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Evaluating exposures to hazardous materials during wildfire debris removal

Presented by:
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Presented for:

UCLA UCI
Southern California NIOSH
Education and Research Center

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Hazardous Materials in ash and debris

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Hazardous Materials in ash and debris may include:

- Asbestos from building materials (floor tile, mastic, roofing, siding, plaster, fireplace insulation, sheetrock, joint compound, etc.)

- Metals from vehicle, batteries, electronics and personal items
- Automotive chemicals
- Combustion byproducts - polycyclic aromatic hydrocarbons (PAHs), chlorinated polycyclic aromatic hydrocarbons

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Environmental Impact

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Hazardous materials in wildfire ash and debris are an environmental threat:

- Level of metals in ash and debris may exceed environmental screening levels and may exhibit CA (non-RCRA) or federal (RCRA) hazardous waste characteristics
  - Burn debris from the 2003 Old Fire (San Bernardino) and 2007 Witch Fire (San Diego) showed presence of metals such as Sb, As, Cd, Cu, Pb and Zi.
- Uncontrolled ash and debris can contaminate drinking water supplies.
  - As and Mn exceeded MCLs in Sutherland Lake following the 2003 Cedar Fire (San Diego) with measured increases in metals in other reservoirs.
- Removal of fire ash and debris to reduce or eliminate contamination is in the public interest
  - Minimal impact to San Diego County drinking water supplies due to coordinated debris removal program following 2007 wildfires.

Human Health Impact

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Hazardous materials in ash and debris may also represent a health risk to workers conducting debris removal activities:

- Routes of exposure include inhalation as well as inadvertent ingestion (hand to mouth)
- Cal/OSHA monitoring in burned residential areas (Cedar, Paradise Fires) showed As and Cu exposures potentially exceeded CA OEHHA "acute reference exposure levels" and Cal/OSHA As and Pb "action levels"
  - Extrapolated from total dust measurements, using concentrations of metals identified in other studies.
- NIOSH showed skid steer operator exposures to silica (RCS) approached or exceeded applicable OELs for 2 of 45 workers during debris removal following 2018 Carr Fire (Shasta/Trinity Counties).
  - Skid steer, excavator operator and laborer exposures to asbestos (21 samples), metals and PAHs (20 samples) were below applicable OELs
  - NIOSH "Evaluation of Fire Debris Cleanup Employees' Exposure to Silica, Asbestos, Metals, and Polyaromatic Hydrocarbons" (Report 2018-0094-3355, August 2019)

- Dust from uncontained ash and debris can create elevated concentrations of ambient particulate matter, representing possible exposure for the public

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A (Short) History of CA Wildfire Debris Removal

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- Until the early 2000's, asbestos was the primary hazardous materials concern - was ash "asbestos containing material" (ACM) under the National Emissions Standards for Hazardous Air Pollutants (NESHAP)
- Inconsistent management of emergency debris removal actions throughout CA and increasing awareness of other hazards led to the development of guidance for state and local agencies.

A (Short) History of CA Wildfire Debris Removal

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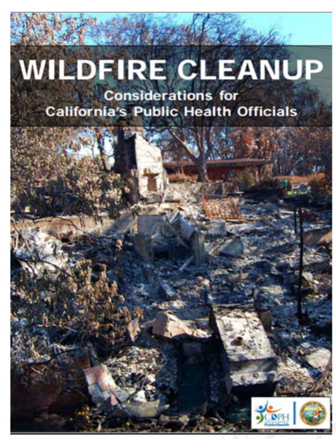
Protocols have been developed to ensure coordinated response to assess, contain, identify and remove hazardous materials, waste and debris that pose threats to public health and the environment

Guidance for Conducting Emergency Debris, Waste and Hazardous Material Removal Actions Pursuant to a State or Local Emergency Proclamation

October 7, 2011, Version 1.4.3

2011 Cal/EPA "Best Management Practices" (BMPs) for the removal of debris and hazardous materials (including asbestos) from residential and commercial structures after a natural disaster or large-scale incident.



2019 Cal/EPA Wildfire Clean-up Considerations for California's Public Health Officials

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Characterizing Debris and Ash Contaminants

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- 2007, 2015 studies conducted by Cal/EPA (DTSC)
- 2015 Study:
  - Composite samples from destroyed residential structures in Butte (n=43) and Lake fires (n=40). September and October 2015 Butte and Valley Wildfires located primarily in Calaveras and Lake Counties, California
  - Randomly selected parcels, composite samples from random locations within footprint, based on estimated volume of waste, following removal of recognizable household hazardous waste (HHW).
- Samples homogenized and submitted for analysis for metals (CAM17) by EPA Method 6010B/7471A (CA TTLC).
  - Field QC, Standard sample handling, chain-of-custody procedures followed,
  - Spiked lab QC samples used to evaluate accuracy, precision and other data quality objectives.

ASSESSMENT OF BURN DEBRIS - 2015 WILDFIRES
LAKE AND CALAVERAS COUNTIES, CALIFORNIA

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Geosyntec consultants

7 December 2015

Results

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Six metals (Arsenic, Cadmium, Copper, Lead, Nickel, Zinc) detected at levels exceeding one or more environmental or health hazard screening levels (SLs):

	Arsenic	Cadmium	Copper	Lead	Nickel	Zinc
Maximum (mg/kg)	910	390	280,000	63,000	370	140,000
Detect Median (mg/kg)	26	38	910	230	34	2700
Mean (mg/kg)	60.64	11.34	7,505	1,478	49.84	6,749
Geo. Mean (mg/kg)	16.03	6.68	1,096	148	32.96	2,057
95%ile UCL (mg/kg)	71.58	27.04	38,565	11,729	48.98	6,453
Background (mg/kg)	11	1.7	9.64	97.1	509	236
DTSC SL (Res. Soil) (mg/kg)	0.11	4.5	3,100	80	0.42	23,000
EPA RSL-GW (mg/kg)	0.0015	0.38	28	14	26	370

Notes:
- 95%ile for all samples, LOD/√2 substitution used for censored data (results < LOD)
- DTSC-SL - DTSC-modified Screening Levels per OEHHA Human Health Risk Assessment (HHRA) Note 3, May 2022
- EPA RSL-GW – EPA Regional Screening Level (RSL), Resident to Groundwater
- Results are not normally, log-normally or gamma distributed

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Environmental Screening Levels

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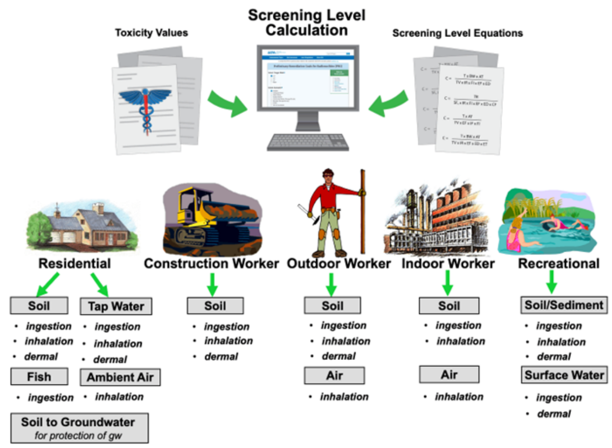
- Conservative concentrations of chemicals in soil, groundwater and air below which potential impacts to human health and the environment are not expected,
  - Screening levels for residential/commercial exposures to soil, air, and drinking water
  - Used to determine if further investigation or remediation is needed – not regulatory cleanup standards
- General human health risk assessment (HHRA) methodology from EPA "Risk Assessment Guidance for Superfund" (RAGS), Pub. # 9285.7-01B, 12/91, as revised
  - EPA "regional screening levels" (RSLs) incorporate cancer/non-cancer toxicity values, default exposure assumptions, physical and chemical properties.
- Other agencies/entities may derive their own SLs, based on different priorities or emphasis
  - CA DTSC-SLs incorporate different toxicity criteria



What do soil levels tell us about potential inhalation hazards?

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Can soil concentrations be used to assess potential inhalation hazards for workers or the public?

- Worker inhalation exposures are evaluated with respect to occupational exposure limits (OELs)
- OELs represent a level of exposure that will not lead to significant adverse health effects over a working lifetime
  - Control measures should be used to keep worker exposures as low as practical/feasible for all routes of exposure
  - Requiring "no detectable exposure" is not realistic (key concept)
- Typically based on 8-hour time-weighted average (TWA) exposures
  - Expressed in mg of contaminant per cubic meter of air (mg/m^3) for particulates
- OELs include:
  - OSHA (and Cal/OSHA) Permissible Exposure Limits (PELs) – legal limits
  - ACGIH Threshold Limit Value (TLV) – professional standard
- Based on exposure assessment assumptions for workers:
  - Healthy enough to be at work, basic knowledge to implement protective measures, acceptance of nuisance odors, minor discomfort irritation
  - OELs are not applicable to general public

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Dust Action Levels

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- Metals and asbestos cannot be measured using real-time instruments, however there are instruments to measure ambient dust levels
  - Ambient dust can then be used as a surrogate for specific contaminants.
- Calculate "Dust Action Levels" based on concentration of a soil contaminant and the applicable OEL
  - Applicable OEL (mg/m^3) / Contaminant Concentration (mg/kg) = Dust Action Level (mg/m^3)
- Dust Action Level is the highest total dust level that a worker can be exposed to without exceeding the applicable OEL for that contaminant
  - Based on real-time measurement of dust level, soil concentration and OEL

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Dust Action Level - Arsenic

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- Arsenic – 71.58 mg/kg - from 2015 Cal/EPA Study
  - 95% UTL of 95%UCL
  - 71.58 mg arsenic per 1,000,000 mg of ash/debris
  - Concentration of arsenic in suspended dust (no soil) is 0.00007158 mg/mg or 0.007158% by weight
- If we know airborne dust (in mg/m^3), we can estimate maximum arsenic level
  - Airborne Dust * Concentration of Contaminant in ash = Airborne Contaminant Concentration

  1 mg/m^3 (total particulate) * 0.00007158 mg As/mg ash = 0.00007158 mg/m^3 Arsenic
- Can also calculate level of airborne dust required to reach OEL
  - OEL (mg/m^3) / Concentration of Contaminant in ash (mg/mg) = Dust Action Level

  0.01 mg/m^3 (As OEL) / 0.00007158 mg As/mg ash = 139 mg/m^3
- Based on this soil concentration, airborne dust needs to reach 139mg/m^3 (as 8-hr TWA) for worker exposures to exceed the OEL
  - This will never happen!

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Dust Action levels (Occupational Exposure)

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	As	Cd	Cu	Pb	Ni	Zn
Overall 95%ile UCL (mg/kg)	71.58	27.04	38,565	11,729	48.98	6453
OEL (mg/m^3)	0.01	0.005	0.1	0.05	0.5	5
Dust Action Level (mg/m^3)	**139.70**	**184.91**	**2.59**	**4.26**	**10208.25**	**774.83**

- Conclusion:
  - An unrealistic level of exposure would be required for worker inhalation to exceed OELs
  - (But we will still continue to use common-sense precautions)
- Conservative model
  - Based on lowest OEL (Cal/OSHA PEL), 95%ile soil concentration estimate, ignores particle size
- Consistent with Cal/OSHA and NIOSH results
  - Cal/OSHA study used OEHHA "acute reference levels", using different exposure assessment assumptions
  - Ash/debris are not the source of silica (for NIOSH study)

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What about non-worker exposures?

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- Worker assessment was easy – Use conservative, possibly unrealistic assumptions about concentration, compare to applicable OELs and move on
  - Doesn't mean we don't take precautions and use engineering, administrative controls and PPE (including respiratory protection) but provides some perspective
- Similar assessment for non-worker inhalation exposures is complicated
  - Simplistic approach would be to use residential air quality screening limits and upper limit soil concentrations
- Is this realistic though?

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Applicable General Public Exposure Limits

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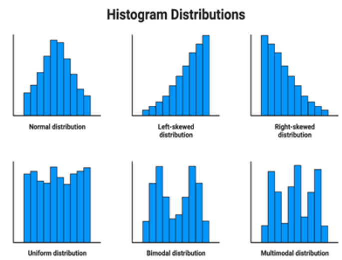
- Public (resident) air quality standards (e.g., DTSC SLs, EPA RSLs) based on assumptions that may not apply (duration, route, etc.)
  - Incorporate standard risk-assessment assumptions and toxicological parameters - 26 years, 350 days/year, 24 hours/day
  - Not applicable to wildfire debris
- Soil concentration sample results may not be representative
  - Heavily censored data for some analytes
  - Non-parametric distribution (not normal, log-normal, gamma)
  - Cannot reliably calculate descriptive or compliance statistics
  - Median is the best measure of central tendency for non-parametric distributions



- Conservative assumptions regarding concentration in ash/debris may be appropriate for evaluating long-term environmental risks
  - Worker (and public) exposures (and potential health risks) from ash/debris exposure during debris clean-up are short-term

Public "Dust Action Levels"

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Based on "site-specific" RSLs (6-month exposure) and median soil concentration

	As	Cd	Cu	Pb	Ni	Zn
0.5 yr RSL Resident (µg/m³)	0.0304	0.0203	NA	0.15	0.0284	NA
0.5 Yr RSL Dust Action Level (mg/m³):						
Based on 95th %ile soil level	0.425	0.751	NA	0.013	0.580	NA
Based on median soil level (detected)	**1.169**	**0.534**	NA	**0.652**	**0.835**	NA

Notes:

- As, Cd, Ni RSLs from RSL Calculator - https://epa-prgs.ornl.gov/cgi-bin/chemicals/csl_search/
  - Hazard quotient =1, Target risk = 10e-6, resident, air, site-specific, sub-chronic, Edres=0.5, Efres=180, Etres=24
- EPA NAAQS for lead
- Soil concentrations based on Geosyntec/DTSC 2015 study, overall 95%ile/median values

Conclusion –

Simplistic modeling still shows an unrealistically high level of airborne dust is required for potential exposures to exceed applicable resident screening levels for these metals.

- Overall dust levels are not likely to be this high even for short periods. Based on this, inhalation exposures for residents and others in the area are not likely to exceed applicable SLs.
- Based on a lot of assumptions!

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What About Real-Life?

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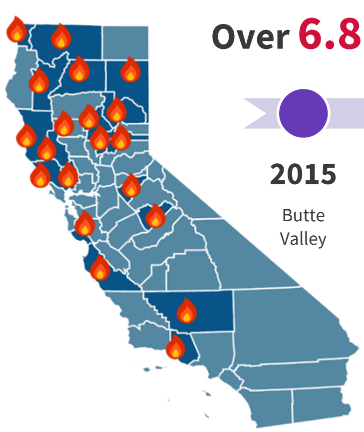
Our team helps communities recover from disasters…



Over 6.8 million tons of wildfire debris removed

2015	2016	2017	2018	2020	2021
Butte Valley	Soberanes Erskine Clayton	Thomas NorCal Detwiler Helena	Woolsey-Hill Camp Fire Mendocino Complex Fire Carr Fire	North Branch Wildfire Programs CZU Lightning Complex Fire	Dixie Fire Caldor Fire 2021 Wildfire Program

Plus additional wildfire response experience in Texas, Colorado, and New Mexico

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Debris Removal Overview

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2-Phases for wildfire debris removal (for destroyed structures only):

- Phase 1 – Remove visible household hazardous waste (HHW)
  - "Emergency" activity (no ROE required).
  - Conducted by local environmental agencies – EPA or Cal/EPA (DTSC).
- Phase 2 **-** Remove remaining ash and debris.
  - Managed by federal, state or local entity (USACE for LA fires)
  - "Opt in" program - Homeowners submit Right of Entry (ROE) to authorize work
  - No direct cost to HO (any insurance for debris removal is assigned to the government).
  - Homeowners who opt-out must hire a licensed contractors and obtain necessary permits from the local authority.
- Tetra Tech helps implement Phase 2 debris removal activities
- This is a general summary only!
  - Go to https://recovery.lacounty.gov/ for specific information related to LA fires

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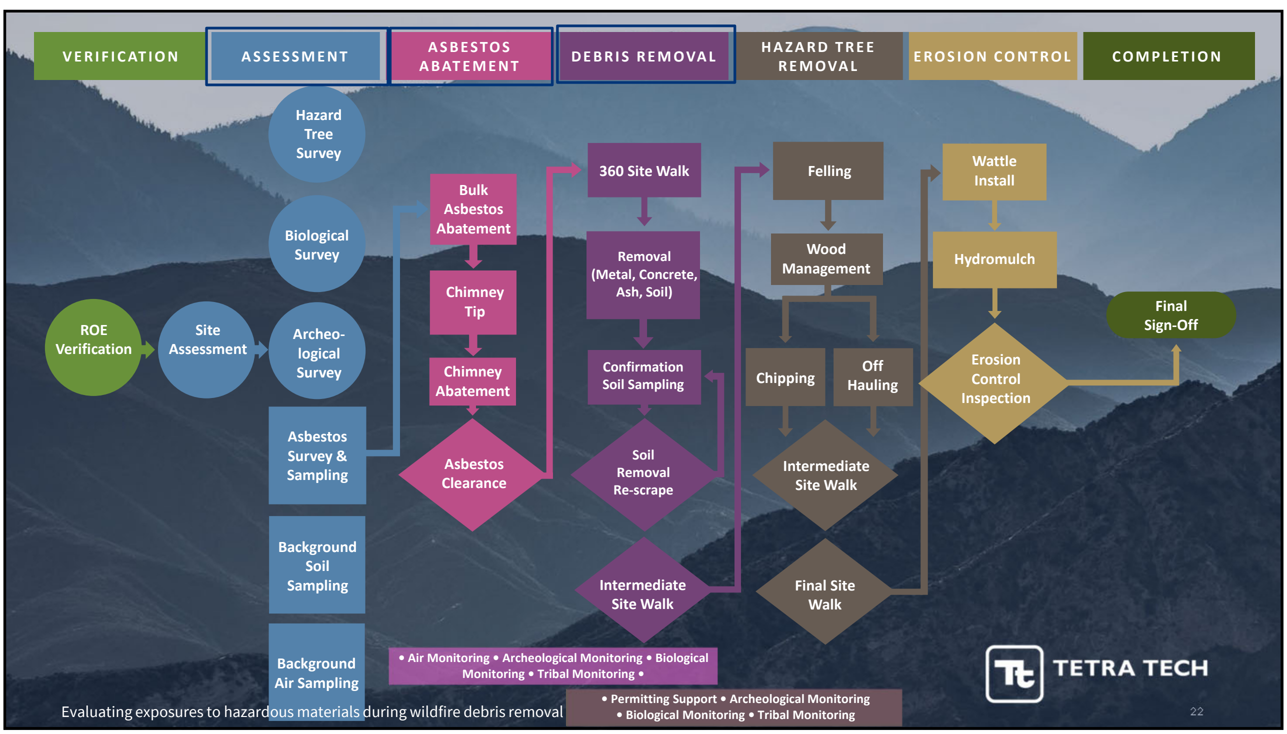

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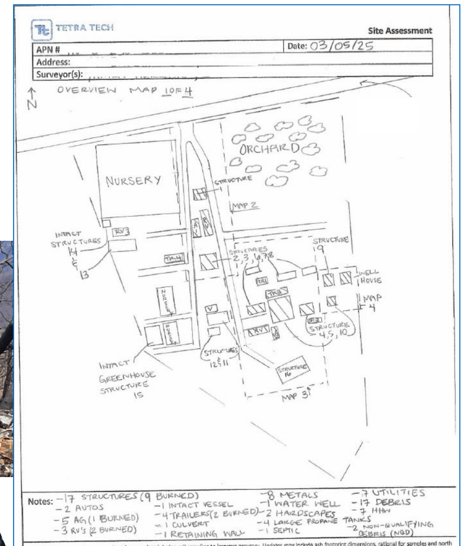
Site Assessment

- Identify physical hazards:
  - Standing walls, chimneys
  - Hazard trees
  - Archeological/biological resources
- Hazardous materials assessment
  - Radiation, mercury screening
  - Asbestos assessment
- Document site conditions
  - Record vehicles, septic location
  - Map debris footprint
  - Identify site access issues
- Generally no entry into ash footprint
  - (except for asbestos assessment)



Asbestos Abatement

- Abatement is conducted on properties where assessment found asbestos.
  - Work conducted in the ash footprint
- Hand tools are used move ash/debris, find, package and remove asbestos-containing materials (ACM).
  - Engineering controls and work practices are used to minimize dust generation.
  - Abatement workers use appropriate PPE
- Abatement monitors track activities from outside the abatement area

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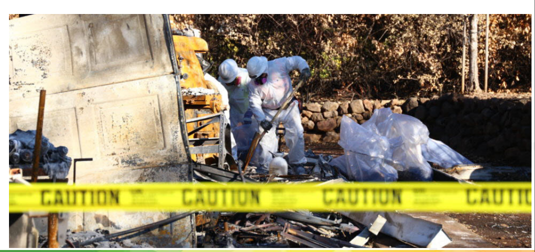

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Debris Removal

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- Contractors working in ash footprint, operating excavators, loaders and similar equipment to remove debris and damaged/contaminated concrete
  - Metal, Ash, Soil, Concrete
- Debris monitors and others work outside the footprint
- Confirmation soil sampling in potentially contaminated areas

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Personal Exposures to Metals/Asbestos During Debris Removal

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- Personal air sampling is conducted for Tetra Tech personnel during debris removal projects
  - Measure inhalation exposures to metals (CAM17), asbestos, other hazardous materials
- Community and perimeter air monitoring at debris removal sites may also be provided
- Personal breathing zone (PBZ) samples collected according to established procedures.
  - Sampling pumps draws a known volume of air through specialized filters during work activities.
  - Amount of contaminant on filter determines airborne concentration over sample period.
- Results are considered representative for workers performing similar tasks - "similar exposure groups" (SEGs)

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Limit of Detection

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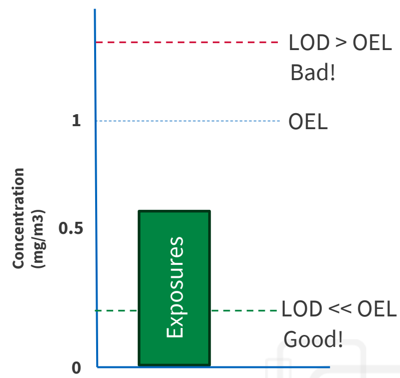
- All sampling and measurement methods have a "limit of detection" (LOD)
  - We can never say there was "no" contaminant, just that concentration was less than LOD (<LOD)
- For air samples, LOD is based on sample time (and air volume) as well as the sensitivity of the laboratory procedure.
- To be useful the LOD of an air sample must be less than the exposure limit we are using:
  - If we are collecting air samples to evaluate worker exposures, the LOD needs to be lower than the OEL
  - Similarly, if we are collecting air samples to evaluate resident exposures, the LOD needs to be lower than applicable resident screening levels



Metals Results

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Personal air sample results for metals – Park, Borel, Mountain fires (2024 -2025):

	Arsenic	Cadmium	Copper	Lead	Nickel	Zinc
Maximum (µg/m³)	2.758	0.552	2.758	1.414	2.758	3.890
Minimum (µg/m³)	0.375	0.078	0.375	0.1909	0.375	0.375
GM (µg/m³)	0.591	0.118	0.595	0.296	0.591	0.61
GSD	1.520	1.520	1.540	1.520	1.52	1.66
95%ile UTL (µg/m³)	1.440	0.287	1.480	0.723	1.44	1.78
Cal/OSHA PEL (µg/m³)	**10**	**5**	**100**	**50**	**100**	**5000**

- 41 personal samples from site assessment (n=13), asbestos abatement monitors (n=9), debris removal monitors (n=16) & soil sampling (n=3)
  - All metals results were <LOD (100% censored data)
- Statistical evaluation is not reliable (based on entirely on substituted values - LOD/√2)
  - Results are consistent with model – exposures for workers outside the footprint during ash-disturbing activities are not likely to exceed applicable OELs.
- Sample LOD is much lower than OELs, appropriate for worker exposures, different methods would be required for an LOD lower than resident SLs.
- Even though sample results are not sensitive enough to confirm, these results also support the conclusions that resident exposures outside footprint are not likely to exceed applicable SLs

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Asbestos Results

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Personal air sample results for asbestos (PCM)– Park, Borel, Mountain fires:

	O/A	Site Assess	Abatement	Monitor	Soil Sample
n	40	17	12	8	3
<LOD	19	8	4	4	3
% Censored	48%	47%	33%	50%	100%
Maximum	0.0498	0.0105	0.0053	0.0498	0.0016
Minimum	0.00106	0.00106	0.00113	0.00120	0.00120
GM	0.0027	0.0025	0.0029	0.0043	0.0013
GSD	2.01	2.036	1.967	3.957	1.191
95%ile	0.009	0.0082	0.0087	0.0411	0.0018
95%ile UTL	0.013	0.0149	0.0182	0.343	0.0051

- 40 personal samples for site assessment (n=17), asbestos abatement monitors (n=12), debris removal monitors (n=8) & soil sampling (n=3)
- Cannot use asbestos assessment results to calculate DAL, but all results are low with respect to the Cal/OSHA (and OSHA) PEL of 0.1 f/cc
  - 48% of results < LOD, Log-normally distributed, 95%ile below OEL for all SEGs
  - Relatively high variability for Debris Monitors

Conclusions

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- Inhalation exposures to hazardous materials in wildfire ash and debris during work activities near the ash footprint are low, and are not likely to exceed applicable OELs, even when ash-disturbing activities are being conducted.
  - These conclusions apply to these specific tasks – Exposures for debris removal workers inside the ash footprint (skid steer, excavator operator, laborer, etc.) may be different.
- These results can also be used as a "worst case" estimate of potential exposures for members of the community living or working near ash and debris.
  - Based on these results, inhalation exposures to hazardous materials in wildfire ash and debris for members of the community are not likely to exceed applicable screening levels.
- These results indicate that inhalation exposures to hazardous materials near debris removal projects are low, and can be effectively controlled using engineering controls, administrative controls and PPE
  - Workers as well as community members still need to minimize contact with ash and debris, use gloves and other PPE, wash their hands and face following contact and follow other basic chemical safety precautions minimize exposures via inadvertent ingestion.
- This assessment is based on available data on hazardous materials in ash and debris and on air sample data collected to evaluate worker inhalation exposures.
  - Additional assessment of hazardous materials in ash and debris as well as additional sampling near debris removal projects could provide additional information to help refine these conclusions.

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Questions?

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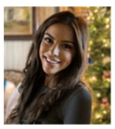

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