Health and Safety Hazards for Fires: Considerations for Returning Water Utility Buildings to Safe Use

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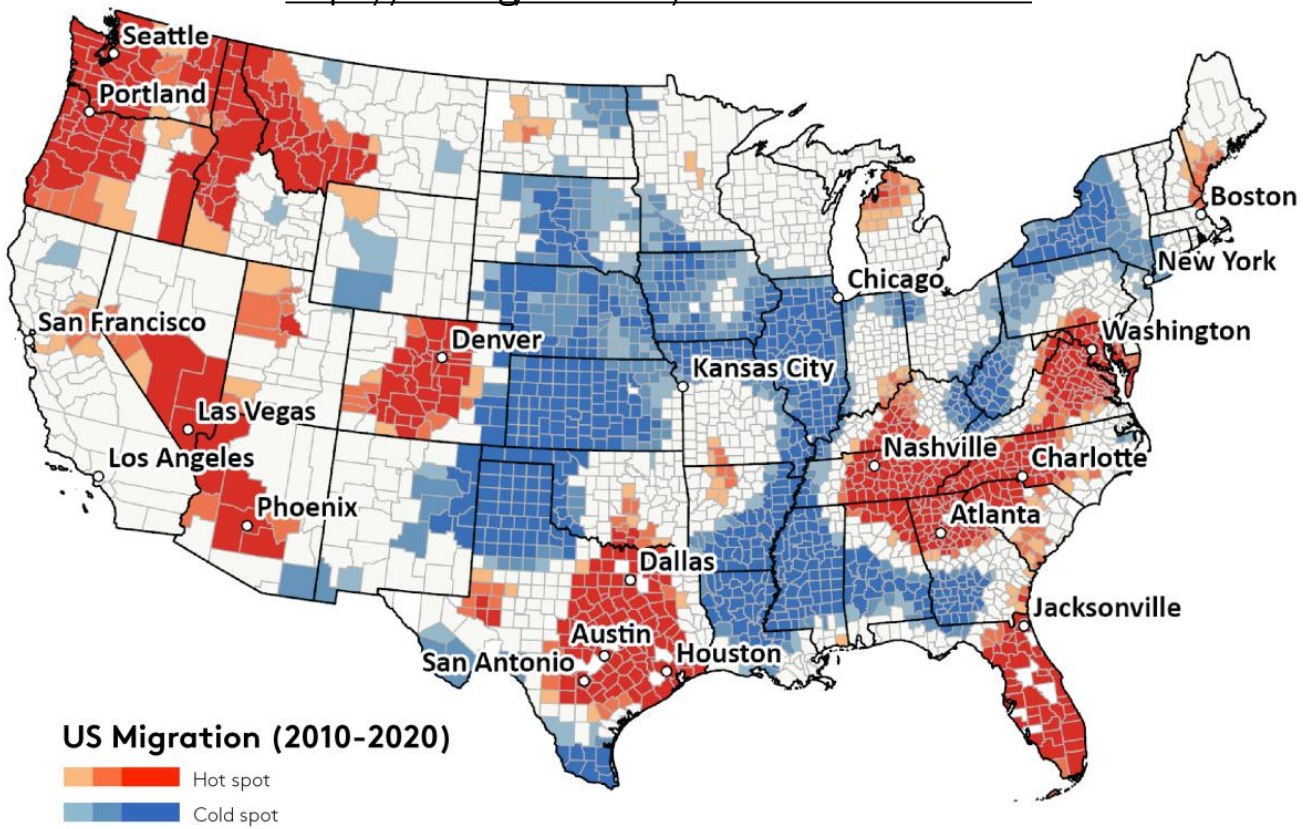
Clark et al. 2022. *Frontiers in Human Dynamics.* https://doi.org/10.3389/fhumd.2022.886545



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)

Fire is a hot topic nowadays

Wildland Fire: Natural vegetation, forests, grasslands

WUI Fire: Natural vegetation next to human development, allows wildfires to spread to homes, vehicles, and other buildings

Urban Fires: Incidents in human developments, homes, vehicles, and other buildings

A few notable incidents (of many)

Fire Name	U.S. State	Year	# of Structures Destroyed
Camp	California	2018	18,000
Marshall	Colorado	2022	550
Lahaina	Hawaii	2023	2,200
Palisades	California	2025	6,833
Eaton	California	2025	9,418
Spokane	Washington	2026	850

Fires can destroy structures and spread contamination miles away

Camp Fire, CA, 2018
(Credit: SFGate)

Marshall Fire, CO, 2022
(Credit: Hart Van Denburg/ CPR, AP Pool)

Lahaina Fire, HI, 2023
(Credit: Max Whittaker/ NYT)

Palisades Fire, CA, 2025
(Credit: Brian van der Brug/ LA Times)

Eaton Fire, CA, 2025
(Credit: Philip Cheung/ NYT)

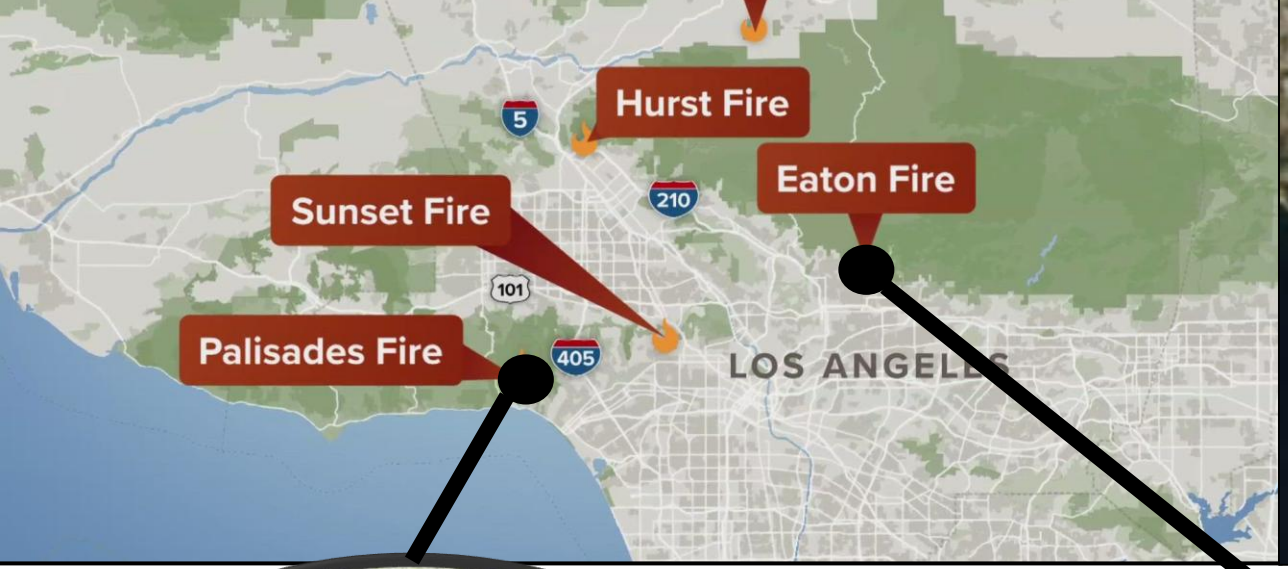
Spokane Fire, WA, 2026
(Credit: David Ryder/ Reuters)

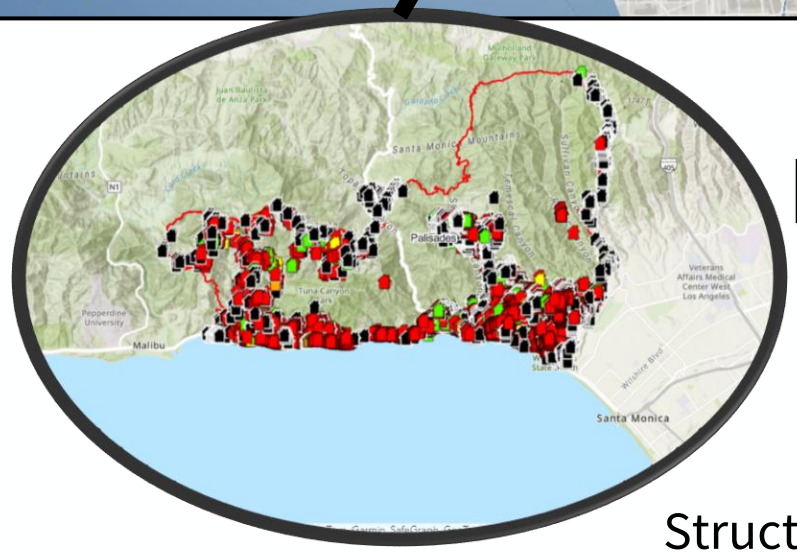
Water utility buildings and grounds can be impacted by this contamination

- Customer service, billing and administration buildings
- Treatment plants
- Storage tanks & towers
- Pump stations
- Maintenance buildings/yards
- Supply buildings/yards
- Vehicles

- People who visit these spaces after the fire is out may be workers, but also the general public and children

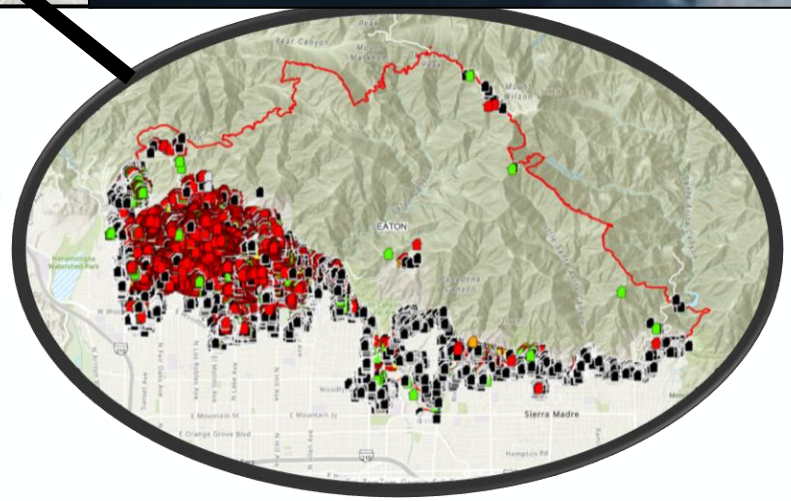
Credit: City of Clearwater, FL





Palisades Fire

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



Eaton Fire

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

180,000+ people were under evacuation, 1.4% of L.A. County was burned.

After the January 2025 Palisades Fire and Eaton Fire in southern California, health officials warned about the post-fire hazards

Hazards mentioned:

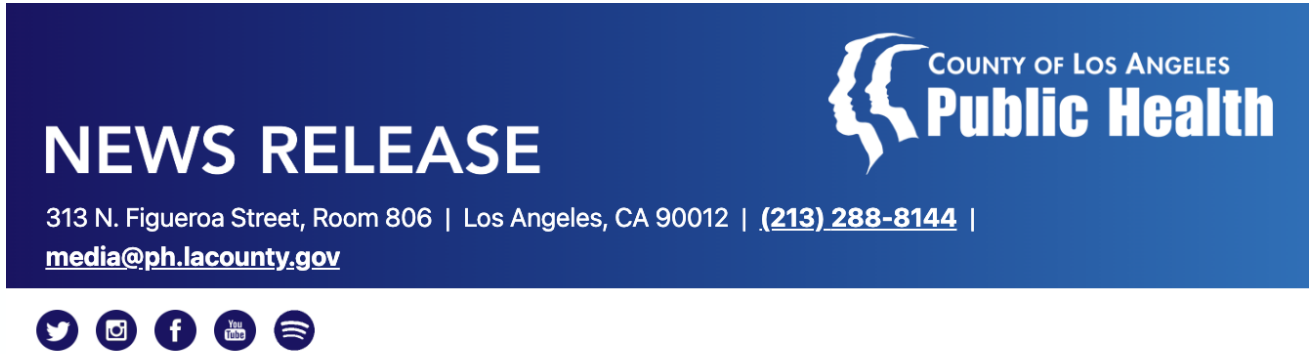
Asbestos

Metals like lead

Hazardous chemicals

Fine particulate matter

Ash, soot, and fire debris



NEWS RELEASE

County of Los Angeles Public Health

313 N. Figueroa Street, Room 806 | Los Angeles, CA 90012 | (213) 288-8144 |
media@ph.lacounty.gov

For Immediate Release:

February 11, 2025

Public Health Advisory Noted for Those Residing Near Burned Structures in Palisades and Eaton Areas

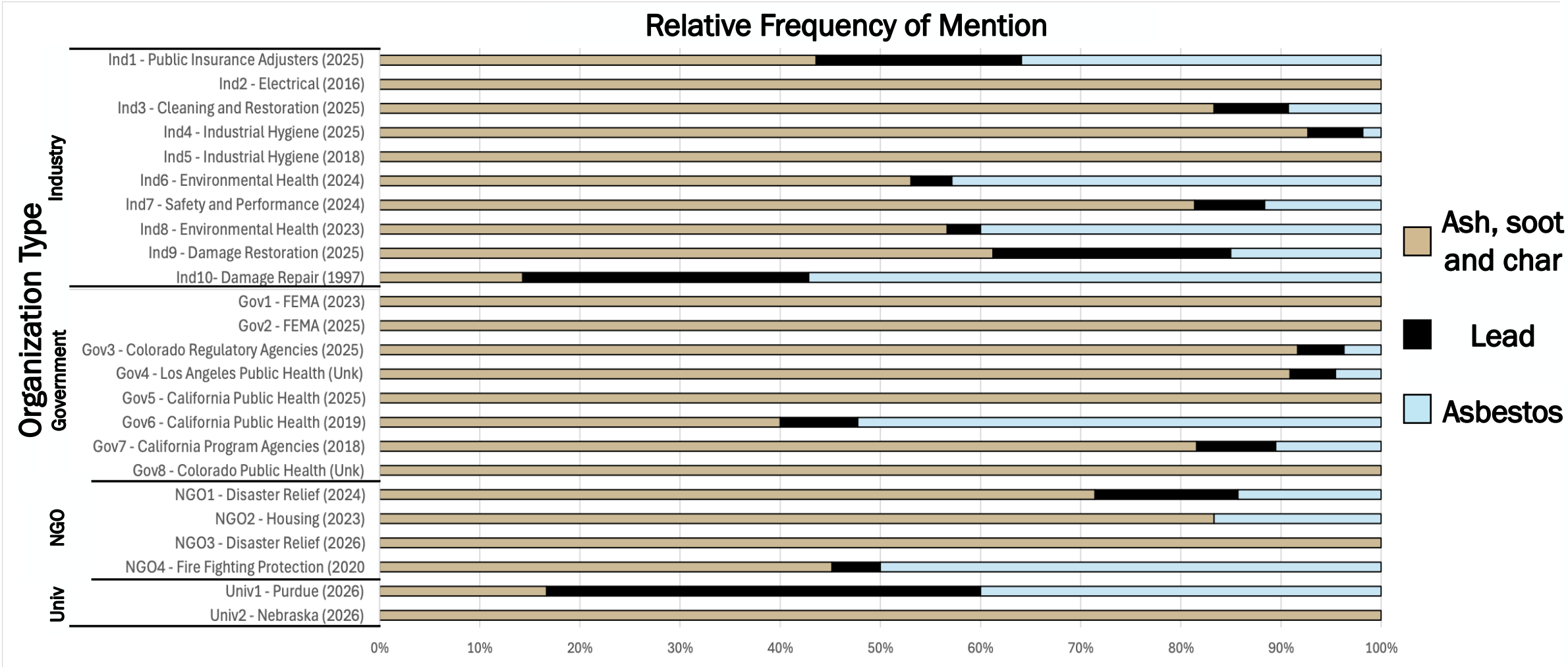
The Los Angeles County Department of Public Health is reminding residents about the dangers associated with fire debris and issuing a **Public Health Advisory** for individuals residing within **250 yards of a burned structure or parcel** within or near the **Palisades and Eaton burn areas**.

Residents in these areas may face an increased risk of exposure to hazardous substances from ash, soot, and fire debris before the completion of **Phase 1 (hazardous materials removal)** and **Phase 2 (fire debris removal)**. Exposure to these materials may lead to **physical health symptoms** (American Chemical Society, EST Air, 2025, 2, 13-23) and may pose long-term health impacts.

Fire debris from burned structures can contain a variety of harmful substances, including:

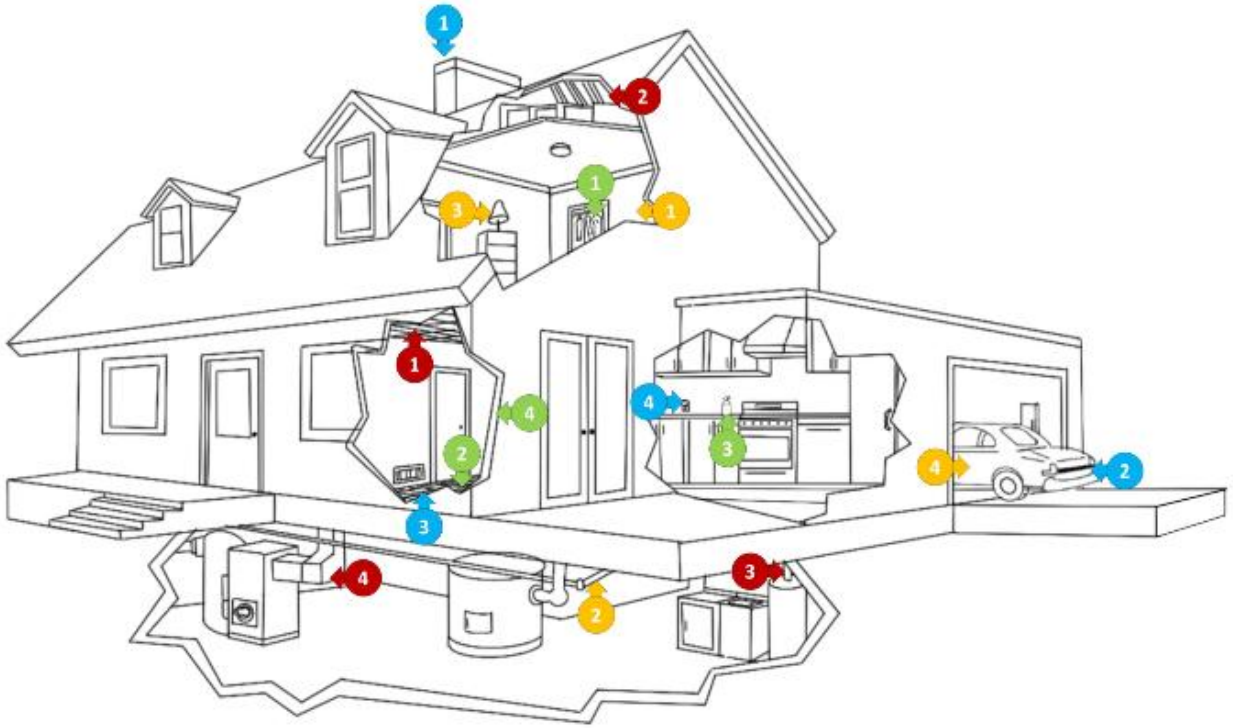
- **Asbestos** from older building materials
- **Heavy metals like lead**
- **Hazardous chemicals** from household products
- **Fine particulate matter** created by the fire

Government and industry organizations warn of “ash, soot, and char” a lot more frequently than lead or asbestos



A variety of chemicals are inside structures

Contaminants released into the air can originate from fire-damaged structures



A Asbestos
1. Ceilings
2. Insulation
3. Piping
4. Ductwork

B Metals
1. Paint
2. Plumbing
3. Batteries
4. Vehicles

C VOCs
1. Clothing
2. Wood
3. Plastics
4. Drywall

D SVOCs
1. Ash
2. Vehicles
3. Wood
4. Plastics

Credit: Keira Murphy, Purdue University

Our Study Goal, Objectives, and Methods

Goal: To better understand property owner experiences with home environmental sampling and testing after the January 2025 fires in California (Eaton Fire and Palisades Fire)

Credit: Andrew Whelton, Purdue University

Objectives

1. Conduct an onsite visit and interview property owners
2. Collect and review home environmental testing reports for standing homes focusing on lead, asbestos, ash, soot, and char contaminants
3. Compare differences between the approaches and relationships between test results and homes

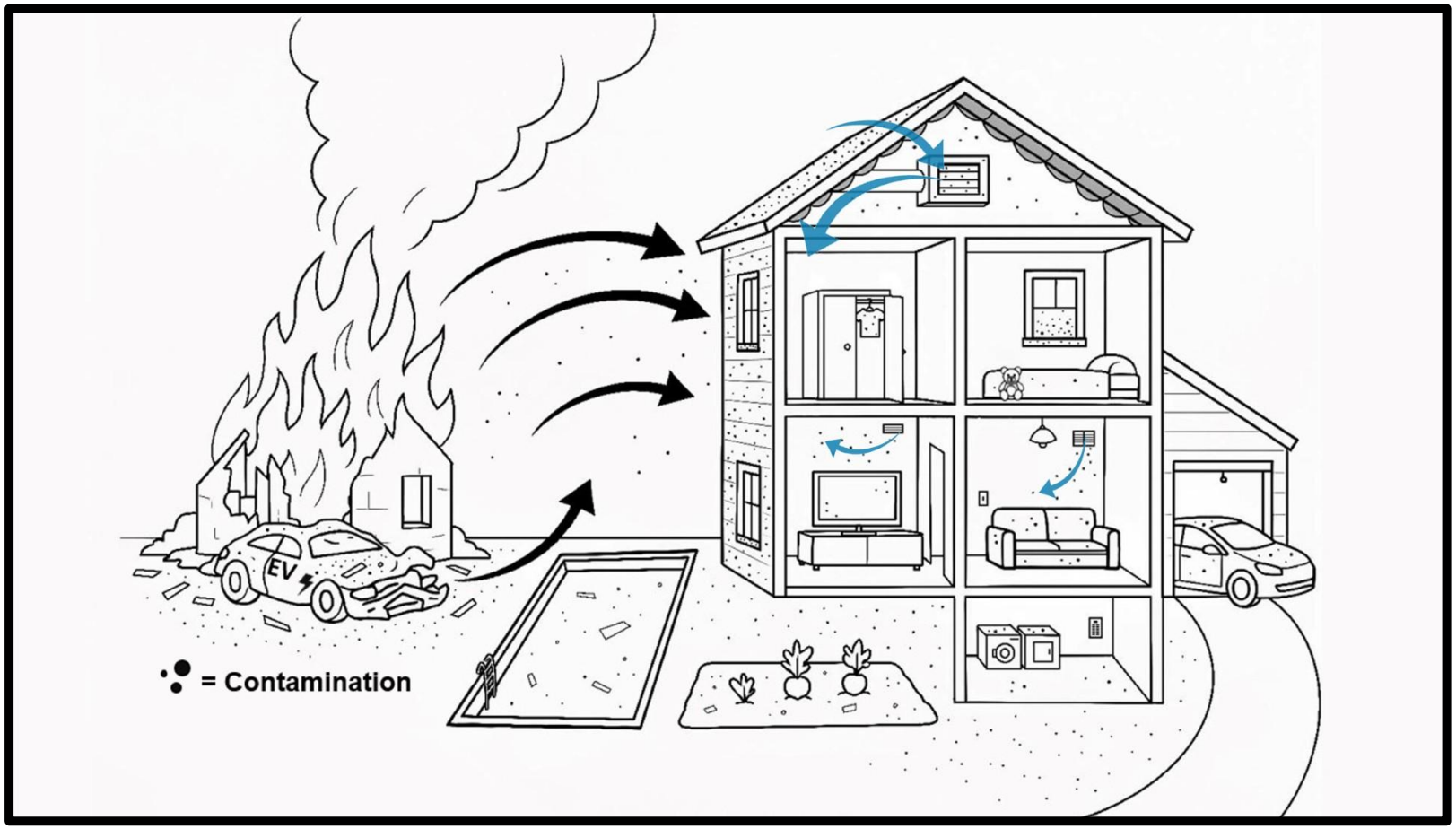
Methods

- Survey: Standing home property owners were encouraged to upload their environmental sampling and testing reports
- Word of the survey was spread through household-to-household communication and community group notifications and newsletters
- Files were anonymized and confirmed to be near the PF or EF impact area and related to the fire

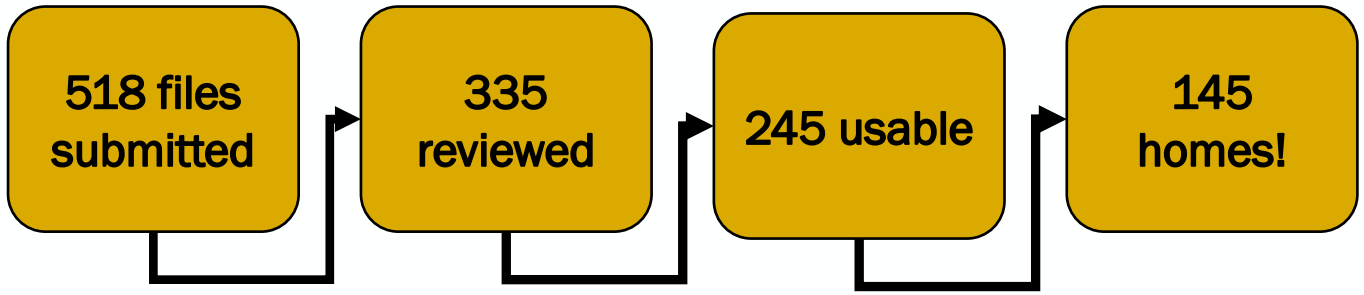
Testing Reports

- From January 1, 2025 – November 3, 2025, there were **518** files submitted to the survey
- The first **335** (65%) were reviewed
  - 90 duplicates
  - 8 not testing reports
  - 11 lacking addresses
- **245** usable files
  - 94 PF homes
  - 51 EF homes

  Total **145** homes!



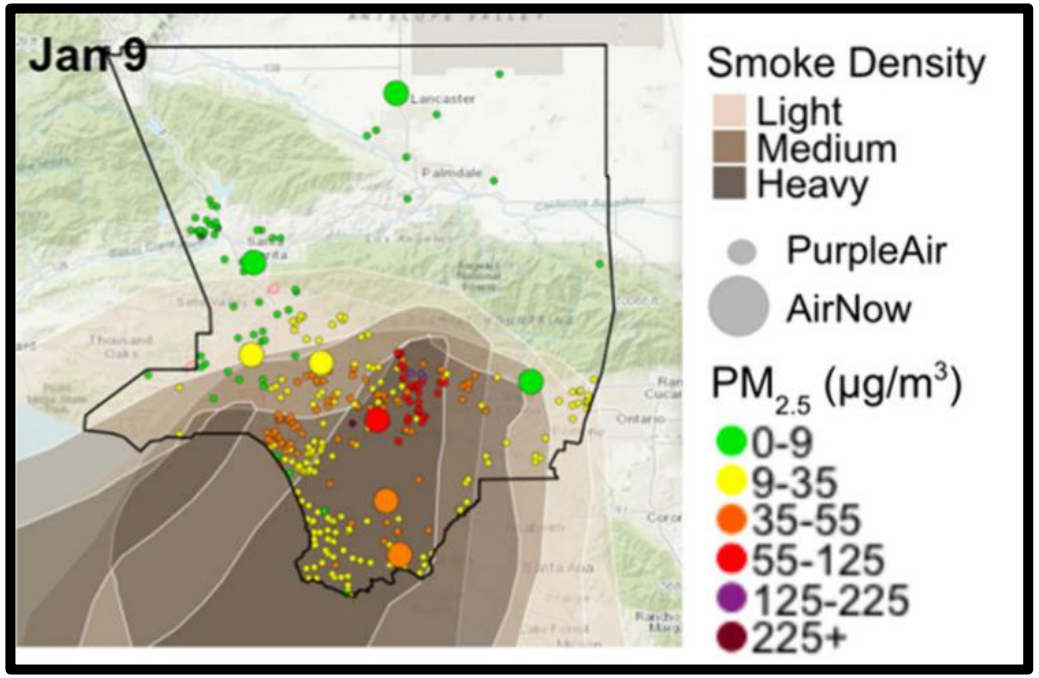
Credit: Kaitlyn Wayne, Purdue University



Preliminary Results

Property Characteristics

- 72% of PF homes inside fire perimeter
- 57% of EF homes inside fire perimeter
- 100% of homes inside smoke plumes
- EF homes generally older (EF mean age 1937 vs. PF mean age 1978)
- EF homes generally smaller (EF mean 2,137 vs. PF mean 3,238 sqft)



Schollaert et al. 2025. *Environmental Science & Technology Letters*. https://doi.org/10.1021/acs.estlett.5c00486

Declared Credentials

- 54 companies conducted lead & asbestos work
- They declared 925 "credentials" of all types
- 83% of lead reporting was done by someone without a self-declared lead-related credential
- 81% of asbestos reporting was done by someone without a self-declared asbestos-related credential

Since there are no post-fire building safety thresholds, consultants are using a variety of contaminant limits

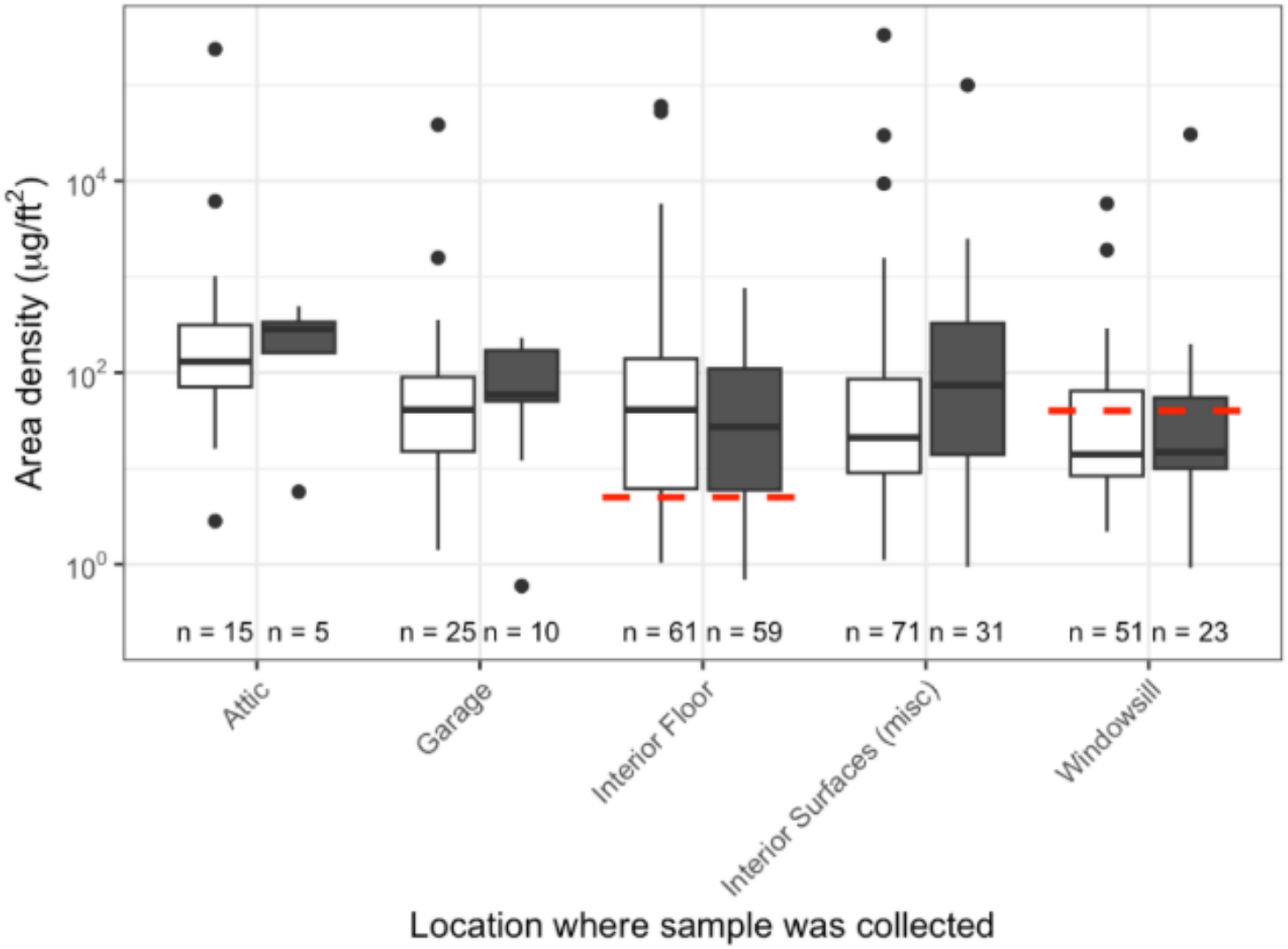
Location	Organization and Level of Concern		
	U.S. EPA (2024), Dust Reportable Action Level (DRAL)	**CDPH (2022)**	**U.S. HUD (1997, 2012)**
Lead			
Interior floor	5 μg/ft²	10 μg/ft²	5 μg/ft²
Windowsills	40 μg/ft²	-	250 μg/ft²
Window troughs	100 μg/ft²	-	400 μg/ft²
Horizontal surfaces	-	100 μg/ft²	-
Exterior horizontal surfaces	-	400 μg/ft²	-
In paint by XRF	-	-	1.0 mg/cm²
Organization	**Conditions**		
Asbestos			
U.S. EPA (2009)	(School) <0.003 fibers/cm^3 SEM analysis (School) <0.005 fibers/cm^3 TEM		
	(School) 70 structures/mm^2 (7,000 structures/cm^2)		
CDPH (2025)	(School) 0.01 fibers/cm^3		

Extreme contamination was sometimes reported

- 60% of lead minimum reporting levels (MRLs) exceeded the USEPA floor threshold, meaning some labs couldn't detect lead at health-relevant concentrations
- 21% of asbestos MRLs were not capable of detecting asbestos at health-relevant concentrations

Contaminant and Statistic	Palisades Fire	Eaton Fire
Lead, μg/sqft	**62 homes, 223 samples**	**29 homes, 128 samples**
Mean ± Std. Dev. / Med.	3,677 ± 28,036 / 28	1,161 ± 9,215 / 39
Min - Max	1.04 to 334,451	0.59 to 100,000
Asbestos, structures/cm^2	**7 homes, 13 samples**	**6 homes, 12 samples**
Mean ± Std. Dev. / Med.	81,552 ± 214,241 / 2,310	36,893 ± 100,717 / 4,767
Min - Max	0 to 765,000	943 to 354,000

78% of all floor samples exceeded the USEPA lead threshold of 5 μg/sqft



When pooled across testing reports, no difference was found…BUT major differences were detected within properties. Each property should be tested individually.

Soot, ash, and char contaminants were the most looked for but have no health-based standards

Consultants disagreed on what ash, soot, and char levels are a problem. Some said,

Consultant:

<1% typical-low

1-3% typical-upper background

3-10% atypical

>10% elevated

Other Consultants:

>1% unacceptable

>2% unacceptable

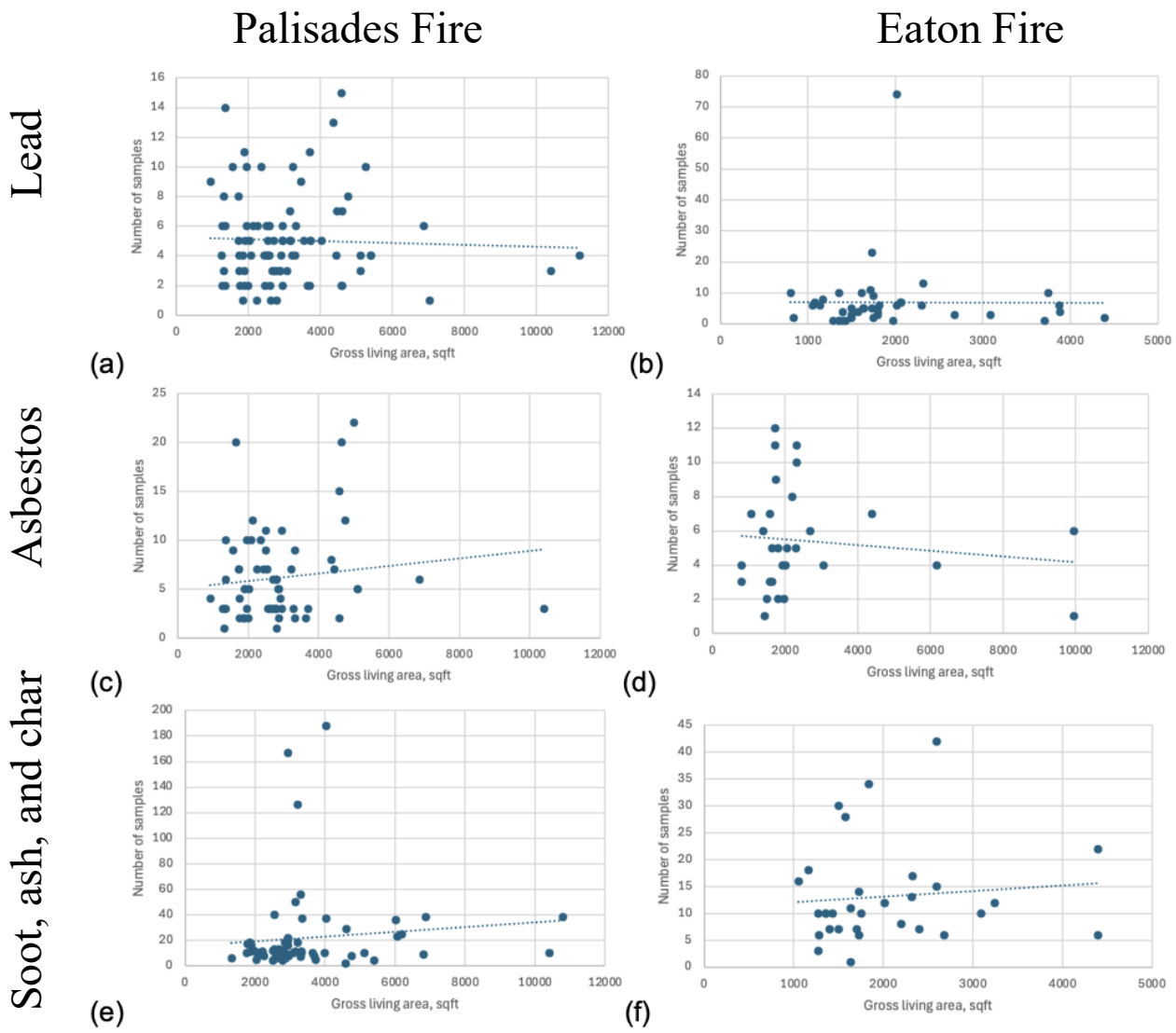
>3% unacceptable

>5% unacceptable

>10% unacceptable

Contaminant and Statistic	Palisades Fire	Eaton Fire
Soot, %	**30 homes, 239 samples**	**10 homes, 49 samples**
Mean ± Std. Dev. / Med.	2.95 ± 5.8 / 2	6.41 ± 9.5 / 3
Min - Max	0 to 66.1	0 to 43
Char, %	**57 homes, 621 samples**	**22 homes, 206 samples**
Mean ± Std. Dev. / Med.	10.4 ± 10.4 / 5.5	10.8 ± 12.5 / 6
Min - Max	0 to 60	0.6 to 60
Ash, %	**49 homes, 390 samples**	**18 homes, 107 samples**
Mean ± Std. Dev. / Med.	5.10 ± 6.2 / 3	4.54 ± 5.4 / 2
Min - Max	0 to 44	0.5 to 31
Combustion Byproduct Total, %	**16 homes, 197 samples**	**9 homes, 102 samples**
Mean ± Std. Dev. / Med.	18.64 ± 19 / 10	11 ± 11.5 / 6.5
Min - Max	0 to 83.5	0.8 to 57

The number of samples collected was not related to the size of a home



Sampling across contaminants

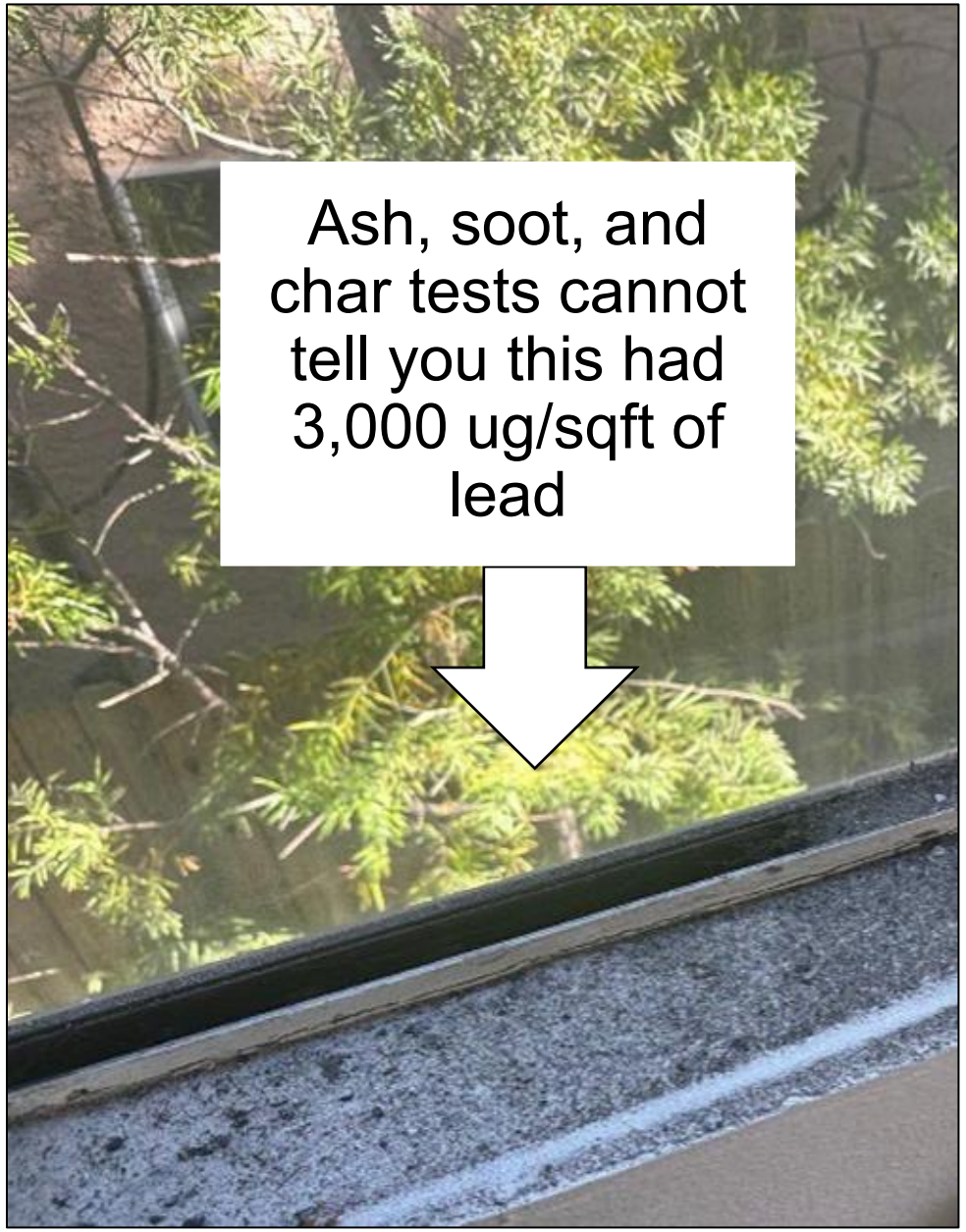
- 1,388 samples were collected for soot, ash, and char
- 708 samples were collected for lead
- 290 samples were collected for asbestos

Reporting of contamination

- 28 reports covered lead, asbestos, and at least one soot, ash, or char
- 12 covered none of these
- 169 covered only 1 contaminant

What other contaminants were tested for?

- Arsenic
- Antimony
- Barium
- Beryllium
- Cadmium
- Chromium
- Cobalt
- Copper
- Mercury
- Molybdenum
- Nickel
- Selenium
- Silver
- Thallium
- Vanadium
- Zinc
- VOCs
- SVOCs
- Furans
- Dioxins
- PAHs
- Mold
- Chloride anions
- And others…



Implications & Further Research

There is a lack of evidence-based standards for fire impacted buildings:

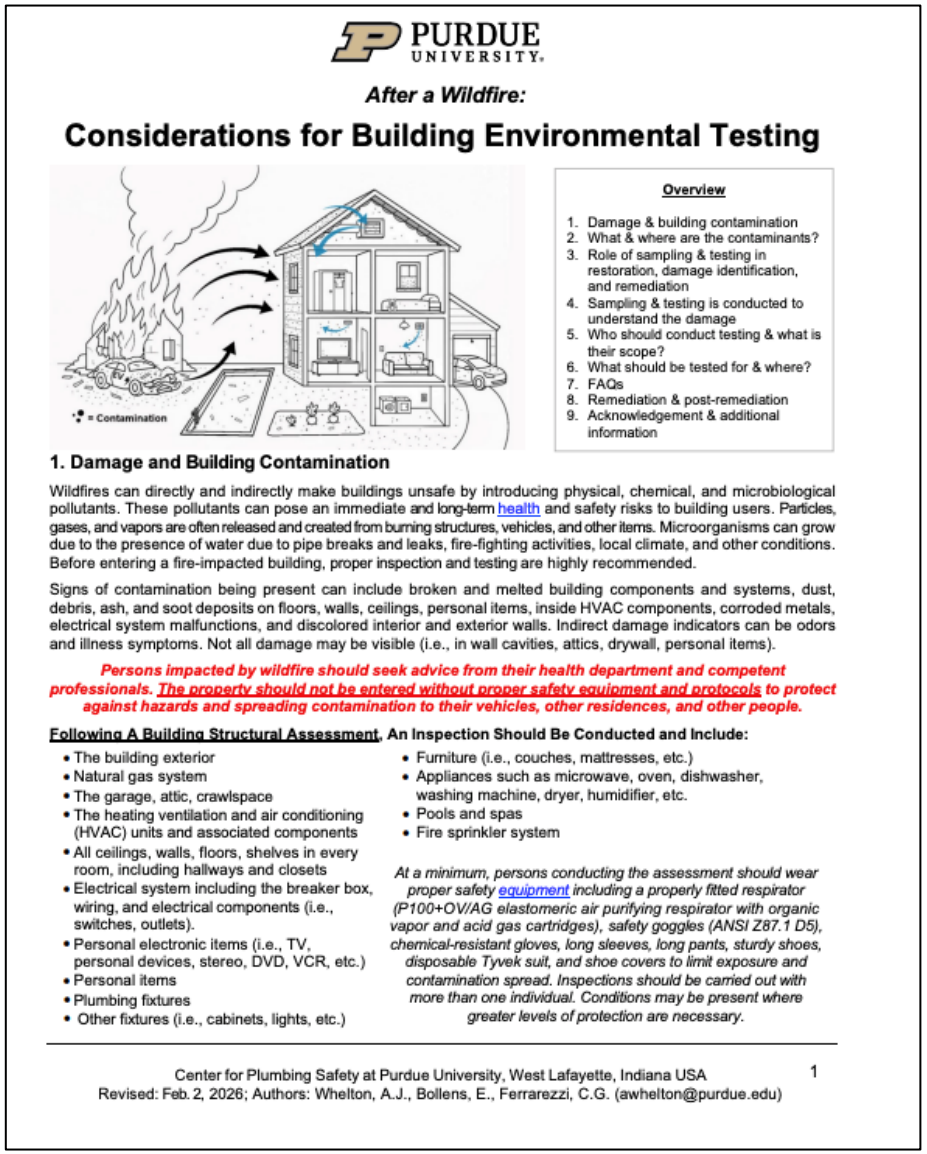
1. Inspection of buildings
2. Designing and executing a sampling plan
3. Collecting samples
4. Determining what analytical methods and MRLs to use
5. Data interpretation and risk assessment

There is also lack of evidence-based standards for building remediation:

1. When does drywall need to be replaced?
2. When do contents need to be replaced?
3. What items are challenging to remediate?
4. What remediation processes are necessary and where are the specs?
5. What confirmatory testing is needed to validate the health hazard has been removed?

Recommendations: What Now?

- After a fire, do not enter a building without a qualified professional assessment
- Chemical contamination can travel downwind, miles away. Vehicle ash is extremely toxic
- Hire professionals with relevant experience in disaster response to inspect and potentially test the buildings.
  - *FYI: Care is needed to protect utility workers.* ***Make certain they have the proper PPE and training. Consider this too*** ➡️ **https://docs.lib.purdue.edu/red/7**
- Interpreting test results should consider the characteristics of exposed populations. Will children ever be in that space?



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After a Wildfire:

Considerations for Building Environmental Testing

Overview

1. Damage & building contamination
2. What & where are the contaminants?
3. Role of sampling & testing in restoration, damage identification, and remediation
4. Sampling & testing is conducted to understand the damage
5. Who should conduct testing & what is their scope?
6. What should be tested for & where?
7. FAQs
8. Remediation & post-remediation
9. Acknowledgement & additional information

1. Damage and Building Contamination

Wildfires can directly and indirectly make buildings unsafe by introducing physical, chemical, and microbiological pollutants. These pollutants can pose an immediate and long-term health and safety risks to building users. Particles, gases, and vapors are often released and created from burning structures, vehicles, and other items. Microorganisms can grow due to the presence of water due to pipe breaks and leaks, fire-fighting activities, local climate, and other conditions. Before entering a fire-impacted building, proper inspection and testing are highly recommended.

Signs of contamination being present can include broken and melted building components and systems, dust, debris, ash, and soot deposits on floors, walls, ceilings, personal items, inside HVAC components, corroded metals, electrical system malfunctions, and discolored interior and exterior walls. Indirect damage indicators can be odors and illness symptoms. Not all damage may be visible (i.e., in wall cavities, attics, drywall, personal items).

Persons impacted by wildfire should seek advice from their health department and competent professionals. The property should not be entered without proper safety equipment and protocols to protect against hazards and spreading contamination to their vehicles, other residences, and other people.

Following A Building Structural Assessment, An Inspection Should Be Conducted and Include:

- The building exterior
- Natural gas system
- The garage, attic, crawlspace
- The heating ventilation and air conditioning (HVAC) units and associated components
- All ceilings, walls, floors, shelves in every room, including hallways and closets
- Electrical system including the breaker box, wiring, and electrical components (i.e., switches, outlets).
- Personal electronic items (i.e., TV, personal devices, stereo, DVD, VCR, etc.)
- Personal items
- Plumbing fixtures
- Other fixtures (i.e., cabinets, lights, etc.)
- Furniture (i.e., couches, mattresses, etc.)
- Appliances such as microwave, oven, dishwasher, washing machine, dryer, humidifier, etc.
- Pools and spas
- Fire sprinkler system

At a minimum, persons conducting the assessment should wear proper safety equipment including a properly fitted respirator (P100+OV/AG elastomeric air purifying respirator with organic vapor and acid gas cartridges), safety goggles (ANSI Z87.1 D5), chemical-resistant gloves, long sleeves, long pants, sturdy shoes, disposable Tyvek suit, and shoe covers to limit exposure and contamination spread. Inspections should be carried out with more than one individual. Conditions may be present where greater levels of protection are necessary.

Center for Plumbing Safety at Purdue University, West Lafayette, Indiana USA
Revised: Feb. 2, 2026; Authors: Whelton, A.J., Bollens, E., Ferrarezzi, C.G. (awhelton@purdue.edu)

https://docs.lib.purdue.edu/red/

August 31, 2026 at 10:10pm EDT: The Calif. Legislature passed the 1st in the nation smoke damage building contamination testing standards

Thank You.
Questions?

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

AB 1642 (Harabedian) creates the scientific, health standards
AB 1795 (Gipson) requires insurance companies to follow them

Acknowledgements

Special thanks is extended to the property owners who participated

This study was initially designed and conducted without financial support until late 2025. The purpose was to assist households make decisions in their recovery.

Partial financial support was then made available by:

- Private donors
- U.S. National Science Foundation grant FIRE-2536797
- R&S Kayne Foundation

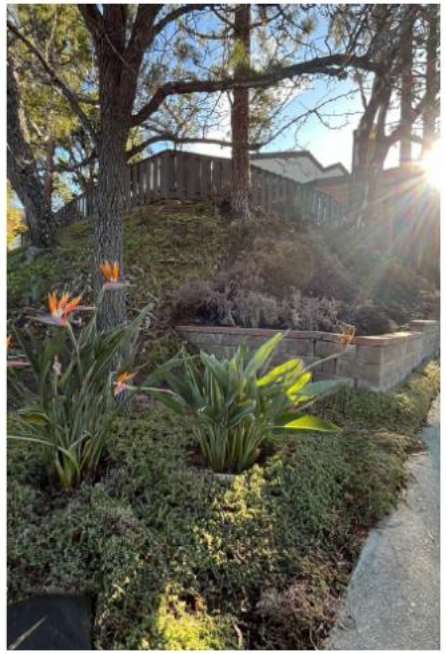
Special thanks are also extended to Larry Vein at Pali Strong and Jane Lawton-Moore at Eaton Fire Residents United for sharing the study with their communities. Appreciation is extended to Purdue University student Ella Kornick for helping compile literature and Paula Coelho for help with data analysis.

Additional Information

Webinar Series:
After the Fires

Register for the webinars at
www.PlumbingSafety.org





Response and Recovery Lessons Learned from Fires

August 2025	**September 2025**	**September 2025**	**October 2025**	**August 2026**
The LA Pools Study: What was in the water?	Soils, Debris, Fruit, Gardens, and More	The REBUILD Survey: Overview and First Look	Physical and mental health resources	Practical, Science-Backed Steps for Recovery

Free guidance resources ➔ Resilience to Emergencies and Disasters Series, Purdue University ➔

UCLA Tufts University Cal Poly Pomona PURDUE UNIVERSITY CAL POLY SAN LUIS OBISPO USC University of Southern California

HEART

Health-based Environmental Assess. & Re-Occupancy Testing

Evidence-based practices for safely restoring homes

100s of homes participating

REBUILD

Recovery Efforts by Uniting Individuals, Listening, & Discovery

Household experiences with evac., housing, testing, chemical exposures, insurance, & rebuilding.

1,229 households participating

ASHES

Fire Ash & Soil History Evaluation

Evidence-based practices for safely returning property soil to pre-fire condition.

Ash & 100,000+ soil samples across multiple states

L.A. Pools

Swimming Pool Fire Recovery

Evidence-based practices for restoring swimming pools.

20+ households participating

CRIBS

Chemical Risk In Baby Product Sorption

Evidence-based guidance on handling baby products exposed to contaminated drinking water.

Designed with input from affected families

MITIGATE

Mitigation of Impacts Through Innovative Guidance, Adaptation, & Technology

Evidence-based practices to reduce impacts and expedite recovery.

10+ water utilities participating

Ongoing work...

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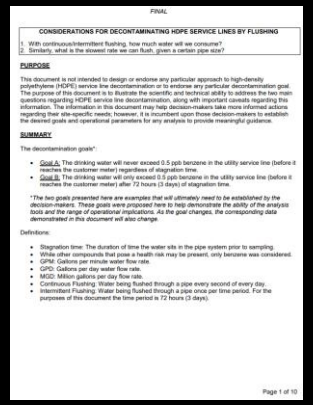
Evidence-Based Resources for Fire Recovery

Available from Purdue University: https://docs.lib.purdue.edu/red/

- ✓ Considerations for Personal Safety When Visiting Fire-Damaged Property
- ✓ Considerations for Building Environmental Testing
- ✓ Considerations for Residential Property Soil Testing and Soil Restoration
- ✓ Water Safety Considerations for Private Wells
- ✓ Water Safety Considerations Inside Buildings
- ✓ Water Safety Considerations for Agriculture Water Systems

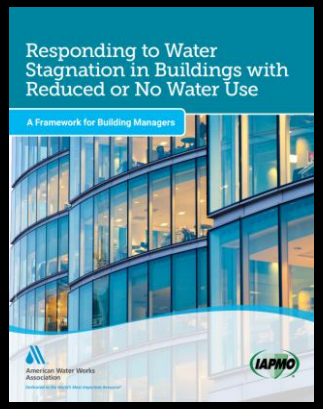
Concept of Operations (CONOPS) Plan for Water Distribution System Testing and Recovery. 2024. Prepared by Purdue University for the Water Research Foundation. Denver, Colorado. Request a free copy here: https://www.waterrf.org/contact-us

Post-Fire Sampling…



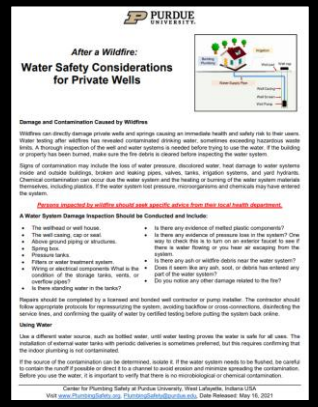
2019

Inside Buildings…



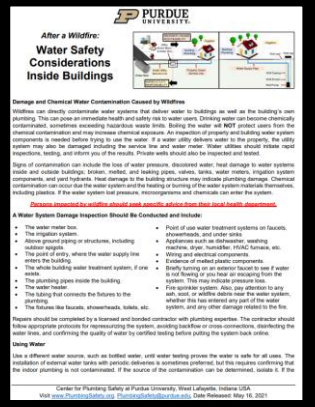
2020

Private wells…



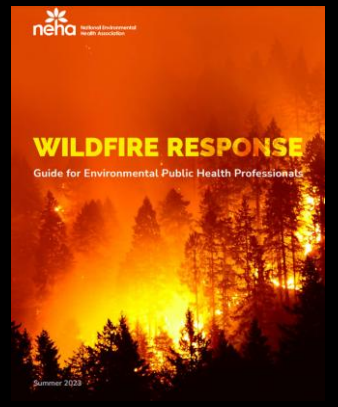
2021

Inside Buildings…



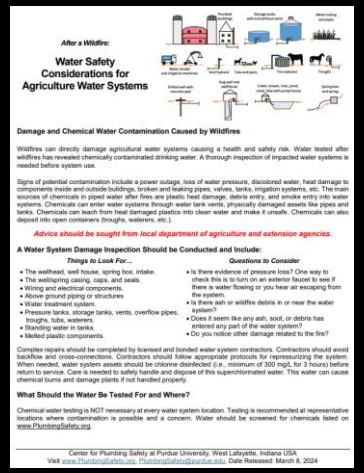
2021

Environmental health basics…



2023

Agricultural water systems…

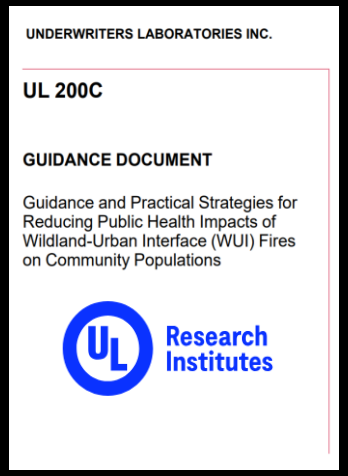


2023

Bipartisan Commission report…

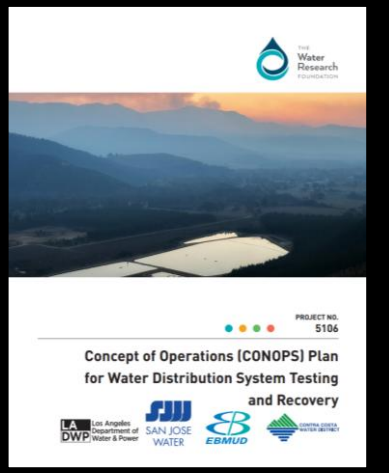
2023

Public health basics…



2024

Post-fire utility and health decisions



2024

LA Blue Ribbon Commission

2025

…

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WELCOME
to the
ZOO
ZONE 5


SOUTH
ENTRANC
WE HAVE A
RIDGE
BERKELEY

John Snow Pump
Soho, London

Water & Infrastructure Resilience: Public Health & Extreme Events

March 14-23, 2025

Aero. & Astronautical Eng.
Chem. Eng.
Civil Eng.
Construction Eng.
Electrical Eng.
Environ. & Eco. Eng.
Environ. & Nat. Res. Eng.
Mechanical Eng.

Study Abroad Engagement:

LFB LONDON FIRE BRIGADE

dwi

love every drop anglianwater

The Guardian

Imperial College London

PURDUE UNIVERSITY

CE 597: Disasters & Emergencies

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

Course Description: Focused on introducing and inspiring students about the engineering, science, and policy challenges associated with disasters and emergencies. Topics will span infrastructure, the environment, public safety, and public health.

Learning Objectives:

- ID key population needs following natural and man-made disasters;
- Explain the roles and responsibilities of common organizations responding to incidents;
- Recognize the wide-breadth of expertise involved in response and recovery;
- Communicate technical concepts effectively with audiences with widely-varying backgrounds;
- Recognize the different expertise involved in incident response and recovery.

Approach: Field trip; NIIMS/ICS training; NSF CONVERGE trainings; Speaker reflections; Sci. paper/report reflections; quizzes; Hurricane exercise; Chemical exercise; Press conference; Final report and video.

Help us make a difference

Our efforts are only possible because of the support we receive from people who wish to make a difference. By supporting our work, no matter how big or how small, we can hire students, collect data, analyze the results, and share results with the people and businesses most affected. As we have done for 20+ years, we then channel those results into driving positive change improving health, safety, and welfare related to emergencies and disasters.

Many people who donate want to pay it forward because they know how critical rapid and useful information can be.

If you would like to help, you can consider donating online to our efforts (click here). In the notes, be sure to mention "Whelton Disaster Response and Recovery".

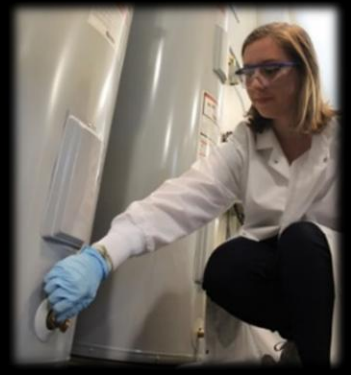
Or, a check can be separately provided to:

Make Check Payable to: Lyles School of Civil and Construction Engineering
ATTN: Andrew Whelton
Purdue University
In the notes, mention: Whelton Disaster Response and Recovery
3145 Hampton Hall, West Lafayette, Indiana 47907

Or, securities donations are also accepted. These require special care before provision.

Please contact Professor Andrew Whelton at awhelton@purdue.edu with any questions.

Thank you

Special thanks to…

Paradise Irrigation District
City of Louisville, Colorado · Since 1878
County of Maui, State of Hawaii
Boulder County
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LA DWP Los Angeles Department of Water & Power
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Support from…

Rotary Club of Paradise, California
NSF
United States Environmental Protection Agency
The Water Research Foundation
R&S Kayne Foundation
Andrew Whelton's Wallet

Visit our wildfire response and recovery resources page at www.PlumbingSafety.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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