U.S. DEPARTMENT of ENERGY | Federal Energy Management Program

Control Strategies to Support Water Resilience

T02-S01, August 5th, 2025

FEMP Summer CAMP (Courses Aligned with Mission Priorities)

David Sandberg, CEM

Senior Solutions Developer
Southland Industries

Agenda

- Session Learning Objectives
- Presentation 1: Susan Loper – Water Basics, Importance, Sources and Tools
- Presentation 2: Eric Elam – Water Conservation in Action, Case Studies
- Conclusion and Q&A

Session Learning Outcomes

1. Identify strategies and technologies that enhance on-site water resilience.
2. Recognize O&M impacts of alternate water control systems.
3. Evaluate design and installation benefits of on-site water options.
4. Select key benefits of water resilience technologies.

Susan Loper

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Why Focus on Water?

- Humans can survive 3 to 5 days without water
- Extreme drought in some areas and flooding in others
- Water quality concerns from contamination and saltwater intrusion
- Degraded infrastructure
- Increased competition for overdrafted resources
- Increasing costs

Basic Water Terms

Water Supply Types

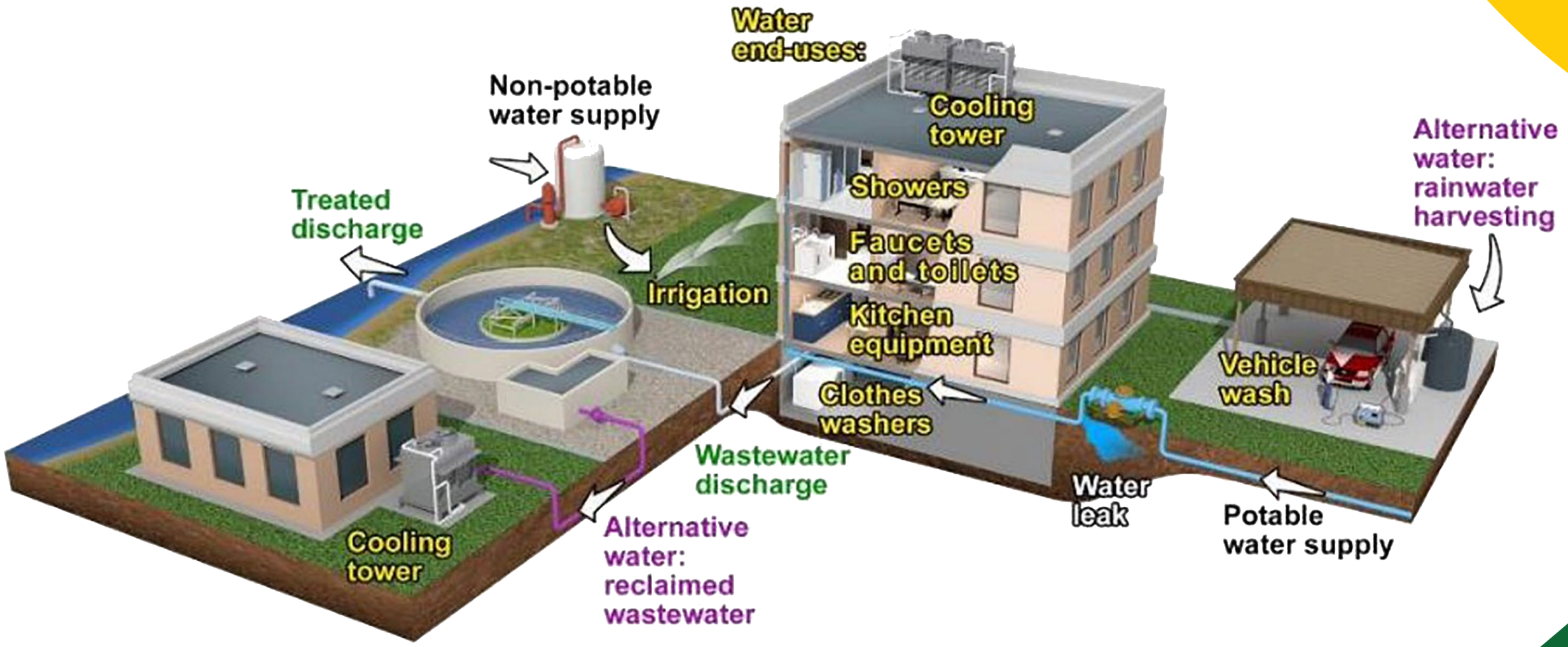
Freshwater:
Sources from surface or groundwater

Alternative Water:
Sustainable sources not from freshwater (e.g., harvest rainwater, captured condensate

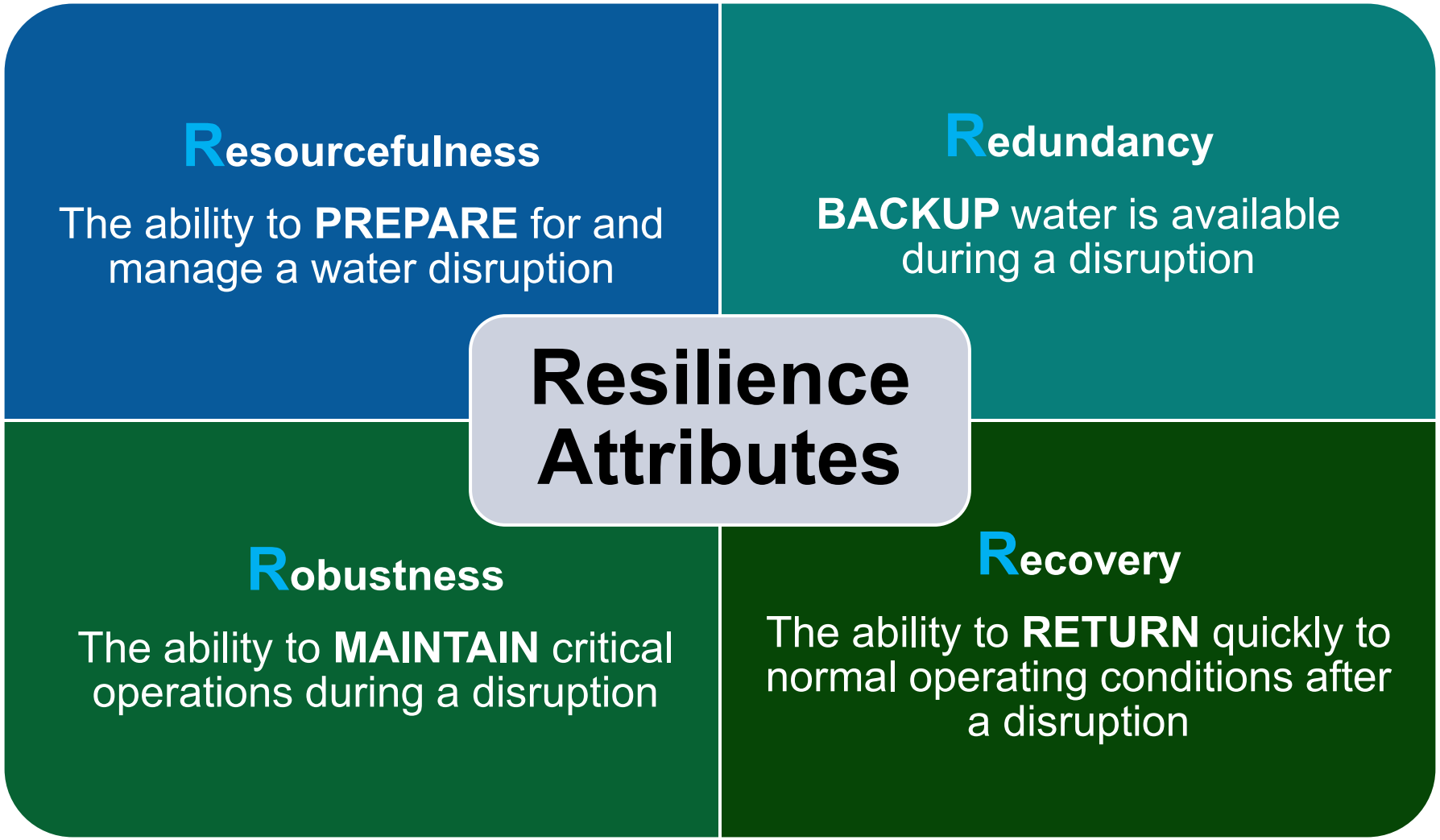
Water Treatment Levels

Potable Water:
Safe and permitted for human consumption

Non-Potable Water:
Not safe or permitted for human consumption


Water end-uses:
Non-potable water supply
Cooling tower
Showers
Faucets and toilets
Kitchen equipment
Clothes washers
Irrigation
Treated discharge
Alternative water: rainwater harvesting
Vehicle wash
Wastewater discharge
Water leak
Potable water supply
Cooling tower
Alternative water: reclaimed wastewater

The “4 Rs of Resilience”



Importance of Alternative Water

Alternative water use will help reduce the demand on freshwater sources and help facilities become more self-sufficient and water resilient

Resilient

- Provides diversity in water sources which promotes water resilience
- Utilizes non-potable water where potable water is currently being used

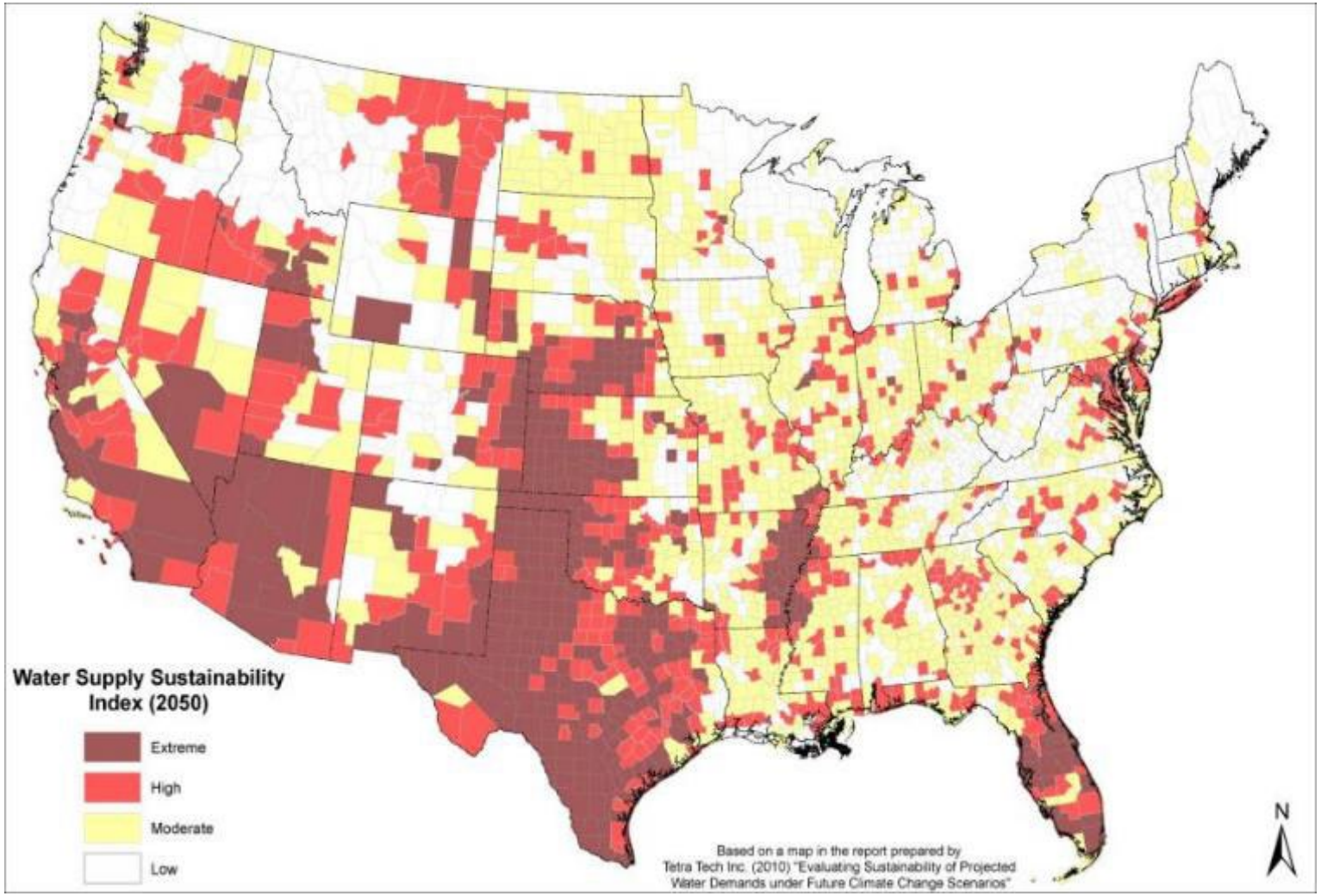
Sustainable

- Reduces groundwater decline and may provide aquifer recharge
- Contributes to environmental sustainability by minimizing wastewater discharge
- Protects natural water ways

Cost Effective

- Decreases treatment requirements when used for non-potable applications
- Reduces pressure on existing water systems

Why is Alternative Water Important?



"One third of all counties in the US will face high risk of water shortages by the middle of century."

Alternative Water Sources

- Harvested Rainwater
- Harvested Stormwater
- Reclaimed Wastewater
- Captured Condensate
- Graywater
- Processed Reuse
- Desalinated Water
- Atmospheric Water Generation
- Foundation Water
- Blowdown Water

Alternative Water Sources

Harvested Rainwater - rainwater diverted from rooftops or other covered surfaces.

Harvested Stormwater - precipitation runoff over ground-level surfaces that has not infiltrated into the ground and has not entered a waterway such as a stream or lake.

Reclaimed Wastewater - water that is discharged from buildings and processes, treated at a wastewater treatment facility.

Captured Condensate - water condenses on the cooling coils of mechanical equipment such as packaged or rooftop units, dedicated outdoor air units, and air handling units when humid air contacts these cool surfaces.

Graywater - lightly contaminated water that is generated by bathroom sinks, showers, and clothes washing machines.

Alternative Water Sources

Process Reuse - water purification systems remove impurities from a water supply for processes that require ultra-pure water. Some of the water supplied to the system is purified, while the remaining water, containing the filtered impurities, is rejected from the system.

Desalinated Water - brackish water or seawater from which the dissolved minerals, salts, and other contaminants have been removed.

Atmospheric Water Generation - utilizes a device to extract water vapor (humidity) directly from the air, by using condensation of cooling surfaces, desiccant capture, or gas separation using membrane technologies.

Foundation Water - water that collects around a building's foundation and basement/crawlspaces from groundwater or drainage from stormwater runoff.

Blowdown Water - water that is drained from cooling equipment and boilers to remove mineral buildup that develops during evaporative cooling or steam production.

Common Applications

Non-Potable

- Irrigation
- Vehicle wash
- Cooling tower make up
- Toilet/urinal flushing
- Dust suppression

Potable

- Drinking water
- Handwashing
- Showering
- Kitchen uses
- Steam Boilers

Considerations

- Potential alternative uses available
- Treatment level needed
- Permits from state or local government
- Regular operation and maintenance
- Design of infrastructure requirements (piping, storage, plumbing codes, etc.)
- Equipment will not obstruct daily operations

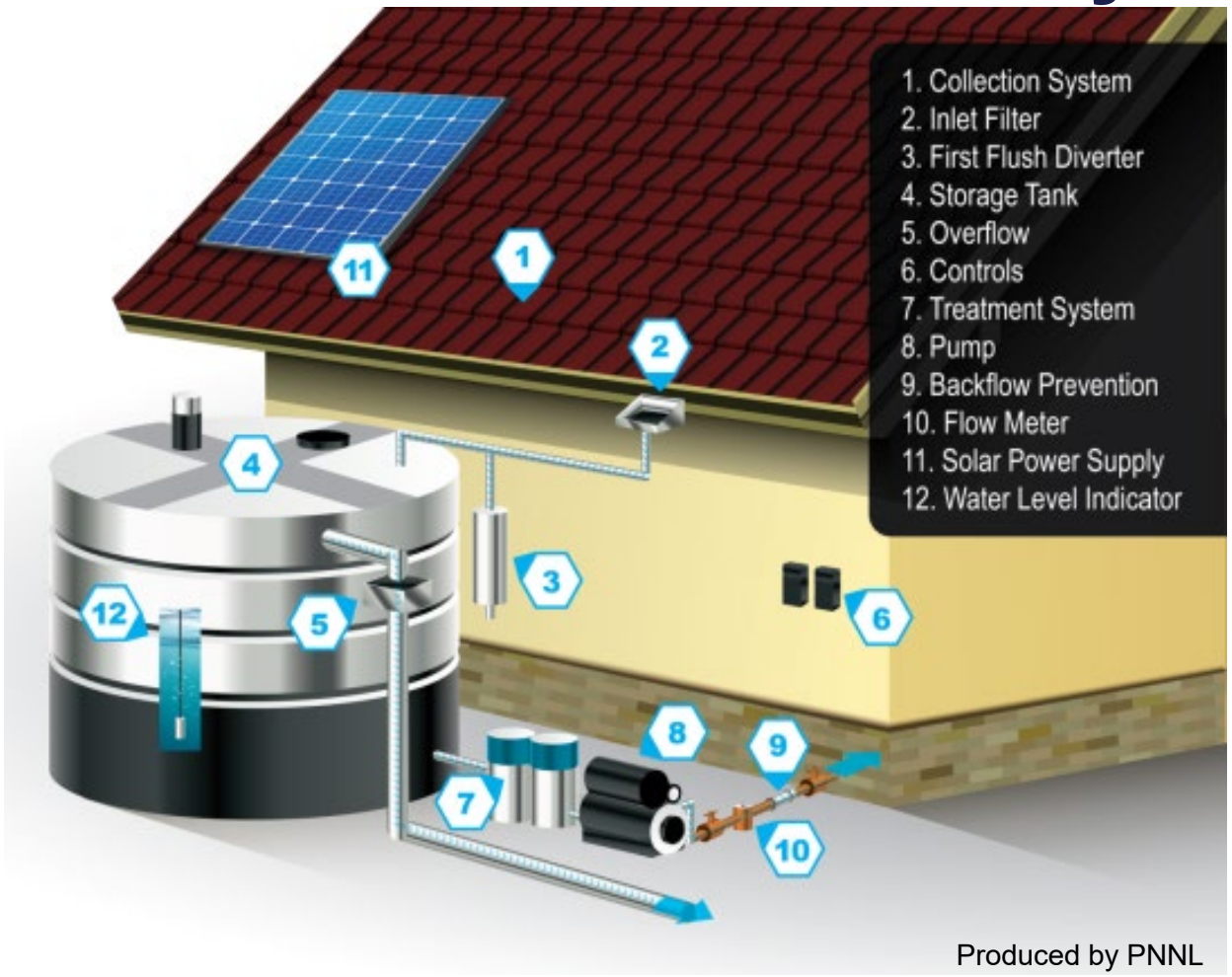
FEMP Alternative Water Tools

Objective is to provide strategic guidance to agencies on where to deploy alternative water projects

Tools and Resources:

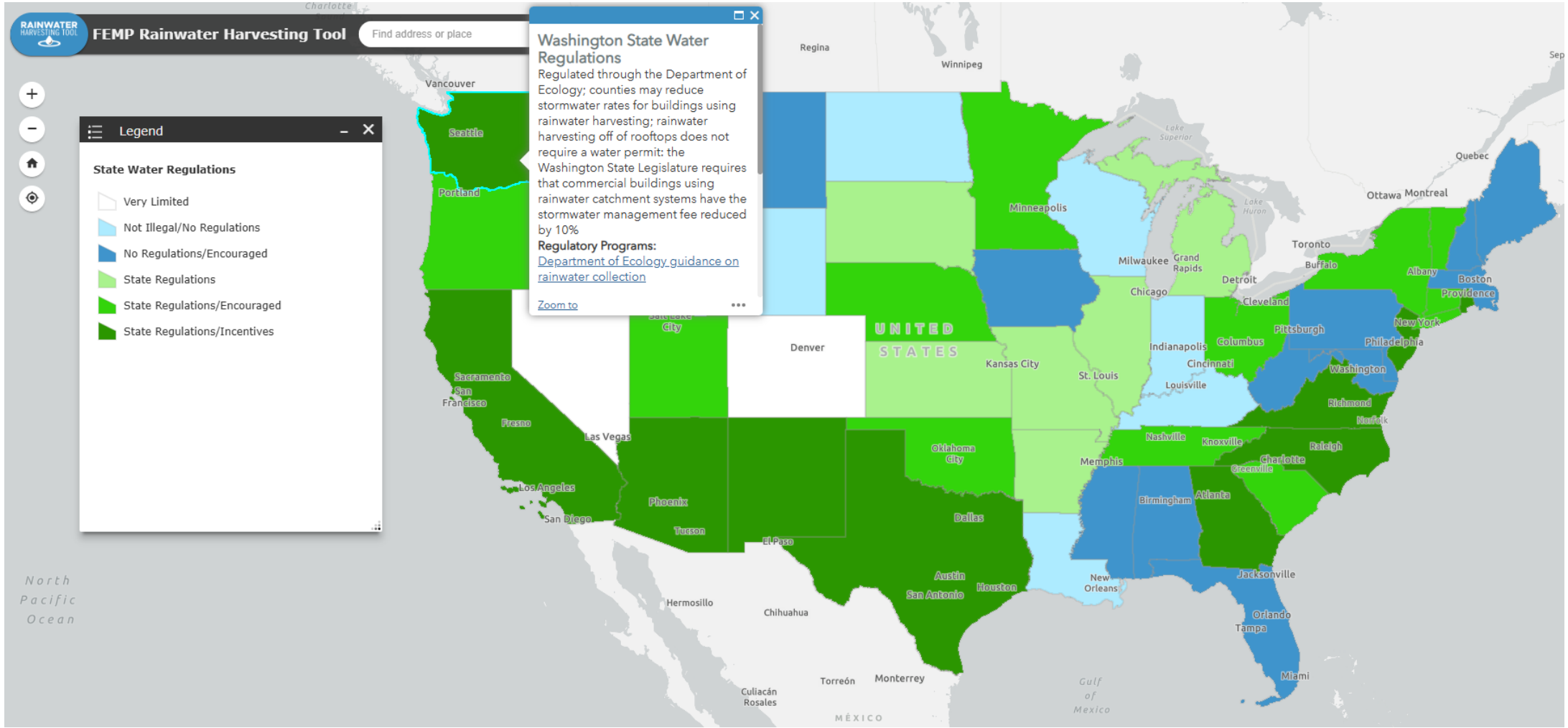
- Alternative Water Projects: Implementation Steps
- Best Management Practices
- Technology Opportunities
- Rainwater Harvesting Regulations and Technical Resources
- Rainwater Harvesting Potential
- Rainwater Harvesting Calculator
- Condensate Capture Potential
- Reclaimed Wastewater Providers

Technical Opportunity: Rainwater Harvesting / On-Site Wastewater Treatment System

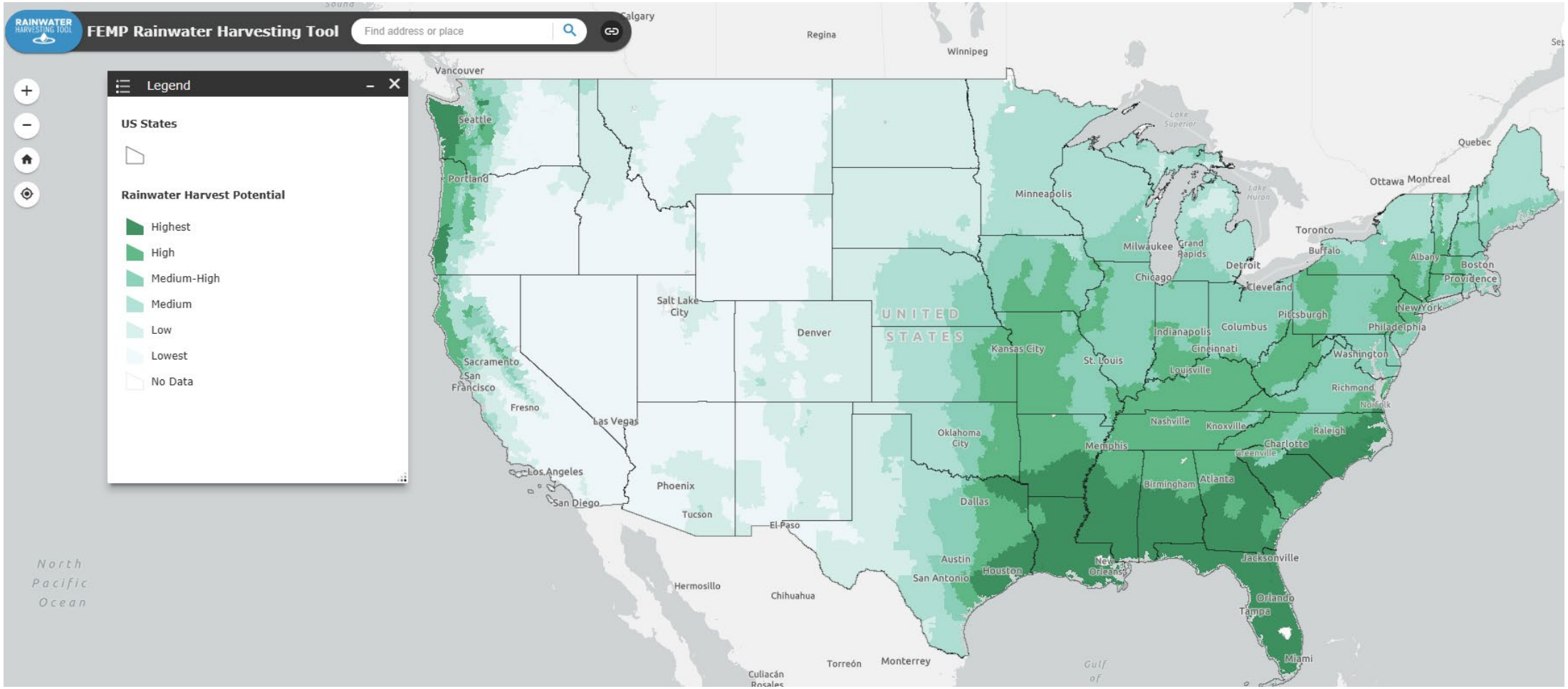


Produced by PNNL

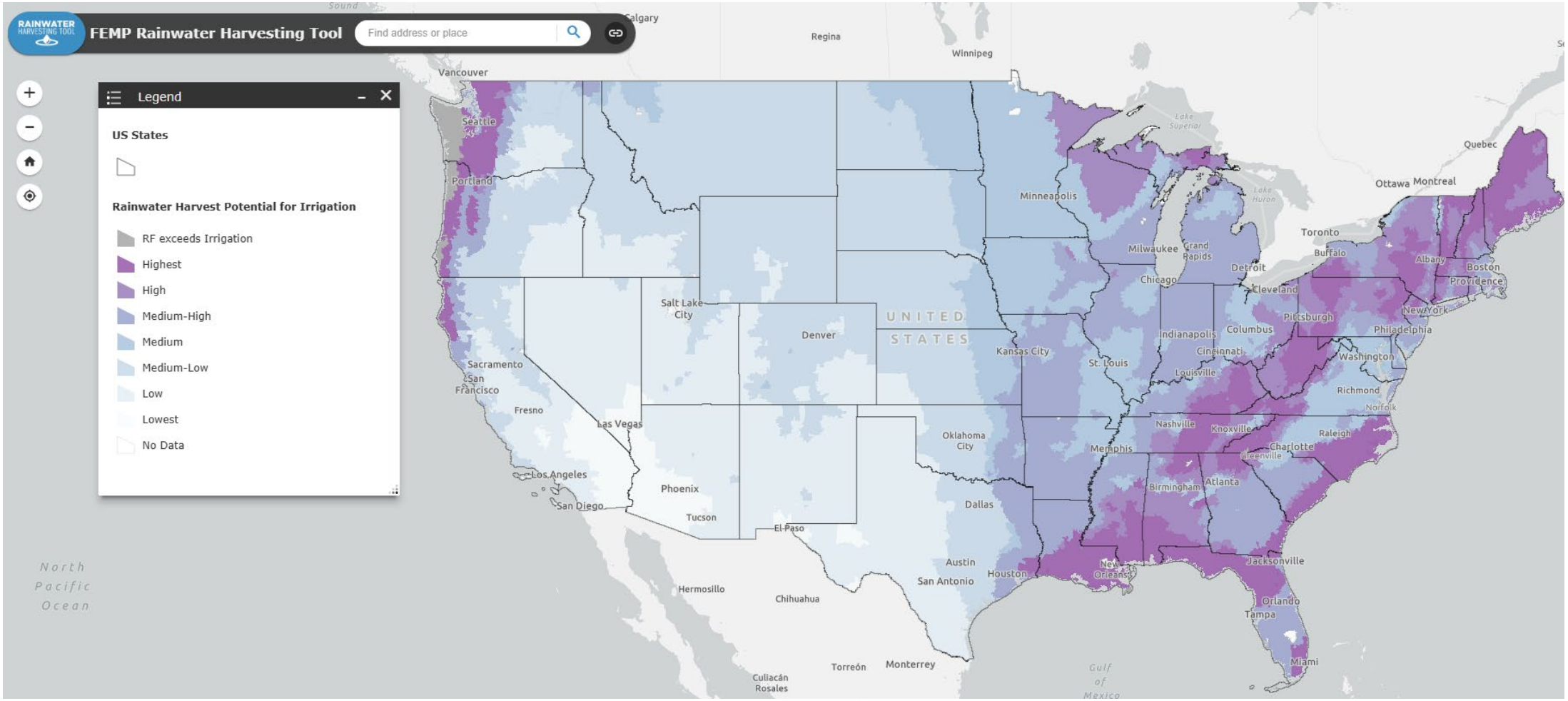
Rainwater Harvesting Regulations



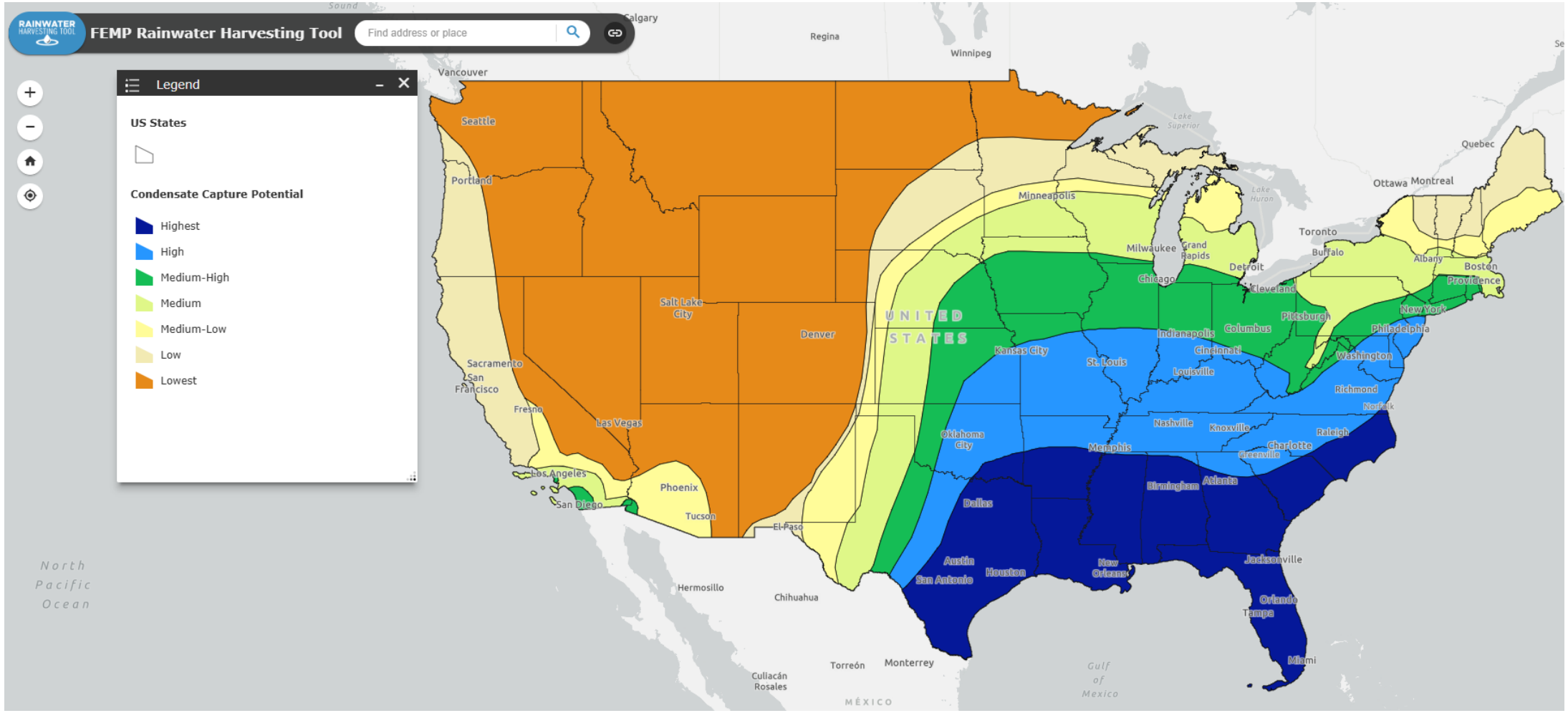
Rainwater Harvesting Potential



Rainwater Harvesting Potential for Irrigation



Condensate Capture Potential



Reclaimed Wastewater Utility Providers

STATE

All

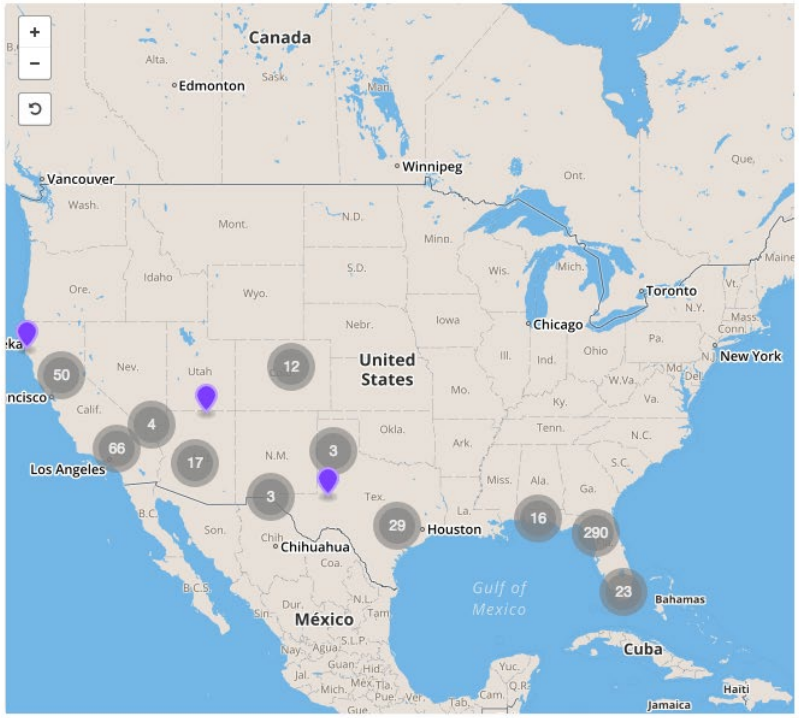
CITY

All

UTILITY NAME

All

Download All Water Reclamation Utility Data



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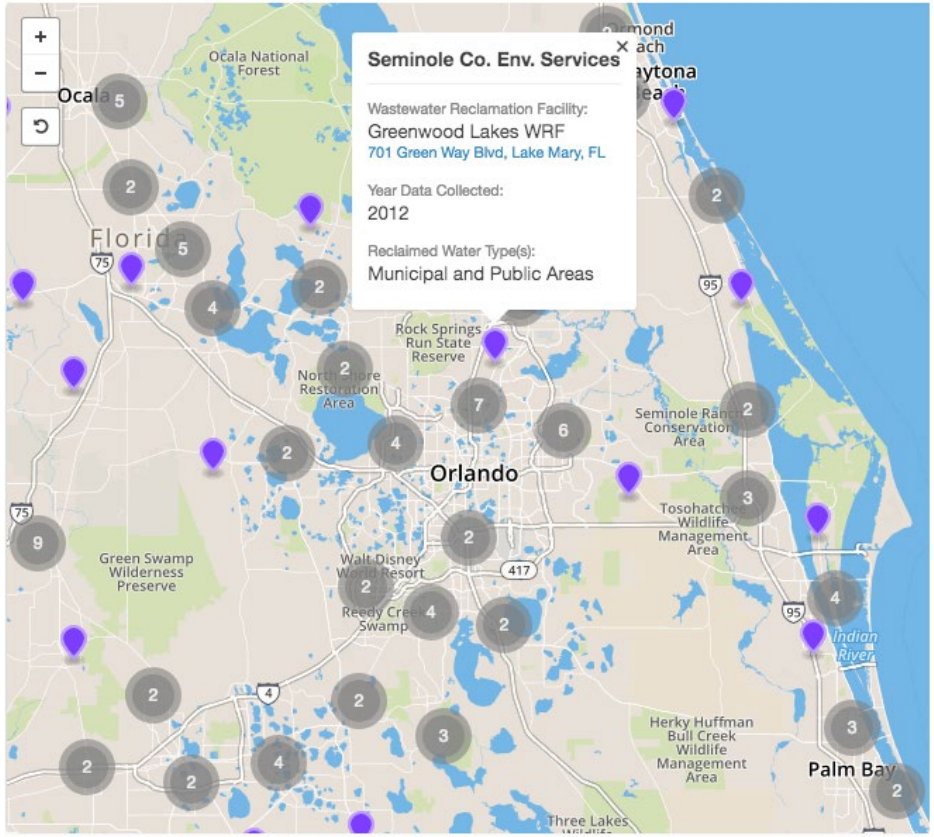
Search:

UTILITY NAME	WASTEWATER RECLAMATION FACILITY	FACILITY STREET ADDRESS	CITY	STATE	YEAR DATA COLLECTED	RECLAIMED WATER TYPE(S)
Town of Oro	Oro Valley Reclaimed WDS	11000 N. La Canada Drive	Ajo	AZ	2010	Municipal and Public Areas
Arizona City	Sanitary District	12922 S. Kashmir Rd.	Arizona City	AZ	2010	Municipal and Public Areas
Liberty Water	Gold Canyon WWTP	6520 E. Hwy 60	Arizona City	AZ	2010	Commercial



Data provided by The WateReuse Research Foundation

Resources

- FEMP tools and resources: https://www.energy.gov/femp/alternative-water-sources
- Alliance for Water Efficiency: https://www.allianceforwaterefficiency.org/resources/alternate
- WateReuse: https://watereuse.org/
- WateReuse How Reuse Works: https://watereuse.org/educate/water-reuse-101/how-reuse-works/
- WateReuse Framework for Direct Potable Reuse: https://watereuse.org/watereuse-research/framework-for-direct-potable-reuse/
- EPA Alternative Water Sources Research: https://www.epa.gov/water-research/alternative-water-sources-research
- EPA Safe Drinking Water Act: https://www.epa.gov/sdwa
- EPA Regulations & End-Use Specifications Explorer (REUSExplorer): https://www.epa.gov/waterreuse/regulations-and-end-use-specifications-explorer-reusexplorer
- EPA Potable Water Reuse and Drinking Water: https://www.epa.gov/ground-water-and-drinking-water/potable-water-reuse-and-drinking-water

Practical Applications for Water Efficiency & Sustainability

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Eric Elam, CEM, CWEP

VP, Design/Engineering

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Supply Side Production vs Demand Side Reduction

- Advanced Metering Systems
- Leak Loss Detection & Mitigation
- Alternative Water Harvesting
- Water Quality Improvement through Treatment

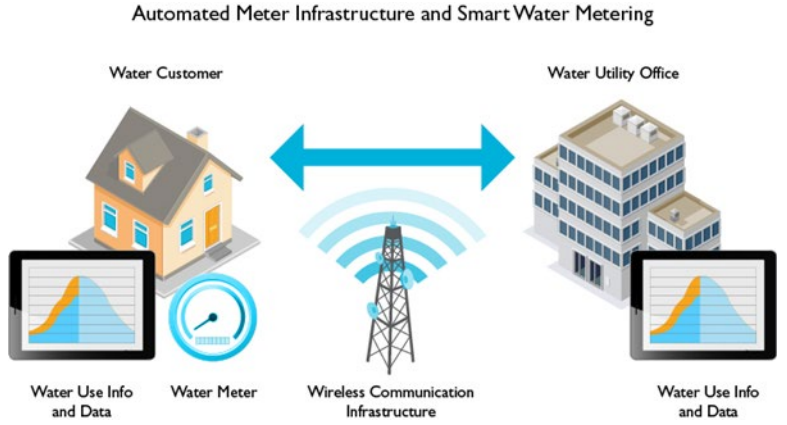
- Advanced Metering Systems
- Traditional Water Efficiency Measures
- Process Waste-stream Reduction
- Intelligent Control Systems

Advanced Metering Systems – Campus Style

AMI

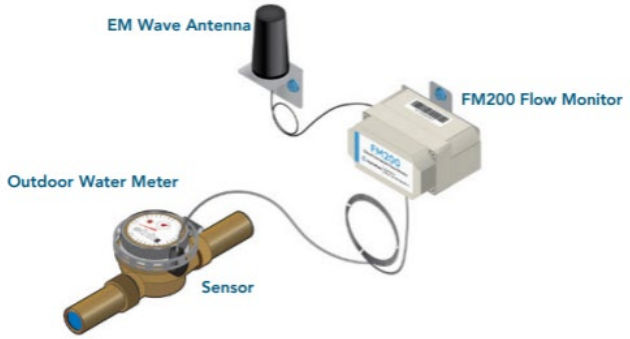
Advanced Metering Infrastructure

A metering system that records consumption hourly or more frequently and that provides for daily or more frequent transmittal of measurements over a communication network to a central collection point.



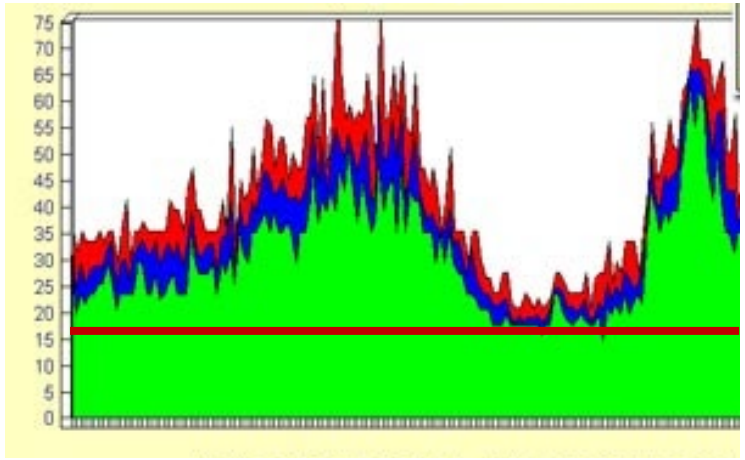
Advanced Metering Systems – Facility Sub-Metering

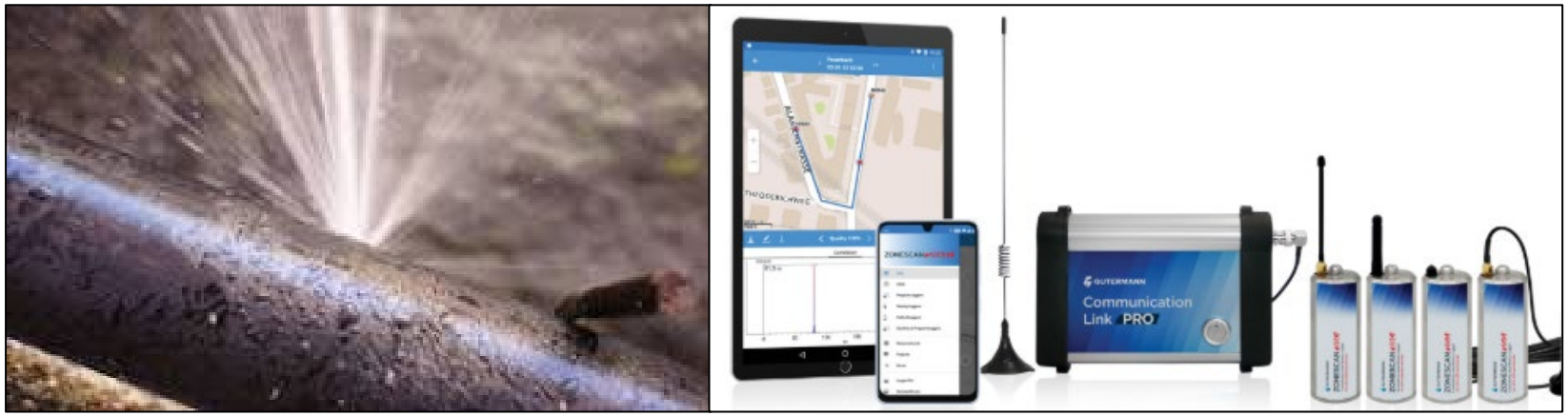
- Excellent solution for campus or facility sub-metering
- Non-invasive ultrasonic or “shadow” meters
- User friendly and intuitive interface
- Offered as a subscription-based service package – no product to maintain



Leak Loss Detection & Mitigation

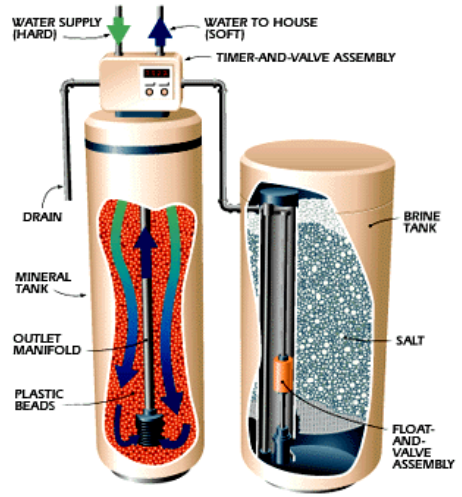
- Sub-meter Monitoring
- Acoustic Leak Detection Equipment

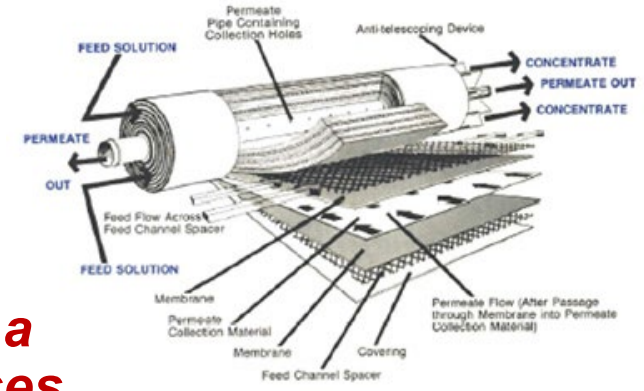




Water Quality Improvement through Treatment

- Filtration
- Organic Removal
- Softening
- Deionization
- Chlorine destruction
- UV / Chemical Disinfection
- Membrane Filtration (RO)





Treatment is NOT a water savings measure, but rather a method to improve efficiency or quality of other processes.

Practical Water Efficiency Measures

1. High Efficiency Domestic Plumbing Fixtures
2. High Efficiency Laundry Equipment
3. Commercial Kitchen Equipment Upgrades
4. Advanced Metering Systems
5. Smart Irrigation System Controllers
6. Water-Efficient Landscape and High Efficiency Distribution
7. Cooling Tower Condenser Water Treatment
8. Cooling Tower Side-Stream Filtration
9. Cooling Tower Blow-Down Recovery Systems
10. Boiler/Steam System Optimization
11. Eliminate Single Pass Cooling
12. Alternate Water Sources

Alternative Water Harvesting

- Rainwater Harvesting
- Stormwater Harvesting
- Groundwater Harvesting
- Gray water
- AHU Condensate Capture
- Process Water Discharge
- Wastewater Reclaim

Applications

- Cooling Tower Make-up
- Steam Boiler Feedwater
- Irrigation
- Toilet/Urinal Flushing
- Laundry Applications
- Vehicle Wash
- Industrial applications

Process Waste-Stream Reduction

Cooling tower condenser water treatment options

Systems / Major Components	Advanced Controller	Side-stream Filters	Water Softeners	Multi-media Filters	Reverse Osmosis Array
Side-Stream Filtration	✓	✓			
Partial Softening	✓	✓	✓		
Partial Demineralization	✓	✓	✓	✓	✓
Blow-down Recovery	✓	✓			✓
Alternative Water Treatment	✓	✓	??	??	??

Process Waste-Stream Reduction

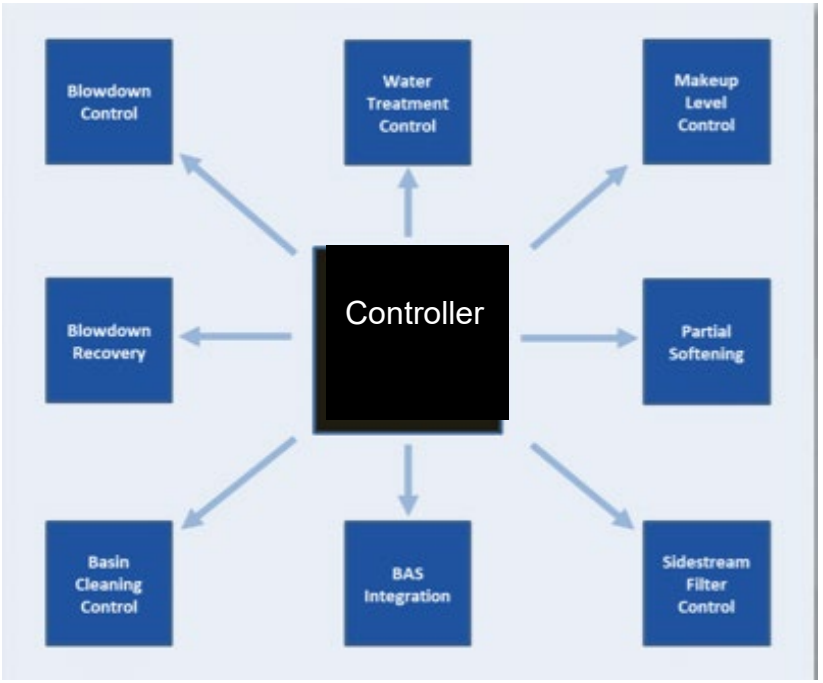
Steam boiler feed water treatment options

Systems / Major Components	Advanced Controller	Sample Cooler	Water Softeners	Dealkalyzers	Reverse Osmosis Array
Blow-down Control	✓	✓			
Feedwater Softening	✓	✓	✓		
Feedwater Dealkalyzing	✓	✓		✓	
Feedwater Demineralization	✓	✓	✓		✓
Feedwater Purification	✓	✓	✓	✓	✓
Alternative water treatment	✓	✓	??	??	??

Intelligent Control Systems

Cooling Tower and Boiler – BAS Integration with Advanced Controllers

- **Allows for real-time monitoring of system conditions**
- **Creates alarm case conditions for targeted maintenance**
- **Provides for accurate measurement and verification of system performance, with over 30 critical data points**



Intelligent Control Systems

Irrigation – Weather-based Web-enabled Smart Controllers

- **Implement master flow control meters**
- **Implement soil moisture sensors and/or rain gauges for localized data points**
- **Implement on-site weather station for localized weather data**

Case Studies

MCRD Parris Island (Parris Island, SC)

Eleven locations with small packaged Partial Softening and Side-stream Filters

(100-300 ton chiller systems)

One location with Centralized Partial Softeners and localized Side-Stream Filters

(4x200 ton chiller system)

Case Studies

National Mine Safety and Health Administration (Beaver, WV)

Centralized Partial Softening and SSF
(750 ton chiller system)

Dual condenser loops that can be isolated for individual chiller/tower operations

22% reduction of make-up water due to blowdown setpoint increases achievable through the use of partially softened make-up water

Case Studies

Corpus Christi Army Depot (Corpus Christi, TX)

Phase 1 – (4 space cooling systems ~2,730 ton total cooling capacity)

- Central Demineralization Plant with Distributed Make-up
- Localized Side Stream Filtration,
- BAS Integration
- 39% net reduction of make-up water

Phase 2 – (10 process cooling towers ~500 ton equiv. each)

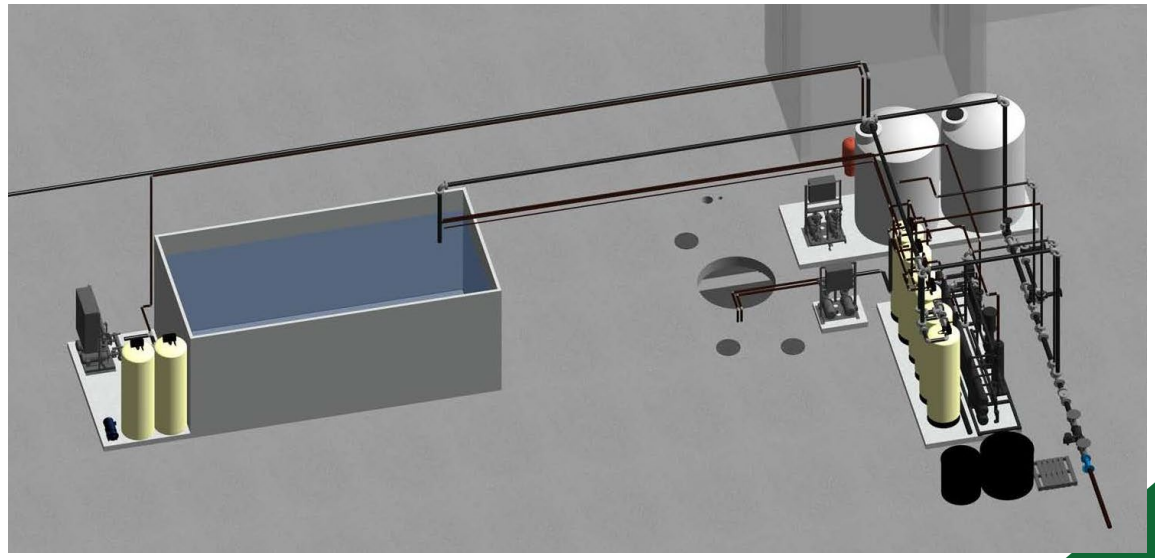
- Partial Softening
- Side-stream Filtration

Case Studies

Department of Interior HQ (Washington, DC)

Groundwater Collection

- Several underground sumps pits to capture ground water
- 2-large sump pumps discharging water to storm sewer system
- Water flow were measured at 30 gallons per minute
- 43,200 Gallons per day or 15,768,000 Gallons per year potential
- Cooling tower annual make-up is 6,500,000 gallons per year



Partial Demineralization with Side-stream Filtration and BAS Integration

- 100% potable water offset achievable during wet season

Questions?

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