THE Water Research FOUNDATION

May 28, 2020

advancing the science of water®

WRF Resources – Building WQ and Flushing

Green Building Design: Water Quality Considerations (4383) – Completed

Evaluation of Flushing to Reduce Lead Levels (4584) - Completed

Flushing Guidance for Premise Plumbing and Service Lines to Avoid or Address a Drinking Water Advisory (4572) - Completed

Demonstrating the Effectiveness of Flushing for Reducing the Levels of *Legionella* in Service Lines and Premise Plumbing (5033) – on-going

WRF Resources – Opportunistic Pathogens

Customer Messaging on Opportunistic Pathogens in Plumbing Systems (4664) – Completed

Three series of *Legionella* Webcasts: Analytical and Monitoring Methods, Technologies for prevention and Mitigation, and Management and Guidance (4726) - Completed

Detection Method Development using molecular method (4721), Sampling and monitoring strategies in DWDS (4911) – on-going

WRF Resources – COVID-19

Two Webcasts on Coronavirus Research Update

Virtual International Water Research Summit on Environmental Surveillance of COVID-19 Indicators in Sewersheds

Environmental Persistence and Disinfection of Lassa Virus and SARS-CoV-2 to Protect Worker and Public Safety (5029) on-going

Webcast Speakers

Jennifer L. Clancy, PhD., M.S. Law
ESPRI

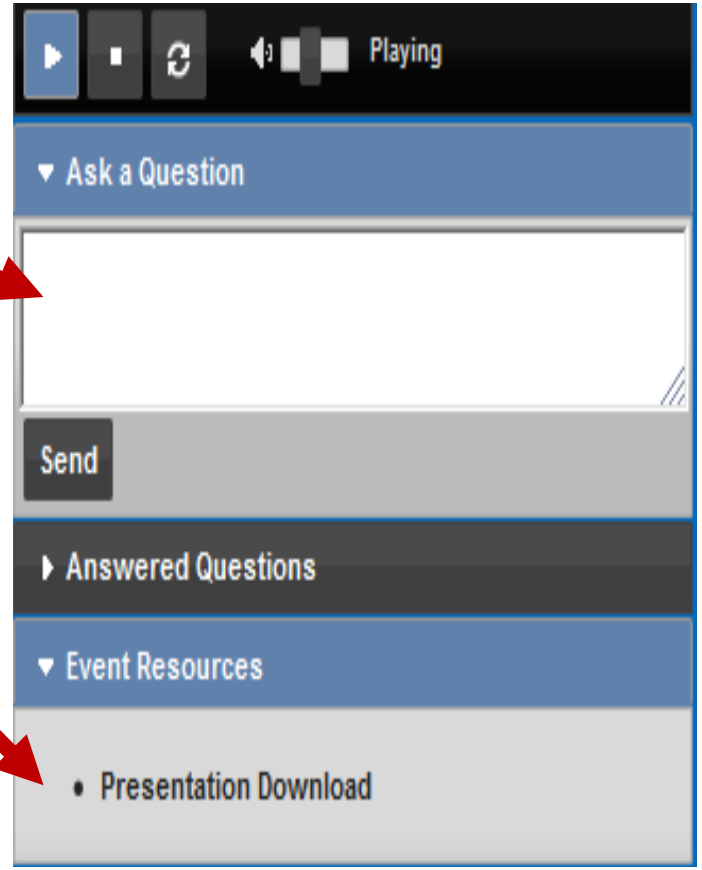
Jasen Kunz, MPH, REHS
CDC

Andrew Whelton, PhD
Purdue University

Michele Prevost, PhD
Polytechnique Montréal

Housekeeping Items

- Submit questions through the question box at any time! We will do a Q&A near the end of the webcast.
- Slides and a recording of the webcast will be available at www.waterrf.org.
- Send an email to Michelle Suazo at msuazo@waterrf.org for a PDH certificate.
- Survey at the end of the webcast.



THE Water Research FOUNDATION

Overview of Water Quality Impact after Prolonged Building Shutdown

Jennifer L. Clancy, Ph.D., M.S. Law
ESPRI

The Issue

- Due to the COVID-19 pandemic, life has changed drastically.
- In some instances, buildings have been shut down or are not operating near capacity.
- This affects water quality.
- Building water quality degradation is a silent but serious issue when water is not used, or water use is significantly reduced.
- How to flush and reopen buildings.
- Many guidance for consideration.

What happened in my building water system while the building was out of use?

- Disinfectant in the water dissipated.
  - Microorganisms grew on pipes, fixtures and tanks.
  - Some of these, e.g. *Legionella pneumophila*, may cause disease if they are inhaled as droplets from aerosolization (e.g., showering).
- The protective scale on pipes could have destabilized.
  - Without the protective scale, toxic metals like lead can dissolve or shear off as particles and end up in water used for drinking or food preparation.
- Potentially harmful substances such as disinfection byproducts (DBPs) built up.
- Mechanical equipment such as cooling towers, boilers and pumps may not have received any routine maintenance.
  - Backflow preventers may have missed annual test cycles.

8 steps to minimize *Legionella* risk before your business or building reopens

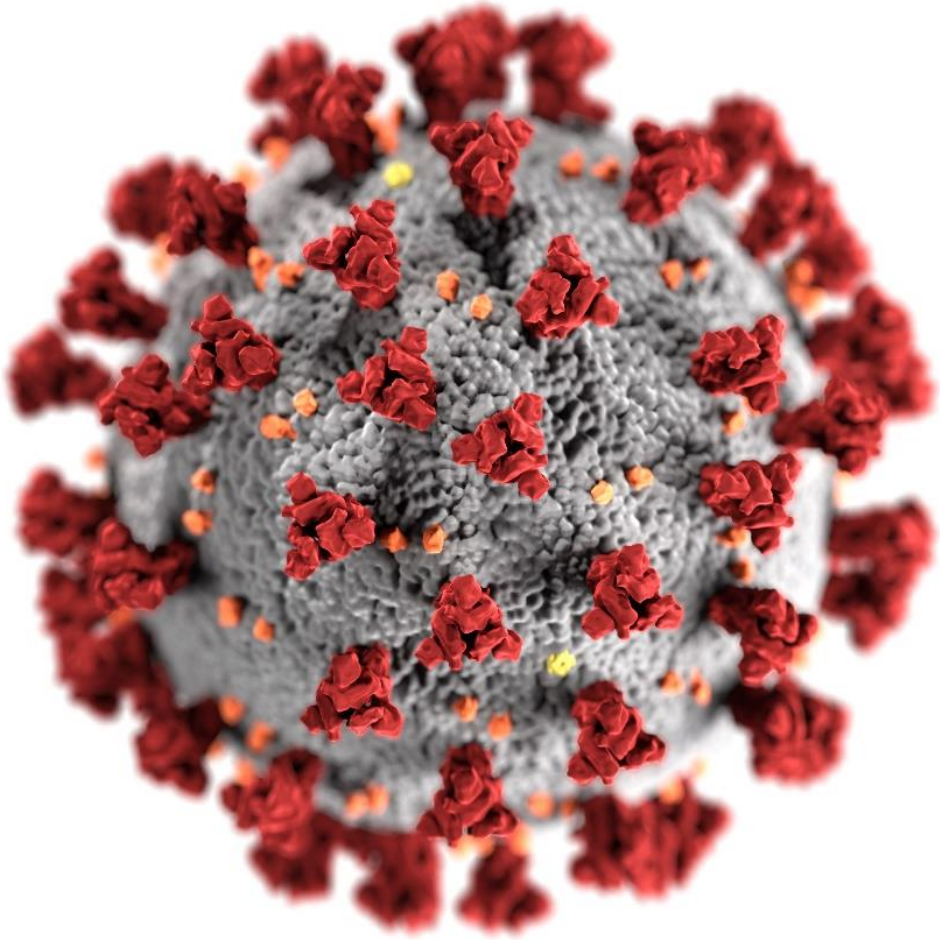
CDR Jasen Kunz, MPH, REHS/RS

Environmental Health Officer

The Water Research Foundation Webcast:

Impact of Prolonged Shutdown on Buildings from a Water Quality Perspective

May 28th, 2020



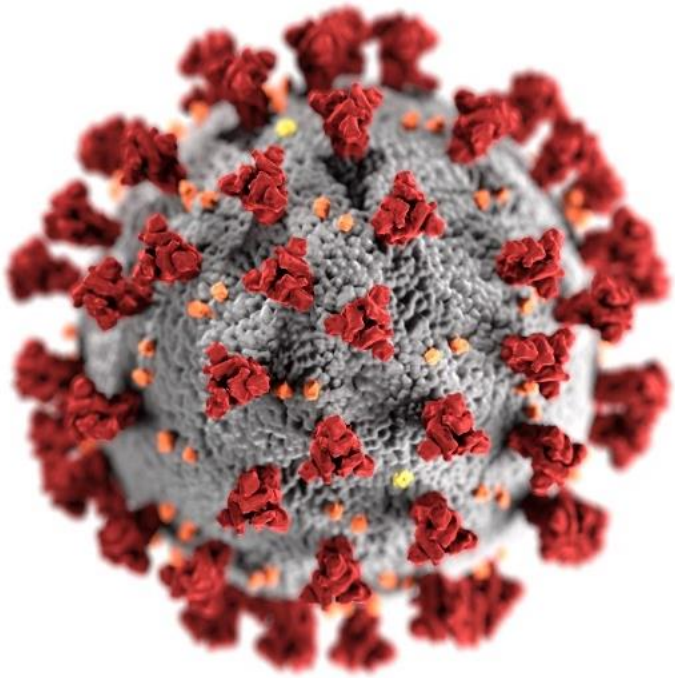
cdc.gov/coronavirus

Overview of Presentation

- COVID-19 pandemic update
- Legionnaires' disease background
- Steps to minimize *Legionella* risk
- EPA* Guidance for Maintaining or Restoring Water Quality in Buildings with Low or No Use

*Environmental Protection Agency

COVID-19: Pandemic update



- Caused by the virus SARS-CoV-2
- First U.S. case reported January 21, 2020
- As of May 25: 1,637,456 cases and 97,669 deaths
- 50 states and 5 U.S.-affiliated jurisdictions have confirmed cases
- www.cdc.gov/coronavirus/2019-ncov/cases-in-us.html

Legionnaires' disease

- First described following an American Legion convention in Philadelphia in 1976
- Causes severe pneumonia and usually requires hospitalization
  - Deadly for 1 in 10 people infected
  - Deadly for 1 in 4 who get it from a healthcare facility

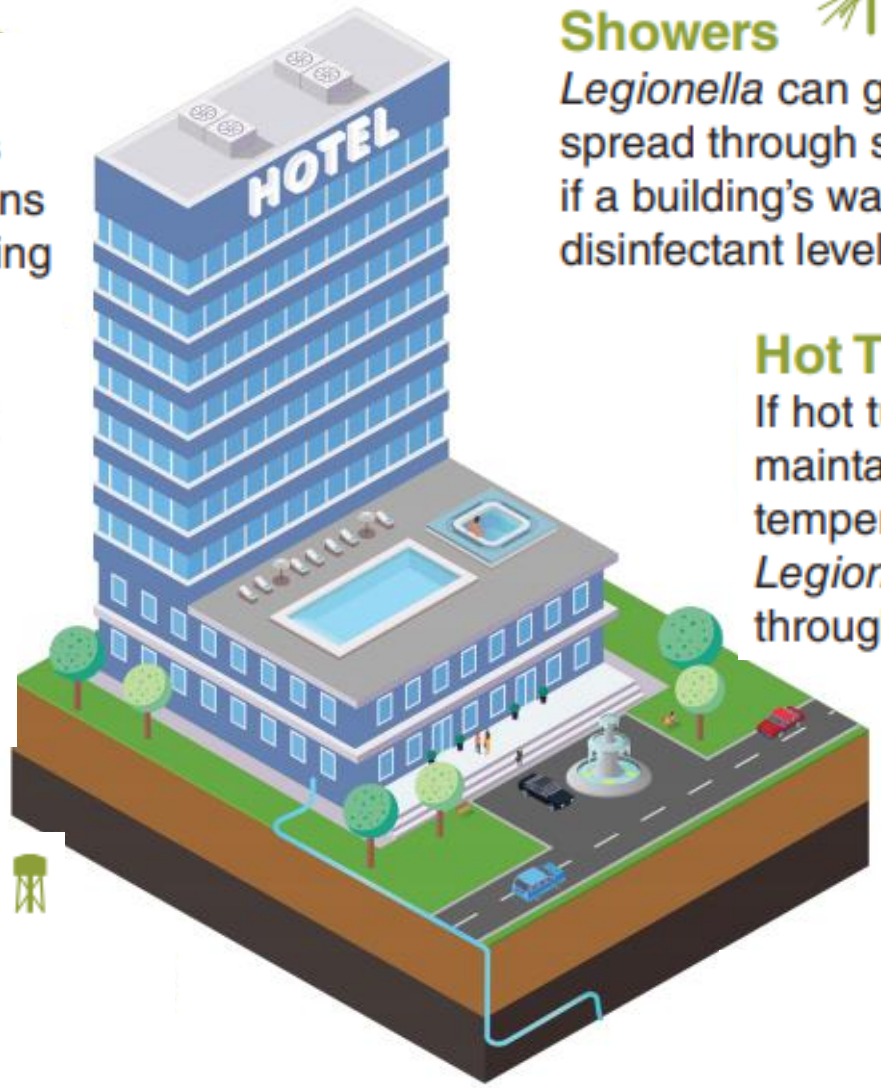
Legionella can grow and spread in many areas of hotels and resorts

Cooling Towers

When disinfectant levels are low, cooling tower fans can spray water containing *Legionella*.

Unoccupied Floors

Low occupancy decreases water flow, which can decrease disinfectant levels and increase the risk of *Legionella* growth.



Showers

Legionella can grow in and spread through showerheads if a building's water has low disinfectant levels.

Hot Tubs

If hot tubs are not well maintained, the warm temperature supports growth of *Legionella*, which can spread through water jets.

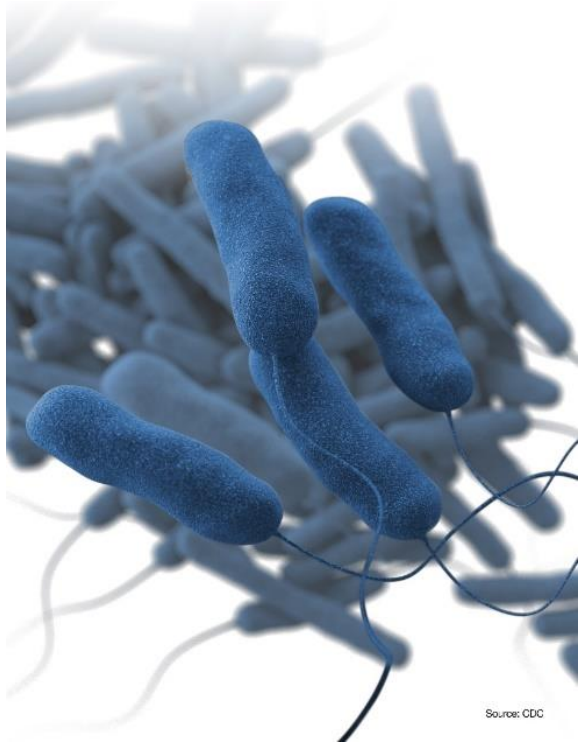
Water Supply Interruptions

Events that interrupt the delivery of municipal water to a building, such as nearby construction, allow dirt to enter the system and use up disinfectant.

Decorative Fountains

Legionella can grow in warm areas of a fountain and splashing can spread water containing *Legionella*.

Ensure that your water system is safe to use after a prolonged shutdown



- Stagnant or standing water in a plumbing system can
  - Increase the risk for growth and spread of *Legionella* and other biofilm-associated bacteria.
  - Facilitate the lowering of hot water temperatures to the *Legionella* growth range (77–108°F, 25–42°C).
  - Lead to low or undetectable levels of disinfectant, such as chlorine.

Prioritize worker safety when conducting reopening activities

- **People at increased risk** of developing Legionnaires' disease, such as those with weakened immune systems, **should consult with a medical provider** regarding participation in flushing, cooling tower cleaning, or other activities that may generate aerosols.

- Wearing a half-face air-purifying respirator equipped with an N95 filter[1], or an N95 filtering facepiece, may be appropriate in enclosed spaces where aerosol generation is likely.

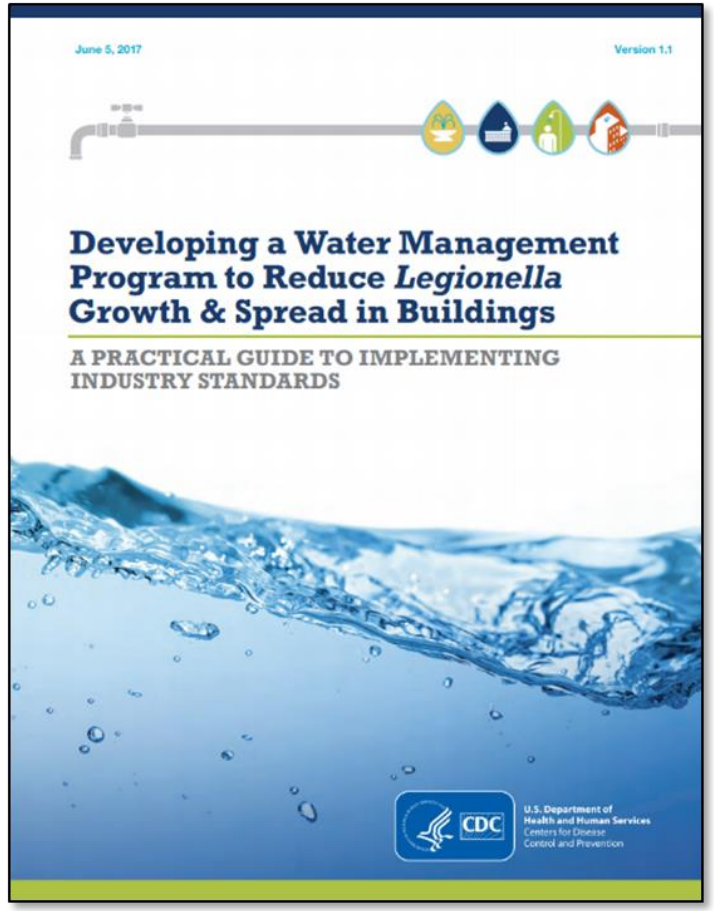
1. Respirators must be used in accordance with a comprehensive respiratory protection program, which includes fit testing, training, and medical clearance ahead of their use (see OSHA standard 29 CFR 1910.134 and OSHA Legionellosis website). For more information about N95 respirators, visit the NIOSH National Personal Protective Technology Laboratory (NPPTL) website.

8 steps to minimize *Legionella* risk before your business or building reopens

Step 1: Develop a comprehensive water management program (WMP)

- Water Management Program Toolkit:
  - www.cdc.gov/legionella/wmptoolkit

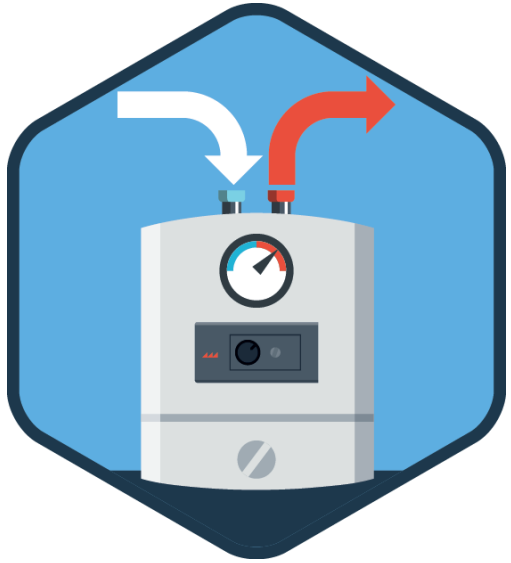
- Preventing Legionnaires' Disease: A Training on *Legionella* Water Management Programs (PreventLD Training):
  - www.cdc.gov/nceh/ehs/elearn/prevent-LD-training.html



Step 2: Ensure your water heater is properly maintained and the temperature is correctly set

- Determine if your manufacturer recommends draining the water heater after a prolonged period of disuse.

- Set your water heater to at least 140°F.
  - Higher temperatures can further reduce the risk of *Legionella* growth
  - Take measures to prevent scalding



Step 3: Flush your water system

- Flush hot and cold water through all points of use.
- Flushing may need to occur in segments based on facility size and water pressure.
- Flush until the hot water reaches its maximum temperature.
- Take care to minimize splashing and aerosol generation.
- Other water-using devices may require additional cleaning steps in addition to flushing.

Step 4: Clean all decorative water features

- Follow any recommended manufacturer guidelines for cleaning.
- Ensure that decorative water features are free of visible slime or biofilm.
- After the water feature has been re-filled, measure disinfectant levels to ensure that the water is safe for use.

Step 5: Ensure hot tubs/spas are safe for use[1]

- Check for existing guidelines from your local or state regulatory agency before use.
- Ensure that hot tubs/spas are free of visible slime or biofilm before filling with water.
- Perform a hot tub/spa disinfection procedure before use.
- *Legionella* testing decisions should be made in consultation with facility water management program staff and relevant public health authorities.

1. See also Considerations for Public Pools, Hot Tubs, and Water Playgrounds During COVID-19: https://www.cdc.gov/coronavirus/2019-ncov/community/parks-rec/aquatic-venues.html

Step 6: Ensure cooling towers are clean and well-maintained

- Maintain cooling towers (including start-up and shut-down procedures) per manufacturer's guidelines and industry best practices[1].

- Ensure that the tower and basin are free of visible slime, debris, and biofilm before use.

- If the tower appears well-maintained, perform an online disinfection procedure.

1. Cooling Technology Institute for guidance on cooling tower start-up and shutdown procedures and disinfection
https://cti.org/pub/cticode.php
http://www.cti.org/downloads/WTP-148.pdf

Step 7: Ensure safety equipment is clean and well-maintained

- Regularly flush, clean, and disinfect these systems according to manufacturers' specifications
  - Fire sprinkler systems
  - Eye wash stations
  - Safety showers

Step 8: Maintain your water system

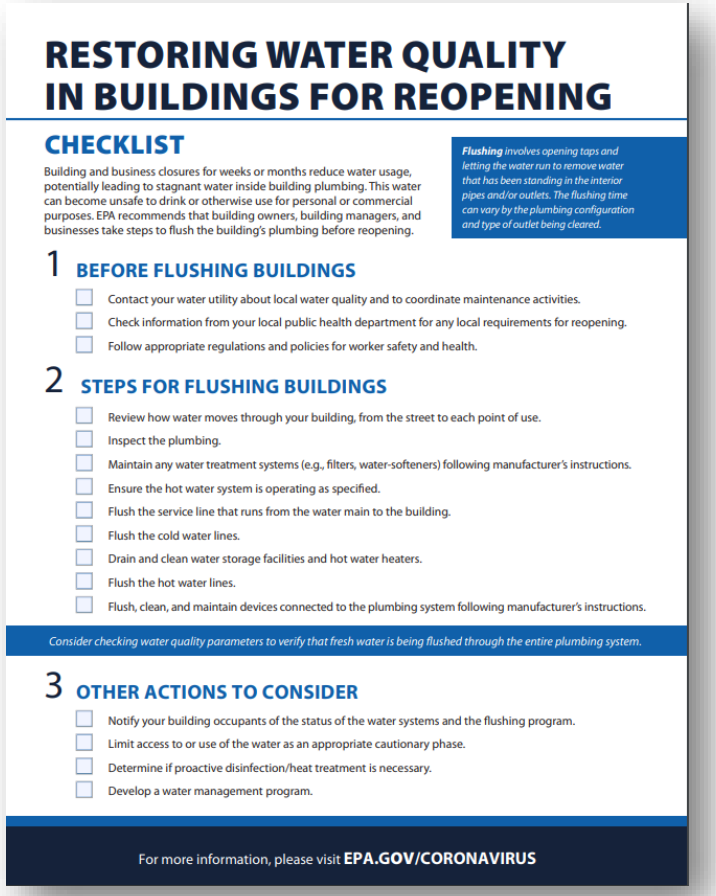
- Consider contacting your local water utility to inquire about any recent disruptions in the water supply.

- After your water system has returned to normal operations, ensure that the risk of *Legionella* growth is minimized by regularly checking water quality parameters such as temperature, pH, and disinfectant levels.

- Follow your water management program, document activities, and promptly intervene when unplanned program deviations arise.

EPA Guidance for Maintaining or Restoring Water Quality in Buildings with Low or No Use

- Aligns with CDC guidance
- Steps to maintain water quality while buildings are closed
- Maintenance procedures for buildings operating at reduced usage
- Steps to prepare the building water system when reopening
- Guidance for non-community water systems



RESTORING WATER QUALITY IN BUILDINGS FOR REOPENING

CHECKLIST

Building and business closures for weeks or months reduce water usage, potentially leading to stagnant water inside building plumbing. This water can become unsafe to drink or otherwise use for personal or commercial purposes. EPA recommends that building owners, building managers, and businesses take steps to flush the building's plumbing before reopening.

Flushing involves opening taps and letting the water run to remove water that has been standing in the interior pipes and/or outlets. The flushing time can vary by the plumbing configuration and type of outlet being cleared.

1 BEFORE FLUSHING BUILDINGS

- ☐ Contact your water utility about local water quality and to coordinate maintenance activities.
- ☐ Check information from your local public health department for any local requirements for reopening.
- ☐ Follow appropriate regulations and policies for worker safety and health.

2 STEPS FOR FLUSHING BUILDINGS

- ☐ Review how water moves through your building, from the street to each point of use.
- ☐ Inspect the plumbing.
- ☐ Maintain any water treatment systems (e.g., filters, water-softeners) following manufacturer's instructions.
- ☐ Ensure the hot water system is operating as specified.
- ☐ Flush the service line that runs from the water main to the building.
- ☐ Flush the cold water lines.
- ☐ Drain and clean water storage facilities and hot water heaters.
- ☐ Flush the hot water lines.
- ☐ Flush, clean, and maintain devices connected to the plumbing system following manufacturer's instructions.

Consider checking water quality parameters to verify that fresh water is being flushed through the entire plumbing system.

3 OTHER ACTIONS TO CONSIDER

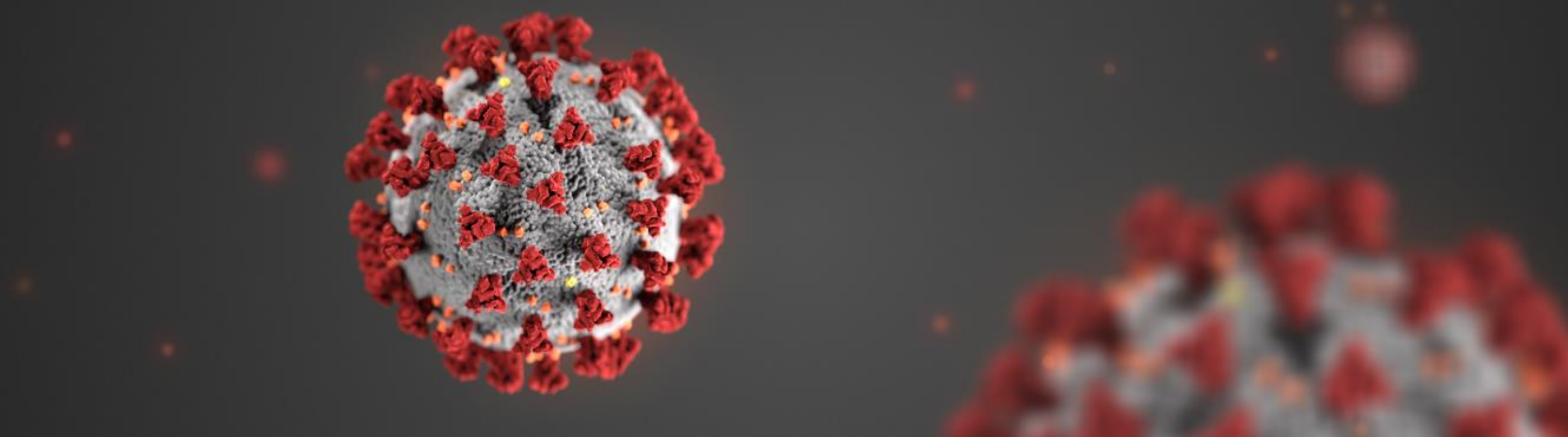
- ☐ Notify your building occupants of the status of the water systems and the flushing program.
- ☐ Limit access to or use of the water as an appropriate cautionary phase.
- ☐ Determine if proactive disinfection/heat treatment is necessary.
- ☐ Develop a water management program.

For more information, please visit **EPA.GOV/CORONAVIRUS**

https://www.epa.gov/coronavirus/information-maintaining-or-restoring-water-quality-buildings-low-or-no-use

COVID-19: CDC Resources

- Latest COVID-19 information: www.cdc.gov/coronavirus
- Reopening Guidance for Cleaning and Disinfection: www.cdc.gov/coronavirus/2019-ncov/community/reopen-guidance.html
- Building Reopening Guidance: www.cdc.gov/coronavirus/2019-ncov/php/building-water-system.html
- Businesses and Workplaces: https://www.cdc.gov/coronavirus/2019-ncov/community/organizations/businesses-employers.html
- COVID-19 prevention: www.cdc.gov/coronavirus/2019-ncov/prevent-getting-sick/index.html
- CDC communication resources: www.cdc.gov/coronavirus/2019-ncov/communication/index.html



For more information, contact CDC
1-800-CDC-INFO (232-4636)
TTY: 1-888-232-6348 www.cdc.gov

The findings and conclusions in this report are those of the authors and do not necessarily represent the official position of the Centers for Disease Control and Prevention.

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Building Water Quality: Flushing Guidance for Periods of Low or No Use

Jennifer L. Clancy, Ph.D., M.S. Law
ESPRI

Flushing to Restore Water Quality

- Developed a brief document to bring awareness to building operators.
- A **general roadmap** for how to flush contaminants from the building and get the plumbing system water quality back to pre-stagnation conditions.
- Each building is different, and flushing will need to be tailored accordingly.

- Tim Bartrand
- Sheldon Masters
- Randi McCuin
- Tom Hargy
- Jen Clancy

- Rich Theiss
- Peter Pommerenk
- Sean McNamara
- Dave Hiltebrand

https://esprinstitute.org/coronavirus-building-flushing-guidance/

Posted April 3, 2020

How do I prepare the building for re-occupancy?

- Best immediate action is to flush the entire building.
- The fresh water will help mitigate the problems (loss of protective scale and biofilm growth).
- If staff are available to flush, start now (**April 3, 2020**)
- Starting flushing now means less deterioration of water quality in the building and a sooner recovery to normal conditions.

How do I prepare the building for re-occupancy?

- Inspect mechanical equipment
  - Cooling towers, boilers, pumps, backflow preventers, etc. and determine if there are any issues regarding their function
- Other actions you could take include:
  - Clean showerheads, faucets and other fixtures that can produce aerosols that people could inhale
  - Develop a **water safety plan**, a long-term plan for keeping water quality high and protecting building occupants and visitors

How to flush

- Flushing should proceed from the service entrance (POE) to the periphery of the plumbing system (distal points).
- Some buildings have water treatment systems like filters and water softeners at the building water supply.
  - Those treatment systems were installed for a reason and should not be bypassed.
  - Those treatment systems need to be cleaned, flushed and maintained as part of bringing the building back into use.

How to flush – water storage

- Building water systems have a variety of places where water is stored.
  - At a minimum, they should all be identified, drained, and flushed with clean cold water, after the building cold water service is properly restored. These include, but are not limited to:
    - Hot water storage (some buildings have more than one type of heating system and hot water storage),
    - Hot water recirculating loop(s),
    - Humidifiers,
    - Ice machines,
    - Dishwashers, and
    - Cooling towers.

Initial flushing and cleaning

- The initial flush clears out contaminants that accumulated during stagnation and draws in fresh, high-quality water to the piping.
- Cleaning of fixtures removes contaminants from the complex internal structures at the point of discharge.
- Clean fixtures.
  - Clean showerheads.
  - Replace/maintain point of use filters.
- Complete the initial flushing and cleaning steps before resuming normal building operation

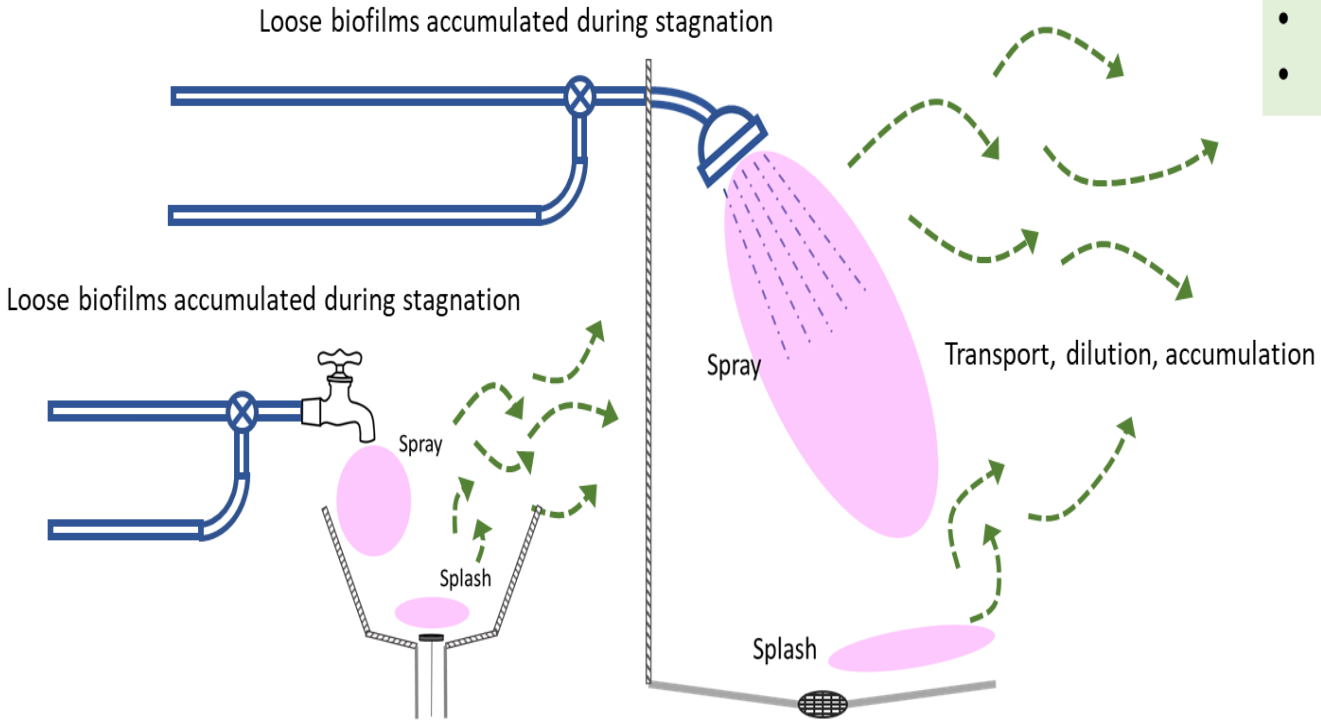
Initial flushing and cleaning

- Flush zone-by-zone.
  - Zones are branches of the building water system with a common source or parts of the building water system served by a common riser.
- The first zone to flush is the one nearest the building supply.
  - Flush zones progressively outward from the supply.
- In each zone, flush the cold water plumbing first and hot water second.
- Begin flushing at the POU nearest to the origin of the zone.
  - Remove aerators at the POU nearest the beginning of the zone
  - Open taps wide.

Initial flushing and cleaning

- Open other taps on the same branch, moving from the faucet nearest the origin to the most distant POU tap.
  - Continue flushing until the final POU tap is flushed for at least 5 minutes AND the cold water temperature at the final POU tap is steady.
  - Measure chlorine residual to look for increase.
- Drain hot water tanks on the first flush after resumption of flow.
  - If draining is not possible, hot water flushing time depends upon the size of water heater tank.
  - Maintain the water heater temperature.
  - DO NOT turn the heater off as water temperature is critical to prevent microorganisms from growing in the heater and being disseminated in aerosols.

Exposures during flushing



Opportunities for multiple barriers and worker protection

- In the plumbing and fixtures
- At the point of use (POU)
- In the room
- PPE

Ongoing flushing

- Repair destabilized scale and control biofilms.
- Re-stabilizing scale and controlling biofilms is an ongoing process.
  - 12 weeks for protective scale to re-stabilize and for lead borne on particles to be thoroughly washed from the plumbing system.

Ongoing flushing recommendations

- Open each POU tap daily.
- Flush the full building once per week during ongoing flushing.
  - Still flush the cold and hot water systems separately – cold first and hot second.
- If possible, measure the water quality of water coming into the building and at some taps in the building.
  - Many building operators will not have the equipment or the ability to make measurements.
  - ***Even if operators cannot measure water quality, they should still flush the building.***

Ongoing flushing recommendations

- The most important measurements:
  - Disinfectant concentration in the building supply (POE) and in the cold water of the most distant tap of each zone after that tap is fully flushed.
  - By comparing the POE and distal tap levels you can tell whether the disinfectant is protecting the whole plumbing system.
  - There is no benefit to measuring the disinfectant in the hot water system. At elevated temperature, disinfectant dissipates, esp. free chlorine.

What to do after flushing

- **Implement a Water Management Plan (WMP)**
  - To maintain high quality water in a building at all times, building owners and operators should implement a WMP that follows industry recommendations, e.g., ASHRAE 188 (2018), EU Guidelines for *Legionella* Control (2017).
  - Flushing is one of the management tools in WMPs.

Many Other Flushing Guidances

- Over 60 guidance documents out now
  - AWWA
  - CDC
  - EPA
  - State of WA
  - CWWA
  - AIHA
  - Purdue University
  - Others

THE Water Research FOUNDATION

If it is a terrifying thought that life is at the mercy of microbes, it is a consoling hope that Science will not always remain powerless before such enemies...

-Louis Pasteur

advancing the science of water®

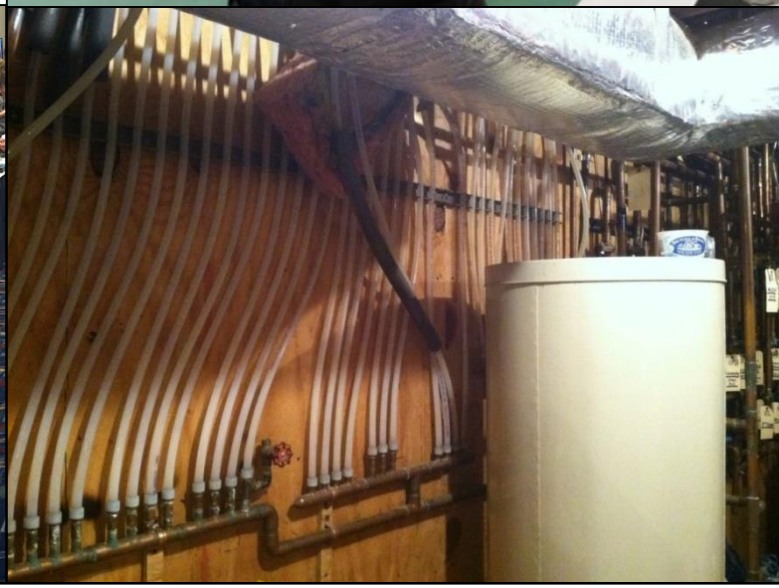
Where Do We Go From Here?

Andrew J. Whelton, Ph.D.

Civil, Environmental, and Ecological Engineering


THE SEAL OF THE GOVERNOR OF WEST VIRGINIA


ZONE 5



Commercial district

Street

Fire Hydrant

PROPERTY OWNER RESPONSIBILITY

Single vs. Multiple tenants

BUILDING PLUMBING

Water meter

Corporation Stop

Water Main (metal or plastic)

WATER UTILITY RESPONSIBILITY

Utility Service Line (metal or plastic)

Property Service Line (metal or plastic)

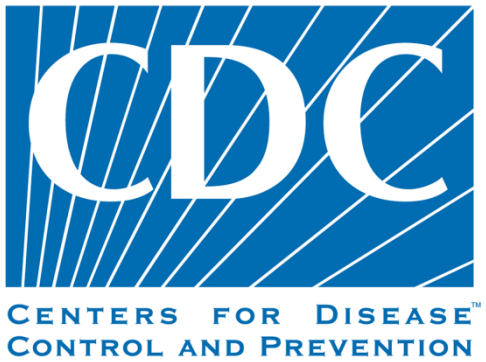
[sometimes other water sources]

Stagnation *noun*

stag·na·tion | \ stag-ˈnā-shən

a state or condition marked by lack of flow, movement

When water does not flow well; areas of stagnant water encourage biofilm growth and reduce temperature and level of



U.S. National Science Foundation RAPID Award 2027049

Shutdowns and Consequences - Extreme Plumbing Stagnation and Recommissioning

1. Support to the plumbing and public health sectors on building water safety guidance and decisions, ***ongoing***
2. Building water safety review due to prolonged stagnation with experts from 8 private and public sector organizations, ***ongoing***
3. Field testing to determine how impacted building water safety is in actual large buildings, ***ongoing***
4. Lab testing to determine how to fully recover contaminated building water system devices and equipment, ***planned***
5. Help transform public awareness, ***ongoing***

Helping

IAPMO

American Water Works Association

astho™

SLOAN

Whirlpool Corporation

NRDC

Washington State Department of Health

ASDWA

Ohio Environmental Protection Agency

ASPE American Society of Plumbing Engineers

NEHA Training

SAFE WATER ENGINEERING

#2. Building water safety review due to prolonged stagnation with experts from 7 private and public sector organizations

Collaborative effort

Caitlin R. Proctor, Ph.D., Purdue University

William Rhoads, Ph.D., Virginia Tech

Tim Keane, Legionella Risk Management, Inc.

Maryam Salehi, Ph.D., University of Memphis

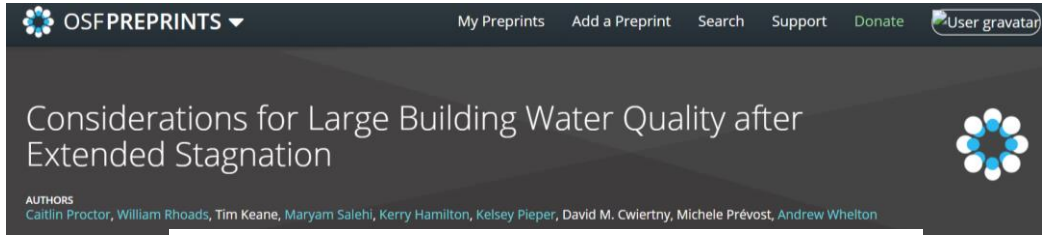
Kerry Hamilton, Ph.D., Arizona State University

Kelsey J. Pieper, Ph.D., Northeastern University

David R. Cwiertny, Ph.D., University of Iowa

Michele Prévost, Ph.D., Polytechnique Montreal

Andrew J. Whelton, Ph.D., Purdue University



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8. Professor and Principal Chairholder, NSERC Industrial Chair on Drinking Water, Civil, Geological and Mining Engineering, Polytechnique Montreal, CP 6079 Succ Centre-ville, Montréal, Québec, Canada H3C 3A7, michele.prevost@polymtl.ca, T: (514) 340 4778
9. Purdue University, Lyles School of Civil Engineering, Division of Environmental and Ecological Engineering, 550 Stadium Mall Drive, West Lafayette, IN 47906; awhelton@purdue.edu; T: (765) 494-2160

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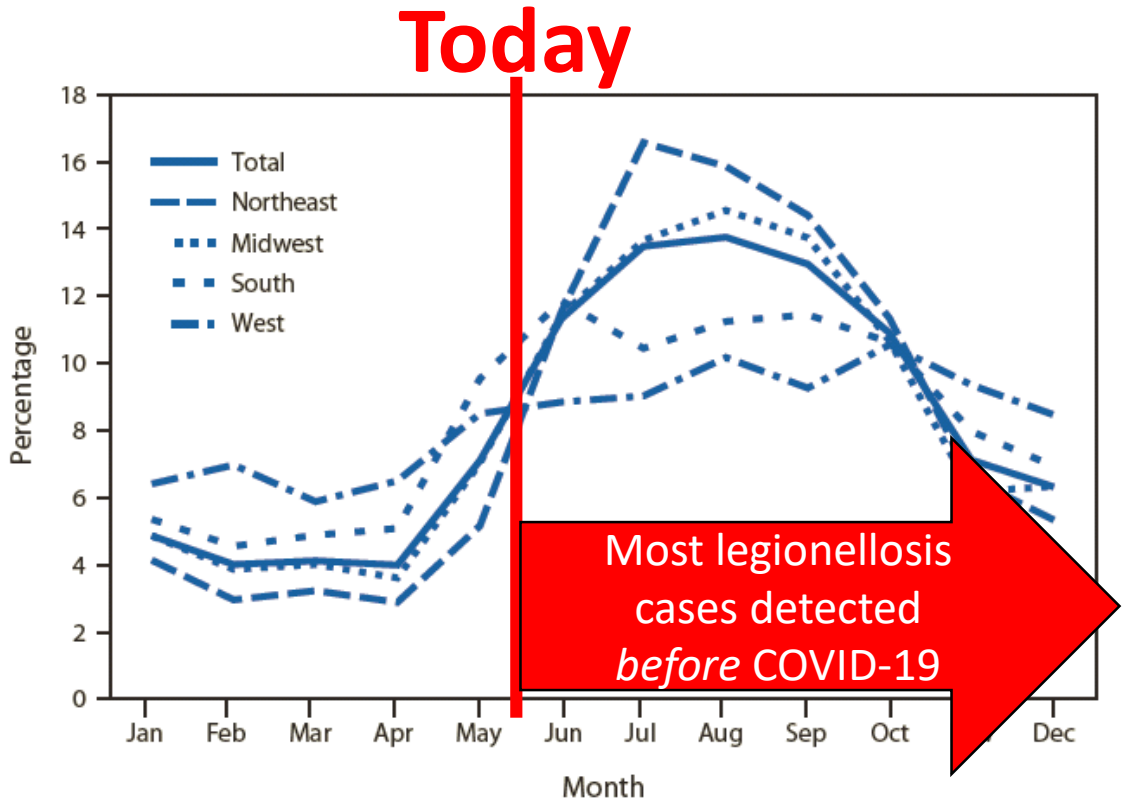
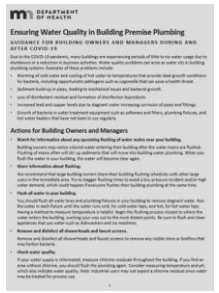
https://doi.org/10.31219/osf.io/qvj3b

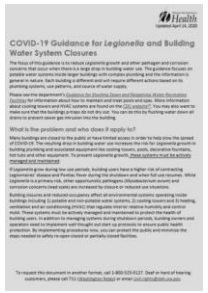
Available information only pertains to less than 2 weeks of stagnation or low water use

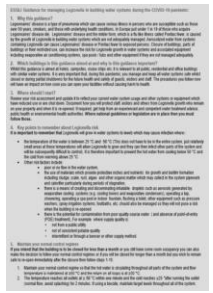
- **Copper** can leach
  - Nausea, vomiting, diarrhea, abdominal cramps
- **Lead** can leach
  - Nausea, vomiting, diarrhea, abdominal cramps, longer-term developmental issues with children
- **Scale** can be suspended
- **Harmful organisms** (e.g., *Legionella pneumophila* and other opportunistic pathogens) can grow - better
  - Many organisms cause respiratory illness, and other infections can occur

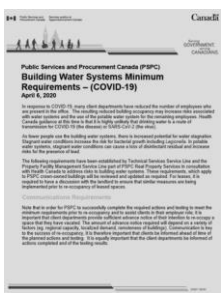


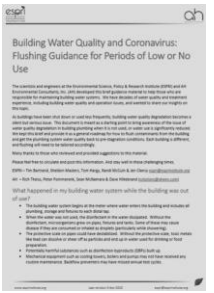
Exposure Routes of Concern: Ingestion, Dermal, Inhalation

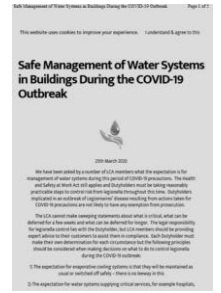


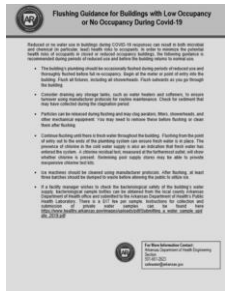




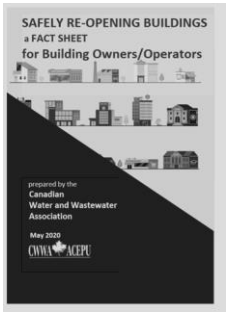




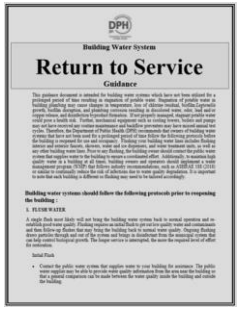


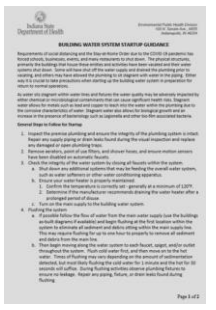


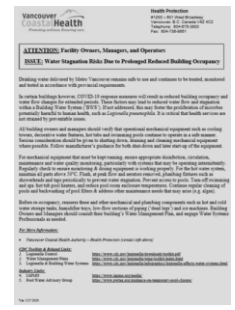
Since March 2020, there have been more than ***45+*** guidance documents telling building owners what they could do to prevent and deal with stagnation situations.



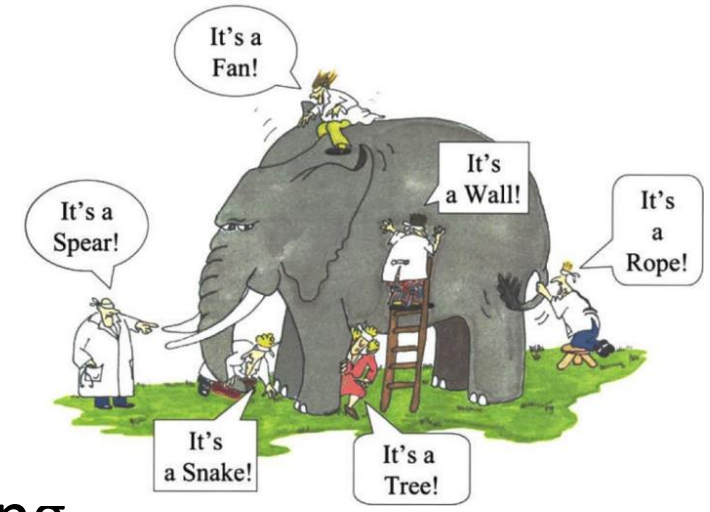
Many differ quite dramatically. Some lack key info (safety, devices, sensitive populations, etc.).







Why are they so different?



- Different perspectives - *sides of the elephant*
- Guidance targeted for different readers
- Different starting info. about water safety & plumbing
- Prescriptive step-by-step documents vs. general advice
- Some are derivatives of others, and others…and others!
- Some have been revised (version 3 since March 2020)
- Media, water utilities, and associations issuing very brief messages

Awareness vs. Informational vs. Warnings vs. Actions

How will we know if by following guidance documents we *avoid or cause* waterborne illness?

PURDUE UNIVERSITY

Water Supplier

- Review water meter records
- Relentlessly educate customers
- Temporarily expand disinfectant residual testing and flushing
- Temporarily increase disinfectant level

Health Department

- Relentlessly educate building owners
- Temporarily require water use and action reporting to maintain cert. of occupancy
- Directly advise building owners
- Pay attention to sensitive populations
- Notify laboratories about water testing

Building Owner (may or may not know water)

- Contact the health department (EH) for guidance
- Contact the water supplier about the incoming water
- Keep water fresh, clean plumbing, don’t allow prolonged stagnation
- Test temperature and disinfectant levels
- Create and maintain water use, flushing, and testing records
- Contact external experts for help

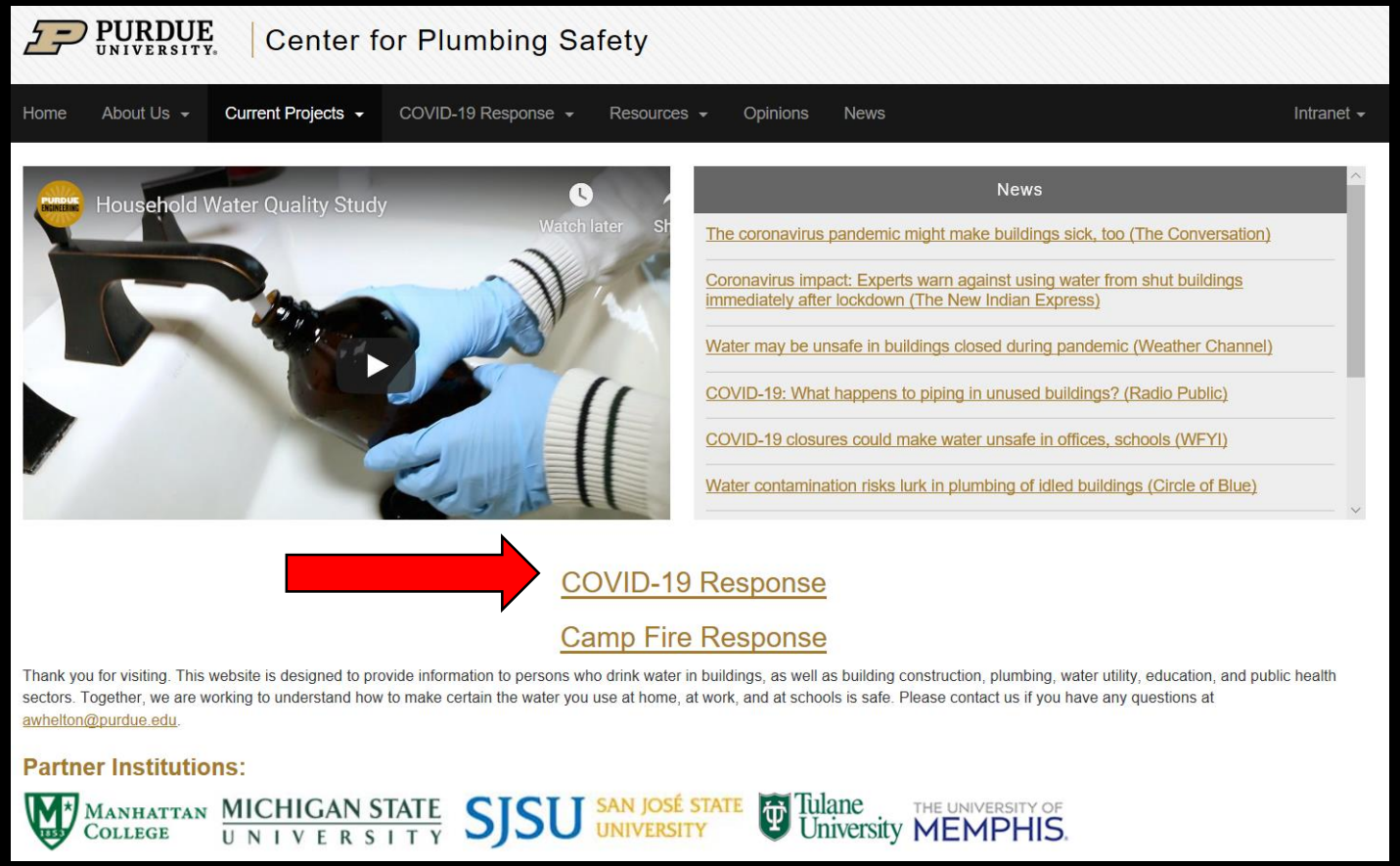
Conclusions

- Low water use and stagnation poses serious health risks. Keep water fresh.

- Much of the building water system guidance issued since the pandemic is projected from short-term stagnation studies. Best to review multiple documents, not 1 as many omit key information.

- **The only way to know if guidance works is to test.**

Thank you… www.PlumbingSafety.org



- ✓ Plumbing education videos
- ✓ Flushing plans
- ✓ Plumbing explainers
- ✓ Plumbing online trainings
- ✓ Scientific opinions
- ✓ Resources ➔ presentations
- ✓ Scientific reports
- ✓ External plumbing docs
- ✓ YouTube Channel

Andrew Whelton, Ph.D. awhelton@purdue.edu
@TheWheltonGroup

POLYTECHNIQUE MONTRÉAL

NSERC INDUSTRIAL CHAIR ON DRINKING WATER

THE Water Research FOUNDATION

Recommissioning buildings after CoVid stagnation: *can intensive flushing restore WQ in large buildings?*

Michèle Prévost
& Marianne Grimard-Conea

Impact of Prolonged Shutdown on Buildings from a Water Quality Perspective, May 28th 2020

Recommendations for restoring service to water distribution systems in vacant buildings

- **CoVid19 pandemic prompted complete and partial closures of buildings across Canada**
- **Staggering number of buildings big and small are affected**

Quebec RBQ issued provincial guidance:

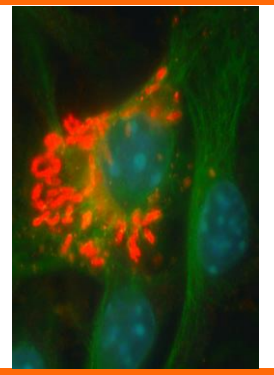
- Triggered after one month of inoccupation or partial occupation (<25%)
- All non residential building owners and managers
- Experts from the Polytechnique, RBQ, Corporation of Master Pipe Mechanics of Québec, UQTR, MOE, MOH and City of Laval
- ***Not a CoVid guidance, a stagnation guidance!***

Recommendations for restoring service to water distribution systems in vacant buildings

POLYTECHNIQUE MONTRÉAL

Main drivers:

- Lead & Copper and *Legionella*



MAJOR STEPS

Step 1 **Locating main components**

Step 2 **Preparation of hot water system**

Step 3 **Flushing hot and cold water outlets**

Communication

Recommendations for restoring service to water distribution systems in vacant buildings

POLYTECHNIQUE MONTRÉAL

Step 2 Hot water system

Check temperatures

- *out of boiler 60°C (140°F)*
- *to outlet 55°C (131°F)*

Check recirculation if any

- *If turned off or out of Temp range: turn on, adjust, and run for 24 h minimum*

- *Important recommendation of the 2029 NASEM report to prevent growth of Legionella*
- *Incorporated in plumbing code in Canada*

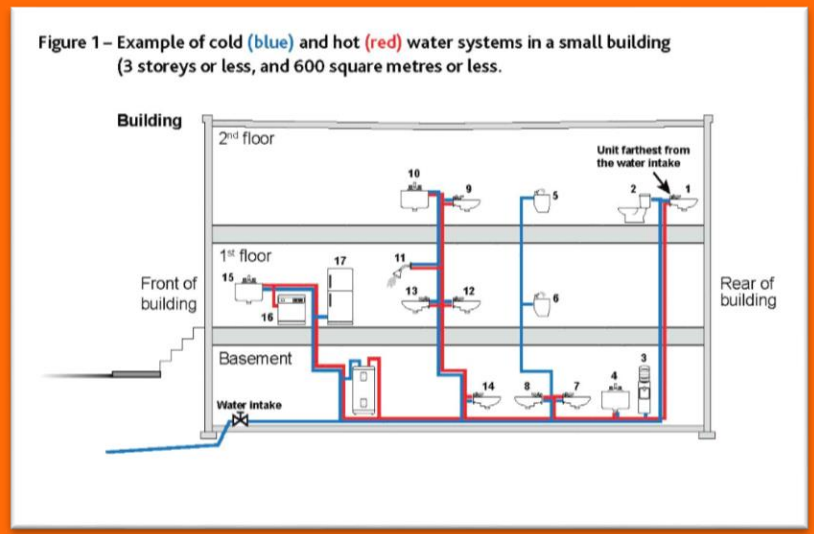
Recommendations for restoring service to water distribution systems in vacant buildings

POLYTECHNIQUE MONTRÉAL

Step 3 Flushing

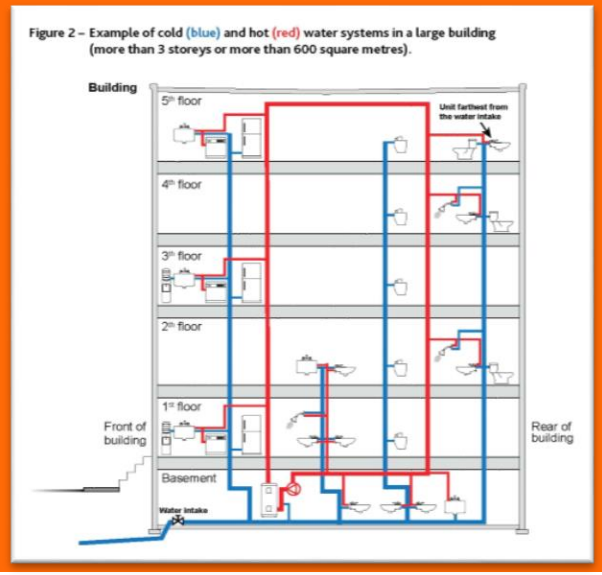
Simple building without recirculation
3 stories or less than 600 m2

- *Rinse points close to POE until stable temperature*
- *Rinse each tap (5M CW and 2M HW) from POE to furthest point*



Larger building with recirculation
> 3 stories or more than 600 m2

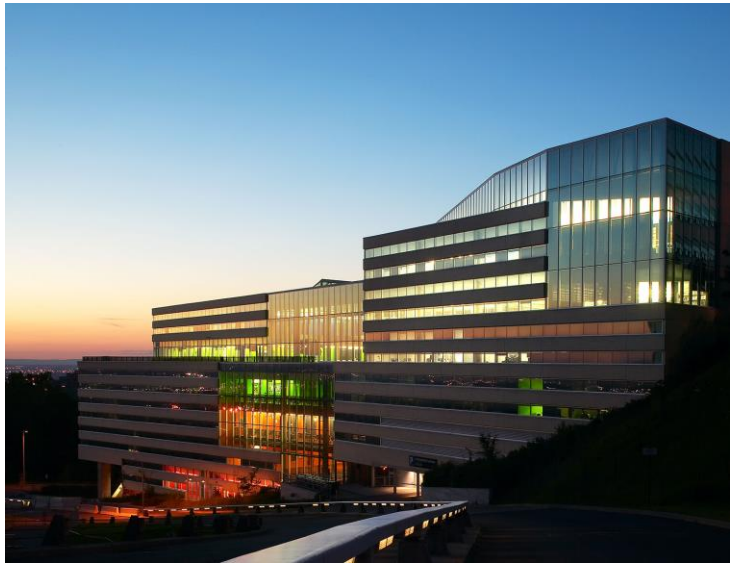
- *Rinse risers/columns until stable temperature*
- *Rinse each tap 2M CW and 2M HW*



Flushing commissioning studies

May-June 2020

After 2 months of stagnation → *During recommissioning* → *10 days after commissioning*



LEED Gold building (2005)

554,298 SQ FT

246 devices: 82 sinks, 83 toilets, 35 urinals, 18 fountains and 6 others

Main building (1959-89)

836,528 SQ FT

351 devices: 135 sinks, 104 toilets, 87 urinals, 20 fountains and 2 others

Flushing commissioning studies

INTENSIVE SAMPLING

Entry point + end of risers + 4 faucets H&C

- Cl_2, Temp, metals, turbidity
- HPC, TDC, TDVC, ATP
- Culture *Legionella*, *E. coli* & TC, *P. a.*, *qPCR NTM and Lp + diversity* 16S

Detailed WQ investigation

SEQUENTIAL SAMPLING

4 points H&C

- 0,2,5,15, & 30 minutes of flushing
- HPCs, TCs, Cl_2 and temperature

Provide more information on duration of flushing

BLITZ SAMPLING

25-30 points

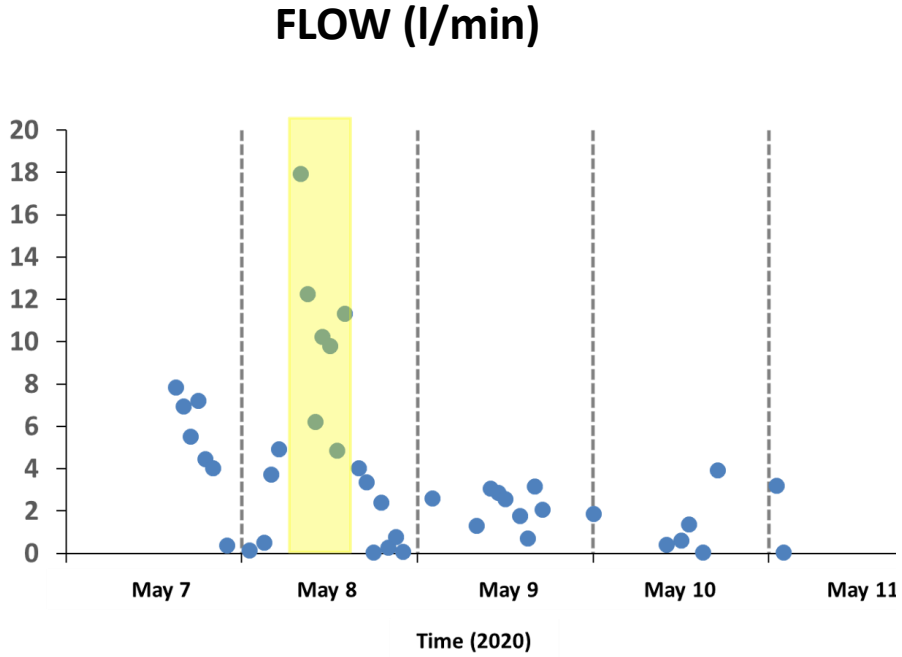
- Cl_2 and temperature

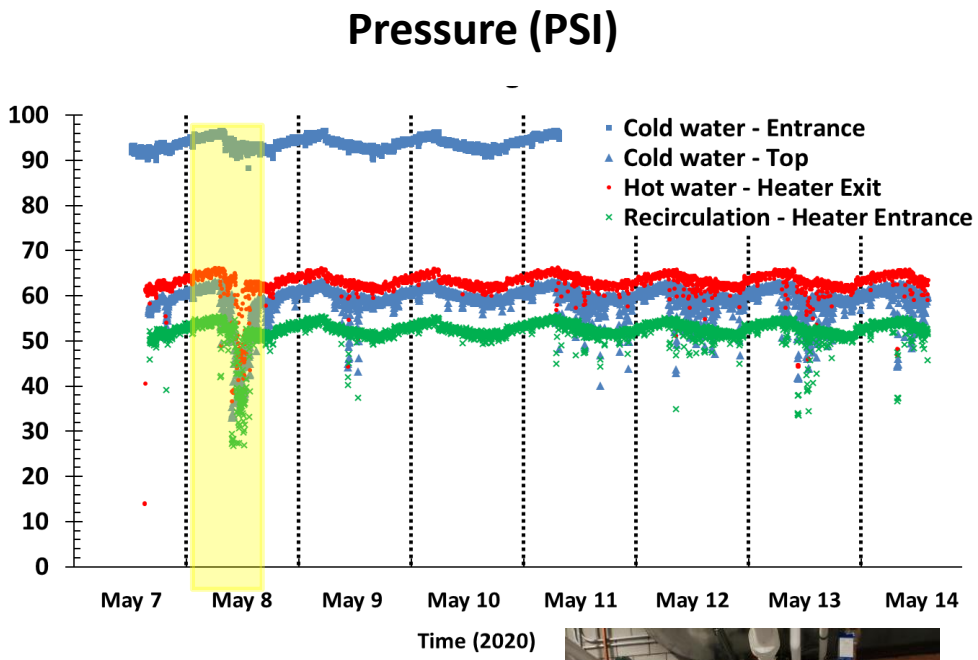
Establish ability of timed flushing to renew water

L. pneumophila **at showers + Lead at fountains**

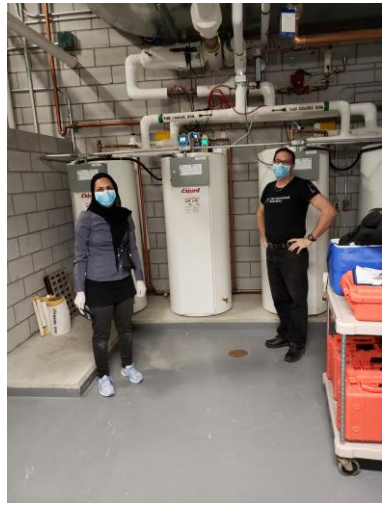
Lab and field team

Impact of flushing on flow and pressure

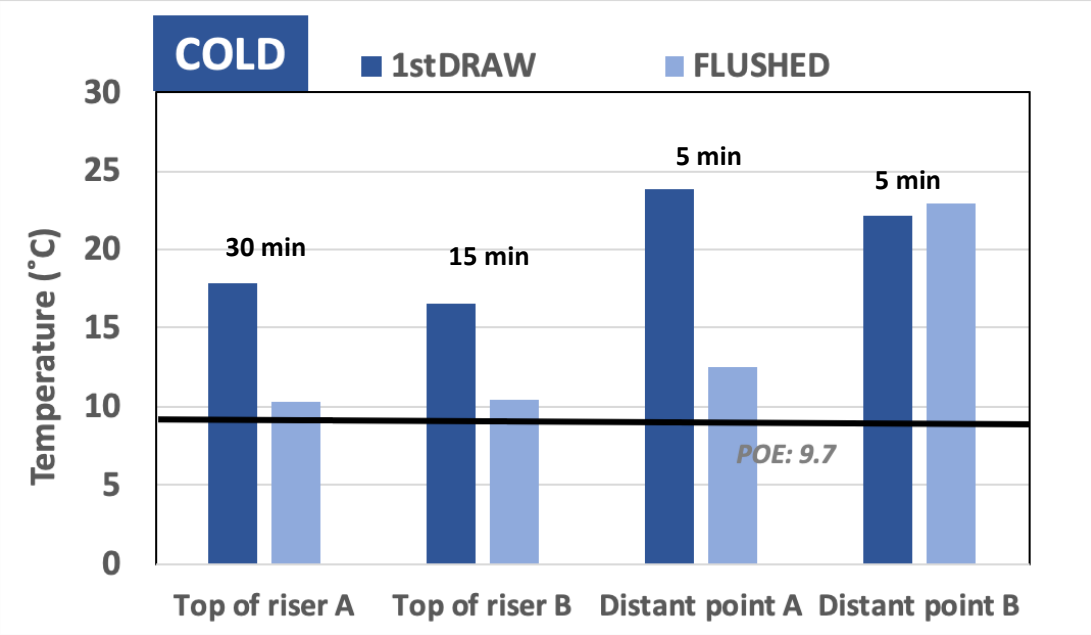


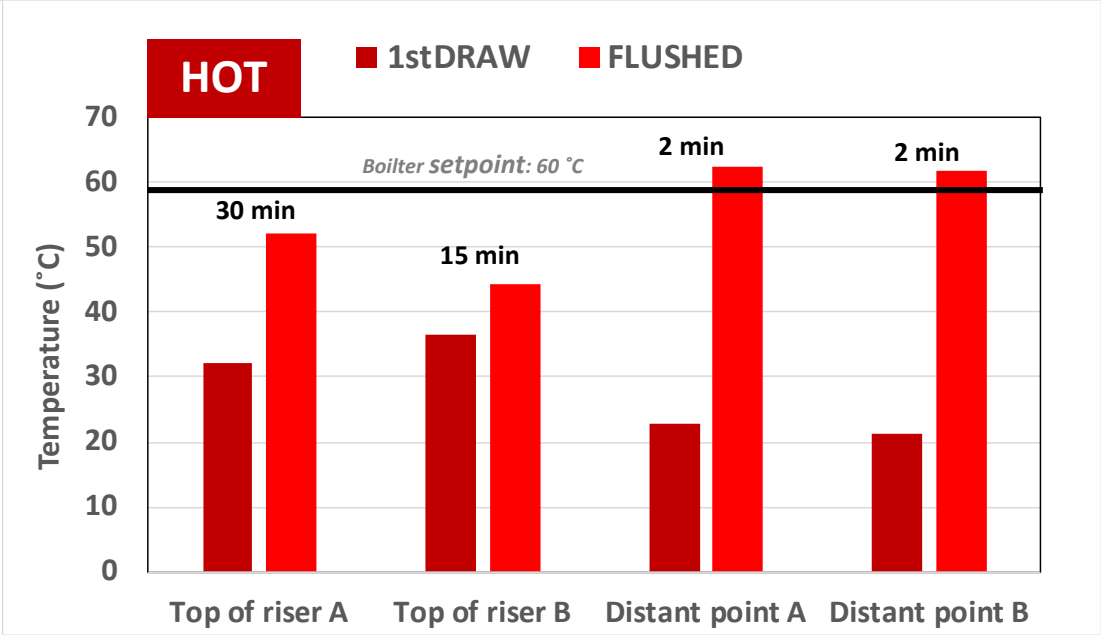


- Flushing increased demand – staged interventions and low flow faucets
- Some loss of pressure during flushing
- All systems instrumented to monitor temp and flow to monitor progressive reoccupancy and develop WQ model
- Costs estimates of preventative flushing



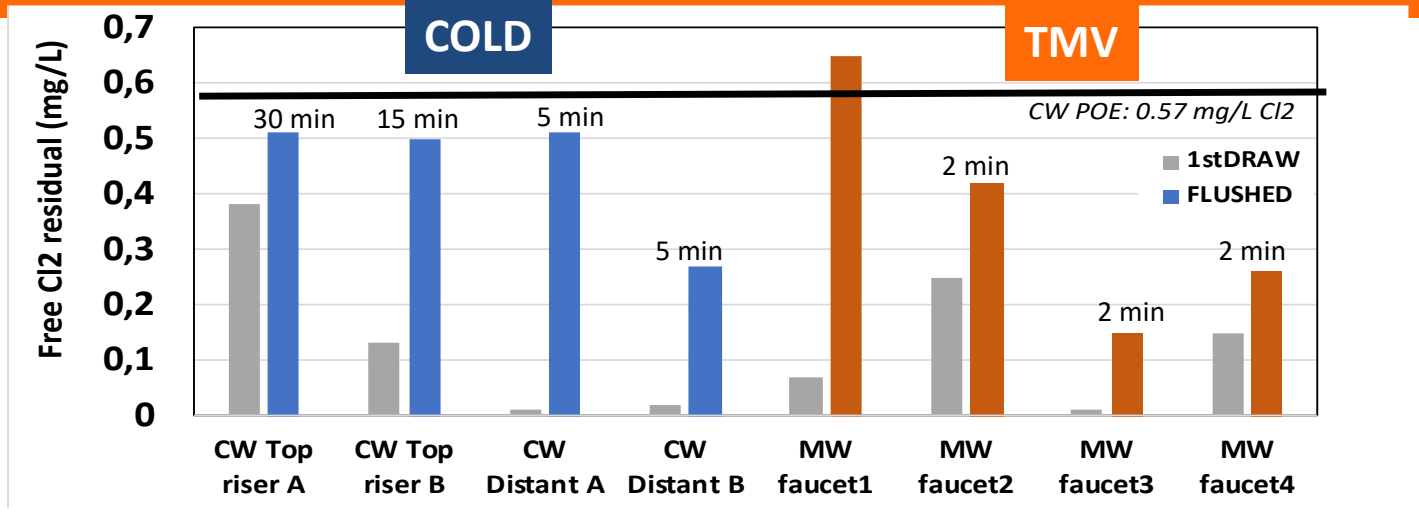
Tiered approach to flushing:
Temperature at risers and points of use

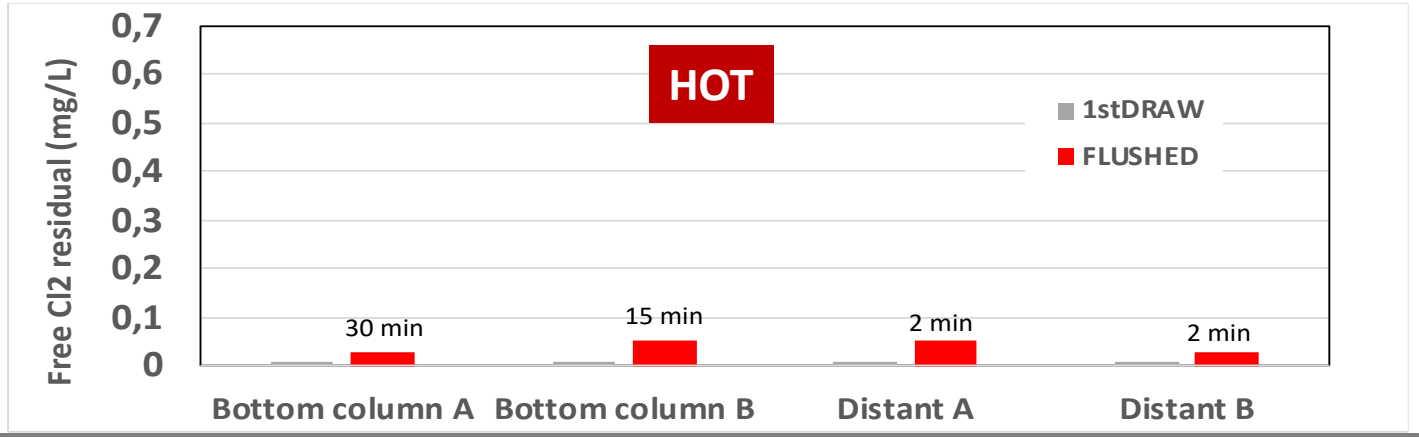




- Bring hot and cold water across the system
- Riser flushing can require over 30 minutes
- Renewal of HW easier than for CW
- 5 minutes is not enough to bring cold water to all faucets

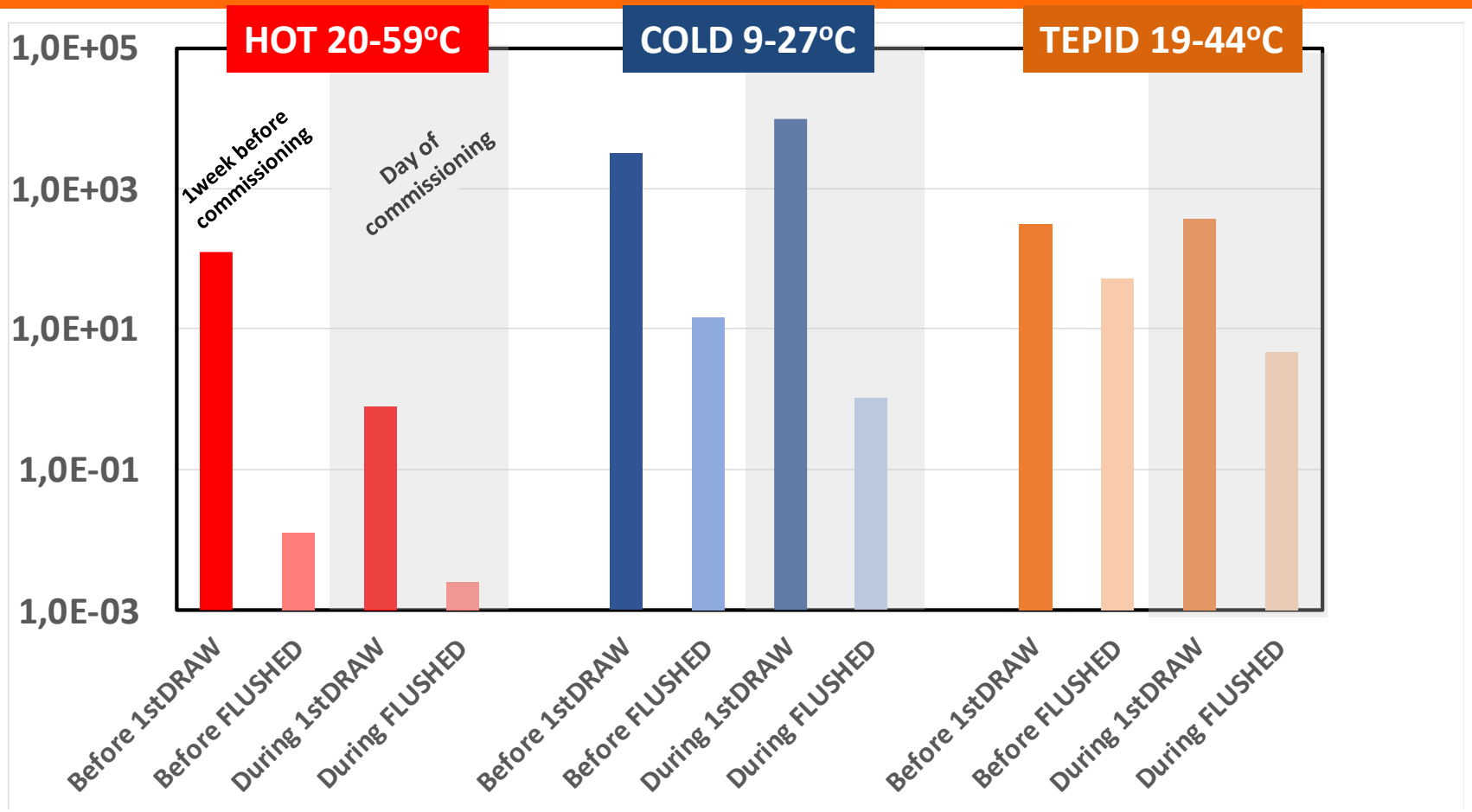
Can tiered flushing rapidly bring chlorine residuals at all faucets?





- Distant faucets and faucets with TMVs can be a challenge
- Hot water does not carry significant residuals
- Is is realistic or justified to require Cl_2 residual detection at all faucets?

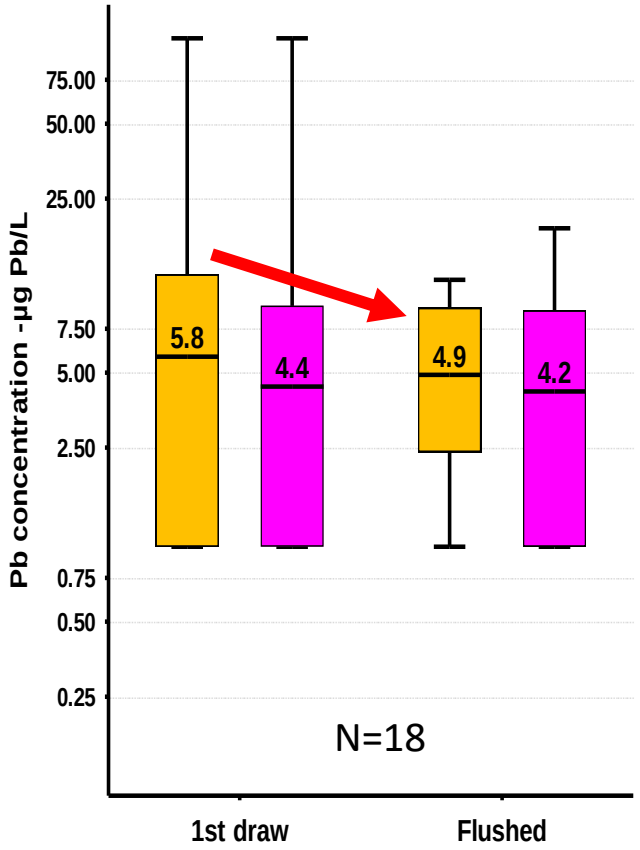
Impact of CoVid stagnation & flushing on HPCs



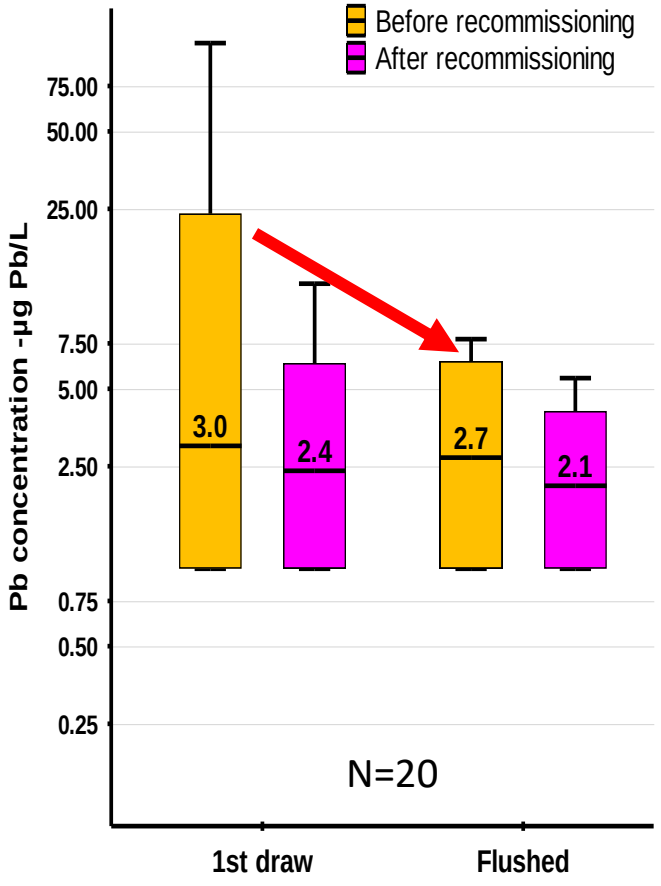
- Flushing decreases HPCs less so in efaucets with TMVs
- Distal amplification shown in cold water 1st draw
- High temps in HWS keep low HPCs in HW

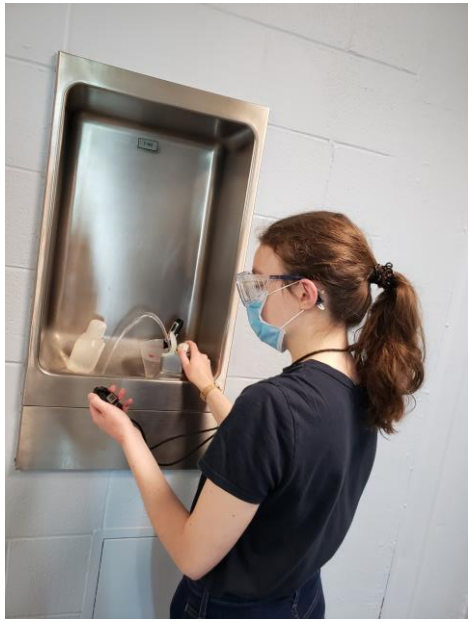
Results: Lead in Fountains

LEED building



Main Building





Recommissioning decreases high lead levels at first draw

Pathogen and indicator monitoring

- *Legionella pneumophila (4+/152) & P. aeruginosa (2+/100)*
- Indicators (TC and *E. coli*) 0+/100
- qPCR for NTM and *Lp* later

Type of point	TIMING	Sample type		Temperature		*L. pneumophila (MPN/L)*	*P. aeruginosa (MPN/L)*
				˚C	˚F		
LEED Building							
Manual faucet	BEFORE (05/05)	HW	Flushed 2M	50	122	110	< 10
On/off valve by defective hot water recirculation	BEFORE (05/05)	HW	1st DRAW	29	84	< 10	> 24 196
E-faucet with TMV	DURING (08/05)	MW	1st DRAW	36.2	97.2	< 10	24 196
Conventional building							
Manual faucet	BEFORE (14/05)	HW	Flushed 20M	56.6	133.9	58	< 10
Shower faucet	BEFORE (13/05)	MW	1st DRAW	22.3	72.1	2 219	< 10
Manual faucet	DURING (19/05)	HW	Flushed 15M	57.5	135.5	110	< 10

Recommissioning take home messages

- **Sample collection**
  - Operating E and low flow faucets, TMVs, Aerators
  - Specs of devices not available
  - Cleaning & disinfection of each aerator & shower head
- **Organizing flushing**
  - Access to up to date drawings
  - Availability of staff
  - No time to draft a WSP: urgency to reopen businesses and institutions
  - Limitations of HW capacity
- **Absence of logs and on line monitoring of HWS**
- **Realistic expectations for any significant monitoring**
  - Justification, lab capacity and costs for *Legionella* testing
  - Appropriateness of fecal indicator monitoring
  - Ability to monitor Cl_2, especially in HWS

Recommissioning opportunities

- Extended stagnation is common in many buildings
- Extent of water quality degradation may vary depending on the building and the demand
- Set standard sampling protocols to be able to compare studies
- Need to measure the impact of recommissioning for different types of buildings
- Only with data can guidance be fully justified
- Must link with risk
- All of this information will be very useful to improve WQ in Green buildings and to mange seasonal closures

Never let a good crisis go to waste

NSERC INDUSTRIAL CHAIR ON DRINKING WATER

POLYTECHNIQUE MONTRÉAL

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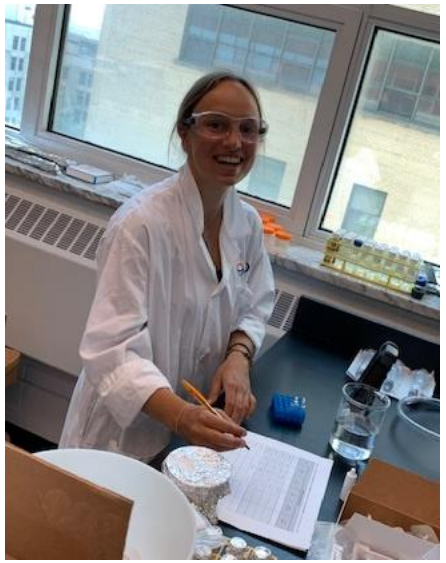

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Questions?

Upcoming Webcasts (June 2020)

A Pre-Workshop Webcast on Holistic Approach to Improved Nutrient Management – June 4, 2020

2020 Technology Scan Webinar: Solids Treatment at High Temperatures – June 16, 2020

Utility Risk and Resilience Assessments: AWIA Lessons Learned from the Trenches – June 17, 2020

Lead Service Line Identification and Inventories – June 23, 2020

THE Water Research FOUNDATION

Thank You!

Comments or questions, please contact:

hjang@waterrf.org

For more information, visit

www.waterrf.org

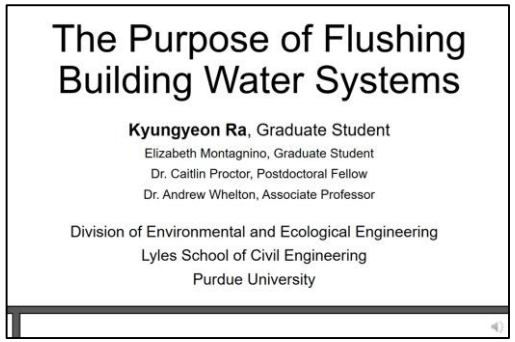
Extra Slides – Andrew Whelton

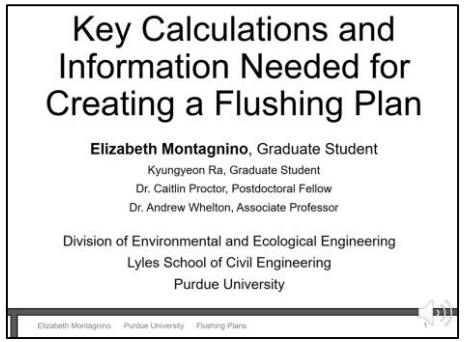
How could we *prevent* water quality problems?

Keep the water moving! ≠ stagnation

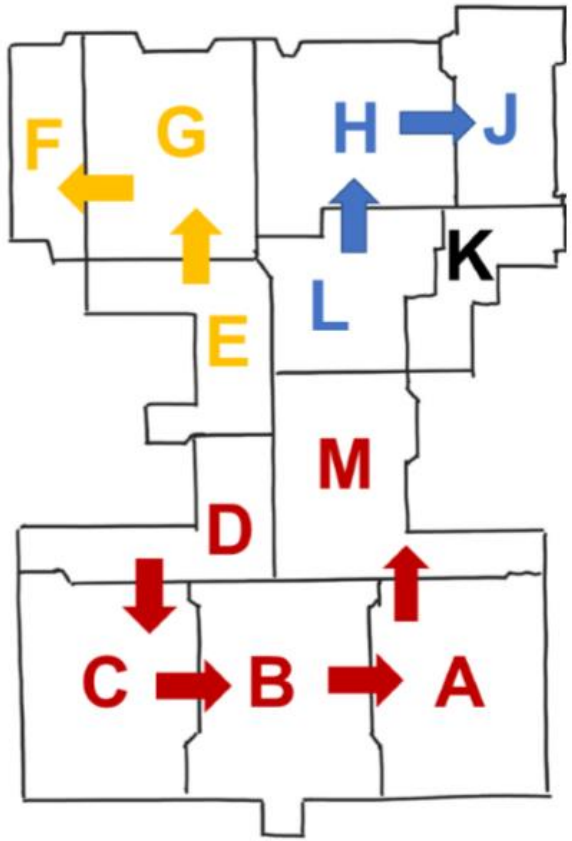
- Source water must be fresh (utility, onsite well, Source may need to flush!)
- Clean devices and equipment
- Flushing – Keep water fresh
- Water heater and recirculation loops – Keep hot water hot, Keep cold water cold

Our YouTube Channel ➔





Flushing Plans



What actions can be taken to *deal with* water quality deterioration?

- Recommissioning plumbing
  - System integrity checks
  - Flushing (and cleaning)
  - Shock disinfection
  - Testing
- Professional help might be needed
  - Address complex mechanical and treatment equipment
  - Develop effective flushing plans
  - Perform shock disinfection safely (thermal or chemical)
  - Perform accurate testing

Flushing and More Intensive System Cleaning Could Make People Sick

Engineering Controls

- Fill sink and floor drains traps with water
- Maintain pressure when flushing
- During flushing (especially initial), many methods to reduce exposure: Cover toilets, showerheads, faucets, reduce splashing, use hoses
- Flooding, cross-connections, dealing with waste

Administrative and Work Practice Controls

- Temporarily forbidding use of high-risk exposure items (showers, hot tubs, decorative fountains)
- Temporarily closing facilities to concentrate use

Personal Protective Equipment (PPE)

- Protect against scalding
- Protect against chemical exposure
- OSHA and other agencies recommend respirators *if* Legionella is *suspected or possible*

OSHA

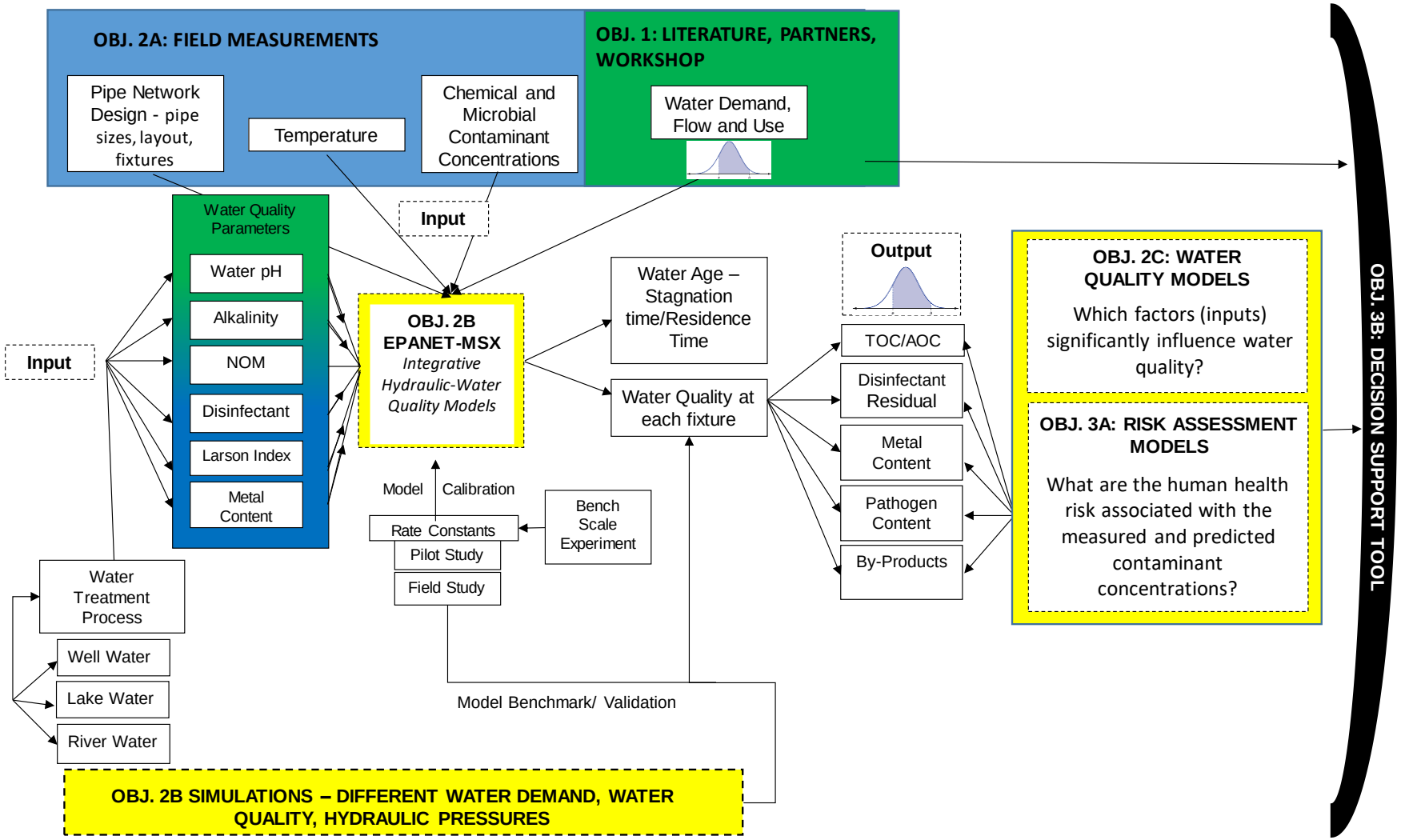
N95 respirators, but recommends voluntary use of N100 "if *Legionella* contamination is possible"

AIHA
Protecting Worker Health

P100 HEPA filter respirators when sampling building water and *Legionella* may be present

The FUTURE? Predict water quality at the tap

Ongoing Residential Home Study Funded by EPA



PURDUE UNIVERSITY

MICHIGAN STATE UNIVERSITY

MANHATTAN COLLEGE

Tulane University

THE UNIVERSITY OF MEMPHIS

Documents to consider to DEVELOP guidance

** Guidance evaluation tool: Virginia Tech, Polytechnique Montreal, Purdue University, Northeastern University*

2020 Peer-reviewed report: Prolonged stagnation *[All contaminants]*
https://www.doi.org/10.31219/osf.io/qvj3b

2020 COVID-19 Building Water System Guidance Evaluation Tool *[All contaminants]*
https://engineering.purdue.edu/PlumbingSafety/covid19/Guidance-Evaluation-Tool.pdf

2020 Consider select documents

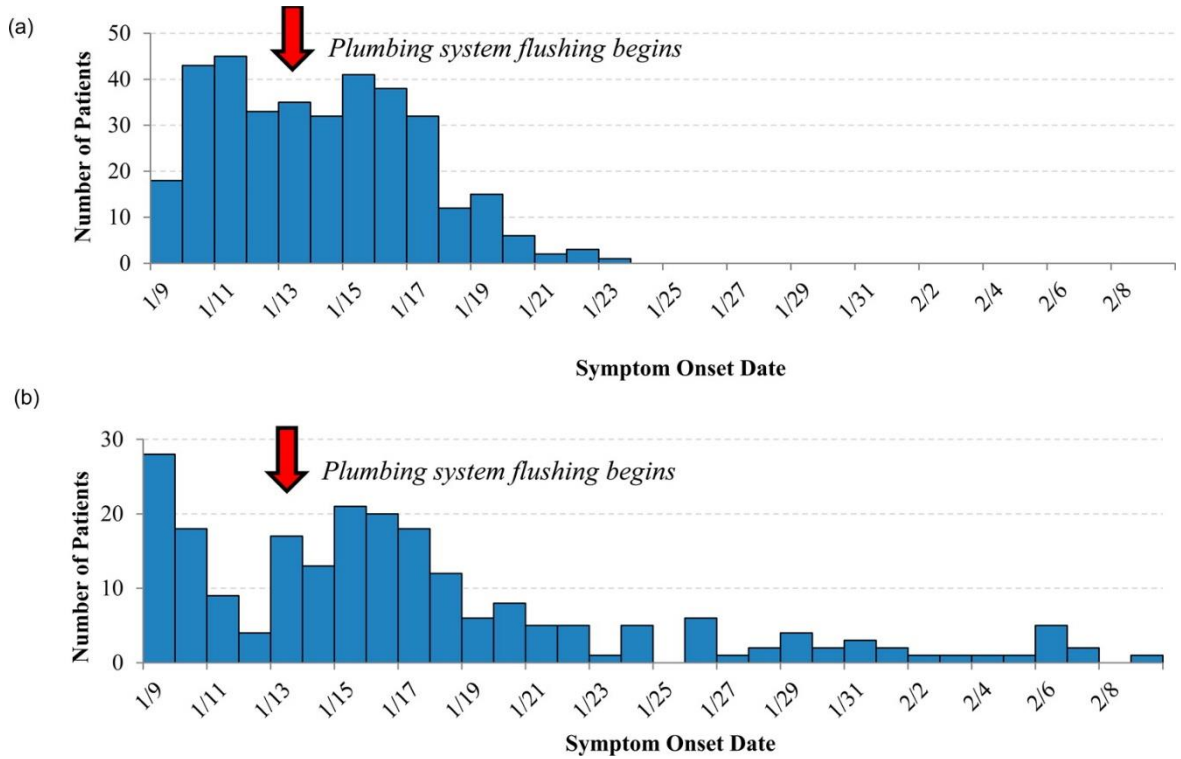
2019 NASEM 2019 Management of Legionella in Water Systems *[Legionella specific]*
https://www.nationalacademies.org/our-work/management-of-legionella-in-water-systems

2018 ASHRAE 188 Legionellosis: Risk Management for Building Water Systems *[Legionella specific]*
https://www.ashrae.org/File%20Library/Technical%20Resources/Bookstore/86611_188-2018preview.pdf

2017 CDC Water Management Plan Toolkit *[Legionella specific]*
https://www.cdc.gov/legionella/downloads/toolkit.pdf

A look back: Residential building water system flushing guidance made people sick

https://doi.org/10.1021/es5040969



2014 WV chemical spill – illnesses caused by flushing guidance

2015 Purdue critical review of past residential flushing guidance shows the absence of a scientific foundation

2017 Purdue water heater flushing study

2018 MetroCOG, CEC LLC, and Purdue provide foundational flushing guidance

2018 USEPA flushing study shows weeks to months needed to decon some plastic plumbing pipes

2019 Camp Fire: USEPA and Purdue estimate months needed to decon HDPE plastic plumbing pipes