Centers for Disease Control and Prevention

Legionella Environmental Assessment Form Marking Guide

HOW TO USE THIS GUIDE

The *Legionella* Environmental Assessment Form Marking Guide (Marking Guide) is supplemental to the *Legionella* Environmental Assessment Form (LEAF). The LEAF Marking Guide walks the user through the LEAF by providing instructions and additional considerations for the questions. Additional considerations for questions provide further context and discuss relevant risk factors for *Legionella* growth and spread that users may find helpful. Using the LEAF Marking Guide will improve users' understanding of a facility's water systems and aerosolizing devices and assist facility management with minimizing the risk of Legionnaires' disease. The LEAF and accompanying Marking Guide can be used along with epidemiologic information to determine whether to conduct *Legionella* environmental sampling and to inform a sampling plan. In addition, findings from the environmental assessment can be used to develop a water management program (WMP) by identifying areas at risk for *Legionella* growth or spread. The assessment should be performed on-site by an epidemiologist or an environmental health specialist with knowledge of the ecology of *Legionella*, building water systems, and water treatment. Public health professionals familiar with CDC resources such as the LEAF Marking Guide, *Legionella* Control Toolkit, and PreventLD have the appropriate knowledge to perform the environmental assessment and complete the LEAF.

For more information and detailed guidance on evaluating the key factors for *Legionella* growth in specific water systems and devices, refer to CDC's Toolkit for Controlling *Legionella* in Common Sources of Exposure. For additional training and information, please see CDC's resources for health departments.

LEGIONELLA ENVIRONMENTAL ASSESSMENT FORM

Please fill out the questions ***Person(s) completing the assessment*** and ***Person(s) interviewed during the assessment***. Several parts of this form may require communicating with a facility manager, facility engineer, facility consultant, industrial hygienist, infection preventionist, etc.

Environmental assessments may occur over multiple days. If this is true for your department, please provide the dates the assessment occurred.

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FACILITY CHARACTERISTICS

Purpose of Questions 1–19: The growth of *Legionella* is largely dependent on the building water system and fixture characteristics, which include type, size, complexity, and associated devices (*e.g.*, cooling tower). Persons at increased risk of Legionnaires' disease may be more likely to be present at certain facility types, such as healthcare or senior living settings. Providing this information gives public health officials an idea of the possible level of risk of *Legionella* growth and spread. Consult with the facility's maintenance or design professionals when needed.

1. **Is this a healthcare facility or facility with skilled nursing care (*e.g.*, hospital, long term care/rehab/skilled nursing facility, clinic), or an assisted or senior living facility?**
   - ► Select ***Yes*** or ***No***. If unsure, consult with the facility leader(s). If any health care is provided at the facility, then select ***Yes***.
   - ► If ***Yes*** is selected, skip to Question 2 and complete Appendix A.
   - ► If ***No*** is selected, select all facility types that are applicable to the facility you are investigating.
   - ► If the facility type is not listed, check ***Other*** and provide a brief description of the facility on the line provided.

2. **Total number of buildings on the premises and Total number of buildings being assessed:**
   - ► Write the total number of buildings on the premises on the line provided.
   - ► Write the total number of buildings being assessed on the premises on the line provided.

   Additional Considerations: Total buildings assessed will likely be based on case epidemiology (*i.e.*, water systems and devices that people with Legionnaires' disease were exposed to). Keep in mind that if a person spent the entire 14 days prior to illness onset (*i.e.*, the entire exposure period) in a single room, then at a minimum the areas under investigation should include the entire water distribution system that serves that room, as well as any devices using water. If other areas are subject to the same conditions (*e.g.*, no WMP, similar water quality parameters), then they should be considered for inclusion, as well.

3. **Total number of rooms that can be occupied overnight (*e.g.*, patient rooms, hotel rooms):**
   - ► Write the total number of rooms that can be occupied overnight (*e.g.*, patient rooms, hotel rooms) on the line provided. This can help provide an estimate of the facility size and the number of people who may have been exposed to *Legionella*.

4. **Does occupancy vary throughout the year?**
   - ► Select ***Yes*** if there is a noticeable occupancy trend in relation to the seasons. Select all seasons with the lowest occupancy.
   - ► Select ***No*** if there is no noticeable occupancy trend, and skip to Question 6.

   Additional Considerations: Reduced occupancy can lead to reduced water flow. Slowly moving or stagnant water increases water age, which provides opportunities for *Legionella* growth. Increased water age also contributes to disinfectant residual loss and water temperatures favorable for *Legionella*. Please note any interventions in Question 7 to address occupancy-related water stagnation.

5. **Are any occupant rooms taken out of service (*e.g.*, annually for low season, routinely for inventory, permanently for reuse as storage or administrative purposes)?**
   - ► Select ***Yes*** if rooms are closed during times of reduced occupancy or for other reasons describe which rooms are closed and where they are located.
   - ► Select ***No*** if all rooms always remain in service.

   Additional Considerations: Note location of rooms taken out of service or unoccupied, as those can result in areas of stagnation without appropriate intervention. The purpose and use of some occupant rooms may have changed

(*e.g.*, from a patient room to an office space). Determine if associated water piping in the rooms was capped off to prevent dead legs. Note the location of identified case rooms in relation to rooms taken out of service or unoccupied. Identify any interventions in Question 7 to address potential water stagnation.

6. Did the facility recently experience (*i.e.*, last 12 months) a period of prolonged, reduced occupancy, or a building closure?

- ► Select ***Yes*** or ***No***. If unsure, consult with a facility manager.
- ► If ***Yes*** is selected, describe which rooms or buildings the reduced occupancy or closure impacted and where they are located.

Additional Considerations: The amount of time required for stagnant water to increase the risk of *Legionella* growth varies by building water system. In general, as occupancy decreases, potential for water quality issues increases. There is not scientific consensus about how to define prolonged stagnation. Prolonged stagnation events commonly occur due to seasonality, construction activities, or other events. Water age is a key factor in *Legionella* growth and increases with stagnation. There are ways to control water age and potential *Legionella* growth, discussed in Question 7.

7. Describe any interventions taken as a result of building occupancy changes or occupant rooms taken out of service (*e.g.*, flushing, hyperchlorination):

- ► If interventions take place to address issues such as water stagnation or water quality issues (*e.g.*, *Legionella* growth) during periods of reduced occupancy or closures, describe them on the lines provided.

Additional Considerations: To control *Legionella* growth during times of water stagnation, facilities may introduce flushing or remediation with disinfectant. Flushing removes old water from the system and replaces it with fresh water containing disinfectant. Note that flushing uses the routine building water supply, and disinfectant residual will not exceed that which is provided by the supply water. Remediation (*e.g.*, hyperchlorination) is an action taken to reduce *Legionella* growth in response to control measures, such as routine *Legionella* test results, that persistently exceed control limits or to events that pose an immediate risk to control of building water systems (*e.g.*, building related closures, reduced occupancy). Note that remediation involves addition of disinfectant beyond the levels provided in the routine water supply. Thermal remediation, or "super heating," is not recommended for building water systems. The CDC *Legionella* Control Toolkit provides more details on control methods.

8. Average length of stay for occupants:

- ► Select one of the stay lengths listed.

Additional Considerations: Longer stays may correspond to increased risk of exposure to *Legionella*. For example, occupants may be more likely to shower repeatedly and use recreational water features in a tourist destination hotel with longer average stays than an overnight accommodation at a roadside hotel.

9. Does the facility have emergency water systems (*e.g.*, fire sprinklers, safety showers, eye wash stations)?

- ► Select ***Yes*** or ***No***. If unsure, consult with the facility manager or engineer.
- ► If ***Yes*** is selected, select whether the systems are regularly tested by a professional through methods like sprinkler head flow tests.
  - ▷ If ***Yes*** is selected, describe how frequent the emergency water systems are tested and provide the date of the last test.

Additional Considerations: Fire sprinklers typically have a backflow preventer to prevent stagnant water in the sprinkler system from flowing into the other potable water systems while other emergency water systems (*e.g.*, safety showers, eye wash stations) may not. If an emergency sprinkler system was not in use or tested during the exposure period for cases, and there is backflow prevention in place, it typically is not necessary to evaluate that system further. Consider safety showers and eye wash stations that are not routinely flushed as a potential stagnation point, especially if they are connected to the potable water system that serves other areas under investigation.

10. Are there any cooling towers or evaporative condensers on the facility premises?

- Select ***Yes*** or ***No***. If unsure, consult with the facility manager or engineer.
- If ***Yes*** is selected, also complete Appendix B.

Additional Considerations: For more information on cooling tower design, please refer to the CDC *Legionella* Control Toolkit.

11. Are there any hot tubs, whirlpool spas, or hydrotherapy spas on the facility premises?

- Select ***Yes*** or ***No***. If unsure, consult with the facility manager or engineer.
- If ***Yes*** is selected, also complete Appendix C.

Additional Considerations: Please consider jetted bathtubs as a potential exposure source, especially in healthcare settings. All these devices have the potential to generate aerosols when in use. Components that do not drain fully between uses provide an opportunity for biofilm development. If infrequently used, these devices may also present potential stagnation points.

12. Are there any decorative fountains, misters, or water features on the facility premises?

- Select ***Yes*** or ***No***. If unsure, consult with the facility manager or engineer.
- If ***Yes*** is selected, also complete Appendix D.

Additional Considerations: Decorative fountains should not be operated in areas intended for use by persons at increased risk of Legionnaires' disease, such as healthcare facilities. All decorative fountains produce aerosols. Disinfectant residual can be depleted quickly as the water aerosolizes, and it is not uncommon for decorative fountains to lack important control measures such as supplemental disinfectant.

13. Does the facility have centralized humidification (*e.g.*, on air-handling units) or any room humidifiers?

- Select ***Yes*** or ***No***. If unsure, consult with the facility manager or engineer.
- If ***Yes*** is selected, describe the location in terms of area served in addition to how they are operated on the lines provided.

Additional Considerations: Humidifiers are devices capable of producing aerosols containing *Legionella* and have been associated with outbreaks. Humidifiers and associated equipment should be properly maintained (*e.g.*, cleaning). Multiple types of humidifiers (*e.g.*, heated element and steam-type, portable, portable impeller) exist with different operation and maintenance requirements. Consult the CDC *Legionella* Control Toolkit or ASHRAE Guideline 12 for additional information.

14. Does the facility have ice machines?

- Select ***Yes*** or ***No***. If unsure, consult with the facility manager or engineer. Hotel maps may describe their locations as well.
- If ***Yes*** is selected, indicate the manufacturer, model, and any other pertinent information.

Additional Considerations: Ice machines should be maintained according to manufacturer recommendations. Ice machines have been identified as the source of exposure to *Legionella* in multiple outbreaks. Ice machines often have carbon filters, which eliminate any disinfectant residual in the water supply. It is common for the compressor to generate heat, resulting in temperatures favorable for *Legionella* growth in the water lines. At temperatures below 68°F, *Legionella* becomes dormant but remains present. Ice used for consumption can be aspirated (*i.e.*, when water or ice "goes down the wrong pipe"), especially in healthcare settings where patients are at increased risk of aspiration. In healthcare settings, ice may also be used for medical procedures or equipment and pose atypical routes of exposure to water.

15. Does the facility have a landscape irrigation or sprinkler system?

- Select ***Yes*** or ***No***. If unsure, consult with a facility manager or engineer.
- If ***Yes*** is selected, describe the location and operation by time of day and seasonality. Discuss how they are maintained, as well as other operational details.

Additional Considerations: Sprinkler systems and irrigation systems may generate aerosols. The systems may be less likely to have *Legionella* control measures in place, such as flushing to prevent stagnation or remediation following periods when not in use. In areas intended for use by persons at increased risk of Legionnaires' disease, such as healthcare facilities, operation should be timed to minimize exposure (*e.g.*, overnight when fewer patients are entering or exiting the building adjacent to sprinklers).

16. Has there been any recent (last 6–12 months) or ongoing major construction on or around the facility premises?

- Select ***Yes*** or ***No***. If unsure, consult with a facility manager or engineer.
- If ***Yes***, also complete Appendix E.

Additional Considerations: Construction may result in pressure drops, which can dislodge biofilm containing *Legionella*. Pressure drops or broken pipes (*e.g.*, water main breaks) can result in intrusion of *Legionella* or sediment that provides conditions favorable for *Legionella* growth. In addition, construction may result in the closure of areas of the building water system, resulting in potential stagnation.

17. Has this facility been associated with a previous legionellosis cluster or outbreak?

- Select ***Yes*** or ***No***. If unsure, consult with a facility manager or health department.
- If ***Yes*** is selected, describe pertinent outbreak information such as number of cases, dates, likely or confirmed source of *Legionella* transmission, if identified, root cause(s), and any interventions (immediate and long-term) to prevent recurrence. Review the extent to which previously identified root causes of *Legionella* growth do or do not persist.

18. Does the facility have a water management program (WMP)?

- Select ***Yes*** or ***No***. If unsure, consult with a facility manager, engineer, or infection preventionist.
- If ***Yes*** is selected, answer whether the facility ever tests for *Legionella* in water samples.
  - If ***Yes*** is selected, obtain copies of the test results or summaries going back at least one year.
- If ***Yes*** is selected, describe the water management program and obtain a written copy of the program policy.

Additional Considerations: Obtaining a copy of the water management program (WMP) is critical to evaluate the effectiveness of the WMP as part of the investigation. WMPs are an industry standard and recommended by CDC for certain building and device types (see the CDC worksheet to identify which buildings and devices should have a WMP: Legionella: Developing a Water Management Program). The lack of a WMP in a facility where recommended is of concern. If the facility lacks a WMP, the information gathered through the environmental assessment may be the only available information about the building water system and potential *Legionella* risk.

If a WMP is available, it is important to review the WMP and ensure that it clearly identifies the areas at risk of *Legionella* growth and spread, states the control measures to prevent *Legionella* growth and spread, lists control limits corresponding to each control measure, and describes corrective actions to take when control limits are not met. The facility should have clear plans for WMP verification (ensuring that the activities are occurring as described in the WMP) and validation (ensuring that the WMP activities are effectively controlling *Legionella* growth). The facility should provide documentation for both verification (*e.g.*, completed checklists and water quality parameter measurements) and validation (*e.g.*, routine environmental sample results for *Legionella*).

If routine environmental sampling has been performed for *Legionella*, review the results, testing method, frequency, and responsible party. See the Routine Testing Module of the *Legionella* Control Toolkit for more information about test type and frequency. Additionally, see Figure 1 for interpretation of routine sampling results.

19. Describe each building that shares water systems (or air systems with centralized humidification), including the main facility.

- In the table provided, fill in all details available on building shared water systems and air systems with centralized humidification. Note that under the "Occupancy Rate" column, "High period" is defined as the time in which the occupancy rate is at its highest in the year. "Low period" is defined as the time in which the occupancy rate is at its lowest in the year.

Additional Considerations: This table is about gaining a better sense of the facility layout, construction history, and facility use to inform the environmental assessment. "Original Construction" indicates age of building piping. "Later Construction" indicates age of building piping and potential complexity of the building water system. "Stories or Levels" indicates complexity of the building water system and is often useful for determining environmental sampling locations. "Occupancy Rate" and "Daily Census" indicates potential for water stagnation and may be used to determine the number of persons potentially exposed to *Legionella*. "Use" indicates potential for people at increased risk for Legionnaires' disease to be exposed to *Legionella*.

Water Supply Source

20. What is the source of the water used by the facility?

- Select all water sources used by the facility. If the water source is not listed, select **Other** and provide a brief description.
- If **Public water system** is selected, provide the name of supplier, check disinfectant used, and whether the disinfectant has been changed within the past year. Consult with municipal water representative if needed.
- If **Private well** is selected, select the disinfectant used and whether the water is filtered on site.

Additional Considerations:

Public water system: Selecting **Other** as the public water system disinfectant is unlikely. Chlorine and monochloramine are the primary disinfectants used throughout the United States. Use the free chlorine test method to measure available chlorine and the total chlorine test method to measure monochloramine.

Changes to municipal water treatment can change the ecology of the public water system. Public water systems that use monochloramine often conduct an annual "chlorine burn" where they temporarily switch to chlorine to reduce nitrification within the public water system. A "chlorine burn" can potentially impact building water quality and result in conditions favorable for *Legionella* growth. Please note the timing of any "chlorine burn" as it relates to case epidemiology (*i.e.*, water systems and devices to which patients were exposed).

Private well: Typically, private wells are not treated with a disinfectant such as chlorine or monochloramine; however, private wells often have filtration or other water quality treatment devices on site (*e.g.*, to reduce sulfur and hardness). Water softener regenerative media and pressure tanks can be a potential reservoir for *Legionella* growth. Additionally, water softeners and filtration can deplete disinfectant.

Other: "Other" sources might include Non-Transient Non-Community Water Systems and Transient Non-Community Water Systems. Per the EPA:

- **Non-Transient Non-Community Water System (NTNCWS):** A public water system that regularly supplies water to at least 25 of the same people at least six months per year. Some examples are schools, factories, office buildings, and hospitals that have their own water systems.
- **Transient Non-Community Water System (TNCWS):** A public water system that provides water in a place such as a gas station or campground where people do not remain for long periods.

21. Have there been any pressure drops, boil water advisories, or water disruptions (*e.g.*, water main break) to the facility in the past 6 months (whether in the public water system before the point of entry and/or on facility property)?

- Select ***Yes*** or ***No***. If unsure, consult with the facility manager, engineer, or municipal water representative.
- Is ***Yes*** is selected, describe the incident and which building(s) or part of building(s) were affected.

Additional Considerations: Changes in water pressure and water main breaks may dislodge biofilm containing *Legionella*, increase sediment that promotes *Legionella* growth, or result in intrusion of *Legionella* into the building water supply.

22. Does the facility monitor incoming water parameters (*e.g.*, residual disinfectant, temperature, pH)?

- Select ***Yes*** or ***No***. If unsure, consult with the facility manager or engineer.
- If ***Yes*** is selected, obtain copies of the logs and describe the ranges for disinfectant residual, temperature, and pH entering the facility.

Additional Considerations: Monitoring incoming water quality is a critical component of a building water management program. It allows facility managers to identify incoming water quality trends over time and make appropriate adjustments to the WMP. Historical readings are relevant when comparing to conditions observed during the environmental assessment. Review values across seasons if possible, as water quality parameters may vary according to ambient temperatures and any routine changes in water treatment (*e.g.*, annual "chlorine burns" described above in Question 20). If there is a clear time frame for potential exposures associated with cases, review water quality parameters for that time (*e.g.*, if there were multiple cases in the first week of December, review water quality parameter values for the month of November to see if changes were made preceding the cases).

Premise Plumbing System

23. Are cisterns and/or water storage holding tanks used to store potable water before it's heated?

- Select ***Yes*** or ***No***. If unsure, consult with a facility manager or engineer.

Additional Considerations: Water storage tanks holding potable water can increase water age, resulting in a decrease in disinfectant. Additionally, improperly insulated tanks or cisterns exposed to sunlight or heat can increase water temperature into the favorable range for *Legionella* growth (77–113°F, 25–45°C). Storage tanks and cisterns can experience irregular flow due to the lack of complete water mixing within the tank or cistern. Recirculation pumps may be installed inside storage tanks and cisterns to ensure proper water mixing and ultimately reduce water aging and avoid temperature stratification.

24. Are water softeners used on incoming water?

- Select ***Yes*** or ***No***. If unsure, consult with a facility manager or engineer.
- If ***Yes*** is selected, briefly describe whether they are installed on the hot, cold, or both water systems on the line provided.

Additional Considerations: Water softeners can deplete disinfectant residual. Try to measure disinfectant residual prior to the water softener and just after the water softener to identify any impact on disinfectant residual.

25. Are water filters used?

- Select ***Yes*** or ***No***. If unsure, consult with a facility manager or engineer.
- Is ***Yes*** is selected, describe where the filters on the water system are installed. In addition, describe the filter type and manufacturer/model.

Additional Considerations: Some filters can deplete disinfectant (*e.g.*, carbon filtration) and are potential reservoirs for microbial growth. It's important to note the location of these filters because a centrally located water filter may affect the entire building's water quality. For example, carbon filters located near the building's water point of entry may result in water without a

detectable disinfectant residual throughout the building, creating conditions favorable for *Legionella* growth. Point-of-use filters used to filter for *Legionella* (0.2 micron or less) typically do not impact disinfectant levels, although they may result in reduced water flow and increased water age. Follow manufacturer recommendations on how often filters should be replaced and review documentation to ensure manufacturer recommendations are being followed.

26. Is there a recirculation system (a system in which water flows continuously through the piping to ensure constant hot water to all endpoints) for the hot water?

- Select ***Yes*** or ***No***. If unsure, consult with a facility manager or engineer.
- If ***Yes*** is selected, describe where the recirculation system runs and what the delivery/return temperatures are, if measured.

Additional Considerations: A recirculation system decreases hot water stagnation and is a common *Legionella* risk reduction measure through temperature control. Buildings without hot water recirculation are at increased risk of *Legionella* growth if the water age of the hot water system is not controlled. It may be difficult to measure the temperature of the water prior to reheating at the water heater if there is not a sampling port. If there is not a sampling port, measure the water temperature at the most distal fixture on the recirculating system (the fixture furthest from the hot water heater along the distribution system). Note the difference between the water supply temperature just after being heated and the return temperature prior to reheating. Deviations between the two temperatures should be noted as they indicate water age and potential stagnation (*i.e.*, as hot water recirculates faster and more efficiently, the temperature differential should decrease). The *Legionella* Control Toolkit recommends that recirculating temperatures do not drop below 120˚F (49°C). If anti-scald regulations require that hot water be delivered at lower temperatures, other controls may be necessary, such as thermostatic mixing valves located adjacent to fixtures (see Question 27).

27. Are thermostatic mixing valves used?

- Select ***Yes*** or ***No***. If unsure, consult with a facility manager or engineer.
- If ***Yes*** is selected, describe where the valves are located on the line provided. In addition, describe the temperature set point(s).

Additional Considerations: Thermostatic mixing valves (*i.e.*, temperature valves) are used to blend hot and cold water to prevent scalding. There are two types of mixing valves: master mixing valves and point-of-use valves. Master mixing valves are centrally located after the water heater, and point-of-use mixing valves are located at the individual fixture level. Thermostatic mixing valves are recommended to be installed as close as possible to fixtures to prevent scalding while permitting circulating hot water temperatures above 120°F (49°C). Master mixing valves may result in temperatures throughout the building water system that are favorable for *Legionella* growth. If a facility is unable to maintain hot water temperatures throughout the system to prevent *Legionella* growth, then other control measures will be critical, such as maintaining presence of disinfectant residual in the hot water.

28. How is the hot water system configured to deliver hot water to each building?

- Fill in the table provided.

Additional Considerations:

Type of System (*e.g.,* instantaneous heater, water heater with a storage tank, solar heating): There are two general types of water heaters: 1) instantaneous and 2) water heater with a storage tank. Instantaneous water heaters do not store water, which is a *Legionella* growth control measure. Water heaters with a storage tank store water and maintain water at a set temperature until the water is used, which increases water age. Water heaters with storage tanks can have temperature stratification (*i.e.*, layers of varying water temperature) resulting in potential temperatures in the favorable range for *Legionella* growth (77–113°F, 25–45°C) despite having a higher temperature set point. Water heaters with storage tanks can also build up sediment and need to be routinely cleaned according to manufacturer recommendations. It is important to

determine whether the heater is gas-fired or electric. Electric heaters may be more prone to temperature stratification due to the heating element design, especially without a pump to recirculate water within the tank. Solar heating is uncommon for potable water and is noteworthy if present, as it has been associated with increased risk of *Legionella* growth.

Name of System (*e.g.*, Boiler #1, Loop #1): Establish a naming convention for individual hot water systems and water heaters. The naming convention allows for efficient communication and development and interpretation of sampling results.

Areas Served (*e.g.*, floor, rooms): Indicate the areas served by each of the systems.

Date of Installation: Installation date of water heater.

Total Capacity (gallons): Storage volume for water heater storage tank. Not applicable for instantaneous heater.

Usual Temperature Setting (˚F): Temperature set point for water heater.

Distal Outlet Temperature (˚F): Maximum temperature observed at distal outlets (*i.e.*, the outlets furthest from the water supply).

29. What is the maximum hot water temperature at the point of delivery permitted by state and local regulations?

- ► Write in the temperature in Fahrenheit or Celsius that the state and local regulations permit at the point of delivery.

Additional Considerations: Regulations to prevent scalding may result in water temperatures within the favorable range for *Legionella* growth (77–113°F, 25–45°C) or under the recommended circulating hot water minimum temperature of 120°F (49°C). Note whether thermostatic mixing valves are installed and, if so, their location (see Question 27). It is concerning if temperatures are in the favorable range for *Legionella* growth (77–113°F, 25–45°C) along the water distribution system. Installation of thermostatic mixing valves near fixtures may enable the facility to increase hot water temperatures along the distribution system and maintain compliance with anti-scald regulations at the fixture.

30. Are hot water temperatures ever measured by the facility at the points of use?

- ► Select ***Yes*** or ***No***. If unsure, consult with a facility manager or engineer.
- ► If ***Yes*** is selected, obtain copies of the temperature logs and write the lowest documented hot water temperature measured at any point within the facility and date it occurred in the space provided.

Additional Considerations: It is important to know whether the hot water temperatures fall within the favorable range for *Legionella* growth (77–113°F, 25–45°C) as water moves through the building water system. Note the difference between the water supply temperature just after being heated and the temperatures at fixtures. Deviations between the two temperatures should be noted as they indicate water age and potential stagnation (*i.e.*, as hot water moves faster and more efficiently, the temperature differential should decrease). Measuring temperatures at points of use is recommended for WMPs. If this is not occurring, facility managers may not be aware of potential risk of *Legionella* growth or building water system control issues, if present.

31. Are cold water temperatures ever measured by the facility at the points of use?

- ► Select ***Yes*** or ***No***.
- ► Is ***Yes*** is selected, obtain copies of the temperature logs. In addition, on the lines provided, record the highest documented cold water temperature measured at any point within the facility and date it occurred. Provide the typical cold water temperature measured within the facility in the summer in Fahrenheit or Celsius on the lines provided.

Additional Considerations: Measuring cold water temperatures at the point of use is recommended in WMPs. If this is not occurring, this may be indicative of a building water system control issue and a potential *Legionella* growth risk factor. Note whether the typical cold water temperature measured within the facility during summer falls within the favorable range for *Legionella* growth (77–113°F, 25–45°C).

32. Are the potable water disinfectant levels (*e.g.*, chlorine) ever measured by the facility at the points of use?

- Select ***Yes*** or ***No***.
- If ***Yes*** is selected, obtain copies of the logs. Describe how often they are measured in the line provided. Lastly, list the range of disinfectant residuals seen in the summer and winter on the lines provided.

Additional Considerations: Measuring potable water disinfectant levels at the points of use is recommended in water management programs. If this is not occurring, facility managers may not be aware of potential risk of *Legionella* growth or building water system control issues, if present. If disinfectant residual measurements are available, note if there is a difference between summer and winter disinfectant residuals. Note if the lower disinfectant level approaches zero or trace levels, which is a *Legionella* growth risk factor. Note the difference between the disinfectant residual value at the water supply (if measured) and at the fixtures. The difference between incoming and point-of-use values can indicate water age, sediment and biofilm, or warm temperatures that increase depletion of disinfectant residuals.

33. Does the facility have a supplemental disinfection system for long-term control of *Legionella* or other microorganisms?

- Select ***Yes*** or ***No***.
- If ***Yes*** is selected, obtain the standard operating procedures (SOPs) for routine use and maintenance as well as maintenance logs and records of disinfection levels, and complete the table provided. Review maintenance logs and records of disinfection levels for any changes preceding the exposure period for persons with Legionnaires' disease.

Additional Considerations:

Buildings with Supplemental Disinfection: Supplemental disinfection occurs when adding disinfectant to a water system on site; this may require permitting for potable water systems. Supplemental disinfection systems for potable water should always be automated and require a trained operator based on regulatory requirements. Ensure a trained operator is available during the environmental assessment.

Types of System (*e.g.*, chlorine, monochloramine, chlorine dioxide, copper-silver): Types of supplemental disinfection include chlorine, monochloramine, chlorine dioxide, and copper-silver ionization. More information on supplemental disinfection systems and other methods for *Legionella* control (*e.g.*, ultraviolet light, ozone) can be found at Technologies for *Legionella* Control in Premise Plumbing Systems: Scientific Literature Review (epa.gov).

Date Installed: Date of installation for supplemental disinfection system(s).

Serves Hot, Cold, or Both: Supplemental disinfection systems typically serve the hot water system. However, they may be installed on the cold water system and/or both systems depending on building water-specific needs.

Maintenance Personnel and Contact Information (in-house or consultant): Personnel familiar with the supplemental disinfection systems are necessary to provide further pertinent information needed in an investigation. Ensure a trained operator is available during the environmental assessment. Supplemental disinfection systems often have consultants who manage the systems. In-house expertise may exist for day-to-day activities.

34. Please describe any maintenance activities (either routine or emergency) carried out on the potable water system in the past year. Obtain records and SOPs, if available.

- Describe in the line provided the maintenance that occurred on the potable water system within the past year.
- If possible, obtain records and SOPs, and attach them to the LEAF.

Additional Considerations: Maintenance activities may result in water pressure changes and water main breaks that may dislodge biofilm containing *Legionella*, increase sediment (which promotes *Legionella* growth), or result in intrusion of *Legionella* into the building water supply. In addition, maintenance may result in the closure of areas of the building water system, resulting in potential stagnation. Maintenance may also alter the design configuration of the building water system, potentially impacting building water quality.

35. Measured Water System Parameters

► Fill in the table provided.

Additional Considerations: Use a thermometer capable of measuring water temperatures up to the maximum water heater temperature. Water heater temperatures may be up to or even greater than 150°F. Ensure that the thermometer is calibrated prior to beginning the environmental assessment.

A digital colorimeter intended for potable water use is recommended to measure disinfectant levels. Digital colorimeters provide accurate objective results, whereas visual test kits are subjective and limit data quality. Ensure necessary reagent is not expired and colorimeter is calibrated per manufacturer recommendations prior to beginning the environmental assessment. Do not use a pool test kit for potable water because it lacks the sensitivity required for the lower disinfectant levels found in potable water versus swimming pools. Ensure that you have distilled water to clean colorimeter sampling components between samples.

Building Name: Building names should be copied from those entered in the Question 19 table.

Name of System: The name of the system should be copied from those entered in the Question 19 table.

Part of System: Increase in distance from water heating source or building cold water entry (*e.g.*, distal fixture location furthest from the water supply) is associated with increased risk of *Legionella* growth. Increased *Legionella* growth risk is due to water age, disinfectant loss, and temperature falling into the favorable range for *Legionella* growth (77–113°F, 25–45°C).

Sampling Site: Provide a name or description of the sampling location that can be easily understood by other staff members and consistent across the document (*e.g.*, "3rd floor, women's bathroom, sink furthest from the door" rather than "1").

Free Chlorine (ppm): Parts per million (ppm) and milligrams per liter (mg/l) are interchangeable. Free chlorine reagent is used to indicate the disinfectant residual available for *Legionella* control when chlorine is the disinfectant. If chlorine is not the disinfectant for the potable water system, then indicate "N/A" for "not applicable."

Monochloramine or Other (ppm): Parts per million (ppm) and milligrams per liter (mg/l) are interchangeable. Total chlorine is used to indicate the disinfectant residual available for *Legionella* control when monochloramine is the disinfectant. Chlorine dioxide requires a specialized reagent to measure for the disinfectant residual available for *Legionella* control. Copper-silver ionization and chlorine dioxide disinfectant, in nearly all cases, will be installed as a supplemental disinfection system. Having the trained operator on site is recommended as they can assist in chlorine dioxide and copper-silver sampling. A commercial laboratory will be needed to analyze the copper-silver samples.

pH: Ensure the pH meter is calibrated prior to performing the environmental assessment. Certain disinfectants have an optimal pH range. More information can be found at Technologies for *Legionella* Control in Premise Plumbing Systems: Scientific Literature Review (epa.gov). For example, the "anti-microbial efficacy of chlorine declines as pH increases >7, with significant loss of efficacy at pH ≥8." In addition, monochloramine's "optimum pH range for formation of monochloramine is 7.5 to 9" (Technologies for *Legionella* Control in Premise Plumbing Systems).

Hot Temp Max, Cold Temp Min: Temperature can be a key factor in *Legionella* growth if in the favorable range for growth (77–113°F, 25–45°C). If warm water temperatures fall below 113°F (45°C) or if cold water temperatures rise above 77°F (25°C), there is potential for *Legionella* growth in the absence of other *Legionella* controls. Hot temp max should be measured after running hot water until it is as hot as it can get. This indicates the maximum circulating hot water temperature in the building in that particular fixture. Cold temp min should be measured after running the cold until it is as cold as it can get. This indicates the minimum cold water temperature in the building in that particular fixture.

Time to Reach Max Temp (min): Measuring the time that it takes for hot water to reach the maximum temperature is an indication of how quickly or efficiently hot water is traveling from the central heater to the point of use. Comparing the time difference across sampling sites in the building water system is helpful to identify potential building water system issues (*e.g.*, cross connection with cold potable water, stagnation, or plumbing design issue). For example, if showers on floors 1–5 take approximately 30 seconds to reach maximum temperature and showers on floors 6–7 take approximately 2 minutes to reach maximum temperature, despite being on the same hot water recirculating system, then further investigation is needed to understand what may be leading to that difference.

APPENDIX A. HEALTHCARE, ASSISTED LIVING, AND SENIOR LIVING FACILITIES

Healthcare, assisted living, and senior living facilities serve at-risk populations and can have large, complex building water systems. It is important to identify the type of facility (*e.g.*, outpatient clinic), population served (*e.g.*, solid organ or bone marrow transplant recipients), building water systems, and devices that use water during the environmental assessment. The environmental assessment and case epidemiology should inform recommendations to interrupt transmission of *Legionella* (*e.g.*, water restrictions, point-of-use filters).

A1. Type of facility

- Select all facilities that apply.
- If **Acute care hospital** is selected, select whether the facility has a solid organ or bone marrow transplant program.
- If the facility type is not listed, check either **Other outpatient clinic** or **Other facility** and provide a brief description.

A2. Number of beds:

- In the blank provided, write the total number of patient beds or units in the facility. If the facility does not house patients or residents overnight, indicate "N/A" for "not applicable."

Additional Considerations: The number of beds gives both an idea of the size of the facility and the number of persons potentially exposed. The latter can enable calculation of attack rate by dividing the number of cases by the number of persons exposed.

A3. Are ice machines used to provide ice for consumption or processing medical equipment?

- Select ***Yes*** or ***No***.
- If ***Yes*** is selected, list the manufacturer and model or catalog number in the line provided.

Additional Considerations: Ice machines should be maintained according to manufacturer recommendations. Ice machines have been identified as the source of exposure to *Legionella* in multiple outbreaks. Ice machines often have carbon filters, which eliminate any disinfectant residual in the supply water. It is common for the compressor to generate heat resulting in temperatures favorable for *Legionella* growth in the water lines. At temperatures below 68°F, *Legionella* becomes dormant but remains present. Ice used for consumption can be aspirated (*i.e.*, when water or ice "goes down the wrong pipe"), especially in settings where patients are at increased risk of aspiration. In healthcare settings, ice may also be used for medical procedures or equipment and pose atypical routes of exposure to water.

A4. Do patients or residents at this facility use respiratory therapy equipment (*e.g.*, CPAP, bronchoscopes)?

- Select ***Yes*** or ***No***.
- If ***Yes*** is selected, describe the source of water used in devices, source of water used to clean devices, and cleaning and drying procedures.

Additional Considerations: Respiratory therapy equipment that uses water containing *Legionella* can cause Legionnaires' disease. Always follow the manufacturer recommendations for operating and cleaning these devices, including the use of sterile water or ice as indicated. More information on cleaning devices can be found at Guideline for Disinfection and Sterilization in Healthcare Facilities, 2008 (cdc.gov).

A5. Has this facility experienced previous Legionnaires' disease cases that were "presumptively" or "possibly" facility-associated?

- Select ***Yes*** or ***No***.
- If ***Yes*** is selected, describe the number of cases, dates, etc.

Additional Considerations: "Presumptive" healthcare-associated disease is defined as a case in which the person spent greater than or equal to 10 days of continuous stay at a healthcare facility during the 14 days before onset of symptoms. "Possible" healthcare-associated disease is defined as a case in which the person spent a portion of the 14 days before date of symptom onset in one or more healthcare facilities, but does not meet the criteria for presumptive healthcare-associated Legionnaires' disease.

Compare current case epidemiology (*i.e.*, potential sources of exposure to water systems and aerosolizing devices for cases) to previous cases of Legionnaires' disease. This may indicate whether current cases are associated with the recurrence of a past issue based on overlapping exposures. Facilities that have experienced cases in the past may have information about prior root cause(s) that can aid in the environmental assessment. Additionally, facilities with a history of associated cases may have experience with response activities and carrying out corrective actions. Healthcare facilities should have a water management program that includes a protocol for responding to associated cases of Legionnaires' disease.

APPENDIX B. COOLING TOWERS AND EVAPORATIVE CONDENSERS

The environmental assessment should be performed on site by a person with knowledge of cooling tower mechanics, water treatment, and *Legionella* ecology. Public health professionals familiar with CDC resources such as the LEAF Marking Guide, Legionella Control Toolkit, and PreventLD have the appropriate knowledge to perform this assessment. Complete the form in as much detail as possible. Do not leave sections blank; if a question does not apply, write "N/A" in the space. If a question applies but cannot be answered, explain why. Where applicable, specify the units of measurement being used (*e.g.*, ppm). Remember to take pictures and attach them to the report to visually support the written findings.

Please fill out the LEAF Appendix B for each individual cooling tower associated with an investigation. List all cooling towers and evaporative condensers on the facility premises.

- Fill in the table provided.

Additional Considerations:

Cooling Tower ID (*e.g.*, CT1): Establish a naming convention for cooling towers. The naming convention allows for efficient communication and development and interpretation of sampling results.

Operational (Y/N): Determining if the cooling tower was operational during the case exposure period(s) can rule in or rule out a cooling tower as a possible exposure source. Cooling towers that operate intermittently due to cooling demand (*e.g.*, industrial or seasonal) may be at increased risk for *Legionella* growth if improperly maintained (CDC *Legionella* Control Toolkit).

Manufacturer and Model #: Manufacturer and model are useful information in understanding individual cooling tower design characteristics. There are many types of cooling tower configurations (*e.g.*, open- and closed-circuit cooling towers).

All cooling towers use the evaporation of water to remove heat and release it into the atmosphere. Cooling towers use circulating water to cool chillers, heat pumps, compressors, condensers, heat exchangers, and other process devices. Both open- and closed-circuit cooling towers require the same basic operation and maintenance protocols. Both types of cooling towers can release aerosolized water to the atmosphere and are at risk for potential *Legionella* growth and spread. If *Legionella* is present, the aerosolized water can spread the bacteria over long distances (typically within 0.5–1 miles, but greater distances are possible). Closed-circuit cooling towers have an additional closed loop that can keep the fluid used in the cooling processes from being exposed to the atmosphere. Closed-circuit cooling towers can operate in cool temperatures in a "dry" mode that does not use water or generate aerosols.

Date of Installation: The age of the cooling tower may impact system performance and risk of *Legionella* growth due to normal wear and tear over the lifespan of system components. For example, accumulation of scale and sediment may occur on cooling tower fill despite routine maintenance (see Questions B16 and B17).

Location of Device: Describe the location of the device (*e.g.*, on roof of medical building). Cooling tower drift (*i.e.*, aerosols blown from the cooling tower fan) can be pulled into nearby building air intakes and open windows. Cooling towers should be located at least 25 feet from building air intakes to reduce likelihood that the cooling tower's drift is not drawn into a ventilation system (CDC *Legionella* Control Toolkit). Cooling towers at ground level or those on roofs adjacent to outdoor areas intended for use (*e.g.*, rooftop patios, open-air parking garage) may be at greater risk for spread if they contain *Legionella*.

Number of Cells: Cooling towers can appear as one unit but have individual subunits (*e.g.*, cells) contained within the single structure. Each cell will have a fan and a water basin which may share water between the other cells. If there are multiple cells, it is possible that some operate less frequently and intermittently idle depending on cooling demand.

Operating times should be balanced among cooling towers (when multiple cooling towers exist) and among cells (when multiple cells exist) to prevent stagnation (CDC *Legionella* Control Toolkit). Understanding the number of cells and, if multiple, their operational relationship is important for identifying areas of potential *Legionella* growth and for developing a representative sampling plan.

Drift Eliminators Used (Y/N): Drift is aerosolized water from a cooling tower that can contain *Legionella*. Drift represents only a small percentage of the water circulating in the cooling tower. Drift eliminators are installed at the air discharge to minimize the escape of drift from the cooling tower and can have different designs (*e.g.*, wavy plastic or metal). Drift eliminators should not be confused with cooling tower fill, which can appear similar in design. Cooling tower fill is used to increase the surface area where water flows, which allows for more contact between the air and the water, to increase evaporation rates and improve cooling. Most cooling tower fill is made up of a plastic-like material. (See Question B18 regarding fill.) Water droplets can contain *Legionella* if the cooling tower is improperly maintained. The absence of drift eliminators increases the potential for cooling towers to disperse *Legionella* when present. High-efficiency drift eliminator designs are recommended and defined by ASHRAE Guideline 12.

Purpose of Cooling Towers (*e.g.*, heating/cooling or industrial process): Cooling towers are heat rejection devices that transfer heat to the atmosphere through evaporation. The most common uses include air conditioning and removing heat from commercial and industrial processes. Cooling towers can operate infrequently or year-round based on cooling need.

Note that individual room air-conditioning units do not use water to cool the air, so they are not a risk for *Legionella* growth.

General Cooling Tower Disinfection, Operation and Maintenance Characteristics

B1. Disinfectant used in cooling tower(s)?

- Select ***Yes*** or ***No***.

Additional Considerations: Disinfectant programs are recommended for cooling towers. Cooling towers without a disinfectant program are at significant risk of *Legionella* growth.

B2. What type of disinfectant is used?

- Select ***Yes*** or ***No*** if the disinfectant is oxidizing.

Additional Considerations: Cooling towers will alternate between oxidizing and non-oxidizing biocides as a best practice for managing bacterial growth. Chlorine- and bromine-containing compounds, including some with proprietary trade names, are typical oxidizing biocides. Examples of non-oxidizing biocides include glutaraldehyde, isothiazolone, and products with proprietary trade names. When in doubt, consult with a person familiar with the operation and maintenance of the cooling tower.

B3. List name(s) of disinfectant used (*e.g.*, chlorine, bromine):

- Name the disinfectant(s) used.

Additional Considerations: Make sure to indicate which are oxidizing or non-oxidizing if multiple disinfectants are used.

B4. Target range in which the disinfectant is regularly maintained:

- Give the target range.

Additional Considerations: The disinfectant range is based upon manufacturer recommendations including product label concentration and contact time (CDC *Legionella* Control Toolkit).

B5. Type of disinfectant dosing system.

- Select ***Yes*** or ***No*** if the disinfectant dosing system is hand-fed.
- Select ***Yes*** or ***No*** if the disinfectant dosing system is automatic.

Additional Considerations: Hand-feeding a cooling tower disinfectant is not recommended. Risk of *Legionella* growth and spread is higher for cooling towers with disinfectant that is hand-fed than for cooling towers with automated disinfectant application. Cooling tower disinfectant application should be automated, as should the disinfectant level monitoring (CDC *Legionella* Control Toolkit). Check that chemical feed pumps are working properly. Chemical feed pumps may have lights or display screens that will indicate if they are not working or are in an error status.

B6. Schedule of adding disinfectant (*e.g.*, daily, weekly, as needed):

- Describe the frequency in which disinfectant is added to the cooling tower(s) on the line provided.

Additional Considerations: Disinfection frequency varies depending on factors such as manufacturer recommendations, cooling tower operation, and cooling tower water management program performance. Note that if the cooling tower is operating with non-oxidizing biocide at the time of the assessment, there may be little to no oxidizing disinfectant. It is recommended that oxidizing disinfectants (*e.g.*, chlorine and bromine) maintain measurable residuals throughout each day when in use. For non-oxidizing disinfectants, maintain disinfectant residual based on product label concentration and contact time (CDC *Legionella* Control Toolkit).

B7. Are disinfectant levels monitored?

- Select ***Yes*** or ***No***.
- If ***Yes*** is selected, describe how often and by whom on the line provided. In addition, select ***Yes*** or ***No*** to indicate whether chemical metering pumps are properly maintained and in good condition.

Additional Considerations: Cooling tower disinfectant level monitoring should be automated, as should the disinfectant application (CDC *Legionella* Control Toolkit). If disinfectant level monitoring is not automated, risk of *Legionella* growth increases. Routine monitoring of disinfectant levels and other water parameters such as pH is a best practice and is an important component of cooling tower water management. The frequency of monitoring should be based on performance of the water management program or other performance indicators for control of *Legionella*. Monitoring frequency should be adjusted according to the stability of these performance indicators. For example, the monitoring frequency should be increased if there is a high degree of measurement variability (CDC *Legionella* Control Toolkit).

B8. Scale and/or corrosion inhibitors used?

- Select ***Yes*** or ***No***.
- If ***Yes*** is selected, describe the frequency at which scale and corrosion inhibitors are added to the cooling tower(s) on the line provided.

Additional Considerations: Scale and corrosion inhibitors are typically used in cooling towers. Alternatives exist, including careful control of pH or addition of polymeric dispersants. If scale and corrosion are not being managed in a cooling tower, the potential for *Legionella* growth increases. The frequency with which scale and corrosion inhibitors should be added is based on manufacturer recommendations and cooling tower operation and maintenance effectiveness. Monitor scale and corrosion inhibitor levels as indicated by water quality measurements (CDC *Legionella* Control Toolkit).

B9. Describe the scale/corrosion inhibitor dosing system.

- Select ***Yes*** or ***No*** if the scale/corrosion inhibitor dosing system is hand-fed.
- Select ***Yes*** or ***No*** if the dosing is done by automated chemical controllers.

Additional Considerations: Hand-feeding scale/corrosion inhibitor is not recommended and increases risk of *Legionella* growth. It is recommended to automate scale/corrosion inhibitor dosing and monitoring (CDC *Legionella* Control Toolkit).

B10. Is there an adequate supply (at least 30 days) of chemicals on hand?

- Select ***Yes*** or ***No***.

Additional Considerations: Having an adequate supply of chemicals on hand ensures there is enough available between maintenance intervals. Typical maintenance intervals can range from weekly to monthly with facilities using external consultants. Having enough chemicals on hand also provides time to order additional chemicals before existing chemicals run out.

B11. Is *Legionella* testing ever performed on the cooling tower?

- Select ***Yes*** or ***No***.
- If ***Yes*** is selected, describe the testing method, frequency, and responsible party on the line provided.
- If **Yes**, request copies of recent (e.g., 6–12 months) test results.

Additional Considerations: Past *Legionella* testing results, if available, are valuable during an environmental assessment. *Legionella* testing results are an indicator of past cooling tower performance (possibly during the Legionnaires' disease case exposure period).

If routine environmental sampling has been performed for *Legionella*, review the results, testing method, frequency, and responsible party. See the Routine Testing Module of the *Legionella* Control Toolkit for more information about test type and frequency. Additionally, see Figure 1 for interpretation of routine sampling results.

B12. Is the cooling tower turned off at any time?

- Select ***Yes*** or ***No***.
- If ***Yes*** is selected, describe the schedule on the line provided.

Additional Considerations: When turned off, water in cooling towers can become stagnant, lose disinfectant, and increase risk for *Legionella* growth.

B13. Are there start-up and shut-down procedures for the cooling tower?

- Select ***Yes*** or ***No***.
- If ***Yes*** is selected, describe the procedures on the lines provided.

Additional Considerations: Cooling towers may be shut down due to system maintenance, low cooling demand, redundant design (*e.g.*, multiple cooling towers), or seasonal operation (*e.g.*, cool temperatures in winter). It is important that procedures to reduce *Legionella* growth are performed during system shut-down or start-up. For example, during wet system standby (*i.e.*, when water remains in the system and the system is shut down for less than five days), the water treatment program should be maintained and water should be circulated three times per week through the open loop of a closed-circuit cooling tower and through an entire open-circuit cooling system (CDC *Legionella* Control Toolkit). Consult ASHRAE Guideline 12 for detailed dry shut-down and system start-up procedures.

Specific Cooling Tower Disinfection, Operation, and Maintenance Characteristics

- Fill in the table provided.

Additional Considerations:

Cooling Tower ID: Copy Cooling Tower ID from the table at the beginning of Appendix B.

Current Disinfectant Level: Report the current observed disinfectant residual level. The absence of disinfectant residual is a Legionella growth risk. Please refer to Questions B2–4, which identify type and target range. Use free chlorine to measure chlorine residual and total chlorine to measure bromine residual. It is typically impractical to measure non-oxidizing disinfectant levels on site. A cooling tower maintenance contractor may be of assistance in measuring disinfectant levels.

Current Water Temperature: Report the current observed water temperature. Note if temperatures are in the favorable range for *Legionella* growth (77–113°F, 25–45°C).

Current Water pH: Report the current observed water pH. As detailed in Question 35. Measured Water System Parameters, Additional Considerations, there are optimal pH ranges for each disinfectant. Ensure the pH levels are based on manufacturer recommendations.

B14. Were there any recent (*i.e.*, last 6 months) special (non-routine) treatments, maintenance, or repairs to the cooling tower(s)?

- Select ***Yes*** or ***No***.
- If ***Yes*** is selected, specify cooling tower ID(s), date, and actions taken.

Additional Considerations: Recent special or non-routine treatments may indicate a cooling tower system that was at increased risk of *Legionella* growth. Treatment decisions may have been based on *Legionella* test results or other water quality parameters. Understanding what led to implementation of non-routine treatments may better inform whether the system was at increased risk of *Legionella* growth. Maintenance or repairs may similarly indicate a cooling tower system that was at increased risk of *Legionella* growth if either the issue that prompted repair or the repair process resulted in conditions favorable for *Legionella* growth. It is important to understand what type of repairs and/or system components were impacted (e.g., disinfection feeder).

B15. When was an offline cleaning last performed on the cooling tower?

- Write the date that the cooling tower was last cleaned on the line provided.
- Describe the frequency of the cleanings and the cleaning process.
- At what frequency are the scheduled cleanings performed and what do they include?

Additional Considerations: It is recommended to perform an offline disinfection and cleaning at least annually (CDC *Legionella* Control Toolkit). Note that cleaning means taking the cooling tower offline and physically scrubbing and disinfecting surfaces.

Visual Inspection of Cooling Towers

Purpose of Questions B16–19: It is important to compare the visual inspection with the other elements in the cooling tower environmental assessment. The goal is to confirm that visual inspection findings are consistent with the WMP.

Some scale, sediment, debris, and biofilm may be encountered in a well-managed cooling tower. If a cooling tower is not cleaned at least yearly as recommended, the visual inspection is more likely to reveal increased amounts of scale, sediment, debris, and biofilm compared to one that is cleaned regularly. Other factors, such as whether scale or corrosion is managed through inhibitors or pH, will also have an impact on visual appearance. Take pictures of the cooling tower and any observed scale, sediment, and debris for documentation and additional interpretation.

B16. Is pitting or other evidence of corrosion visible on internal metal surfaces?

- Select ***Yes*** or ***No***.
- If ***Yes*** is selected, write the cooling tower ID(s) on the line provided.

Additional Considerations: Pitting and corrosion may be indicative of water quality issues that could impact *Legionella* growth. Water quality issues could include disinfectant and pH levels outside the manufacturer recommendations. The cooling tower should have a scale and corrosion management program (see Question B8). Sediment build-up can also lead to corrosion.

B17. How much scale, sediment, and debris are visible in the basin and on drift eliminators? Describe in the notes and include pictures in the report:

- Describe the amount of scale, sediment, and debris that is visible in the basin and drift eliminators. Include notes and pictures with the LEAF.

Additional Considerations: Note that in areas that are dusty (*e.g.*, desert or construction environments), sediment may build up more quickly in the basin, which may necessitate more frequent cleaning. The potential for significant scale, sediment, and debris build up increases with poor cooling tower operation and maintenance.

B18. Biofilm build-up observed on cooling tower fill?

- Select ***Yes*** or ***No***.
- If ***Yes*** is selected, write the cooling tower ID(s) on the line provided and any relevant notes.

Additional Considerations: Cooling tower fill is used to increase the surface area where water flows, which allows for more contact between the air and the water to increase evaporation rates and improve cooling. Most cooling tower fill is a plastic-like material. Visible biofilm build-up is of particular concern as *Legionella* can survive within biofilm. Some biofilm may be encountered in a well-managed cooling tower. It is important to take pictures of observed biofilm for documentation and additional interpretation. The potential for biofilm increases with poor cooling tower operation and maintenance.

B19. Is poor water clarity observed in cooling tower basin (*e.g.*, green color, extreme foam)?

- Select ***Yes*** or ***No***.
- If ***Yes*** is selected, write the cooling tower ID(s) on the line provided and any relevant notes.

Additional Considerations: Basin water should appear clear in a well-managed cooling tower. Some foam is acceptable. Green or discolored basin water are indicators of poor cooling tower operation and maintenance.

Record Keeping Review

B20. Are records available regarding cooling tower operation and maintenance?

- Select ***Yes*** or ***No***.
- If ***Yes*** is selected, write the cooling tower ID(s) on the line provided and any relevant notes.

Additional Considerations: Records indicate past cooling tower operation and maintenance. It is helpful to request cooling tower operation and maintenance records dating back 12 months prior and/or the previous cooling tower season, if seasonally operated. The records review supports the findings of the environmental assessment. For example, check for start-up and shut-down procedures, disinfectant operating levels, cooling tower equipment issues, and any operation and maintenance abnormalities. Pay particular attention to the time of case exposure period and several months prior, focusing on any cooling tower operation and maintenance issues or anomalies described above.

APPENDIX C. HOT TUBS, WHIRLPOOL SPAS, AND HYDROTHERAPY SPAS

C1. Who operates and maintains the hot tub (*e.g.*, name of on-site facilities management, name and affiliation of outside contractor)? Describe their role and frequency of maintenance:

► Provide the hot tub operator contact information and describe their role and frequency of maintenance on the line provided.

Additional Considerations: Public hot tubs are frequently maintained by an outside contractor. The contractor may visit periodically depending on contract requirements (this may range from weekly to monthly). In the meantime, daily oversight of the hot tub (*e.g.*, disinfectant level checks) may be performed by on-site staff. During the environmental assessment, look for gaps in routine operation and maintenance (*e.g.*, daily record keeping requirements). Not all hot tubs are subject to regulation, but they are all at risk for *Legionella* growth and spread, and all should have *Legionella* control measures in place.

C2. Describe each hot tub and how it is disinfected:

► Fill in the table provided. For any information deemed pertinent, place in the notes section.

Additional Considerations:

Hot Tub Descriptor/Location: Note location as it relates to case epidemiologic information. For example, did patients with Legionnaires' disease report using the hot tub or being around the hot tub; or is the hot tub located in an area (*i.e.*, near a lobby or meeting space) where people may have been exposed to hot tub aerosols without realizing it? If the hot tub is an enclosed area, observe whether there are vents that may direct hot tub aerosols to other areas where people could be exposed.

Indoor or outdoor: Indoor and outdoor hot tubs generate aerosols that can expose bathers and anyone spending time near a hot tub. Persons near indoor hot tubs may be at increased risk of aerosol exposure in areas with limited ventilation. Outdoor hot tubs may be exposed to the sun, which can further deplete disinfectant levels which increases the potential for *Legionella* growth.

Max. bather load: Exceeding the maximum bather load can impact hot tub water quality (*e.g.*, deplete disinfectant residual, alter pH), increasing the risk of *Legionella* growth.

Filter type: Each filter type has different operation and maintenance requirements (*e.g.*, backwashing, cleaning, replacement frequency). Filter types include granular media (*e.g.*, sand), precoat, and cartridge. Cartridge filters are difficult to clean and have been associated with *Legionella* growth in previous outbreaks (MAHC annex). A filter containing *Legionella* represents a central source of *Legionella* growth and spread for the hot tub. Please note, filter cartridges cannot be remediated. If the filter contains *Legionella*, then the filter or filter media should be replaced.

Date filter was last changed: Indicate the date the filter was last changed and confirm with records if possible.

Frequency of filter/filter media replacement: Manufacturer recommendations for filter/filter media replacement should be followed. During the environmental assessment, it is important to establish whether the facility has a filter replacement schedule. If they do not replace filters routinely or at the recommended interval, it is a potential *Legionella* growth risk. *Legionella* can grow in filter media, resulting in dispersal of *Legionella* throughout the hot tub (CDC *Legionella* Control Toolkit).

Date of last filter backwash: Sand and diatomaceous earth filters should be backwashed routinely per manufacturer recommendations. During the environmental assessment, it is important to establish whether the facility is backwashing hot tub filters. If they do not backwash filters routinely, it is a potential *Legionella* growth risk. *Legionella* can grow in filter media, resulting in dispersal of *Legionella* throughout the hot tub (CDC *Legionella* Control Toolkit).

Frequency of filter backwash: Filters need to be backwashed frequently per manufacturer recommendations to maintain hot tub water quality. See above paragraph.

Compensation tank present: A compensation tank is for water overflow during times of increased bather load when water in the hot tub is displaced into a temporary holding tank. A compensation tank ensures that appropriate water level depths are maintained in the hot tub. The compensation tank may represent a potential source of stagnant water or biofilm growth. The compensation tank may be inaccessible or hard to reach.

Type of disinfectant used (include chemical name, formulation, and amount used): Either bromine or chlorine can be used as a hot tub disinfectant. Cyanuric acid or stabilized chlorine products are not recommended for use in hot tubs according to the CDC Model Aquatic Health Code (MAHC).

Current measured disinfectant level (*e.g.*, free chlorine, bromine) (ppm): Report the current observed disinfectant residual level. Disinfectant residuals at levels below the recommended range pose a *Legionella* growth risk. Use the free chlorine test method to measure chlorine disinfectant residuals and the total chlorine test method to measure bromine disinfectant residuals. Free chlorine should be 3–10 ppm for chlorine, and total chlorine should be 4–8 ppm for bromine (CDC *Legionella* Control Toolkit). Refer to and follow state and local regulations for specific requirements, which may differ from CDC recommendations.

Current measured pH: Report the current observed water pH. The recommended pH level should be 7.2–7.8 to ensure disinfectant effectiveness (CDC *Legionella* Control Toolkit). Refer to and follow state and local regulations for specific requirements, which may differ from CDC recommendations.

Method used for adding disinfectant (*e.g.*, automatic feeder, by hand): Hand-feeding disinfectant is not recommended and increases *Legionella* growth risk. Disinfectant addition, as well as monitoring, should be automated (CDC *Legionella* Control Toolkit).

Method used for monitoring and maintaining disinfectant and pH levels (*e.g.*, automatic controllers): Disinfectant monitoring, as well as addition, should be automated (CDC *Legionella* Control Toolkit, MAHC).

Date last drained and scrubbed: Scrubbing can help remove sediment or biofilm build-up. Hot tubs should be vigorously scrubbed each time a tub is drained. Routinely draining and scrubbing a hot tub is an important *Legionella* risk reduction measure because biofilm and sediment promote *Legionella* growth (CDC *Legionella* Control Toolkit).

Water replacement frequency (*e.g.*, complete drain and refill): It is recommended to replace water in hot tubs using the following formula: Water replacement frequency in days = (spa volume in gallons/3)/average # users per day (CDC *Legionella* Control Toolkit, MAHC). Water replacement is an important tool for managing overall water quality in hot tubs.

Was there a recent disinfectant "shock" treatment? If yes, describe the reason and procedures. Provide SOP if available: Recent disinfectant "shock" treatment or hyperchlorination may indicate past water quality issues. A recent "shock" treatment may impact *Legionella* test results (*i.e.*, conditions post-shock may not represent normal operating conditions). The CDC *Legionella* Control Toolkit recommends removing hot tubs from service daily to carry out disinfection with a higher-than-normal disinfectant residual. For example, a free residual of 10 mg/L or 10 times the combined chlorine level, whichever is greater, for at least one to four hours is commonly used (CDC *Legionella* Control Toolkit).

Operating as designed and in good repair? If no, describe issues: If the hot tub is not operating as designed and is not in good repair, it may be an indication of potential *Legionella* growth risk.

APPENDIX D. OTHER WATER DEVICES

▶ Fill in the table provided.

Additional Considerations:

Descriptor/Location: Note location as it relates to case epidemiologic information. For example, did patients with Legionnaires' disease report being near the water device (*e.g.*, decorative fountains, water walls, recreational misters)? Note that all decorative fountains produce aerosols. Decorative fountains or other aerosol-generating devices (*e.g.*, misters, water walls) should not be placed in areas intended for use by persons at increased risk of Legionnaires' disease, such as in healthcare facilities (CDC *Legionella* Control Toolkit) .

Is the device equipped with a filter? Not all decorative fountains or other aerosol-generating devices are equipped with a filter. Filters should be maintained according to manufacturer recommendations. Filters should be considered as a potential reservoir of Legionella during the environmental assessment (e.g., sand or cartridge filters). Note that some filters can deplete disinfectant (e.g., carbon filtration), resulting in conditions favorable for Legionella growth downstream. Additionally, some filter media can promote biofilm accumulation and Legionella growth within the media.

Indoor or outdoor: Indoor and outdoor water devices can generate aerosols that can expose persons near the device. Outdoor water devices (*e.g.*, decorative fountains or recreational misters) may be exposed to the sun, which can further deplete disinfectant levels and increase water temperatures into the favorable range for *Legionella* growth (77–113°F, 25–45°C). When located in enclosed spaces, indoor fountains that contain *Legionella* increase the potential for exposure due to decreased opportunity for aerosol dispersal compared to outdoor devices.

Source of water: Water may come from a public water system, private well, or other source. The source water may or may not have disinfectant.

Operates continuously or intermittently: Devices that work intermittently may be prone to stagnation or disinfectant depletion and be at increased risk of *Legionella* growth. Devices that operate continuously may also deplete disinfectant residual without frequent water replacement or disinfectant addition (see "Type of disinfectant used" below).

Presence of a heat source: A heat source can warm the water into the favorable range for *Legionella* growth (77–113°F, 25–45°C). Common heat sources include lights and the sun. Look for lighting within decorative fountains and determine the bulb type if present. Incandescent bulbs, typically produce more heat than other bulb types, such as LED bulbs.

Observed water temperature: Report the current observed water temperature. Note if temperatures are in the favorable range for *Legionella* growth (77–113°F, 25–45°C).

Type of disinfectant used (include chemical name, formulation, and amount used):

Decorative fountains: Disinfectant feed and monitoring systems should be automated, if possible. For fountains using up to 25 gallons of water, treatment with 3–5 ppm free chlorine for at least 1 hour per day is recommended. For fountains using more than 25 gallons, treatment with 0.5 ppm free chlorine for at least 6 hours per day is recommended (CDC *Legionella* Control Toolkit).

Other Devices: Determine if the facility is using a disinfectant appropriate for the system and in accordance with manufacturer recommendations (CDC *Legionella* Control Toolkit).

Current measured disinfectant level (ppm): Report the current observed disinfectant level. Use the free chlorine method to measure chlorine disinfectant residual and the total chlorine method to measure bromine disinfectant residual. Absence of disinfectant residual is a *Legionella* growth risk.

Current measured pH: Report the current observed water pH. Ensure the pH meter is calibrated prior to performing the environmental assessment. Certain disinfectants have an optimal pH range. More information can be found at EPA's Technologies for *Legionella* Control in Premise Plumbing Systems: Scientific Literature Review. For example, the "anti-microbial efficacy of chlorine declines as pH increases >7, with significant loss of efficacy at pH ≥8." In addition, monochloramine's "optimum pH range for formation of monochloramine is 7.5 to 9" (Technologies for *Legionella* Control in Premise Plumbing Systems).

Is there a maintenance protocol: If yes, describe any type of maintenance being performed not otherwise captured in this section. Refer to the CDC *Legionella* Control Toolkit or ASHRAE Guideline 12 for more details.

Date last cleaned and/or flushed: Cleaning and/or flushing can help remove sediment or biofilm build-up. Routine cleaning and/or flushing water devices is an important *Legionella* risk reduction measure because biofilm and sediment promote *Legionella* growth. Refer to manufacturer recommendations for device cleaning and/or flushing. See Table 1: *Legionella* Control Measures for Decorative Fountains by Volume in U.S. Gallons in the CDC *Legionella* Control Toolkit for cleaning frequency.

Operating as designed and in good repair? If no, describe issues: If not operating as designed and not in good repair, it may be an indication of potential *Legionella* growth risk.

APPENDIX E. RECENT* OR ONGOING MAJOR CONSTRUCTION

**Previous 6–12 months*

E1. Describe in general terms the extent of the construction:

- ► Describe the extent and type of construction on the line provided.

Additional Considerations: Changes in water pressure and water main breaks may dislodge biofilm containing *Legionella*, increase sediment that promotes *Legionella* growth, or result in intrusion of *Legionella* into the building water supply. In addition, nearby construction may result in the closure of areas of the building water system, potentially resulting in stagnation. Note the type of construction. For example, new building construction, potable water construction, and jackhammering or pile-driving may result in conditions favorable for *Legionella* growth, while cosmetic updates to a nearby building are less likely to impact conditions for *Legionella* growth. Note the location of potable water construction as it relates to case epidemiology (*i.e.*, water systems and devices to which associated cases were exposed). For example, did the construction occur on the same hot water recirculating system to which cases were exposed?

E2. Was temporary water service provided to the new construction area (*i.e.*, separate meter)?

- ► Select ***Yes*** or ***No***.
- ► If ***Yes*** is selected, describe the temporary water service on the line provided.

Additional Considerations: If a temporary water service is provided, determine if it was separate from the existing potable water system. A temporary construction water service may be a stagnation risk. Look for any potential cross-connections with the existing potable water system.

E3. Has jackhammering or pile-driving been used during the construction process?

- ► Select ***Yes*** or ***No***.
- ► If ***Yes*** is selected, list dates and locations where jackhammering or pile-driving was used on the line provided.

Additional Considerations: Jackhammering or pile-driving nearby (or even across the street) can dislodge biofilm containing *Legionella* and/or increase sediment which promotes *Legionella* growth.

E4. Have there been disruptions or changes to the existing potable water system during the construction?

- ► Select ***Yes*** or ***No***.
- ► If ***Yes*** is selected, describe the disruptions or changes on the line provided.

Additional Considerations: Disruptions or changes can impact the building water quality. Disruptions can impact various rooms, floors, or wings where the water was shut off during the construction process. Changes can include altering the design of the existing potable water system such as the installation or removal of water heaters, recirculating system pumps, water storage tanks, and water fixtures. Look for changes or disruptions that can increase the risk of *Legionella* growth. For example, installation of a new water heater set to temperatures in the favorable range for *Legionella* growth (77–113°F, 25–45°C), or removal of a sink in a patient room converted to administrative space that creates a dead leg in the piping could increase risk of *Legionella* growth.

E5. Has the potable water changed in terms of taste, odor, or color during the construction process?

- ► Select ***Yes*** or ***No***.
- ► If ***Yes*** is selected, describe the potable water changes including when they started and ended on the line provided.

Additional Considerations: Changes in taste, odor, or color may be indicative of a water quality issue including sediment or biofilm being dislodged during the construction process.

E6. Is there a standard operating procedure (SOP) for shutting down, isolating, and refilling/flushing for water service areas that have been subjected to repair and/or construction interruptions?

- ► Select ***Yes*** or ***No***.
- ► If ***Yes*** is selected, briefly describe the steps used in the SOP on the line provided and include a copy with the LEAF, if possible.

Additional Considerations: Shutting down, isolating, and refilling/flushing are established construction practices and/or required by code. Increased water age may occur in new construction or renovated areas where building water systems are completed, filled with water, and are unused for prolonged periods before the building or floor is occupied. It is important to establish when water system filling/flushing occurred. Note filling/flushing timeframes that extend before two weeks to a month of building use or reoccupation as a potential *Legionella* growth risk.

E7. Was the potable water system flushed before occupying the new building space?

- ► Select ***Yes*** or ***No***.
- ► If ***Yes*** is selected, describe the length of time that passed between flushing and when the building was occupied on the line provided.

Additional Considerations: Note filling/flushing timeframes that occur two or more weeks prior to building use or reoccupation are a potential *Legionella* growth risk. See Question 6 for more information.

E8. Complete the table below:

- ► Fill in the table provided.

Additional Considerations:

New Building/Wing Name or Remodeled Area: Note as it relates to case epidemiology (*i.e.*, water systems and devices to which associated cases were exposed).

Date Construction Began: Note as it relates to case epidemiology.

Estimated Date of Completion: Date of completion is useful in determining when water systems or devices came online and potential for case exposure.

Date Water Service Began or Restarted: Date water service began or restarted is useful in determining when water systems or devices came online and the potential for case exposure.

Relationship to Existing Potable Water System: Determining if the water system is independent or an extension of the existing water system is important for focusing the environmental assessment as it relates to case epidemiology. For example, if the water system under construction is separate from the existing water system (*i.e.*, independent) and there is no known case exposure to the water system under construction, then a detailed investigation of that particular system is not necessary.

Stories and Square Feet Involved (# and sq ft): Understanding the scale of the construction assists in narrowing down potential exposures in the environmental assessment based upon case epidemiology. Additionally, the scale of construction and square feet involved also impact the potential amount of stagnant water.

Uses: Understanding the use of the building and water system under construction (*e.g.*, hotel guest rooms, dining, recreation, utilities, and for healthcare settings: inpatient, outpatient, both, intensive care, transplant) will be helpful in determining the degree of population susceptibility and vulnerability. Additionally, if an area was originally designed for one use but has since been repurposed, it's important to review how fixture types may have changed. For example, if sinks are removed from rooms to update them from patient care to administrative space, then removal of the fixtures could result in dead legs if not capped off at the supply pipe.

Date Occupants Began Occupying New or Remodeled Building: Note as it relates to case epidemiology and answers to Questions E6 and E7. Also review whether occupation may have been gradual in terms of overall occupancy (*e.g.*, periods of lower occupancy overall may have resulted in increased water age) or in terms of area occupied (*e.g.*, if occupants were introduced one floor at a time, then unused floors may have stagnant water if flushing is not implemented).

Floors Currently Occupied: Indicates where occupants (*e.g.*, patients, guests, residents) are located. Compare against relationship with existing water system and other questions in this section. The completed environmental assessment can be used to identify potential risk to occupants on the floors currently occupied and can inform immediate control measures such as installation of point-of-use filters or water restrictions. Note that unoccupied areas may result in stagnant water if flushing is not implemented.

GLOSSARY

Aerosolized water: Small droplets of water in the air (generally, 5 microns in diameter or less), which can contain *Legionella* or other bacteria and can be deeply inhaled into the lungs

Biocide: See disinfectant

Biofilm: Germs and the slime they secrete that stick to and grow on any continually moist surface; provides a stable growth surface and an environment with nutrients for many types of germs, including *Legionella*

Building water systems: Includes hot and cold water distribution systems and all devices that use water to which people can be exposed, such as hot tubs, decorative fountains, and cooling towers

Control: To manage conditions within the building according to a water management program or to maintain established criteria

Control limits: Maximum value, minimum value, or range of values acceptable for the control measures being monitored to reduce risk for *Legionella* growth and spread

Control measures: Actions that can be taken for building water systems to limit growth and spread of *Legionella*, such as heating, adding disinfectant, or cleaning; control measures enable maintenance of control limits

Cooling tower fill: The medium over which water runs to increase surface area and provide increased heat transfer, resulting in increased cooling efficiency

Corrective action: Actions taken to reestablish control when monitoring values or measurements are outside control limits

Dead legs: Piping subject to low or no flow because of design or decreased water use; for example, capped pipes or unused faucets

Disinfectant: Chemical or physical treatment to kill germs; for example, chlorine, monochloramine, chlorine dioxide, bromine compounds, copper-silver ionization, ultraviolet light, or ozone

Disinfectant residual: Amount of disinfectant available in water to kill bacteria

Drift: Water mist or small droplets carried by air, which may include aerosols

Drift eliminator: Device installed in cooling towers where air is discharged to minimize the escape of aerosolized water

Healthcare facility: Hospitals, long-term care facilities, clinics, or other settings where patients seek care, such as dental offices, pharmacies, or outpatient laboratories

***Legionella*:** Bacteria that can cause Legionnaires' disease

Legionnaires' disease: A serious type of pneumonia caused by *Legionella*

Non-potable water: Water not intended for people to drink or ingest, such as water for industrial processes, irrigation, or equipment like cooling towers

People at increased risk for Legionnaires' disease: Includes people 50 years or older, current or former smokers, people with a chronic lung disease (like emphysema), people with weakened immune systems or who take drugs that weaken the immune system, people with cancer, and people with underlying illnesses such as diabetes, kidney failure, or liver failure

Potable water: Hot or cold water intended for people to drink or ingest, such as drinking, bathing, food preparation, and dishwashing

Remediation: Response activities taken to reduce contamination in response to control measures, such as routine *Legionella* test results, that persistently exceed control limits or to events that pose an immediate risk to control of building water systems; required whenever Legionnaires' disease occurs; may also be appropriate for unexpected events such as equipment failure or acts of nature that disrupt the water system

Residual: See *Disinfectant residual*

Routine *Legionella* testing: Testing for *Legionella* to establish a baseline measurement for performance indicators or for validating a water management program or corrective action. Methods and objectives vary from those of non-routine *Legionella* testing

Sediment and scale: Mineral build-up in a water system that uses up disinfectant and supports growth or survival of bacteria

Stagnation: When water does not flow well; areas of stagnation encourage biofilm growth, ambient temperatures, and disinfectant residual reduction

Supplemental disinfection: Adding disinfectant to a water system on site; may require permitting for potable water systems

Thermostatic mixing valves: Plumbing devices used to blend hot and cold water (*i.e.*, to temper water), often to prevent scalding

Validation: Activities to confirm the water management program are working as intended and are effective for *Legionella* control; testing for *Legionella* is one method for validation of a water management program

Verification: Activities to confirm the water management program procedures are occurring as intended; reviewing temperature logs to ensure temperature measurement is occurring at the intended frequency is one method for verification of a water management program

Water age: Amount of time it takes for water to reach a point of use or fixture/device from the point of entry; for example, slow moving water has a greater water age than water moving quickly through a building water system

Water management program (WMP): Multistep process to reduce *Legionella* growth and spread; includes establishing a team, describing building water systems, identifying areas or devices where *Legionella* might grow or spread to people, determining control measures, monitoring control measures, establishing remediation activities and interventions when control measures are not met, ensuring the program is running as designed and is effective, and documenting all program activities

RESOURCES

CDC *Legionella* Control Toolkit:
https://www.cdc.gov/legionella/wmp/control-toolkit/index.html

CDC *Legionella* Water Management Program Toolkit:
https://www.cdc.gov/legionella/wmp/toolkit/index.html

CDC *Legionella* Environmental Assessment Form:
https://www.cdc.gov/legionella/downloads/*legionella*-environmental-assessment-p.pdf

CDC Model Aquatic Health Code (MAHC):
https://www.cdc.gov/mahc/index.html

CDC Model Aquatic Health Code (MAHC) Annex:
https://www.cdc.gov/mahc/pdf/2018-MAHC-Annex-Clean-508.pdf

ASHRAE Guideline 12:
https://www.ashrae.org/technical-resources/standards-and-guidelines

ASHRAE Standard 188:
https://www.ashrae.org/technical-resources/standards-and-guidelines

Cooling Technology Institute Legionellosis Guideline (GDL-159):
https://www.coolingtechnology.org/product-page/legionellosis-guideline-gld-159

EPA Information about Public Water Systems:
https://www.epa.gov/dwreginfo/information-about-public-water-systems

EPA Technologies for *Legionella* Control in Premise Plumbing Systems: Scientific Literature Review:
https://www.epa.gov/sites/default/files/2016-09/documents/legionella_document_master_september_2016_final.pdf

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Centers for Disease Control and Prevention
National Center for Environmental Health

CDC *Legionella* Control Toolkit: https://www.cdc.gov/*legionella*/wmp/control-toolkit/index.html

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