Transforming Community Resilience with Partnerships and Strategy:

Research for Impact

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2023 Kula Fire in Maui, Hawai'i

Water Safety and Disasters

Infrastructure Construction and Repair Technologies

Waste Materials and Management Solutions

***Resilience (n.)**: the ability to bounce back from or adjust to misfortune or change*

B.S. Civil Engineering
M.S. Environmental Engineering

U.S. ARMY

Oak Ridge Institute for Science and Education

Ph.D. Civil Engineering
Postdoctoral Associate

Draper Aden Associates
Engineering • Surveying • Environmental Services

Whelton, LLC

NIST National Institute of Standards and Technology U.S. Department of Commerce

National Academies Sciences Engineering Medicine *NRC Fellowship*

University of South Alabama

Purdue University *(2014-Present)*

Some experience

2014 West Virginia Chemical Spill

2017 Tubbs Fire

2018 Camp Fire

2021 Marshall Fire

2021 Pearl Harbor Chemical Spill

2023 Norfolk Southern Chemical Spill

2023 Maui Wildfires

2025 Los Angeles Fires

Expertise provided to and sought by:

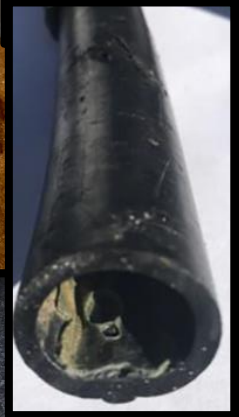
Local and state officials in CA, CO, FL, HI, IN, NM, OH, OR, PA, WV, US EPA, US CDC, US OSHA, NIOSH, Navy, Army, US Senate and H.R. Committees, the White House, utilities, households, and businesses.

Environmental Engineering

Apply technical understanding of environmental systems, systems engineering, biology and chemistry to develop strategies to protect human and environmental health, and design sustainable systems and technologies. To ensure the safety, health, and welfare of society and the sustainability of the natural and built environments.

Environmental Health

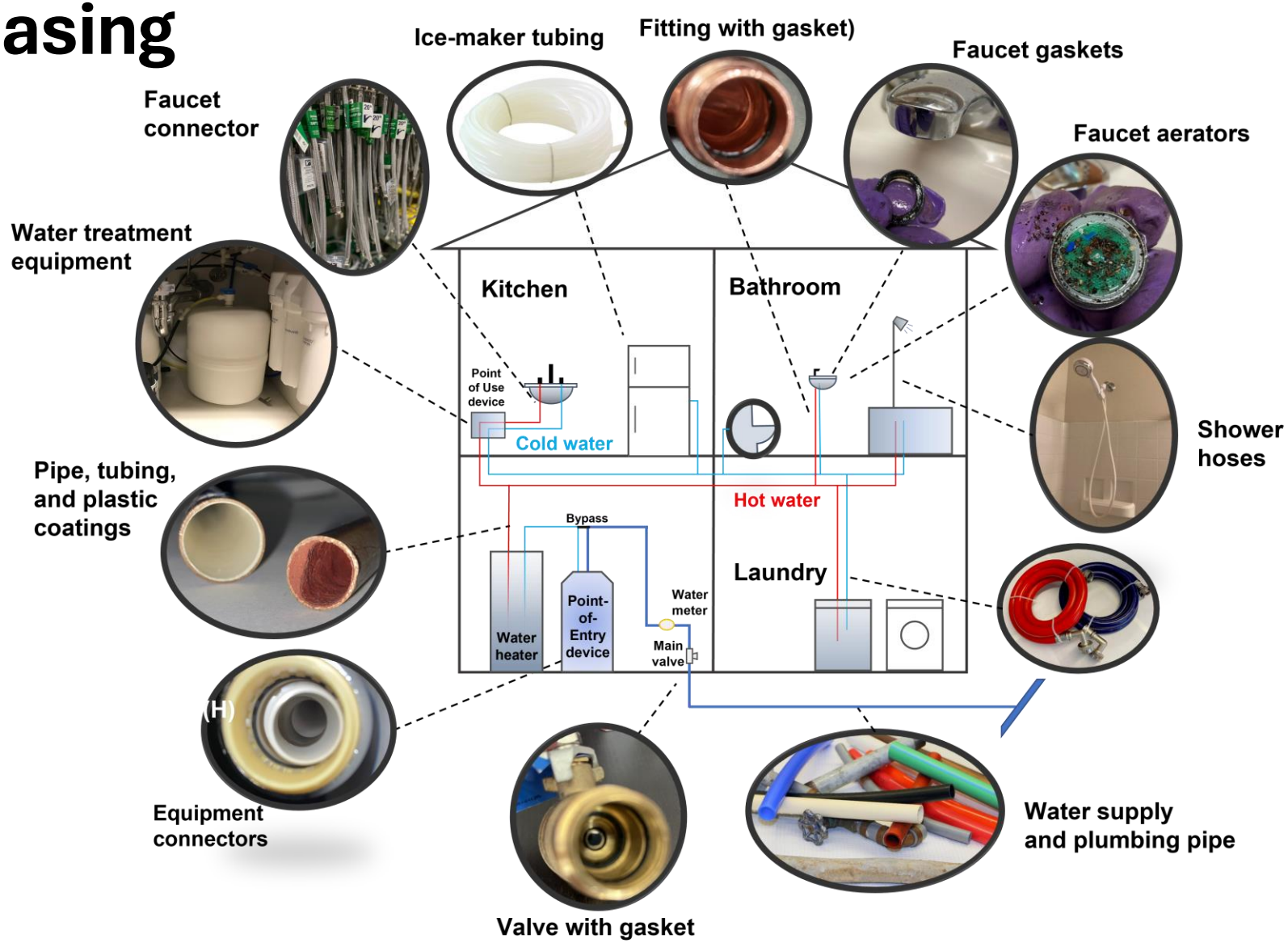
Apply technical understanding to understand and improve the relationships between people and their environment. Advances policies that reduce chemical and other environmental exposures in air, water, soil and food, including improving emergency response and community education.



Plastics

Plastics Use is Increasing

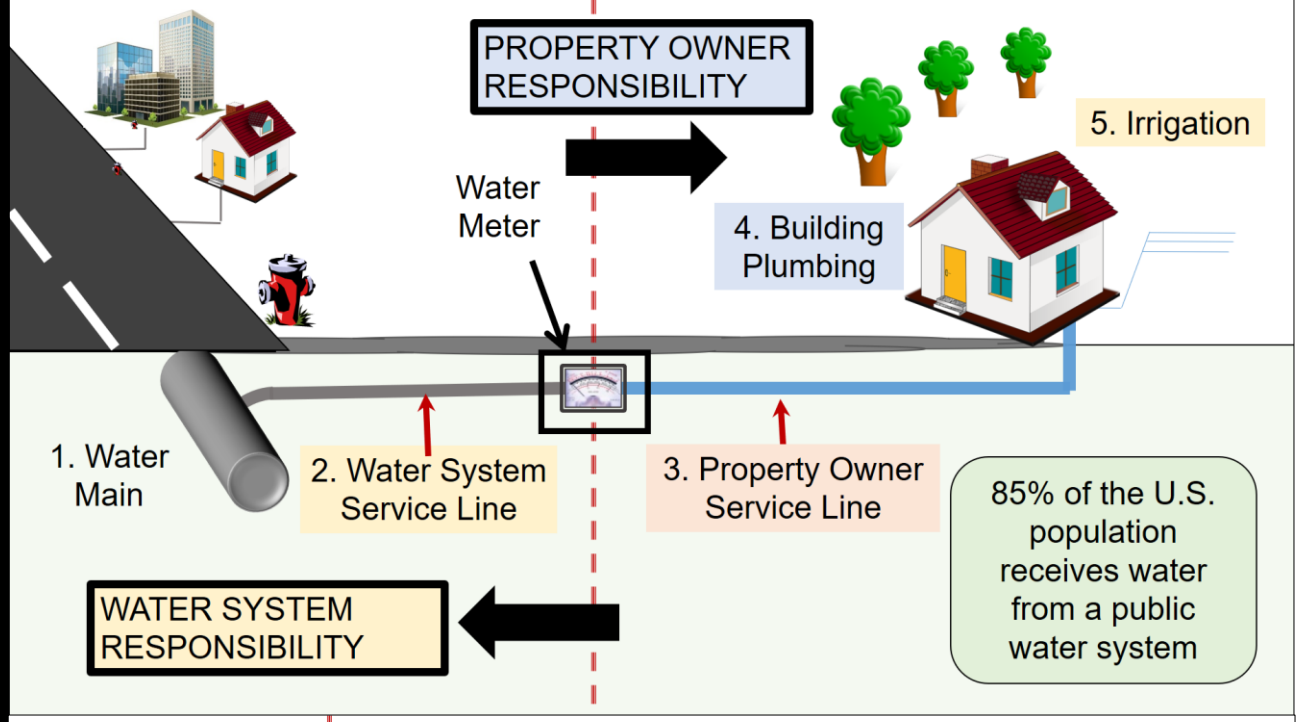
- ✓**Public Water Distribution:** uPVC, HDPE, FRP, EPDM, epoxy coatings, CIPP liners, Viton…
- ✓**Service lines:** HDPE, PEX, uPVC, CPVC, PB
- ✓**Plumbing:** HDPE, PERT, LDPE, MDPE, PEX, uPVC, PVC, CPVC, PB, PP, EPDM, NBR, epoxy coatings…
- ✓**Plumbing:** 5-10x the length of buried systems

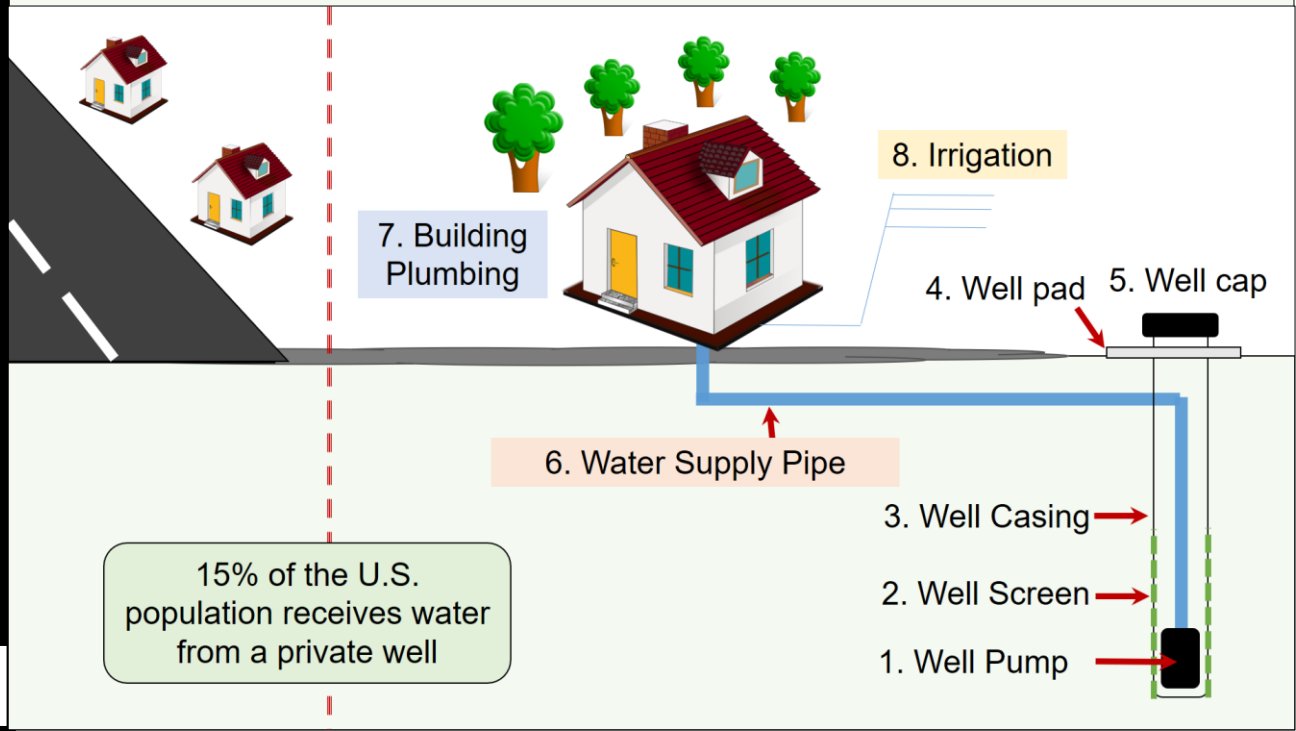


Wildfires threaten the health, safety, and economic security of communities

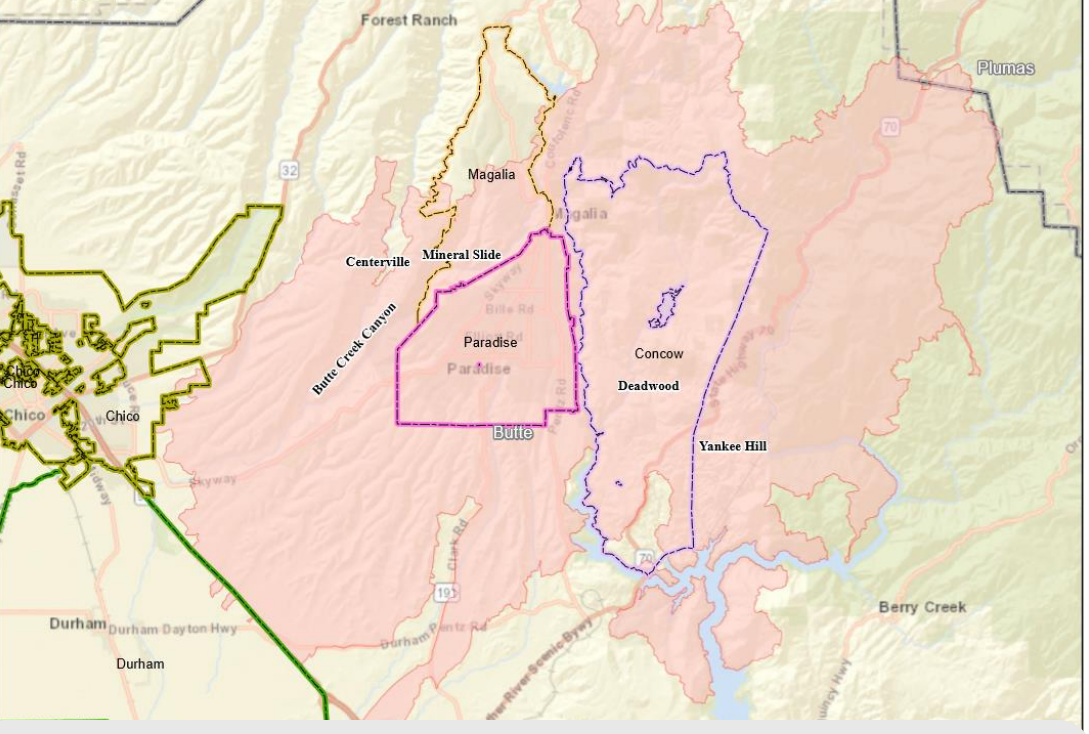
Water System Purpose

- ✓ Fire-fighting
- ✓ Hygiene, sanitation
- ✓ Healthcare
- ✓ Education
- ✓ Business
- ✓ Recreation
- ✓ Agriculture
- ✓ Industry





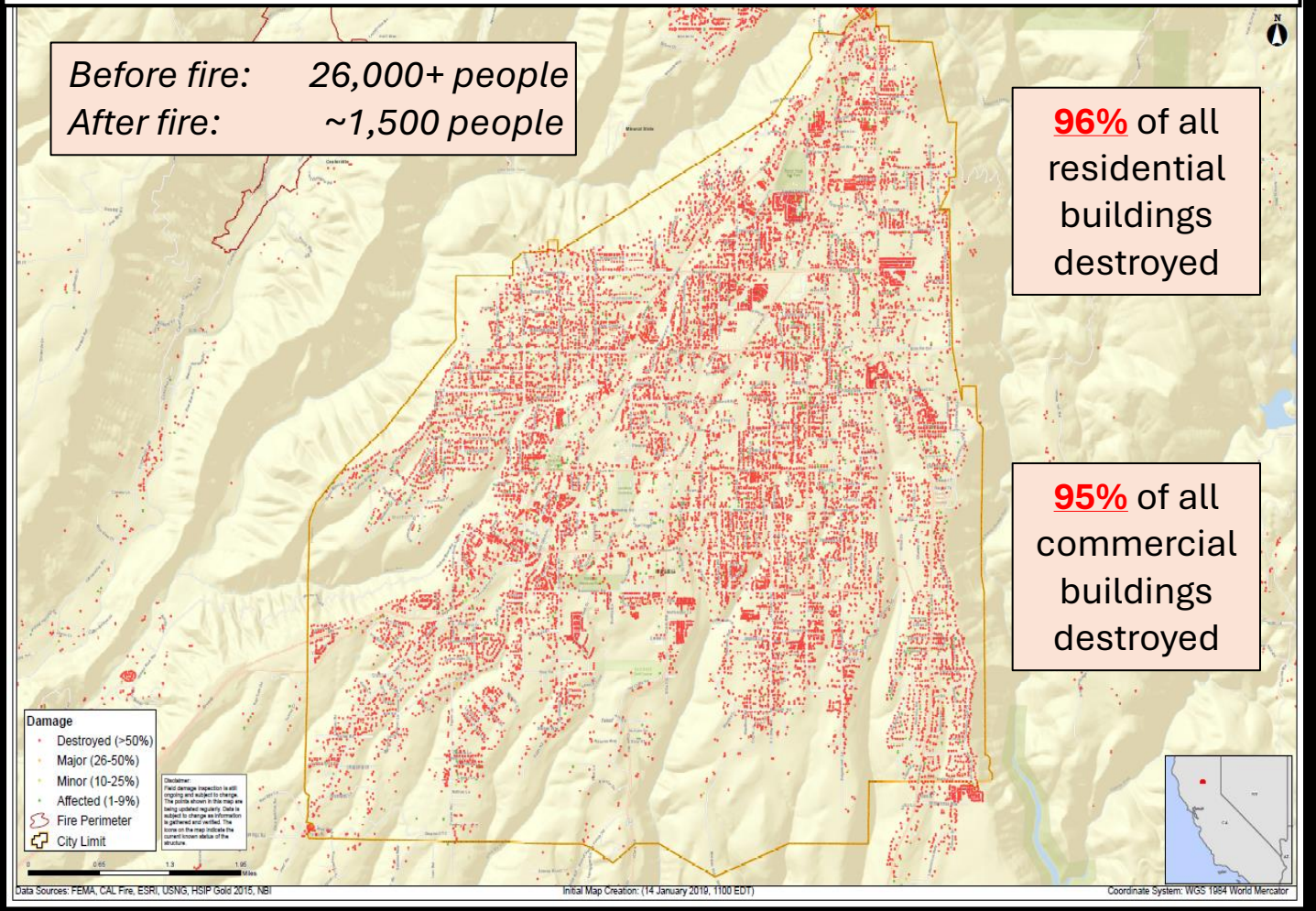
The 2018 Camp Fire in Paradise, California



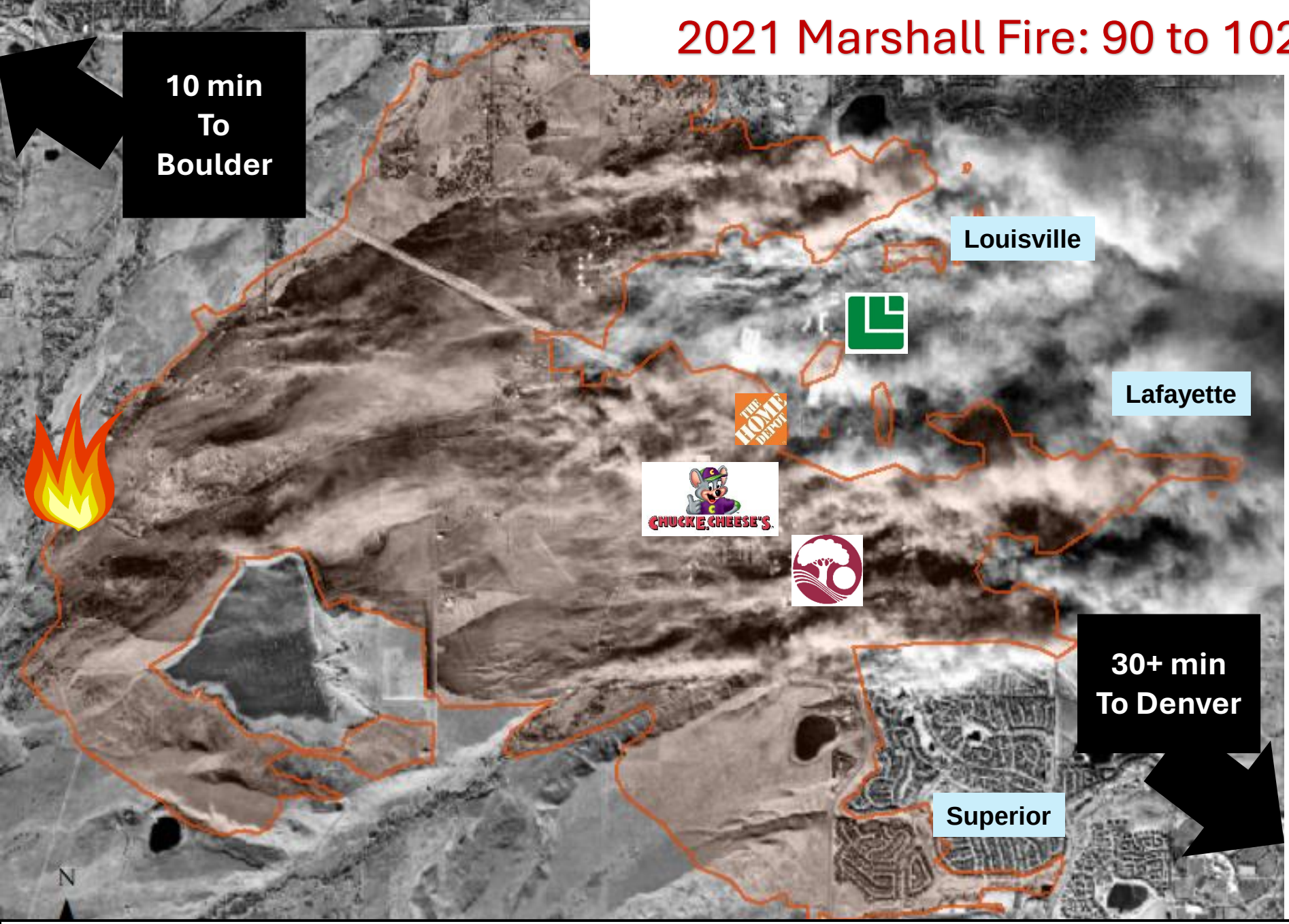
153,336 acres
86 fatalities

~13,972 residences destroyed
14,793 structures destroyed
3 firefighters injured

Town of Paradise Limits



2021 Marshall Fire: 90 to 102 mph wind gusts



December 30, 2021

11:06 am, Fire in Boulder Co.
12:10 pm, Fire in Superior
12:50 pm, Fire in Louisville
1:00pm, 1,000 acres

60,000+ evacuation ordered

The 3 largest communities
Louisville: 21,266
Superior: 13,094
Lafayette: 30,411

6 regulated water systems impacted and private wells

Hurricane Dora

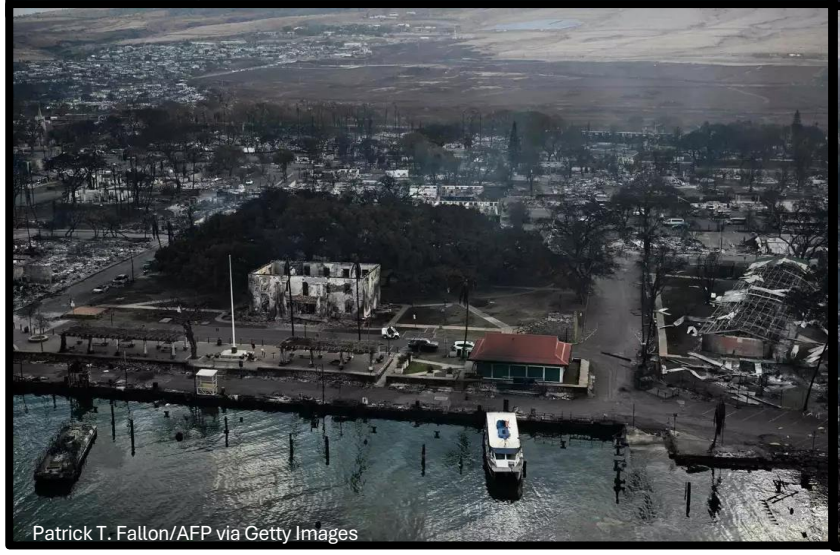
60-80 mph gusts onshore

Olinda Fire: 1,081 ac, 2 structures

Kula Fire: 202 ac, 544 structures

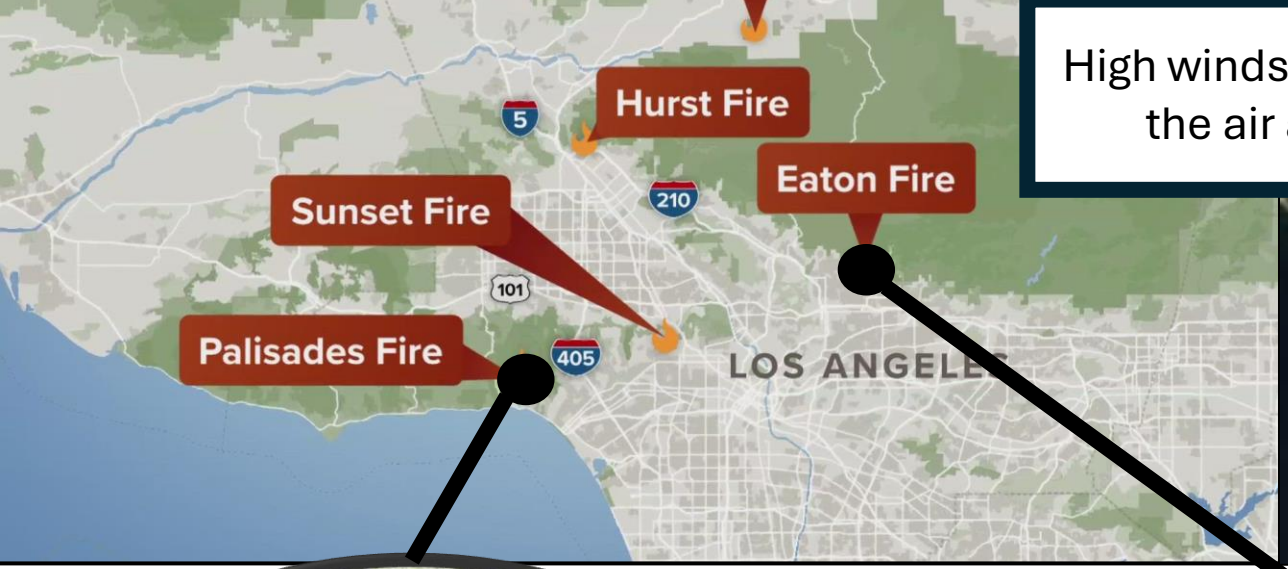
Lahaina Fire: 2,170 ac, 2,207 structures

Puelho Fire: 5,300 ac, 0 structures

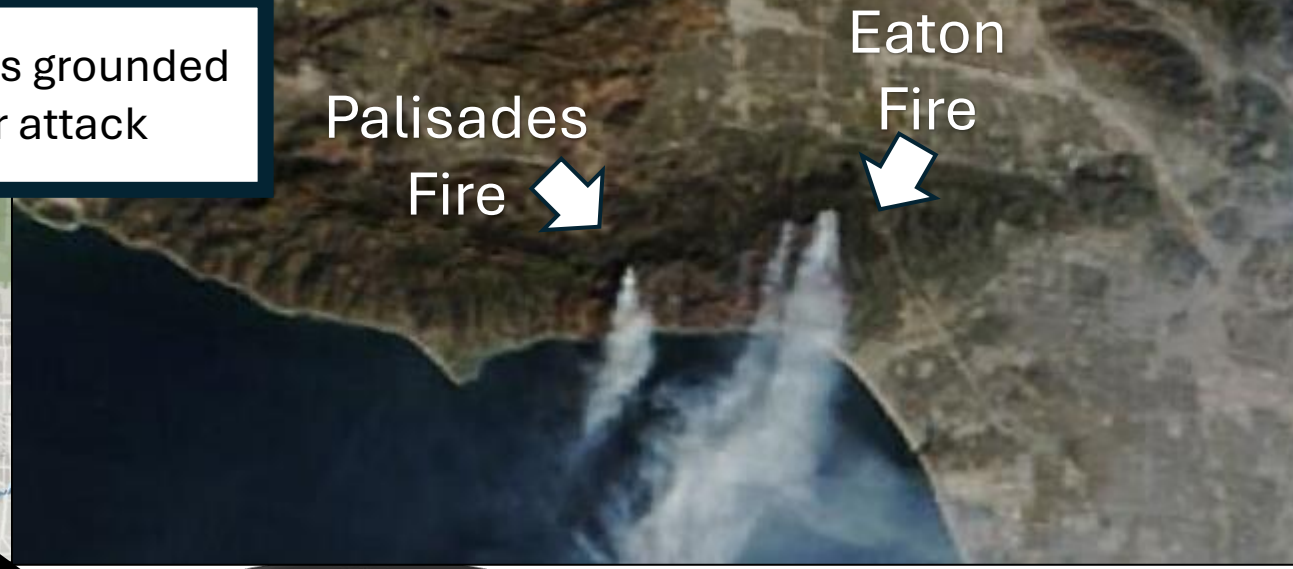


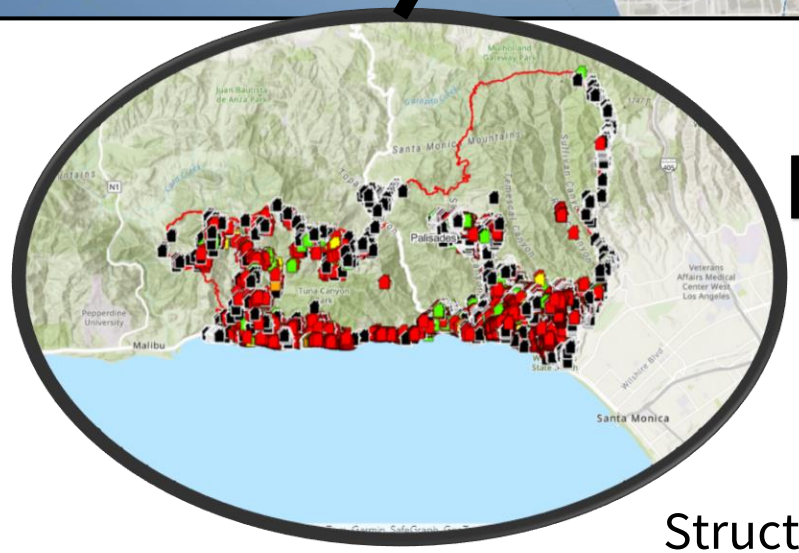
Deadliest wildfire incident in modern U.S. history

Maui Wildfires
August 8, 2023



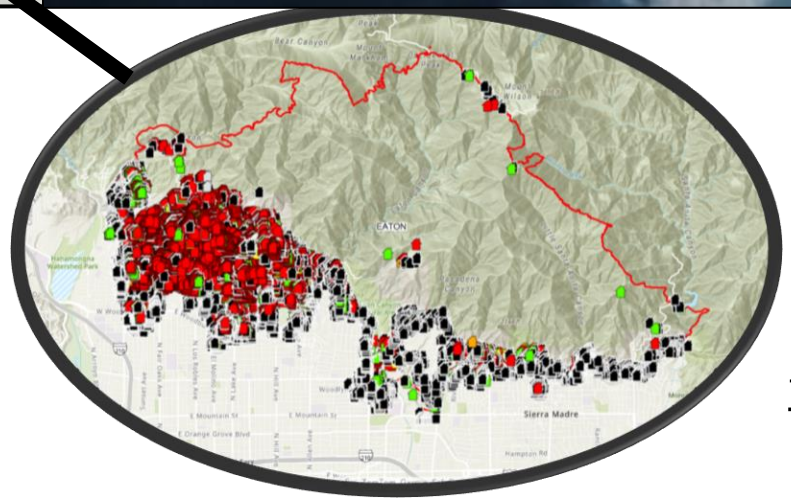
High winds grounded the air attack





Palisades Fire

23,707 acres
12 Fatalities
Structures Destroyed = 6,833
Structures Damaged = 973



Eaton Fire

14,021 acres
17 Fatalities
Structures Destroyed = 9,418
Structures Damaged = 1,073

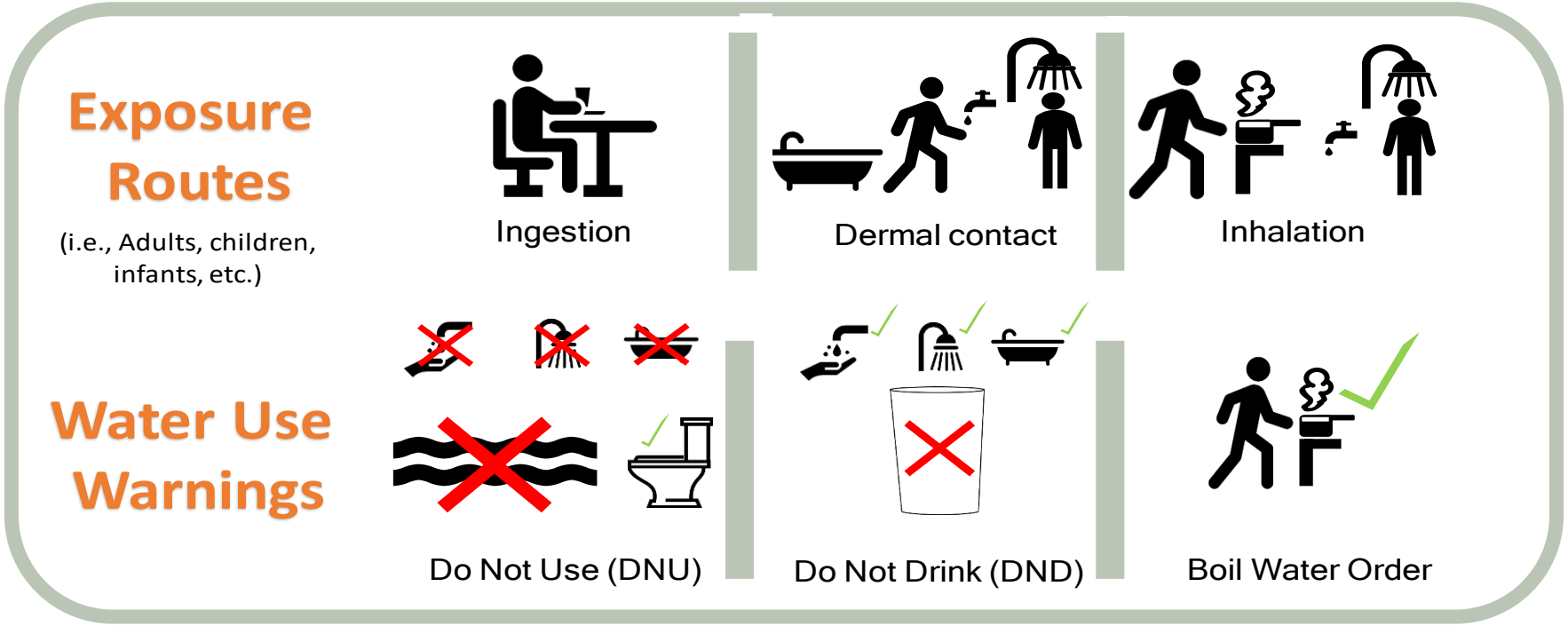
January 7, 2025: 180,000+ people were under evacuation in L.A. County.

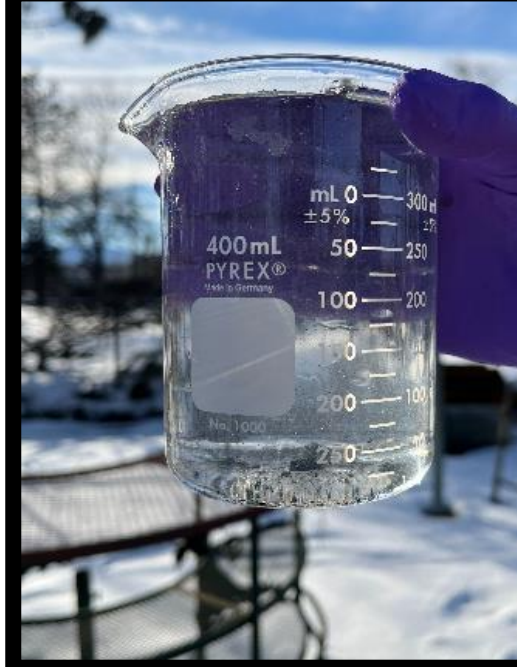
Challenge: Wildfires caused extreme drinking water contamination

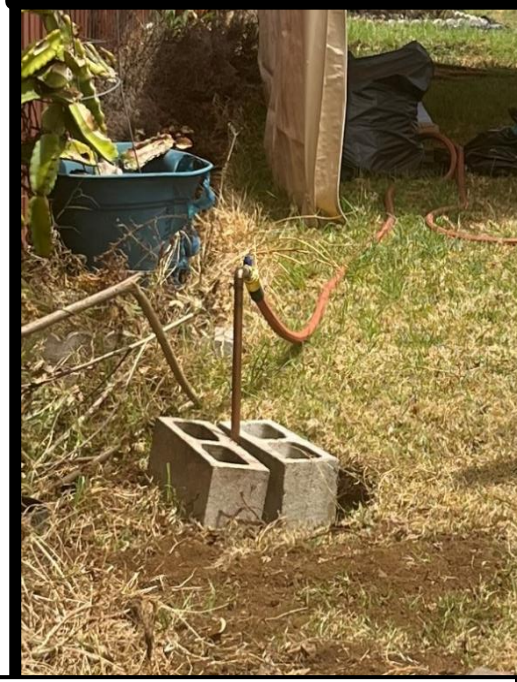
Immediate vs. long-term health risk

VOCs and other organic chemicals

Burned properties: Cross connections







AWWA Wat. Sci. 2020. *AWWA Wat. Sci*. 2023. *Env. Sci.: Wat. Res. Technol*. 2024.

Max. Benzene, ppb	Event / Location	Pop.	System	Year
440	Eaton Fire/ California	4,847	Las Flores Water Co.	2025
31	Eaton Fire/ California	16,126	Lincoln Ave. Water Co.	2025
22.5	Palisades Fire/ California	3,856,043	Los Angeles Dept. Water & Power	2025
40	Lahaina Fire/ Hawai'i	20,036	Maui County – Lahaina	2023
3.8	Kula Fire/ Hawai'i	7,686	Maui County – Upper Kula	2023
5.1	Marshall Fire/ Colorado	500	East Boulder County Water District	2021
220	Marshall Fire/ Colorado	20,319	City of Louisville	2021
5.5	Echo Mountain Fire/ Oregon	120	Whispering Pines Mobile Home Park	2020
11.3	Echo Mountain Fire/ Oregon	362	Hiland WC -Echo Mountain	2020
1.1	Echo Mountain Fire/ Oregon	760	Panther Creek Water District	2020
76.4	Almeda Fire/ Oregon	6,850	City of Talent	2020
44.9	Lionshead Fire/ Oregon	205	Detroit Water System	2020
1.5	North Complex Fire/ California	297	Lake Madrone Water District	2020
1.8	CZU Lightning Complex Fire/ California	1,650	Big Basin Water Company	2020
42	CZU Lightning Complex Fire/ California	21,145	San Lorenzo Valley Water District	2020
>2,217	Camp Fire/ California	26,032	Paradise Irrigation District	2018
38.3	Camp Fire/ California	924	Del Oro Water Co.-Magalia	2018
8.1	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

Oregon 2020 Fires - Regulated Contaminants

At least 7 PWSs contaminated in Oregon as of May 10, 2021

VOCs were the sole focus; EPA method 524.2 for VOCs was applied for all samples

[redacted]

Vinyl chloride and MTBE exceeded federal MCLs in water samples when there was NO benzene.

Methylene chloride was not reported above the 5 ppb MCL

Volatile Organic Compound	Maximum Concentration of Contaminant (ppb)							Exposure Limits (ppb)		
	Detroit Water System	City of Gates	Whispering Pines Mobile Home Park	City of Phoenix	City of Talent	Hiland WC-Echo Mountain	Panther Creek	Federal MCL	CA MCL	USEPA 1-day Health Advisory (for 10kg child)
Benzene	**44.9**	ND	**5.5**	ND	**76.4**	**11.3**	**1.1**	5	1	200
Vinyl Chloride	**0.6**	**8.2**	ND	ND	ND	ND	ND	2	0.5	3,000
Chlorobenzene	**127**	ND	6.08	ND	ND	4.6	ND	100	70	4,000
Dichloroethane	ND	ND	**1.05**	ND	ND	ND	ND	5	0.5	700
1,4-dichlorobenzene	**9**	ND	**10.8**	ND	ND	ND	ND	75	5	11,000
Methyl-*tert*-butyl ether (MTBE)	**358**	ND	ND	589	ND	3.17	ND	N/A	13	N/A
Service Population	205	490	120	4,630	6,850	362	760	___	___	___

Is benzene only testing appropriate?

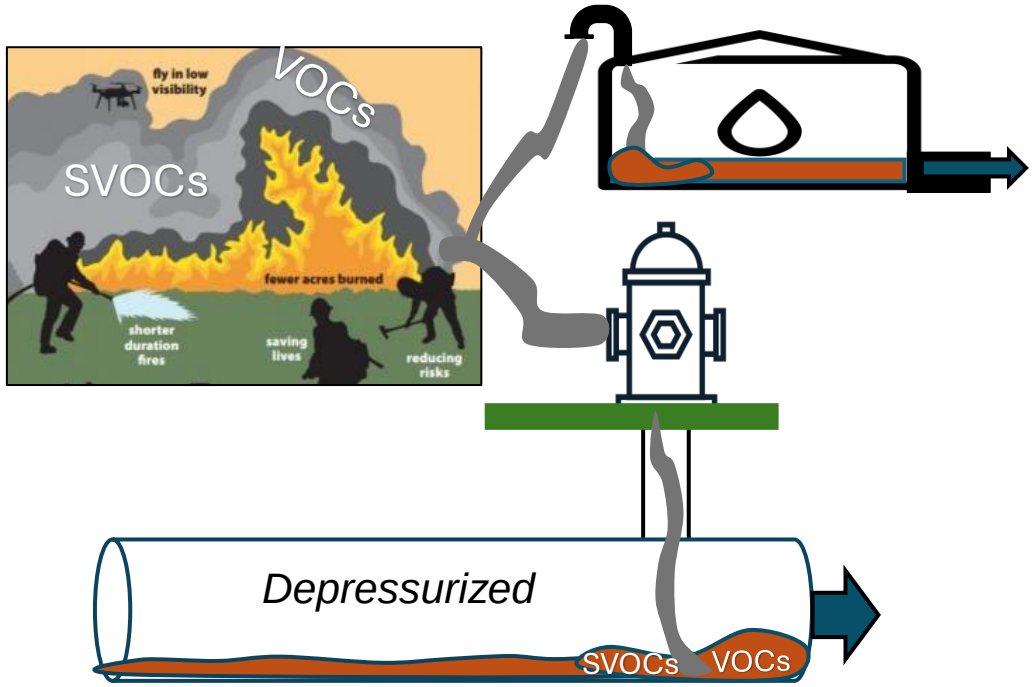
Not if you want to know if the water is safe.

***BOLD and RED* exceeded a health-based drinking water limit in a wildfire impacted water system as of March 2024**

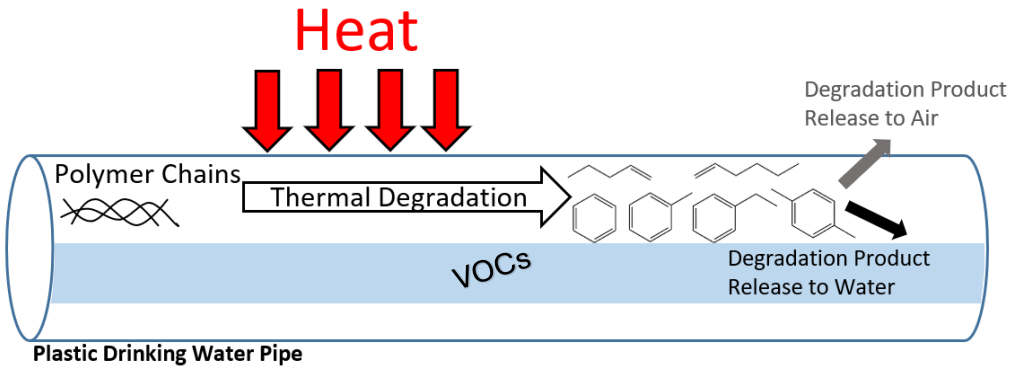
Acetonitrile	Chlorodibromomethane	Ethyl benzene	¥**Toluene****
¥Acetone	Chloromethane	**Ethylene dibromide (EDB) ****	1,2,3-Trichlorobenzene
Acrolein	4-Chlorotoluene	Ethyl-*tert*-butyl ether (ETBE)	1,2,4-Trichlorobenzene
Acrylonitrile	Dibromochloromethane	Iodomethane	1,1,1-Trichloroethane
¥**Benzene ****	**1,2-Dibromo-3-chloropropane (DBCP) ****	Isopropylbenzene	1,1,2-Trichloroethane
Bromochloromethane	1,2-Dichlorobenzene	**Methylene chloride****	Trichloroethylene
Bromodichloromethane	1,4-Dichlorobenzene	¥**Methyl ethyl ketone (MEK) ****	**Trichloromethane ****
Bromoform	1,1-Dichloroethane	Methyl iso butyl ketone (MIBK)	**1,2,3-Trichloropropane (TCP) ****
n-Butylbenzene	**1,2-Dichloroethane ****	**Methyl-*tert*-butyl ether (MTBE) ****	1,2,4-Trimethylbenzene
sec-Butylbenzene	1,1-Dichloroethene	¥**Naphthalene****	1,3,5-Trimethylbenzene
tert-Butylbenzene	*cis*-1,2-Dichloroethene	¥**Styrene****	**Vinyl chloride ****
Carbon disulfide	*trans*-1,2-Dichloroethylene	***tert*-Butyl alcohol (TBA) ****	¥*ortho*-Xylene
Carbon tetrachloride **	**1,2-Dichloropropane ****	Tetrachloroethylene	¥*meta*-Xylene
Chlorobenzene	¥Ethanol	**Tetrahydrofuran (THF) ****	¥*para*-Xylene

There are 3 PRIMARY ways water distribution systems become contaminated

1. Biomass and structure combustion



2. Plastic thermal degradation



3. Contaminated water and material back siphonage

Secondary Sources: Infrastructure desorption

Whelton et al. 2025. Post-Wildfire Distribution System Water Quality Impacts and Potential Responses, Project 5106. Water Research Foundation. Denver, CO.

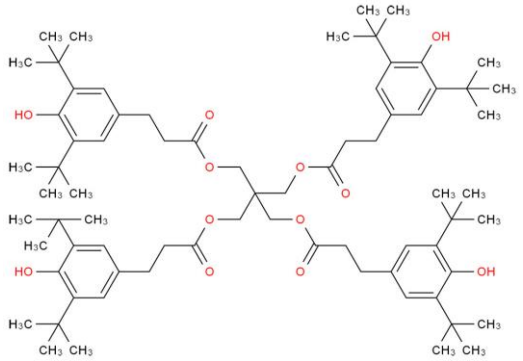
Commercial Plastics are More than Polymers

Resin

Poor mechanical properties

Low oxidative resistance

Not suitable for water conveyance



Antioxidants

Protect plastics against oxidation

Low water solubility

When consumed they become smaller, more soluble compounds

Carbon Black

UV stabilizer

Impacts on thermo-oxidative stability less clear

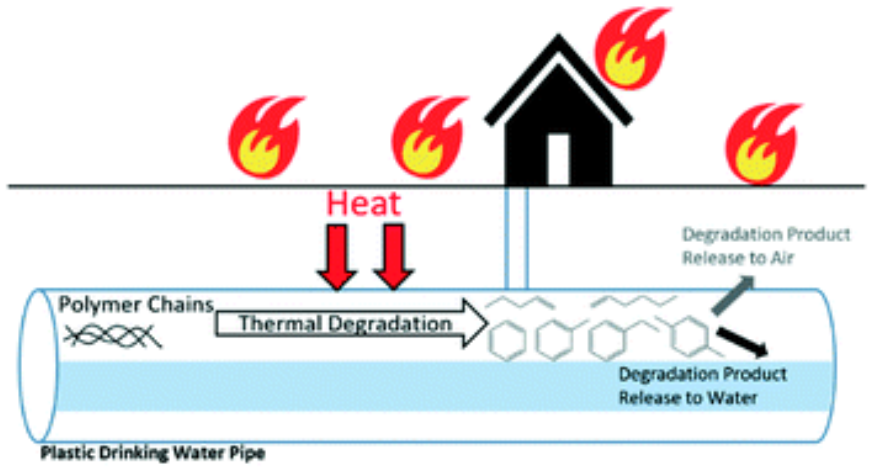
Other additives:

Plasticizers
Fillers
Lubricants
Colorants
And more…

December 2020 Study: Thermally damaged plastic pipes can be a source of water contamination

Environmental Science
Water Research & Technology

rsc.li/es-water



Drinking water contamination from the thermal degradation of plastics: implications for wildfire and structure fire response,

Download FREE here:

https://doi.org/10.1039/D0EW00836B

Heating new HDPE, PEX, PVC, CPVC, and PP pipes < T_{deg} generated VOCs *and* SVOCs

Benzene generated by heating all pipes except PP

Once plastic cooled, chemicals leached into water

200-400˚C	Confirmation of BTEX Components in Water				Number of TICs in extract[a]	
Material	B	T	E	X	Water	*n*-Hexane
Cold water pipes						
PVC	✓	✓	–	–	4	41
HDPE	✓	✓	✓	✓	14	100
Hot and cold water pipes						
CPVC	✓	–	–	–	3	32
PEX-a1-a	✓	✓	✓	✓	19	123
PEX-a1-b	✓	✓	✓	✓	16	122
PEX-a2	✓	✓	✓	✓	22	117
PEX-b	✓	✓	✓	✓	18	127
PEX-c1-a	✓	✓	✓	✓	19	133
PEX-c1-b	✓	✓	✓	✓	17	134
PEX-c1-EVOH	✓	✓	✓	✓	20	109
PP	–	✓	–	–	6	95

Fires are often >200˚C, but ground temperature can be >100˚C for hrs. Root fires can last days to weeks.

Chemistry:

Polymer chain scission
Aromatization
The role of additives
The role of temperature
The role of RH
The role of O_2
Partitioning after generation

Building codes never considered damaged plastic water system materials becoming a 1˚ or 2˚ source of drinking water contamination.

*(est. 300,000 structure fires per year – per **NFPA**)*

2022, Wildfires can contaminate drinking water systems both by thermal damage to *plastic pipes and intrusion of smoke*

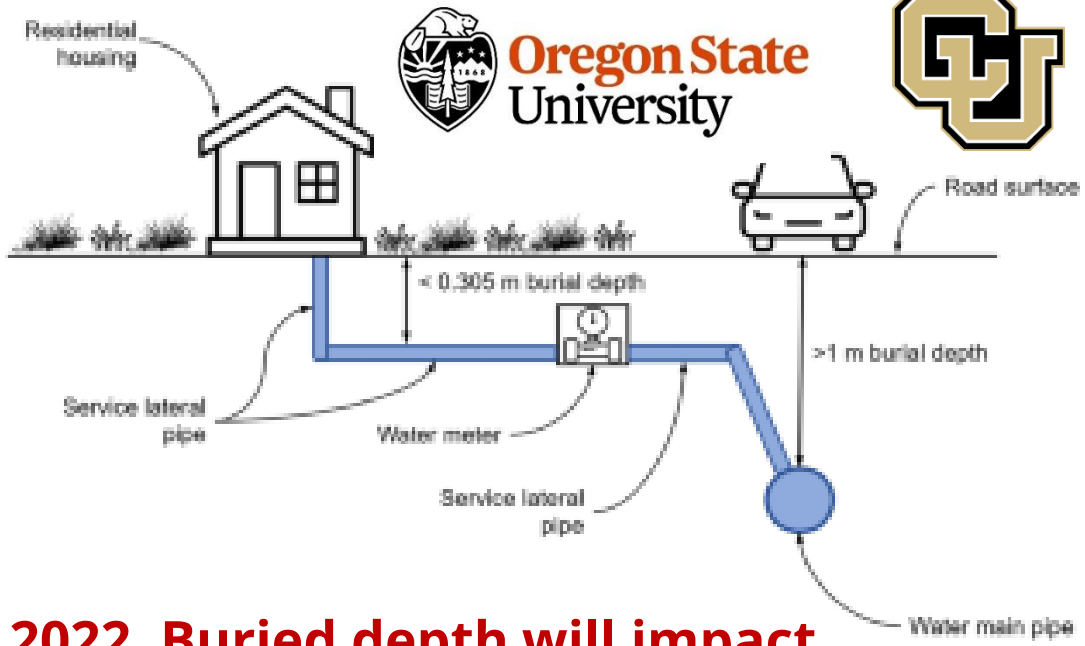
Characterized target and nontarget VOCs and SVOCs in water from **1** contaminated service line after the Camp Fire.

New PVC, PEX, and HDPE pipe **heating experiments** conducted

Results

PVC pipe heating: 32 compounds
HDPE/PEX pipes heating: 28 compounds
Service line: 55 compounds for uncontrolled burning of biomass and waste materials.

Draper et al. 2022. ACS EST Water.



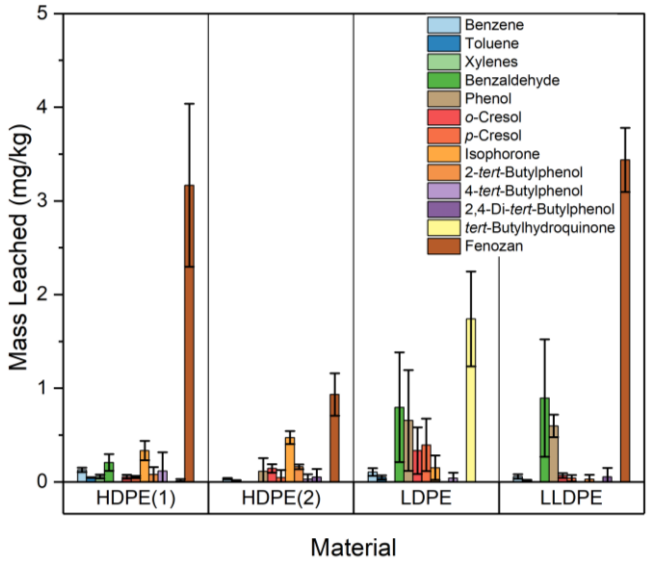
2022, Buried depth will impact thermal vulnerability

Mathematical Thermal Modeling Results

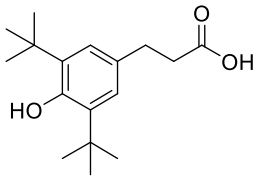
- 200°C assumed exposure
- Upper limit temp. for pressure service was exceeded at depths at 0.45 m (1.5 ft) depth
- Upper limit temp. exceeded at least 50% of the time at 0.19 m (0.6 ft) depth

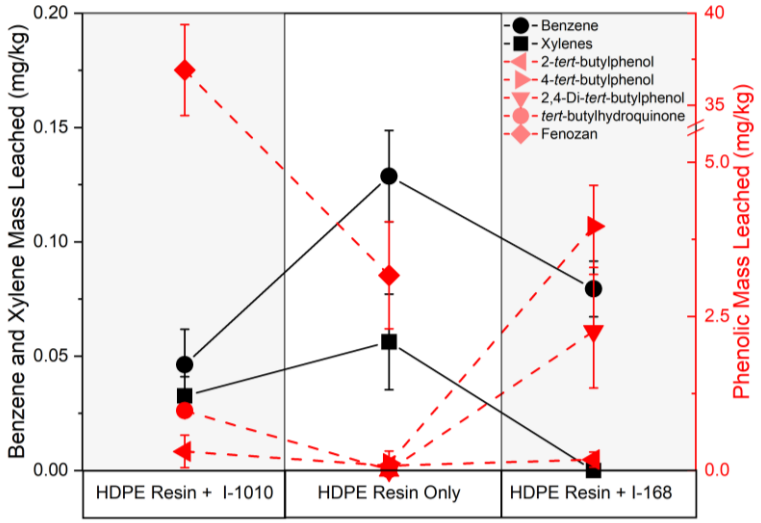
Metz et al. 2022. Fire Technology.

PE resin type, AOX loading, and carbon black influenced VOCs found in water

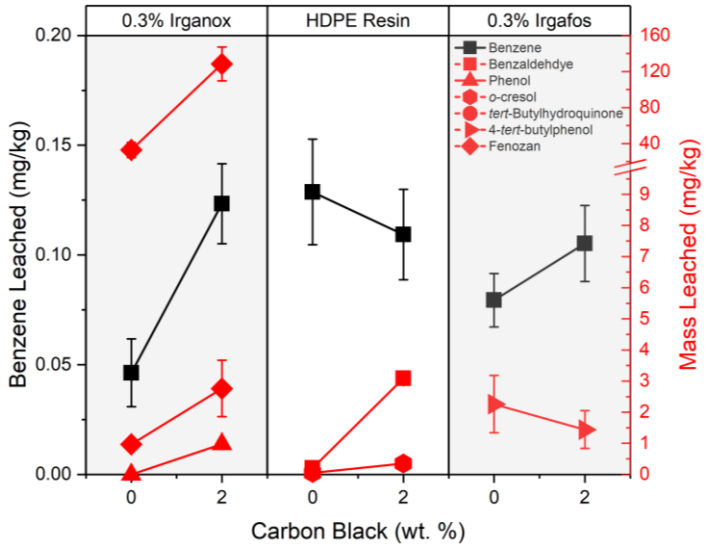


Type of virgin resin impacted VOCs found in water and AOX created Fenozan





The presence of AOX decreased benzene-xylene leached but increased AOX degradation products



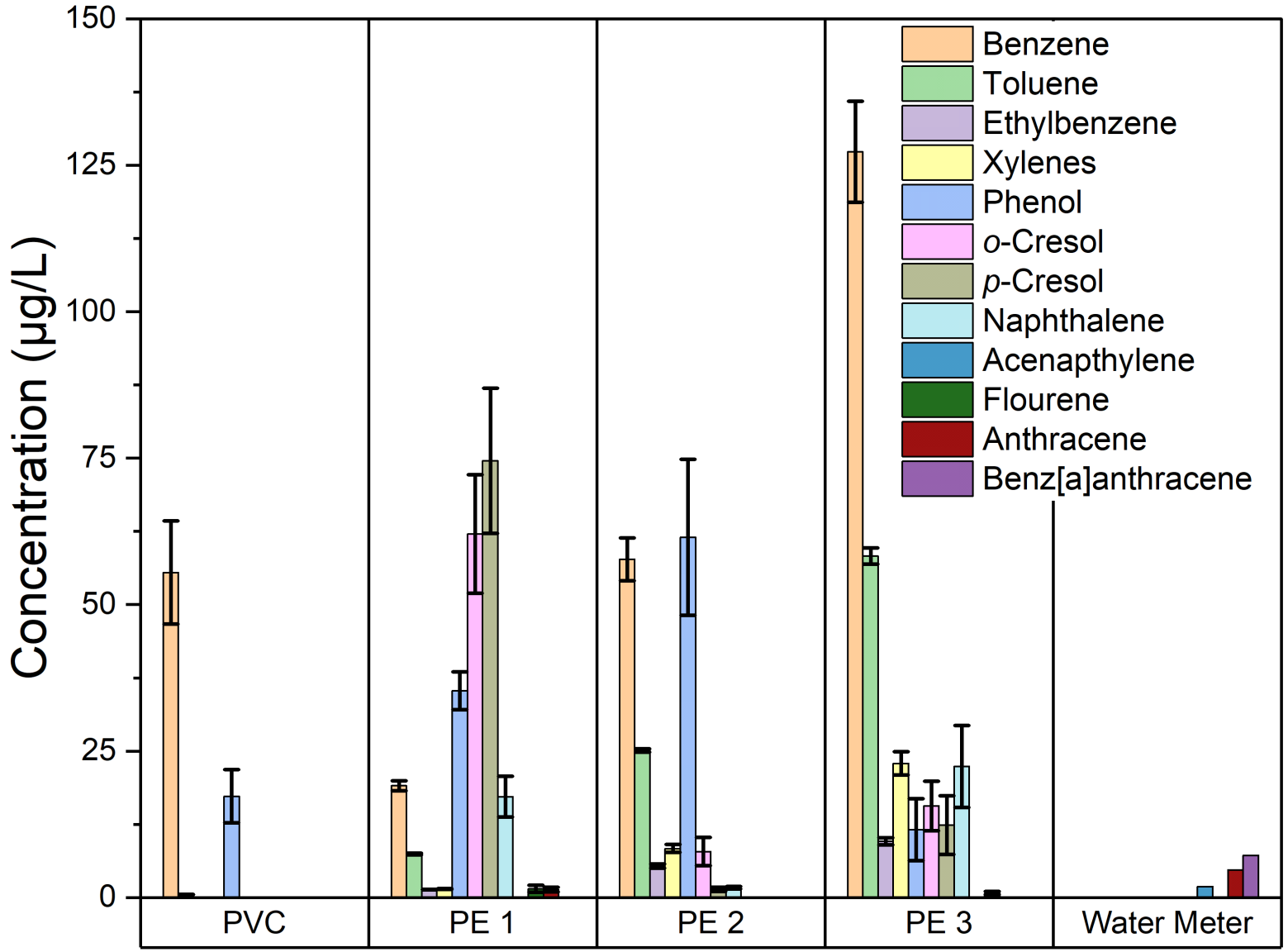
CB had complex impacts on VOCs found in water

When CB ↑, benzene ↓
When AOX1 ↑, benzene ↓
When AOX2 ↑, benzene ↓
When CB + AOX, benzene =

PURDUE UNIVERSITY

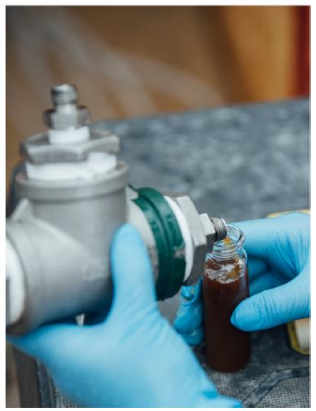
Isaacson et al. 2025. *J. HAZMAT.* https://doi.org/10.1016/j.jhazmat.2025.137562

Exhumed Materials Leached VOC *and SVOCs*



Isaacson et al. 2025. *J. HAZMAT.* https://doi.org/10.1016/j.jhazmat.2025.137562

Pilot Study on Fire Effluent Condensate from Full Scale Residential Fires



Exp. #	Room 1: 1	Room 1: 2	Room 2: 3	Room 2: 4	Room 2: 5
pH	2.56	1.10	1.93	1.96	1.59
Bromide	<3.0	5.5	6.6	9.8	13
Chloride	270	39,000	3,000	2,400	4,700
Nitrate	13	2.4	5.7	<1.0	6.4
Sulfate	330	9,200	2,700	2,100	2,300

ppb

Exp. #	Room 1: 1	Room 1: 2	Room 2: 3	Room 2: 4	Room 2: 5
Benzene	1,100	6,400	2,600	3,600	33,000
Styrene	<400	1,200	470*	1,400	1,800
Toluene	180*	1,000	<340	660	3,900
Xylenes	<290	110*	<740	153	910*
Naphthalene	2,700*	8,100	7,400*	8,100	10,000
2-Butanone	2,100*	3,600*	7,300*	13,000	31,000
Acetone	57,000	31,000	74,000	110,000	250,000
Ethanol	<40,000	<40,000	67,000*	49,000	61,000*

Chemicals often not looked for in water systems post-fire

Horn et al. 2023. *Fire Technology.*

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Butte College

School of Public Health, University of California, Berkeley

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Oregon State University

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ORIGINAL RESEARCH

AWWA WATER SCIENCE

Wildfire caused widespread drinking water distribution network contamination

Caitlin R. Proctor[1,2,3,4] | Juneseok Lee[5] | David Yu[4,6] | Amisha D. Shah[3,4] | Andrew J. Whelton[3,4]

Natural Hazards (2021) 108:947–975
https://doi.org/10.1007/s11069-021-04714-9

ORIGINAL PAPER

Check for updates

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

Tolulope O. Odimayomi[1] · Caitlin R. Proctor[2] · Qi Erica Wang[1] · Arman Sabbaghi[3] · Kimberly S. Peterson[4] · David J. Yu[5] · Juneseok Lee[6] · Amisha D. Shah[7] · Christian J. Ley[1] · Yoorae Noh[8] · Charlotte D. Smith[9,10] · Jackson P. Webster[11] · Kristin Milinkevich[12] · Michael W. Lodewyk[12] · Julie A. Jenks[13,14] · James F. Smith[15] · Andrew J. Whelton[7]

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Drinking water contamination from the thermal degradation of plastics: implications for wildfire and structure fire response†

Kristofer P. Isaacson,[a] Caitlin R. Proctor,[ab] Q. Erica Wang,[a] Ethan Y. Edwards,[a] Yoorae Noh,[c] Amisha D. Shah[ac] and Andrew J. Whelton[ab]

ACS ES&T Water

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pubs.acs.org/estwater

Article

Prediction of Water Distribution System Contamination Based on Wildfire Burn Severity in Wildland Urban Interface Communities

Stefanie S. Schulze* and Erica C. Fischer

PURDUE UNIVERSITY

HAWAI'I

Environmental Science Water Research & Technology

ROYAL SOCIETY OF CHEMISTRY

COMMUNICATION

View Article Online

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Two weeks after the 2023 Maui wildfires: drinking water experiences and needs†

Andrew J. Whelton, Paula D. Coelho, Christopher Shuler, Aurora Kagawa-Viviani, Kellie D. P. Cole, Stefanie Surdyka and Stephanie Heffner

PURDUE UNIVERSITY

CORONA ENVIRONMENTAL CONSULTING

Oregon State University

ORIGINAL RESEARCH

AWWA WATER SCIENCE

The Marshall Fire: Scientific and policy needs for water system disaster response

Andrew J. Whelton[1] | Chad Seidel[2] | Brad P. Wham[3] | Erica C. Fischer[4] | Kristofer Isaacson[5] | Caroline Jankowski[5] | Nathan MacArthur[2] | Elizabeth McKenna[2] | Christian Ley*

UCSF

CDPH

California Water Boards

ACS ES&T Water

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Article

Organic Chemical Contaminants in Water System Infrastructure Following Wildfire

William M. Draper, Na Li, Gina M. Solomon, Yvonne C. Heaney, Reese B. Crenshaw, Richard L. Hinrichs, and R. Esala P. Chandrasena*

Oregon State University

Fire Technology, 58, 1889–1915, 2022
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https://doi.org/10.1007/s10694-022-01232-3

Check for updates

Simulation of Heat Transfer Through Soil for the Investigation of Wildfire Impacts on Buried Pipelines

UCSF

ACS ES&T Water

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Article

Fire and Water: Assessing Drinking Water Contamination After a Major Wildfire

Gina M. Solomon,* Susan Hurley, Catherine Carpenter, Thomas M. Young, Paul English, and Peggy Reynolds

FIRE SAFETY RESEARCH INSTITUTE UL

Fire Technology, 60, 1–18, 2024
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Manufactured in The United States
https://doi.org/10.1007/s10694-023-01487-4

Check for updates

Pilot Study on Fire Effluent Condensate from Full Scale Residential Fires

Gavin P. Horn and Nicholas W. Dow*, Fire Safety Research Institute, UL Research Institutes, Columbia, MD 21045, USA*
Danielle L. Neumann, Enterprise Sustainability, UL Solutions, Brea, CA 92821, USA

PURDUE UNIVERSITY

Environmental Science & Technology

pubs.acs.org/est

Residential Water Soft… Require Remediation …

Caroline M. Jankowski, Lauren A. … Aliya B. Ehde, Madeline B. Larsen, William J. Schmidt, Amisha D. Sh…

ORIGINAL RESEARCH

AWWA WATER SCIENCE

Plastic water supp… contamination, an…

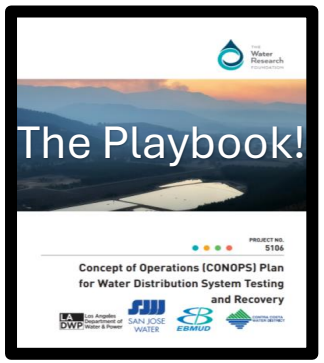
Kristofer P. Isaacson[1] | … Amisha D. Shah[4] | Andr…

ORIGINAL RESEARCH

AWWA WATER SCIENCE

Wildfire damage and contamination to private drinking water wells

Caroline Jankowski[1] | Kristofer Isaacson[1] | Madeline Larsen[1] | Christian Ley[2] | Myles Cook[1] | Andrew J. Whelton[1]



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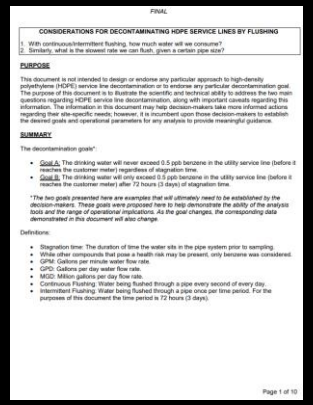
Post-Fire Sampling...



FINAL

CONSIDERATIONS FOR DECONTAMINATING HDPE SERVICE LINES BY FLUSHING

1. With continuous/intermittent flushing, how much water will we consume?
2. Similarly, what is the slowest rate we can flush, given a certain pipe size?

PURPOSE

This document is not intended to design or endorse any particular approach to high-density polyethylene (HDPE) service line decontamination or to endorse any particular decontamination goal. The purpose of this document is to illustrate the scientific and technical ability to address the two main questions regarding HDPE service line decontamination, along with important caveats regarding this information. The information in this document may help decision-makers take more informed actions regarding their site-specific needs; however, it is incumbent upon those decision-makers to establish the desired goals and operational parameters for any analysis to provide meaningful guidance.

SUMMARY

The decontamination goals*:

- Goal A: The drinking water will never exceed 0.5 ppb benzene in the utility service line (before it reaches the customer meter) regardless of stagnation time.
- Goal B: The drinking water will only exceed 0.5 ppb benzene in the utility service line (before it reaches the customer meter) after 72 hours (3 days) of stagnation time.

*The two goals presented here are examples that will ultimately need to be established by the decision-makers. These goals were proposed here to help demonstrate the ability of the analysis tools and the range of operational implications. As the goal changes, the corresponding data demonstrated in this document will also change.

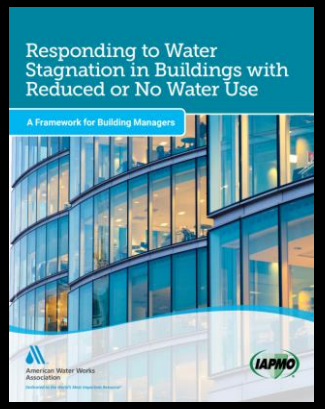
Definitions:

- Stagnation time: The duration of time the water sits in the pipe system prior to sampling.
- While other compounds that pose a health risk may be present, only benzene was considered.
- GPM: Gallons per minute water flow rate.
- GPD: Gallons per day water flow rate.
- MGD: Million gallons per day flow rate.
- Continuous Flushing: Water being flushed through a pipe every second of every day.
- Intermittent Flushing: Water being flushed through a pipe once per time period. For the purposes of this document the time period is 72 hours (3 days).

Page 1 of 10

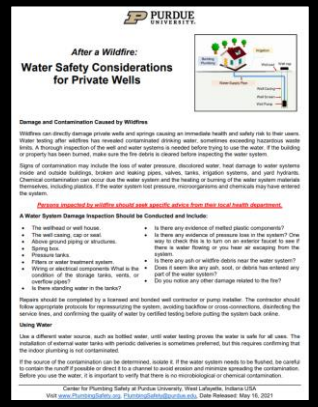
2019

Inside Buildings...



2020

Private wells...



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After a Wildfire:

Water Safety Considerations for Private Wells

Damage and Contamination Caused by Wildfires

Wildfires can directly damage private wells and springs causing an immediate health and safety risk to their users. Water testing after wildfires has revealed contaminated drinking water, sometimes exceeding hazardous waste limits. A thorough inspection of the well and water systems is needed before trying to use the water. If the building or property has been burned, make sure the fire debris is cleared before inspecting the water system.

Signs of contamination may include the loss of water pressure, discolored water, heat damage to water systems inside and outside buildings, broken and leaking pipes, valves, tanks, irrigation systems, and yard hydrants. 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 may have entered 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 wellhead or well house.
- The well casing, cap or seal.
- Above ground piping or structures.
- Spring box.
- Pressure tanks.
- Filters or water treatment system.
- Wiring or electrical components What is the condition of the storage tanks, vents, or overflow pipes?
- Is there standing water in the tanks?
- Is there any evidence of melted plastic components?
- Is there any evidence of pressure loss in the system? One way to check this is to turn on an exterior faucet to see if there is water flowing or you hear air escaping from the system.
- Is there any ash or wildfire debris near the water system?
- Does it seem like any ash, soot, or debris has entered any part of the water system?
- Do you notice any other damage related to the fire?

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

Using Water

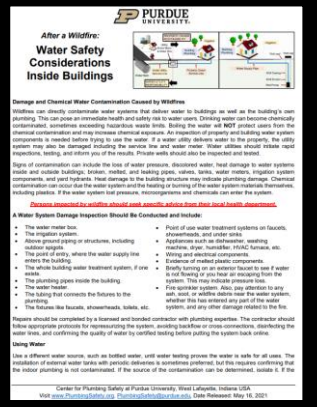
Use a different water source, such as bottled water, until water testing proves the water is safe for all uses. The installation of external water tanks with periodic deliveries is sometimes preferred, but this requires confirming that the indoor plumbing is not contaminated.

If the source of the contamination can be determined, isolate it. If the water system needs to be flushed, be careful to contain the runoff if possible or direct it to a channel to avoid erosion and minimize spreading the contamination. Before you use the water, it is important to verify that there is no microbiological or chemical contamination.

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

2021

Inside Buildings...



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 indicating 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 may 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.

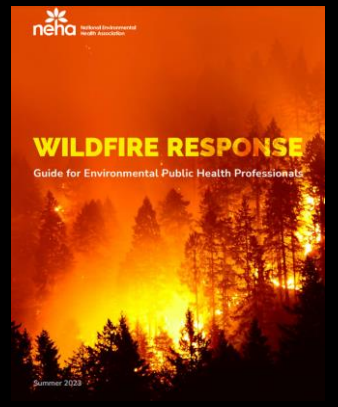
Repairs should be completed by a licensed and bonded contractor with plumbing expertise. The contractor should follow appropriate protocols for representing the system, avoiding backflow or cross-connections, disinfecting the water lines, and confirming the quality of water by certified testing before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

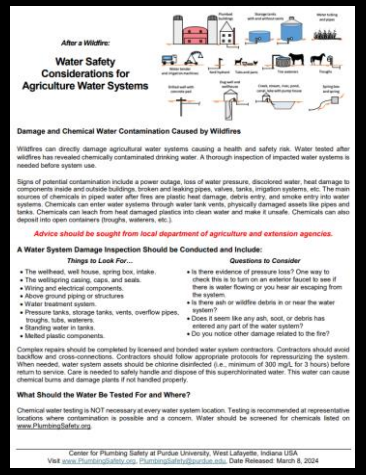
2021

Environmental health basics...



2023

Agricultural water systems...



After a Wildfire:

Water Safety Considerations for Agriculture Water Systems

Damage and Chemical Water Contamination Caused by Wildfires

Wildfires can directly damage agricultural water systems causing a health and safety risk. Water tested after wildfires has revealed chemically contaminated drinking water. A thorough inspection of impacted water systems is needed before system use.

Signs of potential contamination include a power outage, loss of water pressure, discolored water, heat damage to components inside and outside buildings, broken and leaking pipes, valves, tanks, irrigation systems, etc. The main sources of chemicals in piped water after fires are plastic heat damage, debris entry, and smoke entry into water systems. Chemicals can enter water systems through water tank vents, physically damaged assets like pipes and tanks. Chemicals can leach from heat damaged plastics into clean water and make it unsafe. Chemicals can also deposit into open containers (troughs, waterers, etc.).

Advice should be sought from local department of agriculture and extension agencies.

A Water System Damage Inspection Should be Conducted and Include:

Things to Look For...	*Questions to Consider*
• The wellhead, well house, spring box, intake. • The wellspring casing, caps, and seals. • Wiring and electrical components. • Above ground piping or structures • Water treatment system. • Pressure tanks, storage tanks, vents, overflow pipes, troughs, tubs, waterers. • Standing water in tanks. • Melted plastic components.	• Is there evidence of pressure loss? One way to check this is to turn on an exterior faucet to see if there is water flowing or you hear air escaping from the system. • Is there ash or wildfire debris in or near the water system? • Does it seem like any ash, soot, or debris has entered any part of the water system? • Do you notice other damage related to the fire?

Complex repairs should be completed by licensed and bonded water system contractors. Contractors should avoid backflow and cross-connections. Contractors should follow appropriate protocols for representing the system. When needed, water system assets should be chlorine disinfected (i.e., minimum of 300 mg/L for 3 hours) before return to service. Care is needed to safely handle and dispose of this superchlorinated water. This water can cause chemical burns and damage plants if not handled properly.

What Should the Water Be Tested For and Where?

Chemical water testing is NOT necessary at every water system location. Testing is recommended at representative locations where contamination is possible and a concern. Water should be screened for chemicals listed on www.PlumbingSafety.org

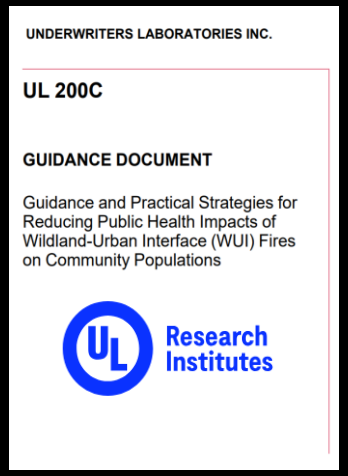
Center for Plumbing Safety at Purdue University, West Lafayette, Indiana USA
Visit www.PlumbingSafety.org PlumbingSafety@purdue.edu Date Released: March 8, 2024

2023

Bipartisan Commission report...

2023

Public health basics...



UNDERWRITERS LABORATORIES INC.

UL 200C

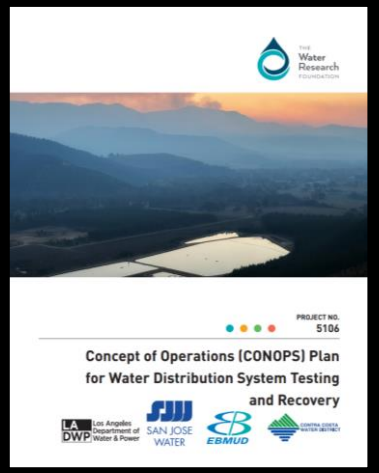
GUIDANCE DOCUMENT

Guidance and Practical Strategies for Reducing Public Health Impacts of Wildland-Urban Interface (WUI) Fires on Community Populations

UL Research Institutes

2024

Post-fire utility and health decisions



2024

...

PURDUE UNIVERSITY

Partnerships and Strategy

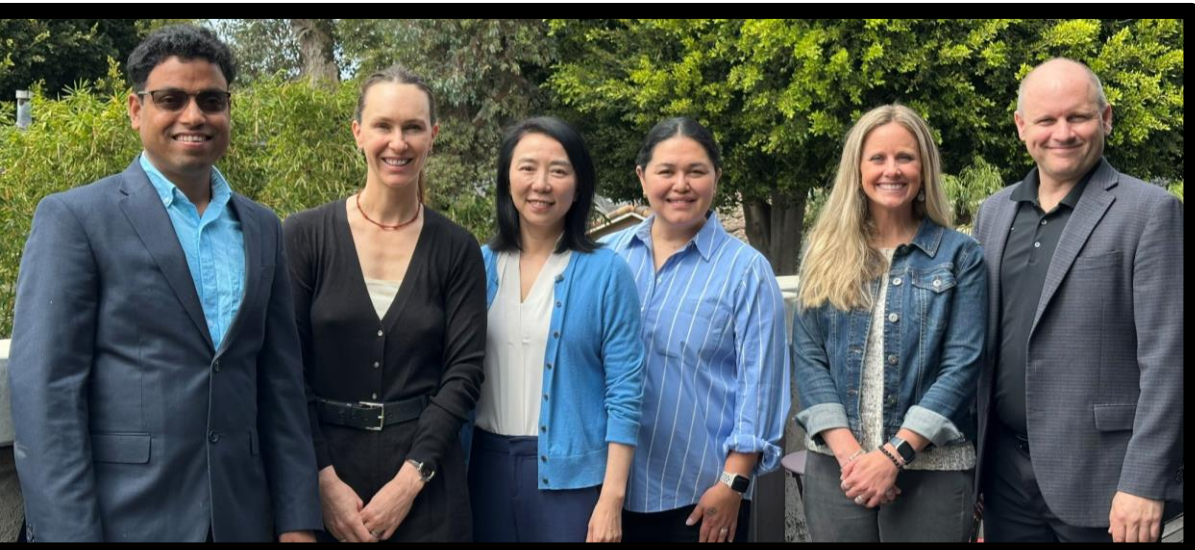
Community Action Project
Los Angeles

CAP.LA

R&S KAYNE FOUNDATION

Empowering Knowledge with Discovery

- Property soil testing
- Swimming pool testing
- Outdoor air testing
- Indoor air testing
- Personal affects testing
- Household survey study
- Household testing report study



Providing households 1-on-1 feedback on their contractor test results

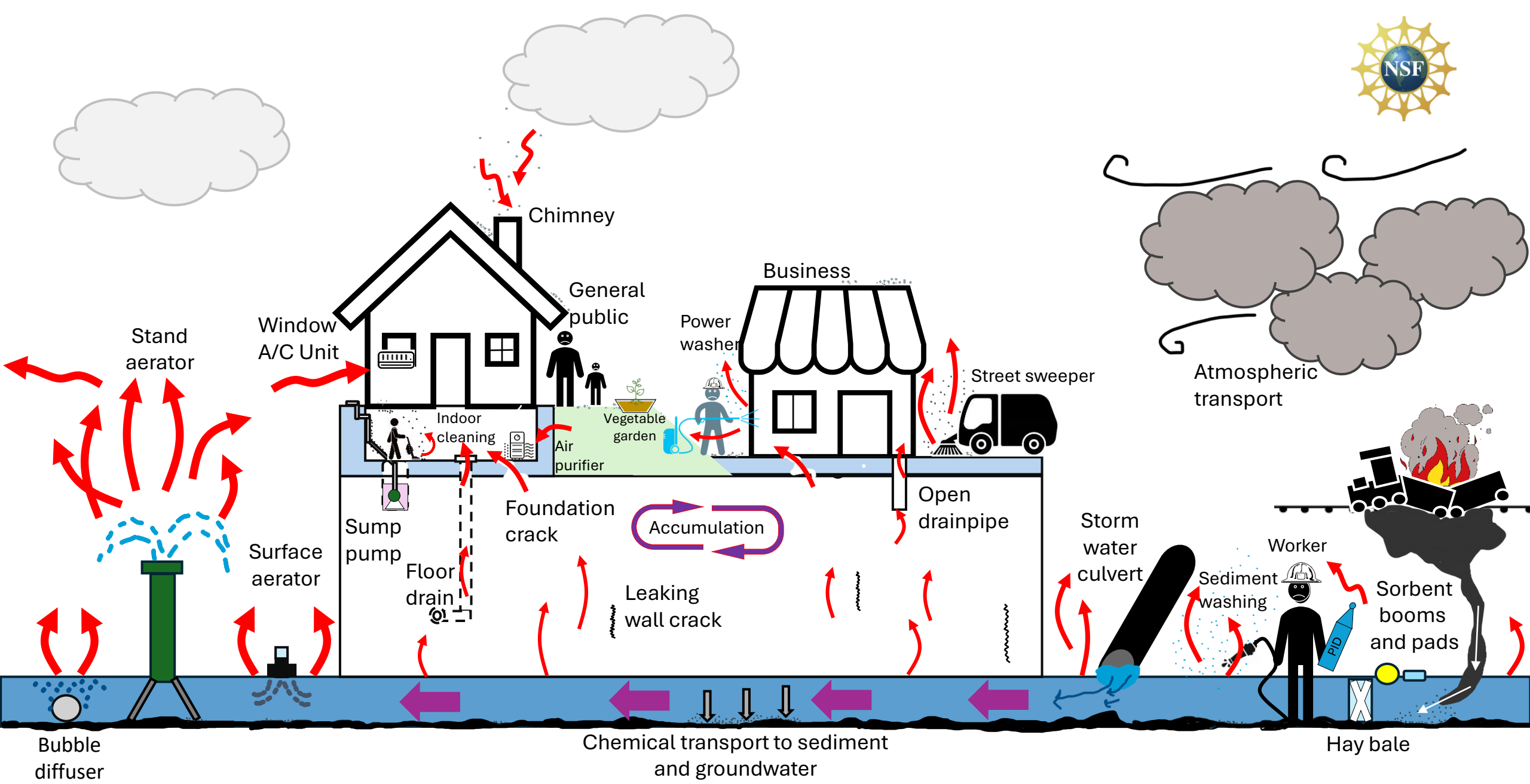
Advising local, county, and state officials

Advising nonprofit organizations

Sharing discoveries more broadly

Among other things…

PURDUE UNIVERSITY · UCLA · Loyola Marymount University · Cal Poly Pomona · USC · Tufts UNIVERSITY · University of Kentucky



Coelho et al. 2024. *Env. Sci.: Wat. Res. Technol.*

Layer of floating organic solvents

Multiple materials:

- Resin
- Particulates
- Water saturated with VOCs, SVOCs

Waxy-substance

Our 2017 NSF RAPID Cured in Place Pipe (CIPP) Study: Plastic manufacturing waste was a multiphase chemical mixture, **NOT Steam** (vapors, particulates, droplets, partially cured resin, nanoplastics, etc.)

Teimouri et al. 2017. *Environ. Sci. Technol. Letters.*
https://doi.org/10.1021/acs.estlett.7b00237

PURDUE UNIVERSITY

Release of Bisphenol A and Other Volatile Chemicals from New Epoxy Drinking Water Pipe Liners: The Role of Manufacturing Conditions

Manufacture

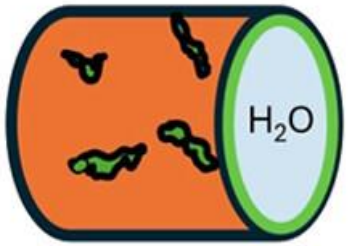
Resin
12 wt% volatile material

Normal drying hardener
48 wt% volatile material

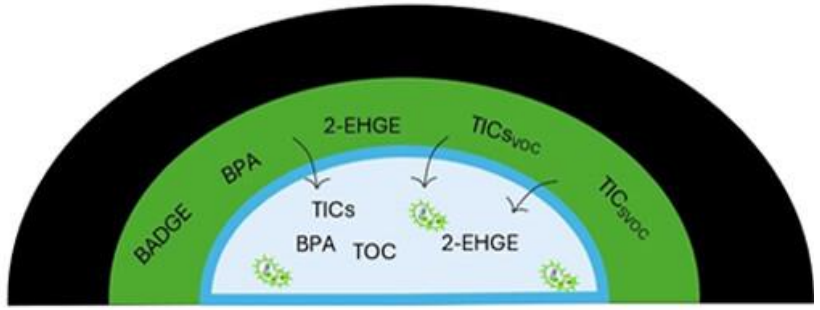
Quick drying hardener
36 wt% volatile material

In raw materials:
BADGE, BPA, 2-EGHE, and 47 VOC and SVOC TICs

CIPP Installed Inside the Damaged Host Pipe



CIPP Use in Service



Normal dried CIPP: *3.2 wt% volatile material*
Quick dried CIPP: *4.8 wt% volatile material*

5% less curing: *No leaching difference*
5% less hardener: *Greater leaching, greater biomass growth*

BPA, 2-EHGE, and other VOCs and SVOCs found in drinking water

Takeaways

47 VOCs and SVOCs were found in the resin and two hardeners. Nearly all do not have drinking water limits.

Some VOCs released into the air, but not ones typically measured by sampling

4 in. (or less) diameter cause BPA levels to exceed a U.S. state drinking water standard, EU, and WHO limits.

Flushing and VOC and SVOC testing should be conducted before use.

Pahari et al. 2025. *Env. Sci. & Technol.*

Right Sizing Tomorrow's Water Systems for Efficiency, Sustainability, & Public Health, 2017-2022

To better understand and predict water quality and health risks posed by declining water usage and low flows

1. **Improve the public's understanding of decreased flow** and establish a range of theoretical premise plumbing flow demands from the scientific literature and expert elicitation with our strategic partners
2. **Elucidate the factors and their interactions that affect drinking water quality** through fate and transport simulation models for residential and commercial buildings
3. **Create a risk-based decision support tool** to help guide decision makers through the identification of premise plumbing characteristics, operations and maintenance practices that minimize health risks to building inhabitants.

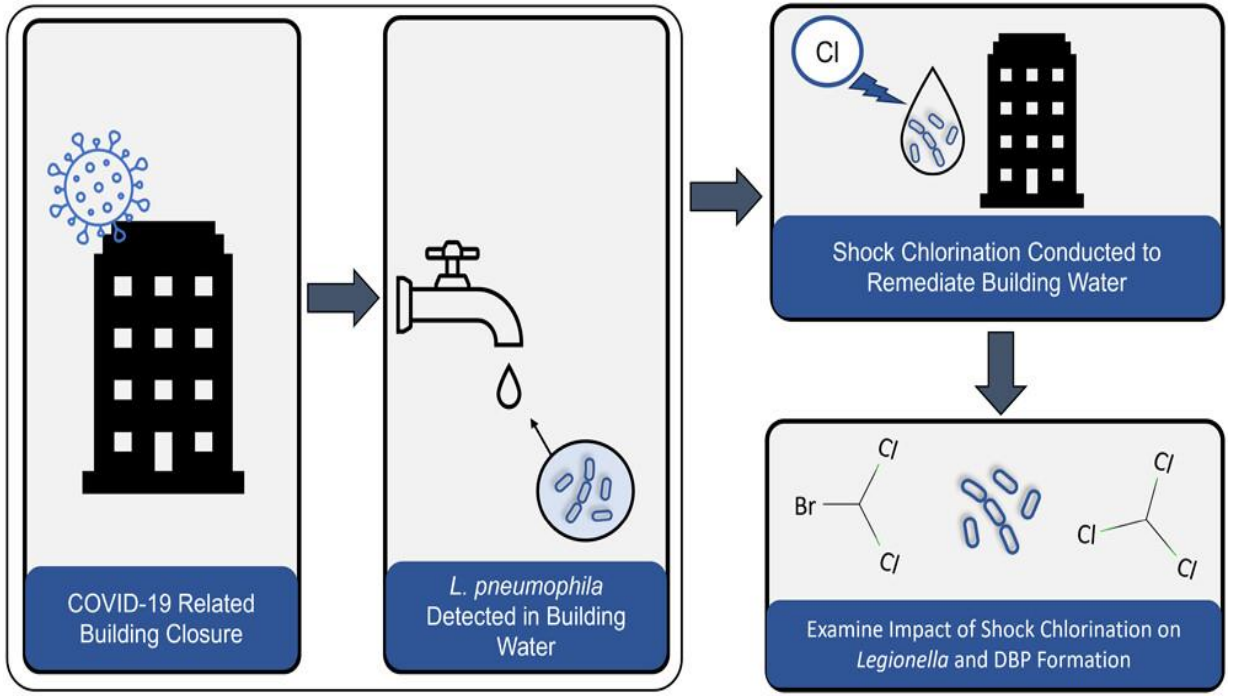
Andrew Whelton, Jade Mitchell, Joan Rose, Juneseok Lee, Pouyan Nejadhashemi, Erin Dreelin, Tiong Gim Aw, Amisha Shah, Maryam Salehi

FINAL REPORT: Posted at www.PlumbingSafety.org
December 2022

PURDUE UNIVERSITY · MICHIGAN STATE UNIVERSITY · SJSU SAN JOSÉ STATE UNIVERSITY · MANHATTAN COLLEGE · Tulane University · THE UNIVERSITY OF MEMPHIS

Protecting Children and Staff from Waterborne Disease When Reopening a Shutdown School: Stagnation, Flushing, and Shock Chlorination

1st draw		10 min.		12 min.		20 min.	
1,641	Fe	223	Fe	21,759	Fe	1,851	Fe
155	Zn	18	Zn	1,303	Zn	243	Zn
544	Cu	63	Cu	6,301	Cu	1,319	Cu
20	Pb	3	Pb	248	Pb	24	Pb
15	Al	3	Al	235	Al	129	Al



- LEED school; 6 months closed, PWS 0.8-1.18 mg/L as Cl_2
- Cold water from a kitchen fixture (21,949 µg/L zinc) exceeded the 6,000 µg/L federal 1 day health advisory for a 10 kg child.
- Approximately 5% of the fixtures sampled tested positive for *L. pneumophila*; a drinking water fountain sample contained 1,289.6 MPN/100 mL
- After shock plumbing disinfection: TTHMs remained elevated, and two fixtures *L. pneumophila* positive.

Mathews et al. 2025. *ACS ES&T Wat.*

CCE 597: Disasters & Emergencies

Science, engineering, policy, law, insurance, social science, communications, journalism

Course Description: Introducing and inspiring students about the engineering, science, and policy challenges associated with disasters and emergencies spanning infrastructure, the environment, public safety, and public health.

Learning Objectives:

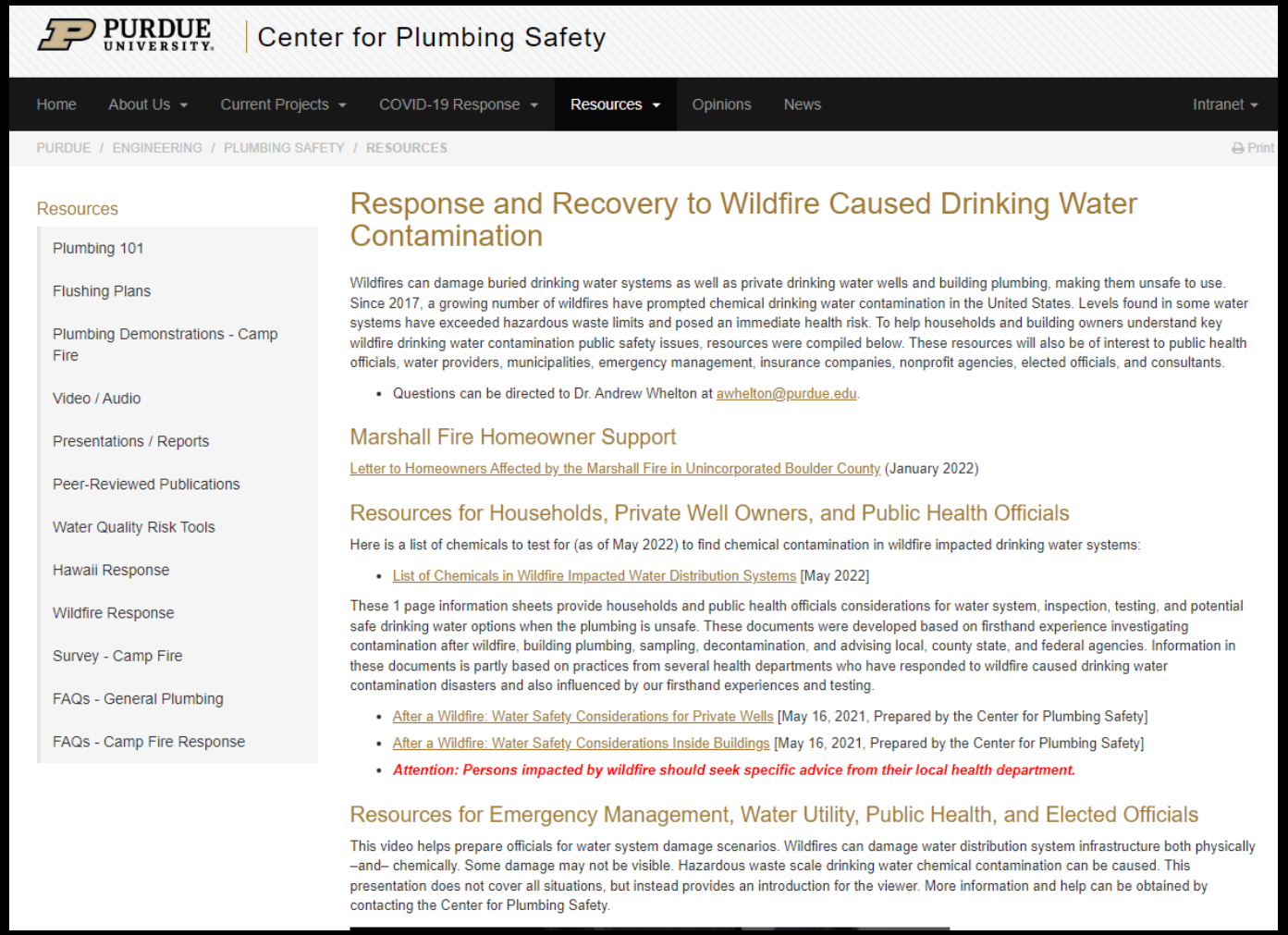
- Identify key population needs following natural and man-made disasters;
- Explain roles and responsibilities of responding organizations;
- Recognize the breadth of expertise in response and recovery;
- Communicate technical concepts effectively with audiences with widely-varying backgrounds;

Approach: Fire dept. field trip; FEMA ICS 100, 200, 700 trainings; NSF CONVERGE trainings; Speaker reflections; Scientific paper/report reflections; WV quiz, CIPP quiz; Hurricane exercise; Chemical exercise; Press conference; Final report and video.

Parting Thoughts: Partnerships and Strategy

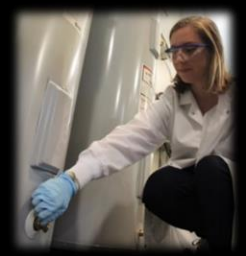
1. ***Ask and answer the right questions***. Listen to others and the community.
2. ***You do not have to know everything, but*** get the best minds to inform your decisions.
3. ***Do not follow others blindly.*** It can get you into trouble and allow harm to occur.
4. People make mistakes. Help prevent and resolve mistakes. Lead by course correcting.
5. Odor and petroleum are not contaminants.
6. ***Avoid, bad decisions that*** increase population and infrastructure injury, recovery, and costs.
7. ***TOC/TPH analysis had little/no value*** for *drinking water* contamination assessments.
8. Academics should train NOT just on fundamentals, but the application of knowledge in difficult situations.
9. Sometimes infrastructure removal and replacement needed, flushing not adequate.
10. ***Feel free to reach out.***

Thank you. awhelton@purdue.edu



www.PlumbingSafety.org

www.CIPPSafety.org



- ✓ Post-fire chemicals to test for
- ✓ Brief videos for emergency managers and health officials
- ✓ Guidance for private well owners
- ✓ Guidance for building owners
- ✓ Government agency resources
- ✓ FEMA mitigation guidance
- ✓ Other training resources
- ✓ Scientific opinions

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