Public Health Ontario | Santé publique Ontario

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Please scroll down this file to view a copy of the slides from the session.

Legionella in Healthcare Settings: When Risk Becomes Reality

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Public Health Ontario Rounds – 28 May 2024

Disclosures

- None (for any presenter)

Objectives

At the end of this session, attendees will:

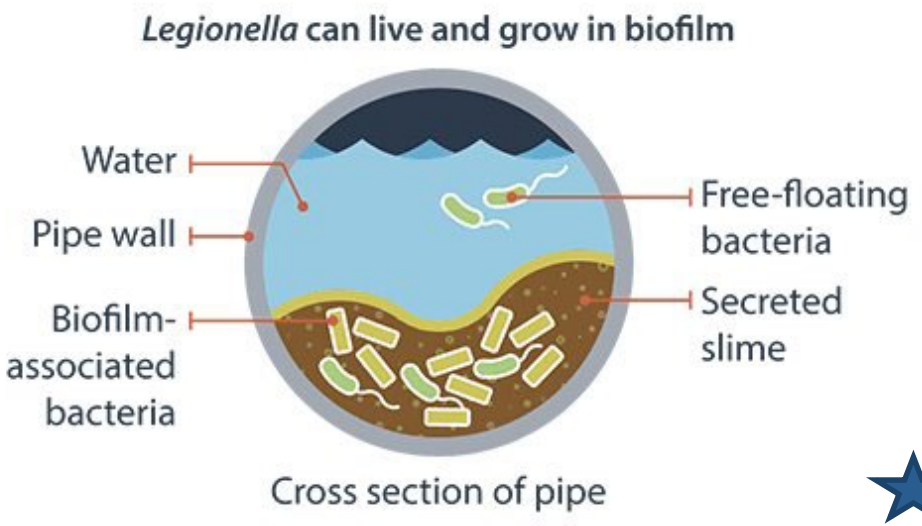
- Recognize factors that promote *Legionella* persistence in healthcare settings
- List (at least 3) key steps to mitigating the risk of *Legionella* in your facility
- Know 3 limitations of *Legionella* testing (in people or environment)
- Be better prepared to formulate practical plans for a presumed healthcare-acquired *Legionella* case / outbreak in your facility

Outline of Today's Presentation

- Background: *Legionella*
- A case study
- Do you know your water / plumbing system?
- Lessons learned
- Future considerations

Background

- *Legionellaceae* – gram negative, intracellular, aerobic bacilli; ubiquitous in freshwater, water systems, and environment
- ~ 60 species, of which ~ half can infect humans
- *Legionella pneumophila* causes most (90%+) human disease
  - 16 serogroups of which 4 (1, 3, 4, 6) cause most human infections
  - Serogroup 1 causes the majority of these
- Legionella grow best in:
  - 25-45C, slow moving water and biofilm (e.g. dead-end plumbing)



https://www.cdc.gov/legionella/causes/index.html

Clinical Disease

Year	Cases (no)	Hospitalizations (no)	Deaths (no)	Rate per 100,000 pop
2021	386	278	24	2.6
2022	360	288	21	2.5
2023*	304	194	11	2.0
Global				0.4 to 2.0

- Incubation period:
  - Pontiac fever: usually within 48 hours
  - Legionnaire's disease (pneumonia): 2 to 14 days (up to 19 days cited; median 4 days, majority of cases within 10 days)
- Transmission:
  - Inhalation of aerosols > aspiration; infectious dose unknown

Public Health Ontario. Infectious Disease Trends in Ontario. https://www.publichealthontario.ca/data-and-analysis/commonly-used-products/reportable-disease-trends-annually#/31 accessed 19 March 2024

Laboratory Identification of *Legionella*: Clinical

- Clinical specimens: respiratory, urine (blood)
  - PCR: not HC approved, not validated for resp specimens; TAT 4 days*
  - Culture: must be requested specifically to be set up properly; TAT 15 days*
  - DFA: not routinely performed, difficult
  - Urinary antigen detection: only for serogroup 1; ≥ 70% sensitivity
  - Serology: not clinically useful in real time

*TAT: turnaround time from time of receipt in Public Health Lab

https://www.publichealthontario.ca/en/Laboratory-Services/Test-Information-Index/Legionella-Respiratory-PCR-Culture;
https://www.publichealthontario.ca/en/Laboratory-Services/Test-Information-Index/Legionella-Water;
https://www.publichealthontario.ca/en/Laboratory-Services/Public-Health-Inspectors-Guide/PHI-Legionella?tab=1

Test	Sensitivity (%)	Specificity (%)
Culture	20–80	100
Urinary antigen for *L. pneumophila* serogroup[1] (Lp1)	70–100	95–100
Polymerase Chain Reaction (PCR)[2]	95–99	>99
Direct Fluorescent Antibody (DFA) Stain	25–75	>95
Paired serology[3]	80–90	>99

[1] Cross reactions with other species and serogroups have been documented.

[2]Avni T, Bieber A, Green H, et al. Diagnostic accuracy of PCR alone and compared to urinary antigen testing for detection of *Legionella* spp.: A systematic review . *J Clin Micro.* 2016;54(2):401–11.

https://www.cdc.gov/legionella/clinicians/diagnostic-testing.html#test-sensitivity

Laboratory Identification of *Legionella*: Environment

- Culture vs PCR vs rapid antigen test
- PCR vs. qPCR (quantifiable)
- Know your test kit
  - Some PCR tests only detect *L. pneumophila* serogroup 1
  - PHL: *Legionella* species, pneumophila and serogroup 1
- *Legionella* rapid antigen tests (for water)
  - Limited sensitivity

https://www.publichealthontario.ca/en/Laboratory-Services/Test-Information-Index/Legionella-Respiratory-PCR-Culture;
https://www.publichealthontario.ca/en/Laboratory-Services/Test-Information-Index/Legionella-Water;
https://www.publichealthontario.ca/en/Laboratory-Services/Public-Health-Inspectors-Guide/PHI-Legionella?tab=1

Laboratory Identification: Environment

- Environmental sampling:
  - Sampling location(s) may matter
  - Prior water treatment may matter
  - Samples: swabs vs water?
  - What quantity of water do you need?
    - Who can collect this in your facility?

Laboratory Identification

- Strain typing
  - Sequence based typing (SBT) vs. whole genome sequencing
  - How do you interpret the results?
- Compare clinical isolate to environmental isolate
  - Clinical isolate Sequence Type (ST) A
  - Environmental isolate Sequence Type (ST) X

Case Study

- One case of laboratory confirmed *Legionella pneumophilia* pneumonia in an inpatient admitted to our facility
- Symptom onset day 13 of admission
- Positive bronchoalveolar lavage day 16
- Bed history – one room prior to symptom onset

Case Study: What Did We Do?

- Access to potable water halted → Bottled water only
- Deployed Point-of-Use (POU) filters → High risk units
- Environmental audit conducted → No obvious sources

Point-of-use (POU) filters

Case Study: What Did We Do?

Public Health Unit notified + sampling of domestic water

- Several positive PCR (9 of 10 samples, no qPCR)
- Samples sent for culture (2 of 9 culture positive *L. pneumophilia* serogroup 1)

Retained Environmental Consultant

- Specific *Legionella* experience
- Accredited testing laboratory

Planned for plumbing system disinfection

- Hyperchlorination gold standard over superheating
- Develop hyperchlorination plan

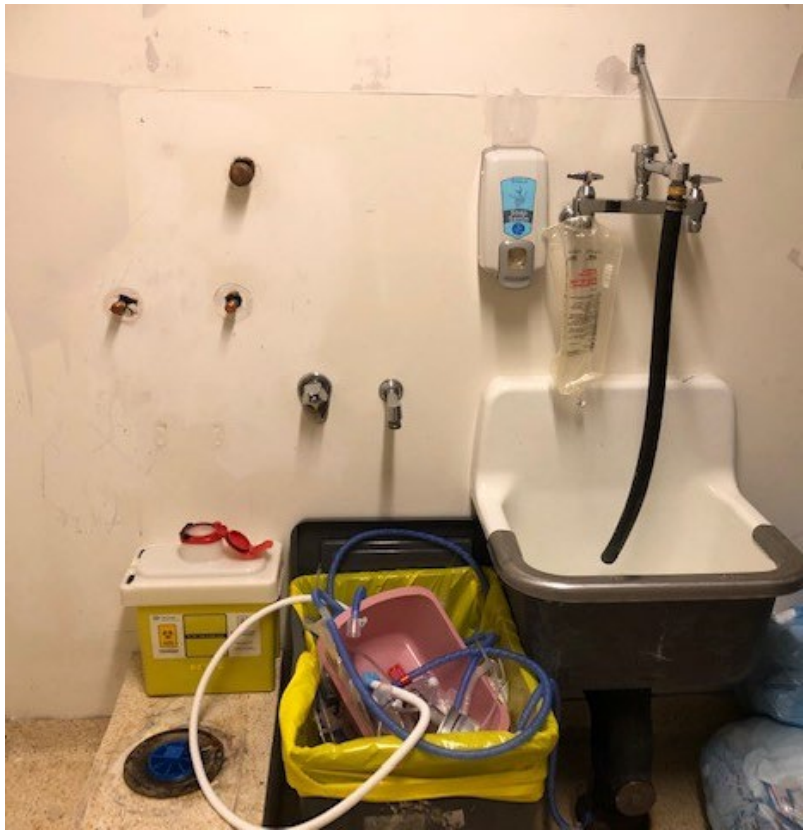
Case Study: Hyperchlorination Process

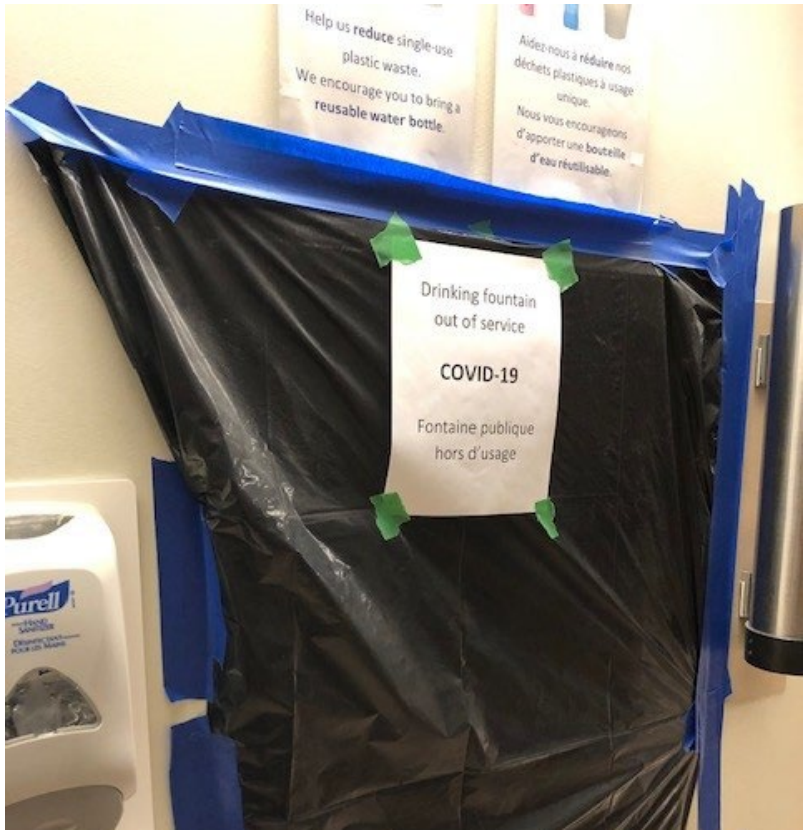
- Chlorine added to the water supply and run through the plumbing pipes of the inpatient tower (feeding the 4th to 8th floors) via a chlorine manifold and pump installed on the incoming water line
- Water flushed **at every outlet** until the appropriate concentration of chlorine was reached (20-40 ppm)
- The chlorine sits in the system for ~2-24 hours (time determined by chlorine concentration at outlet and the disinfectant contact time = CT value)
- Each outlet flushed again to return the water back to baseline chlorine levels

Case Study: System Disinfection

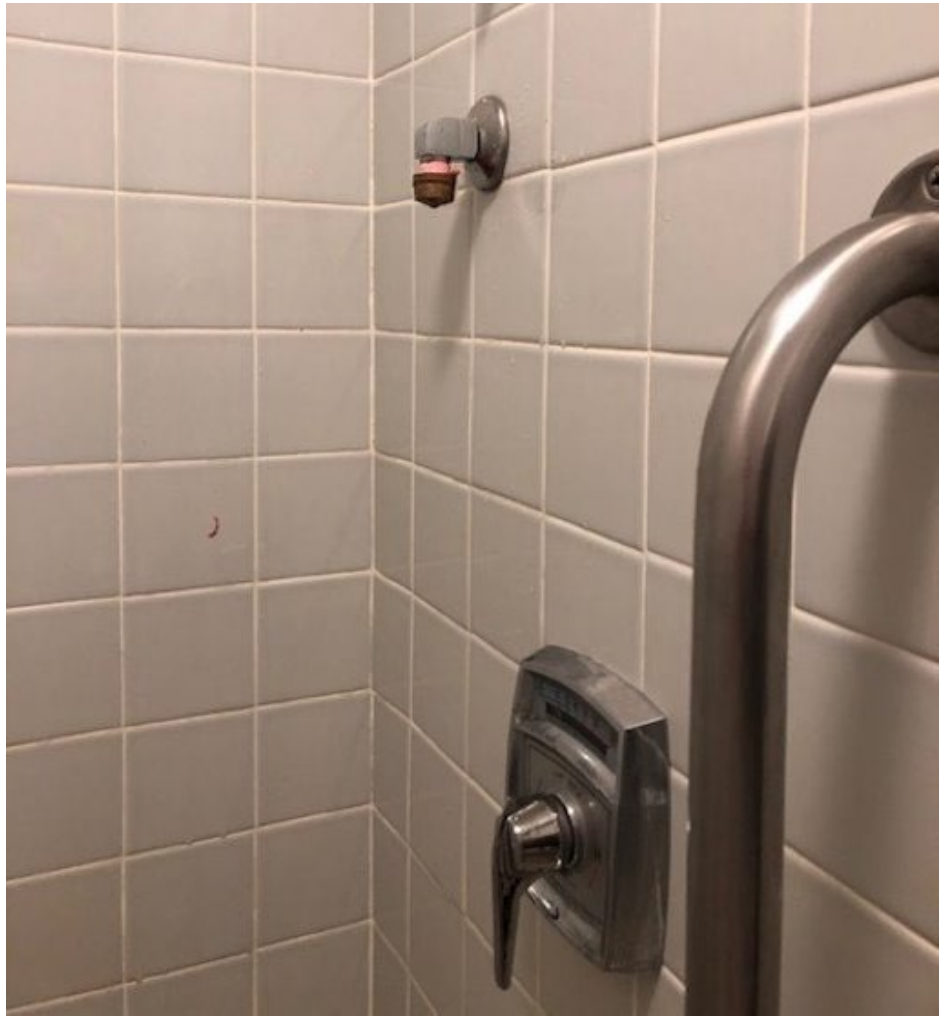
- All shower heads and laminar-flow devices removed and disinfected as part of the flushing process
- Risk assessment on whether at-risk patient populations needed to be moved or additional containment measures were necessary during the flushing process
- Chlorine off-gassing could be a concern for vulnerable populations (NICU, Respirology)

Plumbing Dead-Legs

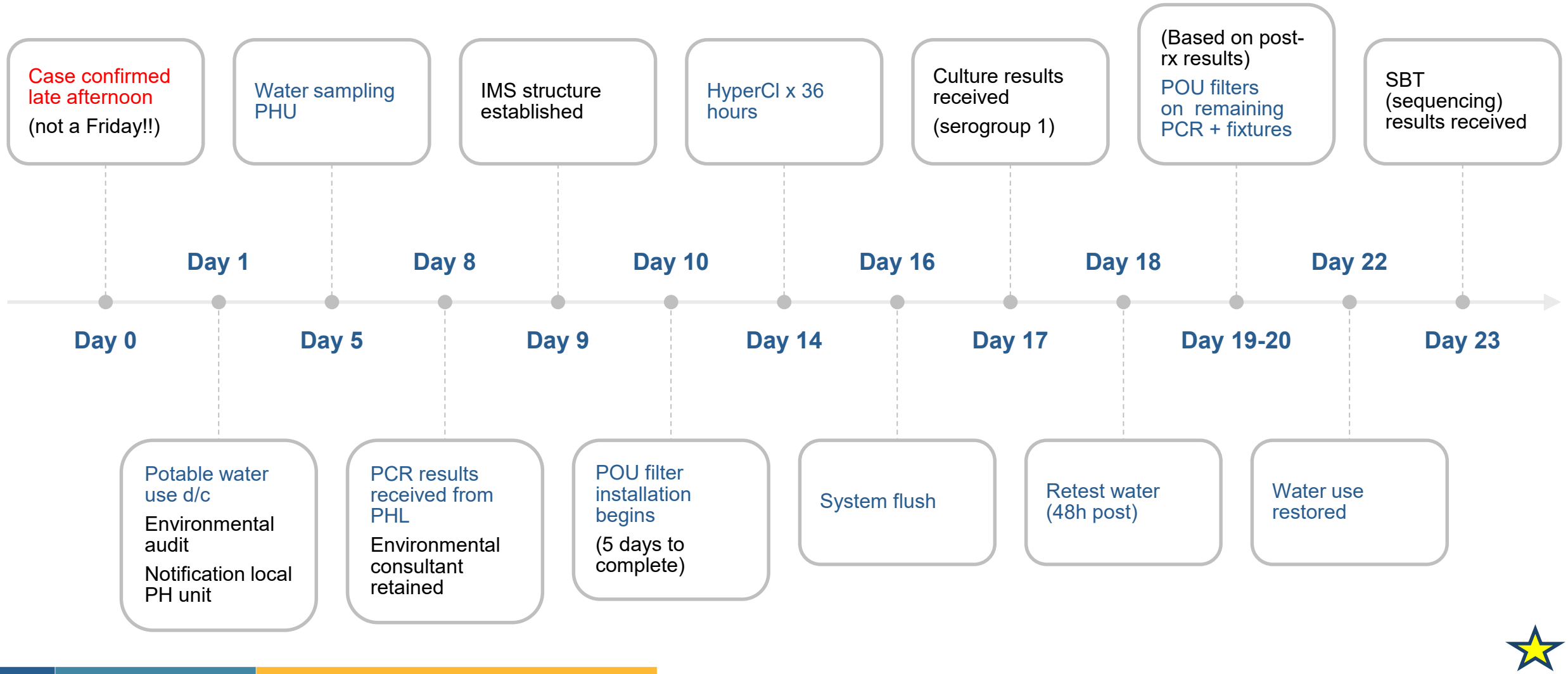




Plumbing Dead-Legs



Case Study: Timeline from Case Confirmation



Resampling / Retesting Water

Resample ~10% of fixtures + environmental swabbing of piping

- qPCR + culture

Very unlikely to eradicate

- When do you resume water use?

Follow-up testing

- Every 2 weeks, for 3 months, and then every 3 months thereafter (Ontario MOH and CDC)

Legionella Concentration vs. Risk

Thresholds or actionable limits

Mitigation strategies

Response time

Table 3: Actions to be taken following *Legionella* sampling in hot and cold water systems in health care institutions with susceptible individuals

Legionella Count (cfu/L)	Recommended actions for health care institutions
Not detected or <100 cfu/L	• In a healthcare institution, the primary concern is protecting susceptible individuals, so any detection of *Legionella* should be investigated and, if necessary, the water system should be re-sampled to aid interpretation of the results, and ensure it is in line with the monitoring strategy and risk assessment.
>100 cfu/L and up to 1000 cfu/L	• If the minority of samples are positive, the water system should be re-sampled. If a similar count is found again, a review of the control measures and risk assessment should be carried out to identify any remedial actions to be taken. • If the majority of samples are positive, the water system may be colonized with a low level of *Legionella*. An immediate review of control measures and risk assessment should be carried out to identify any other remedial action required, which may include disinfection of the water system.
>1000 cfu/L	• An immediate review of the control measures and risk assessment should be carried out to identify any remedial actions, including possible disinfection of the water system. • The water system should be re-sampled, and retesting should take place a few days after disinfection and at frequent intervals thereafter, until a satisfactory level of control is achieved.

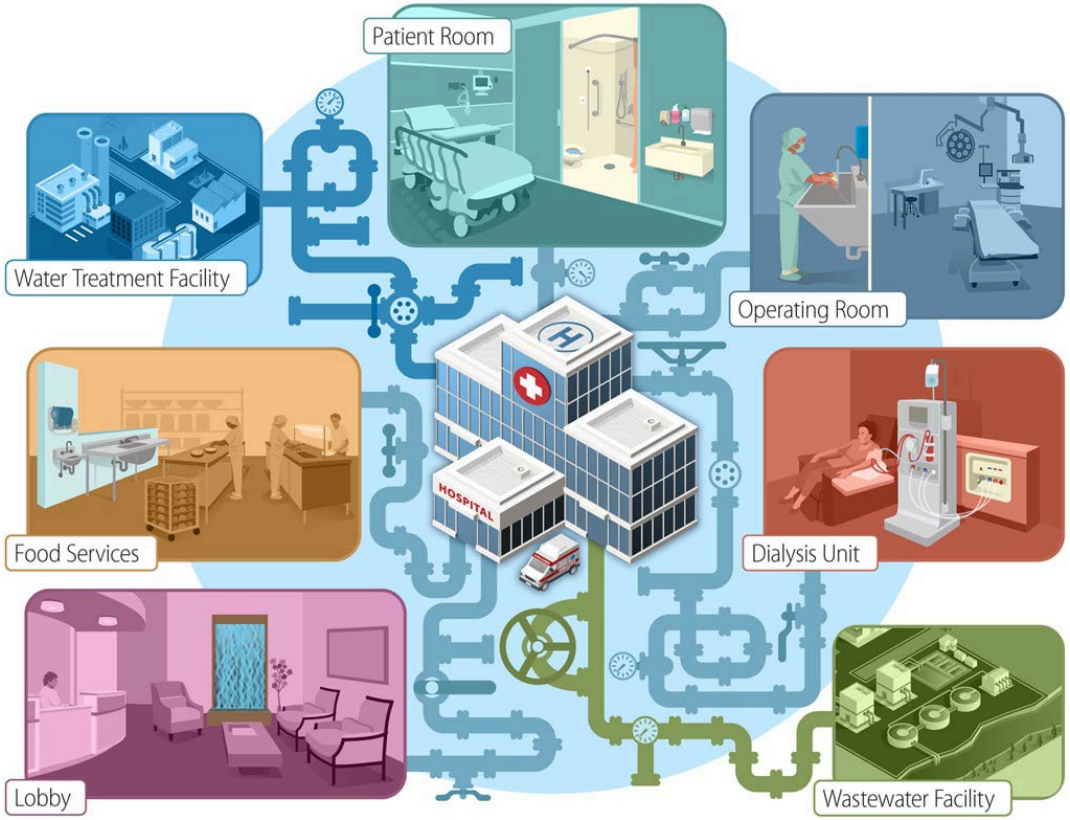
SOURCE: Ontario Ministry of Health and Long-Term Care (2016).

Case Study: Follow-up – Localized Action

- Replacement of all shower heads and hoses
- Replacement of old faucets
- Audit of unused fixtures and plumbing dead-legs
- Flushing protocol for unused fixtures - twice weekly for ~10 minutes
- Check valve inspection/installation

Potable Water System | Overview

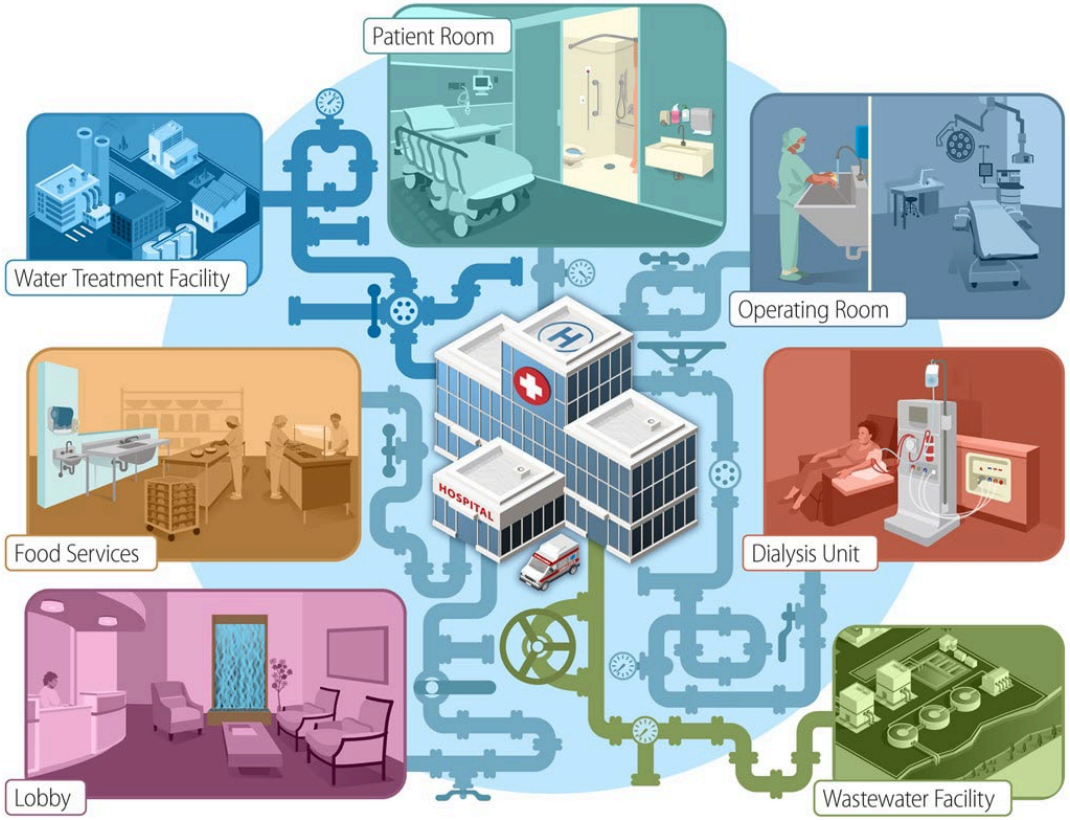
- Health care facilities are not your run-of-the-mill commercial building
- Plumbing systems inside health care facilities tend to be much more complex
  - Dialysis systems, emergency showers and eyewashes, ice/water machines, clean rooms, laboratories, operating rooms, food preparation.



https://www.cdc.gov/hai/prevent/environment/water.html

Potable Water System | Overview

- Many considerations to think about when it comes to designing plumbing systems in health care, the most important being patient and staff safety
- Ensuring clean and safe potable water includes:
  - Using materials that will not impart contaminants into the water
  - System design that delivers water at safe temperatures and essentially free of harmful bacteria



https://www.cdc.gov/hai/prevent/environment/water.html

Potable Water System | Overview

External Factors Affecting Water Quality

- Loss of pressure (testing, breaks, failure)
- Drop of chlorine level

Internal Factors Affecting Water Quality

- Plumbing system age
- Plumbing system design
- RENOVATIONS
- Water stagnation
- Water conservation

Potable Water System | Our Hospital

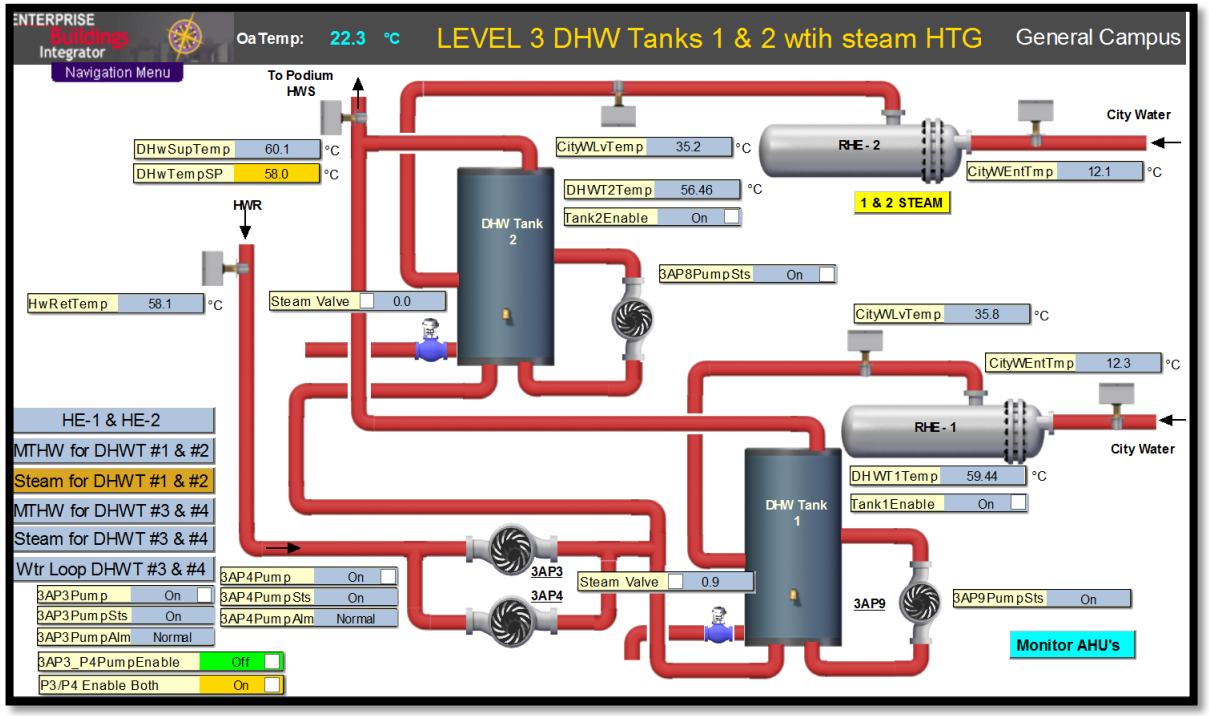
City of Ottawa Potable Water Supply

Backflow Prevention at Inlet to Building

Split to Supply Fire Protection System and Potable Water System

Potable Water System Supplies:

Domestic Hot Water System	Dialysis	Labs	Food Services	Central Plant	Patient Wards	Many, many others



Potable Water System | Our Hospital

- Plumbing System >50 Years Old
- Eight Storeys + Rooftop Equipment
- Over 90 Different Plumbing Risers
- Domestic Cold, Hot, and Hot Recirc Water
- Various Shutoff and Balancing Valves
- Plumbing Fixtures a Mix of Vintage and New

Potable Water System | Reducing Risk

- **In healthcare, how do you reduce risk to patients knowing that:**
- *Potable water does not mean sterile water*
- *Potable water includes bacteria and microbes*

Water Sampling

Water Quality and Temperature

Water Management Plan

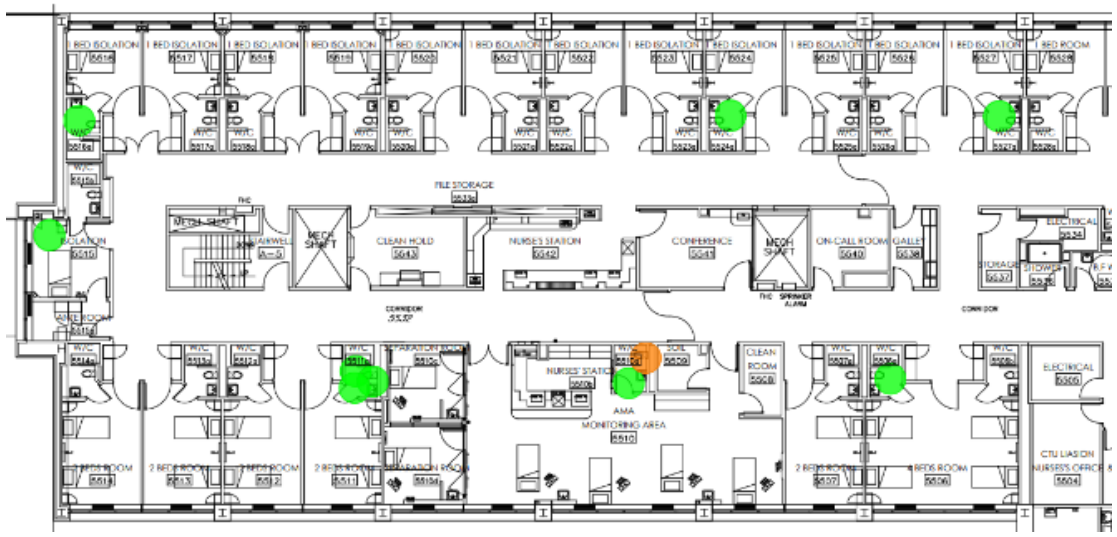
Potable Water System | Reducing Risk

Water Sampling

Water Quality and Temperature

Water Management Plan

- Third party environmental consultant retained to perform follow-up testing
- Representative locations on each plumbing riser – focused on patient care areas and hot water tanks
- Plumbing distribution based on vertical risers



Potable Water System | Reducing Risk

Water Quality and Temperature

Water Management Plan

Water Sampling

- *Legionella* can be controlled by raising hot water temperature
- Requires raising temperature throughout the system, not just in hot water tanks
- CSA Z317.1: Health care must account for scald protection
- Chlorine dissipates more rapidly in water at higher temp

Table 1
Hot water temperatures, °C
(See Clauses 6.3.3.1, 6.3.3.3, 6.3.3.5, 6.3.3.9, 6.3.3.16, 6.3.3.17, 6.3.3.20, and 6.3.3.22.)

Site	Normal operation	Maximum
Hot water storage tanks	70 ± 10	80*
Piping distribution system	60 ± 5	65
Patient/public-use outlets	43	49
General-use outlets, food preparation areas, and central supply rooms	49	60
Automatic washer(s)	77† (minimum)	82†
Laundry	77† (minimum)	82†
Other uses	43	65

Canadian Standards Association. CSA Z317.1 Special requirements for plumbing installations in healthcare facilities, 2016. Table 1

Potable Water System | Reducing Risk

Water Quality and Temperature

Water Management Plan

Water Sampling

Installation of tempering valves on hot water tanks to increase the hot water tank temperature

Installation of temperature sensors within the domestic hot water supply and recirc systems to ensure minimum temperatures are maintained

Feasibility study on secondary disinfection methods

- UV
- Increased chlorine
- Copper silver ionization

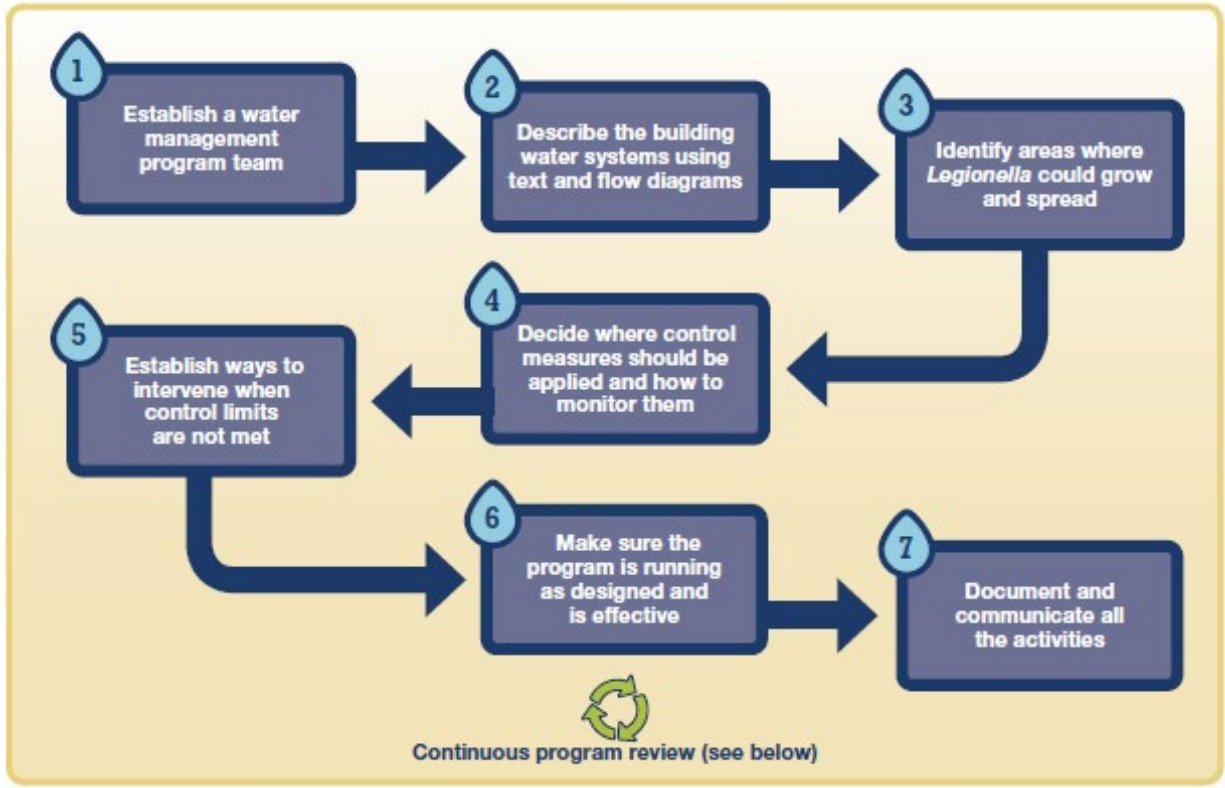
Potable Water System | Reducing Risk

Water Management Plan

Water Sampling

Water Quality and Temperature

- **A detailed Water Management Plan/Water Safety Plan is imperative**
  - Know your plumbing system
  - Identification of areas in the plumbing system that can lead to higher likelihood of *Legionella*
  - Routine flushing of seldom used water fixtures
  - Quarterly testing and tracking of water fixtures to identify problem areas
  - Installation of point of use filters in problem areas



US Centers for Disease Control and Prevention https://www.cdc.gov/legionella/index.html

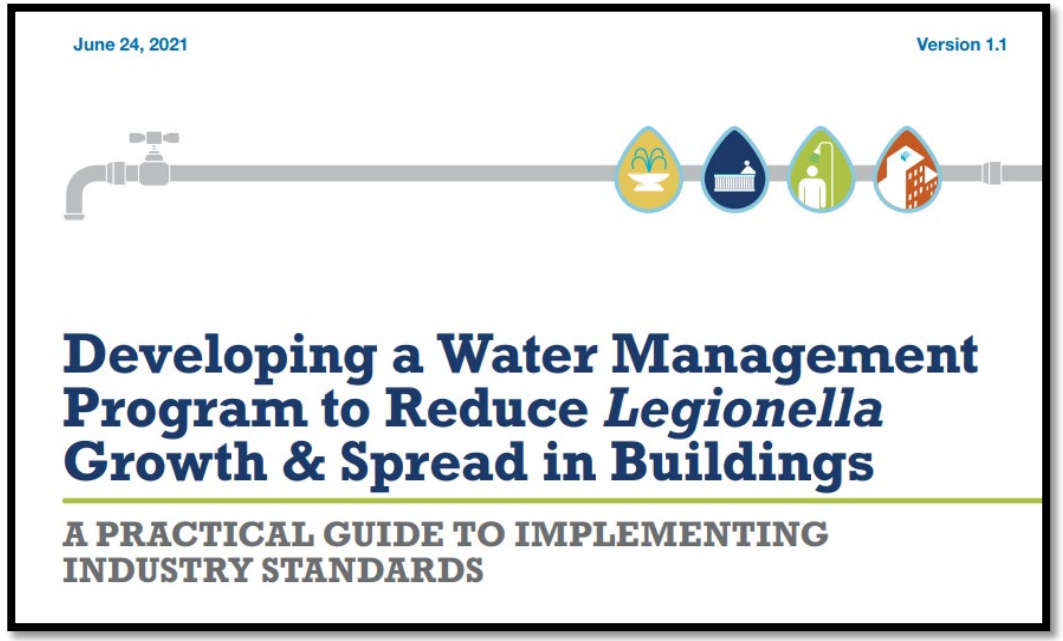
Potable Water System | Reducing Risk

Water Management Plan

Water Sampling

Water Quality and Temperature

- Specific buildings require specific measures
  - Patient populations
  - Services provided
  - Age/complexity/limitations of plumbing infrastructure
- Mock code grey (loss of water)
- CDC *Legionella* toolkit and CSA Z317.1 Plumbing Standard can assist



Lessons Learned

▪DO NOT take your plumbing system for granted

- Minimize the risk before there is a case!
- Audit of unused fixtures and plumbing dead-legs
- Flushing protocol for unused fixtures
- Importance of upgrading plumbing infrastructure
- Have supply of POU filters on hand and a filter / adaptor inventory
- Make sure you have the right accessories for your faucets!

Hyperchlorination

- Contact time for hyperchlorination (What is the minimum required?)
- Personnel for disinfection flushing process (Facilities personnel with IPAC Lead)
- Ensure no leaking valves in your domestic hot water system
- Delay in achieving optimal chlorine concentration (Drain hot water tanks and turn off heating)
- Risks of repeated hyperchlorination on the plumbing system

Lessons Learned

▪Be informed on the process in advance

- Know who your stakeholders are
- PHO, Public Health – approach to specific facility, cases particulars
- Environmental consultant with *Legionella* experience
- Contractor for chlorine disinfection process

Testing techniques

- Quantitative PCR (qPCR) is a helpful tool

Lessons learned: Round 2

- Our Water Management Plan enabled more efficient response to repeat scenario in 2023

Patient Care and Clinical Provider Considerations

Impact on patient treatments requiring water	Alternate hand washing, bathing provisions	Handling human waste	Staffing concerns	Communication plan
• Dialysis	• For patients: pre-packaged "bath-in-a-bag" • For providers: consider where hand washing MAY be needed and ensure alternatives	• "Can we flush the toilets?"	• "If the water isn't safe for patients, is it safe for us?" • Consistency in practice and messaging	• Ensure staff and patients are kept up to date • Minimize speculation

Guidance and Considerations for New Builds

Plumbing Distribution

- Vertical vs. horizontal
- Ability to disinfect locally – per unit or per plumbing riser

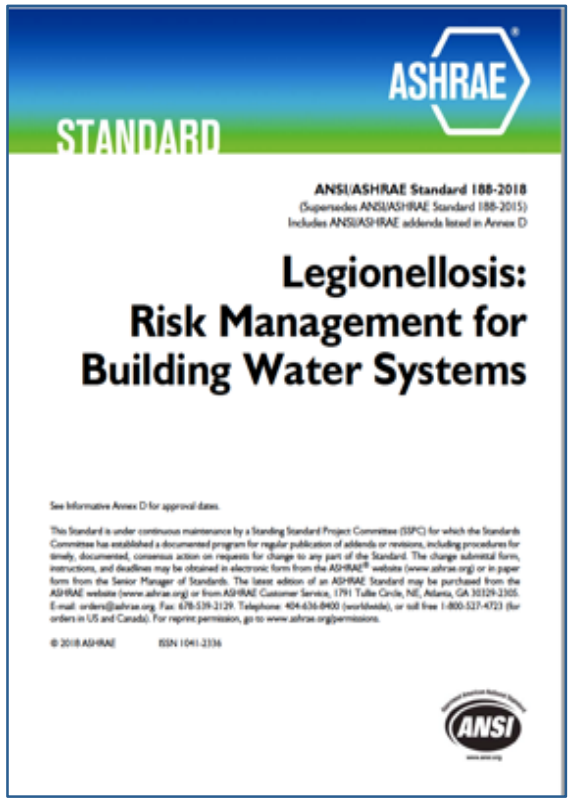
Fixtures

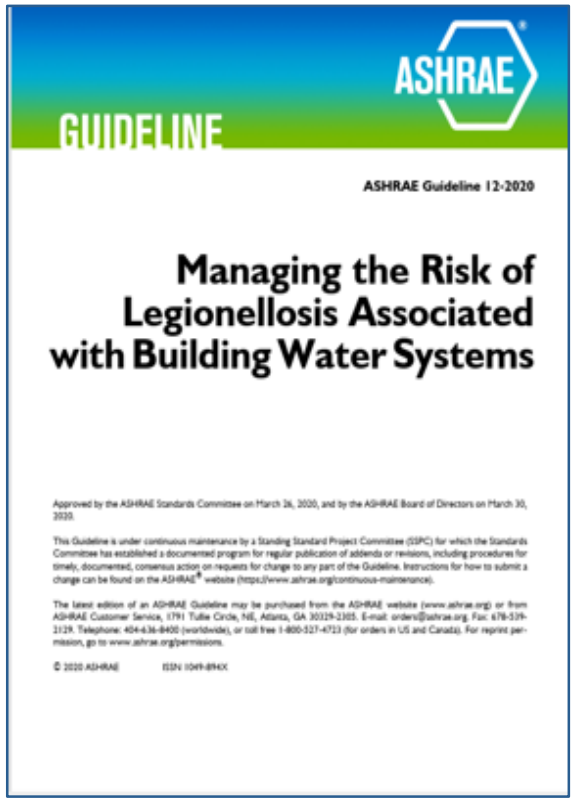
- Auto-purge fixtures
- Faucet design minimizing spray
- Toilet design minimizing spray

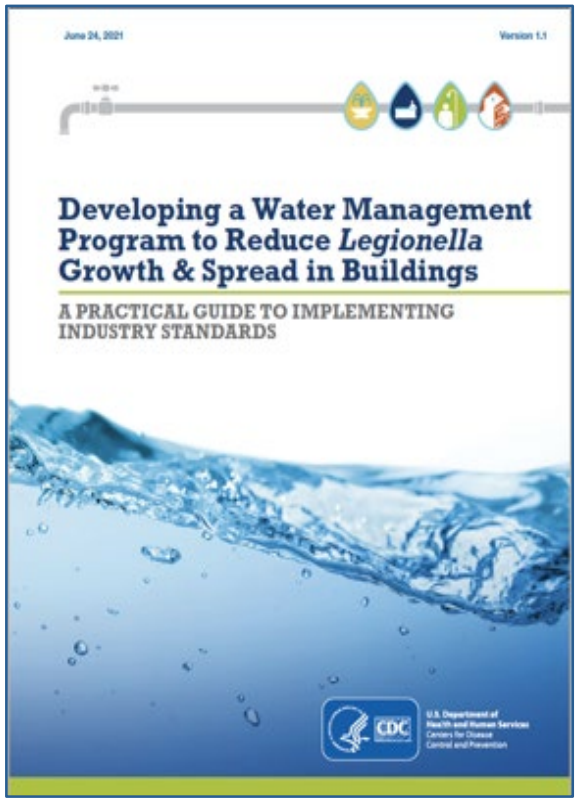
Secondary Disinfection Methods

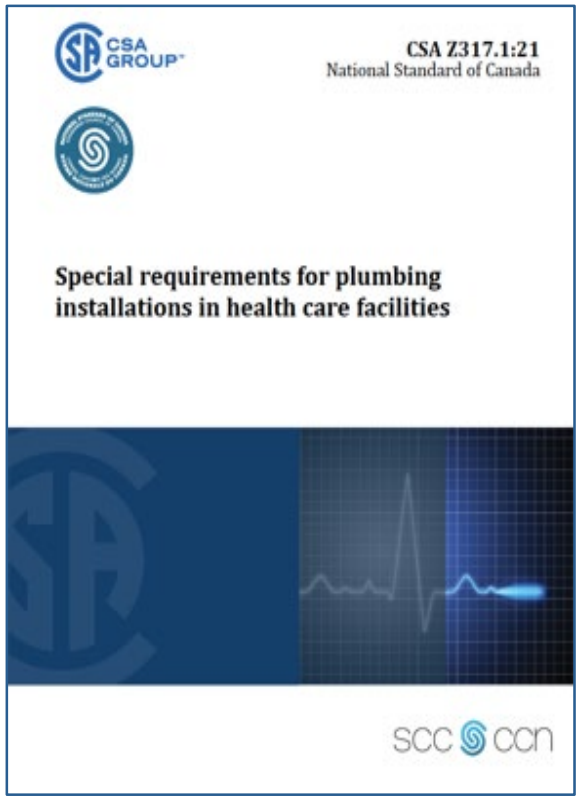
- UV
- Additional chlorine
- Copper-silver ionization

Water Management and *Legionella* Control



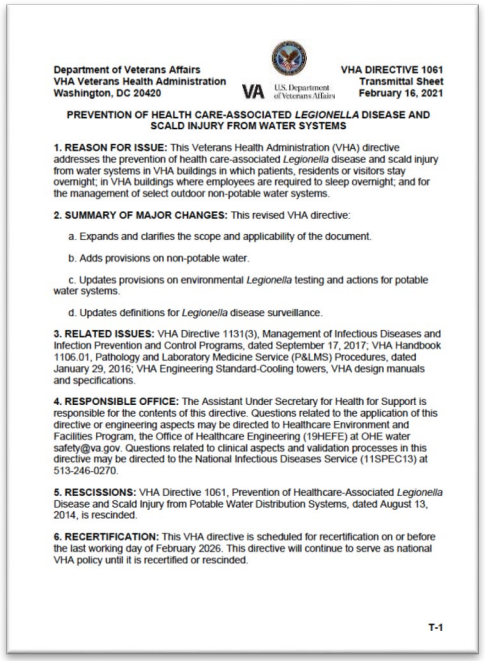






Water Management and *Legionella* Control

NASEM 2019
Management of *Legionella* in water systems



Department of Veterans Affairs
VHA Veterans Health Administration
Washington, DC 20420

VA U.S. Department of Veterans Affairs

VHA DIRECTIVE 1061
Transmittal Sheet
February 16, 2021

PREVENTION OF HEALTH CARE-ASSOCIATED *LEGIONELLA* DISEASE AND SCALD INJURY FROM WATER SYSTEMS

1. REASON FOR ISSUE: This Veterans Health Administration (VHA) directive addresses the prevention of health care-associated *Legionella* disease and scald injury from water systems in VHA buildings in which patients, residents or visitors stay overnight; in VHA buildings where employees are required to sleep overnight; and for the management of select outdoor non-potable water systems.

2. SUMMARY OF MAJOR CHANGES: This revised VHA directive:

a. Expands and clarifies the scope and applicability of the document.

b. Adds provisions on non-potable water.

c. Updates provisions on environmental *Legionella* testing and actions for potable water systems.

d. Updates definitions for *Legionella* disease surveillance.

3. RELATED ISSUES: VHA Directive 1131(3), Management of Infectious Diseases and Infection Prevention and Control Programs, dated September 17, 2017; VHA Handbook 1106.01, Pathology and Laboratory Medicine Service (P&LMS) Procedures, dated January 29, 2016; VHA Engineering Standard-Cooling towers, VHA design manuals and specifications.

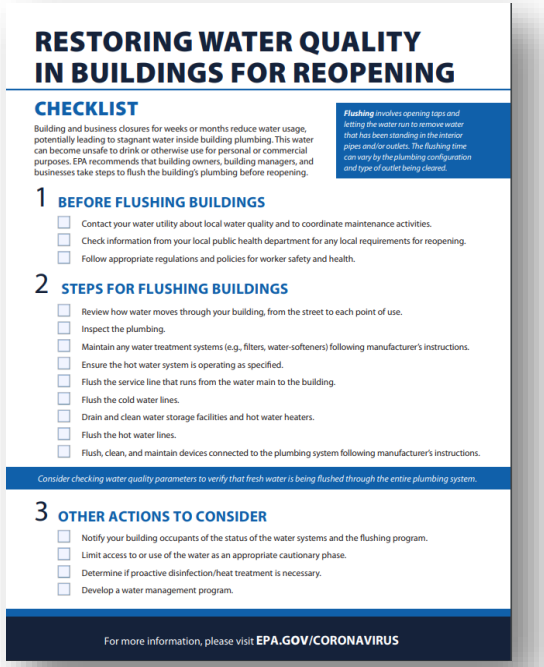
4. RESPONSIBLE OFFICE: The Assistant Under Secretary for Health for Support is responsible for the contents of this directive. Questions related to the application of this directive or engineering aspects may be directed to Healthcare Environment and Facilities Program, the Office of Healthcare Engineering (19HEFE) at OHE water safety@va.gov. Questions related to clinical aspects and validation processes in this directive may be directed to the National Infectious Diseases Service (11SPEC13) at 513-246-0270.

5. RESCISSIONS: VHA Directive 1061, Prevention of Healthcare-Associated *Legionella* Disease and Scald Injury from Potable Water Distribution Systems, dated August 13, 2014, is rescinded.

6. RECERTIFICATION: This VHA directive is scheduled for recertification on or before the last working day of February 2026. This directive will continue to serve as national VHA policy until it is recertified or rescinded.

T-1

VHA 1061 - 2021
Prevention of HCA *Legionella* disease and scald injury from 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**

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

Resources

- Public Health Ontario
  - https://www.publichealthontario.ca/en/Diseases-and-Conditions/Infectious-Diseases/Respiratory-Diseases/Legionellosis
- Canadian Standards Association (CSA, requires subscription)
- American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE, requires subscription)
- US Centers for Disease Control and Prevention
  - https://www.cdc.gov/legionella/index.html
- European Centers for Disease Control *Legionella* Toolbox
  - https://legionnaires.ecdc.europa.eu/?pid=10

Selected References

Clinical / Epidemiology

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Mercante JW et al. Current and emerging *Legionella* diagnostics for laboratory and outbreak investigations. Clin Microbiol Rev 2015;28:95.

Environmental / Water Management

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Questions?

Thank you!