

WHITEPAPER



Where There's Smoke:

Assessing the
Health and Property
Damage Risks of
Wildfire Smoke

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INTRODUCTION

Dramatic videos of exploding fireballs and flames leaping across highways are a frightening reminder of the increasing severity of the wildfire threat.

While visually less dramatic, the smoke generated by these powerful events can have an impact on human health and property that reaches beyond a fire's footprint. Wildfire smoke can climb thousands of feet into the atmosphere and follow wind currents that deposit it hundreds of miles from the fire that produced it.

The effects of wildfire smoke can be harder to gauge, but it's an important topic for worried homeowners, as well as for insurers, lawyers, health and government officials. When does wildfire smoke, either airborne or deposited onto surfaces like buildings, furnishings or walkways, pose a hazard to health or property?

It's a question that has taken on growing importance as wildfire season in the U.S. grows longer and more volatile, with bigger fires and more acres burned each year, according to the U.S. Forest Service. As a result, wildfires are also pushing closer to human habitation. With studies showing that airborne smoke can be toxic, it's important to have a clear understanding of the threat.

This whitepaper will explore both the makeup and the mechanics of wildfire smoke as well as best practices for assessing and remediating wildfire smoke damage.

Richard L. Wade, Principal Scientist at Omega Environmental Services, has studied wildfires in California, Colorado and Texas and is a leading expert on the topic of wildfire smoke impact. His work includes numerous studies and research

conducted as an adjunct professor and visiting lecturer at universities that include the University of California, Irvine, the University of California, San Francisco Medical Center, Oxford University and Harvard University, among others. Dr. Wade has also served in various government and regulatory capacities including as chief toxicologist for the San Francisco Fire Department and Deputy Chief for Occupational Health at Cal/OSHA. His expertise includes fire impact assessment, combustion chemistry and the effects of combustion products on human health and he has designed sampling plans and reviewed fire sample results from hundreds of fire impact studies across the country.

This paper is drawn from his reporting and research as well as his work at Omega Environmental Services, where he frequently consults with insurance companies, law firms and others on the impact of wildfire smoke.

HIGHLIGHTS OF THIS WHITEPAPER

This whitepaper will explore the physical and chemical properties of wildfire smoke as well as an overview of potential impacts, including:

- Potential health effects related to wildfire smoke
- Wildfire smoke and property damage
- Differences between deposited and airborne wildfire smoke
- Difference in composition of wildfire smoke vs. smoke from structural fires
- Best practices for remediation and cleanup of property impacted by wildfire smoke

When does wildfire smoke, either airborne or deposited onto surfaces like buildings, furnishings or walkways, pose a hazard to health or property?

CALIFORNIA'S DEADLY WILDFIRE SEASON

In 2018, California experienced one of the worst wildfire seasons in its history, with **1.8 million acres** burned and more than 100 people killed. Two of the most destructive fires were the Camp fire and the Woolsey fire.

The **Camp fire** killed 86 people and destroyed more than 14,000 homes. The northern California town of Paradise, a retirement community in the Sierra Nevada foothills, saw its population reduced by an estimated 90 percent in the aftermath of the blaze that gutted the town, according to [USA Today](#).

The **Woolsey fire** started in the Santa Susana Mountains near a Superfund site undergoing cleanup for hazardous materials. It was one of the most destructive wildfires in state history with 97,000 acres burned, 1,500 structures in Los Angeles and Ventura Counties destroyed and three people killed, according to [the Los Angeles Times](#). The fires left multimillion dollar mansions and ranches gutted, leaving Malibu looking like what one newspaper described as a "lunar landscape."

This type of destruction is becoming more common as the result of climate change and development, with a growing number of homes and structures being built in close proximity to the wooded areas that serve as sources of fuel for wildfires.

WHAT IS WILDFIRE SMOKE?

Smoke from wildfires is made up of ash and soot, traces of char and both volatile and semi-volatile gases produced by the combustion of wood and other biomaterials. As the smoke travels, pushed by wind and air currents produced by the fire itself, the components of smoke change depending on ambient temperatures and the type of materials that are being combusted.

Here is a brief overview of the components of wildfire smoke:

- **Ash:** This is the residue powder left after combustion and contains naturally occurring earth minerals such as calcium, potassium and magnesium.
- **Soot:** Typically found in wildfire smoke at very low quantities, this is the byproduct of combustion and pyrolysis of carbon-containing material such as vegetation.
- **Char:** This is the solid material that retains, to some degree, the structure of the burned material and is what is left over after gases, carbons and tars have been released during the initial stage of combustion.
- **Particulate matter:** Wildfire smoke is mostly composed of particulate matter. Particles larger than 10 microns can irritate the eyes, nose and throat. Smaller particles of less than 10 microns are capable of entering the bloodstream through inhalation exposure and can damage the lungs and other organ systems.
- **Volatile and semi-volatile organic gases:** These gases can be generated during a wildfire and can contain traces of toxic substances such as formaldehyde and acetone as well as sulfur oxides and nitrous oxides. They are largely instantaneously consumed by the fire and do not reach properties outside the fire zone.

Wildfire smoke outside of the fire zone is composed primarily of ash and char. Volatile and semi-volatile organic compounds as well as other gases such as carbon monoxide and carbon dioxide are diluted or consumed by the fire to such an extent that they are not detectable in wildfire smoke outside of the fire zone.

Volatile and semi-volatile organic compounds may not be detectable in wildfire smoke outside of the fire zone.

THE CHEMISTRY OF WILDFIRES: HIGH TEMPERATURE AND FIREBALLS

Wildfire smoke is generated largely from the combustion of plant material such as vegetation and wood. Structural material from buildings can also be burned in wildfires.

The flashpoint of wildfires is 572 degrees Fahrenheit (300 degrees Celsius), a temperature at which entire trees and surrounding gases explode. Carbon particles from the combustion of plant materials are converted to CO₂, which then explodes into fireballs.

The high heat of the fire destroys gases within a matter of seconds, so they do not travel far beyond the point of combustion. Studies have shown that the gases released by wildfires do not exceed safety standards for firefighters battling the blaze outside of the fire combustion zone. What is left of wildfire smoke outside the immediate footprint of the fire is largely ash and char from which detectable levels of semi-volatile or volatile chemical compounds have been consumed.

DEPOSITED WILDFIRE SMOKE

As the wildfire smoke settles out of the air, its particles settle on surfaces inside and outside wildfire zones. This is known as deposited wildfire smoke and studies show that volatile and semi-volatile compounds detected in ash within the fire zone are typically no longer detectable in ash deposited outside the fire zone.

If residential or commercial properties are burned in a wildfire, there may be additional air contaminants that result from the combustion of the properties' building materials. These can include:

- Asbestos
- Heavy Metals
- Semi-volatile and volatile gases
- Formaldehyde
- Acrolein

Structural fires can leave behind toxic material residues as the result of the combustion of materials like plastic, metals and synthetics. Longer periods of combustion at lower temperatures create greater risk of hazardous smoke and gas emissions from structural fires. Structures in the path of a wildfire, however, are subject to the same high-heat combustion principles, and smoke particulates outside of the wildfire zone are unlikely to contain detectable traces of any volatile compounds.

The combustion of plant material can generate formaldehyde and acrolein but they have a short half-life and are also consumed in the high temperature and combustive effect of wildfires, studies of the Bastrop, Texas and Tubbs, Nunn and Woolsey California fires showed.

AIRBORNE WILDFIRE SMOKE

In contrast to the low risk associated with deposited wildfire smoke, airborne wildfire smoke is a risk to human health because it consists of sub-micron particles (10-2.5 microns) that can irritate and cause damage to the eyes, nose, throat and respiratory tract. Health impacts depend on the concentration and size of the particles and the distance from the wildfire. Airborne ash can be especially harmful to children and people who have preexisting health conditions such as heart disease, asthma or chronic respiratory conditions. Inhaling these particles can contribute to chronic disease such as cancer.

Airborne wildfire smoke is a risk to human health—especially children and those with preexisting health conditions

If odor is present in a home that was exposed to wildfire smoke, it is the result of lingering airborne particulates, which can travel hundreds of miles from a fire site before they settle. During cleaning activities and while the airborne particles are present, a disposable particulate respirator may

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be helpful to prevent inhalation of particles that have not yet settled.

When wildfire odors are present outside, best practices including remaining indoors until the soot and ash are diluted and absorbed by the environment. Use indoor filters and air filtration such as centralized air conditioning and change your filters regularly.

California and Colorado Department of Public Health guidance for protecting yourself from airborne particulates includes:

- Stay inside until nearby structures are cleaned up.
- Limit outdoor time for children and pets.
- Take off shoes and wipe off pets' feet before entering home.
- Keep doors and windows closed.
- Make sure air filters are clean; replace less efficient fiberglass filters with pleated filters.
- Steam clean affected carpets, draperies, furniture and mattresses, changing water solution frequently
- It may be necessary to blow out the interior of electronic equipment such as computers, stereos and televisions, as well as refrigerator condenser coils that can attract particulates.
- Wear respiratory protection while engaging in cleanup.
- Use common sense when engaged in cleaning and recovery.
- Be on guard for companies that attempt to take advantage of the situation. Use reputable local companies, seek recommendations from your insurance company and check with your local Better Business Bureau.

CLEANING AND REMEDIATION

California state guidelines stipulate that wildfire ash can be handled as non-hazardous. Remedial actions can be performed by a homeowner or a household cleaning specialist and waste can be safely deposited at the landfill.

Avoid tracking deposited smoke into your home. Hose down the driveway, cars and all entryways to avoid bringing particles inside with you. Avoid stirring up particles, as airborne wildfire smoke particles can be hazardous to human health.

The good news is that deposited wildfire smoke is water soluble and an insurance industry study showed that washable fabrics and carpeting were easily restored with ordinary cleaning processes and household detergents. Clothes and other fabrics can be washed in the washing machine. Use a vacuum with a HEPA filter to clean the particles from upholstery and carpets inside the home.

Except at sites where a portion of the structure has been burned or where routine cleaning has been unsuccessful, it is rarely necessary to use the services of specialized fire restoration or other specialized remediation contractors to manage the cleanup of deposited wildfire smoke.

Studies of the effect of deposited wildfire smoke on household surfaces also showed no significant effects or damage.

ABOUT OMEGA ENVIRONMENTAL:

Omega is a full-service environmental management and hazardous materials consulting firm with extensive expertise in toxicology and assessment for deposited and airborne wildfire smoke, among a broad array of other environmental assessment and remediation services.

With decades of experience in the assessment and remediation of hazardous materials found in buildings, ground water, soil and indoor air, we have built a reputation for responsiveness, excellent client service, reliability and effectiveness for regulatory compliance.

More at www.omegaenv.com