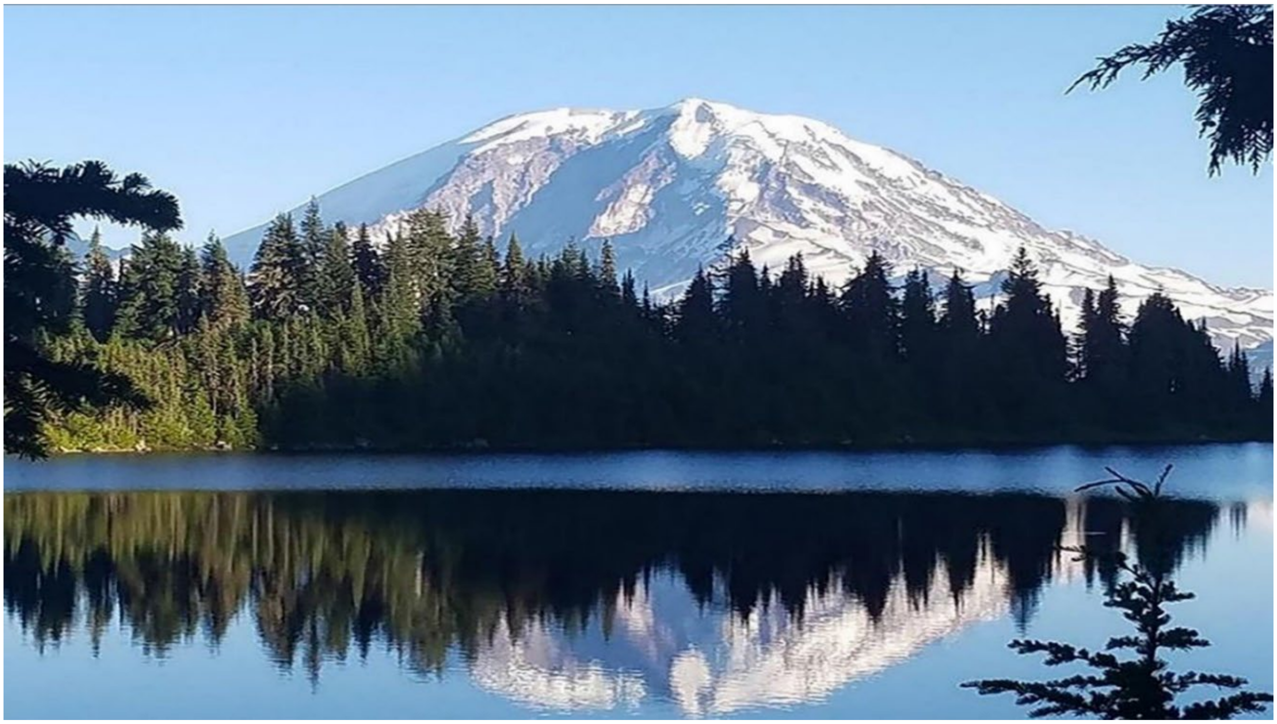

2025 Report: Overburdened Communities Highly Impacted by Air Pollution

Air Quality Program

Washington State Department of Ecology

Olympia, Washington

December 2025, Publication 25-02-037

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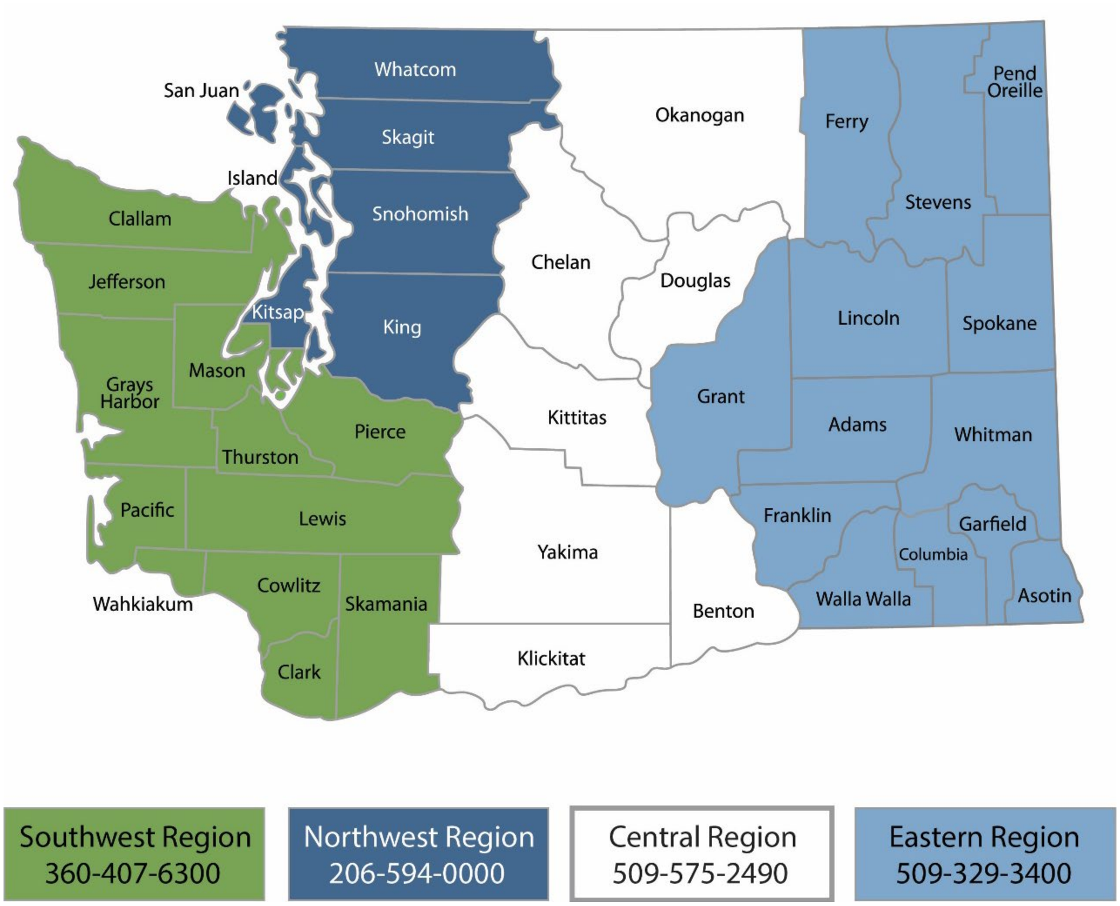

Region	Counties served	Mailing Address	Phone
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Northwest	Island, King, Kitsap, San Juan, Skagit, Snohomish, Whatcom	PO Box 330316 Shoreline, WA 98133	206-594-0000
Central	Benton, Chelan, Douglas, Kittitas, Klickitat, Okanogan, Yakima	1250 W Alder St Union Gap, WA 98903	509-575-2490
Eastern	Adams, Asotin, Columbia, Ferry, Franklin, Garfield, Grant, Lincoln, Pend Oreille, Spokane, Stevens, Walla Walla, Whitman	4601 N Monroe Spokane, WA 99205	509-329-3400
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2025 Report: Overburdened Communities Highly Impacted by Air Pollution

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Glossary

Air Quality Index (AQI) – Tool designed by the United States Environmental Protection Agency (EPA) for reporting daily local air quality based on five criteria air pollutants: particulate matter, ground-level ozone, sulfur dioxide, carbon monoxide and nitrogen dioxide. The AQI has six color-coded categories that correspond to human health concerns. The higher the AQI value, the greater the concern to air pollution and human health.

Anthropogenic (non-biogenic) carbon – Carbon in the atmosphere that originates from human activities, rather than natural processes.

Attainment/nonattainment – As established by the EPA, if the air quality in a geographic area meets or is cleaner than the national air quality standard, it is called an attainment area (designated "attainment/unclassifiable"); areas that don't meet the national air quality standards are called nonattainment areas.

Asthma – A chronic illness in which airways become inflamed and constricted, causing wheezing, coughing, and difficulty breathing with varying degrees of frequency and severity.

Biogenic carbon – Refers to carbon released from the combustion, decomposition, or processing of materials derived from biological sources such as wood, paper, biomass fuels, agriculture residues, food waste, or biogas. Naturally, carbon is stored in organic matter like trees, plants, grasses, and soil. At the end of its life cycle, organic matter decomposes and over time emits absorbed carbon back into the atmosphere. These emissions can be accelerated by human activities or through deforestation and land-clearing.

Cardiovascular disease – A class of diseases that involve the heart and/or blood vessels (arteries and veins).

Census, United States – A complete enumeration, usually of a population, but also of businesses and commercial establishments, housing, farms, governments, and so forth.

Census block group – Subdivision of a census tract that contains a cluster of census blocks, or between 250 and 550 housing units. Census blocks are the smallest geographic census units and change every decade.

Census tract – Small and relatively stable geographic areas with a population between 2,500 and 8,000.

Chronic obstructive pulmonary disease (COPD) – An umbrella term for a group of respiratory tract diseases characterized by airflow obstruction or limitation. Conditions included are chronic bronchitis, emphysema, and bronchiectasis. Tobacco smoking is the most common cause for COPD; it can also result from exposure to airway irritants such as coal dust or solvents, congenital defects, or unknown causes.

Criteria air pollutants (CAPs) – Six pollutants that can be harmful to human health and the environment with National Ambient Air Quality Standards designated by the EPA. The pollutants are particulate matter (PM), ground-level ozone (O_3), nitrogen dioxide (NO_2), carbon monoxide (CO), lead (Pb), and sulfur dioxide (SO_2).

Daily exposure to $PM_{2.5}$ and O_3 – This refers to the ambient concentration of the pollutant averaged (i.e., 24-hour daily mean for $PM_{2.5}$ or daily maximum 8-hour mean for O_3) over a 24-hour period for a given location, often used in short-term (acute) epidemiological analyses.

Design value – A statistic that describes the air quality status of a given monitor relative to the level of the National Ambient Air Quality Standards (NAAQS), as referenced in eCFR 40 Part 50.[2]

Diabetes – A condition where blood sugar levels are higher than normal due to the body's inability to use or store blood glucose for energy.

Environmental Benefits Mapping and Analysis Program-Community Edition (BenMAP-CE) – An open-access, analytic software tool developed by the EPA that can be used to estimate morbidity and mortality associated with air pollutant exposure and the economic value of these health outcomes.

Environmental justice – The fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, rules, and policies. Environmental justice includes addressing disproportionate environmental and health impacts in all laws, rules, and policies with environmental impacts by prioritizing vulnerable populations and overburdened communities, the equitable distribution of resources and benefits, and eliminating harm (from RCW 70A.02.010(8)).

Environmental Protection Agency (EPA), United States – An independent agency of the United States government tasked with environmental protection matters. The EPA delegates some regulatory responsibility to U.S. states and federally recognized Tribes, and sponsors partnerships with businesses, non-profit organizations, and local governments.

Federal Equivalent Methods (FEM) – A method for measuring outdoor criteria air pollutants that the EPA has designated as equivalent to a Federal Reference Method (FRM). FEMs are alternative, often more automated, systems that have been tested and approved to be as accurate and consistent as FRMs, allowing them to be used for monitoring air quality in compliance with the federal Clean Air Act.

Federal Reference Methods (FRM) – Specific, scientifically defensible methods for measuring outdoor air pollutants that are designated by the EPA to ensure accurate and consistent air quality data collection across different locations. They serve as the "gold standard" for

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[2] Code of Federal Regulations- eCFR :: 40 CFR Part 50 -- National Primary and Secondary Ambient Air Quality Standards.

monitoring, against which other methods, called Federal Equivalent Methods (FEMs), are compared and evaluated. FRMs are published in the Code of Federal Regulations, under 40 CFR Part 50.

Geographic Information System (GIS) – A technology used to create, manage, analyze, and map all types of data, drawing connections spatially and communicating complex information.

Ground-level ozone (O_3) – Ozone is gas that is a harmful air pollutant at ground-level because of its effect on human health and the environment.

Hispanic – The Washington State Office of Financial Management (OFM) bases race and ethnicity categories on federal standards that define "Hispanic or Latino" as a person of Cuban, Mexican, Puerto Rican, South or Central American, or other Spanish culture or origin regardless of race.

Ischemic heart disease – Heart disease caused by narrowed coronary arteries, resulting in reduced blood supply to the heart. When blood flow to the heart is blocked completely, this results in a heart attack (myocardial infarction). Exposure to air pollution can contribute to the development of ischemic heart disease and increase the risk of cardiovascular events in people with heart ischemic heart disease.

Listening session (LS)- Facilitated group conversations with those who work, live, or spend time in overburdened communities highly impacted by air pollution. Participants were asked about their experiences with air quality and health.

Lived experience compensation (LEC) – Compensation of eligible community members who participate on an Ecology workgroup, as authorized by RCW 43.03.220 and the Office of Equity Community Compensation Guidelines. Ecology refers to compensation under this authority as “lived experience compensation” instead of “community compensation” to differentiate lived experience compensation from other ways the agency may seek to compensate communities, such as by awarding grants to community-based organizations.

Local Clean Air Agencies (LCAAs) – There are seven local clean air agencies, also known as local air pollution control authorities, that manage air quality for certain counties in Washington. The Washington Department of Ecology manages air quality for counties that do not have a local clean air agency.

Local health jurisdictions (LHJs) – Local government entities, including 30 county health departments, three multi-county health districts, and two city-county health departments, that carry out public health functions in Washington.

Long-term exposure – Continuous inhalation of polluted air over an extended period, typically several months to years. This exposure can occur in various environments. The health effects of long-term exposure can accumulate over time, leading to serious health issues such as chronic respiratory and cardiovascular diseases.

Lung cancer – Cancer that begins in the cells of the lungs. Exposure to air pollution may increase risk of mortality in people with lung cancer.

Major point sources – Industrial, commercial, or institutional stationary sources with the potential to emit 100 tons per year or more of any one criteria pollutant or a combination of criteria pollutants.

Mortality – The number of estimated deaths (from a disease or in general), typically reported on an annual basis.

National Ambient Air Quality Standards (NAAQS) – Regulations set by the EPA to protect public health and the environment from harmful air pollutants. The EPA sets standards for six "criteria" pollutants: ozone, particulate matter, lead, carbon monoxide, nitrogen dioxide, and sulfur dioxide. There are two types of NAAQS: primary standards to protect public health, including sensitive populations like children and the elderly, and secondary standards to protect public welfare, covering things like visibility, crops, and buildings.

National Emissions Inventory (NEI) – A database of estimated emissions of criteria air pollutants, their precursors, and hazardous air pollutants estimated from air emission sources. The NEI is updated every three years using data provided to EPA by state, local and Tribal air agencies.

On-road vehicle emissions – These emissions are generated by operating vehicles on public roadways.

Overburdened community (OBC) – A geographic area where vulnerable populations face combined, multiple environmental harms and health impacts or risks due to exposure to environmental pollutants or contaminants through multiple pathways, which may result in significant disparate adverse health outcomes or effects (RCW 70A.65.010(54)).

Overburdened community highly impacted by air pollution (OBC) – Areas of Washington identified where people who are vulnerable to health, social, and environmental inequities are also highly impacted by criteria air pollution, as referenced in the Ecology Policy Statement: Identification of Overburdened Communities Highly Impacted by Air Pollution.

Particulate matter (particle pollution) – Small inhalable particles of solids or liquids (including dust dirt, soot, and smoke) in the air that can harm human health. PM_{10} is particulate matter less than 10 microns in diameter. $PM_{2.5}$ is particulate matter less than 2.5 microns in diameter and is often referred to as fine particulate matter.

People of color – Individuals who self-report a race other than white alone and/or list their ethnicity as Hispanic or Latino. That is, all people other than non-Hispanic white individuals.

Respiratory disease – A type of disease that affects the lungs and other parts of the respiratory system. Some risk factors include infection, tobacco smoke, occupational chemicals and dust, and other forms of air pollution. Some of the most common respiratory diseases include asthma, chronic obstructive pulmonary disease (COPD), pulmonary fibrosis, pneumonia, and lung cancer.

Seasonal exposure to ozone (O_3) – The average O_3 concentration across a defined season or multi-month period. In this report, we focus on Washington's warm season of May–September. This is when ozone levels are highest as warm temperatures and intense sunlight are needed for its formation.

SensWA – A portable sensor device built by Ecology to provide real-time air quality information about fine particle pollution. Data collected from SensWA devices are used to calculate the Air Quality Index (AQI), which is displayed on Washington’s Air Quality Map.

Short-term exposure – The period when individuals are affected by air pollution, typically lasting from a few days to weeks. This exposure can lead to various health effects, including respiratory issues, eye and throat irritation, and make pre-existing conditions, such as asthma, worse.

Stroke – The sudden impairment of brain function caused when a part of the brain experiences either bleeding or a major reduction in blood flow.

Unhealthy for Sensitive Groups (USG) – A range of the air quality index (AQI) that includes certain groups of people that have an increased risk due to medical or exposure conditions, or who are innately susceptible and may experience health effects when engaged in outdoor activities during periods of elevated air pollution. For particle pollution, the sensitive groups include people with heart and lung disease, older adults, children, people with diabetes and people with lower incomes.

Vehicle Miles Traveled (VMT) – The total number of miles traveled by a vehicle within a specific time. It is used as a metric to measure travel demand and usage over a geographic area, such as a county or state, and to assess highway performance and traffic patterns.

Wildfire smoke – A complex mixture of gases and compounds released when a wildfire burns. The composition and toxicity vary depending on the wildfire environment. Wildfire smoke is the largest source of particle pollution impacting human health in Washington.

X,Y coordinates – A pair of values that represents the distance from an origin (0,0) along two axes, a horizontal axis (x), and a vertical axis (y). On a map, x, y coordinates are used to represent features at the location they are found on the earth's surface.

Yearly exposure to $PM_{2.5}$ – The average concentration of the pollutant over an entire calendar year (or 12-month period) at a location (or population-weighted across locations) and is typically used for chronic-exposure assessments.

Acronyms

ACS – American Community Survey
AIAN – American Indian and Alaska Native
AQI – Air Quality Index
BENMAP-CE – Benefits Mapping and Analysis Program, Community Edition
CAP – Criteria air pollutant
CCA – Climate Commitment Act
CH_4 – Methane
CHARS – Comprehensive Hospital Abstract Reporting System
CHS – Center for Health Statistics
CI – Confidence interval
C-LINE – Community LINE source model
CO – Carbon monoxide
CO_2 – Carbon dioxide
COPD – Chronic obstructive pulmonary disease
CRF – Concentration response function
DNC – Data not collected
EPA – United States Environmental Protection Agency
ED – Emergency Department
GIS- Geographic Information System
MI – Myocardial infarction
NAAQS – National Ambient Air Quality Standard
NEI- National Emissions Inventory
NHOPI – Native Hawaiian and Other Pacific Islander
N_2O – Nitrous oxide
NO_2 – Nitrogen dioxide
NW-AIRQUEST – Northwest-International Air Quality Environmental Science and Technology Consortium
O_3 – Ozone
OBC- Overburdened community highly impacted by air pollution
OFM – Washington State Office of Financial Management
Pb – Lead
PM – Particulate matter
RHINO – Rapid Health Information Network
SO_2 – Sulfur dioxide
VOC – Volatile organic compound
WSCR – Washington State Cancer Registry

Units of measurement:

ppb – parts per billion
ppm – parts per million

MT CO_2e – metric tons of carbon dioxide equivalent (using carbon dioxide equivalent as a measurement captures the cumulative impacts of all greenhouse gases in a single number)
µg/m^3 – micrograms per cubic meter
TPY – tons per year

Executive Summary

The Washington Department of Ecology is responsible for implementing the environmental justice (EJ) provisions of the 2021 Climate Commitment Act (CCA), Washington's landmark climate policy. Ecology is leading the initiative to improve air quality in communities identified as overburdened and highly impacted by criteria air pollution by expanding the air monitoring network, reducing emissions, issuing grants, and conducting rulemaking. The CCA requires Ecology to report criteria air pollution levels and greenhouse gas emissions in Washington.

Ecology and the Washington State Department of Health partnered to produce this report. Following the first two-year EJ report, *Improving Air Quality in Overburdened Communities Highly Impacted by Air Pollution*, published in 2023, this report provides information about criteria air pollutant concentrations and their health impacts, as well as greenhouse gas emissions in 16 overburdened communities highly impacted by criteria air pollution in Washington. These 16 communities include 1.37 million Washingtonians living in rural, urban, and suburban areas.

Key findings

Air pollution

- Between 2022 and 2024, overburdened communities highly impacted by criteria air pollution experienced an average of 2.9 days per year (range 0-8.3 days per year) when air quality was at the level considered "unhealthy for sensitive groups" or worse (101+ AQI).
    - Compared to the 2020-2022 period, this is a marked decrease from an average of 7.5 days per year (range 4.3-12 days per year) of air quality that was unhealthy for sensitive groups or worse.
- Most days of air quality that were unhealthy for sensitive groups or worse occurred during wildfire smoke events.
- On average, $PM_{2.5}$ concentrations decreased from 2022 to 2024. This may be partly because Washington had less impact from wildfire smoke in 2023 and 2024. All 2024 design values were below the established federal 24-hour standards for $PM_{2.5}$, except for data from one monitor in the Wenatchee and East Wenatchee community.
- When wildfire smoke days were excluded, annual $PM_{2.5}$ average concentrations declined by 8–15%. This highlights the impact of wildfire smoke on $PM_{2.5}$ pollution concentrations. Communities in Western Washington were generally less impacted by wildfire smoke than those in Eastern and Central Washington, although wildfire smoke impacted Western Washington in 2022.
- Data from newly established $PM_{2.5}$ monitors and sensors in overburdened communities show relatively low daily $PM_{2.5}$ concentrations in 2024.

- Criteria air pollutants (including PM_{10}, ozone, nitrogen dioxide, sulfur dioxide, and carbon monoxide) that were monitored within overburdened community boundaries met the National Ambient Air Quality Standards (NAAQS).

Health impacts

- According to 2022 Center for Disease Control (CDC) survey data, the 16 communities identified as overburdened and highly impacted by criteria air pollution in Washington have higher levels of chronic diseases (such as asthma, cardiovascular disease, COPD, diabetes, and stroke) compared to the statewide population (Figure 2). Specific overburdened communities show greater disparities between state and community-level prevalence rates.
- The health impacts analysis focuses on exposure to $PM_{2.5}$ and ozone, the criteria air pollutants most likely to affect people's health. While all of Washington meets federal air quality standards for particulate matter and ozone pollution, estimated health impacts of these pollutants were still identified in this report.
- In our statistical models, yearly $PM_{2.5}$ exposure in the 16 overburdened communities was associated with an estimated 430 deaths by any cause among adults ages 18-84 and 261 deaths among older adults ages 65-99. Across overburdened communities, 18--84-year-olds with the highest estimated rates of deaths by any cause associated with $PM_{2.5}$ exposure live in East Yakima, Lower Yakima Valley, and Spokane and Spokane Valley.
- The highest estimated rates of deaths by any cause in overburdened communities were among Hispanic people and non-Hispanic Black people ages 18-84 after accounting for differences in ages across racial and ethnic groups.
- According to our models, $PM_{2.5}$ exposure was also associated with non-fatal health events such as hospitalizations for respiratory and cardiovascular conditions, asthma-related emergency department visits, and lung cancer diagnoses. Ozone exposure was also associated with non-fatal health events, including asthma emergency department visits and cardiovascular and respiratory hospital admissions.
- Within the 16 overburdened communities, seasonal ozone exposure (see glossary) was associated with an estimated 35 deaths by any cause per year and daily ozone exposure was associated with 2 deaths by any cause per year. The overburdened communities with the highest rates of deaths by any cause associated with ozone exposure among 65--99-year-olds were Spokane and Spokane Valley, Tri-Cities to Wallula, and East Yakima.
- For both yearly and daily $PM_{2.5}$ and ozone exposure, unadjusted and age-adjusted rates of all health conditions were higher in the 16 overburdened communities compared to statewide, with some rates up to 2 times higher than statewide rates.

Greenhouse gas emissions

- From 2020 to 2023, we have seen an overall decrease of 20.3% total reported greenhouse gas emissions from facilities in or nearby overburdened communities highly impacted by air pollution.

- There are 49 greenhouse gas facilities that report their emissions located in overburdened communities highly impacted by air pollution and 22 are covered under the Climate Commitment Act. The number of facilities in some of these communities has changed due to closures, and new or voluntary reporting.
- From 2019 to 2021, greenhouse gas emissions from mobile sources (like cars, trucks, and locomotives) in overburdened communities highly impacted by air pollution decreased by 5.4% metric tons of carbon dioxide equivalent (MT CO_2e).
- The Climate Commitment Act provides a dedicated funding source to help a variety of programs across state agencies serving the most vulnerable communities prepare for and cope with the impacts of climate change. In the 2023-2025 biennium, nearly 60% (about $850 million) of Climate Commitment Act investments benefited these communities, exceeding the law's 35% requirement.[3]
- The Cap-and-Invest Program is in the middle of its first compliance period which runs from 2023-2026. Data collection on the program's impact to overburdened communities highly impacted by air pollution is ongoing and information on emissions reductions will be available in future reports. So far, 99.9% of participating entities are in compliance with the program.

Introduction

This publication, the *2025 Environmental Justice Report: Overburdened Communities Highly Impacted by Air Pollution* (EJ Report), was written in accordance with the 70A.65.020(2)(a)[4] provision of the CCA, which directs Ecology:

> "Beginning in 2023, and every two years thereafter, the department must conduct a review to determine levels of criteria pollutants, as well as greenhouse gas emissions, in the overburdened communities identified under subsection (1) of this section. This review must also include an evaluation of initial and subsequent health impacts related to criteria pollution in overburdened communities. The department may conduct this evaluation jointly with the Department of Health."

In 2023, Ecology published the first biennial EJ Report in collaboration with the Department of Health (DOH). This baseline report published levels of criteria air pollutants and their health impacts, as well as greenhouse gas emissions, in each of the 16 communities identified as overburdened and highly impacted by air pollution (OBCs). The 2025 EJ Report expands the collaboration between DOH and Ecology, as DOH greatly contributed to the analysis and writing of the Health Impacts, Listening Sessions, and Demographics sections of this report.

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[3] Report to the Legislature: Climate Commitment Act Investments Fiscal Year 2025 https://apps.ecology.wa.gov/publications/SummaryPages/2514107.html
[4] Environmental Justice Review, RCW 70A.65.020 https://app.leg.wa.gov/RCW/default.aspx?cite=70A.65.020

In Ecology's 2023 EJ Report, we highlighted the need to conduct outreach and engagement in OBCs, expand the Washington Ambient Air Monitoring Network (Washington Network), and work with Tribal and community partners to identify ways to expand our research methods and analysis.

The 2025 EJ Report expands the 2023 baseline report in the following ways:

Listening sessions: The Department of Ecology and Department of Health jointly conducted four pilot listening sessions with staff from Washington's local health jurisdictions and with residents of the South Seattle and Lower Yakima Valley communities. The information gathered through these sessions shaped the format and informed the content of this report and will help guide the development of future biennial EJ Reports.

Community Reports: In response to community input, we published community-specific results and information in separate documents related to this report. The goal of the individual publications is to help present relevant information about each specific community in an organized and accessible way. This document provides more detailed information about the background, methods, and additional results that are not included in the individual Community Reports.

Health Impacts Analysis: The 2025 EJ Report expands the health analysis to include the impacts of short-term (daily) exposure to $PM_{2.5}$ and seasonal exposure to O_3, the CAPs with the greatest potential impact on population health in Washington.[5, 6 ,7] We include deaths (mortalities) associated with respiratory disease, ischemic heart disease, and cardiovascular disease associated with $PM_{2.5}$ exposure for OBCs. Additionally, we analyze illness (morbidities) related to $PM_{2.5}$ and O_3 exposure, including hospitalizations and emergency department (ED) visits for cardiovascular and respiratory conditions and lung cancer diagnoses.

Tribal Partnership: The Department of Ecology has initiated Government-to-Government relationships with Tribes identified as potentially highly impacted by air pollution. Four of the seven identified Tribes have signed MOUs with Ecology to increase CAP monitoring, reduce the impact of air pollution, and expand the EJ Report to provide information about air quality and health on Tribal land. Ecology is partnering with the Department of Health and Tribes to ensure the 2027 EJ Report is published consistently with each Tribe's protocols for data sharing and usage.

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[5] WA Department of Ecology, Air quality studies https://ecology.wa.gov/research-data/scientific-reports/air-quality-studies
[6] WA State Department of Ecology, Air quality standards https://ecology.wa.gov/air-climate/air-quality/air-quality-targets/air-quality-standards
[7] WA State Department of Ecology, Areas meeting and not meeting air standards https://ecology.wa.gov/regulations-permits/plans-policies/areas-meeting-and-not-meeting-air-standards

Monitoring Data: Since the publication of the 2023 EJ Report, Ecology has installed 52 new monitors and sensors in the 16 OBCs, and 50 with Climate Commitment Act funds. There is now at least one $PM_{2.5}$ monitor or sensor in each of the identified communities, which improves the accuracy of our reporting. This report includes $PM_{2.5}$ data from monitors and sensors in each of the 16 communities.

Climate commitment act and environmental justice

The Climate Commitment Act (CCA) is Washington's only economy-wide climate policy that works to cap and reduce greenhouse gas emissions from Washington's largest emitting sources and industries. The CCA also prioritizes the improvement of air quality in Washington with environmental justice in mind. Under the CCA, the state legislature directed the Department of Ecology to reduce criteria air pollution in communities and participating Tribal lands that are highly impacted by air pollution and are historically overburdened with health, social, and environmental inequities and.

RCW 70A.65.005 Outlines some of the findings and intent of the CCA:

> "(3) The legislature further finds that while climate change is a global problem, there are communities that have historically borne the disproportionate impacts of environmental burdens and that now bear the disproportionate negative impacts of climate change. Although the state has done significant work in the past to highlight these environmental health disparities, beginning with senator Rosa Franklin's environmental equity study, and continuing through the work of the governor's interagency council on health disparities, the creation of the Washington environmental health disparities map, and recommendations of the Environmental Justice task force, the state can do much more to ensure that state programs address environmental equity.

Overburdened communities highly impacted by air pollution

The "Improving Air Quality in Overburdened Communities Initiative" is an ongoing environmental justice effort led by the Department of Ecology that strives to reduce air pollution in Washington overburdened communities and Tribes highly impacted by air pollution.

Washington's overburdened communities highly impacted by air pollution (OBCs) were identified by Ecology in 2023. These 16 communities were identified using the Environmental Health Disparities map,[8] EJ Screen Demographic Index,[9] and a combination of the Washington Network, modeling, and emissions data. The community boundaries were finalized following a

[8] Washington Tracking Network, a source for environmental public health data, Department of Health https://fortress.wa.gov/doh/wtnibl/WTNIBL/

[9] Environmental Justice Screening and Mapping Tool (EJScreen) https://19january2021snapshot.epa.gov/ejscreen/environmental-justice-indexes-ejscreen_.html

public comment and engagement process. The OBCs include 1.37 million people, approximately 17.8% of Washington's 2024 population.[10]

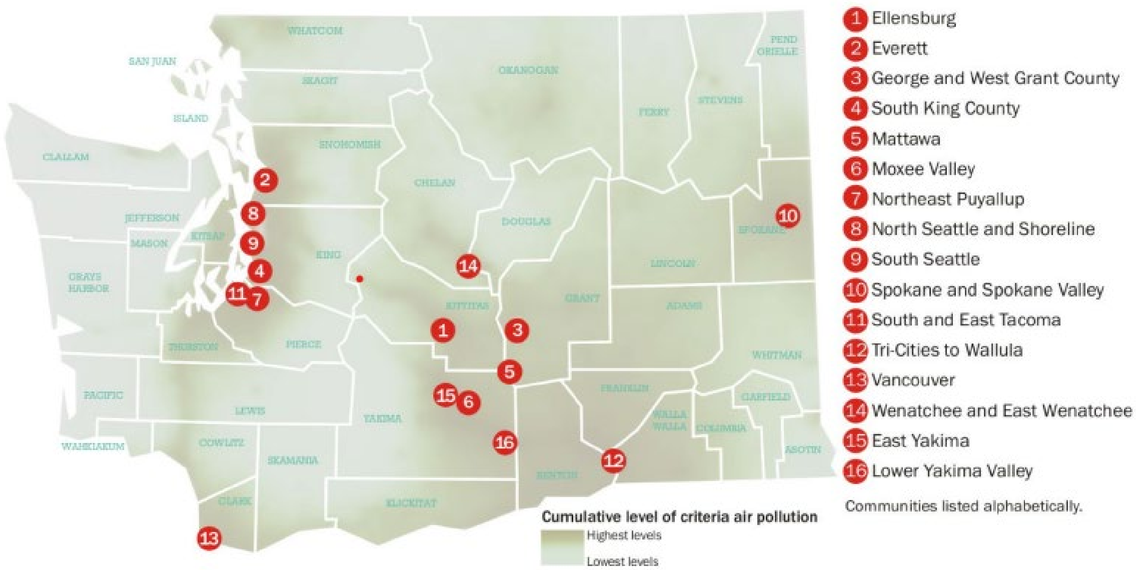

Figure *1*. Statewide map of overburdened communities highly impacted by air pollution.

In 2023, Ecology also identified seven Tribal reservations that are impacted by elevated levels of CAPs. As of December 2025, four Tribes have signed Memoranda of Understanding with Ecology to build long-term partnerships to monitor air quality, access grant resources, and as requested, report on greenhouse gases, CAPs, and their related health impacts. These Tribes include the Confederated Tribes and Bands of the Yakama Nation, Confederated Tribes of the Colville Reservation, Nooksack Indian Tribe, and Tulalip Tribes.

Ecology will re-identify overburdened communities and the Tribes highly impacted by air pollution every six years following a public engagement process. In 2029, we will utilize public input, current sociodemographic data, and air pollution data to reassess the boundaries of OBCs.

More information about the 2023 identification process can be found in the Overburdened Communities Highly Impacted by Air Pollution StoryMap[11] and the Identifying Overburdened Communities Highly Impacted by Air Pollution: Technical Support Document.[12]

[10] Washington Census Bureau Profile https://data.census.gov/profile/Washington?g=040XX00US53
[11] Overburdened Communities Highly Impacted by Air Pollution StoryMap https://storymaps.arcgis.com/stories/c10bdbfc69984a9d85346be1a23f6338
[12] Identifying Overburdened Communities Highly Impacted by Air Pollution: Technical Support Document https://apps.ecology.wa.gov/publications/SummaryPages/2302019.html

Background

Criteria air pollution

Criteria air pollutants (CAPs) are a class of common air pollutants that impact human and environmental health. The federal Clean Air Act requires the Environmental Protection Agency (EPA) to set National Ambient Air Quality Standards (NAAQS) for six criteria air pollutants (Appendix A). The primary NAAQS are set to protect human health. The secondary NAAQS are set to protect the environment, property, agriculture, and animals. Washington is in attainment with the NAAQS, or below the limit, for all CAPs.

The criteria air pollutants are:

- Particulate matter
    - Fine particulate matter ($PM_{2.5}$)
    - Coarse particulate matter (PM_{10})
- Ozone (O_3)
- Nitrogen dioxide (NO_2)
- Sulfur dioxide (SO_2)
- Carbon monoxide (CO)
- Lead (Pb)

In Washington's overburdened communities highly impacted by air pollution (OBCs), $PM_{2.5}$ is the most frequently elevated criteria air pollutant. Wildfires are the dominant source of $PM_{2.5}$ emissions statewide, contributing approximately 44,832 tons per year (TPY).[13] The impact of wildfire smoke on ambient $PM_{2.5}$ concentrations varies year-to-year and can include smoke transported from fires burning outside of Washington.

Residential woodsmoke from home heating, primarily emitted during the colder months, accounts for approximately 17,438 TPY of $PM_{2.5}$ emissions. Agriculture activities, such as tilling and harvesting, contribute an additional 14,895 TPY of $PM_{2.5}$ emissions.

Dust from tilling, harvesting, and livestock contributes to $PM_{2.5}$ and PM_{10} pollution. Spikes in PM_{10} are usually due to wind-blown dust, which is not included in the Washington Comprehensive Emissions Inventory. Other sources of PM_{10} pollution include paved and unpaved roadway dust and construction dust.

[13] WA Department of Ecology, 2020 Washington Comprehensive Emissions Inventory Technical Support Document https://apps.ecology.wa.gov/publications/SummaryPages/2002012.html

Ground-level ozone (O_3) forms when volatile organic compounds (VOCs) and nitrogen oxides (NO_x) react with sunlight and warm temperatures.[14] In Washington, the largest sources of VOC emissions are natural emissions from soil and vegetation (approximately 214,163 TPY), wildfires (121,121 TPY), and industrial, commercial, and consumer solvent use (approximately 69,076 TPY).[15] The highest O_3 concentrations typically occur downwind of urban areas and increase when sunlight is strongest and temperatures are higher. The EPA designates Washington's "ozone season" as May through September, when O_3 concentrations are generally highest.[16]

On-road vehicles are the largest source of nitrogen oxides (NO_x) pollution, contributing approximately 60,029 tons per year (TPY).[17] The highest NO_x concentrations occur near busy roadways, especially in the Seattle and Tacoma metropolitan areas. Major point sources – such as power plants, paper mills, and oil refineries – contribute an estimated 22,934 TPY, while non-road mobile equipment (16,615 TPY), railroads (13,629 TPY), and commercial marine vessels (13,549 TPY) also account for NO_x pollution. Across Washington, ambient NO_2 concentrations generally remain below the NAAQS in Washington, including at monitoring sites located near high-traffic highways. Although current NO_2 levels meet the standard, NO_x emissions contribute to the formation of other pollution like O_3 and $PM_{2.5}$.

SO_2, Pb, and CO concentrations in OBCs are in attainment with the NAAQS in Washington. In recent decades, measures to improve air pollution and closures of major contributing facilities have greatly reduced SO_2 and CO air pollution levels across Washington. All of Washington's counties are in attainment[18] with the NAAQS for SO_2, however, major point sources contribute approximately 7,438 tons/year of SO_2 pollution. Wildfires contribute to SO_2 pollution, but Ecology does not approximate their contribution. Wildfires are the primary source of CO pollution in Washington (approx. 512,337 tons/year). Other contributors include on-road (approx. 330,309 tons/year) and non-road (approx. 224,050 tons/year) mobile sources. Pb emissions are calculated by the EPA for aircrafts that use leaded fuel. Facilities report Pb emissions independently to their permitting agencies.

[14] WA Department of Ecology, Ozone pollution https://ecology.wa.gov/air-climate/air-quality/air-quality-targets/air-quality-standards/ozone-pollution
[15] WA Department of Ecology, 2020 Washington Comprehensive Emissions Inventory Technical Support Document https://apps.ecology.wa.gov/publications/SummaryPages/2002012.html
[16] U.S. EPA, AQS Reference Table, Ozone Seasons https://aqs.epa.gov/aqsweb/documents/codetables/ozone_seasons.html
[17] WA Department of Ecology, 2020 Washington Comprehensive Emissions Inventory Technical Support Document https://apps.ecology.wa.gov/publications/SummaryPages/2002012.html
[18] WA Department of Ecology, Determining if areas in Washington meet NAAQS https://ecology.wa.gov/regulations-permits/plans-policies/areas-meeting-and-not-meeting-air-standards

Wildfire smoke

Wildfire smoke is the greatest source of air pollution in Washington.[19] The majority of wildfires are caused by humans[20], and human-caused climate change increases the frequency and scale of wildfires. The Department of Ecology forecasts smoke levels and partners with other governmental agencies to share information about wildfire smoke impacts within Washington.[21] However, wildfire smoke is not within the Department of Ecology's regulatory authority.

This report includes annual and daily $PM_{2.5}$ summary statistics calculated with and without wildfire smoke days to show the relative impact of wildfires on air quality for a 3-year period, 2022-2024.

The 2023 wildfire smoke season was largely impacted by fires in Canada and the Cascades. Following a heat wave in May, Canada experienced many wildfires that burned more than 45 million acres, which transported smoke into Washington and other parts of the United States.

In 2024, wildfires that impacted Washington were ignited both by lightning and humans. The Retreat, Mission Road, and Pioneer fires were caused by humans, with the greatest smoke impacts experienced in Central and Eastern Washington. Wildfires in Canada and Oregon did not significantly contribute to $PM_{2.5}$ pollution in Washington.

Air monitoring

The Washington Network monitors air quality conditions for all six CAPs and includes monitors operated by Ecology, local clean air agencies (LCAAs), Tribal Nations, and the National Park Service. The Washington Network is designed to provide timely pollution data to the public, support compliance with the National Ambient Air Quality Standards (NAAQS), inform pollution control strategies, and support air pollution research. With the exclusion of the Spokane-Augusta Ave air monitoring site, this report uses 2022-2024 quality-assured data from the Washington Network to ensure accuracy and reliability.

When sites are selected for air monitors and sensors, Ecology's scientific experts consider meteorology, topography, geography, population impacts, emissions information, existing monitoring data, and proximity to pollution sources. In addition, each monitoring location is placed to meet criteria established by Ecology and EPA that ensures that pollution levels within and between communities around the state can be compared. This comparability maximizes understanding of how levels of ambient air pollution varies at the local level, across the state,

[19] WA Department of Ecology, Wildfire smoke information and map https://ecology.wa.gov/air-climate/air-quality/smoke-fire/wildfire-smoke

[20] Boegelsack N, Withey J, O'Sullivan G, McMartin D. A critical examination of the relationship between wildfires and climate change with consideration of the human impact. *Journal of Environmental Protection*. 2018 May 8;9(5):461-7.

[21] Washington Smoke Blog https://wasmoke.blogspot.com/

and how Washington compares to other states around the country. The network of monitors in each OBC is tailored to the pollutants known or expected to be elevated in that community:

- **$PM_{2.5}$:** Since $PM_{2.5}$ is considered the primary CAP of concern in Washington due to routinely elevated concentrations and widespread population impacts, $PM_{2.5}$ is measured in every OBC. Residential wood combustion is the largest anthropogenic source of $PM_{2.5}$ in Washington, and concentrations of $PM_{2.5}$ can vary between neighborhoods at a relatively fine scale. The network of $PM_{2.5}$ monitors and sensors in OBCs can be dense in order to capture this neighborhood-scale[22] variation, with larger OBCs containing up to 12 $PM_{2.5}$ monitors and sensors.
- **PM_{10}:** The largest sources of PM_{10} are dust from agricultural tilling and harvesting, roads, and construction. Ecology prioritizes PM_{10} monitoring in communities where significant dust sources impact ambient PM_{10} concentrations.
- **O_3:** Ground-level ozone is considered a regional pollutant, with monitoring sites representing conditions across broader urban areas and regions. In many cases, ozone monitors are located outside of OBCs because the highest concentrations of ozone are typically found downwind of urban areas. Ecology considers data from these monitors to be representative of the highest concentrations expected in their broader urban areas.
- **NO_2 and CO**: On-road vehicles are the largest anthropogenic source of NO_2 and CO. These pollutants are primarily measured at near-road monitoring sites where concentrations are understood to be the highest in the state. Even at monitoring sites adjacent to the highest-traffic freeways in Washington, concentrations of these pollutants rarely exceed the “Good” range of EPA’s AQI as a result of increasingly stringent federal tailpipe emissions standards. Monitoring is not widely conducted outside the near-road environment because past air monitoring has demonstrated that concentrations are well below federal standards away from dominant sources.
- **SO_2 and Pb:** Monitoring for SO_2 and Pb is not widely conducted because emissions of these pollutants in Washington have declined markedly over the past several decades. In the absence of large industrial sources of these pollutants in Washington, the remaining Pb and SO_2 monitors in the Washington Network typically record near-background levels.

With funds from the CCA, Ecology and LCAAs have added 50 monitors (including sensors) to the Washington Network since 2023, with at least one $PM_{2.5}$ monitor now located in each OBC. Of the newly installed monitors, there are 47 $PM_{2.5}$ monitors, two PM_{10} monitors, and one NO_x monitor. At least one additional $PM_{2.5}$ monitor is scheduled to be installed by early 2026 in the South and East Tacoma community. Three $PM_{2.5}$ monitors are outside of the OBCs (Royal City, Spokane-Thurston Ave, and Seattle-Linden Ave N) and were installed to understand regional transport of $PM_{2.5}$ pollution. Additionally, one monitor was recently installed in the South and

[22] Network Design Criteria for Ambient Air Quality Monitoring, 40 C.F.R. Part 58, Appendix D (2025) https://www.ecfr.gov/current/title-40/chapter-I/subchapter-C/part-58/appendix-Appendix%20D%20to%20Part%2058

East Tacoma community (Tacoma-S Adams St) and one in the South Seattle community (SeaTac-Sunset Park) that were not funded by the CCA but are in OBCs.

Data from sixty-three CAPs monitors and sensors installed either prior to the CCA or before November 2024 are included in this report (Table 1). Three $PM_{2.5}$ monitors included are within 500 meters of the community boundaries (Spokane-E Wellesley Ave, Ellensburg-N Cora St, and Wenatchee 8th St NE), and are representative of air quality in the adjacent OBCs. We also include one $PM_{2.5}$ monitor 700 meters from the Wenatchee and East Wenatchee boundary, as it is representative of the community's air quality. In addition, four O_3 monitors located outside OBC boundaries are included based on Ecology's determination that they reflect O_3 levels within the communities (Table 1).

Table *1*. Number of air monitors included in this report that are representative of air quality in overburdened communities highly impacted by air pollution.

Community	**$PM_{2.5}$**	**PM_{10}**	**O_3**	**NO_2**	**SO_2**	**CO**
Spokane and Spokane Valley	12	2	1*			
Tri-cities to Wallula	3	2	1*			
East Yakima	1 (4)	1				
Lower Yakima Valley	2 (3)					
Moxee Valley	1					
Mattawa	1					
George and West Grant County	1					
Ellensburg	4					
Wenatchee and East Wenatchee	3					
Everett	1 (2)	1				
North Seattle and Shoreline	2					
South Seattle	8 (3)	2	1	2 (1)	1	2
South King County	2 (3)					
Northeast Puyallup	1					
South and East Tacoma	2 (1)			1		
Vancouver	1 (5)		1*			
Total	45 (21)	8	4	3 (1)	1	2

* = O_3 monitor located outside community boundaries
( ) = Monitors installed after November 2024, not included

Health impacts of criteria air pollution

Exposure to criteria air pollution can cause both acute and chronic adverse health impacts (Table 2). Generally, risk of health impacts increases as exposure to the air pollutants increases, and people who are more sensitive are more likely to have adverse health impacts at lower exposure levels than others. PM, NO_2, SO_2 and O_3 are associated with inflammation of the respiratory system, with short-term exposures that can lead to acute responses of irritation, like cough and sore throat. They can also trigger systemic cardiovascular inflammation and oxidative stress. As exposures increase, the impacts can be more severe.

Fine particulate matter and nitrogen dioxide

Older adults, especially those with heart (cardiovascular) or lung (respiratory) conditions, are at an increased risk of morbidity and mortality associated with short-term (days to weeks) or long-term (months to years) $PM_{2.5}$ exposure.[23, 24] Long-term $PM_{2.5}$ and NO_2 exposure have also been associated with an increased risk in the incidence of dementia, depression, stroke, and diabetes.[25, 26] Long-term $PM_{2.5}$ and NO_2 exposure also increases the risk of impaired lung development and asthma in children and infants. Short-term exposure to $PM_{2.5}$ and NO_2 has also been linked to increases in all-cause mortality, hospitalizations and exacerbations of chronic respiratory conditions like asthma and chronic obstructive pulmonary disease (COPD).[27, 28]

Ozone

Short-term O_3 exposure can cause inflammation of the bronchial airways and increases the risk of COPD, asthma exacerbation, and oxidative stress.[29] Older adults and those with preexisting health conditions are disproportionately at risk for these health impacts. Long-term exposure to O_3 is associated with an increased risk for respiratory mortality, pneumonia, and COPD

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[23] Di Q, Dai L, Wang Y, Zanobetti A, Choirat C, Schwartz JD, Dominici F. Association of short-term exposure to air pollution with mortality in older adults. *Journal of the American Medical Association*. 2017 Dec 26;318(24):2446-56.

[24] Papadogeorgou G, Kioumourtzoglou MA, Braun D, Zanobetti A. Low Levels of Air Pollution and Health: Effect Estimates, Methodological Challenges, and Future Directions. *Current Environmental Health Reports*. 2019 Sep;6(3):105-115. doi: 10.1007/s40572-019-00235-7

[25] Pun VC, Manjourides J, Suh H. Association of ambient air pollution with depressive and anxiety symptoms in older adults: results from the NSHAP study. *Environmental Health Perspectives*. 2017 Mar;125(3):342-8.

[26] Paul LA, Burnett RT, Kwong JC, Hystad P, van Donkelaar A, Bai L, Goldberg MS, Lavigne E, Copes R, Martin RV, Kopp A. The impact of air pollution on the incidence of diabetes and survival among prevalent diabetes cases. *Environment International*. 2020 Jan 1;134:105333.

[27] Ma, Yiqun, et al. Short-term exposure to fine particulate matter and nitrogen dioxide and mortality in 4 countries. *JAMA Network Open* 7.3 (2024): e2354607-e2354607.

[28] Mainka, Anna, and Magdalena Żak. Synergistic or antagonistic health effects of long-and short-term exposure to ambient NO_2 and $PM_{2.5}$: a review. *International Journal of Environmental Research and Public Health* 19.21 (2022): 14079.

[29] Kim SY, Kim E, Kim WJ. Health effects of ozone on respiratory diseases. *Tuberculosis and Respiratory Diseases*. 2020 Dec 1;83(Supple 1):S6.

mortality.[30] Children living in communities with high O_3 concentrations have increased risk of asthma, impaired lung development and function, and allergy development, including hay fever.[31, 32, 33]

Environmental justice and health disparities

Sensitive populations, including children, older adults, pregnant people, and people with underlying cardiovascular or respiratory health conditions, are disproportionately impacted by air pollution.[34] Some individuals and groups, such as outdoor workers, people with low incomes, and people who are unhoused, may experience higher levels of air pollution exposure or have less access to interventions and healthcare than the general population. These high exposure levels put them at increased risk for adverse health effects.[35, 36]

Historically, people of color and Tribal communities across the U.S. have been disproportionally exposed to environmental pollutants as a result of multiple overlapping systematic factors.[37,38] For example, redlining, a discriminatory housing lending practice, made communities of color ineligible for federal home loans and often confined these communities to areas next to major pollution sources. These pollution sources, including freeways, industry and manufacturing, ports, and airports, polluted the local air, water, and soil in historically redlined neighborhoods.[39] Over 50 years' worth of research across the U.S. has documented numerous instances of environmental racism, which was defined by civil rights leader Dr. Benjamin F. Chavis Jr. as the deliberate siting of polluting or hazardous facilities in communities primarily

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[30] Turner MC, Jerrett M, Pope CA 3rd, Krewski D, Gapstur SM, Diver WR, et al. Long-term ozone exposure and mortality in a large prospective study. *American Journal of Respiratory and Critical Care Medicine* 2016;193:1134-42

[31] Tétreault LF, Doucet M, Gamache P, Fournier M, Brand A, Kosatsky T, et al. Childhood exposure to ambient air pollutants and the onset of asthma: an administrative cohort study in Québec. *Environmental Health Perspectives* 2016;124:1276-82.

[32] Gauderman WJ, Urman R, Avol E, Berhane K, McConnell R, Rappaport E, et al. Association of improved air quality with lung development in children. *New England Journal of Medicine* 2015;372:905-13.

[33] Parker, Jennifer D., Lara J. Akinbami, and Tracey J. Woodruff. Air pollution and childhood respiratory allergies in the United States. *Environmental Health Perspectives* 117.1 (2009): 140-147.

[34] U.S. EPA, Research on Health Effects from Air Pollution https://www.epa.gov/air-research/research-health-effects-air-pollution#:~:text=Health%20Effects%20of%20Wildfire%20Smoke,-Larger%20and%20more&text=Wildfires%20increase%20air%20pollution%20in,economic%20impacts%20of%20wildfire%20emissions?

[35] American Lung Association, Who is Most Affected by Outdoor Air Pollution? https://www.lung.org/clean-air/outdoors/who-is-at-risk

[36] Scripps Institution of Oceanography, Unhoused People are Highly Vulnerable to Wildfire Smoke https://scripps.ucsd.edu/news/unhoused-people-are-highly-vulnerable-wildfire-smoke

[37] Morello-Frosch R, Zuk M, Jerrett M, Shamasunder B, Kyle AD. Understanding the cumulative impacts of inequalities in environmental health: implications for policy. *Health Affairs*. 2011 May 1;30(5):879-87.

[38] Fernández-Llamazares A, Garteizgogeascoa M, Basu N, Sonnewend Brondizio E, Cabeza M, Martínez-Alier J, McElwee P, Reyes-García V. A State-of-the-Art Review of Indigenous Peoples and Environmental Pollution. *Integrated Environmental Assessment and Management*. 2011 May 1; 16(3):324-341.

[39] The Seattle Civil Rights and Labor History Project https://deptswashington.edu/civilr/segregated.htm

populated by Black, Hispanic, Indigenous, Asian American, or Pacific Islander people as well as migrant farmworkers and low-wage workers.[40, 41, 42]

Exposure to environmental pollutants has been found to increase the risk of adverse health outcomes for people, communities, and sovereign nations that have historically and systematically endured social, economic, and environmental harms.[43] In addition to environmental racism, numerous studies have documented disproportionate exposure to illnesses including gastrointestinal diseases, HIV/AIDS, and COVID-19[44] alongside discriminatory treatment in healthcare and other negative social determinants of health.[45, 46] Cumulatively, these practices and policies have contributed to ongoing inequities in health outcomes among people of color, particularly among Black, Indigenous, and Hispanic individuals, in communities across the U.S.[47, 48]

Table 2. Summary of criteria air pollutant sources and their health impacts.

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[40] Natural Resources Defense Council, What is Environmental Racism https://www.nrdc.org/stories/what-environmental-racism

[41] National Geographic, The Origins of Environmental Justice-and Why it's Finally Getting the Attention it Deserves https://www.nationalgeographic.com/environment/article/environmental-justice-origins-why-finally-getting-the-attention-it-deserves

[42] Encyclopedia of Puget Sound, Why is so Much Pollution Found in Disadvantaged Communities? https://www.eopugetsound.org/magazine/IS/pollution-disadvantaged-communities

[43] Morello-Frosch R, Zuk M, Jerrett M, Shamasunder B, Kyle AD. Understanding the cumulative impacts of inequalities in environmental health: implications for policy. *Health Affairs*. 2011 May 1;30(5):879-87.

[44] National Library of Medicine, PubMed Central, Race, Healthcare, and Health Disparities: A Critical Review and Recommendations for Advancing Health Equity https://pmc.ncbi.nlm.nih.gov/articles/PMC10527840/#s1

[45] Kaiser Family Foundation, Race, Inequality, and Health https://www.kff.org/racial-equity-and-health-policy/health-policy-101-race-inequality-and-health/?entry=table-of-contents-introduction

[46] National Library of Medicine, PubMed Central, Changing the Narrative: Structural Barriers and Racial and Ethnic Inequities in COVID-19 Vaccination https://pmc.ncbi.nlm.nih.gov/articles/PMC8470519/

[47] Lane HM, Morello-Frosch R, Marshall JD, Apte JS. Historical redlining is associated with present-day air pollution disparities in US cities. *Environmental Science & Technology Letters*. 2022 Mar 9;9(4):345-50.

[48] Gochfeld M and Burger J. Disproportionate Exposures in Environmental Justice and Other Populations: The Importance of Outliers. *American Journal of Public Health*. 2011 Dec;101 Suppl 1(Suppl 1):S53-63.

Pollutant	Major Sources	Health Impacts	Sensitive Populations
Fine Particulate Matter ($PM_{2.5}$)[49]	• Wildfire smoke • Residential wood smoke • Home heating • Vehicle emissions • Industrial facilities • Outdoor burning • Dust from agriculture and construction	• Increases risk of death, stroke, nervous system conditions, cancer and adverse birth outcomes • May contribute to the susceptibility of respiratory infections • Worsens respiratory illness, respiratory disease (e.g. asthma), cardiovascular disease, diabetes	• Children • Outdoor workers • Older adults • Newborns • Pregnant people • People with existing health conditions
Coarse Particulate Matter (PM_{10})	• Dust from agriculture, roadways, and construction • Pollen • Mold • Industrial facilities	• Causes upper airway respiratory irritation • Worsens asthma and other respiratory diseases	• Children • Outdoor workers • Older adults • Newborns • Pregnant people • People with existing health conditions
Ground level Ozone (O_3)[50]	• Secondary formation from reaction of nitrogen oxides (NOx) and volatile organic compounds (VOCs) with sunlight and heat • Sources of VOCs and NOx include vehicle emissions, industrial activities, household and industrial solvents, and wildfires	• Irritates airways • Worsens asthma • Reduces lung function • Increases risk for metabolic, cardiovascular, and respiratory illness	• People with asthma • Children • Older adults • Outdoor workers

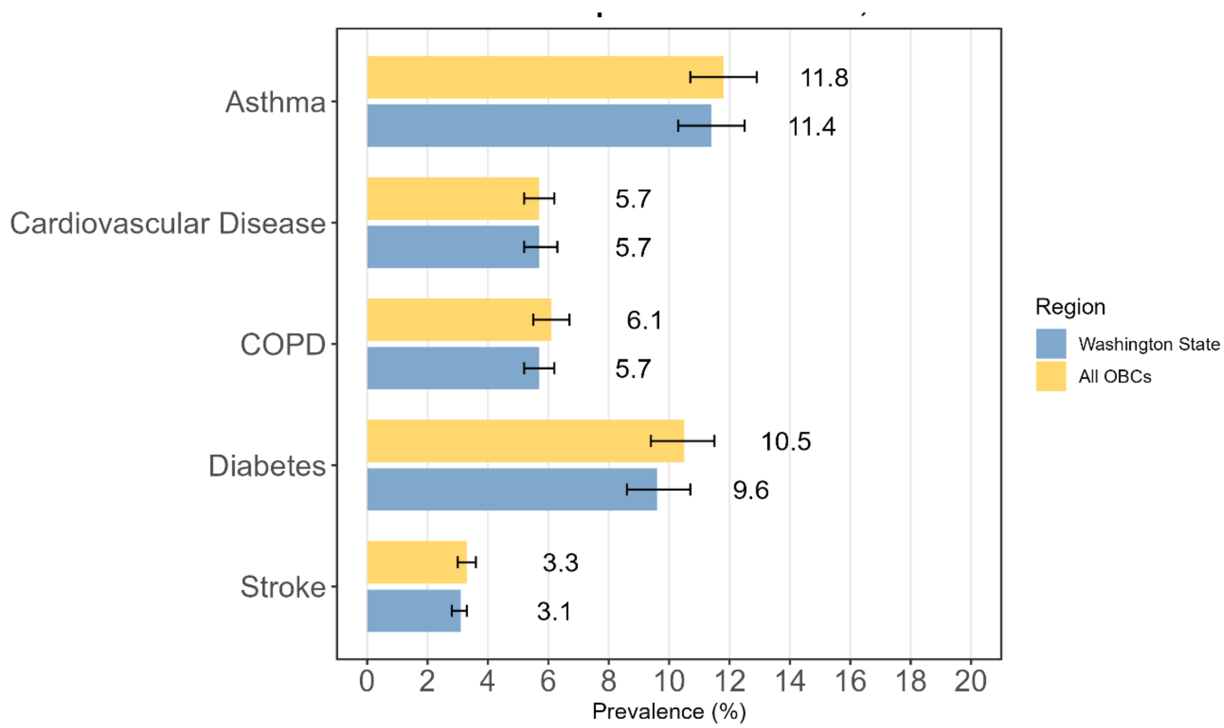
[49] U.S. EPA, Health and Environmental Effects of Particulate Matter https://www.epa.gov/pm-pollution/health-and-environmental-effects-particulate-matter-pm
[50] U.S. EPA, Health Effects of Ozone Pollution https://www.epa.gov/ground-level-ozone-pollution/health-effects-ozone-pollution

Pollutant	Major Sources	Health Impacts	Sensitive Populations
Nitrogen Dioxide (NO_2)[51]	• Fossil fuel combustion • Emissions from vehicles, ships, locomotives, power plants, industrial facilities, and residential fuel combustion	• Worsens asthma • May contribute to the development of asthma and susceptibility to respiratory infections	• People with asthma • Children • Older adults
Sulfur Dioxide (SO_2)[52]	• Fossil fuel combustion • Emissions from marine vessels, oil refineries, and industrial facilities (paper mills, refineries, power plants)	• Irritates upper airway respiratory system • Inflammation of airways • Can increase risk of asthma and bronchitis	• People with asthma • Children • Older adults
Carbon Monoxide (CO)[53]	• Emissions from motor vehicles, fuel combustion in industrial processes, generators, and residential heating	• Reduces oxygen delivery to organs • Can increase risk of cardiovascular morbidity, dizziness, unconsciousness, and death	• People with pre-existing cardiac conditions • Children • Older adults

[51] U.S. EPA, Basic Information about NO_2 https://www.epa.gov/no2-pollution/basic-information-about-no2
[52] American Lung Association, Sulfur Dioxide https://www.lung.org/clean-air/outdoors/what-makes-air-unhealthy/sulfur-dioxide
[53] U.S. EPA, Basic Information about Carbon Monoxide Outdoor Air Pollution https://www.epa.gov/co-pollution/basic-information-about-carbon-monoxide-co-outdoor-air-pollution

Pollutant	Major Sources	Health Impacts	Sensitive Populations
Lead (Pb)[54]	• Leaded aviation fuel • Past sources included leaded gasoline and smelters	• Detrimental to kidney function, the nervous system, reproductive systems, and cardiovascular health • High levels of exposure can cause permanent brain damage and neurocognitive impairment in children	• Children • Infants

CDC data from 2022 suggest that communities that are overburdened and highly impacted by air pollution have slightly higher prevalences of chronic diseases compared to the statewide population; however, overlapping confidence intervals indicate that these differences might not be statistically significant (Figure 2).[55]



[54] U.S. EPA, Lead Air Pollution https://www.epa.gov/lead-air-pollution
[55] U.S. Centers for Disease Control and Prevention, PLACES Data Portal https://www.cdc.gov/places/tools/data-portal.html

Figure 2. Prevalence of chronic health conditions in census tracts within overburdened communities highly impacted by air pollution compared with Washington statewide.

Data in Figure 2 come from CDC PLACES, 2024 release, which uses 2022 survey data.[55] Black lines indicate a 95% confidence interval.

Environmental impacts of air pollution

Criteria air pollution is also detrimental to the environment, as it intensifies water acidification, acid rain, crop damage, and the depletion of nutrients in the soil.[56] Smog and haze can impede plants' ability to photosynthesize by limiting the sunlight that reaches their leaves.[57] This can reduce crop yields or diminish the health of forests. Particulate matter can also increase the acidity of water and soil, which disrupts the life cycles for aquatic and terrestrial organisms.[58]

Additional resources

More information about the criteria air pollutants and their health impacts:

- Criteria air pollution and health impacts Improving Air Quality in Overburdened Communities Highly Impacted by Air Pollution: 2023 Report[59]
- Eco-Health Relationship Browser Eco-Health Relationship Browser | EnviroAtlas | US EPA[60]
- Global Burden of Disease attributable to air pollution Air pollution - Level 2 risk | Institute for Health Metrics and Evaluation[61]
- Health effects of smoke Health effects from smoke - Washington State Department of Ecology[62]
- Health impacts of air pollution and the Clean Air Act Community Health Impacts of Air Pollution in the U.S. [63]

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[56] U.S. EPA, Health and Environmental Effects of Particulate Matter https://www.epa.gov/pm-pollution/health-and-environmental-effects-particulate-matter-pm

[57] Frontiers. "Environmental and Health Impacts of Air Pollution: A Review." Public Health, 2020 Feb. https://www.frontiersin.org/journals/public-health/articles/10.3389/fpubh.2020.00014/full#B3

[58] Zuhara S, Isaifan R. The impact of criteria air pollutants on soil and water: a review. *Journal of Environmental Science and Pollution Research*. 2018 Jun;4(2):278-84.

[59] Improving Air Quality in Overburdened Communities Highly Impacted by Air Pollution: 2023 Report https://apps.ecology.wa.gov/publications/UIPages/documents/2302115.pdf

[60] U.S. EPA EnviroAtlas Eco-Health Relationship Browser https://enviroatlas.epa.gov/enviroatlas/Tools/EcoHealth_RelationshipBrowser/

[61] Institute for Health Metrics and Evaluation, Global Burden of Disease tools https://www.healthdata.org/gbd-tool-access-changes

[62] WA Department of Ecology, Health effects from smoke https://ecology.wa.gov/air-climate/air-quality/smoke-fire/health-effects

[63] Community Health Impacts of Air Pollution in the U.S. Jan 2024 https://cdn.catf.us/wp-content/uploads/2024/01/19170229/community-health-impacts-air-pollution.pdf

- Criteria air pollutants and national air quality standards [Air quality standards - Washington State Department of Ecology](https://ecology.wa.gov/air-climate/air-quality/air-quality-targets/air-quality-standards#criteria)[64]

Greenhouse gas emissions

Human sources of greenhouse gas emissions contribute to climate change and are accelerating its impacts. This can result in economic hardship, and intensifying events like heatwaves, droughts, floods, and wildfires, which impact human health.[65]

Since 1900, Washington has warmed nearly two degrees Fahrenheit as the result of human-caused greenhouse gas emissions, and our extreme heat days are projected to increase 6 to 9 times by the 2050s.[66] Modeling also shows the impact of warming temperatures will result in more frequent and more severe climate change impacts in Washington. Shifts in temperature can facilitate the spread of infectious diseases or the risk of cardiovascular disease, posing direct health risks.[67] Climate change will lead to an increase of ground-level O_3 due to hotter temperatures and sunlight, or an increase in PM from more intense wildfires and wind-blown dust in some locations,[68] as this varies by region.

Greenhouse gases[69], such as carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O), generally do not cause acute health effects at the levels normally present in outdoor air. However, short-term exposure, continuous, or high concentrations, of these gases may cause temporary physiological stress[70] and can cause serious health consequences in enclosed spaces without ventilation. The link between environmental exposure to CH_4 emissions and cardiovascular diseases is a topic of growing interest to the scientific community, and how CH_4 can contribute to the formation of O_3 and $PM_{2.5}$.[71]

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[64] WA Department of Ecology, monitored criteria air pollutants and national air quality standards https://ecology.wa.gov/air-climate/air-quality/air-quality-targets/air-quality-standards#criteria

[65] U.S. EPA Report on the Environment. Jun 2025 https://www.epa.gov/report-environment/greenhouse-gases

[66] WA Department of Ecology, 2025 Summary Report on the Science of Human Caused Climate Change and Recommendations for Washington State's Greenhouse Gas Emissions Reduction Limits https://apps.ecology.wa.gov/publications/SummaryPages/2514064.html

[67] Mohammadali Kiehbadroudinezhad, Adel Merabet, Homa Hosseinzadeh-Bandbafha, Chapter 12, Health Impacts of Greenhouse Gas Emissions on Humans and the Environment, Advances and Technology Development in Greenhouse Gases: Emission, Capture and Conversion, Elsevier, 2024, Pgs.265-291 https://www.sciencedirect.com/science/article/abs/pii/B9780443192319000119

[68] U.S. Centers for Disease Control and Prevention, Climate and Health https://www.cdc.gov/climate-health/php/effects/air-pollution.html

[69] Chapter 173-441-040 WAC, Greenhouse Gases https://app.leg.wa.gov/WAC/default.aspx?cite=173-441-040

[70] Smith KR, Jerrett M, Anderson HR, Burnett RT, Stone V, Derwent R, Atkinson RW, Cohen A, Shonkoff SB, Krewski D, Pope CA. Public health benefits of strategies to reduce greenhouse-gas emissions: health implications of short-lived greenhouse pollutants. *The Lancet*. 2009 Dec 19;374(9707):2091-103.

[71] Mendoza-Cano O, Trujillo X, Huerta M, Ríos-Silva M, Lugo-Radillo A, Bricio-Barrios JA, Rueda-Abad JC, Pérez-Rodríguez RY, Quintanilla-Montoya AL, Uribe-Ramos JM, Mendoza-Olivo VA, Murillo-Zamora E. Assessing the relationship between energy-related methane emissions and the burden of cardiovascular diseases: a cross-sectional study of 73 countries. *Scientific Reports*. 2023 Aug 19;13(1):13515.

The Washington Legislature set new greenhouse gas emission limits into law in 2020 to combat the threat of climate change and protect the environment, our economy, and the health and safety of our communities. Under the law, the state is required to reduce statewide emissions by 45% by 2030, 70% by 2040, and 95% by 2050. In order to meet these requirements, our state has implemented a strong suite of climate policies that work together to lower emissions. As Washington's most far-reaching climate policy, the CCA plays a key role.

Reducing greenhouse gas emissions

The CCA created the Cap-and-Invest Program, a market-based policy that limits and lowers climate pollution. This program puts a price on greenhouse gas emissions and requires major emitters to compete to buy allowances during quarterly auctions for every metric ton of greenhouse gases they release. The number of allowances available each year are gradually reduced through 2050.[72]

The Cap-and-Invest Program is the CCA's primary tool for reducing greenhouse gas emissions. Projects funded by the revenue generated through Cap-and-Invest auctions may *further* reduce emissions. The Cap-and-Invest auction revenue[73] is appropriated by the legislature, and the funds received from this program flow through state agencies to numerous projects statewide in order to reduce climate and air pollution. Ecology publishes an annual report and the Governor's Office created a CCA dashboard[74] to track how funds are invested in Washington's communities. According to the latest report[75], 60% (about $850 million) of total CCA investments benefited communities across Washington in the 2023-25 biennium, exceeding the law's 35% requirement.

Tracking greenhouse gas emissions

Ecology tracks greenhouse gas emissions two primary ways: through the greenhouse gas inventory and the mandatory greenhouse gas reporting program.

The greenhouse gas emissions inventory[76] is the historical record of Washington's contribution to global climate change, using data primarily from the EPA. The inventory measures the state's progress towards meeting mandatory greenhouse gas emission limits[77] by estimating statewide

[72] WA Department of Ecology, Washington's Cap-and-Invest Program https://ecology.wa.gov/air-climate/climate-commitment-act/cap-and-invest
[73] WA Department of Ecology, Cap-and-Invest auction revenue https://ecology.wa.gov/air-climate/climate-commitment-act/auction-revenue
[74] CCA Dashboard: How Climate Commitment Act funds are invested https://climate.wa.gov/washington-climate-action-work/climate-commitment-act-polluters-pay-communities-benefit/cca-dashboard-how-climate-commitment-act-funds-are-invested
[75] Report to the Legislature: Climate Commitment Act Investments Fiscal Year 2025 https://apps.ecology.wa.gov/publications/SummaryPages/2514107.html
[76] WA Department of Ecology, Washington's greenhouse gas inventory https://ecology.wa.gov/air-climate/reducing-greenhouse-gas-emissions/tracking-greenhouse-gases/ghg-inventories
[77] WA Department of Ecology, Reducing greenhouse gas emissions https://ecology.wa.gov/air-climate/reducing-greenhouse-gas-emissions

emissions and reductions compared to a 1990 baseline. The most recent Washington State Greenhouse Gas Emissions Inventory report[78] summarizes Washington's greenhouse gas emissions from 1990 through 2021. Ecology is working to decrease the lag time between collecting emissions data and publishing the inventory by reducing reliance on federal data.

In July 2025, the Washington State Legislature passed Senate Bill 5036[79] which changes the frequency of the Washington Greenhouse Gas Inventory. Ecology is now required to publish a full inventory each even-number year through 2030, data summaries in 2027 and 2029 in lieu of a full report, and then annually beginning in 2031. The bill updates the requirement for the data used in the report to match the reality of data availability, changing "from the most recent two years of data" to "the two most recent years for which data is available."

In addition to producing the greenhouse gas inventory, Ecology collects emissions data directly through Washington's mandatory Greenhouse Gas Reporting Program.[80] Facilities that emit at least 10,000 MT CO_2e per year of greenhouse gas emissions have been required to report their emissions to Ecology since 2012. In 2022, requirements were updated to include a broader group of industries and align with the requirements of the Cap-and-Invest Program. Using this information, businesses that emit over 25,000 MT CO_2e are also subject to the Cap-and-Invest Program (covered sources). The Cap-and-Invest Program began on January 1, 2023, which is in its first compliance period that runs from 2023 to 2026. Data collection is ongoing and information on emission reductions will be available in the future.

While the scope of the Cap-and-Invest Program focuses on carbon pollution reductions from covered sources statewide, the environmental justice provision in RCW 70A.65.020 of the CCA requires Ecology to report levels of criteria air pollution and its resultant health impacts, as well as greenhouse gas emissions in the identified OBCs. This provision has several other requirements, like identifying the greatest contributors to CAP emissions (stationary and mobile sources), tracking emission trends, and achieving reductions of CAPs in OBCs.

The 2023[81] and 2025 EJ Reports use the same methodology to calculate the greenhouse gas results. We include updated information on greenhouse gas emissions from facilities that reported through Washington's Greenhouse Gas Reporting Program and estimates for mobile sources in overburdened communities highly impacted by air pollution.

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[78] WA Department of Ecology, Washington State Greenhouse Gas Emissions Inventory 1990-2021 https://apps.ecology.wa.gov/publications/SummaryPages/2414077.html

[79] Senate Bill 5036 Climate Policy https://app.leg.wa.gov/billsummary?billnumber=5036&year=2025

[80] WA Department of Ecology, Mandatory greenhouse gas reports https://ecology.wa.gov/air-climate/reducing-greenhouse-gas-emissions/tracking-greenhouse-gases/mandatory-greenhouse-gas-reports

[81] WA Department of Ecology, Improving Air Quality in Overburdened Communities Highly Impacted by Air Pollution: 2023 Report, Washington State Department of Ecology https://apps.ecology.wa.gov/publications/SummaryPages/2302115.html

Further Washington climate policy

Burning fossil fuels emit both greenhouse gases and criteria air pollutants. Policy-driven efforts to reduce air pollution, especially within more vulnerable communities, is expected to yield benefits for environmental and human health. As Washington advances these efforts, state and local planning frameworks are incorporating climate-focused requirements.

In 2023, House Bill 1181[82] was signed into law and added a climate goal to the Growth Management Act. This law requires that cities and counties planning under the Growth Management Act include a "climate element" that reduces greenhouse gas emissions in their comprehensive plans.[83] The Washington Department of Commerce has developed intermediate guidance for those cities and counties to use.[84] In addition to this, some local governments produce their own greenhouse gas inventories required by a city ordinance. For example, the City of Spokane publishes a greenhouse gas inventory using community-level data sources.[85] When available, county and city inventories are linked in the individual Community Reports of this publication.

The transportation sector continues to emit the most greenhouse gases according to the Washington Greenhouse Gas Emissions Inventory, accounting for 39.7% of greenhouse gas emissions in 2021.[86] The Clean Fuel Standard[87], Chapter 173-424 WAC[88], curbs carbon pollution from transportation by reducing greenhouse gas emissions from the production and supply of transportation fuels. The low-emission vehicle standards and zero-emission vehicle standards under the Clean Vehicles Program[89] apply to automakers and contribute to the reduction of carbon emissions. Further policy and reports can be found on Ecology's website.[90]

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[82] Climate Change-Planning, House Bill 1181, July 23, 2023. https://lawfilesext.leg.wa.gov/biennium/2023-24/Pdf/Bills/Session%20Laws/House/1181-S2.SL.pdf?q=20230615091639

[83] Washington Department of Commerce, Growth Management Services https://www.commerce.wa.gov/growth-management/#:~:text=The%20Growth%20Management%20Act%20%28GMA%29%20requires%20that%20the,every%20ten%20years%20to%20ensure%20they%20remain%20up-to-date.

[84] Washington Department of Commerce, Growth Management Services, Climate Planning https://www.commerce.wa.gov/growth-management/climate-planning/

[85] City of Spokane's Greenhouse Gas Inventory, StoryMap, April 15, 2025 https://storymaps.arcgis.com/stories/3a4abcd7bc9642408002603847b84566

[86] WA Department of Ecology, Washington State Greenhouse Gas Emissions Inventory: 1990-2021 https://apps.ecology.wa.gov/publications/SummaryPages/2414077.html

[87] WA Department of Ecology, Clean Fuel Standard https://ecology.wa.gov/air-climate/reducing-greenhouse-gas-emissions/clean-fuel-standard

[88] Clean Fuels Program, Chapter 173-424 WAC https://ecology.wa.gov/regulations-permits/laws-rules-rulemaking/rulemaking/wac-173-424

[89] WA Department of Ecology, Vehicle emissions standards https://ecology.wa.gov/air-climate/reducing-greenhouse-gas-emissions/vehicle-emissions-standards

[90] WA Department of Ecology, Reducing greenhouse gas emissions https://ecology.wa.gov/air-climate/reducing-greenhouse-gas-emissions

In 2019, the Clean Energy Transformation Act (CETA) was signed into law, which requires utility companies to supply residents and businesses with carbon-free resources by 2045.[91]

Additional resources

- U.S. EPA's State Inventory and Projection Tool to help states develop greenhouse gas emissions inventories State Inventory and Projection Tool | US EPA[92]
- U.S. EPA's Local Greenhouse Gas Inventory Tool Local Greenhouse Gas Inventory Tool | US EPA93
- Washington's biggest climate policies at work Washington climate action at work | Climate[94]
- Washingtons electric vehicle mapping tool for supply equipment or charger infrastructure Zero-emission and electric vehicles mapping tool | WSDOT[95]
- Air quality in overburdened communities grants and Ecology's grant-funded projects map Overburdened communities grants - Washington State Department of Ecology[96]
- Quick facts of methane gas Methane Gas Fact Sheet[97]

Listening sessions

The Department of Ecology and Department of Health jointly developed a pilot process for conducting listening sessions with local clean air agencies, LHJs, community-based organizations, residents of OBCs, and other interested parties. Conducting these sessions aligns closely with the community engagement strategy as outlined or prescribed by the CCA. The Environmental Justice review of section of the CCA, RCW 70A.65.020, requires the Department of Ecology to proactively seek input from individuals and groups impacted by air pollution.

When developing the listening session methodology, Ecology and DOH referred to the Community Engagement Values and Guidance created by the Washington State Environmental Justice Council. The listening sessions were additionally intended to respond to calls from

[91] Washington Clean Energy Transformation Act, Chapter 19.05 RCW https://app.leg.wa.gov/RCW/default.aspx?cite=19.405&full=true
[92] U.S. EPA, State Inventory and Projection Tool https://www.epa.gov/statelocalenergy/state-inventory-and-projection-tool
[93] U.S. EPA, Local Greenhouse Gas Inventory Tool https://www.epa.gov/statelocalenergy/local-greenhouse-gas-inventory-tool
[94] Washington climate policies https://climate.wa.gov/washington-climate-action-work
[95] Washington electric vehicle mapping tool https://wsdot.wa.gov/business-wsdot/grants/zero-emission-vehicle-grants/zero-emission-and-electric-vehicles-mapping-tool
[96] WA Department of Ecology, Air quality in overburdened communities grants https://ecology.wa.gov/about-us/payments-contracts-grants/grants-loans/find-a-grant-or-loan/overburdened-communities-grants
[97] Ohio Department of Health Bureau of Environmental Health Assessment, U.S. EPA publications 2012, methane gas fact sheet https://semspub.epa.gov/work/05/437170.pdf

environmental justice advocates for further engagement with frontline community members in decision making processes relating to environmental justice and health.[98]

The following central goals guided the pilot listening session process:

- Determine how the EJ Report can provide meaningful, informative, and accessible information to OBC members to support their understanding of air quality and its health impacts.
- Learn how the EJ Report can be delivered in a format that is accessible and valuable to community partners, organizations, and individuals.
- Expand Community Reports in the EJ Report to better reflect changing demographics, lived experiences, and priorities relating to air quality and health in each OBC. Include updated descriptions of each community in the 2025 EJ Report and the online StoryMap.

Methods

Demographics and community descriptions

The EJ Report aggregates demographic data from the Washington State Office of Financial Management[99] (OFM) and the American Community Survey[100] (ACS) by the U.S. Census Bureau. OFM demographic indicators are modeled on data from the decennial census; ACS data are estimates based on representative samples of geographic areas across the U.S., and both are based on self-reported survey data. We used 2023 census tract data from OFM's small area estimates program (SAEP) to report on population by race, ethnicity, and age; and 2023 ACS census tract level data to report population estimates by education, employment, and health metrics (Table 3).

Table 3. Data sources of demographic indicators and community descriptions.

[98] Front and Centered - 2024 Frontline Report on HEAL Progress
[99] WA Office of Financial Management, Population & demographics https://ofm.wa.gov/data-research/population-demographics/
[100] U.S. Census Bureau, American Community Survey Data https://www.census.gov/programs-surveys/acs/data.html

Indicator	Source	Year	Specifications
Race/Ethnicity	Office of Financial Management[101]	2023	Race categories are mutually exclusive. “Hispanic” ethnicity category includes people of all self-identified races, whereas American Indian/Alaska Native, Native Hawaiian/Pacific Islander, Black, Asian, and white include only people identifying as non-Hispanic.
Age	Office of Financial Management[102]	2023	OFM provides population estimates for people ages 0 to 99 in 5-year intervals.
Educational attainment	American Community Survey[103]	2023	Estimates from 2020 census data. Includes individuals 25 years or older.
Employment	American Community Survey[100]	2023	Includes individuals 16 years or older. Excludes incarcerated individuals and active-duty members of the Armed Forces.
Healthcare coverage	American Community Survey[100]	2023	Public and private insurance.
Non-English language spoken at home	American Community Survey[100]	2023	Non-English language spoken in addition to or instead of English at home for individuals 5 years and older.
Below federal poverty line	American Community Survey[100]	2023	Household poverty threshold calculated based on age and number of household members.[104]

[101] WA Office of Financial Management, Race and ethnicity information page https://ofm.wa.gov/data-research/population-demographics/forecasts-projections/age-sex-race-and-hispanic-origin/information/
[102] WA Office of Financial Management, Estimates of April 1 population by age, sex, race and Hispanic origin https://ofm.wa.gov/data-research/population-demographics/estimates/age-sex-race-and-hispanic-origin/
[103] Census Glossary https://www.census.gov/glossary/?term=Educational+attainment
[104] Poverty Thresholds https://www.census.gov/data/tables/time-series/demo/income-poverty/historical-poverty-thresholds.html

Indicator	Source	Year	Specifications
Disability	American Community Survey[100]	2023	Disability status for individuals 18 years of age and older. The ACS includes a series of questions about hearing, vision, cognitive, ambulatory, self-care, or independent living difficulties; respondents who indicate any one of the six disability types are considered to have a disability.[105]

We calculated and reported proportions and counts for all census tracts that fall fully or partially within the boundaries of overburdened communities highly impacted by air pollution (OBCs). These counts are compared to statewide estimates.

This report followed the Federal 1997 Office of Management and Budget (OMB) standard for reporting races and ethnicities, which the Washington Office of Financial Management currently follows for reporting population estimates.[106] We recognize that this system of classification does not fully represent the broad spectrum of racial and ethnic identities of individuals and communities living in OBCs. The Community Reports use qualitative insights gathered through community engagement to help provide greater context to the factors that shape community members' experiences of air quality and health.

Data from the aforementioned sources are reported in each of the 16 Community Reports, informing the Demographic and Social and Economic Characteristics sections.

Criteria air pollution

Since 2023, Ecology has installed 52 (49 $PM_{2.5}$, two PM_{10}, and one NO_x) CAPs monitors and sensors in OBCs, with plans for more monitors and a high-resolution mobile monitoring study. Monitored pollutant levels in Washington remain below the NAAQS, and the entirety of the state is in attainment of these standards. Additional monitoring data has provided critical information for this EJ Report.

[105] How Disability Data are Collected from the American Community Survey https://www.census.gov/topics/health/disability/guidance/data-collection-acs.html
[106] WA Office of Financial Management, Race and ethnicity, https://ofm.wa.gov/data-research/population-demographics/forecasts-projections/age-sex-race-and-hispanic-origin/information/

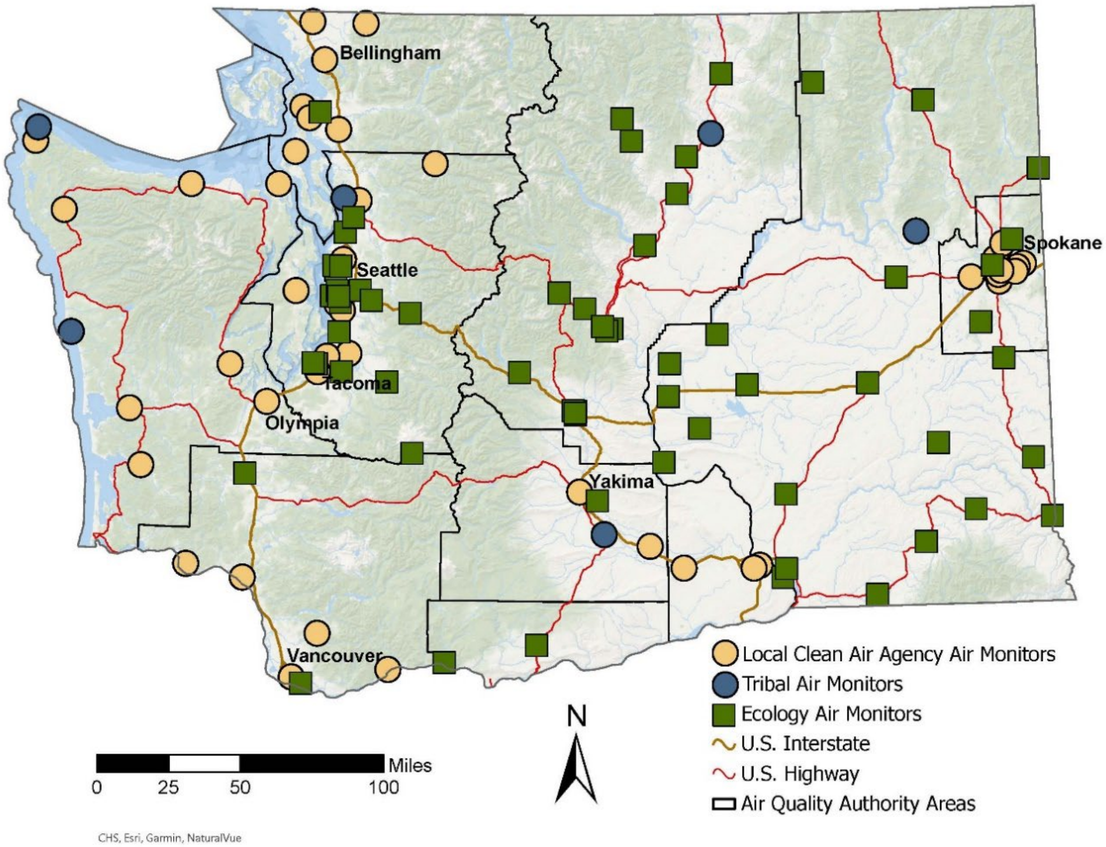

Figure 3. Ambient air monitoring sites across Washington.

In the 2023 EJ Report, we used monitoring data from 2020–2022 to report on criteria air pollution levels in OBCs. We also incorporated estimates of NO_2 and O_3 concentrations using model-monitor interpolation and roadway modeling tools. With the expansion of the monitoring network over the last two years, we were able to use monitoring data solely for the current report, minimizing the relatively larger uncertainty associated with modeling results.

For this report, we exclusively relied on data from the Washington Network. Limiting the data to the state's monitoring network ensures that this report reflects the most accurate and reliable information available, which is validated through Ecology's quality assurance process. By only using monitoring data, we avoid the uncertainties introduced by modeling methods that rely on outdated data inputs, allowing us to easily track pollution trends over time.

Design values (DVs) are three-year averages that describe the air quality at a given location and are used to determine compliance with the NAAQS.[107] DVs and estimated DVs are calculated

[107] National Primary and Secondary Ambient Air Quality Standards, 40 C.F.R. Part 50 (2025) https://www.ecfr.gov/current/title-40/chapter-I/subchapter-C/part-50?toc=1

following the NAAQS methodology developed by the EPA, as described in 40 CFR Part 50.[108] A valid reporting year must have data from at least 75% of the sampling days in each calendar quarter.

We used data from regulatory monitors to report three-year DVs for pollutants that were continuously monitored between 2022 to 2024. We reported estimated DVs from sensors (SensWA) designed and built by Ecology and non-regulatory monitors that collected three consecutive years of data from 2022-2024. For pollutants that were not monitored continuously between 2022 to 2024, we report an average of available annual summary statistics.

$PM_{2.5}$

$PM_{2.5}$ (particles with a diameter less than or equal to 2.5 micrometers) is measured by Federal Reference Method (FRM) monitors, Federal Equivalent Method (FEM) monitors, non-regulatory monitors, and Ecology's SensWA devices.[109] These measurements are collected from 45 monitoring sites (FRM/FEMs and non-FRM/FEMs) and SensWA devices that are within or representative of OBCs, as some sites are located just outside the boundaries of the 16 communities highly impacted by air pollution. The monitoring data is used to calculate the annual summary statistics, the annual 98th percentile of daily concentrations, and the 2024 design values for the 2022-2024 period.

These data were processed following the EPA's methodology outlined in 40 CFR Part 50, Appendix N.[110] The annual $PM_{2.5}$ design value is the annual mean averaged over three years. This value is compared to the annual $PM_{2.5}$ NAAQS threshold of 9.0 µg/m³. The 24-Hour $PM_{2.5}$ design value is the annual 98th percentile of 24-hour average concentrations. This value is averaged over three years and compared to the 24-hour $PM_{2.5}$ NAAQS of 35 µg/m³.

Exclusion of wildfire smoke days

We calculated the annual $PM_{2.5}$ summary statistics with wildfire days both included and excluded to show the relative impact of wildfire smoke on annual and daily $PM_{2.5}$ concentrations. Wildfire season usually lasts from July-September, though it may begin earlier or last longer. For example, in 2022 the wildfire season persisted into October. July 4th and 5th, which are normally impacted by pollution from Independence Day fireworks, are included in all calculations, as fireworks are an anthropogenic source of emissions.

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[108] National Primary and Secondary Ambient Air Quality Standards, 40 C.F.R. Part 50 (2025) https://www.ecfr.gov/current/title-40/chapter-I/subchapter-C/part-50?toc=1

[109] WA Department of Ecology, Focus on SensWA, November 2023, pub 23-02-113 https://apps.ecology.wa.gov/publications/summarypages/2302113.html

[110] Interpretation of the National Ambient Air Quality Standards for $PM_{2.5}$ 40 C.F.R. Part 50, Appendix N (2025) https://www.ecfr.gov/current/title-40/chapter-I/subchapter-C/part-50/appendixAppendix%20N%20to%20Part%2050

During the wildfire season, days on which the annual 24-hour 98th percentile exceeded 35.4µg/m^3 were reviewed by Ecology to determine if the exceedance was caused by wildfire smoke. These days were removed to calculate "days excluding wildfire smoke" annual summary statistics and design values. This shows the relative impact of wildfire smoke on annual and daily $PM_{2.5}$ concentrations. We followed an internal process consistent with the EPA's methodology to review and exclude exceptional events, including wildfire smoke days. To calculate the $PM_{2.5}$ annual summary statistics without wildfire smoke, Ecology reviewed days on which the maximum $PM_{2.5}$ concentration exceeded 15.0 ug/m^3 during wildfire season. Days on which these exceedances were caused by wildfire smoke were removed from the "days excluding wildfire smoke" calculation.

PM_{10}

There are eight PM_{10} monitoring sites within five OBC boundaries. The PM_{10} design values are the number of expected exceedances of the primary and secondary 24-hour NAAQS of 150 µg/m^3 (Appendix A). PM_{10} levels are well below the NAAQS throughout Washington. Occasional exceedances are usually caused by wind-blown dust or construction dust. Recently, Ecology added PM_{10} monitors in the Duwamish Valley and Everett based on community concerns about dust from unpaved roadways and construction sites.

Ozone

Ozone (O_3) is measured by FEM monitors. There are three continuously operational and ten seasonal O_3 monitors in Washington. Since O_3 is a regional pollutant, we report design values from four monitors Ecology deems representative of the O_3 concentrations within the boundaries of overburdened communities highly impacted by air pollution. We followed the NAAQS methodology for calculating O_3 design values.[111] The annual fourth-highest daily maximum 8-hour concentrations are averaged over 3 years and compared to the NAAQS of 0.070 ppm.

Nitrogen dioxide

There are four NO_2 FEM and FRM monitors in Washington's OBCs. Daily maximum 1-hour design values were calculated following the NAAQS methodology[112]. The NO_2 design values are the average of three years of the 98th percentile daily 1-hour maximum, compared to the 1-hour NAAQS of 100 ppb (Appendix A).

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[111] National 8-hour primary and secondary ambient air quality standards for ozone, 40 C.F.R. Part 50.10 (2025) https://www.ecfr.gov/current/title-40/chapter-I/subchapter-C/part-50/section-50.10

[112] Interpretation of the Primary National Ambient Air Quality Standards for Oxides of Nitrogen, 40 C.F.R. Appendix S to Part 50 (2025) https://www.ecfr.gov/current/title-40/chapter-I/subchapter-C/part-50/appendix-Appendix%20S%20to%20Part%2050

Sulfur dioxide

Sulfur dioxide (SO_2) is measured by FEM monitors. SO_2 monitoring is limited because monitored pollution levels are far below the NAAQS. The SO_2 design values are the 99th percentile of the daily maximum 1-hour SO_2 concentrations, averaged over three years and compared to the NAAQS of 75 ppb. There is one SO_2 site within an OBC in the I-5 corridor.

Carbon monoxide

Carbon Monoxide (CO) is measured by FRM monitors. CO has a one-hour and an 8-hour averaging periods to calculate their respective primary standards. The 1-hour and 8-hour CO standards are compared to the NAAQS levels of 35 ppm and 9 ppm, respectively, and are not to be exceeded more than once per year. The hourly CO values for the recent years are all below the NAAQS levels. The 8-hour CO primary standard is the highest of the second-highest annual 8-hour maximum concentration from years 2023 and 2024. There are two CO monitoring sites within OBCs in the I-5 corridor.

Number of days with unhealthy air quality

The Air Quality Index (AQI),[113] developed by the EPA, categorizes health risks from CAPs. We calculated the annual number of days with air quality Unhealthy for Sensitive Groups (USG) or worse by counting the days when the maximum AQI exceeded 100 (see Appendix B). We use the term “unhealthy air quality” to describe the number of days that exceed this AQI threshold. For communities with multiple monitors, we used data from the monitor with the most days above this threshold. If less than a full year of data was available, all available days were included in the average. We then averaged the annual number of unhealthy air quality days from years 2022-2024 to provide a three-year snapshot of each community’s exposure to unhealthy air quality. The AQI utilizes a distinct methodology from the NAAQS to provide localized information about air quality.

Health impacts

The 2023 and 2025 EJ Reports employ the same methodology to calculate the Health Impacts results, which uses the United States Environmental Protection Agency (EPA)’s Benefits Mapping and Analysis Program, Community Edition (BenMAP-CE).

In this report, we focus on the health impacts of $PM_{2.5}$ and O_3, the CAPs with the greatest potential impact on population health in Washington.[14, 114] Sources of both types of pollution are common across the state, including wood stoves and fireplaces, vehicles, dust, outdoor burning, industry , vehicles, and other sources for O_3. While all of Washington meets air quality

[113] Technical Assistance Document for the Reporting of Daily Air Quality – the AQI https://document.airnow.gov/technical-assistance-document-for-the-reporting-of-daily-air-quailty.pdf
[114] WA Department of Ecology, Particle pollution in Washington’s air https://ecology.wa.gov/air-climate/air-quality/air-quality-targets/air-quality-standards/particle-pollution

standards for PM and O_3 pollution, there are still several areas of concern that are monitored closely.[115, 116] In the 2023 EJ Report, an assessment of various sources of air quality data, including monitor data, modeling, and available studies[117, 118, 119, 120], showed that levels of Pb, SO_2, and CO were determined to likely be low across the state.

BenMAP-CE

BenMAP-CE is an open-access, analytic software tool developed by the EPA that can be used to estimate morbidity and mortality associated with air pollutant exposure and the economic value of these health outcomes.[121] In this report, we used BenMAP-CE to estimate 1) the yearly impact of $PM_{2.5}$ exposure (mean annual $PM_{2.5}$ concentration) on human health; 2) the daily impact of $PM_{2.5}$ exposure (mean 24-hour $PM_{2.5}$ concentration) on human health; 3) the seasonal impact of O_3 exposure (mean seasonal O_3 concentration from May to September) on human health; and 4) the daily impact of O_3 exposure (mean daily maximum 8-hour O_3 concentration) on human health. The four main inputs for the BenMAP-CE model were: (1) baseline $PM_{2.5}$ and O_3 concentrations and natural background $PM_{2.5}$ and O_3 concentration from Cheeka Peak, a remote monitoring site with minimal sources of air pollution from human activity that serves as Washington's regional background site (2) Washington census tract population averages for 2022-2023, (3) baseline mortality and morbidity rates from Washington State Department of Health 2022-2023 data sources, and (4) effect estimates from nationally representative studies or studies from the Pacific Northwest examining $PM_{2.5}$ or O_3 exposure and mortality or morbidity (Figure 4).

[115] WA Department of Ecology, Determining if areas in Washington meet national air quality standards https://ecology.wa.gov/regulations-permits/plans-policies/areas-meeting-and-not-meeting-air-standards
[116] WA Department of Ecology, Air quality studies https://ecology.wa.gov/research-data/scientific-reports/air-quality-studies
[117] WA Department of Ecology, Lead in Washington's air https://ecology.wa.gov/air-climate/air-quality/air-quality-targets/air-quality-standards/lead
[118] WA Department of Ecology, Sulfur dioxide in Washington's air https://ecology.wa.gov/air-climate/air-quality/air-quality-targets/air-quality-standards/sulfur-dioxide
[119] WA Department of Ecology, Carbon monoxide in Washington's air https://ecology.wa.gov/air-climate/air-quality/air-quality-targets/air-quality-standards/carbon-monoxide
[120] WA Department of Ecology, 2012 Airport Lead Study: Auburn Municipal Airport and Harvey Field https://apps.ecology.wa.gov/publications/SummaryPages/1302040.html
[121] U.S. EPA, Environmental Benefits Mapping and Analysis Program - Community Edition (BenMAP-CE) https://www.epa.gov/benmap

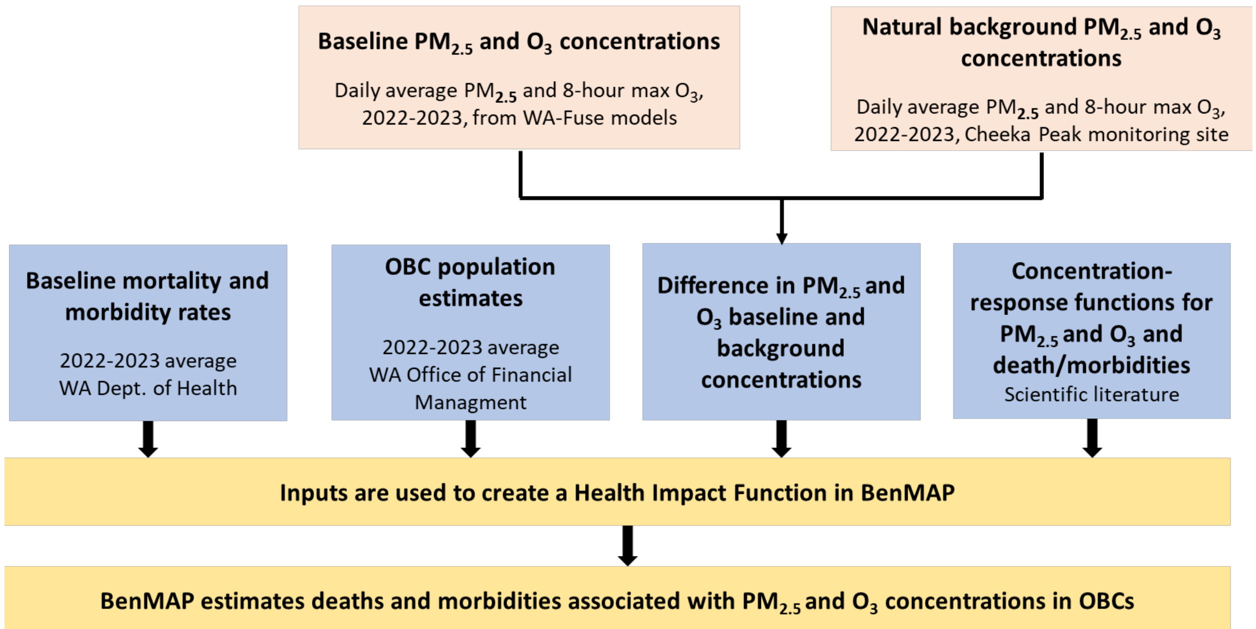

Figure 4. Flowchart of data inputs included in BenMAP-CE to produce estimates of deaths and morbidities associated with $PM_{2.5}$ and O_3 concentrations in overburdened communities highly impacted by air pollution.

BenMAP-CE was run using 2020 census tract boundaries, with results reported at the same geographic level, focusing on census tracts where communities were fully or partially identified as overburdened and highly impacted by air pollution. The health impact functions in BenMAP-CE use the following general equation:

$$\Delta Y = \left(1 - e^{-\beta * \Delta AQ}\right) * Yo * Pop$$

Where ΔY is the estimated health impact associated with yearly $PM_{2.5}$ or O_3 exposure in overburdened communities, *β* is the beta coefficient from an epidemiologic study on the association between $PM_{2.5}$ or O_3 concentrations and risk for the respective health outcome, *ΔAQ* is the change in annual or daily $PM_{2.5}$ or O_3 concentrations, *Yo* is the baseline rate of the respective health outcome per population, and *Pop* is population exposed to $PM_{2.5}$ or O_3 in overburdened communities.

Table 4. BenMAP-CE input data and sources.

Inputs	Data Source	Year	Scale
Baseline $PM_{2.5}$ and O_3 concentrations	WA-Fuse	2022-2023	Census Tract
Natural background $PM_{2.5}$ and O_3 concentrations[122]	Monitors at Cheeka Peak, WA	2022-2023	Point
Population[123]	WA Office of Financial Management	2022-2023	Census Tract
Baseline rates per population — Deaths[124]	Center for Health Statistics/WA DOH	2022-2023	Census Tract
Baseline rates per population — Hospital admissions[125]	Comprehensive Hospital Abstract Reporting System (CHARS)/WA DOH	2022-2023	ZIP code
Baseline rates per population — ED visits[126]	Rapid Health Information Network (RHINO)/WA DOH	2022-2023	Census Tract
Baseline rates per population — Lung cancer diagnoses[127]	Washington State Cancer Registry/WA DOH	2022	Census Tract

ED = emergency department; PM = particulate matter; WA DOH = Washington State Department of Health

[122] WA Department of Ecology, Improving Air Quality in Overburdened Communities Highly Impacted by Air Pollution: 2023 Report, Washington State Department of Ecology https://apps.ecology.wa.gov/publications/SummaryPages/2302115.html

[123] WA Department of Ecology, Improving Air Quality in Overburdened Communities Highly Impacted by Air Pollution: 2023 Report, Washington State Department of Ecology https://apps.ecology.wa.gov/publications/SummaryPages/2302115.html

[124] Washington State Department of Health, Death data https://doh.wa.gov/data-and-statistical-reports/health-statistics/death

[125] Washington State Department of Health, Comprehensive Hospital Abstract Reporting System (CHARS) https://doh.wa.gov/data-statistical-reports/healthcare-washington/hospital-and-patient-data/hospital-discharge-data-chars

[126] Washington State Department of Health, Syndromic Surveillance (RHINO) https://doh.wa.gov/public-health-provider-resources/healthcare-professions-and-facilities/data-exchange/syndromic-surveillance-rhino

[127] Washington State Department of Health, Cancer data https://doh.wa.gov/public-health-provider-resources/healthcare-professions-and-facilities/data-exchange/syndromic-surveillance-rhino

Population and health data

Population estimates for census tracts, including age and racial and ethnic groups, were the average of 2022-2023 Washington State Office of Financial Management (WA OFM) population and demographics datasets.[128] Health data for our analysis came from multiple DOH sources: death statistical datasets from the Center for Health Statistics (CHS),[124] hospital admission data from the Comprehensive Hospital Abstract Reporting System (CHARS),[125] emergency department (ED) visit data from the Rapid Health Information Network (RHINO),[126] and lung cancer diagnosis data from the Washington State Cancer Registry (WSCR).[127] We obtained individual-level data from each data source for years 2022-2023, except for WSCR for which we used 2022 data as 2023 cancer records were not finalized at the time of analysis. Definitions that we used to identify each of our health outcomes with each data source can be found in Table D1.

Using these health data sources and census tract population data from WA OFM, we calculated baseline rates per population of each health outcome included in our analysis, including deaths by any cause and/or cause-specific deaths (i.e., "mortality rates"), hospitalizations, ED visits, and cancer diagnoses. Incidence rates were calculated as the sum of each health outcome that was identified in the data divided by the total population. Incidence rates were calculated for each 5-year age group (e.g., 0–4, 5–9, 10–14, …, 80–84, and 85–99) within each census tract. Census tract information was available for all DOH records except for CHARS hospital admission data, which was at the ZIP (Zone Improvement Plan) code level. We used data crosswalks developed by the U.S. Department of Housing and Urban Development to assign census tracts to CHARS records based on the ZIP code.[129] Separate rates were calculated for each age group so that we could adjust health impact estimates for age. We further stratified mortality rates due to any cause by racial and ethnic groups to assess disparities in mortality between racial and ethnic groups. We were unable to include race- and ethnicity-specific results for other health outcomes in our analysis given the lack of race- and ethnicity-stratified effect estimates for these conditions in the published literature. We calculated the yearly average rate for each health outcome across 2022-2023.

$PM_{2.5}$ and ozone concentration data

WA-Fuse is a modeling tool that incorporates $PM_{2.5}$ and O_3 monitored pollutant concentrations to provide statewide pollutant concentration maps for the years 2021–2024. Although we report the estimated health impacts of O_3 in every OBC, O_3 pollution concentrations are only reported where the pollutant is monitored by the Washington Network.

[128] Washington State Office of Financial Management, Estimates of April 1 population by age, sex, race and Hispanic origin https://ofm.wa.gov/data-research/population-demographics/estimates/age-sex-race-and-hispanic-origin/

[129] Housing and Urban Development Office of Policy Development and Research, USPS ZIP Code Crosswalk Files https://www.huduser.gov/portal/datasets/usps_crosswalk.html

WA-Fuse generates gridded concentration maps of daily $PM_{2.5}$ average and the daily 8-hr maximum O_3 at the spatial resolution of 5 km x 5 km. To generate daily and annual mean $PM_{2.5}$ and O_3 at the census tract level for 2022–2023, we used a population-weighted approach based on 2020 census block populations. $PM_{2.5}$ and O_3 values from WA-Fuse grid cells were assigned to each block by matching the block centroid to the nearest grid cell, excluding days with $PM_{2.5}$ above 35.4 µg/m³. Population values were then used to weigh each block's $PM_{2.5}$ and O_3 contribution when aggregating to the tract level, ensuring that more populous areas had a greater influence on the estimates.

Yearly and daily health impact analyses were calculated by comparing baseline air quality data to the natural background $PM_{2.5}$ concentration level at Cheeka Peak, Washington. For the yearly analyses, the 2022–2023 annual mean (i.e., $PM_{2.5}$: 2.24 µg/m³) and seasonal mean (i.e., O_3: 28.77 ppb) at the Cheeka Peak monitoring site were used to represent the natural background level of $PM_{2.5}$ and O_3 without sources of air pollution from human activity. The annual and seasonal baseline air quality data included in this analysis is 2022–2023 WA-Fuse derived $PM_{2.5}$ and O_3 data, respectively, at the census tract level. For the daily analyses, the 2022–2023 daily means at the Cheeka Peak monitoring site were used to represent the natural background level of $PM_{2.5}$ and O_3 (May-September). The daily baseline air quality data are derived from WA-Fuse during 2022-2023.

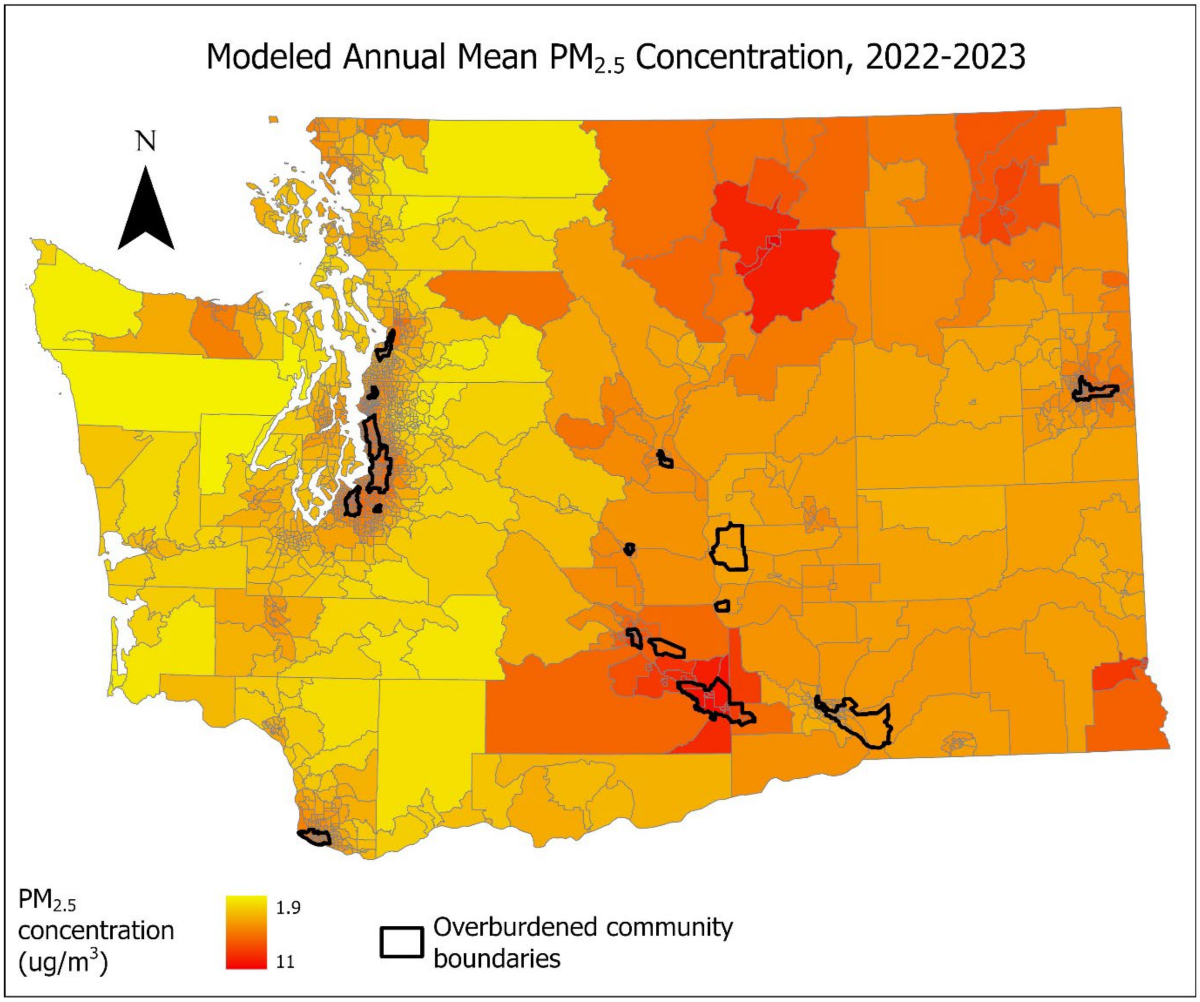

Figure 5. Census tract-level $PM_{2.5}$ concentrations based on the WA-Fuse modeled data during 2022-2023. Wildfire days exceeding 35.4 µg/m^3 have been removed. Annual mean $PM_{2.5}$ NAAQS concentration is 9.0 µg/m^3.

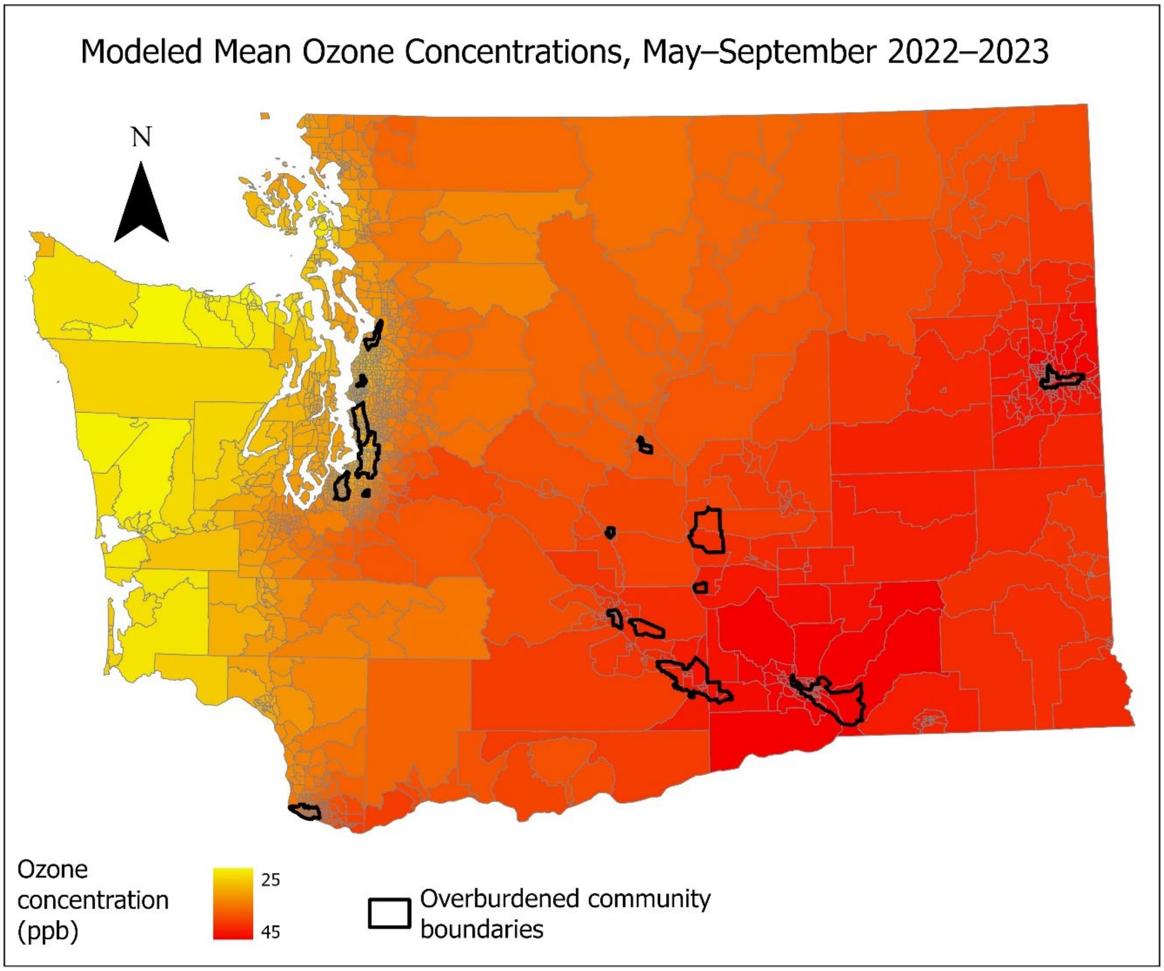

Figure 6. Census tract-level O_3 concentrations based on the WA-fuse model during 2022-2023. O_3 NAAQS concentration is 70 ppb.

Health impact functions

We identified specific health outcomes to include in our health impacts assessment in the scientific literature based on the following criteria: 1) whether there is evidence to support a causal relationship between the health outcome and $PM_{2.5}$ or O_3 in the scientific literature, 2) whether the necessary state-level health data on that outcome was available, and 3) if the scientific literature provides appropriate estimates of the amount of excess risk for that outcome associated with ambient $PM_{2.5}$ or O_3 concentrations.

We applied these criteria to the health impact functions that are preloaded by EPA and available to use in BenMAP-CE as well as carried out our own literature review to identify other relevant studies published since the latest version of BenMAP-CE was published (2020). Our literature review focused on studies published between January 2020 and April 2024 that focused on national population-based data or populations, studies carried out in Washington, or surrounding states or regions (Oregon, Northern California, Idaho). Studies that we identified were reviewed and scored by two epidemiologists for risk of bias. The PubMed literature search strategy and risk of bias scoring tool that we used are provided in Texts D1 and D2 in the Appendix.

In Appendix D, Tables D2 and D3 show the specific health outcomes that were included in our analysis of $PM_{2.5}$ based on these criteria, and Tables D4 and D5 show the specific health outcomes that were included in our analysis of O_3 based on these criteria.

Crude and age-adjusted mortality and morbidity

Using the specified health impact functions in BenMAP-CE, we estimated the annual number of deaths, hospitalizations, ED visits, and lung cancer diagnoses in Washington associated with the difference in baseline pollutant concentrations ($PM_{2.5}$ or O_3) for each of the identified overburdened communities highly impacted by air pollution (OBCs) and the natural background $PM_{2.5}$ concentration (measured at the Cheeka Peak control monitoring site) with respective 95% confidence intervals (CI). In other words, our estimates indicate the numbers of excess health outcomes that are related to the $PM_{2.5}$ or O_3 concentrations in each community. It is important to note that the underlying studies that drive our models were not designed to estimate causal relationships between pollutants and health outcomes; therefore, it cannot be said that the numbers of health outcomes we report are directly caused by $PM_{2.5}$ or O_3. Using these estimates and population estimates from WA OFM, we calculated crude rates for all OBCs combined and each individual OBC. CIs are proportional to population sizes reflecting higher uncertainty when estimating effects with smaller numbers of people. CIs that include 0 indicate that it is plausible that no deaths are associated with $PM_{2.5}$ in this group in this community.

Because mortality and morbidity risks increase with age, and age distributions vary across communities and demographic subgroups, we adjusted the crude mortality and morbidity rates for age to allow for direct comparison across groups. Age-adjusted rates were calculated by using the 2023 Washington age distribution as the standard population. For each 10-year age group (e.g., 20–29-year-olds, 30–39-year-olds), we multiplied the crude rate by the state population for that age group to determine the expected number of conditions statewide. The numbers of expected conditions were summed across age groups and divided by the statewide population for the included age range for each health outcome to determine the age-adjusted rate. We used BenMAP-CE to analyze race- and ethnicity-stratified mortality rates due to any cause separately, then averaged the point estimates from the model outputs to present the final estimates.

Greenhouse gas emissions

For the 2025 reporting period, we included greenhouse gas emission totals from reporting facilities and estimates from mobile sources.

Facilities

Washington's Greenhouse Gas Reporting Program requires entities that produce over 10,000 metric tons of carbon dioxide equivalent (MT CO_2e) per year to report their greenhouse gas emissions annually.[130] Entities are required to continue to report their greenhouse gas emissions unless they emit less than 10,000 MT CO_2e per year for five consecutive years, as required by WAC 173-441-030(6).[131] The CCA builds upon this existing greenhouse gas reporting framework and also has its own specific reporting requirements. With some exceptions, an entity is covered by the CCA if it emits more than 25,000 MT CO_2e annually. Entities have a compliance obligation to report their greenhouse gas emissions for a full compliance period of four years, even if they report below 25,000 MT CO_2e in a calendar year.

Emissions that are reported use the Intergovernmental Panel on Climate Change (IPCC)[132] Fourth Assessment Report (AR4) Global Warming Potentials (GWPs) to convert greenhouse gas emissions into CO_2e. Each gas has a GWP, which describes how much heat it traps in the atmosphere relative to CO_2 over a specific time horizon (20, 100, or 500 years). The IPCC published AR4 GWPs in 2007. The Greenhouse Gas Reporting Program uses AR4 GWPs mainly for regulatory stability, consistency, and alignment with other federal programs.

Information from the Greenhouse Gas Reporting Program is used to understand the amount and sources of carbon pollution in Washington. The reporting program allows the Department of Ecology to track emissions and reductions over time, and to also support the Cap-and-Invest Program.

The reporting facilities include many industrial sectors[133]:

- Chemicals
- Food Production
- Government
- Healthcare
- Livestock – cattle feedlots
- Manufacturing
- Metals
- Minerals
- Natural Gas Systems
- Petroleum Systems

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[130] WA Department of Ecology, Mandatory greenhouse gas reports https://ecology.wa.gov/air-climate/reducing-greenhouse-gas-emissions/tracking-greenhouse-gases/mandatory-greenhouse-gas-reports
[131] Reporting of Emissions of Greenhouse Gases, Applicability, WAC 173-441-030 https://app.leg.wa.gov/WAC/default.aspx?cite=173-441-030
[132] Intergovernmental Panel on Climate Change https://www.ipcc.ch/
[133] Greenhouse gas reporting program, Pie by sector chart https://data.wa.gov/Natural-Resources-Environment/GHG-Reporting-Program-Pie-by-Sector/9zij-tfi5

- Power Plants
- Pulp and Paper
- Waste – landfills
- Wood Products

Some sectors do not have a stationary location that can be identified on a map (x, y coordinates), some report statewide totals that cannot be disaggregated, and certain entities import liquid fuels and therefore report emissions generated outside the state. These emissions were excluded from greenhouse gas facility totals in overburdened communities highly impacted by air pollution (OBCs), but still contribute to overall statewide greenhouse gas emissions. They include:

- Bulk power transmission and distribution – provides electricity statewide and emissions (fluorinated greenhouse gas) are counted as a statewide total
- Electric power distribution marketers
- Imported liquid fuels – fossil fuels imported from out of state
- Fuel suppliers – natural gas and petroleum supplied statewide for wholesale and retail
- Natural gas distribution – leaks from pipelines that locally distribute natural gas, emissions are counted as a statewide total

Facility sector greenhouse gas emissions that are exempt from coverage under the CCA but are required to report greenhouse gas emissions:

- Landfills – Washington established a landfill-specific methane-reduction program adopted by Ecology under Chapter 173-408 WAC[134] in 2024
- Coal plants – exempt in statute RCW 70A.65.080(7)(c)[135]
- National security – military bases
- Hanford Nuclear Waste Site
- Cattle feedlots – exemptions for covered greenhouse gas emissions regarding agriculture equipment and manure management, but can voluntarily report emissions.

Using Esri[136] Geographic Information Systems (GIS), we spatially determined the location of greenhouse gas reporting facilities within OBCs. Facilities within a three-mile radius of the community boundary were also included and are described as “nearby”, consistent with the

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[134] Landfill Methane Emissions, Chapter 173-408 WAC https://ecology.wa.gov/regulations-permits/laws-rules-rulemaking/closed-rulemaking/wac-173-408

[135] Greenhouse gas emissions-Cap and Invest Program, Program coverage, Chapter 70A.65 RCW https://app.leg.wa.gov/RCW/default.aspx?cite=70A.65.080

[136] Esri ArcGIS https://www.esri.com/en-us/home

reporting process used in the 2023 EJ Report. We utilized 2022 and 2023 reported data from the Greenhouse Gas Reporting Program.[137]

Many of the greenhouse gas reporting facilities also emit criteria air pollutants. Air pollution is not constrained by community boundaries, which is why facilities within a three-mile radius of the community boundaries were included in this report. The choice of using a three-mile radius is not in statutory language, but rather used as a screening distance to capture near-community area around sources of air pollution. Other examples like the Colorado Department of Public Health and Environment's Air Toxic Act[138] and California Air Resources Board Community Health Protection Program[139] consider distance buffers in their policies. Furthermore, the Code of Federal Regulations (CFR)[140] and EPA's "Quality Assurance Handbook for Air Pollution Measurement Systems"[141] define spatial scales for network design criteria for ambient air quality monitoring.

[137] WA Department of Ecology, Washington State Greenhouse Gas Reporting Program https://ecology.wa.gov/air-climate/reducing-greenhouse-gas-emissions/tracking-greenhouse-gases/mandatory-greenhouse-gas-reports

[138] Air Toxics Act, Colorado Department of Public Health and Environment https://cdphe.colorado.gov/air-toxics-act

[139] California Air Resources Board (CARB) AB 617, Community Health Protection Program https://www.baaqmd.gov/community-health/community-health-protection-program

[140] Network Design Criteria for Ambient Air Quality Monitoring, 40 C.F.R. Appendix D to Part 58 (2025) https://www.ecfr.gov/current/title-40/chapter-I/subchapter-C/part-58/appendixAppendix%20D%20to%20Part%2058

[141] EPA Quality Assurance Handbook for Air Pollution Measurement Systems Volume II Ambient Air Quality Monitoring Program, 6.1 Monitoring Objectives and Spatial Scales, Jan 2017 https://www.epa.gov/sites/default/files/2020-10/documents/final_handbook_document_1_17.pdf

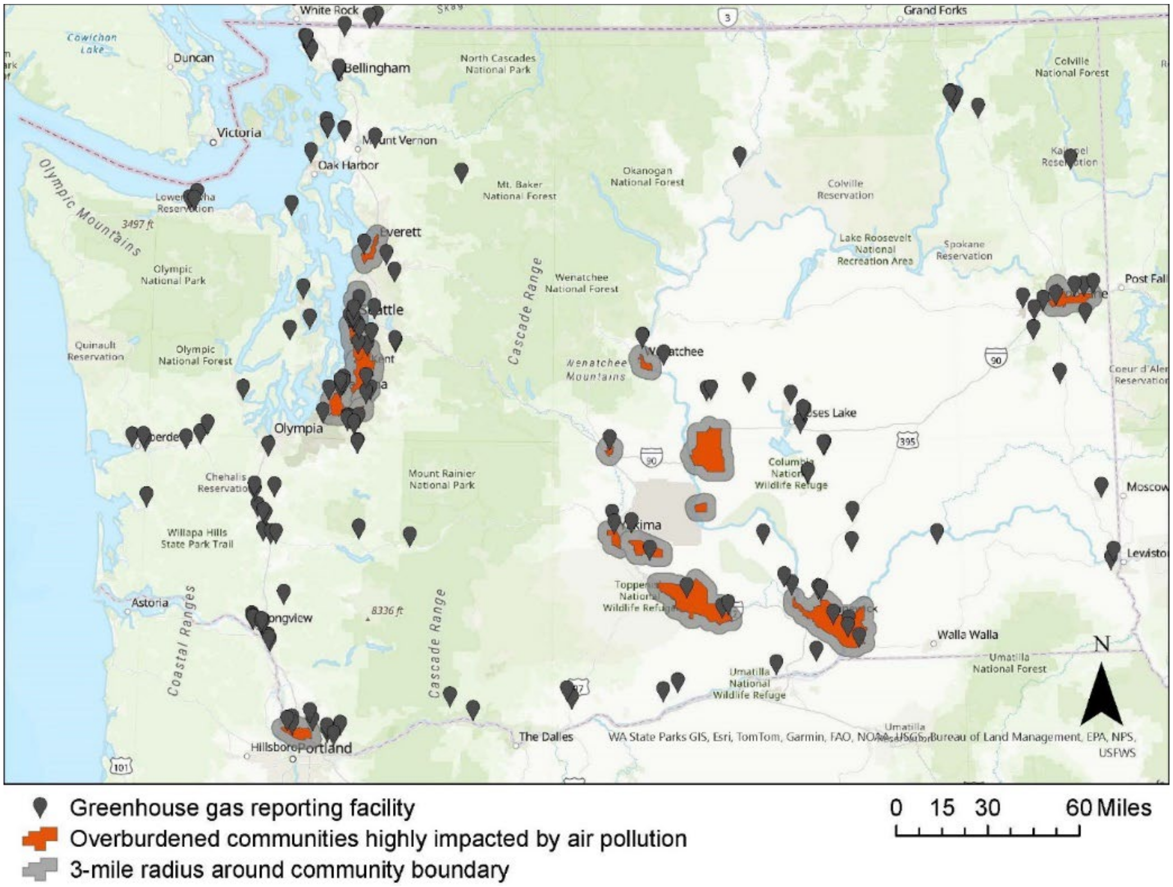

Figure 7. Statewide greenhouse gas reporting facilities, 2023.

Mobile sources

Greenhouse gas emissions from on-road and non-road mobile sources were estimated by using existing data from EPA's National Emissions Inventory (NEI), Washington's statewide greenhouse gas emissions inventory, and census population data.

We provided greenhouse gas emissions estimates for mobile sources using the following data sources:

- The 2020 EPA National Emissions Inventory (NEI)[142] published every three years, which uses EPA's Motor Vehicle Emission Simulator (MOVES) and other tools that report activity for ships, trains, and airplanes. The NEI uses process-based emissions calculators that rely on local fuel, fleet, and travel information for mobile source estimates.

[142] U.S. EPA, 2020 National Emissions Inventory (NEI) Data https://www.epa.gov/air-emissions-inventories/2020-national-emissions-inventory-nei-data

- The Washington State Greenhouse Gas Emissions Inventory: 1990-2021[143], which relies on the EPA's State Inventory Tool (SIT)[144] to estimate emissions for the transportation sector.
- The 2020 Washington Census for county and block group populations[145]

To estimate greenhouse gas emissions from mobile sources, we began by finding the ratio of county to state emissions from mobile sources for each county from EPA's 2020 NEI. We then apportioned the total statewide emissions from the transportation sector in 2020 and 2021 from the Washington State Greenhouse Gas Emissions Inventory to counties using these ratios, as shown below:

> County emissions (MT CO_2e) = (County mobile emissions from NEI ÷ Statewide mobile emissions from NEI) x Statewide transportation emissions total from WA Greenhouse Gas Emissions Inventory

Next, we allocated the county-level estimates of greenhouse gas emissions from mobile sources to the overburdened communities highly impacted by air pollution using population data from the 2020 Census. We then found the emissions per capita in each community, as shown below:

> Community emissions (MT CO_2e) = (County emissions ÷ County population) × Community population

> Community emissions per capita (MT CO_2e/capita) = Community emissions ÷ Community population

The results use the IPCC's Fifth Assessment Report (AR5)[146] GWPs to convert greenhouse gas emissions into CO_2e. The gases included in this conversion are carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O). The IPCC published AR5 GWPs in 2013-2014 and AR6 GWPs in 2021-2022. The Washington Greenhouse Gas Emissions Inventory uses AR5 GWPs in mobile source emission estimates, as its greenhouse gas accounting models are updated periodically as science improves.

Listening sessions

In June 2025, the Departments of Ecology and Health jointly conducted four pilot listening sessions to gather community perspectives, inform this report, and improve future engagement and reporting processes.

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[143] Washington State Department of Ecology, Greenhouse Gas Inventories https://ecology.wa.gov/air-climate/reducing-greenhouse-gas-emissions/tracking-greenhouse-gases/ghg-inventories
[144] U.S. EPA, State Inventory and Projection Tool https://www.epa.gov/statelocalenergy/state-inventory-and-projection-tool
[145] Washington State Office of Financial Management, 2020 Census https://ofm.wa.gov/washington-data-research/population-demographics/decennial-census/2020-census, https://ofm.wa.gov/washington-data-research/population-demographics/gis-data/census-geographic-files
[146] Intergovernmental Panel on Climate Change https://www.ipcc.ch/

Methodology development

Ecology and DOH staff reviewed existing listening session protocols for other state agencies and conducted a literature review of methodologies for governments conducting community-based participatory research. Agency staff also attended multiple listening sessions led by the Department of Health and the University of Washington to identify best practices when hosting these types of sessions. This informed the development of a Listening Session Discussion Guide, which outlined:

- Script describing listening sessions and their purpose
- Informed consent explanation and form
- Information management and retention
- Questions for participants
- Evaluation forms

Planning and implementation of listening sessions

For the pilot listening sessions, our team chose to invite local public health and community partners that have existing relationships with the Departments of Health and Ecology. We held two online sessions for staff of local health jurisdictions (LHJs) in various roles related to their agencies' work on environmental health, community outreach, or health promotion. The two in-person listening sessions were geared towards community members who live or work in two overburdened communities highly impacted by air pollution in Central and Western Washington, specifically South Seattle and the Lower Yakima Valley. Community participants were invited to these two in-person sessions by local leaders involved with environmental justice organizations.

The project team conducted the following four pilot listening sessions in 2025:

- June 23rd and 24th: Virtual listening sessions with staff from each of the 11 LHJs that serve the 16 identified communities (15 participants)
- June 24th: In-person listening session in Burien in partnership with the Duwamish Valley Sustainability Alliance, a local community-based organization (22 participants)
- June 26th: In-person listening session in Sunnyside with farm workers (16 participants)

Each of these four sessions featured a facilitated discussion about pollutants of concern, health impacts, vulnerable groups, available resources to protect residents, communication channels, and community priorities.

For the virtual listening sessions, we invited staff from the 11 LHJs that work in each of the 16 identified communities to participate. These sessions were held online, due to feasibility, accessibility, and familiarity with virtual platforms among the participants. Online sessions were conducted in English since no participants expressed a need for a translation.

Staff from the following agencies participated:

- Benton-Franklin Health District
- Chelan-Douglas Health District
- Clark County Public Health
- Grant County Health District
- Kittitas County Public Health Department
- Public Health-Seattle/King County
- Spokane Regional Health District
- Snohomish County Health Department
- Tacoma-Pierce County Health Department
- Walla Walla County Department of Community Health
- Yakima Health District

The in-person listening sessions were hosted entirely in Spanish. All materials, including the consent and feedback forms, presentation, and discussion questions, were translated into Spanish. The in-person events were also hosted in locations recommended by the partnering community leaders.

All four pilot listening sessions followed the same format First, ECY and DOH staff shared a 10-minute presentation on air quality, health, and Washington's environmental justice work under the Climate Commitment Act, followed by information about the purpose of the listening session and the intended uses of the information shared by participants. Then, the consent form was explained to participants, who were invited to ask questions about the form before voluntarily signing.

Once consent forms were signed, the facilitators guided participants through community agreements to ensure respectful and engaged participation. When there were more than eight total participants, facilitators divided participants into two groups for the discussion. In each group, facilitators asked the same eight questions, including the following:

"What do you think contributes to poor air quality in your community? What types of pollution are you or your community most concerned about?"

"What information about greenhouse gas emissions, criteria air pollutants, and health impacts from air pollution would help protect your community?"

After participants had the opportunity to respond to the questions, breakout groups rejoined to share and reflect on the key takeaways from discussions. Finally, participants were invited to fill out an evaluation form to provide recommendations for improving future listening sessions.

Facilitators followed the discussion guide questions but had the opportunity to ask follow-up questions not included in the guide to clarify or expand on each topic. Notetakers recorded observations and abbreviated statements. Recordings, transcripts, and notes were taken anonymously to protect participant's privacy. Notes and transcripts recorded in Spanish were translated to English by a bilingual DOH staff member.

Information analysis

Two project staff independently reviewed the notes and transcripts from each listening session. Key themes, comments, and specific ideas were identified from each transcript. This information is incorporated into the statewide results in this document as well as the South Seattle and Lower Yakima Valley Community Reports. Information gathered during the listening sessions is being used to inform the dissemination strategy of this report. Further, the Department of Ecology is referring to the participants' concerns regarding air quality and health when planning the analysis for the 2027 EJ Report.

Lived experience compensation

Ecology's Office of Equity and Environmental Justice recently introduced Lived Experience Compensation (LEC), a form of compensation for community members who directly contribute to a state agency's work. Participants who were not otherwise compensated for participation in listening sessions and had direct lived experience with air quality and its resultant health impacts were compensated for their participation. Each in-person participant received a one-time gift card for $100 after the end of the session.

Statewide Results

Demographic data

The demographic results are reported for Washington, each overburdened community highly impacted by air pollution (OBC), and the aggregate of all census blocks fully or partially included in OBC boundaries. There are two times as many Black and Native Hawaiian/Pacific Islander residents in OBCs as compared to statewide averages (Figure 9). A third of residents in OBCs speak a language other than English at home, compared to 22% of all Washington residents. The proportion of residents who do not have health care coverage is higher in OBCs (10%) than the statewide average (6%).

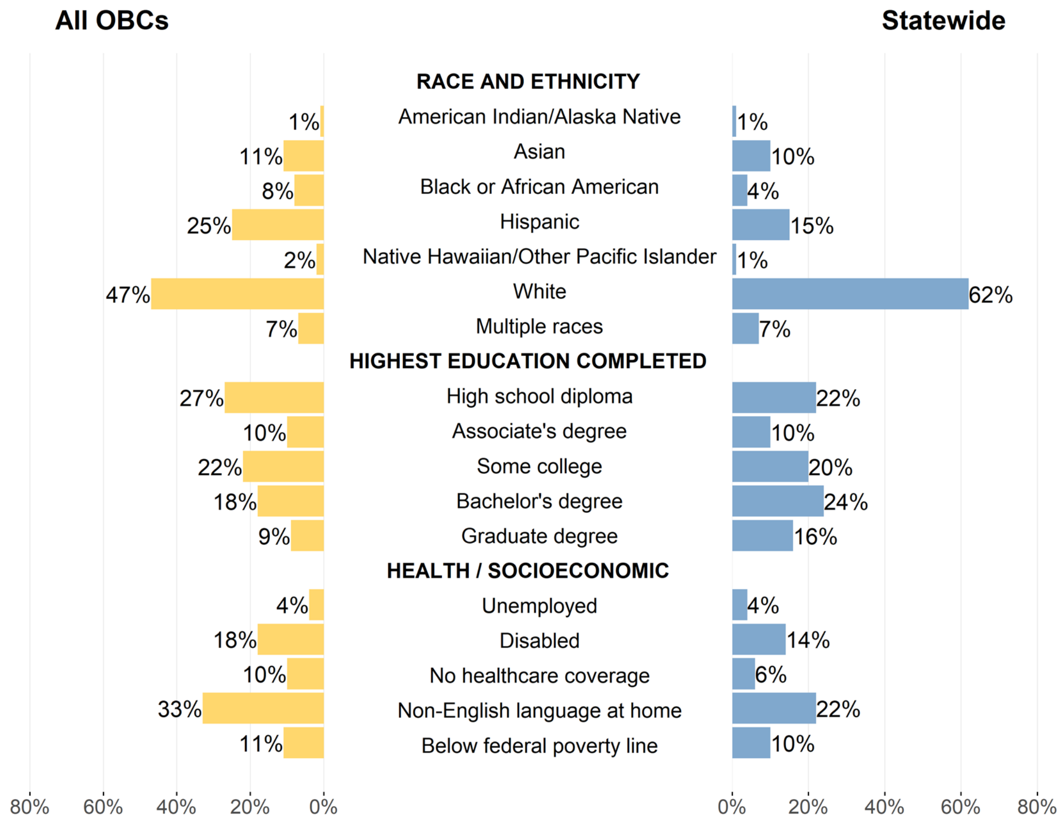

Figure 8. Statewide proportions compared to all census tracts fully or partially identified as overburdened communities highly impacted by air pollution.

Race and ethnicity estimates are from the Washington State Office of Financial Management, 2023. Education, health, and socioeconomic estimates are from the 2023 American Community Survey. Washington's population was 8,035,700 in 2024.[147]

Criteria air pollution

Fine particulate matter ($PM_{2.5}$) contributes to the greatest number of elevated AQI days per year. In 2022-2024, most days on which the AQI exceeded 101 (the minimum threshold for the "Unhealthy for Sensitive Groups" category) occurred during wildfire events. Due to these events, some monitors across Washington reported concentrations above the $PM_{2.5}$ and PM_{10} NAAQS threshold. On average, there were fewer days with unhealthy air quality between 2022-2024 compared to 2020-2022 (Table 5).

[147] WA Office of Financial Management, Nov 2024 Data Tables, Population by age and sex https://ofm.wa.gov/wp-content/uploads/sites/default/files/public/dataresearch/pop/stfc/stfc_2024.xlsx

Table 5*.* Average maximum number of days with unhealthy air quality in overburdened communities, 2022-2024. Days impacted by wildfire smoke are included in this calculation.

Community Name	**Pollutant of concern**	**Avg. annual days with unhealthy air quality (2020-2022)**	**Avg. annual days with unhealthy air quality (2022-2024)***
Spokane and Spokane Valley	$PM_{2.5}$ 24-hour; $PM_{2.5}$ annual; Cumulative criteria air pollution	7.3	3.7
Tri-Cities to Wallula	O_3; $PM_{2.5}$ 24-hour; PM_{10}; Cumulative criteria air pollution	8.3	2.3
East Yakima	$PM_{2.5}$ 24-hour; $PM_{2.5}$ annual; Cumulative criteria air pollution	11	2.7
Lower Yakima Valley	$PM_{2.5}$ 24-hour; $PM_{2.5}$ annual; Cumulative criteria air pollution	10.7	4
Moxee Valley	$PM_{2.5}$ 24-hour; Cumulative criteria air pollution	DNC	2
George and West Grant County	$PM_{2.5}$ 24-hour	DNC	2
Mattawa	$PM_{2.5}$ 24-hour	DNC	2
Ellensburg	$PM_{2.5}$ 24-hour; Cumulative criteria air pollution	5.7	3
Wenatchee and East Wenatchee	$PM_{2.5}$ 24-hour	12	8.3
Everett	$PM_{2.5}$ 24-hour	5.7	0
North Seattle and Shoreline	$PM_{2.5}$ 24-hour; Cumulative criteria air pollution	5.3	0
South Seattle	$PM_{2.5}$ 24-hour; $PM_{2.5}$ annual; Cumulative criteria air pollution	6.7	4.7

Community Name	Pollutant of concern	Avg. annual days with unhealthy air quality (2020-2022)	Avg. annual days with unhealthy air quality (2022-2024)*
South King County	$PM_{2.5}$ 24-hour; Cumulative criteria air pollution	6.3	3.7
Northeast Puyallup	Cumulative criteria air pollution	DNC	0
South and East Tacoma	$PM_{2.5}$ 24-hour; Cumulative criteria air pollution	7	5.7
Vancouver	$PM_{2.5}$ 24-hour; Cumulative criteria air pollution	4.3	1.7

* = All available monitoring data from 2022-2024 are included in the three-year average. Partial years' data is weighted the same as a full years' data. Years for which the data was not collected were not included in the three-year average.
DNC = Data not collected

Between 2022 and 2024, air quality monitoring across Washington shows a general decline in average daily and annual $PM_{2.5}$ concentrations. When wildfire-impacted days are excluded, all overburdened communities highly impacted by air pollution (OBCs) maintained levels below the National Ambient Air Quality Standards (NAAQS) (Table 6 and 7).

Communities with longer established monitoring sites, such as Spokane and Spokane Valley, East Yakima, Lower Yakima Valley, South Seattle, South King County, South and East Tacoma, and Vancouver, show year-to-year decreases in average daily $PM_{2.5}$ values (Table 6). East Yakima and Lower Yakima Valley followed this trend, with notable decreases in annual $PM_{2.5}$ concentrations over a three-year period between 2022 to 2024 (Table 7). Western Washington communities, including South Seattle and Tacoma, experienced smaller but consistent reductions in annual $PM_{2.5}$ concentrations, reflecting fewer days impacted by wildfire smoke than in eastern regions (Table 7).

A second clear pattern is the effect of wildfire smoke on annual summary statistics for 24-hour $PM_{2.5}$, particularly in Central and Eastern Washington (Table 6). Communities such as Spokane and Spokane Valley, and Lower Yakima Valley showed 8–15% reductions in average daily $PM_{2.5}$ values when wildfire smoke days were excluded (Table 6). In contrast, Western Washington communities exhibited smaller differences (4-8%) when including and excluding wildfire days, reflecting less impact from wildfire smoke. The Wenatchee-Fifth St $PM_{2.5}$ monitor in the Wenatchee and East Wenatchee community exceeded the NAAQS threshold of 35 $\mu g/m^3$ for the 2022-2024 period due to a significant wildfire smoke contribution in 2022. The George

$PM_{2.5}$ monitor in the George and West Grant County community exceeded the NAAQS threshold in 2023 due to wildfire smoke. Otherwise, no other monitors reported data that exceeded the NAAQS threshold.

Communities with monitors installed in 2024, including Moxee Valley, Wenatchee and East Wenatchee, North Seattle and Shoreline, Everett, and Northeast Puyallup, report relatively low ambient daily $PM_{2.5}$ levels, generally between 14 and 26 $\mu g/m^3$. These concentrations are in attainment with the NAAQS.

These $PM_{2.5}$ levels provide the foundation of a trend that will be analyzed through subsequent publications of the EJ Report. Concentrations of other criteria air pollutants that are monitored in some OBCs – including PM_{10}, O_3, NO_2, SO_2 and CO – were consistently below the NAAQS thresholds from 2022-2024. Currently, there is not sufficient data available to establish a trend, as many of the monitors are newly installed and policy stemming from the Climate Commitment Act is still being implemented. More information on individual communities can be found in the Community Reports of this publication.

Table 6. *24-hour $PM_{2.5}$ (98th percentile) summary statistics and 2024 design values (µg/m³) in overburdened communities highly impacted by air pollution, 2022-2024. Summary statistics in brackets [ ] exclude wildfire-impacted days when the average $PM_{2.5}$ concentration exceeded 35.4 µg/m³. 24-hour $PM_{2.5}$ (98th percentile) NAAQS is 35 µg/m³.*

Community Name	Monitoring Site	2022 24-hour 98th Percentile	2023 24-hour 98th Percentile	2024 24-hour 98th Percentile	2024 Design Value
Spokane and Spokane Valley	Spokane-Augusta Ave	33.3 [28.1]	*24.3 [23.1]*	21.2 [21.2]	*26 [24]*
	Spokane-E Broadway Ave	29.7 [25.4]	24.7 [21.0]	21.4 [21.4]	25 [23]
	Spokane-E Garland Ave	DNC	DNC	*22.7 [22.7]*	*
	Spokane-E Joseph Ave	DNC	DNC	*24.4 [24.4]*	*
	Spokane-E Sprague Ave	DNC	DNC	*23.6 [23.6]*	*
	Spokane-E Stonewall Ave	DNC	DNC	*19.7 [19.7]*	*
	Spokane-N Howard St	DNC	DNC	*28.8 [28.8]*	*
	Spokane-N Perry St	DNC	DNC	*26.5 [26.5]*	*
	Spokane-S Pittsburg St	DNC	DNC	*18.1 [18.1]*	*
	Spokane Valley-E Buckeye Ave	DNC	DNC	*20.6 [20.6]*	*
	Spokane Valley-E Wellesley Ave	DNC	DNC	*18.3 [18.3]*	*
	Spokane Valley-N Pines Rd	DNC	DNC	*22.4 [22.4]*	*

Community Name	Monitoring Site	2022 24-hour 98th Percentile	2023 24-hour 98th Percentile	2024 24-hour 98th Percentile	2024 Design Value
Tri-cities to Wallula	Kennewick-Metaline	17.1 [15.9]	*16.1* [14.8*]*	15.5 [15.5]	16 [15]
	Burbank-Maple St	DNC	*15.0 [14.7]*	19.8 [19.8]	*17 [17]*
	Finley-S Finley Rd	DNC	DNC	*20.0 [20.0]*	*
East Yakima	Yakima-4th Ave	29.4 [29.0]	25.4 [23.0]	26.4 [22.1]	27 [25]
Lower Yakima Valley	Prosser-Highland Dr	*21.7 [21.7]*	20.1 [16.8]	*23.7 [23.1]*	*22 [21]*
	Sunnyside-S 16th St	34.4 [32.3]	*29.5 [20.1]*	25.2 [24.6]	*30 [26]*
Moxee Valley	Moxee-E Seattle Ave	DNC	DNC	*26.1 [23.2]*	*
Mattawa	Mattawa-Wahluke High School	DNC	18.3 [15.9]	13.8 [13.8]	*
George and West Grant County	George	DNC	*105.5 [18.0]*	15.1 [15.1]	*
Ellensburg	Ellensburg-Ruby St	25.1 [24.5]	18.4 [17.0]	14.7 [14.7]	19 [19]
	Ellensburg-Discovery Hall	DNC	DNC	*13.8 [13.8]*	*
	Ellensburg-Mountain View Ave	DNC	DNC	*11.4 [11.4]*	*
	Ellensburg-N Cora St	DNC	DNC	*15.4 [15.4]*	*

Community Name	Monitoring Site	2022 24-hour 98th Percentile	2023 24-hour 98th Percentile	2024 24-hour 98th Percentile	2024 Design Value
Wenatchee and East Wenatchee	Wenatchee-Fifth St	70.9 [21.7]	19.9 [16.8]	16.8 [16.8]	36 [18]
	Wenatchee-Methow St	DNC	DNC	*16.4 [16.4]*	*
	East Wenatchee-8th St	DNC	DNC	*15.8 [15.8]*	*
Everett	Everett-Beverly Park Rd	DNC	DNC	*13.9 [13.9]*	*
North Seattle and Shoreline	Seattle-NE 127th St	DNC	DNC	*15.2 [15.2]*	*
	Seattle-College Way N	DNC	DNC	*14.4 [14.4]*	*
South Seattle	Seattle-10th & Weller	*29.7 [27.7]*	19.1 [18.3]	15.8 [15.8]	*22 [21]*
	Seattle-Beacon Hill	27.7 [23.3]	19.4 [15.9]	12.0 [12.0]	20 [17]
	Seattle-Duwamish	27.6 [25.3]	22.7 [22.4]	16.5 [16.5]	22 [21]
	Seattle-South Park	31.1 [24.3]	20.8 [20.8]	15.7 [15.7]	23 [20]
	Tukwila-Allentown	30.5 [26.3]	24.2 [23.3]	18.7 [18.7]	24 [23]
	Seattle-16th Ave S	DNC	DNC	*14.4 [14.4]*	*
	Seattle-23rd Ave SW	DNC	DNC	*21.8 [21.8]*	*
	Seattle-S Myrtle St	DNC	DNC	*16.5 [16.5]*	*

Community Name	Monitoring Site	2022 24-hour 98th Percentile	2023 24-hour 98th Percentile	2024 24-hour 98th Percentile	2024 Design Value
South King County	Kent-James & Central	33.7 [32.7]	*16.0 [16.0]*	DNC	*25 [24]*
	Auburn-29th St	38.5 [26.2]	17.4 [17.0]	16.0 [16.0]	24 [20]
South and East Tacoma	Tacoma-S 36th St	30.7 [25.7]	21.5 [19.5]	14.9 [14.9]	22 [20]
	Tacoma-L Street	38.1 [31.0]	28.5 [27.1]	19.0 [19.0]	29 [26]
Northeast Puyallup	Puyallup-Pioneer Way E	DNC	DNC	*18.5 [18.5]*	*
Vancouver	Vancouver-NE 84th Ave	29.4 [26.4]	25.4 [24.8]	16.6 [16.6]	24 [23]

Italics indicate incomplete annual data, DNC = data not collected, NAAQS = national ambient air quality standards, PM = particulate matter, µg/m^3 = micrograms per cubic meter, * = incomplete data for 3-year design value

Table 7. *Annual mean $PM_{2.5}$ concentrations and 2024 design values (µg/m^3) in overburdened communities highly impacted by air pollution, 2022–2024. Annual means in brackets [ ] exclude wildfire-impacted days when the average $PM_{2.5}$ concentration exceeded 15.0 µg/m^3. Annual $PM_{2.5}$ NAAQS is 9.0 µg/m^3.*

Community Name	Monitoring Site	2022	2023	2024	2024 Design Value
Spokane and Spokane Valley	Spokane-Augusta Ave	8.94 [7.52]	*8.64 [7.10]*	6.88 [6.46]	*8.2 [7.0]*
	Spokane-E Broadway Ave	7.73 [6.36]	7.72 [6.29]	5.81 [5.46]	7.1 [6.1]
	Spokane-E Garland Ave	DNC	DNC	*6.09 [5.56]*	*
	Spokane-E Joseph Ave	DNC	DNC	*5.98 [5.49]*	*
	Spokane-E Sprague Ave	DNC	DNC	*5.21 [4.84]*	*
	Spokane-E Stonewall Ave	DNC	DNC	*5.04 [4.68]*	*
	Spokane-N Howard St	DNC	DNC	*6.92 [6.38]*	*
	Spokane-N Perry St	DNC	DNC	*8.32 [7.30]*	*
	Spokane-S Pittsburg St	DNC	DNC	*5.44 [5.09]*	*
	Spokane-Valley E Buckeye Ave	DNC	DNC	*5.34 [4.94]*	*
	Spokane-Valley E Wellesley Ave	DNC	DNC	*4.14 [3.86]*	*
	Spokane-Valley N Pines Rd	DNC	DNC	*5.49 [5.06]*	*
Tri-cities to Wallula	Kennewick-Metaline	5.55 [4.89]	6.57 [5.25]	4.43 [4.28]	5.5 [4.8]
	Burbank-Maple St	DNC	*5.62 [5.29]*	*5.23 [5.06]*	*5.4 [5.2]*
	Finley-S Finley Rd	DNC	DNC	*5.94 [5.72]*	*

Community Name	Monitoring Site	2022	2023	2024	2024 Design Value
East Yakima	Yakima-4th Ave	9.14 [8.43]	8.79 [7.78]	7.13 [6.36]	8.4 [7.5]
Lower Yakima Valley	Prosser-Highland Dr	*9.20 [9.20]*	7.32 [6.13]	*5.42 [4.70]*	*7.3 [6.7]*
	Sunnyside-S 16th St	11.18 [7.09]	*9.05 [7.25]*	6.79 [6.16]	*9.0 [6.8]*
Moxee Valley	Moxee-E Seattle Ave	DNC	DNC	*5.49 [4.57]*	*
Mattawa	Mattawa-Wahluke High School	DNC	6.21 [4.63]	3.42 [3.34]	*4.8 [4.0]*
George and West Grant County	George	DNC	*9.61 [5.93]*	3.84 [3.68]	*6.7 [4.8]*
Ellensburg	Ellensburg-Ruby St	7.07 [6.46]	6.49 [5.54]	4.70 [4.59]	6.1 [5.5]
	Ellensburg-Discovery Hall	DNC	DNC	*3.74 [3.66]*	*
	Ellensburg-Mountain View Ave	DNC	DNC	*3.46 [3.46]*	*
	Ellensburg-N Cora St	DNC	DNC	*4.05 [3.87]*	*
Wenatchee and East Wenatchee	Wenatchee-Fifth St	10.21 [6.10]	7.20 [6.21]	5.19 [5.19]	7.5 [5.8]
	Wenatchee-Methow St	DNC	DNC	*3.35 [3.18]*	*
	East Wenatchee-8th St NE	DNC	DNC	*3.72 [3.53]*	*
Everett	Everett-Beverly Park Rd	DNC	DNC	*4.30 [4.30]*	*

Community Name	Monitoring Site	2022	2023	2024	2024 Design Value
North Seattle and Shoreline	Seattle-NE 127th St	DNC	DNC	*5.50 [5.50]*	*
	Seattle-College Way N	DNC	DNC	*4.31 [4.31]*	*
South Seattle	Seattle-10th & Weller	*10.53 [7.00]*	7.86 [7.46]	6.47 [6.39]	*8.3 [7.0]*
	Seattle-Beacon Hill	7.02 [5.47]	6.02 [5.66]	4.19 [4.19]	5.7 [5.1]
	Seattle-Duwamish	8.78 [7.44]	7.75 [7.39]	6.47 [6.42]	7.7 [7.1]
	Seattle-South Park	9.52 [7.72]	8.15 [7.80]	7.18 [7.13]	8.3 [7.5]
	Tukwila-Allentown	8.11 [6.55]	7.51 [7.17]	6.84 [6.79]	7.5 [6.8]
	Seattle-16th Ave S	DNC	DNC	*4.59 [4.59]*	*
	Seattle-23rd Ave SW	DNC	DNC	*7.05 [7.05]*	*
	Seattle-S Myrtle St	DNC	DNC	*4.58 [4.58]*	*
South King County	Kent-James & Central	9.25 [8.97]	*7.36 [7.36]*	DNC	*8.3 [8.2]*
	Auburn-29th St	8.88 [6.86]	6.93 [6.38]	5.99 [5.92]	7.3 [6.4]
South and East Tacoma	Tacoma-S 36th St	8.34 [6.93]	6.43 [6.14]	4.71 [4.71]	6.5 [5.9]
	Tacoma-L Street	8.70 [7.23]	7.18 [6.89]	5.11 [5.07]	7.0 [6.4]
Northeast Puyallup	Puyallup-Pioneer Way E	DNC	DNC	*8.06 [8.06]*	*

Community Name	Monitoring Site	2022	2023	2024	2024 Design Value
Vancouver	Vancouver-NE 84th Ave	7.70 [6.88]	6.40 [6.22]	4.45 [4.35]	6.2 [5.8]

Italics indicate incomplete annual data, DNC = data not collected, NAAQS = national ambient air quality standards, PM = particulate matter, μg/m^3 = micrograms per cubic meter, * = incomplete data for 3-year design value

Health impacts

$PM_{2.5}$

Yearly exposure

Among all 16 overburdened communities highly impacted by air pollution (OBCs), we estimated 430 deaths by any cause among adults 18-84 years old (42 deaths per 100,000 population) associated with annual $PM_{2.5}$ exposure per year (Table 8). Among older adults ages 65–99 years old, we estimated 261 total deaths (137 deaths per 100,000) each year associated with annual $PM_{2.5}$ exposure (Table 9).

The communities with the highest estimated number of deaths per population associated with yearly $PM_{2.5}$ exposure among 18–84-year-olds were:

- East Yakima: 78 deaths per 100,000 population
- Lower Yakima Valley: 56 deaths per 100,000 population
- Spokane and Spokane Valley: 56 deaths per 100,000 population

Complete findings on health impacts of $PM_{2.5}$ in specific communities can be found in their respective Community Reports (Appendix E).

Age-adjusted rates are the most appropriate comparison to statewide rates given that they are standardized to match the statewide age distribution. Figure 9 shows the unadjusted and age-adjusted mortality rates by any cause associated with yearly $PM_{2.5}$ exposure among adults ages 18-84 years old in OBCs compared to statewide. We estimated the age-adjusted rate for OBCs to be 48 [95% CI: 35-61] deaths per 100,000 population compared to 27 [95% CI: 19-34] deaths per 100,000 population statewide (Figure 9).

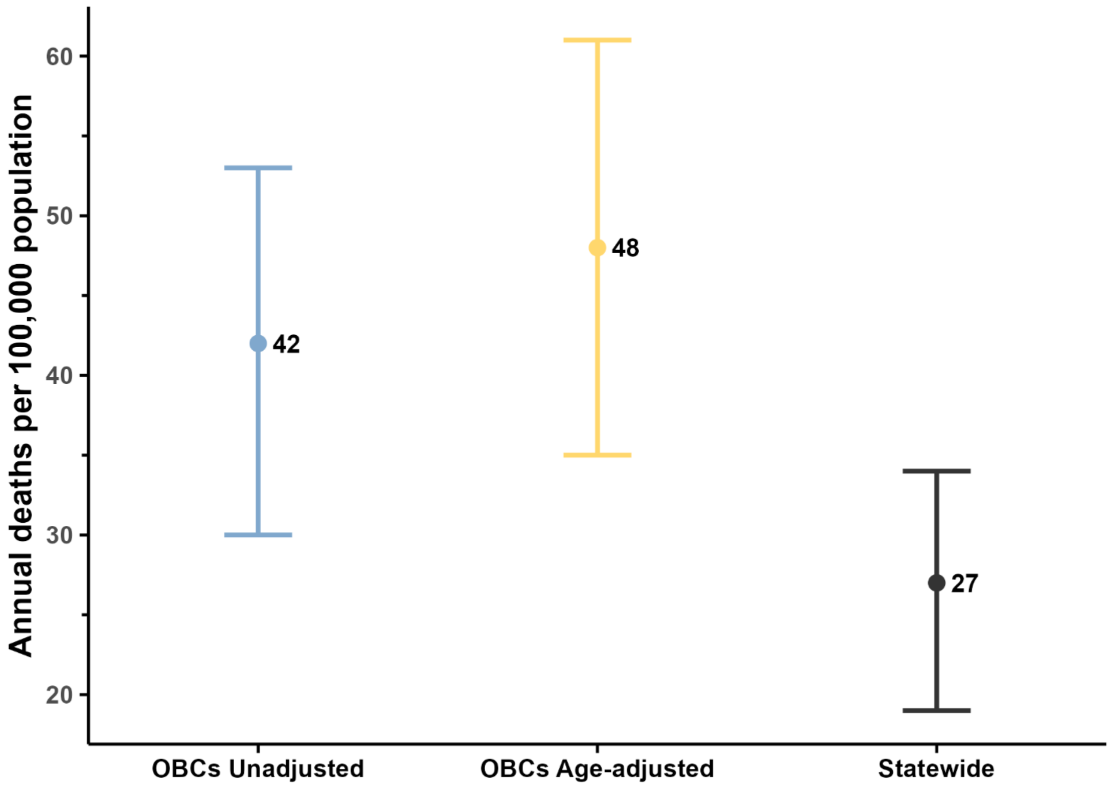

Figure 9. Unadjusted and adjusted $PM_{2.5}$ associated annual, mortality rates by any cause for all 16 overburdened communities highly impacted by air pollution compared to the statewide average based on the study of Pope et al., 2019[148], 2022-2023. Bars indicate 95% confidence intervals.

Among different racial and ethnic groups (Table 8), we estimated the highest rate of $PM_{2.5}$ related deaths by any cause per year among non-Hispanic Black people (54 annual deaths per 100,000 population) and non-Hispanic white people (53 annual deaths per 100,000 population) in the 16 OBCs. However, the annual age-adjusted mortality rate, which accounts for the ages of people in each racial and ethnic group, was highest among Hispanic people (85 deaths per 100,000 population) and non-Hispanic Black people (71 deaths per 100,000 population) (Table 8; Figure 9). The age-adjusted mortality rate for non-Hispanic white people was 49 deaths per 100,000 population. These disparities persist among older adults ages 65-99 where the highest age-adjusted mortality rates are among Black and Hispanic people at 308 and 211 deaths per 100,000 population, respectively (Table 9).

[148] Pope, C. A., 3rd, Lefler, J. S., Ezzati, M., Higbee, J. D., Marshall, J. D., Kim, S. Y., Bechle, M., Gilliat, K. S., Vernon, S. E., Robinson, A. L., & Burnett, R. T. (2019). Mortality Risk and Fine Particulate Air Pollution in a Large, Representative Cohort of U.S. Adults. *Environmental Health Perspectives*, 127(7), 77007.

Table 8. Estimated annual deaths by any cause associated with yearly $PM_{2.5}$ exposure among 18–84-year-olds in all 16 overburdened communities highly impacted by air pollution by racial and ethnic group, 2022–2023 (based on effect estimates in study by Pope, et al., 2019).

Racial[149] and Ethnic Group	Population[150] (18-84 year-olds)	Annual Number of Deaths [95% CI][151]	Annual Deaths Per 100,000 Population [95% CI]	Age-Adjusted[152] Annual Deaths Per 100,000 Population [95% CI]
All	1,027,215	430 [310 to 544]	42 [30 to 53]	48 [35 to 61]
Hispanic	215,569	94 [53 to 132]	44 [25 to 61]	85 [48 to 119]
Non-Hispanic AIAN	10,763	5 [-3 to 11]	42 [-29 to 105]	50 [-34 to 124]
Non-Hispanic Asian	116,527	47 [-32 to 119]	40 [-28 to 102]	44 [-30 to 110]
Non-Hispanic Black	79,896	43 [13 to 71]	54 [17 to 89]	71 [22 to 116]
Non-Hispanic NHOPI	16,258	4 [-3 to 10]	25 [-17 to 63]	45 [-31 to 114]
Non-Hispanic 2+ races	57,464	17 [-11 to 42]	29 [-20 to 73]	47 [-32 to 119]
Non-Hispanic White	530,739	279 [182 to 371]	53 [34 to 70]	49 [32 to 66]

AIAN: American Indian and Alaska Native; CI: confidence interval; NHOPI: Native Hawaiian and Other Pacific Islander; $PM_{2.5}$: Particulate matter with diameter 2.5 micrometers or less

[149] Race categories only include people who identify as non-Hispanic to reflect the race categories used in the study by Pope, et al.

[150] Population is the average of the 2022 and 2023 Washington State Office of Financial Management estimates for the census tracts that comprise overburdened communities.

[151] CIs are inversely proportional to population sizes reflecting higher uncertainty when estimating effects with smaller numbers of people. CIs that include 0 indicate that it is plausible that no deaths are associated with $PM_{2.5}$ in this group in this community.

[152] The age-adjusted rate indicates the expected rate if the age distribution in overburdened communities matched that of Washington State.

Table 9. Estimated annual deaths by any cause related to yearly $PM_{2.5}$ exposure among 65–99-year-olds in all 16 overburdened communities highly impacted by air pollution by racial and ethnic group, 2022–2023 (based on effect estimates in study by Di, et al., 2017[23])23.

Racial[153] and Ethnic Group	Population[154] (65-99 year-olds)	Annual Number of Deaths [95% CI][155]	Annual Deaths Per 100,000 Population [95% CI]	Age-Adjusted[156] Annual Deaths Per 100,000 Population [95% CI]
All	190,102	261 [253 to 268]	137 [133 to 141]	134 [130 to 138]
Hispanic	15,098	29 [25 to 33]	192 [166 to 216]	211 [182 to 238]
AIAN	2,843	4 [2 to 5]	128 [79 to 175]	138 [85 to 188]
Asian	23,346	33 [26 to 40]	142 [112 to 170]	139 [110 to 167]
Black	10,679	31 [30 to 32]	290 [279 to 301]	308 [296 to 320]
NHOPI	1,315	2 [1 to 2]	135 [83 to 184]	155 [95 to 211]
2+ races	8,809	12 [7 to 16]	135 [83 to 184]	146 [90 to 199]
White	143,109	141 [136 to 146]	99 [95 to 102]	96 [92 to 99]

AIAN: American Indian and Alaska Native; CI: confidence interval; NHOPI: Native Hawaiian and Other Pacific Islander; $PM_{2.5}$: Particulate matter with diameter 2.5 micrometers or less

Figure 10 is based on the study by Pope et al. (2019)[148], where AIAN refers to American Indian and Alaska Native; NH to non-Hispanic; and NHOPI to Native Hawaiian and Other Pacific Islander. The bars indicate a 95% confidence interval (CI) for each rate.

[153] Race categories include Hispanic and non-Hispanic people to reflect the race categories used in the study by Di, et al.

[154] Population is the average of the 2022 and 2023 Washington State Office of Financial Management estimates for the census tracts that comprise overburdened communities.

[155] CIs are inversely proportional to population sizes reflecting higher uncertainty when estimating effects with smaller numbers of people. CIs that include 0 indicate that it is plausible that no deaths are associated with $PM_{2.5}$ in this group in this community.

[156] The age-adjusted rate indicates the expected rate if the age distribution in overburdened communities matched that of Washington statewide.

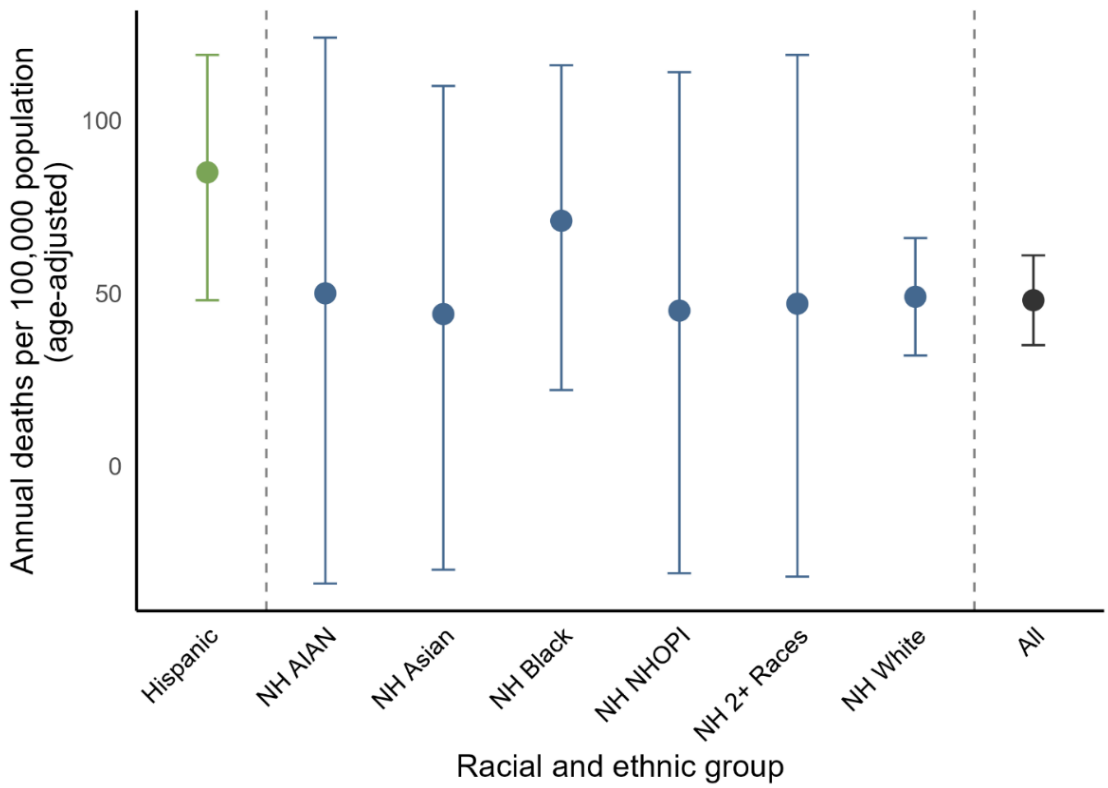

Figure 10. Age-adjusted annual death rates by any cause associated with yearly $PM_{2.5}$ exposure among ages 18-84 by racial and ethnic group in all 16 overburdened communities highly impacted by air pollution.

When assessing specific causes of death related to yearly $PM_{2.5}$ exposure (Table 10), we estimated 129 deaths due to cardiovascular disease (12 deaths per 100,000 population), 126 to 204 deaths due to ischemic heart disease (16 to 25 deaths per 100,000 population), and 21 to 31 deaths per year due to lung cancer (3 to 4 deaths per 100,000 population) among adults in OBCs. The ranges represent variability depending on the study used to develop our health impact functions.

Regarding morbidities, 195 hospital admissions (19 visits per 100,000 population) for acute myocardial infarction were estimated to be associated with yearly $PM_{2.5}$ exposure among all adults (Table 10). Additionally, 108 lung cancer diagnoses per year were associated with yearly $PM_{2.5}$ exposure among adults ages 30-99 (13 diagnoses per 100,000 population) from 2022-2023.

Table 10. Estimated annual mortality and morbidity associated with yearly $PM_{2.5}$ exposure (yearly 24-hour average concentrations) in all 16 overburdened communities highly impacted by air pollution, 2022-2023. Brackets [ ] include 95% confidence interval.

Health Outcome	Age Group	Source of Risk Estimate	Population	Estimated Annual Number [95% CI]	Estimated Annual Rate Per 100,000 Population [95% CI]	Estimated Age-Adjusted Annual Rate Per 100,000 Population [95% CI]	Estimated Statewide Annual Rate Per 100,000 Population [95% CI]
Deaths – Any cause	65 to 99	Di et al., 2017[23]	190,102	261 [253 to 268]	137 [133 to 141]	134 [130 to 138]	86 [83 to 88]
Deaths – Any cause	18 to 84	Pope et al., 2019[148]	1,027,215	430 [310 to 544]	42 [30 to 53]	48 [35 to 61]	27 [19 to 34]
Deaths – Cardiovascular disease	18 to 99	Alexeeff et al., 2023[157]	1,048,055	129 [50 to 204]	12 [5 to 19]	14 [5 to 22]	8 [3 to 13]
Deaths – Ischemic heart disease	30 to 99	Jerrett et al., 2017[158]	800,760	135 [101 to 166]	17 [13 to 21]	19 [14 to 23]	10 [8 to 13]
Deaths – Ischemic heart disease	30 to 99	Krewski et al., 2009[159]	800,760	204 [166 to 239]	25 [21 to 30]	28 [23 to 33]	16 [13 to 19]

[157] Alexeeff SED, K.Van Den Eeden, S.Schwartz, J.Liao, N. S.Sidney, S. Association of Long-term Exposure to Particulate Air Pollution with Cardiovascular Events in California. *JAMA Network Open*. 2023;6(2):e230561.
[158] Jerrett, 2017. Comparing the Health Effects of Ambient Particulate Matter Estimated Using Ground-Based Versus Remote Sensing Exposure Estimates. *Environmental Health Perspectives*. 2017 Apr;125(4):552-559. doi: 10.1289/EHP575. Epub 2016 Sep 9.
[159] Krewski D, Jerrett M, Burnett R, et al. 2009. Extended Follow-Up and Spatial analysis of the American Cancer Society Linking Particulate Air Pollution and Mortality. Health Effects Institute, Cambridge MA

Health Outcome	Age Group	Source of Risk Estimate	Population	Estimated Annual Number [95% CI]	Estimated Annual Rate Per 100,000 Population [95% CI]	Estimated Age-Adjusted Annual Rate Per 100,000 Population [95% CI]	Estimated Statewide Annual Rate Per 100,000 Population [95% CI]
Deaths – Ischemic heart disease	30 to 99	Pope et al., 2019[148]	800,760	126 [92 to 159]	16 [12 to 20]	17 [13 to 22]	10 [7 to 12]
Deaths – Lung Cancer	30 to 99	Krewski, et al., 2009[160]	800,760	31 [13 to 48]	4 [2 to 6]	4 [2 to 7]	3 [1 to 4]
Deaths – Lung Cancer	30 to 99	Turner et al. 2016[161]	800,760	21 [6 to 35]	3 [1 to 4]	3 [1 to 5]	2 [1 to 3]
Hospital Admissions – Acute Non-Fatal Myocardial Infarction	18 to 99	Alexeeff, et al.[157]	1,048,055	195 [110 to 275]	19 [10 to 26]	21 [12 to 30]	12 [7 to 17]
Lung Cancer Diagnoses	30 to 99	Gharibvand et al. 2016[162]	800,760	108 [35 to 171]	13 [4 to 21]	15 [5 to 24]	9 [3 to 15]

[160] Krewski D, Jerrett M, Burnett R, et al. 2009. Extended Follow-Up and Spatial analysis of the American Cancer Society Linking Particulate Air Pollution and Mortality. Health Effects Institute, Cambridge MA

[161] Turner, M.C., Jerrett, M., Pope, C.A., III, Krewski, D., Gapstur, S.M., Diver, W.R., Beckerman, B.S., Marshall, J.D., Su, J., Crouse, D.L., & Burnett, R.T. (2016). Long-term ozone exposure and mortality in a large prospective study. *American Journal of Respiratory Critical Care Medicine* 193(10): 1134-1142.

[162] Gharibvand, L., Shavlik, D., Ghamsary, M., Beeson, W.L., Soret, S., Knutsen, R., & Knutsen, S.F. (2016). The association between ambient fine particulate air pollution and lung cancer incidence: results from the AHSMOG-2 study. *Environmental Health Perspectives* 125 (3): 378?384

CI: confidence interval. CIs are inversely proportional to population sizes reflecting higher uncertainty when estimating effects with smaller numbers of people. CIs that include 0 indicate that it is plausible that no deaths are associated with $PM_{2.5}$ in this group in this community.

Population is the average of the 2022 and 2023 Washington State Office of Financial Management estimates for the census tracts that comprise OBCs.

Health outcomes were selected based on the availability of effect estimates for that outcome relevant to the Washington population in the scientific literature. Where multiple effect estimates exist, we listed the model results separately for each. See the Method section for more information.

Age-adjusted rate indicates the expected rate if the age distribution in OBCs matched that of Washington statewide.

Daily exposure

We estimated that daily $PM_{2.5}$ exposure was associated with 8 to 23 deaths by any cause (1 to 12 deaths per 100,000 population), 83 asthma hospital admissions (7 admissions per 100,000 population), 34 to 39 acute non-fatal myocardial infarction hospital admissions (3 to 4 admissions per 100,000 population), 319 to 599 asthma-related ED visits among all people (24 to 44 visits per 100,000 population), and 340 asthma-related ED visits among youths ages 0 to 17 years (112 visits per 100,000 population) (Table 11). Among older adults ages 65-99, daily $PM_{2.5}$ was associated with 157 hospital admissions (82 admissions per 100,000 population) for all respiratory conditions.

Table 11. Estimated annual mortality and morbidity associated with daily $PM_{2.5}$ exposure (daily 24-hour average concentrations) in all 16 overburdened communities highly impacted by air pollution, 2022-2023. Brackets [ ] include 95% confidence interval.

Health Outcome	**Age Group**	**Source of Risk Estimate**	**Population**	**Estimated Annual Number [95% CI]**	**Estimated annual rate per 100,000 population [95% CI]**	**Estimated age-adjusted annual rate per 100,000 population [95% CI]**	**Estimated statewide annual rate per 100,000 population [95% CI]**
Deaths – Any cause	0 to 99	Ito et al., 2013[163]	1,351,509	8 [0 to 16]	1 [0 to 1]	1 [0 to 1]	0 [0 to 1]
Deaths – Any cause	65 to 99	Zanobetti et al., 2014[164]	190,102	23 [15 to 31]	12 [8 to 16]	12 [8 to 16]	8 [5 to 10]
Deaths – Cardiovascular disease	0 to 99	Liu et al., 2022[165]	1,351,509	14 [3 to 25]	1 [0 to 2]	1 [0 to 2]	1 [0 to 1]
Deaths – Respiratory	0 to 99	Liu et al., 2022[165165]	1,351,509	19 [-1 to 37]	1 [0 to 3]	2 [0 to 3]	1 [0 to 2]

[163]Ito, K., Ross, Z., Zhou, J., Nádas, A., Lippmann, M. and Thurston, G.D., 2013. NPACT Study 3. Time-series analysis of mortality, hospitalizations, and ambient $PM_{2.5}$ and its components. National Particle Component Toxicity (NPACT) Initiative. https://www.healtheffects.org/publication/national-particle-component-toxicity-npact-initiative-integrated-epidemiologic-and

[164] Zanobetti, A., Dominici, F., Wang, Y. and Schwartz, J.D., 2014. A national case-crossover analysis of the short-term effect of $PM_{2.5}$ on hospitalizations and mortality in subjects with diabetes and neurological disorders. *Environmental Health*, 13(1), p.38.

[165] Liu, R.A., Wei, Y., Qiu, X., Kosheleva, A. and Schwartz, J.D., 2022. Short term exposure to air pollution and mortality in the US: a double negative control analysis. *Environmental Health*, 21(1), p.81.

Health Outcome	Age Group	Source of Risk Estimate	Population	Estimated Annual Number [95% CI]	Estimated annual rate per 100,000 population [95% CI]	Estimated age-adjusted annual rate per 100,000 population [95% CI]	Estimated statewide annual rate per 100,000 population [95% CI]
Hospital Admissions – Acute Non-Fatal Myocardial Infarction	18 to 99	Sullivan et al., 2005[166]	1,048,055	34 [-44 to 108]	3 [-4 to 10]	4 [-5 to 12]	2 [-3 to 7]
Hospital Admissions – Acute Non-Fatal Myocardial Infarction	18 to 99	Zanobetti et al., 2009[167]	1,048,055	39 [18 to 59]	4 [2 to 6]	4 [2 to 6]	2 [1 to 4]
Hospital Admissions – All Respiratory	65 to 99	Zanobetti et al., 2009[164167]	190,102	157 [89 to 221]	82 [47 to 116]	82 [46 to 115]	46 [26 to 65]

[166] Sullivan, J., L. Sheppard, A. Schreuder, N. Ishikawa, D. Siscovick and J. Kaufman. 2005. Relation between short-term fine-particulate matter exposure and onset of myocardial infarction. *Epidemiology*. Vol. 16 (1): 41-8.
[167] Zanobetti, A., Franklin, M., Koutrakis, P. and Schwartz, J., 2009. Fine particulate air pollution and its components in association with cause-specific emergency admissions. *Environmental Health*, 8(1), p.58.

Health Outcome	Age Group	Source of Risk Estimate	Population	Estimated Annual Number [95% CI]	Estimated annual rate per 100,000 population [95% CI]	Estimated age-adjusted annual rate per 100,000 population [95% CI]	Estimated statewide annual rate per 100,000 population [95% CI]
Hospital Admissions – Asthma	0 to 64	Sheppard et al., 2003[168]	1,161,407	83 [31 to 132]	7 [3 to 11]	7 [3 to 12]	4 [2 to 7]
ED Visits – Asthma	0 to 99	Mar et al., 2010[169]	1,351,509	599 [150 to 1019]	44 [11 to 75]	44 [11 to 75]	25 [6 to 42]
ED Visits – Asthma	0 to 99	Slaughter, J. C., et al., 2005[170]	1,351,509	319 [-275 to 869]	24 [-20 to 64]	24 [-20 to 64]	13 [-11 to 36]
ED Visits – Asthma	0 to 17	Norris, G., et al., 1999[171]	303,454	340 [174 to 490]	112 [57 to 162]	112 [57 to 161]	61 [31 to 88]

[168] Sheppard, L. Ambient Air Pollution and Nonelderly Asthma Hospital Admissions in Seattle, Washington, 1987-1994. In: Revised Analyses of Time-Series Studies of Air Pollution and Health. 2003, Health Effects Institute: Boston, MA. p. 227-230.
[169] Mar, T. F., J. Q. Koenig and J. Primomo. 2010. Associations between asthma emergency visits and particulate matter sources, including diesel emissions from stationary generators in Tacoma, Washington. *Inhalation Toxicology*. Vol. 22 (6): 445-8.
[170] Slaughter, J. C., E. Kim, L. Sheppard, J. H. Sullivan, T. V. Larson and C. Claiborn. 2005. Association between particulate matter and emergency room visits, hospital admissions and mortality in Spokane, Washington. *Journal of Exposure Analysis and Environmental Epidemiology*. Vol. 15
[171] Norris, G., et al. An association between fine particles and asthma emergency department visits for children in Seattle. *Environmental Health Perspectives*, 1999. 107(6): p. 489-93.

Health Outcome	Age Group	Source of Risk Estimate	Population	Estimated Annual Number [95% CI]	Estimated annual rate per 100,000 population [95% CI]	Estimated age-adjusted annual rate per 100,000 population [95% CI]	Estimated statewide annual rate per 100,000 population [95% CI]

ED: emergency department; CI: confidence interval. CIs are inversely proportional to population sizes reflecting higher uncertainty when estimating effects with smaller numbers of people. CIs that include 0 indicate that it is plausible that no deaths are associated with $PM_{2.5}$ in this group in this community.

Population is the average of the 2022 and 2023 Washington State Office of Financial Management estimates for the census tracts that comprise OBCs.

Health outcomes were selected based on the availability of effect estimates for that outcome relevant to the Washington population in the scientific literature. Where multiple effect estimates exist, we listed the model results separately for each. See the Method section for more information.

Age-adjusted rate indicates the expected rate if the age distribution in OBCs matched that of Washington statewide.

For both yearly and daily $PM_{2.5}$ exposure, we estimated health outcome rates that were 1.5- to 2-times higher in OBCs compared to statewide. This included deaths by any cause, deaths from ischemic heart disease, and hospital admissions for acute MI related to yearly $PM_{2.5}$ exposure and asthma-related ED visits and hospital admissions for MI, asthma, and all respiratory conditions associated with daily $PM_{2.5}$ exposure.

Ozone

Seasonal exposure

We estimated that O_3 exposure during warm season (May-September) was associated with 67 deaths by any cause among older adults ages 65-99 (33 deaths per 100,000 population) (Table 12).

The communities with the highest estimated number of deaths per population associated with seasonal O_3 exposure among older adults ages 65-99 were:

- Spokane and Spokane Valley: 79 deaths per 100,000 population
- Tri-Cities to Wallula: 74 deaths per 100,000 population
- East Yakima: 73 deaths per 100,000 population

Daily exposure

Daily O_3 exposure was associated with 23 deaths by any cause (2 deaths per 100,00 population) and 689 asthma-related ED visits (51 visits per 100,000 population) among all people in OBCs and 290 respiratory hospital admissions (152 admissions per 100,000 population) among older adults ages 65-99.

Like $PM_{2.5}$ related health impacts, the rates of all examined health outcomes associated with daily and seasonal O_3 exposure are higher in OBCs compared to statewide.

Table 12. Estimated annual mortality and morbidity associated with seasonal and daily O_3 exposure (seasonal and daily 8-hour maximum concentrations) in all 16 overburdened communities highly impacted by air pollution, 2022-2023. Brackets [ ] include 95% confidence interval.

Health Outcome	Age Group	Source of Risk Estimate	Population	Estimated Annual Number [95% CI]	Estimated annual rate per 100,000 population [95% CI]	Estimated age-adjusted annual rate per 100,000 population [95% CI]	Estimated statewide annual rate per 100,000 population [95% CI]
Deaths – Any cause (Seasonal)	65 to 99	Di, et al., 2017[23]	190,102	67 [46 to 87]	35 [24 to 46]	33 [23 to 44]	23 [16 to 30]
Deaths – Any cause (Daily)	0 to 99	Zanobetti and Schwartz, 2008[172]	1,351,509	23 [12 to 33]	2 [1 to 2]	2 [1 to 3]	1 [1 to 2]
ED Visits – Asthma (Daily)	0 to 99	Mar and Koenig, 2009[173]	1,351,509	689 [172 to 1135]	51 [13 to 84]	51 [13 to 84]	31 [8 to 51]

[172] Zanobetti, A. and Schwartz, J., 2008. Mortality displacement in the association of ozone with mortality: an analysis of 48 cities in the United States. *American Journal of Respiratory and Critical Care Medicine*, 177(2), pp.184-189.
[173] Mar, T.F. and Koenig, J.Q. (2009). Relationship between visits to emergency departments for asthma and ozone exposure in greater Seattle, Washington. *Annals of Allergy, Asthma & Immunology*, 103, 474-479.

Health Outcome	Age Group	Source of Risk Estimate	Population	Estimated Annual Number [95% CI]	Estimated annual rate per 100,000 population [95% CI]	Estimated age-adjusted annual rate per 100,000 population [95% CI]	Estimated statewide annual rate per 100,000 population [95% CI]
Hospital Admissions – All Respiratory (Daily)	65 to 99	Schwartz, 1995[174]	190,102	290 [83 to 477]	152 [44 to 251]	151 [44 to 249]	96 [28 to 158]

ED: emergency department; CI: confidence interval. CIs are inversely proportional to population sizes reflecting higher uncertainty when estimating effects with smaller numbers of people. CIs that include 0 indicate that it is plausible that no deaths are associated with PM2.5 in this group in this community.

Population is the average of the 2022 and 2023 Washington State Office of Financial Management estimates for the census tracts that comprise OBCs.

Health outcomes were selected based on the availability of effect estimates for that outcome relevant to the Washington population in the scientific literature. Where multiple effect estimates exist, we listed the model results separately for each. See the Method section for more information.

Age-adjusted rate indicates the expected rate if the age distribution in OBCs matched that of Washington statewide.

[174] Schwartz, J., 1995. Short term fluctuations in air pollution and hospital admissions of the elderly for respiratory disease. *Thorax*, 50(5), pp.531-538.

Greenhouse gas emissions

Facilities

Table 13 summarizes the total number of facilities and greenhouse gas emissions in and near each overburdened community highly impacted by air pollution (OBC) in 2022 and 2023. Biogenic carbon (biogenic CO_2) [175] emissions are expected to be partially recaptured as part of the natural carbon cycle. For reporting purposes, biogenic CO_2 is subtracted from total metric tons of CO_2e, even though it has the same atmospheric warming effect as non-biogenic CO_2.

We reviewed data from 165 facilities in 2022 and 166 in 2023. In both reporting years, 49 facilities, or 30%, were within or nearby[176] OBCs. Of the 49 facilities, 22 are covered under the CCA as of 2023. Ecology's 2023 EJ Report included facility emissions from 2020 and 2021. Since 2020, total reported greenhouse gas emissions from facilities within and near OBCs have decreased by 20.3%, and by 6.3% after subtracting biogenic CO_2 emissions.

Some facilities that emit greenhouse gas emissions also emit significant amounts of criteria air pollutants. The proximity of industrial sites to where people live and work can cause public health concerns. Facility locations and additional information are included in each of the Community Reports that are part of this publication.

Table 13. Total number of facilities and greenhouse gas emissions reported in 2022 and 2023 in and nearby each overburdened community highly impacted by air pollution. Biogenic CO_2 is in brackets [ ].

Community Name	2022 Number of Facilities	2022 Emissions (MT CO_2e)	2023 Number of Facilities	2023 Emissions (MT CO_2e)
Spokane and Spokane Valley	5	443,941 [149,245]	5	432,774 [147,283]
Tri-Cities to Wallula	9	1,104,535 [385,234]	7	697,423 [228,624]
East Yakima	2	26,444 [0]	2	27,628 [0]

[175] Biogenic carbon refers to greenhouse gases released from the combustion, decomposition, or processing of materials derived from biological sources – such as wood, paper, biomass fuels, agriculture residues, food waste, or biogas. Under the Washington Greenhouse Gas Reporting Program, these emissions are reported separately from fossil-derived emissions because they result from carbon that circulates within the short-term natural carbon cycle rather than long-term carbon stores. Biogenic CO_2 acts the same way in the atmosphere as non-biogenic CO_2. Anthropogenic processes that include these emissions reduce a facility's environmental impact.

[176] "Nearby" refers to facilities within a three-mile radius of the community boundary that were included in this analysis.

Community Name	2022 Number of Facilities	2022 Emissions (MT CO_2e)	2023 Number of Facilities	2023 Emissions (MT CO_2e)
Lower Yakima Valley	3	61,768 [0]	3	62,347 [0]
Moxee Valley	2	174,253 [0]	2	178,342 [0]
Mattawa	0	0 [0]	0	0 [0]
George and West Grant County	0	0 [0]	0	0 [0]
Ellensburg	1	13,700 [0]	1	12,790 [0]
Wenatchee and East Wenatchee	2	25,291 [0]	2	22,202 [0]
Everett	1	69,711 [0]	1	66,124 [0]
North Seattle and Shoreline	0	0 [0]	0	0 [0]
South Seattle	9	717,063 [0]	9	755,589 [0]
South King County	3	66,302 [0]	3	64,784 [0]
Northeast Puyallup	2	47,294 [0]	2	62,121 [0]
South and East Tacoma	6	1,192,728 [853,428]	7	920,753 [568,579]
Vancouver	4	695,179 [0]	5	736,686 [0]
Total	**49**	**4,638,209 [1,387,907]**	**49**	**4,039,563 [944,486]**

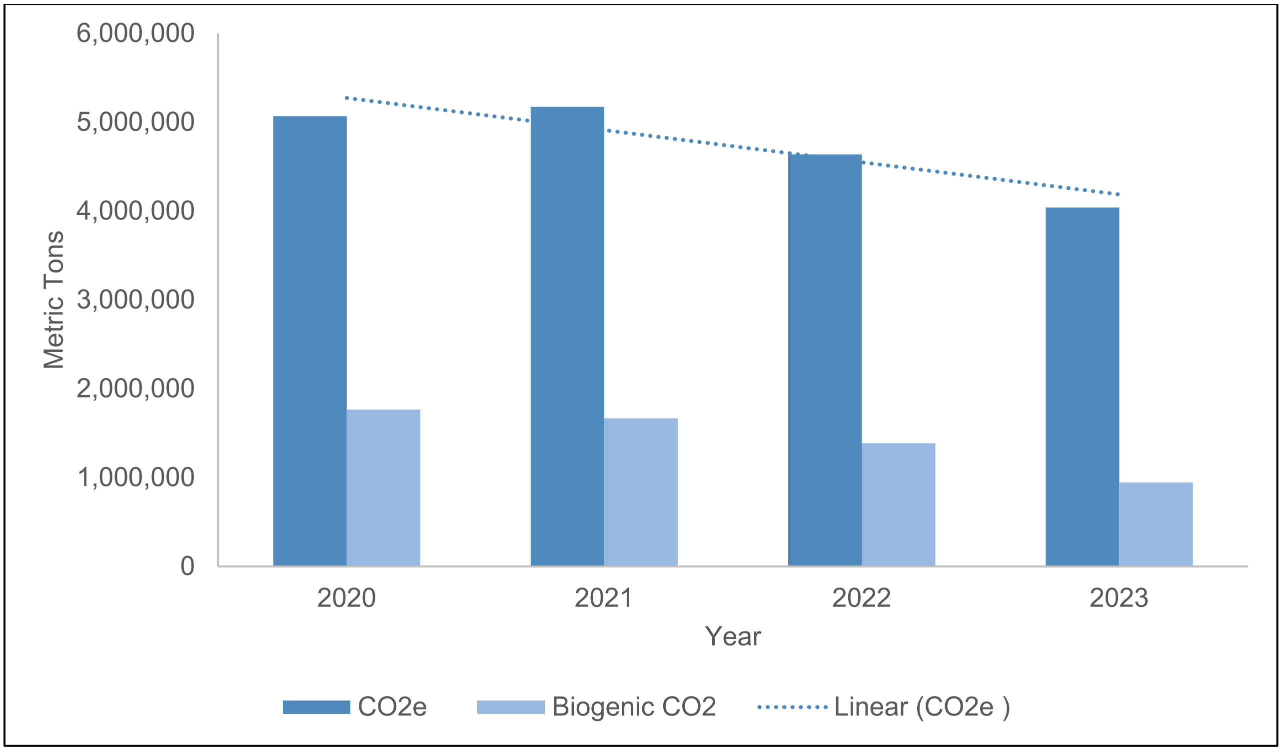

Figure 11. Comparison of annual CO_2e and biogenic CO_2 in metric tons (MT) from greenhouse gas reporting facilities that are in and nearby overburdened communities highly impacted by air pollution, 2020-2023.

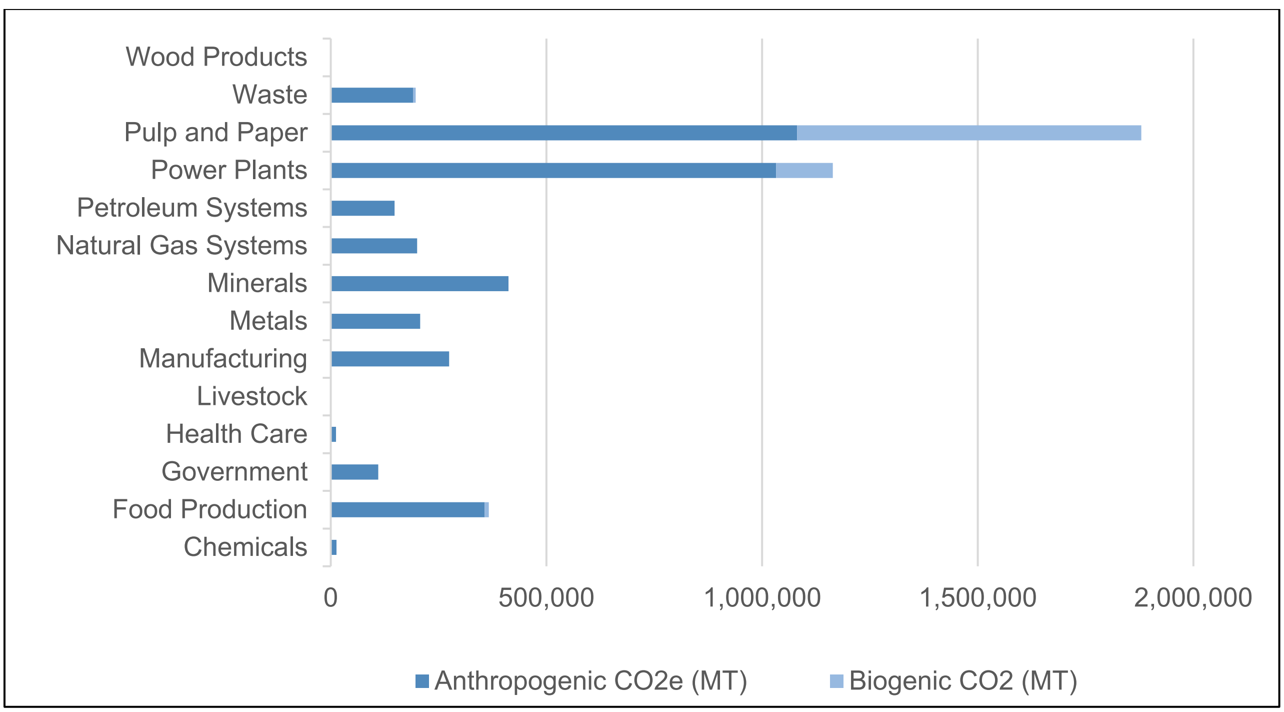

Figure 12. 2023 greenhouse gas emissions by facility sector within and nearby overburdened communities highly impacted by air pollution.

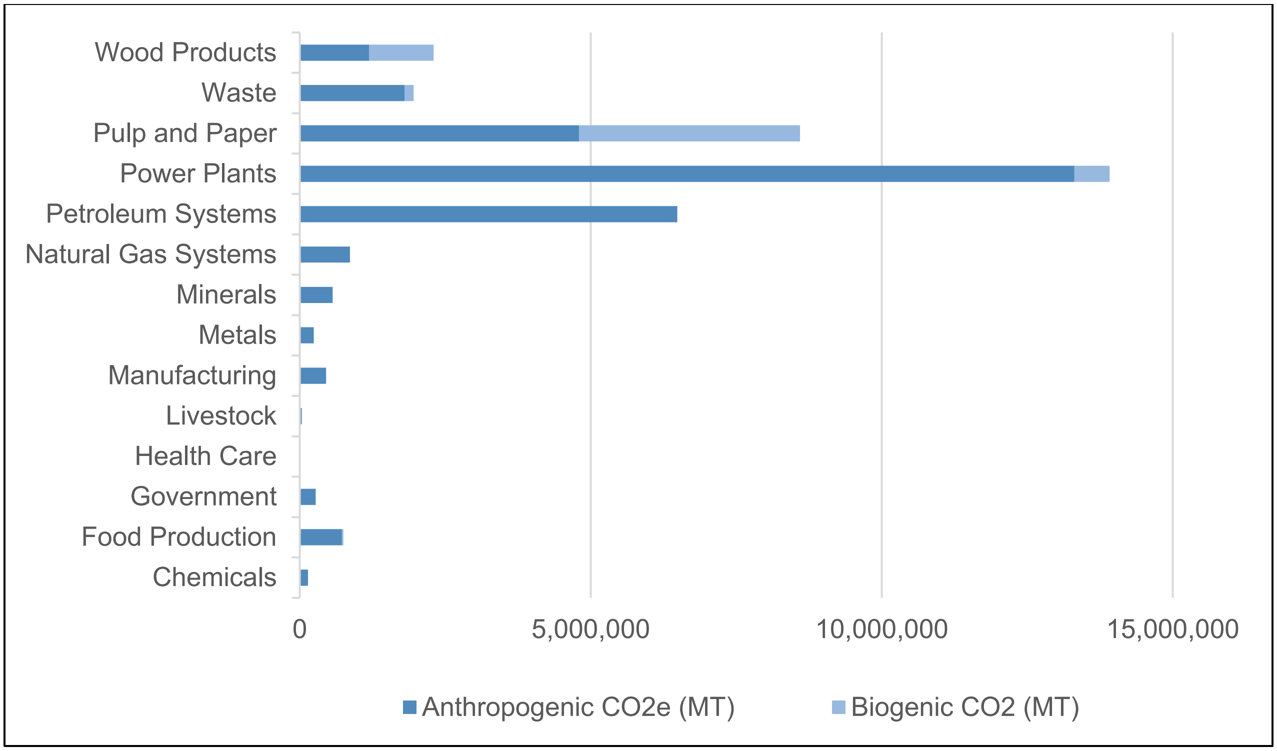

Figure 13. 2023 statewide greenhouse gas emissions by facility sector.

Mobile sources

Mobile sources create greenhouse gases as petroleum fuels are burned. Mobile sources include a variety of vehicles, engines, and equipment that can be categorized as either on-road or non-road.

On-road sources include:

- Passenger cars
- Trucks
- Buses
- Motorcycles

Non-road sources include:

- Marine vessels
- Aircraft
- Locomotives
- Lawn and agriculture equipment
- Construction equipment

- Recreation equipment

Table 14. Greenhouse gas emissions from mobile sources, 2019-2021.

Year	OBC (MT CO_2e)	Statewide (MT CO_2e)
2019	6,093,191	40,331,455
2020	4,766,401	31,549,052
2021	5,765,927	38,164,967

OBC = overburdened community highly impacted by air pollution

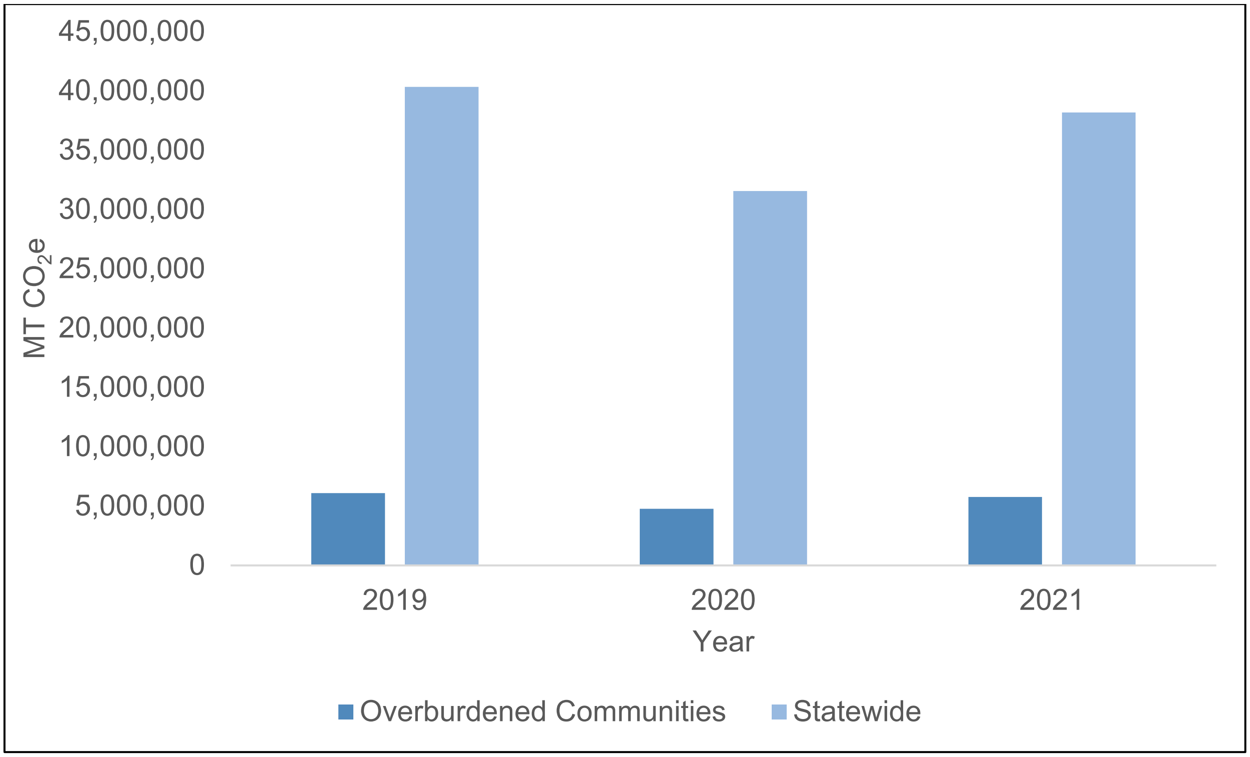

Figure 14. Comparison of annual statewide MT CO_2e from mobile sources to overburdened communities highly impacted by air pollution between 2019-2021.

The COVID-19 pandemic impacted Vehicle Miles Traveled (VMT)[177], and emissions from the transportation sector. According to the Washington State Department of Transportation (WSDOT), there was a 15% decrease in statewide VMT estimates between 2019 and 2020.[178]

[177] VMT are used in MOVES to calculate emissions while the vehicle is in motion or during short periods of idling on public roadways. WSDOT makes estimates of county VMT by functional roadway classification using the national Department of Transportation's Highway Performance Monitoring System (HPMS) data.
[178] WSDOT annual mileage and travel information https://wsdot.wa.gov/about/transportation-data/travel-data/annual-mileage-and-travel-information

This drop in VMT estimates means that people drove fewer miles on public roadways. This contributed to a decrease in greenhouse gas emissions between 2019 to 2020, which is reflected in the Washington State Greenhouse Gas Emissions Inventory. The emission reductions during this time period are considered a temporary effect of COVID-19.

Listening sessions

Air pollution and health concerns

> "When industries are fully operating, black smoke comes out and pollutes the whole area where people live." – Burien listening session participant

All four pilot listening session participant groups—Burien, Sunnyside and local health jurisdiction (LHJ) staff—mentioned roadway pollution and wildfires as air pollution sources of concern. Additional local sources of concern were air traffic and residential mold for the group in Burien and pesticide application and agricultural burning for the group in Sunnyside. Participants in the sessions with LHJ staff mentioned warehouse traffic, agricultural pollution (including pesticide drift, fertilizers, and odors from dairies), airports, pollen, prescribed burns, industrial facilities, landfills, and seasonal pollutants such as O_3 in warmer months and smoke from wood stoves in colder months. They also mentioned dust, particularly dust spread by trucks on dirt roads and dust storms that occur during strong wind events.

Participants in both the Burien and Sunnyside listening sessions mentioned that air quality is better in the winter and worse in the summer, especially during the hottest times of day and when wildfires are burning. Although discussions focused on air pollution, several participants in both sessions also raised concerns regarding land and water pollution, as well as a shortage of trees and green spaces in their communities.

Participants in listening sessions shared concerns about health impacts for themselves, family members and community members resulting from both acute and long-term exposure to air pollution. All three participant groups brought up asthma numerous times. Participants were concerned with the high prevalence of asthma in their communities, particularly among children, as well as the increased severity of asthma related to air pollution exposure. In both in-person sessions, participants mentioned allergies, the physical and mental health effects of staying indoors during unhealthy air quality events, and the costs of accessing care to treat the effects of air pollution, particularly for people without health insurance.

In the LHJ sessions, local health practitioners shared concerns that included poor air quality, worsening chronic health conditions for people who already have them, and concerns from parents about children breathing polluted air during outdoor sports seasons. In the Burien session, participants expressed interest in knowing how to protect their families from air pollution, as well as concerns about shorter life expectancy in Seattle's South Park neighborhood, which many had previously heard of. In the Sunnyside session, attendees mentioned eye irritation from heavy air pollution.

Places and populations of concern

Listening session participants shared concerns about places where populations sensitive to air pollution congregate, also known as sensitive receptor locations, as well as places more highly exposed to air pollution. The places mentioned included agricultural fields and areas near them, schools, outdoor sport and recreation facilities, areas near roadways, assisted living facilities, and outdoor events and concerts. One participant mentioned that while rural areas may have fewer industrial facilities than large urban areas, some of the rural facilities have people living close to them who may be highly exposed to air pollution.

Participants also listed groups of people who experience greater vulnerability to air pollution. They mentioned groups more sensitive to air pollution, including children, older adults, pregnant people, people with disabilities, and people with chronic diseases, particularly COPD, asthma, and cardiovascular disease. Among groups more highly exposed to air pollution, participants mentioned children playing sports, people with low incomes, public transit and commercial drivers, unhoused people, and outdoor workers such as agricultural and construction workers.

Strategies for addressing air pollution

Local health jurisdictions serving each of the 16 identified communities are already making efforts to prioritize populations with less access to resources. Staff from all 11 LHJs described actions their organizations are taking to protect residents from harmful air pollution, particularly during wildfire smoke events. Some of the activities they mentioned included:

- Supporting public health messaging for the community
    - Developing general messaging as well as focused messaging for schools
    - Utilizing DOH guidance and National Weather Service materials
    - Posting notices during smoke events with information on how best to protect oneself
- Using different colored flags for different air quality readings
- Distributing box fans, filters, and do-it-yourself fan kits
- Distributing N95 masks and highlighting their use to prevent breathing unhealthy air
- Giveaways through both focused outreach and public events
- Establishing clean air sites and cooling centers with partners such as churches and libraries, focusing on residents who do not have home air filtration
- Multilingual communication
- Partnering with community organizations and other trusted messengers, including healthcare providers, community navigator programs and community health workers
- Calling 911 to be added to the Vulnerable Persons Registry

Participants in the Burien listening session brought up air filters in different ways, including purchasing their own, which can be costly, and sometimes being able to obtain them from community giveaways. They commented that not enough filters are distributed to the people who need them and that many people don't hear about those events. In the Sunnyside listening session, participants mentioned receiving information related to environmental health from local organizations, including how to clean up the yard to avoid fire damage. One person mentioned a box fan distribution in nearby Wapato, outside the identified Lower Yakima Valley community's boundaries. In both in-person sessions, several people said they weren't aware of any available resources. In addition, they shared that they stayed indoors when air quality was especially bad.

Information needs and communication channels

> "This is a good time for the Department of Ecology to take note of the most vulnerable neighbors, like us who live in South Park. In what way can we at home take care of our health, which is essential for us? With good health we can work and generate income. Without health we cannot work; we can't pay rent. Many situations can arise in our lives if we don't have good health. Therefore, learning to take care of our family from home with tools the Department of Ecology can give us would be great for everyone." – Burien listening session participant

> "We talk a lot about priorities, but I think we, our families, are the priorities with regard to pollution, because it really affects our health, our children, adults, all families, really. We are a priority. I would also like for the Department of Ecology to give us tools for how we can help, how we can stop polluting and take care of ourselves at home." – Burien listening session participant

Listening session participants expressed a need for more accessible, concise and precise materials about air quality and health that use easy-to-understand language. They also discussed topics on which they would like to have more information available, which largely fell into two categories:

- Air monitoring
    - How to read and interpret air monitoring data, including the Air Quality Index
    - More distributed monitor capacity—participants pointed out that when very limited sensors are used to cover large areas, data is unreliable and puts credibility at risk
    - More widespread ability to measure CAPs other than PM, e.g. O_3 monitors
    - Explaining types of sensors and comparing quality or ease of use
    - Monitoring for ultrafine particles
    - More accurate or reliable data about pollution from industrial sources to be able to confidently provide health guidance to residents

- Air pollution impacts on health
  - Better understanding how air quality and prolonged exposure impact the prevalence of certain diseases or increase the health burden of asthma, especially for people who are more sensitive to negative impacts
  - Identifying where risk factors (e.g. elevated pollution levels, sensitive populations) overlap and developing targeted messaging
  - Creating or co-creating messaging for health care providers which reflect how people talk about air pollution in public spaces or at the dinner table
  - Specifying local pollution sources and describing how they affect human health

Participants also discussed effective communication tools and strategies to disseminate information in their local communities. These included the following:

- Local radio and TV, including Spanish radio
- Local newspapers
- Newsletters
- Schools, both through environmental education in class and distribution of materials
- Flyers at kiosks/community billboards
- Word of mouth
- Door-to-door education
- Social media, including videos
- Webpages, including dedicated wildfire smoke pages
- Mobile applications

Discussion

The 2023 EJ Report included 'Next Steps' that recommended the expansion and strengthening of the data analysis in subsequent publications of the biennial report. The 2025 EJ Report sought to address many of these recommendations in the following ways:

- Increase the spatial granularity of monitoring data: since 2023, the Department of Ecology has installed 45 new air monitors and sensors in or near overburdened communities highly impacted by air pollution (OBCs). Data collected through the end of 2024 from these monitors and sensors are included in this report.
- Account for wildfire smoke in the analysis: we reported $PM_{2.5}$ concentrations both with wildfire days included and excluded to show the relative impact of wildfire smoke on air quality in OBCs.

- Expand analysis of the health impacts of CAPs: this report included the analysis of both the short-term and yearly health impacts of exposure to $PM_{2.5}$ and O_3, including mortality and morbidity health outcomes. We included more recent years of mortality data (2022 and 2023) and calculated age- and race-adjusted mortality rates. We refined this analysis by using risk estimates that are specific to the Pacific Northwest and Northern California, which have similar socio-demographic compositions to Washington.
- Include socio-cultural information and incorporate qualitative research methodologies: we expanded our reporting of socio-cultural information. This information was gathered by community engagement specialists from the Departments of Health and Ecology, provided by community partners and organizations, or gained through the pilot listening sessions. The pilot sessions gathered information about community members' concerns, priorities, and strategies for addressing air quality and health. What we learned is reflected in the South Seattle and Lower Yakima Valley Community Reports, statewide listening session results, and the format and content of the EJ Report.
- Report levels of greenhouse gas emissions in communities: Ecology leveraged information from the statewide greenhouse gas inventory and greenhouse gas reporting program. One goal is to provide more information at community-level scales in future reports.

Criteria air pollution

This is the first EJ Report to include data from $PM_{2.5}$ monitors and sensors within all 16 overburdened communities highly impacted by air pollution (OBCs). Some of these $PM_{2.5}$ monitors and sensors were installed in late 2023 and 2024, so this report does not include three comprehensive years of data from each community. The next publication of the EJ Report will include monitoring data from 2024-2026, so there will be at least one reporting period of data available from nearly all the OBCs. This will provide more robust information for Ecology to report on trends in $PM_{2.5}$ levels over time.

Overall, annual and daily levels of $PM_{2.5}$ were lower in the 2022-2024 reporting period compared to 2020-2022. This may be attributed to the lesser impact of wildfire smoke on Washington in 2023 and 2024. Other criteria air pollutants that are monitored in the OBCs were below the NAAQS.

The 2025 Environmental Justice Report uses updated methods to report CAPs concentrations in OBCs. The 2023 report included modeled NO_2 data from Community-LINE (C-LINE) source model and O_3 concentrations from the NW-AIRQUEST Regional Background Concentration tool.[179] The models' data sources and tools have not been updated since the publication of the 2023 report. While modeling of NO_2 and O_3 concentrations for the 2025 report would have provided more extensive estimates of CAPs concentration levels, these values would not have had the same degree of accuracy as values reported from CAPs monitors.

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[179] NW-AirQuest Regional Background Concentration tool, Background Concentrations 2014-2017 https://idahodeq.maps.arcgis.com/apps/MapSeries/index.html?appid=0c8a006e11fe4ec5939804b873098dfe

Therefore, this report includes CAPs concentrations data from only the Washington Network. The CAPs concentrations included in this report are the most up-to-date and accurate values available in Washington.

Health impacts

The first EJ Report published in 2023 focused on mortality associated with long-term (yearly) $PM_{2.5}$ exposure.[180] In this second iteration of the report, we expand the scope of our health impacts assessment by including a second criteria air pollutant (O_3), estimating health impacts of both daily and yearly pollutant exposure, and including morbidities as health outcomes, including hospital admissions, ED visits, and cancer diagnoses. Because the methodology for producing the pollution concentration estimates for the BenMAP-CE modeling is different between the two reports, the health impact results from 2023 should not be directly compared to those included in this report.

Using EPA analytic tools, we estimated 430 deaths by any cause each year were associated with yearly $PM_{2.5}$ exposure among adults ages 18-84 in overburdened communities highly impacted by air pollution (OBCs) and 261 deaths by any cause among older adults ages 65-99 during 2022-2023. In the 18-84 age group, the age-adjusted mortality rate associated with yearly $PM_{2.5}$ exposure was nearly twice the statewide rate (48 vs 27 deaths per 100,000 population).

As in the 2023 health impacts assessment,[181] we found that Hispanic and Black individuals had the highest age-adjusted mortality rates associated with yearly $PM_{2.5}$ exposure among all racial and ethnic groups across the OBCs. Communities of color, particularly Black and Hispanic communities, have historically been disproportionately exposed to criteria air pollution in the U.S. A 2021 study found that nearly all $PM_{2.5}$ emitter types contributed to racial disparities for pollutant exposure, regardless of state, urban and rural area, income levels, and exposure levels, demonstrating how pervasive this problem is.[182] Racial inequities in environmental health have roots in discriminatory housing policies, deliberate siting of contaminated sites and industries that generate emissions near communities of color, and other systemically racist practices. Studies have shown that historical redlining and racially restrictive housing covenants, practices that restricted home ownership for predominantly Black communities and

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[180] WA Department of Ecology, Air quality studies https://ecology.wa.gov/research-data/scientific-reports/air-quality-studies

[181] WA Department of Ecology, Improving Air Quality in Overburdened Communities Highly Impacted by Air Pollution: 2023 Report, Washington State Department of Ecology https://apps.ecology.wa.gov/publications/SummaryPages/2302115.html

[182] Tessum CW, Paolella DA, Chambliss SE, Apte JS, Hill JD, Marshall JD (2021) $PM_{2.5}$ polluters disproportionately and systemically affect people of color in the United States. Sci Adv 7(18).

other communities of color in the 20th century, are predictive of racial disparities in air pollution exposure and poor health outcomes across the U.S. today.[183,184]

Our review demonstrates that Black and Hispanic individuals in communities overburdened by air pollution face disproportionate health impacts. These results highlight the need to understand the causes of these disparities, improve access to healthcare services, and reduce air pollution to prevent $PM_{2.5}$ associated death and morbidity in Washington. Given a lack of published studies that assess the health effects of $PM_{2.5}$ and O_3 by racial and ethnic groups in populations applicable to our analysis of WA residents, we were unable to do assessments of racial and ethnic disparities of other health outcomes. We will continue to explore ways to further assess the racial and ethnic health inequities associated with CAP exposure in future reports as new data become available in the scientific literature.

Additionally, our results indicate that $PM_{2.5}$ and O_3 have a broad impact on population health in OBCs that include cause-specific deaths and non-fatal respiratory and cardiovascular conditions among people of all ages. These conditions include deaths from cardiovascular disease, including ischemic heart disease, deaths from lung cancer, hospital admissions associated with acute myocardial infarction, asthma exacerbations, and all respiratory conditions, asthma-related ED visits, and lung cancer diagnoses. Estimated rates of health outcomes were estimated to be higher than the statewide rates for nearly all conditions, suggesting that individuals in OBCs are at higher risk for adverse health conditions that are caused or exacerbated by $PM_{2.5}$ and O_3 exposure.

Some limitations of our analysis should be considered when interpreting our findings:

- We made assumptions about where individuals were exposed to $PM_{2.5}$ and O_3 based on their residential address at the time of the health event. We did not have information to consider exposures at job sites or changes in residence throughout the year. Additionally, we may have misidentified the census tract, and therefore OBC, of residence for individuals with inaccurate, incomplete or missing residential address information in reported health records.

[183] Lane HM, Morello-Frosch R, Marshall JD, Apte JS (2022) Historical redlining is associated with present-day air pollution disparities in U.S. cities. Environ Sci Technol Lett 9(4):345–350
[184] West KL, Allen E, LaPlante A, Durben AN, Palma VD (2024) Lasting legacy: the enduring relationship between racially restrictive housing covenants and health and wellbeing. J Urban Health (Preprint).

- The health impact functions used in our model are based on the best information available in the literature on the relationship between $PM_{2.5}$ and O_3 and respective health outcomes. The underlying studies might have methodological limitations that bias the resulting effect estimates, include a population that is not generalizable statewide, or contain results that are out of date. This could lead to either overestimation or underestimation of the calculated numbers of outcomes associated with $PM_{2.5}$ or O_3 concentrations in OBCs. Additionally, estimates for the same or related outcome representing different age groups are not directly comparable. This is due to differences in the underlying studies, including different geographies representing populations with different rates of health conditions, different time periods, and different sources and toxicities of $PM_{2.5}$.
- BenMAP-CE does not have the functionality to include daily health data for daily exposure analyses. Rather it assumes uniform daily rates based on the yearly average baseline rate. This is not representative of the variable risk of health outcomes throughout the year, where there are seasonal patterns, and likely introduces bias into our estimates.
- Each of the health datasets comes with its own limitations. ED visit data used for this analysis comes from the Washington state syndromic surveillance system which provides a near real-time summary of activity in healthcare facilities statewide. Records do not undergo a review or validation process before being reported, which can result in misclassification of diagnoses and other clinical information assigned to some records.
- Our analysis was limited to health outcomes for which there are concentration response functions in the published literature among study populations that are somewhat comparable to Washington's population (i.e., national population-based surveys and studies conducted in the Pacific Northwest region). Therefore, it excludes certain health conditions linked to $PM_{2.5}$ and O_3 exposure, such as renal conditions, adverse pregnancy outcomes, and neurocognitive conditions. We will continue to review the scientific literature to identify new health outcomes to include in our analysis, as well as identify more appropriate and rigorous scientific studies for health outcomes we did include.

Greenhouse gas emissions

While the Climate Commitment Act (CCA) directs Ecology to ensure that the Cap-and-Invest Program achieves emissions reductions and to report greenhouse gas levels in the overburdened communities highly impacted by air pollution (OBCs), it does not require Ecology to develop a comprehensive local inventory for each of the 16 communities. The Cap-and-Invest Program tracks covered entities and their greenhouse gas reductions while generating pass- through funding for climate pollution reduction projects and implementing climate and air quality policies. The greenhouse gas information provided in this report aligns with the CCA's requirements.

The OBCs have unique boundaries, some encompassing multiple or partial counties and cities. Because of this complexity, it would be difficult to meaningfully quantify greenhouse gas inventories for each OBC. Some county- and city-wide greenhouse gas inventories already exist throughout the state, with more expected to be published to measure progress toward climate protection goals and to inform local climate action plans.

Greenhouse gases primarily influence the global atmosphere but also have local implications through associated co-pollutants and localized climate effects. In future reports, we plan to include additional information on greenhouse gas trends and emission reductions related to air quality and climate programs, grant projects, and policies occurring within the communities.

Next Steps

Ecology, in consultation with DOH, will continue to expand and improve our analysis for future publications of the biennial EJ Report. The next report will be published by December 31, 2027. We will seek to improve the EJ Report in the following ways:

- Partner with Tribes highly impacted by air pollution who have signed MOUs with Ecology to develop Tribe-specific air quality and health reports for partnering Tribes. We intend to engage with Tribes through government-to-government meetings to develop agreements for data collection, analysis, and dissemination process for forthcoming publications of the EJ Report. Ecology and DOH are collaborating to maintain respect for each Tribe's data sovereignty protocols.
- Disseminate the report to communities that are overburdened and highly impacted by air pollution. Share results in accessible and meaningful ways.
- Develop further greenhouse gas analyses. Explore additional sources of data for inclusion in the report.
- Evaluate impacts of cap-and-invest on emissions from covered entities in overburdened communities highly impacted by air pollution.
- Explore additional data resources and tools for reporting CAPs levels. As the Washington Network expands, we will include data from additional monitors.
- Pursue additional methods for understanding the health impacts of cumulative air pollution exposure in multiple ways. First, we will explore the inclusion of new data sources to expand the types of health outcomes we are including in the report. We will also complete a literature review to identify new studies that we can apply to our health impact assessment. Additionally, we will explore the development of Washington-specific effect estimates for our model inputs using state-level data to limit reliance on studies from populations outside of Washington. We will additionally look at the co-impacts of greenhouse gas and criteria air pollution on human health.

Appendix A. National Ambient Air Quality Standards

Table A1. National Ambient Air Quality Standards.[185]

Pollutant	Primary/ Secondary	Averaging Time	Level	Form
Carbon Monoxide (CO)	Primary	8 hours	9 ppm	Not to be exceeded more than once per year
	Primary	1 hour	35 ppm	Not to be exceeded more than once per year
Lead (Pb)	Primary and secondary	Rolling 3 month average	0.15 µg/m3 (1)	Not to be exceeded
Nitrogen Dioxide (NO_2)	Primary	1 hour	100 ppb	98th percentile of 1-hour daily maximum concentrations, averaged over 3 years
	Primary and secondary	1 year	53 ppb (2)	Annual Mean
Ozone (O_3)	Primary and secondary	8 hours	0.070 ppm (3)	Annual fourth-highest daily maximum 8-hour concentration, averaged over 3 years
Particle Pollution ($PM_{2.5}$)	Primary	1 year	9.0 µg/m^3	annual mean, averaged over 3 years
	Secondary	1 year	15.0 µg/m3	annual mean, averaged over 3 years
	Primary and secondary	24 hours	35 µg/m^3	98th percentile, averaged over 3 years

[185] NAAQS Table | US EPA

Pollutant	Primary/ Secondary	Averaging Time	Level	Form
Particle Pollution (PM_{10})	Primary and secondary	24 hours	150 µg/m^3	Not to be exceeded more than once per year on average over 3 years
Sulfur Dioxide (SO_2)	Primary	1 hour	75 ppb (4)	99th percentile of 1-hour daily maximum concentrations, averaged over 3 years
	Secondary	1 year	10 ppb	annual mean, averaged over 3 years

Appendix B. Air Quality Index

Table B1. Air Quality Index.[186]

Air Quality Index Level	24-hour $PM_{2.5}$	24-hour PM_{10}	8-hour O_3	8-hour Carbon Monoxide	1-hour Sulfur Dioxide	1-hour Nitrogen Dioxide
Good (Green)	0-9.0 µg/m^3	0-54 µg/m^3	0-54 ppb	0-4.4 ppm	0-35 ppm	0-53 ppb
Moderate (Yellow)	9.1.1-35.4 µg/m^3	55-154 µg/m^3	55-70 ppb	4.5-9.4 ppm	36-75 ppm	54-100 ppb
Unhealthy for Sensitive Groups (Orange)	35.5-55.4 µg/m^3	155-254 µg/m^3	71-85 ppb	9.5-12.4 ppm	76-185 ppm	101-360 ppb
Unhealthy (Red)	55.5-125.4 µg/m^3	255-354 µg/m^3	86-105 ppb	12.5-15.4 ppm	186-304 ppm	361-649 ppb
Very Unhealthy (Purple)	125.5-225.4 µg/m^3	355-424 µg/m^3	106-200 ppb	15.5-30.4 ppm	305-604 ppm (24-hour)	650-1249 ppb
Hazardous (Maroon)	≥225.5 µg/m^3	≥425 µg/m^3	≥201 ppb	≥30.5 ppm	≥605 ppm (24-hour)	≥1250 ppb

[186] Air Quality Index Technical Assistance Document for the Reporting of Daily Air Quality – the Air Quality Index (AQI)

Appendix C. Air Quality and Health Eco-Health Relationship

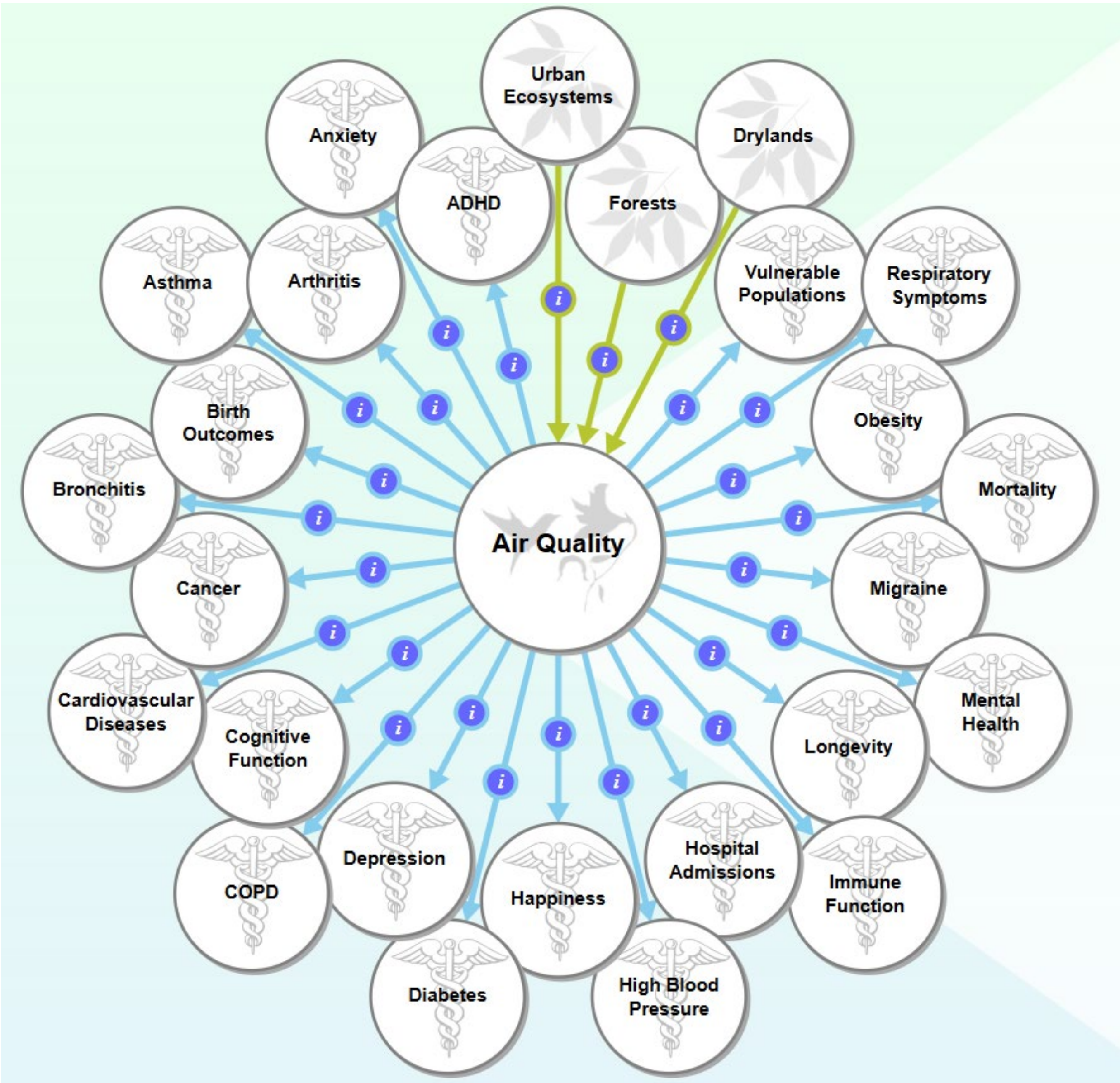

Figure C1. Linkages between air quality and health outcomes (blue arrows) and ecosystems (green arrows). Source: EPA Eco-Health Relationship Browser[187]

[187] U.S. EPA EnviroAtlas, Eco-Health Relationship Browser https://enviroatlas.epa.gov/enviroatlas/Tools/EcoHealth_RelationshipBrowser/

Appendix D. Health Impacts Supplemental Materials

Table D1. Definitions used to identify health outcomes in Washington Department of Health datasets.

Health Outcome	WA DOH Data Source	Fields Used	Definition	Definition Source
Deaths – Any cause	CHS death statistical dataset[124]	None	Any death record, regardless of cause	None
Deaths – Cardiovascular disease	CHS death statistical dataset[124]	Cause of death (ACME_Cause _Category 1-20)	If any of the following ICD-10 codes are listed as a cause of death for a person: B33.2|G45|G46.0|G46.1|G46.2|G46.3|G46.4|G46.5|G46.6|G46.7|G46.8|I01|I02.0|I05|I06|I07|I08|I09|I11|I20|I21|I22|I23|I24|I25|I28.0|I28.1|I28.2|I28.3|I28.4|I28.5|I28.6|I28.7|I28.8|I30|I31.0|I31.1|I31.8|I31.9|I32|I33|I34|I35|I36|I37.0|I37.1|I37.2|I37.3|I37.4|I37.5|I37.6|I37.7|I37.8|I38|I39|I40|I41|I42.1|I42.2|I42.3|I42.4|I42.5|I42.6|I42.7|I42.8|I43|I47|I48|I51.0|I51.1|I51.2|I51.3|I51.4|I60|I61|I62|I63|I65|I66|I67.0|I67.1|I67.2|I67.2|I67.3|I67.5|I67.6|I68.0|I68.1|I68.2|I69.0|I69.1|I69.2|I69.3|I70.2|I70.3|I70.4|I70.5|I70.6|I70.7|I70.8|I71|I72|I73|I77|I78|I79|I80|I81|I82|I83|I86|I87|I88|I89.0|I89.9|I98|K75.1	BenMAP-CE user manual, Table D-2: https://www.epa.gov/benmap/benmap-ce-manual-and-appendices
Deaths – Ischemic heart disease	CHS death statistical dataset[124]	Cause of death (ACME_Cause _Category 1-20)	If any of the following ICD-10 codes are listed as a cause of death for a person: I20|I21|I22|I23|I24|I25	BenMAP-CE user manual, Table D-2: https://www.epa.gov/benmap/benmap-ce-manual-and-appendices

Health Outcome	WA DOH Data Source	Fields Used	Definition	Definition Source
Deaths – Lung Cancer	CHS death statistical dataset[124]	Cause of death (ACME_Cause_Category 1-20)	If any of the following ICD-10 codes are listed as a cause of death for a person: C30|C31|C32|C33|C34|C35|C36|C37|C38|C39	BenMAP-CE user manual, Table D-2: https://www.epa.gov/benmap/benmap-ce-manual-and-appendices
Deaths – Respiratory	CHS death statistical dataset[124]	Cause of death (ACME_Cause_Category 1-20)	If any of the following ICD-10 codes are listed as a cause of death for a person: J00|J01|J02|J03|J04|J05|J06|J09|J10|J11|J12|J13|J14|J15|J16|J17|J18|J19|J20|J21|J22|J23|J24|J25|J26|J27|J28|J29|J30|J31|J32|J33|J34|J35|J36|J37|J38|J39|J40|J41|J42|J43|J44|J45|J46|J47|J48|J49|J50|J51|J52|J53|J54|J55|J56|J57|J58|J59|J60|J61|J62|J63|J64|J65|J66|J67|J68|J69|J70|J71|J72|J73|J74|J75|J76|J77|J78|J79|J80|J81|J82|J83|J84|J85|J86|J87|J88|J89|J90|J91|J92|J93|J94|J95|J96|J97|J98	BenMAP-CE user manual, Table D-2: https://www.epa.gov/benmap/benmap-ce-manual-and-appendices
Hospital Admissions – Acute Non-Fatal Myocardial Infarction	CHARS[125]	Diagnostic categories (DIAG1-DIAG25)	If any of the following ICD-10 diagnostic codes are assigned to a patient's hospitalization record: I21|I22	IHME diagnostic code list: https://ghdx.healthdata.org/record/ihme-data/gbd-2017-cause-icd-code-mappings

Health Outcome	WA DOH Data Source	Fields Used	Definition	Definition Source
Hospital Admissions – Asthma	CHARS[125]	Diagnostic categories (DIAG1-DIAG25)	If any of the following ICD-10 diagnostic codes are assigned to a patient's hospitalization record: J45|J46.0	IHME diagnostic code list: https://ghdx.healthdata.org/record/ihme-data/gbd-2017-cause-icd-code-mappings
Hospital Admissions – All Respiratory	CHARS[125]	Diagnostic categories (DIAG1-DIAG25)	If any of the following ICD-10 diagnostic codes are assigned to a patient's hospitalization record: J00|J01|J02|J03|J04|J05|J06|J09|J10|J11|J12|J13|J14|J15|J16|J17|J18|J19|J20|J21|J22|J23|J24|J25|J26|J27|J28|J29|J30|J31|J32|J33|J34|J35|J36|J37|J38|J39|J40|J41|J42|J43|J44|J45|J46|J47|J48|J49|J50|J51|J52|J53|J54|J55|J56|J57|J58|J59|J60|J61|J62|J63|J64|J65|J66|J67|J68|J69|J70|J71|J72|J73|J74|J75|J76|J77|J78|J79|J80|J81|J82|J83|J84|J85|J86|J87|J88|J89|J90|J91|J92|J93|J94|J95|J96|J97|J98	IHME diagnostic code list: https://ghdx.healthdata.org/record/ihme-data/gbd-2017-cause-icd-code-mappings

Health Outcome	WA DOH Data Source	Fields Used	Definition	Definition Source
ED Visits – Asthma	RHINO[126]	Chief complaint and discharge diagnosis (CCDD) field	CDC Asthma CCDD v1: Search CC and DD Field: (,^asthma^,or,^[;/]asma^,or,asma^,or,^asthama^,or,^asthma^,or,^asthmia^ ,or,^bronchospasm^,or,(,(,(,^Airway^,or,^Disease^,),AND, ^Reactive^,),or,(,^Airway^,AND,^Disease^,),),or,^J45^,or,^ [;/]281239006^,or,^[;/]195967001^,or,^[;/]708038006^,or,^[;/]405944004^,or,^[;/]708090002^,or,^[;/]56018004^,or,^[;/]304527002^,or,^[;/]1751000119100^,or,^[;/]401000119107^,or,^[;/]426979002^,or,^[;/]409663006^,or,^[;/]266364000^,or,^[;/]31387002^,or,^[;/]389145006^,or,^[;/]442025000^,or,^[;/]708093000^,or,^[;/]135171000119106^,or,^[;/]99031000119107^,or,^[;/]135181000119109^,or,^[;/]425969006^,or,^[;/]370218001^,or,^[;/]57546000^,or,^[;/]312453004^,or,^[;/]707446004^,or,^[;/]427295004^,or,^[;/]370219009^,or,^[;/]233678006^,or,^[;/]195949008^,or,^[;/]707447008^,or,^[;/]707445000^,or,^[;/]233683003^,or,^[;/]708094006^,or,^[;/]55570000^,or,^[;/]426656000^,or,^[;/]707980005^,or,^[;/]390798007^,or,^[;/]5281000124103^,or,^[;/]370221004^,),ANDNOT,^not asthma^	National Syndromic Surveillance Program Community of Practice: https://knowledgerepository.syndromicsurveillance.org/cdc-asthma-ccdd-v1

Health Outcome	WA DOH Data Source	Fields Used	Definition	Definition Source
Lung Cancer Diagnoses	WSCR[127]	ICD-O-3 site code (primarySite); NCI SEER Cancer Site	primarySite has ICD-O-3 code C34.0-C34.9, excluding histology codes 9140, 9050-9055 and 9590-9993 NCI SEER Cancer Site: "Lung and bronchus"	Gharibvand, et al. 2017. *Environ Health Perspect*. 2017 Mar;125(3):378-384 https://pubmed.ncbi.nlm.nih.gov/27519054/

CHARS: Comprehensive Hospital Abstract Reporting System; CHS: Center for Health Statistics; ED: Emergency department; ICD: International Classification of Diseases; IHME: Institute for Health Metrics and Evaluation; NCI: National Cancer Institute; RHINO: Rapid Health Information Network; SEER: Surveillance, Epidemiology, and End Results Program of the National Cancer Institute; WSCR: Washington State Cancer Registry.

Text D1. Health impact function literature review PubMed search strategy

(particulate matter OR $PM_{2.5}$ OR aerosol OR ozone OR O_3 OR (nitrogen AND (oxides OR oxide OR dioxide)) OR nitric oxide OR NO_2 OR NOx OR carbon monoxide OR sulfur dioxide OR SO_2 SOx OR (sulfur AND (oxides OR oxide OR dioxide)) OR NAAQS OR ((air OR airborne) AND criteria) OR "criteria air pollutants" OR "criteria pollutants" OR air pollutants)

AND

(response factor OR response function OR dose response OR concentration-response function OR concentration response function OR odds ratio OR risk ratio OR relative risk OR relative rate OR "RR" OR incidence rate OR "IR" OR incidence rate ratio OR "IRR" OR rate ratio OR hazard ratio OR association)

AND

(Hospitalization OR hospitalized OR emergency department OR emergency room OR inpatient OR inpatients OR outpatient OR outpatient OR outpatient clinics, hospital OR death OR mortality OR mortality rate OR morbidity OR hospital admission)

AND

(Environmental Justice OR disadvantaged OR minority OR overburdened OR socio-demographic OR sociodemographic OR socioeconomic OR disparity OR disparities OR (social AND (position OR hierarchy)) OR race OR ethnicity OR underserved OR disproportionately impacted OR racial groups OR White People [MeSH] OR Black People [MeSH] OR Hispanic [MeSH] or Latino Or Asian People [MeSH] OR American Indian or Alaska Native [MeSH] OR Native Hawaiian or Other Pacific Islander [MeSH] OR Ethnic and Racial Minorities OR vulnerable populations OR Medically Underserved Area)

AND (2020:2024[pdat])

Text D2. Concentration-response literature review risk of bias assessment tool

If a study gets a ‘yes’ for each of the 6 criteria below they will be determined to have lower risk of bias. If a study gets one or more ‘no’ they will be determined to be of higher risk of bias.

- Generalizability to Washington population:
    - Yes: Study conducted in Washington, the Pacific Northwest (including Oregon and Idaho), or nationwide in US AND is a representative or population-based sample
    - No: Non-population-based national study OR conducted in state/region outside of the PNW, including settings outside the US
- Participant selection:
    - Yes: For survey-based studies, response rate is higher than 60% AND the attrition rate is less than 20% in follow-up studies
    - No: For survey-based studies, response rate is <=60% AND the attrition rate is >=20% in longitudinal follow-up studies (or no mention of these metrics are made)
    - N/A: Not a survey-based or longitudinal study
- Quality of air pollution data:
    - Yes: Ambient levels of $PM_{2.5}$ and O_3 are estimated from representative monitoring data and/or published and validated air pollution prediction models. If prediction modeling is used, R^2 is reported and is >=0.80. Spatial resolution of exposure data is reported and is at census tract level or more granular.
    - No: Above criteria are not met (examples include studies that use only the nearest monitoring data to assign exposure to a population)
- Quality of health data:
    - Yes: The health outcome of interest is objectively measured OR taken from medical records OR taken from an appropriate surveillance system OR taken from questionnaires or interviews using a known scale or validated assessment method. Spatial resolution of the health data is reported and is at ZIP code level or more granular.
    - No: None of the above criteria are met
- Accounting for important confounders:
    - Yes: Important confounders are accounted for in the analysis. At a minimum, effect estimates are adjusted for/conditioned on age and sex.
    - No: Does not measure or adjust for confounding variables (or make mention thereof)

- General quality of methods/statistical modeling:
  - Yes: Study design, methods, data, assumptions, limitations are clearly stated. Statistical methods for analyses are appropriate, and the results provide enough precision to support the conclusions
  - No: Significant concerns about one or more of the above study characteristics

Table D2. Health effect estimates (% change) used for yearly $PM_{2.5}$ analysis.

Health Effect	Age Group	Effect Estimate (%) (Mortality/Hospital admissions associated with 10 µg/m³ increase in annual average $PM_{2.5}$)	Study Region	Source
Death- any cause	18 to 84	1.13 (12% overall increase) among all people; 1.04 (11% increase) among non-Hispanic whites; 1.40 (15% increase) among non-Hispanic Blacks; 0.95 (10% increase) among non-Hispanic Asians, AIAN, NHOPI, and two or more races; 1.82 (20% increase) among Hispanics	Nationwide U.S.	Pope et al., 2019
Death- any cause	65 to 99	0.7 (7.3% overall increase) among older adults; 0.61 (6.3% increase) among non-Hispanic whites; 1.89 (20.8% increase) among non-Hispanic Blacks; 0.92 (9.6% increase) among non-Hispanic Asians, AIAN, NHOPI, and two or more races; 1.1 (11.6% increase) among Hispanics	Nationwide U.S.	Di et al., 2017[23]
Death- cardiovascular disease	18 to 99	0.77 (8% increase)	Northern California	Alexeeff et al., 2023
Death- ischemic heart disease	30 to 99	2.15 (15% increase)	116 U.S. cities	Krewski et al., 2009
Death- ischemic heart disease	30 to 99	1.31 (14% increase)	Nationwide U.S.	Pope et al., 2019
Death- ischemic heart disease	30 to 99	1.40 (15% increase)	Nationwide U.S.	Jerrett et al., 2017
Death-lung cancer	30 to 99	1.31 (11% increase)	116 U.S. cities	Krewski et al., 2009[Error! Bookmark not defined.]

Health Effect	Age Group	Effect Estimate (%) (Mortality/Hospital admissions associated with 10 µg/m^3 increase in annual average $PM_{2.5}$)	Study Region	Source
Death-lung cancer	30 to 99	0.86 (13% increase)	Nationwide U.S.	Turner et al., 2016
Hospital admissions- acute myocardial infarction	18 to 99	1.13 (12% increase)	Northern California	Alexeeff et al., 2023 Error! Bookmark not defined.
Lung cancer	30 to 99	3.78 (42% increase)	Nationwide U.S. and 5 Canadian provinces	Gharibvand et al., 2016

AIAN = American Indian and Alaska Native, NHOPI = Native Hawaiian and Other Pacific Islander, PM = particulate matter, µg/m^3 = micrograms per cubic meter

Table D3. Health effect estimates used for daily $PM_{2.5}$ analysis.

Health Effect	Age Group	Effect Estimate (%) (Mortality/Hospital admissions associated with 10 µg/m^3 increase in daily $PM_{2.5}$)	Study Region	Source
Death- any cause	0 to 99	0.0145 (NA)% increase	150 cities across U.S. 46 states	Ito et al., 2013
Death- any cause	65 to 99	0.0638 (0.64% increase)	121 U.S. communities	Zanobetti et al., 2014
Death-cardiovascular disease	0 to 99	0.079 (0.79% increase)	7 U.S. states	Liu et al., 2022 Error! Bookmark not defined.
Death-respiratory disease	0 to 99	0.116 (1.16% increase)	7 U.S. states	Liu et al., 2022
ED visits - asthma	0 to 99	0.56 (4% increase)	Greater Tacoma, Washington	Mar et al., 2010
ED visits - asthma	0 to 17	0.414 (12.1% increase)	Seattle, Washington	Norris, G., et al., 1999

Health Effect	Age Group	Effect Estimate (%) (Mortality/Hospital admissions associated with 10 µg/m³ increase in daily $PM_{2.5}$)	Study Region	Source
ED visits - asthma	0 to 99	0.271 (3% increase)	Spokane, Washington	Slaughter, J. C., et al., 2005
Hospital admissions- asthma	0 to 64	0.332 (3.4% increase)	Seattle, Washington	Sheppard et al., 2003
Hospital admissions- nonfatal acute myocardial infarction	18 to 99	0.198 (2% increase)	King County, Washington	Sullivan et al., 2005
Hospital admissions- nonfatal acute myocardial infarction	18 to 99	0.225 (2.25% increase)	26 U.S. Communities	Zanobetti et al., 2009
Hospital admissions- all respiratory	65 to 99	0.207 (2.07 % increase)	26 U.S. Communities	Zanobetti et al., 2009Error! Bookmark not defined.

ED = emergency department, PM = particulate matter, µg/m³ = micrograms per cubic meter

Table D4. Annual health effect estimates used for seasonal O_3 analysis.

Health Effect	Age Group	Effect Estimate (Mortality associated with 10 ppb increase in O_3)	Study Region	Source
Death- any cause	65 to 74	0.119 (1.2% increase)	Nationwide U.S.	Di et al., 2017Error! Bookmark not defined.
Death- any cause	75 to 84	0.04 (0.4% increase)	Nationwide U.S.	Di et al., 2017Error! Bookmark not defined.
Death- any cause	85 to 99	0.149 (1.5% increase)	Nationwide U.S.	Di et al., 2017Error! Bookmark not defined.

ED = emergency department, PM = particulate matter, µg/m³ = micrograms per cubic meter

Table D5. Annual health effect estimates used for daily 8-hour maximum O_3 analysis.

Health Effect	Age Group	Effect Estimate (Mortality/hospital admissions associated with 10 ppb increase in daily O_3)	Study Region	Source
Death- any cause	0 to 99	0.051 (0.32% increase)	48 U.S. cities	Zanobetti and Schwartz, 2008
ED visits - asthma	0 to 99	1.044 (multiple estimated increases in 0 to 17); 0.77 (multiple estimated) increases in 18 to 99	Seattle, Washington	Mar and Koenig, 2009
Hospital admissions-All Respiratory	65 to 99	0.49 (NA%) increase	Tacoma, Washington	Schwartz, 1995

ED = emergency department, PM = particulate matter, ppb = parts per billion

Appendix E. Community Reports

Ellensburg Community Report[188]

Everett Community Report[189]

George and West Grant County Community Report[190]

South King County Community Report[191]

Mattawa Community Report[192]

Moxee Valley Community Report[193]

Northeast Puyallup Community Report[194]

North Seattle and Shoreline Community Report[195]

South Seattle Community Report[196]

Spokane and Spokane Valley Community Report[197]

South and East Tacoma Community Report[198]

Tri-Cities to Wallula Community Report[199]

Vancouver Community Report[200]

Wenatchee and East Wenatchee Community Report[201]

East Yakima Community Report[202]

Lower Yakima Valley Community Report[203]

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[188] https://apps.ecology.wa.gov/publications/parts/2502037part1.pdf
[189] https://apps.ecology.wa.gov/publications/parts/2502037part2.pdf
[190] https://apps.ecology.wa.gov/publications/parts/2502037part3.pdf
[191] https://apps.ecology.wa.gov/publications/parts/2502037part4.pdf
[192] https://apps.ecology.wa.gov/publications/parts/2502037part5.pdf
[193] https://apps.ecology.wa.gov/publications/parts/2502037part6.pdf
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