

# Spokane Climate Impacts and Climate Justice

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*The WA Department of Commerce climate planning grant is supported with funding from Washington's Climate Commitment Act. The CCA supports Washington's climate action efforts by putting cap-and-invest dollars to work reducing climate pollution, creating jobs, and improving public health. Information about the CCA is available at [www.climate.wa.gov](http://www.climate.wa.gov).*

# 1 Executive Summary

## 1.1 Objectives

Climate change does not impact everyone equally. Climate impacts hit people wherever they live, work, and play in Spokane—but those impacts are not distributed evenly. This memo identifies climate hazards and vulnerable groups to inform the City of Spokane’s Climate Risk and Vulnerability Assessment (CRVA). Following HB 1181 requirements and guidelines, the approach prioritizes climate justice by focusing on vulnerable populations and overburdened communities. While climate impacts do not necessarily follow boundaries, the focus of this memo and analysis is the jurisdictional boundary for City of Spokane. This memo uses local and regional assessments, spatial mapping, and peer reviewed publications to:

- Identify **impacts due to a changing climate** affecting Spokane.
- Highlight **unequal climate impacts** and how they disproportionately affects communities of color, Tribal and Indigenous peoples, and lower-income populations in Spokane, creating a need for climate resilience focused on equitable outcomes.
- Guide climate justice and resilience planning by **informing the community and Tribal engagement processes**, including specific communities to engage in depth.
- Inform the City’s Comprehensive Plan (2026-2046) to **develop policies** that guide Spokane’s preparedness and resilience towards evolving climate risks.

Climate change refers to the long-term shifting of environmental conditions and weather patterns, primarily caused by human activity, particularly the emission of GHG emissions from burning fossil fuels.

It affects the environment with rising temperatures, drought, flooding, wildfire risk and smoke, and in turn impacts systems like water, energy, transportation, ecosystems, health, food, and more.

## 1.2 Key Findings

A changing climate is creating significant risks for Spokane, with a range of impacts that disproportionately affect the City's most vulnerable populations and overburdened communities<sup>1</sup>.

This assessment synthesizes climate science to identify climate trends that affecting Spokane:

- **Rising Temperatures:** Average annual temperatures in Spokane have increased by 2°F since 1950, and peak August temperatures, a key stressor during summer, have risen by 3.5°F since 1979. Summer temperatures are projected to increase by another 3.6°F by mid-century (2046) and up to 11°F by the end of the century (2099). Rising temperatures vary across the City, with some neighborhoods having higher peak temperatures than other areas.
- **Extreme Weather Events:** Changing climate trends are linked to severe weather events, like the 2021 heat dome which resulted in 19 heat-related deaths in Spokane, overwhelming local emergency services and infrastructure. According to Spokane County, several of those deaths occurred in the Central City (e.g., Riverside neighborhood) and Northeast Spokane (e.g., Nevada/Lidgerwood neighborhood) (Gonzaga Institute for Climate, Water, and the Environment, 2023).
- **Changing Precipitation Patterns:** Summer rainfall is projected to decline by 14% by 2099, leading to increased drought conditions, while streamflow in the winter may rise by 84%, increasing flood risks.
- **Wildfire Smoke and Air Quality:** Wildfire danger days are projected to rise, increasing air pollution and unhealthy and hazardous air quality levels from smoke and posing respiratory health risks, especially in neighborhoods already experiencing poor air quality.

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<sup>1</sup> Washington State Department of Commerce, in its Intermediate Planning Guidance, provides these definitions:

**Vulnerable populations:** Groups that are more likely to be at higher risk for poor health outcomes in response to environmental harms, due to: adverse socioeconomic factors such as unemployment, high housing and transportation costs relative to income, limited access to nutritious food and adequate health care, linguistic isolation, and other factors that negatively affect health outcomes and increase vulnerability to the effects of environmental harms; and, sensitivity factors, such as low birth weight and higher rates of hospitalization. Vulnerable populations include but are not limited to: racial and ethnic minorities; low-income populations; and, populations disproportionately impacted by environmental harms.

**Overburdened community:** Geographic areas where vulnerable populations face combined, multiple environmental harms and health impacts.

- **Decreased Snowpack and Water Resource Strain:** Snowpack, critical for water supplies, may drop below 75% of current levels by the end of the century, straining water resources in warmer months.

Additionally, this assessment examined regional and national assessments and mapping to better understand vulnerable populations and overburdened communities in Spokane more at risk to climate impacts (see Exhibit 1-1):

- Communities at heightened risk include Native Americans, Black and Latino residents, low-income residents, houseless individuals, youth, older adults, people with disabilities, those with chronic health conditions, outdoor workers, and residents in areas with high environmental justice concerns.

### Key vulnerable populations in Spokane:

- Native Americans
- Black and Latino residents
- Low-income residents and those experiencing poverty
- Houseless residents (sheltered, unsheltered, unstably housed)
- Youth and older residents
- Residents with disabilities
- Residents with chronic health conditions
- Outdoor workers
- Residents living in environmental justice communities/areas that are exposed to environmental harms like air pollution.

- Vulnerable populations often live in regions prone to climate hazards—such as extreme heat, pollution, wildfire risk, and flood-prone zones—or in neighborhoods with older infrastructure less able to withstand climate impacts.

- Data from the Washington Tracking Network Health Disparities Map and the EPA's Environmental Justice Screening Tool pinpoint overburdened communities, particularly along the I-90 corridor and Northeast Spokane, where indicators like high asthma prevalence and urban heat exposure are prevalent.

This analysis underscores the need for resilience planning focused on Spokane's most affected areas and communities—those facing compounding climate and social vulnerabilities.

**Exhibit 1-1: Climate Hazards and Impacts**

Climate Impact	Climate indicator(s)	Projected (RCP8.5) or historic change	Timeframe	Data source
<b>AQI Index</b>	PM2.5 concentrations	Spikes trending in recent years	1999-2024	A.
<b>Annual Average Temperature</b>	Historic change in annual temperature	Increase of 2°F (1.1°C)	1895-2024	B.
<b>Summer (Jun-Aug) Average Temperature</b>	Projected change in temperature	Increase of 11°F (6.1°C)	Baseline (1951-2005) to 2099	C.
<b>Annual Precipitation</b>	Projected % change in total annual rainfall	10% increase	Baseline (1951-2005) to 2099	C.
<b>Summer Precipitation (Jun-Aug)</b>	Projected % change in total summer rainfall	14% decrease	Baseline (1951-2005) to 2099	C.
<b>February Streamflow</b>	Projected % change in Feb streamflow along the Spokane River	84% increase	Baseline (1951-2005) to 2070-2099	D.
<b>May Streamflow</b>	Projected % change in May streamflow along the Spokane River	60% decrease	Baseline (1951-2005) to 2070-2099	D.
<b>Drought</b>	Projected change in the rate of water drying from soil and plants	Increase of 8.2 inches (208 mm)	Baseline (1951-2005) to 2099	C.

Climate Impact	Climate indicator(s)	Projected (RCP8.5) or historic change	Timeframe	Data source
<b>Snowpack</b>	Projected likelihood of the April 1 snowpack being below 75%	100%	Baseline (1980-2009) to 2070-2099	E.
<b>Wildfire Danger</b>	Projected change in "extreme" fire danger days	Increase of 11 days	Baseline (1971-2000) to 2070-2099	F.

- A. (EPA, Air Data - Multiyear Tile Plot, 2023)
- B. (NOAA National Center for Environmental Information, 2024)
- C. (Hegewisch & Abatzoglou, Future Time Series, n.d.)
- D. (Hegewisch, Abatzoglou, & Chegwiddden, Future Streamflows, n.d.)
- E. (Chegwiddden, Nijssen, Rupp, & Mote, 2017)
- F. (Hegewisch & Abatzoglou, Future Boxplots, n.d.)

### 1.3 Next Steps

In the forthcoming CRVA, the project team will build upon this initial analysis by integrating findings from a policy audit and community engagement activities. The CRVA will:

- Systematically assess climate vulnerability by prioritizing climate hazards and addressing climate justice concerns.
- Identify physical and social vulnerabilities across five focus areas, using data from various sources to evaluate exposure, sensitivity, and adaptive capacity.
- In accordance with the [Community Engagement Plan](#), collaborate with internal and external advisory groups, community members, and Tribal members to understand climate risks from different lived experiences. This includes tailored outreach strategies to honor Tribal governance and cultural protocols, while ensuring inclusion of urban Tribal members.
- Include narratives on key vulnerabilities and spatial analysis of significant climate impacts and vulnerabilities in Spokane.



The CRVA's comprehensive assessment will guide future strategies for resilience planning across identified focus areas, enhancing Spokane's preparedness for climate risks while supporting the needs of vulnerable populations and addressing requirements in HB 1181.

# 2 Background

Changing climate trends do not impact everyone equally. Climate impacts hit people wherever they live, work, and play in Spokane—but those impacts are not distributed evenly. Who faces the greatest risk depends on their level of exposure to climate impacts and their capacity to respond and adapt. Communities of color, Tribal and Native American peoples, and communities with lower wealth and incomes tend to face the greatest climate risks. Being on the frontlines of worsening climate and environmental threats creates or exacerbates social, economic, and health issues (Front and Centered; WA State Department of Commerce, 2023).

**The City of Spokane is currently undergoing an effort to plan for climate resilience that enables environmentally equitable and just outcomes.** Climate impacts—including drought, heat, and smoke from wildfires—are already affecting Spokane and are projected to worsen under a variety of climate scenarios. Communities in Spokane may experience climate impacts in many ways, such as disruptions to the local economy, impacts to physical and mental health, stressors to infrastructure systems, effects on community wellbeing, and harms to local ecosystems.

This memo identifies climate hazards and vulnerable populations across Spokane to support the development of a detailed Climate Risk and Vulnerability Assessment (CRVA) to be completed in 2025. The approach used in this memo and the forthcoming CRVA is designed to center opportunities for building climate resilience and climate justice across Spokane. The Washington Department of Commerce (“Commerce”) describes the goal of climate resilience as to “improve climate preparedness, response and recovery efforts” (Commerce, 2024). Furthermore, this

### Memo Objectives:

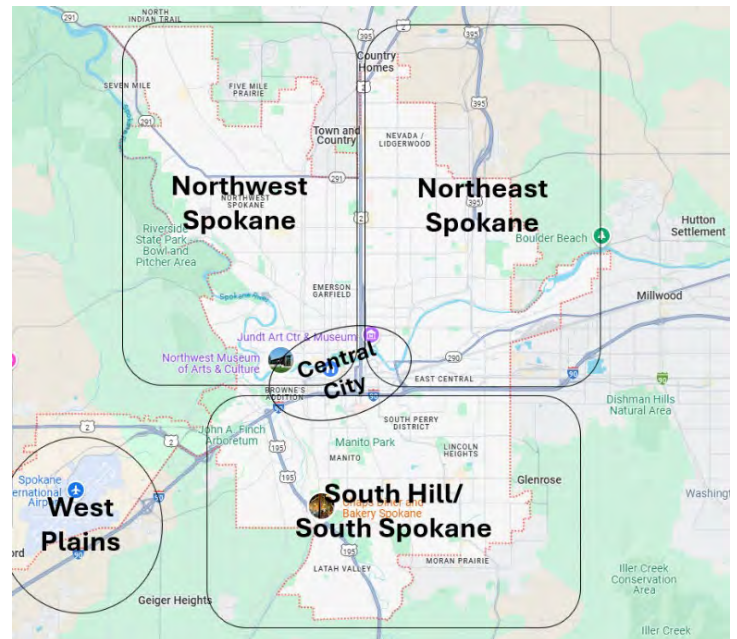
- Identify Impacts due to a changing climate
- Highlight Unequal Climate Impacts
- Guide Climate Justice and Resilience Planning and Engagement
- Inform Future Policies

document, in compliance with [HB 1181](#), is part of the City's Comprehensive Plan update for 2026-2046<sup>2</sup>.

## 2.1 Climate Justice Overview

Climate justice focuses on addressing the unequal impacts of the changing climate by prioritizing the health and safety of those who face the greatest risk from climate events (Washington Department of Health, n.d.). Climate justice is an ethical framework that centers climate-vulnerable populations and overburdened communities.

Overburdened community refers to a community within a geographic area where vulnerable populations face combined, multiple environmental harms and health impacts, and includes, but is not limited to, highly impacted communities as defined in [RCW 19.405.020](#).



**Exhibit 2-1 Regions of Spokane**

The Department of Commerce provides further guidance for climate justice in the [Summary Report: Climate Justice in Growth Management](#), which centers on addressing the unequal climate impacts and prioritizing communities and individuals who face the greatest risk from climate events. The report details how the Washington Environmental Health Disparities map and various other applicable resources can help outline the potential cumulative environmental and human health harms and benefits of different agency actions. These actions are assessed using the relevant data to identify the appropriate communities for equitable engagement efforts. This process can be used to identify ways to prevent further environmental harms and deliver community-defined benefits. This memo and the

<sup>2</sup> The Washington State Growth Management Act (GMA) was amended in 2023 under House Bill (HB) 1181, requiring cities and counties to integrate climate mitigation and resilience policies into comprehensive plan updates. The required policy changes address greenhouse gas emissions and climate impacts, while considering co-benefits of climate action and integration with other planning elements such as housing, transportation, and land use. As a large city, the City of Spokane is required to complete both a Resilience Sub-Element and a Greenhouse Gas Emissions Sub-Element for its Comprehensive Plan (Washington State Department of Commerce, Climate Element Planning Guidance, 2023).

[Community Engagement Plan](#) respond to those directives. The memo considers the different geographic regions of Spokane (see Exhibit 2-1).

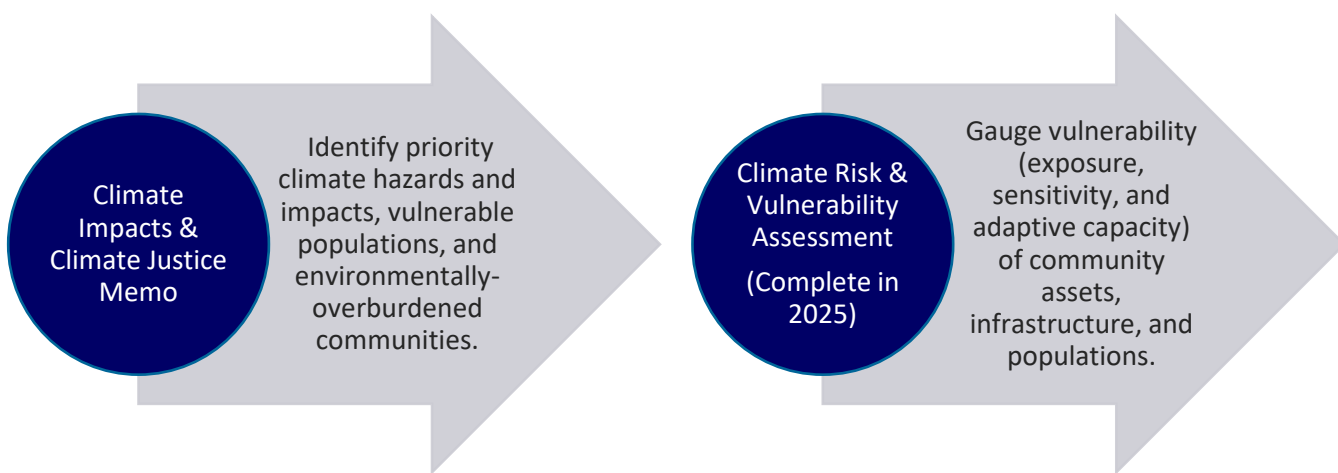
**Climate justice** focuses on addressing the **unequal impacts of climate change** by prioritizing the health and safety of **those who face the greatest risk from climate events** (Washington Department of Health, n.d.).

A key climate justice consideration in Spokane are climate related impacts on Tribal members and Native Americans. The Spokane, Kalispel, and Coeur d'Alene Tribes are key rightsholders in the area, and have deep ancestral, traditional, historical, and ongoing connections to the land. From a Tribal perspective, climate justice is about safeguarding the rights, lands, and cultural heritage of Indigenous communities as they face the climate impacts. It emphasizes the need for policies recognizing and respecting the traditional knowledge and practices of Native peoples. Climate justice in this context is about ensuring Indigenous

communities have a say in decisions affecting their territories and livelihoods, addressing historical injustices, and supporting their resilience against the changing climate. Thus, Tribal and Native American justice concerns, particularly regarding sovereign rights, cultural resources, and urban Native Americans, are a priority in this work.

## 2.2 Climate Risk and Vulnerability Assessment (CRVA)

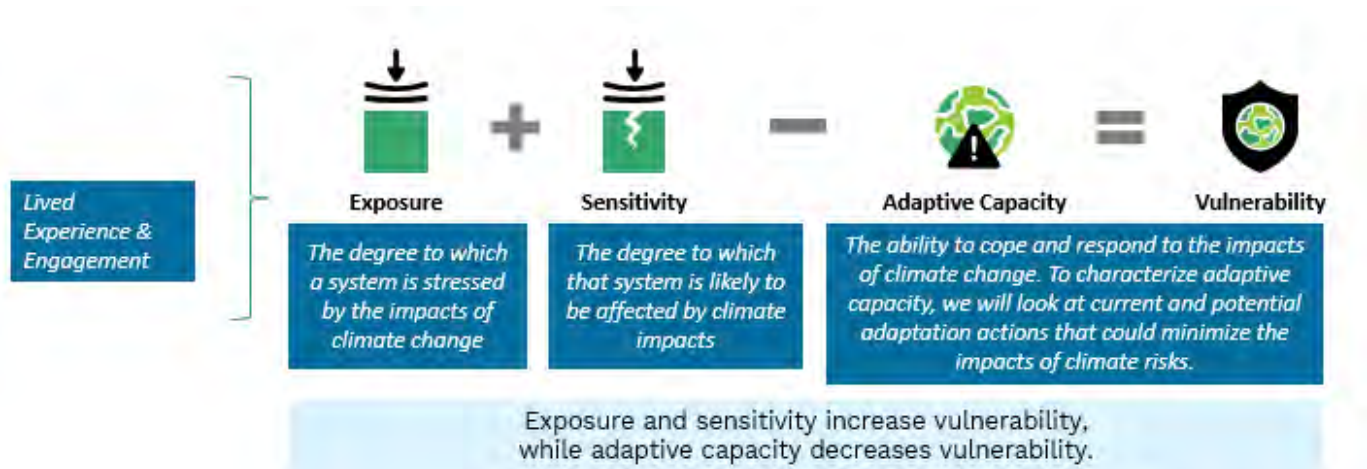
This memo on climate impacts and climate justice implications across Spokane is an initial product that precedes a comprehensive CRVA analyzing future changes in hazard risk due to the changing climate.



The CRVA will assess the **exposure, sensitivity** and **adaptive capacity** of key assets and communities to understand what actions the City can take to increase resilience from the climate impacts (Exhibit 2-2). The information used for the CRVA will include metrics identified by

datasets, reports, and studies, as well as qualitative information pertaining to the lived experiences of community members, city staff and partners, community organizations and businesses, and Tribal members to understand climate impacts from a range of perspectives.

**Exhibit 2-2: Key components of the Climate Risk and Vulnerability Assessment**



Throughout the CRVA process, the project team will work with City employees, agency and institutional partners, Tribal members and entities, community-based organizations, and Spokane community members to develop a shared understanding of climate risks and the vulnerability of priority community assets and vulnerable populations.

## 2.3 Climate Resilience Policy and Climate Justice Context

Spokane, with a vision of “an exceptional sense of community, healthy environment, and high quality of life,” is the second largest city in Washington state and a state leader in ambitious community planning efforts (City of Spokane, Shaping Spokane: Comprehensive Plan for the City of Spokane, 2017). Spokane has already established a goal to incorporate strategies “to reduce Spokane’s carbon footprint and support local, state, and national efforts to limit the release of greenhouse gases (“GHG”) into the atmosphere, incentivize the growth and development of a local clean energy economy, and secure the economic benefits of becoming an environmentally-responsible, sustainable, and resilient city” (City of Spokane, Spokane Municipal Code - Section 15.05.010, 2017). In 2021, the City Council adopted a Sustainability Action Plan (City of Spokane, Sustainability Action Subcommittee, n.d.).

The CRVA and the Climate Element for the City’s Comprehensive Plan are an opportunity for **the City of Spokane to take further action to foster climate resilience**, responding to community priorities and new state requirements. While changes in climate trends will affect everyone in Spokane, the impacts will not be experienced by everyone in the same way. Some

community members will experience climate impacts first and worse, due to greater exposure to heat, flooding, wildfire smoke and more, and with less ability to respond, adapt, and decide. Climate justice is focused on addressing unequal climate impacts as we prepare for and recover from climate events, with the goals of making sure no one is left behind in the climate crisis while transitioning to a healthier and more fair future for all living beings (Washington Department of Health, n.d.).

In Spokane, key **overburdened communities and vulnerable groups**

include Native Americans, Black and Latino

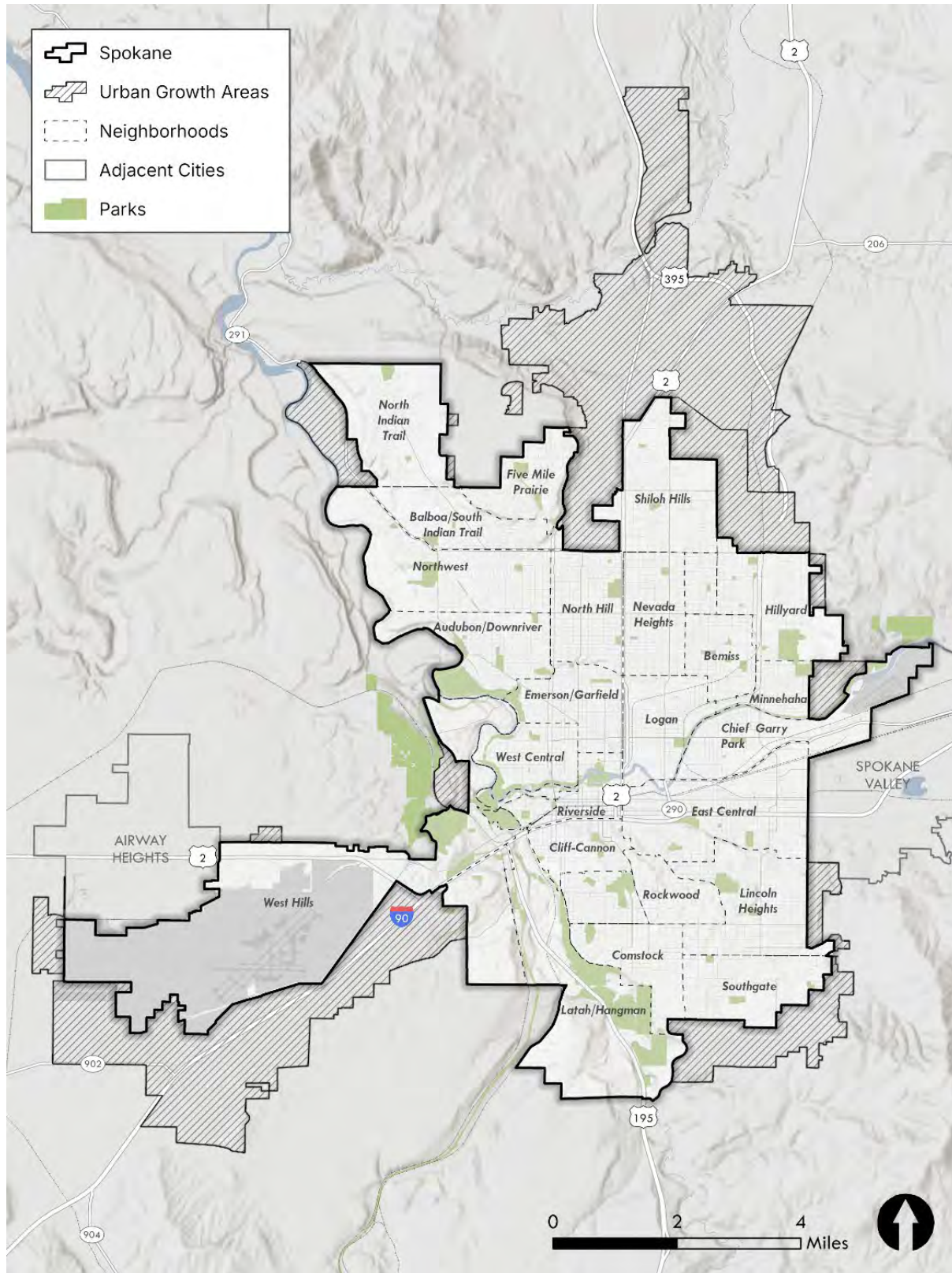
residents, low-income residents and those experiencing poverty, houseless people, residents with disabilities, residents with chronic health conditions, youth and older residents, outdoor workers, and people exposed to environmental harms like air pollution ([see Section 5](#)).

## 2.4 Methodology

Cascadia Consulting Group (“Cascadia”) used reports, regional assessments, spatial analysis, and peer-reviewed resources to identify observed and projected climate trends relevant for Spokane and examine vulnerable populations and health disparities (see Exhibit 2-4 and Exhibit 2-5). Throughout this memo, regions (see Exhibit 2-1) and neighborhoods (see Exhibit 2-3) of the City are referenced.



### Exhibit 2-3: Map of Spokane Neighborhoods



Source: BERK 2024

**Exhibit 2-4: Key sources used to identify historical and projected climate hazards for Spokane. Full list of sources in [References](#).**

### Climate Impacts

- NOAA Climate at a Glance Time Series Tool
- The U.S. Global Change Research Program's Fifth National Climate Assessment, Northwest chapter and national climate impacts for different hazards and sectors
- NOAA's National Integrated Drought Information System
- Local, regional, and state-level assessments such as the Spokane Sustainability Action Plan, Spokane County Hazard Mitigation Plan, and resources from Washington Department of Environmental Quality and other state agencies
- University of Washington, Climate Impacts Group, Climate Mapping for a Resilient Washington

**Exhibit 2-5: Key sources which will be used to identify Social Vulnerability and Health Disparities for the CRVA. Full list of sources in [References](#).**

### Social Vulnerability and Health Disparities

- U.S. Census Bureau, American Community Survey
- U.S. Center for Disease Control, CDC/ATSDA Social Vulnerability Index
- U.S. Environmental Protection Agency, Environmental Justice Screener
- Washington Department of Health, Health Disparities Map
- University of Washington Center for Health and the Global Environment, Climate Health and Risk Tool
- Expert and community input (See Engagement Plan), with attention to equitable engagement of people impacted first and worst



# 3 Climate Hazards and Impacts

## 3.1 Climate Hazards and Impacts

Climate change refers to the long-term shifting of environmental conditions and weather patterns, primarily caused by human activity, particularly the emission of greenhouse gas emissions (GHGs) from burning fossil fuels. Higher levels of atmospheric GHGs, notably carbon emissions, have driven increases in land and ocean temperatures since the Industrial Revolution, leading to various biophysical impacts such as more frequent and intense heatwaves, wildfires, storms, droughts, melting glaciers, sea-level rise, and ocean acidification.

Communities across Washington state, including Spokane, are already experiencing climate impacts, including changing precipitation patterns, warming temperatures, and increased wildfires and smoke events. From 1950 to 2024, average annual temperatures in Spokane

increased by 2°F (Appendix A; NOAA, n.d.).

Additionally, maximum temperatures in August, which reflect summer heat stress, have risen by 3.5°F between 1979 and 2023 (Hegewisch, Abatzoglou, & Chegwidde, Future Streamflows, n.d.).

The June 2021 heat dome event, partially attributable to climate change, was associated with hundreds of premature deaths across Washington state, including 19-heat-related deaths in Spokane (Gonzaga Institute for Climate, Water & Environment, 2024). It also affected Spokane's infrastructure systems and stretched the City's emergency response and social service systems.

### Climate Change Projections:

This memo and the forthcoming CRVA, uses Representative Concentration Pathway (RCP) 8.5, which represents a 'business-as-usual' scenario in which emissions continue at their current trajectory. It is a high emissions scenario and projects a global temperature warming of about 4.3 °C by 2100 relative to pre-industrial temperatures. Climate trends under RCP 8.5 do not differ significantly compared to RCP 4.5 for Spokane during the planning horizon.

The key climate risks in Spokane under the RCP 8.5 emissions scenario are summarized in Exhibit 3-1 below, with a more detailed Climate Impacts Summary in Appendix A. Notable trends include increasing summer heat, warmer winters, decreasing snowpack, increasing

stream temperatures, increasing risk of wildfire, and increases in wildfire smoke. These climate hazards will be used to assess climate vulnerability across community assets and vulnerable community groups in greater detail, identifying who and what in the city will be exposed and the level of sensitivity to these impacts.

**Exhibit 3-1: Climate Hazards and Impacts**

Climate Impact	Climate indicator(s)	Projected (RCP8.5) or historic change	Timeframe	Data source
<b>AQI Index</b>	PM2.5 concentrations	Spikes trending in recent years	1999-2024	A.
<b>Annual Average Temperature</b>	Historic change in annual temperature	Increase of 2°F (1.1°C)	1895-2024	B.
<b>Summer (Jun-Aug) Average Temperature</b>	Projected change in temperature	Increase of 11°F (6.1°C)	Baseline (1951-2005) to 2099	C.
<b>Annual Precipitation</b>	Projected % change in total annual rainfall	10% increase	Baseline (1951-2005) to 2099	C.
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<b>February Streamflow</b>	Projected % change in Feb streamflow along the Spokane River	84% increase	Baseline (1951-2005) to 2070-2099	D.
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<b>Drought</b>	Projected change in the rate of water drying from soil and plants	Increase of 8.2 inches (208 mm)	Baseline (1951-2005) to 2099	C.

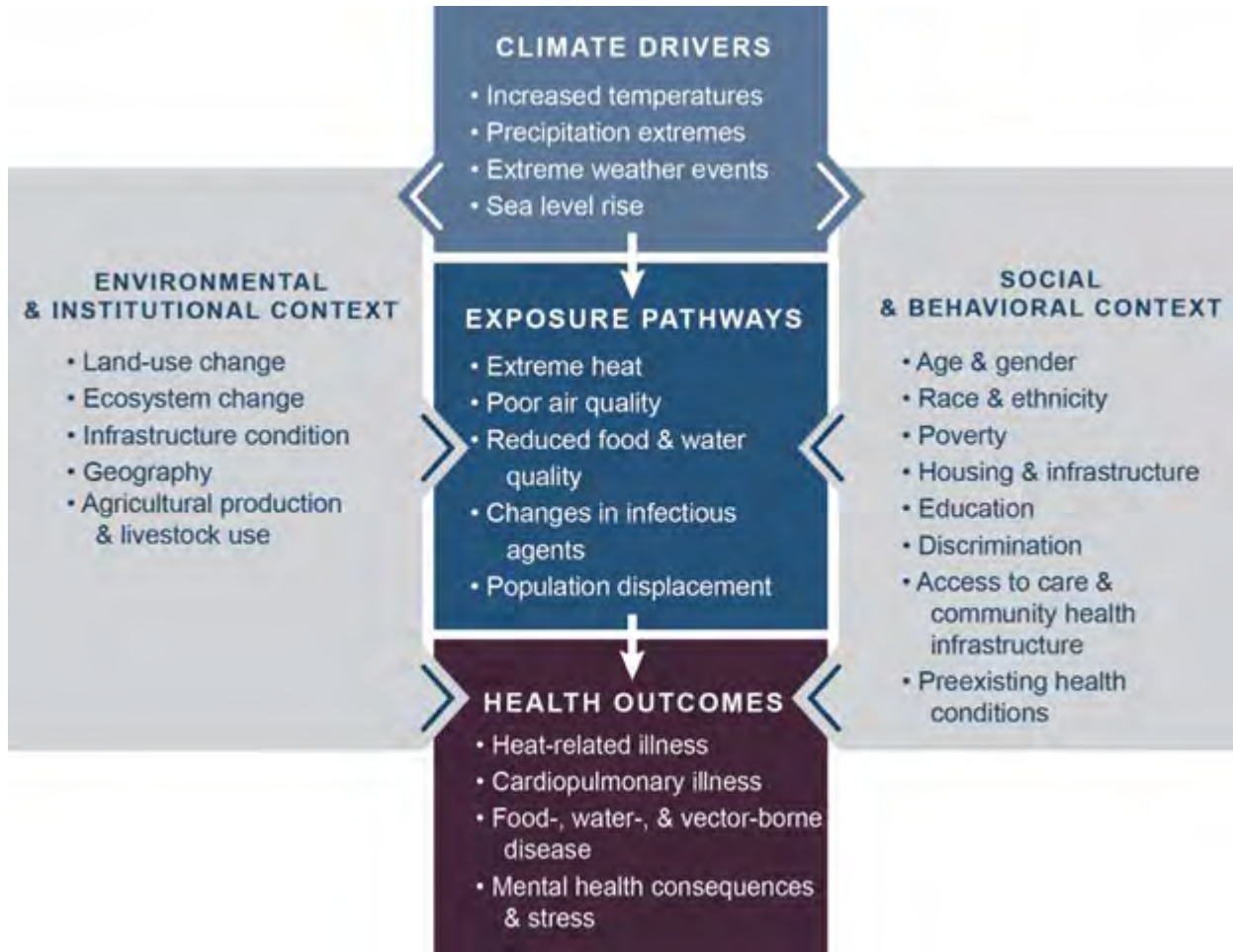
Climate Impact	Climate indicator(s)	Projected (RCP8.5) or historic change	Timeframe	Data source
<b>Snowpack</b>	Projected likelihood of the April 1 snowpack being below 75%	100%	Baseline (1980-2009) to 2070-2099	E.
<b>Wildfire Danger</b>	Projected change in "extreme" fire danger days	Increase of 11 days	Baseline (1971-2000) to 2070-2099	F.

- A. (EPA, Air Data - Multiyear Tile Plot, 2023)
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# 4 Vulnerable Populations and Health Disparities

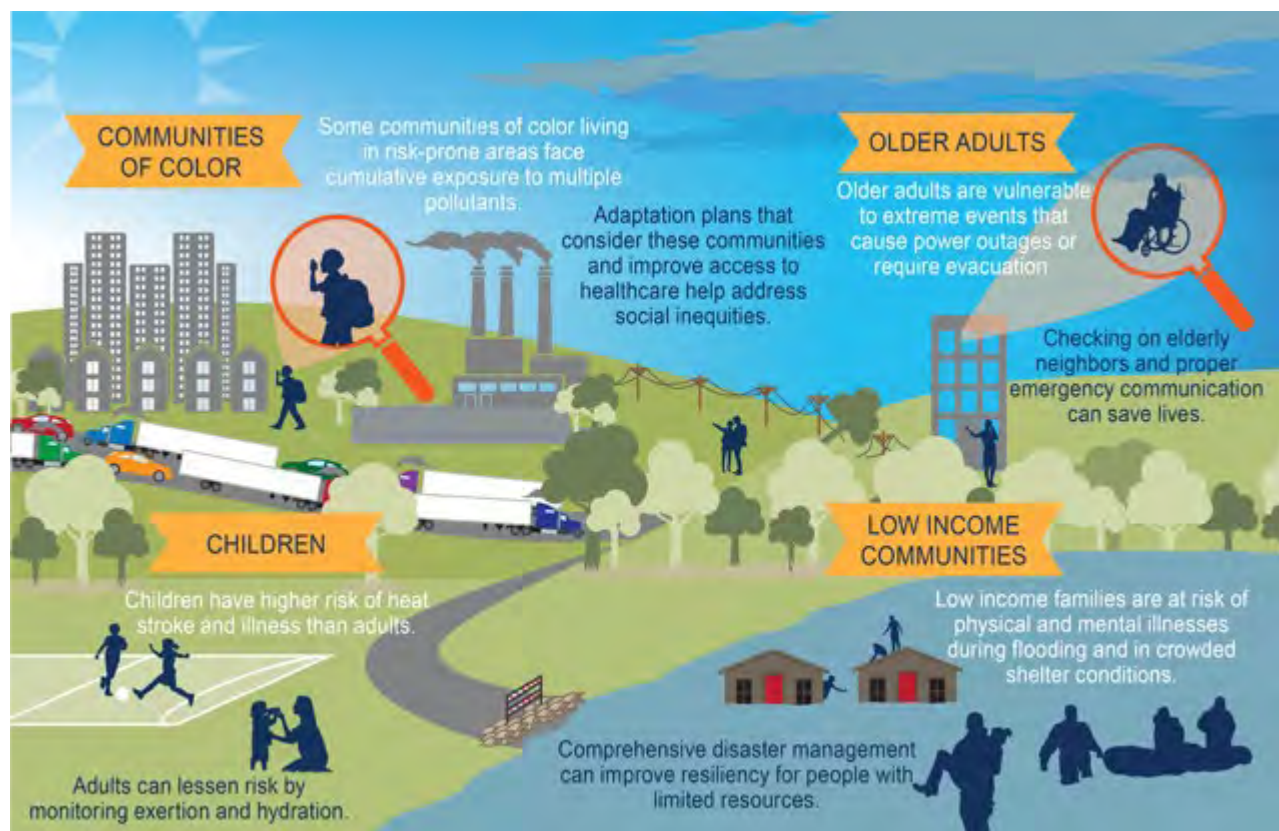
Not one person in Spokane is immune to health and other impacts associated with a changing climate. However, some individuals and communities are more vulnerable to health risks due to social, political, and economic factors, which is a key focus of climate justice. Specific communities and populations are more likely to experience barriers to preparing for and recovering from climate events. Many of these barriers are connected to institutional and structural discrimination that often put these communities and populations in challenging life circumstances and unhealthy environments (WA Department of Health, n.d.). This is also collectively known as social determinants of health. These determinants influence daily living conditions—like living and working environments, access to healthcare, and opportunities for healthy behaviors. In disadvantaged groups, social determinants of health interact with climate vulnerability, and climate impacts can exacerbate inequitable social conditions. These can lead to greater exposure to risks, increased sensitivity to health impacts, and reduced ability to adapt to climate impacts (see Exhibit 4-1 and Exhibit 4-2 below).

### Exhibit 4-1: Climate drivers and determinants of health outcomes



Source: [The Impacts of Climate Change on Human Health in the United States: A Scientific Assessment](#), USGCRP, 2016

## Exhibit 4-2: Climate impacts and health equity



Source: *The Fourth National Climate Assessment*

As the Environmental Protection Agency (EPA) notes (EPA, Climate Change and the Health of Socially Vulnerable People, n.d.) certain groups may be more at risk because:

- They may live in **locations that are prone to climate-related health hazards**, such as flooding, extreme heat, wildfire risk, and wildfire smoke, which may be worsened by decades of infrastructural disinvestment and/or proximity to other pollution sources.
- They can have greater rates of **existing medical conditions**, such as physical disabilities, poor mental health, kidney disease, diabetes, asthma, or heart disease, which can be worsened by climate impacts.
- They may live in areas with **poorly maintained, aging infrastructure, or areas that are historically isolated with limited connectivity** that may not be able to handle climate-related events or be able to adapt as well. Such infrastructure can include buildings, utilities, transportation, and health care systems. Individuals in these communities may also struggle to access **resources and care** during and after extreme weather events.



- They may **have limited financial resources or cultural, language, or citizenship barriers** that restrict their access to health care, social services, and safe, nutritious food (EPA, Climate Change and the Health of Socially Vulnerable People, n.d.).

## 4.1 Identifying Vulnerable Populations in Spokane

The key groups in Spokane identified in this assessment as being vulnerable to climate impacts include Native American communities, Black and Latino residents, residents experiencing poverty, and the houseless residents. Additionally, youth and older adults, residents with disabilities or chronic health conditions, outdoor workers, and those living in communities marginalized by underinvestment and overburdened with significant environmental hazards (e.g., air pollution) are also recognized as high-priority groups.

### Key vulnerable populations in Spokane:

- Native Americans
- Black and Latino residents
- Low-income residents and those experiencing poverty
- Houseless residents (unsheltered, in emergency shelters, unstably housed)
- Youth and older residents
- Residents with disabilities
- Residents with chronic health conditions
- Outdoor workers
- Residents living in environmental justice communities/areas that are exposed to environmental harms like air pollution.

Individuals who belong to multiple vulnerable groups may face intersecting risks, heightening their overall vulnerability. For example, a low-income construction worker with asthma might feel they have to work during a wildfire smoke event because they cannot afford to take time off, risking an asthma attack and hospitalization or lost wages. Such individuals face a disproportionate share of social, economic, and environmental challenges, which are compounded by climate impacts like extreme heat, wildfire risk, and poor air quality, and exasperated by resource disparities. The CRVA will use an intersectional<sup>3</sup> lens to reflect a climate-justice-forward approach, which considers how different aspects of a person's lived experience and identity interact in unequal and disparate

ways in a term coined by legal scholar Kimberlé Crenshaw in 1989 (Crenshaw, 1989).

<sup>3</sup> "Intersectional" means that there is an interaction between and a cumulative effect of experiencing multiple forms of discrimination affecting the daily lives of individuals.

The following highlights from the U.S. Census Bureau profile provide context about Spokane's communities (also see Exhibit 4-3, summarizing populations vulnerable to climate impacts, and Exhibit 4-4 to Exhibit 4-9, maps of select demographics)<sup>4</sup>.

- **Native Americans:** Spokane is home to about 230,000 people. Nearly 2% identify as American Indian or Alaska Native alone (while more may identify as two or more races). Meanwhile, the Spokane region is home to a much larger population of Tribal and Native residents from a variety of U.S. Tribes and First Nations of Canada (U.S. Census Bureau, 2022). The Spokane, Kalispel, and Coeur d'Alene all have Tribal government presences in the region.
- **Non-White:** More than 20% of residents identify as Asian, Black or African American, Native Hawaiian and Pacific Islander, or other races. Additionally, around 7% of residents are Hispanic or Latino (of any race).
- **Low Income:** The median income across households is about \$65,000 (lower than the County and state median), with about 13% of the population living below the federal poverty level. Census block groups with the lowest median household income are primarily located in the central city, which also shows the highest poverty rates (see Exhibit 4-5 and Exhibit 4-6).
- **Disabled Residents:** About 18% of residents have disabilities, higher than in the state (13.5% per the Census Bureau). Central City and Northeast Spokane have a higher proportion of individuals with disabilities (see Exhibit 4-7).
- **Under 5:** Several Census block groups in Northeast Spokane have the highest proportion of the population under 5 years of age in the city (see Exhibit 4-8).
- **Over 65:** When looking at the percentage of residents aged 65 and over by Census block group, the highest shares of older residents are found in areas of upper Northeast Spokane, central city/downtown, and the South Hill (see Exhibit 4-9).

As Spokane plans for a climate-resilient future, it is critical to incorporate the unique needs and adaptive capacities of these communities. Targeted research and direct community engagement are essential to effectively address the compounded vulnerabilities and promote climate justice within Spokane's diverse populations. This section serves as a foundation for exploring specific vulnerabilities, resilience challenges, and recommended strategies for enhancing Spokane's climate resilience across these key communities.

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<sup>4</sup> The maps in this section highlight community demographics within Spokane and its Urban Growth Areas (UGAs). The source data, collected from the American Community Survey, is based on block groups, which often extend beyond city and UGA boundaries (U.S. Census Bureau, 2022). To avoid assumptions about population distribution within each block group, all calculations were performed using these full block group geographies. For mapping clarity and to emphasize the planning area, sections of block groups that intersect with the city of Spokane and its UGAs but are located outside these boundaries are not displayed.

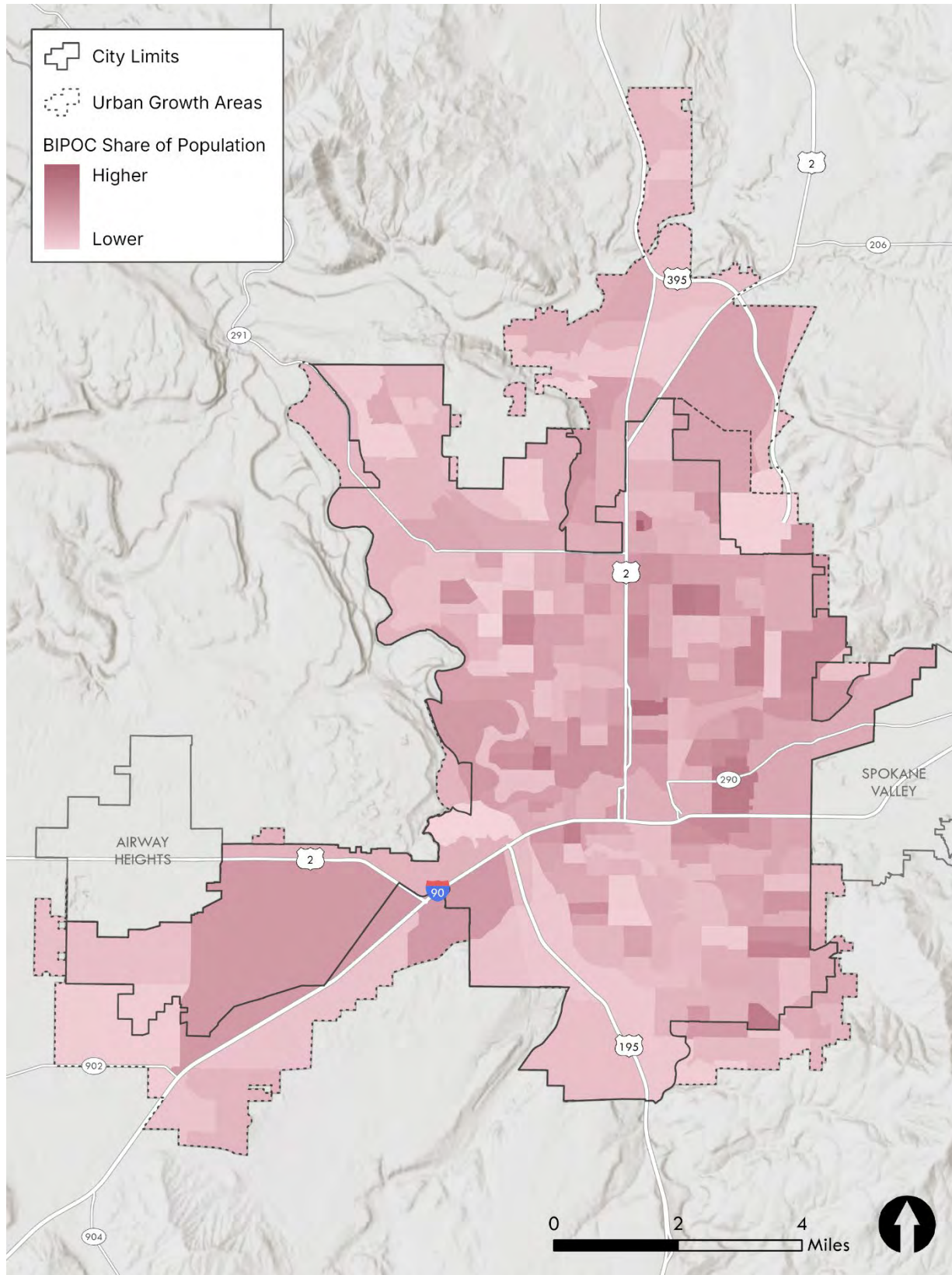


**Exhibit 4-3: Table of Climate-Vulnerable Populations in City of Spokane**

Indicator	Source	Population (Spokane)	Percent of Population (Spokane)
<b>American Indian and Alaska Native alone</b>	Table <a href="#">DP05</a> , 2018-2022 ACS Population: 227,922	2,882	1.3%
<b>Black or African American alone</b>	Table <a href="#">DP05</a> , 2018-2022 ACS Population: 227,922	6,006	2.6%
<b>Hispanic or Latino</b>	Table <a href="#">DP05</a> , 2018-2022 ACS Population: 227,922	16,457	7.2%
<b>Below Poverty</b>	Table <a href="#">S1701</a> , 2018-2022 ACS Population: 222,429	32,913	14.8%
<b>Houseless People (County)</b>	<a href="#">Commerce's Snapshot of Homelessness</a> (2024)	16,890 (County)	3% (of County)
<b>Seniors (65+)</b>	Table <a href="#">S0101</a> , 2018-2022 ACS Population: 227,922	36,836	16.2%
<b>Youth (Under 5)</b>	Table <a href="#">S0101</a> , 2018-2022 ACS Population: 227,922	12,068	5.3%
<b>People with disabilities</b>	Table <a href="#">S1810</a> , 2018-2022 ACS Population: 224,831	37,409	16.6%
5 to 17 years	Table <a href="#">S1810</a> , 2018-2022 ACS Population: 34,072	2,921	8.6%
65 to 74 years	Table <a href="#">S1810</a> , 2018-2022 ACS Population: 22,347	6,228	27.9%

Indicator	Source	Population (Spokane)	Percent of Population (Spokane)
75 years and over	Table <a href="#">S1810</a> , 2018-2022 ACS Population: 13,306	6,946	52.2%
With a hearing difficulty	Table <a href="#">B18102</a> , 2018-2022 ACS Population: 224,831	8,925	4.0%
With a vision difficulty	Table <a href="#">B18103</a> , 2018-2022 ACS Population: 224,831	6,361	2.8%
With a cognitive difficulty	Table <a href="#">B18104</a> , 2018-2022 ACS Population: 212,764	17,122	8.0%
With an ambulatory difficulty	Table <a href="#">B18105</a> , 2018-2022 ACS Population: 212,764	16,893	7.9%
With an independent living difficulty	Table <a href="#">B18107</a> , 2018-2022 ACS Population: 178,692	14,538	8.1%
<b>Population in overburdened areas</b> ( <i>Ranking 10 [Very High] in Environmental Health Disparities</i> ) (see Section 4.2)	<a href="#">Environmental Health Disparities V 2.0, Washington Tracking Network (WTN)</a> , 2022 2018-2022 ACS	70,988	32.7%

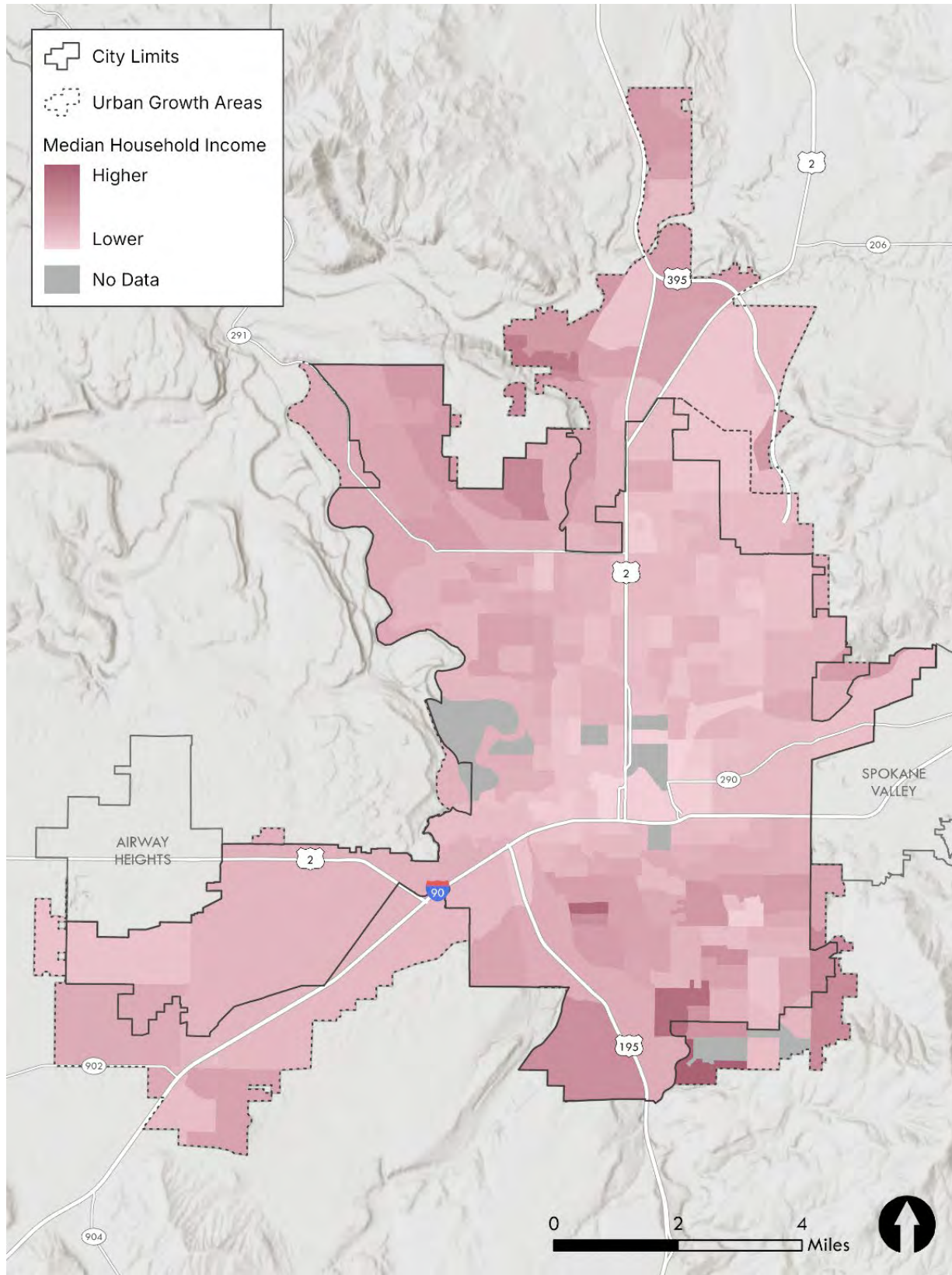
### Exhibit 4-4: Black, Indigenous, People of Color, 2022



Sources: US Census Bureau, 2018-2022 American Community Survey 5-Year Estimates; BERK, 2024.

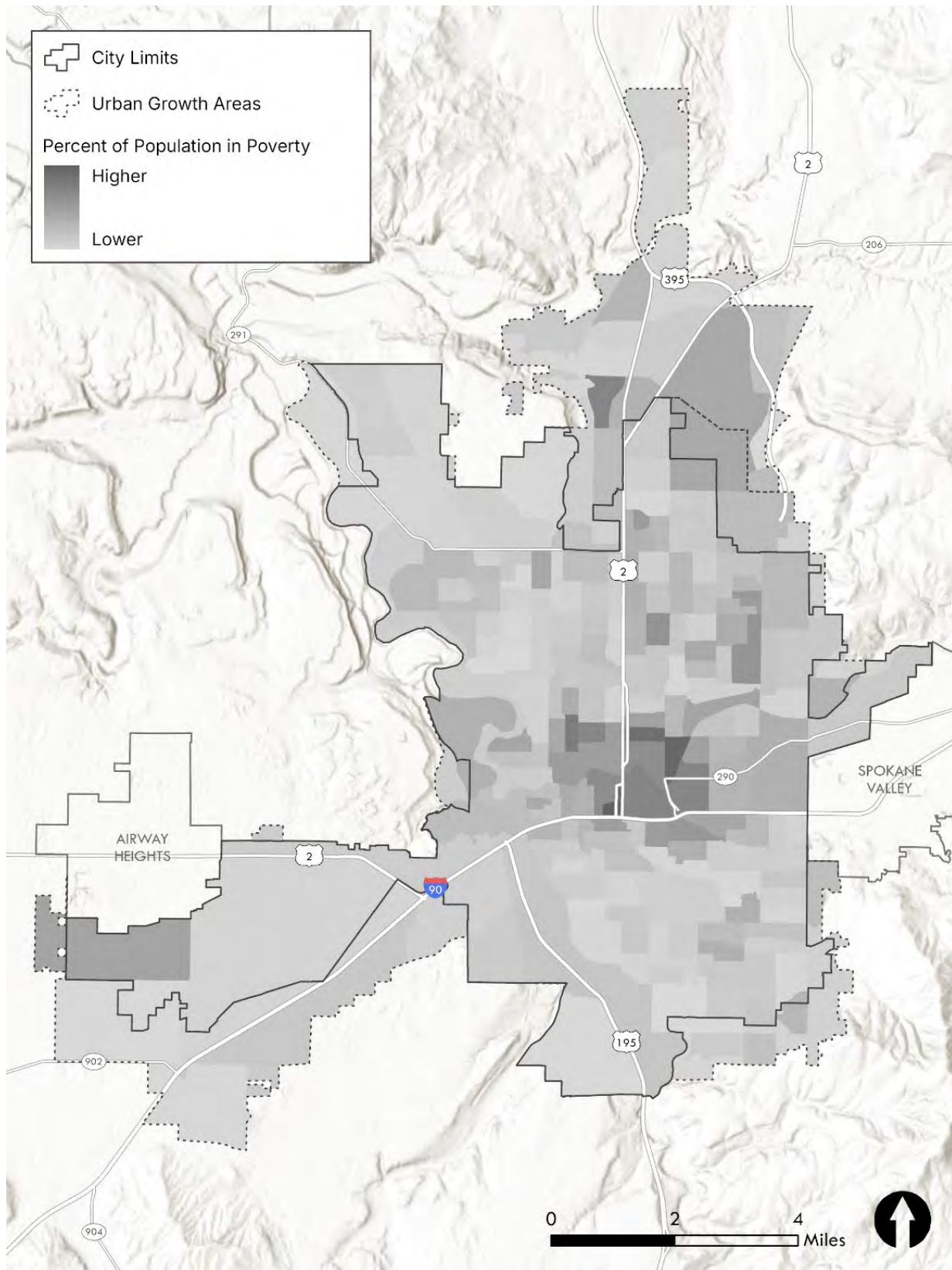


### Exhibit 4-5: Median household income, 2022



Sources: US Census Bureau, 2018-2022 American Community Survey 5-Year Estimates; BERK, 2024.

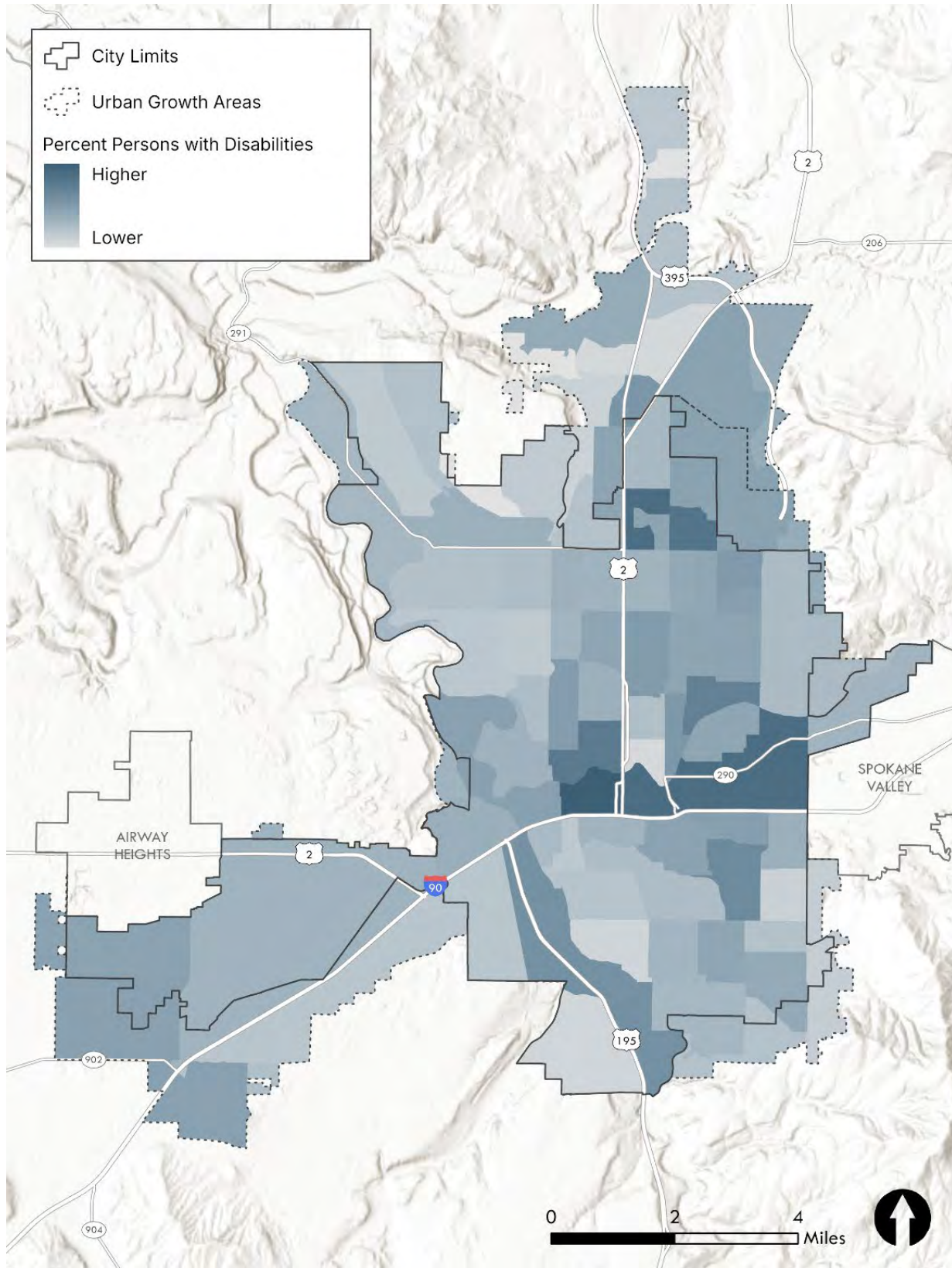
### Exhibit 4-6: Percentage of population in poverty, 2022



Sources: US Census Bureau, 2018-2022 American Community Survey 5-Year Estimates; BERK, 2024.

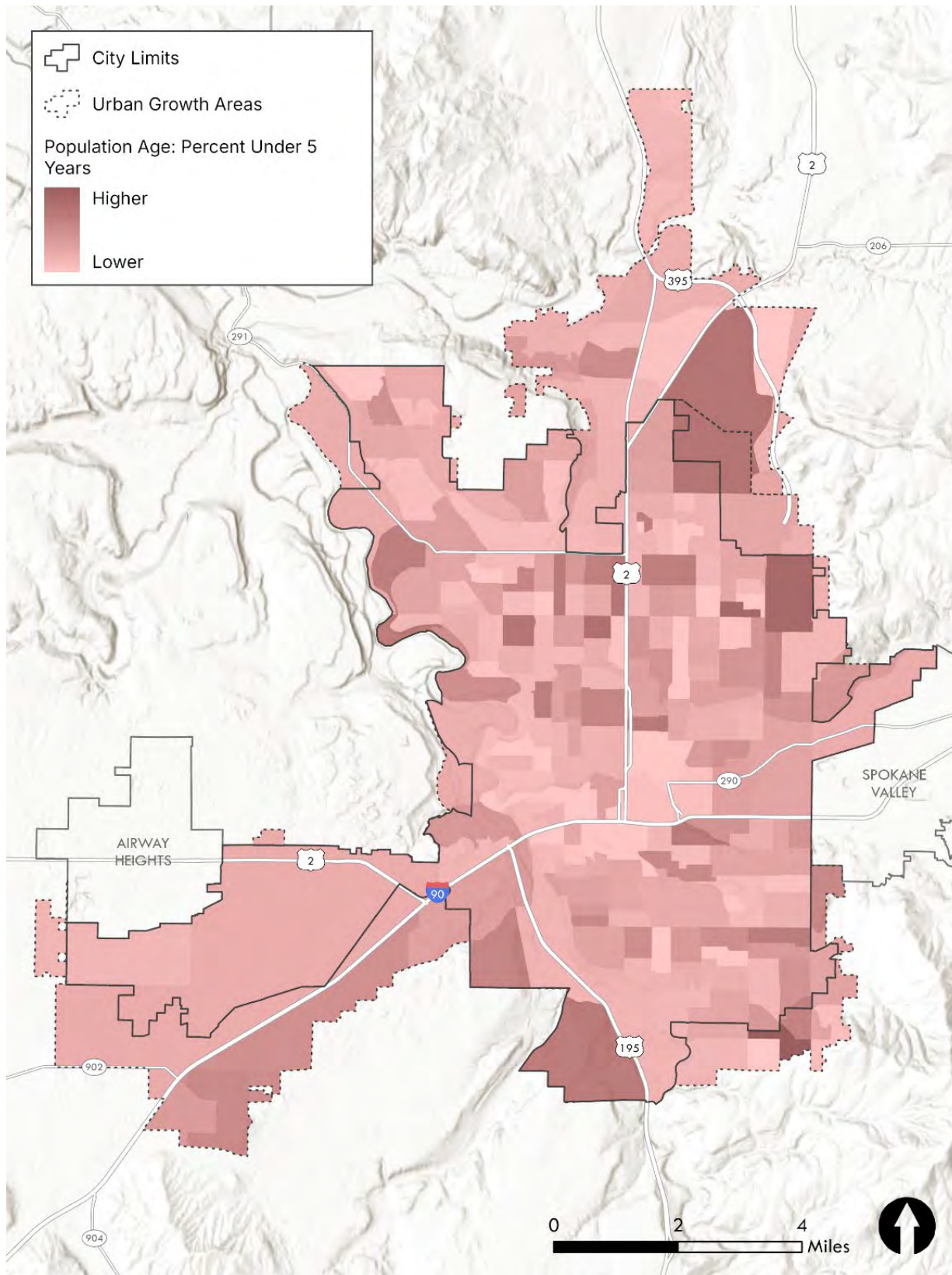


### Exhibit 4-7: Percentage of persons with disabilities, 2024



Sources: United States Environmental Protection Agency, EJScreen, 2024; BERK, 2024.

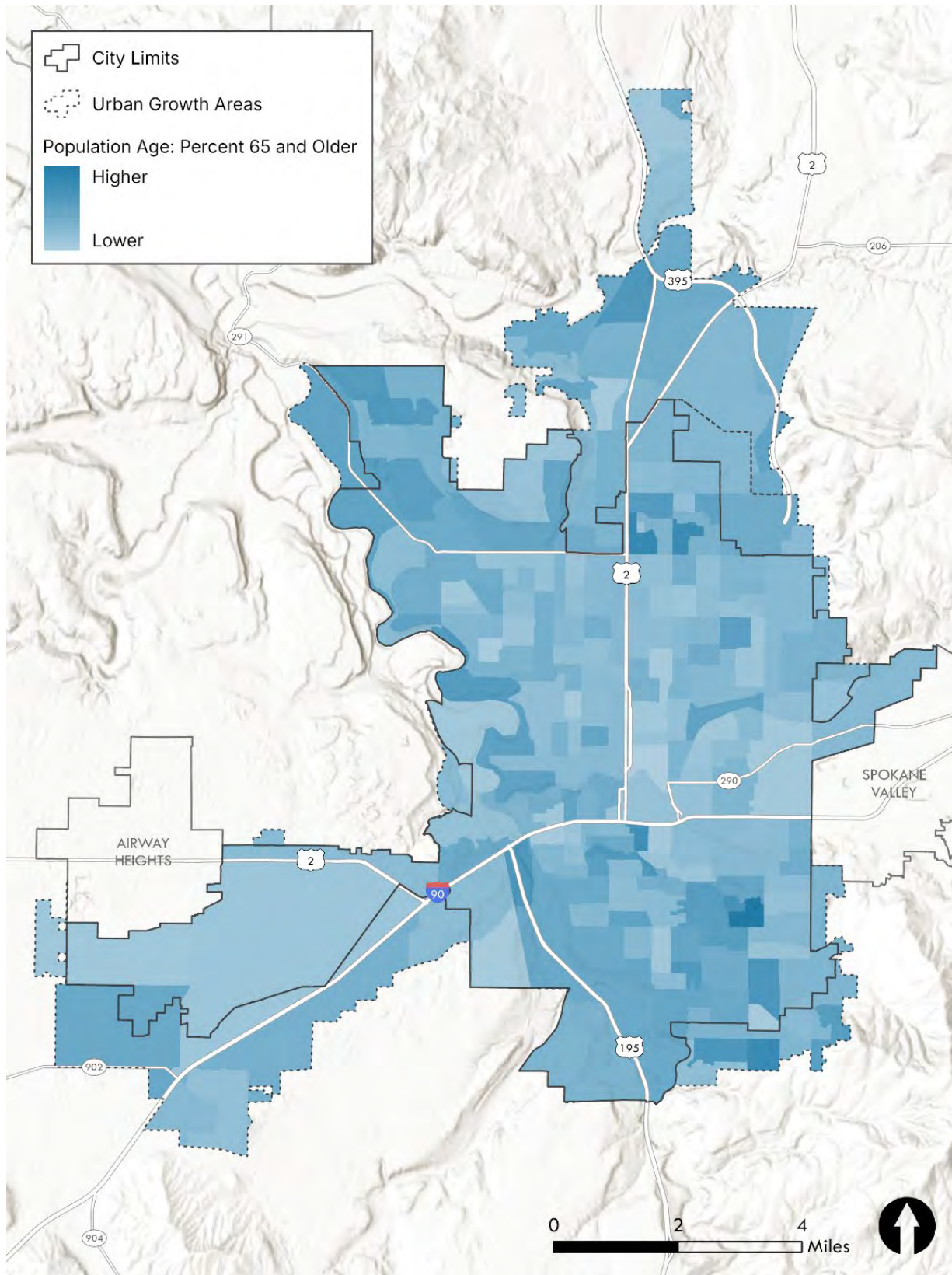
### Exhibit 4-8: Percentage of population under 5 years of age, 2022



Sources: US Census Bureau, 2018-2022 American Community Survey 5-Year Estimates; BERK, 2024.



### Exhibit 4-9: Percentage of population 65 years and over, 2022



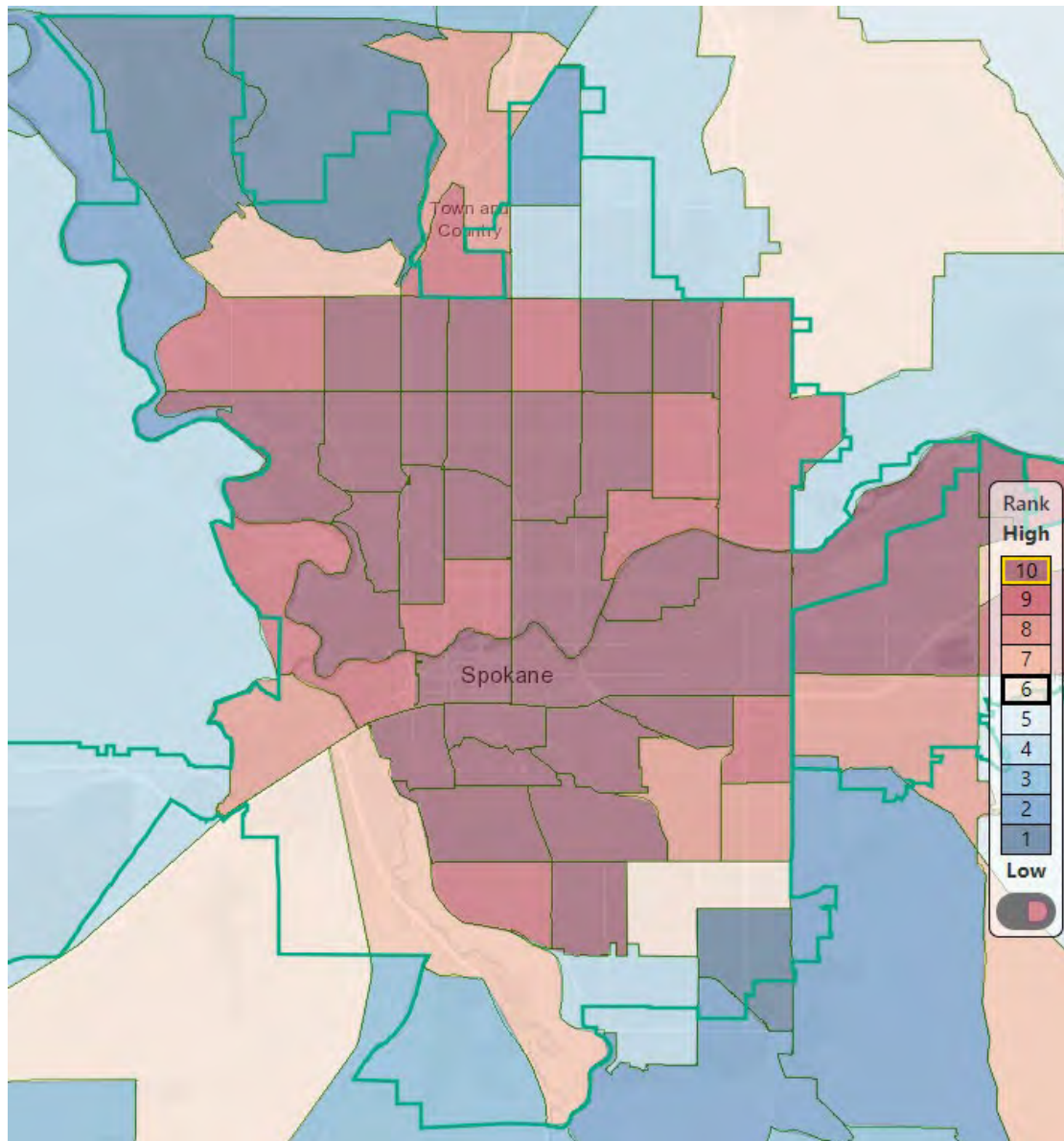
Sources: US Census Bureau, 2018-2022 American Community Survey 5-Year Estimates; BERK, 2024.



## 4.2 Identifying Overburdened Areas in Spokane

Almost one-third of Spokane’s population (32.7%) live in an area that is considered extremely environmentally overburdened, ranking 10 out of 10 on the Washington Department of Health’s (DOH) map comparing environmental health disparities across the state (see Exhibit 4-10). This is a Washington state specific tool that brings in environmental justice concerns that can contribute to or be exacerbated by climate impacts. There are a range of indicators available for Spokane and the surrounding area.

**Exhibit 4-10: Washington Department of Health Environmental Health Disparities Map**



Source: (Washington Tracking Network & Washington State Department of Health, Washington Environmental Health Disparities Map, n.d.)

The map shows a high ranking across Spokane, when compared with other census tracts in Washington, of environmental health disparities (e.g., with high diesel exhaust PM 2.5 emissions, high PM 2.5 concentration, lead risk from housing) alongside environmental effects, socioeconomic factors, and sensitive populations in Spokane. The highest-ranking census tracts are along the I-90 corridor and Northeast Spokane, which tracks similarly to other mapping tools, as well as lower South Hill.

Exposure to high levels of pollution affects residents' health. According to DOH, Spokane has higher rates of death from cardiovascular disease and lower birth weights than much of the state, especially in central neighborhoods in the city, like downtown, West Central, and East Central. However, there are differences across and within communities living in areas facing environmental disparities, affecting the health risks and outcomes experienced by individuals. This diversity of experiences and outcomes is not easy to visualize via spatial mapping and will be important to surface in the CRVA using other data like comments collected during community engagement events.

### 4.3 Other Mapping Tools and Vulnerability Indices

There are a number of other mapping tools showing vulnerability indices, environmental justice, and cumulative environmental burden. Note that these tools utilize different source data and are not always directly comparable. While they can provide helpful overviews, indices assembled by federal agencies tend to have limitations and drawbacks including their use of older data, choice of variables which may not be locally relevant, and coarse spatial resolution, typically at the county or census tract level (Painter, Shah, & Damestoit, 2024). Due to these limitations, the CRVA will use a census block group-scale index developed by BERK specifically for the City of Spokane.

The following section reviews highlights of overarching vulnerability patterns in the City shown in other mapping tools.

#### U.S. Council on Environmental Quality, Climate and Economic Justice Screening Tool

This federal tool focuses on the intersection of climate and economic justice. Spokane has some notable existing environmental and climate concerns relative to the rest of the state and country. The tool shows that Spokane is in the 80<sup>th</sup> percentile or above (amongst the most exposed areas) relative to the rest of the US in the following categories:

- **Environmental burdens:** High particulate matter (harmful air pollutant); High nitrogen dioxide levels (harmful air pollutant); Superfund site proximity (highly contaminated site)
- **Climate indicators:** High wildfire risk
- **Health conditions:** High asthma rates

Spokane is also home to census tracts that are considered overburdened and underserved, mainly Northeast Spokane, north of I-90 and east of Hwy 2, including neighborhoods like Logan, Nevada Heights, Minnehaha, Whitman, Hillyard, and Chief Garry Park.

## U.S. Center for Disease Control, Social Vulnerability Index

This index uses census-derived-factors categorized into four themes (socioeconomic status, household characteristics, race and ethnic minority status, and housing type/transportation). While it can be useful at a high-level, it does not enable a deep examination of community or climate-specific vulnerabilities. However, this tool shows that Spokane has areas with higher rates of communities with social vulnerability. Areas with high overall vulnerability are mainly along the I-90 corridor and in Northeast Spokane, though there are census tracts with high vulnerability throughout the city depending on the specific characteristic used. Spokane used this index in the development of its displacement risk assessment in the City's 2021 Housing Action Plan (City of Spokane, 2021).

## Neighborhoods at Risk, Headwater Economics

This tool uses federal data sources and climate projections from the Applied Information System at Cornell University and intersects them with a small set of socioeconomic characteristics. The number of census tracts with elevated vulnerabilities differs depending on which characteristics are selected. For example, Spokane intersects 21 census tracts where vulnerabilities to climate impacts exceed the community median, according to these three characteristics of households at risk: rental units, households with no car, and people with disabilities. Meanwhile, 15 tracts show as vulnerable according to the characteristics of People of Color and Hispanic, families in poverty, and people who do not speak English well.

According to this tool overall, in Spokane 2.3% of the area is in the 500-year floodplain, 9.4% of properties are at flood risk, 87.6% of the area lacks tree canopy, and 26.1% has high impervious surface.

## U.S. Environmental Protection Agency, Environmental Justice Screening Tool

The tool enables mapping of many of the same characteristics and risks as other tools, using available federal data, and like the Washington Tracking Network Environmental Health Disparities Map above, considers environmental health and justice considerations alongside climate impacts. According to this tool, Spokane has neighborhoods with people with disabilities at high rates relative to the national average. The map also shows the locations of hospitals compared to the rate of people with disabilities. This kind of analysis can help illustrate one type of community that is particularly vulnerable during events like extreme heat and wildfire smoke and barriers they may face in getting medical care.

## City of Spokane Parks and Natural Lands Master Plan, Social and Equity Priority Zones

Notably, the City of Spokane has highlighted social and equity priority zones in its Parks and Recreation Plan, using the following variables: population density, housing density, CDC Social Vulnerability Index, asthma, health prevalence, mental health distress, physical inactivity, transit stops, public schools, and Spokane parks and natural lands. The map highlights, as some of the other tools above do, neighborhoods along the I-90 corridor and in Northeast Spokane, especially in areas north of Francis Avenue in North Spokane, even when using some different variables.

## City of Spokane Comprehensive Plan, Transportation Appendix

The City of Spokane developed an equity-focused prioritization matrix for transportation projects using six evaluation categories: transportation choices, access to daily needs, economic opportunity, natural and neighborhood assets, public health and safety, and fiscal responsibility. The Disadvantaged Accessibility subcategory of the Access to Daily Needs evaluation category addresses equity concerns and awards points to areas with disadvantaged accessibility. This increases the priority level of projects in underserved areas. As shown in other tools, many neighborhoods along the I-90 corridor are highlighted as disadvantaged in this evaluation.

## 4.4 Climate Impacts on Vulnerable Populations and Overburdened Communities

The Climate Risk and Vulnerability Assessment (CRVA) will involve a closer look at populations and communities/areas in Spokane described in Sections 4.1 and 4.2 where there may be elevated exposure to climate impacts, specific vulnerabilities to climate impacts, and specific

abilities to adapt to a changing climate (or that lack of the ability to adapt). The CRVA team will also engage directly with those communities, who are essential to the City's culture, economy and society, to validate or "ground-truth" vulnerabilities that mapping tools are showing. This may include Native American and Tribal communities and other populations of interest.

## Native American and Tribal communities

As mentioned previously, Native American and Tribal communities are an important focus in Spokane. Both reservation-based Tribal members and Native peoples living in Spokane face important climate-related vulnerabilities, such as health disparities and loss of traditional food sources. Data and insights from Tribal health organizations will help highlight these

### Exhibit 4-11: Spokane Falls Tribal Significance



Spokane Falls and its surroundings have been a gathering place and home for Native peoples for at least 9,000 years (**Spokane Tribe of Indians, n.d.**), and continues to draw Indigenous communities for events like the Expo '74 50th Celebration Pow Wow at the Falls held in May 2024.

to integrate the experiences of these populations through the engagement process. In Exhibit 4-12, we identify populations in Spokane and climate vulnerability considerations for each. Geographic areas are also referenced in Exhibit 4-13. These vulnerabilities are often intersecting and possibly compounding. For example, residents with physical disabilities who are also low-income face compounded vulnerabilities.

issues in the forthcoming CRVA. In the forthcoming policy recommendations, the project team will propose policies and actions for resilience. Incorporating Traditional Ecological Knowledge and urban perspectives will provide a more inclusive approach, though with care and respect that Tribal leaders and members have sovereignty of their knowledge systems.

## Other populations of interest

For other populations of interest, data is often available down to the census tract (and sometimes blocks), and it may be possible to highlight where vulnerable or frontline communities are exposed to specific climate risks/hazards (like flooding), and their proximity to community assets (like tree cover) as one way of assessing adaptive capacity. It will also be important



**Exhibit 4-12: Vulnerable Populations and Health Disparities**

Category	Vulnerable Population	Relevance and example considerations for climate impacts
<b>Socio-economic</b>	Low income	<p>Low-income communities tend to have greater sources of environmental risk, including higher ambient air pollution concentrations. Workers with low-income levels may experience more hardship associated with reduced pay from lost labor hours (EPA, Climate Change and Social Vulnerability in the United States: A Focus on Six Impacts, 2021).</p> <p>Lacking financial resources also reduces a person’s ability to respond to climate risks (e.g., their ability to rebuild their home, afford health care, or evacuate/relocate to a less risk-prone location) (Gamble, et al., 2016).</p>
	Housing cost burdened	<p>Housing cost burden can lead to financial stress and limit a household's ability to afford other essentials, such as healthcare and education.</p>
	Energy cost burdened	<p>Rising energy costs may additionally burden already energy cost-burdened residents. These households may have to forgo A/C, heat, and other adaptation actions.</p>
	Transportation cost burdened	<p>Rising transportation costs (e.g., longer commute times due to climate-related events) may hit residents who are already transportation cost-burdened harder. Transit dependent residents may face extreme weather disruptions.</p>
	Food insecure	<p>Food insecure populations already struggle to get nutritious food. Climate-related food shortages and supply chain issues could make it even more difficult for people to get healthy food (EPA, Climate Change and the Health of Socially Vulnerable People, n.d.).</p>
<b>Housing-related</b>	Renters	<p>Renters have less agency to do efficiency upgrades and may be subjected to higher energy and water costs or go without things like A/C because it is too expensive.</p>
	Houseless residents	<p>A changing climate will impact the health of houseless people through increased heat waves, increased air pollution, increased severity of floods and storms, and changing infectious disease vectors (Ramin &amp; Svoboda, 2009). Houseless residents could include those who are unsheltered, in emergency shelters, or unstably housed.</p>

Category	Vulnerable Population	Relevance and example considerations for climate impacts
	Residents of housing built pre-1960	Homes built prior to modern building codes were often built without prioritization of energy efficiency, e.g., without insulation and with single-paned windows. These can be energy cost burdens to occupants and expensive to retrofit.
<b>Race and/or ethnicity</b>	Black	The historical redlining of Black and other minority neighborhoods is linked with more intense urban heat islands and exposes residents to more risk due to extreme heat than other communities (Cusick & E&E News, 2020; Dannen, n.d.).
	Linguistic isolation	Adults with limited English proficiency may not get important information and access to resources in climate events when information is not provided in a language they speak (California Office of Environmental Health Hazard Assessment, n.d.).
	Tribal and Native American	Tribal and Native residents are likely to experience a range of nutritional, physical, mental, and cultural health and wellbeing impacts from future changes to climate, which will be compounded by historical and multigenerational trauma (Whyte, et al., 2023). Impacts can include the loss of traditional food sources.
<b>Age</b>	Elderly > 65 years	Older individuals are more susceptible to the negative health consequences of heat exposure (EPA, Climate Change and Social Vulnerability in the United States: A Focus on Six Impacts, 2021).
	Youth < 5 years	Children under 5 years of age are likely to experience higher risks for long-term mental health and socioeconomic impacts from climate hazards. They may be more susceptible to asthma, which can be made worse with increasing air pollution.
<b>Health status</b>	People with disabilities	Residents with disabilities may be impacted in several ways due to climate hazards. Emergency warnings may not address the needs of those with low vision, blindness, or hearing loss. Those with mobility difficulties may have trouble getting to safe places during flooding and heat waves. A climate-related disaster may inconvenience and endanger those dependent on transit.
	People with mental health conditions	People with mental illness are at higher risk for poor physical and mental health due to extreme heat. Meanwhile, many people exposed to climate-related or weather-related disasters experience stress and serious mental health consequences. Certain groups of people are more likely to experience mental

Category	Vulnerable Population	Relevance and example considerations for climate impacts
		health effects from climate impacts. These groups may already face barriers to getting mental health care, counseling in native languages, and medication. Extreme weather can disrupt access to mental health care even further, which can cause or worsen mental health effects (Dodgen, et al., 2016).
	Adults without health insurance	People without health insurance may be more vulnerable to the potential health effects of heat exposure, and more impacted economically by seeking emergency services.
	People with chronic health conditions like asthma, pulmonary disease, cardiovascular disease, and diabetes, or those reliant on medical devices	<p>Chronic medical conditions can be worsened by climate hazards. Increasing climate hazards can lead to more outdoor air pollutants (already at higher levels in Spokane) and increased allergens and asthma (already high in Spokane), which can especially impact people with asthma and chronic obstructive pulmonary disease (COPD), among other illnesses (Balbus, et al., 2016).</p> <p>Over 5,500 Medicare beneficiaries in the County of Spokane rely on electricity-dependent durable medical and assistive equipment (DME) and devices to live independently in their homes, and some of those individuals also have health care service dependencies (U.S. Dept. of Health and Human Services, 2024). Severe weather and other emergencies, especially those with prolonged power outages, can be life-threatening for these individuals.</p>
<b>Employment</b>	Small businesses	Small businesses may have fewer resources to manage extreme weather impacts, like extended heat waves or smoke events.
	Outdoor workers/climate exposed occupations	Outdoor workers are exposed to heat and smoke. They and other people dependent on natural resources may also experience anxiety and consequences to their economic stability from income loss (EPA, Climate Change and Social Vulnerability in the United States: A Focus on Six Impacts, 2021).



**Exhibit 4-13: Overburdened Communities (Geographic Areas)**

Category	Over-burdened Community	Relevance and example considerations for climate impacts
<p><b>Environmental burden</b></p>	<p>High impervious surface</p>	<p>High amounts of impervious surface contribute to urban heat islands, which negatively affects nearby residents in many ways, including higher energy consumption, elevated emissions of air pollutant, and higher daytime and evening temperatures (EPA, Learn about Heat Islands, n.d.).</p>
	<p>High PM 2.5 concentration</p>	<p>An expected intensification of air pollution (PM2.5) is projected to increase annual premature deaths of those 65 and older across much of the U.S. (EPA, Climate Change and Social Vulnerability in the United States: A Focus on Six Impacts, 2021).</p>
	<p>Proximity to high traffic roadways</p>	<p>High traffic roadways can affect nearby residents and employees through noise pollution, injuries, smog, and air pollution, the latter of which can be worsened in extreme heat (Washington Tracking Network &amp; Washington State Department of Health, Washington Environmental Health Disparities Map, n.d.).</p>
	<p>Proximity to streams and/or waterbody with poor water quality</p>	<p>Hazards such as increased stormwater runoff can further affect water quality, affecting people living near bodies of water. (EPA, Climate Adaptation and Source Water Impacts, n.d.).</p>
	<p>Other environmental justice indexes and indicators</p>	<p>See full list of EJ indexes in Appendix B.</p> <p>Indicators like lack of tree canopy can represent an environmental injustice while also being highly correlated with urban heat islands, a climate impact. The CRVA will utilize a number of measures of climate vulnerability which may be worse in certain neighborhoods due to historic disinvestment or disproportionate burden of pollution sources.</p>

# 5 Synthesis and Next Steps

This memo identifies climate risks and vulnerable populations and overburdened communities within Spokane. In the forthcoming CRVA, the project team will take a deeper look at the data introduced here and integrate findings from the policy audit and community and stakeholder engagement. In the CRVA, we will systematically assess climate vulnerability, prioritizing climate hazards and climate justice concerns.

The CRVA will identify physical and social vulnerabilities across five focus areas (see Exhibit 5-1). We will analyze data from a diverse set of sources, including reports, datasets, and engagement activities, to assess the physical and social exposure, sensitivity, and adaptive capacity within the five focus areas. The CRVA will include narrative around key vulnerabilities, figures (e.g., charts, tables) showing projected climate impacts, and spatial analysis indicating notable physical and social vulnerabilities in Spokane.

**Exhibit 5-1: Climate Risk and Vulnerability Assessment Focus Areas**

Focus area	Description
<b>Human Well-being and Emergency Management</b>	<ul style="list-style-type: none"> <li>▪ <b>Public health:</b> Physical health risks (medical care; climate-related illness, injury, and death); environmental and socioeconomic health disparities; mental health</li> <li>▪ <b>Social services:</b> Childcare, correctional facilities</li> <li>▪ <b>Educational facilities:</b> Pre-K, K-12, Community college, university</li> <li>▪ <b>Emergency management:</b> Critical facilities; emergency services; communication systems; community safety and security</li> </ul>

Focus area	Description
<b>Cultural and Natural Resources</b>	<ul style="list-style-type: none"> <li>▪ <b>Cultural resources:</b> Community gathering places, groups and programs; cultural and heritage assets and sites</li> <li>▪ <b>Food systems:</b> Food processing in industrial areas and community gardens in urban areas; food access</li> <li>▪ <b>Parks, trails, open space:</b> Multiuse trails, greenways, public lands, and parks</li> <li>▪ <b>Shorelines:</b> Habitat, access to recreation and significant sites</li> <li>▪ <b>Urban forest:</b> Urban canopy, street trees, wildland urban interface</li> </ul>
<b>Infrastructure</b>	<ul style="list-style-type: none"> <li>▪ <b>Energy:</b> Supply (energy grid, utilities, and fuel), infrastructure (powerlines, substations, and energy transmission and distribution systems), and consumption/demand</li> <li>▪ <b>Major facilities:</b> Event spaces and public buildings</li> <li>▪ <b>Transportation:</b> Auto-oriented infrastructure (Highway/roadway), mass transit; pedestrian and bicycle systems, railways</li> <li>▪ <b>Waste:</b> Recycling centers, transfer stations, landfills, waste to energy facility</li> <li>▪ <b>Water and wastewater infrastructure:</b> Pipes, pump stations, water treatment facilities</li> </ul>
<b>Ecosystems and Water Resources</b>	<ul style="list-style-type: none"> <li>▪ <b>Critical areas:</b> Wetlands, fish and wildlife habitats, geologically hazardous areas</li> <li>▪ <b>Water supply:</b> Groundwater supplies, water storage and transmission systems</li> <li>▪ <b>Stormwater:</b> Gray and green (e.g., swales) stormwater infrastructure, impervious v. pervious surfaces, water retention and treatment facilities</li> <li>▪ <b>Surface water:</b> Rivers, streams and lakes</li> <li>▪</li> </ul>
<b>Community Design, Land Use, and Economic Development</b>	<ul style="list-style-type: none"> <li>▪ <b>Buildings:</b> Building footprints, design and regulation</li> <li>▪ <b>Businesses:</b> Industrial areas, local and independent businesses, major employers, recreation and tourism businesses</li> <li>▪ <b>Neighborhoods:</b> Downtown and growth areas</li> <li>▪ <b>Housing:</b> Single and multi-family residential buildings, affordable housing (subsidized and not)</li> </ul>

# 6 Appendices

## Appendix A: Spokane Climate Impacts Summary

### Introduction

This summary examines historical trends and future projections to highlight the current and expected effects of changing climate trends and related hazards on Spokane. Without significant reductions in greenhouse gas (GHG) emissions both regionally and globally, the City is likely to experience the following impacts:

- **Higher annual average temperatures**, with higher temperatures during the summer and winter seasons, and more prolonged and consistent heatwaves.
- **Reduced snowpack**, resulting in less water availability for streams during the late summer months, and less recharge in groundwater.
- **Increased stormwater and riverine flooding** from increases in precipitation in winter months, **and decreased flows** during the summer months.
- **Increased risk of drought**, leading to greater wildfire, smoke, and air quality risks.

The purpose of the climate impacts summary is to identify historical and projected climate impacts to support and inform the City's Climate Risk and Vulnerability Assessment.

### Summary of Climate Impacts

The increase in greenhouse gas emissions has already led to significant changes in climate trends, as outlined previously. Climate projections, including the anticipated escalation and intensification of climate hazards over the next century, rely on various climate scenarios. These scenarios consider factors such as future land use, population growth, technological advancements, and global GHG emission levels.

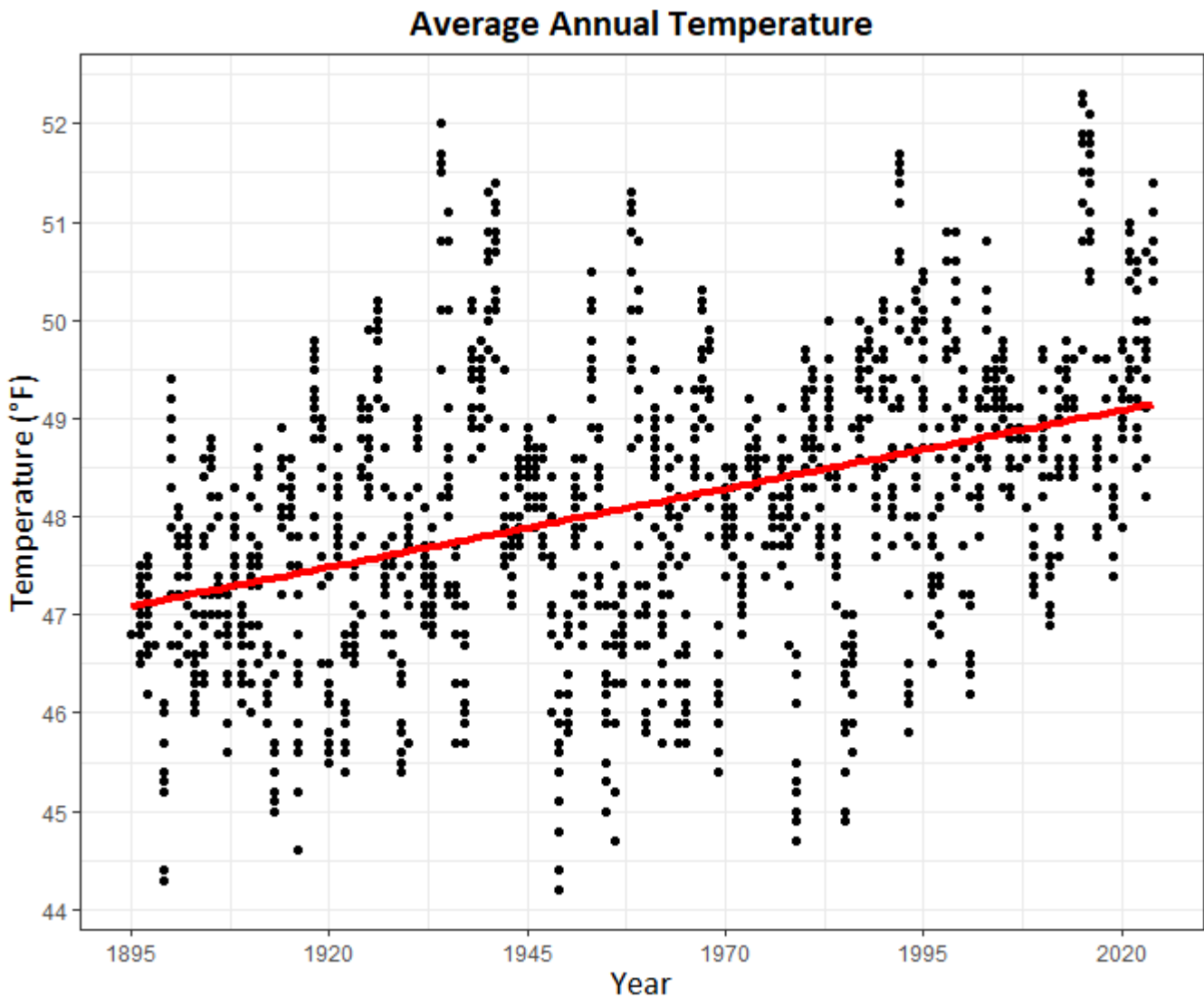
This Climate Impacts Summary utilizes Representative Concentration Pathway (RCP) 8.5. RCP 8.5 represents a "business-as-usual" scenario, where emissions continue their current trajectory. As the highest emissions scenario, it predicts a global temperature increase of approximately 4.3°C by 2100 compared to pre-industrial levels. RCP8.5 was selected for this

assessment to ensure that adaptation policies address anticipated climate impacts, thereby reducing risks to communities, infrastructure, and natural resources.

## Temperature

From 1895 to 2024, average annual temperatures in Spokane increased by 2°F, as shown in Exhibit A-1 (NOAA National Centers for Environmental Information, 2024).

**Exhibit A-1. Average monthly temperature between 1899 and 2024 in Spokane, WA.** The red line indicates the average monthly temperature between 1899 and 2024 in Spokane, WA.

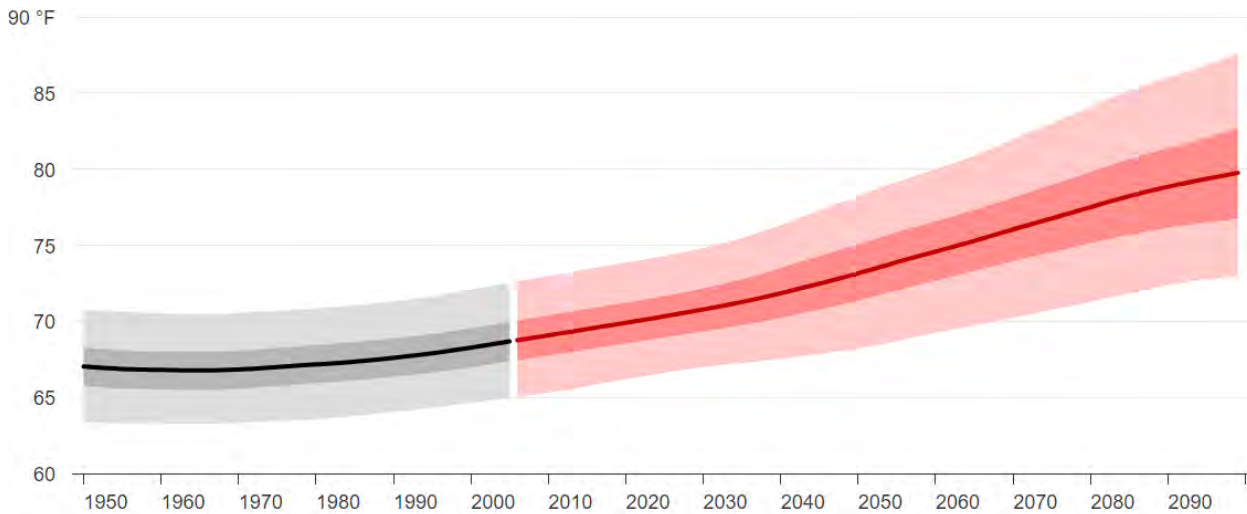


Source: NOAA's National Centers for Environmental Information. Accessed 27 July 2024. Graph created by Cascadia Consulting Group.

Although year-to-year temperature fluctuations are affected by natural climate patterns like El Niño-Southern Oscillation (ENSO) and Pacific decadal oscillation (PDO), there is a trend of warming. Additionally, maximum temperatures in August, which may reflect potential summer heat stress, have risen by 3.5°F between 1979 and 2023 (Hegewisch & Abatzoglou, Future Time Series, n.d.).

Relative to the 1951 to 2005 historic average, the annual maximum temperature in Spokane is projected to rise from 60.6°F to 69.5°F under the RCP8.5 scenario, by 2099. Under the same scenario and timeframe, average summertime temperatures (Jun-Aug) are projected to increase by 11°F (Exhibit A-2), and wintertime temperatures (Dec-Feb) are projected to increase by 8.9°F (Exhibit A-3).

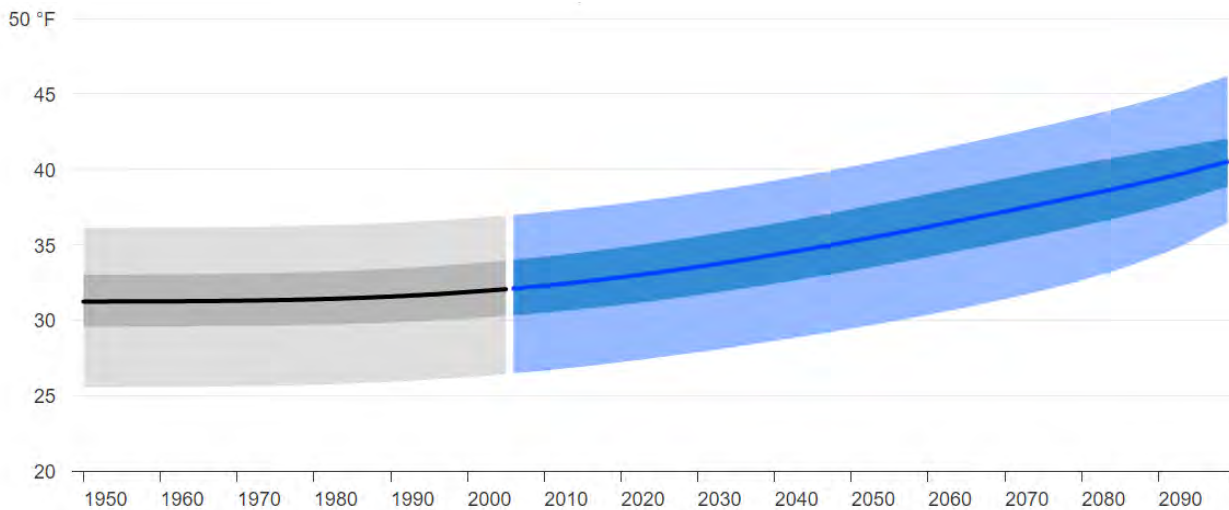
**Exhibit A-2: Projected increase in average summertime (Jun-Aug) temperature under the RCP8.5 scenario, in Spokane, Washington.**



Source: Climate Toolbox. Accessed 27 July 2024.



**Exhibit A-3: Projected increase in average wintertime (Dec-Feb) temperature under the RCP8.5 scenario in Spokane Washington.**



Source: Climate Toolbox. Accessed 27 July 2024.

The projected increase in temperature is associated with an increase in the frequency and intensity of heat waves and “hot” days (Exhibit A-4) within Spokane.

**Exhibit A-4 Projected change in the number of hot days per year in the County of Spokane under the RCP8.5 scenario, compared to the 1980-2009 baseline.**

Timeframe	2040-2069	2050-2079	2060-2089	2070-2090
Change in number of days above 100°F	9.8	14.1	19.0	23.8

Source: Climate Toolbox. Accessed 27 July 2024.

Increases in the number of hot days will pose greater risks to all residents of Spokane but will be particularly impactful to outdoor workers, due to their exposure to the heat.

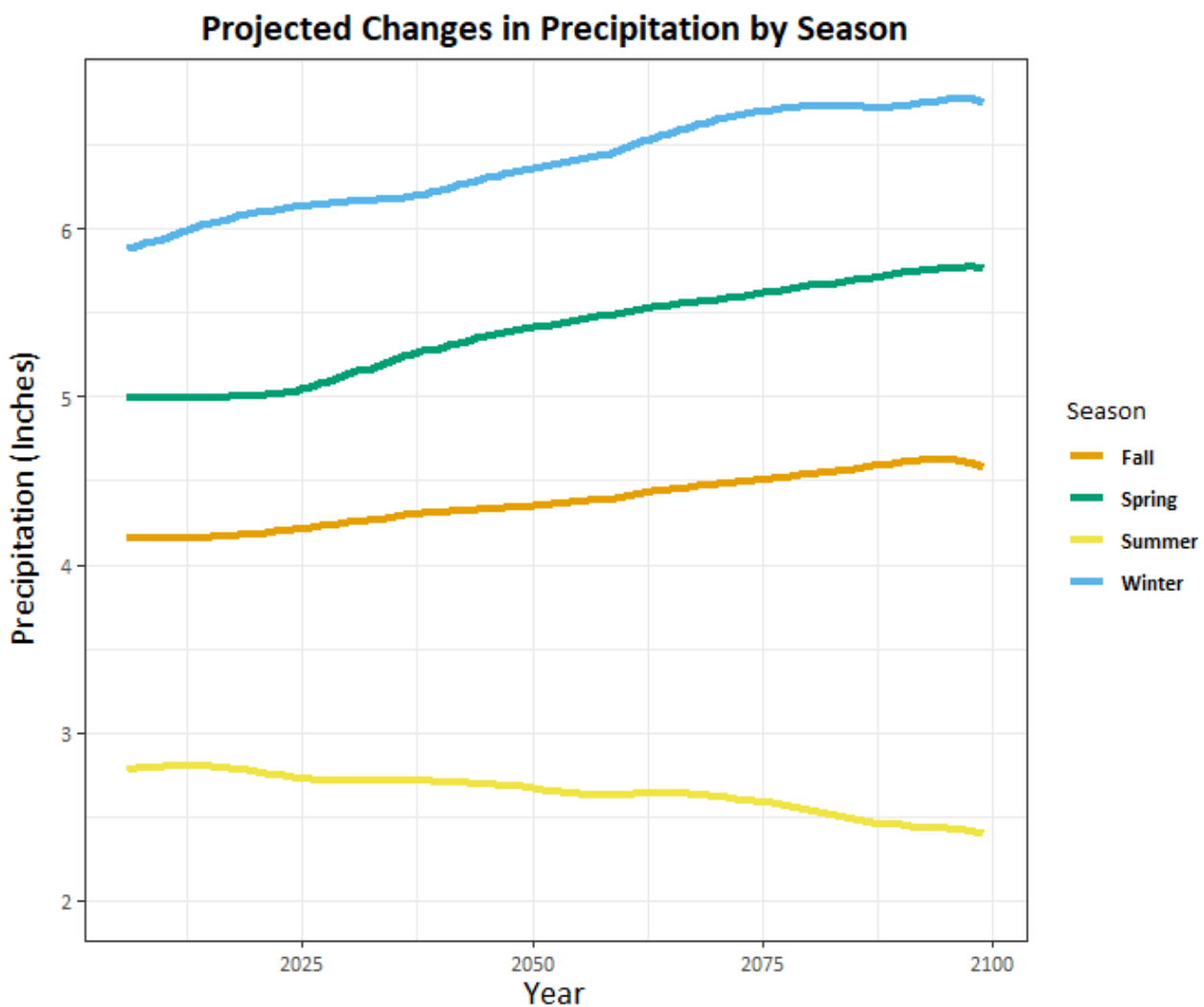
Meanwhile, cold weather events or cold waves are projected to become less frequent in Spokane. This is evidenced by an increase in the number of days with a minimum temperature above 32 °F. By the end of the century, the RCP8.5 scenario projects an increase of 87 such days per year (Hegewisch & Abatzoglou, Future Boxplots, n.d.).

## Precipitation, Snowpack, and Drought

### Precipitation

From 1981 to 2010, Spokane received an average of 17.6 inches of rainfall annually. In recent years, there has been a slight increase in rainfall, mainly due to more precipitation in the fall, winter, and spring (Breems & Booth, 2020). These trends are projected to continue, as fall, winter, and spring precipitation is projected to increase while summer precipitation is projected to decrease, as shown in Exhibit A-5 (Hegewisch & Abatzoglou, Future Time Series' web tool, 2020).

**Exhibit A-5: Projected seasonal precipitation changes compared to the baseline (1951-2005). The graph displays total seasonal precipitation projections (RCP8.5) by year.**



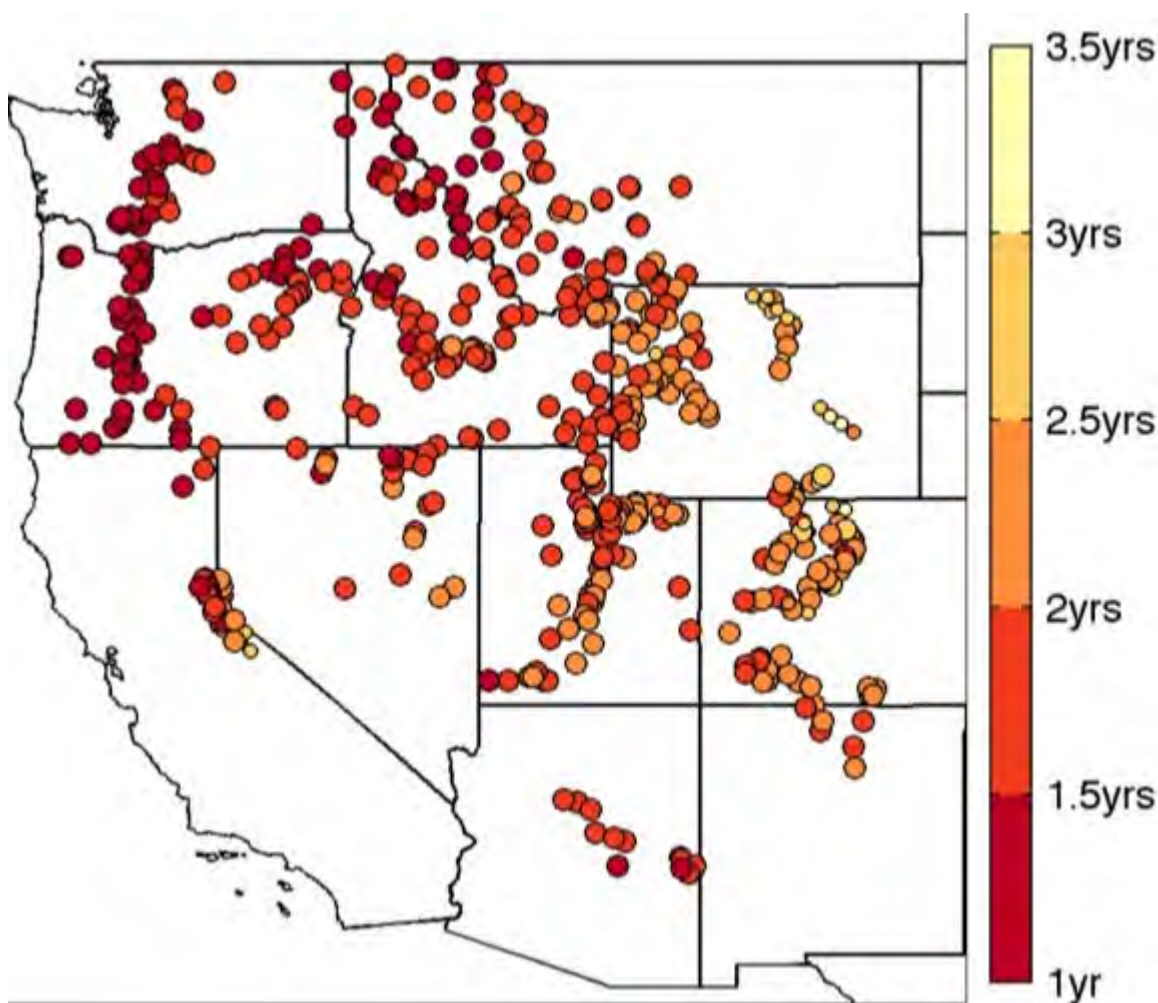
Source: Data from Climate Toolbox. Accessed 27 July 2024. Figure created by Cascadia Consulting Group.

Compared to the baseline period of 1951-2005, annual precipitation is projected to increase by 10% by 2099. However, summertime precipitation is expected to decrease by 14% during the same period (Hegewisch & Abatzoglou, Future Time Series, n.d.).

Snowpack

Warming temperatures are expected to cause a shift from snow to rain across many western mountain ranges. In the Spokane region, snow stations in the Cascades and Northern Rockies are projected to experience low-snowfall years almost every year by midcentury, compared to the baseline average of every four years, as shown in Exhibit A-6 (Lute, Abatzoglou, & Hegewisch, 2015).

**Exhibit A-6: Low-snowfall year return intervals by mid-century in western mountain ranges.**



Source: Figure from AGU. Accessed 25 July 2024.

The increase in the frequency of low-snowfall years—those when the snowfall water equivalent falls below the 25th percentile—will likely lead to significant changes in snowpack.

Under the RCP8.5 scenario, the likelihood of the April 1 snowpack in the Spokane county area being below 75% of the 1980-2009 average by the end of the century, is nearly 100% (Chegwidden, Nijssen, Rupp, & Mote, 2017).

The projected decrease in snowpack and increase in low-snowfall years will significantly impact the region's winter recreation tourism and economy, similar to other Northwest areas with a snow-based recreation industry (Chang, et al., 2023).

## Drought

Currently, approximately 62% of Spokane County's land mass is categorized as being in moderate drought, including the City of Spokane and its surrounding area. Another 38% is classified as being abnormally dry. The City of Spokane primarily pumps its water from the Spokane Valley-Rathdrum Prairie aquifer. Although slight increases in precipitation are projected, the benefits may be offset by decreased snowpack, potentially leading to less recharge of the aquifer (Meixner, et al., 2016).

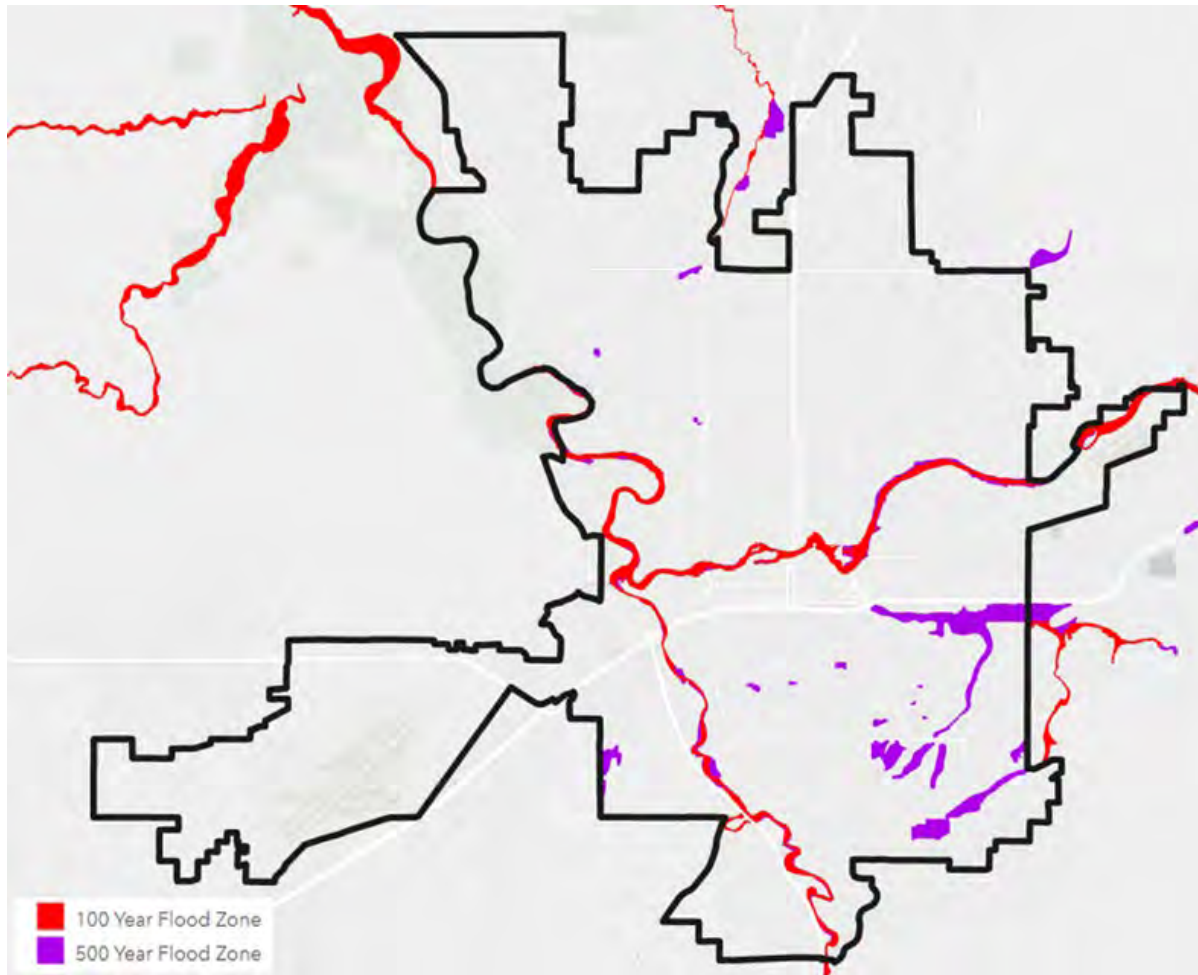
Additionally, Spokane and Kootenai counties, which surround the aquifer, are projected to see increases in evapotranspiration of 8.2 inches and 9.1 inches, respectively, by the end of the century under the RCP8.5 scenario (Hegewisch & Abatzoglou, Future Time Series, n.d.). These increases could further diminish the aquifer's recharge rate, potentially leading to more intense and prolonged drought in Spokane.

## **Streamflow and Inland Flooding**

Spokane has previously faced impacts from inland flooding, with a significant proportion of the city exposed to high-risk flood zones. The 100-year flood zone, highlighted in red in Exhibit A-7, represents areas with a 1% chance of flooding in any given year. Additionally, the 500-year flood zone, shown in purple, indicates regions with a 0.2% chance of flooding annually

(City of Spokane, Economy, n.d.). These flood zones, concentrated along the City's major waterways and extending into urban areas, underscore the City's vulnerability.

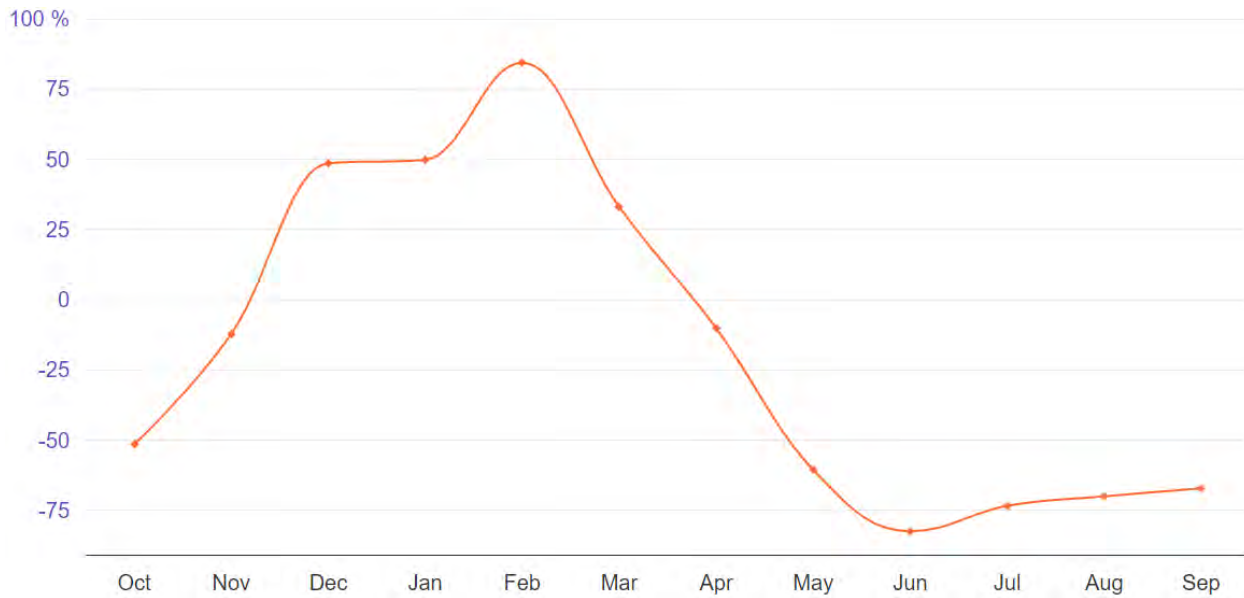
**Exhibit A-7: 100-year and 500-year flood zones within Spokane.**



*Source: Figure from Map Spokane. Assessed 21 July 2024.*

Inland flooding is expected to intensify and become more frequent as winter (December through March) streamflow in the Spokane River is projected to increase. By the end of the century, February streamflow at the Monroe Street gauge along the Spokane River is projected to be 84% higher than the historical average, as shown in Exhibit A-8 (Hegewisch, Abatzoglou, & Chegwiddden, Future Streamflows, n.d.).

**Exhibit A-8: Projected (2070-2099) percent change in non-regulated streamflow vs historical in the Spokane River at Monroe Street.**

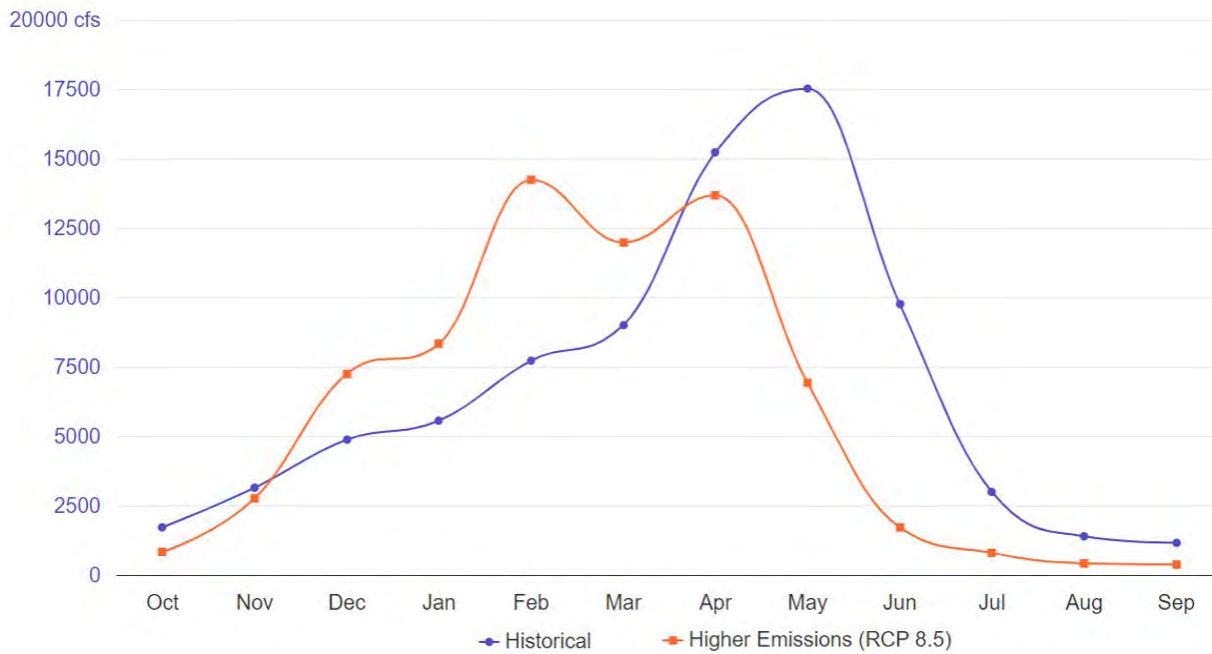


Source: Figure from Climate Toolbox. Accessed 27 July 2024.

In contrast to the increasing winter streamflow, summertime streamflow is expected to decrease significantly in volume and begin earlier in the year. Under the RCP8.5 scenario, by the end of the century, May streamflow is projected to decrease by 10,598 cubic feet per second—a 60% reduction compared to the historical average, as demonstrated in Exhibit A-9 (Hegewisch, Abatzoglou, & Chegwidan, Future Streamflows, n.d.).



**Exhibit A-9: Projected and historic non-regulated streamflow in the Spokane River at Monroe Street.**



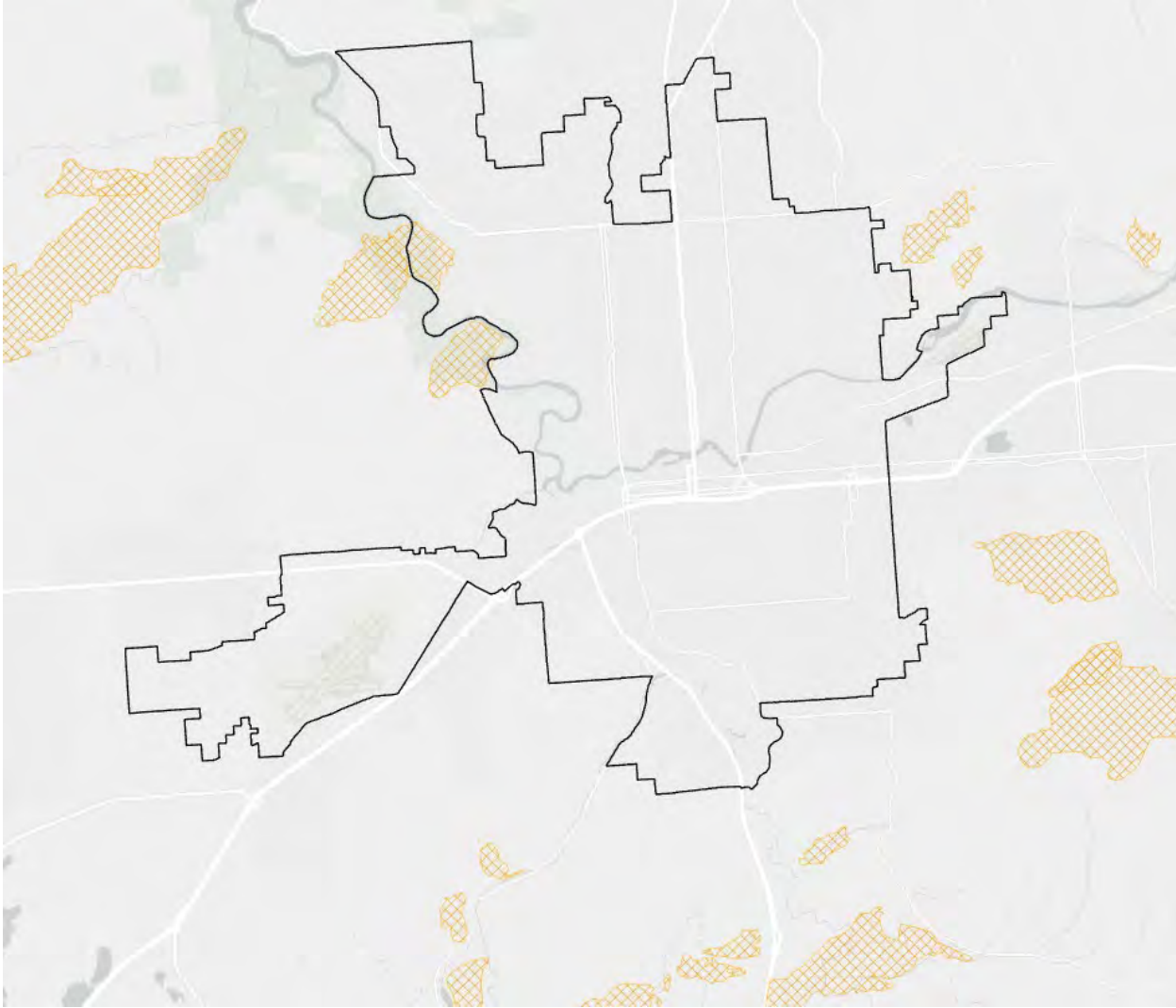
Source: Figure from Climate Toolbox. Accessed 27 July 2024.

The reduction in summer streamflow will significantly affect the City’s outdoor recreation economy, leading to a shorter season and reduced water flow for activities like rafting and other river-based tourism (Rains, Porcello, Odegard, Schultz, & Morin, 2020).

The impacts of rising air temperatures, diminishing snowpack, and reduced summer flow are projected to cause warmer temperatures in low- and mid-elevation streams across Washington state, including the Spokane River (Gates, Quinn, & Georgiadis, 2022). Additionally, the combination of decreased flow and warmer stream temperatures can negatively affect the river’s water quality, leading to increased levels of geological contaminants and higher turbidity (Snover, Mauger, Binder, Krosby, & Tohver, 2013).

**Wildfires and Smoke**

Due to its location being surrounded by forests, Spokane has been historically at higher risk of wildfires. From 1878 to 2019 several wildfires have crossed or come close to the City of Spokane boundaries, as shown in Exhibit A-10 (Welty & Jeffries, 2020).

**Exhibit A-10: Historic wildfires from 1878 to 2019 near Spokane.**

Source: Figure from Map Spokane. Accessed 21 July 2024.

As summertime precipitation decreases and temperatures rise, the amount of dead vegetation will increase, heightening the likelihood of wildfires (Chang, et al., 2023). Under the RCP8.5 Scenario, Spokane is projected to experience an additional 16 “very high” fire danger days and 11 “Extreme” fire danger days by midcentury (Hegewisch & Abatzoglou, Future Boxplots, n.d.). Moreover, under the same RCP8.5 scenario, Spokane County is projected to see an increase in wildfire probability. By the end of the century, the likelihood of climate and fuel conditions within Spokane County being favorable for wildfire in any given year is expected to be 87%, as shown in Exhibit A-11 (Sheehan, Bachelet, & Ferschweiler, 2015).

**Exhibit A-11: Likelihood of climate and fuel conditions being favorable for wildfire in any given year in Spokane County.**

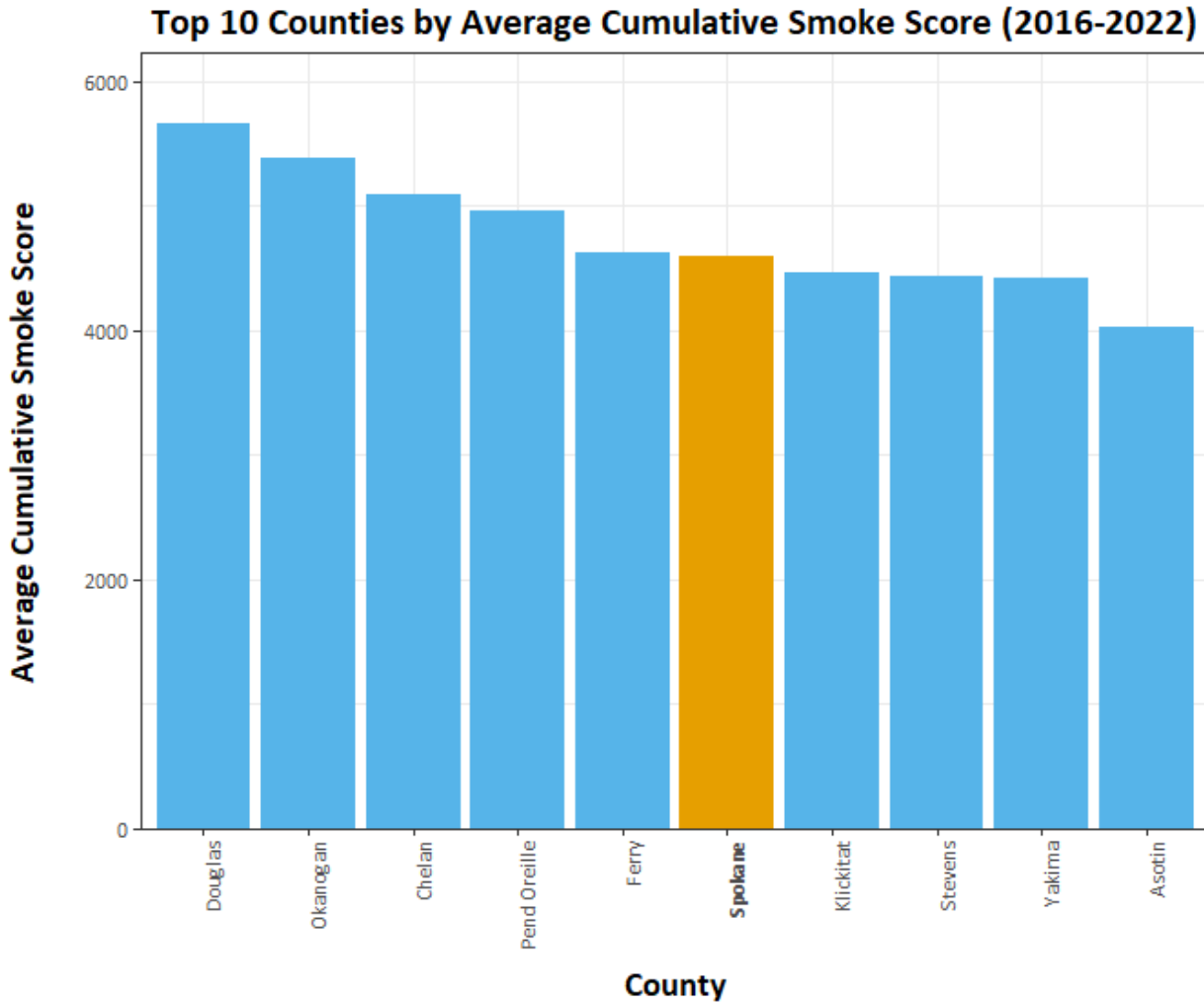


Source: Raymond & Rogers 2022. Accessed 21 July 2024.

In addition to the extensive physical damage caused by wildfires, the regional smoke they produce degrades air quality and leads to significant health and economic issues for Spokane. Wildfire smoke is strongly associated with increased hospital admissions and the worsening of respiratory and cardiac conditions (Wilgus & Merchant, 2024).

Spokane is already experiencing the impacts of wildfire smoke, with Spokane County having one of the highest wildfire smoke scores in Washington state (Exhibit A-12). These scores reflect elevated particulate matter concentrations on days affected by wildfire smoke (Washington Tracking Network & Washington State Department of Health, Wildfire Smoke Cumulative Score, 2023).

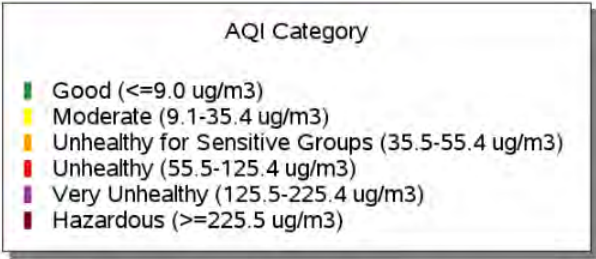
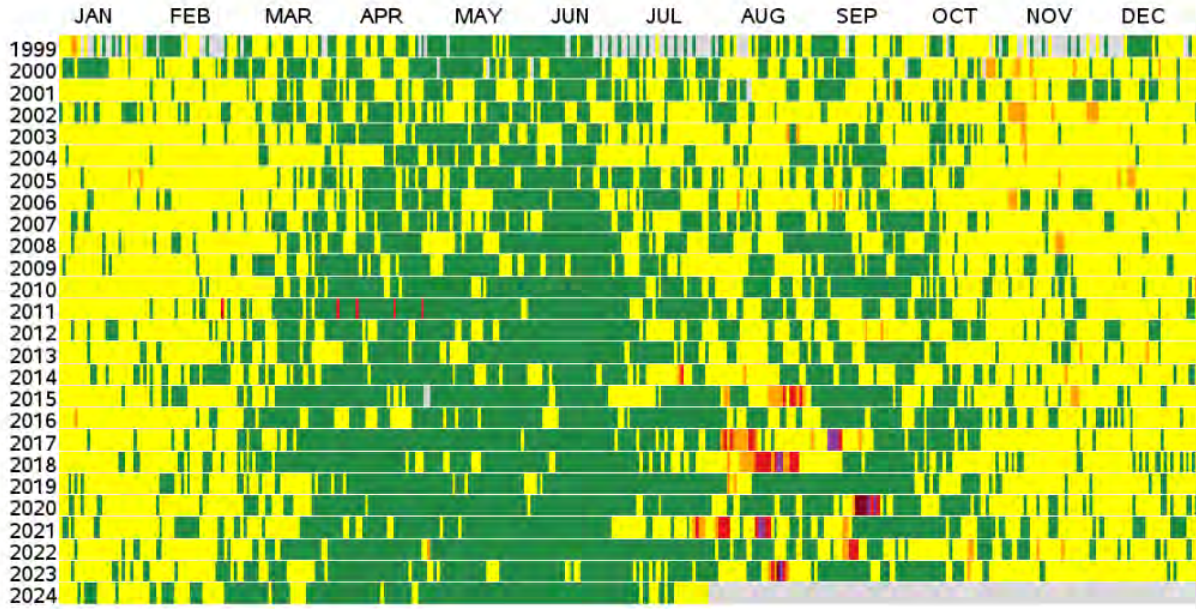
**Exhibit A-12: Washington state counties ranked by average cumulative smoke score (2016-2022).**



Source: Data from Washington Tracking Network, Washington State Department of Health. Figure created by Cascadia Consulting Group. Accessed 27 July 2024.

While there is no discernible long-term trend, the Spokane-Spokane Valley area is susceptible to experiencing high levels of pollution, such as PM2.5, in any given year, as demonstrated in Exhibit A-13 (Washington Tracking Network & Washington State Department of Health, Wildfire Smoke Cumulative Score, 2023). While particulate matter is difficult to project, recent years have seen notable spikes, indicating unhealthy pollution levels for residents (EPA, Climate Change Land and Emergency Management: Resiliency and Adaptive Capacity, n.d.).

**Exhibit A-13: PM<sub>2.5</sub> AQI Index from 1999 to 2024 in the Spokane-Spokane Valley region.**



Source: Figure from AirData, Environmental Protection Agency. Accessed 27 July 2024.

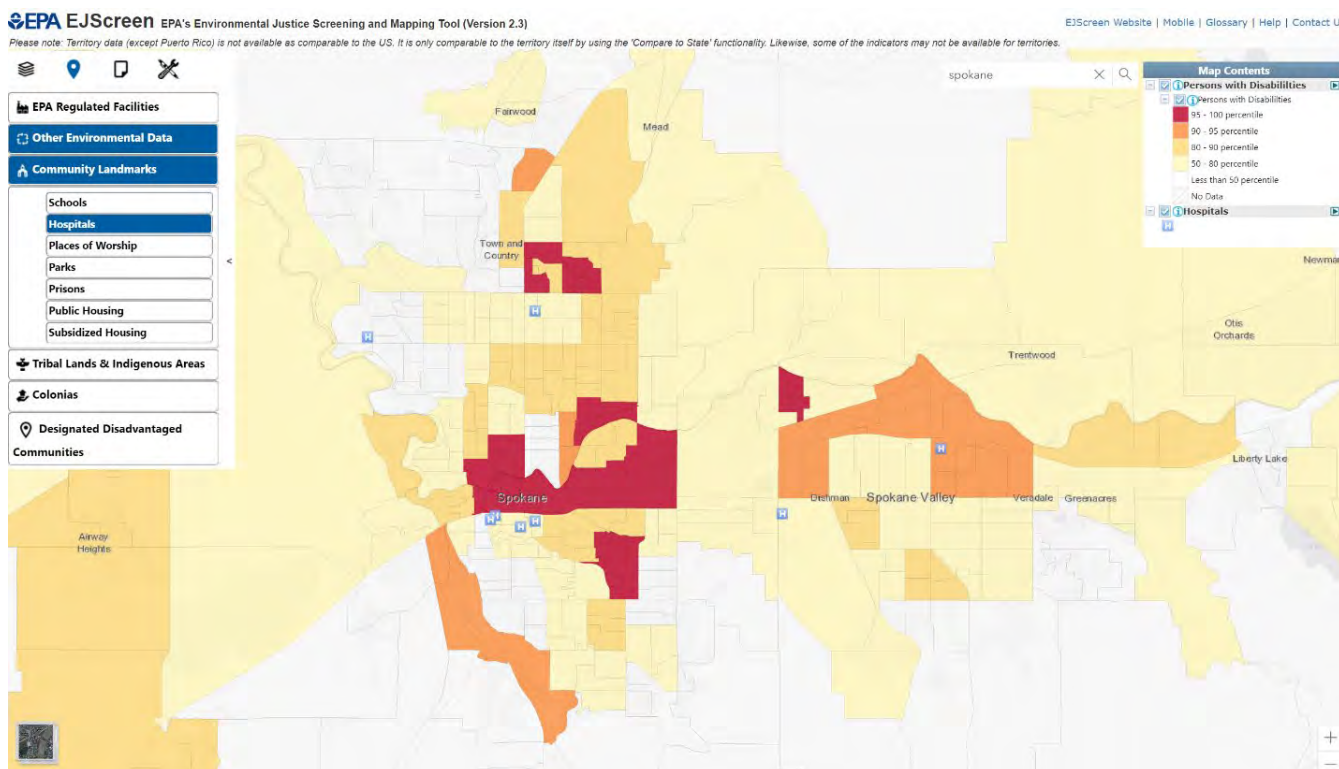


## Appendix B: Vulnerable Populations & Health Disparities

In Section 5 we discussed commonly used federal and Washington State mapping tools and vulnerability indices. Here we elaborate on those and provide example illustrative maps. As noted earlier, these maps can provide helpful overviews, but they also have limitations and drawbacks including their use of older data, choice of variables which may not be locally relevant, and coarse spatial resolution, typically at the county or census tract level (Painter, Shah, & Damestoit, 2024). The forthcoming CRVA will include more detailed and localized mapping.

Exhibit B-1 illustrates the importance of community assets in the context of climate risks. The map shows the locations of hospitals, overlaid with high rates of people with disabilities.

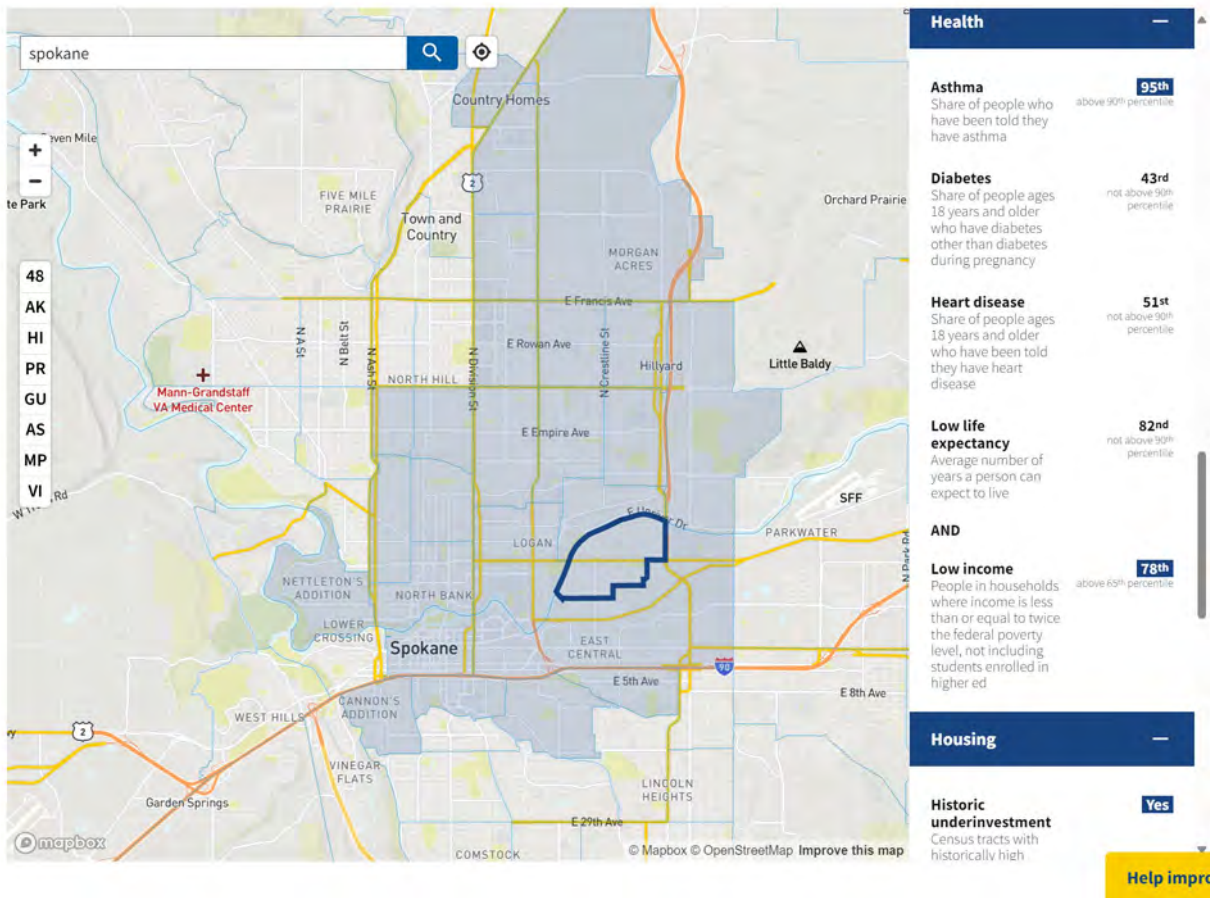
**Exhibit B-1: Map from U.S. Environmental Protection Agency, Environmental Justice Screening Tool**



In the Climate and Economic Justice Screening Tool, as shown in Exhibit B-2, census tracts that are overburdened and disadvantaged are highlighted in blue on the map. Highlighted in dark blue is tract number: 53063002600.



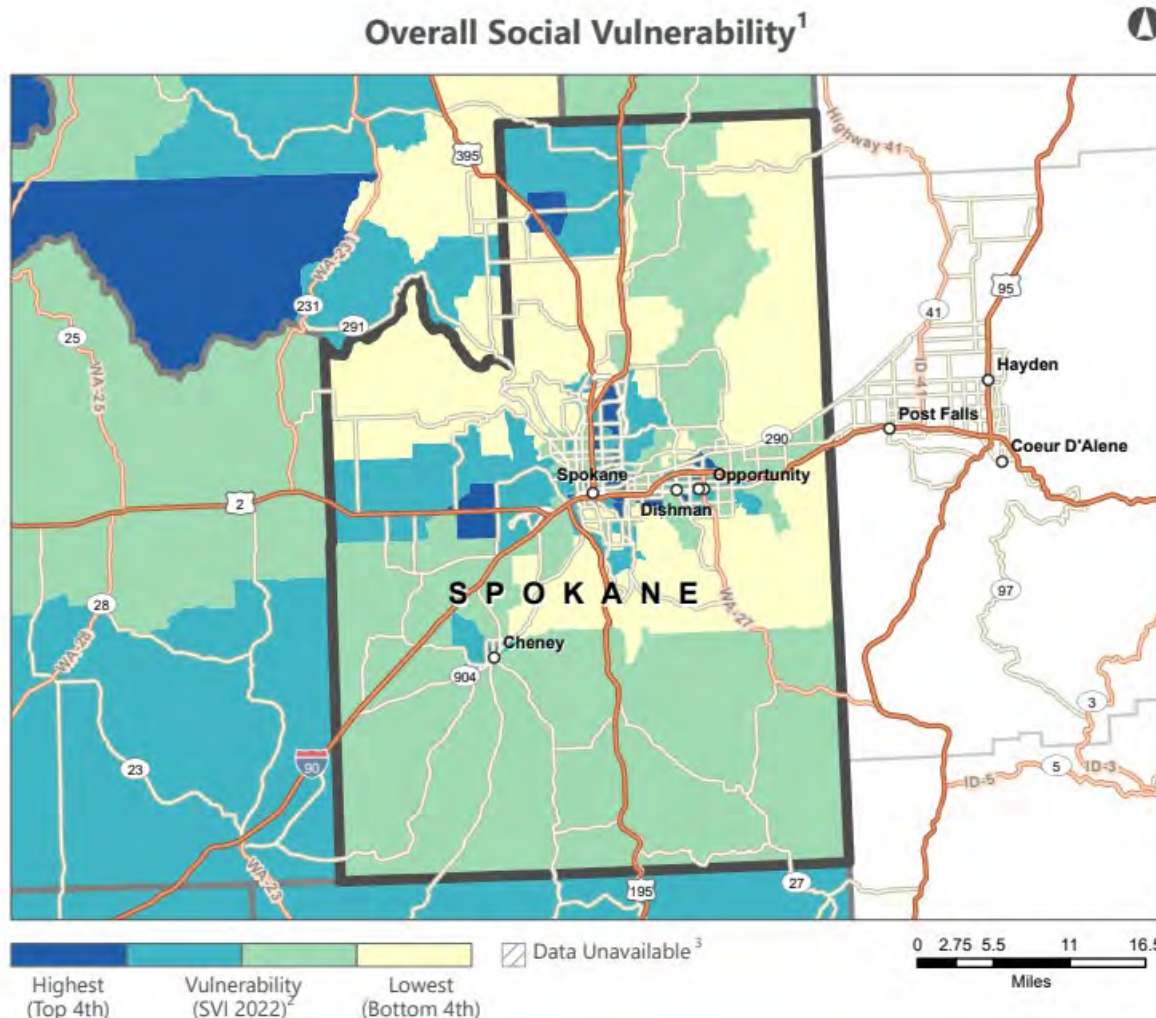
## Exhibit B-2: Map from U.S. Council on Environmental Quality, Climate and Economic Justice Screening Tool



Source: (EPA, EPA’s Environmental Justice Screening and Mapping Tool, n.d.)

The social vulnerability index from the Centers for Disease Control and Prevention uses census-derived-factors categorized into 4 themes (SES status, household characteristics, race and ethnic minority status, and housing type/transportation). While it can be useful at a high-level, it does not enable a deep examination of community or climate specific vulnerabilities. What it does show is that Spokane has areas with higher rates of communities with social vulnerability. Areas with high overall vulnerability are mainly along the I-90 corridor and in Northeast parts of the city, though there are census tracts with high vulnerability throughout Spokane, depending on the specific characteristic used. See Exhibit B-3 below for an example map.

**Exhibit B-3: Map from Centers for Disease Control and Prevention, Social Vulnerability Index**

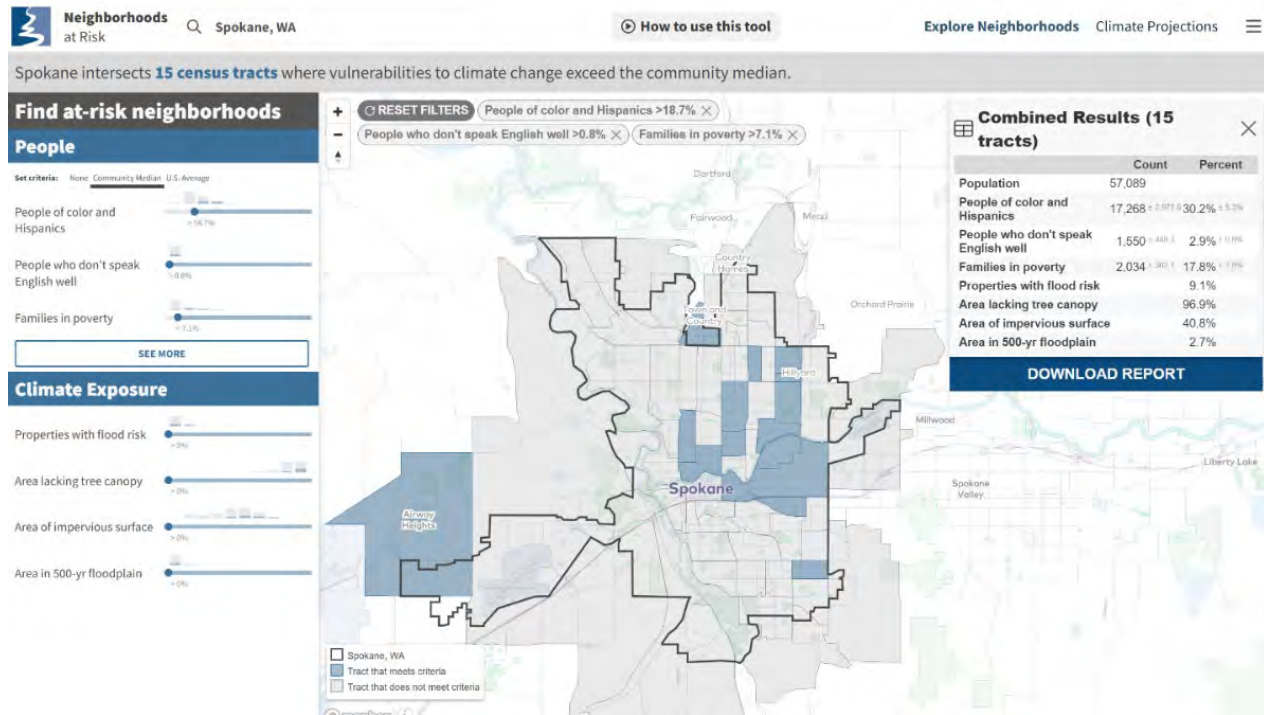
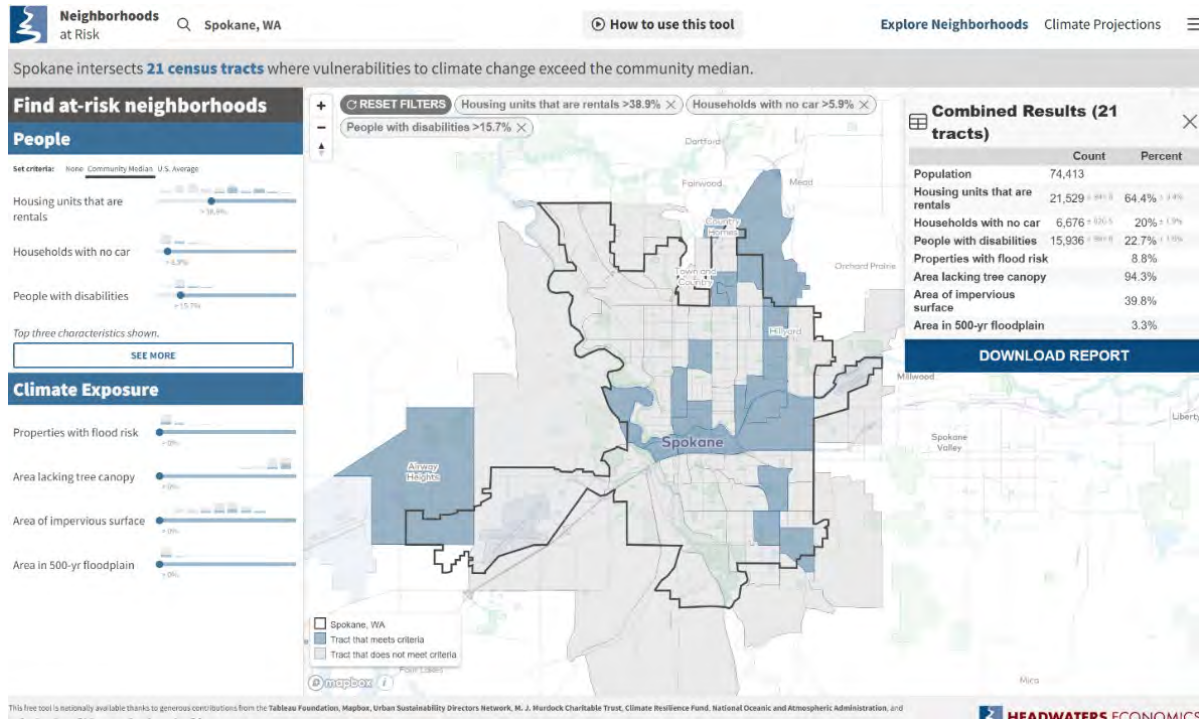


Source: (Centers for Disease Control and Prevention & Agency for Toxic Substances and Disease Registry, 2022)

The Neighborhoods at Risk tool, as shown in Exhibit B-4, uses federal data sources and climate projections from the Applied Information System at Cornell University and intersects them with a small set of socioeconomic characteristics. Spokane intersects 21 census tracts where vulnerabilities to climate impacts exceed the community median, according to these three characteristics of households at risk: rental units, households with no car, and people with disabilities. Meanwhile, 15 tracts show as vulnerable according to the characteristics of People of Color and Hispanic, families in poverty, and people who do not speak English well. Overall, in Spokane according to this tool, 2.3% of the area is in the 500-year floodplain, 9.4% of properties are at flood risk, 87.6% of the area lacks tree canopy, and 26.1% has high impervious surface.



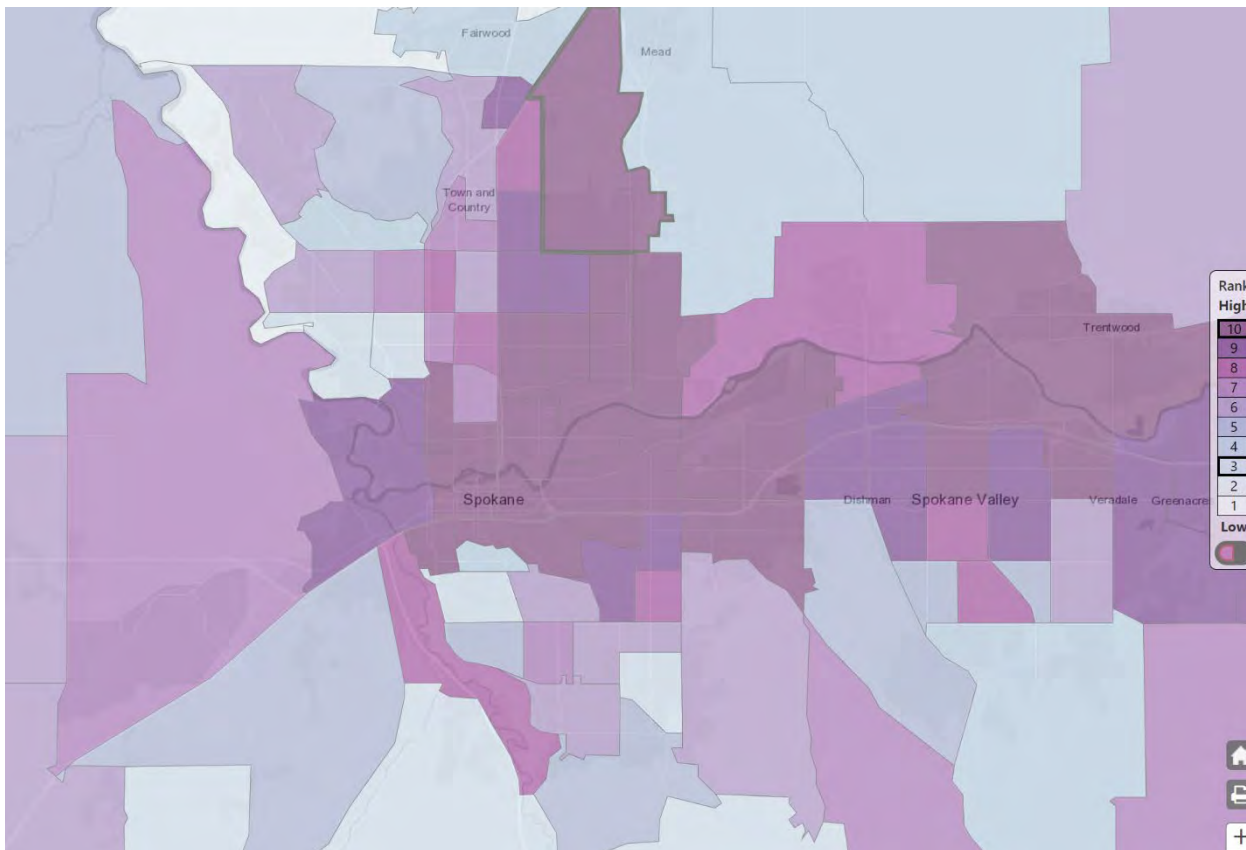
### Exhibit B-4: Maps from Headwaters Economics, Neighborhoods at Risk Tool



Source: (Headwater Economics, n.d.)

The Environmental Health Disparities Map, as shown in Exhibit B-5, shows a high ranking of environmental health disparities (e.g., with high diesel exhaust PM 2.5 emissions, high PM 2.5 concentration, lead risk from housing and more) alongside environmental effects, socioeconomic factors, and sensitive populations in Spokane along the I-90 corridor, Northeast Spokane, and South Hill, which tracks similarly to other mapping tools.

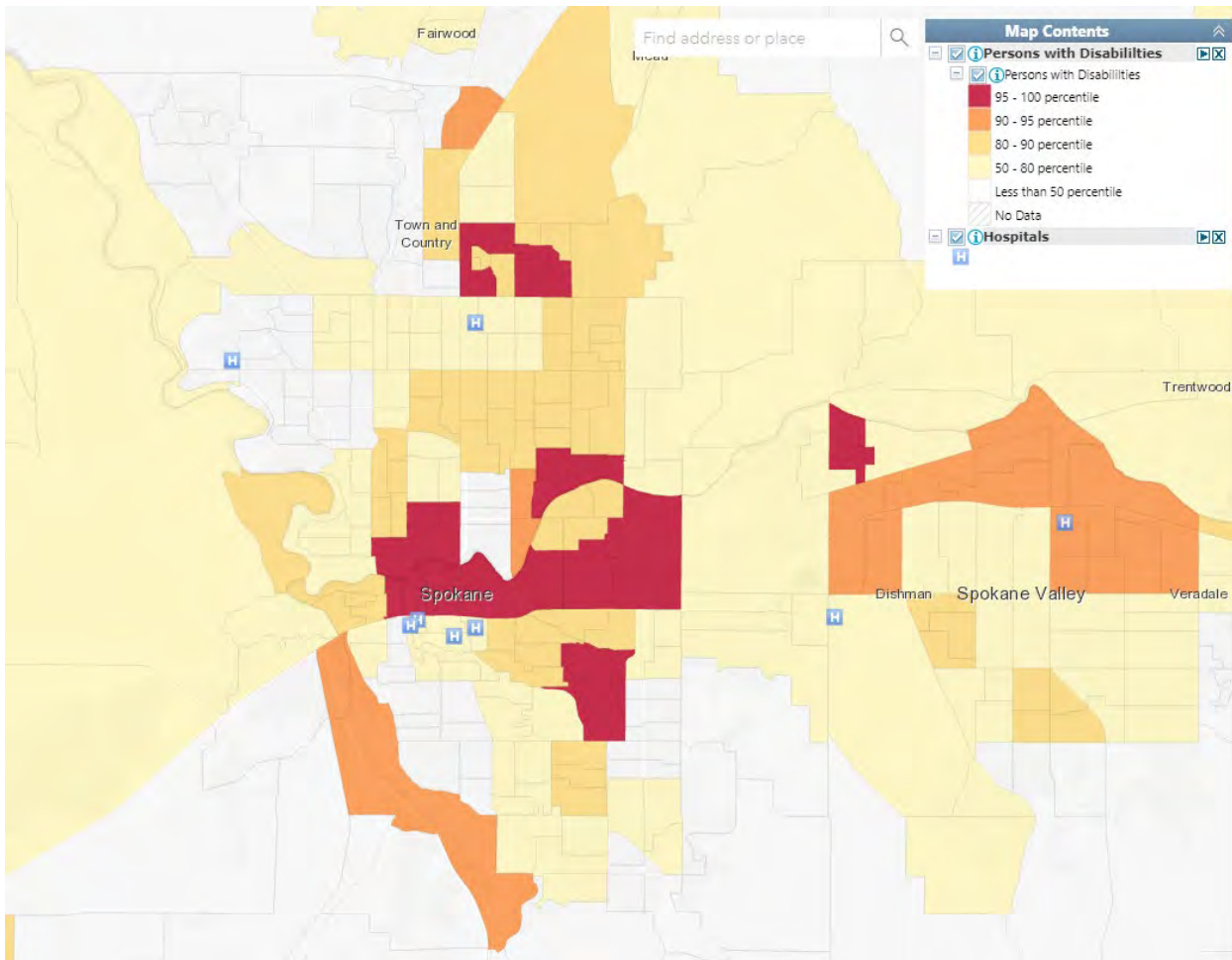
### Exhibit B-5: Map from Washington State Department of Health, Environmental Health Disparities Map



*Source:* (Washington Tracking Network & Washington State Department of Health, Washington Environmental Health Disparities Map, n.d.)

The Environmental Justice Screening and Mapping Tool, as shown in Exhibit B-6, enables mapping of many of the same characteristics and risks other tools do, using federal available data, and like the above one, considers environmental health and justice considerations alongside climate impacts. The map below shows neighborhoods with people with disabilities, which are at high rates relative to the national average. The map also shows locations of hospitals. This kind of analysis can help illustrate one type of community that is particularly vulnerable during events like extreme heat and wildfire smoke, and barriers they may face in getting medical care.

### Exhibit B-6: Map from U.S. Environmental Protection Agency, Environmental Justice Screening and Mapping Tool

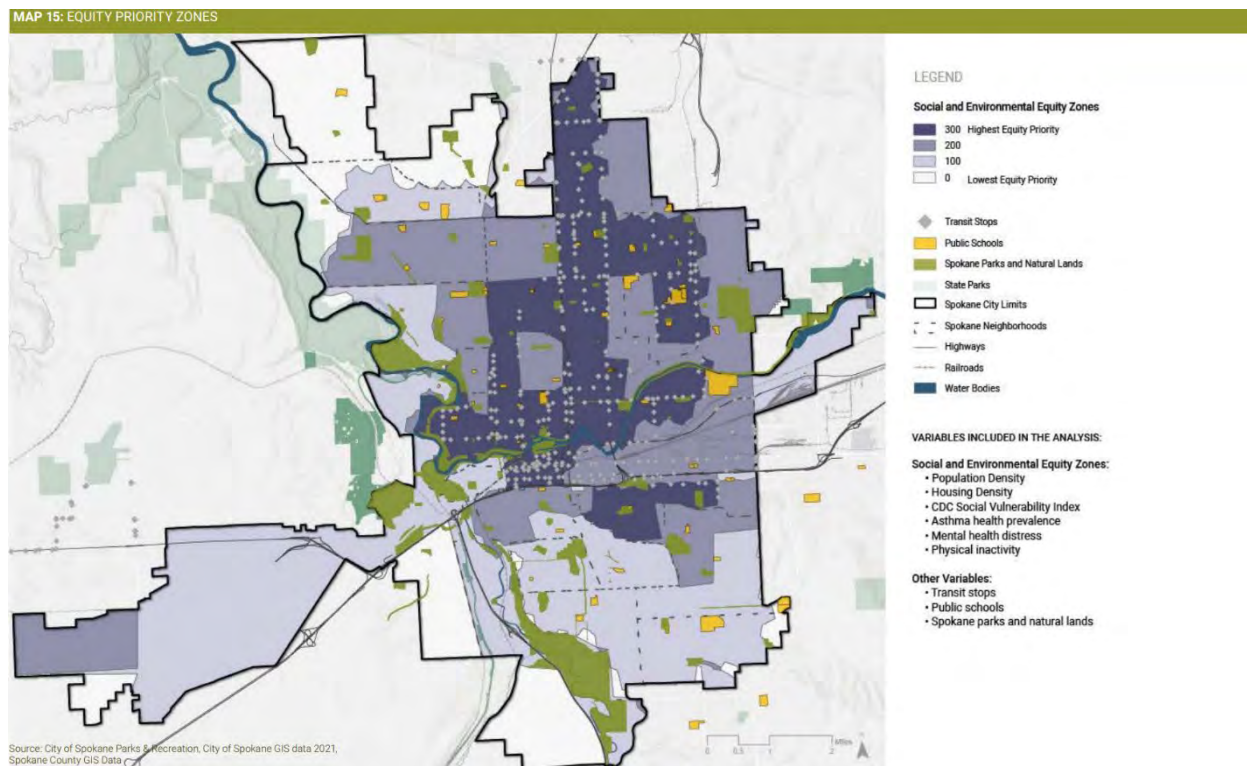


Source: (EPA, EPA's Environmental Justice Screening and Mapping Tool, n.d.)

As shown in Exhibit B-7, the City of Spokane has highlighted social and equity priority zones in its Parks and Recreation Plan, using the following variables: population density, housing density, CDC Social Vulnerability Index, asthma, health prevalence, mental health distress, physical inactivity, transit stops, public schools, and Spokane Parks and natural lands. The map below highlights, like some of the above do, neighborhoods along the I-90 corridor and in Northeast Spokane, especially in the far North, even when using some different variables.



## Exhibit B-7: Map from City of Spokane Parks and Recreation Plan, Social and Equity Priority Zones



Source: (City of Spokane Parks & Recreation, 2021)

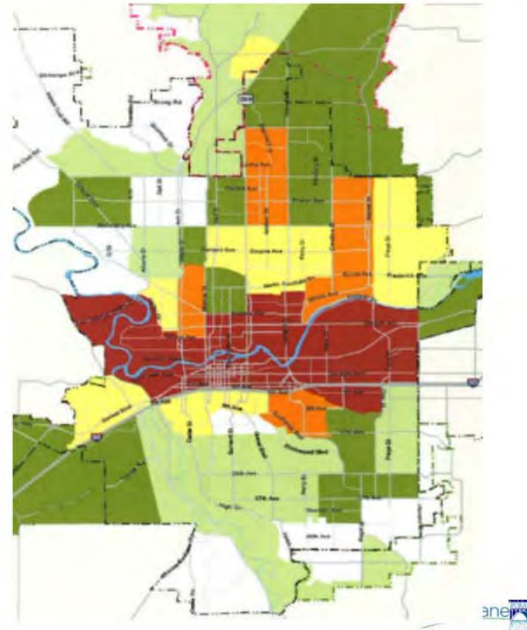
As shown in Exhibit B-8, the City of Spokane developed an equity-focused prioritization matrix for transportation projects using six evaluation categories: transportation choices, access to daily needs, economic opportunity, natural and neighborhood assets, public health and safety, and fiscal responsibility. The Disadvantaged Accessibility subcategory of the Access to Daily Needs evaluation category addresses equity concerns and awards points to areas with disadvantaged accessibility. As shown in other tools, many neighborhoods along the I-90 corridor are highlighted as disadvantaged in this evaluation.



**Exhibit B-8: Map of Disadvantaged Accessibility, from Spokane Comprehensive Plan**

**Access to daily needs**  
**Disadvantaged Accessibility**

- 0 pts - 0% - 6.92%
- 1 pts - 6.93% - 11.43%
- 2 pts - 11.43% - 19.36%
- 3 pts - 19.37% - 26.4%
- 4 pts - 26.45% - 32.9%
- 5 pts - 32.91%



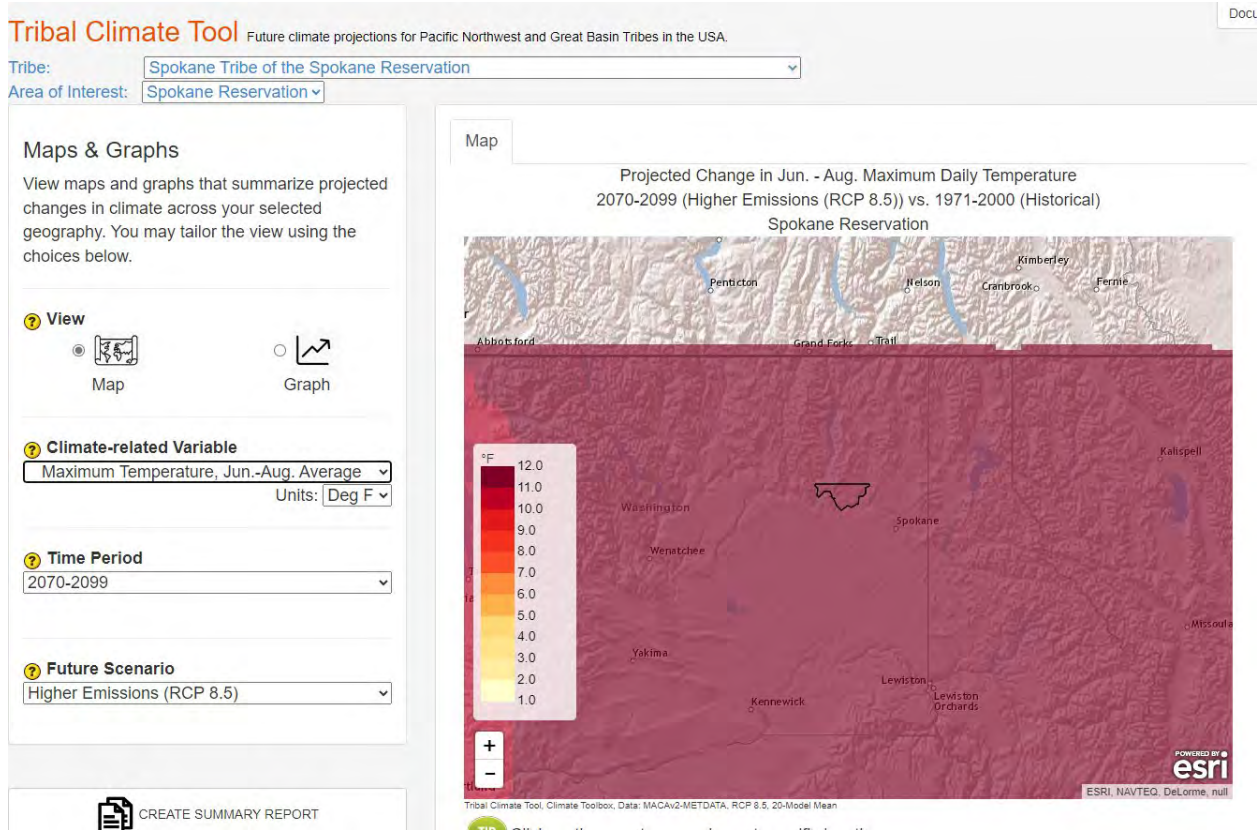
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*Source:* (City of Spokane, Shaping Spokane: Comprehensive Plan for the City of Spokane, 2017)

Native American and Tribal communities are an important focus in Spokane. The UW Climate Impacts Group offers a Tribal Climate Tool, as shown in Exhibit B-9, with options for deeper exploration. One limit of this tool is it only considers federally recognized Tribes and reservation lands, so does not consider Native Americans living or working within Spokane City boundaries, though it can offer a sense of concerns for nearby Tribal communities. As one example of its utility, we mapped the Spokane Tribe, Spokane Reservation, under a higher emissions scenario. The map below shows that in 2070-2099 the Jun. - Aug. maximum daily temperature is projected to be 92.9 °F, an increase of 11.9 °F from the historical value.

### Exhibit B-9: Map from UW Climate Impacts Group, Tribal Climate Tool



Source: (Krosby, et al., 2018)

# 7 References

- Balbus, J., Crimmins, A., Gamble, J., Easterling, D., Kunkel, K., Saha, S., & Sarofim, M. (2016). Ch. 1: Introduction. *The Impacts of Climate Change on Human Health in the United States: A Scientific*, 25-42. doi:<http://dx.doi.org/10.7930/J0VX0DFW>
- Baussion, D. (2015). *Social Cohesion: The Secret Weapon in the Fight for Equitable Climate Resilience*. Retrieved from Adaptation Clearinghouse.
- Breems, J., & Booth, K. (2020). Precipitation Study for Spokane, Washington. *The Spokane Climate Vulnerability and Resilience Assessment*. Retrieved from <https://www.spokaneclimateproject.org/precipitation#historical-climate-precipitation>.
- California Office of Environmental Health Hazard Assessment. (n.d.). *Linguistic Isolation*. Retrieved August 1, 2024, from California Office of Environmental Health Hazard Assessment: <https://oehha.ca.gov/calenviroscreen/indicator/linguistic-isolation>
- Carmen, E., Ross, H., Prager, K., Fazey, L., Bedinger, M., & Smith, F. (2022). Building community resilience in a context of climate change: The role of social capital. *Ambio*, 51(6), 1371-1387.
- Centers for Disease Control and Prevention, & Agency for Toxic Substances and Disease Registry. (2022). *CDC/ATSDR Social Vulnerability Index 2022*. Retrieved from Centers for Disease Control and Prevention: [https://svi.cdc.gov/Documents/CountyMaps/2022/Washington/Washington2022\\_Spokane%20County.pdf](https://svi.cdc.gov/Documents/CountyMaps/2022/Washington/Washington2022_Spokane%20County.pdf)
- Chang, M., Erikson, L., Araujo, K., Asinas, E., Chisholm Hatfield, S., Crozier, L., . . . Shandas, V. (2023). Ch. 27. Northwest. *Fifth National Climate Assessment*. doi:<https://doi.org/10.7930/NCA5.2023.CH27>
- Chegwidden, O., Nijssen, B., Rupp, D., & Mote, P. (2017). Hydrologic Response of the Columbia River System to Climate Change. *Zenodo*. doi:10.5281/zenodo.854763
- City of Spokane. (2017). *Shaping Spokane: Comprehensive Plan for the City of Spokane*. Retrieved from <https://static.spokanecity.org/documents/shapingspokane/comprehensive-plan/approved-comprehensive-plan-2017-v12-2023-09-07.pdf>
- City of Spokane. (2017). *Spokane Municipal Code - Section 15.05.010*. Retrieved from <https://my.spokanecity.org/smc/?Section=15.05.010>

- City of Spokane. (2021). *Understanding Housing Displacement Risk in Spokane*. Retrieved from My Spokane City: <https://my.spokanecity.org/news/stories/2021/01/19/understanding-housing-displacement-risk-in-spokane/>
- City of Spokane. (2024). *Centers and Corridors Study*. Retrieved from My Spokane City: <https://my.spokanecity.org/projects/centers-and-corridors-study/>
- City of Spokane. (n.d.). *Economy*. Retrieved August 1, 2024, from My Spokane City: <https://my.spokanecity.org/about/economy/>
- City of Spokane Parks & Recreation. (2021). Map 15: Equity Priority Zones. *City of Spokane Parks & Recreation Plan*. Retrieved from <https://static.spokanecity.org/documents/parksrec/master-plan/maps/social-and-economic-equity-priority-areas-map.pdf>
- City of Spokane. (n.d.). *Sustainability Action Subcommittee*. Retrieved from My Spokane City: <https://my.spokanecity.org/bcc/committees/public-infrastructure-environment-and-sustainability/sustainability-action-subcommittee/>
- Commerce, W. S. (2024, May 22). *Climate Program*. Retrieved from <https://www.commerce.wa.gov/serving-communities/growth-management/growth-management-topics/climate-change-2/>.
- Crenshaw, K. (1989). Demarginalizing the Intersection of Race and Sex: A Black Feminist Critique of Antidiscrimination Doctrine, Feminist Theory and Antiracist Politics. *The University of Chicago Legal Forum*.
- Cusick, D., & E&E News. (2020). *Past Racist "Redlining" Practices Increased Climate Burden on Minority Neighborhoods*. Retrieved from Scientific American: <https://www.scientificamerican.com/article/past-racist-redlining-practices-increased-climate-burden-on-minority-neighborhoods/>
- Dannen, R. (n.d.). *Facing the Legacy of Redlining in Spokane*. Retrieved August 1, 2024, from YWCA Spokane: <https://ywcaspokane.org/sar-redlining/>
- Dodgen, D., Donato, D., Kelly, N., La Greca, A., Morganstein, J., Reser, J., . . . Ursano, R. (2016). Ch. 8: Mental Health and Well-Being. *The Impacts of Climate Change on Human Health in the United States: A Scientific Assessment*, 217-246. doi:<http://dx.doi.org/10.7930/J0TX3C9H>
- EPA. (2021). *Climate Change and Social Vulnerability in the United States: A Focus on Six Impacts*. Retrieved from [https://www.epa.gov/system/files/documents/2021-09/climate-vulnerability\\_september-2021\\_508.pdf](https://www.epa.gov/system/files/documents/2021-09/climate-vulnerability_september-2021_508.pdf)

- EPA. (2023). *Air Data - Multiyear Tile Plot*. Retrieved from U.S. Environmental Protection Agency: <https://www.epa.gov/outdoor-air-quality-data/air-data-multiyear-tile-plot>
- EPA. (n.d.). *Climate Adaptation and Source Water Impacts*. Retrieved August 1, 2024, from U.S. Environmental Protection Agency: <https://www.epa.gov/arc-x/climate-adaptation-and-source-water-impacts>
- EPA. (n.d.). *Climate Change and the Health of Socially Vulnerable People*. Retrieved August 1, 2024, from U.S. Environmental Protection Agency: <https://www.epa.gov/climateimpacts/climate-change-and-health-socially-vulnerable-people>
- EPA. (n.d.). *Climate Change Land and Emergency Management: Resiliency and Adaptive Capacity*. Retrieved August 1, 2024, from U.S. Environmental Protection Agency: <https://www.epa.gov/climate-change-land-and-emergency-management/resiliency-and-adaptive-capacity>
- EPA. (n.d.). *EPA's Environmental Justice Screening and Mapping Tool*. Retrieved August 1, 2024, from U.S. Environmental Protection Agency: <https://ejscreen.epa.gov/mapper/>
- EPA. (n.d.). *Learn about Heat Islands*. Retrieved August 1, 2024, from U.S. Environmental Protection Agency: <https://www.epa.gov/heatislands/learn-about-heat-islands>
- ESRI, NASA, NGA, & USGS. (n.d.). *ArcGIS*. Retrieved from ESRI: [https://www.arcgis.com/home/webmap/viewer.html?url=https%3A%2F%2Fservices.spo-kanegis.org%2Farcgis%2Frest%2Fservices%2Fpublic%2FMapSpokane\\_WM\\_Dynamic%2FMapServer&source=sd](https://www.arcgis.com/home/webmap/viewer.html?url=https%3A%2F%2Fservices.spo-kanegis.org%2Farcgis%2Frest%2Fservices%2Fpublic%2FMapSpokane_WM_Dynamic%2FMapServer&source=sd)
- Front and Centered; WA State Department of Commerce. (2023). *Summary Report: Climate Justice in Growth Management*. Retrieved from <https://deptofcommerce.app.box.com/s/dgf52my0egwxldcj04s0fke1qp8cztkr>
- Gamble, J., Balbus, J., Berger, M., Bouye, K., Campbell, V., Chief, K., & Conlon, K. (2016). Ch. 9: Populations of Concern. *The Impacts of Climate Change on Human Health in the United States: A Scientific Assessment*, 247-286. doi:<http://dx.doi.org/10.7930/J0Q81B0T>
- Gates, K., Quinn, T., & Georgiadis, N. (2022). *The Future of Instream Water in Washington State*. Retrieved from <https://wdfw.wa.gov/sites/default/files/publications/02352/wdfw02352.pdf>
- Gonzaga Institute for Climate, Water & Environment. (2024). *Spokane Beat the Heat*. Retrieved from ArcGIS StoryMaps: <https://storymaps.arcgis.com/stories/e989c85c20494cac8056476552f4d9b7>



- Gonzaga Institute for Climate, Water, and the Environment. (2023). *2021 Northwest Heat Dome*. Retrieved from Spokane Beat the Heat: <https://storymaps.arcgis.com/stories/e989c85c20494cac8056476552f4d9b7>
- Harvard Law Review. (2023). Climate Carceralism: The Future of Climate-Linked Prison Labor. *Harvard Law Review*, 137(2). Retrieved from <https://harvardlawreview.org/print/vol-137/climate-carceralism-the-future-of-climate-linked-prison-labor/>
- Headwater Economics. (n.d.). *Neighborhoods at Risk*. Retrieved August 1, 2024, from Headwater Economics: <https://nar.headwaterseconomics.org/>
- Hegewisch, K., & Abatzoglou, J. (n.d.). *Future Boxplots*. Retrieved August 1, 2024, from Climate Toolbox: <https://climatetoolbox.org/tool/future-boxplots>
- Hegewisch, K., & Abatzoglou, J. (n.d.). *Future Time Series*. Retrieved August 1, 2024, from Climate Toolbox: <https://climatetoolbox.org/tool/Future-Time-Series>
- Hegewisch, K., Abatzoglou, J., & Chegwidan, O. (n.d.). *Future Streamflows*. Retrieved August 1, 2024, from Climate Toolbox: <https://climatetoolbox.org/tool/Future-Streamflows>
- ICAO. (n.d.). *Climate Resilient Airports*. Retrieved August 1, 2024, from <https://www.icao.int/environmental-protection/Documents/Climate%20resilient%20airports.pdf>
- Krosby, M., Hegewisch, K., Norheim, R., Mauger, G., Yazzie, K., & Morgan, H. (2018). *Tribal Climate Tool*. Retrieved from Climate Impacts Group and Climate Toolbox: <https://climate.northwestknowledge.net/NWTOOLBOX/tribalProjections.php>
- Lee, H., Romero, J., Calvin, K., Dasgupta, D., Krinner, G., & Thorne, P. (2023). *Climate Change 2023: Synthesis Report of the Sixth Assessment Report of the Intergovernmental Panel on Climate Change*. Intergovernmental Panel on Climate Change. doi:10.59327/IPCC/AR6-9789291691647
- Lute, A., Abatzoglou, J., & Hegewisch, K. (2015). Projected changes in snowfall extremes and interannual variability of snowfall in the western United States. *Water Resources Research*, 51(2). doi:<https://doi.org/10.1002/2014WR016267>
- Meixner, T., Manning, A., Stonestrom, D., Allen, D., Ajami, H., Blasch, K., . . . Walvoord, M. (2016). Implications of projected climate change for groundwater recharge in the western United States. *Journal of Hydrology*, 534, 124-138. doi:<https://doi.org/10.1016/j.jhydrol.2015.12.027>.
- National Oceanic and Atmospheric Administration, U.S. Department of Agriculture, & National Drought Mitigation Center. (2024). *U.S. Drought Monitor*. Retrieved from National Integrated Drought Information System: <https://www.drought.gov/>

- NOAA National Center for Environmental Information. (2024). *Climate at a Glance Global Time Series*. Retrieved from National Centers for Environmental Information: <https://www.ncei.noaa.gov/access/monitoring/climate-at-a-glance/global/time-series>
- NOAA National Centers for Environmental Information. (2024, November). *Climate at a Glance: City Time Series*. Retrieved from <https://www.ncei.noaa.gov/access/monitoring/climate-at-a-glance/city/time-series>
- Painter, M., Shah, S., & Damestoit, G. (2024). A systematic scoping review of the Social Vulnerability Index as applied to natural hazards. *Natural Hazards*, 120, 7265–7356. doi:<https://doi.org/10.1007/s11069-023-06378-z>
- Perlwitz, J., Knutson, T., Kossin, J., & LeGrande, A. (2017). Large-scale circulation and climate variability. *Climate Science Special Report: A Sustained Assessment Activity of the U.S. Global Change Research Program*. doi:10.7930/JORV0KVQ.
- Rains, K., Porcello, J., Odegard, K., Schultz, J., & Morin, B. (2020). Streamflow Impact Study for Spokane, Washington. Retrieved from [https://pnwcirc.org/sites/pnwcirc.org/files/4-streamflow\\_scap.pdf](https://pnwcirc.org/sites/pnwcirc.org/files/4-streamflow_scap.pdf).
- Ramin, B., & Svoboda, T. (2009). Health of the Homeless and Climate Change. *J Urban Health*, 86, 654–664. doi:<https://doi.org/10.1007/s11524-009-9354-7>
- Raymond, C., & Rogers, M. (2022). Climate Mapping for a Resilient Washington. Retrieved from <https://cig.uw.edu/resources/analysis-tools/climate-mapping-for-a-resilient-washington/>
- Sheehan, T., Bachelet, D., & Ferschweiler, K. (2015). Projected major fire and vegetation changes in the Pacific Northwest of the conterminous United States under selected CMIP5 climate futures. *Ecological Modelling, Volume 317*, 16-29. doi:<https://doi.org/10.1016/j.ecolmodel.2015.08.023>.
- Snover, A., Mauger, L., Binder, W., Krosby, M., & Tohver, I. (2013). *Climate Change Impacts and Adaptation in Washington State: Technical Summaries for Decision Makers*. Climate Impacts Groups, University of Washington. Retrieved from <https://cig.uw.edu/wp-content/uploads/sites/2/2020/12/snoveretalsokexecsum819.pdf>
- Spokane Tribe of Indians. (n.d.). *Spokane Tribal History*. Retrieved from Spokane Tribe of Indians: <https://www.spokanetribe.com/resources/dnr/preservation/history/>
- U.S. Census Bureau. (2022). *American Community Survey*. Retrieved from U.S. Census Bureau: [https://data.census.gov/profile/Spokane\\_city,\\_Washington?g=160XX00US5367000](https://data.census.gov/profile/Spokane_city,_Washington?g=160XX00US5367000)

- U.S. Dept. of Health and Human Services. (2024). *HHS emPower Map of Medicare At-Risk Populations by Geography*. Retrieved from HHS.gov: <https://empowerprogram.hhs.gov/empowermap>
- WA State Department of Health. (n.d.). *Climate Justice*. Retrieved from Climate and Health: <https://doh.wa.gov/community-and-environment/climate-and-health/climate-justice>
- Washington Department of Commerce. (2023). *Climate Element Planning Guidance*. Retrieved from <https://deptofcommerce.app.box.com/s/fpg3h0lbwln2ctqjg7jg802h54ie19jx>
- Washington Department of Commerce. (2023). *Climate Element Planning Guidance*. Retrieved from <https://deptofcommerce.app.box.com/s/fpg3h0lbwln2ctqjg7jg802h54ie19jx>
- Washington Department of Health. (n.d.). *Climate Justice*. Retrieved August 1, 2024, from <https://doh.wa.gov/community-and-environment/climate-and-health/climate-justice>.
- Washington State Department of Commerce. (2023). *Climate Element Planning Guidance*. Retrieved from <https://deptofcommerce.app.box.com/s/fpg3h0lbwln2ctqjg7jg802h54ie19jx>
- Washington State Department of Health. (n.d.). *Extreme Heat and Climate Change*. Retrieved August 1, 2024, from Washington State Department of Health: <https://doh.wa.gov/community-and-environment/climate-and-health/extreme-heat>
- Washington Tracking Network, & Washington State Department of Health. (2023). *Wildfire Smoke Cumulative Score*. Retrieved from Washington State Department of Health: <https://fortress.wa.gov/doh/wtn/WTNPortal/#!q0=8909>
- Washington Tracking Network, & Washington State Department of Health. (n.d.). *Washington Environmental Health Disparities Map*. Retrieved August 1, 2024, from Washington State Department of Health: <https://fortress.wa.gov/doh/wtnibl/WTNIBL/>
- Welty, J., & Jeffries, M. (2020). Combined wildfire datasets for the United States and certain territories, 1878-2019. *U.S. Geological Survey data release*. doi:<https://doi.org/10.5066/P9Z2VVRT>.
- Wetty, J., & Jeffries, M. (2020). Combined wildfire datasets for the United States and certain territories,. *U.S. Geological Survey data release*, 1878-2019. doi:<https://doi.org/10.5066/P9Z2VVRT>.
- Whyte, K., Novak, R., Laramie, M., Bruscatto, N., David-Chavez, D., Dockry, M., . . . Leonard, K. (2023). Ch. 16. Tribes and Indigenous Peoples. *Fifth National Climate Assessment*. doi:<https://doi.org/10.7930/NCA5.2023.CH16>

Wilgus, M., & Merchant, M. (2024). Clearing the Air: Understanding the Impact of Wildfire Smoke on Asthma and COPD. *Healthcare (Basel)*, 12(3). doi:10.3390/healthcare12030307

World Health Organization. (n.d.). *Climate Change and Health*. Retrieved August 1, 2024, from World Health Organization;: <https://www.who.int/teams/environment-climate-change-and-health/climate-change-and-health/country-support/building-climate-resilient-health-systems/emergency-preparedness-and-management>