



Legionella Outbreak Manual

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Introduction

Legionnaires' disease and Pontiac fever outbreaks typically occur when two or more people are exposed to *Legionella* in the same place and get sick around the same time. Outbreaks are commonly associated with buildings or structures that have complex water systems, like hotels and resorts, long-term care facilities, hospitals, and cruise ships. The most likely sources of infection include water used for showering, hot tubs, decorative fountains, and cooling towers (structures that contain water and a fan as part of centralized air-cooling systems for a building or industrial processes). Healthcare sources of *Legionella* generally include complex large building water systems, with hospital or nursing homes coming from showerheads, sink facets, cooling towers, ice machines, and specialized equipment respiratory devices or hydrotherapy tubs. These systems, if not maintained, allow for bacteria to grow and then become aerosolized.

Legionnaires' disease and Pontiac fever outbreaks can be difficult to identify. Sometimes people travel to a common location, are exposed to *Legionella*, and then return home before becoming sick. State, territorial, and local health departments take the lead in investigating outbreaks. They also identify control measures to remove *Legionella* from the water identified as the source of infection.

Etiology

Bacteria of the genus *Legionella* cause Legionnaires' disease, Pontiac fever, and extrapulmonary infections. There are at least 60 different species of bacteria and at least 20 of them are known to cause human disease. Although there are many species of bacteria, the majority of infections are caused by *Legionella pneumophila* with most isolates belonging to serogroup 1.

After *Legionella* grows and multiplies in a building water system, water containing *Legionella* can spread in droplets small enough for people to breathe in. People can get Legionnaires' disease or Pontiac fever when they breathe in small droplets of water in the air that contains the bacteria.

Less commonly, people can get sick by aspiration of drinking water containing *Legionella*. This happens when water accidentally goes into the lungs while drinking. People at increased risk of aspiration include those with swallowing difficulties.

In general, people do not spread Legionnaires' disease or Pontiac fever to other people. However, this may be possible under rare circumstances.

Individuals at highest risk for Legionnaires disease include those 50 years or older, current or former smokers, and people with weakened immune systems or chronic diseases like cancer, diabetes, or lung cancer.

Legionellosis Case Ascertainment and Clinical Specimen Collection

Clinical Criteria

Legionnaires' disease (LD): LD presents as pneumonia, diagnosed clinically and/or radiographically. Evidence of clinically compatible disease can be determined several ways: a) a clinical or radiographic diagnosis of pneumonia in the medical record **OR** b) if "pneumonia" is not recorded explicitly, a description of clinical symptoms that are consistent with a diagnosis of pneumonia.

Case Classification

Suspect: A clinically compatible case of LD with supportive laboratory evidence for *Legionella*.

Probable: A clinically compatible case with an epidemiologic link during the 14 days before onset of symptoms.

Confirmed: A clinically compatible case of LD with confirmatory laboratory evidence for *Legionella*.

Clinical Specimen Collection

The preferred diagnostic tests for LD are culture of lower respiratory secretions (e.g., sputum, bronchoalveolar lavage) on media that supports growth of *Legionella* paired with the *Legionella* urinary antigen test.

- Isolation of *Legionella* by culture is important for detection of all species and serogroups of *Legionella*. Culture also allows for comparison of clinical and environmental isolates during an outbreak investigation. In contrast, the urinary antigen test only detects *Legionella pneumophila* serogroup 1.
- Best practice is to obtain both lower respiratory culture and the urinary antigen test concurrently.
- Obtain lower respiratory culture prior to antibiotic administration. However, antibiotic treatment should not be delayed facilitating this process (and culture can be attempted even after antibiotic therapy has been initiated).
- The urinary antigen test can detect LD in some cases for days to weeks (or longer, under rare circumstances) after treatment.
- Laboratories sometimes reject lower respiratory specimens during a work-up for pneumonia based on specimen quality (e.g., due to lack of white blood cells in the sample, contamination with other bacteria). However, laboratories should *not* reject lower respiratory specimens for these reasons when working-up Legionnaires' disease because *Legionella* can often be recovered.
 - Sputum produced by patients with LD may not have many white blood cells.
 - Contaminating bacteria does not negatively impact isolation of *Legionella* on selective media (e.g., Buffered Charcoal Yeast Extract [BCYE] agar plus antibiotics).

Outbreak Response

Legionella outbreaks can occur in several different settings including healthcare-associated, travel-associated, and community-associated. Every outbreak investigation is unique and requires planning and assessments to determine all steps that are needed to control the risk of further transmission. See below for considerations based on the setting type.

Basic Steps for All Outbreaks

When an outbreak is suspected or confirmed, public health officials will determine if a full investigation is needed. During a full investigation, the following basic steps should be taken (please refer to each type of outbreak for more specific actions related to each setting):

- The outbreak is called in to the Epidemiologist on call in the West Virginia Department of Health, Bureau for Public Health's Office of Epidemiology and Prevention Services (OEPS), an outbreak is opened, and involved entities are notified.
- A meeting is conducted with all entities involved including the facility, environmental consultants (if applicable), local health department, OEPS, and Office of Environmental Health Services (OEHS).
- The facility provides a copy of their water management program (WMP) to OEHS, who assist with the review and potential revision of the document.
- The facility should complete the Legionella [Environmental Assessment Form \(LEAF\)](#) document and return it within 72 hours.

Local Health Department (LHD) Responsibilities

- As soon as a suspected/confirmed outbreak is discovered, notify the OEPS Epidemiologist on call immediately at 304-558-5358.
- Notify the facility of the outbreak being opened and determine availability for a call to take place, ideally within the next 24 hours.
- Develop a line list for cases associated with the outbreak.
- Assist with collecting clinical information and conducting sampling (if needed) related to the case patient(s) and environmental sources identified.
- Follow the outbreak through closure, including the environmental sampling follow-up. Provide timely updates to OEPS regarding the progress of the investigation, challenges, needs, etc.

State Health Department Responsibilities

Office of Epidemiology and Prevention Services (OEPS)

- Open an outbreak and notify all involved parties including the OEPS Office Director and State Epidemiologist.

- Schedule a call with involved parties including the outbreak facility, environmental consultant (if applicable), LHD, OEPS, and OEHS.
 - Discussion should include the information available at the time, answering any questions, and discussing next steps for the investigation including the LEAF and the sampling plan if needed.
- Perform a retrospective review of cases in the West Virginia Electronic Disease Surveillance System (WVEDSS) to identify earlier cases with possible exposures to the same setting or geographic area.
- Request Healthcare-associated Infections and Antimicrobial Resistance (HAI-AR) Regional Nurse Manager to perform an Infection Control Assessment Response (ICAR) to review a healthcare facility's infection risks posed by water exposures, review related policies, and guide further investigation and educational needs as deemed appropriate.
- Work with appropriate parties to identify additional cases (e.g., through retrospective review of medical or laboratory records) and facilitate testing for *Legionella* using both culture of lower respiratory secretions on media that supports growth of *Legionella* and the *Legionella* urinary antigen test.
- Determine how long heightened disease surveillance and environmental sampling should continue to ensure the outbreak is over and communicate expectations to the facility.

Office of Environmental Health Services (OEHS)

- Assist in the evaluation of potential exposure points from the facility potable water system.
- Determine sampling sites in conjunction with the facility based on the *Legionella* LEAF if needed.
- Send an OEHS representative onsite to assist with the environmental assessment and sampling if needed.
- Assist with sampling the potable water system and other water sources located at the facility with facility personnel and/or consultants if necessary.
- Consider recommendations for restricting water exposures including installation of Point of Use Filters.
- Make recommendations for [remediation](#) of possible environmental source(s) if indicated.
- Work with appropriate parties to review and possibly revise the [WMP](#).
- Assess the effectiveness of implemented measures by reviewing water sampling results and outcomes of other recommendations.

Laboratory Responsibilities

- Environmental samples should be tested through a [CDC ELITE lab](#).
 - Environmental consultants collecting samples can be sent through the lab they typically work with as long as they are one of the ELITE labs.
 - If sampling is completed by local health in conjunction with OEHS, the samples should be routed to OLS to send off to an ELITE lab for testing.
- Any clinical samples related to an outbreak that need to be sent to CDC for culturing should be routed through the Office of Laboratory Services. Please contact OLS for approval at (304) 558-3530.
 - Accepted specimens for culture include sputum, bronchial lavage (BAL), bronchial washings, tracheal aspirate, endotracheal tube washes, and fresh lung tissue.
 - For more details on CDC testing and specimen shipping instructions, see CDC's [Legionella species Detection and Identification from Clinical Specimens or Isolates](#).

Subtype and compare clinical and environmental isolates if available.

Facility Responsibilities

- Participate in a conference call with public health partners ideally within 24 hours of identifying an outbreak.
- Provide the LHD and BPH with a copy of your facility's WMP within one week of notification of the outbreak.
- Complete the [LEAF](#) **within 72 hours** of notification of the outbreak.
- If needed, complete the first round of water and environmental sampling **within one week** of notification of the outbreak following the [Legionella Sampling Procedure and Potential Sampling Sites \(LSPSS\)](#) document.
 - This sampling can be completed by an Environmental Consultant or facility personnel in consultation with the local health department (LHD) in conjunction with OEHS. All samples need to be tested by an ELITE certified laboratory.
- Follow remediation and testing guidance provided by LHD and BPH following initial sampling (if determined necessary) until the outbreak is closed.
- Maintain contact with LHD for the duration of outbreak.

Setting-specific Outbreak Guidelines and Recommendations

Healthcare-associated Outbreaks

Background

A patient's exposure to healthcare settings during the 14 days before the date of symptom onset is an important consideration when identifying the source of potential LD outbreaks. Healthcare facilities often have large, complex building water systems. They frequently undergo construction and plumbing changes. They often have aerosol-producing devices, like cooling towers, decorative fountains, and other devices unique to healthcare facilities (e.g., respiratory therapy equipment, hydrotherapy tubs, heater-cooler units, ice machines), and other fixtures that may grow or spread *Legionella* (e.g., shower hoses). Patients in these settings often have [risk factors for Legionnaires' disease](#), such as advanced age, weakened immune systems, and chronic medical conditions.

Facilities

For LD surveillance, CDC defines a healthcare facility as a hospital, long-term care facility, or clinic. Other healthcare facilities include associated sites such as pharmacies and outpatient laboratories. This healthcare definition does not include assisted living facilities, senior living facilities, prisons, or group homes (for these types of facilities, please follow steps for a [Community-associated Outbreak](#)).

CDC tracks the type of healthcare exposure (inpatient, outpatient, visitor or volunteer, employee) and the healthcare facility setting. Healthcare facility setting categories are as follows:

Hospitals	Long-term care facilities	Clinics
• Acute care hospital (general or specialty) • Critical access hospital • Children's hospital • Psychiatric hospital	• Skilled nursing facility • Nursing home • Inpatient hospice • Rehabilitation hospital • Psychiatric residential treatment facility	• Outpatient clinic general • Ambulatory (same day) surgery center • Outpatient rehabilitation clinic • Dialysis center • Dental clinic

Definition of Healthcare-associated Case

Patients who [meet clinical and laboratory criteria](#) for confirmed LD are further classified based on the duration of healthcare exposure:

- Presumptive healthcare-associated LD: A case with ≥ 10 days of continuous stay at a healthcare facility during the 14-day exposure period.
- Possible healthcare-associated LD: A case that stayed at or visited one or more healthcare facilities during any portion of the 14 days before date of symptom onset and does not meet the criteria for presumptive healthcare-associated LD.

Outpatient Exposure

Public health officials should consider patients with outpatient-only exposures as possible healthcare-associated cases. These patients could have acquired the infection at a healthcare facility, but they also had other possible sources of exposure during the 14 days before the date of symptom onset.

Visitor and Employee Exposure

Public health officials should consider visitors to and employees at healthcare facilities during the 14 days before date of symptom onset as possible healthcare-associated cases.

Healthcare-associated Outbreak Definition

- $\geq$ One case of presumptive healthcare-associated LD at any time.
- $\geq$ Two cases of possible healthcare-associated LD within 12 months of each other.

Specific Activities

How health department investigators respond to healthcare-associated cases and outbreaks of LD depends on several factors. These factors include (but are not limited to):

- Type and size of the healthcare facility
- Existing capacity of the facility and health department
- Number of cases
- WMP performance
- Routine environmental sampling results

Public health officials should work closely with healthcare facility staff at each step in the process. The appropriate healthcare facility point of contact (e.g., administrator, infection preventionist, healthcare provider, quality assurance representative, facility manager or engineer) may vary, depending upon the step.

Response to identification of laboratory-confirmed healthcare-associated *Legionella* cases

In Facilities That Do Not House Severely Immunocompromised Patients (e.g., Hematopoietic Stem Cell Transplantation or Solid-Organ Transplant Recipients):

When a single case of laboratory-confirmed presumptive health-care-associated Legionnaires disease is identified, or when two or more cases of laboratory confirmed possible health-care-associated Legionnaires disease occur within six months of each other:

1. Contact the local or state health department.
2. Conduct an epidemiologic investigation through a retrospective review of microbiologic, serologic, and postmortem data to identify previous cases, and begin an intensive prospective surveillance for additional cases of health-care-associated Legionnaires disease.
 - a. If no evidence of continued transmission exists, continue the intensive prospective surveillance for cases for > two months after surveillance is begun.
 - b. If evidence of continued transmission exists:
 - Conduct an environmental investigation to determine the source(s) of *Legionella* spp. By collecting water samples from potential sources of aerosolized water and saving and subtyping isolates of *Legionella* spp. Obtained from patients and the environment. Sampling sites can be determined after an environmental assessment is completed.
 - If a source is not identified, continue surveillance for new cases for > two months and, depending on the scope of the outbreak, decide to either defer decontamination pending identification of the source(s) of *Legionella* spp. Or proceed with decontamination of the health-care's water distribution system. If a source of infection is identified by epidemiologic and environmental investigations, promptly decontaminate the source. (see remediation section on page 24 for more information)
 - c. Keep adequate records of all infection control measures, including maintenance procedures, and of environmental test results for cooling towers and potable-water systems.

In Facilities with HSCT or Solid-Organ Transplant Recipients:

When one inpatient of a Hematopoietic Stem Cell Transplant (HSCT) or solid-organ transplant unit develops a case of laboratory-confirmed presumptive (i.e., after >10 days of continuous inpatient stay) or two possible (i.e., within two to nine days of inpatient stay) health-care-associated Legionnaires disease, or when two or more patients develop laboratory-confirmed Legionnaires disease within six months of each other and after having visited an outpatient transplant unit during part of the two to 10-day period before illness onset:

1. Contact the local or state health department.
2. In consultation with the facility's infection control team, conduct a combined epidemiologic and environmental investigation to determine the source(s) of *Legionella*. Include but not limit the investigation to such potential

sources such as showers, water faucets, cooling towers, hot-water tanks, and carpet-cleaner water tanks. On its identification, decontaminate or remove the source of *Legionella*.

3. Do not conduct an extensive facility investigation when an isolated case of possible health-care-associated Legionnaires disease occurs in a patient who has had little contact with the inpatient transplant unit during most of the incubation period of the disease.
4. Keep adequate records of all infection control measures, including maintenance procedures, and of environmental test results for cooling towers and potable-water systems.

If public health officials determine a full investigation is needed, in addition to the [basic steps](#) listed above, they should:

- Develop a [line list](#) of possible and presumptive cases associated with the healthcare facility in the past year.
- Work with healthcare facility staff to identify all [new and recent patients](#) with healthcare-associated pneumonia and test them for *Legionella* using both culture of lower respiratory secretions on media that supports growth of *Legionella* and the *Legionella* urinary antigen test.

Conducting Additional Case Finding

Looking for patients with LD with healthcare exposures is an important part of a healthcare-associated LD outbreak investigation. To find cases, investigators should:

- Determine if the facility routinely conducts surveillance for healthcare-associated pneumonia and if the facility tests any identified patients for *Legionella*. If so, what tests does the facility use?
- Perform a retrospective chart review of patients for the past [12 months](#) to identify pneumonia cases that could have been healthcare-associated. If additional cases are identified, determine if patients were tested for *Legionella*.
- Review facility laboratory records for all *Legionella* testing and any positive results. Consider also reviewing laboratory records for other healthcare facilities in the same catchment area, especially for patients recently discharged from the healthcare facility of concern.

CDC's [Line List Template](#) is a helpful tool to summarize case demographic, clinical, and exposure information specific to a healthcare-associated outbreak. The CDC [LD Medical Record Abstraction Form Template](#) may also assist with record review for healthcare facility investigations.

Conducting Active Clinical Surveillance

Active clinical surveillance is a period of enhanced surveillance during which healthcare facility staff proactively and systematically identify patients with healthcare-associated pneumonia (pneumonia with onset ≥ 48 hours after admission). During this time, they also ensure that

clinicians perform *Legionella*-specific testing for each of those patients. It is crucial for detecting additional cases of healthcare-associated LD in a healthcare facility. Options for identifying patients with healthcare-associated pneumonia diagnoses could include:

- Daily review of chest radiographs and CT scans ordered to diagnose pneumonia.
- Daily review of new pneumonia diagnoses occurring in patients in intensive care units.
- Daily review of laboratory testing ordered to diagnose pneumonia (e.g., sputum Gram stain and culture).

Once cases of healthcare-associated pneumonia are identified, healthcare facility staff should perform *Legionella* testing. *Legionella* testing includes using both cultures of lower respiratory secretions on media that supports growth of *Legionella* and the *Legionella* urinary antigen test. Healthcare facilities should retain clinical specimens for the duration of the investigation.

During an investigation, public health officials should:

- Review the healthcare facility's protocol for active clinical surveillance (or work with healthcare facility staff to create one).
- Coordinate submission of clinical specimens for additional testing, as indicated.
- Specify that laboratories performing *Legionella* urinary antigen tests should have a rapid turnaround time (within ~48 hours).
- An on-site Infection Control Assessment and Response (ICAR) will be completed using module 11.

Timeframe for active clinical surveillance

Once initiated, active clinical surveillance should continue for at least two months, as described in the Healthcare Infection Control Practices Advisory Committee [\(HICPAC\)](#) guidance.

Water Restrictions and Control Measures for Healthcare-associated Outbreaks with Transmission

If the LHD believes a healthcare facility's internal potable water system is a source of *Legionella* transmission, implementation of water restrictions and/or installation of 0.21µm (micron) point-of-use (POU) filters by the facility should be considered immediately. Water control measures should take into consideration the structural characteristics of the building. Water restrictions and point-of-use filters do not remove the need for remediation actions to address the growth and amplification of *Legionella* bacteria in a facility's building water systems.

Examples of Water Restrictions and Control Measures

- Restrict the use of showers and whirlpools tubs/hot tubs (use sponge baths).
- Bottled water restrictions for individuals with swallowing difficulty.
- Avoid use of water from sink/tub faucets in patient rooms to avoid creating aerosols.

- For immunocompromised patients, using sterile water for tooth brushing, drinking, and flushing feeding tubes; for other susceptible patients, using bottled water.
- For patients with swallowing difficulties, limit consumption of non-sterile ice from facility ice machines.
- Confirm that contingency responses and corrective actions are implemented according to the facility's WMP.
- Shut down decorative fountains or other sources of aerosolization.
- Install 0.2µm POU water filters and replace them according to the manufacturer's recommendations.

Note: In healthcare settings, sterile water should be used to fill and clean reservoirs of respiratory equipment intended for nebulization/aerosolization under all circumstances (not just during an outbreak).

Travel-associated Outbreaks

Background

Approximately 10% of all reported cases of LD in the United States occur in people who have traveled during the 10 days before symptom onset. Travelers who are >50 years old, are current or former smokers, have chronic lung conditions, or are immunocompromised are at increased risk for infection when exposed to aerosolized water containing *Legionella* species. Patients with LD often do not recall specific water exposures because exposure frequently occurs during normal activities. Travel-associated LD outbreaks can occur:

- On cruise ships
- In hotels (or shared vacation properties such as Airbnb or VRBO rentals)
- In or near a hot tub
- At resorts
- Standing near a decorative fountain
- Touring in cities with buildings that have cooling towers

Travel-associated Outbreak Definition

CDC defines travel-associated outbreaks as two or more LD cases associated with the same travel accommodation in a 12-month period.

Conduct a full investigation if you have identified two or more cases of LD or Pontiac fever in people who:

1. Stayed overnight in the same accommodation during the exposure period for LD (14 days before date of symptom onset) or Pontiac fever (typically 24–72 hours before date of symptom onset), **AND**
2. Had symptom onsets within 12 months of each other.

Specific Activities

- Obtain a detailed exposure history and identify patterns:
 - Ensure that you have obtained as detailed of an exposure history as possible for each case from the patient or a proxy. Capture this information on [the Legionellosis Case Report Form](#).
 - Use the CDC [Line List Template](#) to track the outbreak and summarize case demographic, clinical, and exposure information.
- Conduct additional case finding for travel-associated cases:
 - OEPS will notify CDC of the outbreak via travellegionella@cdc.gov. CDC staff can search the Supplemental Legionnaires' Disease Surveillance System (SLDSS) for additional cases among people who reported staying at the accommodation during their exposure periods.
 - OEPS will submit an [Epi-X call for cases](#) to alert other states and request that they immediately report any additional cases associated with the accommodation to the investigating state, territorial, or local health department.
- Communicate with travel accommodation owners/managers:
 - Notify the accommodation manager or owner about the outbreak. Ask management whether they are aware of any guests or employees who have reported LD symptoms or illness. Ask management to report any consistent illnesses to the health department.
 - Depending upon the circumstances, consider notifying incoming guests and staff about possible exposure to *Legionella* and symptoms of LD and Pontiac fever. Encourage them to speak with their physician if they develop symptoms.
 - If the cases were recent, request a guest list for the prior investigation time period. Consider notifying past guests of their possible exposure to *Legionella* if they may still be within the exposure period or recently developed illness, as it may prompt them to seek care earlier if they experience symptoms.
 - Review employee absentee data and/or employee clinic records to obtain information about clinically compatible illnesses among staff.
 - Water sample collection should be encouraged for pools and hot tubs with exposure source indication. Sampling should be done *before* disinfecting and sanitizing. Detailed information on how to perform water sampling is discussed previously in the Environmental Sampling section.
 - Encourage property owners and managers to establish or improve their cleaning and maintenance log for pools, hot tubs, and air conditioning systems.
 - Discuss and ensure proper disinfecting procedures for their housekeeping staff or cleaning company for pools and hot tubs to prevent future cases (for both

hotels and/or shared vacation properties such as Airbnb or VRBO rentals).
Educational resources on cleaning can be found [here through the CDC](#).

Community-associated Outbreaks

Background

Community outbreaks of legionellosis have been linked to decorative fountains, humidifiers, respiratory therapy devices, and misters (such as those found in the produce section of grocery stores), and most often cooling towers. While cooling towers are a common source of LD outbreaks, outbreaks in correctional settings are rare and have not been reported in detail.

Community-associated Outbreak Definition

CDC defines community-associated outbreaks as an increase in LD cases in a certain geographic area beyond what one would normally expect for the same time and place.

- Conduct a full investigation if:

You have identified one or more cases of LD at a correctional facility or other facility where people cannot leave the premises (and therefore spent the entire exposure period there). In general, you should treat outbreaks of LD at such facilities with the same considerations as healthcare-associated outbreaks.

- Consider conducting a full investigation if:

You have analyzed available data and found an increase in LD in a certain geographic area (e.g., comparing five-year average rate of LD to the current incidence).

- Data can be used from various resources including interviews with suspected or confirmed cases, review of surveillance data, illness complaint systems, syndromic surveillance, increased absentee reports, increased calls to poison control centers, and passive surveillance from healthcare providers.

If epidemiologic evidence is not strong enough to warrant environmental sampling, consider conducting at least an environmental assessment to help determine if conditions for *Legionella* growth exist where cases may have been exposed.

Specific Activities

Obtain a detailed exposure history and identify patterns:

- Since *Legionella* is reportable in West Virginia, an initial interview should be conducted using the [CDC extended case report form](#). Sometimes a second interview can be helpful based on new information that you have gathered during the course of the outbreak investigation. Ensure that you have obtained as detailed of an exposure history as possible for each case from the patient or a proxy.
- Use the CDC [Line List Template](#) to track the outbreak and summarize case demographic, clinical, and exposure information.

Conduct additional case finding for community-associated cases:

- Interview additional cases of *Legionella* to look for common exposures.
- Work with OEPS to notify local clinical laboratories and healthcare providers for additional case finding. Consider issuing a health advisory notification [HAN] and provide guidance for appropriate diagnostic testing and encourage retention of clinical *Legionella* isolates.

Other Considerations:

- Map all patient residences and sites for daily activities (e.g., work, shopping, destinations, home address).
- Contact the local water authority to determine changes that could have contributed to *Legionella* growth (e.g., modifications to potable water disinfection, water main breaks, major construction activity, water service interruptions).
- Consider cooling towers as a possible source if cases are tightly clustered in time and neighborhood but patients lack common potable water exposures. See [Procedures for Identifying Cooling Towers](#) for more information.

Environmental Assessment and Response

Environmental Assessment

The purpose of conducting an environmental assessment is to gain a thorough understanding of a facility's building water systems and to assist facility management with minimizing the risk of Legionellosis. The assessment can be used along with epidemiologic information to determine whether to conduct *Legionella* environmental sampling and to develop a sampling plan. An Environmental Assessment includes visual inspections and monitoring of water quality parameters (e.g., water temperature, pH, residual disinfectant). The Environmental Assessment should be conducted by individuals with experience in environmental health, WMP, and/or conducting *Legionella* assessments.

Before arriving on site, the LHD should make the following requests of the facility:

- Request the attendance of the lead facility manager as well as others who have a detailed knowledge of the facility's water systems, such as facility engineer or industrial hygienist.
- Request that they have maintenance, and cooling tower water treatment logs in addition to plumbing blueprints available for the meeting.
- Bring the following supplies for testing water quality parameters including the following: clear plastic bottle or container, thermometer, pH test kit, and a chlorine test kit that can detect a wide range of residual disinfectant (<one for potable water and up to 10 ppm for whirlpool spas). Electronic chlorine/PH meters can be used.

- If the epidemiologic information available suggests a particular source (e.g., whirlpool spa, cooling tower, water feature, etc.) request that they shut it down for use, secure and do not replace the filter or filter media in use for a recreational water facility, secure the blowers/fans from use to prevent transmission, and do not drain or disinfect.

Legionella Environmental Assessment Form (LEAF)

The LEAF is a fillable form to document a facility's water systems, help determine whether to conduct *Legionella* environmental sampling, and, if so, develop a sampling plan. This needs to be completed by the facility within 72 hours of the notification of an outbreak. The LEAF Marking Guide is also available as an instructional resource to complete the LEAF.

For further resources and education on the environmental assessment, please see the following tools and instructional video from the Centers for Disease Control and Prevention (CDC):

[Conducting and Interpreting the Environmental Assessment](#): Learn useful tips about conducting an environmental assessment and how to interpret the results of key questions on LEAF

[Legionella Environmental Assessment Form \(LEAF\)](#): Use this fillable form to document a facility's water systems, help determine whether to conduct *Legionella* environmental sampling, and, if so, develop a sampling plan.

[Legionella Environmental Assessment Form Marking Guide](#): Use this instructional resource to complete the LEAF, as well as increase awareness of conditions that may promote *Legionella* growth and spread.

Environmental Sampling

Completing an environmental assessment is required before creating a sampling plan. The environmental assessment, epidemiologic information, and plumbing/floor plans should be used to determine whether to conduct *Legionella* environmental sampling in a facility. These documents are also utilized to develop a comprehensive sampling plan. There is no minimum/maximum number of samples to be collected, each facility will be different based upon the review of the documents. The goal is to collect samples that will give a good overall understanding of the facility's water system. As stated above, sampling should be performed within one week of opening the outbreak. Sampling must be performed by a hired legionella consultant and be tested by a CDC ELITE Lab.

If sampling is needed, refer to the recommended testing locations outlined in the setting-specific sections above (Healthcare-associated, Travel-associated, Community-associated). Consider consulting with OEHS and OEPS for testing recommendations. Environmental samples should be collected for culturing at two-week intervals for three months. If *Legionella* isn't detected during that time, then continue to collect cultures monthly for another three months.

If *Legionella* is detected in one or more cultures, then:

- Review and modify the WMP

- Perform additional remediation, if indicated
- Implement a new six-month period for post-remediation follow-up sampling

The following tools and videos were designed by the CDC to assist in developing sampling plans and how to sample:

- [Sampling Procedure and Potential Sampling Sites](#): CDC's protocol for collecting environmental samples for *Legionella* culture during a cluster or outbreak investigation or when cases of disease may be associated with a facility
- [Sample Data Sheet](#): Use this form to keep track of bulk water and swab samples taken for *Legionella* culture during an investigation
- [How to Make a Sampling Plan](#): Learn how to choose the number of samples to take and where to take them
- [How to Sample Potable Water](#): Learn CDC's procedure for collecting potable water samples for *Legionella* culture
- [How to Sample Cooling Towers](#): Learn the CDC's procedure for collecting environmental samples from a cooling tower
- [How to Sample Spas and Fountains](#): Learn CDC's procedure for collecting environmental samples from spas (hot tubs) and decorative fountains

All showers and faucets in all case rooms should be sampled with biofilm swabs in addition to both first draw and post-flush 1-Liter bulk water samples. Similarly, it is important to sample showers and sink faucets in additional rooms that are proximal, medial, and distal to risers or hot water heaters. These samples should include point-of-use devices (especially showers) on various floors based on environmental assessment findings. Ideally, a sample will be collected at point-of-use outlets on every floor and/or building wing.

Sampling Supplies

- Sterile plastic 1L bottles (glass bottles are not recommended due to the risk of breakage during transport)
- Sterile plastic 15 mL screw top tubes (with a tube rack) for biofilm swabs
- Disposable Dacron/polypropylene-tipped swabs with wooden or plastic stems. Do NOT use cotton-tipped swabs as they inhibit *Legionella* growth
- Labels
- 0.1N solution of sodium thiosulfate ($\text{Na}_2\text{S}_2\text{O}_3$) (15.81 g/L in distilled water. Replace every 12 months) OLS will prepare sampling supplies with sodium thiosulfate if their supplies are used during an investigation
- Pipettes and bulbs for adding 0.5 mL of 0.1N sodium thiosulfate solution into 1L samples
- Sterile plastic 500 mL or 1 L bottle for testing chlorine level, pH and temperature
- A pH test kit

- Chlorine test kit sensitive enough to detect chlorine level from 0-10 ppm (may need two kits). Free chlorine may be measured when it is known that chlorine is the method of disinfection (as opposed to monochloramine, bromine, or another disinfectant). Otherwise, measure total chlorine
- Thermometer
- Sample data sheets and pens
- Large cooler, preferably with wheels. A 70 quart (66.2 L) horizontal cooler (a standard large picnic cooler) should fit 25 1-liter bottles, 25 15mL plastic tubes for biofilm swabs, thermometer, pH and chlorine test kits. For sampling of a larger facility (60-100 samples total), a second cooler with bottles, swabs and tubes may be needed. The cooler may be packed ahead of time and stored at ambient temperature for an unlimited time if the sodium thiosulfate solution is replaced every twelve months.

Environmental Sampling Procedures

Perform an Environmental Assessment and create a sampling plan before collecting samples.

Sampling Hot and Cold Potable Water at the Points of Use

1. Swab sampling of showers/faucets.

When sampling showers with a swab remove shower heads, then turn on hot or cold water for a couple seconds to moisten the interior of the pipe. Collect 3-5ml of the first flush in a sterile plastic tube, then turn off the water. Insert a sterile swab deep into the shower pipe and swab around various surfaces inside the pipe (careful not to break the swab stick). Also swab the inside of the shower head if it has visible biofilm growth. Place the swab in the plastic tube with the first flush water and snap off (cut if necessary) the swab stick about one inch from the top of the tube, make sure there is enough water to cover the swab during transportation. Then add .1 ml normal sodium thiosulfate solution (to neutralize residual disinfectants), install tube cap, and label the tube with a unique identifier. Place the tube in a cooler for storage and transportation, then record the sample on the Sample Data Sheet.

These same steps can be taken to collect a swab sample from a faucet by removing the faucet aerator.

2. Bulk water pre-flush sampling of water (hot or cold water).

Collecting a pre-flush 1-liter bulk water samples of hot water lines turn on and immediately collect the water into the sterile 1-liter plastic sample bottle. Add .5 ml normal sodium thiosulfate solution to neutralize the residual disinfectant, and then cap the bottle. Label the bottle with a unique identifier, record the type and location of the sample on the sample data sheet then place the bottle into the cooler for storage and transportation.

3. Bulk water post-flush sampling of water (hot or cold water).

When collecting a post-flush 1-liter bulk water sample of hot water, turn on the water and run until warm (a couple minutes). The goal is to collect water currently in the

distribution system along with any material shed from the biofilm. Collect 1-liter of this water into a sterile plastic sample bottle, leaving one inch of space at the top of the bottle, then add .5 ml Normal Sodium Thiosulfate solution to neutralize the residual disinfectant, and cap the bottle. Label the bottle with a unique identifier, record the type and location of the sample on the sample data sheet then place the bottle into the cooler for storage and transportation.

Measure hot water parameters in conjunction with each environmental sample collected. (See Measuring Hot Water Parameters below)

Sampling Potable Water at the Hot Water Heaters

1. Collect 1-liter bulk water samples.

Fill a sterile 1-liter bottle from the hot water heater/tank drain valve leaving one inch of space at the top of the bottle. Add .5 ml Normal Sodium Thiosulfate solution to neutralize the residual disinfectant, and then cap the bottle. Label the bottle with a unique identifier and place it in the cooler for storage and transportation.

2. Measure Hot Water Parameters in Hot Water Heater & Water Storage Tanks.

Use a 1-liter bottle for all sample locations. Run the water until it is as hot as it will get, then collect water in the bottle and perform the following:

- Measure temperature
- Measure pH with color indicator strips or a digital pH meter
- Measure total chlorine residual

For tankless water heaters samples need to be taken from a pipe as near as possible to the heater outlet.

For a building with a recirculating hot water piping system, the hot water pipe sample should be taken as the water returns to the hot water storage/heater tank.

3. Measure Hot Water Parameters.

Use a 1-liter bottle for all sample locations. Run the water until it is as hot as it will get then collect some water in the bottle and perform the following:

- Measure temperature
- Measure pH with color indicator strips or a digital pH meter
- Measure total chlorine residual

Label the bottle with a unique identifier and place it in the cooler for storage and transportation.

4. Measure Cold Water Parameters.

Use the same bottle used for hot water parameter testing and perform tests for the same parameters. Record the results on the data sheet

Sampling Hot Tubs

1. Secure Hot Tub.

Call ahead and instruct the facility to turn off the spa (i.e., blowers or jets) but DO NOT drain or shut off the pumps or the heater for the spa. This will limit the risk of aerosolization and exposure to the hot tub but allow samples to be collected in normal operating conditions. Instruct the facility to close off the spa to the public (i.e., out of service tape) and post visible signs stating that the spa is out of order. When aerosol producing devices cannot be secure, wear half face respirators equipped with N95 filters. Follow OSHA standard 29 CFR 1910.134

2. Bulk Water Sample Collection.

Fill a sterile one-liter bottle to within one inch of the top with water from the spa and add .5 ml of sodium thiosulfate to sample. Label the bottle with a unique identifier and place it in the cooler with ice packs.

If the spa is partially drained, a 15 ml swab tube may be used to collect remaining water. If the spa has been completely drained, ask facility maintenance for access to the compensation tank for collection of overflow water and take a bulk water sample. Then add .5 ml of Sodium Thiosulfate to sample, cap, label with unique identifier, and place in the cooler.

3. Biofilm Swab Collection.

Collect several swabs from the jets and at the waterline of the spa in addition to a bulk water sample from the spa. Collect 3-5 ml of water from the spa into a 15 ml sterile plastic tube and place each individual swab into a sterile tube with .1N Sodium Thiosulfate (one drop), cap tube, label tube with unique identifier, record on data sheet, and place in cooler for transportation to the lab. Repeat for all swab samples.

Helpful tip: When completing the Sample Data Sheet, draw a diagram of the hot tub on the back with locations of jet and waterline samples. This will facilitate consistent sampling if a repeat sampling event is warranted

4. Filter Media Sample Collection.

Ask the facilities' maintenance personnel to open the filter assemblies for inspection and sampling. Collection of a sample from the filter assembly is very important. Gloves should be worn due to the high organic load and the abrasive or caustic nature of some filter filling material. The methodology for filter sample collection type depends on the filter type.

The three types of filters likely to be encountered:

- Sand - Collect sand and enough water to cover it in a 1-liter bottle
- Cartridge - Cut some filter material, place in a test tube 1-liter bottle with enough water to cover it.

- Diatomaceous earth – Collect 300-500 ml of water from a filter chamber into a sterile one-liter bottle, use a sterile swab to scrape diatomaceous powder from the grid. Be sure the powder is covered by at least one inch of water.

With each sample add .5 ml of 0.1N Sodium Thiosulfate, cover, label with a unique identifier and place in cooler.

5. Water Parameters Collection.

Collect water in a separate plastic bottle that is not being utilized for *Legionella* bacteria sample collection, and measure temperature, pH, residual biocide, and temperature. Spas may use bromine as a biocide instead of chlorine. Log this important information on the Sample Data Sheet. If the residual biocide levels exceed the maximum limit of the test kit, perform serial dilutions to bring the sample within the test kit's range. If there is a very small amount of disinfectant in the water, use the potable water test kit as its test range is much lower. Record all data on the sample data sheet. Remember it is possible for a hot tub to pass a routine environmental health inspection yet still harbor *Legionella*.

Sampling Cooling Towers

1. Secure Cooling Tower Fans.

- If it is not possible to secure the fans, then attending personnel should don NIOSH N95 respirator filter masks
- Use of some form of waterproof glove should also be considered

2. Bulk Water Sample Collection.

Collect a 1-liter water sample from the cooling tower basin. This sample should be collected as far away from the cooling tower make-up water discharge line as possible, and preferably with the condenser or circulating pump in operation. Add 0.5 mL of a 0.1N sodium thiosulfate solution to the bulk water sample, put a lid securely on the bottle, label the bottle with a unique identifier, record the sample and unique identifier on the sample data sheet and place the bottle in a cooler with ice packs for storage/transportation to the lab.

3. Biofilm Swab.

Collection of biofilm samples should occur at various locations throughout the cooling tower. These are locations to consider when collecting biofilm swab samples:

- Basin waterline
- Tower fill
- Drift eliminators
- Tribution tray and associated nozzles

Run swabs firmly along the wetted surfaces and collect 3-5 mL of associated cooling tower water in the 15 mL tube, place the swab into the tube with water and snap off the tip of the swab into the tube about one inch from the top of the tube. Add a drop of

0.1N sodium thiosulfate to water in the tube and cap the tube. Label the tube with a unique identifier, log the sample and its associated identifier on the sample data log sheet and place it in the tube rack of the cooler. The water will keep the swab tip moist during storage and transportation to the lab for culturing.

4. Water Parameter Collection.

Collection of cooling tower environmental parameters should include biocide residual (either in ppm or ORP mV), pH and temperature. The ORP mV readings would be taken from the cooling tower biocide controller.

To perform these tests, collect basin water in a separate 1-liter bulk sample bottle that is not being utilized for *Legionella* bacteria sample collection, making sure to collect the water as far away as possible from the make-up water discharge into the cooling tower basin. Perform tests and record the data on the Sample Data Sheet.

Sampling Decorative Fountains

1. Secure Fountain Operation.

Call the facility ahead of visit and ask to have the fountain secured from operation to minimize the risk of exposure to aerosolized water being generated. Clearly state that the fountain should not be drained, nor should any remediation practices be conducted like chemical shocking or draining of the fountain water.

2. Bulk Water Sample Collection.

Fill a sterile 1-liter bottle with fountain water to within one inch of the top of the bottle and add .5 ml of sodium thiosulfate to sample. If the fountain was partially drained, a 15 ml swab tube may be used to collect any remaining water. If the fountain has been completely drained, ask facilities maintenance for access to the compensation tank or filter assembly for collection of water and take a bulk water sample at that location. If it is possible, always collect bulk water or swab filter samples. Then add .5 ml of sodium thiosulfate to sample, cap, label with unique identifier, and place in the cooler.

3. Biofilm Swab Collection.

Collect several swabs at the waterline of the fountain in addition to the bulk water sample. Collect 3-5 ml of water from the fountain in a 15 ml sterile plastic tube and place each individual swab into that sterile tube with 0.1N sodium thiosulfate (one drop), cap tube, label tube with unique identifier, record on data sheet, and place in cooler for transportation to the lab. Repeat for all swab samples.

4. Water Parameter Collection.

Collect water in a separate plastic bottle that is not being utilized for *Legionella* bacteria sample collection, and measure temperature, pH, residual biocide and temperature. Fountains may use bromine as a biocide instead of chlorine. Log this important information on the data sheet. If the residual biocide levels exceed the maximum limit of the test kit, perform serial dilutions to bring the sample within the test kit's range. If

there is a very small amount of disinfectant in the water, use the potable water test kit as its test range is much lower. Record all data on the Sample Data Sheet

Special Considerations for Possible Sources of Exposure

Potable Water

- Potable water is a common source for *Legionella* outbreaks. Potable water outbreaks are typically less “explosive” than outbreaks associated with cooling towers. However, without remediation, building water systems colonized with *Legionella* may cause disease over years before a problem is recognized.
- Potable water can come from either a public utility or from a private source. The U.S. Environmental Protection Agency (EPA) regulates public water quality and requires a minimum amount of disinfectant to be present (i.e., disinfectant residual). Building owners are responsible for maintaining the quality of the water once it enters the building water system(s). However, buildings that have their own disinfection systems may also be subject to EPA and/or state regulations. Water quality, including disinfectant level, can drop as water travels through building water systems. Residual disinfectant supplied by the public utility is lost as organic matter consumes it, it naturally off-gases, and as water ages. Heating the water speeds up loss of residual disinfectant in pipes or fixtures.
- Treatment plants sometimes switch from one type of disinfectant to another, based on seasonal changes, or one-time changes in treatment methods. These changes can affect *Legionella* growth.
- Showerheads are only one possible source of potable water exposure. Spending time near sink faucets and aspiration of drinking water or ice chips are possible routes of transmission, particularly among immunocompromised patients.

Cooling Towers

- A cooling tower is a structure that contains water and a fan as a part of a centralized air-cooling system for a building or industrial processes. Cooling towers remove unwanted heat from the system by exposing heated water to cooler air. In contrast, home air conditioning units do not use water to cool, so they do not aerosolize water and are not a risk for *Legionella* growth and spread.
- In areas with many buildings, identifying all cooling towers can be challenging. However, some areas are starting to require registration of cooling towers to track their locations. Using Geospatial Information Systems (GIS) technology may be useful for aerial cooling tower identification. Sometimes certain entities, such as water utility companies, may provide permits for cooling towers and have location information.
- Some cooling towers are located on the ground or on sides of buildings and may be difficult to see from aerial photography. A physical assessment, street view imagery, or checking with building owners and managers is necessary in some circumstances. [Learn about Procedures for Identifying Cooling Towers.](#)

- If you implicate a cooling tower as a possible source of exposure, ensure that it has been shut down, but not drained or hyperchlorinated, before sampling.

Hot Tubs and Pools

- Being in or near a hot tub or hydrotherapy tub while it is turned on is a possible exposure risk because of the ability to aerosolize water containing *Legionella*.
- If you implicate a hot tub as a possible source of exposure, ensure that it has been turned off, but not drained, before sampling.
- *Legionella* are unlikely to grow in typical swimming pools because water temperatures are usually too cold. However, you should sample pools if they are associated with a possible exposure or temperatures are within the permissive range (i.e., 77–113°F).

Decorative Fountains

- Decorative fountains are a possible exposure source for *Legionella*, particularly in enclosed spaces.
- Submerged lighting and warm ambient temperatures in fountains can contribute to *Legionella* growth.
- If you implicate a fountain as a possible source of exposure, ensure that it has been turned off, but not drained, before sampling.

Remediation

Before remediation is conducted, request a copy of the remediation plan from the consultant or facility for review. Remediation options can include:

- Hyperchlorination
- Flushing the potable water system and unused plumbing outlets
- Draining and scrubbing devices
- Consider removing aerosolizing devices that are not necessary for the function of the facility (e.g., decorative fountains, waterfalls, hot tubs)
- Targeted disinfection for hot tubs, decorative fountains, and cooling towers

Potable Water Systems

Potable water, which is also known as drinking water, comes from surface and ground sources and is treated in a way that meets state and federal standards for consumption. If the presence of *Legionella* is confirmed in the potable water system in the presence of an outbreak, the following remediation steps should be taken. Choose a remedial treatment procedure after considering the system infrastructure, water quality parameters, and available sampling results. Consult with a water treatment professional as certain procedures should only be undertaken by a professional. Following a successful *Legionella* remediation procedure, recolonization of the water system is likely unless the underlying conditions supporting *Legionella* growth are addressed.

- Chemical shock using an elevated level of a disinfectant, such as chlorine, for a limited duration can control *Legionella* in a potable water system. Consult scientific evidence and technical expertise before choosing a specific chemical shock procedure. In addition:
 - Consider which components of the water system need remediation.
 - Chemical shock of a hot water system may have improved efficacy if the temperature is lowered.
 - Chemical shock options may be impacted by regulations (e.g., chemicals allowed into sewer discharge) and may require permitting.
- Thermal shock of water systems is not recommended due to frequent failure and rapid recolonization of *Legionella*.

Legionella Control Measures for Potable Water Systems

Water Parameter	Control Measure	Recommendations
Sediment and Biofilm	Flushing, cleaning, and maintenance	● Flush after an intrusion event (e.g., water main break). ● Clean and maintain water system components such as water heaters, mixing valves, aerators, showerheads, hoses, and filters regularly as indicated by water quality measurements.
Temperature	Control limits	● Store hot water above 140°F (60°C) and maintain circulating hot water above 120°F (49°C). ● Store and maintain circulating cold water below the growth range most favorable to <i>Legionella</i> (77–113°F, 25– 45°C). Note that <i>Legionella</i> may grow at temperatures as low as 68°F (20°C).
Water Age	Flushing	● Flush low-flow pipe runs and dead legs at least weekly. ● Flush infrequently used fixtures regularly.

Disinfectant Residual*	Control limits	- Chlorine: Detectable residual as directed by WMP. - Monochloramine: Detectable residual as directed by WMP.
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* Disinfectant residual recommendations apply to disinfectants delivered by the municipal water authority. Supplemental disinfection system control limits are not prescribed here and must be dictated by the water treatment professional and WMP.

Hot Tubs

Hot tubs that contain *Legionella* bacteria can cause outbreaks of disease. It is critical to collect water samples, then disinfect hot tubs linked to cases of LD or Pontiac fever.

1. Drain all water from the hot tub. Dispose of the water to waste or as directed by the local regulatory authority.
2. Vigorously scrub all hot tub surfaces, skimming devices, and circulation components. Use water with free chlorine at a minimum concentration of five parts per million (ppm) to remove any biofilm (slime). After scrubbing, rinse the tub with clean water and flush to waste.
3. Replace filters (for cartridge or diatomaceous earth filters) or filter media (for sand filters). Bag these and dispose of them as normal solid waste.
4. Make any needed repairs. Inspect the hot tub thoroughly for any broken or poorly functioning components such as valves, sensors, tubing, or disinfectant feeders.
5. Refill the tub with fresh potable water. Hyperchlorinate the water to 20 ppm free chlorine. Keep the hydrotherapy jets off and let the hyperchlorinated water circulate for one hour in all of the components of the hot tub including the compensation/surge tank, filter housing, and piping. Turn on the hydrotherapy jets to circulate the hyperchlorinated water for 9 additional hours. Maintain 20 ppm of free chlorine in the system for the entire 10 hours.
6. Flush the entire system with fresh potable water and refill. This removes hyperchlorinated water from all equipment.
7. Take new samples to confirm the elimination of *Legionella*. At least 48 hours after the device has been restored to normal operating conditions, collect samples from:
 - a. Tub
 - b. Hydrotherapy jets
 - c. Drain
 - d. Filters or filter media
 - e. Any part of the hot tub that originally tested positive for *Legionella*

8. Keep the hot tub closed until testing confirms the elimination of *Legionella*. If laboratory testing is positive for *Legionella*, repeat steps 1-7 until all testing is negative. If laboratory testing is negative for *Legionella*, proceed to step 9.
9. Ensure water quality prior to reopening the hot tub for use. Ensure that halogen (chlorine or bromine) and pH levels meet local and state standards.
10. Maintain water quality according to local and state standards. If the hot tub is associated with an outbreak, the above continued laboratory testing schedule will be recommended.

Legionella Control Measures for Hot Tubs and Whirlpool Spas

Water Parameter	Control Measure	Recommendations
Sediment and Biofilm	Flushing, cleaning, and maintenance	● Flush after an intrusion event (e.g., water main break). ● Clean and maintain water system components such as water heaters, mixing valves, aerators, showerheads, hoses, and filters regularly as indicated by water quality measurements.
Temperature	Control limits	● Store hot water above 140°F (60°C) and maintain circulating hot water above 120°F (49°C). ● Store and maintain circulating cold water below the growth range most favorable to <i>Legionella</i> (77–113°F, 25–45°C). Note that <i>Legionella</i> may grow at temperatures as low as 68°F (20°C).
Water Age	Flushing	● Flush low-flow pipe runs and dead legs at least weekly. ● Flush infrequently used fixtures regularly.
Disinfectant Residual*	Control limits	● Chlorine: Detectable residual as directed by WMP. ● Monochloramine: Detectable residual as directed by WMP.

†Recommendation based on guidance from CDC's *Model Aquatic Health Code* (MAHC), accessible at: <https://www.cdc.gov/model-aquatic-health-code/php/our-work>.

‡Cyanuric acid or stabilized chlorine products should not be used in hot tubs as they slow disinfection.

Cooling Towers

Cleaning, disinfecting, and remediating cooling towers involves a hierarchy of protocols. Determine how the following response protocols fit into your WMP. The protocols are listed in order of increasing intensity from routine treatment to offline emergency disinfection. Consult ASHRAE Guideline 12 for instructions for each response. These steps may require customization based on system components, operating conditions, or other factors.

- Online remedial treatment
- Online disinfection
- Offline cleaning and disinfection
- Offline emergency cleaning and disinfection

If an associated outbreak or illness is suspected, perform an offline emergency cleaning and disinfection using the procedures below. Consult a water treatment professional for guidance on applying these procedures.

1. Review the current water treatment program (e.g., cleanliness, maintenance, disinfectant program).
2. Remove heat load from the cooling system. Shut off fans associated with the cooling tower. Disengage all automated chemical feed and control equipment.
3. Shut off system blowdown and keep make-up water valves open and operating.
4. Close building air intake vents near the cooling tower, especially those downwind, until after the cleaning procedure is complete.
5. Circulate water through all system equipment, including any bypass or standby components.
6. Add an oxidizing disinfectant sufficient to achieve a disinfectant residual of at least 20 ppm as free available oxidant.
7. Add an appropriate dispersant and apply antifoam, if needed. Apply appropriate corrosion inhibitors.
8. Reduce the cycles of concentration (if necessary) to achieve and maintain a pH of less than 8.0 for chlorine-based disinfectants or less than 8.5 for bromine-based disinfectants.
9. Maintain a free available oxidant residual of 10 ppm for a minimum of 24 hours. Shorter contact times can be effective at higher concentrations.

10. Drain the system after the disinfection period to the sanitary sewer, following all applicable rules, regulations, and permits.
11. Physically clean all accessible system equipment including all cooling tower equipment, fill pack, drift eliminators, equalizer lines, remote sumps, basins, strainers, chillers, free cooling heat exchangers, and any bypass or standby components.
12. Refill the system and circulate water through all system equipment including any bypass or standby components.
13. Add an oxidizing disinfectant and maintain a free available oxidant residual of at least 10 ppm for one hour.
14. Drain the system after the disinfection period to the sanitary sewer following all applicable rules, regulations, and permits that may be required.
15. Refill the system and return all chemical feed and control equipment to normal operation.

Legionella Control Measures for Cooling Towers

Water Parameter	Control Measure	Recommendations
Sediment and Biofilm	Cleaning frequency, scale, and corrosion inhibitors	● Cleaning frequency varies based on operational factors. ● Remove from service, clean, and disinfect at least annually. ● Monitor scale and corrosion inhibitor levels frequently as indicated by water quality measurements.
Temperature	Control limits	● Operate at the lowest possible water temperature outside <i>Legionella's</i> favorable growth range (77–113°F, 25–45°C).
Water Age	Make-up water quality and turnover frequency	● Flush low-flow pipe runs and dead legs at least weekly. ● During wet system standby (water remains in system and shutdown for less than five days), maintain water treatment program and circulate water three times a week through the open loop of a closed-circuit cooling tower and entire open-circuit cooling system.

		● Ensure system water quality is managed through automated system blow down. Use potable water for system make-up water or ensure reclaimed or condensate sources are appropriately managed.
Disinfectant Residual	Control limits	● pH: Maintain based on type of disinfectant used and manufacturer recommendations to prevent corrosion. ● Oxidizing disinfectants (e.g., chlorine & bromine): Maintain measurable residuals throughout each day. Consult manufacturer recommendations.
		● Non-oxidizing disinfectants: Maintain based on product label concentration and contact time.

Decorative Fountains

If an associated outbreak or illness is suspected by public health, test to confirm the presence of *Legionella* before remediation and to confirm the elimination of *Legionella* after remediation. Steps to take include:

1. Remove the decorative fountain from service.
2. Drain the decorative fountain.
3. Scrub all surfaces.
4. Replace filters or filter media (if applicable).
5. Repair parts as needed.
6. Refill the decorative fountain.
7. Hyperchlorinate, maintaining a minimum of 20 ppm free chlorine for 10 hours.
8. Drain and rinse all components of the decorative fountain.
9. Refill with fresh potable water.
10. Return the decorative fountain to the routine disinfectant residual level before use.

Legionella Control Measures for Decorative Fountains by Volume in US Gallons

Water Parameter	Control Measure	Recommendations		
		< 5 gallons	5–25 gallons	> 25 gallons
Sediment and Biofilm	Cleaning frequency	Weekly	Monthly	Routinely to remove scale and deposits as indicated by water quality measurements
		Any time there is visible biofilm or debris (in addition to above routine cleaning)		
Temperature	Control limits	Maintain water temperature below 77°F (25°C).*		
Water Age	Water turnover, flow, replacement	Water turnover and flow are needed to maintain water treatment applied for microbial control. Avoid idle periods. Run at least daily.		
Disinfectant Residual	Control limits	3–5 ppm free chlorine for at least one hour per day	3–5 ppm free chlorine for at least one hour per day	0.5 ppm free chlorine for at least six hours/day

* Exposure to warm air, heat-generating submerged lights, or other factors that elevate water temperature into the favorable growth range (77–113°F, 25–45°C) will require additional mitigation

Other Devices

In the absence of control, *Legionella* can grow in almost any system or equipment containing nonsterile water, such as tap water, at temperatures favorable to *Legionella* growth. Devices that may grow *Legionella* in the absence of control include the following:

- All types of secondary water collection, storage, and use for recycled water, gray water, rainwater, and groundwater
- Water storage for high-demand or emergency use and expansion tanks
- Lawn sprinklers and irrigation systems
- Solar water heating systems
- Fire suppression systems

- Safety showers and eyewash stations
- Produce and recreational misters
- Evaporative air coolers
- Spray and pressure washing equipment
- Machine/metalworking lubrication and coolant systems
- Dental and medical equipment (e.g., scalers, CPAP, bronchoscopes, heater-cooler units)
- Ice machines
- Humidifiers

If an outbreak or illness is suspected by public health, consider remediation options. Water system managers should choose a remedial treatment procedure after considering the system infrastructure, water quality parameters, and available sampling results. Certain procedures should only be undertaken in consultation with a water treatment professional. Following a successful *Legionella* remediation procedure, recolonization of the water system is likely unless the underlying conditions supporting *Legionella* growth are addressed.

Legionella Control Measures for Other Devices

Water Parameter	Control Measure	Recommendations
Sediment and Biofilm	Flushing, cleaning, and maintenance	Clean and maintain water system components regularly in accordance with manufacturer recommendations.
Temperature	Control limits	Store and maintain water at temperatures outside the favorable growth range for <i>Legionella</i> (77–113°F, 25–45°C); Note that <i>Legionella</i> may grow at temperatures as low as 68°F (20°C).
Water Age	Flushing and water replacement	Flush and replace water according to manufacturer recommendations.
Disinfectant Residual	Control limits	Consider using a disinfectant appropriate for the system and in accordance with manufacturer recommendations.

Post-Remediation Environmental Sampling

Recommendations regarding the frequency of environmental sampling and parameter testing after an outbreak include sampling every two weeks for the first three months post remediation. If no cases are identified and no positive samples are cultured during the three-month time frame the sampling frequency can be extended to once a month for another three-month time frame. Again, if no further cases are identified and no further positive

samples are cultured during this three-month time frame the facility can fall back to the sampling frequency outlined in their WMP.

If at any time during the previously described six-month enhanced sampling schedule a new case is identified, or a sample culture is positive for *Legionella*, the six-month clock begins again after repeat remediation efforts are completed. If additional remediation is necessary, the facility should consider hiring a consultant with *Legionella*-specific environmental expertise to help make decisions about and/or perform remediation. Please refer to the [CDC's Considerations When Working with Legionella Consultants](#) for choosing a consultant with the proper expertise.

Control

Use a WMP to protect building operators, staff, and visitors from exposure to *Legionella* in potable water systems. No single measure can ensure *Legionella* control. A comprehensive WMP allows water system operators to layer a series of complementary control measures to create environmental conditions that prevent bacterial intrusion, growth, and transmission. Develop or refine a WMP with the following guidelines in mind:

- Monitor temperature, disinfectant residuals, and pH frequently based on performance of WMP or *Legionella* performance indicators for control. Adjust measurement frequency according to the stability of performance indicator values. For example, the measurement frequency should be increased if there is a high degree of measurement variability.
- Store hot water at temperatures above 140°F (60°C) and ensure hot water in circulation does not fall below 120°F (49°C). Recirculate hot water continuously, if possible.
- Store and circulate cold water at temperatures below the favorable range for *Legionella* (77– 113°F, 25–45°C); *Legionella* may grow at temperatures as low as 68°F (20°C).
- Ensure a disinfectant residual is detectable throughout the potable water system.
- Flush low-flow piping runs and dead legs at least weekly and flush infrequently used fixtures (e.g., eye wash stations, emergency showers) regularly as-needed to maintain water quality parameters within control limits.
- Clean and maintain water system components, such as thermostatic mixing valves, aerators, showerheads, hoses, filters, and storage tanks, regularly.
- Do not presume supplemental disinfection systems will control *Legionella* without an adequate WMP.
 - Selecting or operating a supplemental disinfection system inappropriately may result in system damage or health hazards (e.g., disinfectant byproducts). Consult with a water treatment professional regarding supplemental disinfection systems. They may require permitting.

- Recognize that point-of-use microbial filters with an effective pore size of 0.2-microns or less that comply with the requirements of [ASTM F838](#) can provide immediate control at individual fixtures in a water system if integrated into a WMP.
 - POU filters protect only the connected fixture. Correct location selection is critical to *Legionella* exposure prevention across the water system.
 - Follow the manufacturer recommendations regarding frequency of replacement and appropriate operating conditions.
 - POU filters may need to be removed before performing an acute remediation procedure.
- Consider testing for *Legionella* in accordance with the [routine testing module](#) of this toolkit.

For additional information for *Legionella* control, please refer to the [Toolkit for Controlling *Legionella* in Common Sources of Exposure \(Legionella Control Toolkit\)](#).

Determining When Outbreak or Investigation is Concluded

Public health officials performing the investigation will need to make decisions about the end of an outbreak on a case-by-case basis. Possible considerations include:

- No new cases of LD identified during a period of careful monitoring for new cases (typically two months from last case identified).
- No new cases of LD following implementation of long-term *Legionella* control strategies as part of a [WMP](#).
- No detection of *Legionella* in post-remediation environmental samples.
 - If sampling is conducted, it should consist of collecting environmental samples for culture at two-week intervals for three months. If *Legionella* isn't detected during that time, then collect cultures monthly for another three months. Adjust the sampling plan over time based on trend data.

Before you can consider an outbreak over, an effective [WMP](#) to prevent ongoing transmission of *Legionella* should be in place. You can extend the timeframe for enhanced environmental and clinical surveillance following an outbreak at any point if public health officials have concern for the potential for ongoing transmission of *Legionella*. Concerns about the potential for ongoing transmission would be based on factors such as *Legionella*-positive environmental cultures, new cases of LD, or suboptimal performance of the WMP.

References

Centers for Disease Control and Prevention (2021, March 25). *Legionella (Legionnaires' Disease and Pontiac Fever)*. <https://www.cdc.gov/Legionella/>

Centers for Disease Control and Prevention (2021, March 25). *Legionella (Legionnaires' Disease and Pontiac Fever): Defining Healthcare Facilities and Healthcare-associated Legionnaires' Disease*. <https://www.cdc.gov/investigate-legionella/php/healthcare-resources/healthcare-facilities.html>

Council of State and Territorial Epidemiologists (2022, June 1). *Legionnaires' Disease Risk Communication Toolkit*. https://cdn.ymaws.com/www.cste.org/resource/resmgr/leg-toolkit/ld_risk_communications_toolk.pdf

Cohn, P. D., Gleason, J. A., Rudowski, E., Tsai, S. M., Genese, C. A., & Fagliano, J. A. (2014). Community outbreak of legionellosis and an environmental investigation into a community water system. *Epidemiology and Infection*. <https://doi.org/10.1017/S0950268814001964>

Lucas, K. D., Wheeler, C., McLendon, P., Leistikow, B. N., & Mohle-Boetani, J. C. (2018). Outbreak of Legionnaires' disease associated with cooling towers at a California state prison, 2015. *Epidemiology and Infection*, 146(3), 297-302. <https://doi.org/10.1017/S0950268818000110>

Healthcare Infection Control Practices Advisory Committee (2003). *Healthcare-Associated Pneumonia Prevention Guideline*. <https://www.cdc.gov/infection-control/hcp/pneumonia-prevention/index.html>

Linked Resources

Line List Templates: [Healthcare-associated Outbreak Line List](#), [Travel-associated Outbreak Line List](#), [Community-associated Outbreak Line List](#)

Toolkit: Developing a Water Management Program to Reduce *Legionella* Growth and Spread in Buildings: This toolkit is designed to help people understand which buildings and devices need a *Legionella* water management program to reduce the risk for Legionnaires' disease, the key elements of a water management program, and how to develop it. <https://www.cdc.gov/Legionellahttps://www.cdc.gov/control-legionella/media/pdfs/toolkit.pdf>

Toolkit for Controlling *Legionella* in Common Sources of Exposure: Provides public health and building owners and operators with concise, actionable information on controlling *Legionella* in commonly implicated sources of Legionnaires' disease outbreaks. It helps focus and improve *Legionella* control efforts and protect the safety of a building's employees, visitors, and surrounding community. <https://www.cdc.gov/Legionellahttps://www.cdc.gov/control-legionella/media/pdfs/Control-Toolkit-All-Modules.pdf>

Preventing Legionnaires' Disease: A Training on *Legionella* Water Management Programs (PreventLD Training): Take this free training from CDC and partners on creating a water management program to reduce risk for Legionnaires' disease. PreventLD Training aligns with industry standards (ASHRAE 188) on managing risk for *Legionella* bacteria. https://www.cdc.gov/control-legionella/php/training/?CDC_AAref_Val=https://www.cdc.gov/nceh/ehs/elearn/prevent-LD-training.html

ANSI/ASHRAE Standard 188-2021, Legionellosis: Risk Management for Building Water Systems: Establishes minimum legionellosis risk management requirements for building water systems. https://store.accuristech.com/standards/ashrae-188-2021?product_id=2229689

Worksheet to Identify Buildings at Increased Risk for *Legionella* Growth and Spread <https://www.cdc.gov/Legionellahttps://www.cdc.gov/control-legionella/php/toolkit/wmp-worksheet.html>

Centers for Medicare and Medicaid Services (CMS) Requirement to Reduce *Legionella* Risk in Healthcare Facility Water Systems to Prevent Cases and Outbreaks of Legionnaires' Disease (LD) <https://www.cms.gov/Medicare/Provider-Enrollment-and-Certification/SurveyCertificationGenInfo/Downloads/QSO17-30-HospitalCAH-NH-REVISED-.pdf>

Legionnaires' Disease Risk Communication Toolkit: This offers comprehensive communications guidance for health departments, including setting- and scenario-specific modules. https://cdn.ymaws.com/www.cste.org/resource/resmgr/leg-toolkit/ld_risk_communications_toolk.pdf

Infection Control Assessment and Response (ICAR) Tool for General Infection Prevention and Control (IPC) Across Settings Module 11: Water Exposure Facilitator Guide. [CDC ICAR Module 11: Water Management](#)