

Chapter 4.6

Severe Weather Risk Assessment

Introduction

Thurston County has received nine federal disaster declarations related to severe storms since 1965. Hazardous temperatures and storm activity impacts people, property, and the economy every year. When not accounting for extreme heat deaths, Washington State has suffered over 103 fatalities and over \$2.2 billion in weather related losses over the last decade (Table 4.6.1).¹

A record-breaking heat wave killed 156 people in Washington in June 2021. Climate change will exacerbate weather hazards, and greater losses may be experienced in the decades to come. The Pacific Northwest is expected to experience warmer wetter winters and longer warmer and dryer summers that will pose challenges to communities to adapt to and mitigate the effects of climate hazards.

This chapter profiles the three major types of weather hazards that affect Thurston County:

- Hazardous temperatures
- Hazardous precipitation
- Hazardous wind

Each hazard is described including their impacts, previous incidents, probability of occurrence, and the effects of climate change on the hazards for Thurston County communities.

Table 4.6.1 2012-2022 Summary of Hazardous Weather Fatalities, Injuries, and Damage Costs in Washington State

Year	Fatalities	Injuries	Property Damage (millions \$)	Crop Damage (millions \$)	Total Damage (millions \$)
2012	6	5	\$27.3	\$1.1	\$28.5
2013	4	16	\$12.8	\$0.5	\$13.3
2014	50	34	\$328.2	\$1.1	\$329.3
2015	8	7	\$28.9	\$0.0	\$29.0
2016	5	6	\$8.4	\$0.0	\$8.4
2017	1	7	\$82.5	\$0.0	\$82.5
2018	2	0	\$141.8	\$0.0	\$141.8
2019	1	17	\$5.0	\$0.0	\$5.0
2020	6	12	\$1,340.3	\$0.5	\$1,340.8
2021*	17	7	\$85.0	\$0.1	\$85.1
2022	3	2	\$210.1	\$0.2	\$210.3
Totals	103	113	\$2,270.3	\$3.5	\$2,273.8

*Note: Totals for 2021 do not include heat related deaths and injuries.

Hazardous Temperatures

Daytime and nighttime surface air temperatures are generally mild throughout the year in the Pacific Northwest. Periods of above normal highs in the summer and below normal lows in the winter can be hazardous in Thurston County, especially for socially vulnerable populations.

Definition - Extreme Heat or Heat Wave

A heat wave is a prolonged period with higher-than-average summer daytime air surface temperatures without significant nighttime cooling. The Center for Disease Control and Prevention (CDC) describes extreme heat conditions when the temperature reaches extremely high levels or when a combination of heat and humidity makes the air become oppressive. Washington Department of Labor and Industries requires employers to implement measures to prevent heat-related illnesses for outdoor workers when the temperature reaches 80° F. Several public health institutions, including the Washington Department of Health cite extreme heat as the deadliest weather-related hazard in the United States. Prolonged periods of summer heat without appreciable precipitation increases the likelihood and severity of wildfires.

Area of Impact for Extreme Heat

In general, all Thurston County communities are affected by extreme heat events. Most homes in Western Washington lack air conditioning and the region's population is not accustomed to hot summer temperatures. Temperatures can vary geographically. The region's urban areas are susceptible to the heat island effect from buildings, parking lots, and roadways. This effect raises ambient daytime temperatures and reduces nighttime cooling. Conditions for lower daytime temperatures and greater nighttime cooling occurs in areas with sparse development, denser tree canopy, and naturally vegetated ground cover. More research is necessary to map areas that are most prone to heat island effects.

Extent for Extreme Heat

For western states, the National Weather Service uses the HeatRisk prototype forecast to issue excess heat watches, warnings, and advisories. This system provides risk guidance to decision makers and heat sensitive populations. HeatRisk identifies unusual heat conditions specific to a location's climate and date over a seven-day period. HeatRisk temperature thresholds vary by time of year; lower in the winter and fall and higher in the spring and summer. The temperature thresholds are related to regional emergency department heat-related injury data from the CDC that accounts for populations who are vulnerable to heat illness and deaths.

The HeatRisk system assigns a daily (24 hour) value that is displayed in a numeric and color-coded green, yellow, orange, red, magenta four-level scale. The scale communicates the level of heat risk for groups who are at risk (Figure 4.6.1). HeatRisk warnings are issued when forecast maximum and minimum temperatures exceed the established thresholds over a 48-hour period. HeatRisk levels 3 and 4 present the greatest risk for the majority of the population of Thurston County. For these events, the maximum daytime temperature exceeds 90° F and minimum nighttime temperatures generally do not fall below the upper 80° F.

Previous Incidents for Extreme Heat

There have been no federal disaster declarations for Thurston County for extreme heat events. Between 2005 and 2022, Thurston County experienced five level 3 (red) days: two in 2006, two in 2009, and one in 2021. On June 26 and 27, 2021, Thurston County experienced its first ever HeatRisk level 4 (magenta). Thurston County Public Health and Social Services reported 131 people visited or were admitted to local hospital emergency rooms in 2021 for heat related illnesses including effects of heat and light, heat stroke, heat exhaustion, heat cramps, exposure to excess natural heat, and accidents. 108 people visited or were admitted to Emergency Rooms heat related health impacts in 2022.

Figure 4.6.1 National Weather Service HeatRisk Forecast Prototype Levels and Risks (modified)ⁱⁱ

Level	Who is at Risk?*	How Common in Thurston County	Count of Daily HeatRisk Levels for Thurston County 2005-2022
0	<ul style="list-style-type: none"> Level of heat poses little to no risk 	Most Common	4,024
1	<ul style="list-style-type: none"> Heat of this type is tolerated by most; however, there is a low risk for sensitive to experience health effects 	Very Common	2,353
2	<ul style="list-style-type: none"> Moderate risk for members of heat sensitive groups to experience health effects Some risk for the general population who are exposed to the sun and are active For those without air conditioning, living spaces can become uncomfortable during the day, but should cool below dangerous levels at night 	Common	186
3	<ul style="list-style-type: none"> High risk for much of the population who are 1) exposed to the sun and active, or 2) are in a heat sensitive group Dangerous to anyone without proper hydration or adequate cooling Poor air quality is possible Power interruptions may occur as electrical demand increases for cooling 	Uncommon	5
4	<ul style="list-style-type: none"> Very high risk for entire population Very dangerous to anyone without proper hydration or adequate cooling. This is a multi-day extreme heat event. Prolonged heat is dangerous to anyone not prepared. Poor air quality is likely Power outages are increasingly likely as electrical demands for cooling may reach critical levels 	Rare	2

*Risk descriptions courtesy of Public Health Seattle and King County.

June 25-29, 2021, Heat Dome

An anomalous pattern of atmospheric conditions led to multiple days with daytime temperatures exceeding 100° F in Western Washington. The National Weather Service issued a Level 3 HeatRisk warning for June 26 and a Level 4 HeatRisk for June 27-28. On June 28, the Olympia Regional Airport recorded an all-time high record of 110° F.

The Washington State Department of Health reported the record-breaking heat from this event led to 157 heat-related fatalities statewide; six deaths were reported for Thurston County. This event produced the largest number of weather-related fatalities recorded in recent history. 74 people visited or were admitted to Olympia hospital emergency departments for heat-related illnesses during this period.¹ Thurston County Emergency Management did not activate the Emergency Coordination Center for this event, but it distributed public information about cooling shelters throughout the county. The Thurston County Hazardous Weather Task Force was activated to provide emergency cooling shelters for people experiencing homelessness. Shelter providers served 272 individuals during this period. There were no appreciable impacts to property or infrastructure documented for this event.

Probability of Occurrence for Extreme Heat Events

Thurston County communities have experienced five HeatRisk Level 3 and two Level 4 days in the last 17 years. From June through August 2022, the Olympia Regional Airport recorded 14 days with daytime high temperatures exceeding 89° F. There is a high likelihood the region will experience multiple extreme heat events with a HeatRisk Level 3 or higher in the next 25 years. As such there is a high probability of occurrence for an extreme heat event.

Researchers estimate the June 2021 Heat Dome event has a 0.1 percent chance of an annual occurrence. Although this was a rare event, some climatologists believe it would have been virtually impossible without climate change.ⁱⁱⁱ

Effects of Climate Change on Extreme Heat

Research and climate forecasts offer evidence that long-term climate change will have a measurable impact on the frequency of extreme heat events. The University of Washington Climate Impacts Group “State of Knowledge: Climate Change in the Puget Sound” reports that air temperatures are projected to warm

¹ 2023. Data courtesy of Thurston County Public Health and Social Services.

rapidly during the 21st century. By mid-century, warming will be outside of the range of historical variations. Warming is projected for all seasons but will be greatest for summer. The impacts of these changes are documented in Thurston Regional Planning Council’s 2018 Climate Adaptation Plan Vulnerability Assessment. Warmer drier summers will have adverse impacts on Thurston County communities.

Table 4.6.2 shows the average summer maximum temperature changes from a 1980-2009 historical baseline compared to two modeled scenarios.^{iv}

Table 4.6.2 Thurston County Change in Average Summer (June - Aug) Maximum Temperature²

	Model Median	Model* Range (10th To 90th Percentile)
1980-2009		
Historical Baseline	75 °F	75 to 76 °F
2020-2049		
Higher Scenario (RCP 8.5)	3.4 °F	2.2 to 4.4 °F
Lower Scenario (RCP 4.5)	2.7 °F	1.4 to 4.1 °F
2030-2059		
Higher Scenario (RCP 8.5)	4.4 °F	2.9 to 6.0 °F
Lower Scenario (RCP 4.5)	3.4 °F	1.6 to 4.7 °F
2040-2069		
Higher Scenario (RCP 8.5)	5.9 °F	3.7 to 7.5 °F
Lower Scenario (RCP 4.5)	4.2 °F	2.2 to 6.0 °F

Vulnerabilities and Impacts for Extreme Heat

Impacts to People

The CDC reports that more than 600 people in the United States are killed by extreme heat every year. Outdoor workers, older adults, the very young, people who are unsheltered, and people with mental illness and chronic disease are at highest risk.

² Representation concentration pathways, or RCPs are climate model scenarios for the 21st century. RCP 4.5 — a “low” scenario that assumes greenhouse gas emissions (GHG) stabilize by mid-century and fall sharply thereafter; and RCP 8.5 — a “high” scenario that assumes substantial GHG increases until the end of the 21st century.

Heat related illnesses such as heat exhaustion or heat stroke occur when people are exposed to high temperatures, become dehydrated, and their body is no longer able to properly cool itself. Increased rates of accidental drownings are often attributed to high temperatures for inexperienced swimmers attempting to seek relief from heat. The effects of heat can also compound air quality problems from wildfire smoke and pose health issues for people with chronic respiratory disease.

Impacts to Structures and Systems

Surges in heat related illnesses can overwhelm first responders, emergency medical services, and hospital emergency room capacities. Prolonged periods of extreme weather events can stress the ability of social service providers and shelter operators to provide adequate resources to people seeking refuge from heat. Extreme heat complicates fire service operations as firefighters need to adapt protective equipment and tactics to reduce their risk for heat injuries.

Extreme heat events create drought-like conditions and can place above average demands on municipal water systems from households using excess water for landscape irrigation or recreational uses. Wildfires can disrupt electricity transmission resulting in disruptions to communications networks, healthcare, and businesses.

Impacts to Natural, Cultural, and Historic Resources

Extreme heat and drought conditions can stress native plants in both forest and prairie ecosystems resulting in loss of wildlife habitat. Heat can exacerbate algal blooms and deteriorate lake and marine water quality impacting the health of humans, fish, and wildlife. Warming can increase drought-like conditions and increase risks for wildfires which can threaten historic or community valued properties.

Impacts to Activities

Hazardous temperatures can result in suspension of outdoor sporting events, concerts, and recreational activities. Outdoor construction activity can be slowed or suspended and can increase costs.

Definition – Extreme Cold or Cold Wave

An extreme cold event is a prolonged period with sustained lower than average daytime and nighttime winter air surface temperatures that fall below 32° F. Cold air conditions result when an Arctic front pushes cold air by northeasterly winds through the Fraser River Valley gap in British Columbia into Northwest Washington and further south to Oregon. Cold weather conditions can be hazardous for individuals depending on their length of exposure. Increases in wind speed cause more rapid loss of body heat.

Area of Impact for Extreme Cold

While extreme cold weather events are uncommon for Thurston County, all areas within the county are subject to subfreezing temperatures.

Extent for Extreme Cold

The National Weather Service issues hazardous winter weather advisories, watches, and warnings when the maximum daily temperature fall below freezing for two or more days. In general, such threat levels are issued for cold events when maximum daily temperatures fall below 25° to 20° F.^v

Previous Incidents for Extreme Cold

Thurston County has not received federal disaster declarations related specifically to hazardous freezing temperatures. However freezing temperatures accompany severe winter storms. An examination of Olympia Regional Airport weather records from 1972 to 2022 shows there have been at least 28 incidents where maximum daily temperatures did not exceed 32° F for at least two consecutive days. For these incidents, minimum daily temperatures ranged from 30° to -8° F. Since the adoption of the last Hazard Mitigation Plan in 2017, the Thurston County Hazardous Weather Task

Force activated emergency warming shelters for hazardous cold weather in 2019, 2020, and 2021 and served a combined total of 1,670 individuals experiencing homelessness. Between 2019 and 2023, Hospitals and emergency departments received 252 and 526 visits, respectively, for cold-related illnesses including hypothermia, frostbite, and other cold-related conditions.³ During the same period, there was a combined estimate of 58 visits to hospitals and emergency departments for unintentional carbon monoxide exposure among Thurston County residents.

Probability of Occurrence for Extreme Cold

Thurston County has experienced hazardous cold weather events in 27 of the last 50 years. There is a high likelihood the region will experience multiple cold weather hazard incidents in the next 25 years.

Effects of Climate Change on Extreme Cold

Long-term climate projections for the Puget Sound Region indicate that winters will become warmer through the 21st Century. However, Thurston County is expected to continue experiencing cold weather events with daily maximum temperatures below freezing level.

³ Washington Department of Health. Rapid Health Information Network (RHINO), 2019-2023. Data courtesy of Thurston County Public Health and Social Services.

Vulnerabilities and Impacts for Extreme Cold

Impacts to People

Exposure to cold winter temperatures may lead to serious health problems. Older adults, the very young, people who are without shelter or who are stranded, or who live in a home that is poorly insulated or without heat are at greatest risk. People can suffer medical emergencies from hypothermia and frost bite. People using unsafe heating sources in non-ventilated spaces can suffer burns or asphyxiation from carbon monoxide poisoning. People can suffer falls and fractures from hazardous icy surfaces.

Impacts to Structures and Systems

After rain or snowfall, subfreezing temperatures can produce hazardous icy conditions for most modes of travel resulting in collisions, injuries, death, loss of property, and delay. A prolonged freeze can rupture exposed water pipes causing damage to homes and buildings that are not adequately insulated. The use of unsafe heating devices in interior spaces can create risks for structure fires.

Impacts to Activities

Hazardous cold temperatures can result in suspension of outdoor events and activities. Icy road conditions cause school and business closures or delays. Outdoor construction activity is slowed or suspended and can increase costs.

Storm Activity

Western Washington storms typically occur October through February but can extend through late spring. Winter storm systems often arrive in succession consisting of multi-day periods with higher-than-normal precipitation, sustained high speed-directional winds with higher speed wind gusts, and sub-freezing temperatures. Thunderstorm activity is less common but can occur throughout the year. Winter storms also cause destructive flooding and landslides. This section describes the storm weather elements including precipitation and winds that impact Thurston County communities.

Definitions for Hazardous Precipitation

Hail

Hail consists of ice particles that form small ball shaped clusters that range from 3 to 10 mm in diameter. Hail forms in cumulonimbus or thunderstorm clouds that have strong updrafts. The region typically experiences hail in the early spring. While not a source of major impacts to communities that warrants mitigation, hail is short lived and can produce hazardous conditions for transportation or potential injury to people who are exposed.

Heavy Rain

Heavy rain is defined as 3 to 4 inches of rain that falls in a 12-hour period. Stormwater flows can overwhelm the capacity of stormwater infrastructure within a neighborhood or streams within a watershed. Heavy rain is common to the Pacific Northwest during the fall and winter seasons, especially during years with La Niña conditions generating deep low-pressure storms in the eastern Pacific. Large scale atmospheric rivers are the principal source of sustained heavy rains. For western states, atmospheric rivers are the primary source for mountain snowpack, but also the primary cause riverine

flooding. Atmospheric rivers deliver massive volumes of warm water vapor from the tropical and subtropical Pacific Ocean through a narrow band in the atmosphere. As these systems make landfall, the water vapor cools and descends as rain in the lowlands.

Heavy rains are the leading cause of riverine and high groundwater flooding and can lead to slope failure causing mudslides or landslides. On its own, heavy rain produces urban flash flooding, erosion, roof failure, foundation failure, and structural and interior damage from excess stormwater leaks and penetration.

The science behind atmospheric rivers

An atmospheric river (AR) is a flowing column of condensed water vapor in the atmosphere responsible for producing significant levels of rain and snow, especially in the Western United States. When ARs move inland and sweep over the mountains, the water vapor rises and cools to create heavy precipitation. Though many ARs are weak systems that simply provide beneficial rain or snow, some of the larger, more powerful ARs can create extreme rainfall and floods capable of disrupting travel, inducing mudslides and causing catastrophic damage to life and property. Visit www.research.noaa.gov to learn more.

A strong AR transports an amount of water vapor roughly equivalent to 7.5–15 times the average flow of water at the mouth of the Mississippi River.

ARs are a primary feature in the entire global water cycle and are tied closely to both water supply and flood risks, particularly in the Western U.S.

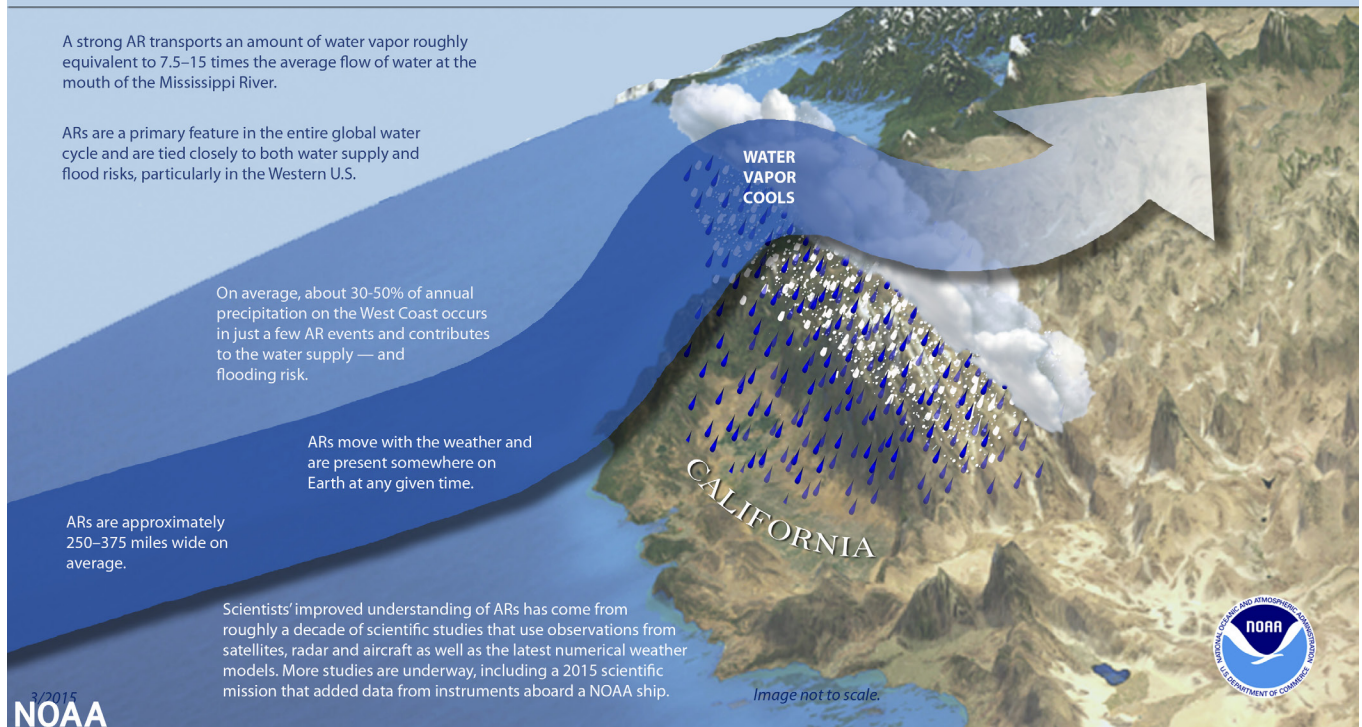
On average, about 30-50% of annual precipitation on the West Coast occurs in just a few AR events and contributes to the water supply — and flooding risk.

ARs move with the weather and are present somewhere on Earth at any given time.

ARs are approximately 250–375 miles wide on average.

Scientists' improved understanding of ARs has come from roughly a decade of scientific studies that use observations from satellites, radar and aircraft as well as the latest numerical weather models. More studies are underway, including a 2015 scientific mission that added data from instruments aboard a NOAA ship.

Image not to scale.



NOAA





Freezing Rain

Ice storms are infrequent but common to the Pacific Northwest. Freezing rain occurs when rain descends and passes through a subfreezing air mass. The precipitation remains in liquid form, but rapidly becomes supercooled and freezes on contact with cold surfaces. A glaze of ice continues to accumulate as long as conditions persist. Accumulations can range from a trace amount to over one inch thick. Severe ice storms create extremely hazardous conditions for all forms of surface transportation. Ice storms cause large tree limbs to break and down powerlines. Ice storms followed by a windstorm can cripple electric power transmission over a very large area and cause substantive damage to vehicles, roofs, and other property.

Heavy snow

Heavy snow is characterized as four inches of snowfall in 12 hours or six inches in 24 hours for lowland areas. Sustained periods with subfreezing temperatures and excess snowfall and accumulations frequently exceeds communities' ability to remove snow from roadways. Western Washington communities regularly experience significant transportation disruptions when excess snow and subfreezing conditions persist over several days.



Definitions for Hazardous Winds

High Winds/Windstorms

The National Weather Service defines high winds as “sustained wind speeds of 40 mph or greater lasting for one hour or longer, or winds of 58 mph or greater for any duration.” Figure 4.6.2 shows the impacts of wind speed based on the Beaufort Scale. Generally, winds above 30 mph can cause widespread damage and those above 50 mph can lead to more serious disasters. Most large windstorms that affect the region are generated by mid-latitude eastern Pacific cyclones. Northern Hemisphere cyclones are large-scale storms with winds that rotate counterclockwise around a central region of low atmospheric pressure. Cyclones obtain their energy from the large horizontal variation in temperature in the mid-latitudes (30° to 60° north). While not as powerful as tropical hurricanes, cyclones can produce wind speeds in excess of 100 mph and can maintain their strength farther inland and affect a much larger area.^{vi} The Puget Sound Region’s most powerful southerly and westerly winds typically come from these storm systems when their low-pressure centers move from southwest to northeast and cross the coast between the northern tip of the Olympic Peninsula and central Vancouver Island. Other landfall trajectories from northern Oregon to the central Washington coast are also capable of causing widespread destruction in Thurston County.

Figure 4.6.2 Beaufort Wind Scale

Beaufort Scale	Wind Speed mph	Description	Conditions
0	<1	Calm	Calm. Smoke rises vertically.
1	1 to 3	Light air	Wind motion visible in smoke.
2	3 to 7	Light breeze	Wind felt on exposed skin. Leaves rustle.
3	8 to 12	Gentle breeze	Leaves and smaller twigs in constant motion.
4	13-17	Moderate breeze	Dust and loose paper raised. Small branches begin to move.
5	18-24	Fresh breeze	Branches of a moderate size move. Small trees begin to sway.
6	25-30	Strong breeze	Large branches in motion. Whistling heard in overhead wires. Umbrella use becomes difficult. Empty plastic garbage cans tip over.
7	31-38	High wind, Moderate Gale, Near Gale	Whole trees in motion. Effort needed to walk against the wind. Swaying of skyscrapers may be felt, especially by people on upper floors.
8	39-46	Fresh Gale	Twigs broken from trees. Cars veer on road.
9	47-54	Strong Gale	Larger branches break off trees, and some small trees blow over. Construction/temporary signs and barricades blow over. Damage to tents and canopies.
10	55-63	Whole Gale/Storm	Trees are broken off or uprooted, saplings bent and deformed, poorly attached asphalt shingles and shingles in poor condition peel off roofs.
11	64-72	Violent storm	Widespread vegetation damage. More damage to most roofing surfaces, asphalt tiles that have curled up and/or fractured due to age may break away completely.
12	≥73	Hurricane-force	Considerable and widespread damage to vegetation, a few windows broken, structural damage to mobile homes and poorly constructed sheds and barns. Debris may be hurled about.

Tornado

The National Weather Service defines a tornado as “a violently rotating column of air, usually pendant to a cumulonimbus [cloud], with circulation reaching the ground. It nearly always starts as a funnel cloud and may be accompanied by a loud roaring noise. Tornadoes are unpredictable weather phenomena. While rare in the Pacific Northwest, tornadoes have been observed in Thurston County. Of the documented tornadoes, they have been Fujita Scale 0-1 events, and their impacts have been limited and isolated. Figure 4.6.3 shows the impacts of tornadoes by windspeed based on the Fujita Scale.

Figure 4.6.3: The Fujita Scale

F-Scale	Wind Strength	Description of Damage
F0	40-72 mph	Minimal Damage - Some damage to chimneys, TV antennas, roof shingles and windows. Breaks branches off trees, pushes over shallow-rooted trees, damages sign boards.
F1	73-112 mph	Moderate Damage - Automobiles overturned, carports destroyed, trees uprooted, peels surface off roofs, mobile homes pushed off foundations or overturned, moving autos pushed off the roads.
F2	113-157 mph	Major Damage - Roofs torn off frame homes, sheds and outbuildings are demolished, mobile homes overturned or destroyed, boxcars pushed over; large trees snapped or uprooted, light object missiles generated.
F3	158-206 mph	Severe Damage - Exterior walls and roofs blown off well-built houses, metal buildings collapsed or are severely damaged, trains overturned, forests and farmland flattened, heavy cars lifted off the ground and thrown.
F4	207-260 mph	Devastating Damage - Few walls, if any, standing in well-built houses, structures with weak foundations blown off some distance, large steel and concrete missiles thrown far distances, cars thrown.
F5	261-318 mph	Incredible Damage - Homes leveled with all debris removed, strong frame houses lifted off foundations and carried considerable distances to disintegrate. Schools, motels, and other larger structures have considerable damage with exterior walls and roofs gone, steel reinforced concrete structures badly damaged. Automobile sized missiles fly through the air in excess of 100 meters, trees debarked.

Thunderstorm/Microburst Winds

Thunderstorms are uncommon in the Pacific Northwest, but they have been observed and documented in Thurston County. They typically include lightning and thunder. Notably, microbursts can produce high speed wind gusts that can exceed 70 mph. Microbursts are associated with a sudden emergence of dark cloud formations. These small energetic storms are short lived but can be locally destructive in developed areas. Winds from these storms can knock down limbs, snap large trees, and topple power poles causing damage to surface infrastructure, vehicles, structures, and other personal property. Wet microbursts can produce heavy rainfall that quickly overwhelms stormwater systems and cause urban flash flooding.

Location of Storm Activity

All areas of Thurston County experience storm activity. The countywide risk assessment for storms and severe weather treats the entire planning area uniformly.

Previous Incidents of Storm Activity

From 1965 to 2022, Thurston County has been included in 21 federal disaster declarations that included losses from storm incidents. Of these, 12 declarations were issued principally for flood losses. Table 4.6.3 summarizes federal disaster declarations issued principally for storm losses.

Table 4.6.3 Federal Disaster Declarations for Thurston County Resulting from Storm Losses

Disaster Number	Title	Begin Date	End Date
DR 981	Severe Storms & High Wind	1993-01-20	1993-01-21
DR 1079	Severe Storms, High Wind, and Flooding	1995-11-07	1995-12-18
DR 1159	Severe Winter Storms, Land & Mudslides, and Flooding	1996-12-26	1997-02-10
DR 1499	Severe Storms and Flooding	2003-10-15	2003-10-23
DR 1671	Severe Storms, Flooding, Landslides, And Mudslides	2006-11-02	2006-11-11
DR 1682	Severe Winter Storm, Landslides, and Mudslides	2006-12-14	2006-12-15
DR 1734	Severe Storms, Flooding, Landslides, and Mudslides	2007-12-01	2007-12-17
DR 1825	Severe Winter Storm and Record and Near Record Snow	2008-12-12	2009-01-05
DR 4056	Severe Winter Storm, Flooding, Landslides, and Mudslides	2012-01-14	2012-01-23

Probability of Occurrence of Storm Activity

Over the last 50 years, Thurston County has experienced 21 federal disaster declarations attributed in a large part to storms from higher-than-normal levels of precipitation and higher-than-normal wind speeds. There is a high likelihood that Thurston County communities will experience strong storm activity that will impact people, property, and the environment in the next 25 years.

Effects of Climate Change on Storm Activity

The University of Washington Climate Impacts Group “State of Knowledge: Climate Change in the Puget Sound” reports that overall annual precipitation levels are forecast to remain the same, but there will be greater seasonal variation. Winters will become wetter. Climate change models are not forecasting significant variation for the nature and type of windstorms that are presently common in the region. The frequency of the region’s peak 24-hour rain events is expected to more than triple by the end of the 21st century. Winter storms are also expected to become more intense, with greater rainfall occurring in shorter periods of time. For the Thurston County planning area, such changes in precipitation patterns are anticipated to impact flood and landslide conditions and endanger public safety and welfare.

A continued rise in the average annual temperature over the 21st century will result in more winter precipitation falling as rain instead

of snow in the Puget Sound region. Watersheds will become increasingly rain dominant and streamflow is projected to peak earlier in winter and decrease in spring and summer. Winter streamflow is projected to increase by 28 to 34 percent on average by the 2080s.

Table 4.6.4 shows the percent change in the maximum amount of water from the 24-hour rainstorm that occurs on average once every two years relative to the average for 1980-2009.^{IV} Table 4.6.5 shows the percent change in the amount of water contained in snowpack on April 1 relative to the average for 1980-2009.

Table 4.6.4 Thurston County Percent Change in Maximum in Water from 24-hour Rainstorms, 2020-2069¹

	Model Median	Model Range (10th to 90th percentile)
1980-2009		
Historical Baseline	n/a	n/a
2020-2049		
Higher Scenario (RCP 8.5)	7%	-3 to 15 %
2030-2059		
Higher Scenario (RCP 8.5)	7%	-1 to 21 %
2040-2069		
Higher Scenario (RCP 8.5)	14%	-4 to 25 %

¹ Representation concentration pathways, or RCPs are climate model scenarios for the 21st century. RCP 8.5 — a “high” scenario that assumes substantial GHG increases until the end of the 21st century.

Table 4.6.5 Thurston County Percent Change in Water in Snowpack, 2020-2069⁴

	Model Median	Model Range (10th to 90th percentile)
1980-2009		
Historical Baseline	0 inches	0 to 0 inches
2020-2049		
Higher Scenario (RCP 8.5)	-95%	-100 to -4 %
Lower Scenario (RCP 4.5)	-95%	-100 to -40 %
2030-2059		
Higher Scenario (RCP 8.5)	-100%	-100 to -11 %
Lower Scenario (RCP 4.5)	-99%	-100 to -53 %
2040-2069		
Higher Scenario (RCP 8.5)	-100%	-100 to -87 %
Lower Scenario (RCP 4.5)	-100%	-100 to -78 %

Vulnerabilities and Impacts for Storm Activity

Impacts to People

Hazardous winds, precipitation, and winter temperatures pose a great number of known risks. Underserved communities and socially vulnerable individuals and households are at greater risk of impacts from winter storms and extended power outages. People who are unsheltered, experiencing homelessness, or are low income and cannot afford safe adequate heating sources are vulnerable to hypothermia. They are also at a higher risk for carbon monoxide poisoning or structure fires as a result of using unsafe devices to heat improperly ventilated spaces. Falling branches, trees, and other debris caused by high-speed winds also creates risk for injuries and fatalities for people who are unsheltered. Extended power outages can result in spoilage of food, exacerbating food insecurity.

Snow and ice create hazardous conditions for surface transportation and increases the traveling public's risk for accidents, property damage, injuries, and fatalities. Fallen trees on roadways, downed power lines, and other transportation disruptions cause delays and impact people who are commuting to work, school, medical appointments, and other important trips.

Impacts to Structures and Systems

Homes, outbuildings, commercial buildings, and other structures are susceptible to a variety of damage from hazardous weather. Roofs not adequately constructed could suffer failure from excess loads of snow or excess loads of stormwater if drainage systems are not properly maintained. Crawl spaces and foundations can also suffer erosion, subsidence, or flood damage from excess stormwater. Excess stormwater can erode steep slopes or cause landslides and cause structural failure of power, water, wastewater utility lines, and transportation infrastructure.

Saturated soils and high-speed winds can topple large trees which can cause significant damage to buildings. Buildings can be further damaged if fire suppression sprinkler system water lines are severed in ceilings resulting in interior flooding.

Ice and snowstorms can topple numerous trees across power lines resulting in prolonged electrical blackouts for neighborhoods or some areas of the county. Power disruptions force the closure of government offices, businesses, and schools impacting a wide range of services and operations. Winter storms also disrupt multimodal transportation networks impacting the mobility of people, freight, goods, and services.

When power outages occur simultaneously with heavy stormwater flows, sewer lift stations are prone to failure without auxiliary power supplies. Computer servers and other equipment can be damaged if auxiliary power, cooling equipment, or shut down procedures fail during power outages.

Hazardous winter weather can stress the capacity of shelter providers and strain resources to protect people who are unsheltered or experiencing homelessness. It can also strain police and fire services from responding to numerous vehicle collisions and accidents.

Impacts to Natural, Cultural, and Historic Resources

Storms can damage valued trees and vegetation in parks and open spaces. Fallen trees or limbs can damage historic homes, monuments, or other valued community assets. Losses are more pronounced from impacts caused by flooding, landslides, and wildfires. The effects of climate change will likely present landscape level ecological changes throughout the planning area. Natural resource areas that were established to preserve and protect the region's unique ecological areas could be at risk. The areas' endemic flora and fauna will likely be stressed by warmer drier summers and will eventually be succeeded by other resilient native or invasive species.

Impacts to Activities

The region's population is accustomed to taking refuge indoors during winters' inclement weather. The shorter days and longer nights also influence behavior to spend time indoors. On the other hand, Pacific Northwesterners embrace their summers and want to maximize their time outdoors. Communities will experience challenges increasing public awareness and education about summer hazards that posed very little risk just a decade ago. Outdoor sports, events, and recreational activities will be impacted more frequently as extreme heat and poor air quality from wildfire smoke becomes more common due to the effects of climate change. People with respiratory diseases and other chronic health problems are at greater risk for summer hazards. Interventions and outreach efforts to inform people about steps they can take to reduce their exposure to inclement weather should focus on underserved communities and socially vulnerable populations.

Risk Ratings

Social Vulnerability Rating and National Risk Index

Social vulnerability is the susceptibility of social groups to the adverse impacts of natural hazards, including disproportionate death, injury, loss, or disruption of livelihood. As a consequence enhancing risk component of the National Risk Index, a Social Vulnerability Score and rating represent the relative level of a community's social vulnerability compared to all other communities at the same level.

A community's Social Vulnerability Score measures its national rank or percentile. A higher Social Vulnerability score results in a higher Risk Index score. Thurston County's overall Social Vulnerability Score is 37.24 or relatively low. Thurston County's Social Vulnerability Score and Ratings vary by Census Tract from very low to very high (Map 4.6.1).

The Federal Emergency Management Agency National Risk Index (NRI) provides risk index ratings for severe weather hazards in Thurston County. The rating represents a community's relative risk for a hazard when compared to the rest of the United States. In addition, the NRI provides an Expected Annual Loss (EAL). This represents the average economic loss in dollars resulting from natural hazards each year. It is calculated for each hazard type and quantifies loss for relevant consequence types including buildings, people, and agriculture. Figure 4.6.9 shows Thurston County NRI ratings and EAL for each severe weather hazard.

Table 4.6.6 Thurston County National Risk Index Ratings for Severe Weather Hazards

Hazard Type	Risk Index	Estimated Annual Loss
Heat Wave	66.6, Relatively Low	\$0.21 million
Cold Wave	No rating	\$0
Hail	7.5, Very Low	\$5.8 thousand
Ice Storm	74.6, Relatively Moderate	\$0.19 million
Lightning	52.7, Relatively Low	\$0.11 million
Strong Wind	4.9, Relatively Low	\$15 thousand
Tornado	27.9, Relatively Low	\$0.39 million
Winter Weather	35.3, Relatively Low	\$30 thousand

Community Hazard Risk Ratings for Severe Weather Hazards

Severe weather including hazardous temperatures and storm activity has no geographic boundaries in Thurston County. There is no means to measure loss estimates for weather hazards in the absence of a defined hazard area and readily available modeling tools. As such, no severe weather hazard exposure and loss estimation tables were developed. For planning purposes, an overall subjective risk rating is presented for the combined severe weather elements including hazardous temperatures, and storm activity (hazardous precipitation and hazardous winds) that impact Thurston County communities (Table 4.6.7) and special purpose districts (Table 4.6.8).

The risk rating for severe weather hazards is medium for all the planning partners.

- The probability of hazardous weather occurring in the planning areas over the next 25 years is high.
- Hazardous weather has a low impact on people as events typically affect less than ten percent of the population.
- Impacts on property is low as less than ten percent of the total replacement value of assets are exposed.
- The impact on the economy is medium as the estimated losses from the hazard is between five and nine percent of the total replacement value of damaged assets.

Table 4.6.7 Hazardous Weather Hazard Risk Rating for Thurston County Communities

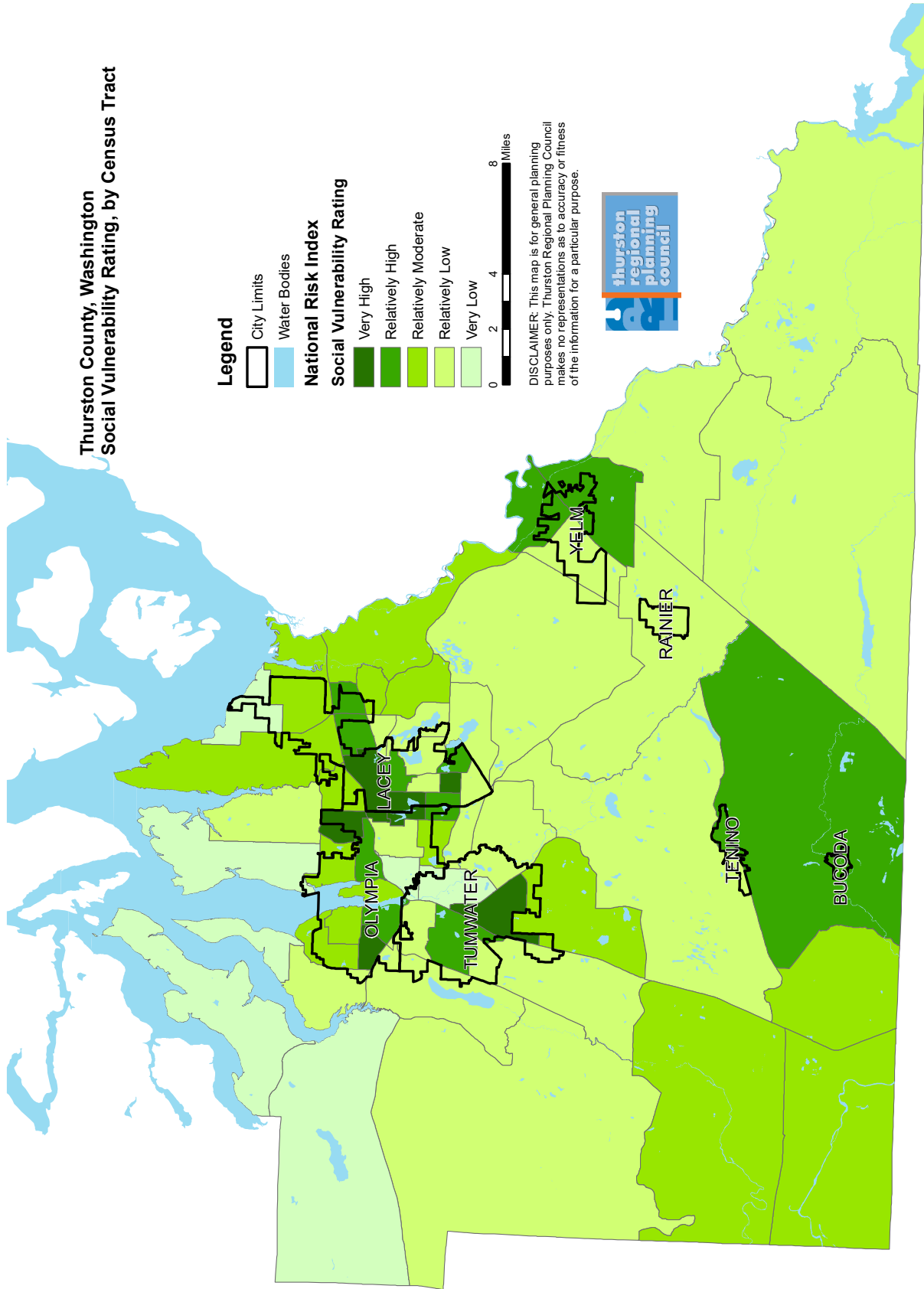
Community	Probability	Impact on People	Impact on Property	Impact on Economy	Hazard Risk Rating
Bucoda	High	Low	Low	Medium	Medium
Lacey	High	Low	Low	Medium	Medium
Olympia	High	Low	Low	Medium	Medium
Rainier	High	Low	Low	Medium	Medium
Tenino	High	Low	Low	Medium	Medium
Tumwater	High	Low	Low	Medium	Medium
Yelm	High	Low	Low	Medium	Medium
Unincorporated	High	Low	Low	Medium	Medium
Total	High	Low	Low	Medium	Medium

**Table 4.6.8 Hazardous Weather Hazard Risk Rating for Thurston County
Special Purpose Districts**

Community	Probability	Impact on People	Impact on Property	Impact on Economy	Hazard Risk Rating
East Olympia Fire District	High	Low	Low	Medium	Medium
Intercity Transit	High	Low	Low	Medium	Medium
Lacey Fire District	High	Low	Low	Medium	Medium
McLane Black Lake Fire District	High	Low	Low	Medium	Medium
Olympia School District	High	Low	Low	Medium	Medium
SE Thurston Fire Authority	High	Low	Low	Medium	Medium
The Evergreen State College	High	Low	Low	Medium	Medium
Thurston PUD	High	Low	Low	Medium	Medium



Map 4.6.1 Thurston County Social Vulnerability Index Rating by Census Tract



Source: Federal Emergency Management Agency National Risk Index. <https://hazards.fema.gov/nri/map>. 2023.

Endnotes

ⁱNOAA National Centers for Environmental Information Storm Events Database, <https://www.ncdc.noaa.gov/stormevents/>

ⁱⁱNational Weather Service HeatRisk Prototype. 2023. <https://www.wrh.noaa.gov/wrh/heatrisk/>

ⁱⁱⁱThe New York Times. July 7, 2021. Climate Change Drove Western Heat Wave's Extreme Records, Analysis Finds. <https://www.nytimes.com/2021/07/07/climate/climate-change-heat-wave.html>.

^{iv}Climate Mapping for a Resilient Washington, University of Washington, Climate Impacts Group in partnership with the University of Idaho, Research Data & Computing Services for web development. <https://cig.uw.edu/resources/analysis-tools/climate-mapping-for-a-resilient-washington/>

^vPersonal Communication, Reid Wolcott, Warning Coordination Meteorologist, NWS, Seattle. February 10, 2023.

^{vi}Cliff Mass. 2008. The Weather of the Pacific Northwest. The University of Washington Press, Seattle, WA.

*NOAA Tsunami warning siren at Ocean Shores.
Photo courtesy of NOAA.*

