CITY OF PUYALLUP | COMMUNITY VULNERABILITY ASSESSMENT

Document Roadmap

This community vulnerability assessment is organized by the following sections:

- A description of the methodology used in this vulnerability assessment, including the guiding framework for the vulnerability assessment
- An overview of climate trends, projections, and impacts for Puyallup and the broader Puget Sound region
- Community risk and vulnerability assessment across four areas:
    - **Buildings & Energy**
    - **Natural Systems & Water**
    - **Transportation**
    - **Public Health & Economic Wellbeing**

Executive Summary

Report Goals

Over the last decade, the Puget Sound region has experienced more extreme heat days, prolonged periods of wildfire smoke from more frequent and intense wildfires in the Pacific Northwest, wetter winters, and drier summers. This climate vulnerability assessment, developed by Cascadia Consulting Group (Cascadia) for the City of Puyallup, provides a summary of climate trends and projections in Puyallup and the risks and impacts to the City's infrastructure, natural systems, public health, and economy. These assessment findings can support the City to develop strategies and actions to address climate risks within its Environmental and Sustainability Action Plan (ESAP). The findings can also inform updates to other relevant City planning documents including the Hazard Mitigation Plan and Hazard Identification and Vulnerability Analysis.

Climate Change Impacts

Puyallup is already experiencing multiple types of climate change impacts, including rising temperatures and extreme heat; increases in winter precipitation, storms, and flooding; changing streamflow; and more frequent and prolonged wildfire-related smoke days. Each of these impacts will likely have direct and cascading effects on Puyallup's City's infrastructure, natural systems, public health, and economy.

Climate Trends and Projections	
	**Rising Temperatures and Extreme Heat** Summer maximum temperatures will continue to increase, and heat waves are projected to lengthen and intensify. By 2080, the average summer temperature in Puyallup is projected to increase 11.1°F and extreme high daytime temperatures are projected to rise 12.0°F under an RCP 8.5 scenario.[1]
	**Intensifying Winter Storms and Flooding** Precipitation will shift seasonally, with summer rainfall declining by 12.2% and winter precipitation increasing by 13.1% by 2080, under an RCP 8.5 scenario. In addition, rain events have already become heavier and will continue to intensify. Puyallup will likely experience increased flooding and landslide risk, particularly in the winter.
	**Changing Streamflow** The timing of streamflow in the Puyallup and White Rivers, as well as Clarks, Deer, Silver, and Meeker Creeks is shifting. Winter streamflow will increase due to greater winter precipitation and heavier rain events, leading to more frequent and intense flooding. Meanwhile, summer streamflow will decrease due to reduced snowpack in the mountains and lower summer precipitation, with adverse impacts to riparian habitat.

[1] Representative Concentration Pathways (RCPs) are different greenhouse gas concentration scenarios used in climate modeling. RCP 8.5 represents a high-emissions, "business-as-usual" scenario with no efforts to curb emissions. Under this scenario, the globe will warm an average of 8.5 watts per square meter (4.3 degrees Celsius) by 2100, relative to preindustrial levels.

More Frequent and Intense Wildfire and Smoke Events

As temperatures rise and water availability declines in the summer, the incidence of prolonged and highly destructive wildfires is increasing across the Pacific Northwest. Wildfires can destroy homes, critical infrastructure, and wildlife habitat, while associated smoke and poor air quality threaten public health. Parts of Pierce County and surrounding King, Mason, and Thurston Counties face moderate wildfire danger [1]. In 2018, wildfire smoke in the Puget Sound region caused 24 days of poor air quality, nine of which were considered either unhealthy for sensitive groups or unhealthy for everyone [2].

Implications for Puyallup's Communities and Systems

Heavy rain and flooding will threaten buildings and stormwater infrastructure

Heavier rain and flooding will threaten structures, including homes, schools, businesses, and grocery stores in the 100- and 500-year flood zones, especially if aging levees and revetments fail. These events can also overwhelm the City's stormwater systems – which have older drainage capacity or lower conveyance capacity – and retention facilities more frequently. Some population groups – such as low-income households who cannot afford the high cost of repair and rebuilding after a flood or renters who live in housing units more likely to be older and located in low-lying areas – will have more difficulty recovering from flooding damage.

Hotter summers will increase energy demand for air conditioning and strain energy systems

More frequent and intense heat events during the summer will strain energy systems and increase energy demand for cooling, which can lead to brownouts and power outages in summer months. A portion of Puyallup's energy comes from hydropower, and hydropower reliability will decrease as earlier snowmelt and more frequent high- and low-runoff events affect seasonal energy supply. Residents with low income often occupy housing with poor insulation and limited weatherproofing and are overburdened by higher energy bills. More frequent and heavier floods and intensifying winter storms can damage powerlines and utility poles, especially in low-lying areas, affecting energy delivery to customers.

Rising temperatures and shifting precipitation patterns pose risks to salmon and urban green spaces and tree canopy

Salmon mortality will likely increase due to warmer stream temperatures, lower summer streamflow, and increased flooding during winter, threatening all parts of a salmon lifecycle. Rising summer temperatures and more extreme rainfall will stress Puyallup's urban green spaces and tree canopy, increasing the risk for insect and disease outbreaks and damage from extreme rain events.

Flooding and landslides will disrupt transportation routes, and extreme heat will degrade transportation infrastructure

More frequent and intense floods and landslides associated with heavier rainfall will lead to road damage and access disruptions that could impair Puyallup's transportation system. Roads in steep areas are more prone to experience landslides. Extreme heat will also accelerate the degradation of transportation infrastructure, resulting in higher maintenance costs and impacts for public safety. During extreme events, residents in more isolated neighborhoods will have less access to transportation networks and social and emergency services.

Extreme events will affect public health, hinder emergency and social services, and disrupt local businesses

Extreme events – such as flooding, landslides, wildfire smoke, and heatwaves – will lead to more negative health outcomes for residents, particularly those who work outside, the elderly and very young, the unhoused, and those living in poorly insulated housing or with limited access to air conditioning. These extremes can also affect access to social services, including physical and mental health care, emergency and relief services, and public facilities. Additionally, local businesses, public facilities, and residential areas in the current 100-year and 500-year floodplains along the Puyallup and White Rivers and Clarks Creek are at risk from damage from a major flood event, hindering business operations, damaging property, and decreasing property value (see Figure 4).

Methodology

Purpose

The purpose of this community vulnerability assessment is to identify current climate risk in terms of exposure and sensitivity; anticipate and flag areas of future risk; highlight areas of strength and resilience that support adaptive capacity; and identify and evaluate strategies that can help the community adapt to changing climate conditions. The community vulnerability assessment is intended to support the City of Puyallup with the following:

- Identify and communicate anticipated climate change impacts and risks to various sectors and communities.
- Identify adaptation considerations to address climate risks within the Environmental and Sustainability Action Plan (ESAP).
- Identify adaptation considerations to address climate risks in other relevant City planning efforts.

Vulnerability Assessment Framework

The Intergovernmental Panel on Climate Change defines vulnerability as a factor of exposure, sensitivity, and adaptive capacity. We use the following concepts to better understand climate vulnerabilities in Puyallup.

- **Climate risks** are the range of potential impacts a system would be affected by climate change and is dependent on exposure and sensitivity. To characterize risks, we looked at:
    - **Exposure** is the degree to which a system is stressed by the impacts of climate change.
    - **Sensitivity** is the degree to which that system is likely to be affected by climate change.

- **Adaptive capacity** is the ability to moderate, cope, or adapt to climate change. To characterize adaptive capacity, we looked at current and potential adaptation actions that could minimize the impacts of climate risks.

Climate risks increase vulnerability, while adaptive capacity helps to decrease vulnerability. Conducting a vulnerability assessment aids in identifying strategic opportunities to improve adaptive capacity or to mitigate risks to increase resiliency to climate change. For this report, climate risks and adaptive capacity were assessed via a document and data review of city assets, plans, and community functions. Each sub-sector nested under the four City sectors received a vulnerability ranking for climate risk, adaptive capacity, and an overall vulnerability score. See **Appendix A: Vulnerability Ranking Framework** for a detailed vulnerability ranking methodology.

Climate impacts will be disproportionately experienced across different communities within Puyallup. The City's most vulnerable communities often experience the earliest and most acute impacts of climate change, face historic and current inequities, and have limited resources and/or capacity to adapt [3]. These communities often include low-income, older adults, youth, immigrants, non-English speakers, and Black, Indigenous, People of Color (BIPOC), and individuals with chronic illnesses and disabilities [4]. This report includes an assessment of how vulnerable communities are impacted by climate and weather-related impact within each City sector.

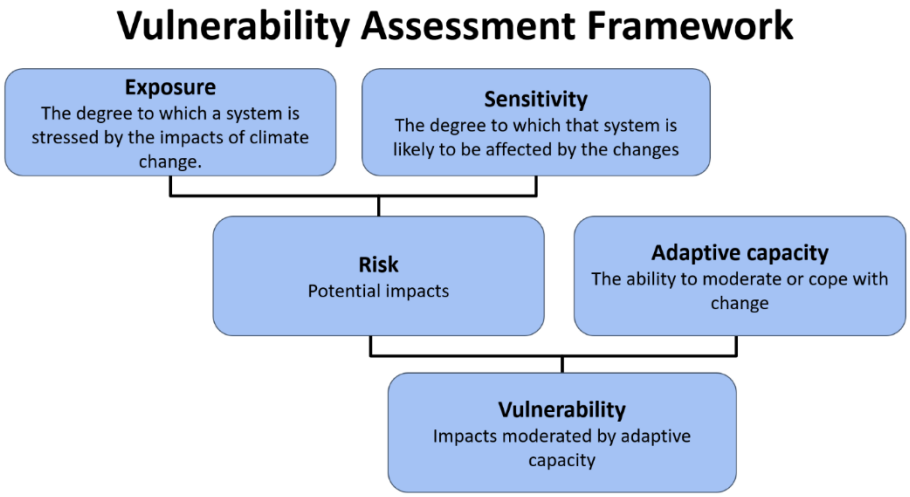

Figure 1. Vulnerability Assessment Framework

Sources

To contextualize Puyallup's climate risk within the broader Puget Sound region, a combination of data and information sources were used: local plans that identified current risks and hazards; regional scientific research; and input from City staff from relevant programs. The table below shows the publications and reports that informed this vulnerability assessment.

Publication or Report	Entity	Year	Geographic Scope

King County Strategic Climate Action Plan	King County DNRP	2020	King County
An Unfair Share Exploring the Disproportionate Risks from Climate Change Facing Washington State Communities	UW Climate Impacts Group, UW Department of Environmental and Occupational Health Sciences, Front and Centered and Urban@UW	2018	Washington State
Washington State Climate Summary 2022	NOAA	2022	Washington State
State of Knowledge: Climate Change in the Puget Sound	Climate Impacts Group of University of Washington	2015	Puget Sound
City of Puyallup Hazard Mitigation Plan (2020-2025)	City of Puyallup	2020	City of Puyallup
City of Puyallup Tree Canopy Assessment	EnCo Environmental Corporation	2011	City of Puyallup
Energy Supply, Delivery, and Demand. Fourth national Climate Assessment	US Global Change Research Program	2018	US
Climate Change and Extreme Heat: What You Can Do to Prepare	Centers for Disease Control and Prevention (CDC)	2016	US
Pierce County Sustainability Report, 2017	Pierce County Office of Sustainability	2017	Pierce County
Our People, Our Planet, Our Power	Got Green Seattle	2016	South Seattle
City of Puyallup 20-Year Natural Open-Spaces Restoration Plan	City of Puyallup	2015	City of Puyallup
City of Puyallup Water System Plan	City of Puyallup	2018	City of Puyallup
Coordinated Water System Plan and	Pierce County, Washington	2021	Pierce County, WA

Regional Supplement: 2021 Update			
Climate Impacts Vulnerability Assessment	Washington State Department of Transportation	2011	Washington State
Comprehensive Transportation Plan	City of Puyallup	2018	City of Puyallup
Puyallup Moves: Active Transportation Plan	City of Puyallup		City of Puyallup
Working on a Warmer Planet: The Impact of Heat Stress on Labour Productivity and Decent Work	International Labour Organization	2019	Global
Return on Investment Analysis of Flood Risk Management Solutions for Pierce County	Earth Economics	2013	Pierce County
City of Puyallup Comprehensive Plan	City of Puyallup	2023	City of Puyallup
City of Puyallup Comprehensive Storm Drain Plan	City of Puyallup Public Works Department	2012	City of Puyallup

Climate Trends, Projections, and Impacts

Contemporary climate change is defined as long-term, global shifts in biophysical and weather conditions attributed to human activities. The Pacific Northwest, including the Puget Sound region in which the City of Puyallup lies, is facing significant climatic changes. These changes include rising temperatures, shifting rainfall patterns, reduced winter snowpack and glacial retreat, and increased frequency and risk of wildfires. Air temperatures in Washington State have warmed almost 2°F since the beginning of the 20th century, and almost every year since 1986 has been warmer than the long-term (1895-2020) average [5]. In 2018, wildfire smoke in the Puget Sound region caused 24 days of poor air quality, nine of which were considered either unhealthy for sensitive groups or unhealthy for everyone [2].

These changes have affected communities and systems in multiple ways across the Pacific Northwest, including for the City of Puyallup. Increased flooding and landslide risk, reduced water supply and streamflow, impaired ecosystems and habitat, prolonged periods of drought, and wildfires and wildfire smoke are some of the impacts that have manifested across the region [6]. The table below shows projected changes in temperature, precipitation, and streamflow through 2080 in the Pacific Northwest under RCP 8.5.

Table 1. Projected environmental changes in the Pacific Northwest [6].

Environmental Change	2050	2080
Average Summer Temperature Jun-Aug	↑ 6.9°F increase	↑ 11.1°F increase
Maximum Daytime Temperature Protected changes in extreme high daytime temperatures	↑ 7.5°F increase	↑ 12.0°F increase
Average Winter Temperature Dec-Feb	↑ 4.9°F increase	↑ 8.3°F increase
Total Summer Precipitation Apr-Sep	↓ 8.1% decrease	↓ 12.2% decrease
Total Winter Precipitation Oct-Mar	↑ 9.4% increase	↑ 13.1% increase
Precipitation Intensity Projected change in a 25-year, 1 hour rain event	↑ 33% increase	↑ 43% increase
April 1st Snowpack	↓53% decrease	↓74% decrease
Summer Runoff Jul-Sep, includes any overland water flows in addition to subsurface runoff in shallow groundwater	↓ 4.1% decrease	↓ 4.5% decrease
Winter Runoff Dec-Feb, includes any overland water flows in addition to subsurface runoff in shallow groundwater	↑ 8.5% increase	↑ 11.6% increase

Similar to other cities in the Puget Sound Region, the City of Puyallup is experiencing drier and hotter summers and warmer and wetter winters, a trend that is projected to continue through the next century. Reduced snowpack in the nearby Cascade Range and changes in streamflow to the Puyallup River, White River, and upland watersheds will reduce overall water availability regionally during summer months (Figure 2). These and other environmental changes will have implications across all City sectors, including Puyallup's built environment and energy systems, transportation, natural systems and water, and community and economic wellbeing.

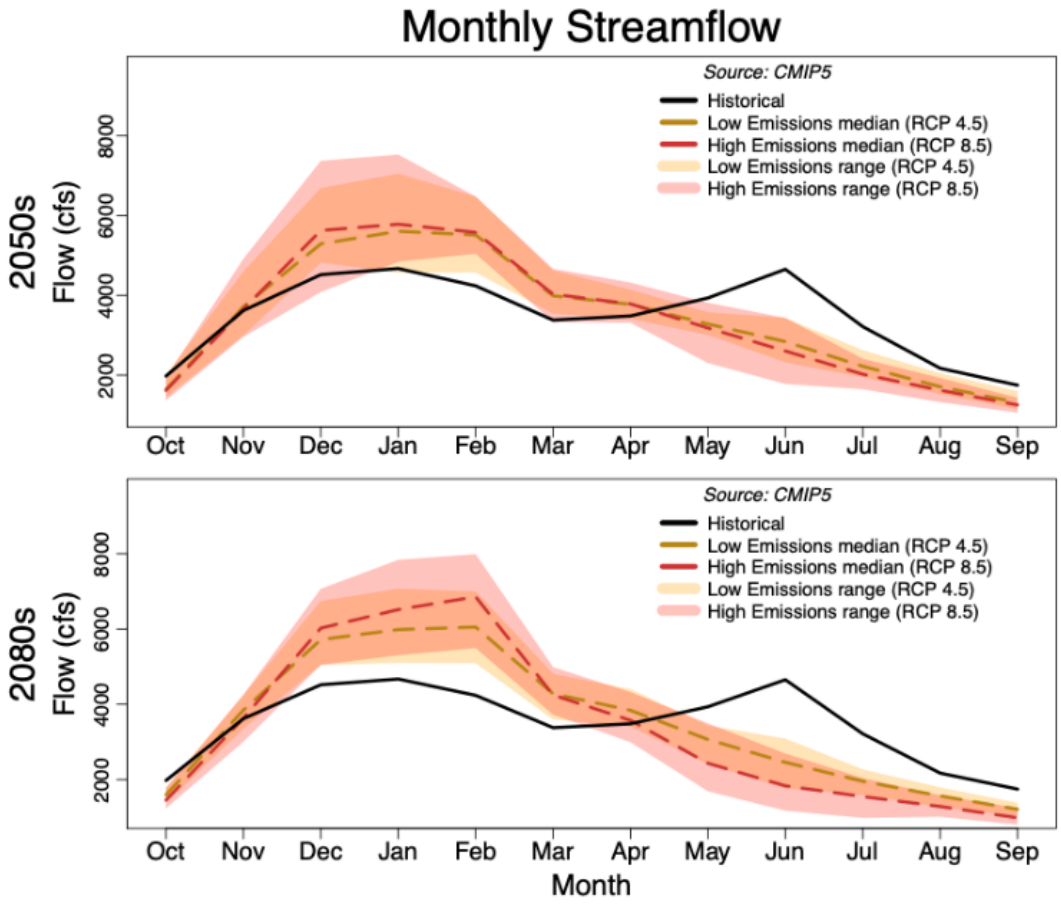

Figure 2. Streamflow changes in the Puyallup River Watershed under RCP 4.5 and RCP 8.5 scenarios by the 2050s and 2080s.

Climate impacts disproportionately impact certain communities in Puyallup, including those with low-income, older adults, young children, those with disabilities, and Black, Indigenous, People of Color (BIPOC) [4]. Residents with low-income have fewer financial and material resources to cope with and recover from climate hazards such as extreme heat and flooding. Those who are unhoused face prolonged exposure to the elements with few options for respite or medical care. Meanwhile older adults and young children have physiological and mobility limitations to coping with extreme heat and wildfire smoke. Due to historical racial inequities, BIPOC are more likely to be low-income and unhoused, have poorer health outcomes, and live in areas that are more exposed to climate hazards (e.g., low-lying areas prone to flooding, neighborhoods with less shade to moderate heat), making these communities more sensitive to the impacts of climate change [7].

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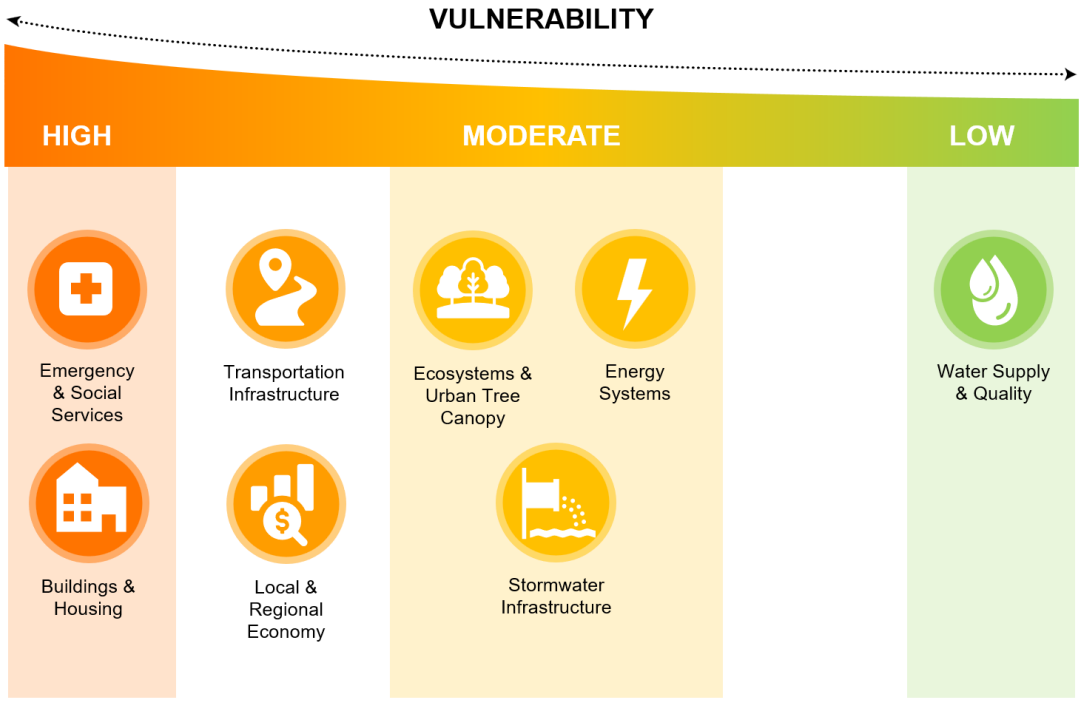
Community Vulnerability Areas:

The areas evaluated in this vulnerability assessment were identified based on a review of City planning documents, relevant regional studies, and discussion with City planning staff.

Areas	Description of Area
Built Environment & Energy	Puyallup's buildings, homes, and energy consumption and needs.
Natural Systems & Water	Puyallup's natural systems including rivers and streams, habitat for wildlife species, parks, open spaces, urban forests, and stormwater systems including ditches, pipes, and culverts.
Transportation	Puyallup's infrastructure for different modes of transportation.
Public Health & Economic Wellbeing	Puyallup's social services, physical and mental health of residents, emergency preparedness, and local and regional economy.

Each evaluated subsector is shown below according to its overall vulnerability ranking (high, moderate, low). The sector summaries below provide a detailed assessment for each subsector, including individual rankings of climate impacts (exposure and sensitivity) and adaptive capacity, as well as an overall vulnerability ranking that considers both climate impact and adaptive capacity rankings.



Buildings & Energy

This section assesses climate exposure, sensitivity, and adaptive capacity for Puyallup's built environment and energy sector, including commercial, residential, institutional, and government buildings and energy systems.

Buildings & Housing

Climate Risk (Exposure + Sensitivity): *Moderate-high*	**Overall Vulnerability**
An increase in the frequency and intensity of flooding events will put **existing and future structures in the 100- and 500-year flood zone at high risk of flooding** and **structures adjacent to these flood zones at moderate risk**. This is because flood zone maps developed by FEMA are based on historical trends rather than future climate projections. The most common flood zones in the City are rivers and creeks, which swell during heavy rainfall, rain-on-snow events, and when ice melts from Mount Rainier and the Cascade Mountain Range in the spring. **Areas with a large proportion of impervious surfaces such as the Downtown and South Hill neighborhoods could face a higher risk of flooding**, as impervious surfaces prevent rainwater from being absorbed into the ground and gradually seeping into streams and other bodies of water.	**High Vulnerability**
Adaptive Capacity *Low*	

Puyallup has implemented higher regulatory standards for buildings in flood hazard areas, is designing a setback levee on the Puyallup River, and coordinates with other jurisdictions in Pierce County and FEMA representatives on flood disaster mitigation.

However, Puyallup's levees and revetments are 60 to 100 years old and do not meet modern design criteria. Further, the levees are not certified by the Federal Emergency Management Agency (FEMA) and would therefore expose parts of the City to flooding during a 100-year flood event. Given Puyallup's outdated and uncertified levees, the City's adaptive capacity to future flooding is low.

Climate Risk

Projected increases in heavy rainfall will lead to more frequent flooding and landslides, posing greater risks to current and future buildings and housing, especially those in Puyallup's 100- and 500-year floodplain (Figure 3 and Figure 4). New buildings within the 100-year floodplain are required to be built above the 100-year floodplain elevation indicated on FEMA Flood Insurance Rate Maps but can still be damaged by fast moving floodwaters. The Puyallup River and the White River drive riverine flooding in Puyallup during high rainfall or snowmelt events. These rivers flow from glaciers on Mount Rainier and are therefore heavily influenced by precipitation patterns on Mount Rainer and the surrounding Cascade Mountain Range. Other creeks that are mainly influenced by rain in urban areas include Clarks, Deer, Silver, Wildwood, and Meeker Creek [8].

Figure 3. Flooding along the Puyallup River in 2009 [37]

Puyallup is prone to flooding on an annual basis, with flooding being the cause of most disaster declarations in the City. Major flooding events from 1996 to 1997 caused the most damage in recent City history [8]. There are 308 square miles (35%) of incorporated Puyallup and 275 square miles (34%) of unincorporated Puyallup that are exposed to flooding risk. Additionally, about 5% of the population, 15% of land value and improved value, and 23% of properties are exposed to flood risk. Historically, the highest frequency flood areas in Puyallup have been 12th Ave SE and 25th Street SE, Meeker Ditch from 11th Street SW to 14th Street SW, Pioneer Creek on 14th Street SW, and Clarks Creek. Buildings lying in these areas include schools, residential neighborhoods, places of worship, businesses, and recreational facilities [8]. Impervious surfaces prevent rainwater from being absorbed into the ground and increases flood risk. Puyallup's landcover is 33% impervious surfaces, with relatively high proportion of impervious surfaces in the Downtown and South Hill neighborhoods [9].

2017 FEMA Flood Map

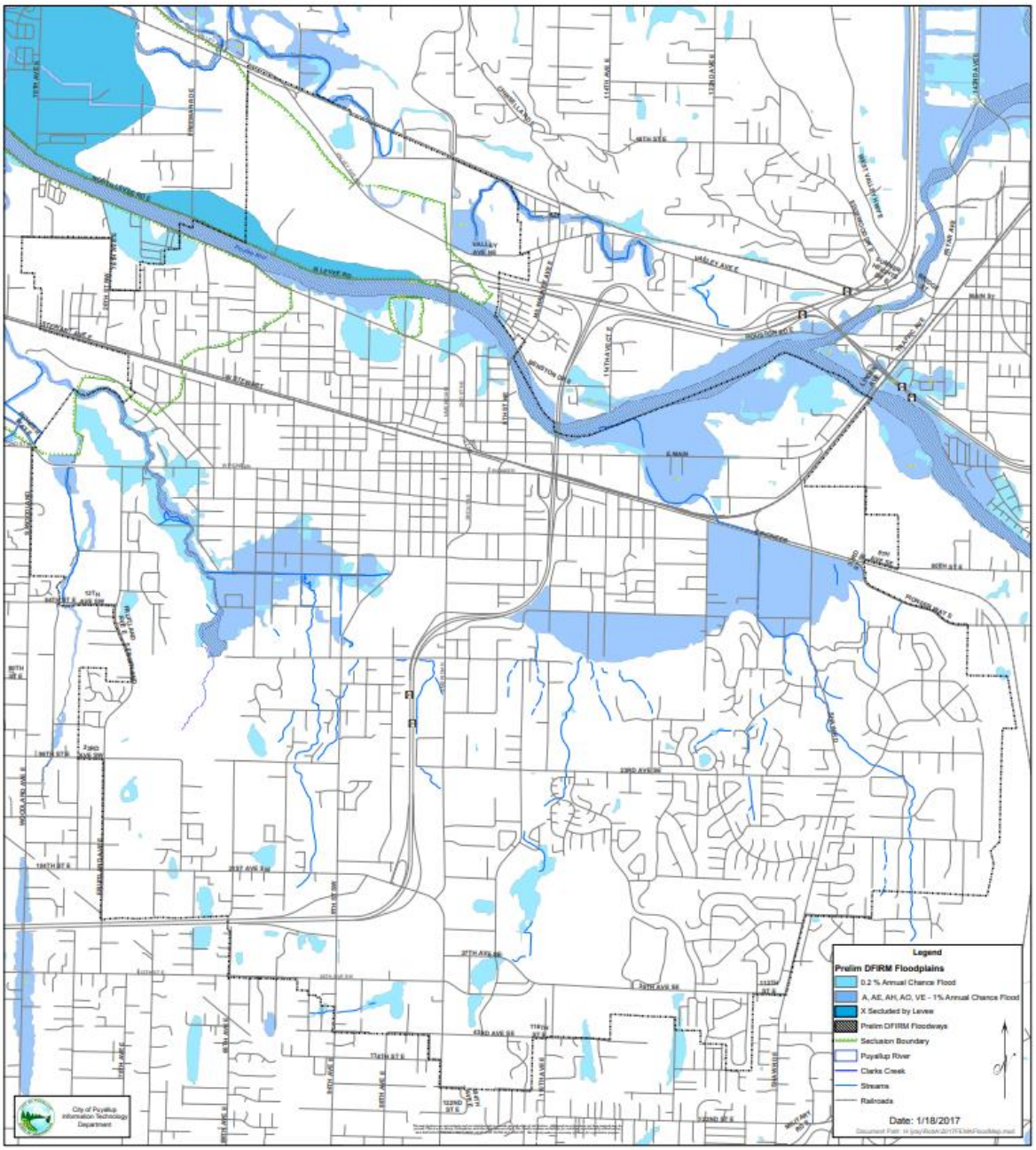


Figure 4. City of Puyallup 2017 FEMA flood map showing areas residing in the 100- and 500-year floodplain

About 30% of the City's housing stock was constructed over 50 years ago [10]. Older homes in Puyallup are more vulnerable to flooding because they were not built according to modern flood risk mitigation standards and codes. Community groups with greater vulnerability to flooding include those with low-income, those living in rental housing units, communities of color, people with disabilities, the elderly, and households without a car [11]. Low-income residents often do not have the financial means to recover from flood damage and loss and are more likely to live in flood zones. Affordable and older housing units, including rental units, are less likely to be built according to modern flood protection standards and more likely to be in flood hazard areas. Communities of color tend to live in lower-income neighborhoods in low-lying areas and have fewer resources to recover and relocate after a flood. People with disabilities, the elderly, and those without a car can face challenges evacuating – especially in extreme storm events and flash floods – due to mobility limitations.

Adaptive Capacity

Over the last several decades, the City, in partnership with other public agencies and jurisdictions in Pierce County, has invested in capital improvement projects to reduce flooding hazards and improve disaster response and management. Some examples of these actions include the following [8]:

- Coordinate with other jurisdictions in Pierce County and FEMA representatives on disaster mitigation.
- Update FEMA Flood Insurance Rate Maps for more accurate floodplain regulations and increase public awareness of floodplains.
- Placement of setback levees to increase flood storage within the active channel area;
- Maintenance of City-owned flood control infrastructure (i.e., ponds, levees, and revetments) to reduce the chance of failure during flood events and to optimize their storage capacity.
- Implement higher regulatory standards for buildings in flood hazard areas.
- Construction of new facilities to enhance flooding storage during storm events such as ponds and setback levees.
- Installation of additional USGS river level gauge monitors on City-owned bridged along the Puyallup River and Clarks Creek for more accurate flood forecasts, early dissemination of warning, and increased public awareness.
- Implementing flood protection improvements for the Water Pollution Control Plant.

The City's Stormwater Capital Facilities Plan includes projects to improve stormwater management along Deer Creek, including realignment and culvert replacements. In 2023, the City will also update its Stormwater Comprehensive Plan to identify additional projects to reduce flood damage.

However, the City's aging levees, which are 60 to 100 years old, do not have sufficient height and have not been certified by FEMA. For example, the U.S. Army Corps of Engineers decertified the levees along the Lower Puyallup River in 2004 because the levees no longer satisfied the requirement that the top of the levee be at least 3 feet above predicted 100-year water levels; sediment accumulation along the bottom of the river had raised water surface levels [15]. Although the City has adopted updated FEMA floodplain maps, these maps are based on historical precipitation data and do not account for projected increases in precipitation. Further, the updated 2017 FEMA floodplain maps include seclusion zones behind uncertified levees that reflect flood zones from the 1987 FEMA floodplain maps. As such, Puyallup's adaptive capacity to future flood risk is low.

Figure 5. Puyallup River setback levee [38]

Energy Systems

Climate Risk (Exposure + Sensitivity) *Moderate-high*	**Overall Vulnerability**
The City is prone to power outages during **winter storms, floods,** and **extreme heat** events, which are projected to intensify under climate change. Falling trees and branches, erosion, and flooding during winter storms can damage energy infrastructure such as transmission and distribution lines, while increased demand for air conditioning during extreme heat events can strain the electricity grid, leading to power outages. Low-income communities that do not have energy efficiency upgrades and have limited access to energy services will be at most risk to **rising summer temperatures** and **heatwaves.**	
Adaptive Capacity *Moderate*	
Within the City, approximately 18 buildings have either LEED (Leadership in Energy and Environmental Design) or Energy Star certification [12]. Having more energy efficient buildings increases Puyallup's ability to provide essential heating and cooling for residents and essential operations during extreme weather events while decreasing the risk of power outages due to strain on the electrical grid. The City is also taking action to manage stormwater, erosion, and flooding around critical energy infrastructure, and has installed backup generators for critical city infrastructure. Puyallup gets its electricity from Puget Sound Energy (PSE), which relies on hydroelectric power for nearly one third of its energy supply portfolio. Given future projections of lower streamflow in the summer, PSE's current energy supply portfolio may likely be insufficient to meet future energy demand, especially during the summer.	**Moderate Vulnerability**

Climate Risk

The region has experienced noticeable intensification of winter storms and extreme heat events. Flooding, windstorms, hail, snow, ice storms, and tornadoes have all impacted the City in the past [8]. These conditions are expected to intensify, posing greater stress and damage to

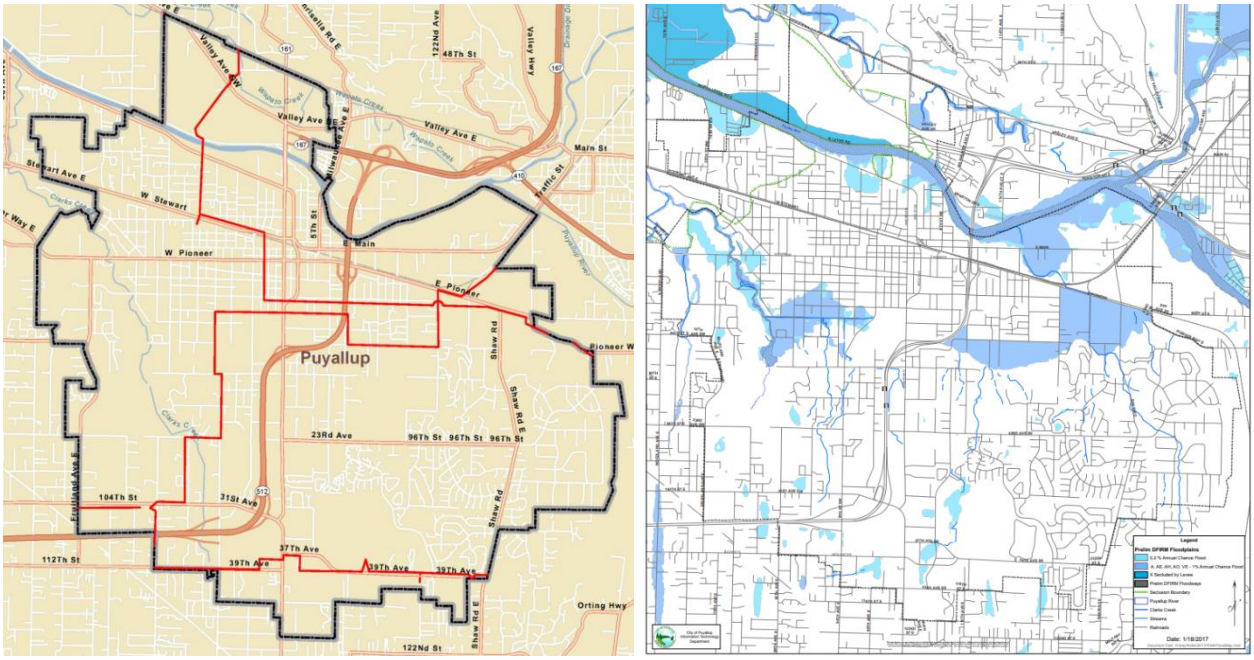


Figure 6. Puget Sound Energy (PSE) transmission lines [36] relative to Puyallup's 2017 FEMA floodplains

electricity energy infrastructure [13]. Energy transmission and distribution lines, stations, and substation in floodplains are particularly vulnerable to flooding (Figure 6).

Rising temperatures and extreme heat events also lead to greater air conditioning use to cool homes and indoor spaces, further putting stress on energy systems and which may lead to more power outages as extreme heat events become more prolonged and intense. In addition to power loss, Puyallup residents may experience increased energy costs as demand for air conditioning grows. Lower-income residents, who have fewer resources to pay for air conditioning and may have higher energy bills due to energy-inefficient housing conditions, as well as young children and older adults are more vulnerable to extreme heat events [14].

Adaptive Capacity

Puyallup is improving its energy resiliency to climate change by increasing its buildings' energy efficiency and reducing energy demand particularly during periods of high energy loads such as heatwaves. Within City borders, there are approximately 18 buildings with green certifications like LEED and Energy Star. Some of these buildings include Puyallup City Hall, the Patient Care Tower of Good Samaritan Hospital, Group Health/Kaiser Permanente, the South Hill Business & Technology Center, the Pierce College STEM and Arts/Health buildings, and retail spaces [12]. Puyallup's City Hall is a LEED Gold certified building that is 20% more energy efficient than required by the Washington code. The City is also managing stormwater, erosion, and flooding

around critical energy infrastructure and has installed backup generators for critical city infrastructure (See **Buildings & Energy** adaptive capacity section) [8].

Puget Sound Energy (PSE) supplies electricity to Puyallup, and hydroelectric sources make up almost one third of PSE's current energy supply portfolio [15]. Future decreases in winter snowpack, shifts in timing of peak flows, and lower summer flows are likely to affect the reliability of hydroelectric power and energy generation in the region. Therefore, PSE's current energy supply portfolio may likely be insufficient for meeting future increases in energy demand, especially during the summer.

Energy bills are expected to rise as demand for cooling increases with warmer temperatures [13]. To help residents with financial need keep their homes cool, reduce their energy bills, and better afford air conditioning, PSE has programs to help qualifying customers pay their energy bills and upgrade their homes to reduce energy consumption. For example, customers with household incomes less than 150% of the federal poverty level can participate in the Low-Income Home Energy Assistance Program (LIHEAP), which is a federally funded program that reduces the cost of home energy bills and weatherization. Customers with incomes less than 80% of the area median household income would qualify for PSE's Home Energy Lifeline Program (HELP), which provides customers with assistance in paying their energy bills beyond LIHEAP [16]. In 2019, PSE administered $7.8 million in weatherization benefits to over 1,800 households. From 2019 to 2020, PSE distributed $10 million to over 26,000 customers through HELP [17].

Natural Systems & Water

This section assesses the exposure, sensitivity, and adaptive capacity of Puyallup's natural systems and water sector. This sector includes ecosystems and urban tree canopy, stormwater infrastructure, and water supply and security.

Ecosystems and Urban Tree Canopy

Climate Risk (Exposure + Sensitivity) *Moderate-high*	**Overall Vulnerability**
Hotter and drier summers with lower streamflow in the Puget Sound Region will strain ecosystems, watersheds and urban tree canopy, making them more susceptible to **invasive plant species and pests.** **Reduced rainfall and streamflow** in the summer will **degrade critical habitat for salmon**, which rely on sufficient streamflow for upstream migration and reproduction each year. **Flooding** due to higher rainfall in winter will **increase runoff of contaminants and debris** into creeks and the Puyallup and White Rivers and could **scour salmon nests from streambeds.**	**Moderate Vulnerability**
Adaptive Capacity *Moderate-high*	
The City's **20-Year Natural Open Spaces Restoration Plan** aims to restore and maintain natural open spaces that **support healthy ecosystems and waterways through community stewardship.** Puyallup's tree canopy coverage is 26%, falling short of the recommended 40% tree canopy coverage for cities by American Forests. Puyallup's Green City Partnership Program aims to get the City **recertified as a Tree City USA.**	

Climate Risk

Puyallup has about 360 acres of parks, trails, and open spaces and is located 50 miles from Mount Rainier and its surrounding wilderness areas. The combined impacts of rising temperatures, extreme heat, drought, wildfires, insect outbreaks, and tree diseases are already causing widespread tree mortality across Northwest forests – including urban forests and parks – and will continue to transform all types of forests in the future. These transformations can increase the risk of large wildfires – especially in the Cascades – potentially increasing the risk of Puyallup's natural areas and communities to wildfire-related damage [18]. Parts of Pierce County and surrounding King, Mason, and Thurston Counties face moderate wildfire danger [1]. Areas located in or near the wildland-urban interface or intermix (WUI), or places where development transitions into undeveloped areas, are especially at risk from fire damage [19]. Parts of Puyallup and its surrounding areas are WUI, indicating that wildfire will pose an increasing risk (Figure 7).

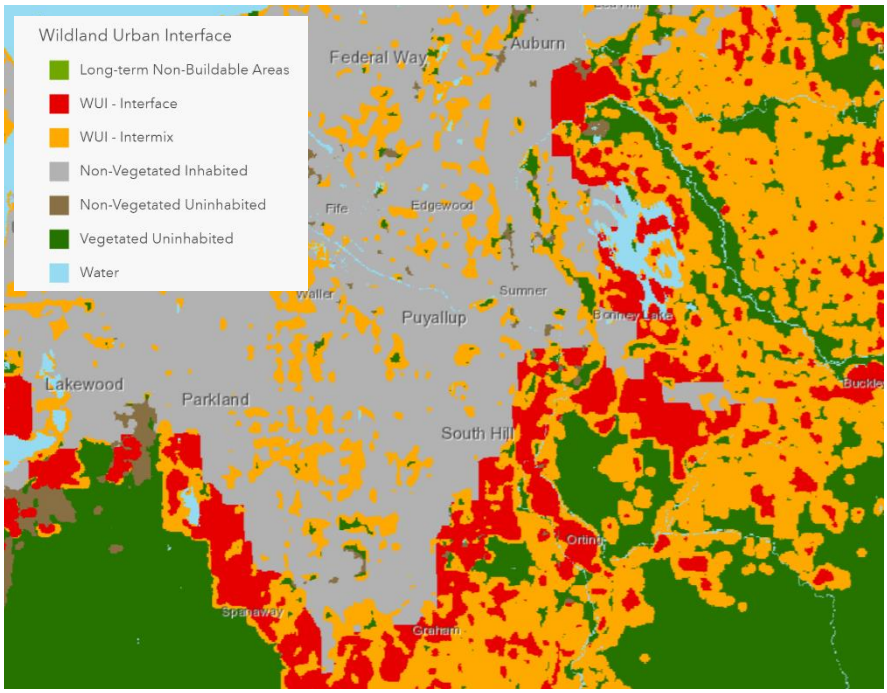


Figure 7. Wildland-Urban Interface (WUI in and around Puyallup

Warming stream temperatures, low summer streamflow, as well as increased runoff of contaminants from winter flooding events will degrade critical habitat for salmon and other aquatic species. The Puyallup River, Meeker Creek, Silver Creek, Deer Creek and Clarks Creek provide habitat for fish, including Chinook, Coho, chum, sockeye, and pink salmon, steelhead, and cutthroat trout, several of which are listed as threatened under the Federal Endangered Species Act.

Tree canopy coverage can also affect how other systems are affected by climate change. For example, urban heat islands will become more pronounced in areas with a high proportion of impervious surfaces where tree canopy is sparse, such as downtown, industrial, and commercial areas [20]. This can lead to disproportionate exposure for systems and communities – such as roadways, landscaping, households – to warmer temperatures and extreme heat. Urban tree canopy coverage tends to be lower in low-income

Figure 8. Riverine flooding on Riverwalk Trail in October 2017

neighborhoods [21], which tend to have more rental units that are less energy efficient, have limited air condition capacity, and have less access to parks.

Adaptive Capacity

The City of Puyallup is building a network of natural open spaces and restoring and maintaining over 350 acres of land through the Green Puyallup Partnership, a collaboration between the City, Pierce Conservation District, and Forterra. The Partnership, with a budget of $80,000, launched the 20-Year Open Space Restoration Plan in 2015 to restore and support healthy ecosystems and waterways. In 2020, the City updated its 2014 Parks, Recreation & Open Space (PROS) Plan, which provides a blueprint for improving city parks, trails, and recreation areas that can enhance the resiliency of the city's natural systems. The City has also completed several creek and wetland restoration projects. For example, in 2012, the Clarks Creek Riparian Project replaced 8,000 square feet of impervious road and path with pervious surface and planted 17,000 square feet of riparian habitat along a salmon bearing portion of Clarks Creek.

The City's municipal code protects environmentally critical areas and protects their functions and values, while allowing for economically beneficial or productive use of land on private property. Environmentally critical areas identified in the ordinance include wetlands, fish and wildlife habitat areas, critical aquifer recharge areas, geologically hazardous areas, and frequently flooded areas.

In 2011, Puyallup had about 26% citywide tree canopy coverage (Figure 9), which falls 14% short of American Forests' recommended city tree canopy coverage [22]. In 2014, the City was recognized as a Tree City USA by the Arbor Day Foundation but lost that designation in 2020 due to changes in funding criteria, lack of staffing needed to the support the program, and insufficient number of trees planted. Through its Green City Partnership Program, Puyallup plans to get recertified as a Tree City USA. Some actions the City will take to accomplish this include the following [23]:

- Dedicate at least $2 per capita (approximately $88,000-90,000 in 2021) to tree planting, maintenance, and removal
- Increase staff capacity/time to host Arbor Day celebration events
- Engage in tree education and public outreach
- Prepare documentation of a coordinated urban forestry program
- Support a dedicated planning effort and capacity to organize a consistent city tree program

Of the city's zoning designations, commercial zoning had the lowest percentage of tree coverage in Puyallup (7%), with parks making up the second lowest percentage of tree coverage (9%). Conversely, residential areas made up the highest percentage of tree coverage (56%), followed by other and vacant land areas (28%). Pavement and asphalt made up about 26% of Puyallup's land cover, with buildings covering about 13% [22].

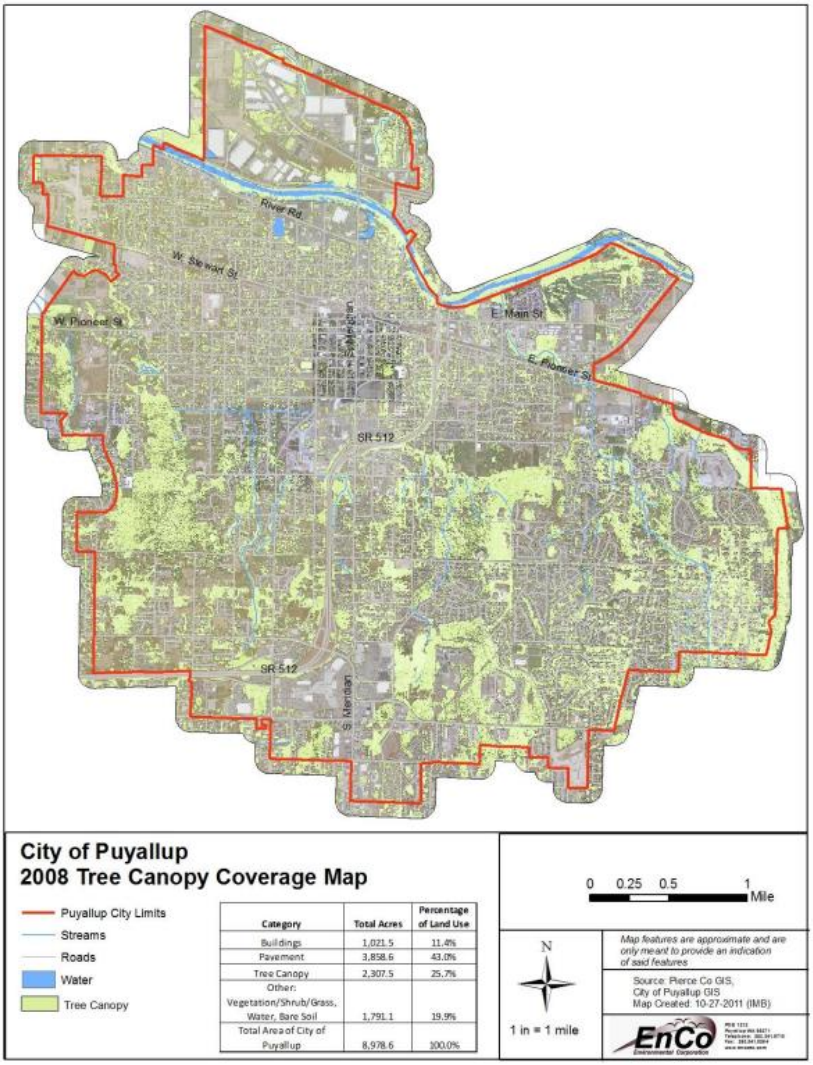


Figure 9. Map of Puyallup Tree Canopy Cover in 2008

Stormwater Infrastructure

Climate Risk (Exposure + Sensitivity) *Moderate-high*	**Overall Vulnerability**
With more intense heavy rain and flooding events, the probability that stormwater systems and retention facilities will be overwhelmed will increase. The City's storm drainage pipes are outdated, and many were designed for historical precipitation and flooding trends and may not have sufficient conveyance capacity for increasingly heavy rainstorms, particularly those in the 100- and 500-year flood zones. Drainage pipes on the valley floor are especially at risk of overflowing. Stormwater outfalls to the river will also experience more frequent and greater backflows when the river level rises with more frequent and intense flood events.	**Moderate Vulnerability**
Adaptive Capacity *Moderate*	

Each year, the City updates its Stormwater Management Program Plan (SWMPP) to comply with the Clean Water Act, and its stormwater management municipal code establishes minimum requirements for stormwater quantity and quality. The City's Hazard Mitigation Plan includes actions to retrofit the Lower Puyallup River levee system and in 2020, the City updated its FEMA floodplain map and flood insurance rate maps to inform current and future development and improve stormwater management. However, these maps are based on historical data trends and do not reflect future climate change projections.	

Climate Risks

By 2050, winter precipitation intensity will increase by 33% and winter runoff will increase by 8.5% under an RCP 8.5 scenario [6]. This will increase runoff volume to drains, pipes, and culverts as well as regional rivers and streams, including the Puyallup River, Clarks Creek, Silver Creek, Deer Creek, Woodland Creek, Wapato Creek, and Meeker Creek. This runoff will carry additional oil and other urban pollutants, leading to additional acute contamination events of local waterways and negatively impacting water quality.

Impervious surfaces increase flooding risk, as stormwater is not able to naturally infiltrate into soils and pervious surfaces, which leads to standing nuisance flooding. This also leads to increased runoff into streams and creeks, exacerbating the risk of flash floods. Citywide land cover is about 33% impervious surfaces [9]. The Downtown and South Hill neighborhoods have more impervious surface areas, making them more susceptible to stormwater runoff and flooding.

Stormwater systems have limits to their conveyance capacity. Many of Puyallup's storm drainage pipes are older and were designed with historical precipitation trends. Thus, many may not have sufficient conveyance capacity during heavy rainstorms. Aging and undersized systems that are not retrofitted to withstand greater capacity can exacerbate flooding and lead to greater risks to property and human health. More frequent and intense flood events will also lead to more frequent and greater backflows in stormwater outfalls as river levels rise during flood events.

Adaptive Capacity

Urban development adds impervious surface, which increases stormwater runoff. By updating its stormwater management plan the City can ensure that its stormwater systems can adequately handle the impacts of anticipated urban growth. Each year, the City updates its Stormwater Management Program Plan (SWMPP) to comply with the Clean Water Act's Phase II Permit requirements for stormwater discharge into Washington's waterbodies. This update reflected changes in the City's infrastructure needs, community priorities, and industry best practices and will improve the City's adaptive capacity to more intense rainfall events. The City is also currently updating its 2012 Comprehensive Storm Drainage Plan.

Puyallup's stormwater management municipal code establishes water quality standards to control the quantity and quality of stormwater coming from development, redevelopment, and construction site activities. In 2020, the City also updated its FEMA floodplain map and flood insurance rate maps to inform current and future development and improve stormwater management. However, these maps are based on historical data and do not consider climate change projections.

Water Supply and Quality

Climate Risk (Exposure + Sensitivity) *Moderate-low*	**Overall Vulnerability**
Intensifying drought and higher temperatures are expected to reduce overall regional water availability in summer. **Heavier winter rainfall and flooding** can cause septic systems to overflow, threatening water quality. The City of Puyallup sources its drinking water from two natural springs (Maplewood Spring and Salmon Spring), four deep wells, and an intertie with the City of Tacoma. Due to the City's spring and deep well water sources and high standards for water quality monitoring and purification, the climate risk is relatively low for Puyallup's municipal water supply. However, water in private wells and spring, which make up 8.7% of total domestic water use, may be at a higher risk of water availability decline during droughts in the summer and at higher risk of contamination during extreme rainfall events in the winter.	**Low Vulnerability**
Adaptive Capacity *High*	
The City of Puyallup has two main types of underground water sources, creating redundancy in some areas of the city. The City implements water conservation programs to reduce consumption, monitors and invests in water storage and treatment infrastructure, and thoroughly tests the City's water supply. Its Water System Plan delineates strategies to address current and project water demands. For example, the City has applied for additional water rights to increase its capacity to meet maximum daily water demand in 2038.	

Climate Risk

The City of Puyallup sources its water from wells and springs, which ultimately come from underground aquifers. Four City-owned wells (ranging from 290 to 880 feet deep) provide 24% of the City's drinking water, while Maple and Salmon Springs provide the remaining 76% of the water [24]. A small proportion (0.5%) of the City's water can come from the Tacoma Intertie, which is reserved for emergency use [25].

Intensifying drought conditions and warmer temperatures are expected to reduce water availability in summer, and heavier rainfall can degrade water quality by carrying more contaminants in runoff to water sources and by overwhelming septic systems during flood events [6]. Private wells, which contribute 8.7% of total water for domestic use [26], may become more susceptible to bacterial and chemical contamination, especially because they tend to be shallower than commercial and municipal wells. However, rain events can continue to recharge aquifers.

Adaptive Capacity

Water demand in Puyallup is expected to increase from 4.1 million gallons per day in 2020 to 5.8 million gallons per day by 2040. Puyallup has developed a Water System Plan to address potential deficits and evaluate water supply alternatives to meet these anticipated future water shortages. The City of Puyallup is projected to have a water surplus to meet projected average daily demand and maximum daily demand through 2035. However, the City is projected to face a deficit in water supply when trying to meet its maximum daily demand in 2038 [27]. If the

Tacoma Intertie, which can deliver up to 2 million gallons a day, is used to supplement the City's water sources, the City will not need additional source capacity through 2038. As the City would like to reserve the Tacoma Intertie for emergencies, it has applied for additional water rights or a water rights transfer for a new well, which would have a capacity of 1,000 gallons per minute [24].

Improvements to the City's water distribution system and operation and maintenance program such as tank recoating, seismic retrofitting of water tanks, and water main replacement are planned for the next 20 years. Puyallup employs a thorough water quality testing and monitoring program to ensure drinking water complies with the Washington State Department of Health water quality standards. The City's Water System Plan did not identify any water treatment deficiencies [24].

Transportation

This section assesses the exposure, sensitivity, and adaptive capacity of Puyallup's transportation infrastructure.

Transportation Infrastructure

Climate Risk (Exposure + Sensitivity) *High*	**Overall Vulnerability**
More frequent and intense floods and landslides associated with heavy rains will lead to road damage and closures that could temporarily impair Puyallup's transportation system. Roads in steep areas are more prone to landslides. **Extreme heat** will also accelerate the degradation of transportation infrastructure, resulting in higher maintenance costs and greater threats to public health and safety. During **extreme weather** events, residents in more isolated neighborhoods will have less access to transportation networks and social and emergency services.	
Adaptive Capacity *Moderate*	**Moderate-High Vulnerability**
Puyallup has identified areas at high risk of landslides, but there is limited funding available to implement a landslide warning or notification systems [8]. The Comprehensive Plan's Transportation Element provides a plan to increase network redundancy, provide safer and more efficient transportation, and encourage diversification of transportation modes (public and active transport). The City's Active Transportation Plan (Puyallup Moves) and Americans with Disabilities Act (ADA) Plan aim to make variety of transportation modes more accessible to residents of all abilities.	

Climate Risk

Flooding in Pierce County is expected to increase in frequency and intensity during the winter and spring. Puyallup's hilly terrain also increases its risk of landslides during heavy rain events (Figure 4). For example, areas that surrounds the hill that separates South Hill from Downtown Puyallup is especially vulnerable to landslides. Combined with windstorms, which has impacted the City numerous times in the past, these impacts can damage and block roadways and impair transit infrastructure, and can limit residents' access to essential and emergency services [8] (See **Emergency and Social Services** sector). For example, landslides and mudslides associated with extreme rains have regularly disrupted or closed highways across Puyallup and Pierce County, particularly in winter months.

Figure 10. Mudslides in Puyallup (East Pioneer) in winter 2017 after heavy rains.

The area where SR-167 runs along the Puyallup River, largely situated within Puyallup's Urban Growth Area, is considered an area of concern. In 2010 this portion of the river was at high risk of extreme flooding and overtopping dikes. Future increases in extreme precipitation events can increase the risk of riverine flooding. Additionally, while Puyallup does not have any coastal areas, sea level rise and high tides can reduce outflow and drainage capacity within the Puyallup watershed, causing a "squeeze" effect that can amplify the risk of flooding in this area to transit routes such as SR-167v [28].

Heatwaves and extreme heat during the summer can accelerate degradation of infrastructure, such as corroding and buckling asphalt and damaging railroad tracks and bridges. Infrastructure degradation can increase public safety risks and higher maintenance costs. For example, pavement rutting can cause tire blowouts and present more pedestrian tripping hazards.

Figure 11. Pavement rutting in Washington State [39]

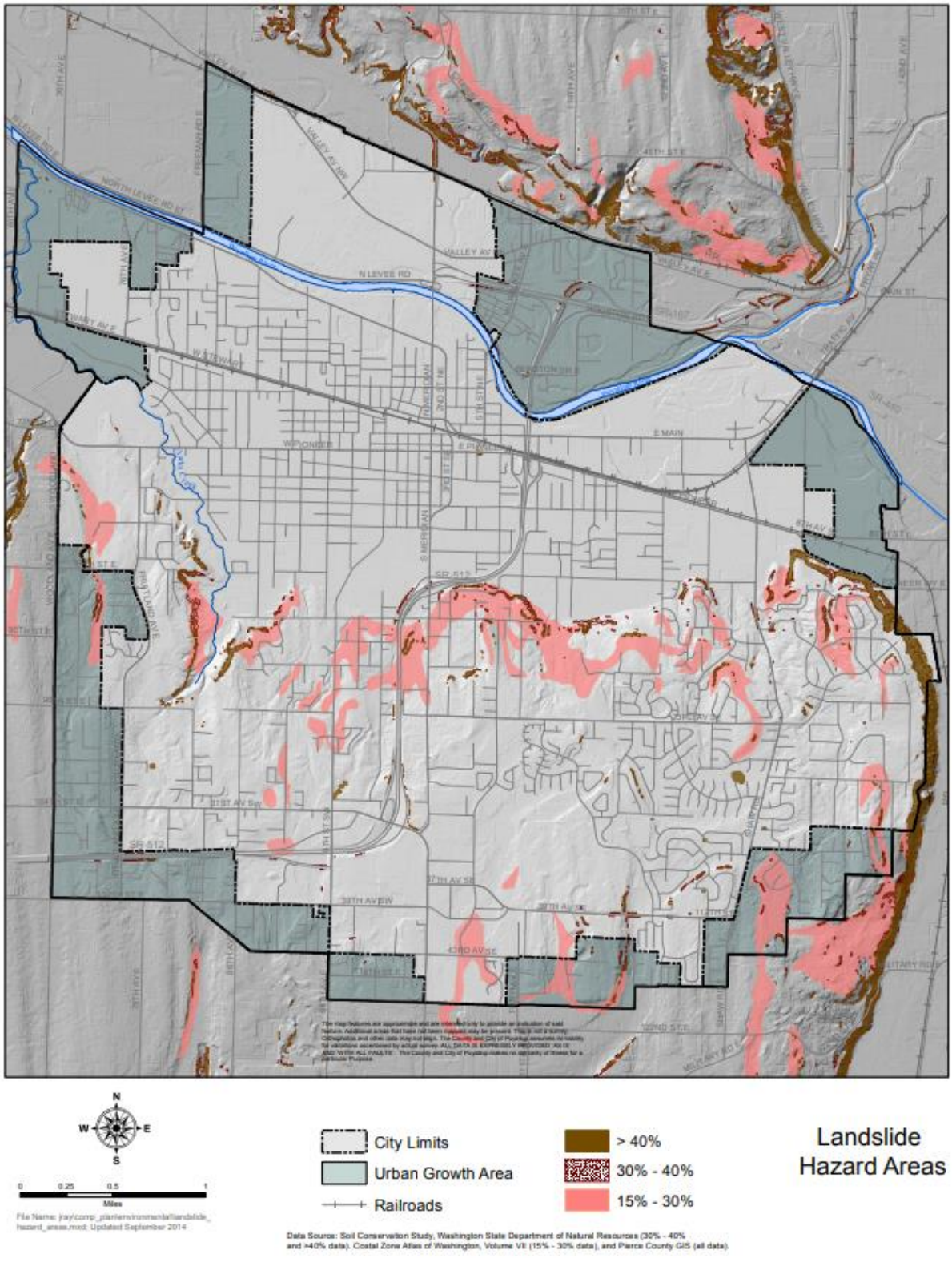


Figure 12. Map of landslide hazard areas in Puyallup [5]

Adaptive Capacity

Puyallup's Transportation Element of the Comprehensive Plan lays out a 20-year plan to repair and upgrade transportation infrastructure to reduce congestion, increase safety and accessibility to paths that connect to transit and railway systems, promote and establish an interconnected system of street grid and improve bicycle and pedestrian safety and connectivity [29].

Connectivity and mobility are a critical component of adaptive capacity to climate change, but the City's hilly topography and previous land use planning decisions that promoted neighborhood transportation networks intentionally disconnected from each other (e.g., cul-de-sacs) presents a challenge to this, particularly for those with mobility challenges, disabilities or those who do not own a personal vehicle/cannot drive (See **Emergency and Social Services** section below). The City is making efforts to connect Puyallup's transportation system to increase redundancy of transit routes and to ensure public and active transport options are equitably distributed. The City also developed an ADA Transition Plan in 2018 to ensure that the City's transportation system, capital facilities, and city services are accessible to everyone.

Puyallup Moves, the City's first active transportation plan, was developed in 2016 to kickstart the City's multimodal transportation system and create connections for walking, biking, skateboarding, in-line skating, and using a wheelchair. The plan also outlined four bicycle projects that were selected based on a combination of location, safety benefits, connectivity, and feasibility of implementation [30].

Public Health & Economic Wellbeing

This section evaluates the climate risk and the adaptive capacity of the overall physical, mental, and economic wellbeing of Puyallup's community members. This includes an assessment of social and emergency services, as well as the strength of the local and regional economy.

Emergency and Social Services

Climate Risk (Exposure + Sensitivity) *High*	**Overall Vulnerability**
Flooding, landslides, wildfire smoke, and heatwaves will strain or reduce access to social services, including physical and mental health care, emergency and relief services, and public facilities, disproportionately impacting some frontline communities—or groups that experience climate change impacts "first and worst"—such as older adults, young children, disabled persons, those with pre-existing health conditions, and individuals experiencing homelessness. During **extreme weather events,** social and emergency response services may not be accessible or experience disruptions in services.	**High Vulnerability**
Adaptive Capacity *Moderate-low*	
Puyallup will use funding it received from the State of Washington for capital improvements that will improve livability, transportation, sewer and water systems, and access to public services in the South Hill and Downtown neighborhoods. The City also has multiple programs to assist residents with food, housing, and transportation.	

Climate Risk

Under climate change, Puyallup will face more intense flooding and heatwaves and more frequent landslides and days with poor air quality due to wildfire smoke. These impacts will negatively impact roads, bridges, and transportation systems (See

Transportation Sector), which will in turn put the health and safety of the Puyallup community as risk, as access to critical social and emergency services during extreme events will be compromised.

Some community members, such as the elderly, young children, people with disabilities, those with pre-existing health conditions, and those experiencing homelessness will face disproportionate impacts to climate change and barriers accessing social services before, during, and after climate-related extreme events. Within Puyallup, 15% of City's population is over 65 years old, 12% is under 10 years old, and 10% of people under 65 years old have a disability [31]. There are an estimated 4,300 people experiencing homelessness in Pierce County, and these people experience higher exposure from extreme heat and cold and rain [32].

Climate change impacts will exacerbate underlying vulnerabilities and health disparities of frontline community groups. The following considerations include some ways that these groups can experience climate impacts disproportionately:

- Communities of color can have a subset of members who do not speak English well and therefore face additional challenges to access emergency services even if the services are physically nearby. They can also face structural discrimination when trying to access these services or be unaware of existing resources.
- Individuals over 65 years old and those with pre-existing health conditions are more likely to have physical and mental limitations that inhibit their ability to travel to social and emergency services and effectively communicate their needs to others.
- Individuals who live alone, particularly older adults, are less likely to have help evacuating during emergencies and can struggle to recover after extreme events given their limited social network.
- Those experiencing homelessness who cannot access shelters before, during, and after climate and weather-related events are exposed to the elements and have limited ability to obtain medicine, protective shoes, and warm, dry clothing. As a result, they are more likely to suffer injury, disability, or loss of life during extreme climate events.
- Low-income residents who do not have the financial resources to rebuild or retrofit their homes after damage due to natural disasters such as floods and landslides (See **Buildings & Housing**Buildings & Housing sector).

Adaptive Capacity

The City of Puyallup has numerous social and community services to address the needs of the most vulnerable groups. The programs and services include, but are not limited to, the following:

- **Food, Meals, and Basic Needs** (Puyallup Food Bank, St. Francis House, Puyallup Salvation Food Pantry)
- **Physical and Behavioral Health** (Sea Mar Community Health Services, Behavior Bridges)
- **Affordable Housing** (Helping Hand House, Tacoma-Pierce County Habitat for Humanity, City of Puyallup Hotel Pilot Project)

- **Services for Seniors** (Puyallup Activity Center, Senior Services, "Age-Friendly City" designation by AARP/World Health Organization, Puyallup Age Friendly City Action Plan Transportation Task Force)
- **Veteran Services** (Veterans Assistance Program)

In 2016, Puyallup became the first city in Washington to receive designation as an "Age-Friendly City" by AARP and the World Health Organization. The City aims to provide better opportunities for people of all ages by promoting safe and walkable streets, easy access to health care and other services, a variety of housing and transportation options, and ways for residents to get involved in the community.

The City has several systems in place to help alert residents of extreme weather events and allow them time respond, including Puyallup Alerts, Pierce County ALERT, and PulsePoint. Residents and workers can opt into these services and apps to receive emergency notifications which provide subscribers with important safety information during an emergency, such as an extreme weather event. Puyallup's volunteer Community Emergency Response Team (CERT), the Puyallup Police Department, and Central Pierce Fire and Rescue help individuals prepare and respond to disasters by providing quick basic life support and technical rescue to residents.

The City assesses the potential impacts and risks associated with flooding, landslides, drought, and severe weather in its Hazard Mitigation Plan 2020-2025 and includes robust strategies to address these issues; however, an analysis of how these impacts may be exacerbated by projected climate impacts for the region is not included. Through the ESAP, the City should consider developing strategies aimed at addressing climate and weather-related impacts to its most vulnerable communities, including development of accessible community resilience hubs that provide temporary and emergency shelter with cooling and heating during extreme weather events and power outages, financial rebates for heat-pumps and home weatherization, and accessible, culturally appropriate education and outreach materials. The City may not have the capacity to provide certain emergency services to its most vulnerable communities. For example, there are 1,300 emergency shelter beds and 30 safe parking units available across the County, but there are almost 3,000 people without shelter every night who must seek shelter in their car, an encampment, or elsewhere [32].

Local and Regional Economy

<table>
<tr><td>Climate Risk (Exposure + Sensitivity)
Moderate-high</td><td rowspan="4">Overall Vulnerability

Moderate-high Vulnerability</td></tr>
<tr><td>Puyallup has 5,022 structures in the 100-year floodplain including local businesses, public facilities, and residential areas along the Puyallup and White Rivers and Clarks Creek. A major flood event in these areas can negatively impact the local economy by significantly hindering business operations, incapacitating transportation to and from these areas and causing major property damage and decreasing housing value.</td></tr>
<tr><td>Adaptive Capacity
Moderate-low</td></tr>
<tr><td>Over the last several decades, Puyallup has used resources such as the "LIFT" (Local Infrastructure Financing Tool) grant to improve commerce-related infrastructure and its economic and industrial resilience. A significant challenge for Puyallup's economy is its high proportion of jobs in the service industry. These</td></tr>
</table>

jobs often do not pay a living wage, causing workers in the service industry to have to rely on multiple jobs to support their families. Historically the retail commercial hub for East Pierce County, Puyallup is facing competition in retail sales from larger retailers in unincorporated Puyallup.

Climate Risks

The City's business sectors include industrial uses (e.g., distribution centers and manufacturing facilities), general commercial and retail, healthcare, and academic institutions (e.g., Washington State University Puyallup Research and Extension Center, Pierce College, and Puyallup School District) [33].

Historically, flooding has been the most common natural hazard that has caused the most damage in Puyallup. Flooding, as well as extreme heat and wildfire smoke could affect energy costs for businesses and lead to lost employee productivity and revenue [34]. There are 5,022 structures in the 100-year floodplain of the Puyallup and White Rivers [8]. Climate-related natural disasters could create short- or long-term operational disruptions for businesses and facilities located in the floodplain.

There is approximately a 33% chance of flooding occurring each year in Puyallup. A study conducted by Pierce County in 2013 estimated that a major flood in the County could result in losses over $725 million [35].

Extreme flooding events also threaten the livelihoods and homes of the City's residents and workers. Nearly 12,000 jobs are located within the 100-year floodplain and roughly 22,100 people in 9,340 homes (as of 2009) live within the Puyallup River floodplain. Lost wages due to flooding property damage or inability to access work sites could impact Puyallup's workforce and exacerbate financial constraints for those already cost-burdened. Total personal property losses could be as high as $521 million [35]. For the City, flooding impacts on homes could mean less property tax revenue if homes are damaged and residents are forced to relocate out of City or do not have the financial means to rebuild.

Adaptive Capacity

Because of Puyallup's location and history within the broader Puget Sound region, it has historically attracted many residents, industries, and businesses. Puyallup has a well-trained and educated local work force and is home to the Washington State Fair, which draws many visitors to the City. This area is also part of the greater "gateway" to Mt. Rainier National Park, a popular tourist destination for outdoor recreation [36].

Climate change is expected to affect tourism and recreation opportunities in multiple ways—from shifting outdoor seasons to start earlier to increasing risks from climate-related hazards for visitors such as landslides and flooding—and will have cascading impacts on communities that provide services to visitors. For Puyallup, the service industry (e.g., retail, food services) makes up the single-largest portion of jobs. Changes to demand for service industries—which are already typically lower-paying jobs—can affect the financial resilience of residents and community-wide economic resilience [36]. Puyallup is also seeing greater competition in retail sales from larger retailers in unincorporated South Hill and other nearby areas [36]. This can depress City sales and property taxes and fees, thereby negatively affecting the City's ability to respond to and recover from climate stressors on the economy.

Over the last decade, Puyallup has invested in capital improvements to mitigate flood hazards and loss in partnership with Pierce County and neighboring jurisdictions (See **Buildings & Energy** sector above for examples of specific flood mitigation efforts in Puyallup). The City is also using resources such as the “LIFT” (Local Infrastructure Financing Tool) grant to build industrial and economic resilience [36].

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APPENDICES

Appendix A: Vulnerability Ranking Framework

Tables 1 and 2 below provide details for low, moderate, and high ranking for both climate (exposure and sensitivity) and adaptive capacity. Table 3 shows how overall vulnerability rankings were determined based on climate risk and adaptive capacity rankings.

Table 1. Climate Risk (Exposure + Sensitivity)

Low	Moderate	High
Low probability of climate change impacts occurring. • Climate projections 100 years from now have a low probability of occurring. If the projections don't indicate significant change by 2040, then it could be considered "low". • Wildfires burn <1,000 acres in the western Cascades, and projections by 2040 will have this only increase slightly. Thus, there is a low probability of having a large wildfire in the western Cascades. Low probability of climate change impacts affecting the sector: • Some sectors may be exposed to a climate impact, but they might not be especially sensitive to that impact. Considerations and examples include: • Tree canopy coverage is high and has a diverse forest composition.	Chance of climate impact occurring is Moderate. • The climate impact in 2040 has a significant difference in average, peak, or low compared to historic conditions. • Currently we experience about 5 extreme precipitation days, and in the future, this can range from 5 to 15 extreme precipitation days. Thus, this might be considered a Moderate probability. Moderate probability of climate change impacts affecting the sectors: • Sectors are exposed and are sensitive to the climate impact but can still maintain some function during the climate exposure due to system redundancy. • Many roads will flood, but there are alternative routes that won't flood.	Chance of climate impact occurring is high. • The climate impact in 2040 has a significant difference in average, peak, or low compared to historic and we have already experienced record-breaking conditions that look closer to future climate projections. • We have already experienced historic extreme heat events and successively warmer years, which is projected to continue. Thus, there is a high probability of this impact to occur. High probability of climate change impacts affecting the sectors: • Sectors are exposed and are sensitive to the climate impact and have significantly reduced system function during climate event.

• Mortality from heat/drought/infestation could occur but species diversity could minimize impact. • Flooding will only be an issue on one road, but all other roads will be fine, so overall sensitivity is low.		• During an extreme heatwave there will be many more heat related illnesses and deaths.

Table 2. Adaptive Capacity

Low	Moderate	High
The sector is plan and resource poor or there is little redundancy. They may have a plan and some staff, but limited resources within the sector.	Plans and resources are in place that address climate issues but may not account for the future climate trajectories. There is staff capacity and resources available to address the climate impacts coming to the sector.	Robust plans in place with staffing and resources for implementation. Actions are being taken to address the issue and those actions are already having an impact.

Table 3. Overall Vulnerability Scoring Matrix

		Climate Risk				
		Low	**Moderate-low**	**Moderate**	**Moderate-high**	**High**
Adaptive Capacity	**Low**	Moderate-High	Moderate-High	Moderate-High	High	Very High
	Moderate-low	Moderate	Moderate	Moderate	Moderate-High	High
	Moderate	Low-Moderate	Moderate	Moderate	Moderate	Moderate-High
	Moderate-high	Low	Low-Moderate	Moderate	Moderate	Moderate-High
	High	Very Low	Low	Low-Moderate	Moderate	Moderate-High