Some results and reflections:

Water quality during reduced occupancy due to COVID-19 and select intervention methods

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Thanks to NSF

Some of our efforts involved testing building water systems in response to the pandemic

11 buildings across 4 studies

All free chlorine disinfectant

3-5 months of low/no water use

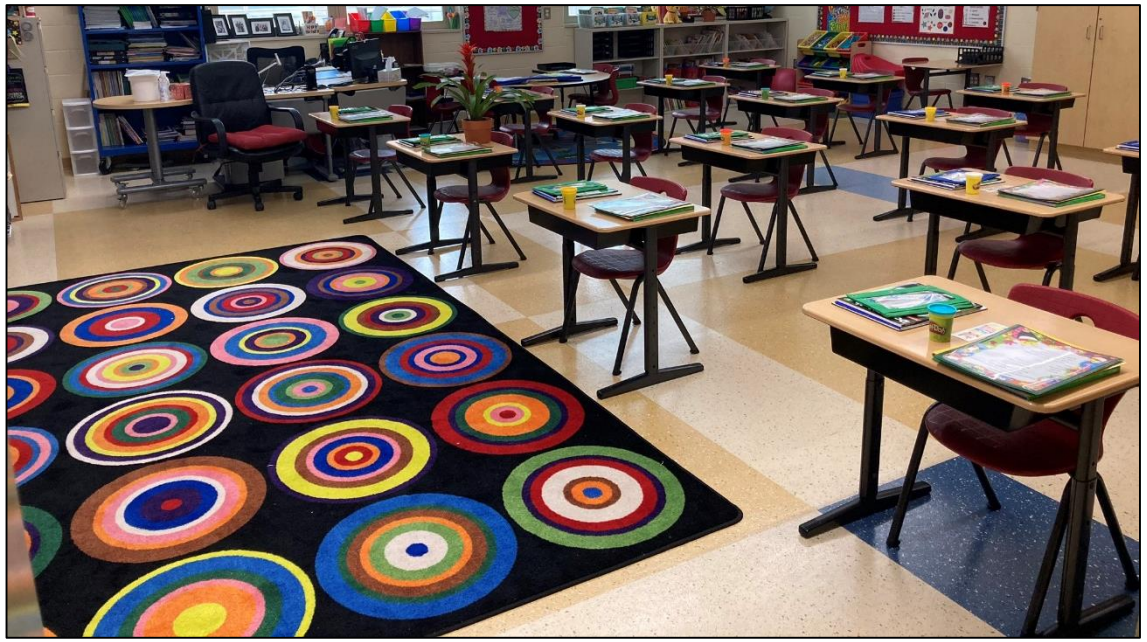
Some served by the same utility

Some have recirculation loops, in-building storage, showers

All had indoor copper pipe

Up to 400 water outlets/building

Not all had as-built drawings



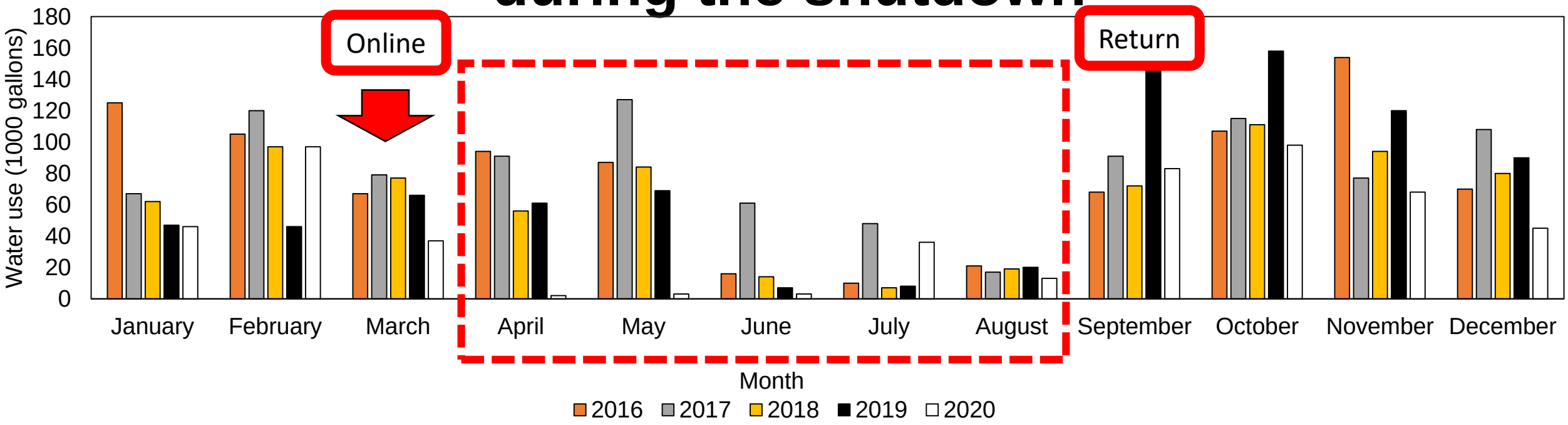
1. Elementary school, Indiana (Ra et al.)
2. Large residential building, Indiana (Angert et al., led by Proctor, Ph.D.)
3. Institutional buildings, Indiana (Ra et al.)
4. Elem/mid/high school, Ohio (Ley et al.)

In Ohio, a utility and an 8 year old LEED K-12 school reached out for assistance.

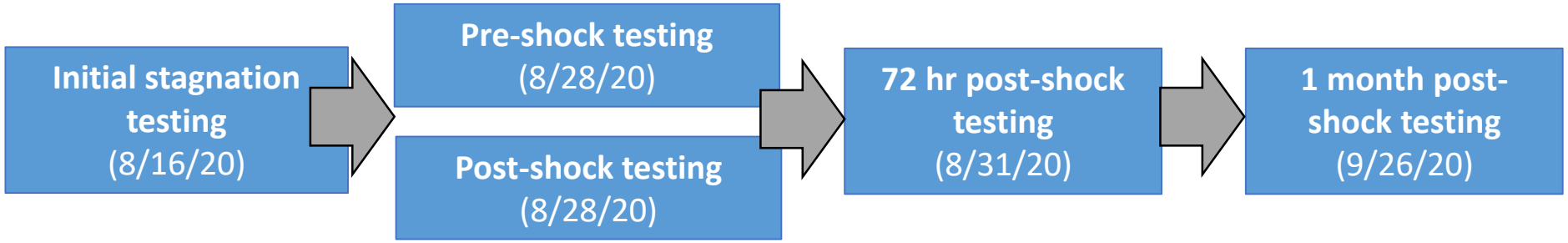
- Utilities across the U.S. saw increased residential demand (+43%) and reductions in commercial (-46%) and industrial (-21%) demands (Faust et al. 2021)
- 1 water utility found that after 6 months of low water use, free chlorine levels were not detectable after the school building had been flushed
- We setout to examine water quality in the 2 story building
  - No water management program or flushing plan
  - 220 sinks, 31 water fountains, 30 showers, and 1 hydrotherapy spa in the facility's athletic training room.
  - Water heating set at 140° F (60° C). 2 boilers with a 500 gallon hot water storage tank. No recirculation system.
  - Rainwater used for toilet flushing – NOT potable water –

Ley et al. (In preparation)

The school had a >95% reduction in water use during the shutdown



Approach



Ley et al. (In preparation)

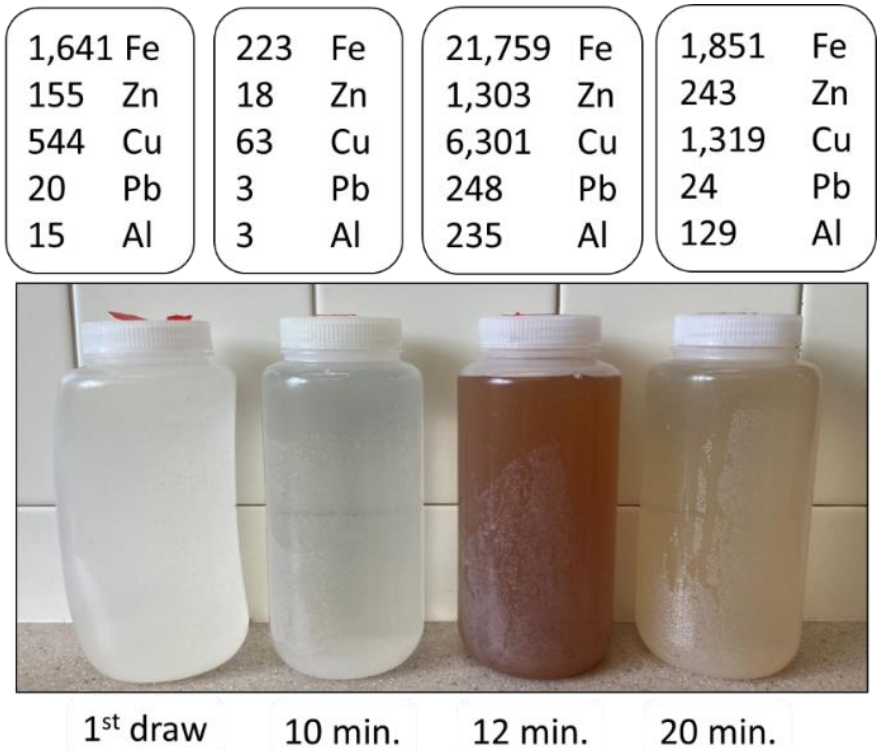
Metal levels were not consistent across the school, were impacted by flushing, and the 8 year old hot water system was excessively corroding

Some **Cu** levels exceeded the acute health-based limit of 1,300 µg/L, while others did not

Zn exceeded the USEPA health advisory level at 1 cafeteria soup filling station because of nonuse and stainless steel piping

Nonpotable fixtures used for potable purposes

Hot water system had excessive corrosion. Discolored water was observed



Ley et al. (In preparation)

Legionella was detected before and immediately after the shock disinfection + flushing intervention

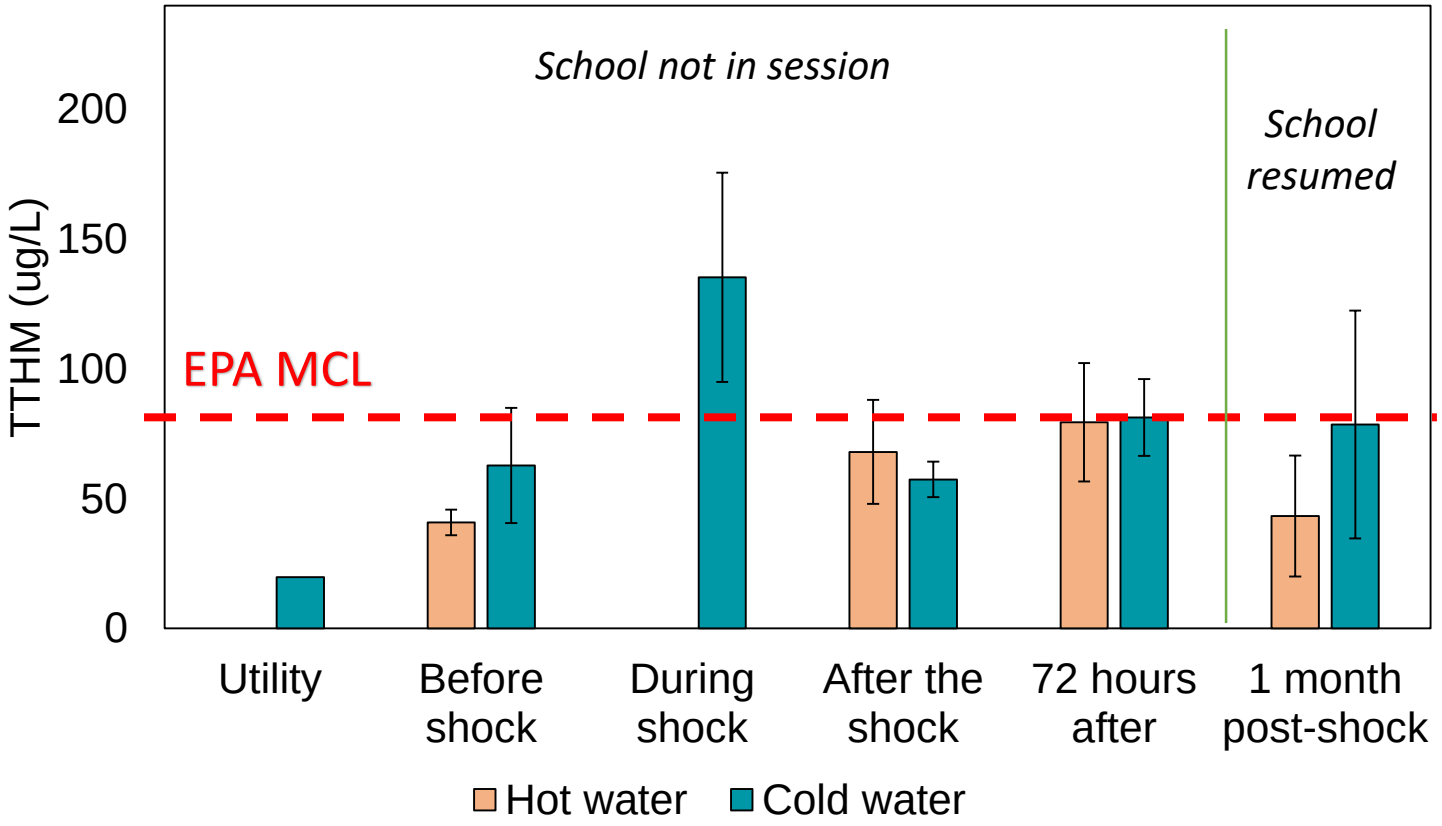
Sample type	Fixture type	*L. Pneumophila* conc., MPN/100 mL	Exceeded suggested *L. pneumophila* Limit, 106 CFU/mL
Initial stagnation	Water fountain	239.6	Yes
	Staff sink (cold)	1,289.6	Yes
	Cafeteria sink (cold)	3.5	No
	Cold faucet (distal end)	1	No
	Cold faucet (central)	1.1	No
Pre-shock chlorination	Various	0	No
Immediately after shock	Various	0	No
	Fountain	3.9	No
	Bathroom sink	7.9	No
72 hr post-shock	Various	0	-
1 mo. post-shock	Various	0	-

Stagnation:
5.3% (n=5 of 94 total) of sampled fixtures tested positive for *L. pneumophila*.

After shock:
L. pneumophila was detected in 2 fixtures (drinking water fountain, sink thermostatic mixed valve)

One month after shock:
L. pneumophila not detected 1 month after the shock disinfection

TTHM and copper levels were affected by the shock disinfection and flushing procedure



TTHM levels in plumbing >> water utility's distribution system

Highest TTHM levels: Shock chlorination (mean: 135.3 µg/L).

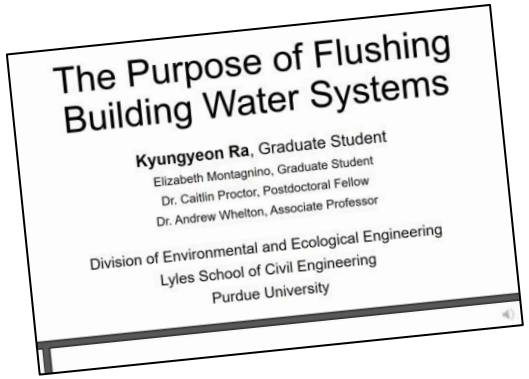
Highest number of exceedances: 72 hours after the shock + flushing, 7 / 15 samples

Some samples had copper levels exceed 1.3 mg/L post-shock, while lead was unaffected.

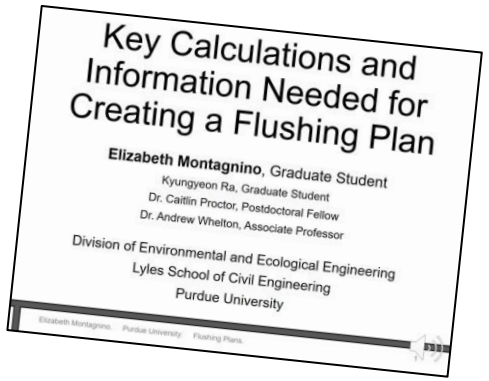
Hypochlorite shock disinfection levels varied 160-340 mg/L+

Ley et al. (In preparation)

An Indiana School: 3 buildings and a 3 month shutdown



YouTube



- Little to no chlorine found at stagnant fixtures
- Ni exceeded the health based limit in 3 month stagnant water before flushing, but other metals were okay. Cu did not exceed safe limits. Pb found at a maximum of 3.5 ug/L.
- *L. pneumophila* detected in all buildings, but not at all locations (1.1 to 188 MPN/100mL): bathroom sinks, class sinks, water fountains.
- After complete building flushing and 2 weeks later, the pathogen was not detected.

Ra et al. (In preparation)

The pandemic put a spotlight on plumbing safety...

health officials, industry, governments, institutions, and more responded.

To Address the Public Health Knowledge Gap

Building Water Essentials – Public Health

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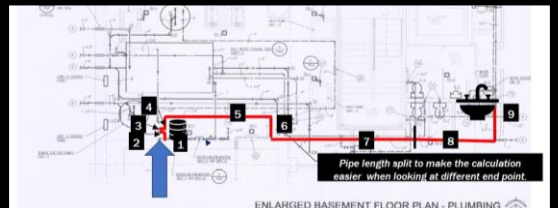
Input from practicing engineers, scientists, utilities and public health officials.

A training tool, an encyclopedia, and an extensive FAQ, designed to be immediately applicable in the field.

Modules do not have to be taken in sequence.



If interested e-mail EngrOnline@purdue.edu

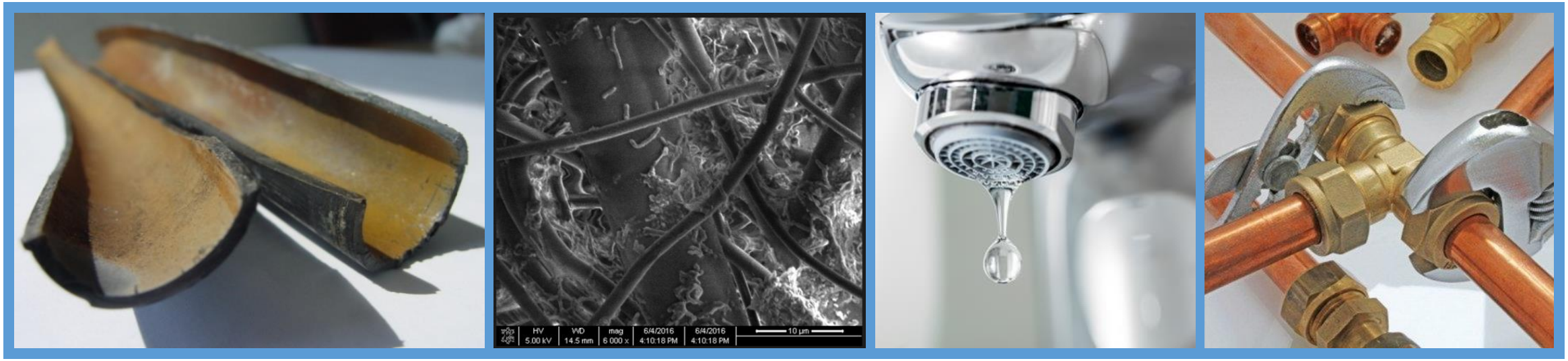
Info and registration: https://cutt.ly/Sg4RXJv

Plumbing Safety Decision Support Tool Coming Soon:

Right Sizing Tomorrow's Water Systems for Efficiency, Sustainability, and Public Health, 2016-2021

Supported by a grant from:

EPA



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Manhattan College

Michigan State University

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Tulane University

The University of Memphis

Thank you.

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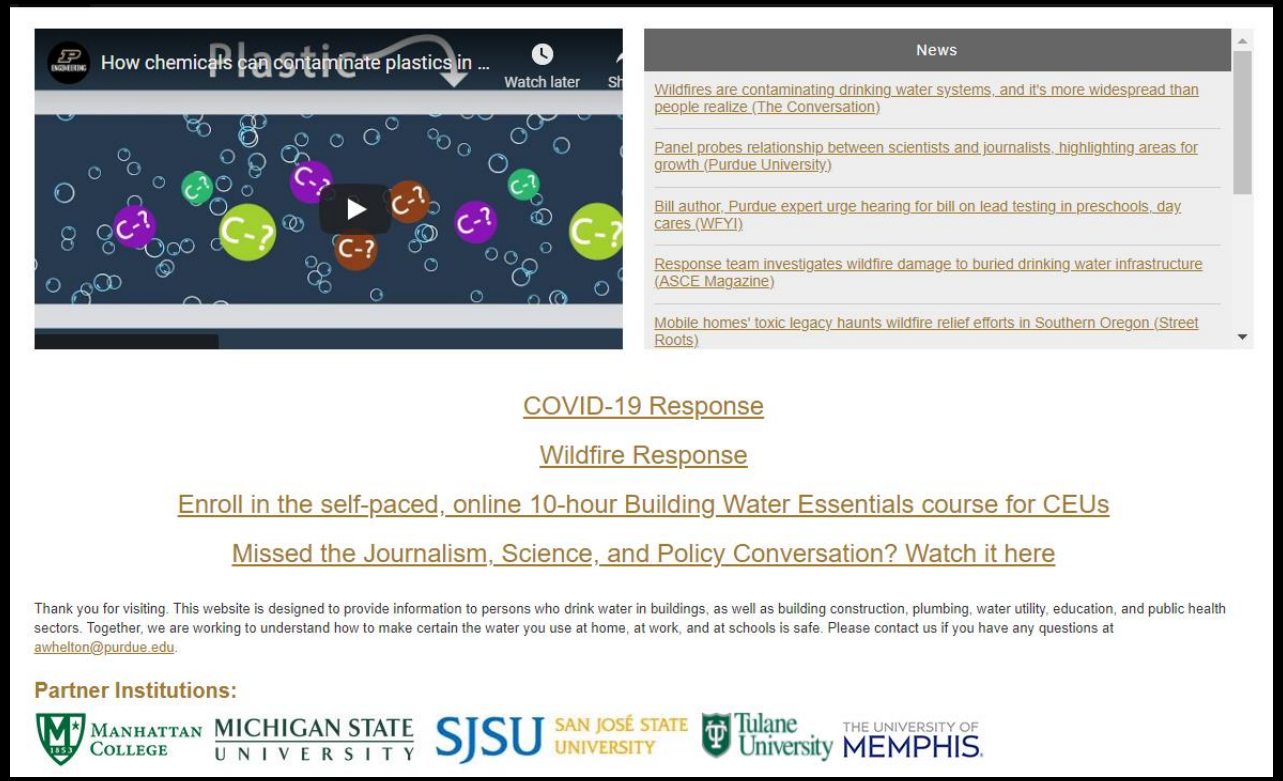

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