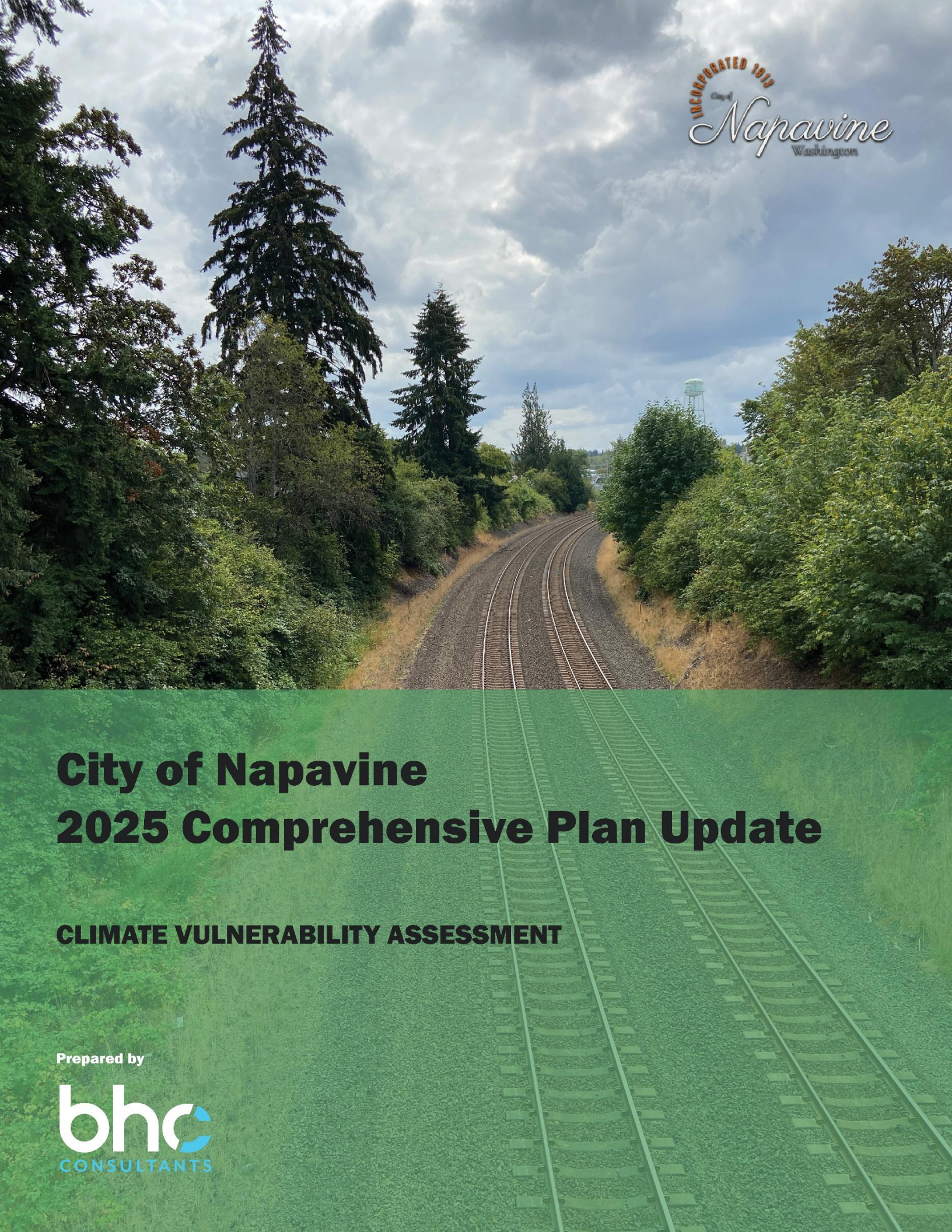




City of Napavine 2025 Comprehensive Plan Update

CLIMATE VULNERABILITY ASSESSMENT

Prepared by

bhc
CONSULTANTS

NAPAVINE CLIMATE VULNERABILITY ASSESSMENT

Introduction

Napavine, along with the rest of Washington state, will continue to be impacted by changes in precipitation, the frequency and duration of heat waves, and increased wildfire activity throughout the state, among other natural hazards and extreme weather events exacerbated by changes in regional climate. The compounding effects of multiple hazards happening simultaneously or in quick succession may lead to extreme impacts that exceed projections. This Climate Vulnerability Assessment (CVA) provides a high-level discussion of the regional changes in climate and the frequency and intensity of natural hazards most relevant to Napavine and its potential effect on infrastructure, services, businesses, and at-risk populations, and discusses the City's adaptive capacity to various climate and natural hazards. This CVA also identifies potential strategies to enhance the City's resilience and informs the 2025 Comprehensive Plan Update that will include a new Climate Resilience Element, per HB 1181 (2023) adopted as [RCW 36.70A.070\(9\)](#).

Key Risks

- Napavine is vulnerable to wildfire and public health impacts from wildfire smoke. In addition to affecting human life and property, wildfires can potentially disrupt the provision of reliable utilities, emergency services, and the overall economic development of the city.
- As annual precipitation continues to increase and heavy precipitation events become stronger, Napavine will be increasingly vulnerable to flooding.
- As heat waves and hot days become stronger and more frequent, residents and infrastructure in the city will be increasingly impacted by extreme heat, especially residents without access to air conditioning or other means of relief from the heat.

Policy Recommendations

- Consider adopting the International Wildland-Urban Interface Code (IWUIC), or elements of it, to reduce the risk of impacts from wildfires.
- Consider the strategic planting of trees or the installation of green stormwater infrastructure to mitigate extreme heat and flooding impacts in the city, prioritizing areas with increased impervious cover or more vulnerable neighborhoods.
- Update the City's Comprehensive Plan by including goals and policies to strengthen emergency response protocols, foster a sense of community, cohesion, and collective action by supporting community-based and grassroots organizations, and strengthen interagency and interjurisdictional plans and agreements for emergency response.

Additional recommendations distributed throughout this assessment are **bolded**.

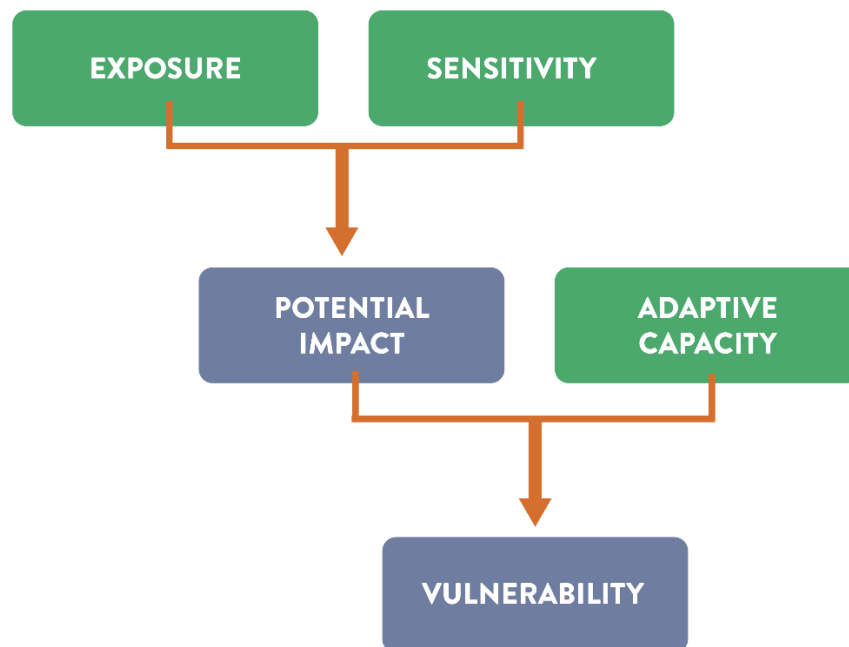
Climate Change Impact Assessment

There are several climate impacts that are projected to impact Napavine throughout the next 20 years and beyond. Most notably, increased wildfire activity, changes in precipitation, and increases in the frequency and duration of heat waves. These trends are discussed in further detail in this assessment. While there are additional impacts from natural hazards and extreme weather events exacerbated by climate change that Napavine could experience in the near future and throughout the 20-year planning period, this assessment focuses on these three main impacts that have already been affecting Napavine and are projected to continue for decades to come. These impacts also most closely relate to the built environment and can be influenced by planning efforts and coordination in Napavine and with neighboring jurisdictions.

Climate Vulnerability

Climate vulnerability is based on three main components: **exposure, sensitivity, and adaptive capacity** (Exhibit 1). Together, these three components provide a picture of the overall vulnerability of Napavine to changes in regional climate conditions and the frequency and severity of natural hazards and extreme weather events. Understanding climate vulnerabilities is the first step in minimizing impacts to the City and its residents. Identifying potential vulnerabilities in Napavine can help the City identify where to focus investment and proactively address potential negative impacts to community-wide infrastructure, property, and public health.

Exhibit 1. Components of Climate Vulnerability



Source: BHC Consultants. Note: Climate vulnerability is based on three primary components: exposure, sensitivity, and adaptive capacity. Together, the exposure and sensitivity to stressors such as climate-related disasters contribute to the potential impact on communities. The overall vulnerability of a place to climate-related disasters is then based on the areas where the potential impact outweighs the adaptive capacity of a community.

Climate vulnerability is also important to consider as the City continues to make decisions surrounding land use and other changes to local environmental conditions, as these decisions could increase the impact of, or Napavine’s overall susceptibility to, these hazards. This brief assessment of climate vulnerability in Napavine informs the development of the goals and policies included in the new Climate Resilience Element required as part of the 2025 Comprehensive Plan update, which addresses gaps in preparedness to build the city’s resilience to natural hazards and impacts of extreme weather on infrastructure, buildings, and the public health and well-being of residents.

The following section discusses the natural hazards that pose the greatest risk to Napavine in the context of the three main components of climate vulnerability: exposure, sensitivity, and adaptive capacity. Most analysis in this section was completed using the University of Washington Climate Impacts Group’s (CIG) Climate Mapping for a Resilient Washington mapping tool. For each hazard discussed using the CIG tool, the analysis assumes a high-emissions scenario (RCP 8.5) as a worst-case scenario so the City is prepared for the most extreme hazards and can build the strongest community resilience. The analysis also uses a timeframe of 2040-2069 compared to a 1980-2009 baseline (unless otherwise noted) to align with the Comprehensive Plan planning time horizon through 2045.

EXPOSURE

The exposure of a place to changes in natural hazards and extreme weather events exacerbated by climate change is based on the magnitude and frequency of shocks or impacts to people, infrastructure, natural systems, and other intangible resources important to the community. This section provides a brief description of the overall exposure of Napavine to natural hazards and extreme weather events exacerbated by climate change, specifically in terms of wildfire, changes in precipitation, and extreme heat.

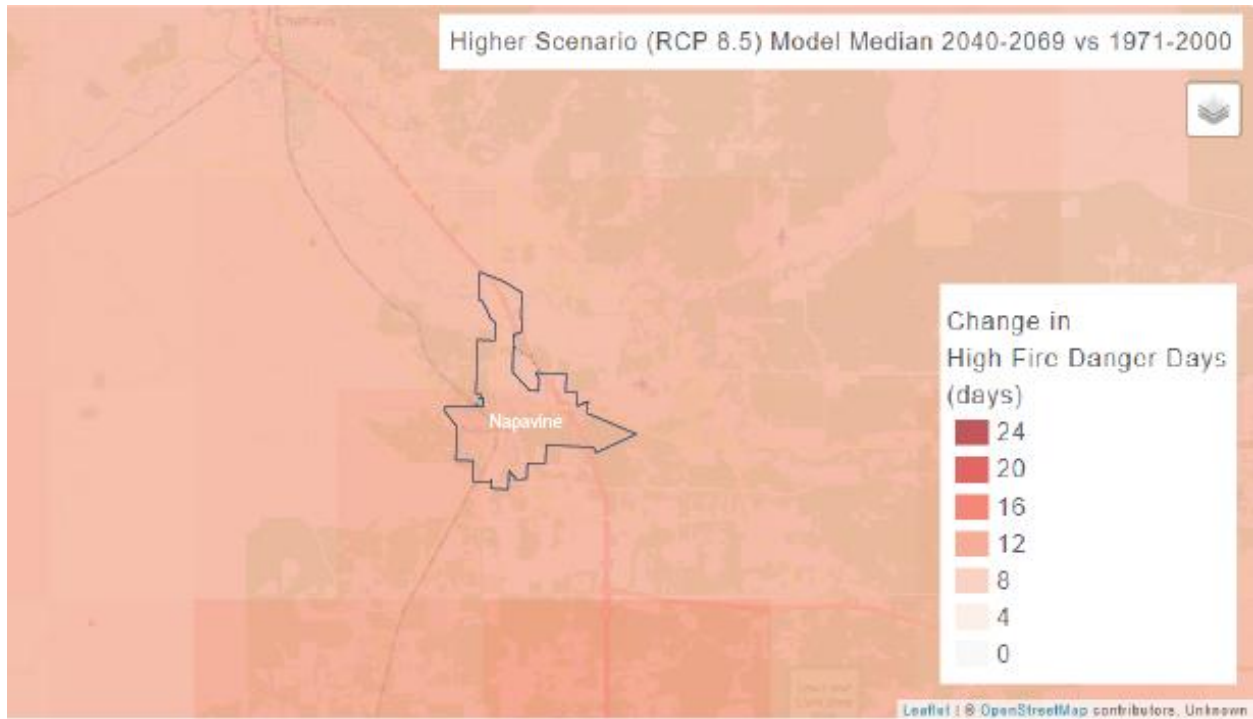
Wildfire Activity + Smoke

Wildfire activity affects many jurisdictions, whether that is from direct impacts to the built environment or indirect impacts such as hazardous air quality that disproportionately affects vulnerable communities, such as those with preexisting health conditions. As wildfire activity is increasing and becoming more destructive in Washington state, there have been increasing impacts to not only the built and natural environment but also human life and public health.¹

WILDFIRE RISK

By 2040-2069, there is a projected increase of 10 more high fire danger days per year compared to 1971-2000 data in Napavine, compared to an increase of 8 more days in Lewis County as a whole. Exhibit 2 provides a visual for how Napavine’s potential for wildfire activity compares to surrounding areas in the County. A high fire danger day means that there is a greater potential for wildfire activity compared to historical data from 1971-2000, assuming sufficient fuel is present along with a source of ignition. Furthermore, places with lower emergency management capacity may be disproportionately impacted by an increase in high fire danger days and likelihood of wildfire.

¹ Mauger, G.S., J.H. Casola, H.A. Morgan, R.L. Strauch, B. Jones, B. Curry, T.M. Busch Isaksen, L. Whitely Binder, M.B. Krosby, and A.K. Snover, 2015. State of Knowledge: Climate Change in Puget Sound. Report prepared for the Puget Sound Partnership and the National Oceanic and Atmospheric Administration. Climate Impacts Group, University of Washington, Seattle. doi:10.7915/CIG93777D

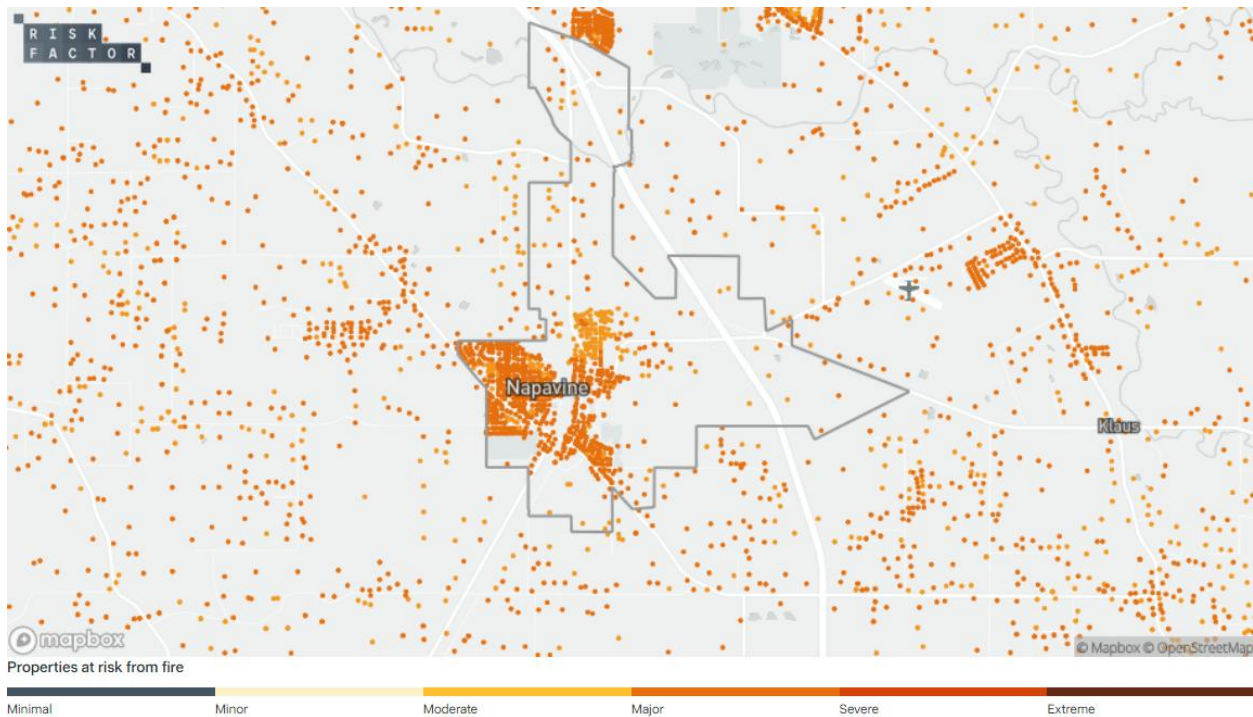
Exhibit 2. Change in High Fire Danger Days in 2040-2069 vs. 1971-2000.

Source: University of Washington Climate Impacts Group, 2022. Climate Mapping for a Resilient Washington Mapping Tool.

According to Risk Factor, which determines fire risk based on a location's vegetation (or available "fuel"), topography, and likely weather conditions, Napavine has an overall moderate risk of wildfire in the next 30 years (based on the level of risk the properties face, not the proportion of properties at risk), as shown in Exhibit 3. Around 94% of all properties in Napavine are at risk of being affected by wildfire over the next 30 years.

Increased wildfire activity could impact businesses, destroy private property, damage infrastructure, and affect public health and wellbeing. Wildfires can also cut access to utilities, transportation networks, emergency services, evacuation routes, and impact the local economy. Even for communities that are not near active wildfires, an increase in wildfires can greatly impact communities with hazardous air pollution levels from wildfire smoke. To minimize potential damage from wildfires and wildfire smoke, **policies addressing emergency management, community networks, the distribution of information and resources to residents, and wildfire preparedness and recovery strategies are important to consider.**

Exhibit 3. Napavine's risk of wildfire is classified as moderate



Source: First Street, 2024. Risk Factor

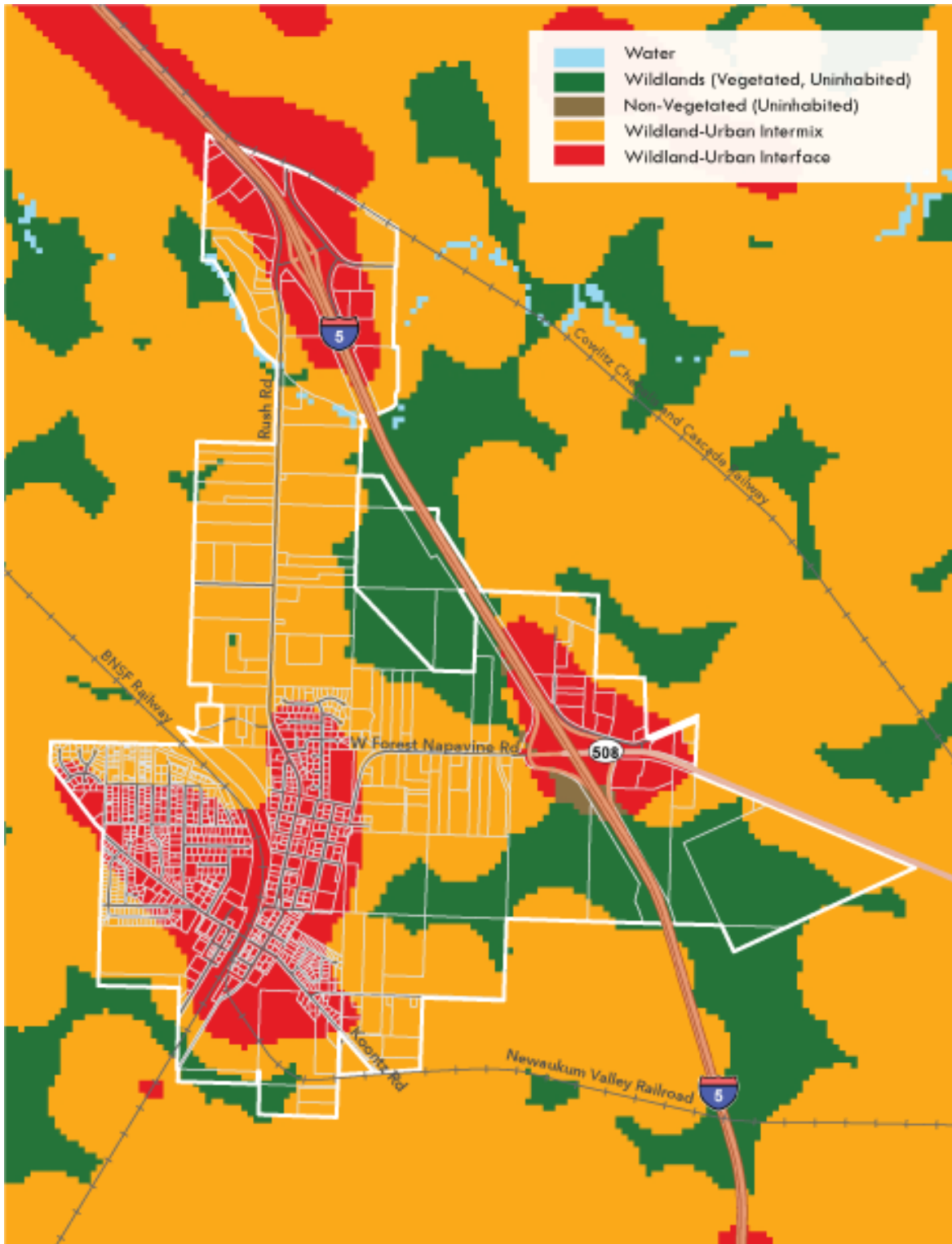
WILDLAND-URBAN INTERFACE

Other factors that may influence how wildfires impact Napavine include the capacity of emergency management services and the location of structures or valuable infrastructure in the wildland-urban interface. The Wildland Urban Interface, or WUI, are the areas where wildlands and urban development meet or intermingle, but it is important to note that WUI *does not define* wildfire risk. Wildlands in Washington state include any area with more than 50% burnable vegetated cover, which includes grassland, forest, and sagebrush steppe. In contrast, urban areas include areas of dense human development, or areas with less than 50% vegetative cover.

The wildland-urban **interface** (shown in Exhibit 4 in red) is usually found along the outskirts of urban areas, where development is adjacent to or bordered by wildland on at least one side. The wildland-urban **intermix** (shown in Exhibit 4 in yellow) includes areas where structures or urban development are intermixed with wildlands, and where a development or structure is surrounded by wildlands on 2 or more sides. Areas within the WUI are at the highest risk of wildfire due to the proximity of flammable vegetation and are where most human-caused fires are started.

To reduce the risk of impacts from wildfires, the City should **consider either adopting the International Wildland-Urban Interface Code (IWUIC)**, or elements of it, or **developing building and maintenance standards consistent with the Firewise USA program** from the National Fire Protection Association.

Exhibit 4. Wildland Urban Interface



WILDLAND-URBAN INTERFACE

City of Napavine Climate Vulnerability Assessment | August 2024



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Source: Data from Washington State Department of Natural Resources, 2019. Wildland Urban Interface (WUI).

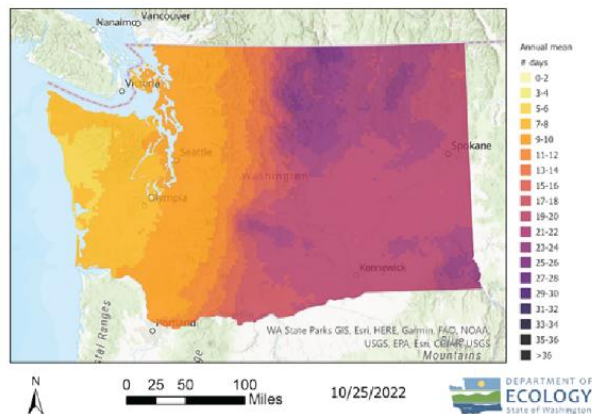
WILDFIRE SMOKE

Wildfires can impact Napavine not just by direct damage to property, infrastructure, or human life, but wildfire smoke can impact residents by contributing to hazardous air quality. Exhibit 5 shows how unpredictable the impacts of smoke can be, comparing average smoke days from 2015-2021 to the average smoke days in 2022. The average smoke days shown on the maps range from 0-2 smoky days to over 36 smoke-filled days. As shown on the maps, Napavine experienced around 5-10 smoke-filled days on average between 2015-2021, and around 7-12 smoke-filled days in 2022. The impact wildfire smoke will continue to have on Napavine depends on where the fires are located, how long they burn, and local weather conditions, but Napavine residents should be prepared for potential prolonged smoke exposure.

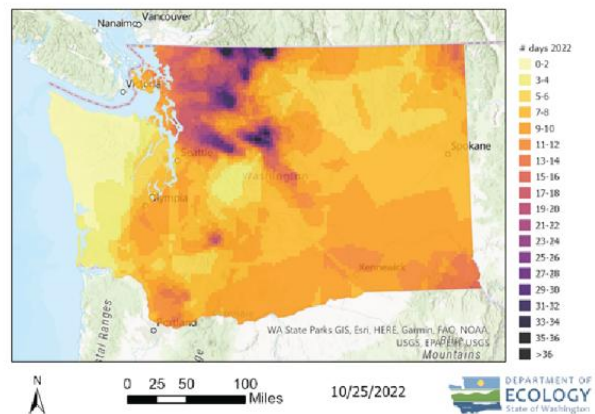
The increased frequency and duration of smoke-filled days will impact some populations in Napavine more than others, including children and the elderly, those with preexisting health conditions, low-income communities, outdoor workers, and those who do not have health insurance or access to relief from the smoke and increased exposure to particulate matter. Additional discussion of potential vulnerabilities can be found in the [Sensitivity](#) section.

Exhibit 5. Annual mean number of heavy wildfire smoke days in Washington State from 2015-2021, compared to heavy wildfire smoke days in 2022

Average smoke-filled days from 2015-2021



Average smoke-filled days in 2022



Source: Vaughn, 2022. Washington Department of Ecology.

Changes in Precipitation

Precipitation patterns are shifting across the state, with winter precipitation increasing overall and falling as more rain than snow, and summer precipitation decreasing. Together, the combination of decreasing summer precipitation and more precipitation falling as rain rather than snow can contribute to increased risk of drought. Washington relies heavily on snowpack melting and providing water in the spring and summer. A decrease in snowpack changes the timing of water availability as there will be less snowmelt available in the summer months, when precipitation is lower to begin with. Less snowmelt impacts the water supply and exacerbates drought conditions. At the same time, the trend of heavier precipitation events in the winter contributes to an increased risk of flooding.

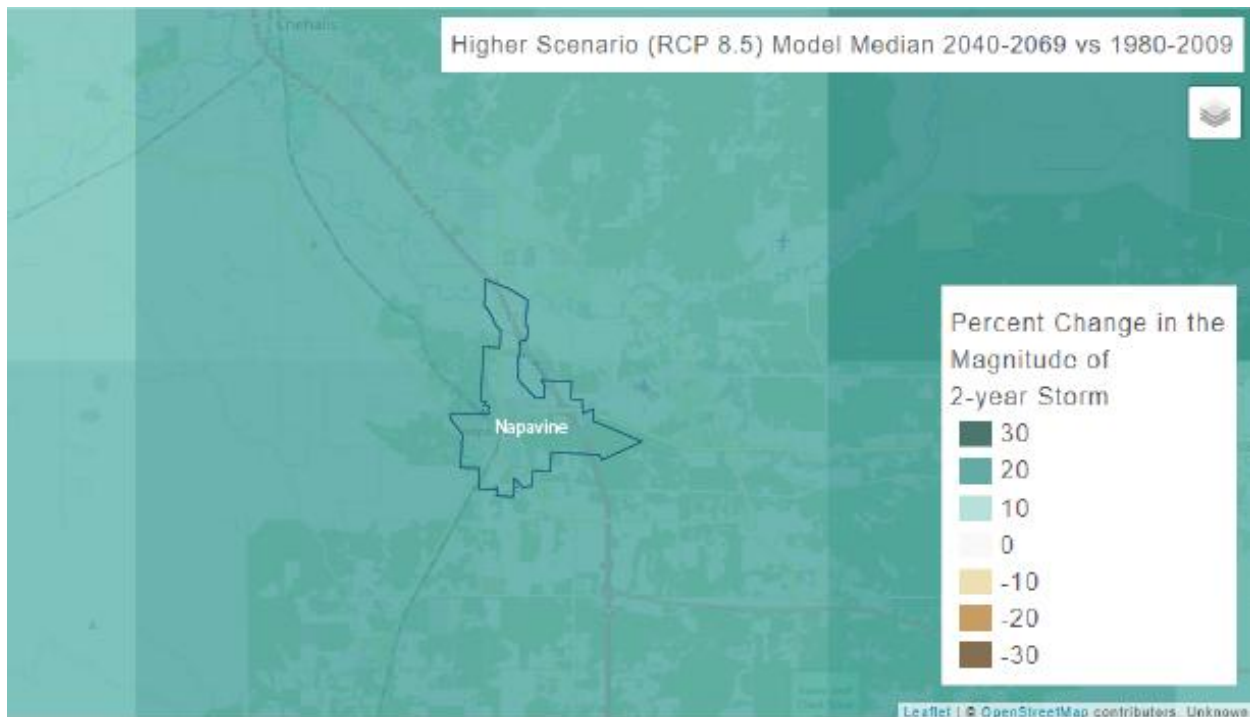
HEAVY PRECIPITATION EVENTS

Heavy precipitation events are those that occur on average once every two years. Heavy precipitation has affected Napavine in recent years, such as at the atmospheric river storm in the Pacific Northwest in

December 2023.² In Napavine, it is projected that heavy precipitation events in 2040-2069 will have on average 16% more precipitation than the heavy precipitation events experienced from 1980-2009, as shown in Exhibit 6. Napavine will likely experience heavier precipitation than Lewis County, which is expected to experience an average of 12% more precipitation during heavy precipitation events. Heavy precipitation events are more likely to damage infrastructure and other community resources and property than other changes in annual precipitation because of the magnitude of precipitation that occurs in a shorter amount of time.

Without sufficient stormwater management or drainage capacity, larger precipitation events can contribute to slope instability, erosion, flooding, and the inundation of low-lying areas, most notably underneath the I-5 overpass on Rush Road and some commercial areas. Even minor increases in the magnitude of precipitation can have profound impacts on infrastructure and the community at large if the additional stormwater is not effectively managed or existing storm water systems are overwhelmed. Efforts to **improve stormwater management capacity through the addition of green stormwater infrastructure or street trees** in Napavine would help lessen the impact of these heavy precipitation events, especially as they are becoming more frequent and intense.

Exhibit 6. Percent Change in the Magnitude of the 2-Year Storm 2040-2069 vs. 1980-2009.



Source: University of Washington Climate Impacts Group, 2022. Climate Mapping for a Resilient Washington Mapping Tool.

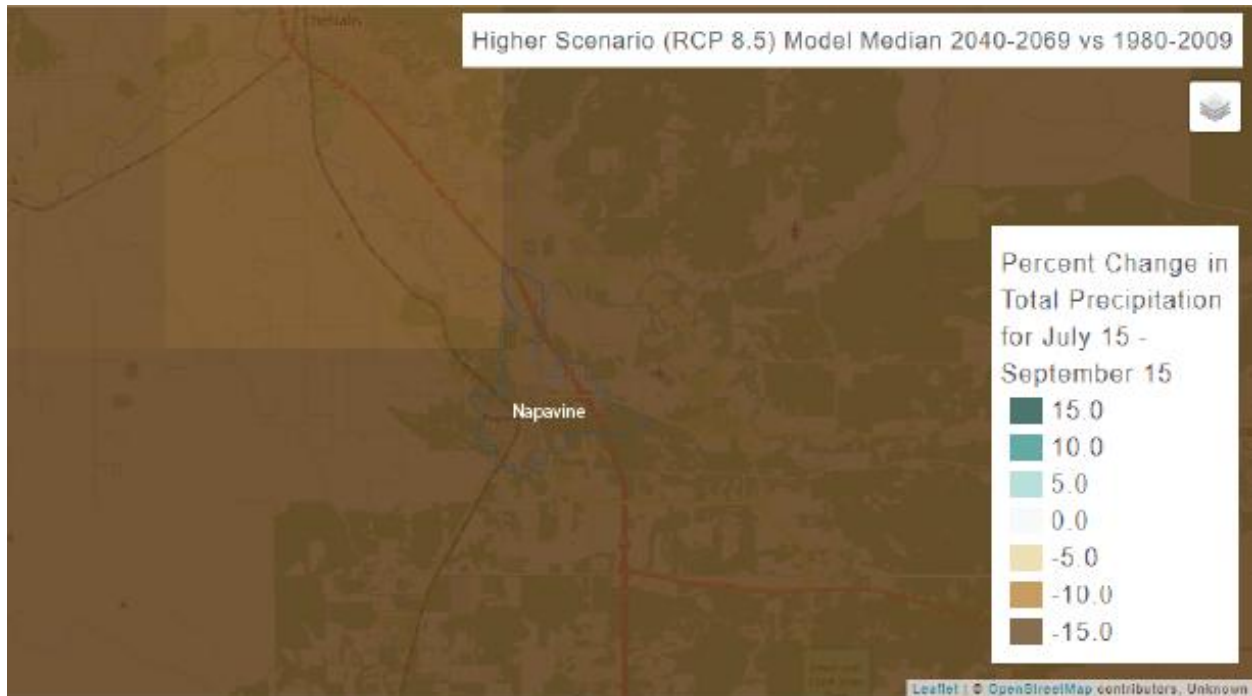
LATE SUMMER PRECIPITATION

Changes in late summer precipitation (July-September) influence the availability of water and the fuel moisture during summer months, which are typically the driest and most fire-prone. A decrease in summer precipitation can contribute to heat stress, lower stream flows, drought conditions, degraded water quality, increased wildfire potential, and increased water temperatures which can impact stream habitat, among

² NASA. (2023, December 4). Atmospheric River flows into the Pacific Northwest. NASA Earth Observatory. <https://earthobservatory.nasa.gov/images/152164/atmospheric-river-flows-into-the-pacific-northwest>

other impacts. As shown in Exhibit 7, Napavine is projected to experience a decrease of around 17% in late summer precipitation, which is a little less than the countywide decrease of 20%, from 2040-2069 as compared to 1980-2009 late summer precipitation. Depending on water storage capacity and the amount of precipitation that falls as snow in the winter and melts into streams and aquifers in the summer, some areas of the county might be more impacted than others.

Exhibit 7. Percent Change in Late Summer Precipitation From 2040-2069 vs. 1980-2009.



Source: University of Washington Climate Impacts Group, 2022. Climate Mapping for a Resilient Washington Mapping Tool.

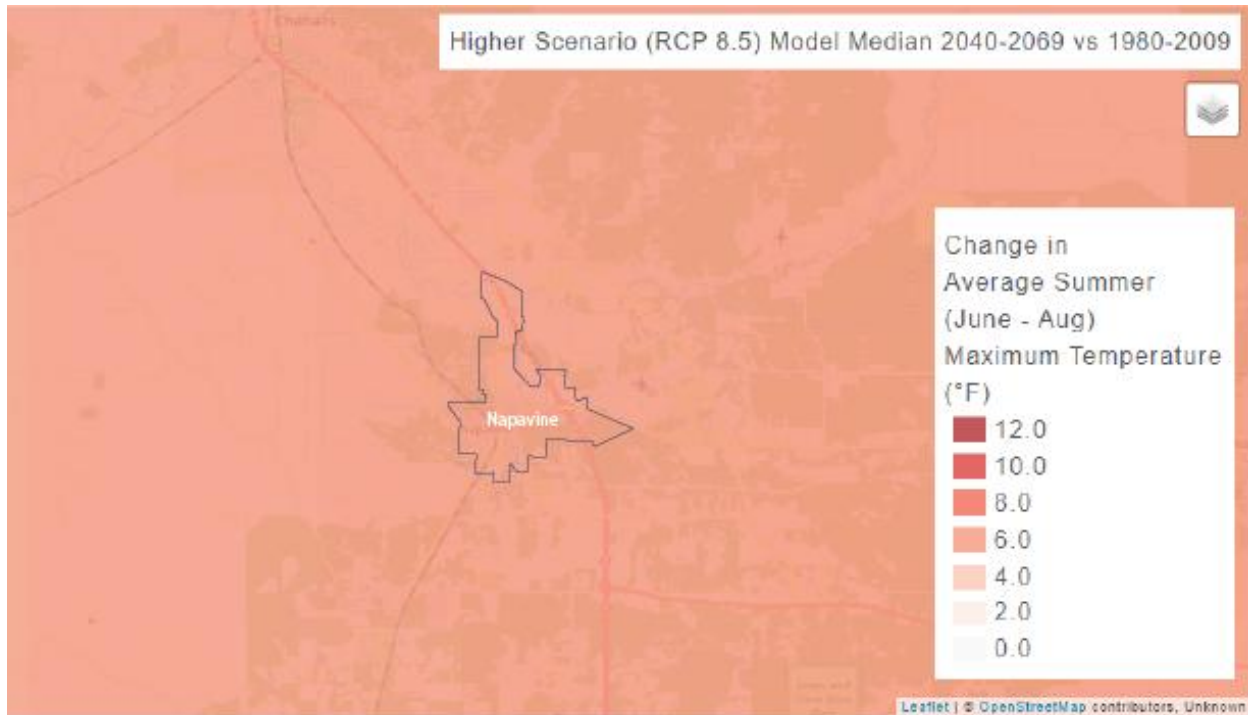
Extreme Heat

Extreme heat is another important hazard for Napavine to consider in its resilience planning efforts. Washington state has already experienced extreme heat events in the past several years, and heat waves and days with extreme heat will continue to get hotter, last longer, and occur more frequently.

AVERAGE SUMMER MAXIMUM TEMPERATURE

Under a high-emissions scenario, by 2040-2069, the change in average summer temperature, when compared to 1980-2009 levels, is projected to be 5.6°F higher, which is slightly less than the countywide average of a 6.1°F increase. The increase in average summer temperature poses different public health threats for various communities in Napavine and may impact infrastructure. For instance, extreme heat can disproportionately affect those who work outdoors, individuals experiencing homelessness, the elderly, those with pre-existing health conditions, and those without access to air conditioning or other means of relief from the heat. The [Urban Heat Island](#) discussion in this assessment provides some additional context to the factors contributing to extreme heat.

Exhibit 8. Degree Change in the Average Summer Maximum Temperature From 2040-2069 vs. 1980-2009.



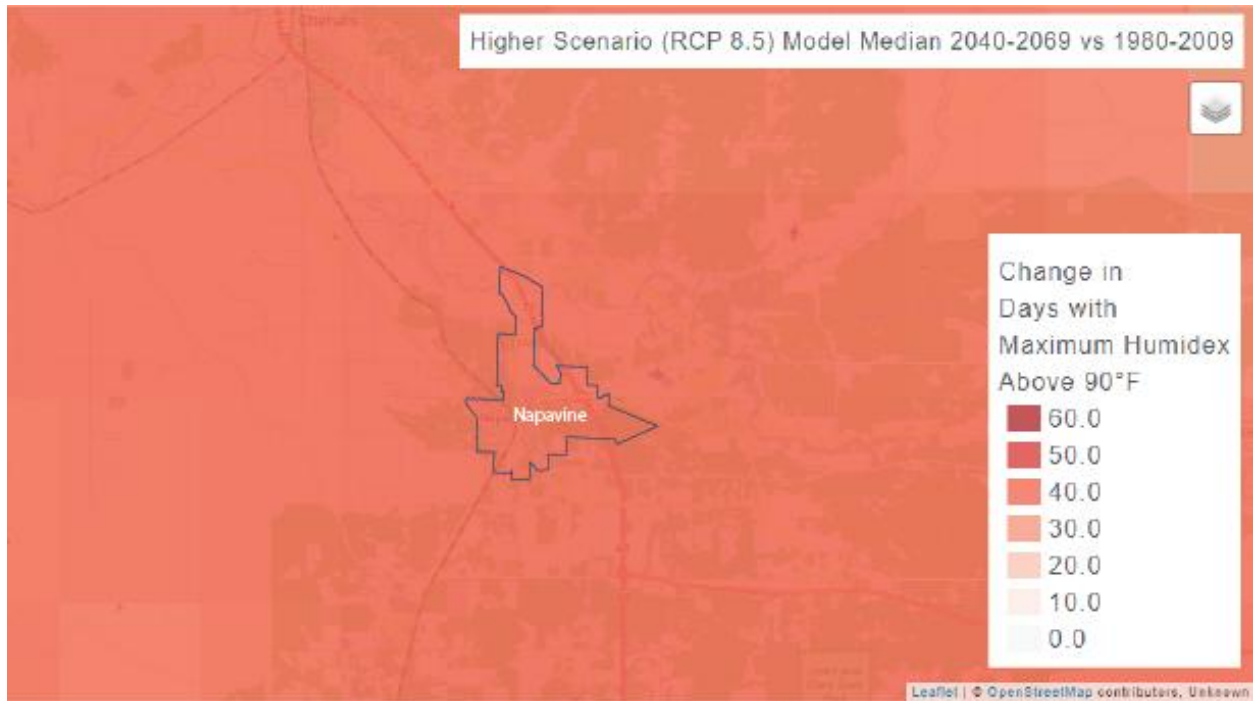
Source: University of Washington Climate Impacts Group, 2022. Climate Mapping for a Resilient Washington Mapping Tool.

HEAT STRESS

Heat stress approximates human thermal comfort, or how the temperature feels to the average person, given outside temperature, humidity, wind speed, and radiant heat. It reflects how extreme heat impacts the human body and gives a more accurate reading of how hot it is outside. Exhibit 9 shows the annual change in days above 90°F maximum humidex days, or the number of days where the experienced heat conditions (accounting for temperature and humidity) are 90°F or greater. In Napavine, there is projected to be a significant increase of 38-39 days per year of extreme heat, compared to an average 24 day increase across Lewis County. An increase in days over a maximum humidex of 90°F is an indicator of daytime heat stress, which can disproportionately impact sensitive populations, such as children, the elderly, those with preexisting health conditions or disabilities, and outdoor workers, among others. Prolonged exposure to heat can also cause additional impacts to human life and the integrity of infrastructure, including roads.

Strategies to improve the longevity of infrastructure and protect human health in the face of more frequent and severe hot days and heat waves are important for the City to consider, such as increasing tree cover or shade structures in the warmest areas of the City (see Exhibit 20 in the [Urban Heat Island](#) discussion of this assessment).

Exhibit 9. Change in Days with Maximum Humidex Above 90 Degrees Fahrenheit From 2040-2069 vs. 1980-2009.



Source: University of Washington Climate Impacts Group, 2022. Climate Mapping for a Resilient Washington Mapping Tool.

SENSITIVITY

Sensitivity, in this context, is the degree to which an environmental, built, or social system is directly or indirectly affected by hazards or disruptions. This section discusses the elements of the built environment or specific human populations in Napavine that may be more sensitive to various changes in climate conditions, natural hazards, and extreme weather events. To develop effective policy, it is important to consider how the impacts outlined in the previous section will affect Napavine residents, and to acknowledge that some populations will be disproportionately affected by hazards.

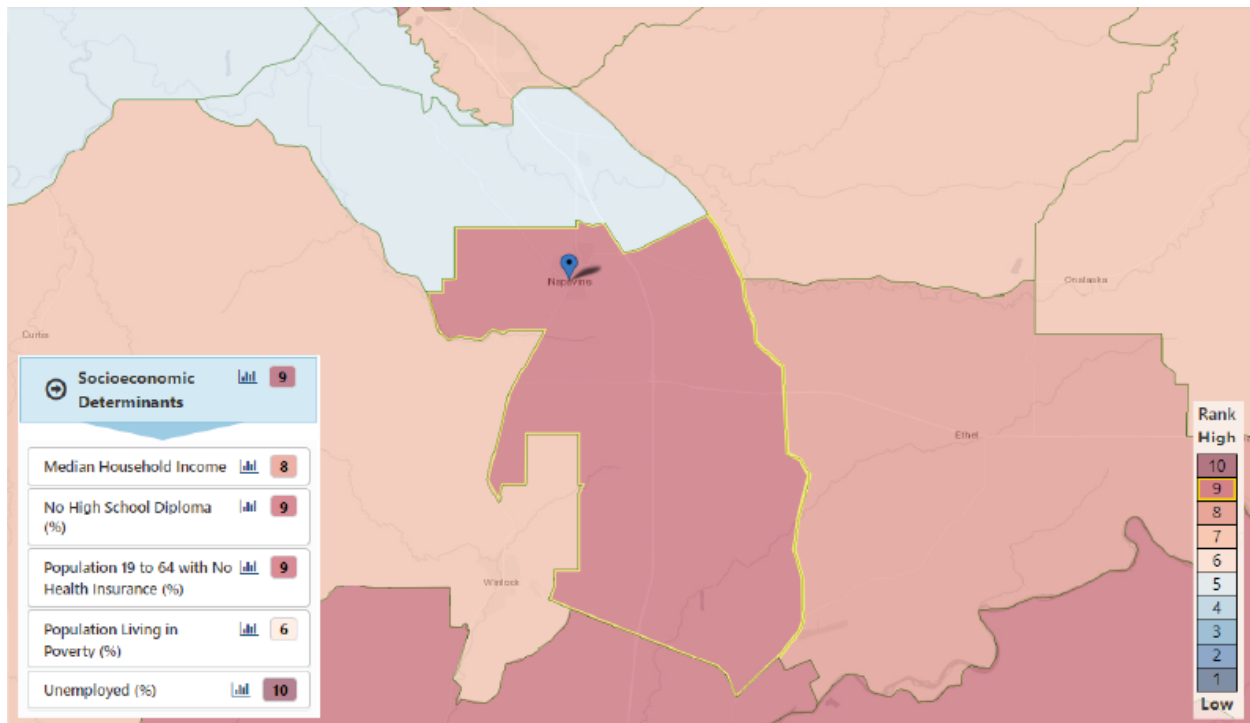
Social

Natural disasters and extreme weather events can greatly impact one's physical and mental health, especially if the hazards force people from their homes. Power outages from extreme weather can cause food spoilage, which can greatly affect the ability of households with limited access to maintain a steady supply of food, threatening their food security. Certain populations in Napavine are more vulnerable to these hazards such as increases in wildfire smoke, flooding, and prolonged heat events, among others. These populations experience a disproportionate share of public health impacts from extreme weather events and will need more assistance to ensure that some residents are not disproportionately affected. Vulnerable populations may include those with pre-existing or chronic health conditions, houseless individuals, children, the elderly, low-income households, and those who work outside. See the [Vulnerability Matrix](#) section of this assessment for a matrix comparing potentially vulnerable populations to impacts from extreme weather and natural hazards.

SOCIOECONOMIC DETERMINANTS OF HEALTH

Socioeconomic factors contribute heavily towards the health and vulnerability of a community. Those who are unemployed, which is a relatively high amount in Napavine compared to surrounding census tracts, are more likely to be impacted. Similarly, households with lower household incomes are more likely to be impacted by climate impacts because they typically have less disposable income to be able to recover from impacts from natural disasters, have less access to air conditioning or other means of air filtration, or may not be aware of the extent such events can impact their well-being or what resources are available to them in the face of such events.

Exhibit 10. Socioeconomic vulnerabilities are high in Napavine relative to surrounding census tracts



Source: Washington State Department of Health, 2022. Health Disparities Map.

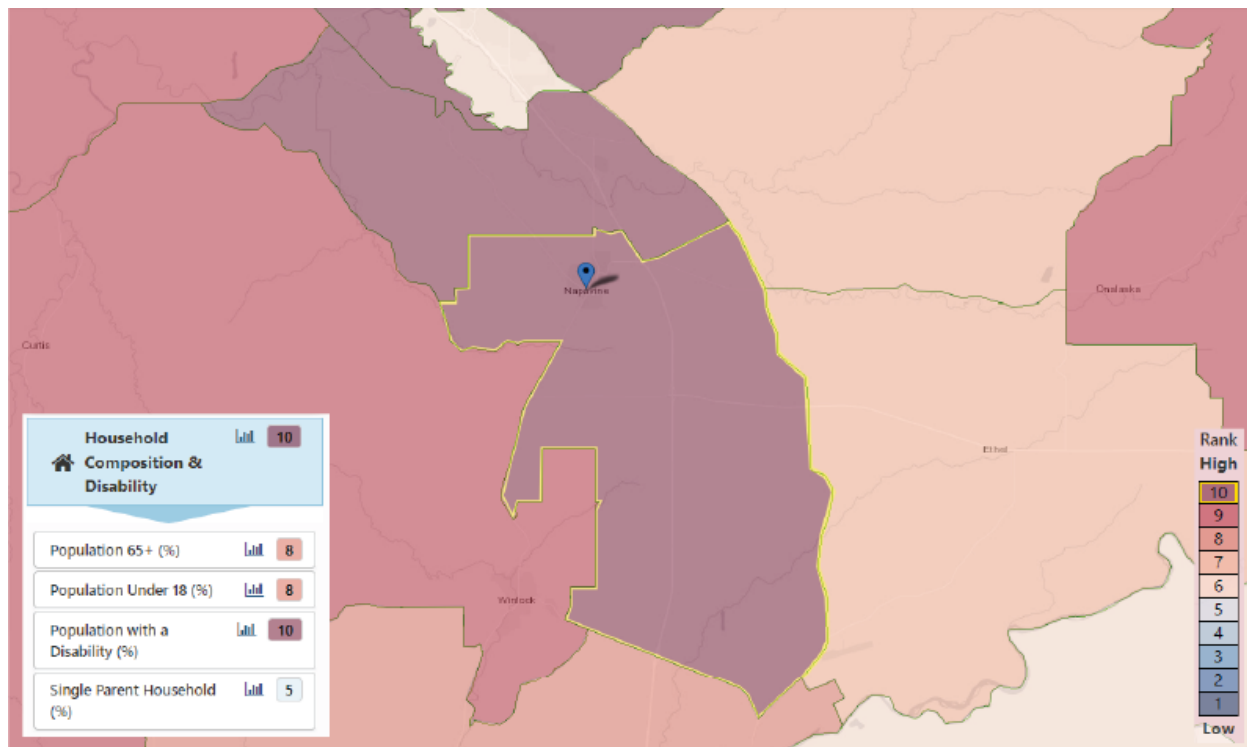
There is also a high percentage of people aged 19 to 64 living without health insurance. This is especially concerning as changes in regional climate can exacerbate existing health issues. Individuals with pre-existing or chronic health conditions, especially cardiovascular or respiratory illnesses or diseases, such as asthma, may experience greater public health impacts or injury from extreme weather events. Lewis County had an estimated asthma rate of 10.9% from 2019-2021.³ Even short-term exposures to wildfire smoke can cause difficulty breathing and exacerbate asthma or other respiratory illnesses or can increase the risk of heart attack or stroke.

Other potential vulnerabilities in Napavine stem from household composition; in the Health Disparities Map (Exhibit 11) this includes the percentage of population that is over 65 or under 18 years of age, people with a disability, and single parent households. In Napavine, there is a relatively high percentage of individuals living

³ 2013 National Center for Health Statistics (NCHS) Urban-Rural Classification Scheme for Counties and 2019-2021 Behavioral Risk Factor Surveillance System (BRFSS). Accessed on <https://www.cdc.gov/asthma/national-surveillance-data/asthma-prevalence-state-classification.htm>.

with a disability, compared to surrounding census tracts, as well as a high percentage of people over the age of 65 and younger than the age of 18. A higher percentage of people over the age of 65 or under the age of 18 could indicate greater vulnerabilities in Napavine, as elderly people typically have limited mobility, pre-existing medical conditions, and/or lower immunity that could affect their ability to cope with extreme weather hazards or evacuate when needed. On the other hand, children and youth may be more vulnerable to hazards due to biological sensitivities due to the fact that children are still developing, consume more air and water for their body weight, and are closer to ground-level pollutants due to their shorter height.

Exhibit 11. Household composition and disability vulnerabilities in Napavine are high

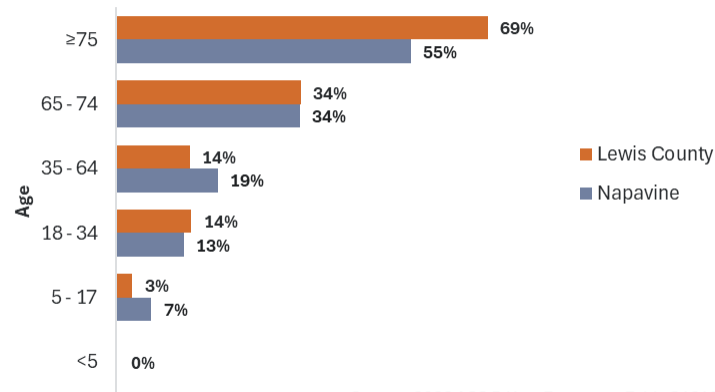


Source: Washington State Department of Health, 2022. Health Disparities Map.

Exhibit 12 shows that those over 75 years of age are more likely to have a disability, which could contribute to compounded vulnerabilities, especially if these individuals live alone or are dependent on others for assistance. Individuals with a disability may be more sensitive to climate-related disasters due to an increased likelihood of compromised health or difficulties understanding or responding to warnings or evacuation information. Additionally, those with pre-existing or chronic health conditions are vulnerable, especially if they use medical equipment that relies on electrical power or are dependent on others for mobility assistance. Other populations in Napavine that are at greater risk to natural hazards include houseless individuals and outdoor workers such as farmers, landscapers, transportation workers, paramedics, and firefighters, primarily due to their increased exposure to extreme heat and air pollution.

Exhibit 12 Elderly Napavine community members are most likely to have a disability

Percent with a disability by age, 2022

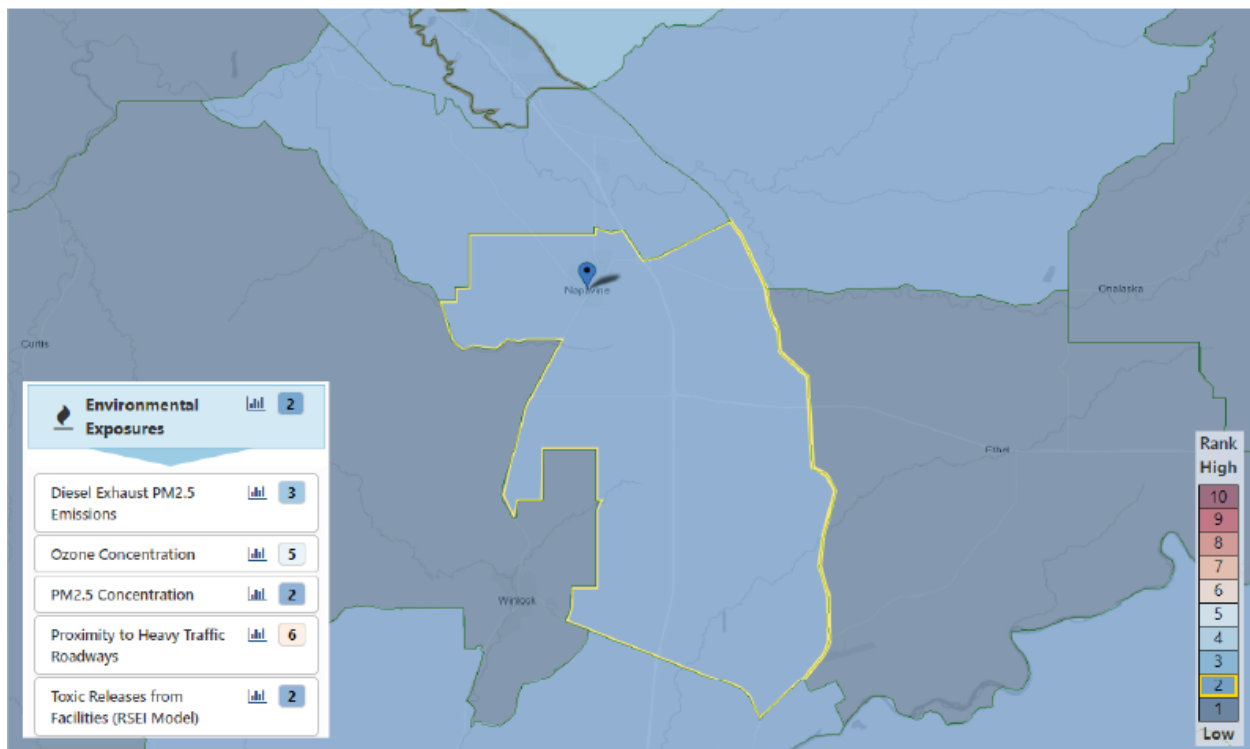


Source: 2022 ACS 5-Year Estimates, Table S1810

Environmental

Overall sensitivities due to environmental factors are relatively low in Napavine, similar to surrounding census tracts. The environmental exposures included in Exhibit 13 are exposure to diesel exhaust emissions, particulate matter (PM 2.5), proximity to heavy traffic roadways or toxic emissions, and high ozone concentrations. Napavine's proximity to I-5 contributes to relatively high exposures to air pollution, which could be exacerbated during periods of wildfire smoke. This could be especially harmful to those with respiratory health issues.

Exhibit 13. Environmental exposures are relatively low despite Napavine's proximity to I-5



Source: Washington State Department of Health, 2022. Health Disparities Map.

The proportion of tree cover in the City also influences how Napavine will be able to withstand or adapt to climate-related disasters like extreme weather events or natural hazards. The following [Urban Heat Island Effect](#) section provides a more in-depth description of the tree canopy in Napavine.

Built Environment

The primary hazards facing Napavine’s built environment include damage from wildfires, extreme heat, and flooding, which could damage structures or infrastructure such as roads and utilities. Concrete and steel bridges can expand and contract in the heat and cold, asphalt can crack or become brittle with prolonged exposure to extreme temperatures, and heavy precipitation events can flood roads, wash out bridges, or accelerate erosion. Wildfires can destroy physical structures but can also contribute to disruptions in the provision of infrastructure or essential services like telecommunications or electricity. Extreme weather can pose multiple challenges to transportation, communication, and economic systems, and can make it more difficult for people to access health care. Areas with less tree cover or stormwater management infrastructure may be more heavily impacted during heat waves and flooding events, which may cause untreated wastewater to flow into local water bodies. It is important to **prioritize investment in Napavine for the assets and areas that need repair or improvement** to reduce the amount of damage that occurs from extreme weather events and natural hazards. Addressing structural vulnerabilities and gaps in sufficient infrastructure can greatly improve the City’s resilience to climate related hazards.

ADAPTIVE CAPACITY

Community resilience is dependent on the ability of communities to recover from climate or natural hazard-related disturbances. It is influenced by the community’s adaptive capacity, which refers to the ability of a person, asset, or system (i.e., built or natural system) to adjust to a hazard, cope with change, and take advantage of new opportunities.

Jurisdictions can increase their adaptive capacity by proactively ensuring their infrastructure is better able to withstand changes to regional climate conditions and the frequency and intensity of natural hazards. While Napavine cannot eliminate all potential hazards and threats to its residents and infrastructure, it can make small incremental changes that can make large differences in the ability of the community to avoid impacts or recover from extreme weather events or natural hazards. For instance, **Napavine can increase its stormwater management capacity to alleviate flooding or can designate a local building as a heating or cooling center for use during extreme weather conditions (City Hall currently provides air conditioning)**. Such actions are included in the goals and policies of the Climate Resilience Element. This section includes a brief discussion of Napavine’s adaptive capacity in terms of social, environmental, and built environment factors.

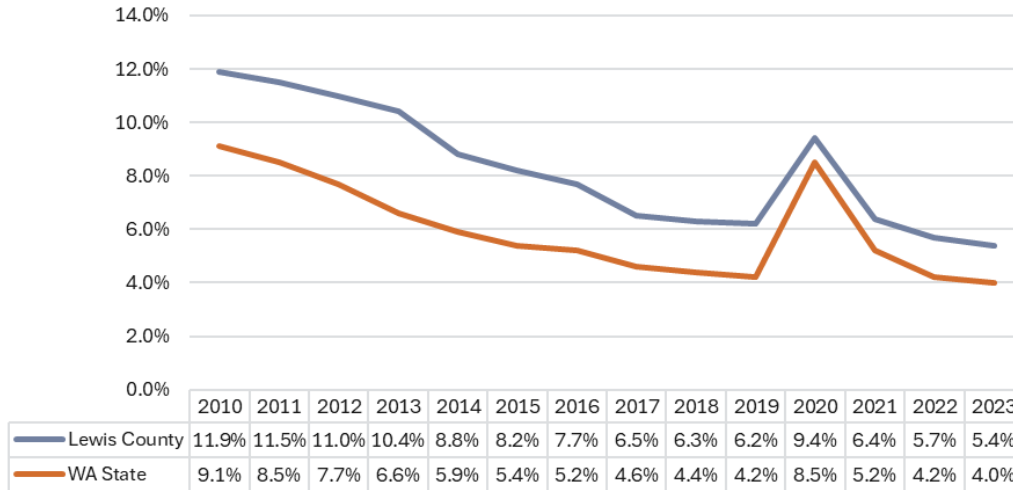
Social

Socioeconomic factors may influence one’s ability to recover from or cope with the disturbances and changes that extreme weather events and natural hazards may bring. Some populations may require greater assistance to recover from natural hazards, such as those who are unemployed, without access to a vehicle, or have less than a high school degree.

Unemployment rates in Lewis County are higher than Washington state as a whole, as Exhibit 14 below shows. The Washington State Employment Security Department has designated Lewis County as a “distressed area”. This is important to consider as unemployment, or the potential loss of employment due to natural disasters, may slow one’s recovery due to limited financial resources.

Exhibit 14 Unemployment in Lewis County has consistently been higher than the statewide average

Annual average unemployment rates

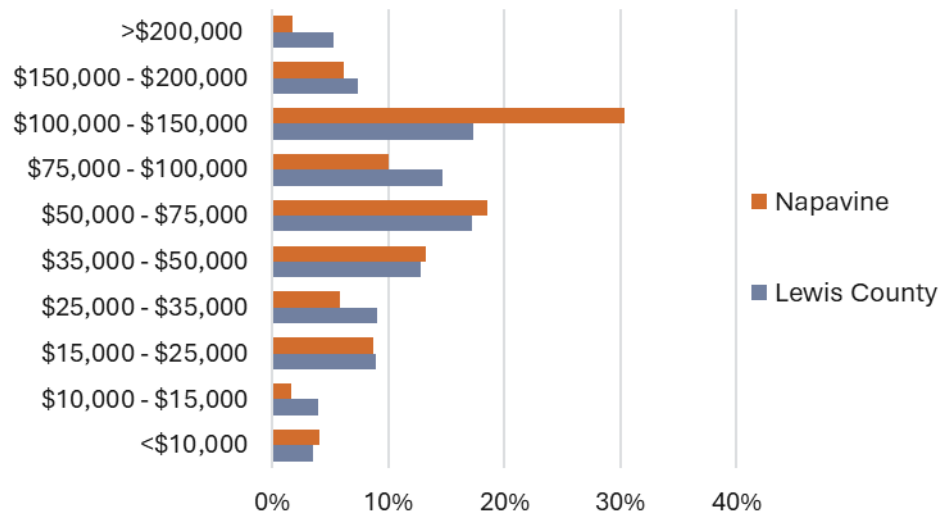


Sources: U.S. Bureau of Labor Statistics, Washington State Employment Security Department

Household incomes in Napavine are slightly higher than the county's, as Exhibit 15 shows. Around 7.8% of Napavine's population falls below the poverty threshold, with women comprising a larger share of those under the poverty threshold than men.⁴ It is important to ensure any resilience efforts undertaken by the City **prioritize strategies that decrease the burdens of those who are unemployed or low income.**

Exhibit 15 Distribution of household incomes

Percentage of households with annual incomes for each bracket



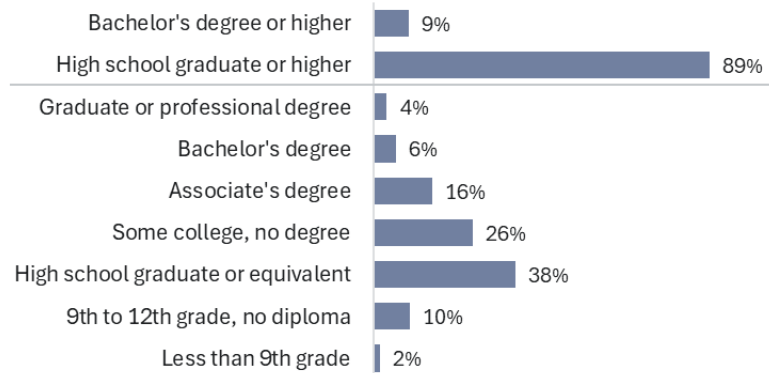
Source: ACS 5-Year Estimates, Table S1901

⁴ U.S. Census Bureau, American Community Survey, 5-Year Estimates, 2022, Table S1701.

Another socioeconomic factor that may affect the ability of a person to withstand or recover from extreme weather events is their level of education, which may influence one's ability to understand warnings or emergency protocol or recovery information. While most of Napavine's residents have at least a high school diploma or equivalent, there is a lower percentage of those with college degrees when compared to Lewis County as a whole (see Exhibit 16, below).

Exhibit 16 Most Napavine community members have at least a high school diploma

Highest level of education attained, ages 25+ in 2022

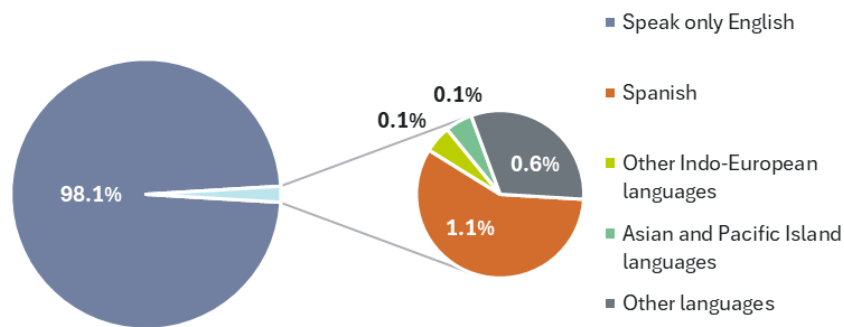


Source: 2022 ACS 5-Year Estimates, Table S1501

Additionally, those who do not speak English may be disproportionately impacted if warning, evacuation, and recovery information or guidance is not translated. While there is a small percentage of residents in Napavine that primarily speak a language other than English (1.9%), it is important to **provide translation when developing any outreach materials or emergency protocols** to ensure residents that speak Spanish or other languages are not overlooked.

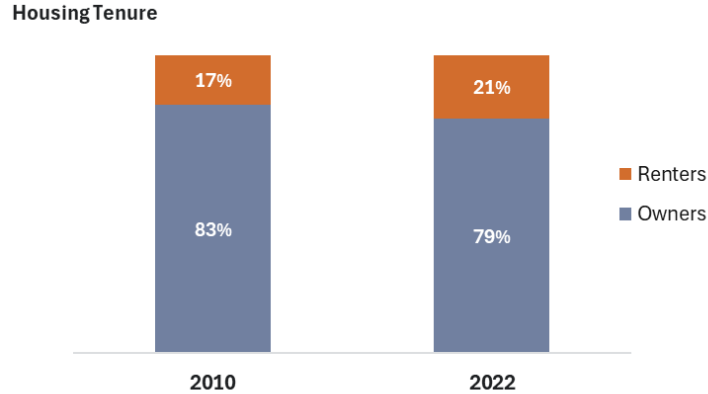
Exhibit 17 Most Napavine residents only speak English at home

Languages spoken at home



Source: 2022 ACS 5-Year Estimates, Table S1601

The type of housing one lives in also influences their ability to adapt to or recover from disturbances or disasters. Renters may not have as much control over the maintenance or repair of the property, when compared to homeowners, and they also tend to be more cost-burdened than homeworkers, which could make financial recovery more difficult for renters following a disaster. While most of Napavine's households are homeowners, it is important to **consider how recovery efforts or emergency protocols affect renters**.

Exhibit 18 Napavine households have remained primarily homeowners

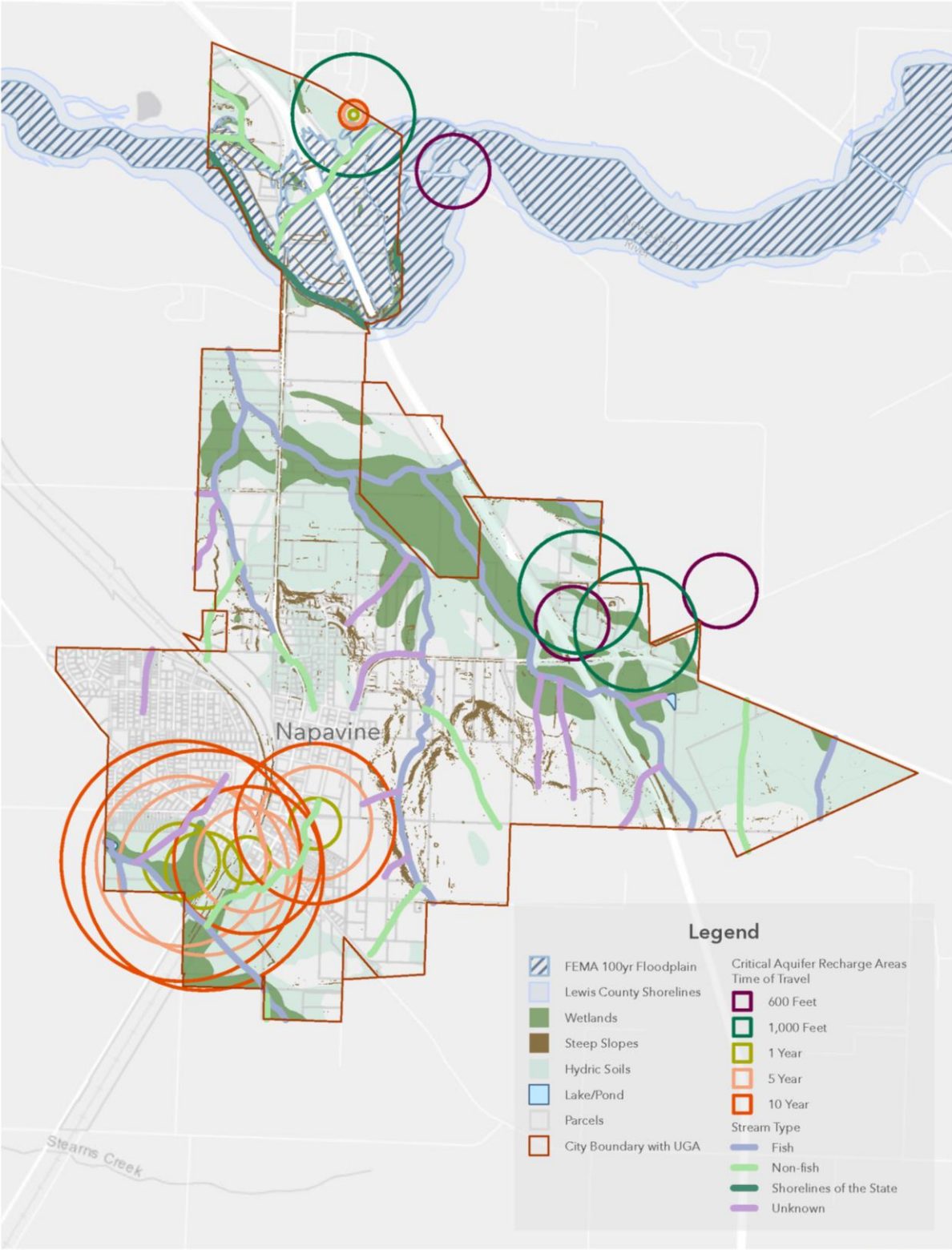
Source: 2022 ACS 5-Year Estimates, Table DP04

Given the many potential social vulnerabilities among residents in Napavine, it is important for the City to keep these populations in mind as it prepares for and seeks to increase its resilience to climate-related disasters in order to ensure that certain populations are not disproportionately impacted.

Environmental

There are many critical areas present in Napavine that may affect the City's adaptive capacity to sudden changes from extreme weather events or natural hazards. A map of critical areas in the city can be found in Exhibit 19, following. For instance, increases in the frequency and severity of precipitation events could further exacerbate the flooding risks from the 100-year floodplain present in the north side of the city. The City's proximity to the Newaukum River could affect how Napavine is impacted by heavy or extreme precipitation events. Changes in seasonal precipitation patterns likely will bring more precipitation in the form of rain in the winter, and less precipitation in summer, in addition to less water availability in the summer due to decreased snowpack. Extreme precipitation could also exacerbate the risks of landslides or erosion of steep slopes and change soil stability in areas with hydric soils in Napavine. Extreme heat and other extreme weather events can affect the health and biological tolerances of trees, which could potentially lead to a decrease in the city's tree canopy or the quality of trees over time. A more thorough discussion of tree canopy in Napavine can be found in the [Urban Heat Island Effect](#) section.

Exhibit 19. Environmentally Sensitive Areas in Napavine



CRITICAL AREAS

City of Napavine Climate Vulnerability Assessment | March 2025

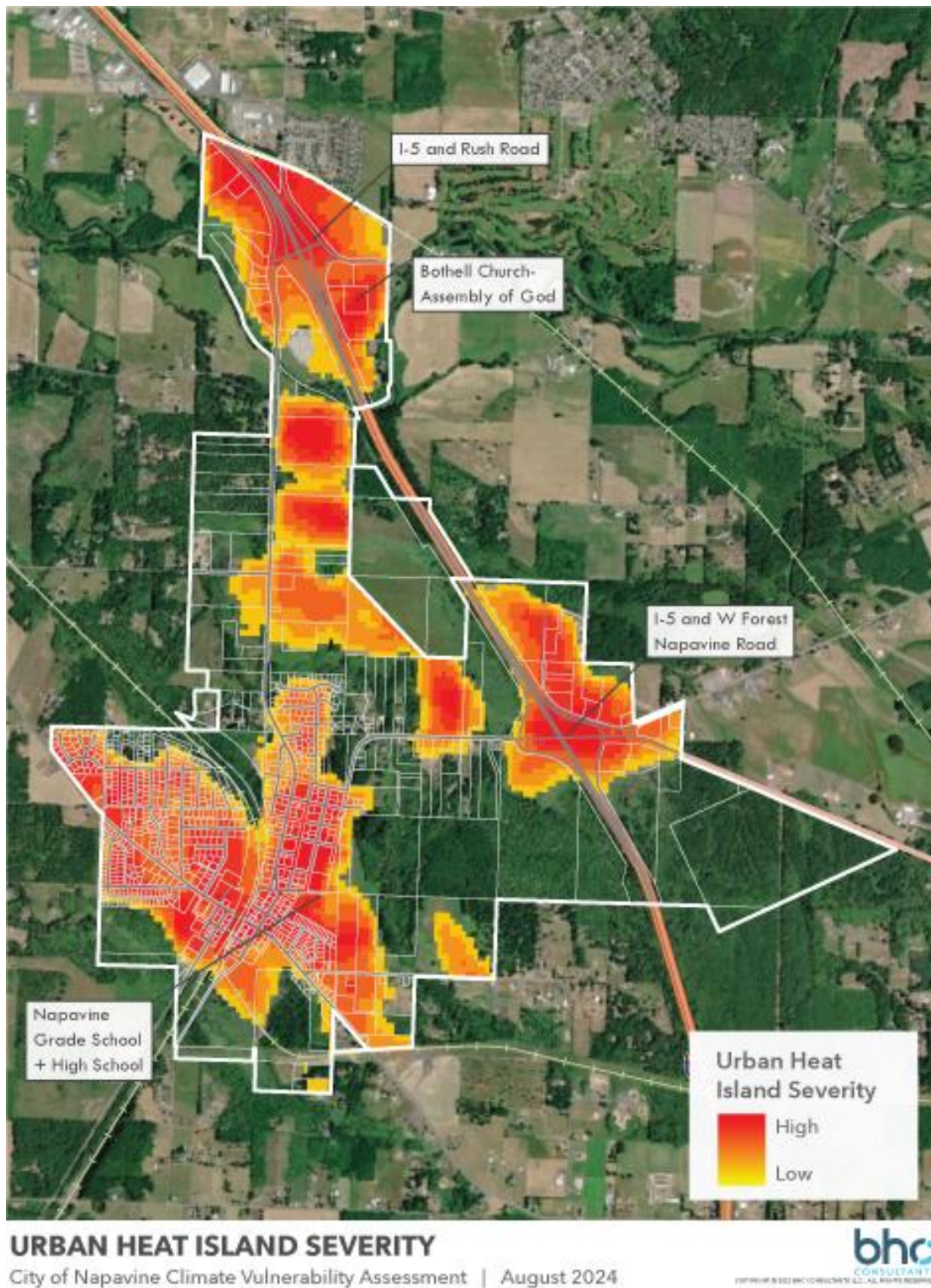
Built Environment

The built environment also heavily contributes to how natural disasters and regional climate changes affect the ability of the city to recover from stressors and the overall resilience of communities. The amount of impervious surface is one of the primary factors in how the built environment influences how natural hazards, such as flooding, impact cities. Impervious surfaces prevent rainfall from infiltrating into the ground. Rain falling on impervious surfaces like streets or parking lots becomes stormwater runoff that can flow directly into nearby lakes, rivers, or other bodies of water. Stormwater runoff can contribute to flooding where there is insufficient drainage and can also contribute to degrading water quality as it picks up pollutants and debris as it flows over surfaces. Tree canopy coverage can influence the ability of cities to cope with extreme heat and flooding, as areas with a higher tree cover coverage will generally be cooler and able to withstand greater amounts of precipitation.

URBAN HEAT ISLAND EFFECT

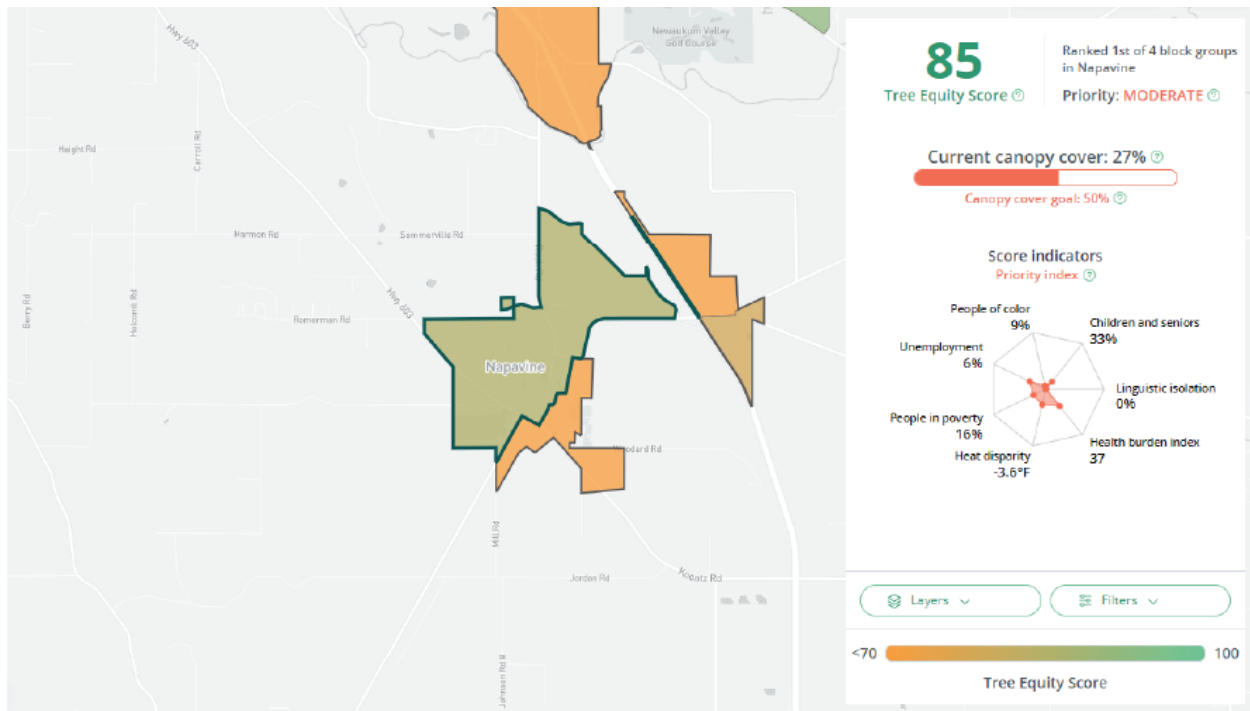
Extreme heat is one of the deadliest climate risks in the United States and is heavily influenced by the built environment. Urban areas also experience heat waves more intensely than natural landscapes due to a phenomenon known as the **urban heat island effect**. Urban heat islands are formed within developed areas because buildings, roads, and other hardscaped surfaces absorb and slowly re-emit heat from the sun more than natural landscapes. The following map in Exhibit 20 shows areas of Napavine that are hotter than the average temperature of Napavine as a whole, due to the urban heat island effect. Heat severity is shown on a scale of 1 (yellow) to 5 (red); 1 being an area that is slightly above the mean surface temperature for the city, while 5 is an area that is significantly above the mean surface temperature for the city.

Several areas of Napavine, primarily in the south side of the city near Napavine Grade School and Napavine High School, are likely to experience warmer temperatures when compared to the rest of the city. Other places in the city, such as the parking lot of the Bethel Church-Assembly of God, and where I-5 crosses over Rush Road or W Forest Napavine Road, are also significantly warmer than other parts of the city. In most cases, warmer temperatures are related to the lack of vegetation and extensive impervious surfaces such as hardscaping (pavement or asphalt) and buildings found in these areas. City strategies or **policies to mitigate the effects of extreme heat should target the warmest areas of the City.**

Exhibit 20. Urban Heat Island Severity in Napavine

Source: Trust for Public Land, 2023. Urban heat island severity for U.S. cities. *Note:* this map represents the relative heat severity for each city, based on surface level temperature from the summer of 2023. The thermal readings do not account for changes in heat during a single day and are taken at surface level, whether that surface is the ground or the top of a building. Though there is a strong correlation between surface temperature and air temperature, they are not the same.

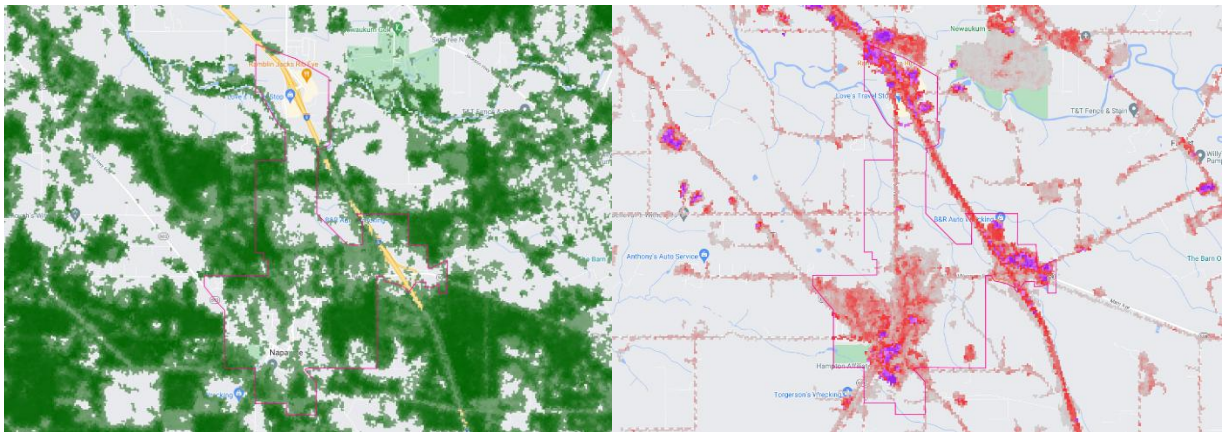
Exhibit 21. Tree Equity Score



Source: American Forests. Tree Equity Score Map.

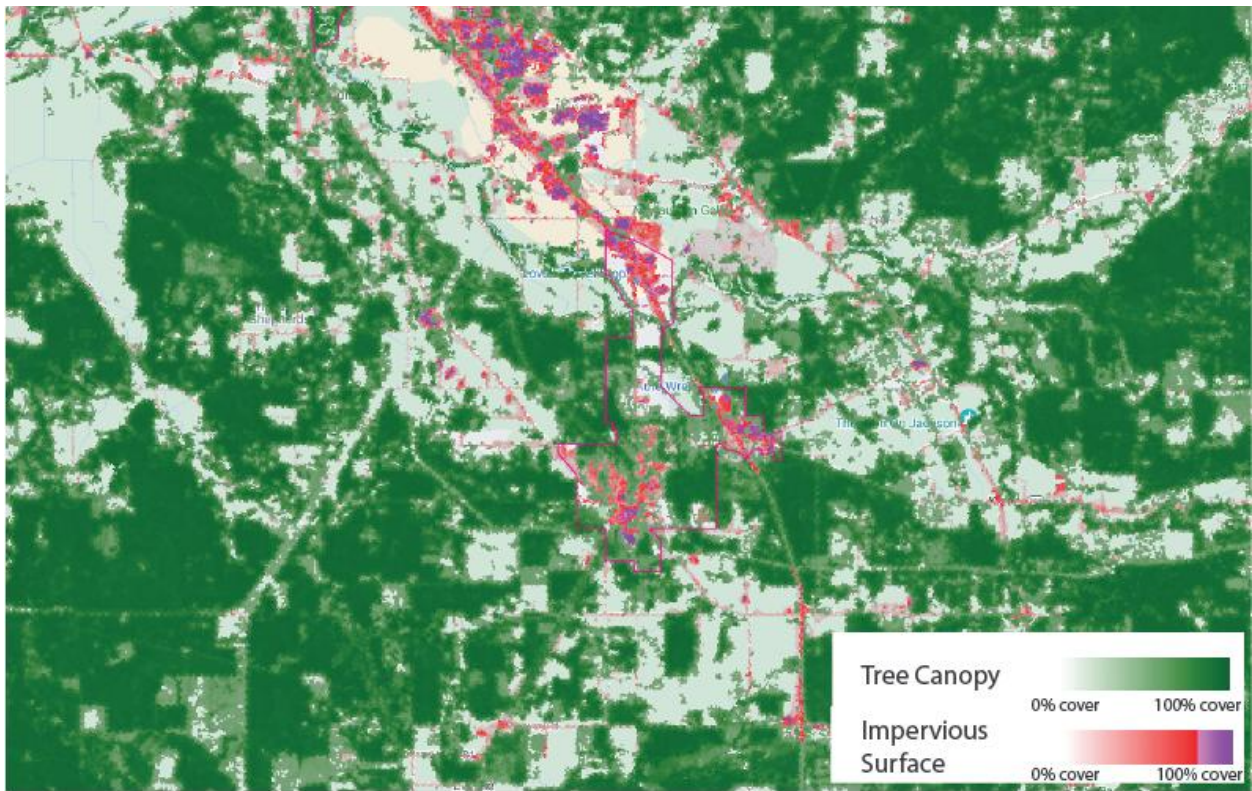
Increasing the proportion of tree cover is an effective way to provide more shade to cool the air and help alleviate the impacts of extreme heat on people and infrastructure. Throughout Napavine, tree cover is fairly equitably distributed and covers around 27% of the city as shown in Exhibit 21. Furthermore, Exhibit 22 shows the tree canopy compared to the presence of impervious surfaces in Napavine. Areas of the city with a higher proportion of tree cover will be cooler during extreme heat events; areas of the city with less tree cover will be more impacted by extreme heat and heat waves. On the other hand, areas with a higher proportion of impervious surfaces can increase the temperature felt on the ground, as impervious surfaces like concrete and asphalt absorb and retain heat throughout the day. The areas with higher-than-average surface temperatures in Exhibit 20 are reflected in the impervious areas of Exhibit 22 that do not have adequate tree cover. Currently, tree cover in Napavine is greatest in areas with less impervious surfaces, but **evenly distributing trees throughout areas with greater impervious cover, where feasible, would help the city remain cooler during heat waves and hot days, and provide some relief for those who walk around the city.** Additional tree cover would also improve aesthetics and increase the stormwater management capacity of the city.

Exhibit 22. Tree Canopy and Impervious Surface Coverage in Napavine



Tree cover (0-100% tree cover, light – dark green)

Impervious surface (0-100% impervious, light red – purple)



Source: USDA Forest Service. iTree Landscape Mapping Tool. Tree cover and impervious surfaces displayed together.

Vulnerability Matrix

Based on the Climate Vulnerability discussion above, this section evaluates the potential risk of the key hazards presented in this assessment on the social, built environment, and governmental systems in Napavine. The matrix categorizes potential risk as follows:

- **LOW** risk or impact. The hazard will not adversely affect the population or infrastructure.
- **MODERATE** risk or impact. The hazard has the potential to adversely affect the population or infrastructure.
- **HIGH** risk or impact. The hazard will adversely affect the population or infrastructure.

Exhibit 23. Vulnerability Matrix

Risk of Adverse Impact				
Key Vulnerabilities	Flooding	Extreme Heat	Wildfire Damage	Wildfire Smoke
SOCIAL				
Children and Youth (age 0 -19) Vulnerable due to their smaller size, developing immunities and organs, dependency on adults, and increased amount of time spent outside.	High	High	Mod.	High
Communities of Color Sensitivities due to their size, developing immunities, dependency on adults, and amount of time spent outside.	High	High	Mod.	High
Elderly (age 65+) Vulnerable due to their higher likelihood of chronic or pre-existing medical conditions, limited mobility, low immunity, and reliance on others.	High	High	Mod.	High
Individuals with a Disability Vulnerable due to their higher likelihood of chronic medical conditions, limited mobility, reliance on others, and potential difficulties understanding instructions.	High	High	Mod.	High
Individuals Living Alone These individuals may be less connected to information or the larger community. This vulnerability is compounded if they are also new residents of the community.	High	Mod.	Mod.	Low
Limited English Proficiency Residents with limited English proficiency may have trouble understanding emergency preparedness information or instructions, or emergency personnel during an emergency.	High	High	High	Mod.
Low-Income Households Vulnerable due to less financial resources and means to evacuate or mitigate impacts, and a higher likelihood of inadequate infrastructure or lack of healthcare.	High	High	High	Mod.
Low Educational Attainment Lower education could affect the ability of individuals to understand or access warning or recovery information and guidance.	Low	Low	Mod.	Low
Outdoor Workers Outdoor workers are more exposed to extreme temperatures, natural disasters and hazards, air pollution, water pollution, and biological hazards.	Mod.	High	High	High
Pre-existing or Chronic Health Conditions Increased risk of injury and premature death from climate-related hazards, exacerbated respiratory or cardiovascular diseases, or threats to mental health.	High	High	High	High
Pregnant Individuals An increased exposure to high temperatures or air pollution could increase the likelihood of complications during pregnancy or the health of the baby.	Mod.	High	Low	Mod.

Risk of Adverse Impact				
Key Vulnerabilities	Flooding	Extreme Heat	Wildfire Damage	Wildfire Smoke
SOCIAL				
Unemployed Unemployed individuals may be slower to recover from climate-related disasters due to limited financial resources, and disasters may result in the loss of employment.	Mod.	Low	Mod.	Low
BUILT ENVIRONMENT				
Capital Facilities Climate-related disasters may heavily impact vulnerable public facilities and community assets like parks, especially those in need of repair or upgrades.	High	Low	High	Low
Communications Climate-related disasters may disrupt the reliability or availability of communication infrastructure.	Mod.	Mod.	Mod.	Low
Economic Core Climate-related disasters may disrupt local industry due to road closures, disrupted communication, or electrical grid failure.	Mod.	Low	Mod.	Low
Electric Utilities Climate-related disasters may heavily impact the integrity of electrical infrastructure or cause electrical grid failure.	Mod.	Mod.	High	Low
Housing Stock and Buildings Most buildings in the City have been constructed meeting outdated standards that don't account for changes in extreme weather patterns or meet updated energy codes.	High	Low	High	Low
Stormwater and Wastewater Facilities Increased precipitation may increase stormwater runoff, excess flows, wastewater pollution of local water bodies, or groundwater contamination. Climate-related disasters may also affect stormwater or wastewater infrastructure.	High	Low	Mod.	Low
Transportation Network Extreme precipitation and temperatures affect the integrity of steel and concrete structures, which expand and contract in the heat and cold, and contribute to road closures from increased stormwater runoff and erosion or landslides.	Mod.	Mod.	Mod.	Low
GOVERNANCE				
Emergency Response The City's emergency response capacity may be constrained due to potentially widespread impacts of climate-related disasters.	High	Mod.	High	Low
Financial Resources Climate-related disasters may require extensive fiscal resources that may affect the City's ability to recover from such disasters, especially if long-term investment is required.	High	Mod.	High	Low

Community Resilience Strategies

This discussion of Napavine's potential vulnerabilities to extreme weather events and natural hazards informs the development of goals and policies included in the Climate Resilience Element of the 2025 Comprehensive Plan update. While this high-level vulnerability assessment focused on three primary impacts, there are additional related climate impacts that could directly or indirectly affect Napavine, including drought or decreased summer precipitation, changes in the quantity and timing of snowmelt, and changes in water quality, among others. Per HB 1181 (2023), the Climate Resilience Element included as part of this Comprehensive Plan update is required to address ways to increase Napavine's resilience to relative natural hazards and extreme weather events that are exacerbated by climate change, protect and enhance

natural areas to foster community resilience, and mitigate the community's social vulnerabilities to extreme weather events and natural hazards. This provides Napavine with a great opportunity to proactively address the impact various hazards may have on residents and infrastructure in the City throughout the 20-year planning period, and to ensure that vulnerable populations are not disproportionately impacted.