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Legionella Exposure Control Plan

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1.0 Introduction

1.1 It is the policy of The Ohio State University (OSU) to take precautions to eliminate potential hazards in the workplace. The purpose of this Legionella Exposure Control Plan is to specify the standard practices to be used by facility management to prevent legionellosis associated with building water systems. Legionellosis refers to two illnesses associated with Legionella bacterium. When the bacterium Legionella causes pneumonia, the disease is referred to as Legionnaires' disease. Legionella can also cause a less severe influenza-like illness known as Pontiac Fever. Most all cases of legionellosis are the result of exposure to Legionella associated with building water systems.

The presence alone of Legionella bacteria in building water systems is not sufficient to cause legionellosis. Other factors including environmental conditions, water temperatures, biofilms, etc. and a means of transmitting the bacteria to people in the building via aerosol generation are necessary to cause outbreak of disease as a result of exposure. Legionellosis is contracted via inhalation of Legionella bacteria. Disease is not transmitted person-to-person and susceptible persons are more at risk for legionellosis including, but not limited to, the elderly, dialysis patients, and persons with weakened immune systems.

In 2015, ASHRAE developed a new standard aimed at preventing the growth and spread of Legionella. Created as a voluntary consensus standard, ASHRAE 188 provides guidance that does not have regulatory authority unless it is incorporated into local building codes, and was developed by a committee comprised of academic, industry and government subject matter experts. By creating a framework for proactively managing building water systems and reducing the potential for Legionella growth in these systems, following this standard can help building and facility managers minimize the risk for exposure to legionella.

The scope of this program outlines the following:

- Potential risks and preventative measures associated with building water systems including potable water systems (including emergency eyewash/shower stations); cooling towers and evaporative condensers; health care facilities; hotels; spas, hot tubs, & swimming pools; decorative fountains; and water aerosolizing equipment such as humidifiers.
- Responding to a legionellosis case/outbreak through environmental sampling and water treatment.
- Disinfection methods for the various types of building water systems within a facility.
- The development and contents of a Water Management Plan for a facility, or group of facilities.

2.0 Responsibilities

2.1 Environmental Health & Safety

2.1.2 Environmental Health & Safety (EHS) provides program oversight and consultation to OSU work groups regarding potential risks, exposure prevention and training relating to Legionella.

2.2 OSU Department (Facilities Operations & Development (FOD); Athletics; OSU Medical Center (OSUMC); Student Life; et. al.)

2.2.1 Each department with responsibilities for maintaining buildings or facilities where water systems are present are responsible for the following.

2.2.1.1 Ensure the applicable components of the Legionella Exposure Control Plan are available to all affected employees.

2.2.1.2 Provide applicable training to employees expected to work in, or with, building water systems where there is a potential risk of Legionella being present.

2.2.1.3 Develop and maintain a Water Management Plan for all facilities under the direction of the work group.

2.2.1.3.1 The Water Management Plan, which is described in detail within this plan, involves facility managers to characterize the Legionella risk associated with a building and its potential occupants. If a Legionella risk is present, a hazard analysis must be performed to identify potential hazards, determine what hazard/exposure control methods are in place, and any corrective actions to take if an exposure to Legionella occurs.

2.3 Supervisors

2.3.1 OSU employees who supervise personnel with responsibilities to work in areas where there is a risk of exposure to Legionella, must ensure employees are properly trained on the applicable contents of the Legionella Exposure Control Plan and are provided appropriate personal protective equipment (PPE) when conducting such work.

2.4 Authorized Person

2.4.1 Employees working in areas where there is an identified risk of Legionella exposure must be properly trained on all applicable elements of the OSU Legionella Exposure Control Plan; and be provided and utilize the appropriate PPE for the task being performed.

3.0 Definitions

3.1 The following definitions are provided to allow for a better understanding of the OSU Legionella Exposure Control Plan.

Biocide:	A substance which can deter, kill, or render harmless a target organism or microorganism.
Biofilm:	A group of microorganisms/bacteria where cells stick to each other on a surface such as cooling tower screens, water sink faucets, humidifiers, etc.
Cooling Tower:	An evaporative heat transfer device in which atmospheric air cools wastewater, with direct contact between the water and the air through evaporation. Air movement through such a tower is typically achieved by fans and uses a media to achieve improved contact between the water and cooling air.
Emergency Water System:	A building water system not intended for human consumption but rather for emergency use only, including fire suppression/sprinkler system and emergency eyewash and shower systems. It is not uncommon for emergency water systems to be fed from a potable water system.
Water Management Plan:	A risk assessment method for building water systems and their potential to promote the presence of Legionella; hazard exposure

	control methods and response to Legionella presence in building water systems.
Legionnaires' Disease:	An acute bacterial infection of the lower respiratory tract with accompanying pneumonia.
Legionella:	The name of the genus of bacteria that was subsequently discovered as the disease causative pathogen associated with the 1976 outbreak of disease at the American Legion Convention in Philadelphia. Legionella are common aquatic bacteria found in natural and man-made water systems, as well as occasionally in some soils. More than 50 species of Legionella have been identified; however, Legionella pneumophila is associated with the majority (90%) of legionellosis cases.
Legionellosis:	The term used to describe any illness caused by exposure to Legionella bacteria. Legionnaires' disease and Pontiac fever are the two most common types of legionellosis, with Legionnaires' disease being the more serious and of primary concern.
Potable water system:	A building water distribution system that provides water intended for human consumption (drinking, food preparation, direct human contact) including hot and cold water distribution.

4.0 Legionella Risk Factors, Control & Preventative Measures

Legionella pneumophila bacteria are widely distributed in water systems. They tend to grow in biofilms or slime on the surfaces of lakes, rivers and streams; and they are not eliminated by the chlorination used to purify domestic water systems. Low, and sometimes detectable levels of Legionella can colonize a water source and grow to elevated concentrations under the right conditions. Conditions that promote growth of Legionella include heat, sediment, scale, and supporting microorganisms in the water. Common water organisms including algae, amoebae and other bacteria may amplify Legionella growth by providing nutrients for the organisms. Due to Legionella's ability to remain viable in domestic water systems, it is capable of rapid multiplication under proper conditions.

Water conditions, which tend to promote the growth of Legionella include:

- Stagnant water
- Water temperatures between 68^0 – 122^0F
- pH between 5.0 - 8.5
- Presence of sediment that tends to promote growth of legionella and symbiotic organisms
- Presence of other microorganisms including algae and other bacteria, which supply nutrients for the growth of Legionella.

Water sources, which frequently provide optimal growth conditions for Legionella include:

- Cooling towers, evaporative condensers, and fluid coolers that use evaporation to reject heat.
- Domestic hot water systems with water heaters that operate below 140^0F and deliver water to taps below 122^0F.
- Humidifiers and decorative fountains that create a water spray or mist and use water at temperatures favorable to Legionella growth.
- Dental water lines, which are frequently maintained at temperatures above 68^0F and reach 98.6^0F for patient comfort.

- Other sources including stagnant water in fire sprinkler systems and warm water for eye washes and safety showers.

The following outlines areas of a building/facility, which pose a potential risk for the colonization of Legionella bacteria and the common control measures that can/should be implemented to minimize the likelihood of Legionella exposure.

4.1 Cooling Towers & Evaporative Condensers

Cooling towers and evaporative condensers (closed circuit cooling towers) are heat transfer devices in which warm water is cooled through evaporation in atmospheric air. These devices are used as part of a building system to provide cooling for industrial processes; provide refrigeration in cold stores; and to cool water for air-conditioning for buildings. Air movement through the tower or condenser is produced by fans or by natural convection. Aerosols generated during the operation of the cooling tower or condenser may contain Legionella bacteria and must therefore be considered a potential source, requiring control measure implementation.

4.1.1 Risk factors associated with Legionella and cooling towers/condensers include the following:

4.1.1.1 Source water quality:

4.1.1.1.1 The make-up water for a cooling tower or evaporative condenser typically comes from a municipal supply. However, sometimes a holding tank is utilized, which may contain rust, sludge and sediment, which can promote Legionella growth.

4.1.1.2 System design/Materials of construction:

4.1.1.2.1 Areas of standing/stagnant water, such as dead legs, prevent proper chemical treatment of the system, which may allow Legionella to proliferate.

4.1.1.3 Biofilms:

4.1.1.3.1 Cooling towers and evaporative condensers move large quantities of air, and are excellent air scrubbers. Thus, dirt, dust and other particulate matter enter the cooling tower water during the cooling process. Organic matter and other debris present in the air can accumulate in the cooling water. Biofilms, which can support the growth of Legionella, may be present on all wet or moist surfaces throughout the system.

4.1.1.4 Temperature:

4.1.1.4.1 Typical water temperatures in an operating cooling tower range from $85^0 – 95^0$F, which promote Legionella growth.

4.1.1.5 Aerosol generation:

4.1.1.5.1 Even through appropriate design, installation and proper operation, cooling towers can generate water droplets small enough to be inhaled (< 5µm in diameter). Aerosol generation of inhalable water droplets contaminated with Legionella can pose an exposure risk to personnel working around these units.

4.1.2 Control/Preventative Measures used to minimize the growth and proliferation of Legionella includes the following. The overall goal of most preventative measures is to minimize microbial growth, corrosion, rust, and sediment build up and temperature control.

4.1.2.1 Source water quality:

4.1.2.1.1 Where a holding tank is used to house make-up water, the tank should be free of rust, sludge and sediment whenever the tower is cleaned and disinfected (bi-annual is recommended).

4.1.2.1.2 To reduce the concentration of dissolved minerals, such as calcium and magnesium, water softening techniques can be used. Water softening reduces the potential of the system forming biofilms.

4.1.2.1.3 Reduction of the organic content in the source water through chlorination or filtration removes nutrients that could promote Legionella growth.

4.1.2.2 System design/Materials of construction:

4.1.2.2.1 Cooling towers should be designed to be easy to clean, avoid the accumulation of sludge and deposits and provide easy access for preventative maintenance activities.

4.1.2.2.2 A system should be designed to ensure water circulates through all parts of the system. Dead legs on existing systems should be removed or shortened to prevent buildup of stagnant water.

4.1.2.2.3 Dirt, organic matter and other debris should be kept to a minimum.

4.1.2.2.4 Corrosion inhibitors can be utilized to minimize corrosion of metal surfaces. Use of these chemicals will assist in efficient heat transfer at metal surfaces and ensure better water flow through the system.

4.1.2.2.5 Cooling towers should be located away from building air intakes to ensure aerosolized water droplets are not introduced into occupied areas of buildings/facilities.

4.1.2.2.6 New systems should be designed to minimize spray generated by the system. Older systems can be retrofitted with high-efficiency drift eliminators

4.1.2.3 Biofilms:

4.1.2.3.1 Use of a dispersant/detergent along with biocides will assist in penetration of biofilms.

4.1.2.4 Temperature:

4.1.2.4.1 Systems should be designed to operate at the lowest possible temperature to minimize Legionella growth.

4.1.2.4.2 Sump water should be maintained at or below 68^0F to control bacterial growth.

4.1.2.5 Aerosol generation:

4.1.2.5.1 Cooling towers are equipped with spray drift eliminators, which vary in effectiveness. Systems should be inspected regularly and either cleaned and disinfected; or replaced as necessary. Older systems may require more frequent inspections and cleaning.

4.1.3 Preventative maintenance of cooling towers is essential for minimizing Legionella growth. The following procedures are effective options for maintaining a clean system:

4.1.3.1 Regularly scheduled physical cleaning.

4.1.3.1.1 Drain, clean and disinfect cooling towers quarterly or at least twice a year if the unit is not used year round. This should be completed before initial start-up at the beginning of the cooling season and afer shut-down in the fall.

4.1.3.1.2 Any system that has been out of service for an extended period should be cleaned and disinfected.

4.1.3.1.3 Newly installed systems must be cleaned and disinfected prior to start-up.

4.1.3.2 Addition of treatment chemicals to the water at a rate to maintain concentrations at a level which minimizes bacterial growth.

4.1.3.3 Cleaning of wetted components.

4.1.3.4 Treatment of water to prevent corrosion of metals associated with the system.

4.1.3.5 Personnel performing routine maintenance and inspection of cooling towers do not normally need to wear personal protective equipment, such as a particulate respirator to eliminate exposure to Legionella.

4.1.3.5.1 If there is a reason to expect the presence of Legionella in cooling tower water (i.e. period of inactivity, or optimal growth conditions) personal protective equipment should be utilized by the personnel conducting maintenance. N95 respirators provide protection against airborne bacteria.

4.1.3.5.2 During cleaning of cooling towers, especially if power washing equipment is utilized, Legionella in biofilm buildup can be released into the air. N95 respirators should be utilized by personnel during cleaning operations.

4.1.3.5.3 There are no regulatory exposure limits for Legionella, however it is recommended N95 respirators be used based on the aforementioned items. Users should be enrolled in the OSU Respiratory Protection Program.

4.1.4 A water treatment program allows cooling towers to utilize water appropriate for the system while minimizing microbial growth, scale, corrosion and sediment build up, which can promote Legionella growth.

4.1.4.1 Controlling scaling and corrosion is necessary in certain water treatment settings.

4.1.4.1.1 Scaling can be controlled through the use of inhibitors containing phosphates and polymers to keep calcium and carbonate in solution and prevent scaling.

4.1.4.1.2 Corrosion can be minimized through the use of inhibitors such as phosphate, azoles, molybdenum and zinc.

4.1.4.1.3 The use of these inhibitors not only controls scaling and corrosion, but assists in microbial control.

4.1.4.1.4 Adding a surfactant, such as a detergent, will allow the inhibitors to work effectively against biofilms.

4.1.4.2 Microbial growth is controlled through the use of biocides, with are compounds selected for their ability to kill microbes while having relatively low toxicity for plants, animals and humans. There are two groups of biocides used for water treatment:

4.1.4.2.1 Oxidizing biocides include bromine and chlorine based compounds that act as reducing agents in a chemical reaction. This type of biocide reacts with microbial membrane proteins causing the protein to become ineffective, thus killing the microorganism.

4.1.4.2.2 Nonoxidizing biocides include organic compounds and react with various areas of the microorganisms to control their growth.

4.1.4.2.3 It is generally accepted practice to vary the treatment process for cooling tower water to ensure microbes do not build up a resistance to certain treatment methods.

4.1.5 When a shut-down or period of inactivity longer than 36 hours is anticipated for a cooling tower system, it is recommended the entire system be drained or pre-treated with an appropriate biocide before startup.

4.2 Potable & Emergency Water Systems

Potable water systems in regards to Legionella control begin where the water supply enters the building, and end where water exits the piping at a faucet, showerhead, dental line, etc. The potable water system includes all piping, hot water heaters, storage tanks, faucets, nozzles, and other fixtures and valves.

4.2.1 Risk factors associated with Legionella and potable water systems include the following.

4.2.1.1 Chlorine concentration/disinfection controls:

4.2.1.1.1 Municipal water supplies are chlorinated to control the presence of microorganisms typically associated with sewage. Legionella may be more tolerate to these chlorine concentrations resulting in their potential presence in supply water.

4.2.1.2 Temperature:

4.2.1.2.1 Water temperatures between 77^0 – 108^0F will sustain Legionella growth. Hot water supply lines or hot water tanks within a facility where temperatures in this range exist are at a potential risk for Legionella population.

4.2.1.3 Plumbing system design:

4.2.1.3.1 Legionella may be present in stagnant areas of water within a potable water system. Dead legs/dead ends, infrequently used storage tanks, hoses, nozzles and tap faucets are common areas where bacteria can proliferate.

4.2.1.3.2 Water fixtures, which produce aerosols, such as eyewash and shower stations, toilets and humidifiers, can be an exposure source for Legionella.

4.2.1.3.3 The materials used in construction of the potable water system can promote the growth of Legionella. Metallic materials, such as copper and cast iron, are typically more resistant to bacterial growth; however older systems can promote biofilm growth through corrosion of the piping. Newer plumbing materials, such as polyvinyl chloride (PVC) and polybutylene may vary in their potential to support bacterial growth as organic materials may be leached into the system over time. Additionally, rubber washers and fittings have been proven to provide adequate sites for bacterial growth.

4.2.2 Control/Preventative Measures used to minimize the growth and proliferation of Legionella within a potable water system includes the following. The overall goal of most preventative measures is to minimize microbial growth, corrosion, rust, and sediment build up and temperature control.

4.2.2.1 Chlorine concentration/disinfection controls:

4.2.2.1.1 Water supplied from municipal systems should meet minimum requirements for nutrient and disinfection levels. Levels of Legionella are typically controlled in water supplied from a municipal system. Supply water from a well or holding tank may require additional treatment to ensure disinfection methods minimize the potential for Legionella growth.

4.2.2.2 Temperature:

4.2.2.2.1 In health care facilities and other high risk facilities, cold water should be stored and distributed at temperatures below 68^0F; and hot water should be stored above 140^0F and circulated with a minimum temperature of 124^0F.

4.2.2.2.2 In all other facilities, hot water should be maintained at a temperature of 120^0F or above.

4.2.2.2.3 Hot water tanks should be inspected and cleaned annually to reduce sediment, scaling and corrosion.

4.2.2.3 Plumbing system design:

4.2.2.3.1 Control of Legionella begins during the design stages of a potable water system. In general, pipe runs should be as short as possible. Dead legs/dead ends should be avoided at all times during design and construction phases; and in existing systems should be eliminated or removed as necessary. If removal is not possible, regular flushing of the system is recommended. Materials used in the construction of a potable water system should be applicable to the system being installed and be designed to minimize bacterial growth.

4.2.2.3.1.1 Detailed plans for the hot and cold water supply for a facility should be readily available.

4.2.2.3.1.2 Hot water tanks and other water storage vessels should have a drainage point to allow for flushing of the system.

4.2.2.3.2 Water efficiency devices, such as diffusers, reduce water use but can increase aerosol production. In high risk facilities, such as hospitals, the use of diffusers is not recommended.

4.2.2.3.3 Eyewash and shower stations as well as dental supply lines should be flushed at least weekly. Exposures to water from fire sprinkler systems, which discharge automatically in the event of a fire, are unlikely due to building evacuation. Personnel responding to a fire where the sprinkler system has been discharged or to a malfunctioning sprinkler head which is discharging water should don appropriate respiratory protection since fire sprinkler water remains stagnant until used.

4.2.2.3.4 Other controls including copper-silver ionization, ultraviolet (UV) disinfection, etc., may be used if determined necessary.

4.3 Heated Spas

Heated spas include whirlpools, hot tubs, hydrotherapy pools and baths. Water temperature in these spas, baths and pools is typically in the range of 90^0 – 104^0F, which is close to the optimum temperature for the multiplication of Legionella. Typically water is constantly recirculated within the heated spa via high-velocity jets and/or injection of air.

4.3.1 Risk factors associated with Legionella and heated spas include the following.

4.3.1.1 Organic material:

4.3.1.1.1 Due to the small size of heated spas and the fact most are not drained between uses, the amount of organic material, such as skin cells, body oils, bacteria and cosmetics/body lotions, constantly increases. This results in the biocide to become inactive more rapidly, which can encourage microbial growth. Many users fail to adhere to the advice to shower before entering a heated spa.

4.3.1.2 Temperature:

4.3.1.2.1 A water temperature in heated spas is between $90^0 – 104^0$F, which can promote the growth of Legionella and other microorganisms.

4.3.1.3 Design, operation & maintenance:

4.3.1.3.1 Heated spas, specifically hot tubs and whirlpool spas, which are designed and constructed with various tubes, pipes and valves, are susceptible to Legionella contamination. Pipes are often inaccessible and difficult to clean and drain, and may have areas of stagnation allowing biofilms to form. Other pipework, such as those supplying air to the spa, may not circulate treated water through the system, providing an area for Legionella to grow and biofilms to form.

4.3.1.3.2 Heavy use of a heated spa can result in a change in the pH of the water, which can reduce the effectiveness of the active biocide treatment method.

4.3.1.4 Aerosols:

4.3.1.4.1 Due to the operational features of heated spas, including water and air jets, aerosols are generated near the surface of the spa, within the breathing zone of the users. Microorganisms, such as Legionella, if in the water can be present in these aerosols.

4.3.2 Control/Preventative Measures used to minimize the growth and proliferation of Legionella within heated spas includes the following. The overall goal of most preventative measures is to minimize microbial growth, biofilm and temperature control. Heated spas should be treated with a biocide at all times. Common biocides used in heated spas include chlorine or bromine, which are sometimes combined with additional treatment techniques such as UV light or ozone. Heated spas should be on a preventative maintenance program to ensure biocide levels are maintained and pH levels remain acceptable.

4.3.2.1 Organic material:

4.3.2.1.1 To maintain organic material levels at a low level, heated spa users should practice good personal hygiene and should be encouraged to shower before entering a heated spa; adhere to posted bather load limits; and limit the time spent in a heated spa. It is recommended no user spend more than 15 minutes in a heated spa.

4.3.2.2 Temperature:

4.3.2.2.1 The water temperature for heated spas is intended to be maintained at warmer levels according to therapeutic benefits and user comfort. With the addition of biocides and preventative maintenance operations, the levels of microorganisms should be controlled and water temperatures can be maintained.

4.3.2.3 Design, operation & maintenance:

4.3.2.3.1 Heated spas should be designed, constructed, installed and operated to minimize Legionella growth.

4.3.2.3.1.1 Minimize surface area in the spa piping system

4.3.2.3.1.2 Use materials that do not support microbial growth.

4.3.2.3.1.3 Pipework should be accessible and removable to accommodate cleaning to remove biofilms.

4.3.2.3.1.4 Jets should be removable to accommodate cleaning to remove biofilms.

4.3.2.3.2 Biocide treatment and maintenance schedules should be developed, documented and completed for all heated spas. Heated spas should be frequently cleaned and disinfected to remove any biofilms and ensure microbial growth is eliminated.

4.3.2.3.2.1 Many heated spas fall under the jurisdiction of the local health department. Operators must ensure all applicable health code parameters are followed in regards to treatment, testing and recordkeeping.

4.3.2.3.2.2 Filters should be cleaned, disinfected and/or replaced as recommended by the manufacturer.

4.3.2.3.2.3 Water chemistry should be checked on a regular basis and maintained as required by applicable agency standards.

4.3.2.3.3 Maximum capacity limits/bather load should be posted in a visible area near all heated spas.

4.3.2.4 Aerosols:

4.3.2.4.1 Water and air jets should be set to automatically turn off every 15-20 minutes to encourage users to exit the heated spa. This will allow the water to recover from the organic load input from previous users and provide a stable system for future users. Aerosol generation is common in heated spas due to the nature of operation. The combination of biocide treatment schedules and preventative maintenance operations should prevent microorganism proliferation.

4.4 Decorative Water Features

Decorative water features typically have a water holding area where pumps circulate the water, which is typically either sprayed into the air, or cascaded over decorative features, such as rocks where the water returns to the holding area.

4.4.1 Risks involved with the use/presence of decorative water features include the following:

4.4.1.1 System operation:

4.4.1.1.1 Often times decorative water features are only used during the day, resulting in periods of inactivity where the water remains stagnant. Stagnant water promotes microbial growth and can lead to the formation of biofilms where Legionella can proliferate.

4.4.1.2 Temperature:

4.4.1.2.1 Typically water temperatures in decorative water features are maintained below 77^0F. However, outdoor water features can have elevated water temperatures, which can allow for the growth of Legionella. Additionally, water pumps can generate heat and elevate water temperature in a water feature. Intermittent use can also result in elevated temperatures of water features.

4.4.1.3 Aerosols:

4.4.1.3.1 Due to the nature of water being pumped and either sprayed or cascading, aerosol generation can pose an exposure risk in areas around these decorative water features.

4.4.2 Control/Preventative Measures used to minimize the growth and proliferation of Legionella within decorative water features includes the following.

4.4.2.1 System operation:

4.4.2.1.1 Decorative water features should use minimum pipe distances to achieve the desired fountain operation.

4.4.2.1.2 Drains should be located in the system to allow for complete drainage and cleaning operations.

4.4.2.1.3 Decorative water features and all associated pumps and piping should be cleaned regularly and the use of filters should be considered

4.4.2.1.4 Water used in decorative water features should be treated water from a municipal water system. Additional microbial control may be necessary if conditions reach levels of optimal growth for Legionella.

4.4.2.2 Temperature:

4.4.2.2.1 Water temperature should be maintained below 70^0F to minimize microbial growth.

4.4.2.3 Aerosols:

4.4.2.3.1 Aerosol generation is common in decorative water features due to the nature of operation. The combination of using treated water, additional biocide treatment schedules and preventative maintenance operations should prevent microorganism proliferation

4.5 Humidifiers & Air Misters

Humidifiers increase the amount of water vapor in the air and are typically used locally in low humidity areas or as part of a HVAC system to promote comfort levels in a facility. Air misters produce a fine spray of water to act as a cooling agent in elevated temperature environments and can be found in agricultural settings, such as a greenhouse.

4.5.1 Due to nature of operation of humidifiers and air misters and the direct input of aerosolized water in the air, microbial growth control should be integrated into the preventative maintenance program.

4.5.1.1 Humidifiers and air misters should only be used with treated water from a municipal water treatment facility.

4.5.1.2 Humidifiers and air misters should be cleaned and disinfected on a regular basis to remove biofilm buildup.

4.5.1.3 Water temperatures should be maintained below 70^{0}F.

5.0 Environmental Sampling for Legionella

Sampling for Legionella may be necessary depending on the application and water system being sampled or in the event of a suspected exposure to Legionella. Reasons for environmental sampling include the following:

- Regular testing of water within a system, such as a cooling tower
- Verification of an existing water treatment system
- Exposure response and determination of Legionella presence in water systems
- Verification of a decontamination process conducted on a water system
- In potable water system in health care facilities or where high risk individuals are housed

Where environmental sampling is conducted, proper sampling protocol should be followed. Water sample analysis should be performed by an independent laboratory and results should be interpreted by OSU personnel to determine appropriate follow up measures to take, if necessary.

The use of the following OSHA guidelines in Table 1 should be used to assess the effectiveness of water system maintenance and to interpret sampling results. The values in Table 1 are applicable to facilities/buildings occupied by generally healthy individuals. Medical centers may utilize more conservative values when interpreting Legionella sampling results.

Table 1: OSHA Recommended Legionella in Water Systems

Results provided in number of colony forming units (CFU) of Legionella per milliliter (ml) of water.			
Action/Response	Cooling Tower / Evaporative Condenser	Potable Water	Humidifiers / Misters
Continue current treatment methods.	0 – 100	0 – 10	0
Clean and disinfect system followed by biocide treatment if necessary	100 – 1,000	10 – 100	1 – 10

Immediate cleaning and disinfecting of the system followed by biocide treatment. Prevent employee and public exposure.	>1,000	>100	>10

5.1 Building managers are responsible for implementing acceptable sampling protocols based on the types of water systems present within the building/facility.

5.1.1 Cooling towers and evaporative condensers should be sampled on a regular basis. The recommended sampling interval is twice per year to ensure treatment methods are effective.

5.1.2 Other water systems, including potable water and emergency water; heated spas; decorative water features; and humidifiers and misters should be sampled when there is a potential risk for Legionella growth.

5.1.2.1 Medical centers, hospitals and facilities housing high risk individuals may require additional testing.

5.2 During the sampling process, the personnel taking the samples should don the appropriate PPE including respiratory (N95) and hand protection. If additional hazards exist, the appropriate PPE must be utilized.

5.3 The following guidelines should be followed when conducting sampling.

5.3.1 Cooling towers and Reservoirs:

5.3.1.1 Collect sample of water from the reservoir or condensation pan using a sterile screw-cap container. Place the container under the surface of the water and obtain at least 100ml of water.

5.3.1.2 Avoid collecting excessive sediment into the sample water.

5.3.2 Faucet:

5.3.2.1 Swab sample the faucet fixture allowing water to trickle from the faucet.

5.3.2.2 Collect a bulk sample in a sterile container. Typically, hot water samples should be collected.

5.3.3 Showerheads, eyewash and emergency showers:

5.3.3.1 Swab sample the faucet fixture allowing water to trickle from the faucet.

5.3.3.2 Collect a bulk sample in a sterile container. Typically, hot water samples should be collected.

5.4 In the event of elevated Legionella in a water system, the appropriate disinfection methods must be employed to ensure levels decrease below generally accepted limits outlined in Table 1.

6.0 Disinfection Methods

The growth of Legionella can be controlled through regular maintenance activities and a disinfection program. Facility managers should determine the best method for disinfection based on treatment effectiveness, cost and potential for piping/system corrosion.

Domestic water systems, which are supplied from municipal treatment plants, are pretreated with biocides to eliminate biological growth. Additional treatment methods can be employed to ensure Legionella proliferation does not occur. Facility managers are responsible for determining when additional treatment methods are required or recommended; based on the types of water systems in place within a building/facility. The following treatment methods are outlined as regular treatment regimens or treatment in response to Legionella detection in a water system. In the event of the detection of Legionella in a water system, one of the following methods must be utilized to eliminate Legionella from the system. Specific water treatment methods should adhere to the recommendations provided by ASHRAE and outlined in ASHRAE Guideline 12-2000 – Minimizing the Risk of Legionellosis Associated with Building Water Systems.

6.1 Thermal Heat and Flush

6.1.1 Elevating water temperatures above 160^0F for up to 30 minutes can sterilize a water system of Legionella. The system can then be flushed to ensure water is moved through all piping within a system to eliminate stagnant areas.

6.1.2 This method is chemical free and typically used in health care settings.

6.1.3 The heat and flush method is labor intensive and can result in longer down times in the water system. Additionally, use of this method alone is not sufficient for long term control of Legionella.

6.2 Shock Chlorination

6.2.1 Shocking a water system with elevated chlorine levels involves injecting chlorine into the water distribution system. Chlorine levels can be as high as 50 parts per million.

6.2.2 Elevated chlorine levels can be corrosive to piping and is not as effective in elevated water temperatures.

6.3 Chlorine Dioxide

6.3.1 The use of chlorine dioxide for treatment of potable water systems is an effective way to eliminate Legionella presence in water.

6.3.2 Chlorine dioxide should only be used by personnel knowledgeable in its properties and how to treat a system.

6.4 Copper-Silver Ionization

6.4.1 This technique involves the installation of a metallic ion unit to continuously treat water systems with copper and silver ions.

6.4.2 This treatment technique is particularly useful when treating hot water systems.

7.0 Outbreak Protocol

7.1 In the event of confirmed Legionella exposure, the following protocol can be followed to ensure additional exposures do not occur.

7.2 After a contaminated system has been treated, sampling can be used to verify the effectiveness of the treatment. Subsequent testing of cooling-system water at the following intervals can verify that ther is no significant bacterial re-growth.

7.2.1 Test weekly for the first month after return to operation

7.2.2 Teste every two weeks for the next two months.

7.2.3 Test monthly for the next three months.

8.0 Water Management Plan

Facility managers should develop and document a Water Management Plan for at risk facilities. The purpose of a Water Management Plan is to reduce the risk of Legionellosis by specifying the types of water systems in a facility; identifying risk factors, which may present favorable conditions for Legionella growth; establishing practices to address the identified risks; implementing sound preventative maintenance practices utilizing effective controls; and establishing ways to intervene when control limits are not met. The Water Management Plan concept is based on the proposed ASHRAE 188 Standard: “Prevention of Legionellosis Associated with Building Water Systems”.

To determine if a facility requires a Water Management Plan the following survey should be conducted. If any of the answers on the survey are “YES”, a Water Management Plan should be implemented.

If you answer YES to any of questions 1 through 4, you should have a water management program for *that building's* hot and cold water distribution system.

Healthcare Facilities

Yes ____ No ____ 1. Is your building a healthcare facility where patients stay overnight or does your building house or treat people who have chronic and acute medical problems† or weakened immune systems?

Yes ____ No ____ 2. Does your building primarily house people older than 65 years (like a retirement home or assisted-living facility)?

Yes ____ No ____ 3. Does your building have multiple housing units and a centralized hot water system (like a hotel or high-rise apartment complex)?

Yes ____ No ____ 4. Does your building have more than 10 stories (including basement levels)?

Devices in buildings that can spread contaminated water droplets should have a water management program even if the building itself does not. If you answer NO to all of questions 1 through 4 but YES to any of questions 5 through 8, you should have a water management program for *that device*.

Yes ____ No ____ 5. Does your building have a cooling tower*?

Yes ____ No ____ 6. Does your building have a hot tub (also known as a spa) that is not drained between each use?

Yes ____ No ____ 7. Does your building have a decorative fountain?

Yes ____ No ____ 8. Does your building have a centrally-installed mister, atomizer, air washer, or humidifier?

The following steps are provide a strategy to ensure a Water Management Plan is a multi-step, continuous process, with a high level of detail to mitigate any potential Legionella hazards.

1. Establish a water management program team
2. Describe the building water systems using text and flow diagrams
3. Identify areas where Legionella could grow and spread
4. Decide where control measures should be applied and how to monitor them
5. Establish ways to intervene when control limits are not met
6. Ensure the program is running as designed and is effective
7. Document and communicate all activities

8.1 Establish a Water Management Program Team

8.1.1 The Program Team should consist of personnel with the skills and knowledge necessary to formulate the Water Management Plan. These sets of skills and knowledge include:

8.1.1.1 Knowledge of the water systems in place within a facility
8.1.1.2 The ability to identify legionella growth control locations and control limits
8.1.1.3 The ability to identify and take corrective actions if legionella risks are identified
8.1.1.4 The ability to monitor and document program performance
8.1.1.5 The ability to perform program performance
8.1.1.6 The ability to communicate regularly about the Water Management Program and make revisions when necessary.

8.1.2 Generally, job classifications which are involved in a Water Management Program Team include building operators, managers and administrators; maintenance and engineering staff; safety officers; equipment/chemical suppliers; contractors/consultants such as water treatment professionals; industrial hygienists; microbiologists; environmental health specialists; and epidemiologists.

8.1.2.1 In healthcare settings the Program Team should also include staff knowledgeable in accreditation standards and applicable licensing requirements; infection control professionals and clinicians; and risk/quality management staff.

8.2 Describing building water systems

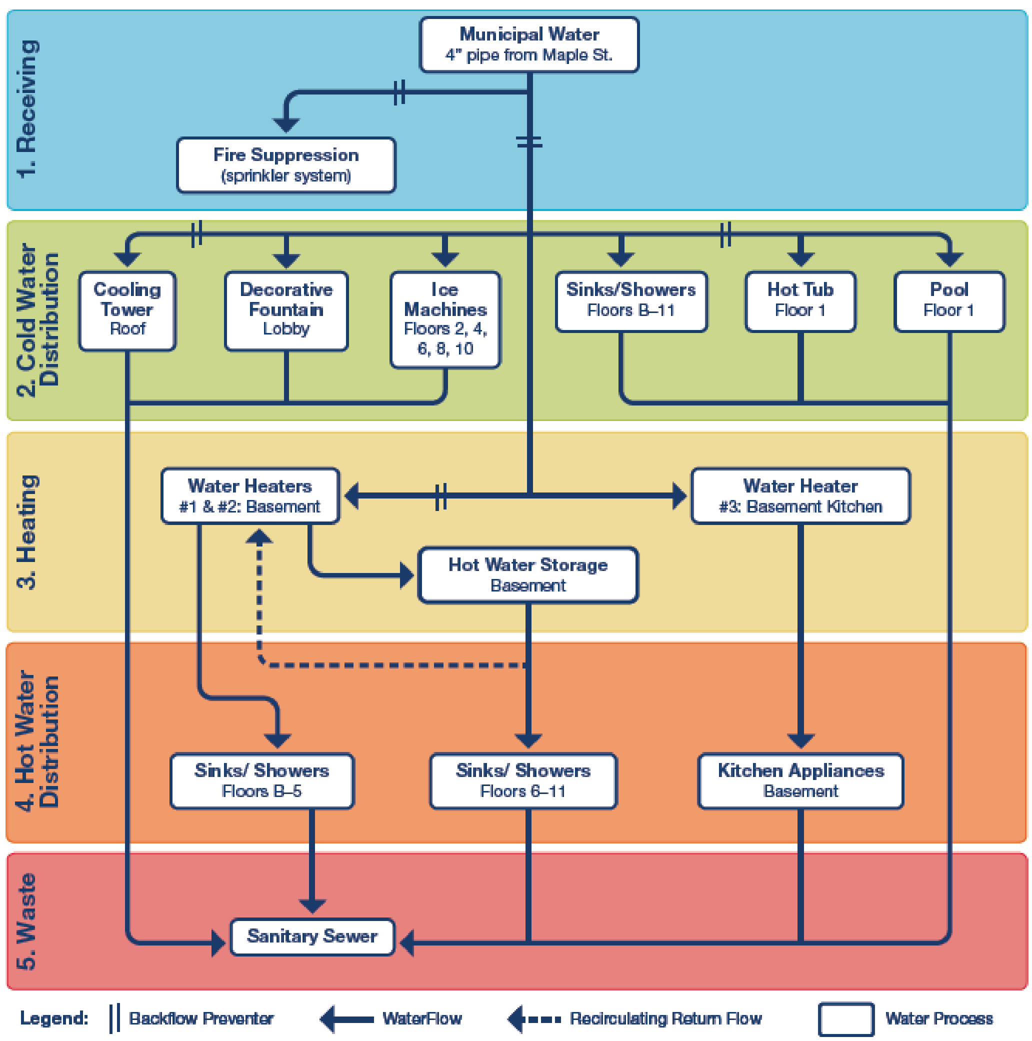
Building water systems should be described in text and graphically to include details such as where the building connects to the municipal water supply, how water is distributed and locations of pools/hot tubs/cooling towers/water heaters/boilers/decorative fountains.

8.2.1 Using an "as-built" diagram of a building plumbing system may be useful in creating a text description of the building water system. An example of a building water system description is provided:

Water supply: *Water enters the basement of the property via a 4-inch main from the municipal water line at (Street Name). Water is drawn off to charge the fire suppression system. Remaining water is sent through cold-water distribution. There is backflow prevention throughout the system, including between cold-water distribution and city water main; and between cold-water distribution and fire suppression system.*
Cold water distribution: *Cold water is distributed to the decorative fountain in the lobby, the cooling tower on the roof, the hot tube and pool on the first floor, the ice machines on floors 2, 4, 6, 8 and 10,*

and shower/faucet fixtures on all 12 floors of the building. All internal plumbing consists of 2-inch copper and PVC piping. There is backflow prevention between cold-water distribution and utility lines serving the cooling tower.
Heated water: *Cold water is heated to 140^{0}F by two 120-gallon water heaters. The heaters supply a 500-gallon storage tank.*
Hot water distribution: *Hot water is distributed to plumbing fixtures in the basement through floor 5 from the joined water heaters on a direct line. Hot water is distributed to floors 6-12 from the hot water storage tank with a recirculating line to return water to the basement water heaters. Hot water is tempered at the fixtures by mixing valves.*
Waste water: *Hot, cold and tempered waste water is discarded through the sanitary sewer line.*

8.2.2 In addition to developing a written description of a building water system, a process flow diagram should be created to visually describe the building water system. An example of a process flow diagram is provided:

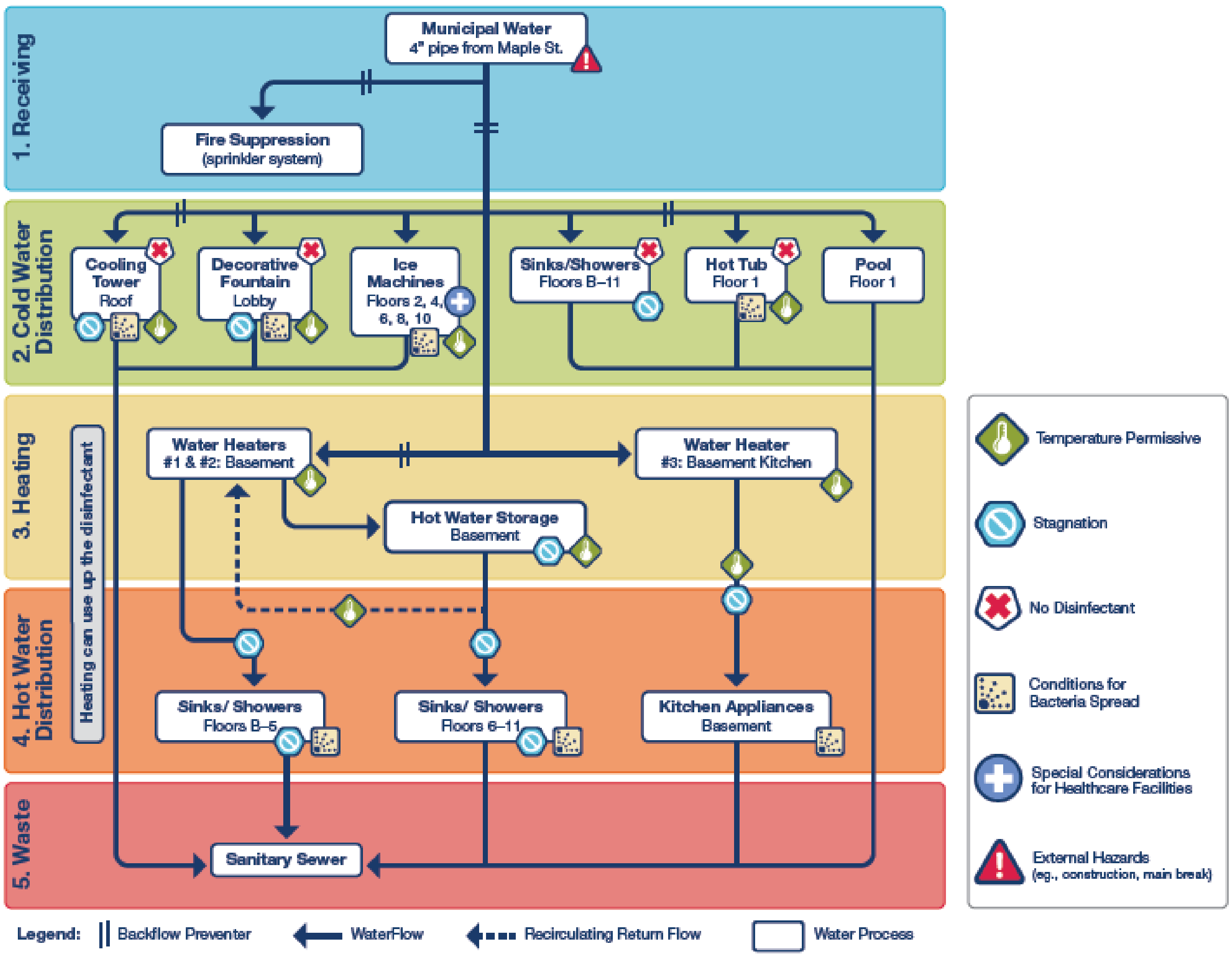


8.3 Identify areas where Legionella could grow and spread

Once a building water system has been described and represented graphically, it is possible to identify high-risk areas where Legionella could grow. An example of identification of high risk locations is provided below.

Health care facilities should pay special attention to:

- Areas where medical procedures may expose patients to water droplets, such as hydrotherapy
- Areas where patients are more vulnerable to infection, such as bone marrow transplant units, oncology floors or intensive care units.



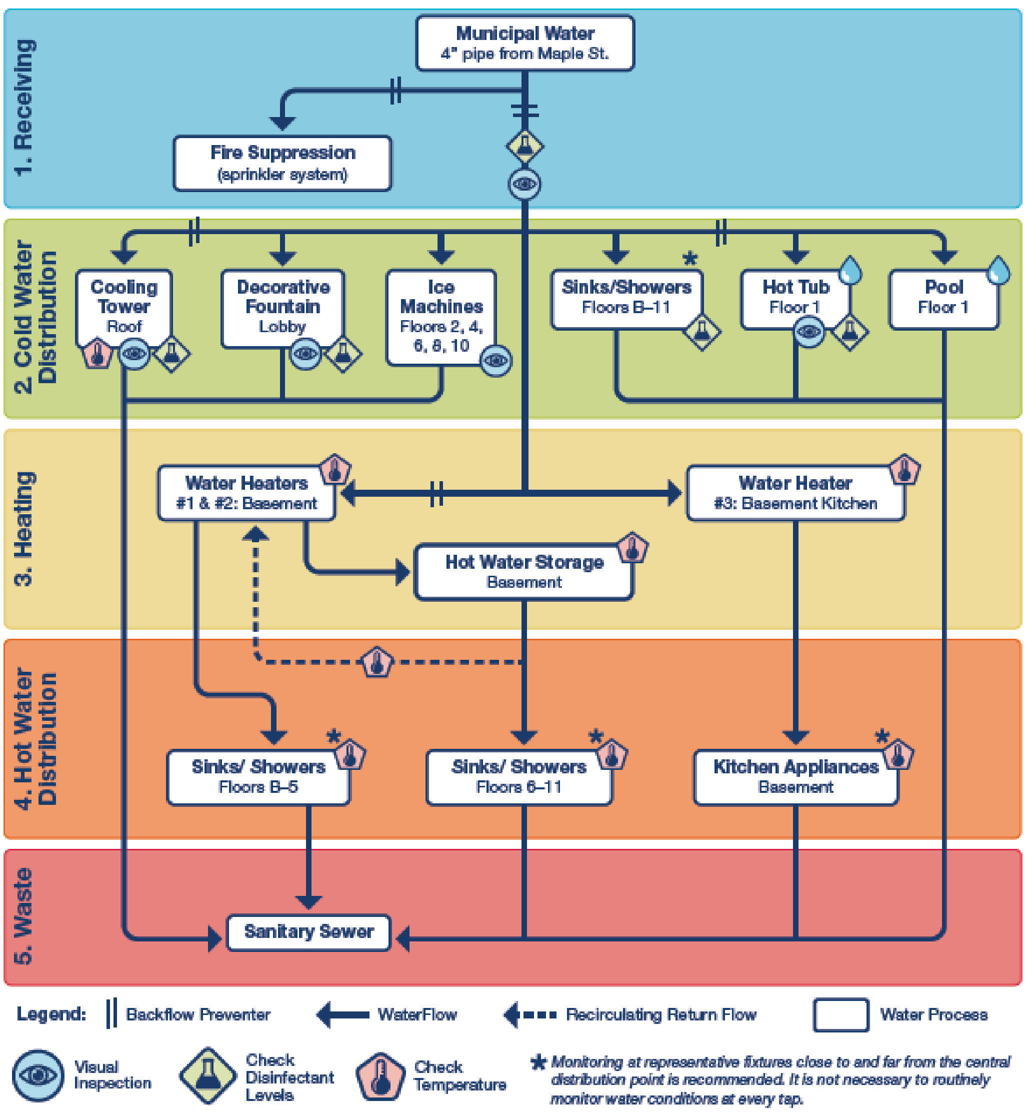
8.4 Decide where control measures should be applied

For each control point identified in 8.3 of this program, a control measure and limit should be established. Regular monitoring is required to ensure a control measure is performing as intended. Control limits, in which a chemical or physical parameter must be maintained, should include a minimum and maximum value.

Examples of control measures and limits to reduce the risk of Legionella growth include:

- Water quality including pH and chlorine/disinfectant levels
- Hot water temperatures
- Presence of biofilm on decorative fountains/hot tubs/spas/cooling towers/other water systems
- Disinfectant and other chemical levels in cooling towers.

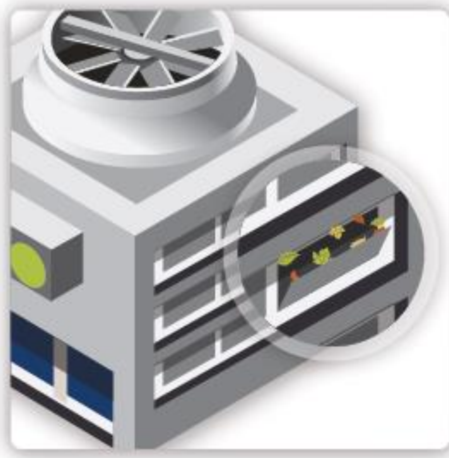
Special considerations for Healthcare facilities include testing patients with healthcare-associated pneumonia for Legionnaire's disease.



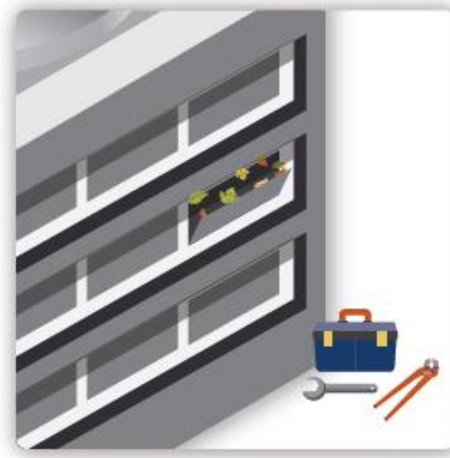
8.5 Establish ways to intervene when control limits are not met

In the event a control limit is not met, and there is a high risk of Legionella presence or Legionella growth is confirmed, corrective actions must be applied. Corrective actions must be applied in a timely manner to prevent Legionella exposure. Examples of corrective actions are provided:

Example 1: Debris in the cooling tower:



1. During weekly inspection of the cooling tower, Michelle discovers that leaf litter has accumulated in the reservoir.



2. Upon further investigation, she finds that a panel has become dislodged, allowing windblown debris to enter.

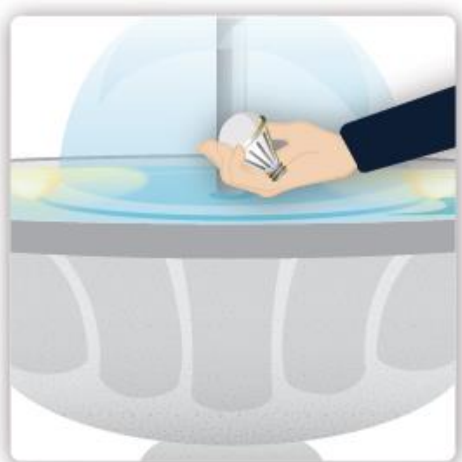
3. After replacing the panel and skimming out the debris, Michelle checks the disinfectant levels and performs a heterotrophic plate count as an indicator of water quality.

4. She documents her actions in her log book. She also makes a note to check the disinfectant levels daily for a week to make sure that the cooling tower remains within control limits. She reviews her actions and documentation with her supervisor.

Example 2: Biofilm growth in a fountain

1. During the annual review of the water management program, supervisor Anson Cho notes that Michelle and Jason performed six interim cleanings of the lobby fountain due to excessive biofilm growth in the past year.

2. Upon further review of the logs, he discovers that the biofilm growth was observed near the inner wall where incandescent lighting illuminates the water.



3. Anson decides to replace the incandescent bulbs with LED bulbs to prevent the lights from heating the water to a temperature that allows biofilm to grow.

4. After three months of routine inspections show that this corrective action reduces biofilm growth and eliminates the need for interim cleaning, Anson amends the water management program to specify use of only LED bulbs in the fountain and he informs the owner.

8.6 Ensure the Water Management Program is operating as designed and is effective

8.6.1 Verification: The Program Team should establish procedures to confirm, on an ongoing basis, the Water Management Program is being implemented as designed. *For example: the Water Management Plan requires daily chlorine tests in a hot tub, which should be recorded in a log. Is this being completed? If a problem was found, was it corrected?*

8.6.2 Validation: A Water Management Plan should be effective and efficient. The Program Team should ensure the plan is effective through validating the control measures put in place eliminate the risk of Legionella exposure. Environmental testing for Legionella can be used to validate the effectiveness of control measures.

8.6.2.1 If testing for Legionella is conducted, protocols should be specified and documented in advance and all local and state regulations; and accreditation standards must be followed.

8.7 Document and communicate activities of the Water Management Plan

Documenting the Water Management Plan is important to maintain continuity during personnel changes and when emergencies arise. The written program should include:

- Program Team: include names; job titles; contact information; role on the team
- Building description: location, age, uses and occupancy
- Water system description: general summary, uses of water, aerosol-generating devices, and process flow diagrams
- Control measures: points in the water system where critical limits can be monitored and where controls are applied.
- Verification and validation procedures: testing parameters and protocols

Communicate the contents of the plan with applicable personnel including building occupants, contractors, OSU Environmental Health and Safety, OSU FOD, and other users of the building.

The OSU Legionella Exposure Control Plan was developed using the guidelines and recommendations from the following resources and related policies:

World Health Organization, “Legionella and the prevention of legionellosis”, 2007.

ASHRAE, “Standard 188, Legionellosis: Risk Management for Building Water Systems” 2015.

ASHRAE Guideline 10-2000, “Minimizing the risk of legionellosis associated with building water systems”, 2000.

ASHRAE Position document on Legionellosis, 2012.

OSHA Technical Manual Section III: Chapter 7, “Legionaires’ Disease”,

CDC Guide to Developing a Water Management Program to Reduce Legionella Growth & Spread in Buildings