



UVLEDs: From the Plant to the Pipe

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Thursday 28th 2022

PNWS-AWWA

OVERVIEW

1. UV and UVLED basics

2. UVLEDs at the plant (*centralized treatment*)

Typhon case study – 8MGD

Aquisense case study- 2 MGD

METAWATER case study- 1 MGD

3. UVLEDs in POE/POU systems (*decentralized treatment*)

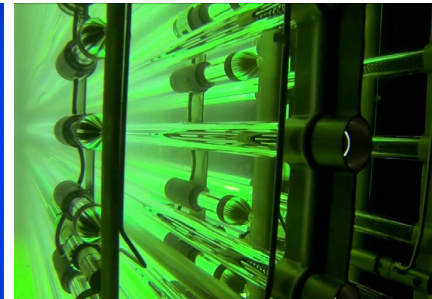
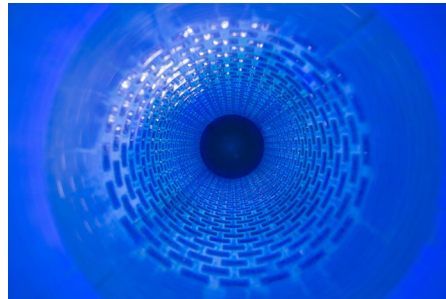
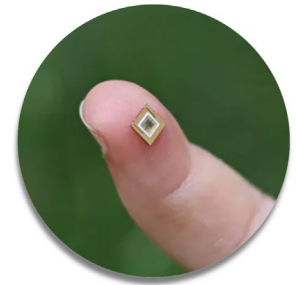
Potential advantages

Research Needs

UV light emitting diodes (UVLEDs)

UVLEDs are an emerging UV technology with several characteristics that make them ideally suited for water treatment.

	LED	Mercury
Lifetime [hrs]	20,000+	8,000 to 15,000
ON/OFF cycles	Unlimited	4 per day
Operating temp	Ambient	100 to 600 °C
Warm-up time	100 mS	Up to 10 min
Mercury content*	-	20-600 mg +



Three-State Area Threatened by Chlorine Shortage

T

Jun

Cities ask people to reduce water use due to chlorine shortage

By Associated Press

Published: June 19, 2021, 4:40pm

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FEATURED

Update / Chlorine Shortage: State issues advisory

The Chronicle Jun 18, 2021 Updated Jun 29, 2021 0



Just The Facts

OEM said there is no need to start amassing additional volumes of water.

TOP STORY

West Coast chlorine shortage reaches Eastern Oregon

By CARLOS FUENTES The Observer Jun 29, 2021 0

A chlorine shortage could put Oregon's drinking water at risk



By Alex Hasenstab (OPB)

Published: June 19, 2021, 4:40 a.m.

Water is currently safe, and the public will be notified if it's not

Experiencing a shortage of chlorine, the chemical used in small amounts by water utilities to prevent harmful bacteria growth in drinking water supply. State officials say plan to help water districts across Oregon get the chlorine they need if their stockpiles there's no threat to the water the public depends on.

Water use during

Salem reassures residents water is safe amid chlorine shortage



Virginia Barreda

Salem Statesman Journal

Published 6:20 p.m. PT June 17, 2021 | Updated 7:18 p.m. PT June 17, 2021

View Comments



State officials are scrambling to address a potential shortage of chlorine, a

AT THE PLANT: COST CONSIDERATIONS

What are the highest costs for traditional mercury systems?

- *Electrical requirements/ maintenance*
- *Ballast replacement*
- *Wiper seals*
- **Lamp replacement**

Replacement costs of mercury lamps are high:

Mercury lamps have to be replaced annually to every few years

- Delicate, difficult, hazardous process

Anecdotal evidence- Aurora Binney Water Treatment facility (50 MGD), 2019

- 6,900 mercury lamps that are replaced annually
- One operator can effectively change ~20 bulbs/day
- Need one operator who is a full-time bulb replacer



CENTRALIZED CASE STUDY 1 : TYPHON- 8MGD DRINKING WATER FACILITY

Implemented the first UVLED reactor for disinfection

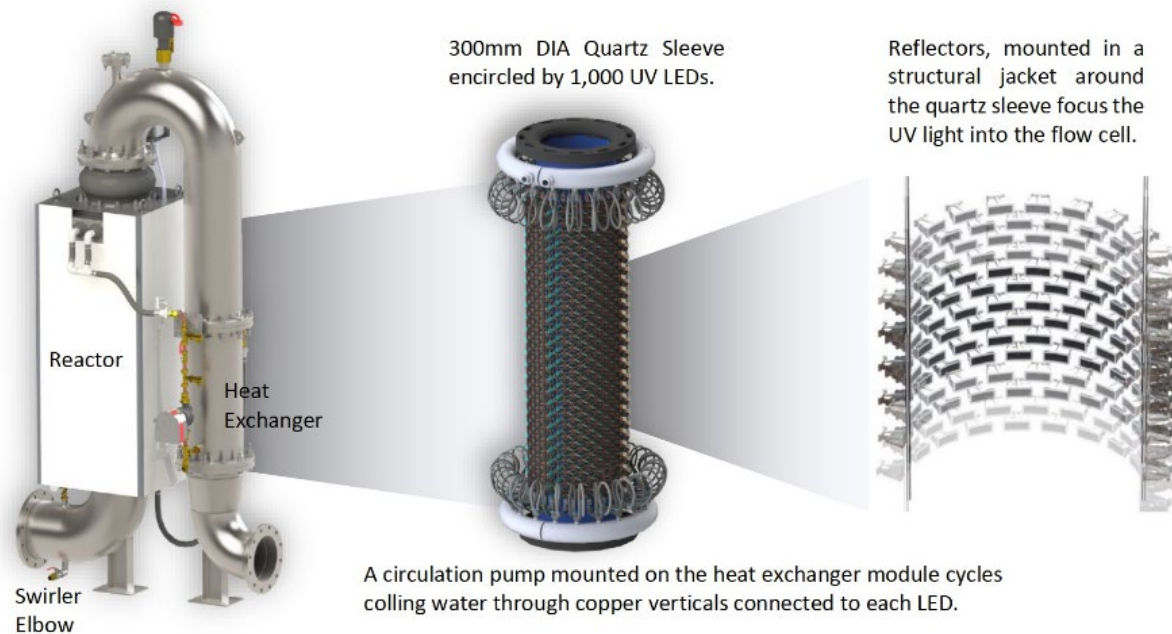
1. USEPA UVDGM Validated up to 2.6 MGD
2. LEDs provide increased component reliability and reduced maintenance with no hard water scaling of quartz.
3. Designed for >90% UVT applications
4. LEDs replaced every (3-4 years now, 4-5 years in future)
5. Reactors are in-line:
 - Reduced instrumentation
 - one flow meter
 - no mercury trap
 - no duty changeover sequence
 - One goes down, others go up without delay.
 - All maintenance can be performed while flow is on due to immediate dose compensation



CENTRALIZED CASE STUDY 1 : UK MARKET

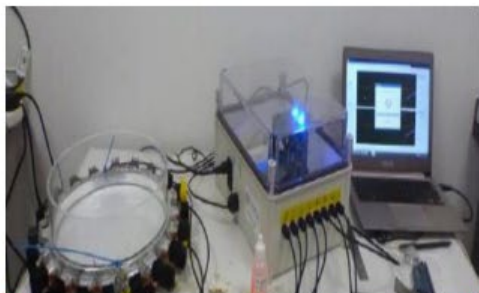
TYPHON- 8MGD DRINKING WATER FACILITY

The key elements of the Typhon BIO-310 UVLED reactor



CENTRALIZED CASE STUDY 1 : UK MARKET

TYPHON- 8MGD DRINKING WATER FACILITY



Lab scale
Treatment for **5 litres/day**

1.32 gal/day



24
months



Pilot plant scale
Treatment for **6,000,000**
litres/day

1.6 MGD



12
months



Full scale implementation
Treatment for **30,000,000**
litres/day

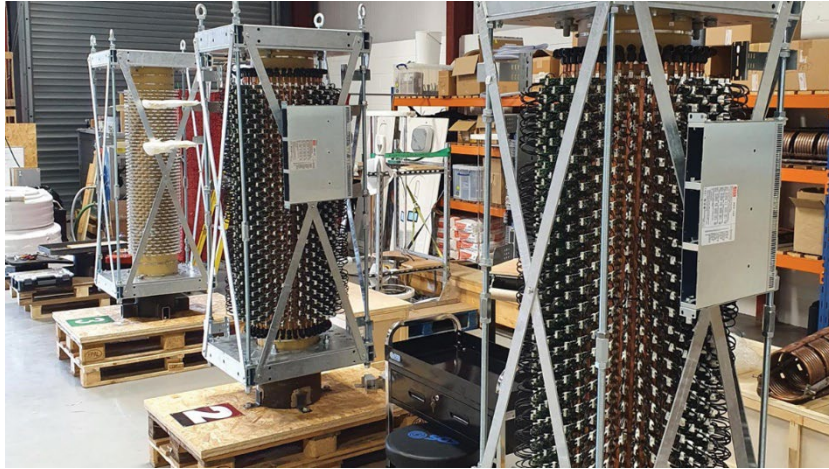
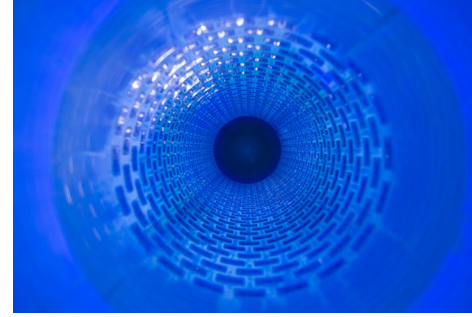
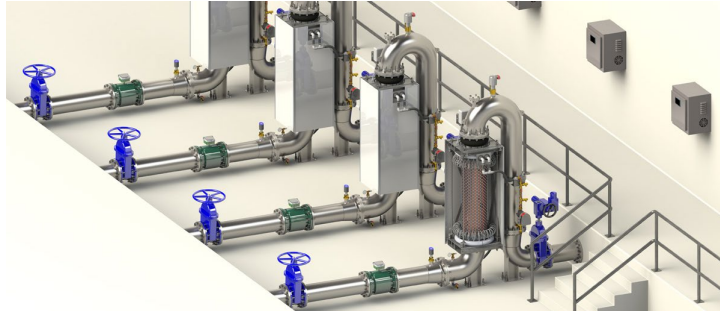
7.9 MGD

Proven for biological and taste and smell at large scale – a real scientific breakthrough and game-changer:

- This new technology uses up to 90% less energy, is more flexible and easier to operate
- Technology reduces reliance on chemical use
- Provides solution for increased resilience in water treatment
- Offers precision control for efficiency optimisation
- The physical footprint is up to 75% less than a traditional solution

CENTRALIZED CASE STUDY 1 : UK MARKET

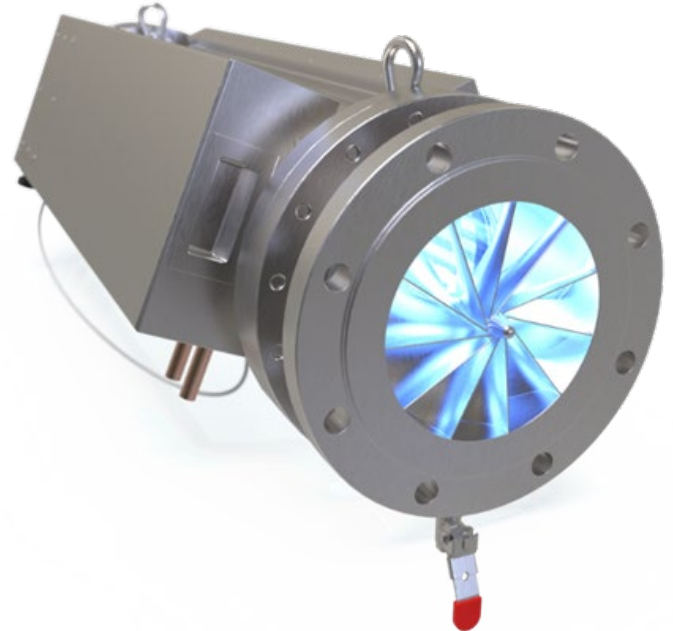
TYPHON- 8MGD DRINKING WATER FACILITY



CENTRALIZED CASE STUDY 2: US MARKET

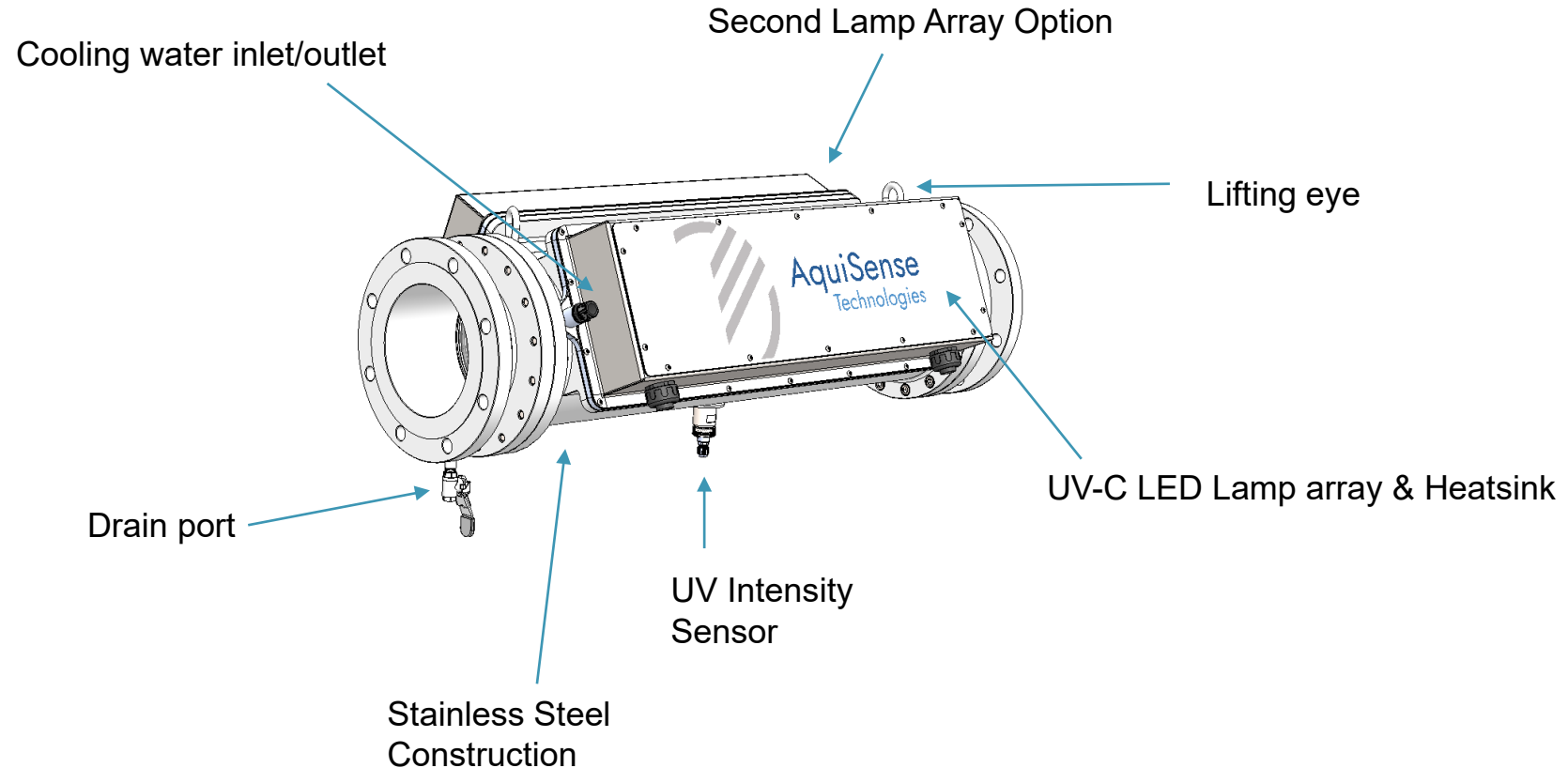
Aquisense PearlAqua Tera

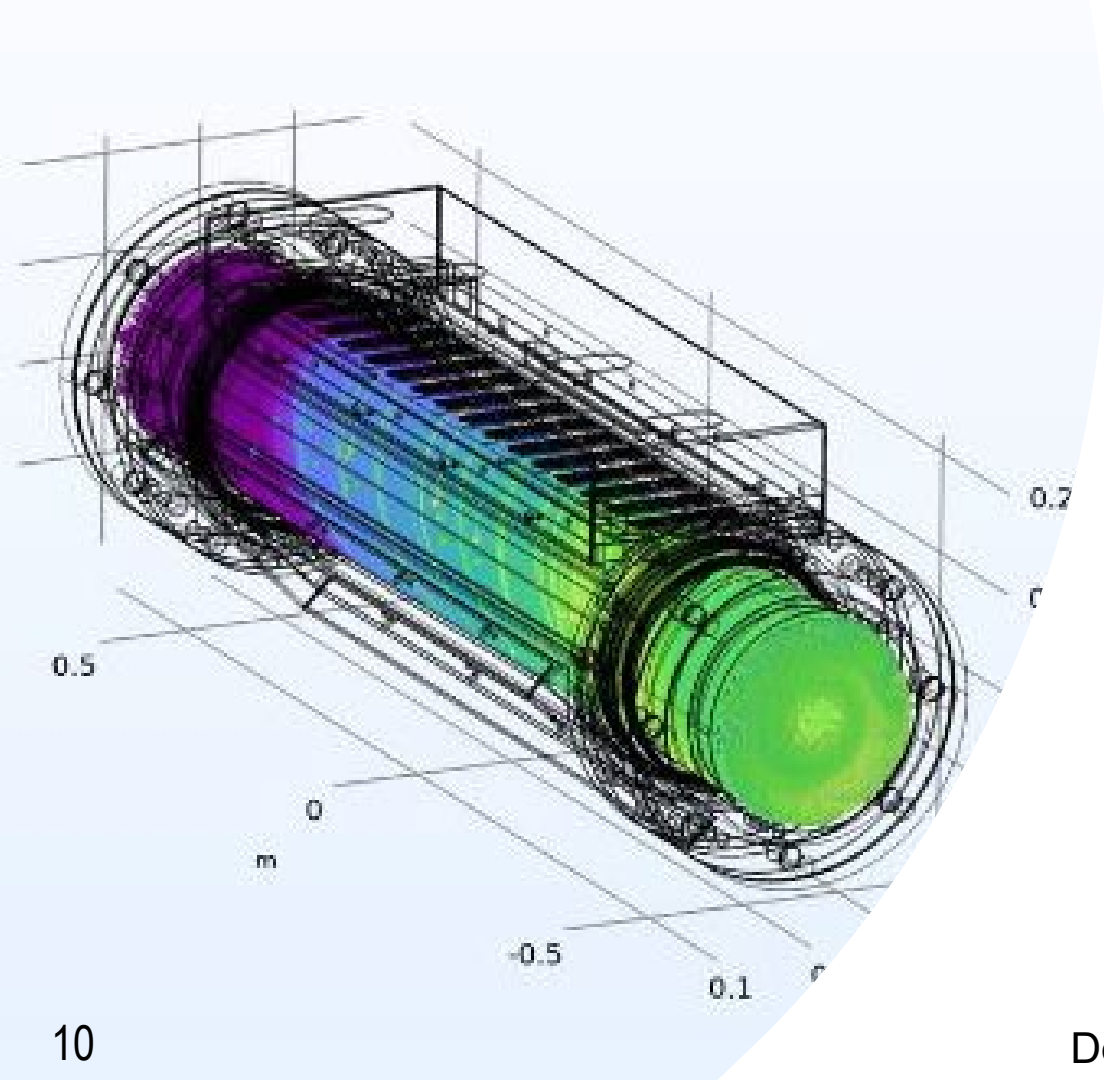
- Drinking Water Applications
- Flexible Product Platform – multiple flange sizes
- 1, 2 or 3 LED Lamp Arrays - based on target UV Dose
- Capable over 2 MGD
- Instant on/off and variable power delivery according to demand
- On-line UV Intensity Monitoring





External Details





First Installation – USA

December 2021

AquiSense Technologies



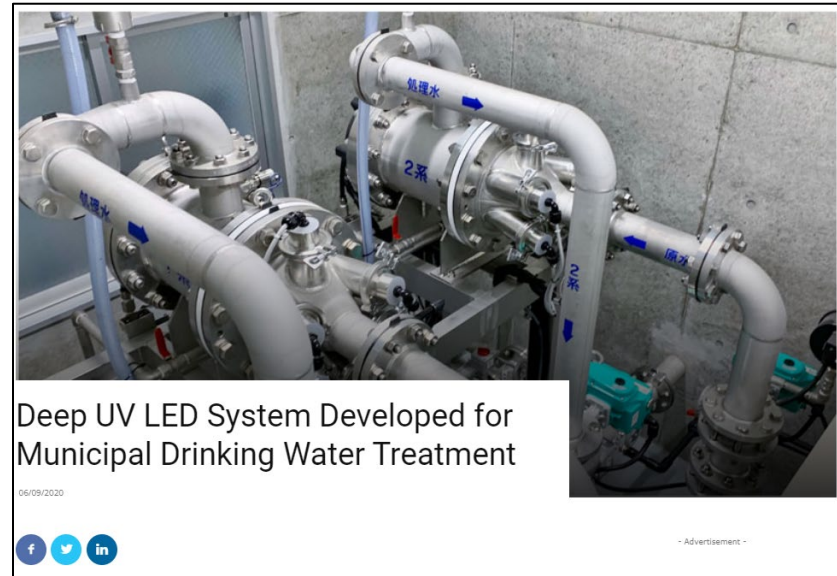
CENTRALIZED CASE STUDY 3: JAPANESE MARKET

METAWATER

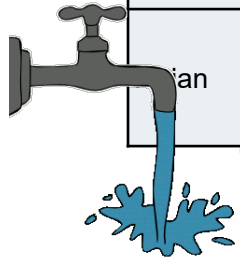
The first municipal LED disinfection system (1MGD, 2 reactors) was installed at a drinking water treatment plant in Ka-goshima Prefecture, Japan, in February 2019.

DRIVERS:

- Small footprint
- Long life of light source:
15 years LCC (lifecycle cost), which is equivalent to low-pressure UV lamp products
- The number and frequency of replacement parts are small and maintenance is easy.



Centralized UVLED systems						
Vendor	Device	input power (kW)	Lifetime (hours)	Max flow per unit (MGD)	Application	Stage of development
Typhon	BIO-310	5.8	35000	3.2	disinfection/ AOP	Commerically available
METAWATER	MWLED series	-	45000	0.08	disinfection	Commerically available
Aquisense	Terra	-	-	1.2	disinfection/ AOP	Piloting
Example mercury systems						
Vendor	Device/ lamp type	input power (kW)	Lifetime (hours)	Max flow per unit (MGD)	Application	Stage of development
Calgon carbon	Sentinel /high intensity MP	360	5000	51	disinfection/ AOP	Commerically available
Aqua	UV Phox/ LP high output	3-18.5	12000		AOP	Commerically available
	UV Swift/ LP high output	1.8-200	12000	6-40	disinfection/ AOP	Commerically available



To the pipe!



To the pipe: 2015 Drinking Water Infrastructure Needs Survey

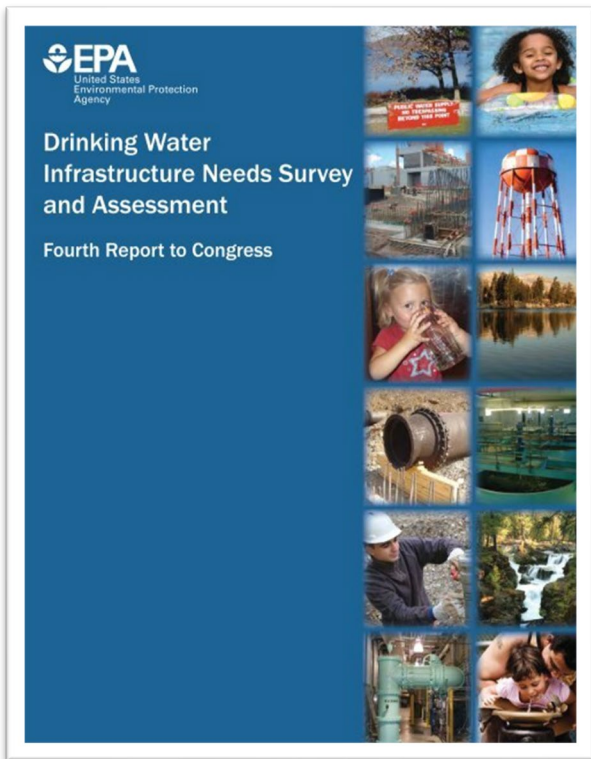
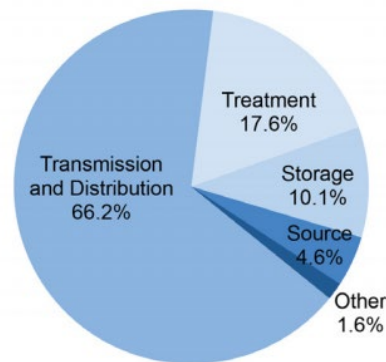
Findings:

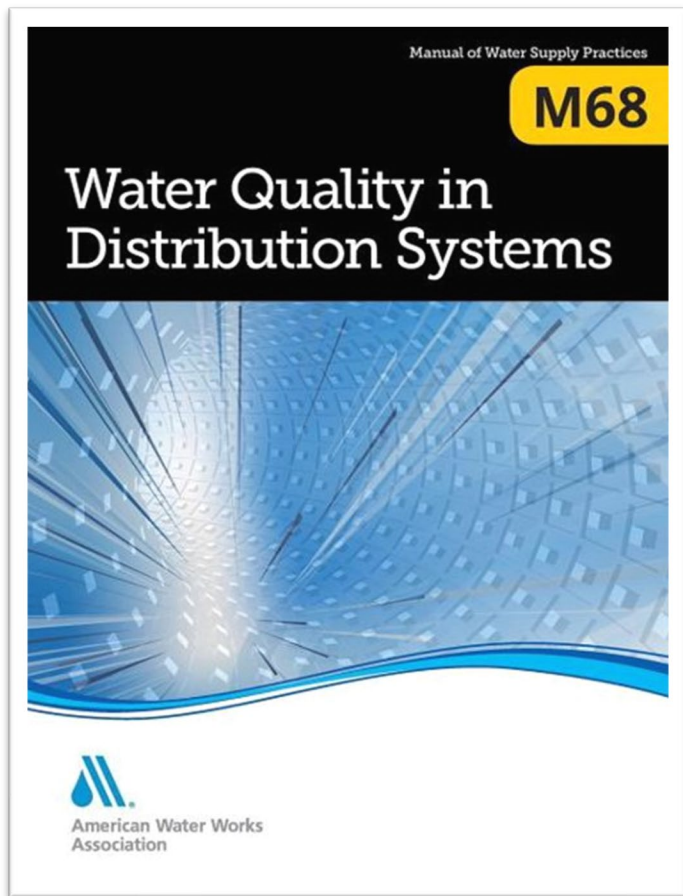
- U.S. water systems need **\$472.6 billion of investment by 2035** to continue providing clean safe drinking water.
- \$312.6 billion of the total national investment need is for **transmission and distribution**.

Solutions and Sustainable Alternatives:

- “Periodic rehabilitation, repair, and replacement of water distribution infrastructure would help improve water quality and avoid leaks”
- “**Reduce chemical use** for treatment by efficient process design, recycling of sludge, and recovery and reuse of chemicals”

Need by 2035, by Project Type¹⁰





AWWA Practice Manual: M68 Water Quality In Distribution Systems



CHAPTER 8: DISINFECTANTS AND DBPS

Balance risks of microbial pathogens and DBPs



TIMELINE OF REGULATIONS

1989: Microbial regulations (set minimum disinfectant requirements)

SWTR

- Eligible disinfectants, disinfectant residuals, log inactivation
- Built on by the LT1 and LT2 ESWTRs

TCR

- MCLs for coliform bacteria in distribution systems

1998: DBP regulations (set maximum disinfectant requirements)

Stage 1 and 2 DBPRs

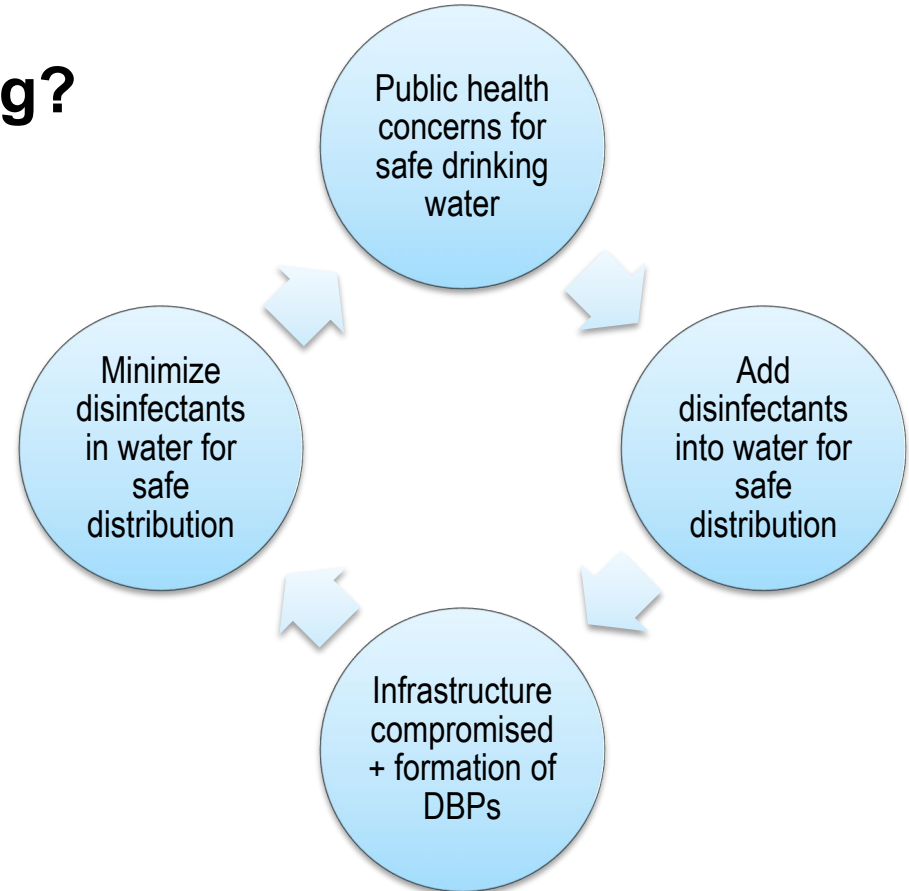
- MRDLs and MRDLGs for disinfectants
- MCLs and MCLGs for DBPs

How is the system functioning?

- In the US, 93.7% of the population received water with a secondary disinfectant.
- On average, the US has ~19X more total coliform rule violations than countries who do not use chemical secondary disinfectants.
- “To eliminate or minimize DBP formation, water engineers need to focus on two fundamental things: First, find ways to incorporate technology for the removal of organics; and second, identify a good alternative disinfectant for chlorine.”

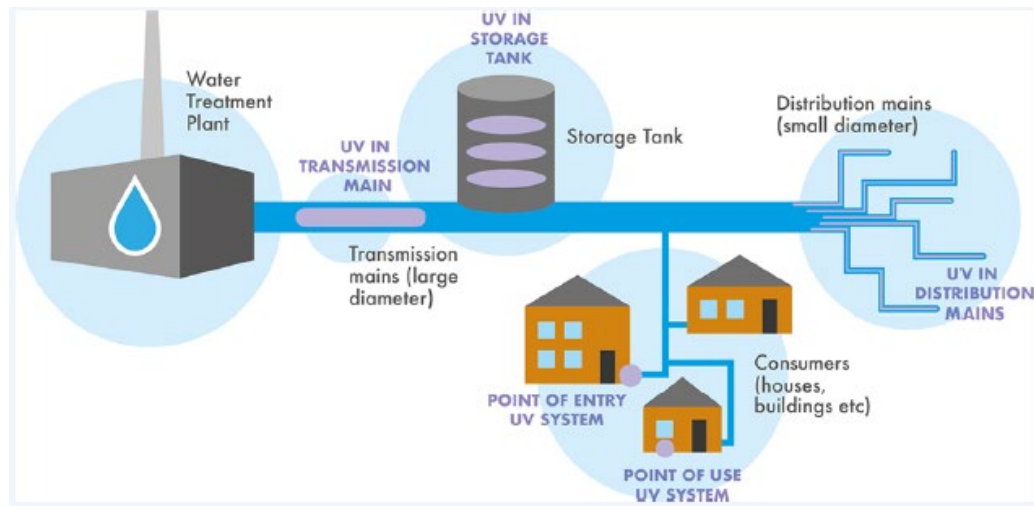
Shahid Parvez, assistant professor, Indiana University Fairbanks School of Public Health
“Disinfection Byproducts: Treatment Options And Challenges For Public Water Suppliers”

Could UVLEDs be a good alternative to chlorine?



What would a water distribution system look like with UVLEDs as a secondary disinfectant?

“Thinking Outside the Treatment Plant: UV for Water Distribution System Disinfection.”



Specific applications of UV in distribution systems include:

- Booster/pump stations
Already has a power source!
- UV in storage tanks or at inlets/outlets
- LEDs distributed along pipe walls
- Small point of use/entry treatment for buildings/homes/taps
- Integration into PRVs

As we attempt to rebuild the 312.6 billion dollars of water transmission and distribution infrastructure needed in the US, **now is the time** to consider innovative and paradigm-shifting technologies.

Validation for Ultraviolet Microbiological Water Treatment Units

NSF/ANSI 55 Standard

- ***Classes of treatment***

There are two classes of systems established for POU/POE LED UVC systems: Class A and Class B.

- Class A systems are considered to be water purification devices
- Class B systems are considered to be devices for supplemental treatment of potable water

- ***Criteria based on log reduction***

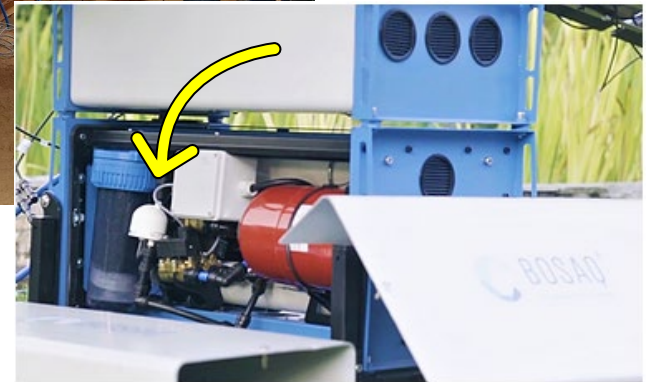
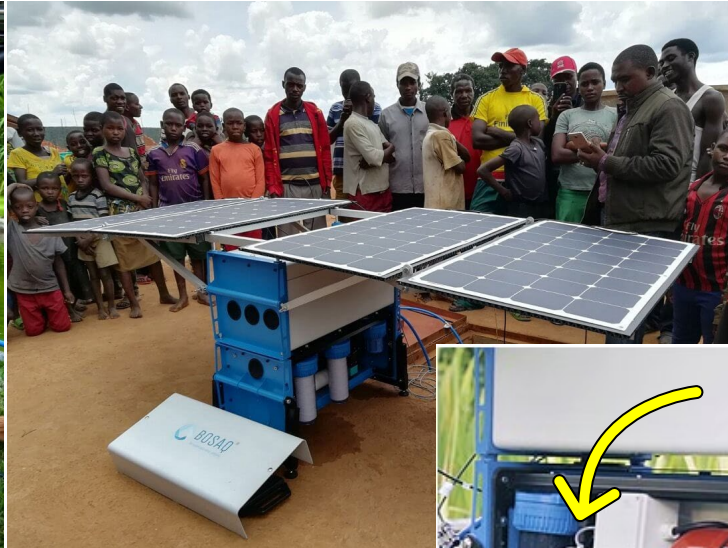
Instead of using a dose-response curve and criteria based on calculated dose, the new standard evaluates pass/fail based on log reduction.

- Class A systems require a 4-log reduction
- Class B systems require 1.5-log reduction for those systems that have a UV sensor, or 2.14-log reduction for those systems that do not have a UV sensor. The rationale behind 2.14-log reduction is that it is equivalent to 1.5-log reduction at 70-percent UV transmittance

POU/POE Applications

BOSAQ- “The world’s most compact and user-friendly off-grid drinking water purification system”

The BOSAQ team has engineered the SolarAQ, a long-lasting, cost-effective, and durable water treatment system designed to treat any water source including sea, fresh, rain, and brackish water. The design requires a compact size and low power consumption as it is self-sustaining through a solar array.



POU/POE Applications

BIOWYSE “BIOCONTAMINATION INTEGRATED CONTROL OF WET SYSTEMS FOR SPACE EXPLORATION”

Enabling Safe Water and Habitat Management Onboard ISS and Future Human Space Exploration Vehicles and Planetary Outposts

The BIOWYSE project required a **compact solution to control biomass growth in the integrated water handling system in both recirculation and direct delivery modes**. The patent protected UV-C LED

Decontamination Module was designed for:

- High durability (e.g. vibration resistance)
- Lightweight design
- Extended lifetime through smart operation
- Advanced system monitoring and control capabilities



Result

This technology can provide safe water and habitat management onboard the ISS and future human space exploration vehicles and planetary outposts. The creation of this system has spurred the development of an entirely new generation of UV technologies better suited for challenging environments.



POU/POE Applications

Aquisense PearlAqua



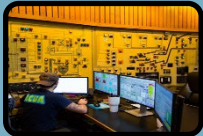
RESEARCH NEEDS



For regulators, a critical review of distribution management approaches and causes/frequency of noncompliance is needed.



Powering and monitoring UVLEDs throughout a distribution network is an engineering challenge.



Departure from chemical-based secondary disinfection will require new approaches to overall management of a distribution system (SWTR..)



Controlling fouling from biofilms and mineral deposits in UV-based secondary disinfection systems needs further investigation

Thank you! Questions?

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