Water Resilience as a Manufacturing Strategy

Water Reuse Action Plan – Action 8.14

Disclaimer

This webinar series is intended for educational purposes and does not constitute legal, regulatory, or compliance advice.

Action 8.14 *Engage with Industry and Manufacturing Leaders to Scale Water Reuse*

Planned Actions under 8.14

- Webinar: Water Resilience as Manufacturing Strategy *(Today!)*
- Panel Discussion: Making Industrial Water Reuse Projects Pencil Out (December 2026)
- Water Reuse Challenge Based Roundtables (2027)

Action Leaders: National Association of Manufacturers, Water Environment Federation, WateReuse Association

WRAP Action 8.14

Faced with water scarcity, greater water demand and increased cost for water, some industry leaders are interested in implementing water reuse as a manufacturing or processing strategy. Action leaders plan to host a series of sector-specific roundtables and webinars to help identify opportunities and best practices to expand the use of recycled water.

Agenda

- WRAP Action 8.14 Context

  Reagan Giesenschlag, Director Sustainability Policy, National Association of Manufacturers
- Circular Water Economy Framework

  Fidan Karimova, Sr. Director, Circular Water Economy, Water Environment Federation

  Gregg Brill, Senior Environmental Scientist, LimnoTech
- Solutions Provider & Manufacturer Perspectives

  Walt Kozlowski, Sr. Director Industrial Sustainability Solutions, Xylem

  Hector Gonzales, Environmental and Sustainability Director, Celanese

Circular Water Economy: Opportunities for American Manufacturing

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Traditional Linear Model

In the traditional linear model, water flows one way



Traditional water systems follow a take-use-dispose model. For manufacturers, increasing water demand, supply constraints, and rising treatment costs create operational risks and opportunities to improve resource efficiency.

This model depends on continuous access to abundant and reliable freshwater supplies

Circular Water Economy

A circular water economy no longer treats water as a **one-time-use** resource but seeks to use it more efficiently, recapture value from waste and work in harmony with natural systems

Characteristics

- Reduces water demand
- Improves resilience
- Recovers valuable resources
- Creates economic value
- Reduces environmental impacts
- Regenerates nature



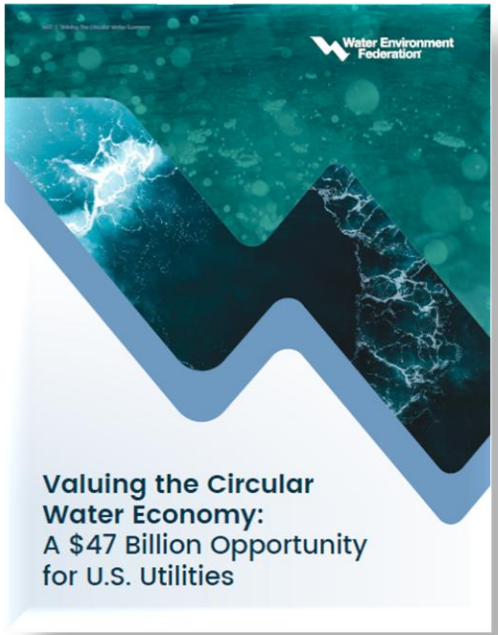
Water is treated as an asset rather than a consumable input, recovering resources and value

The Value of Circular Water

A national transition toward a circular water practices could unlock up to **$47 billion** annually in direct economic value for U.S. water utilities and municipalities

For manufacturers, circular water practices can also reduce operating costs, improve water security, and create opportunities for resource recovery and industrial partnerships.

Scan the QR-code to view the report



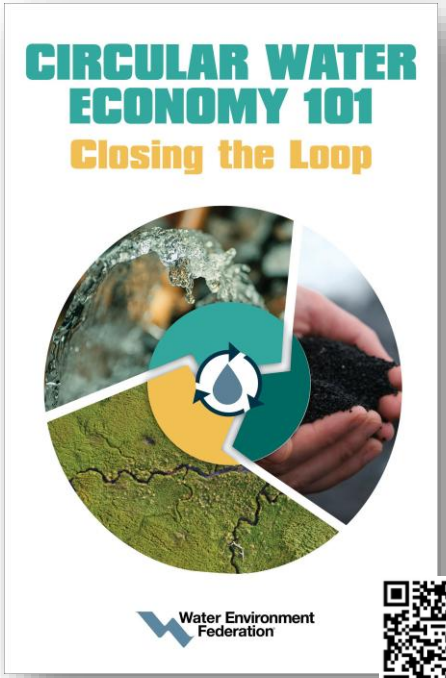
Financing the Circular Water Economy

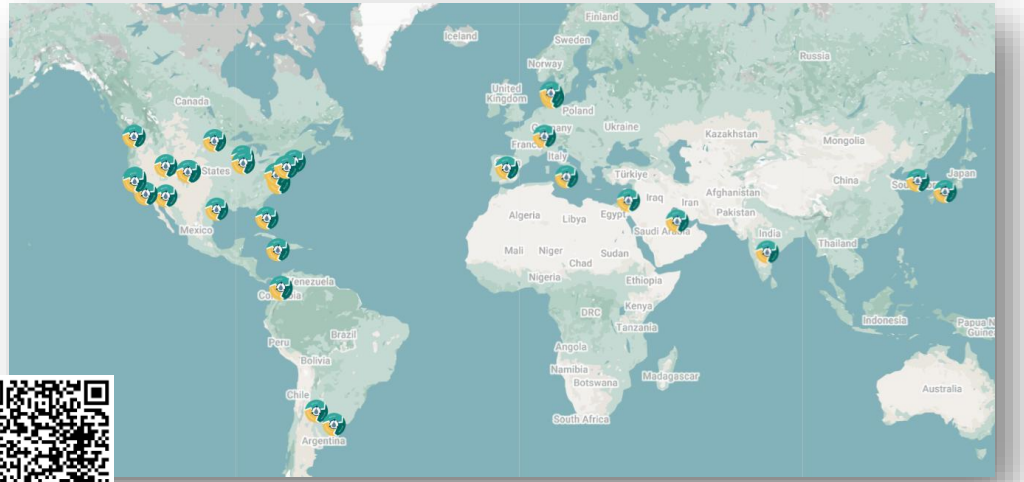
U.S. water infrastructure is evolving into a climate-aligned, investable asset class, requiring diversified financing solutions to meet growing long-term capital demands

Scan the QR-code to view the report

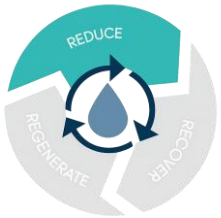


Circular Water in Action





Loudoun Water



Challenge

Explosive data center growth created large-volume cooling demand, straining public water supplies and competing with residential needs during peak summer months

Solution

Loudoun Water built a reclaimed water program centered on the Broad Run Water Reclamation Facility and a dedicated “purple pipe” network, delivering treated wastewater for non-potable data center cooling



Financing

Funded through utility capital and customer connection fees; reclaimed water is priced below potable water, creating a built-in incentive for data centers to participate

Outcomes

Supply of reclaimed water to dozens of data centers, easing demand on potable supplies, cutting nutrient loads to local waterways and providing a lower-cost cooling alternative

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Reclaimed water can meet fast growing industrial demand without straining drinking water supplies

Barriers to Scaling Circular Water in Industry

- **Economics**: Low water prices and high upfront investments can make reuse projects difficult to justify.
- **Regulation**: Permitting complexity and inconsistent requirements can slow implementation.
- **Infrastructure**: Limited connectivity between industrial facilities and water utilities can constrain opportunities.
- **Collaboration**: Greater coordination is needed between manufacturers, utilities, technology providers, and regulators.

The full value of circular water must be recognized to create investable projects

Circular Water Economy Toolkit

Phase 1: Foundation

PHASE 1: FOUNDATION
Sep – Dec 2026

PHASE 2: CORE TOOLKIT
Oct 2026 – Jul 2027

PHASE 3: SOCIALIZATION
Jul – Aug 2027

Toolkit Design

Architecture, audience, and alignment

- Define purpose, intended users, and scope
- Structure guidance around Reduce, Recover, Regenerate
- Align with WEF guidance and leading frameworks

Landscape Assessment

Grounding the Toolkit in evidence

- Review definitions, practices, metrics, and regulations
- Synthesize barriers and gaps in current guidance
- Validate findings through expert interviews

Grounding the Toolkit in current evidence and practitioner needs

Phase 2: Core Toolkit



PHASE 1: FOUNDATION
Sep – Dec 2026

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Reduce

Efficiency, demand management, system optimization

- Water audits and baselines
- Efficiency and loss reduction
- Water-efficient technologies

Recover

Reuse, resource recovery, circular value

- Water reuse and reclamation
- Energy, nutrient, and solids recovery
- Industrial reuse and cascading

Regenerate

Nature-based solutions, water resilience

- Grey-green infrastructure
- Watershed stewardship
- Groundwater recharge

Practical guidance, metrics, and case studies for each pillar

Phase 3: Socialization

PHASE 1: FOUNDATION
Sep – Dec 2026

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Launch Package

- Executive summary and launch webinar

WEF Platform

- Hosted on WEF's portal with Circular Water Economy 101 course, case study map, possible Circular Water Economy platform

WEFTEC

- Targeted launch at WEF's flagship annual conference

Feedback Loop

- Embedded user survey to track adoption and guide future updates

Getting the Toolkit into the hands of utilities and industry

Knowledge Exchange

Don't just read and learn about it – see it in action
2025: Denmark, Japan
2026: Costa Rica, UMC, South Korea
2027: Brazil, Denmark, Australia/New Zealand, WEFTEC, Industrial Water Solutions Conference



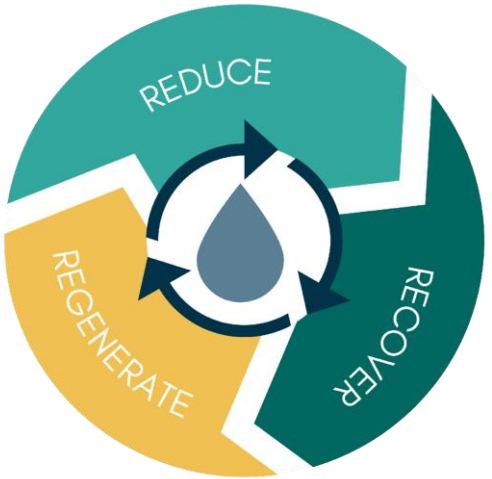


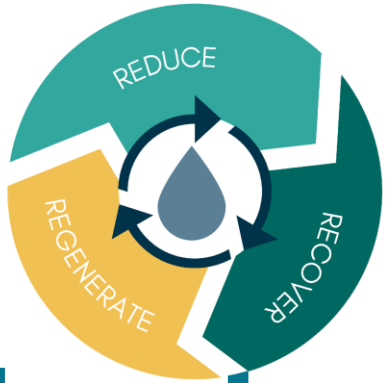




Call to Action

1. **Help shape the Circular Water Economy Framework**
2. **Share manufacturing success stories (case study map, WEFTEC, Industrial Water Solutions)**
3. **Identify opportunities for collaboration**





Thank You!

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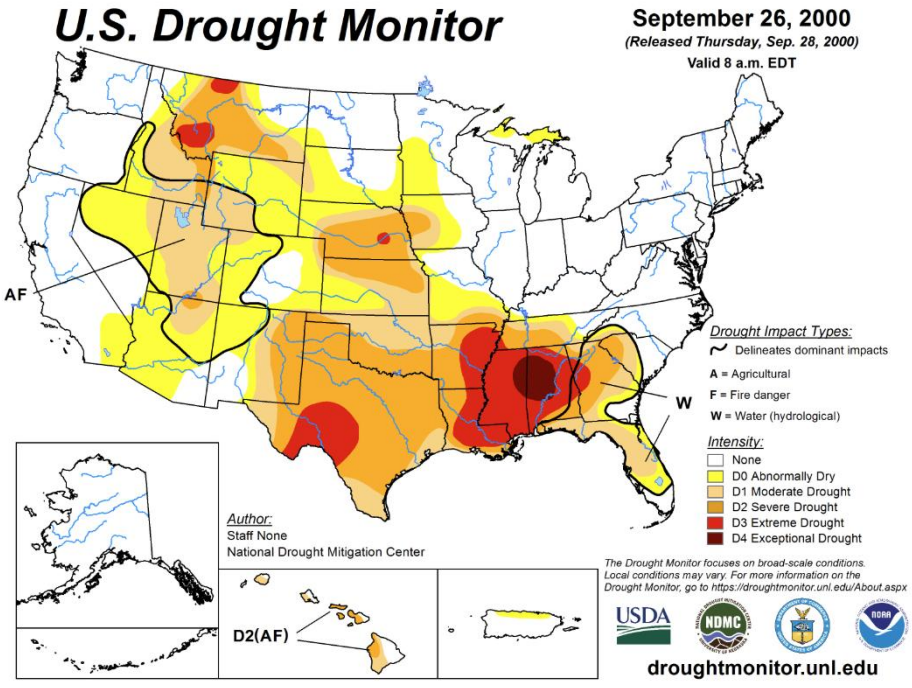


Water Resilience as a Manufacturing Strategy

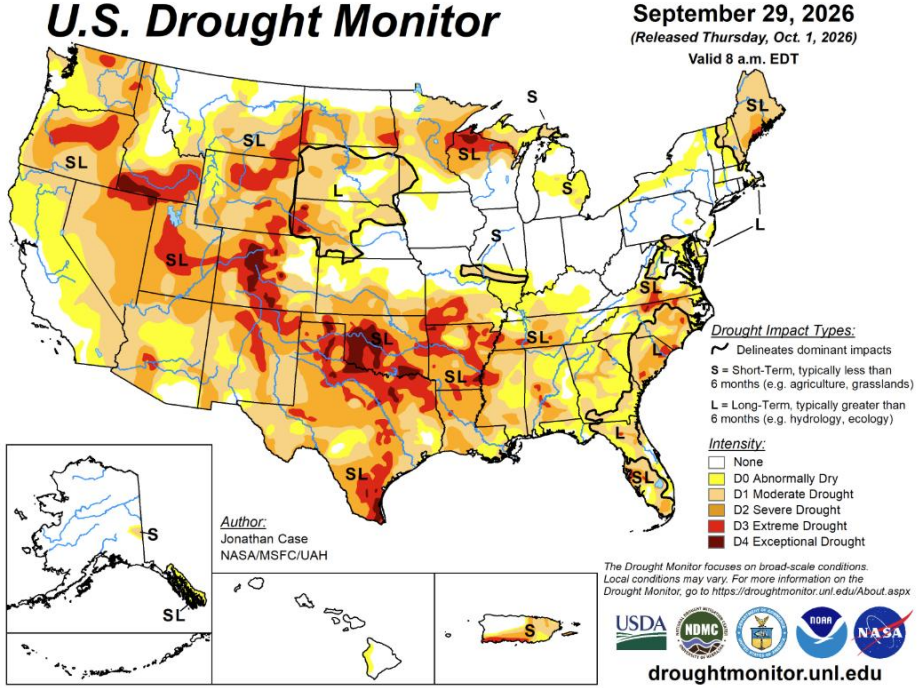
Drought evolution

26 YEAR PERIOD

FROM THIS



TO THIS



Industrial Water Costs

Average US water rate*:

- *$3.86 per kgal (2021)*

Average US wastewater rate:

- *$6.95 per kgal (2021)*
- *Additional surcharges for discharge to POTW for BOD, TSS, NH_3, other)*

Average total US water costs*:

- *$10.81 per kgal (2021)*

Estimated cost for Reuse:

- *$1.00 - $10.00+ per kgal*

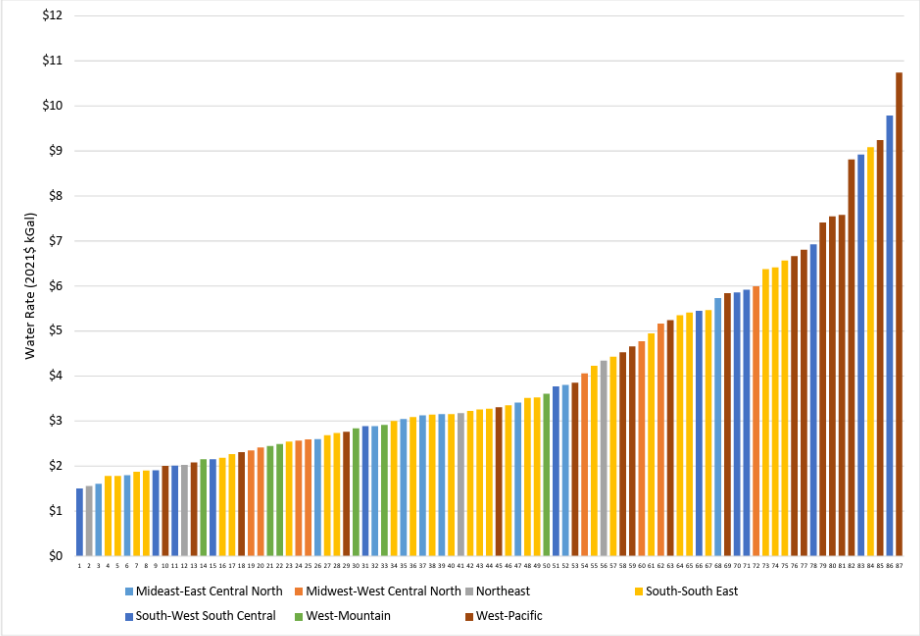


Figure 2. Industrial Water Rates for Water Utilities Included in this Study (in 2021$).

Source: Water and Wastewater Annual Price Escalation Rates for Selected Cities Across the United States: 2023 Edition (https://www.osti.gov/biblio/1975260)

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Water Reduction Steps

Step 1: Baseline

- **Gather** Data
- **Understand** your current water footprint/use
  - Define your feed source(s) (city water, well water, surface water, etc.)
  - Review historical and current water and wastewater discharge costs
  - Understand fluctuations in flow and volume caused by production demand
- What is water used for in your plant?

Step 2: Commit & Plan

- **Set goals** & determine where/how reuse will be implemented
  - Will your plant production potentially expand and increase water use?
  - Where is the best quality water available for reuse?
- Consider quality, logistics, current water costs vs. cost and service needs of equipment

Step 3: Implement

- **Focus** initial efforts on cleanest waters with highest flows

Step 4: Evaluate

- **Review** performance vs. objectives, adjust as needed

Step 6: Communicate & Disclose

- **Report**/share performance with all stakeholders



The Alliance for Water Stewardship (AWS) provides a guidance document on best practices for water management

https://a4ws.org/aws-standard/aws-standard-documents/

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MLD versus ZLD

"Choose your adventure"

MLD – Minimum Liquid Discharge

- **Supports Sustainability Programs**
  - MLD is a more strategy than objective
  - May be absolute (if target is identified, or intensity based)
  - Reduce/Reuse/Recycle solutions typically utilized
- **Impacts Wastewater Process/Discharge**
  - Reduces Wastewater Flow
  - Increases Wastewater Concentration
- **Low Impact on Energy Use**
  - May or may not require membrane technologies (ex. RO)
- **ROI Typically manageable**
  - Site/water cost dependent
  - May require OPEX and/or CAPEX

ZLD – Zero Liquid Discharge

- **Supports Sustainability Programs**
  - ZLD is more objective than strategy
  - Is absolute, not intensity based
  - Reduce/Reuse/Recycle/Evaporate solutions typically utilized
- **Eliminates Wastewater Discharge**
- **High Impact on Energy Use**
  - Typically requires membrane technologies (RO)
  - Typically requires evaporation and/or crystallization solutions
- **ROI Typically Lengthy**
  - Can be CAPEX & OPEX intensive
  - Increased energy use may offset water reduction

Reviewing a thorough cost/benefit analysis will ensure that the best path is selected for a facility!

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Point-Source & End-of-Pipe Reuse

Which is best?

End-of-Pipe Reuse

Pros:

- Allows for single reuse system
- Consolidates maintenance needs
- Easier remote monitoring

Cons:

- Higher Capex (typically)
- More complex wastewater
- Variability may require set-level treatment
- Larger space requirements
- Future expansion may be costly
- Piping & pumping costs

Point-Source Reuse

Pros:

- Lower Capex (typically)
- Less-complex treatment solution
- Allows for easier expansion
- Fit-for-purpose treatment simplified
- Shorter piping requirements
- Smaller footprint

Cons:

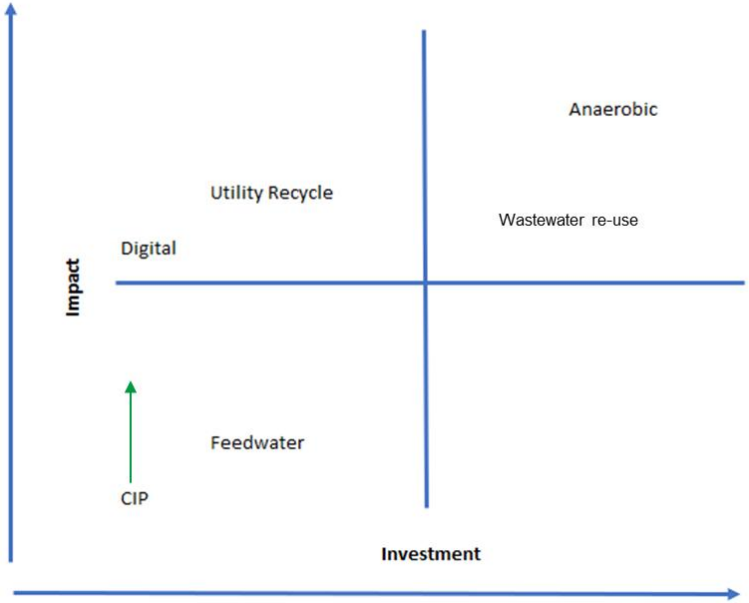
- Remote monitoring more complex
- Multiple-system maintenance needs
- Concentrate/waste management

Point-Source supports starting small/continuous improvement driving towards higher recoveries

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Where to Start?

- Not all sites subject to same constraints
- Define local financial and environmental variables associated with water supply, use and discharge
  - Cost and availability of water
  - Energy costs
  - Age, condition and efficiency of existing systems
  - Wastewater treatment costs
  - High-strength waste hauling costs
  - Installation and piping costs
  - Space availability/footprint
  - Future production goals
  - What have you already done / current status
- Prioritize projects in context of local variables, corporate objectives, financial constraints (OPEX vs. CAPEX)



The **Alliance for Water Efficiency** studied five sites in 2012 and determined that a combined 66 million gallons of water per year could be saved via simple methods*

Average annual ROI was 84%, average payback was 1.2 years

An equal reduction in wastewater flow was typical

*__Source:__ Alliance for Water Efficiency, “Assessing the Economic & Environmental Benefits of Industrial Water Use Efficiency”, final report, November 2012

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Cooling Water Sustainability

Common Water Reduction Opportunities

Reuse of CT blowdown – Opportunistic Value

- Treatment solution determined by goals + economics
- Reuse treatment may match or improve MU water quality
- Piping is usually simple and manageable
- Start simple (ex. filtration + ion exchange)
- Waste disposal - brine management/higher concentration challenge



Recycle water from other areas – Opportunistic Value

- Recycle rinse waters
- Tertiary treated wastewaters
- Rainwater collection
- Avoid complex wastewaters
  - Residual or challenging COD, TN, toxicity, etc.
  - High variabilities
  - Polymer residuals may foul membranes used for recycle
- Consider cost of infrastructure (piping, pumping, etc.)

Maximize cycles of concentration – Opportunistic Value

- Improve makeup water quality using media or membranes
- Align new water quality with chemical program
- Diminishing returns as cycles increase above 8-9

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Boiler Water Sustainability

Common Water & Energy Reduction Opportunities

Reduce unnecessary losses - Restorative Value

- Review RO/DI/IX operation integrity
- Identify short runs, leaking valves, etc.
- Ensure conductivity controller calibration - Are you really operating at the targeted cycles?
- Deaerator performance - Align temp/pressure with O2 solubility
- Steam trap inspections

Increase Cycles of Concentration – Opportunistic Value

- Improve Feedwater quality
  - Investigate upgrade to pretreatment system
  - Reduce condensate losses (steam traps, leaks, etc.)
  - Upgrades determined by value of water and heat
  - Can experience diminishing returns when targeting >50 cycles – ROI will be higher

Recycle water from other areas – Opportunistic Value

- Explore similar water sources as for CT reuse
- High-organic waters should be avoided
  - Will cause foaming in boiler and potential carryover

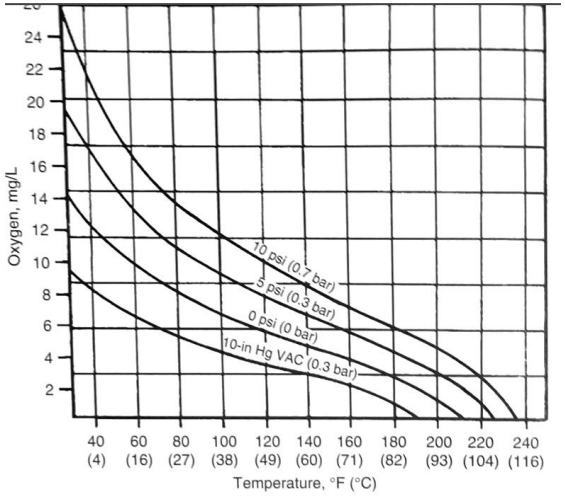


FIGURE 10.8 Solubility of oxygen in pure water versus temperature.

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Reuse Challenges/Watch-Outs

- The **location of reclaimed stream** and physical distance from the targeted reuse
- Availability of **adequate footprint** for equipment
- **Installation cost** of treatment equipment, storage tanks and subsequent piping to get treated water to target reuse
- Highly **variable influent water** quality
- **Labor** needs for additional treatment equipment
- Impact to **existing wastewater treatment** (flow/loading changes)
- **Segregation of wastewater streams** (from individual processes) and storm water run off
- Facility **sewer infrastructure** requires minimum flow to flush
- **Waste disposal** fate
  - Brine disposal/treatment
  - Solids disposal



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Thank you!

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Water Resilience Planning

NAM WRAP Workshop – October 28, 2026

Background – Why action was urgent

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2025	May 2026	Now
Stage 3 restrictions	7.7% combined lake level	38% reservoir capacity

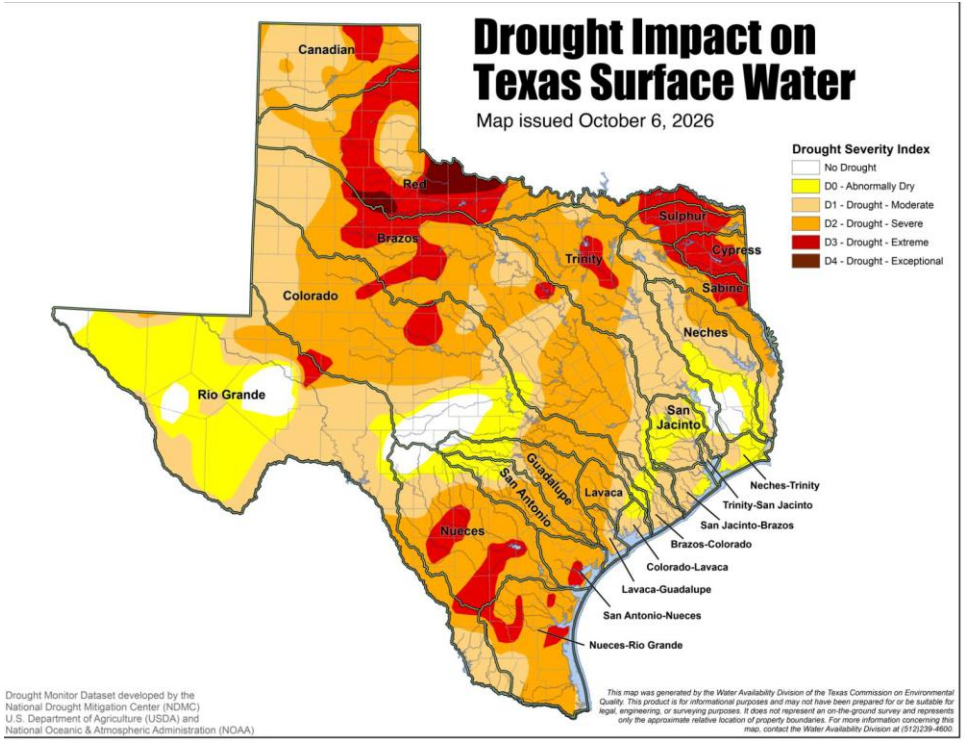
PRESSURE POINTS

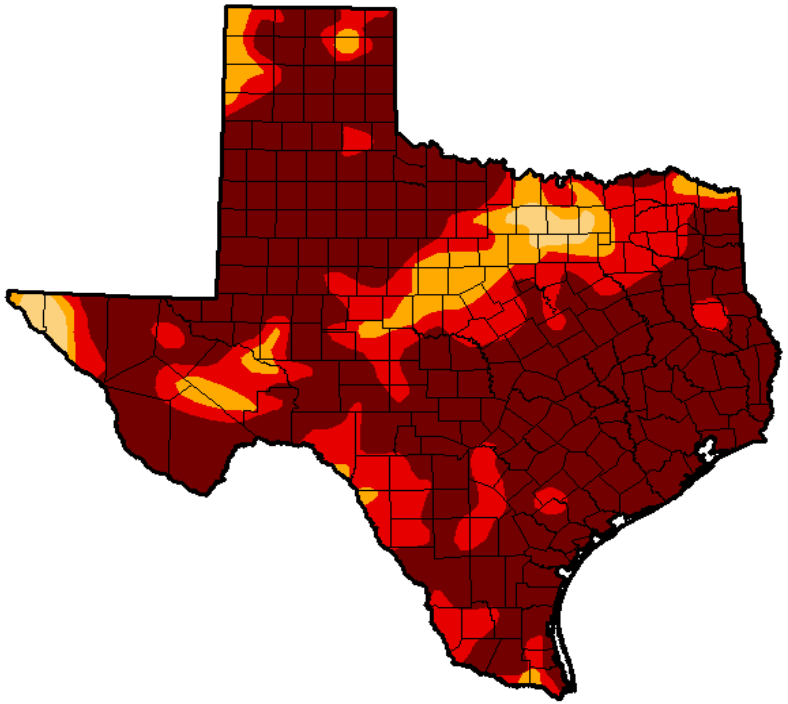
- **Persistent drought** — Multi-year drought conditions and surcharges
- **Emergency outlook** — Projected emergency conditions as early as May 2026
- **Supply response** — City added groundwater capacity, creating water-quality concerns
- **Partial recovery** — June rains improved storage, but restrictions remained



Treat recent rainfall as recovery time, not as though the risk has passed.

Background – Drought maps: Current (2026) vs Past (2011)





Current Strategy - Efficiency, Recycling & Treatment

Look at prioritizing actions based on impact, capital investment, operational considerations



Strategy Considerations: reduce demand → recycle internally → treatment options/optimization

1 Internal recycling

Evaluate all potential sources of recycling*: Condensate returns, onsite WWTP effluent, storm water retention/reuse, steam trap management

2 Cooling optimization

Engage the water-treatment vendor; heat-exchanger survey and optimization increasing cooling tower cycles.

3 Treatment options

Where water quality limits reuse or cooling performance, consider:

- Pre-treatment/filtration
- Reverse osmosis
- Ion exchange

*** Important to note that certain recycling/reuse activities have regulatory requirements that must be addressed prior to implementation.**

Building diversified water supplies

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Screen each water source against location, volume, quality, infrastructure cost and permitting needs.

Surface water

Regulatory authorizations
Untreated vs Treated/Potable
Availability

Groundwater wells

Expanded groundwater use in regions
Regulatory considerations / ground water conservation districts
Higher constituents create treatment challenges
Additional treatment and residual-disposal considerations

Reclaimed water

Corpus Christi began issuing contracts
Regulatory authorizations required
Capital investment for infrastructure
Availability



DECISION LENS

Availability	Is dependable volume accessible at the site?
Quality	Can operational and regulatory concerns be managed?
Economics	Does the volume justify infrastructure and treatment?
Authorization	Are source, treatment and disposal pathways permitted?

Align permitting, risk & sustainability

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01 **Define the technical pathway**

Characterize treatment residues and disposal options.

02 **Engage early**

Site aligned with legal, Government Relations, SME's and then coordinated with state and federal regulators.

03 **Align the enterprise**

Connect permitting decisions with corporate sustainability and capital planning.

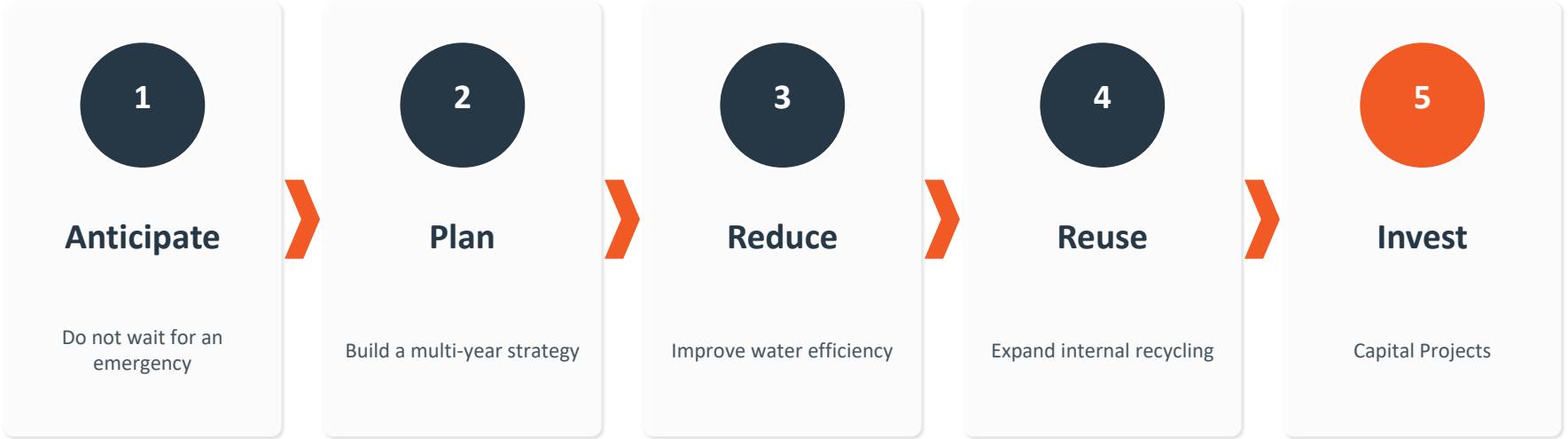
Shift the sustainability conversation from one-size-fits-all consumption/intensity targets to site-specific water-risk mitigation.

Water-stress areas | Risk mitigation | Water reduction

Operating principle: transparency + collaboration + clear permitting pathways

Act before water scarcity becomes an operating crisis

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The resilient portfolio is not one project. It is a sequenced program of efficiency, recycling, treatment, supply diversification and regulatory requirements.

Q&A Session

Additional Resources

- DOE Industrial Water Reuse Series: Educational webinars exploring industrial water reuse opportunities and practices.
- Advancing Water Reuse Act (H.R. 2940 | S. 4506): Proposed 30% investment tax credit for qualifying water reuse projects.
- EPA Industrial Water Reuse Resources: Technical guidance, sector resources, and project examples.
- EPA REUSExplorer: Explore state reuse regulations and guidelines by water source and end use.
- WRAP Online Platform: Explore related actions, partners, and opportunities to engage.

Upcoming Events Under Action 8.14

- Panel Discussion: Making Industrial Water Reuse Projects Pencil Out (December 2026)
- Water Reuse Challenge Based Roundtables (2027)