What's New?
COVID-19, Building Water Safety, and Fixing Pipes

Andrew J. Whelton, Ph.D.

Civil, Environmental, and Ecological Engineering

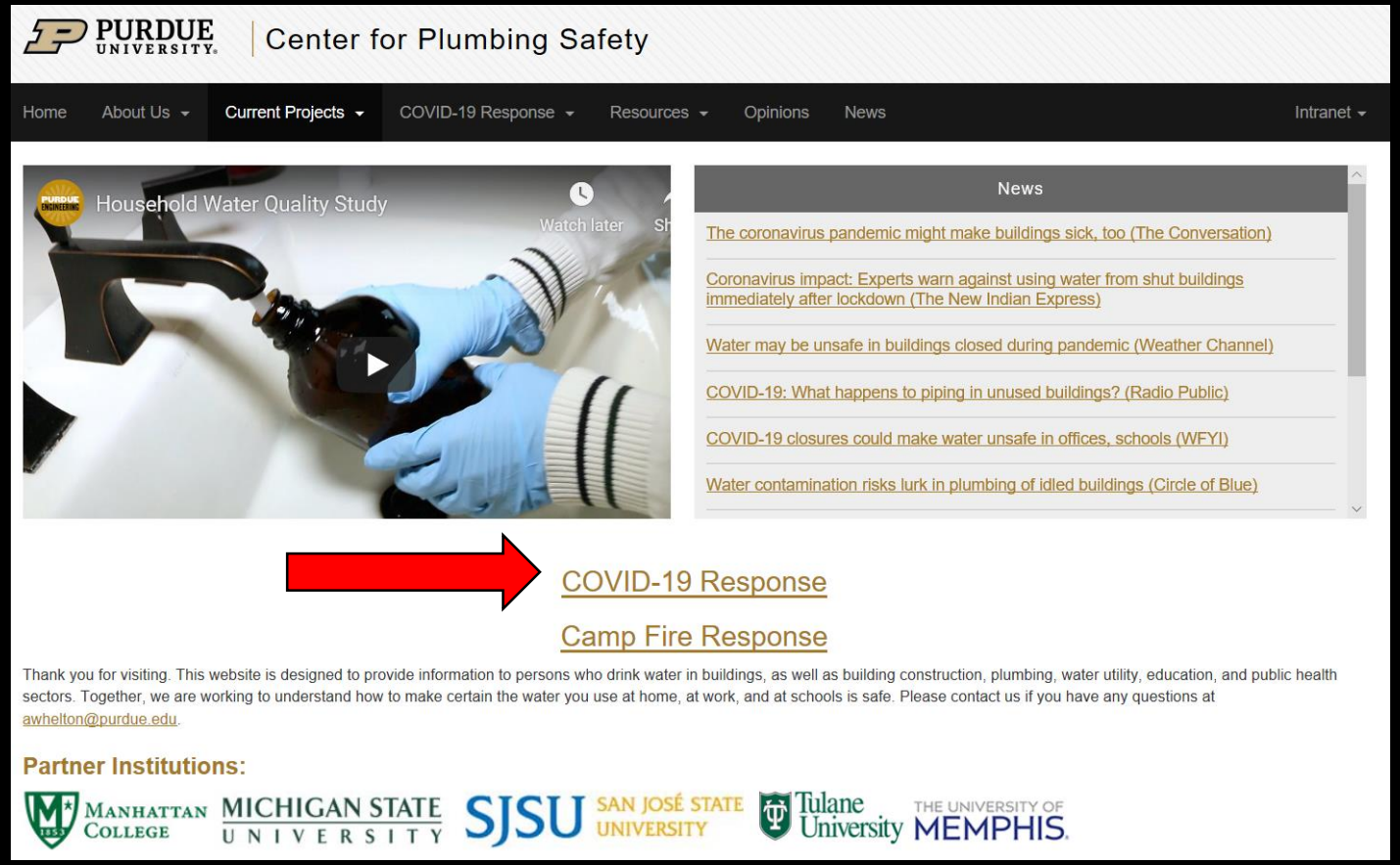
Onsite Education & YouTube Channel

Nearby Innovation Partner with Full-Scale Testing Facility

Plumbing Testing Facility at Purdue

Onsite Testing and Technical Support

More information here… www.PlumbingSafety.org



Access to world-class expertise, capabilities, and education in and outside Purdue

A Resource for All

- ✓ Plumbing news
- ✓ Plumbing education videos
- ✓ Plumbing explainers
- ✓ List of projects
- ✓ Scientific opinions
- ✓ Resources ➔ presentations
- ✓ Scientific reports
- ✓ External plumbing docs

Many thanks to Brad Caffery at Purdue University

COVID Specific Building Water Safety Support Resources

Restoring Water to Medical, Residential, and Commercial Buildings, Shutdowns, Unsafe Water

The COVID-19 pandemic has caused widespread building shutdowns, but also emergency restoration of water to previously closed medical facilities and homes. Several serious building drinking water safety risks exist. As people begin using the water again, they will encounter extremely stagnated water with excessive lead, copper, and bacterial concentrations, that may include harmful organisms like legionella that can cause disease outbreaks.

There are no national or industry guidelines for building reopening after extended shutdowns.

The U.S. National Science Foundation funded Purdue University researchers to rapidly address this serious public health concern. This rapid response effort involves partnerships with the American Society of Plumbing Engineers and International Association of Plumbing and Mechanical Officials and collaborations with other building water and public health experts from across North America.

[NSF government website description of this rapid response grant]

Questions

I am looking for...

- A list of your rapid response efforts in response to the COVID-19 outbreak
- Advice on what I should do as a public health official, building owner, or water utility
- Download a copy of the Experts Building Water Safety Study released April 7, 2020
- Guidance on how to create a building flushing plan
- Brief educational videos on building water safety topics

- ✓ Advice for building owners, health officials, utilities
- ✓ Building water safety education videos
- ✓ Guidance on how to create flushing plan
- ✓ Access to the Building Water Safety Study
- ✓ Guidance issued on building water safety

The coronavirus pandemic has prompted low to no water use in >5.6 millions buildings – in the U.S. alone

Commercial district

Street

Fire Hydrant

PROPERTY OWNER RESPONSIBILITY

Single vs. Multiple tenants

BUILDING PLUMBING

Water meter

Corporation Stop

Water Main (metal or plastic)

WATER UTILITY RESPONSIBILITY

Utility Service Line (metal or plastic)

Property Service Line (metal or plastic)

[sometimes other water sources]

Stagnation *noun*

stag·na·tion | \ stag-ˈnā-shən

a state or condition marked by lack of flow, movement

When water does not flow well; areas of stagnant water encourage biofilm growth and reduce temperature and level of disinfectant

U.S. National Science Foundation RAPID Award 2027049

Shutdowns and Consequences - Extreme Plumbing Stagnation and Recommissioning

1. Support to the plumbing and public health sectors on building water safety guidance and decisions, ***ongoing***
2. Building water safety review due to prolonged stagnation with experts from 7 private and public sector organizations, ***ongoing***
3. Field testing to determine how impacted building water safety is in actual large buildings, ***ongoing***
4. Lab testing to determine how to fully recover contaminated building water system devices and equipment, ***initiating***
5. Help transform public awareness, ***ongoing***

Helping

IAPMO

American Water Works Association

astho™

SLOAN

Whirlpool Corporation

NRDC

Washington State Department of Health

ASDWA

Ohio Environmental Protection Agency

ASPE American Society of Plumbing Engineers

NEHA Training

SAFE WATER ENGINEERING

Building water safety review due to prolonged stagnation with experts from 7 private and public sector organizations – FREE DOWNLOAD

Collaborative effort

Caitlin R. Proctor, Ph.D., Purdue University
William Rhoads, Ph.D., Virginia Tech
Tim Keane, Legionella Risk Management, Inc.
Maryam Salehi, Ph.D., University of Memphis
Kerry Hamilton, Ph.D., Arizona State University
Kelsey J. Pieper, Ph.D., Northeastern University
David R. Cwiertny, Ph.D., University of Iowa
Michele Prévost, Ph.D., Polytechnique Montreal
Andrew J. Whelton, Ph.D., Purdue University

AWWA WATER SCIENCE

Considerations for Large Building Water Quality after Extended Stagnation

https://doi.org/10.1002/aws2.1186

Evidence used as the basis of guidance recommendations.

PURDUE UNIVERSITY
VIRGINIA TECH
LEGIONELLA RISK MANAGEMENT
THE UNIVERSITY OF MEMPHIS
ASU Arizona State University
Northeastern University
THE UNIVERSITY OF IOWA
POLYTECHNIQUE MONTRÉAL

Water safety in commercial plumbing

Water source

Service line

Safety devices including valves

Water treatment devices

Water service and distribution piping and faucet connectors

Hot water heating, recirculation system

Fixture and fixture fittings

Pumps, tanks

Point-of-use devices

Table 1. Types of building plumbing components

Components	Description
Water source	Municipal water, onsite well, treated surface water, rainwater.
Service line	Pipe system that carries water from the source to the building water system. Service line materials are variable and may or may not be the same as indoor pipes.
Safety devices including valves	Pressure relief valve, pressure reduction value, isolation valve, mixing valve, thermostatic mixing valves, backflow prevention device, water hammer arrestors. Materials can include aluminum, brass, copper, lead, plastic, and stainless steel.
Water treatment devices	Filter, strainer, water softener, chemical addition equipment for disinfection and corrosion control.
Water service and distribution piping and faucet connectors	Various material types have been used to include acrylonitrile butadiene styrene (ABS), brass, cast iron (CI), chlorinated polyvinyl chloride (CPVC), copper, crosslinked polyethylene (PEX), ductile iron (DI), high density polyethylene (HDPE), lead, lead lined steel, multilayer pipes, polyethylene raised temperature (PERT), polypropylene (PP), unplasticized polyvinyl chloride (uPVC), polyvinylidene fluoride (PVDF), black steel, stainless steel.
Hot water recirculation system	Hot water is pumped through primary and secondary water heater loops, which serve different building zones to reduce delivery time of hot water. These have to be hydraulically balanced. Equipment includes master mixing valves, local mixing valves, flow balancing valves, pressure reducing valves,hot water return pumps and water heaters. Multiple temperature loops may exist. Operation of pumps may be intermittent in some systems.
Fixtures and fixture fittings	Aerator, air washers, atomizers, bathtub, bidet, decorative fountains, dishwasher, drinking fountain, eyewash stations, manual faucet, electronic faucet, faucet flow restrictors, hoses, point of use mixing valves, hot tubs, humidifiers, ice machines, misters, shower head, shower wand, sink, tub spout, toilet, urinal, washbasin
Pumps	Pumps are often used for pressure boosting within the building (i.e., for multi-story buildings) where water pressure entering the building is not adequate for water use at distal locations. Pumps are also used for hot water recirculation systems.
Tanks	Standard water heater, pressure tanks, on-demand water heater, hydropneumatic tanks, cold water supply storage tank. Water heaters can contain Mg or Al sacrificial anodes and plastic dip tubes.
Point-of-use devices	On-faucet treatment system, under sink treatment system.

https://doi.org/10.31219/osf.io/qvj3b

Food Prep Facility

Stagnation has impacted various buildings

Gyms
Salons
Offices
Restaurants
Retail
Daycares
Schools
Government Buildings
Colleges & Universities
Hotels & Motels
Sports & Entertainment Venues
Casinos
and more…

Domestic Hot Water

Industrial Facility

Cartridge Filters

Courtesy of: Gordon & Rosenblatt, LLC

Bathrooms

Water fountains

Food preparation areas

Point-of-entry devices

Point-of-use devices

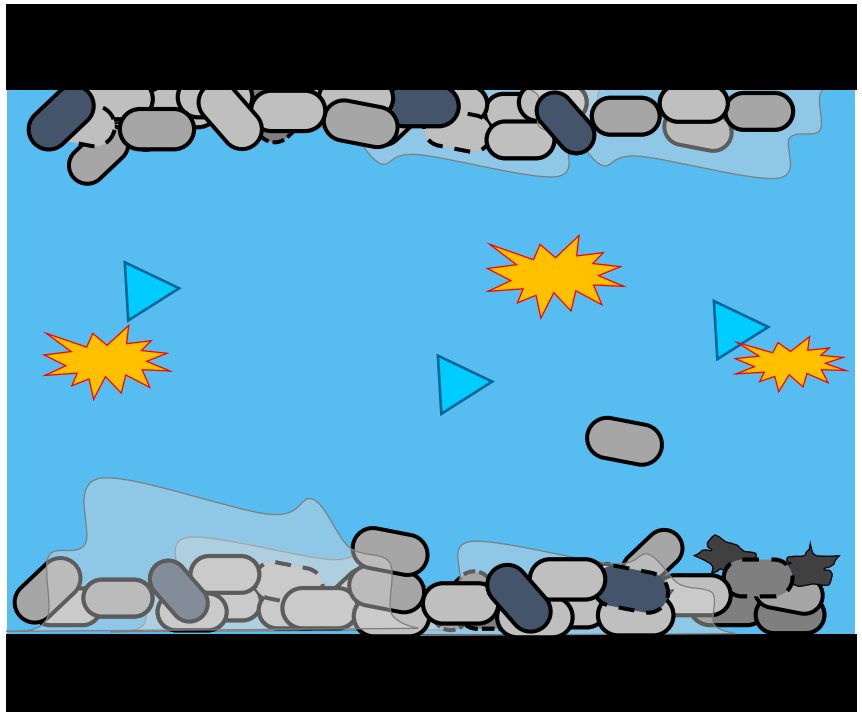
Breakrooms

Point-of-use devices

Stagnation causes water to get older

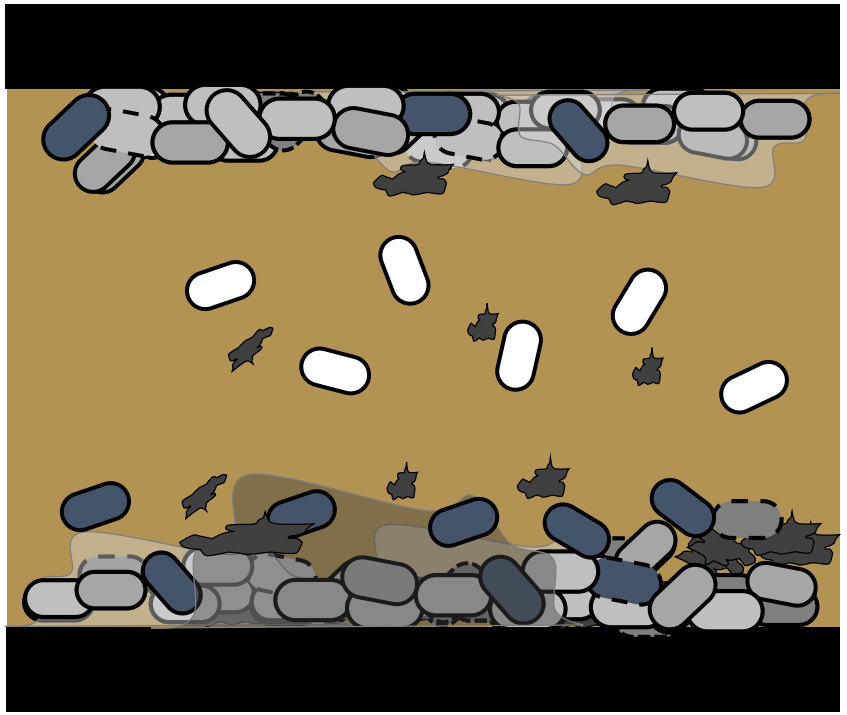
Normal water use refreshes:

- disinfectant residual &
- corrosion control



Old water (not refreshed):

- bacterial growth &
- corrosion not controlled



Disinfectant in water – used to reduce microbial growth in water, typically chlorine

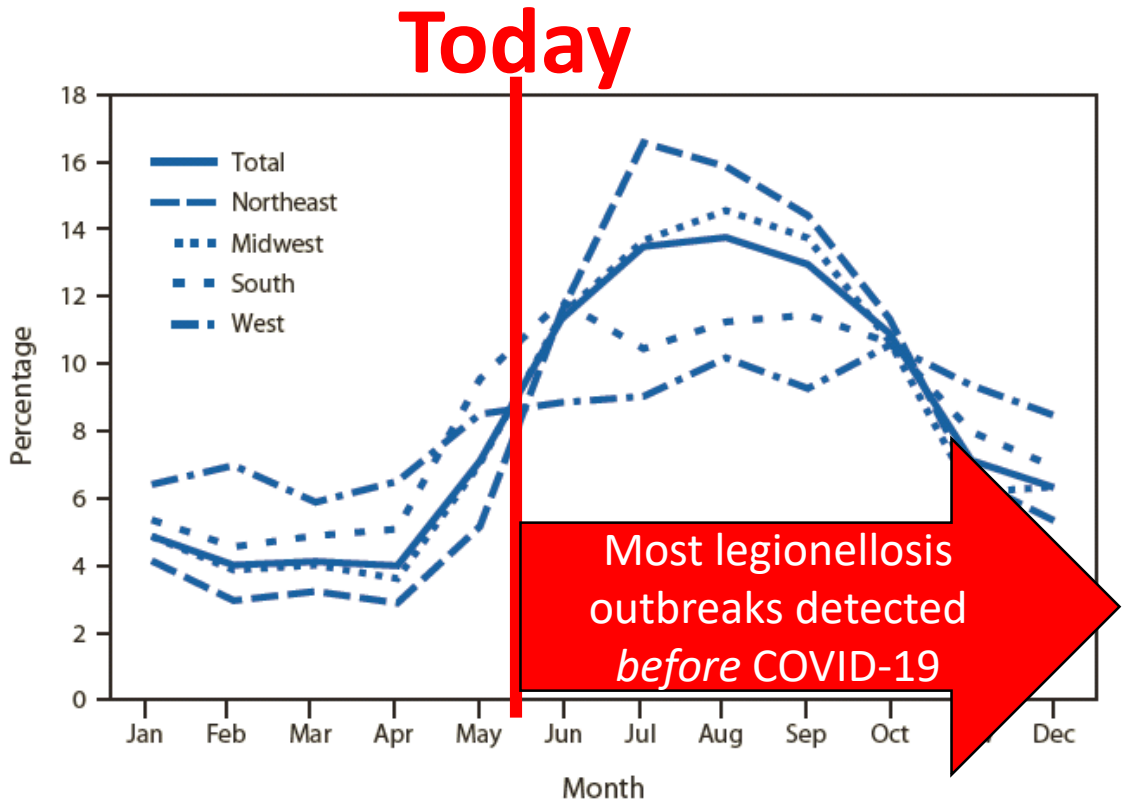
Corrosion control – used to reduce metals leaching, stabilizes pH and may add chemicals

Slide from our YouTube Videos

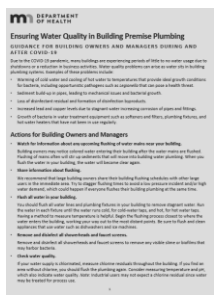
Prior to the pandemic, stagnation posed health **risks**

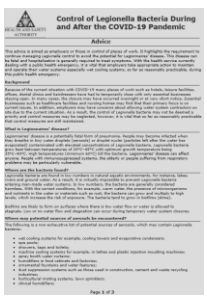
The time scale of concern can sometimes be just a few days

- **Copper** can leach
  - Nausea, vomiting, diarrhea, abdominal cramps
- **Lead** can leach
  - Nausea, vomiting, diarrhea, abdominal cramps, longer-term developmental issues with children
- **Scale** can be suspended
- **Harmful organisms** (e.g., *Legionella pneumophila* and other opportunistic pathogens) can grow - better
  - Many organisms cause respiratory illness, and other infections can occur



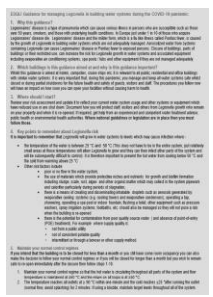
Exposure Routes of Concern: Ingestion, Dermal, Inhalation


Ensuring Water Quality in Building Premise Plumbing


Control of Legionella Bacteria During and After the COVID-19 Pandemic

Advice

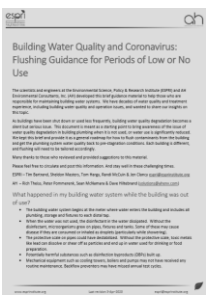

COVID-19 Guidance for Legionella and Building Water System Closures

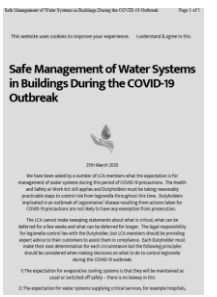

Public Health England

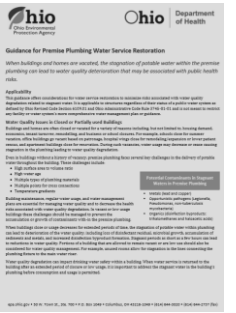

Canada

Public Services and Procurement Canada (PSPC)

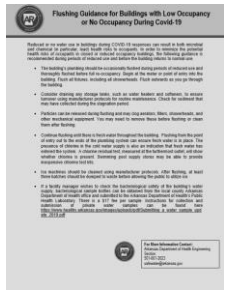
Building Water Systems Minimum Requirements – (COVID-19)

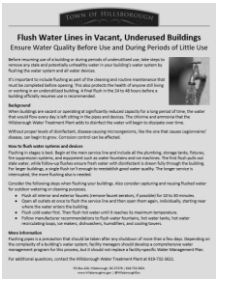

Building Water Quality and Coronavirus: Flushing Guidance for Periods of Low or No Use


Safe Management of Water Systems in Buildings During the COVID-19 Outbreak

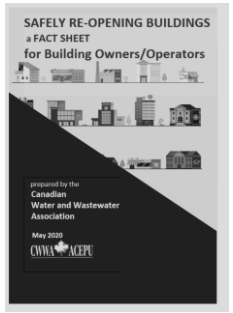

Ohio Department of Health

Guidance for Premise Plumbing Water Service Restoration


Flushing Guidance for Buildings with Low Occupancy or No Occupancy During Covid-19


Flush Water Lines in Vacant, Underused Buildings

Ensure Water Quality Before Use and During Periods of Little Use


SAFELY RE-OPENING BUILDINGS

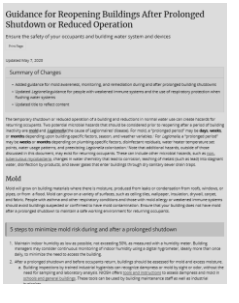
a FACT SHEET

for Building Owners/Operators

prepared by the Canadian Water and Wastewater Association

May 2020

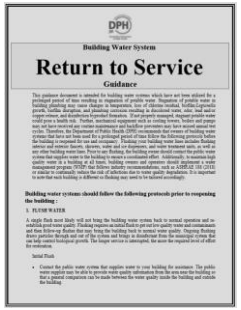
CWWA ACEPU


Guidance for Reopening Buildings After Prolonged Shutdown or Reduced Operation

Summary of Changes

5 steps to minimize mold risk during and after a prolonged shutdown

Mold

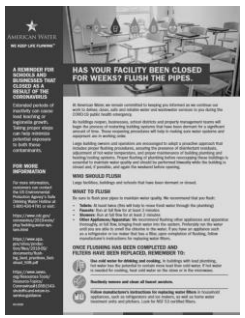

Building Water System

Return to Service

Guidance

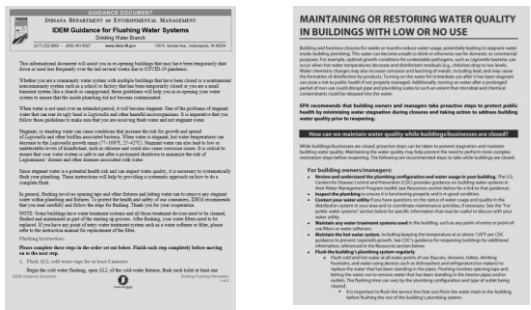

BUILDING PERFORMANCE

ENSURING THE SAFETY OF YOUR BUILDING WATER SYSTEM POST COVID 19 LOCKDOWN


HAS YOUR FACILITY BEEN CLOSED FOR WEEKS? FLUSH THE PIPES.


Public Health

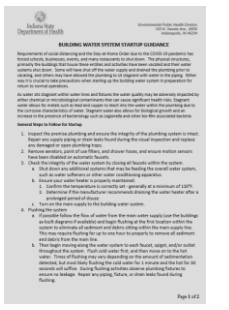
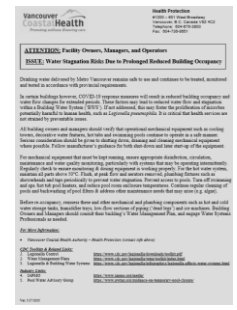
Water Quality and Your Business: Tips for Re-opening After Closure


INDIANA DEPARTMENT OF ENVIRONMENTAL MANAGEMENT

IDEM Guidance for Flushing Water Systems

Drinking Water Branch

MAINTAINING OR RESTORING WATER QUALITY IN BUILDINGS WITH LOW OR NO USE



Vancouver Coastal Health

BUILDING WATER SYSTEM STARTUP GUIDANCE

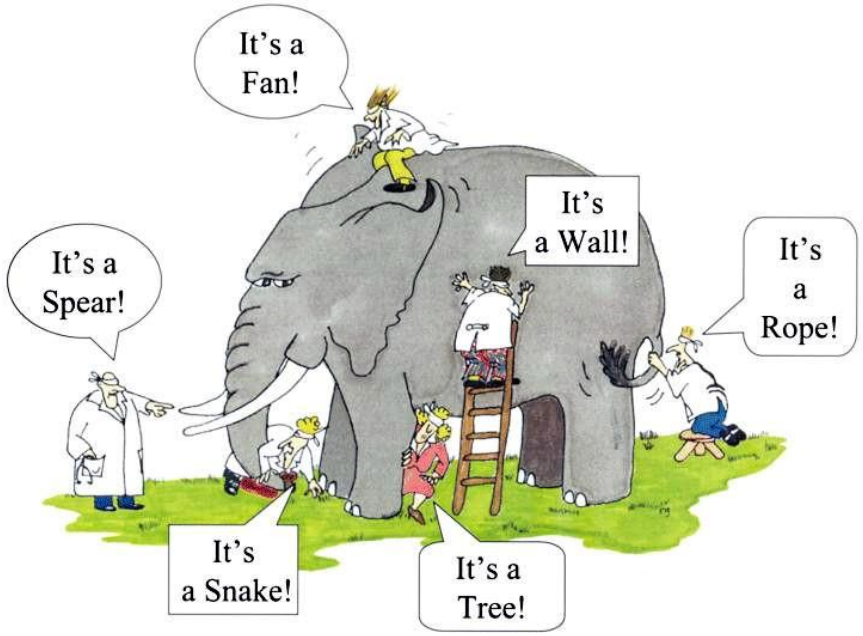

OKLAHOMA DEPARTMENT OF ENVIRONMENTAL QUALITY

Water Quality Recommendations for Opening Closed or Less Frequently Used Buildings

Since March 2020, there have been more than ***45+*** guidance documents telling building owners what they could do to prevent and deal with stagnation situations.

Many differ quite dramatically. Some lack key info (safety, devices, sensitive population, etc.).

Why are they so different?

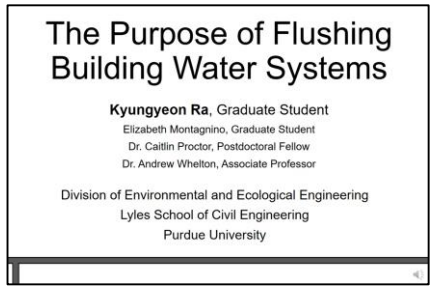


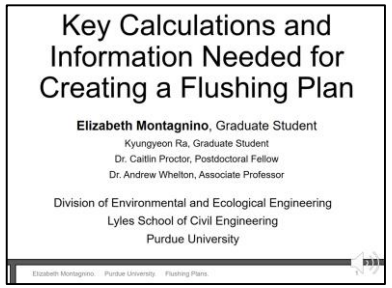
- Different perspectives - *sides of the elephant*
- Different starting information about water safety or plumbing
- Guidance targeted for different readers
- Deliberate step-by-step documents vs. general advice
- Some are derivatives of others, & others… & others!
- Some have been revised (version 3 since March 2020)
- Media, water utilities, & associations making even brief(er) messages

How could we *prevent* water quality problems?

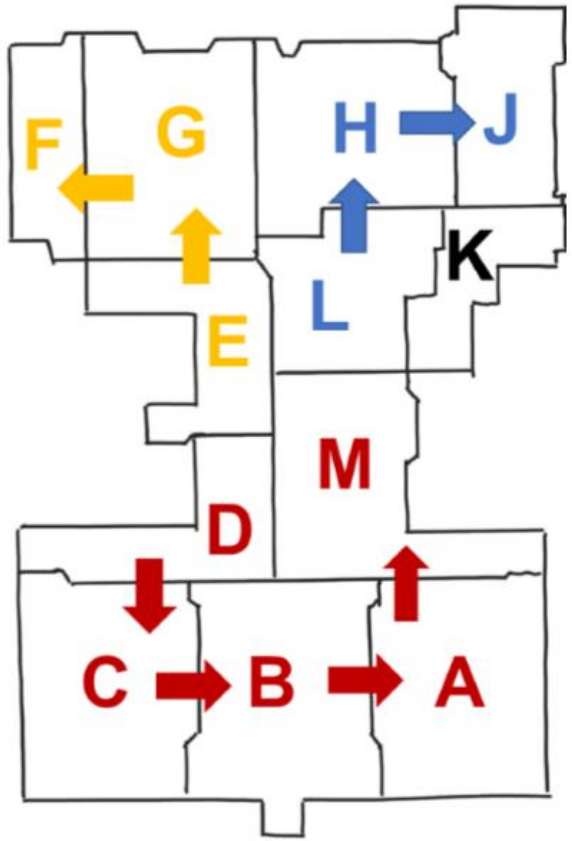
Keep the water moving! ≠ stagnation

- Source water must be fresh (utility, onsite well, Source may need to flush!)
- Clean devices and equipment
- Flushing – Keep water fresh, start at entry
- Water heater and recirculation loops – Keep hot water hot, Keep cold water cold
- Document, document, document





Flushing Plans



What actions can be taken to *deal with* water quality deterioration?

- Recommissioning plumbing
  - System integrity checks
  - Flushing (and cleaning)
  - Shock disinfection
  - Testing
- Professional help might be needed
  - Address complex mechanical and treatment equipment
  - Develop effective flushing plans
  - Perform shock disinfection safely (thermal or chemical)
  - Perform accurate testing

Centers for Disease Control and Prevention
CDC 24/7: Saving Lives, Protecting People™

Search

EMERGING INFECTIOUS DISEASES®

EID Journal > Volume 26 > Early Release > Main Article

Volume 26, Number 7—July 2020

Dispatch

Legionella

Transmission of Legionnaires' Disease through Toilet Flushing

Jeanne Couturier✉, Christophe Ginevra, Didier Nesa, Marine Adam, Cyril Gouot, Ghislaine Descours, Christine Campèse, Giorgia Battipaglia, Eolia Brissot, Laetitia Beraud, Anne-Gaëlle Ranc, Sophie Jarraud, and Frédéric Barbut

Author affiliations: Hôpital Saint-Antoine, Paris, France (J. Couturier, D. Nesa, M. Adam, C. Gouot, G. Battipaglia, E. Brissot, F. Barbut); Faculté de Pharmacie de Paris, Université de Paris, France (J. Couturier, F. Barbut); Centre National de Référence des Légionelles, Lyon, France (C. Ginevra, G. Descours, L. Beraud, A.-G. Ranc, S. Jarraud); Université Claude Bernard Lyon 1, Villeurbanne, France (C. Ginevra, G. Descours, L. Beraud, A.-G. Ranc, S. Jarraud); Santé Publique France, Saint-Maurice, France (C. Campèse); Sorbonne Université, Paris, France (E. Brissot)

Suggested citation for this article

Flushing and More Intensive System Cleaning Could Make People Sick

Engineering Controls

- Fill sink and floor drains traps with water
- Maintain pressure when flushing
- During flushing (especially initial), many methods to reduce exposure: Cover toilets, showerheads, faucets, reduce splashing, use hoses
- Flooding, cross-connections, dealing with waste

Administrative and Work Practice Controls

- Temporarily forbidding use of high-risk exposure items (showers, hot tubs, decorative fountains)
- Temporarily closing facilities to concentrate use

Personal Protective Equipment (PPE)

- Protect against scalding
- Protect against chemical exposure
- OSHA and other agencies recommend respirators *if* Legionella is *suspected or possible*

OSHA

N95 respirators, but recommends voluntary use of N100 "if *Legionella* contamination is possible"

AIHA
Protecting Worker Health

P100 HEPA filter respirators when sampling building water and *Legionella* may be present

COMING SOON: Online Short-Course

"Building Water Systems"



Instructors:

Prof. Andrew Whelton, Dr. Caitlin Proctor, Civil, Environmental , Ecological, Biomedical, Materials Engineering Depts.

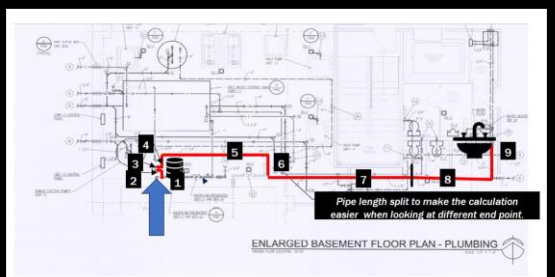
Building water systems are sitting at low to no occupancy across the globe due to the COVID-19 pandemic. Stagnant water in them can pose significant human health risks due to chemical and microorganism accumulation and exposure. Professionals will be introduced to engineering and science principles underlying building water systems, issues associated with system maintenance, and strategies for investigating and responding to issues.

PURDUE UNIVERSITY

The learning objectives are to:

1. Describe the chemical and microbiological contaminants common to building water systems for stagnant and flowing water,
2. Explain the factors that control contaminant accumulation in building water systems,
3. Recognize water testing methods and limitations,
4. Identify remediation practices for reducing contaminated water from the systems, and
5. Recognize how to create and test building water system flushing plans,
6. Develop strategies to avoid and remediate water quality problems, using real-building examples, as-built drawings, and other resources.
7. Recognize where to find additional resources.



If interested, email awhelton@purdue.edu.

Pre-requisites: Be at a health department, regulatory agency, or utility.

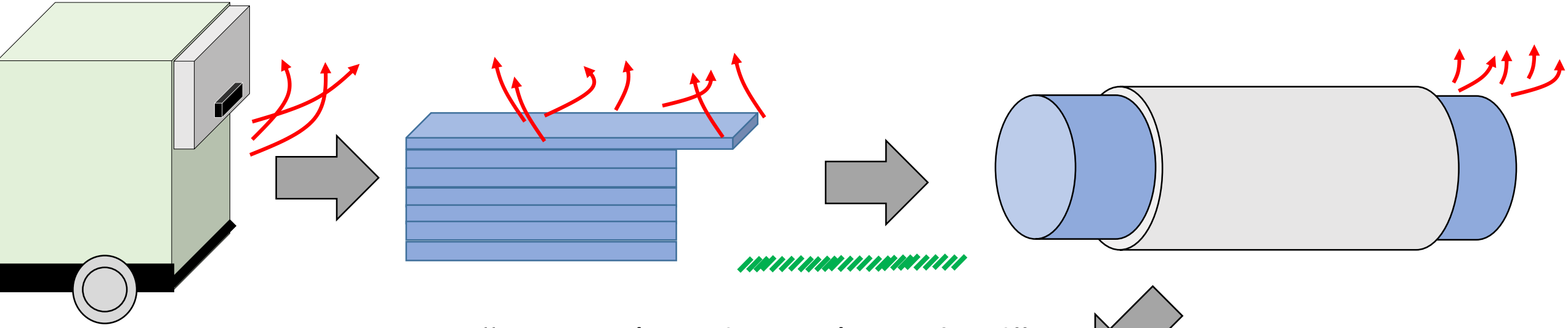
Cured-in-Place-Pipe (CIPP) for sanitary sewer, storm sewer, and potable water pipe repairs

PURDUE UNIVERSITY

Uncured **RESIN** tube delivered on a truck

Uncured **RESIN** tube inserted into damaged pipe (raw chemicals)

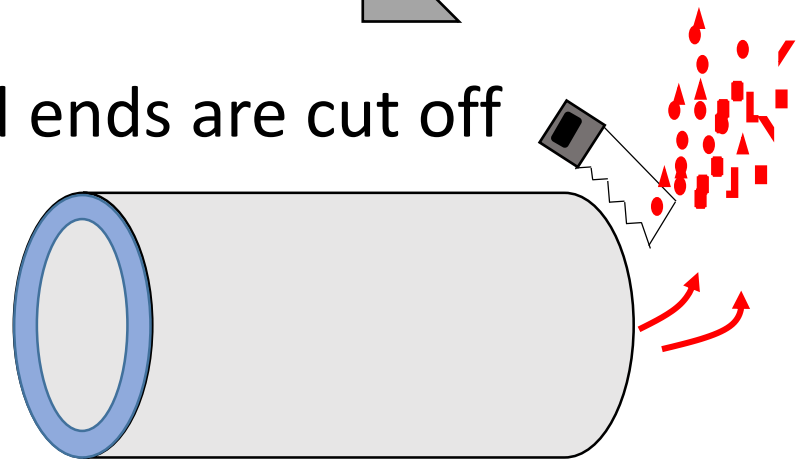
Uncured **RESIN** tube inflated with air inside host pipe



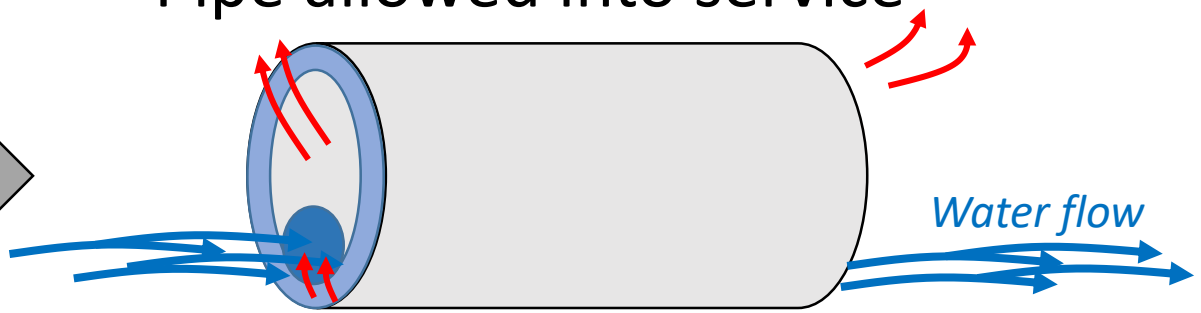
"Curing (Hardening) Method"

Hot Water or Steam or UV Light

Hard ends are cut off



Pipe allowed into service



PURDUE UNIVERSITY

What is Waste? Merriam-Webster Dictionary

waste *noun*

Save Word

\ ˈwāst \

4 **a** : damaged, defective, or superfluous material produced by a manufacturing process: such as

(1) : material rejected during a textile manufacturing process and used usually for wiping away dirt and oil

// cotton *waste*

(2) : SCRAP

(3) : an unwanted by-product of a manufacturing process, chemical laboratory, or nuclear reactor

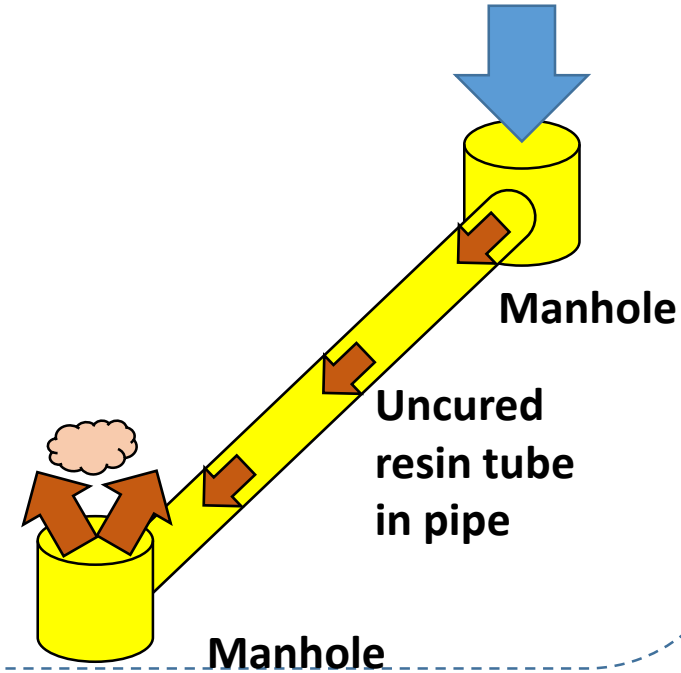
// toxic *waste*

// hazardous *waste*

// nuclear *waste*

www.dictionary.com

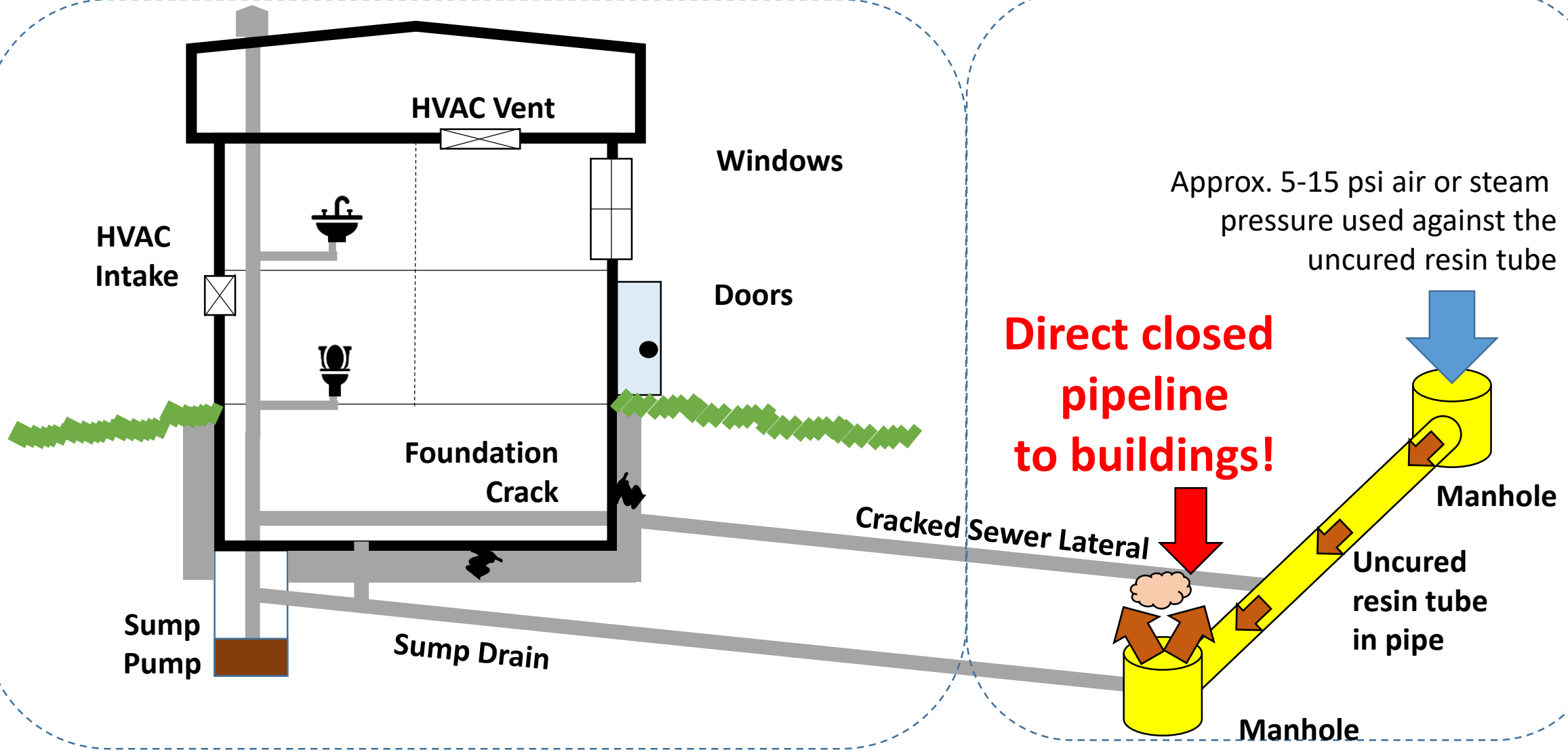
Utility/City Property
(Worksite only for contractors)



At the street….

Private Property
(NOT for contractors)

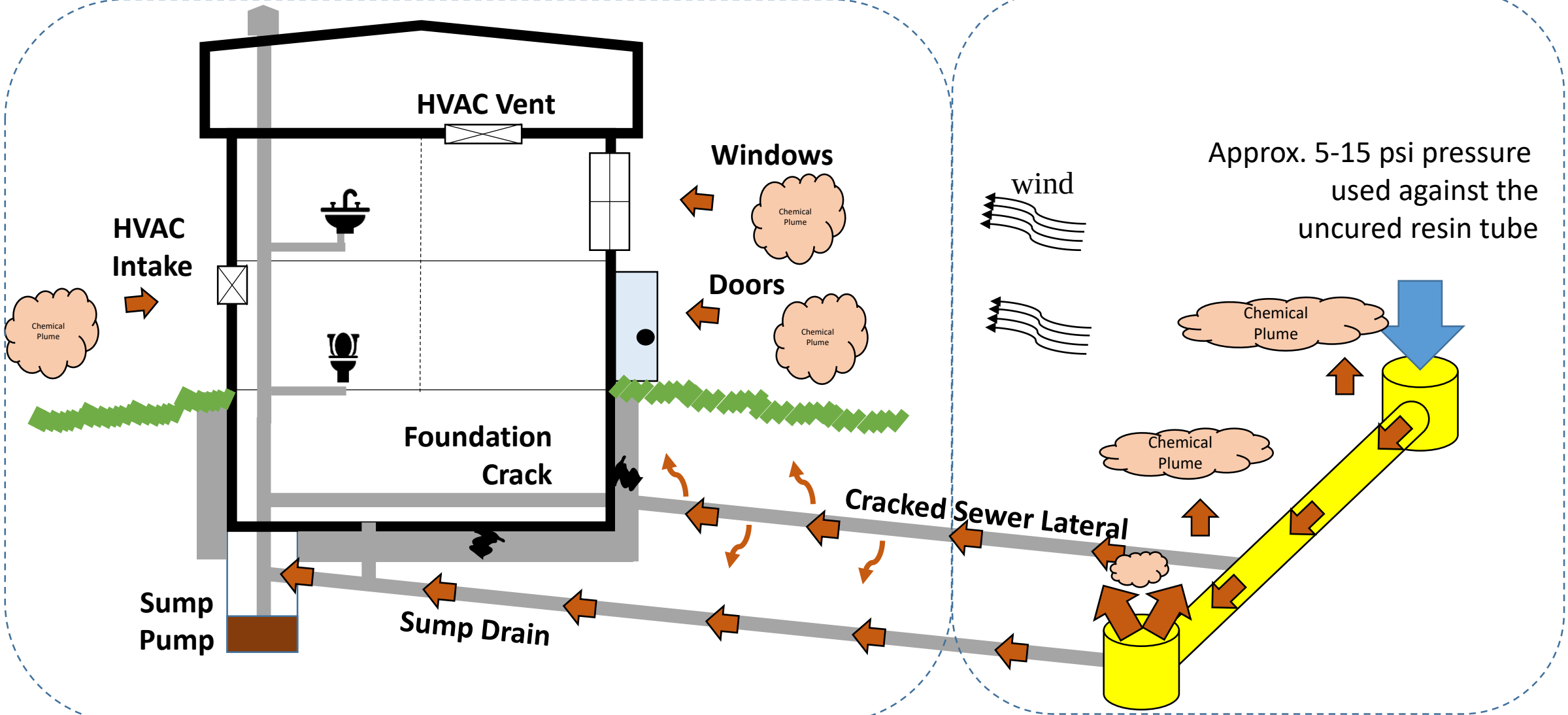
Utility/City Property
(Worksite only for contractors)



While Contractors work at the street….

Private Property (NOT for contractors)

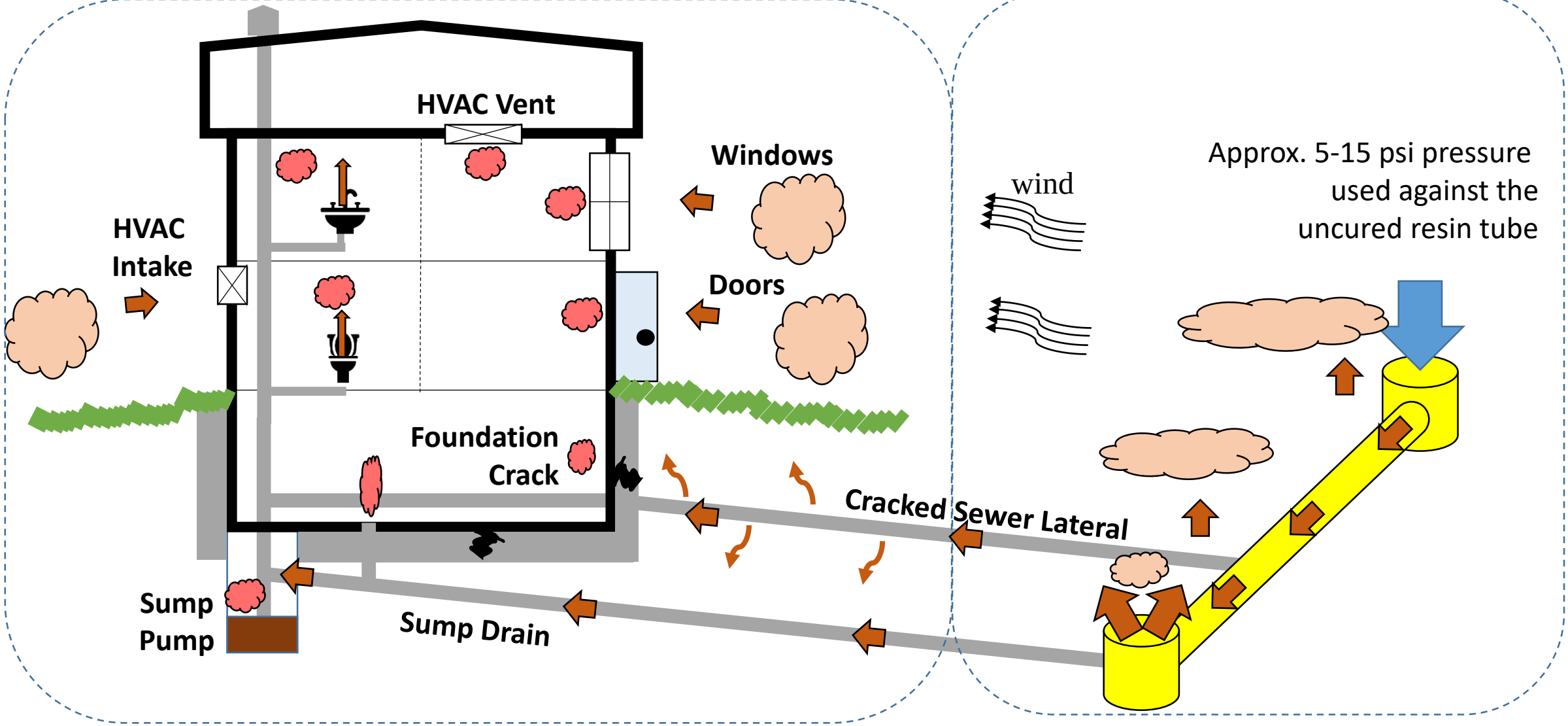
Utility/City Property (Worksite only for contractors)



Their chemical waste leaves their worksite – traveling above <u>and</u> below ground

Private Property
(NOT for contractors)

Utility/City Property
(Worksite only for contractors)



Contractors blow chemical waste into buildings and the environment

Layer of Floating Organic Solvents

Emulsion blown into air:

- Resin
- Water
- Dissolved VOCs/SVOCs
- Plastic pieces

This is NOT steam. This WASTE contains particulates, droplets, partially cured resin, VOCs, SVOCs, and more…

Many workers have not been wearing respiratory or dermal protection.
Waste has been allowed to enter buildings and public spaces.

Since our 2017 study revealed serious worker and public safety risks due to the CIPP process…

- ✓ 140+ chemical exposure incidents found involving children and adults in schools, homes, and office buildings
- ✓ 1 NIOSH UV CIPP study (health risk exists) [NIOSH thermal CIPP in progress]
- ✓ 1 worker fatality, OSHA investigation (IL)
- ✓ 1 criminal investigation (PA)
- ✓ 5 peer-reviewed testing & toxicology studies
- ✓ 1 industry study
  - Not just styrene found, benzene plus more, only looked at vapors not mixture
  - Styrene found well above 3.1 ppm, the max. level previously claimed by industry (and cities) for 20+ years
  - Some data are not interpretable. Other data buried in the appendix.
- ✓ California issued statewide CIPP safety alert in May 2020 with requirements
- ✓ Cities and contractors *still* permit waste discharge into nearby buildings

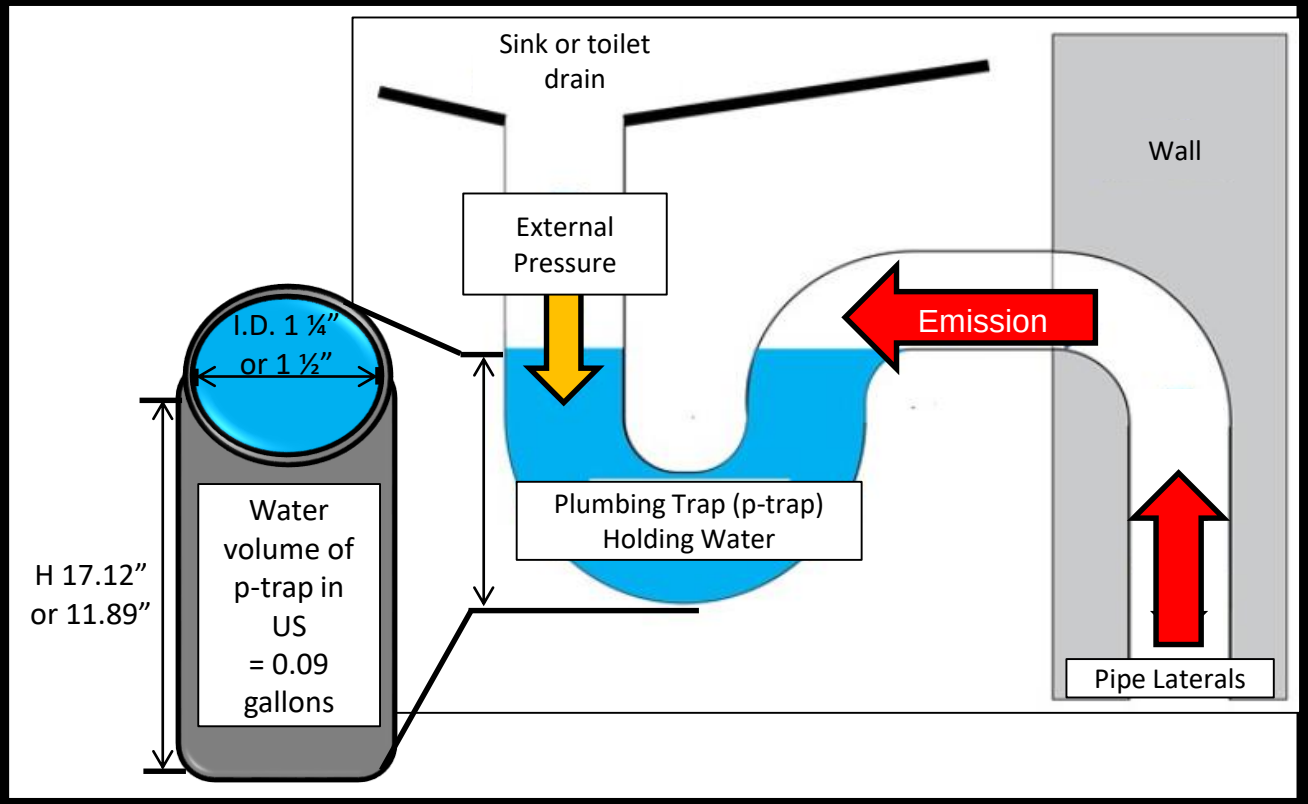
PURDUE UNIVERSITY

Today, CIPP Presents Serious Safety Risks

- CIPP process waste is blown into the air, leaves worksite
- Cities do not explicitly prohibit this in contracts
- People (i.e., children, pregnant women, others) have been and can be exposed inside and outside buildings
- Waste can enter buildings by many pathways
- SDSs lack key chemical information, unreliable
- 4-gas meters are ineffective, PIDs can give false readings
- Often
  - Exposure victims are directed to call the Construction Contractor, not health department (PROBLEM!)
  - Contractors, Public Works, Engineering Firms, City Officials issue blanket safety claims for any exposure
  - Health officials are not informed, during or after incidents – victims are on their own
- Critical air testing rarely conducted
- Tip of the iceberg. Exposures happening, some very serious.

PURDUE UNIVERSITY

Pouring water in drains does not prevent indoor exposure during CIPP manufacture



This implies their chemical waste *will* leave their worksite and enter private property

Less than 1 psi pressure

can cause water blowback in an average plumbing trap (p-trap)

CIPP contractors use 5-15 psi pressure at street

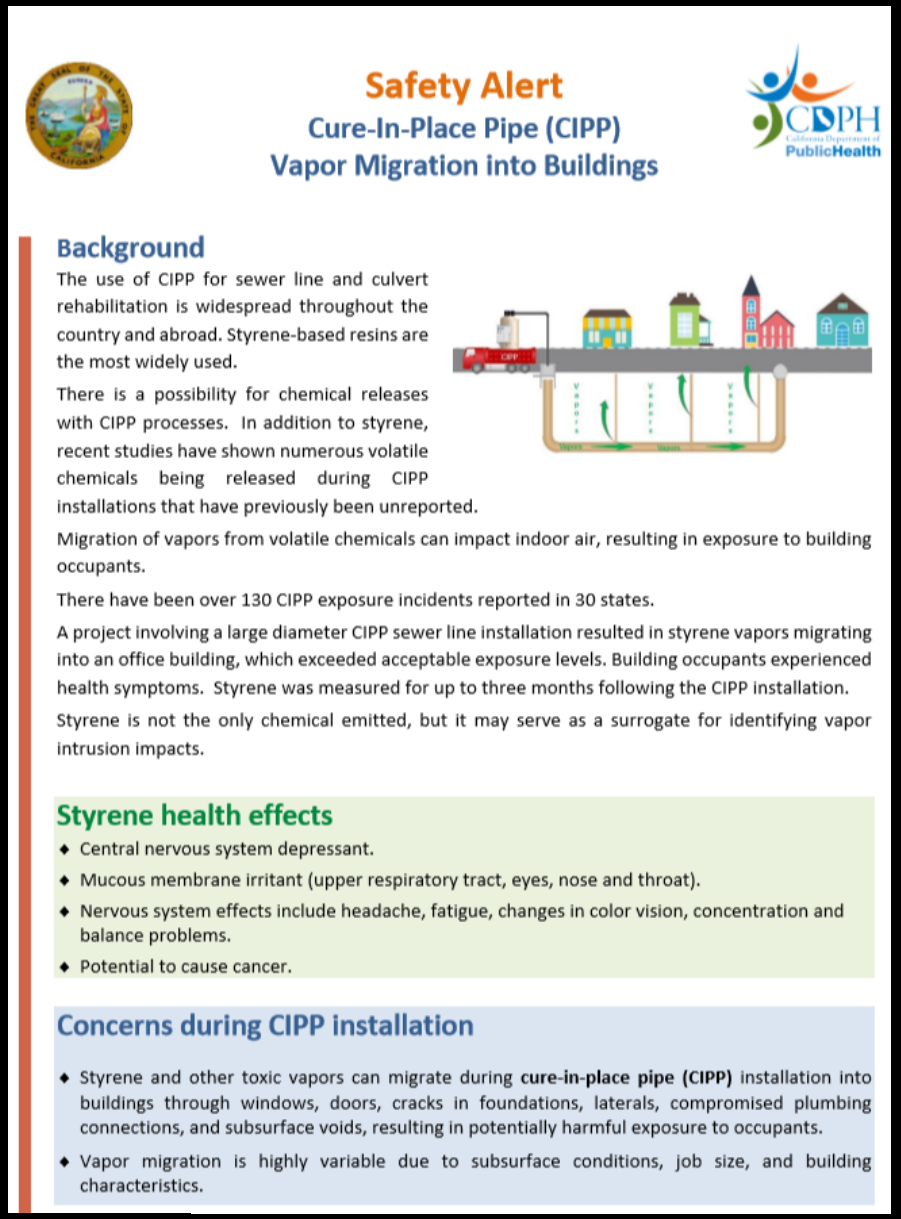
Contractors also may say:

1) Put a towel in the drains

2) Wrap toilet with towel

3) Wrap toilet with saran wrap

PURDUE UNIVERSITY



Safety Alert
Cure-In-Place Pipe (CIPP)
Vapor Migration into Buildings

Background

The use of CIPP for sewer line and culvert rehabilitation is widespread throughout the country and abroad. Styrene-based resins are the most widely used.

There is a possibility for chemical releases with CIPP processes. In addition to styrene, recent studies have shown numerous volatile chemicals being released during CIPP installations that have previously been unreported.

Migration of vapors from volatile chemicals can impact indoor air, resulting in exposure to building occupants.

There have been over 130 CIPP exposure incidents reported in 30 states.

A project involving a large diameter CIPP sewer line installation resulted in styrene vapors migrating into an office building, which exceeded acceptable exposure levels. Building occupants experienced health symptoms. Styrene was measured for up to three months following the CIPP installation.

Styrene is not the only chemical emitted, but it may serve as a surrogate for identifying vapor intrusion impacts.

Styrene health effects

- Central nervous system depressant.
- Mucous membrane irritant (upper respiratory tract, eyes, nose and throat).
- Nervous system effects include headache, fatigue, changes in color vision, concentration and balance problems.
- Potential to cause cancer.

Concerns during CIPP installation

- Styrene and other toxic vapors can migrate during **cure-in-place pipe (CIPP)** installation into buildings through windows, doors, cracks in foundations, laterals, compromised plumbing connections, and subsurface voids, resulting in potentially harmful exposure to occupants.
- Vapor migration is highly variable due to subsurface conditions, job size, and building characteristics.

California Department of Public Health, Revised May 2020

Overview

- Health effects
- Concerns during CIPP installation
- Recommendations for permitting agencies

Chemical Exposure Symptoms Reported for Persons Associated with Exposure to the Air and Liquid CIPP Wastes

Headache, Nausea, Vomiting, Loss of consciousness, Eye irritation, Nostrils burning, Dizziness, Shortness of breath, Tightness of chest, Lethargy, Faint, Gagging, Confusion

PURDUE UNIVERSITY

Free Online Plastics & CIPP Education Videos, government reports, images

Access www.CIPPSafety.org

What You Will Learn About

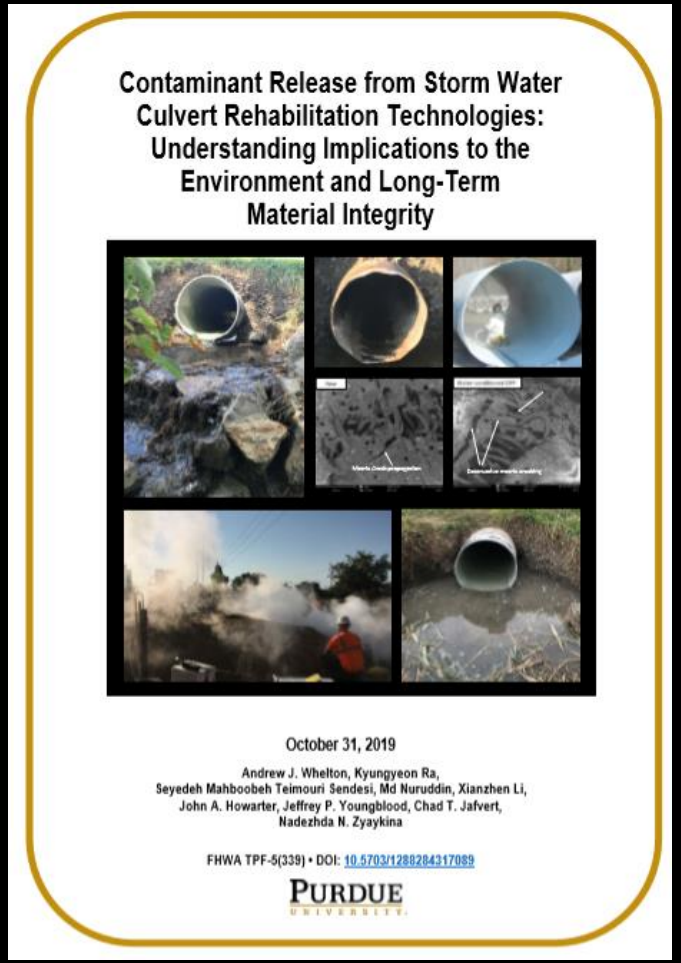
1. The Basics of Plastics
2. The CIPP Manufacturing Process
3. Waste is Created During CIPP Manufacture and It's Forms and Composition are Varied
4. How Chemicals Enter Nearby Buildings and Public Spaces
5. Human Health and Environmental Impacts

Highlights

- 4-gas meters are not effective for monitoring CIPP waste discharge.
- Photoionization detectors (PIDs) [sometimes called organic vapor monitors] may indicate something is changing, but at CIPP worksites they can be off by a factor of 10x to 1000x.

PREVENTION – CIPP associated HAZMAT incidents

1. Explicitly require air and liquid waste capture in construction contract. Do not permit chemical discharge into the air.
2. Explicitly require air monitoring to PROVE no release of chemicals above and below ground.
3. Require physical setback distances that prevent the public from being near waste discharge points.
4. Do Not Approach worksite unless proper PPE donned. (i.e., respirators, etc.)
5. Require contractors direct any and all complaints to medical professionals. They are NOT doctors.
6. If related odors are in buildings, demand an immediate halt to installation because of public safety.
7. Health department should be monitoring each installation and be prepared to respond.
8. Sometimes contractors and public works say untrue statements about exposures to parents and others during response, and never alert health department (city, county, state).



Recommendations here
https://docs.lib.purdue.edu/jtrpaffdocs/30/

PURDUE
UNIVERSITY

Andrew Whelton, Ph.D.
awhelton@purdue.edu

Learn more at:
www.PlumbingSafety.org
and
www.CIPPSafety.org

Follow Us
@TheWheltonGroup