Technical Guide No. 391

Medical Treatment Facility
Water Management Program Assistance Visit

Environmental Health Engineering Division
Garrison Water Branch

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APHC

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1. PURPOSE

This TG describes how to conduct a water system survey at Army medical treatment facilities (MTFs), specifically addressing elements necessary for a Water Management Program (WMP). Completing a comprehensive survey is a significant piece of developing a WMP. The purpose of a WMP is to reduce the risk of a waterborne disease outbreak due to *Legionella* or other waterborne pathogens.

2. REFERENCES

Appendix A provides a list of references used in this technical guide (TG). The Glossary provides a list of acronyms and terms used in this TG.

3. SCOPE AND APPLICABILITY

MTFs that are accredited hospitals must have a WMP. In addition, if an MTF meets any of the four criteria below, the facility must have a WMP for its building water system. Facilities may choose to implement a WMP even if they do not meet the following criteria:

- Facility has overnight patients.
- Facility has patients with chronic and acute medical conditions (e.g., burns, cancer, solid organ or bone marrow transplant, kidney disease, diabetes, or chronic lung disease).
- Facility treats immunocompromised patients.
- Facility has more than 10 stories, including basement levels.

Even if a facility's building water system is not required to have a WMP, the facility may need a WMP for specific devices within the building. The devices listed below will require a WMP:

- Cooling tower.
- Hot tub that is not drained between each use.
- Decorative fountain.
- Centrally-installed mister, atomizer, air washer, or atomizer.

4. BACKGROUND

4.1 Legionnaires' Disease

There are at least 60 *species* of *Legionella* bacteria and most are pathogenic. *Legionella* can cause legionellosis, which collectively refers to Legionnaires' disease and Pontiac Fever. *Legionella pneumophilia (L. pneumophilia)* is the most virulent and is responsible for approximately 90% of all cases of legionellosis. *L. pneumophilia* serogroup 1 (Allegheny)

causes 70 to 80% of these cases; however, *L. pneumophilia* serogroups 2–6 can also cause disease, as can *L. micdadei*, *L. bozemanii*, *L. dumoffii*, *L. longbeachii*, and *L. anisaalso*.

There were nearly 7,500 cases of Legionnaires' disease reported in the U.S. in 2017; however, public health officials believe the number of actual cases is higher.

The annual number of cases of Pontiac Fever are more difficult to estimate. Most occurrences of Pontiac Fever are undiagnosed and unreported since it is a self-limiting illness resembling the flu and generally lasting approximately 5 days. The incubation period for Legionnaires' disease is typically 2 to 10 days from the time of exposure to symptom onset, averaging 5 to 6 days, but in some rare circumstances much longer incubation periods of up to 26 days have been reported.

Legionnaires' disease can result in severe pneumonia requiring hospitalization with a case-fatality rate of 10% for community-acquired cases and 25% for nosocomial-acquired cases. Nosocomial infections are those acquired during a stay at a hospital. Risk factors for nosocomial pneumonia include: recent surgery, intubation and mechanical ventilation, aspiration, and use of respiratory therapy equipment.

4.2 Risk Factors

Legionella is transmitted from an environmental source to a human host when it is spread via aerosolized water containing the organism or when contaminated water is aspirated (water is breathed into the lungs). Certain conditions must be present to allow amplification of *Legionella* within building water systems, primarily water ranging in temperatures from 20 to 50 degrees (°) Celsius (C) (68 °Fahrenheit (F) to 122 °F) and lack of disinfectant in segments of the building's pipelines. Water temperatures most conducive to the bacteria amplification is 25 to 45° C (77° to 113 °F). Initial *Legionella* amplification may begin in the facility hot water storage tank when the water is not maintained at a sufficiently high temperature. Other conditions that encourage *Legionella* growth include the presence of scale or biofilm in water pipes or sediment in water storage tanks or pipes. There must also be some means available for creating an aerosol or respirable droplets to transmit the organism, such as a shower or fountain. The particular strain of *Legionella* present in the water must be virulent. The *L. pneumophilia* serogroup 1 seems to be especially virulent, causing most documented infections. Lastly, the bacteria must be introduced to a susceptible host.

Generally speaking, the risk of infection once an individual is exposed to *Legionella* depends on the exposure dose and the individual's resistance. Although the exact dose needed to cause infection is unknown, research shows that relatively high numbers of a particularly virulent strain are required to infect young, healthy individuals. Conversely, fewer bacteria are required to infect older and immunocompromised individuals due to their lowered resistance. Those at greatest risk of infection are organ transplant, hematologic malignancy, and end-stage renal disease patients. Other individuals with an increased risk of infection are individuals 50 years or older, smokers and those with diabetes mellitus, chronic lung disease, non-hematologic malignancies, or HIV. Infection is rare among children.

4.3 Sources of Transmission

Healthcare-associated cases of Legionnaires' disease comprise approximately 20% of all legionellosis cases reported in the U.S. Travel-associated cases comprise another 20% of legionellosis cases and are typically associated with hotels, cruise ships, or other lodging facilities. Most cases in the U.S. are community-acquired, meaning they are not acquired from travel, hospitals, or long-term care facilities.

In general, any device that aerosolizes water or produces a spray has the potential to transmit *Legionella*. Typical culprits in legionellosis outbreaks are potable hot water systems and cooling towers. Ornamental fountains, whirlpool hot tubs, showers, faucets, and humidifiers are also documented sources of legionellosis outbreaks. There are no documented cases of person-to-person of transmittal of *Legionella* causing illness.

4.4 *Legionella* in Building Water Systems

Current U.S. Environmental Protection Agency (EPA) drinking water regulations do not require water treatment facilities to test their water for *Legionella*, so MTFs cannot be confident that the incoming water does not contain *Legionella*. Studies have indicated that *Legionella* bacteria can survive routine water treatment processes and may enter a distribution system in low numbers. Therefore, facilities must be vigilant in maintaining their building water systems to protect against *Legionella* contamination. If the building water distribution system is not properly maintained *Legionella* present in the source is able to amplify.

Several key conditions in building water supply systems lead to *Legionella* growth:

- Lukewarm water – Optimal temperatures for *Legionella* growth are between 25 to 45 °C (77 to 113 °F). However, temperatures outside this range are still favorable for *Legionella* growth. When possible, maintain cold water temperatures below 20 °C (68 °F) and hot water temperatures above 49 °C (120 °F) at points of use.
- Lack of disinfectant – Disinfectants help control *Legionella* growth. Maintaining a disinfectant residual of 0.2 – 0.5 parts per million (ppm) is optimal.
- Stagnation/dead legs – When water sits in a system without movement the concentration of disinfectant residual decreases, allowing *Legionella* growth.
- Biofilm – When biofilm forms (a layer of organisms and other material forms on interior walls of water pipes), it protects *Legionella* from heat and disinfectant.

Although the following conditions may occur within building plumbing, they may also be linked with *Legionella* growth on a larger scale within the water distribution system:

- Sediment and scale – Sediment and scale are coatings deposited on surfaces in contact with hard water. Like biofilm, sediment and scale protect *Legionella* from heat and disinfectants.
- Corrosion – *Legionella* bacteria can multiply in water pipes that have an abundance of organic material due to pipe corrosion.

- Cross connections – Cross connections between potable and non-potable water can introduce *Legionella* and other waterborne pathogens into the potable water supply system.

In addition to the conditions listed above, certain events can raise the risk of *Legionella* in the water system. Disturbances in the water system, such as water pressure shock, major construction, and opening new or renovated buildings, can create conditions favorable for *Legionella* growth.

5. REGULATIONS, STANDARDS, AND GUIDELINES

Numerous guidelines and regulations issued by a variety of organizations, from government to trade organizations, address the control of *Legionella*. The following is a summary of those most notable.

5.1 U.S. Environmental Protection Agency

The EPA sets a maximum contaminant level (MCL) to regulate many contaminants; however, where there is no reliable method that is economically and technically feasible to measure a contaminant at particularly low concentrations it implements a treatment technique (TT). A TT is an enforceable procedure or level of performance that a water system must follow to ensure control of a contaminant. The EPA presumes that if water meets the disinfection and filtration standards for *Giardia lambia* and viruses, as outlined in the Surface Water Treatment Rule, then *Legionella* will also be controlled (EPA 1989).

5.2 ASHRAE

ASHRAE (originally formed as the American Society of Heating, Refrigerating and Air-Conditioning Engineers) is a trade organization that focuses on building systems (in part) within the industry. They have contributed three major *Legionella* resources. The first was Guideline 12-2000, *Minimizing the Risk of Legionellosis Associated with Building Water Systems* (ASHRAE 2000). This document is written for a technically-minded audience rather than clinical and presents environmental and operational guidance. ASHRAE Guideline 12-2020, *Managing the Risk of Legionellosis Associate with Building Water Systems* (ASHRAE 2020), expands upon Guideline 12-2000, provides information and guidance to assist in control of legionellosis, and provides guidance useful in the implementation of ANSI/ASHRAE Standard 188-2018, *Legionellosis: Risk Management for Building Water Systems*, which establishes minimum risk management requirements for building water systems through the prescribed use of WMP (ASHRAE 2018). ANSAI/ASHRAE Standard 188 is the basis for establishing a building water management plan and also provides requirements specific to health care facilities.

Currently, ASHRAE is developing SPC 514, *Risk Management for Building Water Systems: Physical, Chemical, and Microbial Hazard*s. NSF® International initially drafted this document as NSF Standard Draft Standard 444 in 2018. However by mutual agreement of the two organizations, ASHRAE will complete the standard. The ASHRAE SPC 514 builds on the

ASHRAE documents cited above, and NSF Draft Standard 444 and addresses building water quality and the importance of managing water systems to help prevent contaminant exposures.

5.3 Centers for Disease Control and Prevention

The Centers for Disease Control and Prevention (CDC) published the primary guidance document for developing a WMP, the *Legionella* toolkit, "Developing a Water Management Program to Reduce *Legionella* Growth & Spread in Buildings: a Practical Guide to Implementing Industry Standards." This toolkit simplifies ASHRAE Standard 188 in order to assist building owners and managers with developing an effective WMP (CDC 2017).

More recently, the CDC published its "Toolkit for Controlling *Legionella* in Common Sources of Exposure (*Legionella* Control Toolkit)" in 2021 (CDC 2021a). This document offers assistance on evaluating hazardous conditions associated with potable water systems and implementing *Legionella* control measures for potable water systems per ASHRAE Guideline 12-2020. The CDC also published its "Guidelines for Environmental Infection Control in Health-Care Facilities" in 2003 and updated it in 2019 (CDC 2003). This document is a compilation of recommendations for the prevention and control of infectious diseases, including Legionellosis, associated with healthcare environments.

5.4 Centers for Medicare and Medicaid Services

The Centers for Medicare and Medicaid Services (CMS) issued a memo in 2018 (QSO-17-30) requiring Medicare-certified hospitals, critical access hospitals, and long-term care facilities to develop, implement, and monitor the effectiveness of WMPs in order to provide protection against waterborne pathogens (CMS 2018).

5.5 Veterans Health Administration

The Veterans Health Administration (VHA) Directive 1061, "Prevention of Healthcare-Associated Legionella Disease and Scald Injury from Water Systems," established policy and engineering control measures for the prevention and control of healthcare-associated *Legionella* disease in VHA-owned buildings in which visitors, staff, patients, or residents stay overnight (Department of Veterans Affairs (VA) 2021). Specifically the Directive requires facilities to implement WMPs, continuously monitor water quality, and conduct quarterly *Legionella* monitoring in those facilities that house visitors, staff, patients, or residents overnight.

5.6 World Health Organization

The World Health Organization (WHO) published "*Legionella* and the Prevention of Legionellosis" (WHO 2007). This document is a comprehensive source of information regarding *Legionella*, including guidance on assessment and management of risks with respect to potentially hazardous environments. It was the original resource regarding WMPs, which ASHRAE, the CDC, and the VHA have based their guidance document upon.

5.7 The Joint Commission

The Joint Commission (TJC) (formerly Joint Commission on Accreditation of Healthcare Organizations (JCAHO)) is an independent organization that sets performance standards and provides accreditation for healthcare organizations. TJC accredits a variety of programs including hospitals and ambulatory care clinics. Army MTFs typically receive TJC accreditation surveys every 3 years.

Joint Commission Standard E.C. 02.05.02, effective January 2022, requires accredited hospitals to have a WMP that addresses *Legionella* and other waterborne pathogens (TJC 2022). The WMP must have an individual or team responsible for oversight and implementation of the program. The person or team responsible for the program will develop a water diagram of the hospital, a water risk management plan, an evaluation of the patient population to identify high risk patients, a plan to address stagnant water conditions, and monitoring protocols and acceptable ranges for control measures. The facility must review its WMP annually or if conditions change.

6. DEVELOPING A WATER MANAGEMENT PROGRAM

A WMP is a means of managing identified health risks from exposure to *Legionella* and other waterborne pathogens. Because healthcare facilities provide services to people at increased risk of Legionnaires' disease, many of these facilities need a WMP to reduce that risk. The goal of a WMP is to identify areas and devices in healthcare facilities where there is elevated risk for *Legionella* growth and transmission. The American National Standards Institute (ANSI)/ASHRAE Standard 188 establishes minimum risk requirements for building water systems, outlining the necessary steps to create an effective WMP (ASHRAE 2018). These steps include:

- Establishing a water management program team (WMPT).
- Describing the water system.
- Conducting a hazard analysis and identifying **control points** (locations in the water system where control measures are necessary).
- Identifying **control measures** at each control point and designating **control limits** (maximum, minimum, or range of values to be monitored) for each measure.
- Creating **corrective actions** to implement when monitoring shows parameters have exceeded control limits.
- Developing verification/validation procedures.
- Documenting procedures and activities, including an outbreak and contingency response plan.

6.1 Establishing a Water Management Program Team

MTFs with WMPs must establish a WMPT. Team members should have knowledge of the water system and be able to identify control locations/limits, identify and implement corrective actions, and verify/validate program performance. Members should include Directorate of Public Works

staff (e.g., maintenance, engineering, environmental (drinking water representative)), safety officer, industrial hygienist, installation Public Health (PH) staff, infection control officer, and someone familiar with accreditation/licensing standards. Ideally, the MTF will have identified members of the WMPT prior to the U.S. Army Public Health Center (APHC) site visit.

6.2 Water Management Program Assistance Visit Preparation

Before arriving onsite, coordinate with the appropriate point of contact (POC), most likely the PH Chief, to discuss the scope of the project to ensure all parties understand what the project will entail. Develop a plan to survey the water system and discuss the logistical details of the site visit.

When developing the plan to survey the water system, discuss the following details:

- Names and contact information of escorts for APHC team.
- Availability of key personnel (infection control officer, facility manager or someone familiar with the building water system).
- Plan of attack (which buildings, approximate time allowed).
- Process of obtaining approval to photograph MTF equipment such as hot water boiler, water treatment devices, ornamental fountains, water-using medical equipment, and other water fixtures.
- Start and end times for the workday.
- Date and time of outbrief (if requested).
- Availability of senior MTF staff members for exit briefing.
- Access to a meeting room for APHC assessors to use as needed during the week.
- Transportation issues.

In addition, request that pertinent documents, records, and procedures are provided prior to (preferred) or upon arriving onsite. These may include:

- Blueprints/drawings of the water system.
- Prior analysis of the water system for potentially hazardous conditions (dead legs, lack of disinfectant, etc.).
- Existing control measures and associated records.
- Monitoring procedures.
- Information related to corrective actions (e.g., POCs/contact information and operation and maintenance procedures related to water).
- Existing WMP documentation (memorandums, water sampling plans, flushing plans).

Invite the WMPT to an initial kickoff meeting. If the MTF has not established a WMPT, confer with the PH Chief (or other appropriate POC) to identify and invite potential members of the WMPT. The purpose of the kickoff meeting is to review the information provided, review what is missing, and to resolve any other questions or issues that have arisen during the preliminary review of existing documentation. The kickoff meeting can occur virtually prior to the site visit or the first day during the site visit.

7. WATER SYSTEM SURVEY

The initial step of the WMP process is to survey the building water system to identify potentially hazardous conditions. The survey provides an understanding of the water system characteristics, potential hazards and the risks they may create, and how they may impact the water quality (e.g., processes and practices). Complete a walk-through of the MTF (Appendix B contains a checklist to assist).

7.1 Water System Diagram

If the MTF does not have a process flow diagram of its water system, create one to identify locations of potentially elevated risk in the water system. The diagram should show the normal flow of water through the MTF, from the point of entry to the outlets, showing connecting water lines, flushing points, and direction of flow. Provide a brief description of each component's end use, such as "laundry" or "therapy pool." Key components to include in the diagram:

- Incoming water sources.
- Onsite cold water storage.
- Water heaters.
- Hot water storage.
- Backflow prevention devices.
- Potable water usage (fixtures/clinical water use).
- Thermostatic mixing valves (TMVs).
- Water meters, stop valves.
- Fire suppression system.
- Cooling towers.
- Return loops, especially for warm water systems.
- Waste water disposal points that are not part of the main sewer.

Develop the diagram using Word®, Excel®, or PowerPoint® (or any specialized program). Depending on the complexities of the MTF's water system, there may be one or more flow diagrams necessary.

7.2 Water System Description

In addition to creating a water system diagram, write a description of the building water system. The description of the water system should expand on everything noted in the diagram and should document and/or describe the following:

- The incoming water supply, to include where entry points to the MTF are located, water treatment protocol, whether or not the MTF provides secondary treatment of water, water quality characteristics (e.g., disinfectant residual, temperature, pH, turbidity, bacteriological quality, concentrations of metals of concern), and if the quality of the water is consistent and reliable.
- Emergency sources of water for the MTF, if they exist.

- The use of high risk features such as cooling towers, evaporative air conditioners, ornamental fountains and water features, and hot tubs, spas and whirlpools. Note disinfection procedures for these water system components.
- The fire suppression system, including the water source. If it uses the potable water supply, indicate if there is backflow prevention.
- Water flow within each building, including return loops.
- The location, capacity, and temperature setting for hot water heaters and the presence of recirculating hot water loops.
- All potable water uses (such as drinking, bathing and food preparation, including ice machines and cold water dispensers). Note the number and type of outlets within a facility (the location of every individual fixture is not required). Indicate presence of TMVs at faucets/showerheads.
- Clinical water use (may include dialysis, dental chairs and heater cooler perfusion devices). Describe water sources specific to patient care areas, clinical support areas, and components and devices that can expose patients to aerosolized water.
- Sterile or boiled water uses (e.g., nebulizers and CPAP devices).

Visually inspect each water system point-of-use (POU), photographing an example of each type of fixture or equipment, particularly those that may present a hazard. It is not necessary to document the location of every fixture (such as faucets or showerheads), instead record the number of each type of fixture in the building. For specialized system components (such as hot water heaters, fountains, hot tubs, medical equipment that uses tap water), record more details, such as the exact location, make and model, age, and type of material. Note any suspected areas where biofilm may be present, or *Legionella* and other pathogens could proliferate.

It is especially important to document the presence and location of areas treating susceptible populations. These areas may include burn units, dialysis units, hematology/oncology, intensive care, long term care, pediatric/neonatal intensive care, surgery, or transplant units.

8. IDENTIFYING CONTROL POINTS

Using the flow diagram, identify locations where potentially hazardous conditions may occur and conduct a risk analysis for each location. Hazardous conditions can include contaminated incoming water, inadequate temperatures, stagnant water, biofilm growth, or improperly maintained infrastructure. If there is significant risk at a given location, then that location will be designated as a **control point**, and will have a corresponding **control measure** and **control limit**. A control measure is a means to maintain the desired physical or chemical conditions of the water that will prevent hazardous conditions. This can include maintaining disinfectant concentrations, heating, cooling, filtering, or flushing. Control limits are established maximum values, minimum values, or range of values for a biological, chemical, or physical parameter associated with a particular control measure. When a control limit is out or range, corrective actions are necessary to bring the control measure back within its specified limits.

8.1 Identifying Hazardous Conditions

When determining possible hazardous conditions, consider areas and/or fixtures where the temperature is generally in the ideal range for *Legionella* growth, disinfectant residual concentrations are low or non-existent, there is potential for aerosol generation, or there are areas of stagnation. Also consider all areas that expose patients to possible *Legionella* transmission, as well as areas where susceptible patients are located (e.g., transplant units, oncology, intensive care units). Table 1 presents various hazard sources and the potential hazardous conditions that may exist.

Table 1. Hazard Sources and Hazardous Conditions in Water Systems

Hazard Source	Potential Hazardous Conditions
Incoming water	• Boil water advisories • Water main break • Loss of supply • Low pressure events • Hydrant flushing • Discolored water • Cross connection
Boundary to building plumbing	• Untreated incoming water • Cross connections
Cold water distribution and storage	• Untreated incoming water • Sludge build-up • Stagnation • Low chlorine residual • Water temperature >20 °C • Discolored water • Dead legs
Hot water distribution and storage	• Storage temperature below 60 °C • Thermal stratification • Stagnation/dead legs • TMV failure • Loss of power/heat source • System corrosion • Circulation pump failure • Low chlorine residual
Drinking water fountains	• Discolored water • Temperature failure • Filter failure • Stagnation • Low chlorine residual

8.2 Conducting Risk Assessment

After identifying locations in the MTF's water system where potential hazards may exist, conduct a risk assessment to determine if those hazards create a significant risk. All areas identified in the flow diagram must be assessed for risk and risk assessment decisions should take existing data into account when possible. When determining if the risk is significant, take into account the probability of occurrence and the severity of the adverse impact. All locations that pose a significant risk should be control points and should have associated control measures and control limits. The CDC developed a Water Infection Control Risk Assessment (WICRA), which is specific geared to healthcare settings (CDC 2021b). This particular tool is a useful risk assessment model in that it generates numerical scores of perceived risk that can assist in prioritizing monitoring and mitigation efforts. The total risk scores generated using this tool assist with assigning priorities specific to each facility. Table 2 shows the scoring for each of the categories within the WICRA and Table 3 shows sample entries using the WICRA tool. Appendix C contains the WICRA document.

Table 2. Risk Analysis Criteria

Category	Scoring and Classification Description
Patient Susceptibility	4 – Highest (organ transplant, oncology or burn units)
	3 – High (operating rooms, intensive care units)
	2 – Moderate (general inpatient units)
	1 – Low (waiting rooms, administrative areas)
Patient Exposure	3 – High (high frequency, magnitude, and duration)
	2 – Moderate (combination of high/low frequency, magnitude and duration)
	1 – Low (low frequency, magnitude, and duration)
	0 – None (patients not exposed)
Current Preparedness	3 – Poor (limited policies, procedures, and mitigation strategies)
	2 – Fair (some policies, procedures, and mitigation strategies)
	1 – Good (robust policies, procedures, and mitigation strategies)

Table 3. Sample Risk Assessment

Water Source	**Potentials Hazards**	**Patient Susceptibility (PS)** Highest = 4 High = 3 Moderate = 2 Low =1	**Patient Exposure (PE)** (High = 3 Moderate = 2 Low = 1 None = 0	**Current Preparedness (CP)** Poor = 3 Fair = 2 Good = 1	**Total Risk Score (PS x PE x CP)**	**Comments**
Incoming water	Low chlorine residual	3	3	1	9	Continuous monitoring of chlorine residual
Third floor patient rooms	Stagnation	2	3	3	18	Institute a flushing plan
Staff showers	Aerosolization	1	1	2	3	Showers used daily
Operating room respiratory equipment	Aerosolization	3	2	2	12	Check disinfection log

9. IMPLEMENTING CONTROL MEASURES

Identify control measures and control limits for all control points. A control measure is a means to maintain the desired physical or chemical conditions of the water to prevent hazardous conditions (e.g., limit the growth of *Legionella*). Control measures can be a one-time event (e.g., insulating hot water recirculation pipes) or can be recurring events such as monitoring, regular maintenance, or operational response procedures. Common control measures may include disinfecting, heating, cooling, filtering, or flushing the building water system. Table 4 shows examples of control measures and subsequent sections provide additional details regarding common control measures.

Table 4. Examples of Hazards, Control Limits, and Control Measures

Hazard	Control Point	Control Limit	Monitoring Frequency	Sample Control Measures
Elevated turbidity – incoming water	Entry point	Turbidity > 1 NTU	Online, weekly or event based	• Request water provider reduce turbidity. • After turbidity reduced, flush plumbing to waste. • Filter and/or disinfect at point of entry.
Stagnation in plumbing	Monitor/record use of water in rooms/facilities	Outlet unused for 7 days	Weekly	• Flush unused outlets. • Remove dead legs.
Water temperature insufficient	Hot water fixtures	Water temperature <49 °C at fixture	Online continuous monitoring of hot storage and return water temperatures	• Increase hot water heater temperature. • Insulate hot water pipes.
Low disinfectant residual in plumbing	At cold outlets furthest from point-of-entry and hot water outlets furthest from water heater	Free residual chlorine between 0.2 and 0.5 mg/L	Weekly	• Boost disinfectant residual at point of entry to facility. • Increase flushing to prevent loss of disinfectant residual within facility. • Test again to verify effectiveness of controls.

Legend:
NTU = nephelometric turbidity unit
°C = degrees Celsius
mg/L = milligrams per liter

The WMP should document all control measures, control limits, and monitoring procedures. Control limits are set maximum or minimum values, or range of values, of a chemical or physical parameter associated with a particular control measure. Assigned personnel will monitor or implement control measures at a regular predetermined frequency. Monitoring control measures continuously is ideal because automated systems will provide immediate feedback if control limits are out or range. If this is not practical, personnel will need to collect water samples for testing on a regular basis to determine if parameters are within the established control limits. At a minimum the samples should be testing for temperature and disinfectant residual concentrations. The WMPT may choose to test for additional parameters such as pH, total organic carbon, or heterotrophic plate count (HPC). There is a higher risk of *Legionella* growth when a control limit out of range, so a corrective action must be implemented to bring the parameter back into the appropriate range.

9.1 Disinfectant Residual Limits

Maintaining an adequate disinfectant residual concentration in the distribution system is a critical control measure. Monitor the disinfectant residual concentration where the water enters

the MTF, at distant points in the water distribution system, and in high risk locations. If the MTF includes multiple buildings, floors, or wings, select multiple sampling points for each of the buildings, floors or wings, to provide a representative overview. If the MTF adds supplemental disinfectant to the incoming water, sample immediately past the disinfection point to verify proper dosing. Table 5 outlines the recommended frequency and locations for disinfectant residual monitoring.

Table 5. Recommended Monitoring For Disinfectant Residual

System	No. of Samples	Monitoring Frequency	Monitoring Locations
Hot water system with return loop	Minimum of three residual checks from each loop or building wing	Monthly, at a minimum Increase frequency if low occupancy, low residuals, or other disruptions that affect the residual (e.g., interruption of water supply)	• Hot water storage device or outlet closest to it. • Outlet at approximate mid-point in the flow loop. • Outlet at the end of the flow loop, prior to the return to the hot water supply
Hot water system with return loop (multiple floors on single loop)	Minimum of three residual checks per floor		
Hot water system with no return loop	Minimum of three residual checks per each hot water system		• Hot water storage device or outlet closest to it. • Outlet at approximate mid-point in the system. • Outlet furthest from the hot water supply.
Hot water system with no return loop (multiple floors on single system)	Minimum of three residual checks per floor		
Cold water system	Minimum of three residual checks from each loop or building wing		• Cold water storage tank or outlet closest to the entry point of the mains cold water supply. • Outlet at approximate mid-point in the system. • Outlet furthest from the mains incoming cold water supply.
Cold water system with multiple floors	Minimum of three residual checks per floor		

To sample hot water storage tanks, check the residual within the device by operating the heater's pressure relief valve. If this is not possible, sample at the hot water outlet closest to the hot water heater. To sample cold water storage tanks, partially open the tank's drain valve and record the disinfectant residual at the discharge into the drain. If this is not possible, sample at the cold water outlet nearest to the storage tank. When sampling at hot and cold water outlets, run the tap for at least 60 seconds in order to collect a representative sample.

9.2 Water Temperature Limits

Maintaining the appropriate water temperatures in the distribution system is a critical control measure to minimize *Legionella* growth. Optimal temperatures for *Legionella* growth are between 25 – 45 °C (77 – 113 °F); however, temperatures outside this range are still favorable

for *Legionella* growth. When possible, maintain cold water temperatures below 20 °C (68 °F) and hot water temperatures above 49 °C (120 °F) at points of use. Table 6 shows recommended temperatures for hot and cold water systems and provides guidance on where to collect samples.

Table 6. Recommended Monitoring For Water System Temperatures

System	Proper Temperature	Time to Reach Temperature	Number of Samples	Recommended Monitoring/Control Point Locations
Hot water heaters	≥ 60 °C (140 °F)	Instantaneous	One per hot water heater or return loop	Hot water heater egress and return, if applicable
Recirculating hot water systems – return water	≥ 49 °C (120 °F)			
Hot water system at points of use	≥ 49 °C (120 °F)	Within 1 minute of flushing	• Minimum of three per loop or wing • Minimum of three per floor	• Fixture closest to hot water outlet • Fixture at mid-point (approximate) • Most distant fixture
Cold water system at point of use	< 20 °C (68 °F)	Within 2 minutes of flushing	• Minimum of three per loop or wing; • Minimum of three per floor	• Fixture closest to hot water outlet • Fixture at mid-point (approximate) • After pipes pass through warmer areas (e.g., roof space) • Most distant fixtures

Legend:
°C = degrees Celsius
°F = degrees Fahrenheit

To measure the temperature at hot water storage tanks, record the temperature of the stored water (as shown on the heater temperature gauge). If the tank does not have a gauge, check the temperature by operating the heater's temperature relief valve or by checking the nearest hot water outlet. To measure the temperature at the cold water storage tank, partially open the tank's drain valve and allow the water to discharge into the drain and measure the temperature from the discharge. As an alternative, measure the temperature at the nearest cold water outlet.

When measuring the temperature of hot and cold water at outlets, fill a glass or a beaker with water and let it overflow into the sink. Measure the temperature from the glass once it has stabilized. If the temperature fluctuates, note the minimum and maximum temperatures. Record any locations that take longer than one minute to stabilize. Check those locations to ensure that the delay is due to a long pipe run and not a pipe obstruction or faulty equipment. To avoid

scalding when monitoring hot water temperatures, use caution. In addition, avoid inhaling aerosols and/or exposing MTF staff and patients to aerosols during this process.

9.3 Incoming Water Supply

An MTF does not have many opportunities to control its incoming water supply since a water supplier typically provides the water. Two water quality parameters of primary concern with respect to *Legionella* growth are temperature and disinfectant residual concentration. If the incoming water temperature is too warm, the MTF may need to employ an alternative measure to reduce risk such as an ultraviolet light or filtration in problem locations.

In order to suppress *Legionella* growth in the water distribution system, a free chlorine residual of 0.2 milligrams per liter (mg/L) should be present at the most distant outlet in the water distribution system. If the residuals are too low, the MTF should notify the water supplier and determine if the water supplier can take actions to increase the residual in the MTF water supply. If this is not possible, the MTF may want to consider alternative means of ensuring water quality, such as implementing a flushing program, filtering the incoming water, or installing a treatment devices for on-site disinfection of the water supply. Implementing on-site disinfection may change the status of the MTF to a water provider, requiring them to meet all of the applicable water monitoring and reporting requirements. To avoid this, the MTF can consider installing a chlorine dosing point to accommodate a “one-off” disinfection procedure in the event that *Legionella* is not controlled by other means.

9.4 Distribution System Maintenance

Routine maintenance is also a vital control measure for water systems. In addition to routine maintenance procedures, the MTF may need to implement some one-time fixes such as insulating hot or cold water pipes or eliminating dead legs. If it is not possible to eliminate dead legs, cap or plug the pipes as close to the supply line as possible.

It is not feasible to monitor water stagnation via immediate feedback (e.g., online monitoring); stagnation can be identified by reviewing room occupancy records and use of fixtures. Routine flushing to prevent stagnation should occur at all plumbing fixtures not used in more than a week, water storage devices, and in long runs of plumbing pipework without outlets (i.e., dead ends). Routine flushing can accompany routine temperature checks and disinfectant residual monitoring. When conducting flushing operations, take measures to avoid patient exposure to aerosols. Flush the water system if the water smells or is discolored, which are indicators of stagnation. Flush affected outlets until the water runs clear and there is no longer an odor.

Clean water systems components on a regular basis, including faucets and showerheads, aerators, water storage tanks, ice machines, filters, water softeners, TMVs, water hammer arrestors, and backflow prevention devices. Maintain these components in accordance with manufacturer’s specifications.

Occasionally there may be situations within a water system that could create hazardous conditions such as system start up/shut down; regularly scheduled maintenance; renovations,

construction, or installation of new equipment; equipment failure; prolong periods of disuse; or water main breaks/service interruptions. The MTF should have contingency plans in the event one of the scenarios described above occurs. If one of these scenarios occurs, implement appropriate corrective actions and increase the amount and frequency of monitoring to ensure the safety of the water supply.

9.5 Ice Machines and Medical Equipment

Ice machines, chilled water dispensing machines, and certain pieces of biomedical equipment are potentially hazardous with respect to *Legionella* growth. The MTF should identify these devices as control points and should have control measures in place to minimize risk. Regular cleaning and disinfection procedures are a common control measure.

The chiller compressors in ice and water dispensing machines generate heat, providing suitable temperatures for growth in the incoming cold water lines. Also, these machines typically contain a carbon filter, which removes the disinfectant residual and facilitates *Legionella* growth. Do not provide ice or water from these machines to high risk populations, due to the risk of aspiration of *Legionella* contaminated water. As an alternative, use boiled or micro-filtered (i.e., non-carbon, 0.2 micron pore size filter) tap water and freeze/chill in conventional-style fridges or freezers for these patients. The MTF should service these machines according to manufacturer's instructions and use a non-carbon filter when possible.

Several pieces of biomedical equipment (e.g., dialysis and heart-lung machines, automated endoscope re-processors) use water for specific processes (including re-processing) and procedures. These pieces of equipment may rely on regular, deionized, or reverse osmosis water. Consider these pieces of equipment when identifying control points within the facility. Control measures should ensure that there is no standing water in the equipment that will allow for the growth of *Legionella*.

10. CORRECTIVE ACTIONS

Confer with the facility to identify corrective actions to implement if control measures fall outside of their control limits. For example, if an operational monitoring result shows the hot water storage tank temperature is below the set control limit, the specified corrective action (e.g., increasing temperature setting, repairing gauge) would be set in motion to address the problem. All corrective actions should have written procedures that identify the person responsible for implementing the action and the response time. After implementing a corrective action, consider increasing monitoring activities to ensure the corrective action is effective. Additionally, following a corrective action, attempt to assess the root cause for why the controls were not within the established limits and determine if the existing control measures are adequate or if they needed to be adjusted or added upon and amend the WMP as necessary.

In some circumstances, remediation may be a necessary corrective action. Appendix D contains information regarding the two most common remediation techniques: shock hyperchlorination and thermal disinfection. Another form of remediation is the use of POU filters. Using POUs in high-risk patient settings can eliminate *Legionella* and other pathogenic bacteria found in water.

The filters attach to individual faucets and showerheads and are useful for fixtures used by high-risk patients. They are easy to install and are preferable to providing bottled water and/or restricting patients' showers. The filters must be capable of removing microorganisms and certified against either ANSI Standard 53 (Drinking Water Treatment Units – Health Effects) or Standard 58 (Reverse Osmosis Drinking Water Treatment Systems) for removal of microbial contaminants (ANSI 2019; ANSI 2021). Lists of certified POU devices are available from Underwriters Laboratories (www.ul.com), NSF International (www.nsf.org/certified/dwtu) and the Water Quality Association (www.wqa.org). A study published in 2005 found that POU filters were able to completely eliminate *Legionella* and *Mycobacterium* from hot water samples (Sheffer et. al. 2005). POU filters require maintenance and periodic replacement in accordance with manufacturer's specification or there may be increased concentrations of bacteria, membrane fouling, and potential exposure to pathogens as biofilm eventually sloughs off.

11. VERIFICATION AND VALIDATION

Identify validation and verification procedures for the MTF. In simplest terms, verification is defined as "are we doing what we said we would do?" and validation is defined as "is our program actually working?"

11.1 Verification Monitoring

The purpose of verification is to ensure the WMP is being implemented as designed. Operational monitoring, procedures, and tests are means to conduct verification monitoring. For example, if the WMP specifies that personnel will check water temperature weekly and record results, did staff do so? If the temperatures were outside of prescribed control limits, did staff implement appropriate corrective actions? Staff will administer verification procedures, but they should not verify the systems for which they are responsible. Verification monitoring should be ongoing and performed quarterly, at a minimum.

As part of the verification process the WMPT should review sampling results to determine trends, changes in system performance, or emerging problems.

11.2 Validation Monitoring

Validation testing for *Legionella* shows if control measures are successful and the WMP is effective. Routine environmental sampling for *Legionella* and active clinical surveillance are two common validation techniques. There are two potential applications of *Legionella* monitoring – routine monitoring for validation purposes and detecting an imminent threat of a legionellosis outbreak.

Validation monitoring generally occurs less frequently than verification monitoring. The WMPT must create a validation monitoring plan that will include the parameters to monitor, monitoring locations and frequency, and recordkeeping requirements. When collecting validation samples, be sure to measure the typical field parameters (i.e., disinfectant residual, pH, temperature) at the same time. This information can provide context in the event of elevated HPC results or *Legionella* detections. All validation monitoring results that are outside quality standards or

critical limits and confirmed cases of legionellosis require action (e.g., remediation and/or disinfection).

11.2.1 Routine Environmental Sampling

Routine environmental sampling for *Legionella* is one means of validating a WMP. A facility may want to consider environmental sampling for *Legionella* if the water system has difficulty meeting control limits, a history of Legionnaires' disease associated with the water system, or if a healthcare facility provides inpatient services to those at increased risk for Legionnaires' disease. The WMP Team should determine the following before implementing routine environmental sampling:

- Frequency of sampling.
- Type of *Legionella* analysis (see paragraph 11.3.3).
- Species of *Legionella* that will be tested (see paragraph11.3.3).
- Control limits that will trigger corrective actions (see paragraph 11.3.4).

Routine environmental sampling for *Legionella* should not be used as a control measure for several reasons. There is no proven correlation between culture results and human health risk and the number of *Legionella*e necessary to cause an outbreak is unknown, so the culture results do not have significant meaning. In addition, control measures should have immediate or quick results, as there is a significant lag in receiving results from cultured samples.

The MTF may be monitoring heterotrophic bacteria within the building's water system. Although HPC do not indicate the presence of *Legionella* and are not an indicator of health risk, they can show where microbial regrowth is occurring within an MTF's distribution system. HPC count greater than 500 colony-forming units (CFU)/mL are cause for concern and require implementation of appropriate corrective actions.

11.2.1 Active Clinical Surveillance

Active clinical surveillance is a second option for validating the effectiveness of a WMP. If *Legionella* infections are present, this may indicate there is a problem with the facility's water quality. To provide active clinical surveillance, healthcare facility staff proactively and systematically identify patients with healthcare-associated pneumonia and ensure that clinicians perform *Legionella*-specific testing. A certified infection preventionist (or other qualified individual) should be the one to conduct active clinical surveillance. Options for identifying these patients include:

- Daily review of chest radiographs and CT scans ordered to diagnose pneumonia.
- Daily review of new pneumonia diagnoses occurring in intensive care unit patients.
- Daily review of laboratory testing ordered to diagnose pneumonia.

In the event that there is more than one *confirmed* case of nosocomial Legionnaires' disease (patient spent 10 days prior to onset of Legionnaires' disease in the MTF), or more than two

possible cases of nosocomial Legionnaires' disease identified, the MTF must conduct a full investigation. The CDC has resources online to assist with investigations and sampling (https://www.cdc.gov/Legionella/health-depts/environmental-inv-resources.html). The sampling associated with an outbreak will differ from routine environmental monitoring.

11.3 *Legionella* Sampling

11.3.1 Sample Selection, Collection, and Transport

Routine environmental sampling plans for *Legionella* testing should consider the entire building water system and should include central distribution points, areas identified as having low-flow conditions, and points of use close and far from where the water enters the building and/or leaves the onsite storage tank. Obtain samples from every floor/wing within the building. The total number of samples and frequency of sampling will depend on variables such as the water system complexity, the level of risk identified within the facility, and the number of high risk patients within the facility. At a minimum, sampling should occur annually, though in practice many facilities sample quarterly. The WMPT must define appropriate limits/action levels and determine how they will interpret and use *Legionella* test results. It is important to realize that *Legionella* testing results do not provide a measure of health risk.

11.3.2 Sample Technique

Prior to collecting *Legionella* samples, consult with the laboratory regarding sample collection and transportation requirements and recommendations. Typically, personnel will collect a water sample between 250 mL to 1 L, add sodium thiosulfate to the sample to deactivate any disinfectant residual, and place the samples in insulated coolers at ambient room temperature for transport and delivery to the laboratory. Be sure to follow the proper collection procedures, depending upon whether the facility is collecting first draw samples or representative samples. First draw samples will typically have little to no residual disinfectant and may contain higher *Legionella* concentrations. Representative samples require a period of flushing prior to collecting the water sample. Regardless of sample type, properly label all samples and complete the chain of custody form for tracking purposes. Use caution when sampling hot water to avoid creating aerosols and to prevent scalding. When collecting *Legionella* samples, be sure to measure the typical field parameters (i.e., disinfectant residual, pH, temperature) at the same time. This information can provide context in the event of *Legionella* detections.

11.3.3 *Legionella* Test Methods

There are two primary methods used to test water for *Legionella*: culture-based analysis and polymerase chain reaction (PCR) testing. The facility needs to be aware on the benefits and drawbacks to each method before choosing. Historically culture-based analysis was the "gold standard" for *Legionella* sampling and the CDC still recommends this method for outbreak investigations since it is capable of detecting particular species; however, PCR testing is gaining popularity for evaluating environmental samples.

Culture-based analysis detects all viable *Legionella* and can differentiate between *Legionella* species. Results from culture tests are typically available 7 to 14 days after analysis and reported in CFU per volume. The reported detection limit is approximately 10 CFU/mL. This method of analysis is often preferred for evaluating growth trends. Since this method is subject to the skill and experience of the laboratory technicians, laboratories conducting culture-based analysis should be Environmental Legionella Isolation Techniques Evaluation (ELITE) certified. ELITE-certified laboratories should be proficient at culturing *Legionella* and should be able to determine if *Legionella pneumophilia* serogroup 1 is present in the samples. The CDC maintains a list of ELITE certified laboratories on its website: https://www.cdc.gov/elite/Public/MemberList.aspx. In addition to choosing a laboratory that is ELITE-certified, the laboratory should also be Environmental Laboratory Accreditation Program (ELAP) accredited. ELAP accreditation ensures laboratories generate environmental and public health data of known, consistent, and documented quality to meet stakeholder needs.

PCR is the most commonly-used nonculture method. It detects *Legionella*-specific DNA but does not differentiate between live and dead bacteria. This mean that *Legionella* cell parts may result in a positive PCR test even though there are no viable cells capable of causing infection. Other limitations include the inability to differentiate between *Legionella* species and false positive results due to cross-reactions with non-*Legionella* bacteria. A study published in 2020 shows that false positives occurred more than 45% of the time (n=11,185) (Fisher et al. 2020). Results can be available the same day the laboratory receives the sample. PCR test results are typically reported in genomic units (GU), which cannot be equated with CFUs.

Regardless of the test method used, test results can be useful in confirming that the facility's control measures are working as intended. Other applications for testing include establishing a baseline measurement for performance indicators, evaluating potential growth and transmission sources, and confirming success or failure of remediation TTs.

11.3.4 Control Limits

It is important to know that *Legionella* test results do not provide a measure of health risk and are not predictive of disease. Unlike temperature controls there are no firm guidelines to measure the risk of *Legionella* growth nor are there regulatory limits; however, various entities have developed guidelines for consideration. The facility must decide what approach and associated control limits are appropriate. There are three different approaches for establishing control limits for environmental monitoring of *Legionella*: concentration, change in concentration over time, or extent of detection. Table 7 shows guidelines published by ASHRAE and the CDC for interpreting test results using each of the three approaches (ASHRAE 2020; CDC 2021a). The guidelines shown in the table are conservative. Other entities use or recommend less conservative control limits. Specific examples follow:

- New York State regulations require hospitals and other healthcare facilities to monitor their potable water systems for culturable Legionella and implement control measures when 30% or more of the samples contain Legionella species (New York State Department of Health (NYSDOH) 2019).

- The American Industrial Hygiene Association (AIHA) asserts that <10 CFU/mL is acceptably low, 10 – 100 CFU/mL indicates possible amplification, and > 100 CFU/mL indicates amplification in potable water (AIHA 2015).
- A National Academies of Sciences, Engineering, and Medicine (NASEM) study found that a Legionella concentration greater than 50 CFU/mL was a breakpoint that differentiated Legionella concentrations in outbreaks compared with sporadic cases and offered that as an action level for immediate remediation (NASEM 2017).

Table 7. Approaches for Interpreting *Legionella* Results for Routine Monitoring

Approach	Uncontrolled	Poorly Controlled	Well Controlled
Concentration	≥10 CFU/mL in potable water[a]	1.0 – 9.9 CFU/mL in potable water	Detectable to 0/9 CFU/mL in potable water
Change in concentration over time	100-fold or greater increase in concentration	10-fold increase in concentration	Concentration steady (<10-fold increase)
Extent of detection	Detection in multiple locations AND a common source location[b] **OR** Detection across many locations within a water system	Detection in a common source location that serves multiple locations **OR** Detection in more than one locations within a water system	Detection in a few of many tested locations within a water system

Legend:
CFU/mL = colony-forming units per milliliter
Notes:
[a] For concentrations expressed in units other than CFU/mL, consult with the testing laboratory for appropriate interpretation of the results.
[b] Common source locations include water heaters, hot water returns, and storage tanks.

Regardless of the control limit used, If monitoring detects the presence of *Legionella* (or other waterborne pathogens) above control limits, appropriate corrective actions must be implemented, and the WMPT should update the control measure(s) as necessary.

12. DOCUMENTATION AND REVIEW

Documenting the various aspects of the WMP is important for continuity purposes and also if outside entities, such as TJC, need to review the program for accreditation purposes. The water management plan should provide the location of all program documents and should include the following, at a minimum:

- WMPT information (names, titles, contact info, roles on team).
- Building description (location, age, uses, occupants/visitors).
- Water system description and process flow diagrams.

- Control limits and control measures.
- Corrective actions.
- Validation and verification procedures.
- Contingency plan.

Having an outbreak and contingency response plan will assist the MTF if a *Legionella* outbreak occurs. An MTF must notify the local or State health department when a patient is diagnosed with Legionnaires' disease. If the health department believes an outbreak investigation is needed, they will coordinate with the MTF to complete the investigation. In most cases, the health department will provide oversight during the investigation process to ensure it adheres to public health recommendations. The outbreak and contingency response plan should include the following information:

- Contact information for the health department to report a case of Legionnaires' disease.
- Responsibilities for the WMPT, including identification of the individual who will report to the health department and identification of a spokesperson who issue statements within the organization and communicates with the public and/or installation Public Affairs Officer.
- Procedures to identify new and recent patients with healthcare associated pneumonia using culture of lower respiratory secretions and/or urinary antigen tests.
- Procedures to implement control measures restricting patient water exposure. Possible control measures may include options such as restricting showers and using sponge baths instead, providing patients sterile water for tooth brushing, drinking, and for flushing nasogastric tubing or installing 0.2 micron biological POU filters on any showerheads or sink/tub faucets intended for use.

The WMPT should review the WMP annually. However, circumstances may necessitate a review before that time. For example, if the facility experiences recurrent detections of Legionella, a Legionnaires' disease diagnosis, or a significant change in water infrastructure or water supply then the WMP requires review and possible modification.

APPENDIX A
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APPENDIX B
WATER MANAGEMENT PROGRAM
SITE ASSISTANCE VISIT CHECKLIST

PURPOSE

To provide APHC personnel with a checklist of items to investigate while conducting site assistance visits to help develop WMPs. This checklist is divided into sections that align with WMP guidance documents published by the CDC and ASHRAE. There are seven elements of a water management program: establishing a WMPT, describing the building water system, identifying areas where *Legionella* could grow and spread, establishing control methods, establishing corrective actions, program verification, and documentation. This checklist addresses all of these elements, with the exception of documentation.

GENERAL FACILITY CHARACTERISTICS

Take note of general background information for the facility.

- Building age/year of construction
- Number of stories
- Indicate type of facility: hospital, ambulatory care clinic, health clinic
- Prior outbreaks associated with water at the facility. If yes, indicate organism, date(s), and unit(s) affected.
- Is there a Water Management Program in place, yes or no. If yes, does it specifically address *Legionella,* yes or no.
- Is there a routine flushing program in place, yes or no.
- Bed capacity
- Do window in patients' room open, yes or no. If yes, is there a cooling tower visible?

ESTABLISH A WATER MANAGEMENT PROGRAM TEAM

A WMPT is necessary to implement an effective WMP. This team must be a cross-functional with members that have the knowledge, skills and abilities to develop and implement the WMP.

- The WMPT must have the capabilities to:
  - Understand and be familiar with the facility water system.
  - Identify control locations and control limits.
  - Identify and implement corrective actions.
  - Monitor and document the program performance.
  - Communicate regularly about the program.
  - Oversee the program.
  - Access resources to implement changes.

- At a minimum, the WMPT should include representation from the following:
  - Building manager/administrator.
  - Facilities management.
  - Facilities engineer.
  - Environmental protection or health specialist with drinking water experience.
  - Infection prevention.

- Other team members from the following areas may be included on the WMPT:
  - Water system representative.
  - Safety office.
  - Industrial hygienists.
  - Microbiologists.
  - Clinical departments.

- The WMPT must have a charter that identifies the team lead, defines the responsibilities for members, and states the frequency of meetings.

BUILDING WATER SYSTEM DESCRIPTION

The WMP will include a written description of each building's water system as well as a flow diagram.

- Include a written description of the building's water system.
  - Indicate the water supply: surface water, ground water, or other.
  - Indicate the inflow pipe size.
  - Describe the disinfection method for potable water and describe any supplemental disinfection processes.

- Describe the typical water quality characteristics of incoming water: residual, temperature, pH, and bacteriological quality.
- Identify the target disinfectant residual concentration and describe sampling processes (frequency, sampling locations) related to monitoring the disinfection residual concentration.
- Indicate if there is a fire suppression system and if it has backflow prevention devices.
- Describe the location, capacity, and temperature setting for hot water heaters. Indicate if there is a recirculating hot water loop and if the temperature of returning water is monitored.
- Describe the location and general characteristics of any high risk features, such as cooling towers; decorative fountains; hot tubs, whirlpools or spas; and centralized humidification systems. Note any disinfection procedures for these water system components.
- Describe location and size of onsite emergency water storage equipment, if applicable. Indicate the residence time for water storage units.
- List potable water uses (such as drinking, bathing and food preparation, including ice machines and cold water dispensers). Note the number and type of outlets within a facility (the location of every individual fixture is not required). Include eye washes and safety showers.
- Indicate the presence of TMVs at faucets/showerheads.
- List clinical water uses (may include dialysis, dental chairs and heater cooler perfusion devices). Describe water sources specific to patient care areas, clinical support areas, and components and devices that can expose patients to aerosolized water.

- Include a flow diagram for building's water system. If the MTF has more than one building, there should be a separate flow diagram for each building. Key components should include:
  - Incoming water sources.
  - On-site cold water storage.
  - Water heaters.
  - Hot water storage.
  - Backflow prevention devices.
  - Potable water usage (fixtures/clinical water use).
  - Thermostatic mixing valves (TMVs).
  - Water meters, stop valves.
  - Fire suppression system.
  - Cooling towers.
  - Return loops, especially for warm water systems.
  - Waste water disposal points that are not part of the main sewer.

HAZARD IDENTIFICATION

Identify areas where *Legionella* and other opportunistic pathogens may grow and spread. To aid in the hazard analysis APHC will sample water from a representative number of devices and will record the pH, temperature, and the disinfectant residual concentration to:

- Identify areas with no or inadequate residual disinfectant.
- Identify areas where temperatures can support microbial growth.
- Indicate the highest documented COLD water temperature (degrees and location).
- Indicate the lowest document HOT water temperature (degrees and location).

Identify and document the location of other potential hazards:

- Identify medical equipment that use water (e.g., dialysis machines, nebulizers).
- Identify storage tanks (describe water turnover rates, residence times).
- Identify areas of stagnation (dead legs, vacant rooms/units).
- Identify areas with hand-held showers, faucets with aerators/ flow restrictors.
- Identify locations of toilets and hoppers. Indicate if they have covers that can be closed when flushing and/or if they are in a separate room with a door that can be closed.
- Identify sinks:
    - Do sinks in patient care areas have aerators and/or flow restrictors?
    - Do sinks in patient care areas have drains offset from faucet flow stream?
    - Are there barriers (splash guards) between sinks and adjacent medication preparation areas?
    - If not, is medication prep and clean supply storage more than 3 feet from sinks?

RISK ASSESSMENT

- Identify patients at increased risk:
  - Burn units
  - Dialysis units
  - Intensive care unit
  - Oncology unit
  - Transplant unit

- Identify potential exposures to water:
  - Operating rooms (include oral surgery)
  - Respiratory therapy
  - Hydrotherapy
  - Patient care shower areas

- Determine risk by assessing and scoring patient susceptibility, patient exposure, and facility preparedness for each hazard. Use the CDC Water Infection Control Risk Analysis process.

IDENTIFY CONTROL MEASURES AND CONTROL LIMITS

For each water system component where there is significant risk, there must be control measures. Control measures should include the monitoring method, frequency, and associated corrective actions if the control limits are not within range.

- Identify control measures and control limits for control points. Examples of common control measures are:
  - Maintain hot water temperatures.
  - Maintain adequate disinfectant residual.
  - Monitor total organic carbon, pH, and/or heterotrophic plate count.
  - Maintain a flushing plan.

- Coordinate with the WMPT to determine method and frequency of monitoring and to assign responsibilities for monitoring and corrective actions.

IDENTIFY CORRECTIVE ACTIONS

Identify corrective actions to implement if control measures fall outside of their control limits. Assign responsibility for each corrective actions. Corrective actions can be one-time or recurring actions. Examples are:

- One-time actions:
  - Eliminate dead legs
  - Remove or repurpose high risk features (decorative fountains)
  - Change fixtures (remove aerators)
  - Install point of use filtration for highest risk patients

- Recurring actions:
  - Raise hot water temperatures
  - Flush taps/fixtures
  - Supplemental disinfection procedures
  - Thermal or chemical remediation

- Verify that the facility has correction action plans to address external hazardous such as water main breaks, low pressure events, boil water advisories, and/or hydrant flushing events.

VERIFICATION

APHC will recommend verification procedures to the WMPT. Verification procedures are intended to determine if the water management program is implemented as designed.

- Determine how frequently will monitoring records be reviewed.
- Identify who will review monitoring records.

VALIDATION

Identify the validation procedures that confirm the facility's water management program is effective.

- Routine environmental sampling for *Legionella*
- Clinical surveillance for infections due to *Legionella* and other opportunistic pathogens

APPENDIX C
WATER INFECTION CONTROL RISK ANALYSIS FOR HEALTHCARE SETTINGS

Water Infection Control Risk Assessment (WICRA) for Healthcare Settings

INTRODUCTION

- A water infection control risk assessment (WICRA) is a critical component of water management programs (WMP) in healthcare settings. WMP team members can use a WICRA to evaluate water sources, modes of transmission, patient susceptibility, patient exposure, and program preparedness.
- A WICRA may be conducted during the initial development of a WMP and updated over time. The frequency of subsequent assessments should be informed by and defined in the WMP.
- Performing a WICRA using this tool will generate numerical scores of perceived risk, which can assist in prioritizing WMP activities such as monitoring and mitigation efforts. Total risk scores are intended for internal prioritization and do not hold significance outside the context of each site-specific WMP. Typically, the risks with highest scores will be used for priority focus, though some with lower scores may be given special consideration (e.g., mitigation can be quickly and easily implemented). Specific risk management actions should be determined in accordance with WMP activities.
- This WICRA tool provides a completed example for a Burn Intensive Care Unit (BICU). This may be used as a reference when completing the fillable document, which is intended to be flexible for different WMP needs.

For more information about water-associated pathogens, see CDC's Reduce Risk from Water page.

INSTRUCTIONS

- **Step 1:** Identify the areas within your facility to assess using the WICRA tool. Consider grouping each page by location (e.g., unit/ward/wing/building). Use the Location column for additional information (e.g., space/room/area).
- **Step 2:** Identify potential water sources, considering the examples on the next page. Each row of the WICRA table may be used for a unique exposure, or set of like exposures, in a location (e.g., sink, hopper, shower, fountain, ice machine).
- **Step 3:** Categorize potential modes of transmission for water-associated pathogens, considering the categories on the next page. Record this in the Modes of Transmission column.
- **Step 4:** Classify the patient susceptibility for each water source, considering the categories on the next page (highest, high, moderate, low). Record a score in the Patient Susceptibility column (e.g., from 4 to 1).
- **Step 5:** Characterize patient exposure, considering the categories on the next page (high, moderate, low, none). Record a score in the Patient Exposure column (e.g., from 3 to 0).
- **Step 6:** Determine the current level of preparedness in your WMP, considering the categories on the next page (poor, fair, good). Record a score in the Current Preparedness column (e.g., from 3 to 1).
- **Step 7:** Multiply the numerical scores in each column to calculate a total risk score for each water source. Record notes on specific pathogens or other considerations in the Comments column.
- **Step 8**: Rank the total risk scores, by location and across the facility. Use this internal ranking to inform WMP activities.

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Centers for Disease Control and Prevention

WATER SOURCES

Patients are potentially exposed to water via the healthcare environment, equipment, or procedures. Water sources include, but are not limited to:

- Sinks
- Water source
- Sinks
- Drains
- Showers
- Toilets
- Hoppers
- Humidification devices
- Mechanical ventilators
- Endoscopes
- Heater cooler devices
- Ice machines
- Indoor decorative fountains
- Lactation equipment
- Enteral feeding
- Bathing procedures
- Oral care

MODES OF TRANSMISSION

When assessing risk of healthcare-associated infections caused by waterborne pathogens, consider the diverse modes of transmission, including:

- **Direct contact** *(e.g., bathing, showering)*
- **Ingestion of water** *(e.g., consumption of contaminated ice)*
- **Indirect contact** *(e.g., from an improperly reprocessed medical device)*
- **Inhalation of aerosols dispersed from water sources** *(e.g. faucets with aerators)*
- **Aspiration of contaminated water** *(e.g. use of tap water to flush enteral feedings)*

PATIENT SUSCEPTIBILITY

Patient populations with compromised immune status, comorbidities, and exposure to certain procedures are more vulnerable to infections caused by waterborne pathogens. Units/wards/wings can be classified according to those patients treated in these areas:

- **Highest** *(e.g., BMT, solid-organ transplant, hematology, medical oncology, burn unit, NICU)*
- **High** *(e.g., non-transplant ICUs, ORs)*
- **Moderate** *(e.g., general inpatient units)*
- **Low** *(e.g., waiting rooms, administrative office areas)*

PATIENT EXPOSURE

In order to characterize patient exposure to water sources, consider a categorization scheme that encompasses factors such as the frequency (how often), magnitude (how much), and duration (how long) of exposure:

- **High** *(e.g., high frequency, magnitude, and duration)*
- **Moderate** *(e.g., combination of high and low frequency, magnitude, and duration)*
- **Low** *(e.g., low frequency, magnitude, and duration)*
- **None** *(e.g., patients are not exposed to the water source)*

CURRENT PREPAREDNESS

Consider how your WMP addresses different water sources, as determined by factors such as policies and procedures already in place, relevant staff practice, and implemented mitigation strategies.

- **Poor** *(e.g., limited policies and procedures, staff practice, and mitigation strategies)*
- **Fair** *(e.g., some policies and procedures, staff practice, and mitigation strategies)*
- **Good** *(e.g., robust policies and procedures, staff practice, and mitigation strategies)*

Water Infection Control Risk Assessment (WICRA) for Healthcare Settings

Facility Name: Hospital A **Assessment Location:** Burn ICU

Performed By (names): Jane Smith and John Doe **Assessment Date:** 10/01/2020

WMP Team Role(s) *(check all that apply):*

- [x] Hospital Epidemiologist/Infection Preventionist
- [x] Facilities Manager/Engineer
- [ ] Environmental Services
- [ ] Compliance/Safety Officer
- [ ] Risk/Quality Management Staff
- [ ] Infectious Disease Clinician
- [ ] Consultant
- [ ] Equipment/Chemical Acquisition/Supplier
- [ ] Other *(please specify):*

Location	Water Source	Modes of Transmission	Patient Susceptibility Highest = 4 High = 3 Moderate = 2 Low = 1	Patient Exposure High = 3 Moderate = 2 Low = 1 None = 0	Current Preparedness Poor = 3 Fair = 2 Good = 1	Total Risk Score = Patient Susceptability *x* Patient Exposure *x* Preparedness	Comments
BICU Inpatient Rooms	Sink counter storage of patient care supplies	Indirect contact; splashing onto supplies	4	3	3	36	Install splash guards; QI for sink hygiene; and flushing
BICU Inpatient Rooms	Toilets without lid	Direct contact	4	3	2	24	Place lid on toilet if in patient room
BICU Soiled Utility	Hopper, no lid, behind closed door	Indirect contact	4	2	1	8	Automatic door closure; appropriate soiled equipment storage
BICU Medication Preparation Room	Sink with aerator, no splash guard	Aerosolization, and potential for splashing	4	2	3	24	Install splash guards; evaluate removing aerator
BICU Hydrotherapy Room	Debridement showers	Direct contact	4	3	1	12	Monthly EVS audits room indicating 95% adherence to policies
BICU Nurses Station	Sink closest to door	Indirect contact; HCW hands; devices	4	2	3	24	Install splash guards or move IV bags storage

APPENDIX D
REMEDIATION TECHNIQUES

D-1. PURPOSE

It may be necessary to perform emergency remediation of a facility's water system if there are known or suspected cases of Legionnaires' disease associated with the water system or identification of *Legionella*-positive water results during routine environmental surveillance. The two commonly used emergency remediation methods are shock hyperchlorination and thermal disinfection.

Based on recent guidance documents, shock chlorination is the preferred approach; however, it is necessary to consider the characteristics of the building and the capability of personnel when choosing an approach (ASHRAE 2020; CDC 2021). This Appendix provides a brief overview of each of the remediation methods.

D-2. SHOCK HYPERCHLORINATION

Shock hyperchlorination entails injecting elevated concentrations of chlorine into the facility's water system to achieve a level of at least 2 mg/L of free chlorine throughout the system with a contact time between 2 and 24 hours. Shock hyperchlorination can lead to increased corrosion of metal pipes or fixtures if applied incorrectly or too frequently. The efficacy of chlorine can be decreased by pH >7, with significant loss of effectiveness at pH >8. Also, use caution when exercising this method to avoid exposure to high disinfectant levels.

The list below summarizes recommendations for conducting shock hyperchlorination effectively and safely (ASHRAE 2000; CDC 2003; EPA 2016 and VA 2014):

- If possible, perform shock chlorination when the fewest building occupants are present.
- Post sings and warning notices at all fixtures to alert occupants of the potential chemical hazard.
- If possible, shut off and bypass water treatment equipment (e.g., water softeners, carbon filters).
- Add enough chlorine to achieve a free chlorine residual of at least 2mg/L throughout the system, which may require chlorination of the water heater or tank to levels between 20 and 50 mg/L. Maintain the water pH between 7.0 and 8.0.
- Flush each outlet until the odor of chlorine is detected.
- Allow the chlorine to remain in the system for a minimum of 2 hours (but not to exceed 24 hours).
- Flush the system until the residual chlorine concentration returns to its normal level (typically between 0.2 and 0.5 mg/L).

- Conduct *Legionella* sampling to determine if remediation efforts achieved short-term control. If *Legionella* persists, repeat the process but with a higher chlorine residual throughout the system (10 mg/L).
- Monitor the plumbing system for pipe damage.

D-3. THERMAL DISINFECTION

The thermal disinfection method entails increasing the water temperature in the facility's hot water heaters high enough to ensure hot water (70°C) is delivered to all fixtures and then flushing the system for an appropriate period of time (typically between 20 and 30 minutes). While this method does not requires special equipment or supplies, it is labor intensive and time consuming. It is important to note that this method is only effective when all distant outlets receive water that is high enough in temperature throughout the entire flushing process, which necessitates sufficient hot water heating capacity.

There are several drawbacks associated with thermal disinfection. Thermal disinfection is frequently ineffective and *Legionella* recolonization can occur quickly. Very high water temperatures can cause damage to plumbing system components such as electronic faucets, TMVs, and plastic pipes. Also, thermal disinfection will not disinfect downstream of thermostatic mixer valves so these devices require removal.

The list below summarizes recommendations for conducting thermal disinfection effectively and safely (ASHRAE 2020; CDC 2003; EPA 2016 and VA 2014):

- To minimize the risk of scalding, perform thermal disinfection and flushing when the fewest building occupants are present.
- Post sings and warning notices at all fixtures to alert occupants of the potential scalding hazard.
- Maintain water heater temperatures between 71 and 77°C (160 – 170°F) while progressively flushing each outlet in the system for up to 30 minutes at 65°C (149°F), ensuring that the distant outlets are flushed last.
- If flushing multiple outlets simultaneously, ensure that the water heater can maintain temperature and has adequate flow capacity.
- Perform flushing in an effort to reduce the risk of scalding and aerosolization of potable water in patient care areas.
- Following thermal disinfection, maintain hot water system temperatures > 60°C (140°F) in all hot water lines and maintain an adequate concentration of disinfectant residual (0.2 – 0.5 mg/L).
- After the water temperature has returned to normal, collect water samples from the distant outlets and test for *Legionella.* Repeat the sampling procedure approximately 2 weeks later to determine if remediation efforts achieved short-term control. If *Legionella* is still present, repeat the thermal disinfection procedure.

D-4. REFERENCES

ASHRAE. 2020. ASHRAE Guideline 12-2020, *Managing the Risk of Legionellosis Associated with Building Water Systems*.

CDC. 2003. Guidelines for Environmental Infection Control in Health-Care Facilities. Recommendations of CDC and the Healthcare Infection Control Practices Advisory Committee (HICPAC). Updated 2019. https://www.cdc.gov/infectioncontrol/pdf/guidelines/environmental-guidelines-P.pdf

CDC. 2021. Toolkit for Preventing *Legionella* in Common Sources of Exposure (*Legionella* Control Toolkit), version 1.1. January 2021.

EPA. 2016. Technologies for *Legionella* Control in Premise Plumbing Systems: Scientific Literature Review.

VA. 2021. VHA Directive 1061. Prevention of Healthcare-Associated *Legionella* Disease and Scald Injury from Potable Water Distribution Systems.

Glossary

Acronyms/Abbreviations

°
Degrees

AIHA
American Industrial Hygiene Association

ANSI
American National Standards Institute

APHC
U.S. Army Public Health Center

C
Celsius

CDC
Centers for Disease Control and Prevention

CFU
Colony Forming Units

CMS
Centers for Medicare and Medicaid

EC
Environment of Care

ELAP
Environmental Laboratory Accreditation Program

ELITE
Environmental Legionella Isolation Techniques Evaluation

EPA
Environmental Protection Agency

F
Fahrenheit

HPC
Heterotrophic Plate Count

L
liter

MCL
Maximum Contaminant Level

mL
milliliter

MTF
medical treatment facilities

PCR
Polymerase Chain Reaction

PH
Public Health

POU
point-of-use

ppm
parts per million

TG
Technical Guide

TJC
The Joint Commission

TMV
Thermostatic Mixing Valve

TT
Treatment Technique

VA
Department of Veterans Affairs

VHA
Veterans Health Administration

WICRA
Water Infection Control Risk Assessment

WHO
World Health Organization

WMP
Water Management Plan

WMPT
Water Management Program Team

Terms

Control limit
The maximum value, minimum value, or range of values that are acceptable for the established control measures.

Control measure
Ways to limit the growth and spread of *Legionella* in a building water system, such as heating, adding disinfectant, or cleaning.

Corrective action
Measures taken to reestablish control when monitoring or measurement values are outside control limits