Disaster Public Health Decisions for Drinking Water Systems Contamination

Andrew J. Whelton, Ph.D.

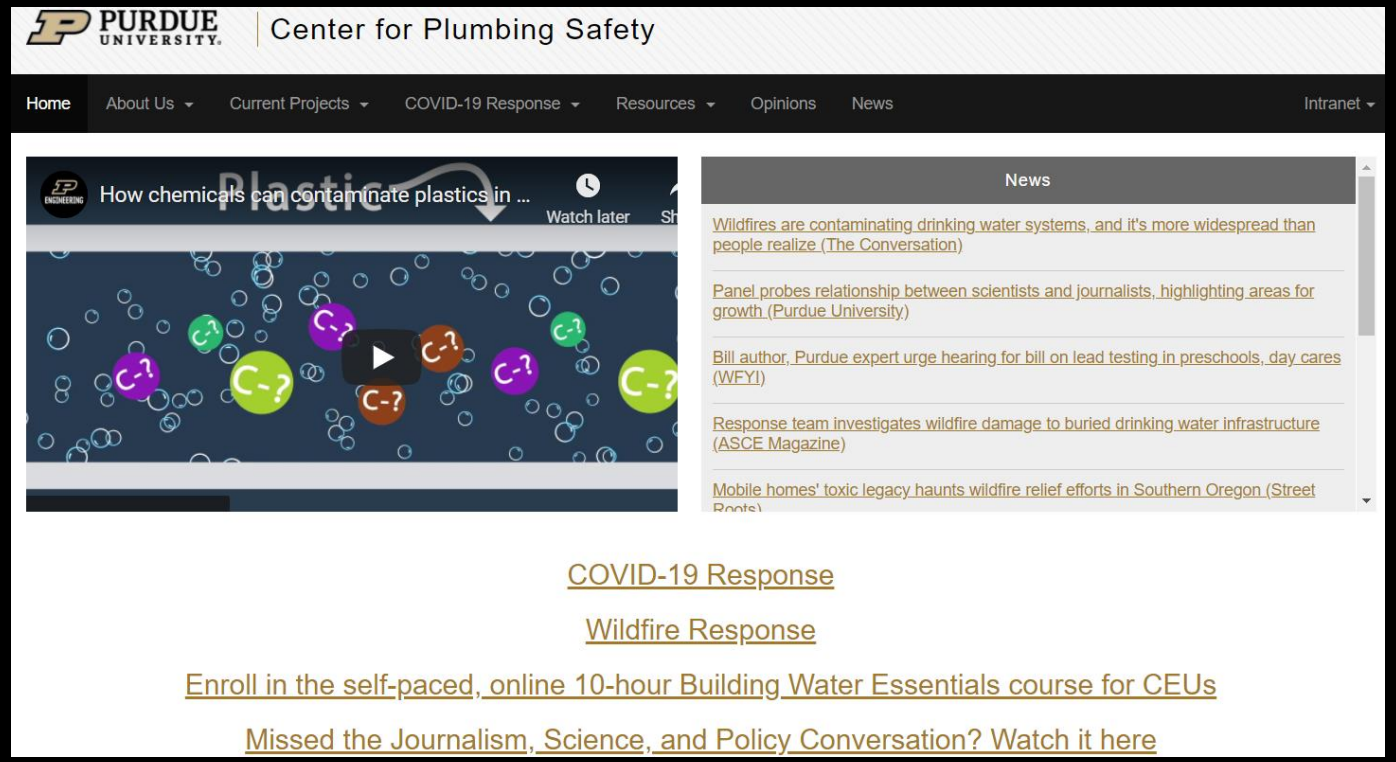
Civil, Environ., and Eco. Engineering

awhelton@purdue.edu

@TheWheltonGroup

Web: PlumbingSafety.org

More information here…



www.PlumbingSafety.org

- ✓ Wildfire response
  - Info sheets
  - Videos
  - Studies
  - Links to FEMA materials
- ✓ COVID-19 response
  - Info sheets
  - Videos
  - Studies
  - Links to CDC resources
- ✓ Other resources
  - Project summaries
  - Scientific opinions
  - Reports & presentations
  - External plumbing docs

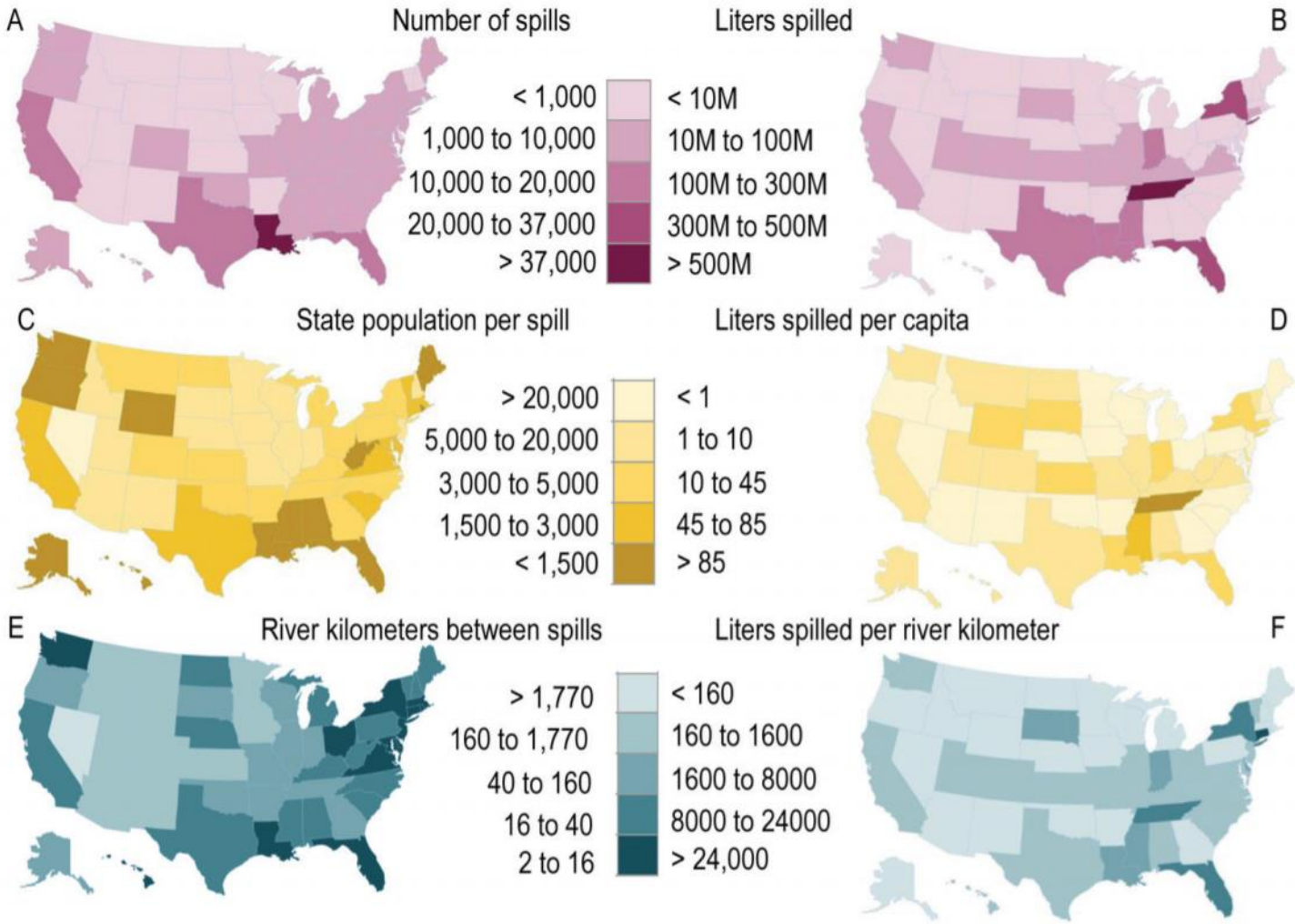
From 2004-2014, 351,000+ chemical spills affected water resources, National Response Center

351,000+: incidents or chemical spills

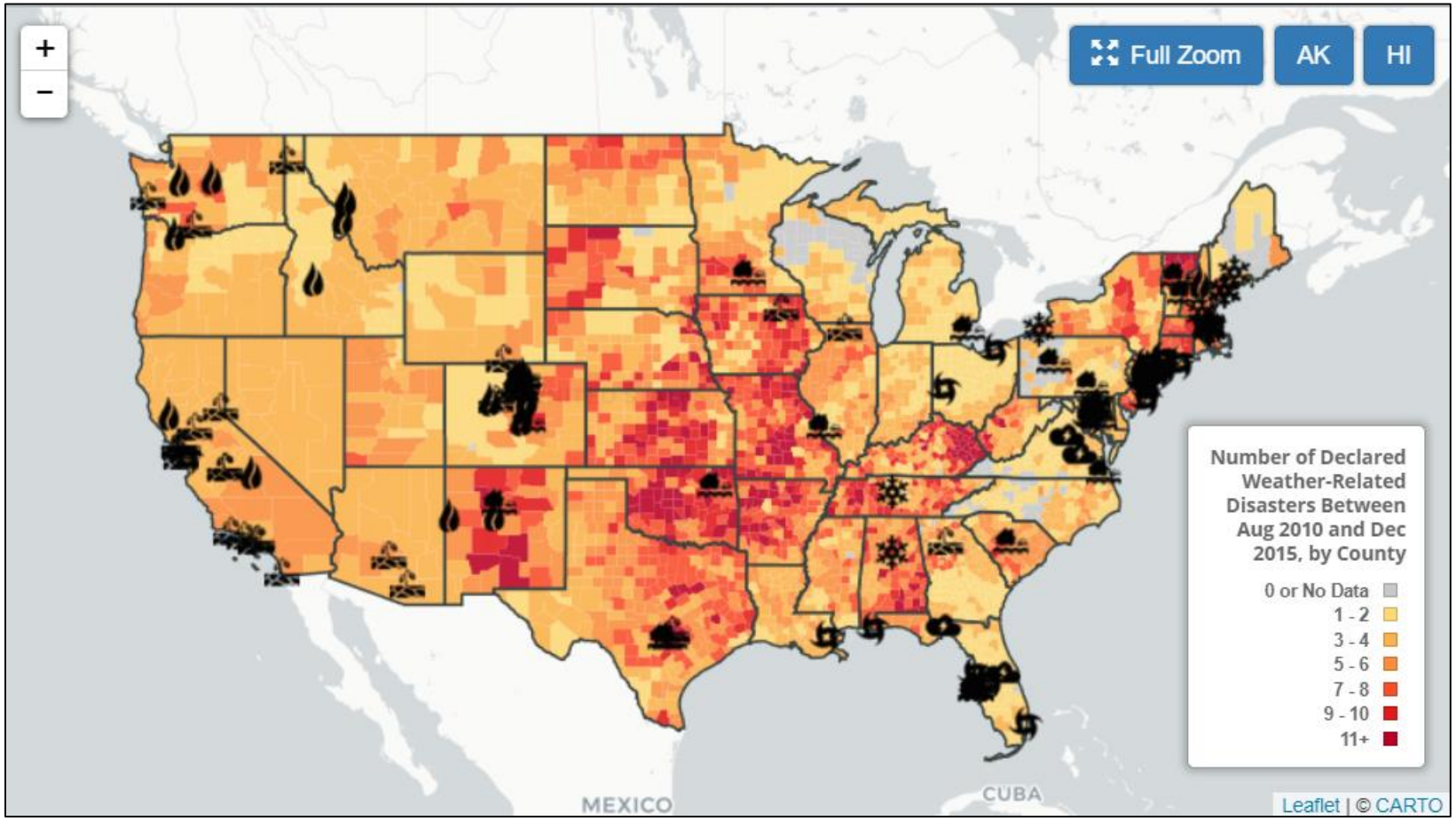
172,000+: impacted US water bodies in areas with higher population centers

88,000: petroleum and natural gas

8,000: chemicals with known and limited toxicity information available



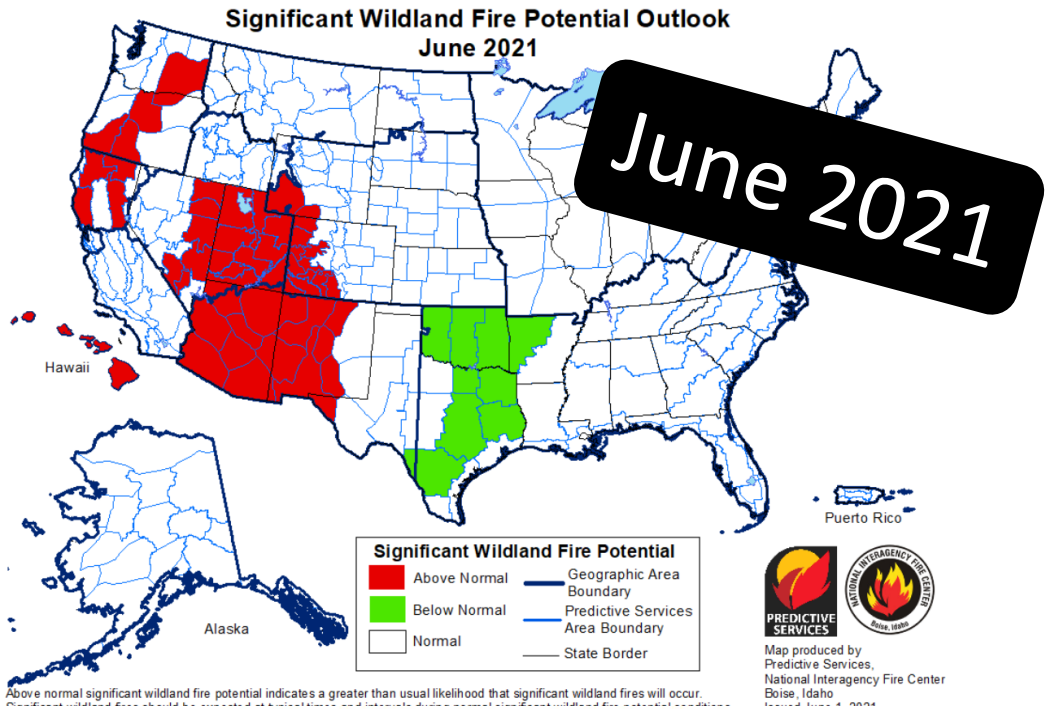
Weidhass et al. 2016. https://www.doi.org/10.2134/JEQ2016.03.0090

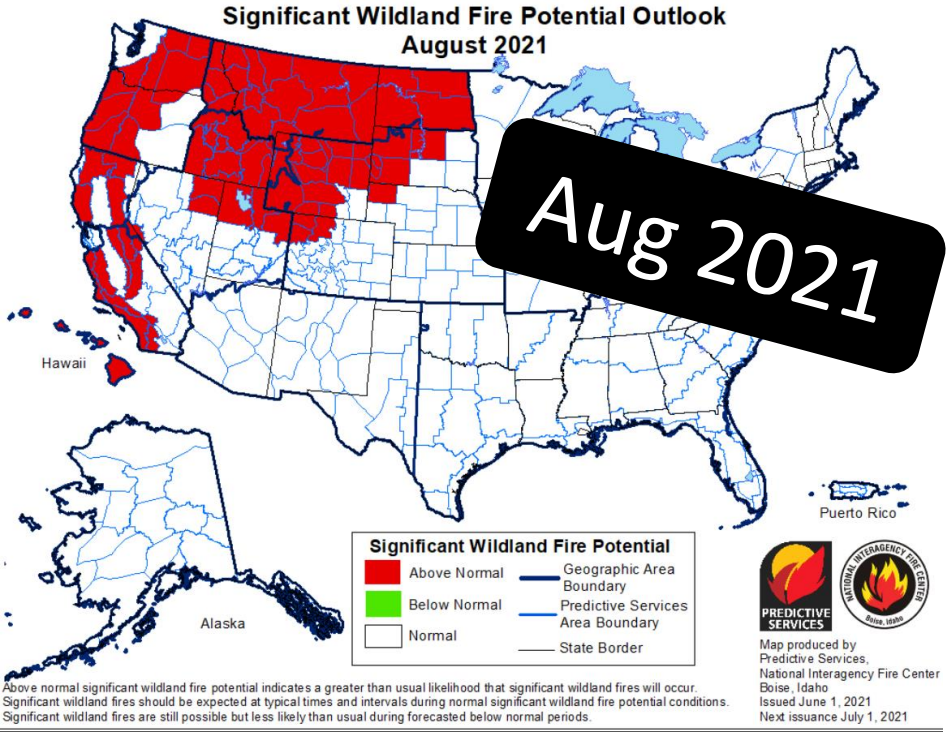


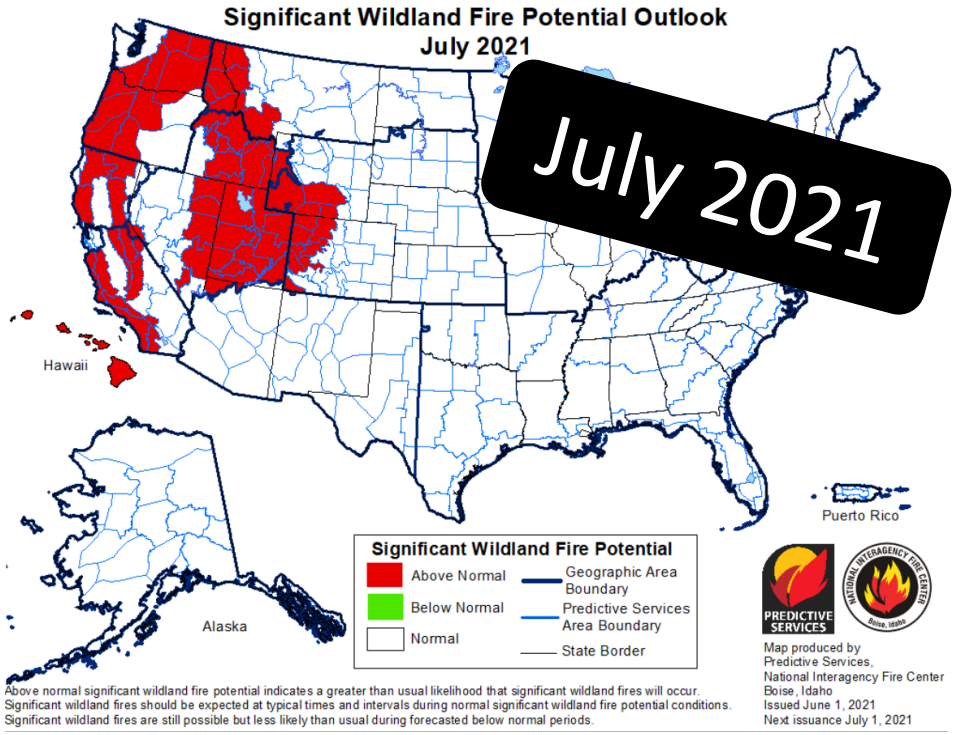
Wildfires
Droughts
Floods
Tornadoes
Snow & Ice
Tropical Storms
Severe Storms
Hurricanes

Natural disasters affect 1,000s of communities each year prompting drinking water microbial and chemical risks

EnvironmentAmerica.org







Arizona	Montana	Oregon
Arkansas	Nebraska	South Dakota
California	Nevada	Texas
Colorado	New Mexico	Utah
Hawaii	North Dakota	Washington
Idaho	Oklahoma	Wyoming

U.S. wildfires impacted 10 million+ acres in 2020

4 out of the 5 largest wildfires in California on record occurred in 2020

But, the deadliest, most destructive wildfires did not occur in 2020

1. October 2017 **Tubbs Fire**
   - Sonoma and Napa Counties
   - 22 fatalities
2. November 2018 **Camp Fire**
   - Butte County
   - 85 fatalities

In California alone, 2.7+ million people live in very high fire hazard severity zones. WUI – Wildland Urban Interface

Disasters continue to expose a deficiency of knowledge and this has profound impacts on health, safety, and economic prosperity

Maximum Benzene Level	Event/Location	Population Affected	System Name	Year
6	Echo Mountain Fire/Oregon	120	Whispering Pines Mobile Home Park	2020
11	Echo Mountain Fire/Oregon	362	Hiland WC - Echo Mountain	2020
1	Echo Mountain Fire/Oregon	760	Panther Creek Water District	2020
76	Almeda Fire/Oregon	6,850	City of Talent	2020
45	Lionshead Fire/Oregon	205	Detroit Water System	2020
2	CZU Lightning Complex Fire/California	1,650	Big Basin Water Company	2020
42	CZU Lightning Complex Fire/California	21,145	San Lorenzo Water District	2020
2,217	Camp Fire/California	26,032	Paradise Irrigation District	2018
38	Camp Fire/California	924	Del Oro Water Co.-Magalia	2018
8	Camp Fire/California	1,106	Del Oro Water Co.-Lime Saddle	2018
530	Camp Fire/California	11,324	Del Oro Water Co.-Paradise Pines	2018
40,000	Tubbs Fire/California	175,000	City of Santa Rosa	2017

Hazardous waste levels of benzene in drinking water. More VOCs, SVOCs above safe limits.

Sources: Smoke and plastics thermal degradation

Some plumbing plastics uptake chemicals and leach them back out making clean water unsafe

Health agencies are often looked to after disaster under the National Response Framework

Emergency Support Function (ESF) #8 – Public Health and Medical Services

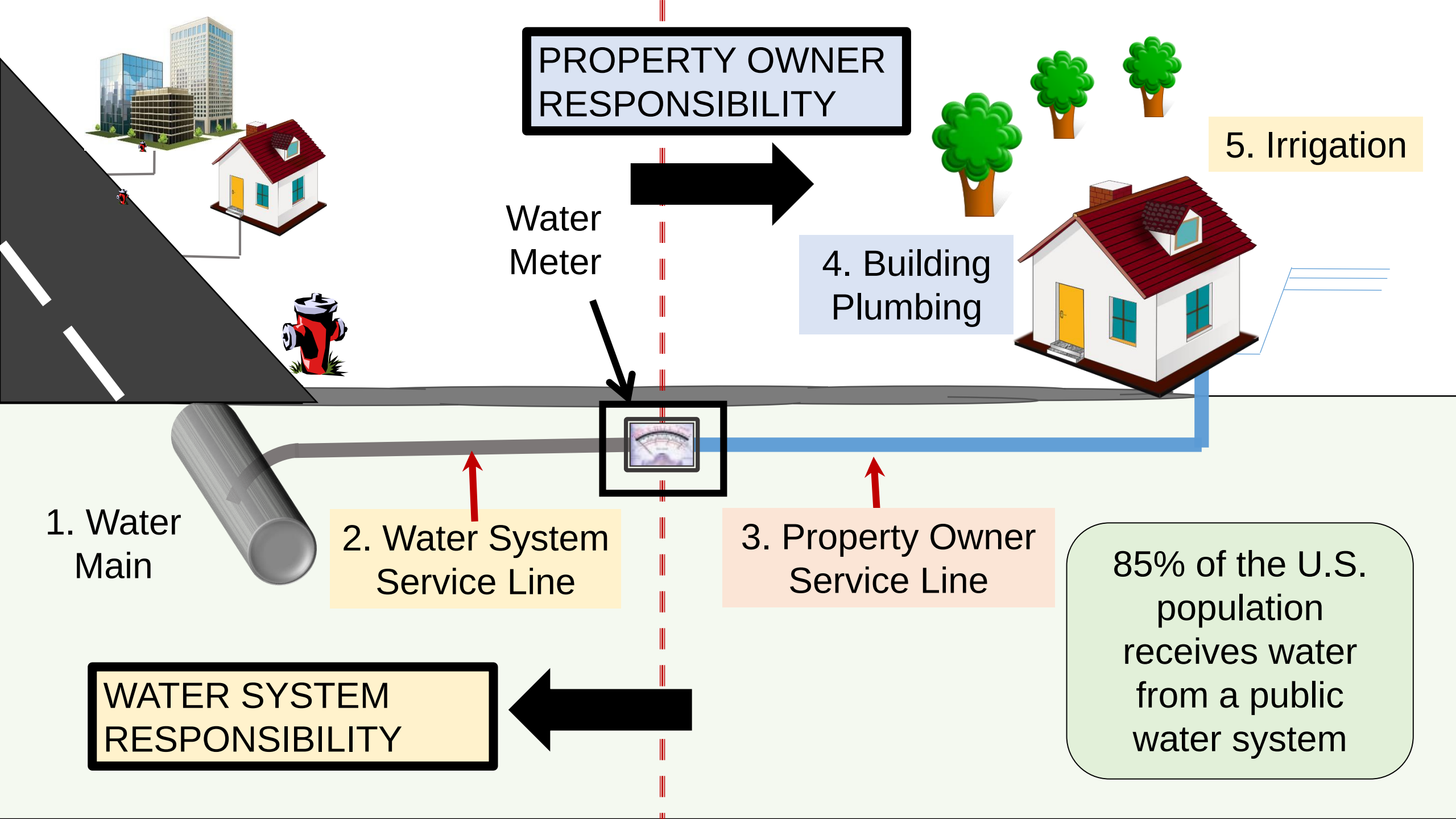
"…provides the mechanism for Federal assistance to supplement local, state, tribal, territorial, and insular area resources in response to a disaster, emergency, or incident that may lead to a public health, medical, behavioral, or human service emergency, including those that have international implications."

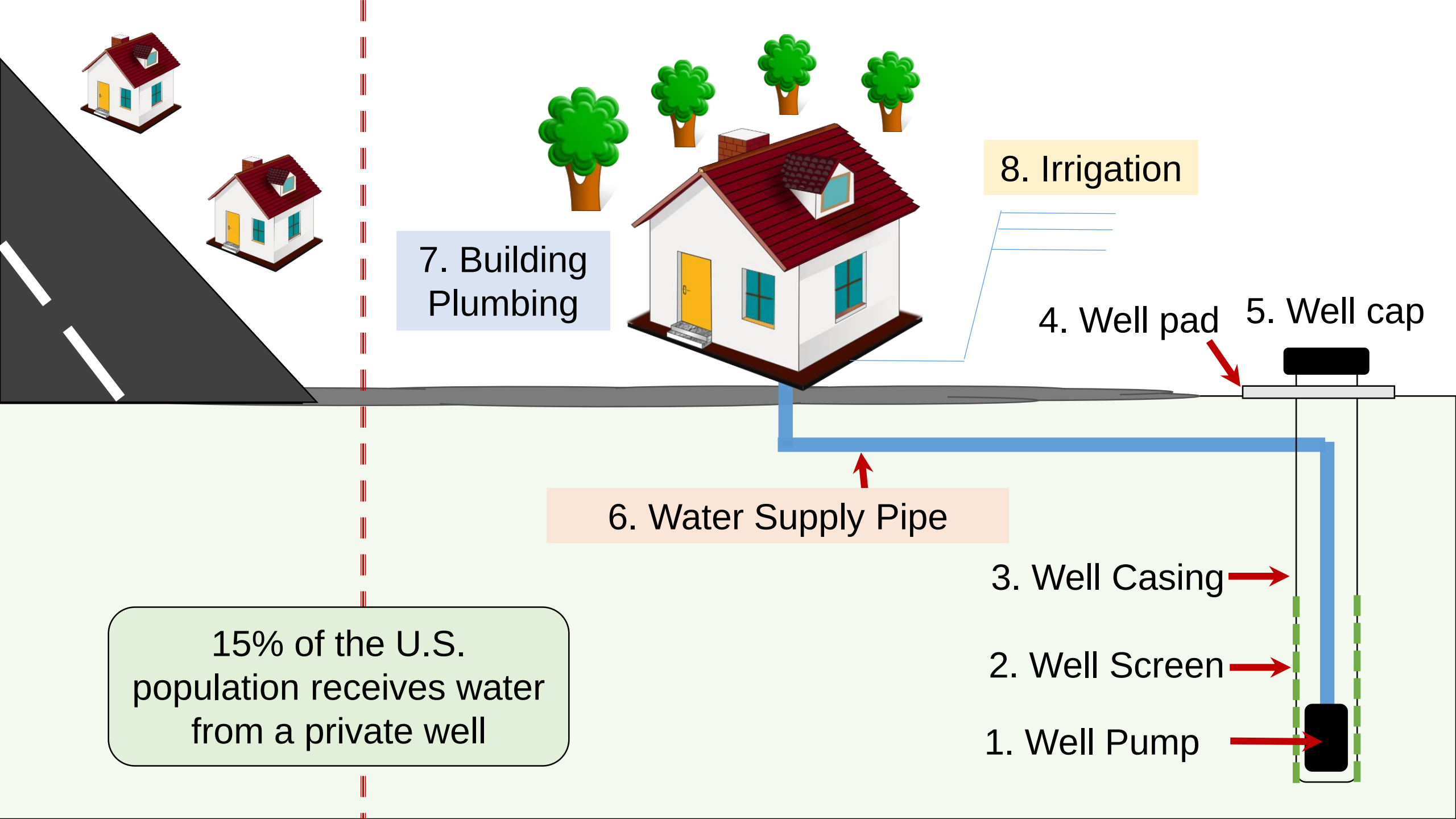
Public Health Aspects of Potable Water/Wastewater and Solid Waste Disposal

- Assists in assessing potable water, wastewater, solid waste disposal, and other environmental health issues related to public health in establishments holding, preparing, and/or serving food, drugs, or medical devices at retail and medical facilities, as well as examining and responding to public health effects from contaminated water; conducting field investigations, including collection and laboratory analysis of relevant samples; providing equipment and supplies as needed; and providing technical assistance and consultation.

"… disseminates public health information on protective actions related to exposure to health threats or environmental threats (e.g., to potable water and food safety).

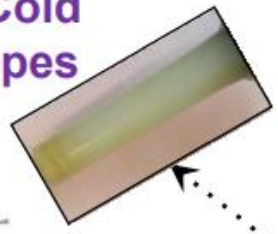
Emergency Support Function #8 – Public Health and Medical Services Annex (fema.gov)


PROPERTY OWNER RESPONSIBILITY
Water Meter
5. Irrigation
4. Building Plumbing
1. Water Main
2. Water System Service Line
3. Property Owner Service Line
WATER SYSTEM RESPONSIBILITY
85% of the U.S. population receives water from a public water system


8. Irrigation
7. Building Plumbing
4. Well pad
5. Well cap
6. Water Supply Pipe
3. Well Casing
2. Well Screen
1. Well Pump
15% of the U.S. population receives water from a private well

Residential

Hot vs. Cold Water Pipes



Metals and Plastics

Fixtures and Aerators

POU Devices

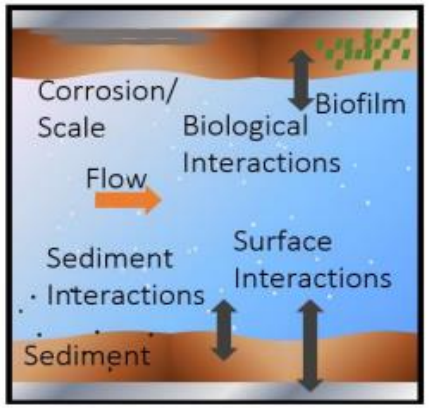
Water Heater

Corrosion Products

Water Softener

Whole House Filter

Service Lines



Habitat

Commercial

Bathrooms

Water fountains

Food preparation areas

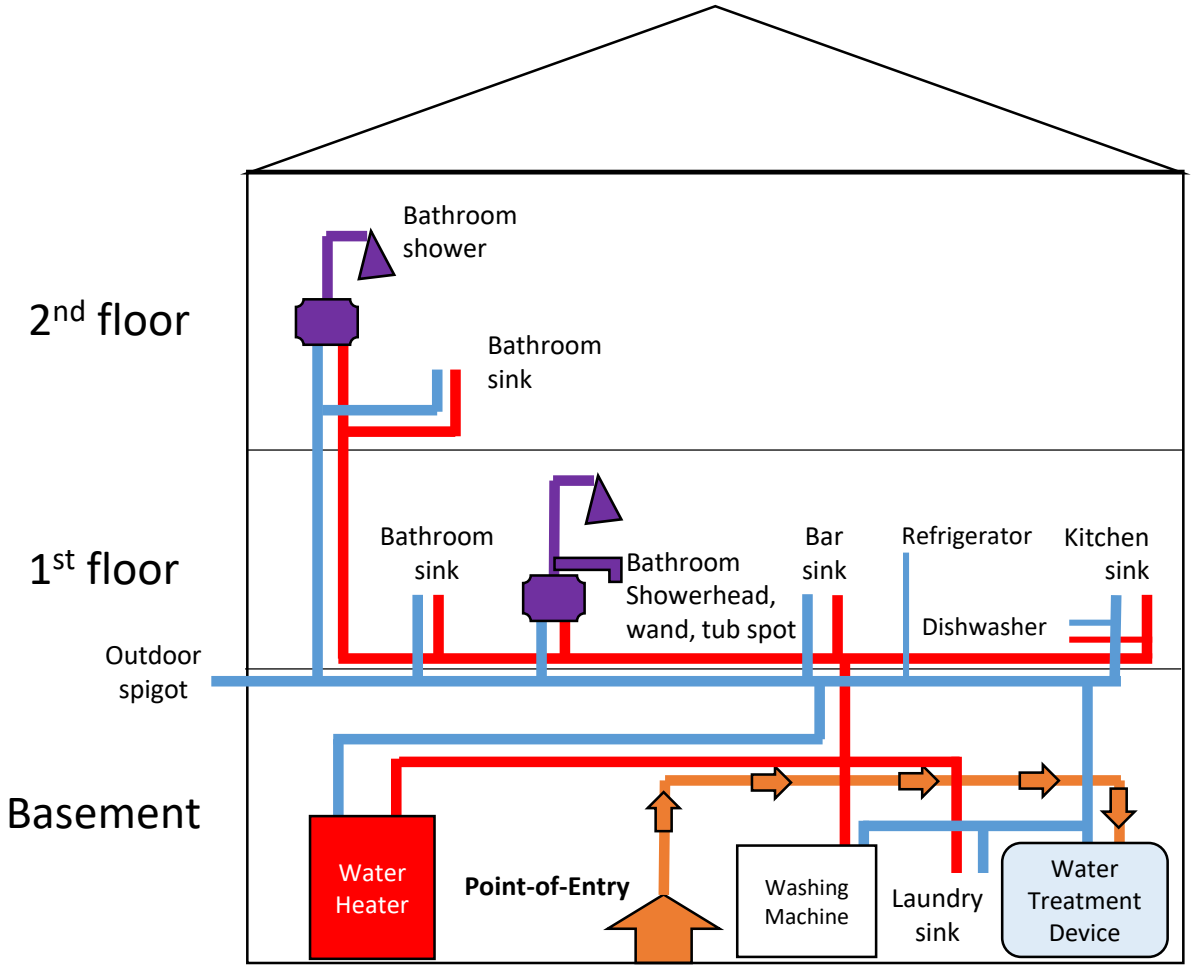
Point-of-entry devices

Point-of-use devices

Breakrooms

Point-of-use devices

Example single family home / trunk and branch design with a centralized water heater

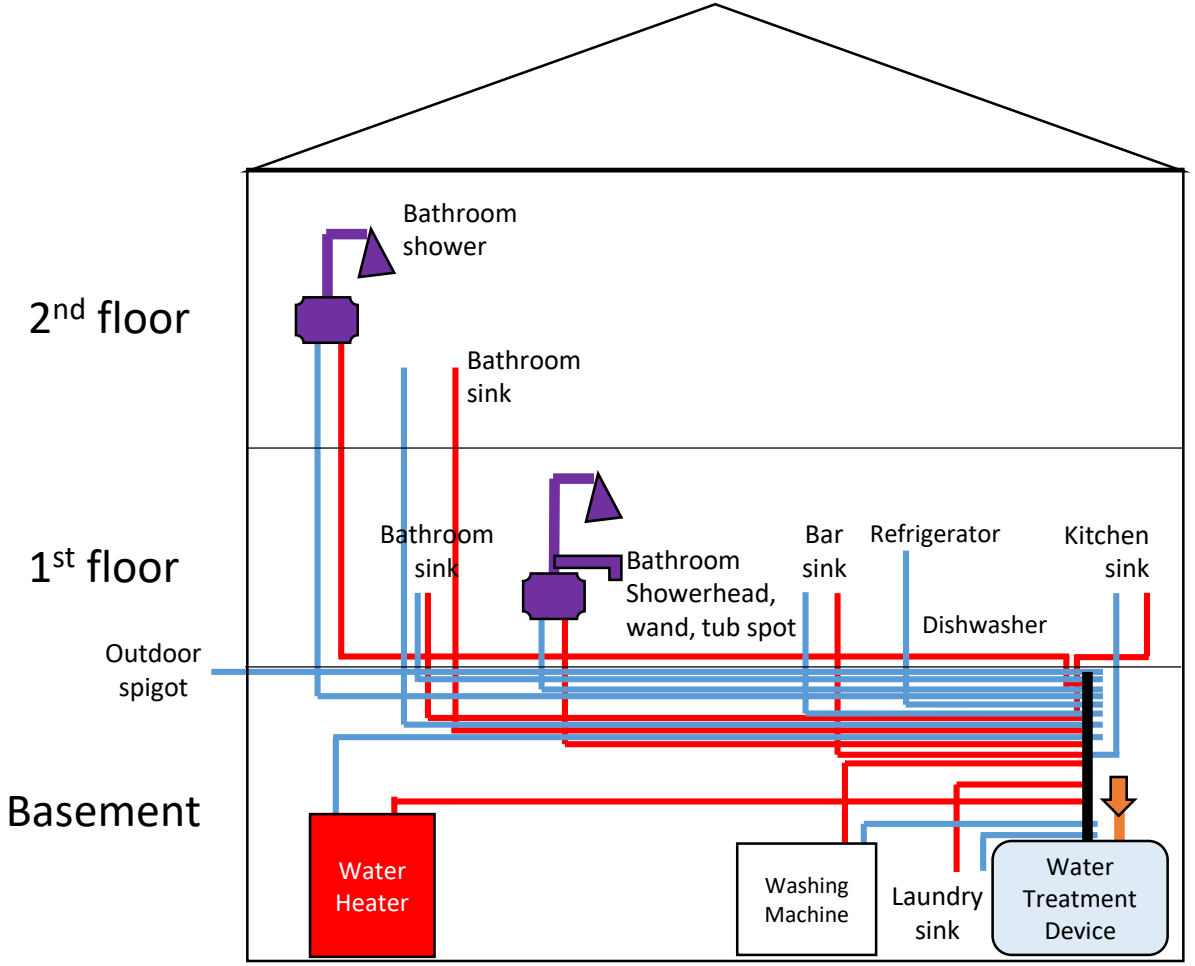


Cold and hot water flow through separate pipes

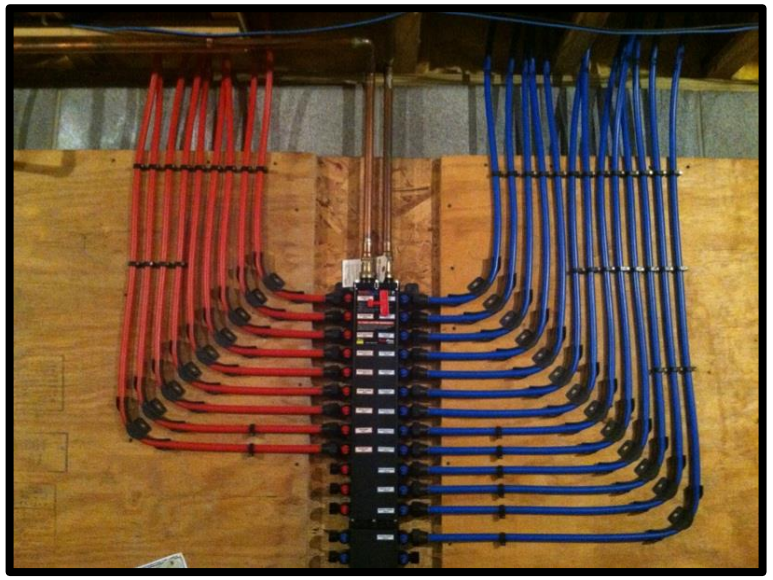
Some locations are downstream from others, but branch off into separate pipes

A whole house water treatment device may or may not be present

Single family home / PEX manifold plumbing design and central water heater



Cold and hot water flow through separate pipes
Each fixture has it's own isolated pipe
No two pipes convey the same water
Co-located shutoff location for all each fixture
Smaller diameter pipes compared to T/B design



Questions health officials will be asked during about drinking water safety and plumbing

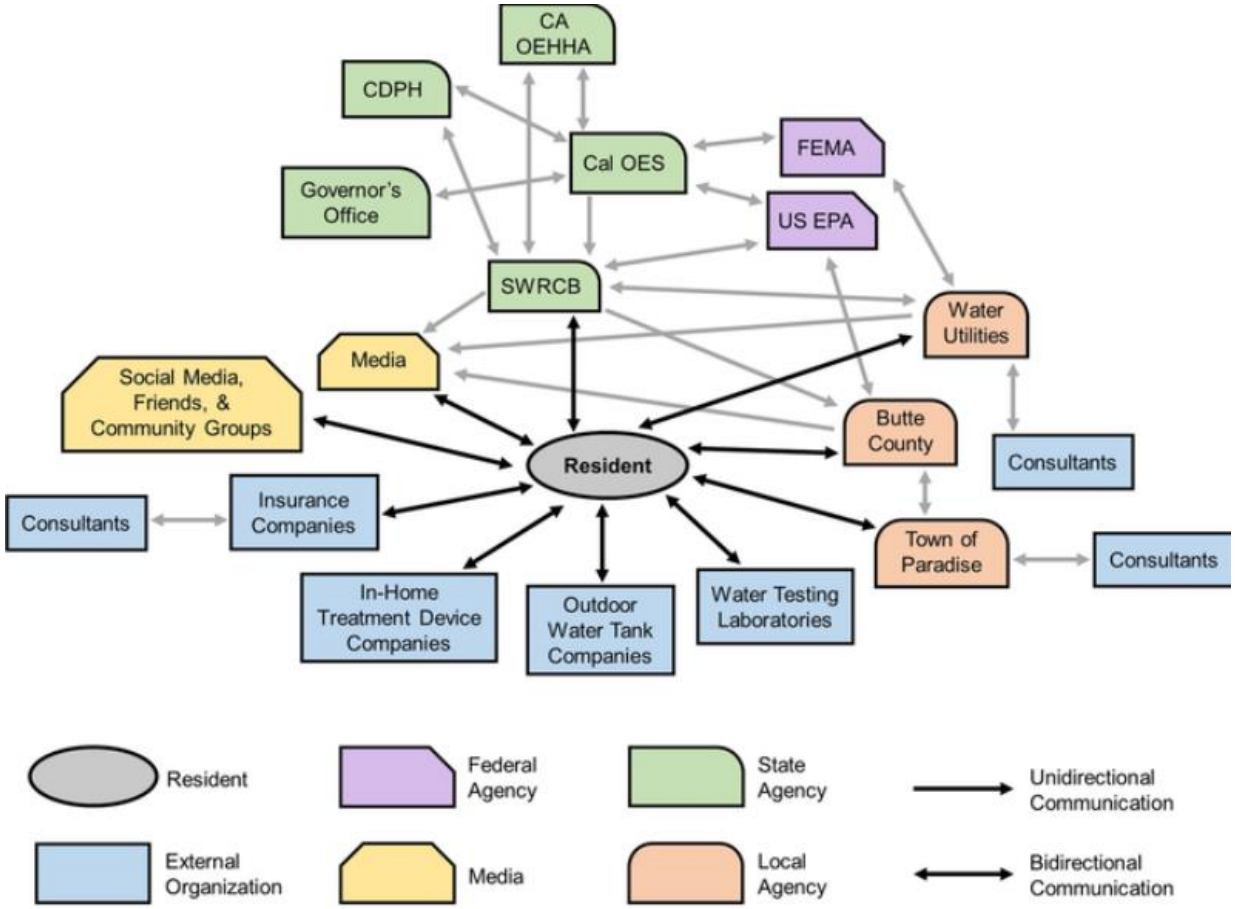
- Could the water be contaminated? Issue a water use order. Content here.
- What are the contaminants?
  - Microbial (*E. coli, Naegleria fowleri, legionella pn.*, etc.)
  - Chemicals
    - Inorganics (acids, bases, heavy metals, etc.)
    - Organics (petroleum compounds, chemical spill, pesticides, microcystins, etc.)
  - Radionuclides
- Where do they go in plumbing? Do they permeate plastics and then leach out?
- Do they deposit in plumbing scale and then leach out?
- Are they originating from thermally damaged plumbing materials?
- Do they react and transform into other contaminants?

Water safety attitudes, risk perception, experiences, and education for households impacted by the 2018 Camp Fire

Natural Hazards, Published May 2021 https://doi.org/10.1007/s11069-021-04714-9

Critical Public Health Issues

1) Water use restrictions,
2) **Plumbing** sampling and testing,
3) **Plumbing** decontamination methods and validation,
4) Water tank selection and maintenance,
5) In-home treatment device selection and maintenance, and
6) **Plumbing** design and material selection for property repairs and new construction.

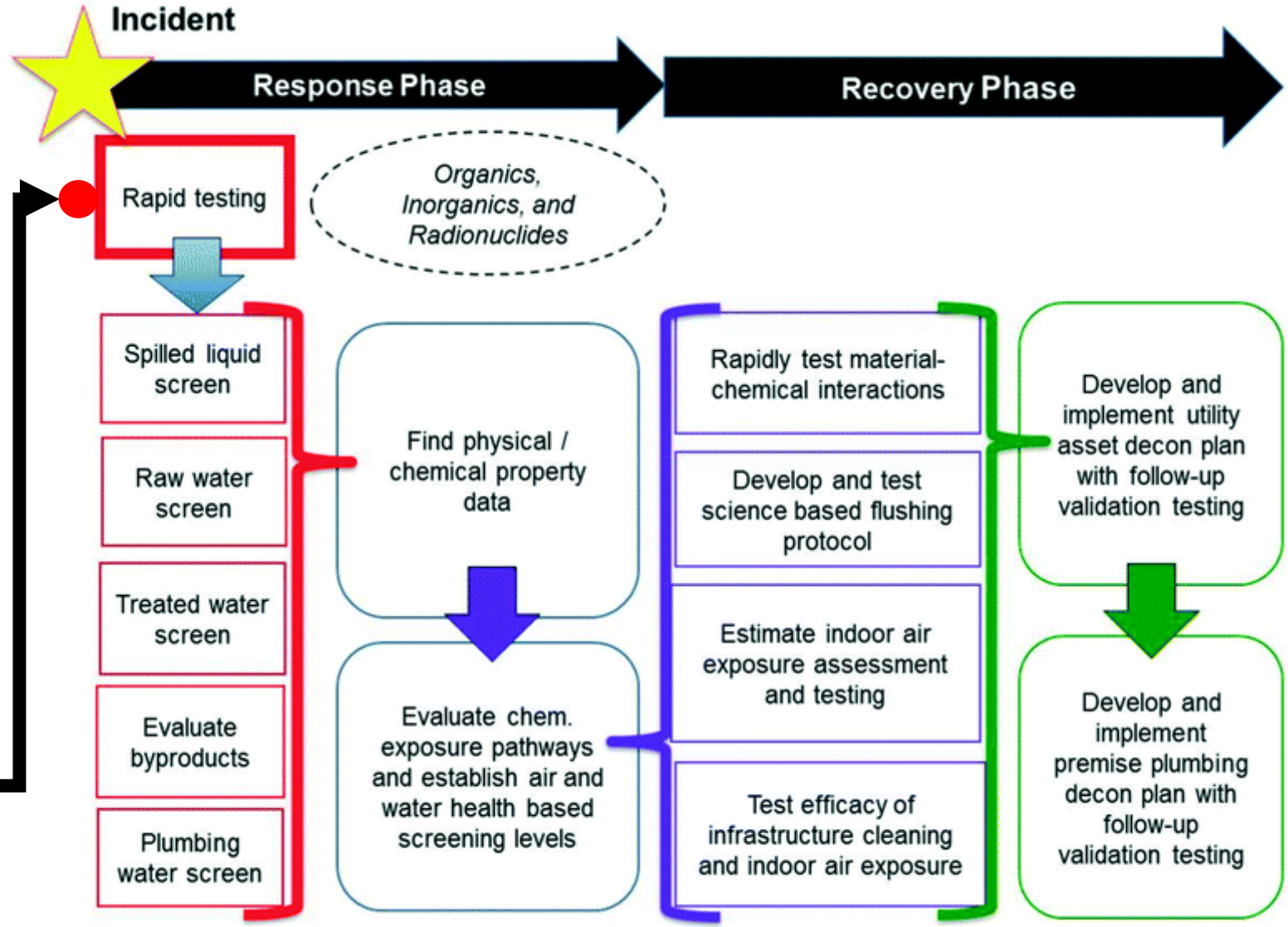


Big Picture For "Chemicals"

Do you know what's in the water?

Issue Water Use Order

1. Boil Water Advisory
2. Do Not Drink
3. Do Not Drink-Do Not Boil
4. Do Not Use except toilet flushing
5. Do Not Use



Case study: the crude MCHM chemical spill investigation and recovery in West Virginia USA - Environmental Science: Water Research & Technology (RSC Publishing) DOI:10.1039/C5EW00294J

Officials should carefully consider plumbing cleaning and decontamination options

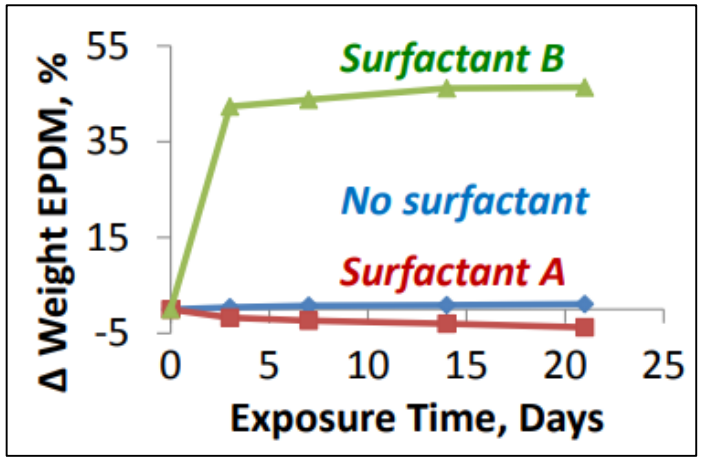
Exposure: inhalation, dermal, PPE

Septic system overflow / damage

Hazardous flushing waste disposal

Contaminant fate considerations

Water testing is critical to validate removal: For what, where, how often



- **Flushing doesn't always work**
  - Post-Tubbs Fire: Flushed for 3 months then replaced some infrastructure
  - Post-Camp Fire: Purdue/EPA estimated >288 d, 24 hr/d, 7 d/wk flushing at 2 gpm for moderately contaminated HDPE pipes
  - Pesticides, VOCs, SVOCs are problematic
- Adequate stagnation before sampling is key for organic chemicals and microbials; Is it gone?
- Post-2014, West Va. Health Dept. recommended replacing flexible tubing for restaurants

New resources for officials on wildfire drinking water contamination

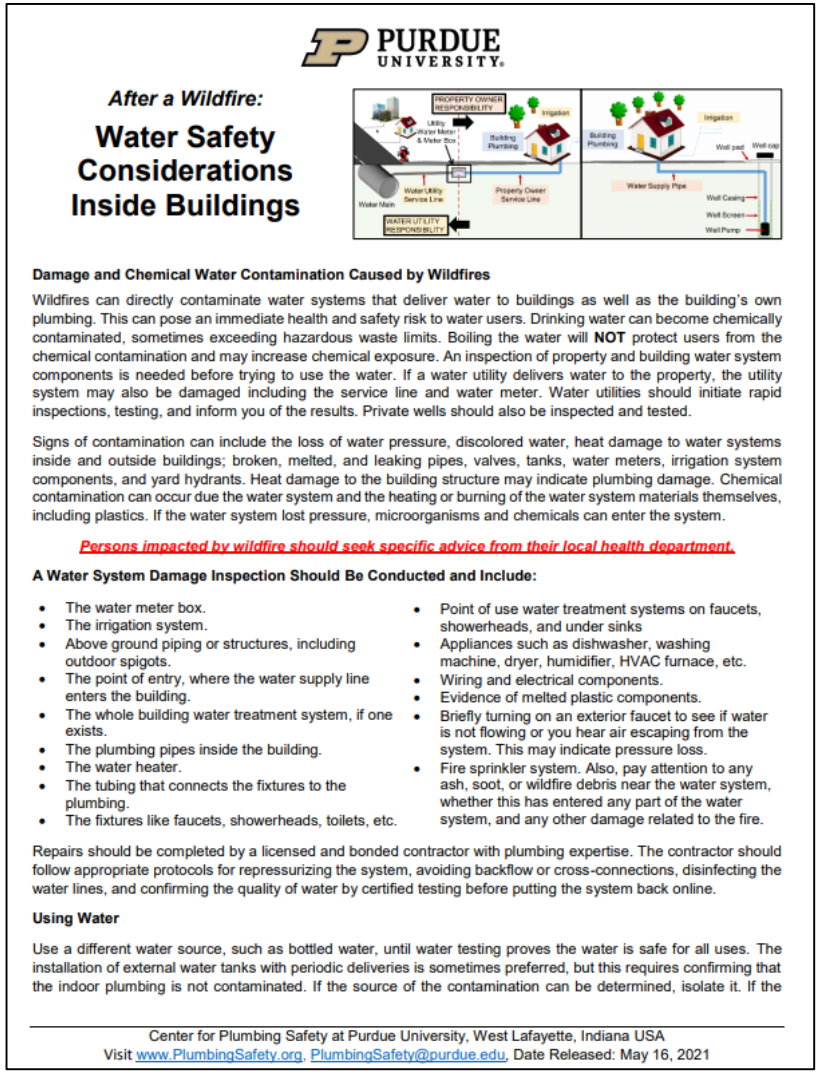
May 2021, New private well and building water system contamination guidance for public health officials and property owners

May 2021, New study about household level impacts and needs when wildfire contaminates a public water system, private wells, and/or plumbing

December 2020, FEMA policy to authorize Hazard Mitigation Assistance ($$$$) for water contamination response

NOW until July 11, 2021: FREE online course, Plastics in Infrastructure and the Environment | edX

NOW and through 2021, Self-paced: Building Water Essentials course, 10 hour, 1 CEU: Water Quality Issues in Buildings: Certificate Program | Purdue Online



PURDUE UNIVERSITY

After a Wildfire:

Water Safety Considerations Inside Buildings

Damage and Chemical Water Contamination Caused by Wildfires

Wildfires can directly contaminate water systems that deliver water to buildings as well as the building's own plumbing. This can pose an immediate health and safety risk to water users. Drinking water can become chemically contaminated, sometimes exceeding hazardous waste limits. Boiling the water will **NOT** protect users from the chemical contamination and may increase chemical exposure. An inspection of property and building water system components is needed before trying to use the water. If a water utility delivers water to the property, the utility system may also be damaged including the service line and water meter. Water utilities should initiate rapid inspections, testing, and inform you of the results. Private wells should also be inspected and tested.

Signs of contamination can include the loss of water pressure, discolored water, heat damage to water systems inside and outside buildings; broken, melted, and leaking pipes, valves, tanks, water meters, irrigation system components, and yard hydrants. Heat damage to the building structure may indicate plumbing damage. Chemical contamination can occur due the water system and the heating or burning of the water system materials themselves, including plastics. If the water system lost pressure, microorganisms and chemicals can enter the system.

Persons impacted by wildfire should seek specific advice from their local health department.

A Water System Damage Inspection Should Be Conducted and Include:

- The water meter box.
- The irrigation system.
- Above ground piping or structures, including outdoor spigots.
- The point of entry, where the water supply line enters the building.
- The whole building water treatment system, if one exists.
- The plumbing pipes inside the building.
- The water heater.
- The tubing that connects the fixtures to the plumbing.
- The fixtures like faucets, showerheads, toilets, etc.
- Point of use water treatment systems on faucets, showerheads, and under sinks
- Appliances such as dishwasher, washing machine, dryer, humidifier, HVAC furnace, etc.
- Wiring and electrical components.
- Evidence of melted plastic components.
- Briefly turning on an exterior faucet to see if water is not flowing or you hear air escaping from the system. This may indicate pressure loss.
- Fire sprinkler system. Also, pay attention to any ash, soot, or wildfire debris near the water system, whether this has entered any part of the water system, and any other damage related to the fire.

Repairs should be completed by a licensed and bonded contractor with plumbing expertise. The contractor should follow appropriate protocols for repressurizing the system, avoiding backflow or cross-connections, disinfecting the water lines, and confirming the quality of water by certified testing before putting the system back online.

Using Water

Use a different water source, such as bottled water, until water testing proves the water is safe for all uses. The installation of external water tanks with periodic deliveries is sometimes preferred, but this requires confirming that the indoor plumbing is not contaminated. If the source of the contamination can be determined, isolate it. If the

Center for Plumbing Safety at Purdue University, West Lafayette, Indiana USA
Visit www.PlumbingSafety.org, PlumbingSafety@purdue.edu, Date Released: May 16, 2021

You can download and access these materials at www.PlumbingSafety.org:
https://engineering.purdue.edu/PlumbingSafety/resources/wildfire-response

Q: Should in-home POU water filtration devices be used to treat wildfire contaminated drinking water?

Water Collected and Analyze	Preliminary Results, ppb			
	Benzene	Toluene	Ethyl Benzene	Xylene
Entering the filter	713	911	87	212
Exiting the filter				
1 L	20	15	3	4
1.5 L	33	30	5	9
2 L	47	46	6	11
3 L	64	75	10	21
3.5 L	62	75	10	20
4 L	24	22	4	5
4.5 L	87	98	11	21
5 L	37	37	5	8

The devices are NOT designed for this. The range of contamination must be known + testing.

In 2019, CA OEHHA concluded that short-term 26 ppb benzene exposure would prompt an increased risk of blood effects in children such as a decrease in lymphocytes and white blood cells; Benzene has a 5 ppb Federal MCL, 1 ppb CA MCL

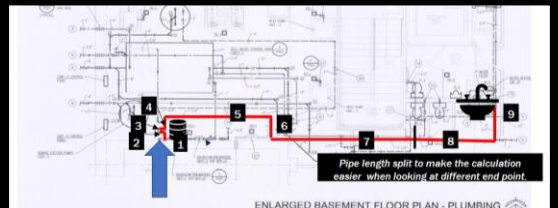
Edwards E, K Isaacson, CR Proctor, AD Shah, AJ Whelton

NEW: Building Water Essentials – Open 10 Hour, Online Short-Course

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.

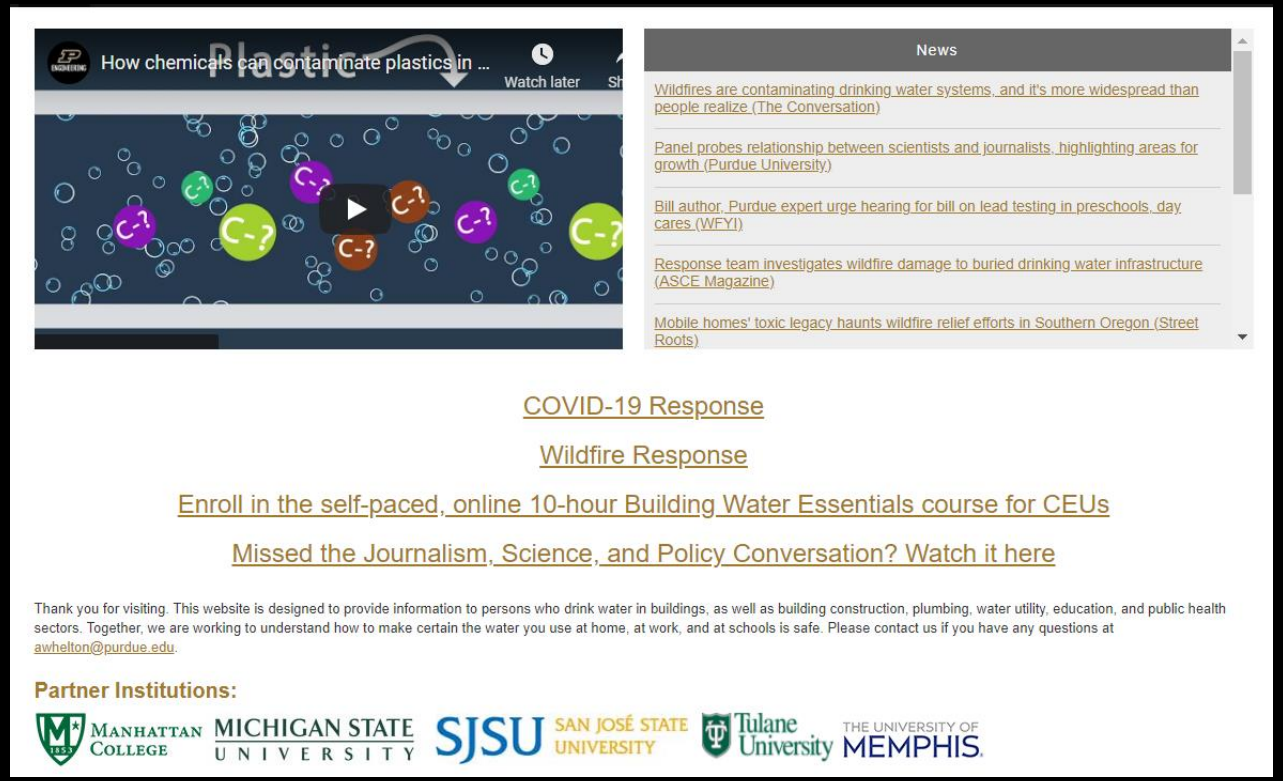


If interested e-mail EngrOnline@purdue.edu

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

Thank you.

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



www.PlumbingSafety.org

- ✓ Online short-course
- ✓ Plumbing education videos
- ✓ Flushing plans
- ✓ Plumbing explainers
- ✓ List of projects
- ✓ Scientific opinions
- ✓ Resources ➔ presentations
- ✓ Scientific reports
- ✓ External plumbing docs
- ✓ YouTube Channel

10 hr, 1 CEU, Self-paced, Online Building Water Essentials Short-Course:
https://engineering.purdue.edu/online/certifications/building-water-essentials