3.6 Wildfire and Wildfire Smoke

In the 2017 version of this plan, it was noted that Multnomah County had escaped from having the types of large fires that had become commonplace across Oregon during summer fire seasons. The plan further explained that changing climate conditions, large amounts of vegetative wildfire fuel and continued development in rural and urban edge areas of the county, had created conditions conducive to a large fire event.

Even as that plan was being reviewed and adopted around September 2017, just such an event occurred in eastern Multnomah County. The Eagle Creek Fire set a new modern standard for wildfire impact to Multnomah County, and may be a precursor for similar or even larger events in the future.

The public health impacts of wildfire smoke were noted as a hazard needing more consideration in the Wildfire chapter of the 2017 plan. This too predicted a catastrophic event in 2020, as smoke from regional fires caused local air quality to reach unprecedented levels of health hazard across the county. This update to the NHMP has elevated Wildfire Smoke as a hazard. While it is still combined into a chapter with wildfire, it now has an expanded description and more detailed connection to local mitigation strategies.

Wildfire and wildfire smoke are significant to all participating entities in this plan, but wildfire smoke has a more universal impact. Like the climate hazards described in the chapter for Severe Weather, the impacts of wildfire smoke have been felt across the entire county, and are especially harmful to those already most at risk from disparate impacts in disasters, such as those unable to access clean air spaces and those with existing health conditions. Wildfire smoke is also a hazard that does not require being originated in the county, meaning the probability of annual health impact due to smoke is vastly increased because of threat from fires from other parts of Oregon, across the Western United States and even Western Canada.

The largest risk of wildfire is to unincorporated Multnomah County, because of large forested or vegetated areas in the eastern and western reaches of the county. However, the possibility exists for large fires to impact communities in Wildland Urban Interface (WUI) areas at or within city boundaries, and for wildfires to happen on a smaller, but still dangerous, scale in urban locations when conditions are severe.

Climate change is a major driver of wildfire risk, and therefore of wildfire smoke risk as well. Oregon has continued to see a consistent elevation in the number of fires and acres burned over the last 20 years. A continuation of the warming climate will further reduce snowpack and dry out vegetation over longer, hotter summers, making fire and smoke a hazard that is expected to only grow in risk over coming years.

Five-Year Report, 2017-2022

- *Eagle Creek Fire 2017*

The Eagle Creek fire began on September 2, 2017 when a recreational park user threw fireworks into a steep canyon from the Eagle Creek Trail in the Mount Hood National Forest, right on the county line between Multnomah County and Hood River County.

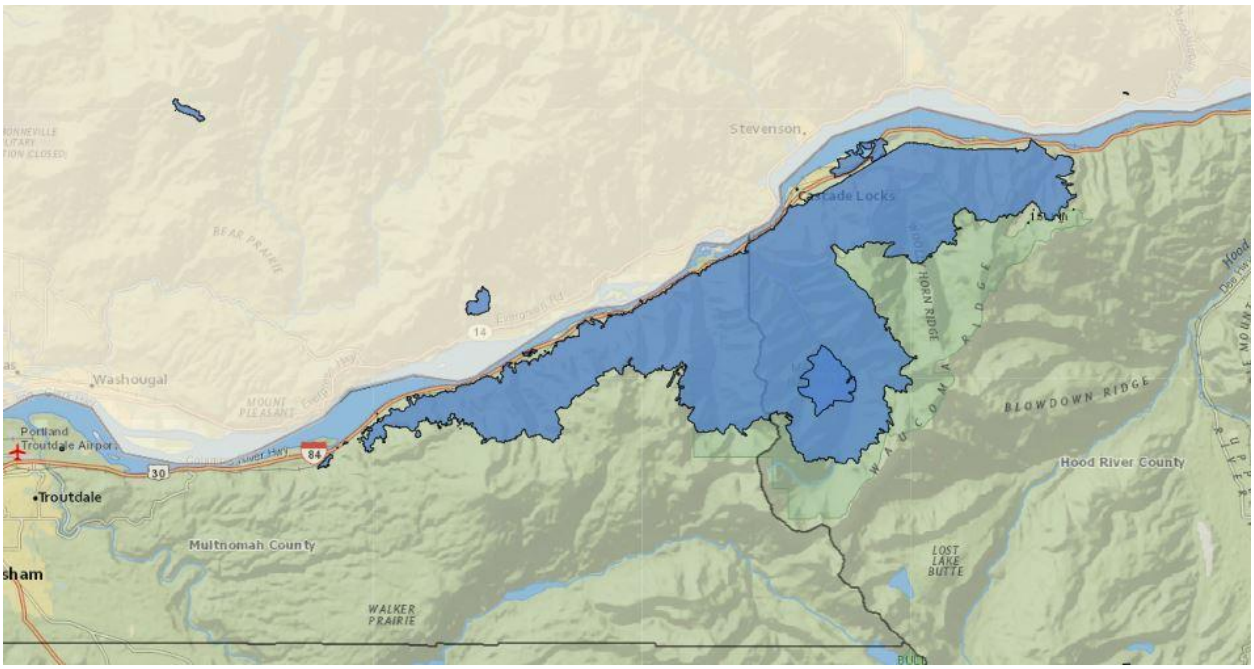

Figure 94 - Map showing full extent of the 2017 Eagle Creek Fire in Multnomah and Hood River Counties.

By the time the fire was contained on November 30, it had burned nearly 49,000 acres in the two counties, as well as a few spot fires that started across the Columbia River in Washington. Impacts to life and property were limited thanks to favorably shifting weather conditions and highly coordinated firefighting response. No one was killed and there were only four minor injuries and four burned structures. One-hundred seventy six hikers had to be rescued after being trapped by the fire. The Eagle Creek Fire was named a federally declared disaster, FM-5203.

The fire burned in primarily hemlock and fir forests, almost entirely on federal lands[80]. Although less than half of the area in the fire perimeter burned with moderate (30%) or high (15%) intensity, this was enough to cause severe and long-lasting impacts to the area. The fire did not reach incorporated areas or cause significant damage to unincorporated communities in the Columbia River Gorge. The blaze did require broad evacuations, including evacuation warning alert levels as far as the City of Troutdale.

[80] Eagle Creek Fire Story & Data, US Forest Service

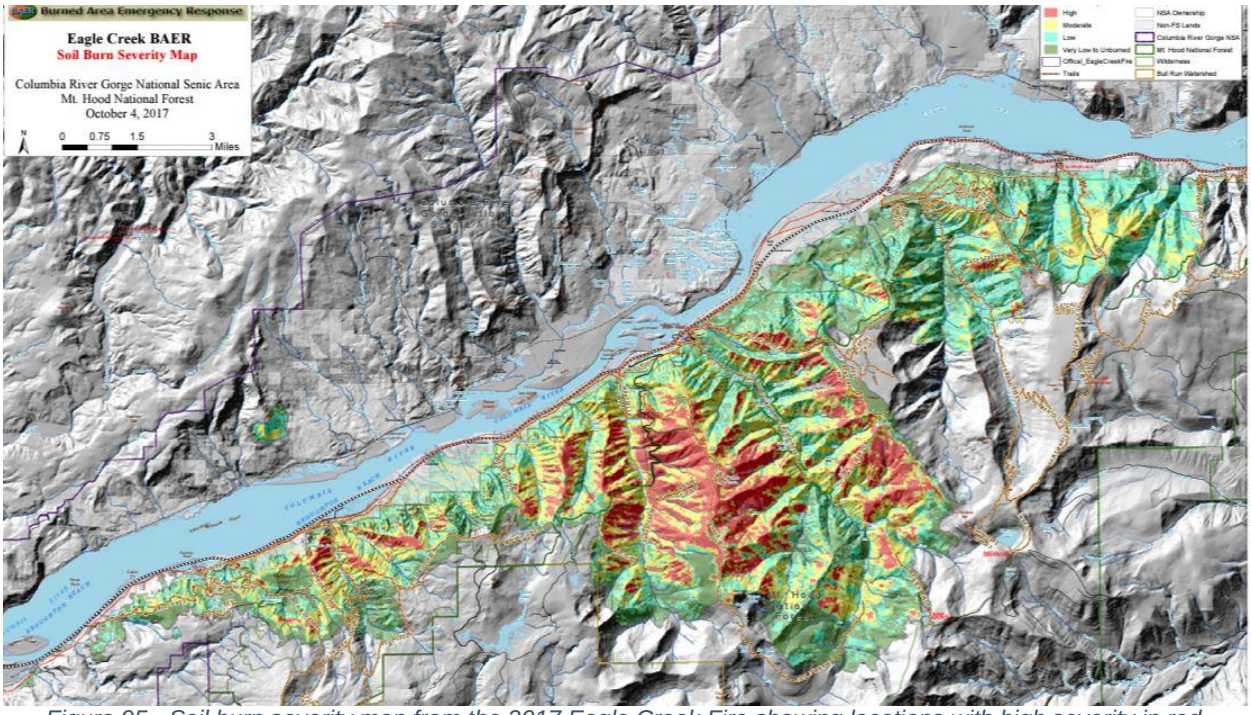

Figure 95 - Soil burn severity map from the 2017 Eagle Creek Fire showing locations with high severity in red, moderate severity in yellow, low severity in light green and very low to no impact in dark green. In low severity areas, ground cover is reduced but intact and the soil structure is unchanged, showing the normal mosaic of impacts in a large wildfire. Map from US Forest Service Eagle Creek Fire Story and Data page.

The fire was a traumatic event that caused sudden evacuation for those living in the Columbia River Gorge, threatened historic buildings and important infrastructure, and damaged recreational areas, closing some heavily used trails for multiple years. The fire produced smoke and ash throughout Multnomah County, and created dangerous conditions for rockfall, debris flows, and flash floods below burned slopes. The burn scar area was likely a contributing factor to a fatal 2020 landslide in Dodson.

Figure 96 - Landscape after the 2017 Eagle Creek Fire from Angel's Rest looking west in the Columbia River Gorge.

The fire closed Interstate Highway 84, a critical route, for 11 days going westbound and 19 days going eastbound. Rail transport through the Columbia River Gorge was closed for three days and river traffic on the Columbia River for two days.

The fire significantly raised the awareness of risk to wildfire in Multnomah County, as the largest fire in the county since at least 1902. Mitigation for wildfire was prioritized by communities across the county after the fire, including initiating a revision to the county's Community Wildfire Protection Plan.

- *Urban Wildfire, Portland August 2019*

A wildfire in Portland on August 26, 2019 was notable in that it was started on a small vegetated area within a highly urbanized area, and damaged five homes, two businesses and a number of vehicles. The total damage of the four-acre fire was around $2 million[81]. The fire occurred during a red-flag warning, a time when fire danger was considered to be critical because of dry vegetation, low humidity and high winds.

Figure 97 - Aerial photo of damage from the 2019 fire in Portland. Photo Portland Fire

The fire started in a brushy lot that had previously been a golf driving range, and was caused by arson. It is difficult to establish a probability of wildfire at this scale, yet many of the participating entities in this plan have vegetated lots large enough to create a fire that could spread to developed areas and become an urban fire, or vice versa. These smaller fires may also threaten unhoused residents living in or near open areas. The wildfire probability data used in this chapter defines an area with wildfire risk as being a potential source of a fire of 250 acres or more. A fire of that size may not be a significant risk for many of the entities in this plan. But as this fire showed, much smaller wildfires can still have dangerous potential in urban areas.

- *Wildfire Smoke 2020*

[81] Arrested for Northeast Portland Arson, *The Portland Observer*, November 26, 2019

The 2020 Oregon wildfire season was one of the worst in recent memory, burning over one million acres and destroying more than 4,000 homes statewide. Local fire districts were able to suppress wildfires that started in Multnomah County, sparing local communities from the devastation that occurred in other parts of the state. However, smoke from wildfires elsewhere caused the unhealthiest air ever recorded in Multnomah County.

Acute health impacts during this event were observed by a 75% spike of asthma-like symptoms seen in emergency rooms and urgent care clinics. Chronic health impacts from this event may take time to fully understand, but research indicates that exposure to wildfire smoke has tremendously negative health effects and leads to significant additional deaths over time.

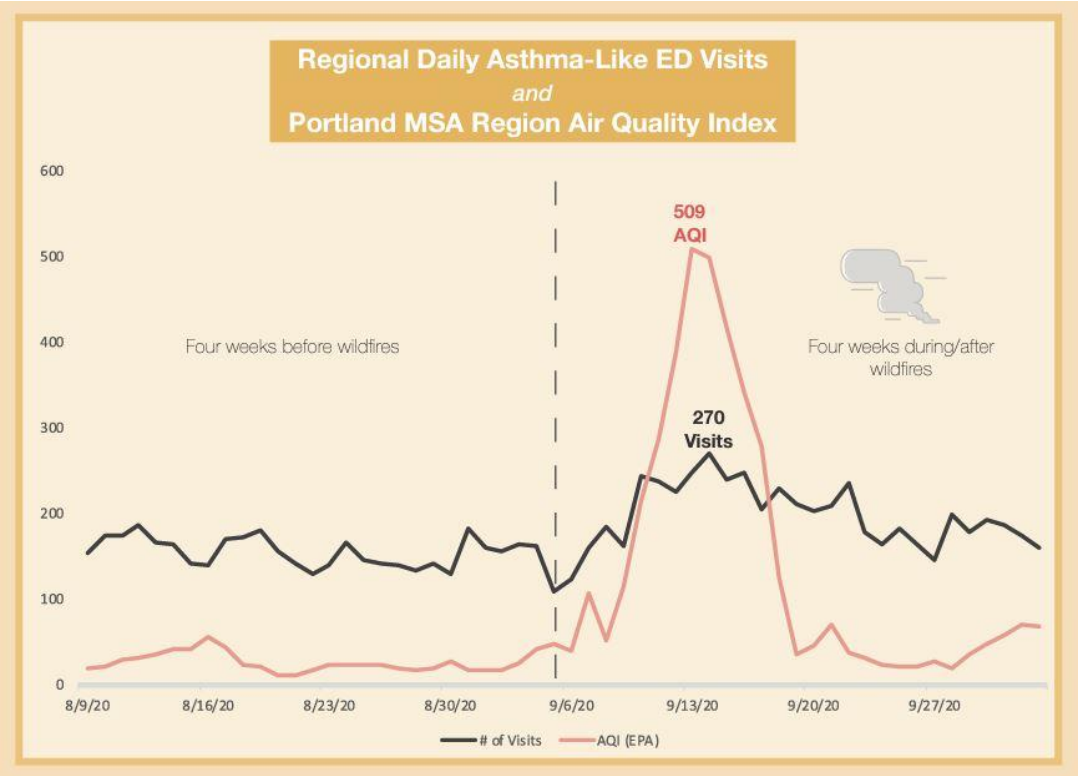

Figure 98 - Regional emergency visits for asthma-like symptoms before and after the 2020 Wildfire Smoke event. Graph by the US Environmental Protection Agency and used in the 2010-20 Regional Climate and Health Monitoring Report

The arrival of extreme winds on September 7, 2020 caused an explosion of new fires across Oregon and fanned existing fires into massive blazes. The largest fires burned in many different counties, primarily on the west slopes of the Cascades, and the smoke from these huge regional fires blanketed Multnomah County.

For a few days after the fires began, air quality in Multnomah County ranged from good to moderate, but on September 10, changes in wind direction caused fine particulate matter readings (PM2.5) to spike and kick off a week of record concentrations of these harmful particles. Concentrations peaked on September 13, with the highest Air Quality Index (AQI) reading in Multnomah County at 509, beyond the highest category on the measurement scale and considered to be immediately hazardous to health.

This was the first time that an AQI for PM2.5 had been recorded above 300[82] in Multnomah County. That record was exceeded for five consecutive days. Wind conditions eventually changed again and blew the lingering smoke out of the county fairly suddenly on September 16 and healthy air quality readings returned.

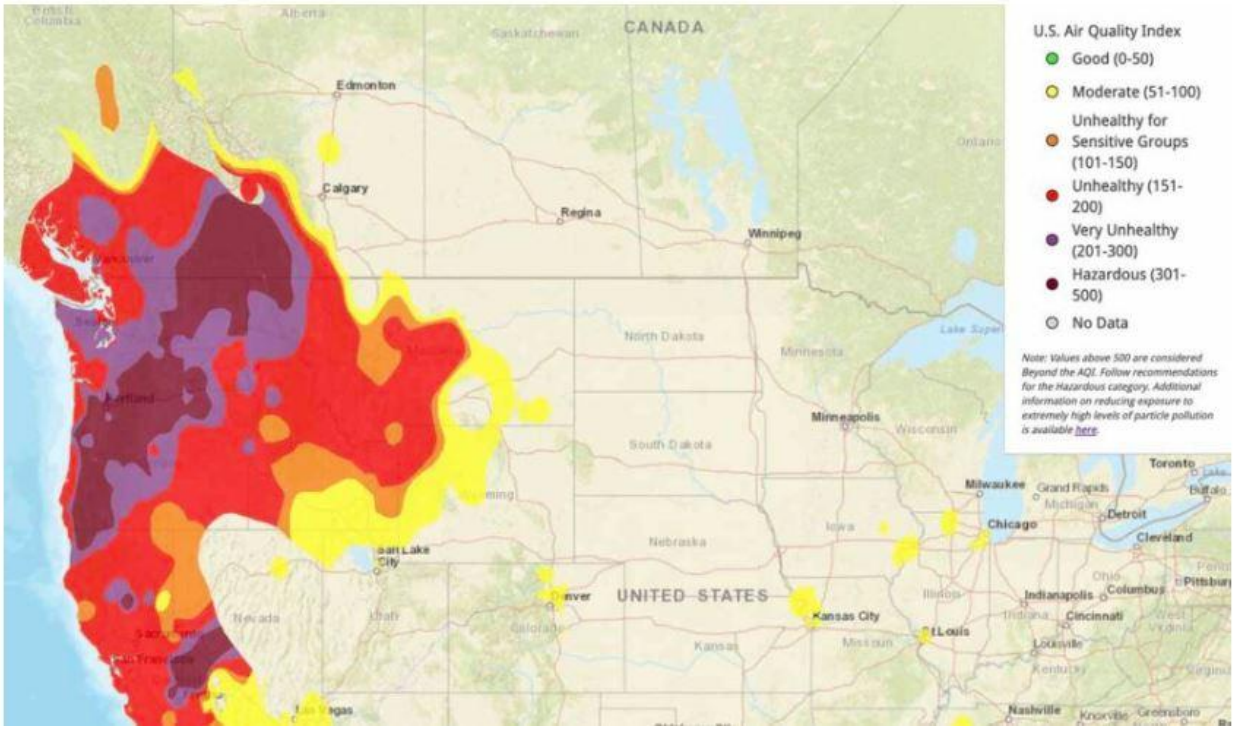

Figure 99 – Archived AirNow map showing concentrations of PM2.5 during the 2020 Wildfire Smoke event. Current real-time air quality information is available at AirNow.

No other recent wildfire smoke events have approached the 2020 event in severity, but unhealthy air levels have been reached several other times, most recently in October 2022.

Wildfire and Wildfire Smoke New Data, Analysis and Policy

- A revision to the 2011 Multnomah County Community Wildfire Protection Plan (CWPP) was initiated in late 2019, through post-wildfire grant funding available from FEMA after the Eagle Creek Fire. That process is ongoing and will be completed in early 2023. The revised plan will reflect the increased risk from climate change and heightened public concern over wildfire risk, incorporate updated risk assessment information, revise mitigation strategies, and include a new section on Wildfire Smoke mitigation. The section on Wildfire Smoke will create coordinated mitigation strategies for that hazard for the first time. That work has informed this portion of the NHMP and will be used in further updates after the completion of the CWPP.

- Risk, probability and vulnerability data for this chapter comes primarily from the Pacific Northwest Quantitative Wildfire Risk Assessment (QWRA), published by Pyrologix for the U.S. Forest Service in 2018. This project served to create a new foundational source

[82] 301-500 is the threshold for highest hazard.

of data for Oregon and Washington to use in wildfire disaster planning. The assessment considered multiple factors in creating its assessment of all locations in the two states:

- the likelihood of a fire burning
- the intensity of a fire if one should occur
- the exposure of assets and resources based on their locations
- the susceptibility of those assets and resources to wildfire.

The assets and resources considered include people, property, infrastructure and natural resources. The 2017 NHMP used an aggregated risk model with best available inputs at that time from the 2011 Multnomah County CWPP. Although that CWPP is still effective, the QWRA has superseded the risk analysis from that plan. Risk assessment inputs and QWRA outputs are hosted by the Oregon Wildfire Risk Explorer, a data product provided by the Oregon Department of Forestry.

- Senate Bill 762 was passed by the Oregon Legislature in 2021. This bill implemented policy recommendations made by the Oregon Governor's Wildfire Council, initiated in January 2019.

  Senate Bill 762 addressed mitigation strategies for both wildfire and wildfire smoke on a statewide level. The legislation is expected to provide mapping that will supersede some of the QWRA data, and be used to classify risk areas in Oregon for assessing newly funded mitigation programs. Programs will fund clean air shelters, air filtration systems and land restoration and management projects. The bill will also mandate higher building code standards for wildfire resistant structures in high-risk locations. Implementation is occurring as this plan is being reviewed, with the first mapping efforts published in summer of 2022. However the initial map release was pulled back and the QWRA maps are still considered to be the best available data for the time being. The Senate Bill 762 maps are expected to be released again in 2023.

- The Regional Climate and Health Monitoring Report for the Tri-County Region (Clackamas, Multnomah, Washington) was updated in 2021 to include data from climate change impacted events between 2018 and 2020. This update included specific health related impact information from the 2020 smoke event.

- A risk reduction report and workshop was jointly developed by the U.S. Environmental Protection Agency (EPA), Metro, and the Regional Disaster Preparedness Organization (RDPO) in April 2021. The report focused on extreme heat and wildfire smoke because of their effects on public health, inequitable impacts, and increased risk caused by climate change. The report outlined risk and vulnerability to wildfire smoke, and provided a selection of potential mitigation strategies to reduce impacts from future events.

Climate Change Impacts

The rate of wildfire across the western United States has steadily increased and is linked to climate change.

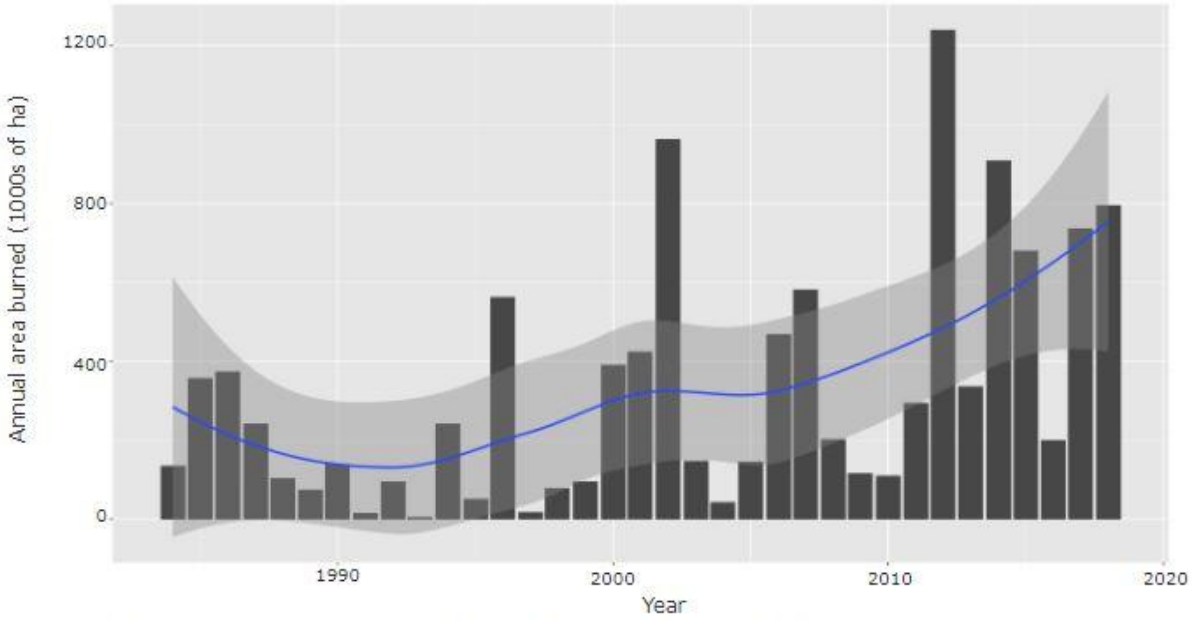

Figure 2. Annual area burned in Oregon from 1984–2018. Fires smaller than 988 acres (400 ha) were omitted. Data source: Monitoring Trends in Burn Severity (Eidenshink et al. 2007).

Figure 100 - Graph used in the Fifth Oregon Climate Assessment..

The effects of climate change that are most likely to lead to increased high-severity wildfire in Multnomah County are extreme heat and drought conditions, especially when they intersect with late summer/early fall dry easterly winds. Additional impacts are being seen from the change of tree species due to the warmer climate, additional tree mortality from drought or disease, and the advance of invasive plant species that may be more fire-prone or alter local fire ecologies.

Fire frequency and area burned are both expected to increase in Multnomah County, but the recent levels of fire and area burned had been small before Eagle Creek. Evidence exists that fire was periodically widespread in the area during previous major drought periods, before colonial settlement and widespread wildfire suppression.

The past fire history of Multnomah County has been of infrequent but very large fires, which makes it difficult to project exactly when and where those fires will become more likely. The complexity of how changes to forest species are changing risk is also challenging to predict. However, it is expected that the impacts of climate change locally are the exact same drivers that increase the probability of another catastrophic wildfire in Multnomah County.

3.6.1 Wildfire and Wildfire Smoke Location and Extent

Wildfire Location and Extent

Wildfire can happen in almost any vegetated area of even small size when conditions become hazardous enough. Forests have the most fuel to support the largest fires, but grass and brush fires and agricultural fires can also be origination points of damaging wildfires.

Areas of the highest risk were identified in the 2011 Community Wildfire Protection Plan. The Oregon Department of Forestry maintains these locally-identified areas statewide as 'Communities at Risk'.

Table 40 – Wildfire Communities at Risk in Multnomah County

Portland Fire & Rescue Bureau	• Skyline Ridge • Mount Tabor • Kelly Butte • Powell Butte • Johnson Creek Watershed • Oaks Bottom • Springwater & Flavel • Sullivan's Gulch • Willamette Bluffs Escarpment • Forest Heights	• Smith/Bybee Lake • Forest Park • Linnton • NW Portland (Pittock Mansion area) • Tryon Creek • Terwilliger Curves • Oregon Zoo & Hoyt Arboretum • Riverdale • Bull Run Watershed
Port of Portland Fire	• Elrod Road	• Government Island (Unprotected)
Gresham Fire Department	• Walters Hill/Gresham Butte • Ritchie Road • Oxbow Park • Lower Sandy River Bend	• 1000 Acres (a.k.a. Sandy River Delta) • Blue Lake • Wisteria Lane • Wistful Vista
Scappoose Fire District	• Holbrook Road • Logie Trail Road	• Gilkenson Road
Corbett Fire	• Trout Creek Road • Tout Creek Camp • Aims Road • Mannthay Road • Deverell Road • Gordon Creek • North Oxbow • Camp Angeles • Corbett Watershed • Brower/Palmer Mill	• Ricker/O Regan Roads • Howard Road • Alder Meadows • Maffet Road • Red Elder • Haines/Thompson Mill • Columbia Historic Hwy • Latourell/Alex Barr • Bridal Veil Lakes
Tualatin Valley Fire & Rescue	• Skyline Ridge • Cornelius Pass	
Structurally Unprotected Areas	• Warrendale-Dodson • Bonneville • Ainsworth	• Government Island • Eagle Creek
Sauvie Island	• Entire Island	

Locations of future fires are most likely to come where human activity intersects with wildfire risk caused by dry fuels and high winds. Nearly all fires in Multnomah County are human caused—with outdoor debris burning, cigarettes, campfires, equipment/vehicles and arson being the most common causes. In order to limit fire ignition, limitations have been placed on camping, outdoor burning and fireworks in some communities during high hazard periods.

Locations of wildfire events are also determined by where fires are most likely to escape control after ignition. Wildfire spotting and alerting can affect the probability of this outcome as well as the ability of fire services to access specific locations, the distance from a fire start to firefighting resources, and water availability. Ninety-eight percent of new wildfires are knocked down before

they become uncontrolled[83], making the location of catastrophic fires very dependent on conditions.

The locations of past fires give an idea of where risk of ignition may continue to be highest, because of continuing vegetation growth and intersection with human uses. The map below shows locations of fires between 1992 and 2019. Nearly every fire recorded was human-caused (red) rather than caused by lightning (yellow). The lack of fires in the old-growth forest of the Bull Run Watershed, which is not publicly accessible because of its critical importance as a drinking water source, further underlines how linked human uses are with wildfire ignition in Multnomah County. Lightning is a significant cause of fire in Southern Oregon and East of the Cascade Mountains.

An interactive version of this map can be found here (Fire History and Active Fires – Fire Locations 1992-2019)

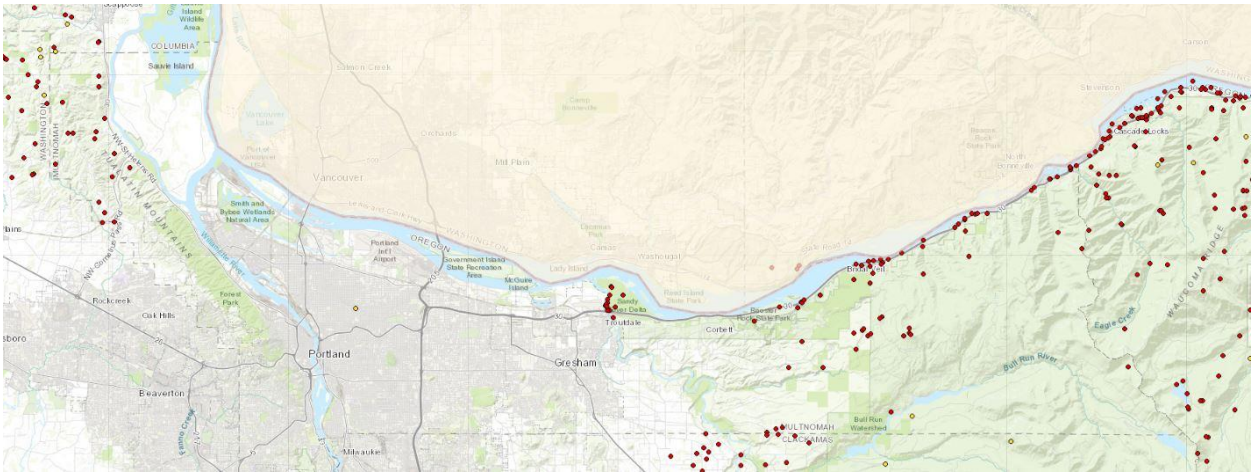

Figure 101- Map from Oregon Wildfire Explorer using data from a variety of sources.

This data set is limited by it including all fires of a tenth of an acre or more, and only including fires recorded in Oregon Department of Forestry service areas. Therefore, factors more likely to lead to catastrophic large fires (such as time of year or ignition location) are not captured and wildfires in urban locations are not included.

Wildfire Smoke

No local climate or geographical effects have been shown that significantly impact the smoke risk to different locations in Multnomah County. Wind direction and other atmospheric effects have been more important in determining when a smoke intrusion event occurs, and even smoke from distant wildfires can be extremely hazardous to health[84]. The majority of US mortality and asthma morbidity from wildfire smoke fine particulate matter occurs outside of the West.
The Air Quality Index for fine particulate matter readings (PM2.5) in Multnomah County during the Eagle Creek fire in 2017 peaked at 157—much lower than levels reached during the Labor

[83] The 98% Suppression Rate: Analyzing Extreme Wildfire Behavior, US Forest Service, Andrew Avitt, September 2022
[84] Estimated Mortality and Morbidity Attributable to Smoke Plumes in the United States: Not Just a Western US Problem, *GeoHealth*, August 21, 2021, K. O'Dell, K. Bilsback, B. Ford, S. Martenies, S. Magzamen, E. Fischer, J. Pierce.

Day smoke event in 2020, even though the smoke in 2020 came from outside of Multnomah County. Consequently, mitigation planning for wildfire smoke has treated the entire county as roughly equally subject to the hazard, and mitigation strategy has focused on protecting those most at risk from disparate health impacts.

3.6.2 Wildfire and Wildfire Smoke Probability and History

Wildfire

Historically, the wet forests of western Oregon have burned infrequently, but have periodically experienced catastrophic stand replacement fires where much of the forest is burned to the ground and eventually regenerates itself. The reason for this history is the wet climate, which promotes productive vegetation growth over long periods of time until severe enough drought combined with high winds creates conditions for huge fires. Some of the largest recorded fires in state history, such as the Silverton Fire in 1865 and the Tillamook Burn between 1933 and 1951, occurred in northwest Oregon.

Different parts of Oregon have extremely different natural rates of wildfire, and different ecosystems within those regions also have different rates. Dry forests in eastern Oregon may have natural return rates of fire of around a decade, as low-intensity fires frequently cleared underbrush and small trees while not killing large trees. The return rate of wildfire in wet Oregon forests, on the other hand, has been estimated as occurring every 100 to 400 years, creating similarities in frequency and scope with other infrequent but extremely catastrophic hazards like earthquakes. Areas dominated by grasslands, shrubs, and oak savannas have return wildfire rates closer to 35-100 years, even in a wet climate.

This vastly different fire probability carries a risk of creating an oversimplified understanding of vulnerability in statewide mapping, as most of the northwestern Oregon region is shown to have low risk of fire compared to other parts of the state. That probability does not necessarily reflect the large amount of people, structures and infrastructure at risk in wildland-urban interface areas, nor the potential risk to life safety created by infrequent wind-driven catastrophic fires. Therefore, vulnerability maps are used to define risk at the jurisdiction/district level in this plan rather than probability maps.

Currently probability maps hosted by the Oregon Department of Forestry show the highest risk of annual fire in Multnomah County occurring in the eastern portion of the county. These maps only consider fuel and topography characteristics and do not include future climate change impacts to probability.

An interactive version of this map can be found here (Burn Probability – Burn Probability)

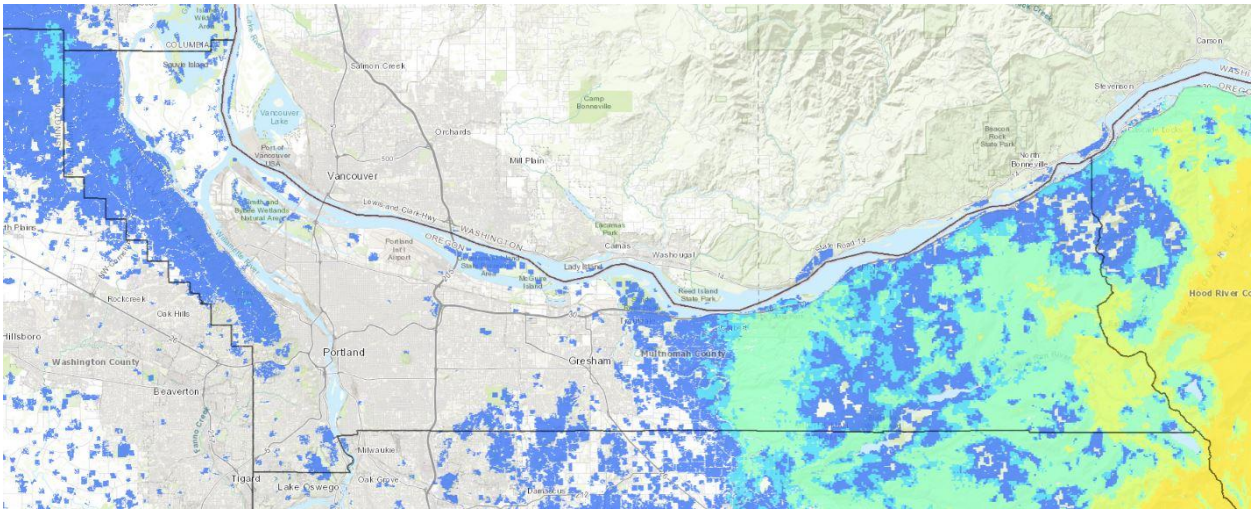

Figure 102 - Map showing burn probability at locations across Multnomah County. Map from the Oregon Wildfire Explorer using data collected in the PNW-QWRA. Most of western Multnomah County is considered to have low to moderate burn probability in this analysis with parts of western Multnomah County having moderate to high burn probability.

Wildfire Smoke

Probability of a wildfire smoke event is much higher than that of wildfire, as the county is susceptible to smoke coming from locations across the region. During drought periods with active fire seasons across the west coast, there is a likelihood that Multnomah County will experience at least some wildfire smoke impacts every summer. Acute disasters on the level of the 2020 event are clearly much rarer and were driven by fires nearer to Multnomah County. However, health impacts even from distant fires can still be extremely significant.

3.6.3 Wildfire and Wildfire Smoke Vulnerability

Wildfire

Wildfire vulnerability has not been quantified in the same way as hazards like earthquake or landslide. The overall fire risk in different locations has been classified, but the exact ignition location and intensity of future fires is highly variable and impacts are extremely dependent on circumstances. In the 2020 Oregon fire season, the Almeda Drive Fire in Jackson County in Southern Oregon started as a brush fire and burned only 3,200 acres—less than 10% the size of the Eagle Creek Fire. But because the fire traveled alongside a highway through populated areas it destroyed nearly 3,000 structures, far more than any other Oregon fire that year.

Mapping indicates which parts of Multnomah County face vulnerability from a major wildfire event. The Wildland Urban Interface (WUI) is the transition zone between developed land and major wildfire fuels. The WUI provides a high-level view of risk and includes highly developed locations that are not in vegetated areas, but could be impacted by embers from a large wildfire. In a 2010 analysis by the U.S. Forest Service, it was determined that 3.8% of Oregon is located in a WUI. The amount of WUI in Multnomah County is significantly higher because of the large county population located near Urban Growth Boundaries or large urban parks.

An interactive version of this map can be found here (Planning and Cadastral – Oregon WUI Hazard Rating)

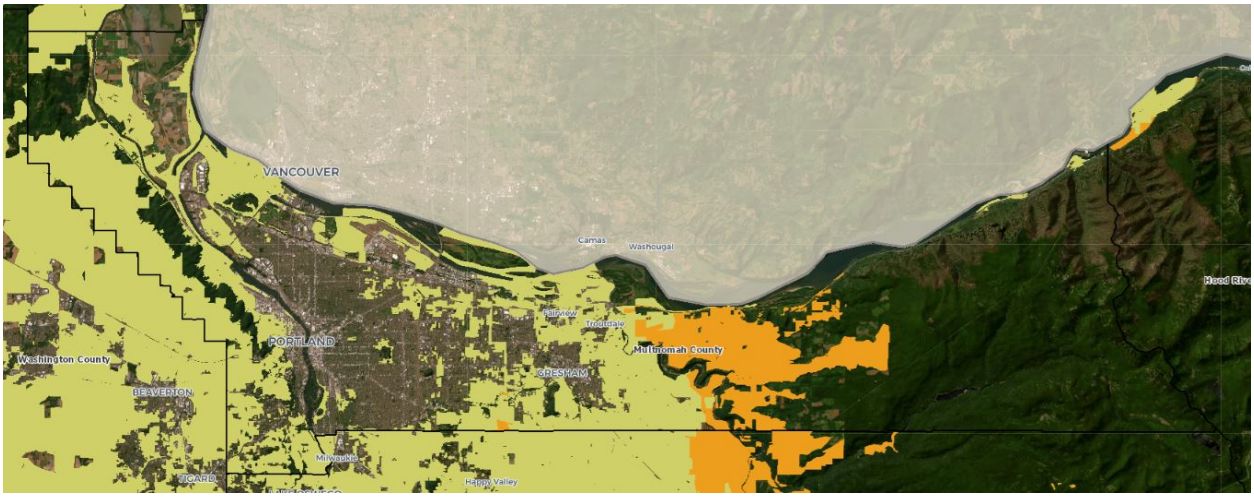

Figure 103 - A map showing identified WUI areas in Multnomah County as of 2017, using data from the 2011 CWPP. The orange areas are of higher risk than the yellow. Core urban areas are not considered WUI because they are not adjacent to wildfire fuels. Areas in eastern Multnomah County and the center of Forest Park in Portland are not consider WUI because of the lack of adjacent urban development. Map from the Oregon Wildfire Explorer with data from the Oregon Department of Forestry

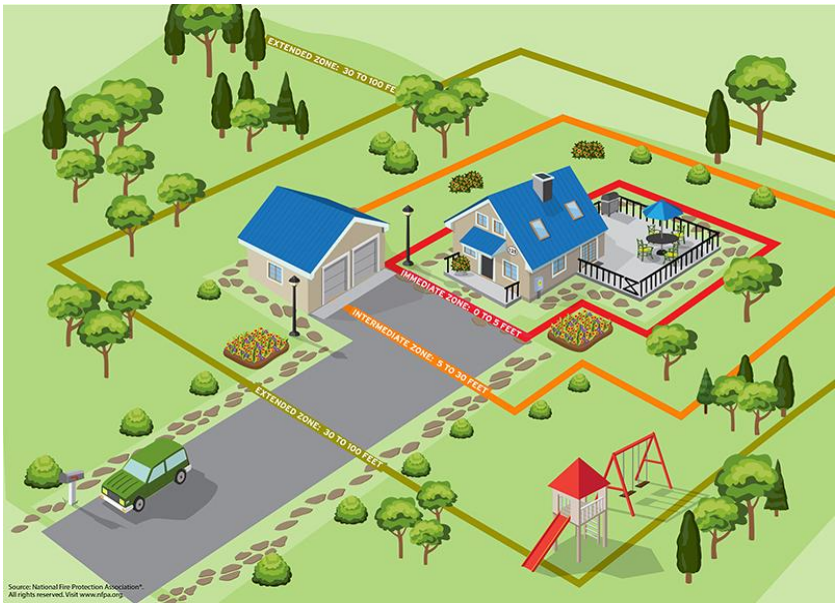

Figure 104 - A diagram of the home ignition zone, where work can be done to make it less likely a structure will ignite in a wildfire. Each zone has specific recommendations. Graphic from the National Fire Protection Association

A large wildfire can send embers up to a mile ahead of the main fire, creating spot fires and setting structures ablaze. Mitigation activities are recommended in WUI areas to increase the resilience of structures by clearing gutters and roofs of flammable material and the immediate areas around the structure of woodpiles and brush. Once structures catch on fire, they can spread the fire to adjacent structures and further spread embers into new neighborhoods or adjacent forests or brush.

WUI areas have been collected by ODF based on local determination. Senate Bill 762 is expected to standardize the definition and location of WUI areas statewide, but local areas will still be able to define their own risk based on local conditions.

Another way to consider wildfire vulnerability is to look at the PNW-QWRA's analysis of potential wildfire impacts, including risk to people, structures, infrastructure and natural resources. While statewide analysis of fire vulnerability often indicates low relative risk of wildfire in Multnomah County, this map indicates the high level of potential impact to the county's resources. This map only considers vulnerability in areas with wildfire potential, so it works well in coordination with

the WUI map – it classifies vulnerability in areas that are not included in the WUI map because they do not have structures but have infrastructure and natural resource values. Areas of vulnerability expand to include roads, high-tension power lines, and the Bull Run Reservoir, which could see significant erosion impacts on water quality after a major fire.

An interactive version of this map can be found here (Wildfire Potential Impact – Overall Potential Impact)

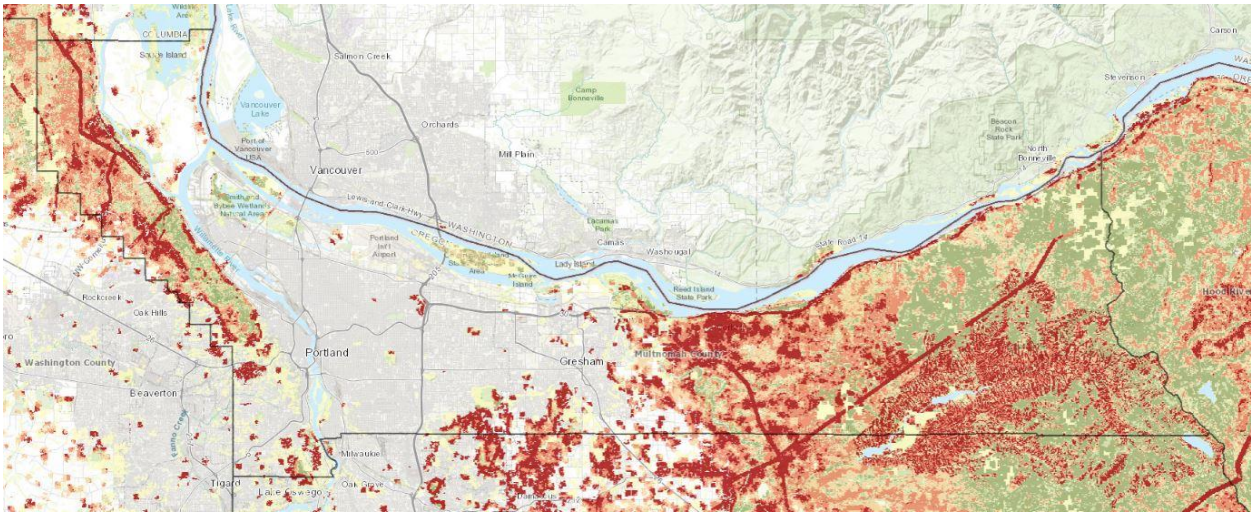

Figure 105 - Map showing risk to people and infrastructure from wildfire in Multnomah County. Darker red indicates highest risk. Map from the Oregon Wildfire Explorer, with data from the PNW-QWRA

Public Safety Power Shutoffs

Beginning in the summer of 2021, Portland General Electric (PGE) announced that they would implement a program of preventative power shutoffs in extreme wildfire conditions. This program had already been used in other parts of Oregon, and was extended to Multnomah County.

The other electricity providers in Multnomah County—Pacific Power, Columbia River PUD, and Cascade Locks City Electric—have not initiated this program in this county. Each of these providers has much smaller or more urban service areas compared to PGE.

The purpose of the shutoffs is to limit the possibility of wildfire ignition coming from power equipment, such as transmission lines and transformers. Factors that determine when this preventative shutoff might occur are extremely dry conditions and high winds. The first shutoff occurred in September 2022, when all four Public Safety Power Shutoff (PSPS) zones in Multnomah County were subject to late summer dry conditions and a high wind event similar in timing to the fire weather that led to the September 2020 Oregon wildfire event.

The lowering of ignition risk from electricity infrastructure is an important mitigation strategy to limit wildfire impact during the highest hazard periods. However, the potential shutoff of power for multiple days until conditions change and lines and other equipment can be inspected, does create vulnerability for those most reliant on powered medical devices, refrigerated medicines, air conditioning and air filtration. Multnomah County provided power and other supplies at two resource centers during the 2022 shutoff.

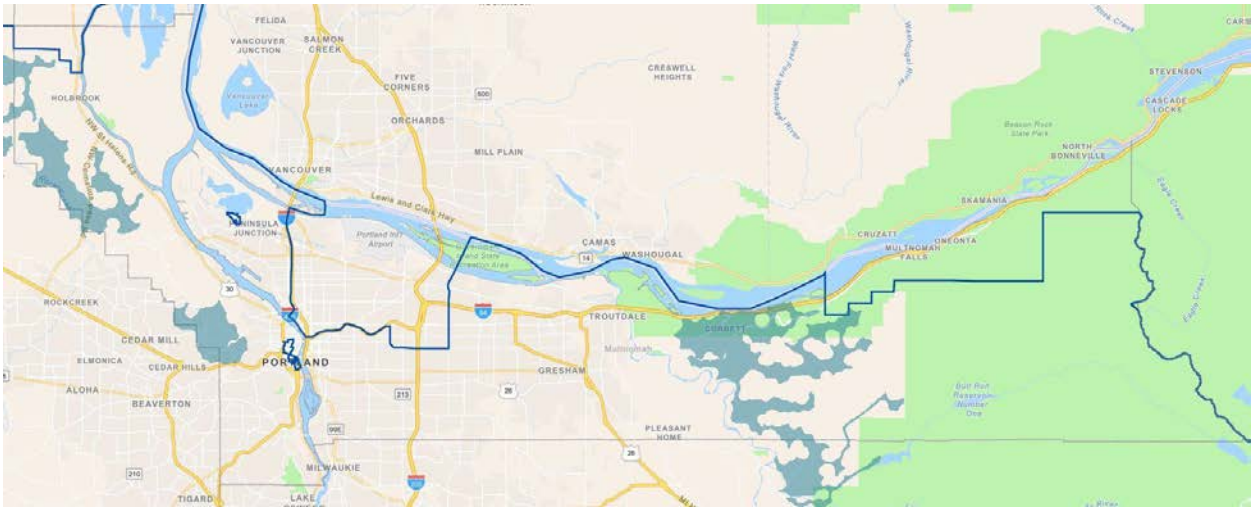

Figure 106 - Map showing PGE service area and PSPS zones during Summer 2022. This map should not be used to confirm PGE's planned power shutoff areas – instead check PGE's live map.

The current map of potential shutoff areas impacts only unincorporated Multnomah County and the City of Portland, with the most county residents affected in the Corbett area in east Multnomah County and in Portland's West Hills. However, these areas are re-evaluated every year, and are subject to change.

Wildfire Smoke

Vulnerability to wildfire smoke is centered on those most likely to suffer impacts. The fine particulate matter in wildfire smoke is harmful to people during an event, as evidenced by the sharp increase in emergency room visits during the 2020 September Smoke Event. But wildfire smoke also causes long-term chronic health impacts.

Those identified by the EPA as having the highest risk from wildfire smoke are:

- People with asthma and other respiratory diseases
- People with cardiovascular disease
- Children under the age of 18
- Those pregnant, and their fetuses
- Older adults
- Those without resources to avoid exposure to hazardous air, either through access to spaces with air filtration or the ability to leave the area
- Those required to work outside

Wildfire smoke is made up of a number of substances, many of which exist as solid or liquid particles suspended in the air. The smallest of these particles, known as PM2.5 (less than 2.5 microns in diameter) are particularly harmful to health and are commonly used as the measurement for hazardous air quality. Because of their size, these particles can easily make their way into homes and other buildings. Once breathed in they are small enough to enter the lungs and cause serious effects to the lungs and heart.

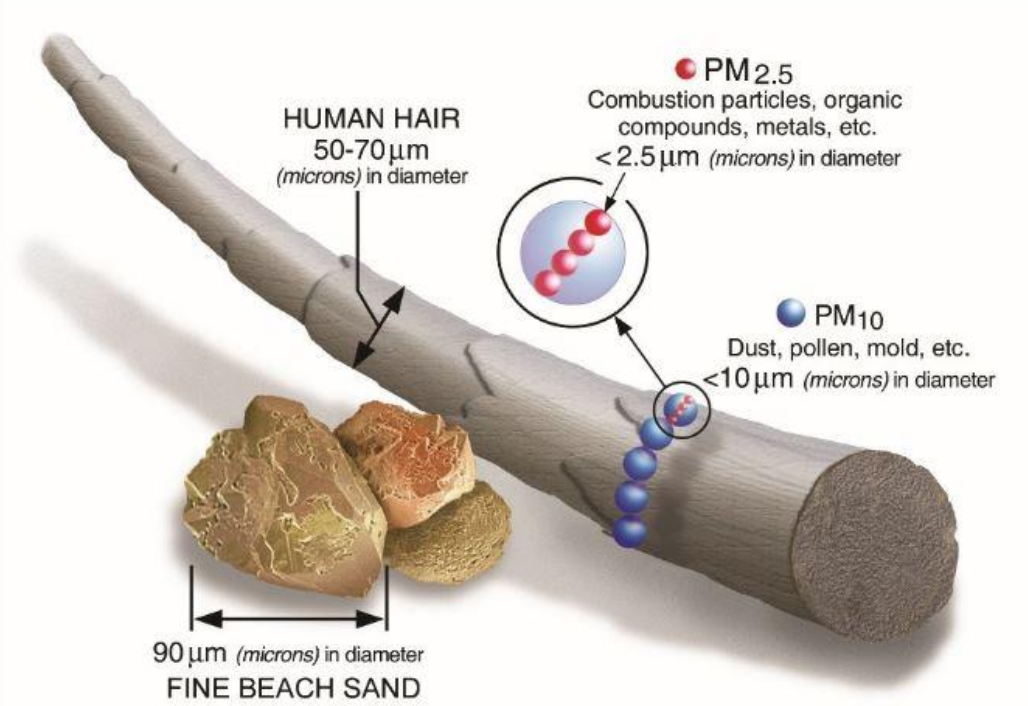

Figure 107 - Diagram showing the small size of wildfire smoke particles. Graphic from the US Environmental Protection Agency.

High concentrations of PM2.5 are the most likely to require immediate emergency medical care. But there is evidence that as smoke oxidizes over time, it may become more carcinogenic, meaning that even smoke from faraway fires can have long-term health impacts. Studies have indicated that thousands of deaths in the United States occur each year because of chronic exposure to PM2.5, and that the majority of those deaths occur east of the Rocky Mountains, showing the continuing danger of smoke even as it drifts far away from fires.

Rates of asthma, respiratory disease and cardiovascular disease are often higher in communities already facing disparate impacts from poor air quality. Impacts of smoke are also magnified in county locations that lack tree canopy to filter the air and prevent urban heat islands which simultaneously stress human systems. As noted in the Severe Weather chapter, areas with low rates of tree canopy are often linked with higher poverty rates, further establishing wildfire smoke as a hazard with a high potential for disparate impacts to underserved communities.

Interventions to prevent these disparate impacts have included the establishment of public clean air spaces and emergency shelters, distribution of home filters, and home weatherization programs