Considerations for returning plumbing to safe use after chemical contamination

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www.PlumbingSafety.org

Our Focus

Water Safety and Disasters

Infrastructure Construction and Repair Technologies

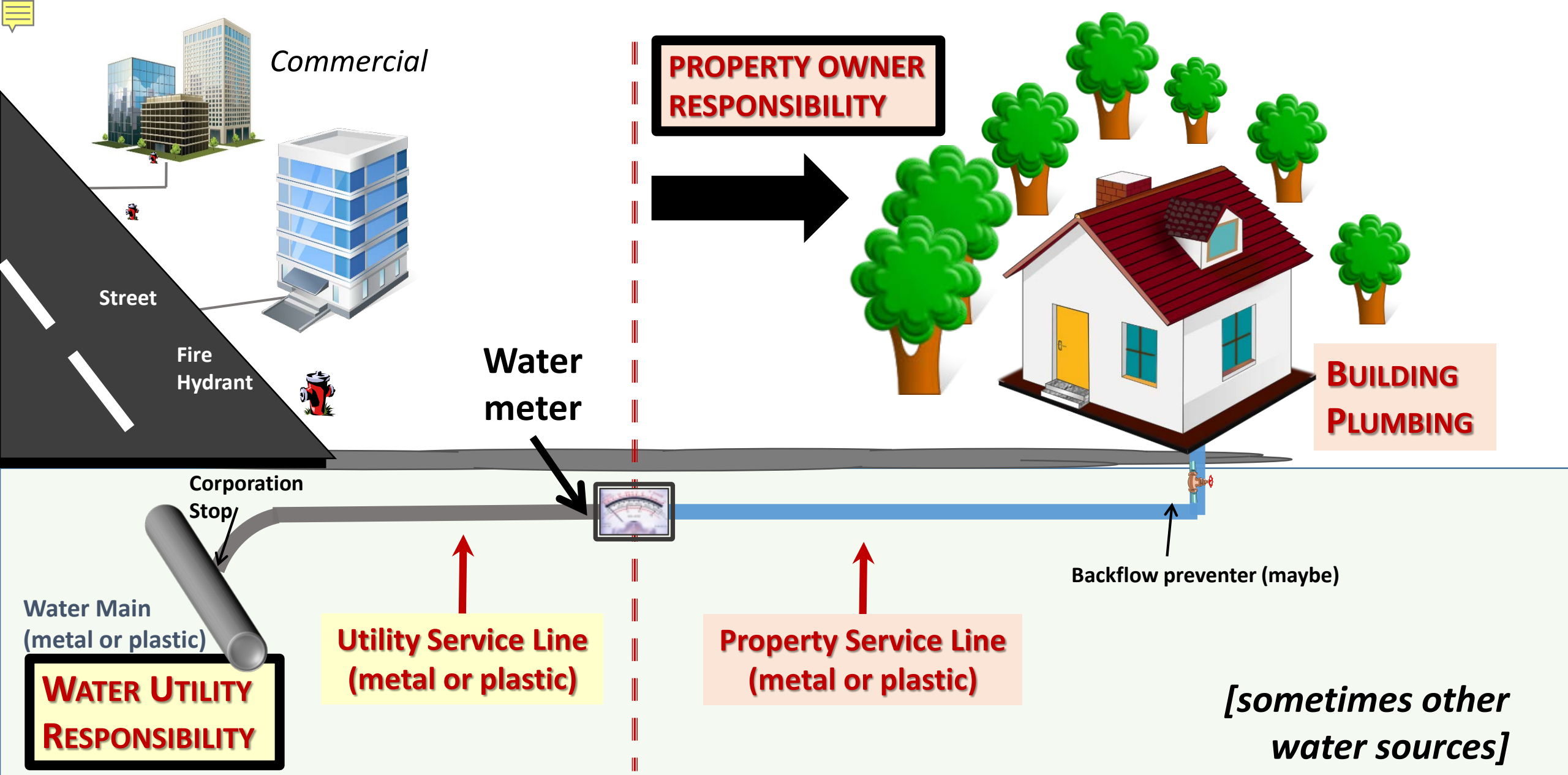
Waste Materials and Management Solutions










Commercial
PROPERTY OWNER RESPONSIBILITY
Street
Fire Hydrant
Water meter
BUILDING PLUMBING
Corporation Stop
Backflow preventer (maybe)
Water Main (metal or plastic)
WATER UTILITY RESPONSIBILITY
Utility Service Line (metal or plastic)
Property Service Line (metal or plastic)
[sometimes other water sources]

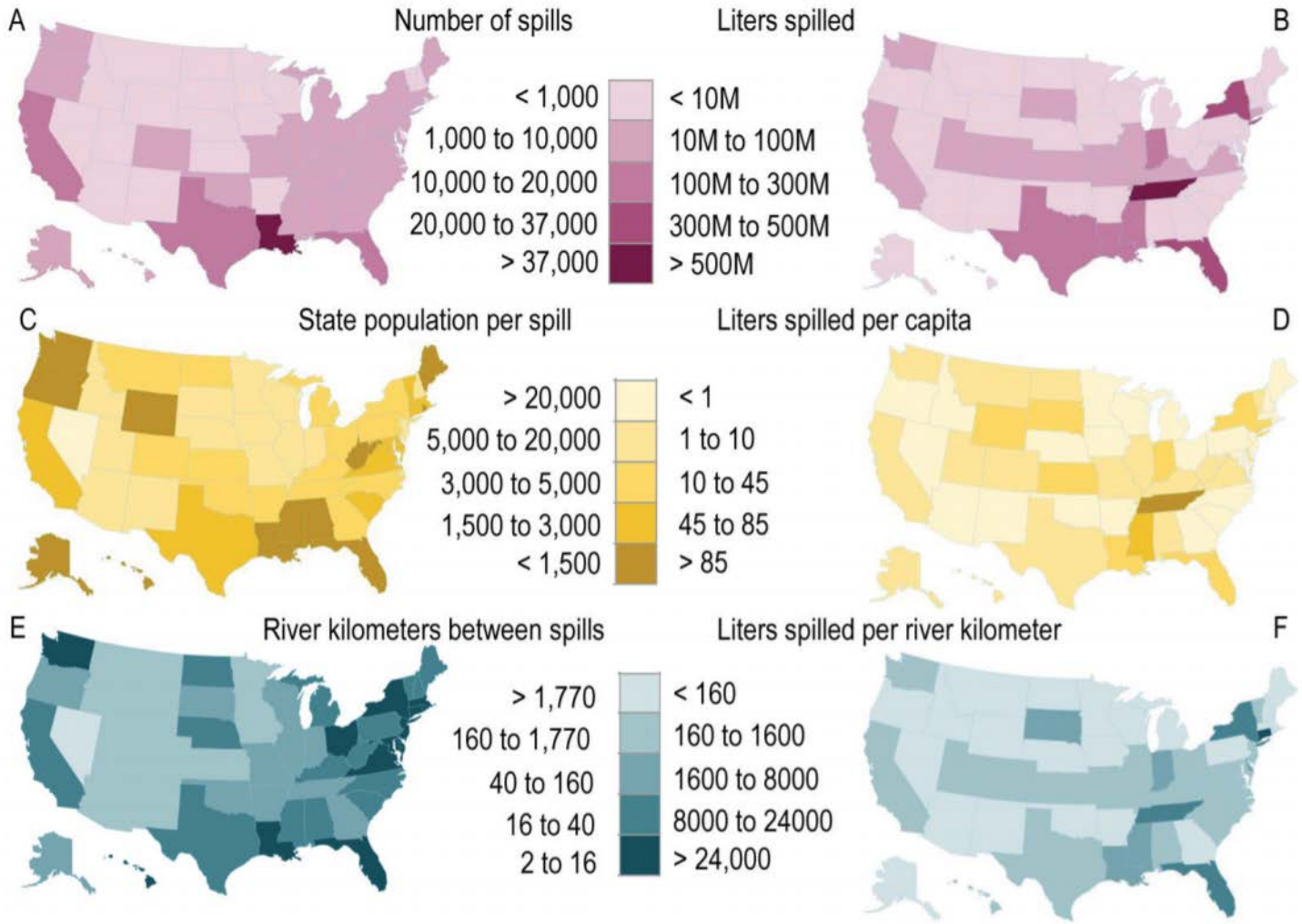
From 2004-2014, 351,000+ chemical spills affected water resources, National Response Center

351,000+: incidents or chemical spills

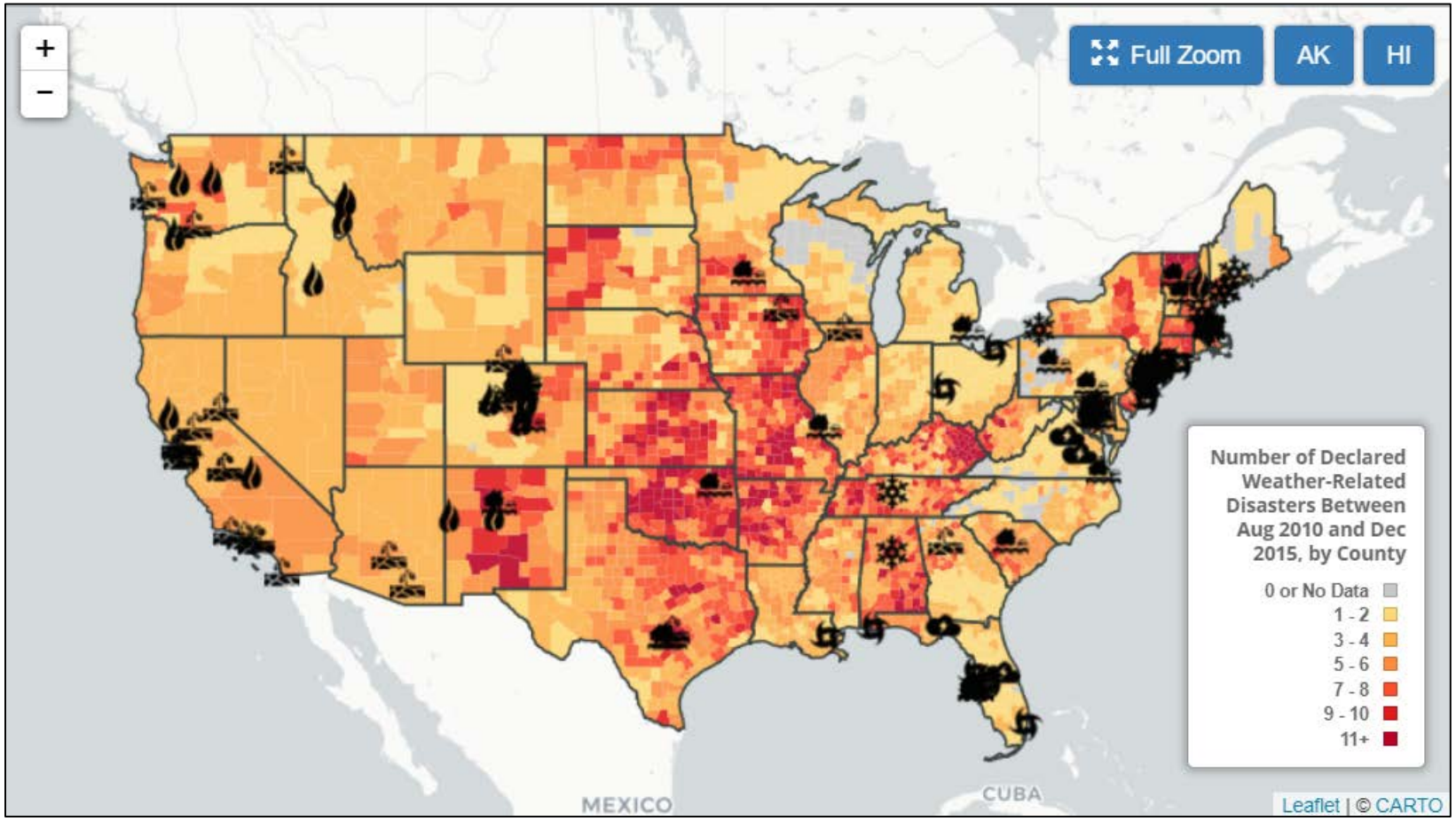
172,000+: impacted US water bodies in areas with higher population centers

88,000: petroleum and natural gas

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



Weidhass et al. 2016. Enabling Science Support for Better Decision-Making when Responding to Chemical Spill. 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 microbial and chemical risks

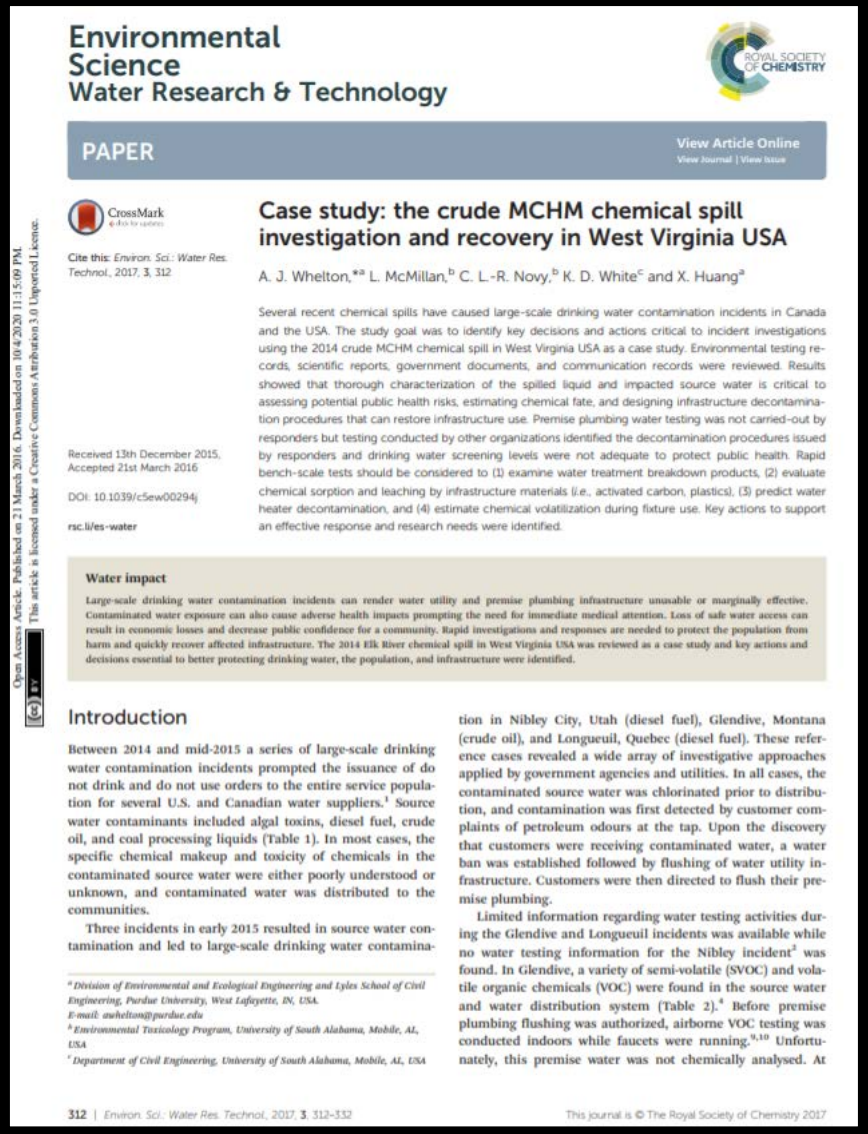
EnvironmentAmerica.org

Location	Year	Cause	Contaminant	Plumbing system decon method	Population affected	Health impacts	Duration, days
Nibley City, UT[45]	15	Truck spill	Diesel fuel	Flushing	5000	nr	1
Glendive, MT[46]	15	Pipe rupture, spill	Crude oil	Flushing	6000	Yes	5
Longueuil, QC, CN	15	Tank rupture, spill	Diesel fuel	None	230 000	No	2
Washington, D.C.[47]	14	Unknown	Petroleum product	Flushing	Est. 370	nr	3
Toledo, OH[48]	14	Algal bloom	Microcystins[c]	Flushing	500 000	No	2
Charleston, WV[1]	14	Tank rupture, spill	Coal chemical	Flushing	300 000	Yes	9[b]
Jackson, WI[49]	12	Pipe rupture, spill	Petroleum product	nr	50	nr	30
Safed, Israel[38]	10	DS backflow	Diesel fuel	Flushing; surfactant	3000	nr	3
Boise, ID[50]	05	Unknown	TCE	Flushing	117	nr	nr
Stratford, ON, CN[51]	05	DS backflow	2-Butoxyethanol	Flushing	32 000	Yes	Up to 7
Northeast Italy[52]	02	New pipe install	Cutting oil	Flushing	4 bldgs	nr	Months
Guelph, CN[53]	97	DS backflow	Petroleum product	nr	48 000	nr	3
Charlotte, NC[36]	97	DS backflow	Fire suppressant (AFFF)[d]	Flushing	29 bldgs	No	nr
Tucumcari, NM[32,54]	95	DS backflow	Toluene, phenol, *etc.*[a]	Flushing	nr	Yes	nr
Uintah Highlands, UT[32]	91	DS backflow	TriMec; 2,4-D; dicamba	nr	2000 homes	Yes	nr
Hawthorne, NJ[36]	87	DS backflow	Heptachlor	Cl_2 flush; replacement	63	No	nr
Gridley, KS[54]	87	DS backflow	Lexon DF	nr	10 homes, 1 business	nr	nr
Hope Mills, NC[36]	86	DS backflow	Heptachlor, chlordane	Flushing	23 homes	No	3
Pittsburgh, PA[54]	81	DS backflow	Heptachlor, chlordane	Flushing; replacement	300 (23 bldgs)	No	27
Lindale, Georgia[55]	80	DS construction	Phenolic compounds	Super-chlorination	Hospital	Yes	nr
Montgomery Cnty, PA[35]	79	Tank rupture, spill	TCE	nr	500	Yes	nr

Casteloes et al. 2015. Decontaminating chemically contaminated residential premise plumbing systems by flushing. https://doi.org/10.1039/C5EW00118H.

January 2014: Chemical Spill, Charleston, West Virginia – Licorice smelling water for 300,000+ people

- Do Not Use order issued for 9 days
- Chemical screen not conducted.
- CDC's 4-MCHM chemical risk assessment didn't consider inhalation exposure (ingestion only)
- Multiple chemicals present posing health risks. Risk assessment and testing limited.
- Population flushed hot contaminated water into their homes as recommended by the utility. This prompted illness. Contamination remained for 2 months.



Environmental Science
Water Research & Technology

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Cite this: *Environ. Sci.: Water Res. Technol.*, 2017, 3, 312

Case study: the crude MCHM chemical spill investigation and recovery in West Virginia USA

A. J. Whelton,*[a] L. McMillan,[b] C. L.-R. Novy,[b] K. D. White[c] and X. Huang[a]

Several recent chemical spills have caused large-scale drinking water contamination incidents in Canada and the USA. The study goal was to identify key decisions and actions critical to incident investigations using the 2014 crude MCHM chemical spill in West Virginia USA as a case study. Environmental testing records, scientific reports, government documents, and communication records were reviewed. Results showed that thorough characterization of the spilled liquid and impacted source water is critical to assessing potential public health risks, estimating chemical fate, and designing infrastructure decontamination procedures that can restore infrastructure use. Premise plumbing water testing was not carried-out by responders but testing conducted by other organizations identified the decontamination procedures issued by responders and drinking water screening levels were not adequate to protect public health. Rapid bench-scale tests should be considered to (1) examine water treatment breakdown products, (2) evaluate chemical sorption and leaching by infrastructure materials (i.e., activated carbon, plastics), (3) predict water heater decontamination, and (4) estimate chemical volatilization during fixture use. Key actions to support an effective response and research needs were identified.

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DOI: 10.1039/c5ew00294j

rsc.li/es-water

Water impact

Large-scale drinking water contamination incidents can render water utility and premise plumbing infrastructure unusable or marginally effective. Contaminated water exposure can also cause adverse health impacts prompting the need for immediate medical attention. Loss of safe water access can result in economic losses and decrease public confidence for a community. Rapid investigations and responses are needed to protect the population from harm and quickly recover affected infrastructure. The 2014 Elk River chemical spill in West Virginia USA was reviewed as a case study and key actions and decisions essential to better protecting drinking water, the population, and infrastructure were identified.

Introduction

Between 2014 and mid-2015 a series of large-scale drinking water contamination incidents prompted the issuance of do not drink and do not use orders to the entire service population for several U.S. and Canadian water suppliers.[1] Source water contaminants included algal toxins, diesel fuel, crude oil, and coal processing liquids (Table 1). In most cases, the specific chemical makeup and toxicity of chemicals in the contaminated source water were either poorly understood or unknown, and contaminated water was distributed to the communities.

Three incidents in early 2015 resulted in source water contamination and led to large-scale drinking water contamination in Nibley City, Utah (diesel fuel), Glendive, Montana (crude oil), and Longueuil, Quebec (diesel fuel). These reference cases revealed a wide array of investigative approaches applied by government agencies and utilities. In all cases, the contaminated source water was chlorinated prior to distribution, and contamination was first detected by customer complaints of petroleum odours at the tap. Upon the discovery that customers were receiving contaminated water, a water ban was established followed by flushing of water utility infrastructure. Customers were then directed to flush their premise plumbing.

Limited information regarding water testing activities during the Glendive and Longueuil incidents was available while no water testing information for the Nibley incident[2] was found. In Glendive, a variety of semi-volatile (SVOC) and volatile organic chemicals (VOC) were found in the source water and water distribution system (Table 2).[4] Before premise plumbing flushing was authorized, airborne VOC testing was conducted indoors while faucets were running.[9,10] Unfortunately, this premise water was not chemically analysed. At

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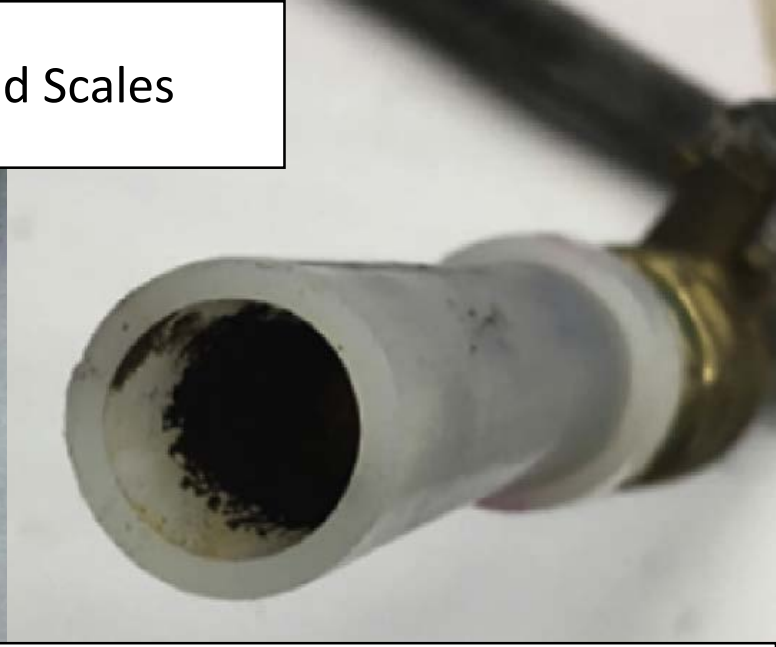
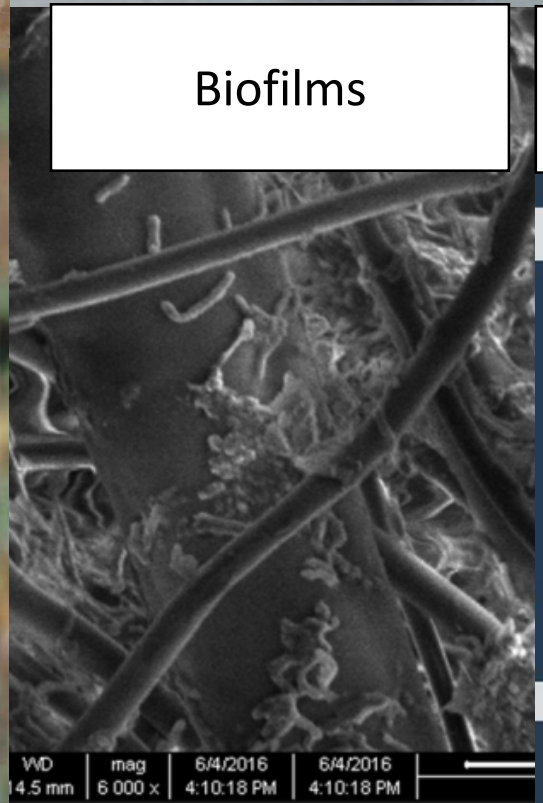
Whelton et al. 2017. Case study: the crude MCHM chemical spill investigation and recovery in West Virginia USA. https://doi.org/10.1039/C5EW00294J

Piping and Tubing Types, and Coatings

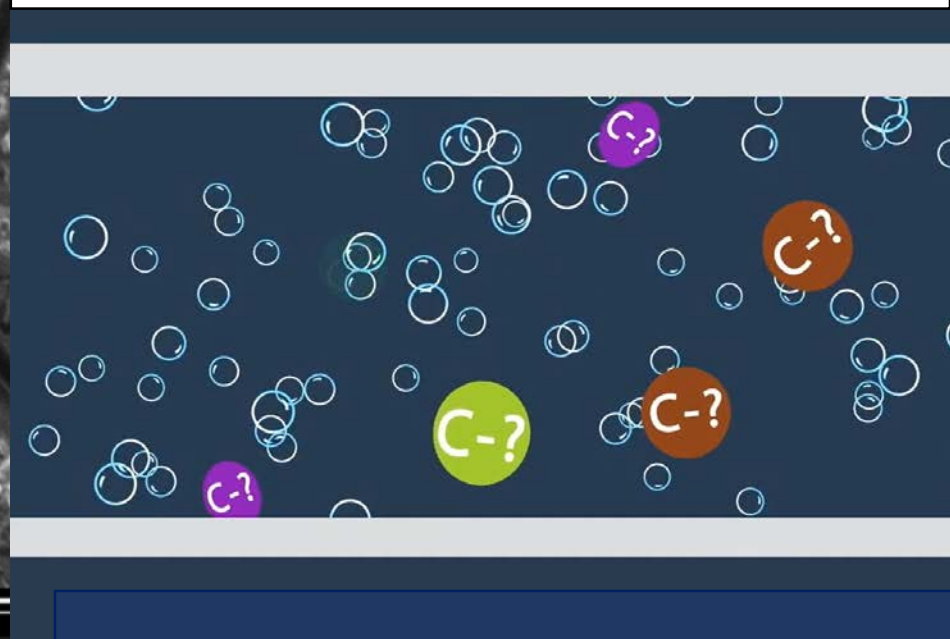
Sediment and Scales





Biofilms

Plastics can Uptake Organic Chemicals



Plumbing component	Type of material
Service lines	Polyvinyl chloride (PVC), high-density polyethylene (HDPE), cross-linked VC), copper, lead, multilayer pipes arrier layers could be aluminum or
Piping and tubing	temperature, copper, ductile iron, steel, black steel, malleable iron, stic layer–barrier layer–plastic layer; ene vinyl alcohol)
Pipe and tank coatings	
Fixture fittings, valves, fittings	ess steel
Gaskets	and peroxide cross-linked], natural eoprene
Water-heater specific	nterior linings, magnesium, or
Domestic storage and cistern	, HDPE
In-building treatment	ers), plastic housing for sorbent or ge resin, stainless steel
Small-diameter tubing for faucet conn humidifiers, dishwasher supply, wash machine supply, in-building water treatment systems	er, PVC, HDPE

Residential Systems

Service line (single vs. shared)
POE/POU devices
Central vs. on-demand water heaters
Recirculation loops
Irrigation
Mixing valves
Fixture types and internals
Faucet gaskets and aerators

Julien et al. 2020. https://doi.org/10.1002/aws2.1177

2015 Study: Flushing as a plumbing decontamination approach for chemical contamination

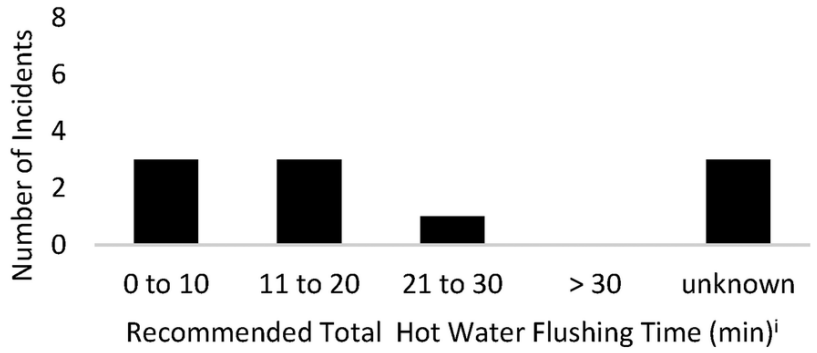
Decontaminating chemically contaminated residential premise plumbing systems by flushing

Download FREE here:

https://doi.org/10.1039/C5EW00118H

Minimal data available on flushing protocol design and effectiveness.

Plumbing design, operational conditions, contaminants present and their properties, as well as building inhabitant safety have not been fully considered in flushing protocol design.



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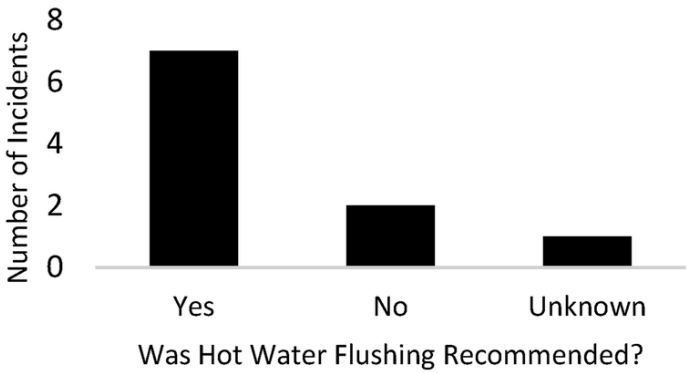

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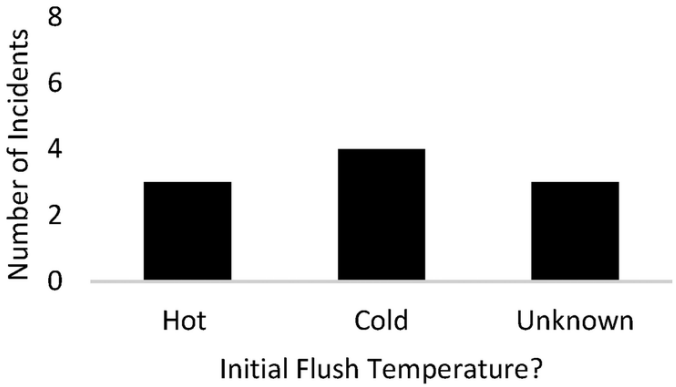


(c)

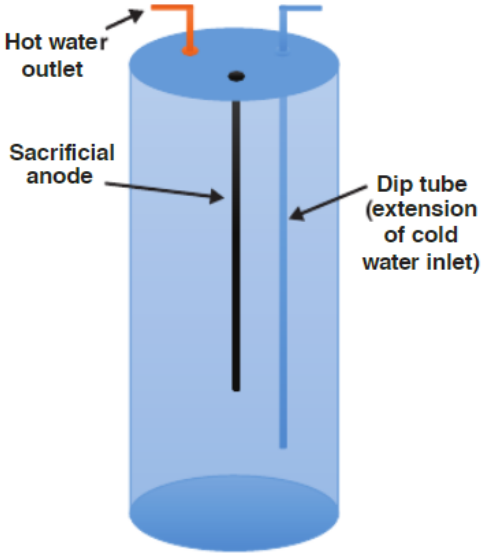
When you look back at U.S. incidents, flushing guidance for single family homes varied drastically, would likely not work, nor was it followed up with confirmatory sampling

Flushing protocols often did not consider water heater volume or fluid dynamics

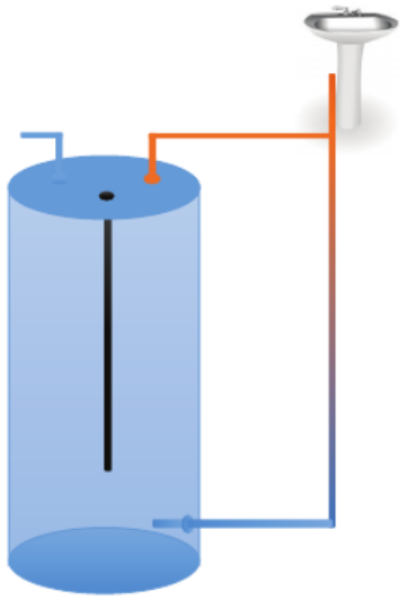
Short water heater
Common in point-of-use applications and manufactured homes

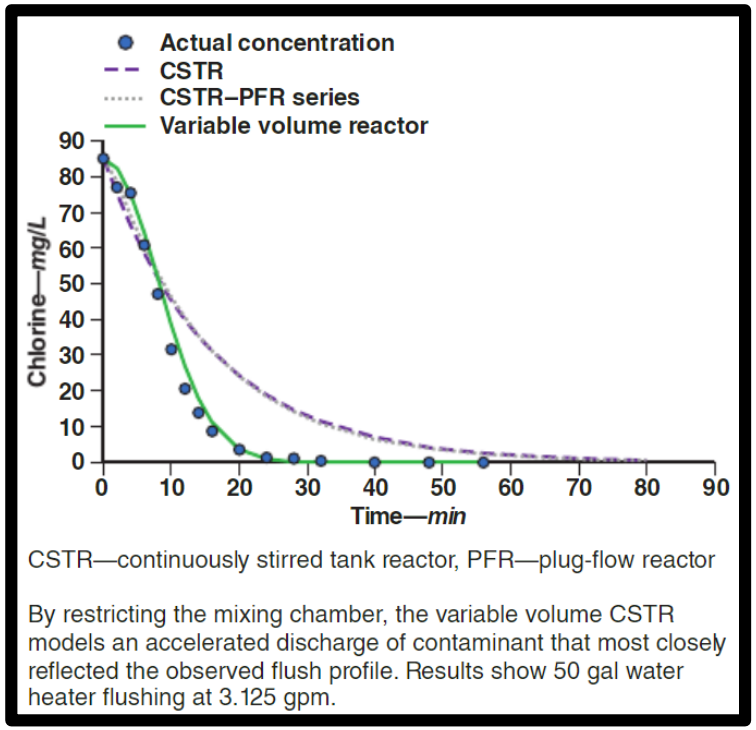
Side-feed water heater
A variant configuration. This variation and variation in dip tube length and shape in traditional heaters present challenges to general water heater models.

"Tallboy" stand water heater: 30–49 gal
Typical of American residences



Hot water recirculation water heater
Recirculation water heater systems return cold water in the supply line to the heater, resulting in a near-instant hot water source at the tap.



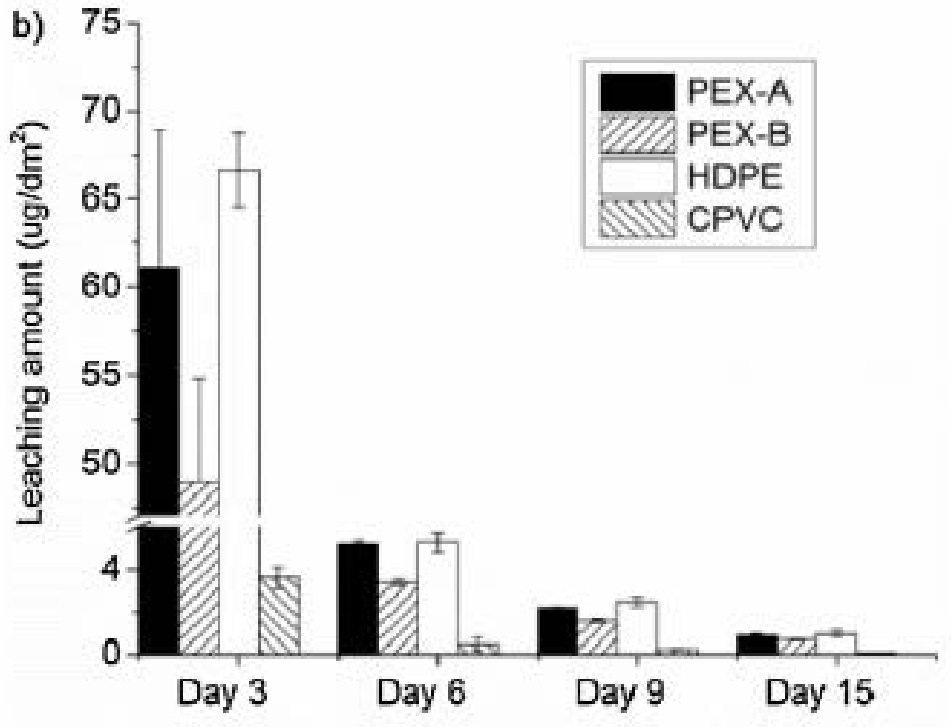


CSTR—continuously stirred tank reactor, PFR—plug-flow reactor

By restricting the mixing chamber, the variable volume CSTR models an accelerated discharge of contaminant that most closely reflected the observed flush profile. Results show 50 gal water heater flushing at 3.125 gpm.

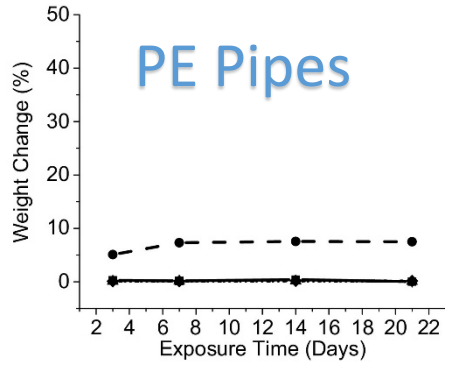
Hawes et al. 2016. Predicting Contaminated Water Removal From Residential Water Heaters Under Various Flushing Scenarios. https://doi.org/10.5942/jawwa.2017.109.0085

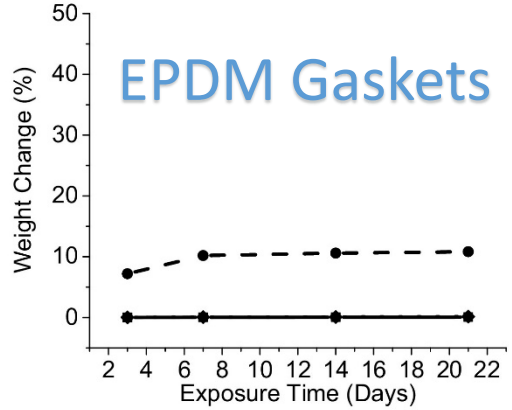
Not Considered: VOCs Diffuse In and Out of Plastic Plumbing Slowly

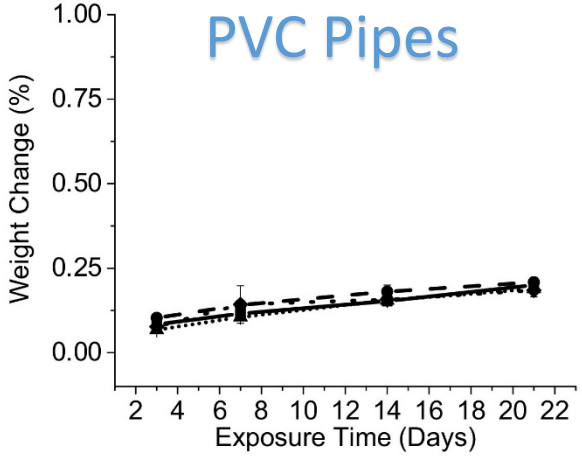


Casteloes et al. 2016. Crude oil contamination of plastic and copper drinking water pipes. https://doi.org/10.1016/j.jhazmat.2017.06.015

Surfactant-Plastic Interactions are Not Trivial







Surfactant Liquids

Alconox (●)
MAG (*)
Dawn (▲)
Tap (■)

Huang et al. 2017. The interaction of surfactants with plastic and copper plumbing materials during decontamination. https://doi.org/10.1016/j.jhazmat.2016.11.067

U.S. wildfires burned 10 million+ acres (40,406 km^2) 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

Amazing People

Beautiful Butte County

Paradise Rocks

Thursday, November 8, 2018

5:30 am – PG&E notifies 911 about a fire located in Pulga, Butte Co, CA

7:33 – Houses on fire, Concow

7:41 – Fire in Paradise

8:03 – Sheriff calls for evacuation

8:24 – 911 operator: No one can come help you, get out

Later – Routes blocked, evacuate, find shelter

For hours some trapped inside as the fire rolled through

Fire Speed:
60 football fields per minute

The 2018 Camp Fire – A Different Scale

Executive Department
State of California

November 8, 2018

Proclamation of a State of Emergency

WHEREAS on November 8, 2018, the Camp Fire began burning in Butte County and continues to burn; and

WHEREAS this fire has destroyed homes and continues to threaten additional homes and other structures, necessitating the evacuation of thousands of residents; and

WHEREAS the fire has forced the closure of roadways and continues to threaten critical infrastructure; and

WHEREAS high temperatures, low humidity, and erratic winds have further increased the spread of this fire; and

WHEREAS the Federal Emergency Management Agency has approved a Fire Management Assistant Grant to assist with the mitigation, management, and control of the Camp Fire; and

WHEREAS the circumstances of this fire, by reason of its magnitude, are or are likely to be beyond the control of the services, personnel, equipment, and facilities of any single local government and require the combined forces of a mutual aid region or regions to combat; and

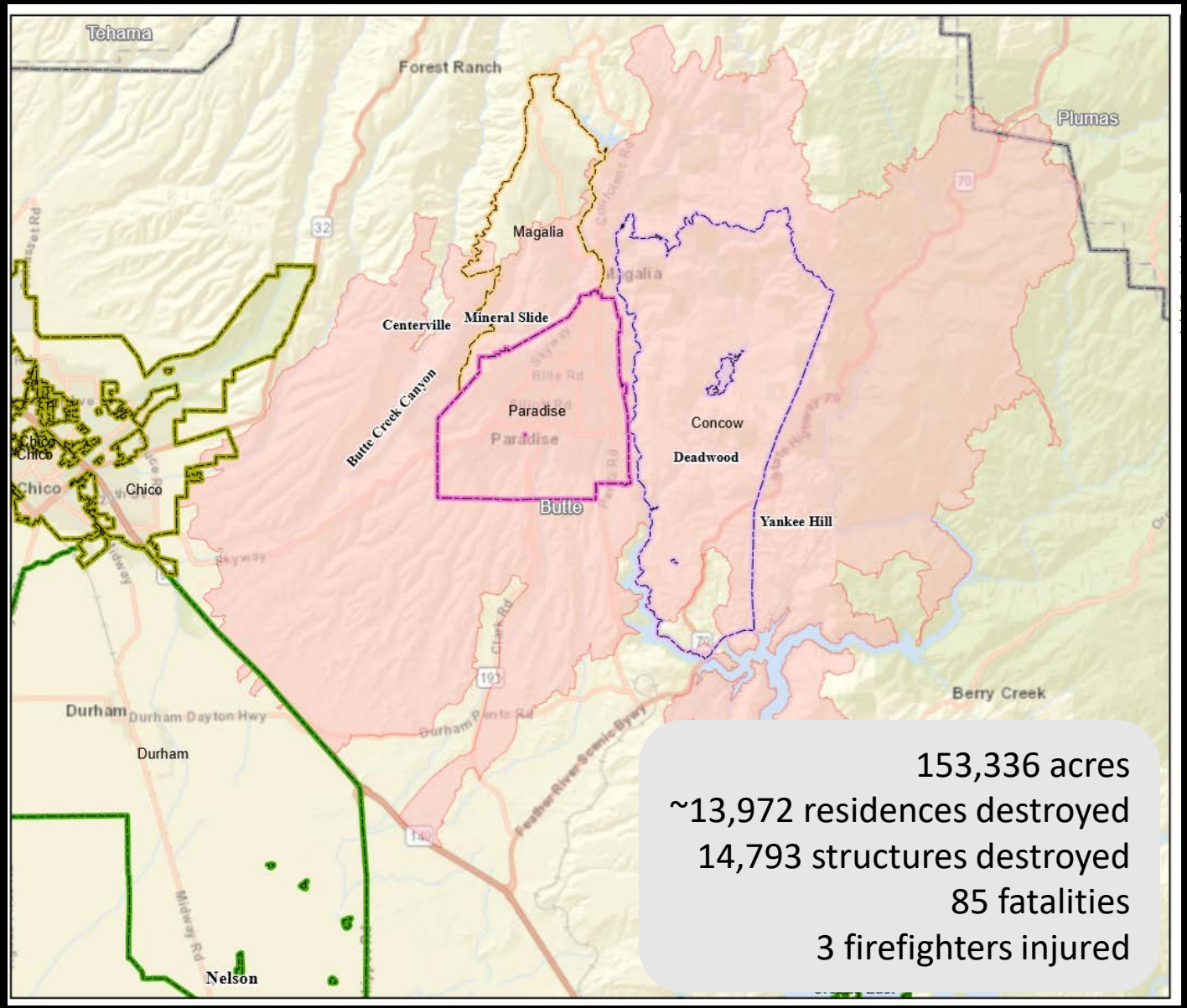
WHEREAS under the provisions of Government Code section 8558(b), I find that conditions of extreme peril to the safety of persons and property exists in Butte County due to this fire; and

WHEREAS under the provisions of Government Code section 8571, I find that strict compliance with the various statutes and regulations specified in this order would prevent, hinder, or delay the mitigation of the effects of the Camp Fire.

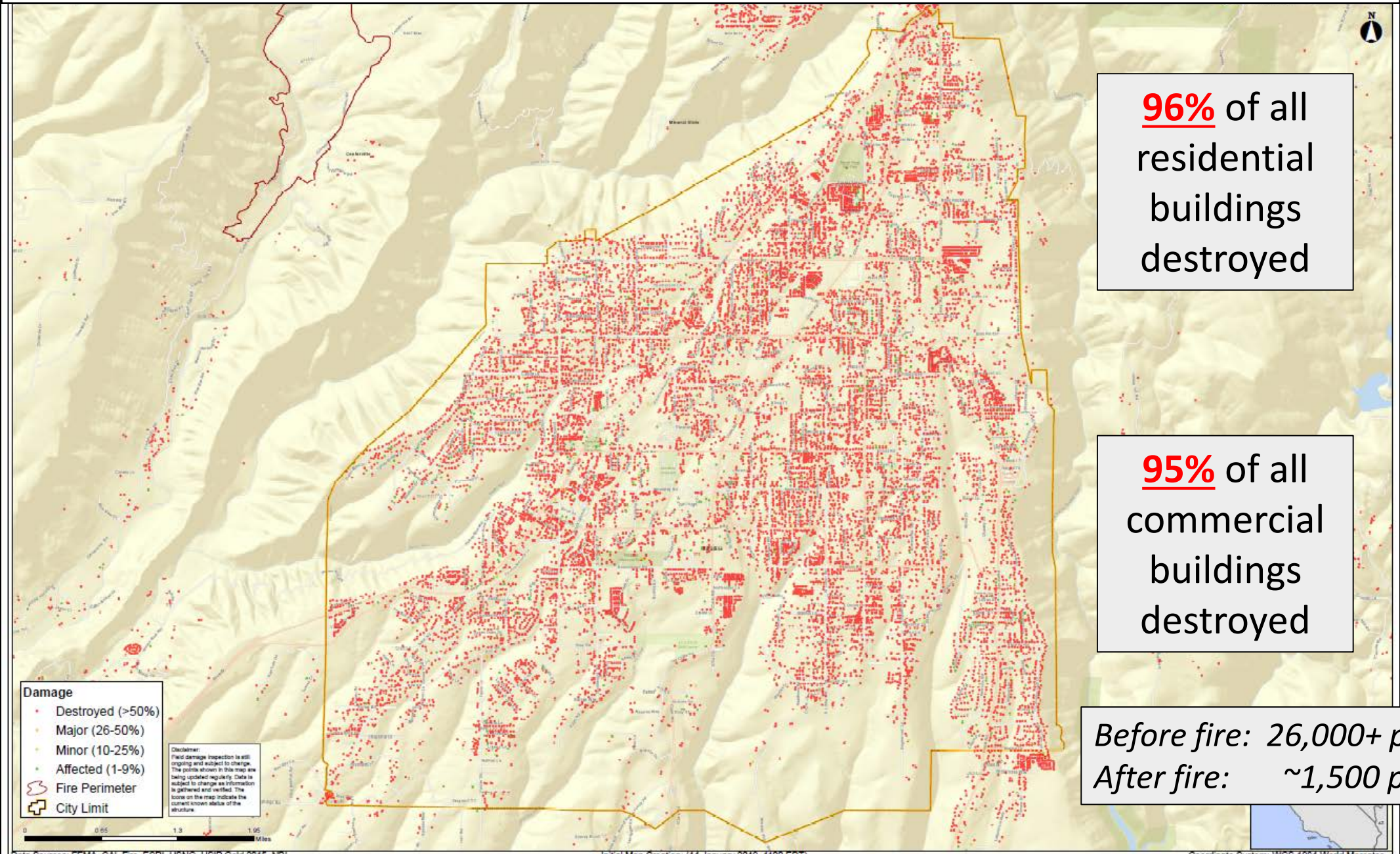
NOW, THEREFORE, I, GAVIN NEWSOM, Acting Governor of the State of California, in accordance with the authority vested in me by the State Constitution and statutes, including the California Emergency Services Act, and in particular, Government Code section 8625, **HEREBY PROCLAIM A STATE OF EMERGENCY** to exist in Butte County due to the Camp Fire.

IT IS HEREBY ORDERED THAT:

1. All agencies of the state government utilize and employ state personnel, equipment, and facilities for the performance of any and all activities consistent with the direction of the Office of Emergency Services and the State Emergency Plan. Also, all citizens are to heed the advice of emergency officials with regard to this emergency in order to protect their safety.
2. The Office of Emergency Services shall provide local government assistance to Butte County, if appropriate, under the authority of the California Disaster Assistance Act, Government Code section 8680 et seq., and California Code of Regulations, Title 19, section 2900 et seq.



Town of Paradise Limits



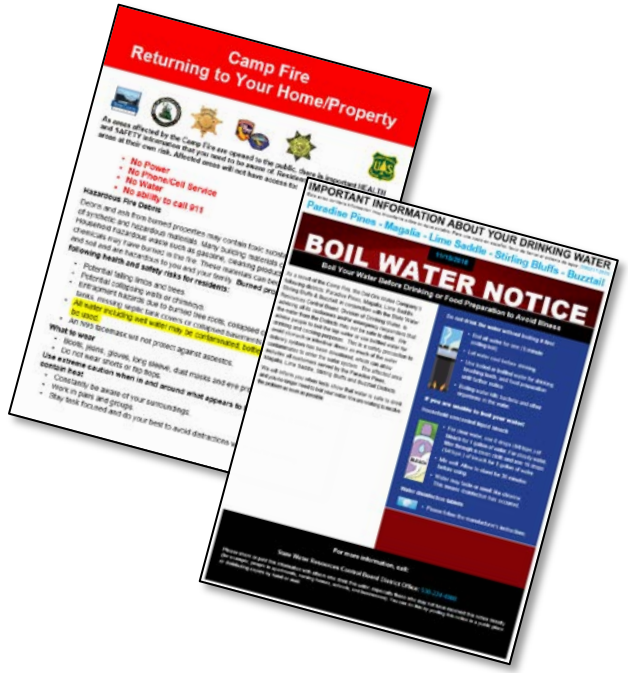
96% of all residential buildings destroyed

95% of all commercial buildings destroyed

Before fire: 26,000+ people
After fire: ~1,500 people

Public Water Systems (% Homes Gone)	Population	Source Water
Paradise Irrigation District (PID) (-96%)	26,032	Surface
Del Oro Water Company (DOWC) – Paradise Pines (-38%)	11,324	Surface
DOWC – Lime Saddle (-50%)	1,106	Surface
DOWC – Magalia (-89%)	924	Ground
DOWC – Stirling Bluffs (0%)	548	Surface
DOWC – Buzztail (-34%)	106	Ground
Foothill Solar Community	180	Ground
Forest Ranch Mobile Home Park	25	Ground
Forest Ranch Mutual Water Company	92	Ground
Gran Mutual Water Company	202	Ground
Humboldt Woodlands Mutual Water Company	75	Ground
Meadowbrook Oaks Mobile Home Park	50	Ground
Mountain Village Homeowners Association	40	Ground

Boil water advisories were issued to 40,000 people



Private wells
13,227 exist in Butte County
2,438 wells in Camp Fire area

February 2019

3 months post-fire





PURDUE UNIVERSITY

MANHATTAN COLLEGE

CalOES, SWRCB, BCHD, FEMA, PID, DOWC, Town, CalFire did not understand how to proceed

< 50 samples had been collected by PID & DOWC

Benzene testing only; State assumed benzene was the only chemical present

Our onsite recommendations:

- Find out what's in the water (not just benzene)
- Reevaluate water use restrictions
- Isolate → Test (72hr) → Decon/replace
- Population in homes needs help, they've been left to fend for themselves

Onsite Visit Response and Recovery Observations Presented to PID February 13, 2019

Purdue University & Manhattan College
Andrew J. Whelton, Ph.D., Amisha Shah, Ph.D.,
Juneseok Lee, Ph.D., P.E., Caitlin Proctor, Ph.D., David Yu, Ph.D.
Questions: awhelton@purdue.edu

A. Overall

- PID has done a good job in moving towards stabilizing their infrastructure. This includes repressurizing distribution systems, identifying damaged assets, fixing breaks/leaks, flushing out contaminated water, issuing appropriate water advisories, and other activities.
- The water system is still in the response phase because the system is not yet stabilized and there are many challenges to resolve: for example, how to test for contamination.
- Persons living in the disaster area have complicated the response because PID has had to take action to both respond to their system damage but also to requests of customers.
- A recommendation is that PID focus on completing the response and moving into recovery, but this is and will continue to be slowed by multiple demands on limited resources. For example, PID staffing has been reduced since the disaster took place and the disaster has created an enormous need for additional staffing for response and recovery.
- A critical element to moving forward in a timely manner will be clear and straight-forward recommendations from CalOES and FEMA regarding funding of response efforts.

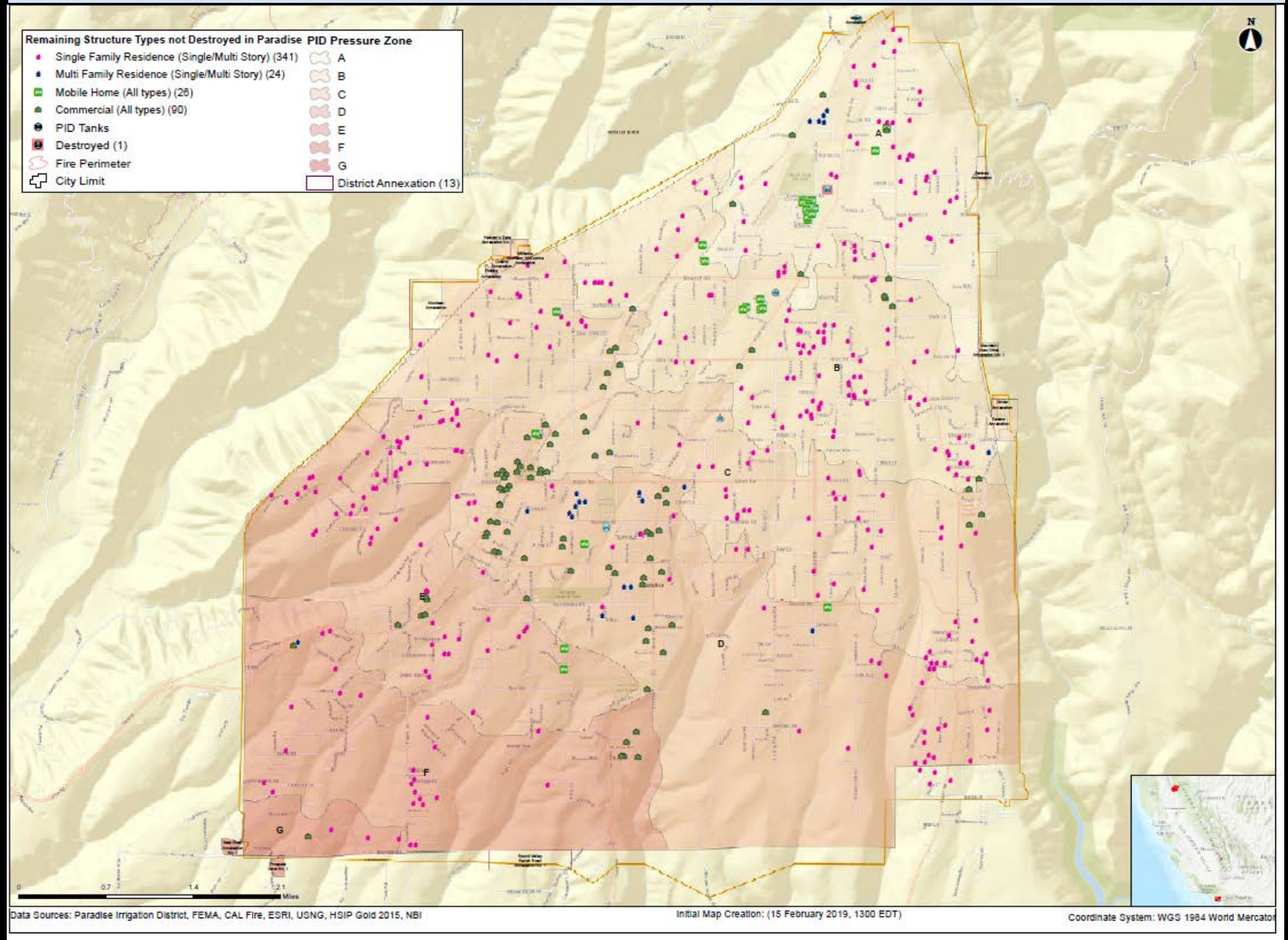
Standing homes were scattered throughout the contaminated water systems: PID Example

2 sources
1 treatment plant

7 pressure zones
172 miles of buried pipe
- PVC (35%)
- Steel (33%)
- CML (19%)
- AC (10%)
- Irons (6%)

1,400 fire hydrants
10,600 service lines and meters
- Cu, Brass, GIP, GSP, HDPE, PB

PID Pressure Zones vs. Standing Structures



Damage

90%+ of their 172 mile water distribution system depressurized for hours to weeks

100s+ of leaks


11,000+ homes

Drinking Water Distribution System Impacts

500 ppb benzene – U.S. Federal RCRA hazardous waste limit

Chemical that Exceeded a Drinking Water Limit	2018 Camp Fire (8 months after the fire)				2017 Tubbs Fire (11 months after the fire)		
	PID	DOWC	Exceedance		Santa Rosa		
	Max, ppb	Max, ppb	Exceeded Long-Term Limit?	Exceeded ***Short-Term*** Limit?	Max, ppb	Exceeded Long-Term Limit?	Exceeded ***Short-Term*** Limit?
Benzene	>2,217	530	**Yes**	**Yes**	40,000	**Yes**	**Yes**
Methylene chloride	45	NA	**Yes**	No	41	**Yes**	No
Naphthalene	693	NA	**Yes**	**Yes**	6,800	**Yes**	**Yes**
Styrene	378	NA	**Yes**	No	460	**Yes**	No
Tert-butyl alcohol	13	NA	**Yes**	-	29	**Yes**	-
Toluene	676	NA	**Yes**	No	1,130	**Yes**	No
Vinyl chloride	1	NA	**Yes**	No	16	**Yes**	No

Long-term limit for an adult for 70 years
Short-term (1 day) limit for a 1 year old child

AWWA Water Science, Proctor et al. 2020
https://doi.org/10.1002/aws2.1183

Possible Primary Sources

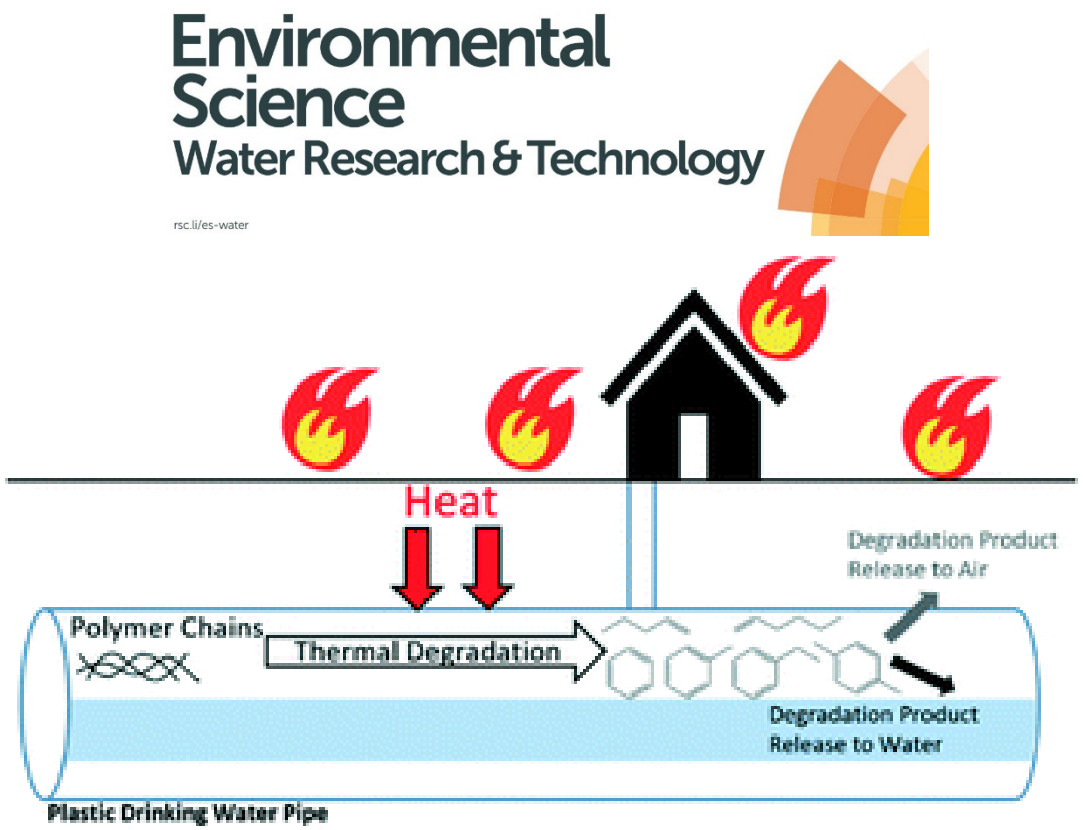
1. *In-situ* plastic thermal decomposition (PVC pipes, HDPE pipes, PB pipes, gaskets, meter components, etc.)
2. Contaminated air/materials drawn into depressurized system
3. Contaminated water from building plumbing drawn into compromised distribution system

Confirmed Secondary Sources

Partitioning/Adsorption/Absorption:
Water ⟷ Material

See video at
www.PlumbingSafety.org

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

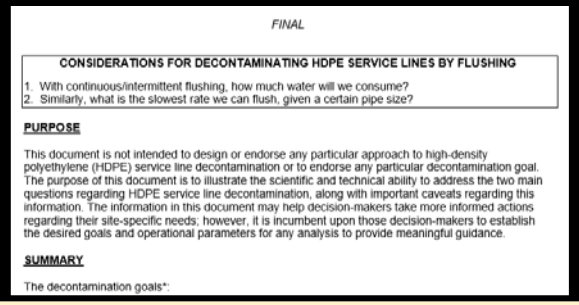
Download FREE here:

https://doi.org/10.1039/D0EW00836B

Heating new PE, PEX, PVC, CPVC, and PP pipes < Tdeg generated VOCs and SVOCs

Benzene generated by all pipes except PP

Once plastic cooled, chemicals leached into water



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*:

Science was applied to *some* water distribution system testing and decontamination decisions, but more work is needed

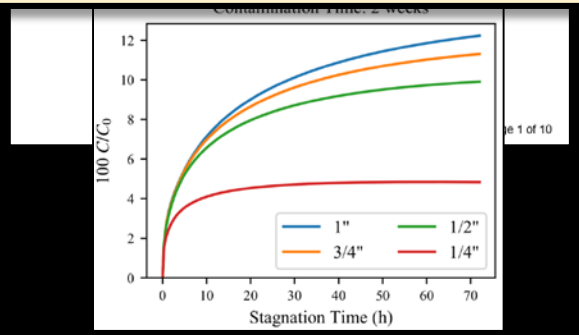
Water Distribution System Decontamination

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)

Initial measurement concentration (C_2)	Goal A (never above 0.5 ppb)		Goal B (only exceed 0.5 ppb after 72 hours of stagnation)	
	Continuous	Intermittent (once/72 hrs)	Continuous	Intermittent (once/72 hrs)
100 ppb	286	312	195	240
50 ppb	246	270	156	198
20 ppb	195	213	104	141
10 ppb	155	171	66	99
5 ppb	116	129	33	60
2 ppb	64	74	8	20

https://engineering.purdue.edu/PlumbingSafety/opinions/Final-HDPE-Service-Line-Decontamination-2019-03-18.pdf

‘Standing Home’ Public Health Implications

Citizens were not adequately protected from contaminated water

- State officials told people to SMELL (not test) water to determine if its safe
- 2 DOWC systems contaminated (530 ppb max), no water restrictions
- Some PID customers did not follow water use restrictions

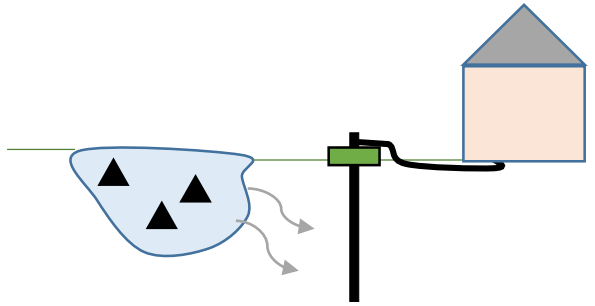
Contaminated water entered home plumbing for 6+ months

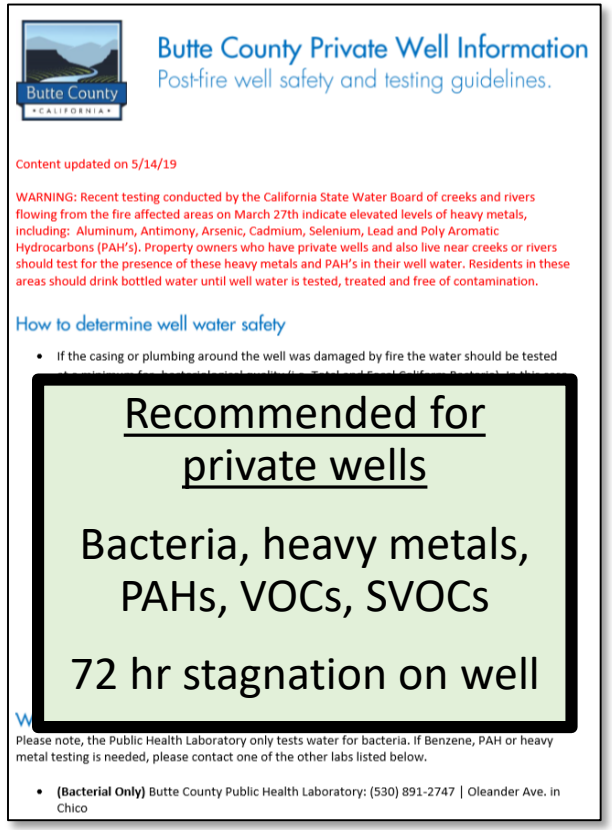
- Benzene found in homes by residents, State said they had no knowledge (because they didn’t credibly sample)
- Utilities were still trying to identify their contaminated assets
- Checkerboard recovery: Loss of pressure (main break, leak) *could move* contaminated water into a standing home service line

Plumbing received 6+ months of contaminated water

Cold and hot water systems became nonpotable
Trunk-and-branch vs. homerun designs
In-home treatment devices (est. $7 million)
Paying for water testing, results not representative
External water tank maintenance and microbiological growth
Some have no economic capacity to purchase bottled water, devices

Insurance companies made decisions (not USEPA, State or health department) about in-home treatment





Butte County Private Well Information

Post-fire well safety and testing guidelines.

Content updated on 5/14/19

WARNING: Recent testing conducted by the California State Water Board of creeks and rivers flowing from the fire affected areas on March 27th indicate elevated levels of heavy metals, including: Aluminum, Antimony, Arsenic, Cadmium, Selenium, Lead and Poly Aromatic Hydrocarbons (PAH’s). Property owners who have private wells and also live near creeks or rivers should test for the presence of these heavy metals and PAH’s in their well water. Residents in these areas should drink bottled water until well water is tested, treated and free of contamination.

How to determine well water safety

- If the casing or plumbing around the well was damaged by fire the water should be tested

Recommended for private wells

Bacteria, heavy metals, PAHs, VOCs, SVOCs

72 hr stagnation on well

Please note, the Public Health Laboratory only tests water for bacteria. If Benzene, PAH or heavy metal testing is needed, please contact one of the other labs listed below.

- **(Bacterial Only)** Butte County Public Health Laboratory: (530) 891-2747 | Oleander Ave. in Chico

WELCOME

DRINKING WATER AND PLUMBING AFTER THE CAMP FIRE

4 – 6 pm: **Interactive demonstrations of drinking water sampling, testing, and plumbing**

6 – 7pm: **Break**

7 – 8:30 pm: **Purdue University Camp Fire Drinking Water Survey Results**

Hosted by

PURDUE UNIVERSITY

MANHATTAN COLLEGE

Financial support provided by the Paradise Rotary Foundation

Paradise Rotary Foundation

In collaboration with

CAMP FIRE ZONE PROJECT

BUTTE-GLENN COMMUNITY COLLEGE DISTRICT — Butte College

School of Public Health, UNIVERSITY OF CALIFORNIA, BERKELEY

CALIFORNIA STATE UNIVERSITY CHICO

Live stream 7-8:30PM at https://m.facebook.com/campfirezoneproject

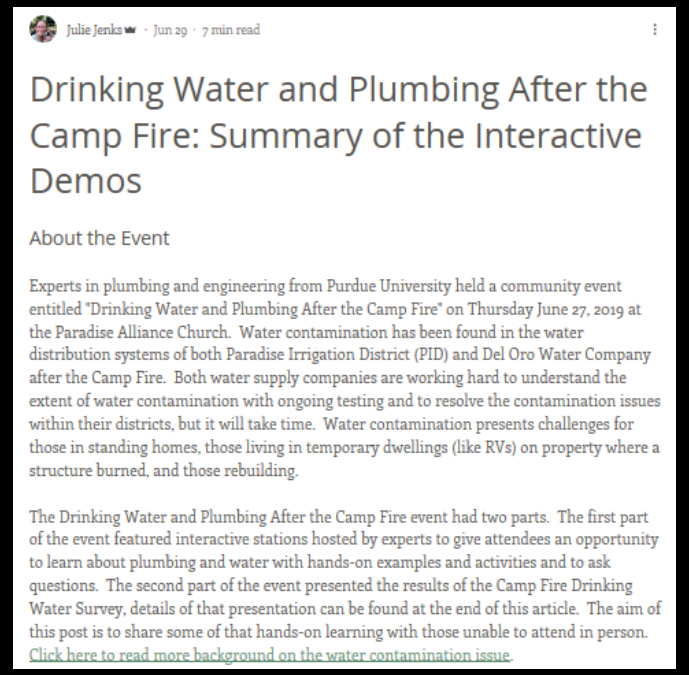
Paradise Alliance Church, June 27, 2019, Paradise, California

Post-disaster plumbing education

➔ 4,000+ people reached

Grant from the Paradise Rotary Foundation

In response to public concerns we conducted a Community Health Survey and Plumbing Education Event after the fire



Julie Jenks · Jun 29 · 7 min read

Drinking Water and Plumbing After the Camp Fire: Summary of the Interactive Demos

About the Event

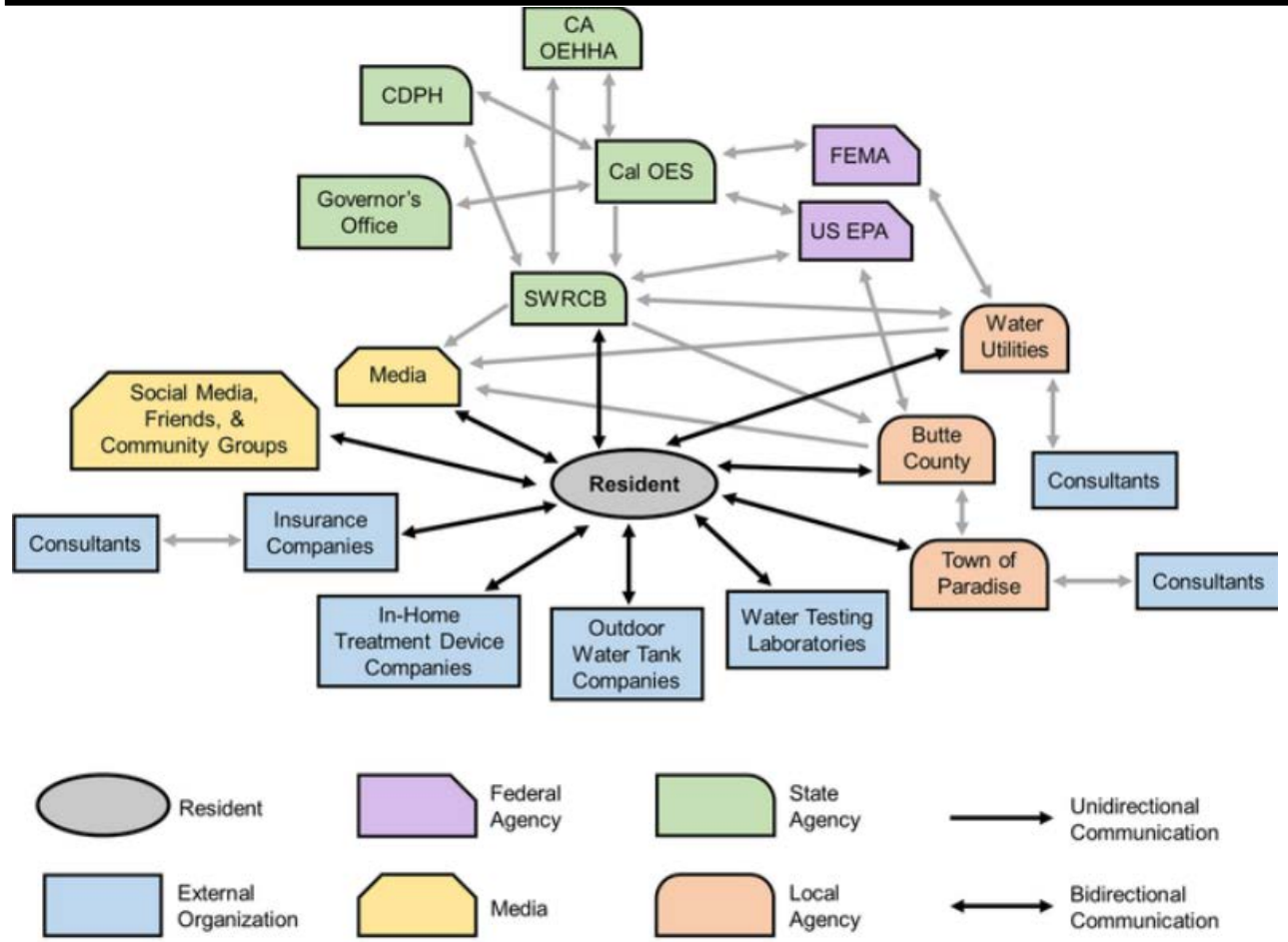
Experts in plumbing and engineering from Purdue University held a community event entitled "Drinking Water and Plumbing After the Camp Fire" on Thursday June 27, 2019 at the Paradise Alliance Church. Water contamination has been found in the water distribution systems of both Paradise Irrigation District (PID) and Del Oro Water Company after the Camp Fire. Both water supply companies are working hard to understand the extent of water contamination with ongoing testing and to resolve the contamination issues within their districts, but it will take time. Water contamination presents challenges for those in standing homes, those living in temporary dwellings (like RVs) on property where a structure burned, and those rebuilding.

The Drinking Water and Plumbing After the Camp Fire event had two parts. The first part of the event featured interactive stations hosted by experts to give attendees an opportunity to learn about plumbing and water with hands-on examples and activities and to ask questions. The second part of the event presented the results of the Camp Fire Drinking Water Survey, details of that presentation can be found at the end of this article. The aim of this post is to share some of that hands-on learning with those unable to attend in person. Click here to read more background on the water contamination issue.

Go to PlumbingSafety.org
“RESOURCES” Tab
“DEMONSTRATIONS” Tab

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

Download here: https://doi.org/10.1007/s11069-021-04714-9



1) Water use restrictions,
2) Plumbing water sample collecting 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.

7 Months after the Fire, Populations Affected Did Not Have Adequate Guidance on How to Properly Sample Their Buildings

Topic	SWRCB Guidance to the Public (Policy!)		Guidance from Plumbing and Water Experts from 5 Universities
	November 2018-June	7 months after the fire	
Exposure Pathways Included	Ingestion only	Ingestion only	Ingestion, **inhalation, and skin contact**
Number of Indoor Locations	1, kitchen sink cold water	1, kitchen sink cold water	**All exposure locations + service line**
Systems to Test	Cold water only	Cold water only	Cold and **hot water**
Stagnation Period Required	**None**	**At least 8 hour**	**72 hour**
VOCs to Look For	Benzene only	Benzene only	**All VOCs detected post-fire**

CHICO STATE

PURDUE UNIVERSITY

Butte College

Berkeley
UNIVERSITY OF CALIFORNIA

UCSF
University of California
San Francisco

In-home testing was conducted 11 months after the fire

125 homes: PID (101), Del Oro (24)

First draw, kitchen sink cold water only, 12+ hr stagnation.

Looked for more than benzene

2 homes: benzene found, but less than 1 ppb CA MCL

4 homes: methylene chloride exceeded USEPA 5 ppb MCL (max. 9.2 ppb)

THF found above other state limits (no CA or federal limit)

Unclear home location or plumbing system type (plastic vs. metal)

Not statistically representative, homeowner service lines not tested

Hot water systems are separate, where inhalation exposure occurs, but were not tested

We recommended in-home testing to CalOES 8 months before, it was never initiated

1 Year Later….Paradise and Beyond

Population: Less than 3,000 of 26,000 pre-fire (now certified as rural)

Homes rebuilt: 11 of the 11,000+ homes that were destroyed

Debris removed: 7.3 billion pounds of ash, debris, metal, concrete, and contaminated soil (2x World Trade Center)

PID water:

- 150 of 172 miles of water main cleared free of contamination
- 47% of meter/service lines 'standing structures' cleared of contamination; Service lines to destroyed structures still need testing, maybe contaminated

Homeowners:

- Responsible for testing THEIR service line and THEIR plumbing – negligible support
- Insurance only sometimes covered plumbing testing and not full plumbing
- Many exclusively relied on in-home treatment systems, some on water tanks
- Some stayed, some returned, others left, others uncertain

Looking Ahead: Plumbing Testing and Recovery

Type of contaminant (inorganic vs. organic chemicals vs. microbial)

Exposure routes: Dermal vs. Ingestion vs. Inhalation

Exposure populations: Healthy adults vs. immunocompromised

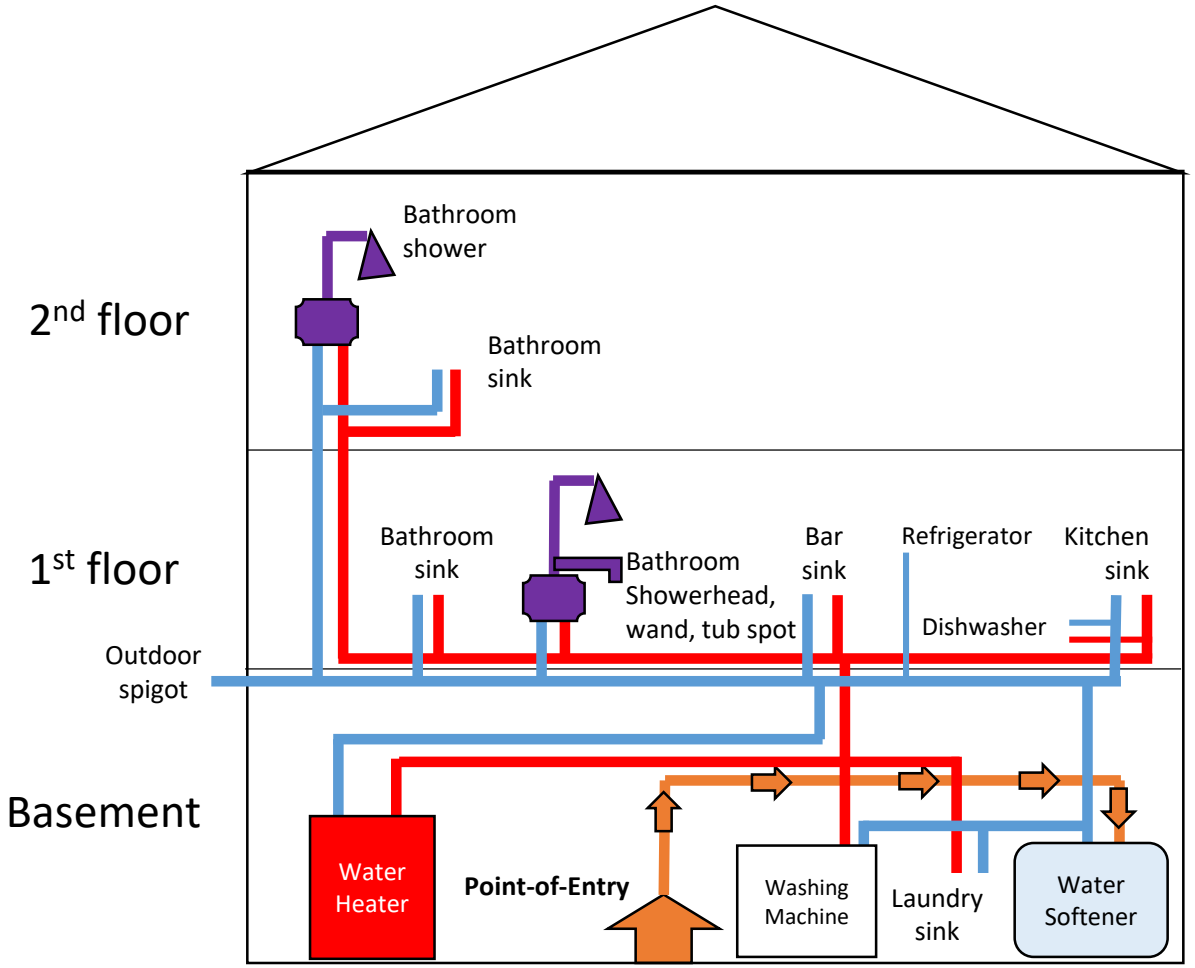
Building type: Residential vs. Commercial vs. Other

Plumbing Design (source, layout, device types, materials)

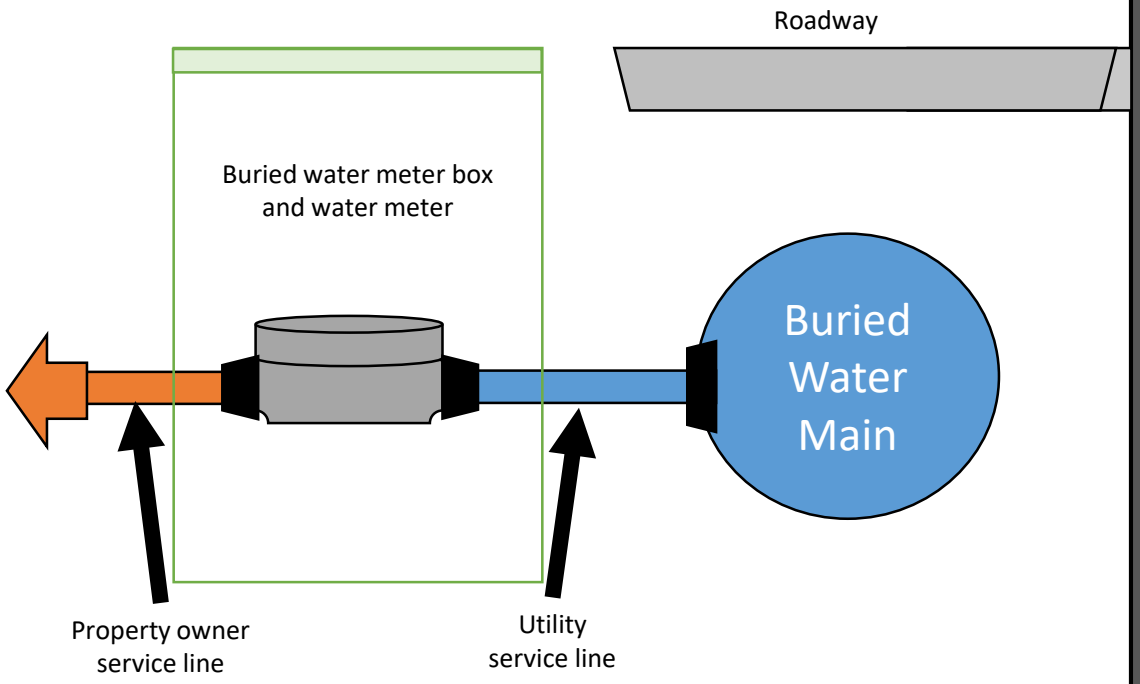
Before sampling

- Contaminant exposure due to flushing
- Waste disposal of flush water (sewer, septic, ground, tanker trucks)
- Bulk water vs. contaminated sediment/scales vs. fixture debris
- Stagnation vs. no stagnation for detectability
- Flush or no flush

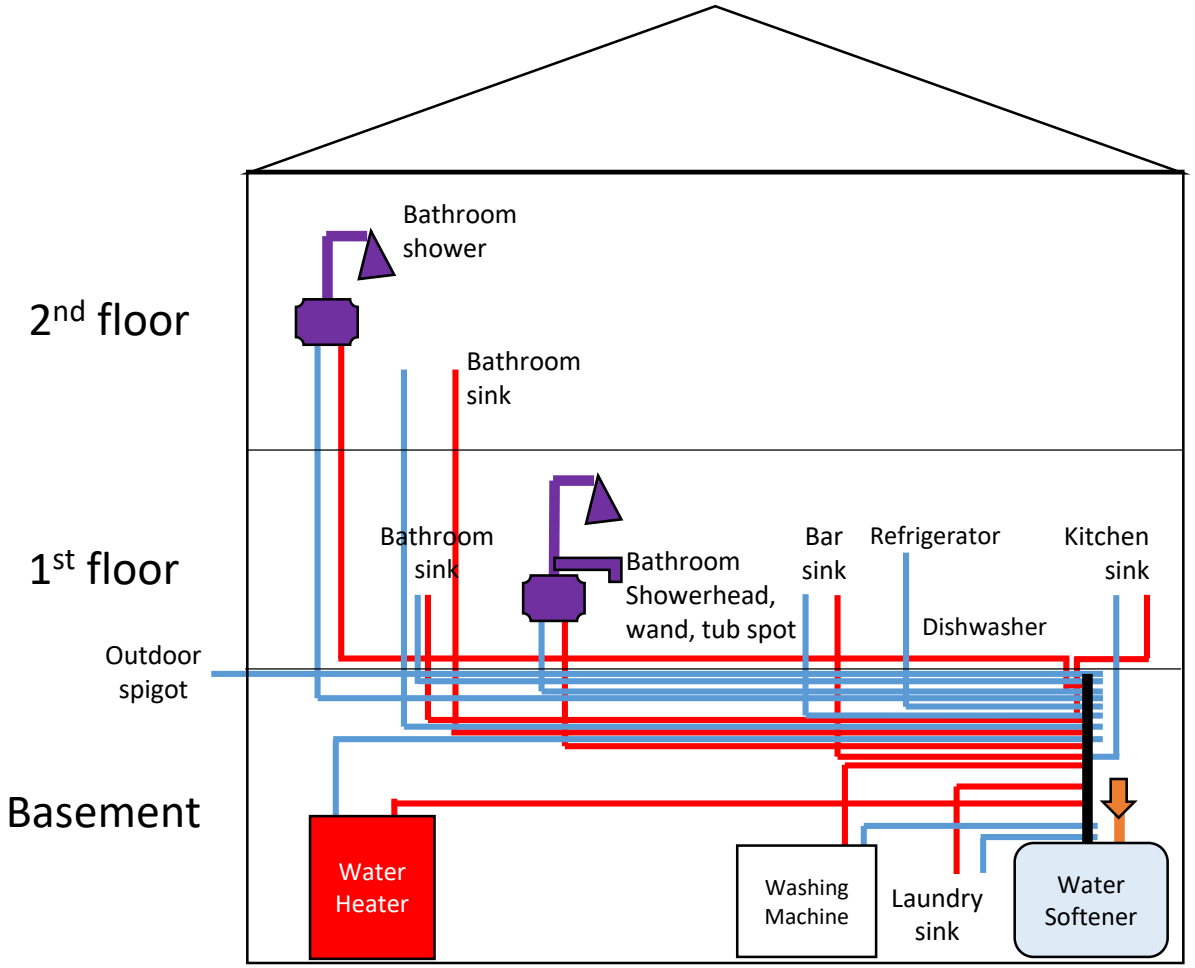
Single family home trunk and branch design with a centralized water heater



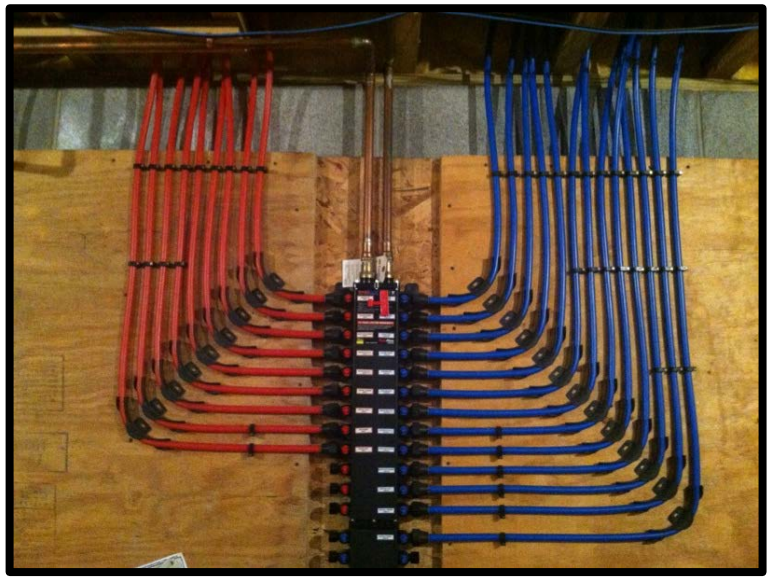
Cold and hot water flow through separate pipes
Some locations are downstream from others, but branch off into separate pipes



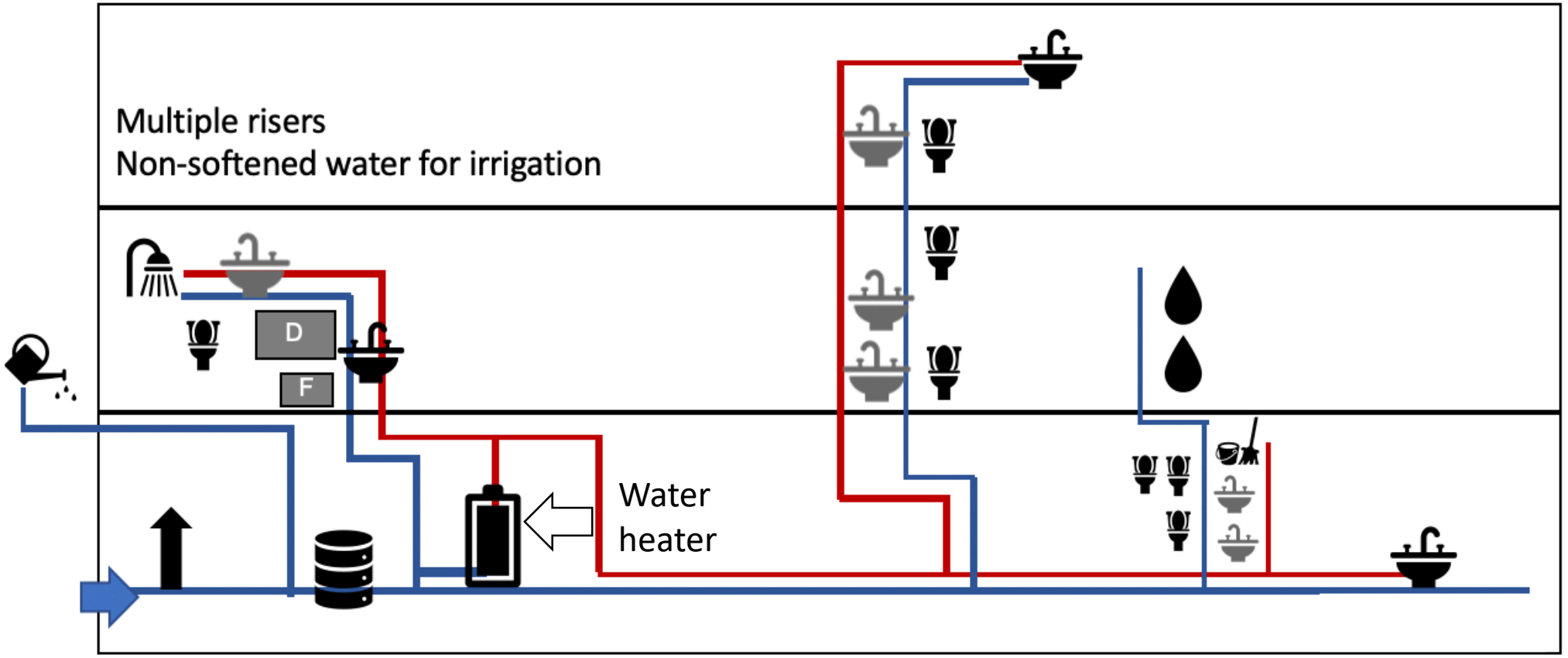
A home with PEX manifold plumbing and central water heater



Cold and hot water flow through separate pipes
Each fixture has it's own isolated pipe
No 2 pipes convey the same water
Co-located shutoff location for all each fixture
Smaller diameter pipes compared to T/B design



A 3 story office building with 3 risers and a centralized water heater



Legend

Pipes: Hot, Cold

Sinks: Kitchen, Bathroom, Janitorial

Toilet, Fountain

Shower, Irrigation

Appliances
F - fridge
D - dishwasher
C - water cooler

What is the main question you want answered?

How much will this cost me?

Are the contaminants inside the biofilm?

What's in the water?

Will the hot water cause harm?

Should I remove and replace the plumbing?

Did the decontamination action work?

Is the service line or well contaminated?

When should I collect water samples?

Did the contaminants sorb to biofilm?

Are the pipes contaminated?

Is the water heater contaminated?

How many water samples do I need to collect?

Is the fixture contaminated?

Will the cold water cause harm?

How long do I need to stagnate water before sampling?

Did the contaminants sorb to scales?

Where are the contaminants in the plumbing?

Other comments

Number and type of sampling locations

What question are you trying to answer?

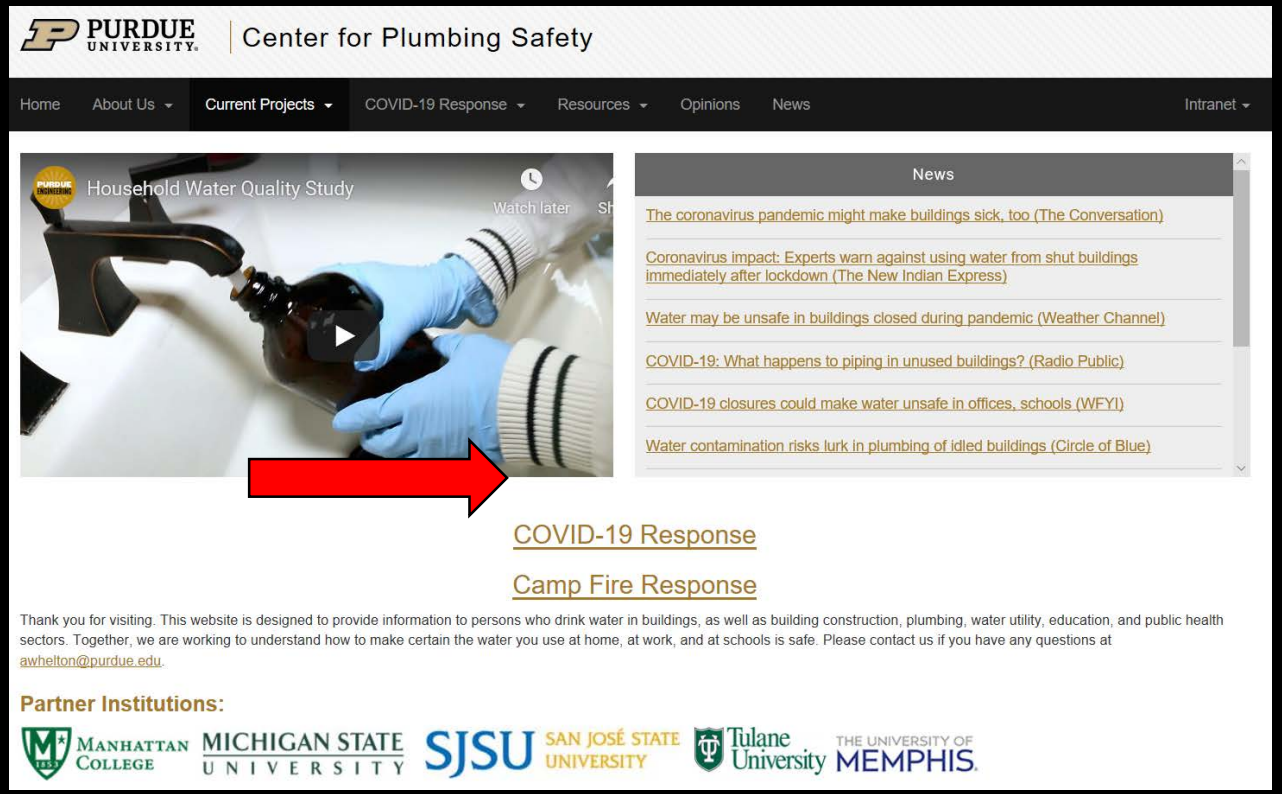
What's a health protective approach?

What is a "**representative sample**"?

Proportionately reflect characteristics of plumbing design, fixture types, locations, and water use conditions. We should be able to apply statistics to determine the probability that you would have an exceedance at a location that you did not sample

Thank you.

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



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

Enroll in the 10 hr, 1 CEU Building Water Essentials Short-Course:
https://engineering.purdue.edu/online/certifications/building-water-essentials

www.PlumbingSafety.org