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Subject: Epi-Aid 2015-037 Trip Report: "Undetermined source of an healthcare-associated outbreak of Legionnaire's disease — Illinois, 2015"

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ACRONYMS

ACHD	Adams County Health Department
ASHRAE	American Society of Heating, Refrigerating and Air-Conditioning Engineers
BCYE	Buffered Charcoal Yeast Extract agar
CDC	Centers for Disease Control and Prevention
CTI	Cooling Technology Institute
DBD	Division of Bacterial Diseases
DSEPD	Division of Scientific Education and Program Development
EIS	Epidemic Intelligence Service
ELITE	Environnemental *Legionella* Isolation Techniques Evaluation Program
EMR	Electronic Medical Record
GPCV	PCV agar with glycine
IDPH	Illinois Department of Public Health
IDPH-EH	IDPH's Division of Environmental Health
IVH	Illinois Veterans Home
LabCorp	Laboratory Corporation of America
LD	Legionnaires' disease
Lp1	*L. pneumophilia* serogroup 1
MAb2	Monoclonal Antibody 2
NCIRD	National Center for Immunizations and Respiratory Diseases
PCR	Polymerase Chain Reaction
PCV	BCYE agar with polymyxin B, cycloheximide and vancomycin
PF	Pontiac Fever
PPM	Parts Per Million
QMG	Quincy Medical Group
Quest	Quest Diagnostics
RDB	Respiratory Diseases Branch
SBT	Sequence-based typing
ST36	Sequence Type 36
UAT	*Legionella* urine antigen tests
VFD	Variable Frequency Drive
VHA	Veterans Health Administration
VistA	Veterans Health Information Systems and Technology Architecture

BACKGROUND

On August 23, 2015, the Illinois Department of Public Health (IDPH) notified the U.S. Centers for Disease Control and Prevention (CDC) of five laboratory-confirmed cases of Legionnaires' disease (LD) among residents and staff of the Illinois Veterans Home (IVH). This is a state run long-term care facility, in Quincy, Illinois. The outbreak evolved rapidly, resulting in 28 cases of laboratory-confirmed legionellosis by August 30, 2015. Patients had a median age of 85 years (range: 57–94 years) and illness onset dates between July 24 and August 26, 2015. Two outbreak associated deaths had been reported as of August 28, 2015. In addition, four cases were identified in the surrounding community that had no known association with IVH. Possible *Legionella* exposures included a large two-cell cooling tower and an old and complex hot water infrastructure. On August 30, 2015, IDPH formally requested an Epi-Aid to assist with the epidemiological and environmental investigation.

The objectives of this Epi-Aid were to:

1. Monitor for additional cases of LD among residents and staff of IVH and the surrounding community;
2. Assist with the environmental assessment and sampling at IVH and identify any potential community exposures;
3. Assist with an epidemiologic investigation including case interviews and medical chart abstraction at IVH, hospitals, and clinics serving the community; and
4. Recommend interventions to prevent ongoing disease transmission and future cases.

Description of the Illinois Veterans Home in Quincy, Illinois

IVH is a 126 year-old 200 acre facility comprised of more than 30 buildings, employing 550 staff/volunteers, and providing care to as many as 683 residents with levels of care ranging from independent living to skilled nursing care including two dementia units. At the time of this outbreak the resident census was 433 with approximately 45% in care for dementia. IVH operates within the U.S. Department of Veterans Affairs (VA) system as a State Veterans' Home, which is owned, operated, and managed by the state of Illinois. While the VA does not manage the facility, an annual survey is conducted to ensure VA standards are met [1]. IVH is not part of the Veterans Health Information Systems and Technology Architecture (VistA) Electronic Health Record system [2], and does not currently have a comprehensive electronic medical records system.

METHODS

Epidemiologic Investigation

Surveillance Assessment

We conducted in-person interviews with the head of nursing services and the infection preventionist at IVH and surveillance epidemiologists at Adams County Health Department between August 31 and September 11, 2015. The goal of these interviews was to understand the current, enhanced surveillance for LD as well as the baseline surveillance strategies at the IVH facility and statewide.

Case-finding

Cases of LD were identified through both active and passive methods. Active case-finding included daily checks with IVH, Blessing Hospital (the only acute in-patient hospital serving Quincy), and the Quincy Medical Group (QMG), which manages a number of outpatient clinics. Contacts at each reporting facility were asked for any new positive *Legionella* tests, the current number of pending *Legionella* tests, and updates on all cases under care. All *Legionella* urine antigen tests (UAT) were performed by two national contracting laboratories: Laboratory Corporation of America (LabCorp) and Quest Diagnostics (Quest). Each laboratory was contacted daily during the most intensive period of testing (Aug 25 to September 11, 2015) to confirm samples received and in-process and to facilitate reporting of results.

Passive case-finding included the existing system for reporting of positive *Legionella* tests to Adams County Health Department (ACHD) and IDPH. During the outbreak, this passive system was augmented by a series of mass notifications sent to area physicians. Notifications to providers gave basic information regarding the *Legionella* outbreak at IVH in an effort to prompt reporting of increased respiratory disease and/or pneumonia and to encourage *Legionella* testing and sputum sample collection. By report, IVH, Blessing hospital, and QMG clinics performed UAT for all IVH residents or staff members presenting with an elevated temperature ($\geq$99.0) or with new pneumonia. All IVH residents with signs and symptoms consistent with a lower respiratory tract infection were given a chest x-ray to assess for pneumonia. We did not attempt case-finding for undiagnosed cases. We requested that any available clinical isolates be shipped to CDC's *Legionella* laboratory for subtyping.

Case Definitions

Legionnaires' disease (LD)

1. **Confirmed case (LD)**: An illness in an individual with (1) exposure to IVH or Quincy, Illinois from July 24, 2015 to September 20, 2015 within their 14-day incubation period, (2) pneumonia on chest x-ray OR a physician's diagnosis of pneumonia, and (3) laboratory confirmation of *Legionella pneumophila* infection with a urine antigen test, sputum/tissue culture, or tissue-validated nucleic acid assay (PCR).
2. **Suspect case (LD)**: An illness in an individual with (1) exposure to IVH or Quincy, Illinois from July 24, 2015 to September 20, 2015 within their 14-day incubation period, (2) pneumonia on chest x-ray OR a physician's diagnosis of pneumonia, and (3) no available *Legionella* testing.

Pontiac Fever (PF)

1. **Confirmed case (PF)**: An illness in an individual with (1) exposure to IVH from July 24, 2015 to September 20, 2015, (2) fever and malaise/myalgia, (3) no indication of pneumonia, AND (4) laboratory confirmation of *Legionella pneumophila* infection.
2. **Suspect case (PF)**: An illness in an individual with (1) exposure to IVH from July 24, 2015 to September 20, 2015, (2) fever and malaise/myalgia, (3) no indication of pneumonia, and (4) no available *Legionella* testing.

Healthcare Association (Confirmed LD)

1. **Definite healthcare-associated LD:** A confirmed case of LD who spent their ENTIRE 10-day incubation[1] period as a resident of IVH.
2. **Probable healthcare-associated LD:** A confirmed case of LD who had some exposure to IVH during their incubation period as a resident who left the facility, staff, or as a visitor.
3. **Community acquired LD:** A confirmed case of LD with NO documented/reported exposure to the IVH facility or the area approximately 1-mile around the facility during their 10-day incubation period.

Staff and Exposure Assessment

We used a combined medical chart abstraction form and questionnaire developed and administered by IDPH (appendix 1) to collect demographic, medical history, exposure, and clinical course information for all confirmed LD and PF resident and staff cases. Using this information, we classified case residents into definitely healthcare-associated, probably healthcare-associated, and community acquired according to the case definitions above.

[1] A shorter 10-day incubation period was used to increase the specificity of the healthcare association.

Due to the identification of multiple likely *Legionella* exposures and the decision to rapidly and aggressively address each regardless of the most likely cause of this outbreak, the decision was made to not perform additional epidemiologic study involving non-ill resident or staff controls.

Building-Specific Attack Rate Calculation

IVH resident attack rates were calculated for each facility building as the number of confirmed LD case-patients in that building divided by the average census for August, 2015 of that building. Due to variable movement of staff throughout the facility, building-specific attack rates were limited to IVH residents.

Environmental Methods

Environmental Assessment

Between August 21 and 27, 2015, a series of environmental assessments were completed by IDPH's Division of Environmental Health (IDPH-EH) and ACHD to identify high-risk *Legionella* exposures and to implement initial risk mitigation strategies. CDC's environmental assessment began on September 1, 2015, and included a review of water system operation and maintenance records, sampling protocols and results, water emergency plans, and discussion with staff about training and experience with *Legionella* prevention and control. Specific areas assessed included resident care areas, resident bathing areas, facility common areas, decorative fountains, and the hot and cold-water infrastructure.

A series of discussions with IVH nursing administrative staff, infection prevention, and IDPH epidemiologists were completed to determine the characteristics of the resident populations living in each building, care equipment used, and clinical equipment maintenance practices. Staff provided verbal information and allowed access to both paper and electronic medical records. We also reviewed recent events such as water system repairs, storm damage, and electrical outages.

No detail on this critical information

Environmental Sampling

Environmental samples were primarily collected at two time points. IDPH led the first sample collection between August 21 and August 31 — prior to CDC arrival. This initial sampling focused on water sources that early case-patient residents of the Elmore building would have been exposed to as well as facility-wide exposures including the central potable hot-water tanks, a ground level cooling tower, and decorative fountains. CDC and IDPH collaborated to collect the second sample set from September 1 to September 3, 2015, focusing on the representativeness of the potable water system, improved sample resolution within the cooling tower specifically addressing the fill media, and targeted sources to which later case-patients may have been exposed. All sample collection was done following procedures as described in CDC's Manual for the Recovery of *Legionella*

from the Environment [3]. The strategy for selection of water sample locations for the second, representative, sampling followed guidance provided by the environmental sampling protocol previously published [4].

Laboratory Methods

Environmental sample processing and analysis was performed by a contracting laboratory participating in CDC's Environmental *Legionella* Isolation Techniques Evaluation (ELITE) Program using previously published standard procedures [3]. A subset of 23 *L. pneumophila* serogroup 1 isolates were selected and sent for further analyses to CDC's *Legionella* laboratory. All received isolates were typed using a dot blot technique with specific antisera to verify whether the organisms were *L. pneumophila* serogroup 1 and if they reacted positively with monoclonal antibody 2 (MAb2), which is considered a marker for increased strain virulence. The isolates also underwent sequence-based typing (SBT) analysis [5-7]. Isolates were selected for SBT based on location, including rooms where LD case-patients resided, the bathing facilities used, and areas that LD staff cases had likely aerosolized water exposure.

Lung samples obtained at autopsy were cultured at CDC's *Legionella* Lab. In brief, tissue was divided using a sterile scalpel and swabbed directly to 1 standard buffered charcoal yeast extract (BCYE) agar plate, two selective BCYE plates containing polymyxin B, cycloheximide and vancomycin (PCV), and two PCV plates with glycine added (GPCV). Additionally, a 1:10 suspension of tissue was made in sterile distilled water and homogenized. A 1:10 dilution was then prepared from this suspension for a final 1:100 dilution. Ten microliters (10µl) of both the 1:10 and 1:100 dilutions were streaked onto one BCYE, two PCV, and two GPCV plates. All plates were incubated for up to two weeks at 35°C in a humidified incubator with an atmosphere of 2.5% of CO_2. All plates were inspected daily for *Legionella*-like colonies, starting 72 hours after inoculation.

RESULTS

Epidemiologic Results

Surveillance Assessment

IVH has a well-established clinical infection surveillance and prevention program in place. Infections of interest are counted per month and disease rates are calculated based on building/unit census. Based on these surveillance data, pneumonia rates in 2015 exceeded one standard deviation above a baseline average of the previous four years in January, April, and August (Figure 1). A targeted record review indicated that the January spike was related to increased influenza cases. The April pneumonia episodes occurred primarily in residents with underlying respiratory conditions, with no single causative etiology identified. To our knowledge, no *Legionella* testing was performed and no clinical samples were available for retrospective analysis from residents associated with the April increase. The August increase represents cases associated with this outbreak.

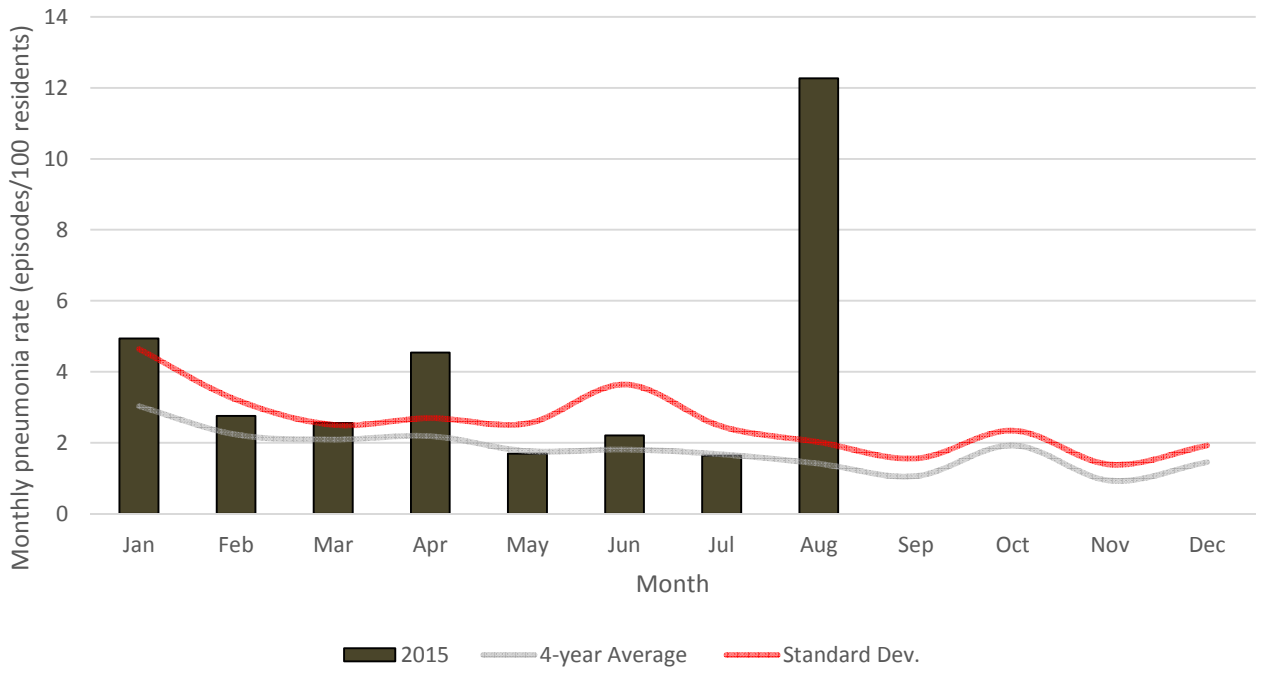

Figure 1: 2015 Pneumonia rate in residents at the Illinois Veterans Home with a 4-year monthly average baseline and standard deviation shown.

From the identification of the outbreak on August 21, 2015, IVH clinical staff performed checks on all residents in skilled care every four hours, and twice daily for all residents in independent living (Anderson/Somerville buildings). Per established IVH protocol, any resident developing symptoms consistent with a lower respiratory infection had a chest x-ray performed immediately for pneumonia diagnosis. This standard protocol was expanded to include urine and sputum sample collection for *Legionella* testing throughout the outbreak period. Residents diagnosed with pneumonia were transferred to Blessing Hospital for treatment unless they refused or treatment was contraindicated due to a standing "comfort care only" order. Additionally, UAT samples were collected from any resident with an elevated temperature. By verbal report, however, "elevated temperature" resulted in UAT sample collection from residents with a variety of often mild symptoms. IVH chose to empirically treat these residents in an effort to ensure patient safety. Similar *Legionella* testing practices extended to Blessing Hospital and QMG clinics where UAT testing was reportedly based largely on exposure to IVH rather than meeting clinical criteria. Based on IVH resident medical charts and staff files, 220 individuals were evaluated and 186 individuals were tested for *Legionella* between August 21 and October 1 with 57 (31%) positive.

Strong existing relationships between ACHD and area clinical care providers as well as active case-finding minimized lag between case identification and reporting to public health with case reports and lab results transmitted at least twice daily. However, neither of the two clinical care locations available to IVH residents and staff (Blessing Hospital and QMG clinics) had *Legionella* UAT testing available on-site. The time required for specimen transport to contracting laboratories increased the time for UAT test results from what might have been less than three hours with on-site testing to approximately four days.

Description of Cases

As of October 13, 2015, 58 cases of legionellosis were identified with 46 confirmed as LD and 12 confirmed as PF. Of the 46 LD cases, 35 were IVH residents, 6 were IVH staff, and 5 were community cases. All 12 PF cases were in IVH residents. The LD outbreak epi-curve indicated a likely point-source outbreak with a peak on August 23-24, which had largely resolved by August 31 (figure 2). Of the 35 resident LD cases, 28 (82%) had information available to determine if they had any possible exposures outside the facility within their incubation period (10 days prior to symptom onset). Of these 28 residents, 3 (11%) had no exposure outside the IVH facility and were defined as definite healthcare-associated. Of the 46 total LD cases identified, 41 (89%) identified some exposure to IVH within 10 days of symptom onset and were defined as probable healthcare-associated, and 5 (11%) cases had no known IVH exposure and were defined as community cases. Based on a lack of exposure to the IVH facility or the area within an approximately 1-mile radius, the decision was made to consider the 5 community

cases as sporadic LD and to limit outbreak-associated cases to those exposed to IVH. All numbers provided from this point, including figure 2, represent IVH-associated case-patients only.

The last LD case patient associated with this outbreak was an IVH resident with onset of symptoms on September 18. Due to the time since the decontamination of the cooling tower and potable water restrictions, the most likely exposure for this final case was a break in water restrictions prior to potable water remediation on September 9 (figure 2).

A total of twelve IVH residents with Legionellosis died; one death was in a confirmed Pontiac fever case with no indication of pneumonia and 11 were from LD. Case fatality in IVH residents was 32% (11/35 residents) for LD and 8% (1/12) for PF. No staff with legionellosis (6 LD cases) died of their illness. Resident cases were predominantly male and elderly, which reflects the overall facility population. Staff and volunteer case-patients had a median age of 60 years (range 47 to 91) and, while reporting fewer underlying risk factors than residents, all had at least one risk factor for disease including age >65 years (N=2), being a current smoker (N=3), and history of chronic lung disease (N=1) (table 1).

The locations of each facility building and staff case location with select points of interest are provided in figure 3. Because it housed the most residents, the Fifer building was used as the reference group for rate comparisons. Compared to residents of the Fifer building, residents of the skilled nursing units in the Elmore building and the independent-living buildings of Somerville/Anderson had significantly increased odds of LD (table 2). Elmore houses individuals with conditions requiring more direct clinical management; these residents are generally restricted in their movement throughout the facility. Residents at Somerville/Anderson receive clinical checks/care only intermittently and have no restrictions on their movement within the facility or outside in the surrounding community. The majority of LD case residents had some outdoor exposure with just 7 (21%) having no evidence of an exposure outside their resident building (table 2). An inverse relationship is observed in which buildings with lower attack rates have relatively higher proportion of case residents with no outdoor exposure; however, because we did not determine exposures of well control residents, any importance of this association is difficult to determine. Additionally, documentation of outside exposure may be more complete for residents requiring more staff assistance or based on specific building layout and design. All resident rooms have at least one window and all windows can be opened approximately six inches. Information on daily window status was not available. By primary work location, staff cases occurred in the Schapers (N =1) and Elmore resident buildings (N=1), the aquatic therapy building (N=1), a small facility coffee shop (N=1), and central food service in the Nielson building (N=2).

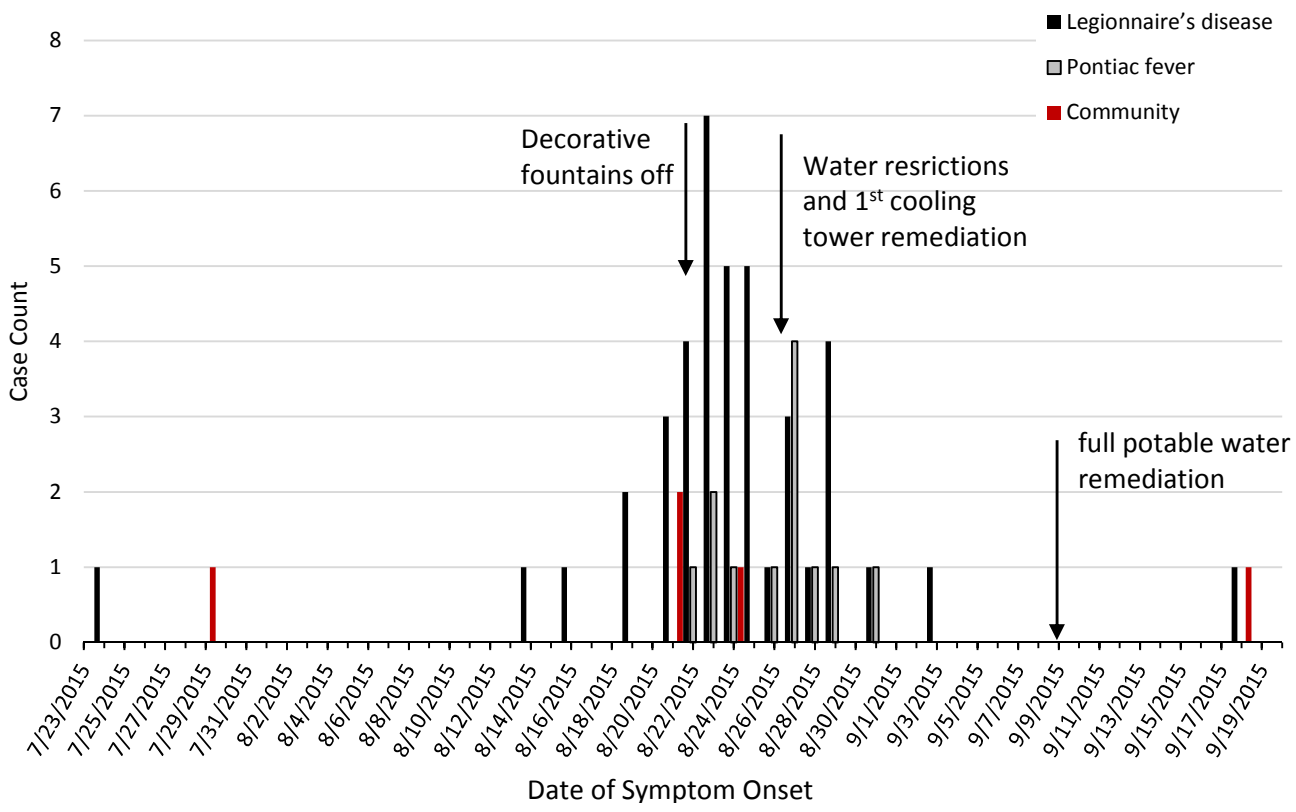

Figure 2: Epi-curve of confirmed Legionnaires' disease Pontiac fever cases by date of symptom onset with select dates of interventions shown – Illinois Veterans Home, Quincy, Illinois – 2015

* Community cases are confirmed Legionnaires' disease case-patients with no exposure to the IVH facility or surrounding area.

Table 1: Select characteristics of confirmed Legionnaires' disease (LD) and Pontiac Fever (PF) cases - Illinois Veterans Home, Quincy Illinois - July 24 to October 1, 2015

Characteristic	Resident - LD N (%)	Resident - PF N (%)	Staff - LD N (%)
Total Cases	**35**	**12**	**6**
Age in years: Median (Range)	85 (58 – 94)	90 (81 – 98)	60 (47 – 91)
Sex: Male	28 (80%)	10 (83%)	3 (50%)
Immunocompromised*	2 (6%)	0 (0%)	0 (0%)
Trouble Swallowing	2 (6%)	3 (25%)	0 (0%)
Chronic Lung Disease **	13 (37%)	5 (42%)	1 (17%)
Smoker: Former	15 (43%)	8 (67%)	0 (0%)
Smoker: Current	2 (6%)	0 (0%)	3 (50%)

* Includes individuals currently receiving chemotherapy, systemic steroids, or with an HIV/AIDS diagnosis

** Includes individuals diagnosed with chronic obstructive pulmonary disease or emphysema

Table 2. Legionnaires' disease attack rates and number of ill residents with no outside exposure by building of residence; odds ratios were calculated based on comparison with the Fifer building - Illinois Veterans Home, 2015

Building	Number of Ill residents	Number Exposed	Attack Rate	OR	p-value	Ill Residents with no outside exposure*
Elmore	13	88	15%	5. 8	<0. 01	1 (8%)
Somerville/Anderson	6	43	14%	5. 4	0. 02	0 (0)
Fletcher	4	34	12%	4. 4	0. 06	0 (0)
Schapers	5	53	6%	3. 5	0. 12	2 (40%)
Markword	4	96	4%	1. 4	0. 71	3 (75%)
Fifer	**3**	**103**	**3%**	**REF**	**REF**	1 (33%)
Total	**35**	**417**				**7**

* Outside exposure includes report or documentation of walking the grounds, sitting on an outside patio, sitting by an open window, or time spent away from the facility in the 10 days prior to symptom onset.

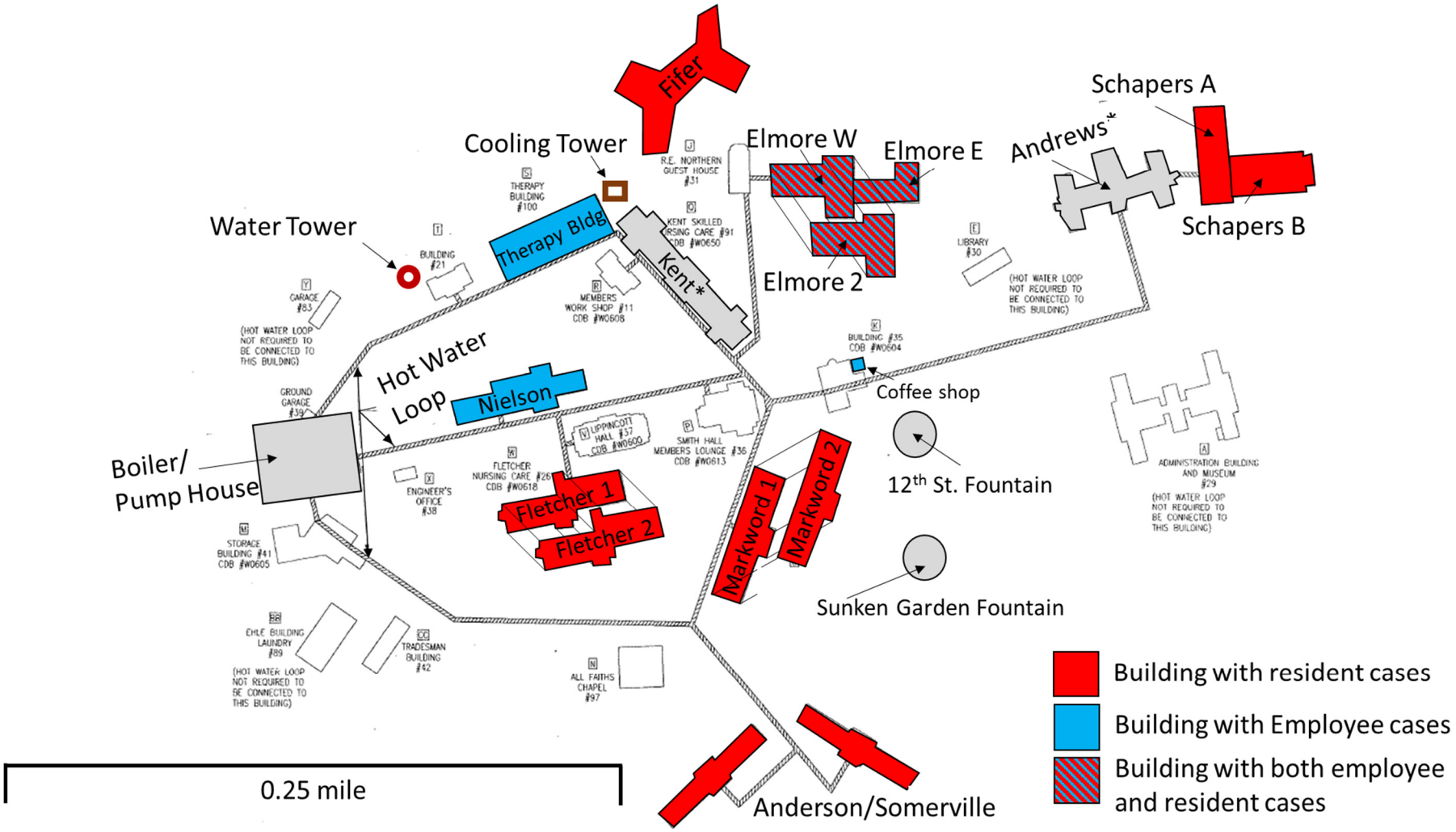

Figure 3. Relative location of facility buildings by presence of resident and staff Legionnaires' disease cases.

* The Kent and Andrews buildings have been decommissioned for resident use.

Environmental Results & Remediation

Potable Water System

The Illinois Veterans Home is a historic healthcare/long-term-care facility that has been in continuous operation since establishment in 1886. A number of major water utility upgrades and construction projects have been undertaken since that time with the 1999 [8] installation of the current recirculating hot water loop and the 2012 installation of the two-cell evaporative cooling tower being the most recent. These changes represent primarily centralized upgrades connecting to the existing peripheral water infrastructure of varying age and quality. In our inspection, three potable water system issues were identified that are often associated with *Legionella* amplification and dissemination: 1) sub-optimal hot-water holding temperature throughout the entire campus, 2) inadequate disinfectant levels sustained in facility potable water system, and 3) a water distribution system with dead-end lines, opportunities for water stagnation, and irregular flow.

Not sure what was told to CDC epi investigator

The IVH facility uses a twin boiler system to heat and hold water that enters the recirculation system for use. Due to the age of some endpoints of this system, thermostatic mixing valves are not installed. As a result the hot-water in the system is held at or below 120°F within the boilers and water at points of use was approximately 110°F meeting state mandated anti-scalding requirements. This means that water never reaches the minimum temperature (140°F) needed to kill *Legionella* bacteria in most environments [9]. A system disruption did occur in July of 2015 when one boiler was taken offline, but not drained, and allowed to cool for approximately 30 days. This water was then reheated to the standard holding temperature of 120°F before being released through the system on August 6, 2015.

IVH potable water is served by the City of Quincy Municipal Water Works, which is the sole provider of potable water within the city. City of Quincy uses a chloramine-based disinfection strategy designed to deliver approximately 2 parts per million (ppm) throughout the public water distribution system. Chloramine levels at points of use at IVH were not routinely monitored. At the time of our inspection, the facility had been on water restrictions for approximately six days, reducing water flow and making chloramine measurements difficult to compare with normal operating conditions. A limited number of chloramine samples were taken throughout the facility and all were non-detectable.

As a consequence of central system upgrades tying into older peripheral systems and the temporary and partial decommissioning of buildings, many individual lines and building water systems within IVH are significantly underutilized resulting in low flow conditions. Further, a lack of backflow prevention throughout the system and multiple connections to the city water main allow for unconstrained and irregular flow of water throughout the

IVH potable water system. These conditions may facilitate *Legionella* amplification in any given location to be distributed throughout the entire facility water system.

This complex water system includes a 500,000 gallon water storage tower. By report from IVH facility engineering staff, the water tower was part of a legacy system when water pressure had to be generated on site. Currently, the City of Quincy meets IVH's water pressure needs. IVH engineering staff estimated that IVH uses approximately 100,000 gallons of water a day. However, given the two water main connections and backflow and irregular flow concerns, the water tower does not have predicable inflow and outflow. This means that it is difficult to determine how long water may be stored in the tower, and extended water storage is known to contribute to *Legionella* amplification.

By report from IVH facility engineering, potable water pressure measurements from the first quarter of 2015 suggests that the 500,000 gallon water tower contained an unknown quantity of water. However, an engineering firm brought on-site to assess the potable system was able to perform an inspection inside the 150 foot tall tower and determined that, as of September 4, 2015, water was only in the stem of the tower. IVH engineering staff determined that the main pressure sensitive valve supplying water to the tower malfunctioned and remained in the closed position, thereby allowing the eventual emptying of the tower body. It is unknown when the body of the tower last contained water; however, water system records suggest that water was held in the tower in the months prior to this outbreak. The rate at which this water may have entered the potable system is unknown.

Cooling Tower

The other primary focus of our environmental assessment was a large (approximately 20ft by 20ft wide and 10ft tall) two-cell cooling tower located at ground level in the northeast quadrant of the facility. Installed in 2012, the cooling tower was designed as integral to the cooling needs (air conditioning) of several resident buildings during the summer months. An initial inspection and decontamination of the cooling tower was performed on August 28, prior to our arrival. At that time, operation and maintenance records were not available and biofilm formation was observed inside and on the outside surface of the cooling tower. IVH reported that the cooling tower was checked daily and that bromide tablets were added when necessary. Additionally, IDPH had concerns about the biocide delivery mechanism's ability to maintain adequate biocide levels within the tower.

The CDC and IDPH re-inspection of the cooling tower revealed additional evidence of biofilm contamination on the outside of the fill media of the tower; in response, additional cleaning, decontamination, and targeted water sample collection was performed. Additionally, CDC and IDPH followed-up on IDPH's earlier concern about the biocide delivery system. It was determined that the cooling tower utilizes a bromine tablet erosion feeder

system. The erosion feeder provides biocide when water is actively being recirculated within the cooling tower. This type of feeding system can allow for variation in bromine levels within the cooling tower during periods of intermittent use or low cooling demand. The cooling tower fans are connected to a variable frequency drive (VFD) that is utilized for energy conservation purposes. The VFD allows the cooling tower to operate without fan assistance during periods of low to moderate cooling demand with high fan speed used to increase evaporation and heat exchange through high demand periods. The combination of low biocide levels leading to *Legionella* amplification and potential sudden increases in fan speed could result in sudden aerosolization of *Legionella*-contaminated cooling water.

Other Risk Factors and Possible Sources of Water Aerosolization

In addition to the aerosolization risk of the cooling tower, two decorative fountains were identified (figure 4). The decorative fountain at the termination of N. 12th Street was surrounded by roadways and had no immediate seating. To the east, the second decorative fountain formed the center of a large greenspace. Seating was available around this fountain; however, this seating was infrequently used due to the relative inaccessibility of the area. Both decorative fountains were of a recirculating spillover type, with makeup water fed from the municipal cold-water system with no secondary treatment. A larger spray fountain was also noted that provided aeration to a water retention pond. This fountain pulls water directly from the pond and has no connection to the facility water infrastructure. No environmental testing was done of the water in the retention pond or the aeration spray fountain. All fountains were turned off as of August 21, 2015.

Specific hot water aerosolization risks were identified, including resident inpatient sinks, shared shower rooms, shared patient whirlpool-type bathing tubs, and high-power sprayers dietary staff used to clean food service equipment. The whirlpool bathing tubs were of particular concern due to their incorporation of water jets, a handheld shower-type spray nozzle, and a warm water reservoir used for rapid tub filling. Several different designs of these whirlpool type bathing tubs were found throughout the facility including both the reservoir type (i.e., retains warm water) and standard drain after use tubs. Maintenance records for tubs were not available and the cleaning strategy was not standardized across the facility. All sink aerators had been removed and hot-water restrictions precluded shower and tub use as of August 26, 2015.

Environmental Sampling Conducted by IDPH and CDC

Initial environmental sampling (Aug 24 through 31) included a total of 39 samples with 23 (59%) positive for *L. pneumophilia* serogroup 1 (*Lp*1) – the most prevalent disease-causing species and serogroup of *Legionella* [10]. The CDC/IDPH representative sampling effort completed on September 3 included a total of 75 additional samples with 47 (63%) found to be *Lp*1 positive. Appendix 2 provides *Lp*1 results of all environmental samples

collected. Figure 1 provides a facility map with the location of environmental *Legionella* findings at the building level. Results combine *Legionella* culture with *Legionella* detection by PCR if no culture results available.

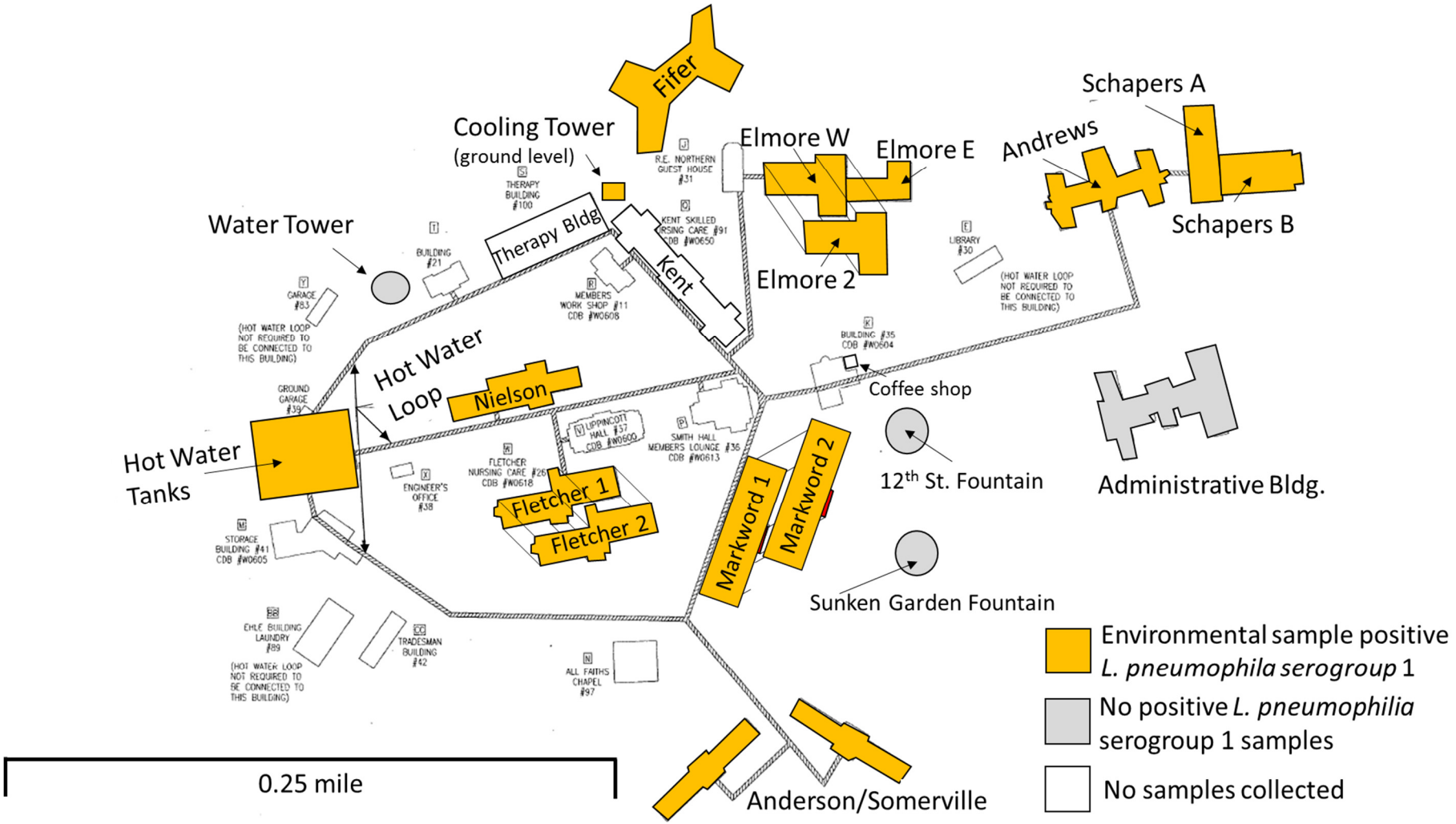

Figure 4: Building level location and result of environmental samples tested for L. pneumophila serogroup 1 – Quincy, IL, 2015

Laboratory Results

Legionella-specific Culture Results

CDC received clinical autopsy samples from three deceased cases. Samples included lung tissue and tracheal swabs. Isolation of *L. pneumophilia* serogroup 1 (*Lp1*) was successful from lung samples of two cases. All samples from the third case were PCR and culture negative. Based on these clinical isolates, the outbreak strain was identified as Lp1 MAb-2 positive with sequence type 36 (ST36). ST36 was the cause of the original 1976 Philadelphia Legionnaires' disease outbreak and, based on examination of Lp1 isolates received at CDC's *Legionella* lab from 1982 to 2012, is overrepresented among outbreak strains while being found relatively infrequently among sporadic and environmental isolates.

Samples from all 11 resident buildings/units, the cooling tower, central potable hot-water tanks, Nielson food service area, and the decommissioned Andrew infirmary grew *Lp1*, and the outbreak strain (ST36) was identified from the selected samples from all locations tested (figure 4). This ubiquity of *Lp1* outbreak strain growth indicates widespread pathogenic *Legionella* colonization throughout the facility. The only areas where samples were *Lp1* negative were the decorative fountains, the administrative building, and the water storage tower (table 3 and figure 4). Due to feasibility of access, the only sample possible from the water storage tower was from the exit line. This sample may not reflect conditions within the tower or when in operational condition.

Potable Water Remediation

Following extensive review of the facility water system design and construction details, a multidisciplinary team with representatives from IDPH-EH, facility engineering and administrative staff, Quincy's municipal water works, *Legionella* control contractors, and CDC environmental health and epidemiology field team members developed a potable water remediation strategy.

In brief, to provide the necessary amount of hyperchlorinated water required to charge the entire potable system in a timely manner, the municipal water inputs were limited to one source main so that incoming water could be hyperchlorinated and used to fill the facility water tower. The single source main was then closed, isolating the facility water system from the municipal system. Water held in the hot-water holding tanks/boilers was independently hyperchlorinated and both the hot-water loop and cold-water mains were charged with hyperchlorinated water. Hot and cold-water at each point-of-use was then run until a free-chlorine level of $\geq$ 3 ppm was measured. Lastly, after a 24-hour hold the hyperchlorinated water was flushed from the system. Post remediation samples taken at 15 select locations throughout the facility on September 11, 2015 and September 24, 2015 showed no *Legionella* growth.

Table 3: Isolation of L. pneumophilia serotype 1 by culture in environmental samples with sequence type by location -Illinois Veterans Home, Quincy Illinois - September, 2015

Sample Location*	*L. pneumophilia* (sero 1)	ST**
Resident Buildings		
Elmore 2	Yes	36
Elmore East	Yes	36
Elmore West	Yes	36
Fifer	Yes	36
Fletcher	Yes	36
Schapers A/B	Yes	36
Somerville/Anderson	Yes	36
Markword	Yes	36
Utility Locations		
Cooling Tower – sample 1	Yes	36
Cooling Tower – sample 2	Yes	1
Hot Water Tank A (1,000 gal)	Yes	36
Hot Water Tank B (1,600 gal)	Yes	36
Water Tower†	No	NA
Staff Buildings		
Administrative Bldg.	No	NA
Andrew Infirmary	Yes	36
Nielson Dish room	Yes	36
Fountains		
12th Street Fountain	No	NA
Garden Fountain	No	NA
Clinical Isolates		
Patient A - Lung Sample	Yes	36
Patient B - Lung Sample	Yes	36

* Multiple samples per location shown if ST type differed

** ST: Sequence Type by Sequence Based Typing

†: Water Tower testing limited to a single point in the exit line when tower was not operating

DISCUSSION

This outbreak occurred in a setting with no formal water management plan and no *Legionella*-specific prevention plan. Neither plan is required by IDPH and the U. S. Department of Veterans Affairs Veterans Health Administration (VHA) Directive 1061 applies only to VHA-owned buildings [11]. Our investigation identified widespread colonization of the facility's potable water system and cooling tower with a highly pathogenic strain of *Legionella* and an at-risk patient population. These factors, combined with either a contaminated aerosol plume or a dissemination of a contaminated potable water bolus likely explains the rapid onset of the outbreak.

Factors that Contributed to the Outbreak

Environmental Factors and Policies

1. The age of facility water infrastructure likely contributed to this outbreak through the natural biofilms which tend to grow within older plumbing systems. This process is worsened in situations of low chlorination, decreased water flow, and dead-end water lines – all of which were likely issues at the facility. Biofilms are an important factor for L*egionella* growth as they provide the nutrients and environment best suited to *Legionella* growth and can provide a mechanism by which the bacteria can resist remediation [12-14].
2. Maintenance of the cooling tower did not meet ASHRAE Standard 188-2015 (published June 2015) [15], allowing system contamination and possible dissemination of the outbreak strain. Specifically, periods of potential suboptimal biocide treatment and a system that was operating while not clean upon visual inspection were identified issues.
3. There was water only in the stem of the water tower as of September 4, 2015 due to a failure of the main pressure sensitive valve that supplies water to the tower from the facility water main. It is unknown when the tower last contained water. The significance of this finding is that water may have remained for an unspecified period of time in a sun exposed water tower until pressure changes within the IVH system allowed for the water to be drawn down from the tower. This represents a major pressure change within the potable water system and a potentially sizeable contaminated bolus that could have impacted the facility's potable water system.
4. The hot potable water holding and peripheral delivery system were below the temperature required to control *Legionella* growth and colonization. Low hot water system temperature can allow the establishment of *Legionella* within the system as well as, decrease the likelihood that the bacteria will be eliminated once present [9].

5. The lack of backflow prevention devices throughout the water distribution system and multiple connections to the city water main allowed for irregular flow of water throughout the IVH potable water system. This allows the possibility of any *Legionella* amplification that might occur in a specific location to be distributed throughout the entire facility.
6. This facility did not have a comprehensive water management plan and/or a *Legionella* prevention plan consistent with the ANSI/ASHRAE Standard 188-2015 in place prior to the outbreak. These plans, when properly developed, provide an understanding of water system details necessary for the prevention and control of *Legionella* contamination [15].

Epidemiologic and Surveillance Factors

1. The lack of on-site rapid *Legionella* Urinary Antigen testing with local clinical care providers delayed the identification of confirmed cases for exposure assessment and added an unnecessary layer of complexity to specimen tracking, accountability, and the consistent reporting of cases across response partners. Additionally, there is evidence that limited access to timely testing may limit case detection, which may have slowed early identification of this outbreak and limited the validity of baseline Legionnaires' disease in the community [16].
2. Clinical surveillance of infections including pneumonia and lower respiratory infections at the facility were in place and sufficient to detect this outbreak; however, limitations in timeliness and the lack of established methods for detecting increases above the threshold precluded the information guiding clinical decisions (e. g. , increased diagnostic testing of pneumonias) or prompting environmental investigation.

RECOMMENDATIONS

CDC continues to work closely with IDPH and ACPH to provide detailed environmental and clinical health recommendations to the Illinois Veterans Home. The focus of our recommendations is to control the growth of *Legionella* in the potable water system, control growth within the on-site cooling tower, and to rapidly identify cases should they occur.

Recommendations in place prior to CDC arrival

1. Potable water use restrictions except for handwashing and toilet flushing. These restrictions included discontinuing the use of whirlpool tubs until cleared for use, discontinuing use of showers until point of use filters were installed, shutting off drinking water fountains, disconnecting ice machines, coffee machines, fountain soda dispensers and other machines from the water system, removing aerators on all plumbing fixtures, posting signs at all faucets to advise residents and staff of the restrictions, conversion to disposable food service items, and securing a supply of commercially bottled or hauled water from an approved source.
2. Decorative fountains turned off and drained.
3. Acquire the services of environmental consultants to advise and assist with decontamination of the potable water system and cooling tower.
4. Increase cooling tower disinfection and monitoring. Increase cooling tower sump pump rate to increase biocide distribution, decrease cooling tower exhaust fan to minimize aerosolization, and clean cooling tower media as possible.
5. New admissions to the facility stopped.

The following recommendations were provided to the facility, IDPH, and ACPH throughout the response from September 1–11, 2015 and as a final oral summary provided on September 11, 2015. Implementation of these recommendations began in September and they continue to be implemented at this time.

Cooling Tower Recommendations

1. Ensure adequate and continuous biocide levels within the cooling tower water system.
2. Ensure continuous water flow through both cooling tower cells and basins at all times.
3. Ensure fan speed is maintained at the lowest speed possible to minimize aerosol dispersion and explore the use of drift eliminators.
4. Apply scale and corrosion inhibitors as appropriate.
5. Maintain overall system cleanliness to minimize the buildup of sediments and biofilm that can harbor or provide nutrients for bacteria and other organisms.
6. Ensure adequate record-keeping to describe cooling tower operations (i.e., biocide residuals, cleaning).
7. Develop and implement a cooling tower *Legionella* prevention plan consistent with the ANSI/ASHRAE Standard 188-2015 and the CTI guideline: Best Practices for the Control of *Legionella* [15, 17].

Potable Water Recommendations

1. Introduce point-of-use filters capable of removing *Legionella* bacteria for all faucets and showerheads fed from the potable hot-water system. Ensure filters are maintained and changed per the manufacturer's recommendations. Point-of use filters should remain in place until successful remediation of the potable water system is complete.
2. Ensure adequate disinfection levels are maintained per EPA recommendations within the potable water system.
3. Ensure hot-water temperatures are maintained at levels (140°F or higher) to prevent *Legionella* growth. CDC does recognize current limitations of the hot-water system and the engineering considerations that will be needed to meet this recommendation.
4. Ensure adequate flow throughout the potable water system to eliminate stagnant water and dead-end lines in the distribution and premise plumbing system.
5. Evaluate the utility of the water tower, eliminate if possible and/or fix the main pressure valve to ensure the water tower is operating as designed.
6. Install backflow prevention devices as appropriate within the system.
7. Continue post-remediation testing at the 15 selected sample locations every two weeks for three months followed by every month for an additional three months. If samples show *Legionella* growth, appropriate remediation should be undertaken and this post-remediation timeframe restarted.
8. Develop and implement a potable water *Legionella* prevention plan consistent with the ANSI/ASHRAE Standard 188-2015 [15].

Clinical / Surveillance Recommendations

1. Hold new admissions through one 14-day incubation period following confirmation of successful remediation of both the cooling tower and potable water system. Confirmation of remediation is defined as all samples showing no *Legionella* growth following an established post-remediation sampling strategy adhering to CDC's *Legionella* sampling protocol and processing methodology - or equivalent.
2. Consider the following enhancements to IVH's clinical/infection control pneumonia and respiratory disease surveillance:
    a. Increase data collection and analysis to provide weekly, rather than monthly, information availability.
    b. Investigate options for surveillance automation and/or integration into development of electronic medical record (EMR) system.

c. Formalize communication of pertinent findings with care providers and environmental health with development of response protocols.

d. Adopt methods to establish surveillance baselines and trigger levels:

- Simple baseline - monthly average rate based on available previous years' data.
- Simple threshold - one standard deviation above previous years' mean.
- Expected counts based on time series analysis.

3. Continue standardized reflex chest x-rays for identified lower respiratory infections with standing *Legionella* testing for all new onset pneumonias indefinitely into the future.
4. Any case of confirmed Legionnaires' disease should trigger an epidemiologic investigation including environmental testing of, at a minimum, the potable water system, the cooling tower if operating, and areas specific to the case.

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APPENDIX 1 – QUESTIONNAIRES

Case Report Form for Legionellosis Cases at the Illinois Veterans Home - <u>Residents</u>

Patient Information			
Last name:	First name:	DOB (*mm/dd/yyyy)*	Age:
Gender: ☐ Female ☐ Male	Race: ☐ White/Caucasian ☐ African American/Black ☐ Asian ☐ Other ☐ Unknown	Ethnicity: ☐ Hispanic/Latino ☐ Non-Hispanic/Latino ☐ Unknown	
Location of residence (building name):	Floor number:	Room number:	Number of Roommates:

Clinical Information			
Onset date (*mm/dd/yyyy)*:	Was patient seen in ED? ☐ Yes ☐ No ☐ Unknown	ED visit date (*mm/dd/yyyy*):	ED name: ED address:
Symptoms: ☐ Fever (Tmax _____) ☐ Cough ☐ Shortness of breath ☐ Physician diagnosed pneumonia ☐ Myalgia ☐ Diarrhea	Was patient hospitalized? ☐ Yes ☐ No ☐ Unknown	Hospitalization date (*mm/dd/yyyy*): Release date (*mm/dd/yyyy)*	Hospital name: Hospital address:

☐ Other_____			

Underlying medical conditions:

Organ transplant ☐Yes ☐No

Immunocompromised (e.g. chemotherapy, systemic steroids, HIV/AIDS) ☐Yes ☐No

Chronic lung disease (e.g. COPD, emphysema) ☐Yes ☐No

Diabetes ☐Yes ☐No

History of stroke ☐Yes ☐No

Difficulty swallowing ☐Yes ☐No

☐ Other _____

Smoker:

☐ Current (or quit in past 1 year) ☐ No

☐ Former Year Stopped_____ ☐ Unknown

If current or former:

Number of packs/day_____

Number of years smoked_____

Is the resident Bedbound?

☐Yes ☐No

Use of respiratory therapy equipment in 10 days prior to symptoms onset?	If yes, what type?	If yes, type of water used in device?
☐ Yes	☐ CPAP	☐ Sterile
☐ No	☐ BiPAP	☐ Distilled
☐ Unknown	☐ Nebulizer	☐ Tap
	☐ Other_____	☐ Other_____

Chest x-ray done:	Result:	Description of x-ray findings (if done):	Patient outcome:
☐ Yes	☐ Pos for PNA	_____	☐ Recovered
☐ No	☐ Neg for PNA	_____	☐ Still ill
	☐ Unknown	_____	☐ Died

Treatment Information:			
Did the patient receive treatment? ☐ Yes ☐ No ☐ Unknown	Treatment type: ☐ Antibiotic ☐ Other	Treatment name(s), dosage, and length of treatment:	Date started (mm/dd/yyyy): Date ended (mm/dd/yyyy):

Laboratory Results:	
Specimen type 1: ☐ Urine ☐ Respiratory ☐ Blood ☐ Serum (acute) ☐ Serum (convalescent) ☐ Other _____	Collection Date (*mm/dd/yyyy):* Type of Test: ☐ Urinary antigen ☐ Culture ☐ DFA ☐ PCR ☐ Immunofluorescence antibody ☐ Other_____ Results: ☐ Positive ☐ Negative ☐ Other _____
Specimen type 2: ☐ Urine	Collection Date (*mm/dd/yyyy):* Type of Test: ☐ Urinary antigen

☐ Respiratory ☐ Blood ☐ Serum (acute) ☐ Serum (convalescent) ☐ Other _____	☐ Culture ☐ DFA ☐ PCR ☐ Immunofluorescence antibody ☐ Other_____
	Results: ☐ Positive ☐ Negative ☐ Other _____
Specimen type 3: ☐ Urine ☐ Respiratory ☐ Blood ☐ Serum (acute) ☐ Serum (convalescent) ☐ Other _____	Collection Date (*mm/dd/yyyy):* Type of Test: ☐ Urinary antigen ☐ Culture ☐ DFA ☐ PCR ☐ Immunofluorescence antibody ☐ Other_____ Results: ☐ Positive ☐ Negative ☐ Other _____

Epidemiologic/Exposure Information:

The following questions are about water exposures in the 10 days prior to symptom onset at the Illinois Veterans Home.

1. Did the patient shower? ☐ Yes ☐ No ☐ Unknown
   If yes:
   a) Date(s): _____
   b) Location of shower in building:_____
   c) Average length of shower _____ minutes

2. Did the patient bathe in the whirlpool bath? ☐ Yes ☐ No ☐ Unknown

If yes:

a) Date(s): _____
b) Location of bath in building: _____
c) Average length of bath_____minutes

3. Was patient bathed using a bedside bath? ☐ Yes ☐ No ☐ Unknown
If yes:

a) Date(s):_____
b) Average length of bath_____minutes
c) Tap water used? ☐ Yes ☐ No ☐ Unknown

4. Did the patient walk on the facility grounds? ☐ Yes ☐ No ☐ Unknown
If yes:

a) Date(s): _____
b) Average length of time on facility grounds per day_____

5. Did the patient sit on a patio? ☐ Yes ☐ No ☐ Unknown
If yes:

a) Date(s)_____
b) Average length of time spent on patio per day_____
c) Location of patio_____

6. Did the patient go near a decorative fountain? ☐ Yes ☐ No ☐ Unknown
If yes:

a) Date(s): _____
b) Location of fountain on facility grounds: _____
c) Average length of time spent near fountains per day_____

7. Did the patient use or go near the physical therapy pool? ☐ Use ☐ Go near ☐ No ☐ Unknown
If yes:

a) Date(s): _____
b) Average length of time spent in pool per use_____

8. Did the patient spend time in an IVH building other than residence? ☐ Yes ☐ No ☐ Unknown
If yes:

a) Date(s): _____
b) Name of building(s): _____

9. Did the patient visit the beauty salon? ☐ Yes ☐ No ☐ Unknown
If yes:

a) Date(s):_____

b) Activities_____
c) Location_____

10. Is there a sink located in the patient's room? ☐ Yes ☐ No ☐ Unknown
    If yes, is there an aerator on the faucet? ☐ Yes ☐ No ☐ Unknown

11. Is there a humidifier located in the patient's room? ☐ Yes ☐ No ☐ Unknown

12. Did the patient participate in group activities (e.g. Bingo)?
    If yes:

    a) Specify type_____
    b) Location_____

13. On a typical day, time spent in room:
    ☐ Only at night ☐ At night and a few hours each day
    ☐ At night and about half the day ☐ At night and most of the day

14. Average number of hours spent outside per day:_____

15. Did the resident have his/her window open?
    ☐Yes ☐No

16. Is the resident's bed by the window?
    ☐Yes ☐No

In the 10 days prior to symptom onset, did the patient spend time away from the Illinois Veterans Home (restaurants, medical or dental visits, grocery stores, entertainment, private homes, etc.)?

☐ Yes ☐ No ☐ Unknown

If yes, please list name and dates of locations visited outside of the Illinois Veterans Home:

Name of location	Date(s) visited (*mm/dd/yyyy)*	Address

Other than at the Illinois Veterans Home, did the patient have exposure to any of the following?			
	Name of location	Date(s) (*mm/dd/yyyy)*	Address
Decorative Fountain			
Hot tub/whirlpool spa			
Inpatient hospitalization			
Outpatient medical visit			
Dental clinic visit			
Grocery store mister			

In the 10 days prior to symptom onset, did the patient spend any nights away from his/her home (hotel/motel stay)?

☐ Yes ☐ No ☐ Unknown

If yes, provide the information below:

Accommodation name	Dates of stay	Address	City	State

Case Report Form for Legionellosis Cases at the Illinois Veterans Home - <u>Staff</u>

Patient Information			
Last name:	First name:	DOB (*mm/dd/yyyy)*	Age:
Gender: ☐ Female ☐ Male	Race: ☐ White/Caucasian ☐ African American/Black ☐ Asian ☐ Other ☐ Unknown	Ethnicity: ☐ Hispanic/Latino ☐ Non-Hispanic/Latino ☐ Unknown	
Typical Shift:	Area of IVH where worked:	Length of time worked at IVH:	

Clinical Information			
Onset date (*mm/dd/yyyy)*:	Was patient seen in ED? ☐ Yes ☐ No ☐ Unknown	ED visit date (*mm/dd/yyyy*):	ED name: ED address:
Symptoms: ☐ Fever (Tmax _____) ☐ Cough ☐ Shortness of breath ☐ Physician diagnosed pneumonia ☐ Myalgia ☐ Diarrhea Other_____	Was patient hospitalized? ☐ Yes ☐ No ☐ Unknown	Hospitalization date (*mm/dd/yyyy*):	Hospital name: Hospital address:
Underlying medical conditions:			

Organ transplant ☐Yes ☐No

Immunocompromised (e.g. chemotherapy, systemic steroids, HIV/AIDS) ☐Yes ☐No

Chronic lung disease (e.g. COPD, emphysema) ☐Yes ☐No

Diabetes ☐Yes ☐No

History of stroke ☐Yes ☐No

Difficulty swallowing ☐Yes ☐No

☐ Other _____

Smoker:

☐ Current (or quit in past 1 year) ☐ No

☐ Former Year Stopped_____ ☐ Unknown

If current or former:

Number of packs/day_____

Number of years smoked_____

Chest x-ray done:	Result:	Description of x-ray findings (if done):	Patient outcome:
☐ Yes	☐ Pos for PNA	_____	☐ Recovered
☐ No	☐ Neg for PNA	_____	☐ Still ill
	☐ Unknown	_____	☐ Died

Treatment Information:			
Did the patient receive treatment? ☐ Yes ☐ No ☐ Unknown	Treatment type: ☐ Antibiotic ☐ Other	Treatment name(s), dosage, and length of treatment:	Date started (mm/dd/yyyy): Date ended (mm/dd/yyyy):

Laboratory Results:	
Specimen type 1: ☐ Urine ☐ Respiratory ☐ Blood ☐ Serum (acute) ☐ Serum (convalescent) ☐ Other _____	Collection Date (*mm/dd/yyyy):* Type of Test: ☐ Urinary antigen ☐ Culture ☐ DFA ☐ PCR ☐ Immunofluorescence antibody ☐ Other_____ Results: ☐ Positive ☐ Negative ☐ Other _____
Specimen type 2: ☐ Urine ☐ Respiratory ☐ Blood ☐ Serum (acute) ☐ Serum (convalescent) ☐ Other _____	Collection Date (*mm/dd/yyyy):* Type of Test: ☐ Urinary antigen ☐ Culture ☐ DFA ☐ PCR ☐ Immunofluorescence antibody ☐ Other_____ Results:

	☐ Positive ☐ Negative ☐ Other _____

Outcome? ☐ Recovered ☐ Still ill ☐ Died

Epidemiologic/Exposure Information:

The following questions are about water exposures in the 10 days prior to symptom onset at the Illinois Veterans Home.

1. Did the staff member assist residents in the shower? ☐ Yes ☐ No ☐ Unknown
   If yes:
   d) Date(s): _____
   e) Location of shower in building:_____
   f) Average number of showers per day _____

2. Did the staff member assist residents in the whirlpool bath? ☐ Yes ☐ No ☐ Unknown
   If yes:
   d) Date(s): _____
   e) Location of bath in building: _____
   f) Average number of baths per day_____

3. Did the staff member walk on the facility grounds? ☐ Yes ☐ No ☐ Unknown
   If yes:
   c) Date(s): _____
   d) Average length of time on facility grounds per day_____

4. Did the staff member sit on the patio? ☐ Yes ☐ No ☐ Unknown
   If yes:
   d) Date(s)_____
   e) Average length of time spent on patio per day_____

5. Did the staff member go near a decorative fountain? ☐ Yes ☐ No ☐ Unknown
   If yes:
   d) Date(s): _____
   e) Location of fountain on facility grounds: _____
   f) Average length of time spent near fountains per day_____

6. Did the staff member use, go near, or assist residents in the physical therapy pool? ☐ Use ☐ Go near ☐ Assisted ☐ No ☐ Unknown
   If yes:

   c) Date(s): _____
   d) Average length of time spent in pool per use_____
   e) Description of use_____

7. Did the staff member visit the beauty salon? ☐ Yes ☐ No ☐ Unknown
   If yes:

   d) Date(s):_____
   e) Activities_____
   f) Location_____

8. Did the staff member assist in group activities (e.g. Bingo)?
   If yes:

   c) Specify type_____
   d) Location

9. Average number of hours spent outside per day:_____

10. Staff position:
    ☐ CNA ☐ LPN/RN ☐ Physical Therapy ☐ Activities ☐ Housekeeping ☐ Volunteer

    ☐ Admin/Office ☐ Maintenance ☐ Other_____

11. Job Duty description_____

In the 10 days prior to symptom onset, list locations where patient spend time away from the Illinois Veterans Home (restaurants, medical or dental visits, grocery stores, entertainment, private homes, etc.)

☐ Yes ☐ No ☐ Unknown

If yes, please list name and dates of locations visited outside of the Illinois Veterans Home:

Name of location	Date(s) visited (*mm/dd/yyyy)*	Address

Other than at the Illinois Veterans Home, did the patient have exposure to any of the following?			
	Name of location	Date(s) (*mm/dd/yyyy)*	Address
Decorative Fountain			
Hot tub/whirlpool spa			
Inpatient hospitalization			
Outpatient medical visit			
Dental clinic visit			
Grocery store mister			

In the 10 days prior to symptom onset, did the patient spend any nights away from his/her home (hotel/motel stay)?

☐ Yes ☐ No ☐ Unknown

If yes, provide the information below:

Accommodation name	Dates of stay	Address	City	State

APPENDIX 2 – ENVIRONMENTAL SAMPLE RESULTS

Table 4: Sample location, type, date collected, and Lp1 detection environmental samples collected prior to CDC arrival – Quincy, IL, 2015

Location	Sample Type	Date Collected	Lp1 Detected
Elmore West Tub Inlets (composite)	Swab	8/24/2015	Yes
Elmore West Tub Showerhead	Swab	8/24/2015	Yes
Elmore East Tub Inlets (composite)	Swab	8/24/2015	Yes
Elmore East Tub Showerhead	Swab	8/24/2015	Yes
12th Street Fountain Pool	Water	8/24/2015	No
Sunken Garden Pool	Water	8/24/2015	No
Cooling Tower Well/Sump	Water	8/24/2015	Yes
Cooling Tower Well/Sump	Water	8/24/2015	Yes
Elmore East 114 reservoir for Apollo tub	Water	8/24/2015	Yes
Hot Water Storage Tank #1 - 1,000 gallons	Water	8/26/2015	Yes
HW Storage Tank #2 - 1,600 gallons	Water	8/26/2015	Yes
HW Storage Tank #1 Hose - draining from top of tank	Water	8/26/2015	Yes
Markword Cafe Sink Faucet	Swab	8/26/2015	No
Markword Cafe Hand Sink Faucet	Swab	8/26/2015	Yes
Markword Ice Chest	Swab	8/26/2015	No
Markword Showerhead FL1 Tub Room	Swab	8/26/2015	No
Elmore Café Sink Faucet	Swab	8/26/2015	Yes
Elmore 2 Showerhead (last stall)	Swab	8/26/2015	Yes
Cooling Tower Water	Swab	8/26/2015	No
12th Street Fountain Drain/Return	Swab	8/26/2015	No
Cooling Tower Well/Sump	Swab	8/26/2015	Yes
12th Street Fountain Spouts	Swab	8/26/2015	No
HW Storage Tank #2 a (inside hatch)	Swab	8/27/2015	Yes
HW Storage Tank #2 b (arm's length)	Swab	8/27/2015	Yes
Elmore West Tub Inlets (composite)	Swab	8/27/2015	Yes
Elmore West Tub Showerhead	Swab	8/27/2015	Yes
Elmore East Tub Showerhead	Swab	8/27/2015	No
Elmore East Tub Inlets (composite)	Swab	8/27/2015	Yes
Cooling Tower Well	Water	8/27/2015	No
12th Street Fountain HRS Filter	Water	8/27/2015	No
Sunken Garden Pool	Water	8/27/2015	No
Cooling Tower	Water	8/31/2015	Yes
Power House	Water	8/31/2015	No
Cooling Tower	Swab	8/31/2015	No
Cooling Tower	Swab	8/31/2015	No
Power House	Swab	8/31/2015	No
Power House	Swab	8/31/2015	No

Cooling Tower	Water	8/31/2015	Yes
Power House	Water	8/31/2015	No

Table 5: Sample location, type, date collected, and Lp1 detection environmental samples collected with CDC assistance – Quincy, IL, 2015

Location	Sample Type	Date Collected	Lp1 Detected
Cooling Tower media (exterior)	Swab	9/1/2015	No
Fountain Basin Sunset LTC	Water	9/1/2015	No
Cooling Tower media (exterior)	Swab	9/1/2015	Yes
Fountain Basin Sunset LTC	Water	9/1/2015	No
Admin Bldg. Public restroom hand sink near conference room	water	9/2/2015	No
Admin Bldg. Public restroom hand sink near conference room	swab	9/2/2015	No
Admin Bldg. Public restroom cold-water utility	water	9/2/2015	No
Admin Bldg. Public restroom cold-water utility	swab	9/2/2015	No
Fifer XX Whirlpool tub faucet	water	9/2/2015	No
Fifer XX Whirlpool tub faucet	water	9/2/2015	Yes
Fifer XX Tub Faucet and hose	swab	9/2/2015	Yes
Fifer XX Tub Faucet and hose	swab	9/2/2015	Yes
Fifer XX sink	water	9/2/2015	Yes
Fifer XX sink	water	9/2/2015	Yes
Fifer XX sink	swab	9/2/2015	No
Fifer XX sink	swab	9/2/2015	Yes
Fifer XX shower	water	9/2/2015	Yes
Fifer XX shower	water	9/2/2015	Yes
Fifer XX shower	swab	9/2/2015	No
Fifer XX shower	swab	9/2/2015	Yes
Fletcher XX tub hose	water	9/2/2015	Yes
Fletcher XX tub hose	water	9/2/2015	Yes
Fletcher XX tub hose	swab	9/2/2015	No
Fletcher XX tub hose	swab	9/2/2015	Yes
Fletcher XX shower	water	9/2/2015	No
Fletcher XX shower	water	9/2/2015	Yes
Fletcher XX shower	swab	9/2/2015	Yes
Fletcher XX shower	swab	9/2/2015	Yes
Fletcher XX right sink	water	9/2/2015	Yes
Fletcher XX right sink	water	9/2/2015	Yes
Fletcher XX right sink	swab	9/2/2015	Yes
Fletcher XX right sink	swab	9/2/2015	Yes
Nielson Dishwasher sink	water	9/2/2015	Yes
Nielson Dishwasher sink	water	9/2/2015	Yes

Nielson Dishwasher sink	swab	9/2/2015	No
Nielson Dishwasher sink	swab	9/2/2015	Yes
Nielson Trayline Sink	water	9/2/2015	Yes
Nielson Trayline Sink	water	9/2/2015	Yes
Nielson Trayline Sink	swab	9/2/2015	No
Nielson Trayline Sink	swab	9/2/2015	Yes
Schaper B Whirlpool Tub	water	9/2/2015	Yes
Schaper B Whirlpool Tub	water	9/2/2015	Yes
Schaper B Whirlpool Tub	swab	9/2/2015	No
Schaper B Whirlpool Tub	swab	9/2/2015	Yes
Schaper B Rm XX Bathroom sink (fatal case location)	swab	9/2/2015	Yes
Schaper B Rm XX Bathroom sink (fatal case location)	swab	9/2/2015	Yes
Schaper B Rm XX Bathroom sink (fatal case location)	water	9/2/2015	Yes
Schaper B Rm XX Bathroom sink (fatal case location)	water	9/2/2015	No
Schaper A Shower Rm Pipe	water	9/2/2015	Yes
Schaper A Shower Rm Pipe	water	9/2/2015	No
Schaper A Shower Rm Pipe	swab	9/2/2015	No
Schaper A Shower Rm Pipe	swab	9/2/2015	No
Andrew Infirmary Break rm Hand sink in bathroom	water	9/2/2015	Yes
Andrew Infirmary Break rm Hand sink in bathroom	water	9/2/2015	Yes
Andrew Infirmary Break rm Hand sink in bathroom	swab	9/2/2015	No
Andrew Infirmary Break om Hand sink in bathroom	swab	9/2/2015	No
Andrew Infirmary Rotunda bathroom	water	9/2/2015	Yes
Andrew Infirmary Rotunda bathroom	water	9/2/2015	Yes
Andrew Infirmary Rotunda bathroom	swab	9/2/2015	Yes
Andrew Infirmary Rotunda bathroom	swab	9/2/2015	Yes
Somerville women's restroom shower - last stall in rm	water	9/2/2015	Yes
Somerville women's restroom shower - last stall in rm	water	9/2/2015	Yes
Somerville women's restroom shower - last stall in rm	swab	9/2/2015	Yes
Somerville women's restroom shower - last stall in rm	swab	9/2/2015	No
Somerville Rm XX (case) hand sink	water	9/2/2015	Yes
Somerville Rm XX (case) hand sink	water	9/2/2015	Yes
Somerville Rm XX (case) hand sink	swab	9/2/2015	Yes
Somerville Rm XX (case) hand sink	swab	9/2/2015	No
Somerville Common Men's Bathroom sink nearest door	water	9/2/2015	Yes
Somerville Common Men's Bathroom sink nearest door	water	9/2/2015	Yes
Somerville Common Men's Bathroom sink nearest door	swab	9/2/2015	No
Somerville Common Men's Bathroom sink nearest door	swab	9/2/2015	No
Water Tower	Swab	9/3/2015	No
Water Tower Box	Water	9/3/2015	No
Water Tower Fire Hydrant	Water	9/3/2015	No