Tackling WaterSense®
Mechanical Systems

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Tackling WaterSense

WaterSense and ENERGY STAR are hosting a joint webinar series throughout 2016 to help you tackle your facility's water use

Tackling WaterSense—Sanitary Fixtures & Equipment	***January 28***
Tackling WaterSense—Outdoor Water Use	***March 30***
Tackling WaterSense—Mechanical Systems	**May 10**
Let's Go on an Energy and Water Treasure Hunt	**July 12**
Tackling WaterSense—Commercial Kitchens	**September 20**

Agenda

- Introduction to WaterSense
- Eliminate single-pass cooling
- Optimize cooling tower performance
- Minimize steam boiler water use
- Case study
- WaterSense resources

WaterSense Can Help

WaterSense is a voluntary program launched by EPA in 2006 that provides a simple way to identify water-efficient:

- Products
- Programs
- Practices
- Homes

Products are independently certified for water efficiency **and** performance

WaterSense Labeled Products

Flushing Urinals

Lavatory Faucets

Irrigation Controllers

More than 16,000 product models have earned the WaterSense label

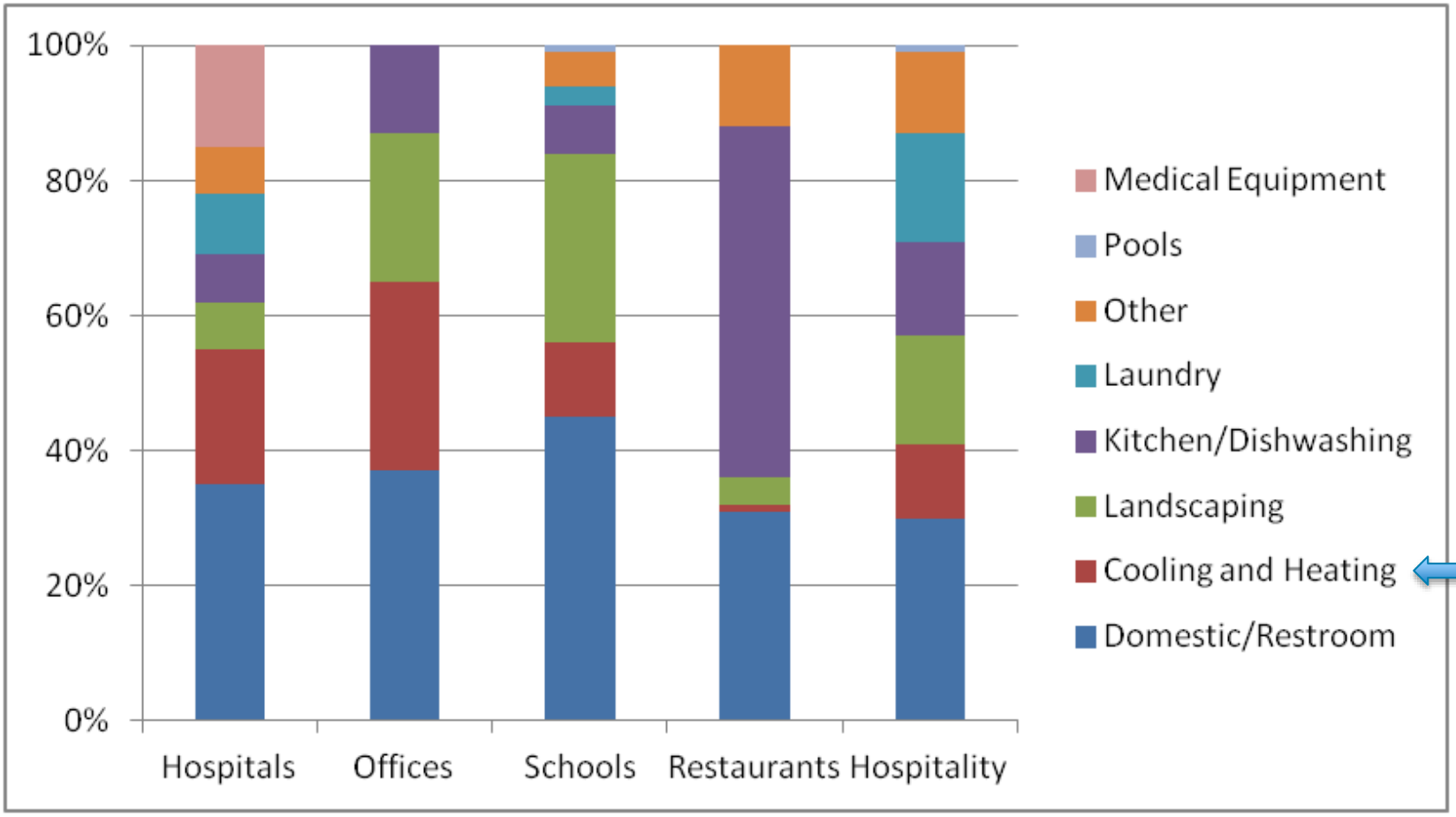
Tank-Type Toilets

Showerheads

Pre-Rinse Spray Valves

New! Flushometer-Valve Toilets

Water Use Profiles of Commercial Facilities



Created by analyzing data from: New Mexico Office of the State Engineer, American Water Works Association (AWWA), AWWA Research Foundation, and East Bay Municipal Utility District

Why Look at Mechanical Water Use?

Save operational costs

- Water and sewer rates have risen well above the Consumer Price Index
- Improving system efficiency can reduce maintenance requirements

Water-energy nexus

- Saving water often saves energy and vice versa

Minimal impact on building occupants

- Water savings do not impact occupant or customer comfort or convenience

Just Add Water!

- Include water usage in existing energy management efforts
- Track water usage in ENERGY STAR Portfolio Manager®
- Measure water use with properly installed meters and submeters
- Conduct a facility water audit and include leak detection in regular assessments

EPA

How Is Water Used in Mechanical Systems?

Single-pass cooling

Chilled water systems and cooling towers

Steam boiler systems

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Identifying Single-Pass Cooling

- Single-pass or once-through cooling systems use water to remove heat and cool equipment
- Types of equipment that could use single-pass cooling include:
  - Air conditioners
  - Refrigeration systems
  - Air compressors
  - Ice machines
  - Wok stoves
- Use approximately 40 times more water to remove the same heat load than a cooling tower

Single-Pass Cooling Alternatives

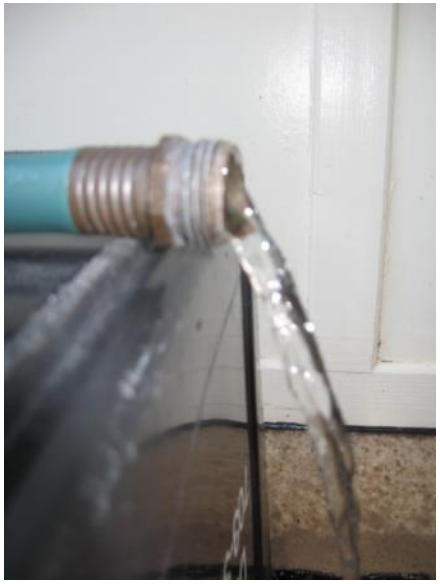
If you can, eliminate all instances of single-pass cooling

- Replace with air-cooled equipment
- Consider a closed-loop recirculation system
  - Use an air-cooled point-of-use chiller
  - Connect cooling lines to existing chilled water loops

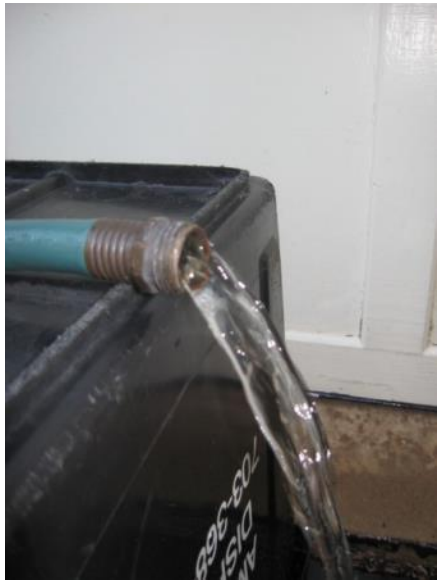
If you can't retrofit or replace your water-cooled equipment

- Use minimum flow rate required for cooling
- Install a control valve to turn off cooling water when there is no heat load
- Regularly check operation of the water control valve
- Identify methods for reusing single-pass cooling water

Single-Pass Cooling Savings Potential



1 gpm
500,000 gal/year
$4,415/year*



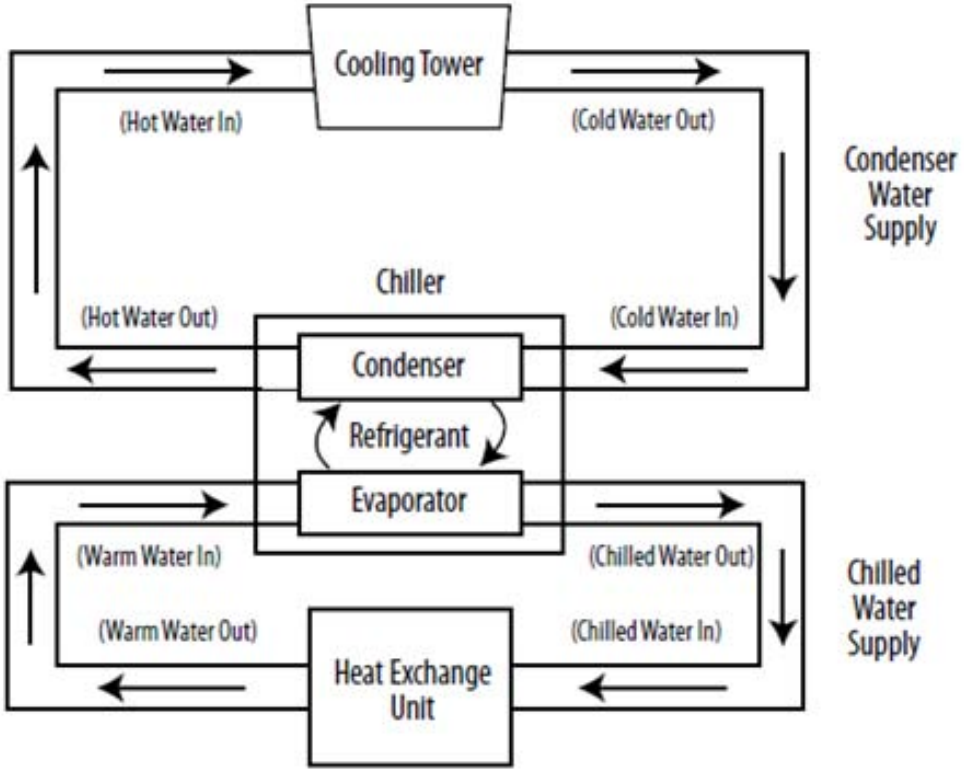
2 gpm
1,000,000 gal/year
$8,830/year*

6 gpm
3,000,000 gal/year
$26,490/year*

*at national average commercial cost of $8.83 per 1,000 gallons

Chilled Water Systems

- Alternative to single-pass cooling
- Water is recirculated in a closed loop
- Improvements in energy efficiency improve water efficiency
- Install and read a make-up water meter on the chilled water loop
- Ensure chilled water pipes are insulated



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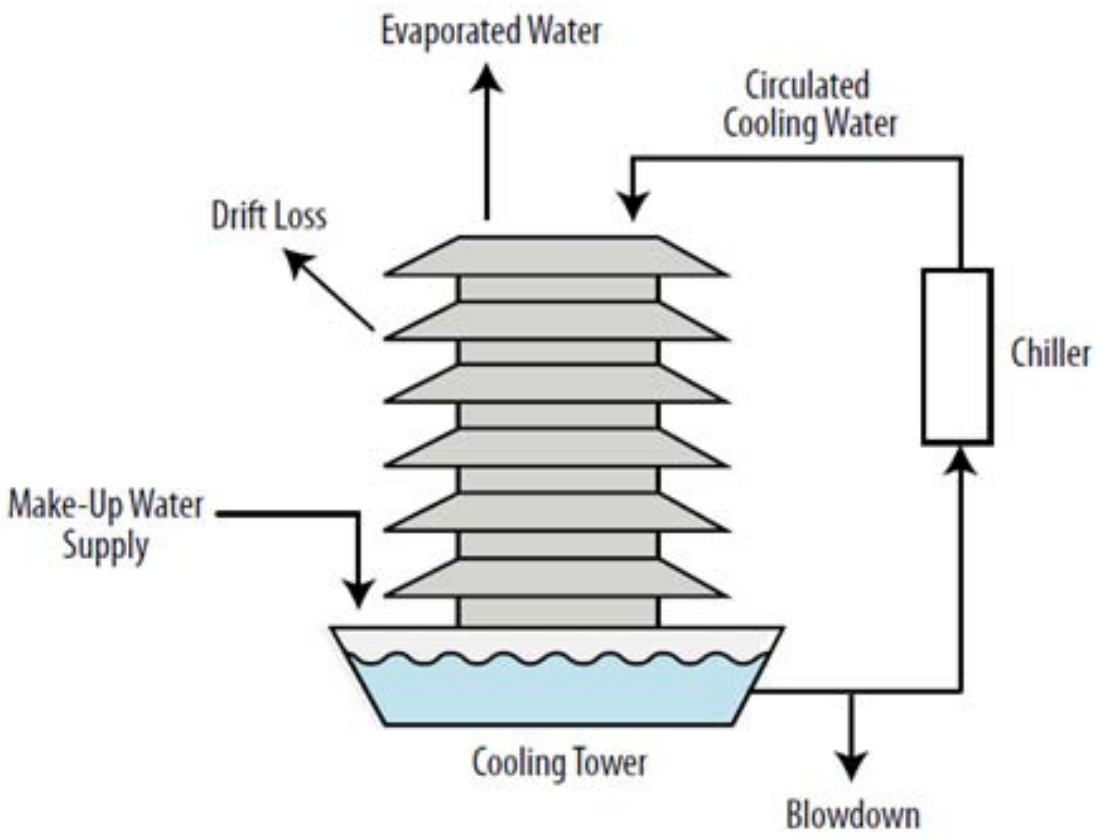
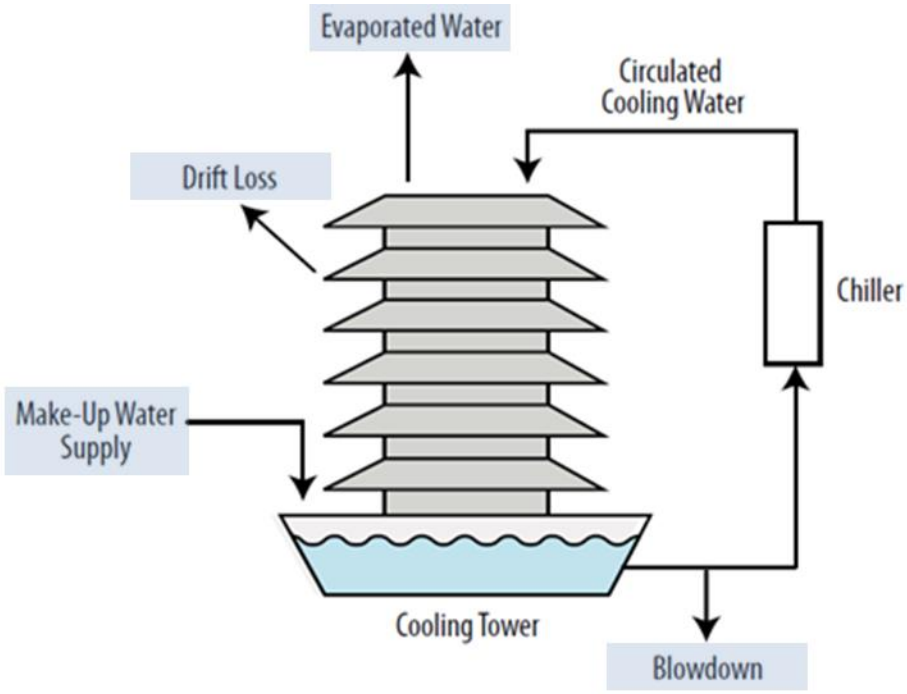
Cooling Towers: How They Work



Where Can You Save?



- Reduce the evaporative heat load on the cooling tower
- Reduce drift loss
- Reduce blowdown
- Eliminate opportunities for leaks
- Provide alternate make-up water supply

Reduce Evaporative Heat Load

- Every ton of cooling (12,000 Btu/hour) requires evaporation of 1.5 gallons of water/hour
- Building energy-saving projects provide direct water savings
- Classic example of the water-energy nexus
- Evaporated water is a consumptive use!

Minimize Losses from Drift and Leaks

Drift

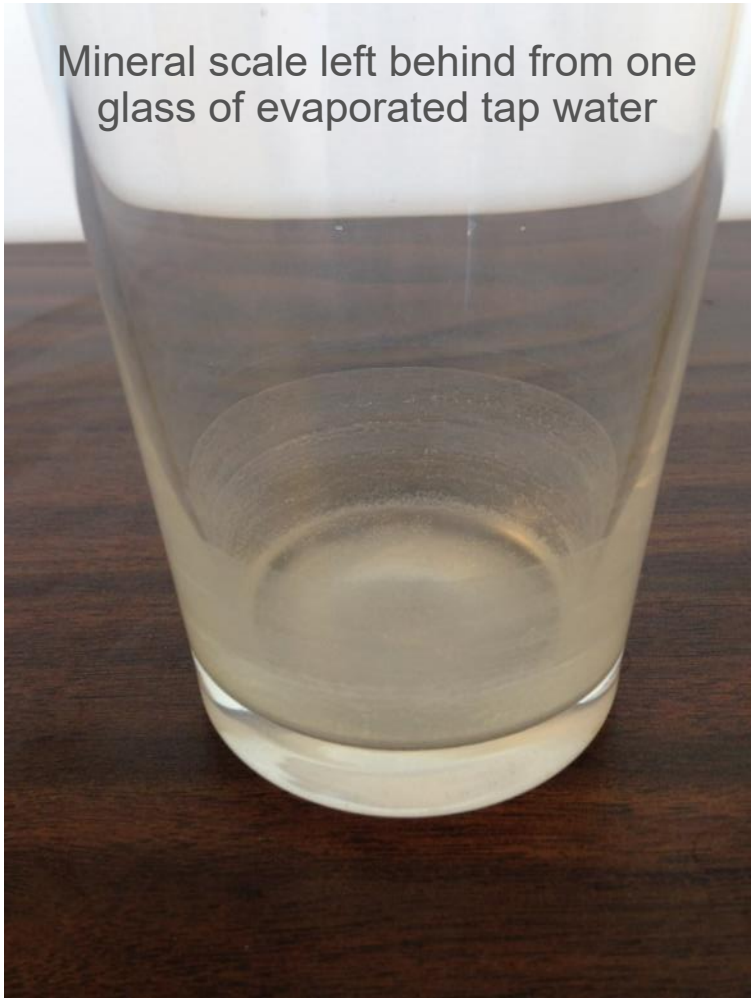
- Misting and droplets that are carried from the cooling tower
- Up to 0.2 percent of water use
- Drift eliminators can reduce this to negligible amounts

Leaks and overflow

- Overflow drains are provided in case of malfunction
- Install overflow alarm

Reduce Blowdown

- Make-up = Evaporation + Blowdown + Drift (negligible)
- Minimize make-up quantity by minimizing blowdown
- Why is blowdown necessary?



Mineral Control

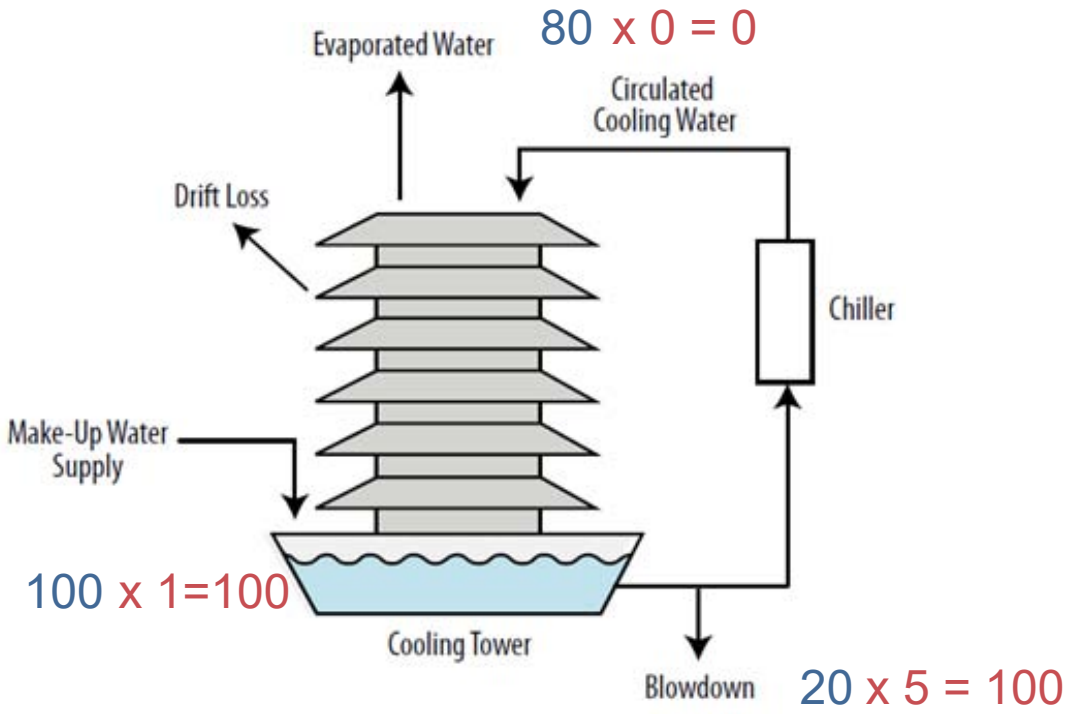
Goal

- Concentrate minerals in recirculating system
- Eliminate minerals from the system using blowdown stream

Cycles of Concentration

- The ratio of the concentration of minerals in the blowdown water to the concentration of minerals of the make-up water

Why Are Cycles of Concentration Important?



$$\text{Cycles of Concentration} = \frac{\text{C blowdown}}{\text{C makeup}} = \frac{\text{Q makeup}}{\text{Q blowdown}}$$

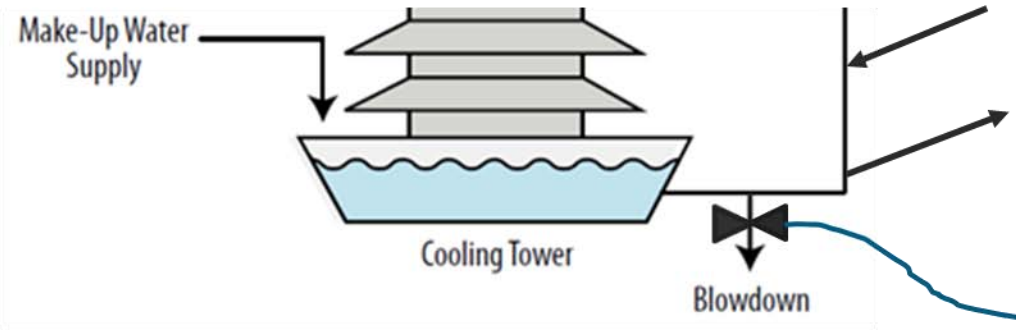
$$\text{Cycles of Concentration} = \frac{5}{1} = \frac{100}{20}$$

Conductivity (µS/cm) is used as the measure of total mineral content

Maintaining High Cycles of Concentration

Strategy

- Keep minerals in solution by managing water chemistry
  - pH control
  - Corrosion inhibitor
  - Scale inhibitor
- Engage a cooling tower water treatment vendor



Typical controller set-up

Ways to Improve Cycles of Concentration

Install meters and automated control systems

- Control blowdown with a conductivity controller
- Install chemical feed systems on larger cooling tower systems (more than 100 tons)
- Install flow meters on make-up and blowdown water lines

Improve cooling tower water quality

- Consider installing a sand filter or cartridge filter to reduce sediment in basin water
- Consider installing a water softening system on the make-up water line to prevent hardness from limiting increased cycles of concentration

Contact your utility for a sewer charge deduction for water lost to evaporation

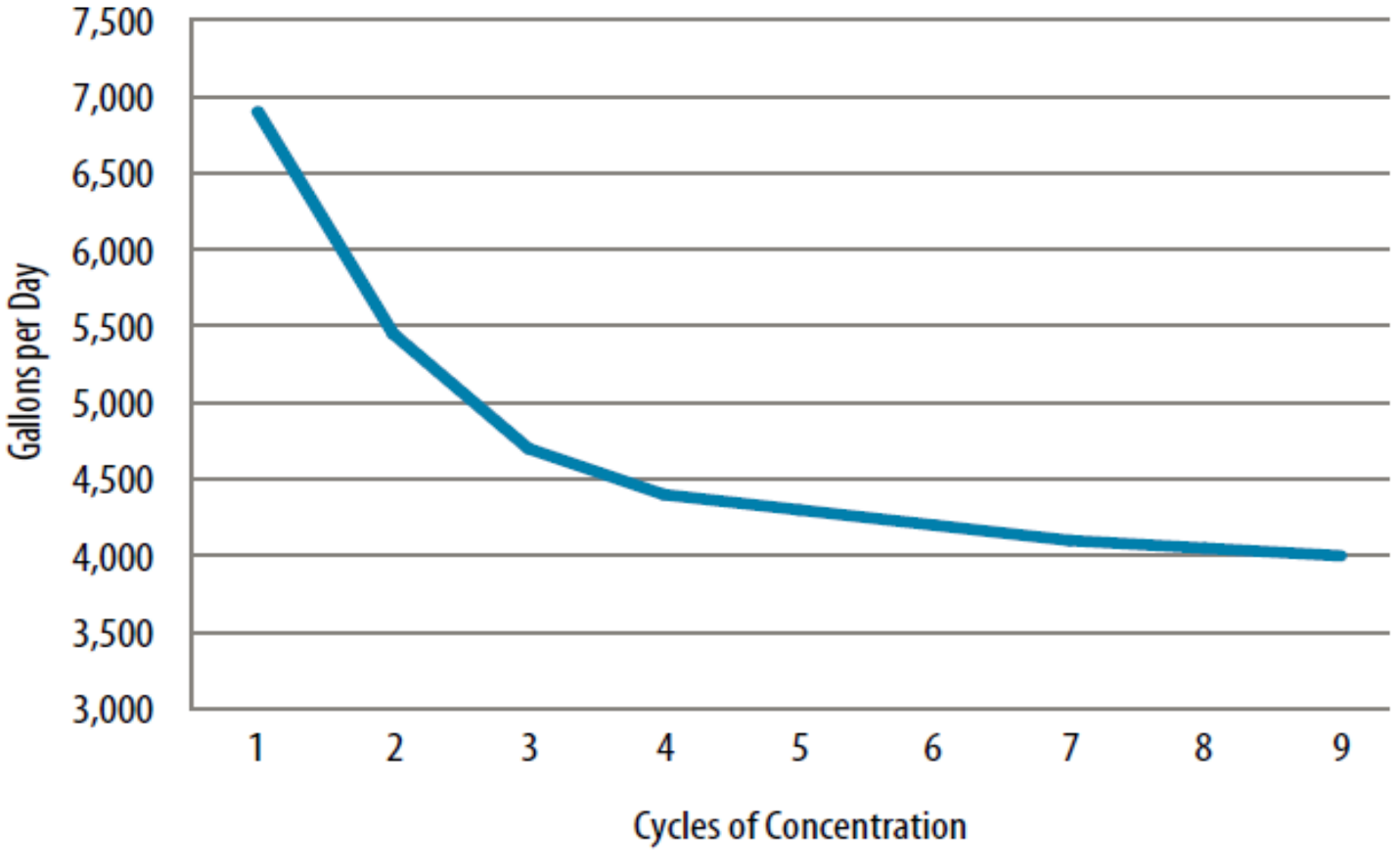
Savings Potential From Increased Cycles

Increasing cycles of concentration from 3 to 6 reduces cooling tower water usage by 20 percent

Initial Concentration Ratio (Cri)	New Concentration Ratio (CRf)											
		2	2.5	3	3.5	4	5	6	7	8	9	10
	1.5	33%	44%	50%	53%	56%	58%	60%	61%	62%	63%	64%
	2.0	–	17%	25%	30%	33%	38%	40%	42%	43%	44%	45%
	2.5	–	–	10%	16%	20%	25%	28%	30%	31%	33%	34%
	3.0				7%	11%	17%	20%	22%	24%	25%	26%
	3.5	–	–	–	–	5%	11%	14%	17%	18%	20%	21%
	4.0	–	–	–	–	–	6%	10%	13%	14%	16%	17%
	5.0	–	–	–	–	–	–	4%	7%	9%	10%	11%
	6.0	–	–	–	–	–	–	–	3%	5%	6%	7%

Savings Potential From Increased Cycles

Cooling Tower Water Usage at Various Cycles of Concentration for a 100-Ton Tower



Sample Chemistry Report

WATER TREATMENT SERVICE REPORT

Address: US EPA Region 6 Laboratory
10625 Fallstone Rd.
Houston, TX. 77099

Report Date: 10/4/2010

below target range
above target range

Copies To: Dan Peronis, Ashland File

System	Today's Sample	Average	# Samples in Average	Control Range
Make-Up Water				
pH	7.7	7.6	45	
Conductivity (umhos)	428	522	46	
Calcium Hardness (ppm)	0	13	44	
Total Alkalinity (ppm)	100	184	42	
Cooling Tower Water				
pH	9.10	9.0	45	8.5 - 9.5
Conductivity (umhos)	2755	2509	46	< 2750
Calcium Hardness (ppm)	16	14	41	< 40
ORP	194	171	44	record
Enviroplus 1503	5.9	6.1	46	4.5 - 6.0
Microbiological Counts (CFU/mL)	100	1188	30	<10,000

CoC = 2755/428 = 6.4

Alternative Sources of Make-Up Water

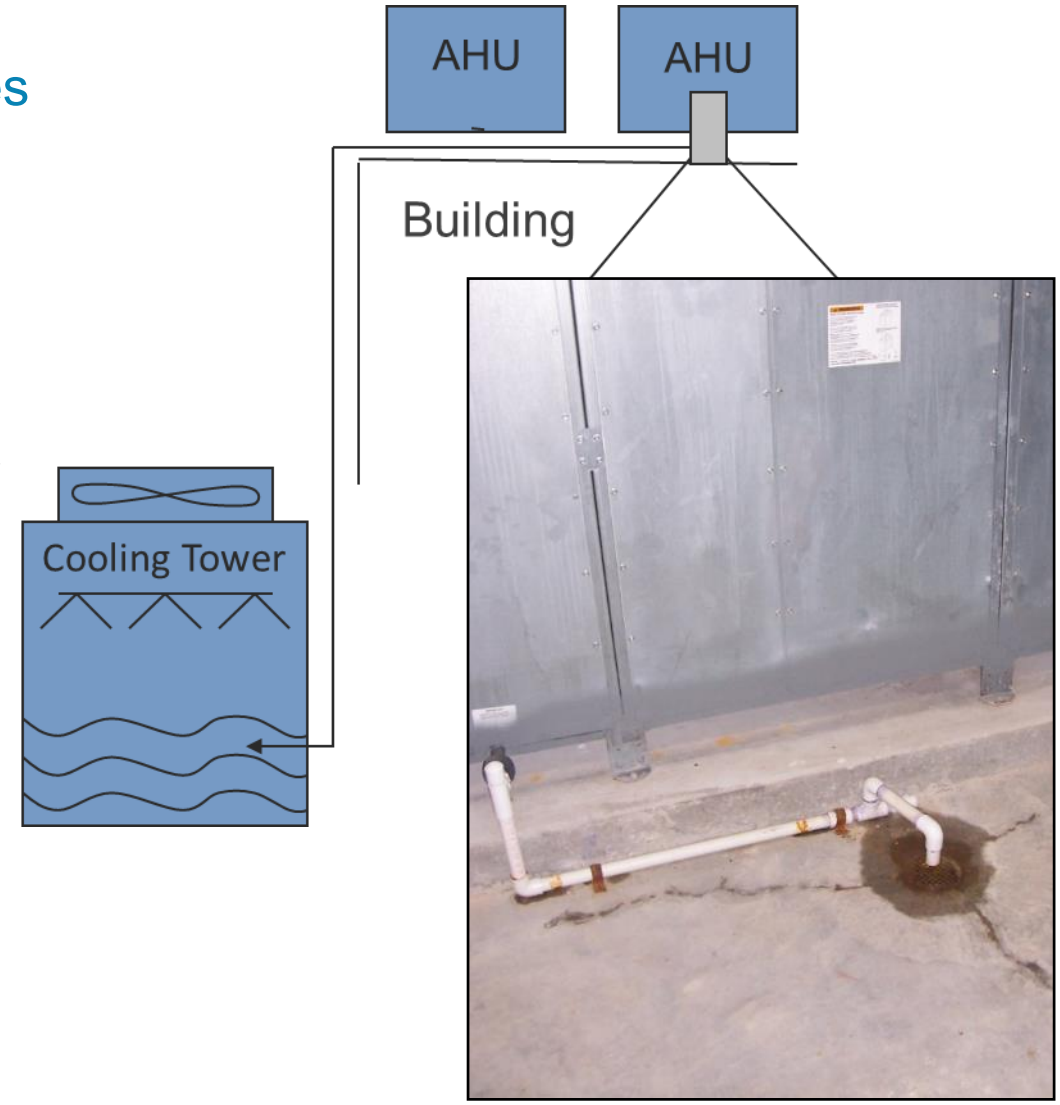
- Reclaimed wastewater
- Rainwater
- Foundation drain water
- Air conditioner condensate

Alternate source water **quality**, **quantity**, and **availability** are key considerations

Air Handler Condensate Recovery

Water vapor in the air condenses as it comes into contact with an air conditioner's cooling coils

- Condensate is typically sent to the sewer
- Condensate generation ranges from 3 to 10 gallons per day per 1,000 square feet of air-conditioned space
- Free of minerals and total dissolved solids (TDS)
- Cooler than ambient air
- Generated in highest volumes during periods of high cooling loads



Example Air Handler Recovery Retrofit Designs

Example Savings from Cooling Tower Projects

Location	Tower Size	Improvement Project	Savings
Oklahoma	450 Tons	Improved make-up control; corrected overflows	500,000 gallons/year
Michigan	2,000 Tons	RO concentrate as make-up water; water softening of make-up water; increase cycles from 3.25 to 5	800,000 gallons/year
Georgia	450 Tons	Correct blowdown control scheme and reconfigure overflow drain	1,000,000 gallons/year
Florida	200 Tons	Captured air handler condensate and routed to cooling tower	400,000 gallons/year

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Boiler and Steam Systems

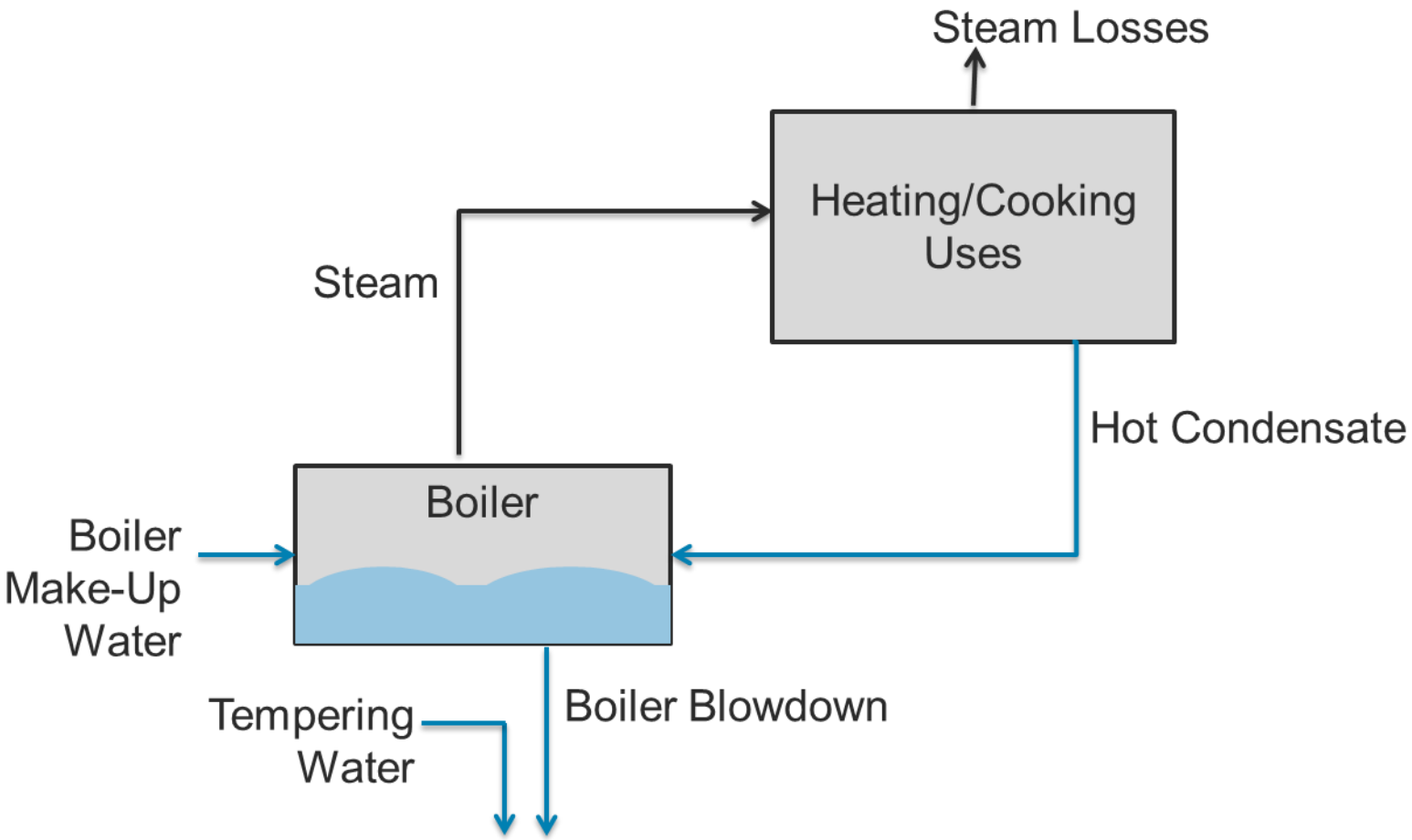
Hot water boilers

- Open systems provide hot water for end uses such as restrooms and laundry
- Closed systems are often used for building space heating
- Do not produce steam

Steam boilers

- Used to provide steam for heating or cooking
- Distribute steam and generate condensate as heat is transferred
- Require chemical treatment and/or blowdown

Steam Boiler System Overview



Steam Boiler Condensate Recovery

Install and maintain a condensate recovery system

- Reduces the amount of make-up water required
- Eliminates need to add tempering water to cool condensate before discharge
- Reduces frequency of blowdown, as condensate is highly pure and adds little to no additional TDS

Other Steam Boiler Best Management Practices

Maintain boilers, steam lines, and steam traps

- Regularly check steam and hot water lines for leaks
- Regularly clean and inspect boiler water and fire tubes
- Develop and implement an annual boiler tune-up program
- Properly insulate piping and the central storage tank to conserve heat
- Implement a steam trap inspection program for boiler systems with condensate recovery

Ensure tempering water is only applied when needed

- Employ an expansion tank to temper hot condensate, rather than adding water to cool it

Other Steam Boiler Best Management Practices

Read meters and water chemistry reports

- If available, read the make-up, blowdown, and condensate return flow meters regularly
- Review water chemistry reports provided by your water treatment vendor to ensure conductivity and cycles of concentration goals are met

Minimize blowdown and maximize cycles of concentration

- Work with the water treatment vendor to prevent scaling and corrosion and maximize cycles

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Maximum Sustainable Cooling Tower Water Conservation

Definition: The ability to conserve the greatest amount of water while maintaining complete system integrity... indefinitely.

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Maximum Sustainable Cooling Tower Water Conservation

Performance & Efficiency: Must first control scale, minimize corrosion, and eliminate biological fouling, under all operating conditions.

Technology & Performance: Chemical water treatment programs are the most widely used means of protecting cooling tower systems. Of all the treatment products available for cooling towers, it is the scale inhibitor alone that determines the level of sustainable water conservation.

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Maximum Sustainable Cooling Tower Water Conservation

Conventional Scale Inhibitors: Conventional scale inhibitors raise the saturation point of the condenser water to some degree, allowing more elements to be held in solution. Although this reduces the amount of wastewater that must be dumped from the system, the performance is limited. To control the elements in water and eliminate scale, conventional treatment programs ***require an average of 30% to 50% wastewater discharge*** to dilute the system water.

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Maximum Sustainable Cooling Tower Water Conservation

Emerging Scale Inhibitor Technology: The scale inhibitor used in the following case studies is a hydrolytically stable, high-strength chemistry that systematically controls cationic ions in water through sequestration, threshold stabilization, and crystal modification. The extreme ionic potential of this chemistry creates a synergistic attraction, or bond between the advanced scale inhibitor and the scale forming elements in water.

The unique characteristics and exceptional bonding strength of this advanced scale inhibitor significantly increases the saturation point of the system water***, effectively reducing the bleed-off requirement of any cooling tower to only 3% wastewater***, which sufficiently dilutes the system water to maintain complete system integrity.

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Case Study

Proposed Project Goals

1) Determine and verify if there are water treatment technologies capable of protecting the cooling tower and chiller systems, while providing, substantial water conservation savings.

2) If such technologies exist, determine and verify that they are economically feasible for utilization throughout any building portfolio.

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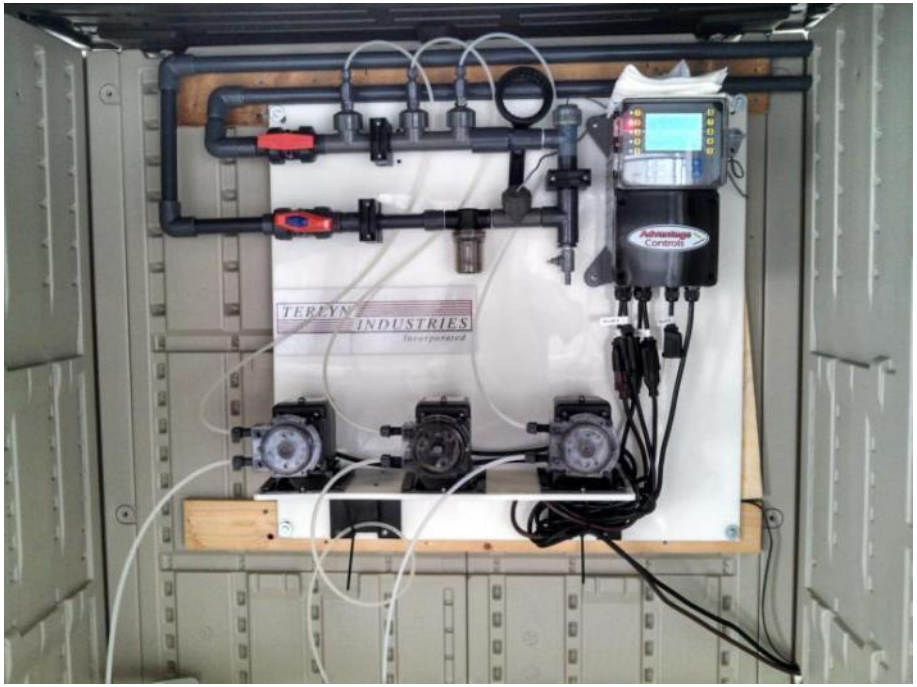
Case Study

How We Saved!

- Conducting minor repairs and adjustments
- Maintaining complete system integrity
- Reducing wastewater discharge to only 3%



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Parkshore Plaza Condominiums

30 story high-rise building with 120 luxury condominium units, a variety of retail businesses on the ground floor, and a highly rated fine dining restaurant

Project Details:

Cooling Towers:	2
Total Tonnage:	1200
Manufacturer:	Evapco
Total Chillers:	1
Heat Exchangers:	2
Water/Sewer Cost:	$14.12/1K gal.
TERLYN ROI:	4 Months

During the first 2 years, system water consumption and wastewater discharge was reduced by **54.27%**, saving **4,394,220 gallons** of potable water for the community.

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Regatta Beach Club Resort

With over 300 units, Regatta Beach Club Resort is one of the largest beach front condominium communities on Clearwater Beach, FL.

Project Details:

Cooling Towers:	2
Total Tonnage:	1200
Manufacturer:	Evapco
Total Chillers:	0
Heat Exchangers:	2
Water/Sewer Cost:	$17.77/1K gal.
TERLYN ROI:	3 Months

In the first 2 years, the system water consumption and wastewater discharge was reduced by **50.09%**, saving **4,551,267 gallons** of potable water for the community.

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Bayfront Tower Condominiums

868,000 square foot waterfront condominium houses
250 residential units and 11 commercial units

Project Details:

Cooling Towers:	3
Total Tonnage:	933
Manufacturer:	Marley
Total Chillers:	2
Heat Pumps:	250
Water/Sewer Cost:	$8.90/1K gal.
TERLYN ROI:	6 Months

In the first 6 months, system water consumption and wastewater discharge was reduced by **50%**, saving **2,144,100 gallons** of potable water for the community.

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Impact of Implementing Maximum Sustainable Cooling Tower Water Conservation Program

1,000 ton unit
$10.00/Kgal

Cycles of Concentration	% Waste Water	Annual Waste Water Bleed Off Gallons	Cost of Bleed Off
3	33%	7,884,000	$78,822
Savings:	3 to 6 cycles	4,730,400	$47,293
6	16.7%	3,153,600	$31,529
Savings:	6 to 30 cycles	2,609,876	$26,093
30	3.3%	543,724	$5,436

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WaterSense Resources

- Water use information by facility type
- Best management practices
- Water-saving tips
- Assessment tools
- Worksheets and checklists
- Live and recorded training webinars
- Case studies and more!

www.epa.gov/watersense/commercial/tools.html

Other Resources

AT&T and the Environmental Defense Fund (EDF) Water Management Application (WaterMAPP) Tool

- Created to evaluate cooling tower efficiency and Water Management Application (excel tool), WaterMAPP
  - Calculates the costs and benefits of cooling tower efficiency improvements
  - Estimate Cycles of Concentration
  - Suggests cost savings from free air cooling opportunities
- Educational YouTube introduction webinar

gemi.org/EDFGEMIwaterMAPP/index.html

What You Can Do Right Now

- Check to ensure you are using the minimum flow rate required for cooling in instances of single-pass cooling
- You can't manage what you don't measure; install and read meters on:
  - All make-up water lines to cooling towers, boilers, and chilled water loops
  - Blowdown water lines
  - Condensate return lines
- Track main meter and submeter readings in ENERGY STAR Portfolio Manager
- Read water chemistry reports
- Calculate cooling tower cycles of concentration and work with your water treatment vendor to increase cycles to 6 or more
- Assess feasibility of using air handler condensate for cooling tower make-up

Upcoming Webinars

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Let's Go on an Energy and Water Treasure Hunt	**July 12**
Tacking WaterSense—Commercial Kitchens	**September 20**

www.epa.gov/watersense/commercial/webinars.html

Questions?

ENERGY STAR

For technical questions related to Portfolio Manager or the ENERGY STAR program, please visit:

www.energystar.gov/buildingshelp

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