CHAPTER IV
Risk Assessment

Introduction

The purpose of the Risk Assessment chapter is to provide the factual basis for the mitigation initiatives which are proposed in the next chapter. This chapter meets the following federal criteria for the Risk Assessment:

- Identifying hazards, that is, to describe the type of natural hazard most likely to affect the region.
- Profile hazard events, which are defined as describing the location and extent of the natural hazard, including information on previous occurrences.
- Assessing vulnerability, that is, to provide information on the impact of the hazard on the community in terms of identifying assets and estimating potential losses.

The chapter begins with some multi-hazard information, including federal disaster declarations, hazard analysis definitions, and hazard identification. However, the bulk of the chapter consists of hazard specific information including: Hazard Area maps which describe the location and extent of the identified hazards, a description of historical occurrences and impacts, which is followed by extensive and detailed vulnerability assessment data tables. These data tables are of three types: 1) Population at risk within hazard areas, 2) Vulnerability Assessment tables, providing an estimate of the inventory of assets and their dollar value for the year 2000 and 2025, and 3) the number and type of Critical Facilities within hazard areas. The chapter concludes with a discussion of the methodology used to calculate the inventory, forecast, and dollar value of assets in the vulnerability assessment tables.

Federal Disaster Declarations

Thurston County is susceptible to a variety of natural hazards. The number of Federal Disaster Declarations affecting the county gives some idea of the risk natural hazards pose to the area. Since 1964, only 185 counties in the country have had more than 10 Federal Disaster Declarations. Thurston County is part of this top 6 percent of counties. Since October 1962, Thurston County has been declared a federal disaster area 17 times. The following table lists Federal Disaster Declarations which have included Thurston County.

Date	Federal Declaration #	Event
Oct 1962	137	Flooding, Wind (Columbus Day Storm)
May 1965	196	Earthquake
Jan 1971	300	Flooding
Jan 1972	322	Severe Storms/Flooding
Feb 1972	328	Heavy Rains/Flooding
Jan 1974	414	Severe Storms/Flooding
Dec 1975	492	Severe Storms/Flooding
Dec 1977	545	Severe Storms/Mudslides/Flooding
May 1980	623	Volcano (Mt. St. Helens Eruption)
Jan 1990	852	Severe Storms/Flooding/Landslide/Wind
Nov 1990	883	Severe Storms/Flooding
Jan 1993	981	Windstorm (Inaugural Day Storm)
Nov 1995	1079	Flooding/Windstorm
Feb 1996	1100	Flooding
Dec 1996-Feb 1997	1159	Ice, Wind, Snow, Landslide, Flooding
Mar 1997	1172	Heavy Rains/Landslide, Flooding
Feb 2001	1361	Earthquake (Nisqually Earthquake)

Hazard Analysis Definitions

To make its analysis of hazards more useful, Thurston County's *Hazard Identification and Vulnerability Analysis* (HIVA) established adjective descriptors (High, Moderate, and Low) for each hazard's probability of occurrence and vulnerability, and a risk rating has been assigned based on a subjective estimate of their combination. The risk rating is assigned on the probability of a hazard occurring over the next 25 years. This interval was chosen because it is the long term recurrence interval of a dangerous earthquake, the hazard of the greatest risk to Thurston County.

The following terms were used in the county HIVA, and are referenced in this plan to analyze the hazards considered:

Probability of Occurrence: An adjective description (High, Medium, or Low) of the probability of a hazard impacting Thurston County within the next 25 years.

- High: There is great likelihood that a hazardous event will occur within the next 25 years.
- Medium: There is moderate likelihood that a hazardous event will occur within the next 25 years.
- Low: There is little likelihood that a hazardous event will occur within the next 25 years.

Vulnerability: An adjective description (High, Medium, or Low) of the potential impact a hazard could have on Thurston County. It considers the population, property, commerce, infrastructure and services at risk relative to the entire county.

- High: The total population, property, commerce, infrastructure and services of the county are uniformly exposed to the effects of a hazard of potentially great magnitude. In a worse case scenario, there could be a disaster of major to catastrophic proportions.
- Medium: The total population, property, commerce, infrastructure, and services of the county are exposed to the effects of a hazard of moderate influence; or The total population, property, commerce, infrastructure, and services of the county are exposed to the effects of a hazard of moderate influence, but not all to the same degree; or An important segment of population, property, commerce, infrastructure and services of the county are exposed to the effects of a hazard. In a worse case scenario there could be a disaster of moderate to major, though not catastrophic, proportions.
- Low: A limited area or segment of population, property, commerce, infrastructure, or service is exposed to the effects of a hazard. In a worse case scenario, there could be a disaster of minor to moderate proportions.

Risk Rating: An adjective description (High, Medium, or Low) of the overall threat posed by a hazard over the next 25 years. It is a subjective estimate of the combination of probability of occurrence and vulnerability.

- High: There is strong potential for a disaster of major proportions during the next 25 years; or History suggests the occurrence of multiple disasters of moderate proportions during the next 25 years.
- Medium: There is moderate potential for a disaster of less than major proportions during the next 25 years.
- Low: There is little potential for a disaster during the next 25 years.

Hazard Identification

Based on the county and other local jurisdictional *Hazard Identification and Vulnerability Analysis* (HIVA) reports, the following hazards have been identified as those most likely to occur in the Thurston Region:

- Critical Shortage – Critical shortages are the lack or reduction of essential goods or services due to a disruption in their supply. They are distinguished from shortages due to local emergencies by being caused by events that occur elsewhere. These events could include embargoes, strikes, natural disasters, epidemics, crop failures, over exploitation of a natural resource, terrorist activities and political unrest.

- Dam failure – There are 33 dams in or adjacent to Thurston County. Many of them serve more than one purpose such as hydroelectric power generation, irrigation, and recreation. Washington State uses a Downstream Hazard Classification system for dams which assigns a “low”, “significant” or “high” rating for populations at risk of economic loss and environmental damage should the dam fail. In Thurston County, most dams are

rated “low” with a few rated “significant” and three dams being rated “high”. The three potential high hazard dams are Alder and LaGrande Dams on the Nisqually River and the Skookumchuck Dam on the Skookumchuck River. Each of these dams could affect a population of 300 or more, inundate major transportation routes and industries, and have long term effects on water quality and wildlife.

- Drought – Drought is a condition of climatic dryness that is severe enough to reduce soil moisture levels and water levels below the minimum necessary for sustaining plant, animal and human life systems.

- Earthquake - Washington State is situated near a tectonic collision boundary where the oceanic Juan de Fuca plate dives beneath the continental North American plate. The plate boundary is the Cascadia Subduction Zone which lies about fifty miles offshore, extending from near Vancouver Island to northern California. These plates are converging at a rate of 1 to 1 ½ inches per year.

  As the Juan de Fuca plate slides beneath the North American plate, cracks or faults develop at their boundary and at the surface in response to bending. The friction caused by this sliding movement tends to stick the two plates or two sides of a fault together. Over time, tremendous pressure builds up and friction is overcome. When this happens, one plate or one side of a fault moves relative to the other plate or side resulting in the sudden release of energy that is felt as an earthquake.

- Epidemic – Epidemics are outbreaks of disease that affect or threaten to affect a significant portion of a population in a relatively short period of time. Although usually referring to a human contagious disease, epidemics can also affect domestic and wild animals as well as crops. Epidemic diseases are usually introduced into an area from remote regions and inflict devastation because there is not natural or induced immunity.

- Flood – Of all natural hazards that affect Thurston County, floods are the most common and, on an annual average basis, the most costly. Four types of flooding occur in the county: river or stream building floods, flash floods, tidal floods, and groundwater flooding.

- Hazardous Material Incidence – Hazardous materials include chemicals used in manufacturing, household chemicals, crude oil and petroleum products, pesticides, herbicides, fertilizers, paints, medical wastes, radioactive materials and a host of other substances. Their manufacture, transport, storage, use and disposal place the public property and environment at risk from their inadvertent or intentional release.

- Heat Wave – A heat wave is generally characterized by five or more consecutive days of unusually hot weather. Locally, the National Weather Service considers hot weather to be 90 degrees or higher.

- Landslide – Landslides are the release of rock, soil, or other debris and its subsequent movement down a slope or hillside. They are generally caused or controlled by a combination of geology, topography, weather and hydrology and can be influenced by development practices. Landslides vary greatly in size and composition: from a thin mass of soil a few yards wide to deep-seated bedrock slides miles across. The travel rate of a landslide can range from a few inches per month to many feet per second depending on the slope, type of materials, and moisture content.

- Storm – Destructive storms come in several varieties: wind, rain, ice, snow and combination. Nearly all destructive local storms occur from November through April when the jet stream is over the western United States and Pacific low pressure systems are more frequent. The trajectory of those lows determines their effect locally. The more southerly ones bring heavy rains while the more northerly ones bring cold air and the potential for snow and ice. Any winter storm, regardless of its trajectory, can pack high winds. Generally, winds above about thirty miles per hour can cause widespread damage and those above about fifty miles per hour can be disastrous. High winds of short duration, such as tornadoes and strong gusts from thunderstorms can also be destructive though generally not as widespread.

- Terrorism – Terrorism is the force or violence against persons or property violating the criminal laws of the United States for purposes of intimidation, coercion, or ransom. Terrorists often use threats to create fear among the public; try to convince citizens that their government is powerless to prevent terrorism; and try to get publicity for causes.

  A terrorist attack can take several forms depending on the technological means available to the terrorist, the nature of the political issue motivating the attack, the points of weakness of terrorist targets. Bombings are the most frequently used terrorist method in the United States. Other possibilities include attacks upon transportation facilities, utilities, or other public services, or an incident involving chemical or biological agents.

- Tsunami – A tsunami is a sea wave of extremely long length generated by a seismic disturbance (earthquake, volcanic eruption or debris slide) below or on the ocean floor. Tsunamis have wave lengths of more than sixty miles and travel at speeds of 300-600 miles per hour. They can be of local origin or may originate from a considerable distance such as Alaska or Japan. Tsunamis can be very destructive to coastal areas and can occur at any time.

- Volcano – A volcano is a mountain connected to a reservoir of molten rock below the surface of the earth. They are built up by an accumulation of their own eruptive products, lava and ash. Though there are not volcanoes within Thurston County, active volcanoes exist to our east (Mount Rainier) and to our south (Mount St. Helens). These are Cascade volcanoes which tend to erupt explosively due to internal pressure from gas and molten rock.

- Wild/Forest Fire – Any instance of uncontrolled burning in grasslands, brush, or woodlands is classified as a wildfire. An uncontrolled burning within a forested area is a forest fire. Forest and wildfires are most likely to occur during the local dry season – mid-May through October or anytime during prolonged dry periods causing drought or near-drought conditions. The probability of a destructive fire depends on weather, fuel conditions, topography and human activities such as debris burning, land clearing, camping, and construction. Greater than four out of five forest and wildfires are started by people, often due to negligent behavior such as failure to properly extinguish smoking materials or campfires.

Budget resources and time constrained a full analysis of every potential hazard identified above. The natural hazards of earthquake, flood, storm and landslide have been fully analyzed in this plan because they fell into the following criteria:

1) There is a high probability of the natural hazard occurring in Thurston County within the next 25 years.
2) There is the potential for significant damage to impacted buildings and infrastructure.
3) There is the potential for loss of life.

According to the Thurston County Hazard Identification and Vulnerability Analysis the following natural hazards meet the above criteria:

Hazard	Thurston County HIVA Summary Assessment
Earthquake	High Probability of Occurrence High Vulnerability High Risk
Flood	High Probability of Occurrence Moderate Vulnerability High Risk
Landslide	High Probability of Occurrence Low Vulnerability Moderate Risk
Storm	High Probability of Occurrence High Vulnerability High Risk

Overview of Risk Assessment Data

The following pages contain information useful in assessing the risk the county faces from the hazards identified above. Hazard specific information includes a description of the hazards, their previous occurrences and historical impacts on the community, and vulnerability assessment data tables. An explanation of the methodology used to determine the inventory, forecast, and dollar value of vulnerable assets concludes the risk assessment analysis.

The descriptions of natural hazards, previous occurrences, and past impacts to the community are drawn primarily from local jurisdictional HIVAs, and state and federal hazard related documents. News reports were consulted regarding the Nisqually Earthquake and Carlyon Beach landslide. This information is not, nor is it intended to be, a rigorous or scientific analysis. It does provide a basic level of knowledge through limited analysis of the hazards posing the greatest risk to Thurston County.

Earthquake Hazard Description

Earthquakes are one of nature's most damaging hazards. The earth's surface is constantly moving. Giant plates, called tectonic plates, make up the earth's crust and move very slowly over the surface of the globe. In areas where the plates are in contact, stresses build up. An earthquake is a sudden motion or trembling that is caused by a release of strain accumulated within or along the edge of tectonic plates.

Where tectonic plates overlap, as one plate slides under another, subduction zones are created. Washington State is situated near a tectonic collision boundary where the oceanic Juan de Fuca plate dives beneath the continental North American plate. The plate boundary is the Cascadia Subduction Zone which lies about 50 miles offshore, extending from near Vancouver Island to northern California. These plates are converging at a rate of 1-1 ½ inches per year.

As the Juan de Fuca plate slides beneath the North American plate, cracks, or faults, develop at their boundary and at the surface in response to bending. The friction caused by this sliding movement tends to stick the two plates, or two sides of a fault, together. Over time, tremendous pressure builds up and friction is overcome. When this happens, one plate or one side of a fault moves relative to the other plate or side resulting in the sudden release of energy that is felt as an earthquake.

The epicenter of an earthquake is the point on the earth's surface directly above the earthquake's focus. The severity of an earthquake is dependent on the amount of energy released from the fault or epicenter. The effects of an earthquake can be felt far beyond the site of its occurrence. They usually occur without warning and after just a few seconds can cause massive damage and extensive casualties.

The variables that characterize earthquakes are ground motion, surface faulting, ground failures, and seismic activity. Ground motion is the vibration or shaking of the ground during an earthquake. When a fault ruptures, seismic waves radiate, causing the ground to vibrate. The severity of the vibration increases with the amount of energy released and decreases with distance from the causative fault or epicenter, but soft soils can further amplify ground motions.

Surface faulting is the differential movement of two sides of a fracture - - in other words, the location where the ground breaks apart. The length, width, and displacement of the ground characterize surface faults.

Liquefaction is the phenomenon that occurs when ground shaking causes loose soils to lose strength and act like viscous fluid. Liquefaction causes two types of ground failure: lateral spread and loss of bearing strength. Lateral spreads develop upon gentle slopes and entail the sidelong movement of large masses of soil as an underlying layer liquefies. Loss of bearing strength results when the soil supporting the structures liquefies. This can cause structures to tip and topple.

There are several common measures of earthquakes. The Richter Magnitude Scale is a mathematical scale which measures the intensity of ground motion. Because of the logarithmic

basis of the scale, each whole number increase in magnitude represents a ten-fold increase in measured amplitude, and 31 times more energy released. The Modified Mercalli Intensity Scale measures the earthquake intensity by the damage it causes. Peak ground acceleration (PGA) is a measure of the strength of ground movements. It expresses an earthquake's severity by comparing its acceleration to the normal acceleration due to gravity.

Three kinds of earthquakes are recognized in the Pacific Northwest: shallow earthquakes, subduction zone earthquakes, and deep earthquakes.

Shallow earthquakes occur along faults close to the surface of the North American plate. They have a maximum depth of about 19 miles though most occur much nearer to the surface. The majority of earthquakes in the Pacific Northwest are of the shallow type. They could potentially produce magnitudes as high as 7.5, though most are less than 3.0.

Subduction zone earthquakes occur when there is motion between the two plates rather than at localized faults. The movement can occur over hundreds of miles and last for several minutes. Subduction zone earthquakes are considered to be the most destructive with potential magnitudes of 9.0 or greater.

Deep earthquakes occur along faults in the Juan de Fuca plate as it sinks beneath the North American plate. Their depths generally range from 16-62 miles. Magnitudes of 7.5 have been recorded.

Earthquake Hazard Historical Occurrences and Impacts

Thurston County is located in a seismically active region. Each year, since 1980, the Pacific Northwest Seismograph Network has recorded an average of more then two thousand earthquakes in Washington and Oregon.

Shallow earthquakes: The vast majority of earthquakes are shallow earthquakes (>98%) with a magnitude less than 3.0 (>99%). The shallow 1972 earthquake in the North Cascades was the largest in the history of Washington and Oregon. It had an estimated magnitude of 7.4 and was followed by many aftershocks. In 1993, a magnitude 5.6 earthquake in the Willamette Valley of Oregon caused $28 million in damages, and a pair of earthquakes near Klamath Falls, Oregon of magnitude 5.9 and 6.0 caused two fatalities and $7 million in damage. Large shallow earthquakes occur in the Pacific Northwest about once every 50 years.

Subduction zone earthquakes: A subduction zone earthquake has not occurred locally since modern record keeping began. However, similar subduction zones worldwide have produced earthquakes of magnitude 8 or larger. An example is the magnitude 9.2 Alaska earthquake of 1964. Geologic evidence indicates that the Cascadia Subduction Zone has generated great earthquakes at roughly 500 year intervals, most recently about 300 years ago. Researchers estimate there is a 10% chance of a local subduction zone earthquake within the next 200 years.

Deep earthquakes: On February 28, 2001, a 6.8 magnitude earthquake was centered in the Nisqually Reach northeast of Olympia. The Nisqually earthquake was a deep earthquake, occurring 30 miles below the Nisqually wetland. There was one significant aftershock on March 1, 2001. Causing damage across much of the state, the Nisqually earthquake was the second-worst earthquake in recent Washington history. On the day of the earthquake, the state declared a state of emergency. The next day, the Governor requested federal assistance and estimated the economic consequences at $2 billion. On March 1, 2001, a Presidential Disaster Declaration was issued state-wide.

According to scientists, other historical earthquakes that caused damage in western Washington bear similarities to the Nisqually earthquake. In 1965 a deep earthquake with a magnitude of 6.5, located between Seattle and Olympia, caused 3 fatalities. Scientists say the 1965 earthquake had a similar fault orientation as the 2001 Nisqually earthquake. Another deep earthquake, with a magnitude of 7.1, occurred in 1949 and caused eight fatalities. The epicenter of the Nisqually earthquake was near that of the 1949 earthquake. Both of these earlier earthquakes caused significant damage. Other deep earthquakes occurred in 1882, 1909, and 1939. Large deep earthquakes are estimated to occur about once every 25 years.

During the 1949 quake, eight capitol buildings in Olympia were damaged with a loss of two million dollars. Nearly all large buildings in Olympia were damaged through cracked or fallen walls and plaster. Two large smokestacks and many chimneys fell. Streets were damaged extensively. Water and gas mains were broken. A large portion of a sandy spit jutting into Puget Sound north of the city disappeared completely during the earthquake.

Damage from the 1965 quake was estimated to be $12,500,000 with much of the loss in King County. It isn't clear how much of this occurred in Thurston County. Some of the reported damage included: The Union Pacific Railroad reported a hillside fill slid away from beneath a 400-foot section of a branch line just outside Olympia. Several capitol campus buildings were damaged, including the inner dome of the rotunda. The 5-ton chandelier in the Capitol Building swung like a pendulum clock on its 110 foot chain in a 1-foot orbit for half an hour after the shock.

The 2001 Nisqually earthquake produced strong ground shaking over a wide area. However, the depth of the earthquake minimized the intensity of the shaking and limited the impact to the built environment. In addition, drought conditions in the Puget Sound region reduced the number of landslides and amount of liquefaction that would have otherwise been caused by a quake of that magnitude. Nevertheless, according to geotechnical researchers, observations of liquefaction were widespread in parts of Olympia and South Seattle, and several significant lateral spreads, embankment slides, and landslides occurred. The relatively long duration of the event and the relatively low cyclic resistances of some of the fills in the area are likely causes for the significant liquefaction and ground failure which occurred.

The Nisqually earthquake resulted in 400 injuries (a dozen of them serious) and one confirmed death (a trauma-induced heart attack). FEMA reported that 41,414 people registered for federal disaster aid, more than three times the number of a previous disaster in Washington.

One year after the earthquake, news reports put reported property damage at approximately $500 million. However, when factoring in unreported damage, actual losses may run significantly higher. A University of Washington study of damage to households only, estimates that the earthquake caused $1.5 billion in damage to nearly 300,000 residences, or almost one in four households in the Puget Sound area. This estimate does not include public and business sector losses. Other estimates of the combined losses to public, business, and household property have ranged from $2 billion to $3.9 billion.

Building damage varied throughout the region. In particular, Downtown Olympia, including many historic structures, and Seattle's historic Pioneer Square area were hit hard. Unreinforced brick masonry buildings with un-braced parapets and without wall anchors were particularly vulnerable, resulting in several collapses. In many cases, fallen brick resulted in damage to objects, such as cars and canopies, outside the building.

Most buildings performed well from a life-safety standpoint, in that the limited structural damage that occurred caused no loss of life or collapse. However, the economic cost of nonstructural damage, i.e., damage to nonessential building elements, such as architectural features, ceiling failures, shifting of equipment, fallen furniture/shelving, desktop computer damage, fallen light fixtures, and losses due to lost productivity, was high. In general, new buildings and buildings that had recently been seismically upgraded typically displayed good structural performance, but many still sustained non-structural damage.

In the Puget Sound region, over a thousand buildings were either red-tagged or yellow-tagged for inspection. Many of these businesses were declared unsafe and were closed for weeks. Other businesses, most with non-structural, cosmetic damage, closed temporarily for detailed inspections. While severe structural damage to businesses was relatively limited, non-structural damage, and the associated business disruption, caused significant economic loss.

In the City of Olympia, 300 buildings were inspected, two buildings red-tagged, and 43 buildings yellow-tagged. On the Capitol Campus, 31 buildings were inspected, three buildings red-tagged, and two buildings yellow-tagged. In Unincorporated Thurston County, 120 buildings were inspected, two buildings red tagged, and six buildings yellow-tagged.

Several of the government buildings in Olympia, including the capitol, were significantly damaged. Other state agency buildings were closed for inspection and repair. The 74 year-old capitol dome sustained a deep crack in its limestone exterior and damage to supporting columns. There were a number of other non-structural damage areas throughout the Legislative Building. Previously scheduled renovation of the building was started early to accommodate $20 - $22 million in earthquake repairs and seismic upgrades. The building is expected to reopen to lawmakers and the public in January 2005.

Damage to residences came in a variety of forms, from severe mudslide destruction of entire houses to breakage of replaceable personal property. The most common damage was to chimneys. FEMA records indicate that one-third of the 30,000 homes inspected by FEMA sustained chimney damage. In the City of Olympia, chimney damage in the South Capitol neighborhood was the most concentrated of anywhere in Puget Sound. The 40-80-foot depth of

loosely consolidated soils and gravel found in the South Capitol neighborhood of Olympia serves as a conduit for earthquake energy that is particularly hard on single-family homes.
Other residential areas hit hard include road and foundation failures in a Nisqually area mobile home park and the Tumwater Mobile Estates in Tumwater. Residents of 50 mobile homes in Tumwater Mobile Estates were evacuated when a gas line ruptured during the earthquake. Part of a street located within the mobile home park, a block of Pine Street, collapsed into a neighboring pond, taking two unoccupied cars into the water.

Transportation systems suffered extensive damage. There was serious damage to the region's largest airport, the Seattle-Tacoma International Airport. While the area's overall road network remained functional, numerous parts of highways, roads, and bridges were damaged. Several state routes and local roadways were closed due to slumping and pavement fractures.

The 4th Avenue Bridge in Olympia was one of four bridges in the state to suffer substantial damage from the quake. Constructed in 1920 and retrofitted after the 1949 earthquake, the bridge had been scheduled for replacement even before the 2001 earthquake. The closure of the bridge severely restricted access to downtown Olympia. Replacing the bridge has been estimated to cost almost $20 million and is the largest public works endeavor in the city's history. The new bridge is expected to open to vehicles in December 2003. Removal of a temporary bridge used during construction of the new bridge, along with other related improvements, is expected to be completed by June 2004.

According to the State, the Deschutes Parkway in Olympia suffered the most damage of any road in the state. Waterlogged soil under the road liquefied during the shaking. Huge voids were created beneath portions of the concrete road surface. Sections of road and sidewalk buckled from the force of the earthquake. A vital link between downtown Olympia, the city's west side and Tumwater, the road was closed to traffic for 20 months. Preliminary estimates to fix the road were put at $7 million.

A number of landslides occurred. Most of these slides occurred in natural materials, including a 400 foot slide on the northeast side of Capitol Lake. Other slides occurred in engineered fills, particularly at locations where they spanned low-lying areas of natural soils. A flow slide removed part of Highway 101 just west of Olympia, closing both northbound lanes of traffic, as well as Madrona Beach Road. Some damage to earth structures occurred. The failure of a large retaining wall (a mechanically stabilized earth wall, or MSE) supporting the parking lot of the Extended StayAmerica hotel on Mottman Road was caused by the earthquake.

With the exception of transportation systems, lifeline systems generally performed well during the earthquake. Lifeline systems include water, wastewater, electrical power, communications, natural gas and liquid fuels, and transportation systems. The impact of lifeline damage was in most cases minimal. Puget Sound Energy reported 200,000 customer power outages, and Seattle City Light reported 17,000 outages, but power was restored to most within a day. Landline and wireless communication systems were extremely overloaded immediately following the earthquake.

Only five of the state's 290 dams were found to have earthquake-related damage. One of these was the McAllister Springs Reservoir Dam in Thurston County.

Earthquake Hazard Assessing Vulnerability

Summary Assessment

History suggests a high probability of occurrence of another damaging earthquake sometime in the next 25 years. With the 2001 Nisqually earthquake still fresh in the region's memory, it is important to note that it was not the largest earthquake event possible in the Puget Sound region. Damage from the 1949, 1965, and 2001 earthquakes indicate that a large earthquake could have a catastrophic impact on Thurston County suggesting high vulnerability. Accordingly, the county has assigned a high risk rating.

Delineation of Earthquake Liquefaction Hazard Area

Map 5, North Urban Area Liquefaction Susceptibility Map.

Ground motion data is not currently available for Thurston County. Liquefaction susceptibility data is currently available for only the north urban area of Thurston County. Although, the entire county is vulnerable to damage from a major earthquake, for the purposes of the data tables in this report, the Earthquake Liquefaction Hazard area has necessarily been limited to the area for which data is available. In the map legend, the Liquefaction Risk Levels which define the hazard area are the "High" and "Low to Moderate" categories. The location of damage from the 2001 Nisqually earthquake was part of the assessment in determining which risk levels to use in defining the Liquefaction Hazard area.

The "Total" columns in the data tables provided for the flood and landslide hazards provide useful information in assessing the population and assets at risk from a countywide hazard.

Population in Hazard Area

Table IV-1, Earthquake Liquefaction Hazard Area Population, 2000 and 2025.

This table assesses an aspect of current and future vulnerability by providing data on the number of people living within the hazard area as compared to total population, by jurisdiction, in the years 2000 and 2025. Please note that the data in these tables is limited to the area for which liquefaction susceptibility data is available. For example, the "Total" column for the Unincorporated County does not refer to the entire Unincorporated County, but only to that portion included in the liquefaction susceptibility assessment, as shown on Map 5. This applies similarly to all the jurisdictions for which data is provided in these tables, as well as to the other data tables provided in the earthquake hazard section.

Inventory of Assets and Dollar Value in Hazard Area

Tables IV-2a through IV-2d, Earthquake Liquefaction Hazard Area, Vulnerability Assessment, 2000 and 2025.

These tables provide an estimate of the number of existing and future structures which are potentially impacted by the hazard, as well as an estimate of structure and building contents value, in order to provide information on potential dollar losses. Tables are provided by jurisdiction, for the year 2000 and 2025. Please note that the data in these tables is limited to the area for which liquefaction susceptibility data is available.

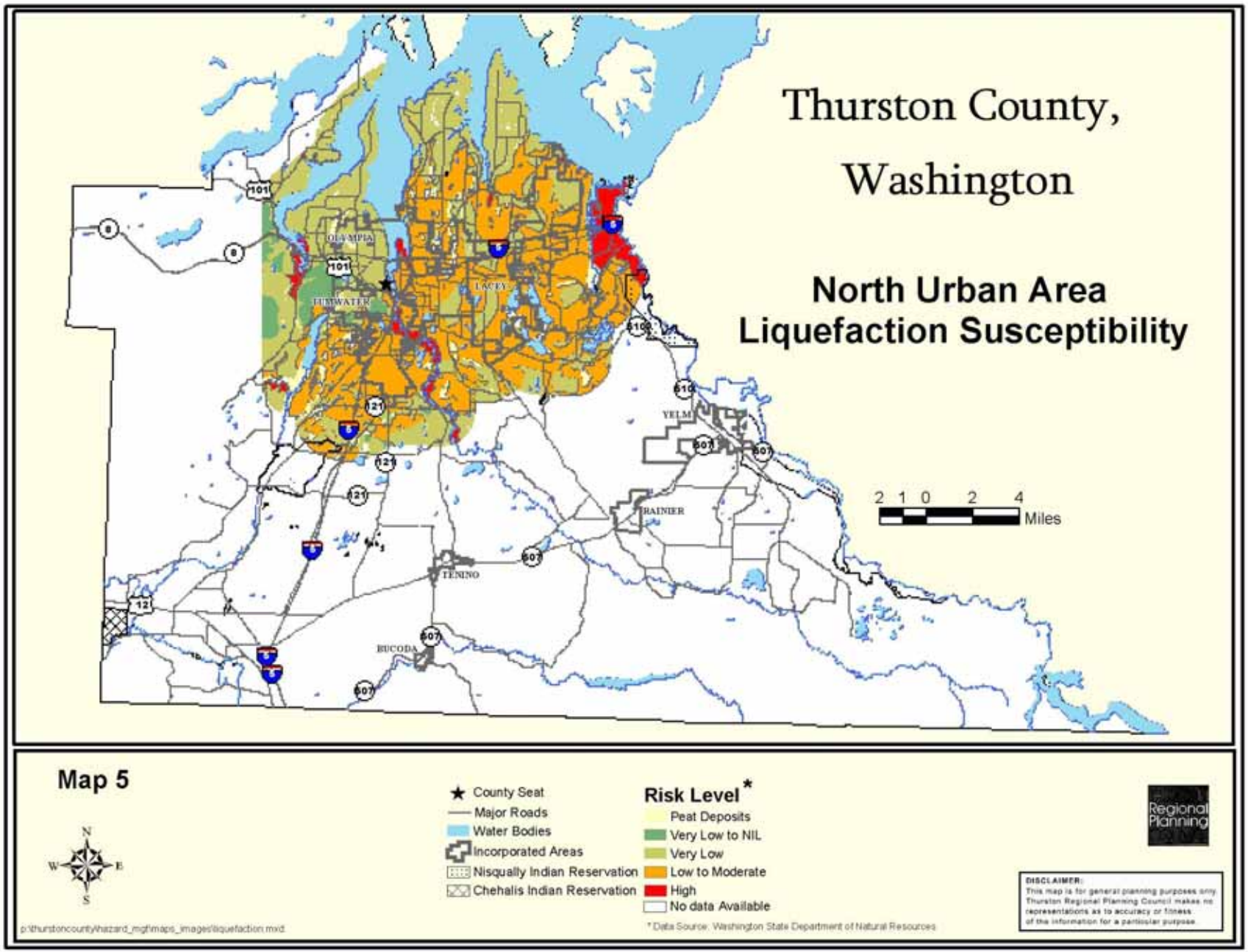
Critical Facilities and Infrastructure in Hazard Area

Based on the community impact which historical occurrences of natural hazards caused, it is clear that natural hazards can destroy or damage facilities that may be critical for responding to the disaster and for maintaining a safe environment and public order. Among these are communications installations; electrical generating and transmission facilities; water storage, purification, and pumping facilities; sewage treatment facilities; hospitals; and police stations. In addition, natural hazards can seriously disrupt the transportation network; bridges can be knocked out, and roads and highways damaged or blocked by debris, further isolating resources. In a major disaster, almost all surface means of transportation within a community may be disrupted, particularly in the initial stages of the hazard event.

Specific information on the location of critical facilities and infrastructure is housed with the Emergency Management Council of Thurston County. However, Table IV-3 shows the number of Priority I and II Critical Facilities located in the hazard area. Please note that the data in this table is limited to the area for which liquefaction susceptibility data is available.

Priority I facilities included in this table fall into the following categories: Medical, Fire Districts & Departments, Law Enforcement Correctional Facilities, Emergency Services Centers, Radio & TV Stations, Humanitarian & Volunteer Services, Electrical Distribution & Components, and Telephone Service & Components. Although State and County Transportation Lifelines are Priority I Critical Facilities, it is not currently possible to include an analysis of them in the data table. Priority II facilities consist of Clinics, Facilities Pre-Designated as Shelters by the Red Cross, Animal Shelters, Newspapers, Sewage Treatment, and Water Distribution Systems & Components.

Critical facilities include both public and private facilities. Table IV-3 indicates the number of facilities which are located in the jurisdiction, not their ownership. For example, hospitals are critical facilities but are privately owned. Likewise a facility owned by one jurisdiction may be located within the boundaries of another; such as the County Courthouse complex which is located in the City of Olympia.


Thurston County,
Washington
North Urban Area
Liquefaction Susceptibility
OLYMPIA
LACEY
TUMWATER
YELM
TENINO
BUCODA
RAINIER
2 1 0 2 4
Miles
Map 5
County Seat
Major Roads
Water Bodies
Incorporated Areas
Nisqually Indian Reservation
Chehalis Indian Reservation
Risk Level*
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* Data Source: Washington State Department of Natural Resources
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Regional Planning
DISCLAIMER:
This map is for general planning purposes only.
Thurston Regional Planning Council makes no
representations as to accuracy or fitness
of the information for a particular purpose.

Table IV-1
Earthquake Liquefaction Hazard Area, Population, 2000 and 2025

Jurisdiction		2000 Population Estimate Total	2000 In Hazard Area	2000 % in Hazard Area	2025 Population Forecast Total	2025 In Hazard Area	2025 % in Hazard Area
Lacey							
	City	30,958	26,605	85.9%	48,049	42,092	87.6%
	UGA	28,029	26,736	95.4%	46,648	44,185	94.7%
	Total	**58,986**	**53,341**	**90.4%**	**94,697**	**86,278**	**91.1%**
Olympia							
	City	42,519	24,148	56.8%	56,969	32,440	56.9%
	UGA	8,911	6,290	70.6%	22,057	15,164	68.7%
	Total	**51,429**	**30,438**	**59.2%**	**79,025**	**47,604**	**60.2%**
Tumwater							
	City	12,939	9,676	74.8%	19,423	13,823	71.2%
	UGA	7,068	6,230	88.1%	18,742	16,740	89.3%
	Total	**20,007**	**15,906**	**79.5%**	**38,165**	**30,563**	**80.1%**
Nisqually Reservation		**599**	**530**	**88.6%**	**1,056**	**667**	**63.1%**
Total Cities		**86,415**	**60,429**	**69.9%**	**124,440**	**88,356**	**71.0%**
Total UGAs		**44,007**	**39,256**	**89.2%**	**87,447**	**76,089**	**87.0%**
Total Urban Areas		**130,422**	**99,685**	**76.4%**	**211,888**	**164,445**	**77.6%**
Rural Unincorporated County		**67,709**	**14,569**	**21.5%**	**102,852**	**21,413**	**20.8%**
Thurston County Total		**198,730**	**114,785**	**57.8%**	**315,797**	**186,525**	**59.1%**

Table IV-2a
Earthquake Liquefaction Hazard Area, Vulnerability Assessment, Lacey
For Years 2000 and 2025

	2000 Dwelling Units Estimate			2000 Commercial and Industrial Floor Space Estimate			2000 Value of Structures and Building Contents Estimate		
Land Use by Ownership in 2000	Total	In Hazard Area	% in Hazard Area	Total [1,000 sq. ft.]	In Hazard Area [1,000 sq. ft.]	% in Hazard Area	Total [1,000 $]	In Hazard Area [1,000 $]	% in Hazard Area
Residential	12,601	10,895	86.5%	1	1	100.0%	$1,148,978	$951,280	82.8%
Commercial/Industrial	431	430	99.8%	5,178	4,655	89.9%	$398,500	$359,349	90.2%
Religious Institutions & Private Schools	17	16	94.1%	479	330	68.7%	$42,235	$38,634	91.5%
Local Government	7	5	71.4%	1,066	665	62.3%	$98,505	$62,645	63.6%
State Government	8	8	100.0%	458	458	100.0%	$93,344	$93,344	100.0%
Roads, Railroads, & Rights of Way	0	0	0.0%	0	0	0.0%	$26	$0	0.0%
Natural Resources (Public and Private)	8	7	87.5%	16	12	77.7%	$1,009	$783	77.6%
Parks, Preserves, Water, & Open Space	6	6	100.0%	3	2	85.3%	$1,537	$1,035	67.4%
Total	**13,078**	**11,367**		**7,201**	**6,122**		**$1,784,134**	**$1,507,071**	

	2025 Dwelling Units Forecast			2025 Commercial and Industrial Floor Space Forecast			2025 Value of Structures and Building Contents Forecast		
Land Use by Ownership in 2000*	Total	In Hazard Area	% in Hazard Area	Total [1,000 sq. ft.]	In Hazard Area [1,000 sq. ft.]	% in Hazard Area	Total [1,000 $]	In Hazard Area [1,000 $]	% in Hazard Area
Residential	13,547	11,790	87.0%	191	182	95.3%	$1,251,598	$1,048,485	83.8%
Commercial/Industrial	1,961	1,960	99.9%	5,310	4,784	90.1%	$548,436	$509,034	92.8%
Religious Institutions & Private Schools	17	16	94.1%	492	342	69.5%	$43,375	$39,774	91.7%
Local Government	7	5	71.4%	1,148	768	66.9%	$106,011	$72,122	68.0%
State Government	8	8	100.0%	463	463	100.0%	$93,857	$93,857	100.0%
Roads, Railroads, & Rights of Way	0	0	0.0%	0	0	0.0%	$7	$0	0.0%
Natural Resources (Public and Private)	524	505	96.4%	337	256	76.0%	$76,933	$67,995	88.4%
Parks, Preserves, Water, & Open Space	6	6	100.0%	0	0	0.0%	$1,287	$822	63.9%
Undeveloped land	4,297	3,552	82.7%	2,804	2,631	93.8%	$644,099	$561,137	87.1%
Total	**20,366**	**17,842**		**10,746**	**9,427**		**$2,765,603**	**$2,393,227**	

*Explanation: Please note that 2025 estimates are shown according to 2000 land use ownership, since land ownership for 2025 is unknown.

Table IV-2b
Earthquake Liquefaction Hazard Area, Vulnerability Assessment, Olympia
For Years 2000 and 2025

	2000 Dwelling Units Estimate			2000 Commercial and Industrial Floor Space Estimate			2000 Value of Structures and Building Contents Estimate		
Land Use by Ownership in 2000	Total	In Hazard Area	% in Hazard Area	Total [1,000 sq. ft.]	In Hazard Area [1,000 sq. ft.]	% in Hazard Area	Total [1,000 $]	In Hazard Area [1,000 $]	% in Hazard Area
Residential	19,018	10,427	54.8%	1	1	100.0%	$1,729,120	$960,988	55.6%
Commercial/Industrial	610	594	97.4%	10,664	6,181	58.0%	$982,536	$572,357	58.3%
Religious Institutions & Private Schools	12	7	58.3%	1,117	881	78.9%	$131,766	$97,674	74.1%
Local Government	49	48	98.0%	2,149	1,584	73.7%	$376,202	$291,117	77.4%
State Government	2	2	100.0%	3,484	3,137	90.0%	$768,694	$750,120	97.6%
Federal Government	0	0	0.0%	37	37	100.0%	$1,898	$1,898	100.0%
Roads, Railroads, & Rights of Way	0	0	0.0%	0	0	0.0%	$0	$0	0.0%
Natural Resources (Public and Private)	7	7	100.0%	83	83	100.0%	$2,843	$2,843	100.0%
Parks, Preserves, Water, & Open Space	4	2	50.0%	6	6	100.0%	$9,326	$7,591	81.4%
Total	**19,702**	**11,087**		**17,540**	**11,908**		**$4,002,384**	**$2,684,588**	

	2025 Dwelling Units Forecast			2025 Commercial and Industrial Floor Space Forecast			2025 Value of Structures and Building Contents Forecast		
Land Use by Ownership in 2000*	Total	In Hazard Area	% in Hazard Area	Total [1,000 sq. ft.]	In Hazard Area [1,000 sq. ft.]	% in Hazard Area	Total [1,000 $]	In Hazard Area [1,000 $]	% in Hazard Area
Residential	22,048	12,273	55.7%	625	556	89.0%	$2,104,448	$1,213,459	57.7%
Commercial/Industrial	773	691	89.4%	11,675	6,786	58.1%	$1,135,516	$663,981	58.5%
Religious Institutions & Private Schools	12	7	58.3%	1,209	958	79.2%	$144,385	$108,149	74.9%
Local Government	49	48	98.0%	3,216	2,362	73.4%	$521,303	$396,884	76.1%
State Government	2	2	100.0%	3,651	3,268	89.5%	$791,415	$767,973	97.0%
Federal Government	0	0	0.0%	61	61	100.0%	$5,206	$5,206	100.0%
Roads, Railroads, & Rights of Way	0	0	0.0%	0	0	0.0%	$0	$0	0.0%
Natural Resources (Public and Private)	851	832	97.8%	449	449	100.0%	$133,566	$131,763	98.6%
Parks, Preserves, Water, & Open Space	8	6	75.5%	6	6	100.0%	$9,726	$7,992	82.2%
Undeveloped land	4,858	2,427	50.0%	4,232	2,035	48.1%	$1,041,167	$509,389	48.9%
Total	**28,601**	**16,287**		**25,124**	**16,480**		**$5,886,733**	**$3,804,796**	

*Explanation: Please note that 2025 estimates are shown according to 2000 land use ownership, since land ownership for 2025 is unknown.

Table IV-2c
Earthquake Liquefaction Hazard Area, Vulnerability Assessment, Tumwater
For Years 2000 and 2025

	2000 Dwelling Units Estimate			2000 Commercial and Industrial Floor Space Estimate			2000 Value of Structures and Building Contents Estimate		
Land Use by Ownership in 2000	Total	In Hazard Area	% in Hazard Area	Total [1,000 sq. ft.]	In Hazard Area [1,000 sq. ft.]	% in Hazard Area	Total [1,000 $]	In Hazard Area [1,000 $]	% in Hazard Area
Residential	5,891	4,303	73.0%	0	0	0.0%	$486,926	$346,728	71.2%
Commercial/Industrial	55	51	92.7%	3,764	1,985	52.7%	$250,677	$162,013	64.6%
Religious Institutions & Private Schools	3	3	100.0%	181	173	95.3%	$15,605	$14,913	95.6%
Local Government	1	0	0.0%	1,756	1,545	88.0%	$126,153	$103,849	82.3%
State Government	0	0	0.0%	575	562	97.8%	$97,624	$96,827	99.2%
Federal Government	0	0	0.0%	14	14	100.0%	$1,040	$1,040	100.0%
Roads, Railroads, & Rights of Way	0	0	0.0%	0	0	0.0%	$0	$0	0.0%
Natural Resources (Public and Private)	0	0	0.0%	1	0	10.4%	$137	$24	17.8%
Parks, Preserves, Water, & Open Space	1	1	100.0%	5	5	100.0%	$7,125	$6,902	96.9%
Total	**5,951**	**4,358**		**6,297**	**4,285**		**$985,287**	**$732,295**	

	2025 Dwelling Units Forecast			2025 Commercial and Industrial Floor Space Forecast			2025 Value of Structures and Building Contents Forecast		
Land Use by Ownership in 2000*	Total	In Hazard Area	% in Hazard Area	Total [1,000 sq. ft.]	In Hazard Area [1,000 sq. ft.]	% in Hazard Area	Total [1,000 $]	In Hazard Area [1,000 $]	% in Hazard Area
Residential	7,579	5,502	72.6%	86	85	99.0%	$640,175	$457,564	71.5%
Commercial/Industrial	236	70	29.6%	4,034	2,138	53.0%	$288,263	$176,113	61.1%
Religious Institutions & Private Schools	3	3	100.0%	187	178	95.4%	$16,021	$15,329	95.7%
Local Government	1	0	0.0%	3,099	2,874	92.7%	$235,280	$211,865	90.0%
State Government	0	0	0.0%	609	567	93.2%	$100,410	$97,261	96.9%
Federal Government	0	0	0.0%	14	14	100.0%	$1,040	$1,040	100.0%
Roads, Railroads, & Rights of Way	0	0	0.0%	0	0	0.0%	$0	$0	0.0%
Natural Resources (Public and Private)	222	222	100.0%	220	107	48.4%	$37,243	$27,953	75.1%
Parks, Preserves, Water, & Open Space	1	1	100.0%	5	5	100.0%	$7,125	$6,902	96.9%
Undeveloped land	1,427	941	65.9%	1,352	1,106	81.8%	$233,549	$171,422	73.4%
Total	**9,470**	**6,740**		**9,607**	**7,076**		**$1,559,106**	**$1,165,447**	

*Explanation: Please note that 2025 estimates are shown according to 2000 land use ownership, since land ownership for 2025 is unknown.

Table IV-2d
Earthquake Liquefaction Hazard Area, Vulnerability Assessment, Unincorporated Thurston County
For Years 2000 and 2025

	2000 Dwelling Units Estimate			2000 Commercial and Industrial Floor Space Estimate			2000 Value of Structures and Building Contents Estimate		
Land Use by Ownership in 2000	Total	In Hazard Area	% in Hazard Area	Total [1,000 sq. ft.]	In Hazard Area [1,000 sq. ft.]	% in Hazard Area	Total [1,000 $]	In Hazard Area [1,000 $]	% in Hazard Area
Residential	29,188	20,799	71.3%	0	0	100.0%	$3,377,218	$2,224,573	65.9%
Commercial/Industrial	120	97	80.8%	2,935	2,400	81.8%	$158,874	$125,637	79.1%
Religious Institutions & Private Schools	68	66	97.1%	276	216	78.5%	$36,876	$27,867	75.6%
Local Government	22	19	86.4%	1,189	894	75.2%	$198,631	$142,204	71.6%
State Government	17	15	88.2%	1,299	109	8.4%	$176,318	$10,749	6.1%
Federal Government	0	0	0.0%	53	53	100.0%	$6,750	$6,750	100.0%
Tribal	0	0	0.0%	0	0	0.0%	$0	$0	0.0%
Roads, Railroads, & Rights of Way	0	0	0.0%	0	0	0.0%	$159	$159	100.0%
Natural Resources (Public and Private)	266	200	75.2%	481	479	99.6%	$50,388	$40,373	80.1%
Parks, Preserves, Water, & Open Space	16	12	75.0%	26	19	73.6%	$10,018	$8,783	87.7%
Total	**29,697**	**21,208**		**6,259**	**4,170**		**$4,015,231**	**$2,587,094**	

	2025 Dwelling Units Forecast			2025 Commercial and Industrial Floor Space Forecast			2025 Value of Structures and Building Contents Forecast		
Land Use by Ownership in 2000*	Total	In Hazard Area	% in Hazard Area	Total [1,000 sq. ft.]	In Hazard Area [1,000 sq. ft.]	% in Hazard Area	Total [1,000 $]	In Hazard Area [1,000 $]	% in Hazard Area
Residential	38,141	28,244	74.1%	284	213	75.0%	$4,304,809	$2,993,608	69.5%
Commercial/Industrial	299	243	81.4%	3,165	2,605	82.3%	$199,892	$160,876	80.5%
Religious Institutions & Private Schools	68	66	97.1%	286	225	78.8%	$37,912	$28,778	75.9%
Local Government	22	19	86.4%	1,689	1,324	78.4%	$248,701	$185,222	74.5%
State Government	17	15	88.2%	1,553	363	23.3%	$201,731	$36,163	17.9%
Federal Government	0	0	0.0%	64	64	100.0%	$7,862	$7,862	100.0%
Tribal	0	0	100.0%	0	0	0.0%	$43	$43	100.0%
Roads, Railroads, & Rights of Way	0	0	0.0%	0	0	0.0%	$159	$159	100.0%
Natural Resources (Public and Private)	4,871	4,099	84.2%	772	736	95.3%	$542,033	$457,712	84.4%
Parks, Preserves, Water, & Open Space	16	12	75.0%	15	8	55.3%	$8,896	$7,684	86.4%
Undeveloped land	10,057	7,427	73.8%	1,473	1,059	71.9%	$1,157,529	$851,877	73.6%
Total	**53,492**	**40,126**		**9,302**	**6,597**		**$6,709,567**	**$4,729,982**	

*Explanation: Please note that 2025 estimates are shown according to 2000 land use ownership, since land ownership for 2025 is unknown.

Table IV-3
Earthquake Liquefaction Hazard Area, Critical Facilities

Jurisdiction*		Priority I Facilities			Priority II Facilities		
		Total	In Hazard Area	% in Hazard Area	Total	In Hazard Area	% in Hazard Area
Bucoda							
	Total	**1**	**0**	**0.0%**	**0**	**0**	**0.0%**
Lacey							
	City	4	2	50.0%	13	8	61.5%
	UGA	1	1	100.0%	8	8	100.0%
	Total	**5**	**3**	**60.0%**	**21**	**16**	**76.2%**
Olympia							
	City	19	11	57.9%	20	17	85.0%
	UGA	1	0	0.0%	1	1	100.0%
	Total	**20**	**11**	**55.0%**	**21**	**18**	**85.7%**
Rainier							
	City	2	0	0.0%	1	0	0.0%
	UGA	0	0	0.0%	0	0	0.0%
	Total	**2**	**0**	**0.0%**	**1**	**0**	**0.0%**
Tenino							
	City	3	0	0.0%	4	0	0.0%
	UGA	0	0	0.0%	0	0	0.0%
	Total	**3**	**0**	**0.0%**	**4**	**0**	**0.0%**
Tumwater							
	City	5	4	80.0%	6	5	83.3%
	UGA	2	1	50.0%	1	1	100.0%
	Total	**7**	**5**	**71.4%**	**7**	**6**	**85.7%**
Yelm							
	City	3	0	0.0%	5	0	0.0%
	UGA	0	0	0.0%	1	0	0.0%
	Total	**3**	**0**	**0.0%**	**6**	**0**	**0.0%**
Grand Mound UGA							
	Total	**2**	**0**	**0.0%**	**0**	**0**	**0.0%**
Total Cities		**37**	**17**	**45.9%**	**49**	**30**	**61.2%**
Total UGAs		**6**	**2**	**33.3%**	**11**	**10**	**90.9%**
Total Urban Areas		**43**	**19**	**44.2%**	**60**	**40**	**66.7%**
Rural Unincorporated County		**32**	**3**	**9.4%**	**11**	**1**	**9.1%**
Thurston County Total		**75**	**22**	**29.3%**	**71**	**41**	**57.7%**

*Explanation: Please note that this table indicates the number of critical facilities which are located in the jurisdiction, not their ownership. For example, the County Courthouse is owned by the County but is located in the City of Olympia. Similarly, hospitals are privately owned facilities located within jurisdicitonal boundaries.

Flood Hazard Description

Of all natural hazards that effect Thurston County, floods are the most common and, on an annual average basis, the most costly. They can occur at any time of the year, and at any time of day or night. Most injuries and deaths occur when people are swept away by flood currents, and most property damage results from inundation by sediment-filled water.

Several factors determine the severity of floods, including rainfall intensity (or other water source) and duration. A large amount of rainfall over a short time span can result in flash flood conditions. A small amount of rain can also result in floods in locations where the soil is saturated from a previous wet period or if the rain is concentrated in an area of impermeable surfaces such as large parking lots, paved roadways, or other impervious developed areas. Topography and ground cover are also contributing factors for floods. Water run-off is greater in areas with steep slopes and little or no vegetative ground cover. Frequency of inundation is affected by the climate, soil, and channel slope.

Four types of flooding occur in Thurston County: river or stream building floods, flash floods, tidal floods, and groundwater flooding.

River and stream building floods occur because of prolonged heavy rainfall, a rapidly melting snow pack or a combination of these. Historically, Thurston County must experience two or three days of rainfall averaging 2-5 inches per day for this type of flooding to occur. Actual duration and rainfall amounts needed to cause flooding depend on the initial condition of the river or stream, groundwater conditions, and run-off conditions. The county is also vulnerable to events beyond our borders. Both the Nisqually River and the Chehalis River have flooded in Thurston County because of events in their watersheds outside the county. River and stream building floods are the most common in Thurston County because of our many rivers and streams, and development patterns along them.

Thurston County defines three levels of river flooding:

- Nuisance flooding: The river exceeds bank-full conditions at one or more locations, generally flooding fields and forests. Some roads may be covered but passable. There may be enhanced erosion of some river banks.
- Moderate flooding: Individual residential structures are threatened and evacuation is recommended for selected properties. Some roads may be closed. Moderate damage may be experienced.
- Major flooding: Neighborhoods and communities are threatened and evacuation is recommended for residents living on specified streets, in specified communities or neighborhoods, or along specified stretches of river. Major thoroughfares may be closed and major damage is expected.

A type of stream building flood characterized by a quick rise and fall of water level is the flash flood. Flash floods generally result from intense storms dropping large amounts of rain within a short period of time onto watersheds that cannot absorb or slow the flow. The natural terrain and vegetation in Thurston County helps to reduce the potential for flash floods. However, the

Deschutes River and many smaller streams react in a "flashy" manner, making them more difficult to forecast. As development continues, increasing the distribution and proportion of impervious surfaces, the threat from flash floods will increase.

Extremely high tides combined with low atmospheric pressure, excessive run-off, or strong northerly winds, can lead to either localized or general tidal flooding in coastal areas. Spring tides, the highest tides during any month, occur with each full and new moon. When these coincide with a northerly wind piling water in south Puget Sound, tidal flooding can occur. The tides can also enhance flooding in delta areas when rivers or creeks are at or near flood stage. The area at greatest risk to tidal flooding is the Olympia waterfront, but it is also a threat to the low lying farm lands in the Nisqually Valley and McLane Creek near Mud Bay. In the county, tidal impact is of most concern in delta areas when rivers are at flood stage and high tide exacerbates the situation.

Groundwater flooding occurs whenever there is a high water table and persistent heavy rains. The situation is caused in areas where an upper, thin layer of permeable soils overlays an impermeable layer of hard pan. As the ground absorbs more and more rain water, the groundwater table rises and shows itself as flooding in areas where the land surface is below the water table. The condition has historically been most severe in the second and subsequent years of consecutive wet years. According to the U.S. Army Corps of Engineers, the frequency of a groundwater flooding disaster is probably on the order of every 25 years.

Most of the known floodplains in the United States have been mapped by FEMA. The 100-year flood designation applies to the area that has a 1 percent chance, on average, of flooding in any given year. Based upon existing mapping, countywide there are 41.7 square miles within the 100-year floodplain, and an additional 5.1 square miles within the 500-year floodplain. Floodplains cover about 7.5 percent of the county.

The high groundwater areas in the county were mapped from January 1997 aerial photographs, showing the severe impact of winter storms that year. Preliminary calculations indicated that 71 percent of the flooding occurred outside the mapped 100-year floodplain. However, 66 percent of the high groundwater area occurred within mapped wetlands, and 55 percent of this flooding occurred on Hydric Soils (one of the three wetland parameters) which are often wet during the winter.

There are 33 dams in or adjacent to Thurston County. Dam failures can be caused by nature, such as flooding or an earthquake, but mostly they are caused by human error such as poor construction, operation, maintenance, or repair. The effects of a dam failure are highly variable depending on the dam, the amount of water stored behind the dam, the current stream flow, and the size and proximity of the downstream population. There are three potential high hazard dams in the county, Alder and La Grande Dams on the Nisqually River and the Skookumchuck Dam on the Skookumchuck River. Alder Reservoir has a storage capacity of 232,000 acre-feet, and the smaller La Grande Reservoir, 2,700 acre-feet. Firm flood control storage is not provided for either reservoir, although the operation at Alder Dam can be adjusted when a flood is expected. This can reduce flood peaks on the Nisqually River. The Skookumchuck Dam, located approximately eight miles upstream of Bucoda, has a storage capacity of 42,000 acre-feet. Its major function is water supply for the Steam-Electric Project and it provides little protection from large floods.

Flood Hazard Historical Occurrences and Impacts

Since 1964, only 185 counties in the country have had more than 10 Federal Disaster Declarations. Thurston County is part of this top 6 percent of counties. Since October 1962, Thurston County has been declared a federal disaster area 17 times, 13 of them for flooding.

Flooding history of the Nisqually River: The Nisqually River watershed drains the area along the eastern boundary of the county. Much of the land along the Nisqually River, from the Nisqually Delta at Puget Sound to McKenna (on the Pierce County side), is occupied by the Nisqually Indian Reservation and Fort Lewis Military Reservation. Historically, nuisance flooding occurs when the flow rate exceeds about 8,000 cubic feet per second (cfs). Since 1972, the river exceeded this flow rate 12 times. Moderate flooding occurs when the flow rate exceeds 15,000 cfs. Since 1972, this occurred seven times. Major flooding occurs when the flow rate exceeds about 22,000 cfs. This has been exceeded twice since 1972, in November 1995 and February 1996. The February 1996 flow rate, which exceeded 45,000 cfs, established the flood of record. Creeks within the Nisqually can be affected by localized rainfall events but in general they flood whenever the river is flooding. Also, it can take much less rainfall for creeks to rise to threatening levels without the nearby river flooding.

Flooding history of the Deschutes River: The Deschutes River flows diagonally across the central portion of the county and enters into Budd Inlet via Capitol Lake. Historically, nuisance flooding occurs when the flow rate exceeds about 3,000 cfs. Since 1972, the river has exceeded this flow rate 27 times. Moderate flooding occurs when the flow rate exceeds about 4,000 cfs. Since 1972, this has occurred 14 times. Major flooding occurs when the flow rate exceeds about 6,000 cfs. This has happened six times since 1972, in January 1972, January 1974, January 1990, April 1991, February 1996, and December 1996. The flood of record was in January 1990 when the flow rate reached 9,600 cfs. Creeks within the Deschutes Watershed can be affected by localized rainfall events but in general they flood whenever the river is flooding. Also, it can take much less rainfall for creeks to rise to threatening levels without the nearby river flooding.

Flooding history of the Skookumchuck River: The Skookumchuck River extends for approximately 24.7 miles in south-central Thurston County and has a wide floodplain from the county line upstream for 15 miles. Land use on the floodplain is mostly agricultural, and though flooded often, little damage is done. Historically, nuisance flooding occurs when the flow rate exceeds about 4,000 cfs. Since 1972, the river has exceeded the flow rate 22 times. Moderate flooding occurs when the flow rate exceeds 4,900 cfs. Since 1972, this has occurred 16 times. Major flooding occurs when the flow rate exceeds 6,500 cfs. This has happened 7 times since 1972: March 1977, December 1977, January 1990, February 1990, November 1990, April 1991, and February 1996. The flood of record was established in February 1996 when the flow rate reached nearly 7,200 cfs.

Flooding history of the Chehalis River: The Chehalis River extends for only 8.6 miles in Thurston County, but has an extensive floodplain, covering over eight square miles. Land use is primarily agricultural, houses are scattered sparsely over the area. Some flooding occurs nearly every year, but damage is usually light. Historically, nuisance flooding occurs when the flow rate exceeds about 14,000 cfs. Since 1972, the river has exceeded the flow rate 48 times. The

typical year will have a flood in November or December and a second flood in January or February. Moderate flooding occurs when the flow rate exceeds about 26,000 cfs. Since 1972, this has occurred 21 times. Major flooding occurs when the rate exceeds about 45,000 cfs. This has happened six times since 1972: January 1972, December 1975, November 1986, January 1990, November 1990, and February 1996. The flood of record was established in February 1996 when the flow rate reached nearly 75,000 cfs.

Flooding history of the Black River: The Black River is a slow, meandering stream that flows through Thurston County for approximately 19 miles. Extending south from Black Lake, the river is lined by marshland, and the water table is perennially at or above the ground surface. Little development has occurred near the river for this reason. The preponderance of flooding along the Black River is caused by back-flow from the Chehalis River and similar recurrence intervals can be expected.

History of Groundwater Flooding: Nearly all residents of Thurston County rely on groundwater for their drinking water supplies. Various parts of the county have very different groundwater aquifers. Groundwater in the county is of generally high quality and adequate supply, with some exceptions. Groundwater flooding has historically been most severe in the second and subsequent years of consecutive wet years. According to the U.S. Army Corps of Engineers post event report on the winter storm of 1996-1997, the frequency of a groundwater flooding disaster is probably on the order of every 25 years. This was the first widespread groundwater flooding since 1972 and the worst on record until the winter of 1998-1999, which is now the "event of record." Statistically, the Corps estimates there is approximately a 70 percent chance that the 1996-1997 flooding will be equaled or exceeded at least once during a 30-year mortgage cycle. According to FEMA records of the March 1997 high groundwater flood event, only 15 of 237 damage sites (6 percent) occurred within the mapped 100-year floodplain. This was only increased to 9 percent when the 100- and 500- year floodplains coverages were added together.

History of Dam Failure: There has not been a major dam failure in Thurston County, and the three high hazard dams in the county are well-maintained and comply with current dam safety regulations. The Thurston County HIVA has assigned a low risk rating to all three high hazard dams in the county. However, in the event of a dam failure, each of the three dams could affect a population of 300 or more, inundate major transportation routes and industries, and have long-term effects on water quality and wildlife. Of the three dams, only the Skookumchuck is an earthen dam, whereas La Grande and Alder are both concrete structures. The high hazard dams in Thurston County are primarily for electrical power generation and are licensed by the Federal Energy Regulatory Commission. Accordingly, they are inspected regularly and staffed 24 hours a day.

Although relatively low percentages of land area and population are exposed to the threat of flooding, they are important segments. Both the north and south extensions of major thoroughfares and railroad lines cross a floodplain at the county border. This is also true of the eastern extensions. Petroleum pipelines, natural gas pipelines, and the major electricity feeder lines enter the county over a floodplain. The potential consequences are enormous as the following summaries of damages from flooding in 1996 and 1997 demonstrate:

The February 1996 flood:

- Destroyed over two dozen homes and caused major damage to more than 200 others;
- Caused nearly 1,000 people to evacuate their homes;
- Required more than 300 people to be rescued;
- Damaged more than 300 sections of the county road system;
- Destroyed a Native American school;
- Caused the closure of I-5 at the Lewis County line and the closure of the main north-south railroad line at the Pierce County line;
- Cost Thurston County government in excess of $2 million;
- Cost other government entities and utilities in excess of $20 million; and
- Cost uninsured private property losses in excess of $22 million.

The December 1996 and March 1997 winter storm and ground flooding:

- Inundated approximately 200 homes countywide;
- Contaminated approximately 200 drinking water wells;
- Caused wide spread failures of on-site septic systems;
- Severely impacted a number of business operations;
- Cost Thurston County government in excess of $340,000;
- Cost other government entities & utilities in excess of $750,000; and
- Cost uninsured private property losses in excess of $1.75 million.

Repetitive Loss Properties

According to county records, there are 13 identified repetitive loss properties in Thurston County. Map 6, Flood Hazards map, shows the general location of these properties.

General Location – Street, Zip Code	Dates of Flooding
11600 block of 6th Ave SE, 98513	December 1995 February 1996
17800 block of Corbin Dr SE, 98597	January 1990 February 1996
8900 block of Armstrong Rd SW, 98512	April 1990 March 1997
8800 block of Littlerock Rd SW, 98512	March 1997 (twice) January 1999
18500 block of Cedar Park Ln SE, 98597	January 1990 February 1996 December 1996
19400 block of Goebel Rd SE, 98589	January 1990 November 1990

17800 block of Deschutes Dr SE, 98597	January 1990 December 1996
14900 block of Turner Rd SE, 98576	January 1990 February 1996
18700 block of Dynamite Dr SE, 98597	January 1990 February 1996 January 1997
22600 block of Paul Bunyon Rd SE, 98597	January 1990 February 1996
400 block of Riverbend Ln SE, 98513	December 1995 February 1996
400 block of Riverbend Ln, SE, 98513	December 1995 February 1996
11400 block of 6th Ave, SE, 98513	November 1995 February 1996

Flood Hazard Assessing Vulnerability

Summary Assessment

Historically, flooding occurs along one or more of the county's waterways every year, suggesting a high probability of occurrence. Because of the relative land area and population affected, the county is exposed to moderate vulnerability. On a jurisdictional basis, an exception is the Town of Bucoda, which has a high vulnerability to flooding due to its location within a 100-year floodplain. Although the vulnerability is moderate, the frequency of flooding, the potential for simultaneous flooding events, plus the historical record of recurrent flooding and cumulative costs, all suggest the assignment of a high risk rating.

Delineation of Flood Hazard Area

Map 6, Flood Hazards Map.

The Flood Hazard Area consists of those parcels in the county in 100- and 500-year floodplains, and areas of High Groundwater Flooding.

Population in Hazard Area

Table IV-4, Flood Hazard Area Population, 2000 and 2025.

This table assesses an aspect of current and future vulnerability by providing data on the number of people living within the hazard area as compared to total population, by jurisdiction, in the years 2000 and 2025.

Inventory of Assets and Dollar Value in Hazard Area

Tables IV-5a through Table IV-5i, Flood Hazard Area Vulnerability Assessment, 2000 and 2025.

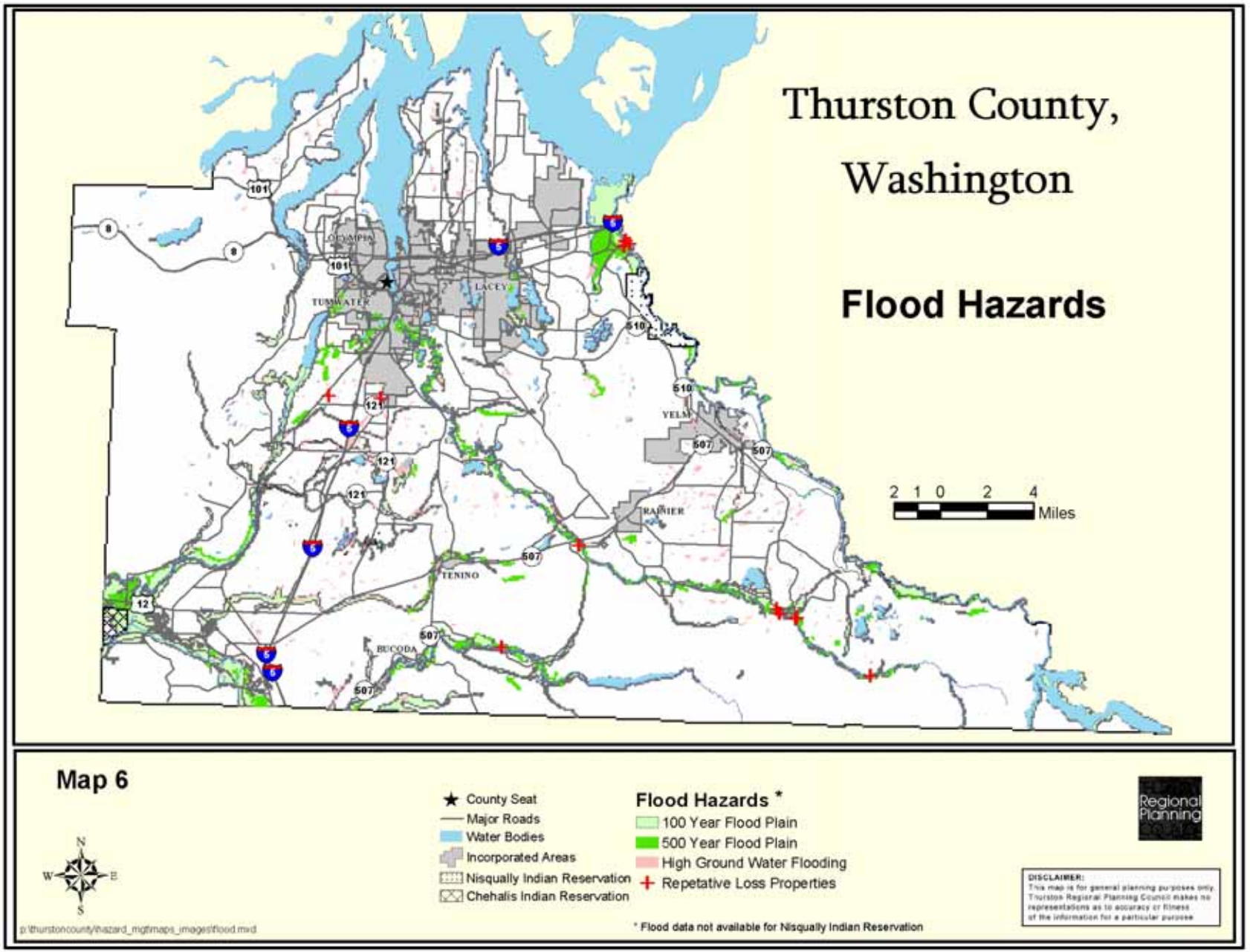
These tables provide an estimate of the number of existing and future structures which are potentially impacted by the hazard, as well as an estimate of structure and building contents value in order to provide information on potential dollar losses. Tables are provided by jurisdiction, for the years 2000 and 2025.

Critical Facilities and Infrastructure in Hazard Area

Based on the community impact which historical occurrences of natural hazards caused, it is clear that natural hazards can destroy or damage facilities that may be critical for responding to the disaster and for maintaining a safe environment and public order. Among these are communications installations; electrical generating and transmission facilities; water storage, purification, and pumping facilities; sewage treatment facilities; hospitals; and police stations. In addition, natural hazards can seriously disrupt the transportation network; bridges can be knocked out, and roads and highways damaged or blocked by debris, further isolating resources. In a major disaster, almost all surface means of transportation within a community may be disrupted, particularly in the initial stages of the hazard event.

Specific information on the location of critical facilities and infrastructure is housed with the Emergency Management Council of Thurston County. However, Table IV-6 shows the number of Priority I and II Critical Facilities located in the hazard area. Priority I facilities included in this table fall into the following categories: Medical, Fire Districts & Departments, Law Enforcement Correctional Facilities, Emergency Services Centers, Radio & TV Stations, Humanitarian & Volunteer Services, Electrical Distribution & Components, and Telephone Service & Components. Although State and County Transportation Lifelines are Priority I Critical Facilities, it is not currently possible to include an analysis of them in the data table. Priority II facilities consist of Clinics, Facilities Pre-Designated as Shelters by the Red Cross, Animal Shelters, Newspapers, Sewage Treatment, and Water Distribution Systems & Components.

Critical facilities include both public and private facilities. Table IV-6 indicates the number of facilities which are located in the jurisdiction, not their ownership. For example, hospitals are critical facilities but are privately owned. Likewise a facility owned by one jurisdiction may be located within the boundaries of another; such as the County Courthouse complex which is located in the City of Olympia.


Thurston County,
Washington
Flood Hazards
OLYMPIA
LACEY
TUMWATER
YELM
RAINIER
TENINO
BUCODA
2 1 0 2 4
Miles
Map 6
County Seat
Major Roads
Water Bodies
Incorporated Areas
Nisqually Indian Reservation
Chehalis Indian Reservation
Flood Hazards *
100 Year Flood Plain
500 Year Flood Plain
High Ground Water Flooding
Repetative Loss Properties
N
W
E
S
Regional Planning
DISCLAIMER:
This map is for general planning purposes only. Thurston Regional Planning Council makes no representations as to accuracy or fitness of the information for a particular purpose.
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* Flood data not available for Nisqually Indian Reservation

Table IV-4
Flood Hazard Area, Population, 2000 and 2025

Jurisdiction		2000 Population Estimate Total	2000 In Hazard Area	2000 % in Hazard Area	2025 Population Forecast Total	2025 In Hazard Area	2025 % in Hazard Area
Bucoda							
	Total	**584**	**446**	**76.5%**	**641**	**494**	**77.0%**
Lacey							
	City	30,958	1,668	5.4%	48,049	4,201	8.7%
	UGA	28,029	1,672	6.0%	46,648	3,656	7.8%
	Total	**58,986**	**3,339**	**5.7%**	**94,697**	**7,857**	**8.3%**
Olympia							
	City	42,519	3,728	8.8%	56,969	8,093	14.2%
	UGA	8,911	390	4.4%	22,057	3,923	17.8%
	Total	**51,429**	**4,118**	**8.0%**	**79,025**	**12,017**	**15.2%**
Rainier							
	City	1,356	40	2.9%	2,127	88	4.2%
	UGA	34		0.0%	186		0.0%
	Total	**1,390**	**40**	**2.9%**	**2,314**	**88**	**3.8%**
Tenino							
	City	1,521	91	6.0%	1,566	109	7.0%
	UGA	120	32	27.0%	365	106	29.1%
	Total	**1,641**	**124**	**7.5%**	**1,931**	**216**	**11.2%**
Tumwater							
	City	12,939	918	7.1%	19,423	1,888	9.7%
	UGA	7,068	1,255	17.8%	18,742	5,759	30.7%
	Total	**20,007**	**2,173**	**10.9%**	**38,165**	**7,648**	**20.0%**
Yelm							
	City	3,174	272	8.6%	8,559	2,505	29.3%
	UGA	1,071	116	10.9%	2,827	706	25.0%
	Total	**4,245**	**389**	**9.2%**	**11,386**	**3,210**	**28.2%**
Grand Mound UGA							
	Total	**720**	**13**	**1.8%**	**2,064**	**27**	**1.3%**
Chehalis Reservation		**34**	**29**	**84.6%**	**126**	**114**	**90.7%**
Nisqually Reservation		**599**	**184**	**30.8%**	**1,056**	**276**	**26.2%**
Total Cities		**93,050**	**7,164**	**7.7%**	**137,334**	**17,379**	**12.7%**
Total UGAs		**45,952**	**3,478**	**7.6%**	**92,890**	**14,178**	**15.3%**
Total Urban Areas		**139,002**	**10,642**	**7.7%**	**230,223**	**31,557**	**13.7%**
Rural Unincorporated County		**67,709**	**16,661**	**24.6%**	**102,852**	**31,557**	**30.7%**
Thurston County Total		**207,344**	**27,516**	**13.3%**	**334,258**	**63,505**	**19.0%**

Table IV-5a
Flood Hazard Area, Vulnerability Assessment, Bucoda
For Years 2000 and 2025

	2000 Dwelling Units Estimate			2000 Commercial and Industrial Floor Space Estimate			2000 Value of Structures and Building Contents Estimate		
Land Use by Ownership in 2000	Total	In Hazard Area	% in Hazard Area	Total [1,000 sq. ft.]	In Hazard Area [1,000 sq. ft.]	% in Hazard Area	Total [1,000 $]	In Hazard Area [1,000 $]	% in Hazard Area
Residential	225	171	76.0%	1	0	0.0%	$11,225	$8,245	73.5%
Commercial/Industrial	1	1	100.0%	20	19	99.0%	$642	$642	100.0%
Religious Institutions & Private Schools	0	0	0.0%	2	2	100.0%	$228	$228	100.0%
Local Government	0	0	0.0%	11	11	95.4%	$671	$547	81.4%
Roads, Railroads, & Rights of Way	0	0	0.0%	0	0	0.0%	$0	$0	0.0%
Natural Resources (Public and Private)	3	3	100.0%	0	0	0.0%	$5	$5	100.0%
Parks, Preserves, Water, & Open Space	0	0	0.0%	0	0	0.0%	$17	$17	100.0%
Total	**229**	**175**		**34**	**32**		**$12,787**	**$9,683**	

	2025 Dwelling Units Forecast			2025 Commercial and Industrial Floor Space Forecast			2025 Value of Structures and Building Contents Forecast		
Land Use by Ownership in 2000*	Total	In Hazard Area	% in Hazard Area	Total [1,000 sq. ft.]	In Hazard Area [1,000 sq. ft.]	% in Hazard Area	Total [1,000 $]	In Hazard Area [1,000 $]	% in Hazard Area
Residential	227	173	76.1%	1	0	0.0%	$11,326	$8,333	73.6%
Commercial/Industrial	1	1	100.0%	20	19	98.4%	$646	$642	99.3%
Religious Institutions & Private Schools	0	0	0.0%	2	2	100.0%	$228	$228	100.0%
Local Government	0	0	0.0%	14	13	93.2%	$772	$631	81.7%
Roads, Railroads, & Rights of Way	0	0	0.0%	0	0	0.0%	$0	$0	0.0%
Natural Resources (Public and Private)	11	11	100.0%	0	0	0.0%	$367	$367	100.0%
Parks, Preserves, Water, & Open Space	0	0	0.0%	0	0	0.0%	$17	$17	100.0%
Undeveloped land	19	14	73.4%	4	1	19.1%	$1,051	$679	64.6%
Total	**258**	**198**		**41**	**35**		**$14,406**	**$10,896**	

*Explanation: Please note that 2025 estimates are shown according to 2000 land use ownership, since land ownership for 2025 is unknown.

Table IV-5b
Flood Hazard Area, Vulnerability Assessment, Chehalis Reservation*

2000 Dwelling Units Estimate		
Total	**In Hazard Area**	**% in Hazard Area**
13	11	84.6%

2000 Commercial, Industrial, and Tribal Assets - Floor Space Estimate		
Total [1,000 sq. ft.]	**In Hazard Area [1,000 sq. ft.]**	**% in Hazard Area**
97	96	99.9%

2000 Value of Structures and Building Contents Estimate		
Total [1,000 $]	**In Hazard Area [1,000 $]**	**% in Hazard Area**
$27,443	$27,394	99.8%

New Tribal Assets Planned for 2004		
Total [1,000 sq. ft.]	**Construction Cost Estimate [1,000 $]**	**% in Hazard Area**
10	$1,300	0.0%

*Thurston County portion only.

Table IV-5c
Flood Hazard Area, Vulnerability Assessment, Lacey
For Years 2000 and 2025

Land Use by Ownership in 2000	2000 Dwelling Units Estimate			2000 Commercial and Industrial Floor Space Estimate			2000 Value of Structures and Building Contents Estimate		
	Total	In Hazard Area	% in Hazard Area	Total [1,000 sq. ft.]	In Hazard Area [1,000 sq. ft.]	% in Hazard Area	Total [1,000 $]	In Hazard Area [1,000 $]	% in Hazard Area
Residential	12,601	710	5.6%	1	0	25.4%	$1,148,978	$48,483	4.2%
Commercial/Industrial	431	0	0.0%	5,178	607	11.7%	$398,500	$28,403	7.1%
Religious Institutions & Private Schools	17	2	11.8%	479	85	17.8%	$42,235	$7,909	18.7%
Local Government	7	0	0.0%	1,066	128	12.0%	$98,505	$16,049	16.3%
State Government	8	0	0.0%	458	334	73.1%	$93,344	$88,425	94.7%
Roads, Railroads, & Rights of Way	0	0	0.0%	0	0	0.0%	$26	$0	0.0%
Natural Resources (Public and Private)	8	4	50.0%	16	12	77.7%	$1,009	$652	64.6%
Parks, Preserves, Water, & Open Space	6	6	100.0%	3	1	24.2%	$1,537	$302	19.7%
Total	**13,078**	**722**		**7,201**	**1,167**		**$1,784,134**	**$190,223**	

Land Use by Ownership in 2000*	2025 Dwelling Units Forecast			2025 Commercial and Industrial Floor Space Forecast			2025 Value of Structures and Building Contents Forecast		
	Total	In Hazard Area	% in Hazard Area	Total [1,000 sq. ft.]	In Hazard Area [1,000 sq. ft.]	% in Hazard Area	Total [1,000 $]	In Hazard Area [1,000 $]	% in Hazard Area
Residential	13,547	891	6.6%	191	58	30.6%	$1,251,598	$70,151	5.6%
Commercial/Industrial	1,961	195	9.9%	5,310	659	12.4%	$548,436	$50,758	9.3%
Religious Institutions & Private Schools	17	2	11.8%	492	85	17.3%	$43,375	$7,909	18.2%
Local Government	7	0	0.0%	1,148	178	15.5%	$106,011	$20,646	19.5%
State Government	8	0	0.0%	463	334	72.2%	$93,857	$88,425	94.2%
Roads, Railroads, & Rights of Way	0	0	0.0%	0	0	0.0%	$7	$0	0.0%
Natural Resources (Public and Private)	524	216	41.2%	337	234	69.4%	$76,933	$40,058	52.1%
Parks, Preserves, Water, & Open Space	6	6	100.0%	0	0	0.0%	$1,287	$242	18.8%
Undeveloped land	4,297	471	11.0%	2,804	849	30.3%	$644,099	$120,268	18.7%
Total	**20,366**	**1,781**		**10,746**	**2,398**		**$2,765,603**	**$398,457**	

*Explanation: Please note that 2025 estimates are shown according to 2000 land use ownership, since land ownership for 2025 is unknown.

Table IV-5d
Flood Hazard Area, Vulnerability Assessment, Olympia
For Years 2000 and 2025

	2000 Dwelling Units Estimate			2000 Commercial and Industrial Floor Space Estimate			2000 Value of Structures and Building Contents Estimate		
Land Use by Ownership in 2000	Total	In Hazard Area	% in Hazard Area	Total [1,000 sq. ft.]	In Hazard Area [1,000 sq. ft.]	% in Hazard Area	Total [1,000 $]	In Hazard Area [1,000 $]	% in Hazard Area
Residential	19,018	1,685	8.9%	1	0	0.0%	$1,729,120	$137,018	7.9%
Commercial/Industrial	610	9	1.5%	10,664	1,059	9.9%	$982,536	$73,785	7.5%
Religious Institutions & Private Schools	12	0	0.0%	1,117	2	0.2%	$131,766	$1,816	1.4%
Local Government	49	48	98.0%	2,149	1,105	51.4%	$376,202	$116,756	31.0%
State Government	2	1	50.0%	3,484	1,845	52.9%	$768,694	$202,920	26.4%
Federal Government	0	0	0.0%	37	0	0.0%	$1,898	$0	0.0%
Roads, Railroads, & Rights of Way	0	0	0.0%	0	0	0.0%	$0	$0	0.0%
Natural Resources (Public and Private)	7	4	57.1%	83	58	69.9%	$2,843	$1,559	54.8%
Parks, Preserves, Water, & Open Space	4	0	0.0%	6	6	100.0%	$9,326	$4,098	43.9%
Total	**19,702**	**1,747**		**17,540**	**4,074**		**$4,002,384**	**$537,952**	

	2025 Dwelling Units Forecast			2025 Commercial and Industrial Floor Space Forecast			2025 Value of Structures and Building Contents Forecast		
Land Use by Ownership in 2000*	Total	In Hazard Area	% in Hazard Area	Total [1,000 sq. ft.]	In Hazard Area [1,000 sq. ft.]	% in Hazard Area	Total [1,000 $]	In Hazard Area [1,000 $]	% in Hazard Area
Residential	22,048	2,130	9.7%	625	105	16.8%	$2,104,448	$193,945	9.2%
Commercial/Industrial	773	125	16.1%	11,675	1,454	12.5%	$1,135,516	$138,564	12.2%
Religious Institutions & Private Schools	12	0	0.0%	1,209	2	0.2%	$144,385	$1,816	1.3%
Local Government	49	48	98.0%	3,216	1,562	48.6%	$521,303	$178,832	34.3%
State Government	2	1	50.0%	3,651	1,845	50.5%	$791,415	$202,957	25.6%
Federal Government	0	0	0.0%	61	0	0.0%	$5,206	$0	0.0%
Roads, Railroads, & Rights of Way	0	0	0.0%	0	0	0.0%	$0	$0	0.0%
Natural Resources (Public and Private)	851	529	62.1%	449	401	89.3%	$133,566	$98,498	73.7%
Parks, Preserves, Water, & Open Space	8	0	0.0%	6	6	100.0%	$9,726	$4,098	42.1%
Undeveloped land	4,858	1,231	25.3%	4,232	939	22.2%	$1,041,167	$245,697	23.6%
Total	**28,601**	**4,063**		**25,124**	**6,313**		**$5,886,733**	**$1,064,408**	

*Explanation: Please note that 2025 estimates are shown according to 2000 land use ownership, since land ownership for 2025 is unknown.

Table IV-5e
Flood Hazard Area, Vulnerability Assessment, Rainier
For Years 2000 and 2025

	2000 Dwelling Units Estimate			2000 Commercial and Industrial Floor Space Estimate			2000 Value of Structures and Building Contents Estimate		
Land Use by Ownership in 2000	Total	In Hazard Area	% in Hazard Area	Total [1,000 sq. ft.]	In Hazard Area [1,000 sq. ft.]	% in Hazard Area	Total [1,000 $]	In Hazard Area [1,000 $]	% in Hazard Area
Residential	547	16	2.9%	0	0	0.0%	$41,288	$964	2.3%
Commercial/Industrial	10	0	0.0%	83	0	0.0%	$4,031	$0	0.0%
Religious Institutions & Private Schools	0	0	0.0%	5	0	0.0%	$251	$0	0.0%
Local Government	0	0	0.0%	164	0	0.0%	$16,371	$0	0.0%
Roads, Railroads, & Rights of Way	0	0	0.0%	0	0	0.0%	$0	$0	0.0%
Natural Resources (Public and Private)	2	0	0.0%	0	0	0.0%	$134	$0	0.0%
Parks, Preserves, Water, & Open Space	0	0	0.0%	0	0	0.0%	$0	$0	0.0%
Total	**559**	**16**		**253**	**0**		**$62,074**	**$964**	

	2025 Dwelling Units Forecast			2025 Commercial and Industrial Floor Space Forecast			2025 Value of Structures and Building Contents Forecast		
Land Use by Ownership in 2000*	Total	In Hazard Area	% in Hazard Area	Total [1,000 sq. ft.]	In Hazard Area [1,000 sq. ft.]	% in Hazard Area	Total [1,000 $]	In Hazard Area [1,000 $]	% in Hazard Area
Residential	625	29	4.7%	13	0	0.0%	$48,393	$1,966	4.1%
Commercial/Industrial	10	0	0.0%	84	0	0.0%	$4,134	$0	0.0%
Religious Institutions & Private Schools	0	0	0.0%	5	0	0.0%	$251	$0	0.0%
Local Government	0	0	0.0%	173	0	0.0%	$17,099	$0	0.0%
Roads, Railroads, & Rights of Way	0	0	0.0%	0	0	0.0%	$0	$0	0.0%
Natural Resources (Public and Private)	153	0	0.0%	0	0	0.0%	$11,660	$0	0.0%
Parks, Preserves, Water, & Open Space	0	0	0.0%	0	0	0.0%	$0	$0	0.0%
Undeveloped land	57	6	10.5%	37	0	0.0%	$7,484	$463	6.2%
Total	**845**	**35**		**313**	**0**		**$89,021**	**$2,429**	

*Explanation: Please note that 2025 estimates are shown according to 2000 land use ownership, since land ownership for 2025 is unknown.

Table IV-5f
Flood Hazard Area, Vulnerability Assessment, Tenino
For Years 2000 and 2025

	2000 Dwelling Units Estimate			2000 Commercial and Industrial Floor Space Estimate			2000 Value of Structures and Building Contents Estimate		
Land Use by Ownership in 2000	Total	In Hazard Area	% in Hazard Area	Total [1,000 sq. ft.]	In Hazard Area [1,000 sq. ft.]	% in Hazard Area	Total [1,000 $]	In Hazard Area [1,000 $]	% in Hazard Area
Residential	600	34	5.7%	0	0	0.0%	$41,885	$1,404	3.4%
Commercial/Industrial	19	0	0.0%	206	22	10.7%	$9,555	$1,889	19.8%
Religious Institutions & Private Schools	0	0	0.0%	13	0	0.0%	$1,603	$0	0.0%
Local Government	0	0	0.0%	235	165	70.3%	$31,459	$23,574	74.9%
Roads, Railroads, & Rights of Way	0	0	0.0%	0	0	0.0%	$42	$0	0.0%
Natural Resources (Public and Private)	1	1	100.0%	0	0	0.0%		$0	0.0%
Parks, Preserves, Water, & Open Space	0	0	0.0%	8	0	0.0%	$908	$0	0.0%
Total	**620**	**35**		**463**	**187**		**$85,452**	**$26,867**	

	2025 Dwelling Units Forecast			2025 Commercial and Industrial Floor Space Forecast			2025 Value of Structures and Building Contents Forecast		
Land Use by Ownership in 2000*	Total	In Hazard Area	% in Hazard Area	Total [1,000 sq. ft.]	In Hazard Area [1,000 sq. ft.]	% in Hazard Area	Total [1,000 $]	In Hazard Area [1,000 $]	% in Hazard Area
Residential	604	35	5.8%	16	14	87.2%	$43,641	$2,747	6.3%
Commercial/Industrial	19	0	0.0%	220	22	10.1%	$10,834	$1,889	17.4%
Religious Institutions & Private Schools	0	0	0.0%	13	0	0.0%	$1,603	$0	0.0%
Local Government	0	0	0.0%	280	188	67.2%	$35,654	$25,716	72.1%
Roads, Railroads, & Rights of Way	0	0	0.0%	0	0	0.0%	$42	$0	0.0%
Natural Resources (Public and Private)	27	6	21.8%	0	0	0.0%	$1,618	$304	18.8%
Parks, Preserves, Water, & Open Space	0	0	0.0%	2	0	0.0%	$383	$0	0.0%
Undeveloped land	18	6	32.4%	31	0	0.0%	$3,993	$368	9.2%
Total	**669**	**47**		**562**	**224**		**$97,767**	**$31,024**	

*Explanation: Please note that 2025 estimates are shown according to 2000 land use ownership, since land ownership for 2025 is unknown.

Table IV-5g
Flood Hazard Area, Vulnerability Assessment, Tumwater
For Years 2000 and 2025

	2000 Dwelling Units Estimate			2000 Commercial and Industrial Floor Space Estimate			2000 Value of Structures and Building Contents Estimate		
Land Use by Ownership in 2000	Total	In Hazard Area	% in Hazard Area	Total [1,000 sq. ft.]	In Hazard Area [1,000 sq. ft.]	% in Hazard Area	Total [1,000 $]	In Hazard Area [1,000 $]	% in Hazard Area
Residential	5,891	479	8.1%	0	0	0.0%	$486,926	$20,858	4.3%
Commercial/Industrial	55	4	7.3%	3,764	678	18.0%	$250,677	$32,333	12.9%
Religious Institutions & Private Schools	3	0	0.0%	181	93	51.1%	$15,605	$8,784	56.3%
Local Government	1	0	0.0%	1,756	711	40.5%	$126,153	$56,797	45.0%
State Government	0	0	0.0%	575	493	85.9%	$97,624	$92,637	94.9%
Federal Government	0	0	0.0%	14	0	0.0%	$1,040	$0	0.0%
Roads, Railroads, & Rights of Way	0	0	0.0%	0	0	0.0%	$0	$0	0.0%
Natural Resources (Public and Private)	0	0	0.0%	1	0	0.0%	$137	$0	0.0%
Parks, Preserves, Water, & Open Space	1	1	100.0%	5	5	100.0%	$7,125	$6,531	91.7%
Total	**5,951**	**484**		**6,297**	**1,981**		**$985,287**	**$217,939**	

	2025 Dwelling Units Forecast			2025 Commercial and Industrial Floor Space Forecast			2025 Value of Structures and Building Contents Forecast		
Land Use by Ownership in 2000*	Total	In Hazard Area	% in Hazard Area	Total [1,000 sq. ft.]	In Hazard Area [1,000 sq. ft.]	% in Hazard Area	Total [1,000 $]	In Hazard Area [1,000 $]	% in Hazard Area
Residential	7,579	783	10.3%	86	2	2.6%	$640,175	$47,338	7.4%
Commercial/Industrial	236	20	8.3%	4,034	774	19.2%	$288,263	$41,410	14.4%
Religious Institutions & Private Schools	3	0	0.0%	187	98	52.5%	$16,021	$9,200	57.4%
Local Government	1	0	0.0%	3,099	1,033	33.3%	$235,280	$82,957	35.3%
State Government	0	0	0.0%	609	520	85.4%	$100,410	$94,794	94.4%
Federal Government	0	0	0.0%	14	0	0.0%	$1,040	$0	0.0%
Roads, Railroads, & Rights of Way	0	0	0.0%	0	0	0.0%	$0	$0	0.0%
Natural Resources (Public and Private)	222	0	0.0%	220	0	0.0%	$37,243	$0	0.0%
Parks, Preserves, Water, & Open Space	1	1	100.0%	5	5	100.0%	$7,125	$6,531	91.7%
Undeveloped land	1,427	118	8.2%	1,352	221	16.4%	$233,549	$28,176	12.1%
Total	**9,470**	**921**		**9,607**	**2,653**		**$1,559,106**	**$310,406**	

*Explanation: Please note that 2025 estimates are shown according to 2000 land use ownership, since land ownership for 2025 is unknown.

Table IV-5h
Flood Hazard Area, Vulnerability Assessment, Unincorported Thurston County
For Years 2000 and 2025

	2000 Dwelling Units Estimate			2000 Commercial and Industrial Floor Space Estimate			2000 Value of Structures and Building Contents Estimate		
Land Use by Ownership in 2000	Total	In Hazard Area	% in Hazard Area	Total [1,000 sq. ft.]	In Hazard Area [1,000 sq. ft.]	% in Hazard Area	Total [1,000 $]	In Hazard Area [1,000 $]	% in Hazard Area
Residential	43,845	7,283	16.6%	0	0	0.0%	$4,607,949	$814,816	17.7%
Commercial/Industrial	191	47	24.6%	4,080	589	14.4%	$211,870	$34,725	16.4%
Religious Institutions & Private Schools	115	102	88.7%	361	54	14.9%	$50,421	$8,237	16.3%
Local Government	30	4	13.3%	1,608	367	22.8%	$248,850	$55,453	22.3%
State Government	20	18	90.0%	1,655	1,452	87.8%	$208,986	$192,123	91.9%
Federal Government	0	0	0.0%	53	1	1.9%	$6,750	$512	7.6%
Tribal	0	0	0.0%	0	0	100.0%	$0	$0	0.0%
Roads, Railroads, & Rights of Way	0	0	0.0%	0	0	0.0%	$398	$323	81.2%
Natural Resources (Public and Private)	729	404	55.4%	1,100	291	26.5%	$137,013	$72,461	52.9%
Parks, Preserves, Water, & Open Space	41	32	78.0%	32	21	64.3%	$14,272	$8,443	59.2%
Total	**44,971**	**7,890**		**8,890**	**2,775**		**$5,486,508**	**$1,187,094**	

	2025 Dwelling Units Forecast			2025 Commercial and Industrial Floor Space Forecast			2025 Value of Structures and Building Contents Forecast		
Land Use by Ownership in 2000*	Total	In Hazard Area	% in Hazard Area	Total [1,000 sq. ft.]	In Hazard Area [1,000 sq. ft.]	% in Hazard Area	Total [1,000 $]	In Hazard Area [1,000 $]	% in Hazard Area
Residential	54,705	9,459	17.3%	503	55	11.0%	$5,748,920	$1,038,897	18.1%
Commercial/Industrial	488	188	38.4%	4,520	740	16.4%	$285,775	$63,980	22.4%
Religious Institutions & Private Schools	125	112	89.6%	377	54	14.2%	$53,003	$9,229	17.4%
Local Government	30	4	13.3%	2,304	822	35.7%	$318,579	$100,956	31.7%
State Government	20	18	90.0%	1,928	1,641	85.2%	$236,358	$211,071	89.3%
Federal Government	0	0	0.0%	71	1	1.4%	$8,511	$512	6.0%
Tribal	1	0	50.0%	0	0	100.0%	$86	$43	50.0%
Roads, Railroads, & Rights of Way	0	0	0.0%	0	0	0.0%	$398	$323	81.2%
Natural Resources (Public and Private)	10,913	5,347	49.0%	1,630	582	35.7%	$1,212,741	$598,020	49.3%
Parks, Preserves, Water, & Open Space	41	32	78.0%	21	11	53.9%	$13,150	$7,502	57.0%
Undeveloped land	15,479	3,871	25.0%	2,056	418	20.3%	$1,760,373	$430,552	24.5%
Total	**81,802**	**19,031**		**13,410**	**4,324**		**$9,637,895**	**$2,461,085**	

*Explanation: Please note that 2025 estimates are shown according to 2000 land use ownership, since land ownership for 2025 is unknown.

Table IV-5i
Flood Hazard Area, Vulnerability Assessment, Yelm
For Years 2000 and 2025

	2000 Dwelling Units Estimate			2000 Commercial and Industrial Floor Space Estimate			2000 Value of Structures and Building Contents Estimate		
Land Use by Ownership in 2000	Total	In Hazard Area	% in Hazard Area	Total [1,000 sq. ft.]	In Hazard Area [1,000 sq. ft.]	% in Hazard Area	Total [1,000 $]	In Hazard Area [1,000 $]	% in Hazard Area
Residential	1,273	113	8.9%	0	0	0.0%	$91,116	$6,597	7.2%
Commercial/Industrial	25	2	8.0%	1,093	126	11.5%	$66,679	$3,204	4.8%
Religious Institutions & Private Schools	4	0	0.0%	48	8	15.5%	$6,333	$0	0.0%
Local Government	1	0	0.0%	324	75	23.2%	$55,255	$11,453	20.7%
Roads, Railroads, & Rights of Way	0	0	0.0%	0	0	0.0%	$0	$0	0.0%
Natural Resources (Public and Private)	14	5	35.7%	1	1	100.0%	$763	$248	32.5%
Parks, Preserves, Water, & Open Space	0	0	0.0%	2	0	0.0%	$27	$0	0.0%
Total	**1,317**	**120**		**1,467**	**209**		**$220,172**	**$21,501**	

	2025 Dwelling Units Forecast			2025 Commercial and Industrial Floor Space Forecast			2025 Value of Structures and Building Contents Forecast		
Land Use by Ownership in 2000*	Total	In Hazard Area	% in Hazard Area	Total [1,000 sq. ft.]	In Hazard Area [1,000 sq. ft.]	% in Hazard Area	Total [1,000 $]	In Hazard Area [1,000 $]	% in Hazard Area
Residential	1,599	205	12.8%	189	87	46.2%	$132,627	$21,297	16.1%
Commercial/Industrial	32	2	7.1%	1,206	141	11.7%	$77,199	$4,551	5.9%
Religious Institutions & Private Schools	4	0	0.0%	48	8	15.5%	$6,333	$0	0.0%
Local Government	1	0	0.0%	358	75	21.0%	$58,283	$11,453	19.6%
Roads, Railroads, & Rights of Way	0	0	0.0%	0	0	0.0%	$0	$0	0.0%
Natural Resources (Public and Private)	414	195	47.1%	83	9	11.4%	$38,481	$15,468	40.2%
Parks, Preserves, Water, & Open Space	0	0	0.0%	2	0	0.0%	$27	$0	0.0%
Undeveloped land	1,636	676	41.4%	324	22	6.7%	$153,429	$53,541	34.9%
Total	**3,684**	**1,078**		**2,210**	**342**		**$466,379**	**$106,309**	

*Explanation: Please note that 2025 estimates are shown according to 2000 land use ownership, since land ownership for 2025 is unknown.

Table IV-6
Flood Hazard Area, Critical Facilities

Jurisdiction*		Priority I Facilities Total	Priority I Facilities In Hazard Area	Priority I Facilities % in Hazard Area	Priority II Facilities Total	Priority II Facilities In Hazard Area	Priority II Facilities % in Hazard Area
Bucoda							
	Total	**1**	**1**	**100.0%**	**0**	**0**	**0.0%**
Lacey							
	City	4	0	0.0%	13	0	0.0%
	UGA	1	0	0.0%	8	0	0.0%
	Total	**5**	**0**	**0.0%**	**21**	**0**	**0.0%**
Olympia							
	City	19	0	0.0%	20	0	0.0%
	UGA	1	0	0.0%	1	0	0.0%
	Total	**20**	**0**	**0.0%**	**21**	**0**	**0.0%**
Rainier							
	City	2	0	0.0%	1	0	0.0%
	UGA	0	0	0.0%	0	0	0.0%
	Total	**2**	**0**	**0.0%**	**1**	**0**	**0.0%**
Tenino							
	City	3	0	0.0%	4	0	0.0%
	UGA	0	0	0.0%	0	0	0.0%
	Total	**3**	**0**	**0.0%**	**4**	**0**	**0.0%**
Tumwater							
	City	5	0	0.0%	6	0	0.0%
	UGA	2	0	0.0%	1	0	0.0%
	Total	**7**	**0**	**0.0%**	**7**	**0**	**0.0%**
Yelm							
	City	3	0	0.0%	5	0	0.0%
	UGA	0	0	0.0%	1	0	0.0%
	Total	**3**	**0**	**0.0%**	**6**	**0**	**0.0%**
Grand Mound UGA							
	Total	**2**	**0**	**0.0%**	**0**	**0**	**0.0%**
Total Cities		**37**	**1**	**2.7%**	**49**	**0**	**0.0%**
Total UGAs		**6**	**0**	**0.0%**	**11**	**0**	**0.0%**
Total Urban Areas		**43**	**1**	**2.3%**	**60**	**0**	**0.0%**
Rural Unincorporated County		**32**	**1**	**3.1%**	**11**	**0**	**0.0%**
Thurston County Total		**75**	**2**	**2.7%**	**71**	**0**	**0.0%**

*Explanation: Please note that this table indicates the number of critical facilities which are located in the jurisdiction, not their ownership. For example, the County Courthouse is owned by the County but is located in the City of Olympia. Similarly, hospitals are privately owned facilities located within jurisdicitonal boundaries.

Landslide Hazard Description

Landslides are the movement of rock, soil, or other debris, down a slope. The term landslide includes a wide range of ground movement, such as rock falls, deep failure of slopes, and shallow debris flows. Gravity acting on an overly steep slope is the primary cause of a landslide. However, they are influenced by both natural factors (geology, topography, weather, and hydrology) and human activity (mining and construction of buildings, railroads, and highways). Landslides are activated by storms, fires, earthquakes, volcanoes, and various human activities.

Landslides vary greatly in size and composition: from a thin mass of soil a few yards wide to deep-seated bedrock slides miles across. Mudflows (or debris flows) are flows of rock, earth, and other debris saturated with water. They develop when water rapidly accumulates in the ground, such as during heavy rainfall or rapid snowmelt, changing the earth into a flowing river of mud or "slurry" which can travel at avalanche speeds, growing in size as it picks up trees, cars, and other materials along the way. Other types of landslides include: rock slides, slumps, mudslides, and earthflows. All of these differ in terms of content and flow. The travel rate of a landslide can range from a few inches per month to many feet per second depending on the slope, type of material, and moisture content.

The following factors will affect the severity of a landslide:

- Erosion – Erosion caused by rivers, glaciers, or ocean waves created by overly steep slopes.
- Unstable slopes – Rock and soil slopes are weakened through saturation by snowmelt or heavy rain.
- Earthquakes – The shaking from earthquakes creates stress that makes weak slopes fail.
- Volcanic eruptions – Eruptions produce loose ash deposits and debris flows.
- Vibrations – Machinery, traffic, blasting, and even thunder may cause vibrations that trigger failure of weak slopes.
- Increase of load – Weight of rain/snow, fills, vegetation, stockpiling of rock or ore from waste piles or from man-made structures may cause weak slopes to fail.
- Hydrologic factors – Rain, high water tables, little or no ground cover, and numerous freeze/thaw cycles may cause weak slopes to fail.
- Human activity – These include development activities such as cutting and filling along roads and removal of forest vegetation. Such activities are capable of greatly altering slope form and groundwater conditions which can cause weak slopes to fail.
- Removal of lateral and underlying support – Erosion, previous slides, road cuts and quarries can trigger failure of weak slopes.
- Increase of lateral pressures – Hydraulic pressures, tree roots, crystallization, swelling of clay soil may cause weak slopes to fail.
- Regional tilting – Geological movements can trigger weak slopes to fail.

Landslide Hazard Historical Occurrences and Impacts

The State of Washington rates landslide losses second to flood losses for the state as a whole with the Puget Sound basin having the greatest vulnerability. This is because of increased population density and development on and below bluffs and slopes. In Thurston County, as development continues in high risk areas, vulnerability will increase. The greatest risk is to individual residential structures on or below bluffs or slopes, roads, pipelines, and electrical and communications distribution lines.

In September 1990, a major landslide occurred on the Nisqually River approximately five miles downstream from La Grande Dam. Over a quarter-million cubic yards of material blocked the River causing the channel to shift several hundred yards to the north.

During the floods of February 1996, large sections of conglomerate bluff slid into the Nisqually River in the vicinity of Thuja Lane near Yelm when groundwater, under heavy pressure from near record rains, spewed out of the hillside eroding and weakening the bluff. Several residences were subsequently declared unsafe to occupy.

Also in February 1996, a landslide broke the two main sewer lines that carried the majority of Tumwater's and the brewery's wastewater to the LOTT treatment plant near downtown Olympia. The pipelines were on a hillside under the Union Pacific Railroad tracks at the south end of Capitol Lake.

During and following most major rain events, there are several slides along county roads in the hill areas of south county. These slides are usually of the nuisance variety, causing roads to be closed for a few hours or days. However, in February 1996, a landslide removed a section of Flumerfelt Road, southwest of Bucoda, which could not be reopened for several months.

Following the December 1996 and March 1997 rain storms, sections of the coastal bluff near Hunter Point across from Squaxin Island slid a few feet resulting in two residences being declared unsafe to occupy. These storms also caused a slide south of Rainier which threatened a section of the Northwest Pipeline and the disruption of natural gas supplies.

In the winter of 1998-99, three years of above average winter rainfall contributed to a massive slide in the Hunter Point, Carlyon Beach area. The community impact has been significant. The 66-acre landslide ultimately left 40 homes uninhabitable. Homeowners were requested to evacuate and most of the affected homes were demolished. In a press release, the Governor noted that "many landslide victims face catastrophic financial losses because there is no insurance to cover landslide damage to homes and personal property."

Landslide Hazard Assessing Vulnerability

Summary Assessment

Thurston County has a history of landslides and their numbers seem to be increasing, suggesting a high probability of occurrence. Although there are exceptions, such as the Carlyon Beach landslide, landslides tend to occur in isolated, sparsely developed areas threatening individual structures and remote sections of the transportation, energy, and communications infrastructure suggesting low vulnerability. Because of the high probability of occurrence and the trend to more frequent landslides, the county has assigned a moderate risk rating.

Delineation of Landslide Hazard Area

Map 7 - Slope Map.

For the purposes of the data tables in this report, the Landslide Hazard Area has been defined as those parcels in the county on which slopes of 40 percent or more occur.

Population in Hazard Area

Table IV-7, Landslide Hazard Area Population, 2000 and 2025.

This table assesses an aspect of current and future vulnerability by providing data on the number of people living within the hazard area as compared to total population, by jurisdiction, in the years 2000 and 2025.

Inventory of Assets and Dollar Value in Hazard Area

Tables IV-8a – IV-8i, Landslide Hazard Area Vulnerability Assessment, 2000 and 2025.

These tables provide an estimate of the number of existing and future structures which are potentially impacted by the hazard, as well as an estimate of structure and building contents value, in order to provide information on potential dollar losses. Tables are provided by jurisdiction, for the years 2000 and 2025.

Critical Facilities and Infrastructure in Hazard Area

Based on the community impact which historical occurrences of natural hazards caused, it is clear that natural hazards can destroy or damage facilities that may be critical for responding to the disaster and for maintaining a safe environment and public order. Among these are communications installations; electrical generating and transmission facilities; water storage, purification, and pumping facilities; sewage treatment facilities; hospitals; and police stations. In

addition, natural hazards can seriously disrupt the transportation network; bridges can be knocked out, and roads and highways damaged or blocked by debris, further isolating resources. In a major disaster, almost all surface means of transportation within a community may be disrupted, particularly in the initial stages of the hazard event.

Specific information on the location of critical facilities and infrastructure is housed with the Emergency Management Council of Thurston County. However, Table IV-9 shows the number of Priority I and II Critical Facilities located in the hazard area. Priority I facilities included in this table fall into the following categories: Medical, Fire Districts & Departments, Law Enforcement Correctional Facilities, Emergency Services Centers, Radio & TV Stations, Humanitarian & Volunteer Services, Electrical Distribution & Components, and Telephone Service & Components. Although State and County Transportation Lifelines are Priority I Critical Facilities, it is not currently possible to include an analysis of them in the data table. Priority II facilities consist of Clinics, Facilities Pre-Designated as Shelters by the Red Cross, Animal Shelters, Newspapers, Sewage Treatment, and Water Distribution Systems & Components.

Critical facilities include both public and private facilities. Table IV-9 indicates the number of facilities which are located in the jurisdiction, not their ownership. For example, hospitals are critical facilities but are privately owned. Likewise a facility owned by one jurisdiction may be located within the boundaries of another; such as the County Courthouse complex which is located in the City of Olympia.

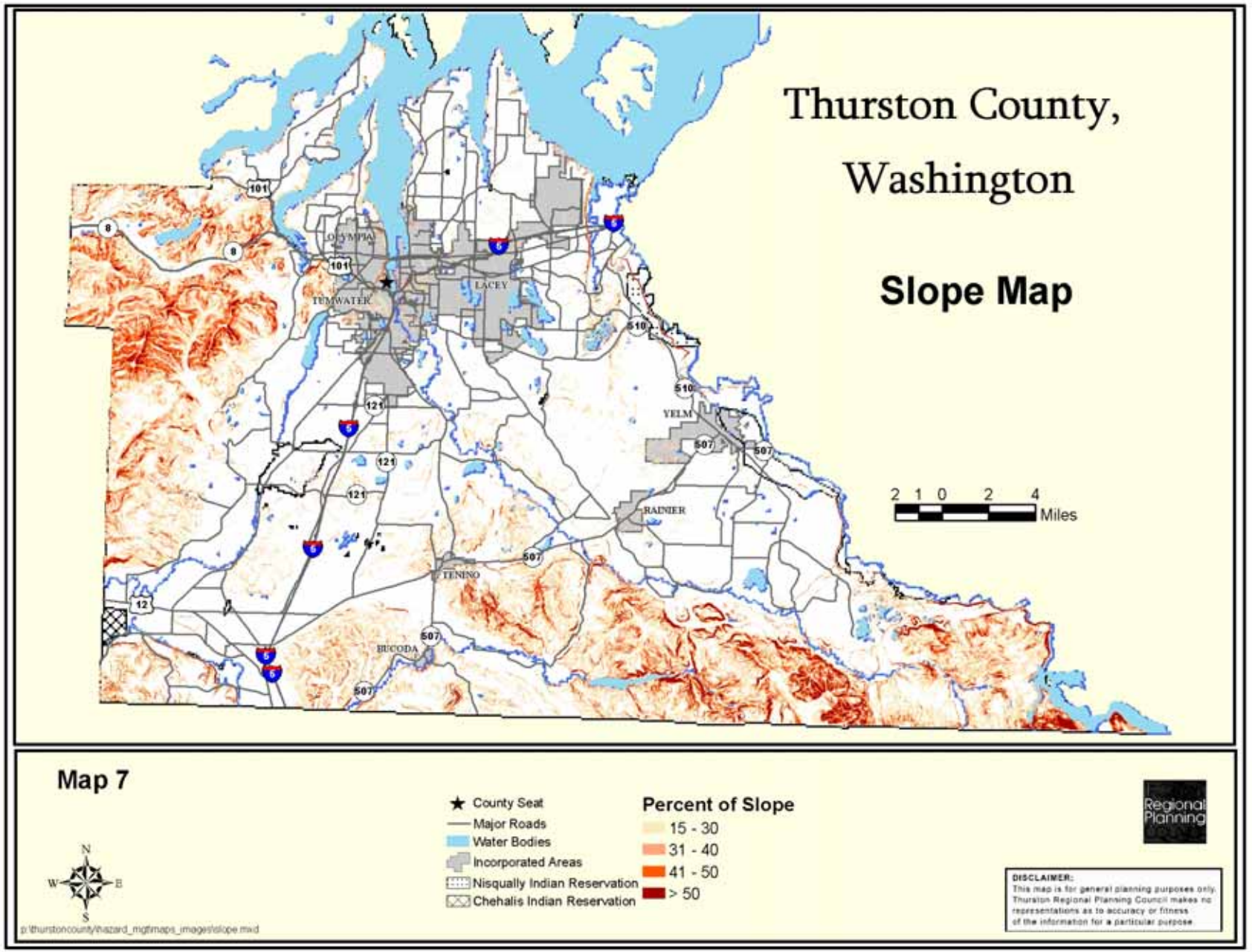
Thurston County,
Washington
Slope Map
OLYMPIA
LACEY
TUMWATER
YELM
RAINIER
TENINO
BUCODA
101
8
5
510
121
507
12
2 1 0 2 4
Miles
Map 7
County Seat
Major Roads
Water Bodies
Incorporated Areas
Nisqually Indian Reservation
Chehalis Indian Reservation
Percent of Slope
15 - 30
31 - 40
41 - 50
> 50
N
W
E
S
p:\thurstoncounty\hazard_mgtmaps_images\slope.mxd
Regional Planning
DISCLAIMER:
This map is for general planning purposes only. Thurston Regional Planning Council makes no representations as to accuracy or fitness of the information for a particular purpose.

Table IV-7
Landslide Hazard Area, Population, 2000 and 2025

Jurisdiction		2000 Population Estimate			2025 Population Forecast		
		Total	In Hazard Area	% in Hazard Area	Total	In Hazard Area	% in Hazard Area
Bucoda							
	Total	**584**	**3**	**0.5%**	**641**	**27**	**4.2%**
Lacey							
	City	30,958	5	0.0%	48,049	768	1.6%
	UGA	28,029	45	0.2%	46,648	646	1.4%
	Total	**58,986**	**50**	**0.1%**	**94,697**	**1,414**	**1.5%**
Olympia							
	City	42,519	1,326	3.1%	56,969	1,874	3.3%
	UGA	8,911	131	1.5%	22,057	887	4.0%
	Total	**51,429**	**1,457**	**2.8%**	**79,025**	**2,761**	**3.5%**
Rainier							
	City	1,356	10	0.7%	2,127	15	0.7%
	UGA	34		0.0%	186		0.0%
	Total	**1,390**	**10**	**0.7%**	**2,314**	**15**	**0.7%**
Tenino							
	City	1,521	15	1.0%	1,566	43	2.8%
	UGA	120		0.0%	365		0.0%
	Total	**1,641**	**15**	**0.9%**	**1,931**	**43**	**2.2%**
Tumwater							
	City	12,939	154	1.2%	19,423	824	4.2%
	UGA	7,068	21	0.3%	18,742	506	2.7%
	Total	**20,007**	**176**	**0.9%**	**38,165**	**1,330**	**3.5%**
Yelm							
	City	3,174	0	0.0%	8,559	2,298	26.9%
	UGA	1,071	5	0.5%	2,827	29	1.0%
	Total	**4,245**	**5**	**0.1%**	**11,386**	**2,328**	**20.4%**
Grand Mound UGA							
	Total	**720**	**0**	**0.0%**	**2,064**	**0**	**0.0%**
Chehalis Reservation		**34**	**0**	**0.0%**	**126**	**0**	**0.0%**
Nisqually Reservation		**599**	**227**	**37.9%**	**1,056**	**396**	**37.5%**
Total Cities		**93,050**	**1,513**	**1.6%**	**137,334**	**5,849**	**4.3%**
Total UGAs		**45,952**	**203**	**0.4%**	**92,890**	**2,068**	**2.2%**
Total Urban Areas		**139,002**	**1,716**	**1.2%**	**230,223**	**7,917**	**3.4%**
Rural Unincorporated County		**67,709**	**2,981**	**4.4%**	**102,852**	**10,738**	**10.4%**
Thurston County Total		**207,344**	**4,924**	**2.4%**	**334,258**	**19,051**	**5.7%**

Table IV-8a
Landslide Hazard Area, Vulnerability Assessment, Bucoda
For Years 2000 and 2025

	2000 Dwelling Units Estimate			2000 Commercial and Industrial Floor Space Estimate			2000 Value of Structures and Building Contents		
Land Use by Ownership in 2000	Total	In Hazard Area	% in Hazard Area	Total [1,000 sq. ft.]	In Hazard Area [1,000 sq. ft.]	% in Hazard Area	Total [1,000 $]	In Hazard Area [1,000 $]	% in Hazard Area
Residential	225	1	0.4%	1	0	0.0%	$11,225	$0	0.0%
Commercial/Industrial	1	0	0.0%	20	0	0.0%	$642	$0	0.0%
Religious Institutions & Private Schools	0	0	0.0%	2	0	0.0%	$228	$0	0.0%
Local Government	0	0	0.0%	11	0	0.0%	$671	$0	0.0%
Roads, Railroads, & Rights of Way	0	0	0.0%	0	0	0.0%	$0	$0	0.0%
Natural Resources (Public and Private)	3	0	0.0%	0	0	0.0%	$5	$0	0.0%
Parks, Preserves, Water, & Open Space	0	0	0.0%	0	0	0.0%	$17	$0	0.0%
Total	**229**	**1**		**34**	**0**		**$12,787**	**$0**	

	2025 Dwelling Units Forecast			2025 Commercial and Industrial Floor Space Forecast			2025 Value of Structures and Building Contents Forecast		
Land Use by Ownership in 2000*	Total	In Hazard Area	% in Hazard Area	Total [1,000 sq. ft.]	In Hazard Area [1,000 sq. ft.]	% in Hazard Area	Total [1,000 $]	In Hazard Area [1,000 $]	% in Hazard Area
Residential	227	1	0.4%	1	0	0.0%	$11,326	$0	0.0%
Commercial/Industrial	1	0	0.0%	20	0	0.0%	$646	$0	0.0%
Religious Institutions & Private Schools	0	0	0.0%	2	0	0.0%	$228	$0	0.0%
Local Government	0	0	0.0%	14	0	0.0%	$772	$0	0.0%
Roads, Railroads, & Rights of Way	0	0	0.0%	0	0	0.0%	$0	$0	0.0%
Natural Resources (Public and Private)	11	5	46.7%	0	0	0.0%	$367	$235	64.0%
Parks, Preserves, Water, & Open Space	0	0	0.0%	0	0	0.0%	$17	$0	0.0%
Undeveloped land	19	5	25.2%	4	0	0.0%	$1,051	$222	21.1%
Total	**258**	**11**		**41**	**0**		**$14,406**	**$456**	

*Explanation: Please note that 2025 estimates are shown according to 2000 land use ownership, since land ownership for 2025 is unknown.

Table IV-8b
Landslide Hazard Area, Vulnerability Assessment, Chehalis Reservation*

2000 Dwelling Units Estimate		
Total	**In Hazard Area**	**% in Hazard Area**
13	0	0.0%

2000 Commercial, Industrial, and Tribal Assets - Floor Space Estimate		
Total [1,000 sq. ft.]	**In Hazard Area [1,000 sq. ft.]**	**% in Hazard Area**
97	0	0.0%

2000 Value of Structures and Building Contents Estimate		
Total [1,000 $]	**In Hazard Area [1,000 $]**	**% in Hazard Area**
$27,443	$0	0.0%

New Tribal Assets Planned for 2004		
Total [1,000 sq. ft.]	**Construction Cost Estimate [1,000 $]**	**% in Hazard Area**
10	$1,300	0.0%

*Thurston County portion only.

Table IV-8c
Landslide Hazard Area, Vulnerability Assessment, Lacey
For Years 2000 and 2025

	2000 Dwelling Units Estimate			2000 Commercial and Industrial Floor Space Estimate			2000 Value of Structures and Building Contents Estimate		
Land Use by Ownership in 2000	Total	In Hazard Area	% in Hazard Area	Total [1,000 sq. ft.]	In Hazard Area [1,000 sq. ft.]	% in Hazard Area	Total [1,000 $]	In Hazard Area [1,000 $]	% in Hazard Area
Residential	12,601	2	0.0%	1	0	0.0%	$1,148,978	$0	0.0%
Commercial/Industrial	431		0.0%	5,178	0	0.0%	$398,500	$0	0.0%
Religious Institutions & Private Schools	17	0	0.0%	479	0	0.0%	$42,235	$0	0.0%
Local Government	7	0	0.0%	1,066	0	0.0%	$98,505	$0	0.0%
State Government	8	0	0.0%	458	0	0.0%	$93,344	$0	0.0%
Roads, Railroads, & Rights of Way	0	0	0.0%	0	0	0.0%	$26	$0	0.0%
Natural Resources (Public and Private)	8	0	0.0%	16	2	11.6%	$1,009	$116	11.5%
Parks, Preserves, Water, & Open Space	6	0	0.0%	3	0	0.0%	$1,537	$0	0.0%
Total	**13,078**	**2**		**7,201**	**2**		**$1,784,134**	**$116**	

	2025 Dwelling Units Forecast			2025 Commercial and Industrial Floor Space Forecast			2025 Value of Structures and Building Contents Forecast		
Land Use by Ownership in 2000*	Total	In Hazard Area	% in Hazard Area	Total [1,000 sq. ft.]	In Hazard Area [1,000 sq. ft.]	% in Hazard Area	Total [1,000 $]	In Hazard Area [1,000 $]	% in Hazard Area
Residential	13,547	2	0.0%	191	0	0.0%	$1,251,598	$0	0.0%
Commercial/Industrial	1,961	0	0.0%	5,310	0	0.0%	$548,436	$0	0.0%
Religious Institutions & Private Schools	17	0	0.0%	492	0	0.0%	$43,375	$0	0.0%
Local Government	7	0	0.0%	1,148	0	0.0%	$106,011	$0	0.0%
State Government	8	0	0.0%	463	0	0.0%	$93,857	$0	0.0%
Roads, Railroads, & Rights of Way	0	0	0.0%	0	0	0.0%	$7	$0	0.0%
Natural Resources (Public and Private)	524	0	0.0%	337	103	30.4%	$76,933	$9,353	12.2%
Parks, Preserves, Water, & Open Space	6	0	0.0%	0	0	0.0%	$1,287	$0	0.0%
Undeveloped land	4,297	323	7.5%	2,804	0	0.0%	$644,099	$29,127	4.5%
Total	**20,366**	**325**		**10,746**	**103**		**$2,765,603**	**$38,480**	

*Explanation: Please note that 2025 estimates are shown according to 2000 land use ownership, since land ownership for 2025 is unknown.

Table IV-8d
Landslide Hazard Area, Vulnerability Assessment, Olympia
For Years 2000 and 2025

	2000 Dwelling Units Estimate			2000 Commercial and Industrial Floor Space Estimate			2000 Value of Structures and Building Contents Estimate		
Land Use by Ownership in 2000	Total	In Hazard Area	% in Hazard Area	Total [1,000 sq. ft.]	In Hazard Area [1,000 sq. ft.]	% in Hazard Area	Total [1,000 $]	In Hazard Area [1,000 $]	% in Hazard Area
Residential	19,018	503	2.6%	1	0	0.0%	$1,729,120	$48,410	2.8%
Commercial/Industrial	610	2	0.3%	10,664	123	1.2%	$982,536	$7,543	0.8%
Religious Institutions & Private Schools	12	0	0.0%	1,117	0	0.0%	$131,766	$0	0.0%
Local Government	49	0	0.0%	2,149	209	9.7%	$376,202	$33,252	8.8%
State Government	2	1	50.0%	3,484	1,634	46.9%	$768,694	$249,209	32.4%
Federal Government	0	0	0.0%	37	0	0.0%	$1,898	$0	0.0%
Roads, Railroads, & Rights of Way	0	0	0.0%	0	0	0.0%	$0	$0	0.0%
Natural Resources (Public and Private)	7	0	0.0%	83	0	0.0%	$2,843	$0	0.0%
Parks, Preserves, Water, & Open Space	4	0	0.0%	6	6	100.0%	$9,326	$1,087	11.7%
Total	**19,702**	**506**		**17,540**	**1,971**		**$4,002,384**	**$339,500**	

	2025 Dwelling Units Forecast			2025 Commercial and Industrial Floor Space Forecast			2025 Value of Structures and Building Contents Forecast		
Land Use by Ownership in 2000*	Total	In Hazard Area	% in Hazard Area	Total [1,000 sq. ft.]	In Hazard Area [1,000 sq. ft.]	% in Hazard Area	Total [1,000 $]	In Hazard Area [1,000 $]	% in Hazard Area
Residential	22,048	659	3.0%	625	9	1.5%	$2,104,448	$64,602	3.1%
Commercial/Industrial	773	27	3.5%	11,675	144	1.2%	$1,135,516	$12,878	1.1%
Religious Institutions & Private Schools	12	0	0.0%	1,209	0	0.0%	$144,385	$0	0.0%
Local Government	49	0	0.0%	3,216	215	6.7%	$521,303	$34,179	6.6%
State Government	2	1	50.0%	3,651	1,634	44.8%	$791,415	$249,209	31.5%
Federal Government	0	0	0.0%	61	0	0.0%	$5,206	$0	0.0%
Roads, Railroads, & Rights of Way	0	0	0.0%	0	0	0.0%	$0	$0	0.0%
Natural Resources (Public and Private)	851	0	0.0%	449	0	0.0%	$133,566	$0	0.0%
Parks, Preserves, Water, & Open Space	8	0	0.0%	6	6	100.0%	$9,726	$1,087	11.2%
Undeveloped land	4,858	254	5.2%	4,232	385	9.1%	$1,041,167	$76,710	7.4%
Total	**28,601**	**941**		**25,124**	**2,394**		**$5,886,733**	**$438,665**	

*Explanation: Please note that 2025 estimates are shown according to 2000 land use ownership, since land ownership for 2025 is unknown.

Table IV-8e
Landslide Hazard Area, Vulnerability Assessment, Rainier
For Years 2000 and 2025

	2000 Dwelling Units Estimate			2000 Commercial and Industrial Floor Space Estimate			2000 Value of Structures and Building Contents Estimate		
Land Use by Ownership in 2000	Total	In Hazard Area	% in Hazard Area	Total [1,000 sq. ft.]	In Hazard Area [1,000 sq. ft.]	% in Hazard Area	Total [1,000 $]	In Hazard Area [1,000 $]	% in Hazard Area
Residential	547	4	0.7%	0	0	0.0%	$41,288	$477	1.2%
Commercial/Industrial	10	0	0.0%	83	0	0.0%	$4,031	$0	0.0%
Religious Institutions & Private Schools	0	0	0.0%	5	0	0.0%	$251	$0	0.0%
Local Government	0	0	0.0%	164	0	0.0%	$16,371	$0	0.0%
Roads, Railroads, & Rights of Way	0	0	0.0%	0	0	0.0%	$0	$0	0.0%
Natural Resources (Public and Private)	2	0	0.0%	0	0	0.0%	$134	$0	0.0%
Parks, Preserves, Water, & Open Space	0	0	0.0%	0	0	0.0%	$0	$0	0.0%
Total	**559**	**4**		**253**	**0**		**$62,074**	**$477**	

	2025 Dwelling Units Forecast			2025 Commercial and Industrial Floor Space Forecast			2025 Value of Structures and Building Contents Forecast		
Land Use by Ownership in 2000*	Total	In Hazard Area	% in Hazard Area	Total [1,000 sq. ft.]	In Hazard Area [1,000 sq. ft.]	% in Hazard Area	Total [1,000 $]	In Hazard Area [1,000 $]	% in Hazard Area
Residential	625	6	1.0%	13	0	0.0%	$48,393	$631	1.3%
Commercial/Industrial	10	0	0.0%	84	0	0.0%	$4,134	$0	0.0%
Religious Institutions & Private Schools	0	0	0.0%	5	0	0.0%	$251	$0	0.0%
Local Government	0	0	0.0%	173	0	0.0%	$17,099	$0	0.0%
Roads, Railroads, & Rights of Way	0	0	0.0%	0	0	0.0%	$0	$0	0.0%
Natural Resources (Public and Private)	153	0	0.0%	0	0	0.0%	$11,660	$0	0.0%
Parks, Preserves, Water, & Open Space	0	0	0.0%	0	0	0.0%	$0	$0	0.0%
Undeveloped land	57	0	0.0%	37	0	0.0%	$7,484	$0	0.0%
Total	**845**	**6**		**313**	**0**		**$89,021**	**$631**	

*Explanation: Please note that 2025 estimates are shown according to 2000 land use ownership, since land ownership for 2025 is unknown.

Table IV-8f
Landslide Hazard Area, Vulnerability Assessment, Tenino
For Years 2000 and 2025

	2000 Dwelling Units Estimate			2000 Commercial and Industrial Floor Space Estimate			2000 Value of Structures and Building Contents Estimate		
Land Use by Ownership in 2000	Total	In Hazard Area	% in Hazard Area	Total [1,000 sq. ft.]	In Hazard Area [1,000 sq. ft.]	% in Hazard Area	Total [1,000 $]	In Hazard Area [1,000 $]	% in Hazard Area
Residential	600	5	0.8%	0	0	0.0%	$41,885	$0	0.0%
Commercial/Industrial	19	0	0.0%	206	0	0.0%	$9,555	$0	0.0%
Religious Institutions & Private Schools	0	0	0.0%	13	0	0.0%	$1,603	$0	0.0%
Local Government	0	0	0.0%	235	0	0.0%	$31,459	$607	1.9%
Roads, Railroads, & Rights of Way	0	0	0.0%	0	0	0.0%	$42	$0	0.0%
Natural Resources (Public and Private)	1	1	100.0%		0	0.0%	$0	$0	0.0%
Parks, Preserves, Water, & Open Space	0	0	0.0%	8	0	0.0%	$908	$52	5.7%
Total	**620**	**6**		**463**	**0**		**$85,452**	**$658**	

	2025 Dwelling Units Forecast			2025 Commercial and Industrial Floor Space Forecast			2025 Value of Structures and Building Contents Forecast		
Land Use by Ownership in 2000*	Total	In Hazard Area	% in Hazard Area	Total [1,000 sq. ft.]	In Hazard Area [1,000 sq. ft.]	% in Hazard Area	Total [1,000 $]	In Hazard Area [1,000 $]	% in Hazard Area
Residential	604	6	0.9%	16	0	0.0%	$43,641	$32	0.1%
Commercial/Industrial	19	0	0.0%	220	0	0.0%	$10,834	$0	0.0%
Religious Institutions & Private Schools	0	0	0.0%	13	0	0.0%	$1,603	$0	0.0%
Local Government	0	0	0.0%	280	0	0.0%	$35,654	$607	1.7%
Roads, Railroads, & Rights of Way	0	0	0.0%	0	0	0.0%	$42	$0	0.0%
Natural Resources (Public and Private)	27	12	44.7%	0	0	0.0%	$1,618	$689	42.6%
Parks, Preserves, Water, & Open Space	0	0	0.0%	2	0	0.0%	$383	$52	13.5%
Undeveloped land	18	1	4.9%	31	0	0.0%	$3,993	$56	1.4%
Total	**669**	**19**		**562**	**0**		**$97,767**	**$1,435**	

*Explanation: Please note that 2025 estimates are shown according to 2000 land use ownership, since land ownership for 2025 is unknown.

Table IV-8g
Landslide Hazard Area, Vulnerability Assessment, Tumwater
For Years 2000 and 2025

	2000 Dwelling Units Estimate			2000 Commercial and Industrial Floor Space Estimate			2000 Value of Structures and Building Contents Estimate		
Land Use by Ownership in 2000	Total	In Hazard Area	% in Hazard Area	Total [1,000 sq. ft.]	In Hazard Area [1,000 sq. ft.]	% in Hazard Area	Total [1,000 $]	In Hazard Area [1,000 $]	% in Hazard Area
Residential	5,891	56	1.0%	0	0	0.0%	$486,926	$11,535	2.4%
Commercial/Industrial	55	3	5.5%	3,764	59	1.6%	$250,677	$746	0.3%
Religious Institutions & Private Schools	3	0	0.0%	181	0	0.0%	$15,605	$0	0.0%
Local Government	1	0	0.0%	1,756	38	2.2%	$126,153	$1,335	1.1%
State Government	0	0	0.0%	575	0	0.0%	$97,624	$0	0.0%
Federal Government	0	0	0.0%	14	0	0.0%	$1,040	$0	0.0%
Roads, Railroads, & Rights of Way	0	0	0.0%	0	0	0.0%	$0	$0	0.0%
Natural Resources (Public and Private)	0	0	0.0%	1	1	100.0%	$137	$119	86.5%
Parks, Preserves, Water, & Open Space	1	0	0.0%	5	2	34.8%	$7,125	$317	4.4%
Total	**5,951**	**59**		**6,297**	**101**		**$985,287**	**$14,051**	

	2025 Dwelling Units Forecast			2025 Commercial and Industrial Floor Space Forecast			2025 Value of Structures and Building Contents Forecast		
Land Use by Ownership in 2000*	Total	In Hazard Area	% in Hazard Area	Total [1,000 sq. ft.]	In Hazard Area [1,000 sq. ft.]	% in Hazard Area	Total [1,000 $]	In Hazard Area [1,000 $]	% in Hazard Area
Residential	7,579	285	3.8%	86	1	1.3%	$640,175	$31,419	4.9%
Commercial/Industrial	236	3	1.3%	4,034	117	2.9%	$288,263	$5,439	1.9%
Religious Institutions & Private Schools	3	0	0.0%	187	0	0.0%	$16,021	$0	0.0%
Local Government	1	0	0.0%	3,099	38	1.2%	$235,280	$1,335	0.6%
State Government	0	0	0.0%	609	0	0.0%	$100,410	$0	0.0%
Federal Government	0	0	0.0%	14	0	0.0%	$1,040	$0	0.0%
Roads, Railroads, & Rights of Way	0	0	0.0%	0	0	0.0%	$0	$0	0.0%
Natural Resources (Public and Private)	222	0	0.0%	220	220	100.0%	$37,243	$17,956	48.2%
Parks, Preserves, Water, & Open Space	1	0	0.0%	5	2	34.8%	$7,125	$317	4.4%
Undeveloped land	1,427	114	8.0%	1,352	30	2.3%	$233,549	$12,373	5.3%
Total	**9,470**	**402**		**9,607**	**410**		**$1,559,106**	**$68,838**	

*Explanation: Please note that 2025 estimates are shown according to 2000 land use ownership, since land ownership for 2025 is unknown.

Table IV-8h
Landslide Hazard Area, Vulnerability Assessment, Unincorporated Thurston County
For Years 2000 and 2025

	2000 Dwelling Units Estimate			2000 Commercial and Industrial Floor Space Estimate			2000 Value of Structures and Building Contents Estimate		
Land Use by Ownership in 2000	Total	In Hazard Area	% in Hazard Area	Total [1,000 sq. ft.]	In Hazard Area [1,000 sq. ft.]	% in Hazard Area	Total [1,000 $]	In Hazard Area [1,000 $]	% in Hazard Area
Residential	43,845	1,213	2.8%	0	0	0.0%	$4,607,949	$185,290	4.0%
Commercial/Industrial	191	2	1.0%	4,080	57	1.4%	$211,870	$3,621	1.7%
Religious Institutions & Private Schools	115	44	38.3%	361	11	3.1%	$50,421	$5,496	10.9%
Local Government	30	2	6.7%	1,608	9	0.6%	$248,850	$4,573	1.8%
State Government	20	1	5.0%	1,655	1	0.1%	$208,986	$1,811	0.9%
Federal Government	0	0	0.0%	53	0	0.0%	$6,750	$0	0.0%
Tribal	0	0	0.0%	0	0	0.0%	$0		0.0%
Roads, Railroads, & Rights of Way	0	0	0.0%	0	0	0.0%	$398	$0	0.0%
Natural Resources (Public and Private)	729	67	9.2%	1,100	19	1.8%	$137,013	$7,228	5.3%
Parks, Preserves, Water, & Open Space	41	5	12.2%	32	0	0.0%	$14,272	$866	6.1%
Total	**44,971**	**1,334**		**8,890**	**97**		**$5,486,508**	**$208,885**	

	2025 Dwelling Units Forecast			2025 Commercial and Industrial Floor Space Forecast			2025 Value of Structures and Building Contents Forecast		
Land Use by Ownership in 2000*	Total	In Hazard Area	% in Hazard Area	Total [1,000 sq. ft.]	In Hazard Area [1,000 sq. ft.]	% in Hazard Area	Total [1,000 $]	In Hazard Area [1,000 $]	% in Hazard Area
Residential	54,705	1,648	3.0%	503	8	1.7%	$5,748,920	$229,791	4.0%
Commercial/Industrial	488	37	7.6%	4,520	76	1.7%	$285,775	$9,036	3.2%
Religious Institutions & Private Schools	125	54	43.1%	377	15	3.9%	$53,003	$6,844	12.9%
Local Government	30	2	6.7%	2,304	211	9.2%	$318,579	$24,851	7.8%
State Government	20	1	5.0%	1,928	15	0.8%	$236,358	$3,272	1.4%
Federal Government	0	0	0.0%	71	0	0.0%	$8,511	$0	0.0%
Tribal	1	0	0.0%	0	0	0.0%	$86	$0	0.0%
Roads, Railroads, & Rights of Way	0	0	0.0%	0	0	0.0%	$398	$0	0.0%
Natural Resources (Public and Private)	10,913	2,840	26.0%	1,630	34	2.1%	$1,212,741	$287,191	23.7%
Parks, Preserves, Water, & Open Space	41	5	12.2%	21	0	0.0%	$13,150	$866	6.6%
Undeveloped land	15,479	866	5.6%	2,056	99	4.8%	$1,760,373	$96,917	5.5%
Total	**81,802**	**5,453**		**13,410**	**459**		**$9,637,895**	**$658,768**	

*Explanation: Please note that 2025 estimates are shown according to 2000 land use ownership, since land ownership for 2025 is unknown.

Table IV-8i
Landslide Hazard Area, Vulnerability Assessment, Yelm
For Years 2000 and 2025

	2000 Dwelling Units Estimate			2000 Commercial and Industrial Floor Space Estimate			2000 Value of Structures and Building Contents Estimate		
Land Use by Ownership in 2000	Total	In Hazard Area	% in Hazard Area	Total [1,000 sq. ft.]	In Hazard Area [1,000 sq. ft.]	% in Hazard Area	Total [1,000 $]	In Hazard Area [1,000 $]	% in Hazard Area
Residential	1,273	0	0.0%	0	0	0.0%	$91,116	$0	0.0%
Commercial/Industrial	25	0	0.0%	1,093	0	0.0%	$66,679	$0	0.0%
Religious Institutions & Private Schools	4	0	0.0%	48	0	0.0%	$6,333	$0	0.0%
Local Government	1	0	0.0%	324	0	0.0%	$55,255		0.0%
Roads, Railroads, & Rights of Way	0	0	0.0%	0	0	0.0%	$0		0.0%
Natural Resources (Public and Private)	14	0	0.0%	1	0	0.0%	$763		0.0%
Parks, Preserves, Water, & Open Space	0	0	0.0%	2	0	0.0%	$27		0.0%
Total	**1,317**	**0**		**1,467**	**0**		**$220,172**	**$0**	

	2025 Dwelling Units Forecast			2025 Commercial and Industrial Floor Space Forecast			2025 Value of Structures and Building Contents Forecast		
Land Use by Ownership in 2000*	Total	In Hazard Area	% in Hazard Area	Total [1,000 sq. ft.]	In Hazard Area [1,000 sq. ft.]	% in Hazard Area	Total [1,000 $]	In Hazard Area [1,000 $]	% in Hazard Area
Residential	1,599	0	0.0%	189	0	0.0%	$132,627	$0	0.0%
Commercial/Industrial	32	0	0.0%	1,206	0	0.0%	$77,199	$0	0.0%
Religious Institutions & Private Schools	4	0	0.0%	48	0	0.0%	$6,333	$0	0.0%
Local Government	1	0	0.0%	358	0	0.0%	$58,283	$0	0.0%
Roads, Railroads, & Rights of Way	0	0	0.0%	0	0	0.0%	$0	$0	0.0%
Natural Resources (Public and Private)	414	0	0.0%	83	0	0.0%	$38,481	$0	0.0%
Parks, Preserves, Water, & Open Space	0	0	0.0%	2	0	0.0%	$27	$0	0.0%
Undeveloped land	1,636	989	60.5%	324	0	0.0%	$153,429	$75,523	49.2%
Total	**3,684**	**989**		**2,210**	**0**		**$466,379**	**$75,523**	

*Explanation: Please note that 2025 estimates are shown according to 2000 land use ownership, since land ownership for 2025 is unknown.

Table IV-9
Landslide Hazard Area, Critical Facilities

Jurisdiction*		Priority I Facilities			Priority II Facilities		
		Total	In Hazard Area	% in Hazard Area	Total	In Hazard Area	% in Hazard Area
Bucoda							
	Total	**1**	**0**	**0.0%**	**0**	**0**	**0.0%**
Lacey							
	City	4	0	0.0%	13	0	0.0%
	UGA	1	0	0.0%	8	0	0.0%
	Total	**5**	**0**	**0.0%**	**21**	**0**	**0.0%**
Olympia							
	City	19	0	0.0%	20	0	0.0%
	UGA	1	0	0.0%	1	0	0.0%
	Total	**20**	**0**	**0.0%**	**21**	**0**	**0.0%**
Rainier							
	City	2	0	0.0%	1	0	0.0%
	UGA	0	0	0.0%	0	0	0.0%
	Total	**2**	**0**	**0.0%**	**1**	**0**	**0.0%**
Tenino							
	City	3	0	0.0%	4	0	0.0%
	UGA	0	0	0.0%	0	0	0.0%
	Total	**3**	**0**	**0.0%**	**4**	**0**	**0.0%**
Tumwater							
	City	5	0	0.0%	6	0	0.0%
	UGA	2	0	0.0%	1	0	0.0%
	Total	**7**	**0**	**0.0%**	**7**	**0**	**0.0%**
Yelm							
	City	3	0	0.0%	5	0	0.0%
	UGA	0	0	0.0%	1	0	0.0%
	Total	**3**	**0**	**0.0%**	**6**	**0**	**0.0%**
Grand Mound UGA							
	Total	**2**	**0**	**0.0%**	**0**	**0**	**0.0%**
Total Cities		**37**	**0**	**0.0%**	**49**	**0**	**0.0%**
Total UGAs		**6**	**0**	**0.0%**	**11**	**0**	**0.0%**
Total Urban Areas		**43**	**0**	**0.0%**	**60**	**0**	**0.0%**
Rural Unincorporated County		**32**	**0**	**0.0%**	**11**	**0**	**0.0%**
Thurston County Total		**75**	**0**	**0.0%**	**71**	**0**	**0.0%**

*Explanation: Please note that this table indicates the number of critical facilities which are located in the jurisdiction, not their ownership. For example, the County Courthouse is owned by the County but is located in the City of Olympia. Similarly, hospitals are privately owned facilities located within jurisdicitonal boundaries.

Storm Hazard Description

Destructive storms come in several varieties: wind, rain, ice, snow, and combination. Nearly all destructive local storms occur from November through April when the jet stream is over the U.S. west coast and Pacific low-pressure systems are more frequent. The trajectory of these lows determines their effect locally. The more southerly ones bring heavy rains while the more northerly ones bring cold air and the potential for snow and ice. Any winter storm, regardless of its trajectory, can pack high winds. Generally, winds above about 30 miles per hour can cause widespread damage and those above about 50 miles per hour can be disastrous. High winds of short duration, such as tornados and strong gusts from thunderstorms, can also be destructive though generally not as widespread.

Storm Hazard Historical Occurrences and Impacts

Storms are frequent in Thurston County. Between 1972 and 1997 Thurston County dealt with the impact of 15 severe storms, 12 of them leading to federal disaster declarations. The majority of these were combination events with high winds, heavy rain, snow or ice, and subsequent flooding. The following are examples of the type of impact from recent storms.

A weather front in November of 1981 brought strong winds and rain to the area. Thurston County Commissioners declared the county a disaster area as a result of the storm, estimating $3.4 million damage to private property throughout the county. Governor Spellman signed an order declaring a state of emergency as a result of the storm losses throughout Western Washington. The winds left over 60,000 people in Thurston County without electricity. In the City of Olympia, high winds sent debris from boats moored at the West Bay Marina out into Budd Inlet. About 150 boats broke loose and were strewn for miles.

Winds up to 70 miles per hour struck the county in January 1986. During a 24-hour period that January, the area was hit with 3.4 inches of rain, accompanied by winds up to 55 miles per hour. About 20,000 Puget Sound Power and Light customers were without electricity one night that month. Recurring winds and rain caused mud slides and an estimated $186,000 damage to storm drains and roads. City storm drains were unable to handle the run-off. The City of Olympia Fire Department received 30-40 calls every half hour during one day. The majority of callers were city residents with flooding in their homes.

In January 1993, the Inaugural Day Storm affected all of Western Washington. Virtually the entire South Sound area was left without power for 36 hours. Across Western Washington citizens were ill-prepared for such an event. There were five fatalities area-wide, 870,000 persons without power and 60 dwellings destroyed. Recent studies show that severe windstorms are expected to occur approximately every five years.

Other recent storms of major impact, other than flooding, were the windstorm of December 1995, and the ice and windstorm of December 1996. Costs associated with destructive storms can be significant. The ice and windstorms of December 1996 cost the county nearly $1 million in non-flood related costs, primarily due to large amounts of debris and damage to the road

system; caused power outages to nearly one-half of the county population for several days; required the expenditure of nearly $10 million by Puget Sound Energy to make repairs to the power distribution system; and resulted in an estimated $3 million in uninsured losses to private property. Similar costs were incurred as a result of the Inaugural Day Storm in 1993.

The entire county is vulnerable to the effects of a storm.

High winds can bring down trees, down telephone and electrical lines, and interrupt transportation, communications and power distribution, leaving large areas without electric power.

Prolonged heavy rains can cause the ground to be saturated, rivers, and streams to rise, and result in local flooding and landslides in rural areas. In the urban area, city storm drains may be unable to handle the run-off. In the cities served by LOTT, there can be a loss of LOTT communications links, damage to LOTT plant functions, flooding of streets and intersections, mudslides off steep slopes and costly street damage from these mudslides.

Ice storms occur when rain falls out of a warm atmospheric layer into a cold one near the ground. The rain freezes on contact with cold objects including the ground, trees, structures, and power lines, causing buildings to collapse and power lines to break.

Snow storms primarily impact the transportation system and the availability or timing of public safety services. Snow accumulations can also cause roofs to collapse. Snow accompanied by high winds is a blizzard which can affect visibility, cause large drifts and strand residents for up to several days. Melting snow adds to river loading and can turn an otherwise benign situation into a local disaster.

Each of these when in combination with any other or if accompanied by freezing temperatures can exacerbate a storm's impact. Isolated residents without power are more likely to use wood fires to stay warm or to cook, possibly resulting in an increase in the number of structural fires. Residents without food or water may attempt to use impassable roads and thereby increase the potential rescues. Since stress can bring on medical problems, there tends to be an increase in calls for medical assistance. High winds, heavy snows, and heavy rains often result in increased automobile accidents as well.

Storm Hazard Assessing Vulnerability

Summary Assessment

Storm history suggests a high probability of occurrence. Historical damage and cumulative costs of destructive storms suggest high vulnerability. Accordingly, the county has assigned a high risk rating.

Delineation of Storm Hazard Area, Population and Assets Data

The entire county is vulnerable to the effects of a storm. As a result, a separate Storm Hazard Area has not been delineated. The "Total" columns in the Population and Assets tables provided for the flood and landslide hazards provide useful information in assessing the population and assets at risk from a countywide hazard.

Critical Facilities and Infrastructure in Hazard Area

Based on the community impact which historical occurrences of natural hazards caused, it is clear that natural hazards can destroy or damage facilities that may be critical for responding to the disaster and for maintaining a safe environment and public order. Among these are communications installations; electrical generating and transmission facilities; water storage, purification, and pumping facilities; sewage treatment facilities; hospitals; and police stations. In addition, natural hazards can seriously disrupt the transportation network; bridges can be knocked out, and roads and highways damaged or blocked by debris, further isolating resources. In a major disaster, almost all surface means of transportation within a community may be disrupted, particularly in the initial stages of the hazard event.

Specific information on the location of critical facilities and infrastructure is housed with the Emergency Management Council of Thurston County. However, the "Total" columns in the Critical Facilities tables provided for the flood and landslide hazards provide useful information in assessing the risk for these assets from a countywide hazard.

Vulnerability – Methodology for Inventory, Forecast, and Dollar Value of Assets

Introduction

The Buildable Lands Program is a state Growth Management Act review and evaluation program. It included an extensive land use analysis for the cities and the county. A tax-parcel based inventory of residential dwelling units and commercial and industrial buildings was compiled for the program and is the basis for the inventory of assets in this hazard mitigation plan. However, tribal areas were not included in the Buildable Lands Program. This means there is a significant difference in the datasets available for the tribal areas as compared to the rest of the county. This is reflected in the more limited data available in the data tables in this plan. Data in the Vulnerability Assessment tables for the Chehalis Tribe is a combination of TRPC data and data provided by the Chehalis Tribe.

For more information on the Buildable Lands Program, please refer to Buildable Lands Report for Thurston County, 2002, Thurston Regional Planning Council, and Buildable Lands Report for Thurston County: Technical Documentation, 2002, Thurston Regional Planning Council.

Inventory of Assets

Dwelling units were adjusted to 2000 Census counts by Census Block Group in the fall of 2002. An estimate of population was made by multiplying dwelling units by type (single-family, multifamily, and manufactured homes) by household size and vacancy rate at the Census Tract level. The estimate of population is consistent with 2000 Census population counts at the county and census tract level, but may differ at the jurisdiction level.

The value of individual structures was determined through a multi-tiered approach. First, data from the Thurston County Assessor's (Assessor) office for the year 2000 was obtained and used to determine a basic building value. Secondly, the value of the building's contents was assumed to be proportionate to the building value. Residential buildings were assumed to have contents worth 50 percent of the building value. Commercial and industrial buildings were assumed to have contents worth 100 percent of the building value. Adding these together gave a total value of buildings and contents.

Finally, individual jurisdictions provided additional sources of valuation for government owned or leased facilities as it was felt that the Assessor's records may not contain complete information for government-owned facilities. This supplemental information also provided valuation for structures other than buildings, including playground equipment, pump stations, and other government owned facilities. A list of supplemental information on government assets that has been received from jurisdictions in Thurston County is found below. Only those assets that could be identified through a tax parcel number could be included in the assets tables.

Supplemental Information from Jurisdictions on Government Owned Assets

	General Facilities	Library	Fire	Waste Water Management Systems	Stormwater Ponds	Parks	Public Art	Water
Bucoda	-	-	-	N/A	-	-	-	-
Lacey	✔	✔	-	✔	-	✔	✔	✔
Olympia	✔	✔	✔	✔	*	✔	*	✔
Rainier	-	-	-	N/A	-	-	-	-
Tumwater	✔	✔	✔	-	✔	✔	-	*
Tenino	✔	✔	-	N/A	-	✔	-	✔
Yelm	-	-	-	N/A	-	-	-	-
Thurston County	✔	N/A	-	✔	-	✔	-	-
Chehalis Reservation	✔	-	-	✔	-	*	-	✔
Nisqually Reservation	-	-	-	-	-	-	-	-

Legend	
Data included in assets analysis	✔
Data not provided or not available	-
Data not included - partial data	*
Not applicable	N/A

Note: General Facilities include city halls, police stations, Lucky Eagle Casino, maintenance centers, and miscellaneous facilities.

The extent of each hazard was mapped using a geographic information system (GIS). The boundaries were overlain on tax-parcels to provide for an indication as to whether an asset lay within or outside of a specific hazard area. If the hazard area overlapped with all or part of a tax parcel, the structures on that tax parcel were determined to lie within a hazard area. In this manner, the extent of a particular hazard was overestimated rather than underestimated to err on the side of caution.

Forecast of Assets

The capacity for future development, described in terms of dwelling units and square feet for commercial and industrial floor space, was determined for each tax parcel. For future residential development, capacity was based on the availability of buildable land and the density of development by zoning district. For commercial and industrial development, capacity was determined based on the availability of buildable land for commercial or industrial uses, and an estimate of the floor space to area (FAR) ratio expected for a particular jurisdiction. Much of this methodology was developed under the Buildable Lands Program. Since development assumptions for the Confederated Tribes of the Chehalis Reservation and the Nisqually Indian Tribe were not included in the Buildable Lands program, it is not currently possible to produce an estimate of forecast assets for tribal areas.

Capacity provides a determination of the total amount of new development a tax parcel can potentially hold, given current zoning and development conditions. However, it is well understood that zoning and development patterns are subject to change in both the long and short term.

To support local planning efforts, TRPC provides periodic population and employment forecasts for Thurston County to the traffic analysis zone (TAZ), jurisdiction, and planning area level within Thurston County. The estimates of population are described in terms of dwelling units (with household size and vacancy rate adjustment factors) and employment. For more information on the forecast please refer to Population and Employment Forecast for Thurston County, Final Report, 1999, Thurston Regional Planning Council.

Population Forecast

The amount of new growth, as measured in new dwelling units, by jurisdiction was obtained from the forecast. This growth was then allocated to the parcels based on their capacity to hold new growth. An estimate of population was derived by multiplying dwellings by a household size and vacancy rate factor. Using this methodology, growth was distributed evenly throughout a jurisdiction without regard to planning areas. For this reason, this estimate provides only a rough approximation of where growth is forecast to occur.

Employment Forecast

The demand for new commercial and industrial building floor space was determined in the Buildable Lands work program. The new floor space was evenly allocated to the tax-parcel level based on available capacity for commercial or industrial growth. As with the dwelling unit allocation, the new growth was distributed evenly throughout each individual jurisdiction without regard to planning area growth trends. For this reason, this estimate provides only a rough approximation of where growth is forecast to occur.

Values

The future value of assets is an unknown; therefore, the dollar values for the future building assets were determined by projecting current day values into the future. As a result, all dollar values are shown in current dollars, making it possible to compare values across time.

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