

June



# WATER RECLAMATION AND REUSE

OPTIMIZING EFFLUENT WATER QUALITY

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# THE WATER APOCALYPSE

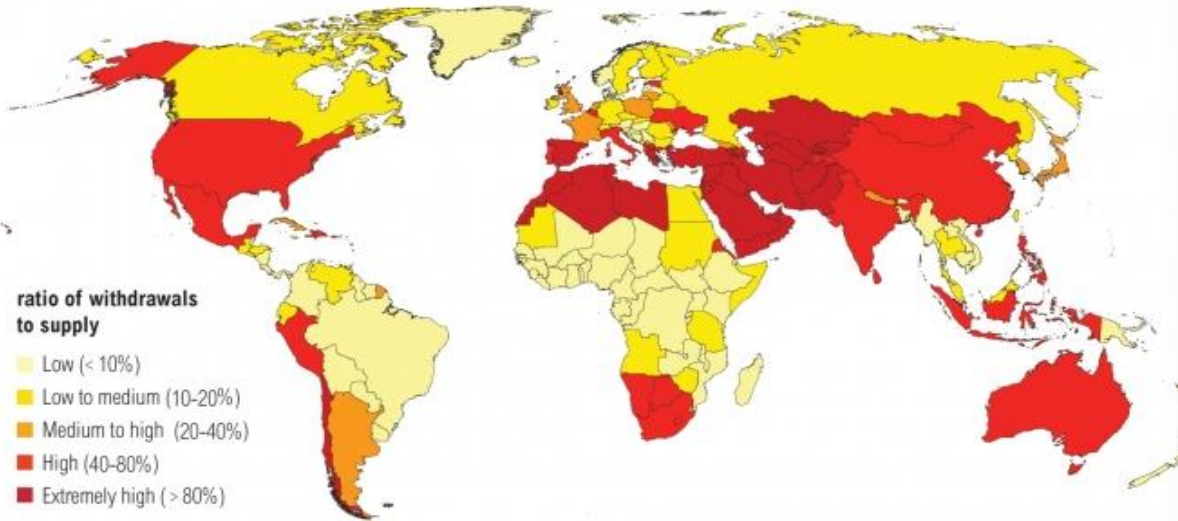


Together These Factors Will Completely Change Water Management



# WATER SCARCITY THREATENS OUR NATION

## Water Stress by Country: 2040



NOTE: Projections are based on a business-as-usual scenario using SSP2 and RCP8.5.

For more: [ow.ly/RiWop](http://ow.ly/RiWop)

 WORLD RESOURCES INSTITUTE

“The United States is on the verge of a national crisis...the situation has grown so dire the US Office of the Director of National Intelligence now ranks water scarcity as a major threat to national security alongside *terrorism*.”





- The Hill, April 2016

**SUSTAINABLE BUSINESS OREGON**

### Drought should be an ever-present concern, even in wet years

The state needs a comprehensive plan for drought periods to prevent issues during drought years, say guest columnists from the University of Arizona and the Oregon Environmental Council.

Apr 28, 2016, 9:56am PDT  
INDUSTRIES & TRADE Insurance, Weather

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Robert Glennon and Samantha Murray

As ancient Roman adage cautions, "In times of peace, prepare for war." The idea is that peacetime provides the breathing room to conceive, plan and execute a military strategy.

Because once war has arrived, it's too late.

**BUSINESS PHASE**

Are you more likely to buy products from B Corporations?

**RELATED CONTENT**

3 questions with the Columbia Riverkeeper Brett Vanderveer

Oregon could be head to water shortages, despite record rain (Video)

**ADDITIONAL TOPICS**

Why some businesses switching to LED lights

**HOME OF THE DAY**

French Chateau Estate

**THE HILL**

**TRENDING:** Donald Trump | Hillary Clinton | Future of Energy

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House bill would require DHS report on...

**HOME, POLICY, ENERGY & ENVIRONMENT**

### Clean water crisis threatens US

3,481  24K  216  COMMENTS 3228

By Sarah Ferris and Peter Sullivan • 04/28/16 08:00 AM EDT

The United States is on the verge of a national crisis that could mean the end of clean, cheap water.

Hundreds of cities and towns are at risk of sudden and severe shortages, either because available water is not safe to drink or because there simply isn't enough of it.

The situation has grown so dire the U.S. Office of the Director of National Intelligence now ranks water scarcity as a major threat to national security alongside terrorism.

The problem is being felt most acutely in the West, where drought conditions and increased water use have helped turn lush agricultural areas to dust.

But dangers also lurk underground, in antiquated water systems that are increasingly likely to break down or spread contaminants like lead.

The crisis gripping Flint, Mich., where the water supply has been rendered undrinkable, is just a preview of what's to come in towns and cities nationwide, some warn.

"We are billions of dollars behind where we could and should be," said Rep. Jared Huffman (D-Calif.), who spent 12 years on a municipal water board before running for state office. "People in the clean-water world would tell you they've been shouting about this for a long time."

**70,000 co-op employees working hard every day to keep the lights on for 42 million consumers.**

**AMERICA'S ELECTRIC COOPERATIVE**

**THE POWER OF RELIABILITY**

**NRECA**  
nreca.org/innovation

**MORE ENERGY & ENVIRONMENT**

Clinton pledges support for economic 'tragedy' in coal country

Obama won't drink Flint's water during visit

Colorado court overrules fracking bans

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Energy & Environment RSS feed »

## Water Scarcity is Not Just a Concern Outside of the U.S.





# INFRASTRUCTURE A NATIONAL CONCERN



**Hoboken, NJ: Water Main Break Causes Massive Sinkhole**



**Atlanta, GA: Water Main Break Causes Extensive Travel Delays and Road Closures**



**Los Angeles: Nearby Water Main Break Causes \$13 Million in Flood Damage to UCLA**



**Chicago, IL: 22 Billion Gallons of Water Lost Annually from One Leaky Pipe**

**Between \$400 and \$600 Billion in Water & Wastewater Infrastructure Needed Over 20 Years**





# TIGHTENING GOVERNMENTAL REGULATIONS

The federal & state regulatory environment is constricting to eliminate ground and surface water pollution as well as provide greater control over critical water resource management. A few regulatory issues driving water reuse:

- A move toward water withdrawal limitations
- Federal mandates to resolve CSO & SSO issues
- Stricter nitrogen & phosphorus discharge standards
- Stricter drinking water testing parameters



Water Withdrawal Limits



Combined Sewer Overflows



Point Source Pollution Control



U.S. DEPARTMENT OF  
**ENERGY**

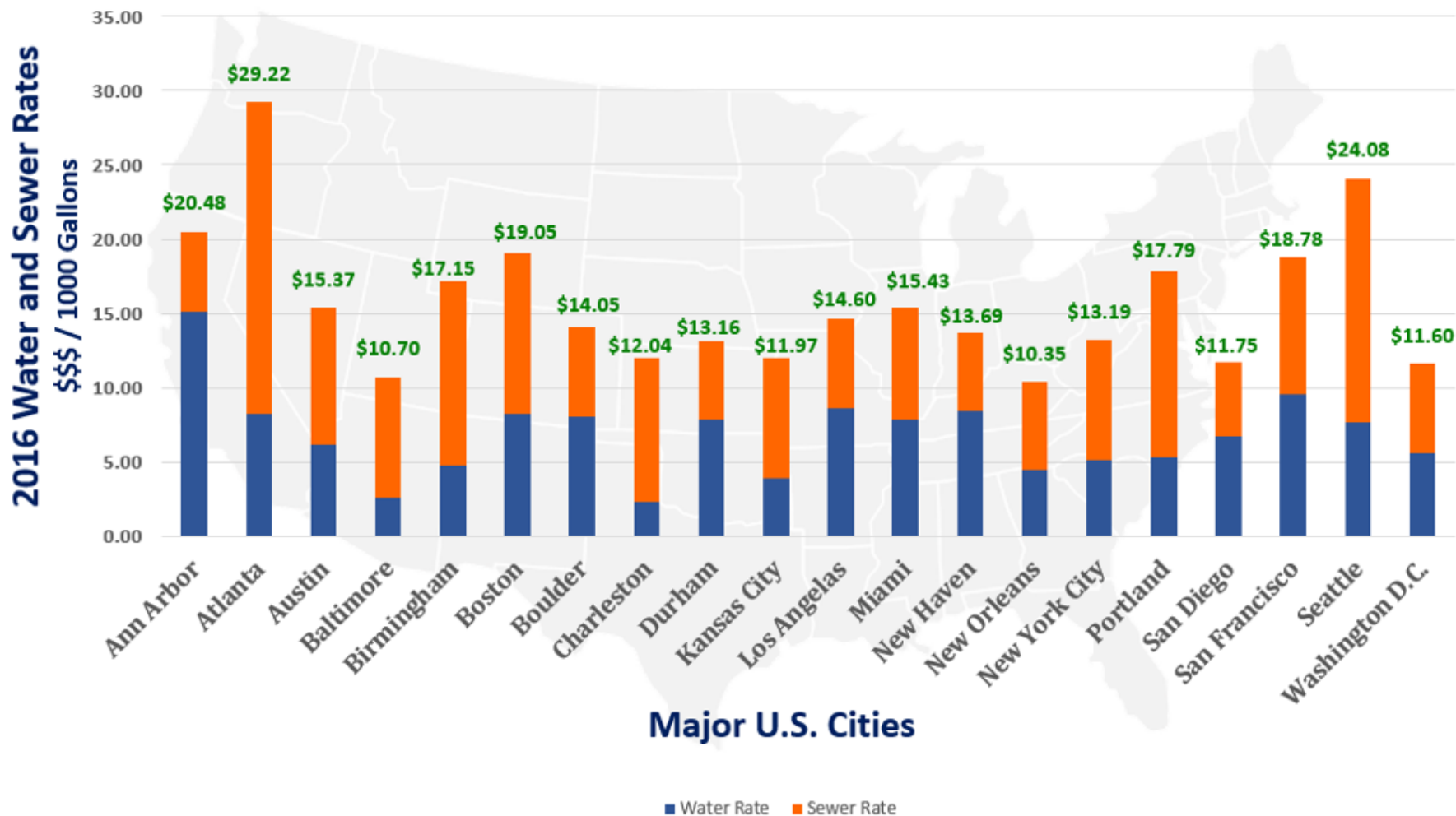


Unfunded Mandates Drive Rate Increases



# HOW RATES COMPARE NATIONALLY

## 2016 Water and Sewer Rates for 20 Major U.S. Cities



The Average Combined Water and Sewer Rate is \$15.72 / 1,000 Gal.





# THE EVOLUTION OF WATER CONSERVATION

LEVEL OF SOPHISTICATION & IMPACT →



STICKERS



LOW FLOW  
FIXTURES



RAIN BARRELS



STORMWATER REUSE



RECLAMATION & REUSE

**SIMPLE SOLUTIONS**

**BUILDING-BASED SOLUTIONS**

**CAMPUS-WIDE SOLUTIONS**

The Most Impactful Solution That Does Not Require Behavioral Change



# FLEXIBILITY: INDEPENDENCE & RESILIENCE

**Reduces  
freshwater  
withdrawal**

**Expands Muni.  
Infrastructure Capacity**

**Additional On-  
Site Storage**

**Reliable & local  
water supply**

**Zero Discharge:  
reduced contribution  
to CSOs and  
wastewater discharge  
to environment**

**Lower Life  
Cycle Costs**

**Protects valuable  
research experiments**

**Minimum recovery time**

**Multiple Benefits Allow for Cross Facility Collaboration**





# A SUSTAINABLE WATER CYCLE...DECENTRALIZED WATER RECLAMATION & REUSE



Risk Management | Cost Savings | Environmental Responsibility



# ECOLOGICAL WATER TREATMENT TECHNOLOGIES



**ReCip®  
Tidal Wetlands**



**Hydroponic  
& Fixed Media**



**Moving Bed  
Bioreactor (MBBR)**



**Membrane  
Bioreactor (MBR)**



**Conventional  
Activated Sludge**



**CAPITAL EXPENSE**



**OPERATING EXPENSE**



**ENERGY EFFICIENCY**



**EFFLUENT QUALITY**



**FOOTPRINT**



**AESTHETICS**



**Innovative Technology Increases Biodiversity & Reduces Energy Requirements**





# RISK MITIGATION



## Provides Critical Infrastructure With

- Redundant water supply
- Additional on-site storage
- Flexibility & Resilience
- Independence/water security
- Minimum recovery time
- Insulation from rising water costs

Delivers Consistent Water Supply, Quality, and Security to Utilities



# THE WATERHUB AT EMORY UNIVERSITY





# FROM CONCEPT TO REALITY



**400K GPD and up to 140M GPY Displaced**  
**Up to 40% of Total Campus Demand**  
**90% of Utility Water Demand**  
**3 Chiller Plants/1 Steam Plant/ 1 Dorm**



**Permitted for Use in Utilities, Irrigations, and Toilet Flushing**





# WATERHUB PROCESS DESIGN

## How the WaterHub Works

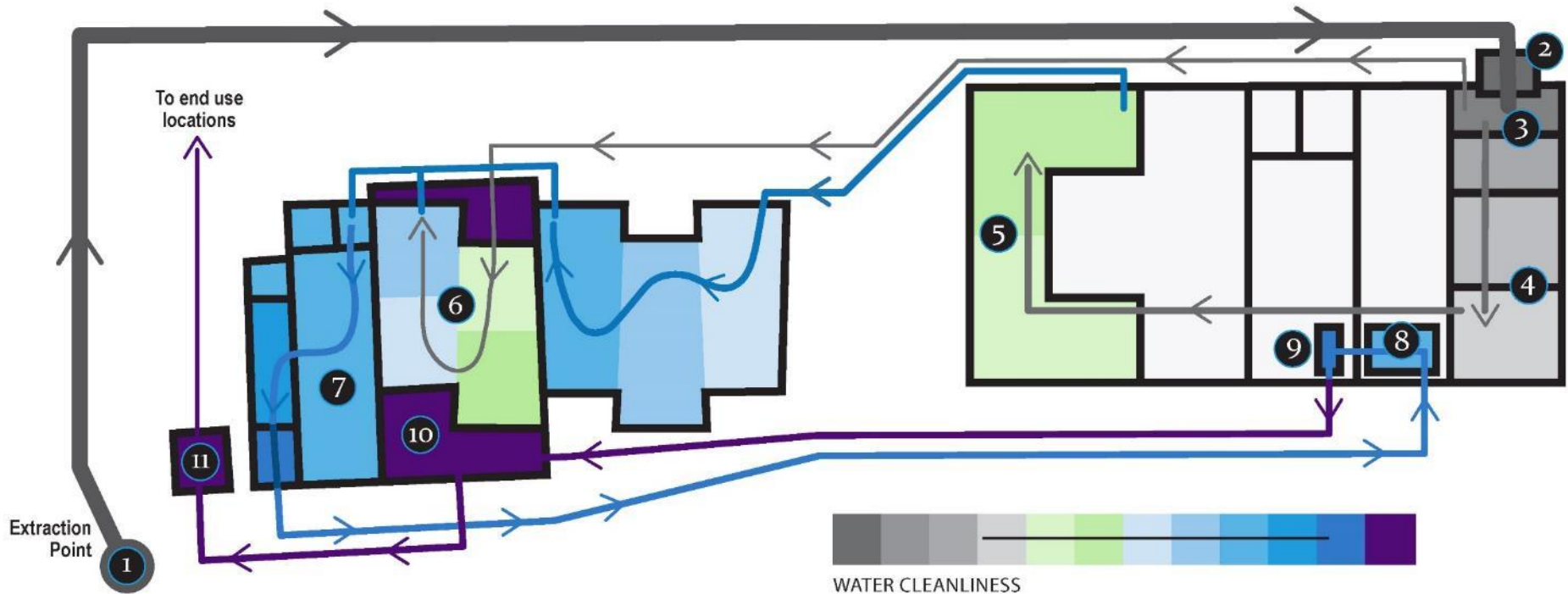
- 1 2 Extraction Point & Rotary Screen**  
Wastewater is diverted from the sewer system and sent through a screen to remove debris.

- 3 Anoxic Moving Bed Bioreactors**  
Wastewater enters a low-oxygen environment where microorganisms living on honeycombed plastic pellets (mid-density housing for microbes) begin to metabolize carbon and nitrogen.

- 4 Aerobic Moving Bed Bioreactors**  
Wastewater enters an oxygen containing environment with a different community of microbes that continue the treatment process. Diffusers add air bubbles to assist treatment. Odorous gasses are removed with charcoal filters.

- 5 Hydroponic Reactors**  
Water clarity increases as water is treated in tanks with suspended plant roots. Water is cleaned by microbes living on the plant roots and on the specially engineered bio fabric (high-density housing for microbes) located below the plant roots.

- 6 Demonstration Reciprocating Wetlands**  
An alternate treatment system, this area demonstrates a highly energy efficient treatment process applicable for rural areas and developing countries. Screened wastewater is pumped to four 8' deep cells. Cells are alternately filled-and-drained 8 to 18 times a day. The system mimics the behavior of natural tidal wetland areas and uses gravel and plant roots to provide microbial habitat.



- 7 Clarifier Tank**  
In a still water tank, Phosphorus and any remaining solids are removed as the particles hit interior baffles and slide to the bottom.

- 8 Disk Filter**  
Very clean water is sent through a felt filter to remove any remaining particulate material.

- 9 Ultraviolet Disinfection**  
Water is treated with ultraviolet light that provides extensive disinfection, producing water that complies with state and local health requirements.

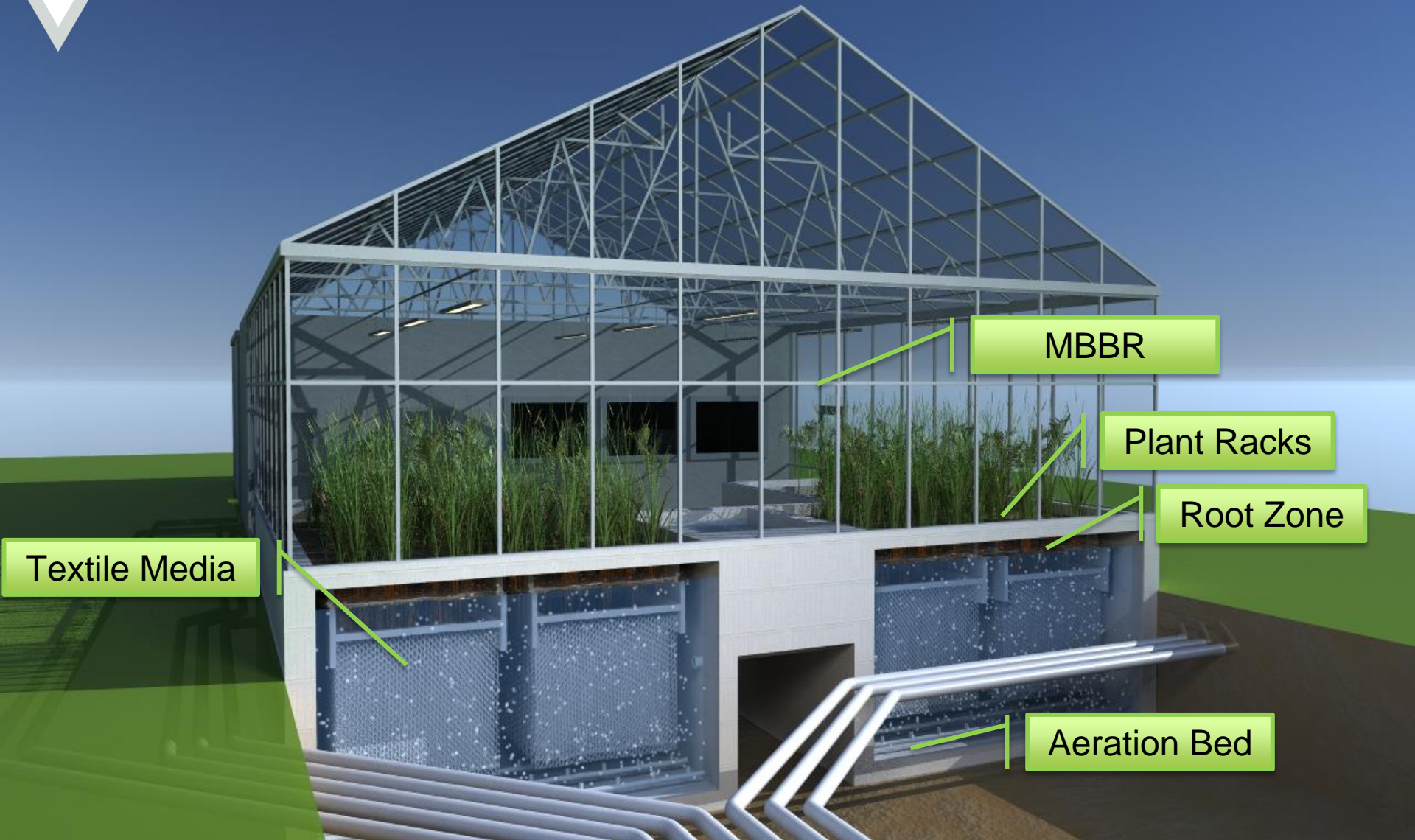
- 10 50,000 Gallon Storage Tank**  
Fully treated water is stored underground as a reserve supply.

- 11 Campus Distribution**  
Water is distributed to the steam and chiller plants for use as process make-up water. In the future, water will be sent to residence halls for toilet flushing.





# GLASSHOUSE (UPPER SITE)



GlassHouse Footprint Compact and Efficient at 2,100 ft<sup>2</sup>



# OUTDOOR SYSTEM (LOWER SITE)

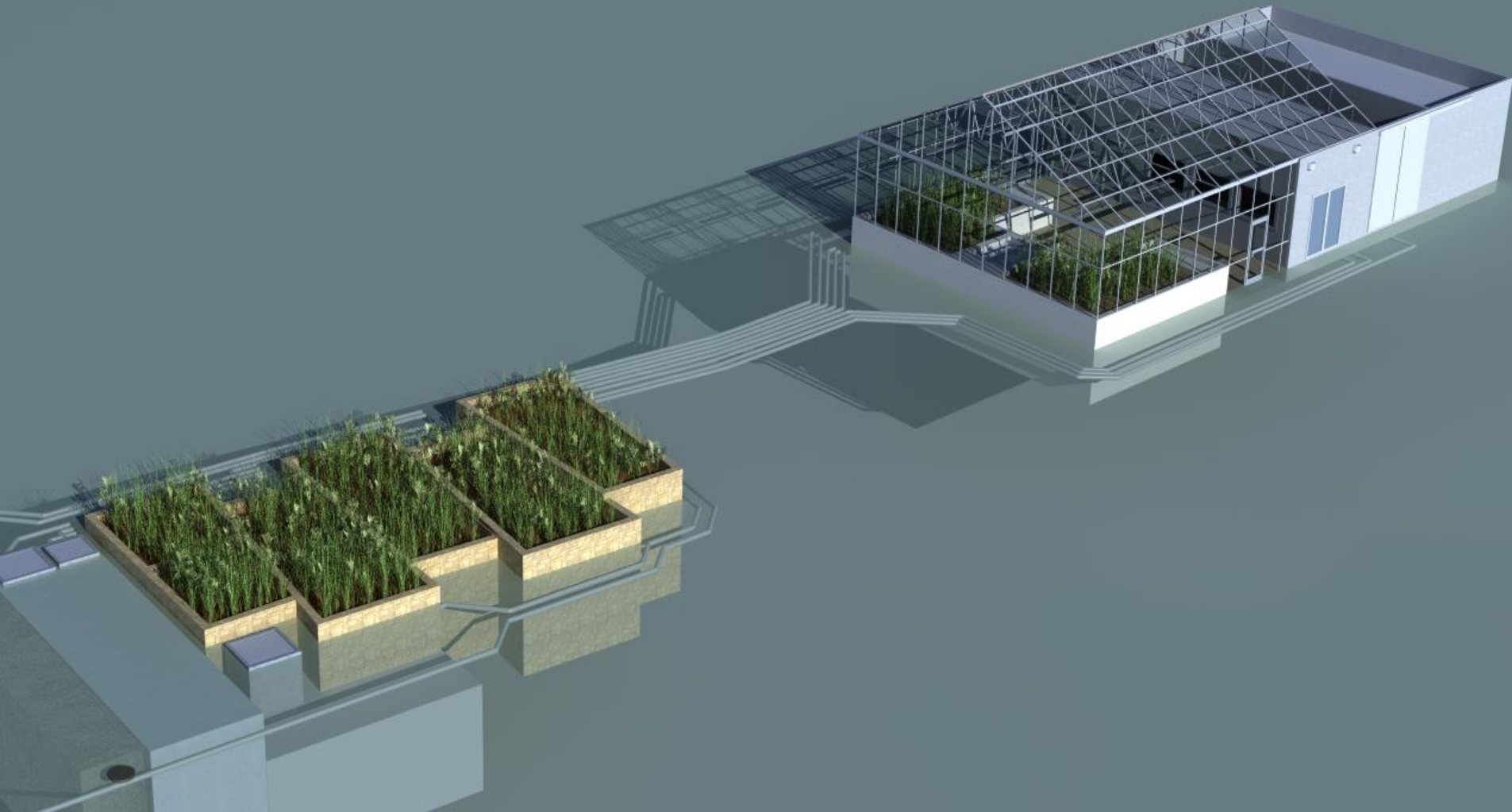


Convergence of Multiple Ecological Treatment Technologies





# ECOLOGICAL TREATMENT DESIGN



Seamlessly Integrated Into the Built Environment



# CAMPUS UTILITY OVERVIEW-STEAM PLANT

Startup Year	1922
Number of Buildings Served	70
Total Square Footage Served	7,500,000 sq. ft.
Central Plant Capacity	500,000 lb/hr steam
Satellite Plant Capacity	N/A
Number of Boilers	5 boilers
Fuel Types	Natural gas, No. 2 fuel oil
Distribution Network Length	3.5 trench miles
Piping Type	Majority Class A direct-buried & some walk-through tunnels
Piping Diameter Range	1-1/2 to 12 inches
System Pressure	125 psig
System Temperatures	44353 F/180 F condensate return
System Water Volume	N/A



Growing Campus: Complex Systems with Critical Loads





# CAMPUS UTILITY OVERVIEW- CHILLER PLANTS



## Emory University Chiller Systems

Startup Year	1960s
Number of Buildings Served	50
Total Square Footage Served	4,390,000 sq. ft.
Central Plant Capacity	20,300 tons (3 plants)
Number of Chillers	20 chillers
Fuel Types	Electric
Distribution Network Length	2.5 trench miles
Piping Type	Direct-buried insulated steel
Piping Diameter Range	4 to 18 inches
System Pressure	90 psig
System Temperatures	44 F supply/54 F return
System Water Volume	295,000 gal

Growing Campus: Complex Systems with Critical Loads



# CAMPUS WATER FOOTPRINT, FY13-14



We looked at where we currently use the most potable water in our facilities — *applications where we don't really need drinking-water quality water* — and it came down to our toilets, our steam plants and our chiller plants.

- Brent Zern, Assistant Director of Operational Compliance and Maintenance Programs, Emory University

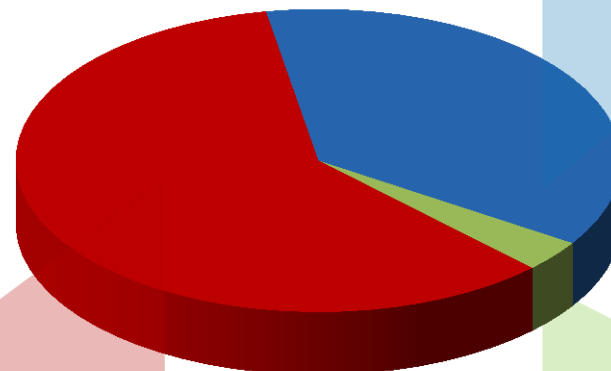


HVAC

122,973,384  
37%

333 Million  
Gallons Per Year

EMORY



198,711,516  
60%

Domestic/Sanitary



11,141,100  
3%

Irrigation



- Utilities
- Irrigation
- Domestic
- 

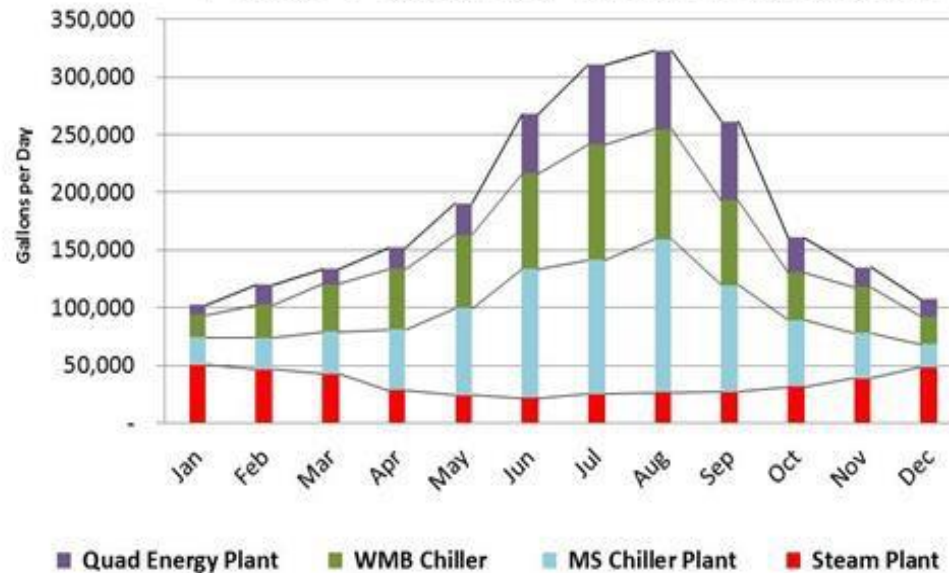
40% Non Potable Demand Identified and Strategy Formulated



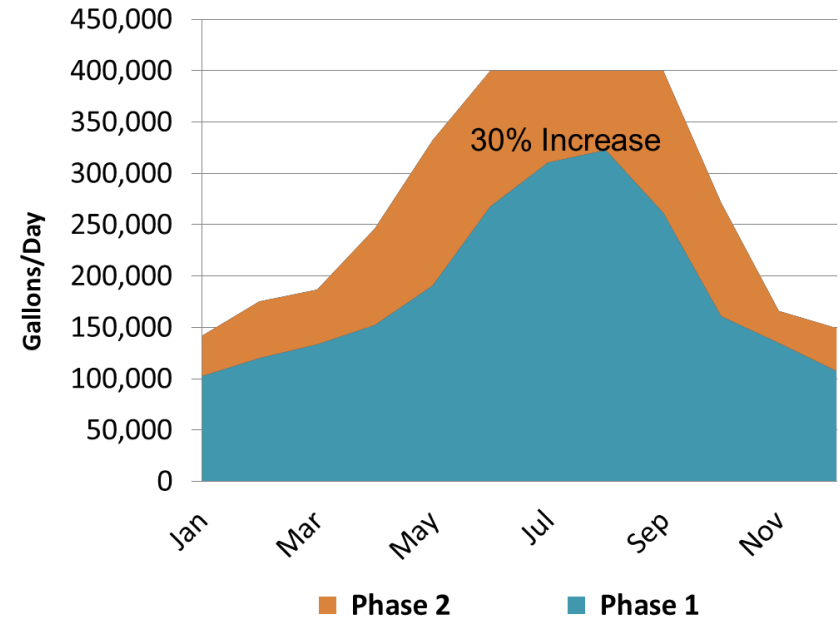


# RECLAIMED WATER DISTRIBUTION

## Phase 1 Reclaimed Water Distribution



## Phase II Reclaimed Water Distribution Expansion

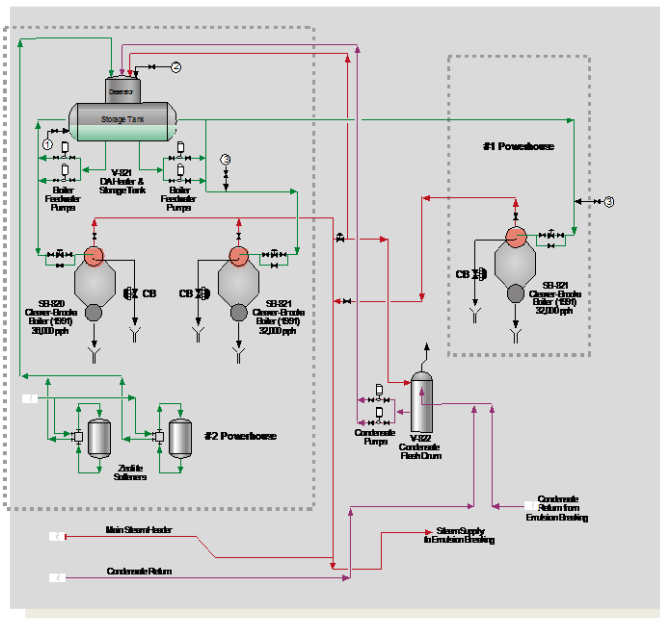
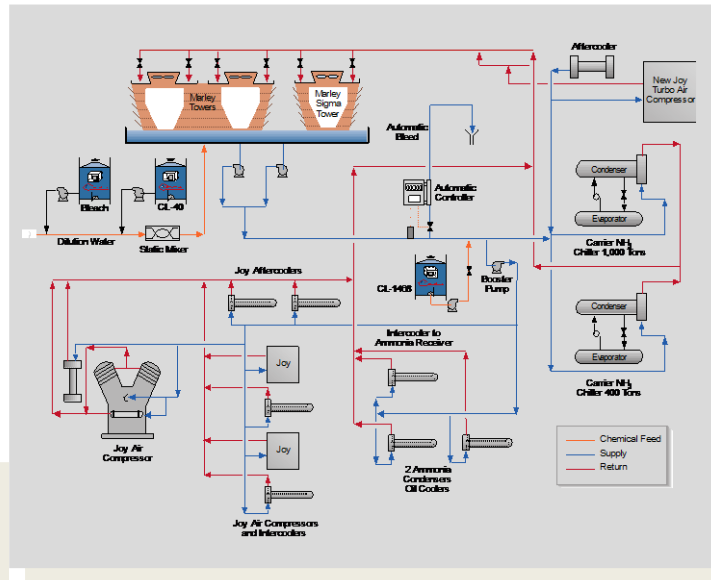


Additional Reclaimed Water Supply Will Address Future Demands



# UTILITY ASSESSMENT OVERVIEW

- Biological studies
- Corrosion studies
- Automation
- Treatability studies
- Equipment integrity



## Recommendations:

- Treatment specifications
- Conservation
- Training
- Modifications
- Mechanical



Systematic Audit of Existing Conditions to Confirm Reliability





# UTILITY WATER ASSESSMENT PROCESS



Equipment Inventory



Equipment Conditions



Operations & Maintenance



Treatment Program Admin



Reclaimed Water Modeling



Process Design

Plant Recommendations:  
Products | Equipment | Operations

Utility Systems Inform Process Design & Total Water Management Approach



## A & W TREATMENT OVERVIEW

- Goals: Corrosion, Deposition, & Biological
- Areas of Concern: Diurnal & Seasonal Variability
  - Phosphate, Chloride, Sulfate, Ammonia, TSS
  - Demand cycles: Off-line Condensers
- Solutions:
  - Chemistry:
    - Custom Polymer, Halogen, Non-Oxidizing Biocide
  - Equipment:
    - Direct PTSA Control, ORP, pH, Web-Based Data
  - Service:
    - Corrosion Monitoring, Bacteria Study, Lab Analysis





## PROGRAM RESULTS

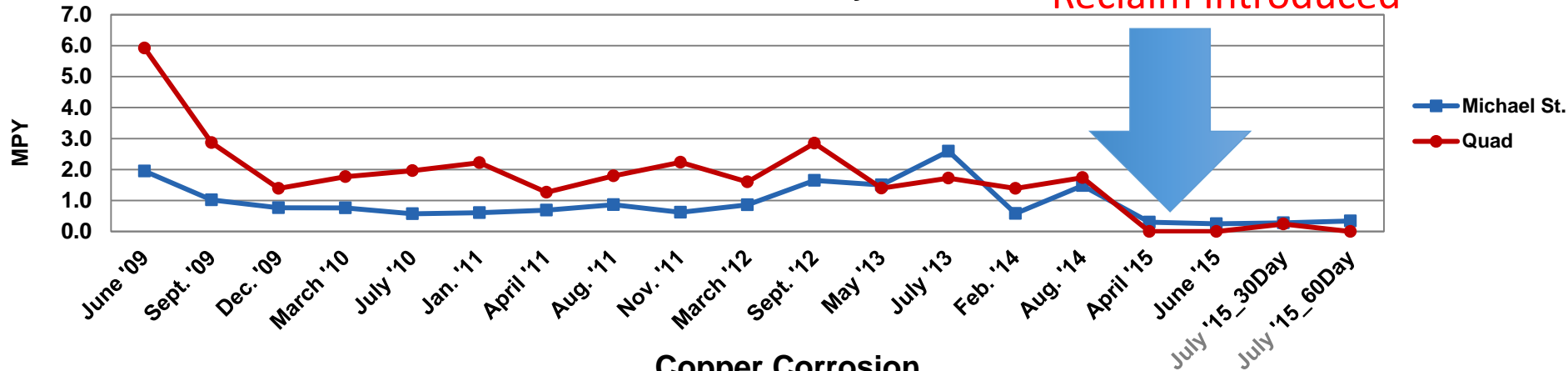
- Reclaimed Water Successfully Replaced City Water - 10 million gallons per month
- Displaced 99% of potable water for utilities
- During a very hot 2015
- Corrosion: < 0.5 MPY Steel, < 0.1 MPY Copper
- Biological: < 1,000 cfu/ml
- Deposition: No issues, consistent approaches



# MILD STEEL & COPPER CORROSION CHILLERS

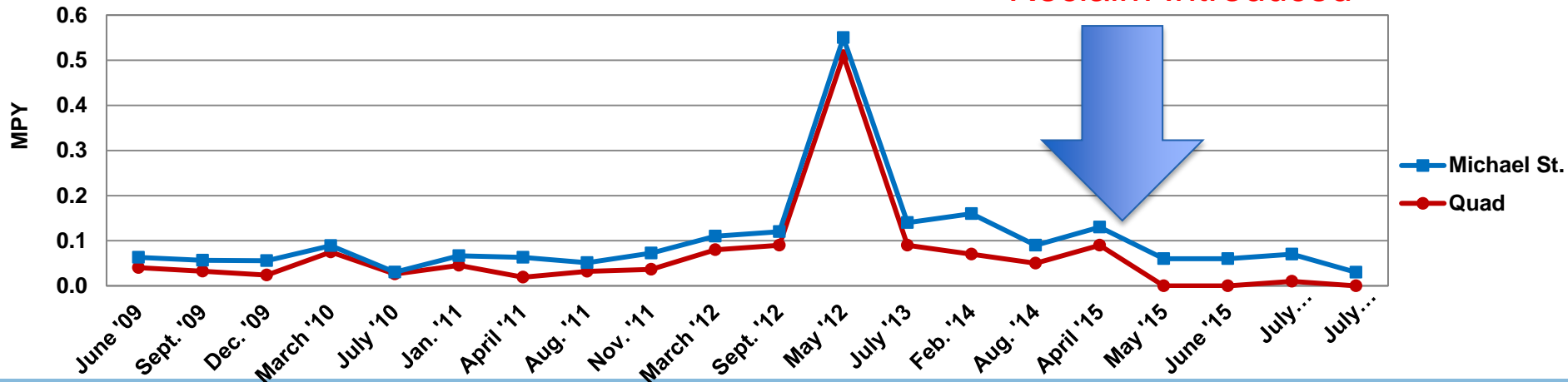
Mild Steel Corrosion  
June, 2009 - July, 2015

Reclaim Introduced



Copper Corrosion  
June, 2009 - July, 2015

Reclaim Introduced



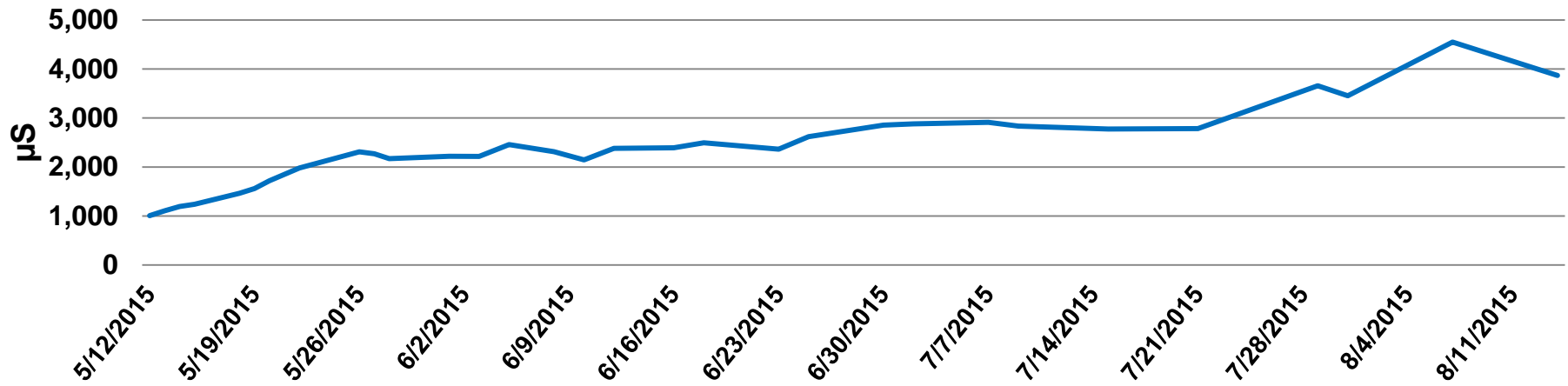
Program Delivers 50% Reduction in Corrosion



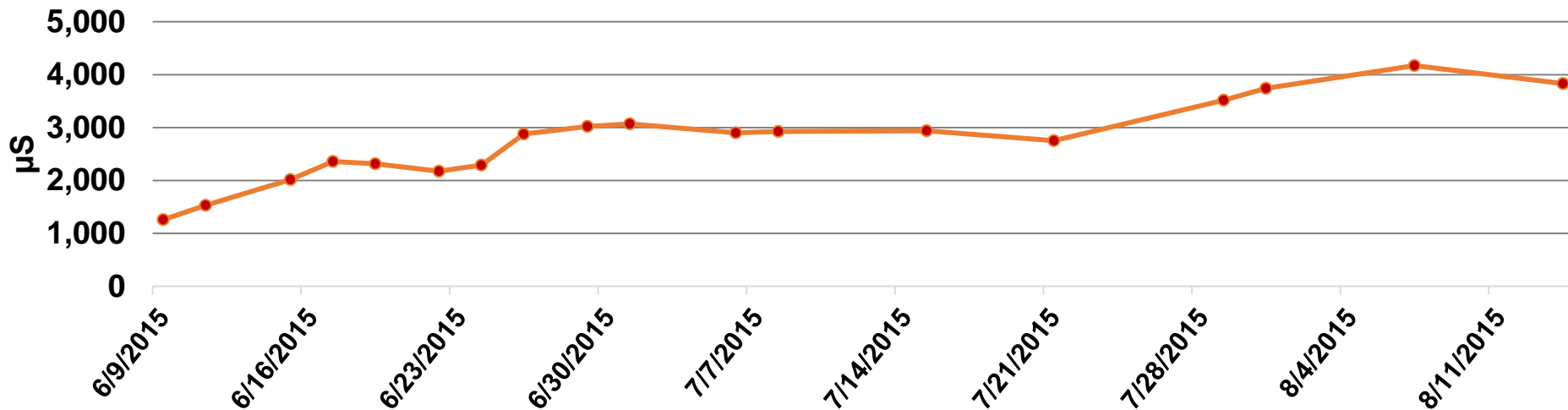


# TOWER CONDUCTIVITY

Conductivity, Michael Street Tower



Conductivity, Quad Tower

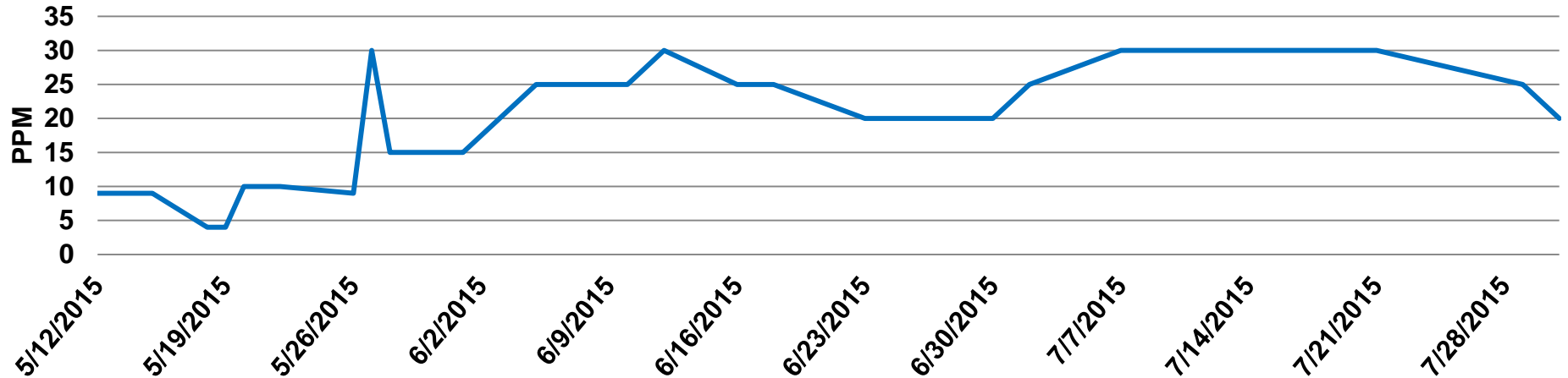


Automation and Treatment Program Maximizes Cycles

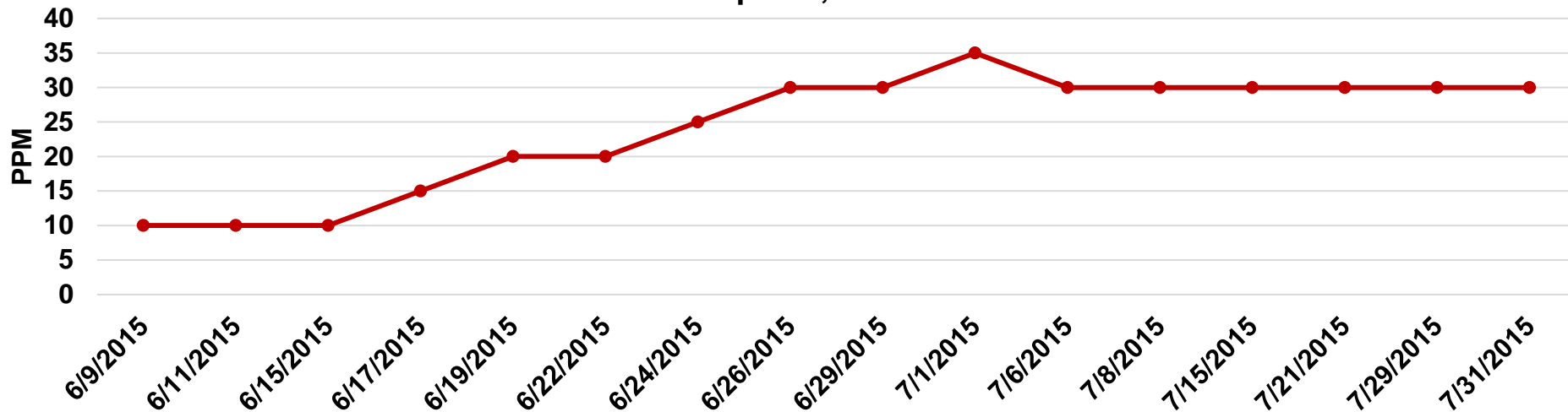


# TOWER ORTHO PHOSPHATE

Ortho Phosphate, Michael Street Tower



Ortho Phosphate, Quad Tower

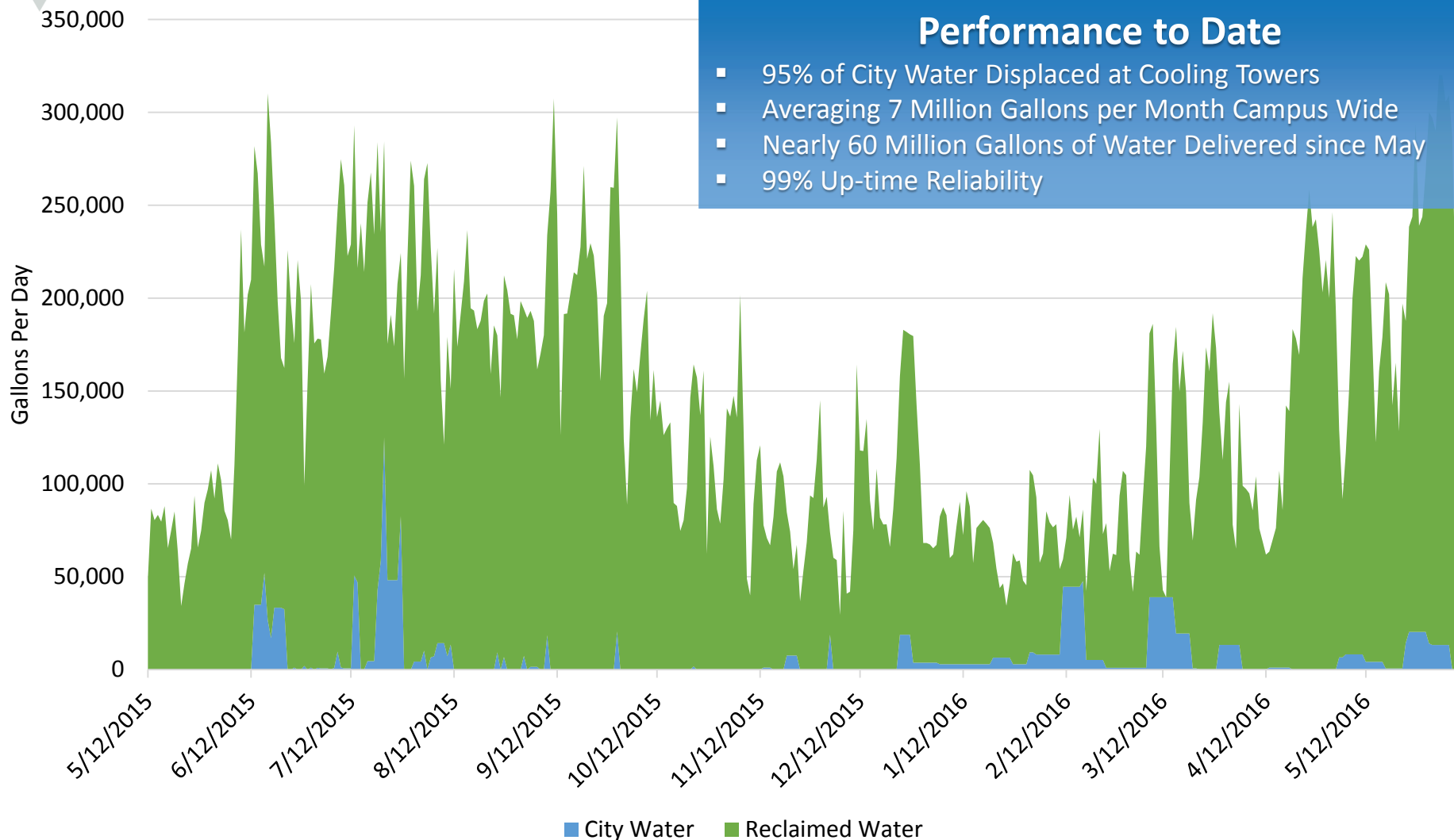


Specialized Program Leverages Available Phosphate in Reclaimed Water





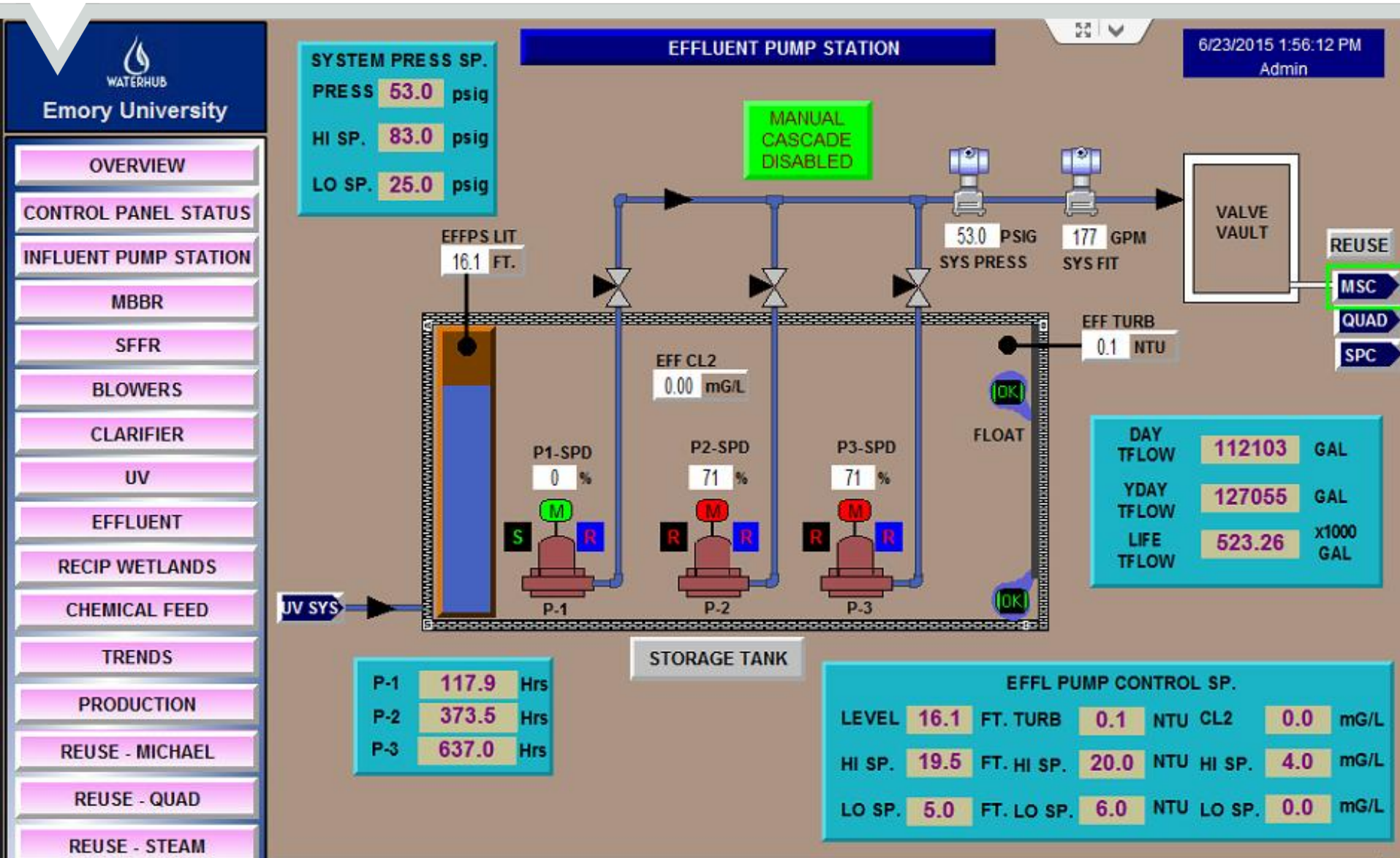
# HISTORICAL WATER USE AT END USERS



Reliable Supply of Reclaimed Water with Proven Results



# STATE OF THE ART CONTROLS

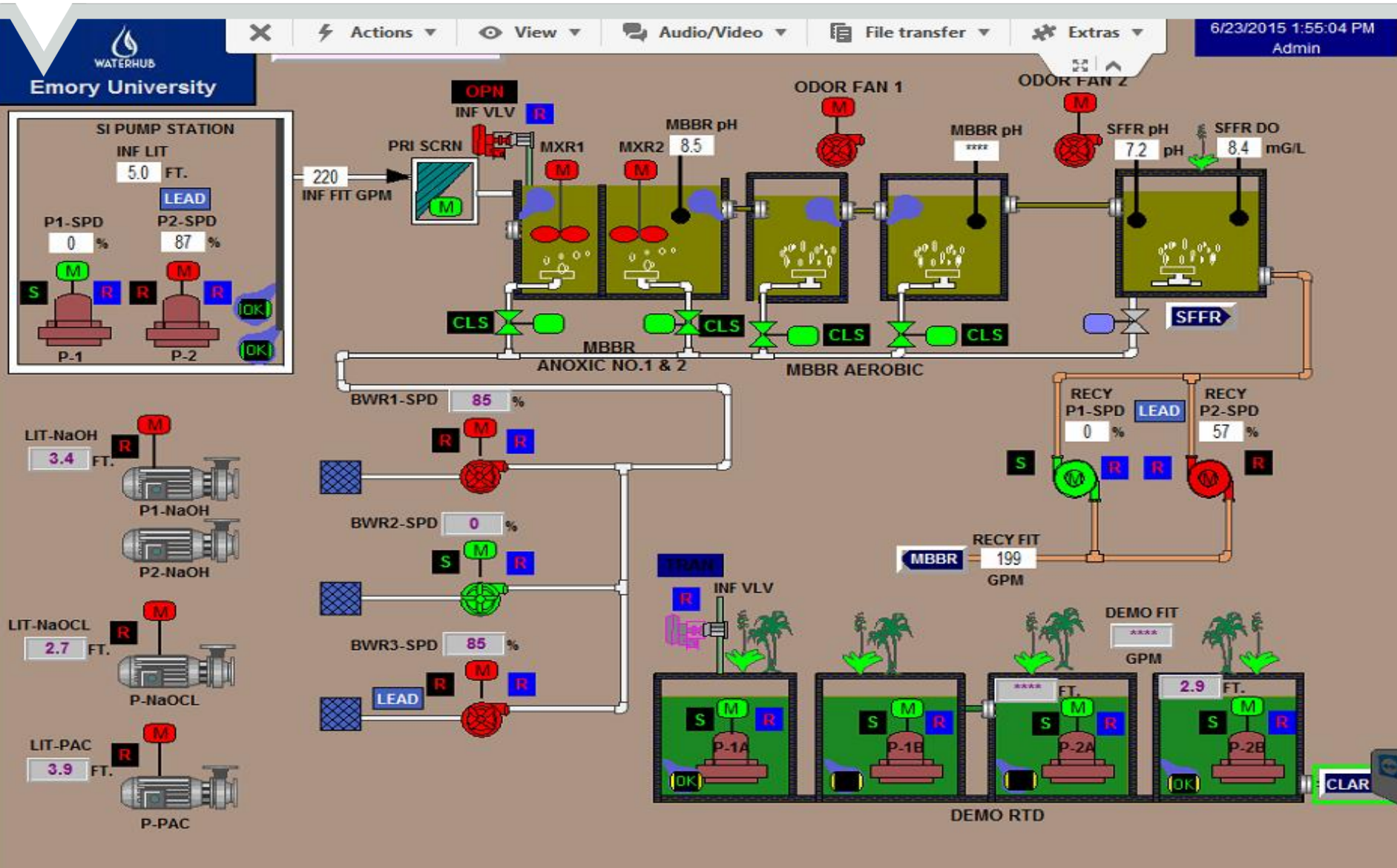


Real Time Remote Access Allows for Proper Oversight

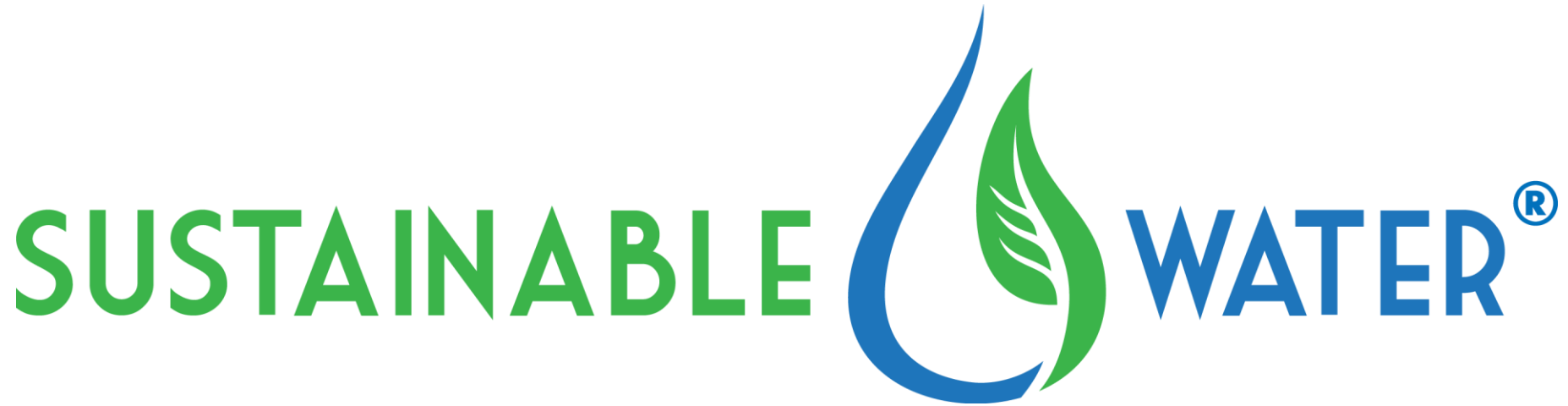




# STATE OF THE ART CONTROLS



Real Time Remote Access Allows for Proper Oversight



EXTENDING THE LIFECYCLE OF WATER

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