City of Walla Walla Climate Impacts Assessment Summary

The City of Walla Walla Climate Element 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.

Contents

OVERVIEW

This climate impacts summary discusses historical trends and future climate projections to provide a foundational understanding of how future changes in the climate and associated hazards will affect the City of Walla Walla now and in the future. The City of Walla Walla is expected to experience the following impacts (detailed in the Summary of Climate Impacts section):

- Extreme Heat: Higher annual average temperatures, with especially high temperature increases during the summer months.
- Wildfire and Smoke: Increased wildfire activity due to extreme heat and heighted drought, resulting in increased smoke and poor air quality.
- Drought: Declining summer precipitation, leading to more frequent, longer, and severe regional droughts.
- Extreme Precipitation and Flooding: Increased flooding due to more frequent and intense extreme precipitation events.

The purpose of the climate impacts summary is to identify historical and projected climate impacts in order to support the climate gaps and opportunities assessment of the City of Walla Walla's Comprehensive Plan and inform the City of Walla Walla's climate vulnerability assessment (CVA). These components will ultimately inform the Climate Element and Resilience Sub-Element in the Comprehensive Plan.

Legislative Background

WA House Bill (HB) 1181

The Washington Growth Management Act (GMA) was amended in 2023 under Washington House Bill (HB) 1181, requiring cities and counties to integrate climate policies[1] into comprehensive plan updates. For the City of Walla Walla ("the City"), these required policy changes must address climate impacts and increase resilience across local sectors. Jurisdictions must adopt climate policies through a framework consistent with the Department of Commerce's ("Commerce") Climate Planning Guidance (Washington Department of Commerce, 2023).

Climate Planning Guidance in WA

To comply with State guidance, the first step in developing a Climate Element is exploring climate impacts most prevalent to your community following Commerce's Resilience Guidance framework (Washington Department of Commerce, 2023). This guidance integrates the U.S. Climate Resilience Toolkit's framework and best practices from various organizations such as the Association of Washington Cities (AWC), Municipal Research and Services Center of Washington (MRSC), and the American Planning Association (APA). Commerce's framework offers a flexible approach for jurisdictions to incorporate the latest available climate science, assess local impacts, and consider resilience policy options. This climate impacts summary mirrors **Commerce's "Climate Element Workbook" Step 3 Task 1.1, 1.2, and 1.3**, with the goal of exploring how expected changes in the climate could exacerbate natural hazards (e.g., droughts, floods, etc.) and impact critical assets and sectors (e.g., ecosystems, infrastructure, public health, etc.).

Climate Impacts Assessment

Methodology

To perform this climate impacts assessment, Cascadia Consulting Group ("Cascadia") used a variety of established and peer-reviewed resources—including the University of Washington's Climate Impacts Group's Climate Mapping for a Resilient Washington, NOAA National Centers for Environmental Information WA State Climate Summary, the 5th National Climate Assessment's Northwest Chapter, and other relevant studies and datasets—to identify observed and projected climate trends relevant for the City. When city-scale data was not available, Cascadia relied on Walla Walla county-scale climate impact data, as noted throughout the document. This climate impacts assessment will inform the next phase of hazard vulnerability and risk analysis by building considerations for future changes in hazard risk due to climate change.

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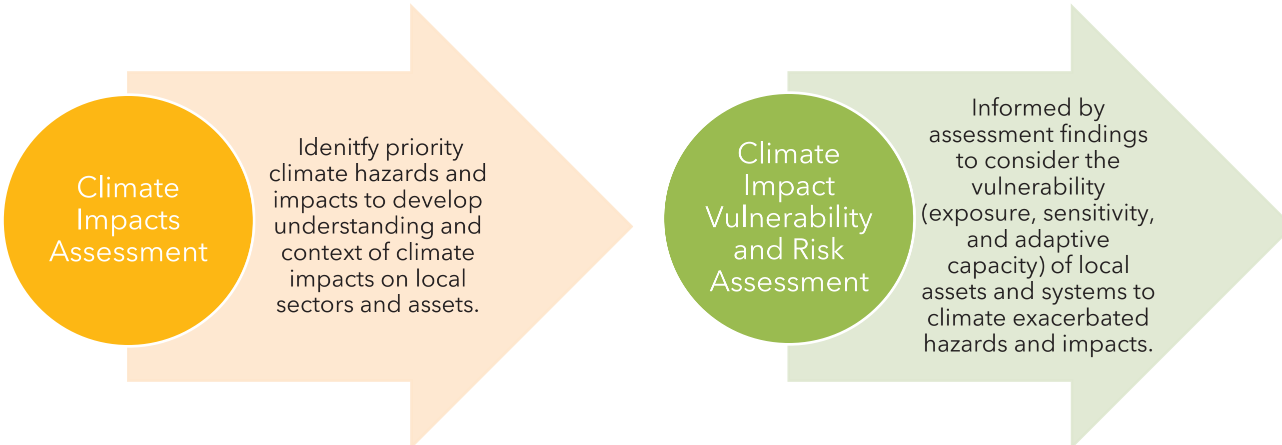
[1] Climate resilience policies are required for all jurisdictions planning under the GMA. GHG emission reduction policies are only required for 11 of the fastest growing counties and cities within them.



Throughout the climate impacts and vulnerability assessment process, Cascadia will work with the City to come to a shared agreement and understanding of the climate impacts and hazards most relevant to the City to determine priority assets that may be exposed to climate change.

Climate Drivers and Variability

Climate change refers to the long-term shifting of environmental conditions and weather patterns. Climate change is primarily caused by human activity, particularly the emission of GHGs from burning fossil fuels. Higher levels of atmospheric GHGs, notably carbon emissions, have driven the increase 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 (Marvel, et al., 2023).

Natural feedback processes like the El Niño-Southern Oscillation and the Pacific Decadal Oscillation contribute to variations in air temperature, extreme weather events, precipitation, and ocean conditions over interannual and interdecadal periods. However, the rate of climate change caused by human activities far exceeds any natural variability from these processes (Perlwitz, Knutson, Kossin, & LeGrande, 2017).

Climate Scenarios and Projection Models

The rise in GHG emissions in the atmosphere has already caused the climate to change significantly, as described above. Models projecting future climate conditions and impacts, including how climate hazards will increase and intensify over the next century, use a variety of climate scenarios. These scenarios are based on factors such as future land use, population growth, technological innovation, and global GHG emission levels.

The Representative Concentration Pathways (RCPs) are scenarios developed by the Intergovernmental Panel on Climate Change (IPCC) to model potential climate futures based on different levels of greenhouse gas concentrations. Each RCP represents a different "pathway" or possible level of carbon dioxide and other emissions in the atmosphere, depending on a range of possible human behaviors and climate processes. These pathways allow researchers, policymakers, and communities to explore potential risks and plan for changes (IPCC, 2022).

This climate impacts summary will primarily use 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 (approximately 7.7 ˚F) by 2100 relative to pre-industrial temperatures (IPCC, 2022). This climate impacts summary primarily uses RCP 8.5 because it represents the most realistic emissions trajectory that we are currently on.

SUMMARY OF CLIMATE IMPACTS

The following sections provide an overview of key climate change impacts and how they are expected to affect local sectors. This assessment aims to build a baseline awareness to guide the City's resilience planning within the Climate Element.

Extreme Heat

Average temperature in the Northwest and Washington state has warmed over the last century and is expected to warm at a faster rate through the next century and beyond. The Northwest's average yearly temperature has increased by 2°F since the early 20th century. Additionally, the coldest day of the year from 1986 to 2016 was 4.78°F warmer compared to 1901 to 1960. In the City of Walla Walla, annual average temperatures have increased by approximately 2.05°F since 1900 (Figure 1) (Office of the Washington State Climatologist, 2023).

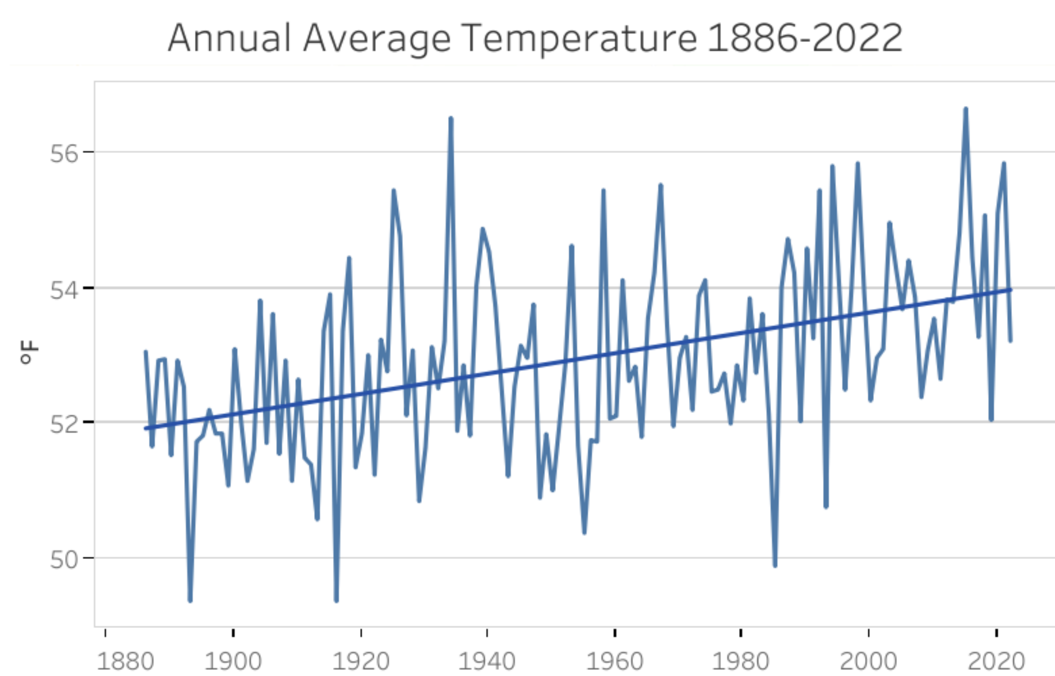


Figure 1. Annual Average Temperature City of Walla Walla. Figure shows historical temperature variability and linear trend of average annual temperature (Office of the Washington State Climatologist, 2023).

By the 2080s, annual average temperature in the Northwest is projected to increase by 10.0°F under a very high scenario (SSP5-8.5) relative to the period 1950–1999 (Chang, et al., 2023). In Walla Walla County, there were 17.6 days per year above 95°F from 1981-2010. Even under a low-emissions scenario, this is projected to increase to 35.3 days by 2059 and 42 days by 2099 (Walla Walla Watershed Management Partnership, 2021).

Figure 2 shown below, illustrates the change in summer (June-August) average maximum temperature in Walla Walla County for future 30-year periods compared to the 1980-2009 average. The change in average summer maximum temperature is an indicator of heat stress for people, ecosystems, and infrastructure (Raymond & Rogers, 2022). By mid-century (2040-2069), average summer maximum temperature is expected to increase by 6.7°F in the county. By end-century (2070-2099), average summer maximum temperature is expected to increase by 11.4°F in the county.

Walla Walla County, Washington. Change in Average Summer (Jun-Aug) Maximum Temperature

Higher Scenario (RCP 8.5), Historical (1980-2009) Value: 85.7 degrees F

Figure 2. Summer Average Maximum Temperature Walla Walla County. Figure shows expected changes for Walla Walla county for all future time periods through 2100, as well as the expected range among models for each time period. The bars represent high values (90th percentile), low values (10th percentile), and median values (red line) for each time period (Raymond & Rogers, 2022).

SECTORS AFFECTED BY EXTREME HEAT

Sector	Impacts
Agriculture and Food Systems	• Shifting frost and freeze dates, affecting fruit crops and other industries. • Heat stress reduces crop yields and increases pest survival. • Rising demand for irrigation.
Building and Energy	• Higher cooling demand during summers. • Variable hydroelectric capacity due to changing streamflow, causing timing mismatches in electricity supply and demand.
Economic Development	• Lost revenue from agriculture, wine, and other key industries. • Tourism and recreation industry revenue loss.
Ecosystems	• Species unable to adapt may be at risk of population loss or face range shifts, such as snow geese, shad, and sagebrush. • Increased stress on cold-water species such as salmon and steelheads in lakes and rivers.
Emergency Management	• More frequent and intense heatwaves or heat domes. • Greater strain on emergency services due to heat-related health issues and travel disruptions.
Health and Well-being	• Rise in heat-related deaths and illnesses, especially among vulnerable populations. • Warmer water temperatures increase the spread of harmful algal blooms, raising the risk of waterborne diseases.
Transportation	• Heat damage to roads and bridges increases maintenance costs and economic disruptions.
Water Resources	• Water scarcity from reduced snowpack, altered spring melt timing, and lower summer streamflow. • Increased aquifer depletion and competition for water.

Wildfire, Smoke, and Air Quality

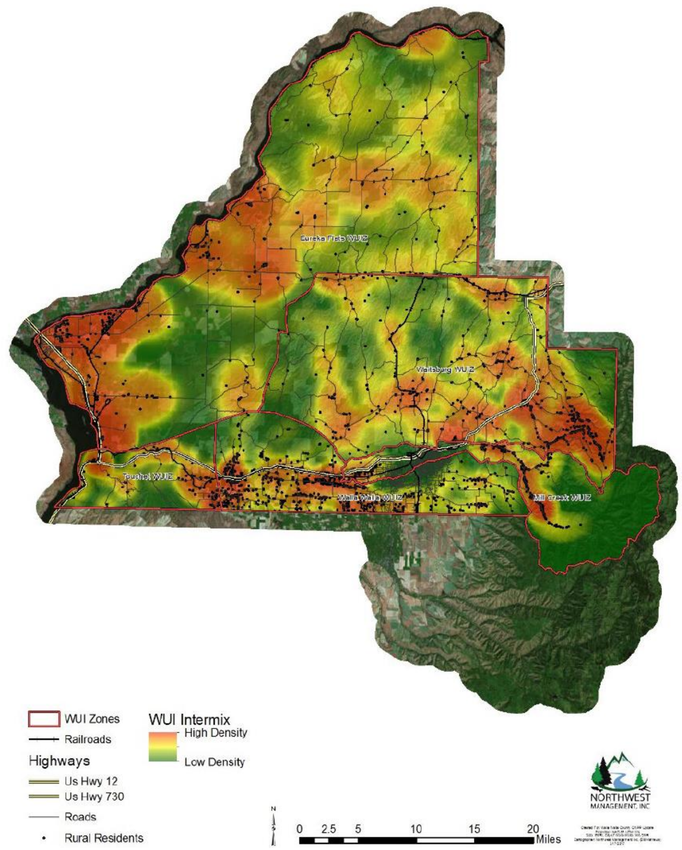


Figure 3. Map of Walla Walla County and the Mill Creek Watershed that identifies the Wildland Urban Interface (WUI) zones and risk ratings

The City of Walla Walla's mild climate, high solar irradiance, and low precipitation make the area highly prone to wildfires. While much native grassland has been converted to agriculture, remaining native vegetation and farmland dry out early in summer, staying combustible until winter (Walla Walla Hazard Mitigation Plan). Wildfire and wildfire smoke can be severe in the region, especially in highly populated areas of eastern Washington (Chang, et al., 2023). Figure 3 is pulled from the 2017 Mill Creek and Walla Walla County Washington Community Wildfire Protection Plan and highlights Wildland Urban Interface Zones delineated to address fire frequency, emergency service response time, and highlights critical infrastructure.

Wildfire activity is expected to rise in central and eastern Washington as temperatures increase. In the Columbia River Basin, the area burned by fire is expected to triple relative to the 1916-2006 median by the 2040s (Walla Walla Watershed Management Partnership, 2021).

Table 1 presents the change in high fire danger days in Walla Walla County, indicating a greater potential for wildfire activity if ignition sources and ample fuels are present.

Table 1. Wildfire Danger Walla Walla County.

	2010-2039	2040-2069
Wildfire Danger (T. Sheehan, et al., 2015) *Accessed via Climate Mapping for a Resilient Washington.**	Walla Walla County	Walla Walla County
Change in annual high fire danger days	6 days (-2 to 10 days)	10 days (3 to 15 days)

**Table shows the change in annual high fire danger days compared to the 1971-2000 average of 54 days. The values represent the model's median for each indicator, while the range (in parentheses) indicates 10th and 90th percentile of values.*

Figure 4 shows the likelihood of climate and fuel conditions favorable for wildfire in the county for future 30-year periods. For example, a value of 0.74 for the county in 2030-2059 means that there is a 74% chance that a year in that time period will have climate and fuel conditions that are favorable for wildfire. Throughout this century (2020-2099), the median likelihood of conditions favorable for a wildfire in the county fluctuate between 67-74%. While there is a high degree of wildfire patterns through the end of the century, depending on changes to vegetation and climate patterns, this region may see increased future temperatures and longer, dryer summers causing the vegetation to shift from conifer forests to less dense, more drought-tolerant mixed forest.

Walla Walla County, Washington. Likelihood of Climate and Fuel Conditions for Wildfire
Higher Scenario (RCP 8.5), Historical (1980-2009) Value: 0.49 (49%)

Figure 4. Wildfire Likelihood Walla Walla County. Figure shows expected changes for Walla Walla county for all future time periods through 2100, as well as the expected range among models for each time period. The bars represent high values (90th percentile), low values (10th percentile), and median values (red line) for each time period (Raymond & Rogers, 2022).

Increased frequency, size, and severity (acres burned) of wildfires will also lead to increased exposure to wildfire smoke and reduced air quality, which is especially harmful to older adults, young children, pregnant people, and those with pre-existing conditions, such as asthma, heart disease, and diabetes, among others (Chang, et al., 2023).

SECTORS AFFECTED BY WILDFIRE AND SMOKE

Building and Energy	•Damaged energy infrastructure, leading to prolonged service interruptions. •Damage to homes and buildings in the wildland-urban interface.
Economic Development	•Business disruptions and financial loss. •Impact on industries such as agriculture, wine tourism, and recreation.
Ecosystems	•Introduction of invasive and flammable species, such as cheatgrass. •Increased erosion impacting forests, grasslands, and water sources.
Emergency Management	•Emergency responder stress and capacity constraints from increased frequency and intensity of fires. •Blocked evacuation routes delaying emergency responses and resource access.
Health and Well-being	•Health impacts from loss of life, injury, and mental health issues due to extreme events. Poor air quality worsening respiratory conditions, particularly for vulnerable populations.
Water Resources	•Damage to water distribution infrastructure. •Decreased water quality in reservoirs, leading to greater treatment needs.
Zoning and Development	•Damage to buildings, especially in the wildland-urban interface.

Drought

In the Northwest, summer precipitation is projected to decline under all scenarios, contributing to more frequent, longer, and more severe regional drought conditions that increase wildfire risk and decrease water availability (Chang, et al., 2023). The City of Walla Walla relies on the Mill Creek Municipal Watershed for 90% of its water supply. Located near the wildland-urban interface, this forested area has heavy fuel loads and is vulnerable to wildfires, which could severely impact water quality and availability (Walla Walla HMP). Walla Walla County is projected to experience a decrease in summer precipitation of 22% by mid-century (2050-2079) and 27% by end-century (2070-2099) (Table 2).

Table 2. Precipitation Drought Walla Walla County

	2050-2079	2070-2099
Precipitation Drought (Salathé, E.P. et al., 2010) *Accessed via Climate Mapping for a Resilient Washington.**	Walla Walla County	Walla Walla County
Likelihood of a year with summer precipitation below 75% of historical normal	22% (16 to 35%)	27% (10 to 34%)

**Likelihood that summer (June-August) precipitation in any given year is below 75% of average precipitation, the historical normal for the period 1980-2009.*

Changes in snowpack levels and increased demand for water will impact the region's water supply. Projected temperature increases will raise the likelihood that precipitation will fall as rain instead of snow, reducing water storage in the snowpack (Frankson, et al. , 2022). The Walla Walla basin is predicted to experience one of the largest declines in snowpack in the Pacific Northwest. The Walla Walla River streamflow is expected to decrease by up to 66% by the 2040s and as much as 89% by the 2080s (Washington Department of Ecology, 2023). These changes will impact communities, agriculture, tourism, and wildlife in the basin.

Table 3 shows the percent change over the next century of April 1 snowpack in Walla Walla County. April 1st snowpack is used as an indicator for the amount of stored water that becomes available during the melt season. In the Pacific Northwest, this melt season often spans from late spring through early summer, roughly from April or May through July, although the exact timing can vary based on elevation and year-to-year weather patterns.

The projected decrease of April 1st snowpack indicates that less stored water will be available to supply streams, soil, and reservoirs during the melt season (Raymond & Rogers, 2022). For both mid- and end-century projections, April 1st snowpack in Walla Walla County is expected to decrease by 99% compared to the 1980-2009 average (

Table 3).

Table 3. Snowpack Drought Walla Walla County

	2050-2079	2070-2099
Percent change in April 1st snowpack. *Accessed via Climate Mapping for a Resilient Washington.*	Walla Walla County	Walla Walla County
Percent change in April 1st snowpack for future 30-year periods compared to the 1980-2009 average (RCP 8.5)	-99% (-93 to -100%)	-99% (-99 to -100%)

SECTORS AFFECTED BY DROUGHT

Sector	Impacts
Agriculture and Food Systems	•Reduced water availabiltiy for key industries such as wineries. •Higher irrigation needs due to longer, warmer growing seasons.
Building and Energy	•Lower hydroelectric power production.
Cultural Resources and Practices	•Loss of temperature-sensitive, culturally important foods, such as salmon and steelhead.
Ecosystems	•Stressed vegetation and worsened habitat quality. •Greater wildfire risk due to stressed ecosystems and increased fuel loads.
Emergency Management	•Increased demand for emergency services to address water shortages.
Health and Well-being	•Erosion and wildfire risks affecting vulnerable populations. •Fewer outdoor recreation opportunities reliant on water and snowpack.
Water Resources	•Reduced snowpack and water availability in Walla Walla basin. •Lower water quality due to less pollutant dilution.

Extreme Precipitation and Flooding

The frequency and intensity of extreme precipitation events is projected to increase across the Northwest region, as well as more winter precipitation falling as rain rather than snow (Chang, et al., 2023). By mid-century, heavy rainfall events in the Northwest are expected to become more severe, with a 13% increase in days with over an inch of rain by the 2050s compared to 1971-2000 (Walla Walla Watershed Management Partnership, 2021). Washington's heaviest rain events could be 22% more intense by the 2080s, primarily in the fall, leading to more extreme floods. Meanwhile, summer precipitation is projected to decrease by 6-8% on average, with some estimates showing up to a 30% decline (Walla Walla Watershed Management Partnership, 2021). While projections of annual precipitation are variable, Walla Walla County is projected to experience an increase in total annual precipitation through mid- and end-century, based on an RCP 8.5 scenario (Table 4).

Table 4. Annual Precipitation Walla Walla County

	2050-2079	2070-2099
Total Annual Precipitation (Salathé, E.P. et al., 2010) *Accessed via Climate Mapping for a Resilient Washington.*	Walla Walla County	Walla Walla County
Percent change in average total annual precipitation for future 30-year periods compared to the 1980-2009 average.	12.9% (9.7 to 20.9%)	14.4% (10.0 to 28.2 %

Seasonal precipitation projections are mixed for jurisdictions east of the Cascades; however, a majority of models project increases in precipitation for winter, spring, and fall precipitation and decreases in summer precipitation. Figure 5 shows projected change in total summer and winter precipitation (%) for the region east of the Cascades through mid- and end-century. The high emissions scenario projects an 8.5% increase in winter precipitation in the 2050s and 6.3% decrease in the summer through the 2050s (Rogers, 2021). Through the 2080s, winter precipitation is projected to increase by 14.6%, while summer precipitation is expected to decrease by 9.9% (Rogers, 2021).

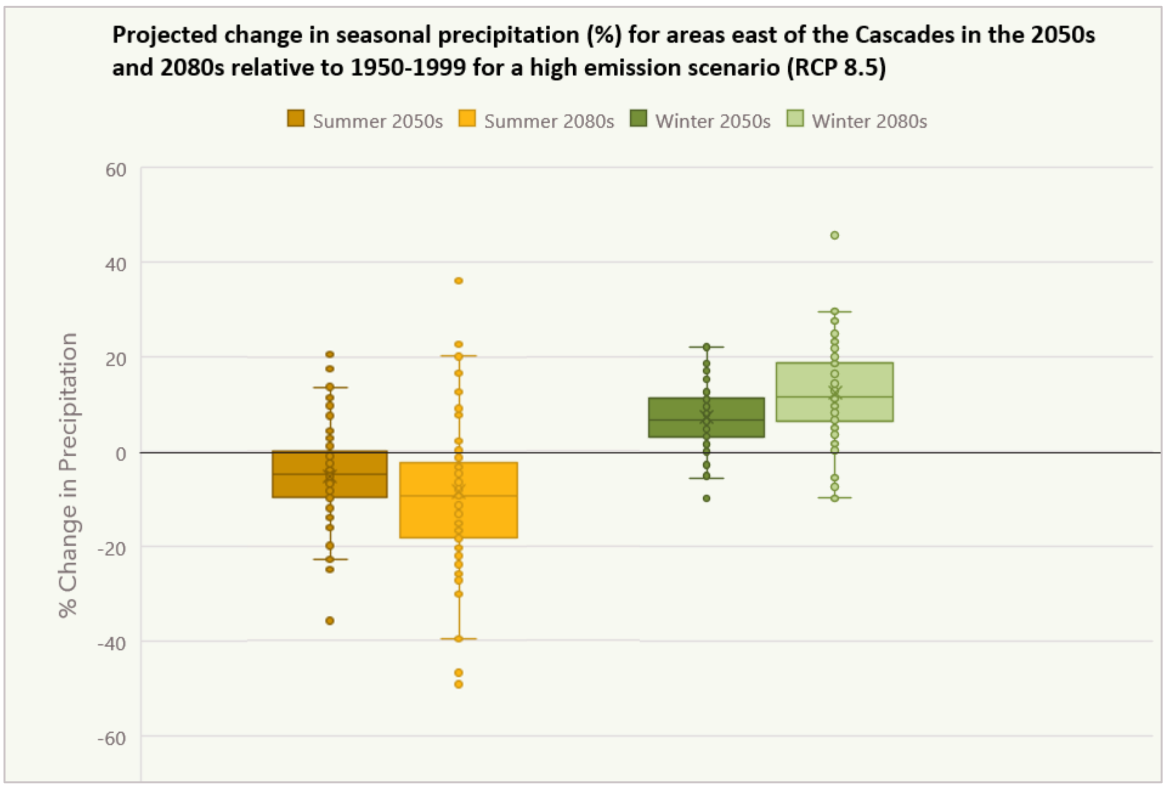


Figure 5. Projected change in summer and winter precipitation (%) for areas east of the Cascades in the 2050s and 2080s relative to 1950-1999 for a high emission scenario (Rogers, 2021). This figure is a box and whisker plot, which shows a range of projected change in seasonal precipiation based on several different climate models. The box represents the middle range of projections, while the lines and dots outside the box highlight any variations or outliers between model projections.

SECTORS AFFECTED BY EXTREME PRECIPITATION AND FLOODING

Sector	Impacts
Agriculture and Food Systems	•Delayed planting, lower crop quality, and increased erosion.
Cultural Resources and Practices	•Potential damage to community assets like vineyards, historic and cultural sites, and local businesses.
Economic Development	•Higher insurance costs due to more frequent flooding.
Ecosystems	•Loss of riparian habitat from flooding and erosion. •Altered streamflow and sedimentation affecting aquatic life and water quality.
Emergency Management	•Disrupted emergency and medical services due to damaged infrastructure and roads.
Health and Well-being	•Increased health risks, including injuries, disease spread, and respiratory and mental health issues.
Transportation	•Flood and erosion damage to roads from Russel Creek and Mill Creek, raising maintenance costs and disrupting services.
Water Resources	•Strain on stormwater and sewer systems from major flood events, such as Mill Creek in 2020.
Zoning and Development	•Damaged critical infrastructure, homes, and other development.

SOCIAL AND ECONOMIC VULNERABILITY

Introduction

Assessing how climate policies identify, protect, and enhance community resilience, including social, economic, and built-environment factors that support climate adaptation consistent with environmental justice is a core requirement of HB 1181. In developing the climate element, a "one-size-fits-all" approach should be avoided. Instead, the process must actively involve affected communities, ensuring their voices and priorities are central. This requires public engagement and social vulnerability analysis methods that adapt to the unique needs and perspectives of community members and their representative organizations.

Identification and integration of social vulnerability into the climate element and vulnerability assessment process includes identifying characteristics that can make individuals more vulnerable to climate hazards. Social vulnerability is defined by the Center for Disease Control and Prevention (CDC) as characteristics of a person or group that affect their capacity to anticipate, cope with, resist, and recover from the impact of a discrete and identifiable disaster in nature or society.

SOCIAL VULNERABILITY INDEX METHODOLOGY

The CDC Social Vulnerability Index uses 16 U.S. census variables from the 5-year American Community Survey (ACS) to identify communities in need of support before, during, or after disasters. These variables are organized into four themes, resulting in a single measure of overall social vulnerability. Per the CDC, several socioeconomic factors and additional characteristics influence social vulnerability such as socioeconomic status and income, minority status and language, age, and health status. The Index is calculated using percentile ranks to score the social vulnerability of a community on a scale of 0 to 1, with 1 representing most vulnerable or the highest level of vulnerability. The percentile ranking represents the proportion of tracts that are equal to or lower than a tract of interest in terms of social vulnerability. These ranges are relative and reflect percentiles based on the distribution of Index scores across communities:

- Low Vulnerability: Tracts scoring below the 25th percentile.
- Medium Vulnerability: Tracts scoring between the 25th and 75th percentiles.
- High Vulnerability: Tracts scoring above the 75th percentile.

Social Vulnerability in Walla Walla

In the City of Walla Walla, census tracts in the west and north areas of the city are reported by the CDC as having a high level of social vulnerability (Figure 6). These areas have higher percentages of socioeconomic determinants of vulnerability such as socioeconomic status (Figure 7), household characteristics (Figure 8), racial and ethnic minority status (Figure 9), and housing type and transportation (Figure 10).

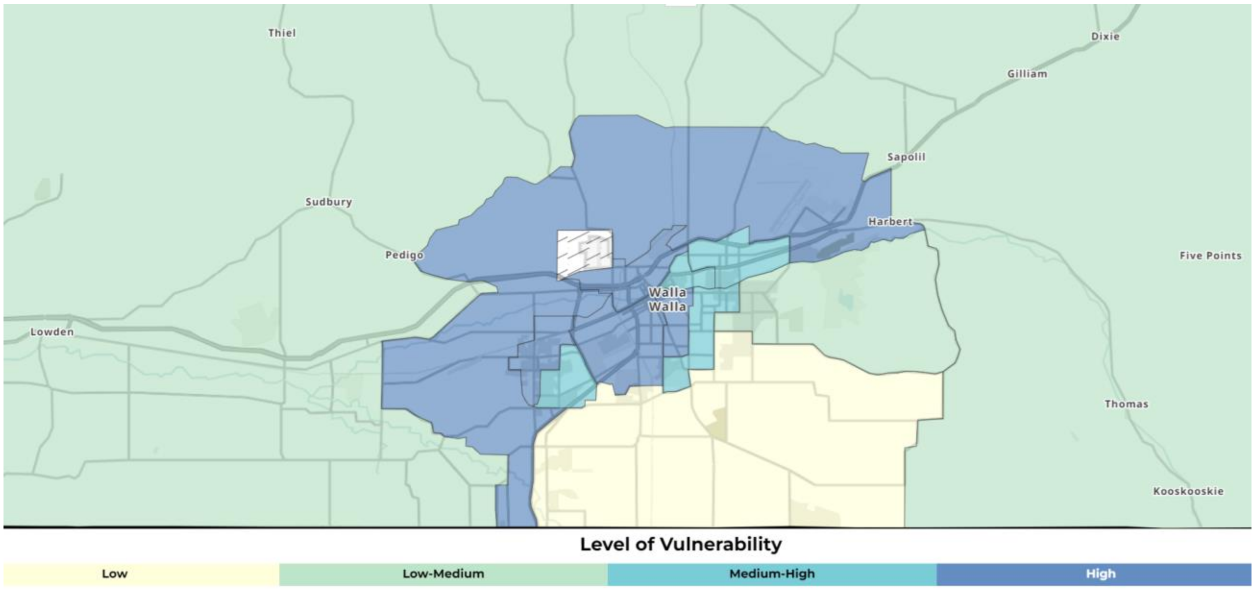


Figure 6. ***CDC Social Vulnerability Index Overall Vulnerability***

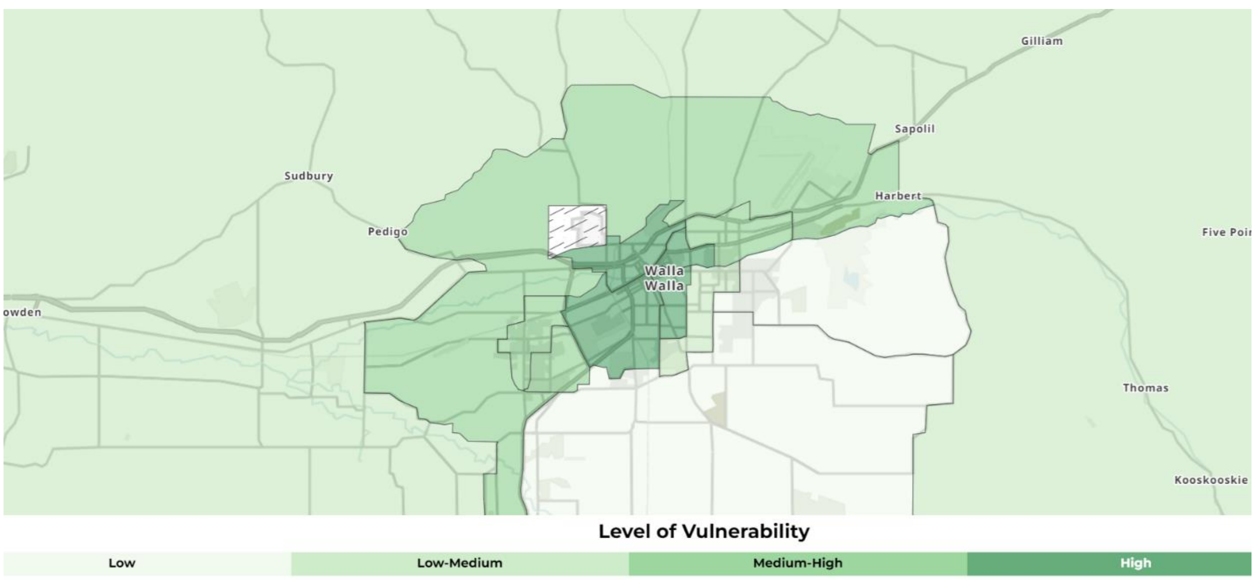


Figure 7. ***Socioeconomic Status*** *includes indicators such as residents living below 150% poverty rate, unemployment, housing cost burden, education, and lack of health insurance.*

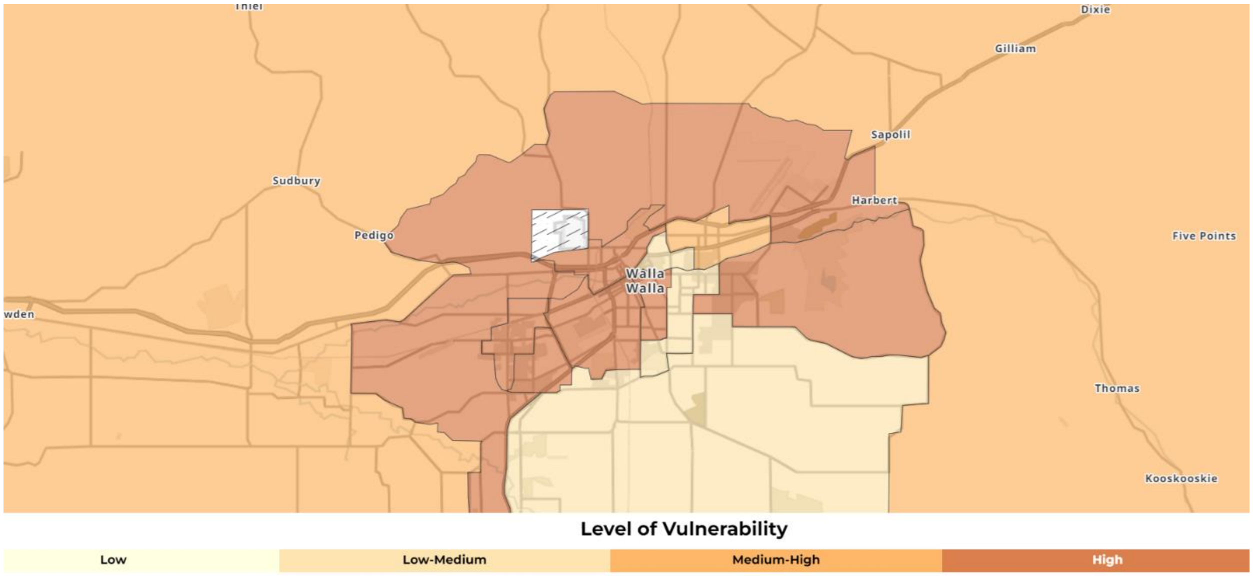


Figure 8. ***Household Characteristics*** *includes indicators such as elderly, children, residents with a disability, single-parent households, and English language proficiency.*

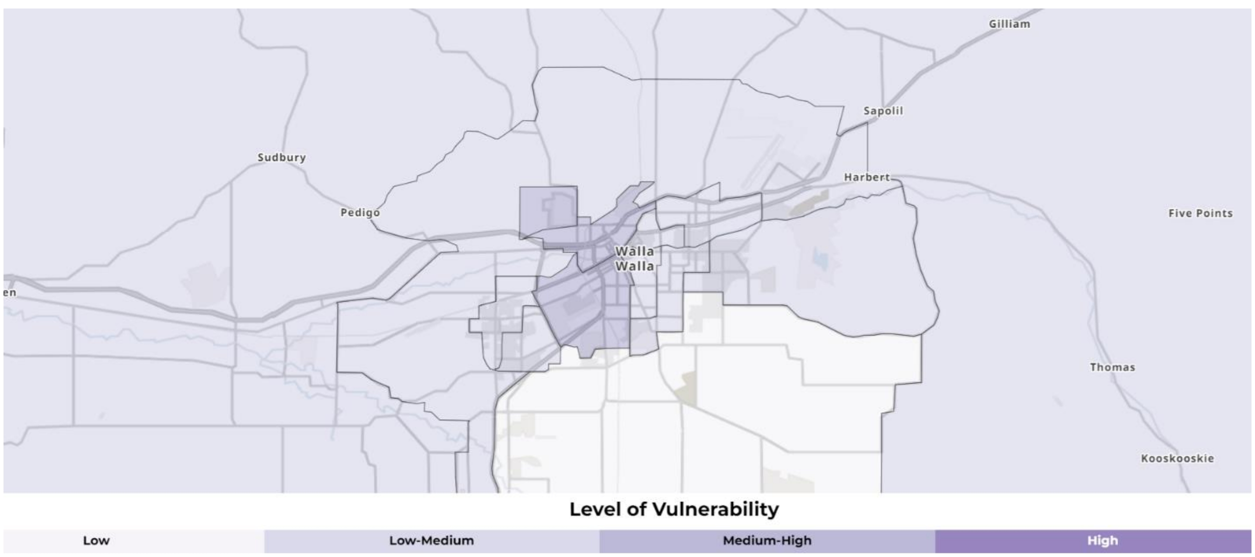


Figure 9. ***Racial & Ethnic Minority Status*** *includes residents who identify as Hispanic or Latino (of any race); Black and African American, American Indian and Alaska Native, Asian, Native Hawaiian and Other Pacific Islander, Two or More Races, Other Races.*

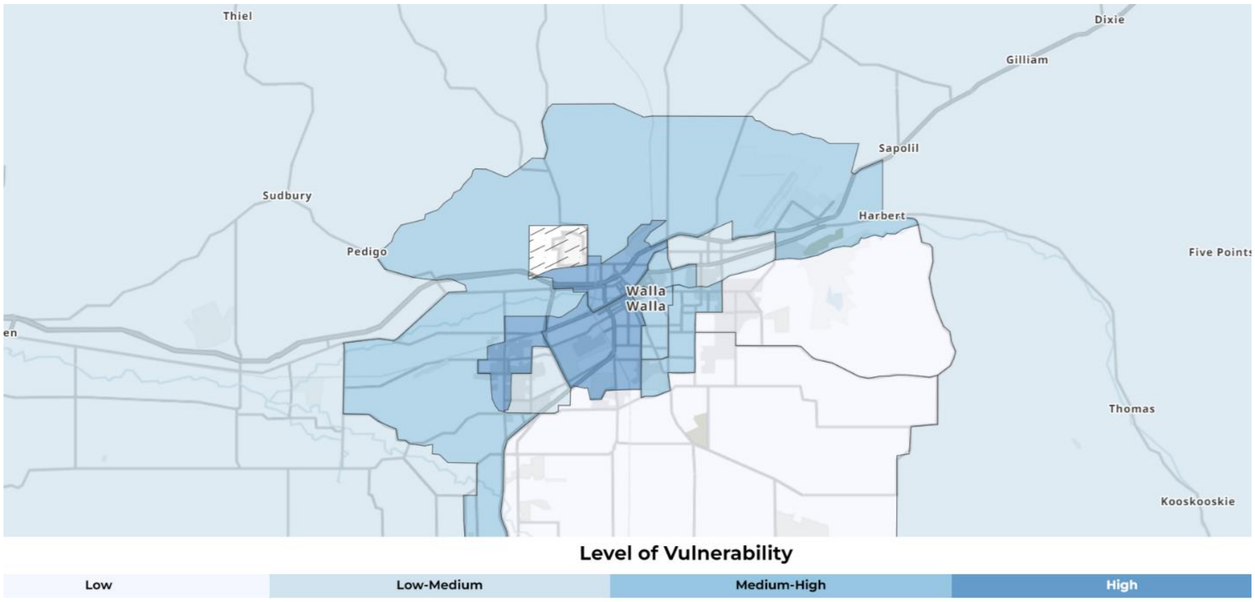


Figure 10. ***Housing Type & Transportation*** *includes indicators such as multi-unit structures, mobile homes, no vehicle, or crowding.*

Throughout the climate element development process, we will examine how socioeconomic stressors—such as poverty and inadequate housing—affect overburdened communities. These factors can exacerbate vulnerability when coupled with climate stressors, deepening societal inequities. By addressing this interplay, we aim to ensure that climate equity is a central focus of the Resilience Sub-Element. Additional analysis on social vulnerability in the City will be completed through the Climate Vulnerability Assessment, policy audit, and local engagement.

NEXT STEPS

The climate impacts summary identifies historical and projected climate impacts, with the goal of supporting the climate policy audit and identifying gaps and opportunities within Walla Walla's Comprehensive Plan. This work will inform the City's Climate Vulnerability Assessment (CVA), which will ultimately guide the development of the Climate Resilience Sub-Element for the Comprehensive Plan.

Moving forward, Cascadia will seek review and feedback from the community and City staff to ensure that the climate impacts summary is comprehensive and accurately reflects local concerns and priorities. Cascadia will use this Impacts Summary as a base for the Climate Vulnerability Assessment, which will explore how climate impacts affect different sectors and communities across the City. This input will be crucial for informing the upcoming policy development, ensuring that the policies identified are robust and responsive to the climate challenges identified.

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