| Hazard Type |
| --- |
| LANDSLIDE/ MUDSLIDE |
| Probability of Occurrence |
| HIGH |
| Vulnerability |
| LOW |
| Risk |
| MODERATE |

# Chapter 4.4
# Landslide/Mudslide Hazard Profile

## Introduction

People build homes on hilltops, marine bluffs, and tops of river banks to acquire stunning views of the mountains, Puget Sound, and rivers or lakes below. However, people located on or near the edge of slopes may knowingly or unknowingly live within a landslide hazard area. Western Washington landscapes provide ample evidence that the surface of the earth is constantly rearranging from the forces of nature and the impacts of human activity.

The United States Geological Survey (USGS) reports that landslides cause between 25 and 50 deaths each year in the United States, on average. The USGS also conservatively estimates that landslides cause between $2 and $4 billion in losses per year (2010 estimates).[1] The Washington State Growth Management Act requires counties and cities to enforce Critical Areas Ordinances that limit development and redevelopment around geologically hazardous areas such as steep slopes or other landforms prone to landslide hazards. To protect property owners from both physical harm and property damage, a geologic assessment is required when an owner applies for a building permit within or adjacent to an area potentially at risk for landslides or mudslides. Development regulations provide additional safeguards. However, significant residential development, roads, and utilities preceded current ordinances and regulations. Therefore, nearly the entire marine shoreline of Thurston County is dotted with residences and roads and other infrastructure that do not meet current standards.

Landslides occur on an almost annual basis. The high probability of their occurrence combined with their destructive, but localized impacts, results in an overall moderate risk rating.

## Hazard Identification

Landslides are the movement of rock, soil, or other debris, down a slope. In general, the term landslide includes a wide range of ground movement, such as rock falls, deep failure of slopes, and shallow debris flows.

Mudflows (or debris flows) are flows of rock, earth, and other debris saturated with water. They develop when water rapidly saturates the

ground from precipitation or a sudden influx of water that destabilizes the ground. As materials give way to gravity and move down a slope, a flowing river of mud or "slurry" can reach avalanche speeds and grow as it picks up trees, rocks, and other materials along the way.

Landslides occur naturally from heavy rain or snow storms, earthquakes, and volcanoes. However, a land form's stability can be compromised by human activity such as construction of buildings or other infrastructure, logging, and mining. Landforms and slopes fail, resulting in landslide, from a variety of factors including:

- Erosion caused by rivers, glaciers, or ocean waves
- Earthquake induced stressors
- Volcanic eruptions
- Load – Weight of rain/snow, fills, vegetation, stockpiling of rock or ore from waste piles or from man-made structures
- Hydrologic factors – Rain, high water tables, little or no ground cover, and numerous freeze/thaw cycles
- Human activity can drastically modify landforms and groundwater conditions – development activities with poor drainage control, cutting, filling, and grading along roads, and logging practices that remove timber from steep slopes
- Increase of lateral pressures – Hydraulic pressures, tree roots, crystallization, swelling of clay soil
- Regional tilting – Geological movements

It is difficult to predict precisely when and where a landslide will occur, however most Puget Sound marine shoreline landslides occur during the wet season, typically from October through April, peaking  December through February. The USGS has researched past shoreline landslides and rainfall levels in the Seattle area to identify when such landslides are likely to occur. One measure is a formula called the "precipitation threshold." The cumulative precipitation threshold measures precipitation over the previous 18 days and indicates when the ground is saturated enough to be susceptible to landslides. Between 3.5 and 5.3 inches exceeds this threshold. Between 1978 and 2003, 85 percent of Seattle area landslides occurred when this threshold was met or exceeded. By comparing recent and forecast rainfall levels, emergency management staff could notify media and at risk communities when to anticipate and take precautions for a potential landslide. The model was developed principally for the east Puget Sound area from Tacoma to Everett, but the USGS states that the threshold can serve as preliminary guidance for other Puget Sound Counties including the northern section of Thurston County.[2]

The Washington State Department of Ecology Shorelands and Environmental Assistance Program summarizes where slides are likely to occur along marine shorelines (used with permission)[3]:

| Where Landslide Occur | Factors |
|---|---|
| Sites of previous landslides | Large, deep-seated slides tend to be a reactivation of existing landslide complexes. Slope stability maps can provide an excellent indication of unstable areas. A competent geological analysis can usually provide an estimate of stability of problem areas on a site. It cannot reliably provide a probability of failure or an exact map of the area to be affected. |
| Steep slopes | Steep slopes are typically found along shorelines where centuries of wave or river currents have eroded the toe of the slope. Most steep slopes around Puget Sound have experienced sliding in the past one or two hundred years. |
| Benches | Relatively level benches on an otherwise steep slope often indicate areas of past slope movement. |
| Sites where drainage is causing a problem | Landslides are often triggered by the failure of drainage systems. Large amounts of water flowing from driveways, roof areas, roads and other impermeable surfaces can cause slides. |
| Sites where certain geologic conditions exist | Landslides occur where certain combinations of soils are present. When layers of sand and gravel lie above less permeable silt and clay layers, groundwater can accumulate and zones of weakness can develop. In Puget Sound, this combination is common and widespread. Glacial outwash, often Esperance Sand or gravel overlies the fine-grained Lawton Clay or Whidbey formation. |

Despite the difficulty in predicting landslides, the environment provides visual indicators of where the earth is moving. Discovering sites of prehistoric landslides is difficult, as telltale signs are often obscured by vegetation or human development. The Washington State Department of Ecology also provides warning signs of earth movement (used with permission)[4]:

| Environment | Warning Signs |
|---|---|
| Landscape | Head scarps or steep cliffs at the top of a slope |
| | Benches, scarps, and large cracks |
| | Exposed clays uplifted on the beach |
| | Hummocky and uneven terrain |
| | Trees or large blocks of clay partially buried in beach, not just drift logs |
| Roads, Utilities, Buildings | Sagging or taut utility lines |
| | Separation of foundation from sill plate |
| | Growing cracks in walls and window corners |
| | Broken or leaking water or sewer lines |
| | Doors not closing properly |
| | Significant cracking of concrete slabs and pavement |
| Vegetation | Tilted trees |
| | Curved trees |
| | Split trunks and stretched roots |
| | Large clusters of trees of similar age (often Alder) |
| Water | Small ponds on otherwise sloping terrain |
| | Disrupted natural drainage |
| | Unusually heavy or muddy seepage |
| | Unusual increase or decrease in flow from springs |

## Severity

There is no standard approach to measure the severity of a landslide. Severity can be measured in total cost of damages, impacts to transportation or utility systems, displaced households, or in terms of injuries and fatalities. The landslides on Steamboat Island Peninsula in winter 1998-1999 – the most damaging landslide recorded in Thurston County's history – cost $24 million in damages and response and recovery costs. This slow-moving landslide caused no serious injuries or deaths, but many residents in the densely developed Carlyon Beach community lost their homes. This incident did not impact the region's residents outside the affected area, but Thurston County staff, other emergency management personnel, and local area residents were significantly challenged.

The severity of a landslide can also be measured in terms of its 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 material, and amount of saturation with water.

## Impacts

The impacts of landslide hazards in Thurston County are numerous. While no deaths have occurred from a landslide in Thurston County, such events can injure or kill people caught in the path of rapid moving earth. In January 1997, a family of four on Bainbridge Island was buried and killed by 2,000 cubic feet of earth. The fast moving landslide slammed into

the back of their home in the early morning hours while the family was still in bed.[5] On March 22, 2014 a tremendous debris-avalanche flow landslide killed 43 people and buried nearly 40 homes and structures near Oso, Washington.

Past landslides highlight the fact that homeowners often lack insurance covering landslide hazards. Many Thurston County residents have lost their homes due to the damaging effects of landslides, which can render properties unstable and permanently uninhabitable. Rebuilding onsite is often not an option, resulting in immense financial loss for some homeowners. People suffer great mental stress from losing both their home and their property. Small business owners also face similar financial losses and mental stress.

Landslides can physically damage or destroy almost any infrastructure including buildings, utilities, streets, rail lines, bridges, and tunnels. Communities at large can face transportation disruptions from the loss of critical travel corridors, like U.S. Highway 101, resulting in lengthy detours. Public health and safety can be compromised from loss of energy, communications, water, and uncontrolled wastewater discharge.

Local governments, public works, building inspectors, and other safety officials can become overwhelmed if a landslide hazard impacts a significant portion of the community. Landslide events necessitate monitoring. Buildings and other infrastructure must be inspected to determine whether they are safe for occupancy or use. If a building is deemed unsafe, law enforcement personnel may need to increase patrols to decrease the risk of theft, criminal trespassing, or simply owners seeking to retrieve their belongings or inventory.

## Probability of Occurrence

A review of local newspaper media, internet sources, Department of Natural Resources landslide data, and Federal Disaster Declarations for Thurston County suggest that the incidences of landslides are concurrent with winter storms, flooding, and earthquakes. Heavy precipitation triggers most of the region's landslides. The Carlyon Beach/Hunter Point landslide represents a large scale, but infrequent, event for the region. Many smaller landslides regularly block roads with debris or wash out transportation facilities and rupture utility pipes. Between 1997 and 2007, seven Federal Disaster Declarations were declared and all included landslides around the greater south Puget Sound Region (the 1998-1999 winter landslides did not receive a Federal Disaster declaration). Destructive landslides have a high probability of occurrence and are certain to reoccur within a 25-year period.

## Effects of Climate Change on Landslides/Mudslides

Research and climate forecasts offer evidence that long-term climate change will have a measurable impact on the frequency of landslides. The University of Washington Climate Impacts Group published a detailed report on the state of science on climate change and its effects within the region titled, "State of Knowledge: Climate Change in the Puget Sound." The report identifies several factors that will influence flooding for communities around the Puget Sound.

Air temperatures are increasing in the Puget Sound Region. They are projected to warm rapidly during the 21st century. By mid-century, warming will be outside of the range of historical variations. Warming is projected for all seasons, but will be greatest for summer. As a result of warmer winters, watersheds will become increasingly rain dominant and streamflow is projected to peak earlier in winter and decrease in spring and summer. Winter streamflow is projected to increase by 28 to 34 percent on average by the 2080s. For the Thurston County planning area, excess saturation of soils during warmer and wetter winters will make steep and unstable slopes vulnerable to landslides and mudslides.

Overall annual precipitation levels are forecast to remain the same, but there will be greater seasonal variation. Summers will become drier and winters will be wetter. The frequency of the region's peak 24-hour rain events is expected to more than triple by the end of the 21st century. Such heavy storms are also expected to become more intense, with greater rainfall occurring in shorter periods of time. The region's risk for landslides could change from moderate to high due to the effects of more intense winter storms.

# Landslide Historical Occurrences and Impacts

Several landslides have impacted Washington State and the Thurston County region over the last several decades. These events highlight the severity, costs, and the region's vulnerabilities to landslide hazards. Previous landslide events offer an indication of the types of losses that local communities are likely to experience in the future.

### March 22, 2014 Federal Disaster 4168: Washington Flooding and Mudslides, Oso or "SR530 Landslide," Snohomish County, Washington

On March 22, a large landslide occurred two miles east of the community of Oso in Snohomish County along State Route 530. Higher than normal rainfall and other factors contributed to the collapse of a portion of an unstable slope, north of the Stillaguamish River, generating a massive debris-avalanche flow that crossed the river and covered nearly one half square mile. The landslide killed 43 people and buried over 40 homes and other structures in a rural neighborhood known as Steelhead Haven.

This tragic event is notable because the landslide was much larger, traveled much further, and had a greater destructive force than others previously experienced at or near the site. The USGS states that the area overrun by the landslide moved 18 million tons of sand, till, and clay – enough material to cover approximately 600 football fields 10 feet deep. The landslide was believed to have reached an average speed of 40 miles per hour.[6] Thurston County Emergency Managers, and countless other citizens and local, state, and federal personnel assisted Snohomish County during the recovery efforts.

*Photo courtesy of The Seattle Times*

There is still much to learn about the Oso Landslide, as to why landslides happen and how they behave, particularly for this landslide's high mobility – likely caused by excessive soil saturation.

### December 1-7, 2007 Federal Disaster 1734: Severe Winter Storms, Flooding, Landslides, and Mudslides

On December 3, an estimated 97 households were isolated by a complete washout of Cedar Flats Road in northwestern Thurston County. Washington State Department of Natural Resources' landslide reconnaissance found that heavy "...warm rains rapidly melted snow on the ground in Capitol State Forest, saturating soils that began to slide. Three landslides on the tributary to Swift Creek triggered three debris flows, carrying debris and sediment into Swift Creek and creating a hyper concentrated flow. By 8:30 a.m., debris appeared to have clogged the culverts where Swift Creek flows under Cedar Flats Road."[7] The clogged culverts impeded creek flow and forced the surrounding embankment under the road to wash out. By the following day, the McLane Fire Department shuttled residents who needed to move in and out on a footpath and logging road. By Thursday, the County Road Department opened a temporary one-and-a-half-mile detour route that served residents for several months until a temporary bridge was constructed. The emergency detour route construction cost nearly $135,000 and construction of the temporary and new bridge cost $891,000.

On December 3, a mudslide on Kennedy Creek Road in northwestern Thurston County destroyed the Ranch House BBQ restaurant and surrounding structures. Damage was estimated at $1 million. The owners received a $914,000 Small Business Administration loan to rebuild. Slides also caused at least two homes to be tagged as uninhabitable off Sunset Beach Road.

### February 28, 2001, Federal Disaster 1361: Nisqually Earthquake

The 2001 Nisqually Earthquake resulted in a landslide that wiped out the northbound lanes of U.S. Highway 101 near Mud Bay in northwest Thurston County. This landslide caused nearly $1 million in damages. Area commuters were forced to use a 30-mile detour through the town of McCleary, causing two and one-half-mile backups through the small Grays Harbor County community.

### Winter 1998 – 1999, South Puget Sound Landslides

Sixty-two inches of rain fell between November 1998 and March 1999. Several landslides occurred during this time along several south Puget Sound shorelines in north Thurston County. Landslides in Sunrise Beach, Sunset Beach, Gravelly Beach, Carlyon Beach, and Hunter Point forced many families out of their homes. County inspectors initially condemned or deemed 55 homes uninhabitable. In the end, 39 homes were condemned and 113 properties had their values significantly reduced or zeroed

by the Thurston County Assessor's Office. The northeastern corner of Carlyon Beach was the hardest hit area with 37 homes declared unsafe for habitation. This landslide occurred on relatively flat to gentle sloping ground. Pencil cracks in driveways slowly expanded from inches to several feet causing slumping and subsidence, destroying the foundations of many residents' homes. Geologists determined that the landslide – likely caused by heavy winter rains – was a reactivation of an ancient slide. The 66-acre slide caused substantial damage to the private community which maintains its own streets and water treatment system.[8]

The landslides resulted in $15 million in uninsured losses to homeowners and businesses and $9.5 million in costs to county government.[9] Despite declarations of emergency and requests for federal aid from both Thurston County and Washington State Governor Gary Locke, no Federal Disaster Declaration was issued, however Federal Small Business Administration loans were provided to some families to rebuild new homes. While some families had their mortgages dismissed, others were less fortunate.

The landslide hazard persists for the Carlyon Beach/Hunter Point area although movement has ceased. Thurston County has subsequently identified 54 parcels in this area as a designated landslide hazard area. The County's Critical Areas Ordinance prohibits substantial improvements to these properties.

### December 1996 to March 1997 Rainstorms

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 the City of Rainier which threatened a section of the Northwest Pipeline and the disruption of natural gas distribution. A 26-inch diameter line was shut down, but gas was diverted to another line.

### February 1996, Federal Disaster 1100: Flooding

On February 8, Nisqually River flooding and groundwater under heavy pressure from near record rains caused a 70-foot deep, 50-foot long, and 40-foot wide landslide. Nearly 100 dump trucks of material disappeared into the river in the Nisqually Pines neighborhood on Thuja Avenue west of Yelm. Although no homes were destroyed, the landslide threatened area residences. Thurston County declared seven homes unsafe for occupancy.[10]

On February 10, heavy rains caused a mudslide on the steep slope below Capitol Way, just west of Carlyon Avenue. It broke two sewer lines that served nearly two-thirds of Tumwater and the Olympia Brewing Company. The mudslide also tore out 50 feet of Burlington Northern rail line. It is possible that the pipes leaked prior to heavy rains and contributed to the weakening of the slope. Before repair, the damaged pipes leaked

over five million gallons of untreated waste water into Capitol Lake. Public health notices were posted around the lake to warn residents not to touch lake waters and Tumwater residents were asked to curtail their water use until the line was repaired. Emergency repairs took nearly two weeks and cost nearly $1 million.[11]

The February floods caused nearly $2.5 million in damages to Thurston County roads. Heavy rains triggered a landslide on a steep slope over Flumerfelt Road, southwest of Bucoda, closing the road for several months. A Burlington Northern railroad tunnel collapsed onto Durgin Road SE and a 20-foot-wide by 100-foot-deep pothole closed Old Pacific Highway just before the Nisqually River bridge.

# Landslide Hazard Exposure Analysis

## Delineation of Landslide Hazard Area

For the purposes of the landslide hazard risk analysis, the landslide hazard area has been defined as those parcels in the county on which slopes of 40 percent or more occur. Slope was calculated using LIDAR (light detection and ranging) data using grid analysis tools within a geographic information system. In addition, Washington State Department

of Natural Resource's known and historic mapped landslide database is included. This geographical delineation was then related to parcel data that was used to estimate the region's population, employment, and the assets that fall into the hazard area. Approximately 1.1 percent of Thurston County's total land area is characterized with having slopes of 40 percent or steeper. This delineation likely understates the hazard for the marine shoreline and overstates the hazard zone for areas outside of the marine shoreline. Map 4.4.1 shows the landslide hazard area for Thurston County.

## Communities Most Vulnerable to Landslides

The Washington State Department of Natural Resources Division of Geology and Earth Resources has mapped shallow and deep seated landslide occurrences and landslide landforms along the entire Thurston County marine shoreline zone and the shorelines of Capitol Lake. Though useful, the data is not a comprehensive summary of all landslide events and hazards. Geologists mapped data based on interpretation of aerial photos, LIDAR data, topography, and field visits. This information is useful as a reconnaissance-level screening tool, but is no substitute for site-specific geological evaluation of local conditions.

Coarse GIS analysis suggests that virtually the entire marine shoreline of Thurston County is moderate to highly vulnerable to landslides (Map 4.4.1), especially where bluffs are located.[12, 13] The steep slopes around Capitol Lake in downtown Olympia are also vulnerable in an area with moderate residential development densities. Approximately 3,017 parcels along Thurston County's shoreline have experienced some form of landslide activity, either before or after properties were developed. Over 6,000 parcels along Thurston County's shoreline or creeks draining to the inlets have a moderate to high landslide hazard rating. In many instances, only a portion of a parcel is at risk, but in some areas, entire parcels are potentially vulnerable.

Thurston County and the cities each have similar but varying definitions for landslide hazard areas in their Critical Areas Ordinance. The permit assistance centers within each community can help a property owner or developer to identify potential hazard areas. The permitting process addresses each site on a case by case basis. Thurston County defines a landslide hazard area as:

"Landslide hazard areas" means those areas which are potentially subject to risk of landslide due to a combination of geologic, topographic, and/or hydrologic factors; and where the vertical height is fifteen feet or more, excluding those wholly manmade slopes created under the design and inspection of a geotechnical professional. The following areas, at a minimum, are subject to landslide hazards:

A. Any area with a combination of:

   1. Slopes of fifteen percent or steeper, and

2. Impermeable subsurface material (typically silt and clay), frequently interbedded with granular soils (predominantly sand and gravel), and
3. Springs or seeping groundwater during the wet season;

B. Slopes of forty percent or greater;

C. Any areas located on a landslide feature which has shown movement during the Holocene Epoch (post glacial) or which is underlain by mass wastage debris from that period;

D. Known hazard areas, such as areas of historic failures, including areas of unstable, old and recent landslides. Appendix B Appendix B

E. Breaks between landslide hazard areas shall be considered part of the landslide hazard area under the following condition: The length of the break is twice the height or less than the height of the slope below or above the break, whichever is greater; and the combined height is fifteen feet or more. When this condition is present, the upper and lower landslide hazard areas and the break shall be combined into one landslide hazard area.

In general, landslide hazards occur throughout the county, especially along the marine shoreline of northern Thurston County including the Nisqually bluffs.

## Population and Employment in the Hazard Area

As of 2015, approximately 12,600 residents (4.7 percent) live in areas with 40 percent slopes or steeper. By 2040, the number of residents within this area is forecast to reach 18,800 residents. Presently, approximately 6,500 employees (4.9 percent) work within the hazard area. Tables 4.4.3 through 4.4.6 summarize estimates of the region's population and employment in the landslide hazard area. These tables assess an aspect of current and future vulnerability by providing data on the number of people living and working within the hazard area as compared to total population, by jurisdiction, in the years 2015 (2014 for employment) and 2040.

## Residential Dwellings in the Hazard Area

In 2015, nearly 5,400 or 4.7 percent of residential dwelling units were in the landslide hazard area. By 2040, the number of dwelling units in the hazard area is expected to reach 8,300. Tables 4.4.7 and 4.4.8 show estimates of the region's dwelling units in the landslide hazard area in the years 2015 and 2040.

## Inventory of Assets and Dollar Value in the Hazard Area

No detailed landslide hazard scenario analysis of potential losses was conducted during the planning process. Countywide, an estimated $861 million in assets is in the landslide hazard area. Estimates of the region's structures and their contents in the landslide hazard area is summarized in tables 4.4.9 and 4.4.10. To determine potential dollar losses, these tables provide an estimate of the number of existing structures which may be potentially affected by the hazard, as well as an estimate of structure and building contents value.

## Essential Facilities and Infrastructure in Hazard Area

Based on the community impacts which historical occurrences of natural hazards caused, landslides destroy or damage facilities that may be critical for responding to the disaster and for maintaining a safe environment and public order. This includes communications installations, electrical generating and transmission facilities, water storage, purification, and pumping facilities, sewage treatment facilities, hospitals and health care clinics, and police stations. In addition, landslides and mudslides 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 and type of facilities is maintained by Thurston County Emergency Management. Table 4.4.11 lists the type and number of essential facilities located in the landslide hazard area.

# Summary Assessment

Frequently triggered by heavy rains and almost guaranteed to occur with destructive earthquakes, landslides are assigned 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 region has assigned a moderate risk rating.

**Summary Risk Assessment for Landslides/Mudslides in the Thurston Region**

| Probability of Occurrence | Vulnerability | Risk |
|---|---|---|
| High | Low | Moderate |

## Table 4.4.1: Landslide Hazard Area by Jurisdiction

| Jurisdiction | | Landslide Hazard Area Total Acres | In Hazard Area Acres | In Hazard Area % |
|---|---|---|---|---|
| Bucoda | **Total** | **380** | **55** | **14.6%** |
| Lacey | City | 10,778 | 338 | 3.1% |
| | UGA | 10,416 | 428 | 4.1% |
| | **Total** | **21,193** | **766** | **3.6%** |
| Olympia | City | 12,089 | 1,090 | 9.0% |
| | UGA | 3,887 | 180 | 4.6% |
| | **Total** | **15,976** | **1,270** | **7.9%** |
| Rainier | City | 1,105 | 53 | 4.8% |
| | UGA | 320 | 18 | 5.6% |
| | **Total** | **1,425** | **71** | **5.0%** |
| Tenino | City | 922 | 75 | 8.2% |
| | UGA | 65 | 10 | 14.7% |
| | **Total** | **987** | **85** | **8.6%** |
| Tumwater | City | 11,354 | 693 | 6.1% |
| | UGA | 2,875 | 145 | 5.0% |
| | **Total** | **14,229** | **837** | **5.9%** |
| Yelm | City | 3,634 | 155 | 4.3% |
| | UGA | 2,396 | 41 | 1.7% |
| | **Total** | **6,030** | **196** | **3.3%** |
| Grand Mound UGA | **Total** | **983** | **47** | **4.8%** |
| Chehalis Reservation[1] | **Total** | **833** | **16** | **2.0%** |
| Nisqually Reservation[1] | **Total** | **2,147** | **175** | **8.2%** |
| **Total Cities** | | **40,261** | **2,460** | **6.1%** |
| **Total UGAs[2]** | | **20,943** | **869** | **4.2%** |
| **Total Reservations[1]** | | **2,979** | **192** | **6.4%** |
| **Rural Unincorporated County[3]** | | **322,865** | **886** | **0.3%** |
| **Thurston County Total** | | **387,047** | **4,406** | **1.1%** |

**Explanations:** Landslide Hazard includes areas with a 40% slope or greater.
1. Data are for the Thurston County portion of reservation only.
2. Urban Growth Area (UGA): Unincorporated area designated to be annexed into city limits over 20 years to accommodate urban growth.
3. Rural unincorporated county is the portion of the unincorporated county that lies outside UGA and Reservation boundaries.

## Table 4.4.2: Landslide Hazard Area by Special District

| Jurisdiction | | Landslide Hazard Area Total Acres | In Hazard Area Acres | In Hazard Area % |
|---|---|---|---|---|
| **Fire Protection Districts** | | | | |
| 1,11 | West Thurston Reg. Fire Authority | 100,131 | 15,625 | 15.6% |
| 2, 4 | S.E. Thurston Reg. Fire Authority | 56,030 | 3,638 | 6.5% |
| 3 | Lacey | 36,820 | 2,313 | 6.3% |
| 5, 9 | McLane-Black Lake | 51,828 | 19,218 | 37.1% |
| 6 | East Olympia | 19,677 | 1,036 | 5.3% |
| 8 | South Bay | 20,974 | 1,170 | 5.6% |
| 12 | Tenino | 19,914 | 1,695 | 8.5% |
| 13 | Griffin | 14,864 | 2,545 | 17.1% |
| 16 | Gibson Valley | 18,038 | 4,378 | 24.3% |
| 17 | Bald Hills | 13,926 | 2,004 | 14.4% |
| **School Districts** | | | | |
| Centralia[1] | | 12,851 | 2,927 | 22.8% |
| Griffin | | 21,355 | 5,248 | 24.6% |
| North Thurston | | 47,081 | 2,787 | 5.9% |
| Olympia | | 49,894 | 12,383 | 24.8% |
| Rainier | | 35,550 | 7,271 | 20.5% |
| Rochester[1] | | 55,061 | 10,384 | 18.9% |
| Tenino | | 70,500 | 11,092 | 15.7% |
| Tumwater | | 73,845 | 13,202 | 17.9% |
| Yelm[1] | | 104,853 | 23,235 | 22.2% |
| **Other Districts** | | | | |
| Intercity Transit | | 63,130 | 2,619 | 4.1% |
| LOTT Clean Water Alliance[2] | | 15,875 | 755 | 4.8% |
| Port of Olympia | | 387,047 | 4,406 | 1.1% |
| Thurston County PUD | | 387,047 | 4,406 | 1.1% |

**Explanations:** Landslide Hazard includes areas with a 40% slope or greater.
1. Data are for Thurston County portion of the district only.
2. Includes the sewered area.

## Table 4.4.3: Landslide Hazard Area, Population by Jurisdiction, 2015 and 2040

| | | 2015 Population Estimate | | | 2040 Population Forecast | | |
|---|---|---|---|---|---|---|---|
| | | Total | In Hazard Area | | Total | In Hazard Area | |
| Jurisdiction | | # | # | % | # | # | % |
| Bucoda | **Total** | **565** | **20** | **3.5%** | **1,215** | **110** | **9.1%** |
| Lacey | City | 46,230 | 550 | 1.2% | 55,160 | 870 | 1.6% |
| | UGA | 33,980 | 1,170 | 3.4% | 59,030 | 1,650 | 2.8% |
| | **Total** | **80,210** | **1,720** | **2.1%** | **114,190** | **2,520** | **2.2%** |
| Olympia | City | 51,020 | 2,770 | 5.4% | 71,840 | 3,670 | 5.1% |
| | UGA | 11,920 | 300 | 2.5% | 16,770 | 610 | 3.6% |
| | **Total** | **62,940** | **3,070** | **4.9%** | **88,610** | **4,280** | **4.8%** |
| Rainier | City | 1,880 | 40 | 2.1% | 2,810 | 90 | 3.2% |
| | UGA | 110 | 0 | 0.0% | 640 | 15 | 2.3% |
| | **Total** | **1,990** | **40** | **2.0%** | **3,450** | **105** | **3.0%** |
| Tenino | City | 1,730 | 20 | 1.2% | 3,675 | 340 | 9.3% |
| | UGA | 15 | 0 | 0.0% | 110 | 20 | 18.2% |
| | **Total** | **1,745** | **20** | **1.1%** | **3,785** | **360** | **9.5%** |
| Tumwater | City | 22,370 | 1,660 | 7.4% | 37,350 | 2,510 | 6.7% |
| | UGA | 3,270 | 30 | 0.9% | 8,960 | 370 | 4.1% |
| | **Total** | **25,640** | **1,690** | **6.6%** | **46,310** | **2,880** | **6.2%** |
| Yelm | City | 8,170 | 90 | 1.1% | 25,080 | 830 | 3.3% |
| | UGA | 1,420 | 10 | 0.7% | 5,690 | 60 | 1.1% |
| | **Total** | **9,590** | **100** | **1.0%** | **30,770** | **890** | **2.9%** |
| Grand Mound UGA | **Total** | **1,285** | **5** | **0.4%** | **1,990** | **0** | **0.0%** |
| Chehalis Reservation[1] | **Total** | **70** | **0** | **0.0%** | **190** | **10** | **5.3%** |
| Nisqually Reservation[1] | **Total** | **605** | **15** | **2.5%** | **705** | **20** | **2.8%** |
| **Total Cities** | | **131,970** | **5,150** | **3.9%** | **197,120** | **8,420** | **4.3%** |
| **Total UGAs[2]** | | **52,000** | **1,520** | **2.9%** | **93,190** | **2,720** | **2.9%** |
| **Total Reservations[1]** | | **670** | **20** | **3.0%** | **890** | **30** | **3.4%** |
| **Rural Unincorporated County[3]** | | **82,770** | **5,880** | **7.1%** | **102,470** | **7,640** | **7.5%** |
| **Thurston County Total** | | **267,400** | **12,600** | **4.7%** | **393,700** | **18,800** | **4.8%** |

**Source:** Thurston Regional Planning Council Population Forecast, 2015
**Explanations:** Landslide Hazard includes areas with a 40% slope or greater. Numbers may not add due to rounding.
1. Data are for the Thurston County portion of reservation only.
2. Urban Growth Area (UGA): Unincorporated area designated to be annexed into city limits over 20 years to accommodate urban growth.
3. Rural unincorporated county is the portion of the unincorporated county that lies outside UGA and Reservation boundaries.

## Table 4.4.4: Landslide Hazard Area, Population by Special District, 2015 and 2040

| Jurisdiction | 2015 Population Estimate Total # | 2015 Population Estimate In Hazard Area # | 2015 Population Estimate In Hazard Area % | 2040 Population Forecast Total # | 2040 Population Forecast In Hazard Area # | 2040 Population Forecast In Hazard Area % |
|---|---|---|---|---|---|---|
| **Fire Protection Districts** | | | | | | |
| 1,11 West Thurston | 22,010 | 600 | 2.7% | 31,120 | 980 | 3.1% |
| 2, 4 S.E. Thurston | 24,650 | 470 | 1.9% | 50,770 | 1,470 | 2.9% |
| 3 Lacey | 91,660 | 2,370 | 2.6% | 128,070 | 3,370 | 2.6% |
| 5, 9 McLane-Black Lake | 15,890 | 1,810 | 11.4% | 20,770 | 2,580 | 12.4% |
| 6 East Olympia | 11,140 | 350 | 3.1% | 14,810 | 540 | 3.6% |
| 8 South Bay | 11,820 | 890 | 7.5% | 15,380 | 1,040 | 6.8% |
| 12 Tenino | 6,230 | 170 | 2.7% | 9,530 | 620 | 6.5% |
| 13 Griffin | 5,060 | 830 | 16.4% | 5,700 | 910 | 16.0% |
| 16 Gibson Valley | 590 | 90 | 15.3% | 1,130 | 240 | 21.2% |
| 17 Bald Hills | 4,090 | 500 | 12.2% | 5,440 | 670 | 12.3% |
| **School Districts** | | | | | | |
| Centralia[1] | 490 | 80 | 16.3% | 1,180 | 260 | 22.0% |
| Griffin | 5,950 | 1,240 | 20.8% | 6,710 | 1,370 | 20.4% |
| North Thurston | 99,300 | 2,550 | 2.6% | 138,340 | 3,530 | 2.6% |
| Olympia | 66,140 | 4,400 | 6.7% | 87,700 | 5,720 | 6.5% |
| Rainier | 5,210 | 180 | 3.5% | 13,800 | 840 | 6.1% |
| Rochester[1] | 14,060 | 380 | 2.7% | 18,080 | 690 | 3.8% |
| Tenino | 9,850 | 410 | 4.2% | 15,510 | 1,040 | 6.7% |
| Tumwater | 39,500 | 2,220 | 5.6% | 63,820 | 3,640 | 5.7% |
| Yelm[1] | 26,900 | 1,120 | 4.2% | 48,530 | 1,700 | 3.5% |
| **Other Districts** | | | | | | |
| Intercity Transit | 176,450 | 6,980 | 4.0% | 269,860 | 10,810 | 4.0% |
| LOTT Clean Water Alliance[2] | 120,960 | 5,040 | 4.2% | 249,110 | 9,680 | 3.9% |
| Port of Olympia | 267,400 | 12,600 | 4.7% | 393,700 | 18,800 | 4.8% |
| Thurston County PUD | 267,400 | 12,600 | 4.7% | 393,700 | 18,800 | 4.8% |

**Source:** Thurston Regional Planning Council Population Forecast, 2015
**Explanations:** Landslide Hazard includes areas with a 40% slope or greater.
1. Data are for Thurston County portion of the district only.
2. Includes the sewered area for 2015 and the Lacey-Olympia-Tumwater Urban Area for 2040.

## Table 4.4.5: Landslide Hazard Area, Employment by Jurisdiction, 2014 and 2040

| Jurisdiction | | 2014 Employment Estimate Total # | 2014 In Hazard Area # | 2014 In Hazard Area % | 2040 Employment Forecast Total # | 2040 In Hazard Area # | 2040 In Hazard Area % |
|---|---|---|---|---|---|---|---|
| Bucoda | **Total** | **90** | **0** | **0.0%** | **200** | **10** | **5.0%** |
| Lacey | City | 25,610 | 530 | 2.1% | 41,180 | 760 | 1.8% |
| | UGA | 5,620 | 200 | 3.6% | 8,520 | 260 | 3.1% |
| | **Total** | **31,230** | **730** | **2.3%** | **49,700** | **1,020** | **2.1%** |
| Olympia | City | 53,350 | 3,790 | 7.1% | 74,950 | 5,340 | 7.1% |
| | UGA | 1,800 | 50 | 2.8% | 2,230 | 70 | 3.1% |
| | **Total** | **55,150** | **3,840** | **7.0%** | **77,180** | **5,410** | **7.0%** |
| Rainier | City | 455 | 5 | 1.1% | 690 | 10 | 1.4% |
| | UGA | 25 | 0 | 0.0% | 80 | 0 | 0.0% |
| | **Total** | **480** | **5** | **1.0%** | **770** | **10** | **1.3%** |
| Tenino | City | 870 | 10 | 1.1% | 1,505 | 30 | 2.0% |
| | UGA | 0 | 0 | - | 5 | 0 | 0.0% |
| | **Total** | **870** | **10** | **1.1%** | **1,510** | **30** | **2.0%** |
| Tumwater | City | 22,350 | 710 | 3.2% | 33,720 | 1,090 | 3.2% |
| | UGA | 760 | 20 | 2.6% | 1,420 | 40 | 2.8% |
| | **Total** | **23,110** | **730** | **3.2%** | **35,140** | **1,130** | **3.2%** |
| Yelm | City | 3,830 | 20 | 0.5% | 11,490 | 380 | 3.3% |
| | UGA | 430 | 10 | 2.3% | 670 | 10 | 1.5% |
| | **Total** | **4,260** | **30** | **0.7%** | **12,160** | **390** | **3.2%** |
| Grand Mound UGA | **Total** | **1,115** | **10** | **0.9%** | **1,375** | **10** | **0.7%** |
| Chehalis Reservation[1] | **Total** | **760** | **60** | **7.9%** | **1,550** | **140** | **9.0%** |
| Nisqually Reservation[1] | **Total** | **975** | **90** | **9.2%** | **1,865** | **220** | **11.8%** |
| **Total Cities** | | **106,560** | **5,070** | **4.8%** | **163,730** | **7,620** | **4.7%** |
| **Total UGAs[2]** | | **9,740** | **270** | **2.8%** | **14,300** | **380** | **2.7%** |
| **Total Reservations[1]** | | **1,740** | **150** | **8.6%** | **3,410** | **360** | **10.6%** |
| **Rural Unincorporated County[3]** | | **15,880** | **1,030** | **6.5%** | **18,270** | **1,190** | **6.5%** |
| **Thurston County Total** | | **133,900** | **6,500** | **4.9%** | **199,700** | **9,500** | **4.8%** |

**Source:** Thurston Regional Planning Council Population Forecast, 2015
**Explanations:** Landslide Hazard includes areas with a 40% slope or greater. Numbers may not add due to rounding.
1. Data are for the Thurston County portion of reservation only.
2. Urban Growth Area (UGA): Unincorporated area designated to be annexed into city limits over 20 years' time to accommodate urban growth.
3. Rural unincorporated county is the portion of the unincorporated county that lies outside UGA and Reservation boundaries.

## Table 4.4.6: Landslide Hazard Area, Employment by Special District, 2014 and 2040

| | 2014 Employment Estimate | | | 2040 Employment Forecast | | |
|---|---|---|---|---|---|---|
| | Total | In Hazard Area | | Total | In Hazard Area | |
| Jurisdiction | # | # | % | # | # | % |
| **Fire Protection Districts** | | | | | | |
| 1,11 West Thurston | 6,290 | 190 | 3.0% | 8,480 | 300 | 3.5% |
| 2, 4 S.E. Thurston | 6,710 | 90 | 1.3% | 15,170 | 470 | 3.1% |
| 3 Lacey | 34,540 | 970 | 2.8% | 54,170 | 1,410 | 2.6% |
| 5, 9 McLane-Black Lake | 3,630 | 340 | 9.4% | 4,350 | 400 | 9.2% |
| 6 East Olympia | 1,960 | 90 | 4.6% | 2,350 | 110 | 4.7% |
| 8 South Bay | 1,830 | 110 | 6.0% | 2,250 | 110 | 4.9% |
| 12 Tenino | 1,500 | 50 | 3.3% | 2,210 | 80 | 3.6% |
| 13 Griffin | 990 | 120 | 12.1% | 1,060 | 130 | 12.3% |
| 16 Gibson Valley | 150 | 20 | 13.3% | 180 | 30 | 16.7% |
| 17 Bald Hills | 470 | 40 | 8.5% | 570 | 50 | 8.8% |
| **School Districts** | | | | | | |
| Centralia[1] | 120 | 20 | 16.7% | 170 | 30 | 17.6% |
| Griffin | 1,110 | 170 | 15.3% | 1,190 | 180 | 15.1% |
| North Thurston | 42,280 | 1,080 | 2.6% | 66,290 | 1,490 | 2.2% |
| Olympia | 48,850 | 3,950 | 8.1% | 65,910 | 5,440 | 8.3% |
| Rainier | 980 | 30 | 3.1% | 1,860 | 90 | 4.8% |
| Rochester[1] | 4,630 | 150 | 3.2% | 6,230 | 260 | 4.2% |
| Tenino | 2,340 | 90 | 3.8% | 3,320 | 140 | 4.2% |
| Tumwater | 25,670 | 780 | 3.0% | 38,080 | 1,200 | 3.2% |
| Yelm[1] | 7,850 | 230 | 2.9% | 16,580 | 690 | 4.2% |
| **Other Districts** | | | | | | |
| Intercity Transit | 115,570 | 5,530 | 4.8% | 176,500 | 8,280 | 4.7% |
| LOTT Clean Water Alliance[2] | 91,010 | 4,610 | 5.1% | 162,020 | 7,560 | 4.7% |
| Port of Olympia | 133,900 | 6,500 | 4.9% | 199,700 | 9,500 | 4.8% |
| Thurston County PUD | 133,900 | 6,500 | 4.9% | 199,700 | 9,500 | 4.8% |

**Source:** Thurston Regional Planning Council Population Forecast, 2015
**Explanations:** Landslide Hazard includes areas with a 40% slope or greater.
1. Data are for Thurston County portion of the district only.
2. Includes the sewered area for 2014 and the Lacey-Olympia-Tumwater Urban Area for 2040.

## Table 4.4.7: Landslide Hazard Area, Residential Dwellings by Jurisdiction, 2015 and 2040

| | | 2015 Dwelling Estimate | | | 2040 Dwelling Forecast | | |
|---|---|---|---|---|---|---|---|
| | | Total | In Hazard Area | | Total | In Hazard Area | |
| Jurisdiction | | # | # | % | # | # | % |
| Bucoda | **Total** | **245** | **10** | **4.1%** | **535** | **50** | **9.3%** |
| Lacey | City | 19,840 | 230 | 1.2% | 24,400 | 360 | 1.5% |
| | UGA | 13,500 | 470 | 3.5% | 23,930 | 660 | 2.8% |
| | **Total** | **33,340** | **700** | **2.1%** | **48,330** | **1,020** | **2.1%** |
| Olympia | City | 24,170 | 1,260 | 5.2% | 35,610 | 1,750 | 4.9% |
| | UGA | 4,850 | 130 | 2.7% | 7,100 | 280 | 3.9% |
| | **Total** | **29,020** | **1,390** | **4.8%** | **42,710** | **2,030** | **4.8%** |
| Rainier | City | 775 | 15 | 1.9% | 1,140 | 35 | 3.1% |
| | UGA | 50 | 0 | 0.0% | 290 | 5 | 1.7% |
| | **Total** | **825** | **15** | **1.8%** | **1,430** | **40** | **2.8%** |
| Tenino | City | 755 | 10 | 1.3% | 1,855 | 200 | 10.8% |
| | UGA | 5 | 0 | 0.0% | 40 | 10 | 25.0% |
| | **Total** | **760** | **10** | **1.3%** | **1,895** | **210** | **11.1%** |
| Tumwater | City | 9,970 | 760 | 7.6% | 16,870 | 1,210 | 7.2% |
| | UGA | 1,420 | 20 | 1.4% | 3,820 | 170 | 4.5% |
| | **Total** | **11,390** | **780** | **6.8%** | **20,690** | **1,380** | **6.7%** |
| Yelm | City | 3,000 | 30 | 1.0% | 9,820 | 330 | 3.4% |
| | UGA | 550 | 0 | 0.0% | 2,280 | 20 | 0.9% |
| | **Total** | **3,550** | **30** | **0.8%** | **12,100** | **350** | **2.9%** |
| Grand Mound UGA | **Total** | **415** | **0** | **0.0%** | **740** | **0** | **0.0%** |
| Chehalis Reservation[1] | **Total** | **20** | **0** | **0.0%** | **65** | **0** | **0.0%** |
| Nisqually Reservation[1] | **Total** | **200** | **10** | **5.0%** | **255** | **10** | **3.9%** |
| **Total Cities** | | **58,760** | **2,310** | **3.9%** | **90,230** | **3,930** | **4.4%** |
| **Total UGAs[2]** | | **20,790** | **620** | **3.0%** | **38,190** | **1,150** | **3.0%** |
| **Total Reservations[1]** | | **220** | **10** | **4.5%** | **320** | **10** | **3.1%** |
| **Rural Unincorporated County[3]** | | **34,250** | **2,480** | **7.2%** | **41,730** | **3,190** | **7.6%** |
| **Thurston County Total** | | **114,000** | **5,400** | **4.7%** | **170,500** | **8,300** | **4.9%** |

**Source:** Thurston Regional Planning Council Population Forecast, 2015
**Explanations:** Landslide Hazard includes areas with a 40% slope or greater. Numbers may not add due to rounding.
1. Data are for the Thurston County portion of reservation only.
2. Urban Growth Area (UGA): Unincorporated area designated to be annexed into city limits over 20 years to accommodate urban growth.
3. Rural unincorporated county is the portion of the unincorporated county that lies outside UGA and Reservation boundaries.

## Table 4.4.8: Landslide Hazard Area, Residential Dwellings by Special District, 2015 and 2040

| | 2015 Dwelling Estimate | | | 2040 Dwelling Forecast | | |
|---|---|---|---|---|---|---|
| | Total | In Hazard Area | | Total | In Hazard Area | |
| Jurisdiction | # | # | % | # | # | % |
| **Fire Protection Districts** | | | | | | |
| 1,11 West Thurston | 8,480 | 170 | 2.0% | 11,930 | 300 | 2.5% |
| 2, 4 S.E. Thurston | 9,800 | 190 | 1.9% | 20,190 | 590 | 2.9% |
| 3 Lacey | 38,120 | 960 | 2.5% | 54,160 | 1,390 | 2.6% |
| 5, 9 McLane-Black Lake | 6,490 | 790 | 12.2% | 8,670 | 1,140 | 13.1% |
| 6 East Olympia | 4,510 | 140 | 3.1% | 6,010 | 220 | 3.7% |
| 8 South Bay | 4,940 | 380 | 7.7% | 6,370 | 440 | 6.9% |
| 12 Tenino | 2,580 | 70 | 2.7% | 4,200 | 310 | 7.4% |
| 13 Griffin | 2,580 | 420 | 16.3% | 2,910 | 460 | 15.8% |
| 16 Gibson Valley | 240 | 40 | 16.7% | 440 | 90 | 20.5% |
| 17 Bald Hills | 1,770 | 220 | 12.4% | 2,370 | 290 | 12.2% |
| **School Districts** | | | | | | |
| Centralia[1] | 200 | 30 | 15.0% | 470 | 100 | 21.3% |
| Griffin | 3,030 | 620 | 20.5% | 3,430 | 700 | 20.4% |
| North Thurston | 41,820 | 1,030 | 2.5% | 59,460 | 1,460 | 2.5% |
| Olympia | 29,690 | 1,950 | 6.6% | 41,150 | 2,630 | 6.4% |
| Rainier | 2,190 | 70 | 3.2% | 5,690 | 350 | 6.2% |
| Rochester[1] | 5,260 | 80 | 1.5% | 6,670 | 180 | 2.7% |
| Tenino | 4,130 | 170 | 4.1% | 6,720 | 490 | 7.3% |
| Tumwater | 16,940 | 990 | 5.8% | 27,630 | 1,680 | 6.1% |
| Yelm[1] | 10,790 | 470 | 4.4% | 19,260 | 700 | 3.6% |
| **Other Districts** | | | | | | |
| Intercity Transit | 76,200 | 3,030 | 4.0% | 119,200 | 4,840 | 4.1% |
| LOTT Clean Water Alliance[2] | 53,760 | 2,215 | 4.1% | 111,730 | 4,430 | 4.0% |
| Port of Olympia | 114,000 | 5,400 | 4.7% | 170,500 | 8,300 | 4.9% |
| Thurston County PUD | 114,000 | 5,400 | 4.7% | 170,500 | 8,300 | 4.9% |

**Source:** Thurston Regional Planning Council Population Forecast, 2015
**Explanations:** Landslide Hazard includes areas with a 40% slope or greater.
1. Data are for Thurston County portion of the district only.
2. Includes the sewered area for 2015 and the Lacey-Olympia-Tumwater Urban Area for 2040.

## Table 4.4.9: Landslide Hazard Area, Valuation of Buildings and Contents by Jurisdiction, 2014

| | | Residential | | | Commercial/Industrial | | | Government/Institutional | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Total | In Hazard Area | | Total | In Hazard Area | | Total | In Hazard Area | |
| Jurisdiction | | Mil. $ | Mil. $ | % | Mil. $ | Mil. $ | % | Mil. $ | Mil. $ | % |
| Bucoda | **Total** | **12** | **1** | **8.3%** | **1** | **0** | **0.0%** | **3** | **0** | **0.0%** |
| Lacey | City | 2,394 | 37 | 1.5% | 914 | 21 | 2.3% | 602 | 5 | 0.8% |
| | UGA | 1,715 | 82 | 4.8% | 69 | 2 | 2.9% | 273 | 8 | 2.9% |
| | **Total** | **4,109** | **119** | **2.9%** | **983** | **23** | **2.3%** | **875** | **13** | **1.5%** |
| Olympia | City | 2,695 | 160 | 5.9% | 1,199 | 55 | 4.6% | 1,941 | 125 | 6.4% |
| | UGA | 785 | 28 | 3.6% | 27 | 0 | 0.0% | 26 | 0 | 0.0% |
| | **Total** | **3,480** | **188** | **5.4%** | **1,226** | **55** | **4.5%** | **1,967** | **125** | **6.4%** |
| Rainier | City | 76 | 2 | 2.6% | 5 | 0 | 0.0% | 30 | 0 | 0.0% |
| | UGA | 5 | 0 | 0.0% | 0 | 0 | - | 1 | 0 | 0.0% |
| | **Total** | **81** | **2** | **2.5%** | **5** | **0** | **0.0%** | **31** | **0** | **0.0%** |
| Tenino | City | 50 | 1 | 2.0% | 12 | 0 | 0.0% | 67 | 0 | 0.0% |
| | UGA | 1 | 0 | 0.0% | 0 | 0 | - | 0 | 0 | - |
| | **Total** | **51** | **1** | **2.0%** | **12** | **0** | **0.0%** | **67** | **0** | **0.0%** |
| Tumwater | City | 1,209 | 104 | 8.6% | 528 | 16 | 3.0% | 556 | 5 | 0.9% |
| | UGA | 130 | 1 | 0.8% | 13 | 0 | 0.0% | 7 | 0 | 0.0% |
| | **Total** | **1,339** | **105** | **7.8%** | **541** | **16** | **3.0%** | **563** | **5** | **0.9%** |
| Yelm | City | 357 | 4 | 1.1% | 105 | 0 | 0.0% | 140 | 0 | 0.0% |
| | UGA | 49 | 1 | 2.0% | 6 | 0 | 0.0% | 13 | 0 | 0.0% |
| | **Total** | **406** | **5** | **1.2%** | **111** | **0** | **0.0%** | **153** | **0** | **0.0%** |
| Grand Mound UGA | | **34** | **0** | **0.0%** | **13** | **0** | **0.0%** | **5** | **0** | **0.0%** |
| Chehalis Reservation[1] | | **1** | **0** | **0.0%** | **4** | **0** | **0.0%** | **0** | **0** | **-** |
| Nisqually Reservation.[1] | | **16** | **0** | **0.0%** | **3** | **0** | **0.0%** | **0** | **0** | **-** |
| **Total Cities** | | **6,793** | **309** | **4.5%** | **2,763** | **92** | **3.3%** | **3,338** | **135** | **4.0%** |
| **Total UGAs[2]** | | **2,719** | **112** | **4.1%** | **128** | **2** | **1.6%** | **325** | **9** | **2.8%** |
| **Total Reservations[1]** | | **17** | **0** | **0.0%** | **6** | **0** | **0.0%** | **0** | **0** | **-** |
| **Rural Unincorp. County[3]** | | **4,977** | **440** | **8.8%** | **113** | **7** | **6.2%** | **1,033** | **7** | **0.7%** |
| **Thurston County Total** | | **14,506** | **861** | **5.9%** | **3,010** | **102** | **3.4%** | **4,696** | **150** | **3.2%** |

**Source:** Thurston Regional Planning Council Population Forecast, 2015
**Explanations:** Landslide Hazard includes areas with a 40% slope or greater. Numbers may not add due to rounding.
1. Data are for the Thurston County portion of reservation only.
2. Urban Growth Area (UGA): Unincorporated area designated to be annexed into city limits over 20 years to accommodate urban growth.
3. Rural unincorporated county is the portion of the unincorporated county that lies outside UGA and Reservation boundaries.

## Table 4.4.10: Landslide Hazard Area, Valuation of Buildings and Contents by Special District, 2014

| | Residential | | | Commercial/Industrial | | | Government/Institutional | | |
|---|---|---|---|---|---|---|---|---|---|
| | Total | In Hazard Area | | Total | In Hazard Area | | Total | In Hazard Area | |
| Jurisdiction | Mil. $ | Mil. $ | % | Mil. $ | Mil. $ | % | Mil. $ | Mil. $ | % |
| **Fire Protection Districts** | | | | | | | | | |
| 1,11 West Thurston | 979 | 25 | 2.6% | 57 | 1 | 1.8% | 216 | 3 | 1.4% |
| 2, 4 S.E. Thurston | 1,073 | 23 | 2.1% | 133 | 1 | 0.8% | 202 | 1 | 0.5% |
| 3 Lacey | 4,823 | 171 | 3.5% | 1,008 | 23 | 2.3% | 896 | 14 | 1.6% |
| 5, 9 McLane-Black Lake | 1,121 | 165 | 14.7% | 31 | 1 | 3.2% | 676 | 3 | 0.4% |
| 6 East Olympia | 743 | 24 | 3.2% | 14 | 0 | 0.0% | 49 | 0 | 0.0% |
| 8 South Bay | 939 | 78 | 8.3% | 13 | 2 | 15.4% | 47 | 0 | 0.0% |
| 12 Tenino | 277 | 8 | 2.9% | 17 | 0 | 0.0% | 73 | 0 | 0.0% |
| 13 Griffin | 430 | 76 | 17.7% | 3 | 0 | 0.0% | 26 | 0 | 0.0% |
| 16 Gibson Valley | 20 | 4 | 20.0% | 0 | 0 | - | 1 | 0 | 0.0% |
| 17 Bald Hills | 176 | 22 | 12.5% | 6 | 2 | 33.3% | 7 | 0 | 0.0% |
| **School Districts** | | | | | | | | | |
| Centralia[1] | 17 | 3 | 17.6% | 0 | 0 | - | 1 | 0 | 0.0% |
| Griffin | 498 | 104 | 20.9% | 3 | 0 | 0.0% | 26 | 0 | 0.0% |
| North Thurston | 5,394 | 187 | 3.5% | 1,292 | 31 | 2.4% | 969 | 14 | 1.4% |
| Olympia | 3,990 | 325 | 8.1% | 960 | 50 | 5.2% | 2,344 | 127 | 5.4% |
| Rainier | 241 | 9 | 3.7% | 11 | 1 | 9.1% | 34 | 0 | 0.0% |
| Rochester[1] | 539 | 9 | 1.7% | 42 | 1 | 2.4% | 187 | 3 | 1.6% |
| Tenino | 462 | 21 | 4.5% | 21 | 0 | 0.0% | 81 | 1 | 1.2% |
| Tumwater | 2,155 | 143 | 6.6% | 546 | 17 | 3.1% | 877 | 5 | 0.6% |
| Yelm[1] | 1,208 | 60 | 5.0% | 135 | 2 | 1.5% | 176 | 1 | 0.6% |
| **Other Districts** | | | | | | | | | |
| Intercity Transit | 9,247 | 442 | 4.8% | 2,865 | 95 | 3.3% | 4,172 | 143 | 3.4% |
| LOTT Clean Water Alliance[2] | 6,724 | 322 | 4.8% | 2,498 | 86 | 3.4% | 2,443 | 140 | 5.7% |
| Port of Olympia | 14,506 | 861 | 5.9% | 3,010 | 102 | 3.4% | 4,696 | 150 | 3.2% |
| Thurston County PUD | 14,506 | 861 | 5.9% | 3,010 | 102 | 3.4% | 4,696 | 150 | 3.2% |

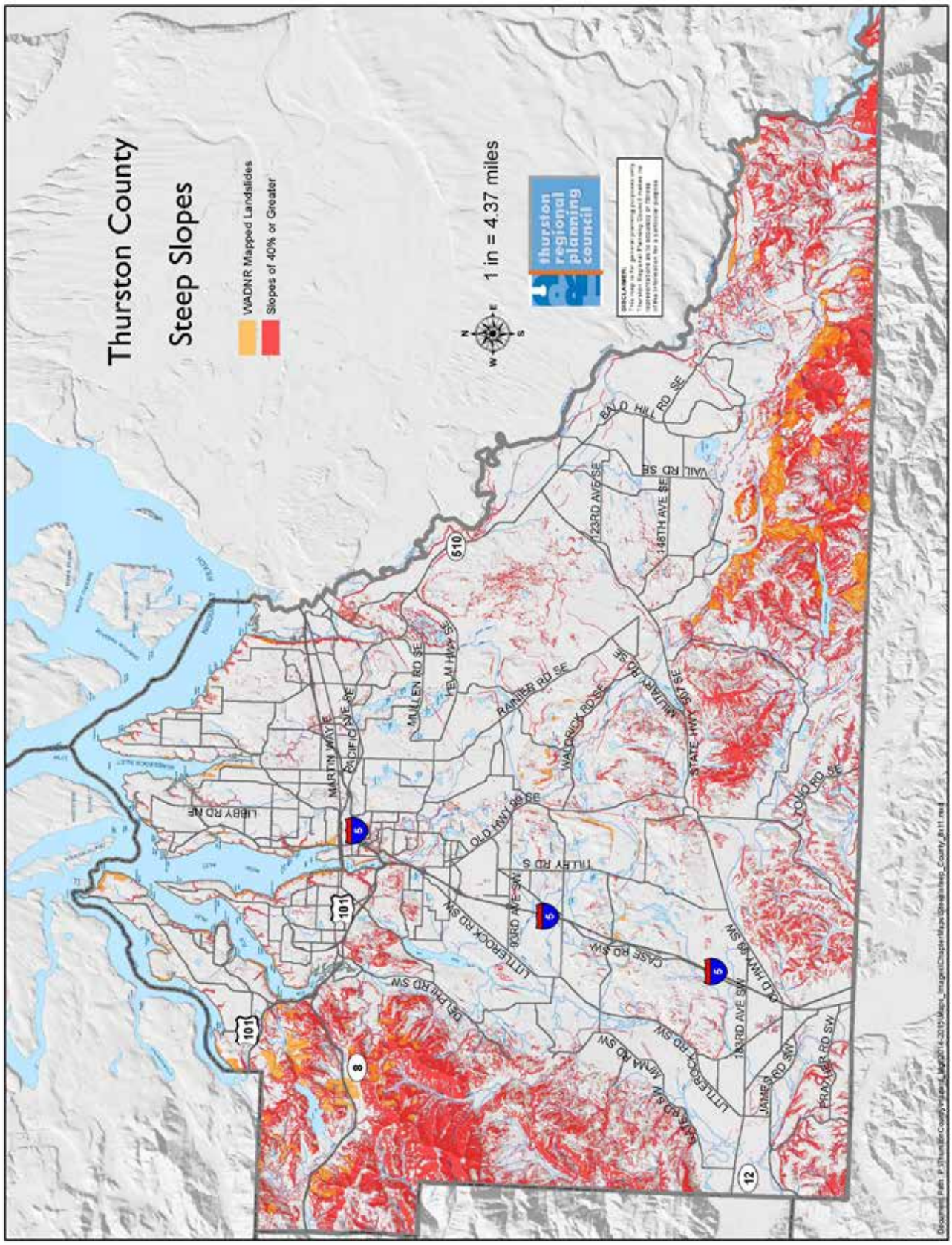
**Source:** Thurston Regional Planning Council Population Forecast, 2015
**Explanations:** Landslide Hazard includes areas with a 40% slope or greater.
1. Data are for Thurston County portion of the district only.
2. Includes the sewered area.

## Table 4.4.11: Essential Facilities in the Landslide Hazard Area

| Facility Type | Total # | In Hazard Area # | In Hazard Area % |
|---|---|---|---|
| **Medical Care** | | | |
| Adult Family Home | 124 | 1 | 0.8% |
| Assisted Living | 14 | 0 | 0.0% |
| Dentist | 110 | 1 | 0.9% |
| Dialysis Center | 3 | 0 | 0.0% |
| Funeral Home | 6 | 0 | 0.0% |
| Hospital | 2 | 0 | 0.0% |
| Nursing Home | 7 | 1 | 14.3% |
| Pharmacy | 42 | 0 | 0.0% |
| Primary Care | 91 | 0 | 0.0% |
| Urgent Care | 6 | 0 | 0.0% |
| **Government** | | | |
| Court Services | 3 | 0 | 0.0% |
| Cultural Significance | 2 | 0 | 0.0% |
| Detention/Corrections | 1 | 0 | 0.0% |
| Fairgrounds | 35 | 0 | 0.0% |
| Fire Service | 53 | 0 | 0.0% |
| Government Services | 56 | 3 | 5.4% |
| Health and Human Services | 2 | 0 | 0.0% |
| Law and Justice | 4 | 0 | 0.0% |
| Law Enforcement | 8 | 0 | 0.0% |
| Port Facilities | 35 | 0 | 0.0% |
| Public Education | 344 | 0 | 0.0% |
| Public Higher Education | 52 | 0 | 0.0% |
| Public Works | 33 | 0 | 0.0% |
| Solid Waste | 20 | 0 | 0.0% |
| Transit | 4 | 0 | 0.0% |
| Utilities | 238 | 7 | 2.9% |
| **Transportation (Centerline Miles)** | | | |
| Roads | 2,210 | 113 | 5.1% |
| Intercity Transit Routes | 157 | 5 | 3.2% |
| Rural Transit Routes | 96 | 6 | 6.5% |

**Explanations:** Landslide Hazard includes areas with a 40% slope or greater.

## Map 4.4.1: Steep Slopes



# Endnotes

[1] United States Geological Survey. 2016. USGS FAQs. Landslides. https://www2.usgs.gov/faq/taxonomy/term/9752.

[2] Rex Baum, et al. 2007. Landslide Hazards in the Seattle, Washington Area. United States Geological Survey Fact Sheet 2007-3005.

[3] Washington State Department of Ecology. 2009 Puget Sound Landslides: Signs of Movement. http://www.ecy.wa.gov/programs/sea/landslides/signs/signs.html

[4] Ibid

[5] Linda Ashton. 1997. Bainbridge Mudslide Kills Family. The Associated Press. Published in The Olympia, January 20, 1997.

[6] United States Geological Survey. 2015. One Year Later- The Oso Landslide in Washington. https://www2.usgs.gov/blogs/features/usgs_top_story/one-year-later-the-oso-landslide-in-washington/

[7] Washington State Department of Natural Resources. 2009. Landslide Reconnaissance Following the December 3, 2007 Storm – Thurston County.

[8] Lorrine Thompson. 2001. Struggle to Recover Continues After Slide. Published in The Olympian. February 17, 1996.

[9] Jennifer Olson. 1999. Landslide Victims Won't Get Aid. Published in The Olympian, August 27, 1999.

[10] Joel Coffidis. 1996. Nisqually Rips Yard from Homeowners. Published in The Olympian, February 17, 1996.

[11] John Dodge. 1996. Sewage Flow Into Lake Halted. Published in The Olympian, February 23, 1996.

[12] Michael Polentz, et al. 2008. Thurston County Marine Shore Landslides and Landforms Data. Unpublished Data. Washington Geological Survey Division on Geology and Earth Resources, Washington Department of Natural Resources.

[13] Personal Communication with Michael Polenz and Tim Walsh, Geologists, Washington Geological Survey Division on Geology and Earth Resources, Washington Department of Natural Resources. March 9, 2009.