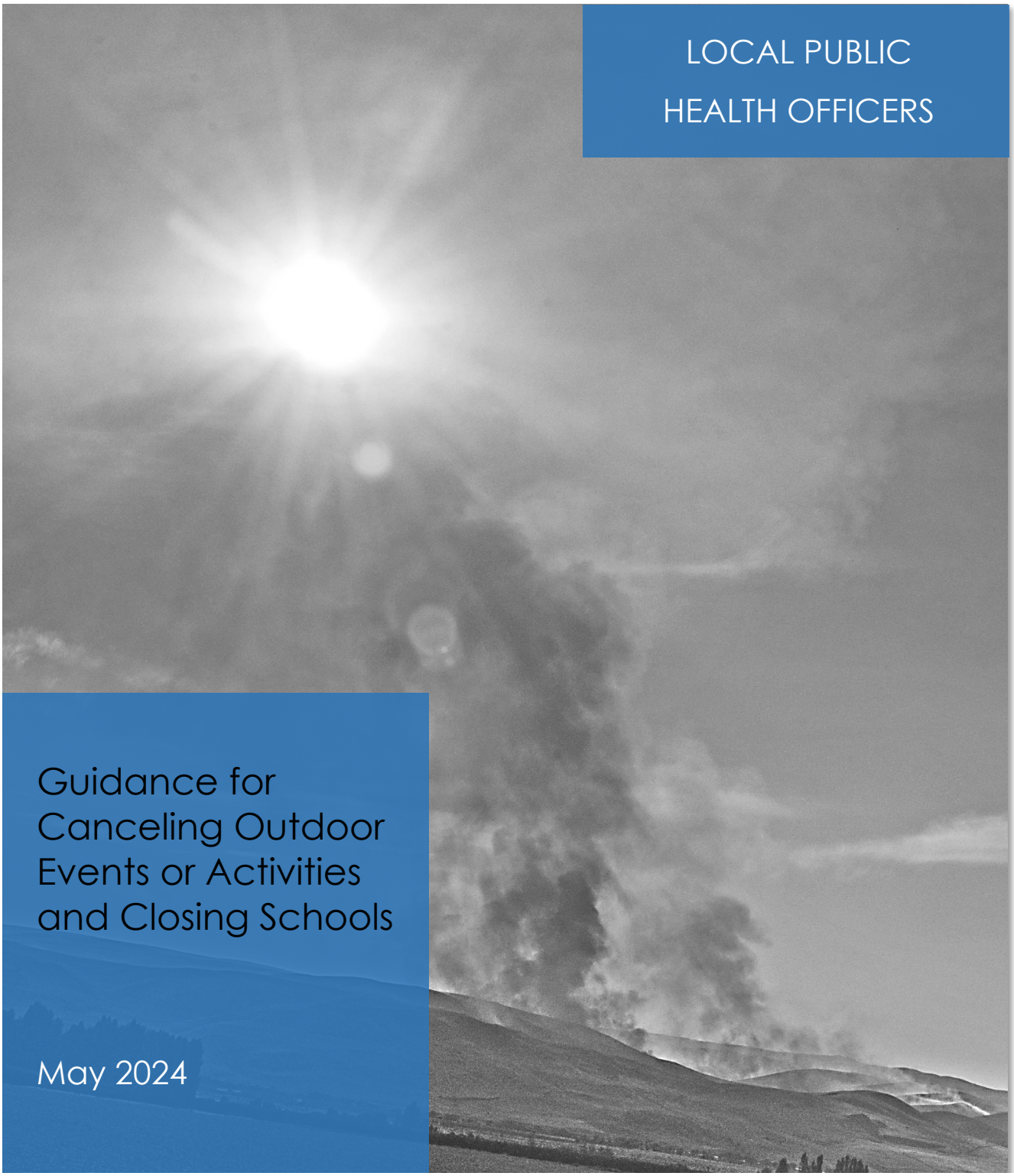
# Wildfire Smoke



LOCAL PUBLIC HEALTH OFFICERS

## Guidance for Canceling Outdoor Events or Activities and Closing Schools

May 2024

DEPARTMENT OF ECOLOGY
State of Washington

Washington State Department of HEALTH

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## CURRENT AIR QUALITY & FORECASTS

Current outdoor $PM_{2.5}$ levels from agency monitors are available as Air Quality Index (AQI) Values that are updated hourly on the Washington Smoke Blog and EPA's AirNow App. Forecasts are also increasingly available during wildfire season on the WA Smoke Blog and Washington State Department of Ecology's Smoke Forecast website. Low-cost $PM_{2.5}$ sensors can provide helpful information outdoors where there is not a nearby agency monitor and indoors, where there are no agency monitors, though these are less accurate than agency monitors and uncorrected sensor measurements should not be directly compared to $PM_{2.5}$ action levels. Publicly reported $PM_{2.5}$ outdoor sensor measurements with an applied smoke correction factor are also available on the WA Smoke Blog.

# Introduction

The Washington state departments of Health and Ecology have been asked about when to cancel outdoor events and activities or close schools due to wildfire smoke impacts on public health. Decisions about closures, relocations, or evacuations are made at the local level in Washington. This document provides guidance for local health officers about air concentrations of smoke, measured as fine particulate matter ($PM_{2.5}$), considered a health threat.

# Recommended particulate matter action levels for closures and cancellations

**When the current or forecasted outdoor AQI for $PM_{2.5}$:**

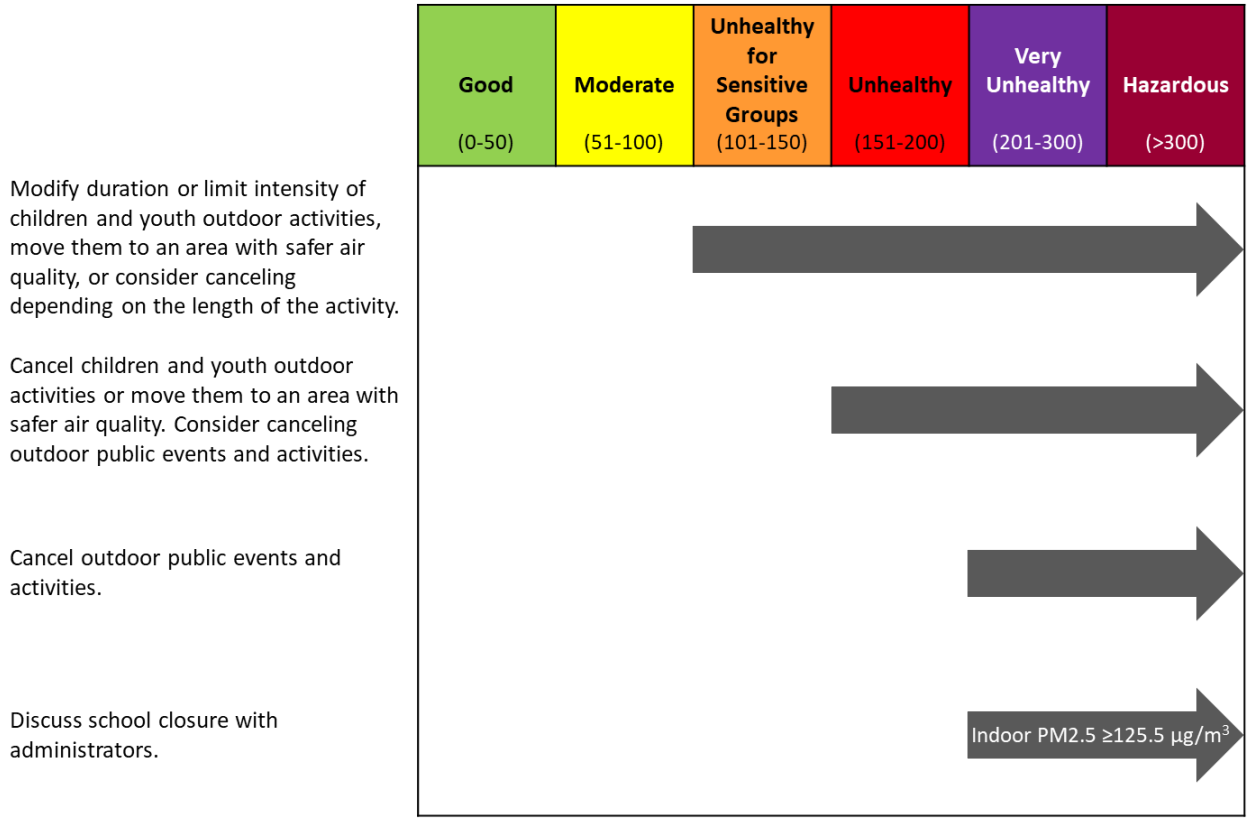
- Equals or exceeds an AQI value of 101 ("Unhealthy for Sensitive Groups" category or worse), modify duration or limit intensity of children and youth outdoor activities, move them to an area with safer air quality, or consider canceling depending on the length of the activity.
- Equals or exceeds an AQI value of 151 ("Unhealthy" category or worse), cancel children and youth outdoor activities or move them to an area with safer air quality. Consider canceling outdoor public events and activities.
- Equals or exceeds an AQI value of 201 ("Very Unhealthy" category or worse), cancel outdoor public events and activities.

**When school is in session and indoor $PM_{2.5}$ concentrations:**

- Equal or exceed 125.5 $\mu g/m^3$ (indoor equivalent to AQI value 201 and "Very Unhealthy" category or worse), discuss school closure with administrators.

$PM_{2.5}$ concentrations are reported across six health hazard levels in the AQI. The $PM_{2.5}$ action levels described here are each at a cut-point of a hazard level. The AQI is designed for outdoor pollutants, though the school closure action level is based on an indoor $PM_{2.5}$ concentration with an equivalent AQI value in the absence of established hazard levels for the general public designed for indoor use.

*Figure 1. AQI thresholds for recommended closures and cancellations*




# Factors to consider for cancelling outdoor events and activities, and closing schools

In addition to the $PM_{2.5}$ action levels, consider other factors and issues specific to your area when deciding about closures and cancellations to protect health and welfare.

## Outdoor Events and Activities

- What is the forecast for how long wildfire smoke levels will remain high?
- Are smoke conditions getting worse, getting better, or staying about the same?
- Is there an option to relocate to an area with cleaner air?
- If children or others requiring care are involved, will adults be available as caretakers?
- Will there be impacts on economic or job security by canceling the activity or event?
- Are there other weather factors to consider, like excessive heat or humidity, that would further increase risk from outdoor exposure?

- Is the visibility safe for driving?

### Schools

- What is the forecast for how long wildfire smoke levels will remain high?
- Have all options to improve indoor air quality been attempted?
- Are students and staff who are sensitive to smoke allowed to stay home if it is safer?
- Is it safe to walk or bike to school?
- Is the visibility safe for driving?
- Are there other weather factors to consider, like excessive heat or humidity, that would further increase health risks?
- Where will children be relocated if schools are closed? Is the air quality better there?
- If children or others requiring care are involved, will adults be available as caretakers?
- Will there be impacts to economic or job security for parents missing work to attend to children?
- While moving to another location, will people be more exposed outdoors than if they had just stayed indoors?
- Are there other safety concerns about relocating people?

### Steps to reduce smoke exposures

- Reduce outdoor time and activities.
- Stay indoors and keep indoor air as clean as possible.
- Keep windows closed and only allow entry of outside air through filtration.
- Restrict use of outside doors; double door entries can help keep smoke out.
- Wildfires often occur on hot days, and many schools and other indoor facilities do not have air conditioning. Pay attention to the heat and take steps to cool buildings.
- For more information:
    - Improving Ventilation and Indoor Air Quality during Wildfire Smoke Events (PDF)
    - DOH Smoke from Fires

## Measuring wildfire smoke levels

The concentration of $PM_{2.5}$ – particles less than 2.5 micrometers in diameter – is the most useful measurement of smoke levels to protect health. The Department of Ecology (Ecology), local clean air agencies, and Tribes routinely monitor these levels outdoors. $PM_{2.5}$ concentrations are grouped into health hazard levels within the U.S. Environmental Protection Agency's (EPA) Air Quality Index (AQI) six categories (Figure 1). Health precautions in each category are based on current conditions weighted to "24 hour-like" average concentrations. AQI values are from hourly monitored concentrations using EPA's NowCast algorithm.

NowCast particulate matter ($PM_{2.5}$) concentrations use averages of between 3 and 12 hours that can be compared to 24-hour standards and health indexes. EPAs' NowCast algorithm is designed to respond when air quality conditions are rapidly changing, which is common during

wildfire smoke events. NowCast concentrations use longer averaging times when air quality is stable, and shorter averaging times when conditions are changing quickly. NowCast concentrations, unlike hourly data, are suitable for comparison with federal standards and the AQI.

## Outdoor measurements, trends and forecasts

Three key pieces of information about smoke conditions are available on public agency websites and apps: the current $PM_{2.5}$ AQI, current $PM_{2.5}$ trends (whether smoke conditions are getting worse, getting better, or staying the same), and smoke forecasts. Whenever possible, decision-making around canceling outdoor events and activities, closing facilities or relocating people should consider all three pieces of information. Forecasts more than two days in the future should be used with caution, as they have greater uncertainty.

The Washington Smoke Blog is the recommended public agency website for accessing information on current conditions, trends, and forecasts, as it provides all three in a single map. On a smartphone, EPA's AirNow is the recommended app, though its forecasts are limited to most parts of Washington. Users who do not see forecast information in their area on the AirNow app can also refer to Ecology's smoke forecast, which covers the whole state. Instructions for all these resources are provided below.

### Outdoor Air Sensors

The recommended maps show agency monitoring sites as larger circles, temporary monitors as medium-size circles, and publicly reporting $PM_{2.5}$ low-cost sensors as smaller circles. Low-cost $PM_{2.5}$ sensors are small devices available commercially. They are generally less accurate than agency monitors, and since many are operated by members of the public, their performance, siting, and maintenance are unknown. Though EPA conducts some limited quality control screening on sensor data and applies a correction factor to account for known sensor bias, sensor data has greater uncertainty and is generally lower quality than agency monitoring data.

Where available, nearby agency monitors are the best data source. However, agency monitors may also represent different smoke conditions if they are at a different elevation or in a different type of environment. In places far from agency monitors, nearby air sensors are likely better data sources than distant agency monitors. However, sensor data should be interpreted with caution, especially when one sensor shows very different values than other nearby sensors. Considering values from multiple nearby sensors can help offset the greater uncertainty of sensor measurements.

### Recommended Website: Washington Smoke Blog

To see the current $PM_{2.5}$ AQI and trend using the Washington Smoke Blog map:

- Click the agency monitor or sensor closest to the area of interest.

- A pop-up will appear that indicates the $PM_{2.5}$ AQI value, trend, and link to recommended health actions.

Additional features shown on the map include: fire icons for large fire incidents, small glowing points for satellite fire detections, and gray polygons for smoke plume locations.

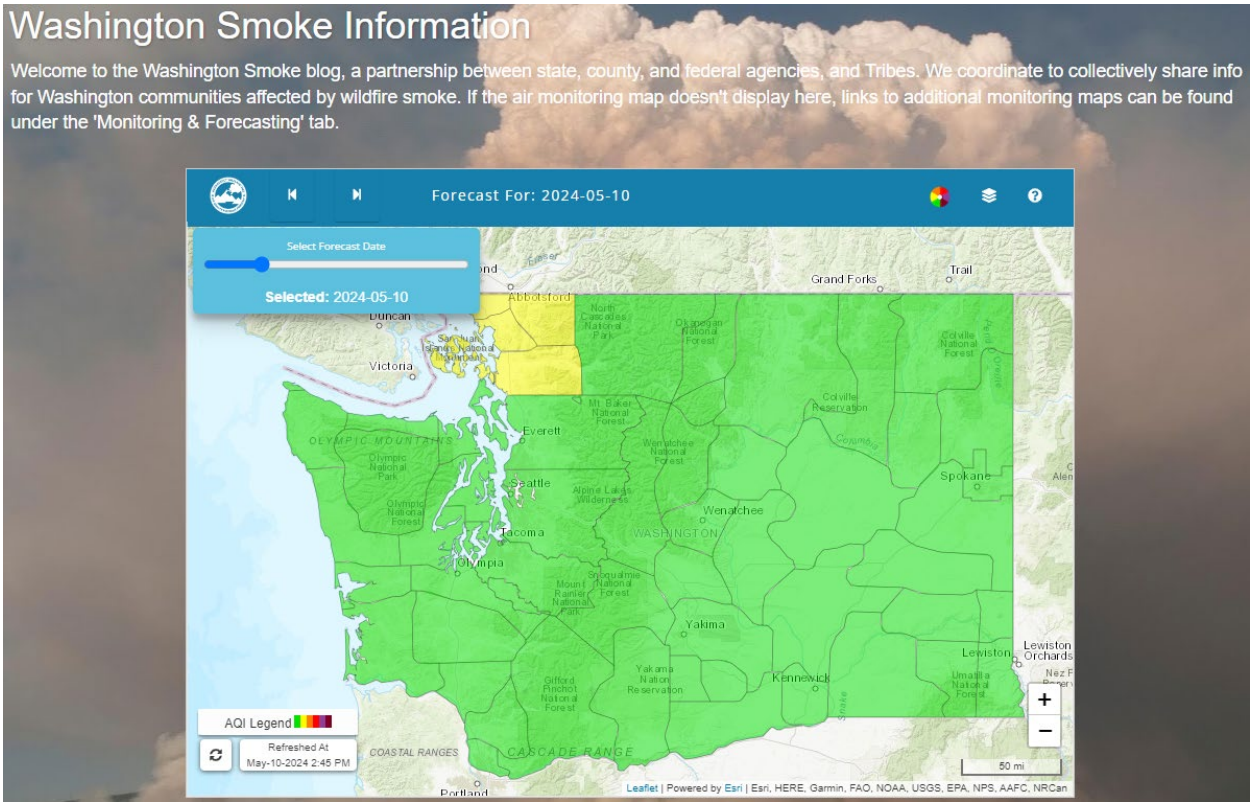
***Figure 2. Washington Smoke Blog map pop-up***


*Note: Though the design of EPA's Fire and Smoke map will change in 2024, the three main elements of the map – current conditions, forecast, and trends – will all remain available.*

To see the smoke forecast:

- Close any visible pop-ups on the map.
- Under "Select Forecast Date" in the top left corner of the map, use the slider to advance the date to the desired forecast date.
- The shaded polygons on the map indicate the 24-hour $PM_{2.5}$ AQI category forecasted for the selected date.

*Figure 3. Washington Smoke Blog forecast display*




The Washington Smoke Blog also contains text and graphical discussions of statewide, regional, or local air quality forecasts when wildfire smoke events are in progress. The Monitoring and Forecasting tab on the blog contains more information on several available higher-resolution smoke simulations.

## Recommended Smartphone App EPA's AirNow

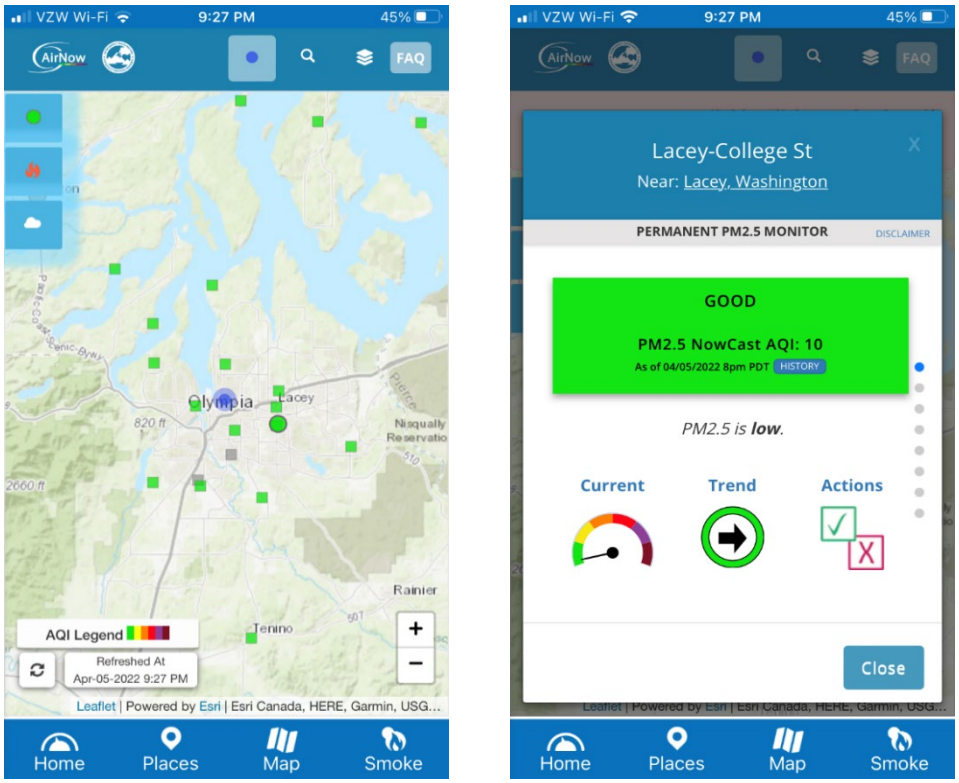
The landing page of EPA's AirNow app shows the current AQI and the daily forecast for some areas. Sometimes the current AQI is based on ground-level ozone or $PM_{10}$ conditions instead of $PM_{2.5}$. Click "Details" below the AQI dial to see the AQI value for $PM_{2.5}$.

*Figure 4. EPA's AirNow App home screen*


For more detailed monitoring data, click the "Smoke" button in the bottom right corner of the app. This map shows the same display of agency monitors and air sensors visible on the Washington Smoke Blog map.

- Click the agency monitor or sensor closest to the area of interest.
- A pop-up will appear that indicates the $PM_{2.5}$ AQI value, trend, and link to recommended health actions.

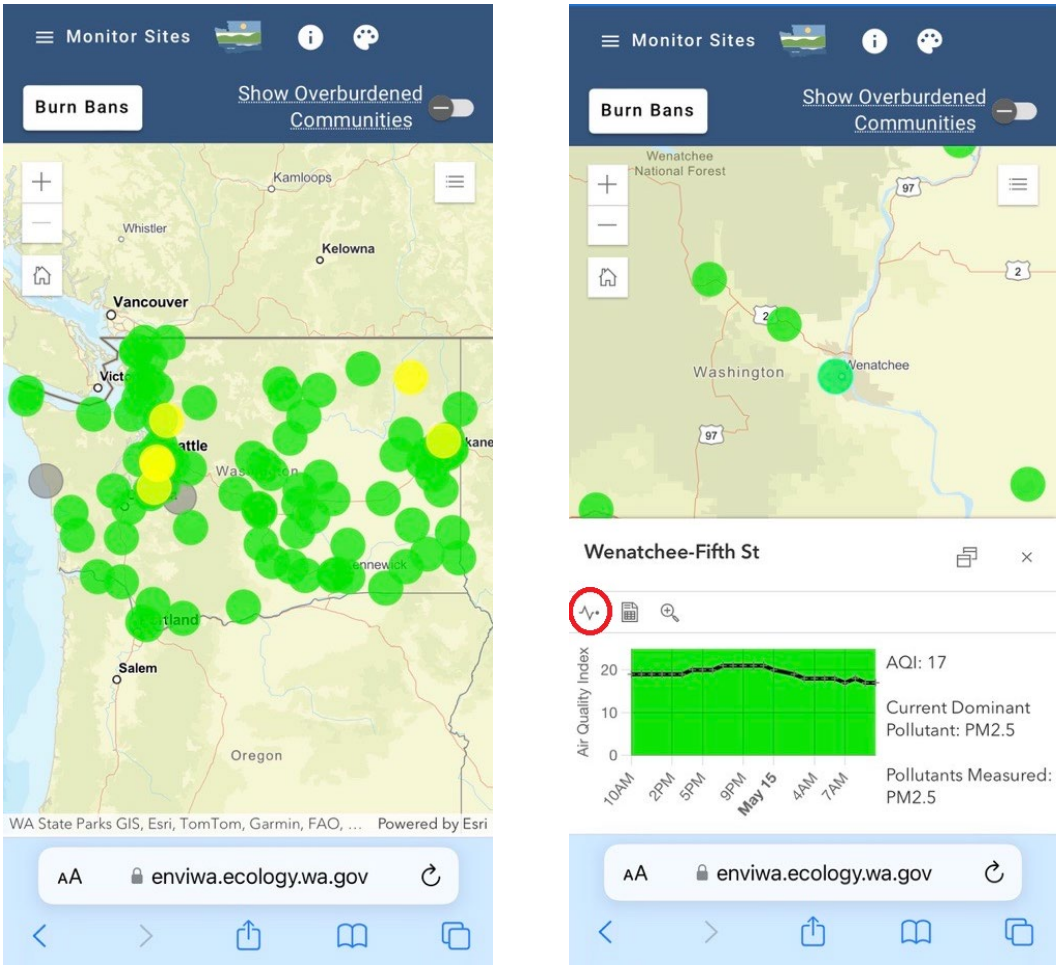
*Figure 5. Accessing AQI values on EPA's AirNow App*




## Alternative Smartphone App: Ecology AirQualityWA Web Application

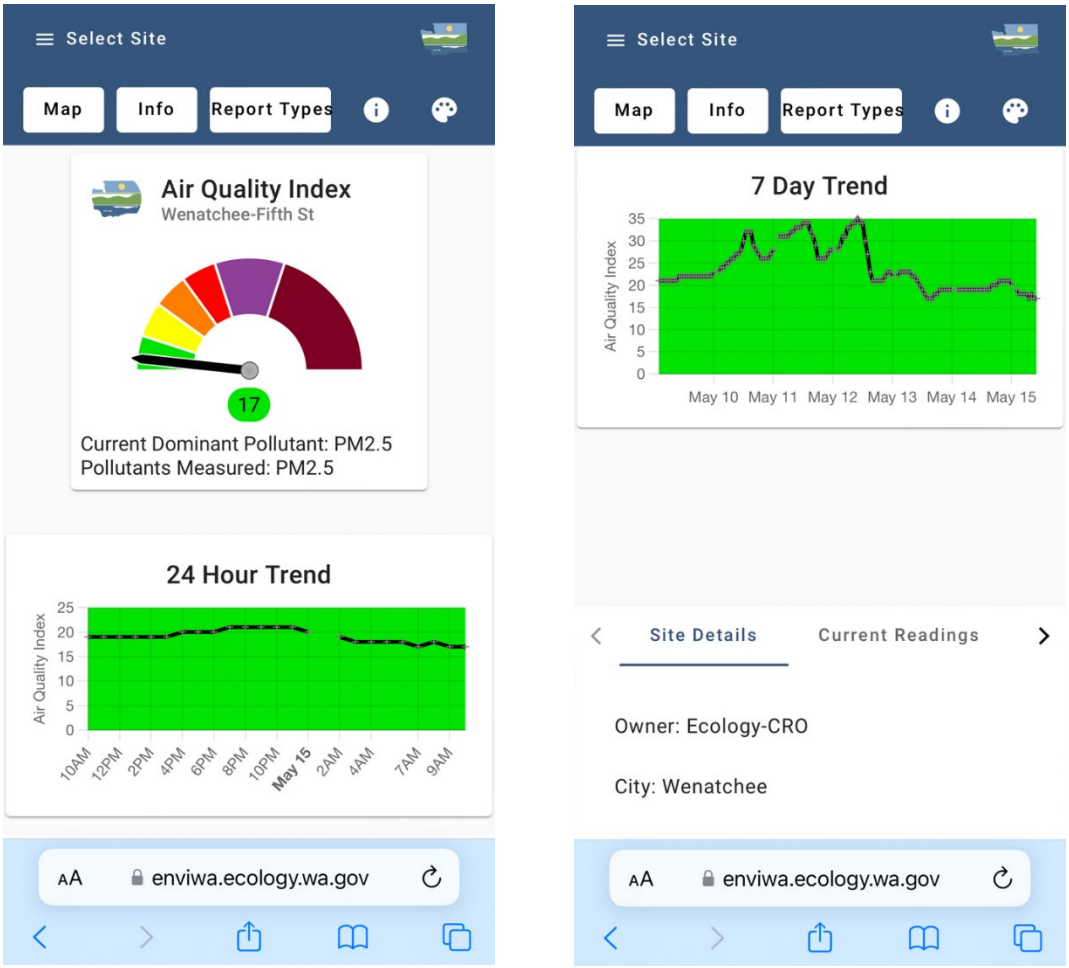
Ecology's air monitoring webpage is a progressive web application. It can be saved as a shortcut on a smartphone home screen and will behave like a smartphone app. It shows the current AQI and graphs of recent AQI conditions. The smoke forecast will be added with a toggle button in early summer 2024. As new features will be added to the web application throughout 2024, screenshots below may not be current.

*Figure 6. Home screen of Ecology's AirQualityWA web application (left) and example site popup (right).*




Select a site by clicking the map to see its AQI and trend graph. Click the graph icon on the popup (circled in red in the screenshot above on the right) to access site details.

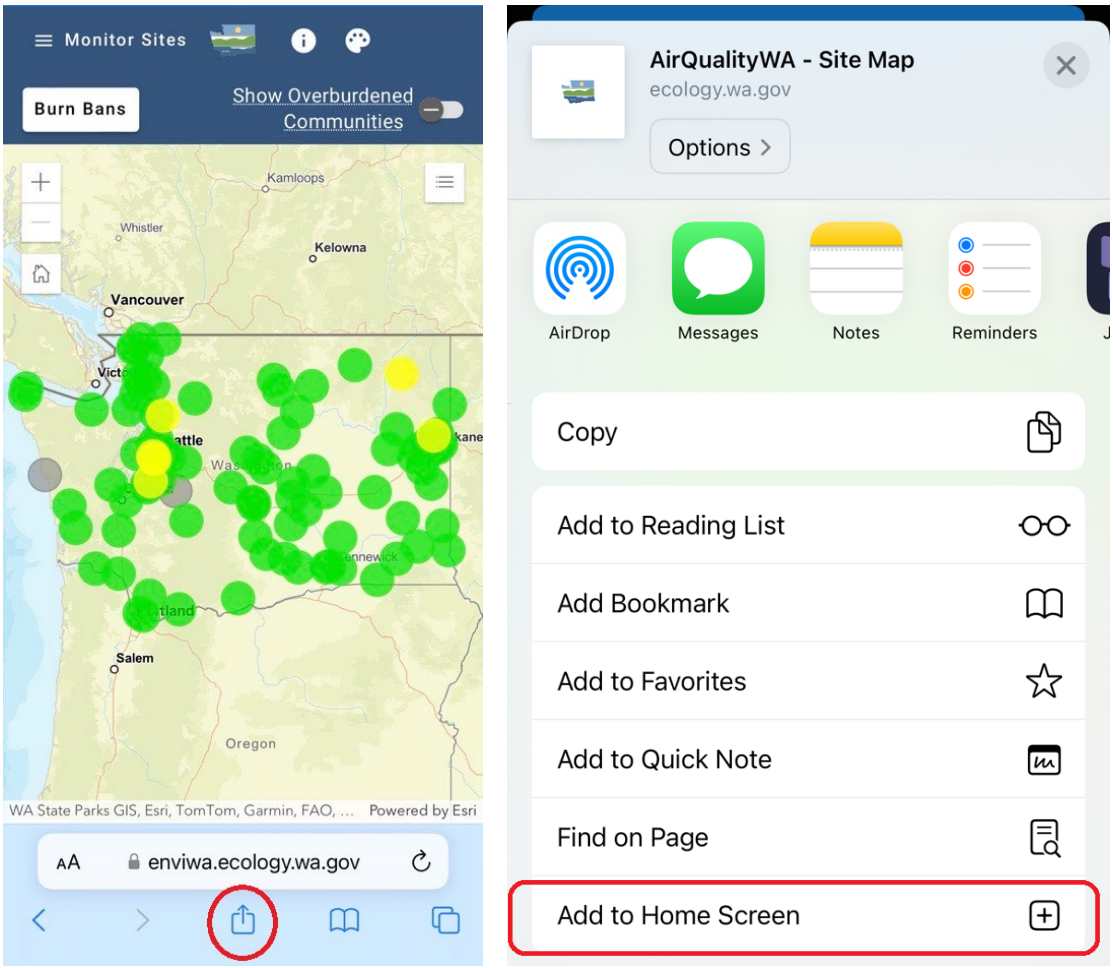
*Figure 7. Example site details page showing 24-hour trend graph (left). Scroll down for 7-day trend graph and site details (right).*




For app-like functionality, the web application can be saved to a smartphone home screen. Users who reference one monitoring site frequently may choose to save that site's details page rather than the map itself for quick access.

To save the web application to a smartphone, select the share button and choose "Add to Home Screen." On an iPhone using Safari, this is the button with a square and a vertical arrow as shown in red below. On an Android phone using Chrome, open the menu using the three dots in the top right.

*Figure 8. Saving the Ecology AirQualityWA web application to an iPhone home screen.*




## Other websites and apps

$PM_{2.5}$ AQI values, trends and smoke forecasts are also available from other public agency websites and apps. The information from these resources and instructions for viewing the $PM_{2.5}$ AQI are summarized in Table 1 below.

*Table 1. Summary of websites and apps providing monitoring data and forecasts*

| Resource | Instructions for viewing $PM_{2.5}$ AQI | Provides forecast? | Provides trend information? | Includes low-cost air sensor data? |
|---|---|---|---|---|
| Washington Smoke Blog Webpage | • $PM_{2.5}$ AQI is shown by default. | Yes. Use "Select Forecast Date" slider. | Yes, see "Trend" link on each site's popup. | Yes |
| Ecology's Air Monitoring Network Webpage and Progressive Web App* | • Select "$PM_{2.5}$" button at the top of the page. | Yes. See "Smoke Forecast" toggle button. | No | No |
| EPA Fire and Smoke Map Webpage | • PM2.5 AQI is shown by default. | No | Yes, see "Trend" link on each site's popup. | Yes |
| EPA AirNow Webpage | • Default view shows combined ozone/PM AQI. Scroll down to "Current Air Quality" to see AQI for $PM_{2.5}$ only.<br>• Click "Monitors Near Me" and check "Monitors" > "$PM_{2.5}$" in the top left to see the map of monitoring sites. | Yes, only in some locations. | No | No |
| EPA AirNow App | • Default view shows combined ozone/$PM_{2.5}$ AQI. Click "Details" under AQI dial to see AQI for $PM_{2.5}$ only. | Yes, only in some locations. | Only on "Smoke" map, click "Smoke" in the bottom right. | Yes, click "Smoke" in the bottom right. |
| EPA SmokeSense App | • See AQI value next to "Particle" under AQI dial. | Yes, only in some locations and only one day ahead. See "AQI Tomorrow" dial. | Yes, click "Fire & Smoke Near Me Map." | Yes, click "Fire & Smoke Near Me Map." |

*Ecology's webpage is a progressive web application. It can be saved as a shortcut on a smartphone home screen and will behave like a smartphone app.

A number of private companies also provide AQI values and forecasts through websites and apps, including popular weather apps. While some pull this information from EPA, others use proprietary methods that are not always accurate or transparent, and some use AQI breakpoints incorrectly. The public agency websites and apps listed above are recommended over private or third-party websites and apps to ensure that users have the most accurate information on smoke conditions and forecasts.

## Indoor $PM_{2.5}$ Measurement in Schools

Low-cost $PM_{2.5}$ sensors can provide helpful information about indoor air quality in making decisions about school closures and school activities. While sensor measurements are less accurate than those from agency monitors, there are no agency monitors indoors, and correction factors can sometimes be used to increase accuracy. If using a correction factor is not possible, do not directly compare uncorrected sensor data to AQI breakpoints or $PM_{2.5}$ action levels. Instead, use sensor data to check how different parts of the school compare to each other and how indoor $PM_{2.5}$ levels compare to outdoor levels. When comparing indoors to outdoors, ensure both measures are uncorrected or using the same correction factors. Uncorrected sensor data can still indicate whether indoor concentrations are lower or higher than outdoor concentrations and whether some indoor spaces are cleaner than others.

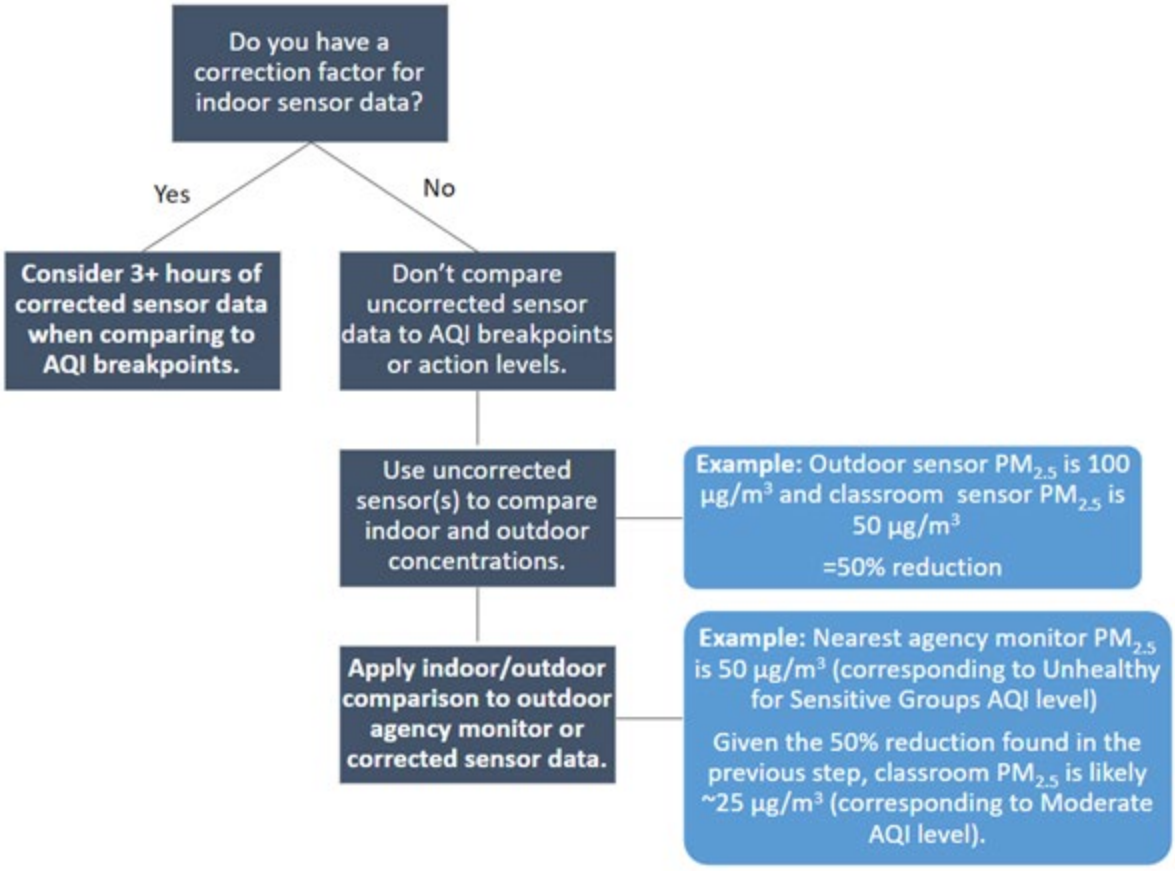
Two strategies are helpful in evaluating indoor $PM_{2.5}$ levels in schools during periods of wildfire smoke.

1. Assess variation in indoor air quality, ventilation, and filtration throughout the building(s) of the school:
    - Conduct a walk-around of the building(s) and outdoors using a portable sensor when outside $PM_{2.5}$ levels reach "Unhealthy for Sensitive Groups" (AQI value ≥ 101). Do this during times when the building is in use and ventilation is in normal operating conditions.
    - Select rooms where indoor air quality and ventilation, as well as children's activity levels are expected to vary. Include rooms used by children that are expected to have worse ventilation or indoor air quality (like no air filtration), rooms where physical activity is usually more vigorous (like the gym), rooms where external doors are opened frequently, and any external buildings (like portables).
    - In each room and outdoors, let the sensor measurements stabilize, then estimate average measurements over 5 to 10 minutes.
    - Complete the walk-around while outside $PM_{2.5}$ levels are stable, likely best achieved by completing within a few hours.
    - Determine the relative difference across the building(s) compared to outside $PM_{2.5}$ levels. For example, if the gym's indoor $PM_{2.5}$ level is 75 $\mu g/m^3$ and the outdoor $PM_{2.5}$ is 100 $\mu g/m^3$, then there is a 25% reduction of outdoor air pollution in the gym. If a regular classroom's indoor $PM_{2.5}$ level is 50 $\mu g/m^3$ and the outdoor $PM_{2.5}$ is 100 $\mu g/m^3$, then there is a 50% reduction of outdoor air pollution in the classroom. This suggests that the classroom would have cleaner air than the gym.
    - Prioritize steps to reduce exposure in the rooms with highest $PM_{2.5}$ levels or relocate children away from these rooms to cleaner air spaces if necessary.
    - If possible, repeat the walk-around throughout the poor air quality or smoke event. Also repeat the walk-around as needed if outside $PM_{2.5}$ levels increase or operating conditions change that would impact ventilation or indoor air quality. For example, if

portable air cleaners are added, if windows cannot be kept closed, or if there are major changes in how the rooms are being used.

2. Track indoor air quality during wildfire smoke events:
    - Place a stationary sensor in a room that is representative of the indoor air quality of the building(s) that has typical building use, and/or in a space with high physical activity levels or where students would go for indoor recess (like the gym). Avoid the cafeteria, where there are often sources of indoor $PM_{2.5}$ from cooking.
    - When outdoor $PM_{2.5}$ levels reach "Unhealthy for Sensitive Groups" (AQI value ≥ 101):
        - For school activities including games or practices, check the trend of indoor $PM_{2.5}$ concentrations over time (i.e. whether smoke conditions are getting worse, getting better, or staying the same).
        - For decisions about school closures, check the one-hour averages of indoor $PM_{2.5}$ concentrations over a period of 3 hours or more, and consider the forecast of outside $PM_{2.5}$ for the day.
    - Compare indoor stationary sensor measurements to outdoor stationary sensor measurements (ensure that either both are uncorrected or they have the same correction factor). Then apply this comparison to the nearest agency monitor. For example, if the indoor stationary sensor measurements are half of the outdoor stationary sensor measurements, assume that the indoor $PM_{2.5}$ concentrations are half of what the agency monitor is reporting. If there is no outdoor stationary sensor, refer to the assessment from the walk-around (above) to determine the relative difference between the room with the indoor stationary sensor and outdoors (Figure 9). If there is no nearby agency monitor, consider installing a publicly reporting outdoor stationary sensor that could show up on the EPA Fire and Smoke Map with a correction factor applied. Currently, outdoor Purple Air sensors are displayed on the EPA Fire and Smoke Map. Other sensors may also be included on the map in the future.
    - Refer to the assessment from the walk-around (above) to determine relative estimates of the $PM_{2.5}$ levels in other rooms throughout the building(s) compared to the room with the indoor stationary sensor.
    - Prioritize efforts on reducing $PM_{2.5}$ levels in the rooms with highest levels or relocate children away from these rooms to cleaner air spaces if necessary.

*Figure 9. Decision tree for comparing sensor measurements to determine indoor PM2.5 concentrations*




Check the performance evaluations developed by South Coast AQMD when selecting low-cost $PM_{2.5}$ sensors. A Field $R^2$ value near 1 and a relatively low Field MAE indicate a better-performing sensor, though even data from better-performing sensors may still need a correction factor applied to correct bias. Note that EPA's Fire and Smoke Map displays publicly reporting outdoor sensors (such as Purple Air) with a correction factor applied. The Fire and Smoke Map does not show indoor sensors. If you are comparing indoor and outdoor measurements from sensors such as Purple Air, make sure you are comparing uncorrected indoor data to uncorrected outdoor data, or that the two are using the same correction factor. If you're not sure whether indoor $PM_{2.5}$ levels are lower than outside, assume levels are similar and take precautionary steps to reduce exposures. For technical assistance with indoor sensor measurements, contact: airquality@doh.wa.gov.

## Other sources of $PM_{2.5}$ air pollution in Washington

Major sources of $PM_{2.5}$ in Washington are wildfire, dust from tilling and harvesting, agricultural and silvicultural burning, and residential wood burning. Industrial and mobile sources also emit

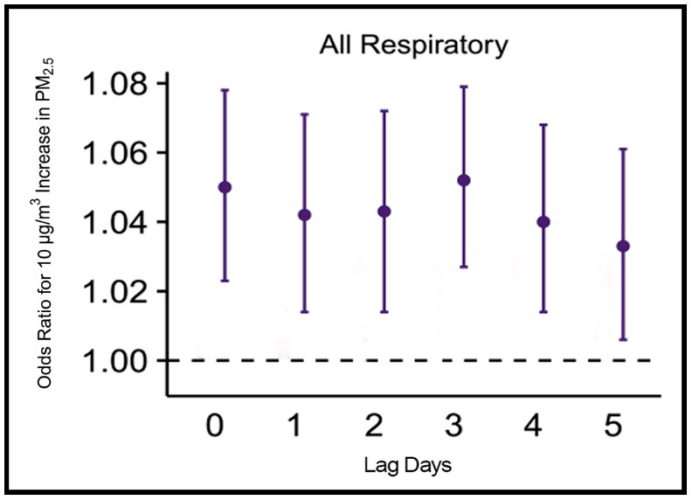
$PM_{2.5}$, though in smaller amounts than these other sources. While there is concern about $PM_{2.5}$ from each of these sources of pollution, the chemical compositions can differ, and this can affect toxicity. There are also different seasonal patterns. For example, residential wood burning generally occurs over several months and contributes to routinely high $PM_{2.5}$ concentrations, particularly during cold and stagnant weather. In contrast, wildfire smoke tends to last for a few weeks and the $PM_{2.5}$ concentrations can have very high daily peaks. Some of the highest acute exposures to air pollution in Washington are from wildfire smoke.

## Health Concern of Smoke Exposures

Exposure to wildfire smoke, like all smoke, can cause health problems. Minor symptoms include burning eyes, runny nose, coughing, and headaches. More severe effects include asthma attacks, COPD flare-ups, abnormal heart rhythms, heart attacks, and strokes. Several epidemiologic studies focusing on health impacts of wildfire smoke have been published recently, with just a few specific to Washington.

A study of Washington wildfire smoke impacts from fires in 2012 found that for a 10 µg/m$^3$ increase in $PM_{2.5}$ from wildfire smoke there is a 5% increased risk in same-day respiratory hospitalizations (odds ratio 1.052, 95% confidence interval 1.025-1.080) (Figure 10) [1]. The study found that, when focusing on specific respiratory impacts, there is an 8% increased risk for same-day asthma-related admissions for a 10 µg/m$^3$ increase in $PM_{2.5}$ from wildfire smoke (odds ratio 1.076, 95% confidence interval 1.019-1.136) [1].

***Figure 10. Hospital admissions--wildfire smoke***




Hospital admissions classified as emergency or urgent care associated with wildfire smoke exposures for a 10 µg/m$^3$ increase in $PM_{2.5}$ from wildfire smoke in Washington in 2012. Includes lag analysis (0-5 days).

*Figure adapted from Gan et al. 2017; results limited to GWR estimation of smoke* [1]

The state Department of Health (Health) collaborated with several local health jurisdictions in central Washington to examine emergency department and outpatient clinic visits during 2012

wildfires. Health found that average daily patient visits were 28% higher for cardiovascular disease and 18% higher for respiratory disease during wildfires, compared to the two-week period before wildfires [2]. The increased daily patient visits were most pronounced for respiratory disease in children [2].

A University of Washington study in collaboration with the departments of Ecology and Health investigated mortality and wildfire smoke in Washington from 2006 to 2017 [3]. The risk of dying from all non-traumatic deaths (i.e. not including accidents) was found to increase 2% the day after wildfire smoke compared to days without wildfire smoke. The increase remained two days after the smoke but was no longer statistically significant. As a sub-analysis, the risk of dying on the day of wildfire smoke was generally higher when focusing on respiratory causes of death.

A University of Washington study examined emergency department visits and wildfire smoke in Washington from 2017 to 2020 [4]. The risk of asthma emergency department visits increased 13% on the day of wildfire smoke exposure compared to days without wildfire smoke. This increase remained for the following five days. The risk of respiratory emergency department visits was also elevated on the five days following initial exposure. The study found mixed results for cardiovascular-related emergency visits by age group.

People with increased risk of adverse health effects when smoke levels are high include people with heart and lung diseases, people with respiratory infections, people with diabetes, people 18 and younger or older than 65, pregnant people, people living with disabilities, people who smoke, outdoor workers, people of color, Tribal members and Indigenous people, and people with low-income. For wildfire smoke and other air pollution exposures, a smaller portion of the population will suffer from the most severe health impacts, such as death and hospitalizations, and a larger portion of the population will suffer subclinical effects (headache, cough, eye irritation, and so on). The most severe impacts first occur in sensitive populations. However, as wildfire smoke exposures increase, more of the public will start to experience these severe impacts (Figure 11).

*Figure 11. Range of health effects from wildfire smoke exposure*

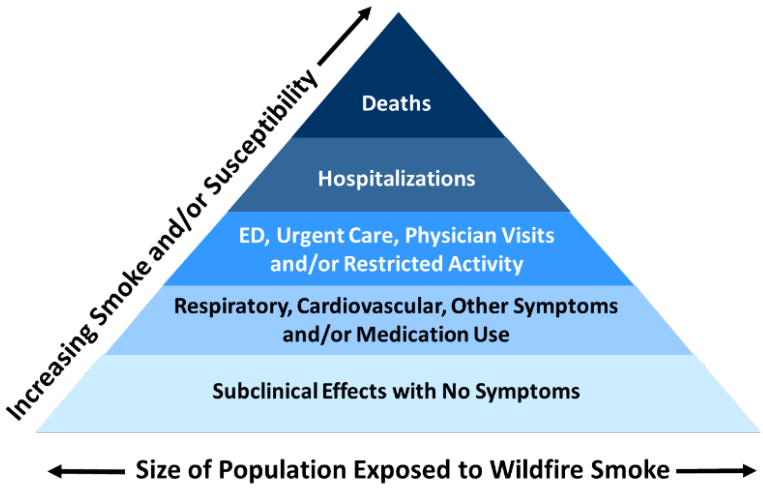



*Figure adapted from Cascio 2018 [5]*

Increasing evidence suggests that $PM_{2.5}$ from wildfire smoke may be more toxic than $PM_{2.5}$ from other sources [6], and that exposure to wildfire smoke is not experienced equally [7-9]. Most epidemiologic research of wildfire smoke focuses on acute health effects that occur within a week of elevated 24-hour $PM_{2.5}$ exposures. There is growing consensus that short-term exposure to wildfire smoke increases the risk of all-cause mortality, respiratory morbidity, including asthma and COPD exacerbations, and mixed evidence for cardiovascular morbidity [10]. Additionally, increasing evidence suggests short-term wildfire smoke exposure may be associated with adverse birth outcomes [11], and mental health impacts [12]. There is also evidence suggesting that wildfire smoke exposure increases the risk of respiratory infection, including for influenza [13], and for COVID-19 cases and mortality[14, 15]. In scenarios of short-term exposure to wildfire smoke, most people will likely recover a few weeks after inhalation of wildfire smoke. However, there may be some residual physical damage; thus, everyone should take steps to reduce exposure during wildfire smoke events. However, communities in Washington are increasingly experiencing long-term exposure to wildfire smoke, combined with other smoke sources, such as residential wood burning and agricultural burning. There is a very limited body of research on long-term health effects of wildfire smoke exposure, indicating an increase in mental health impacts [16].

There is a much larger body of published research about $PM_{2.5}$ exposures from other sources of air pollution beyond wildfire smoke, and outside of Washington. Meta-analyses combining the results of several studies demonstrate that short-term increases in $PM_{2.5}$ from a wide range of sources are associated with higher rates of deaths and hospitalizations [17, 18]. Many of these deaths and hospitalizations are due to cardiovascular and

respiratory effects. Increased cardiovascular hospitalizations include congestive heart failure and ischemic heart disease [19]. Underlying respiratory diseases that are worsened include asthma, chronic obstructive pulmonary disease (COPD) and pneumonia [19]. In adults and children, research indicates that elevated exposures to $PM_{2.5}$ leads to poor lung function [20, 21]. Exposure to $PM_{2.5}$ in children may not only worsen asthma, but may lead to development of asthma [22]. While worsening heart and lung effects from $PM_{2.5}$ exposure have been studied the most, there is increasing evidence that $PM_{2.5}$ may also lead to several other effects, such as strokes [23], development of type 2 diabetes [24, 25], neurological and cognitive impairment [26, 27], and poor birth outcomes like pre-term delivery or babies born with low birth weight [28, 29]. Though there is less research about these impacts specific to wildfire smoke $PM_{2.5}$ exposures, the pattern of impacts appears similar to or worse than that of $PM_{2.5}$ from other sources.

## Summary Guidance

- Summary Wildfire Smoke Guidance for Closing Schools
- Summary Wildfire Smoke Guidance for Canceling Outdoor Events or Activities

# Air Quality and Public Health Guidance Resources

*Figure 12. Washington Guide for Public Health Actions for Wildfire Smoke*

## Washington Guide for Public Health Actions for Wildfire Smoke

This guide is designed for air quality, public health, and other officials making local decisions.

| Air Quality Index | Recommended Public Health Actions<br>Check current and forecasted air quality at wasmoke.blogspot.com |
|---|---|
| Good<br>(0-50) | **Prior to wildfire season:**<br>• Coordinate a local plan for public health actions and distribute preparedness information to the public.<br>• Identify indoor spaces where individuals will seek cleaner air during wildfire smoke events and develop plans to protect indoor air quality, including filtration.<br>» Indoor spaces used by sensitive groups, such as schools, child care facilities, and long-term care facilities.<br>» Community cleaner air settings, such as libraries.<br>» Temporary cleaner air shelters.<br>**During wildfire season:**<br>• Monitor wildfires, smoke forecasts, and air quality at WA Smoke Blog.<br>• If forecasts predict smoke in your area, review the Washington Wildfire Response document for Severe Smoke Episodes and the Wildfire Smoke Guide for Public Health Officials. |
| Moderate<br>(51-100) | **Above recommendations, plus:**<br>• Distribute health information to the public, including steps to take with health advisory categories: Washington Air Quality Guide for Particle Pollution.<br>» Refer to the WA Smoke Blog for information about wildfires, smoke forecasts, and air quality.<br>» Identify and focus outreach efforts for sensitive groups.<br>• Coordinate with public health partners to follow recommended public health actions.<br>• Recommend following the Washington Children and Youth Activities Guide for Air Quality.<br>• For outdoor workers, start following WA Department of Labor and Industries' requirements. |
| Unhealthy for Sensitive Groups<br>(101-150) | **Above recommendations, plus:**<br>• Recommend sensitive groups take steps to reduce exposure (limit time outside, avoid strenuous outdoor activity, and follow tips for cleaner indoor air).<br>• Recommend sensitive groups spend time in a cleaner air setting in the community, such as a library, if they cannot maintain cleaner air at home.<br>• Cancel children's outdoor athletic events and practices or move them to an area with safe air quality, either indoors or at a different outside location: Washington Children and Youth Activities Guide for Air Quality.<br>• For an extended duration of smoke, consider opening a cleaner air shelter for sensitive groups. |

| Air Quality Index | Recommended Public Health Actions<br>Check current and forecasted air quality at wasmoke.blogspot.com |
|---|---|
| **Unhealthy**<br>(151-200) | **Above recommendations, plus:**<br>• Recommend everyone take steps to reduce exposure (limit time outside, avoid strenuous outdoor activity, and follow tips for cleaner indoor air).<br>• Recommend everyone spend time in an identified cleaner air setting in the community, such as a library, if they cannot maintain cleaner air in their residence.<br>• Consider canceling outdoor public events and activities: Wildfire Smoke Guidance for Canceling Outdoor Events or Activities and Closing Schools.<br>• For an extended duration of smoke, consider opening a cleaner air shelter for the public. |
| **Very Unhealthy**<br>(201-300) | **Above recommendations, plus:**<br>• Strongly recommend everyone take steps to reduce exposure (stay inside and filter indoor air to keep it cleaner; go elsewhere for cleaner air if needed and possible).<br>• Cancel outdoor public events and activities: Wildfire Smoke Guidance for Canceling Outdoor Events or Activities and Closing Schools.<br>• If school is in session, discuss school closure with administrators if indoor air cannot be kept lower than $PM_{2.5}$ 125.5 µg/m$^3$ (AQI value of 201): Wildfire Smoke Guidance for Canceling Outdoor Events or Activities and Closing Schools.<br>• Distribute NIOSH-approved particulate respirators, such as N95 masks, as available, for limited use outside. Include training material for proper fit and use.<br>• For an extended duration of smoke, consider recommending that sensitive groups voluntarily relocate to an unimpacted area. |
| **Hazardous**<br>(>300) | **Above recommendations, plus:**<br>• For an extended duration of smoke, consider recommending that everyone voluntarily relocate to an unimpacted area. |

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*Figure 13. Washington Air Quality Guide for Particle Pollution*

# Washington Air Quality Guide for Particle Pollution

**Check current and forecast conditions at enviwa.ecology.wa.gov**

Vehicle exhaust, woodstove emissions, industrial emissions, wildfire smoke, windblown dust, and other sources contain fine particles with diameters 2.5 micrometers or smaller (PM2.5) that can be dangerous to your health.

**The Air Quality Index (AQI) reports the level of air quality and health concern across six categories:**

| *Air Quality Index* | *What Should I Do?* |
|---|---|
| **Good** 0–50 | It's a great day to be active outside and a good time to make a plan if worse air quality is in the forecast. |
| **Moderate** 51–100 | Some people are especially sensitive to lower levels of particle pollution and should reduce exposure. For example, limit time outside and avoid strenuous outdoor activity. All sensitive groups should watch for symptoms. |
| **Unhealthy for Sensitive Groups** 101–150 | Sensitive groups should take steps to reduce exposure. Limit time outside, avoid strenuous outdoor activity, and follow tips for cleaner indoor air. Everyone should watch for symptoms as a sign to reduce exposure. |
| **Unhealthy** 151–200 | Everyone should reduce exposure. Limit time outside, avoid strenuous outdoor activity, and follow tips for cleaner indoor air. |
| **Very Unhealthy** 201–300 | Everyone should reduce exposure. Stay inside and filter indoor air to keep it cleaner. Go elsewhere for cleaner air, if needed. |
| **Hazardous** >300 | Everyone should reduce exposure. Stay inside and filter indoor air to keep it cleaner. Go elsewhere for cleaner air, if needed. |

**Know the symptoms!**

- Burning eyes
- Coughing
- Throat and nose irritation
- Headaches
- Fatigue
- Wheezing and shortness of breath
- Irregular heartbeat
- Chest pain

**If your symptoms become serious, seek medical attention. High exposure to PM2.5 can lead to hospitalizations and increase the risk of death.**

*See back page for steps to reduce exposure and a list of sensitive groups with increased risk.*

*For information on wildfire smoke and protecting health, go to doh.wa.gov/smokefromfires.*

*For information on wildfire smoke and outdoor worker safety, see WA State Department of Labor and Industries requirements.*

# Steps to Reduce Exposure

**Limit duration and intensity of outside physical activity.**

**Stay inside with cleaner indoor air:**

- Close windows and doors, unless it is too hot to maintain safe temperatures.
- Don't add to indoor air pollution, such as cigarette smoking or burning candles.
- Filter indoor air through an HVAC system, HEPA portable air cleaner, or DIY box fan filter.
- Set air conditioning to recirculate.

**If unable to maintain clean air at home, go elsewhere for cleaner air such as a friend's place, public space, or unimpacted area.**

**If you must be outside, wear a properly fitted, NIOSH-approved particulate respirator, such as an N95 mask.**

## Sensitive Groups with Increased Risk

- People with health conditions
  - Lung diseases, such as asthma and COPD
  - Heart diseases
  - Respiratory illnesses
  - Diabetes
- People 18 and younger or older than 65
- Pregnant people
- Outdoor workers
- People of color
- Tribal and indigenous people
- People with low income

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*For information on wildfire smoke and protecting health, go to doh.wa.gov/smokefromfires.*

*For information on wildfire smoke and outdoor worker safety, see WA State Department of Labor and Industries requirements.*

*Figure 14. Washington Children and Youth Activities Guide for Air Quality*

# Washington Children and Youth Activities Guide for Air Quality

**The following public health recommendations are to protect children and youth (18 years and younger) from fine particle air pollution (PM2.5). Apply this guide to school, child care, athletic practices and games, before and after school programs, camps, field trips, and other outdoor programming and activities.**

**Check current and forecast air quality at AirNow.gov or during wildfire smoke at wasmoke.blogspot.com**
*(See Appendix A)*

## Outside Air Quality Index (AQI): PM2.5

| Activity Duration | Good (0-50 AQI) | Moderate (51-100 AQI) | Unhealthy for Sensitive Groups (101-150 AQI) | Unhealthy, Very Unhealthy, or Hazardous (≥151 AQI) |
|---|---|---|---|---|
| **15 mins to 1 hour** (e.g., recess, PE, classes typically held outside) | No restrictions. | Allow children and youth with health conditions to opt out or stay indoors. Limit intensity of activities for these children and youth if needed. | Limit to moderate intensity activities outside. For children and youth with health conditions, further limit intensity or move to an area with safer air quality if needed. | Cancel outdoor activity or move to an area with safer air quality, either indoors with filtered air or to a different location. Limit to light intensity activities indoors if indoor PM2.5 levels are elevated. |
| **1-4 hours** (e.g., athletic events and practices) | No restrictions. | Allow children and youth with health conditions to opt out or stay indoors. Limit intensity of activities for these children & youth if needed. | Limit to light intensity activities or to a 1-hour total duration with moderate intensity activities. If intensity level and time cannot be modified, consider canceling outdoor activity or move to an area with safer air quality, either indoors or to a different location. For children & youth with health conditions, further limit time or intensity if needed. | Cancel outdoor activity or move to an area with safer air quality, either indoors with filtered air or to a different location. Limit to light intensity activities indoors if indoor PM2.5 levels are elevated. |
| **> 4 hours** (e.g., outdoor school or programming, day camp, overnight camp) | No restrictions. | Move children and youth with health conditions to an area with safer air quality, either indoors or to a different location if needed. Allow children and youth without health conditions to opt out or stay indoors and limit intensity of activities. | Limit to light intensity activities and under 4-hr total duration. If intensity level and time cannot be modified, cancel outdoor activity, or move it to an area with safer air quality, either indoors or to a different location. For children and youth with health conditions, further limit time or intensity if needed. | Cancel outdoor activity or move to an area with safer air quality, either indoors with filtered air or to a different location. Limit to light intensity activities indoors if indoor PM2.5 levels are elevated. |

### ADDITIONAL CONSIDERATIONS

**Close windows and doors when activities are moved indoors. Pay attention to heat.**

**Indoor air filtration can reduce elevated levels of indoor PM2.5. *See Appendix C.* To measure indoor PM2.5 levels, *see Appendix B.***

**Consider time spent in transit in activity duration.**

**All children and youth 18 and younger are considered a sensitive group. Health conditions include but are not limited to asthma and other lung disease, heart disease, diabetes, and respiratory infection (e.g., RSV and pneumonia).**

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| | |
|---|---|
| **Sources of PM2.5** | The primary sources of PM2.5 are typically wildfire smoke during warmer months and smoke from home heating during colder months, though this varies by location. Other sources include vehicle exhaust, industrial emissions, and prescribed burning. |
| **Children's Health & Increased Risk** | Children and youth are more sensitive to health effects from breathing in PM2.5 because they breathe in more air than adults for their body weight. This increases their total dose of air pollution. The respiratory system also develops until about age 21. Children and youth with health conditions (including asthma and other lung diseases, heart disease, and diabetes) have a higher risk of emergency department visits and hospitalizations compared to children without health conditions. Children and youth may also be at risk for declines in academic performance, neurodevelopmental problems, and chronic conditions in adulthood. Children with asthma should follow their **Asthma Action Plan**. |
| **Symptoms** | Symptoms of PM2.5 exposure include burning eyes, coughing, throat and nose irritation, fatigue, headache, wheezing, and shortness of breath. Monitor symptoms. If symptoms become serious, seek medical attention. Symptoms can continue or appear in the week following exposure to PM2.5. |
| **Physical Activity** | **CDC recommends** children and youth 6-17 years old exercise an hour or more every day as an important part of health. WAC 110-300-0360(2)(c) requires minimum outdoor activity/active play in child care programs with an exception for extreme weather. Safe outdoor play when PM2.5 levels are high, especially for days or weeks, requires precautions. People breathe deeper and take more air into their lungs when exercising, thus taking in more air pollution. Children and youth's breathing rates increase over 2 times during light intensity physical activity, over 4 times during moderate intensity activity, and over 8 times during high intensity activity compared to being at rest. Intensity level is related to the exertion and varies individually, but as examples:<br>» Light Intensity Activities: playing board games, playing catch, and stacking blocks<br>» Moderate Intensity Activities: climbing on playground, dodgeball, four-square, golf, gymnastics, hopscotch, lightly riding a tricycle/bicycle, marching band, moderate or brisk walking, shooting basketballs, softball/baseball, table tennis, volleyball, weight training, and yoga<br>» Vigorous Intensity Activities: aerobic dance, basketball, cheer, competitive swimming, football, jogging, jumping jacks, jump rope, karate, race walking, running, soccer, swimming, tennis, and vigorous bicycling<br>For a more detailed list see **CDC's guidance, Measuring Physical Activity Intensity.** |
| **Reducing Exposures** | As PM2.5 pollution increases, each action is increasingly important to protect health: limit duration and intensity of outside physical activity (e.g., increase rest periods), stay indoors when possible and keep indoor air clean. Consider a child's total exposure throughout the day and night, including time spent at school, home, and in transit. Walking, biking, or riding in a bus with windows opened is time outdoors. Some children may not have cleaner air at home. |
| **Masks & Respirators** | A NIOSH approved N95 or other particulate respirator can be an option when you have no other way to avoid wildfire smoke. NIOSH approved respirators do not come in suitable sizes for very young children and have not been tested for broad use in children. Effective use requires proper selection, size and fit. See **Western States PEHSU guidance** on respirator use by children. More **NIOSH information** here. |
| **Air Quality Monitoring & Low-Cost Sensors** | Outdoor Air Monitoring: Use air pollution forecasts and government agency monitors on **AirNow.gov** for non-wildfire smoke pollution. Use the **Washington Smoke Blog** for wildfire smoke. The Smoke Blog includes low-cost sensors and has the most relevant forecasts for Washington wildfire smoke. See Appendix A.<br><br>Indoor Air Monitoring: Indoor low-cost sensors can be used for indoor activities. Do not compare uncorrected sensor data to the AQI. Compare sensor data in locations throughout the facility and indoors vs outdoors. See Appendix B. |
| **Indoor Air Quality** | During high levels of PM2.5 or extended durations of poor air quality, taking steps to improve indoor air quality is extra important because PM2.5 will seep into buildings. If you're not sure whether indoor PM2.5 levels are lower than outside, assume levels are similar and increase steps to reduce exposure. Indoor air filtration (HVAC systems with enhanced filtration or HEPA portable air cleaners) can reduce indoor levels of PM2.5. Do not use air cleaners that produce ozone or have additive technology, such as ionization and plasma. See Appendix C. |
| **Adult Staff & Volunteers** | Adult staff and volunteers can be impacted by air pollution, see **WA Air Quality Guide for Particle Pollution**. For policies on outdoor workers during wildfire smoke, see **WA L&I's Wildfire Smoke Workplace Safety & Health webpage**. |
| **School Closures** | Consider school and facility closures if you cannot maintain indoor 125.5 µg/m3 (AQI value of 201). See **Summary Wildfire Smoke Guidance for Closing Schools**, which includes factors to consider. |
| **Resources** | Websites: WA DOH's **Air Quality and Health** or **Smoke from Fires and Health**, **EPA's Air Quality Flag Program**.<br>For technical assistance: **airquality@doh.wa.gov**. |

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