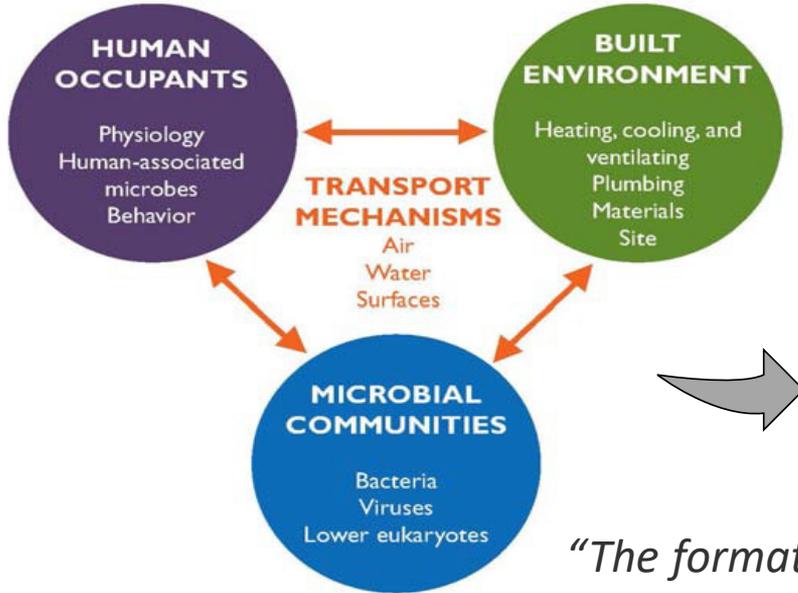


Understanding the water microbiome to inform water management plans to minimize the growth of *Legionella* in buildings

Laura Boczek, Vicente Gomez-Alvarez, and Randy Revetta

U.S. Environmental Protection Agency, Office of Research and Development, Cincinnati, OH
45268

Built Environment Ecosystem



DWDS: a complex system

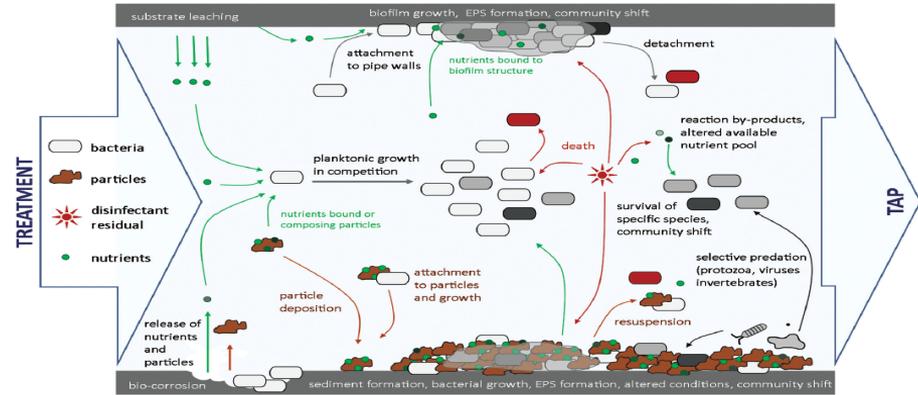
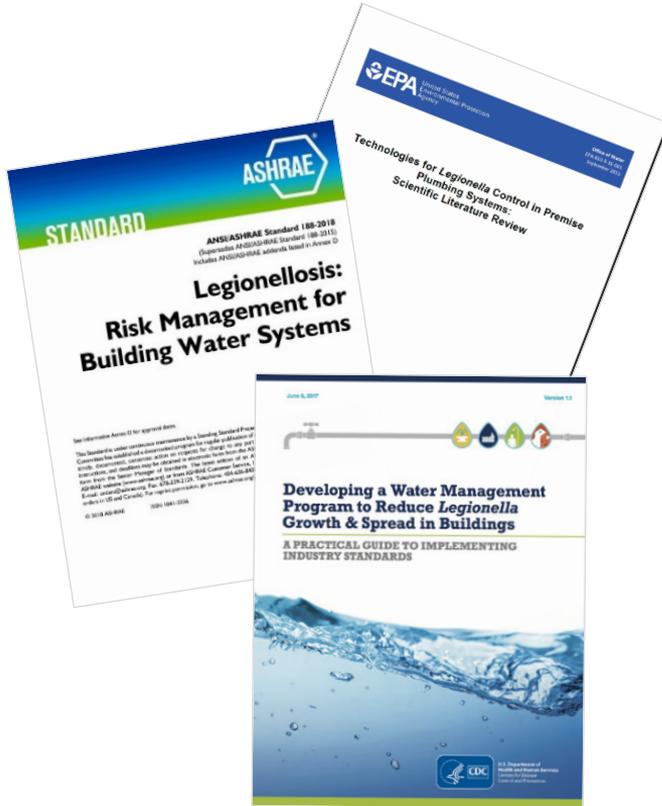


Image: Prest *et al.*, (2016) *Front Microbiol.* 7:45.

*“The formation, dynamics, and functions of [ecosystems] in built environments are shaped by complex interactions of factors related to the characteristics of a building, its human occupants, and the **microbial communities** associated with both.”*

Built Environment Ecosystem: practical impact

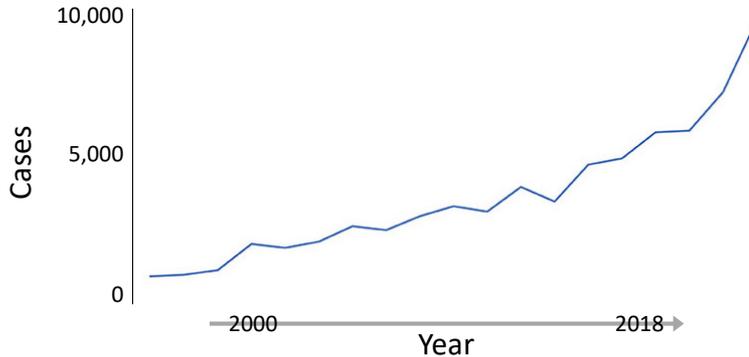


Understanding changes in microbial communities in built environments is essential for monitoring biological stability to ensure ecosystem health.

This information could be incorporated into water management programs and greatly enhance our ability to predict responses to disturbances in the ecosystem.

Premise Plumbing: why *Legionella*?

Reports of Legionnaires' Disease are on the Rise in the United States



Legionella pneumophila

In the United States, reported cases of Legionnaires' disease have grown by nearly four and a half times since 2000. (From the National Notifiable Diseases Surveillance System (CDC) <https://www.cdc.gov>.)

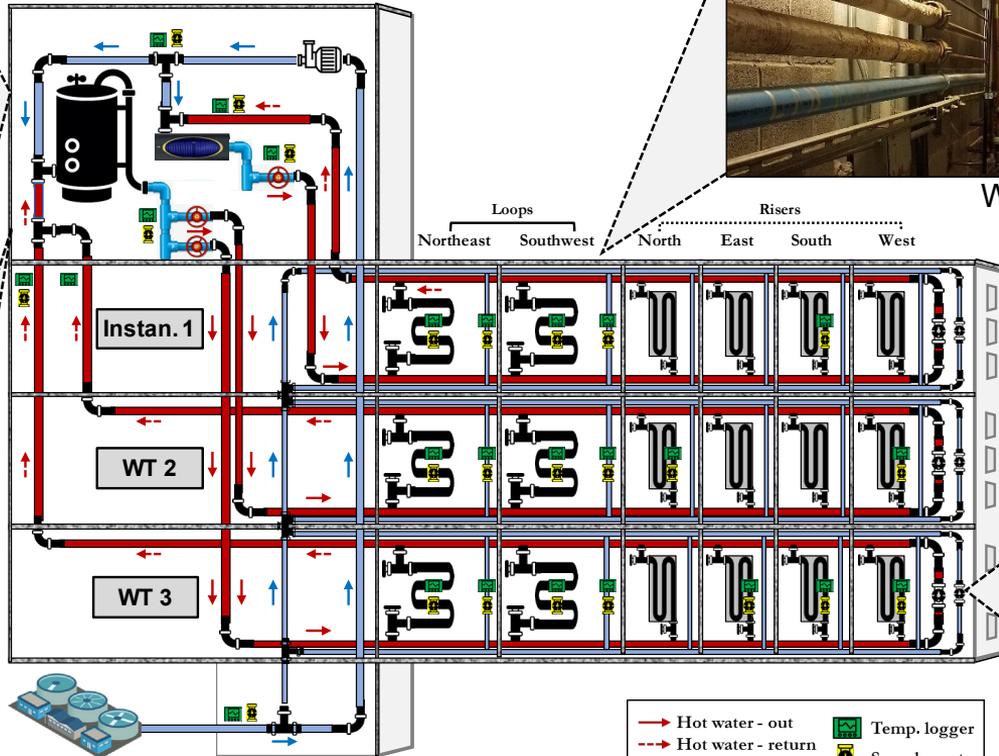
Premise Plumbing: sampling site



Water heater tank



Instantaneous
heater



Water main

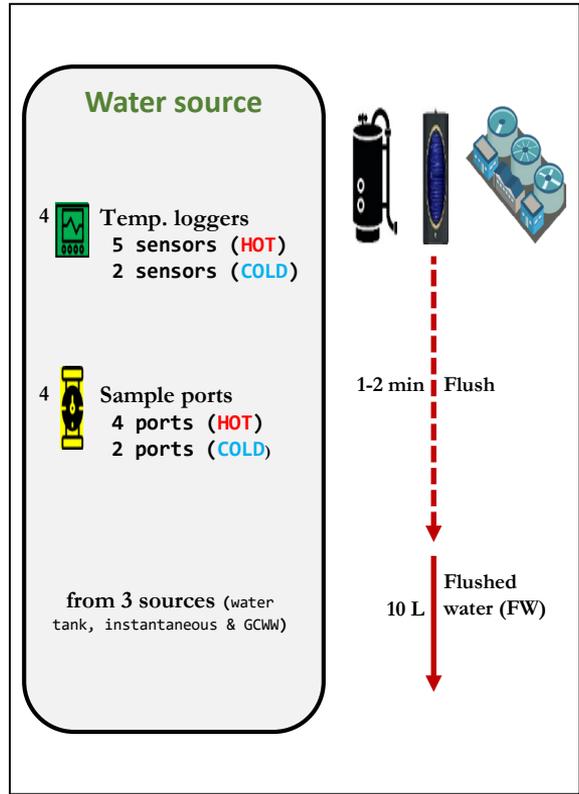
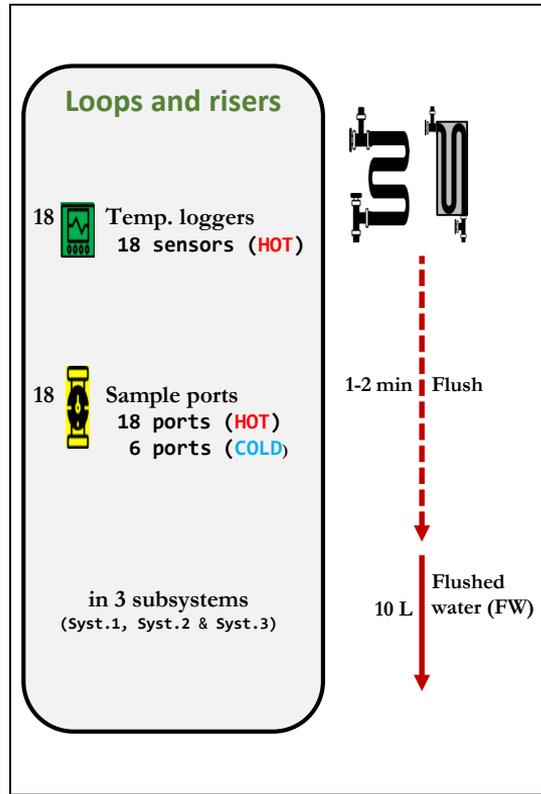
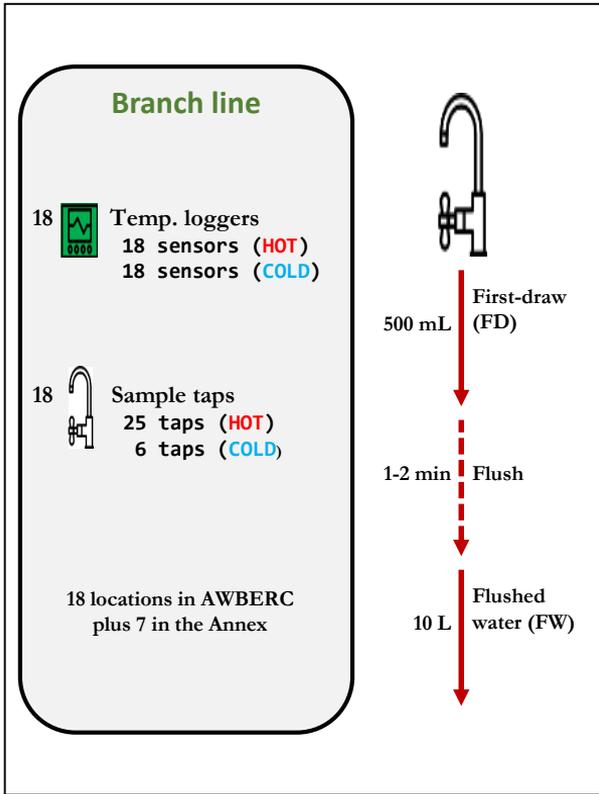


Water loops
and risers



Branch line

Premise Plumbing: methodology



L. pneumophila: characterization

Sample Collection

First Draw



Flushed

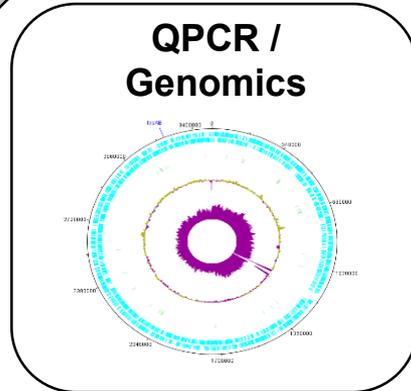


Culture methods

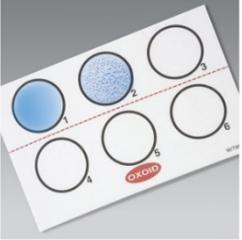
BCYE agar Plate



Legiolert

Agglutination



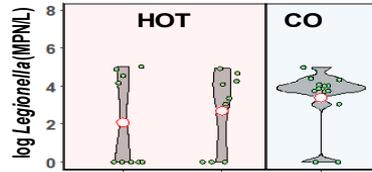
L. pneumophila
(Serogroup I)

Identification

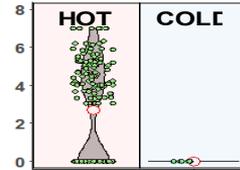
- ▲ Lp subsp. pneumophila str. Paris
- ▲ AW-BL01 HW A
- ▲ AW-BL03 HW A
- ▲ AW-BL05 HW A
- ▲ AW-BL09 HW A
- AW-LR13 HW B
- AW-LR35 HW B
- AW-LR39 HW B
- AW-WS17 CW A
- AW-WS18 HW B
- Lp subsp. pneumophila str. OLDA
- ▲ AW-BL02 HW A
- ▲ AW-BL04 HW A
- ▲ AW-BL08 HW A
- ▲ AW-LR11 HW B
- AW-WS22 HW B
- AW-LR36 HW B
- AW-LR42 HW B
- AW-WS17 CW B
- AW-WS20 HW B
- Lp subsp. pneumophila str. Flint 2
- Lp subsp. pneumophila str. Birmingham 1

Dominated by *L. pneumophila* subsp. pneumophila (Sequence Type I)

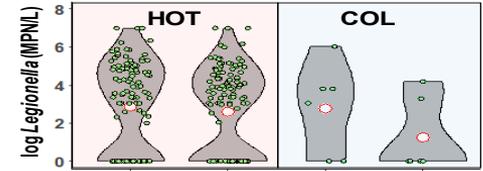
Microbial Communities: waterborne pathogens



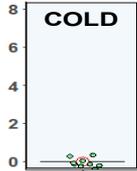
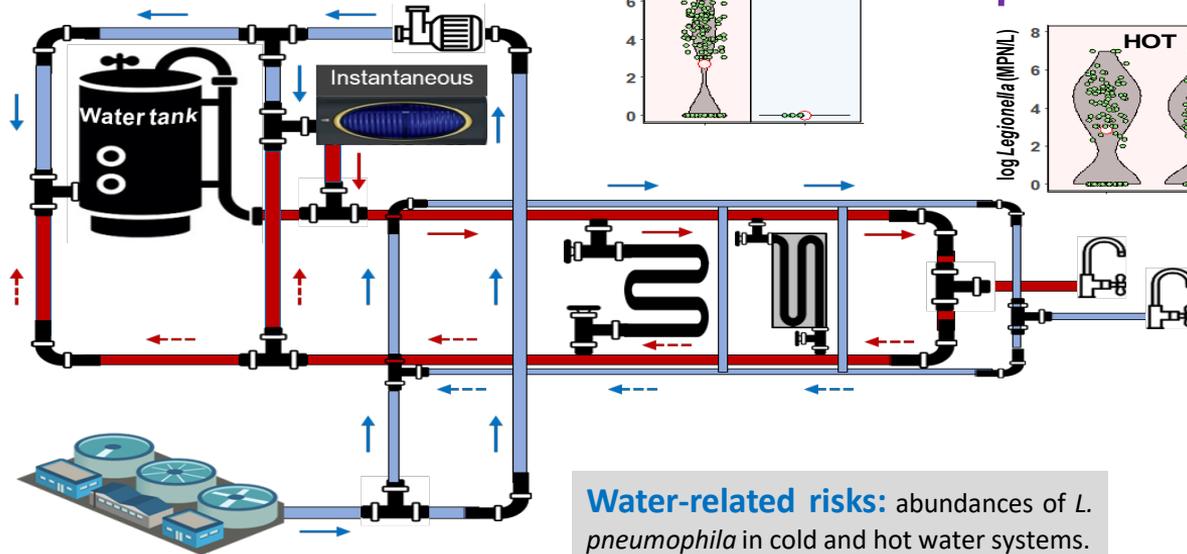
Recirculation Loops & Risers (LP/RS)



Branch line (BL)



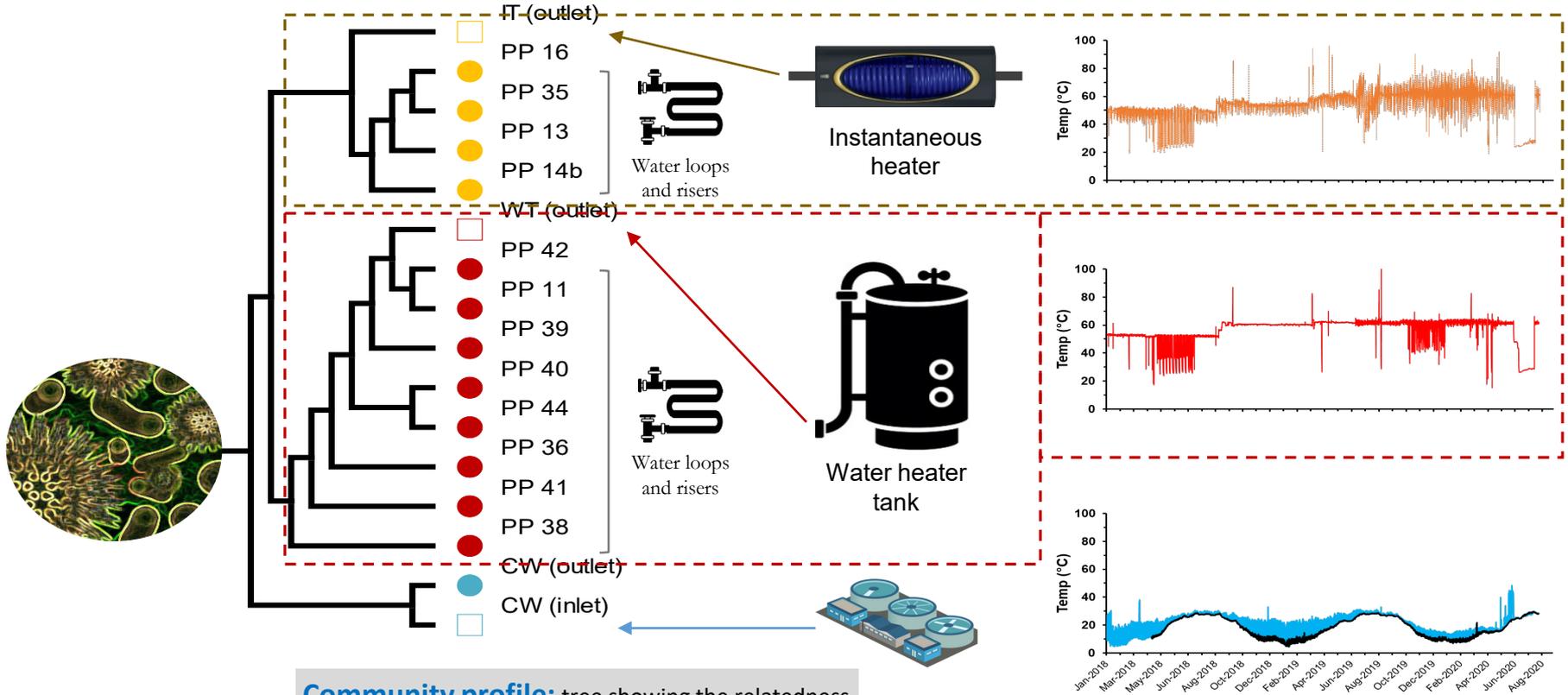
Hot & cold-water source (WS)



Water main (WM)

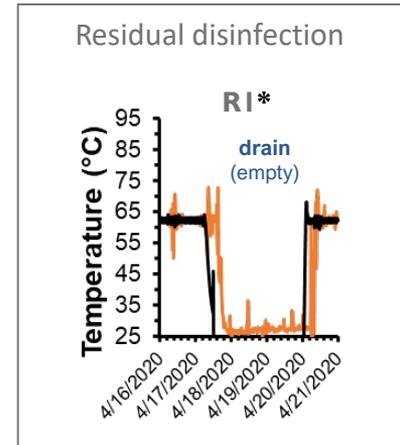
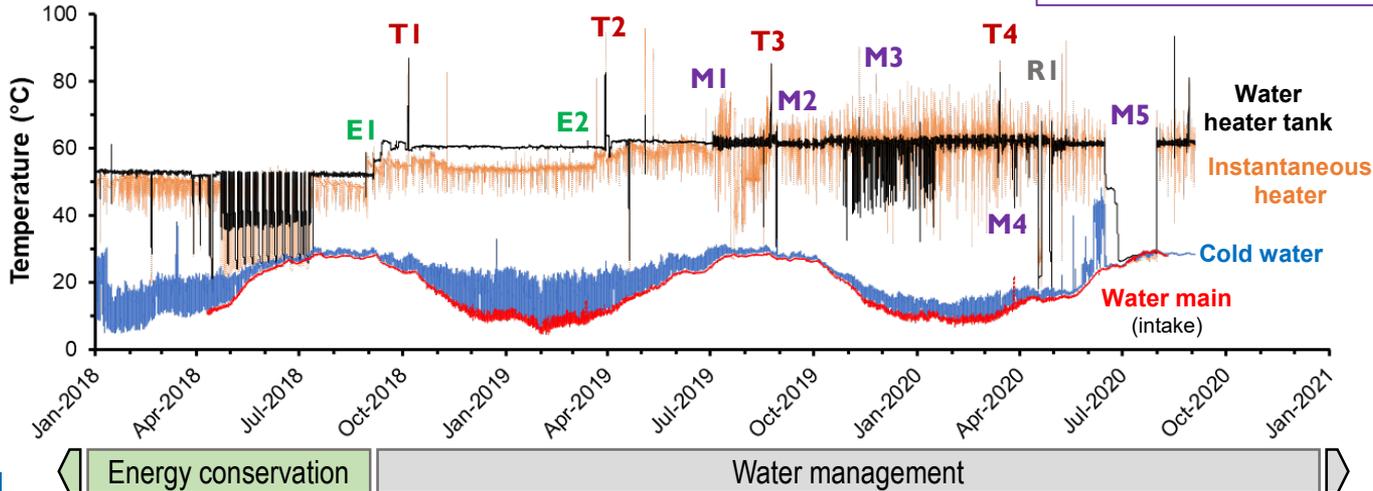
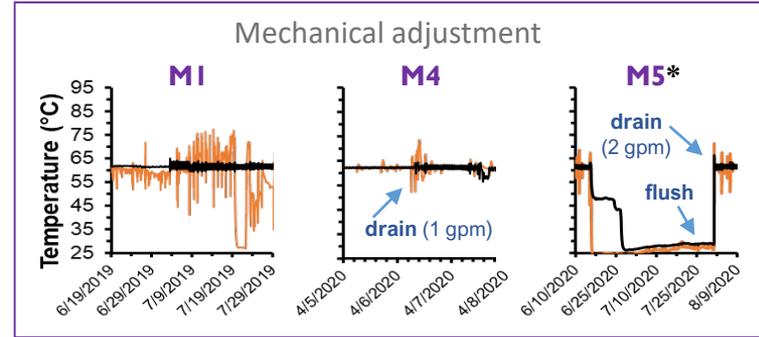
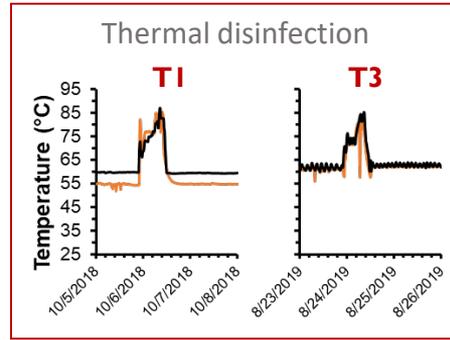
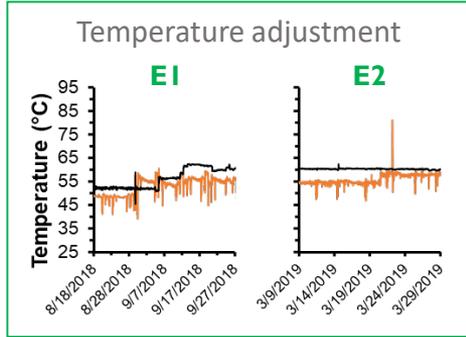
Water-related risks: abundances of *L. pneumophila* in cold and hot water systems.

Microbial Communities: diverse and resilient microbial community



Community profile: tree showing the relatedness to their corresponding water ecosystems.

Premise Plumbing: events and water management plan actions



*energy source is off

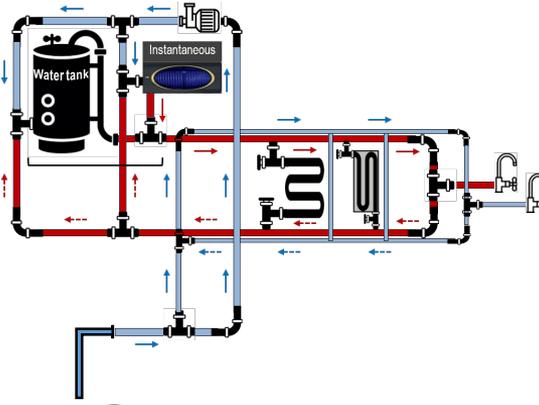
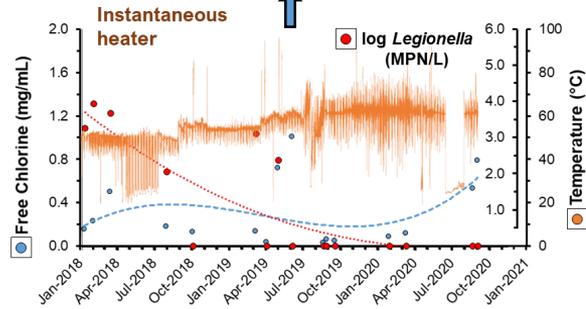
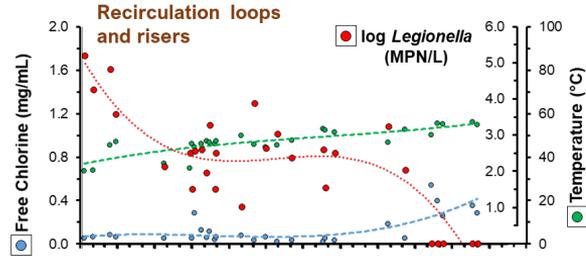
Energy conservation

Water management

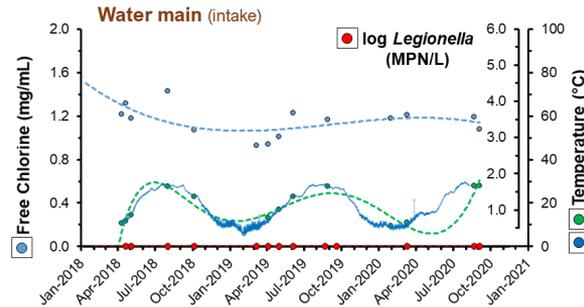
Premise Plumbing: water quality monitoring



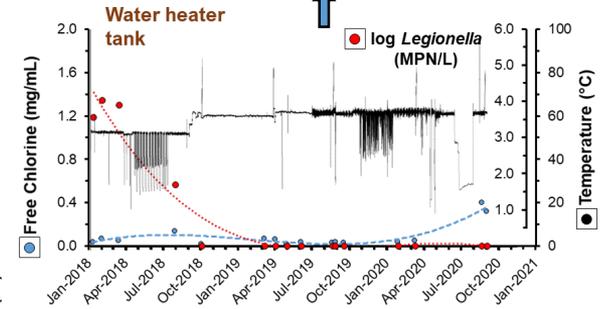
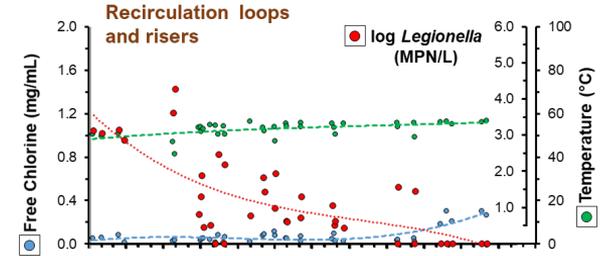
**Instantaneous
heater system**



**Municipal water
(chlorinated)**



**Water heater
tank system**





Progress for a Stronger Future

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