



March 2023

WILDFIRE SMOKE

Opportunities to Strengthen Federal Efforts to Manage Growing Risks

GAO Highlights

Highlights of [GAO-23-104723](#), a report to congressional requesters

Why GAO Did This Study

The U.S. has recently experienced some of its worst wildfire seasons on record, creating unhealthy smoke that affected tens of millions of Americans. The 2018 *Fourth National Climate Assessment* projects that climate change will likely increase the frequency of large wildfires and worsen health effects from smoke.

EPA's mission is to protect human health and the environment. Managing risks to air quality and public health from wildfire smoke includes (1) ensuring communities can prepare for and respond to the risks, and (2) hazard mitigation to potentially reduce smoke risks from future fires.

GAO was asked to review issues related to the effects of wildfires on air quality and public health. This report examines, among other things, (1) EPA actions to manage risks to air quality and public health from wildfire smoke and to coordinate with other federal agencies, and (2) how EPA could better manage these risks.

GAO reviewed laws, regulations, and other documents; interviewed federal officials and 15 stakeholder entities, including tribal, state, and local agencies; and analyzed actions to reduce risks using criteria, including GAO's *Disaster Resilience Framework*.

What GAO Recommends

GAO is making six recommendations, including that (1) EPA develop a coordinated approach for its actions to manage wildfire smoke risks; and (2) EPA, USDA, and Interior align air quality and land management goals for wildfire risk mitigation. EPA, USDA, and Interior generally agreed with the recommendations.

View [GAO-23-104723](#). For more information, contact J. Alfredo Gómez at (202) 512-3841 or gomezj@gao.gov.

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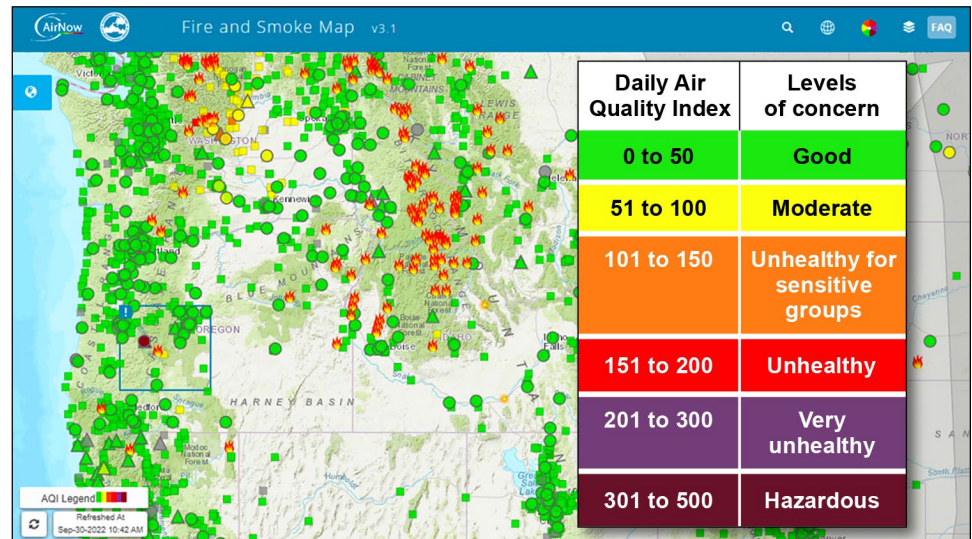
WILDFIRE SMOKE

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What GAO Found

The Environmental Protection Agency (EPA) has partnered with other agencies to provide a range of information and tools to help communities prepare for and respond to wildfire smoke events. For example, EPA partnered with the U.S. Department of Agriculture's (USDA) Forest Service to develop an online map that shows near real-time air quality data, along with the locations of wildfires and where smoke is traveling.

Fire and Smoke Map, Showing Air Quality Information, Fire Locations, and Smoke Coverage



Source: fire.airnow.gov. | GAO-23-104723

GAO identified opportunities for EPA to better manage the growing risks from wildfire smoke by building on its actions to help communities prepare for and respond to wildfire smoke events. In particular, EPA could take a more coordinated approach to its actions that aligns with leading practices for collaboration. EPA's actions are spread across program and regional offices and conducted in an ad hoc manner with no dedicated program or budget. By developing a coordinated approach to guide these actions, EPA could better ensure that the agency directs limited resources toward its highest priorities.

EPA also has opportunities to enhance its role in supporting hazard mitigation through methods to reduce the likelihood of catastrophic wildfires and resulting smoke events. For example, EPA could work with federal land management agencies—the Forest Service and agencies within the Department of the Interior—to strengthen federal coordination. EPA and the land management agencies have identified areas where their respective agency missions and goals for wildfire risk mitigation are not aligned. For example, land management agency officials said that EPA's air quality requirements can limit the use of certain land-management methods, such as prescribed burns, that have the potential to reduce smoke from future wildfires. By better aligning their goals for wildfire risk mitigation, the federal agencies can more effectively reduce risks to air quality and public health from wildfire smoke over the long term.

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Abbreviations

CDC	Centers for Disease Control and Prevention
EPA	Environmental Protection Agency
HVAC	heating, ventilation, and air conditioning
NAAQS	National Ambient Air Quality Standards
NOAA	National Oceanic and Atmospheric Administration
USDA	U.S. Department of Agriculture

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March 13, 2023

Congressional Requesters

Since 2015, the United States has experienced its three most catastrophic wildfire seasons on record in terms of area burned, according to data from the National Interagency Fire Center.¹ Smoke from these wildfires has created hazardous and unhealthy air quality conditions for tens of millions of Americans and, in some instances, for locations thousands of miles from the fires. For example, in July 2021, smoke from wildfires in the western United States and Canada prompted unhealthy air quality alerts for multiple days in East Coast cities, including New York City and Washington, D.C. Climate change is likely to increase the frequency of and area burned by wildfires and exacerbate health effects from wildfire smoke, according to the 2018 *Fourth National Climate Assessment*.²

Wildfire smoke and its related health threats also increase the fiscal exposure of the federal government through increased health care costs. The federal government is the nation’s largest purchaser of health care services through programs that often serve older adults and people with

¹The National Interagency Fire Center started collecting data on annual area burned in 1983. The National Interagency Fire Center is the nation’s federal support center for wildland firefighting. Its members are the Bureau of Indian Affairs, Bureau of Land Management, Fish and Wildlife Service, and National Park Service within the Department of the Interior; and Forest Service within the U.S. Department of Agriculture. Other partners include the National Association of State Foresters, U.S. Fire Administration, and National Weather Service. According to the National Park Service, a wildfire is an unplanned fire caused by lightning or other natural causes, accidental human ignitions, arson, or an escaped prescribed burn. A prescribed burn is an intentionally ignited fire set for land management objectives. Wildland fire is an overarching term that encompasses both wildfires and prescribed burns. In this report, we use the term “prescribed burn” to mean “prescribed fire,” except in cases where we are referring to reports or legal documents that use “prescribed fire.”

²U.S. Global Change Research Program, *Impacts, Risks, and Adaptation in the United States: Fourth National Climate Assessment*, vol. 2 (Washington, D.C.: 2018).

fewer resources who face higher risks from wildfire smoke.³ A 2022 report from the Office of Management and Budget estimated that wildfire smoke exposure could increase federal health care expenditures by between \$128 million and \$226 million per year by the end of the century.⁴

Through its mission to protect human health and the environment, the Environmental Protection Agency (EPA) has a primary role in managing risks to air quality and public health from air pollution sources. EPA works through its headquarters and regional offices to preserve and improve air quality and protect public health by administering the Clean Air Act and providing support and guidance to the tribal, state, and local agencies that are responsible for managing air quality in their jurisdictions.⁵

Other federal agencies have key roles in managing risks from wildfire smoke. For example, the U.S. Department of Agriculture's (USDA) Forest Service and the Department of the Interior's Bureau of Indian Affairs, Bureau of Land Management, Fish and Wildlife Service, and National Park Service manage wildfire risks on federal lands and, in the case of the Bureau of Indian Affairs, tribal lands.⁶ These agencies coordinate with partners such as Tribes, state and local agencies, and communities on

³According to EPA, older adults are more likely to have certain preexisting conditions that wildfire smoke exposure may exacerbate. People with fewer resources may have less access to measures that can reduce some exposure, such as indoor air filtration, according to EPA. The Congressional Budget Office reported that federal spending on Medicare, Medicaid, and other health care programs has totaled about 35 percent of national health care expenditures in recent years. Congressional Budget Office, *Wildfires* (June 2022).

⁴Estimates are reported in 2020 dollars. Office of Management and Budget, *Climate Risk Exposure: An Assessment of the Federal Government's Financial Risks to Climate Change (White Paper)* (Apr. 2022).

⁵EPA's Office of Air and Radiation is the headquarters office responsible for developing national programs, policies, and regulations for controlling air pollution and administering the Clean Air Act, among other things. EPA has 10 regional offices, which are responsible for partnering with Tribes, states, and territories in their respective regions to execute EPA programs. The 10 regional offices are Region 1 (Boston), Region 2 (New York City), Region 3 (Philadelphia), Region 4 (Atlanta), Region 5 (Chicago), Region 6 (Dallas), Region 7 (Kansas City), Region 8 (Denver), Region 9 (San Francisco), and Region 10 (Seattle).

⁶Tribal lands include those held in trust by the federal government for the benefit of the Tribe or individual Indians, as well as restricted fee lands, which are those owned by a Tribe or individual Indians subject to certain restrictions. For purposes of this report, we use the term tribal lands to refer collectively to tribal and individual Indian trust and restricted fee lands.

efforts to manage fire risks on lands across the country. The Forest Service also leads efforts to assess and communicate to tribal, state, and local agencies and the public risks posed by smoke during wildfires.⁷

In addition, the Department of Health and Human Service's Centers for Disease Control and Prevention (CDC) provides science-based guidance to help protect the nation from environmental hazards—such as wildfire smoke—that affect public health, and the Department of Commerce's National Oceanic and Atmospheric Administration (NOAA) predicts air quality impacts from wildfire smoke through modeling. While each of these agencies has its own role and mission, each partners with other federal agencies on efforts to manage risks from wildfire smoke.

Since 2013, in recognition of the federal government's significant stake in managing the impacts of climate-related disasters, we have included Limiting the Federal Government's Fiscal Exposure by Better Managing Climate Change Risks on our High-Risk List.⁸ In our prior work, we have found that enhancing resilience to disasters can help limit the federal government's fiscal exposure because investing in resilience is a risk management strategy that can reduce the need for more costly steps in the future. Enhancing resilience to disasters means taking actions to reduce potential future losses by planning and preparing for hazards such as smoke from wildfires. We published *the Disaster Resilience Framework* in 2019 to serve as a guide for analysis of federal actions to

⁷Specifically, the Forest Service led the effort to develop and implement the Interagency Wildland Fire Air Quality Response Program called for by the John D. Dingell, Jr. Conservation, Management, and Recreation Act. Pub. L. No. 116-9, § 1114(f), 133 Stat. 580, 617 (2019). The program was created to directly assess, communicate, and address risks posed by wildland fire smoke to the public as well as fire personnel.

⁸The High-Risk List identifies federal program areas that are at high risk of vulnerabilities to fraud, waste, abuse, and mismanagement or in need of transformation. See GAO, *High-Risk Series: An Update*, [GAO-13-283](#) (Washington, D.C.: Feb. 13, 2013); and *High-Risk Series: Dedicated Leadership Needed to Address Limited Progress in Most High-Risk Areas*, [GAO-21-119SP](#) (Washington, D.C.: Mar. 2, 2021).

promote resilience to disasters and address the actual and anticipated effects of climate change.⁹

You asked us to review issues related to the effects of increasingly frequent catastrophic wildfires on air quality and public health. This report (1) describes key federal roles related to managing risks to air quality and public health from wildfire smoke, (2) identifies the actions EPA has taken to help manage these risks and how EPA coordinates with other federal agencies on these actions, and (3) examines how EPA could better help manage these risks.

To (1) describe key federal roles related to managing risks to air quality and public health from wildfire smoke and (2) identify the actions EPA has taken to help manage these risks and how EPA coordinates with other federal agencies on these actions, we analyzed documents and conducted interviews with federal officials. Specifically, we analyzed relevant laws and regulations, as well as documents from EPA and other federal agencies, such as memoranda of understanding that describe coordination between EPA and other federal agencies. We also analyzed our relevant prior work and other federal reports related to managing risks to air quality and public health from wildfire smoke. In addition, we conducted and analyzed interviews with officials (1) from EPA headquarters program offices that have responsibilities related to managing the risks to air quality and public health from wildfire smoke, and (2) from a nongeneralizable sample of five EPA regional offices selected to correspond to areas with recent experience managing risks to air quality and public health from wildfire smoke. We also interviewed officials from the CDC, Bureau of Indian Affairs, Bureau of Land Management, Fish and Wildlife Service, Forest Service, National Park Service, and NOAA.

⁹GAO, *Disaster Resilience Framework: Principles for Analyzing Federal Efforts to Facilitate and Promote Resilience to Natural Disasters*, [GAO-20-100SP](#) (Washington, D.C.: Oct. 23, 2019). We have also previously reported on risks that wildfires can pose to life, property, and health. See, for example, GAO, *Household Hazardous Waste Removal: EPA Should Develop a Formal Lessons Learned Process for Its Disaster Response*, [GAO-22-104276](#) (Washington, D.C.: Mar. 17, 2022); *Wildfire: Information on Forest Service Response, Key Concerns, and Effects of the Chetco Bar Fire*, [GAO-20-424](#) (Washington, D.C.: Apr. 29, 2020); and *Wildfire Disasters: FEMA Could Take Additional Actions to Address Unique Response and Recovery Challenges*, [GAO-20-5](#) (Washington, D.C.: Oct. 9, 2019).

To examine how EPA could better help manage risks to air quality and public health from wildfire smoke, we reviewed relevant literature and interviewed knowledgeable stakeholders to identify potential actions that EPA could take to better manage such risks. Specifically, we conducted a literature search and identified, reviewed, and analyzed 28 academic studies; law review articles; and other reports. We also conducted and analyzed interviews with a nongeneralizable sample of 15 stakeholders.¹⁰ These stakeholders were (1) officials from nine tribal, state, and local air agencies selected based on having had recent experience managing risks to air quality and public health from wildfire smoke and to provide geographic diversity, and (2) six stakeholders with relevant expertise—from academic, nonprofit, and other organizations—selected to represent a variety of organization types, geographic areas, and areas of expertise. Our findings from these interviews cannot be generalized to stakeholders we did not interview.

We performed a content analysis of the literature and interviews to compile a list of potential actions that EPA could take to better manage the risks to air quality and public health from wildfire smoke. We then grouped similar actions into broad categories. We also compared EPA's current and potential actions to manage risks with our *Disaster Resilience Framework* principles for enhancing disaster resilience, selected leading practices for collaboration, and essential elements of enterprise risk management.¹¹ See appendix I for a more detailed discussion of our scope and methodology. Appendix II provides tables summarizing the results of our content analysis.

We conducted this performance audit from January 2021 to March 2023 in accordance with generally accepted government auditing standards. Those standards require that we plan and perform the audit to obtain sufficient, appropriate evidence to provide a reasonable basis for our findings and conclusions based on our audit objectives. We believe that

¹⁰We considered each entity we interviewed as one stakeholder even though multiple officials or representatives participated in many of the interviews.

¹¹For our *Disaster Resilience Framework*, see [GAO-20-100SP](#). For leading practices for collaboration, see GAO, *Managing for Results: Key Considerations for Implementing Interagency Collaborative Mechanisms*, [GAO-12-1022](#) (Washington, D.C.: Sept. 27, 2012). For essential elements of enterprise risk management, see GAO, *Enterprise Risk Management: Selected Agencies' Experiences Illustrate Good Practices in Managing Risk*, [GAO-17-63](#) (Washington, D.C.: Dec. 1, 2016).

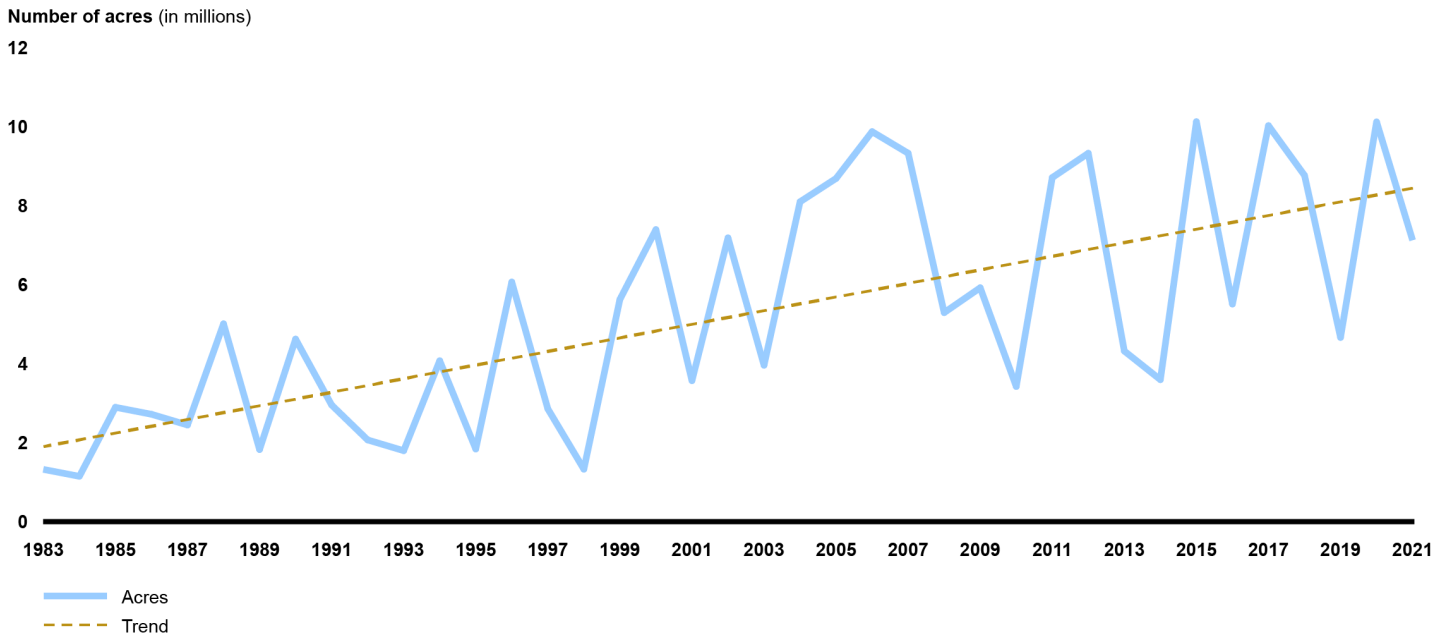
the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objectives.

Background

Wildfire Trends

Over the past three decades in the United States, the average number of acres burned by wildfires has increased even though the number of wildfires each year has declined, indicating a growing number of larger, more catastrophic wildfires since official data collection began in the 1980s. Data from the National Interagency Fire Center indicates that the area burned by wildfires each year in the United States has significantly increased since 1983 (see fig. 1). In each of the years 2015, 2017, and 2020, more than 10 million acres—an area larger than Maryland—burned nationwide, according to the Forest Service.¹²

Figure 1: Area Burned by Wildfires Annually, 1983–2021



Source: GAO analysis of National Interagency Fire Center data. | GAO-23-104723

¹²U.S. Department of Agriculture, Forest Service, *Confronting the Wildfire Crisis: A Strategy for Protecting Communities and Improving Resilience in America's Forests* (Washington, D.C.: Jan. 2022).

Changes in the climate—such as warmer and drier conditions—have lengthened the wildfire season and increased the frequency of large fires, according to the 2018 *Fourth National Climate Assessment*.¹³ The *Fourth National Climate Assessment* also states that human expansion into wildland areas in the past few decades and fire management policies that suppressed fires in the past century have contributed to the increasing frequency of large fires. The assessment also projects that wildfire frequency and area burned in the United States will continue to increase over this century, leading to an increase in wildfire smoke.¹⁴

Effects of Wildfire Smoke on Air Quality and Public Health

Wildfire smoke poses a growing threat to air quality and public health, according to a 2022 report from the National Academies of Science, Engineering, and Medicine.¹⁵ Of the pollutants found in wildfire smoke, fine particulate matter is the main pollutant of concern with regard to

¹³The 2018 *Fourth National Climate Assessment* and other studies have found that increases in the frequency of wildfires in the western United States are due in part to climate change, which has contributed to increasing temperatures and droughts in the West, as well as a later onset of rains that end fire seasons. The assessment expresses high confidence that rising temperatures and earlier spring snowmelt will very likely result in lengthening the wildfire season in portions of the United States, leading to an increased frequency of wildfires and associated smoke. According to the assessment, there is very high confidence that increasing exposure to wildfire smoke will increase adverse health impacts. However, the assessment notes that the frequency and severity of wildfire occurrence in the future will be largely determined by forest management practices and climate adaptation measures, which are very uncertain. Additionally, the assessment reports that it is unclear if the apparent climate-related increase in area burned by wildfire is outside the range of what has been observed over centuries of fire occurrence. U.S. Global Change Research Program, *Fourth National Climate Assessment*. See also Holden, Z. A. et al., “Decreasing fire season precipitation increased recent western US forest wildfire activity,” *Proceedings of the National Academy of Sciences*, vol. 115, no. 36 (2018): E8349-E8357.

¹⁴The 2018 *Fourth National Climate Assessment* states that there is a broad and consistent evidence base leading to a high-confidence conclusion that the increasing impacts of wildfire are very likely, including increased smoke and adverse effects on air quality. U.S. Global Change Research Program, *Fourth National Climate Assessment*.

¹⁵National Academies of Science, Engineering, and Medicine, *Wildland Fires: Toward Improved Understanding and Forecasting of Air Quality Impacts: Proceedings of a Workshop* (Washington, D.C.: 2022).

human health.¹⁶ EPA estimated that wildfire smoke contributed approximately 30 percent of the nation’s directly emitted fine particulate matter pollution in 2017.¹⁷

Fine particulate matter can cause health problems because it is small enough to be inhaled deep into the lungs and enter the bloodstream, according to EPA. Exposure to fine particulate matter may lead to a range of health effects, from minor effects, such as eye and respiratory tract irritation, to more serious effects, such as bronchitis, heart failure, and death. Certain groups of people may potentially be more at risk from various health effects from wildfire smoke exposure. For example, according to EPA, people with fewer resources may have both increased exposure and higher likelihood of insufficiently treated conditions that can exacerbate effects. Some of these individuals may already be disproportionately affected by pollution, according to EPA. Appendix III provides additional information on other populations potentially at greater risk from wildfire smoke exposure.

Smoke from wildfires, which can travel thousands of miles, affects tens of millions of people in the United States, creating local, regional, and national air quality and public health concerns (see text box and fig. 2).¹⁸ EPA uses the term “smoke event” to describe an episode in which wildfire smoke makes the air unhealthy to breathe. Smoke events can last days, weeks, or even months.

¹⁶According to EPA, particulate matter is a mixture of solid particles and liquid droplets found in the air. EPA distinguishes between two categories of particulate matter: (1) particles with diameters generally larger than 2.5 micrometers and smaller than or equal to 10 micrometers (such as dust, pollen, or mold), known as PM₁₀; and (2) fine particles with diameters generally 2.5 micrometers or smaller, known as fine particulate matter or PM_{2.5}, which is about 25 times smaller than the diameter of a human hair. Approximately 90 percent of particulate matter in smoke is fine particulate matter.

¹⁷Environmental Protection Agency, *2017 National Emissions Inventory (NEI) Data* (Jan. 2021), accessed Nov. 17, 2022, <https://www.epa.gov/air-emissions-inventories/2017-national-emissions-inventory-nei-data>.

¹⁸In addition to direct health effects, wildfire smoke can affect the economy through, for example, effects on agricultural production, outdoor worker productivity, tourism, and recreation. Wildfire smoke can also affect transportation due to decreased visibility on roads. In addition to affecting air quality, wildfires can also have significant effects on water quality. These effects are not addressed in this report.

Examples of Wildfire Effects on Air Quality and Public Health in Specific Areas

Officials we interviewed from tribal, state, and local agencies said that wildfire smoke has been progressively worsening in recent years and is affecting air quality and public health in their communities:

Hoopa Valley Tribe. An official from the Hoopa Valley Tribe located in California said that the Hoopa Valley region has seen wildfires become more intense and wildfire seasons last longer. Every year, the resulting poor air quality severely affects the health of communities in Hoopa Valley and the surrounding areas, according to the official.

Yurok Tribe. An official from the Yurok Tribe located in California said that wildfire smoke events have become more frequent and intense in recent years, creating hazardous air quality. The Yurok Tribe has observed health effects from wildfire smoke on the population, including on babies and elders, according to the official.

California. Officials from the California Air Resources Board said that wildfire smoke has been increasing and contributing to worsening air quality in recent years. These officials said that in 2020, the state experienced the highest annual acreage burned in recorded history, which resulted in 70 days affected by poor air quality. That year, over 95 percent of the state's population experienced one or more days of poor air quality due to wildfire smoke, according to the officials. The officials also said that wildfires are expected to become more widespread and severe, which may lead to the entire population of almost 40 million people in California experiencing the effects of wildfire smoke.

Colorado. Officials from the Colorado Department of Public Health and Environment said that, in 2020, much of the state experienced the effects of wildfire smoke and that the state issued 167 health advisories that year. According to the officials, in August 2021, the city of Denver was reported to have the worst air quality of any city in the world for several hours during a day when smoke from western wildfires polluted the area.

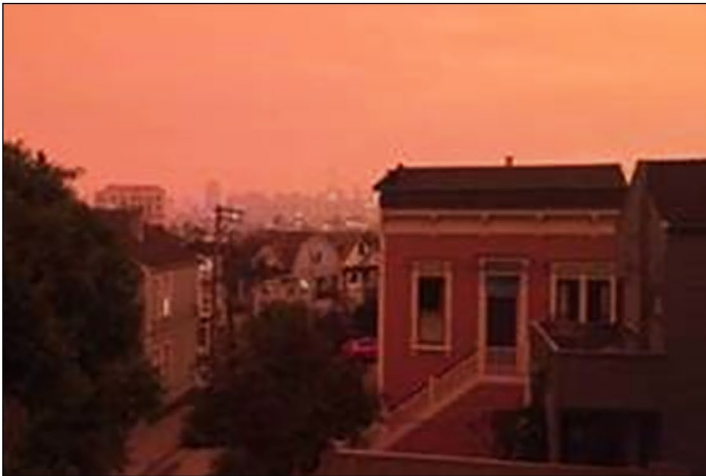
Oregon. Officials from the Oregon Department of Environmental Quality told us that wildfire smoke has been progressively worsening in recent years. They said that, in 2021, the community of Klamath Falls experienced wildfire smoke nearly every day from August 1 through October 1.

Clark County, Nevada. Officials from the Clark County Division of Air Quality stated that air quality impacts from wildfire smoke have progressively worsened over the past decade. These officials said that wildfire smoke generally affects Clark County, which includes the city of Las Vegas, from May through September each year and that wildfire smoke events are becoming more prolonged, lasting days or weeks.

Missoula City-County, Montana. Officials from the Missoula City-County Health Department said that Missoula County has experienced high levels of wildfire smoke with notable impacts on air quality for 5 of the 10 years from 2012 through 2021. These officials said that, in 2017, the area experienced 1.5 months of continuous wildfire smoke.

Source: GAO analysis of information from stakeholders. | GAO-23-104723

Figure 2: Examples of Wildfire Smoke Effects on Air Quality



Smoky skies in San Francisco from several California wildfires, late morning, Sept. 9, 2020.

Source: GAO. | GAO-23-104723



Smoky sunset in Yellowstone National Park from wildfires in Montana, Aug. 22, 2020.

In addition to fine particulate matter, wildfire smoke contains a complex mixture of other pollutants that degrade air quality. The pollutants found in wildfire smoke can vary depending on factors such as the temperature of the fire, the type of vegetation burned, and whether the fire burns structures and other human-made materials. Pollutants in wildfire smoke can include air toxics, carbon monoxide, and pollutants that lead to ozone formation. All of these pollutants can lead to a range of negative health effects. Appendix III provides more information on wildfire smoke pollutants and health effects.

In addition to affecting outdoor air quality, wildfire smoke can enter buildings and affect indoor air quality in places such as homes and schools. Wildfire smoke can enter buildings through open windows and doors; heating, ventilation, and air-conditioning (HVAC) systems; bathroom or kitchen fans that vent outdoors; and small openings around closed windows and doors.

Managing Disaster Risks and Enhancing Disaster Resilience

Disaster Risk Management

According to a 2012 report by the National Academies, the risks posed by disasters, such as wildfires, depend on factors, including (1) the severity

and likelihood of a hazard causing a risk; (2) vulnerability to—or the potential for harm and disruption from—the risk; and (3) the number of people and assets exposed to the risk.¹⁹ The report identified the following phases of managing disaster risk to address the hazard, vulnerability, and exposure:

- **Hazard mitigation:** Investing in hazard mitigation is one way to reduce future risk to people and property from disasters. Hazard mitigation is any sustainable action taken in advance of disasters that reduces or eliminates long-term risk to people and property from future disasters, according to the Federal Emergency Management Agency. In the case of wildfires and their effects on air quality and public health, hazard mitigation could include wildfire risk mitigation—that is, taking actions before a fire occurs to reduce the risk of future wildfires that produce large amounts of smoke. As we have previously reported, such actions may include implementing strategies for reducing the buildup of materials that can fuel a fire.²⁰
- **Preparedness:** Actions to prepare in advance of disasters can help address risks that remain after hazard mitigation. As noted in the 2014 National Cohesive Wildland Fire Management Strategy, fire is a natural process necessary for the maintenance and health of many ecosystems.²¹ Therefore, there will always be wildfires and wildfire smoke. According to EPA, actions to help communities prepare for smoke events could include (1) identifying populations vulnerable to smoke and effective ways to provide information to help them plan for how to protect themselves during smoke events; (2) setting up communication methods so that community members know where to find critical information; (3) creating and effectively using public “cleaner air” centers where community members can go for healthy indoor air; and (4) purchasing, storing, and establishing plans for distributing protective equipment such as N95 respirators, portable air cleaners, or high efficiency HVAC filters.
- **Response:** Response actions occur during or immediately after a disaster to save lives, protect property and the environment, and meet

¹⁹National Research Council of the National Academies of Science, Engineering, and Medicine, *Disaster Resilience: A National Imperative* (Washington, D.C.: 2012).

²⁰GAO, *Wildland Fire: Federal Agencies' Efforts to Reduce Wildland Fuels and Lower Risk to Communities and Ecosystems*, [GAO-20-52](#) (Washington, D.C.: Dec. 19, 2019).

²¹U.S. Department of Agriculture and Department of the Interior, *National Strategy, The Final Phase in the Development of the National Cohesive Wildland Fire Management Strategy* (Apr. 2014).

basic human needs. The effectiveness of these actions depends on the level of preparedness in place to reduce vulnerabilities. Wildfire smoke response actions are aimed at helping reduce smoke exposure for firefighters and the public. For wildfire smoke events—which, unlike other disasters, can sometimes last for weeks or months—response actions could include (1) monitoring and communicating information about air quality, how it may change, and what measures people should take to protect themselves; (2) distributing protective equipment and providing instructions on its proper use; and (3) modifying wildfire management strategies and tactics to reduce smoke impacts on firefighters and the public.²²

- **Recovery:** Recovery actions involve helping communities restore essential services and repair damages caused by an event. Wildfire smoke events do not typically require the recovery actions needed after many types of disasters, such as rebuilding infrastructure systems and restoring health, social, and community services. However, in some instances when a wildfire burns close to populated areas, buildings and homes may sustain smoke damage and require remediation.

Disaster Resilience Framework

In October 2019, we issued the *Disaster Resilience Framework* to help federal agencies and policymakers consider what kinds of actions they could take to reduce disaster risk and thereby enhance disaster resilience.²³ Disaster resilience refers to the ability to prepare for anticipated hazards, adapt to changing conditions, and withstand and recover rapidly from disruptions. The *Framework* is organized around three high-level and overlapping principles—integration, information, and incentives—that can help identify opportunities to enhance federal efforts to reduce disaster risk and enhance disaster resilience. Users of the *Framework* can consider its principles to analyze any type of existing federal effort across all phases of disaster management: hazard mitigation, preparedness, response, and recovery. Such an analysis can help federal agencies and policymakers consider what kinds of actions to take if they seek to promote and facilitate disaster risk reduction.

²²These are examples of potential response actions identified by the CDC, Forest Service, or Interior.

²³[GAO-20-100SP](#). We reported that funding disaster resilience primarily in reaction to disasters that have already occurred has not worked efficiently across federal programs. We also noted that, due to the complexity and seriousness of natural disasters, solutions will be multifaceted and often require cooperation across agencies, governments, and sectors.

According to the Framework, the federal government can help enhance resilience to disasters by, for example:

- **Integrating** planning to bring together agencies with different missions and across sectors to take coordinated resilience actions. In this regard, federal efforts can (1) help to establish overarching strategies that guide national resilience efforts, and (2) convene stakeholders with different perspectives and interests to create whole systems solutions.
- Providing reliable and authoritative **information** about current and future risk to help decision makers understand the risks they face and assess alternative strategies to reduce the risks. In addition, information on risks can help contribute to an understanding of approaches for estimating the returns on investments to reduce disaster risk.
- Providing **incentives** and reducing disincentives—including in the form of federal regulatory requirements or as conditions of federal financial assistance—to enhancing disaster resilience, which can make risk reduction measures more viable and improve program design to motivate risk-reduction actions.

EPA Implements Federal Air Quality Requirements, and Federal Land Management Agencies Mitigate Wildfire Risks and Respond to Wildfire Smoke Events

EPA Implements Federal Air Quality Requirements to Protect Public Health, Including by Assessing Data about Air Affected by Wildfire Smoke

EPA is the federal agency responsible for implementing federal air quality requirements through administration of the Clean Air Act.²⁴ The act requires EPA to establish standards for certain pollutants in the ambient—or outdoor—air to protect the public health or welfare. EPA has set these National Ambient Air Quality Standards (NAAQS) for six “criteria” pollutants, including particulate matter, ozone, and carbon monoxide—all pollutants in wildfire smoke.²⁵

Under the Clean Air Act, states—and in some instances, local governments—are responsible for managing air quality in their jurisdictions, including by monitoring air quality and by establishing State Implementation Plans that describe how each state will attain and

²⁴42 U.S.C. § 7401 et seq. The purposes of the Clean Air Act include, among other things, to protect and enhance the quality of the nation’s air resources so as to promote the public health and welfare and the productive capacity of its population. 42 U.S.C. § 7401(b)(1).

²⁵The remaining three criteria air pollutants are lead, sulfur dioxide, and nitrogen dioxide. For particulate matter, EPA has established standards for both PM_{2.5} and PM₁₀. Criteria pollutants are pollutants that come from numerous or diverse mobile or stationary sources and that the emissions of which, in EPA’s judgment, cause or contribute to pollution that may reasonably be anticipated to endanger public health or welfare. The Clean Air Act establishes two types of NAAQS: primary, which are health based, and secondary, which are welfare based.

maintain compliance with the NAAQS.²⁶ Further, under EPA's Tribal Authority Rule, Tribes have the ability to develop air quality management programs.²⁷ To determine compliance with NAAQS, tribal, state, and local governments operate air quality monitors that are part of a national monitoring system to measure air pollution levels around fixed locations using standardized methods.²⁸

EPA has established procedures for assessing data about the quality of air affected by wildfire smoke and, in certain cases, excluding such data in determining compliance with NAAQS. Specifically, the Clean Air Act, as amended in 2005, called for EPA to promulgate regulations governing the review and handling of air quality monitoring data influenced by an "exceptional event."²⁹ The Clean Air Act also provides that such regulations are to, among other things, include a process for EPA to exclude air quality monitoring data influenced by these events from use in

²⁶A State Implementation Plan is a collection of regulations and documents used by a state or local air district to implement, maintain, and enforce the NAAQS and to fulfill other requirements of the Clean Air Act. These plans are required to include, among other things, enforceable emissions limitations and other control measures and a program to provide for the enforcement of such measures. Contents submitted with these plans include, for example, documentation of permitting programs, vehicle inspection and maintenance plans, monitoring networks, and emissions inventories.

²⁷The Tribal Authority Rule, finalized in February 1998, implements the provisions of section 301(d) of the Clean Air Act authorizing eligible Tribes to implement their own tribal programs. See 63 Fed. Reg. 7254 (Feb. 12, 1998) (implementing 42 U.S.C. § 7601(d)).

²⁸For additional information, see our prior report on the national air quality monitoring system, GAO, *Air Pollution: Opportunities to Better Sustain and Modernize the National Air Quality Monitoring System*, [GAO-21-38](#) (Washington, D.C.: Nov. 12, 2020).

²⁹Pub. L. No. 109-59, § 6013(a), 119 Stat. 1144, 1882 (amending 42 U.S.C. § 7619 to address exceptional events). Under the Clean Air Act, an "exceptional event" is an event that affects air quality, is not reasonably controllable or preventable, is caused by human activity that is unlikely to recur at a particular location or a natural event, and is determined by EPA through a process established by regulation to be an exceptional event. 42 U.S.C. § 7619(b)(1); 40 C.F.R. § 50.1(j). Regulations implementing the Clean Air Act provide that meteorological events involving high temperatures or lack of precipitation do not directly cause pollutant emissions and are not considered exceptional events. The regulations further note, however, that conditions involving high temperatures or lack of precipitation may promote occurrences of particular types of exceptional events, such as wildfires or high-wind events, which do directly cause emissions. 40 C.F.R. § 50.1(j).

EPA's determination of whether an area complies with the NAAQS.³⁰ EPA has issued regulations determining several types of events, including wildfires, as added in 2016 when EPA substantially revised its regulations, to be exceptional events.³¹ The Exceptional Events Rule establishes criteria and procedures for determining whether an event is an exceptional event, including that there must be a clear causal relationship between the specific event and the monitored exceedance of NAAQS.³² If a tribal, state, or local air agency demonstrates, to EPA's satisfaction, that emissions from wildfires caused an exceedance of one or more NAAQS—through an analysis called an exceptional event demonstration—EPA is to exclude the air quality monitoring data from use in determinations of whether the area was in compliance with NAAQS.³³

Since EPA started tracking exceptional event demonstrations, the number of wildfire exceptional event demonstrations submitted by air agencies has generally increased (see fig. 3).³⁴ As of September 2022, EPA had concurred with 26 exceptional events demonstrations for wildfires

³⁰Specifically, under the Clean Air Act, EPA's regulations are to, among other things, provide that there are criteria and procedures for a state to petition EPA to exclude air quality monitoring data that is directly due to exceptional events from use in determinations by EPA with respect to exceedances or violations of the NAAQS. 42 U.S.C. § 7619(b)(3)(B)(iv).

³¹40 C.F.R. § 50.14(b)(4). In addition to wildfires, other types of events that EPA has determined to be exceptional events include high-wind dust events, prescribed fires, and stratospheric intrusions.

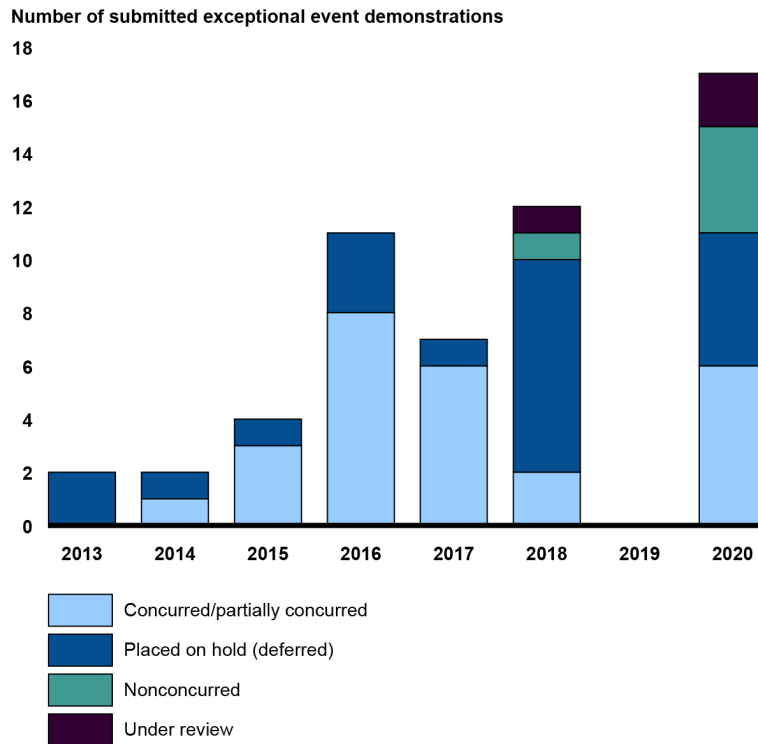
³²See 40 C.F.R. § 50.14.

³³Specifically, EPA is to exclude data from use in determinations of exceedances and violations of NAAQS for certain regulatory determinations where a tribal, state, or local air agency demonstrates to EPA's satisfaction that emissions from wildfires caused a specific air pollution concentration in excess of one or more NAAQS at a particular air quality monitoring location and otherwise satisfies the requirements of the Exceptional Event Rule. 40 C.F.R. § 50.14(b)(4).

³⁴EPA began formally tracking exceptional event demonstration submissions after promulgation of the final Exceptional Events Rule in 2016. See 81 Fed. Reg. 68,216 (Oct. 3, 2016). Demonstrations submitted in 2016 cover exceptional events that occurred as far back as 2013.

occurring from 2013 through 2020 in states across the country, including California, Colorado, Rhode Island, and Texas.³⁵

Figure 3: Number of Wildfire Exceptional Event Demonstrations Submitted to EPA, and EPA Decisions, Fiscal Years 2013–2020, as of Sept. 1, 2022



Source: GAO analysis of Environmental Protection Agency (EPA) data. | GAO-23-104723

Note: EPA did not receive any exceptional event demonstrations for wildfires occurring in 2019. According to the National Interagency Fire Center, 2019 was a below-average year in the United States for both fire frequency and size.

When an area has recurring exceptional events—at least three events in a 3-year period—the Exceptional Events Rule requires that the Tribe,

³⁵Data were current as of September 2022. These 26 demonstrations include those for which EPA partially concurred. According to EPA officials, the agency may partially concur with a demonstration when, for example, only some of the days covered in the demonstration had pollutant concentrations that would affect compliance with NAAQS.

state, or locality develop a mitigation plan.³⁶ EPA regulations require each mitigation plan to include provisions for (1) public notification to and education programs for affected or potentially affected communities; (2) steps to identify, study, and implement mitigating measures; and (3) periodic review and evaluation of the mitigation plan and its implementation and effectiveness by the air agency and all interested stakeholders.³⁷ As of April 2022, EPA had identified 15 areas in California, Colorado, Montana, and Nevada that were required to develop mitigation plans for wildfires.³⁸

Federal Land Management Agencies Lead Efforts to Mitigate Wildfire Risk and Respond to Wildfire Smoke Events

Federal land management agencies—the Forest Service and Interior’s Bureau of Land Management, Fish and Wildlife Service, and National Park Service—lead efforts to mitigate wildfire risk on federal lands, which can help reduce the amount of potential smoke from future wildfires. The Forest Service also coordinates an interagency program for responding to wildfire smoke events that provides technical specialists to assess and communicate smoke risks during wildfires.

Federal Efforts to Mitigate Wildfire Risk

Federal land management agencies have primary responsibility for managing the risk of wildfires on federal and tribal lands. The Forest Service, Bureau of Land Management, Fish and Wildlife Service, and National Park Service manage more than 670 million acres of federal land across the country. In addition, the Bureau of Indian Affairs is responsible for administering approximately 55 million acres of lands held in trust by the United States for Indian Tribes, individuals, and Alaska Natives. The federal land management agencies have estimated that over 100 million

³⁶40 C.F.R. § 51.930(b)(1). Specifically, the Exceptional Events Rule requires all states having areas with historically documented or known seasonal events, which include events of the same type and pollutant that recur in a 3-year period, to develop a mitigation plan.

³⁷40 C.F.R. § 51.930(b)(2).

³⁸EPA recommends that Tribes and states determine the boundaries for such areas based on five factors: (1) air quality data, (2) emissions data, (3) meteorology, (4) geography or topography, and (5) jurisdictional boundaries. The 15 areas required to develop mitigation plans for wildfires are Butte County, CA; Nevada County, CA; Sacramento, CA; Santa Barbara County, CA; San Joaquin Valley, CA; South Coast, CA; Tehama County, CA; Ventura County, CA; Denver-Boulder-Greeley-Ft. Collins-Loveland, CO; Missoula County, MT; Ravalli County, MT; Carson City, NV; Clark County, NV; Douglas County, NV; and Washoe County, NV.

acres of federal lands are at high risk from wildfire.³⁹ State forestry agencies and other nonfederal entities—including tribal, county, city, and rural fire departments—have primary responsibility for managing the risk of wildfires on nonfederal lands.⁴⁰ A report by the National Association of State Foresters estimated that over 63,000 communities nationwide are considered to be at risk from wildfire in fiscal year 2021.⁴¹

Land management agencies mitigate wildfire risk using methods that reduce fuels on the landscape.⁴² Reducing fuels in areas where a large amount has accumulated can help reduce a wildfire’s intensity, which in turn can help mitigate the risk that the wildfire poses to communities, structures, and firefighter safety, as well as to air quality and public health, according to the 2014 National Cohesive Wildland Fire Management Strategy developed by USDA and Interior.⁴³ As we reported in 2019, according to Forest Service and Interior documents and officials, methods used to reduce fuels to mitigate the risk of wildfires include

³⁹In 2018, the Forest Service estimated that there were approximately 63 million acres of national forest lands at high to very high risk from wildfire. In July 2019, Interior officials estimated that 54 million acres of the lands Interior’s agencies manage or administer were at high or very high risk from wildfire.

⁴⁰We previously reported on federal-nonfederal collaboration to reduce wildfire risks. See GAO, *Wildland Fire Risk Reduction: Multiple Factors Affect Federal-Nonfederal Collaboration, but Action Could Be Taken to Better Measure Progress*, [GAO-17-357](#) (Washington, D.C.: May 10, 2017).

⁴¹National Association of State Foresters, *Communities at Risk, Fiscal Year 2021 Report* (Washington, D.C.: 2022). The National Association of State Foresters is a non-profit organization composed of the directors of forestry agencies in the 50 states, the District of Columbia, five U.S. territories, and three nations in compacts of free association with the United States.

⁴²As we previously reported, fires have an important ecological role on the nation’s landscapes. However, various management practices over the past century—including fire suppression, timber harvesting, and grazing—have altered the normal frequency of fires in many forest and grassland ecosystems and have increased these ecosystems’ vulnerability to catastrophic fire. This history of fire suppression and forest management has resulted in a buildup of surface fuels and the overstocking of some forests with trees and other fuels. See [GAO-20-52](#).

⁴³The Federal Land Assistance, Management, and Enhancement Act of 2009 required the Secretary of the Interior and the Secretary of Agriculture to submit to Congress a report that contains a cohesive wildfire management strategy. Pub. L. No. 111-88, tit. V, § 503, 123 Stat. 2968, 2971. The subsequent National Cohesive Wildland Fire Management strategy provides a national framework designed to more fully integrate fire management efforts across jurisdictions, manage risks, and protect firefighters, property, communities, and landscapes. See U.S. Department of Agriculture and Department of the Interior, *The National Cohesive Wildland Fire Management Strategy*.

mechanical treatments, prescribed burns, and herbicides and targeted grazing (see table 1 and fig. 4).⁴⁴

Table 1: Fuel Reduction Methods to Help Mitigate Wildfire Risk

Fuel reduction method	Description and benefits	Potential limitations and considerations
Mechanical treatments	This method entails using equipment such as chainsaws, masticators, bulldozers, or mowers to cut and remove vegetation. Mechanical treatments reduce tree density where there are abnormally dense groups of trees or layers of vegetation close to the ground to help reduce the risk of a wildfire becoming catastrophic.	Mechanical treatments may also increase the amount of smaller fuels on the ground, including treetops, limbs, and other debris from thinning, which can in some cases increase a fire's intensity or rate of spread. In addition, mechanical treatments are often planned in conjunction with prescribed burns to remove or reduce fuels that remain after the treatment.
Prescribed burns	This method entails using deliberate, planned fires set by land managers to reduce fuels and restore or maintain desired ecosystem conditions. Prescribed burns are planned and implemented under specified fuel and weather conditions and are designed to meet land management and safety objectives. Prescribed burns can be effective in removing smaller vegetation that can fuel a fire—such as grasses, leaves, pine needles, and twigs—which can reduce a future fire's intensity and rate of spread.	Smoke produced from prescribed burns and the risk of a prescribed burn spreading into other areas can limit the use of prescribed burns near communities. To reduce the potential effects of smoke from prescribed burns, land managers use established practices for managing smoke, such as (1) evaluating where smoke may travel based on meteorological conditions; (2) monitoring how smoke affects air quality; and (3) using techniques—like allowing the material to dry before burning—to minimize the effects of smoke on the public and avoid exceedances of National Ambient Air Quality Standards. ^a Tribal, state, and local air agencies often require permits for prescribed burns.
Herbicides and targeted grazing	Herbicides can be used to reduce fuels such as by killing fast growing vegetation to maintain an existing fuel reduction project. Targeted grazing—the intentional use of cows, sheep, or goats to eat vegetation in a specified area—can also be used to reduce grasses and other small fuels.	Although herbicide kills vegetation, it does not remove it, potentially increasing an area's susceptibility to wildfire if further action—such as prescribed burning—is not taken to remove the dead fuel.

Source: GAO analysis of information from the U.S. Forest Service and Department of the Interior. | GAO-23-104723

^aThese practices are called Basic Smoke Management Practices. The Environmental Protection Agency's Exceptional Events Rule under the Clean Air Act provides that in order for a prescribed fire to qualify as an exceptional event, a state must either certify that it has adopted and is implementing a smoke management program, or demonstrate that the burn manager employed appropriate Basic Smoke Management Practices identified in the regulations. 40 C.F.R. §50.14(b)(3)(ii)(A). The Forest Service and Interior have policies noting that prescribed fires should generally be conducted using Basic Smoke Management Practices.

⁴⁴GAO-20-52.

Figure 4: Example of a Prescribed Burn That Removed Smaller Vegetation and Left Mature Trees Unharm



Source: Wildland Fire Leadership Council (U.S. Department of Agriculture Forest Service photos). | GAO-23-104723

The federal land management agencies lead key national-level wildfire mitigation groups. The groups include the Wildland Fire Leadership Council, White House Wildfire Resilience Interagency Working Group, and Wildland Fire Mitigation and Management Commission.⁴⁵ These three groups are federal interagency and intergovernmental entities that develop strategies for addressing wildfire risks across the country.

The Wildland Fire Leadership Council oversees implementation of the 2014 National Cohesive Wildland Fire Management Strategy, which sets broad, strategic, and national-level direction for implementing actions and activities across the nation to manage fires and associated risks, among other things.⁴⁶ The Cohesive Strategy describes ways the nation can make strategic investments intended to reduce the effects of wildland fire on high-risk areas. To complement the Cohesive Strategy, the Forest Service and Interior land management agencies have implementation strategies that document their plans and priorities for reducing wildfire risk to people, communities, and natural resources through wildfire mitigation.⁴⁷ For example, the Forest Service's strategy calls for, over 10 years, carrying out fuel reduction activities on 20 million acres in the National Forest system and up to an additional 30 million acres on other federal, tribal, state, and private lands in the West. Funding authorized in

⁴⁵The Wildland Fire Leadership Council was established in 2002 by the Secretaries of Agriculture and the Interior to provide an intergovernmental committee to support the implementation and coordination of federal fire management policy. Its members include federal, tribal, state, county, and municipal government members. The White House Wildfire Resilience Interagency Working Group is chaired by USDA and Interior and was tasked by the President to develop broad, national strategies to address the growing risks from wildfires, according to Forest Service officials. The Wildland Fire Mitigation and Management Commission was established in December 2021 by USDA and Interior, and the Federal Emergency Management Agency in response to the Infrastructure Investment and Jobs Act of 2021. The act called for the establishment of the commission to study and make recommendations to improve federal policies relating to (1) the prevention, mitigation, suppression, and management of wildland fires in the United States; and (2) the rehabilitation of land in the United States devastated by wildland fires. Pub. L. No. 117-58, § 70203(a), 135 Stat. 429, 1252. The commission is co-chaired by USDA and Interior and the Federal Emergency Management Agency. It includes 11 federal members and 36 nonfederal members (18 primary members and 18 alternate members representing diverse backgrounds related to wildfire issues).

⁴⁶U.S. Department of Agriculture and Department of the Interior, *The National Cohesive Wildland Fire Management Strategy*.

⁴⁷See U.S. Department of Agriculture, Forest Service, *Confronting the Wildfire Crisis: A 10-Year Implementation Plan*, FS-1187b (Washington, D.C.: Jan. 2022) and Department of the Interior, *Infrastructure Investment and Jobs Act Wildfire Risk Five-Year Monitoring, Maintenance, and Treatment Plan* (Washington, D.C.: Apr. 2022).

Federal Efforts to Respond to Wildfire Smoke Events

the 2021 Infrastructure Investment and Jobs Act (also known as the Bipartisan Infrastructure Law), including \$1 billion for prescribed fire and mechanical treatments, provides a significant investment in achieving the fuel reduction goals, according to Forest Service officials.⁴⁸

In 2007, the Forest Service initiated the Interagency Wildland Fire Air Quality Response Program to directly assess, communicate, and address risks posed by wildfire smoke to the public and fire personnel.⁴⁹ The program deploys technical specialists with training and expertise in air quality science to certain wildfires. These specialists—known as air resource advisors—predict wildfire smoke dispersion; deploy monitors to measure the effects of wildfire smoke on air quality; provide smoke forecasts that include information about how people can stay safe; and coordinate with tribal, state, and local air quality agencies, public health officials, and community leaders to help them understand and consistently communicate smoke risks.⁵⁰ According to its annual report, in 2021 the Interagency Response Program deployed 101 air resource advisors to incident management teams that respond to wildfires.⁵¹

⁴⁸The Infrastructure Investment and Jobs Act of 2021 authorized almost \$3.4 billion to be appropriated to the Secretary of the Interior and the Secretary of Agriculture to conduct various activities related to wildfire risk reduction, including planning and conducting prescribed fires, as well as conducting certain mechanical treatments. Pub. L. No. 117-58, § 40803(c), 135 Stat. 429, 1097. The act provides that, of federal land and certain tribal land that has been identified as having a very high wildfire hazard potential, Interior and Forest Service are to conduct restoration treatments, by the end of fiscal year 2027, of 10 million acres located in the wildland-urban interface or a public drinking water source area. *Id.* § 40803(b). Additionally, subsequently enacted legislation commonly referred to as the Inflation Reduction Act of 2022 appropriated \$1.8 billion to USDA for hazardous fuels reduction projects on National Forest System land within the wildland-urban interface. Pub. L. No. 117-169, § 23001(a)(1), 136 Stat. 1818, 2023. The act defines “hazardous fuels reduction project” as an activity, including the use of prescribed fire, to protect structures and communities from wildfire that is carried out on National Forest System land. *Id.* § 23001(e)(3).

⁴⁹The Forest Service initiated the Response Program in 2007 to help manage the smoke impacts from active fires. The program was codified in 2019 by the John D. Dingell, Jr. Conservation, Management, and Recreation Act, which called for the Secretaries of Agriculture and the Interior to establish the Interagency Wildland Fire Air Quality Response Program. Pub. L. No. 116-9, § 1114(f), 133 Stat. 580, 617.

⁵⁰Air resources advisors have come from federal, tribal, state, and local air, forestry, and health agencies, as well as the private sector.

⁵¹Interagency Wildland Fire Air Quality Response Program, *2021 Annual Report: A Nation in Wildfire Smoke*.

In addition, the Interagency Response Program maintains a cache of over 100 portable air quality monitors and sensors, according to Forest Service officials. These monitors and sensors can be set up during a fire to provide information in areas without the permanent monitors that Tribes, states, and local governments operate as a part of the national ambient air quality monitoring system. The information collected by the Interagency Response Program’s monitors and sensors is provided to communities affected by smoke.

EPA Provides a Range of Information and Tools That Support Efforts to Help Communities Prepare for and Respond to Wildfire Smoke Events

EPA has provided a range of information and tools to support federal and nonfederal efforts aimed at helping communities prepare for and respond to smoke events, which are two of the four phases of disaster risk management. Stakeholders we interviewed from tribal, state, and local agencies said that EPA’s actions have supported their efforts to manage the risks of wildfire smoke in important ways. The information and tools that EPA has provided, in partnership with other federal agencies in some instances, include the following: (1) research to help decision makers and the public understand the risks to air quality and public health from wildfire smoke, (2) planning information and tools to help communities prepare for wildfire smoke events, and (3) air quality information and tools to help support wildfire smoke response efforts.⁵²

Research to Help Decision Makers and the Public Understand Risks to Air Quality and Public Health from Wildfire Smoke

EPA conducts, supports, and partners on research to help decision makers and the public better understand risks to air quality and public health from wildfire smoke and make informed decisions to help reduce those risks. To identify needed research, among other things, EPA’s Office of Research and Development holds listening sessions with stakeholders, including national and regional air quality associations and tribal, state, and local air agencies, according to EPA officials. The Office of Research and Development incorporates the stakeholder feedback into its *Air, Climate, and Energy Strategic Research Action Plan*, which outlines research priorities to address EPA’s strategic objectives to improve air quality and protect public health and the environment.⁵³

EPA has also partnered with other federal entities on various research efforts. For example, EPA has coordinated with the Joint Fire Science

⁵²EPA maintains a “Smoke-Ready Toolbox” on its website that includes links to many of these information sources and tools (see <https://www.epa.gov/smoke-ready-toolbox-wildfires>).

⁵³Environmental Protection Agency, *Air and Energy Strategic Research Action Plan 2019-2022*, EPA601K20003 (Washington, D.C.: Mar. 2020).

Program and NOAA on research to identify the different amounts and types of pollutants in wildfire smoke and how these different pollutants can affect health.⁵⁴ EPA has also coordinated with the federal land management agencies and National Institute of Standards and Technology on research to examine the air quality and public health effects of prescribed burns compared to wildfire.⁵⁵ Finally, in 2017, EPA—in partnership with the Forest Service, National Park Service, NOAA, National Aeronautics and Space Administration, and the CDC—initiated a Wildland Fire Air Sensors Challenge, a competition aimed at stimulating innovation in the development of air pollutant sensors that can operate in wildfire conditions. See appendix IV for additional information on EPA research to help decision makers and the public understand air quality and public health risks from wildfire smoke.

Planning Information and Tools to Help Communities Prepare for Wildfire Smoke Events

EPA helps communities prepare for wildfire smoke events by providing and partnering on information and tools to help them plan for how to stay safe and reduce smoke exposure. Stakeholders we interviewed from state and local agencies said that this information has been useful in helping communities establish plans before a smoke event occurs to, for example, ensure that appropriate interventions are available. Such interventions may include establishing community cleaner air centers or a cache of home air filters that can be loaned to vulnerable and underserved residents. The information has also helped state and local entities educate the public about the risks of wildfire smoke and how people can protect themselves and their families.

EPA has coordinated with other federal agencies to provide information and tools, such as educational materials and outreach, to help communities prepare for wildfire smoke events. For example, EPA worked with the CDC, Forest Service, California Air Resources Board, and California Office of Environmental Health Hazard Assessment to

⁵⁴The Joint Fire Science Program is funded by the Department of the Interior and Forest Service. It provides funding for scientific studies associated with managing wildland fire, fuels, and fire-impacted ecosystems to respond to emerging needs of managers, practitioners, and policymakers from local to national levels. The Joint Fire Science Program has provided funding for some EPA studies related to wildfire smoke and its effect on public health.

⁵⁵Environmental Protection Agency, Center for Public Health and Environmental Assessment, Office of Research and Development, *Comparative Assessment of the Impacts of Prescribed Fire Versus Wildfire (CAIF): A Case Study in the Western U.S.*, EPA/600/R-21/197 (Research Triangle Park, N.C.: 2021). This work was coordinated through the Wildland Fire Leadership Council.

produce the 2019 Wildfire Smoke Guide for Public Health Officials.⁵⁶ In addition, EPA Region 10 coordinates an annual smoke management meeting focused on raising awareness of smoke issues and sharing new tools and resources.⁵⁷ The meeting brings together people from federal, tribal, state, and local air quality, public health, and land management agencies, as well as researchers, according to EPA officials. Also, an EPA regional office co-leads a workgroup that brings together federal, state, and local officials to discuss ongoing smoke communications work. See appendix IV for additional information on EPA planning information and tools to help communities prepare for wildfire smoke events.

Air Quality Information and Tools to Support Wildfire Smoke Response Efforts

EPA supports the Forest Service-led Interagency Response Program, as well as community efforts to respond to wildfire smoke events. EPA supports these efforts in large part by providing information and tools to help decision makers and the public understand the extent to which smoke has affected or is likely to affect air quality during wildfire smoke events.⁵⁸ Stakeholders from tribal, state, and local agencies we interviewed said that such information and tools have been valuable in supporting their communications with the public about when people should take actions to protect themselves from smoke exposure, such as by limiting outdoor activity if possible or wearing an N95 respirator.

EPA's actions to provide, at times in partnership with other agencies, air quality information and tools during wildfire smoke events include forming a partnership with the Forest Service to develop the Fire and Smoke Map. This map is available on EPA's AirNow website.⁵⁹ The Fire and Smoke Map shows near real-time air quality data from air quality monitors (typically operated by air quality agencies) and low-cost sensors

⁵⁶This guide provides tribal, state, and local public health officials with information to help them establish plans for communicating health risks and taking measures to protect the public when wildfire smoke is present. Environmental Protection Agency, Office of Air Quality Planning and Standards, Health and Environmental Impacts Division, *Wildfire Smoke: A Guide for Public Health Officials, Revised 2019*, EPA-452/R-19-901 (Research Triangle Park, N.C.: Aug. 2019). The California Air Resources Board and California Office of Environmental Health Hazard Assessment were nonfederal partners in this effort.

⁵⁷EPA Region 10 serves Alaska, Idaho, Oregon, Washington, and 271 Tribes.

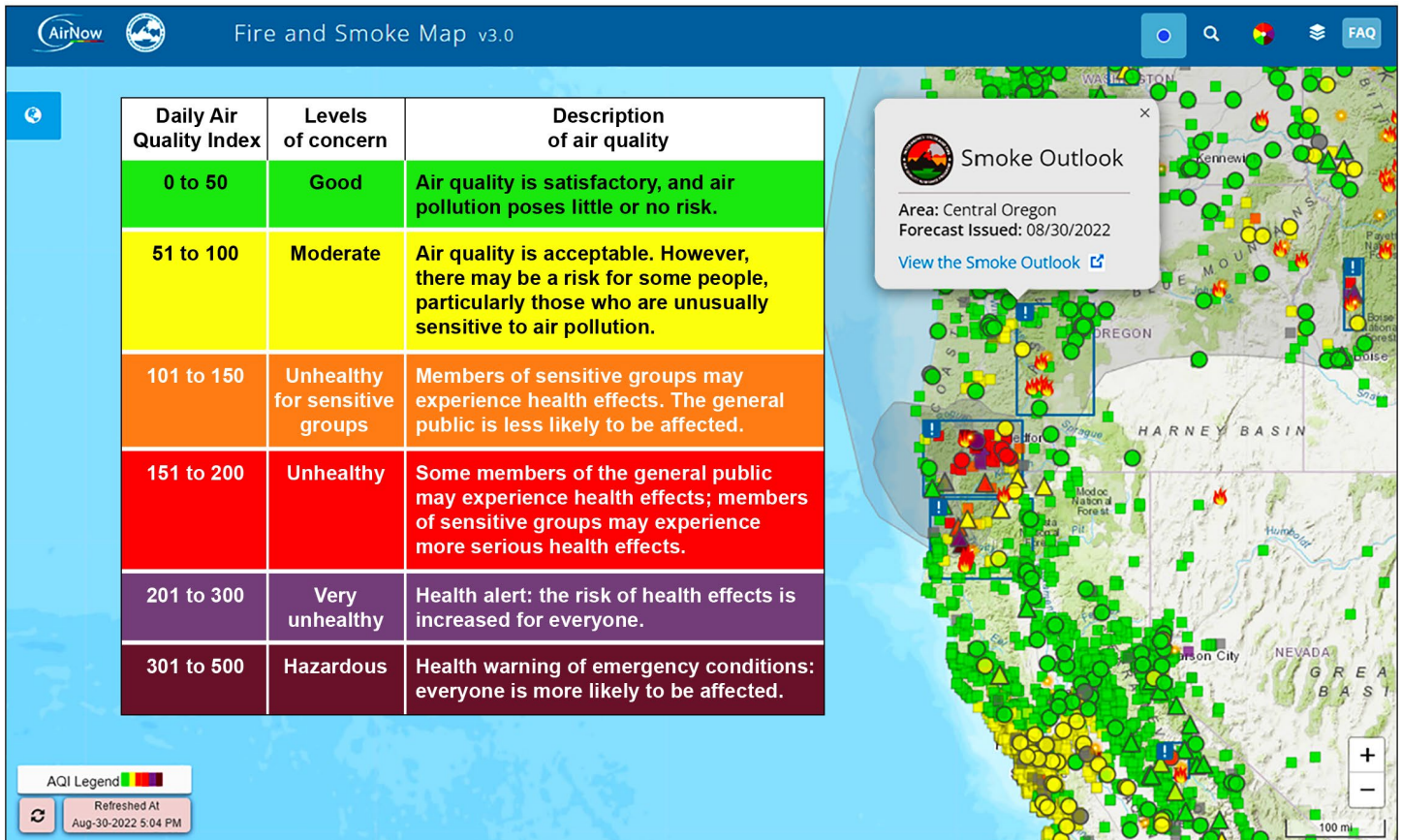
⁵⁸In [GAO-21-38](#), we reported that more widespread air quality monitoring could help air quality managers better understand the effects of wildfire smoke on air quality and public health as it moves through communities.

⁵⁹See Environmental Protection Agency and Forest Service, "Fire and Smoke Map," *AirNow*, accessed Nov. 11, 2022, <https://fire.airnow.gov>.

(operated by groups such as government agencies, community organizations, and the public), along with the locations of wildfires and satellite information on where smoke is traveling (see fig. 5).⁶⁰ In addition, to provide additional air quality monitoring during wildfires, EPA launched the Wildfire Smoke Air Monitoring Response Technology pilot program in 2021 to enhance the availability of air quality monitoring equipment in areas affected by wildfire smoke that have limited or no established air quality monitoring equipment. The program loans air quality sensors and mobile monitoring systems that can be attached to vehicles to provide air quality information at different locations during smoke events. See appendix IV for additional information on EPA air quality information and tools to help support wildfire smoke response efforts.

⁶⁰The Fire and Smoke Map also uses satellite information from NOAA to fill in gaps between ground-based monitors and sensors. A Spanish version of the Fire and Smoke Map was released in September 2022.

Figure 5: Fire and Smoke Map Showing Fire Locations, Smoke Plumes from Satellite Data, and the Air Quality Index from Air Quality Monitors and Sensors on August 30, 2022



Source: fire.airnow.gov. | GAO-23-104723

EPA Has Opportunities to Help Strengthen Efforts to Manage Wildfire Smoke Risks across Various Phases of Disaster Management

We identified opportunities for EPA to help strengthen the management of wildfire smoke risks across various phases of disaster management.⁶¹ In particular, EPA has opportunities to take a more coordinated approach to its existing preparedness and response actions. In addition, EPA has opportunities to enhance its role in supporting wildfire hazard mitigation through working with land management agencies to strengthen federal coordination, developing additional information about smoke risks, and providing incentives for and supporting mitigation activities.

EPA Has Opportunities to Take a More Coordinated Approach to Its Preparedness and Response Actions

EPA does not have a coordinated agency-wide program or dedicated staff and resources for the agency's work related to helping communities prepare for and respond to wildfire smoke, according to EPA officials. Specifically, the officials told us that staff in various EPA program and regional offices plan and implement these actions in an ad hoc manner. Officials from EPA and the Forest Service said that the various offices within EPA working on wildfire smoke issues do not have coordinated strategies and goals. In addition, EPA officials said that EPA has few dedicated resources for managing wildfire smoke issues, and that they are not able to implement all the actions they have identified that could help manage the effects of wildfire smoke. They said that, due to the agency's limited resources, most wildfire smoke activities are done in addition to employees' regular job duties. Other than scientists working specifically on wildfire smoke issues and one staff member in Region 10, as of September 2022, no other positions within EPA formally included wildfire smoke responsibilities, according to EPA officials.

EPA and others have said that efforts to build on the agency's existing work are important for managing the growing risks posed by wildfire smoke. EPA has identified additional actions it plans to take in its strategic plan for 2022 through 2026 and its October 2021 Climate

⁶¹The chronologic order of the disaster management phases is hazard mitigation, preparedness, response, and then recovery. In this section, we discuss preparedness and response actions first because these phases are where EPA has focused most of its actions. Our analysis of literature and stakeholder views did not identify specific opportunities for EPA to better manage risks to air quality and public health from wildfire smoke that were related to the recovery phase of disaster management. We previously reported on improving the federal government's approach to disaster recovery. See GAO, *Disaster Recovery: Actions Needed to Improve the Federal Approach*, [GAO-23-104956](#) (Washington, D.C.: Nov. 15, 2022).

Adaptation Action Plan.⁶² For example, the strategic plan states that EPA will work with federal partners to improve smoke forecasting abilities, identify and communicate when and where smoke events are happening, build local capacity to help communities prepare for the risks of wildfire smoke before wildfires occur, and provide tools and resources for communities for health protection during smoke events.

Furthermore, our analysis of literature and stakeholder views identified examples of potential actions that EPA could take to build on its current preparedness and response actions (see app. II). These actions fell into categories such as providing additional assistance for communities to prepare for wildfire smoke events, helping build more capacity for air quality monitoring during smoke events, and enhancing research on the effectiveness of interventions to reduce exposure during smoke events. For example, a stakeholder said that EPA could invest in further studies to understand the impacts on indoor air quality during wildfire smoke events and help identify effective approaches for protecting indoor air.

We have identified leading practices for collaboration that could provide opportunities for EPA to take a more coordinated approach within the agency as it builds on its current actions for helping communities prepare for and respond to wildfire smoke.⁶³ Specifically, according to selected leading practices, EPA has opportunities take a more coordinated approach by

- **Identifying outcomes and reinforcing accountability.** We have previously reported that leading practices to enhance and sustain collaboration include clearly defining short-term and long-term outcomes and goals and monitoring progress toward meeting those goals.⁶⁴ However, according to EPA officials, EPA has not established

⁶²Environmental Protection Agency, *Fiscal Year 2022-2026 EPA Strategic Plan* (Washington, D.C.: Mar. 28, 2022); and *Climate Adaptation Action Plan* (Washington, D.C.: Oct. 2021).

⁶³GAO-12-1022 identified seven leading practices that can enhance collaboration. We selected three of these practices: (1) identifying outcomes and reinforcing accountability, (2) identifying and leveraging resources, and (3) clarifying roles and responsibilities. We selected these practices because they most closely relate to the nature of EPA's current and potential actions to manage risks to air quality and public health from wildfire smoke. The other practices are bridging organizational cultures, identifying leadership, including relevant participants, and documenting collaboration through written guidance and agreements.

⁶⁴GAO-12-1022.

common goals across the agency for its actions to help communities prepare for and respond to wildfire smoke events. EPA officials said that various groups within EPA working on wildfire smoke issues have different strategies and goals when it comes to this work. Establishing common goals and monitoring progress toward those goals could help EPA assess its priorities for helping communities prepare for and respond to risks from wildfire smoke and better identify ways to build upon the work.

- **Identifying and leveraging resources.** Leading practices for collaboration include identifying and leveraging resources, including funding and staffing, that are needed to sustain a collaborative effort.⁶⁵ According to EPA officials, limited resources constrain the agency's actions to support federal, tribal, state, and local efforts to help communities prepare for and respond to wildfire smoke events. Identifying the resources needed to achieve EPA's priorities for this work would help EPA, its partners, and Congress understand the level of investment required.
- **Clarifying roles and responsibilities.** We also reported that leading practices to enhance and sustain collaboration include clarifying roles and responsibilities.⁶⁶ EPA's actions related to supporting community efforts to prepare for and respond to wildfire smoke events require a high level of coordination with and are integrated into the programs of federal, tribal, state, and local partners, all with different missions, goals, and resources. Working with its partners to develop specific roles and responsibilities could help EPA refine its approach for building on this work on a nationwide level. For example, according to Forest Service officials, EPA could enhance collaboration with the Interagency Response Program by clarifying commitments to provide air resource advisors that communicate smoke risks to affected communities. Additionally, officials from the CDC said that creating a framework for coordinating research related to community preparedness for wildfire smoke could help federal agencies more intentionally plan such research and create a community of practice on the topic.

Using these leading practices for collaboration would provide EPA with opportunities to develop a more coordinated approach for helping communities prepare for and respond to wildfire smoke events. A more coordinated approach that establishes EPA's goals, identifies and

⁶⁵[GAO-12-1022](#).

⁶⁶[GAO-12-1022](#).

leverages resources, and involves clarifying roles and responsibilities with stakeholders could help EPA more effectively work with its partners and take additional actions needed to build on this work. Developing and documenting such an approach to guide EPA's actions would help EPA better target the agency's limited resources toward the highest priorities for managing the risks, particularly as catastrophic wildfires become more frequent and intensify these effects.

EPA Has Opportunities to Enhance Its Role in Supporting Hazard Mitigation

EPA has opportunities to reduce the risks posed by wildfire smoke by enhancing its role in hazard mitigation to reduce the likelihood of future smoke events.⁶⁷ Specifically, EPA has opportunities to (1) work with land management agencies to strengthen federal coordination to reduce smoke risks through wildfire risk mitigation; (2) develop additional information on reducing wildfire smoke risks through wildfire risk mitigation; and (3) provide incentives for and support mitigation activities at the tribal, state, and local levels.

Work with Land Management Agencies to Strengthen Federal Coordination to Reduce Smoke Risks through Wildfire Risk Mitigation

EPA and the federal land management agencies have identified areas where their respective agency missions and goals for wildfire risk mitigation are not aligned. EPA's mission is to protect public health and the environment, including by ensuring that Americans have clean air, and the agency has a strategic plan goal of "ensuring clean and healthy air for all communities."⁶⁸ To help achieve the mission and goal, EPA officials told us that they want to work with land management agencies to increase the attention paid to air quality and public health risks. The officials said that these risks are often overshadowed in national-level discussions about wildfire risk mitigation. They also said that more of an emphasis should be placed on smoke risks because wildfire smoke affects a far greater number of people than the direct effects from the fires.

EPA officials said that EPA has traditionally had informal or limited involvement in wildfire mitigation discussions. EPA's role has mostly focused on advising on issues related to managing smoke from

⁶⁷As noted by EPA officials, EPA does not implement wildfire risk mitigation efforts. Rather, land managers and owners implement such efforts, such as reducing fuels on the landscape, implementing land use and development regulations and ordinances in areas at high risk from wildfire, and educating the public to help prevent fires from starting. For additional information on wildfire risk mitigation efforts, see [GAO-17-357](#) and [GAO-20-52](#).

⁶⁸Environmental Protection Agency, *Fiscal Year 2022-2026 EPA Strategic Plan*.

prescribed burns, according to EPA officials.⁶⁹ More recently, EPA has become an official member of the Wildland Fire Leadership Council, the White House Wildfire Resilience Interagency Working Group, and the Wildland Fire Mitigation and Management Commission. According to EPA officials, the agency has opportunities to use its new position in these groups to help better protect air quality and public health in the future, as the country makes new investments in wildfire risk mitigation through recent legislation such as the Infrastructure Investment and Jobs Act. However, EPA officials said that the agency cannot simply elevate its role in wildfire risk mitigation work at the federal level and increase attention to air quality and public health issues without the support and acceptance of its federal partners.

The federal land management agencies' goals related to wildfire risk mitigation focus on restoring and maintaining landscapes so that they are resilient to fire. In national-level strategies, the agencies also identify air quality as a value at risk affected by wildfires. According to land management agency officials, the agencies view reduced effects on air quality and public health as co-benefits of wildfire risk mitigation because, in general, efforts to reduce the risk of future catastrophic wildfires will likely also reduce the amount of smoke.⁷⁰ Officials from land management agencies told us that, as the agencies begin to implement strategies for increasing wildfire risk mitigation across the landscape, air quality standards could limit their ability to make progress toward the goals for the number of acres they aim to treat with prescribed burns. Specifically, opportunities to obtain permits from state agencies for prescribed burns can be limited in areas out of compliance, or nearly out of compliance, with the NAAQS, according to Forest Service officials. If the NAAQS for fine particulate matter were lowered, a change currently under

⁶⁹According to Forest Service officials, federal land management agencies have taken the lead in identifying strategies to manage smoke from prescribed burns, including the initial development of Basic Smoke Management Practices and development of technical tools to determine prescribed burn smoke dispersion.

⁷⁰For specific wildfire risk mitigation programs or for individual fires, federal land management agency officials told us that agencies thoroughly integrate air quality considerations into their planning and execution. For example, federal land management agency officials told us that when using prescribed burns for wildfire risk mitigation, the agencies conduct extensive analysis and planning to consider and reduce the resulting air quality effects, such as through training, National Environmental Policy Act analyses that identify smoke impacts of different alternatives, smoke management permits, and smoke management compliance. Also, these officials told us that air resource advisors play a role during fires to bring consideration of air quality effects into incident management decision making.

consideration by EPA, many areas nationally would likely be out of compliance with those lower NAAQS, according to land management agency officials.⁷¹ The officials said that this would likely lead to further challenges obtaining permits for prescribed burns.

EPA and the federal land management agencies have taken steps to improve their coordination on air quality issues related to wildfire risk mitigation. In 2017 and again in 2021, the agencies signed a memorandum of understanding to develop a collaborative framework to address issues related to wildland fire and air quality and to promote forest management, including through the use of prescribed burns, to mitigate wildfire risks.⁷² In addition, in 2020, EPA, the federal land management agencies, and the Department of Health and Human Services issued a joint vision document on the relative benefits of prescribed burns to wildfire, including the message that “enhancing and creating healthy forests and rangelands is a paramount natural interest, as is maintaining clean air.”⁷³ Finally, in June 2022, EPA and the Forest Service formed a subgroup of the White House Wildfire Resilience Interagency Working Group to focus on the air quality and public health effects of smoke from wildfires and prescribed burns.

However, EPA and federal land management agency officials identified opportunities to better coordinate and align their goals. For example, EPA officials said that national-level groups working on wildfire risk mitigation strategies should increase attention to air quality and public health effects to help ensure that these strategies better consider such effects. They

⁷¹In June 2021, EPA announced its decision to reconsider a 2020 decision to retain the existing particulate matter NAAQS, noting that the available scientific evidence and technical information indicated that the current standards may not be adequate to protect public health and welfare, as required by the Clean Air Act. In January 2023, EPA issued a proposed rule to revise the primary annual fine particulate matter standard from 12.0 micrograms per cubic meter to a level within the range of 9.0 to 10.0 micrograms per cubic meter. 88 Fed. Reg. 5558 (Jan. 27, 2023).

⁷²Department of Agriculture, Department of the Interior, and Environmental Protection Agency, *Partnership Agreement Between the United States Department of Agriculture, the United States Department of the Interior, and the United States Environmental Protection Agency, Regarding Wildland Fire and Air Quality* (Jan. 12, 2017) and *Memorandum of Understanding Between the United States Department of Agriculture Forest Service and the United States Department of the Interior and the United States Environmental Protection Agency, Wildland Fire and Air Quality Coordination* (Jan. 7, 2021).

⁷³The agencies issued the joint vision document through the Wildland Fire Leadership Council. See Wildland Fire Leadership Council, *Joint Vision and Key Messages on Relative Benefits of Prescribed Fire to Wildfire* (Sept. 2020).

noted that the smoke impacts subgroup of the White House Wildfire Resilience Interagency Working Group could help strengthen communication and coordination across the federal government on issues related to wildfire smoke effects. In addition, Interior officials stated that, since fire has been suppressed on the landscape over the last century, the land management agencies need to have the flexibility to conduct prescribed burns at appropriate scales to restore forest health and resilience. Forest Service and Interior officials said that EPA's implementation of NAAQS and the Exceptional Events Rule can, at times, inhibit that flexibility.⁷⁴

In prior work, we have described the benefits of coordinating efforts across the federal government. For example, our *Disaster Resilience Framework* states that the federal government can help reduce disaster risks by promoting coordination across agency missions, integrating strategic goals, and pursuing whole systems solutions to risk reduction.⁷⁵ EPA and the federal land management agencies have also identified the need for an aligned, whole-of-government approach to wildfire risk mitigation.⁷⁶ In addition, we have identified key features that can help enhance and sustain collaboration among federal agencies, including defining and articulating a common outcome and bridging organizational cultures by establishing mutually reinforcing or joint strategies to help align the partner agencies' activities, core processes, and resources to accomplish the outcome.⁷⁷

⁷⁴Wildfires and prescribed fires are addressed separately and have different requirements for qualifying as an exceptional event, under EPA regulations. See 40 C.F.R. § 50.14(b)(3), (4).

⁷⁵[GAO-20-100SP](#).

⁷⁶EPA's Climate Adaptation Action Plan states that the agency will closely work with other federal agencies to address effects from climate change that cut across agency jurisdictions to improve the efficiency and effectiveness of the combined federal effort as part of a whole-of-government approach. See Environmental Protection Agency, *Climate Adaptation Action Plan*. Also, federal land management agencies, in their wildfire risk mitigation strategies, have committed to implementing those strategies in coordination with other federal partners. The Forest Service's strategy notes that such coordination would bring a whole-of-government approach to addressing wildfires and help achieve mutually desired goals. See U.S. Department of Agriculture, *Wildfire Crisis Implementation Plan*; and U.S. Department of the Interior, *Infrastructure Investment and Jobs Act Wildfire Risk Five-Year Monitoring, Maintenance, and Treatment Plan*.

⁷⁷[GAO-12-1022](#). See also GAO, *Results-Oriented Government: Practices that Can Help Enhance and Sustain Collaboration among Federal Agencies*, [GAO-06-15](#) (Washington, D.C.: Oct. 21, 2005).

By working together to better align air quality and land management goals for wildfire risk mitigation and establish joint strategies for achieving those goals, EPA and the federal land management agencies can create a whole systems approach that may more effectively reduce wildfire disaster risks to air quality and public health over the long term. EPA and federal land management agency officials said that such alignment was particularly important as land management agencies plan to increase the scope and scale of wildfire risk mitigation in the coming years.

Identify and Develop Additional Information on Reducing Smoke Risks through Wildfire Risk Mitigation

Officials from EPA and land management agencies said additional information could help land managers reduce wildfire smoke risks through wildfire risk mitigation. Federal land management agencies generally prioritize areas for wildfire risk mitigation efforts based on the likelihood that an ignition could expose homes, communities, and infrastructure to wildfire, among other things. However, as noted in the national-level strategies for wildfire risk mitigation, risks to air quality from smoke are also components of overall wildfire risk.

According to our analysis of literature and stakeholder views, EPA has opportunities to identify and further develop risk information to help federal agencies better manage risks to air quality and public health from wildfire smoke.⁷⁸ For example, EPA could provide the following information:

- **Relative effects of prescribed burns and potential wildfires to help most effectively use prescribed burns to reduce risks.** Prescribed burns have localized, short-term effects on air quality, but they may decrease long-term smoke effects by reducing the size, severity, and intensity of future wildfires.⁷⁹ However, according to EPA officials, there remain significant limitations and uncertainty in the scientific understanding of these tradeoffs, particularly under different timescales and locations. For example, according to the officials, information needs to be developed to better understand the differences between smoke from prescribed burns and wildfires and to account for the fact that the proportion of prescribed burns to wildfire

⁷⁸See app. II for the results of our analysis of literature and stakeholder views.

⁷⁹Interior officials noted that, while air quality is one consideration when considering prescribed burns, an additional benefit of the burns is to restore the health of ecosystems that naturally rely on fire. Forest Service officials added that many of the wildland ecosystems of the United States evolved and are dependent on fire as a natural and critical disturbance that maintains ecological resilience.

varies across the country. Moreover, some areas are almost exclusively exposed to prescribed burn smoke and rarely to wildfire smoke.⁸⁰ This type of information could help decision makers understand how prescribed burns can be used to reduce the public health impacts of wildfires, according to EPA's 2019 Wildland Fire Research Framework.⁸¹ The information could also be important for gaining greater public acceptance of prescribed burns, according to one stakeholder we interviewed.

- **Extent and costs of wildfire smoke exposure to increase national attention to the risks.** According to our analysis of literature and stakeholder views, additional information is needed on factors such as the number of people affected and costs associated with illness, death, and mental health effects from wildfire smoke, to help federal agencies understand the full costs of wildfires. More information about the risks of wildfire smoke exposure could help increase attention to the risks and underscore the need for large-scale wildfire mitigation to help reduce these risks in the long term, according to one stakeholder. In addition, Forest Service officials told us that EPA could provide additional information on how climate change will likely affect future wildfire smoke emissions and public health.
- **Pollutants in wildfire smoke under different conditions to help manage the greatest risks.** EPA and others have conducted studies on air quality and public health effects from wildfire smoke under different conditions. However, our analysis of literature and stakeholder views indicates that additional information on these effects could help agencies better understand the relative risks of different types of fires, such as fires burning only vegetation versus fires that also burn human-made structures. Better understanding these risks can help identify the best ways to manage them. For example, a 2022 report by the National Academies found that information about the pollutants in smoke from fires that occur in the

⁸⁰The September 2021 study on the comparative effects of prescribed burns versus wildfires cited the following additional limitations: (1) the sparse availability of ground-level air quality monitoring data for wildfire smoke; (2) limited understanding of the health implications of exposures to different durations of wildfire smoke; (3) limited accounting of prescribed burn activity over space and time; (4) variability in exposure indicators used to represent wildfire smoke exposure across epidemiologic studies; and (5) relative lack of epidemiologic studies specifically examining the health effects of prescribed burn smoke exposure. Environmental Protection Agency, *Comparative Assessment of the Impacts of Prescribed Fire Versus Wildfire*.

⁸¹Environmental Protection Agency, *Wildland Fire Research Framework 2019 – 2022*, EPA 600/R-19-001 (Apr. 2019).

wildland-urban interface and that burn homes, cars, and other human-made structures can help decision makers mitigate the potential health impacts of these types of fires.⁸²

- **Locations of vulnerable communities to help prioritize wildfire mitigation efforts.** Certain communities may be at particularly high risk for negative air quality and public health effects. One stakeholder we interviewed also noted that some communities may be more prone to poor air quality from wildfire smoke due to their geographic location in rural areas, prevailing winds, and topography. EPA and the CDC have developed information on different communities' vulnerabilities to wildfire smoke.⁸³ However, EPA officials stated that EPA could better convey information on these types of vulnerabilities to land management agencies for consideration when prioritizing wildfire mitigation efforts.⁸⁴

EPA and land management agency officials said that there are federal efforts to produce these types of information, but they acknowledged that the agencies could better work together to identify additional information needs. For example, federal land management agency officials said that EPA should include federal, tribal, state, and local land managers in its listening sessions with other stakeholders to help identify research needs related to how wildfire risk mitigation can help minimize risks to air quality and public health. According to Forest Service officials, including land managers in these conversations could help make a long-term difference in how EPA and the Forest Service move forward in addressing wildfire smoke research needs.

Based on principles in the *Disaster Resilience Framework*, EPA has opportunities to help reduce disaster risks from wildfire smoke over the long term by identifying and developing additional information on the risks to better target risk management activities. According to the *Disaster Resilience Framework*, federal agencies can reduce disaster risks by

⁸²National Academies of Science, Engineering, and Medicine, *The Chemistry of Fires at the Wildland-Urban Interface (2022)* (Washington, D.C.: The National Academies Press, 2022).

⁸³See, for example, Rappold, A. G. et al., "Community Vulnerability to Health Impacts from Wildland Fire Smoke Exposure," *Environmental Science and Technology*, vol. 51, no. 12 (2017): 6674-6682; and Vaidyanathan, A., F. Yip, and P. Garbe, "Developing an Online Tool for Identifying At-risk Populations to Wildfire Smoke Hazards," *Science of the Total Environment*, vol. 619-620 (2018): 376-383.

⁸⁴According to NOAA officials, there is a growing body of research, including among federal agencies, on the effects of wildfire smoke on vulnerable communities.

providing information on current and future risks and the impact of risk reduction strategies, which can help decision makers better understand overall disaster risk.

The framework also states that information to help analyze the costs and benefits of various disaster risk-reduction alternatives can help decision makers identify and select among such alternatives. Identifying and developing additional information on reducing air quality and public health risks from wildfires through wildfire risk mitigation would align with EPA's strategy of "delivering rigorous scientific research and analyses to inform evidence-based decision-making," which the agency identified in its strategic plan for 2022 through 2026.⁸⁵ By identifying and developing such information, in consultation with federal land management agencies, EPA can help ensure that decisions about investments in wildfire risk mitigation better consider the potential for protecting air quality and public health.

Provide Incentives for and Support Wildfire Risk Mitigation Activities at the Tribal, State, and Local Levels

EPA has opportunities to provide incentives for and support wildfire risk mitigation at the tribal, state, and local levels. Such incentives and support could begin to address concerns over public health and increasing resource burdens as catastrophic wildfires become more frequent. Eight stakeholders we interviewed expressed concerns that, as wildfire conditions have changed, EPA's current approach of excluding wildfire smoke data from NAAQS compliance determinations through the Exceptional Events Rule and requiring mitigation plans in areas with recurring events does not adequately protect public health. In particular, these stakeholders said that people are still breathing polluted air from wildfire smoke irrespective of NAAQS compliance status. Similarly, EPA officials said that this approach identifies air pollution events beyond the control of the states for purposes of regulation, but does not remove the unhealthy air pollution.

Furthermore, as catastrophic wildfires become more frequent, EPA's current approach could increase certain resource burdens on tribal, state, and local air agencies, as well as EPA. These resource burdens come from the extensive analyses agencies conduct to demonstrate that emissions from wildfires caused an exceedance of one or more NAAQS in order to exclude the air quality monitoring data from use in certain

⁸⁵Environmental Protection Agency, *Fiscal Year 2022-2026 EPA Strategic Plan*.

regulatory determinations.⁸⁶ Stakeholders we interviewed representing six state and local air agencies said that these analyses are extremely time consuming and resource intensive to prepare. Officials from two of the agencies said that they had to contract assistance to prepare the analyses.⁸⁷ In addition, according to EPA officials, providing guidance for and reviewing the analyses demand a significant resource investment from the EPA regional offices. However, EPA officials told us that this process is necessarily stringent because approving an exceptional event allows the affected area to have poor air quality without regulatory ramifications.

Our analysis identified actions EPA could consider to address concerns about public health and increasing resource burdens. These actions involve providing incentives and support for tribal, state, and local air agencies to collaborate with land managers, land owners, and communities to reduce the likelihood of future smoke events from catastrophic wildfires through wildfire risk mitigation.⁸⁸ The actions fell into several categories of options, including⁸⁹

- assessing the performance and implementation of the Exceptional Events Rule and considering improvements or alternatives to address any limitations and challenges identified;
- enhancing the effectiveness of mitigation plans required when an area has recurring exceptional events;
- using State Implementation Plans or the exceptional events process to better encourage wildfire risk mitigation; and

⁸⁶See 40 C.F.R. § 50.14(b)(4). As previously discussed in this report, these analyses are referred to as exceptional event demonstrations.

⁸⁷According to officials from NOAA, states often reach out to NOAA's subject matter experts, as well as subject matter experts from the National Aeronautics and Space Administration for assistance with using satellite data for exceptional event demonstrations.

⁸⁸As noted by EPA officials, prescribed burning itself produces smoke, so these actions should include taking steps to minimize the smoke impacts associated with prescribed burning. EPA officials also said that all agencies need to ensure that actions are taken to prepare communities and individuals for smoke events so their exposures can be reduced.

⁸⁹See app. V for additional examples of actions within these categories. See app. II for the results of our analysis of literature and stakeholder views.

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- removing barriers to wildfire risk mitigation methods such as prescribed burns and cultural burns.⁹⁰

EPA officials also identified some actions that could help provide incentives for and support wildfire risk mitigation. For example, EPA officials said that the agency could enhance communication with its tribal, state, and other partners with land and fire management responsibilities about wildfire risk mitigation that could, over the long term, help reduce the risks of smoke from future catastrophic wildfires. They also said that EPA could consider developing an approach for identifying areas anticipated to have wildfire smoke issues and focusing available resources on those areas to proactively address the issues.⁹¹ Also, to remove barriers to certain wildfire risk mitigation strategies, EPA officials said that the agency could, for example, finalize its proposed rule related to permit requirements for air curtain incinerators. Air curtain incinerators are devices for burning debris collected through methods such as mechanical thinning.⁹² According to EPA officials, these devices offer an alternative to prescribed burns and have much fewer emissions than burning debris piles or prescribed burns.

⁹⁰Tribal communities have historically used fire on their lands as an essential part of their cultures to help maintain ecosystem health. Cultural burns are low-intensity controlled fires, similar to prescribed burns, but unlike prescribed burns, they are administered to achieve specific cultural objectives, often involve an elder or other tribal leader, and utilize traditional ecological knowledge. Cultural burns not only reduce fuels and mitigate the risk of wildfires on tribal lands, but also increase ecosystem resilience; manage crops; protect species of cultural importance for uses such as traditional foods, medicines, and weaving; and preserve culture and language.

⁹¹EPA regional offices are starting to take such an approach to anticipating when areas are at risk for not attaining NAAQS and are investing resources to help avoid that situation, according to EPA officials. In addition, in the Exceptional Events Rule, EPA noted that it believes that elements of the Basic Smoke Management Practices, which are designed for prescribed burns, could also be practical and beneficial to apply to wildfires for areas likely to experience recurring wildfires. See 40 C.F.R. § 50.14 (Table 1, table note (a)).

⁹²An air curtain incinerator is an incineration unit that operates by forcefully projecting a curtain of air across an open, integrated combustion chamber (fire box) or open pit or trench (trench burner) in which combustion occurs. The “air curtain” traps and re-burns the fine particulate matter in smoke, so that it is not released into the air. In 2020, EPA issued a proposed rule that would amend its regulations to eliminate a permitting requirement for certain air curtain incinerators that burn only wood waste, clean lumber, and yard waste. See 85 Fed. Reg. 54,178, 54,194 (Aug. 31, 2020). According to Forest Service officials, the use of air curtain incinerators helps reduce woody fuel on a site but does not necessarily reduce the need for prescribed burns to reduce fine surface fuels.

However, according to EPA officials, the agency faces constraints in what it can do to provide incentives for and support wildfire risk mitigation. For example, EPA officials told us that the agency's authority to regulate exceptional events under the Clean Air Act is the only authority it has to regulate fire or smoke. They said that the states have to determine the pollution control measures necessary to manage air pollution and comply with the NAAQS.⁹³ In addition, the Exceptional Events Rule, including its identification of wildfires as "exceptional events," aligns with criteria in the Clean Air Act, according to EPA officials.⁹⁴ The officials also said that the rule strikes a balance between protecting public health and ensuring that tribal, state, and local air agencies are not held accountable for pollution sources outside of their control.⁹⁵ Such pollution sources may include

⁹³While EPA is responsible for reviewing State Implementation Plans and approving them if they meet applicable requirements, states are responsible for the development of the plans themselves, which are to include, among other things, the control measures, means, or techniques necessary or appropriate to comply with the NAAQS. See 42 U.S.C. §§ 7407(a), 7410(a)(2)(A), (k). EPA officials noted that neither the Clean Air Act nor its implementing regulations require that air agencies include wildfire risk mitigation provisions in their State Implementation Plans. The officials also indicated that they were not aware of any regulations that allow for EPA to make approval of an exceptional event demonstration contingent on air agencies working with land managers and owners on wildfire risk mitigation measures. EPA regulations provide that EPA is not to approve an exceptional event demonstration for prescribed fires, in certain contexts, unless air agencies periodically collaborate with burn managers on a process by which air agencies and land managers will work together to protect public health and manage air quality impacts during the conduct of prescribed fires on wildland. However, according to EPA officials, current regulations do not include similar collaboration requirements related to wildfire exceptional event demonstrations. See 40 C.F.R. § 50.14(b)(3)(ii)(B), (4).

⁹⁴Additionally, the conference report accompanying the 2005 amendments to the Clean Air Act, which, among other things, required EPA to issue regulations governing the review and handling of air quality monitoring data influenced by exceptional events, noted that events such as forest fires should not influence whether a region is meeting its federal air quality goals. H.R. Rep. No. 109-203, at 1066 (2005) (Conf. Rep.).

⁹⁵Under the Clean Air Act, EPA's exceptional events regulations are to follow several principles, including, among other things, the principle that protection of public health is the highest priority, and the principle that air quality data should be carefully screened to ensure that events not likely to recur are represented accurately in all monitoring data and analyses. 42 U.S.C. § 7619(b)(3)(A)(i), (v).

smoke originating from a distant wildfire outside of the regulated area's jurisdiction.⁹⁶

Nonetheless, EPA officials also told us that the agency recognizes the magnitude of wildfire smoke issues and the growing risks to air quality and public health as the climate changes. In its strategic plan for 2022 through 2026 and its October 2021 Climate Adaptation Action Plan, EPA identified wildfire smoke pollution as a climate change vulnerability that could affect its ability to meet air quality goals.⁹⁷ Specifically, the strategic plan identified wildfire smoke as an external factor and emerging issue to be considered in developing strategies to carry out the plan. It stated that the increasing intensity, duration, and scale of wildfires in the western United States as the climate changes worsens air quality across the country. The Climate Adaptation Action Plan described wildfires as climate change vulnerability that could affect EPA's mission, facilities, and operations. It noted that more frequent and severe wildfires due to climate change may increase particulate matter concentrations and diminish air quality.

The Biden administration has directed federal agencies to address such climate-related disaster risks, and our prior work has identified principles and strategies for doing so. Specifically, Executive Order 14008 directed federal agencies to prioritize action on climate change in their policy-making and budget processes and develop plans that identify steps they can take to increase resilience to the impacts of climate change based on their climate vulnerabilities.⁹⁸ Our *Disaster Resilience Framework* states

⁹⁶In addition to smoke from U.S. wildfires crossing state boundaries, smoke from international wildfires can affect air quality in the United States. For example, in 2021, wildfires in Canada created hazardous air quality conditions in Michigan, Minnesota, and Wisconsin, according to Forest Service officials. As a result, the Interagency Response Program deployed air resource advisors to help address the smoke impacts in these states.

⁹⁷Environmental Protection Agency, *Climate Adaptation Action Plan*. EPA released its first Climate Change Adaptation Plan in June 2014, followed by 17 Climate Change Adaptation Implementation Plans prepared by its National Environmental Program Offices, National Support Offices, and 10 regional offices. The 2021 EPA Climate Adaptation Action Plan will be followed by updates to the 17 Implementation Plans to report on its progress since 2014 and identify future actions to address agency-wide priorities.

⁹⁸Executive Order 14008 provides that it is the policy of the administration to deploy the full capacity of federal agencies to combat climate change to implement a government-wide approach that, among other things, increases resilience to the impacts of climate change. 86 Fed. Reg. 7619, 7622 (Feb. 1, 2021).

that the federal government can enhance disaster resilience by providing incentives—including through regulatory requirements—to promote forward-looking risk reduction efforts.⁹⁹ According to the framework, such incentives may include those to make risk reduction measures more viable and attractive and to improve program design to motivate risk reduction actions. Our prior work on risk management indicates that EPA has opportunities to better manage wildfire smoke risks into the future by considering and selecting appropriate risk response options for providing these types of incentives.¹⁰⁰

As EPA officials stated, implementing many of these options for providing incentives for and supporting wildfire risk mitigation would require close coordination with tribal, state, and local partners. Further, EPA officials said that some options may fall within EPA's existing authority, while others might require congressional action. By working with its tribal, state, and local partners to evaluate options and establish a plan for implementing appropriate options, including by seeking additional authority from Congress if necessary, EPA could more proactively help reduce disaster risks from wildfire smoke over the long term. This could also help EPA fulfill its mission of protecting human health and the environment as the climate changes.

Conclusions

Smoke from increasingly frequent catastrophic wildfires affects tens of millions of Americans annually through polluted air that can cause a wide range of health effects. As a part of its mission to protect human health and the environment, EPA has partnered with other federal agencies to manage the growing risks to air quality and public health by developing information and tools to help communities prepare for and respond to wildfire smoke events.

However, EPA's actions have been ad hoc and spread out across different program and regional offices. EPA has opportunities to take a more coordinated approach that establishes the agency's goals, identifies ways to leverage resources, and clarifies stakeholder roles. By developing and documenting a coordinated approach for EPA's actions to help communities prepare for and respond to wildfire smoke events that aligns with leading practices for collaboration, the agency could more effectively target limited resources to the highest priorities.

⁹⁹[GAO-20-100SP](#).

¹⁰⁰[GAO-17-63](#).

In addition to opportunities related to preparedness and response, EPA has opportunities to better manage risks to air quality and public health by enhancing its role in supporting hazard mitigation to reduce the likelihood of future smoke events. These opportunities include

- **Strengthening federal coordination.** EPA and the federal land management agencies have not aligned some of their goals for wildfire risk mitigation. By working together to better align their goals and establish joint strategies for achieving those goals, EPA, the Forest Service, and Interior can create a whole systems approach to more effectively reduce wildfire disaster risks to air quality and public health over the long term. Such alignment of goals is particularly important, as land management agencies plan to increase the scope and scale of wildfire risk mitigation in the coming years through funding provided in the Infrastructure Investment and Jobs Act and Inflation Reduction Act of 2022.
- **Identifying and developing additional risk information.** Although there are several federal efforts to produce information related to the effects of wildfire on air quality and public health, some limitations exist. Additional information could help EPA and its federal partners better inform efforts to manage air quality and public health risks through wildfire risk mitigation. Identifying and developing additional information on reducing these risks through wildfire risk mitigation—in consultation with its federal land management agency partners—could help EPA ensure that decisions about investments in wildfire risk mitigation better consider the potential for protecting air quality and public health.
- **Providing incentives for and supporting tribal, state, and local action.** EPA faces constraints in its ability to provide incentives for and support wildfire risk mitigation at the tribal, state, and local levels to help reduce future wildfire smoke risks. However, our analysis and EPA officials identified a range of actions the agency could take, under its current authority or with additional authority, to provide incentives for and support wildfire risk mitigation. By working with its tribal, state, and local partners to evaluate such options and establish a plan for implementing appropriate options, including by seeking additional authority from Congress if necessary, EPA could more proactively help reduce disaster risks from wildfire smoke over the long term. This could also help EPA fulfill its mission of protecting human health and the environment as the climate changes.

Recommendations for Executive Action

We are making a total of six recommendations, including four to EPA and one each to USDA and Interior:

The Administrator of EPA should develop and document a coordinated approach for EPA's actions to help communities prepare for and respond to the air quality and public health risks of wildfire smoke. The approach should align with leading practices for collaboration, including establishing goals, identifying and leveraging resources, and clarifying key stakeholder roles and responsibilities. (Recommendation 1)

The Administrator of EPA should work with the Secretaries of Agriculture and the Interior to better align air quality and land management goals for wildfire risk mitigation and establish joint strategies for achieving those goals. (Recommendation 2)

The Secretary of Agriculture should work with the Administrator of EPA and Secretary of the Interior to better align air quality and land management goals for wildfire risk mitigation and establish joint strategies for achieving those goals. (Recommendation 3)

The Secretary of the Interior should work with the Administrator of EPA and Secretary of Agriculture to better align air quality and land management goals for wildfire risk mitigation and establish joint strategies for achieving those goals. (Recommendation 4)

The Administrator of EPA should, in consultation with federal land management agencies, identify and develop additional information on reducing risks from wildfire smoke to air quality and public health through wildfire risk mitigation. (Recommendation 5)

The Director of EPA's Office of Air and Radiation should work with EPA's tribal, state, and local partners to evaluate options for providing incentives for and supporting wildfire risk mitigation and establish a plan for implementing appropriate options, seeking additional authority from Congress if needed. (Recommendation 6)

Agency Comments and Our Evaluation

We provided a draft of this report to EPA, USDA, Interior, NOAA, and the Department of Health and Human Services for review and comment. In its comments reproduced in appendix VI and summarized below, EPA generally agreed with our recommendations to the agency and asked for additional clarification on one of the recommendations. In its comments reproduced in appendix VII and summarized below, USDA generally agreed with our draft report and recommendations. In its comments

reproduced in appendix VIII and summarized below, Interior concurred with our recommendation to the department. EPA, USDA, and Interior also provided technical comments, which we incorporated as appropriate. NOAA provided technical comments only, which we incorporated as appropriate. The Department of Health and Human Services informed us that it had no comments on the draft report.

In its written comments, EPA stated that in recognition of the magnitude of the air quality problem created by recent wildfire trends, EPA staff and management have informally advanced numerous programs, projects, and collaborations to reduce exposure to smoke and have identified several goals for which the agency intends to take action. Our report discusses much of this work, including the two efforts that EPA highlighted in its letter. EPA also stated that the agency has identified several challenges in its work to address risks from wildfire smoke, and it said its primary challenge is a lack of dedicated funding and organizational structure to house this work.

With regard to our recommendation that EPA develop a coordinated approach for the agency's actions to help communities prepare for and respond to the risks of wildfire smoke, EPA stated that it continues to make progress on its work in this area, and EPA said that this work is underfunded. As we state in the report, implementing our recommendation would help EPA better target its limited resources toward the highest priorities for managing wildfire smoke risks. EPA listed numerous examples of its work, including efforts involving multiple EPA offices. For example, EPA identified an entity established within the agency, referred to as the wildfire sub-lead, which helps coordinate the agency's work related to wildfires. EPA stated that through this sub-lead, the agency is exploring ways to create a more formal structure and strategy to manage wildland smoke work across EPA. The wildfire sub-lead was in its early stages when we were conducting our work, but if it and related efforts align with leading practices for collaboration, they would address our recommendation.

With regard to our recommendation that EPA work with USDA and Interior to better align air quality and land management goals for wildfire risk mitigation, EPA described recent actions it has taken to elevate the public health challenges that arise from both wildfire and prescribed burn smoke. EPA also stated that the agency plans to seek further opportunities to improve interagency collaboration and better mitigate risks from smoke. Ensuring that such actions better align air quality and land management goals and establishing joint strategies with USDA and

Interior to do so, if implemented effectively, would address our recommendation.

With regard to our recommendation that EPA identify and develop additional information on wildfire smoke risks through wildfire risk mitigation, EPA stated that many of the wildfire risk mitigation methods identified in our report are outside the scope of EPA's work and statutory authority. Our report states that EPA does not implement wildfire risk mitigation methods and, rather, land managers and owners do so. We included further clarifying language that land managers would implement wildfire risk mitigation methods, not EPA. EPA also stated that it is currently advancing additional efforts to reduce risks from wildland fire smoke and will continue to consider ways to communicate wildfire smoke impacts to the public in a timely and effective manner. The efforts EPA described in its letter are important for preparing for smoke events and providing information about smoke risks after fires start. However, as discussed in our report, EPA also has opportunities to provide information to help federal agencies better reduce risks from wildfire smoke through wildfire risk mitigation before fires occur. Efforts to identify and develop such information in consultation with federal land management agencies, if implemented effectively, would address our recommendation.

With regard to our recommendation that EPA's Office of Air and Radiation work with tribal, state, and local partners to evaluate options for providing incentives for and supporting wildfire risk mitigation, EPA asked for clarification about what we mean by "evaluate options for providing incentives." EPA has stated that it does not have the authority to regulate how states choose to structure prescribed burn programs, and we recognize the limited role and authority that EPA has in implementing wildfire risk mitigation. However, as discussed in our report, EPA has opportunities to provide incentives for and support wildfire risk mitigation to help the agency more proactively manage wildfire smoke risks into the future and help fulfill its mission. As discussed in our report, incentives can come in the form of regulatory requirements or other mechanisms that may make certain risk reduction actions more viable or motivate risk-reduction actions. The report identifies a range of potential options that EPA could consider to incentivize and support wildfire risk mitigation. For example, the report identifies the option of assessing the performance and implementation of the Exceptional Events Rule for wildfires and considering alternatives or improvements to address limitations with the current approach.

In addition to the potential options identified in our report, the actions EPA described in its written comments could also incentivize wildfire risk mitigation, in large part by removing disincentives. These actions are understanding air quality-related barriers to prescribed burns and exploring ways to make the exceptional events process less resource intensive. Finally, EPA recently described another option to incentivize and support wildfire risk mitigation in a February 2023 fact sheet about its proposed rulemaking to revise the annual fine particulate matter NAAQS. In the fact sheet, EPA stated that the agency is committed to partnering with federal land managers and working with other entities to provide necessary tools and resources to engage in responsible wildfire risk reduction activities while ensuring attainment and maintenance of air quality standards to protect public health and welfare under the Clean Air Act. Evaluating these or other potential options to provide incentives for and support wildfire risk mitigation at the tribal, state, and local level, and establishing a plan for implementing appropriate options, would address our recommendation.

In its written comments, USDA stated that the role of the Forest Service in responding to wildfire smoke and protecting public health, as well as the importance of mitigation efforts to address smoke impacts associated with the wildfire crisis, was captured well in our report, and that this role and mitigation are critical to long-term efforts for wildfire risk reduction. USDA also stated that, as the environmental impacts of catastrophic wildfire extend far beyond air quality, effectively implementing our recommendations requires focused collaboration beyond smoke and its impacts to public health. USDA said that only focusing on the effect of wildfire smoke on public health minimizes the breadth of the current crisis impacting the natural and human environment and neutralizes the most effective mitigation tool that also mimics natural processes—prescribed fire, which, according to USDA, can be managed to minimize impacts on public health.

In addition, USDA said that, as air quality standards become more stringent, expanded interagency discussions are needed to ensure the increased use of prescribed burning as the primary mitigation to catastrophic wildfire. USDA said that bolstering current authorities and approaches mentioned in our draft report should balance impacts on firefighter and public safety, water quality, and protection of municipal water supplies, among other environmental effects. As discussed in our report, EPA has raised other concerns related to the increased use of prescribed burning. We believe USDA would have important opportunities to raise these and related issues as it works with EPA and Interior to

implement our recommendation to better align air quality and land management goals.

In its written comments, Interior stated that to achieve our recommendation to work with EPA and USDA to better align air quality and land management goals, it plans to increase staffing to plan for and manage smoke emissions at the departmental and bureau levels and to work across agencies at the national and regional levels, as well as with tribal, state, and local governments and other external partners. Interior also stated that its management of air quality and wildfire risk mitigation goals will include an increasingly wide array of communications, data management, planning, budget development, wildfire operations, environmental justice efforts, and fuels management implementation, which will be supported by its additional staffing. Interior said these efforts will be initiated this year and will enable coordination of its existing efforts with EPA and USDA and the joint development of further efforts. Interior stated that this will support efforts to increase the pace and scale of fuels management treatments and address the overall wildfire risk reduction objectives included in the Infrastructure Investment and Jobs Act. The actions Interior described, if implemented effectively, would address our recommendation.

We are sending copies of this report to the appropriate congressional committees; Administrator of EPA; Secretaries of Agriculture, the Interior, Commerce, and Health and Human Services; and other interested parties. In addition, the report is available at no charge on the GAO website at <https://www.gao.gov>.

If you or your staff have any questions about this report, please contact me at (202) 512-3841 or gomezj@gao.gov. Contact points for our Offices of Congressional Relations and Public Affairs may be found on the last page of this report. GAO staff who made key contributions to this report are listed in appendix IX.

A handwritten signature in black ink that reads "Alfredo Gómez". The signature is written in a cursive style with a large, stylized initial "A".

J. Alfredo Gómez
Director, Natural Resources and Environment

List of Addressees

The Honorable Zoe Lofgren
Ranking Member
Committee on Science, Space, and Technology
House of Representatives

The Honorable Ami Bera
House of Representatives

The Honorable Suzanne Bonamici
House of Representatives

The Honorable Brad Sherman
House of Representatives

The Honorable Mikie Sherrill
House of Representatives

Appendix I: Objectives, Scope, and Methodology

Our objectives were to (1) describe key federal roles related to managing risks to air quality and public health from wildfire smoke, (2) identify the actions the Environmental Protection Agency (EPA) has taken to help manage these risks and how EPA coordinates with other federal agencies on these actions, and (3) examine how EPA could better help manage these risks.

To (1) describe key federal roles related to managing risks to air quality and public health from wildfire smoke and (2) identify actions EPA has taken to help manage these risks and how EPA coordinates with other federal agencies on these actions, we analyzed relevant laws and regulations. For example, we reviewed the Clean Air Act and Exceptional Events Rule.¹ We also analyzed federal agency documents related to EPA and other federal agency actions to manage risks from wildfire smoke, such as resources in EPA's Smoke-Ready Toolbox, EPA's *Air and Energy Strategic Research Action Plan*, and memoranda of understanding that describe coordination between EPA and other federal agencies.² Finally, we analyzed our prior work and other federal reports related to managing risks to air quality and public health from wildfire smoke.

Additionally, we interviewed EPA officials and officials from other federal agencies who are knowledgeable about EPA's actions to manage risks to air quality and public health from wildfire smoke. Specifically, we conducted and analyzed interviews with EPA officials from headquarters program offices that have responsibilities related to managing the risks to air quality and public health from wildfire smoke. These offices included the Office of Air and Radiation, Office of Air Quality Planning and Standards, Office of Research and Development, and Office of Policy. We also interviewed EPA officials from a nongeneralizable sample of five regional offices selected to correspond to areas with recent experience

¹42 U.S.C. § 7401 et seq.; 40 C.F.R. §§ 50.14, 51.930.

²For EPA's Smoke-Ready Toolbox, see <https://www.epa.gov/smoke-ready-toolbox-wildfires>. For EPA's Strategic Action Research Plan, see Environmental Protection Agency, Office of Research and Development, *Air and Energy Strategic Action Research Plan 2019-2022*, EPA 601K20003 (Mar. 2020).

managing risks to air quality and public health from wildfire smoke.³ The regions we selected are listed in table 2. In addition, we conducted and analyzed interviews with officials from the Centers for Disease Control and Prevention; Department of the Interior agencies, including the Bureau of Indian Affairs, Bureau of Land Management, Fish and Wildlife Service, and National Park Service; the Forest Service; and the National Oceanic and Atmospheric Administration.

Table 2: Environmental Protection Agency (EPA) Regions Selected for Interviews

EPA region	Area served
Region 5 (Great Lakes)	Illinois, Indiana, Michigan, Minnesota, Ohio, Wisconsin, and 35 Tribes
Region 6 (South Central)	Arkansas, Louisiana, New Mexico, Oklahoma, Texas, and 66 Tribes
Region 8 (Mountains and Plains)	Colorado, Montana, North Dakota, South Dakota, Utah, Wyoming, and 28 Tribes
Region 9 (Pacific Southwest)	Arizona, California, Hawaii, Nevada, the Pacific Islands, and 148 Tribes
Region 10 (Pacific Northwest)	Alaska, Idaho, Oregon, Washington, and 271 Tribes

Source: GAO. | GAO-23-104723

To examine how EPA could better help manage the risks to air quality and public health from wildfire smoke, we reviewed academic studies, law review articles, and other reports published between January 2016 and September 2021. We identified literature through searching Scopus and ProQuest literature databases using relevant key search terms, such as “wildfire,” “air,” and “pollution.”⁴ Finally, we identified additional relevant literature that were cited in literature that we reviewed. The literature database search identified 157 potentially relevant pieces of literature. Two analysts reviewed the abstracts of those 157 pieces of literature, and they agreed upon and selected 21 pieces of literature that discussed potential actions that EPA could take to better manage the risks of wildfire smoke. We also identified two additional reports from our interviews.

³EPA has 10 regional offices, which are responsible for partnering with Tribes, states, and territories in their respective regions to execute EPA programs. The 10 regional offices are Region 1 (Boston), Region 2 (New York City), Region 3 (Philadelphia), Region 4 (Atlanta), Region 5 (Chicago), Region 6 (Dallas), Region 7 (Kansas City), Region 8 (Denver), Region 9 (San Francisco), and Region 10 (Seattle). The findings from our interviews with officials from selected regional offices are not generalizable to the regional offices not included in our review.

⁴The ProQuest literature databases are Research Library, SciTech Premium Collection, Sociology Collection, Health & Medical Collection, and Policy File Index.

Finally, we identified five reports through citations in selected articles. In total, we reviewed and analyzed 28 pieces of literature.

We also conducted semi-structured interviews with 15 stakeholders who were either (1) officials from nine tribal, state, and local air agencies with recent experience in managing risks to air quality and public health from wildfire smoke, or (2) six stakeholders with expertise in addressing the risks of wildfire smoke to air quality and public health who can provide a regional or national perspective (see table 3 for affiliations of the stakeholders we interviewed).⁵ During these interviews, we obtained information on the effects of wildfires on air quality and public health, current actions to manage risks to air quality and public health from wildfire smoke, and potential actions that EPA could take to manage the risks from wildfire smoke. Our findings from these interviews cannot be generalized to stakeholders we did not interview.

⁵We considered each entity we interviewed as one stakeholder, even though multiple officials or representatives participated in many of the interviews.

Table 3: Affiliations of 15 Stakeholders We Interviewed

Tribes
Hoop Valley Tribe
Yurok Tribe
States
California
Colorado
Ohio
Oregon
Texas
Local areas
Clark County, NV
Missoula City-County, MT
Organizations
American Lung Association
National Tribal Air Association
Stanford Woods Institute for the Environment
Western States Air Resources Council
Wildland Fire Leadership Council
University of California, San Francisco

Source: GAO. | GAO-23-104723

We selected Tribes, states, local areas, and organizations using the following methodology:

- **Tribes.** To select tribal air agencies, we considered the list of federally recognized Tribes we identified through our methodology. We considered recommendations from stakeholders who were knowledgeable about which tribal agencies may have recent experience with managing risks to air quality and public health from wildfire smoke. From the list of tribal agencies identified through these methods, we selected two tribal agencies.
- **States.** To select state air agencies with recent experience in managing risks from wildfire smoke, we analyzed yearly data from the National Interagency Fire Center to create lists of the 10 states that have had the most wildfires per year and the 10 states that had the largest average number of acres burned per year, during the years 2016 through 2020. We also analyzed data from EPA on areas that have submitted exceptional event demonstrations for wildfire smoke since 2016 and identified the corresponding states. We identified the

states that were on all three lists, and we took into consideration recommendations from stakeholders who were knowledgeable about which states may have recent experience with managing risks to air quality and public health from wildfire smoke to select five state agencies.

- **Local areas.** To select local agencies, we used data from EPA to (1) identify areas subject to the mitigation plan requirements in the Exceptional Events Rule,⁶ and (2) identify areas that have submitted exceptional event demonstrations for wildfire smoke since 2016. We considered recommendations from stakeholders who were knowledgeable about which local agencies may have recent experience with managing risks to air quality and public health from wildfire smoke. From the list of local entities identified through these methods, we selected two local agencies.
- **Stakeholders with expertise.** To select stakeholders with expertise, we created a preliminary list of individuals or organizations (1) referred from federal, state, local, and tribal officials and other stakeholders; (2) who authored a relevant article or report; or (3) who presented or participated in a panel for a relevant conference, hearing, or webinar. We screened these lists to identify those stakeholders whose work primarily focuses on managing risks to air quality and public health from wildfire smoke and who could provide a regional or national perspective. Then, we selected six stakeholders from the list to represent a variety of organization types (e.g., academic institutions, nongovernmental organizations, and regional organizations) and areas of expertise (e.g., public health, land/fire management, air quality, etc.).

To identify categories of potential actions that EPA could take to better manage the risks of wildfires to air quality and public health, we analyzed the content of the articles we reviewed and records of our interviews. First, an analyst reviewed the literature and interviews and recorded information on potential actions EPA could take in a spreadsheet. A second analyst reviewed the literature, interviews, and spreadsheet content to confirm agreement with the work of the first analyst. Any disagreement between the two analysts was documented and resolved. An analyst then categorized potential actions into broad groups of similar actions, and a second analyst performed an independent review of the

⁶Specifically, the Exceptional Events Rule, as amended in 2016, requires all states having areas with historically documented or known seasonal events, as defined by regulation, to develop a mitigation plan. 40 C.F.R. § 51.930(b).

categorization. Any disagreement of the assignment of categories between the two analysts was documented and resolved.

Finally, to identify opportunities for EPA to better help manage risks to air quality and public health from wildfire smoke, we analyzed the information we obtained on EPA's current and potential actions using our *Disaster Resilience Framework*, principles for enhancing disaster resilience, selected leading practices for collaboration, and essential elements of enterprise risk management (references to this work are included in the report where the work is discussed).⁷

We conducted this performance audit from January 2021 to March 2023, in accordance with generally accepted government auditing standards. Those standards require that we plan and perform the audit to obtain sufficient, appropriate evidence to provide a reasonable basis for our findings and conclusions based on our audit objectives. We believe that the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objectives.

⁷For our *Disaster Resilience Framework*, see GAO, *Disaster Resilience Framework: Principles for Analyzing Federal Efforts to Facilitate and Promote Resilience to Natural Disasters*, [GAO-20-100SP](#) (Washington, D.C.: Oct. 23, 2019). For leading practices for collaboration, see GAO, *Managing for Results: Key Considerations for Implementing Interagency Collaborative Mechanisms*, [GAO-12-1022](#) (Washington, D.C.: Sept. 27, 2012). For essential elements of enterprise risk management, see GAO, *Enterprise Risk Management: Selected Agencies' Experiences Illustrate Good Practices in Managing Risk*, [GAO-17-63](#) (Washington, D.C.: Dec. 1, 2016).

Appendix II: Potential Actions for EPA to Better Manage Wildfire Smoke Risks, Identified by Our Analysis

Potential Actions Related to Preparedness and Response

Our content analysis of literature and stakeholder views identified potential actions the Environmental Protection Agency (EPA) could take to help tribal, state, and local entities better (1) help decision makers and the public understand the risks to air quality and public health from wildfire smoke (see table 4); (2) help prepare their communities for wildfire smoke events (see table 5); and (3) respond to the risks of wildfire smoke during a smoke event (see table 6).

According to EPA officials and our analysis of EPA information and tools that support efforts to help communities prepare for and respond to wildfire smoke, EPA has already started taking some of these potential actions identified by literature and stakeholders. For example, EPA officials said that EPA has developed fact sheets about wildfire smoke and has started translating them into other languages. Several of these potential actions build on existing partnerships that EPA has with other federal agencies. EPA officials told us that the agency faces challenges in taking some of these actions, particularly because the agency has limited resources available for reducing the risks of wildfire smoke.

Appendix II: Potential Actions for EPA to Better Manage Wildfire Smoke Risks, Identified by Our Analysis

Table 4: Potential Research Actions That Could Help Decision Makers and the Public Better Understand the Risks to Air Quality and Public Health from Wildfire Smoke, Identified by Content Analysis of Literature and Stakeholder Views

Category of potential Environmental Protection Agency (EPA) research topics or efforts	Illustrative examples identified by literature and stakeholders	Number of times the category was mentioned by stakeholders or in the literature ^a
Extent and costs of smoke exposure	<ul style="list-style-type: none"> • Mental health impacts when smoke forces people to stay indoors or avoid recreational activities for days or weeks at a time. • Economic costs of illness and deaths from wildfire smoke, particularly in more densely populated areas. • Health effects from smoke exposure in the short term, such as multiple days of exposure to high levels of wildfire smoke, and long term, such as exposure over many seasons. 	Stakeholders: 11 times Literature: 7 times
Pollutants in wildfire smoke under different conditions	<ul style="list-style-type: none"> • Relative toxicity of smoke from fires that burn structures versus fires that only burn vegetation. • How the toxicology of particulate matter in smoke compares to other sources of particulate matter. • Factors that affect differences in the quantity, composition, toxicity, and duration of wildfire smoke. 	Stakeholders: 3 times Literature: 5 times
Interagency and cross-disciplinary research	<ul style="list-style-type: none"> • EPA could serve as a centralized coordinator for interagency research on wildfire smoke and its effects and public health. • EPA could help bridge the gap between Tribes and researchers to help understand Tribes' needs, including research needs. 	Stakeholders: 3 times Literature: 4 times
Comparative effects of prescribed burns and wildfires	<ul style="list-style-type: none"> • Relative health and air quality effects from controlled, prescribed burns versus uncontrolled, catastrophic wildfires. • Trade-offs between air quality and other benefits of using prescribed burns or letting wildfires burn to achieve land management goals. 	Stakeholders: 2 times Literature: 3 times
Information on vulnerable communities	<ul style="list-style-type: none"> • Differences in health effects among vulnerable populations of people, such as the elderly or those with preexisting conditions. • Disproportionate impacts of wildfire smoke on different communities. 	Stakeholders: 2 times Literature: 3 times
Relative health effects of wildfire mitigation strategy alternatives	<ul style="list-style-type: none"> • How different land management strategies can potentially affect future wildfire smoke and resulting health effects. • Cost-effectiveness of alternative land management strategies, compared to prescribed burns when health effects are considered. 	Stakeholders: 3 times

Source: GAO analysis of literature and stakeholder views. | GAO-23-104723

^aWe interviewed a total of 15 stakeholders—six stakeholders with experience related to managing wildfire smoke at a national or regional scale from various organization types (academia, nonprofit, regional groups, etc.) and different areas of expertise (air quality, public health, forest management); and officials from nine tribal, state, and local entities in areas that had recent experience in managing wildfire smoke. We performed a literature search and identified 28 pieces of literature and reports from stakeholders to examine how EPA could better help manage the risks to air quality and public health from wildfire smoke.

Appendix II: Potential Actions for EPA to Better Manage Wildfire Smoke Risks, Identified by Our Analysis

Table 5: Potential Actions That Could Help the Environmental Protection Agency (EPA) Build on Existing Actions and Partnerships to Help Communities Prepare for the Risks to Air Quality and Public Health from Wildfire Smoke, Identified by Content Analysis of Literature and Stakeholder Views

Category of potential EPA preparedness actions	Illustrative examples identified by literature and stakeholders	Number of times the category was mentioned by stakeholders or in the literature ^a
Provide additional information for communities on preparing for wildfire smoke events	<ul style="list-style-type: none"> • Translate science into more straightforward and actionable information to improve the public’s knowledge of the health risks of wildfire smoke and how to prepare for those risks. • Make information more accessible to more people, including vulnerable communities, such as by creating fact sheets and other communication materials in additional languages. • Customize information and support for individuals living with different types of health risks, such as those with certain medical conditions, and for spaces with different types of infrastructure, such as different air filtration systems. 	Stakeholders: 9 times Literature: 4 times
Provide additional assistance for communities to prepare for wildfire smoke events	<ul style="list-style-type: none"> • Provide additional resources, such as grant funding, for states and communities to develop smoke-ready communities—communities that are educated and prepared for the risks of wildfire smoke before the wildfire occurs. • Provide additional assistance for communities to address wildfire smoke effects, such as by helping communities procure air filters or set up cleaner air shelters—public spaces where people can seek relief from wildfire smoke. 	Stakeholders: 9 times Literature: 4 times
Integrate actions across disciplines and missions (e.g., air quality, public health, emergency management, etc.) to help communities prepare for wildfire smoke events	<ul style="list-style-type: none"> • Enhance coordination with other federal agencies on smoke preparedness, so that wildfire smoke receives the same level of response as other natural disasters such as hurricanes. • Continue working with organizations such as ASHRAE (formerly known as the American Society of Heating, Refrigerating, and Air-Conditioning Engineers) to improve standards for indoor air quality for public spaces like schools. 	Stakeholders: 1 time Literature: 4 times

Source: GAO analysis of literature and stakeholder views. | GAO-23-104723

^aWe interviewed a total of 15 stakeholders—six stakeholders with experience related to managing wildfire smoke at a national or regional scale from various organization types (academia, nonprofit, regional groups, etc.) and different areas of expertise (air quality, public health, forest management); and officials from nine tribal, state, and local entities from areas that had recent experience in managing wildfire smoke. We performed a literature search and identified 28 pieces of literature and reports from stakeholders to examine how EPA could better help manage the risks to air quality and public health from wildfire smoke.

Appendix II: Potential Actions for EPA to Better Manage Wildfire Smoke Risks, Identified by Our Analysis

Table 6: Potential Actions That Could Help the Environmental Protection Agency (EPA) Build on Existing Actions to Help Communities Respond to the Risks to Air Quality and Public Health from Wildfire Smoke, Identified by Content Analysis of Literature and Stakeholder Views

Category of potential EPA response actions	Illustrative examples identified by literature and stakeholders	Number of times the category was mentioned by stakeholders or in the literature ^a
Build more capacity for air quality monitoring during wildfire smoke events	<ul style="list-style-type: none"> • Provide resources, through means such as grants and training, to help communities purchase, use, and maintain smoke monitors. • Expand air quality monitoring by providing additional sensors in rural and tribal areas, where monitors are typically sparse. 	Stakeholders: 6 times Literature: 4 times
More effectively communicate information on smoke risks during wildfire smoke events	<ul style="list-style-type: none"> • Improve consistency of smoke messaging across levels of government to create unified messages to the public. • Provide more guidance to help the public understand how to interpret and make decisions based on public air quality data, including the Air Quality Index.^b • Provide guidance to strategically communicate information to populations that are not receiving existing messages and populations that have specific health risks from wildfire smoke, such as children, and how to reduce those risks. 	Stakeholders: 5 times Literature: 4 times
Improve smoke modeling and forecasting capabilities for tribal, state, and local entities to better understand where the smoke may travel	<ul style="list-style-type: none"> • With other federal agencies, such as the Forest Service and National Oceanic and Atmospheric Administration, improve or refine air pollution models, such as by making them more user-friendly. • Use additional data, such as satellite data, in models used to forecast wildfire smoke. 	Stakeholders: 4 times Literature: 4 times
Improve and expand technology for air quality monitoring during wildfire smoke events	<ul style="list-style-type: none"> • Help nonfederal entities, such as states, access and use technologies to gather more information on the composition of fine particulate matter. • Improve technology to collect more robust data from air quality sensors and more easily create visualizations from these data. 	Stakeholders: 5 times Literature: 2 times
Support research on interventions to inform how best to respond to wildfire smoke	<ul style="list-style-type: none"> • Support research on risk communication to inform communication strategies, including on how to effectively convey air quality alerts. • Support research on what interventions for wildfire smoke may be the most effective, sufficient, and feasible for different communities and individuals. 	Stakeholders: 2 times Literature: 2 times

Source: GAO analysis of literature and stakeholder views. | GAO-23-104723

^aWe interviewed a total of 15 stakeholders—six stakeholders with experience related to managing wildfire smoke at a national or regional scale from various organization types (academia, nonprofit, regional groups, etc.) and different areas of expertise (air quality, public health, forest management); and officials from nine tribal, state, and local entities from areas that had recent experience in managing wildfire smoke. We performed a literature search and identified 28 pieces of literature and reports from stakeholders to examine how EPA could better help manage the risks to air quality and public health from wildfire smoke.

^bEPA uses a tool called the Air Quality Index to communicate daily air quality. The tool uses color-coded categories and provides statements that describe the air quality in the area and information on how the air quality may impact the health of different groups.

Appendix II: Potential Actions for EPA to Better Manage Wildfire Smoke Risks, Identified by Our Analysis

Potential Actions Related to Hazard Mitigation

Our content analysis identified potential actions EPA could consider to provide incentives for and support tribal, state, and local air agency efforts to collaborate with land managers, land owners and communities to reduce the likelihood of future smoke events from catastrophic wildfires through wildfire risk mitigation. According to EPA officials, the agency does not currently have the authority to take some of these actions (for additional information, see app. V).

Table 7: Potential Actions That Could Help the Environmental Protection Agency (EPA) Provide Incentives for and Support Wildfire Risk Mitigation to Manage the Risks to Air Quality and Public Health from Wildfire Smoke, Identified by Content Analysis of Literature and Stakeholder Views

Category of potential EPA actions to provide incentives for and support wildfire risk mitigation	Illustrative examples identified by literature and stakeholders ^a	Number of times the category was mentioned by stakeholders or in the literature ^b
Remove barriers to wildfire risk mitigation ^c	<ul style="list-style-type: none"> • Generate incentives for innovative use of woody debris—waste wood produced by activities such as logging and land clearing. • Encourage air quality agencies to facilitate prescribed burn permitting, such as through eliminating fees for prescribed burn permits, issuing permits for a broader area, or standardizing permitting processes that currently differ across jurisdictions, such as states. • Provide support for cultural burning—which is part of Tribes’ traditional ecological knowledge and used for multiple purposes, including reducing fuels. 	Stakeholders: 7 times Literature: 7 times
Assess the performance and implementation of the Exceptional Events Rule, and consider improvements or alternatives	<ul style="list-style-type: none"> • Review the consideration of wildfire as an “exceptional event,” which, if a demonstration of a specific wildfire is approved as such an event, excludes air quality data influenced by the wildfire from determination of compliance with National Ambient Air Quality Standards^d • Develop a regulatory approach that considers the transboundary nature of wildfire smoke, which can cross state and international boundaries. • Identify new actions that can be taken to reduce risks from wildfire smoke events, which are no longer “exceptional.” 	Stakeholders: 6 times Literature: 4 times
Use air quality management tools to better incentivize wildfire mitigation	<ul style="list-style-type: none"> • As a prerequisite for approving an exceptional events demonstration, require states to take wildfire mitigation actions through land management. • Require air agencies to include wildfire mitigation provisions in their State Implementation Plans, such as provisions to work with utilities to fix problematic power lines that could start a fire^e • Enhance the effectiveness of exceptional event mitigation plans, such as by requiring them to include provisions for states, potentially through air agencies to work with land managers and owners to reduce wildfire risk^f 	Stakeholders: 4 times Literature: 4 times

Source: GAO analysis of literature and stakeholder views. | GAO-23-104723

^aAccording to EPA officials, the agency would face constraints in implementing many of these actions with its current authority.

^bWe interviewed a total of 15 stakeholders—six stakeholders with experience related to managing wildfire smoke at a national or regional scale from various organization types (academia, nonprofit, regional groups, etc.) and different areas of expertise (air quality, public health, forest management);

**Appendix II: Potential Actions for EPA to
Better Manage Wildfire Smoke Risks, Identified
by Our Analysis**

and officials from nine from tribal, state, and local entities in areas that had recent experience in managing wildfire smoke. We performed a literature search and identified 28 pieces of literature and reports from stakeholders to examine how EPA could better help manage the risks to air quality and public health from wildfire smoke.

^cAccording to EPA officials, protecting public health needs goes hand in hand with removing barriers to prescribed burning.

^dUnder the Clean Air Act, an “exceptional event” is an event that affects air quality, is not reasonably controllable or preventable, is an event caused by human activity that is unlikely to recur at a particular location or a natural event, and is determined by EPA through a process established by regulation to be an exceptional event. 42 U.S.C. § 7619(b)(1). EPA has issued regulations determining several types of events, including wildfires, to generally be exceptional events. See 40 C.F.R. § 50.14(b)(4).

^eState Implementation Plans describe how each state will attain and maintain compliance with National Ambient Air Quality Standards.

^fUnder the Exceptional Events Rule, all states having areas with historically documented or known seasonal events, which include events of the same type and pollutant that recur in a 3-year period, are required to develop a mitigation plan. 40 C.F.R. § 51.930(b)(1).

Appendix III: Additional Information on Wildfire Smoke Pollutants and Health Effects

Fine particulate matter is the main pollutant of concern from wildfire smoke with regard to human health, according to the Environmental Protection Agency (EPA). However, wildfire smoke contains a complex mixture of other pollutants that degrade air quality and cause health effects. Additional pollutants from wildfire smoke include

- **Ozone.** Wildfires can produce volatile organic compounds and nitrogen oxides, which react in sunlight to create ground-level ozone. Ozone can cause health effects such as inflammation of the airways and shortness of breath.
- **Air toxics.** Wildfire smoke can include air toxics, which are pollutants known or suspected to cause cancer or other serious health effects.¹ The amount and types of air toxics in smoke depend on factors such as the type of vegetation burned and whether structures or other human-made materials are burned. Different air toxics can have different health effects.
- **Carbon monoxide.** Carbon monoxide—a colorless and odorless gas—causes effects ranging from chest pain to disorientation, visual impairment, and death. Carbon monoxide may particularly affect populations very close to the fire, such as firefighters.

According to EPA, certain groups of people may potentially be more at risk from various health effects from wildfire smoke exposure (see table 8). Additionally, the Centers for Disease Control and Prevention notes on its website that people with COVID-19 may be at increased risk of health effects from exposure to wildfire smoke due to compromised heart and lung function related to COVID-19. Wildfire smoke events can cause mental health effects when, for example, people experience a reduction in physical activity and isolation from remaining indoors.

¹EPA uses the term “hazardous air pollutants” for air toxics that are specifically listed as relevant to programs in the Clean Air Act. Some air toxics are not included on the list of hazardous air pollutants.

**Appendix III: Additional Information on Wildfire
Smoke Pollutants and Health Effects**

Table 8: Populations Potentially More at Risk of Health Effects from Wildfire Smoke Exposure

Population	Why this population is potentially more at risk	Potential health effects from wildfire smoke exposure
Children	Children’s lungs are still developing, and children may spend more time outdoors, engage in more vigorous activity, and inhale more air per pound of body weight compared to adults.	<ul style="list-style-type: none"> • Breathing difficulties • Chest tightness • Decreased lung function
Older adults	Older adults are more likely to have preexisting lung and heart diseases and less robust defense mechanisms.	<ul style="list-style-type: none"> • Exacerbation of heart and lung diseases
Outdoor workers	Outdoor workers may spend extended periods of time exposed to high concentrations of wildfire smoke.	<ul style="list-style-type: none"> • Breathing difficulties • Exacerbation of heart and lung diseases
People with asthma and other respiratory diseases	Wildfire smoke can trigger severe respiratory responses in those with compromised health status because of underlying respiratory diseases.	<ul style="list-style-type: none"> • Breathing difficulties • Exacerbation of chronic lung diseases, such as asthma
People with cardiovascular disease	Wildfire smoke can trigger severe cardiovascular events in those with compromised health status because of underlying cardiovascular diseases.	<ul style="list-style-type: none"> • Conditions such as heart attack and stroke • Worsening heart failure • Abnormal heart rhythms
People with fewer resources	Less access to health care could lead to higher likelihood of untreated or insufficient treatment of underlying health conditions such as asthma and diabetes. Less access to measures to reduce smoke exposure—such as indoor air filtration—could lead to higher smoke exposure.	<ul style="list-style-type: none"> • Breathing difficulties • Exacerbation of heart and lung diseases
Pregnant people	Pregnancy-related changes, such as increased breathing rates, may increase vulnerability to wildfire smoke. In addition, during critical development periods, the fetus may experience vulnerability to wildfire smoke exposure.	<ul style="list-style-type: none"> • Low birth weight • Preterm birth
Firefighters	Firefighters may spend extended periods of time in close proximity to wildfires and be exposed to high concentrations of wildfire smoke.	<ul style="list-style-type: none"> • Health effects such as increased risk of heart disease or cancer
Individuals in tribal communities	Tribal nations and Indigenous people are often located in areas with higher-than-average wildfire risk and may have fewer resources available to adapt.	<ul style="list-style-type: none"> • Various health effects depending on the individual

Source: GAO summary of information from the Environmental Protection Agency, California Air Resources Board, California Office of Environmental Health Hazard Assessment, Centers for Disease Control and Prevention, and Forest Service. | GAO-23-104723

Appendix IV: Additional Information on EPA's Support of Efforts to Prepare for and Respond to Wildfire Smoke Events

The Environmental Protection Agency (EPA) has contributed to a range of information and tools to support federal and nonfederal efforts aimed at helping communities understand the air quality and health risks from wildfire smoke and prepare for and respond to smoke events. The tools that EPA has provided include (1) research to help decision makers and the public understand air quality and public health risks from wildfire smoke, (2) planning information and tools to help communities prepare for wildfire smoke events, and (3) air quality information and tools to help support wildfire smoke response efforts.

Research to Help Decision Makers and the Public Understand Air Quality and Public Health Risks from Wildfire Smoke

EPA has conducted, supported, and partnered on research on topics, including

- **Wildfire smoke emissions and air quality impacts.** EPA has coordinated with other agencies and institutions, such as the Joint Fire Science Program, the National Oceanic and Atmospheric Administration (NOAA), and academic institutions, on research to identify the different amounts and types of pollutants in wildfire smoke. For example, with support from the Joint Fire Science Program, EPA conducted research to compare particulate matter in smoke from various vegetation types and from flaming fires versus smoldering fires to show differences in effects on air quality.
- **Health effects of wildfire smoke.** EPA has conducted research aimed at understanding health effects of wildfire smoke in general and on different populations, which can help target strategies to protect public health. For example, EPA has produced studies on the toxicity of wildfire smoke and how wildfire smoke exposure is associated with various health outcomes, such as cardiovascular health in individuals age 65 and older. EPA has also conducted research to project changes in air quality and health effects from wildfire smoke under different future climate scenarios. In addition, in 2017, EPA researchers published a Community Health Vulnerability Index to identify the locations of communities most vulnerable to smoke exposure and smoke-related health effects.¹ This type of information can be used to target strategies to help those vulnerable communities, according to the study.
- **Role and relative health effects of prescribed burns.** EPA has examined the air quality and public health effects of prescribed burns

¹Rappold, A. G. et al., "Community Vulnerability to Health Impacts from Wildland Fire Smoke Exposure," *Environmental Science and Technology*, vol. 51, no. 12 (2017): 6674-6682.

compared to wildfire. For example, in September 2021, EPA published the *Comparative Assessment of the Impacts of Prescribed Fire Versus Wildfire (CAIF): A Case Study in the Western U.S.* in collaboration with the Forest Service, Department of the Interior, and National Institute of Standards and Technology.² The report characterized and compared the air quality and public health effects of wildfires that burned in two areas that had been treated with prescribed burns with hypothetical scenarios of how wildfires may have burned with different amounts of prescribed burns in the areas. Among other findings, the report concluded that well-designed prescribed burns may be able to reduce the effects of subsequent wildfires on air quality and public health. The study aimed to inform future land management and fire management strategies and also identified limitations in the current understanding of smoke from prescribed burns and wildfires.

- **Air quality sensor technology.** EPA has several actions to test and develop air quality sensor technologies to understand and enhance their ability to measure fine particulate matter and other smoke pollutants.³ For example, as part of its Mobile Ambient Smoke Investigation Capability study launched in May 2019, EPA collects air measurements from regulatory monitors and low-cost sensors to determine how they perform during wildfires. In addition, in 2017, EPA—in partnership with the Forest Service, National Park Service, NOAA, National Aeronautics and Space Administration, and the Centers for Disease Control and Prevention—initiated a Wildland Fire Air Sensors Challenge, a competition aimed at stimulating innovation in the development of multipollutant sensors that can operate in wildfire conditions. In June 2020, EPA awarded grants for continued development and commercialization of the winning sensors.

²Environmental Protection Agency, Center for Public Health and Environmental Assessment, Office of Research and Development, *Comparative Assessment of the Impacts of Prescribed Fire Versus Wildfire (CAIF): A Case Study in the Western U.S.*, EPA/600/R-21/197 (Research Triangle Park, N.C.: 2021). This work was coordinated through the Wildland Fire Leadership Council.

³In November 2020, we found that low-cost sensors were increasingly available as a tool to measure air quality and provide information in areas not currently monitored. However, we also found that there were concerns about the quality of data they produce, and that users need additional information on accepted applications and proper use of sensors. See GAO, *Air Pollution: Opportunities to Better Sustain and Modernize the National Air Quality Monitoring System*, GAO-21-38 (Washington, D.C.: Nov. 12, 2020). In addition, we reported on air quality sensor technology challenges and opportunities in GAO, *Science & Tech Spotlight: Air Quality Sensors*, GAO-21-189SP (Washington, D.C.: Dec. 7, 2020).

- **Strategies to protect public health.** EPA researchers are working with various partners, including federal, tribal, state, and local agencies, to conduct studies that evaluate the effectiveness of different strategies to communicate information about air quality and health risks and implement measures to reduce exposure to wildfire smoke. For example, EPA is conducting the Wildfire Advancing Science Partnerships for Indoor Reductions of Smoke Exposures study in partnership with the Missoula City-County Health Department in Montana, University of Montana, and Hoopa Valley Tribe located in California. According to the study's authors, the study can inform air quality managers, public health professionals, and others about strategies—such as how to design and operate air filtration and heating, ventilation, and air-conditioning (HVAC) systems—to reduce indoor fine particulate matter concentrations and protect indoor air quality and public health during wildfire smoke events. In addition, EPA co-sponsored with other federal, tribal, state, and local agencies the “Cleaner Indoor Air during Wildfires Challenge” to encourage development of effective, low-cost approaches to removing fine particulate matter from indoor air. Also, EPA awarded more than \$9 million in grant funding, through its Science to Achieve Results program, for researchers to study interventions and communication strategies to reduce exposures and health risks of wildfire smoke.⁴

Planning Information and Tools to Help Communities Prepare for Wildfire Smoke Events

EPA provides information and tools to help communities prepare for wildfire smoke events, such as

- **Educational materials.** EPA provides educational materials—developed in partnership with other federal agencies, state agencies, and local organizations—to help communities and the public prepare for wildfire smoke events and reduce their exposure to smoke. For example, EPA worked with CDC, Forest Service, California Air Resources Board, and California Office of Environmental Health Hazard Assessment to produce the 2019 Wildfire Smoke Guide for Public Health Officials.⁵ This guide provides tribal, state, and local public health officials with information to help them establish plans for communicating health risks and taking measures to protect the public when wildfire smoke is present. EPA also provides educational

⁴EPA awarded 12 grants for this body of research, which is to be conducted between 2021 and 2025, according to agency documents.

⁵Environmental Protection Agency, Office of Air Quality Planning and Standards, Health and Environmental Impacts Division, *Wildfire Smoke: A Guide for Public Health Officials, Revised 2019*, EPA-452/R-19-901 (Research Triangle Park, N.C.: Aug. 2019).

materials for the public on its website. Such materials include health fact sheets—developed with partners such as the CDC, Forest Service, and California Air Resources Board—on reducing an individual's smoke exposure, protecting children from wildfire smoke, and indoor air filtration. EPA has also developed educational materials on indoor air quality issues, including webpages, a video demonstrating how to create a clean room at home, and instructions on how to assemble an air cleaner from a box fan and high-efficiency air filter. Many of these materials have been translated into nine languages to reach more U.S. communities, according to EPA officials.

- **Communication, outreach, and grant support.** EPA conducts outreach to tribal, state, and local partners and the public to help raise awareness of wildfire smoke issues and enhance communities' abilities to plan for smoke events. For example, EPA's Office of Radiation and Indoor Air, Office of Research and Development, and three regional offices we interviewed have conducted outreach through means such as webinars, including one presented entirely in Spanish, on using N95 respirators and indoor air filtration during wildfire smoke events. The offices have also developed targeted messaging on health risks from wildfire smoke for specific audiences, such as tribal communities or schools, and they have posted information on social media about protecting one's health during wildfire season.

In addition, EPA Region 10 coordinates an annual smoke management meeting focused on raising awareness of smoke issues and sharing new tools and resources.⁶ The meeting brings together people from air quality, public health, and land management agencies at the federal, tribal, state, and local levels, as well as researchers, according to EPA officials. Also, an EPA regional office co-leads a workgroup that brings together federal, state, and local officials to discuss ongoing smoke communications work. According to EPA officials, the group discusses topics such as coordinated messages related to smoke and needs and gaps around smoke communication. Finally, EPA has awarded grants to help fund efforts to enhance community preparedness. For instance, in October 2022, EPA

⁶EPA Region 10 serves Alaska, Idaho, Oregon, Washington, and 271 Tribes.

announced a \$4 million grant program to help communities better prepare buildings to protect occupants from wildfire smoke.⁷

- **Guidelines for protecting building occupants from smoke.** EPA staff are serving on an ASHRAE committee to create a guideline for protecting building occupants from wildfire and prescribed burn smoke.⁸ The guideline will apply to commercial, institutional, and similar types of buildings. The committee developed interim guidance that describes actions that should be taken before and during a smoke event, a checklist to determine if a building's HVAC system is ready for a smoke event, and elements that building managers should include in plans to ensure that a building is ready for a smoke event.

Air Quality Information and Tools to Help Support Wildfire Smoke Response Efforts

EPA's actions to provide and partner on providing air quality information and tools to help communities respond during wildfire smoke events include

- **Fire and Smoke Map.** EPA and the Forest Service partnered to develop an online platform and interactive map that shows near real-time air quality data from air quality monitors and low-cost sensors, along with the locations of wildfires and satellite information on where smoke is traveling. According to EPA officials, this map is used extensively by the public during smoke events. The map reports the information through an Air Quality Index that uses color-coded categories to convey the levels of health concern posed by the amount of air pollution. The map also includes links to smoke outlooks that are produced by air resource advisors deployed to a wildfire by the Interagency Response Program. Two stakeholders we interviewed said that EPA's actions to incorporate data from low-cost sensors into the map have been extremely valuable in providing air quality information in areas not covered by monitors operated by air quality agencies.
- **Access to low-cost sensors and other monitoring technology.** EPA has taken various actions to increase air quality monitoring in communities that otherwise do not have sufficient air quality data. For

⁷EPA has also provided grants to Tribes and states for smoke preparedness through the Clean Air Act and Indian Environmental General Assistance Program, according to EPA officials.

⁸ASHRAE is an organization focused on building systems, energy efficiency, indoor air quality, and sustainability for the built environment. The organization conducts research and writes standards, among other things. ASHRAE was formerly known as the American Society of Heating, Refrigerating, and Air-Conditioning Engineers.

example, in 2021, EPA launched the Wildfire Smoke Air Monitoring Response Technology pilot program to enhance the availability of air quality monitoring equipment in areas affected by wildfire smoke that have limited or no established air quality monitoring equipment. The program loans air quality sensors and mobile monitoring systems that can be attached to vehicles.⁹ The equipment is also used by air resource advisors deployed through the Interagency Response Program.¹⁰ In addition, Region 10 has programs for loaning portable sensors to air quality officials and the public in tribal and rural communities. The sensors can be used to provide air quality information during wildfire smoke events.¹¹

- **Smoke forecasting and air quality modeling.** EPA partners with other federal agencies to help develop information about where smoke could travel and how it could affect air quality. For example, EPA has provided air resource advisors for the Interagency Response Program, which is the primary source of smoke forecasting for individual fires using models developed by the Forest Service.¹² In addition, EPA and NOAA collaborate to forecast future air quality conditions across the United States, including how wildfires could affect air quality in the coming 72 hours.¹³

⁹EPA's Vehicle Add-on Mobile Monitoring System was custom built by EPA to combine a fine particulate matter monitor, global positioning system unit, and other equipment. It can be attached to any vehicle to obtain mobile measurements of air quality, which firefighting personnel and air quality advisors can use to compare against smoke models.

¹⁰In addition, since the early 2000s, the Interagency Response Program has maintained a cache of emergency monitors for fine particulate matter and carbon monoxide for use during wildfire smoke events.

¹¹EPA regional offices have developed air sensor loan programs independently and through collaborations with libraries, Tribes, museums, and others to help the public learn about air quality in their communities. The goals, structure, eligibility, and available equipment vary among the programs.

¹²Other federal agencies, including the CDC and NOAA, have also provided air resource advisors.

¹³NOAA officials said that this partnership helps provide short-term air quality predictions and alerts that can inform people of the need to take protective action ahead of dangerous smoke events. NOAA has multiple wildfire smoke models that can provide information to help manage risks from wildfire smoke, according to NOAA officials. For example, NOAA's Rapid Refresh-Smoke model simulates the emissions and transport of smoke from wildfires and predicts the impact of smoke on the weather.

Appendix V: Additional Information on Potential EPA Actions to Provide Incentives for and Support Wildfire Risk Mitigation

Our analysis of literature and stakeholder views identified actions the Environmental Protection Agency (EPA) could consider to provide incentives for and support tribal, state, and local air agencies' efforts to collaborate with land managers, land owners, and communities to reduce the likelihood of future smoke events from catastrophic wildfires through wildfire risk mitigation. The actions identified through our analysis of literature and stakeholder views included the following options (for an overview of the results of our analysis, see app. II):

- **Assessing the performance and implementation of the Exceptional Events Rule and considering improvements or alternatives.** According to our analysis of literature and stakeholder views, EPA could consider a new approach for managing risks to air quality and public health from wildfire smoke or develop a regulatory approach that considers the transboundary nature of wildfire smoke. As one stakeholder noted, identifying a specific solution for an alternative approach is very challenging, but EPA could consider alternatives. For example, according to stakeholders, EPA could consider a more holistic approach that encourages wildfire prevention and mitigation, or an innovative approach that addresses wildfire smoke outside of the Exceptional Events Rule.
- **Using certain air quality management tools to better encourage wildfire mitigation.** Our analysis of literature and stakeholder views identified actions EPA could take to better use existing air quality management tools. For example, according to our analysis, EPA could consider requiring air agencies to include wildfire risk mitigation provisions in their State Implementation Plans.¹ One of these stakeholders suggested that these plans could include programs for state air agencies to work with land managers and utilities to fix problematic power lines or make the electrical grid more resilient to prevent fires from starting. Additionally, according to our analysis, EPA could ask air agencies to show, as a prerequisite for approving a wildfire exceptional event demonstration, that air agencies had taken

¹According to EPA officials, neither the Clean Air Act nor implementing regulations currently require that air agencies include wildfire mitigation provisions in their State Implementation Plans. They said that, while EPA is responsible for reviewing State Implementation Plans or Tribal Implementation Plans that may include wildfire mitigation provisions or smoke management programs, the tribal, state, or local agency determines whether or not to allow individual burns. The officials also said that EPA agrees that regular communication between fire-related federal, state, and other partners is imperative to successful implementation of air quality and fire goals.

steps to coordinate with land managers on implementing wildfire mitigation actions.

- **Enhancing the effectiveness of exceptional event mitigation plans.** According to EPA officials, EPA verifies that mitigation plans contain certain required content but does not evaluate the implementation or the effectiveness of the plans.² Officials we interviewed from three state or local air agencies required by EPA to have mitigation plans said that the plans typically document wildfire smoke response strategies that were already in place, such as how to communicate with the public during smoke events.³ An official we interviewed from one agency said that the agency had almost forgotten that it had the plan since the plan did not require the agency to take any new actions. According to our analysis, to enhance the effectiveness of the plans, EPA could require that the plans contain provisions for state air agencies to work with land managers and land owners to reduce wildfire risks. EPA, in the preamble to the 2016 final rule amending the Exceptional Events Rule, notes that forest management plans—which land managers can use to identify goals and objectives for wildfire mitigation, among other things—might satisfy the mitigation elements for wildfires.⁴ Another stakeholder said that EPA could consider requiring more mitigation plans for wildfire smoke and making them more effective and enforceable.⁵
- **Removing barriers to wildfire risk mitigation.** According to our analysis of literature and stakeholder views, EPA could remove some

²The Exceptional Events Rule requires all states having areas with historically documented or known seasonal events, which include events of the same type and pollutant that recur in a 3-year period, to develop a mitigation plan. 40 C.F.R. § 51.930(b)(1).

³When required to develop mitigation plans, air agencies must include in such plans certain specified provisions, including provisions for public notification to and education programs for affected or potentially affected communities. Agencies must also include steps to identify, study, and implement mitigating measures such as approaches to address, among other things, measures to abate or minimize contributing controllable sources of identified pollutants. 40 C.F.R. § 51.930(b)(2).

⁴81 Fed. Reg. 68,216, 68,274 (Oct. 3, 2016).

⁵According to EPA officials, the agency continues to evaluate the effectiveness of the mitigation requirements within the Exceptional Events Rule. They also noted that the mitigation plan requirements would only apply to areas that have recurring events as determined by submitted demonstrations, and air agencies have the discretion to submit exceptional events demonstrations. Even if an area is affected by multiple wildfires, if the air agency does not submit a demonstration, then the wildfires would not trigger the requirements to develop a mitigation plan, according to EPA officials.

barriers to wildfire risk mitigation methods such as prescribed burns and cultural burns. For example, EPA officials told us that the allowance for certain prescribed burns to be considered exceptional events can incentivize wildfire mitigation. However, two stakeholders we interviewed said that state and local agencies are unlikely to use this provision for prescribed burns because the agencies would not likely approve prescribed burns that could cause National Ambient Air Quality Standards exceedances in the first place. In addition, land management agency officials and one stakeholder said that state and local agencies may not use the provision because exceptional event demonstrations are technically complicated and resource intensive.⁶ To better incentivize wildfire mitigation, one stakeholder noted that EPA could modify its approach to prescribed burn exceptional event demonstrations to make them less burdensome or more expansive to cover an entire prescribed burn program.⁷ This stakeholder also suggested that EPA could encourage state air agencies to standardize processes for prescribed burn permitting or eliminate the cost of prescribed burn permits, since they provide a public benefit.

⁶According to EPA officials, EPA received and concurred with an exceptional events demonstration for prescribed burns causing ozone exceedances in the Flint Hills of Kansas in December 2012. Since that time, as of August 2022, no tribal, state, or local agency had submitted an exceptional event demonstration for a prescribed burn, according to EPA officials.

⁷According to EPA officials, in implementing the Clean Air Act and promulgating the Exceptional Events Rule, EPA considered a wide array of stakeholder feedback and developed an approach for fire-related exceptional events demonstrations that was intended to reduce the administrative burden. They added that EPA continues to work with tribal and state air agencies to address opportunities to improve or clarify program implementation in a manner consistent with the Clean Air Act.

Appendix VI: Comments from the Environmental Protection Agency



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

February 15, 2023

OFFICE OF
AIR AND RADIATION

Mr. Alfredo Gómez
Director
Natural Resources and Environment
U.S. Government Accountability Office
Washington, D.C. 20548

Dear Mr. Gómez:

Thank you for the opportunity to review and comment on the U.S. Government Accountability Office's draft report, "Wildfire Smoke: Opportunities to Strengthen Federal Efforts to Manage Growing Risks," (GAO-23-104723) ("Draft Report"). The purpose of this letter is to provide the U.S. Environmental Protection Agency's (EPA) response to the Draft Report's findings, conclusions, and recommendations. This response provides a detailed discussion of our current progress, goals, and existing challenges in reducing the health risks of wildfire smoke.

Recognizing the magnitude of the air quality problem created by recent wildfire trends, EPA staff and management have informally advanced numerous programs, projects, and collaborations to help reduce exposure to smoke. This report captures some, but not all, of the important work that EPA has undertaken, despite not having dedicated funding or a formal program. For example, EPA has made significant improvements to systems that inform the public of air quality conditions and timely information reporting through the AirNow Fire and Smoke Map. The Agency also uses existing interagency processes and stakeholder collaborations to provide communities with resources that will aide in their preparation and response to wildfire smoke events.

In our continued efforts to advance EPA's work on wildfire smoke, we have identified several goals for which we intend to take action and have requested Agency resources to do so. These actions include: assessing the impact of wildland fire smoke on air quality; improving communication of smoke-related health risks, increasing collaboration among EPA Headquarters and Regional Offices; continuing collaboration with internal and external partners; and providing funding to assist communities with wildfire smoke preparedness. EPA also plans to improve its interagency collaboration by continuing its participation in existing efforts to discuss and plan strategies to address public health issues.

EPA has identified several challenges, first and foremost being the lack of dedicated funding and the lack of an organizational structure to house this work. Further, wildfire risk mitigation methods can have adverse impacts on air quality that require careful consideration and management, and many are outside of the scope of EPA's statutory authority and work. However, EPA is advancing efforts to reduce risks through (1) collaboration between EPA's National Emissions Inventory Team and the United States Forest Service (USFS) to provide smoke emissions estimates using ground and satellite data; (2) assessing smoke impacts using modeling and monitoring tools; (3) continuing to increase public awareness through the fact sheets and information dissemination; and (4) considering fire-related air quality issues in the context of implementation of air quality management programs such as for the national ambient air quality standards, and others.

GAO Recommendations

Recommendation 1. The Administrator of EPA should develop and document a coordinated approach for EPA's actions to help communities prepare for and respond to the air quality and public health risks of wildfire smoke. The approach should align with leading practices for collaboration, including establishing goals, identifying and leveraging resources, and clarifying key stakeholder roles and responsibilities.

EPA Response:

EPA generally agrees with the recommendation and continues to make progress regarding EPA actions to help communities. EPA's work in this area is underfunded; however, EPA has been able to improve communication tools and provide the public with critical information during wildfire smoke events. As the report acknowledges, EPA is limited in its ability to fully respond to this growing threat until sufficient resources are allocated to this important work. EPA has developed several tools to help communities prepare for and respond to the air quality and public health risks of wildfire smoke. Examples include:

- Continued modifications to the Air Quality Index and notifications systems, such as AirNow, which inform the public of poor air quality conditions.
- Collaborating with the other government agencies on Smoke Ready tools and resources. The Smoke Ready Toolbox provides information, such as air quality reports and fact sheets, to help communities prepare for and respond to wildfire and smoke events.
- EPA's Office of Air and Radiation (OAR) implements other programs that include aspects of community engagement, including tools regarding indoor air quality.

One of our most important tools, which EPA continues to enhance, is the AirNow Fire and Smoke Map. The AirNow Fire and Smoke map, which has now been translated into Spanish, has been an on-going collaborative effort between EPA's Office of Air Quality Planning and Standards (OAQPS), Office of Research and Development (ORD), and EPA Regional Offices, USFS, and state, local, tribal air quality officials. The AirNow Fire and Smoke map has many fire and smoke-related features, in addition to air quality data to help inform the public in smoke situations. The Fire and Smoke map is accessible through the AirNow mobile app and EPA's AirNow website, which includes a dedicated wildland smoke section with health-related and other guidance

documents. This tool provides important and timely information regarding air quality across the United States. Staff in OAQPS, ORD and EPA Regional Offices continue to engage and coordinate on improvements to the technical air quality information presented in the map and associated public outreach and communication on appropriate data interpretation.

Staff in OAR, ORD and EPA Regional Offices have established regular coordination and information sharing meetings. Specific examples include the following:

- OAR and ORD have regular staff level coordination meetings specifically devoted to addressing wildland fire issues of joint interest.
- OAQPS has identified the following four strategic goals to facilitate a more coordinated and strategic approach to addressing wildland fire issues:
 - Assess and describe impacts of wildland fire smoke on air quality;
 - Communicate health risks of smoke;
 - Implement the Clean Air Act in light of smoke impacts; and
 - Collaborate with internal and external partners.
- Beginning in 2021, EPA's Regional air programs established a regional office sub-lead, currently Region 9, for wildfire issues under the air program's lead region system wherein individual regions take on responsibility for coordinating across regions on particular topics. The wildfire sub-lead convenes a monthly meeting across OAR, ORD, and the Regional Office to coordinate and enhance communications and activities related to wildfires. Through the sub-lead, we are exploring ways to create a more formal structure and strategy to manage wildland fire smoke work across EPA, though many of these options will require time and resource commitments.

EPA has received \$4 million in its FY2022 appropriation and another \$7M in its FY2023 appropriations to award grants for wildfire smoke preparedness in community buildings and related activities which will be distributed to states, tribes, public preschools, local educational agencies, and non-profit organizations. The Notice of Funding Opportunity (NOFO) for these grants is expected to be published in 2023. EPA's Office of Radiation and Indoor Air (ORIA), which is leading the development of the NOFO, is coordinating with EPA Regions to determine how best to administer the program with limited staff dedicated to this issue.

Recommendation 2. The Administrator of EPA should work with the Secretaries of Agriculture and the Interior to better align air quality and land management goals for wildfire risk mitigation and establish joint strategies for achieving those goals. (PDF P. 43)

EPA Response

EPA generally agrees with the recommendation, while recognizing the challenge presented by the adverse impacts that certain mitigation measures may yield for air quality and public health.

EPA continues to improve interagency collaboration by participating in efforts such as the Wildland Fire Leadership Council (WFLC), the Wildfire Resilience Interagency Working Group (IWG), and the Wildfire Mitigation and Management Commission (Commission). In each of these venues, EPA has been proactive in elevating the public health challenges that arise from both wildfire and prescribed fire smoke. Recent actions include:

- Formation of a smoke subgroup to the IWG that unites representatives across the Federal family with equities in addressing the impacts of smoke.
- Initiated planning for a series of joint workshops between EPA, USDA, and DOI to share understanding of the public health impacts of wildland fire smoke, including what is known and not known about differences between prescribed fire and wildfire smoke, the efficacy of prescribed fires in mitigation wildland fires, and how to improve communication during wildland fire smoke events.

EPA plans to continue the relevant collaboration meetings and seek further opportunities to improve interagency collaboration and better mitigate risk from wildland fire smoke.

Recommendation 5. The Administrator of EPA should, in consultation with federal land management agencies, identify and develop additional information on reducing risks from wildfire smoke to air quality and public health through wildfire risk mitigation. (PDF P. 44)

EPA Response:

EPA generally agrees with the recommendation; we also note that many of the wildfire risk mitigation methods identified in the GAO report are outside the scope of EPA's work and statutory authority. EPA is currently advancing efforts to reduce risk from wildland fire smoke. In addition to the previously identified tools and efforts, EPA is also engaging in the following:

- EPA's National Emissions Inventory Team works closely with the USFS to estimate smoke emissions, using both ground and satellite information, which has resulted in more fire activity information being provided by states, local governments, and tribal governments. Improved information facilitates improved preparedness and communications.
- EPA supports, develops, and evaluates tools (models and monitors) to quantify the smoke impacts of specific fires and wildfires.
- EPA, in collaboration with numerous other Federal and state agencies, continues to develop and enhance the [information and fact sheets](#) associated with the Wildfire Smoke: A Guide for Public Health Officials.

EPA will continue to consider methods of communicating wildfire smoke impacts to the public in a timely and effective manner.

Recommendation 6. The Director of EPA's Office of Air and Radiation should work with EPA's tribal, state, and local partners to evaluate options for providing incentives for and supporting wildfire risk mitigation and establish a plan for implementing appropriate options, seeking additional authority from Congress if needed. (PDF P.44)

EPA Response:

EPA seeks clarification regarding what GAO means in its recommendation that EPA and partners evaluate options for providing incentives. EPA has taken a leadership role in the Wildfire Mitigation and Management Commission, the result of which will include recommendations to Congress as needed to improve wildfire risk mitigation, among other goals.

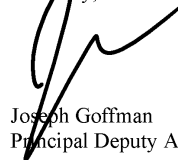
If GAO considers incentives for wildfire risk mitigation to include mechanisms for incentivizing prescribed burns, EPA notes that it does not have the authority to regulate how states choose to structure permitting or prescribed burn programs, or which entities within states are given authority over such programs or priority to conduct such burns. EPA has revised key regulations and guidance regarding implementation of the particulate matter and ozone air quality standards to address smoke from both wildland fires and prescribed fires, and has addressed similar issues in other air quality implementation programs. EPA intends to work with federal, state, local, and tribal partners to understand where air quality concerns may create a barrier to prescribed burns. Further, EPA continues to explore possible approaches to make the exceptional events process less resource-intensive for air agencies, specifically with regards to wildfire and prescribed fire events. As noted above, EPA has established several channels of regular communication with other agencies, including WFLC, the Wildfire Resilience Interagency Working Group, with its smoke subgroup, as well as ongoing collaborations such as dialogues on the impacts of prescribed fire on air quality and the work on the Fire and Smoke Map.

Conclusion:

In summary, EPA generally agrees with GAO's recommendations and appreciates its assessment of issues and possible solutions for managing the risks and impact of wildfire smoke on public health. As funding allows, EPA will continue to consider methods of communicating wildfire smoke impacts to the public in a timely and effective manner. EPA respectfully requests clarification on GAO's recommendation to evaluate options for providing incentives to its tribal, state, and local partners in support of wildfire risk mitigation, given that states have their own, independent authorities to establish approaches on choosing to structure permitting or prescribed burn programs.

I appreciate the opportunity to be of service and trust the information provided is helpful.

Sincerely,



Joseph Goffman
Principal Deputy Assistant Administrator

Appendix VII: Comments from the U.S. Department of Agriculture



United States
Department of
Agriculture

Forest
Service

Washington Office

1400 Independence Avenue, SW
Washington, D.C. 20250

File Code: 1420

Date: January 24, 2023

Mr. Alfredo Gomez
Director, Federal Lands and Water
Natural Resources and Environment
U.S. Government Accountability Office
441 G. Street, NW
Washington, DC 20548

Dear Mr. Gomez:

The U.S. Department of Agriculture (USDA) Forest Service appreciates the opportunity to respond to the U.S. Government Accountability Office's (GAO) draft report titled, *Wildfire Smoke: Opportunities to Strengthen Federal Efforts to Manage Growing Risks* (GAO-23-104723). USDA generally agrees with the GAO draft report and recommendations. Given the significance of the wildfire crisis facing the Nation and our current efforts to increase wildfire mitigation efforts across the country, we look forward to continuing the work to bring needed urgency to this issue.

I appreciate the hard work your team did on such a challenging and complex issue. The role of the Forest Service in responding to wildfire smoke and protecting public health, as well as the importance of mitigation efforts to address smoke impacts associated with the wildfire crisis, was captured well in the report, which is critical to our long-term efforts for wildfire risk reduction. Especially as the environmental impacts of catastrophic wildfire extend far beyond just air quality, the discussions requested by GAO require focused collaboration broadening beyond smoke and its impacts to public health in order to effectively implement the recommendations.

Only focusing on the effect of wildfire smoke on public health minimizes the breadth of the current crisis impacting the natural and human environment and neutralizes the most effective mitigation tool that also mimics natural processes – prescribed fire, which can be managed to minimize impacts on public health. Almost all forest and range types in the United States have evolved with (and are dependent on) fire, making recognition of fire's role in the ecosystem critically important. As air quality standards become more stringent, expanded interagency discussions are needed to ensure the use of prescribed fire, as the primary mitigation to catastrophic wildfire, can increase significantly.

Prescribed fires minimize impacts to public health through smoke management, especially when compared to the uncontrolled duration and severity of wildfires. It is our agency policy to conduct prescribed fires utilizing *Basic Smoke Management Practices* (Fed. Reg. Vol. 81, No. 191, pg. 68278). With our continued work with partners within the National Wildfire Coordinating Group to improve smoke management of prescribed fires, along with our continued agency research leadership, we expect to further develop better management strategies, smoke dispersion models, and enhance emission reduction techniques. Bolstering current authorities and



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**Appendix VII: Comments from the U.S.
Department of Agriculture**

Mr. Alfredo Gomez

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approaches mentioned in the draft report should balance impacts on firefighter and public safety, water quality, and protection of municipal water supplies among other environmental effects.

There will not be a smokeless future, whether through high severity wildfire or use of prescribed fire. I urge consideration of these key areas to strengthen the report and acknowledge the challenges in addressing the Nation's wildfire crisis. If you have any questions, please contact Robert Velasco, Chief Financial Officer, at robert.velasco@usda.gov.

Sincerely,



RANDY MOORE
Chief

Appendix VIII: Comments from the Department of the Interior



United States Department of the Interior

OFFICE OF THE SECRETARY
Washington, DC 20240

J. Alfredo Gomez
Director, Natural Resources and Environment
U.S. Government Accountability Office
441 G Street, NW
Washington, DC 20548

Dear Mr. Gomez:

Thank you for providing the Department of the Interior (Department) the opportunity to review and comment on the draft Government Accountability Office (GAO) report entitled, *Wildfire Smoke: Opportunities to Strengthen Federal Efforts to Manage Growing Risks*, GAO report (GAO-23-104723). We appreciate GAO's review of the increasing risk from wildfire smoke emissions and the likelihood that these risks will continue to increase for the foreseeable future.

The GAO issued several recommendations to multiple agencies, including one to the Department to address its finding. Below is a summary of actions planned to implement the recommendation.

Recommendation 4: *The Secretary of the Interior should work with the Administrator of EPA and Secretary of Agriculture to better align air quality and land management goals for wildfire risk mitigation and establish joint strategies for achieving those goals.*

Response: Concur. To achieve this recommendation, the planned course of action for the Department is to increase staffing to plan for and manage smoke emissions at the Departmental and the bureau levels and to work across agencies at the national and regional levels, as well as with Tribal, state and local government, as well as other external partners. The Department's management of air quality and wildfire risk mitigation goals will include an increasingly wide array of communications, data management, planning, budget development, wildfire operations, environmental justice and fuels management implementation, which will be supported by this additional staffing. These robust efforts will be initiated this calendar year and will enable coordination of numerous existing DOI efforts with EPA and USDA, and the joint development of further efforts. They will also support efforts to increase the pace and scale of fuels management treatments and address the overall wildfire risk reduction objectives included in the Bipartisan Infrastructure Law.

Review of this draft report was coordinated with the Bureau of Indian Affairs, Bureau of Land Management, U.S. Fish and Wildlife Service, and National Park Service. Each of the bureaus concurred with GAO's recommendation. The attached enclosure contains some technical comments from our review for your consideration while finalizing the report.

**Appendix VIII: Comments from the Department
of the Interior**

If you have any questions, please contact Jeff Rupert, Director, Office of Wildland Fire, at Jeff_Rupert@ios.doi.gov or 202-208-2719.

Sincerely,

**JOAN
MOONEY**

Digitally signed by JOAN
MOONEY
Date: 2023.01.19
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Joan M. Mooney
Principal Deputy Assistant Secretary for
Policy, Management and Budget exercising
the authorities of Assistant Secretary

Enclosure

Appendix IX: GAO Contact and Staff Acknowledgments

GAO Contact

J. Alfredo Gómez at (202) 512-3841 or gomezj@gao.gov

Staff Acknowledgments

In addition to the contact named above, Chad M. Gorman (Assistant Director), Anne Hobson (Analyst in Charge), Karen Chen, Jonathan Dent, Ellen Fried, Cindy Gilbert, Kathryn Godfrey, Patricia Moye, Jim Rice, Patricia Roy, Dan Royer, Joseph Dean Thompson, Breanna Trexler, Lisa Van Arsdale, Sarah Veale, and Jack Wang made key contributions to this report.

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Strategic Planning and External Liaison

Stephen J. Sanford, Managing Director, spel@gao.gov, (202) 512-4707
U.S. Government Accountability Office, 441 G Street NW, Room 7814,
Washington, DC 20548

