Water Systems Disaster Response

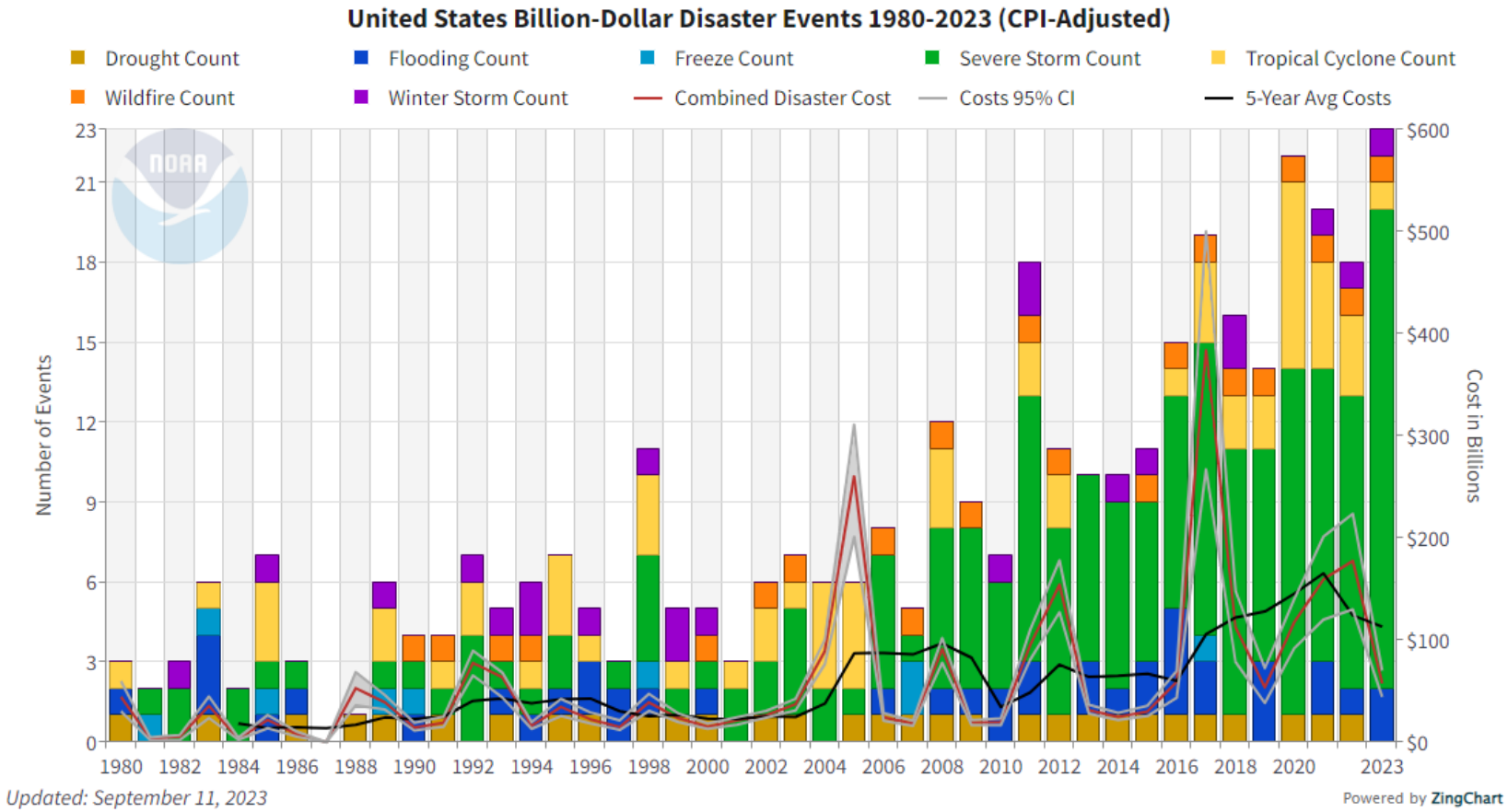
Andrew J. Whelton, Ph.D.

Purdue University

The POU/POE industry is often called upon to respond to disasters, such as wildfires, hurricanes or chemical spills. Emotions can run high as residents of a community demand immediate answers as well as potential solutions. POU/POE treatment professionals can play an important role in restoring water quality but must understand the challenges of the situation, gather data, and provide a knowledgeable solution.

Resilience (n.)

The ability to bounce back from misfortune and change



National Interagency Fire Center (www.nifc.gov)

Current National Statistics

69 Incidents
Total Number of Large Fires

2 Total
New Large Fires

41,944 Incidents
Year-to-date Wildfires

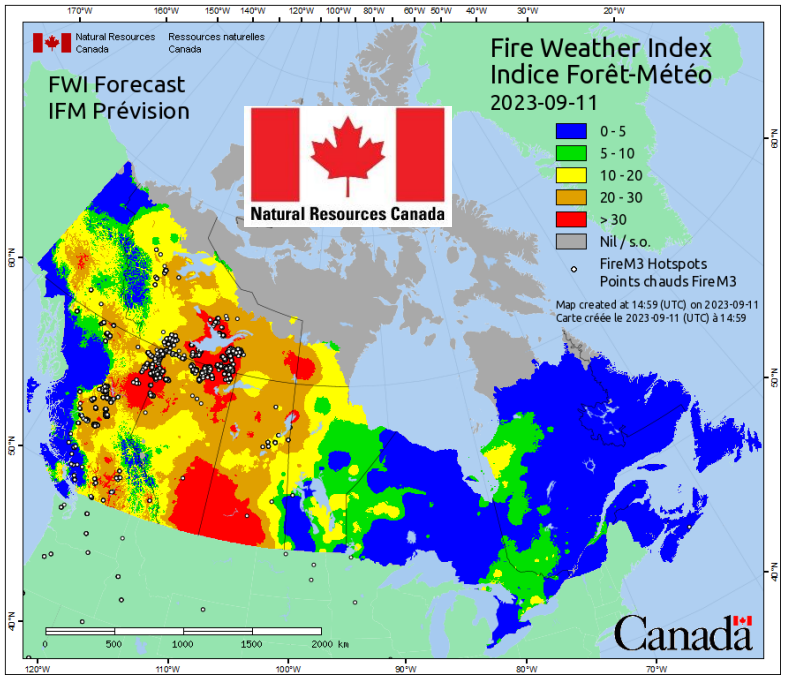
475,924 Acres
Acres Burned on Large Fires

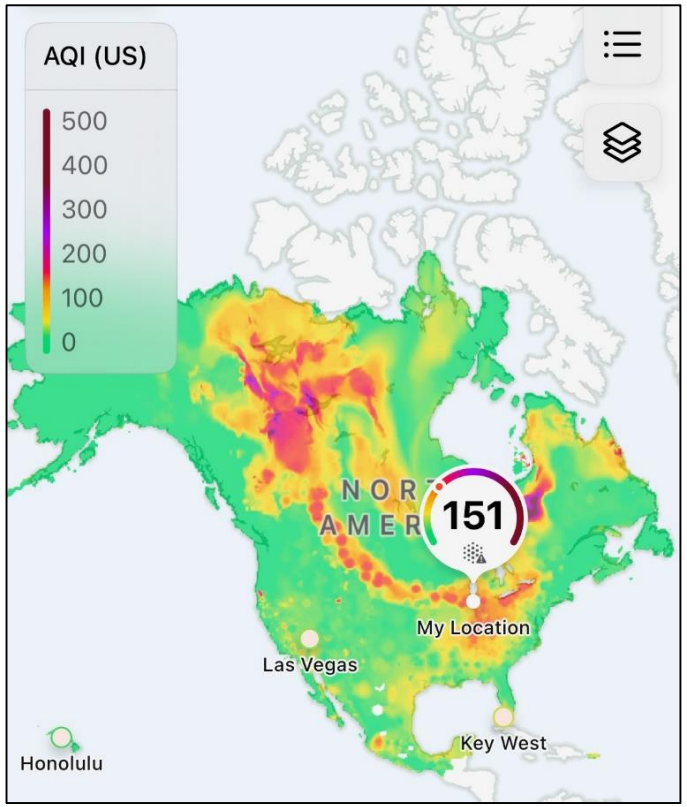
12,391
Personnel Assigned to Wildfires

2,191,140 Acres
Year-to-date Acres Burned

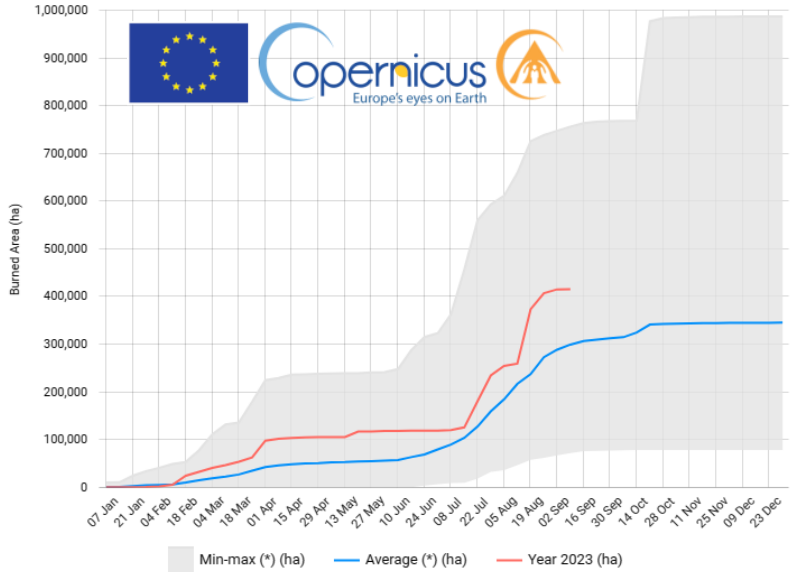
Last Updated: Monday, September 11, 2023 - 08:25

Wildland Fire Information System (nrcan.gc.ca)





European Forest Fire Information System (EFFIS) (europa.eu)



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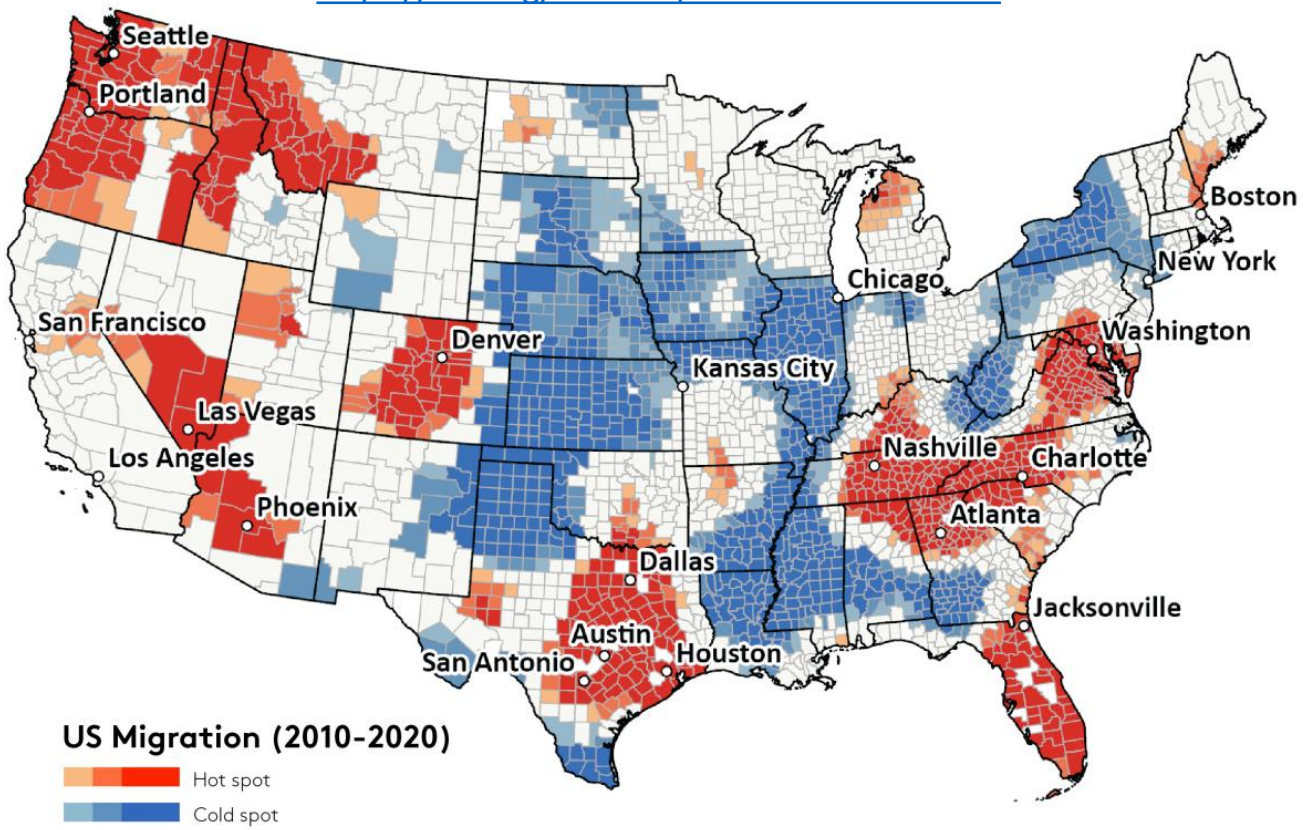
Clark et al. 2022. *Frontiers in Human Dynamics.*
https://doi.org/10.3389/fhumd.2022.886545



Wildfires cause health and safety risks, and are increasing in intensity as well as the number of acres burned (UNEP 2022)

U.S. Fire Administration
Working for a fire-safe America

In the U.S. more than 46 million residences in 70,000 communities are at risk (USFA, 2022)

Public water systems are vulnerable to fire.

USGS 2009

Drinking Water Source

CA Utility 2021

CA Utility 2021

Treatment Facility

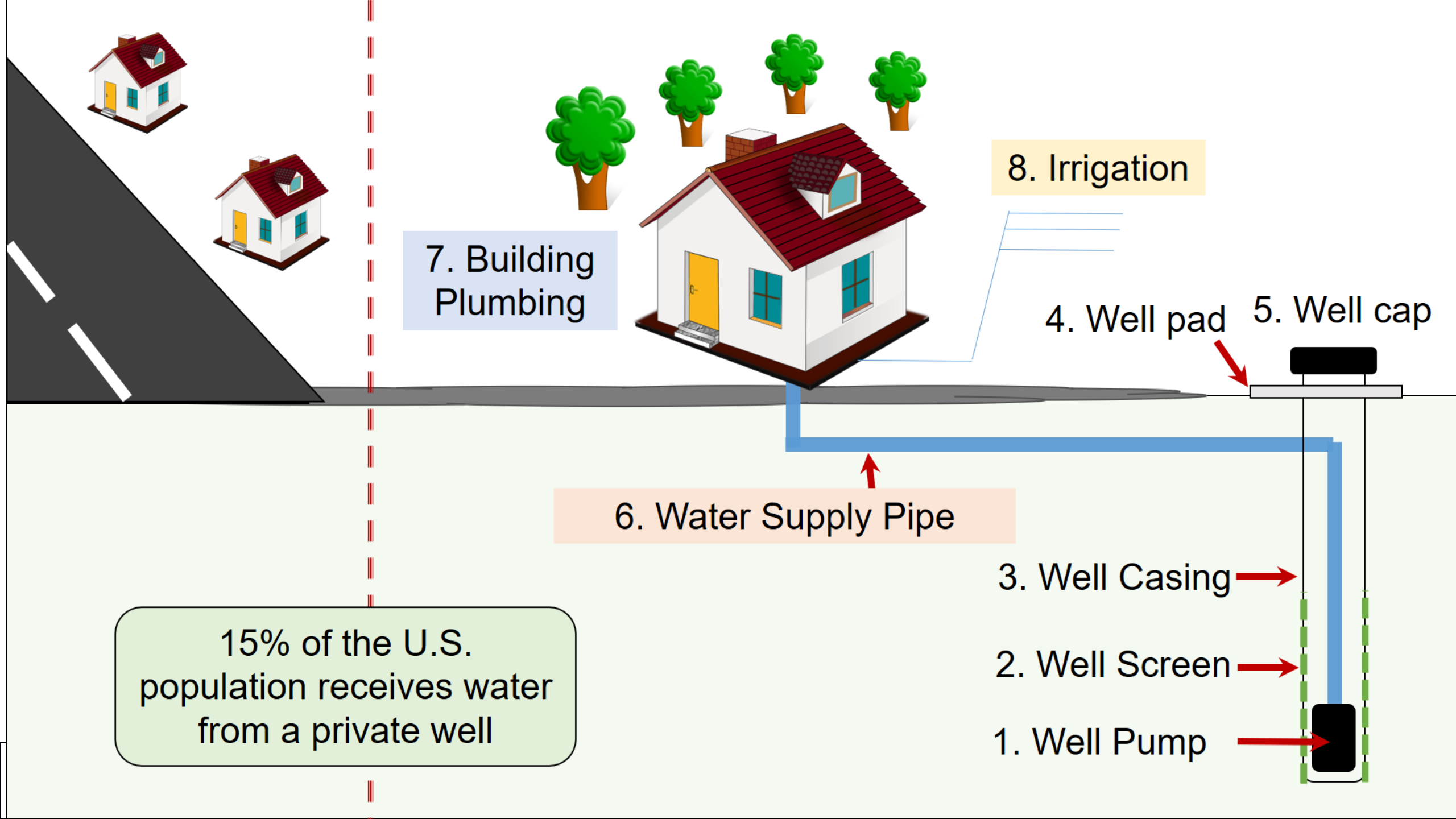
Storage Tank

San Francisco Chronicle
9/3/20, Sara Gobets

System Purpose:

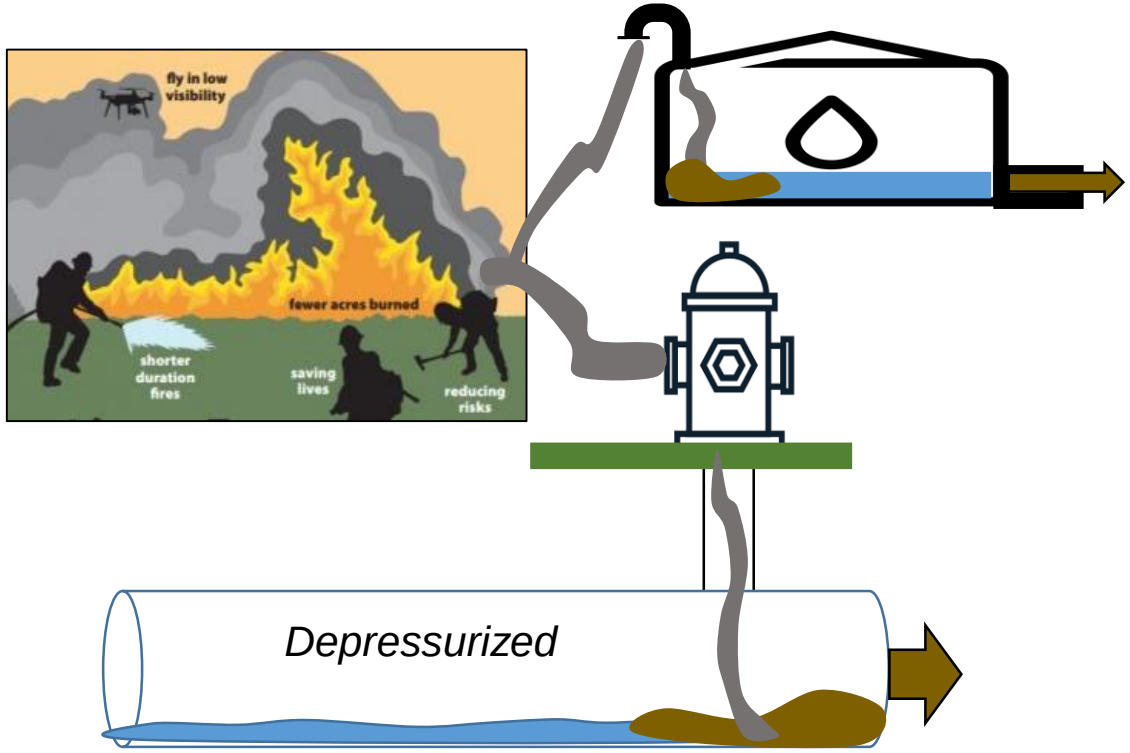
- ✓ Fire-fighting
- ✓ Hygiene, sanitation
- ✓ Business
- ✓ Recreation

15% of US population receives drinking water from a private well

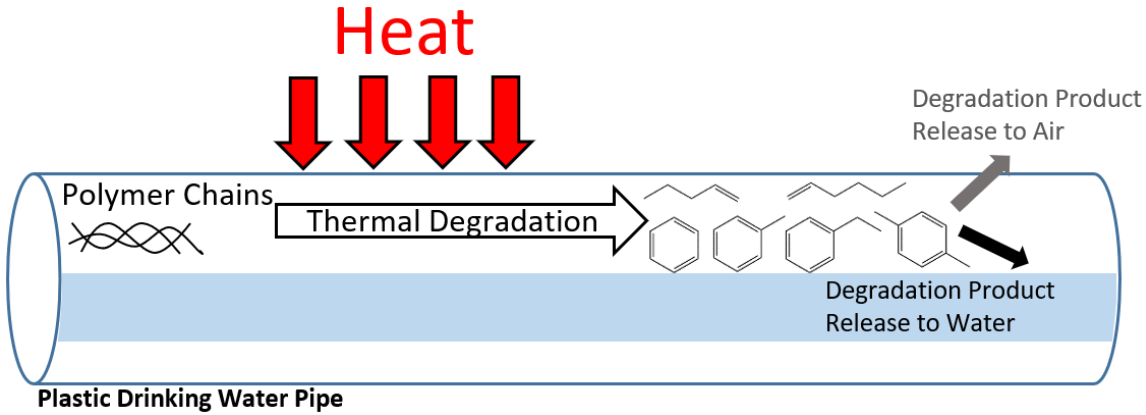

8. Irrigation
7. Building Plumbing
4. Well pad
5. Well cap
6. Water Supply Pipe
3. Well Casing
2. Well Screen
1. Well Pump
15% of the U.S. population receives water from a private well

Potential PRIMARY Sources

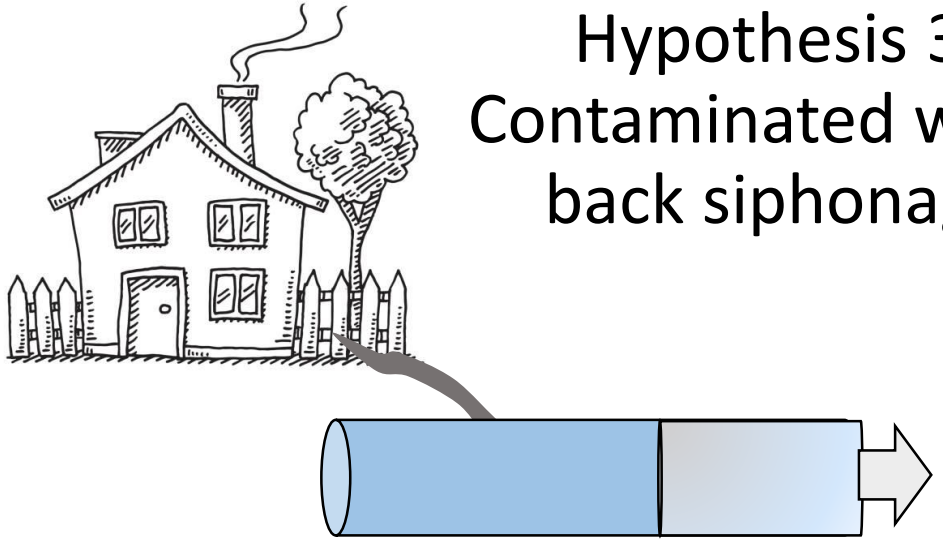
Hypothesis 1. Forest biomass or structure combustion



Hypothesis 2. Plastic thermal degradation



Hypothesis 3. Contaminated water back siphonage



Secondary Sources: Infrastructure desorption

Water Systems Face Multiple Challenges During Response

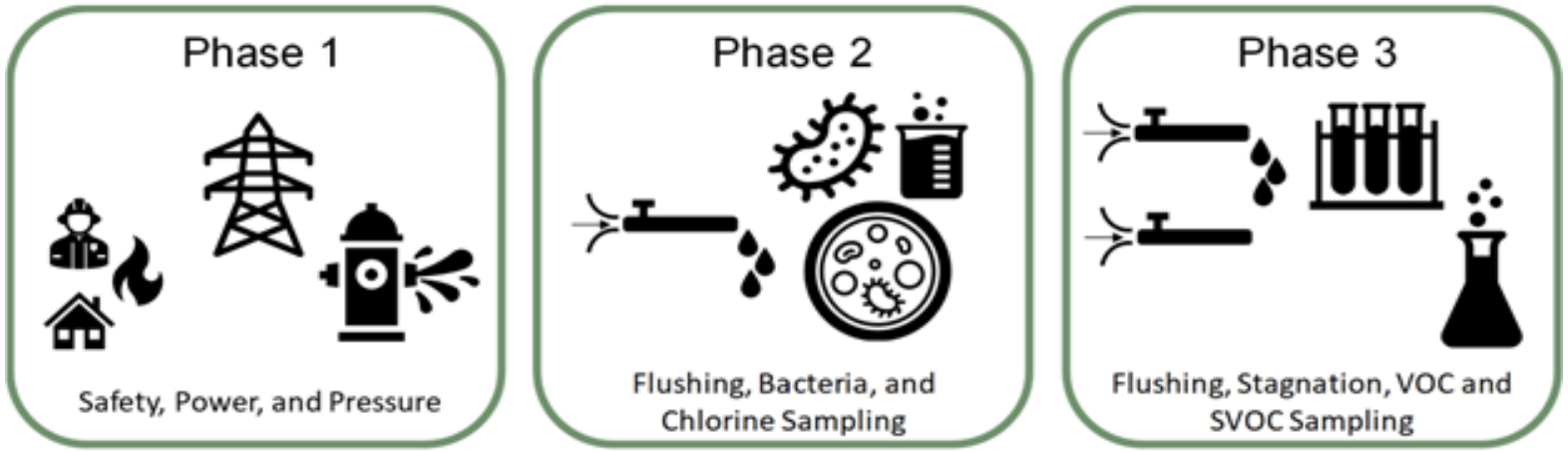
Pressure, utility network and building plumbing: Leaking, destruction

Power: Electric poles down, shutoff by provider, natural gas generators destroyed, lacking fuel

Telecommunications: Outages inhibit tank level, pressure, chemical feed, and pump status monitoring

Personnel: Hazard situations, unable to respond due to staff availability

Contamination: Chemicals and microbiologicals drawn into the water system, immediate health risk



Support firefighting
Isolate damage
Maintain pressure
Water use warnings

Personnel surge
Restore control, pressure
Repeated sampling
Laboratories

Personnel surge
Repeated sampling
Laboratories
Decon, remove, replace

Post Wildfire Distribution System Water Quality Impacts and Potential Responses, WaterRF Project 5106, 2020-2023

Lessons Learned from the 2017 Tubbs Fire and 2018 Camp Fire

AWWA WATER SCIENCE

Wildfire caused widespread drinking water distribution network contamination

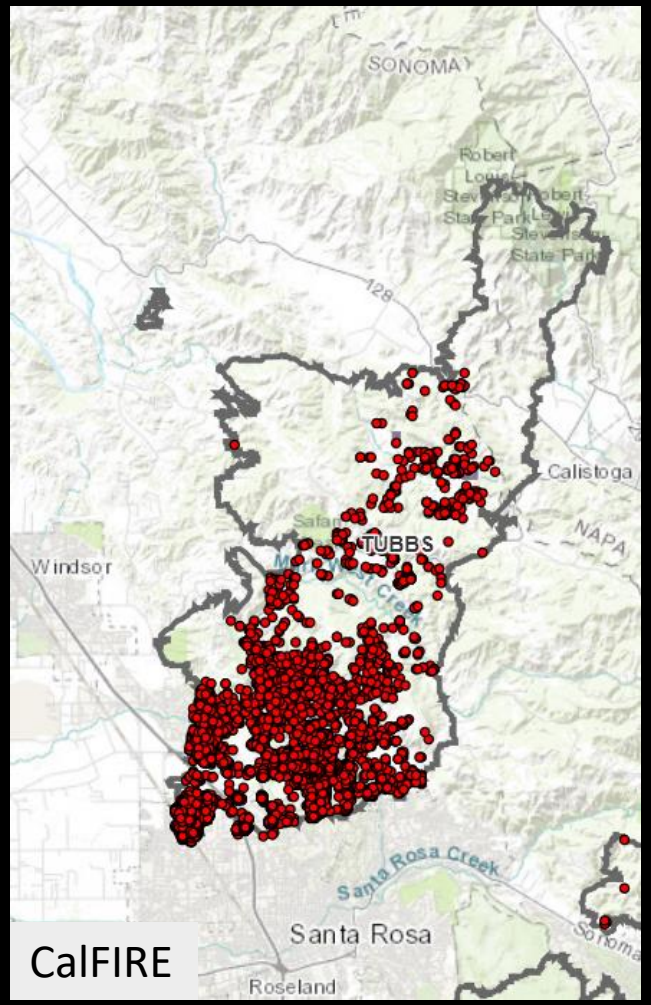
Download FREE here:
https://doi.org/10.1002/aws2.1183

VOCs and SVOCs present, levels can exceed hazardous waste limits (40,000 ppb benzene, etc.)

Do Not Use water order should be issued

Protect homeowners and their plumbing

2017 Tubbs Fire: Drinking Water System Volatile Organic Compound (VOC) Contamination was Discovered



Oct. 8, Fire began – Oct. 31, 2017 contained, 36,807 acres

- 5,656 structures destroyed, in City of Santa Rosa 2,500 parcels burned

Oct. 10, City of Santa Rosa issued boil water advisory

Nov. 8, Drinking water *odor* complaint

- City found benzene > CA MCL (1 ppb) and USEPA MCL (5 ppb)

Nov. 10 – Oct. 11, 2018, Do Not Drink-Do Not Boil advisory

- 352 parcels in advisory area, 0.08% water mains, 0.2% hydrants, 5% of meters, ~5.2 miles
- *Affected only 9 of 13 standing homes (occupied)*
- Less than 20 people affected out of 175,155 on this water system
- Subsequent tests revealed much more VOC water contamination

Proctor et al. (2020) https://doi.org/10.1002/aws2.1183

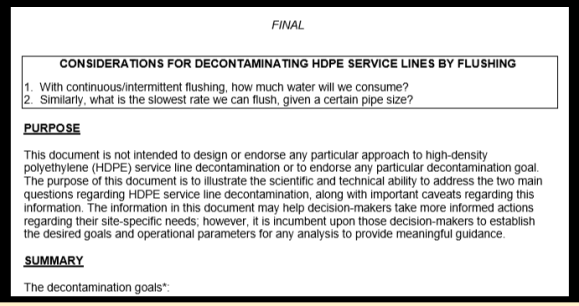
For the Tubbs Fire and Camp Fire, VOCs exceeded *acute* and *chronic* exposure limits

Chemical	Tubbs Fire (11 mo.)		Camp Fire (6 mo. post-fire)					
	Santa Rosa 5.2 miles		PID 172 miles		SWRCB in PID	DOWC (3 systems)		Short-term USEPA 1d-Health Advisory
	n	Max	*n*	Max	*n*=1	*n*	Max	Exceeded
Benzene	8,222	**40,000**	509	**923**	**>2,217**	41-26-82	**8.1**-0-**46**	**Yes (200)**
Methylene chloride	-	< 5	p	**15**	-	p	p	No
Naphthalene	661	**6,800**	p	278	**693**	p	p	**Yes (500)**
Styrene	6,062	**460**	p	**100**	**378**	p	p	No
TBA (NL)	339	**29**	p	**13**	-	p	p	-
Toluene	8,222	**1,130**	p	100	676	p	p	No
Vinyl chloride	6,062	**16**	p	**1**	-	p	p	No

PID used 72 hr stagnation time; DOWC sometimes, but often used 0 hr
p = Utilities did not disclose enough information about their data

Challenges: DECONTAMINATION

Stagnation needed to find contamination



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*:

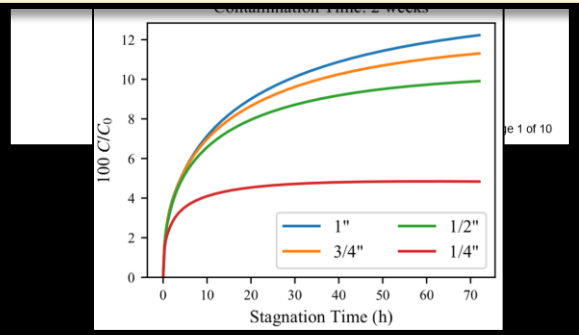
Water Distribution System Decontamination

Collaboration between Us & USEPA

Hydraulics

Polymer Science

Environmental Engineering



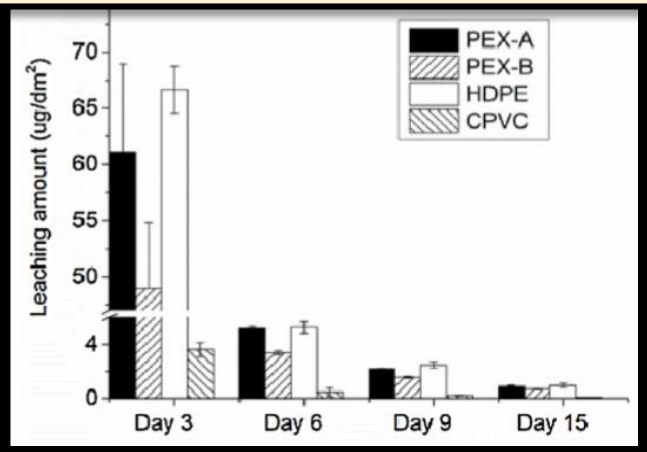
Numerical modeling:

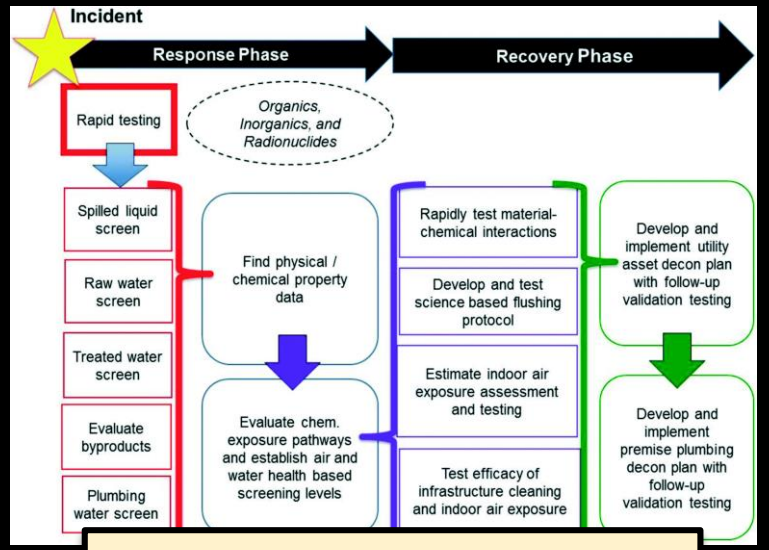
Greater than 286 days vs. less than 64 days of continuous water flushing for 1-inch HDPE service line

(Haupert et al. 2019)

Purdue *(Huang et al. 2017)*

Different plastic pipes uptake and leach different amounts of VOCs and SVOCs





Purdue *(Whelton et al. 2017)*

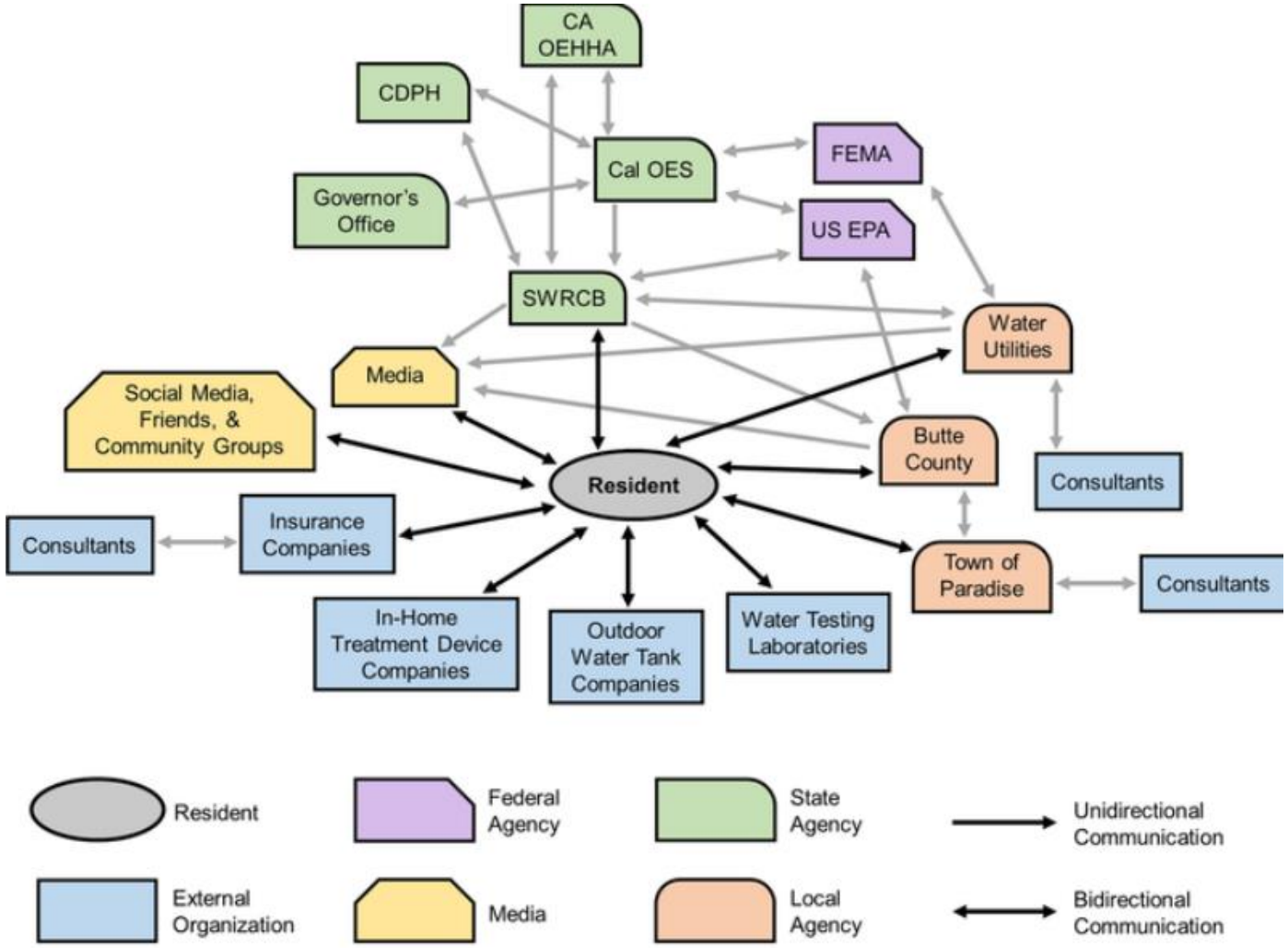
There is a step-wise process for responding to and recovering from contamination

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.



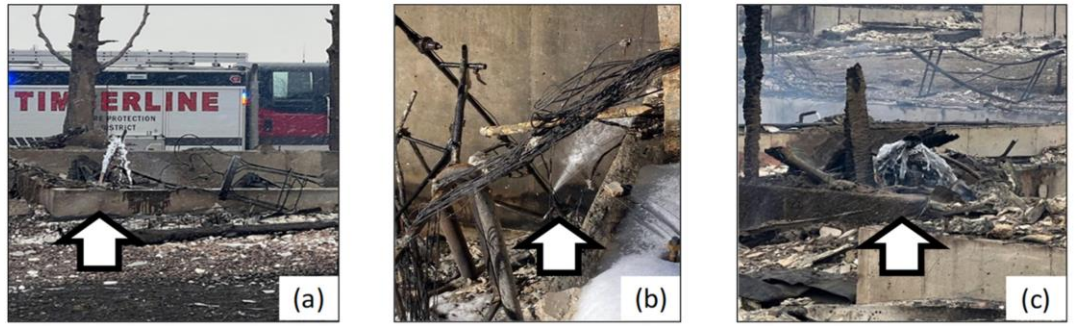
The Marshall Fire: Scientific and policy needs for water system disaster response

AWWA Water Science, Published January 2023
https://doi.org/10.1002/aws2.1318

1) Loss of power jeopardized fire-fighting and caused worker risks
2) Local/external resources were critical
3) SOPs for post-fire sampling, analysis, and rapid external labs are needed
4) Contamination seemed to be related to depressurization and property damage, but more work is needed
5) Clarification on public health risks and water use conditions is needed

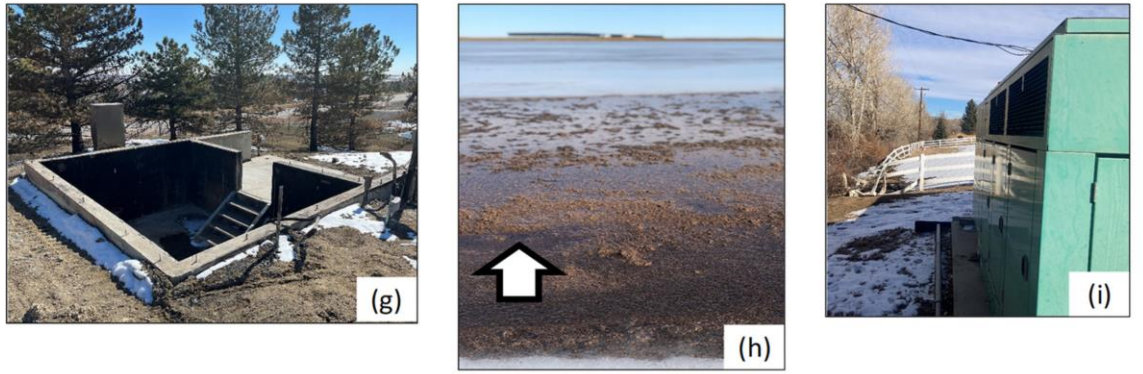
20 scientific and policy needs for improving water system disaster response and recovery

Water Distribution System Damage



Service lines, hydrants, and plumbing were damaged and leaking (a,b,c,d). Some hydrants were left open, fire-fighting equipment was left behind (f). Water meters to properties with destroyed structures were removed (e).

Damage on Facility Property



Ash was visible around and in the Superior reservoir (h), and the water treatment plant emergency generator was destroyed by fire (g). The EBCWD emergency generator air intake


TIM ERLINE
RE PROTECTION
DISTRICT

10,000 ft view of the Marshall Fire water distribution system contamination

Zero systems found bacteria during their return to service

No fire damage: S.S. Mobile Home Park and Eldorado Artesian Springs

The Mobile Home Park lost power for 4 days: no generator, no storage tank

Lafayette, Louisville, and Superior flushed to bring chlorine residual back

Lafayette shutdown the small area (22 homes) affected and did not find VOC contamination

Louisville had isolated depressurized areas; Found VOC and SVOC contamination

Superior found a different type of VOC contamination

Paint thinner odor was reported at the East Boulder County Water District so they flushed and sampled (no stagnation), but did not find contamination; 3 weeks later (with stagnation) they found 5.1 ppb benzene

Smoky, Ash Tray, Camp Fire Flavored Water

Superior received 300+ complaints in a day

Community concerns:

- ✓ Present at 1 household and not the neighbors
- ✓ Present in hot water only, not cold water
- ✓ Water heaters were contaminated
- ✓ The depressurized system sucked in chemicals
- ✓ Contamination was trapped in parts of the system

Smoke flavor after ‘03, ‘13, ‘16 wildfires assumed to be caused by drinking water source ash contamination.

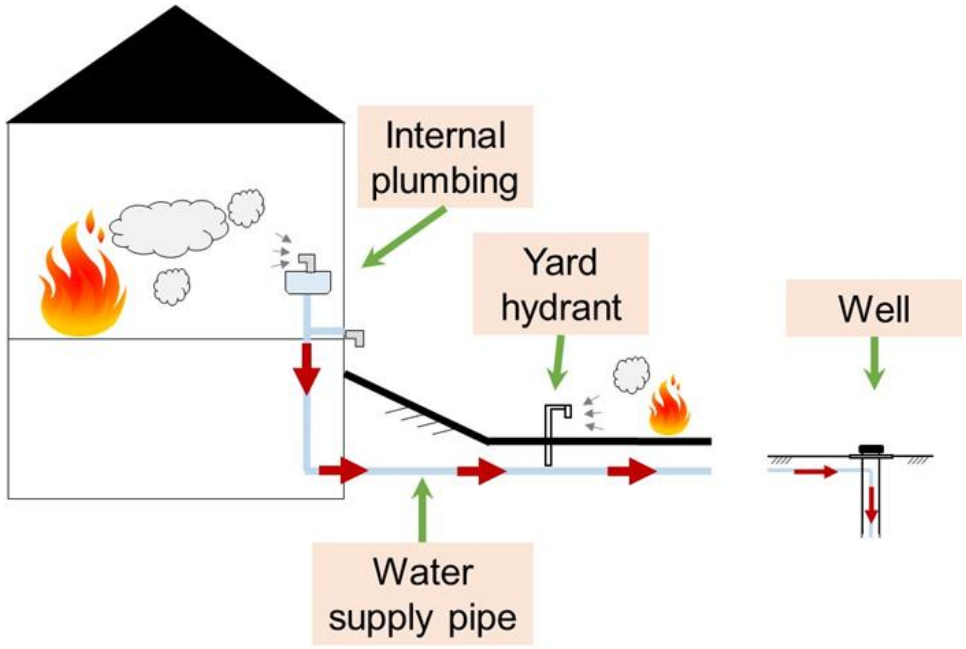
Food science literature: Caused by phenols, *o*-cresol, *p*-cresol, *m*-cresol, guaiacol

CSU Dr. Omur-Ozbek confirmed the flavor was originating from the source water (lake) –*and*– in the treatment plant –*and*– in the water distribution system

CU Boulder Dr. Thurman, Dr. Ferrer, and Corona identified and attributed a tricarboxylic benzoic acid and a dicarboxylic benzoic acid as the “smoky flavor” agents at ppb (Ferrer et al. 2021)

They stated chemicals identified were not known to be a health risk at levels found

Until here, no prior wildfire drinking water well test results were available.



Wildfire damage and contamination to private drinking water wells

AWWA Water Science, January 2023

https://doi.org/10.1002/aws2.1319

1) Debris near wells had VOCs and SVOCs
2) Debris was found in some wells
3) SVOCs detected in some wells
4) Small water system 11 mo., no pressure.
5) Recommendations for
    - How to inspect
    - Water use considerations
    - What chemicals to look for
    - Repair considerations
    - Future research

The Hawaiian archipelago is the most isolated place on earth, more than 2,000 miles from the nearest continent.

2023 Maui Wildfires: August 8, 2023

Hurricane Dora offshore, 60-80 mph gusts onshore

Olinda Fire: 1,081 acres, 2 structures

Kula Fire: 202 acres, 544 structures

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

Puelho Fire: 5,300 acres, 0 structures

Deadliest wildfire incident in modern U.S. history: 155 dead, 66+ missing

Lahaina Sys. Pop. 20,065
Elev. 1 ft.
28% White alone
Median income: $80,035
Median-value home: $0.72M
Seat of Hawaiian Kingdom

County Seat

Kula Sys. Pop. 7,686
Elev. 1,000-3,600 ft.
54% White alone
Median income: $86,938
Median-value home: $1.1M





1. Conduct free in-home drinking water testing for Lahaina, Kula, and Olinda households and survey needs

University of Hawai'i Mānoa

Purdue University

2. Advise Maui County Utilities on how to respond to and recover their damaged water systems

Purdue University

City of Louisville Colorado • Since 1878

ACWA JPIA

PID Serving since 1916

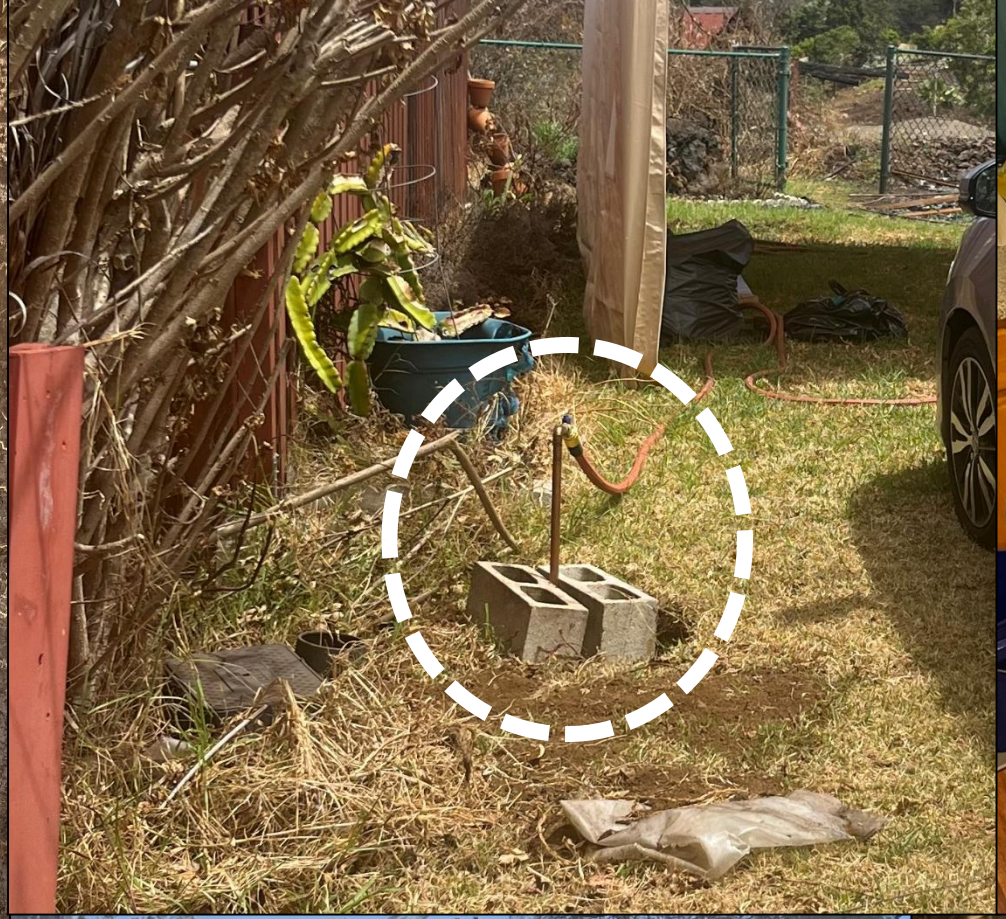
City of Santa Rosa

3. Assist the State of Hawai'i Veterinarian investigate damage and contamination of ranch water systems

Purdue University

University of Hawai'i Mānoa

City of Louisville Colorado • Since 1878




U-HAUL


UNITED STATES
POST OFFICE
LAHAINA, HAWAII
96761
RESERVED PARKING
VAN


POTABLE WATER
500 GALLONS


FREE
FOOD + WATER
Food
+
Drink
Kula
Strong


STATE OF HAWAII
DEPARTMENT
OF
AGRICULTURE

As of today..

Is ***benzene*** THE indicator of contamination?

--No

Is ***BTEX*** THE indicator of contamination?

--No

Is ***VOC*** THE indicator of SVOC contamination?

--No

Oregon 2021: MEK (138 ppm) exceeded the USEPA 1-day health advisory in the absence of benzene

No shortcuts to chemical contamination decisions

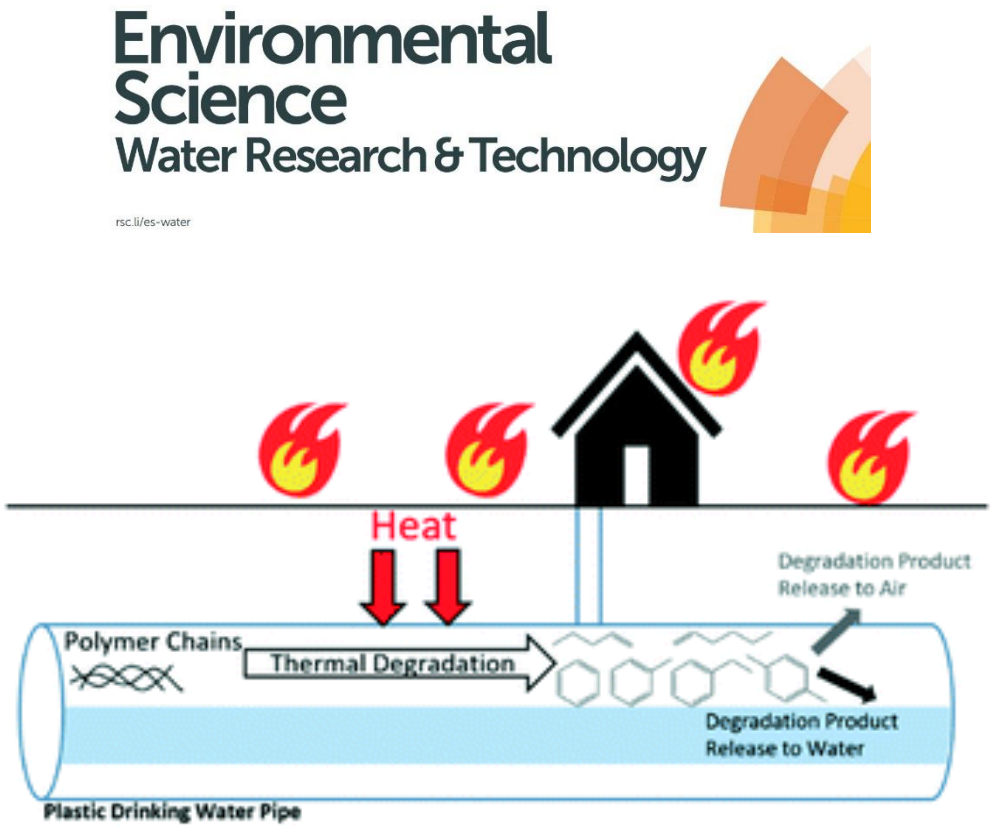
Max. Benzene, ppb	Event / Location	Pop.	System	Year
40	Lahaina Fire/ Hawaii	20,036	Maui County - Lahaina	2023
3.8	Kula Fire / Hawaii	7,686	Maui County - Lahaina	2023
5.1	Marshall Fire/ Colorado	500	East Boulder County Water District	2021
220	Marshall Fire/ Colorado	20,319	City of Louisville	2021
5.5	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

There are no doubt more due to improper sampling.

"Fire package" list of chemicals to screen – BOLD and RED exceeded health limit (list as of March 2024)

Acetonitrile	Chlorodibromomethane	Ethylbenzene	**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

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



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

Download FREE here:

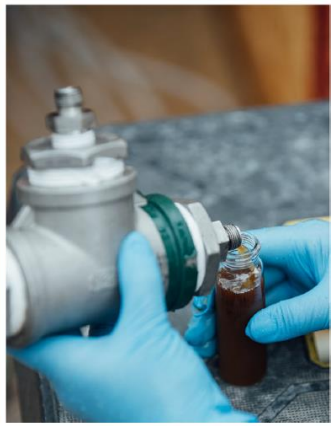
https://doi.org/10.1039/D0EW00836B

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

Pilot Study on Fire Effluent Condensate from Full Scale Residential Fires



Exp. #	Room 1		Room 2		
	1	2	3	4	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

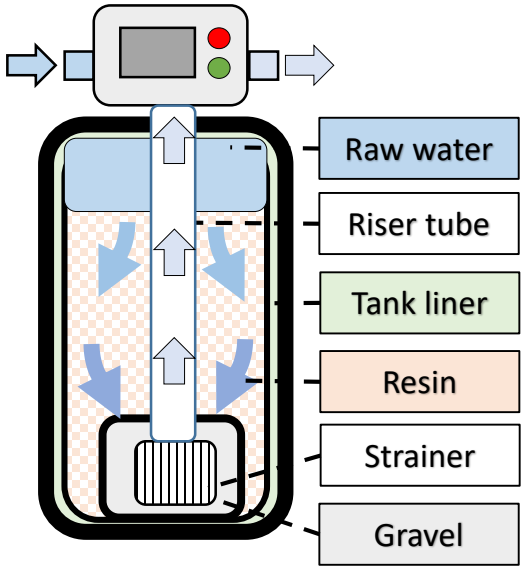
Exp. #	Room 1		Room 2		
	1	2	3	4	5
Benzene	1,100	6,400	2,600	3,600	33,000
Styrene	<400	1,200	470*	1,400	1,800
Toluene	180*	1,000	<340	660	3,900
Xylenes	<290	110*	<740	153	910*
Naphthalene	2,700*	8,100	7,400*	8,100	10,000
2-Butanone	2,100*	3,600*	7,300*	13,000	31,000
Acetone	57,000	31,000	74,000	110,000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

PURDUE UNIVERSITY

(They looked for a limited list of chemicals)

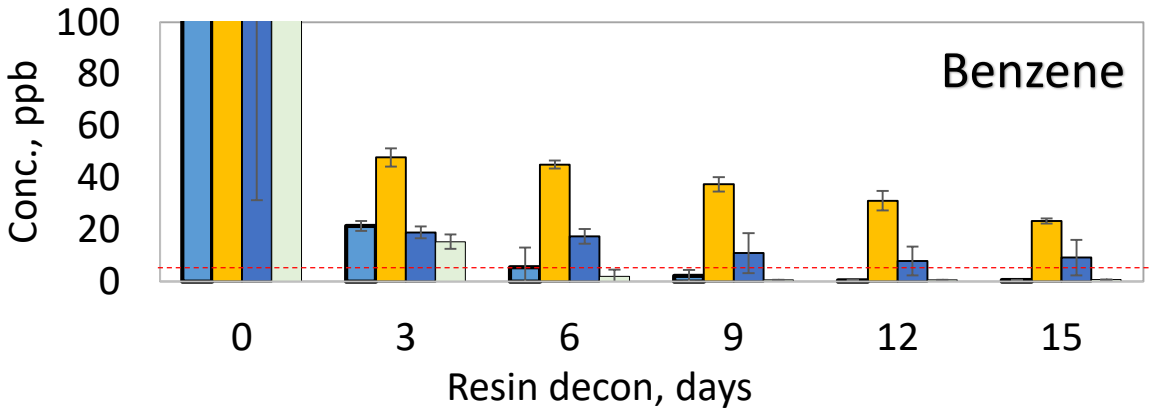
Horn et al. (2023) FSI https://doi.org/10.1007/s10694-023-01487-4

Hydrocarbon Contamination and Decontamination of Water Softeners



Surface area

Resin: 2,800,000+ cm^2
Liner: 9,300 cm^2
Gaskets: 32 cm^2



…. of Water Supply Connectors

After the 2014 West Va. chemical spill, the Health Department recommended discarding tubing at restaurants

Dishwasher connector – PVC

Softener connector – PVC

Ice-maker tubing – PE

Multipurpose tubing – PVC

Faucet supply line – PVC

Ice-maker tubing – PEX

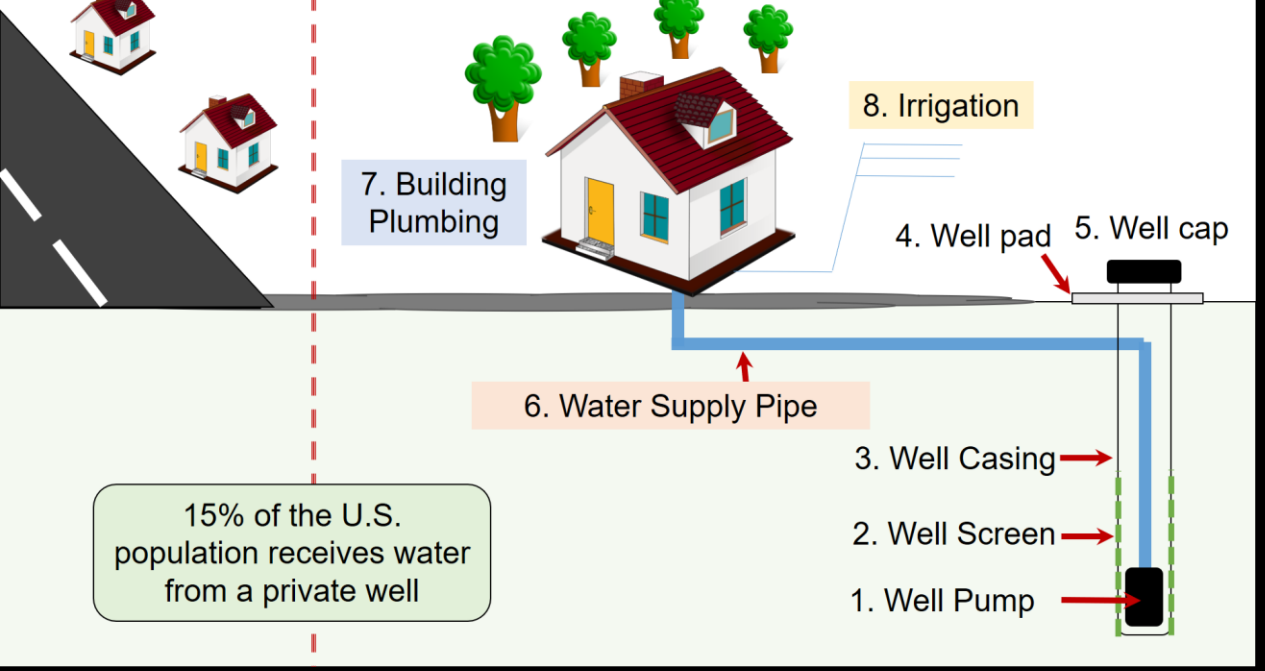
All plastics sorbed 93-100% of the BTEX in 24 hr

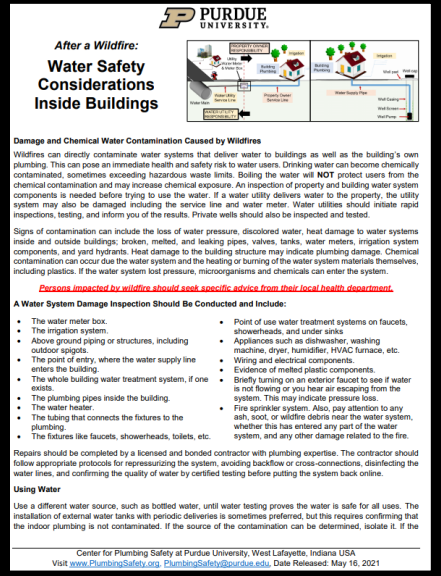
9 of 11 materials still exceeded the benzene MCL after 9 days of decon

Washing machine hose – EPDM

Jankowski et al. 2023. *ES&T.*

Isaacson et al. *S*





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

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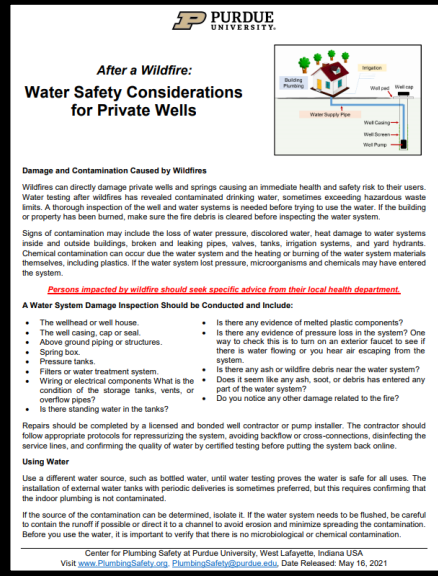

After a Wildfire:

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 repressurizing 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.

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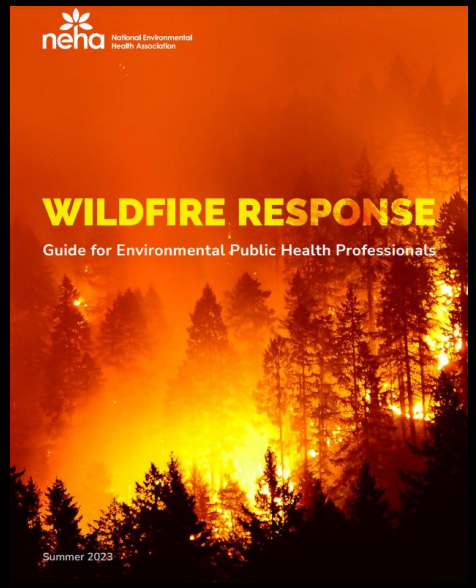

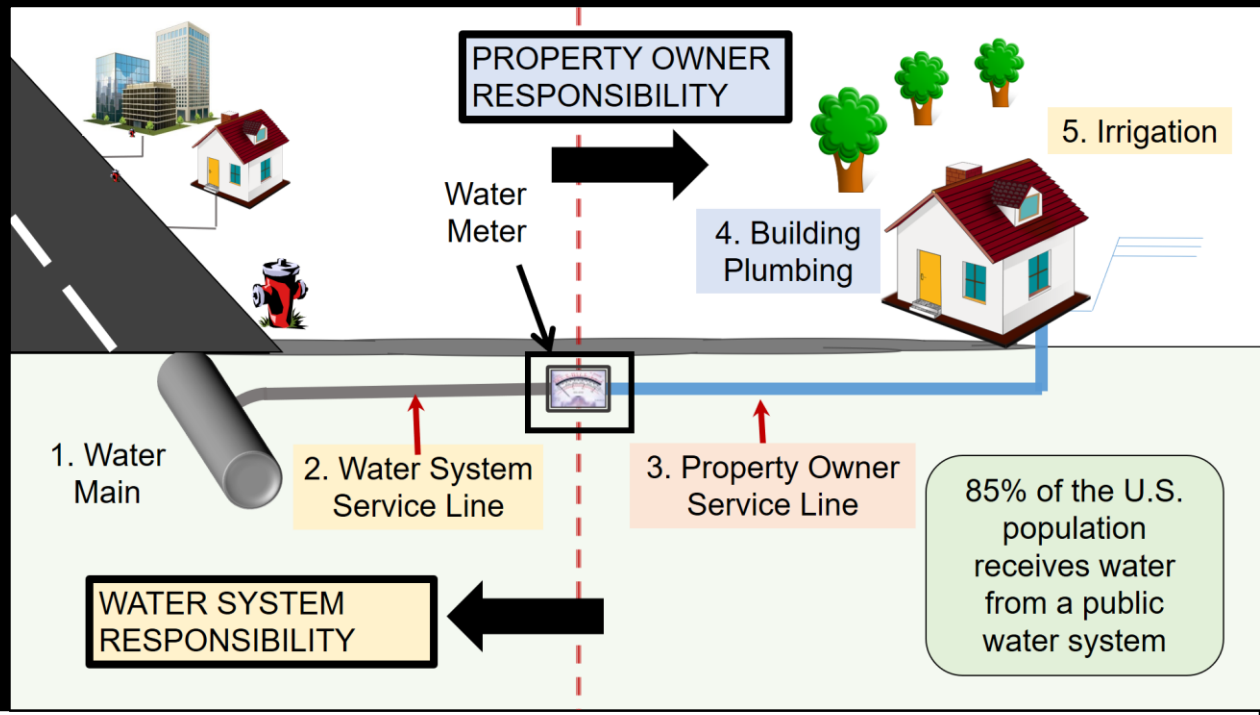

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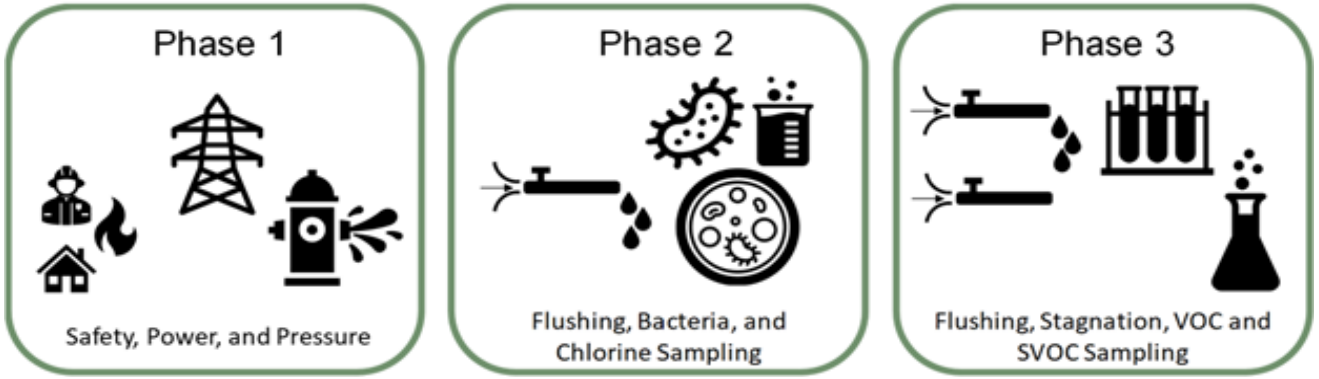
Concept of Operations (CONOPS) for Water Distribution Response and Recovery

[Coming 2024]



1. Roles and responsibilities (PWS, State, Fed, Customers)
2. Water contamination health threats by fire
3. Post-incident progression, phases 1-3
4. Immediate decisions (exposures; water use warning)
5. Emergency drinking water sources
6. Asset and private property damage assessment (risk)
7. Contaminant comparison health-based exposure limits
8. Post-incident chemical lists and laboratories
9. Post-incident water sampling (closed/open areas, priority customers, interpretation, action, mapping)
10. Communication considerations

1. ***Lessen the chance*** water production and pressure loss occurs
   - Establish emergency interconnections with neighboring utilities
   - Backup emergency power (and fuel) for production capacity and pumps
   - Zone the water distribution system
   - Shutoff services for destroyed structures
2. ***Prevent the entry*** of contamination
   - Backflow prevention devices on all service lines
   - Automatic water meter shutoff capability
   - Water meter backflow detection
   - Zone the water distribution system
   - Shutoff services for destroyed structures
3. ***Lessen the chance*** thermal damage occurs
   - Bury assets > 1.5 m
   - 10 ft buried asset (i.e., meter boxes) setback distances from structures (wood) and vegetation
   - Use concrete meter boxes with concrete covers
   - Use metal water meters
   - Use metal pipe and metal fittings

What can we do now

to design and operate systems to better protect infrastructure and people from contaminated water?

Key Considerations for POU/POE Water Treatment Solutions After a Disaster

1. Only enter areas where MULTIPLE organizations have confirmed it is safe. Urge government agencies to rapidly share chemical testing data.
2. Urge government agencies to rapidly conduct THOROUGH chemical water testing and SHARE data publicly (for public water systems).
3. Select lower risk locations for your technologies.
4. Install sample taps at locations BEFORE and AFTER your technology.
5. Conduct your OWN water testing to confirm devices work and REPEAT water sampling to determine breakthrough.
6. Select a credible water testing laboratory. 1 day, 3 day, and 7 day turn around times possible.
7. Recognize sources of chemical contamination may be inside building plumbing. Owner may have to replace plumbing materials (i.e., connectors, softeners, filter media, plastic pipes, etc.)
8. Take government speculative statements about the appropriateness of water treatment technologies post-disaster with a grain of salt (i.e., California refrigerator carbon example). YOU must validate and monitor to protect the user, your reputation, and business. The technologies are NOT certified for all disaster situations.
9. Chemical incidents are more complex and have less information than natural disasters.
10. Feel free to reach out if you have questions.

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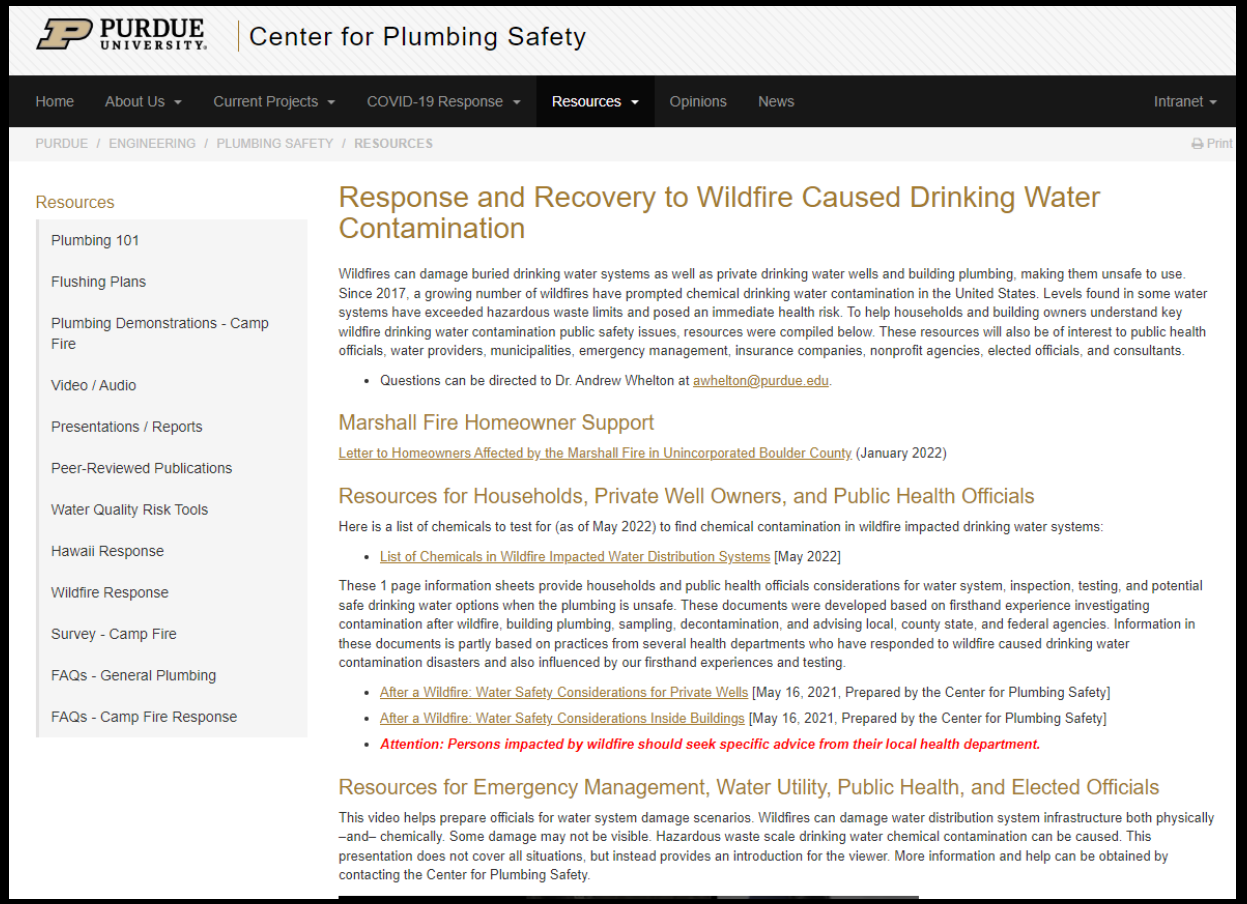
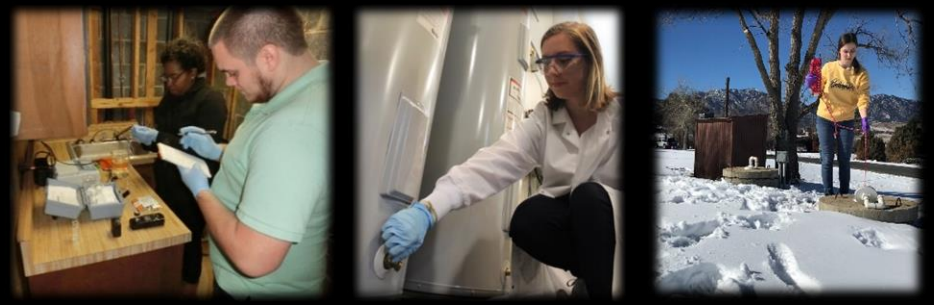
www.PlumbingSafety.org
www.CIPPSafety.org





- ✓ 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

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THE Water Research FOUNDATION
Rotary Club of Paradise, California
UNITED STATES ENVIRONMENTAL PROTECTION AGENCY