



***Water Management Plans to Prevent
Legionellosis and Waterborne Pathogens in
Plumbing Systems***

David Lipton, CIH, Industrial Hygiene Consultant

***Occupational and Environmental Epidemiology Branch
North Carolina Division of Public Health***



Legionellosis

Pulmonary infection caused by *Legionella pneumophila*, naturally occurring at low levels in surface water. At least 15 serotypes --most cases infections of *Legionella pneumophila* serogroup 1

Facultative intercellular parasite in amoeba and protozoa and can replicate in alveolar macrophages

Not transmitted from person to person Two clinical syndromes

- Pontiac fever— Self-limiting flu-like illness --under reported and diagnosed
- Legionnaires Disease aka *Legionella* Pneumonia--About 10% mortality rate
 - Onset about 2-14 days after exposure
 - Severe cough, high fever, chest pain, nausea, vomiting and diarrhea, and confusion and x-exam

Risk factors for Legionnaires disease include

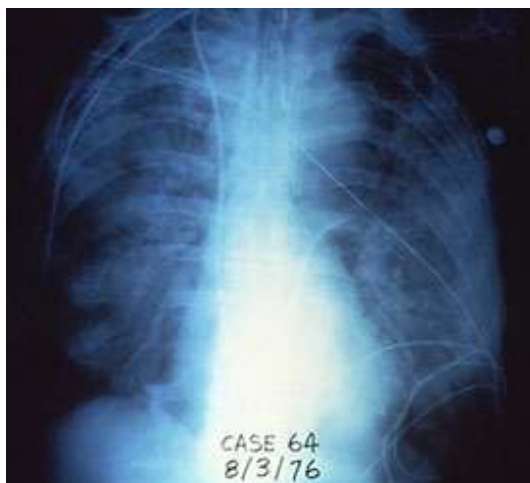
- Age > 50, current or former smoker, chronic Lung Disease (emphysema or COP), immune system disorders
- Diagnosis based on clinical examination and laboratory tests
 - Urinary Antigen Test – sensitive and specific to serotype 1
 - Microbiological isolation of *Legionella species* and *serotype* in patient sputum specimens
- Treatment by antibiotics either quinolones (ciprofloxacin, levofloxacin) and macrolides (azithromycin)



Legionnaires Disease is Reportable

Reportable disease under § 130A-134 and 10A NCAC 41A .0101 (#36)

Communicable Disease Manual- contains instructions for entry into North Carolina Electronic Disease Surveillance System (NCEDS) and to investigate cases



<https://www.cdc.gov/Legionella/about/signs-symptoms.html>

<https://www.webmd.com/lung/ss/slideshow-legionnaires-disease-overview>



Water Management Program goals

Align with the facility infection control program

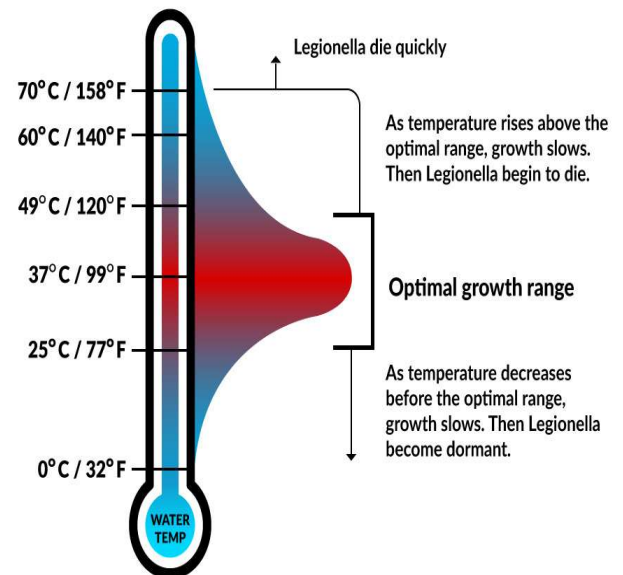
- Prevent *Legionella* and other waterborne pathogens from amplifying and colonizing building water systems and limit
- Dispersal of contaminated water aerosols in a way that people might be exposed.

Prevent water systems from becoming the source of illness in your facility

Strategies

- Manage water temperature
- Prevent stagnation (time, flow, and dead legs)
- Maintain adequate disinfectant levels
- Maintenance and cleaning to prevent sediment, scale, and biofilms
- Pathways for exposure to droplets

Goals need to be realistic, feasible, achievable, defensible



Source: ASHRAE Guideline 12-2020 Figure 1 Temperature effects on survival and growth of Legionella in laboratory conditions



Implementing a Water Management Program

Form a Water Management Team and develop program goals

Team members -- contact information, competencies, roles, and responsibilities

Describe and document water systems, a flow analysis

Perform a with hazard analysis --Physical, chemical or biological conditions that may cause harm and Risk Assessment = probability and severity of harms from the hazards

- Identify control points, places where control measures can be applied
- Control measures engineering, operations, maintenance and activities that are applied to control hazards and reduce risk
- Monitoring -- measurements or observations document control measures are being implemented
- Actions or interventions when control limits are not being met
- Verify that plan is working and update plan periodically
- Validate that program is meeting goals

- *Recordkeeping*
- *Documentation*
- *Communication*
- *Engagement*



Water management team

Interdisciplinary across organization and external partners

Team members should be “competent Persons” – knowledge, skills, and abilities to recognize hazards and authorized to take corrective actions

Documentation and recordkeeping

Integrate into existing programs policies and procedures

Main team

- Facility director
- Facility administrator
- Medical Director
- Nursing Director
- Health and safety
- Infection control
- Environmental services
- Chief engineer
- Maintenance director

Ad Hoc

- Finance
- Human resources
- Legal
- Public affairs
- Contractors & consultants
- Local water Utility
- Regulators



Water Management Plans

Policies, procedures, and practices that

- Limit the potential for *Legionella* and other waterborne pathogens to amplify in building water systems
- Reduce potential for building occupants to be exposed to water containing *Legionella* bacteria and other waterborne pathogens
- Operate building plumbing systems safely and efficiently

Water Management Plans (WMP) are site specific and driven by

- Hazard analysis
- Risk characterization
- Control points

What to do when there if something happens

- Positive *Legionella* case or other water borne disease in your facility?
- Planned, or emergency construction, maintenance or repair that impacts the water system that may cause temporary loss of water pressure and how the water systems are brought back into service



Sources of Legionella in Building Water Systems

Legionella is not a regulated contaminant under the Safe Drinking Water Act (SWDA) -- Public Water Systems do not test for legionella

Requirements of the SWDA most often eliminate a wide range of pathogens, including *Legionella* during treatment and distribution, but not foolproof.

Building water systems can be places where *Legionella* can multiply/amplify

Other potential sources (uncommon)

- Inspiration of contaminated water from ice machines
- Heater cooler units for cardiothoracic surgery –mycobacteria infections



Complexity of the problem

Alliance to prevent Legionnaires Disease <https://preventlegionnaires.org>

Lines of prevention include:

1. Education and awareness
2. Source water treatment - Safe Drinking Water Act -Public water supplies --Opportunities exist for Legionella and other bacteria to colonize and multiply in public water systems-- biofilms, corrosion, and low disinfectant levels
4. Residential water systems
5. *Complex Building water systems*
 - *Greater risk of waterborne bacteria in complex building water systems, fixtures, and equipment*
6. *Water equipment and management*
 - *Proper selection, placement, maintenance, treatment, monitoring, and management of water-based equipment*
 - *Chemical and physical hazards*
7. Investigation protocols – currently single sporadic cases outside of permitted or regulated facilities are rarely thoroughly investigated
8. Ongoing research on causes, prevention and treatment of disease



Ice Machine as Source of Legionella

Water supply line passes near compressor & accumulator

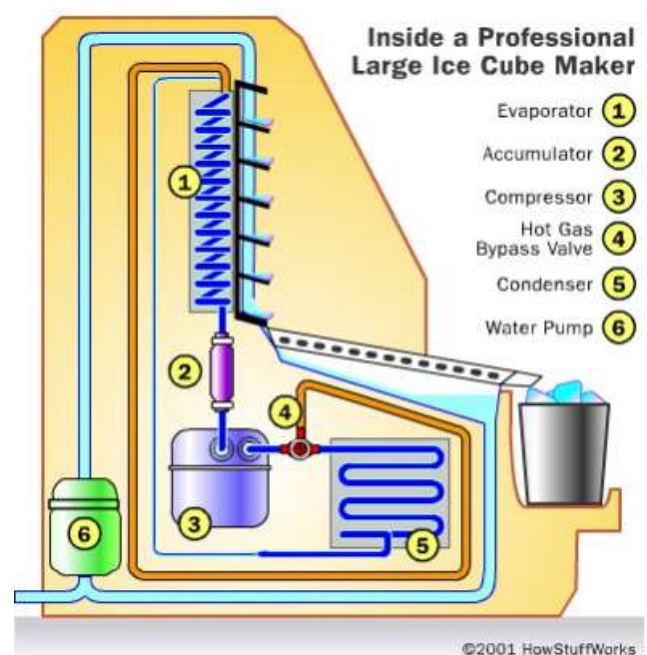
Heat from condenser & accumulator and compressor is dissipated (points 3, 4, and 5)

At the cooling unit refrigerant evaporates and heat is transferred from the water to form ice

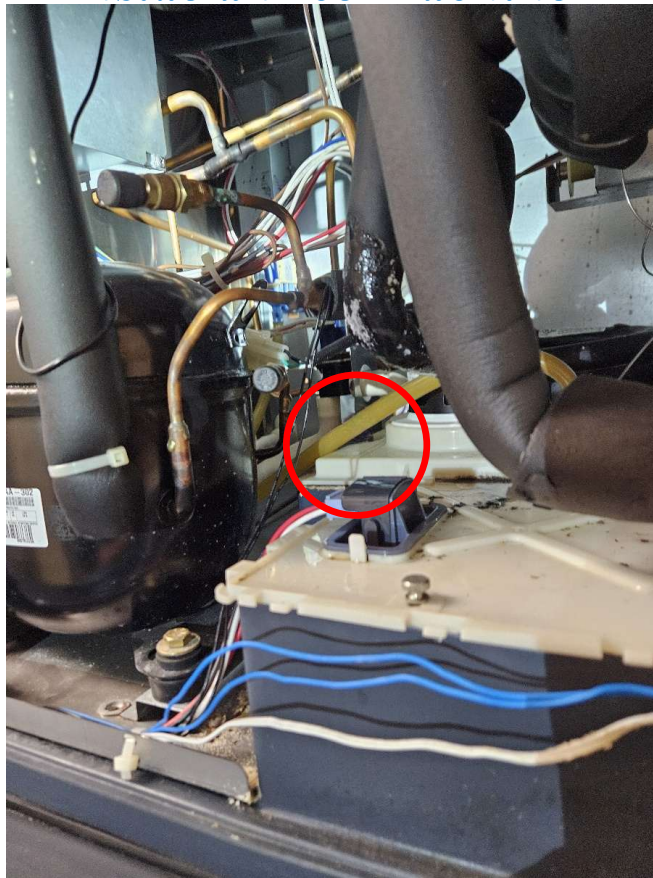
Filters can be reservoirs

Legionella in ice is dormant but not dead

Incidental aspiration of ice



Inside an Ice Machine



Hot tubs and spas



- Permitted -- must meet Rules Governing Public Swimming Pools 15A NCAC 18A .2500 plus additional requirements, inspected by local health departments
- Certified (licensee) pool operators
- Circulation and turnover rate
- Continuous disinfection (2–4 ppm chlorine or 4-6ppm bromine)
- Maintain pH between 7.2–7.8.
- Needs routine cleaning, maintenance, monitoring disinfectant levels, filter changes etc.



Hot tubs at temporary events

Final report – Legionnaires Disease at Mountain State Fair September 2019

136 cases associated with hot tubs on display

https://epi.dph.ncdhhs.gov/cd/legionellosis/MSFOutbreakReport_FINAL.pdf

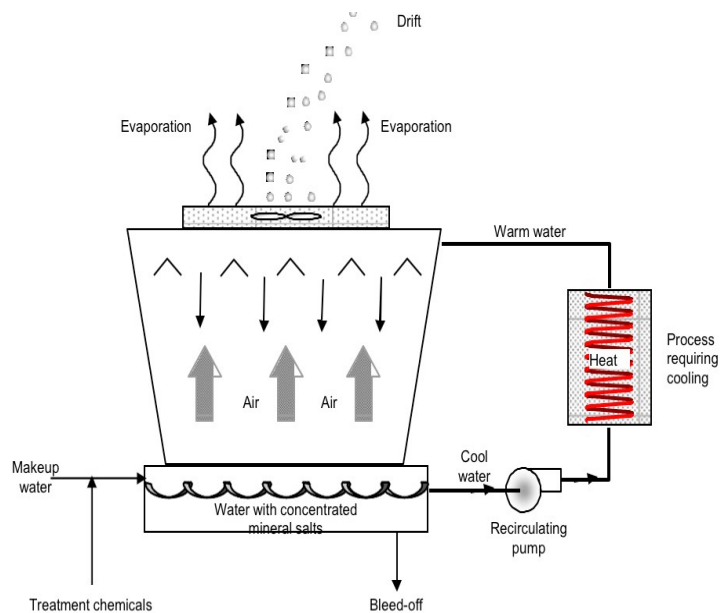
<https://www.cdc.gov/control-legionella/php/toolkit/hot-tub-module.html>

Increase awareness of event planners and hot tub vendors of hazards and risks of hot tubs at displays

- Training for operators and vendors
- Maintain free chlorine (2–4 parts per million or ppm) or bromine (4–6 ppm)
- Maintain the pH level of the water at 7.2–7.8.
- Test pH and disinfectant levels at least twice per day.
- After display is over cleaning, disinfecting, maintenance, and safe storage of hot tubs



Legionnaires Disease --often associated with cooling towers



Original 1976 outbreak traced to mist from a cooling tower cooling tower pulled into an adjacent building's HVAC system
200 people ill and 34 fatalities

August 2015 Bronx New York 128 cases with 12 fatalities traced to a cooling tower at Opera House Hotel

New York City became the first city to register and regulate cooling towers

https://www.globalspec.com/learnmore/manufacturing_process_equipment/heat_transfer_equipment/cooling_towers



North Carolina Electronic Disease Surveillance System (NC-EDS)Legionellosis Communicable Disease Report

<https://epi.dph.ncdhhs.gov/cd/lhds/manuals/cd/reportforms/legionellosis.pdf>

Communicable disease nurses obtain information from health care providers, laboratories, and patients

- Clinical Findings
- Hospitalization
- Predisposing conditions
- Treatment (antibiotics)
- Clinical outcomes
- Travel
- Water exposure
- Patient interview
- HCP interview
- Medical Records
- Other exposures
- Geographical site
- About 90 % of cases are “sporadic” -- no link in time and space with other cases.
- Two or more cases linked in time and space in permitted facilities like lodging places or pools are an outbreak and trigger an environmental investigation
- A single case in a Long-term Care or other Health Care facility may be considered as a “possible” health care associated case or a “sentinel” case



If there is a case of Legionellosis in your facility

- Case definition and investigation steps can be found here
- https://epi.dph.ncdhhs.gov/cd/lhds/manuals/cd/invest/LEGIONELLOSIS_LHD_ST_EPS_0419.pdf
- Call CD Branch (919) 733-3410 for additional information

Was the Patient in your facility during the 14 days prior to onset of symptoms?

Create a timeline

- When was the patient admitted?
- When did symptoms start?
- Did the patient go anywhere else in the 14-day period prior to symptom onset (family member's home, trips, outings, other healthcare facilities)

<https://epi.dph.ncdhhs.gov/cd/lhds/manuals/cd/legionella/Legionellosis-algorithm.pdf>



Possible Healthcare Associated case

(patient was in facility for part of 14 days before symptom onset)

Have there been any other cases of LD among residents, staff, or visitors in the last six months?

NO

Enhanced surveillance for 2 months, patients with signs & symptoms of pneumonia should have Urinary Antigen Test

NO

Monitor for 12 months for any additional cases

NO

Resume routine surveillance and water safety measures

YES

Two or more healthcare associated cases are an outbreak

- Consult with CDB (919)733-3410
- Follow [10 steps for an outbreak investigation](#)
- Retain a legionella consultant

YES

- Conduct [environmental assessment](#)
- Institute [Control Measures](#)
- Environmental Sampling and testing
- Declare outbreak over in Consultation with CDB

[NC Communicable Disease Manual](#)
[Legionella Outbreak Response Materials](#)



Presumptive Healthcare Associated Case

(patient did not leave the facility during 14-day period before symptom onset)

Have there been any other cases of LD among residents, staff, or visitors in the last six months

NO

Sentinel Case investigation

- Consult with CDB
- Conduct a [Site Visit](#) using [Environmental Assessment of Water Systems](#)
- Conduct [six-month retrospective surveillance](#)
- Were other cases of legionellosis identified?

Enhanced surveillance for 2 months, patients with signs & symptoms of pneumonia should have Urinary Antigen Test

Monitor for 12 months for any additional cases

Resume routine surveillance and water safety measures

YES

Two or more healthcare associated cases are an outbreak

- Consult with CDB (919)733-3410
- Follow [10 steps for an outbreak investigation](#)
- Retain a legionella consultant [CDC Working With Legionella Consultants](#)
- Institute [Control Measures](#)
- Environmental Sampling and testing
- Declare Outbreak over in Consultation with CDB

YES

YES



Get the most from outside help

Water management is a growth industry, expect to be solicited by contractors and consultants offering products and services

Think of consultants and contractors as partners in the process

- Make sure that facility and contractor/consultants have clearly defined roles and responsibilities specific to the facility

When selecting contractors and consultants consider

- Experience in developing and implementing WMP
- Expertise in design and operation of plumbing systems
- Knowledge of codes, standards, regulations and best practices –
- May need licenses or certifications like Professional Engineer (PE), Certified Industrial Hygienist (CIH) or Certified Water Technologist (CWT)
- Conflicts of Interest

CDC, Considerations when working with Legionella Consultants

<https://www.cdc.gov/Legionella/maintenance/consultant-considerations.html>



Selecting Consultants

- Expertise in Building Water Systems
- Understanding of Water Flows in buildings
- Risk Assessment Skills
- Knowledge of Water Quality Monitoring
- Experience with Environmental Sampling
- Familiarity with Testing Laboratory Requirements
- Experience with Remediation
- Water Management Program Expertise
- Up-to-date Knowledge



Environmental Sampling

Potential sampling sites

- Point of entry
- Holding tanks
- Centralized hot water heaters supply & returns
- Expansion tanks
- Before and after filters or water softeners
- Showers
- Faucets
- Whirlpools
- Cooling towers
- Decorative fountains
- At distal ends of hot and cold-water systems
- Ice machines
- Dead legs
- Fixtures used infrequently

Measure temperature, pH, and residual disinfectants wherever samples are collected. If possible, use

In lieu of culture-based methods, for environmental sampling, molecular tests (PCR) and antibody assays can be used for verification of effective WMP in the absence of outbreaks or sentinel cases in people

In outbreaks and sentinel case investigations –

[CDC investigating Healthcare Associated Cases and Outbreaks](#)

1-liter water samples and biofilm samples with culture-based analysis by CDC ELITE laboratory is the ‘gold standard’



Interpreting Results

Sample results need to be interpreted in the context of the WMP goals

Some benchmarks to interpret sampling results during *routine testing*

<https://www.cdc.gov/control-legionella/php/toolkit/routine-testing-module.html>

Source	Acceptable	Requires additional investigation and actions	Requires immediate action	reference
Cooling tower	<10CFU/ml	10-1000 CFU/ml	>1000 CFU/ml	New York City
Potable water	<1 CFU/ml	10-100 CFU/ml	>100CFU/ml	AHIA 2015
Decorative fountains	<1CFU/ml	1-10CFU/ml	>10CFU/ML	AIHA 2015
Hot tubs/spas	<1 CFU/ml	1-10 CFU/ml	>100CFU/ml	AIHA 2105



How are standards used?
Who are Authorities having Jurisdiction?

Guidelines-

Standard Standard
of care (SOC)

Policy/law

Best Practices

Minimum Standard of Care

Adoption of standard of care
by reference into legal statute

Authorities having Jurisdiction (AHJ)

- ✓ Organizational (certification, accreditation and reimbursement)
- ✓ Local, state and federal government

What is legally required?

What are best Practices?

Who are the AHJ?



Why Healthcare facilities need water management plans

CMS is an Authority Having Jurisdiction (AHJ) --requires WMP in Hospitals, Critical Access Hospitals, and Long-Term Care <https://www.cms.gov/Medicare/Provider-Enrollment-and-Certification/SurveyCertificationGenInfo/Downloads/Survey-and-Cert-Letter-17-30.pdf>

Joint Commission is an AHJ for Certification -- Water Management Programs [R3 Report: New Standard of Water Management Program - Hospitals, Critical Access Hospitals, and Nursing Care Centers](#)

Industry Standard: Legionellosis: Risk management for building water systems
CDC Toolkits for developing a Water Management Program is an AHJ for best practices

<https://www.cdc.gov/control-legionella/php/toolkit/index.html>

In possible, presumptive cases, and outbreaks in permitted, or regulated facilities the local health department in consultation with the Communicable Disease Branch is the AHJ.



Why other large buildings need WMP

CDC and some states, and ASHRAE 188

[ASHRAE 188-2021 Legionellosis: Risk Management for Building Water Systems](#)

Water management plans for all buildings that meet any of these criteria

- Multi-housing units with one or more centralized circulating water heaters
- More than ten stories tall
- Intended for housing occupants > 65 years old
- ASHRAE standards are not regulatory unless adopted by an Authority Having Jurisdiction

Costs from outbreaks associated with a facility

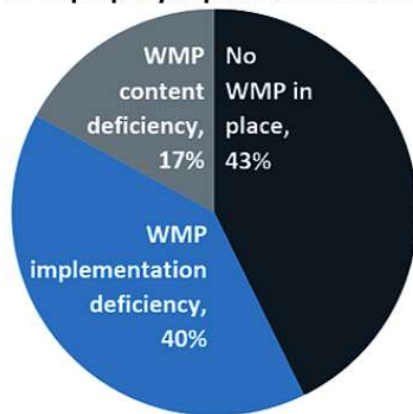
- Disruption of operations, shutdown or equipment, or closure of fixtures and features
- Water use restrictions
- Expensive and difficult to remediate and control hazards
- Liability and negative publicity
- Investigation of outbreaks by local or state health departments and CDC



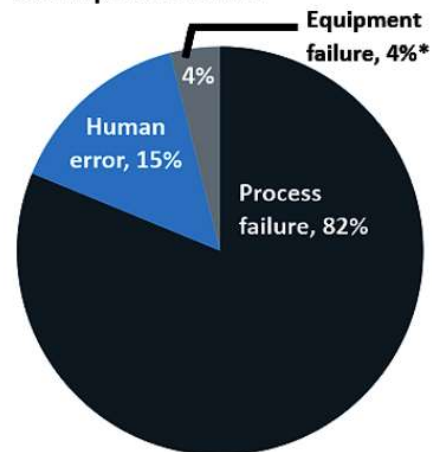
Water Management Plans and Disease Outbreaks

Findings from a review of CDC-led Legionnaires' disease outbreak investigations, 2015–2019

Most WMP deficiencies associated with outbreaks were due to missing or improperly implemented WMPs.



Most environmental deficiencies were due to process failure.



Final Remarks

- Time, energy, resources, and management commitment are needed to an effective water management plan.
- *Complete elimination at all times of Legionella from a water system is not a realistic goal*
- Facilities depend on their Public Water Supply to deliver high quality water with adequate residual disinfectants
- Facilities depend on water temperature, maintenance, cleaning, and preventing stagnation (time, flow, and dead legs) as main control methods
- *There will be places in every water system within the optimum temperature range for Legionella to grow and amplify*
- In the absence of cases linked to the facility CMS expects that healthcare facilities have established a WMP Team and gone through the steps to implement a plan. CMS does not require sampling
- A verified and validated WMP allows enables informed decisions to reduce hazards, risks, optimize costs, and improve efficiency



Online references

Considerations When Working with Legionella Consultants

<https://www.cdc.gov/control-legionella/php/wmp/consultants-considerations.html>

Centers for Medicare & Medicaid Services, S&C 17-30, 06/09/2017 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/Survey-and-Cert-Letter-17-30.pdf>

Association of Water Technologies, Legionella 2019, A Position Statement and Guidance Document

<https://www.awt.org/pub/?id=035C2942-03BE-3BFF-08C3-4C686FB7395C>

Healthcare Facility Water Management Program Checklist

<https://www.cdc.gov/healthcare-associated-infections/media/pdfs/PHS-ReduceWaterRisk-ChecklistTool-508.pdf>



Legionella Consultants

This list was compiled by the North Carolina Division of Public Health; however, our agency does not endorse, suggest, or recommend any specific consultant or company on this list. This list is not exhaustive, is intended for informational use only, and may not be up to date

Phigenics, <https://info.phigenics.com/>. Contact Scott Whip, Regional Manager (704) 236-1357 or swhipp@phigenics.com.

Bill Pearson, Chief Science Officer for Innovative Water Consulting (IWC), Telephone number (919) 880-0829 Bpearson249@icloud.com.

Julie Lo, MS, CIH, Atlas Consulting julie.lo@oneatlas.com Office (919) 871-0999, (919) 348-5957 OneAtlas.com

Elaine Schulman, Nalco Environmental Hygiene Services, 1601 West Diehl Rd, Naperville, IL 60563-1198 (202) 834-0494 eschulman@nalco.com

Legionella Consultants, Inc 25030 Ramm Drive Naperville, IL 60564, (630) 689-5677 or (757) 299-7737 <http://www.Legionellaconsultantsinc.com>

Chem-Aqua (Environmental Sampling Only – will subcontract with a Consulting firm) P.O Box 152170, Irving, TX 75015 800-476-4262, <http://chemaqua.com>

Point of Use Filters - Pall Filter Company

Christopher Connolly, North American Hospital Water Sales Manager, Pall Medical- Hospital Group, 973-632-1920 (cell) 215-383-4351 (fax) chris_connolly@pall.com www.pall.com/medical

Purologix Water Services, Inc, Russ Elmore, Water Specialist/Consultant/Manager
919-577-1178 x104 (office) 919-624-6569 (cell), russ@purologix.com www.purologix.com

AquaMedix LLC, J. Brady Benson CleanSpray Water Filtration Systems
952-479-0636 (office) 612-819-8005 (cell) bbenson@aquamedix.net, www.aquamedix.net



Questions?

Contact me:

David Lipton, CIH
Occupational and Environmental Epidemiology Branch
(919) 707-5900 (main)
(919) 707-5961 (direct)
David.lipton@dhhs.nc.gov
5505 Six Forks Road, Raleigh NC 27609
1912 Mail Service Center, Raleigh NC 27699-1912

