

GPG Outbrief 22

Alternative Water Treatment: Continuous Monitoring & Partial Water Softening

Emerging Building Technologies, GPG Program | U.S. General Services Administration | December 10, 2020



GPG-045 Continuous Monitoring & Partial Softening @ gsa.gov/gpg

- ❑ Infographic
- ❑ 4-page Findings
- ❑ Full Report
- ❑ Additional Resources

The screenshot shows the GSA website page for GPG-045. The page is titled "AWT: Monitoring & Partial Softening" and is part of the "Emerging Building Technologies" section. The page layout includes a navigation bar at the top with the GSA logo and "U.S. General Services Administration" text. Below the navigation bar is a search bar and a "Per Diem Lookup" button. The main content area is divided into a left sidebar and a main content area. The sidebar contains a list of "Published Findings" with "AWT: Monitoring & Partial Softening" highlighted. The main content area features a large green header with the title "AWT: CONTINUOUS MONITORING AND PARTIAL WATER SOFTENING" and the date "OCTOBER 2020". Below the header is a section titled "OPPORTUNITY" with the text "UP TO 50% COOLING WATER IS FLUSHED TO MINIMIZE SCALE BUILD-UP!". This is followed by a "TECHNOLOGY" section with the text "PARTIAL SOFTENING INCREASES BLOWDOWN SETPOINT". A diagram of a cooling tower system is shown, with labels for "WATER SUPPLY (HARD)", "WATER TO TOWER (SOFT)", "Deaer", and "Salt". The diagram illustrates the flow of water through the system, including a deaerator and a salt tank. The page also includes a "4-PAGE REPORT SUMMARY" and a "FULL REPORT—OCT 2020" link, both with PDF icons and file sizes.

GSA U.S. General Services Administration

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AWT: Monitoring & Partial Softening

Emerging Building Technologies

Overview

About GSA's Proving Ground (GPG)

Published Findings

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

Ongoing Assessments

Request for Information

About Pilot to Portfolio (P2P)

4-PAGE REPORT SUMMARY [PDF - 1 MB]

FULL REPORT—OCT 2020 [PDF - 3 MB]

OPPORTUNITY

Why is GSA interested in alternative water treatments (AWT)?

UP TO 50% COOLING WATER IS FLUSHED TO MINIMIZE SCALE BUILD-UP¹

TECHNOLOGY

How does the continuous monitoring and partial water softening system work?

PARTIAL SOFTENING INCREASES BLOWDOWN SETPOINT



SUPPLEMENTAL TREATMENT SYSTEM DETERMINES OPTIMAL BLOWDOWN TO SATISFY WATER CHEMISTRY TARGETS; SIDESTREAM FILTRATION FILTERS DEBRIS

Real-time monitoring sends system alarms via built-in display or

WATER SUPPLY (HARD) WATER TO TOWER (SOFT)

Deaer Salt

Webinar Recording and Slides Available on gsa.gov/gpg

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Emerging Building Technologies

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- Ongoing Assessments
- Request for Information
- About Pilot to Portfolio (P2P)
- Outbrief Webinars**
- GPG-Proven Technologies with GSA Deployment Potential
- Newsletters
- GSA Technology Deployment Maps

Outbrief Webinars



GPG Outbrief webinars are presented by national laboratory researchers and include results from real-world evaluations, as well as feedback from facility managers at test-bed locations. Following Outbrief presentations, researchers and other GSA subject experts field participant questions. Attendees are eligible to receive continuing education credits from the American Institute of Architects for attending webinars.

Upcoming Webinars


AWT: Continuous Monitoring & Partial Softening for Cooling Tower Water Treatment
Thursday, December 10, 2020, at 12:00 pm ET

[Register now](#)

On-Demand Webinars and Presentation Slides

TECHNOLOGY CATEGORY	WEBINAR TOPIC	ON-DEMAND VIDEO	PRESENTATION SLIDES
Building Envelope	Electrochromic Windows for Office Space	2018-04-19 	Outbrief #12
Building Envelope	Hi-R Low-E Window Retrofit System / Low-E Window Film	2017-03-30 	Outbrief #01

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Continuing Education Credit

This GPG webinar offers 1 Continuing Education Credit through the American Institute of Architects

To receive credit:

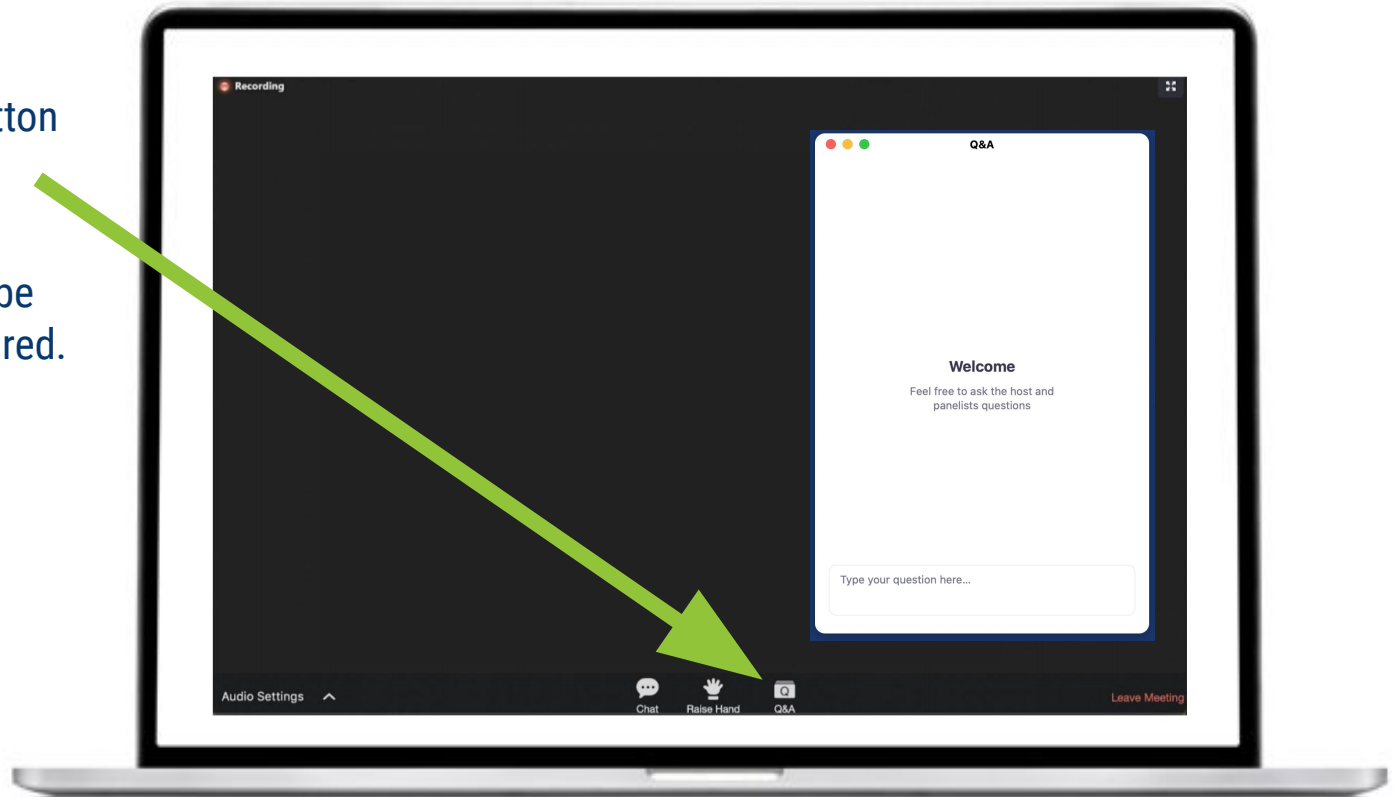
Complete the post-webinar survey, or contact Michael Hobson,
michael.hobson@gsa.gov



How to Ask Questions

Click the Q&A button to ask questions.

The webinar will be recorded and shared.



Introduction



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Webinar Agenda

- ❑ **Introduction (5 minutes)**
Kevin Powell, Director, GSA Center for Emerging Building Technologies
- ❑ **Continuous Monitoring & Partial Water Softening (20 minutes)**
Gregg Tomberlin, National Renewable Energy Laboratory
- ❑ **On-the-ground Feedback, GSA Region 9 (10 minutes)**
Jacob Lewis, Deputy Property Manager
- ❑ **GPG AWT Evaluations (5 minutes)**
Jay Fine, Project Manager, GSA Center for Emerging Building Technologies
- ❑ **Q & A (20 minutes)**

Introduction



Kevin Powell

Director, Center for Emerging Building Technologies

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Opportunity



28%

OF WATER IN COMMERCIAL BUILDINGS
IS USED BY COOLING TOWERS AND OTHER HEATING
AND COOLING SYSTEMS*



137%

INCREASE IN GSA WATER RATES
2007-2019, average yearly increase of 11%

GPG-045

Continuous Monitoring & Partial Water Softening

General Services Administration
Public Buildings Service



GPG-045 | OCTOBER 2020

AWT: CONTINUOUS MONITORING AND PARTIAL WATER SOFTENING

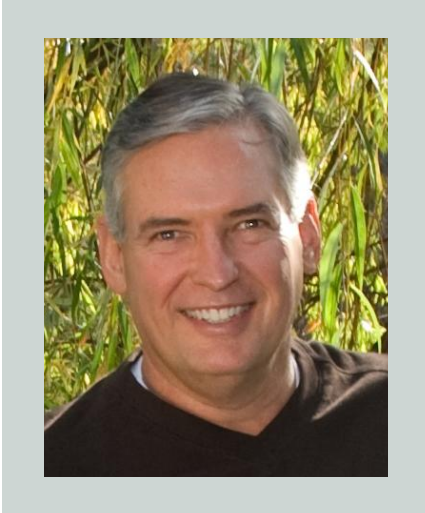


Supplemental Treatment System Saves 15% Water

Cooling towers are responsible for some of the largest potable water loads in commercial office buildings. Traditional chemical-based cooling-tower water treatment systems routinely flush, or “blowdown,” as much as half their water to control mineral build-up. With rapidly rising water rates, GSA Proving Ground (GPG) has evaluated several alternative water treatment (AWT) technologies that can reduce blow down. The most recent evaluation of a continuous-monitoring and partial-water-softening system was conducted by the National Renewable Energy Laboratory (NREL) at the Lloyd D. George Courthouse in Las Vegas, Nevada. Unlike other AWT systems evaluated by GPG, this one does not replace the legacy chemical-water treatment system but rather supplements it. The partial-water-softening technology consists of two components—continuous-programmable logic control (PLC) monitoring and side-stream filtration with partial water softening. The PLC determines the optimal amount of blowdown required to satisfy all water chemistry targets. Side-stream filtration removes suspended matter while dispensing softened water to achieve targeted makeup-water hardness. At the testbed, researchers measured a 52% reduction in blowdown and a 15% reduction in makeup water. At GSA average water rates of \$16.76/kgal and minimum load requirements, payback was under 3 years.

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

Measurement & Verification



Gregg Tomberlin

Senior Engineer

National Renewable Energy Laboratory

Traditional Cooling Tower Treatment

Scale, corrosion and biological growth controlled with chemicals and blowdown

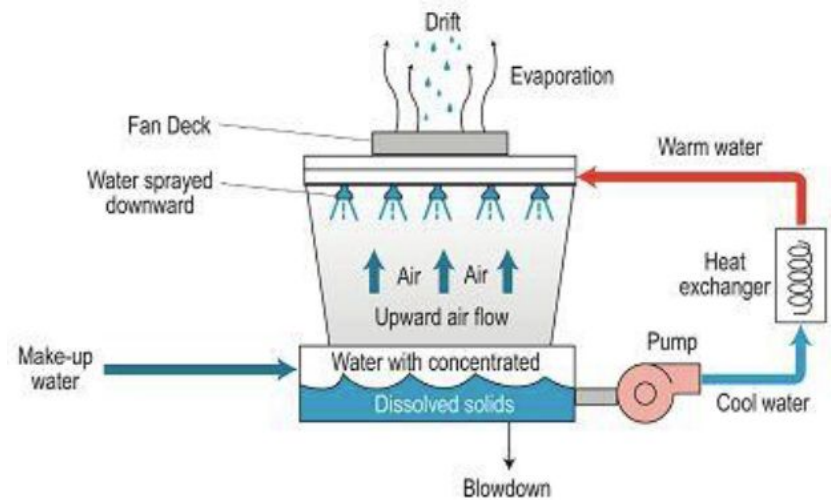
25-50%
COOLING WATER IS FLUSHED
TO MINIMIZE SCALE BUILD-UP

EVAPORATION

- 1,000 Btu/lb
- ~1.8 gal/ton-hour
- Concentrates minerals & chemicals

Evaporative Cooling Basics

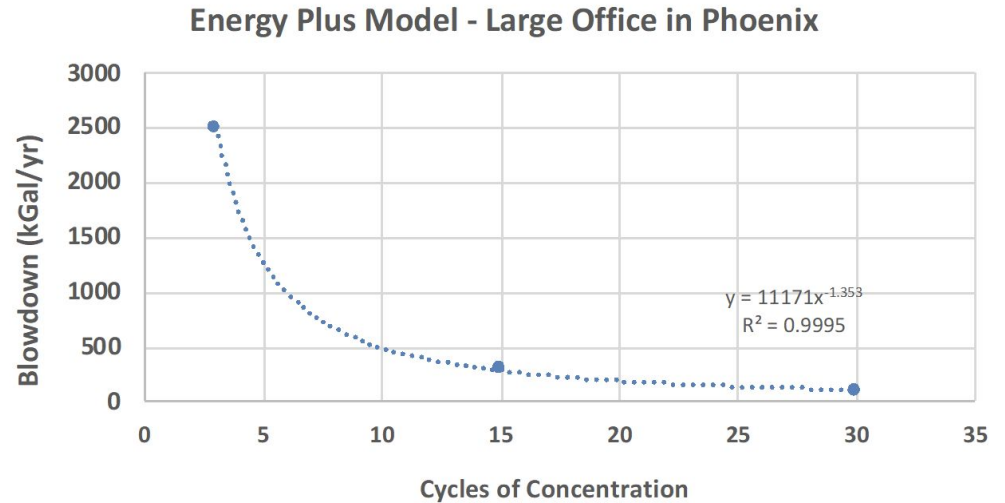
- Evaporation is pure water
- Mineral from makeup is left behind
- Blowdown is needed to limit concentration



Cycles of Concentration

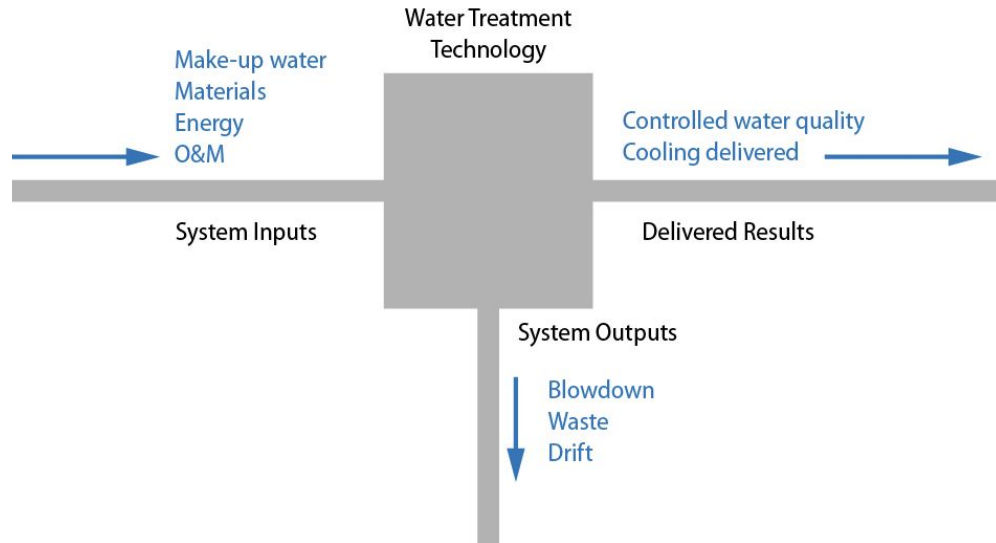
Majority of savings from CoC of 3 to 10, savings level off after CoC of 15

- CoC= Quantity of makeup/quantity of blowdown
- Typical CoC–2.5 to 7
- At a CoC of 3, around 33% of cooling tower water make up is wasted as blowdown



General AWT M&V Framework

Primary objective: measure cooling tower water savings in gal/ton-hr



Typical M&V Points:

- Condenser water supply & return temperatures (°F)
- Condenser water pump status (ON/OFF)
- Chiller water supply and return temperatures (°F)
- Chiller status (ON/OFF)
- Outdoor air temperature (°F) and humidity (%)
- Cooling Tower Make Up Water meter (gal)
- Blowdown Water Meter (gal)

Continuous Monitoring & Partial Softening



Technology for M&V provided
by Aqualogix

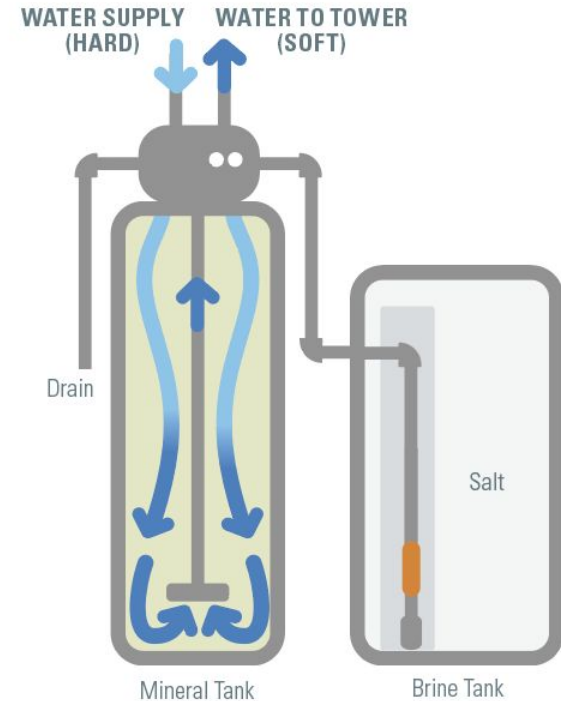


M&V Lloyd D. George Federal Building, Las Vegas, Nevada
One 450-ton cooling tower and two 300-ton cooling towers

Continuous Monitoring & Partial Water Softening (provided by Aqualogix)

Partial softening increases blowdown setpoint

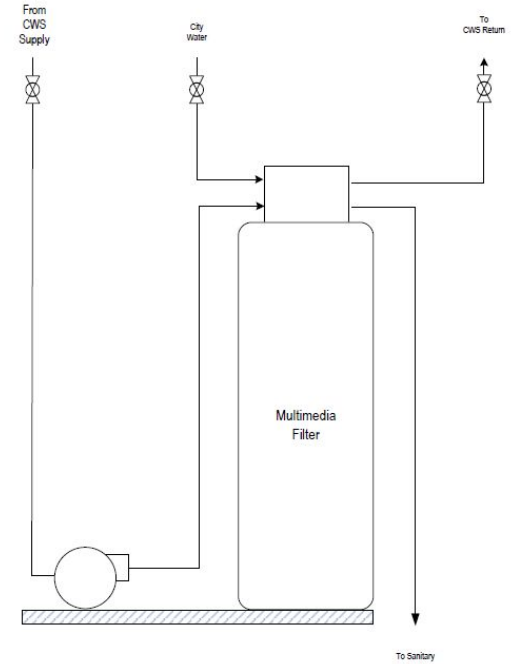
- Unlike other AWT systems GPG has evaluated, this is a supplemental system that works alongside traditional chemical treatment.
- Removes calcium hardness by exchanging with sodium which results in higher conductivity of make-up water but lowered calcium hardness
- Why not make up with fully softened water? Corrosivity is increased which can shorten life of capital equipment.



Continuous Monitoring & Partial Water Softening (provided by Aqualogix)

Side-stream filtration improves performance

- Filters out debris, organics and some bacterial contaminants
- Can reduce corrosion
- Reduces bio-film on heat transfer surfaces
- May result in heat transfer efficiency gains
- Filtration is advantageous although not sized here as large as a commercial SSF system



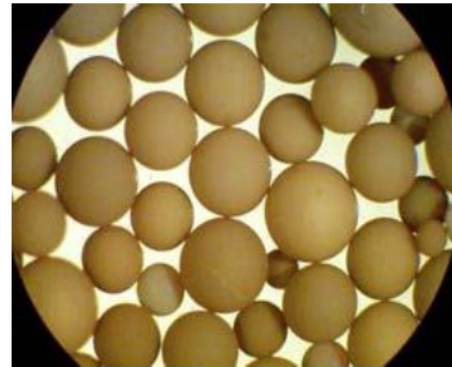
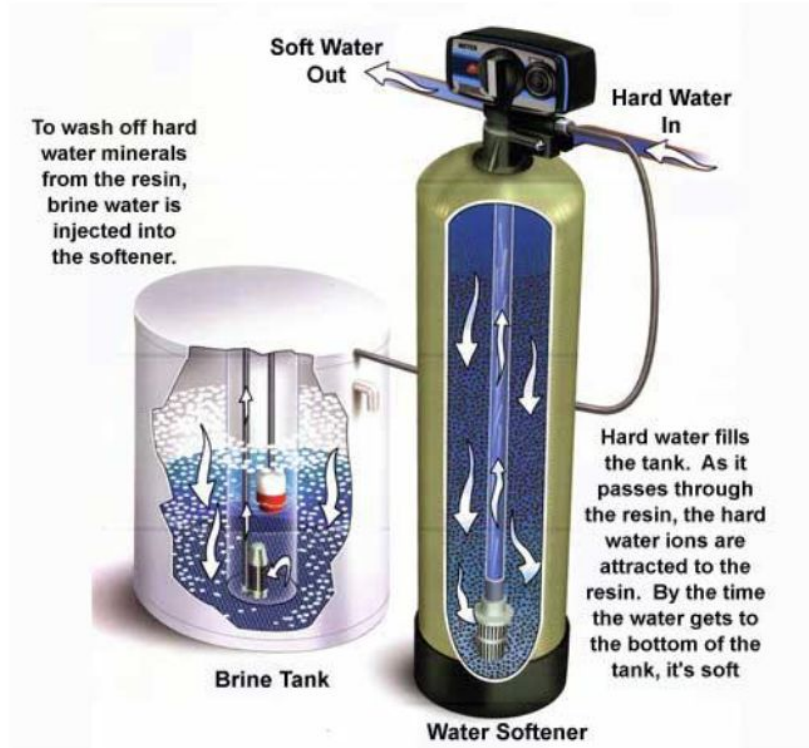
Continuous Monitoring & Partial Water Softening (provided by Aqualogix)

Real-time monitoring

- Real-time monitoring of system conditions
- Sends alarms for targeted maintenance of scale
- Accurate measurement of system performance, with over 30 critical data points
- BAS integration capable with BACNet or MODBUS



Water Softener



M&V Results

CoC

Increased from
2.8 to 4.2

15%

WATER SAVINGS

52% reduction
in blowdown

MET

GSA WATER STANDARDS

Monitors
performance and
sends alarms

Installation

Straight-forward installation

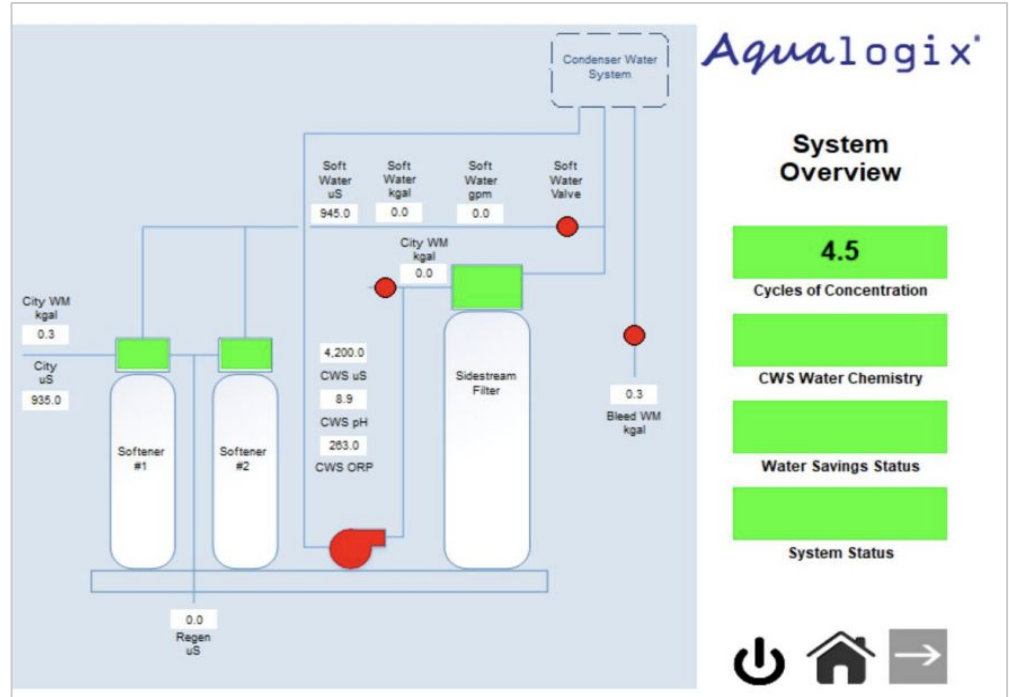
- Installation took 2 days
- Easier if the skid can be situated close to cooling water supply, and return piping
- Skid footprint was 40 inches square with a height of 91 inches and a dry weight of 1,275 lbs (1,625 lbs operating weight). A separate brine tank had a 30-inch-by-30-inch footprint



O&M

O&M unchanged

- Works alongside traditional chemical treatment
- If scaling conditions are present, generates an alarm so anti-scale chemical dosage can be checked or changed



Economics

<3 year payback @ 3-million ton target load & average GSA water/sewer cost \$16.76/kgal

Testbed payback 7.5 years based on measured 1.6 million ton hour load and utility rate of \$12.59 /kgal

	Monitoring & Partial Softening
Installed Equipment (200-1000 ton load) (\$, GSA pricing)	\$38,371
Annual Maintenance (\$)	\$783
Annual Energy Increase (7,735 kWh/yr @\$0.11/kWh)	\$851
Water Savings (938,273 kgal @\$16.76 kgal/yr)	\$14,846
GSA Average Payback (yrs)	2.6
GSA Average Savings-to-Investment Ratio	5.8

GSA Feedback—Las Vegas, Nevada



Jacob Lewis

Deputy Property Manager
GSA, Nevada Field Office
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Installation/Commissioning

Installation consisted of:

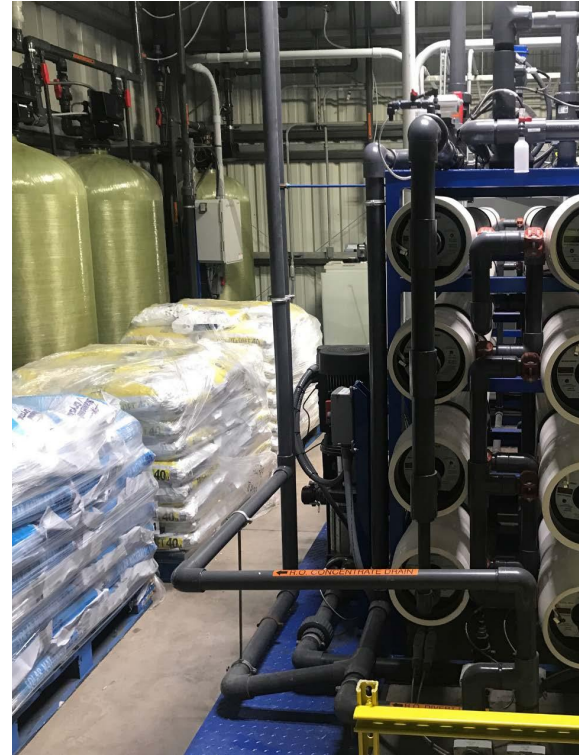
- Connecting to condensate supply and return
- Tapping into a freshwater line (1 ½" copper line) for the makeup water
- Installing a 2" drain line
- Providing 120V power outlet



Ongoing Operations

Works alongside traditional chemical treatment, does not significantly change operations

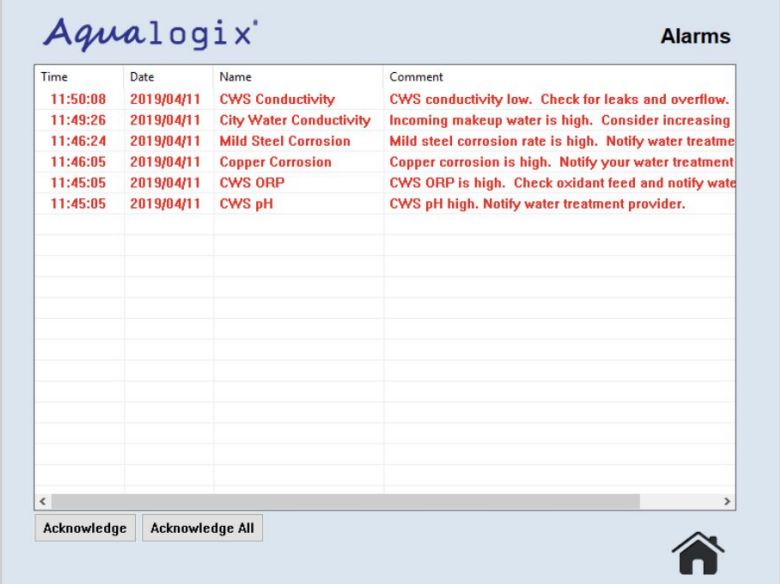
- Staff monitors system daily to make sure its operational and salt is filled
- 40 lb bags of salt need to be added periodically, site was already using salt for water conditioning but there is additional manual labor, bags are heavy
- Add eight 40-lb bags every 3 weeks



Integration with BAS

Data points and alarms can be integrated into BAS

- System installed on 8th floor, BAS in the basement
- Integration sends alarms; so far no alarms
- Integration was challenging because this was the 1st BACnet integration and there was an issue with the system interface; shouldn't be an issue with subsequent installations



The screenshot displays the AquaLogix Alarms interface. At the top left is the AquaLogix logo, and at the top right is the word "Alarms". Below the header is a table with four columns: Time, Date, Name, and Comment. The table contains five rows of active alarms, all with red text. At the bottom of the interface, there are two buttons: "Acknowledge" and "Acknowledge All", and a home icon on the right.

Time	Date	Name	Comment
11:50:08	2019/04/11	CWS Conductivity	CWS conductivity low. Check for leaks and overflow.
11:49:26	2019/04/11	City Water Conductivity	Incoming makeup water is high. Consider increasing
11:46:24	2019/04/11	Mild Steel Corrosion	Mild steel corrosion rate is high. Notify water treatme
11:46:05	2019/04/11	Copper Corrosion	Copper corrosion is high. Notify your water treatment
11:45:05	2019/04/11	CWS ORP	CWS ORP is high. Check oxidant feed and notify wate
11:45:05	2019/04/11	CWS pH	CWS pH high. Notify water treatment provider.

Maintenance

Maintenance is straight forward

- Semi-annual system checks and annual instrument calibration
- \$1095 yearly maintenance contract avoided at testbed by training onsite staff



Lessons Learned

Good communication is key

- Set up direct communication between your water treatment provider and your AWT treatment provider, instead of working through the O&M.
- Get your chemical treatment provider involved in the project from the beginning.
- We're happy with the project. It's saving us water and has been easy to keep it going. We're looking at installing it at another building across the street.

GPG AWT Evaluations



Savings for GPG Evaluated AWT Technologies

	Electrochemical Treatment Dynamic Water Technologies	Advanced Oxidation Process Silver Bullet	Salt Based System WCTI	Chemical Scale Inhibition Terlyn	Continuous Monitoring & Partial Water Softening Aqualogix
Cooling Tower Size (tons)	300 (2 x 150)	500 (2 x 250)	1500 (3 x 500)	1200 (2 x 600)	1150 (450, 2 x 350)
Baseline CoC	3.9	7.9	4.42	Not measured	2.8
Technology CoC	100+	11	30-75	13-18	4.2
Water / Sewer Savings	31.6%	22.7% to 29.7% (estimated)	23%	24%	15%
Water Savings Per Ton-Hour of Cooling	.64	Not measured	.58	.42	.33
Blowdown Reduction	99.8%	Not measured	99%	94%	52%
Chemical Use	100% chemicals eliminated	100% scale and corrosion inhibitors eliminated; biocide used for biological growth	Brine used for scale and corrosion inhibition, biocide used as needed	Scale Inhibitor, Corrosion Inhibitor, Biocide	Salt is added on top of traditional chemical treatment
Cooling Tower Maintenance Savings (yr)	-50%/\$1,200 (32 to 16 hrs)	-50%/ \$1,327 (52 to 26 hours)	-47%/\$3,677 (152 to 80 hrs)	-48%/\$3,217 (132 to 69 hrs)	No change
Water Treatment Maintenance Contract (yr)	+\$1,920 (\$4,080 to \$6,000)	-\$1,195 (\$3,200 to \$2,005)	-\$2,768 (\$7,649 to \$4,881)	+\$5,100 (\$8,400 to \$13,500)	+\$1,095 (\$0 at testbed, personnel trained)
Installation	< 2 days	< 1 day	~2 days	~1 week including side-stream filtration	~2 days

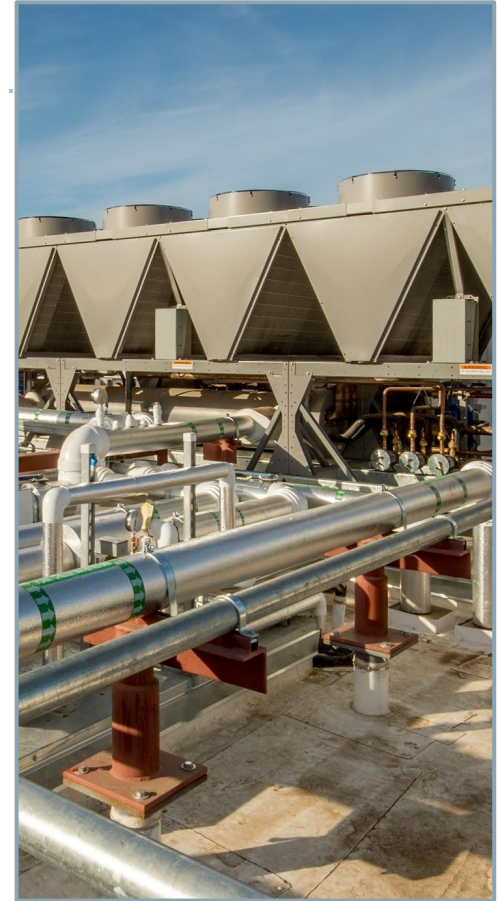
Payback < 3 years for All Systems @ GSA Average Water Rate

	Electrochemical Treatment Dynamic Water Tech.	Advanced Oxidation Process Silver Bullet	Salt Based System WCTI	Chemical Scale Inhibition Terlyn	Continuous Monitoring & Partial Water Softening Aqualogix
Testbed Cooling Tower Size (tons)	300 (2 x 150)	500 (2 x 250)	1500 (3 x 500)	1200 (2 x 600)	1150 (450, 2 x 350)
Total Installed Cost	\$45,340	\$23,425	\$29,600	\$32,511	\$38,371
Installed Cost per Ton	\$151	\$47	\$20	\$27	\$33
Annual Maintenance Change	+\$720	-\$2,522	-\$6,445	+\$1,883	+\$533
Annual Water Savings (kgal)	1,133,857	527,791	401,170	824,448	983,273
Annual Water Savings @ avg. GSA rate \$16.76 kgal	\$19,003	\$8,846	\$6,724	\$13,818	\$16,480
Simple Payback	2.5	2.1	2.2	2.7	2.6
Savings-to-Investment Ratio	6.0	7.1	6.7	5.5	5.8

Deployment Recommendation for AWT

Consider for all cooling towers

- All evaluated AWT systems can be retrofitted to any cooling tower
- Installation for all five AWT systems is straightforward and leaves the balance of the cooling towers unaltered
- Currently evaluating two additional AWT systems



Deployment Considerations

Water savings are site-specific

- Sites in hot climates with long cooling seasons and long cooling-tower run times will typically have the largest water savings.
- Water quality dictates cycles of concentration limits

Full Load Equivalent Cooling Hours

Pacific Northwest = 100-700

Northern CA = 200-800

Northeast = 300-900

Midwest = 700-1200

Mid-Atlantic = 1000-1500

Southern CA = 1200-2000

Southeast = 1500-2300

Texas & Florida = 1700-4000

Hawaii = 5000

Q & A

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Your answer

The information presented in the Outbrief webinar was helpful.

1 2 3 4 5
Strongly Disagree Strongly Agree

I am interested in installing monitoring and partial water softening for cooling tower water treatment

- Yes, in the next 2 years.
- Yes, in the next 5 years.
- Maybe

Thank you



For more information: gsa.gov/GPG

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Jacob Lewis, Property Manager, jacob.lewis@gsa.gov 702.388.5884



Additional Federal Government Deployments of Aqualogix

Agency	Location	Cooling Tower Size (tons)
United States Marine Corps	Parris Island, SC	11 locations 100-300 ton, 1 location 4x200 ton
United States Department of Labor	Beaver, WA	1 750-ton chiller
United States Army	Corpus Christi, TX	1 location 2,730 ton, 10 towers 500 ton each
Department of Interior	Washington, DC	Groundwater collection, side-stream filtration