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PHO Rounds Series:
Legionella Outbreak Investigations: A Practical Approach
Session 2

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May 16, 2023

Public Health Ontario Rounds

Presenter Disclosures – Kelly Briscoe

- I do not have a relationship with a for-profit and/or a not-for-profit organization to disclose

Presenter Disclosures – Anna Majury

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- Allana Murphy
- Austin Zygmunt
- PHO’s Laboratory Teams
  - *Legionella*, Environmental Microbiology, DNA Core

Presentation Objectives

By the end of this session, participants will be able to:

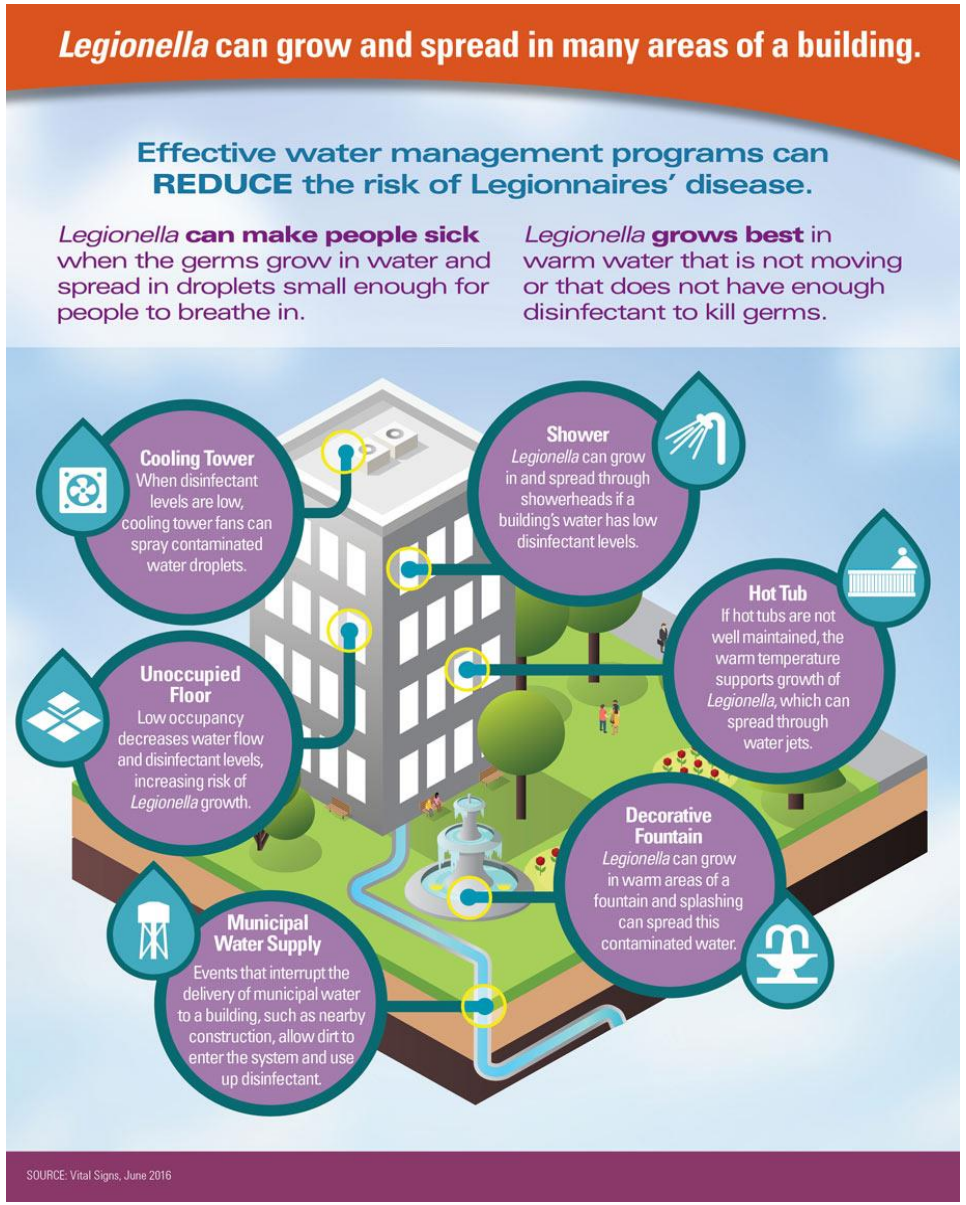
1. Describe an environmental risk assessment and sampling plan components (e.g., health and safety considerations, sample collection) for a *Legionella* investigation
2. Discuss environmental, epidemiological and laboratory data and their interpretation in the investigation of *Legionella* outbreaks
3. Describe control and remediation measures for *Legionella* in water systems

Session 1 Refresher

- *Legionella* bacteria can be found in natural and human made water environments
- *Legionella* bacteria can infect humans through inhalation of aerosolized contaminated water and cause legionellosis
- Case investigations are important to identify potential sources of infection within the incubation period (up to 14 days) before symptom onset (e.g., travel, exposure to water systems)
- Consider a *Legionella* cluster/outbreak when two or more cases are epidemiologically linked by location and time of exposure
- Conducting an Environmental Risk Assessment is the first step in identifying possible sources of *Legionella*

Outline

- Develop a sampling plan
- Laboratory investigation
  - Clinical and environmental testing
  - Specimen and sample collection
  - Interpretation of laboratory findings
- Remediation
- Long term prevention plan
- Risk communication



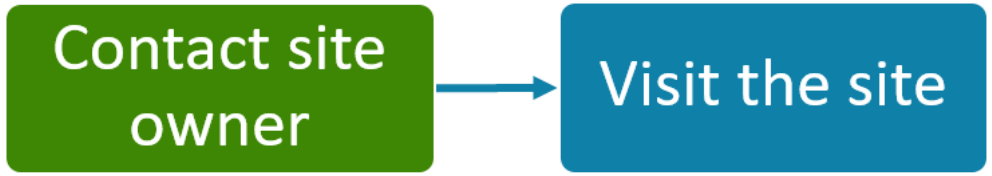
Source: Centers for Disease Control and Prevention (CDC), National Center for Immunization and Respiratory Diseases; National Center for Environmental Health. Legionnaires' disease: use water management programs in buildings to help prevent outbreaks. Vital Signs [Internet], 2016 Jun [cited 2023 Apr 21]. *Legionella* can grow and spread in many areas of a building; p. 3. Available from: . Reference to this material does not imply endorsement by CDC.

Environmental Risk Assessment

Contact site owner

- Owner/operator to prep the site
  - X Temporarily discontinue use of aerosol-generating sources
  - X Avoid super chlorinating, heat shocking, cleaning, draining, changing, and disturbing filter systems

Environmental Risk Assessment



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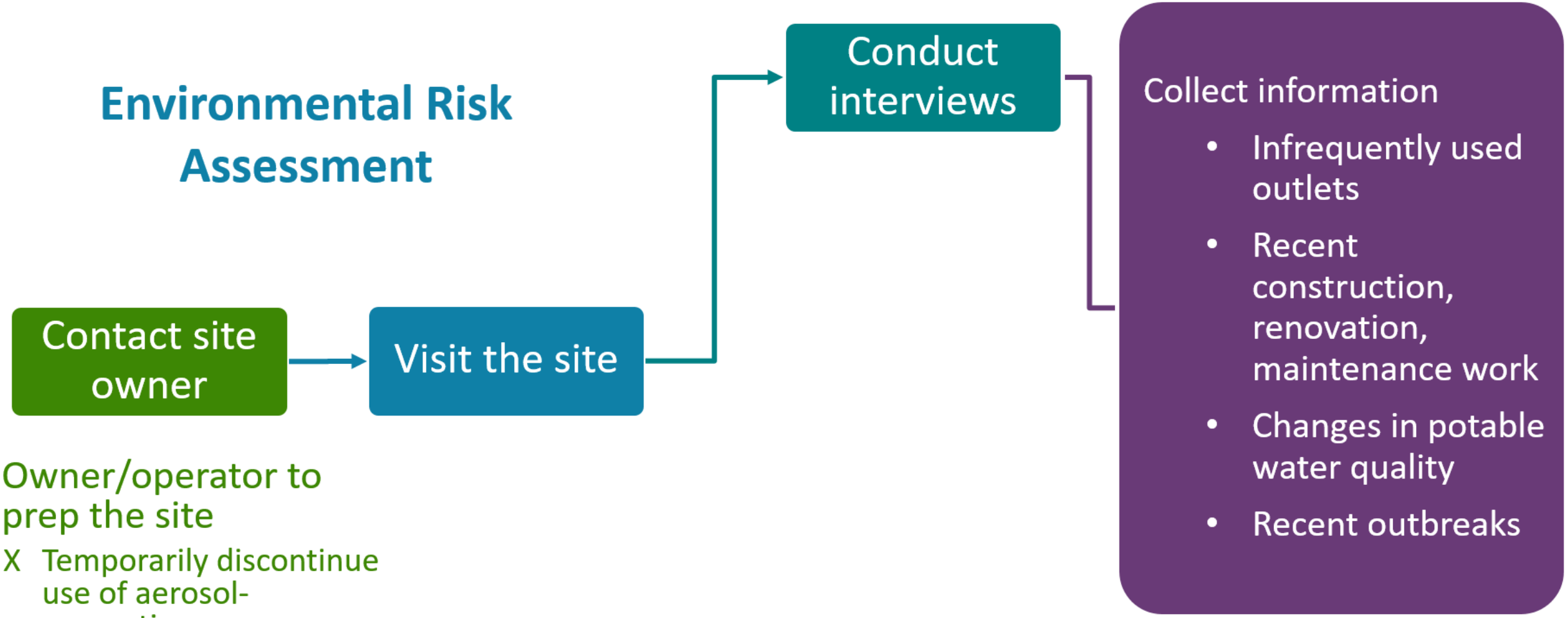
Environmental Risk Assessment



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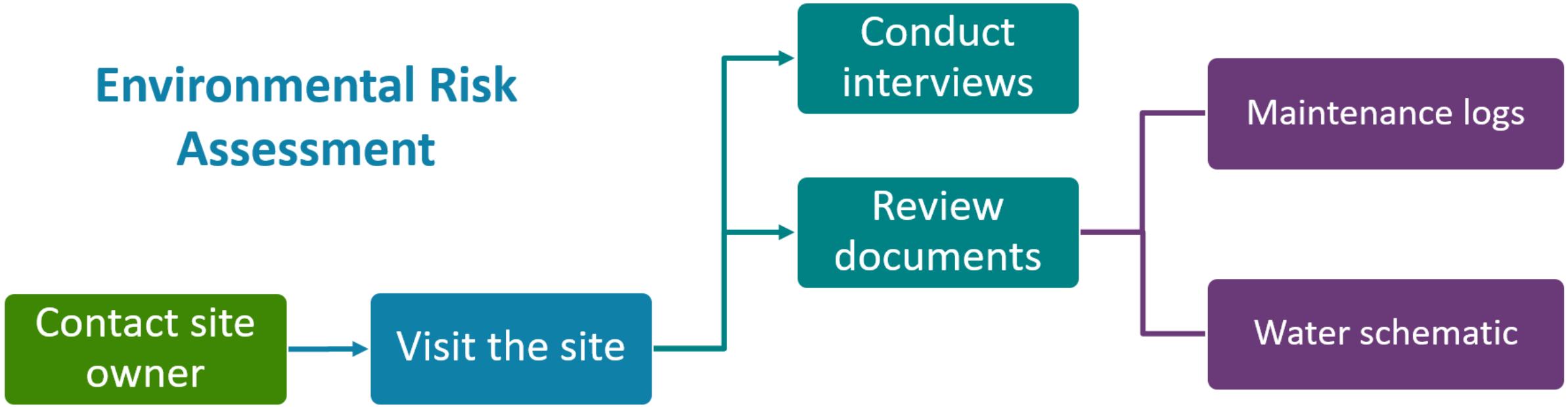
Environmental Risk Assessment



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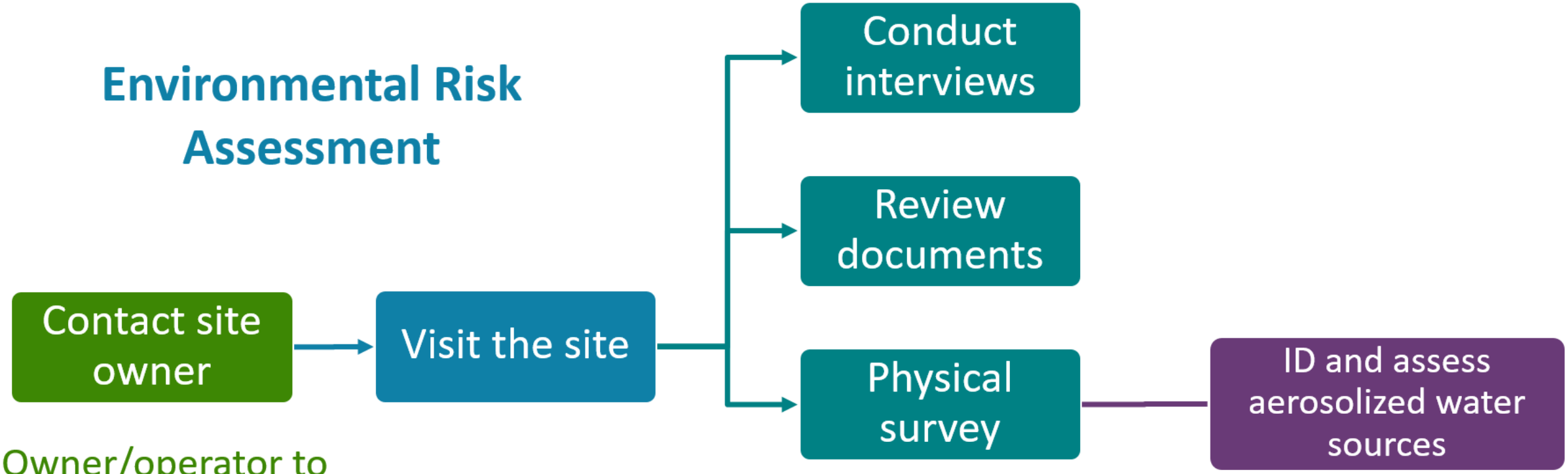
Environmental Risk Assessment



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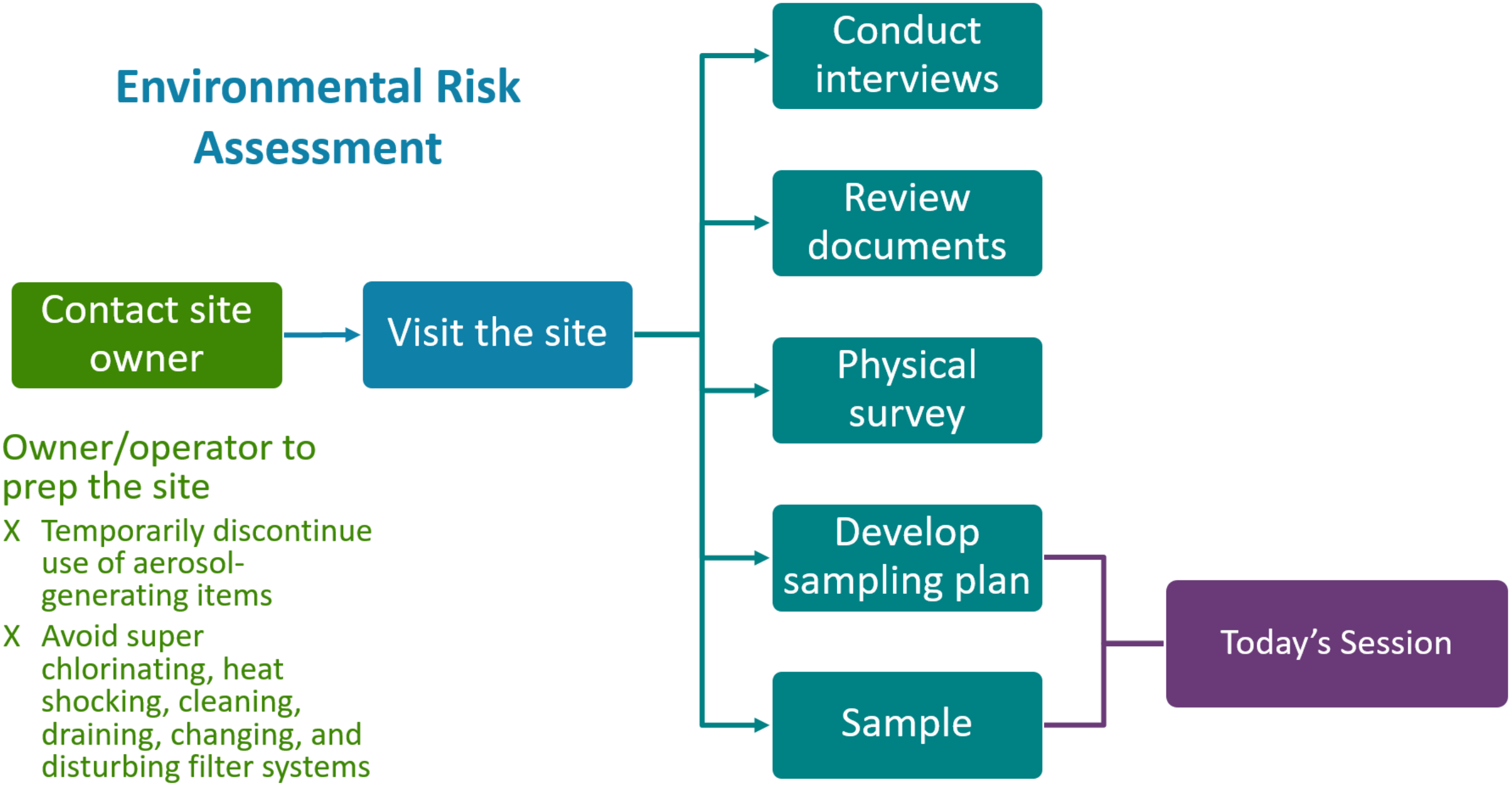
Environmental Risk Assessment



- Owner/operator to prep the site
  - X Temporarily discontinue use of aerosol-generating items
  - X Avoid super chlorinating, heat shocking, cleaning, draining, changing, and disturbing filter systems

Sampling Plan - Purpose and Considerations

- Sampling points are prioritized based on the case exposure history, clinical laboratory information and the environmental risk assessment
  - Sampling is intentional, informed by cases and relevant sources of exposure
- Generally, the purpose for sampling is to identify the source of contamination that resulted in infections
  - **To achieve this goal, both a clinical and an environmental isolate are required for analysis.**
- Ideally, the system should not be treated prior to sampling
- Temperature, disinfectant residual, and pH testing of the water systems should be conducted when sampling

Develop a Sampling Plan

Sources of *Legionella* – Recap from Session 1

Main Sources

- Potable water systems
  - Flexible hoses or connections to faucets
  - Electronic and manual faucets
  - Showerheads
- Cooling towers
- Non-potable water systems
  - Spas/hydrotherapy
  - Decorative fountains

Other Potential Sources

- Aerosol producing humidifiers
- Misting devices
- Water birthing baths (aspiration)
- Medical and dental equipment
- Ice machines (aspiration)
- Car washes
- Street cleaning machines
- Soil (usually potting mixes)
- Hospital dishwashers

Sampling Plan - General Approach

1. Strategically select sampling points, while considering specific points in the water system that may present a source of *Legionella* growth
2. Aerosol sources that the case(s) may have been exposed to should be sampled first, followed by other high-risk sources; examples:
   - Hot water tank, hot water return
   - Heat exchanger
   - Distal ends, dead legs
   - Storage tanks
   - Expansion vessels

3. Sampling points should be reassessed as the investigation progresses

Health and Safety When Sampling

- Take appropriate precautions during sampling
  - Consult Occupational Health and Safety
  - Susceptible staff should not be involved in sampling
  - Taps should be turned on and run gently to minimize aerosols

Wear Protective Equipment Appropriate to the Setting

Examples:

- Respiratory (e.g. fit-tested N95)
- Safety glasses
- Hard hat
- Impermeable gloves (nitrile)
- High visibility vests
- Safety shoes

Legionella Laboratory Investigation: Sample/Specimen Collection, Testing, and Interpretation

Environmental Sample Collection: Sampling Tool Kit

Based on the environmental risk assessment, identify which samples will be collected, and ensure all materials required (tool kit) are available before beginning sample collection:

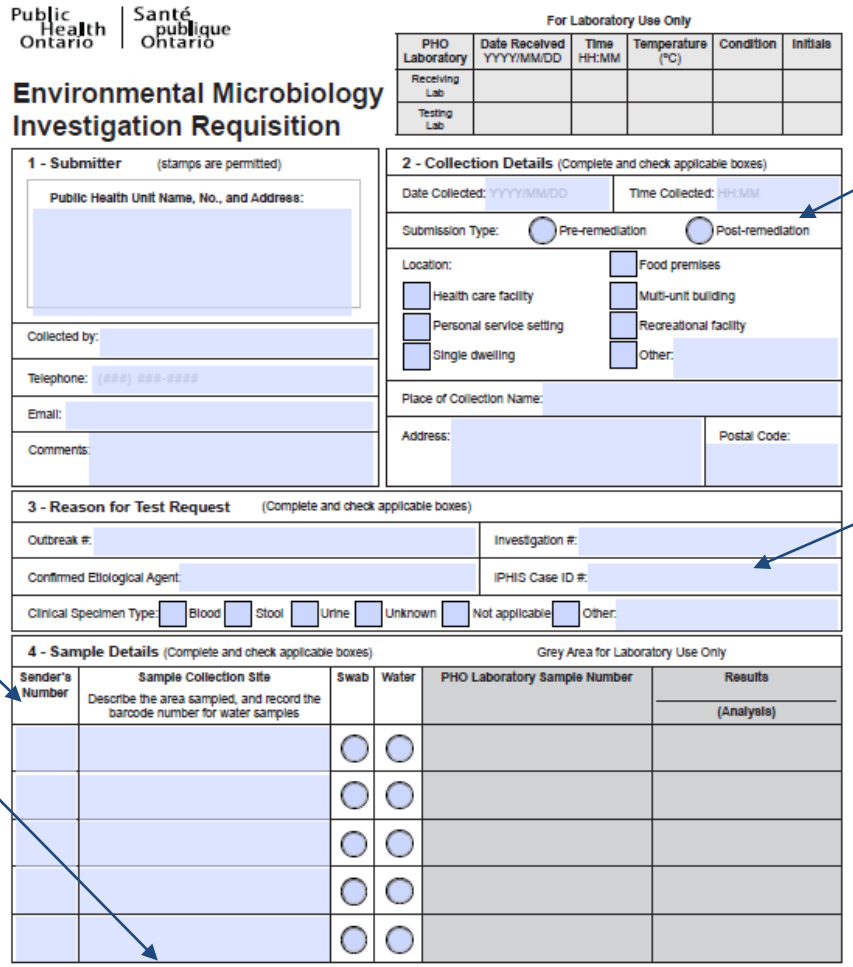
- Environmental swabs/vials and PHOL water collection bottles
- Pen (completing the requisition) and
- Permanent marker (labelling vials/water bottles)
- PHO's Laboratory transport bag with coolant/ice packs
- Requisition(s): Environmental Microbiology Investigation Requisition
- Device to capture photographs
- Any additional instruments/supplies and PPE required to perform other analyses; e.g., pH, temperature, chlorine residual

Sample Submission - Requisition

Sender's number: for traceability, use a unique identifier

Sample collection site: indicate sample location, such as room number, floor, and information about the sampling site (pre- versus post-flush, cold versus hot).

For example, shower, room 123, 2nd floor, pre-flush, cold water



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Environmental Microbiology Investigation Requisition

For Laboratory Use Only

PHO Laboratory	Date Received YYYY/MM/DD	Time HH:MM	Temperature (°C)	Condition	Initials
Receiving Lab					
Testing Lab					

1 - Submitter (stamps are permitted)

Public Health Unit Name, No., and Address:

Collected by:

Telephone: (###) ###-####

Email:

Comments:

2 - Collection Details (Complete and check applicable boxes)

Date Collected: YYYY/MM/DD Time Collected: HH:MM

Submission Type: Pre-remediation Post-remediation

Location: Food premises; Health care facility; Multi-unit building; Personal service setting; Recreational facility; Single dwelling; Other:

Place of Collection Name:

Address: Postal Code:

3 - Reason for Test Request (Complete and check applicable boxes)

Outbreak #: Investigation #:

Confirmed Etiological Agent: IPHIS Case ID #:

Clinical Specimen Type: Blood Stool Urine Unknown Not applicable Other:

4 - Sample Details (Complete and check applicable boxes) Grey Area for Laboratory Use Only

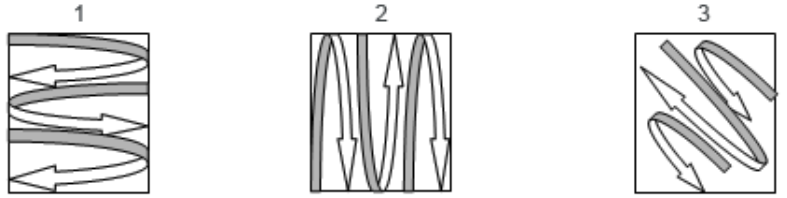
Sender's Number	Sample Collection Site Describe the area sampled, and record the barcode number for water samples	Swab	Water	PHO Laboratory Sample Number	Results (Analysis)

Submission type: pre- versus post- remediation

Outbreak management: outbreak number, iPHIS details and clinical information

Reminder: for water samples, use a single line on the requisition per collection site (such that bottles 1-10 are included on one line and all 10 bottles have the same unique identifier)

Environmental Sample Collection



Swab

- Remove aerator, shower head, or jet nozzle
- Using aseptic technique, use the head of the swab to scoop up any sediment/biofilm
- Swab the inside of the aerator, shower head or jet nozzle, and then the pipe (inside) to which the unit is attached, and return swab to vial
- Then, slowly collect water sample

Water

- Using aseptic technique, collect two litres (ten (10) PHOL water collection bottles = two (2) litres)
  - For **pre-flush** samples – collect water immediately after a faucet or shower is opened – this will represent the water being held within the fitting or tap
  - For **post-flush** samples – collect water to assess the degree of contamination within the water system

Sample Submission

- Samples should be stored at refrigeration temperature (2 to 8°C)
- Ship all samples in containers with hard walls and lids secured in the closed position, on ice packs
- Shipping containers must be labelled with the name of the submitting organization, inspector's name, and contents (e.g. ENVIRONMENTAL SAMPLES) on the outside of the container
- Notify the laboratory of incoming samples and submit samples to your local laboratory

Sample Collection and Testing - Environmental

Sample Type	Sample Container	Analysis	Target	Turn-around time (TAT)
Swab	Sterile PHOL swabs / vials containing neutralizing solution	Culture	*Legionella* species and serogroup**	Up to 14 days
Water – One (1) L	Sterile PHOL water collection bottles*	PCR – Screening	*Legionella* species, *Legionella pneumophila* and *L. pneumophila* serogroup 1	Up to four (4) days
Water – One (1) L	Sterile PHOL water collection bottles*	Culture	*Legionella* species and serogroup**	Up to 14 days

*Sterile PHOL water collection bottles (200 mL) containing 0.8 mM sodium thiosulfate.

**Environmental isolate(s) are required for molecular analyses, in order to determine the relatedness of the clinical isolate(s) to the environmental isolate(s) by Sequence Based Typing (SBT) for outbreak investigations.

Case Scenario

Scenario Recap:

- Three cases of legionellosis (positive by UAT), all of whom live in the same condominium building
- Index case had lower respiratory tract specimen collected. Results were pending

Specimen Collection and Testing - Clinical

Specimen Source	Specimen Container	Analysis	Target	Turn-around time (TAT)
Urine collected during acute phase of illness	>2.0 mL sterile container	Urinary Antigen Testing	*Legionella pneumophila* serogroup 1	Up to two (2) days
Lower respiratory tract specimens*	1 mL of specimen in a sterile container	PCR	*Legionella pneumophila* and *Legionella* species	PCR: up to four (4) days
Lower respiratory tract specimens*	1 mL of specimen sterile container	Culture	*Legionella* species and serogroup**	Culture: up to 15 days

*BAL, bronchial wash, lung tissues, pleural fluid, sputum, etc., collected during the acute phase of illness.

**Clinical isolate(s) are required for molecular analyses in order to determine the relatedness of the clinical isolate(s) to the environmental isolate(s) by Sequence Based Typing (SBT) for outbreak investigations.

Case Scenario Continued

- Condo building has a decorative fountain, pool (currently closed), hot tub and rooftop cooling system
  - All 3 cases reported using the shower in their private unit, the condo hot tub and walking past the decorative fountain in the courtyard
- Based on the environmental risk assessment, the following samples are collected and submitted for testing:
  - Showerheads from individual cases' units (x 3 units)
  - Hot tub
  - Decorative fountain
  - Cooling tower
  - Unable to sample the pool due to closure for renovations

Case Scenario Continued

Laboratory results are now available for the sputum, and all environmental samples:

Description	Sample / Specimen Type	Results
Index Case	Sputum	***Legionella pneumophila* (PCR)**
Index Case	Sputum	***Legionella pneumophila* serogroup 1 (culture)**
Showers (three individual units)	Water, swab	**Not detected**
Hot tub	Water, swab	***Legionella pneumophila* serogroup 1 (culture)**
Decorative fountain	Water, swab	***Legionella pneumophila* serogroup 1 (culture)**
Cooling tower	Water, swab	**Not detected**
Pool	Unable to collect	N/A

Case Scenario Continued: Polling Question

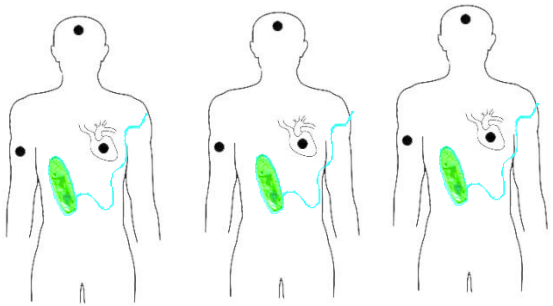
- Based on the information to date, what is/are the most likely source(s) of the *Legionella* infections? Select all that apply.

❑ Shower
❑ Pool
❑ Hot tub
❑ Decorative fountain
❑ Evaporative cooling system (cooling tower)
❑ Other

Case Scenario Continued

Clinical cases

Is there a common exposure?



→ Yes or No → Is a clinical isolate available? → Yes or No

→ **Additional testing**

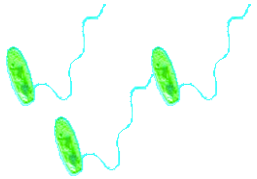
Potential environmental sources

Can we identify the source?

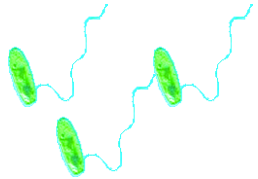
Shower

Not detected

Hot tub



Fountain



Not detected

Cooling tower

Not detected

→ Yes or No → Is the environmental isolate the same species and serogroup as the clinical case? → Yes or No

→ **Additional testing**

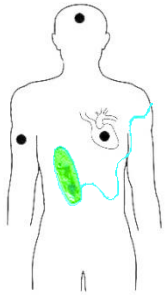
What is Sequence Based Typing?

Sequence Based Typing (SBT)

- Comparative analysis using nucleotide sequences of 7 genes: *asd, flaA, mip, momps, pilE*, *proA* and *neuA*
- Allows comparison between culture isolates (clinical and environmental sources—same Sequence Type?)

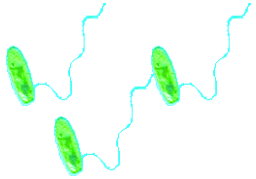
Case Scenario Continued

Index case
(confirmed by culture)



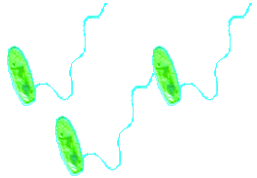
→ Culture: *Legionella pneumophila* Serogroup 1 → **Sequence Type A**

Hot tub



→ Culture: *Legionella pneumophila* Serogroup 1 → **Sequence Type A**

Fountain



→ Culture: *Legionella pneumophila* Serogroup 1 → **Sequence Type B**

Environmental samples
(confirmed by culture)

Interpretation - Additional Considerations

Identifying the environmental source for legionellosis case(s) is **challenging**:

- Unable to perform molecular typing: no environmental isolate available
  - Levels and types of *Legionella* in water systems can fluctuate significantly over time
  - The water system may be overgrown with other microorganisms
  - The water system was treated/disinfected
  - Viable but non-culturable *Legionella* (VBNC) state
- Unable to perform molecular typing: no clinical isolate available
  - Respiratory specimen not collected
  - Patient was treated prior to specimen collection – culture not detected

Source: Ontario Agency for Health Protection and Promotion (Public Health Ontario). Legionella: questions and answers. 2nd ed. Toronto, ON: King's Printer for Ontario; 2019. Available from:

Interpretation - Additional Considerations

Identifying the environmental source for legionellosis case(s) is **challenging**:

- *Legionella* is ubiquitous and environmental sources can support multiple species, serogroups, and sequence types
  - Environmental isolate(s) may differ from the clinical isolate(s), e.g., different species or serogroups identified
  - Sequence type identified in the environmental isolate(s) may differ from the clinical isolate(s)
- The theoretical source may not be the actual source:
  - Review the clinical and environmental investigation data in the context of laboratory findings
  - Consider any new information since the sampling was conducted, e.g., new cases, new exposures, etc.

Results must be interpreted within the context:

- Clinical, environmental, epidemiological and laboratory information/data

Source: Ontario Agency for Health Protection and Promotion (Public Health Ontario). Legionella: questions and answers. 2nd ed. Toronto, ON: King's Printer for Ontario; 2019. Available from:

Case Scenario Continued

Next Steps :

- PHU communicates the findings to the building owner/operator
- If the owner/operator has not yet done so, ensure that all suspect sources are shut down; namely, the hot tub and the decorative fountain.
- Water system consultant/building maintenance team are engaged to assess the situation and begin the remediation process
  - Highlights the importance of a proactive water safety plan
  - Experienced consultant critical to a successful remediation

Immediate Control Measures and Remediation

Immediate Control Measures to Consider

Goal → Cessation of any water-aerosolizing activity

CONSIDER	AVOID
✓ Using sponge baths	X Using showers
✓ Removing aerators	X Using hydrotherapy tubs
✓ Installing point-of-use filters	X Using water faucets in resident rooms
✓ Replacing filters (as needed)	X Using ice machines

- **Shut down aerosolization sources: spas, decorative fountains, etc.**
- **Shut down cooling towers, cooling tower fans, where possible**

Remediation Action Plan

- Implement remediation action plan once environmental source identified
- Often involves an environmental water consultant
  - Look for prior experience dealing with *Legionella* in water systems
- Methods of remediation may include:
  - Thermal disinfection and/or
  - Chemical disinfection
- Once *Legionella* within biofilm has become established in a water system, can be challenging to eradicate

Thermal Disinfection

Maintain water temperatures using a "heat shock" approach while progressively flushing each outlet in the system for a set amount of time

Chemical Disinfection

Chlorine commonly used

Treatment can vary depending on plumbing components

After remediation, all previously contaminated sources should be resampled, to ensure that the re-colonization of *Legionella* has not occurred

NOTE: Biofilms can be difficult to remove even with thermal and chemical disinfection and they may serve as a reservoir for persistent *Legionella* contamination

Case Scenario Continued

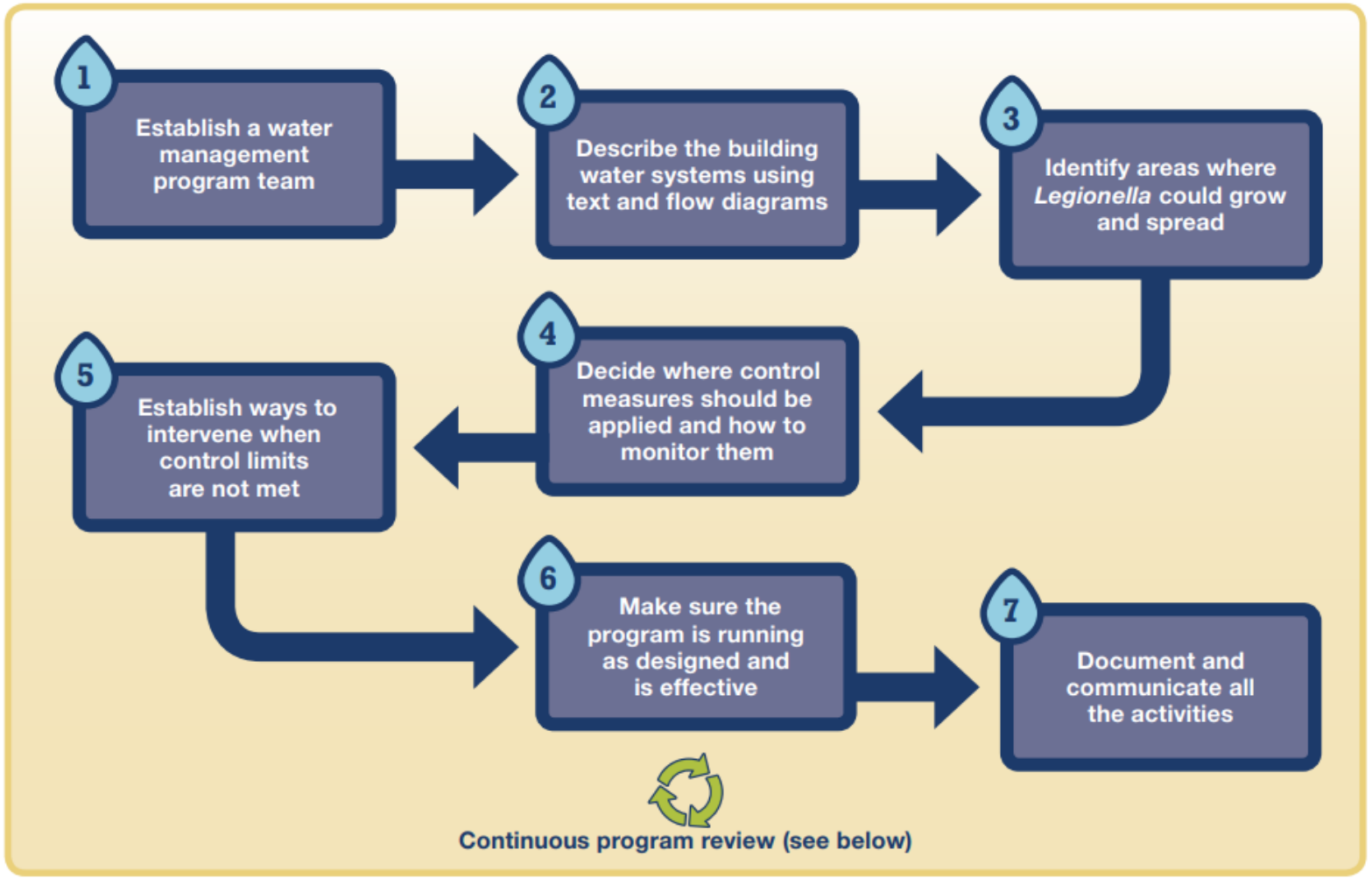
Update:

- No new cases reported
- Remediation and post treatment sampling completed (all results not detected)
- Ongoing monitoring → Water safety plan

What is the Purpose of a Water Safety Plan?

A water safety plan identifies areas or devices that would support the growth of *Legionella,* and to establish actions to prevent *Legionella* growth and reduce overall risk of illness.

Water Safety Plan



Adapted from: Centers for Disease Control and Prevention (CDC). Developing a water management program to reduce Legionella growth & spread in buildings: a practical guide to implementing industry standards [Internet]. Atlanta, GA: CDC; 2018 [cited 2023 Apr 21]. Available from: . Reference to this material does not imply endorsement by CDC.

Resources for Developing a Water Safety Plan

- ANSI/ASHRAE Standard 188-2021

  Legionellosis: Risk Management for Building Water Systems

  - *Best practices document which focuses on identifying hazardous conditions and applying control measures to prevent Legionella growth and transmission*
- CDC - Developing a Water Management Program to Reduce *Legionella* Growth and Spread in Building: A Practical Guide to Implementing Industry Standard
- Cooling Technology Institute Legionellosis Guidelines – GDL 159

- American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE), American National Standards Institute (ANSI). ANSI/ASHRAE Standard 188-2021 Legionellosis: Risk Management for Building Water Systems. 2021.
- Centers for Disease Control and Prevention (CDC). Developing a water management program to reduce Legionella growth & spread in buildings: a practical guide to implementing industry standards [Internet]. Atlanta, GA: CDC; 2018 [cited 2023 Apr 21]. Available from: . Reference to this material does not imply endorsement by CDC.
- Cooling Technology Institute (CTI). Legionellosis Guidelines – GDL 159 [Internet]. Houston, TX: CTI; 2021 [cited 2023 May 2]. Available from:

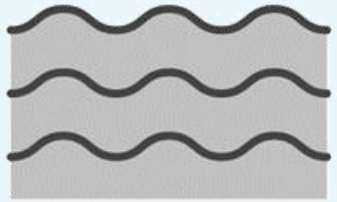
Polling Question

A water safety plan is primarily for long-term care homes and hospitals during a Legionnaires' disease outbreak.

- True or False

Long-Term Prevention

- A key strategy/approach for reducing the risk of Legionnaires' disease, is through a multifaceted preventive control program

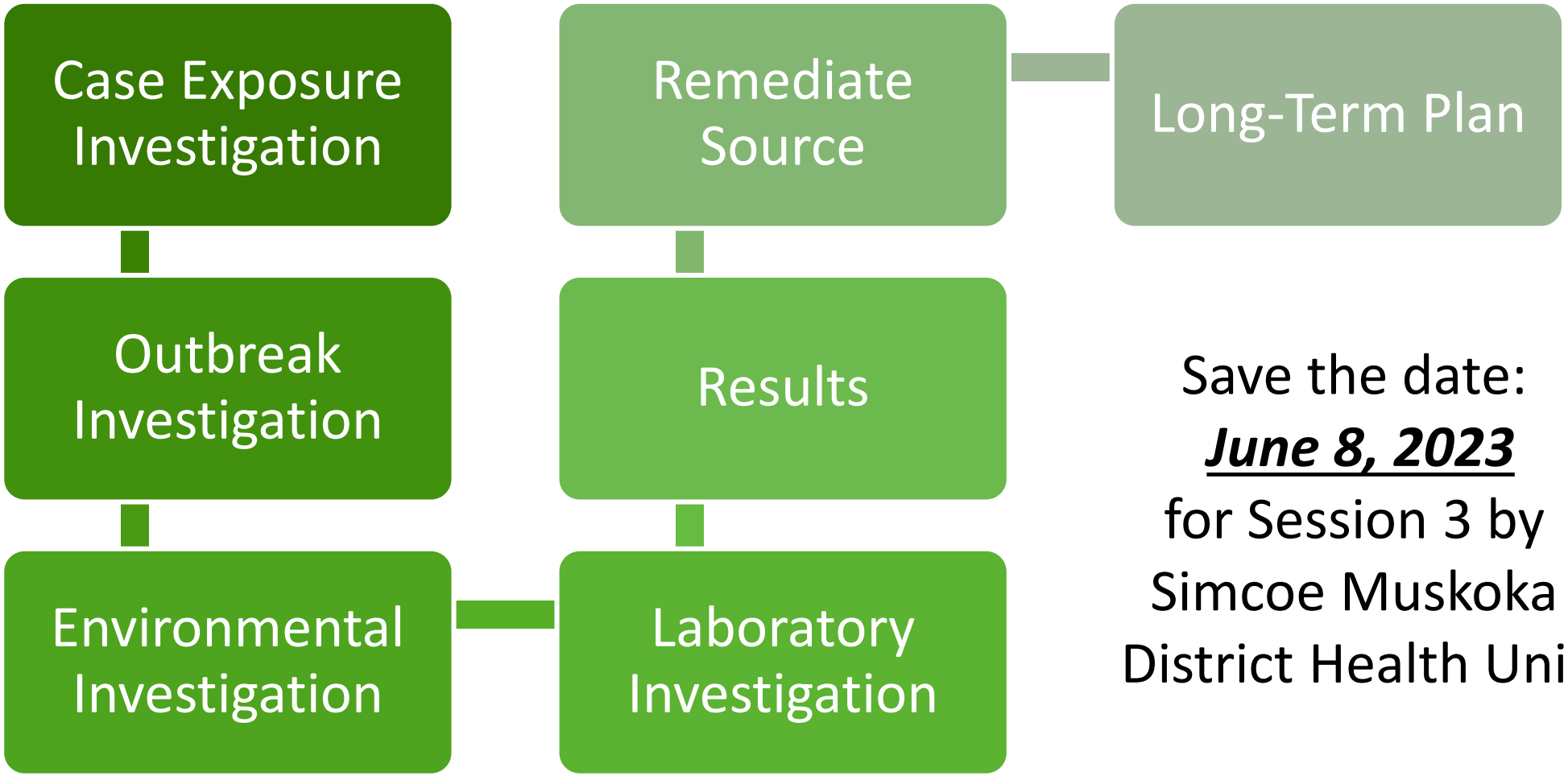
			
Water safety plan	**Eliminate stagnant water conditions**	**Supplemental disinfection**	**Manage water temperature**

Risk Communication

- Two-way exchange (communicator and audience) about human health risk
  - *Legionella* outbreaks can attract media and public attention
- Preparing the strategy:
  - Who is your audience and what type of communication is needed?
    - Outrage management, Precaution advocacy, Crisis communication (www.psandman.com)
  - Simple, Timely, Accurate, Reliable, Credible, Consistent
  - As the situation develops (new info), how can your key messages stay consistent?
  - What is the risk? What is being done? What can individuals do?

- Sources: National Research Council; Committee on Risk Perception and Communication. Improving risk communication. Washington, DC: National Academy Press; 1989. Part 1, introduction. Available from:
  Sandman PM. Introduction to risk communication and orientation [Internet]. Brooklyn, NY: Peter Sandman; 2020 [cited 2023 May 2]. Available from:
- Centers for Disease Control and Prevention (CDC). Crisis emergency risk communication. Atlanta, GA: CDC; 2005 [cited 2023 May 2]. Available from:

Summary



Save the date:
June 8, 2023
for Session 3 by Simcoe Muskoka District Health Unit

Resources

- Ontario Agency for Health Protection and Promotion (Public Health Ontario). Public health inspector's guide to environmental microbiology laboratory testing [Internet]. Evergreen ed. Toronto, ON: Queen's Printer for Ontario; 2021 [cited 2023 May 2]. Available from:

- American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE). Standard 188-2018: Legionellosis: risk management for building water systems. Peachtree Corners, GA: ASHRAE; 2018.
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Resources

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