AABC Commissioning Group

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# The Art of Water Reuse and Optimization in a World of Diminishing Water Supply

AIA Course Number CXENERGY1532

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# Course Description

Water quality has a direct influence on HVAC equipment life in industrial and commercial buildings. These problems necessitate appropriate treatment and control to maintain the value of a cooling water system to the process it serves. For uninterrupted plant productivity, these systems require proper chemical treatment and preventive maintenance. The installation of continuous water quality management and water optimization software can significantly reduce operational and capital asset risk, as well as support regulatory compliance. A forward looking approach to water control management including 24/7 continuous and remote monitoring and control can result in a decrease of a catastrophic system asset failure and operational risk exposure. Water reuse decreases a facility's utility operating expenses, serves as a redundant water supply for critical facilities, can contribute toward LEED certification, and in areas with moderate to heavy rainfall, reduces the on-site storm water. Cooling and process water typically account for 80-90% of industrial water use. This session will explore capturing existing water sources including rainwater, greywater, storm water, and foundation water, then filtering and disinfection, followed by reuse for cooling tower makeup, toilet flushing, irrigation, or any other nonpotable use. The installation of continuous water quality management and water optimization software and how it can significantly reduce operational and capital asset risk, as well as support regulatory compliance, will be addressed.

# Learning Objectives

At the end of the this course, participants will be able to:

1. Learn how water quality affects the performance and lifetime by HVAC equipment in industrial and commercial buildings.

2. Understand how proper chemical treatment and preventative maintenance can help to ensure uninterrupted plant productivity.

3. Learn how water quality management and water optimization software can reduce operational costs and capital asset risk, as well as support regulatory compliance.

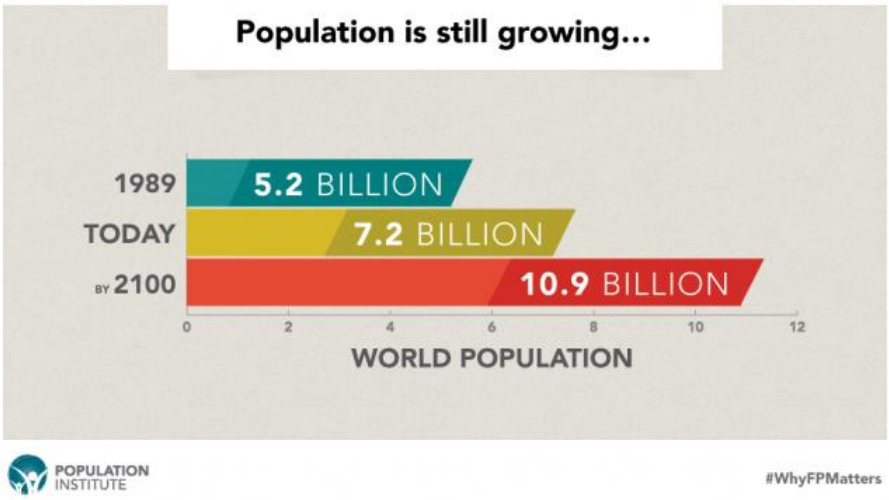
4. Understand how captured existing water sources can be effectively treated and made suitable for reuse for cooling tower makeup, toilet flushing, irrigation, or other non-potable uses.

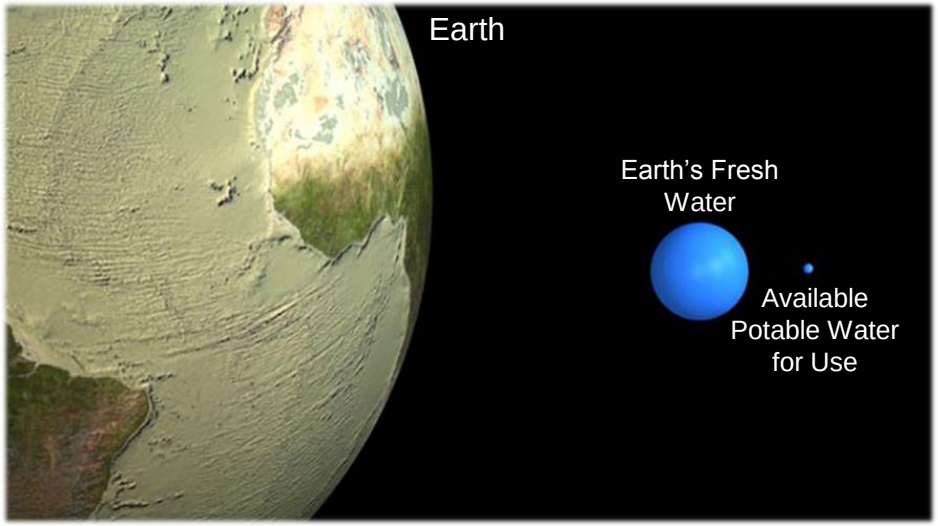
Contents

- Global Water Scarcity
- Water Reuse
- Water Management and Optimization
- Solutions on the Horizon
- Conclusion
- Questions

# Global Water Scarcity

4.8 billion people – more than half the world's population – will be at risk due to water stress by 2050 if status quo continues.



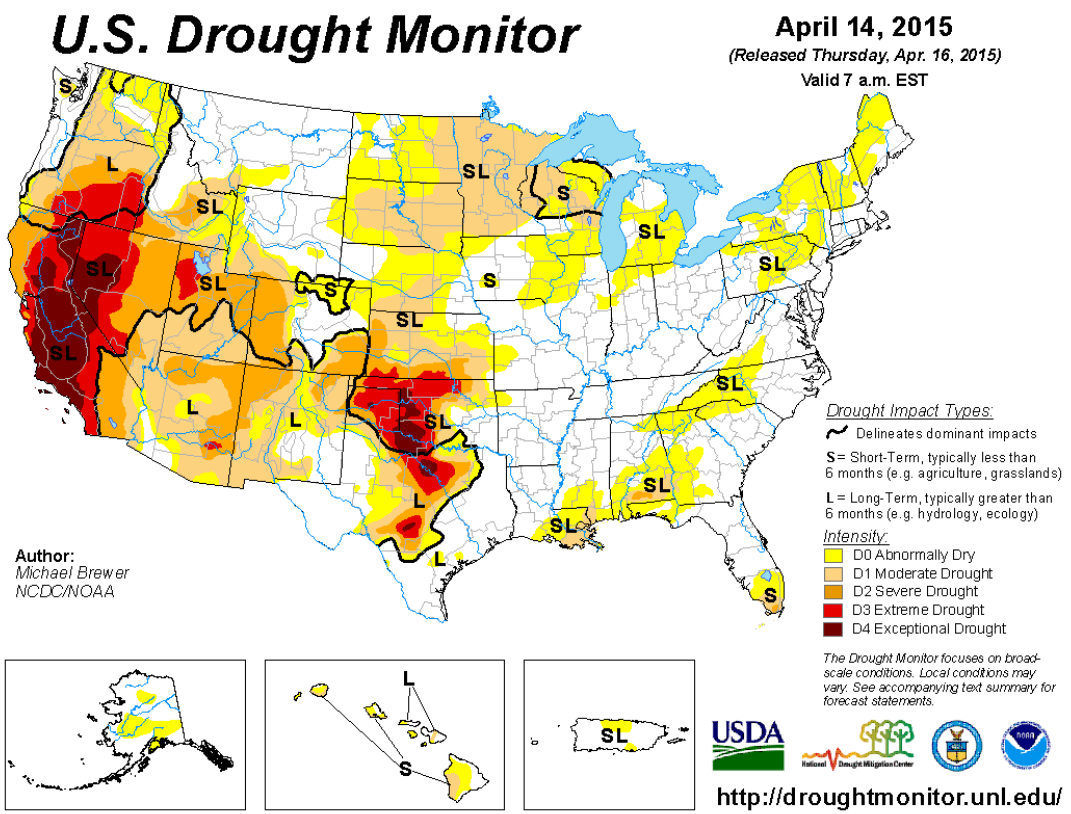

Source: Water in 2050, GrowingBlue.com

# California Crisis: US Drought Monitor

"California will run out of water in 12 months."

– Jay Famiglietti
Senior Water Scientist
NASA Jet Propulsion Laboratory

- 25% mandatory water use reduction statewide
- Title 24 (California Building Standards Commission) mandates operational controls of water treatment in cooling towers



## Water Reuse: What Is It?

- Capture existing water sources:
  - Rainwater
  - Greywater
  - Stormwater
  - Foundation water
  - Steam condensate
  - Air handler condensate
  - Process water

- Filter, disinfect and reuse water:
  - Process water: cooling tower makeup, filter reuse water, boiler feed water, roof misting
  - Irrigation
  - Municipality: street washing
  - Toilet flushing
  - Any other nonpotable use

**Fact:** Cooling and process water often account for 80-90% of industrial water use.

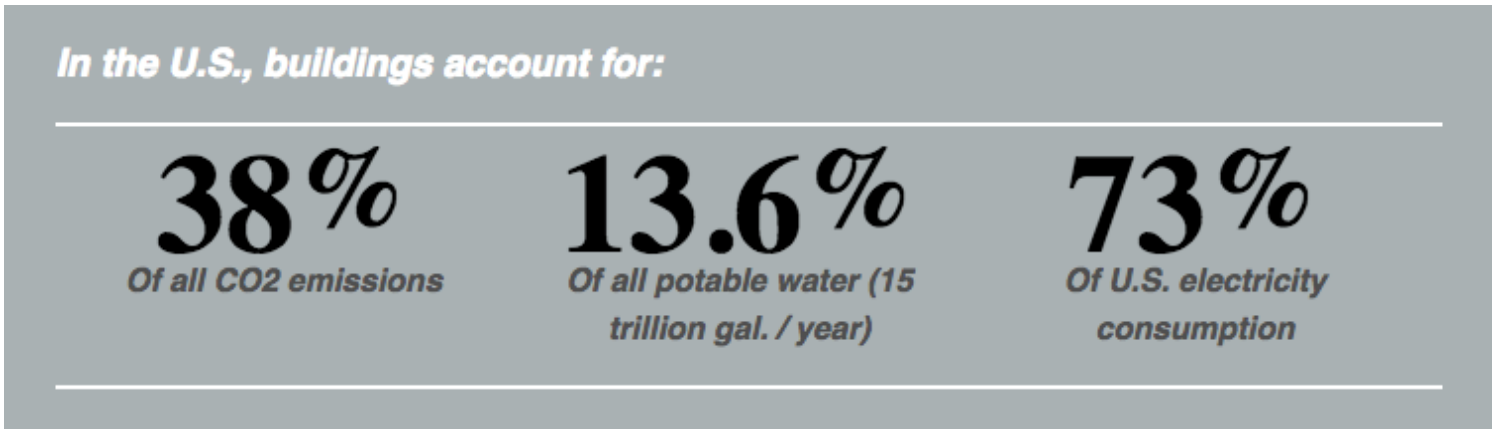
# Water Reuse: Why Do It?

Harvesting non-potable water can:

- Have a measureable impact on a building's operational efficiencies
- Help to meet new mandates / regulation
- Support efforts to earn LEED® points
- Assist in achieving overall sustainability objectives

# LEED® *for* Building Design + Construction (BD+C):

- Reduces stress on the environment by encouraging energy & resource-efficient buildings
- Savings from increased building value, higher lease rates and decreased utility costs
- **88 of the Fortune 100 companies are already using LEED®**
- Effective July 2015, LEED® v4 gives significant opportunity for water side optimization to contribute to LEED® certification

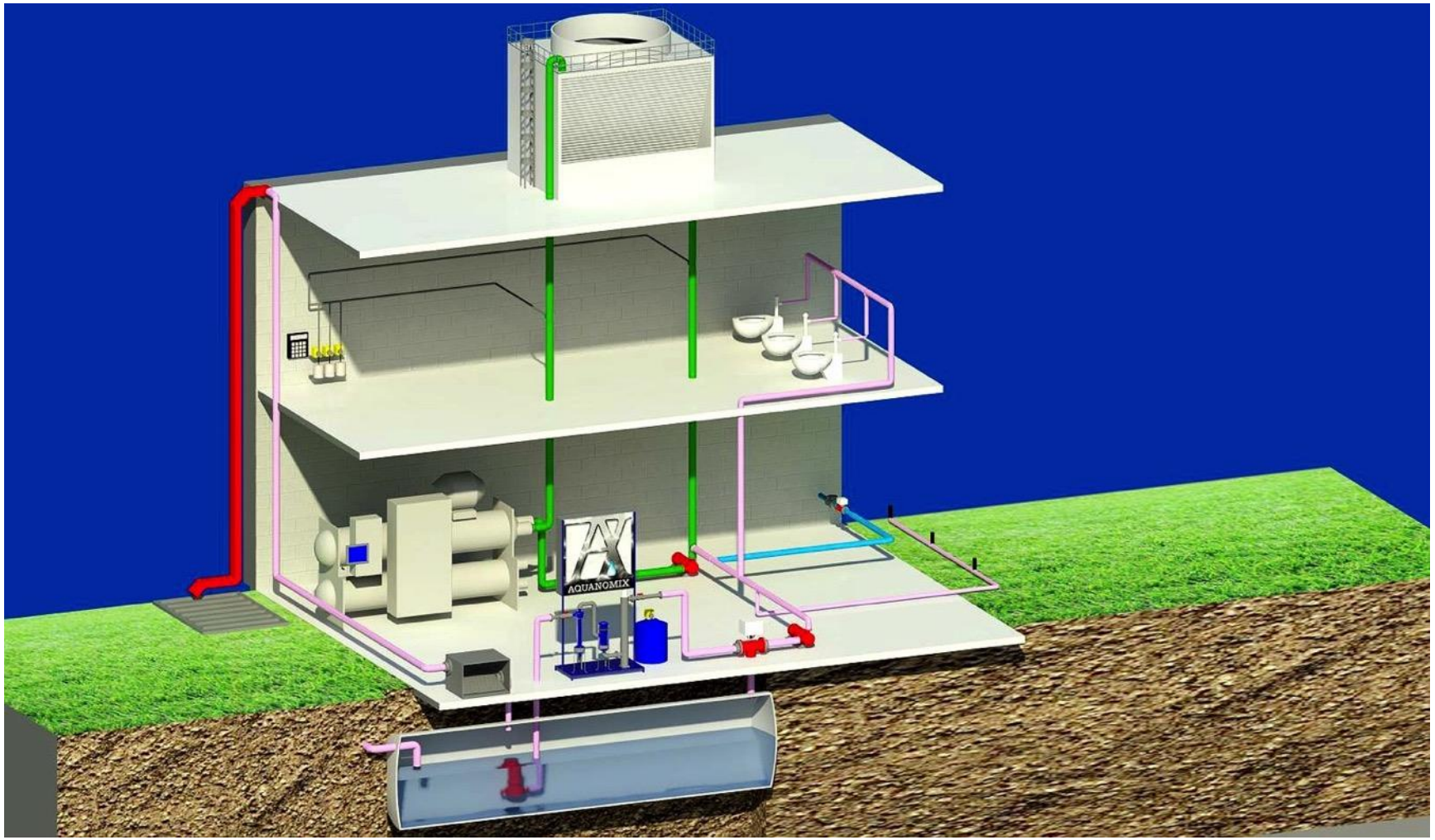


# LEED® *for* Building Design + Construction (BD+C):

| | Credit(s) |
|---|---|
| Stormwater design – quantity control | 1 |
| Stormwater design – quality control | 1 |
| Rainwater management | 1 |
| Sustainable wastewater mgmt | 1 |
| Cooling tower water mgmt | 1 |
| Cooling tower water use | 1 |

| | Prerequisite | Credit(s) |
|---|---|---|
| Rainwater management | | 1-3 |
| 30% reduction landscape water | ✓ | |
| 50% reduction landscape water | | 1-2 |
| Measure whole bldg water use | ✓ | |
| Submetering (at least 2 end uses) | | 1 |
| Cooling tower water management | | 1-2 |

# Water Reuse: System Overview



# Water Reuse: Case Study

George Washington University Science and Engineering Hall

14-story modern research hub, wet and dry labs, collaborative teaching areas, lounges and aquatic suite

Three-story bay built for large-scale experiments, imaging facility and facility for nanotechnology fabrication

8 of the floors are above grade, 2 below for programming and 4 below for parking

# Water Reuse: Case Study

George Washington University Science and Engineering Hall

Details:

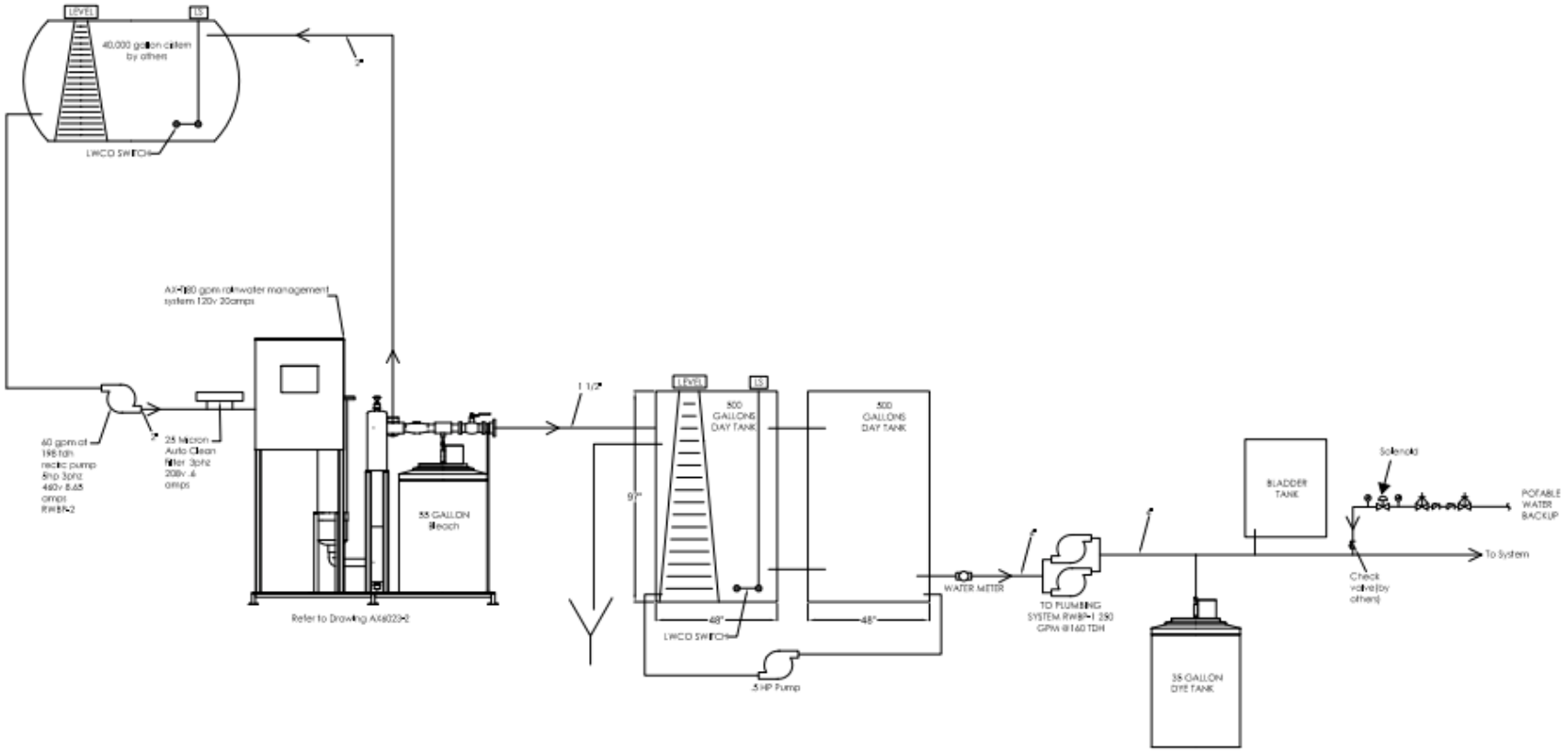
| | |
|---|---|
| Facility Type: | Education |
| Building Size: | 700,000 square feet |
| Cistern Size: | 42,000-gallon |
| System Size: | 60 GPM filtration and pumping station |
| Water Source: | Rainwater from the roof |
| Water End Use: | Toilet flushing |
| Sustainability: | Registered with USGBC and are pursuing LEED® Silver |

Outcome:

Rain from the roof drains into a 42,000-gallon cistern to be filtered and used to flush toilets, saving roughly 850,000 gallons of water per year

# Water Reuse: Case Study

## George Washington University Science and Engineering Hall



# Water Reuse: Case Study

## Smithsonian National Museum of African American History and Culture

The 350,000 sq. ft. project is currently under construction on the National Mall in D.C. on a five-acre tract adjacent to the Washington Monument; deepest museum on the Mall.

Excavators dug 80 feet below street level to lay the foundation at a very low point on the water table where all the surrounding groundwater drains, putting 27.78 pounds/sq. in. on the walls.

85 gallons / minute of water were pumped out every day during construction.

# Water Reuse: Case Study

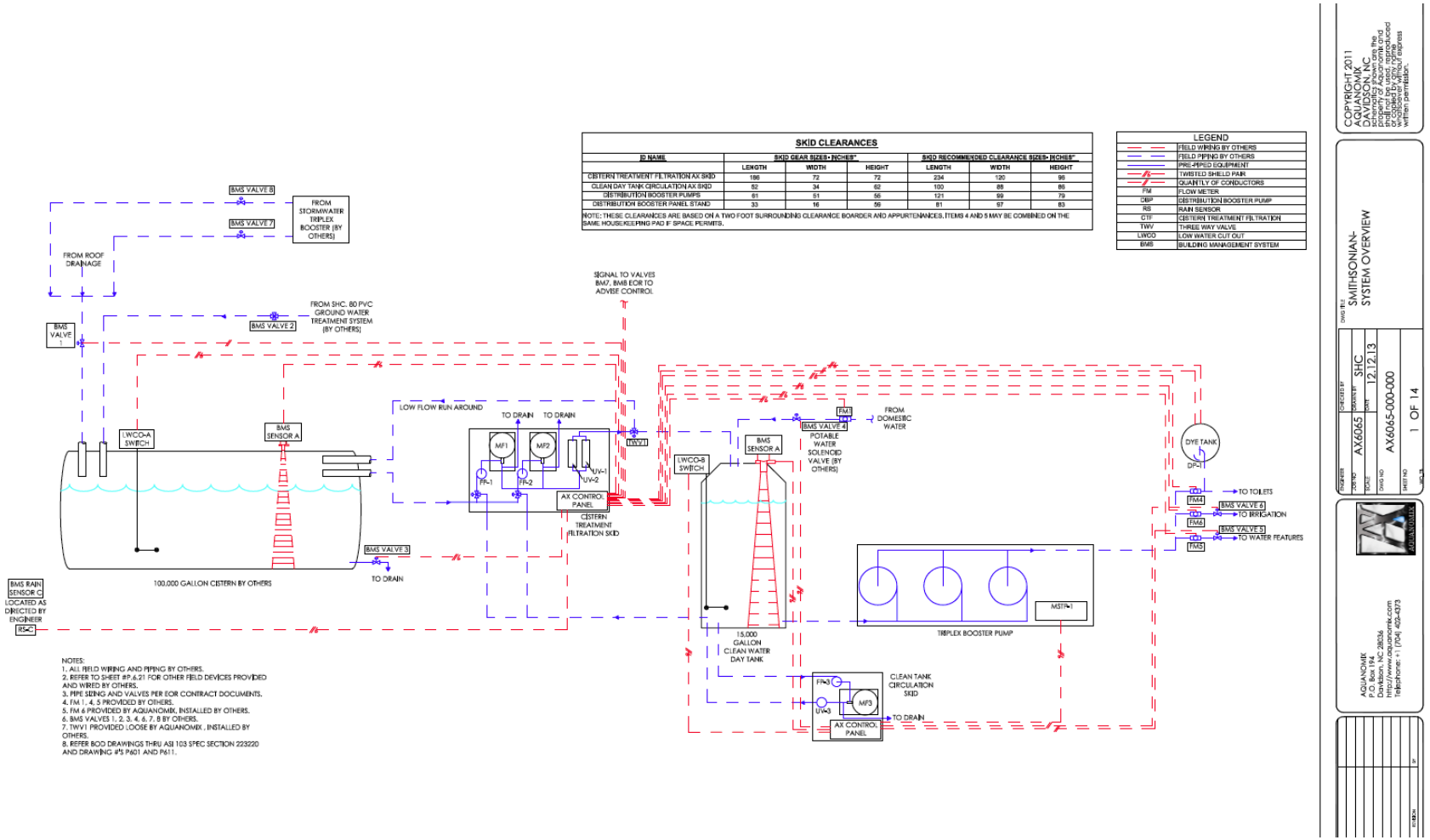
## Smithsonian National Museum of African American History and Culture

Details:

| | |
|---|---|
| Facility Type: | Museum |
| Building Size: | 350,000 sq. ft. |
| Cistern Size: | 100,000 gallon underground |
| System Size: | 15,000 gallon day tank, 100 GPM filtration pumping station, 150 GPM triplex booster pump |
| Water Source: | Groundwater, rainwater, storm water |
| Water End Use: | Toilet flushing, irrigation use, fountain makeup |
| Date Opening: | Late 2016 |

# Water Reuse: Case Study

## Smithsonian National Museum of African American History and Culture



# Water Reuse: Case Study

## Gateway Village – Charlotte, NC

Objective: To revitalize Charlotte's historic Third Ward by developing a 15-acre mixed-use site designed to bring business, retail, restaurants, new residents and visitors to the area.

- Large mixed-use project
- 1.5 million total sq. ft.
- 125,000 sq. ft. retail space
- Data center

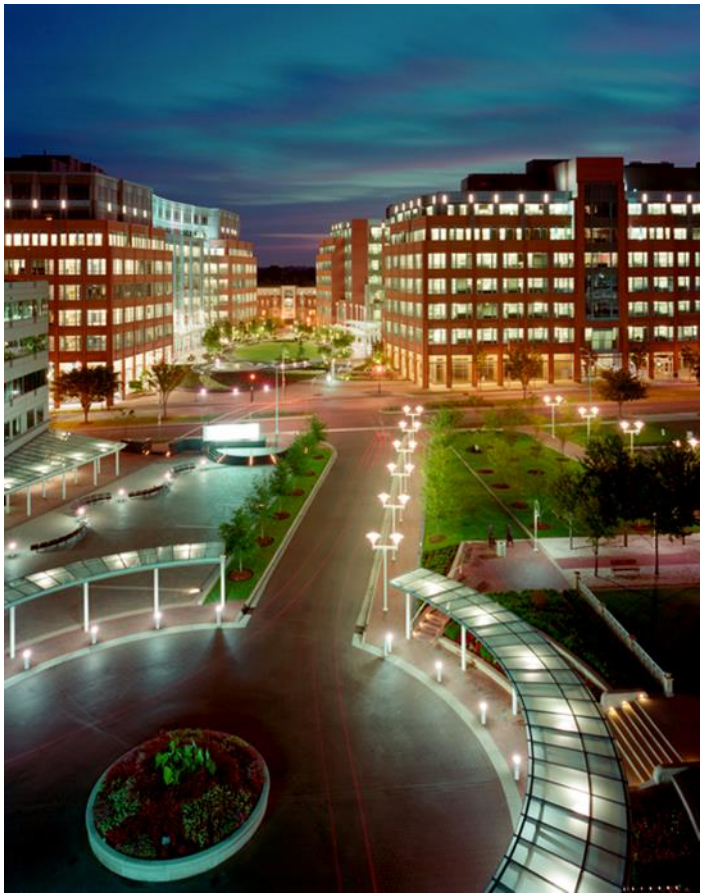
# Water Reuse: Case Study

## Gateway Village – Charlotte, NC

Job: Retrofit a custom-designed water reuse system to help achieve LEED® Gold status and save millions of gallons of city water for the cooling towers

- Water Source: Continuous flow of contaminated foundation water
- Water End Use: Cooling tower makeup
- Type of Construction: Existing building retro-fit

- LEED® Gold Certified
- **3+ million gallons of water saved annually = 15+ million gallons saved to date**
- 4.25 years project payback
- Eliminated potable city water for cooling tower makeup



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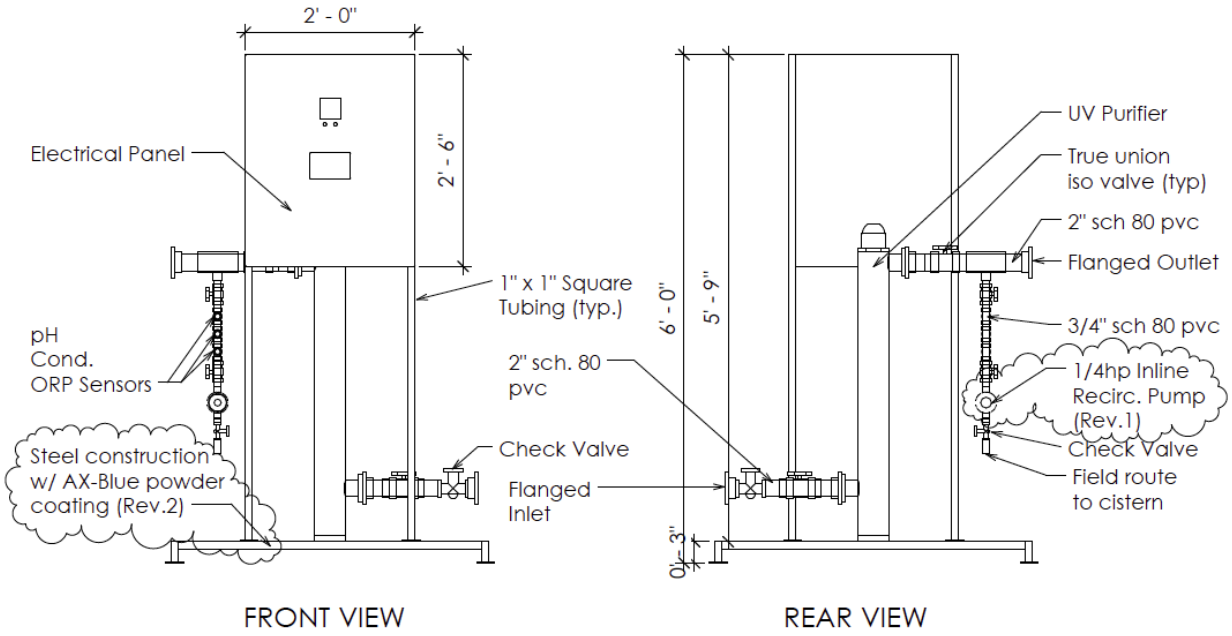
# Water Reuse: Case Study

## Gateway Village – Charlotte, NC




# Water Reuse: Case Study

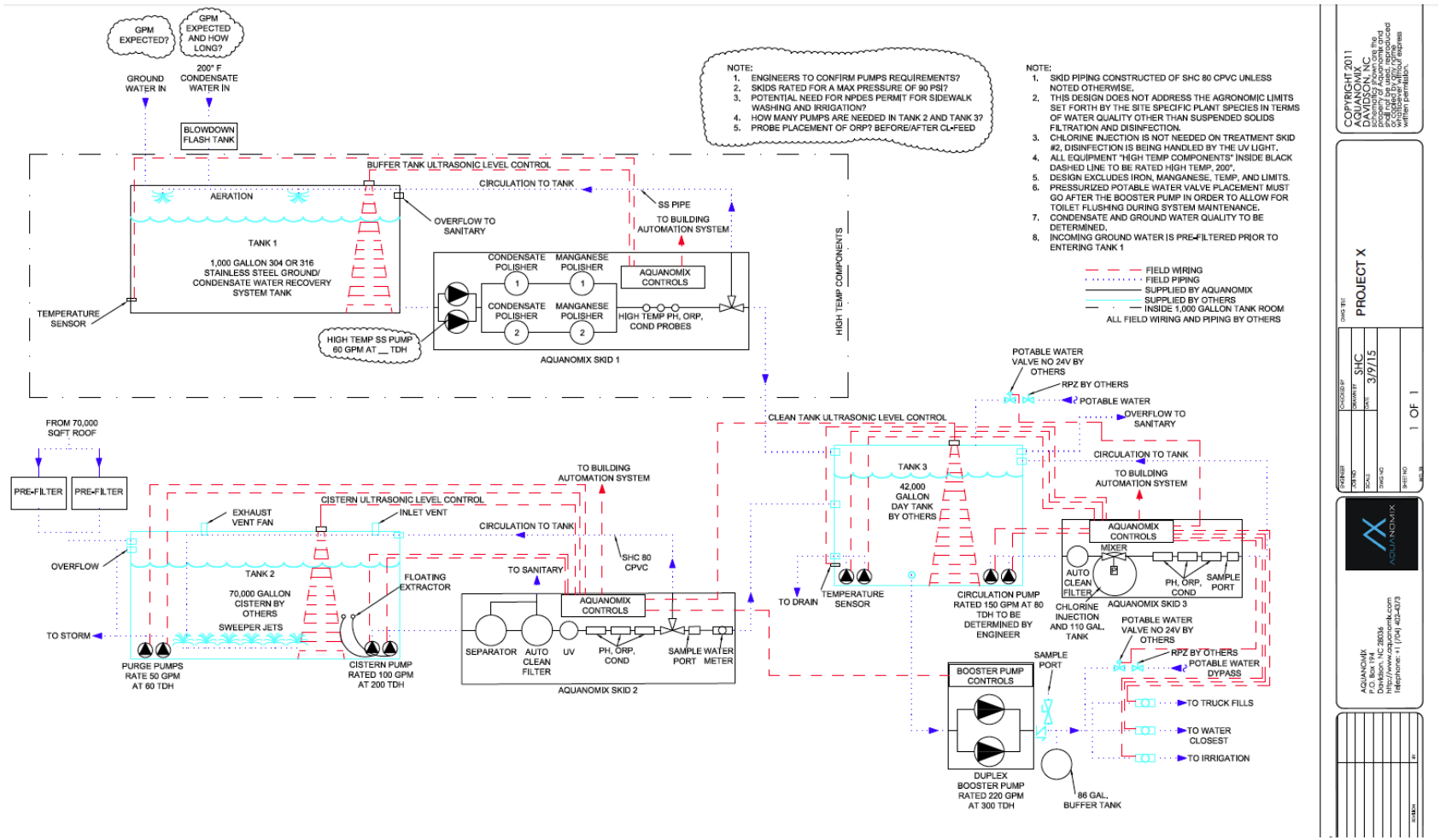
## Project X

Details:

| | |
|---|---|
| Facility Type: | Expansion of largest convention center and exhibition complex in Northern CA |
| Building Size: | Currently 700,000 sq. ft. |
| Expansion: | Adding 550,000 sq. ft. |
| Cistern Size: | 110,000 gallon underground storage |
| Water Source: | Rainwater, groundwater, storm water, steam condensate |
| Water End Use: | Water closets, irrigation, truck filling (to wash city streets) |
| Date Opening: | Summer 2018 |
| Goal: | LEED® Platinum |

# Water Reuse: Case Study

## Project X



## The Future

Water Reuse:

- Decreases a facility's utility operating expenses
- Serves as a redundant water supply for critical facilities
- Can contribute points towards LEED® certification
- Can be an integral part of storm water management calculations and design in areas with moderate to heavy rainfall

Being sustainable is more than an environmental gesture.
It makes long-term economic sense.

# Water Management & Optimization

## A Focus: Evaporative Cooling

*Water needs appropriate treatment and control to maintain the value of a cooling water system to the process it serves.

## Water: What Causes Problems + Failures?

- Scale Formation
- Corrosion
- Biofouling
- Conductivity
- pH
- Flow Rates
- High Turbidity
- Incorrect Cycles of Concentration
- Water Loss
- Stagnant Water

# Potential Dangers of Poor Water Quality

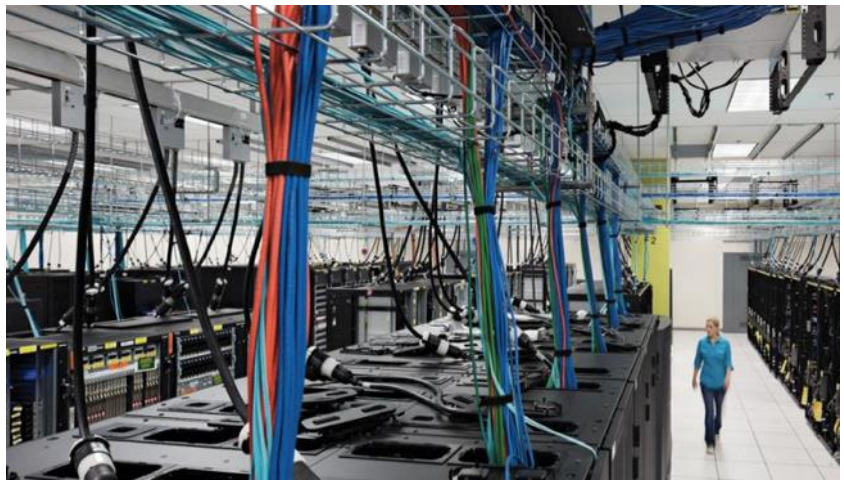
- More frequent shutdowns for cleaning & replacement of system components
- Increased maintenance cost
- Equipment repair or replacement cost
- Reduced heat-transfer efficiency leading to reduced energy efficiency
- Increased energy consumption
- Potential product yield reduction or plant shutdown
- Environmental compliance complications
- Increased greenhouse gas emissions due to higher energy use

## Case In Point

David Troup, VP of Mechanical Engineering, HOK, St. Louis on a data center that had suitable redundancy on all major systems.

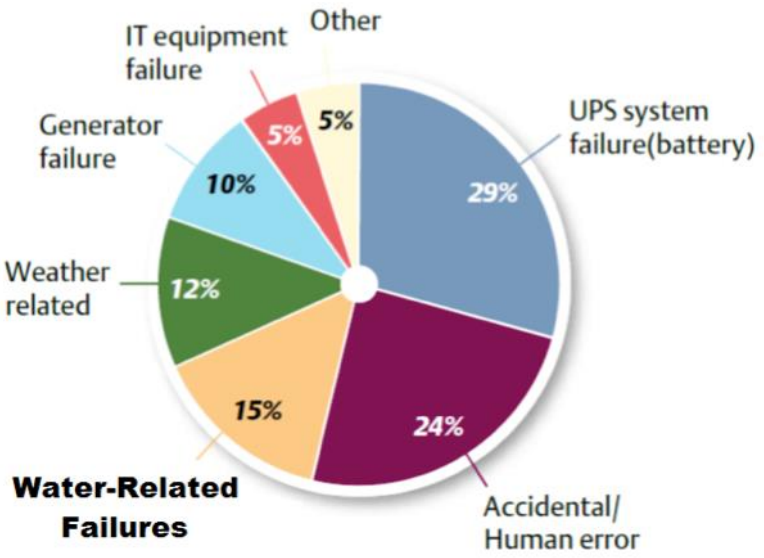
"The tendency is to look at the big equipment and miss the little things like cooling makeup water," said David Troup.

- **Problem:** Getting makeup water to the cooling tower
- **Cause:** A failure at the pump controller took all pumps offline
- **Solution:** Installed a dedicated pump & pump riser to feed the cooling tower



# Critical Asset Preservation & Operational Risk

- One out of every 500 data centers has a severe disaster annually
- Estimated $500,000 per water-related event
- Cost of network downtime ranges from **$350,000 to $11 million** with an average annual loss of $5 million

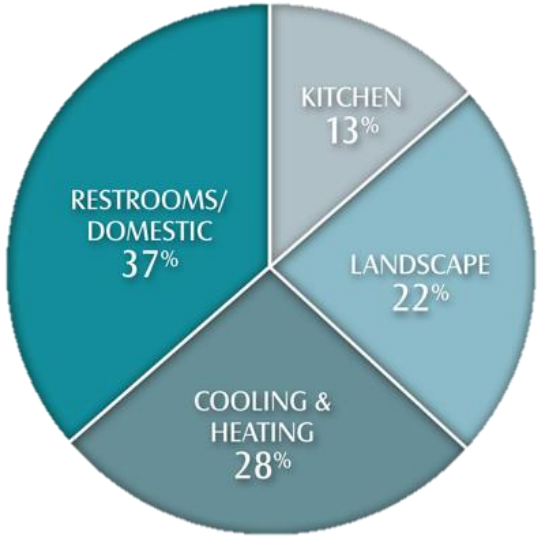



Primary Root Causes of Downtime

*Source: Emerson Global Data Center, Waste Reduction Partners, Manufacturers; Trane, York, Carrier, McQuay, ASHRAE Journal, Air-Conditioning and Refrigeration Institute (ARI)

# Critical Asset Preservation & Operational Risk

- Evaporative HVAC systems are typically the greatest single user of building water + energy
  - Can account for 20% - 40% of facility's energy consumption
- On average, a poorly maintained cooling tower can reduce chiller efficiency by 10% to 35%
- Water and energy efficiency is critical to the financial bottom line, carbon footprint, ROA




Facility Energy Consumption

Sources: Facility Executive, Mary Ann Dickinson & Bill Hoffman Jr: http://facilityexecutive.com/2014/12/special-feature-water-conservation-the-rising-tide/

# Critical Asset Preservation & Operational Risk

## The Cost of Inefficiency in a 1,000-ton Chiller Plant

- Assuming 10% decreased energy efficiency
- Average annual electric utility cost: $127,500
- Annual cost of WASTED ENERGY: **$12,750**

Assumptions: .85kw/ton, $0.06/kwh, 2500 EFLH*

Source: Chillergy Systems LLC; photo courtesy of Ayers Saint Gross, University of Rochester

# Regulatory Compliance

California's new Title 24, California Code of Regulation

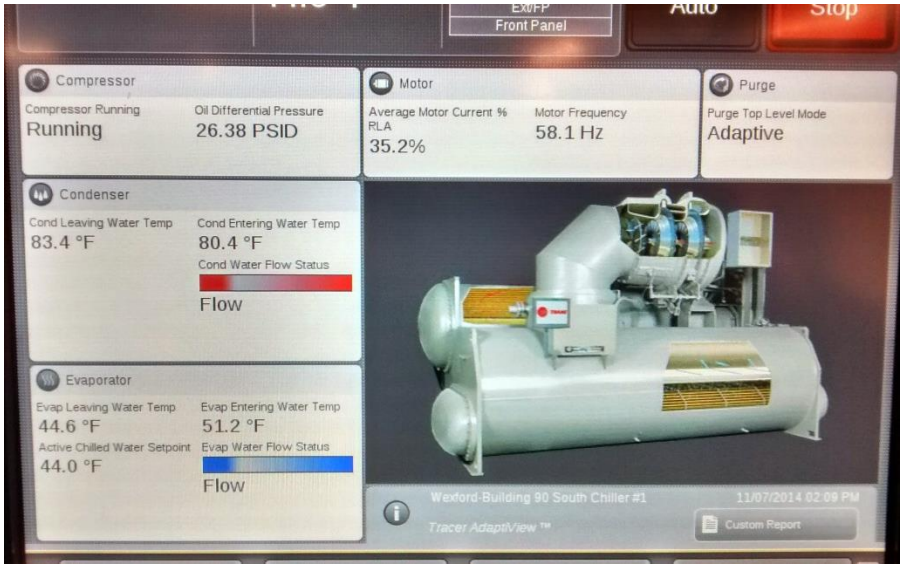
Effective in July of 2014, all buildings in California must now comply with specific Building Energy Efficiency Standards according to Title 24 Energy Code Regulations, which include:

- Automate chemical feed program
- Document max achievable cycles of concentration
- Flowmeter with analog output
- Overflow alarm

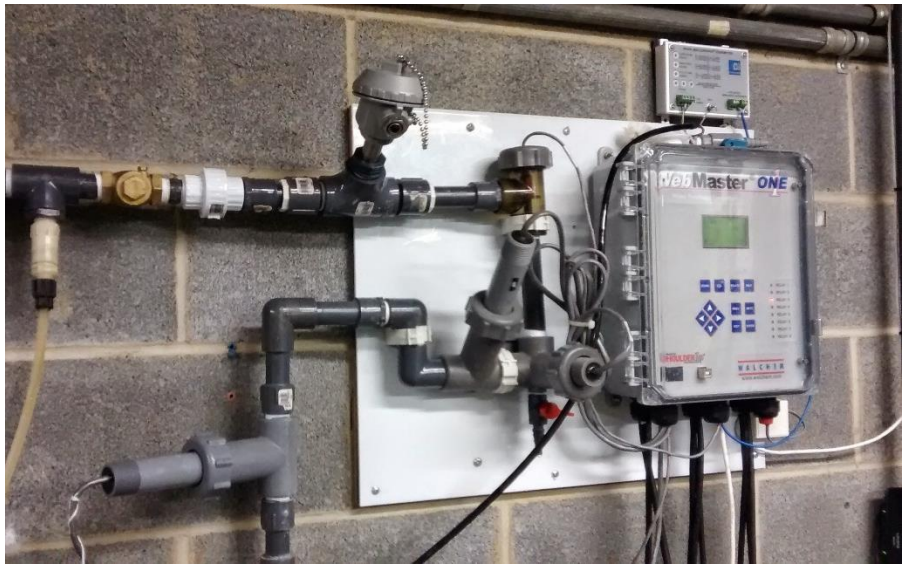

# Separate Data Silos Combined

MECHANICAL ROOM

CHILLER PANEL




WATER TREATMENT CONTROLLER



# Solutions on the Horizon

Integrated water management technologies that support:

- Capital event avoidance
- Water and energy savings throughout lifespan of HVAC system

Technology Advancements:

- Bridges the gap between heat exchangers and water quality
- Uses key performance indicators to drive continuous commissioning and optimization
- Summary view for quick detection of efficiency and system health via 7x24 remote web access
- Data and Analysis

# Water control management is VITAL.
# You can’t manage what you don’t measure.

- 7x24 continuous monitoring results in decreased probability of:
    - Catastrophic system asset failure
    - Operational risk exposure
- The most robust design can be undermined by human error.

## Conclusion

1. Captured existing water sources can be effectively treated and made suitable for reuse for cooling tower makeup, toilet flushing, irrigation, or other non-potable uses.

2. Water quality significantly affects the performance and lifetime of HVAC equipment in industrial and commercial buildings.

3. Proper chemical treatment and preventative maintenance can help to ensure uninterrupted plant productivity.

4. Continuous and transparent water quality management and water optimization software can reduce operational costs and capital asset risk, as well as support regulatory compliance.

Questions?

**Sample Last Slide**

This concludes The American Institute of Architects Continuing Education Systems Course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