Legionella Prevention and Management

Ohio Department of Health

Bureau of Environmental Health and Radiation Protection

Bureau of Infectious Diseases

July 26, 2017

Legionella

- Legionnaires' disease is becoming an increasing concern in the United States and worldwide
- Legionnaires' disease is caused by the *Legionella* bacterium
- *Legionella* is a naturally occurring bacterium that occurs in freshwater lakes and streams, however the quantities in natural water bodies are generally insufficient to cause disease

Legionella Growth

- Growth or amplification of *Legionella* can occur under different environments in water systems.
- Conditions that promote amplification:
  - Water stagnation
  - Warm temperatures (25 - 51° C [77° - 124° F])
  - Presence of scale and sediment
  - Presence of organic matter (biofilms)
  - Protozoa
  - Lack of residual disinfectant

Legionella Transmission

- *Legionella* is dispersed through aerosolization.
- Sources include:
  - Showers and faucets
  - Cooling towers
  - Hot tubs
  - Decorative fountains
  - Large, complex water systems

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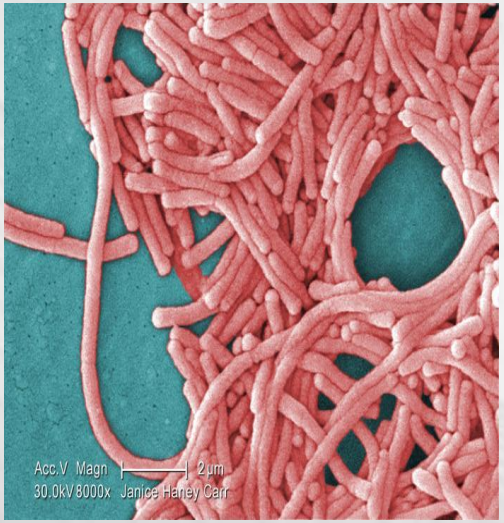
Legionella



Source: Water

Incubation: 2-10 days

Transmission: Airborne, inhalation of aerosolized water; aspiration may be possible

Secondary Cases: No

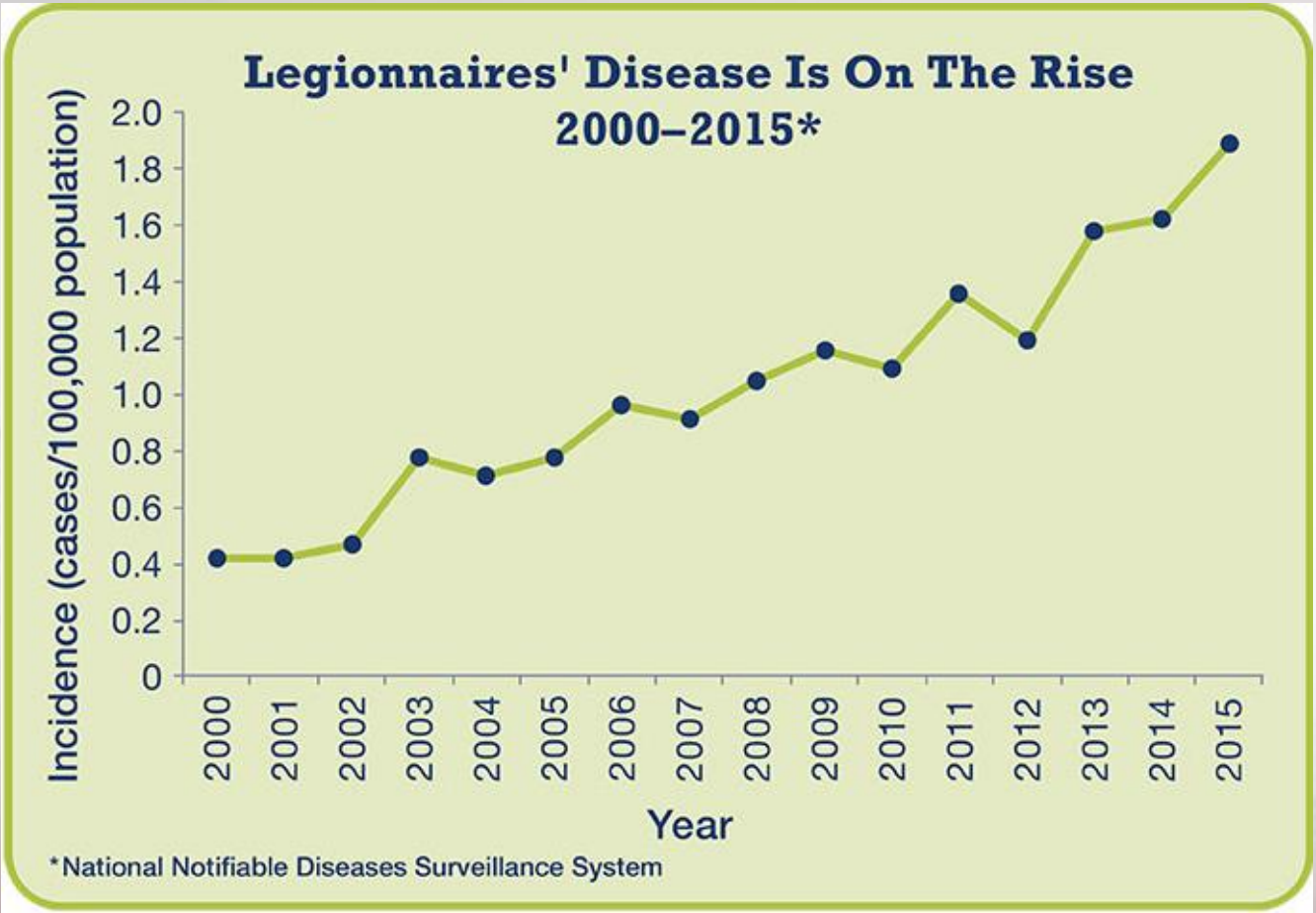
Symptoms: Legionnaires' Disease-pneumonia, cough, shortness of breath, fever, muscle aches, and headaches. **Pontiac Fever-**mild flu-like symptoms, no pneumonia

Mortality: Approximately 10%

Sensitive Populations

- People 50 years or older
- Current or former smokers
- People with a chronic lung disease (chronic obstructive pulmonary disease or emphysema)
- People with weak immune systems or who take drugs that weaken the immune system (transplant or chemotherapy recipients)
- People with cancer
- People with underlying illnesses such as diabetes, kidney failure, or liver failure

Legionnaires' Disease in the US, 2000-2015



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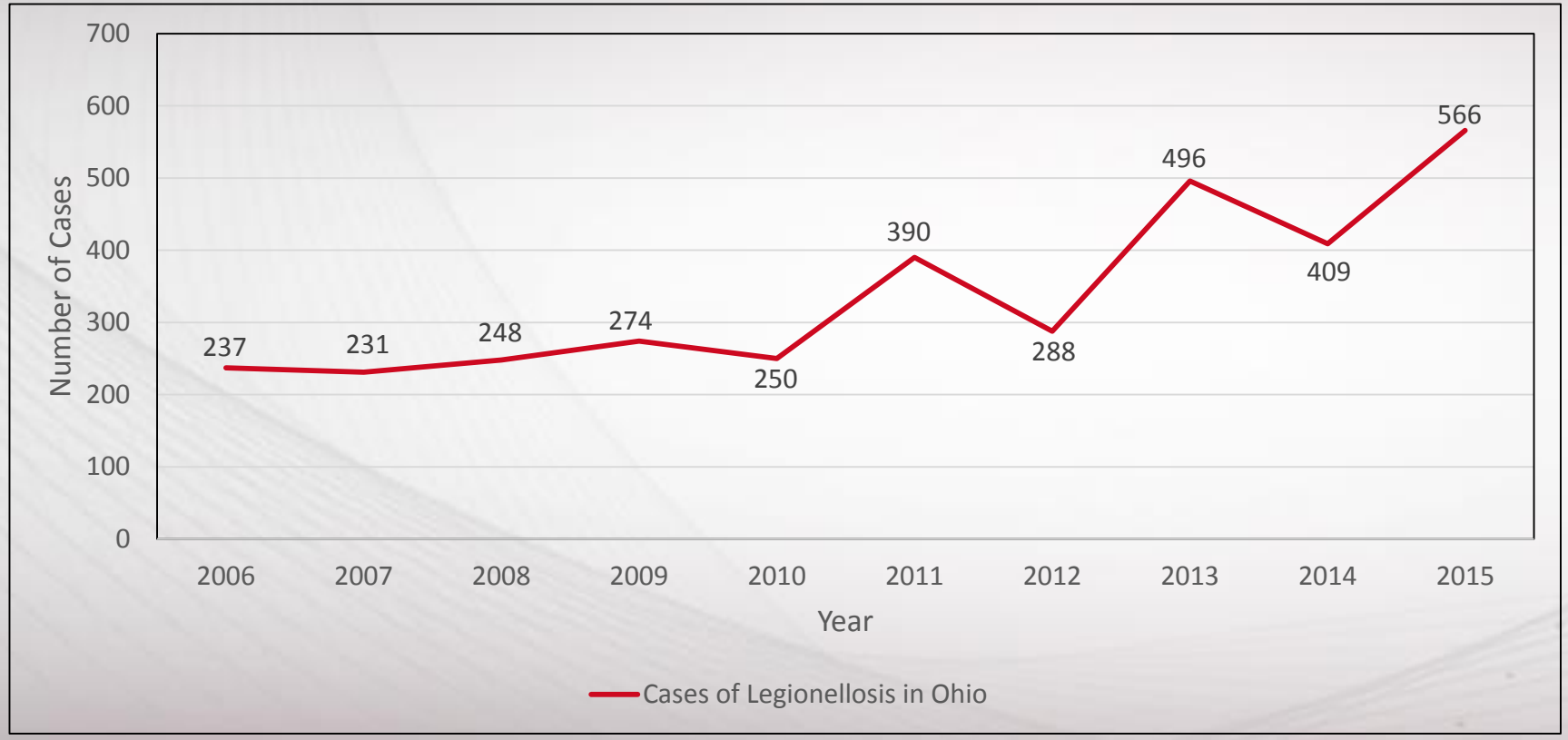
Cases of Legionellosis in Ohio



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Possible reasons for increased number of cases

- Increased use of diagnostic tests
- Increased surveillance
- Increased awareness and testing
- Increased susceptibility of the population – illness, medication, aging
- Increased *Legionella* in the environment due to climate change, aging infrastructure, and water-saving fixtures

CDC Investigation of Building –Associated Outbreaks

- The CDC recently identified that common settings for outbreaks include:
  - Hotels
  - Long-term care facilities
  - Hospitals

Garrison LE et al. *MMWR*. 2016;65(22):557–61.

Source: Soda, 2017.

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CDC Vital Signs

- Healthcare facilities often have large and complex water distribution system
- Serve sensitive populations

https://www.cdc.gov/vitalsigns/pdf/2017-06-vitalsigns.pdf

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CDC Investigations

Exposure to a health care facility in the 10 days prior to symptom onset

- Definite: exposure to a hospital or long-term care facility for the entire 10 days before symptom onset
- Possible: exposure to a health care facility for a portion of the 10 days before symptom onset

CDC Investigations

Definite Health Care Associated Cases

- 16 of 21 Jurisdictions reported definite cases of health care associated Legionnaires' disease in 2015
- Definite cases were associated with long-term care facilities (80%), hospitals (18%), or both (2%)
- The case fatality rate was 25%

Possible Health Care Associated Cases

- Possible cases were associated with long-term care facilities (13%), hospitals (49%), clinics (26%) and other (3%).
- The case fatality rate was 10%.

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Centers for Medicare and Medicaid services

- June 2017 memo
- Identifies *Legionella* control as responsibility of the facility
- https://www.cms.gov/Medicare/Provider-Enrollment-and-Certification/SurveyCertificationGenInfo/Downloads/Survey-and-Cert-Letter-17-30.pdf

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Legionella Prevention Actions

- Clinical
  - Proactive monitoring of cases
  - Reporting of Legionnaires' disease to local health districts
- Environmental
  - Includes facility assessments, water management plans, environmental controls and monitoring

Proactive monitoring for facilities

1. Keep a high index of suspicion for legionellosis.
2. Test patients with pneumonia for *Legionella* spp. (culture from lower respiratory specimen **AND** urine antigen test, preferably).
3. Track and report cases to public health.
4. Work with public health to ensure appropriate prevention and control measures are in place.

Proactive Monitoring for Local Health Departments

1. Educate clinicians and facilities to keep a high index of suspicion for *Legionella*
2. Encourage clinicians and facilities to test patients with pneumonia for *Legionella* spp. (culture from lower respiratory specimen **AND** urine antigen test, preferably)
3. Work with facilities to ensure appropriate prevention and control measures are in place to prevent spread.
4. Investigate all reported cases of legionellosis.

Environmental Sources

- Common sources in buildings
  - Showers, faucets, ice machines
  - Cooling towers
  - HVAC (Heating, Ventilation, and Air-Conditioning) Systems
  - Hot tubs
  - Decorative fountains
  - Large, complicated cold and hot water systems

At-risk facilities

- Facilities housing sensitive populations such as hospitals and long-term care facilities
- Buildings with more than 10 stories
- Buildings with cooling towers
- Building with large, complex hot water distribution systems

Development of Water Management Plans

- Also called Water Safety Plans
- Purpose
  - Prevention of *Legionella* growth
  - Remediation in case of outbreaks
- Means
  - Monitoring of system parameters
  - Remediation measures

Water Management Plans

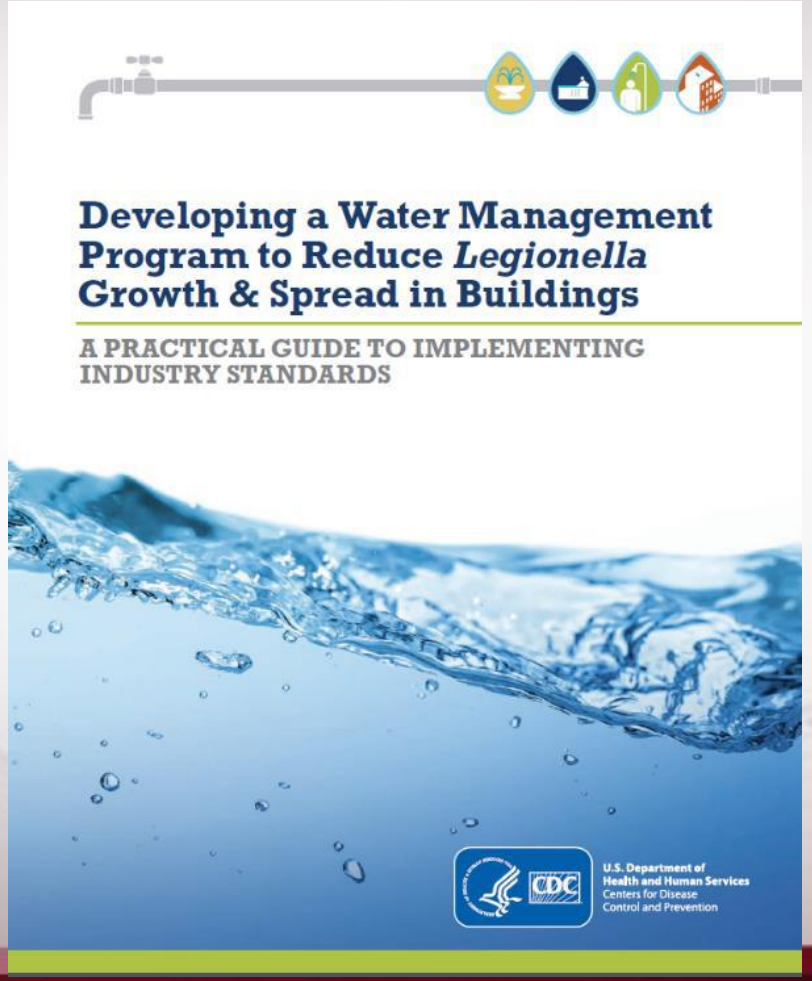
- Components
  1. Establish a water management program team
  2. Describe the building water systems using text and flow diagrams
  3. Identify areas where *Legionella* could grow and spread
  4. Decide where control measures should be applied and how to monitor them
  5. Establish ways to intervene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

Water Management Plans

Resources

ASHRAE (2015). Standard 188-2015, Legionellosis: Risk Management for Building Water Systems. *American Society of Heating, Refrigerating, and Air-Conditioning Engineers, Inc., Atlanta, Ga*.

CDC (2016). Developing a Water Management Program to Reduce *Legionella* Growth & Spread in Buildings. *Centers for Disease Control and Prevention*.



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Facility assessments

Necessary Team Member Skills:

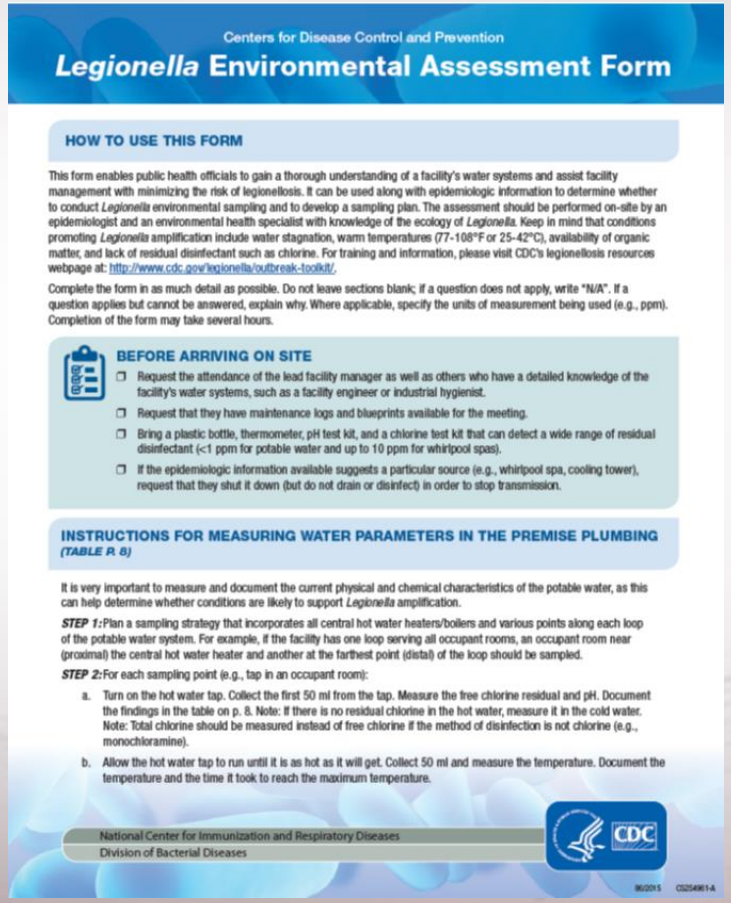
- Knowledge of the water systems
- Infection prevention
- Monitoring and documentation
- Communication

Potential Team Members:

- Building manager or administrator
- Maintenance or engineering employees
- Contractors and consultants
- Infectious disease specialist
- Risk and quality management staff

Importance of Facility Assessments

- Provides a complete understanding of a facility water system and helps identify areas of risk
- Can be used with epidemiological information to determine environmental sampling locations



Centers for Disease Control and Prevention

Legionella Environmental Assessment Form

HOW TO USE THIS FORM

This form enables public health officials to gain a thorough understanding of a facility's water systems and assist facility management with minimizing the risk of legionellosis. It can be used along with epidemiologic information to determine whether to conduct *Legionella* environmental sampling and to develop a sampling plan. The assessment should be performed on-site by an epidemiologist and an environmental health specialist with knowledge of the ecology of *Legionella*. Keep in mind that conditions promoting *Legionella* amplification include water stagnation, warm temperatures (77-108°F or 25-42°C), availability of organic matter, and lack of residual disinfectant such as chlorine. For training and information, please visit CDC's legionellosis resources webpage at: http://www.cdc.gov/legionella/outbreak-toolkit/.

Complete the form in as much detail as possible. Do not leave sections blank; if a question does not apply, write "N/A". If a question applies but cannot be answered, explain why. Where applicable, specify the units of measurement being used (e.g., ppm). Completion of the form may take several hours.

BEFORE ARRIVING ON SITE

- ❒ Request the attendance of the lead facility manager as well as others who have a detailed knowledge of the facility's water systems, such as a facility engineer or industrial hygienist.
- ❒ Request that they have maintenance logs and blueprints available for the meeting.
- ❒ Bring a plastic bottle, thermometer, pH test kit, and a chlorine test kit that can detect a wide range of residual disinfectant (<1 ppm for potable water and up to 10 ppm for whirlpool spas).
- ❒ If the epidemiologic information available suggests a particular source (e.g., whirlpool spa, cooling tower), request that they shut it down (but do not drain or disinfect) in order to stop transmission.

INSTRUCTIONS FOR MEASURING WATER PARAMETERS IN THE PREMISE PLUMBING *(TABLE P. 8)*

It is very important to measure and document the current physical and chemical characteristics of the potable water, as this can help determine whether conditions are likely to support *Legionella* amplification.

STEP 1: Plan a sampling strategy that incorporates all central hot water heaters/boilers and various points along each loop of the potable water system. For example, if the facility has one loop serving all occupant rooms, an occupant room near (proximal) the central hot water heater and another at the farthest point (distal) of the loop should be sampled.

STEP 2: For each sampling point (e.g., tap in an occupant room):

a. Turn on the hot water tap. Collect the first 50 ml from the tap. Measure the free chlorine residual and pH. Document the findings in the table on p. 8. Note: If there is no residual chlorine in the hot water, measure it in the cold water. Note: Total chlorine should be measured instead of free chlorine if the method of disinfection is not chlorine (e.g., monochloramine).

b. Allow the hot water tap to run until it is as hot as it will get. Collect 50 ml and measure the temperature. Document the temperature and the time it took to reach the maximum temperature.

National Center for Immunization and Respiratory Diseases
Division of Bacterial Diseases

CDC

https://www.cdc.gov/legionella/downloads/legionella-environmental-assessment.pdf

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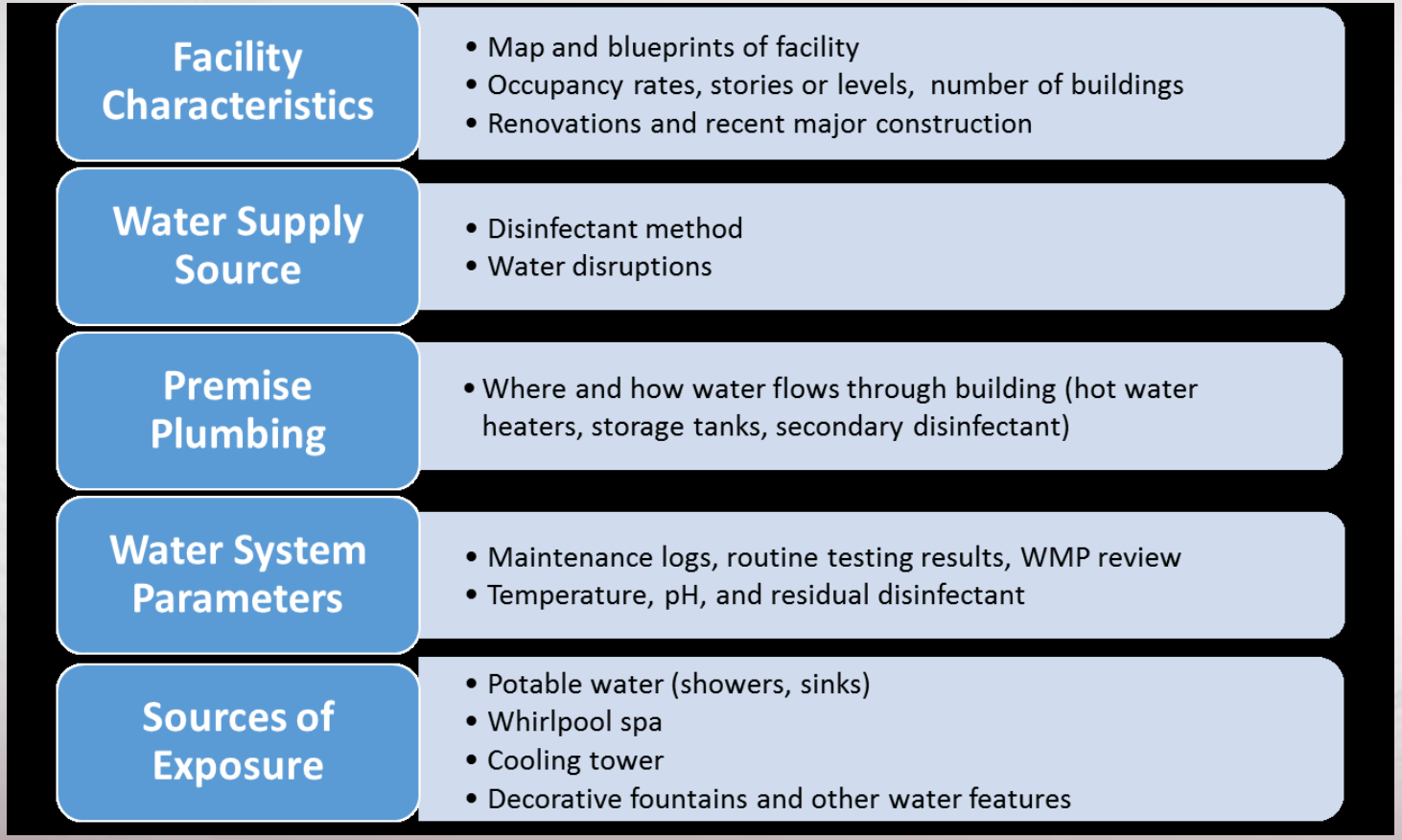
Key components of an environmental assessment



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Facility assessments

Describe the Building Water Systems

- Develop a process flow diagram showing where the building connects to the water supply and how hot and cold water is distributed to the building
- Identification of dead-end plumbing legs or areas of water stagnation – presence of water saving fixtures
- Updates or construction should be based on the initial system assessment and procedures should be in place for updating documentation and schematics

Facility assessments

- Location of open or closed-loop cooling towers or evaporative condensers.
  - Evaluation of maintenance procedures
  - Proximity to indoor air intakes
- Hot water heaters and boilers
  - Distribution pattern through the building
  - Assessment of maintenance
- Identify presence or absence of whirlpools, hot tubs or spas, ornamental fountains, misters, atomizers, air washes, humidifiers, or other aerosol generating devices

Facility assessments

Identify Areas Where *Legionella* Could Grow and Spread

- Identify potentially hazardous conditions within the process flow diagram
- Areas where medical procedures may expose patients to water droplets
- Areas with occupants that are undergoing treatment for burns, chemotherapy, solid organ or bone marrow transplantation, are immunocompromised, are taking drugs that weaken the immune system, have renal disease, diabetes, chronic lung disease, or are over 65 years old

Proactive environmental monitoring

- Measurable standards for ensuring that system is not conducive to *Legionella* growth
- Ex. **Chlorine residual**, **temperature**, flow rate…
- Decide on action levels with a corresponding plan of action when unacceptable
- Use CDC ELITE certified laboratory for any sample analysis

Prevention - Long-term control

- At the discretion of facility managers, based on system characteristics, usage rates, and water quality parameters
- Meant to maintain an environment that is not conducive to *Legionella* growth
- Not sufficient to guarantee the elimination of the risk of *Legionella* exposure
- May require plan approval and licensure as a public water system from Ohio EPA.

Long-term control

Temperature

- Cold water should be maintained below 25° C (77° F)
- **Hot water above 50° C** (122° F)
- Temperature logs and time to reach highest temperature

Chlorine

- Most common chemical method
- **Maintain residual levels of 0.5-1 mg/L minimum**
- Chlorine residual logs

Long-term control

Monochloramine

- Used in hot water systems
- Normal residual rates between 1.0 – 3.0 mg/L

Chlorine dioxide

- Normal residual between 0.1 and 0.5 mg/L
- Remains a gas in solution, harder to maintain residual in hot water

Long-term control

Copper-Silver Ionization

- Water flows through electrically charged flow cells with copper and silver anodes releasing copper and silver ions into the water
- Most commonly used on recirculating hot water systems
- Recommended residual of 0.3 – 0.8 ppm for copper and 0.01 – 0.08 ppm for silver

Long-term control

Ultraviolet (UV)

- Best when used along with another measure

Filtration

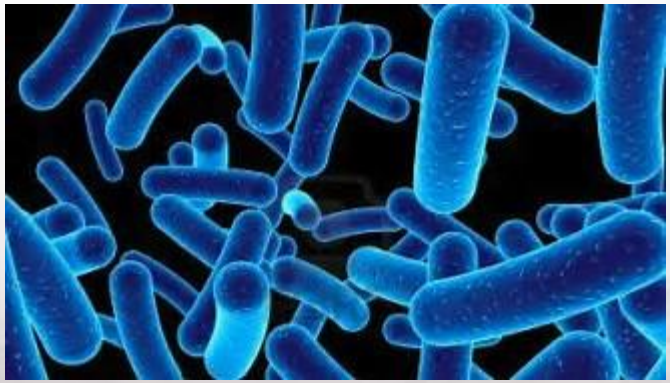
- Point-of-use and point-of-entry
- Reverse osmosis, nanofilters, ultrafilters, and certain microfilters

Ozone

- Almost never used

Response to Outbreaks

- Clinical and epidemiological investigations
- Environmental components



Legionella Outbreak Response

- Consider implementing water use restrictions to prevent additional exposures and cases
  - Showering
  - Ice machines
  - Drinking water
  - Hand – washing and wound care
  - Commercial and industrial uses
- Install temporary water filtration
- *Legionella* testing for all pneumonia cases and enhanced surveillance

Epidemiological Investigations

Case investigations may uncover:

- Two or more cases with a common exposure (long-term care facility, work-site, gym, church, etc.)
- A person whose job involves contact with aerosols (e.g. manufacturing, etc.)
- A person who has been living in a long-term care facility for the 10 days prior to developing symptoms

These all merit further investigation.

Epidemiological Investigations

Further investigation may include:

- Case finding (retro and prospective)
- Use of CDC risk assessment tools
- Water testing

Tools for Case Interviews

- Legionellosis Case Report Form
- CDC Hypothesis Generating Questionnaire (as necessary)

https://www.cdc.gov/legionella/health-depts/inv-tools-single/index.html

Facility outbreak response

Coordinate with local health departments and ODH

Active case monitoring

Short term remediation options

Long term remediation

What to do if you have a case of Legionnaires' Disease

- Individual cases (and outbreaks) are required to be reported to your city or county health department.
- Identify the patient's onset date.
- Where was this person for the 10 days prior to onset (e.g. trips outside your facility)?
- Have there been other cases of pneumonia among residents or staff?
- Have there been other cases of flu-like illness (Pontiac Fever)?
- Follow the CDC Case Definition
- If other cases of pneumonia occur, test promptly for *Legionella*.

Environmental Outbreak Response Actions

- If not done already - conduct a facility assessment
- The CDC assessment tool is a good start –

https://www.cdc.gov/legionella/downloads/legionella-environmental-assessment.pdf

Environmental Outbreak Response Actions

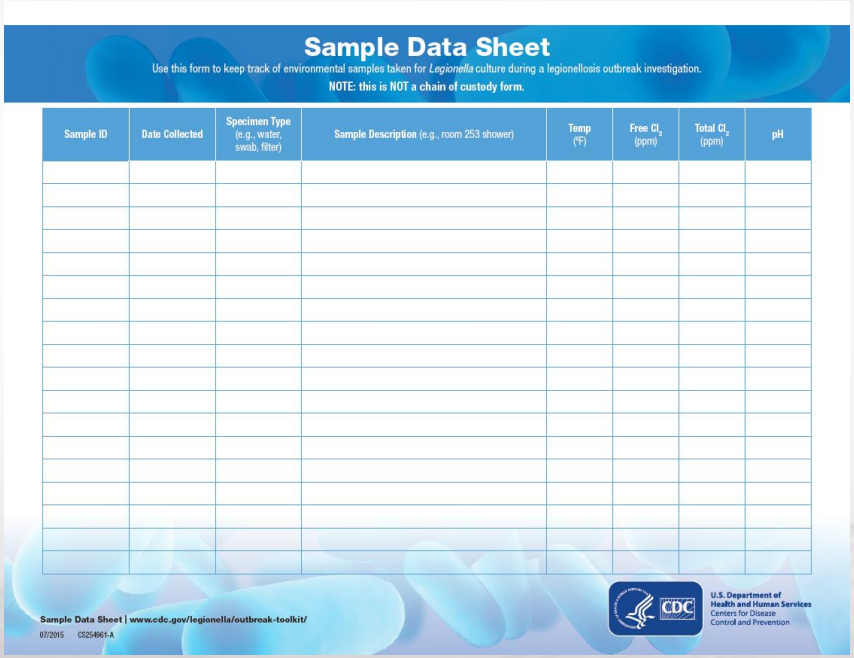
- Evaluate and consider points of exposure
- Compare to data collected from the facility assessment
- Evaluate need to conduct environmental monitoring at key locations where exposure may have occurred

Environmental Outbreak Response

- Install temporary filtration until short term remediation actions are conducted to prevent exposure
  - Legionella bacteria is approximately 2µm in length and 0.3-0.9µm in width,
  - Point of use filtration devices must be capable of removing particles less than 0.3 micron in size at 99.999% efficiency

Environmental Outbreak Response Actions

- Implement short term remediation options
- Conduct environmental monitoring at points of potential exposure prior to and after short term remediation
- https://www.cdc.gov/legionella/downloads/sample-data-sheet.pdf
- Use CDC ELITE certified laboratory for sample analysis



Sample Data Sheet

Use this form to keep track of environmental samples taken for *Legionella* culture during a legionellosis outbreak investigation.

NOTE: this is NOT a chain of custody form.

Sample ID	Date Collected	Specimen Type (e.g., water, swab, filter)	Sample Description (e.g., room 253 shower)	Temp (°F)	Free Cl_2 (ppm)	Total Cl_2 (ppm)	pH

Sample Data Sheet | www.cdc.gov/legionella/outbreak-toolkit/

07/2015 CS254061-A

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Sampling Procedure and Potential Sampling Sites

Protocol for collecting environmental samples for ***Legionella*** **culture** during a **cluster or outbreak** investigation or when **cases of disease** may be associated with a facility.

Sampling should only be performed after a thorough environmental assessment has been done and a sampling plan has been made. This protocol describes how to take standard biofilm swab, bulk water, and filter samples from commonly sampled sites. This protocol may be used in conjunction with the following tools:

***LEGIONELLA* ENVIRONMENTAL ASSESSMENT FORM**

SAMPLE DATA SHEET

LEGIONELLOSIS OUTBREAK INVESTIGATION VIDEOS:

Legionella Ecology and an Introduction to Environmental Health and Engineering
Conducting and Interpreting the Environmental Assessment
How to Make a Sampling Plan
How to Sample Potable Water
How to Sample Cooling Towers
How to Sample Spas and Fountains

National Center for Immunization and Respiratory Diseases
Division of Bacterial Diseases

LIST OF POTENTIAL SAMPLING SITES*

Site	Approximate number of samples	Type of samples	Sample processing†
Potable water			
Incoming water main (where water enters the facility/campus/building from the municipality)	1	1L bulk water	Concentrate
Every well and water tower that supplies water to the facility/campus/building	1 per well or water tower	1L bulk water	Concentrate
Every holding tank or cistern	1 per holding tank/cistern	1L bulk water	Concentrate
Centralized water heater	1	1L bulk water (a biofilm swab if drained)	Direct
Expansion tank for hot water (absorbs excess water pressure caused by thermal expansion within the hot water heater)	1	1L bulk water	Concentrate
Hot and cold water returns	1 each for hot and cold	1L bulk water	Concentrate
For buildings with water softeners, special filters, and disinfection systems, sample water before and/or after these processes		1L bulk water	Concentrate
Shower	2 per shower‡	1 biofilm swab and 1L bulk water	Concentrate
Faucet	2 or 3 per faucet‡	1 biofilm swab inside the faucet, (1 biofilm swab of the inside of the aerator if visual inspection indicates that it's overgrown with biofilm), 1L bulk water	Concentrate
Whirlpool baths§ (i.e., Jacuzzis)	1	1 biofilm swab inside the jets	Concentrate
Cooling towers¶			
Make-up water (water added to replace water loss because of evaporation, drift, or leakage)	1	1L bulk water	Direct
Collection basin (an area below the tower where cooled water is collected and directed to the sump)	2	1L bulk water and a biofilm swab at the water line	Direct
Sump (a depressed chamber contiguous to the basin, where water flows to facilitate pump suction; may also be used as collection point for silt and sludge)	2	1L bulk water and a biofilm swab at the water line	Direct
Storage tank or reservoir in the system	1	1L bulk water	Direct
Drift eliminators or other surfaces that remain moist	1	1 biofilm swab	Direct
Heat sources (e.g., chillers)	1	1L bulk water	Direct

Facility outbreak response

Superheat and Flush

- Raise temperature to 71 - 77 °C (160° - 170° F) allowing for temperatures above 65 °C (149° F) at the outlets
- Duration may vary depending on system, approximately 30 minutes
- Not appropriate for cold water systems
- Restrict water usage during treatment

Facility outbreak response

Hyperchlorination

- Raise chlorine levels to a range between 20 – 50 mg/L
- Maintained for 2-24 hours
- Flushed at 20 mg/L through each distal site or fixture
- Restrict water usage during treatment

Cooling Towers

- Evaluation of cooling tower maintenance
- As necessary conduct physical cleaning
  - Areas that hold water
  - Areas where water circulates
  - Remove any biofilms
- Re disinfection of cooling tower and addition of fresh biocidal agents

Post Outbreak Actions

- After outbreak –
  - Develop or update, and implement water management plan
  - Implement and monitor control measures as needed
  - If necessary, install long term treatment
  - Continue disease surveillance

Legionella and Public Water Systems

Why should a public water system be concerned?

- Distribution temperatures are commonly below 70 degrees F
- Chlorine residuals – incoming cold water to buildings should be above .5 to 1 mg/l

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Legionella Outbreak, Flint Michigan

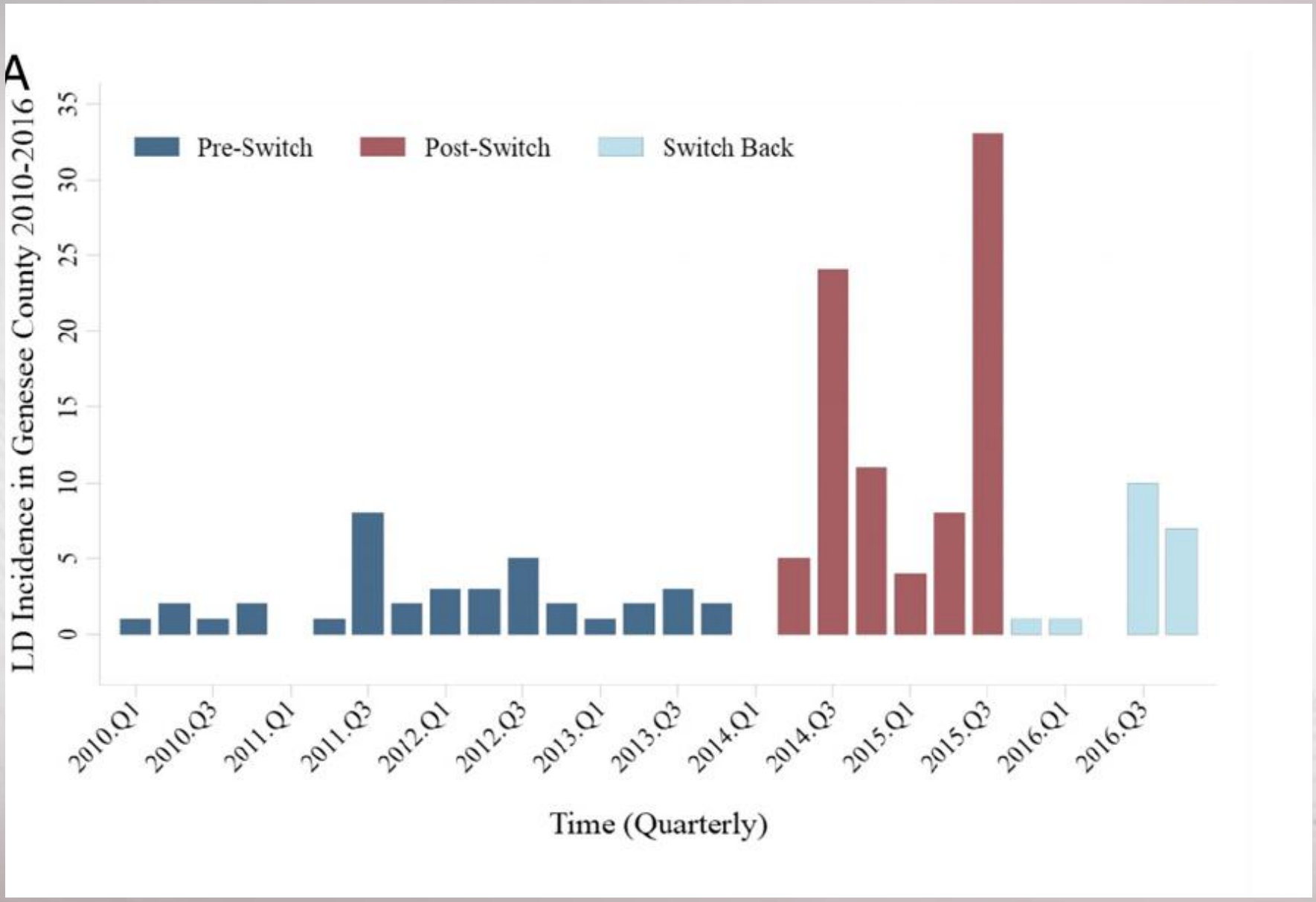
- Assessment of the Legionnaire's disease outbreak in Flint, MI. Zahran, et al, 2018. PNAS, E1730-E1739.
- Outbreak of Legionnaires' disease (LD) in 2014-2015 associated with changes in the source of drinking water in Flint, Michigan.

Legionella Outbreak, Flint Michigan

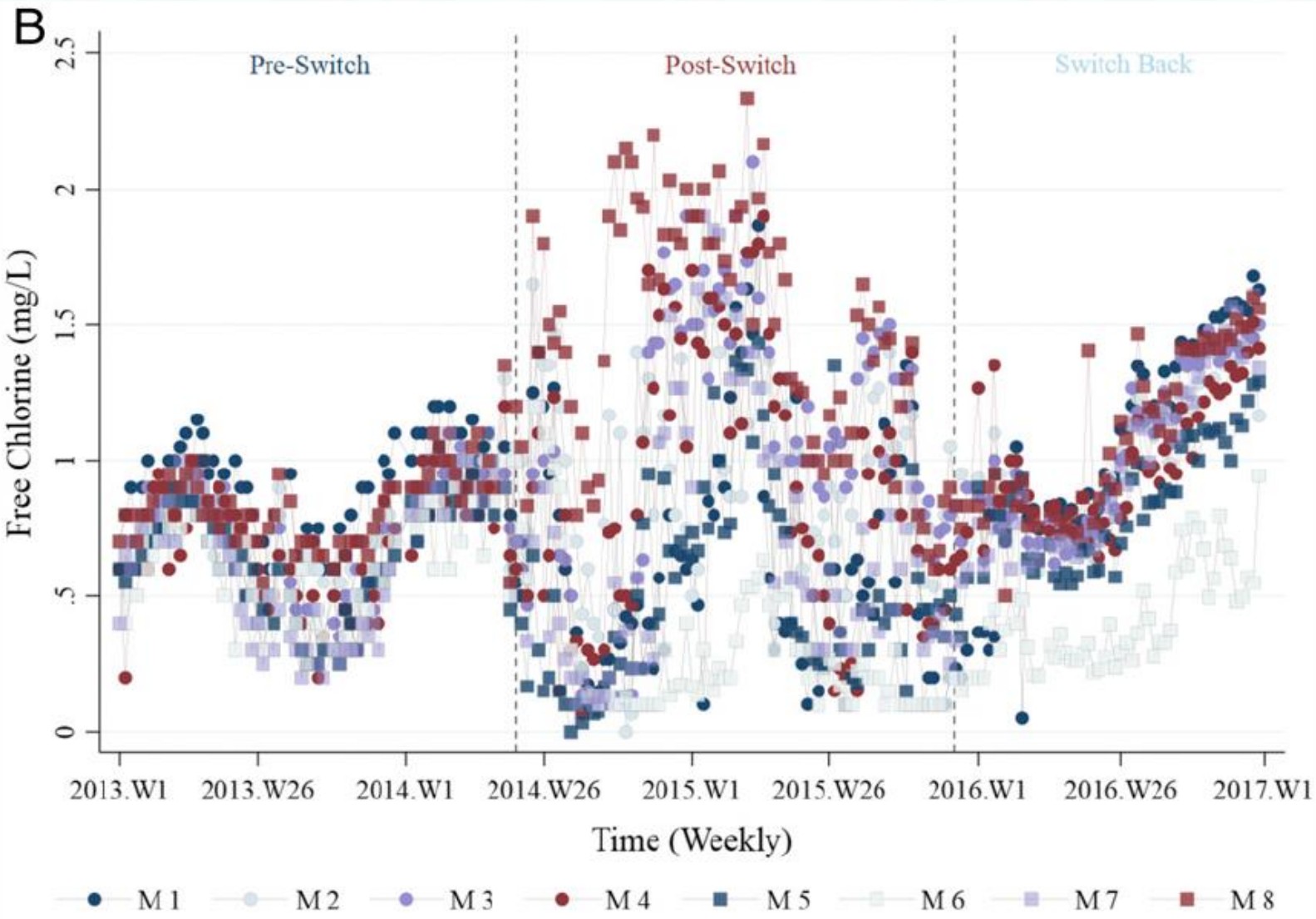
- Following the switch in water supply from Detroit to Flint River water, the odds of a Flint resident contracting LD increased 6.3 fold.
- Risk subsided after boil water advisories were issued (residents avoiding water(
- LD cases returned to normal levels after the switch back to Detroit supplied water.

Legionella Outbreak, Flint Michigan

- During the outbreak, as the concentration of free chlorine decreased, the risk of acquiring LD increased.
- When average weekly chlorine level in a census tract was <0.5 mg/l or < 0.2 mg/l, the odds of an LD case increased by a factor of 2.9 or 3.9 respectively.
- During the switch to the Flint River, the risk of a Flint neighborhood having a case of LD increased by 80% per 1 mg/l decrease in free chlorine.
- During the switch, occurrence of assimilable organic carbon and free iron increased



Source: Zahran, et al, 2018



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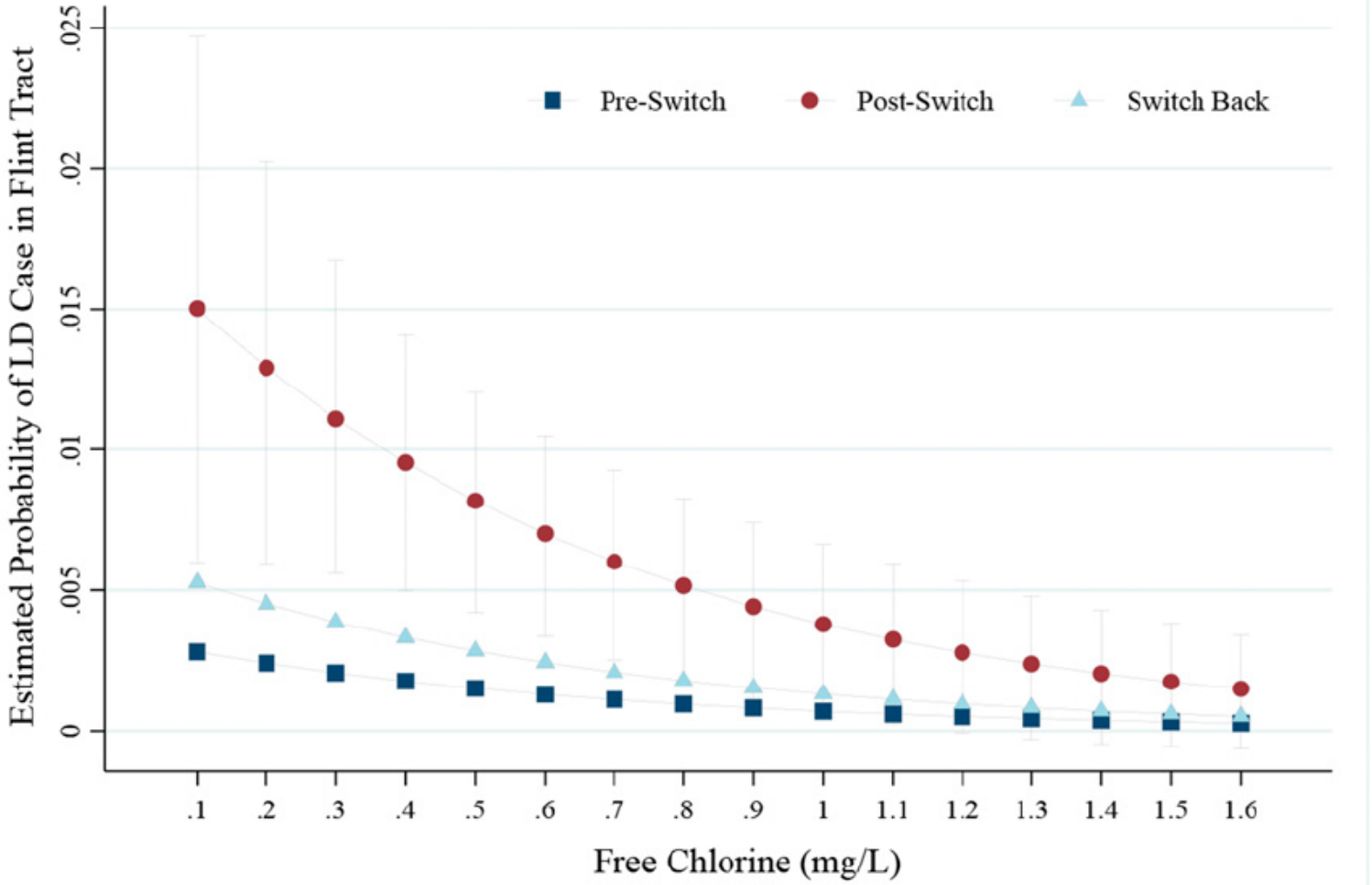

Fig. 3. The probability of an LD case being observed in a given week as a function of free chlorine residual. The estimated probability is calculated for each census tract within the Flint water distribution system for a given week as a function of free chlorine (mg/L as Cl_2) before, during, and after the change in water supply. The probabilities are estimated with other observed model covariates (i.e., meteorological and demographic) fixed at sample means. Bars indicate 95% confidence intervals.

Source: Zahran, et al, 2018

Legionella Outbreak, Flint Michigan

- Thoughts on the study:
  - Free chlorine supplied to homes and buildings was reduced during the water switch
  - This allowed amplification (growth) of legionella in hot water distribution systems in homes and buildings
  - Due to decreased chlorine residuals there was an increase in biolfilm growth and protozoans – conditions where legionella can amplify

Resources and training

- CDC website/toolkit- https://www.cdc.gov/legionella/index.html
- ASHRAE: https://www.ashrae.org/resources--publications/bookstore/ansi-ashrae-standard-188-2015-legionellosis-risk-management-for-building-water-systems
- ODH **- www.odh.ohio.gov/legionella**
- Local Health Departments - http://www.odh.ohio.gov/localhealthdistricts/lhdmain.aspx
- Ohio EPA – Division of Drinking and Ground Waters http://www.epa.state.oh.us/ddagw/DrinkingandGroundWaters.aspx

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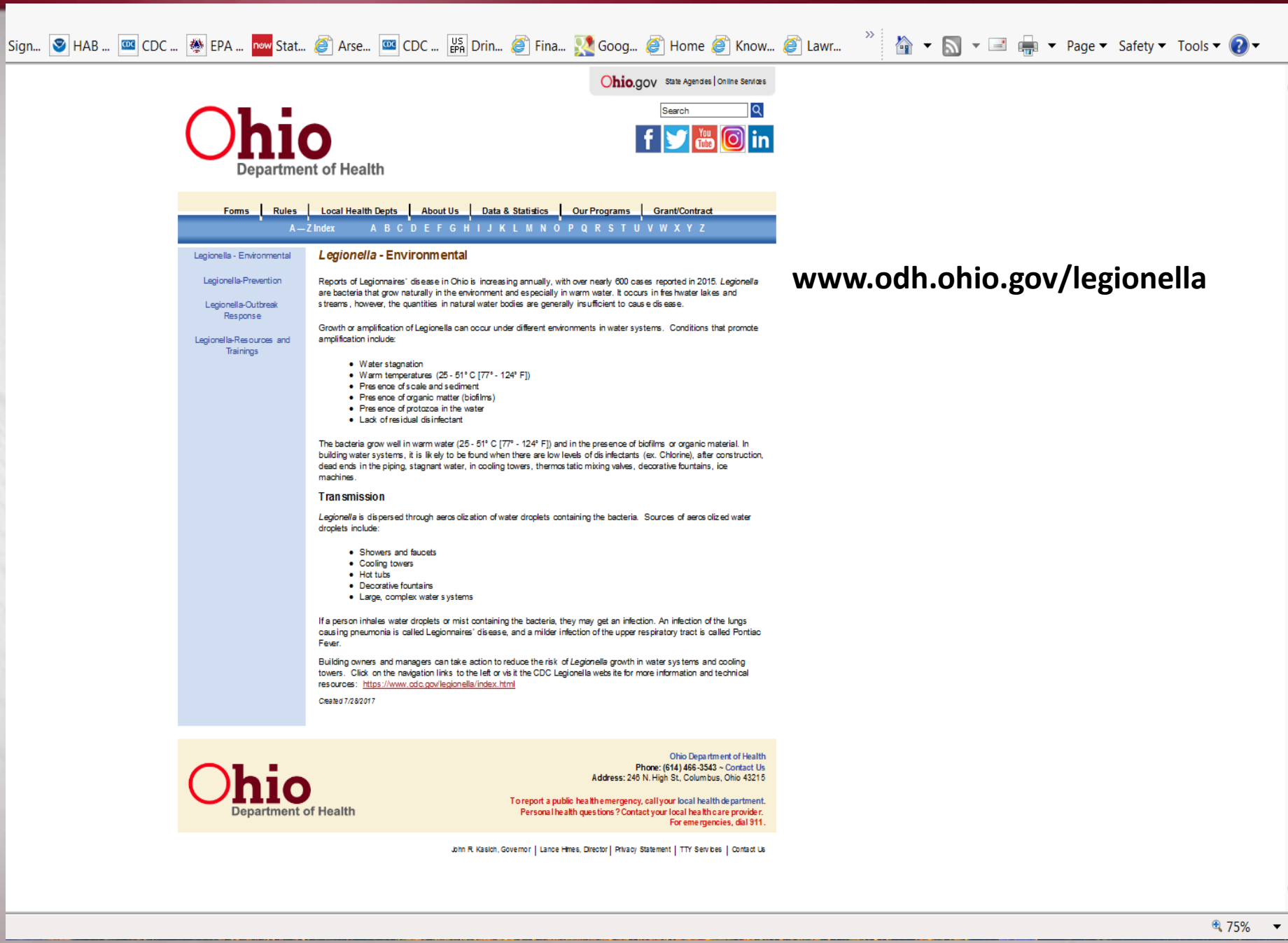
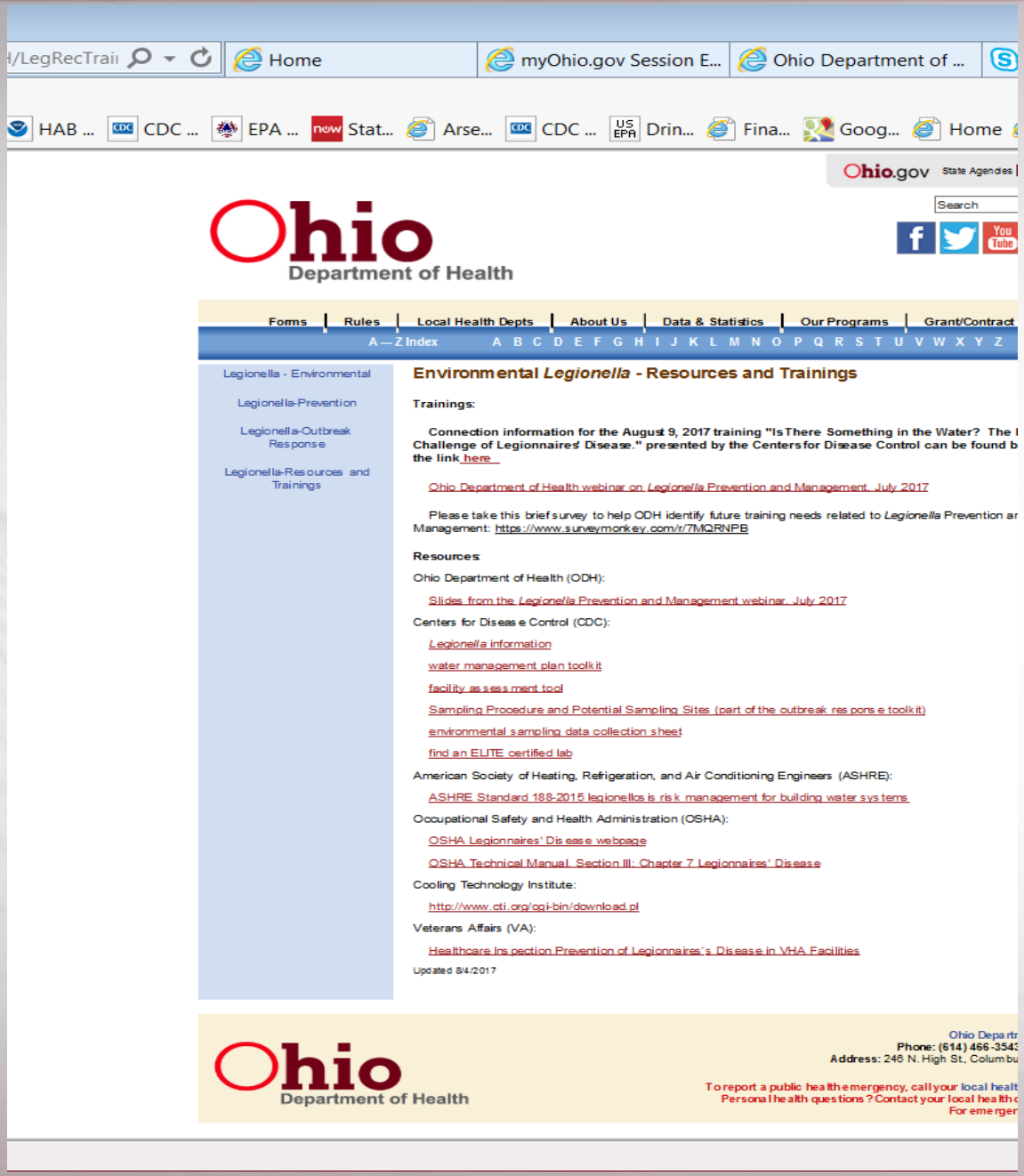


www.odh.ohio.gov/legionella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A B C D E F G H I J K L M N O P Q R S T U V W X Y Z
Legionella - Environmental
Legionella-Prevention
Legionella-Outbreak Response
Legionella-Resources and Trainings
Environmental Legionella - Resources and Trainings
Trainings:
Connection information for the August 9, 2017 training "Is There Something in the Water? The
Challenge of Legionnaires' Disease." presented by the Centers for Disease Control can be found b
the link here
Ohio Department of Health webinar on Legionella Prevention and Management, July 2017
Please take this brief survey to help ODH identify future training needs related to Legionella Prevention ar
Management: https://www.surveymonkey.com/r/7MQRNPB
Resources:
Ohio Department of Health (ODH):
Slides from the Legionella Prevention and Management webinar, July 2017
Centers for Disease Control (CDC):
Legionella information
water management plan toolkit
facility assessment tool
Sampling Procedure and Potential Sampling Sites (part of the outbreak response toolkit)
environmental sampling data collection sheet
find an ELITE certified lab
American Society of Heating, Refrigeration, and Air Conditioning Engineers (ASHRE):
ASHRE Standard 188-2015 legionellosis risk management for building water systems
Occupational Safety and Health Administration (OSHA):
OSHA Legionnaires' Disease webpage
OSHA Technical Manual, Section III: Chapter 7 Legionnaires' Disease
Cooling Technology Institute:
http://www.cti.org/cgi-bin/download.pl
Veterans Affairs (VA):
Healthcare Inspection Prevention of Legionnaires's Disease in VHA Facilities
Updated 8/4/2017
Ohio
Department of Health
Ohio Departr
Phone: (614) 466-354
Address: 246 N. High St., Columbu
To report a public health emergency, call your local healt
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For emerger

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