

After the Wildfire:

***Responding to and
Recovering from Large-Scale
Infrastructure Damage
Caused by the Camp Fire***



Andrew Whelton¹, Caitlin Proctor¹, Amisha Shah¹,

David Yu¹, and Juneseok Lee²

¹Purdue University; ²Manhattan College

November 8, 2018

- Started by Pacific Gas and Electric (PG&E) equipment failure

533,000+ acres burned

14,000+ structures destroyed

85 fatalities

20,000+ people displaced

600,000+ trees need to be cut down

Deadliest and most destructive
in California state history



911 Calls:

<https://www.sfchronicle.com/california-wildfires/article/Camp-Fire-911-calls-As-flames-raced-in-13541139.php>

How the Camp fire grew over time

Nov. 8



20,000 acres

Nov. 9



90,000 acres

Nov. 10



105,000 acres

Nov. 11



111,000 acres

Nov. 12



117,000 acres

Nov. 13



130,000 acres

Areas Affected

- Paradise
- Magalia
- Concow
- Butte Creek Canyon
- Mineral Slide
- Centerville
- Pulga
- Deadwood
- Jarbo
- Park Hill
- Yankee Hill
- And more...

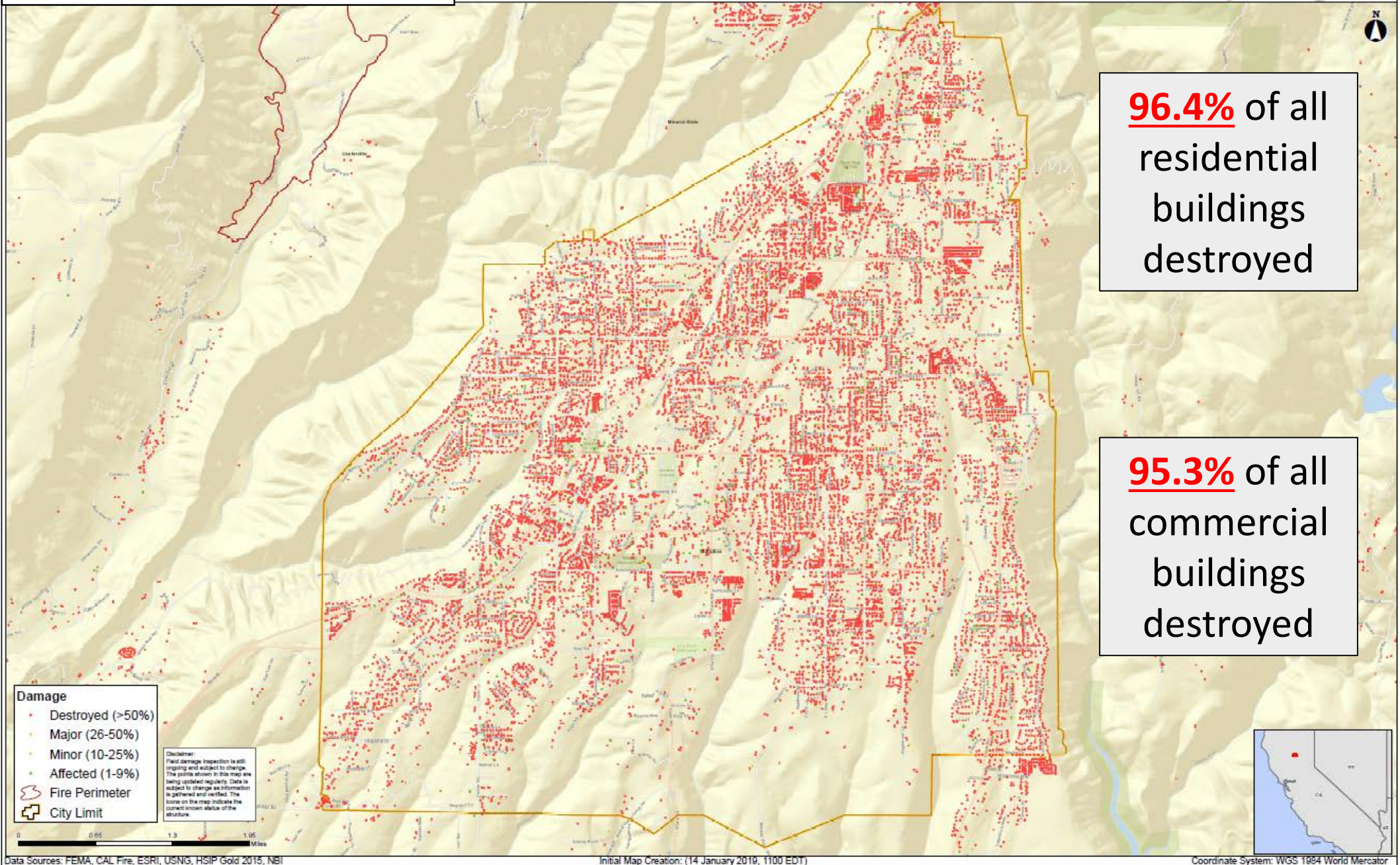


https://www.google.com/search?q=sandy+california+fire&rlz=1C1CHBF_enUS810US810&source=ln_us&tbn=isch&sa=X&ved=0ahUKewi18rbMaNAh4sT48KfVMMBRGQ_AUIdg0&now=1520860675&dpr=2.5#imgre=twUxek5DnAblM

Characteristic	Description as of 2017 US Census	Town of Paradise
Population	Population	26,682
	Under 5 yrs old	4.1%
	Under 18 years	17.5%
	65 years and older	25.1%
Race and Origin	White non-Hispanic	92.1%
	Asian	1.0%
	Other race not mentioned	6.9%
	Foreign Born Persons, 2013-2017	2.4%
Housing and Language	Owner occupied housing units	69.9%
	Median value of those units	\$205,500
	Persons per household, 2013-2017	2.42
	Language other than English spoke at home, 2013-2017	4.7%
Education	High school graduate or higher, percent of persons age 25 years+, 2013-2017	91.4%
	Bachelor's degree or higher, percent of persons age 25 years+, 2013-2017	25.2%
Income and Poverty	Median household income (in 2017 dollars), 2013-2017	\$48,831
	Per capita income in past 12 months (in 2017 dollars), 2013-2017	\$27,272
	Persons in poverty, percent	13.7%

Town of Paradise Limits

Data Layer / Map Description: Overview of the area affected by the event.



Courtesy:
Phillip Ulbrich,
FEMA



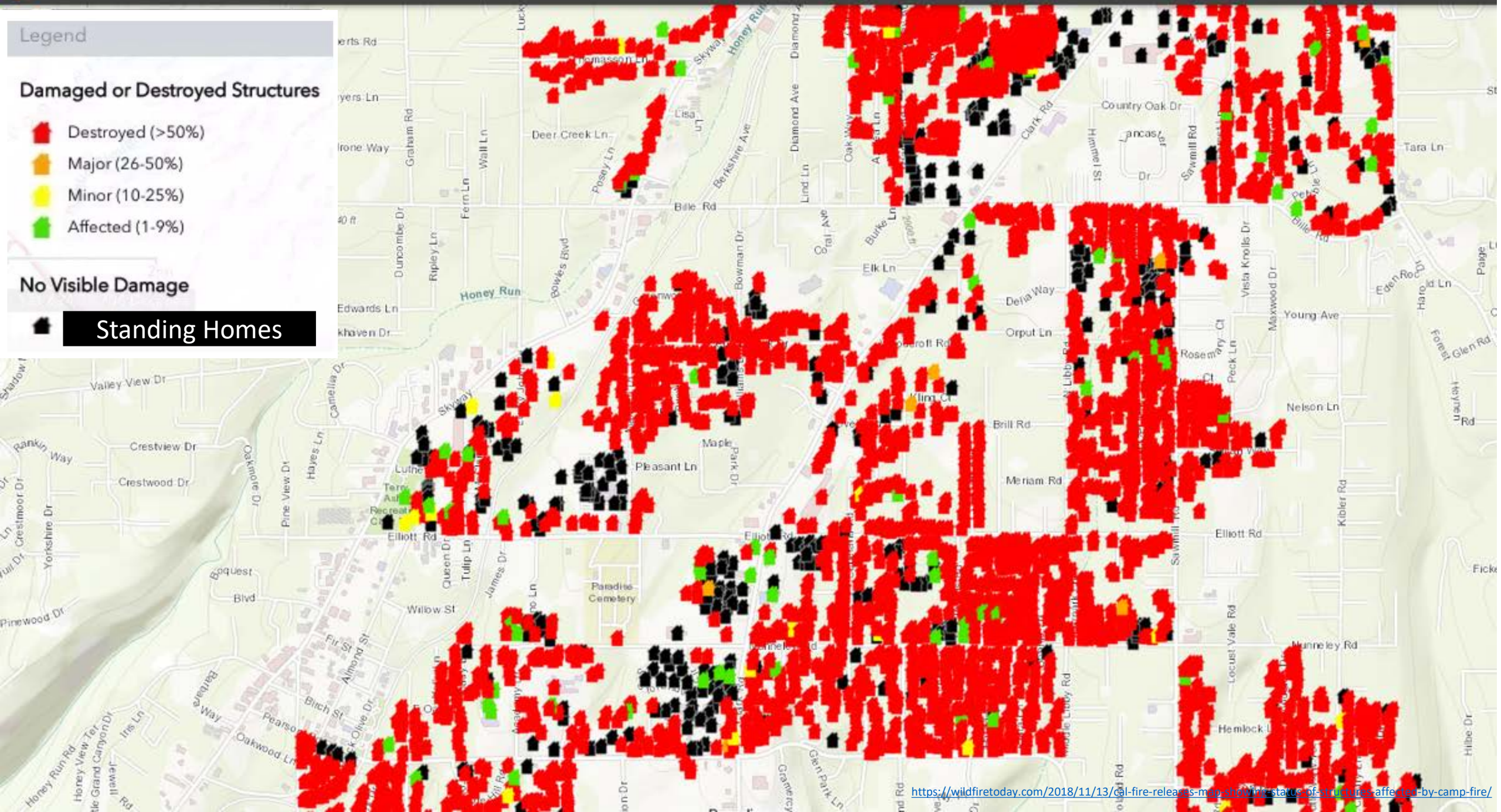
Legend

Damaged or Destroyed Structures

- Destroyed (>50%)
- Major (26-50%)
- Minor (10-25%)
- Affected (1-9%)

No Visible Damage

Standing Homes







Water Heater





Multiple drinking water systems impacted

- Paradise Irrigation District serving 23,000 people
- Del Oro Water Company serving 14,000 people
- Gran Mutual Water Company serving 200 people
- Private wells in burn area: 2,000+ wells serving 6,000+ people

Scientific Support Team Onsite Visits, Feb. 10-14 & Mar. 24-27, 2019

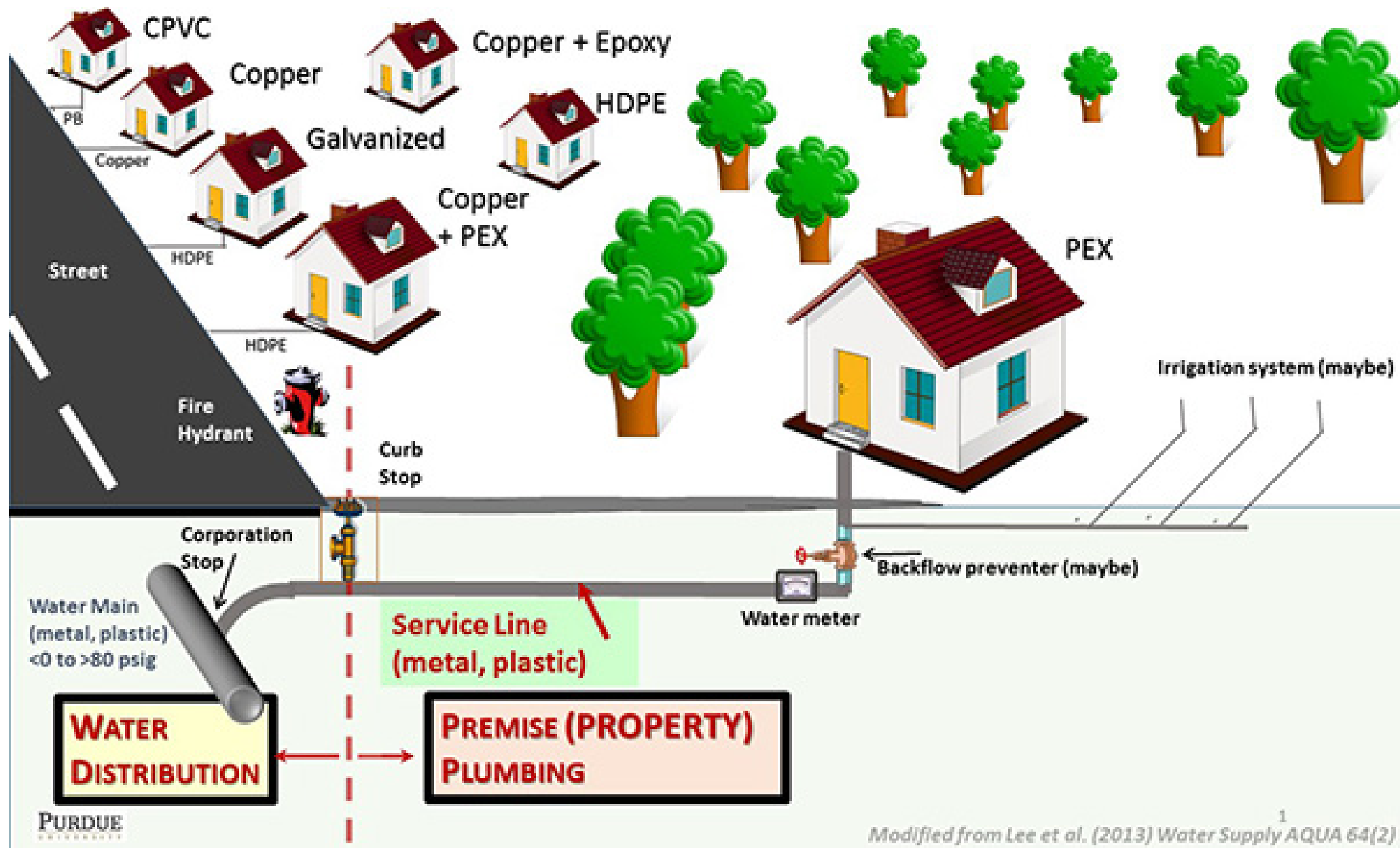


PURDUE
UNIVERSITY



After the fire, Paradise Irrigation District (PID), which supplied water to the town observed **high level of benzene in their water distribution systems and service lines.**

Currently, PID is under state emergency with **Do Not Drink, Do Not Boil order**, and their priority at this point is thus to lift the water ban after safe drinking water can return.



Water Utility Infrastructure Damage



Magalia Reservoir

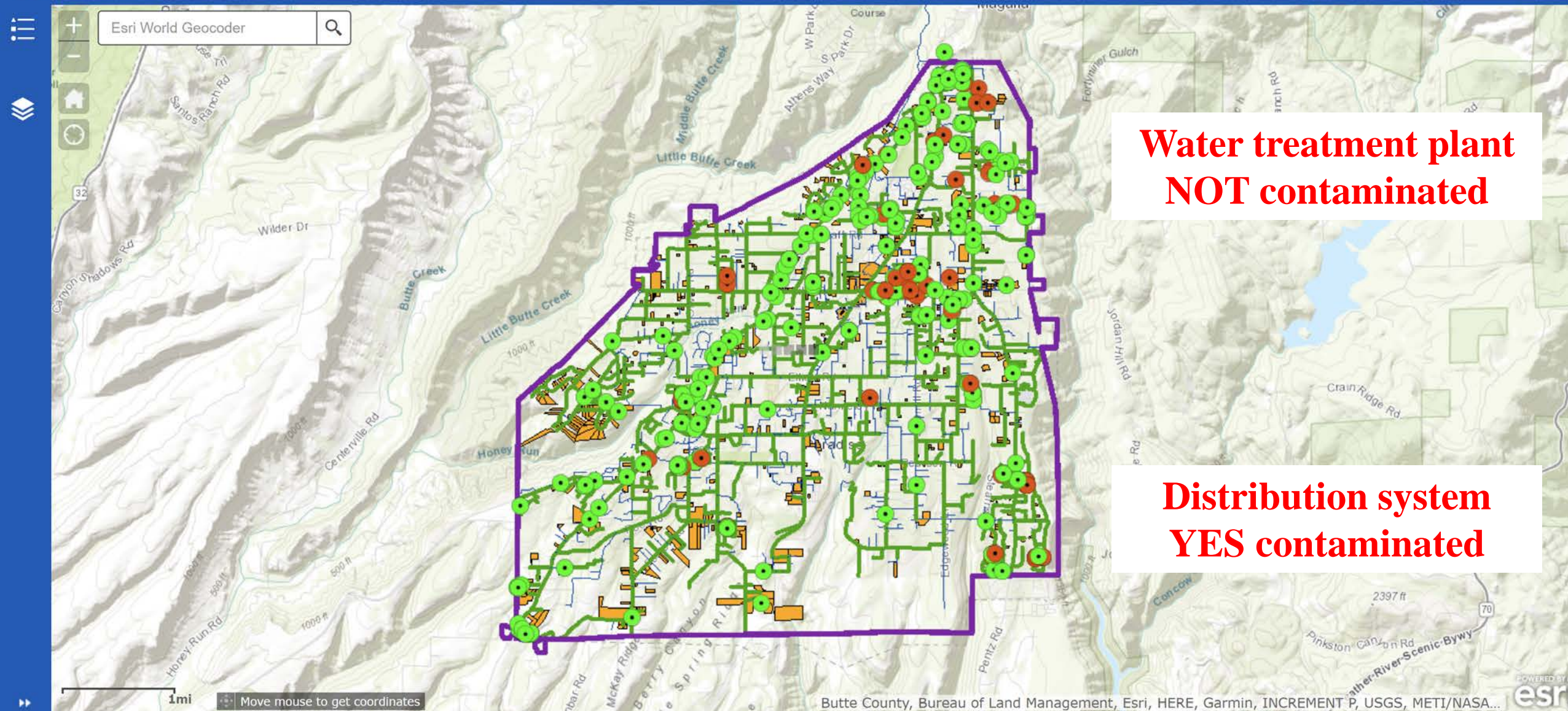


Paradise Lake

Source water: No impacts, high quality

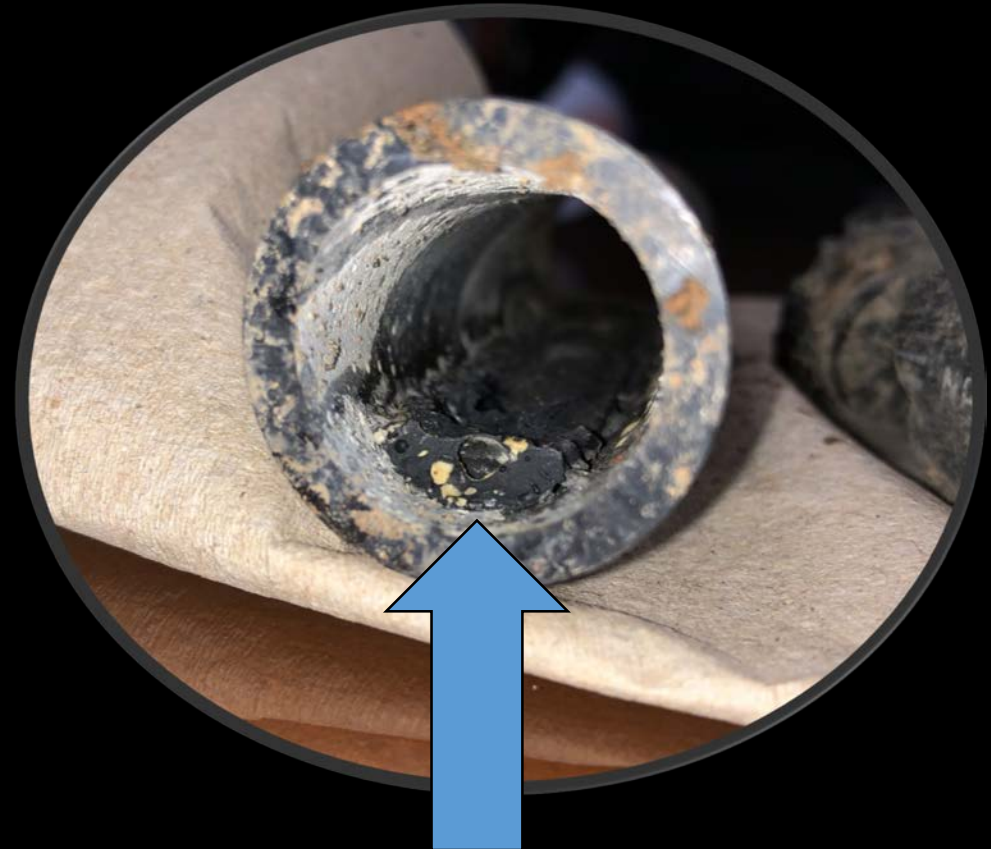
Paradise Irrigation District

Water Quality Monitoring for Benzene

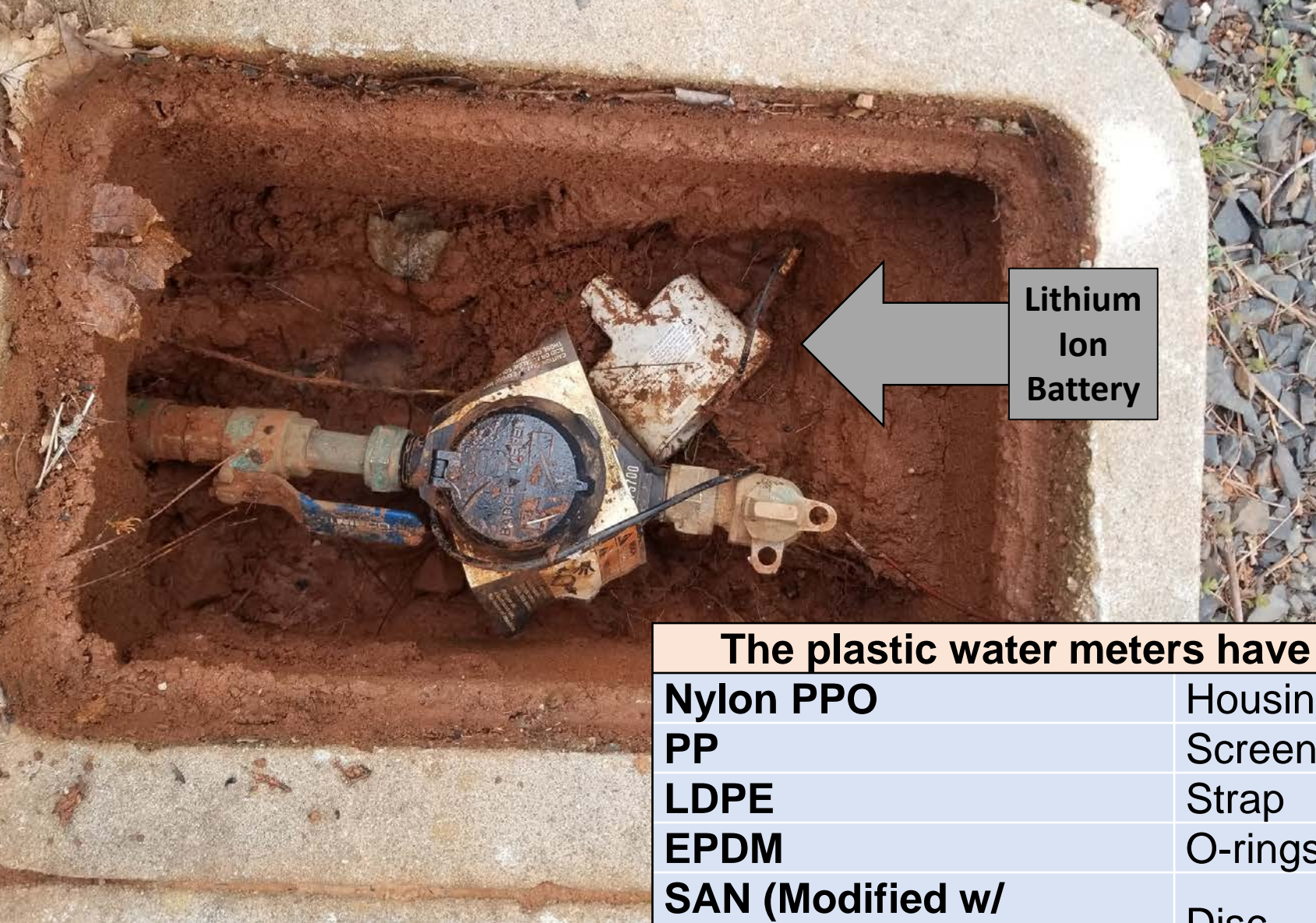




Some water meters did not survive



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	Magnet hub molding, crossbar, thrust roller
31600 Stainless Steel	Disc spindle, magnet spindle, thrust roller
Nylon PPO	Chamber top and bottom

VOC - Volatile organic compounds (VOCs) are organic chemicals that have a high **vapor pressure** at ordinary room temperature.

Review of PID's Water Contamination Data:

So far multiple VOCs have exceeded the drinking water limits, and results are too limited to predict the future

Chemical Detected	PID (5 mo.) 172 mi water system		CA State 1 sample in PID	City of Santa Rosa 5.2 mi water system	
	<i>n</i>	Max		<i>n</i>	Max
Benzene	<200	923	2,217	8,222	40,000
DCM		15	-	-	<5
Naphthalene		278	693	661	6,800
Styrene		100	378	6,062	460
TBA (NL)		13	-	339	29
Toluene		100	676	8,222	1,130
Vinyl chloride		1	-	6,062	16

CA Notification levels (NL): health-based advisory levels established by DDW for chemicals in drinking water that lack maximum contaminant levels (MCLs).

- Santa Rosa: Highest levels typically found at meters
- PID: Not many meter samples yet

Hypothesis | Causal Factors

Potential primary VOC sources are due to the thermal decomposition of plastics

- PVC, HDPE, PB pipes
- Gaskets
- Meter components
- Other plastics

1° Sources vs. 2° Sources





You can view online at www.PlumbingSafety.org hosted by Purdue

Ongoing Scientific Challenges

1. People are living in area and using damaged water system contaminated water
2. Chemical contamination continues to move around the water system
3. Rapidly characterizing the scale of infrastructure damage (physical/chemical)
4. Target threshold for system cleanup.
 - Debates of 0.5 ppb vs. 1.0 ppb vs. 1.4 ppb vs. 5 ppb benzene
5. Can some plastics be decontaminated in place?
 - Flushing time needed will be influenced by mass adsorbed, diffusivity, flowrate, water temperature, chemical concentration in the decon solution, plastic type.
6. Commercial laboratory contamination, no QA/QC spot checking labs
7. Hazardous waste classification of decon water and contaminated water system materials (and plumbing) and their disposal
8. Plumbing contamination and exposures (residential vs. commercial)
9. In-building water treatment despite County Health Dept. warning against it
10. Irrigation water use safety and system integrity
11. Potable water tank safety monitoring

Projects

National Priority Study

Camp Fire Support - Water Safety

Where We Work

Camp Fire Support - Water Safety

In November 2018, residents of Butte County, California experienced the most destructive and deadly wildfire in California's history. More than 500,000 acres were burned, and this wildfire is now called the "Camp Fire." Extensive drinking water system damage and chemical contamination were uncovered in the burn area. The fire rendered large water systems and private wells broken and chemically tainted. Water system components were physically and chemically damaged above and below ground. Water loss caused depressurization and some materials likely reentered the piping networks. The large drinking water systems affected are called the Paradise Irrigation District (PID), and Del Oro Water Company systems named Paradise Pines, Lime Saddle Marina, and Magalia.

As residents rebuild, drinking water contamination is proving to be a **very significant problem**. In January 2019, a team of engineering and science professors from Purdue University and Manhattan College were called in to provide technical assistance. From February 11-13, they inspected damaged areas and visited with water utilities, local, state, and federal officials. While there, the team proposed a prioritization of response actions to expedite damage assessment and community recovery.

One of their major findings was that people living in the burn area lacked much needed building water safety guidance. While many efforts were underway to understand and resolve water distribution system issues, people did not have guidance on how to determine if their plumbing was safe or requires replacement. People also did not have guidance on what they should consider when selecting in-building water treatment devices. This gap was identified to local, state, and federal agencies and a recommendation was made to immediately provide drinking water safety guidance to these individuals.

Thank you for visiting. Please contact the team at PlumbingSafety@purdue.edu if you have any questions, insights, or information you think they should know. We have also posted [frequently asked questions \(FAQ\) received from persons affected by the Camp Fire](#).

Sincerely,

Dr. Andrew Whelton, Dr. Caitlin Proctor, Dr. Amisha Shah, Dr. Juneseok Lee, Dr. David Yu

Questions?

Andrew Whelton, Caitlin Proctor,
Amisha Shah, David Yu
Purdue University

Juneseok Lee, Manhattan College