

GPG Outbrief 29

# Blowdown Recovery System

Emerging Building Technologies, GPG Program | U.S. General Services Administration | October 23, 2023

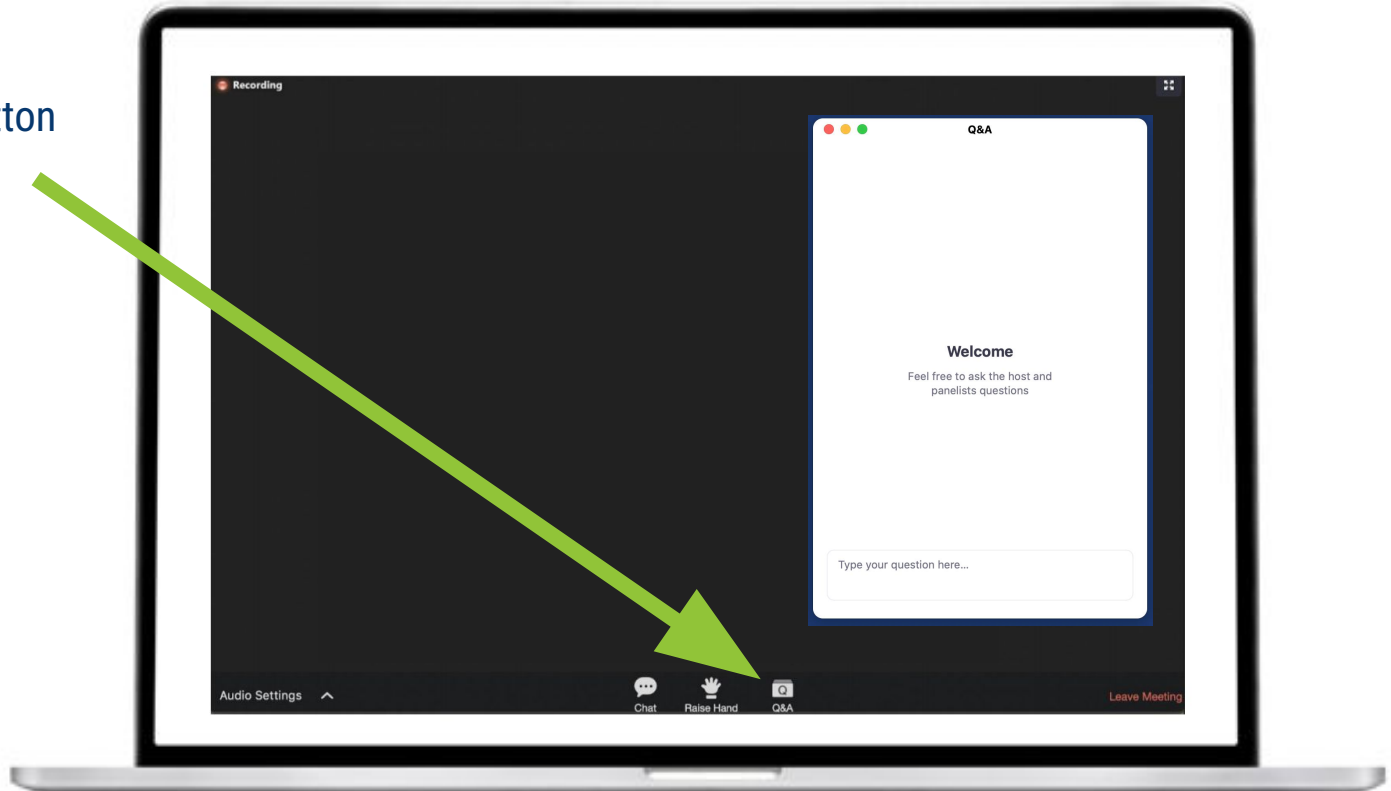
The logo for the U.S. General Services Administration (GSA), consisting of the letters "GSA" in white on a dark blue square background.

GSA

# How to Ask Questions

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Click the Q&A button to ask questions.



# GPG-052 AWT: Blowdown Recovery System @ gsa.gov/gpg

- ❑ Infographic
- ❑ 4-Page Brief
- ❑ Full Report

The screenshot shows the GSA website page for the 'AWT: Blowdown Recovery System for Cooling Tower Water Treatment'. The page is structured with a navigation bar at the top, a breadcrumb trail, a main content area with a title and introductory text, and a sidebar with a table of contents. The main content area includes a 'REPORT' section with links to a 4-page brief and a full report, a 'WEBINAR' section with a registration link, and an 'ADDITIONAL RESOURCES' section with several links to related documents. The sidebar contains a 'Center for Emerging Building Technologies' section with a table of contents listing various assessment categories and specific AWT systems. The main content area also features an infographic titled 'GPG FINDINGS 052 BLOWDOWN RECOVERY SYSTEM FOR COOLING TOWERS' which highlights a 6% annual increase in GSA water rates and describes the system's ability to recover blowdown and purify it for reuse.

**GSA** U.S. General Services Administration

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Home > Climate Action and Sustainability > Center for Emerging Building Technologies > Completed Assessments > Water > AWT: Blowdown Recovery System

## Center for Emerging Building Technologies

Overview

About Green Proving Ground

### Completed Assessments

- Building Envelope
- Energy Management
- HVAC
- Lighting
- On-Site Power & Renewables
- Water
  - AWT: Advanced Oxidation Process
  - AWT: Blowdown Recovery System**
  - AWT: Catalyst-Based Scale Prevention
  - AWT: Electrochemical
  - AWT: GSA Guidance for Cooling Towers
  - AWT: Monitoring & Partial Softening
  - AWT: Salt-Based & Chemical Inhibition
  - Weather Station for Irrigation
  - Wireless Soil-Moisture Sensors
- Ongoing Assessments

## AWT: Blowdown Recovery System for Cooling Tower Water Treatment

Chilled water plants use cooling towers to transfer waste heat to the atmosphere through evaporation. As water evaporates, the mineral content suspended in the remaining water becomes increasingly concentrated and is periodically flushed to minimize mineral build-up and scale, a process known as “blowdown.”

Researchers from the National Renewable Energy Laboratory found that the blowdown recovery system at the testbed reduced blowdown by 53% and overall water use by 16%. [View full-size infographic \(PDF - 299 KB\)](#).

### REPORT

- [4-Page Brief \(PDF - 468 KB\)](#)
- [Full Report \(PDF - 1 MB\)](#)

### WEBINAR

- [Register for upcoming webinar](#) (October 23, 2023)

### ADDITIONAL RESOURCES

- [Best Management Practice Cooling Tower Management \(FEMP\)](#)
- [Side Stream Filtration for Cooling Towers \(FEMP/PNNL, 10-2012\)](#)
- [Side Stream Filtration Fact Sheet \(FEMP/PNNL, 10-2012\)](#)
- [Understanding Cooling Towers and How to Improve Water Efficiency \(FEMP, 02-2011\)](#)

### OPPORTUNITY

*Why is GSA interested in alternative water treatments?*

**6% ANNUAL INCREASE IN GSA WATER RATES**

In the past 10 years, water rates have increased more than 40%. Water is the fastest growing utility rate for GSA.

### TECHNOLOGY

*How does the blowdown recovery system work?*

**RECOVERS BLOWDOWN AND PURIFIES IT FOR REUSE**

Incorporates sidestream filtration, demineralization,

MAKEUP WATER BLOWDOWN COOLING TOWER EVAPORATION

# Webinar Recording and Slides Available on gsa.gov/gpg

The screenshot shows the GSA website's navigation and content for GPG Webinars. The header includes the GSA logo, the text 'U.S. General Services Administration', a 'Per Diem Lookup' icon, and a search bar. A secondary navigation bar lists various categories like 'Buy Through Us', 'Sell To Government', etc. The main content area is titled 'GPG Webinars' and includes a sidebar with navigation links, a description of the program, a list of upcoming webinars with 'Register' buttons, and a table of on-demand technology webinars.

**Center for Emerging Building Technologies**

- Overview
- About Green Proving Ground
- Completed Assessments
- Ongoing Assessments
- Request for Information
- About Pilot to Portfolio
- GPG Webinars**
- About Applied Innovation Learning Lab
- GSA Technology Deployment Maps

## GPG Webinars

GPG webinars present results from real-world evaluations and feedback from facility managers at test-bed locations. Following each presentation, researchers and other GSA subject-matter experts answer questions.

GSA attendees are eligible for one Continuous Learning Point (CLP). Members of the American Institute of Architects (AIA) are also eligible for one health, safety, and welfare (HSW) credit.

### Upcoming webinars

**Blowdown Recovery System for Cooling Towers**  
Monday, October 23, 2023, at 2:00 p.m. ET

[Register](#)

**GPG FY24 RFI Informational Webinar**  
Thursday, November 9, 2023, at 1:00 p.m. ET

[Register](#)

### On-demand technology webinars

Category	Topic	Date	Video
Building Envelope	<a href="#">Electrochromic Windows for Office Space</a>	2018-04	

The webinar is being recorded.

The recording and slides will be shared by email and posted to gsa.gov.

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Emerging Building Technologies YouTube Channel



# Webinar Agenda

- ❑ **Introduction (5 minutes)**  
Erin Lannon, Program Manager, Applied Innovation Learning Lab
- ❑ **Evaluation of a Blowdown Recovery System (20 minutes)**  
David Sickinger, Researcher, National Renewable Energy Laboratory
- ❑ **On-the-Ground Feedback (10 minutes)**  
Jacob Lewis, Sr. Property Manager, Nevada Field Office, GSA
- ❑ **Q&A (20 minutes)**

## Opportunity

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**6%**

### **ANNUAL INCREASE IN GSA WATER RATES**

In the past 10 years, water rates have increased more than 40%. Water is the fastest growing utility rate for GSA.

## Cooling tower water use

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**28%** **OF WATER IN COMMERCIAL BUILDINGS**  
IS USED BY COOLING TOWERS OR OTHER HEATING  
AND COOLING SYSTEMS<sup>1</sup>

# Measurement & Verification

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**David Sickinger**

Researcher

National Renewable Energy Laboratory



GPG-052

# Blowdown Recovery System

General Services Administration  
Public Buildings Service



GPG-052 | AUGUST 2023

## BLOWDOWN RECOVERY SYSTEM FOR COOLING TOWERS



### Supplemental Treatment System Reduces Cooling Tower Water Use by 16%

Chilled water plants use cooling towers to transfer waste heat to the atmosphere through evaporation. As water evaporates, the mineral content suspended in the remaining water becomes increasingly concentrated and is periodically flushed to minimize mineral build-up and scale, a process known as "blowdown." As a result, cooling towers are responsible for some of the largest potable water loads in commercial office buildings (28%).<sup>1</sup> With an average annual rate increase of 6% and droughts across the country, particularly in the West, GSA is exploring alternative water treatment (AWT) technologies that can reduce cooling tower water use.

The blowdown recovery system reduces cooling tower water use by capturing, purifying, and reusing a percentage of blowdown. Green Proving Ground (GPG) worked with researchers from the National Renewable Energy Laboratory (NREL) to assess the effectiveness of the blowdown recovery system at the Lloyd D. George Courthouse in Las Vegas, Nevada. Unlike many AWTs, the system works alongside traditional chemical water treatment instead of replacing it. Researchers found that the blowdown recovery system at the testbed reduced blowdown by 53% and overall water use by 16%. Payback was less than 3 years at the 2017 GSA average combined water/sewer rate of \$16.76/kgal.

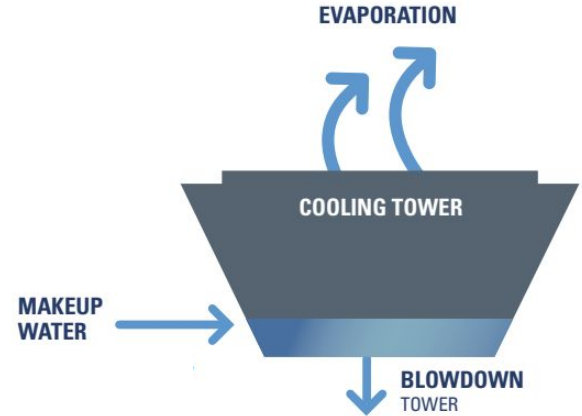
The GPG program enables GSA to make sound investment decisions in next-generation building technologies based on their real-world performance.

# How Do Cooling Towers Work?

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Transfer waste heat to the atmosphere through evaporation

As water evaporates, mineral content becomes increasingly concentrated and water needs to be flushed periodically.

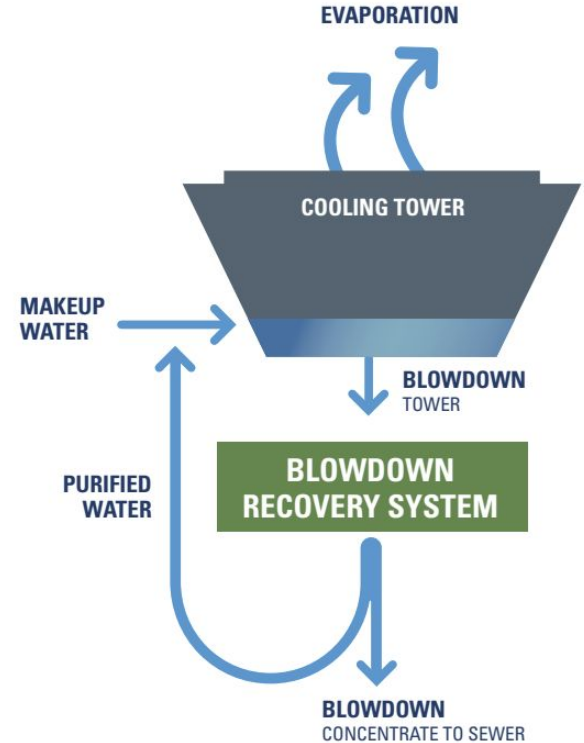


# Blowdown Recovery System from Aqualogix

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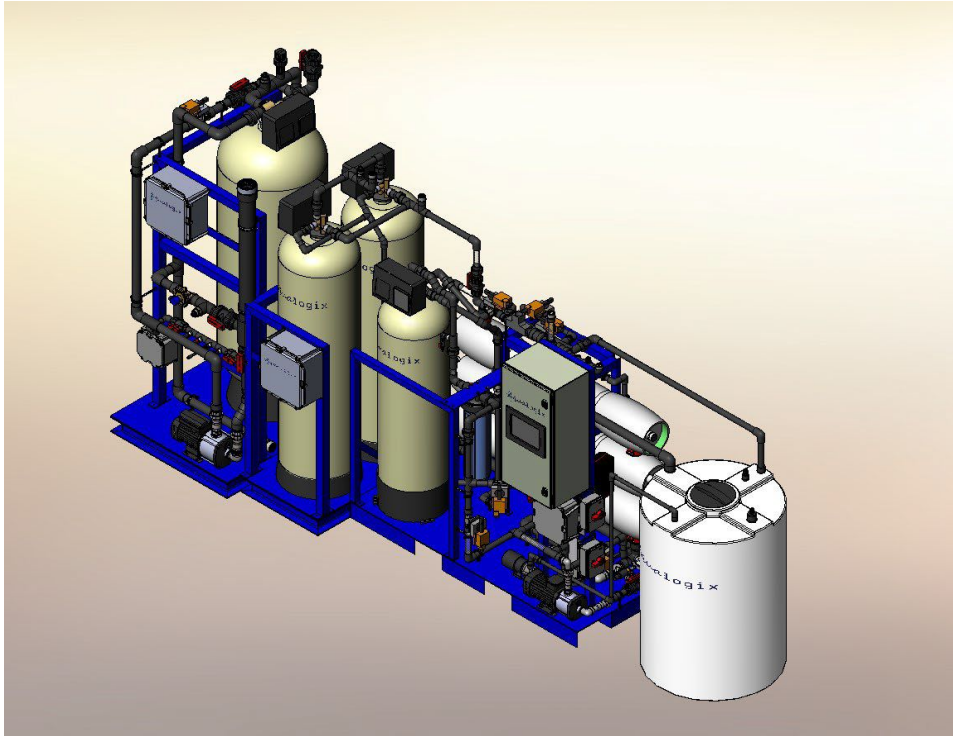
Recovers blowdown and purifies it for reuse

Works alongside traditional chemical treatment and conductivity setpoint remains unchanged.



# Blowdown Recovery System from Aqualogix

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## System Features

- Sidestream filtration
- Demineralization
- Carbon filtration
- Reverse osmosis
- Control system

# Blowdown Recovery System Testbed



## Lloyd D. George Courthouse, Las Vegas, NV

- 450,000 ft<sup>2</sup>
- 1,150-ton chiller plant
- GPG-045, Monitoring & Partial Water Softening
- 80% of water comes from Colorado River which is experiencing the worst drought in recorded history

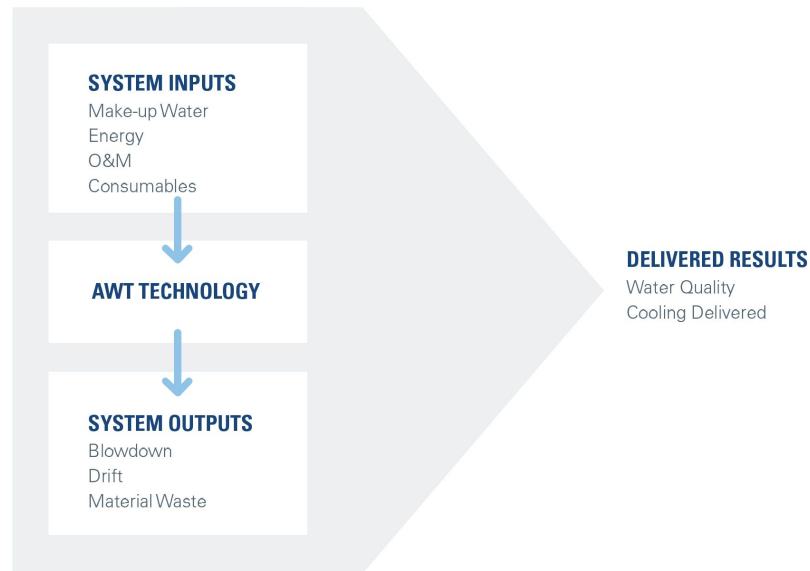
# Evaluation Framework and Schedule

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- Blowdown and makeup water metered
- Water consumption recorded daily and weather normalized
- Assessed water chemistry, corrosion rates, ease of operations and cost-effectiveness
- Two data collection periods:

**June – August 2021**, issues with chemical maintenance and power outage

**August – October 2022**



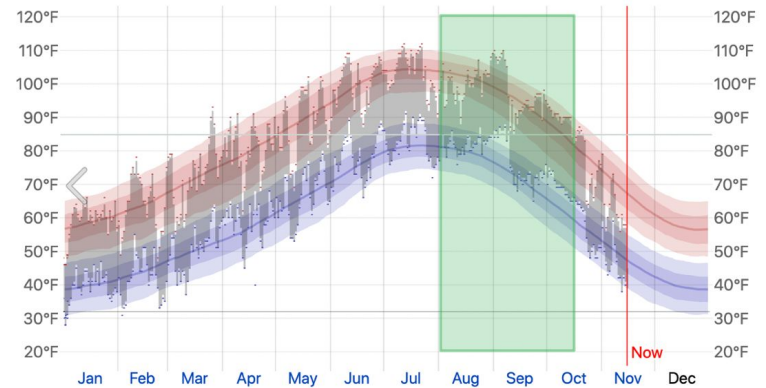
# M&V Test Bed Performance Results

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QUANTITATIVE OBJECTIVE	RESULTS
<b>Water/Sewer Savings</b>	16% makeup water savings 53% blowdown savings
<b>Water Quality</b>	No substantial changes in water quality
<b>Cost-Effectiveness</b>	Testbed: 4.8-year payback 3.1 SIR Target Load: 2.8-year payback 5.3 SIR

# 16% Water Savings and 53% Blowdown Savings

	RESULTS		
	Baseline	2021 Evaluation	2022 Evaluation
Testing Period (days)	30	15	57
Water Consumption per Heat Rejected	177.9	149.0	144.1
CoC Water Balance (volume method)	2.8	4.34	4.91
Water Savings (%)		<b>16.2</b>	<b>16.0</b>
Blowdown Savings (%)		<b>53.5</b>	<b>53.0</b>



Evaluation daily temperature range in 2022 for Las Vegas, NV



# Straightforward Installation

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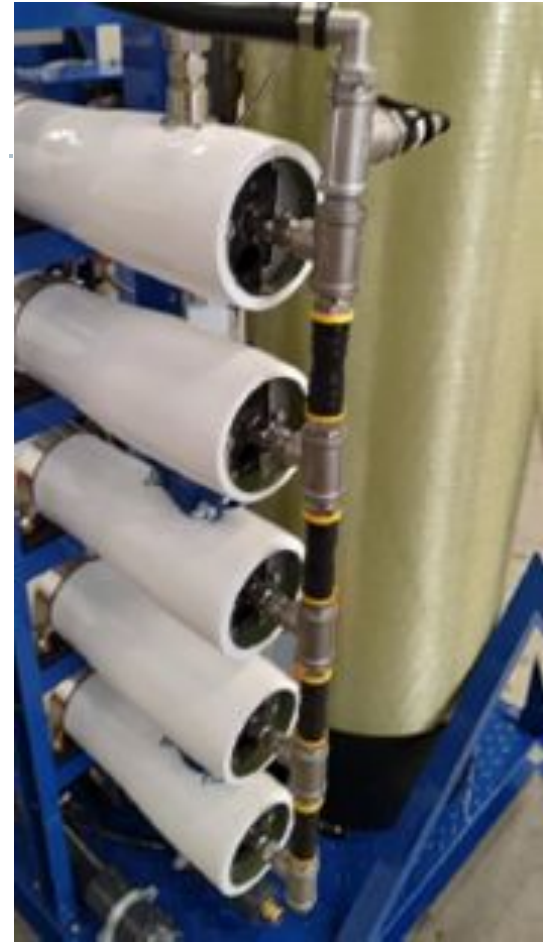
- Installing the skid, wiring, and plumbing took 2 days.
- Requires a nearby drain for discharge and 120/240/480V electricity.
- The system is shipped in a crate that fits through a 3-ft wide door.
- Skid weight was 920 lbs dry (2,400 lbs wet)
- The most variable expense is the piping to and from the skid.



## Ongoing Costs

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- Annual baseline calibration of the conductivity probes: \$350
- RO membrane replacement: \$625 Every 5 years (5 membranes @ \$125)
- Electricity: Technology draws 0.404 kW per hour, electricity use increased 3,541 kWh or \$354 @ \$0.10/kWh at the testbed



# < 3 Year Payback at Target Load and \$16.76/kGal

	Blowdown Recovery System
Equipment (200–1000 ton load)*	\$34,403
Installation**	\$11,422
Annual Maintenance***	\$475
Annual Energy Increase (3,541 kWh/yr @ \$0.11/kWh)	\$390
Water Savings (1,040,400 kgal @ \$16.76 kgal/yr)	\$17,437
<b>GSA Average Payback (yrs)****</b>	<b>2.86</b>
<b>GSA Average Savings-to-Investment Ratio</b>	<b>5.3</b>

\* Includes startup; assumes \$688 shipping and \$1,473 for training

\*\* Assumes no tie-in with Building Automation System

\*\*\* Includes \$350 annual support, membranes replaced every 5 years (\$125 per membrane)

\*\*\*\* Payback assumes target load of 3 million ton hours. Testbed payback was 4.8 years with 1.6 million ton hour load @ 18.97 kgal

# Can be Combined with Partial Water Softening

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- When combined with partial water softening from the same vendor, blowdown was reduced by 60%.
- Vendor estimates up to 93% reduction when the systems are combined.
- Savings for the combined system will be highest for sites with hard water (> 121 MG/L) and moderate conductivity (e.g., less than 500 microsiemens per centimeter  $\mu\text{S}/\text{cm}$ ).
- At the testbed in Las Vegas, water total hardness was 278 ppm, and conductivity was 992  $\mu\text{S}/\text{cm}$ .



# Cycles of Concentration for the Blowdown Recovery System

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## Operational vs. Effective CoC

CoC remains unchanged, but the effective CoC is higher. Because a percentage of blowdown is returned as purified water, the concentrated water that goes to the sewer has a higher CoC. At the testbed site, the CoC increased from 2.8 to 4.9.

Combined Savings for Partial Water Softening & Blowdown Recovery

Operating Cycles	Evaporation (gallons/year)	Blowdown (gallons/year)	Concentration (gallons/year)	Effective CoC	Sewer Reduction
3.3	6,307,200	2,742,261	1,261,440	6.0	64%
5.3	6,307,200	1,466,791	674,724	10.3	81%
7.3	6,307,200	1,001,143	460,526	14.7	87%
9.3	6,307,200	759,904	349,556	19.0	90%
11.3	6,307,200	612,350	281,681	23.4	92%

# Deployment Recommendation

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## Consider Proven AWT for all Cooling Towers

- Can be retrofitted to any cooling tower.
- Facilities are encouraged to get estimates of proven AWT technologies and choose the most cost-effective system for their location.
- Ongoing maintenance costs should be considered when selecting an AWT system.



# GSA Feedback

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**Jacob Lewis**  
Senior Property Manager  
Nevada Field Office



# Partial Water Softening

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- Piping in place, PWS already tested (systems in different rooms)



Blowdown recovery system  
Lloyd D. George U.S. Courthouse



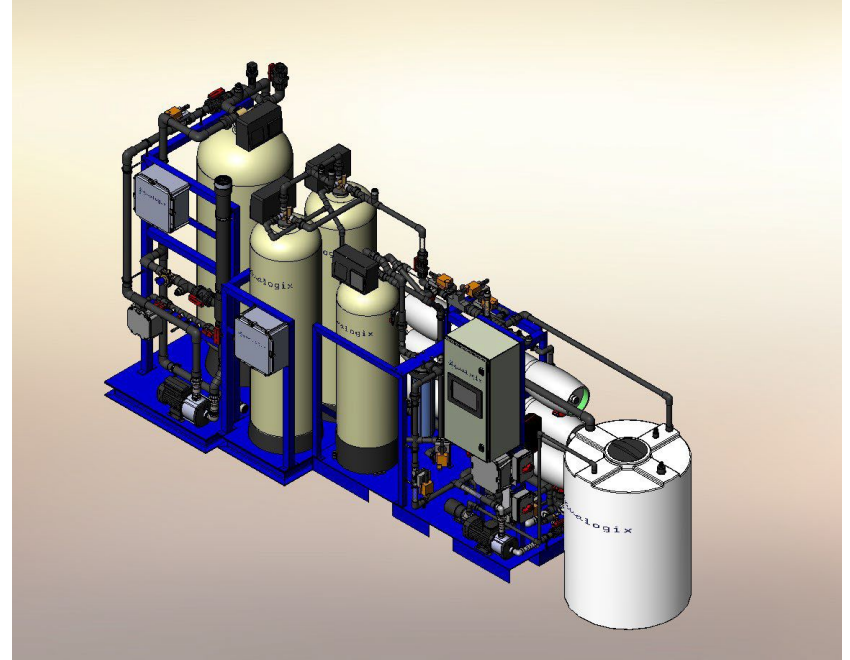
PWS system  
Lloyd D. George U.S. Courthouse



# Combined System

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- Aqualogix now offers a modular BDRS design with simplified piping when BDR and PWS systems are combined.



# Setup and Installation

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- Works with 120V, 240V or 480V. We chose 480V due to the distance of the electrical run and reuse of 480V circuit ran to an “abandoned-in-place” compressor. We have had no issues with pump motors
- Power source was far away but this didn’t create problems
- Skid simplified installation, rolled it right through the door using a basic pallet jack
- System met site safety needs: comes with disconnects and chemicals used aren’t super abrasive



# Impacts Post Installation

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- Several leaks due to prototype nature of the system; feel comfortable that these have been resolved.
  - Overflow because of meter installation; atypical installation but system was modified to make sure this doesn't happen again
  - Rigid PVC connections, replaced with brass fittings (v3.0); Rigid PVC piping replaced with high PSI braided hose (v3.0)
  - Replaced membrane casings (v3.0); now have direct flow ports between each membrane (shown in next slide)



Newest Version (v3.0)

# RO Membrane Cleaning and Treatment

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- During 1st year of the study, had to manually realign valves to modify flow loop and pour cleaning agent into makeup tank.
- Self-cleaning feature added to the system post-installation; software and mechanical upgrade (added automated valves and an independent tank for the cleaning agent)
- Muriatic acid is the cleaning agent. (used in swimming pools)
- Anti-scalant keeps membranes from scaling i.e., prevents the pores from clogging



# O&M

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- Replace chemicals: Need to monitor anti-scalant pump and add chemicals
- Replace membranes: If microsiemens are rising, you may need to replace
- Warranty period: 1-year
- Vendor will provide O&M manual customized for the site and schedule training

# Best Practices and Lessons Learned

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- ❑ Include water treatment provider in system selection and operations.
- ❑ Establish a baseline for your site prior to AWT installation and install metering for makeup water and blowdown during installation to measure water use.
- ❑ Continue water monitoring after the AWT system is installed. Require coupons for monitoring steel and copper corrosion.
- ❑ Add system as a maintained asset in the National Computerized Maintenance Management System (NCMMS).
- ❑ Train local maintenance teams on operating the installed AWT systems. Transfer maintenance requirements when O&M contracts change.
- ❑ Add equipment to daily O&M checklist.
- ❑ For energy savings performance contracts (ESPCs), include O&M&R in the contract.

# Deployment

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- We plan to keep the system operational. It's been going for 1 year.
- Since the blowdown recovery system had all the fittings and PVC replaced there have been no issues with leaks.
- We have been achieving the water savings that were originally promised prior to install.
- Would recommend other facilities consider it, along with partial water softening, area specific.

Q & A



# Survey and Continuing Education Credit

GSA attendees are eligible for 1 Continuous Learning Point (CLP).

To receive credit:

Complete the post-webinar email survey.

## GPG Webinar 29: Blowdown Recovery System for Cooling Towers

Form description

Email \*

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This form is collecting emails. [Change settings](#)

Continuing Education Credit

Check here to request a certificate for 1 CE units. GSA attendees are eligible for one Continuous Learning...

AIA Number

Short answer text

First and Last Name \*

Short answer text

The information presented in the webinar was helpful. \*

Strongly Disagree   1   2   3   4   5   Strongly Agree

Thank you



For more information: [gsa.gov/GPG](https://gsa.gov/GPG)

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