WATERTECH
of America, Inc.

SUPPLEMENTAL DISINFECTION

Technologies, the science behind them, and first-hand field experiences.

WHO IS WATERTECH of America, Inc.

- 40 years of experience in boiler, cooling, wastewater and potable water treatment
- Successful implementation of Water Management Programs in 40+ facilities in Wisconsin alone
- 30 years of experience servicing chlorine, chlorine dioxide, and monochloramine potable water systems

MEET THE SPEAKERS

JEFF FREITAG

- Director of Sales
- 29 years experience in the water treatment industry

DENNIS KWASNY

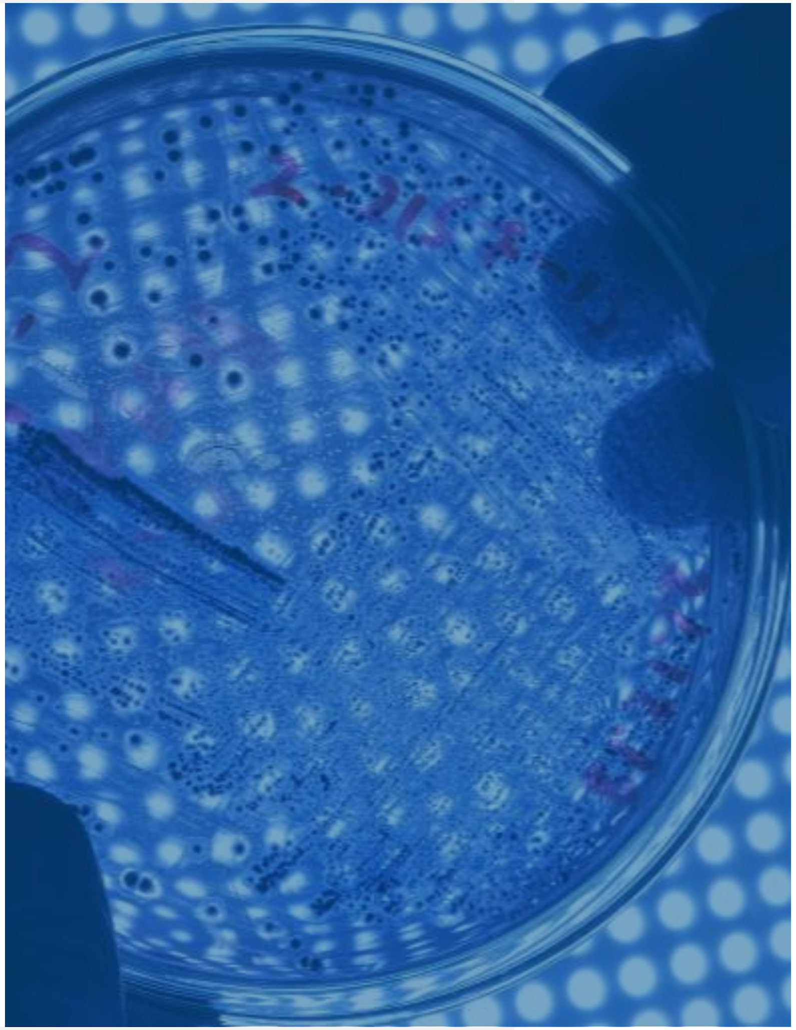
- Territory Manager- Central WI
- 20 years experience in water treatment industry
- Previous career as Hospital Facility Manager

KYLE PACHOWITZ

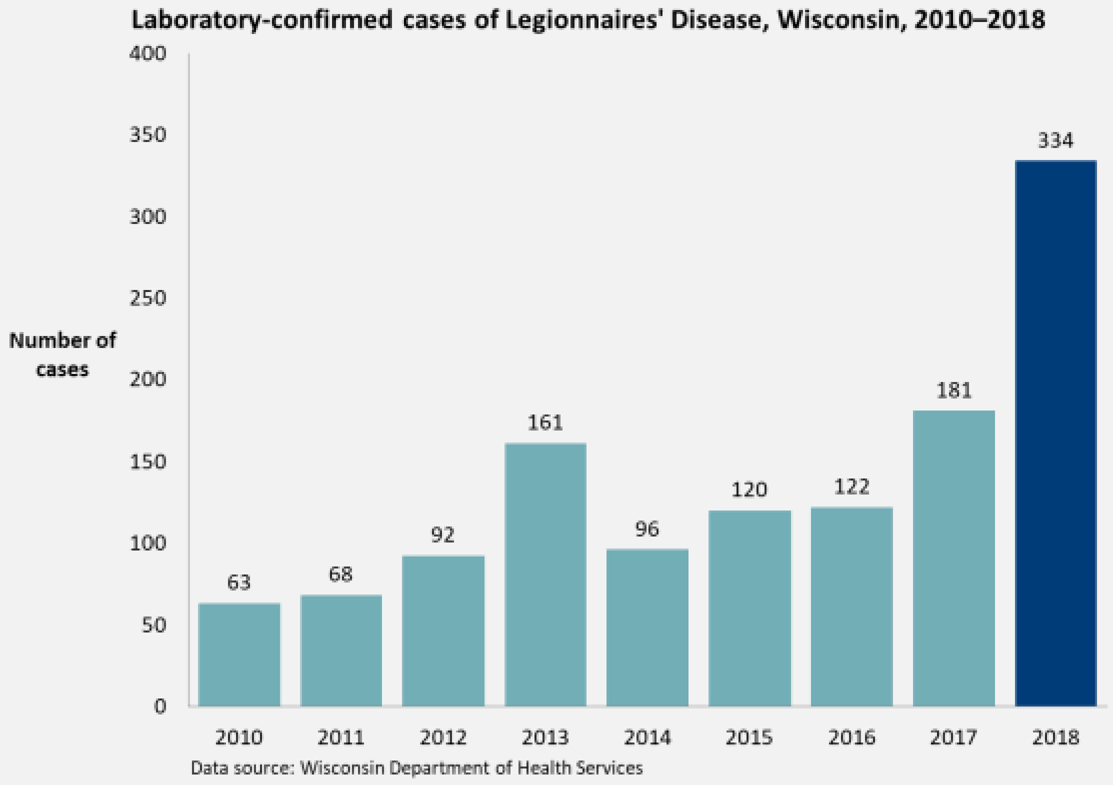
- Director of Water Safety
- 6 years experience in Legionella remediation and prevention
- ASSE 12080 Legionella certified

AGENDA

- Brief review of Legionella/other WBPs
- WMP overview: Where does supplemental disinfection fit
- Governing bodies
- What are your treatment options?
- What are the advantages/disadvantages of each?
- Where should I feed my disinfectant?
- Closer look at monochloramine and what makes it different
- EPA's independent evaluation of monochloramines in domestic water systems



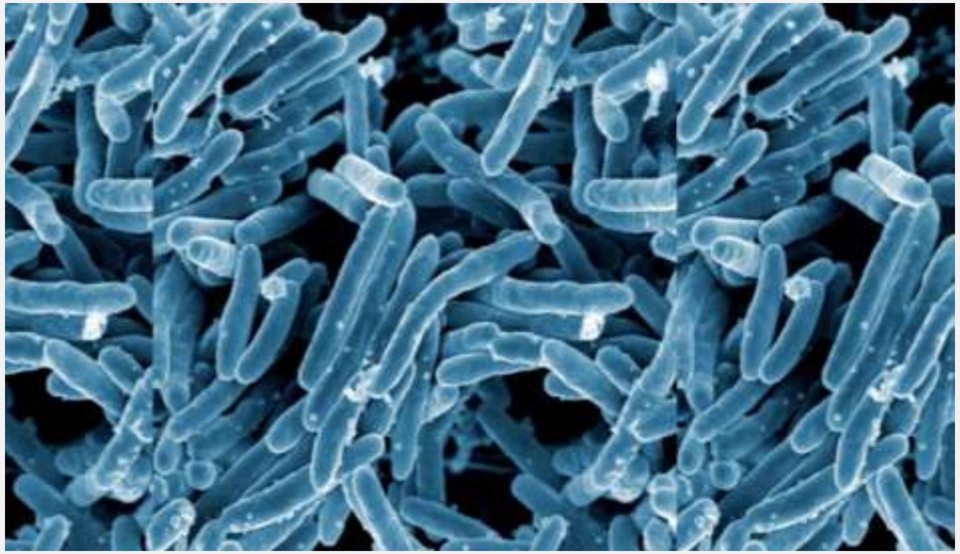
WHAT IS LEGIONELLA?



- **Legionella is a thermo-tolerant waterborne pathogen that causes Legionnaires' disease**
- **It colonizes in warm water environments (75 F - 120 F)**
- Legionella is generally below the detectable level in the source water supply
- It becomes a health risk once the bacteria enters a building complex plumbing system and starts to colonize (especially in the DHW)
- The infection is fatal in approximately 25% – 30% of the cases.

Number of reported cases of Legionnaires' disease from 2010 to 2018 in Wisconsin

WHAT OTHER WBP SHOULD WE WORRY ABOUT?



Other WBP that cause HAIs

- NTM (Nontuberculous Mycobacteria)
  - Lives in the biofilm
- Pseudomonas
  - 32,000 cases/2,700 deaths in US
- Norovirus
  - Children/Elderly
  - NICU
- *Stenotrophomonas maltophilia*
  - Catheters and respiratory equipment
- HPC
  - Not a good representation of safe/unsafe water

- (CDC, 2019)

SHOULD HETEROTROPHIC PLATE COUNT MEASUREMENTS BE USED TO DETERMINE THE RISK OF LEGIONELLA IN A BUILDING WATER SYSTEM?

Conclusion

- There was no overall correlation between levels of HPC bacteria in drinking water and *Legionella* colonization in all sites combined, hot water distal outlets, or hot water returns.
- There was a relationship between HPC levels and *Legionella* in cold water and mixed water, however, the area under the ROC curves indicated poor prediction.
- Using the HPC 500 CFU/mL threshold is a poor predictor of *Legionella* presence and absence of in building water systems.
- Water safety and management plans are important in minimizing risk of exposure to *Legionella* associated with building water systems
- Testing for *Legionella* or other opportunistic pathogens is the only way to determine their presence or absence and to validate an effective building water safety program.

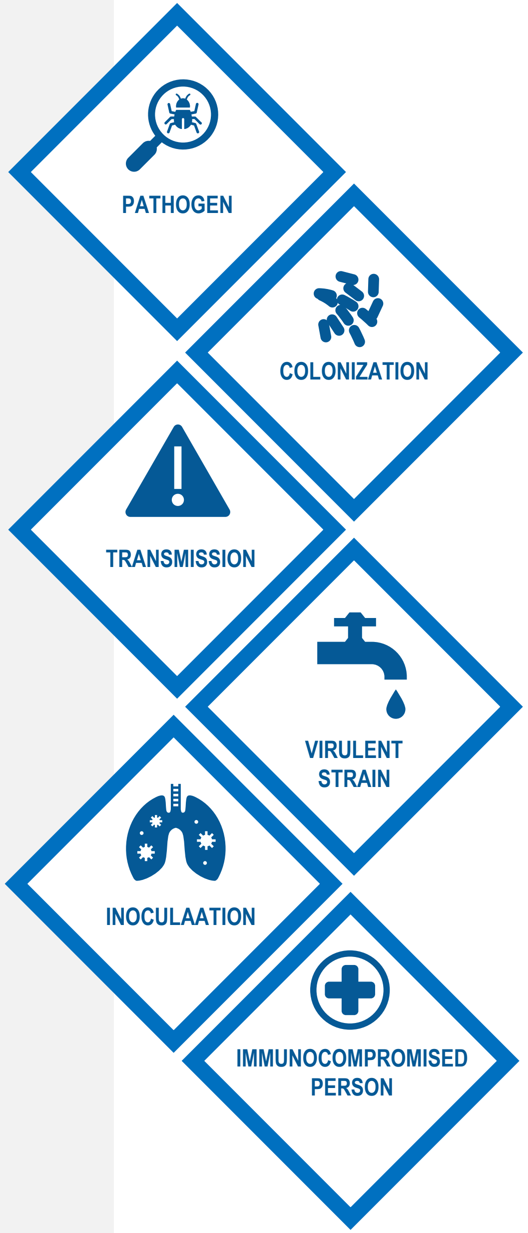
(Stout, 2018)

HOW TO PREVENT LEGIONELLA AND OTHER WBPS

- Legionella bacteria can survive the municipal disinfection process.
- It starts to colonize in the building, it disseminates throughout the plumbing system and contaminates distal sites.
- Legionella is transmitted by breathing in water droplets containing Legionella bacteria.
- An immunocompromised person can contract the infection.

BREAK THE CHAIN:

DEVELOP A WATER MANAGEMENT PLAN



CMS Update: 7-6-18

Requirement to Reduce *Legionella* Risk in Healthcare Facility Water Systems to Prevent Cases and Outbreaks of Legionnaires' Disease (LD)

Expectations for Healthcare Facilities

CMS expects Medicare and Medicare/Medicaid certified healthcare facilities to have water management policies and procedures to reduce the risk of growth and spread of *Legionella* and other opportunistic pathogens in building water systems.

Facilities must have water management plans and documentation that, at a minimum, ensure each facility:

- Conducts a facility risk assessment to identify where *Legionella* and other opportunistic waterborne pathogens (e.g. *Pseudomonas*, *Acinetobacter*, *Burkholderia*, *Stenotrophomonas*, nontuberculous mycobacteria, and fungi) could grow and spread in the facility water system.
- Develops and implements a water management program that considers the ASHRAE industry standard and the CDC toolkit.

CMS SURVEYOR GUIDELINES

Surveyors will review policies, procedures, and reports documenting water management implementation results to verify that facilities:

- Conduct a facility risk assessment to identify where Legionella and other opportunistic waterborne pathogens (e.g. Pseudomonas, Acinetobacter, Burkholderia, Stenotrophomonas, nontuberculous mycobacteria, and fungi) could grow and spread in the facility water system.

- Implement a water management program that considers the ASHRAE industry standard and the CDC toolkit, and includes control measures such as physical controls, temperature management, disinfectant level control, visual inspections, and environmental testing for pathogens.

- Specify testing protocols and acceptable ranges for control measures and document the results of testing and corrective actions taken when control limits are not maintained.

6 STEPS TO DEVELOPING A SUCCESSFUL WATER MANAGEMENT PLAN

1 – SITE EVALUATION

- Collection of site information, documents and map systems

2 – CRITERIA EVALUATION

- Identification of the control points
- Definition of responsibility

3 – RISK ANALYSIS

- Risk analysis for each control point and esablishment of parameters and corrective actions

4 – VERIFICATION

- Establish a procedure to verify that the WMP is executed

5 – VALIDATION

- Validate the efficacy of the WMP (testing)

6 – DOCUMENTATION

- Establish the documentation for your WMP and review annually

Water Management Plans

- A plan isn't just a binder or a website with a login/password.
- A plan is an array of validation testing techniques and correcting the deficiencies.
- A plan is implementing new technologies that are scientifically proven to prevent and remediate water borne pathogens.


Water Safety and Management Plan

WATERTECH

414-425-3330

SPECIAL PATHOGENS LABORATORY

THE LEGIONELLA EXPERTS

SUPPLEMENTAL DISINFECTANTS

The water management plan may suggest the application of a supplemental disinfectant

SUPPLEMENTAL DISINFECTANTS:

- On-site chemical feeders to **supplement** what is needed to keep the building water system safe.
- 0.5 ppm free chlorine from municipality (minimum requirement for WI drinking water) is not enough to ensure a consistent disinfectant residual throughout the buildings water distribution system.
- Disinfectant residual can drop due to different factors (temperature, water age, chemical features…).

REGULATORY ENVIRONMENT

Regulatory compliance to supplemental disinfection in premise plumbing systems

- There is no primary drinking water standard for Legionella.
- Addition of a disinfectant (treatment) to drinking water subjects the facility to the requirements of a Public Water supply (PWS)

WHO MUST COMPLY WITH THE RULE?

The Stage 1 Disinfectants and Disinfection Byproducts Rule applies to all community and nontransient noncommunity water systems that add a chemical disinfectant in any part of the drinking water treatment process and transient NCWSs using chlorine dioxide.

NTNCWS: A public water system that regularly supplies water to at least 25 of the same people at least six months per year (hospitals, nursing homes….)

DISINFECTION TECHNOLOGIES

Treatment options for Legionella control in buildings

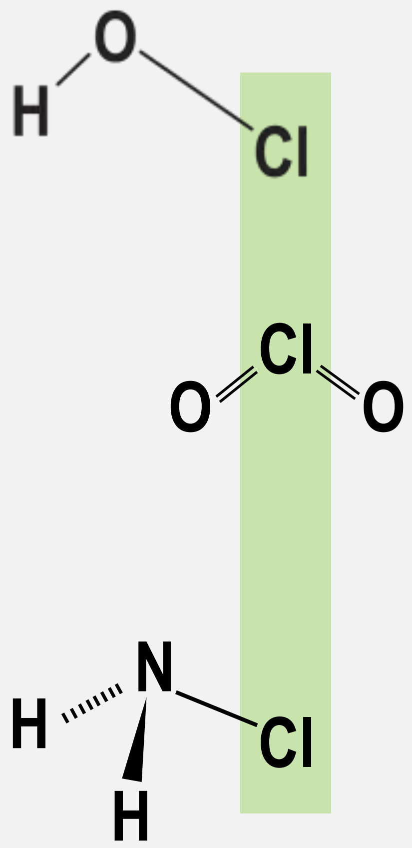
- **Monochloramine**
- **Chlorine**
- **Chlorine dioxide**
- Ozone
- Copper Silver ionization
- UV Light
- Heat and flush
- Superheating

Only three EPA listed disinfectants (Monochloramine, Chlorine, Chlorine dioxide)

EPA

DISINFECTION TECHNOLOGIES

EPA/State of Wisconsin listed primary disinfectants



Hypochlorite → cheap, simple to use, less effective, toxic by-products, high residuals required

Chlorine dioxide → very good disinfectant, used in drinking water

Monochloramine → very good disinfectant, used in drinking water, used for Legionella remediation with success

DISINFECTANT COMPARISON

Disinfectant stability

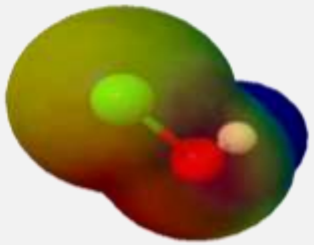
Less Electrons

(+)

(-)

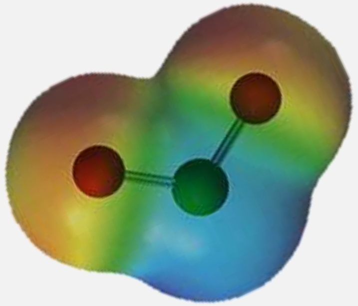
More Electrons

$HOCl$



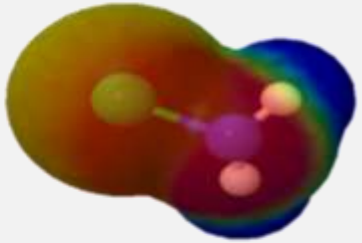
Cl, strongly electronegative, is prone to react to get more electrons (to oxidize)

ClO_2



Electrons clouds is much more dense around O atoms. Cl is higly oxidant to get more electrons

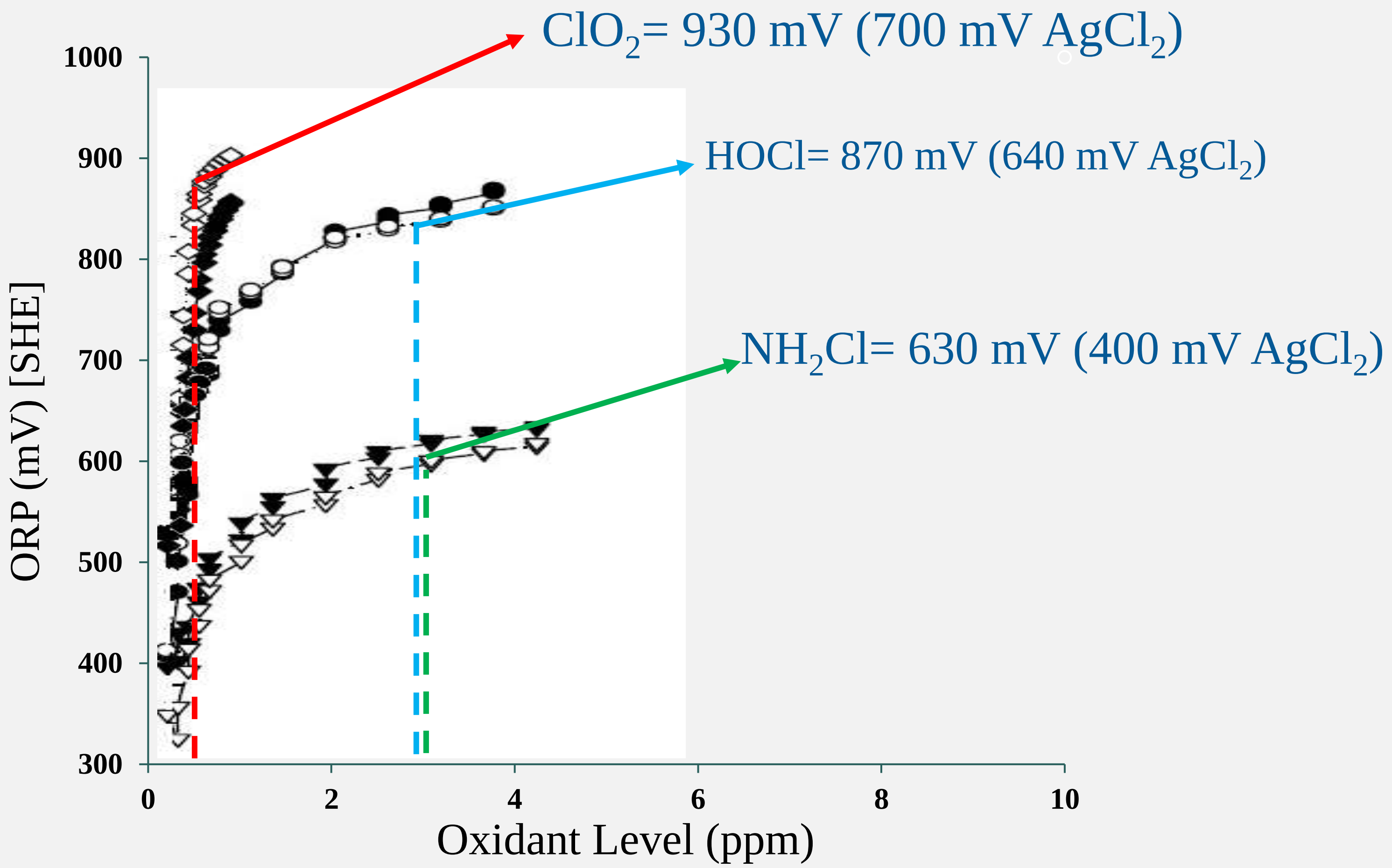
NH_2Cl



Cl shares much more electrons with N and it is less prone to oxidize

DISINFECTANT COMPARISON

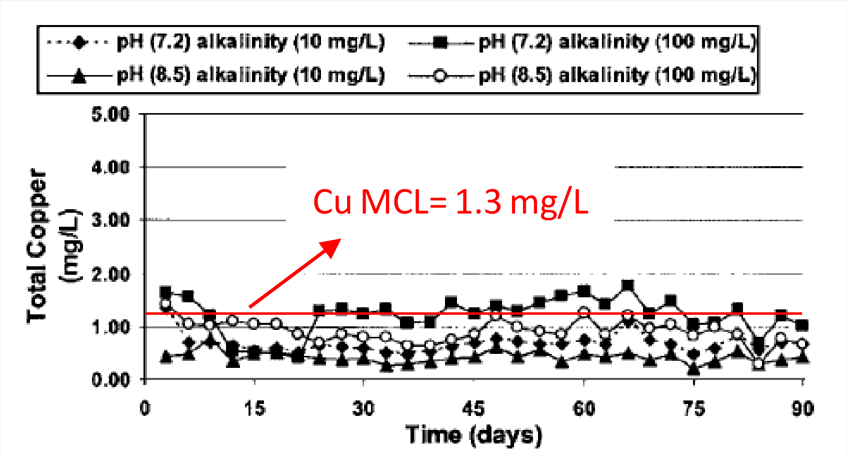
Disinfectant stability



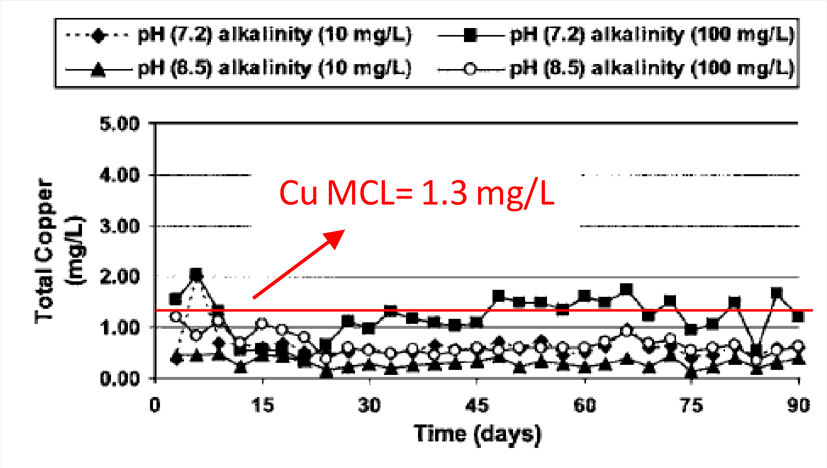
EPA presentation at the NSF Legionella conference, 2018 Baltimore

DISINFECTANT COMPARISON

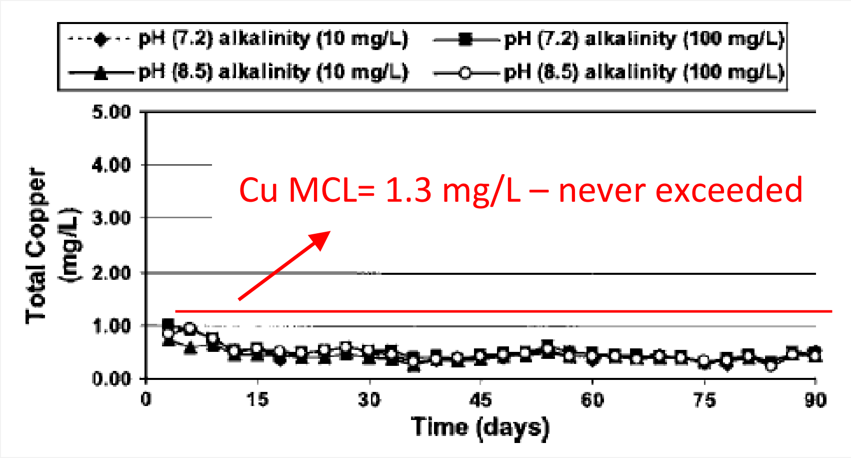
A (Chlorine dioxide)



B (Free chlorine)



C (Monochloramine)

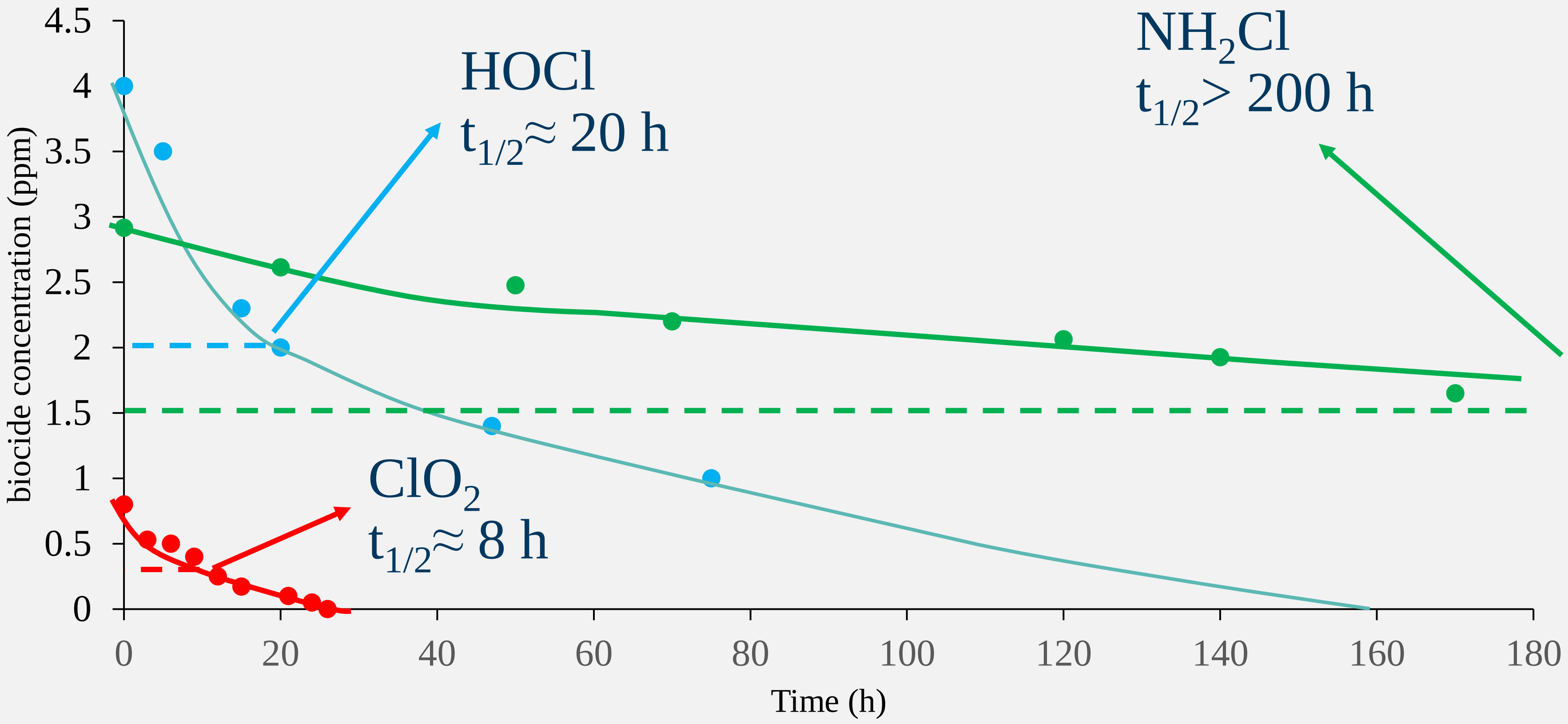


(Rahman, 2007)

Corrosion Studies Review

DISINFECTANT COMPARISON

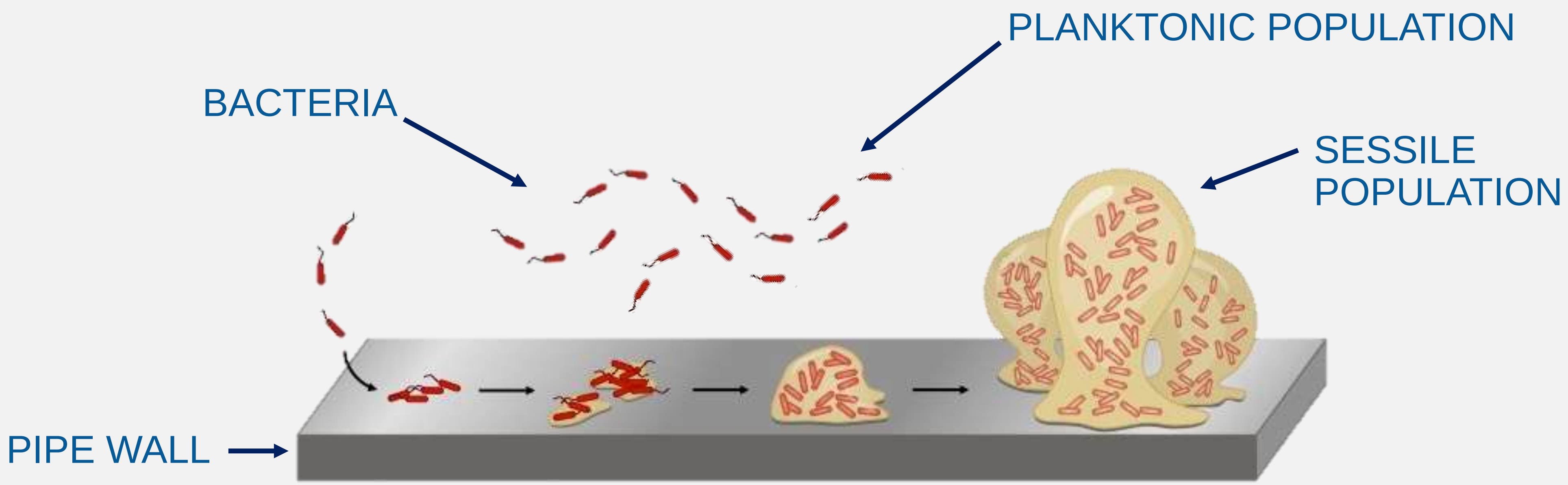
Disinfectant stability



I. Fisher et Al., 2012, Water Research
K. Ozekin et Al., 1996, Water Disinfection and Natural Organic Matter
T.A. Ammar et Al., 2014 Desalination

DISINFECTANT COMPARISON

Biofilm penetration

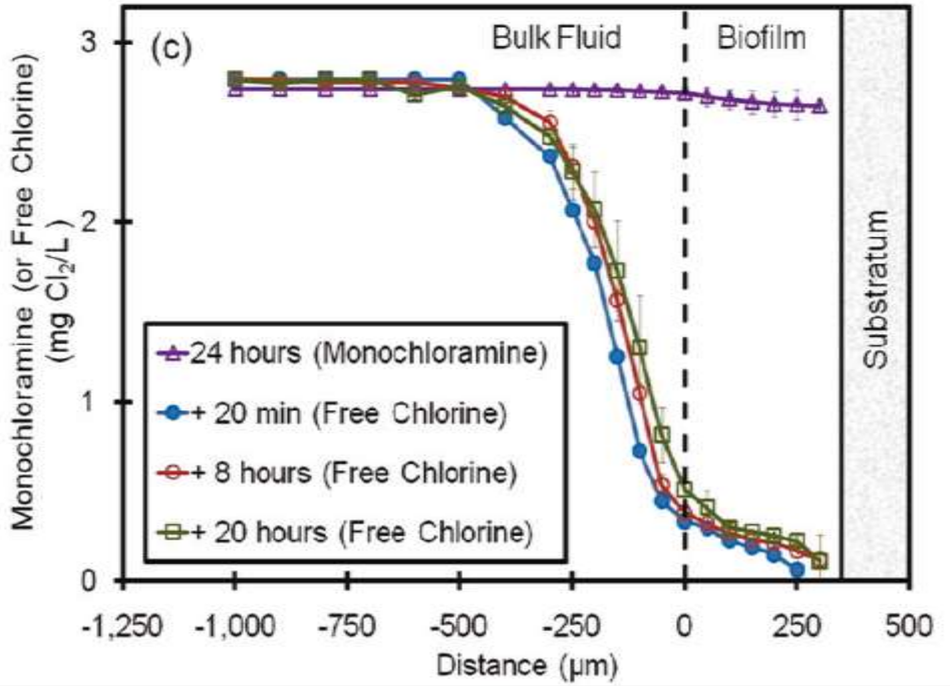


PLANKTONIC vs. SESSILE

DISINFECTANT COMPARISON

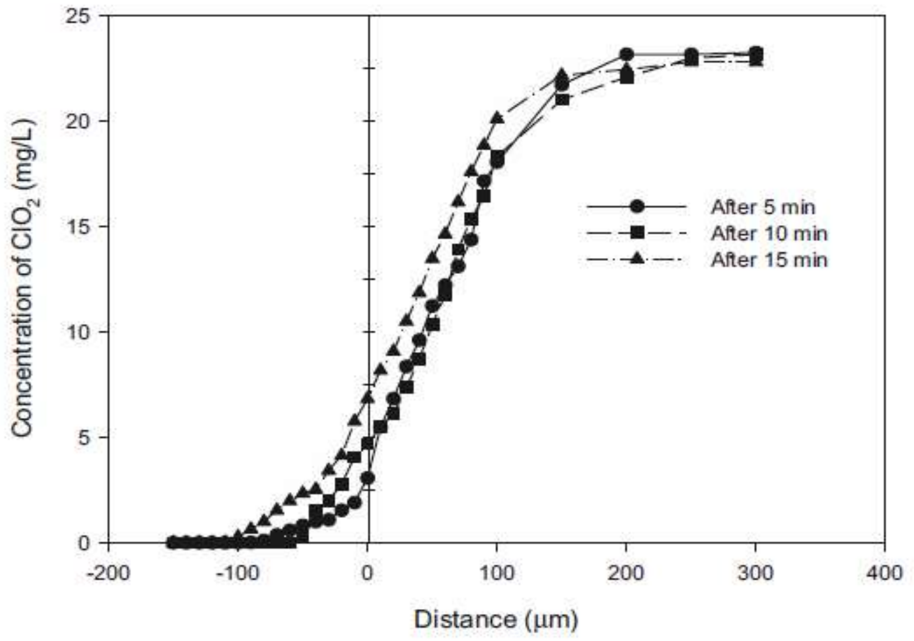
Biofilm penetration

HOCl & NH_2Cl



EPA presentation at the NSF Legionella conference, 2018 Baltimore

ClO_2



CONCLUSION:

NH_2Cl penetrates

ClO_2 and HOCl do not

TESTING REQUIREMENTS BASED ON WI DSPS

Chlorine

The maximum residual disinfection level goals (MRDLGs) as per SPS 382.22, NR809.561, NR809.80:

- The maximum residual disinfectant concentration may not exceed 4.0 mg/L.
- The minimum residual disinfectant concentration must be at least 0.5 mg/L.
- The system shall be designed and installed to achieve the minimum inactivation rate ("CT" value).
- The maximum contaminant level of byproducts must not exceed 0.080 Trihalomethanes (TTHM) and 0.60 Haloacetic Acids (HAA5)

As per SPS 382.22 and NR 809.565, a daily sample shall be taken at the nearest and the furthest point of hot water use from the injection location and tested for chlorine residual

- A potable water disinfection system that has a properly functioning electronic monitoring device installed to control disinfectant residual shall be:
- Manually tested at least once a day for disinfectant residual and pH with an approved test kit
- Managed by a continuous monitoring system in compliance with a water management plan approved by the department.
- Quarterly testing for disinfection by-products (DBP) shall be performed.

TESTING REQUIREMENTS BASED ON WI DSPS

Chlorine Dioxide

The maximum residual disinfection level goals (MRDLGs) as per SPS 382.22, NR 809.561, NR 809.80:

- The maximum residual disinfectant concentration may not exceed 0.8 mg/L (as ClO2).
- The minimum residual disinfectant concentration must be at least 0.2 mg/L (as ClO2).
- The chlorite ion concentration shall not exceed 1.0 mg/L.
- The system shall be designed and installed to achieve the minimum inactivation rate (“CT” value).

As per SPS 382.22 and NR 809.565, a daily sample shall be taken at the nearest and the furthest point of hot water use from the injection location and tested for chlorine dioxide and chlorite concentration levels.

- All water systems (e.g. cold, cold soft) treated by the chlorine dioxide unit shall be tested for the maximum 0.8 mg/l concentration in compliance with SPS 382.40.
- Once a month an additional sample is to be taken in a location representative of average time.

TESTING REQUIREMENTS BASED ON WI DSPS

Chloramines

The maximum residual disinfection level goals (MRDLGs) as per SPS 382.22, NR809.561, NR809.80: T

- The maximum residual disinfectant concentration may not exceed 4.0 mg/L.
- The minimum residual disinfectant concentration must be at least 0.5 mg/L.
- The system shall be designed and installed to achieve the minimum inactivation rate (“CT” value).
- The maximum contaminant level of byproducts must not exceed 0.080 Trihalomethanes (TTHM) and 0.60 Haloacetic Acids (HAA5).

As per SPS 382.22 and NR 809.565, a daily sample shall be taken at the nearest and the furthest point of hot water use from the injection location and tested for residuals

DSPS AND PLAN REVIEW

State DSPS requires plan review for all supplemental disinfection systems

Section 2. PLAN SUBMITTAL REQUIREMENTS.

PLAN SUBMITTAL SHALL INCLUDE THE FOLLOWING IN ACCORD WITH CODE SECTION SPS 382.20.

A complete set of plumbing plans and specifications. Incomplete submittals will be rejected. **Please check the boxes below to ensure your plan submittal is complete.**

Plans shall be legible and pertinent to only plumbing installations. Plans are required to be submitted in a single PDF. All supporting documents shall be provided under “submit additional documentation” (in the eSLA dashboard). Plan documents shall be submitted in the order of the following checklist:

1. ☐ Plan Index
2. ☐ Plot/site plan showing size and pitch of sanitary sewer(s), storm sewer(s) and water service(s).
3. ☐ Exterior storm, submit appropriate architectural roof drainage plans, site grade run off plans and contour lines showing what is drained to the plumbing system. Show all pipe sizes and discharge rates after every inlet. Refer to storm checklist at:
   - ☐ https://dsps.wi.gov/Documents/Programs/Plumbing/SBD10884.pdf
   - ☐ Include completed Storm summary worksheet See: *(Storm summary link)*
   - ☐ For infiltration systems, submit Soil and Site Evaluation Form SBD-10793.
4. ☐ Floor plan showing horizontal drains, water distribution lines, and all fixtures and equipment to be installed.
5. ☐ 30/60 isometric diagrams of the drain, vent, water distribution, interior and exterior storm systems. Indicate water supply, drainage fixture units, and storm area drainage with gpm loads with each change in pipe diameter.
6. ☐ Complete water calculations in accord with SPS 382.40 (7).
7. ☐ Complete storm drain sizing calculations in accordance with SPS 382.36 (5).
8. ☐ Remodeling or additions shall include existing loads.
9. ☐ All plans must be properly signed per SPS 382.20 (4)(c).
10. ☐ For water re-use submittals include information requested in the product approval.

SYSTEM INSTALLATION

HOT or COLD water

Which is the correct answer?

Domestic HOT water system or main incoming COLD water line?

3 Factors to consider:

1. Microbiology
2. Chemistry
3. Economics

SYSTEM INSTALLATION

Microbiology

- Legionella is a thermo-tolerant pathogen; it grows in warm environments and does not proliferate efficiently in cold water < 70 F (< ≈ 20 °C).
- Treating all the incoming cold water could also present some microbiological issues: formation of disinfection by-products due to poor control.
- Dosing the disinfectant on the hot water system still treats all the fixtures.

SYSTEM INSTALLATION

Chemistry

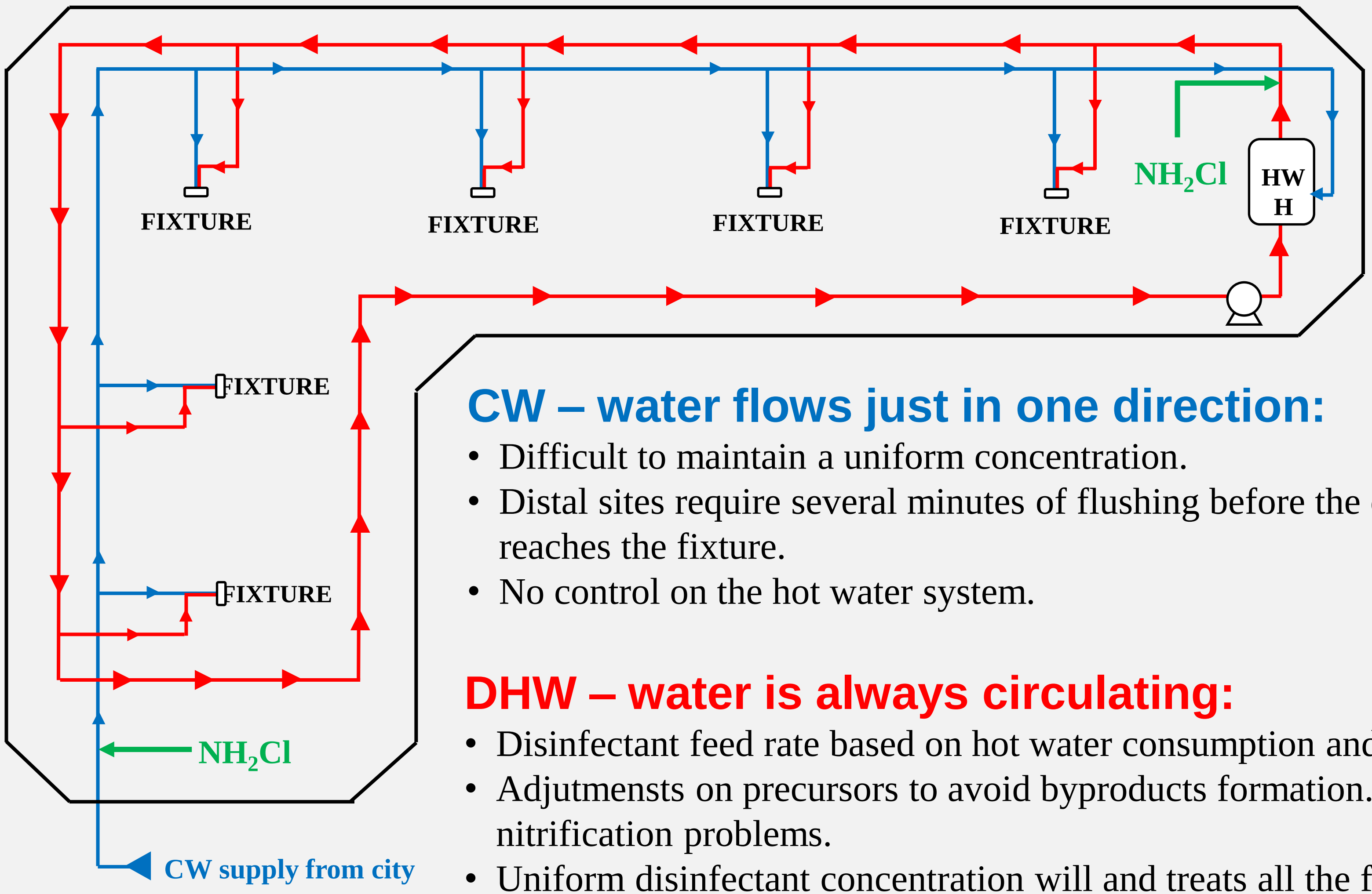
- Disinfectant stability: thermal shock when the disinfectant flows from the cold water system thru the water heaters. Disinfectant decay that leads to lower concentrations and the formation of disinfection by products (THMs and HAA5 or chlorite).
- If disinfectant is fed on the incoming cold water, its decay generates free ammonia, chlorite, and chlorine b- products that could be corrosive to copper pipes.
- If the disinfectant is fed on the main cold, it may be necessary to implement controls (probes) and purge valves on the hot water system to control degradation of the disinfectant.

SYSTEM INSTALLATION

Chemistry

- Water in the hot water system is always circulating: easier to control by-products formation
- Easier to maintain a consistent residual even during low water consumption periods (night hours).
- Limits occupant exposure to elevated levels of disinfectants and DBP's.

SYSTEM INSTALLATION Chemistry



CW – water flows just in one direction:

- Difficult to maintain a uniform concentration.
- Distal sites require several minutes of flushing before the disinfectant reaches the fixture.
- No control on the hot water system.

DHW – water is always circulating:

- Disinfectant feed rate based on hot water consumption and ORP.
- Adjutmensts on precursors to avoid byproducts formation. No nitrification problems.
- Uniform disinfectant concentration will and treats all the fixtures.

SYSTEM INSTALLATION

Economics

- In drinking water applications, the hot water consumption is usually ten to twenty times lower than the cold water consumption.
- Treating all the incoming cold water leads to higher costs (bigger equipment, bigger volumes of reagents).
- Higher volumes of reagents to keep in stock (safety issues).

COLD

HOT

SYSTEM INSTALLATION

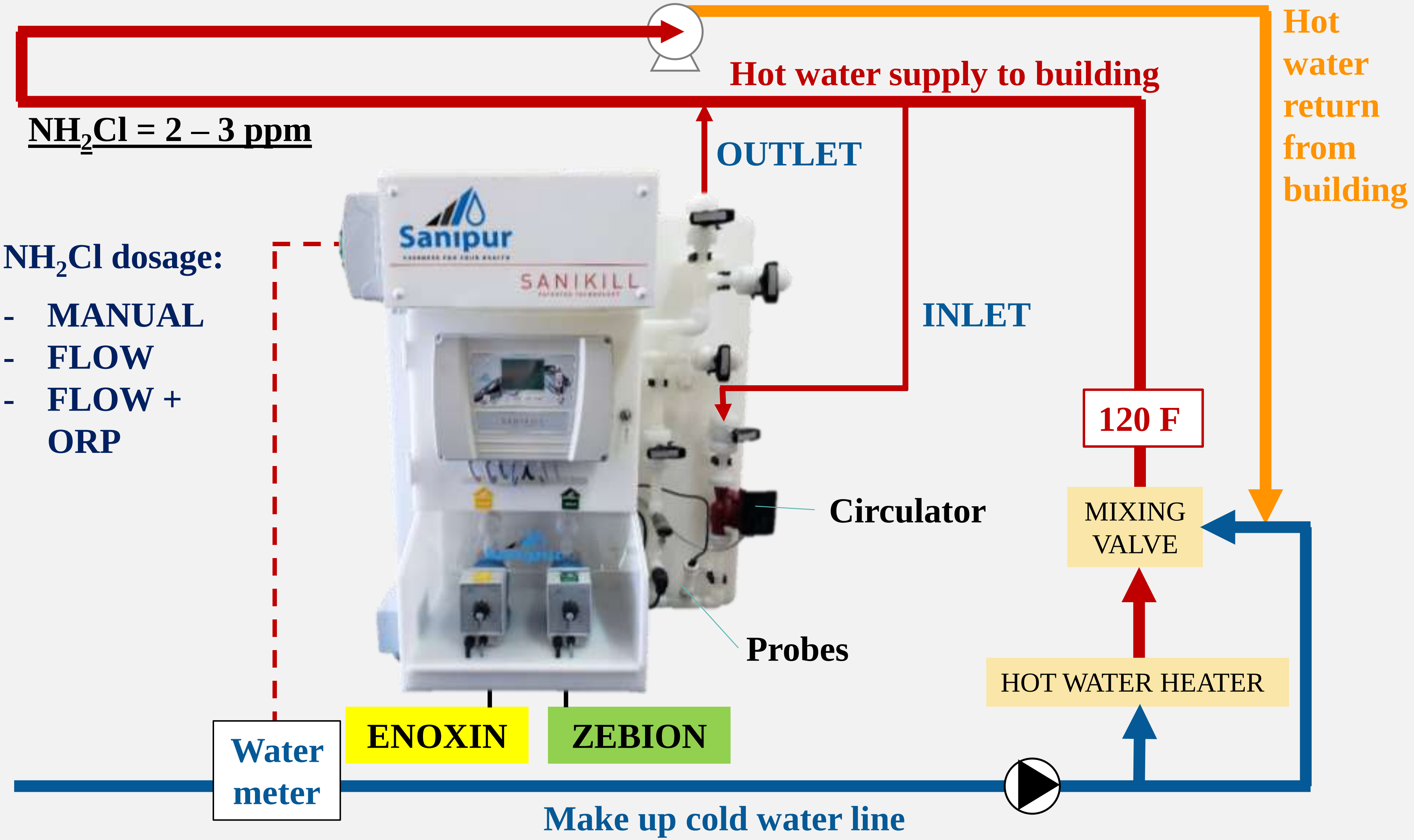
Review

	HOT WATER TREATMENT	COLD WATER TREATMENT
Treats where Legionella typically occurs?	YES	NO
Ability to maintain residual in HOT water?	YES	NO
Ability to control free ammonia formation?	YES	NO
Treats all the fixtures?	YES	YES
Equipment size/cost	SMALL/LOW	BIG/HIGH
Chemical use	LOW	HIGH
Occupant exposed to disinfectant and DBPs	LOW	HIGH

TYPICAL MONOCHLORAMINE SETUP

NH_2Cl dosage:

- MANUAL
- FLOW
- FLOW + ORP



DOSING PUMPS AND REACTION CHAMBER

- Electronic diaphragm pumps for precise reagent control (≈ 0.5 mL/stroke)
- Easy adjustment via stroke knobs to easy control ammonia formation
- Anti-backflow valves and sealed injectors to avoid reagents backflow
- Continuous water flow-thru generator
- Ammonium precursor is injected before for complete THMs formation control

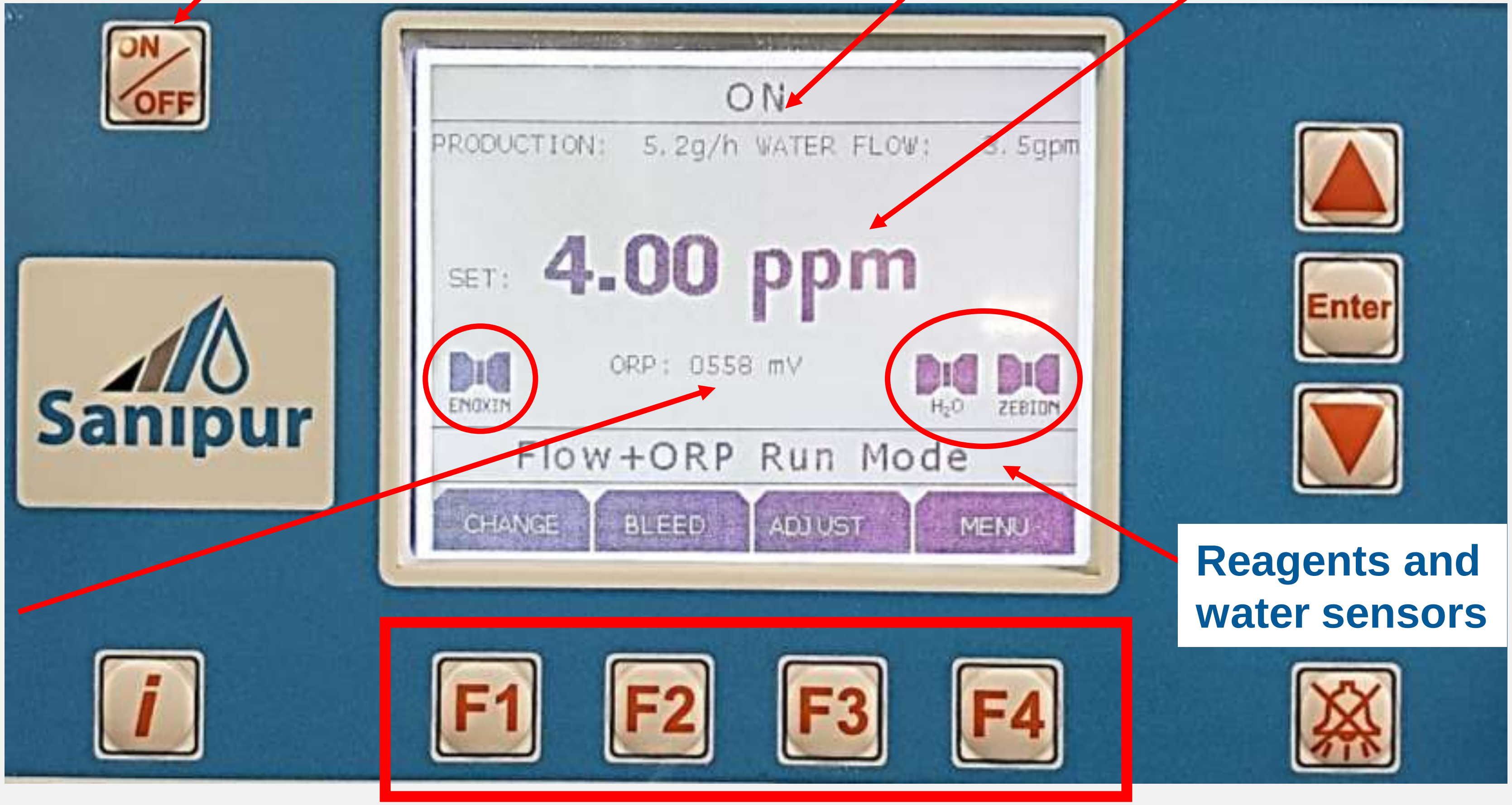
Certified to NSF/ANSI Std. 60 and 61

ELECTRONIC CONTROL

ON/OFF button

State of the unit

SET-POINT



ORP level

Reagents and water sensors

Main Menu Buttons

SAFETY FEATURES: WHAT MAKES IT DIFFERENT

All the Sanikill units are equipped with several safety features:

- Flow sensors for reagent dosing pumps
- Level switch for reagent tanks
- Flow switch for pre-dilution loop
- Make-up flowmeter fault check
- Backpressure valves
- Anti-syphon valves
- Remote monitoring

US EPA INDEPENDENT EVALUATION 2021

A comprehensive evaluation of monochloramine disinfection on water quality, *Legionella* and other important microorganisms in a hospital

Check for updates

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A R T I C L E I N F O

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Drinking water
Hospital
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A B S T R A C T

Opportunistic pathogens such as *Legionella* are of significant public health concern in hospitals. Microbiological and water chemistry parameters in hot water throughout an Ohio hospital were monitored monthly before and after the installation of a monochloramine disinfection system over 16 months. Water samples from fifteen hot water sampling sites as well as the municipal water supply entering the hospital were analyzed using both culture and qPCR assays for specific microbial pathogens including *Legionella*, *Pseudomonas* spp., nontuberculous *Mycobacteria* [NTM], as well as for heterotrophic bacteria. *Legionella* culture assays decreased from 68% of all sites being positive prior to monochloramine addition to 6% positive after monochloramine addition, and these trends were parallel to qPCR results. Considering all samples, NTMs by culture were significantly reduced from 61% to 14% positivity ($p<0.001$) after monochloramine treatment. *Mycobacterium* genus-specific qPCR positivity was reduced from 92% to 65%, but the change was not significant. Heterotrophic bacteria (heterotrophic bacteria plate counts [HPCs]) exhibited large variability which skewed statistical results on a per room basis. However, when all samples were considered, a significant decrease in HPCs was observed after monochloramine addition. Lastly, *Pseudomonas aeruginosa* and *Vermamoeba vermiformis* demonstrated large and significant decrease of qPCR signals post-chloramination. General water chemistry parameters including monochloramine residual, nitrate, nitrite, pH, temperature, metals and total trihalomethanes (TTHMs) were also measured. Significant monochloramine residuals were consistently observed at all sampling sites with very little free ammonia present and no water quality indications of nitrification (e.g., pH decrease, elevated nitrite or nitrate). The addition of monochloramine had no obvious impact on metals (lead, copper and iron) and disinfection by-products.

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BRIEF OVERVIEW:
PRE MONOCHLORAMINE

Medium sized Ohio hospital (317 bed, six floor)
Starting points:

- 71% positivity rate for Legionella
- Nontuberculous Mycobacteria (NTM) positivity rate of 61%
- Mycobacterium positivity rate 92%
- HPCs

LEGIONELLA

Table 3
Legionella culture monitoring results pre- and post-monochloramine treatment. Results are presented by indicating presence (positive).

	Legionella by Culture	
Sampling Site ID	Positives Pre-monochloramine	Positives Post-monochloramine
1	6/6 (100%)	0/7 (0%)
2	5/5 (100%)	1/6 (17%)
3	7/7 (100%)	0/7 (0%)
4	6/6 (100%)	1/7 (14%)
5	6/7 (86%)	0/7 (0%)
6	2/7 (29%)	0/6 (0%)
7	0/6 (0%)	0/7 (0%)
8A	4/7 (57%)	0/7 (0%)
8B	3/7 (43%)	0/7 (0%)
9	1/5 (20%)	1/7 (14%)
10	5/7 (71%)	0/5 (0%)
11A	3/6 (50%)	0/7 (0%)
11B	6/6 (100%)	3/6 (50%)
13	6/7 (86%)	0/7 (0%)
14	5/7 (71%)	0/7 (0%)
Totals	65/96 (68%)	6/100 (6%)

POST MONOCHLORAMINE INSTALL

Discussion and conclusions after 16-month evaluation:

Table 6
Summary of all microbiological parameters before and after monochloramine treatment. Results and statistical comparisons consider all samples collected.

Microbiological Parameter	Units	Pre-Treatment	Post-Treatment	Significance
HPC (culture)	CFU/mL	6952 CFU/mL	1204 CFU/mL	Yes, $p<0.05$ ($p<0.001$)
Mycobacterium (culture)	positivity	33/54 (61%)	14/101 (14%)	Yes, $p<0.05$ ($p<0.001$)
Legionella (culture)	positivity	65/96 (68%)	6/100 (6%)	Yes, $p<0.05$ ($p<0.001$)
Legionella pneumophila sg1 (qPCR)	positivity	40/48 (83%)	31/91 (34%)	Yes, $p<0.05$ ($p = 0.006$)
Mycobacterium (qPCR)	positivity	44/48 (92%)	59/91 (65%)	No, $p>0.05$ ($p = 0.11$)
Pseudomonas aeruginosa (qPCR)	positivity	19/48 (40%)	1/96 (1%)	Yes, $p<0.05$ ($p = 0.011$)
Vermamoeba vermiformis (qPCR)	positivity	42/48(88%)	16/92 (17%)	Yes, $p<0.05$ ($p<0.001$)

- "There were no water quality changes or known unintended consequences after monochloramine addition including increases in lead/copper, iron and disinfection by-products including NDMA."
- Poor microbiological water quality caused by age of plumbing and galvanized plumbing
- Shower locations

KNOWLEDGE CENTER

THANK YOU

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