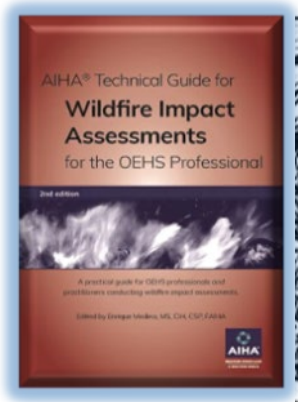
A SYSTEMATIC APPROACH TO POST WILDFIRE ASSESSMENT, TESTING, AND RESTORATION

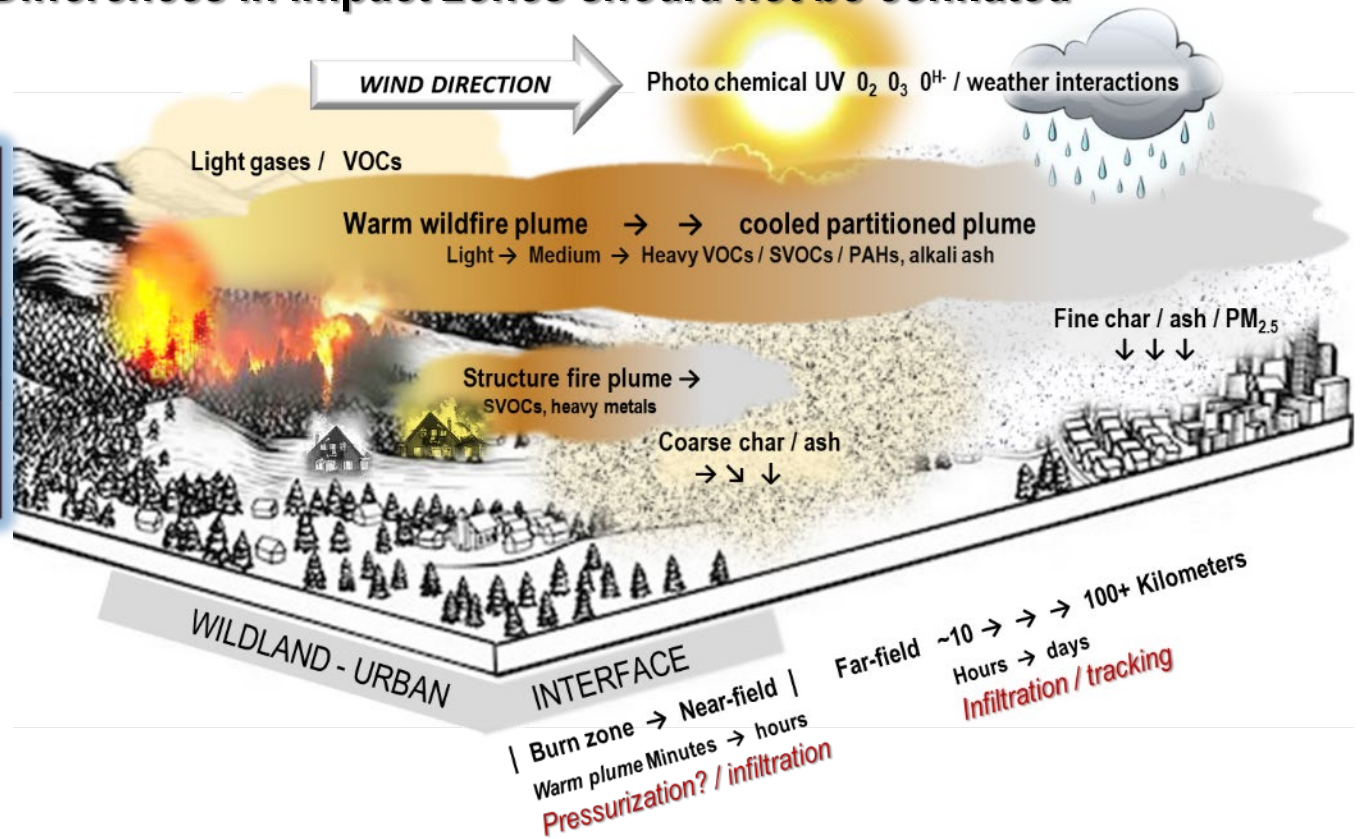
Daniel M. Baxter

R. Christopher Spicer

Dr. Richard Wade

- **Wildfire burn zone is different than downwind (e.g., burn zone → near-field →far field)**
- **Fire chemistry and thermal dynamics are different**
- **Infiltration pathways are different**
- **Testing methods may be different**
- **Cleaning is different**
- **Differences in impact zones should not be conflated**





A SYSTEMATIC APPROACH TO POST WILDFIRE ASSESSMENT, TESTING, AND RESTORATION
(Abridged Biography)

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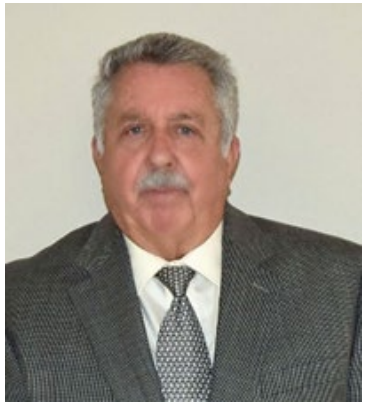

- Governmental agency and institutional research / consulting history – Los Angeles Police Department Criminalists Laboratory, Scripps Institution of Oceanography, SAIC (Field / lab research - California Air Resources Board (CARB), California State Architects Office, AIHA, Defense Nuclear Agency (DNA), US EPA, Nuclear Regulatory Commission (NRC).
- Contributing author - AIHA Technical Guide for Wildfire Impact Assessments for the OEHS Professional, 2nd Edition, May 2025.
- Technical reviewer - 1996 2nd edition of the AIHA Field Guide for the Determination of Biological Contaminants in Environmental Samples. AIHA Biosafety Committee.
- California Air Resource Board - Baxter, D., and R. Ziskind, 1982: Ambient Asbestos Concentrations in California, 1982.
- Contributor - U.S. EPA Interim Technical Guidance Document, Procedures for TEM Measurement of Asbestos in Air Following an Abatement Action, 1985.
- Contributor - National Institute of Building Sciences - Model Guide Specifications For Asbestos Abatement in Buildings,1986.
- Contributor - U.S. EPA (WERL, Cincinnati) - Asbestos dust analysis method in water, June 1989.
- Contributor - U.S. EPA (ORD, RTP) – Asbestos analysis method for PLM bulk samples, July 1989.
- Contributor - U.S. EPA - Asbestos Hazard Emergency Response Act (AHERA), 1986-1989.
- Developer and patent-holder of the Air-O-Cell slit impactor (1993)

A SYSTEMATIC APPROACH TO POST WILDFIRE ASSESSMENT, TESTING, AND RESTORATION
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- Member ASTM D 22-08 Assessment, Sampling and Analysis for Microorganisms
- AIHA Liaison to Institute of Inspection, Cleaning and Restoration Certification (IICRC)
- Author – A probabilistic evaluation of surface loading and concentration as metrics
- for post structural fire assessment soot sampling data. *Fire Technology* 2024
- Author - Assessing background particulate contamination in an historic building – surface lead loading and contamination. *Journal of the Air &Waste Management Association* 2020
- Primary author -Permutation/randomization-based inference for environmental data. *Environmental Monitoring and Assessment*, 2016
- Primary author – Verifying interpretive criteria for bioaerosol data using (Bootstrap) Monte Carlo techniques. *Journal of Occupational and Environmental Hygiene*, 2008

A SYSTEMATIC APPROACH TO POST WILDFIRE ASSESSMENT, TESTING, AND RESTORATION
(Abridged Biography)

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- **Principal Scientist and co-founder Med-Tox, Omega, R-Zero**
- **Medical Toxicologist San Francisco Fire department**
- **Principal scientist and health program director, Exponent**
- **Director of environmental health: Seattle and King County**
- **Director of health policy American Public Health Association**
- **Director of environmental and occupational health: State of Minnesota**
- **Deputy chief of Cal OSHA**
- **Associate, National Academy of Science**
- **Member Naval Studies Board US Dept of Defense**
- **Principal scientist Safeguard EnviroGroup**

2025 AIHA WILDFIRE TECHNICAL GUIDE - CONTRIBUTORS

2025 2ND EDITION OF THE "*TECHNICAL GUIDE FOR WILDFIRE IMPACT ASSESSMENTS FOR THE OEHS PROFESSIONAL*"


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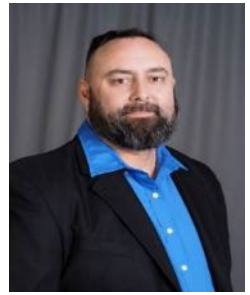
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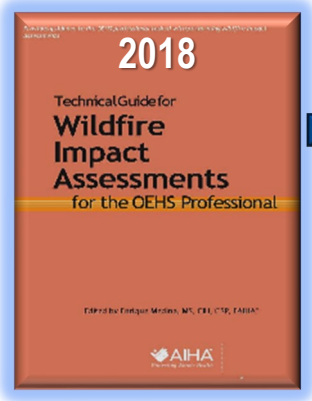
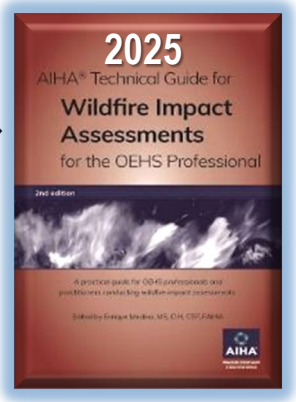




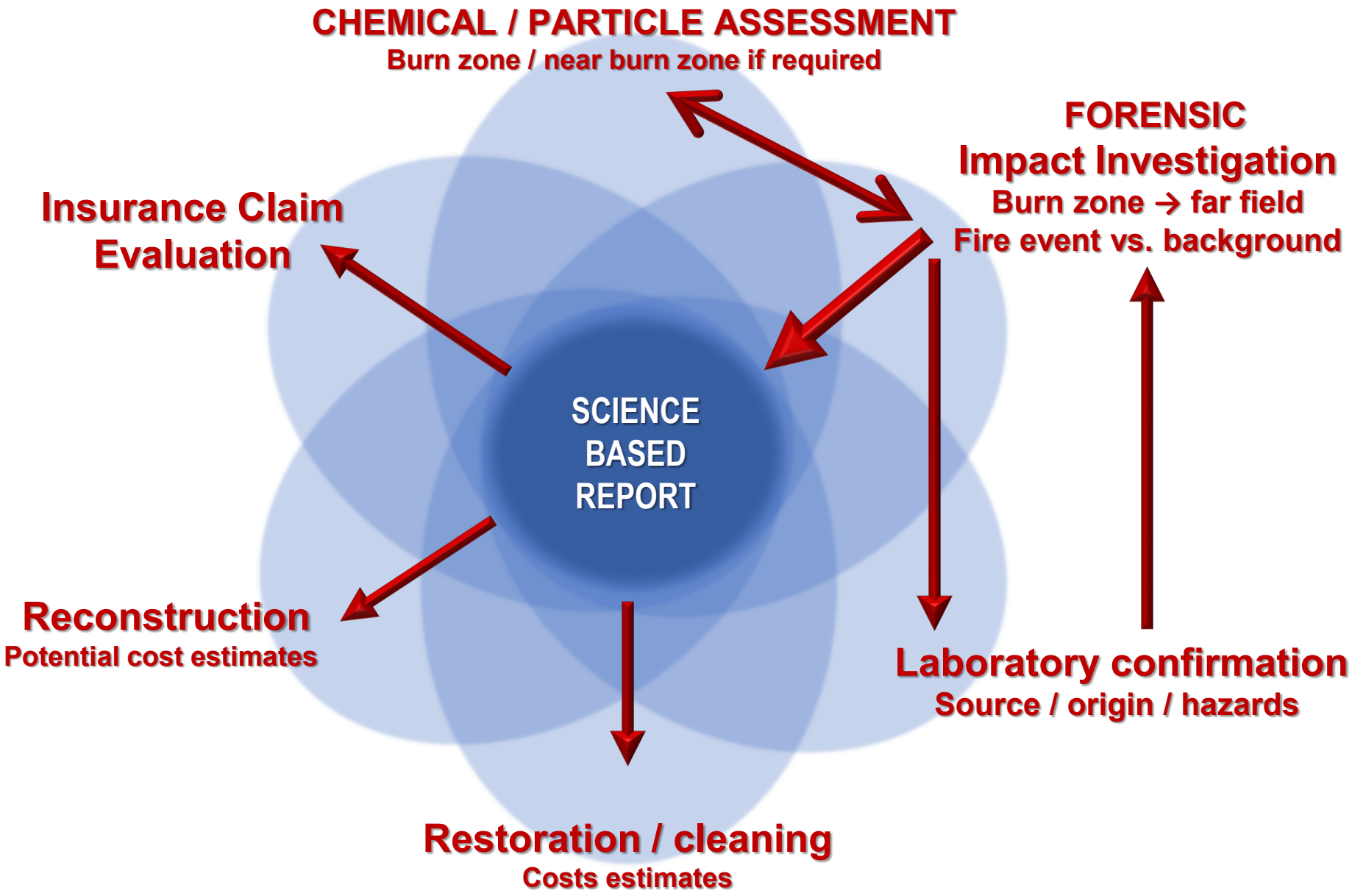
300+ years of combined experience.

Nine internal and external technical peer reviewers.

Every contributor has over 10-20 years investigation, hazards, restoration, and/or laboratory experience managing fire-related claims.

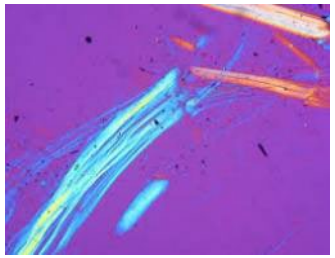
AIHA CONNECT 2025

A FIRE INVESTIGATION REQUIRES A SEQUENTIAL AND BLENDED APPROACH



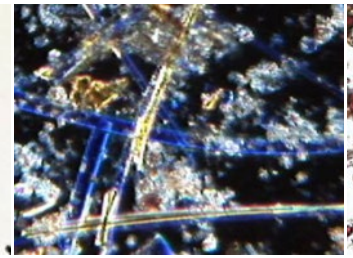
ANALYTICAL MICROSCOPY IS A PRIMARY ENVIRONMENTAL HAZARD ANALYSIS TOOL

Analytical microscopy has been a primary method (for 50+ years) to identify the chemistry, mineralogy, and "hazards" associated with everything from asbestos to mold to fibers to metals.

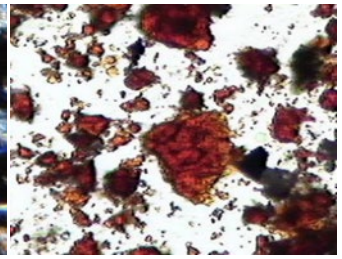


Asbestos

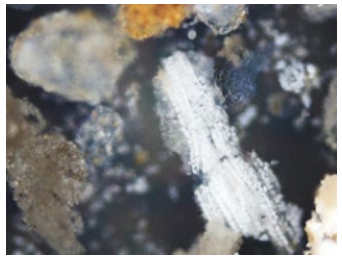
Mold



Fibers



Metals



Wildfire combustion particles

Recent publications and individuals claiming that "microscopical" soot char and ash measurements do not provide useful diagnostic or public health information regarding wildfires are simply <u>WRONG</u> and unaware of 100+ year history going back to the 19th century using microscopy to assess historical fire events (a discipline known as Anthracology).

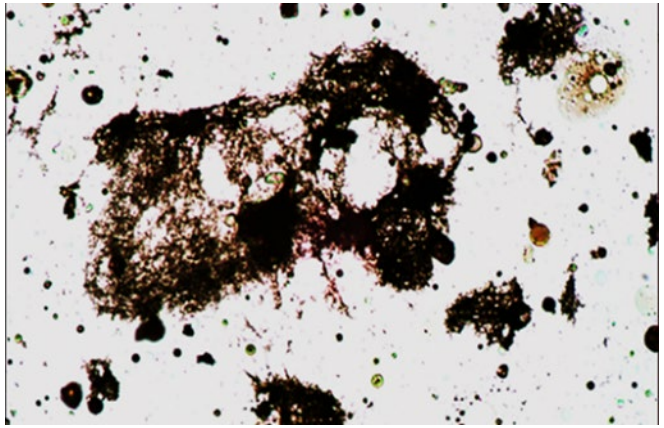
SCA HAS BEEN USED AS A SURROGATE WILDFIRE IMPACT TEST FOR 25+ YEARS
(Combustion particles indicate the fire source and inherent chemistry)

SOOT → → CHAR → → ASH

Partitioned organics >200^{0}F
Source classification *possible
Condensed & desorbing VOC /
SEMI-SOLUBLE SVOCs / PAHs

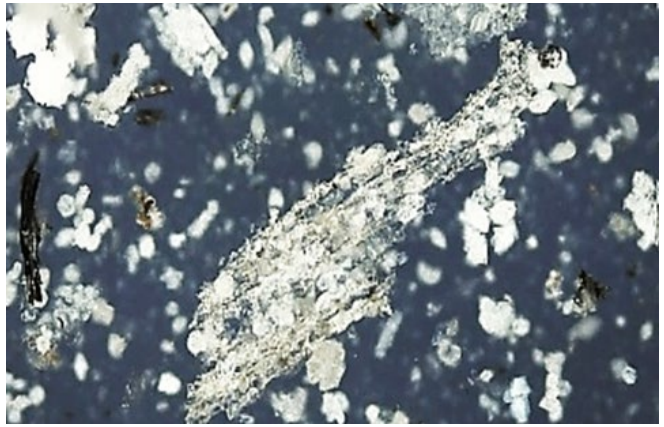
Burned vegetation ~<850^{0}F
Source classification *identified
Desorbing VOCs, SVOC's
Mostly matrix-bound alkali salts

Burned vegetation ~>1,000^{0}F
Source classification *identified
Inorganic compounds, metals, and
SOLUBLE & INSOLUBLE alkali salt
Corrosion cation / anion chemistry



Barbecue grill soot - Tape lift – RLDF ~400x

Mixed leaf / twig char / iron oxide – Tape lift - RLDF~200x



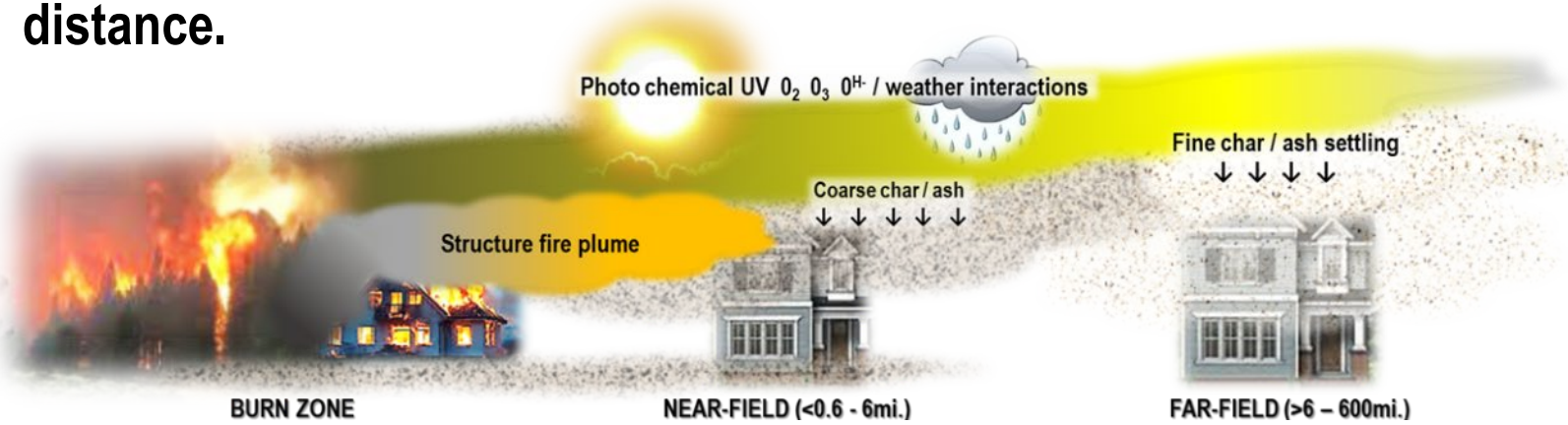
Mixed leaf / twig ash – Tape lift - RLDF~200x

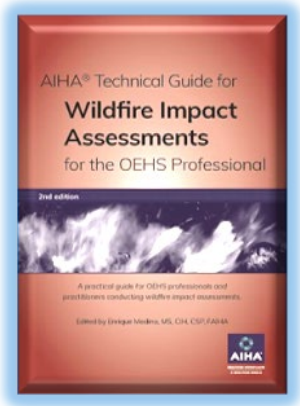
THE RESULT: We can simultaneously determine fire source, infer chemistry, and scope of cleaning.

A SYSTEMATIC APPROACH TO POST WILDFIRE ASSESSMENT, TESTING, AND RESTORATION

(Employing the principles of fate and transport to appropriate inspection / testing methods)

1. <u>The greatest risk to human health is airborne exposure during the fire</u>. Wildfires produce both particulates and airborne chemicals that change, decay, and dilute with time and distance.





2. Fine particles and adsorbed chemicals, <u>when airborne</u>, can be inhaled and provide a direct route for human exposure.

3. All health department advisories should be followed when airborne levels of wildfire residues are of a health concern.

FOLLOWING SLIDES → Effects of time and distance
→ Assessment of impact once the fires are extinguished
→ Provide the basis for appropriate restoration

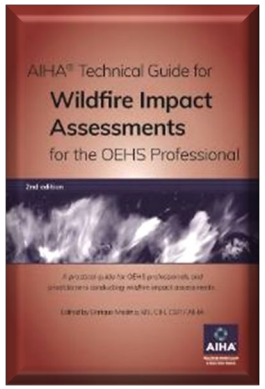
POST FIRE ASSESSMENT - BASIC INDUSTRIAL HYGIENE MODEL - "AREC"

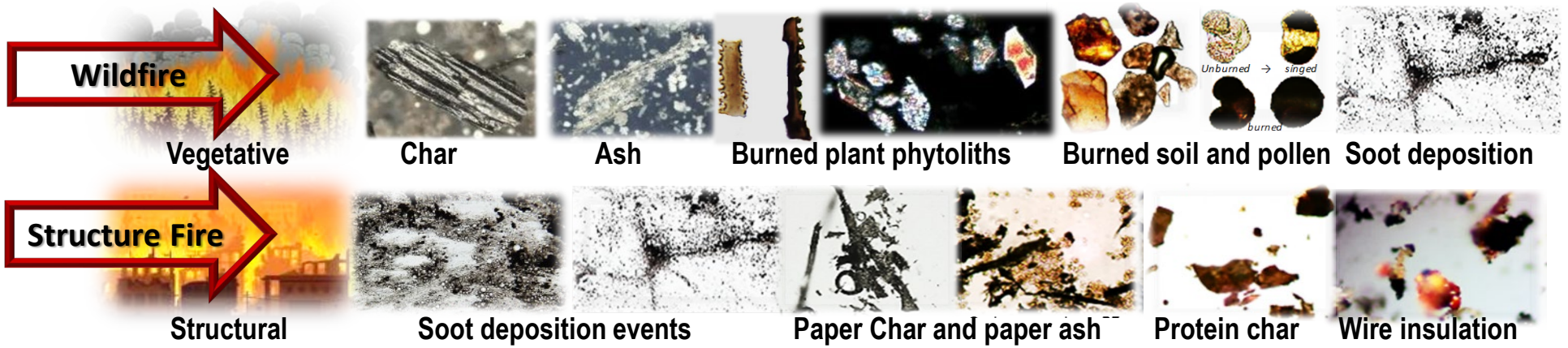
- **Anticipate** **assume soot, char, ash (SCA)** and firestorm debris has adsorbed the organic and inorganic chemistry.
- **Recognize** conditions via a thorough systematic site inspection.
- **Evaluate** by integrating visual inspection with targeted sampling based on time and distance and analytical detection windows.
- **Control** through effective cleaning and restoration.

THE "E" (EVALUATE) IN "AREC" (SAMPLING AND ANALYSIS)

- There are no fixed applicable threshold levels for VOCs, SVOCs, metals etc. and:
- There are always background levels that **require** differentiation.

  What happens with the California "no detectable level" posture for lead / other metals?
- Firestorm "chemistry" infiltrates as particulate soot, char, and ash (SCA).
- Microscopy (BF / RLDF) provides simultaneous quantification and differentiation of fire related particles from the background (Chapters 3,4,5).





This microscopical particle "assemblage" approach has been used for 50+ years in the disciplines of Criminalistics, Industrial Hygiene, Anthracology, Paleontology, Sedimentology, and Archeology.

ASSESSMENT MUST CONSIDER THE LIFE-TIME DECAY OF FIRE-RELATED ORGANIC COMPOUNDS

The gas-phase → particle adsorption → desorption → lifetime decay of organic compounds changes as a function of elapsed time, temperature, and ventilation.

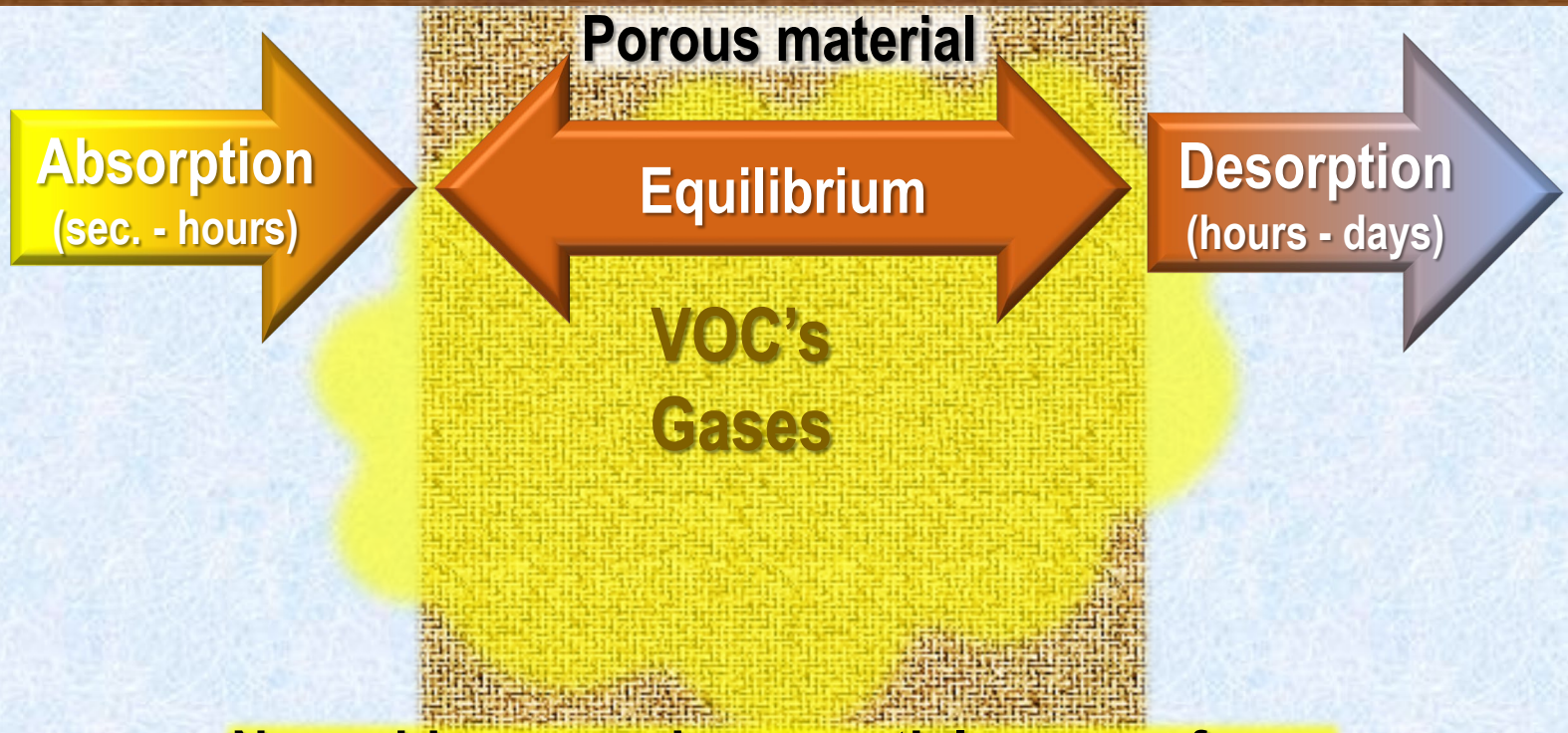
Detecting a significant concentration of an organic compound beyond its' indoor lifetime decay and dilution window confirms it is not associated with the fire event.

GASES / VOCs – INDOOR RESIDENCE TIME DETERMINED BY THERMODYNAMIC PROPERTIES

Requires animation mode for proper viewing

VOC's (M.W. <~200), including HCN, are present as gases at normal atmospheric conditions.

VOC's typically absorb into material void spaces → reach equilibrium → desorb at rates determined by porosity, pressure differential, temperature, concentration, and duration.



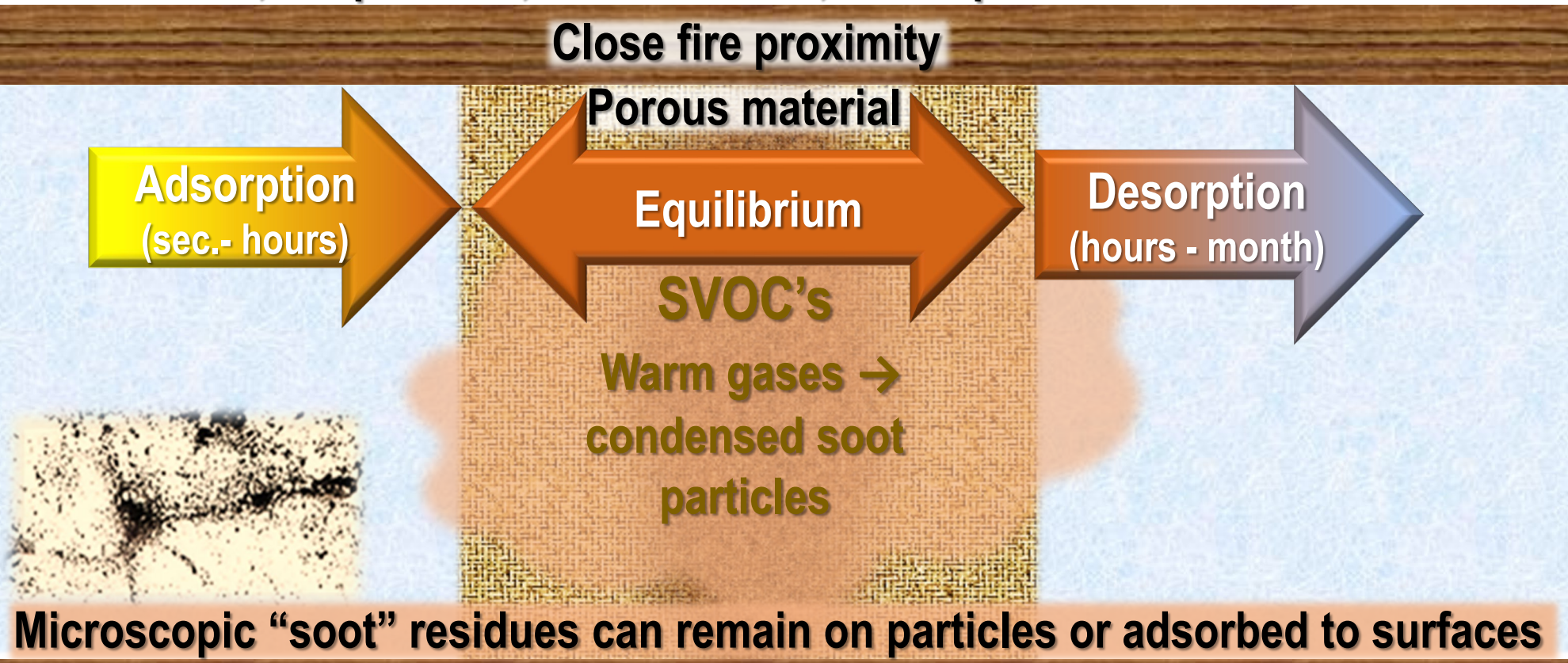
No residues remain on particles or surfaces

SVOCs – INDOOR RESIDENCE TIME DETERMINED BY THERMODYNAMIC PROPERTIES

Requires animation mode for proper viewing

SVOC's (M.W. >200), can be gases or solids / particles based on atmospheric conditions.

Warm SVOC's (burn zone) adsorb or partition to solid phase → infiltrate → settle on surfaces → reach equilibrium → then partially desorb at rates determined by porosity, pressure differential, temperature, concentration, and exposure duration.



THE EVALUATE "E" in "AREC" (SAMPLING AND ANALYSIS)

1. SCA are the most appropriate *surrogate* indicator → simultaneously quantify a fire-related IMPACT → infer potential chemical hazards.

2. IMPACT is NOT an "exposure" measure; however, *potential exposure* may be inferred if an IMPACT can be demonstrated.

3. The SCA IMPACT *surrogate* addresses three confounding issues encountered with using raw chemical analysis data:

    1). The lack of numerical standards for most combustion by-product deposition.

    2). A chemical *number* does not differentiate between the fire event or background.

    3). Microscopy preserves the physical evidence of decreasing compound decay / dilution over time.

THE EVALUATE "E" in "AREC" (SAMPLING AND ANALYSIS)

4. The potential constituents in settled wildfire / structure fire smoke (organics, metals, etc.) can also be conservatively inferred from the SCA "fingerprint".

5. The type and extent of clean-up or necessary restoration can also be inferred.

6. Routinely sampling for every possible "toxin" post fire for a hazard assessment leads us down an unnecessary research project rabbit hole.

7. The "*mere detection*" of contaminants associated with infiltrated SCA does not alter the need or scope of cleanup and often introduces more data confusion than solutions.

EXAMPLES OF "RABBIT HOLE" TESTING NOT RELEVANT TO WILDFIRE INVESIGATIONS

Just as we have basic traffic laws, we need to obey the basic laws of thermodynamics and chemistry.

1. **Hydrogen cyanide (HCN) - is a low molecular weight gas generated during flaming / low O_2 conditions, a concern during a structure fire. HCN does leave infiltrated "solid" residues inside drywall, lumber; or remain "detectable" as a gas from a wildfire more than days to 2 weeks post-fire.**

2. **Chloride (Cl^-) - is not a useful "wildfire" indicator. Wildfires produce alkali hydroxides, primarily K^{OH-} and other Mg and Ca oxides. Synthetic materials in structure fires, produce acidic chlorides from HCL, but require background differentiation from other more common sources.**

3. **Real-time airborne laser particle counters - Useful for simultaneous comparisons of airborne test zones during an episodic event. They cannot differentiate "wildfire" combustion particles from background combustion sources or any other particles.**

4. **Real-time airborne VOC instruments - are limited by the decay and dilution properties over time as previously discussed.**

UNINTENDED CONSEQUENCES OF COLLECTING "RABBIT HOLE" DATA
Inaccurate use of "mere presence data"

CEDARS-SINAI
MEDICAL NETWORK

[redacted]
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LOS ANGELES CA 90048-5901
[redacted]

Medical Necessity for Disposal of Porous Items and Electronics

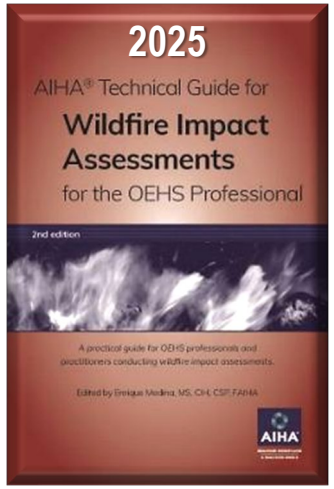
Due to the significant degree of smoke and ash infiltration, all porous items (e.g., clothing, bedding, upholstered furniture, carpets, etc.) and electronics/appliances with internal components that can harbor or emit harmful residues should be disposed of rather than cleaned. These items often retain toxins such as volatile organic compounds (VOCs), polycyclic aromatic hydrocarbons, heavy metals, and particulates.

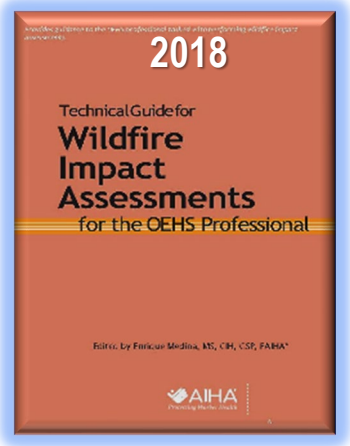
Based on recognized health and safety standards—such as the Institute of Inspection, Cleaning and Restoration Certification (IICRC) guidelines for fire and smoke damage (S700)—I have determined that attempting to clean these porous materials and sensitive electronic devices poses a continued risk to my patient's health. Because of my patient's heightened

Keck Medicine of USC
[redacted]

Medical Necessity for Disposal of Porous Items and Electronics:
Due to the significant degree of smoke and ash infiltration, **all porous items** (e.g., clothing, bedding, upholstered furniture, carpets, etc.) and **electronics/appliances** with internal components that can harbor or emit harmful residues should be disposed of rather than cleaned. These items often retain toxins such as volatile organic compounds (VOCs), polycyclic aromatic hydrocarbons, heavy metals, and particulates.
Based on recognized health and safety standards—such as the Institute of Inspection, Cleaning and Restoration Certification (IICRC)guidelines for fire and smoke damage (S700)—I have determined that attempting to clean these porous materials and sensitive electronic devices poses a **continued risk** to my patient's health. Because of my patient's heightened susceptibility to environmental triggers (particularly given the overlapping conditions of ME/CFS, POTS, Long COVID, and migraine), exposure to even trace contaminants can provoke severe relapses, debilitating headaches, postural instability, and cardiopulmonary distress.

CONSENSUS ASSESSMENT IS ADDRESSED IN THE 2025 AIHA WILDFIRE GUIDELINES





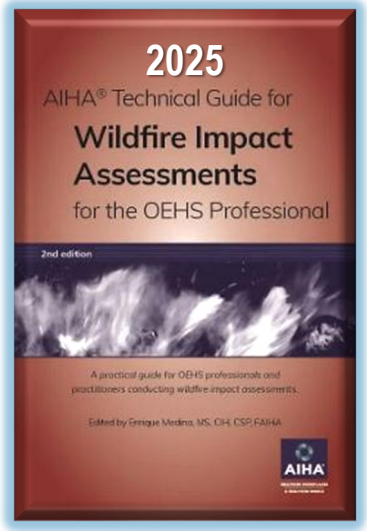
1. **TIME AND DISTANCE** – smoke in the burn zone is not the same as infiltration at some distance and elapsed time (Chapter 1).

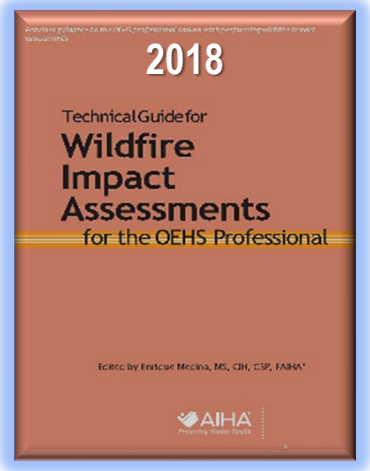
2. **IMPACT** - indicated by detecting a significant difference in wildfire-related Soot, Char, and Ash (SCA) concentrations relative to the background (Chapter 2).

3. **BACKGROUND** - can be conservatively assumed or actually tested depending upon the circumstances (Chapter 5). Chemicals of all types come from outdoor sources (e.g., traffic, industrial pollution, legacy soilborne compounds), and indoor sources (e.g., fabrics, synthetic materials, paint, cooking, fireplaces).

Using "mere detection" is inappropriate risk assessment

CONSENSUS DATA INTERPRETATION IS ADDRESSED IN THE AIHA 2025 WILDFIRE GUIDELINES





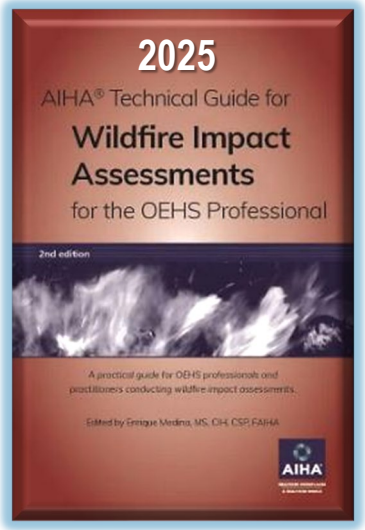
1. **CORRECT DATA EVALUATION PRINCIPLES – compare representative "test zones" with "control zones" or background (Chapter 5).**

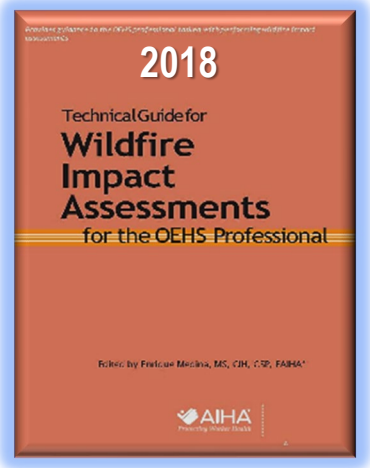
2. **Use probability to infer when a "test zone" is impacted. A single elevated sample in a given zone does not indicate the entire test zone is Impacted, Damaged, or a Hazard.**

3. **A 90% probability of a "difference" in background is an appropriate detection frequency relative to metric, and errs on the side of health and safety.**

4. **There is a 25+ year literature history using difference in detection frequency, and not numerical levels for highly variability data.**

"AREC" AND THE 2025 AIHA TECHNICAL GUIDELINES



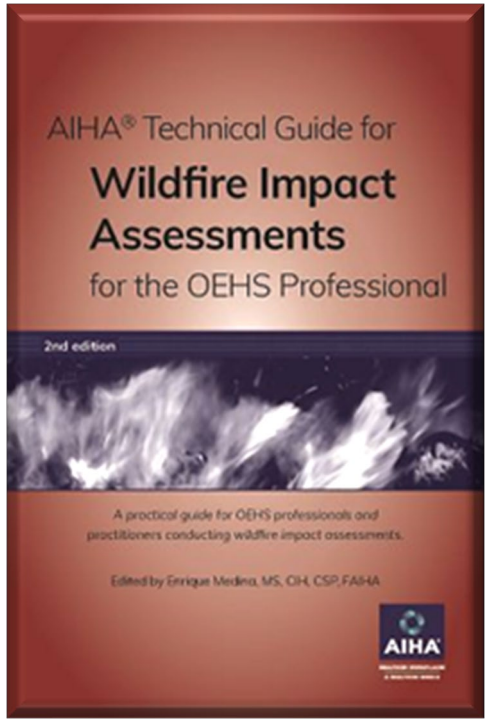


1. **The public health and insurance industry are better served by cleaning up the deposition of smoke-borne contaminants, as indicated through a systematic visual inspection, and well planned SCA sampling and analysis, regardless of the presence of various potential toxins. Some structures in the burn zone may require additional testing and more in-depth restoration procedures.**

2. **While perhaps counterintuitive to some investigators, routine testing for VOCs, SVOCs, metals, etc. is like verifying the sky is blue, *since these residues are already assumed to be in infiltrated and in the settled fire residues (SCA).***

3. **This allows the focus to be on a systematic cost-effective way to determine what needs to be cleaned, without expending time and resources directed at potential environmental toxins for which there are few applicable health-based standards; and are significantly altered and diluted over time and distance.**

A STANDARDIZED ROAD MAP IS ALREADY IN THE 2025 WILDFIRE GUIDE



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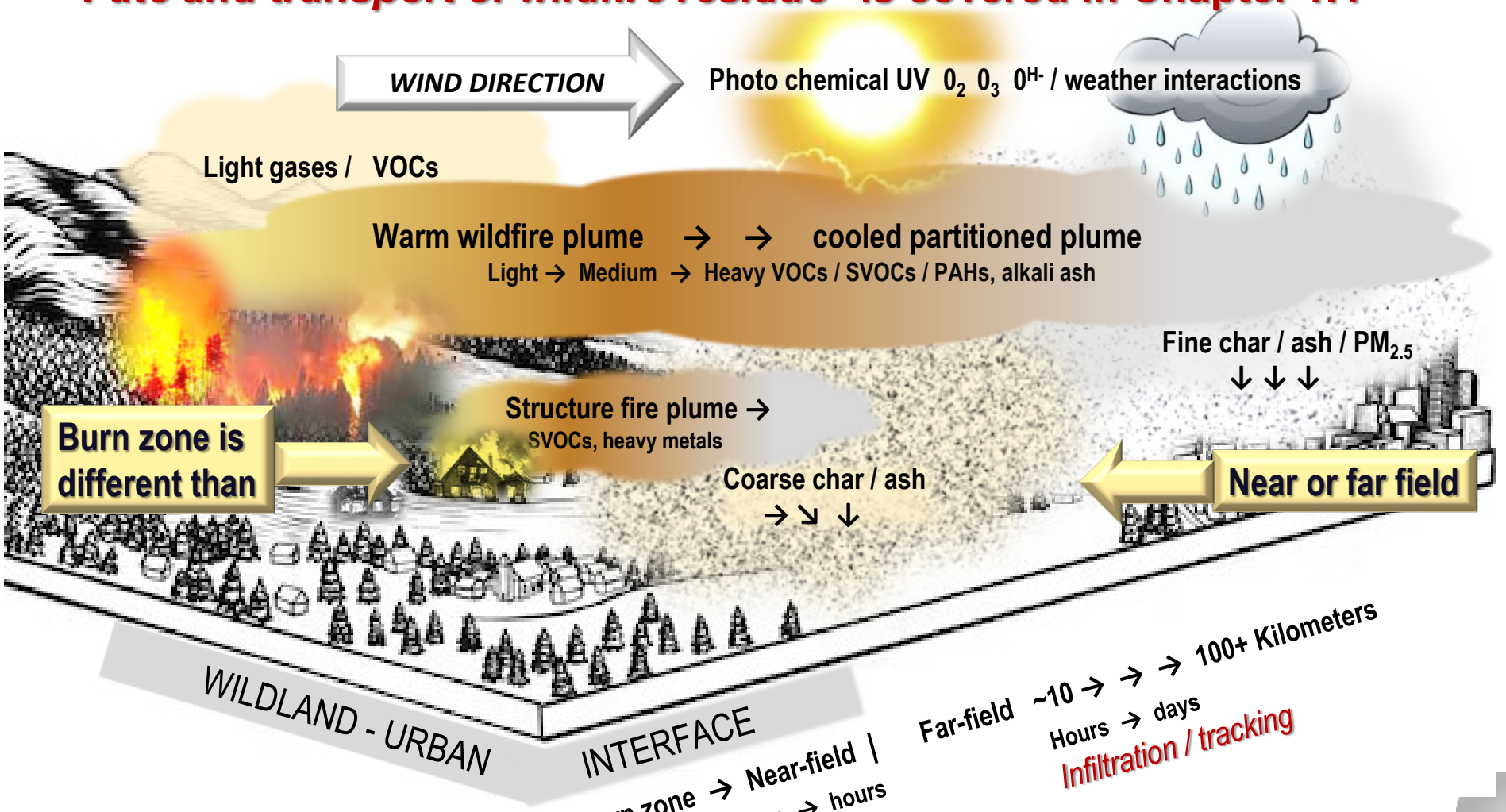
TIME, DISTANCE, AND CHEMISTRY DETERMINES USEFUL TESTING METHODS

FIGURE 1.1 - AIHA 2025 WILDFIRE TECHNICAL GUIDE

"*Fate and transport of wildfire residue*" is covered in Chapter 1.4



A FIRE INVESTIGATION A FORENSIC INVESTIGATION

Contextual evidence is altered by decay, dilution, and manipulation over time!

Fire plume impact
Hours → Days

Distance →time → pathway → decay→ dilution → **background**

Initial disturbance
Hours → weeks

Firefighting activity → post-fire cleanup → re-entrainment

Activity disturbance
Days → months

Inspections → building owner activity → partial cleaning

Manipulation
Weeks → months

Alteration → addition → removal of evidence

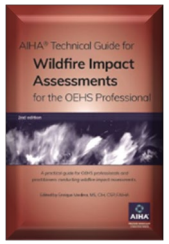
Forensic spatial evidence preservation and hazard assessment both require consideration.

AIHA CONNECT 2025

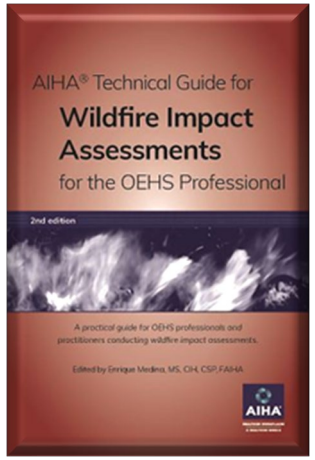
THE END GOAL - STANDARDIZE THE EXPECTED INSPECTION / TESTING / RESTORATION APPROACHES
(The current lack of "standards" at this point in time have confounded the industry)

1. **Define the necessary goals -** forensic impact, hazard assessment, remediation.
2. **Use science-based actions** - based on the behavior of smoke plume gases, particles.
3. **Classify inspection scope** - based on burn zone v. near / far field conditions.
4. **Factor elapsed time and location** - to define appropriate testing methods.
5. **Define appropriate data analysis** - based on comparative zone sampling and background.
6. **Define report expectations and requirements** - to address all concerns
7. **Determine potential cleaning / restoration requirements**
8. **Bad investigations, misguided testing/interpretation, leads to confounding legal rulings!**

*Note: There is a difference between potential impact relative to the burn zone. Wildfires are different than structure fires. There will always be exceptions to what testing is necessary.



THANK YOU – QUESTIONS?



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