Deconstructing Legionella Risk Management A Practical Approach

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Agenda

Background: Legionnaires' Disease

Historic Outbreaks

Pathology: Infection, Diagnosis and Treatment

Legionella in Building Water Systems

Building Water Safety – Standards & Legislation

Water Safety Teams and Water Safety Plans

Technologies, Treatment Strategies and Controls

Testing, Monitoring and Record Keeping

Emergency Response: Internal and External

Legionnaires' Disease

A serious type of lung infection (pneumonia).

First discovered in 1976, following an outbreak at an American Legion convention in Philadelphia which resulted in 34 deaths and 153 hospitalizations.

CDC researchers traced the source to a new type of bacterium. In reference to the outbreak, the genus was named *Legionella*, and the pneumonia it causes became known as *Legionnaires' Disease*.

Legionnaires' Disease – Trending Data

Reported cases have been on the rise since 2000, peaking in 2018 with nearly 10,000 cases reported in the United States that year.

Legionnaires' Disease

Legionnaires' disease in the United States, 2000-2021

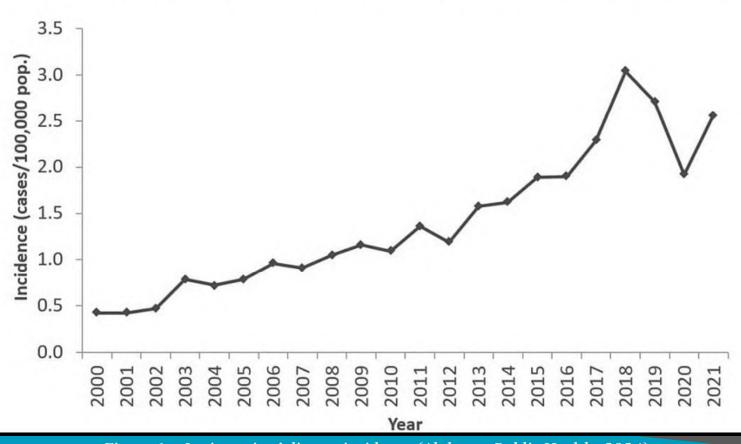


Figure 1 – Legionnaires' disease incidence (Alabama Public Health, 2024)

Legionnaires' Disease – Trending Data

Reported cases have been on the rise since 2000, peaking in 2018 with nearly 10,000 cases reported in the United States that year.

The sharp increase in reported cases is due to a combination of:

- Increased awareness and testing demand.
- Greater susceptibility in the population.
- Larger amounts of Legionella bacteria in the environment.

Legionnaires' Disease – Underdiagnosis

The actual number of cases may be much higher than the "official" numbers due to underreporting and underdiagnosis.

A 2021 study analyzing 2014 data estimated that the actual number of Legionnaires' disease cases in the United States was 2.3 times higher than reported.

In Canada, the number of reported cases is *less than 100 per year*. This is *very likely* due to severe underreporting / underdiagnosis.

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Emergency Response: Internal and External

- 1976 Philadelphia, PA Bellevue-Stratford Hotel (34)
- 1978 Memphis, TN Baptist Memorial Hospital
- 1985 Stafford, UK Stafford District Hospital (28)
- 1996 Christiansburg, VA Department Store (2)
- 1999 Bovenkarspel, NL Westfriese Flora Exhibition (32)
- 2000 Melbourne, AU Sea Life Aquarium (4)
- 2001 Murcia, ES Hospital (6)
- 2002 Barrow-in-Furness, UK Forum 28 Arts Centre (7)
- 2003 Pas-de-Calais, FR Petrochemical Plant (18)
- 2004 Zaragoza, ES Hospital (7)

- 2005 Toronto, ON Seven Oaks Home for the Aged (21)
- 2005 Fredrikstad, NO Factory (10)
- 2007 Jastrzebie Zdroj, PL 2nd District Specialist Hospital (3)
- 2008 New Brunswick, NJ Saint Peter's University Hospital (2)
- 2010 Wales, UK South Wales Valleys (2)
- 2011 Dayton, OH Hospital (5)
- 2012 Quebec City, QC Complexe Jacques-Cartier (13)
- 2012 Calp, ES AR Diamante Beach Hotel (3)
- 2012 Edinburgh, UK Source not confirmed (4)
- 2012 Chicago, IL JW Marriott Hotel (3)

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2012 – Auckland, NZ – Unknown source (1)
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- 2012 Stoke-on-Trent, UK Warehouse Display Hot Tub (1)
- 2012 Pittsburgh, PA Veteran's Administration Hospital (6)
- 2014 Franca de Xira district, PT Widespread (12)
- 2015 Bronx, NY Widespread (13)
- 2015 Quincy, IL Veterans Home (13)
- 2014 2016 Flint, MI Flint Water Crisis (12)
- 2016 Hopkins, MN Citrus Systems (1)
- 2017 Manhattan, NY Police Station (1)
- 2018 Washington Heights, NY Sugar Hill Project (1)

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2019 – Evergem, BE – Port of Ghent (2)
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- 2019 Ohio, NJ Multiple Locations (6)
- 2019 Atlanta, GA Sheraton Hotel
- 2019 Fletcher, NC North Carolina Mountain State Fair (4)
- 2020 Vernon Hills, IL Brookdale Senior Living (5)
- 2020 Portugal Multiple Locations (15)
- 2022 San Miguel de Tucuman, AR Health Clinic (6)
- 2023 Poland Multiple Locations (41)
- 2025 Harlem, NY Multiple Locations (7)
- 2025 London, ON Sofina Foods Inc. (5)

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Legionella bacteria

There are more than 60 species of Legionella.

Most infections are caused by *L.pneumophila*, the same species that caused the original Philadelphia outbreak in 1976.

L.pneumophila is subdivided into many serogroups. Of these, serogroup 1 is the most virulent, responsible for ~80% of reported Legionnaires' disease cases.

Legionnaires' Disease Pathology

Legionella is a waterborne, bacterial pathogen that exists in nature. It can grow and spread in everyday water sources such as building domestic water systems, evaporative cooling systems, spas and hot tubs.

It is **not possible** to contract Legionnaires' disease unless water droplets containing a **pathogenic strain** of *Legionella* enter the lungs. In practical terms, this can only happen through *aerosolization* or *aspiration*.

These are the only modes of transmission that are relevant in the context of *Legionella* risk management for building water safety.

Legionnaires' Disease Pathology – Infection

Exposure does not always cause disease. *Legionella* only infects *susceptible hosts*, and some people are more susceptible than others.

Research shows that risk factors include age, sex, habits, respiratory health, overall health and strength of immune system.

Legionnaires' Disease Pathology – Infection

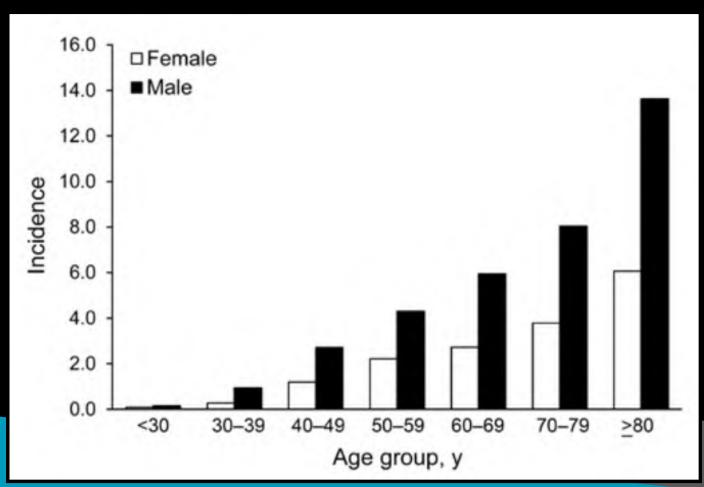


Figure 2 – Legionnaires' disease incidence by sex and age group (Farnham et al., 2014)

Legionnaires' Disease Pathology – Infection

Exposure does not always cause disease. *Legionella* only infects *susceptible hosts*, and some people are more susceptible than others.

Research shows that risk factors include age, sex, habits, respiratory health, overall health and strength of immune system.

It is **not correct** to say that "healthy people" are immune. This is a common belief and a dangerous assumption. In fact, 20% of cases have occurred in people with *none* of the top 16 known risk factors.

Legionnaires' Disease Pathology – Symptoms

Symptoms can include:

- High fever and chills
- o Muscle aches
- Headaches and confusion
- Severe cough and chest pain
- Shortness of breath
- o Diarrhea

NOTE:

Legionella bacteria are also responsible for a much less serious illness known as Pontiac fever.

Standard incubation period is **2–10 days**, with the median being 5 days. Longer incubation (14 days or more) is possible, but rare.

Pontiac Fever

Named after Pontiac, Michigan, where it was first documented in 1968 after an explosive epidemic at a county health department.

Pontiac fever is a self-limiting, flu-like respiratory infection with a zero mortality rate that resolves on its own (without treatment).

Mean incubation period is 36 hours, with symptoms lasting 2-5 days.

By comparison, Legionnaires' disease is a **serious pneumonia** with a high mortality rate, typically requiring hospitalization for treatment.

Legionnaires' Disease Pathology – Diagnosis

Diagnosis of Legionnaires' disease is challenging, because the bacteria will not grow on standard culture media.

Because of this, the attending physician must order a special *Legionella*-specific culture test.

If *Legionella* bacteria are the cause of an infection, but the required test is not performed, the diagnosis will be missed and the case will not be reported as Legionnaires' disease.

Legionnaires' Disease Pathology – Diagnosis

Another option is a urinary antigen test.

This test must also be specially ordered by the physician, which will not happen unless there is suspicion of *Legionella*.

Also, this test is highly specific and only detects antigens of L.pneumophila serogroup 1. This makes it only $\sim 80\%$ reliable. If a patient is infected with a different Legionella serogroup, the diagnosis is missed and not reported.

Legionnaires' Disease Pathology – Treatment

Mortality:

- 10% of community-acquired cases
- 30% of hospital- & healthcare-acquired cases

If correctly diagnosed, Legionnaires' disease is treatable.

- Certain antibiotics are proven effective against Legionella.
- Hospitalization is usually required for recovery.
- Misdiagnosis (failure to identify Legionella as the cause of infection) increases the risk of patient death.

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Legionella in Building Water Systems

Legionella bacteria exists naturally in freshwater sources, but its presence in nature is at very low (often undetectable) levels. In order to present a health risk to humans, the Legionella must grow and multiply to exceedingly high levels.

The ideal growth conditions include:

- Warm temperatures
- Nutrient availability
- Other bacteria and microbes in the water

Legionella in Building Water Systems

Conditions commonly exist in building water systems that allow and encourage *Legionella* bacteria to proliferate.

50% of building systems contain Legionella at detectable levels.

Although cooling towers get all the publicity, the leading source of *Legionella* that leads to infection is **domestic water systems**.

more direct human exposure = more opportunities for infection

Legionella in Buildings – Some Numbers

- 56% of all cases originate from potable water systems.
- The percentage is even higher (67%) in healthcare facilities.
- \circ Cooling towers are the second most common source (22%).
- The vast majority of outbreaks originate from cooling towers.
- Legionella bacteria are found in up to 60% of high-rise buildings, up to 50% of evaporative cooling systems and up to 40% of residential homes.
- Hospitals are hot spots (57% of cases and 85% of deaths).

Building Water Safety – Justification for Action

We know:

- Legionnaires' disease is dangerous and potentially fatal.
- Exposure to this waterborne pathogen is preventable.

We also know:

- Building owners and operators are responsible for the health and safety of their occupants.
- We understand fire safety, elevator safety, building code...
- What about water safety?

Why are we not on top of this?

Building Water Safety – Justification for Action

Minimal action occurs in the absence of legislation, and when legislation exists, only the minimum compliant action is taken.

This may be an over-generalization, but it is backed by data.

Question:

To what extent are building owners and businesses willing to go over-and-above base compliance when there are costs involved?

Building Water Safety – Where to Start

With or without a legislative push, if a facility has "bought in" and committed to proactively improving water safety, what can they do?

THE APPROACH

- 1. Education become informed to make informed decisions.
- 2. Strategy develop and establish a clear plan and framework.
- 3. Execution put the plan into action and stick to it.
- 4. Verification benchmark, evaluate, adjust and improve.

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Building Water Safety – Where to Start

Primary reference material:

- ASHRAE Standard 188
- ASHRAE Guideline 12
- CTI Legionellosis Guideline

Other useful references:

- PWGSC MD 15161
- CDC Legionella Toolkit
- MOH Legionella Investigation Reference Document

ASHRAE Standard 188:2021

Legionellosis: Risk Management for Building Water Systems

Start here.

Minimum Legionellosis risk management requirements for *potable* and *non-potable* water systems in human-occupied ICI buildings.

Voluntary standard, but other legislation can (and does) reference and require full ASHRAE 188 compliance to meet code or approval.

ASHRAE Standard 188:2021

Legionellosis: Risk Management for Building Water Systems

At its core, ASHRAE 188 recommends establishing a Water Safety Team and developing a Water Safety & Management Plan (WSP).

It also describes:

- Who should be included on the Water Safety Team.
- Steps to develop, establish and maintain the Water Safety Plan.
- Types of buildings and water systems that should be covered.

ANSI/IAPMO/ASSE 12080

Legionella Water Safety and Management Specialist Certification

Provides the knowledge, competency and understanding to become a qualified, contributing member of a facility Water Safety Team.

Comprehensive training program to understand *Legionella* in building water systems; conducting risk assessments; sampling and analysis; developing a Water Safety Plan; establishing emergency response procedures; and responding to cases / outbreaks.

ASHRAE Standard 188:2021

Legionellosis: Risk Management for Building Water Systems

Water Safety & Management Plan Components:

- Building analysis and descriptions of how water is used.
- Flow diagrams for potable and utility water systems.
- Control points, control measures and monitoring.
- Verification and validation.
- Documentation and communication.

ASHRAE Standard 188:2021

Legionellosis: Risk Management for Building Water Systems

What's "missing"?

- Water quality specifications or chemistry limits to maintain.
- Prescribed equipment, products or chemicals to employ.
- Emergency response protocols and procedures.

ASHRAE Guideline 12-2023

Minimizing the Risk of Legionellosis Associated with Building Water Systems

Provides specific environmental and operational guidelines to minimize the risk of Legionellosis in building water systems.

Scope: Industrial, commercial, institutional & multi-unit residential.

Intended for facility owners, designers, engineers, operators, maintenance personnel and equipment manufacturers.

ASHRAE Guideline 12-2023

Minimizing the Risk of Legionellosis Associated with Building Water Systems

Detailed breakdowns for many types of building water systems:

- Potable water systems
- Emergency water systems (safety showers, eye wash, fire sprinklers)
- Recreational water systems (heated spas & hot tubs)
- Decorative fountains and waterfalls
- Evaporative cooling systems
- Direct and indirect evaporative air coolers

ASHRAE Guideline 12-2023

Minimizing the Risk of Legionellosis Associated with Building Water Systems

For each system type, the guideline provides:

- System description and scope of relevance
- Operational factors that may influence Legionella growth
- Water droplet size ($< 5 \mu m$)
- Nutrients and contaminants
- Associated cases of Legionnaires' Disease
- Recommended treatment strategies

CTI – Legionellosis

Guideline: Best Practices for Control of Legionella

Provides specific environmental and operational guidance to minimize *Legionella* in **evaporative cooling systems**.

Similar structure and approach to ASHRAE Guideline 12, but more in-depth and specific to evaporative condensers, fluid coolers and cooling towers.

CTI – Legionellosis

Guideline: Best Practices for Control of Legionella

Includes best practices and guidance on:

- Testing, monitoring and target levels
- Halogenation and hyperhalogenation strategies
- Emergency disinfection
- Other treatment approaches
- Equipment Inspections
- Record Keeping
- Design Considerations

CDC Toolkit

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

Intended for use by building owners and managers.

Includes:

- A simple (yes/no) risk assessment worksheet.
- Outlines of the core elements of a *Legionella* WMP (WSP).
- Common water quality issues and responses.
- Special considerations for healthcare facilities.

PWGSC MD15161 – 2013

Control of Legionella in Mechanical Systems, Standard for Building Owners, Design Professionals, and Maintenance Personnel

Federal Standard

- 1. GC buildings shall be designed, constructed and operated in accordance with industry standards and best practices. ASHRAE, CTI and Quebec regulations are called out specifically.
- 2. Legionella Bacteria Control Management Program (LBCMP)
- 3. Includes checklists and forms for consistency and reporting.

PWGSC MD15161 – 2013

Control of Legionella in Mechanical Systems, Standard for Building Owners, Design Professionals, and Maintenance Personnel

Checklists and Forms:

- LCBMP-1: Facility Checklist
- LCBMP-2: Contact List
- LCBMP-3: Susceptible System Inventory
- LCBMP-4: Testing Form
- LCBMP-5: Chemical Products and Substances List
- LCBMP-6: System Risk and Hazard Assessment Form

PWGSC MD15161 – 2013

Control of Legionella in Mechanical Systems, Standard for Building Owners, Design Professionals, and Maintenance Personnel

LCBMP Requirements:

- Must be reviewed and signed by a Professional Engineer.
- Recommends incorporating ASHRAE, CTI, manufacturers' guidelines.
- More prescriptive (testing frequency, action levels, maintenance)
- LCBMP must be reassessed and updated every 5 years, after any major change, or following an action level response.

PWGSC MD15161 – 2013 Components of the LBCMP

Additional requirements:

- Single line schematic plan of each Legionella susceptible system.
- Procedure for maintaining water quality to minimize Legionella.
- Operating and maintenance manuals and procedures.
- Procedures for startup, shutdown, decontamination, water treatment.
- Procedures for water quality testing (methods, locations & frequency).
- Procedures for mechanical verification of equipment & water systems.
- Testing logs, maintenance logs and all other records & documentation.

Ontario Ministry of Health
Legionella Investigation Reference Document (2025)

Ministry Playbook for Investigating Cases & Outbreaks:

- Background (epidemiology, risk factors, period of communicability)
- Roles and responsibilities (MOH, BOH, PHO, owners, consultants)
- Case and contact management
- Outbreak assessment, public and environmental risk assessment
- Environmental sampling and laboratory analysis
- Immediate control measures and remediation (and verification)
- Long-term prevention (water safety plan)

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Water Safety and Management Plans (WSP)

Key Members of a Water Safety Team:

- Water Treatment Consultant (quarterback or coach)
- Health and Safety
- Environmental Services
- Maintenance / Facilities Management
- Infection Control
- HVAC & Equipment Service Provider(s)
- o Other parties identified in the risk analysis

Water Safety and Management Plans (WSP)

Components of a Comprehensive Water Safety Plan:

- 1. Create a Water Safety Team and assign responsibilities.
- 2. Complete ASHRAE 188 compliance audit (self-performed / third-party).
- 3. Generate process flow diagrams (PFDs) & write-ups for all systems.
- 4. Identify all water safety hazards and critical control points (FRA).
- 5. Agree on strategies, establish targets and control measures.
- 6. Highlight deficiencies and implement corrective actions.
- 7. Establish and implement a testing and monitoring protocol.
- 8. Execute the plan and hold all parties accountable to responsibilities.
- 9. Document all findings and maintain adequate records.
- 10. Regularly review, refine and revise the WSP to keep it up to date.

Water Safety – *Legionella* Risk Assessments

How to perform a Facility Risk Assessment (FRA):

- 1. Assign a task force (subset of the Water Safety Team).
- 2. Define the purpose, objectives and scope.
- 3. Collect & assemble facility information (drawings, plans).
- 4. Perform a comprehensive walkthrough of all systems.
- 5. Develop and agree on a sampling and testing plan.
- 6. Collect samples and send to lab for testing.
- 7. Analyze lab test results and evaluate immediate risks.
- 8. Implement corrective actions.
- 9. Repeat sampling as required to capture trends and seasonality.
- 10. Review & refine findings, communicate results to Water Safety Team.

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Water Treatment & Risk Management Strategies

The tools we can use fall into four buckets:

- Technologies and treatment
- Policies and procedures
- Engagement and training
- Verification and evaluation

A robust and comprehensive Water Safety and Management Plan includes tools and strategies from all four categories.

Technologies & Treatment: Domestic Water

Secondary disinfection:

- o Copper-silver ionization systems
- Monochloramine generators
- UV systems

Point-of-use filtration:

- Whole building (every end-point)
- Select key locations based on hazard analysis

Automatic flushing systems

Water treatment for evaporative cooling systems (cooling towers, evaporative condensers, fluid coolers) is well understood with decades of expertise available.

Simply adhering to the established industry standards and best practices for cooling water treatment will go a long way to improving water safety in these systems.

Effective biocide programs are already required on cooling towers to control microbial activity and prevent slime, biofilm & algae blooms.

A well-designed biocide program will effectively control Legionella as long as it is implemented properly and kept in good control.

- ✓ Use a combination of oxidizing and non-oxidizing biocides.
- ✓ Don't rely on timer feed. It does not account for fluctuations in operating load, nor can it respond to increased bio activity.
- ✓ Oxidizing biocides should be fed based on ORP.

Aside from the biocide program, the rest of the cooling tower water treatment program must be kept in good order. This includes bleed and corrosion control.

Cooling towers are notorious air scrubbers. Sidestream filtration is highly recommended to remove excess organic material and foulants.

Failure to maintain good water quality and chemistry in the cooling system can severely impact the system's ability to maintain control of microbiological activity.

Routine maintenance and thorough physical cleaning of the cooling tower should be done at least annually (2x / year is recommended).

Cleanings should be completed by professionals who are trained and qualified to clean cooling towers. *Power-washing the moss off from the outside of the drift eliminators is not a cooling tower cleaning.*

Every cleaning should be followed by a routine system disinfection executed or supervised by the water treatment provider. This should also be done at seasonal startup or when resuming from shutdown.

Operational and Engineering Controls

Don't rely solely on technology. Risk management can be implemented at the *operational* and *policy* levels as well:

- Staff education
- Vendor and occupant education (and signage)
- Faucet & showerhead flushing protocols
- Physical security: limiting public access
- Building startup procedures
- Bottle fillers instead of drinking fountains
- Jugs & sponges for bathing patients

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Testing and Monitoring for Legionella

Regulatory guidance on *Legionella* testing varies by organization. Some enforce or endorse strict testing and reporting frequencies, while others leave this up to the discretion of the facility.

Testing alone does not impact risk, but it is a useful informative tool.

Empirically, it provides verification and validation:

- if our plan is working, and to what degree;
- if we need to make any adjustments or improvements;
- if a special response is required (e.g. emergency disinfection).

Testing and Monitoring for Legionella

Important considerations regarding testing:

- Each test is only a snapshot... a single point on the graph.
- The true value of testing and monitoring comes from trending.
- Testing should be done methodically and consistently.
- The testing program should include adequate sampling distribution and frequency to accurately evaluate performance.
- Facilities should not implement a testing regimen without first establishing a Water Safety and Management Plan that includes clear response protocols in case of high counts.

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Emergency Response Protocols (WSP)

First of all: don't panic. This is an internal response protocol triggered by your Water Safety & Management Program flagging a deficiency.

This simply means the program is working as intended. Upsets and problems are inevitable and bound to happen eventually.

Above all else, communication is key. Inform those who need to be informed, then execute quickly and competently according to the response protocols established in the Water Safety Plan.

Legionnaires' Disease Outbreak Response

First of all: don't panic.

Health unit investigations during & after outbreaks are thorough and extensive, and they will continue until the outbreak is declared over.

If your facility has implemented an **ASHRAE-compliant Water Safety and Management Plan**, and you have good documentation to prove that you are following it, there is very little to worry about.

If not, then you can start being proactive today.

Conclusion – Takeaways

Hopefully, this information drives home the point that every humanoccupied building should be taking water safety seriously and taking steps to build a Water Safety Team and develop a Water Safety Plan.

Eventually, legislation will catch up. Standards will be enforced in more and more jurisdictions over time, and as more outbreaks occur.

Until then, we continue to educate, raise awareness, contribute knowledge and encourage a proactive approach to keeping our buildings safe from all waterborne pathogens, including *Legionella*.

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Questions?

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