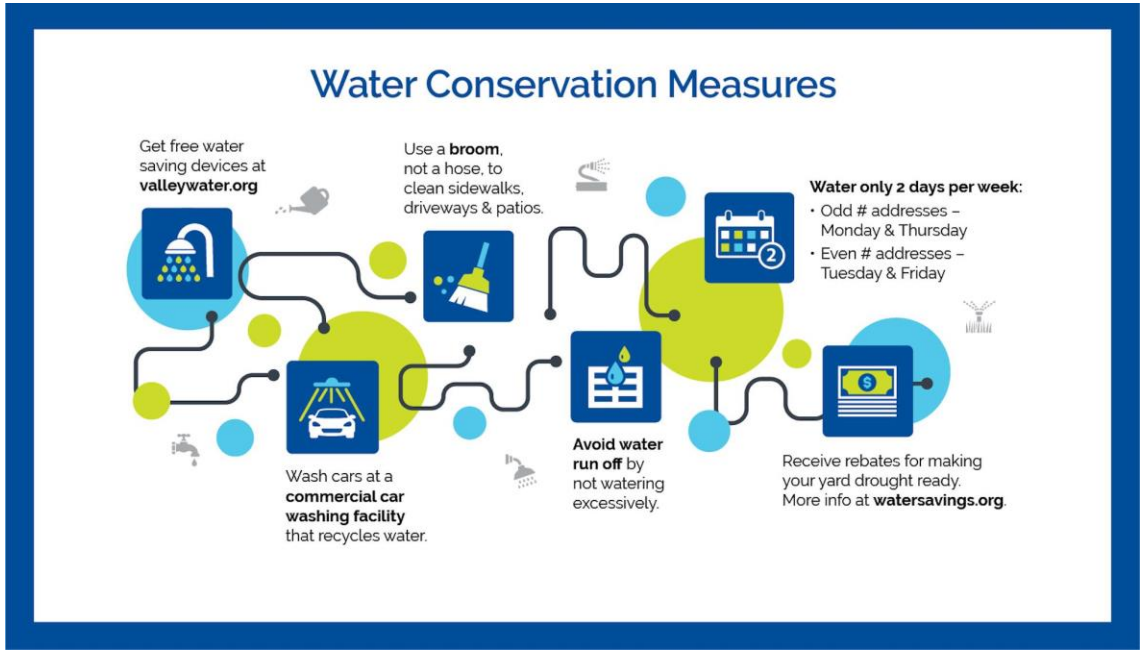
- Financial support for homes and businesses to purchase new fixtures, reduce irrigation, and save water

Codes and regulations

- e.g. irrigation schedules, water loss

Technical assistance

- Support local businesses and industries



***Source**: sjwater.com*

Steps to Implement Water Conservation Programs

Identify vision and goals

- Coordination and public input, evaluate available resources

Evaluate water demand

- Estimate future demand, available supplies, and conservation needs

Estimate conservation potential

- Evaluate conservation options, water savings, and costs/benefits

Document plans and get input

- Document goals: Water conservation master plan
- Funding: How will I pay for conservation programs?
- Align with other plans (capital improvements, rate studies, etc.)

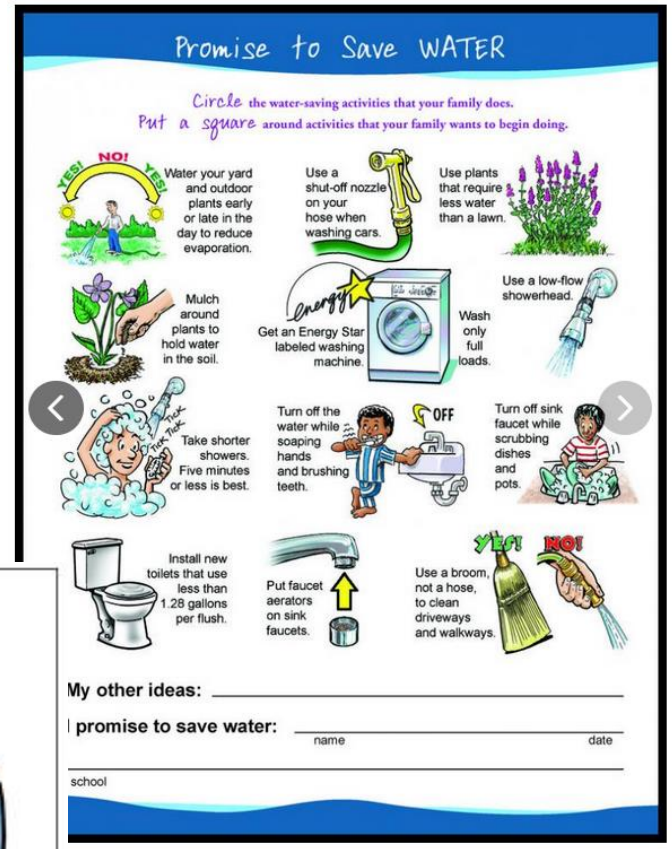
Adoption and implementation

***Source**: spokanecity.org*

Public Education and Outreach

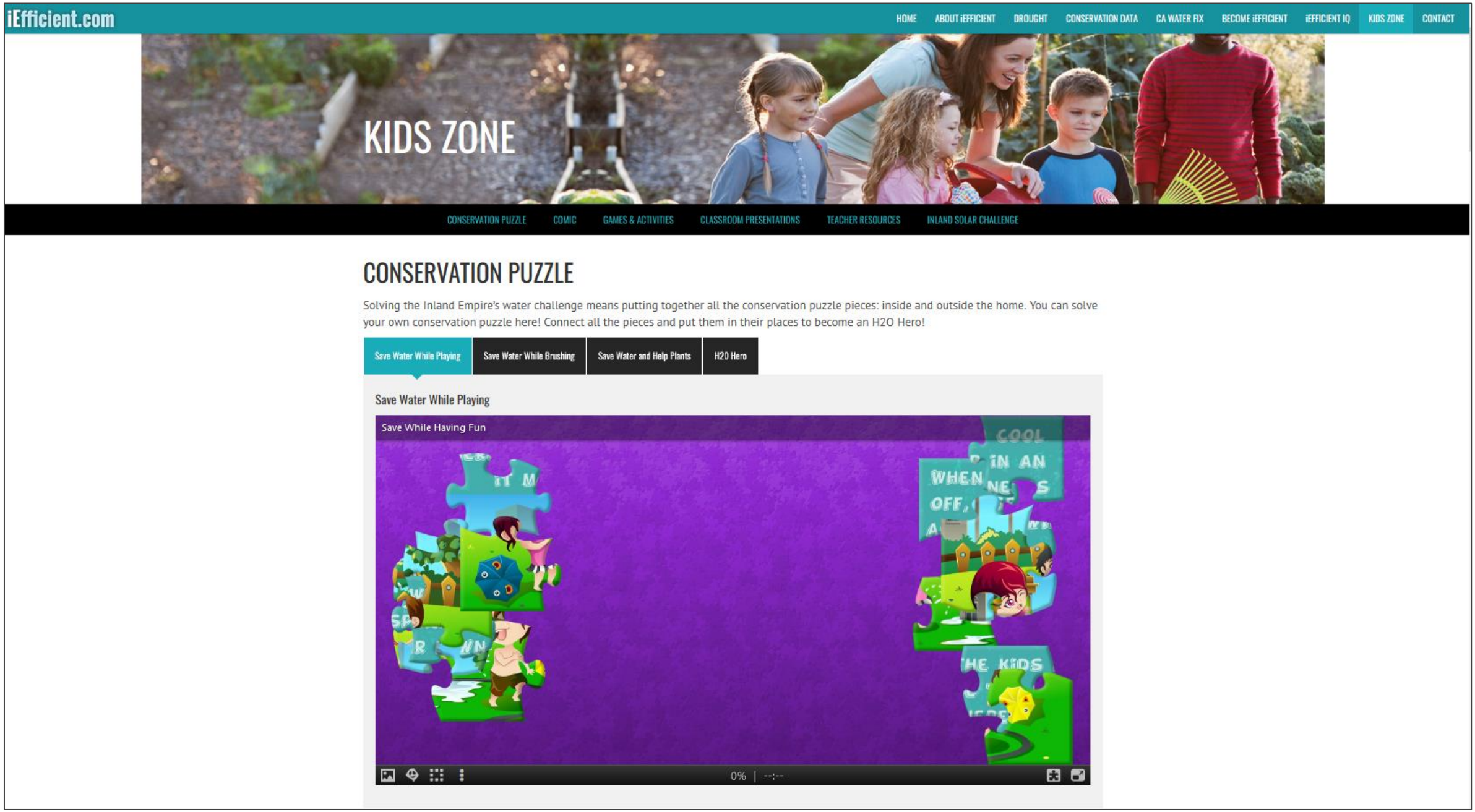
Lots of great examples from around the country!

- School & community programs
- “Tips & tricks” brochures
- Games
- Signage



Sources:

San Bernadino Valley Water District,
Redwood Community Action,
City of Charlottesville,
soquelcreek.org



***Source**: iefficient.org (Inland Empire, California)*

Rebates, Incentives, and Infrastructure Options

Ways to save water:

- Replace residential indoor fixtures
  - Toilets, clothes washers, dishwashers, faucets, showers
- Upgrade outdoor irrigation and landscape
  - Replace turf, invest in efficient irrigation
- Commercial buildings
  - Laundromats, restaurants, office bathrooms
- Leak loss detection
  - Replace leaking water lines, automated household leak detection monitoring

Program	Fixture	Gallon/Use
WaterSense	Toilets	1.28
	Bathroom faucets	1.20
	Kitchen faucets	1.80
	Showerheads	1.80
Energy Star	Dishwashers	3.62
	Clothes washers	19.15

Approximate consumption (gallons per use) of current efficient fixtures

$$V_{total\ reduction\ for\ a\ fixture} = V_{fixture,per\ use} * n_{uses} * P_{future}$$

$V = Volume\ of\ water\ use\ for\ a\ fixture\ (total\ in\ a\ district\ or\ per\ capita\ per\ fixture)$

$n_{uses} = Number\ of\ uses\ of\ a\ fixture\ per\ day$

$P = population$

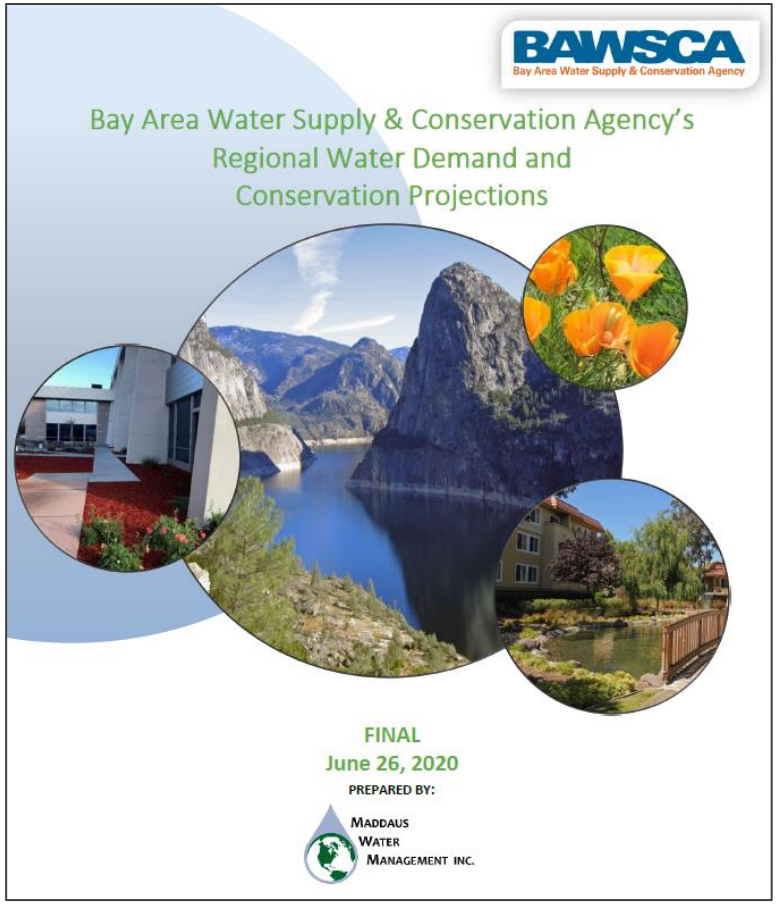
look for WaterSense Meets EPA Criteria

***Source**: EPA Water Sense*

Water Conservation Master Plans

Codifies long-term conservation targets, investments, and funding

- Demand forecast
- Current (if any) water conservation program options
- Evaluation of future conservation program options
- Recommendations
- Funding and financing



***Source**: bawsca.org*

Demand Planning and Forecasting

Demand Planning

Measures of demand:

- **Average-day demand (ADD)** is the total volume of water delivered to the system over a year divided by 365 days
- **Maximum-day demand (MDD)** is the largest total volume of water delivered to the system in a single day
- **Peak-hour demand (PHD)** is the largest single-hour volume of water delivered to the system

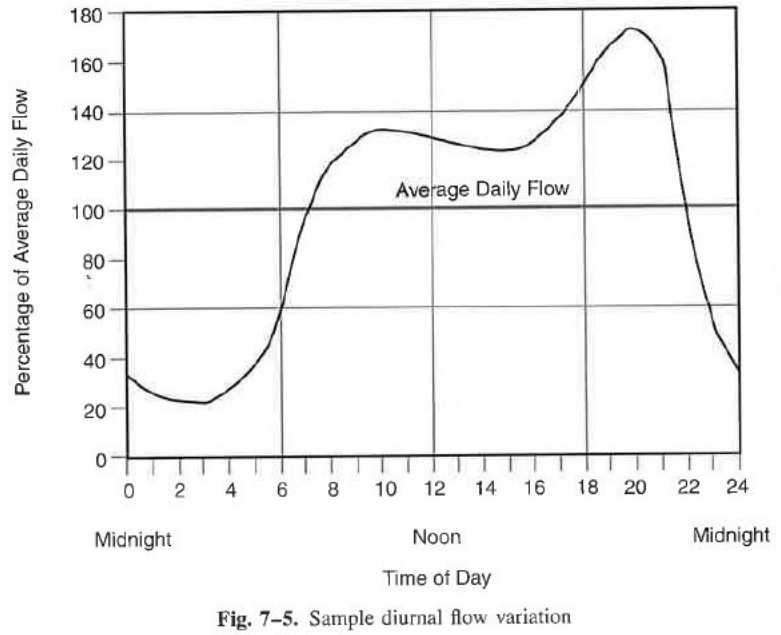


Fig. 7–5. Sample diurnal flow variation

Estimate these demand values with your data

- **Some benchmarks exist**:
  - MDD = from 1.5 to 3x's larger than ADD
  - PHD = from 2.5 to 5x's larger than ADD

Sources: Handbook of Public Water Systems, 2nd Edition (2001), OWP at Sacramento State (2018)

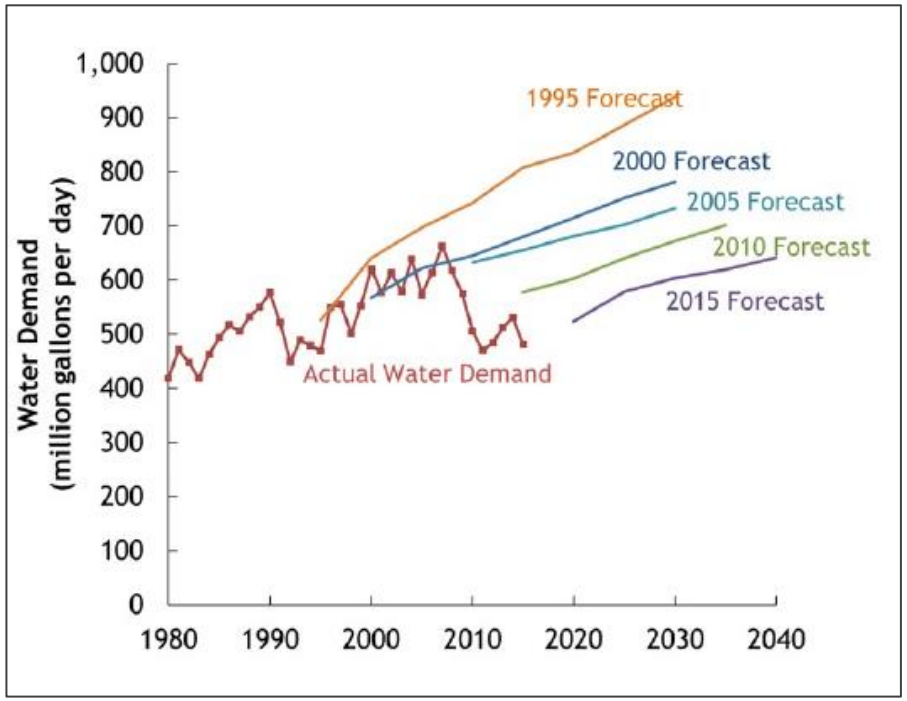
Demand Forecasting

Thinking ahead: How will demand change?

- Consider backup capacity sized to meet future demand → ***Demand forecasting***

Methods for Demand Forecasting:

- **Extrapolation**
  - Use population, current water use, and estimates of conservation rates
- **Statistical modeling**
  - Develop a regression model to understand drivers of demand.
- **End-use modeling**
  - Model fixtures throughout service area
- **Emerging methods**



Sources: *Pacific Institute (2018), Flory 2012*

Demand Forecasting: Extrapolation Approach

Minimum data needs for extrapolation:

- Current land uses and future land use projections
- Population
- Drought and water conservation rates
- Existing water consumption rates

Scenario planning: Low-to-High Ranges

$$D_{total,future} = D_{per\ cap,current} * r_{conservation} * P_{future}$$

$$D = Water\ Demand,$$
$$r_{conservation} = Assumed\ change\ in\ water\ use\ from\ conservation$$
$$p = population$$

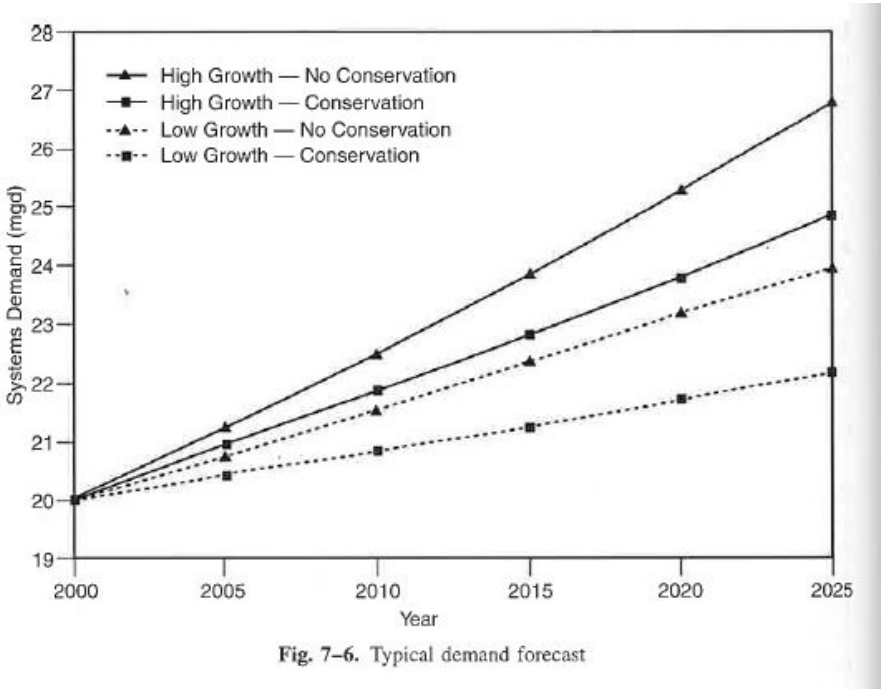


Fig. 7–6. Typical demand forecast

Source: *Handbook of Public Water Systems, 2nd Edition (2001)*

Demand Forecasting: Other Approaches

Demand forecasting can get fancy

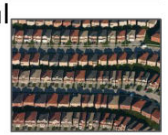
a) Integrate Spatial Data
Link parcels, agencies, and regions

b) Estimate Fixture Efficiencies
Collect from literature

Time Intervals		Appliances					
Years	Reason	Bath Faucet	Kitchen Faucet	Toilet	Clothes Washer	Dishwasher	Shower
pre-1980	Toilets (6 gpf)[1]			Y			
1981-1993	Toilets (3.5 gpf)[2]			Y			
1994-2006	U.S. Energy Policy Act	Y	Y	Y			Y
2007-2009	Washers[3]				Y		
2010	Toilets			Y		Y	
2011	EISA 2007 (42 U.S.C. 6295(g)(9))				Y		
2014	Title 20 & 24 (CalGreen)	Y	Y	Y			Y
2015	Clothes Washers					Y	
2016-2018	Title 20	Y					Y
2018-present	Title 20 & [4] FR 32307 (2012)				Y		Y

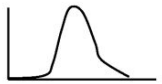
c) Link Fixtures and Buildings
Attribute fixture efficiencies to buildings for each retailer based on parcel attributes

Residential
Commercial
Industrial



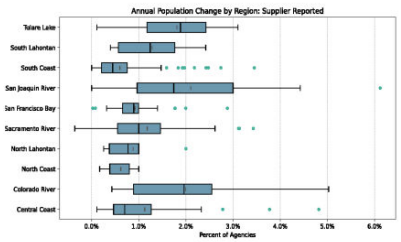
Dates of construction and sale

d) Code-based & Enhanced Replacement
Track changes in fixture efficiency code-based & enhanced upgrades



Track changes in % of buildings falling into bins of fixture efficiency, and use weighted average to evaluate Supplier-wide per capita demand

e) Evaluate Population Change
Evaluate projected population changes from available data sources



f) Project Water Use
Use parameters to project demand (indoor & outdoor),

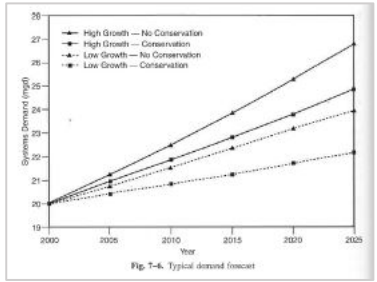


Fig. 7-6. Typical demand forecast

End-Use Modeling
Statistical Modeling

***Source**: OWP at Sacramento State*

Population and Consumption Changes

How does water use change over time?

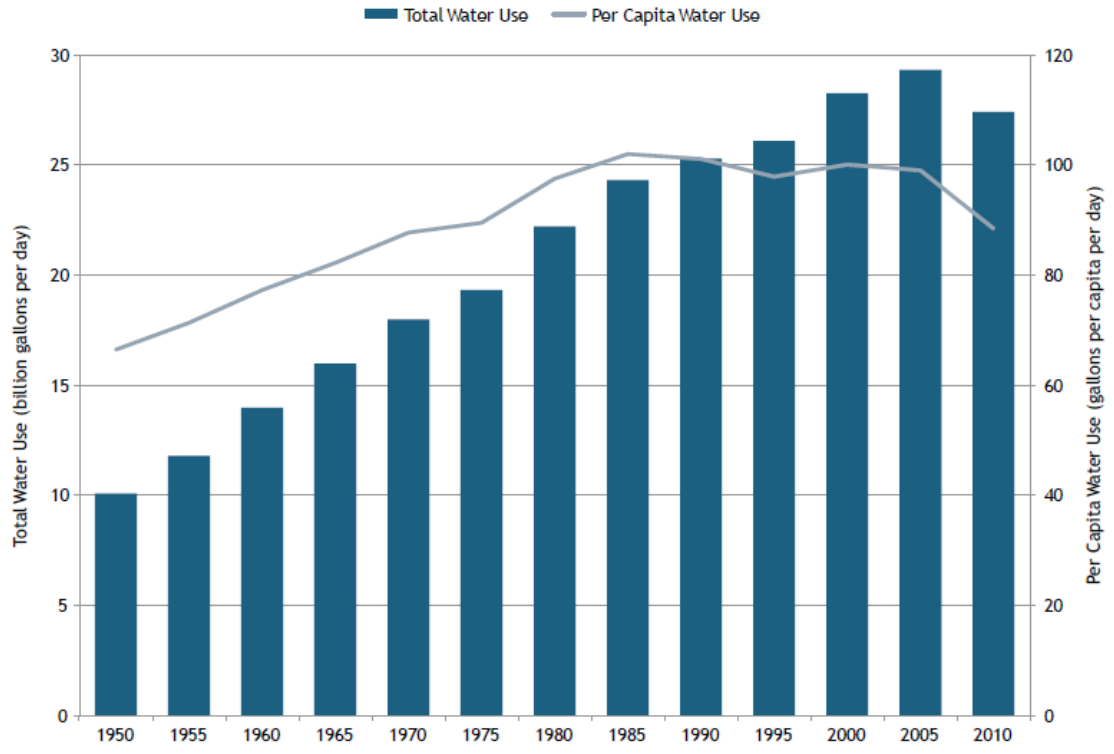


Figure 7. Total and Per Capita Water Use for the Residential Sector (1950-2010)

How Could Total Demand Changes with Population and Per Capita Use?

Population Change	Change in Per Capita Demand (Efficiency)	Change in Total Demand (Conservation)
Same	Decrease	Decrease
Increase	Decrease	Depends on rates of change in population and per capita use
Decrease	Decrease	Decrease

Sources: *Pacific Institute, OWP at Sacramento State*

Demand Planning and Forecasting Resources

Pacific Institute (2018). *Integrating Water Efficiency into Long-Term Demand Forecasting* (No. 4495). Water Research Foundation

AWWA (2008). *Forecasting Urban Water Demand, Second Edition*.

OWP at Sacramento State (2018). *Small Water Systems Operation and Maintenance*.

HDR Engineering, Inc (2001). *Handbook of Public Water Systems.*

Using Water Rates to Pay for and Promote Water Conservation

What is the “Right” Rate Structure?

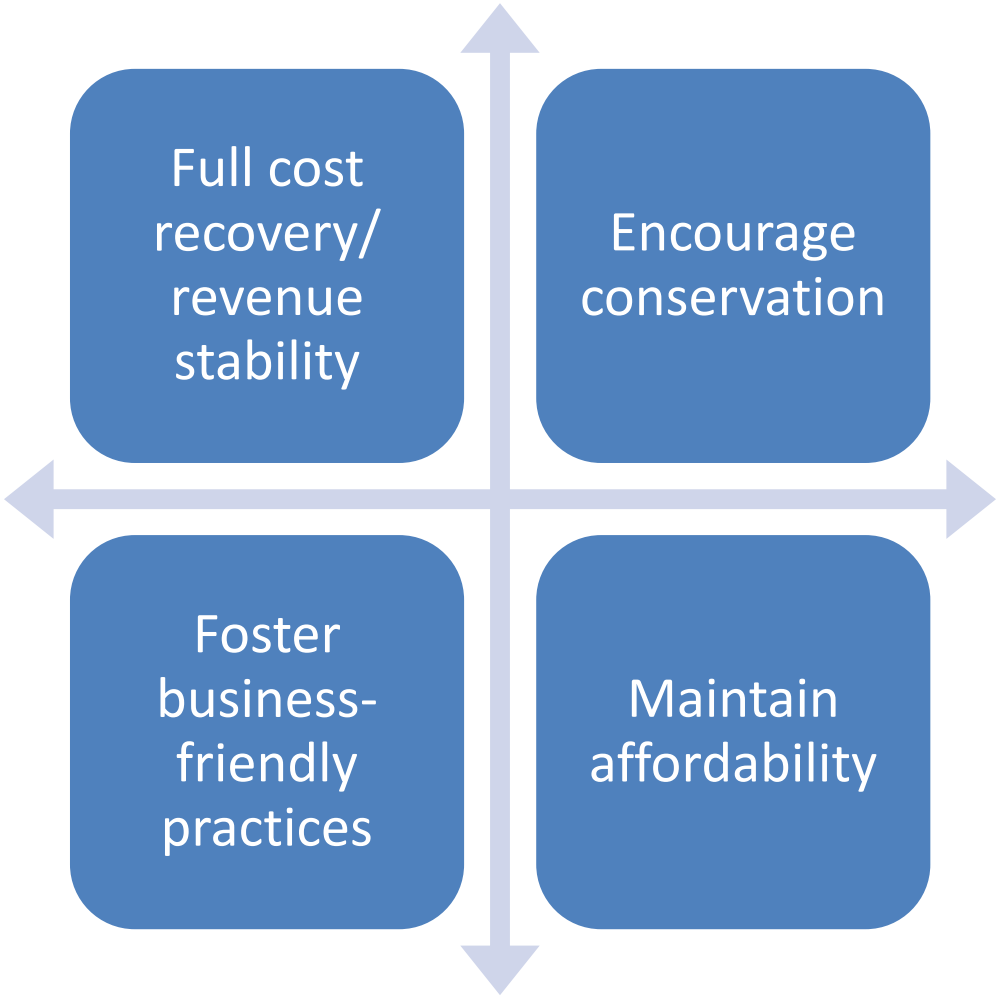
- How does a system decide how much to bill customers?
  - Identify funding needs, collect data, assess community characteristics, explore community desires and needs (by board or customers)

- A well-design rate structure should:
  - Provide adequate funding
  - Achieve a desired Level-of-Service
  - Be affordable for the community
  - Meet regulatory requirements
  - Other objectives…

Source: *tuscon.com*

Examples of Water System Objectives

What kinds of rate structures would meet each of these goals?



Elements of Rate Structure Design

1. Customer classes/distinction
2. Billing period
3. Base charge
4. Consumption allowance included with base charge
5. Volumetric rate structure
6. (If applicable) Number of blocks, block sizes and rate differentials
7. (Optional) Automatic adjustments

Also: frequency of rate reviews and rate changes

Billing Detail

Amount Owed from Last Bill	$135.80
Total Payments Received	135.80
Remaining Balance	**0.00**
Water Base Facility Charge	20.84
12.500 gallons @ $0.00295 per gallon	36.88
Current Water Charges	57.72
Sewer Base Facility Charge	63.80
Rate Case Expense Surcharge Water	2.50
Rate Case Expense Surcharge Sewer	2.50
Regulatory Assessment Fee	1.22
Deferred Capital Expense Surcharge Water	9.94
Deferred Capital Expense Surcharge Sewer	9.94
Amount Due ON or BEFORE 07/07/10	**$147.62**
Amount Due AFTER the Current Due Date	**$159.77**

Example Water Bill (Uniform Rates)
Source: EPA

Components of Water Bill Charges

Base charge
Provides a baseline level of revenue

Volumetric (consumptive) charge
Use more, pay more… but how?

Adjustments and surcharges
Additional charges for particular needs

Rate structures by property type
May help balance equity and affordability

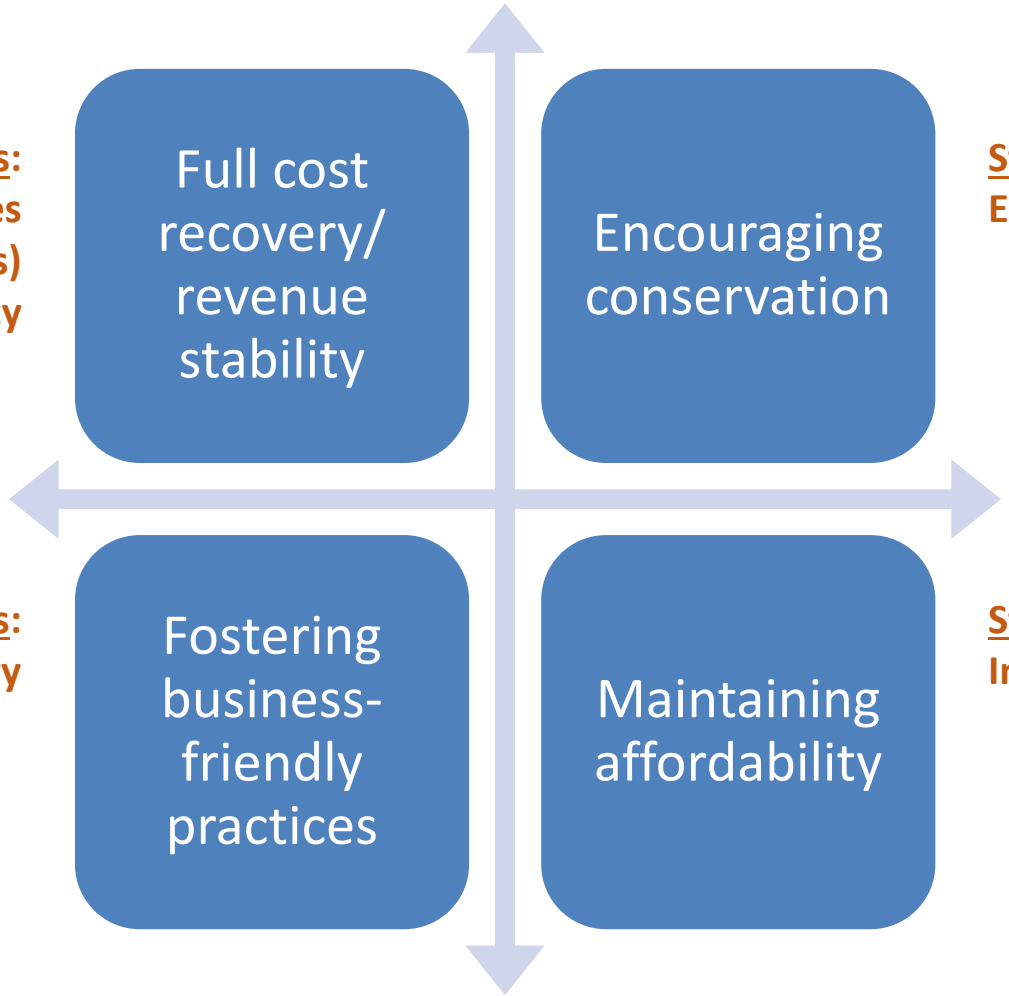
BILL DETAIL			
Your Water Budget for This Period		**19 CCF**	**14,212 gallons**
Your Water Consumption:		12 CCF	8,976 gallons
Service Charge			**$7.00**
Tier 1:	Excellent	10 CCF @ $0.84	$ 8.40
Tier 2:	Efficient	2 CCF @ $0.94	1.88
Tier 3:	Inefficient	0 CCF @ $1.41	0.00
Tier 4:	Excessive	0 CCF @ $1.88	0.00
Tier 5:	Wasteful	0 CCF @ $3.76	0.00
Total Consumption Charge			**$10.28**
Multi-Unit/Special Charge			**0.00**
Sewer Charge			**0.00**
Energy Surcharge			**0.00**
Indio Service Fee			**0.00**
Indio Utility Fee 5%			**0.00**
Returned Check Fee			**0.00**
Late Fee			**0.00**
Total For This Period			**$18.28**
Previous Balance			**0.00**
Total Amount Due			**$18.28**

Example Water Bill (Block Rates)
Source: EPA

Examples of Water System Objectives

What kinds of rate structures would meet each of these goals?

Strategies:
Emphasize fixed charges
Adjustments (i.e. drought rates)
Rate structures by property



Strategies:
Emphasize increasing volumetric charges

Strategies:
Incentivized rates for commercial/industry

Strategies:
Income-based assistance

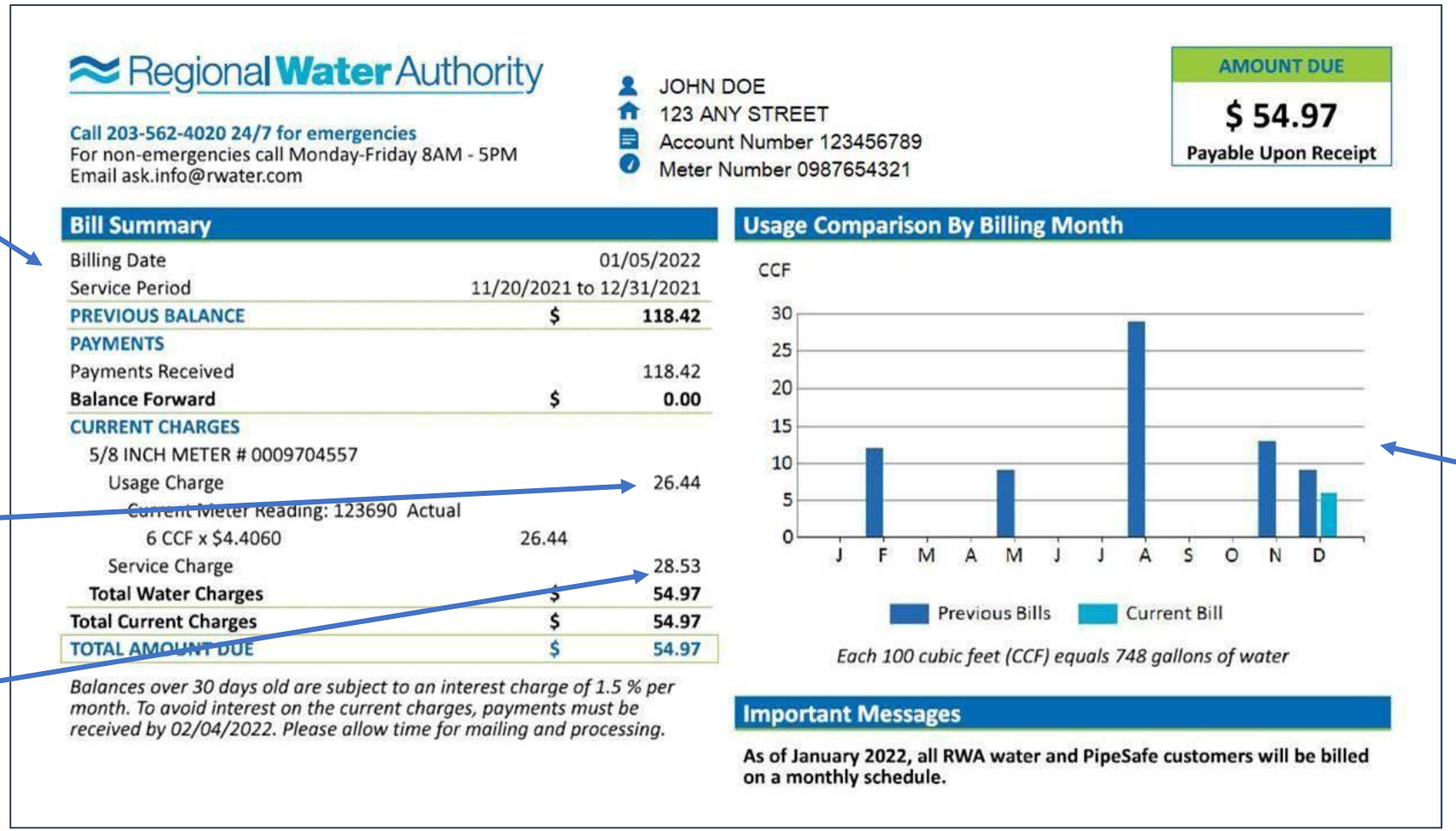
Example Water Bill

Billing Period Information

Volumetric Charge (Usage)

Base Charge (Fixed)

Customer Usage Information



Regional Water Authority

Call 203-562-4020 24/7 for emergencies
For non-emergencies call Monday-Friday 8AM - 5PM
Email ask.info@rwater.com

JOHN DOE
123 ANY STREET
Account Number 123456789
Meter Number 0987654321

AMOUNT DUE
$ 54.97
Payable Upon Receipt

Bill Summary

Billing Date		01/05/2022
Service Period		11/20/2021 to 12/31/2021
PREVIOUS BALANCE	$	118.42
PAYMENTS		
Payments Received		118.42
Balance Forward	$	0.00
CURRENT CHARGES		
5/8 INCH METER # 0009704557		
Usage Charge		26.44
Current Meter Reading: 123690 Actual		
6 CCF x $4.4060	26.44	
Service Charge		28.53
Total Water Charges	$	54.97
Total Current Charges	$	54.97
TOTAL AMOUNT DUE	$	54.97

Balances over 30 days old are subject to an interest charge of 1.5 % per month. To avoid interest on the current charges, payments must be received by 02/04/2022. Please allow time for mailing and processing.

Usage Comparison By Billing Month

Each 100 cubic feet (CCF) equals 748 gallons of water

Important Messages

As of January 2022, all RWA water and PipeSafe customers will be billed on a monthly schedule.

Source: rwater.com

Non-Volumetric Rates: Fixed Charges

Flat rate: All customers are charged a flat free, regardless of how much or little water they use

- The entire water bill is a “base charge”
- Simplest rate structure
- Provides stable revenue
- Common in systems without meters, or for renters
- ***Does not promote conservation***

Photo source: zone7water.com

Volumetric Charges: Fixed vs. Variable

- **How to set a volumetric charge for consumption?**
  - Water systems can set volumetric rates based on uniform or variable structures

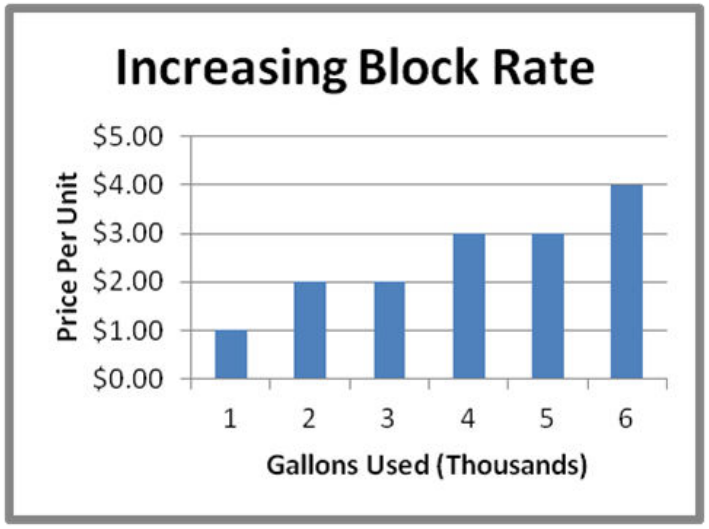
Uniform Rates	Variable Rates
The price per unit does not change during the term of the agreement	Price per unit can change with conditions, such as inflation

  - Revenue certainty may cost more money
    - Bills with fixed rates may be higher for many customers

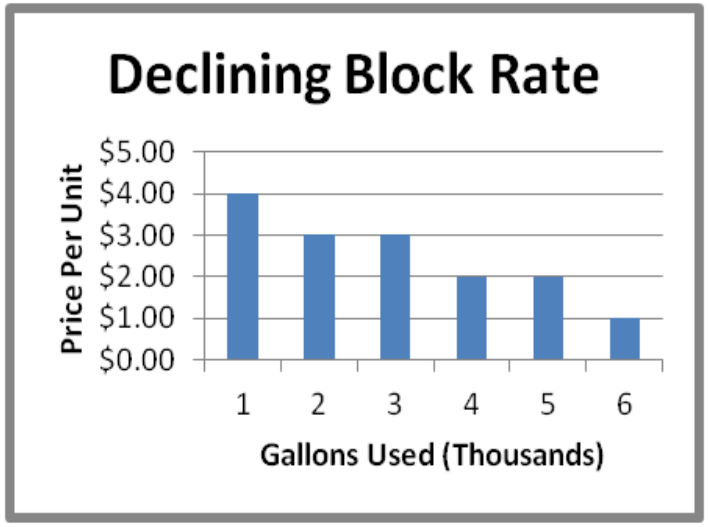
Volumetric Charges: Block Rates

Increasing block rate: uses a structure in which the unit price of each succeeding block of usage is charged at a higher unit rate than the previous blocks

Increasing block rates can be used to promote conservation



Declining block rate: uses a structure in which the unity price of each succeeding block of usage is charged at a lower unit rate than the previous block(s)

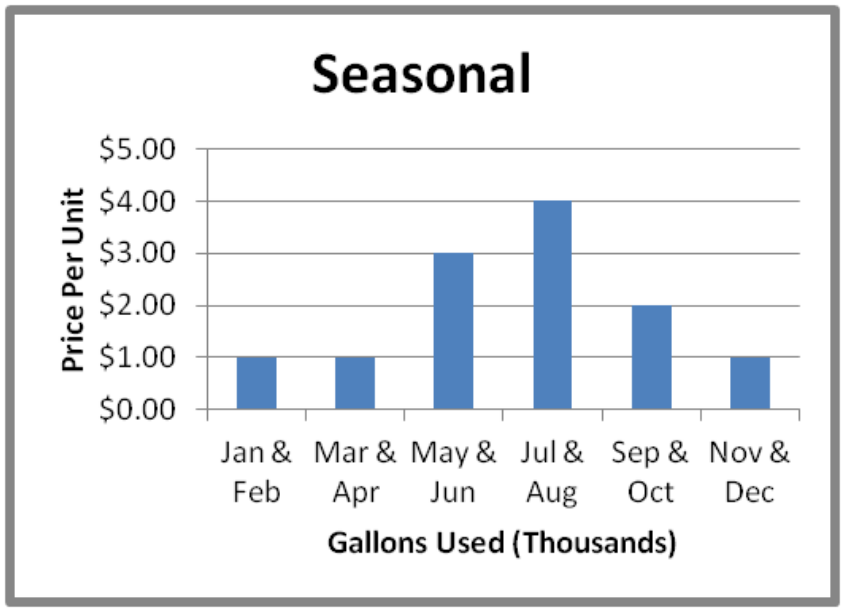


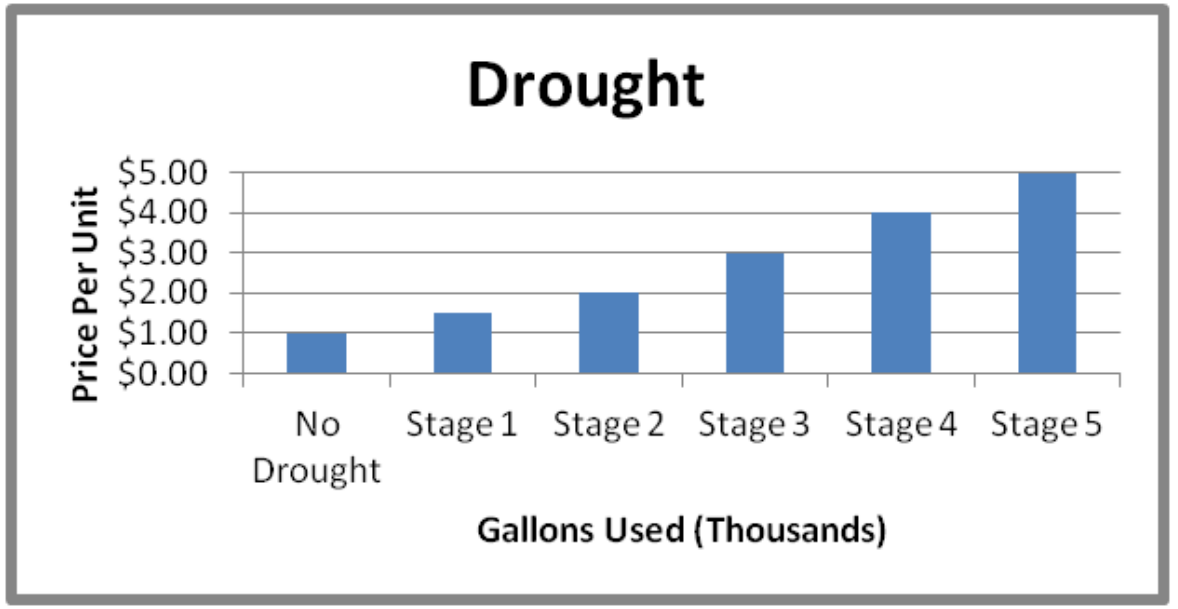
Sources: *US EPA*

Volumetric Charges: Seasonal & Drought Rates

Seasonal Rates: Rates vary by season or month, can encourage conservation during peak use

Drought Rates and Surcharges: Water rate or fees increase during drought

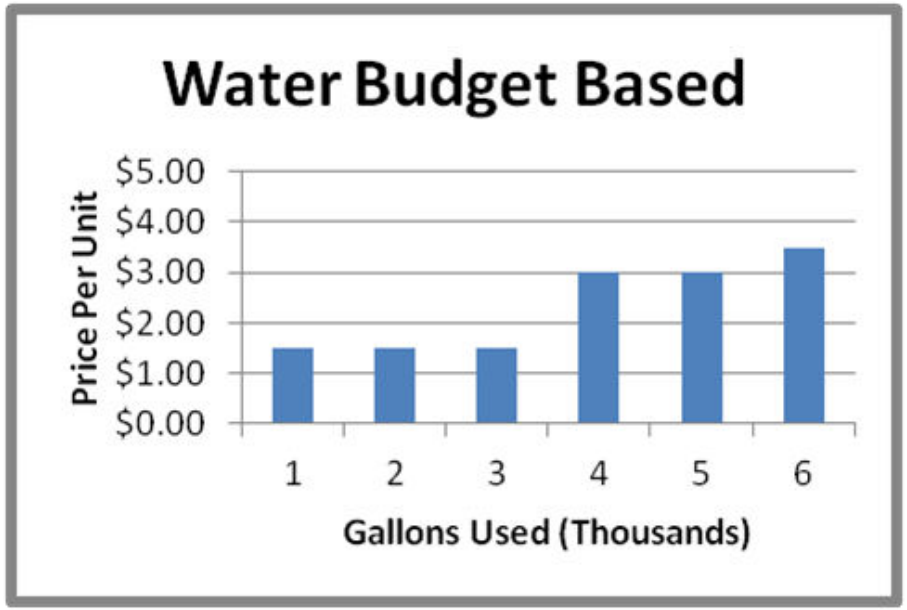




Sources: *US EPA*

Volumetric Charges: “Water Budget” Rates

- Sets water use targets for customers, based on a reasonable anticipated need
  - Users are charged a certain rate for use within a budget, and a higher rate for use that exceeds that budget
  - Goal is to encourage efficient water use



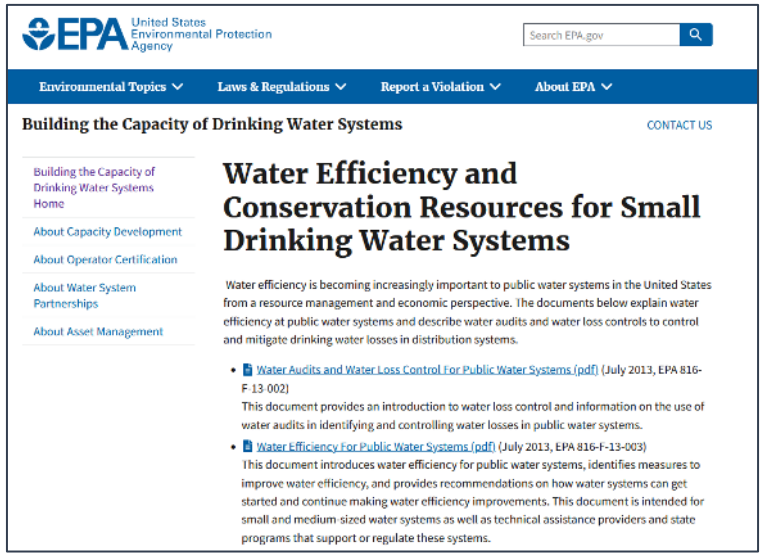
Sources: *US EPA*

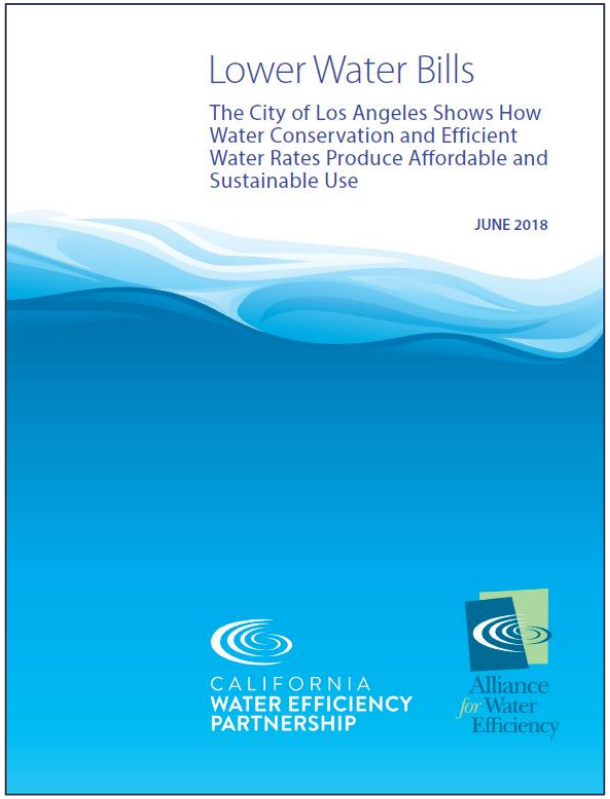
Aligning Rates and Water Conservation

Using water efficiently can save money in the long-term

Some rate structures can promote efficiency or address shortages:

- **Block rates**
- **Budget-based rates**
- **Drought surcharges**





Sources: *US EPA, Alliance for Water Efficiency*

Water Conservation Planning: Takeaways and Resources

Water Conservation Planning: Takeaways

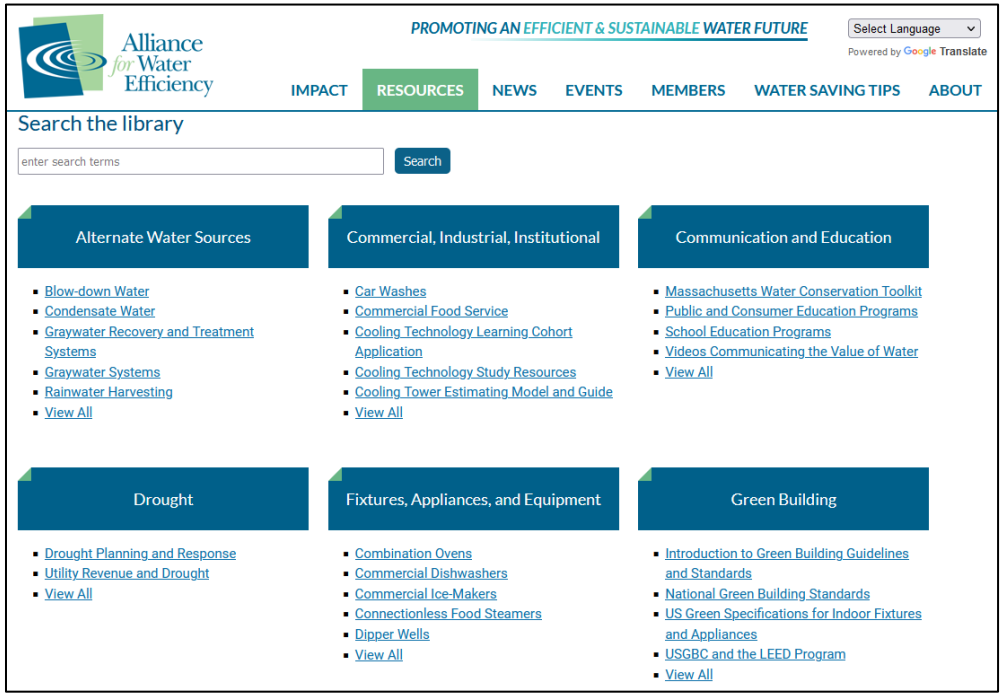
- **Water conservation programs have many benefits**
- **Even if you don't plan for it, your agency will likely see reduced demand in the future**
- **Public support and "buy-in" is a never-ending task**
- **Funding water conservation requires planning**
  - Reducing consumption can reduce revenue

Source: *Delaware Public Radio*

Resources for Water Conservation Planning

- **Alliance for Water Efficiency**

  https://www.allianceforwaterefficiency.org/



- **EPA Water sense**

  https://www.epa.gov/watersense

- **American Water Works Association (AWWA)**

  https://www.awwa.org/Resources-Tools/Resource-Topics/Water-Conservation

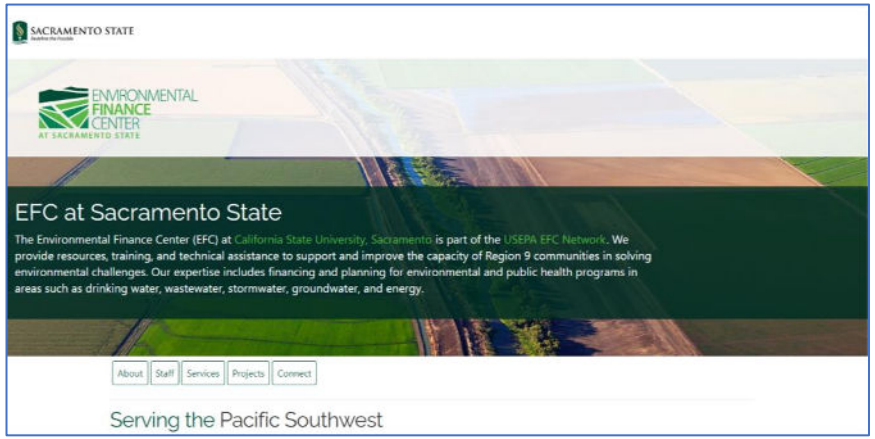
Technical Assistance and More Information

- **Environmental Finance Center Network**

  EFC-Network provides technical assistance
  https://efcnetwork.org

- **Rural Community Assistance Corporation (RCAC)**

  https://www.rcac.org



https://www.efc.csus.edu/

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