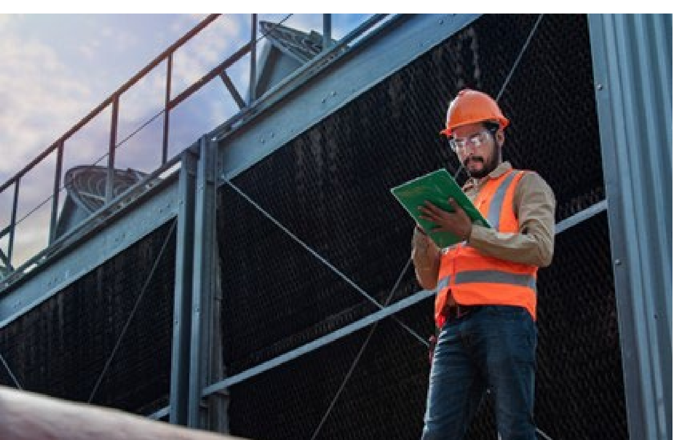
WaterSense at Work

Getting Started With Water Management

1.6 Water Quality Considerations

Best Management Practices for Commercial and Institutional Facilities



EPA WaterSense

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WaterSense® is a voluntary partnership program sponsored by the U.S. Environmental Protection Agency (EPA) that seeks to protect the nation's water supply by transforming the market for water-efficient products, services, and practices.

WaterSense at Work is a compilation of water efficiency best management practices intended to help commercial and institutional facility owners and managers from multiple sectors understand and better manage their water use. It provides guidance to help establish an effective facility water management program and identify projects and practices that can reduce facility water use.

An overview of the sections in *WaterSense at Work* is below. This document, covering water quality considerations, is part of **Section 1: Getting Started With Water Management**. The complete list of best management practices is available at www.epa.gov/watersense/best-management-practices. WaterSense has also developed worksheets to assist with water management planning and case studies that highlight successful water efficiency efforts of building owners and facility managers throughout the country, available at www.epa.gov/watersense/commercial-buildings.

- **Section 1. Getting Started With Water Management**
- **Section 2. Water Use Monitoring**
- **Section 3. Sanitary Fixtures and Equipment**
- **Section 4. Commercial Kitchen Equipment**
- **Section 5. Outdoor Water Use**
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This document is one section from *WaterSense at Work: Best Management Practices for Commercial and Institutional Facilities* (EPA-832-F-23-003). Other sections can be downloaded from www.epa.gov/watersense/best-management-practices. Sections will be reviewed and periodically updated to reflect new information. The work was supported under contract 68HERC20D0026 with Eastern Research Group, Inc. (ERG).

Overview

While the primary focus of the U.S. Environmental Protection Agency's (EPA's) *WaterSense at Work: Best Management Practices for Commercial and Institutional Facilities* is on water use and efficiency, there are opportunities to harmonize water management activities with efforts to understand and reduce risks associated with water quality. The water used in building systems can, at times, serve as a vector for transmitting water contaminants to building occupants and visitors. Therefore, maintaining adequate water quality in building water systems is essential to occupants' health and safety.

Comprehensive Water Management Planning

This section of *WaterSense at Work* discusses development of a water management program focused on reducing risk of water quality issues. EPA suggests a holistic approach to planning for water management in a facility that takes into consideration water efficiency, water quality, emergency planning, and stormwater management in one comprehensive plan. For more information, see *WaterSense at Work Section 1.2 Water Management Planning* at www.epa.gov/watersense/best-management-practices.

The Safe Drinking Water Act (SDWA) establishes national health-based limits on contaminants in drinking water. By ensuring SDWA compliance, EPA, states, Tribes, municipalities, and water utilities help to provide clean, safe water to consumers and businesses throughout the United States. However, water providers are generally only responsible for maintaining safe drinking water up to where it is delivered to a property (e.g., to the property's water meter). Therefore, contamination of water that occurs within a building or campus is instead the responsibility of the facility owner. While facility owners may not be required to adhere to federal regulatory water quality requirements, they have an obligation and opportunity to ensure health and safety for the people who visit and work in their buildings. This section provides an overview of facility water quality concerns and summarizes best management practices for facility owners and managers to monitor and maintain water quality in their buildings.

Water quality and building water safety are broad and complex fields, with several aspects beyond the scope of this guide. This section is not meant to serve as a primary resource for facility owners and managers to understand water quality and safety concerns. However, it provides references, standards, and other technical resources to learn more and develop an effective water management program that addresses water quality and safety. Facility owners and managers are encouraged to use the resources listed in this section, as well as conduct their own research, and consult experts when developing a water management program that addresses water quality and safety.

Contaminants of Concern

Contaminants such as bacteria, viruses, metals, and disinfection byproducts (DBPs) in water systems can lead to illness, disease, reproductive issues, and neurological damage. Infants, children, and people who are elderly, pregnant, or are otherwise sensitive or immunocompromised are especially susceptible to drinking water contaminants or other opportunistic pathogens.

Building owners should have a general understanding of the types of contaminants that pose health risks when present in potable water. Disease-causing bacteria, viruses, and parasites are common pathogens found in building water systems and include *Legionella*, *Mycobacterium*, and *Pseudomonas*. These are often referred to as opportunistic premise plumbing pathogens because of their ability to survive and grow in water distribution and plumbing systems. Opportunistic pathogens are not infectious when consumed, but when inhaled by individuals who are sensitive to infections, they can pose health risks and sometimes death. More information about opportunistic pathogens in premise plumbing can be found on the Centers for Disease Control and Prevention (CDC) website at www.cdc.gov/healthcare-associated-infections/php/toolkit/water-management.html.

DBPs are chemical compounds that form when disinfectants such as chlorine react with organic or inorganic precursor materials in water during the treatment process and throughout the water distribution system. While disinfection is essential to killing harmful pathogens, the resulting DBPs can pose health risks when injested over long periods.

In addition to pathogens and DBPs, heavy metals such as lead and copper often enter drinking water through contact with distribution pipes or premise plumbing components and fixtures that contain these materials. These heavy metals have been known to cause neurological damage and can also damage the liver, kidneys, and reproductive system. While this document focuses on *Legionella,* some of the resources listed in Table 1, Table 2, and Table 3 help address other contaminants of concern.

Legionella

Much of the concern and guidance related to building-level water safety are focused on *Legionella*, a type of bacteria that can be harmful to human health. When not properly maintained, wet environments such as building plumbing systems can provide conditions for microbial growth and lead to the proliferation of *Legionella* and other opportunistic pathogens. Legionellosis is an overarching term for any illness caused by *Legionella* bacteria. The two most common types of legionellosis are Legionnaires' disease, which is a severe form of pneumonia, and Pontiac fever, which is a milder, flu-like illness.

Legionella becomes dangerous when it is aerosolized and inhaled. The most commonly identified sources of infection include cooling towers, decorative fountains, hot tubs, and showers, because they maintain water at temperatures that allow *Legionella* to proliferate,[1] and they create small droplets that can reach the lungs when inhaled.

Legionella pneumophila *under microscopic magnification*

Legionella concerns and Legionnaires' disease outbreaks are most often associated with water systems in hotels, hospitals, long-term care facilities, resorts, and cruise ships. Hospitals and long-term care facilities are especially susceptible to outbreaks due to their large population of high-risk occupants. All types of commercial and institutional building owners and operators should, however, be aware of *Legionella* in building water systems and implement preventative practices to reduce the risk of illness.

The most common causes of outbreaks include process failures (65 percent), human errors (52 percent), equipment failures (35 percent), external conditions (35 percent), or a combination of these (48 percent).[2] Building operators can develop and implement a *Legionella* water management plan, which combines best practices and maintenance efforts, to prevent a legionellosis outbreak. Facility managers should also familiarize themselves with existing industry standards and guidelines on how to maintain water quality in building potable water systems, discussed in more detail in this guide.

Water Quality Degradation

There are numerous factors that can lead to water quality degradation within building water systems, including water age and stagnation within water piping networks; external factors such as nearby construction or water main breaks; and internal factors within the building's water system and operating procedures.

Water Age

Water age refers to the amount of time water spends traveling from the utility source until the point of use. There are many factors that can impact water age, both within a water utility's distribution network and within a building.

[1] The optimal growth temperature range for *Legionella* is 77°F to 113°F (25°C to 45°C), although it can still grow outside of this range.

[2] Garrison LE, Kunz JM, Cooley LA, et al., 2016. "Vital Signs: Deficiencies in Environmental Control Identified in Outbreaks of Legionnaires' Disease—North America, 2000-2014." *Morbidity and Mortality Weekly Report (MMWR)* 2016; 65:576-584. www.cdc.gov/mmwr/volumes/65/wr/mm6522e1.htm

Water age can increase as a result of oversized distribution systems; decreases in building population; reduced water use or demand that has resulted from greater product and operational efficiency; and poor water circulation. The longer it takes for water to travel to the user, the more potential there is for chemical, physical, or biological reactions to occur that can degrade the water quality. For example, chlorine used to disinfect water can react with other chemicals in the water or piping until it is nearly expended, leaving the water vulnerable to pathogen growth. As water sits in distribution pipes, corrosion of pipes or fixtures can cause increasing amounts of metals to enter and contaminate the water.

Within buildings, water systems are sized and built based on an assumed level of water demand. However, building and plumbing code requirements for pipe sizing may have not been adjusted to reflect changing use patterns or more efficient products and systems that are now more prevalent in buildings. Therefore, building water systems are often oversized. In cases where less water is being used than anticipated during the design (such as from lower building population, water efficiency upgrades, or generally more efficient operations), water can sit for a longer time and increase in age. Building managers should be aware of changes in building occupancy or other water use patterns that may affect water age. Additionally, they should be aware of and try to eliminate piping segments in their building that may contribute to aging water, such as old or unused sections of piping (also known as "dead legs"); circuitous piping networks; and long piping runs with infrequent water use.

External Conditions Impacting Building Water Quality[3]

There are multiple factors that can occur outside a building's footprint that can degrade the water quality within a building:

- Nearby construction can cause vibrations, disturbances, or water pressure changes that can dislodge biofilm containing pathogens or heavy metals from water distribution and premise plumbing pipes.
- Water main breaks can impact water pressure, dislodge biofilms, or introduce other dirt and debris into the water system.
- Changes in municipal water quality or treatment practice can result in increased sediment, lower disinfectant residual, increased turbidity, and changes in pH level. Some water utilities also periodically alter the disinfectant used, which can impact building-level water quality.

Internal Conditions Impacting Building Water Quality[4]

Internal conditions also impact water quality within a building:

[3] CDC, 2021. *Developing a Water Management Program to Reduce* Legionella *Growth & Spread in Buildings: A Practical Guide to Implementing Industry Standards*. Version 1.1. June 24, 2021. www.cdc.gov/control-legionella/php/toolkit/index.html
[4] *Ibid*.

- The presence of biofilm in the plumbing network, while not inherently bad, is unavoidable and can provide the conditions for pathogen growth. If disturbed, biofilm can release pathogens and heavy metals into the building water system.
- Scale and sediment build-up can consume disinfectant residual (i.e., remove chlorine) from the water supply. Sediment can also serve as a protected habitat for microbial growth.
- Inadequate disinfection can lead to growth of opportunistic pathogens. In some buildings, processes such as heating, storing, and filtering of water can reduce or remove residual disinfectants and degrade the quality of the water.
- Water temperature fluctuations can occur from cross-connections between hot and cold water piping; heat transfer between hot and cold water pipes or surfaces; heat loss from the hot water distribution piping; heat loss from water stagnation; or pipe exposure to unconditioned spaces. Water heater set points can also influence the growth of opportunistic pathogens.

Water heaters should heat water above the optimal growth temperature range.

- Water pressure can change, which can disturb and dislodge biofilm containing pathogens or heavy metals from premise plumbing.
- Water stagnation can occur from long pipe networks, dead legs in the premise plumbing, or reduced building occupancy.

Facility Water Quality Management Standards, Guidelines, and Resources

There are many standards, guidelines, and other technical resources to help facility owners and managers understand and manage risk associated with water quality and water safety. Table 1 starting on the next page summarizes some of the prominent resources that address water quality, safety, and risk management in commercial and institutional buildings.

Table 1. Standards, Guidelines, and Resources Related to Water Quality Management

Primary Developing Organization	Title	Summary	URL
General Facility Resources			
ASHRAE	ASHRAE 188 *Legionellosis: Risk Management for Building Water Systems*	Standard that establishes minimum legionellosis risk management requirements for building water systems	www.ashrae.org/technical-resources/standards-and-guidelines/guidance-for-water-system-risk-management
ASHRAE	ASHRAE Guideline 12 *Managing the Risk of Legionellosis Associated with Building Water Systems*	Information and guidance to assist in control of legionellosis associated with building water systems	
ASHRAE	ASHRAE 514 *Risk Management for Building Water Systems: Physical, Chemical, and Microbial Hazards*	Standard that establishes safe management practices for building water systems; it addresses microbial risk more broadly than ASHRAE 188 and ASHRAE Guideline 12 (which focus only on *Legionella)*	
CDC	*Developing a Water Management Program to Reduce Legionella Growth & Spread in Buildings*	Tools that explain the buildings and end uses to incorporate into a water management plan to reduce the risk of legionellosis and provides steps to create a water management program	www.cdc.gov/control-legionella/php/toolkit/wmp-toolkit.html
CDC	*Toolkit for Controlling Legionella in Common Sources of Exposure*	Specific guidance for different types of equipment such as potable water systems, hot tubs, and cooling towers	www.cdc.gov/control-legionella/php/toolkit/control-toolkit.html
Cooling Technology Institute (CTI)	Guideline 159: *Legionellosis Guideline Practices to Reduce the Risk of Legionellosis from Evaporative Heat Rejection Equipment Systems*	Guidance on minimizing *Legionella* in evaporative cooling water systems	https://cti-marketplace.myshopify.com/products/gdl-59

Primary Developing Organization	Title	Summary	URL
NSF	NSF P453 *Cooling Tower Water Systems—Treatment, Operation, and Maintenance to Prevent Legionellosis*	Minimum practices required for treatment, operation, and maintenance of cooling tower water systems, including requirements for documentation, recordkeeping, validation, and auditing, in order to prevent Legionellosis	https://store.accuristech.com/standards/nsf-p453-2017?product_id=1995309
Resources for Healthcare Facilities			
Department of Health and Human Services (DHHS) Centers for Medicare and Medicaid Services (CMMS)	*Requirement to Reduce* Legionella *Risk in Healthcare Facility Water Systems to Prevent Cases and Outbreaks of Legionnaires' Disease*	Requirements and expectations for reducing the risk of *Legionella* in hospitals, critical access hospitals, and long-term care facilities	www.cms.gov/Medicare/Provider-Enrollment-and-Certification/SurveyCertificationGenInfo/Downloads/QSO17-30-HospitalCAH-NH-REVISED-.pdf
Veterans Health Administration (VHA)	Directive 1061(4) *Prevention of Health Care-Associated* Legionella *Disease and Scald Injury from Water Systems*	Guidance for preventing *Legionella* disease and scald injury from water systems in VHA buildings that house patients and residents overnight	www.va.gov/vhapublications/publications.cfm?pub=1
Resources for Professionals			
ASSE International/ International Association of Plumbing and Mechanical Officials (IAPMO)	ASSE/IAPMO 12080 *Professional Qualifications Standard for* Legionella *Water Safety and Management Personnel*	Standard that outlines the minimum requirements for becoming a member of a water safety team tasked with reducing the risk of *Legionella* and other waterborne pathogens in a building's water system	https://asse-plumbing.org/personnel-certification/infection-control-and-water-quality

Primary Developing Organization	Title	Summary	URL
Association of Water Technologies	Legionella *2019: A Position Statement and Guidance Document*	Information that water treatment professionals can use to manage the risk of Legionnaires' disease in building water systems	www.awt.org/pub/?id=035C2942-03BE-3BFF-08C3-4C686FB7395C
American Industrial Hygiene Association (AIHA)	*AIHA Technical Framework:* Legionella	Details the fundamental knowledge levels for professionals involved with *Legionella* assessment and summarizes hazards and response coordination	www.aiha.org/education/frameworks/technical-framework-legionella

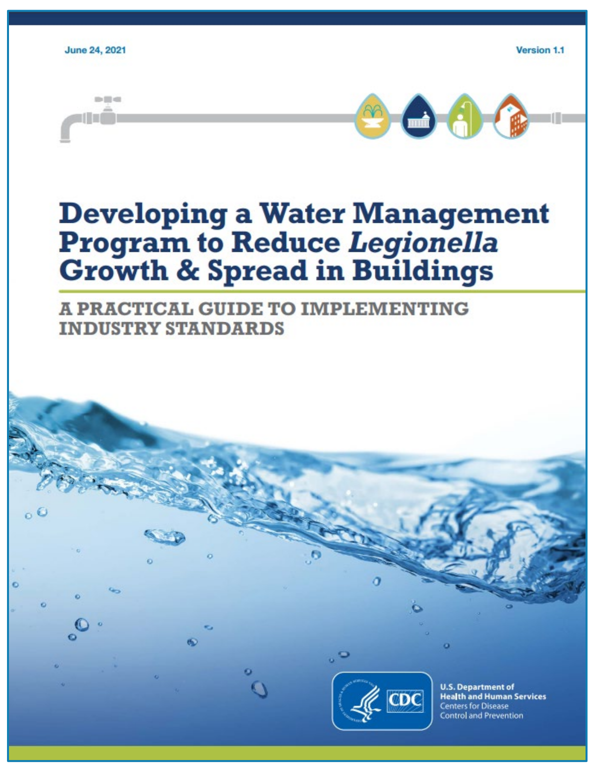
Managing the Problem: Plan and Act

WaterSense at Work Section 1.2 Water Management Planning, available online at www.epa.gov/watersense/best-management-practices, describes the steps that facility managers can take to develop a water management plan focused on reducing water use. To supplement water management planning efforts related to water efficiency, this section discusses elements of a water management program focused on protecting water quality. Much of the information provided in this section is based on documents developed by the CDC. Facility owners and managers are strongly encouraged to refer to the resources in Table 1, as this information can change and this guide is only meant to introduce the topic of facility water quality considerations.

Even though decreases in water demand can increase water age and negatively affect water quality, building managers should not forego water efficiency opportunities, since water quality problems can also occur in inefficient buildings that consume more water. Instead, EPA is providing this information to help facility managers develop and implement a water management program that addresses both water efficiency and water quality.

What Is a Water Management Program?

In the context of water quality, a water management program is a risk management plan developed to prevent and control *Legionella* and other waterborne opportunistic pathogens and contaminants associated with building water systems. It is difficult to completely eliminate the presence of pathogens in building water systems. Therefore, the goal of a water management program is to control the population and spread of pathogens or other water contamination to minimize risk to occupants. Because no single measure can reliably guarantee water quality, water management programs combine multiple control measures to maximize risk management.



Why Develop a Water Management Program?

According to ASHRAE 188 and CDC's *Developing a Water Management Program to Reduce* Legionella *Grown and Spread in Buildings* toolkit available at www.cdc.gov/control-legionella/php/toolkit/index.html, facility owners and managers should develop a water management plan for their building's entire hot and cold water distribution systems if the building:

- Serves as a healthcare facility where patients stay overnight or houses people with immunocompromising injuries, illnesses, or conditions;
- Functions primarily as housing for occupants over 65 years old;
- Includes multiple housing units with one or more centralized hot water systems; or
- Has greater than 10 stories, including those below grade.

If the building does not fit any of the criteria above, but it has one or more of the devices listed below, the facility owner or manager should develop a device-specific water management plan for each applicable device. Device-specific water management plans can include:

- Cooling towers or evaporative condensers
- Whirlpools, spas, or hot tubs
- Decorative fountains
- Misters, atomizers, air washers, or humidifiers

ASHRAE 514, which addresses physical, chemical, and microbial hazards associated with building water systems beyond *Legionella*, establishes broader recommendations. Buildings with risk factors that require water management planning include those that:

- Have greater than six stories;
- House occupants less than two years old or over 65 years old;
- Have supplemental disinfection of potable water;
- Are greater than 50,000 square feet and have a potable water booster pump;
- Have areas for surgeries; or
- Are intended for long-term residential health services (e.g., physical rehabilitation).

Steps to Develop a Water Management Program

To develop a water management program, facility managers should follow the guidance in ASHRAE 514 and ASHRAE 188, two voluntary industry standards that establish minimum risk management requirements for building water systems. Some jurisdictions mandate adherence to ASHRAE 188 and development of a water management program for certain facility types.[5]

[5] Several state health departments coordinated on a water management plan template, available at https://cha.com/wp-content/uploads/2019/03/Water-Management-Program-Template.pdf, that building managers can use to map out the content and organization of their program.

Similar to EPA's steps to water management planning presented in *WaterSense at Work Section 1.2* that focus on water efficiency, CDC's *Developing a Water Management Program to Reduce* Legionella *Growth and Spread in Buildings* (available at www.cdc.gov/control-legionella/php/toolkit/wmp-toolkit.html) outlines the steps facility managers should take to build an effective *Legionella* water management program:

1. Assemble your water management program team (consider including ASSE 12080 certified specialists).
2. Describe the building water system using text and flow diagrams.
3. Identify areas where *Legionella* and other waterborne pathogens could grow and spread and where other physical, chemical, and microbial hazards could occur.
4. Decide where control measures are needed and how to monitor them.
5. Establish ways to intervene when control limits and goals are not met.
6. Ensure the program is running as designed and is effective.
7. Document and communicate all activities.

Facility owners and managers are encouraged to view the full CDC document for more details on the steps listed above. To the extent practicable, WaterSense also encourages owners and managers to look for opportunities to integrate both water quality and water efficiency within their water management program.

Control Measures

Water management programs should combine multiple control measures to ensure effective risk management. Building managers can refer to CDC's *Toolkit for Controlling* Legionella *in Common Sources of Exposure* at www.cdc.gov/control-legionella/php/toolkit/control-toolkit.html for a list of control measures specific to the systems and features that commonly pose a *Legionella* risk (e.g., potable water systems, cooling towers, hot tubs, fountains). Many of the actions that facility designers, engineers, owners, and managers can take to control *Legionella* are also actions that can improve water and energy efficiency. These include:

- Piping system design: Avoid oversizing water pipes and properly insulate hot and cold water pipes where necessary.
- Temperature control: Ensure the hot water storage tank is appropriately sized.
- Cleaning and maintenance: Regularly clean and maintain system components such as showerheads and aerators. Replace devices that are not able to be adequately cleaned of scale, rust, and biofilms.
- Proper cooling tower management: Automate cooling tower water treatment and blowdown, use high-efficiency drift eliminators, and incorporate physical (e.g., filtration) and/or chemical water treatment. Regularly monitor cooling tower

treatment reports to ensure water quality remains within appropriate parameters. Review *WaterSense at Work Section 6.3 Cooling Towers* at www.epa.gov/watersense/best-management-practices for more information.

Other measures include using point-of-use treatment at individual fixtures or, where appropriate, using supplemental disinfection.

If a building experiences a legionellosis outbreak, there are specific steps facility owners or managers should take, including communicating with local health departments. Consult CDC's Investigating Legionnaires' Disease resources at www.cdc.gov/investigate-legionella/php/public-health-strategy/investigations.html for more information on how to address a legionellosis outbreak.

Routine Sampling and Monitoring

Facility managers can perform routine sampling of water quality parameters or *Legionella* and monitoring of control measures as part of a water management program to ensure the control measures they've implemented are effective. Routine sampling and monitoring can help establish a baseline of water quality data, compare changes in water quality over time, monitor potential growth and transmission sources, and identify sources of exposure when an outbreak occurs. Table 2 includes a list of resources with information on monitoring and testing for *Legionella* or other water quality parameters.

Table 2. Sampling and Monitoring Resources

Resource	Summary
Appendix C of ASHRAE Guideline 12, Testing for *Legionella* in Building Water Systems	Guidance on determining which points within the building water system should be sampled, procedures for collecting the samples, and a summary of appropriate responses to the *Legionella* test results
CDC's Routine Testing for *Legionella* web page at www.cdc.gov/control-legionella/php/toolkit/routine-testing-module.html	Information on testing for *Legionella,* including information on sample collection, laboratory considerations, and evaluating test results.
CDC's Environmental *Legionella* Isolation Techniques Evaluation (ELITE) Program web page and member list at wwwn.cdc.gov/elite/public/elitehome.aspx	Information on laboratories that have passed proficiency testing on identifying *Legionella*.

Table 2. Sampling and Monitoring Resources

Resource	Summary
CDC's Environmental Assessment and Sampling Resources web page at www.cdc.gov/investigate-legionella/php/resources/environmental.html	Guidance documents, instructional videos, and sampling forms to help develop and implement *Legionella* sampling plans.
Using Water Quality Monitoring Data for Your Building Water Management Program fact sheet from the Association of State and Territorial Health Officials (ASTHO) and the Association of State Drinking Water Administrators (ASDWA), available at www.asdwa.org/wp-content/uploads/2020/07/Using-Water-Quality-Monitoring-Data-for-Your-Building-Water-Management-Program.pdf	Information on baseline water quality parameter monitoring at the building point of entry

Building Shutdown and Reopening

A temporary building shutdown or significantly reduced occupancy can increase water stagnation and create a greater risk for *Legionella* and other water quality issues within a building water system, as noted during the COVID-19 pandemic. A number of organizations have published resources, summarized in Table 3, that overview actions building owners and managers should take to maintain water quality during a shutdown and/or reduce risk to occupants when the building is reopened.

Table 3. Building Shutdown and Reopening Resources

Resource	Summary
CDC's Reopening Buildings Guidance web page at www.cdc.gov/control-legionella/php/guidance/building-water-system.html	Overview of potential water quality hazards to assess and steps to take prior to building reopening
EPA's Information on Maintaining or Restoring Water Quality in Buildings with Low or No Use web page at www.epa.gov/sdwa/information-maintaining-or-restoring-water-quality-buildings-low-or-no-use	A guide on how to maintain water quality during building closure and a checklist for building reopening

Table 3. Building Shutdown and Reopening Resources

Resource	Summary
American Water Works Association (AWWA) and IAPMO's *Responding to Water Stagnation in Buildings with Reduced or No Water Use* guide at www.awwa.org/wp-content/uploads/responding-to-water-stagnation-in-buildings.pdf	A guide for buildings without a water management program to assess and address building water stagnation
AWWA and IAPMO's *Manual of Recommended Practice for the Safe Closure and Reopening of Building Water Systems* at https://iapmo.org/research/manuals/the-safe-closure-and-reopening-of-building-water-systems-manual	Guidance on risk management practices for preparing water systems when buildings are shut down or prepared for low-use periods
AWWA's *Disinfecting Building Potable Water Plumbing in New or Repaired Systems* guide at www.awwa.org/wp-content/uploads/Disinfecting-Building-Potable-Water-Plumbing-in-New-or-Repaired-Systems.pdf	Procedures for disinfection of new or repaired building potable water systems prior to occupancy; the guide is not intended to be applied as a remedial disinfection procedure

Additional Resources

ASHRAE. *Guidance on Reducing the Risk of* Legionella. www.ashrae.org/technical-resources/standards-and-guidelines/guidance-on-reducing-the-risk-of-legionella

AWWA. *Disinfecting Building Potable Water Plumbing in New and Repaired Systems*. November 2024. www.awwa.org/wp-content/uploads/Disinfecting-Building-Potable-Water-Plumbing-in-New-or-Repaired-Systems.pdf

AWWA and IAPMO. *Manual of Recommended Practices for the Safe Closure and Reopening of Building Water Systems*. 2022. https://iapmo.org/media/gdga2nea/awwa_iapmo-manual-0-2022-the-safe-closure-and-reopening-of-building-water-systems.pdf

AWWA and IAPMO. *Responding to Water Stagnation in Buildings with Reduced or No Water Use*. www.awwa.org/wp-content/uploads/responding-to-water-stagnation-in-buildings.pdf

CDC. Controlling *Legionella*. www.cdc.gov/control-legionella/

CDC. *Healthcare-Associated Infections (HAIs). Considerations for Reducing Risk: Water in Healthcare Facilities*. www.cdc.gov/healthcare-associated-infections/php/toolkit/water-management.html

EPA. Information on Maintaining or Restoring Water Quality in Buildings with Low or No Use. July 2020. www.epa.gov/sdwa/information-maintaining-or-restoring-water-quality-buildings-low-or-no-use

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