NSW GOVERNMENT

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Public Health Response to a Legionellosis Outbreak in Sydney CBD

April - May 2022

Produced by South Eastern Sydney Local Health District

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Authors and Acknowledgements

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1 Executive Summary

On 26 May 2022 South Eastern Sydney Public Health Unit commenced a public health response to an identified cluster of people diagnosed with Legionnaires' disease who had visited or worked in the Sydney CBD during their exposure periods. This response included rapid communication to the City of Sydney and other relevant stakeholders, coordinated inspections of potential environmental sources, and epidemiological and genomic investigations.

Environmental investigations found five cooling towers in four locations containing *Legionella* in their cooling water systems. The epidemiological investigation found eleven cases linked to exposures in the Sydney CBD between late April and May 2022. Bacteria from three of these cases were also genomically linked to the *Legionella* that contaminated the water in one cooling tower.

Importantly, no cases of people diagnosed with Legionnaires' disease have been identified as having exposures in Sydney CBD beyond 26 May 2022, and it is believed that the public health response led to prompt termination of the risk.

2 Background

The Sydney central business district (CBD) is defined in this report as encompassing the portion of the City of Sydney bounded by Circular Quay, Darling Harbour, Central Railway Station and the Royal Botanic Gardens. On any one day there are over 600,000 visitors to the area, which is more than 10% of the total population of Greater Sydney. This is on top of an estimated resident population of 17,252 people. The City of Sydney Council has over 500 registered cooling towers within this area.

Legionnaires' disease is an infection of the lungs (pneumonia) which in its severest form also affects other organs. It is caused by one of a number of bacteria of the genus *Legionella* which are widely distributed in the natural and man-made environment where moisture is present. Legionnaires' disease may occur after a person breathes in contaminated water droplets or dust, and is not spread from person to person. Although there are many different species of *Legionella* bacteria, a main cause of disease in NSW is from *Legionella pneumophila. Legionella pneumophila* can colonise air conditioning cooling towers, whirlpool spas, shower heads and other bodies of water. In Australia, and globally, outbreaks of Legionnaires' disease are most commonly caused by *Legionella pneumophila* serogroup 1 (LP1).

For those who develop Legionnaires' disease, symptoms occur between two to ten days after exposure to the bacteria (referred to as the exposure or incubation period) and may include fever, headache, cough, shortness of breath and muscle aches. People with significant underlying health conditions such as diabetes and chronic obstructive pulmonary disease, those over 50 years old, male, and people who smoke are more likely to develop symptomatic or severe Legionnaires' disease after exposure to the bacteria.

Legionnaires' disease is diagnosed through testing of urine, sputum and / or blood samples of people with symptoms of the illness. Any laboratory that detects the presence of *Legionella* or specific antibodies in these samples is required to notify NSW Health under the *NSW Public Health Act 2010*. *Legionella* may also be detected in water and soil samples.

The *NSW Public Health Act 2010* and *NSW Public Health Regulation 2022* outline the regulatory requirements for regulated systems that may promote the growth of *Legionella pneumophila*, which include air-handling systems, hot water systems, humidifying systems, warm water systems and water cooling systems. Each local government authority is required to maintain a register of regulated systems within its local area. Some water features such as decorative fountains are not regulated but can be a source for *Legionella* growth.

This report outlines the public health response regarding eleven cases of Legionnaires' disease in people who were in the Sydney CBD during April and May 2022.

3 Investigation Methods

3.1 Clinical investigation

A *Legionella* investigation starts with a clinical investigation of a number of patients. A doctor investigating the cause of pneumonia in a person presenting to hospital may order a *Legionella* urinary antigen test. This test is specific for infection with *Legionella pneumophila* serogroup 1. Doctors are also encouraged to collect a sputum sample from the patient. Sputum samples are then tested to see if any *Legionella* bacteria can be isolated. Growing *Legionella* allows for genetic sequencing of the bacteria, essentially identifying the DNA fingerprint of the *Legionella*.

3.2 Case notification

In Australia all cases of Legionnaires' disease are notified to the relevant state and territory public health authority by law. State and territory public health authorities follow nationally agreed guidelines on how to investigate cases of Legionnaires' disease, including their source of infection. For cases of Legionnaires' disease caused by LP1, local public health unit staff interview the case to identify all movements and higher-risk activities undertaken by the case during their exposure period. This may include questions around potential workplace, social, sporting, travel, healthcare and domestic exposures in the two to ten days before onset of symptoms. Any exposures that are identified outside the local public health unit geographical region (such as an interstate exposure) are reported to the relevant state or territory public health authority through a nationally agreed communication process. In this way, the South Eastern Sydney Public Health Unit (SESPHU), the public health unit that encompasses Sydney CBD, is made aware of any cases of Legionnaires' disease that may not live in the SESPHU geographical area, but visited the Sydney CBD during their exposure period.

A *Legionella* outbreak is defined as two or more cases where the onset of illness is closely linked in time (weeks rather than months) and where there is epidemiological evidence of a common source of infection, with or without microbiological evidence.

Between 20 and 26 May 2022 SESPHU was notified of six people with LP1 infection who had been in the Sydney CBD during their exposure period. Two cases were notified on 20 May, one on 25 May and three on 26 May (Appendix A). This clustering of notifications in one week triggered an outbreak investigation. On identification of this outbreak, SESPHU worked with staff of the Council of the City of Sydney and the NSW Ministry of Health to release a media statement on May 26, alerting the public to several cases of Legionnaires'

disease associated with the CBD. SESPHU also notified all NSW public health units so exposures in the CBD could be quickly recognised when interviewing new legionellosis cases. NSW hospitals and general practitioners were also issued alerts about the outbreak and requested that appropriate testing be undertaken for suspected cases. Other states and territories were alerted about the outbreak via Communicable Disease Network of Australia.

On 30 May, 3, 7 & 10 June SESPHU were notified of a further 5 cases of people with LP1 infection who had been in the Sydney CBD during their exposure period.

3.3 Epidemiological investigation

All cases (or a suitable person such as a partner if the case could not be interviewed) were interviewed. The interview comprised of questions as outlined in the National *Legionellosis Investigation Form*.[1] These questions include clinical symptoms experienced, risk factors, and environmental exposures (where the case had been) two to ten days prior to symptom onset. The environmental exposures were used to determine the case's detailed movements through the CBD. These case movements were mapped using QGIS v3.24.0, with a 500m buffer created around these movement locations (Figure 3). Buffers from each case movement were overlayed to refine a likely *Legionella* source area.

3.4 Environmental investigation

The environmental investigation involved a collaboration between SESPHU and the Council of the City of Sydney, and consisted of a field team of approximately 14 environmental health officers from both agencies, and from Sydney PHU and the NSW Ministry of Health. The investigation area was initially defined by a joint Public Health Unit and City of Sydney review of the map of registered towers within a 500m radius of Case 3's location in the CBD (Figure 1) and refined as the central portion of the CBD common to cases 1-5 as bounded by Martin Place to the north, Elizabeth Street to the east, Liverpool Street to the south and Clarence Street to the west.

Desktop investigation consisting of a review of the current risk management plan, the current audit report, and cleaning, maintenance and microbial sampling results from the previous 3-6 months for each cooling water system in the investigation area was undertaken by PHU and Council officers.

Physical inspections with water sampling were undertaken between 27 May – 1 June 2022, with towers prioritised for inspection according to risk rating and results of the desktop review. The field teams focussed on inspecting and sampling all cooling water systems with high risk rating in the area of investigation, cooling water systems at a case's work location, and medium and low risk cooling water systems in the investigation area that either failed or did not have an audit report. All samples were delivered to NSW Health Pathology – Forensic and Analytical Science Service (FASS) for analysis.

Cooling tower locations were mapped in QGIS v3.24.0 geographical software (Figure 4).

[1] https://www.health.gov.au/sites/default/files/documents/2020/02/legionellosis-cdna-national-guidelines-for-public-health-units-legionellosis-investigation-form.pdf (accessed 12/08/2022)

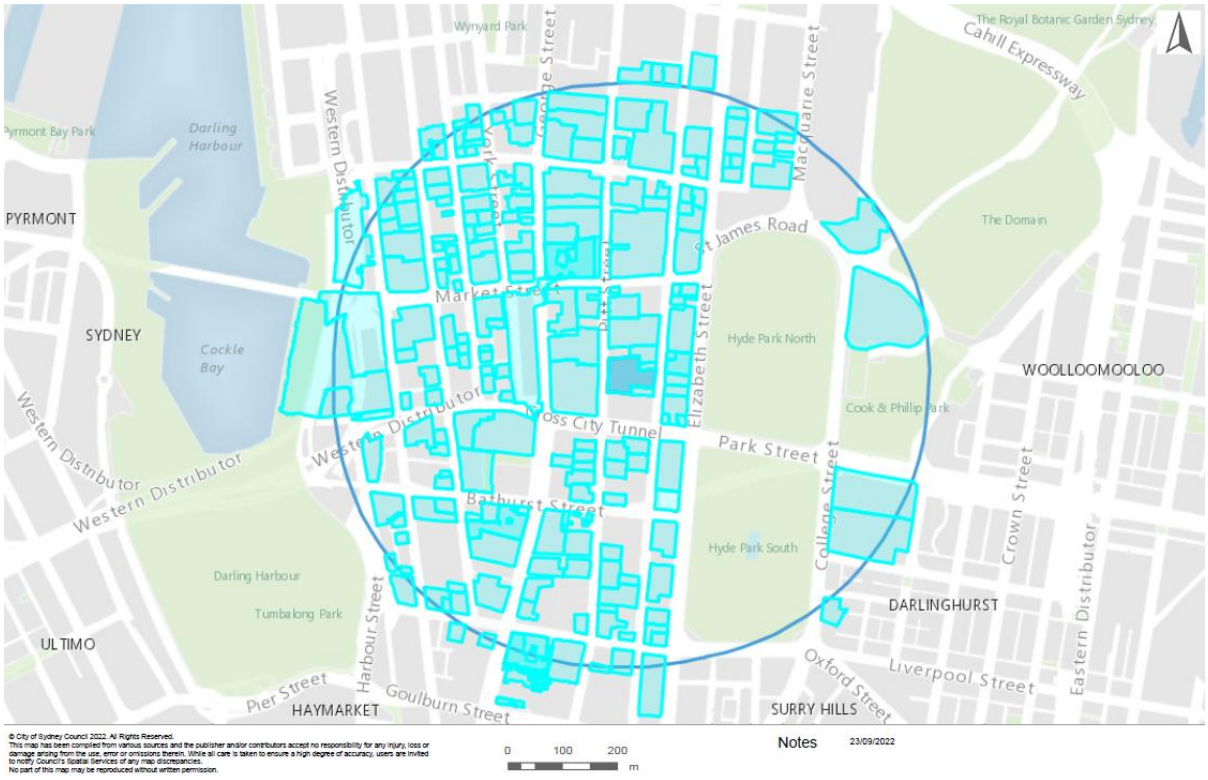

Figure 1. Initial cooling tower investigation area

3.5 Laboratory testing and genomic investigation

Genomic investigation is enabled by availability of LP1 cultures from clinical samples and is undertaken to determine the likelihood of an environmental *Legionella* isolate being the source of a case's infection. This is determined by examining the similarity in the whole genome sequence of the *Legionella* recovered from individual patients' sputa and from a cooling tower's water.

All clinical and environmental LP1 isolates from the investigation were sent to the Centre for Infectious Disease Laboratory Services, ICMPR, NSW Heath Pathology at Westmead Hospital for confirmatory typing and genome sequencing. Sequencing was performed on an Illumina NextSeq, and assembled sequences were genotyped using the Legionella Sequence Based Typing (SBT) scheme.[2] Sequence relatedness and phylogeny was determined using core sequence nucleotide polymorphisms (core SNPs) using snippy [3] and a curated recombination-masked LP1 SBT ST211 reference genome. All available historical ST211 sequences from clinical and environmental isolates at ICPMR were included in the cohort analysis for context.[4] The Case 8 (SBT ST733) and Elizabeth Street (SBT untypeable) isolates were excluded from the cohort as they were too genomically distinct.

[2] Gaia V, Fry NK, Afshar B, Lück PC, Meugnier H, Etienne J, et al. Consensus Sequence-Based Scheme for Epidemiological Typing of Clinical and Environmental Isolates of Legionella pneumophila. Journal of Clinical Microbiology. 2005;43(5):2047-52.

[3] https://github.com/tseemann/snippy (accessed 12/08/2022)

[4] Timms VJ, Rockett R, Bachmann NL, Martinez E, Wang Q, Chen SC-A, et al. Genome Sequencing Links Persistent Outbreak of Legionellosis in Sydney (New South Wales, Australia) to an Emerging Clone of Legionella pneumophila Sequence Type 211. Applied and Environmental Microbiology. 2018;84(5):e02020-17.

4 Results and further action

4.1 Clinical and epidemiological investigation

Eleven cases were identified as epidemiologically linked to the Sydney CBD as they had visited or passed through Sydney CBD during late April or May 2022, two to ten days prior to their onset of symptoms.

All eleven cases were positive for LP1 urinary antigen. Six cases had a sputum sample collected, of which five were successfully cultured to grow *Legionella* colonies.

All cases were identified as having risk factors making them susceptible to *Legionella* infection. The median age of cases was 69 years with a range of 46 – 79 years. All were hospitalised and recovered with the range of hospital stay of 3 to 56 days. Cases were more likely to be male with 8 of 11 cases identifying as male. Onset of symptoms for cases ranged from 29 April to 30 May and are captured in Figure 2.

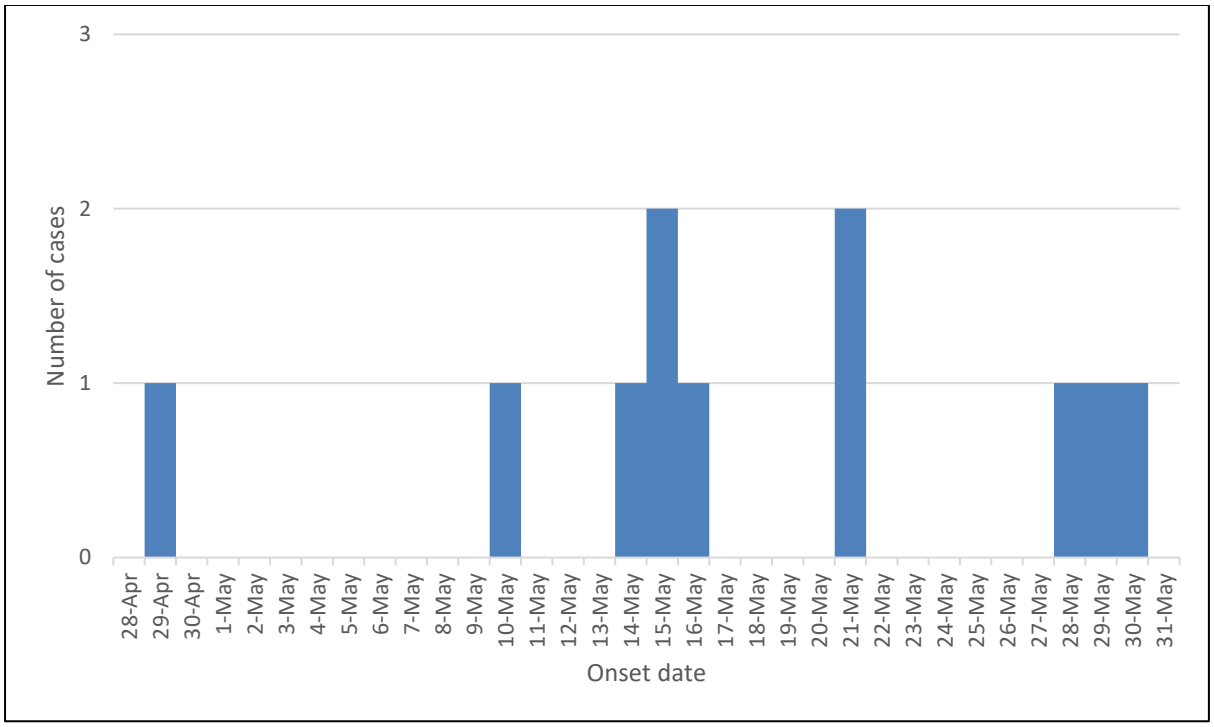

Figure 2. Epidemic curve of Sydney CBD Legionellosis outbreak, April – May 2022

The first and second cases (Case 1 & 2) were notified to SESPHU on 20 May 2022. Case 1 was a City of Sydney resident who walked to the Queen Victoria Building almost every day. Case 2 was a courier driver with multiple exposure locations across greater Sydney, including two visits to the CBD. Case 3 was notified to SESPHU on 25 May and worked in a CBD office building. Cases 4 - 6 were notified to SESPHU on 26 May. Case 4 was an overseas tourist staying in Sydney CBD. Cases 5 & 6 were Sydney Local Health District residents, Case 5 attending a function in the CBD while Case 6 was shopping in the CBD and diagnosed in Western Australia. Cases 7 & 8 were notified to SESPHU on 30 May. Case 7 worked in a CBD office building while Case 8 travelled by car across the CBD with windows down on their way to the Royal Botanical Gardens. [It should be noted that Case 8 was originally notified to SESPHU on 18 May, however a connection to the CBD was not

established till 30 May. Case 8 had multiple exposures in other areas that required investigation]. Case 9 was notified to SESPHU on 3 June and walked through the CBD to the Sydney Conservatorium of Music. Case 10 was notified to SESPHU on 7 June and worked in the CBD and Case 11 was a Victorian resident visiting Sydney CBD during their exposure period, diagnosed in Victoria, and notified to SESPHU on 10 June. Figure 3 is a geographical display of each case's movements in the CBD and their 500m buffer zones, along with the *Legionella* positive cooling towers.

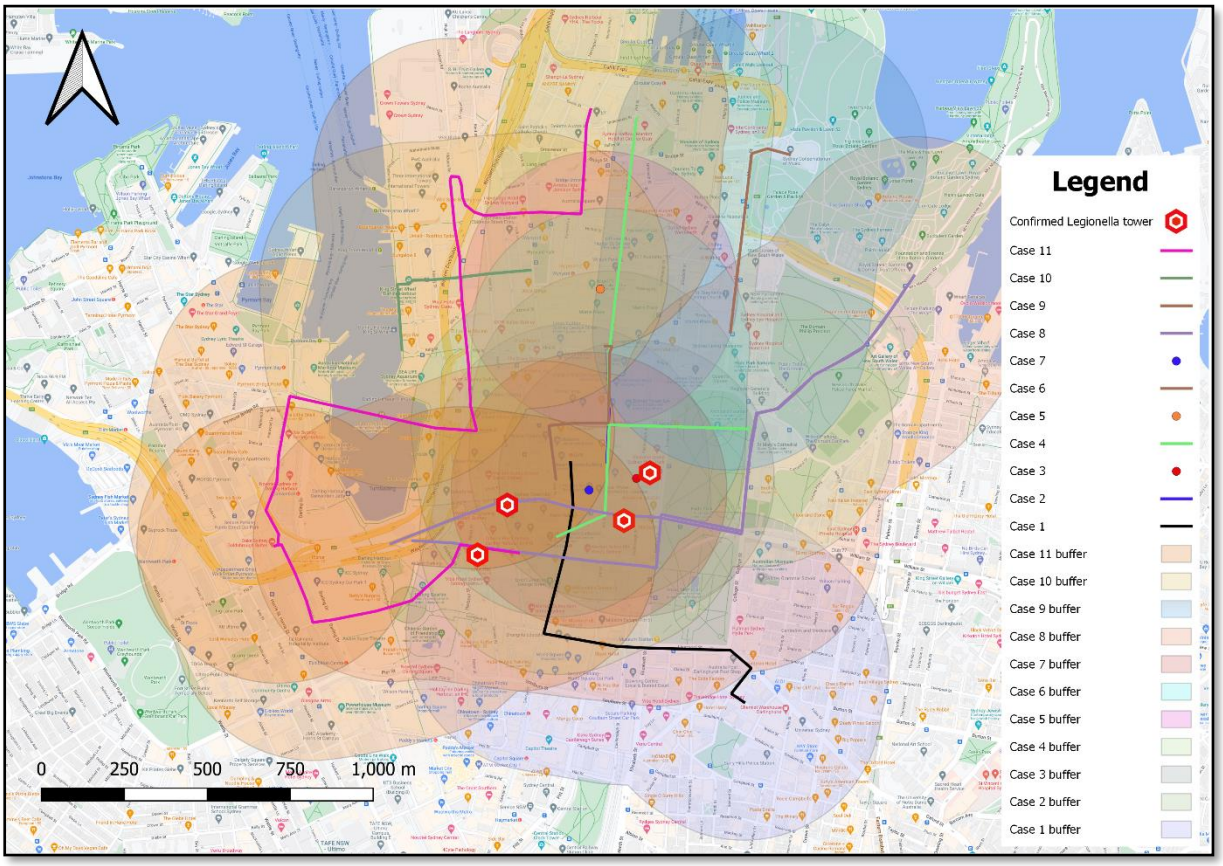

Figure 3. Case movements and 500m buffers in the Sydney CBD, along with *Legionella* positive cooling towers.

Appendix A provides a tabulation of further case information.

4.2 Environmental investigation and action

Three hundred and thirty two cooling water systems were identified in the initial investigation area (Figure 1), of which 123 were inspected. The 123 systems inspected included all those which were identified as high risk in the investigation area (69), plus 54 medium to low risk cooling water systems that were selected because they were a building visited by a case, had a failed or no audit on record or had a past history of *Legionella* contamination.

One hundred and fifty samples were collected from the 123 cooling water systems inspected in the investigation area. Immediate rectification was requested where turbid water or other defects were detected. On 1 June presumptive *Legionella* results were identified in five of these samples from four sites (Appendix B). City of Sydney and SESPHU contacted each of the four sites on 1 June to request immediate on-line disinfection of the five towers.

The test results were finalised on 3 June, confirming *Legionella* contamination in the five samples, and Improvement Notices under the *NSW Public Health Act 2010* were issued for 3 of the sites in Druitt Street, Park Street and Elizabeth Street. A warning letter was issued for the Sussex Street site which had a low level of LP1 (Appendix B).

Figure 4 displays the cooling towers in the CBD and highlights those towers positive for *Legionella*.

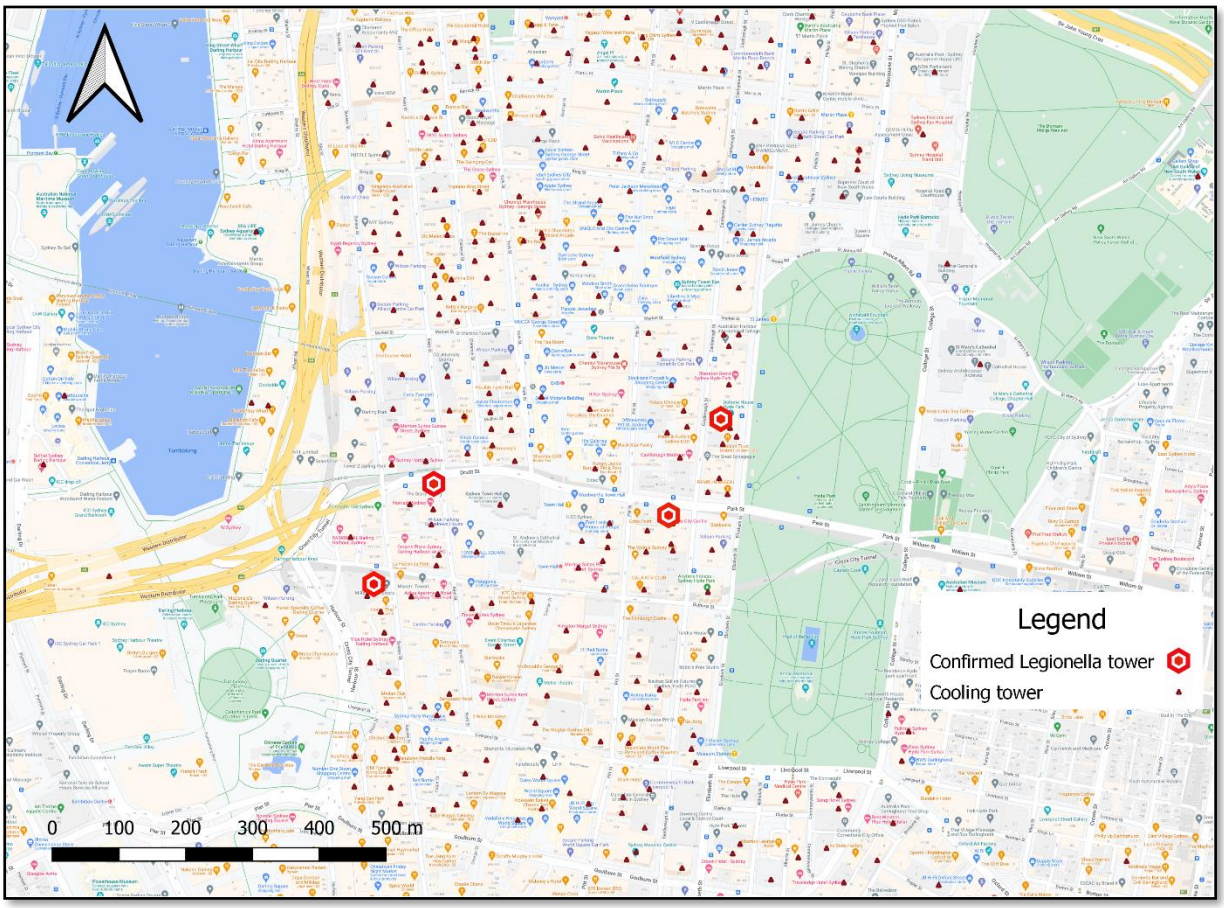

Figure 4. Sydney CBD cooling towers with *Legionella* positive towers identified

4.3 Inferences from genomic investigation

Five clinical isolates and six environmental isolates of *Legionella* were available for genome sequencing and analysis. The five clinical isolates were from Cases 2, 4, 7, 8 and 11. The six environmental isolates were from four cooling towers (Appendix B).

Respiratory LP1 isolates from three cases (Case 2, Case 4 and Case 7) and one environmental isolate from one cooling tower (Druitt St – Cooling Tower 2) in the Sydney CBD formed a genomic cluster based on core genome comparison and SNP phylogeny, indicating the likely source of infection for these three cases was this cooling tower (Figure 5). The isolates from Cases 8 & 11 did not cluster with each other or any of the four cooling tower isolates and thus were considered genomically distinct.

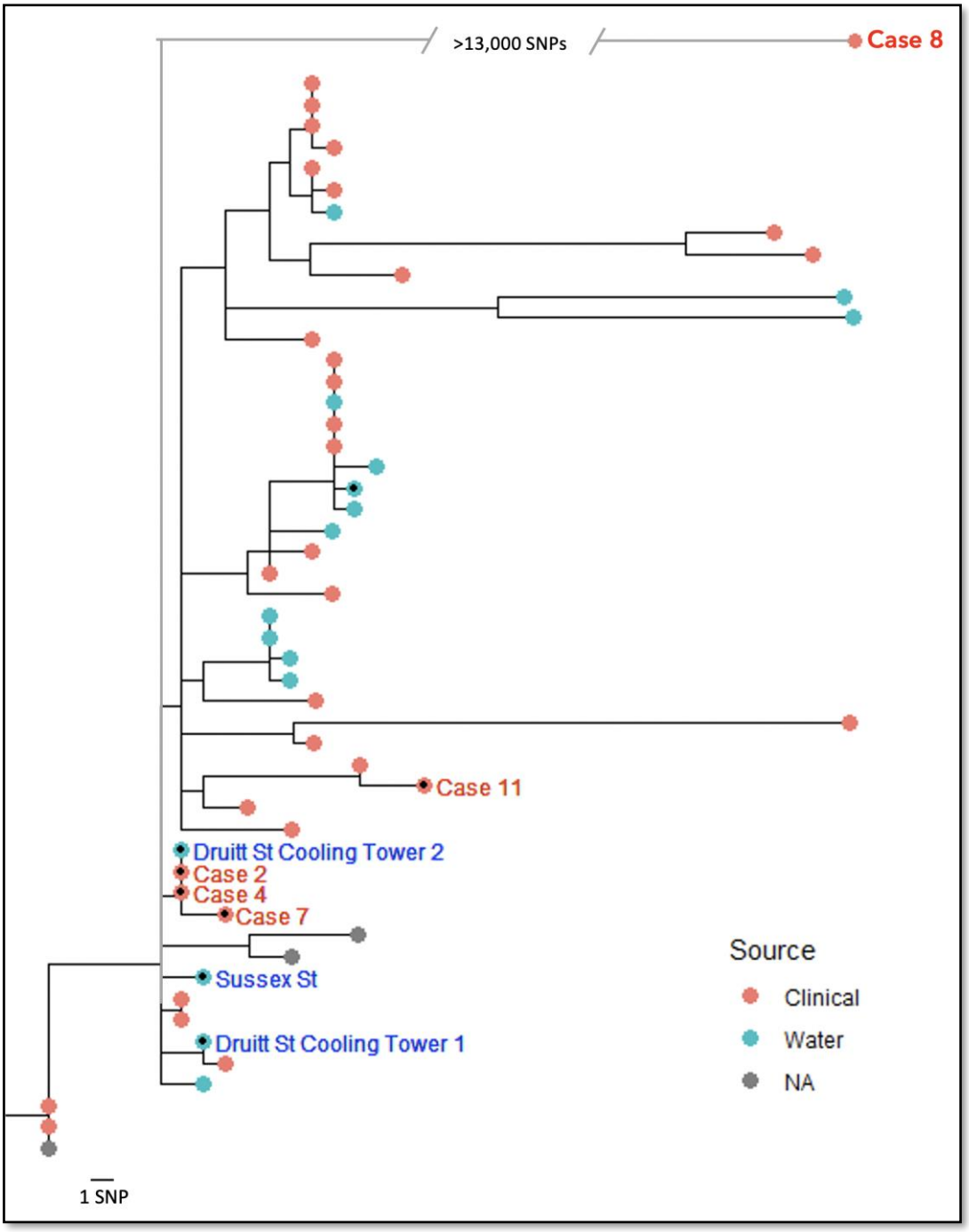

Figure 5. Genome phylogenetic analysis of isolates.
Case 8 (SBT ST733) has been added to the tree manually for reference. The unlabelled clinical and water sample are ST211 isolates from previous CBD-related cases or outbreak investigations and included to provide context for the relatedness of the current isolates.

5 Discussion

A public health response relies on a number of tools to provide insight into an outbreak, all of which have limitations. To overcome these limitations, multiple lines of evidence are considered. These lines of evidence include clinical and environmental sampling along with epidemiological and genomic investigation.

Environmental sampling of the cooling towers occurred after the NSW Health media release regarding a cluster of Legionnaire's' disease cases in the CBD. Reports from the environmental health officers indicated that many of the cooling towers they inspected had a maintenance visit following the media release and had been disinfected prior to the environmental health inspection. This is to be expected, but it does mean that any samples taken from these towers would no longer contain *Legionella*, if *Legionella* was present prior to disinfection. This limits the ability to identify all cooling towers that may have contributed to the outbreak; however, as the main aim of a public health response is to stop the outbreak by ensuring that all sources of *Legionella* are controlled as quickly as possible this is an acceptable limitation to achieve the desired outcome.

The desktop review of registered cooling water systems in the investigation area found that all four sites that grew *Legionella* had no failed results from the previous 3 months' mandatory sampling program. However it was noted that none of these sites had engaged independent companies to undertake mandatory monthly water sampling. Whilst this is not required by the *NSW Public Health Regulation 2012* the Public Health Unit has recommended, as best practice, that the monthly water samples mandated by the Regulation are taken by a company independent of the water treatment company that services the cooling water systems.

For one of these sites (Druitt St), the system was leaking water, potentially leading to dilution of disinfectant, and the cooling towers were found to have a faulty drift eliminator, leading to an unacceptable risk of emission from the towers of water droplets potentially contaminated with *Legionella*. The drift eliminator had been identified as requiring replacement in the risk management plan more than one year earlier.

This investigation has highlighted that despite a new regulatory regime implemented in 2018[5] following the previous CBD outbreak[6], poorly maintained cooling water systems continue to represent a risk to people. The effectiveness of the Regulation could be strengthened by requiring monthly cooling water system testing to be undertaken by a party independent to the maintenance contractor, and by requiring that defects identified in risk management plans are rectified within a reasonable timeframe.

Only six of the eleven notified cases provided sputum samples, and of these only five were successfully cultured. In some instances it was reported that the case could not produce any sputum and in other instances that the patient's attending medical practitioner did not request this collection. The provision of a sputum sample is important in an investigation as positive cultures for LP1 offer an opportunity to examine genomic links to an environmental sample, and during the outbreak messages to clinicians included this recommendation.

The epidemiological investigation attempts to link a cluster of people through place and time, in this instance being in the Sydney CBD between late April and May, two to ten days prior to their onset of symptoms. While all eleven cases met this criterion, only three had an identified genomic link to a contaminated cooling tower, so it is possible that the source for the other eight cases could have been from a number of other places they visited outside the Sydney CBD during their exposure period, or from a Sydney CBD cooling tower that had been disinfected prior to sampling by the investigation teams.

Genomic testing reported a very high degree of similarity between DNA of LP1 isolates recovered from one particular cooling tower in Sydney CBD and the three individuals who were in close proximity to the tower in their respective exposure periods. While genomic testing provided strong evidence of the relationship between the four samples, it does not

[5] https://www.health.nsw.gov.au/environment/factsheets/Pages/legionella-control-new-reqs.aspx
[6] https://www.health.nsw.gov.au/Infectious/Publications/legionella-cbd-report.pdf

assert absolute certainty of causation between the samples. It cannot rule out a chance of another genomically closely related environmental isolate being present in another unidentified cooling tower at the time the individuals were exposed.

Exploring the lines of evidence, this investigation found that case 2, 4 and 7 had the strongest evidence of acquiring their infection in the CBD. These three cases had extensive exposure in the CBD investigation area during their exposure period and were genomically linked to an environmental source.

Case 11 also had strong evidence of infection acquisition in the CBD. This case had extensive exposure in the CBD investigation area during their exposure period and had LP1 in their sputum sample with a genomic structure similar to that of current and historic LP1 samples found in cooling towers in Sydney CBD.

Cases 1, 3 and 6 had strong epidemiological evidence of infection acquisition in the CBD. These cases had extensive exposure in the CBD investigation area during their exposure period, although the lack of a sputum sample limited the ability to link them conclusively to the Sydney CBD.

Cases 5, 9 and 10 had weak evidence of infection acquisition in the CBD. These cases had minor exposure in the CBD investigation area during their exposure period, and a lack of a sputum sample limited the ability to link them genomically to the Sydney CBD.

Finally, it is unlikely that Case 8 acquired their infection in the CBD. This case had fleeting exposure to the CBD investigation area during their exposure period, and sequencing of the *Legionella* isolate from their sputum sample showed it to be genomically quite distinct from environmental *Legionella* strains found in the Sydney CBD.

Appendix A

Line list of LP1 cases, ranked by SES notification date

Case	NSW Health Notification date	SES Notification date	Gender	Age (Years)	Onset Date	Risk Factors	Status	Hospitalisation	Days in hospital	Urinary Antigen LP1	Sputum sample taken	LP1 SBT genotype	Genomically clustered
1	20/05/2022	20/05/2022	Female	72	29/04/2022	Yes	Recovered	Yes	7	Positive	No		
2	19/05/2022	20/05/2022	Male	62	14/05/2022	Yes	Recovered	Yes	56	Positive	Yes	ST 211	Yes
3	24/05/2022	25/05/2022	Male	47	15/05/2022	Yes	Recovered	Yes	14	Positive	No		
4	25/05/2022	26/05/2022	Male	73	21/05/2022	Yes	Recovered	Yes	6	Positive	Yes	ST 211	Yes
5	25/05/2022	26/05/2022	Female	75	21/05/2022	Yes	Recovered	Yes	17	Positive	Yes but no LP1 culture grown		
6	25/05/2022	26/05/2022	Male	58	16/05/2022	Yes	Recovered	Yes	5	Positive	No		
7	20/05/2022	30/05/2022	Male	57	15/05/2022	Yes	Recovered	Yes	22	Positive	Yes	ST 211	Yes
8	18/05/2022	30/05/2022	Female	49	10/05/2022	Yes	Recovered	Yes	29	Positive	Yes	ST 733	No
9	2/06/2022	3/06/2022	Male	79	30/05/2022	Yes	Recovered	Yes	44	Positive	No		
10	4/06/2022	7/06/2022	Male	69	29/05/2022	Yes	Recovered	Yes	3	Positive	No		
11	10/06/2022	10/06/2022	Male	69	28/05/2022	Yes	Recovered	Yes	7	Positive	Yes	ST 211	No

Appendix B

List and results of legionella positive cooling towers

Premises	RMP Risk rating	Inspection date	Sample date	Presumptive initial result (Total *Legionella* CFU/ML)	Action taken	Re-inspection Date	Date of additional Samples taken	Final Action taken	Date of Final Result	FINAL RESULTS - CFU/ML				LP1 SBT genotype	Genomically clustered to cases
										Total Legionella	*Legionella Pneumophila*		Other species		
											Serogroup 1	Serogroup 2-14			
Druitt Street Cooling Tower 1	High	27/05/2022	27/05/2022	>1000	Building manager advised 1/6/22	7/06/2022	7/06/2022	Improvement Notice issued by Council	3/06/2022	1700	1700			ST 211	No
Druitt Street Cooling Tower 2	High	27/05/2022	27/05/2022	>1000	Building manager advised 1/6/22	7/06/2022	7/06/2022	Improvement Notice issued by Council	3/06/2022	1700	1600	100		ST 211	Yes
Elizabeth Street	High	27/05/2022	27/05/2022	>1000	Building manager advised 1/6/22	8/06/2022	8/06/2022	Improvement Notice issued by PHU	3/06/2022	1300	400	900		Untypeable	N/A
Sussex Street	High	27/05/2022	27/05/2022	10-<100	Building manager advised 1/6/22	7/06/2022	7/06/2022	Warning Letter issued by Council	3/06/2022	50	10		40	ST 211	No
Park Street	High	27/05/2022	27/05/2022	> 100	Building manager advised 1/6/22	7/06/2022	7/06/2022	Improvement Notice issued by Council	3/06/2022	810			810	Not undertaken	N/A