Implications for Health: Responding to and Recovering from Wildfire Caused Drinking Water System Contamination

Andrew J. Whelton, Ph.D.[1],

Caitlin Proctor, Ph.D.[1], Juneseok Lee, P.E., Ph.D.[2], Amisha Shah, Ph.D.[1], David Yu, Ph.D.[1], Arman Sabbaghi, Ph.D.[1]

[1]Purdue University; [2] Manhattan College

Implications of the California Wildfires for Health, Communities, and Preparedness

Wildfires in Populated Areas can Trigger Technological Disasters

The deadliest most destructive wildfires have occurred at the WUI

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

In California, 2.7+ million people live in very high fire hazard severity zones

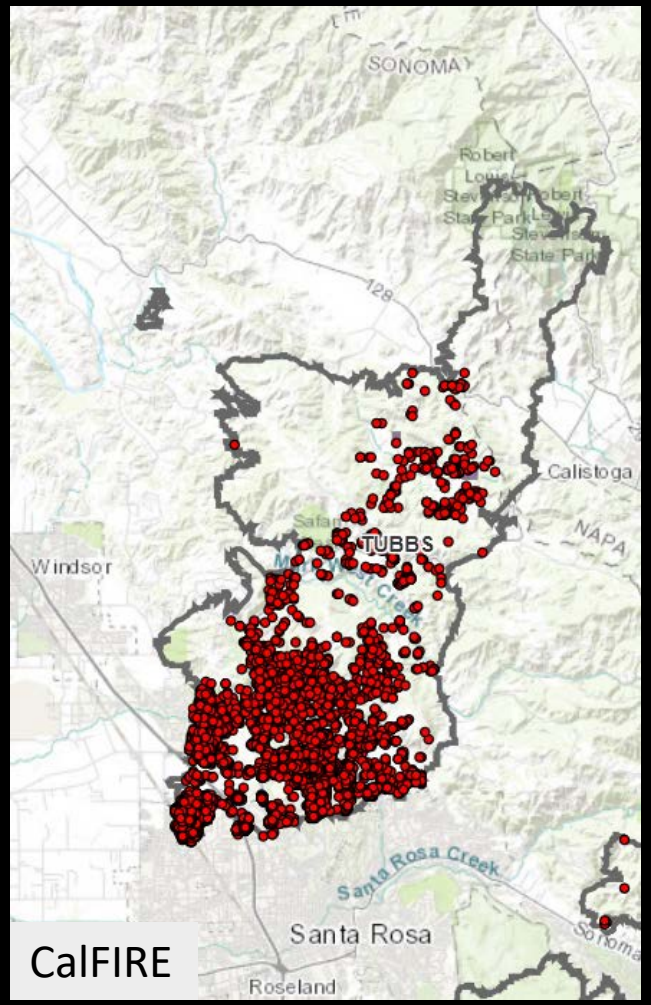
Changing climate → Wildfire risk grows

Drinking water is critical for community health, safety, and economic security

[or water from a private well, (15% of US population)]

Modified from Lee et al. (2013) Water Supply AQUA 64(2)

The 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

Response and recovery was overseen by California's SWRCB and USEPA Region 9

- Initial estimated removal/replacement cost: $44 million
  - ❖Actual investigation and replacement cost: $8 million
- Multiple VOCs, SVOCs, TICs detected
  - ❖Multiple VOCs exceeded acute and chronic drinking water exposure limits
- DND-DNB advisory based on early benzene results

JOINT INFORMATION CENTER
SONOMA FIRES: CENTRAL LNU COMPLEX
PRESS RELEASE

City of Santa Rosa

FOR IMMEDIATE RELEASE
MEDIA CONTACT: 707-565-3040

Date: November 10, 2017

Do-Not-Drink and Do-Not-Boil Water Advisory Issued for Two Specific Areas of Fountaingrove

SANTA ROSA, CA – The City of Santa Rosa Water Department has issued notices to customers in select areas advising them to stop drinking tap water due to recent damage to the water system resulting from the fires.

A total of 13 homes in Fountaingrove received the advisory notice after slightly elevated levels of contaminants were detected in two isolated areas. The Department advised residents in these areas to not use the tap water for drinking and cooking until further notice.
Since the wildfires, the Water Department has increased water sampling beyond required regulations to closely monitor the integrity of the water system and ensure high-quality drinking water for residents. The enhanced sampling identified the contamination, and confirmed that the contamination is isolated to two specific areas of Fountaingrove only. To address the contaminations, Santa Rosa Water is flushing clean water through the system.

Those in the impacted area received the following recommendations:

- Do not drink your tap water – use only bottled water. Bottled water should be used for all drinking (including baby formula and juice), brushing teeth, washing dishes, making ice and food preparation until further notice.
- Do not try and treat the water yourself. Because of the nature of the water contamination, boiling or disinfecting your water will not make it safe to drink.

When the advisory is lifted, properties in the affected areas will be individually notified, and a media notification will also be issued.

###

A Few Lessons Learned

- Water tested for 100+ chems, 34 routinely later in response
- Repeated location sampling was necessary to find contamination
- Stagnation "soak time" was needed to find contamination (often $\geq$ 72 hr)
- More than benzene exceeded acute and chronic exposure limits
- Sometimes $\pm$ 77% benzene difference in duplicate water samples for single location
- Decided $\geq$ 0.5 ppb benzene prompted asset replacement
- Greatest VOC contamination found in service lines (max. 40,000 ppb benzene)
- All contaminated hydrants, water mains, ARVs, blow offs, service lines were replaced
- Long-term VOC monitoring required

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

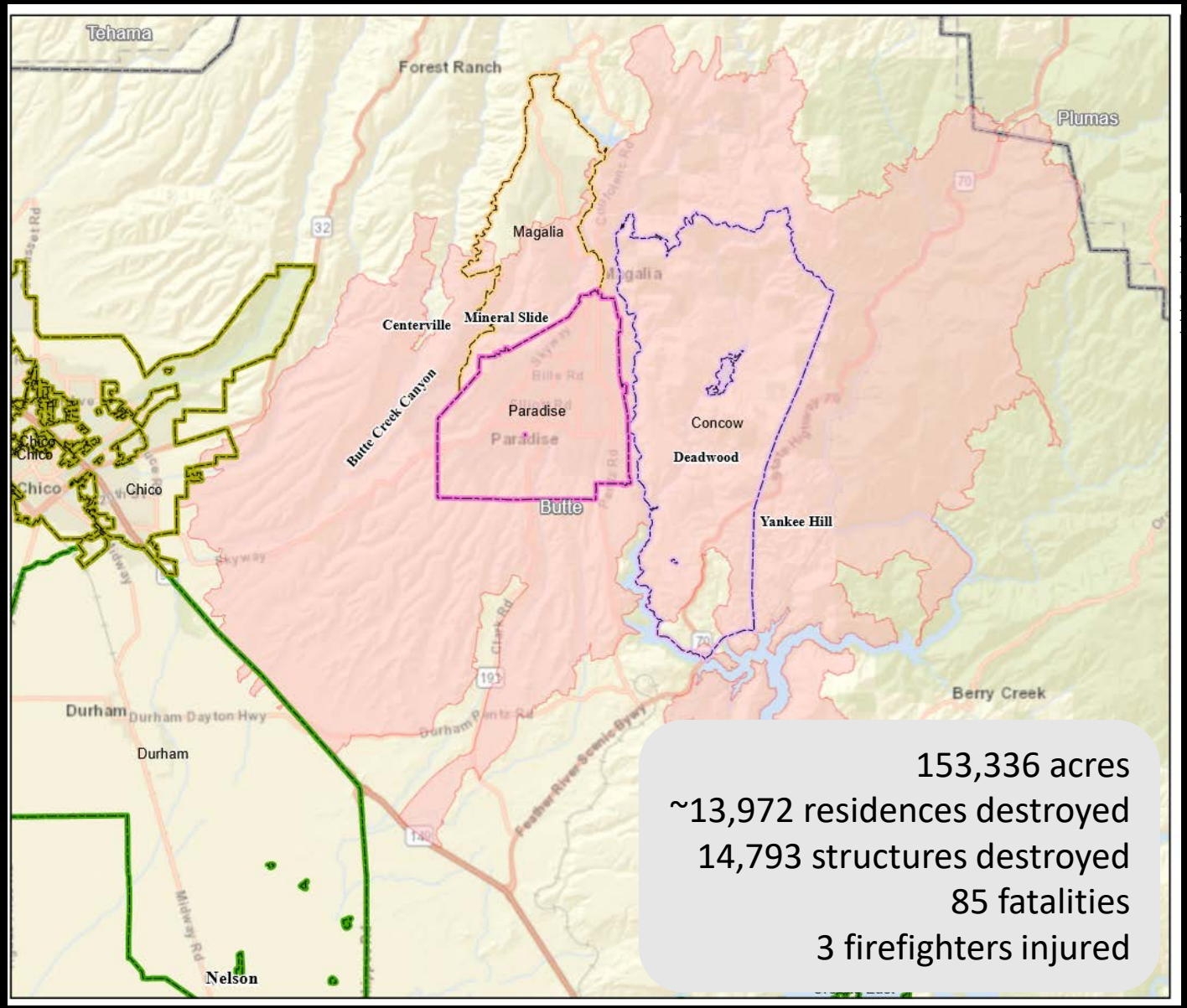
WHEREAS under the provisions of Government Code section 8558(b), I find that conditions of extreme peril to the safety of persons and property exists in Butte County due to this fire; and

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.

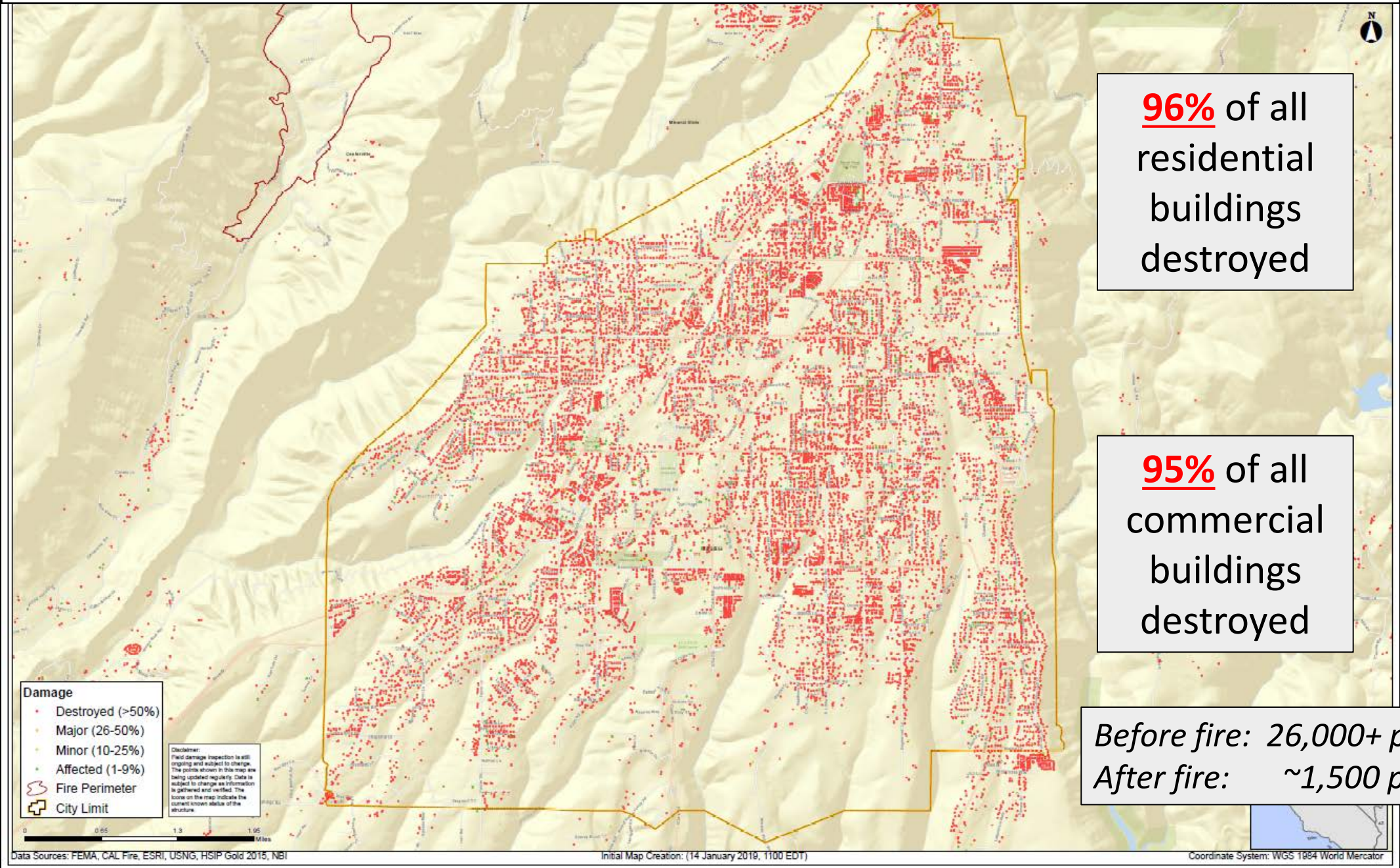
NOW, THEREFORE, I, GAVIN NEWSOM, Acting Governor of the State of California, in accordance with the authority vested in me by the State Constitution and statutes, including the California Emergency Services Act, and in particular, Government Code section 8625, **HEREBY PROCLAIM A STATE OF EMERGENCY**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



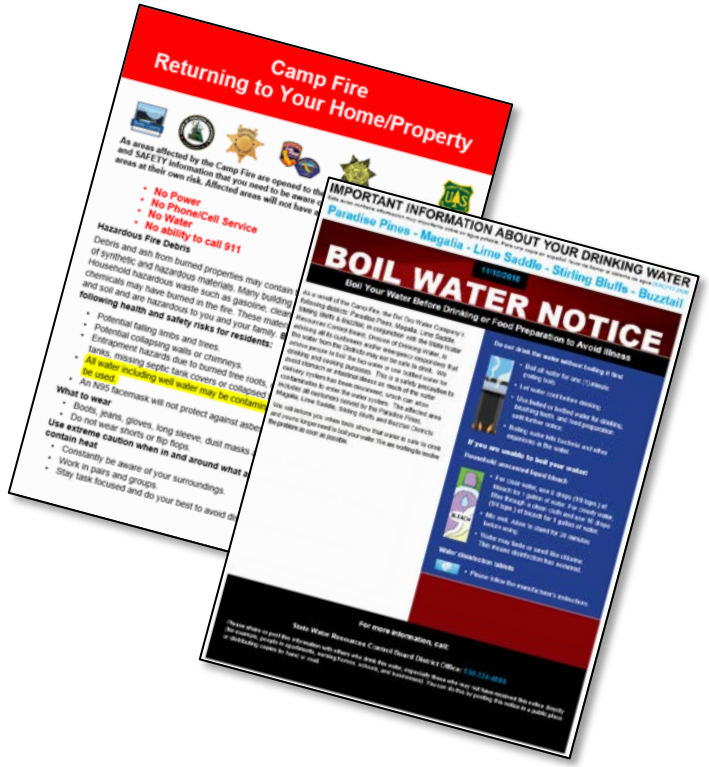
96% of all residential buildings destroyed

95% of all commercial buildings destroyed

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

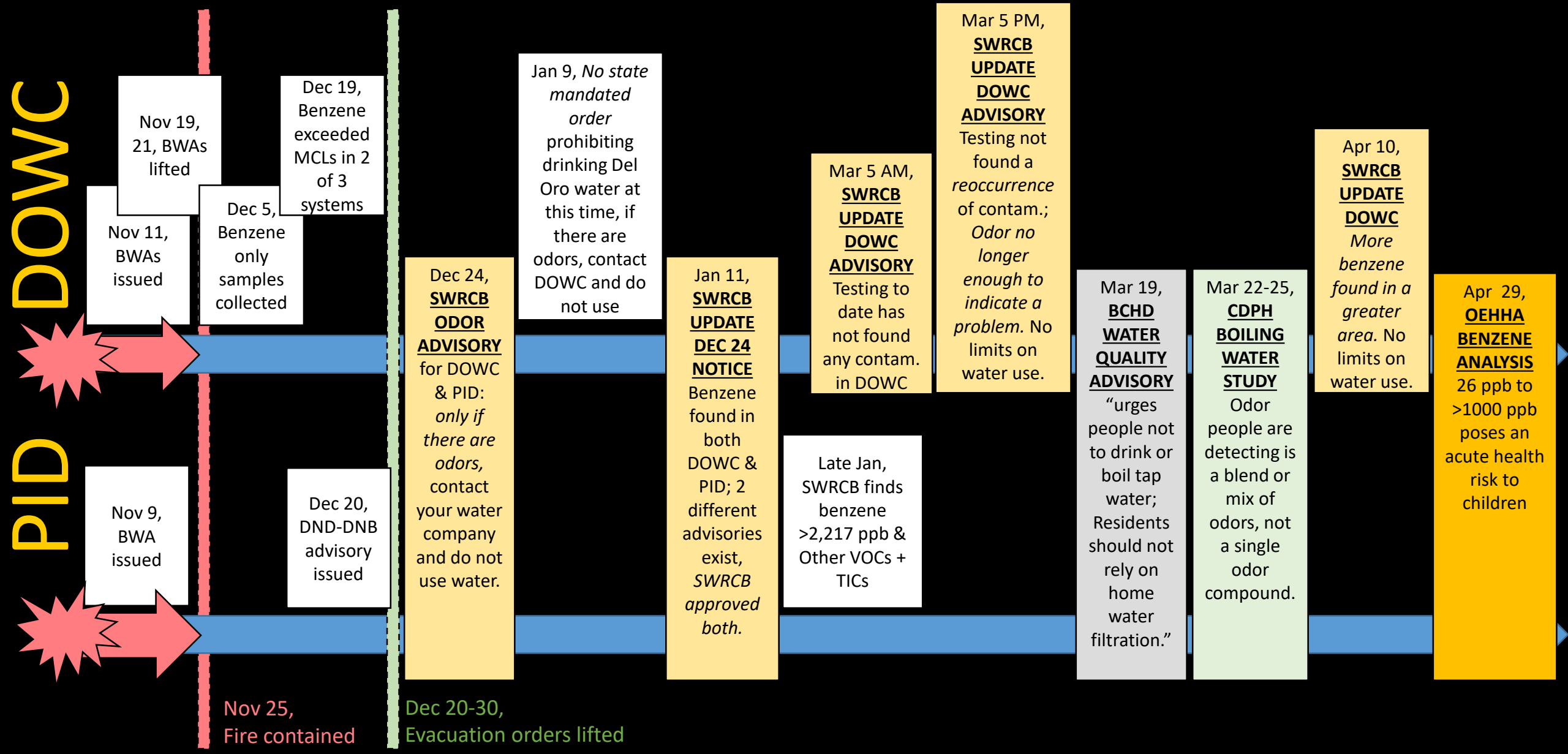
Public Water Systems (% Homes Gone)	Population	Source Water
Paradise Irrigation District (PID) (-96%)	26,032	Surface
Del Oro Water Company – Paradise Pines (-38%)	11,324	Surface
Del Oro Water Company – Lime Saddle (-50%)	1,106	Surface
Del Oro Water Company – Magalia (-89%)	924	Ground
Del Oro Water Company – Stirling Bluffs (0%)	548	Surface
Del Oro Water Company – 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

40,000 people issued a boil water advisory (BWA)



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

Two Different Experiences



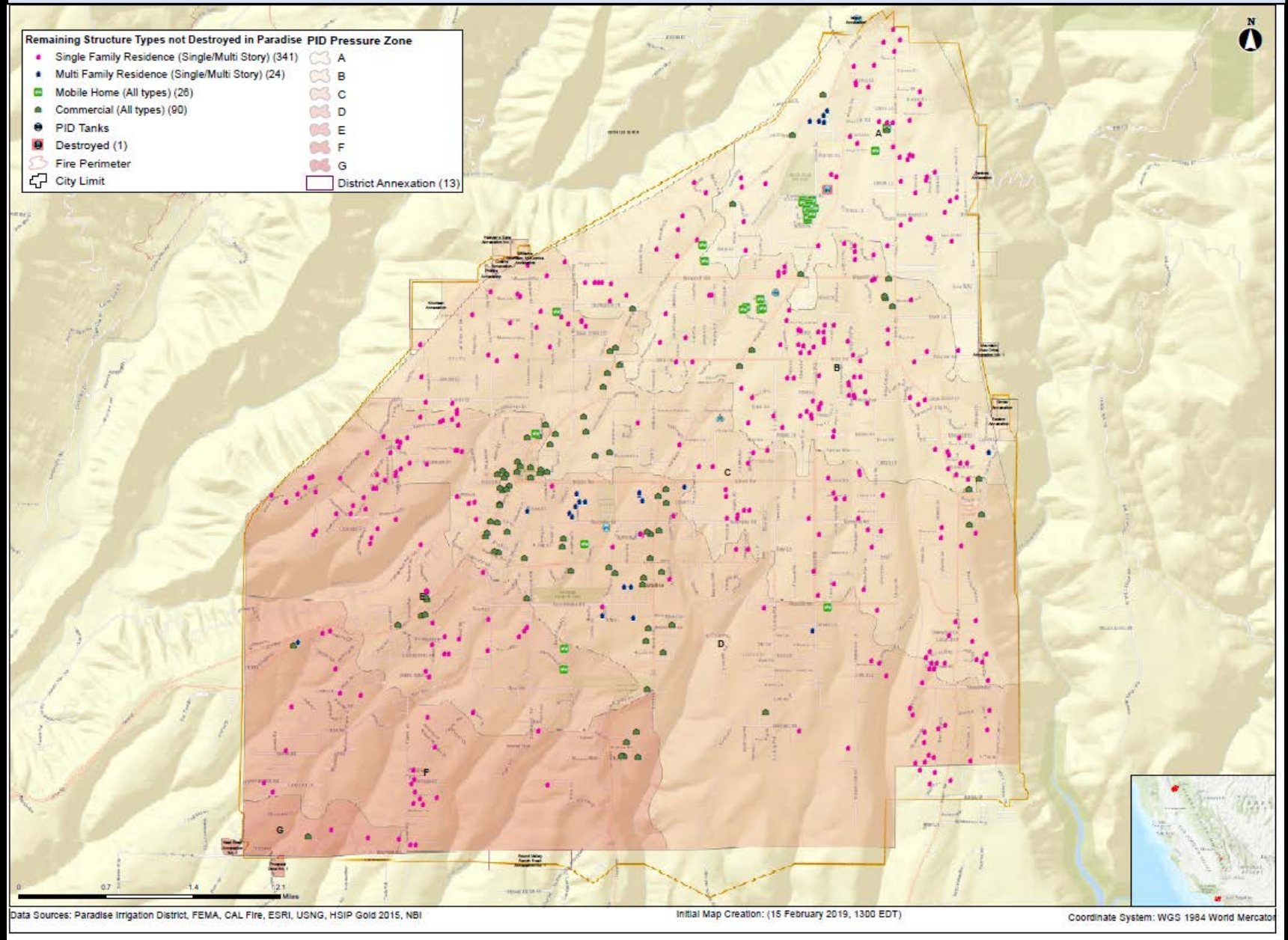
Standing homes are scattered throughout the contaminated water systems: PID Example

2 sources
1 treatment plant

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

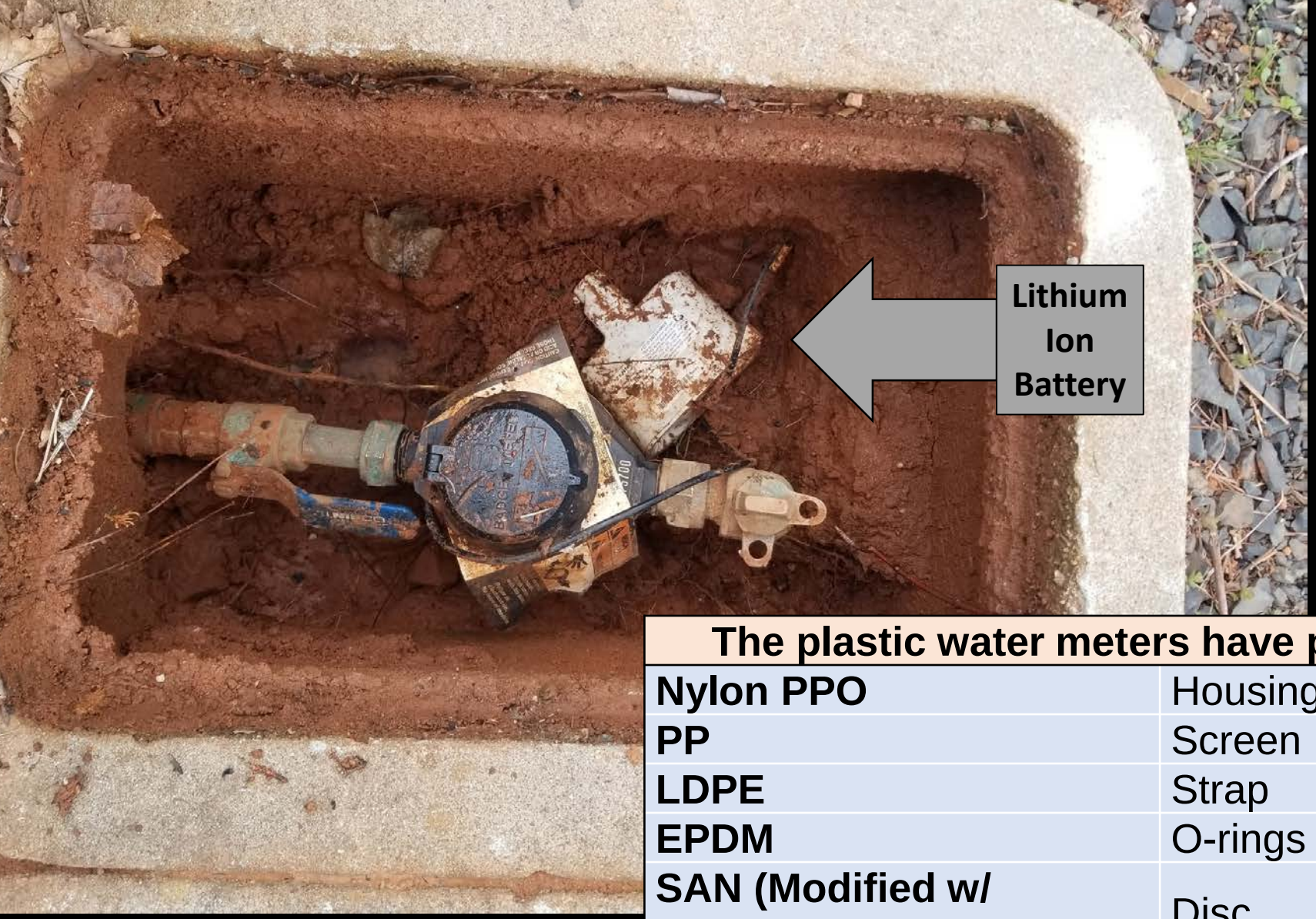
1,400 fire hydrants
10,600 service lines and meters
- Cu, Brass, GIP, GSP, HDPE, PB

PID Pressure Zones vs. Standing Structures



Some water meters did not survive

Some plastics melted,
decomposed, and cooled



Some meters have no visual damage but are chemically contaminated

The plastic water meters have plastic water contact materials	
Nylon PPO	Housing, bottom
PP	Screen
LDPE	Strap
EPDM	O-rings
SAN (Modified w/ graphite, Teflon & mica)	Disc
Nylon 6/12	Magnut hub molding, crossbar, thrust roller
31600 Stainless Steel	Disc spindle, magnet spindle, thrust roller
Nylon PPO	Chamber top and bottom

Review of Santa Rosa, PID, and DOWC Water Distribution System Data:

VOCs post-Camp Fire have exceeded *acute* and *chronic* exposure limits; Limited results cannot predict the future

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 using 72 hr stagnation time; DOWC sometimes, but often using 0 hr
p = Utilities not yet disclosed enough information about their data

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Possible Primary Sources

1. Thermal decomposition of plastics (PVC pipes, HDPE pipes, PB pipes, gaskets, meter components, etc.)

2. Contaminated air/materials drawn into depressurized system

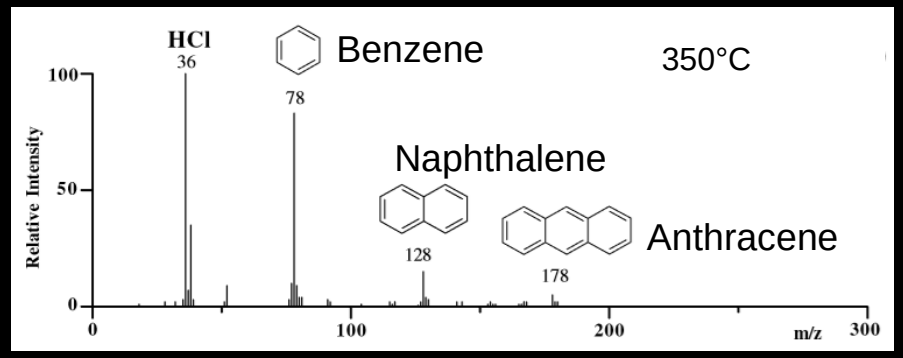
3. Contaminated water from building plumbing drawn into compromised system

Confirmed Secondary Sources

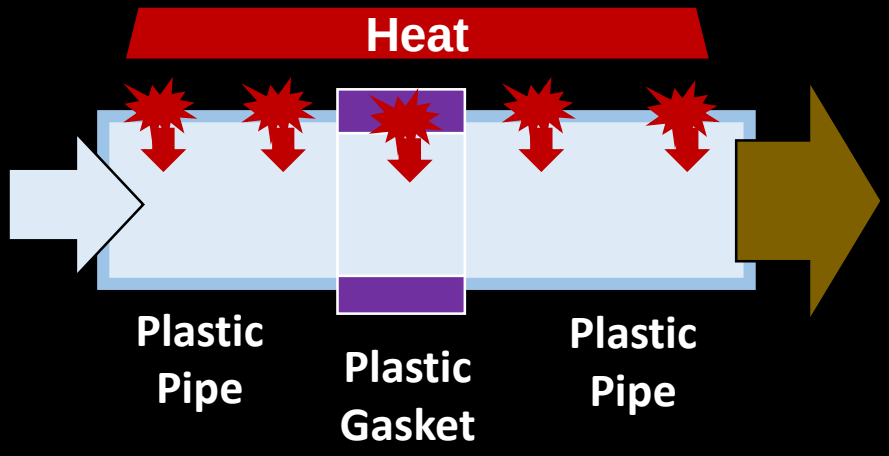
Partitioning/Adsorption/Absorption:
Water ⟷ Material

See video at
www.PlumbingSafety.org

1. Plastic Pyrolysis



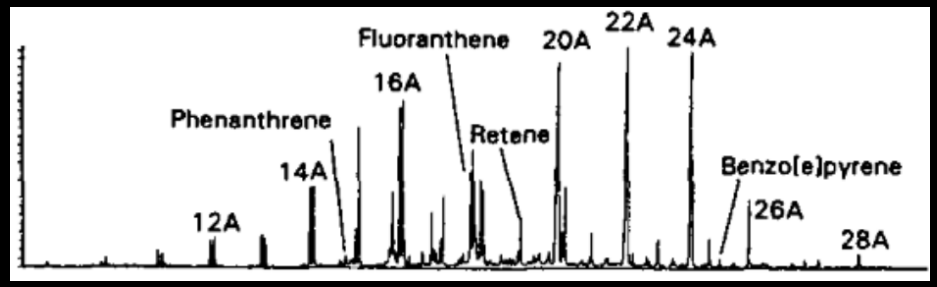
Montaudo & Puglisi (1991)



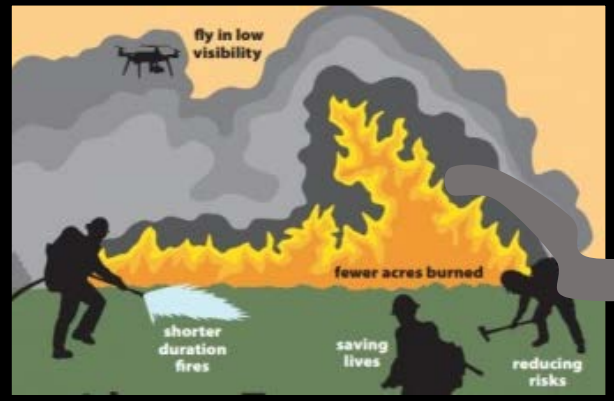
VOCs
SVOCs

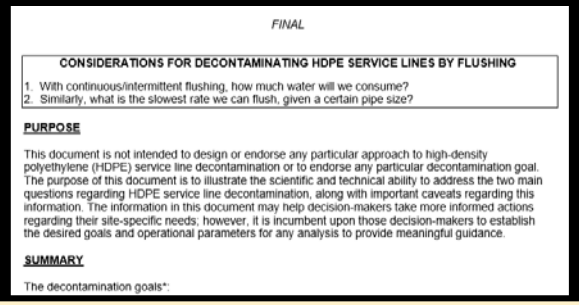
Benzene
Naphthalene
Toluene
Styrene
Xylenes
Benzo[a]pyrene
and more…

2. Forest Biomass Combustion



Simonet et al. (1999)





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 has been applied to some water distribution system testing and decontamination decisions, but more work is needed

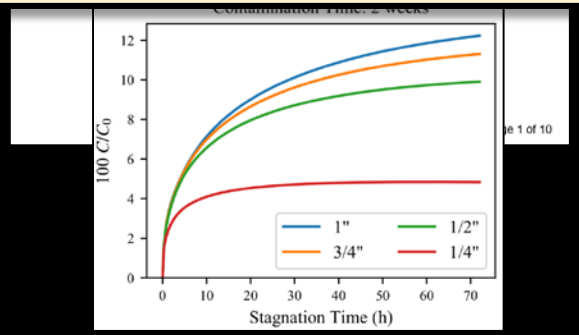
Water Distribution System Decontamination

Collaboration between Us & USEPA

Hydraulics

Polymer Science

Environmental Engineering



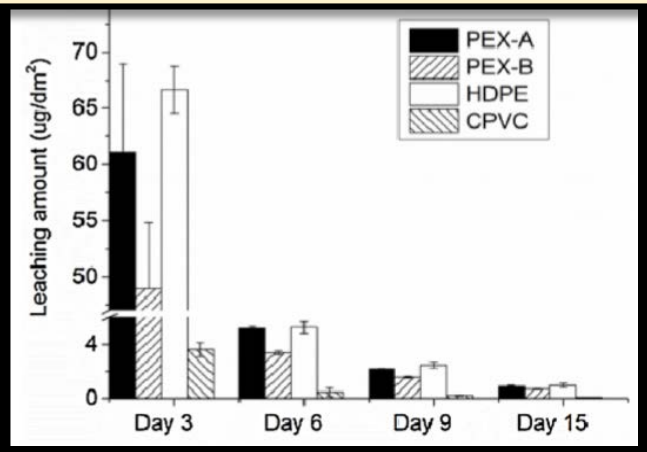
Numerical modeling:

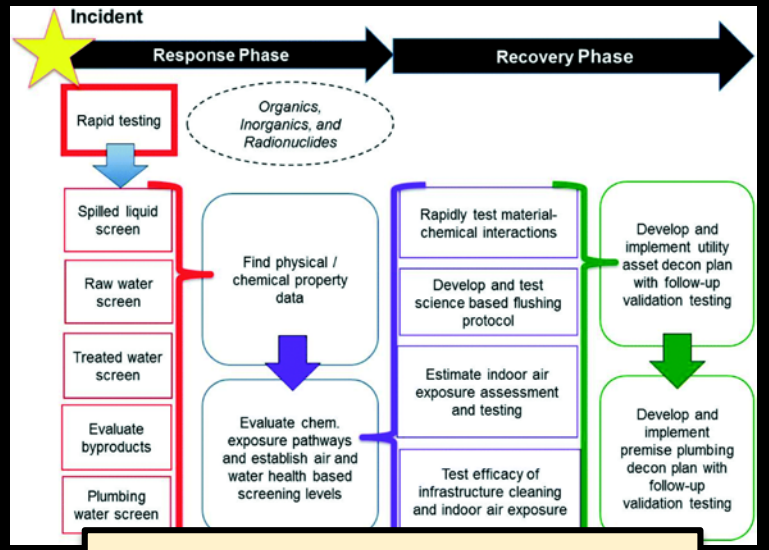
Greater than 286 days vs. less than 64 days of continuous water flushing for 1-inch HDPE service line

(Haupert et al. 2019)

Purdue *(Huang et al. 2017)*

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





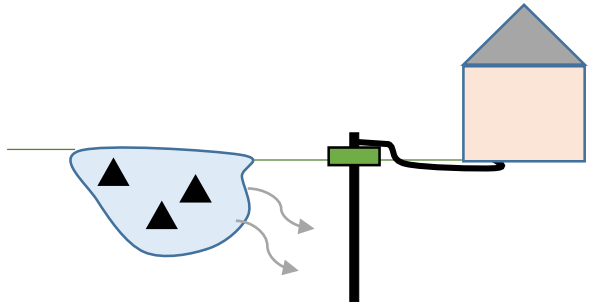
Purdue *(Whelton et al. 2017)*

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

Public Health Implications: Standing Homes

Water use advisories

- 2 DOWC systems contaminated, but have no water advisory
- Some PID customers are not following water use restrictions
- April 2019 OEHHA analysis showed 26 to 1000+ ppb benzene posed an acute exposure risk (Max. so far >2,217 ppb in PID, 46 ppb DOWC)



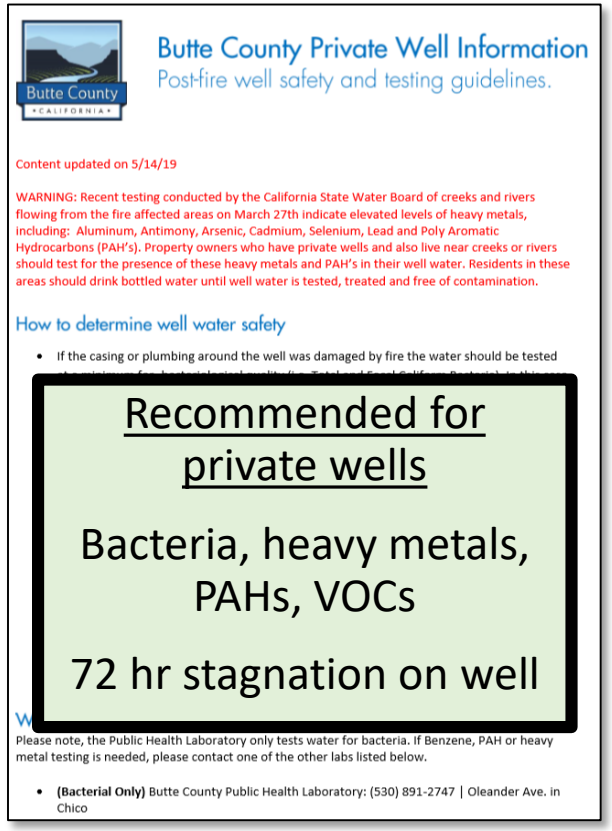
Contaminated water is entering and will continue to enter homes

- Utilities still trying to identify their contaminated assets
- Loss of pressure (main break, leak) *could move* contaminated water into a standing home service line

Plumbing has received up to 6 months of contaminated water

Cold and hot water systems [Now nonpotable]
Trunk-and-branch vs. homerun designs
In-home treatment devices
Paying for water testing, results not representative
No credible plumbing testing guidance
Irrigation system contamination
External water tank maintenance and microbiological growth
Some have no economic capacity to purchase bottled water, devices

Insurance companies making decisions 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

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

More Standing Home Inhabitant Challenges

Want to sample their plumbing… but being told to follow lab directions that flush out their plumbing BEFORE sampling.

Commercial Laboratory: "When sampling from a tap, open the tap and allow the system to flush until the water temperature has stabilized (usually about 10 minutes)."

Want to sample their plumbing… but being told to *only* look for benzene at the cold water kitchen sink (no stagnation needed).

This ignores hot water systems, along with basics of plumbing design, operation, chemical desorption, and more.

Many unaware the SWRCB recommended any damaged property have the customer-side service line replaced to Butte County

Estimated $1,000-$7,000 cost per home. Insurance may or may not pay.

Scientific challenges and opportunities: Implications of the California wildfires for health, communities, and preparedness

1. Determine the sources and sinks of chemical contamination
2. Control for laboratory contamination, data reproducibility, and SOPs
3. Develop evidence-based water use restrictions that protect public health
4. Obtain data to improve decision making for infrastructure testing, decontamination, and replacement
5. Determine the environmental and human health impacts of disposing of chemically contaminated materials
6. Determine evidenced-based private property chemical characterization and recovery steps





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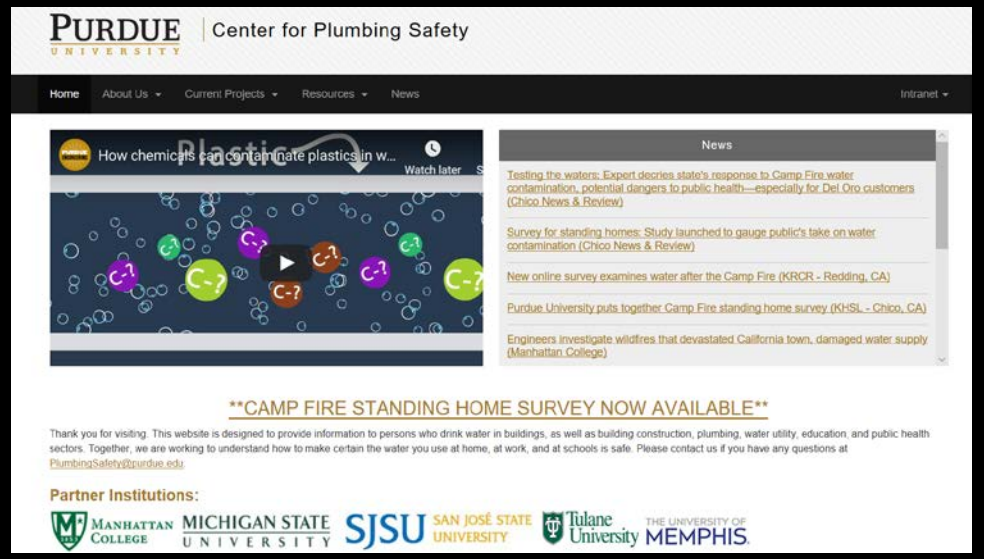
MANHATTAN COLLEGE 1853

Results: Camp Fire Drinking Water Community Survey Coming Soon

Questions?

Andrew Whelton, Ph.D.

awhelton@purdue.edu



Visit www.PlumbingSafety.org

NASEM Workshop, Implications of the California Wildfires for Health, Communities, and Preparedness