3rd EDITION

HAZARDS MITIGATION PLAN

FOR THE THURSTON REGION

The Emergency Management Council of Thurston County

April 2017

Prepared by Thurston Regional Planning Council

Emergency Management Council of Thurston County

The Emergency Management Council was created in 1993 via an interlocal agreement to coordinate emergency management activities with the county, cities, and tribes. The nine-member council includes the emergency management representatives from Thurston County, the Town of Bucoda, the cities of Lacey, Olympia, Rainier, Tenino, Tumwater, and Yelm, the Confederated Tribes of the Chehalis Reservation, and the Nisqually Indian Tribe. The council addresses a wide array of issues related to emergency preparedness, response, recovery, and mitigation.

Town of Bucoda	Alan Carr, Mayor
Confederated Tribes of the Chehalis Reservation	Cal Bray, Emergency Manager
City of Lacey	Joe Upton, Police Commander
Nisqually Indian Tribe	Ken Choke, Emergency Management Director
City of Olympia	Greg Wright, Deputy Fire Chief
City of Rainier	Randy Schleis, Randy Schleis, Mayor
Thurston County	Kurt Hardin, Vice Chair, Director of Emergency Services
City of Tumwater	Scott LaVielle, Fire Chief
City of Yelm	Todd Stancil, Chair, Chief of Police

Hazards Mitigation Workgroup

Cities/Town/County	
Bucoda	Katrina Van Every, Associate Planner
Lacey	Bracy DiLeonardo, Human Resources Analyst, and Tom Palmateer, Management Analyst, Public Works
Olympia	Greg Wright, Deputy Fire Chief, and Patrick Knouff, Emergency Management Senior Program Specialist
Rainier	Katrina Van Every, Associate Planner
Tenino	Katrina Van Every, Associate Planner
Tumwater	David Ginther, Senior Planner
Yelm	Todd Stancil, Chief of Police
Thurston County	Sandy Eccker, Emergency Manager; Andrew Kinney, Emergency Management Coordinator; Vivian Eason, Emergency Management Coordinator, and James Yates, Emergency Management Coordinator
School Districts	
Griffin	Randy Martin, Facilities Supervisor
North Thurston	Brian Eko, Director of Facilities, and Robbi Wright, Loss Prevention Coordinator/Risk Management
Olympia	Wendy Couture, Safety & Risk Reduction Manager
Rochester	Larry Quarnstrom, Maintenance Director
Tenino	Brock Williams, Principal, Parkside Elementary School
Tumwater	Mel Murray, Supervisor of Construction & Capital Projects
Yelm	Chris Hansen, Director of Facilities
Fire Districts	
Fire District No. 8, South Bay	Brian Van Camp, Chief
Fire District No. 17, Bald Hills	Beverly Wright, Lieutenant
Other Special Districts	
Port of Olympia	Bill Helbig, Director of Engineering
Thurston County PUD No. 1	Carrie Bowen, Administrative Assistant
Timberland Regional Library	Bill Wilson, Director of Facilities
Intercity Transit	Jessica Brandt, Environmental & Sustainability Coordinator
Higher Education	
South Puget Sound Community College	Robert Shailor, Director of Safety & Security
The Evergreen State College	William Mikesell, Emergency Response Coordinator, and Matt Lebens, Environmental Health & Safety Coordinator
Workgroup Facilitator	
Thurston Regional Planning Council	Paul Brewster, Senior Planner

Thurston Regional Planning Council

Hazards Mitigation Plan Development Staff

Paul Brewster	Senior Planner, Project Manager
Michael Ambrogi	Senior GIS Analyst
Michael Burnham	Senior Planner
Rosalie Bostwick	Office Manager
Erin Cahill	Communications & Outreach Specialist II
Scott Carte	GIS Coordinator
Burlina Montgomery	Communications & Outreach Specialist I
Karen Parkhurst	Programs & Policy Director
Dave Read	IT Manager
Sarah Selstrom	Administrative Assistant

Table of Contents

Chapter 1.0
Introduction

Hazards Persist, But Disasters Can Be Avoided

The third edition of the Hazards Mitigation Plan for the Thurston Region results from a multi-jurisdictional process to develop a mitigation strategy to reduce the risks of the most destructive hazards that threaten the region. This plan specifically addresses communities and special districts within Thurston County. The region has endured earthquakes, landslides, severe storms, floods, wildland fires, volcanic events, and other less common hazards and threats.

When hazards affect areas that are undeveloped or uninhabited by people, there may be destruction within the natural environment, but such events are rarely characterized as disasters. When hazards adversely affect developed areas, the impacts to the safety and security of people, property, and infrastructure can be great. Such events often lead to a state of emergency, evacuations, and a Federal Disaster Declaration. Thurston County has received multiple disaster declarations:

- Between 1965 and 2016, Thurston County received 22 federal disaster declarations.
- Only 147 counties or U.S. Census designated places have received 20 or more federal disaster declarations; only four percent of counties or U.S. places share this distinction.
- As of 2016, eight counties in Washington State have experienced 20 or more disaster declarations.
- Thurston County has the 5th highest rate of declarations in the state.

Recovery from prolonged disruptions are costly to communities, the state, and the federal government. Hazard mitigation attempts to break the disaster cycle by identifying and implementing sustained actions that eliminate long-term risks to life and property.

The plan's mitigation strategy:
Chapter 2: Mitigation Strategy: Goals, Objectives, and Initiatives

What's the difference between preparedness, response, and mitigation?

Using flood as an example…

Preparedness: activities such as planning or staging of supplies or personnel in anticipation of an emergency. Preparedness involves rescue training, maintaining equipment, and procuring supplies — knowing that response efforts will be necessary in the future.

Response: actions taken during an emergency to protect life and property such as sandbagging, performing rescue or evacuation operations, pumping water to protect assets, or providing emergency shelters to displaced residents.

Mitigation: actions that reduce the demand for preparedness and response activities by minimizing the impacts of flooding. Mitigation activities may include elevating or removing structures in areas that periodically experience flooding. Mitigation can also regulate future development in areas that are prone to flooding.

Hazards in the Pacific Northwest

Thurston County, located at the south end of the Puget Sound in central Western Washington, is cherished by its residents for its natural beauty and the quality of life its communities offer. The region is surrounded with marine shorelines, rivers, lakes, tree-covered hills, prairies, and views of snow-capped mountains. Proximity to beauty however, comes with a price. The region is predisposed to recurrent natural hazards.

Information about the Thurston Region: ***Chapter 3: Thurston County Community Profile***

Washington is one of the most geologically active states of the United States. The Puget Sound Region's geologic past was dominated by prolonged periods of glaciation. Massive glaciers over 3,000-feet tall expanded and retreated across the landscape, carving and crushing the earth's surface in the South Sound. This process left behind a variety of sediment deposits and land forms that are extremely vulnerable to the effects of ground shaking, liquefaction, and landslides.

Washington is directly above the Cascadia Subduction Zone, a major boundary of colliding tectonic plates and source of earthquake activity. Multiple major fault lines cross the state. The region has experienced major earthquakes in 1949, 1965, and in 2001.

Image courtesy of NASA.

The 2001 Nisqually Earthquake caused region wide destruction, particularly damaging older buildings and infrastructure in the state's Capital City.

There are five active volcanoes in Washington State. The May 18, 1980 eruption of Mount St. Helens killed 57 people, destroyed hundreds of miles of roadways, blanketed several Eastern Washington communities with ash, and destroyed tens of thousands of acres of prime forest lands

The state's pronounced mountainous terrain and its immediacy to the vast Pacific Ocean strongly influences the dynamics of the region's weather and hydrologic cycle. The Pacific Northwest frequently experiences intense seasonal precipitation events that result in major lowland flooding, and mudslides and landslides in heavily developed and rural areas. In addition, high speed windstorms frequently buffet Western Washington resulting in region wide power outages, and structural damage that generates tons of debris.

Information about the hazards that threaten the Thurston Region: ***Chapter 4: Risk Assessment***

The Disaster Declaration Process

Local and state governments share the responsibility for protecting communities during disaster events. A local government's capacity to respond to emergencies is often overwhelmed when the natural disaster impacts a significant portion of the population or infrastructure. When the state's capacity to respond to disasters is exceeded, the Governor can request federal assistance. The Stafford Disaster Relief and Emergency Assistance Act requires that "All requests for a declaration by the President that a major disaster exists shall be made by the Governor of the affected State." The Governor makes the request through the regional Federal Emergency Management Agency (FEMA) office. If the President declares that a major disaster or emergency exists, that activates an array of federal programs to assist in the response and recovery effort. The three general categories of assistance:

- Individual Assistance – aid to individuals and households
- Public Assistance – aid to public (and certain private non-profit) entities for certain emergency services and the repair or replacement of disaster damaged public facilities
- Hazard Mitigation Assistance – funding for measures designed to reduce future losses to public and private property

The Disaster Mitigation Act of 2000

To manage risk, contain costs, and promote sustainable communities, the federal government outlined hazard mitigation planning requirements for states, tribes, and local governments in the Disaster Mitigation Act of 2000. Local governments must adopt a federally approved hazard mitigation plan to apply for or to receive federal mitigation assistance program grants.

Hazard mitigation plans must demonstrate that a community's proposed mitigation measures are based on a sound planning process that accounts for the risk to and the capabilities of the individual jurisdiction. The Code of Federal Regulations (CFR), Title 44, Part 201.6 addresses local government mitigation plans. Part 201.7 addresses tribal mitigation plans.

Federal Hazard Mitigation Assistance

Local governments simply lack sufficient personnel and the funds necessary to respond to and to recover from recurrent natural disasters, mitigate hazard prone private properties, and reinforce or replace all aging public infrastructure. The Stafford Act can provide local governments some disaster proofing assistance through hazard mitigation grants. Pre-Disaster Mitigation grants are offered annually and Hazard Mitigation Grant Program funds become available to states only after a federal disaster declaration.

Local governments with an adopted and federally approved hazard mitigation plan may apply for mitigation grants through the state. The Washington State Military Department Emergency Management Division acts as the grantee, with responsibility for notifying potential applicants of the availability of funding, defining the project selection process, ranking and prioritizing projects, and forwarding the projects to FEMA for funding. The applicant or sub-grantee carries out approved projects. With some restrictions, the federal government will provide up to 75 percent of the cost of a mitigation project with both programs. The remaining 25 percent must be matched by the local government or in some instances, the state. Other federal revenue sources cannot be used as match.

Appendix D and the Washington State Emergency Management Division's website: http://mil.wa.gov/grants contain more information about federal mitigation assistance programs.

Authorities

Section 322 of the Robert T. Stafford Disaster Relief and Emergency Assistance Act (Stafford Act), 42 U.S.C. 5165, as amended by the Disaster Mitigation Act of 2000 (DMA) (P.L. 106-390), provides for States, Tribes, and local governments to undertake a risk-based approach to reducing risks to natural hazards through mitigation planning. The National Flood Insurance Act of 1968, as amended, 42 U.S.C. 4001 et seq, reinforced the need and requirement for mitigation plans, linking flood mitigation assistance programs to State, Tribal, and Local Mitigation Plans.

FEMA has implemented the various hazard mitigation planning provisions through regulations at 44 CFR Part 201. These reflect the need for States, Tribal, and local governments to closely coordinate mitigation planning and implementation efforts, and describes the requirement for a State Mitigation Plan as a condition of pre- and post-disaster assistance, as well as the mitigation plan requirement for local and Tribal governments as a condition of receiving FEMA hazard mitigation assistance.

The regulations governing the mitigation planning requirements for local mitigation plans are published under 44 CFR §201.6. Under 44 CFR §201.6, local governments must have a FEMA-approved Local Mitigation Plan to apply for and/or receive project grants under the following hazard mitigation assistance programs:

- Hazard Mitigation Grant Program (HMGP)
- Pre-Disaster Mitigation (PDM)
- Flood Mitigation Assistance (FMA)
- Severe Repetitive Loss (SRL)

Hazard Mitigation Activities

Of the four stages of disaster response – mitigation, preparedness, response, and recovery, only mitigation serves to directly eliminate losses from the effects of hazards. The other stages all occur in reaction to or anticipation of impacts from disaster events. Hazard mitigation planning identifies and prioritizes sustained measures that, if enacted, will reduce or eliminate long-term risk to people and property from hazards and their effects. In the long term, mitigation measures reduce personal loss, save lives, and reduce the cost to local, state, and federal governments for responding to and recovering from recurrent or unusual hazard events.

FEMA identifies six broad categories of actions that constitute hazards mitigation:

1. **Prevention** – Government administrative or regulatory actions or processes that influence the way land and buildings are developed and built. These actions also include public activities to reduce hazard losses. Examples include planning and zoning, building codes, capital improvement programs, open space preservation, and storm water management regulations.
2. **Property Protection** – Actions that involve the modification of existing buildings or structures to protect them from a hazard, or removal from the hazard area. Examples include acquisition, elevation, relocation, structural retrofits, storm shutters, and shatter-resistant glass.
3. **Public Education and Awareness** – Actions to inform and educate citizens, elected officials, and property owners about the hazards and potential ways to mitigate them. Such actions include outreach projects, real estate disclosure, hazard information centers, and school-age and adult education programs.
4. **Natural Resource Protection** – Actions that, in addition to minimizing hazard losses, preserve or restore the functions of natural systems. These actions include sediment and erosion control, stream corridor restoration, watershed management, forest and vegetation management, and wetland restoration and preservation.
5. **Emergency Services** – Actions that protect people and property during and immediately after a disaster or hazard event. Services include warning systems, emergency response services, and protection of critical facilities.
6. **Structural Projects** – Actions that involve the construction of structures to reduce the impact of a hazard. Such structures include dams, levees, floodwalls, seawalls, retaining walls, and safe rooms.

The Role of Hazard Mitigation Planning in Building Safe Communities

Population

Thurston County's population is estimated to reach nearly 393,700 by the year 2040 – more than 100,000 more people than live in the region today. Hazards mitigation planning can be used to support local decision making for managing growth to maintain public safety and achieve community goals. As communities grow, local governments are challenged with managing growth to providing safe and cost-effective public services. Response to and recovery from disasters draws valuable resources and personnel away from the normal business of governance and supporting the economy. Avoiding growth in areas that are vulnerable to liquefaction, flooding, or landslides is in the long-term interest of communities to avoid disaster costs and safeguard residents and businesses.

Hazards mitigation planning must also consider special needs populations. Some people are at greater risk to the effects of hazards because of their age, physical or mental ability, or language. They may lack the resources and capabilities to respond to hazards to safeguard themselves, their loved ones, or their property.

Aging and Vulnerable Infrastructure

Many of Thurston County's cities, towns, and unincorporated rural places are some of the oldest communities in the state. These jurisdictions' aging and deteriorating infrastructure, including government office buildings, community centers, roads, bridges, water systems, sewers, and stormwater conveyance systems, is vulnerable to the effects of hazards.

Historic development occurred in flood plains, on shorelines, and along marine bluffs. Not all construction in hazard prone areas was the result of poor planning, but rather the lack of familiarity and knowledge about what constituted a threat to neighborhoods. Each earthquake, flood, or major winter storm reveals the vulnerability of older infrastructure. Chimneys in Olympia's South Capitol Neighborhood and unreinforced masonry in downtown Olympia crumble with each earthquake. Homes, businesses, and farms in southwest Thurston County suffer each time the Chehalis River crests its banks. In these instances, seismic retrofits, elevation, relocation, or other mitigation activities can mitigate losses.

Information Gaps

Thurston County communities continue to invest in studies to increase their understanding of the region's geology and hydrology. However, these communities need more research, data, and forecasting tools at the local level to create accurate maps of hazard areas, protect public health and safety, and protect the environment. Computer models, aerial photos, and satellite imaging technology have advanced, but acquiring, developing and maintaining local data is expensive.

Mitigation through Regulation

Municipalities can ensure new construction withstands the destructive forces of earthquakes, wind storms, and other hazards by maintaining and enforcing current building codes. An effective approach to mitigating hazards is preventing new development from occurring in hazard prone areas. Local land use authority, zoning codes, the Shoreline Management Act, the Washington State Growth Management Act, and Critical Area Ordinances provide local governments essential regulatory mechanisms to restrict new development in areas that pose risks.

Examples of mitigating flood prone properties

Elevation: Depending on the nature of the flood threat, elevating a structure or incorporating other floodproofing techniques to meet National Flood Insurance Program criteria may be the most practical approach to flood damage reduction. Communities can apply for grants to offer funding programs to property owners to cover the increased construction costs incurred in elevating a home.

Relocation: In some cases, it may be viable to physically move a structure to a new location. Relocated structures must be placed on a site located outside of the 100-year floodplain, outside of any regulatory erosion zones, and in conformance with any other applicable State or local land use regulations.

Acquisition and demolition: Under this approach, the community purchases the flood-damaged property and demolishes the structure. The property owner uses the proceeds of the sale to purchase replacement housing on the open market. The local government assumes title to the acquired property and maintains the land as open space in perpetuity.

Hazards Mitigation Planning in the Thurston Region

In 2003, 15 communities and special districts in Thurston County convened to develop and adopt one of Washington State's first multijurisdictional hazards mitigation plans. In 2009, 17 jurisdictions adopted the second edition. Jurisdictions participated as stakeholders in this third edition.

Federal mitigation planning requirements stipulate that communities update and reapprove local mitigation plans every five years to maintain eligibility for federal mitigation assistance program funds. The five-year update also allows communities to:

- Periodically assess the hazards that affect the planning area
- Educate and promote awareness about mitigation planning
- Consider diverse interests of stakeholders
- Update the mitigation strategy
- Build consensus around mitigation strategy priorities

A multi-jurisdictional plan enables communities to come together and establish a common understanding of the hazards and partner on developing a collective mitigation strategy. Each participating jurisdiction must also review and revise its plan to reflect changes in development, progress in local mitigation efforts, and changes in priorities.

Information about implementing the plan: ***Chapter 5: Adoption, Implementation, Monitoring, and Maintenance***

Terms Used to Describe Participants to this Plan

The terms community, plan partner, agency, local government, and jurisdiction refers to:

Tribe, county, city, town, school district, fire district, transit agency, utility district, special district, or other forms of local government.

"Thurston Region" and "Thurston County" are sometimes used interchangeably when describing the affected planning area. Region is a collective term that refers to more than one or all the local governments, communities, places, as well as the physical geography within the borders of the county. Thurston County is also the municipal government that is a partner to the plan.

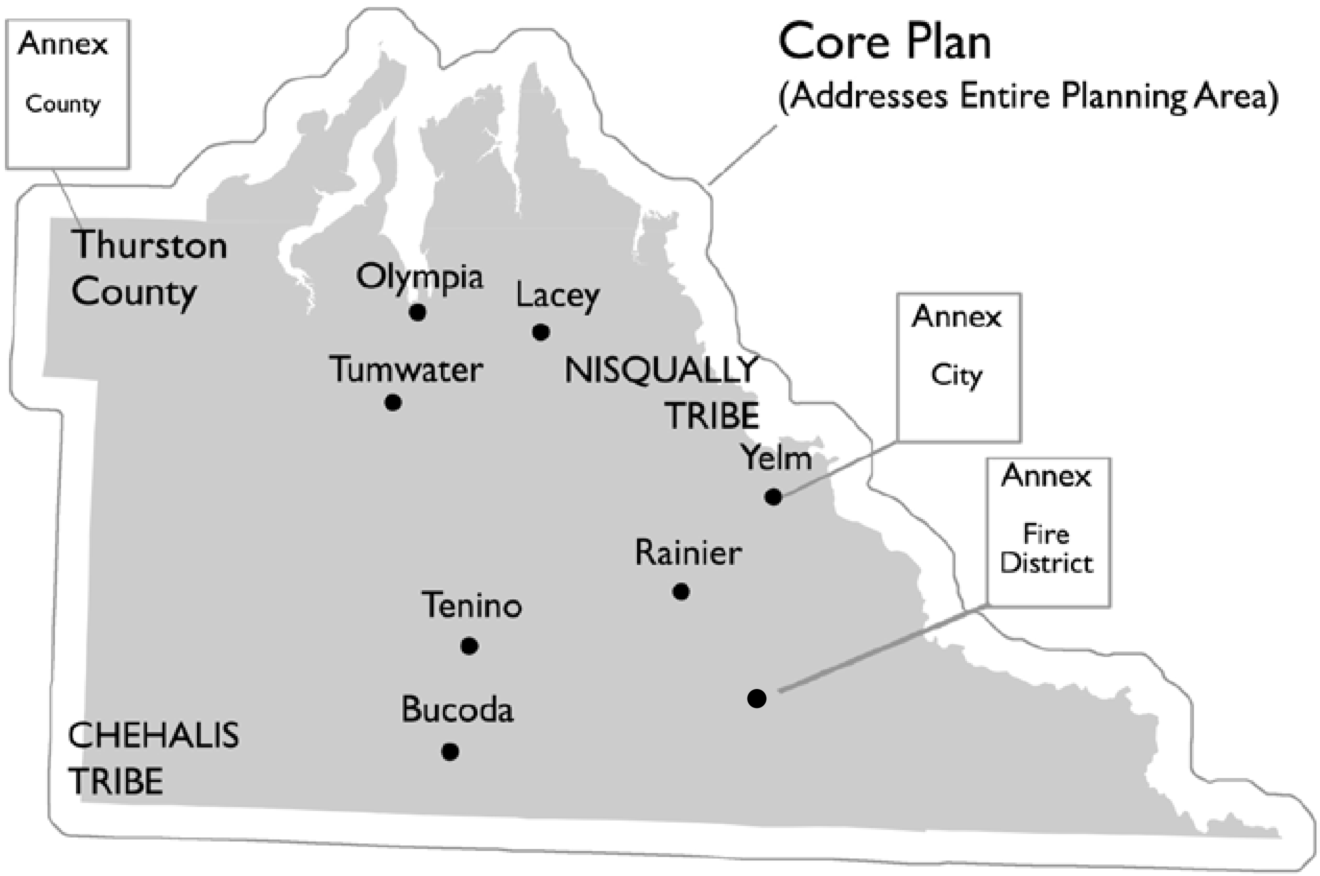
Information about how this plan was developed: ***Chapter 6: Plan Process and Development.***

Plan Structure

The plan meets Federal Disaster Mitigation Act hazard mitigation planning requirements for both the multi-jurisdictional and individual jurisdictional planning requirements. The core plan is divided into six chapters plus appendices. Each participating jurisdiction prepared a plan annex. Outline of plan's contents:

	Chapter	Contents
Core Countywide Multi-Jurisdiction Plan	1. Introduction	An overview of hazard mitigation planning, federal planning requirements, federal mitigation funding, the contents of the plan.
	2. Mitigation Strategy	Mitigation goals and objectives, and countywide recommendations to reduce or prevent impacts from hazards.
	3. Thurston County Community Profile and Capability Assessment	A narrative and statistical profile of Thurston County including information on population, demographics, the environment, development trends, and community services. This chapter also includes an assessment of federal, state, and local mitigation planning capabilities.
	4. Risk Assessment	A comprehensive risk assessment of the hazards that threaten Thurston County and its communities, divided into six hazard profiles: Earthquake, Storm, Flood, Landslide, Wildland Fire, and Volcanism.
	5. Adoption, Implementation, Monitoring, and Maintenance	A description of the plan's implementation, evaluation, and maintenance processes.
	6. Plan Process and Development	A description of the plan's development process.
	Appendices	Public outreach materials and other references, forms and templates, risk assessment data and methodology, and grant program information.
Annex	Annex or Local Plan	A subset of the plan that contains information specific to a single jurisdiction: the mitigation actions, plan process details, variations to the countywide risk assessment, if appropriate, and evidence of adoption.

Figure 1.0.1: Components of the Hazards Mitigation Plan for the Thurston Region, Core Plan and Annexes



Endnotes

[1] Thurston Regional Planning Council. The Profile. Data available online: www.trpc.org/theprofile.

Chapter 2.0

Mitigation Strategy: Goals, Objectives, and Initiatives

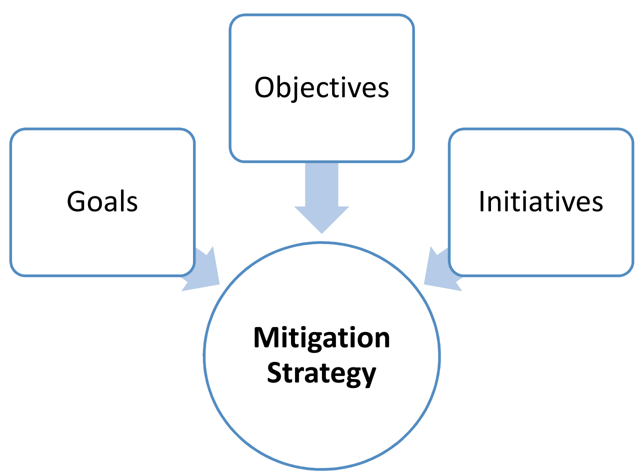
Vision:

All sectors of the community work together to create a disaster resilient region.

Introduction

The mitigation strategy is this plan's call to action. It is the planning partners' blueprint for reducing losses and impacts from the hazards identified in the risk assessment. The plan's goals are the overarching principles that communities will base their mitigation decision-making upon. The objectives supply a range of measurable steps that can meet the goals. The plan's initiatives are specific projects and activities that each jurisdiction identifies, prioritizes, and commits to implementing as a long-term investment in building and maintaining a stronger, more disaster resilient community. Together the goals, objectives, and initiatives form the region's and each partner's mitigation strategy.

As this is a multi-jurisdictional plan, the goals and objectives are applicable to every partner that adopts it. Moreover, each partner has other comprehensive or strategic plans containing safety and security-related goals, policies, or measures that may be integral to their community's hazard mitigation planning process. This plan offers a regional context for how local governments can work together, which can expand each partner's existing hazard reduction strategies to achieve disaster resiliency within their community or organization.



Goals and Objectives

The goals translate the plan's Guiding Policies (Chapter 6) into a more detailed framework for hazard mitigation decision-making. Five goals serve to protect what is most important to the community: people; infrastructure; property; environment; and economy. Four goals are critical for achieving the plan's vision – the effort required to create a disaster resilient region: building community support; expanding understanding of hazards; implementing effective mitigation strategies; and increasing community awareness.

The objectives define actions or results that can be translated into measurable terms and specific assignments for implementation. Each mitigation initiative identified in the core plan and in the plan partners' annexes tie to one or more objectives.

1. **Protect life**
   - A. Design, build, operate, and maintain disaster resistant communication systems that provide emergency notifications and instructions.
   - B. Decrease the impacts of hazards on at risk individuals or special needs populations.[1]
   - C. Address emergency evacuation needs, prioritizing areas of the community where mitigation strategies are ineffective or cost prohibitive.
   - D. Train and equip emergency service providers to effectively respond to hazard events.
2. **Protect infrastructure**
   - A. Maintain and upgrade roads, bridges, and other transportation infrastructure and services to withstand the effects of hazards without prolonged operational disruptions.
   - B. Maintain and upgrade utility systems and services to withstand the effects of hazards.
   - C. Maintain or replace public buildings such as offices, schools, and other facilities to withstand the effects of hazards.
   - D. Strengthen or relocate critical facilities or create protective spaces or infrastructure around them so they are not significantly affected by the effects of hazards
3. **Protect property**
   - A. Minimize the number of properties that are situated in hazard prone locations.
   - B. Protect and preserve vital records, data, information technology systems, and facility contents.
   - C. Safeguard objects or places that have cultural or historic significance.

[1] Special Needs Populations: Populations whose members may have additional needs before, during, and after an incident in functional areas, including but not limited to: maintaining independence, communication, [1]transportation, supervision, and medical care. Individuals in need of additional response assistance may include those who have disabilities; who live in institutionalized settings; who are elderly; who are children; who are from diverse cultures; who have limited English proficiency or are non-English speaking; or who are transportation disadvantaged. Glossary, National Response Framework.

4. **Protect the environment**
    A. When possible, use mitigation strategies that preserve ecological functions of natural systems.
    B. Consider mitigation actions that restore natural systems that provide protective measures to surrounding properties.
    C. Continue evaluating the effectiveness of Critical Areas Ordinances and development regulations and revise as necessary to ensure development does not occur in areas prone to hazards or changing environmental conditions that threaten public safety.
    D. Support efforts to increase local jurisdictions' abilities to appropriately respond to hazardous material releases.
5. **Sustain the economy**
    A. Develop and maintain efforts to prepare recovery plans.
    B. Focus on mitigation strategies that protect medical treatment centers, employment centers, commercial districts, and schools.
    C. Coordinate with regional, state, and federal agencies to identify and prioritize continuity of operations on lifeline transportation corridors and systems.
    D. Strengthen public-private partnerships to reinforce or establish redundancy for critical supply systems.
    E. Develop and maintain continuity of operations plans for essential public safety services.
6. **Build community support**
    A. Coordinate and provide leadership in the hazard mitigation planning process among local, tribal, state, and federal government entities.
    B. Engage residents, businesses, employers, medical centers, utility companies, subject matter experts, community, and faith-based organizations as partners to help identify opportunities to strengthen the region's hazard resilience.
    C. Update the region's Hazards Mitigation Plan every five years, or sooner if necessary to respond to emerging threats.
7. **Expand understanding of hazards**
    A. Monitor and evaluate precipitation, groundwater, and stream flow levels, and survey flood high water marks.
    B. Partner with state and federal agencies, colleges, universities, and non-governmental organizations to participate in modeling programs to map high risk hazard areas.
    C. Participate in regional or statewide disaster scenario exercises to assess mitigation, preparedness, response, and recovery capacities, and apply lessons learned to mitigation activities.

D. Develop a better understanding of the location and mitigation needs of vulnerable and special needs populations within the communities.

E. Document, share, and act on lessons learned following disaster events.

8. **Implement effective mitigation strategies**

A. Focus mitigation efforts on the region's greatest risks and vulnerabilities.

B. Integrate adopted mitigation strategies into other planning documents such as response plans, comprehensive plans, strategic plans, Critical Areas Ordinances, Capital Facility Plans, zoning code, and development regulations.

C. Apply for federal mitigation assistance grants and leverage other funding sources to finance mitigation projects.

9. **Increase public awareness**

A. Develop and sustain ongoing communication campaigns with residents, customers, businesses, and other stakeholders about the known risks of hazard events and the actions that community members or organizations can take to prevent or minimize losses.

B. Conduct broad outreach activities to engage all sectors of the community in the hazards mitigation planning process.

Revisions to Goals and Objectives

During the 2014-2016 plan update process, the Hazard Mitigation Workgroup made substantial revisions to the original goals and objectives to better reflect the needs of mitigation planning in the region. The original goals and objectives remained unchanged through the 10 years of the first two plans. The intent of many of the original goals remain, but were rewritten and reorganized to omit goals and objectives that concentrated on emergency response oriented outcomes. While response and mitigation activities have complementary benefits, mitigation activities are this plan's primary focus. The mitigation workgroup also cited the benefits of aligning the region's goals with the state's hazards mitigation goals. As a result of the changes, every mitigation initiative in this plan was reviewed and updated to reflect its relationship to the updated goals and objectives.

Relationship with the Washington State Enhanced State Hazard Mitigation Plan

The Washington State Enhanced Hazard Mitigation Plan provides guidance for hazard mitigation planning statewide. The mission of the state plan is to "Reduce the adverse impacts and losses caused by natural hazard events."[1] The Thurston region's goals and objectives are specific to the needs of local communities, but consistency is established with the state plan to effectively coordinate mitigation activities between the state and the region as shown in Table 2.01.

Table 2.0.1: Washington State Enhanced Hazards Mitigation Plan Goals and Objectives

State Goals	State Objectives	Thurston Region Objectives
Protect Life	1.1 Improve systems that provide warning and emergency communications.	1A
	1.2 Develop or amend laws so they effectively address hazard mitigation.	4C, 8B
	1.3 Reduce the impacts of hazards on vulnerable populations.	1B, 7D, 8A
	1.4 Strengthen state and local building code enforcement	8B
	1.5 Train emergency responders.	1D, 7C
Protect Property	2.1 Protect assets, particularly critical assets.	2A,B,C,D; 3A,C
	2.2 Protect and preserve facility contents.	3B
	2.3 Reduce repetitive and severe repetitive losses, including those caused by flooding.	3A
Promote a Sustainable Economy	3.1 Provide incentives for mitigation initiatives.	
	3.2 Continue critical business operations.	5C,D,E
	3.3 Form partnerships to leverage and share resources.	
Protect the Environment	4.1 Develop hazard mitigation policies that protect and improve the environment.	3A,B
Increase Public Preparedness for Disasters	5.1 Improve the understanding of natural hazards and the risk they pose.	7A,B
	5.2 Improve hazard information, including databases and maps.	7B
	5.3 Improve public knowledge of hazards and protective measures so individuals appropriately respond during hazard events.	9A,B
	5.4 Develop new policies to enhance hazard mitigation initiatives.	

Progress Toward Goals and Objectives

The region's planning partners have made steady progress toward fulfilling mitigation goals and objectives. Although the original plan set a goal fulfillment date of 2025, most of the plan objectives will require continuous efforts throughout the region. Hazards mitigation planning is a process that requires multiple stakeholders to continuously monitor, evaluate, and revise the plan as appropriate. Planning partnerships must be maintained and communities must continue to invest in projects and their planning capabilities to succeed.

The successful outcome of many of the plan's objectives will be measured by progress made in the locally adopted mitigation initiatives. Some will take considerable time and resources to complete, but evidence of progress is apparent for several jurisdictions in fulfilling the region's objectives. The following accomplishments have made communities in Thurston County more disaster resilient:

1. **Protect life** – On September 1, 2016, eight communities including Bucoda, Lacey, Olympia, Rainier, Tenino, Tumwater, Yelm and Thurston County launched the operation of an Emergency Alert System. The system is capable of pushing emergency text messages to both subscribers and non-subscribers over a wide or narrow area. The system can also issue flood, severe weather, and other hazard warnings to subscriber residents, businesses, and property owners within the affected area. Over 7,400 people have registered to receive notifications.
2. **Protect infrastructure** – Several plan partners performed seismic retrofits to essential facilities or constructed new ones. The City of Olympia constructed a new city hall, Thurston County constructed a new Emergency Coordination Center, and the Evergreen State College completed a seismic retrofit of its "A-Dormitory" student residence building. Thurston County applied for a Hazard Mitigation Grant Program grant tto elevate three homes on the Deschutes River. The Chehalis Flood Authority

awarded the county a grant to elevate four to six homes in February 2017.

3. **Protect property** – In 2015, Thurston County prepared a repetitive (flood) loss analysis for the entire unincorporated area of the county. Residents and property owners at risk of potential flooding or repetitive flooding were provided information about flood insurance and protective measures to reduce flood losses.
4. **Protect the environment** – In December, 2015 and March 2016, Thurston County used grant funds to demolish and remove two homes and structures along the Deschutes and the Nisqually Rivers. Both properties were at risk of river flooding and embankment erosion. The original owners still own the property, however their deeds prohibit future improvements to the properties. As such, they will remain open space, in perpetuity. In 2016, Thurston County, Lacey, Olympia, and Tumwater updated and adopted their Design and Drainage Control Manuals, zoning codes, and development regulations to make low impact development (LID) the common and preferred approach to stormwater management. LID will improve water quality and reduce risks for urban flooding. The county and the cities also updated their Critical Areas Ordinances to protect wetlands and prevent new development from occurring in geologically hazardous areas. In 2016, the City of Tumwater adopted the Endangered Species Act version of the model floodplain ordinance.
5. **Sustain the economy** – Thurston County, the cities, and other transportation stakeholders participated in the Puget Sound Regional Catastrophic Preparedness Plan. Communities worked together to develop a transportation annex and identified measures to mitigate and prioritize the recovery of the transportation system in the event of a major catastrophe. Between 2011 and 2013, Thurston Regional Planning Council (TRPC) convened a Blue Ribbon Economic Development Panel as part of its Sustainable Thurston Development Plan and identified 38 actions to strengthen the region's economy. A public safety panel identified 26 actions to promote public safety, 17 of which are related to disaster mitigation and resiliency.
6. **Build community support** – The Thurston Region updated its Hazards Mitigation Plan for the third time. The Emergency Management Council of Thurston County invited 39 cities, tribes, colleges, fire districts, school districts, and other special districts to participate in the mitigation planning process.
7. **Expand understanding of hazards** – Thurston County continues to strengthen its water resources program by expanding its network of monitoring stations. In 2012, the region acquired its first set of earthquake and flood HAZUS-MH model scenarios, enabling the region to

estimate losses from these hazard events. The results of this data are incorporated into this plan. The region's planning partners continue working with the Federal Emergency Management Agency (FEMA) and stakeholders on the Risk MAP process to delineate the Deschutes, Lower Chehalis, and Nisqually river basins, and the coastal area flood risks. In 2016, TRPC launched a planning process to develop a Thurston Climate Adaptation Plan (see Chapter 3.1: Capability Assessment). The planning process performed and documented a Vulnerability Assessment.

8. **Implement effective mitigation strategies** – Communities struggle with securing adequate funding to implement a wide array of community priorities, not just hazard mitigation projects. This plan continues to exhibit some initiatives that border more on disaster preparedness and response activities than mitigation. The hazard mitigation planning process is one of the few opportunities for multiple partners to convene to discuss hazards and natural disasters. Naturally, conversations gravitate toward the entire emergency management spectrum. However, the plan's partners find value in documenting and institutionalizing emergency preparedness and response activities in their mitigation plan as it is the only plan, for some communities, that documents some form of hazard response. Each mitigation initiative in this plan includes information about its implementation status.

9. **Increase public awareness** – Thurston County distributes an annual flood bulletin to residents in flood affected areas. The Emergency Management Council of Thurston County convened six Executive Disaster and Recovery Seminars over the last three years. The hazards mitigation planning process reached out to community members at community events, through social media, press releases, and an open house. The process used an innovative GIS story map to allow people to explore their community hazards on their own from a computer or mobile device. The City of Olympia hosted

numerous public meetings to inform and engage community members on the risks of climate change and the impacts of sea level rise.

Mitigation Activities

This plan identifies seven categories of mitigation activities. These categories were created during the development of the original plan and were reviewed by the Hazards Mitigation Workgroup during the plan update process. The Workgroup members believe the categories sufficiently cover the range of possible projects included in the plan. Each initiative in this plan fulfills one or more of the following categories:

1. **Public Outreach and Information:** Information delivered in a variety of formats intended to inform and educate community members, elected officials, and property owners about the hazards and potential ways to mitigate them. Such actions include websites, outreach projects, real estate disclosure, fairs and expos, and school-age and adult education programs.
2. **Plan Coordination and Implementation:** Activities that support a jurisdiction's hazards mitigation planning process and implementation strategy within their organization and in conjunction with neighboring jurisdictions and relevant stakeholders.
3. **Data Collection and Mapping:** Actions that relate to the process of gathering and analyzing new data and then mapping or utilizing the information in such a manner that it improves communities' ability to make informed decisions about increasing their disaster resilience.
4. **Development Regulations:** Government administrative or regulatory actions or processes that influence the way land and buildings are developed and built. These actions also include public activities to reduce hazard losses. Examples include planning and zoning, building codes, capital improvement programs, open space preservation, and stormwater management regulations.
5. **Hazard Preparedness:** Advance actions that protect people and property during and immediately after a disaster or hazard event. These could include developing or improving warning systems, emergency response services, and the stockpiling of supplies and materials.
6. **Hazard Damage Reduction:** Actions that involve the modification of existing buildings or structures to protect them from a hazard, or removal from the hazard area. Examples include acquisition, elevation, relocation, structural retrofits, storm shutters, and shatter-resistant glass.
7. **Critical Facilities Replacement/ Retrofit:** Activities targeted specifically at protecting or replacing critical or essential facilities.

Mitigation Initiatives

Central to this plan and the mitigation strategy are the specific projects or activities the planning partners will implement. When implemented, most of these activities – referred to as mitigation initiatives – will have a long-term sustained effect on reducing the loss of life and property from hazardous events.

Most of the plan initiatives will require significant investments in planning, design, and construction or implementation, and may take years to complete. The desired outcomes of this plan are that communities:

- Achieve a greater awareness of their risks;
- Develop a list of practical mitigation activities that are eligible for federal mitigation grants and other funding programs; and
- Implement mitigation activities.

The plan contains two sets of mitigation initiatives:

1. **Countywide Mitigation Initiatives:** Identified by members of the Hazards Mitigation Workgroup, these actions are beneficial across the region or significant portions involving more than one jurisdiction. These activities will be overseen by the Emergency Management Council and will require coordination with multiple stakeholders. Thurston County Emergency Management will play a major role in their implementation. This chapter contains these initiatives.
2. **Jurisdiction Initiatives:** Each jurisdiction identifies actions that are specific to their community and takes responsibility for implementing those actions. Each jurisdiction's annex contains these initiatives.

Mitigation Initiative Format

To support organization, every initiative in the plan follows a consistent format that includes: title, rationale or problem statement, priority, hazard addressed, project category, related Goals and Objectives, department or project lead, estimated cost, estimated timeline for implementation, potential funding sources, relationship to other community planning documents – if applicable – and implementation status. Refer to Figure 2.0.1 to view the layout of the mitigation initiative content.

Figure 2.0.1 Sample Mitigation Initiative

The ranking of the mitigation initiative as assigned by the workgroup or jurisdiction

New, existing, or modified during the plan update

Priority: 5 of 12 **Status: Modified**

Type of hazard addressed and the mitigation activity category

Hazard Addressed: Severe Storm Hazard
Category: Hazard Preparedness

Initiative identification number and project title

CW-SH 1: Develop a disaster debris management strategy.

Statement of need for the mitigation initiative

Rationale: Storms such as the January 2012 Winter Storm, the 1996 Ice Storm, and the 1993 Inaugural Day Wind Storm each generated significant vegetative and building damage debris. HAZUS estimates of earthquake and flood debris generation also highlight the need for a coordinated debris management plan. This plan will improve coordination between local agencies, utility providers, and affected individuals and organizations to manage clean-up efforts.

Relationship to plan goals

Relates to Plan Goal(s) and Objectives: 5C, 5D, 6B, 7E

Implementation details

Implementer: Thurston County, cities, Port of Olympia, Washington State Department of Ecology, Olympic Region Clean Air Authority, Puget Sound Energy, and private contractors

Estimated Cost: Unknown

Time Period: 2017-2021

Funding Source: Unknown

Background information. Some projects may have originated outside the mitigation planning process and are linked to their original source.

Source and Date: 2003 Natural Hazards Mitigation Plan for the Thurston Region

Adopted Plan Number: CW-SH 1

Reference Page: V29

Status of the initiative and progress toward its implementation

Initiative and Implementation Status: Thurston County Emergency Management successfully implemented debris management systems during the 2006 Winter Storm, the 2007 Winter Flood, and the January 2009 Flood. In 2016, Thurston County initiated the development of a debris management strategy. A draft plan is expected in 2017.

Countywide Mitigation Initiatives

The plan contains 12 countywide initiatives that, if implemented, would enhance the region's understanding of the hazards identified in the risk assessment and help reduce risks to people and property across the county. These initiatives will require continuous coordination among this plan's existing and future partners over the five-year life of this plan and beyond. Most of these activities are carried over from the previous plan as more work is necessary and some of the data collection and mapping activities constitute ongoing work programs.

The order of implementation may vary from the identified priority due to changing hazard conditions or the criteria of available grant programs. The federal mitigation grant programs are competitive and the highest priority projects aren't necessarily the appropriate project to submit for any given call for projects.

Table 2.0.2: Summary of Countywide Mitigation Initiatives

Priority	ID-Number	Category	Countywide Mitigation Initiatives
1	CW-MH 4	Hazard Damage Reduction	Create a lifeline transportation route GIS map for the Thurston Region and integrate the data into the Thurston County Emergency Operations Plan and other local planning needs.
2	CW-MH 7	Hazard Preparedness	Strengthen interjurisdictional asset management capabilities.
3	CW-MH 6	Public Information	Develop and maintain a hazards mitigation public outreach strategy.
4	CW-FH 1	Data Collection and Mapping	Develop emergency evacuation routes and update Comprehensive Emergency Management Plans for potential catastrophic dam failure.
5	CW-SH 1	Hazard Preparedness	Develop a disaster debris management strategy.
6	CW-WH 1	Data Collection and Mapping	Map the region's high risk wildland urban interface communities.
7	CW-MH 1	Data Collection and Mapping	Inventory essential facilities and assets to support hazard mitigation planning and emergency management.
8	CW-EH 2	Data Collection and Mapping	Enhance earthquake modeling capacity and integrate into emergency management work programs.
9	CW-MH 11	Data Collection and Mapping	Inventory and assess sheltering facilities.
10	CW-MH 9	Data Collection and Mapping	Map transportation infrastructure that is subject to frequent flooding or is prone to landslide hazards.
11	CW-MH 10	Plan & Coordination Implementation	Develop and adopt a Climate Adaptation Plan.
12	CW-MH 8	Hazard Preparedness	Strengthen the capabilities to establish and maintain situational awareness of health and medical system and resource coordination during an emergency.

Priority: 1 of 12 Status: Modified

Hazard Addressed: Multi-Hazard
Category: Hazard Damage Reduction

CW-MH 4: Create a lifeline transportation route GIS map for the Thurston Region and integrate the data into the Thurston County Emergency Operations Plan and other local planning needs.

Rationale: A "lifeline" transportation route database will assist inspectors with prioritization of post hazard-event transportation facility evaluation and hasten the restoration or redirection of emergency service routes. This effort will focus on essential corridors necessary for public safety. Route and asset information will be mapped in a GIS. Planning will identify key attributes to support field inspections and assessments. Long term maintenance of the database will be considered.

Relates to Plan Goal(s) and Objectives: 1C, 2A, 5C

Implementer: Thurston County Public Works and Emergency Management, cities, Intercity Transit, tribes, school districts, TRPC, and other regional transportation stakeholders

Estimated Cost: Unknown

Time Period: 2017-2021

Funding Source: Unknown

Source and Date: 2003 Natural Hazards Mitigation Plan for the Thurston Region

Adopted Plan Number: CW-MH 4

Reference Page: V25

Initiative and Implementation Status: This was the top ranked initiative in 2009 and 7 of 10 in the 2003 plan. Thurston County transportation stakeholders worked together to develop a Transportation Recovery Annex for the Puget Sound Catastrophic Preparedness plan, but this effort focused on state routes. While Thurston County maintains a comprehensive database of the region's road network, no work has been performed to develop a local network "lifeline" map that would prioritize post disaster recovery efforts. In 2016, TRPC solicited data from local agencies on road segments prone to flooding and landslides. This data was compiled into GIS and shared with public works departments.

Priority: 2 of 12 Status: Existing

Hazard Addressed: Multi-Hazard
Category: Hazard Preparedness

CW-MH 7: Strengthen interjurisdictional asset management capabilities.

Rationale: During disasters, supplemental and/or specialized resources are often in demand by one or more affected communities. Understanding what resources are available and how to acquire them in a timely manner can minimize losses. This initiative proposes a coordinated phased approach to: 1) Convene partners to identify appropriate resources; 2) Establish an online inventory system and create a process to procure resources; and 4) Maintain the system. This tool will streamline resource requests, tracking, and allocation. Examples of shared assets include specialized teams, personnel, and equipment.

Relates to Plan Goal(s) and Objectives: 1D, 5D

Implementer: Thurston County Emergency Management, cities, fire districts, school districts, and other regional stakeholders

Estimated Cost: $50,000

Time Period: 2017-2021

Funding Source: Unknown

Source and Date: 2009 Natural Hazards Mitigation Plan for the Thurston Region

Adopted Plan Number: CW-MH 7

Reference Page: 5-17

Initiative and Implementation Status: This initiative was introduced in the 2009 plan update process. It was amended during the 2014-2016 plan update to describe a phased implementation approach. Planning partners reiterated the importance and usefulness of this initiative.

Priority: 3 of 12 Status: Existing

Hazard Addressed: Multi-Hazard
Category: Public Information

CW-MH 6: Develop and maintain a hazards mitigation public outreach strategy.

Rationale: Ongoing public outreach and education for hazard mitigation activities is necessary to engage and inform all sectors of the community to become more disaster resilient. Messaging will focus on opportunities for households, businesses, and major employers to minimize losses from hazards that threaten the region. Information will be disseminated through a variety of electronic and printed resources, and provided at the annual Emergency Preparedness Expo and other community events.

Relates to Plan Goal(s) and Objectives: 5B, 8A, 8B

Implementer: Thurston County Emergency Management Council, school districts, colleges and universities, and other regional stakeholders

Estimated Cost: $100,000 (Note: $20,000 Annually)

Time Period: 2017-2021

Funding Source: Grants, Emergency Management Council funds, and other local funding

Source and Date: 2009 Natural Hazards Mitigation Plan for the Thurston Region

Adopted Plan Number: CW-MH 6

Reference Page: 5-20

Initiative and Implementation Status: Thurston County Emergency Management regularly attends neighborhood meetings to share resources and information about hazards. TRPC created a GIS hazards story map for the 2016 Emergency Preparedness Expo and the Hazards Mitigation Plan Open House. TRPC staff hosted a hazard mitigation booth at all three expos in 2014-2016. Additional funding resources are required to develop a formal multi-hazards public education program. Other ongoing activities include Thurston County’s participation in the Community Ratings System. In 2016, Thurston County became a class II community for its flood mitigation activities, including public outreach.

Priority: 4 of 12 Status: Modified

Hazard Addressed: Flood Hazard
Category: Data Collection and Mapping

CW-FH 1: Develop emergency evacuation routes and update Comprehensive Emergency Management Plans for potential catastrophic dam failure.

Rationale: Emergency Action Plans are available for the Skookumchuck and the Alder and La Grande Dams. Communication protocols between the dam operators and essential emergency management and public safety personnel exist, however there are no established protocols for notifying affected residents and property owners in Thurston County. This effort will develop evacuation plans to identify routes, signage, coordination with staging areas, alert and public information notification systems, and sheltering.

Relates to Plan Goal(s) and Objectives: 1A, 1C, 1D, 5C, 8B

Implementer: Thurston County Emergency Management and regional stakeholders

Estimated Cost: Unknown

Time Period: 2017-2021

Funding Source: Unknown

Source and Date: 2003 Natural Hazards Mitigation Plan for the Thurston Region

Adopted Plan Number: CW-FH 1

Reference Page: V15

Initiative and Implementation Status: This initiative was priority 4 of 9 in the 2009 plan. It was amended during the 2014-2016 plan update process to focus on developing evacuation routes and updating Comprehensive Emergency Management Plans. In 2016, communities in Thurston County subscribed to an alert and notification system, AlertSense. This system enables emergency managers and other authorities to push warnings with instructions to targeted areas in the community through land-line phones, cell phones, text messaging, email, and social media. Dam flood inundation data is available from the Emergency Action Plans. Additional resources are necessary to process this data in a GIS to conduct a vulnerability assessment. Upon completion of this task, this data will assist stakeholders with developing evacuation plans.

Priority: 5 of 12 Status: Modified

Hazard Addressed: Severe Storm Hazard
Category: Hazard Preparedness

CW-SH 1: Develop a disaster debris management strategy.

Rationale: Storms such as the January 2012 Winter Storm, the 1996 Ice Storm, and the 1993 Inaugural Day Wind Storm each generated significant vegetative and building damage debris. HAZUS estimates of earthquake and flood debris generation also highlight the need for a coordinated debris management plan. This plan will improve coordination between local agencies, utility providers, and affected individuals and organizations to manage clean-up efforts.

Relates to Plan Goal(s) and Objectives: 5C, 5D, 6B, 7E

Implementer: Thurston County, cities, Port of Olympia, Washington State Department of Ecology, Olympic Region Clean Air Authority, Puget Sound Energy, and private contractors

Estimated Cost: Unknown

Time Period: 2017-2021

Funding Source: Unknown

Source and Date: 2003 Natural Hazards Mitigation Plan for the Thurston Region

Adopted Plan Number: CW-SH 1

Reference Page: V29

Initiative and Implementation Status: Thurston County Emergency Management successfully implemented debris management systems during the 2006 Winter Storm, the 2007 Winter Flood, and the January 2009 Flood. In 2016, Thurston County initiated the development of a debris management strategy. A draft plan is expected in 2017.

Priority: 6 of 12 Status: Existing

Hazard Addressed: Wildland Fire Hazard
Category: Data Collection and Mapping

CW-WH 1: Map the region's high risk wildland urban interface communities.

Rationale: The methodology for determining risk for wildfire relies on outdated analysis performed by the Washington State Department of Natural Resources (DNR) that forms the basis of the wildland urban interface fire risk assessment in this plan. Local protection fire districts need updated data and maps that reflect areas of the community that are at risk for wildland fires. This information would assist communities in developing wildfire protection plans, community education, and mitigation activities.

Relates to Plan Goal(s) and Objectives: 1B, 3A, 7B

Implementer: Thurston County Association of Fire Chiefs, DNR, Emergency Management Council, and TRPC.

Estimated Cost: 50,000.

Time Period: 2017-2021

Funding Source: Grants and in-kind staff resources from local fire districts and community development and planning departments.

Source and Date: 2009 Natural Hazards Mitigation Plan Adopted Plan Number: CW-WH 1

Reference Page: 5-20

Initiative and Implementation Status: Thurston County is not identified as a high wildfire priority area and is not presently eligible for DNR's Community Assistance Grant Program. Regional partners will continue working with the Thurston County Fire Chiefs Association to explore additional data sources for mapping wildland urban interface communities. In 2016, TRPC prepared wildland fire urban interface maps for its Climate Adaptation Plan Vulnerability Assessment. This data will be evaluated for future updates to assess risk in the wildland fire hazard profile.

Priority: 7 of 12 Status: Existing

Hazard Addressed: Multi-Hazard
Category: Data Collection and Mapping

CW-MH 1: Inventory essential facilities and assets to support hazard mitigation planning and emergency management.

Rationale: The region continues to grow and critical infrastructure information changes. Maintaining an accurate and comprehensive critical infrastructure database can serve a variety of essential operational and planning functions in the region.

Relates to Plan Goal(s) and Objectives: 2D, 6C, 8A

Implementer: Thurston County Emergency Management and regional Stakeholders

Estimated Cost: $15,000 to develop. Will require annual maintenance.

Time Period: 2017-2021

Funding Source: Unknown

Source and Date: 2003 Natural Hazards Mitigation Plan for the Thurston Region

Adopted Plan Number: CW-MH 1

Reference Page: V19

Initiative and Implementation Status: This initiative was ranked 7 of 9 in the 2009 plan. Significant progress has been made on this initiative. In 2012 and 2015, TRPC coordinated data collection efforts with hazard mitigation partners to compile and update a critical infrastructure database. The current efforts have been completed on an as needed basis, but should be formalized to improve the reliability and the availability of current data to support mitigation planning and vulnerability assessments using GIS and tools such as HAZUS multi-hazard modeling software.

Priority: 8 of 12 Status: Modified

Hazard Addressed: Earthquake Hazard
Category: Data Collection and Mapping

CW-EH 2: Enhance earthquake modeling capacity and integrate into emergency management work programs.

Rationale: Very few tools and resources are available to communities to assess vulnerabilities from the effects of earthquakes. The region will continue efforts to use HAZUS multi-hazard modeling software to evaluate the impacts of earthquakes on population, infrastructure, and services. The region will partner with Washington State Emergency Management Division and FEMA Region X to explore opportunities to build local capacity to build, operate, and maintain a HAZUS model to support mitigation planning and other emergency support functions.

Relates to Plan Goal(s) and Objectives: 1D, 1C, 7B, 7C, 7D, 8B

Implementer: Thurston County Emergency Management and other regional Stakeholders

Estimated Cost: Unknown

Time Period: 2017-2021

Funding Source: Unknown

Source and Date: 2003 Natural Hazards Mitigation Plan for the Thurston Region

Adopted Plan Number: CW-EH 2

Reference Page: V15

Initiative and Implementation Status: This initiative was identified as priority 8 of 9 in the 2009 plan. Thurston County and TRPC worked with FEMA Region X and provided essential facility data to support the development of a series of HAZUS earthquake model scenarios. The results of these scenarios are included in the earthquake risk assessment. Additional support from FEMA and Washington State is necessary to support staff training to build, operate, and maintain local HAZUS models or to develop a statewide framework for building regional models in coordination with local governments. More research is necessary to determine the scope and cost of developing, running, and maintaining a HAZUS model for the Thurston Region.

Priority: 9 of 12 — Status: New

Hazard Addressed: Multi-Hazard
Category: Data Collection and Mapping

CW-MH 11: Inventory and assess sheltering facilities.

Rationale: People are often temporarily displaced from their homes during and after disaster events. Communities in Thurston County have identified facilities such as schools that may serve as emergency shelters, however there is no comprehensive inventory of such facilities and their characteristics. A countywide assessment of sheltering facilities will collect information such as capacity, availability of restrooms, kitchens, backup generators, and other sheltering requirements. This information will assist emergency managers with planning and supporting sheltering asset management and operations during disaster events.

Relates to Plan Goal(s) and Objectives: 1B, 6B, 9B

Implementer: Thurston County Emergency Management, cities, school districts, and other regional stakeholders

Estimated Cost: $25,000

Time Period: 2017-2021

Funding Source: TBD

Source and Date: 2017 Hazards Mitigation Plan

Adopted Plan Number: N/A

Reference Page: N/A

Initiative and Implementation Status: The Hazards Mitigation Workgroup identified this initiative during the plan update process.

Priority: 10 of 12 Status: New

Hazard Addressed: Multi-Hazard
Category: Data Collection and Mapping

CW-MH 9: Map transportation infrastructure that is subject to frequent flooding or is prone to landslide hazards.

Rationale: Numerous road segments and culverts are subject to flooding or the effects of landslides during periods of above normal rainfall. These facilities are routinely closed for public safety, resulting in temporary or prolonged detours that delay travelers and the delivery of emergency services. Public Works maintenance crews have first-hand knowledge of these locations, but they are not systematically mapped. Developing a GIS database of these facilities would assist with planning transportation projects and mitigating potential hazardous situations. This data would also be used for assessing vulnerability and increased risks to transportation infrastructure from the effects of climate change. This initiative's activities will consist of data collection, mapping, and vulnerability analysis.

Relates to Plan Goal(s) and Objectives: 2A, 2B, 8B

Implementer: TRPC and regional stakeholders

Estimated Cost: $12,000

Time Period: 2016-2017

Funding Source: National Estuary Program and Watershed Protection and Restoration Grant and TRPC Regional Transportation Program Funding

Source and Date: 2017 Hazards Mitigation Plan

Adopted Plan Number: N/A

Reference Page: N/A

Initiative and Implementation Status: This is a new initiative and progress is already underway. This task is being completed under the development of a Thurston Climate Adaptation Plan. This plan will assess climate change vulnerabilities, risks, and impacts and identify adaptation strategies and actions for Thurston County communities in watersheds that drain to the Puget Sound. The Climate Adaptation Plan is expected to be completed by the end of 2017. Likely, the vulnerability analysis and impacts will lead to the development of flood and landslide mitigation projects as part of future updates to this plan.

Priority: 11 of 12 Status: New

Hazard Addressed: Multi-Hazard
Category: Plan Coordination and Implementation

CW-MH 10: Develop and adopt a Climate Adaptation Plan.

Rationale: Preparing for and adjusting to the effects of a warming world — is now "unavoidable," the Intergovernmental Panel on Climate Change (IPCC) — the United Nations' climate research arm — concluded in its 2007 climate assessment. Even the most stringent efforts to reduce greenhouse gases "cannot avoid further impacts of climate change in the next few decades," the report explained. TRPC received a U.S. EPA National Estuary Program (NEP) grant administered by the Washington State Department of Commerce to draft a watershed-based climate adaptation plan that will recommend actions Thurston County stakeholders could take to prepare for and cope with floods, droughts, wildfires, and other climate change-exacerbated hazards in the decades ahead. The planning work — which began in late 2015 and will conclude in late 2017 — includes: researching and analyzing climate change projections; assessing regional climate change vulnerabilities and risks; developing adaptation strategies and conducting benefit-cost analyses; and, presenting TRPC policymakers a draft plan with adaptation recommendations.

Relates to Plan Goal(s) and Objectives: 4A, 4B, 4C, 5B, 7D, 8B

Implementer: TRPC and regional stakeholders

Estimated Cost: $270,000

Time Period: 2015-2017

Funding Source: National Estuary Program grant and TRPC Regional Transportation Program funding (funding secured)

Source and Date: Creating Places Preserving Spaces, a Sustainable Development Plan for the Thurston Region

Adopted Plan Number: E-2.1

Reference Page: 211

Initiative and Implementation Status: The adaptation plan's vulnerability analysis will lead to flood and landslide mitigation projects that will be included in future updates to this plan.

Evaluation of Mitigation Initiatives: This is a new initiative and progress will be reported in the next plan update cycle.

Priority: 12 of 12 Status: Modified

Hazard Addressed: Multi-Hazard
Category: Hazard Preparedness

CW-MH 8: Strengthen the capabilities to establish and to maintain situational awareness of health and medical system and resource coordination during an emergency.

Rationale: Prior to an emergency, the public health and health care system in Thurston County must work together to meet the needs of residents. The accurate coordination of information supports decision making processes of local, state, tribal, and private sector partners to carry out effective response measures to reduce harm and exposure to residents.

Partner's use of an information system will provide multi-agency coordination and better assessment of risk, so effective mitigation and response strategies can be implemented. Resources available include patient movement tools such as Region 3 Healthcare Preparedness Coalition Disaster Medical Coordination Center, National Disaster Medical System, and Washington State Disaster Medical Control Center.

Relates to Plan Goal(s) and Objectives: 1D, 5B, 5D

Implementer: Thurston County Health and Social Services Department of Health 7 Region 3 Healthcare Preparedness Coalition

Estimated Cost: Unknown

Time Period: 2017-2021

Funding Source: Grants and Local Match

Source and Date: 2009 Natural Hazards Mitigation Plan for the Thurston Region

Adopted Plan Number: CW-MH 8

Reference Page: 5-24

Initiative and Implementation Status: This initiative was ranked 9 of 9 in the 2009 plan, and was revised to include additional partners that will be responsible for its implementation.

Identification and Preparation of Mitigation Initiatives

Much of this plan is devoted to describing the hazard mitigation planning process, identifying and describing what hazards threaten our communities, and assessing the vulnerabilities or risks from impacts of these hazards. All this information serves as the foundation for informing and developing a mitigation strategy. Thurston Regional Planning Council provided guidance to the Hazards Mitigation Workgroup members who in turn facilitated and guided their jurisdiction's initiative identification process.

Thurston Regional Planning Council provided numerous resources to assist the planning partners with their initiative development process including:

- Updated Risk Assessment
- Hazard delineation maps
- Population, employment, key assets, and other land use hazard exposure analysis tables
- An online GIS "story map" of local infrastructure and assets impacted by hazards
- Updated draft copy of the plan's Goals and Objectives
- A copy of their previous annex with the initiatives
- An updated mitigation initiative form with instructions
- FEMA's "Local Mitigation Planning Handbook"
- FEMA's "Mitigation Ideas: A Resource for Reducing Risk to Natural Hazards"
- A benefit cost review worksheet

The process for evaluating vulnerabilities and identifying a range of alternative mitigation actions to reduce actual and potential hazard exposure varied among jurisdictions depending on their capabilities and resources. In general, workgroup members collaborated with staff and or committees within their jurisdictions that were most familiar with their infrastructure, facilities, key assets, and services, within their incorporated boundaries or service areas. Local planning partners referenced a variety of jurisdiction-specific resources such as their comprehensive plans, strategic plans, emergency management plans, capital facility plans, after action review debriefings, other planning documents, and local knowledge to compile existing mitigation activities. Jurisdictions also considered existing initiatives from the previous plan, and identified new and original initiatives identified as part of this plan's update process.

Benefit Cost Review

A benefit-cost review assists jurisdictions to select mitigation initiatives that warrant inclusion in their mitigation plan, thus allowing them to focus their efforts on practicable solutions. The benefit-cost review needs to be comprehensive to the extent that it can evaluate the monetary as well as the non-monetary benefits and costs associated with each action such as quality of life, community support, or environmental benefits. Plan partners performed a benefit-cost review for each of the initiatives considered for their strategy. This simple and subjective assessment shows whether the costs are reasonable compared to the probable benefits.

Identifying the project that offers the greatest impact for the lowest cost isn't necessarily always the right solution for the entities involved. The benefit-cost review tool can help point out which activities might better align with a community's values. The tool is useful in comparing a range of mitigation actions to solve a particular problem. For example, a jurisdiction could consider alternative mitigation activities for a home that is in a flood plain and is subject to repetitive flooding. The jurisdiction performs a benefit-cost review for three different activities: 1. Help the owner elevate the home above base-flood elevation; 2. Provide relocation assistance to move the home to higher ground, out of the flood plain; or 3. Buy the property from the home owner and remove all the structures from the flood plain. Each option includes varying measurable benefits as well as unique challenges that should be evaluated to select the best solution.

The participating jurisdictions used a "Mitigation Action Evaluation Worksheet" for the benefit-cost review. This worksheet follows a process with criteria offered in FEMA's "Local Mitigation Handbook." Using the mitigation categories as a starting point, the jurisdiction ranked two or more mitigation activities for their benefits and costs across several criteria by assigning points to the project in each category using the values shown below:

Benefits		**Neutral**	**Costs**	
+2	+1	0	-1	-2
Great benefits/ highly effective or high chance of implementation	Moderate effectiveness or good chance of implementation	Not applicable or neutral	Not effective or somewhat challenging to implement	Could cause indirect adverse effects or is very difficult to implement

For each of the projects listed on a worksheet, the following criteria were assigned a positive or negative score:

- **Life safety.** How effectively will the action protect lives and prevent injuries?
- **Property protection.** How significant will the action be at eliminating or reducing damage to structures and infrastructure?
- **Technical.** Is the mitigation action technically feasible? Is it a long-term solution? Eliminate actions that, from a technical standpoint, will not meet the goals.
- **Political.** Does the public support the mitigation action? Is there the political will to support it?
- **Legal.** Does the community have the authority to implement the action?
- **Environmental.** What are the potential environmental impacts of the action? Will it comply with environmental regulations?
- **Social.** Will the proposed action adversely affect one segment of the population? Will the action disrupt established neighborhoods, break up voting districts, or cause the relocation of lower income people?
- **Administrative.** Does the community have the personnel and administrative capabilities to implement the action and maintain it, or will outside help be necessary?
- **Local champion.** Is there a strong advocate for the action or project among local departments and agencies who will support the action's implementation?
- **Other community objectives.** Does the action advance other community objectives, such as capital improvements, economic development, environmental quality, or open space preservation? Does it support the policies of the comprehensive plan?

Jurisdictions tallied the score at the end of the project row. The project that earned a high score offers a high benefit with minimal implementation challenges. Conversely, a project with a low score offers fewer benefits and greater implementation challenges.

*Find examples of Hazard Mitigation Workgroup and planning partner forms and tools in **Appendix B**.*

Prioritization of Countywide Initiatives

For the plan update, the Hazard Mitigation Workgroup used a numerical ranking process to sort the countywide initiatives from highest to lowest priority. Each member of the workgroup used an online survey to perform an initial independent ranking of the initiatives to reflect their priorities. They shared the preliminary results at the next workgroup meeting. The workgroup then discussed the benefits and the significance of each initiative related to the plan's Goals and Objectives and the needs of the region. All the initiatives were subsequently re-prioritized in a workgroup setting to resolve competing priorities. After three iterations of member ranking, the workgroup reached consensus. Table 2.0.2 reflects the results of the countywide mitigation initiative prioritization process.

Prioritization of Jurisdictions' Mitigation Initiatives

Each jurisdiction prioritizes their mitigation activities based on their needs, local conditions, and community values. In general, they are prioritized according to their overall benefit to the community and their relationship to the plan's goals and objectives. Each community describes their mitigation initiative prioritization process in their annex.

Endnotes

[1] Washington State Emergency Management Division. 2014. Washington State Enhanced Mitigation Plan, Element C: Mitigation Strategy

Chapter 3.0
Community Profile

Introduction

This chapter includes a condensed, but data rich, community profile to describe the region's geography, population and demographics, development trends, and economy. Chapter 3.1 provides a high-level assessment of the planning partners' capabilities for implementing hazard mitigation strategies.

Thurston County's population, land use, infrastructure, economy, and government services are unique and provide a context for the portion of the population, community assets, and natural resources exposed to hazards. Managing risk becomes more complex as population increases. Local land use authority can minimize new development from locating in areas that are prone to hazards. However, a larger population results in more people potentially exposed to the effects of hazards while at home, work, recreating outdoors, or traveling. More people generates greater demand for law enforcement, fire services, public works, emergency management, and other local government and private sector services – especially during disaster events. Developing strategies, coordinating resources, and increasing public awareness to reduce risk and prevent loss from future hazard events is critical to establishing and maintaining disaster resiliency and sustaining the economy.

Find additional data about the Thurston Region online at www.trpc.org/theprofile.

Community Profile

Geography

Thurston County, located in Western Washington at the terminus of Puget Sound (see Map 3.0.1), is the 32nd largest county in the state with a total land area of 737 square miles. The county's three tribal areas include the Nisqually Indian Reservation in the east and the Confederated Tribes of the Chehalis Reservation in the southwest. The Squaxin Indian Reservation borders the county in the northwest. Joint Base Lewis-McChord occupies a large tract that extends from Pierce County into central eastern Thurston County. It is subject to heavy military training and recreational use. Capitol State Forest's nearly 100,000 acres are in the Black Hills in western Thurston County. While approximately 86 percent of the county's land area is unincorporated, it includes seven cities and towns and two unincorporated communities:

- Town of Bucoda
- City of Lacey
- City of Olympia
- City of Rainier
- City of Tenino
- City of Tumwater
- City of Yelm
- Grand Mound Urban Growth Area (unincorporated)
- Rochester Community (unincorporated)

The county's topography ranges from coastal lowlands to prairie flatlands to the foothills of the Cascades. The county's geography plays into the incidence of landslides, floods, and earthquakes. Glacial activity from the county's geologic past left the land dotted with lakes. The northernmost boundary of the county is lined with the shoreline of Puget Sound. Inlets exclusive to the county are Budd, Henderson, and Eld. Budd and Henderson inlets are separated by Dana Passage. Totten Inlet divides Thurston and Mason counties, and the Nisqually River separates Thurston from Pierce County (see Map 3.2).

In Thurston County, four local watersheds flow to the Pacific Ocean basin and five flow to the Puget Sound basin. Approximately 43 percent of the county's waters flow into the Pacific Ocean and 57 percent drains to the Puget Sound.

The northwest and southeast corners of the county are marked by peaks ranging from 1,700 to 3,000-foot elevations. Once thought to be the highest in the county, Larch Mountain and Capitol Peak, in the Black Hills, are both over 2,650 feet. However, the United States Geological Survey (USGS) discovered that the highest peaks in the county are in the extreme southeast corner near Alder Lake. Standing at 2,922 feet, Quiemuth Peak was named in 1993 by the Thurston County Historic Commission. Clam Mountain is the second highest peak at 2,725 feet.

Climate

Thurston County has a marine climate with mild temperatures year-round. In the warmest months, the average high temperature ranges between 70 and 80 degrees. In the winter months, high temperatures usually hover around 45 degrees. Like most of Western Washington, Thurston County's weather is characterized by sunny summers and wet winters. With about 52 clear days a year, Thurston County residents live under some form of cloud cover 86 percent of the year, with more than a trace of rain falling on almost half of the days.

Population and Demographics

Thurston County has been one of the fastest-growing counties in Washington State since the 1960s, consistently exceeding the state's overall rate of growth. Two factors drive population growth: net migration (people moving in minus people moving out) and natural increases (births minus deaths). Since 1960, in-migration has caused most of the growth. Between 2010 and 2015, an average of 2,320 people moved to Thurston County per year (68 percent of total growth). While much of this in-migration was likely due to the relatively stable economy in Thurston County, the increasing cost of living in the Seattle metropolitan area also played a role as individuals from the metropolitan area looked for ways to reduce escalating costs of living - particularly in housing.

Thurston Regional Planning Council's 2040 population forecast is 393,700, nearly 121,000 more people than lived in the region in 2016. Most future residents will live in the cities and urban growth areas, however the proportion of residents living in unincorporated Thurston County will increase about five percent.

Over 32,000 people here live below the poverty level. Between 1999 and 2015, that group increased by 3.6 percent. Nearly 13 percent of the population has some form of disability and 2.2 percent is linguistically isolated. Local social service agencies note that people tend to underreport these categories. Tables 3.0.1 through 3.0.7 show data on selected demographic characteristics of Thurston County residents including age, poverty, race, disability, language, and education. Estimates of 2016 and 2040 population density is shown for the county on maps 3.0.3 and 3.0.4.

Housing

Historical trends in the number and type of housing units can be observed using decennial U.S. Census Bureau data. These data provide a glimpse of the changing nature of the county over time and the amount of development during the past 50 years. In 1960, Thurston County had 19,888 dwelling units; since that time, the county has added over 90,000 dwelling units. These units accounted for nearly 82 percent of the county's housing stock in 2010. Only 14 percent of the county's existing housing stock was constructed prior to 1959 and 60 percent was constructed between 1980 and 2016. Tables 3.0.7 through 3.0.11 summarize information about housing in Thurston County.

Development Trends

Trends in urbanization provide insight into changes in the county's physical environment over time. The urban landscape is composed of a variety of physical features, including distinctly urban characteristics, such as roads and buildings, as well as more natural features, such as trees and lawns. As urban landscapes become more predominant, built features replace natural and rural environments. These changes impact a variety of features, including the quality of storm and surface water.

The cities and the county issued over 7,700 residential construction permits between 2010 and 2016. Of these, over 6,300 were in the cities and urban growth areas and over 1,300 in the rural unincorporated county. Single family permits accounted for 70 percent of permits, multi-family 25 percent, and manufactured housing five percent. Table 3.0.12 and Map 3.0.5 show housing permit data for this period.

Large-scale change detectable from satellite imagery indicates that approximately 23,500 acres of land were converted from forest stands, agricultural lands, or large expanses of shrub vegetation to urban landscapes between 1991 and 2006. Watersheds experiencing the highest percentages of this conversion were Henderson Inlet, which saw 14 percent of the total land converted to urban use and the Budd/Deschutes watershed, which saw seven percent of its land urbanized.

Watersheds or basins that have an urban or built land cover of less than 10 percent are generally assumed to have high water quality. Most of the rural basins in Thurston County fall under this threshold, although the Chehalis and Black River watersheds are nearing this mark. Several urban watersheds, however, exceed this level. Urban land cover within the Henderson Inlet watershed is 38 percent of the total land (a number that is due in part to the relatively small size of the watershed), and land cover in the Budd/Deschutes watershed is 21 percent of the total land area. The Nisqually River and Eld Inlet watersheds, both have 12 percent of their total land area developed with urban land cover.

Increases in urbanization are linked directly to increases in impervious surfaces. Parking lots, roof tops, and even compacted lawns all prevent water from returning to groundwater systems and lead to increased water runoff. TRPC has worked with the stormwater utilities of Lacey, Olympia, Tumwater, and Thurston County to develop forecasts of impervious area by linking forecasts of housing and commercial and industrial building space to land cover by watershed for the year 2030. While urban or built land cover data represent only one factor that influences stream health, this factor can be used as a prioritizing tool to develop watershed basin plans. Tables 3.0.13 and 3.14 show land cover by watersheds within Thurston County.

Economy

For many decades, the Thurston Region's economy has been linked with the budget of Washington State — as both an employer and a supplier of contractually-based economic activities. Historically, this kept the region's unemployment rate several points below the statewide average. Government wages earned in the Thurston Region continue to represent approximately 45-50 percent of total wages. With recent declines in state government, the region has worked to expand economic diversity. A diverse economy builds community "immunity" — albeit, not completely — against recessionary forces, and increases the capacity for growing household incomes that supports a larger, more vibrant community. In the years ahead, the region can focus attention and investment in targeted industry clusters to increase local employment, stem imports, and increase the amount of revenue collected and reinvested regionally. It can also take advantage of unique opportunities, including partnerships with regional neighbors, Joint Base Lewis McChord, and emerging businesses in the health, science, and technology fields. Tables 3.0.14 through 3.0.16 show current and forecast employment and median household income by jurisdiction.

Special Districts

Numerous special districts in Thurston County provide a wide variety of services including cemetery, conservation, drainage, fire protection, library, parks, port, school, utility, and transportation benefit districts. In addition, several regional organizations provide community services or regulatory functions to Thurston County and other member counties. Special districts serve as useful stakeholders to hazards mitigation planning for both the perspectives they offer as well as the functional services they can contribute to disaster resiliency. Maps 3.0.6 and 3.0.7 show the school and fire district boundaries, respectively. Table 3.0.18 lists the special districts and other local government agencies within the Thurston region.

Transportation Network and Utilities

The region's highways, local roads, bridges, railroads, ports, and transit systems are crucial to people's daily lives, as well as to the long-term health of the region's economy. Transportation infrastructure is vulnerable to every hazard profiled in this plan and several mitigation initiatives address strengthening the transportation system's operation and infrastructure. Map 3.0.8 shows the major components of the region's transportation system. Map 3.0.9 shows existing and proposed private electricity and natural gas utilities.

Table 3.1: Population Estimates and Forecast, Thurston County Cities, Urban Growth Areas, and Reservations, 2010 to 2040

Jurisdiction	Census	Post Census Estimates						Forecast					
	2010	2011	2012	2013	2014	2015	2016	2020	2025	2030	2035	2040
Bucoda	562	560	560	560	560	565	570	575	675	890	1,065	1,215
Lacey	42,393	42,830	43,600	44,350	45,320	46,020	47,540	49,580	51,080	52,400	53,330	55,160
UGA	33,170	33,380	33,650	33,820	33,940	34,190	34,580	39,030	43,920	49,110	54,380	59,040
Total	75,560	76,210	77,250	78,170	79,260	80,210	82,120	88,610	95,000	101,510	107,710	114,200
Olympia	46,478	46,780	47,500	48,480	49,670	51,020	51,600	55,160	60,750	65,630	68,410	71,840
UGA	11,840	11,910	12,010	12,110	12,220	11,910	12,110	12,690	13,280	14,310	15,990	16,770
Total	58,320	58,690	59,510	60,590	61,890	62,930	63,710	67,850	74,030	79,940	84,400	88,610
Rainier	1,794	1,825	1,825	1,840	1,850	1,880	1,885	2,035	2,175	2,480	2,660	2,810
UGA	110	110	110	110	110	110	110	110	135	360	485	640
Total	1,905	1,935	1,935	1,950	1,960	1,990	1,995	2,145	2,310	2,840	3,145	3,450
Tenino	1,695	1,700	1,705	1,705	1,725	1,730	1,775	1,745	2,010	2,670	3,095	3,675
UGA	15	15	15	15	15	15	15	15	25	80	90	110
Total	1,710	1,715	1,720	1,720	1,740	1,745	1,790	1,760	2,035	2,750	3,185	3,785
Tumwater	17,371	17,570	17,900	18,300	18,800	19,100	23,040	26,780	29,930	32,850	34,670	37,350
UGA	6,350	6,120	6,170	6,300	6,400	6,550	3,310	4,070	5,690	7,310	8,210	8,960
Total	23,720	23,690	24,070	24,600	25,200	25,650	26,350	30,850	35,620	40,160	42,880	46,310
Yelm	6,848	7,008	7,100	7,470	7,915	8,165	8,480	12,570	16,990	19,920	21,980	25,080
UGA	1,355	1,420	1,410	1,415	1,410	1,420	1,440	1,480	1,600	2,540	4,300	5,690
Total	8,205	8,430	8,510	8,885	9,325	9,585	9,920	14,050	18,590	22,460	26,280	30,770
Grand Mound UGA	1,345	1,370	1,195	1,205	1,280	1,295	1,315	1,465	1,630	1,775	1,885	1,990
Chehalis Reservation	64	70	70	70	70	70	70	90	105	125	160	190
Nisqually Reservation	575	595	600	600	600	660	665	985	1,035	1,070	1,120	1,230
Total Cities	**117,141**	**118,273**	**120,190**	**122,705**	**125,840**	**128,480**	**134,890**	**148,450**	**163,610**	**176,840**	**185,220**	**197,120**
Total UGAs [1]	**54,180**	**54,310**	**54,550**	**54,970**	**55,370**	**55,490**	**52,890**	**58,850**	**66,280**	**75,490**	**85,340**	**93,200**
Total Reservations[2]	**639**	**665**	**670**	**670**	**670**	**730**	**735**	**1,070**	**1,140**	**1,200**	**1,280**	**1,420**
Unincorporated County [3]	**80,300**	**80,850**	**81,390**	**81,750**	**82,120**	**82,710**	**84,170**	**87,500**	**91,130**	**95,030**	**98,740**	**101,930**
County Total	**252,264**	**254,100**	**256,800**	**260,100**	**264,000**	**267,400**	**272,700**	**295,900**	**322,200**	**348,600**	**370,600**	**393,700**

SOURCE: Thurston Regional Planning Council. Small Area Population Estimates and Population and Employment Forecast Work Program, 2014.

NOTES: Estimates are for April 1 and reflect city limits on that date. A decrease in UGA population is likely due to annexation. Numbers may not add due to rounding. 1) Urban Growth Area (UGA): Unincorporated area designated to be annexed into city limits over 20 years to accommodate urban growth. 2) Reservations: Estimate is for Thurston County portion of reservation only. 3) Rural Unincorporated County is the portion of the unincorporated county that lies outside UGA and Reservation boundaries. Decrease in Grand Mound population between 2011 and 2012 reflects closure of Maple Lane correctional facility.

Table 3.0.2: Population by Age, Thurston County, 2010-2040

	Population						
Age	2010	2015	2020	2025	2030	2035	2040
0-4	15,381	15,425	16,608	17,680	18,684	19,739	20,857
5-9	15,629	16,845	18,452	19,551	20,768	21,817	23,015
10-14	16,559	17,234	19,504	21,065	22,362	23,617	24,779
15-19	17,216	17,785	19,704	21,817	23,558	24,933	26,277
20-24	16,325	16,466	18,094	19,635	21,487	23,031	24,344
25-29	17,406	16,699	18,581	19,326	20,987	22,600	24,157
30-34	16,609	17,494	18,803	20,207	20,777	22,412	23,996
35-39	16,276	17,784	20,206	21,496	22,977	23,375	25,174
40-44	16,731	17,162	19,445	21,801	23,274	24,711	25,046
45-49	18,108	18,098	19,205	21,295	23,844	25,423	26,913
50-54	18,935	18,900	19,350	20,229	22,276	24,855	26,512
55-59	18,485	18,864	19,411	19,636	20,442	22,372	24,934
60-64	15,840	17,519	18,638	19,163	19,296	19,983	21,781
65-69	11,012	14,639	16,918	18,147	18,764	18,786	19,394
70-74	7,272	9,883	13,607	15,743	17,082	17,722	17,714
75-79	5,557	6,313	8,792	12,068	14,077	15,440	16,109
80-84	4,376	4,425	5,228	7,186	9,928	11,683	13,017
85+	4,547	4,867	5,315	6,124	7,971	8,089	9,651
Total	252,264	266,402	295,861	322,167	348,554	370,589	393,667

SOURCE: Thurston Regional Planning Council Population Forecast.

Table 3.0.3: Individuals Below Poverty Level, by Jurisdiction, 1999-2015

Jurisdiction	1999	2005-2009	2006-2010	2007-2011	2008-2012	2009-2013	2010-2014	2011-2015
Bucoda	162	10	22	44	85	113	167	285
Lacey	2,798	4,160	4,283	4,119	4,386	4,574	4,462	4,350
Olympia	4,982	6,566	7,297	7,135	7,139	7,330	7,696	8,452
Rainier	100	186	191	103	92	166	111	199
Tenino	132	151	167	147	316	292	290	308
Tumwater	1,060	1,765	1,835	2,392	2,077	1,881	1,873	2,262
Yelm	333	686	797	912	1,316	1,489	1,569	1,762
Thurston County	**17,992**	**23,511**	**24,782**	**25,689**	**27,528**	**29,545**	**30,320**	**32,101**
Chehalis Reservation	160	166	143	164	187	167	248	215
Nisqually Reservation	107	125	103	100	76	127	113	148
Washington State	**612,370**	**749,120**	**780,009**	**816,509**	**853,960**	**893,211**	**916,364**	**908,512**

SOURCE: U.S. Bureau of the Census, American Community Survey.
http://factfinder.census.gov/faces/nav/jsf/pages/searchresults.xhtml?refresh=t. Table reference number C17002.

Table 3.0.4: Population by Race and Hispanic Origin, by Jurisdiction, 2010

		RACE							HISPANIC ORIGIN	
Jurisdiction	Total Population	White	Black / African American	American Indian & Alaska Native	Asian	Native Hawaiian & Pacific Islander	Other Race	Two or More Races Total	Hispanic or Latino	Not Hispanic or Latino
Bucoda	562	515	7	5	3	1	10	21	32	530
Lacey	42,393	31,446	2,302	490	3,376	722	1102	2,955	3,886	38,507
Olympia	46,478	38,895	931	498	2,799	180	847	2,328	2,919	43,559
Rainier	1,794	1,628	22	21	19	2	20	82	89	1,705
Tenino	1,695	1,538	3	15	21	5	35	78	125	1,570
Tumwater	17,371	14,769	301	201	841	90	272	897	1069	16,302
Yelm	6,848	5,585	225	125	159	65	191	498	642	6,206
Total Cities	117,141	94,376	3,791	1,355	7,218	1065	2,477	6,859	8,762	108,379
Total Unincorporated	135,123	113,480	2,961	2,160	5,819	896	3,171	6,636	9,025	126,098
Thurston County	**252,264**	**207,856**	**6,752**	**3,515**	**13,037**	**1,961**	**5,648**	**13,495**	**17,787**	**234,477**
		82.4%	2.7%	1.4%	5.2%	0.8%	2.2%	5.3%	7.1%	92.9%
Chehalis Reservation	649	269	2	333	3	0	9	33	23	626
Nisqually Reservation	575	142	6	342	6	12	9	58	44	531
Washington State	**6,724,540**	**5,196,362**	**240,042**	**103,869**	**481,067**	**40,475**	**349,799**	**312,926**	**755,790**	**5,968,750**

SOURCE: U.S. Bureau of the Census - Decennial Census 2010 P4 Census Table.

NOTE: The 2000 Census was the first to allow respondents to select more than one race. The Census has respondents identify Hispanic or Latino origin separately from race; Persons of Hispanic or Latino origin may be of any race. Data are for reservations and off-reservation trust lands as a whole, including those portions outside Thurston County.

Table 3.0.5: Population with a Disability, by Jurisdiction, 2008-2015

		Bucoda	Lacey	Olympia	Rainier	Tenino	Tumwater	Yelm	Thurston County	Chehalis Reservation	Nisqually Reservation
2011-2015	With a Disability	124	5,474	5,760	258	260	2,282	871	32,148	102	70
	Without a Disability	498	37,246	41,716	1,931	1,644	15,997	6,616	224,412	669	573
	Total	**622**	**42,720**	**47,476**	**2,189**	**1,904**	**18,279**	**7,487**	**256,560**	**771**	**643**
	Percent with a Disability	19.90%	12.80%	12.10%	11.80%	13.70%	12.50%	11.60%	12.50%	13.20%	10.90%
2010-2014	With a Disability	91	5,451	5,235	226	286	2,006	1,024	31,029	83	60
	Without a Disability	431	36,485	41,255	1,654	1,592	15,900	6,182	222,196	764	591
	Total	**522**	**41,936**	**46,490**	**1,880**	**1,878**	**17,906**	**7,206**	**253,225**	**847**	**651**
	Percent with a Disability	17.40%	13.00%	11.30%	12.00%	15.20%	11.20%	14.20%	12.30%	9.80%	9.20%
2009-2013	With a Disability	82	5,507	5,327	256	315	2,186	1,057	31,330	80	63
	Without a Disability	428	35,608	40,707	1,672	1,646	15,431	5,836	218,618	781	523
	Total	**510**	**41,115**	**46,034**	**1,928**	**1,961**	**17,617**	**6,893**	**249,948**	**861**	**586**
	Percent with a Disability	16.10%	13.40%	11.60%	13.30%	16.10%	12.40%	15.30%	12.50%	9.30%	10.80%
2008-2012	With a Disability	80	5,212	5,493	236	329	2,171	997	30,248	98	62
	Without a Disability	500	35,020	40,068	1,581	1,850	15,042	5,406	216,187	633	498
	Total	**580**	**40,232**	**45,561**	**1,817**	**2,179**	**17,213**	**6,403**	**246,435**	**731**	**560**
	Percent with a Disability	13.80%	13.00%	12.10%	13.00%	15.10%	12.60%	15.60%	12.30%	13.40%	11.10%

SOURCE: U.S. Bureau of the Census, American Community Survey (ACS). http://factfinder.census.gov/faces/nav/jsf/pages/searchresults.xhtml?refresh=t#. Table reference number B18101

NOTE: The U.S. Bureau of the Census does not recommend comparing overlapping ACS estimates (e.g. 2008-2012 and 2009-2013).

Table 3.0.6: Household Language and Linguistic Isolation, 2000-2015

Language Spoken at Home	2000	2005-2009	2006-2010	2007-2011	2008-2012	2009-2013	2010-2014	2011-2015
English only	**71,610**	**81,797**	**85,214**	**87,057**	**87,572**	**87,312**	**87,690**	**88,676**
Spanish	**3,210**	**4,475**	**5,001**	**4,769**	**4,889**	**4,904**	**5,237**	**5,213**
- Linguistically isolated	360	624	598	640	578	684	655	859
- Not linguistically isolated	2,850	3,851	4,403	4,129	4,311	4,220	4,582	4,354
Other Indo-European languages	**3,339**	**3,134**	**3,235**	**3,047**	**2,842**	**2,856**	**2,679**	**2,972**
- Linguistically isolated	212	157	204	165	120	105	81	73
- Not linguistically isolated	3,127	2,977	3,031	2,882	2,722	2,751	2,598	2,899
Asian and Pacific Island languages	**3,288**	**4,260**	**4,669**	**4,853**	**5,004**	**5,183**	**5,374**	**5,359**
- Linguistically isolated	760	923	1,035	1,025	1,128	1,163	1,310	1,246
- Not linguistically isolated	2,528	3,337	3,634	3,828	3,876	4,020	4,064	4,113
Other languages	**219**	**374**	**372**	**421**	**459**	**546**	**550**	**411**
- Linguistically isolated	17	42	36	56	58	60	78	77
- Not linguistically isolated	202	332	336	365	401	486	472	334
Total Households	**81,666**	**94,040**	**98,491**	**100,147**	**100,766**	**100,801**	**101,530**	**102,631**
Percent Linguistically Isolated	**1.70%**	**1.90%**	**1.90%**	**1.90%**	**1.90%**	**2.00%**	**2.10%**	**2.20%**

SOURCE: U.S. Bureau of the Census, American Community Survey (ACS). Table reference number B16002.

NOTE: A "linguistically isolated household" is one in which no member 14 years old and over (1) speaks only English or (2) speaks a non-English language and speaks English "very well." In other words, all members 14 years old and over have at least some difficulty with English. By definition, English-only households cannot belong to this group. The U.S. Bureau of the Census does not recommend comparing overlapping ACS estimates (e.g. 2008-2012 and 2009-2013).

Table 3.0.7: Highest Level of Education, by Jurisdiction, 2011-2015

	Population Age 25 and Older	No High School Diploma	High School Diploma or GED	Some College	Associate's Degree	Bachelor's Degree	Graduate or Prof. Degree
Bucoda	448	77	134	159	48	18	12
Lacey	29,886	1,913	6,550	8,659	3,033	6,278	3,453
Olympia	34,228	2,282	6,158	8,488	2,854	8,607	5,839
Rainier	1,446	162	472	358	182	196	76
Tenino	1,231	104	418	368	145	93	103
Tumwater	12,737	815	2,482	3,667	1,400	2,442	1,931
Yelm	4,124	306	1,163	1,282	480	672	221
Thurston County	**180,338**	**11,888**	**40,884**	**49,306**	**18,113**	**36,521**	**23,626**
Chehalis Reservation	427	67	152	143	28	27	10
Nisqually Reservation	411	101	147	86	35	28	14
Washington State	**4,721,438**	**451,591**	**1,097,839**	**1,159,463**	**460,415**	**986,653**	**565,477**

SOURCE: U.S. Bureau of the Census, American Community Survey. Http://factfinder.census.gov/faces/nav/jsf/pages/searchresults.xhtml?refresh=t.
Table reference number B15003

Table 3.0.8: Thurston County Homeless Census Counts, 2006-2016

	COUNTY POINT-IN-TIME COUNT			
Year	Sheltered	Transitional	Unsheltered	Total
2006	156	163	122	441
2007	249	143	187	579
2008	168	100	194	462
2009	323	203	219	745
2010	181	432	363	976
2011	95	204	267	566
2012	167	377	164	708
2013	113	321	230	664
2014	172	147	257	576
2015	158	155	163	476
2016	223	174	189	586

SOURCE: Thurston County 2016 Homeless Point-in-time Count Process and Survey Results. http://www.co.thurston.wa.us/health/sscp/PDF/PITCountReport2016.pdf.

Table 3.0.9: Housing Estimates and Forecast, Thurston County Cities, Urban Growth Areas, and Reservations, 2010 to 2040

Jurisdiction	Census	Post Census Estimates						Forecast				
	2010	2011	2012	2013	2014	2015	2016	2020	2025	2030	2035	2040
Bucoda	245	245	245	245	245	245	245	250	295	385	465	535
Lacey	18,490	18,690	18,920	19,220	19,440	19,760	20,140	21,590	22,400	23,110	23,580	24,400
UGA	13,250	13,360	13,440	13,510	13,550	13,610	13,570	15,440	17,550	19,800	21,980	23,930
Total	31,740	32,050	32,360	32,730	32,990	33,370	33,710	37,030	39,950	42,910	45,560	48,330
Olympia	22,090	22,230	22,900	23,110	23,440	24,180	24,620	26,660	29,550	32,140	33,680	35,610
UGA	4,870	4,910	4,930	4,970	5,020	4,850	4,870	5,240	5,520	6,000	6,730	7,100
Total	26,960	27,140	27,830	28,080	28,460	29,030	29,490	31,900	35,070	38,140	40,410	42,710
Rainier	715	735	745	760	765	775	775	805	875	1,005	1,080	1,140
UGA	50	50	50	50	50	50	50	50	60	165	220	290
Total	765	785	795	810	815	825	825	855	935	1,170	1,300	1,430
Tenino	740	745	745	745	750	755	780	760	900	1,275	1,520	1,855
UGA	5	5	5	5	5	5	5	5	10	25	30	40
Total	745	750	750	750	755	760	785	765	910	1,300	1,550	1,895
Tumwater	8,060	8,190	8,370	8,490	8,620	8,690	10,060	11,980	13,440	14,810	15,670	16,870
UGA	2,650	2,560	2,580	2,630	2,660	2,720	1,420	1,730	2,420	3,110	3,490	3,820
Total	10,710	10,750	10,950	11,120	11,280	11,410	11,480	13,710	15,860	17,920	19,160	20,690
Yelm	2,520	2,560	2,610	2,750	2,960	3,000	3,080	4,670	6,440	7,670	8,550	9,820
UGA	530	550	550	550	550	560	560	570	620	1,000	1,710	2,280
Total	3,050	3,110	3,160	3,300	3,510	3,560	3,640	5,240	7,060	8,670	10,260	12,100
Grand Mound UGA	375	385	390	395	415	420	420	490	560	625	685	740
Chehalis Reservation	20	20	20	20	20	20	20	30	35	40	55	65
Nisqually Reservation	190	200	200	200	200	220	220	240	265	280	305	355
Total Cities	52,870	53,400	54,520	55,320	56,220	57,410	59,700	66,720	73,890	80,390	84,550	90,230
Total UGAs [1]	21,730	21,820	21,950	22,120	22,260	22,200	20,890	23,510	26,740	30,720	34,850	38,200
Total Reservations [2]	210	220	220	220	220	240	240	270	300	320	360	420
Unincorporated County [3]	33,380	33,680	33,840	33,990	34,130	34,260	34,410	36,070	37,640	39,200	40,480	41,630
County Total	**108,200**	**109,100**	**110,500**	**111,700**	**112,800**	**114,100**	**115,200**	**126,600**	**138,600**	**150,600**	**160,200**	**170,500**

SOURCE: Thurston Regional Planning Council. Small Area Population Estimates and Population and Employment Forecast Work Program, 2014.

NOTES: Estimates are for April 1 and reflect city limits on that date. A decrease in UGA dwellings is likely due to annexation. Numbers may not add due to rounding. 1) Urban Growth Area (UGA): Unincorporated area designated to be annexed into city limits over 20 years to accommodate urban growth. 2) Reservations: Estimate is for Thurston County portion of reservation only. 3) Rural Unincorporated County is the portion of the unincorporated county that lies outside UGA and Reservation boundaries.

Table 3.0.10: Housing Estimates by Type, Thurston County Cities, Urban Growth Areas, and Reservations, 2016

Jurisdiction	Single-family	Multifamily	Manufactured Home	Total
Bucoda	205	5	35	245
Lacey	12,750	6,400	1,000	20,140
UGA	10,300	1,990	1,280	13,570
Total	23,050	8,390	2,280	33,710
Olympia	12,770	10,950	900	24,620
UGA	3,590	1,180	90	4,870
Total	16,360	12,130	990	29,490
Rainier	590	30	160	775
UGA	35	0	15	50
Total	625	30	175	825
Tenino	540	125	115	780
UGA	5	0	0	5
Total	545	125	115	785
Tumwater	5,900	3,400	760	10,060
UGA	740	140	540	1,420
Total	6,640	3,540	1,300	11,480
Yelm	2,350	600	120	3,080
UGA	380	10	170	560
Total	2,730	610	290	3,640
Grand Mound UGA	205	60	155	420
Chehalis Reservation	10	0	15	20
Nisqually Reservation	205	5	10	220
Total Cities	**35,100**	**21,510**	**3,090**	**59,700**
Total UGAs [1]	**15,250**	**3,390**	**2,250**	**20,890**
Total Reservations [2]	**210**	**0**	**30**	**240**
Unincorporated County [3]	**25,850**	**730**	**7,830**	**34,410**
County Total	**76,400**	**25,600**	**13,200**	**115,200**

SOURCE: Thurston Regional Planning Council Small Area Population Estimates.

NOTES: Estimates are for April 1 and reflect city limits on that date. A decrease in UGA dwellings is likely due to annexation. Numbers may not add due to rounding. 1) Urban Growth Area (UGA): Unincorporated area designated to be annexed into city limits over 20 years' time to accommodate urban growth. 2) Reservations: Estimate is for Thurston County portion of reservation only. 3) Rural Unincorporated County is the portion of the unincorporated county that lies outside UGA and Reservation boundaries.

Table 3.0.11: Occupied Housing Units, by Type and AgeSOURCE: 2011-2015 American Community Survey 5-Year Estimates.

	Occupied housing units		Owner-occupied housing units		Renter-occupied housing units	
	Estimate	Margin of Error	Estimate	Margin of Error	Estimate	Margin of Error
Occupied housing units	102,631	+/-869	66,262	+/-1,068	36,369	+/-980
UNITS IN STRUCTURE						
1, detached	69.20%	+/-0.9	85.70%	+/-0.9	39.10%	+/-1.9
1, attached	4.30%	+/-0.4	2.70%	+/-0.4	7.40%	+/-1.1
2 apartments	2.50%	+/-0.3	0.60%	+/-0.3	5.90%	+/-0.9
3 or 4 apartments	3.40%	+/-0.3	0.30%	+/-0.2	9.10%	+/-0.9
5 to 9 apartments	4.20%	+/-0.5	0.20%	+/-0.1	11.30%	+/-1.3
10 or more apartments	7.60%	+/-0.6	0.50%	+/-0.2	20.40%	+/-1.5
Mobile home or other type of housing	8.90%	+/-0.6	10.00%	+/-0.7	6.80%	+/-1.1
YEAR STRUCTURE BUILT						
2014 or later	0.30%	+/-0.1	0.30%	+/-0.1	0.30%	+/-0.3
2010 to 2013	3.50%	+/-0.5	3.80%	+/-0.6	3.00%	+/-0.7
2000 to 2009	21.00%	+/-0.8	21.80%	+/-1.0	19.60%	+/-1.7
1980 to 1999	35.30%	+/-1.2	36.00%	+/-1.2	34.00%	+/-2.1
1960 to 1979	26.50%	+/-0.9	25.10%	+/-1.0	29.10%	+/-1.7
1940 to 1959	7.70%	+/-0.5	7.50%	+/-0.6	7.90%	+/-1.3
1939 or earlier	5.70%	+/-0.5	5.50%	+/-0.6	6.10%	+/-1.0

SOURCE: 2011-2015 American Community Survey 5-Year Estimates.

Table 3.0.12: Residential Units Permitted, by Jurisdiction, 2010-2015

Jurisdiction	2010	2011	2012	2013	2014	2015
Bucoda	1	1	0	0	1	2
Lacey	267	219	297	226	323	313
UGA	131	92	69	57	51	71
Total	398	311	366	283	374	384
Olympia	627	271	334	419	282	435
UGA	57	32	23	30	53	18
Total	684	303	357	449	335	453
Rainier	24	9	16	6	12	1
UGA	0	0	0	1	0	0
Total	24	9	16	7	12	1
Tenino	9	1	2	7	5	24
UGA	0	0	0	0	0	0
Total	9	1	2	7	5	24
Tumwater	165	202	173	169	123	88
UGA			2	4	3	4
Total	165	202	175	173	126	92
Yelm	44	42	156	203	44	78
UGA	2	1	1	4	1	3
Total	46	43	157	207	45	81
Grand Mound UGA	12	11	3	24	1	5
Chehalis Reservation	0	0	0	0	0	0
Nisqually Reservation	0	0	0	1	0	0
Total Cities	**1,137**	**745**	**978**	**1,030**	**790**	**941**
Total UGAs[1]	**202**	**136**	**98**	**120**	**109**	**101**
Total Reservations [2]	**0**	**0**	**0**	**1**	**0**	**18**
Rural Unincorporated County [3]	**240**	**231**	**204**	**203**	**203**	**230**
Total Single-Family	**953**	**855**	**951**	**868**	**903**	**903**
Total Multifamily	**553**	**193**	**267**	**419**	**278**	**278**
Total Manufactured Housing	**73**	**64**	**61**	**67**	**47**	**47**
Thurston County Total	**1,579**	**1,112**	**1,280**	**1,354**	**1,102**	**1,290**

SOURCE: Thurston Regional Planning Council. Bucoda, Lacey, Olympia, Rainier, Tenino, Tumwater, Yelm and Thurston County building departments.

NOTES: Count of dwelling units permitted; may not reflect actual housing units built. Permits are reported for each calendar year for most recent jurisdiction boundaries. Excludes demolitions and reissued permits. 1) Urban Growth Area (UGA): Unincorporated area designated to be annexed into city limits over 20 years to accommodate urban growth. 2) Reservations: Estimate is for Thurston County portion of reservation only. 3) Rural Unincorporated County is the portion of the unincorporated county that lies outside UGA and Reservation boundaries.

Table 3.0.13: Developed, Grassland/Agriculture, Forest, and Scrub/Shrub Land Cover in Thurston County Watersheds

		DEVELOPED				GRASS/AG.			FOREST			Scrub/Shrub
WATERSHED	TOTAL ACRES	High Intensity	Medium Intensity	Low Intensity	Developed Open Space	Cultivated	Pasture	Grassland	Deciduous	Evergreen	Mixed	Scrub/Shrub
Black River	80,037.00	168.5	680.6	3321.7	2753.4	1583.9	6272	7774.1	5963.5	20375.5	9320.9	12963.5
Budd Inlet	21,906.60	1031.6	2404.3	4925.7	2313.6	76.9	508.1	647.8	2281.9	2136.1	2457.4	948.2
Chehalis River	47,126.90	204.2	701.1	2725.2	1794.4	3287.1	8138.5	3155	3466.4	9561	3826.8	6985.4
Deschutes Mountain Zone	22,487.70	0.9	5.6	151.8	0	0	0	3793.3	244.2	9428.4	1518.7	5564.2
Deschutes River Lower	25,747.70	521.5	2132.5	3972.7	2688.7	249.1	2316.9	1485.2	1443	4374	2490	1402.4
Deschutes River Middle	33,394.90	35.6	149.7	1097.8	655.1	282.3	3188.7	4201.7	1319.2	11461	3322.9	5515.8
Eld Inlet	23,809.20	38.6	375.9	1565.6	1121	17.4	264.8	1762.3	2608.5	7933	4134.1	2855
Henderson Inlet	29,432.30	939.3	2435.9	5361.6	2881.4	66	2130.4	1272.9	2523.3	4494.1	3805.6	1162.5
Nisqually	85,529.80	284.8	1416.2	4432.8	2906.8	504.9	10497.4	5818.7	2855.5	28938.2	8503.7	11221.2
Nisqually Reach	5,238.90	72.5	314.1	705.8	479.4	4.1	144.1	266.3	532	1401.2	886.5	267.1
Skookumchuck River	55,957.40	27.6	71.6	549.4	224.3	162.9	3343.1	4208.8	2961.8	20327.3	4815.5	13970
Totten Inlet	20,386.70	3.5	98.7	633.3	166.4	0	278.4	1717.2	1321.8	8517.9	2908.2	3502
West Capitol Forest	19,456.10	0	10.5	62.6	26.7	3.1	31.2	1433	640	11554.6	1510.9	3495.3

Table 3.0.14: Wetland, Water, and Bare Earth Land Cover in Thurston County Watersheds

		WETLAND				WATER				BARE EARTH
WATERSHED	TOTAL ACRES	Palustrine Forested	Palustrine Scrub/Shrub	Palustrine Emergent	Estuarine Forested	Unconsolidated Shore	Water	Palustrine Aquatic Bed	Estuarine Aquatic Bed	Bare Land
Black River	80,037.00	2473.5	3092	2233.8	0	1.3	481	61.4	0	516.4
Budd Inlet	21,906.60	510.7	265.4	368.6	0.4	77.1	889.9	3.6	0.4	58.9
Chehalis River	47,126.90	905.8	892.4	958.1	0	38.5	245.2	26.9	0	214.9
Deschutes Mountain Zone	22,487.70	296.2	99.4	42.1	0	9.3	4	0	0	1329.6
Deschutes River Lower	25,747.70	985	531.5	632.9	0	1.8	227.7	101	0	191.8
Deschutes River Middle	33,394.90	631.3	419.8	318.7	0	5.3	577.3	18	0	194.7
Eld Inlet	23,809.20	456.7	237.8	215.6	15.3	86.2	30	6	0	85.4
Henderson Inlet	29,432.30	726.6	362.2	341.6	1.4	74.8	653.4	62	0.3	135
Nisqually	85,529.80	2265.2	1292	1951.7	183.9	100.5	1799.4	39.4	0.4	517.1
Nisqually Reach	5,238.90	76.4	18	14	0.9	34.8	4.4	0	0.5	16.8
Skookumchuck River	55,957.40	888.6	972.1	849.7	0	6.2	897.6	0.2	0	1680.7
Totten Inlet	20,386.70	191.8	94.1	134.4	0	22.8	523.8	12.2	0	260.2
West Capitol Forest	19,456.10	242.5	84.4	3.6	0	1.1	6.1	0	0	350.5

SOURCE: NOAA C-CAP: https://coast.noaa.gov/dataregistry/search/collection/info/ccapregional. Washington State Department of Ecology: http://www.ecy.wa.gov/services/gis/data/imageryBaseMapsEarthCover/landcover/landcover.htm

Table 3.0.15: Current and Forecast Employment, by Sector, 2010-2040

Industry	Actual 2010	Forecast 2015	2020	2025	2030	2035	2040
Agriculture, forestry, fishing, & related	2,780	2,480	2,600	2,620	2,640	2,670	2,670
Mining	110	150	160	170	180	200	210
Utilities	180	250	270	280	290	290	300
Construction	5,620	8,380	9,160	10,110	11,010	11,810	12,700
Manufacturing	3,100	3,200	3,480	3,530	3,500	3,540	3,630
Durable Goods	n/a	1,830	2,040	2,070	2,000	1,990	2,020
Nondurable Goods	n/a	1,370	1,440	1,460	1,500	1,550	1,610
Wholesale trade	3,250	3,410	3,630	3,810	3,960	4,100	4,280
Retail trade	14,660	16,100	17,200	18,300	19,500	20,500	21,500
Transportation and warehousing	2,310	2,960	3,190	3,470	3,730	3,940	4,180
Information	1,280	1,630	1,740	1,820	1,890	1,960	2,050
Finance and insurance	4,610	4,380	4,710	5,190	5,650	6,000	6,400
Real estate and rental and leasing	5,470	5,390	5,620	5,960	6,280	6,530	6,810
Professional and business services	13,000	15,300	17,500	19,500	21,800	23,900	26,200
Education, Health, & Social Services	17,000	19,000	20,900	22,500	24,500	26,000	27,500
Arts, entertainment, and recreation	2,750	2,960	3,400	3,780	4,190	4,600	5,020
Accommodation and food services	8,270	9,200	10,000	10,700	11,530	12,170	12,810
Other services, except public administration	7,380	9,070	9,950	10,990	12,030	12,880	13,780
Federal government - civilian	1,010	980	1,110	1,050	1,180	1,120	1,240
State government	24,300	24,900	26,000	27,100	28,200	29,300	30,400
State government, except education	n/a	23,300	24,300	25,200	26,200	27,200	28,200
State education	n/a	1,620	1,710	1,830	1,970	2,100	2,230
Local government	11,400	12,200	13,300	14,700	15,800	16,900	18,000
Total Civilian Employment (1)	**128,500**	**142,000**	**153,900**	**165,600**	**177,800**	**188,400**	**199,700**
Total Military Employment	**4,150**	**4,700**	**4,700**	**4,700**	**4,700**	**4,700**	**4,700**
Net Outbound Civilian Commuters (2)	10,250	10,800	12,000	14,750	17,000	18,650	20,650
Civilian Employed Residents (3)	116,900	122,700	134,400	147,000	160,700	170,800	181,800
Civilian Unemployed Residents	10,400	7,700	7,200	7,700	8,500	9,000	9,600
Total Civilian Labor Force (4)	**127,300**	**130,400**	**141,600**	**154,700**	**169,200**	**179,800**	**191,400**
Total Thurston County Population	**252,300**	**266,000**	**296,000**	**322,000**	**349,000**	**371,000**	**394,000**

SOURCE: Thurston Regional Planning Council. Population and Employment Forecast (2012 Update). Http://www.trpc.org/236/Population-Employment-Forecasting.

NOTE: 1. "Total Civilian Employment" is the number of positions available in Thurston County. Total Local Employment is larger than the Civilian Labor Force, because some individuals within the labor force work multiple jobs. 2. "Net Outbound Civilian Commuters" is calculated by subtracting persons commuting into Thurston County from persons commuting out of Thurston County. 3. "Civilian Employed Residents" is the number of Thurston County residents that are employed. 4. "Total Civilian Labor Force" is calculated by adding Total Civilian Employed Persons and Civilian Unemployed Persons. Medium Growth Scenario. Employment figures represent annual averages. Population figures are for April 1 of each year. Numbers may not add to total due to rounding.

Table 3.0.16: Current and Forecast Employment, by Sector, by Jurisdiction, 2014 and 2040

Employment Sector	Bucoda	Lacey	Olympia	Rainier	Tenino	Tumwater	Yelm	Chehalis Reservation	Nisqually Reservation	Unincorp. County	Thurston County
FIRST QUARTER 2014											
Agriculture, Forestry, Fishing and Mining	5	120	115	15	10	55	10	85	5	2,480	2,905
Construction and Utilities	5	1,155	1,260	15	20	1,040	175	10	20	2,495	6,195
Manufacturing	0	405	870	0	0	1,295	75	0	10	580	3,240
Wholesale Trade	0	895	755	5	25	1,050	75	0	0	875	3,680
Retail Trade	5	4,020	6,560	30	115	2,165	825	0	5	1,275	15,010
Transportation and Warehousing	0	900	530	5	70	645	35	0	0	965	3,160
Information	0	225	710	5	20	60	75	0	0	175	1,270
Finance and Insurance	5	990	2,100	10	35	535	165	0	5	800	4,640
Real Estate, Rental and Leasing	10	1,125	1,595	25	25	575	160	0	5	1,665	5,185
Professional Services	15	4,060	5,465	55	135	1,685	380	0	10	3,405	15,210
Education, Health and Social Services	20	3,355	10,020	60	85	1,635	420	5	15	3,330	18,940
Arts, Entertainment and Recreation	5	640	800	10	30	475	100	0	5	755	2,820
Accommodation and Food Services	5	2,095	3,625	25	55	1,170	465	0	0	1,345	8,790
Tribal and Other Services	5	1,445	3,180	35	40	815	195	660	645	2,185	9,205
Government (includes Public Education)	5	4,180	15,755	155	215	9,145	680	0	340	3,200	33,680
Total	**90**	**25,610**	**53,345**	**455**	**870**	**22,350**	**3,835**	**760**	**1,060**	**25,540**	**133,915**
2040 FORECAST											
Agriculture, Forestry, Fishing and Mining	5	120	115	15	10	55	10	85	5	2,455	2,875
Construction and Utilities	20	2,565	3,405	40	100	2,175	965	75	105	3,555	13,000
Manufacturing	0	525	885	0	10	1,465	140	0	10	595	3,630
Wholesale Trade	0	1,130	830	5	35	1,240	125	0	0	920	4,280
Retail Trade	15	5,890	8,740	50	210	3,290	1,895	0	5	1,400	21,505
Transportation and Warehousing	5	1,250	695	10	75	885	150	0	5	1,120	4,185
Information	10	400	930	10	45	195	195	0	0	265	2,050
Finance and Insurance	10	1,380	2,590	20	65	845	445	0	5	1,035	6,400
Real Estate, Rental and Leasing	20	1,440	2,015	45	65	825	380	0	5	2,020	6,810
Professional Services	30	6,650	9,565	75	185	3,460	1,895	5	15	4,275	26,150
Education, Health and Social Services	30	5,280	13,650	80	135	2,845	1,525	5	20	3,965	27,530
Arts, Entertainment and Recreation	10	1,125	1,435	20	45	840	435	0	5	1,105	5,020
Accommodation and Food Services	15	3,205	4,865	40	120	1,990	1,085	0	0	1,500	12,815
Tribal and Other Services	30	3,010	4,915	60	105	1,790	1,035	1,375	1,495	3,125	16,935
Government (includes Public Education)	10	7,220	20,315	215	300	11,820	1,210	0	315	5,125	46,525
Total	**200**	**41,180**	**74,945**	**690**	**1,505**	**33,720**	**11,495**	**1,550**	**1,980**	**32,460**	**199,715**

SOURCE: Thurston Regional Planning Council Population and Employment Forecast (2015 Update). Estimates are for jurisdiction boundaries as of April 1, 2016.

Table 3.0.17: Median Household Income, by Jurisdiction, 2011-2015

Household Income	Bucoda	Lacey	Olympia	Rainier	Tenino	Tumwater	Yelm	Thurston County	Chehalis Reservation	Nisqually Reservation	Washington State
Less than $10,000	46	889	1,929	38	42	476	233	**6,357**	37	25	**162,559**
$10,000 to $14,999	10	521	1,042	21	55	315	198	**3,921**	23	5	**110,156**
$15,000 to $19,999	13	564	1,172	9	38	628	215	**3,966**	19	7	**113,536**
$20,000 to $24,999	23	622	1,023	31	87	311	43	**3,645**	7	6	**121,452**
$25,000 to $29,999	13	729	1,024	32	22	242	43	**3,899**	8	6	**114,389**
$30,000 to $34,999	3	878	872	5	36	320	219	**4,515**	15	3	**126,984**
$35,000 to $39,999	17	952	850	32	49	366	117	**4,473**	20	10	**117,347**
$40,000 to $44,999	15	992	924	16	26	230	83	**4,436**	13	7	**119,297**
$45,000 to $49,999	21	861	996	52	9	273	183	**4,353**	21	11	**109,832**
$50,000 to $59,999	9	1,985	1,560	58	91	1,152	339	**10,175**	18	19	**213,934**
$60,000 to $74,999	29	2,270	2,318	129	50	873	220	**12,007**	12	25	**282,968**
$75,000 to $99,999	13	3,139	2,850	176	144	1,323	372	**16,235**	21	21	**358,433**
$100,000 to $124,999	16	1,561	1,689	122	47	744	173	**9,822**	7	12	**248,928**
$125,000 to $149,999	0	814	1,179	29	18	312	39	**6,317**	16	15	**156,803**
$150,000 to $199,999	0	717	736	6	16	260	64	**5,019**	8	5	**161,420**
$200,000 or more	3	154	706	5	3	162	54	**3,491**	2	2	**150,874**
Total Households	**231**	**17,648**	**20,870**	**761**	**733**	**7,987**	**2,595**	**102,631**	**247**	**179**	**2,668,912**
Median Income	**$38,603**	**$59,407**	**$53,617**	**$68,942**	**$50,184**	**$56,512**	**$49,029**	**$61,677**	**$38,625**	**$53,438**	**$61,062**

SOURCE: U.S. Bureau of the Census, American Community Survey (ACS). Http://factfinder.census.gov/faces/nav/jsf/pages/searchresults.xhtml?refresh=t# Table numbers B19001, B19013

Table 3.0.18: Special Districts and Other Local Government Agencies in Thurston County, WA

Cemetery Districts
Thurston County Cemetery District No. 1
Thurston County Cemetery District No. 2

Conservation Districts
Thurston Conservation District

Drainage Districts
Hopkins Drainage District No. 2
Thurston County Drainage District No. 3
Zenkner Valley Drainage District No. 07
Thurston County Drainage District No. 11

Emergency Dispatch
TCOMM 9-1-1

Fire Protection Districts
1 - Grand Mound-Rochester - West Thurston Regional Fire Authority
2 - Yelm - SE Thurston Regional Fire Authority
3 - Lacey
4 - Rainier SE Thurston Regional Fire Authority
5 - McLane - Joint with District 9
6 - East Olympia
8 - South Bay (annexed Fire District 7)
9 - Black Lake - Joint with Thurston No. 5
11 - Littlerock - West Thurston Regional Fire Authority
12 - Tenino
13 - Griffin
16 - Gibson Valley
17 - Bald Hills

Park Districts
Olympia Metropolitan Parks District
Tanglewilde Park and Recreation District No. 1

Port Districts
Port of Olympia

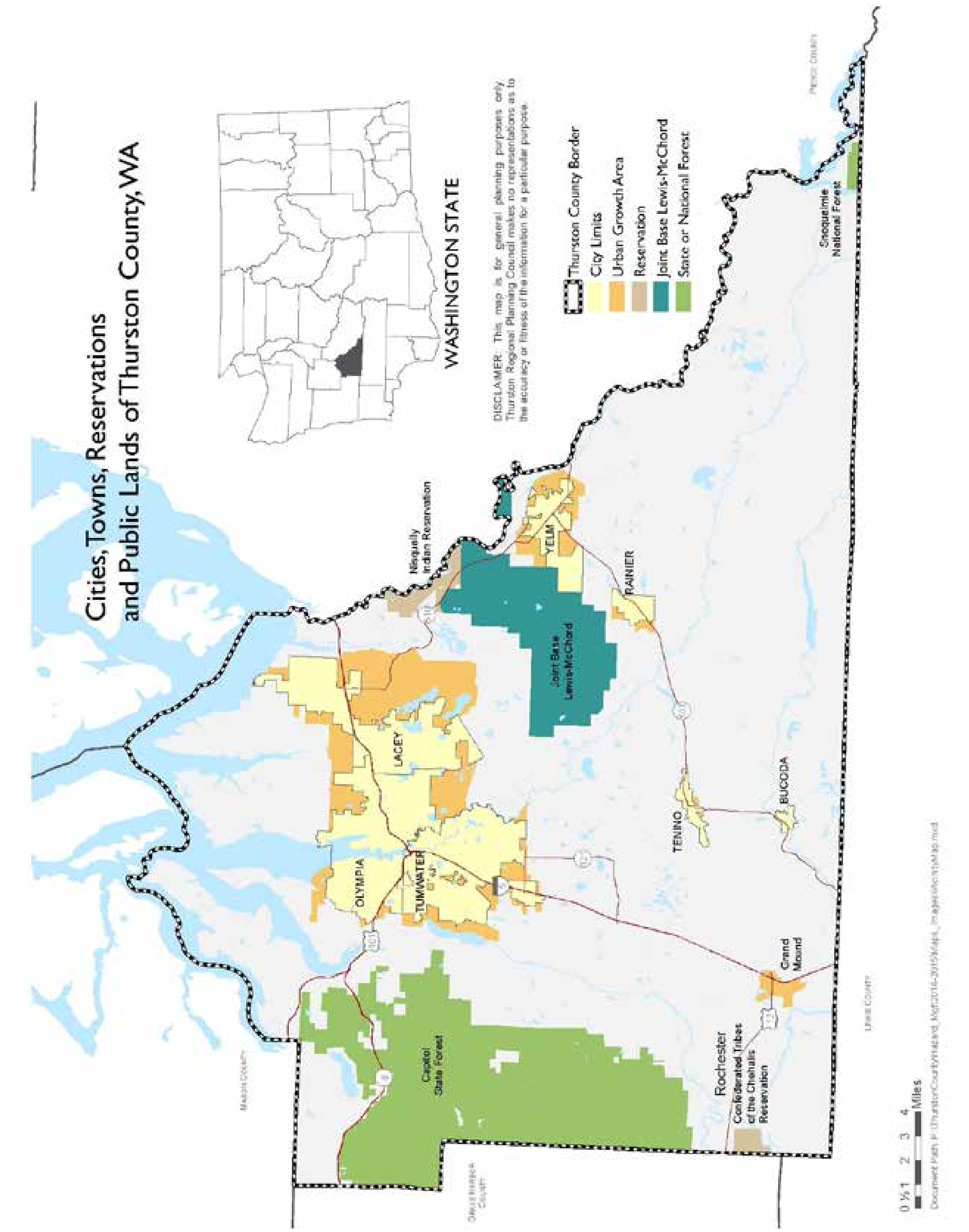
Public Transportation Benefit Area
Intercity Transit

Regional Agencies
Capitol Region Educational Services District 113
Housing Authority of Thurston County
Lewis - Mason - Thurston Area Agency On Aging
Olympic Region Clean Air Agency
Timberland Regional Library
Thurston Regional Planning Council: Metropolitan Planning Organization

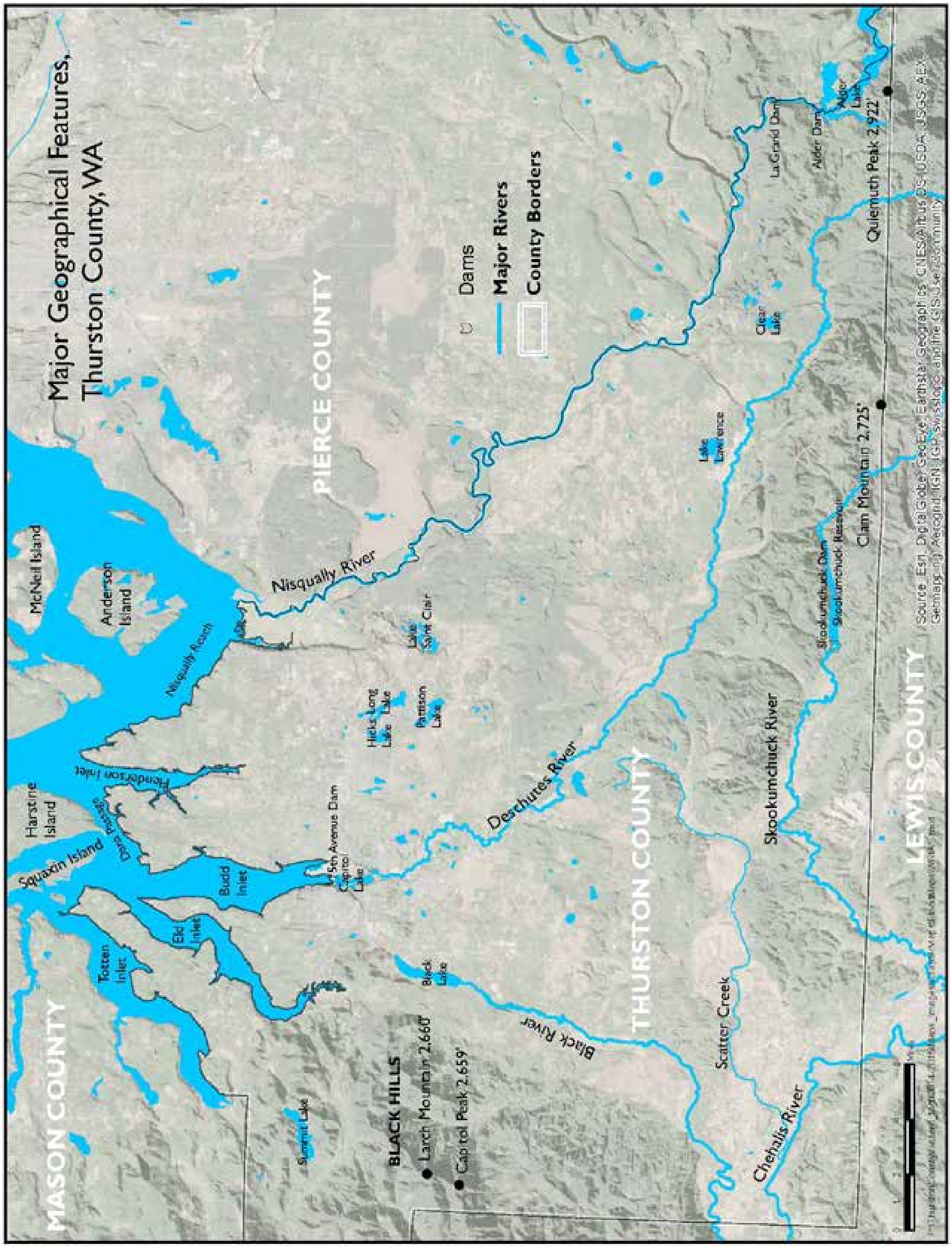
School Districts
Griffin School District No. 324
North Thurston Public Schools
Olympia School District No. 111
Rainier School District No. 307
Rochester School District No. 401
Tenino School District No. 402
Tumwater School District No. 33
Yelm Community School District No. 2

Transportation and Utility Districts
Lacey Transportation Benefit District
Olympia Transportation Benefit District
Tumwater Transportation Benefit District
LOTT Clean Water Alliance
Thurston Public Utility District

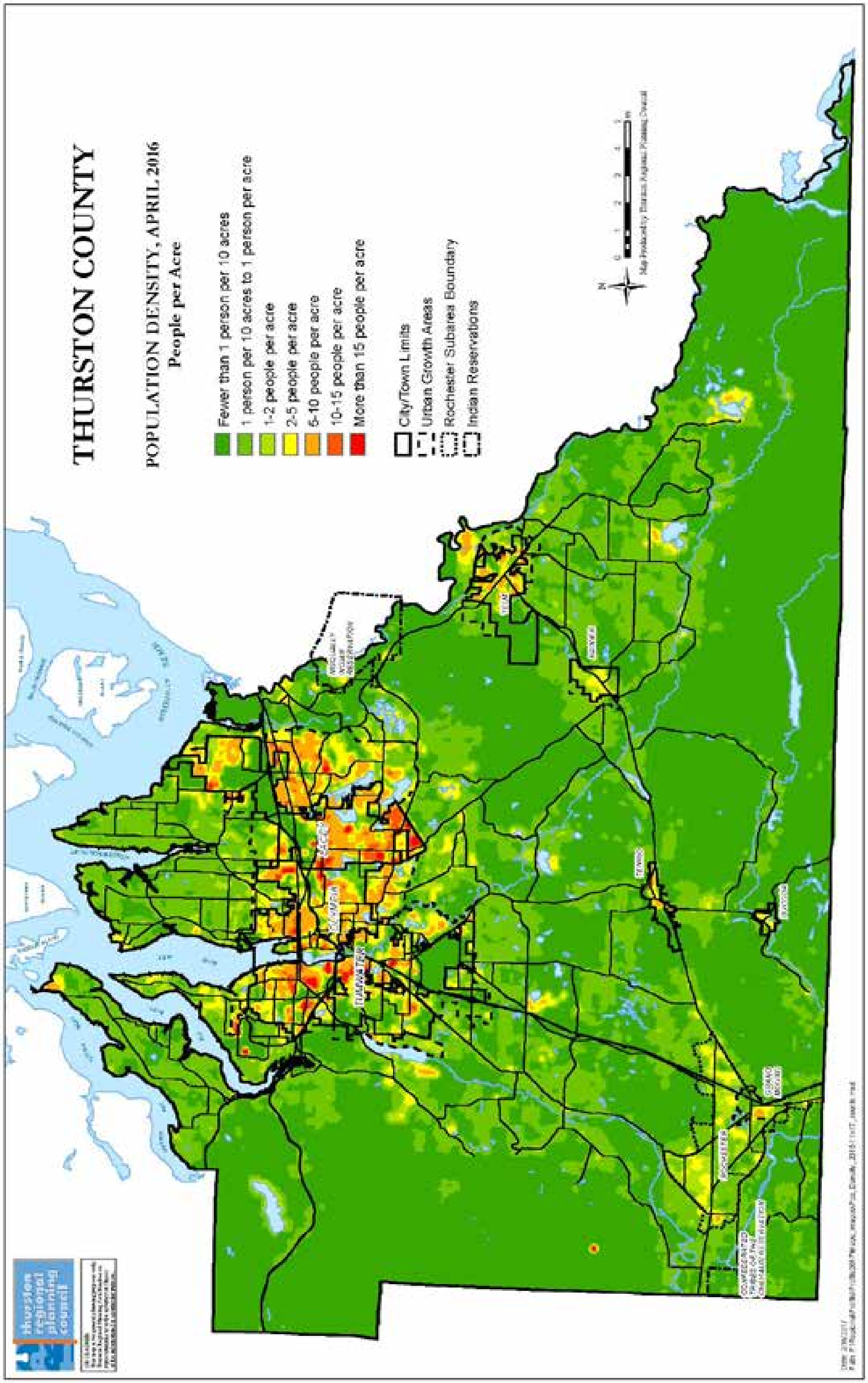
Map 3.0.1: Cities, Towns, Reservations and Public Lands of Thurston County



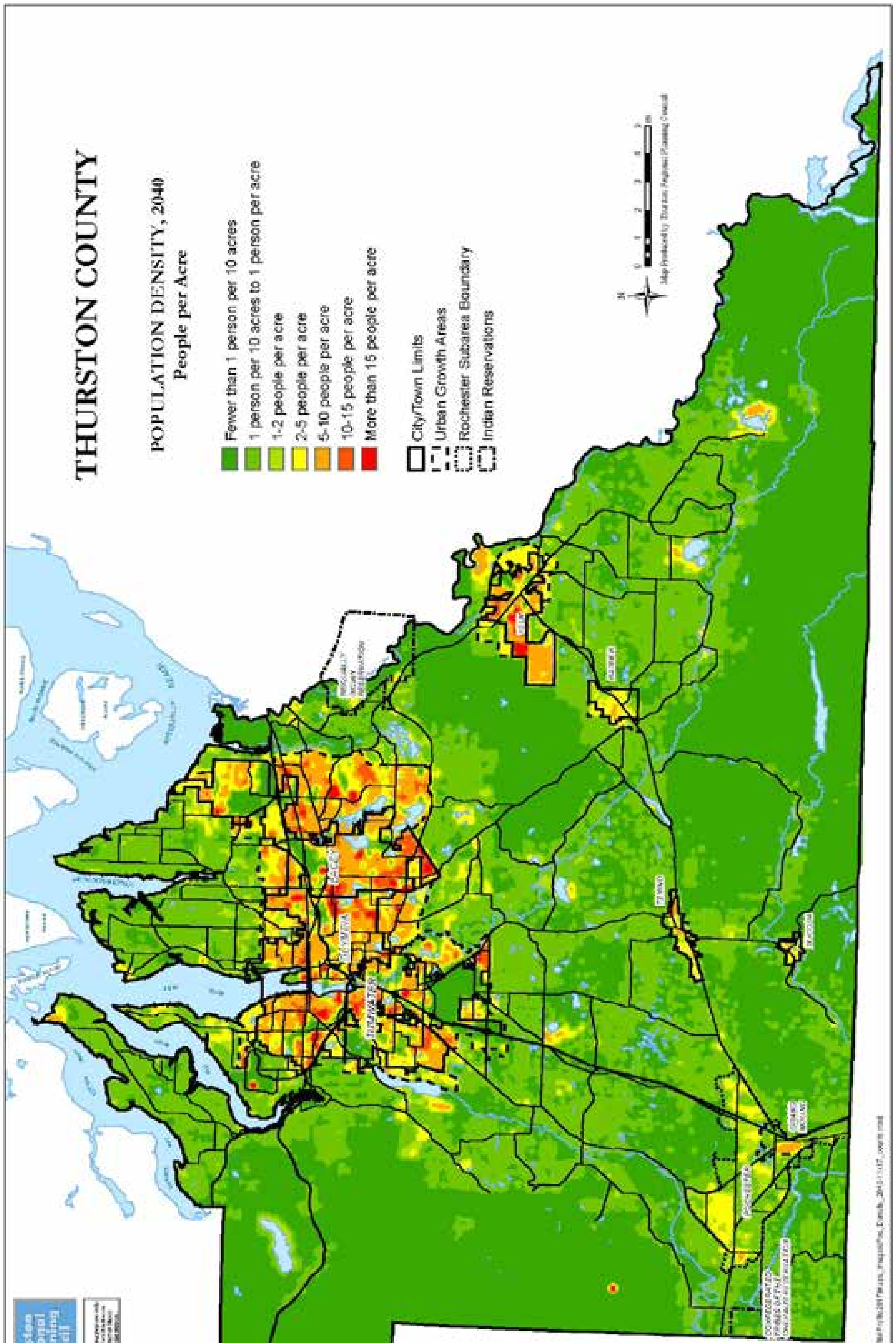
Map 3.0.2: Geography of Thurston County



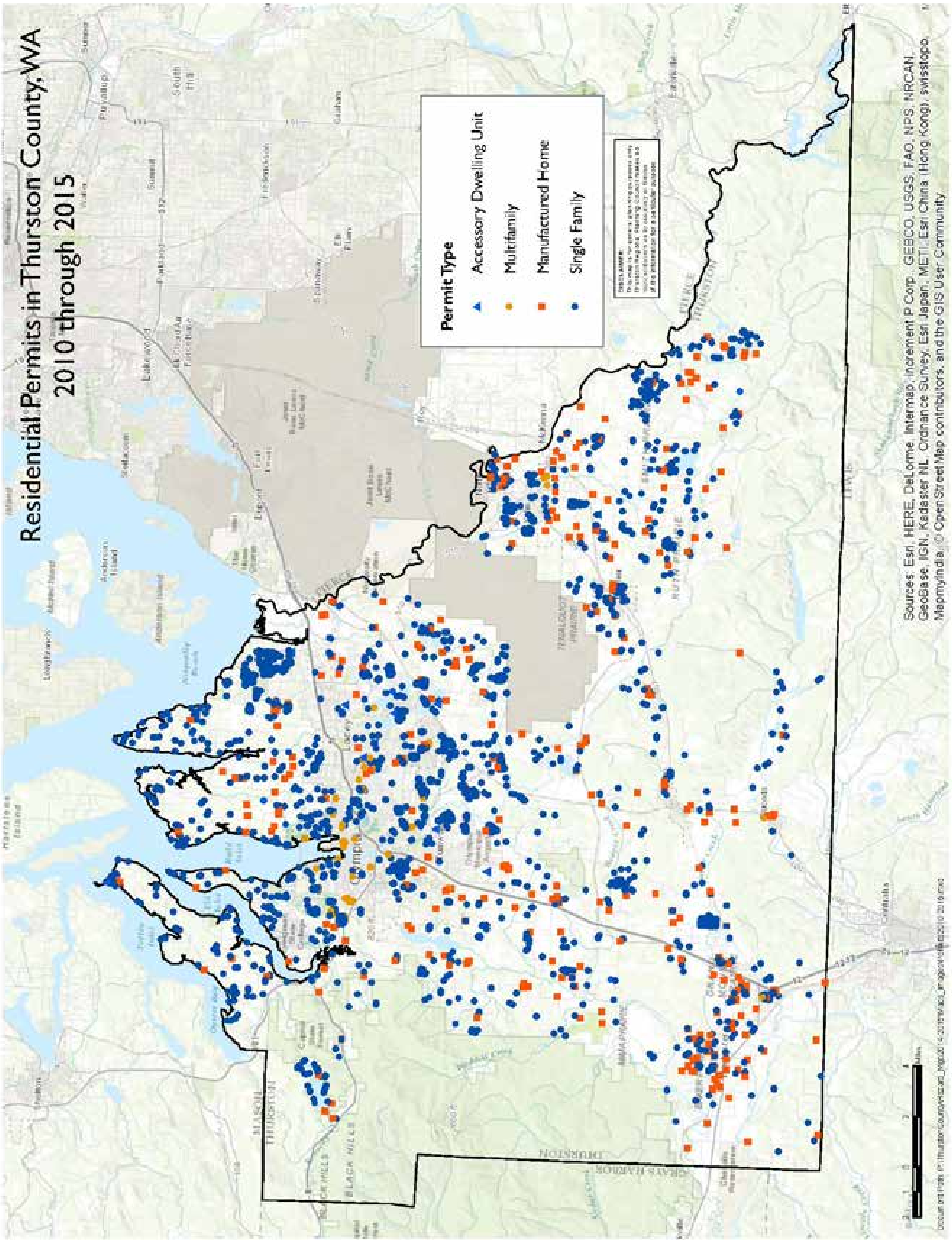
Map 3.0.3: Population Density, Thurston County, 2016



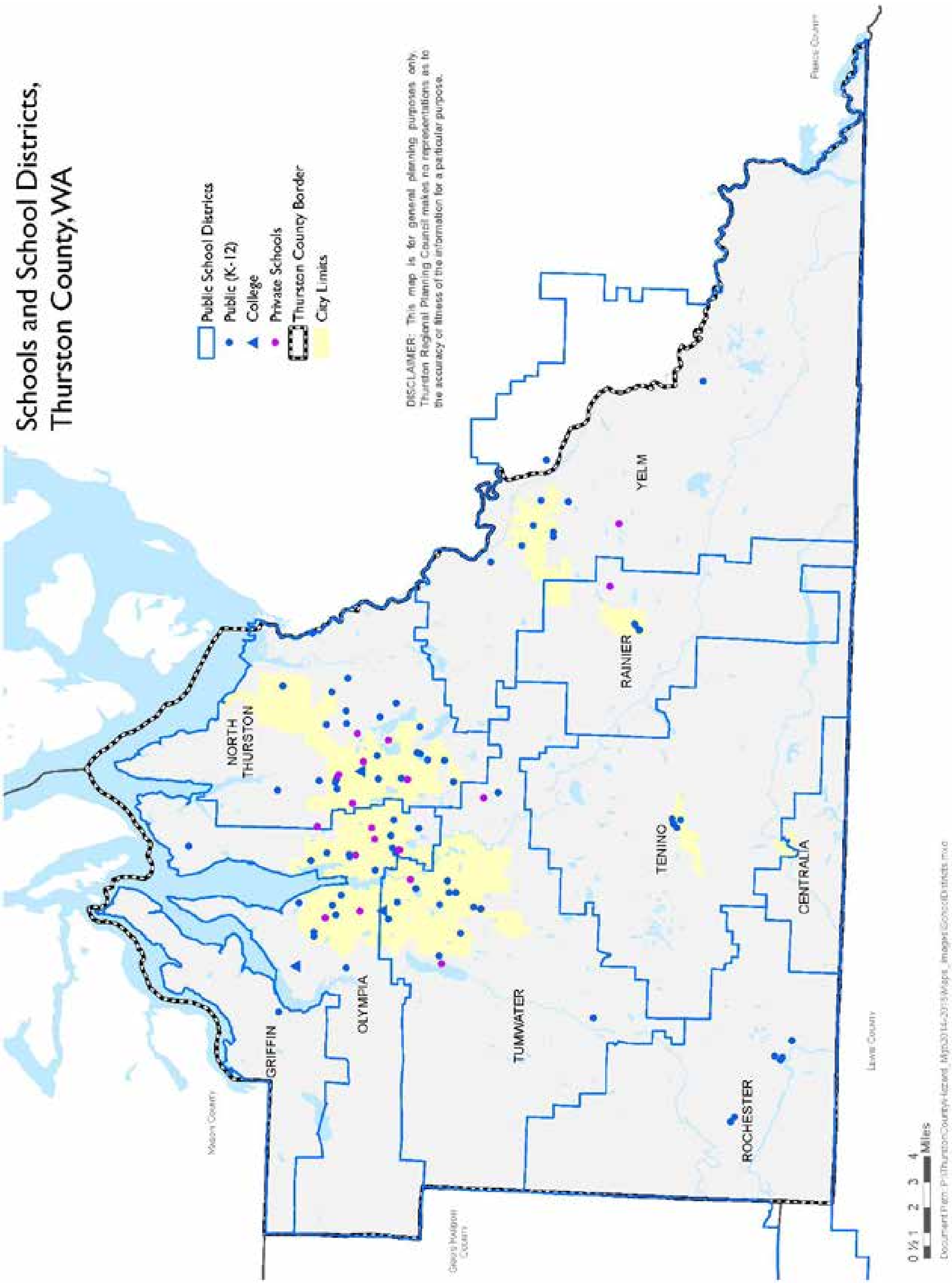
Map 3.0.4: Population Density, Thurston County, 2040



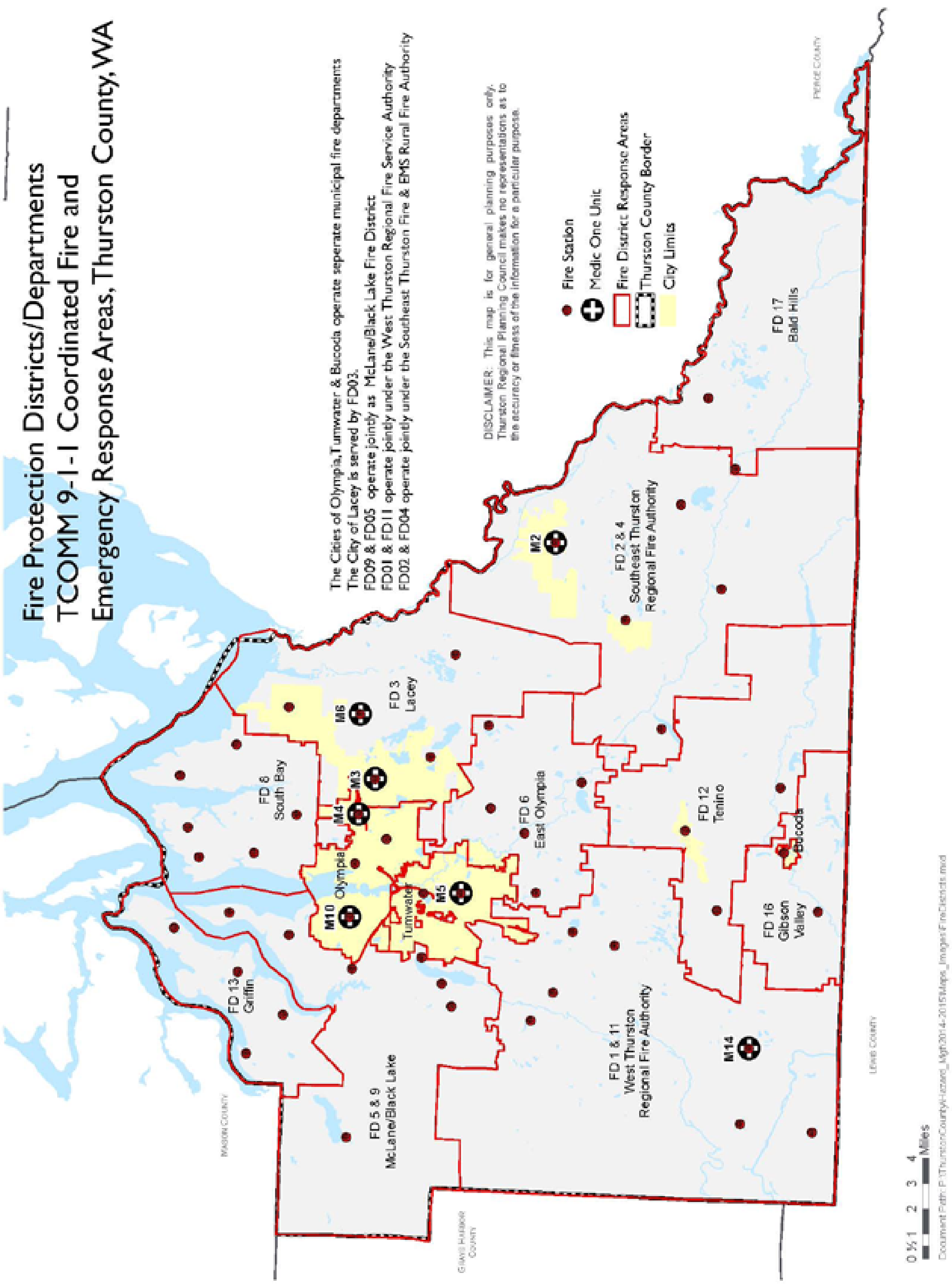
Map 3.0.5: Residential Permits in Thurston County, WA, 2010 through 2015



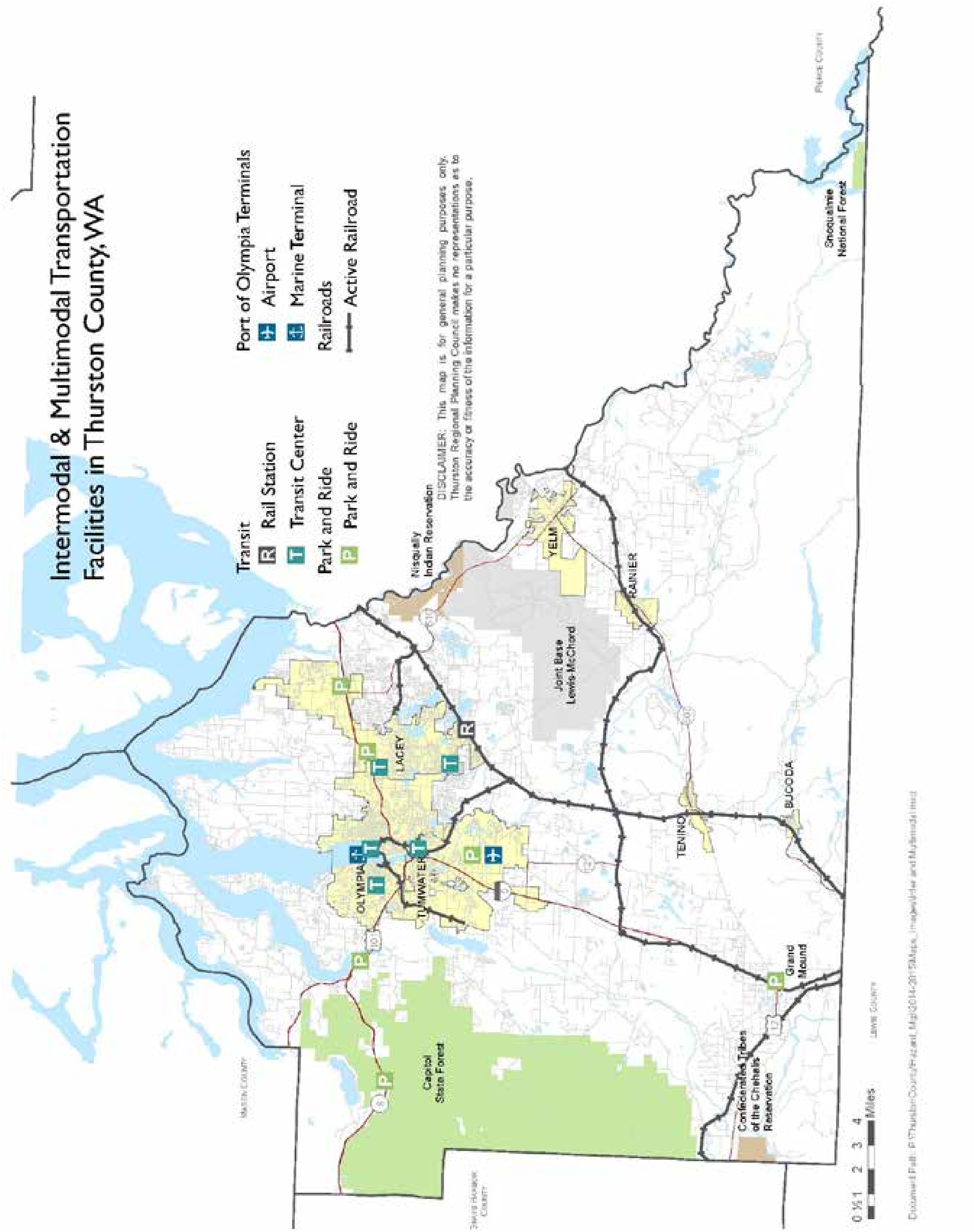
Map 3.0.6: Schools and School Districts, Thurston County, WA



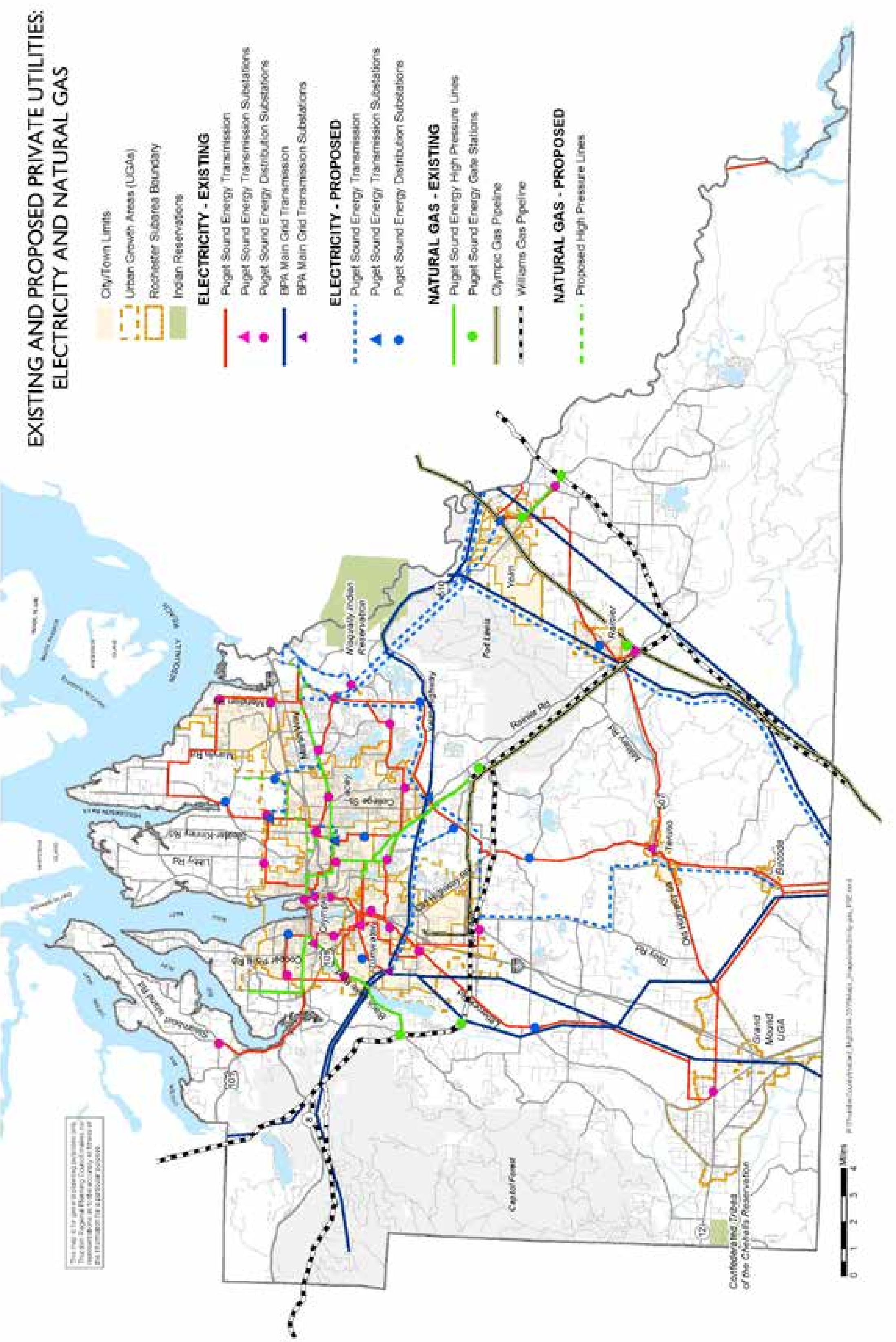
Map 3.0.7: Fire Protection Districts/Departments and Stations, Thurston County, WA



Map 3.0.8: Intermodal and Multimodal Transportation Facilities, Thurston County, WA



Map 3.0.9: Existing and Proposed Private Utilities: Electricity and Natural Gas



Chapter 3.1
Capability Assessment

Introduction

Federal, state, and local laws, ordinances, and plans can support or impact mitigation initiatives identified in this plan. Development of this plan included a review and incorporation, if appropriate, of existing plans, studies, reports, and technical information. The major relevant laws, plans, and mitigation resources are described in this chapter.

Federal

Disaster Mitigation Act of 2000

The federal Disaster Mitigation Act (DMA) of 2000 (Public Law 106-390) provides the legal basis for Federal Emergency Management Agency (FEMA) mitigation planning requirements for state, local, and tribal governments as a condition of mitigation grant assistance. The DMA amended the Robert T. Stafford Disaster Relief and Emergency Assistance Act by replacing previous mitigation planning provisions with new requirements that emphasize the need for planning entities to coordinate mitigation planning and implementation efforts. The law added incentives for increased coordination and integration of mitigation activities at the state level by establishing two levels of state plans. The DMA also established a new requirement for local mitigation plans and authorized up to seven percent of Hazard Mitigation Grant Program funds to be available for development of state, local, and tribal mitigation plans. Chapter 1 provides additional information about the DMA and its grant programs.

The Thurston Region was among the first in Washington State to adopt a multi-jurisdictional hazard mitigation plan. This 3rd edition demonstrates the region's compliance with the DMA and with conducting a continuous, comprehensive, and coordinated approach to hazards mitigation planning.

FEMA Risk MAP

FEMA prepares Flood Insurance Rate Maps (FIRMs) that delineate flood hazard zones and

Base Flood Elevations (BFEs) in the United States. FEMA's current process for updating FIRMs and BFEs is through their Risk MAP program. Because of the importance of understanding the nation's coastal flood risk, FEMA has initiated coastal flood risk studies for the populated coastline as part of its Risk MAP effort.

Thurston County and FEMA completed a Risk MAP project for the Deschutes River basin in 2016 and the County adopted the remodeled and remapped floodway and floodplains into its Critical Area Ordinance in September 2016. The City of Tumwater also adopted the new Deschutes River Flood Insurance Risk MAP and updated the city's flood control ordinance.

The second Risk MAP project for Thurston County was the mapping of the marine coastal area. This Risk MAP assessment was started in 2013. The first set of maps were revised to align more closely with the neighboring Mason and Pierce counties. This project is currently in the "Appeal Period" and the revised maps are expected to become "Effective" in Winter 2017/2018. FEMA is conducting other countywide risk assessments including landslides, earthquake, soil liquefaction, and volcanic hazards.

The third Risk MAP assessment for Thurston County addresses the Lower Chehalis Watershed. This assessment includes the Chehalis, Skookumchuck, and Black rivers, and Scatter Creek. The initial scoping meeting for this assessment was held in March 2010, but funding issues held up work until 2016. Draft maps were released to the participating stakeholders. Preliminary maps are expected in May 2017. The revised maps are expected to become effective in fall 2018.

The fourth assessment will address the Nisqually River Basin. This is planned for fall 2017 with effective maps expected in 2020.

National Flood Insurance Program

The National Flood Insurance Program (NFIP) makes federally backed flood insurance available to homeowners, renters, and business owners in participating communities in exchange for communities enacting floodplain regulations. For most participating communities, FEMA has prepared a detailed Flood Insurance Study. The study presents water surface elevations for floods of various magnitudes, including the one percent annual chance flood (100-year flood) and the 0.2-percent annual chance flood (the 500-year flood). Flood Insurance Rate Maps (FIRMS) show base flood elevations and boundaries of the 100- and 500-year floodplains, and serve as the principal tool for identifying the extent and location of the flood hazard. FIRMs, the most detailed and consistent data source available, represent the minimum area of oversight under some community's floodplain management programs.

Participants in the NFIP must, at a minimum, regulate development in floodplain areas in accordance with NFIP criteria. Before issuing a permit to build in a floodplain, participating jurisdictions must ensure that three criteria are met:

- New buildings and those undergoing substantial improvements must, at a minimum, be elevated to protect against damage by the 100-year flood.
- New floodplain development must not aggravate existing flood problems or increase damage to other properties.
- New floodplain development must exercise a reasonable and prudent effort to reduce its adverse impacts on threatened salmonid species.

Earlier structures permitted or built in the planning area are called "pre-FIRM" structures, and structures built afterward are called "post-FIRM." The insurance rate is different for the two types of structures. The effective date for the current FIRM is October 16, 2012. Post-FIRM properties are eligible for reduced flood insurance rates. Such structures are less vulnerable to flooding since they were constructed under regulations and codes that lead to decreased vulnerability. Properties built before a FIRM is adopted are more vulnerable to flooding because they do not meet code or are located in hazardous areas. The first FIRMs in the planning area were available in 1980.

Eight communities within the planning area participate and are in good standing with the NFIP. As of November 30, 2016, 976 flood insurance policies were in-force countywide with $244 million coverage. A total of $4.3 million in payments for 313 claims were made since 1978. Communities participating in NFIP have adopted regulations that meet the NFIP requirements (see annexes for details pertaining to each jurisdiction's participation in NFIP).

Table 3.1.1: National Flood Insurance Program Policy Statistics for Thurston County Jurisdictions

Community	Date of Entry Initial FIRM Effective Date	Policies In-Force	Insurance In-Force	Written Premium In-Force	Claims Since 1978	Total Payments	CRS Class
Bucoda	9/20/1981	56	$9,129,800	$51,037	43	$257,010	n/a
Lacey	7/16/1980	47	$12,786,000	$16,046	3	$8,088	n/a
Olympia	2/17/1982	104	$34,132,000	$113,093	22	$388,695	n/a
Rainier	10/16/2012	3	$500,000	$769	0	$0	n/a
Tenino	6/4/1980	3	$719,200	$1,519	8	$112,212	n/a
Tumwater	8/1/1980	22	$6,708,000	$10,355	2	$12,514	n/a
Yelm	6/16/1999	18	$4,303,100	$9,586	2	$7,602	n/a
Thurston County*	12/1/1982	723	$175,894,300	$414,261	233	$3,563,642	2
Totals		**976**	**$244,172,400**	**$616,666**	**313**	**$4,349,763**	

SOURCE: FEMA. 2016. Policy and Claim Statistics for Flood Insurance. Data acquired online from: https://www.fema.gov/policy-claim-statistics-flood-insurance. Data current as of November 30, 2016.

Repetitive Loss Properties

A repetitive loss property is defined by FEMA as a NFIP-insured property that has experienced any of the following since 1978, regardless of any changes in ownership:

- Four or more paid losses in excess of $1,000
- Two paid losses in excess of $1,000 within any rolling 10-year period
- Three or more paid losses that equal or exceed the current value of the insured property.

Bucoda, Olympia, Tenino, and Thurston County contain repetitive loss properties (refer to their annex for specific activities related to repetitive losses). Twenty-four repetitive loss properties in the region constitute over $1.3 million in flood insurance loss payments. In 2015, Thurston County completed a repetitive loss area analysis. The county clustered losses into eight areas based on geography and the sources of flooding. This analysis was used to continue efforts to contact repetitive loss property owners to discuss options for minimizing future flood damage, encourage other property owners at risk of flooding to acquire flood insurance, and to help prioritize relocation or acquisition projects as funding becomes available. Thurston County will continue to perform repetitive loss property analysis as part of its participation in the Community Rating System. Table 3.1.2 summarizes repetitive losses for the affected jurisdictions.

Table 3.1.2: Repetitive Loss Property Summary for Thurston County Jurisdictions

	Flood Zone Classification	RL Buildings (Total)	RL Buildings (Insured)	RL Losses (Total)	RL Losses (Insured)	RL Payments (Total)	Building	Contents	RL Payments (Insured)	Building	Contents
Bucoda	AE, A1-30, AO, AH, A	1	0	4	0	$27,421.20	$27,421.20	$0.00	$0.00	$0.00	$0.00
	VE, V1-30, V	0	0	0	0	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
	B, C, X	1	0	2		$31,597.31	$29,654.32	$1,942.99	$0.00	$0.00	$0.00
	TOTAL	2	0	6	0	$59,018.51	$57,075.52	$1,942.99	$0.00	$0.00	$0.00
Olympia	AE, A1-30, AO, AH, A	1	0	4	0	$58,364.83	$56,148.65	$2,216.18	$0.00	$0.00	$0.00
	VE, V1-30, V	0	0	0	0	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
	B, C, X	2	1	6		$218,713.65	$15,260.60	$203,453.05	$18,870.99	$15,260.60	$3,610.39
	TOTAL	3	1	10	4	$277,078.48	$71,409.25	$205,669.23	$18,870.99	$15,260.60	$3,610.39
Tenino	AE, A1-30, AO, AH, A	0	0	0	0	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
	VE, V1-30, V	0	0	0	0	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
	B, C, X	1	1	7		$111,029.79	$111,029.79	$0.00	$111,029.79	$111,029.79	$0.00
	TOTAL	1	1	7	7	$111,029.79	$111,029.79	$0.00	$111,029.79	$111,029.79	$0.00
Thurston County	AE, A1-30, AO, AH, A	10	6	27	17	$761,375.83	$624,728.58	$136,647.25	$573,670.28	$488,969.92	$84,700.36
	VE, V1-30, V	0	0	0	0	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
	B, C, X	8	3	16		$117,911.97	$106,893.46	$11,018.51	$43,492.15	$42,355.29	$1,136.86
	TOTAL	18	9	43	23	$879,287.80	$731,622.04	$147,665.76	$617,162.43	$531,325.21	$85,837.22
Grand Total		24	11	66	34	$1,326,415	$971,137	$355,278	$747,063	$657,616	$89,448

SOURCE: FEMA Community Information System. Data current as of December 31, 2016.

The Community Rating System (CRS)

The CRS is a voluntary program within the NFIP that encourages floodplain management activities that exceed the minimum NFIP requirements. Flood insurance premiums are discounted to reflect the reduced flood risk resulting from community actions to meet the CRS goals of reducing flood losses, facilitating accurate insurance rating, and promoting awareness of flood insurance.

For participating communities, flood insurance premium rates are discounted in increments of five percent. For example, a Class 1 community would receive a 45 percent premium discount, and a Class 9 community would receive a five percent discount. (Class 10 communities do not participate in the CRS and therefore receive no discount.) The CRS classes for local communities are based on 18 creditable activities in the following categories:

- Public information
- Mapping and regulations
- Flood damage reduction
- Flood preparedness

CRS activities can help to save lives and reduce property damage. Communities participating in the CRS represent a significant portion of the nation's flood risk; over 66 percent of the NFIP's policy base is located in these

communities. Communities receiving premium discounts through the CRS range from small to large and represent a broad mixture of flood risks, including both coastal and riverine flood risks.

Enrolled since 2000, Thurston County is the only community within the planning area that participates in the CRS program. Thurston County received a Class II community rating (previously a Class IV) by FEMA in November 2016. This rating entitles property owners in the 100-year floodplain to a 40 percent discount on flood insurance. Those outside the 100-year floodplain receive a 10 percent discount.

The County received its Class II rating because of its floodplain management program, Critical Areas Ordinance, and its public education and outreach activities. Together these programs reduce flood damage, which results in a reduction in insurance premiums. To maintain this rating, the county must complete an annual recertification and a re-verification every three years. The county will update and adopt its flood hazard management plan in 2017.

Endangered Species Act

Enacted in 1973, the federal Endangered Species Act (ESA) intends to conserve species facing depletion or extinction and the ecosystems that support them. The act sets forth a process for determining which species are threatened and endangered and requires conservation of the critical habitat in which those species live. The ESA provides broad protection for species of fish, wildlife, and plants listed as threatened or endangered. Provisions are made for listing species, as well as for recovery plans and the designation of critical habitat for listed species. The ESA outlines procedures for federal agencies to follow when taking actions that may jeopardize listed species. The procedures also include exceptions and exemptions. This enabling legislation for the Convention on International Trade in Endangered Species of Wild Fauna and Flora includes criminal and civil penalties for violations of the ESA and the Convention.

Federal agencies must seek to conserve endangered and threatened species and use their authorities in furtherance of the ESA's purposes. The ESA defines three fundamental terms:

- **Endangered** means that a species of fish, animal, or plant is "in danger of extinction throughout all or a significant portion of its range." (For salmon and other vertebrate species, this may include subspecies and distinct population segments.)
- **Threatened** means that a species "is likely to become endangered within the foreseeable future." Regulations may be less restrictive for threatened species than for endangered species.
- **Critical habitat** means "specific geographical areas that are…essential for the conservation and management of a listed species, whether occupied by the species or not."

The following five sections of the ESA supply information critical to understanding the act:

- **Section 4: Listing of a Species** – The National Oceanic and Atmospheric Administration Fisheries Service (NOAA Fisheries) is responsible for listing marine species; the U.S. Fish and Wildlife Service is responsible for listing terrestrial and freshwater aquatic species. The agencies may initiate reviews for listings, or citizens may petition for them. A listing must be made "solely on the basis of the best scientific and commercial data available." After a listing has been proposed, agencies receive comment and conduct further scientific reviews for 12 to 18 months, after which they must decide if the listing is warranted. Economic impacts cannot be considered in this decision, but it may include an evaluation of the adequacy of local and state protections. Critical habitat for the species may be designated at the time of listing.
- **Section 7: Consultation** – Federal agencies must ensure that any action they authorize, fund, or carry out is not likely to jeopardize the continued existence of a listed or proposed species or adversely modify its critical habitat. This includes private and public actions that require a federal permit. Once a final listing is made, non-federal actions are subject to the same review, termed a "consultation." If the listing agency finds that an action will "take" a species, it must propose mitigations or "reasonable and prudent" alternatives to the action; if the proponent rejects these, the action cannot proceed.
- **Section 9: Prohibition of Take** – It is unlawful to "take" an endangered species, including killing or injuring it or modifying its habitat in a way that interferes with essential behavioral patterns, including breeding, feeding or sheltering.
- **Section 10: Permitted Take** – Through voluntary agreements with the federal government that provide protections to an endangered species, a non-federal applicant may commit a take that would otherwise be prohibited as long as it is incidental to an otherwise lawful activity (such as developing land or building a road). These agreements often take the form of a "Habitat Conservation Plan."
- **Section 11: Citizen Lawsuits** – Civil actions initiated by any citizen can require the listing agency to enforce the ESA's prohibition of taking or to meet the requirements of the consultation process.

With the listing of salmon and trout species as threatened or endangered, the ESA impacts most of the Pacific Coast states. Although some areas have been more impacted than others due to the known presence of listed species, the entire region has been impacted by mandates, programs, and policies based on the presumption of the presence of listed species. Most West Coast jurisdictions must now take into account the impact of their programs on habitat. Thurston County communities are also affected by the listing of prairie species including the Mazama pocket gopher, the Streaked horned lark, the Taylor's checkerspot butterfly, and the Oregon spotted frog. Affected communities within the planning area are currently developing Habitat Conservation Plans to protect these species and their habitats.

The Clean Water Act

The federal Clean Water Act (CWA) employs regulatory and non-regulatory tools to reduce direct pollutant discharges into waterways, finance municipal wastewater treatment facilities, and manage polluted runoff. These tools are employed to achieve the broader goal of restoring and maintaining the chemical, physical, and biological integrity of the nation's surface waters so that they can support "the protection and propagation of fish, shellfish, and wildlife and recreation in and on the water."

Evolution of CWA programs over the last decade included a shift from a program-by-program, source-by-source, pollutant-by-pollutant approach to more holistic watershed-based strategies. The watershed approach places equal emphasis on protecting healthy waters and restoring impaired ones and addresses a full array of issues, not just those subject to CWA regulatory authority. Stakeholder involvement in the development and implementation of strategies for achieving and maintaining water quality and other environmental goals is a hallmark of this approach.

State

Washington State Enhanced Hazard Mitigation Plan

The *Washington State Enhanced Hazard Mitigation Plan* (2013) provides guidance for hazard mitigation throughout Washington. The plan identifies hazard mitigation goals, objectives, actions and initiatives for state government to reduce injury and damage from natural hazards. By meeting federal requirements for an enhanced state plan (44 CFR parts 201.4 and 201.5), the plan allows the state to seek significantly higher funding from the Hazard Mitigation Grant Program following presidential declared disasters (20 percent of federal disaster expenditures as opposed to 15 percent with a standard plan).

The goals and policies of the *Hazards Mitigation Plan for the Thurston Region* is consistent with the state's plan.

Washington State Floodplain Management Law

Washington's floodplain management law (Revised Code of Washington (RCW) 86.16, implemented through Washington Administrative Code (WAC) 173-158) states that prevention of flood damage is a matter of statewide public concern and places regulatory control with the Washington State Department of Ecology (Ecology). Floodplain management literature, including FEMA's national assessment, cites RCW 86.16 as one of the nation's first and strongest. A 1978 major challenge to the law—Maple Leaf Investors Inc. v. Department of Ecology—is cited in legal references to floodplain management issues. The court upheld the law, declaring that denial of a permit to build residential structures in the floodway is a valid exercise of police power and did not constitute a taking. RCW Chapter 86.12 (Flood Control by Counties) authorizes county governments to levy taxes, condemn properties, and undertake flood control activities directed toward a public purpose.

Flood Control Assistance Account Program

The state of Washington passed its first Flood Control Maintenance Program in 1951. In 1984, RCW 86.26 (State Participation in Flood Control Maintenance) established the Flood Control Assistance Account Program (FCAAP), which provides funding for local flood hazard management. FCAAP rules are found in WAC 173-145. The Ecology distributes FCAAP matching grants to cities, counties, and other special districts responsible for flood control. This is one of the few state programs in the U.S. that provides grant funding to local governments for floodplain management. The program has been funded for $4 million per biennium since its establishment, with additional amounts provided after severe flooding events.

To be eligible for FCAAP assistance, flood hazard management activities must be approved by Ecology in consultation with the Washington State Department of Fish and Wildlife. A Comprehensive Flood Hazard Management Plan must have been completed and adopted by the appropriate local authority or be in the process of being prepared to receive FCAAP flood damage reduction project funds. This policy evolved through years of the Flood Control Maintenance Program and early years of FCAAP in response to the observation that poor management in one part of a watershed may cause flooding problems in another.

Local jurisdictions must participate in the NFIP and be a member in good standing to qualify for an FCAAP grant which can provide funding for up to 75 percent of total project cost for comprehensive flood hazard management planning. Flood damage reduction projects can receive grants up to 50 percent of total project cost, and must be consistent with the Comprehensive Flood Hazard Management Plan. Emergency grants are available to respond to unusual flood conditions. FCAAP can also be used for the purchase of flood prone properties, for limited flood mapping, and for flood warning systems. Funding currently is running about 60 percent for planning and 40 percent for projects.

Thurston County updated and adopted its Flood Hazard Management Plan in 2012. The county is currently in compliance and good standing with the FCAAP program. The mitigation initiatives identified in this plan may be eligible for funding under FCAAP. FCAAP funds can be used as matching funds for some types of mitigation projects funded under the FEMA Hazard Mitigation Grant Program.

Shoreline Management Act

The 1971 Shoreline Management Act (RCW 90.58) was enacted to manage and protect the shorelines of the state by regulating development in the shoreline area. A major goal of the act is to prevent the "inherent harm in an uncoordinated and piecemeal development of the state's shorelines." The act covers the Pacific Ocean shoreline and the shorelines of Puget Sound, the Strait of Juan de Fuca, rivers, streams, and lakes above a certain size, and the wetlands associated with these shorelines.

Shoreline management activities "implement policies and regulations to help protect water quality for our marine waters, lakes and stream systems; increase protection of lives and property from flood and landslide damage; protect critical habitat as well as fish and wildlife; promote recreational opportunities in shoreline areas." Often these policies and programs complement or are critical in mitigation programs for communities. Shoreline management programs are local capabilities relevant to mitigation activities.

Growth Management Act

The 1990 Washington State Growth Management Act (RCW Chapter 36.70A) mandates that local jurisdictions adopt land use ordinances to protect the following critical areas:

- Wetlands
- Critical aquifer recharge areas
- Fish and wildlife habitat conservation areas
- Frequently flooded areas
- Geologically hazardous areas

The Growth Management Act regulates development in these areas, and therefore can affect hazard vulnerability and exposure at the local level.

Washington State Building Code

With respect to growth and new development, adhering to the most current building codes can provide a community's greatest line of defense in avoiding future disaster losses. Washington State's building codes are mandatory for residential and commercial buildings, statewide. The Washington State Building Code Council adopted the 2015 editions of national model codes with some amendments. The Washington State Energy Code and Ventilation and Indoor Air Quality Code were also adopted by the council. The 2015 codes went into effect as the Washington model code on July 1, 2016. Hazard loss avoidance is intrinsic with adoption of and compliance with appropriate building codes.

Comprehensive Emergency Management Planning

Washington's Comprehensive Emergency Management Planning law (RCW 38.52) establishes parameters to ensure that the state's preparations will be adequate to deal with disasters, ensure the administration of state and federal programs providing disaster relief to individuals, ensure adequate support for search and rescue operations, protect the public peace, health and safety, and preserve the lives and property of the people of the state. It achieves the following:

- Provides for emergency management by the state, and authorizes the creation of local organizations for emergency management in political subdivisions of the state.
- Confers emergency powers upon the governor and upon the executive heads of political subdivisions of the state.
- Provides for the rendering of mutual aid among political subdivisions of the state and with other states and for cooperation with the federal government with respect to the carrying out of emergency management functions.

- Provides a means of compensating emergency management workers who may suffer any injury or death, who suffer economic harm including personal property damage or loss, or who incur expenses for transportation, telephone or other methods of communication, and the use of personal supplies as a result of participation in emergency management activities.
- Provides programs, with intergovernmental cooperation, to educate and train the public to be prepared for emergencies.

This law requires that emergency management functions of the state and its political subdivisions coordinate to the maximum extent with comparable functions of the federal government, agencies of other states and localities, and of private agencies of every type, to the end that the most effective preparation and use may be made of human resources, resources, and facilities for dealing with disasters.

WAC 118-30-060(1) requires each political subdivision to base its comprehensive emergency management plan on a hazard analysis, and makes the following definitions related to hazards:

- Hazards are conditions that can threaten human life as the result of three main factors:
  - Natural conditions, such as weather and seismic activity;
  - Human interference with natural processes, such as a levee that displaces the natural flow of floodwaters;
  - Human activity and its products, such as homes on a floodplain.
- The definitions for hazard, hazard event, hazard identification, and flood hazard include related concepts:
  - A hazard may be connected to human activity;
  - Hazards are extreme events;
  - Hazards generally pose a risk of damage, loss, or harm to people and/or their property.

Watershed Management Act

Washington's Watershed Management Act of 1998 encourages local communities to develop plans for protecting local water resources and habitat. Lawmakers wanted local governments and citizens to develop plans since they know their own regions best. WRIA is an acronym for "Water Resource Inventory Area." WRIAs are watershed planning areas established by the Department of Ecology. Washington State is divided into 62 WRIAs, each loosely drawn around a natural watershed or group of watersheds. A watershed is an area of land that drains into a common river, lake, or the ocean.

State Environmental Policy Act

The Legislature enacted the State Environmental Policy Act (SEPA) in 1971 to provide a regulatory framework for state and local agencies to address environmental issues in their decisions. The act provides information to agencies, applicants, and the public to encourage the development of environmentally sound proposals. The environmental review process involves the identification and evaluation of probable environmental impacts and the development of mitigation measures to reduce adverse impacts.

Modeled after the National Environmental Policy Act, SEPA ensures that environmental values are considered during decision making by state and local agencies. When the act was adopted, the Legislature identified four primary purposes:

1. To declare state policy which will encourage productive and enjoyable harmony between people and the environment.
2. To promote efforts which will prevent or eliminate damage to the environment.
3. To stimulate the health and welfare of people.
4. To enrich the understanding of the ecological systems and natural resources important to the state and nation.

The law requires local governments to:

- Utilize a systematic, interdisciplinary approach that ensures the integrated use of natural and social sciences and the environmental design arts in planning and decision making that may affect the environment.
- Ensure that environmental amenities and values are given appropriate consideration in decision making along with economic and technical considerations.

Local agencies may use SEPA in combination with their own critical area regulations to provide a robust approach to environmental protection and hazard avoidance. Thurston County, for example, uses SEPA to fill gaps in local regulations related to mitigating hazards. Communities that take the SEPA process seriously can use it to improve their mitigation efforts. A checklist helps communities determine the environmental impact of a proposed development. SEPA review requirements may apply to certain mitigation actions identified in this plan.

Local

Comprehensive Plans

Local agency Comprehensive Plans are the cornerstone of community growth and development. They guide a county or city's physical development and identify transportation and other public facilities needed to meet the needs of population growth. These plans serve as the framework for zoning and other development regulations, which must be consistent with comprehensive plans.

Local Comprehensive Plans may be amended on an annual basis. Bucoda, Lacey, Olympia, Rainier, Tenino, Tumwater, Yelm, and Thurston County Comprehensive Plans are all current or being updated. The Thurston County Comprehensive Plan deals mainly with rural areas of the county (land outside of urban growth areas that surround cities), with subarea plans for the communities of the Nisqually Valley, Rochester, and Grand Mound. Joint plans with cities guide land use in the unincorporated county areas between urban growth area boundaries and the city limits of Bucoda, Olympia, Lacey, Tumwater, Yelm, Tenino, and Rainier. These joint plans are adopted by both the applicable city and Thurston County. The *Thurston County Comprehensive Plan* (2012) references the *Hazards Mitigation Plan for the Thurston Region* in policies that protect the natural environment. The dates of adoption of the communities' Comprehensive Plans are summarized below.

Adoption Status of Comprehensive Plans in Thurston County

Community	Date of Adoption
Town of Bucoda	October 11, 2016
City of Lacey	August 11, 2016
City of Olympia	December 22, 2014
City of Rainier	September 27, 2016
City of Tenino	December 13, 2016
City of Tumwater	December 20, 2016
Thurston County	Update in progress

Emergency Management Plan

The Comprehensive Emergency Management Plan (CEMP) is Thurston County's all-hazards emergency management plan. The plan includes a Basic Plan promulgated in 2015 and Emergency Support Function (ESF) Annexes currently being updated. The plan is consistent with the Washington State Comprehensive Emergency Management Plan and the federal-level National Response Framework (NRF). The basic plan and it's annexes addresses prevention and mitigation, preparedness, response, and recovery activities. The county's Comprehensive Emergency Management Plan is reviewed and updated on a four-year cycle. This plan, and state approval of it, is a requirement for recognition of a jurisdiction's emergency management program under the Revised Code of Washington (RCW) 38.52.070. The county and incorporated cities and towns are required to have a state approved CEMP or be covered under the another jurisdiction's plan.

Critical Areas Ordinance

Washington's Growth Management Act requires local governments to protect five types of critical areas: important fish and wildlife habitat areas, wetlands, critical aquifer recharge areas, frequently flooded areas, and geologically hazardous areas, such as bluffs. Thurston County's critical areas regulations respond to that law, regulating how development and redevelopment can safely occur on lands that contain critical areas. On July 24, 2012, the Board of County Commissioners adopted Ordinance No. 14773 amending the Thurston County Critical Areas Ordinance and other related chapters of the Thurston County Code.

Municipal Stormwater Permits

Stormwater management is an effective tool to control stormwater flooding. Under the Clean Water Act, Ecology regulates the issuance of municipal stormwater permits to local governments. The stormwater permits regulate a community's ability to discharge stormwater into streams, rivers, lakes, and the Puget Sound. Thurston County, Lacey, Olympia, and Tumwater are Phase II Western Washington Municipal Stormwater Permit communities and are required to comply with the Western Washington National Pollutant Discharge and Elimination System Municipal General Stormwater Permit. Phase II counties and cities must make Low Impact Development or LID the preferred and commonly used approach to site development. LID is a stormwater management strategy that is designed to minimize impervious surfaces, maximize native vegetation retention, and filter stormwater on site as much as possible to manage pollutants and control stormwater flows to prevent erosion. The county and cities amended and updated their zoning and development codes and their Design and Erosion Control Manuals in 2016 to incorporate LID strategies into stormwater management practices.

Shoreline Master Program

The Shoreline Master Program is a combined planning and regulatory document that contains policies, goals and specific land-use regulations for shorelines. The master program balances development, public access, and shoreline protection. Six communities in the county must comprehensively update their programs. The status of each jurisdiction's program update:

Shoreline Master Program Update Status

Community	Update Process	Effective Date of State Approval
Town of Bucoda	Completed	June 5, 2012
City of Lacey	Completed	October 13, 2011
City of Olympia	Completed	October 8, 2015
City of Rainier	Not required	
City of Tenino	Completed	June 5, 2012
City of Tumwater	Completed	April 18, 2014
City of Yelm	Not required	
Thurston County	Underway	

WRIA Planning

Although Washington's Watershed Management Act does not require planning, Thurston County and local governments have undertaken related planning activities. Ecology provides technical and financial support for the effort. Thurston County has participated in watershed planning for four WRIAs:

- The Nisqually River Watershed (WRIA 11)[1]
- The Deschutes Watershed (WRIA 13)[2]
- The Kennedy-Goldsborough Watershed (WRIA 14)[3]
- The Upper and Lower Chehalis River Watershed (WRIAs 22 and 23)[4]

[1] Febrary 14, 2007

[2] Final Draft completed October 2004, but not adopted

[3] Final Draft February 2006

[4] Adopted in May 2004

School District Bonds

Under the authority of Superintendent of Public Instruction, school districts may issue bonds for major and minor structural additions to buildings, facilities, structures, and sites (RCW 28A.525). The replacement of aging school buildings with newer, modern facilities, constructed with current building codes, is at its core, a practice in hazard mitigation. Schools are often designated as emergency shelters (as long as they don't interfere with their primary function of education students) due to their strength and emergency provisions such as electrical backup systems, kitchens, and restrooms with shower facilities.

Regional Planning

The Emergency Management Council of Thurston County

The Emergency Management Council was created in 1993 and renewed in 2013 via an interlocal agreement to coordinate emergency management activities with the county, cities, and tribes. The nine-member council includes the emergency management representatives from Thurston County, the Town of Bucoda, the cities of Lacey, Olympia, Rainier, Tenino, Tumwater, and Yelm, the Confederated Tribes of the Chehalis Reservation, and the Nisqually Indian Tribe. The council convenes monthly and regularly invites a variety of stakeholders and subject matter experts to address a wide array of issues related to emergency preparedness, response, recovery, and mitigation. The council also lends their expertise as the steering committee for the Hazards Mitigation Plan for the Thurston Region.

The council has hosted numerous Executive Disaster Recovery Seminars to engage community leaders and to enhance their awareness of regional activities such as hazards mitigation and catastrophic disaster recovery planning.

Thurston Regional Planning Council

As a regional council of governments in Thurston County, Thurston Regional Planning Council (TRPC) fosters the region's livability through collaborative, informed planning. It carries out regionally focused plans and studies on topics such as transportation, growth management, and environmental quality. Decision-makers from 21 jurisdictions and organizations in Thurston County make up the council, which meets monthly to address challenges related to the region's growth. Most, but not all, the partners to this plan are members of TRPC.

TRPC also provides information and education regarding the region and its emerging planning issues. Regional statistics, trends, analyses, and maps provide a basis for planning and decision-making on both the regional and local levels. A variety of council-sponsored community forums relating to regional planning help to educate and promote public participation and dialogue. Below are a few of TRPC's major planning efforts that touch nearly every community in Thurston County.

2040 Regional Transportation Plan: What Moves You

Adopted in July 2016, the Regional Transportation Plan (RTP) serves as a strategic blueprint for the region's transportation system. It provides an overall analysis of how transportation will work in the region over a 20-25-year time frame and supports coordination among jurisdictions. It also acts as an important tool in meeting state and federal transportation requirements, ensuring continued funding from these sources. The RTP identifies those projects and issues that change the way traffic flows throughout the region, complementing the local planning that makes the roadway network function within each jurisdiction. The RTP includes policies to enhance the safety of people who operate, manage, and use the region's transportation network.

Creating Places Preserving Spaces: A Sustainable Development Plan for the Thurston Region

The Sustainable Thurston project began in early 2011 with a simple question for the Thurston Region's quarter-million residents: How do you want your community to look, function, and feel in 2035? Online and in person, thousands of engaged residents helped the Sustainable Thurston Task Force craft a regional vision of sustainable development that encompasses land use, housing, energy, transportation, food, health, public safety, and other interconnected issues. This community conversation identified a vision for a vibrant, healthy, and resilient future, as well as the actions and responsibilities to achieve it: http://www.trpc.org/259/Sustainable-Thurston.

Sustainable Thurston identified several goals and corresponding actions to achieve the region's vision. Two goals specifically addressed public safety:

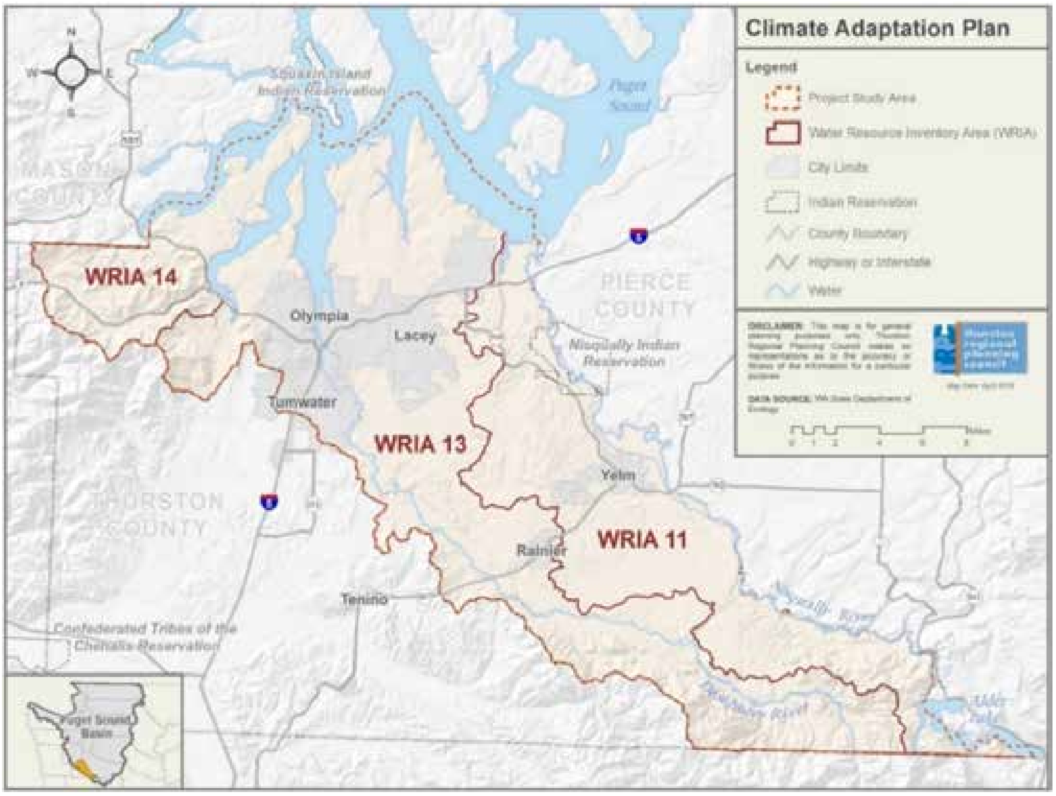
- Public Safety Goal 1: Provide emergency services in a dependable and efficient way to meet the dynamic needs of a diverse society.
- Public Safety Goal 2: Create a resilient region by improving disaster preparedness, response, and recovery efforts as well as by expanding public safety education.

The plan also includes 17 actions to support creating disaster resilient communities:

ID	Action
PS-2.01	Fund an update to the region's FEMA approved hazard mitigation plan every five years.
PS-2.02	Encourage local governments, tribes, schools, special-purpose districts, and major private employers, such as hospitals, to participate in a regional risk-assessment process and adopt local plans.
PS-2.03	Identify cost-effective mitigation actions that provide all sectors of the community protection from disaster events.
PS-2.04	Consider emergency facilities in community planning and permitting.
PS-2.05	Prioritize relationship building among public safety agencies and other entities to leverage response capacities during disaster events.
PS-2.06	Participate in regional emergency exercises and recovery planning processes.
PS-2.07	Convene recovery committees immediately after a disaster to prioritize restoration of vital public safety facilities and other essential community assets.
PS-2.08	Train personnel in best practices following lessons learned.
PS-2.09	Build residents' capacity to mitigate hazards. This includes urging residents: to install and maintain fire extinguishers and smoke and carbon monoxide detectors in every living space; to reduce fire fuels around living structures in wildland-urban interface areas; to perform seismic stabilization retrofits of older homes; and in remote, hard-to-reach areas to install fire sprinkler systems.
PS-2.10	Build residents' capacity to respond to and recover from hazards. This entails: broadly publicizing the locations and descriptions of community disaster shelters to all sectors of the community; encouraging residents to stock rations, medications, backup heating, and emergency supplies to maintain self-sufficiency for at least 72 hours, preferably seven to ten days; and, building relationships among neighbors to leverage skills and resources to assist those in need when public safety services are overextended during a disaster (e.g., build upon the successes of community education and outreach activities like Thurston County's Crime Watch and Map Your Neighborhood programs).
PS-2.11	Enhance local government awareness of the risks of transporting hazardous materials via pipeline, road, rail, marine, and air routes through the region.
PS-2.12	Increase support for hazardous materials inspection, planning, management, and disposal.
PS-2.13	Establish trusting relations with private utility companies to maintain awareness of community risks from major gas and electrical distribution systems.
PS-2.14	Ensure that adequate response contingencies are in place to swiftly address hazardous materials release.
PS-2.15	Jurisdictions with adopted hazard-mitigation plans should actively pursue funding opportunities to implement their highest-priority mitigation actions.
PS-2.16	Coordinate on strategies for containing urban wildfires.
PS-2.17	Expand the eligibility of Federal Emergency Management Agency (FEMA) mitigation grant programs to allow replacement of aging structures (i.e. facilities such as water reservoirs, fire stations, transportation facilities, emergency coordination centers, and buildings used as emergency shelters that are better suited to serve communities in the future.)

Thurston Climate Adaptation Plan

TRPC is using a National Estuary Program (NEP) grant to develop a watershed-based climate adaptation plan with steps that the region could take to prepare for and cope with climate change impacts in the decades ahead. The Washington State Department of Commerce is administering the U.S. EPA funding over the project period, which concludes in early 2018. The planning area includes parts of three watersheds that overlay northern and eastern Thurston County and drain into Puget Sound [See map]. These watersheds defined by Ecology as Watershed Resource Inventory Areas (WRIAs) – include Nisqually (WRIA 11), Deschutes (WRIA 13), and Kennedy/Goldsborough (WRIA 14).



Southwestern Thurston County drains into Grays Harbor via the Chehalis River, so this area is not included in the NEP grant and Puget Sound spatial analysis of climate change impacts. However, many of the strategies developed for the project area will likely be applicable to all of Thurston County and neighboring communities.

The project entails: researching and summarizing climate change projections for the region; assessing climate change vulnerabilities, risks and impacts; developing adaptation strategies and actions; conducting benefit-cost analyses; and drafting a climate adaptation plan for TRPC policymaker adoption. Like TRPC's Sustainable Thurston plan, the Thurston Climate Adaptation Plan will include a menu of options for the region's diverse communities, and identify priorities, leads and partners. The project team has assessed climate change vulnerabilities, risks, and impacts. In early 2017, the team will develop adaptation strategies and actions for inclusion in a draft plan for TRPC policymaker consideration in early 2018.

Chapter 4.0
Risk Assessment

This Chapter is comprised of seven sections:

4.0 Risk Assessment Introduction
4.1 Earthquake Hazard Profile
4.2 Storm Hazard Profile
4.3 Flood Hazard Profile
4.4 Landslide Hazard Profile
4.5 Wildland Fire Hazard Profile
4.6 Volcanic Hazards Profile

This section introduces the basis for conducting a risk assessment, explains its role in informing the plan's mitigation strategy, and articulates how this chapter complies with the Disaster Mitigation Act. The section also describes all the hazards and threats that affect the planning area, and the hazard profile format and hazard analysis definitions to orient the reader to each hazard profile's contents.

Sections 4.1 through 4.6 contain the individual hazard profiles, with detailed information about the six major hazards that constitute the risk assessment.

Risk Assessment Introduction

The Federal Emergency Management Agency (FEMA) states, "Risk, for the purpose of hazard mitigation planning, is the potential for damage, loss, or other impacts created by the interaction of hazards with community assets."

For multi-jurisdictional hazard mitigation plans, each participating community must evaluate the potential impacts of hazards within the planning area and determine its overall vulnerability to those hazards, as those risks are unique to each

Community risk from hazards (FEMA Local Mitigation Planning Handbook).

community and must be addressed. The risk assessment covers both the entire planning area and provides details, where available, for each community within the planning area.

The plan followed the "Local Mitigation Planning Handbook" (FEMA, 2013) to compile a comprehensive risk assessment of the major natural hazards that threaten the Thurston Region. This chapter provides the factual basis for communities to develop effective mitigation strategies. 44CFR Section 201.6(c)(2) of the Disaster Mitigation Act's (DMA) planning regulation identifies the specific requirements needed in the risk assessment. The regulatory requirements of the risk assessment serve as a useful checklist for preparing a comprehensive and meaningful summary of the hazards the region faces. Section 201.6(c) risk assessment planning requirements are as follows: [1]

> (2) … Local risk assessments must provide sufficient information to enable the jurisdiction to identify and prioritize appropriate mitigation actions to reduce losses from identified hazards. The risk assessment shall include:
>
> > (i) A description of the type, location, and extent of all natural hazards that can affect the jurisdiction. The plan shall include information on previous occurrences of hazard events and on the probability of future hazard events.
>
> (ii) A description of the jurisdiction's vulnerability to the hazards described in paragraph (c)(2)(i) of this section. This description shall include an overall summary of each hazard and its impact on the community. All plans approved after October 1, 2008 must also address NFIP insured structures that have been repetitively damaged by floods. The plan should describe vulnerability in terms of:
>
> > (A) The types and numbers of existing and future buildings, infrastructure, and critical facilities located in the identified hazard areas;
> >
> > (B) An estimate of the potential dollar losses to vulnerable structures identified in paragraph (c)(2)(ii)(A) of this section and a description of the methodology used to prepare the estimate;

(C) Providing a general description of land uses and development trends within the community so that mitigation options can be considered in future land use decisions.

(iii) For multi-jurisdictional plans, the risk assessment section must assess each jurisdiction's risks where they vary from the risks facing the entire planning area.

In general, the Federal DMA planning requirements with the words "**shall**" and "**must**" indicate that the item is mandatory and must be included in the plan, otherwise it will not be approved by FEMA. Regulations with the word "**should**" indicate that the item is strongly recommended to be included in the plan, but its absence will not cause FEMA to disapprove the plan.

Federal Disaster Declarations

Communities subject to emergencies resulting from hazards supply the first line of defense. The federal government issues disaster declarations under the Stafford Act when local and state government combined response capabilities cannot address major emergencies. Federal declarations activate a variety of federal funding programs to assist communities, businesses, and individuals with recovery. Hazard mitigation assistance grants are made available to states through the Disaster Mitigation Act following declarations and are a chief source of funding for developing hazard mitigation plans and mitigation projects. Washington State has received 52 major federal disaster declarations since 1956[2].

Photo courtesy Thurston County.

Thurston County has received 22 declarations, six issued since the region's Hazard Mitigation Plan was first adopted in October 2003. Table 4.0.2 lists the Federal Disaster Declarations that have included Thurston County.

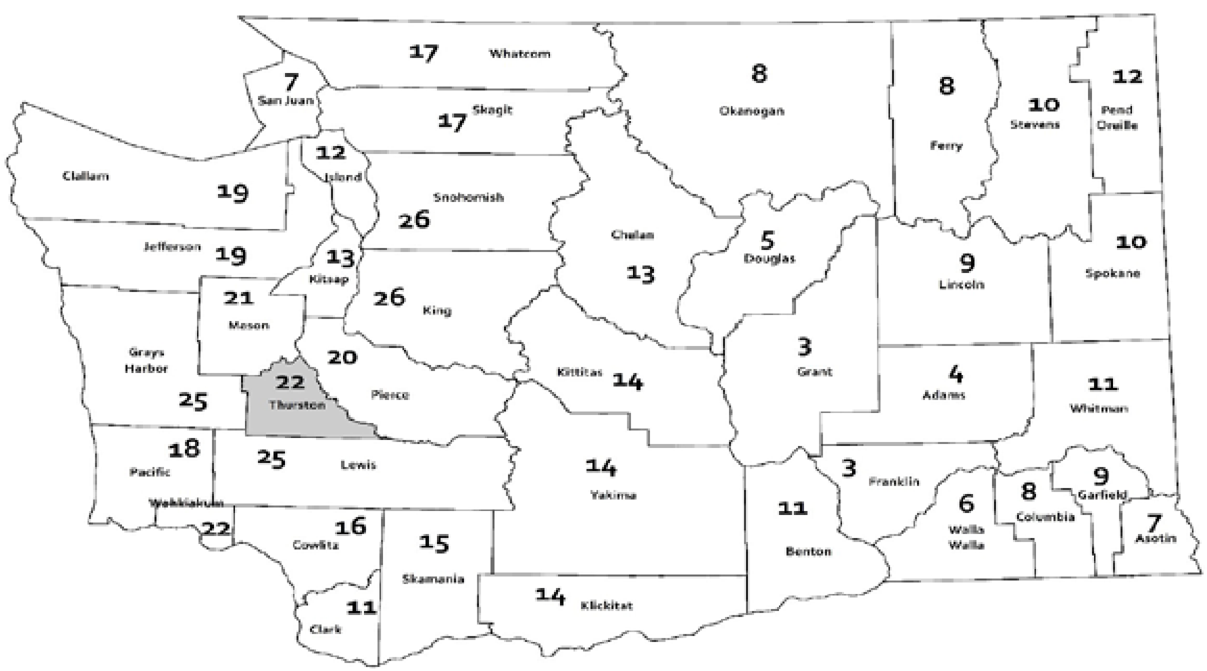
Table 4.0.2: Thurston County Federal Disaster Declarations, 1965 to 2016

Disaster Number	Declaration Date	Incident Type	Title
196	May-1965	Earthquake	Earthquake
322	Feb-1972	Flood	Severe storms & flooding
328	Mar-1972	Flood	Heavy rains & flooding
414	Jan-1974	Flood	Severe storms, snowmelt & flooding
492	Dec-1975	Flood	Severe storms & flooding
545	Dec-1977	Flood	Severe storms, mudslides, & flooding
623	May-1980	Volcano	Volcanic eruption, Mt. St. Helens
852	Jan-1990	Flood	Severe storms & flooding
883	Nov-1990	Flood	Severe storms & flooding
981	Mar-1993	Severe Storm(s)	Severe storms & high wind
1079	Jan-1996	Severe Storm(s)	Severe storms, high wind, and flooding
1100	Feb-1996	Flood	High winds, severe storms and flooding
1159	Jan-1997	Severe Storm(s)	Severe winter storms, land & mudslides, flooding
1172	Apr-1997	Flood	Heavy rains, snow melt, flooding, land & mud slides
1361	Mar-2001	Earthquake	Earthquake
1499	Nov-2003	Severe Storm(s)	Severe storms and flooding
1671	Dec-2006	Severe Storm(s)	Severe storms, flooding, landslides, and mudslides
1682	Feb-2007	Severe Storm(s)	Severe winter storm, landslides, and mudslides
1734	Dec-2007	Severe Storm(s)	Severe storms, flooding, landslides, and mudslides
1817	Jan-2009	Flood	Severe winter storm, landslides, mudslides, and flooding
1825	Mar-2009	Severe Storm(s)	Severe winter storm and record and near record snow
4056	Mar-2012	Severe Storm(s)	Severe winter storm, flooding, landslides, and mudslides

The number and frequency of federal disaster declarations affecting Thurston County paints a picture of the risks that natural hazards pose to the region. The following statistics highlight the frequency of major natural disaster in Thurston County:

- Between 1965 and 2016, Thurston County has received 22 federal disaster declarations.
- Only 147 counties or U.S. Census designated places have received 20 or more federal disaster declarations; only four percent of counties or U.S. places share this distinction.
- As of 2016, eight counties in Washington State have experienced 20 or more disaster declarations. Thurston County and Wahkiakum County are tied for having the 5th highest rate of declarations in the state.

Figure 4.1: Federal Disaster Declarations by Counties in Washington State, 1956 to June 2016



Hazard Identification

Communities in Thurston County are subject to a wide variety of natural hazards and human-induced threats. Some communities face greater risks than others simply due to their location and environmental conditions. This section presents an overview of the hazards and threats, not profiled in the risk assessment, that occur in the planning area or have a likelihood of affecting the Thurston Region.

The plan uses several sources to identify the hazards that threaten the Thurston Region, principally Thurston County's and other local jurisdictions' Hazard Identification and Vulnerability Analysis (HIVA) reports and the Washington State Enhanced Hazard Mitigation Plan (2013). Other sources include the National Climate Data Center, the Hazards and Vulnerability Research Institute, the National Weather Service, the United States Geological Survey, FEMA, and the Washington State Departments of Natural Resources and Ecology.

Critical Shortage – Critical shortage is the lack or reduction of essential goods or services due to a disruption in their supply caused by events that occur elsewhere. These events may include embargoes, strikes, natural disasters, epidemics, crop failures, over exploitation of a natural resource, terrorist activities, or political unrest. For example, a fuel shortage would greatly impact the nation's economy.

Cyber-Attack – A cyber-attack is an offensive maneuver against individuals or organizations that targets computer information systems, infrastructure, networks, or personal devices. These attacks attempt to disable operations, steal information, or hold systems ransom. They may be launched by nation states, criminal organizations, or hackers acting with malicious intent. Local government infrastructure such as signal controllers, water systems, and other utilities that are controlled remotely by computers may be at risk.

Dam Failure – There are 38 dams in or adjacent to Thurston County. The Washington Department of Ecology Dam Safety rates each dam's Downstream Hazard Classification to provide a simple characterization of the setting downstream of a dam to reflect the general nature of consequences if the dam were to fail and release the reservoir into the downstream valley. Three dams are classified as high hazard dams in the county, Alder and LaGrande Dams on the Nisqually River and the Skooumchuck Dam, on the Skookumchuck River. Table 4.0.3 shows the Downstream Hazard Classification of Thurston County dams.

Dam failures can be caused by major floods or an earthquake, but they are also subject to failure from 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. Some of the effects of a major dam failure include loss of life, destruction of homes and property, damage to roads, bridges, powerlines, and other infrastructure, loss of power generation and flood control capabilities, disruption of fish stock and spawning beds, and the erosion of stream and river banks.

The three high hazard dams in the county are well-maintained and comply with current dam safety regulations. Thurston County has not experienced a major dam failure, and the Hazard Inventory and Vulnerability Analysis report has assigned a low risk rating to the

Table 4.0.3: Downstream Hazard Classification of Thurston County Dams

Dam	Classification	Rating
Alder Dam; and Skookumchuck Dam	1A	High – Greater than 300 lives at risk
LaGrande Dam	1B	High – From 31 to 300 lives at risk
All other Dams	39	Low – No lives at risk

other 35 dams. However, in the event of a failure, each of the three dams could affect a population of 300 or more, inundate major transportation routes and industries, and cause long-term effects on water quality and wildlife. The high hazard dams in Thurston County are operated for electrical power generation and are licensed by the Federal Energy Regulatory Commission. Accordingly, they are inspected regularly and staffed 24 hours a day. If a dam were to show signs of failure, dam operators would initiate their emergency action plans and notify emergency management personnel and evacuation procedures would be implemented.

Refer to the Volcanic Hazard Profile for dam failure attributed to a catastrophic lahar. More information regarding Alder and LaGrande Dam failure can be found in Tacoma Power's "Emergency Action Plan for the Nisqually Hydroelectric Project." For the Skookumchuck Dam, refer to TransAlta's "Skookumchuck Dam Emergency Action Plan".

Drought – Drought is a condition of climatic dryness severe enough to reduce soil moisture levels and water levels below the minimum necessary for sustaining plant, animal, and human life systems. While there were no major losses during Thurston County's drought conditions in 2015, there were reports of some residential wells drying up and the death of countless immature trees. Climate change projections for the Puget Sound Region indicate that longer, warmer, and drier summers will become the norm by mid-century. Drought can destroy or lower crop yields, impact fish habitat, and increase risk for wildland fires.

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 and crops. Epidemic diseases such as influenza, West Nile Virus, and the Zika Virus are usually introduced into an area from remote regions and inflict devastation because of a lack of natural or induced immunity.

Hazardous Material Incident – 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 public property and the environment at risk from their inadvertent or intentional release. Local communities have little to no knowledge of when and what type of hazardous materials are being transported by highways or railroads through Thurston County.

Heat Wave – A heat wave is characterized by five or more consecutive days of unusually hot weather. Locally, the National Weather Service considers 90 degrees or higher as hot weather. Prolonged periods of extreme temperatures can result in heat injuries or dehydration for the young, elderly, and people who work outdoors. Heat waves are expected to become more frequent as warmer summers increase from the effects of climate change.

Space Weather/Solar Wind/Geomagnetic Storm – The behavior and energy output of the sun varies according to its 11-year cycle. A coronal mass ejection or other solar phenomena can release magnetic storms that can severely disrupt and damage electrical distribution systems and electric devices on Earth. Some examples: In March 1989, a current surge induced by the changing magnetic fields at ground level affected transformers at power stations in Canada. The surge led to power blackouts throughout Quebec that lasted for several hours, and the power company lost more than 21,500 megawatts of its production capacity. An induced current fatally damaged a transformer at a nuclear-power plant in New Jersey.

Terrorist Attack – 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 garner publicity for their causes. Bombings and mass shootings are the most frequently used terrorist methods 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 an incredibly destructive sea wave of extremely long length generated by a seismic disturbance (earthquake, volcanic eruption, or debris slide) below or on the ocean floor. Wave lengths may exceed sixty miles and travel 300-600 mph. They can be of local or distant origins such as Alaska or Japan. It is unlikely that Thurston County would be directly impacted by such a tsunami, as the wave energy would be depleted by the time it reaches the South Sound. However, the county could be indirectly affected by tsunami impacts to communities on the coast.

Hazard Profiles

The plan includes detailed profiles of hazards that pose the greatest risk to the planning area. Each hazard profile documents each of the following criteria. There is:

1. A high probability of the natural hazard occurring in Thurston County within the next 25 years
2. The potential for significant damage to buildings and infrastructure; and/or
3. The potential for loss of life.

The following hazards meet one or more of the above criteria. Every hazard profile was evaluated and updated during the plan update process.

Hazard	Probability of Occurrence	Vulnerability	Risk
Earthquake	High	High	High
Storm	High	High	High
Flood	High	Moderate	High
Landslide	High	Low	Moderate
Wildland Fire	High	Moderate	Moderate
Volcanic Events	Low	High	Moderate

Contents

The Hazard Profiles in sections 4.1 through 4.6 address the DMA Risk Assessment Planning Requirements identified in the introductory section of this chapter: hazard definitions, causes, sources, severity, effects and impacts, probability of occurrence, historical occurrences, geographic extent or delineation, and the portion of the population, assets, and essential facilities potentially exposed to the hazard. The information is presented for general audiences and includes figures, maps, and tables.

A variety of sources, including local, state, and federal government staff, scientists, plans, scientific journals, newspaper articles, federal and state agency websites, and other online data sources informed development of the hazard profiles. Endnotes are provided. The narrative identifies some gaps where sections in the profile may lack sufficient information and data to adequately address some of the required components of the risk assessment.

Severity: Severity describes or measures the strength or magnitude of hazard elements or hazard events. For example, wind speed can be measured in miles per hour, temperatures in degrees Fahrenheit, snow depth accumulations in inches and, earthquakes in magnitude. Severity can also describe the duration or spatial extent of a hazard effect. Severity is an important factor for assessing vulnerability.

*Find information about the data and procedures used to develop the risk assessment in **Appendix C**.*

Impacts: Descriptions of the adverse physical, economic, environmental, and social consequences resulting from the effects of natural hazards, based on both actual past events in the planning area or in Washington State as well as potential effects.

Probability of Occurrence: Probability is an important component for evaluating risk. This statistical measure articulates the likelihood of a hazard event occurring during a specific time period such as annually, every 25 years, or for a specific period of recorded observations. The plan describes probability in both numeric and qualitative terms. Numerically it is expressed by the ratio of the number of actual occurrences to the total number of possible occurrences. The summary assessment (see below) considers probability for a 25-year interval.

Historical Occurrences and Impacts: Past events reveal the type and extent of losses that communities can expect from future disaster events. This section includes a chronological listing of notable events that impacted Thurston County and the Pacific Northwest. While not an exhaustive list of past events, it offers sufficient representation of the type, location, extent, and specific consequences.

Delineation of Hazard Area: This is a description of the geographical extent of the hazard area based on the hazard profile such as special flood hazard areas, liquefaction zones, and lahar inundation zones, and which communities are most vulnerable to a hazard. Geographical extent is also depicted on one or more countywide maps for every hazard except for the Storm Hazard Profile. Each participating jurisdiction's annex will include community-level maps. The portion of each jurisdiction's area exposed to the hazards are summarized in tables.

Population and Employment in the Hazard Area: Each profile includes several tables that summarize an aspect of current and future planning-level hazard exposure including population, employment, and residential dwelling units. Chapter 3, Thurston County Community Profile, contains more information about population and growth trends. Since the entire county is vulnerable to the effects of storm damage, the plan omits exposure data for storm hazards. Total population affected by storm can be inferred from the "total" columns from the other hazard profiles.

Inventory of Assets and Dollar Value in the Hazard Area: Tabular data reflects a planning-level number of existing and future structures which are potentially impacted by the hazards. An estimate of structure and building contents' value is also included to provide information on potential dollar losses. The plan provides estimates of buildings' value by residential, commercial/industrial, and government/institutional for each hazard. The values in the tables represent the sum of both the building replacement and content replacement values. Tables are provided by jurisdiction for the years 2015 and 2040. Data for storm are not included as the entire county is vulnerable to the effects of storms. Total assets affected by storm can be inferred from the "total" columns from the other hazard profiles.

Essential Facilities in Hazard Area: Hazards can destroy or damage facilities that may be critical for responding to the disaster and for maintaining a safe environment and public order. Nearly 1,300 public and private essential facilities in Thurston County are inventoried in a Geographical Information System. Planning-level estimates on the types and quantities of

Photo courtesy Steve North.

essential facilities that occur in hazard areas is summarized in a table within each profile. Thurston County Emergency Management maintains specific information about the location of critical facilities and infrastructure.

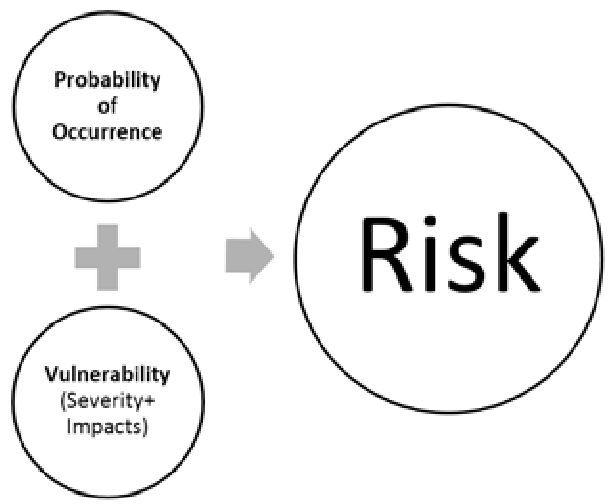
Summary Assessment: An overall risk is assigned to each hazard in the profiles. Each hazard's risk is based on a subjective examination of that hazard's probability of occurrence combined with the region's overall vulnerability to the hazard. A 25-year recurrence interval is the basis for examining a hazard's probability of occurrence. This interval approximates the communities' established forecast horizon for long-range planning, and is within a recurrence interval for a major earthquake, the hazard presenting the greatest risk to Thurston County.

Hazard Analysis Definitions

The Thurston Region Hazard Mitigation Plan uses a subjective risk measurement process based on Thurston County's Hazard Inventory and Vulnerability Assessment or HIVA. This methodology rates elements of each hazard's risk characteristics using the descriptors high, moderate, and low. These descriptors are applied to the hazards' probability of occurrence, vulnerability, and overall risk. The following is an overview of this risk measurement model:

Risk Rating: A description (high, moderate, or low) of the subjective estimate of the combination of any given hazard's probability of occurrence and the region's vulnerability to the hazard.

- High – There is strong potential for a disaster of major proportions.
- Moderate – There is medium potential for a disaster of less than major proportions.
- Low – There is little potential for a disaster.



Probability of Occurrence: A description (high, moderate, 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.
- Moderate – There is medium 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: A description (high, moderate, or low) of the potential impact a hazard could have on Thurston County. Vulnerability can be expressed as a combination of the severity of a hazard's effect and its consequential impacts to the community. 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 worst case scenario, there could be a disaster of major to catastrophic proportions.
- Moderate – 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 worst case scenario, a disaster could be moderate to major, but 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 worst case scenario, there could be a disaster of minor to moderate proportions.

Community Variations to the Risk Assessment

Each planning partner describes where or how their risk varies from what is described in the hazard profiles. Variations are documented in the risk assessment section in their annex to the plan, if appropriate.

Endnotes

[1] 44 Code of Federal Regulations § 201.6(c)(2). Local Mitigation Plans.

[2] FEMA. 2016. Disaster Declarations by State/Tribal Government. Data obtained online: https://www.fema.gov/disasters/grid/state-tribal-government.

Hazard Type
EARTHQUAKE
Probability of Occurrence
HIGH
Vulnerability
HIGH
Risk
HIGH

Chapter 4.1
Earthquake Hazard Profile

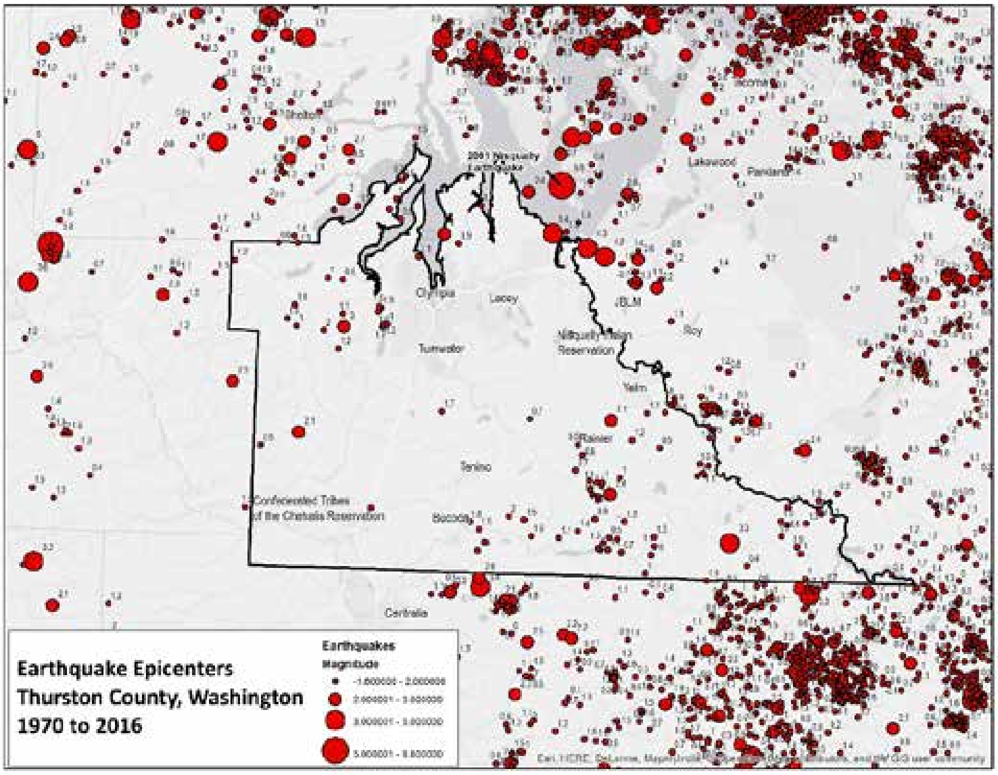
Introduction

Of all hazards that impact the Pacific Northwest, earthquakes cause the most widespread damage to transportation, communications, utilities, buildings, and business, and disrupt services across all sectors of society. Earthquakes are among the most feared natural hazard because they strike without warning and most of the population has little to no personal experience with them.

The July 20, 2015 Pulitzer Prize winning New Yorker article titled, "The Really Big One" described in detail the effects of the entire Cascadia Subduction Zone rupturing with a magnitude 9.0 earthquake and the ensuing tsunami. The article generated significant conversation and concern among Washington and Oregon residents about how such a destructive event would forever change the Pacific Northwest. The article successfully increased public awareness about the region's seismic hazards. However, much work remains to prepare people and communities for what most earth scientists consider a certain catastrophic event.

At least 20 damaging earthquakes have rattled Washington State in the last 125 years — most in Western Washington. Since 1970, over 5,300 earthquakes with epicenters within a 40-mile radius from central Thurston County have been detected.[1] Most of these events are simply captured as data points by seismographs and pass without notice. Ninety-three of these seismic events had epicenters in Thurston County, most less than magnitude 2.

Figure 4.1.1 Earthquake Epicenters in Thurston County



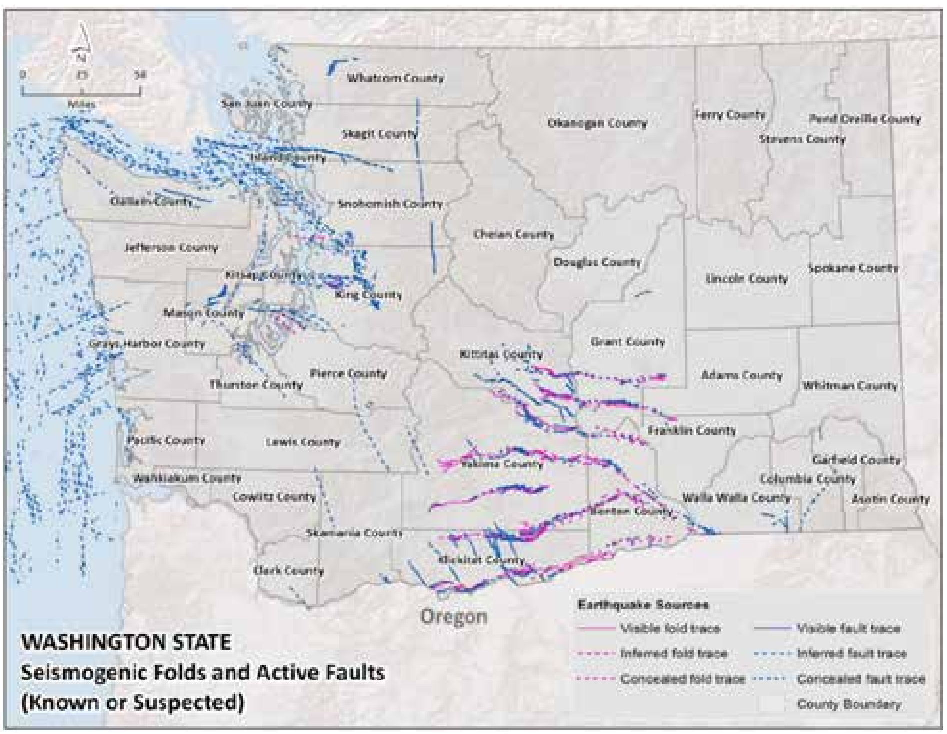
The 1949, 1965, and 2001 Nisqually earthquakes that shook Thurston County are a clear indication that seismic events similar to the Nisqually quake's magnitude or greater are likely to recur within a 25-year horizon – a high probability of occurrence. Each of these historic events caused significant widespread damage to the region. The Nisqually quake is a reminder of the region's vulnerability and as such, the Thurston Region has a high risk rating for earthquake hazards.

This earthquake hazard profile presents an overview of the source, effects, risks, and a summary of historical incidents. Three earthquake scenarios were modeled using a Geographical Information System (GIS) software tool, HAZUS, to evaluate potential losses within Thurston County. In addition, GIS hazard exposure data is shown for the incorporated and unincorporated portions of Thurston County, including local government essential facilities that are potentially at risk to the effects of liquefaction.

Hazard Identification

An earthquake is the result of elastic energy bound within a fault releasing, due to a sudden fracture and movement of rocks inside the Earth. A fault is a fracture in the Earth where the two sides have been displaced relative to each other. Most faults in Washington, such as the Seattle fault, are a combination of strike-slip fault and a thrust or reverse fault. When a fault ruptures, the seismic energy is dispersed in waves that move through the earth in all directions, and with sufficient magnitude will cause the ground to shake violently. This shaking motion and the subsequent behavior of the earth's surface – liquefaction, landslides, ruptures, or ground failure – causes the destruction of buildings and other infrastructure. Large earthquake can also produce secondary destructive effects including tsunamis, flooding, and fires.

Figure 4.1.2 Known and Suspected Faults in Washington State



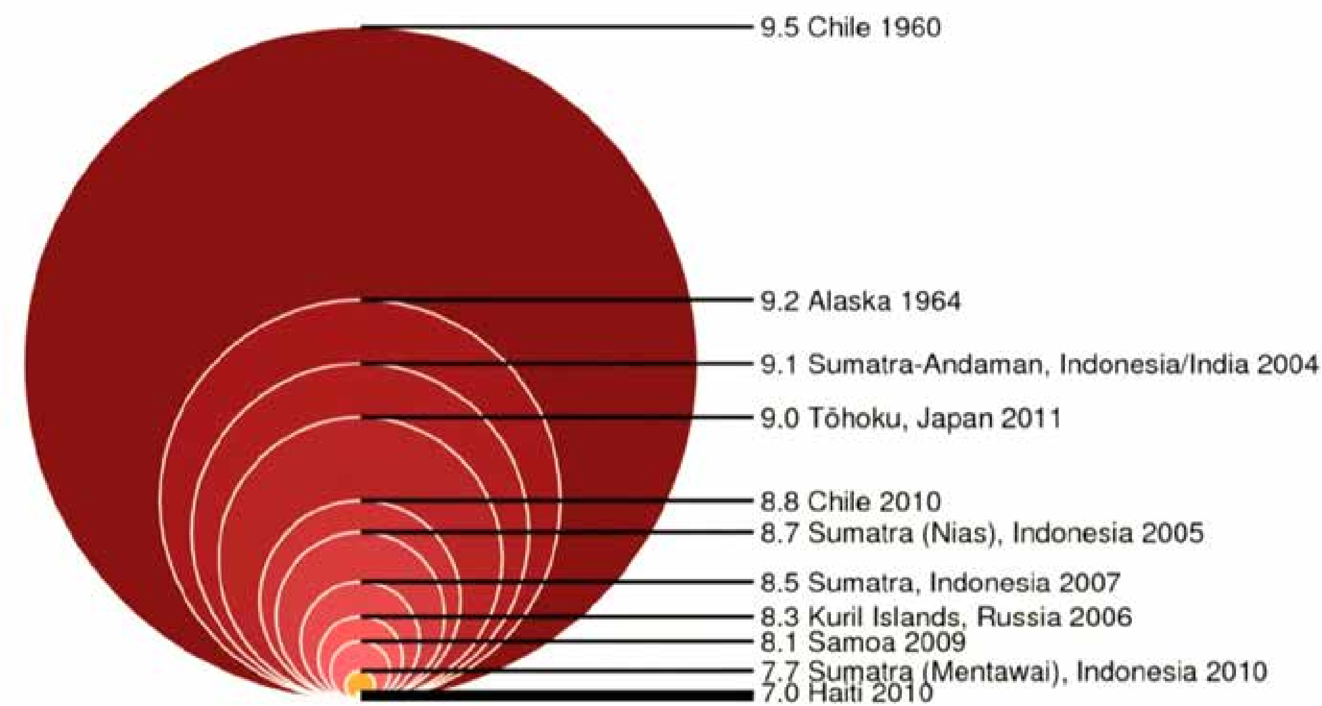
Numerous known and suspected faults or fault zones exist throughout the greater Puget Sound Basin. The Olympia fault runs from northwest to southeast across Thurston County.

Severity – Measuring the Size of an Earthquake

Magnitude

Several common measures are used to articulate earthquake strength. Magnitude (M) is a measurement of the total quantified energy released by an earthquake. "Moment magnitude" is calculated from the amount of movement on the fault causing the earthquake and the area of the fault surface that ruptures during the earthquake. It is a base-10 logarithmic scale, where each whole number increase in magnitude represents a ten-fold increase in measured amplitude, and about 32 times more 'elastic' energy released in the form of seismic waves than the magnitude that precedes it. For example, an M7 earthquake releases about 32 times more energy than a M6, while an M8 releases about 30 times more energy than an M7. A M9 earthquake thereby releases nearly 1,000 times more energy than a large M7 earthquake and nearly 33,000 times more energy than an M6 event. Figure 4.1.4 illustrates the scale of the magnitude of historic earthquakes.

Figure 4.1.4 Comparison of Recent and Historic Earthquakes by Energy Release (Magnitude)[2]



Peak Ground Acceleration

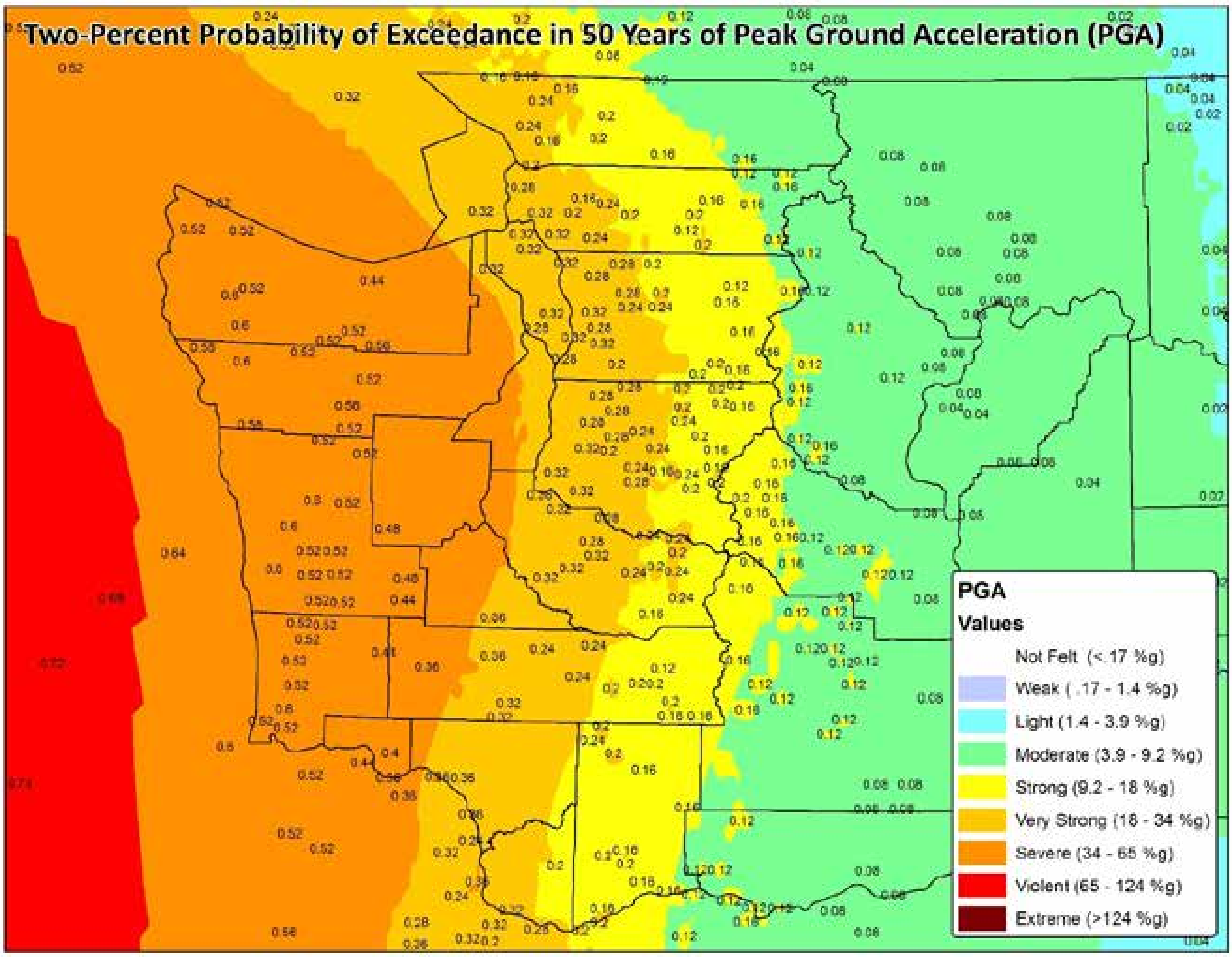
Peak ground acceleration (PGA) is equal to the maximum ground acceleration that occurred during earthquake shaking at a location. PGA is equal to the amplitude of the largest absolute acceleration recorded on an accelerogram at a site during a particular earthquake. Below is an excerpt from the *Washington State Enhanced Hazards Mitigation Plan* describing Peak Ground Acceleration.[3]

> PGA is a measure of the intensity of shaking, relative to the acceleration of gravity (g). For example, an acceleration of 1.0 g PGA is an extremely strong ground motion, which does occur near the epicenter of large earthquakes. With a vertical acceleration of 1.0 g, objects are thrown into the air. With a horizontal acceleration of 1.0 g, objects accelerate sideways at the same rate as if they had been dropped from the ceiling. 10% g PGA means that the ground acceleration is 10% that of gravity, and so on.
>
> Damage levels experienced in an earthquake vary with the intensity of ground shaking and with the seismic capacity of structures. The following generalized observations provide qualitative statements about the likely extent of damages for earthquakes with various levels of ground shaking (PGA) at a given site:

- Ground motions of only 1% g or 2% g are widely felt by people; hanging plants and lamps swing strongly, but damage levels, if any, are usually very low.
- Ground motions below about 10% g usually cause only slight damage.
- Ground motions between about 10% g and 30% g may cause minor to moderate damage in well-designed buildings, with higher levels of damage in more vulnerable buildings. At this level of ground shaking, some poorly built buildings may be subject to collapse.
- Ground motions above about 30% g may cause significant damage in well-designed buildings and very high levels of damage (including collapse) in poorly designed buildings.
- Ground motions above about 50% g may cause significant damage in most buildings, even those designed to resist seismic forces.

The United States Geological Survey's National Seismic Hazard Maps program produces data and maps derived from seismic hazard curves calculated on a grid of sites across the United States that describe the annual frequency of exceeding a set of ground motions. The figure below depicts probabilistic ground motions with a two percent probability of exceedance in 50 years for Washington State.

Figure 4.1.5 Two Percent Probability of Exceedance in 50 Years Map of Peak Ground Acceleration[4]



Modified Mercalli Intensity

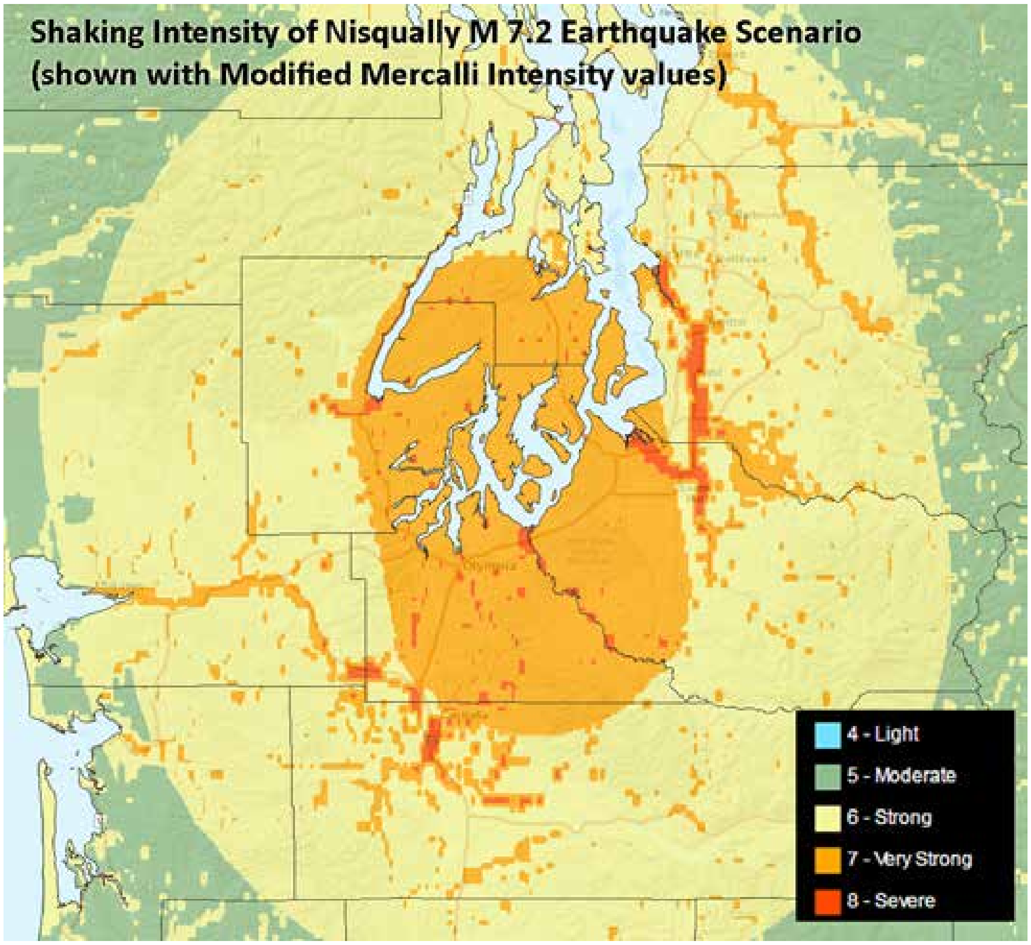
The Modified Mercalli Intensity (MMI) Scale measures the earthquake intensity by the damage it causes. Peak ground acceleration (PGA) is a measure of the strength of ground movements. It expresses an earthquake's severity by comparing its acceleration to the normal acceleration due to gravity. The MMI value assigned to a specific site after an earthquake has a more meaningful measure of severity to the nonscientist than the magnitude because intensity refers to the effects actually experienced at that place. The lower numbers of the intensity scale generally deal with how people feel the earthquake. The higher numbers of the scale are based on observed structural damage. Structural engineers usually contribute information for assigning intensity values of VIII or above.

The intensity of an earthquake is also dependent upon the magnitude, the epicenter, the depth, and the soil or rock conditions at the site. The intensity of ground shaking increases with the amount of energy released and decreases with distance from the causative fault or epicenter.

The following is an abbreviated description of the levels of Modified Mercalli intensity.

Intensity	**Shaking**	**Description/Damage**
I	Not felt	Not felt except by a very few under especially favorable conditions.
II	Weak	Felt only by a few persons at rest, especially on upper floors of buildings.
III	Weak	Felt quite noticeably by persons indoors, especially on upper floors of buildings. Many people do not recognize it as an earthquake. Standing motor cars may rock slightly. Vibrations similar to the passing of a truck. Duration estimated.
IV	Light	Felt indoors by many, outdoors by few during the day. At night, some awakened. Dishes, windows, doors disturbed; walls make cracking sound. Sensation like heavy truck striking building. Standing motor cars rocked noticeably.
V	Moderate	Felt by nearly everyone; many awakened. Some dishes, windows broken. Unstable objects overturned. Pendulum clocks may stop.
VI	Strong	Felt by all, many frightened. Some heavy furniture moved; a few instances of fallen plaster. Damage slight.
VII	Very strong	Damage negligible in buildings of good design and construction; slight to moderate in well-built ordinary structures; considerable damage in poorly built or badly designed structures; some chimneys broken.
VIII	Severe	Damage slight in specially designed structures; considerable damage in ordinary substantial buildings with partial collapse. Damage great in poorly built structures. Fall of chimneys, factory stacks, columns, monuments, walls. Heavy furniture overturned.
IX	Violent	Damage considerable in specially designed structures; well-designed frame structures thrown out of plumb. Damage great in substantial buildings, with partial collapse. Buildings shifted off foundations.
X	Extreme	Some well-built wooden structures destroyed; most masonry and frame structures destroyed with foundations. Rails bent.

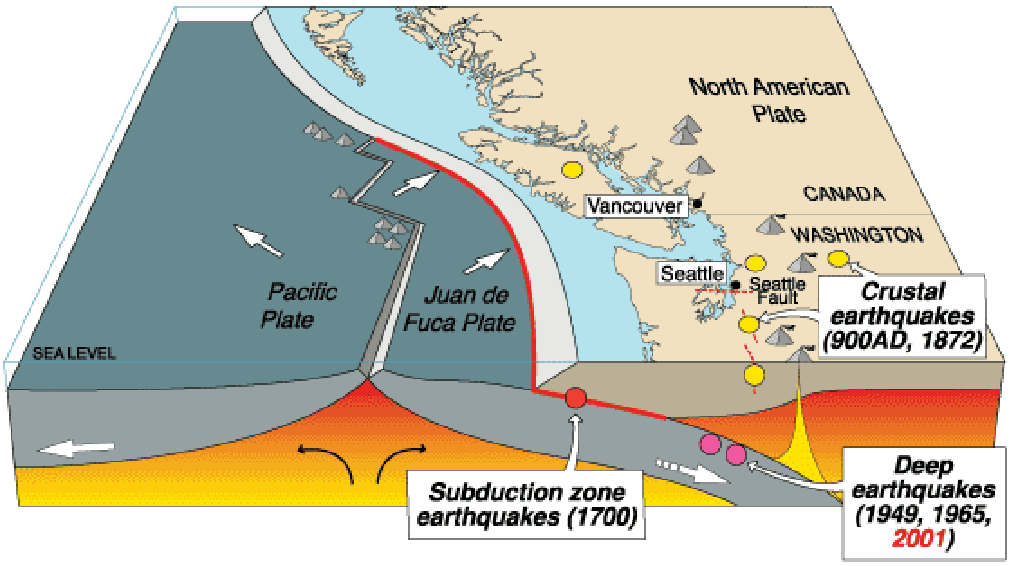
Figure 4.1.3 Nisqually M7.2 Scenario Earthquake Intensity Shown with Modified Mercalli Intensity Values[5]



Sources of Earthquakes Affecting Thurston County

Earthquakes predominantly occur due to the processes of plate tectonics and the Pacific Northwest is one of the most geologically active regions in North America. Seismologists categorize northwest earthquakes into three different source zones (Figure 4.1.1). The three source zones capable of causing major destruction are the Cascadia Megathrust (interplate), Deep Intraplate, and Crustal Faulting zones. The Thurston County region is vulnerable to earthquakes from all three zones. A fourth type, volcanic earthquakes, are generally smaller events and are in remote areas and therefore have less potential to cause damage directly to metropolitan communities.

Figure 4.1.4 Cascadia Earthquake Sources with Maximum Magnitudes and Recurrence Intervals[6]



	Source	Affected area	Max. Size	Recurrence
● (red)	Subduction Zone	W.WA, OR, CA	M 9	500-600 yr
● (pink)	Deep Juan de Fuca plate	W.WA, OR,	M 7+	30-50 yr
● (yellow)	Crustal faults	WA, OR, CA	M 7+	Hundreds of yr?

Cascadia Megathrust or Subduction Zone

Most of the world's most damaging earthquakes take place near the ocean boundary between two or more plates, known as interplate earthquakes. Washington State is located on a convergent continental margin, the boundary between three tectonic plates known as the Cascadia Subduction Zone. Located offshore, it stretches nearly 1,000 kilometers from northern California to Vancouver Island, British Columbia. The younger Juan de Fuca Plate is spreading away from the Pacific Plate and plunging beneath the continental North American Plate. The strain between these plates has slowly built up energy over the last several hundred years, but the plates are locked by friction. When the fault's frictional strength is exceeded and the rocks slip past each other, a megathrust earthquake will occur. When this pressure eventually releases, it will result in "the big one," an earthquake that is estimated to be between a magnitude 8.0 and 9.2. The edge of the North American Plate will lurch suddenly upward and southwest and the oceanic plates will slip under and northeast. The western edge of the North American Plate is expected to flex, causing the coastline to subside or drop as much as 2 meters in elevation. An earthquake of this strength will result in violent ground shaking that can travel hundreds of miles and last for four to six minutes. Subduction zone earthquakes are the largest, most destructive earthquakes on Earth as recently experienced in 2011 in Tohoku, Japan, the 2004 Sumatra-Andaman earthquakes, the 2001 southern Peru earthquake, the 1965 Alaska earthquake, and the 1960 Great Chilean earthquake.

Subduction zone earthquakes also produce the largest tsunamis in the world and will reach coastal communities within 15 to 20 minutes following the ground shaking. Recent tsunami events in the Indian Ocean and Japan leave no doubt of their destructive force on coastal communities and beyond. While Thurston County's shoreline is not in a tsunami inundation zone, the indirect effects of a major tsunami's impact on our coastal neighbors to the west will be significant in terms of displaced populations, strains on local emergency services, and economic losses.

The last subduction zone earthquake in the Pacific Northwest is believed to have occurred in January 1700. Seismologists estimate that such earthquakes have occurred at least seven times in the last 3,500 years with a recurrence interval of 300 to 600 years. The next megathrust earthquake could strike the Pacific Northwest at any time or still be hundreds of years away. Over the next 50 years, scientists believe there is a 37 percent chance of a magnitude 8 to 9 earthquake striking somewhere along the Cascadia Subduction Zone.

Megathrust earthquakes are followed by strong, persistent, and frequent aftershocks in the following weeks, months, and years. Aftershocks gradually diminish, but not without causing additional damage, death, injuries, and seeding deep anxiety in the populations in the earthquake-rattled region. Earthquakes of such magnitude can drastically alter tens of thousands of points of stress along the plates of a subduction zone, completely modifying the frictional stability of the faults and making them susceptible to ruptures. A megathrust quake can also disrupt both deep intraplate and shallow crustal faults inland. The Olympia Structure, a theoretical fault that transverses Thurston County, is one such shallow crustal fault that could be triggered by a megathrust quake.

As of March 2013, two years after the Tohoku earthquake, Japan experienced more than 9,500 aftershocks. While most originated off shore, many registered in the upper and lower range of magnitude 6, strong enough to shake buildings and trigger landslides. The persistent aftershocks forced more than 250,000 people from their homes. Estimates assume that it will take several more years before the frequency of earthquakes returns to pre-disaster levels. In April 2016, a magnitude 7.3 aftershock killed over 40 people and injured more than 1,000 in the city of Kumamoto.[7] In the event of a megathrust earthquake, aftershocks will likely strike the Pacific Northwest with similar frequency and strength. A megathrust earthquake is only the beginning of a series of frequent and strong aftershocks that will alter people and communities in the Cascadia Region for years.

Deep Intraplate Earthquakes

The Pacific Northwest Seismic Network states that Deep Intraplate earthquakes are the most common source of damaging earthquakes in Washington and Oregon. They occur along faults in the subducting portions of the Juan de Fuca plate, originating beneath the North American plate. Earthquakes from this zone are common in the greater Puget Sound Basin. They emanate from depths of 30 to 50 miles and can reach a strength as high as magnitude 7.5. Because they rupture at such great depth, their seismic energy is distributed over a large area, but the intensity is less than a shallow quake of the same strength. Ground shaking generally lasts less than a minute. Aftershocks from these events are not typical. While tsunamis are not expected, earthquake-induced landslides into the Puget Sound may produce a local tsunami. Due to their proximity to larger urban communities in Western Washington, deep earthquakes can cause significant damage.

Historically, earthquakes have originated from this zone about every 30 years. The 1949 Olympia (M6.8), 1965 Seattle (M6.5), and 2001 Nisqually (6.8) earthquakes were all Deep Intraplate events (see Figure 4.1.1). The 2001 Nisqually earthquake's focus was located about 32 miles deep below its epicenter in the Nisqually River Delta. The United States Geological Survey (USGS) estimates there is an 84 percent chance of another deep earthquake, of Magnitude 6.5 or greater, occurring within the Puget Sound Region sometime in the next 50 years.

Crustal Faulting or Shallow Earthquakes

Crustal (shallow) earthquakes occur along faults close to the surface of the North American plate. They are produced in the upper 18 miles of the Earth's crust, though most occur much closer to the surface. Most earthquakes in the Pacific Northwest originate from the Crustal Faulting zone. They could potentially reach magnitudes as high as 7.5, though most are less than 3.0. Scientists are locating and studying active faults within the Puget Sound lowlands (see Figure 4.1.2). The Seattle fault is perhaps the most infamous, as it lies under the most densely populated area of the state.

Evidence suggests that an Olympia fault structure may exist across the north end of Thurston County.[8] A strong earthquake is estimated to have occurred nearly 1,100 years ago, which resulted in rapid one to three-meter subsidence in lowland forests near present day McAllister Creek, the Nisqually River, and at Little Skookum Inlet. A magnitude 6.0 or greater earthquake originating from a surface fault could render incredible destruction (see Estimated Earthquake Losses and Impacts below). More research is necessary to verify the existence of the Olympia fault structure and its probability of rupturing.[9]

Ground shaking from earthquakes on shallow faults typically last from 20 to 60 seconds and is localized to the source. Washington State Department of Natural Resources states that tsunamis in the Puget Sound are possible from these earthquake events.

Effects of Earthquakes

Ground Motion

When a fault ruptures, seismic waves radiate, causing the ground to vibrate. This wave movement causes the ground to shake during an earthquake. The intensity of ground shaking depends on a community's proximity to the source of the event; the closer to the rupture, the greater the ground shaking. The effects of ground shaking produce ground failures. The structure of the underlying earth also affects intensity. Shaking is strongest in areas of soft soils, such as in river valleys or along the shorelines of bays and lakes. Seismic wave velocity is slower in soils than in the underlying rock of the earth's crust. Softer soils amplify ground shaking. The greater the wave velocity difference, the greater the amplification of ground surface shaking. Consequently, ground shaking in areas of soft soils underlain by stiffer soils or rock is generally stronger than in areas where there is little or no variation between the surface and lower layer.[10] Observations of past earthquakes verify this phenomenon as evidenced by damage to buildings and infrastructure in downtown Olympia and Seattle in areas built on fill. Strong ground shaking can damage or destroy buildings, bridges, roads, telecommunications, water treatment systems, and other infrastructure.

Ground Failures

Earthquakes can cause surface faulting, landslides, subsidence, and uplifting. 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. Surface faulting was evident in the damage that occurred along Deschutes Parkway and around Capitol Lake recreational trails near Interstate 5 from the 2001 Nisqually Earthquake. Subsidence is the

sinking of earth and uplifting is the elevation of earth. Unstable and unconsolidated soils are most vulnerable to ground failures and surface faulting.

Liquefaction

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 a structure liquefies. This can cause structures to tip and topple. Liquefaction typically occurs in artificial fills and in areas of loose sandy soils that are saturated with water, such as low-lying coastal areas, lakeshores, and river valleys. Map 4.1.1 shows areas susceptible to liquefaction.

Tsunamis

Tsunamis are large ocean waves generated by sudden changes in the sea floor elevation which displace a significant volume of water. Tsunamis can be caused by subduction zone earthquakes, and surface and submarine landslides. Subduction zone earthquakes can generate Tsunamis tens to thousands of kilometers in length and 10 to 45 meters tall. They can travel up to 500 miles per hour across the ocean and can threaten shorelines around the entire Pacific Rim. Tsunamis behave more like a fast advancing wall of water than a typical breaking wave and inundation can last for several hours from multiple wave sets. Low lying areas, coastal rivers, and bays will be subject to greater inundation. The tidal condition and the level of subsidence the coastline experiences from the earthquake will also influence the extent of inundation.

On December 26, 2004, a 9.2 magnitude earthquake occurred near the west coast of Sumatra. The epicenter was located along a tectonic subduction zone where the India Plate, an oceanic plate, and the Burma micro-plate, part of the larger Sunda plate, collide. This event triggered the worst tsunami ever recorded in terms of lives lost. It ravaged coasts with waves as high as 20 to 30 meters and killed 230,000 people around the Indian Ocean. The 2011 Tohoku, Japan earthquake generated a massive Tsunami that killed nearly 20,000 people. It also toppled seawalls, destroying the diesel backup power systems at the Fukushima Nuclear Power Plant and leading to severe radioactive leakage. Coastal debris from the Tsunami event traveled across the Pacific to Washington's coastal shoreline.

Thurston County is not within a tsunami hazard area for a Cascadia Subduction Zone earthquake or remote Pacific Ocean generated tsunami. The wave energy will be significantly diminished by the time it reaches south Puget Sound waters here. A major landslide on a marine bluff into the Puget Sound generated by an earthquake could trigger a local tsunami, but such a scenario has not been modeled and the risks are considered very low.[11] Thurston County will likely be indirectly affected by tsunami impacts to Washington's Pacific coastal communities. Olympia, Lacey, and Tumwater form the nearest metropolitan area to Washington's central coastal communities. Thurston County may play a major role with emergency management activities when such an event occurs. Local emergency service personnel including fire fighters, paramedics, law enforcement, emergency managers, and public works personnel could be involved in rescue, recovery, and relief efforts directed at coastal communities.

Impacts

The impact from earthquakes to communities is well evidenced by recent catastrophic events around the world: San Francisco, Los Angeles, Japan, China, Pakistan, Haiti, Nepal, Indonesia, Turkey, and many more. Failed buildings, bridges, and other structures can trap or bury people causing injury and mass casualties. Damage to infrastructure such as roads, bridges, rail lines, runways, and almost all types of utilities is certain. Infrastructural failures can result in loss of public and private sector services and business. Communities are likely to face communication, electricity, motor fuel, natural gas, water, food, and general merchandise supply disruptions. Structural fires are a common secondary hazard from earthquake destruction. Individuals and households may be displaced due to damaged homes. A subsequent economic downturn would likely result from major transportation disruptions and loss of revenue from suspended business and services.

In the Puget Sound Region, older unreinforced masonry structures such as buildings, walls, chimneys, and facades are vulnerable to crumbling from ground shaking. Areas with soft soils, such as downtown Olympia and adjacent neighborhoods have experienced this type of destruction during the 1949, 1965, and 2001 earthquakes.

Fire fighters, police, public works, and other safety and emergency personnel can quickly become over extended with response and recovery operations. Transportation disruptions will hinder emergency response to remote or hard-to-reach areas. Building and structural inspections will become priorities for public works and development services personnel and disrupt other operations.

Estimates of Earthquake Scenario Losses

Computer models can simulate earthquakes of varying sources, location, and strength to estimate potential losses for communities. HAZUS is a standardized tool that uses Geographical Information System (GIS) technology to estimate physical, economic, and social impacts of disasters using a variety of data inputs. The Thurston County region did not have access to HAZUS earthquake models until 2014. The Federal Emergency Management Agency (FEMA) Region X used local data provided by Thurston County and TRPC to develop the county's three earthquake HAZUS models:

1. Cascadia Subduction Zone 9.0 (Cascadia Megathrust Earthquake)
2. Nisqually 7.2 (Deep Intraplate Earthquake)
3. Olympia Structure 6.8 (Shallow or Crustal Faulting Earthquake)

For these scenarios, the models calculated debris generation, transportation impacts, building damage, casualties, and sheltering requirements.

Debris Generation

HAZUS provides a planning-level estimate of the total debris generated by earthquake damage by weight and type of material. The Olympia Structure magnitude 6.8 earthquake scenario would generate the most debris from damage to structures due to proximity of the epicenter to the Thurston County's most developed communities.

Estimated Total Debris Generation by Earthquake Scenario

Scenario	Tons	Brick/Wood	Reinforced Concrete	25-ton truckloads
Nisqually 7.2	130,000	50%	50%	5,040
Olympia 6.8	790,000	34%	86%	31,440
Cascadia 9.0	360,000	40%	60%	14,480

Transportation Impacts

For the transportation systems, HAZUS uses national data to compute the direct repair cost for each transportation component only. HAZUS does not computes losses for business interruption due to transportation lifeline outages. These tables provide a detailed breakdown in the expected lifeline losses. The Olympia Structure magnitude 6.8 earthquake scenario causes the most damage to the transportation system.

Estimated Transportation System Economic Losses (Millions of Dollars)

			Nisqually 7.2		Olympia 6.8		Cascadia 9.0	
System	Component	Inventory Value	Economic Loss	Loss Ratio (%)	Economic Loss	Loss Ratio (%)	Economic Loss	Loss Ratio (%)
Highway	Segments	$1,786.14	$20.01	1.1	$48.37	2.7	$46.94	2.6
	Bridges	$2,124.95	$98.93	4.7	$280.82	13.2	$162.64	7.7
	Tunnels	$0.00	$0.00	0.0	$0.00	0.0	$0.00	0.0
	Subtotal	**$3,911.10**	**$118.90**	**3.0**	**$329.20**	**8.4**	**209.60**	**5.0**
Railways	Segments	$129.79	$0.64	0.5	$2.30	1.8	$2.68	2.1
	Bridges	$1.79	$0.07	3.8	$0.13	7.1	$0.10	5.4
	Tunnels	$0.00	$0.00	0.0	$0.00	0.0	$0.00	0.0
	Facilities	$2.66	$0.56	20.9	$1.51	56.6	$0.64	24.1
	Subtotal	**$134.20**	**$1.30**	**1.0**	**$3.90**	**3.0**	**3.40**	**3.0**
Bus	Facilities	$1.20	$0.25	20.9	$0.65	53.9	$0.29	24.1
	Subtotal	**$1.20**	**$0.30**	**25.0**	**$0.60**	**50.0**	**0.30**	**25.0**
Port	Facilities	$7.99	$1.64	20.6	$4.60	57.6	$2.27	28.4
	Subtotal	**$8.00**	**$1.60**	**20.0**	**$4.60**	**58.0**	**2.30**	**29.0**
Airport	Facilities	$21.30	$4.42	20.8	$7.39	34.7	$4.56	21.4
	Runways	$113.89	$0.21	0.2	$3.62	3.2	$1.45	1.3
	Subtotal	**$135.20**	**$4.60**	**3.4**	**$11.00**	**8.1**	**6.00**	**4.4**
	Total	$4,189.70	$126.70	3%	$349.40	8.30%	221.60	5.30%

Building Damage

HAZUS calculates damage estimates to structures by sector. Total valuation, damage estimates, and the loss ratio are estimated for each scenario shown below. The Olympia Structure 6.8 magnitude earthquake scenario is estimated to result in nearly twice the economic losses to facilities than a Cascadia 9.0 earthquake.

Estimated Economic Loss to Buildings by Sector

			Nisqually 7.2		Olympia 6.8		Cascadia 9.0	
Facilities	Number	Valuation	Loss	Loss Ratio	Loss	Loss Ratio	Loss	Loss Ratio
Agriculture	856	$118,337,100	$10,504,033	8.9%	$16,139,766	13.6%	$14,312,861	12.1%
Banks	75	$105,702,100	$27,273,280	25.8%	$66,356,699	62.8%	$35,697,734	33.8%
Church/Membership Organization	176	$173,389,700	$19,517,251	11.3%	$61,848,880	35.7%	$33,456,163	19.3%
Colleges/Universities	2	$10,460,800	$889,426	8.5%	$1,577,051	15.1%	$2,252,748	21.5%
Emergency Response	60	$38,204,000	$6,911,212	18.1%	$17,401,487	45.5%	$11,268,759	29.5%
Entertainment and Recreation	1235	$439,011,400	$48,588,160	11.1%	$130,028,410	29.6%	$76,864,732	17.5%
General Services	271	$2,416,579,000	$700,530,562	29.0%	$1,856,899,676	76.8%	$989,730,735	41.0%
Heavy Industrial	35	$44,689,800	$7,656,283	17.1%	$20,313,411	45.5%	$13,459,867	30.1%
Hospital	209	$406,998,200	$93,245,250	22.9%	$272,702,622	67.0%	$148,357,953	36.5%
Institutional Dormitory	8	$29,017,800	$6,390,846	22.0%	$17,710,849	61.0%	$9,339,234	32.2%
Light Industrial	173	$64,418,600	$10,932,451	17.0%	$22,913,696	35.6%	$19,230,822	29.9%
Mobile Home	6302	$288,894,550	$56,735,817	19.6%	$89,858,128	31.1%	$101,606,785	35.2%
Multi Family Dwelling	3800	$1,683,577,100	$150,048,549	8.9%	$534,456,522	31.7%	$249,196,963	14.8%
Nursing Home	27	$160,219,000	$12,902,086	8.1%	$36,197,014	22.6%	$18,072,236	11.3%
Parking	11	$35,229,700	$9,676,426	27.5%	$23,779,160	67.5%	$12,828,629	36.4%
Personal and Repair Services	317	$244,752,900	$41,772,362	17.1%	$89,896,712	36.7%	$69,339,218	28.3%
Professional/Technical/ Business Services	1121	$1,373,684,400	$327,428,968	23.8%	$793,362,654	57.8%	$465,962,441	33.9%
Retail Trade	896	$861,830,100	$150,856,788	17.5%	$448,609,426	52.1%	$273,696,128	31.8%
Schools/Libraries	99	$1,335,346,300	$89,250,985	6.7%	$348,901,362	26.1%	$154,780,310	11.6%
Single Family Dwelling	73955	$10,466,466,450	$669,516,557	6.4%	$1,761,014,868	16.8%	$951,913,860	9.1%
Temporary Lodging	30	$79,840,400	$11,793,434	14.8%	$33,710,255	42.2%	$18,763,022	23.5%
Theaters	4	$7,442,700	$1,691,196	22.7%	$4,613,787	62.0%	$2,400,801	32.3%
Wholesale Trade	696	$602,522,600	$116,013,369	19.3%	$242,680,333	40.3%	$191,576,645	31.8%
Grand Total	**90358**	**$20,986,614,700**	**$2,570,125,292**	**12.2%**	**$6,890,972,770**	**32.8%**	**$3,864,108,645**	**18.4%**

Casualties

HAZUS estimates casualties in four categories of severity based on three different times of day an earthquake event could occur. The Olympia Structure magnitude 6.8 earthquake scenario could result in nearly 200 deaths, if the earthquake were to occur mid-day. An early pre-dawn earthquake would result in the fewest casualties as most people would be home asleep. The categories of severity are as follows:

- Severity Level 1 Injuries will require medical attention but hospitalization is not needed.
- Severity Level 2 Injuries will require hospitalization but are not considered life-threatening.
- Severity Level 3 Injuries will require hospitalization and can become life threatening if not promptly treated.
- Severity Level 4 Victims are killed by the earthquake.

Casualty Estimates by Earthquake Scenario by Time of Day

Scenario	Time	Level 1	Level 2	Level 3	Level 4
Nisqually 7.2	2 a.m.	78	7	0	1
	2 p.m.	191	27	3	4
	5 p.m.	117	28	20	6
Olympia 6.8	2 a.m.	443	85	9	16
	2 p.m.	2,179	625	105	199
	5 p.m.	1,191	375	147	115
Cascadia 9.0	2 a.m.	208	31	2	4
	2 p.m.	654	140	20	36
	5 p.m.	380	102	50	26

Shelter Requirements

HAZUS estimates the number of displaced households and people requiring temporary shelter.

Estimates of Displaced Households and People Needing Shelter

Scenario	Displaced Households	People Needing Shelter
Nisqually 7.2	347	184
Olympia 6.8	3,236	1,747
Cascadia 9.0	1,366	737

Earthquake Historical Occurrences and Impacts

February 28, 2001, Federal Disaster 1361: Nisqually Earthquake

At 10:54 a.m., a magnitude 6.8 earthquake produced strong ground shaking across Washington State. The epicenter was located near Anderson Island, approximately 10 miles north of Olympia near the Nisqually River Delta. The focus was located nearly 32 miles underground. The depth of the earthquake minimized the intensity of the shaking and softened the impact to surrounding communities. 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 such a magnitude with saturated soils. Nevertheless, the observations of geotechnical engineers indicate that liquefaction was widespread in parts of Olympia and South Seattle. Several significant lateral spreads, embankment slides, and landslides also occurred. The relatively long duration of the event and the relatively low cyclic resistances of some of the fills in the area likely caused the ensuing significant liquefaction and ground failure.

Thurston County was among the hardest hit counties in Washington. A federal disaster declaration was issued only one day after the event. Statewide, the Nisqually earthquake resulted in several hundred injuries (nearly a dozen considered 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 any previous disaster in Washington.

One year after the earthquake, news sources 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 estimates that the earthquake caused $1.5 billion 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 to $4 billion.

Building damage varied throughout the region. For example, the quake hit Downtown Olympia historic structures and Seattle's historic Pioneer Square areas hard. Unreinforced brick masonry buildings lacking braced parapets and wall anchors were particularly vulnerable, resulting in numerous collapses. In many cases, fallen brick caused damage to objects, such as cars and canopies, outside the building. This type of damage mirrored that of the 1949 Olympia earthquake.

Most buildings performed well from a life-safety standpoint, in that the limited structural damage 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 unincorporated Thurston County, 120 buildings were inspected, two buildings red-tagged, and six buildings yellow-tagged. In Olympia, 27 buildings were closed immediately following the earthquake.

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

Damage to residences came in a variety of forms, from severe mudslide destruction of entire houses to breakage of replaceable personal property. FEMA records indicate that one-third of the 30,000 homes they inspected sustained chimney damage – the most common type of 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 that neighborhood 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. A gas line rupture during the earthquake resulted in the evacuation of residents of 50 mobile homes at the Tumwater location. Part of a private 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, including the region's largest airport – Seattle-Tacoma International Airport. While the area's overall road network remained functional, damage occurred to numerous parts of highways, roads, and bridges. 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 and the city's west side. Replacing the bridge and connecting infrastructure cost $39 million; the largest public works endeavor in the city's history.

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, creating huge voids beneath portions of the concrete road surface. Sections of road and sidewalk also buckled from the force of the quake. This road, a vital link between downtown Olympia, the city's west side, and Tumwater, 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 Stay America hotel on Mottman Road was caused by the earthquake.

Except for transportation, lifeline systems generally performed well during the earthquake. Lifeline systems include water, wastewater, electrical power, communications, natural gas and liquid fuels, and transportation systems. In most cases, the impact of lifeline damage was 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.

April 29, 1965, Federal Disaster 196: Seattle Tacoma Earthquake

A magnitude 6.5 earthquake struck the Puget Sound Region at 7:28 a.m. The epicenter was located about 12 miles north of Tacoma at a depth of about 40 miles. This quake killed seven people and damage was estimated to be $12.5 million (1965 dollars); with much of the loss in King County. The Union Pacific Railroad reported a hillside fill slid away from beneath a 400-foot section of a branch line just outside of Olympia. Damage to the Capitol Building – including a crack about 3 feet long on the inside of the inner dome of the rotunda – forced adjournment of the legislative session. The 5-ton chandelier swung like a pendulum clock on its 110-foot chain in a 1-foot orbit for half an hour after the shock. Governor Dan Evans closed the Capitol Campus and halted state government operations except for key personnel and critical services. In the Temple of Justice, cracks developed in the walls of the law library; a cabinet tipped over; books scattered around the floors; and pictures fell from walls. The new post office was damaged considerably and ordered closed. A road around Capitol Lake, at the base of the Capitol complex, was damaged, allowing water to flow beneath the road. St. Peter Hospital reported treating four people for minor injuries. Damage to light fixtures and elevator shafts in the Capitol Building was about $200,000; damage to the road and railroad was estimated at the same amount. Chimney and interior plaster damage occurred throughout Olympia, but the greatest damage occurred in the area between 15th Avenue and 20th Avenue and between Capitol Way and Cherry Street.[12]

April 13, 1949, Olympia Earthquake

A magnitude 6.8 (downgraded from 7.1) earthquake rattled the region at 11:55 a.m. The epicenter was located about eight miles north-northeast of Olympia. Property damage for the Puget Sound Region likely exceeded $25 million (1949 dollars). Eight state government buildings in Olympia were damaged at a loss of two million dollars. Two people died. The quake damaged nearly all large buildings in Olympia – with cracked or fallen walls and plaster. Two large smokestacks and many chimneys fell. Streets were damaged extensively. Water and gas mains broke. A large portion of a sandy spit jutting into Puget Sound north of the city disappeared completely during the earthquake.[13]

Liquefaction Hazard Exposure Analysis

Delineation of the Liquefaction Hazard Area

The entire Thurston County Region will be affected by a catastrophic earthquake, but the amount of damage to infrastructure and property will be dependent upon the source and type of earthquake, soil and rock conditions, and the age and type of construction for buildings and other structures.

In 2003, the hazard mitigation planning workgroup used the location of damage from the 2001 Nisqually earthquake as a factor to determine which risk levels to employ to define the earthquake hazard area. Areas most damaged reflected liquefaction susceptibility levels, as ground shaking is amplified in loose unconsolidated soils deposited by fill or by natural processes. During both the 2009 plan update and this edition, the workgroup determined that the liquefaction hazard risk map remains a useful tool for highlighting areas prone to earthquake damage.

For the plan update, the liquefaction hazard includes the combined areas with a “Low to Moderate,” “Moderate to High,” or “High” liquefaction risk. Map 4.1.1 identifies earthquake liquefaction hazard areas. Tables 4.1.1 and 4.1.2 show the total acreage, by jurisdiction that is within the liquefaction risk areas described above. Countywide, 17.5 percent of the total land area falls within these three risk areas combined. However, only 1.4 percent of the total land area is mapped as a high risk.

Communities Most Vulnerable to Earthquakes

The following communities contain "High" liquefaction susceptibility levels and are at the greatest risk for liquefaction and other earthquake damage (reference Map 4.1.1):

1. The Town of Bucoda
    - While Bucoda does not have any areas characterized with a high risk rating, most of the town (63 percent) is rated with a moderate to high risk for liquefaction due to the prevalence of alluvial soil deposition
2. The City of Olympia
    - The entire Port Peninsula approximately north of State Avenue
    - The entire margin of the north basin of Capitol Lake from Marathon Park to Budd Inlet, including Deschutes Parkway, the isthmus between Capitol Lake and West Bay, and the 4th and 5th Avenue corridors
    - The filled portions of the western shore of West Bay including West Bay Park and the former Hardel Plywood property
    - The Henderson Boulevard/Moxlie Creek corridor from north of Watershed Park to East Bay
3. The City of Tumwater
    - The entire Deschutes River Valley from Henderson Boulevard SE to the former Olympia Brewery
    - Percival Creek vicinity from Trosper Road SW to Sapp Road SW
4. Thurston County
    - The north and west end of Young Cove on the Steamboat Island Peninsula near the Gravelly Beach Road NW and Gravelly Beach Loop NW intersections
    - Mud Bay at the southern end of Eld Inlet along Delphi Road to 40th Avenue SW (U.S. Highway 101 runs through this vicinity)
    - The Deschutes River valley from Henderson Boulevard SE to north of Offut Lake
    - The entire Nisqually River Delta, including the portion of Interstate 5 that runs through it
    - The neighborhoods immediately straddling Mullen Road north of Pattison Lake

Population and Employment in the Hazard Area

Based on 2015 population estimates, approximately 99,000 people or 37 percent of the county's population live in liquefaction hazard areas ranging from low-moderate to high risk. In 2040, the population in those areas could reach 143,200. Nearly 70,300 people (52.5 percent) work in an area characterized as at risk for liquefaction. Estimates of the region's population and employment in the earthquake hazard area are summarized in Tables 4.1.3 through 4.1.6. 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 and 2040 (2014 for employment values).

Residential Dwellings in the Hazard Area

Countywide, approximately 43,400 residential dwelling units (38 percent) are in liquefaction hazard areas characterized as low-moderate to high risk. That number could reach 64,300 by 2040. The majority are in areas characterized as low to moderate and moderate risk.

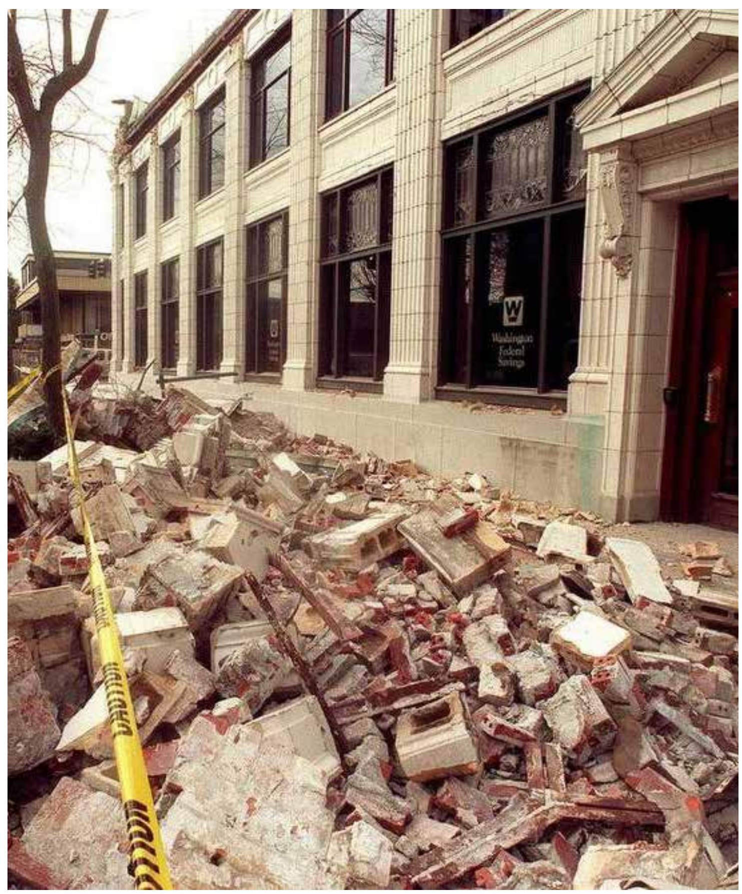
Inventory of Assets and Dollar Value in the Hazard Area

Estimates of the region's structures and their contents in the earthquake hazard area are summarized in Tables 4.1.9 and 4.1.10, which provide an estimate of the existing structures and contents which may be potentially affected by liquefaction. The estimated value of at risk residential property is $5.3 billion in 2014 dollars. Most of this valuation is located within the low to moderate and moderate risk areas. However, nearly 92 percent of the Town of Bucoda's residential valuation is at risk for moderate to high liquefaction. Nearly $1.5 billion in commercial/industrial and $2.1 billion in government/institutional building valuation is within liquefaction prone areas.

Essential Facilities and Infrastructure in Hazard Area

Earthquakes can destroy or damage facilities that may be critical for responding to the disaster and for maintaining a safe environment and public order. These include communications, electrical generation and transmission, natural gas transmission, water storage and purification and pumping facilities, sewage treatment, hospitals, and police and fire stations. In addition, earthquakes can seriously disrupt the transportation network. Bridges can be knocked out and roads and highways damaged or blocked by debris. A major earthquake may disrupt almost all means of surface transportation within a community, especially in the immediate aftermath of a disaster.

Specific information on the location of essential facilities and infrastructure is housed with the Emergency Management Council of Thurston County. Essential facilities include both public and private facilities. Table 4.1.11 lists the type and number of essential facilities located in the liquefaction hazard area.



Summary Assessment

History suggests a high probability of occurrence of a 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 stronger earthquakes are possible in Western Washington. A similar magnitude earthquake could emanate from a shallow crustal fault which would result in much greater damages, as modeled by the Olympia Structure Magnitude 6.8 earthquake scenario. Damage from the 1949, 1965, and 2001 earthquakes indicate that an earthquake of a greater magnitude would have significant adverse consequences to communities in Thurston County. Considering that a large population lives and works in higher risk earthquake hazard areas, the entire region has a high vulnerability rating. Accordingly, a high risk rating is assigned.

Summary Risk Assessment for Earthquakes in the Thurston Region

Probability of Occurrence	Vulnerability	Risk
High	High	High

Table 4.1.1: Liquefaction Hazard Area, by Jurisdiction

Jurisdiction		Total	Low to Moderate Risk		Moderate to High Risk		High Risk		Liquefaction Hazard	
		Acres	Acres	%	Acres	%	Acres	%	Acres	%
Bucoda	**Total**	**380**	**1**	**0.1%**	**237**	**62.5%**	**0**	**0.0%**	**238**	**62.7%**
Lacey	City	10,778	3,884	36.0%	0	0.0%	2	0.0%	3,886	36.1%
	UGA	10,416	2,832	27.2%	0	0.0%	38	0.4%	2,870	27.6%
	Total	**21,193**	**6,716**	**31.7%**	**0**	**0.0%**	**40**	**0.2%**	**6,756**	**31.9%**
Olympia	City	12,089	5,602	46.3%	0	0.0%	460	3.8%	6,062	50.1%
	UGA	3,887	2,378	61.2%	0	0.0%	87	2.2%	2,465	63.4%
	Total	**15,976**	**7,980**	**50.0%**	**0**	**0.0%**	**547**	**3.4%**	**8,528**	**53.4%**
Rainier	City	1,105	0	0.0%	0	0.0%	0	0.0%	0	0.0%
	UGA	320	0	0.0%	0	0.0%	0	0.0%	0	0.0%
	Total	**1,425**	**0**	**0.0%**	**0**	**0.0%**	**0**	**0.0%**	**0**	**0.0%**
Tenino	City	922	0	0.0%	56	6.1%	0	0.0%	56	6.1%
	UGA	65	0	0.0%	0	0.6%	0	0.0%	0	0.6%
	Total	**987**	**0**	**0.0%**	**57**	**5.8%**	**0**	**0.0%**	**57**	**5.8%**
Tumwater	City	11,354	7,829	69.0%	0	0.0%	876	7.7%	8,705	76.7%
	UGA	2,875	1,865	64.9%	0	0.0%	41	1.4%	1,906	66.3%
	Total	**14,229**	**9,694**	**68.1%**	**0**	**0.0%**	**917**	**6.4%**	**10,611**	**74.6%**
Yelm	City	3,634	0	0.0%	0	0.0%	0	0.0%	0	0.0%
	UGA	2,396	0	0.0%	0	0.0%	0	0.0%	0	0.0%
	Total	**6,030**	**0**	**0.0%**	**0**	**0.0%**	**0**	**0.0%**	**0**	**0.0%**
Grand Mound UGA	**Total**	**983**	**0**	**0.0%**	**74**	**7.5%**	**0**	**0.0%**	**74**	**7.5%**
Chehalis Res.[1]	**Total**	**833**	**0**	**0.0%**	**832**	**99.9%**	**0**	**0.0%**	**832**	**99.9%**
Nisqually Res.[1]	**Total**	**2,147**	**0**	**0.0%**	**311**	**14.5%**	**151**	**7.0%**	**462**	**21.5%**
Total Cities		**50,693**	**17,316**	**34.2%**	**294**	**0.6%**	**1,338**	**2.6%**	**18,948**	**37.4%**
Total UGAs[2]		**20,943**	**7,075**	**33.8%**	**74**	**0.4%**	**166**	**0.8%**	**7,315**	**34.9%**
Total Reservations[1]		**2,979**	**0**	**0.0%**	**1,143**	**38.4%**	**151**	**5.1%**	**1,294**	**43.4%**
Rural Uninc. County[3]		**406,934**	**23,950**	**5.9%**	**26,219**	**6.4%**	**4,793**	**1.2%**	**54,962**	**13.5%**
Thurston County Total		**471,117**	**48,341**	**10.3%**	**27,729**	**5.9%**	**6,449**	**1.4%**	**82,519**	**17.5%**

Explanations: Liquefaction Hazard includes areas with a "Low to Moderate," "Moderate to High" or "High" liquefaction risk.
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 4.1.2: Liquefaction Hazard Area, by Special Districts

Jurisdiction	Total Acres	Low to Moderate Risk Acres	Low to Moderate Risk %	Moderate to High Risk Acres	Moderate to High Risk %	High Risk Acres	High Risk %	Liquefaction Hazard Acres	Liquefaction Hazard %
Fire Protection Districts									
1,11 West Thurston RFA	100,131	6,976	7.0%	12,581	12.6%	25	0.0%	19,582	19.6%
2, 4 S.E. Thurston RFA	56,030	0	0.0%	2,364	4.2%	0	0.0%	2,364	4.2%
3 Lacey	36,820	12,422	33.7%	85	0.2%	3,216	8.7%	15,723	42.7%
5, 9 McLane-Black Lake	51,828	1,421	2.7%	282	0.5%	1,010	1.9%	2,713	5.2%
6 East Olympia	19,677	6,820	34.7%	1,232	6.3%	638	3.2%	8,690	44.2%
8 South Bay	20,974	5,060	24.1%	0	0.0%	122	0.6%	5,181	24.7%
12 Tenino	19,914	34	0.2%	2,894	14.5%	0	0.0%	2,928	14.7%
13 Griffin	14,864	7	0.0%	737	5.0%	88	0.6%	833	5.6%
16 Gibson Valley	18,038	1,230	6.8%	2,731	15.1%	0	0.0%	3,961	22.0%
17 Bald Hills	13,926	0	0.0%	1,822	13.1%	0	0.0%	1,822	13.1%
School Districts									
Centralia[1]	12,851	464	3.6%	2,334	18.2%	0	0.0%	2,798	21.8%
Griffin	21,355	6	0.0%	739	3.5%	94	0.4%	839	3.9%
North Thurston	47,081	13,937	29.6%	38	0.1%	3,368	7.2%	17,343	36.8%
Olympia	49,894	7,869	15.8%	218	0.4%	1,471	2.9%	9,557	19.2%
Rainier	35,550	367	1.0%	1,002	2.8%	0	0.0%	1,369	3.9%
Rochester[1]	55,061	514	0.9%	9,691	17.6%	0	0.0%	10,205	18.5%
Tenino	70,500	728	1.0%	6,133	8.7%	151	0.2%	7,012	9.9%
Tumwater	73,845	20,549	27.8%	2,805	3.8%	1,372	1.9%	24,727	33.5%
Yelm[1]	104,853	3,913	3.7%	4,678	4.5%	0	0.0%	8,591	8.2%
Other Districts									
Intercity Transit	64,390	24,129	37.5%	518	0.8%	3,004	4.7%	27,651	42.9%
LOTT Clean Water Alliance[2]	16,016	8,468	52.9%	0	0.0%	310	1.9%	8,779	54.8%
Port of Olympia	471,117	48,341	10.3%	27,729	5.9%	6,449	1.4%	82,519	17.5%
Thurston County PUD	471,117	48,341	10.3%	27,729	5.9%	6,449	1.4%	82,519	17.5%

Explanations: Liquefaction Hazard includes areas with a "Low to Moderate," "Moderate to High" or "High" liquefaction risk.
1. Data are for Thurston County portion of the district only.
2. Includes the sewered area.

Table 4.1.3: Liquefaction Hazard Area, Population by Jurisdiction, 2015 and 2040

Jurisdiction		2015 Population Estimate Total #	2015 In Hazard Area #	2015 In Hazard Area %	2040 Population Forecast Total #	2040 In Hazard Area #	2040 In Hazard Area %
Bucoda	**Total**	**565**	**515**	**91.2%**	**1,215**	**815**	**67.1%**
Lacey	City	46,230	25,140	54.4%	55,160	28,460	51.6%
	UGA	33,980	6,360	18.7%	59,030	15,620	26.5%
	Total	**80,210**	**31,500**	**39.3%**	**114,190**	**44,080**	**38.6%**
Olympia	City	51,020	25,840	50.6%	71,840	36,220	50.4%
	UGA	11,920	7,950	66.7%	16,770	11,430	68.2%
	Total	**62,940**	**33,790**	**53.7%**	**88,610**	**47,650**	**53.8%**
Rainier	City	1,880	0	0.0%	2,810	0	0.0%
	UGA	110	0	0.0%	640	0	0.0%
	Total	**1,990**	**0**	**0.0%**	**3,450**	**0**	**0.0%**
Tenino	City	1,730	65	3.8%	3,675	100	2.7%
	UGA	15	0	0.0%	110	0	0.0%
	Total	**1,745**	**65**	**3.7%**	**3,785**	**100**	**2.6%**
Tumwater	City	22,370	16,560	74.0%	37,350	27,280	73.0%
	UGA	3,270	2,100	64.2%	8,960	6,020	67.2%
	Total	**25,640**	**18,660**	**72.8%**	**46,310**	**33,300**	**71.9%**
Yelm	City	8,170	0	0.0%	25,080	0	0.0%
	UGA	1,420	0	0.0%	5,690	0	0.0%
	Total	**9,590**	**0**	**0.0%**	**30,770**	**0**	**0.0%**
Grand Mound UGA	**Total**	**1,285**	**55**	**4.3%**	**1,990**	**160**	**8.0%**
Chehalis Reservation[1]	**Total**	**70**	**70**	**100.0%**	**190**	**190**	**100.0%**
Nisqually Reservation[1]	**Total**	**605**	**40**	**6.6%**	**705**	**40**	**5.7%**
Total Cities		**131,970**	**68,110**	**51.6%**	**197,120**	**92,890**	**47.1%**
Total UGAs[2]		**52,000**	**16,470**	**31.7%**	**93,190**	**33,230**	**35.7%**
Total Reservations[1]		**670**	**110**	**16.4%**	**890**	**230**	**25.8%**
Rural Unincorporated County[3]		**82,770**	**14,350**	**17.3%**	**102,470**	**16,870**	**16.5%**
Thurston County Total		**267,400**	**99,000**	**37.0%**	**393,700**	**143,200**	**36.4%**

Source: Thurston Regional Planning Council Population Forecast, 2015
Explanations: Liquefaction Hazard includes areas with a "Low to Moderate," "Moderate to High" or "High" liquefaction risk. 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 4.1.4: Liquefaction Hazard Area, Population - Special Districts, 2015 and 2040

	2015 Population Estimate			2040 Population Forecast		
	Total	In Hazard Area		Total	In Hazard Area	
Jurisdiction	#	#	%	#	#	%
Fire Protection Districts						
1,11 West Thurston	22,010	4,690	21.3%	31,120	8,710	28.0%
2, 4 S.E. Thurston	24,650	140	0.6%	50,770	230	0.5%
3 Lacey	91,660	39,540	43.1%	128,070	53,590	41.8%
5, 9 McLane-Black Lake	15,890	1,940	12.2%	20,770	2,730	13.1%
6 East Olympia	11,140	5,290	47.5%	14,810	7,320	49.4%
8 South Bay	11,820	3,380	28.6%	15,380	4,900	31.9%
12 Tenino	6,230	370	5.9%	9,530	510	5.4%
13 Griffin	5,060	180	3.6%	5,700	200	3.5%
16 Gibson Valley	590	140	23.7%	1,130	230	20.4%
17 Bald Hills	4,090	420	10.3%	5,440	480	8.8%
School Districts						
Centralia[1]	490	140	28.6%	1,180	280	23.7%
Griffin	5,950	190	3.2%	6,710	210	3.1%
North Thurston	99,300	40,350	40.6%	138,340	55,170	39.9%
Olympia	66,140	30,570	46.2%	87,700	40,450	46.1%
Rainier	5,210	90	1.7%	13,800	120	0.9%
Rochester[1]	14,060	1,140	8.1%	18,080	1,600	8.8%
Tenino	9,850	1,250	12.7%	15,510	1,770	11.4%
Tumwater	39,500	23,240	58.8%	63,820	39,510	61.9%
Yelm[1]	26,900	2,090	7.8%	48,530	4,120	8.5%
Other Districts						
Intercity Transit	176,450	83,080	47.1%	269,860	119,220	44.2%
LOTT Clean Water Alliance[2]	120,960	67,150	55.5%	249,110	125,030	50.2%
Port of Olympia	267,400	99,000	37.0%	393,700	143,200	36.4%
Thurston County PUD	267,400	99,000	37.0%	393,700	143,200	36.4%

Source: Thurston Regional Planning Council Population Forecast, 2015
Explanations: Liquefaction Hazard includes areas with a "Low to Moderate," "Moderate to High" or "High" liquefaction risk.
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 4.1.5: Liquefaction Hazard Area, Employment, 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**	**85**	**94.4%**	**200**	**175**	**87.5%**
Lacey	City	25,610	12,370	48.3%	41,180	18,570	45.1%
	UGA	5,620	710	12.6%	8,520	1,270	14.9%
	Total	**31,230**	**13,080**	**41.9%**	**49,700**	**19,840**	**39.9%**
Olympia	City	53,350	32,390	60.7%	74,950	45,280	60.4%
	UGA	1,800	1,290	71.7%	2,230	1,580	70.9%
	Total	**55,150**	**33,680**	**61.1%**	**77,180**	**46,860**	**60.7%**
Rainier	City	455	0	0.0%	690	0	0.0%
	UGA	25	0	0.0%	80	0	0.0%
	Total	**480**	**0**	**0.0%**	**770**	**0**	**0.0%**
Tenino	City	870	20	2.3%	1,505	20	1.3%
	UGA	0	0	-	5	0	0.0%
	Total	**870**	**20**	**2.3%**	**1,510**	**20**	**1.3%**
Tumwater	City	22,350	18,680	83.6%	33,720	29,170	86.5%
	UGA	760	510	67.1%	1,420	980	69.0%
	Total	**23,110**	**19,190**	**83.0%**	**35,140**	**30,150**	**85.8%**
Yelm	City	3,830	0	0.0%	11,490	0	0.0%
	UGA	430	0	0.0%	670	0	0.0%
	Total	**4,260**	**0**	**0.0%**	**12,160**	**0**	**0.0%**
Grand Mound UGA	**Total**	**1,115**	**0**	**0.0%**	**1,375**	**10**	**0.7%**
Chehalis Reservation[1]	**Total**	**760**	**760**	**100.0%**	**1,550**	**1,550**	**100.0%**
Nisqually Reservation[1]	**Total**	**975**	**10**	**1.0%**	**1,865**	**10**	**0.5%**
Total Cities		**106,560**	**63,540**	**59.6%**	**163,730**	**93,220**	**56.9%**
Total UGAs[2]		**9,740**	**2,520**	**25.9%**	**14,300**	**3,850**	**26.9%**
Total Reservations[1]		**1,740**	**770**	**44.3%**	**3,410**	**1,560**	**45.7%**
Rural Unincorporated County[3]		**15,880**	**3,510**	**22.1%**	**18,270**	**3,900**	**21.3%**
Thurston County Total		**133,900**	**70,300**	**52.5%**	**199,700**	**102,500**	**51.3%**

Source: Thurston Regional Planning Council Population Forecast, 2015
Explanations: Liquefaction Hazard includes areas with a "Low to Moderate," "Moderate to High" or "High" liquefaction risk. 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 4.1.6: Liquefaction Hazard Area, Employment - Special Districts, 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	1,860	29.6%	8,480	3,230	38.1%
2, 4 S.E. Thurston	6,710	110	1.6%	15,170	110	0.7%
3 Lacey	34,540	14,840	43.0%	54,170	21,790	40.2%
5, 9 McLane-Black Lake	3,630	570	15.7%	4,350	700	16.1%
6 East Olympia	1,960	990	50.5%	2,350	1,140	48.5%
8 South Bay	1,830	590	32.2%	2,250	680	30.2%
12 Tenino	1,500	120	8.0%	2,210	120	5.4%
13 Griffin	990	30	3.0%	1,060	30	2.8%
16 Gibson Valley	150	40	26.7%	180	40	22.2%
17 Bald Hills	470	40	8.5%	570	40	7.0%
School Districts						
Centralia[1]	120	30	25.0%	170	50	29.4%
Griffin	1,110	40	3.6%	1,190	40	3.4%
North Thurston	42,280	20,510	48.5%	66,290	31,210	47.1%
Olympia	48,850	27,550	56.4%	65,910	36,720	55.7%
Rainier	980	20	2.0%	1,860	20	1.1%
Rochester[1]	4,630	1,170	25.3%	6,230	2,140	34.3%
Tenino	2,340	260	11.1%	3,320	350	10.5%
Tumwater	25,670	20,170	78.6%	38,080	31,290	82.2%
Yelm[1]	7,850	520	6.6%	16,580	650	3.9%
Other Districts						
Intercity Transit	115,570	65,820	57.0%	176,500	96,420	54.6%
LOTT Clean Water Alliance[2]	91,010	55,500	61.0%	162,020	96,850	59.8%
Port of Olympia	133,900	70,300	52.5%	199,700	102,500	51.3%
Thurston County PUD	133,900	70,300	52.5%	199,700	102,500	51.3%

Source: Thurston Regional Planning Council Population Forecast, 2015
Explanations: Liquefaction Hazard includes areas with a "Low to Moderate," "Moderate to High" or "High" liquefaction risk.
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 4.1.7: Liquefaction Hazard Area, Residential Dwellings, 2015 and 2040

		2015 Dwelling Estimate			2040 Dwelling Forecast		
		Total	In Hazard Area		Total	In Hazard Area	
Jurisdiction		#	#	%	#	#	%
Bucoda	**Total**	**245**	**225**	**91.8%**	**535**	**360**	**67.3%**
Lacey	City	19,840	10,870	54.8%	24,400	12,720	52.1%
	UGA	13,500	2,600	19.3%	23,930	6,390	26.7%
	Total	**33,340**	**13,470**	**40.4%**	**48,330**	**19,110**	**39.5%**
Olympia	City	24,170	12,170	50.4%	35,610	18,070	50.7%
	UGA	4,850	3,270	67.4%	7,100	4,830	68.0%
	Total	**29,020**	**15,440**	**53.2%**	**42,710**	**22,900**	**53.6%**
Rainier	City	775	0	0.0%	1,140	0	0.0%
	UGA	50	0	0.0%	290	0	0.0%
	Total	**825**	**0**	**0.0%**	**1,430**	**0**	**0.0%**
Tenino	City	755	30	4.0%	1,855	40	2.2%
	UGA	5	0	0.0%	40	0	0.0%
	Total	**760**	**30**	**3.9%**	**1,895**	**40**	**2.1%**
Tumwater	City	9,970	7,290	73.1%	16,870	12,290	72.9%
	UGA	1,420	890	62.7%	3,820	2,520	66.0%
	Total	**11,390**	**8,180**	**71.8%**	**20,690**	**14,810**	**71.6%**
Yelm	City	3,000	0	0.0%	9,820	0	0.0%
	UGA	550	0	0.0%	2,280	0	0.0%
	Total	**3,550**	**0**	**0.0%**	**12,100**	**0**	**0.0%**
Grand Mound UGA	**Total**	**415**	**20**	**4.8%**	**740**	**60**	**8.1%**
Chehalis Reservation[1]	**Total**	**20**	**20**	**100.0%**	**65**	**60**	**92.3%**
Nisqually Reservation[1]	**Total**	**200**	**10**	**5.0%**	**255**	**20**	**7.8%**
Total Cities		**58,770**	**30,580**	**52.0%**	**90,230**	**43,480**	**48.2%**
Total UGAs[2]		**20,790**	**6,770**	**32.6%**	**38,190**	**13,800**	**36.1%**
Total Reservations[1]		**220**	**40**	**18.2%**	**320**	**80**	**25.0%**
Rural Unincorporated County[3]		**34,250**	**6,000**	**17.5%**	**41,730**	**6,920**	**16.6%**
Thurston County Total		**114,000**	**43,400**	**38.1%**	**170,500**	**64,300**	**37.7%**

Source: Thurston Regional Planning Council Population Forecast, 2015
Explanations: Liquefaction Hazard includes areas with a "Low to Moderate," "Moderate to High" or "High" liquefaction risk. 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 4.1.8: Earthquake Hazard Area, Residential Dwellings - Special Districts, 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	1,890	22.3%	11,930	3,490	29.3%
2, 4 S.E. Thurston	9,800	60	0.6%	20,190	90	0.4%
3 Lacey	38,120	16,880	44.3%	54,160	23,250	42.9%
5, 9 McLane-Black Lake	6,490	850	13.1%	8,670	1,200	13.8%
6 East Olympia	4,510	2,110	46.8%	6,010	2,940	48.9%
8 South Bay	4,940	1,420	28.7%	6,370	2,000	31.4%
12 Tenino	2,580	150	5.8%	4,200	210	5.0%
13 Griffin	2,580	90	3.5%	2,910	100	3.4%
16 Gibson Valley	240	60	25.0%	440	90	20.5%
17 Bald Hills	1,770	180	10.2%	2,370	200	8.4%
School Districts						
Centralia[1]	200	60	30.0%	470	120	25.5%
Griffin	3,030	100	3.3%	3,430	110	3.2%
North Thurston	41,820	17,530	41.9%	59,460	24,440	41.1%
Olympia	29,690	13,800	46.5%	41,150	19,280	46.9%
Rainier	2,190	40	1.8%	5,690	50	0.9%
Rochester[1]	5,260	440	8.4%	6,670	600	9.0%
Tenino	4,130	530	12.8%	6,720	740	11.0%
Tumwater	16,940	10,030	59.2%	27,630	17,260	62.5%
Yelm[1]	10,790	870	8.1%	19,260	1,680	8.7%
Other Districts						
Intercity Transit	76,200	36,710	48.2%	119,200	54,400	45.6%
LOTT Clean Water Alliance[2]	53,760	29,915	55.6%	111,730	56,820	50.9%
Port of Olympia	114,000	43,400	38.1%	170,500	64,300	37.7%
Thurston County PUD	114,000	43,400	38.1%	170,500	64,300	37.7%

Source: Thurston Regional Planning Council Population Forecast, 2015
Explanations: Liquefaction Hazard includes areas with a "Low to Moderate," "Moderate to High" or "High" liquefaction risk.
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 4.1.9: Liquefaction Hazard Area, Valuation of Building and Contents, 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**	**11**	**91.7%**	**1**	**1**	**100.0%**	**3**	**3**	**100.0%**
Lacey	City	2,394	1,155	48.2%	914	368	40.3%	602	196	32.6%
	UGA	1,715	369	21.5%	69	7	10.1%	273	19	7.0%
	Total	**4,109**	**1,524**	**37.1%**	**983**	**375**	**38.1%**	**875**	**215**	**24.6%**
Olympia	City	2,695	1,467	54.4%	1,199	635	53.0%	1,941	1,401	72.2%
	UGA	785	539	68.7%	27	21	77.8%	26	14	53.8%
	Total	**3,480**	**2,006**	**57.6%**	**1,226**	**656**	**53.5%**	**1,967**	**1,415**	**71.9%**
Rainier	City	76	0	0.0%	5	0	0.0%	30	0	0.0%
	UGA	5	0	0.0%	0	0	-	1	0	0.0%
	Total	**81**	**0**	**0.0%**	**5**	**0**	**0.0%**	**31**	**0**	**0.0%**
Tenino	City	50	2	4.0%	12	0	0.0%	67	0	0.0%
	UGA	1	0	0.0%	0	0	-	0	0	-
	Total	**51**	**2**	**3.9%**	**12**	**0**	**0.0%**	**67**	**0**	**0.0%**
Tumwater	City	1,209	867	71.7%	528	430	81.4%	556	429	77.2%
	UGA	130	98	75.4%	13	9	69.2%	7	7	100.0%
	Total	**1,339**	**965**	**72.1%**	**541**	**439**	**81.1%**	**563**	**436**	**77.4%**
Yelm	City	357	0	0.0%	105	0	0.0%	140	0	0.0%
	UGA	49	0	0.0%	6	0	0.0%	13	0	0.0%
	Total	**406**	**0**	**0.0%**	**111**	**0**	**0.0%**	**153**	**0**	**0.0%**
Grand Mound UGA		**34**	**1**	**2.9%**	**13**	**0**	**0.0%**	**5**	**0**	**0.0%**
Chehalis Reservation[1]		**1**	**1**	**100.0%**	**4**	**4**	**100.0%**	**0**	**0**	**-**
Nisqually Reservation.[1]		**16**	**0**	**0.0%**	**3**	**0**	**0.0%**	**0**	**0**	**-**
Total Cities		**6,793**	**3,502**	**51.6%**	**2,763**	**1,434**	**51.9%**	**3,338**	**2,030**	**60.8%**
Total UGAs[2]		**2,719**	**1,006**	**37.0%**	**128**	**37**	**28.9%**	**325**	**39**	**12.0%**
Total Reservations[1]		**17**	**1**	**5.9%**	**6**	**4**	**66.7%**	**0**	**0**	**-**
Rural Unincorp. County[3]		**4,977**	**806**	**16.2%**	**113**	**26**	**23.0%**	**1,033**	**72**	**7.0%**
Thurston County Total		**14,506**	**5,315**	**36.6%**	**3,010**	**1,500**	**49.8%**	**4,696**	**2,140**	**45.6%**

Source: Thurston Regional Planning Council Population Forecast, 2015
Explanations: Liquefaction Hazard includes areas with a "Low to Moderate," "Moderate to High" or "High" liquefaction risk. 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 4.1.10: Earthquake Hazard Area, Valuation of Building and Contents - Special Districts, 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	199	20.3%	57	13	22.8%	216	32	14.8%
2, 4	S.E. Thurston	1,073	8	0.7%	133	0	0.0%	202	0	0.0%
3	Lacey	4,823	1,971	40.9%	1,008	396	39.3%	896	235	26.2%
5, 9	McLane-Black Lake	1,121	105	9.4%	31	12	38.7%	676	3	0.4%
6	East Olympia	743	400	53.8%	14	12	85.7%	49	19	38.8%
8	South Bay	939	233	24.8%	13	2	15.4%	47	16	34.0%
12	Tenino	277	17	6.1%	17	0	0.0%	73	0	0.0%
13	Griffin	430	16	3.7%	3	0	0.0%	26	0	0.0%
16	Gibson Valley	20	6	30.0%	0	0	-	1	0	0.0%
17	Bald Hills	176	14	8.0%	6	0	0.0%	7	0	0.0%
School Districts										
Centralia[1]		17	6	35.3%	0	0	-	1	0	0.0%
Griffin		498	16	3.2%	3	0	0.0%	26	0	0.0%
North Thurston		5,394	2,044	37.9%	1,292	610	47.2%	969	255	26.3%
Olympia		3,990	1,848	46.3%	960	434	45.2%	2,344	1,396	59.6%
Rainier		241	5	2.1%	11	0	0.0%	34	0	0.0%
Rochester[1]		539	45	8.3%	42	6	14.3%	187	19	10.2%
Tenino		462	48	10.4%	21	1	4.8%	81	4	4.9%
Tumwater		2,155	1,178	54.7%	546	446	81.7%	877	465	53.0%
Yelm[1]		1,208	125	10.3%	135	3	2.2%	176	1	0.6%
Other Districts										
Intercity Transit		9,247	4,472	48.4%	2,865	1,469	51.3%	4,172	2,049	49.1%
LOTT Clean Water Alliance[2]		6,724	3,655	54.4%	2,498	1,337	53.5%	2,443	1,521	62.3%
Port of Olympia		14,506	5,315	36.6%	3,010	1,500	49.8%	4,696	2,140	45.6%
Thurston County PUD		14,506	5,315	36.6%	3,010	1,500	49.8%	4,696	2,140	45.6%

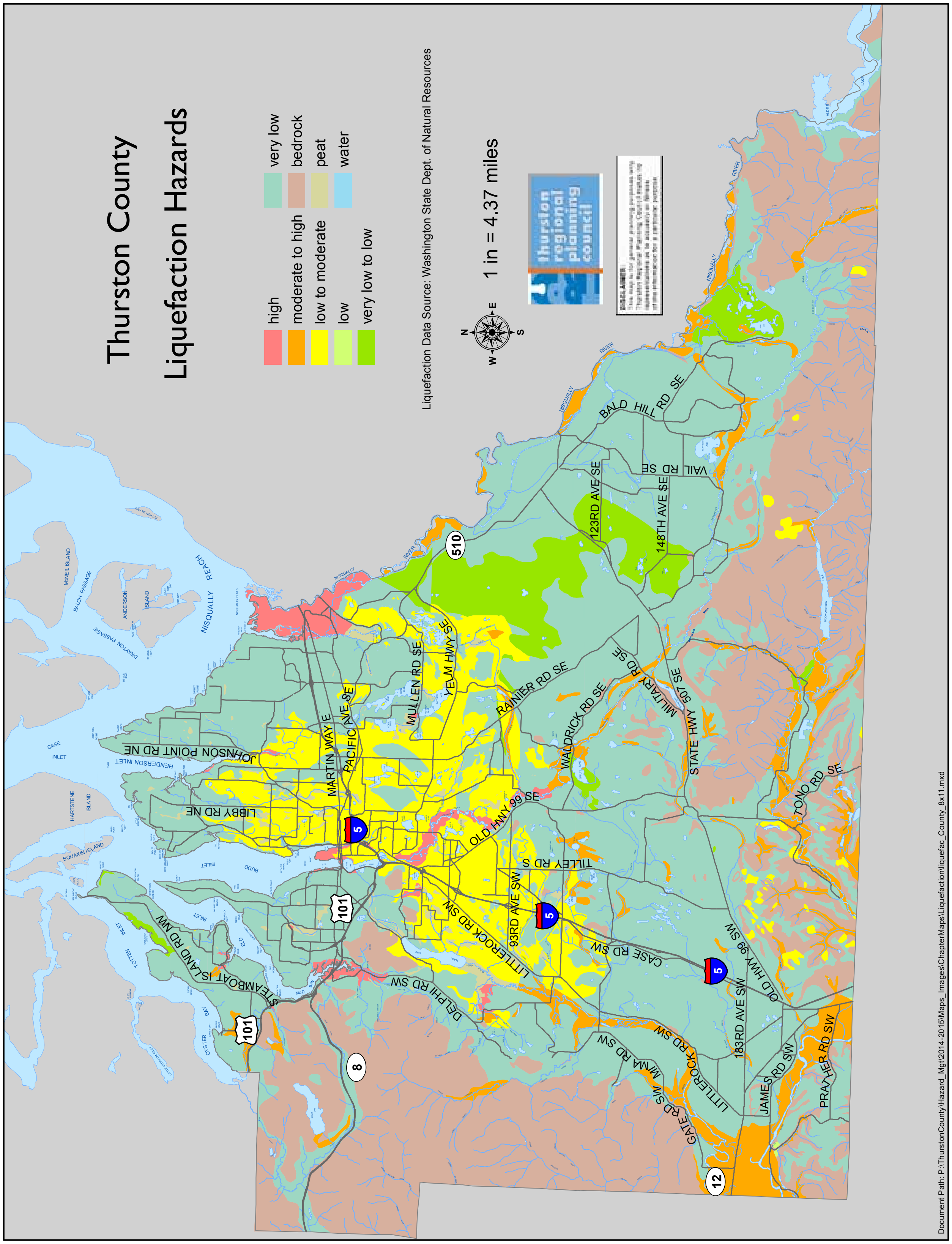
Source: Thurston Regional Planning Council Population Forecast, 2015
Explanations: Liquefaction Hazard includes areas with a "Low to Moderate," "Moderate to High" or "High" liquefaction risk.
1. Data are for Thurston County portion of the district only.
2. Includes the sewered area.

Table 4.1.11 Essential Facilities in Liquefaction Hazard Area

Facility Type	Total #	In Hazard Area #	In Hazard Area %
Medical Care			
Adult Family Home	124	57	46.0%
Assisted Living	14	6	42.9%
Dentist	110	71	64.5%
Dialysis Center	3	1	33.3%
Funeral Home	6	5	83.3%
Hospital	2	1	50.0%
Nursing Home	7	3	42.9%
Pharmacy	42	21	50.0%
Primary Care	91	39	42.9%
Urgent Care	6	4	66.7%
Government			
Court Services	3	1	33.3%
Cultural Significance	2	0	0.0%
Detention/Corrections	1	0	0.0%
Fairgrounds	35	0	0.0%
Fire Service	53	15	28.3%
Government Services	56	20	35.7%
Health and Human Services	2	2	100.0%
Law and Justice	4	2	50.0%
Law Enforcement	8	4	50.0%
Port Facilities	35	35	100.0%
Public Education	344	111	32.3%
Public Higher Education	52	0	0.0%
Public Works	33	15	45.5%
Solid Waste	20	0	0.0%
Transit	4	4	100.0%
Utilities	238	88	37.0%
Transportation (Centerline Miles)			
Roads	2,210	670	30.3%
Intercity Transit Routes	157	89	56.9%
Rural Transit Routes	96	21	21.6%

Explanations: Liquefaction Hazard includes areas with a "Low to Moderate," "Moderate to High" or "High" liquefaction risk.

Map 4.1.1 Liquefaction Hazards, Thurston County



Endnotes

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Hazard Type
WINTER STORM
Probability of Occurrence
HIGH
Vulnerability
HIGH
Risk
HIGH

Chapter 4.2
Storm Hazard Profile

Introduction

Severe weather events are the most frequent source of natural disasters for Thurston County and its communities. Between 1965 and 2016, 18 of 22 Presidential Disaster Declarations involving Thurston County were attributed to damage resulting from winter storms (principally flood damage). Storms cause injury and sometimes death, and can also significantly damage property and disrupt people's lives. Between 2010 and 2015, severe storms killed 77, injured 75, and caused $430.6 billion in damages statewide in Washington[1] (43 of the deaths were caused by the 2014 Oso mudslide).

Refer to the Flood and Landslide Hazard Profiles for more information about these hazards.

2010 – 2015 Summary of Hazardous Weather Fatalities, Injuries, and Damage Costs in Washington State

Year	Fatalities	Injuries	Property Damage (millions $)	Crop Damage (millions $)	Total Damage (millions $)
2010	3	8	11	0.09	11.09
2011	6	5	18.82	0.68	19.49
2012	6	5	27.32	1.13	28.45
2013	4	16	12.84	0.5	13.33
2014	50	34	328.16	1.12	329.28
2015	8	7	28.94	0.02	28.96
Total	77	75	427.08	3.54	430.6

Advances in weather forecasting technology allow for relatively accurate predictions of pending storms and their area of impact three to five days before they occur. Advanced weather notification enables people and communities to take safety precautions. But even with warnings, communities remain vulnerable as evidenced by storm impacts that have frequently buffeted this region over the last decade.

The high recurrence rate of Pacific Northwest storms, the record of historical damage, and the repetitive response and recovery costs associated with these destructive events make the region highly vulnerable to storm events. Thus, the overall risk rating for severe storms in the Thurston Region is high.

Hazard Identification

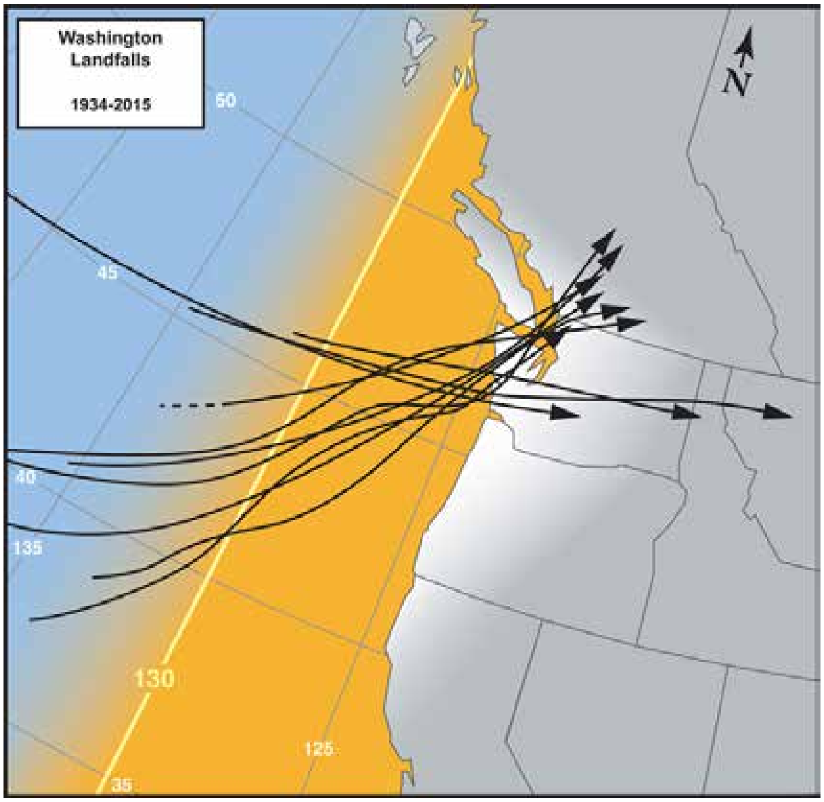
A severe storm is a meteorological event generated by atmospheric conditions. The most destructive storms in Western Washington occur from October through April delivering sustained high speed directional winds and higher than normal levels of precipitation. These storms cause significant property damage, power loss, and disruption to services across all sectors of communities. High winds, heavy rain, heavy snow, freezing rain, tornados, hail, and lightning all impact the Thurston Region. Each element poses a threat and is included in this hazard profile. Winter storms that affect Thurston County usually pack more than one hazardous element at a time or deliver elements in consecutive blows such as a snow storm followed by heavy rain and a windstorm. This section defines each element, its severity, its impacts, and its probability of occurrence.

1. High Winds/Windstorms

Definition

The National Weather Service defines high winds as "sustained wind speeds of 40 mph or greater lasting for one hour or longer, or winds of 58 mph or greater for any duration."[2] Generally, winds above 30 mph can cause widespread damage and those above 50 mph can lead to more serious disasters. Most large windstorms that affect the region are delivered by mid-latitude eastern Pacific cyclones. Northern Hemisphere cyclones are large-scale storms with winds that rotate counterclockwise around a central region of low atmospheric pressure. These cyclones obtain their energy from the large horizontal variation in temperature in the mid-latitudes (30° to 60° north). Mid-latitude cyclones are not as powerful as tropical hurricanes. However, they can generate wind speeds in excess of 100 mph and can maintain their strength farther inland and affect a much larger area of land.[3] The Puget Sound Region's most powerful southerly and westerly winds typically come from these storm systems when their low pressure centers move from southwest to northeast and cross the coast between the northern tip of the Olympic Peninsula and central Vancouver Island. Other landfall trajectories from northern Oregon to the central Washington coast are also capable of causing wide spread destruction in Thurston County.

Trajectories of Washington's Strongest Storms[4]



Severity

The coastal mountains afford Thurston County some protection from severe southerly and westerly winds, buffering and shielding the region from extreme winds in excess of 80 mph. Thurston County does not experience the 100 mph or greater winds that sometimes wreak havoc on Washington's Pacific Coast communities. Nevertheless, the entire county is directly or indirectly susceptible to the effects of high speed winds. Neighborhoods with isolated, non-wind firm stands of tall evergreen trees or deciduous trees with leaf-laden canopies in the early fall are the most susceptible to blowing over and causing damage to surrounding property. All communities can suffer extended power outages.

The average wind speed at the Olympia Airport, as recorded over a 68-year period, is six mph. Between 1948 and 2016, 117 unique windstorm events with hourly wind speeds over 30 mph and 14 windstorm events with wind speeds over 40 mph have buffeted Thurston County.[5] The most powerful windstorm in the last 100 years occurred on Columbus Day, October 12, 1962. This storm tracked northeast along the Washington coast and produced record peak wind gusts of 78 mph at the Olympia Airport. The Beaufort Scale (on the next page) provides a reference for observable effects relative to wind speed.

Beaufort Scale

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

Impacts

The Thurston Region, like most of Western Washington, is vulnerable to high winds because of the climatic conditions and the prevalence of non-wind firm tall mature coniferous trees surrounding developed properties and infrastructure. High winds weaken standing trees and structures that are weighted with snow or ice. Douglas fir and Western hemlock have shallow lateral root systems with top heavy crowns. Regular autumn rains saturate soils and decrease tree root adherence to soils. Sustained high winds and gusts cause trees to sway significantly. Repetitive swaying motion can eventually weaken a tree's hold and force it to topple. Tall columnar trees and their massive branches act like giant hatchets and sever electrical transmission lines, crush vehicles, damage homes and buildings, and block transportation routes. Falling tree limbs and other flying debris can injure or cause the death of people and animals. Downed power lines have caused electrocutions elsewhere in the greater Puget Sound Region.

Widespread power outages can take several days to restore. The total mass of downed debris on the transportation network impedes the response of emergency personnel and utility crews. Electrical blackouts force the closure of government offices, businesses, and schools. Power outages can disrupt transportation, generating traffic snarls resulting in thousands of motorists seeking few available alternate routes on local arterials and collectors, complicated by blocked roads. When power outages occur simultaneously with heavy stormwater flows, public works crews may struggle to provide auxiliary power to sewer lift stations to prevent backups or flooding in suburban and urbanized areas.

People without power may lack backup home heating systems, and risk hypothermia if temperatures persist below freezing levels. Out of desperation, some people may resort to heating their homes with BBQ grills, unaware of the risks of carbon monoxide poisoning. The potential for home fires increases county-wide as people use candles for lighting or start wood fires in stoves or fireplaces that are structurally faulty or have excessively dirty or blocked chimneys. Individuals with home-powered life support systems, such as oxygen respirators or suction equipment, may be at risk of health complications without backup power systems. Low income populations are particularly impacted by loss of food due to spoilage from lack of refrigeration.

Between 1960 and December 2015, windstorms impacting Thurston County resulted in combined adjusted property damages of more than $36.8 million dollars (adjusted to 2016-dollar value).[6]

Probability of Occurrence

The 2013 Washington State Enhanced Natural Hazards Mitigation Plan identifies Thurston County and 29 other counties as susceptible to high winds. These counties have an annual high wind recurrence rate of 100 percent. Numerous extratropical cyclones have impacted the Pacific Northwest and the Thurston Region in the last 25 years, thus probability of occurrence is high.

2. Heavy Rain

Definition

The quantity of rainfall that constitutes heavy conditions varies by location and season. In general, heavy rainfall is any amount of rain produced in a relatively short time period that exceeds the capacity of natural systems' or stormwater infrastructures' ability to effectively and safely convey the flow of stormwater. Excess water flows and accumulations can lead to hazardous conditions such as flooding and erosion. Excess rainfall can saturate soils on steep slopes which make them susceptible to mudslides or landslides. (See Flood Hazard Profile for more information on precipitation patterns related to flooding).

Severity

Prolonged heavy rains directly or indirectly affect the entire region and typically occur from November through February. Properties at greater risk include those in flood plains, with high ground water, with stormwater drainage problems, or those closely adjacent to steep slopes. The region overall is moderately vulnerable to flood.

Photo courtesy of The Olympian

Impact

The most common impacts from heavy rainfall are flooding and erosion. Prolonged rain delivered by weather systems north of the Hawaiian Islands dubbed atmospheric rivers, can rapidly melt snow in the Cascade Mountains and lowlands. This precipitation can cause: rivers to rise quickly; flooding downstream in valleys; and widespread landslides both in the uplands and the lowlands. Local rainfall also swells local creeks and streams, exacerbating local flood potential. Refer to the Flood and Landslide Hazard Profiles for more information on these impacts.

Probability of Occurrence

Considering that 19 of 22 federal disaster declarations, for the period of 1965 to 2012, resulted from major flooding, damaging heavy rain has a 38 percent annual probability of occurrence. Damaging heavy rains have a high probability of occurring.

3. Freezing Rain

Description

Freezing rain occurs when rain descends through a cold air mass, cools, and then subsequently freezes on contact with cold surfaces. An ice coat will continue to accumulate on surfaces as long as conditions exist. Ice can accumulate to thicknesses greater than one inch.

Severity

The entire county is susceptible to the effects of an ice storm of the magnitude experienced on December 26, 1996. This storm resulted in ice accumulations of one-quarter to three-quarters of an inch. The December 2008 winter storm delivered freezing rain, but accumulations of ice were less than one-tenth of an inch. Ice can accumulate on nearly every surface including tree branches, power lines, roof tops, motor vehicles, streets, sidewalks, and traffic signals and signs. Transportation networks are especially vulnerable to freezing rain as it coats nearly every exposed paved surface.

Impacts

The weight of thick ice accumulations can stress structures, causing trees tops and branches and power lines to snap. Downed live power lines

Photo courtesy of Komo News

can ignite fires. Dangerous driving conditions and power outages almost guarantee the closure of government offices, businesses, and schools. Despite the issuance of alerts to avoid travel, the demand for emergency assistance to respond to traffic accidents can quickly overwhelm the capacity of local fire and law enforcement personnel.

Probability of Occurrence

Although trace freezing rain events occasionally occur, the December 26, 1996 event was the most damaging Pacific Northwest ice storm in the last 50 years. The scarcity of an event of this magnitude suggests that the annual recurrence rate may be one to two percent or occur every 50 to 100 years. Therefore, the probability of a major destructive freezing rain event in the next 25 years is low.

4. Heavy Snow

Definition

The Washington State Hazard Mitigation Plan defines heavy snow as four inches of snowfall in 12 hours or six inches in 24 hours for non-mountainous areas. This amount is sufficient to disrupt activities in Thurston County. In general, heavy snow is any amount of snowfall that exceeds the ability of communities to maintain relatively normal levels of public and private sector services.

Falling snow mixed with high winds produces a blizzard. According to the National Weather Service, a blizzard occurs with the following conditions." [Three hours or more of] sustained wind or frequent gusts to 35 miles an hour or greater; and considerable falling and/or blowing snow (i.e., reducing visibility frequently to less than ¼ mile)."

Severity

Heavy snowfall affects all of Thurston County. Snowfall in the Puget Sound lowlands typically occurs from mid-November through early March, with most accumulations occurring from December through February. Light snow, less than four inches deep, can temporarily disrupt normal traffic operations on roads and streets until public works departments clear priority routes. In general, snow hazards and road clearing abilities become more problematic with decreasing temperatures, increasing snow depth, and length of time that snow remains on the ground. Even when priority routes are clear, numerous neighborhood streets and local collectors can remain impassable for many motorists when snow depths exceed one foot.

The average annual snowfall for Thurston County is approximately 17 inches (average maximum of all weather stations in Thurston County, 1948-2015). Most periods of snow fall generally do not exceed six inches within a 24-hour period. However, weather station records indicate that such snowfalls have occurred 39 times in Thurston County since 1948. Between December 1968 and January 1969, 81.5 inches of snow fell, resulting in snow depths likely exceeding the 24 inches recorded at the Olympia Regional Airport weather station. Snow remained at one-half to one-foot deep through the first two weeks of February. Larger snowfall accumulation typically occurs at higher elevations and distances further away from the Puget Sound.

Total days with 12 inches or greater of snow on the ground in Thurston County, 1948 to 2015

Year	12-inch snow days
1950	7
1954	4
1969	7
1972	8
1980	3
2008	10
2012	4

Impacts

Heavy snowfall and blizzard like conditions drastically reduce motorists' visibility, especially in the dark, increasing the risk for motor vehicle accidents. Heavy snow affects all modes of transportation. Snow, even in windless conditions, presents serious hazards. Icy road conditions are a major cause of vehicle accidents resulting in property damage, traumatic injuries, and fatalities. Significant snowfall can disrupt surface transportation networks for several days and overwhelm the snow removal capabilities of public works departments, delay public transit services, as well as delay response times of emergency responders. Delayed freight distribution can also occur, with possible shortages of goods such as fuel. Deep snow and sustained freezing temperatures can force the suspension or closure of both public and private sector services for several days. Excessive snow loads on structures can cause roofs and utility lines to collapse. Structural collapses are more likely when snow loads gain additional weight from subsequent absorption of rain. Flat roofs, sheds, carports, and awnings are vulnerable to collapse from excessive snow loads. During the melting period, snow can block storm drains and cause localized flooding.

Probability of Occurrence

Between 1948 and 2015, weather stations in Thurston County recorded 39 daily snowfall events with depths of six inches or greater. The annual recurrence rate for at least one day with a total accumulation of 12 inches or greater in a year is 67 percent or about every 8.9 years on average. The probability of a snow storm in Thurston County is high.

5. Tornado

Definition

The National Weather Service defines a tornado as "a violently rotating column of air, usually pendant to a cumulonimbus [cloud], with circulation reaching the ground. It nearly always starts as a funnel cloud and may be accompanied by a loud roaring noise. On a local scale, it is the most destructive of all atmospheric phenomena." Tornadoes are the most unpredictable weather phenomena.

Severity

The extent and severity of a tornado depends on its location, the length of touchdown time, and the strength or wind speed of the tornado event. The Fujita scale classifies tornados according to their wind speed (see next page). In Western Washington, tornados have occurred during March, April, May, June, August, September, October, November, and December. A total of 94 tornados have been documented in Washington State between 1950 and 2005.[7] Of these, 46 were F0, 29 were F1, 12 were F2, and three were F3. Damaging tornados are rare in Thurston County, and none have adversely affected densely populated areas. Damage from historic events was isolated to small areas. Storm records suggest that a tornado could potentially touch down anywhere in the lowlands of the county, but would not likely exceed a Fujita scale 1 (F1). Between 1950 and 2008, four small tornados (three F0, and one F1) occurred in Thurston County near Bucoda, Tenino, Yelm, and Lacey in 1994, 2003, 2004, and 2006 respectively.[8]

No deaths or serious injuries resulting from tornados have occurred in the county. It is interesting to note that during the 58-year period of recorded observations, three of the tornados occurred within a three-year period. Although tornados are rare in Thurston County, disastrous tornados have occurred elsewhere in Western Washington. On April 5, 1972, an F3 tornado (wind speed 158-206 mph) touched down in Portland, Oregon and created a nine-mile path of destruction north to Vancouver, Washington. In Vancouver, the tornado ripped through a grocery store, a bowling alley, a shopping mall, and an elementary school. It caused six deaths, 300 injuries, and nearly $50 million in damages.[9]

The Fujita Scale

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

Impacts

High speed rotating winds can rip apart buildings, fences, street signs, and vegetation. The tornado and the circulating winds in its vicinity can hurl objects and debris several hundred feet away from the source of destruction. Flying objects can injure or kill people and animals.

Probability of Occurrence

Based on little published data available from the National Climate Data Center, the probability of a tornado occurring in Thurston County is low.

6. Hail

Description

Hail is precipitation that takes the form of ice balls or clusters of ice clumps, ranging from two-tenths of an inch to several inches in diameter. Hail forms in cumulonimbus or thunderstorm clouds that have strong updrafts.

Severity

Most hail storms in Thurston County produce small non-destructive hail. The records of damaging hail storms are scant and suggest limited damage from these events with only small geographical areas likely affected. Although it is possible that a hail storm could unleash destruction to any portion of the county, the extent of the damage would likely be limited.

Impacts

Hail poses the greatest risk during its descent. Large hailstones can cause serious injury by striking people and animals and damage structures and vehicles. Hail storms may damage crops, but the extent or cost estimates of any past agriculture related damage within Thurston County is unknown. While little is known about a hail storm on April 8, 1992, it is estimated to have caused $8,447 in property damage (adjusted for 2016-dollars). [10]

Probability of Occurrence

Damaging hail storms are rare in Thurston County. Based on the historical information available, a hail storm producing hail greater than 0.75 inches in diameter has a five percent annual recurrence rate. The probability of a damaging hail event is low.

7. Lightning

Description

Lightning is an atmospheric discharge of electricity that typically occurs with thunderstorms. A lightning bolt can travel at 60,000 meters per second and reach temperatures of 54,000° F.

Severity

Lightning storms in Thurston County are short lived and generally only affect a small area. However, the entire county is potentially vulnerable to lightning strikes. Historically, lightning has not caused widespread damage nor posed a serious threat to the region.

Records indicate that lighting storms in Thurston County are most likely to occur from April through September. This time coincides with the dry season, so it is conceivable that a larger than normal wildfire could result from lightning strikes over forestlands in Thurston County.

Impacts

There are no documented lightning fatalities in Thurston County. Multiple lightning events have resulted in some injuries and damage in various locations. Lightning can strike people causing burn injuries, paralysis, or even death. It can also start fires, split trees, and disrupt power transmission. Since 1960, at least 11 lightning storms have caused $207,808 in property damage in Thurston County (adjusted for 2016-dollars). Since 1972, lightning ignited at least 28 wildland fires. A total of 28 acres are known to have burned. The largest fire burned 15 acres on private timberland in a remote area of southeast Thurston County in June 2004.[11] Damage estimates for these fires are unknown. History suggests the probability of a lightning event causing damage or injury is low.

Probability of Occurrence

The likelihood of lightning storms is high. However, the overall risk of a destructive lightning storms is low.

Effects of Climate Change on Storms

Research and climate forecasts offer evidence that long-term climate change will have a measurable impact on the frequency and intensity of storms. 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 storms for the Pacific Northwest and 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.

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. For the Thurston County planning area, such changes in precipitation patterns will impact flood and landslide conditions. Climate change models are not forecasting significant variation for the nature and type of windstorms that are presently common in the region.

Storm Historical Occurrences and Impacts

Several notable storms have impacted the Thurston County region over the last few decades. Highlighting the effects and damages of these storms emphasizes the severity, cost, and vulnerabilities associated with these events. Estimates of potential dollar losses for future storm events were not calculated as part of this hazard profile. At present, historic storm events offer the best indication of the type and extent of future losses that local communities are likely to experience.

January 14-23, 2012, Federal Disaster 4056: Severe Winter Storm, Flooding, Landslides, and Mudslides

A series of winter storms dubbed "Snowmaggedon" hit Western Washington in mid-January. An upper level trough and Arctic air pushed into Western Washington and combined to produce widespread heavy lowland snow. Several bands of snow showers fell from January 14 through 18. Multiple weather stations in Thurston County recorded snow depths of 12 or more inches. Portions of the Alpine Hills subdivision near Black Lake received nearly 30 inches.

Roads and transportation systems were severely disrupted from snow and fallen branches and trees. Residents calling and requesting to have their roads cleared overwhelmed public works agencies. Crews worked rotating 12-hour shifts through the week to plow arterials and collectors. Sixteen of 24 Intercity Transit bus routes were running on detour routes, and service to the west side of Olympia was temporarily cancelled. The Washington State Patrol reported handling 205 collisions in Thurston and Pierce counties in a 14-hour period.[12] Thurston County Medic One added an additional paramedic unit to both Yelm and the Grand Mound Rochester areas to respond to 9-1-1 call demands and compensate for increased travel times resulting from icy road conditions.

Schools and most local government offices were closed, including the county courthouse in Olympia. Multiple emergency and warming shelters were opened around the county. The Salvation Army reported that their downtown Olympia shelters were full with homeless people escaping the winter storm. Toppled trees pulled down powerlines and some neighborhoods reported not having access to water. However, Puget Sound Energy reported no significant wide-spread power outages in Thurston County.

On February 21, 2012, Governor Christine Gregoire requested a major disaster declaration due to a severe winter storm, flooding, landslides, and mudslides during the period of January 14-23, 2012. The Governor requested a declaration for Public Assistance for 11 counties and Hazard Mitigation statewide. During the period of February 6-10, 2012, joint federal, state, and local government Preliminary Damage Assessments (PDAs) were conducted in the requested counties. Thurston County's per capita impact was $13. On March 5, 2012, President Obama declared a major disaster in the state of Washington.

December 12-27, 2008, Federal Disaster 1825: Severe Winter Storm[13]

Near record snowfalls, freezing rain, and rain combined with sustained subfreezing temperatures froze the Thurston Region for a period of nearly two weeks making it one of the worst snow-laden winter storms in decades. Successive snowfall over the first week resulted in 18 to 20 inch depths in the Lacey, Olympia, and Tumwater area. Depths of 36 inches were reported by some county residents at higher elevations. Governor Gregoire declared a state of emergency on December 24. On March 2, a Presidential Disaster Declaration was declared for 27 counties, including Thurston County.

Public works crews struggled to keep roads free of daily snow accumulations, resulting in slick roads with deep icy ruts on many road segments throughout the cities and county. Most neighborhood streets never saw a snow plow, making vehicular travel and outings near-impossible for many of the county's residents. Blizzard like conditions on Interstate 5 caused about 20 collisions in one hour alone, including a pile up involving three tractor trailers and six cars that closed the interstate near Littlerock Road. By December 18, the Washington State Patrol responded to 54 collisions and assisted 45 drivers with disabled vehicles in Thurston County.

Over 7,000 residents and businesses lost power. Area shelters operated above capacity to care for the region's homeless population. On December 26, fire officials evacuated about 65 seniors from a wing of the Olympics West Retirement Inn in Tumwater due to unstable roof conditions stressed by excessive snow load.

Area schools closed three days prior to Christmas break. Thurston County closed its offices on December 18 and 22. Other local governments and colleges also closed their offices entirely or opened late or closed early due to road conditions.

On December 25, a 2,500 square foot section of Capital High School's roof, on Olympia's west side, collapsed from the strain of the snow load. Overhead fire sprinklers activated and caused water damage to parts of the school's interior, including the library. A natural gas pipe rupture contributed to a week delay of the school's reopening after Christmas break. Preliminary damage assessment estimates for the damage to public facilities, response costs, and snow removal costs exceeded $500,000 for all local agencies region wide (excluding Capitol High School). Private sector structural damage estimates exceeded $430,000 and personal damage was estimated around $114,000.

December 1-7, 2007 Federal Disaster 1734: Severe Winter Storm, Landslides, and Flooding

Snow followed by heavy rain and winds caused record flooding on the Chehalis River. The Deschutes and Black rivers rose above their banks. Communities experienced stream and urban flooding. Flash flood conditions in the Capital Hills and Capital Forest resulted in washouts, landslides, and urban flooding on major intersections in Olympia's west side. See flood and landslide hazard profiles for more details on this event.

October 18, 2007 Windstorm

The Olympian reported that wind gusts of 44 mph knocked down trees and power lines across Thurston County causing scattered power outages in mostly rural areas. The City of Olympia closed its parks as an emergency measure. A power line fell on an Olympia School District bus en route to pick up students; the driver was not injured.

January 5, 2007 Windstorm

Sustained winds of 22 mph and a peak gust of 40 mph toppled trees and disrupted power for about 9,500 households in Thurston County.

December 14-15, 2006 "The Hanukkah Eve Storm" Federal Disaster 1682: Severe Winter Storm, Landslides, and Mudslides

The December 14-15 storm included snow, rain, and high winds. The windstorm may have produced the most damaging winds to hit the Pacific Northwest since the Columbus Day

Storm of October 12, 1962. The Hanukkah eve storm achieved sustained winds of 36 mph and gusts of 53 mph as recorded at the Olympia Airport weather station before it lost power. KGY Radio, located on Budd Inlet, reported a wind gust of 78 mph at 12:30 a.m. on the 15th. Wind gusts exceeded 100 mph along parts of the Oregon coast. November rains saturated area soils resulting in significant fallen trees and broken limbs. Strong winds knocked down 85 of Puget Sound Energy's 208 high-voltage transmission lines and 159 of 358 neighborhood substations. 700,000 PSE customers lost power. An estimated 1.5 million customers of all northwest utilities combined lost power. In Washington, the storm claimed at least 13 lives. The Thurston Region experienced the following impacts and losses:

- 9-1-1 received over 5,000 calls on the evening of December 14.
- In the City of Olympia, 13 residences were red-tagged and six were yellow-tagged.
- Over 80,000 homes, businesses, and critical facilities lost power in Thurston County. Some households were without power for over one week.
- In the urban corridor, entire phone switches went down and the phone service's central offices were either not operational or on battery backup.
- On December 16, the county documented over 70 closed roads. Many more went undocumented.
- The power outage affected gasoline, water, sewage, and solid waste disposal facilities. City water and sewage pump stations relied on generators or other means of backup power. Critical environmental instrumentation at the County Waste and Recovery Center operated on backup power.
- Some cable television customers lost service for nearly a week, disrupting a vital news source and internet access.
- Heavy rains produced flooding on the Chehalis, Deschutes, and Skookumchuck rivers. It also caused flooding from storm water runoff. This resulted in additional road closures and damage to county and private roads and bridges.
- Five Thurston County residents were transported for specialized medical care because of carbon monoxide poisoning; at least one died.
- Downed trees caused multiple vehicle accidents including two fatalities from two separate incidents.
- The storm cost Thurston County $456,000 in response and recovery costs.
- Countywide, a total of $898,000 in damages to local government buildings, facilities, and parks was reported to Thurston County Emergency Management.

November 2-11, 2006 Federal Disaster 1671: Severe Winter Storm, Flooding, Landslides, and Mudslides

On November 6, 3.4 inches of rain fell; a 24-hour rainfall record for that day of the year. The heavy rains caused flooding of urban roads and streets throughout the Thurston Region. Preliminary damage assessments for personal and business property damage exceeded $300,000.

May 27, 2004 F1 Tornado

An F1 tornado touched down four miles southwest of Tenino tearing a metal roof off a barn, splintering the building timbers, breaking windows in an adjacent building, and snapping a 12-inch diameter ponderosa pine tree into two. Debris was strewn in an area 200 yards wide by a quarter mile long. The damages estimate was $50,000 to $75,000.[14]

January 6, 2004 Snow Storm

Six to nine inches of snow fell around Thurston County. Area schools and some businesses closed for up to three days.

May 17, 2003 Lightning Strike

A Thurston County woman was temporarily partially paralyzed when lightning struck a nearby tree outside her mobile home.[15]

October 15-23, 2003 Federal Disaster 1499: Severe Storms and Flooding

Thurston County was included in this federal disaster declaration, but storm damage to Thurston County was negligible.

June 17, 2002 Lightning Strike

A 17-year old boy was struck by lightning while he was working outside in Lacey. He sustained minor burns, some hearing loss and a headache. The tree next to him was stripped of its bark.[16]

September 5, 2002 Lightning Strike

Lightning struck a garage in Lacey, a state-owned building, and a tree in the Olympia area. The garage, filled with antiques, was destroyed. The state-owned building lost power and the tree was split.[17]

December/January 1996/1997 Federal Disaster 1159, Ice, Wind, Snow, Landslides, and Flooding

Snow, ice, and freezing rain crippled Thurston County on December 26. This storm produced the worst freezing rain event to hit the south Puget Sound Region in decades. Due to snapped power lines and downed trees, 53,000 electric customers lost power. Downed power lines ignited four tree fires in the Tumwater Hill neighborhood. Sub-freezing temperatures and power outages persisted for over a week into early January. A family of four suffered carbon monoxide poisoning after using a BBQ grill to heat their home. County-wide, local governments reported $3.14 million in damage and cleanup costs. Residents reported $980,000 in uninsured damages.

September 1, 1997 Hail Storm

Golf ball sized hail was reported near Yelm, which broke several car windshields. No estimate of damages is available from this event.[18]

December 12, 1995 Windstorm

A windstorm caused widespread destruction from northern California to British Columbia. Wind gusts of 57 mph rattled the Thurston Region causing widespread power outages to nearly 45,000 households and businesses. Road closures from fallen trees and limbs forced the closure of many local and state government offices and area businesses. One Mason County woman was killed when a power transformer exploded near her home, setting her residence on fire. First responders could not reach her home due to road blocks.

April 6, 1994 F0 Tornado

An F0 tornado touched down near the main street of Bucoda. Several buildings sustained damage, including aluminum sheds blown over or moved, rain gutters torn off buildings, and a twisted street sign. A piece of one aluminum shed was seen 80 feet above the ground caught in a tree. The total damage from this event was estimated at $50,000.[19]

January 20, 1993 Inaugural Day Windstorm, Federal Disaster 981, Windstorm

One of the most powerful windstorms to hit Western Washington since the 1962 Columbus Day Storm, caused nearly $130 million in damages, resulted in five deaths, and destroyed 52 residential units statewide. Winds reached gusts of 55 mph at the Olympia Airport weather station.

The Thurston County region suffered near blackout conditions, only a few neighborhoods around the City of Tenino retained their power. The power outage forced the LOTT Wastewater Treatment Plant in Olympia to discharge nearly 1.3 million gallons of barely treated wastewater into Budd Inlet. Customers flooded local area stores for provisions – creating shortages in batteries, candles, and bottled water. The Hawks Prairie BP gas station was one of only two operational stations in the county and hundreds of people lined up for hours to fuel their vehicles. Lacey Police were called in to control the crowd; no arrests were made.[20]

August 27, 1983 Hail Storm

Two hail storms occurred 30 minutes apart on one evening in Thurston County. Both events reported three quarter inch size hail. No estimate of damage is known for this event.[21]

November 14-15, 1981 Windstorms

Two back-to-back windstorms brought winds with peak gusts of 64 mph to the region over a two-day period resulting in power outages for 60,000 households and businesses in the county. Nearly 150 boats broke loose from marinas in Budd Inlet. An estimated $3.4 million was reported in private property damages.

Storm Hazard Exposure Analysis

Severe storms affect every jurisdiction in the county. As a result, storm hazard exposure tables were not developed. The “total” columns in the population, employment, and assets tables provided for the other hazards provide useful information in assessing the population and assets at risk from a countywide hazard.

Essential Facilities and Infrastructure in Hazard Area

Based on the historical occurrence of natural hazards causing community impacts, severe storms 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 health care clinics, 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.

All essential facilities in Thurston County are located within the storm hazard area. Specific information on the location and type of facilities is maintained by Thurston County Emergency Management. Essential facilities include both public and private facilities. Table 4.2.1 lists the type and number of essential facilities located in the storm hazard area.

Summary Assessment

The probability of each storm element's occurrence varies, but winter storms frequently pack several hazardous elements across a period of consecutive days or weeks, therefore the overall probability of winter storm occurrence is high. The overall impacts described in both the hazard profile and the brief record of historical occurrences demonstrates that the region's vulnerability is also high. Therefore, the overall risk rating for severe winter storms is high.

Thunderstorms do occur in Thurston County, but the probability of occurrence of this storm element is low. Even thunderstorms that produce a combination of the listed elements rarely cause destruction beyond isolated areas. Therefore, the overall probability of occurrence, the vulnerability rating, and the overall risk for thunderstorms are all low.

Summary Risk Assessment for Winter Storms and Thunderstorms in the Thurston Region

Storm Type	Storm Hazard Element	Probability of Occurrence	Vulnerability	Risk
Winter Storm	High Winds	High	High	High
	Heavy Rain	High	Moderate	High
	Freezing Rain	Low	High	Moderate
	Heavy Snow	High	Moderate	Moderate
Overall	Assessment	High	High	High
Thunder Storm	Tornado	Low	Low	Low
	Hail	Low	Low	Low
	Lightning	High	Low	Low
Overall	Assessment	Low	Low	Low

Table 4.2.1 Essential Facilities in the Storm Hazard Area

Facility Type	TOTAL #	IN HAZARD AREA #	%
Medical Care			
Adult Family Home	124	124	100.0
Assisted Living	14	14	100.0
Dentist	110	110	100.0
Dialysis Center	3	3	100.0
Funeral Home	6	6	100.0
Hospital	2	2	100.0
Nursing Home	7	7	100.0
Pharmacy	42	42	100.0
Primary Care	91	91	100.0
Urgent Care	6	6	100.0
Government			
Court Services	3	3	100.0
Cultural Significance	2	2	100.0
Detention/Corrections	1	1	100.0
Fairgrounds	35	35	100.0
Fire Service	53	53	100.0
Government Services	56	56	100.0
Health and Human Services	2	2	100.0
Law and Justice	4	4	100.0
Law Enforcement	8	8	100.0
Port Facilities	35	35	100.0
Public Education	344	344	100.0
Public Higher Education	52	52	100.0
Public Works	33	33	100.0
Solid Waste	20	20	100.0
Transit	4	4	100.0
Utilities	238	238	100.0
Transportation (Centerline Miles)			
Roads	2,210	2,210	100.0
Intercity Transit Routes	157	157	100.0
Rural Transit Routes	96	96	100.0

Endnotes

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[16] Ibid

[17] Ibid

[18] Ibid

[19] Ibid

[20] John Dodge. 1993. "Wild Winds Whip Through South Sound." The Olympian. January 21, 1993.

[21] National Climatic Data Center. 2016

Hazard Type
FLOOD
Probability of Occurrence
HIGH
Vulnerability
MODERATE
Risk
HIGH

Chapter 4.3
Flood Hazard Profile

Introduction

Floods in Thurston County are common, and on an annual average basis, are the costliest natural hazard. Between 1962 and 2016, Thurston County received 18 federal disaster declarations related in some part to the adverse effects of flooding. Total countywide flood damage estimates over this period exceed $206 million.[1] The February 1996 flood cost uninsured private property owners in Thurston County losses of more than $22 million. Statewide, the Federal Emergency Management Agency (FEMA) has provided over $72 million in aid to flood victims, businesses, and local governments for the December 2007 floods and over $12.8 million for the January 2009 floods.

Comprehensive flood hazard management must address an entire watershed because rivers and their flood plains span multiple administrative boundaries. Activities outside of Thurston County's border such as forestry, development, and stormwater management practices can adversely influence the severity of flooding in communities downstream within the county. Flood hazard management is a complex process that must balance resource protection, natural ecological functions, flood damage protection, and community growth and development.

This flood hazard profile presents an overview of the sources, effects, risks, and a summary of historical incidents. In 2012 and 2016, Thurston County completed flood scenario modeling using a Geographical Information System (GIS) software tool, HAZUS, to estimate the effects of flooding and potential losses and impacts to Thurston County. This profile includes the results of this modeling from the *Thurston County Flood Hazard Mitigation Plan* and more recent analysis as part of a FEMA RISK MAP process. In addition, GIS hazard exposure data is shown for the incorporated and unincorporated portions of Thurston County, including local government and non-government essential facilities potentially at risk to floods.

Hazard Identification

In general, a flood is a temporary condition in which a normally dry area of land or infrastructure is inundated by excess standing or flowing water. Floods can occur during any season and at any time. Four principal sources of flooding impact Thurston County and are addressed individually in this hazard profile:

1. Riverine (river and stream)
2. Groundwater
3. Tidal
4. Urban

1. Riverine Flooding

Rivers and their floodplains are dynamic systems that perform important ecological functions, benefitting both wildlife and humans. Attempts to control floods by altering the physical characteristics of rivers and flood plains with dams, levees, or other flood control facilities, result in the loss, alteration, or significant reduction in the intrinsic ecological benefits these systems offer.

Flooding is a natural function of rivers, with their effects supporting productivity of wildlife and potentially increasing the fertility of farmlands within flood plains. Communities must balance the need to preserve the natural functions of floodplains with the need to protect property and human activities. Understanding how, when, and where to expect flood impacts is a first step in developing a mitigation strategy to minimize losses from floods and to protect the environment.

Riverine flooding occurs when excess flow and volume of water crests a river channel's normal capacity. Floodwaters consequently inundate areas within the river's floodway, flood plain, and other low lying areas that may not be mapped as flood hazard areas.

Cause of Riverine Flooding

Two to three days of prolonged rainfall, averaging two to five inches per day, a rapidly melting snow pack, or a combination of these conditions trigger such floods. The actual duration and rainfall amount needed to cause flooding depends on the initial condition of the river or stream, and groundwater and runoff conditions. The Nisqually River and the Chehalis River's extensive watersheds are subject to events outside the county that influence flooding downstream in the county.

Thurston County hydrological research reveals increased rainfall intensity in the region in the last two decades. The county continues to analyze stream flow and precipitation gauge data from its own network of monitoring stations, as well as the National Weather Service and United States Geological Survey (USGS) data. This research provides clues about the types of precipitation patterns that trigger small stream, riverine, and shallow groundwater basin flooding in the county. Initial findings reveal that six precipitation patterns appear to affect peak flood flow pulses in small Thurston County streams and shallow groundwater basins. These heavy rainfall scenarios have occurred within the last two decades (1998-2016) – some more than once. The precipitation patterns also correlate with larger river flood events. The previous five decades of the Olympia rainfall record show only one, two or three of the identified scenarios per decade.

Late wet season precipitation patterns seem to have the most significant effect on groundwater flooding and deep seated landslide susceptibility. Saturation of the subsurface soils peaks in March here. Any additional rainfall during this natural high water mark tends to rapidly overwhelm the remaining horizontal groundwater flow component in near-saturated soils.[2] Table 4.3.1 shows the precipitation patterns that cause major flood events on stream and rivers.

Table 4.3.1: Six Rainfall Patterns that influence Puget Sound Stream Flooding in Thurston County

<table>
<tr><th>Pattern</th><th>Description</th><th>Example</th></tr>
<tr><td>1</td><td>Early or late wet season rainfall (greater than 3-inch daily storm events) in October (Horton Overland Flow) or prolonged, above average rain in October or March and April</td><td>October 20, 2003: 4.14” storm event;
October 2, 1981: 3.56” storm event;
September – early October 2013 (September record rainfall);
March –April 2016 (prolonged well above average rainfall);
October –November 2016 (October record rainfall; November prolonged well-above average)</td></tr>
<tr><td>2</td><td>Five or six consecutive days of greater than 1-inch storm events punctuated by a greater than 2.5-inch storm event in the same series</td><td>November 2, 2006, 1.08”
November 3, 2006,1.02”
November 4, 2006, 1.5”
November 5, 2006, 1.88”
November 6, 2006, 4.31”
November 7, 2006, 1.02”</td></tr>
<tr><td>3</td><td>Two or more consecutive days of greater than 2-inch daily storm events</td><td>2007:
December 2, 2.2”;
December 3, 3.19”</td></tr>
<tr><td>4</td><td>Greater than 4-inch daily storm events (high landslide potential)</td><td>January 7, 2009, 4.82 inches
November 6, 2006, 4.31 inches
October 20, 2003, 4.14 inches
November 19, 1962, 4.25 inches</td></tr>
<tr><td>5</td><td>Three or more consecutive months of at or greater than 11-inch monthly totals (larger potential for ground water flooding in key basins)</td><td>Monthly Totals
<table>
<tr><th>Years</th><th>Nov</th><th>Dec</th><th>Jan</th><th>Feb</th></tr>
<tr><td>1955 – 1956</td><td>12.18</td><td>12.59</td><td>10.75</td><td></td></tr>
<tr><td>1973 – 1974</td><td>12.95</td><td>11.61</td><td>10.57</td><td></td></tr>
<tr><td>1998 – 1999</td><td>15.28</td><td>12.99</td><td>12.25</td><td>15.5</td></tr>
<tr><td>2001 – 2002</td><td>13.01</td><td>11.86</td><td>11.42</td><td></td></tr>
</table></td></tr>
<tr><td>6</td><td>A greater than 15-inch monthly total</td><td>November, 2006, 19.68”
February, 1999, 15.5”
November, 1998, 15.28”
November, 1990, 15.06”
November, 1964, 15.00”
November, 1962, 15”
January, 1953, 19.84”</td></tr>
</table>

Severity

Many factors influence the severity of riverine flooding such as the pre-existing condition of the ground water saturation levels, the topography and size of the watershed, freezing level, and the influence of human activity on the landscape (total amount of impervious surface, stormwater management, and other large-scale land uses such as logging). Thurston County Emergency Management issues three levels of flood severity to monitor flood stages and notify the public:

1. **Minor flooding (or flood stage):** A 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.
2. **Moderate flooding:** Individual residential structures are threatened and evacuation is recommended for selected properties. Some roads may be closed. Moderate damage may be experienced.
3. **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.

Thurston County Emergency Management identifies flood severity thresholds based on stream flow rates and gauge heights for the Deschutes, Chehalis, Nisqually, and Skookumchuck rivers using select gauges in the region (no USGS gauges are established on the Black River). Rivers are dynamic and all channels are subject to dimensional changes over time due to factors such as sediment and coarse woody debris deposition, and channel migration and braiding. Therefore, a direct comparison of flood events between years or decades for any given river based on flood gauge heights will vary.

The principal factors affecting flood damage are flood depth and velocity. The deeper and faster flood flows become, the greater the potential for damage and adverse impacts. Shallow flooding with high velocities is also capable of causing damage, as is deep flooding with slow velocity. This is especially true when a channel migrates over a broad floodplain, redirecting high velocity flows and transporting debris and sediment. Flood severity is often evaluated by examining peak discharges. Table 4.3.2 lists peak flows FEMA uses to map the floodplains of the planning area.

Table 4.3.2: Summary of Peak Discharges of Streams and Rivers within Thurston County

Source	Location	Drainage area (sq. mi.)	Discharge (cubic feet/second) 10-Year	50-Year	100-Year	500-Year
Black River	At County limits	124	2,820a	4,100a	4,940a	6,790
	Downstream of confluence with Beaver Creek	99	1,550	2,220	2,490	3,200
	Downstream of confluence with Waddell Creek	58.7	1,250	1,770	2,000	2,560
	Outlet of Black Lake - At Black Lake	5	210	303	342	431
Chehalis River	U.S. Geological Survey Gauge #12027500 near Grand Mound	895	38,600	50,100	55,000	66,600
Deschutes River	Downstream of Henderson Blvd.	160	5,990	7,960	8,800	10,800
	Upstream of confluence with Spurgeon Creek	127	5,630	7,450	8,230	10,100
	At Vail Loop Rd, Crossing	89.8	4,950	6,500	7,150	8,690
	Upstream of confluence with Mitchell Creek	44.1	2,690	3,590	3,980	4,900
	Upstream of limit of detailed study	33.3	2,120	2,860	3,180	3,930
Nisqually River	At Mouth	711	21,500	29,000	33,000	45,000
	Upstream of confluence with Horn Creek	488	21,000	28,000	32,000	44,000
	Upstream of Confluence with Tanwax Creek	446	20,500	27,000	31,000	43,000
Percival Creek	At Sapp Rd., SW	1.8	94	128	145	180
	At 54th Ave., SW	0.5	33	45	50	62
Scatter Creek	At downstream limit of detailed study	15.5	403	561	633	803
	At confluence with Scatter Creek tributary	11.0	314	436	492	622
	Upstream confluence with Scatter Creek tributary	4.6	167	230	258	324
	Scatter Creek Tributary - At confluence with Scatter Creek	6.4	212	293	330	415
	Scatter Creek Tributary - At State Route 507	10.3	66	90	102	126
Skookumchuck River	At State Route 507	113	6,990	9,100	9,980	12,100
	Upstream of Bucoda	90.2	6,400	8,290	9,060	10,900
	Upstream of confluence with Thompson Creek	65.9	5,790	7,440	8,110	9,700
Woodland Creek	At Pleasant Grade Rd., NE	24.6	151	205	228	284
Yelm Creek	From 1st St. to Centralia Canal	11.2	220	310	350	445
	From 103rd Ave. to 1st St.	9.8	200	285	325	410
	Upstream end of study reach, to 103rd Ave.	9.3	185	265	300	375

a= Includes effect of overflow from Chehalis River

Frequency of Riverine Floods

Floods are commonly described as having a 10-, 50-, 100-, and 500-year recurrence interval, meaning that floods of these magnitudes have (respectively) a 10-, 2-, 1-, or 0.2-percent chance of occurring in any given year. The frequency and severity of flooding are measured using a discharge probability, which is the probability that a certain river discharge (flow) level will be equaled or exceeded in a given year. Flood studies use historical records to determine the probability of occurrence for the different discharge levels. The flood frequency equals 100 divided by the discharge probability. For example, the 100-year discharge has a one percent chance of being equaled or exceeded in any given year. The "annual flood" is the greatest flood event expected in a typical year.

Many agencies use the extent of flooding associated with a one percent annual probability of occurrence (the base flood or 100-year flood) as the regulatory boundary. Also referred to as the Special Flood Hazard Area (SFHA), this boundary serves as a convenient tool for assessing vulnerability and risk in flood-prone communities. Many communities' maps show the extent and likely depth of flooding for the base flood. Corresponding water-surface elevations describe the elevation of water resulting from a given discharge level, which is one of the most important factors used in estimating flood damage.

These measurements reflect statistical averages only; it is possible for two or more rare floods (with a 100-year or higher recurrence interval) to occur within a short time period. Assigning recurrence intervals to historical floods on different rivers can help indicate the intensity of a storm over a large area. For example, the 1996 flood event exceeded the flood with 100-year recurrence interval on the Chehalis River, while the recurrence interval of that event for tributaries to the Chehalis such as the Skookumchuck River was determined to be 75 years.[3]

Recent history shows that Thurston County can expect an average of one episode of minor river flooding each winter. Large, damaging floods typically occur every two to five years. Urban portions of the county annually experience nuisance flooding related to stormwater drainage issues.

Sources of Riverine Floods

Six rivers in Thurston County (Map 4.3.1) experience episodic flooding: 1) Black; 2) Chehalis; 3) Deschutes; 4) Nisqually; 5) Scatter Creek; and 6) Skookumchuck. All the rivers, except for the Nisqually River, are lowland rivers fed primarily by watershed precipitation and groundwater flows. FEMA has mapped the SFHA for each river (Map 4.3.3). Although not a major river, Scatter Creek also has a designated high risk flood zone and has historically produced major floodwaters in southwest Thurston County. The following sections describe the six river systems and their flood stages within the planning area.

Flood Definitions

Flood Plain: A strip of relatively smooth land bordering a stream, built of sediment carried by the stream and dropped in the slack water beyond the influence of the swiftest current.

100-Year Floodplain: Lands which are subject to a one percent chance of flooding in any year. These areas are mapped as the "A" zone on the Flood Insurance Rate Maps (FIRM) of FEMA.

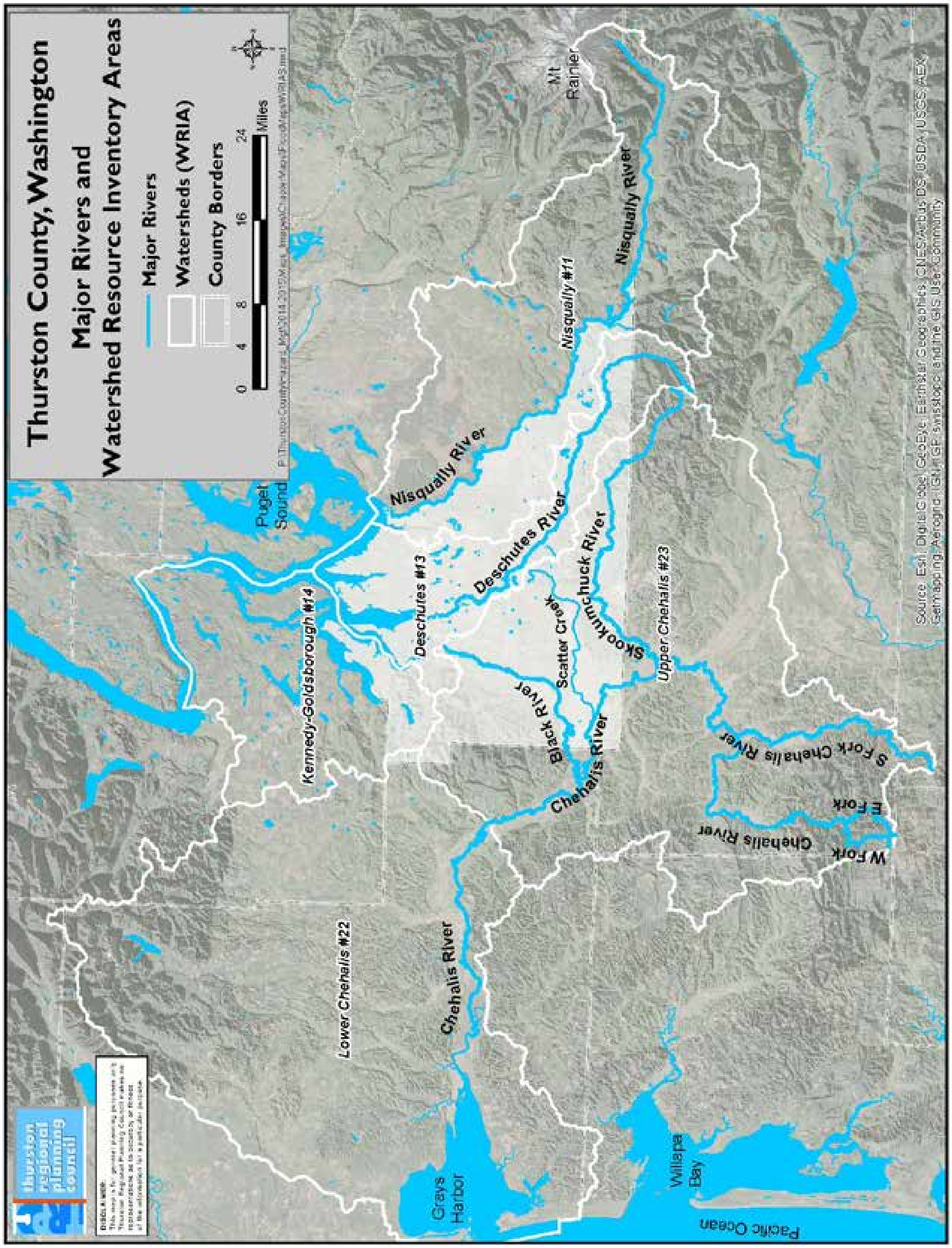
500-Year Floodplain: Lands which are subject to a 0.2 percent chance of flooding in any year. These areas are mapped as the "B" zone on the FIRM of FEMA.

Flood Stage: The stage at which overflow of the natural streambanks begins to cause damage in the reach in which the elevation is measured. Flood stages for each USGS gaging station are usually provided by the National Weather Service.

Floodway: The portion of the floodplain adjoining and including the river channel which discharges the flood water and flow of the river. It does not include portions of the floodplain where water is just standing. These areas are mapped as "Floodway" on both the Floodway and the FIRM of FEMA.

Special Flood Hazard Area (SFHA): The land area covered by the floodwaters of the base flood is the Special Flood Hazard Area (SFHA) on National Flood Insurance Program (NFIP) maps. The SFHA is the area where the National Flood Insurance Program's floodplain management regulations must be enforced and the area where the mandatory purchase of flood insurance applies. The SFHA includes Zones A, AO, AH, A1-30, AE, A99, AR, AR/A1-30, AR/AE, AR/AO, AR/AH, AR/A, VO, V1-30, VE, and V.

Map 4.3.1: Major Rivers and Watershed Resource Inventory Areas, Thurston County



Black River Basin

The Black River drains southwest from the south end of Black Lake into the Chehalis River near Oakville in Grays Harbor County. The Black River drainage is approximately 144 square miles, with 105 square miles in Thurston County. In general, the Black River is a slow flowing river with a broad floodplain. Most flooding along the main stem of the river is inundation flooding with low-velocity floodwaters.

The Black River drainage basin is divided into two parts. The west half of the basin drains the Capitol Forest area. The main tributaries in this section include Dempsey, Waddell, and Mima creeks. This area ranges in elevation from 2,659 feet at Capitol Peak to 200 feet at the Black River valley floor. The basin is subject to high-intensity, short-duration rain events that can produce flash flooding in these creeks. In general, snowmelt alone does not cause flooding in this area, however snow can compound this flooding.

The east half of the basin drains the relatively flat area south of Tumwater, west of Offutt Lake and north of Tenino. The elevation difference here is approximately 200 feet. The Salmon and Beaver creeks and Bloom Ditch are the main streams that drain this basin. These very slow-flowing water systems tend to cause inundation flooding with no velocity. This side of the basin is susceptible to high-groundwater flooding during periods of extended rain.

Because of its flat topography, the Black River is also susceptible to flooding by waters backing up from the Chehalis River. This appears to be the situation when flooding on the Chehalis River is concurrent with high tides along the coast.

Black River Flood Stage Impacts

In April 2005, the Washington State Department of Ecology established a river gauging station on the Black River where it crosses U.S. Highway 12 at River Mile 2. Unlike the gauging stations on the Chehalis at Prather Road Bridge and at Porter, this gauge has not been rated and is not modeled to forecast flood levels. However, the following table reflects Thurston County Emergency Management's summary for flood stages at this river gauge.

Black River Flood Stages and Historic Crests

Flood Stage	Gauge Height	Conditions and Previous Years of Occurrence
Action	6 Feet	At 6 feet, residents should be aware that the river is likely to flood. 2006, 2007, 2009, 2010, 2011, 2012, 2015
Flood	8 Feet	At 8 feet, the Black River has reached flood stage; the river will spill out of its banks into nearby fields and woods with limited water over a few spots on local roads. 2006, 2007, 2010, 2011, 2015
Moderate	10 Feet	At 10 feet, moderate flooding will occur. This stage corresponds to 15.5 feet at the Prather Road Bridge on the Chehalis River. At this level, the Chehalis River in Thurston County will flood several roads in Independence Valley with swiftly moving water, including U.S. Highway 12 and James, Independence, Moon and Anderson Roads. Floodwaters will cut off access to and from the Chehalis Reservation and inundate nearby farmlands. Some residential structures may be threatened. 2006, 2007, 2015
Major	12 Feet	Major flooding occurs when the Black River reaches 12 feet. During the December 2007 flood, the gauge on the Black River recorded a stage of 14.5 feet. 2007

Chehalis River Basin

The 174-mile long Chehalis River emerges from three forks in remote forest lands in Lewis and Pacific counties. The river is divided into two watersheds, the Upper Chehalis (WRIA #23) and the Lower Chehalis (WRIA #22). The Chehalis River grows at the confluence of the West Fork Chehalis River and East Fork Chehalis River. From there, the Chehalis flows north and east, collecting tributary streams that drain the Willapa Hills and other lowland mountains in southwestern Lewis County. The South Fork Chehalis River joins the main river a few miles west of the City of Chehalis. The Newaukum River joins the Chehalis River at Chehalis, after which the river turns north, flowing by the city of Centralia, where the Skookumchuck River joins. Beyond Centralia, the Chehalis River flows north and west for a nine-mile course through the southwestern corner of Thurston County.

The Chehalis River flows into Thurston County (WRIA #23) approximately two miles west of Interstate 5 and flows north toward Grand Mound where it drains the Michigan Hill area and receives water from Prairie Creek and Scatter Creek. The river courses west through largely undeveloped rural lowlands scattered with small farms and gentle sloping forested hills. The river continues west and passes through the Confederated Tribes of the Chehalis Reservation before entering Grays Harbor County where it joins the mouth of the Black River.

Beyond Thurston County, the Chehalis River continues northwest where it joins the tributaries of the Satsop and Wynoochee rivers near the City of Montesano. The Chehalis River becomes increasingly affected by tides beyond this location and gradually widens into the Grays Harbor estuary where it is joined by several other rivers, becoming Grays Harbor.

Due to its large drainage area, the Chehalis River tends to rise slowly over a long period. Thurston County Emergency Management describes the three common scenarios for flooding on the Chehalis River within Thurston County:

- The most predictable scenario for the Chehalis occurs when rains fall over all southwestern Washington and all regional rivers and streams rise.
- The Chehalis River can also experience flooding when there is little or no rain in Thurston or Grays Harbor counties, but heavy rain in Lewis and Pacific counties. This causes flooding to occur later than normal.
- Flooding also occurs when heavy rain falls in Grays Harbor County, but not in Thurston or Lewis counties. Feeder streams can then fill the Chehalis and cause water to "back up" into Thurston County.

Chehalis River Flood Stage Impacts

The flood of record is 20.23 feet from December 4, 2007. The table below summarizes the flood impacts based on the Chehalis River flood stages at the gauge near Grand Mound at Prather Road Bridge, River Mile 59.9.

Chehalis River Flood Stages and Historic Crests

Flood Stage	Gauge Height and Discharge	Conditions and Previous Years of Occurrence
Action	12.2 Feet or 16,600 CFS	At 12.2 feet, the Chehalis River will locally spill out of its banks into nearby fields and over a few roads. 1933, 1936, 1943, 1945, 1946, 1948, 1949, 1953, 1954, 1955, 1956, 1964, 1966, 1980, 1983, 1984, 2003, 2009, 2011, 2012, 2013, 2014, 2015
Flood	14 or 22,900 CFS	At 14 feet, the Chehalis River will flood several roads in Independence Valley, including James Road, Independence Road and Moon Road. Flood waters will also cover nearby farm lands. 1933, 1937, 1939, 1941, 1945, 1946, 1947, 1948, 1949, 1950, 1954, 1955, 1956, 1957, 1958, 1959, 1960, 1961, 1963, 1964, 1965, 1966, 1967, 1968, 1970, 1971, 1972, 1974, 1975, 1980, 1981, 1982, 1983, 1986, 1989, 1990, 1992, 1995, 1997, 1998, 1999, 2001, 2002, 2003, 2004, 2005, 2006, 2007, 2010, 2011, 2012, 2014, 2015
Moderate	15.5 Feet or 29,600 CFS	At 15.5 feet, the Chehalis River will flood several roads in Independence Valley with swiftly moving water, including SR-12 and James, Independence, Moon and Anderson Roads. Floodwaters will cut off access to and from the Chehalis Reservation and inundate nearby farm lands. Some residential structures may be threatened. 1934, 1936, 1949, 1953, 1954, 1955, 1962, 1964, 1966, 1970, 1976, 1977, 1982, 1986, 1987, 1994, 1996, 1997, 1999, 2001, 2006, 2015
Major	17 Feet or 38,800 CFS	At 17 feet, the Chehalis River will cause major flooding, inundating roads and farm lands in Independence Valley. Deep and swift floodwaters will cover SR-12 and James, Independence and Moon Roads. Flooding will occur all along the river, including headwaters, tributaries and other streams within and near the Chehalis River Basin. 1935, 1937, 1951, 1971, 1972, 1974, 1975, 1986, 1990, 1991, 1994, 1995, 1996, 1998, 1999, 2007, 2009, 2015

Deschutes River Basin

The Deschutes River is a 53-mile-long lowland river that gives rise within Mt. Baker-Snoqualmie National Forest in north Lewis County. The river is in the Deschutes Watershed (WRIA #13). The Deschutes lies west of the Nisqually River and flows in a parallel pattern. The Deschutes is the fastest rising and falling river in the county, responding quickly to local rainfall and runoff. The river's watershed encompasses a great majority of the land area for the cities of Lacey, Olympia, and Tumwater. As the Deschutes River enters the urban growth area and the City of Tumwater, the river bank and surrounding land use becomes more developed, with several residences in the Tumwater Valley around the periphery of the Tumwater Golf Course. A riprap bank and additional hard banking channels the river through the Tumwater Valley Golf Course and parts of Tumwater Falls Park before it discharges into Capitol Lake near the Historic Olympia Brewery in Tumwater, just south of Interstate 5.

Capitol Lake is an artificial lake formed by a small dam at the north end of the lake in downtown Olympia. Washington State Department of Enterprise Services regulates the dam, which creates a freshwater lake to complement the Capitol Campus. Percival Creek joins the Deschutes River in Capitol Lake's central basin, near Marathon Park, just north of Interstate 5. When the tides and lake water level conditions permit the opening of the dam's radial gate, Capitol Lake drains into Budd Inlet.

Sediments carried down river are slowly accumulating on the lake bottom and effectively decreasing the lake's capacity. A multi-stakeholder study is underway to evaluate how the mouth of the Deschutes River will ultimately interface with Budd Inlet and how it will be managed within a heavily developed urban environment. This study evaluates the environmental, social, and economic implications for a variety of long-term management alternatives. Any final decision will have implications for flood management at the lowest end of the Deschutes River.

Deschutes River Flood Stage Impacts

The flood of record is 17.01 from January 9, 1990. The table below summarizes the flood impacts based on Deschutes River flood stages at the Rainier Vail Loop Bridge Gauge, River Mile 25.9.

Deschutes River Flood Stages and Historic Crests

Flood Stage	Gauge Height and Discharge	Conditions and Previous Years of Occurrence
Action	9 Feet or 2,570 CFS	At 9 feet, the Deschutes River locally spills over its banks into low fields and forested lands, mainly along Vail Cutoff Road and Reichel Road. 1949, 1950, 1951, 1952, 1953, 1954, 1955, 1956, 1957, 1958, 1959, 1960, 1961, 1962, 1964, 1965, 1966, 1967, 1968, 1970, 1972, 1974, 1975, 1977, 1979, 1982, 1989, 1990, 1991, 1992, 1994, 1995, 1996, 1997, 1998, 1999, 2001, 2002, 2007, 2009, 2011, 2015
Flood	11 or 3,950 CFS	At 11 feet, the Deschutes River will flood downstream in Tumwater Valley, including the golf course. Minor flooding will also occur in several residential areas, mainly Cougar Mountain and Driftwood Valley. Many roads and farm lands will also be flooded. 1949, 1953, 1955, 1957, 1960, 1962, 1963, 1964, 1966, 1967, 1970, 1971, 1972, 1975, 1977, 1982, 1987, 1988, 1990, 1994, 1996, 1997, 1998, 2001, 2003, 2006, 2011, 2012, 2014, 2015
Moderate	13.5 Feet or 5,970 CFS	At 13.5 feet, the Deschutes River will flood residential areas, especially Cougar Mountain, Driftwood Valley and Falling Horseshoe. Downstream flooding will occur in areas of Tumwater Valley, including the golf course. Many roads and farm lands will also be flooded. 1991, 1996, 1998, 2007, 2009
Major	15 Feet or 7,330 CFS	At 15 feet, the Deschutes River will cause major flooding, with swift and deep water flooding roads, farmlands and the residential areas of Cougar Mountain, Driftwood Valley, Falling Horseshoe and areas downstream in the Tumwater Valley. Flooding will occur all along the river including headwaters, tributaries and other streams within and near the Deschutes River Basin. 1972, 1974, 1990, 1996

The Nisqually River

The Nisqually River is the only river system within Thurston County that is fed primarily by melting snow pack and glacial ice. This 80-mile river is located within the Nisqually Watershed (WRIA #11). The river's headwaters begin on the southwestern slope of Mount Rainier at the base of the Nisqually Glacier in Mount Rainier National Park in Pierce County. The river flows west along the Pierce and Lewis County line until constrained by the Alder Dam; nearly halfway (river mile 44.2) to the river mouth at the Puget Sound. From Alder Reservoir, the Nisqually River forms a natural border for approximately 48 miles between Pierce and Thurston counties.

Alder Dam is a 330-foot high concrete arch dam with a crest length of about 1,600 feet, with a spillway designed for a maximum discharge of 85,000 cubic feet per second (cfs). Alder Reservoir is about seven miles long with a 3,065-acre surface area and a 214,500-acre-foot total storage capacity. The LaGrande Dam, a gravity structure 212 feet high and about 710 feet long, is 1.7 miles downstream from Alder Dam. The dam's spillway was also designed for a maximum discharge of 85,000 cfs. The LaGrande Reservoir provides a total storage capacity of 2,676 acre-feet. Tacoma Power operates both dams for hydroelectric power generation.[4] The reservoirs of both dams are relatively small and Tacoma Power is not required to provide flood control. Even so, Tacoma Power lowers the elevation of the lake, when possible, during winter months to enable some capture of high water inflows from rainstorms and snow melt.

The Nisqually River resumes a mostly natural unrestricted flow as it traverses northwest away from the LaGrande Dam, passing a diversion dam owned by the City of Centralia. The diversion dam and a canal divert water from the Nisqually River to generate 12 megawatts of hydroelectric power during peak flows at a plant northwest of the City of Yelm. The dam provides no floodwater storage capacity. The river courses past scattered residences in unincorporated Thurston County before it passes the communities of McKenna, Yelm, the Nisqually Pines neighborhood, the Nisqually Indian Reservation, and the undeveloped range lands of Joint Base Lewis McChord. Several small farms and residences are in the Nisqually Valley in the vicinity around Interstate 5 and Old Pacific Highway. The river enters the Puget Sound near the Billy Frank Jr. Nisqually National Wildlife Refuge.

Nisqually River flooding relates largely to the amount of water released from Alder and LaGrande dams. Feeder streams such as Ohop, Yelm, and Tanwax creeks also influence flooding, as do high tides in the Nisqually Delta. Conservation efforts including dike removal and revegetation work were recently completed to restore ecological functions of the Nisqually Estuary. It is unknown how this restoration will affect floods in the lower reaches of the river, as major flooding has not occurred since this work was completed.

Nisqually River Flood Stage Impacts

The flood of record is 17.13 feet from February 8, 1996. The National Weather Service issues a flood warning for the Nisqually River when forecast models indicate the river will reach a stage of 12 feet or higher at the McKenna Gauge at River Mile 21.8. The table below summarizes the flood impacts based on Deschutes River flood stages at this gauge.

Nisqually River Flood Stages and Historic Crests

Flood Stage	Gauge Height and Discharge	Conditions and Previous Years of Occurrence
Action	8 Feet or 9,970 CFS	At 8 feet, residents should be aware that the river is likely to flood. 1967, 2011, 2014
Flood	10 or 14,700 CFS	At 10 feet, the Nisqually River will flood at the lower end near the mouth. High tide levels on Puget Sound may increase the amount of flooding. The Nisqually River will also spill over its banks between LaGrande and McKenna. 1951, 1953, 1955, 1959, 1961, 1964, 1977, 1980, 1982, 1990, 1991, 1994, 1995, 1997, 2003, 2006, 2009, 2015
Moderate	13 Feet or 23,300 CFS	At 13 feet, the Nisqually River will flood from LaGrande downstream through McKenna to the mouth. Swift waters will flood roads, farms and some residential areas, including the residential care facility in McKenna. Erosion will likely damage properties along river banks. 1991, 1996, 1998, 2007, 2009
Major	14 Feet or 26,500 CFS	At 14 feet, the Nisqually River will cause major flooding from LaGrande downstream through McKenna to the mouth. Deep and swift waters will flood roads, farms and residential areas, including the residential care facility in McKenna. Erosion may cause severe damage. Flooding will occur all along the river, including headwaters, tributaries and other streams within and near the Nisqually River Basin. 1972, 1974, 1990, 1996

Scatter Creek

Located in the Upper Chehalis Watershed (WRIA #23), Scatter Creek is approximately 20 miles long with an additional 9.5 miles of tributaries. The creek flows west-southwest from McIntosh Lake, east of Tenino, to the Chehalis River near Rochester.

The creek crosses lands chiefly composed of highly porous glacial outwash materials. After Scatter Creek passes through the City of Tenino, the river flows through mostly undeveloped small farmland with scattered residences through unincorporated Thurston County. The lower end of the creek passes through the Grand Mound area which is scattered with residences and light industrial plants and businesses. The lower six miles maintains a year-round flow of water due to pumped groundwater sourced from effluent from a commercial fish farm. Significant reaches of the creek up stream remain dry during the summer because of a lowering of the water table from a variety of active water rights and exempt wells within the watershed.

The Scatter Creek Aquifer system is like a "propped up bathtub" that feeds into the Chehalis (a high ground water gradient and velocity). Ground water flooding in Scatter Creek impacts the municipal well field which is shallow – only 90 feet below ground surface. Even in years when the Chehalis does not flood, the ground water comes to ground surface at the well field. Also, the LIDAR data reveals Scatter Creek as large ancestral flood channels, so the stream itself does not seem to overbank as dynamically as a normal flood plain in the upgradient areas. The river just follows the larger ancestral 'scours.'[5]

No permanent long-term stream flow gauges exist on this creek, so little is known about its long-term hydrography. In addition, very little flood history data is published for this riverine system. The Scatter Creek Habitat Conservation Plan states that from 1993 to 1999, the wet season flows typically ranged from 80 to 400 cfs, with less frequent peaks in the range of 400 to 1,400 cfs. The maximum mean daily discharge during this period was 1,362 cfs on February 14, 1996 (historically a very wet year, coinciding with record flood levels for the Skookumchuck River).

The Scatter Creek Habitat Conservation Plan includes the following passage regarding flood flows[6]:

> *…About 50 percent of the basin delivers stormflow runoff to the valley bottom from the hill portions of the basin. This flow is mostly delivered from seven tributary creeks that enter Scatter Creek and elevated groundwater return flow. If stormflow runoff enters from the tributaries after a dry summer, it takes a while to fill the local groundwater and channel areas. Stormflow onto wet basin conditions creates the largest stormflow peaks. There are insufficient years of recorded flows on Scatter Creek to determine the relationship between flood frequency and magnitude.*

In 1996, Scatter Creek experienced major flooding, covering several county roads along its westward flow including Old Highway 99, Sargent Road, 183rd Avenue, State Route 12, and Denmark Street.[7]

The Skookumchuck River Basin

The Skookumchuck River is 43-miles-long with headwaters originating within Mt. Baker- Snoqualmie National Forest in north Lewis County. Located in the Upper Chehalis Watershed (WRIA #23), the river is arch-shaped and arcs upward into Thurston County for nearly 26 miles before it returns to Lewis County. The river flows northwest into Thurston County through commercial forest lands with relatively steep forested valley slopes. The Skookumchuck Dam, located about 10 miles east and upstream from the Town of Bucoda, constrains the river as it traverses west. The dam – a rolled earthfill embankment with a crest length of 1,320 feet and a height above streambed of 160 feet – has a gross storage capacity of 35,000 acre-feet. The dam's spillway, an ungated concrete ogee section 130 feet long, can pass the Probable Maximum Flood of 32,500 cfs.[8] TransAlta operates the dam, with a primary function to provide a controlled release of cooling water at the Centralia Steam Electric Plant in Lewis County.

The Skookumchuck River emerges from the reservoir and passes through a relatively flat open valley comprised of scattered small farms and residences. As the river bends south toward Lewis County, the valley narrows as the river flows through the Town of Bucoda. The river winds along the eastern edge of the town's core developed area. From here, the river flows southwest and runs roughly parallel with State Route 507 into Lewis County. The river continues south until it enters the more densely populated City of Centralia. The Skookumchuck River drains into the Chehalis River, in Centralia, just west of Interstate 5 and south of Harrison Avenue.

Skookumchuck River Flood Stage Impacts

The flood of record is 17.87 feet from February 8, 1996. The National Weather Service issues a flood warning for the Skookumchuck River when forecasts indicate that the river will reach a stage of 13.5 feet at the gauge near Bucoda. The table below summarizes the flood impacts based on Skookumchuck River flood stages at the gauge four miles downstream from Bucoda.

Skookumchuck River Flood Stages and Historic Crests

Flood Stage	Gauge Height and Discharge	Conditions and Previous Years of Occurrence
Action	11.5 Feet or 2,750 CFS	At 11.5 feet, residents should be aware that the river is likely to flood. 1968, 1970, 1972, 1977, 1980, 1982, 1986, 1987, 1994, 1997, 1998, 2001, 2006, 2007, 2010, 2012, 2014
Flood	13.5 Feet	At 13.5 feet, the Skookumchuck River will flood a few roads and low pasture lands near Bucoda. 1968, 1972, 1974, 1975, 1976, 1982, 1983, 1986, 1994, 1995, 1996, 1998, 1999, 2001, 2002, 2004, 2005, 2006, 2007, 2011
Moderate	15 Feet or 5,500 CFS	At 15 feet, the Skookumchuck River will flood several residential and business areas around Bucoda. Flood waters will cover many roads. 1971, 1972, 1974, 1975, 1977, 1986, 1987, 1990, 1991, 1995, 1996, 1998, 1999, 2001, 2003, 2006, 2014, 2015
Major	17 Feet or 8,650	At 17 feet, the Skookumchuck River will cause major flooding in the Bucoda area, with deep and swift flood waters inundating residential and business areas and numerous roads. Flooding will occur all along the river, including headwaters, tributaries and other streams within and near the Skookumchuck River Basin. 1990, 1996, 2009

Riverine Flood Impacts

Floods kill people in the United States every year. People caught unprepared and isolated by swift moving or flash flood waters can die from drowning, hypothermia, or trauma. The February 1996 flood caused nine deaths in the Pacific Northwest. Fortunately, advances in weather forecasting technology and hydrologic modeling produce accurate flood stage forecasts that provide communities with timely information. Radio broadcasts, television news, websites, social media, and telephone and simple text alert systems can provide residents of flood prone properties timely notification to safeguard belongings or evacuate.

While Thurston County has not experienced any flood-related fatalities in recent years, the 1996 flood involved rescue operations for 300 people. The December 2007 flood also involved rescue efforts for 36 individuals in and around the Rochester community. People with disabilities, elderly individuals, and people lacking transportation are vulnerable to floods as they may require assistance to evacuate or lack a safe place to take temporary shelter.

Fast rising flood waters can also eliminate the opportunity to provide for the safety of livestock and pets. Floods kill livestock and pets causing both economic and emotional hardship. Health risks may also arise if animal carcasses are not properly disposed.

Major and moderate flooding frequently inundate low lying roads around Thurston County, resulting in area-wide transportation disruptions. Flooding has closed both State Route 12 and Interstate 5 multiple times. As flood waters recede, woody debris and other objects left behind can pose hazards to travelers. Electric, gas, water, and communication utilities are also subject to damage and disruption.

Swift moving flood waters can damage or destroy bridges, roads, and railroads. Flood waters also erode streams and river banks and cause loss of wildlife and habitat. Slow moving flood waters can also significantly damage buildings and mechanical equipment. Inundation and sediment deposits can be extensive and require costly clean up and repairs to homes and buildings. Flood waters also damage or destroy vehicles and mechanical equipment. Homeowners are particularly hard hit due to the loss of shelter, furniture, bedding, clothing, household appliances, food, and other personal items. If not properly abated, sanitation problems can arise from contaminated wells, fouled septic systems, and mold growth.

Flood damage renders homes and businesses unsafe for occupancy, displacing individuals and families, and necessitating alternative housing and shelters for extended periods. The cleanup and recovery period is stressful for flood victims and disrupts their normal activities of daily living. Children miss school days, and business owners lose revenue. People recovering from floods may lose income absent emergency leave from their employer.

Despite the many adverse impacts from floods, river flooding is a natural process that can also benefit a variety of wildlife and natural resources. Flood waters can force rivers to change their course. The natural processes of erosion, stream braiding, sediment deposits, and channel migration are critical to the long-term viability of fish and wildlife habitat. The formation of oxbow lakes can support avian, mammalian, and amphibian populations. Deposits of gravel and sediments can foster the growth of alders, willows, and other vegetation and establish new riparian habitat. Trees that fall into rivers from bank erosion can entangle with other trees and coarse woody debris to form fish habitat. Flood deposition of upland sediments can enhance the fertility of valley floors and further support both native vegetation and agriculture.

Probability of Occurrence

Because rivers and streams cause nuisance flooding annually, and major riverine flooding occurs about every two to five years in Thurston County, there is a high probability of occurrence.

2. Groundwater Flooding

Groundwater flooding occurs when there is a high-water table and persistent heavy rains in an area where an upper, thin layer of permeable soils overlays an impermeable layer of hard pan. As the ground absorbs more and more rainwater, the groundwater table rises and causes flooding where it is higher than the surface of the ground. Map 4.3.3 shows high groundwater hazard areas in Thurston County.

Modes of Groundwater Flooding in Thurston County

Combined local and National Oceanic and Atmospheric Administration data reveal two types of weather patterns that trigger groundwater flood events:

Type 1: Intense – Short Duration Successional Storms: These storms are composed of long atmospheric river systems driven by the Pacific jet stream that draw sub-tropical moisture from the Pacific Ocean and release abundant rainfall as they reach land in the Pacific Northwest. They are characterized with warmer than normal temperatures and intense steady rainfall. Groundwater flooding occurs with two separate but successive storm events within a month, or if an atmospheric river system arrives later in the season after normal winter rains have "primed" the groundwater levels to near maximum. Normal high groundwater levels occur in mid- to late March, so if an atmospheric river system coincides with this normal peak, the capacity of the soils is exceeded and groundwater flooding occurs. This pattern appears to be increasing in frequency and intensity. Type 1 storm events also contribute to urban and stream flooding and landslides.

Type 2: Persistent Low-intensity Precipitation Pattern: This weather pattern is less common, but produces similar ground water flooding effects. Characterized by weeks of persistent low intensity daily rainfall measuring less than an inch per day that gradually topples the groundwater table. In most cases, this weather pattern causes more widespread flooding throughout the county, both in areas that routinely flood and in those not generally susceptible to groundwater flooding. The county has only experienced this pattern twice in the last decade – in 2002-2003 and in 2006-2007. In both instances, groundwater flooding was widespread and included areas not previously identified as susceptible to routine groundwater flooding. This implies that Type 2 events generate more widespread flooding than Type 1 events. Type 2 events do not appear to cause riverine flooding or landslides, but the data is insufficient to be certain of this conclusion.

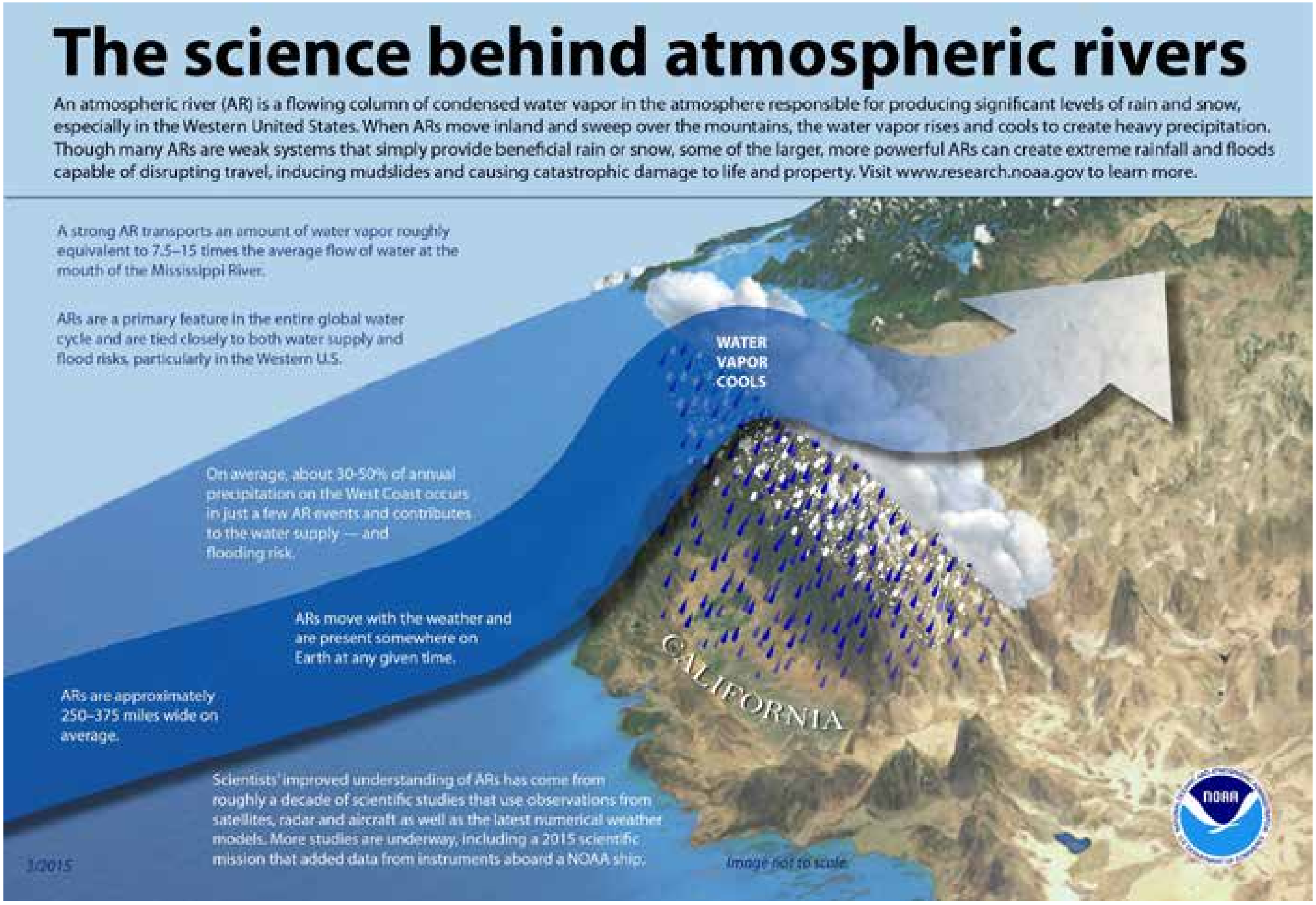


Image courtesy of the National Oceanic and Atmospheric Administration

Severity

Historic groundwater flooding has been most severe in the second and subsequent years of consecutive wet years. According to the U.S. Army Corps of Engineer's 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 first widespread groundwater flood event since 1972 and the worst on record until the winter of 1998-1999, is now the "event of record." This event set the benchmark for high groundwater flood hazard requirements implemented by Thurston County.

Extent

Nearly 54 square miles or 34,363 acres countywide (around seven percent) have experienced groundwater flooding. Areas that experience such flooding are scattered throughout the lowlands in Thurston County (Map 4.3.3), but it is most prevalent around the western and southern end of the Olympia Regional Airport, near Littlerock Road, and south of Tumwater along Case Road. Although groundwater flooding occurs sporadically throughout Thurston County, the geologic conditions present in the Salmon Creek Basin south of Tumwater create the "worst case scenario" for such flooding here.

Since areas of high groundwater are relatively flat, flood waters can remain standing for several months, resembling ponds or lake like conditions. The Salmon Creek Basin experienced significant flooding in 1999, resulting in contiguous bodies of standing flood waters ranging from small puddles to 113 acres. Depths ranged from near ground surface to over 12 feet deep. The volume of flood water above the surface of the ground in the basin was equivalent to 603 football fields covered with four feet of water. This amount combined with the volume of groundwater below the surface at the septic drain field level would be equal to 977 football fields or 28,655 acre feet.

Since 1999, this basin has experienced floods four more times, though none were as severe as in 1999. The combination of increasing storm severity and intensity in the past decade, coupled with population increases in the county, have brought people and floods ever closer together in developing areas. Other affected areas are in the Scatter Creek/lower Black system near Grand Mound and Rochester, eastern portions of the Lacey Urban Growth Area (UGA), Beaver Creek, the Spurgeon Creek systems, and in the Yelm UGA.

Impacts

In general, the damaging effects of groundwater flooding resemble those of riverine flooding. Traffic disruption may result from road closures. Homes may be inundated if they are not elevated above flood levels. Even if a home is elevated above floodwaters, crawl spaces and basements are subject to flooding. Deep water may surround the properties and make it nearly impossible to access and exit without a boat or makeshift elevated walkway. Septic tanks can become fouled and wells can be rendered useless from contamination. Underground utilities, drainage facilities, and storage tanks are also susceptible to damage from groundwater flooding. In many ways, groundwater flooding impacts can be difficult to mitigate because of limited options. For example, sandbagging and pumping have little effect on this type of flooding. Temporary relocation or evacuation of affected areas is often the best option.

Probability of Occurrence

Statistically, the U.S. Army Corps of Engineers (Corps) estimates an approximately 70 percent chance that the county will equal or exceed the 1996-1997 flooding at least once during a 30-year mortgage cycle. The Corps estimates that the frequency of a groundwater flooding disaster in Thurston County is probably on the order of every 25 years. Although not as frequent as riverine flooding, this recurrence rate is a high probability of occurrence. Detailed studies of climate trends by the University of Washington and others indicate that the Corps may be overly optimistic in their recurrence interval. In the past decade, the incidence and frequency of large rainfall events has increased, and climate models indicate that this trend may be here to stay. The studies that Thurston County has performed appear to support the trends detailed by climate agencies.

3. Tidal Flooding

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. Tidal flooding can also occur without the effect of storm surge. The tides can also enhance flooding in delta areas when rivers or creeks are at or near flood stage.

Severity

Puget Sound marine flooding by itself does not produce major flooding in the region. However, such flooding will become more frequent and present more adverse impacts in the second half of the 21st Century as sea levels rise. The Climate Change discussion provides more information on the impacts of sea level rise in downtown Olympia and unincorporated Thurston County.

Extent

The downtown Olympia waterfront, including Port of Olympia properties, face the greatest risk from tidal flooding. Localized flooding is common along 4th and 5th Avenues near the isthmus between Capitol Lake and Budd Inlet and nuisance tidal flooding occurs downtown at 17 feet mean lower low water. Low-lying farmlands in the Nisqually Valley and along McLane Creek near Mud Bay are at risk. Tidal flood impacts are also a concern in delta areas when rivers are at flood stage and high tide exacerbates the situation. Sea level rise will increase the extent of inundation during tidal flooding.

Impacts

During extreme high tide events, low lying areas are vulnerable to marine flooding. Numerous downtown Olympia stormwater outlets to Budd Inlet lack valves or flood gates and will back up, causing stormwater drains to overflow. Flood waters disrupt traffic, limit access to properties, and can interupt business. This problem is exacerbated during heavy rain events, increasing the extent of flooding in areas of downtown. Storm surge from wind can result in more extensive inundation. Tidal flooding generally subsides as tides recede. Presently, tidal floods are short, often lasting only one to two hours.

High tides influence the timing of dam water release from Capitol Lake near 5th Avenue in downtown Olympia. During the re-construction of portions of Heritage Park, an earthen berm was installed around the north and eastern perimeter of Heritage Park to prevent major flood waters from flowing into downtown from Capitol Lake. However, if the Deschutes River experiences major flooding and a high tide prohibits discharge of lake water into Budd Inlet, floodwaters could crest the lake bank at the southeast end of the north basin and flow into downtown Olympia along the utility road between the Capitol Campus Steam Plant and Water Street. Such flood conditions have not occurred since the berm was constructed.

Probability of Occurrence

Olympia experiences nuisance tidal flooding one to two times a year. Sea level rise will drastically increase the frequency of tidal floods.

4. Urban Flooding

Urban flooding occurs when excess precipitation is not readily absorbed by the ground and stormwater runoff exceeds the ability of stormwater facilities' capacity to safely convey and divert water within suburban and urban environments. As a result, streets, parking lots, homes, and businesses may experience localized flooding.

Excess water accumulation flowing off and over impervious surfaces from heavy rainfall or melting snow over a short period is the most common cause of urban flooding in the cities and developed areas of the county. Leaves, branches, snow or ice, and other debris that clog stormwater drains compounds the problem. Other forms of urban flooding occur in residential neighborhoods constructed with insufficient stormwater conveyance capacity. Until flooding reveals the problem, residents or municipalities may be unaware of deficient drainage systems in newer developments. New urban development or neighborhoods with faulty stormwater systems may adversely impact adjacent neighborhoods that previously did not experience stormwater flooding.

Severity

In general, properties impacted by urban flooding are not widespread and flood conditions are often localized. However, the impacts to transportation networks can be great. Downtown Olympia is vulnerable to urban flooding when extreme high tides coincide with persistent heavy rainfall and major flooding on the Deschutes River. The city can easily mitigate some stormwater flooding through regular cleaning and maintenance of stormwater conveyance systems.

Extent

Although it occurs throughout every city in Thurston County, urban flooding has historically impacted west and downtown Olympia.

Impacts

The impacts of urban flooding on homes, buildings, and utilities are similar to riverine and high groundwater flooding. Standing water can damage buildings and their contents. Excess stormwater flows can overwhelm urban creeks and cause washouts and landslides along steep slopes. Deep standing or flowing water over roads can result in moderate to major traffic disruptions affecting thousands of motorists during peak daily travel periods. Floodwaters can cause power disruptions or disable traffic signal controllers. Engine failure can strand motorists in their cars in deep water.

Probability of Occurrence

Some level of minor to moderate urban flooding coincides with major flooding on the Deschutes River; about every four and a half years. This frequency suggests a high probability of occurrence.

Effects of Climate Change on Flooding

Research and climate forecasts offer evidence that long-term climate change will have a measurable impact on the frequency and severity of flooding. 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 these communities.

Air temperatures are increasing in the Puget Sound Region, and are projected to warm rapidly during the 21st century, especially during the summer. By mid-century, warming will be outside of the range of historical variations. Because of warmer winters, watersheds will become increasingly rain dominant with streamflow 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.

Overall annual precipitation levels are forecast to remain the same, but with greater seasonal variation. Summers will become drier and winters 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.

For the Thurston County planning area, the following sections describe how climate change is anticipated to impact flood conditions on two fronts—hydrology and sea level rise.

Hydrology

Changes in temperature and precipitation will continue to decrease snow pack, affecting stream flow and water quality throughout the Pacific Northwest. Warmer temperatures will result in more winter precipitation falling as rain rather than snow, particularly in mid-elevation basins where average winter temperatures are near freezing. This change will result in less winter snow accumulation and higher winter stream flows. The Nisqually River, fed by snowmelt, will likely see earlier peak spring stream flow and lower summer stream flows.

The decline of the region's snowpack is predicted to be greatest at low and middle elevations due to increases in air temperature and less precipitation falling as snow. The average decline in snowpack in the Cascade Mountains, for example, was about 25 percent over the last 40 to 70 years, with most of the decline due to the 2.5°F increase in cool season air temperatures over that period. As a result, seasonal stream flow timing will likely shift significantly in sensitive watersheds.

Thurston County's rivers are less impacted by snowpack than other rivers in Western Washington, so would see less impact from changes to snowpack. However, any change in hydrograph associated with more concentrated, intense rainfall would greatly impact Thurston County's rivers.

Rivers with dams could experience significant impacts from a changed hydrograph, since dams are designed partly based on assumptions about a river's flow behavior, expressed as hydrographs. Changes in weather patterns can have significant effects on the hydrograph used for the design of a dam. If the hygrograph changes, it is conceivable that the dam can lose some or all its designed margin of safety, also known as freeboard. If freeboard is reduced, dam operators may be forced to release increased flows earlier in a storm cycle to maintain required margins of safety. Such early releases of flow can increase flood potential downstream. Throughout the western United States, communities downstream of dams are already experiencing increases in stream flows caused by earlier releases from dams.

Use of historical hydrologic data has long been the standard of practice for designing and operating water supply and flood protection projects. For example, historical data are used for flood forecasting models and to forecast snowmelt runoff for water supply. This method assumes that the climate of the future will be like that of the period of historical record. However, the hydrologic record cannot be used to predict changes in frequency and severity of extreme climate events such as floods. Going forward, model calibration or statistical relation development must happen more frequently; new forecast-based tools must be developed; and a standard of practice that explicitly considers climate change must be adopted.

Climate change is already impacting water resources, and resource managers have observed the following:

- Historical hydrologic patterns can no longer be solely relied upon to forecast the water future.
- Precipitation and runoff patterns are changing, increasing the uncertainty of water supply and quality, flood management, and ecosystem functions.
- Extreme climatic events will become more frequent, necessitating improvement in flood protection and emergency response.

Sea Level Rise

In 2016, Thurston Regional Planning Council (TRPC) performed a climate change vulnerability assessment for the development of the *Thurston Climate Adaptation Plan*. The assessment evaluated the impacts of climate change on the troposphere, fresh water ecosystems, marine ecosystems, terrestrial ecosystems, and human health and welfare. The assessment was drawn from numerous publications and data sources.

The marine ecosystems assessment accounted for sea level rise forecast conditions included in the University of Washington Climate Impacts Group's *State of Knowledge: Climate Change in the Puget Sound*. In addition, TRPC evaluated technical reports commissioned by the City of Olympia and LOTT Clean Water Alliance including the *City of Olympia Engineered Response to Sea Level Rise* by Coast and Harbor Engineering and the *Budd Inlet Treatment Plant Vulnerability Assessment Attributed to Climate Change* by Brown and Caldwell. City of Olympia and LOTT Clean Water Alliance staff both contributed data and empirical observations to this assessment. The following passage from TRPC's Thurston Climate Adaptation Plan Vulnerability Assessment describes sea level rise scenarios and their impacts to downtown Olympia and unincorporated Thurston County (the citations may be found in the original report).

> Throughout the 21st century, the Puget Sound region is expected to experience continued, and possibly accelerated, sea-level rise as a result of melting ice sheets and warmer oceans. This may result in permanent inundation of some low-lying areas, and increased frequency, depth, and duration of coastal flooding due to increased reach of tides and storm surges. Sea-level rise may also exacerbate river flooding by slowing the ability of water to drain into Puget Sound, as well as degrade drinking water sources.
>
> Globally, average sea level rose about 8 inches – roughly the same level recorded at the Seattle tidal gauge – during the 20th century. The Puget Sound region's sea level is projected to rise another 24 inches (range: +4 to +56 inches) by the end of this century, relative to [the year] 2000. Levels could be higher or lower than this range, however, depending on the rate that the local coastline is sinking or rising due to geologic factors and the rate that polar ice is melting. The analysis below examines how built and natural assets are vulnerable to coastal flooding and erosion associated with sea-level rise.

A March 2016 king tide event inundated downtown Olympia's Percival Landing and Sylvester Street. Sea-level rise is expected to raise the risk of coastal flooding associated with such high-tide events. Source: TRPC

Most Thurston County shorelines are stable. However, Olympia City Hall in downtown is subsiding by about 2.5 millimeters (0.9 inch) per decade. Thus, City of Olympia engineers estimate that sea-level rise could be 11 inches greater amid low-lying downtown – much of which is built atop fill – than the surrounding shoreline areas.

The City of Olympia established a policy in 2010 to protect downtown from flooding resulting from high runoff combined with a high tide that inundates the gravity-fed stormwater drainage system. Downtown Olympia generally experiences nuisance flooding just once or twice a year – sometimes more during periodic El Niño events – but the risk rises with the sea:

- With one foot of sea-level rise, Olympia could expect nuisance flooding 30 times annually, affecting approximately 261 structures and inundating up to 163 acres;
- With two feet of sea-level rise, Olympia could expect nuisance flooding 160 times annually; affecting approximately 328 structures and inundating up to 252 acres;
- With four feet of sea-level rise, Olympia could expect nuisance flooding 440 times annually or during more than half of its high-tide events, affecting approximately 402 structures and inundating up to 368 acres.

Downtown Olympia's importance to the region cannot be understated. The densely-built area is home to dozens of businesses, the Port of Olympia marine terminal, Olympia City Hall, LOTT Budd Inlet Treatment Plant, and other important facilities. Fortunately, local or state government agencies own or control most of the area's shoreline.

In addition to potentially disrupting commerce and damaging billions of dollars in public and private property, flooding amid the greater downtown Olympia area could pose temporary safety risks (e.g., inhibiting the movement of emergency service vehicles), as well as long-term health risks (e.g., mobilizing toxic chemicals at former industrial sites and inundating sewer lines and treatment facilities). To prepare for and cope with such risks, in 2017, the city will begin work on a sea-level rise management plan and funding strategy with assistance from partners including the State of Washington, Port of Olympia, and LOTT Clean Water Alliance.

The LOTT Clean Water Alliance also hired a consultant to evaluate the vulnerability of its Budd Inlet Treatment Plant – a critical facility that handles wastewater from almost 90,000 residential, commercial and industrial customers served by the sewer utilities of Lacey, Olympia, and Tumwater. The 2014 assessment, prepared by the consultant firm Brown and Caldwell, used five scenarios that incorporated University of Washington Climate Impact Group's sea-level rise projections – including combinations of sea-level rise, 100-year tidal flooding, and storm surge flooding – to identify inundation areas and high-level vulnerabilities at the treatment plant.

Under the three higher scenarios, critical infrastructure, including the effluent pump station, main utilidors (underground access tunnels), and a Puget Sound Energy substation, would be inundated. The two most extreme scenarios would also inundate the headworks building, administration building, multiple substations, and backup generators.

Any failure of these core services would likely shut down key sections of the plant, resulting in potential backup. If shutdown or failure of the core infrastructure were to occur, flow would back up through the collection system and exacerbate flooding throughout the sewer system, downtown Olympia, and possibly areas farther upstream.

The assessment recommended a variety of adaptation actions, most of which focus on raising electrical distribution panels above the projected high-water line, and preparing methods to seal off critical areas from flood waters.

Low-lying sections of Interstate 5 and U.S. Route 101 could also be vulnerable to the combined effects of flooding and sea-level rise in the future. These highways are critical to ensuring that commercial trucks, commuter cars, emergency service vehicles, and other automobiles can move within and through the Thurston County region.

McAllister Creek occasionally floods Interstate 5 on- and off-ramps south of the Billy Frank Jr. Nisqually National Wildlife Refuge (milepost 114). Sea-level rise would worsen this, according to a recent Washington State Department of Transportation vulnerability assessment of transportation infrastructure. The embankment atop which Interstate 5 sits was never evaluated for open water at its toe. The levee removal at the Nisqually delta and the rising sea level exposes the toe to potential wave action.

Similarly, along U.S. Route 101, as it crosses Mud Bay west of Olympia, water currently backs up in culverts and floods the highway's median during high tides. There is the potential for water to flood travel lanes temporarily due to sea-level rise.

Increased exposure to water and wave energy resulting from sea-level rise is expected to erode unprotected coastal bluffs, causing both detrimental and beneficial impacts. Coastal bluff erosion may threaten nearby buildings and occupants, yet this naturally occurring process may also contribute sand and gravel that would allow for down-drift shores to become higher and move landward, thereby maintaining the beach profile.

More than a quarter of Puget Sound's shoreline is armored with rock revetments, seawalls and other materials built to protect homes, roads, and other infrastructure. However, such barriers do not guarantee that the land behind them is invulnerable to the sea's growing reach.

Seawalls and revetments are usually designed for a particular set of conditions. If rising sea levels continue to magnify the effects of high tides and waves, the original freeboard will be exceeded by seawater gradually and overtopping will become more frequent. This would increase the probability of structural damage.

Steven Wyble / Nisqually Valley News

Estimates of Flood Losses

Computer models can simulate flood scenarios to estimate potential property losses and other impacts to communities. The HAZUS Flood Model is a standardized tool that uses Geographical Information System (GIS) technology to estimate physical, economic, and social impacts of disasters using a variety of data inputs. FEMA Region X performed a level 2 analysis using local data provided by Thurston County and Thurston Regional Planning Council to develop the county's flood model. The models included the recently adopted Deschutes River SFHA and draft versions of the Chehalis and Coastal SFHAs. Loss estimates were derived for 10-, 25-, 50-, 100-, and 500-year flood scenarios. For these, scenarios, debris generation, sheltering requirements, building exposure, and building losses are presented.[12]

Debris Generation

HAZUS provides an estimate of the total debris generated by floods. The 500-year flood event – the most wide-spread flood scenario – generates the most debris. HAZUS breaks the debris generation estimates into three categories:

1. Finish (dry wall, flooring, insulation, etc.)
2. Structure (framing, walls, exterior cladding)
3. Foundation (concrete slabs, concrete block or other foundation)

The table below summarizes debris generation for the Chehalis Basin, Deschutes Basin, coastal SFHA, and countywide.

Estimated Tons of Debris Generation by Flood Scenario

CATEGORY	FLOOD EVENT	TOTAL	CHEHALIS	COASTAL	COUNTYWIDE	DESCHUTES
FINISH	0.2 PERCENT	3179.09	1967.22	N/A	N/A	1211.87
	1 PERCENT	8272.71	1556.28	626.31	5094.64	995.48
	2 PERCENT	2324.55	1418.81	N/A	N/A	905.74
	4 PERCENT	2176.42	1368.81	N/A	N/A	807.61
	10 PERCENT	1475.76	790.96	N/A	N/A	684.8
STRUCTURE	0.2 PERCENT	1404.55	1240.07	N/A	N/A	164.48
	1 PERCENT	3072.16	700.96	544.4	1713.68	113.12
	2 PERCENT	675.26	578.69	N/A	N/A	96.57
	4 PERCENT	618.88	537.42	N/A	N/A	81.46
	10 PERCENT	320.79	255.95	N/A	N/A	64.84
FOUNDATION	0.2 PERCENT	1895.82	1618.28	N/A	N/A	277.54
	1 PERCENT	4168.87	1027.56	449.28	2489.01	203.02
	2 PERCENT	1064.7	886.61	N/A	N/A	178.09
	4 PERCENT	992.12	838.36	N/A	N/A	153.76
	10 PERCENT	559.44	432.79	N/A	N/A	126.65
GRAND TOTAL	0.2 PERCENT	6479.51	4825.61	N/A	N/A	1653.9
	1 PERCENT	15513.98	3284.85	1620.1	9297.38	1311.65
	2 PERCENT	4064.43	2884.07	N/A	N/A	1180.36
	4 PERCENT	3787.48	2744.58	N/A	N/A	1042.9
	10 PERCENT	2356	1479.66	N/A	N/A	876.34

Shelter Requirements

The following HAZUS table provides estimates of the number of people who are displaced by flooding and who may require short-term sheltering.

Estimates of Displaced People and Sheltering Needs

	FLOOD EVENT	TOTAL	CHEHALIS	COASTAL	COUNTYWIDE	DESCHUTES
DISPLACED POPULATION	**0.2 PERCENT**	**3028**	**1705**	**N/A**	**N/A**	**1323**
	1 PERCENT	9697	1503	412	6552	1230
	2 PERCENT	2581	1423	N/A	N/A	1158
	4 PERCENT	2425	1356	N/A	N/A	1069
	10 PERCENT	1936	979	N/A	N/A	957
SHORT-TERM SHELTERING	0.2 PERCENT	1982	1090	N/A	N/A	892
	1 PERCENT	6028	901	274	4041	812
	2 PERCENT	1577	822	N/A	N/A	755
	4 PERCENT	1445	766	N/A	N/A	679
	10 PERCENT	1033	439	N/A	N/A	594

Building Exposure

HAZUS provides estimates of the number of buildings exposed to floods. Countywide, a total of 5,156 buildings are in Special Flood Hazard Areas.

Estimates of Buildings in Special Flood Hazard Areas

COMMUNITY	BUILDINGS IN A SPECIAL FLOOD HAZARD AREA	BUILDINGS IN ZONES A, AE, AO (RIVERINE/STILLWATER)	BUILDINGS IN ZONE AE (COASTAL)	BUILDINGS IN ZONE VE (COASTAL)
Bucoda	194	194	0	0
Chehalis Reservation	3	3	0	0
Lacey	27	27	0	0
Nisqually Reservation	2	2	0	0
Olympia	355	291	43	21
Rainier	0	---	---	---
Tenino	5	5	0	0
Tumwater	82	79	3	0
Yelm	23	23	0	0
Thurston County	1,887	1,724	40	123
TOTAL	**2,578**	**2,348**	**86**	**144**

Note: Buildings identified in a Special Flood Hazard Area by using parcel centroids. Effective Special Flood Hazard Area data used inland. Preliminary Special Flood Hazard Area data used for coastal flood zones.

Building Value Loss

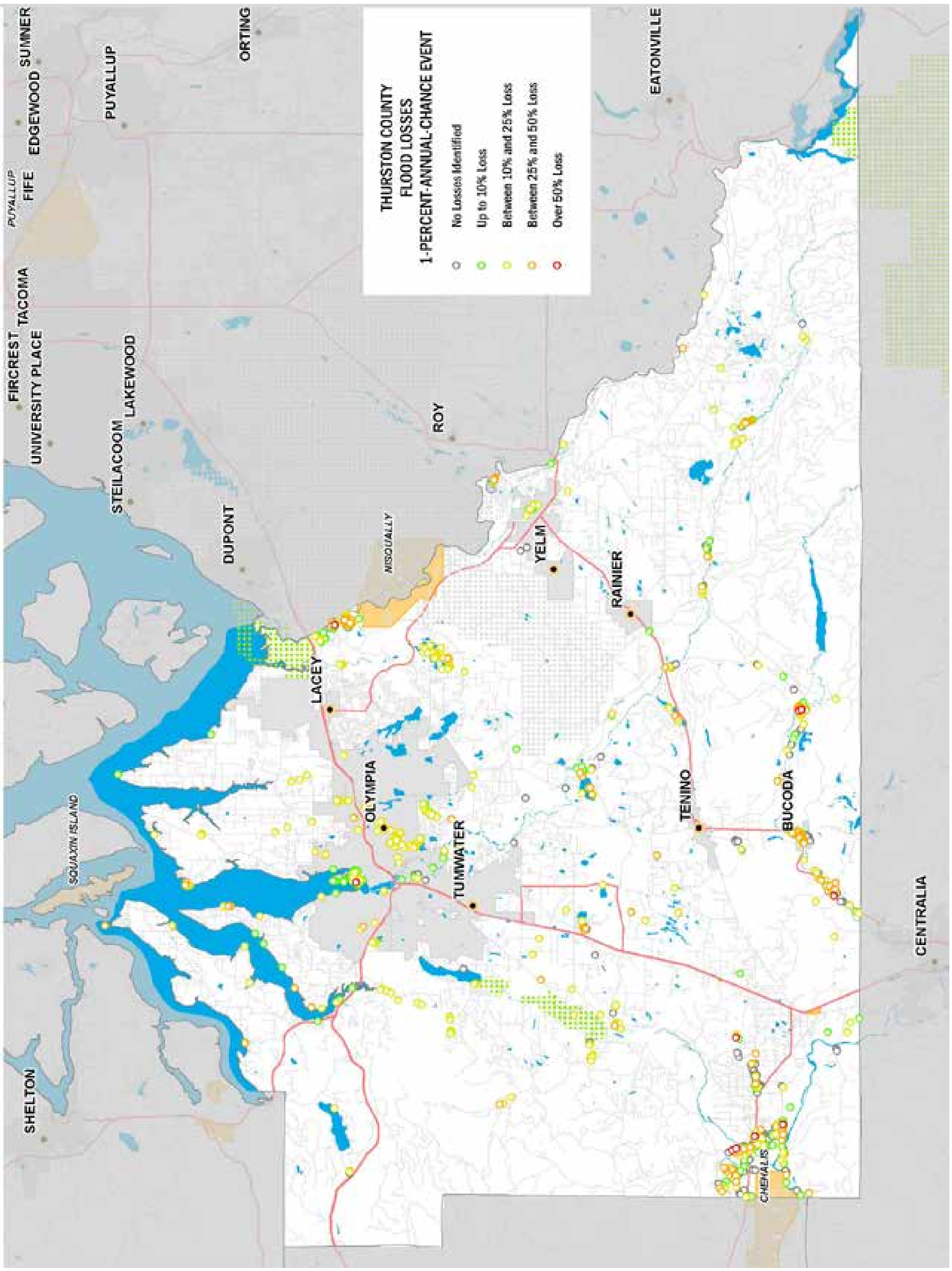
HAZUS calculates estimates of the economic loss of buildings and their contents due to damage from flooding. Below is a summary of losses, by jurisdiction for the 10-, 25-, 50-, 100-, and 500-year flood scenarios. Map 4.3.2 shows the location of building losses for the 100-year flood.

Estimates of Building Losses by Flood Event

			0.2% ANNUAL CHANCE FLOOD		1% ANNUAL CHANCE FLOOD		2% ANNUAL CHANCE FLOOD		4% ANNUAL CHANCE FLOOD		10% ANNUAL CHANCE FLOOD	
COMMUNITY	COUNT	TOTAL VALUE	LOSS VALUE	LOSS RATIO	LOSS VALUE	LOSS RATIO	LOSS VALUE	LOSS RATIO	LOSS VALUE	LOSS RATIO	LOSS VALUE	LOSS RATIO
Bucoda	115	7.48	1.52	20.30%	1.34	17.80%	1.09	14.60%	1.09	14.60%	0.27	3.60%
Chehalis Reservation	5	0.29	0.01	4.10%	---	---	---	---	---	---	---	---
Lacey	1	0.25	---	---	0.03	10.40%	---	---	---	---	---	---
Nisqually Reservation	2	0.32	---	---	0.03	9.50%	---	---	---	---	---	---
Olympia	251	244.33	---	---	26.31	10.80%	---	---	---	---	---	---
Rainier	0	---	---	---	---	---	---	---	---	---	---	---
Tenino	0	---	---	---	---	---	---	---	---	---	---	---
Tumwater	18	12.98	0.98	7.50%	0.36	2.70%	0.04	0.30%	0.02	0.20%	0	0.00%
Yelm	8	1.46	---	---	0.09	6.40%	---	---	---	---	---	---
Thurston County	802	95.71	9.36	9.80%	12.18	12.70%	4.23	4.40%	3.75	3.90%	1.33	1.40%
TOTAL	**1,202**	**362.83**	**11.87**	**3.30%**	**40.33**	**11.10%**	**5.36**	**1.50%**	**4.86**	**1.30%**	**1.6**	**0.40%**

Note: Values are expressed in millions of dollars. Dollar losses are reported, as well as a loss ratio, which is calculated as the total building losses/total building value. The loss values are for building and contents only; additional damages to infrastructure are not captured in this table.

Map 4.3.2: Thurston County Flood Losses, 100-Year (1-Percent Annualized Chance) Flood Event



Flood Historical Occurrences and Impacts

Several major floods have impacted the Thurston Region over the last two decades. Describing the effects and damages from the most significant events highlights the region's vulnerability to floods and the extent of their damage. Past floods serve as useful reminders to communities to develop strategies to mitigate, prepare, and respond to future floods. The top 10 historic crests for the Nisqually, Deschutes, Skookumchuck, and Chehalis rivers:[9]

Top Ten Historic Crests for Thurston County Rivers

	Nisqually at McKenna		Deschutes near Rainier		Skookumchuck near Bucoda		Chehalis near Grand Mound	
Rank	Gauge Height	Date	Gauge Height	Date	Gauge Height	Date	Gauge Height	Date
1	17.13	02/08/1996	17.01	01/09/1990	17.87	02/08/1996	20.23	12/04/2007
2	13.00	01/29/1965	15.74	02/08/1996	17.72	01/08/2009	19.98	02/09/1996
3	12.48	11/30/1995	15.68	01/15/1974	17.33	01/10/1990	19.34	01/10/1990
4	12.39	12/26/1980	15.28	01/21/1972	17.23	11/25/1990	18.41	11/25/1986
5	12.38	12/12/1955	14.29	12/29/1996	16.82	01/21/1972	18.39	12/29/1937
6	11.78	11/23/1959	14.10	01/08/2009	16.82	04/05/1991	18.21	01/21/1972
7	11.31	01/10/1990	13.76	04/05/1991	16.76	12/30/1996	18.18	01/09/2009
8	11.30	02/11/1951	13.75	12/03/2007	16.60	02/11/1990	18.12	11/25/1990
9	11.14	04/05/1991	13.55	11/26/1998	16.60	12/09/2015	17.73	12/05/1975
10	11.04	12/10/1953	13.42	12/28/1998	16.51	03/09/1977	17.66	04/06/1991

January 6-16, 2009, Federal Disaster 1817: Severe Winter Storms, Landslides, Mudslides, and Flooding

An atmospheric river storm raised temperatures and dropped heavy rains throughout Western Washington following one of the worst Pacific Northwest snow storms in decades. Severe flooding occurred throughout Western Washington, including the Chehalis, Skookumchuck, Deschutes, Nisqually, and Black rivers. The Skookumchuck River crested at 17.72 feet on January 8, making it the second worst flood in the river's recorded history. The Chehalis River crested at 18.18 feet near Grand Mound causing major flooding in the Chehalis River Basin only 13 months after the December 2007 floods.

Interstate 5 was closed for 20 miles for nearly two days. State Route 12, State Route 8 and Highway 101 were also closed for a period, some for multiple days. During the height of the flood event, 49 county roads were closed. Over 200 homes were isolated in the Bald

Hills Road/Clearwood area, likely over 100 in the Rochester, Grand Mound, and Gate communities, and likely another 50 homes had access issues in the area around Bucoda.

Damages to homes throughout Thurston County were estimated at $3 million. Damage was concentrated in and around the town of Bucoda, the Rochester community, and along the Deschutes River outside of Yelm. Damages to public facilities and roads around Thurston County and the overtime cost for city and county officials to respond to the flooding cost $2.5 million.

Volunteer firefighters went door to door in Bucoda warning residents of imminent flooding before floodwaters swallowed a nine-block stretch of the town (the town's worst flood event since 1996). Residents were forced to evacuate and a Thurston County dive team was deployed to assist residents. At least two households required rescue assistance. One home was identified as too dangerous to inhabit and 12 homes were deemed moderately damaged and only accessible during the daytime. The Intersection of 3rd Avenue and North Nenant Street incurred damages exceeding $12,000. Extensive road damage along five blocks of Market Street also occurred. At least one municipal well was forced to shut down due to possible contamination. The town-owned RV park restroom was also contaminated by floodwaters and required extensive clean up.

On January 8, the City of Lacey shut down two streets for the first time in at least nine years due to urban flooding. Crews closed Rainier Road at the south end of city limits around the Burlington Northern Santa Fe (BNSF) railroad trestle. The City also closed 32nd Avenue Northeast off Marvin Road in the Hawks Prairie area. The heavy rains entering the sewer system in Olympia forced the LOTT Alliance to discharge 6.3 million gallons of partially treated wastewater from its Budd Inlet Sewer Treatment Plant via its emergency outfall at the Fiddlehead Marina.

December 1-7, 2007, Federal Disaster 1734: Severe Winter Storms, Flooding, Landslides, and Mudslides[10]

Snow followed by a "Pineapple Express" on December 2 and 3 caused major flooding throughout southwest Washington. Heavy rainfall and melting snow resulted in record flooding on the Chehalis River, which crested at 20.23 feet, six feet over flood stage at the Grand Mound gauge. Some sites in the Willapa Hills area collected 14 to 18 inches of rain over the two-day period. Widespread flooding occurred in southwest Thurston County heavily impacting the Rochester community, Grand Mound, and the Independence Valley area. Lewis County was especially hard hit, particularly around the cities of Centralia and Chehalis and the farms around Adna and the Boisfort Valley.

The Deschutes and Black rivers also rose above their banks. The Deschutes River crested 2.75 feet above flood stage near Rainier and flooded residential areas and the Tumwater Valley. The region also experienced stream and urban flooding and flash flood conditions in the Capitol Forest, resulting in washouts and landslides (see landslide hazard profile for other details on this event).

On December 4, Rochester Fire Department developed a command post for evacuation and rescue. They partnered with the Thurston County Sheriff's Office Dive Team, local search and rescue volunteer groups, and the Washington State National Guard and rescued 63 people – 17 by helicopter. Nearly 300 people were rescued or forced to evacuate in Lewis County – some seeking refuge in local area shelters. Thurston County opened a flood relief center at the Rochester Community Center to assist affected residents.

Thurston County documented 44 county roads and bridges that closed from storm and flood damage. The county and cities carried out round-the-clock road repair and maintenance. Estimates reflect that over 400 homes in the area were affected by the road closures in the southwest Thurston County. Interstate 5 closed for 20 miles between Chehalis and Grand Mound for five days. Some portions of Interstate 5 were covered with 10 feet of water. The Washington State Department of Transportation estimated that the closure resulted in $47 million in lost of economic output statewide.[11] Additional closures along Highway 101 and Highway 8 disrupted traffic for thousands of people who live or work in Thurston County, or who were passing through. A railroad bridge over the Nisqually River suffered significant damage due to debris collection against the bridge, resulting in a disruption of statewide rail traffic. West coast rail traffic was also shut down for several days due to flooding.

Nearly 10 inches of rain fell on the City of Olympia's west side resulting in the worst urban flooding ever experienced in that area. On December 3, 2007 during the morning peak commute period, the west side of Olympia experienced major traffic backups for hours due to road closures. One of the highest traffic volume intersections in the region, Cooper Point Road and Black Lake Boulevard off Highway 101, experienced major flooding resulting in permanent damage to the signal controller. Several motorists attempted to drive through the water only to become stranded and forced to abandon their vehicles. Some vehicles were eventually completely submerged. Inundation forced the closure of the Percival Creek Bridge on Cooper Point Road. Several businesses on Olympia's west side were affected by floodwaters and power outages. Puget Sound Energy turned off power as a safety precaution requiring businesses to temporarily close. The Woodshed, a furniture retailer, lost their entire inventory to three feet of water. Replacement cost was estimated at $250,000.

On December 3, the enormous volume of rainfall and runoff caused LOTT Clean Water Alliance's Budd Inlet Sewer Treatment Plant to discharge untreated wastewater into Budd Inlet. At its peak, an estimated 1 million gallons per hour bypassed treatment processes and was sent through the emergency outfall near Fiddlehead Marina. After the flooding, many wells and water supplies were contaminated and non-functional in the unincorporated areas of the county. Public health advisories were issued to flood affected areas to inform the public to boil their water or consume only bottled water.

Preliminary cost estimates for the response, preventive measures, and the damage to public facilities exceeded $4.6 million throughout Thurston County. In many ways, the dollar figures reported for response costs only reflect a fraction of the actual response costs to local governments. For example, the estimates may not include volunteers, such as the local fire districts' volunteer firefighters who provided emergency response. Damage to Thurston County roads and bridges for non-federal aid routes was $2.7 million. Three sites of federal aid roads incurred over $32,000 in damages.

For this disaster, nearly 267 Thurston County residents applied to FEMA for assistance with over $6 million claims in property damages. FEMA awarded $544,928 in aid and the Small Business Administration granted $1.7 million to 30 homeowners and 2 businesses.

October15-23, 2003, Federal Disaster 1499: Severe Storms and Flooding

At least 11 people reported flood damage within Thurston County, with at least two structures possibly incurring damage exceeding their replacement value. Thurston County was not seriously impacted by this storm event and received a disaster declaration because it bordered counties that experienced more severe flooding (Mason, Pierce, and Grays Harbor counties).

February 1999 High Ground Water Flooding

Higher than normal rainfall caused major groundwater flooding and urban stormwater flooding throughout Thurston County and its communities. Although no federal disaster was issued, major flooding affected over 200 properties in Lacey, Olympia, Tumwater, and Thurston County. (See landslide hazard profile for more on landslide impacts during this event).

December 1996 (Federal Disaster 1159) to February 1997 Winter Storm and Flooding

1996 was the third wettest year of the 20th Century. December was especially wet, receiving over twice its normal monthly rainfall. During this time:

- 200 homes countywide were flooded
- 200 drinking water wells were contaminated
- Septic system failures occurred throughout the county
- Response and recovery efforts cost Thurston County government over $340,000
- Response, recovery, and repair costs for other government entities and utilities exceeded $750,000
- Private property owners incurred over $1.75 million in uninsured losses

February 1996, Federal Disaster 1100: Flooding

The February 1996 flood is one of the most devastating floods on record for Thurston County. Every major river and stream crested their banks. Record flooding occurred on the Nisqually River near McKenna when the river crested at 17.13 feet, seven feet over flood stage on February 8, 1996. Record flooding also occurred on the Skookumchuck River near Bucoda when the river crested at 17.87 feet, four feet over flood stage. Major flooding also occurred on the Deschutes and Chehalis rivers. The 1996 flood resulted in the following impacts:

- Of the over 350 homes inspected, 190 were declared uninhabitable
- 47 homes were destroyed in the Nisqually Valley
- Over two dozen homes were destroyed elsewhere
- Nearly 1,000 people evacuated their homes
- 300 people required rescuing
- More than 300 sections of the county road system were damaged
- Wa He Lut, a contract U.S. Bureau of Indian Affairs School, was destroyed by the Nisqually River
- Interstate 5 was closed at the Lewis County line
- The main north-south railroad line at the Pierce County line was closed
- Response and recovery efforts cost Thurston County government over $2 million
- Response, recovery, and repair costs for other government entities and utilities exceeded $20 million
- Private property owners incurred over $22 million in uninsured losses.

January 1990, Federal Disaster 852: Severe Storm and Flooding

The Deschutes River at Rainier crested at 17.01 feet, six feet over flood stage – setting the flood record. Major flooding also occurred on the Nisqually, Deschutes, Skookumchuck, and Chehalis rivers. The Thurston Region experienced the following impacts:

- Flood waters in Lewis County killed two people
- Interstate 5 closed for several days between Chehalis and Thurston County
- 83 elderly residents from the Nisqually Valley Care Center in McKenna were evacuated to a Red Cross Shelter at the Yelm High School gymnasium
- Floodwaters reached four feet deep on Bucoda streets and prompted nearly 600 residents to evacuate; one elderly man died from natural causes during the evacuation
- Lowland Nisqually Valley residents were urged to evacuate their homes
- Portions of downtown Olympia experienced urban flooding

Flood Hazard Exposure Analysis

Delineation of the Flood Hazard Area

Map 4.3.3 shows the flood hazard areas for the Thurston County planning area. It consists of both the one percent annualized chance of flooding (100-year flood) and the 0.2 percent annualized chance of flooding (500-year flood) Special Flood Hazard Areas from the most current Digital Flood Insurance Rate Map (DFIRM 2012). This map incorporates the latest Deschutes River flood hazard areas provided by FEMA. It also includes Thurston County's High Groundwater Hazard Areas (including 300-foot buffers). These boundaries were used to perform a flood hazard exposure analysis employing a Geographical Information System (GIS) to summarize the total area, population, employment, residential dwellings, valuation of buildings and contents, and essential facilities. This information is summarized by jurisdiction and special districts in Tables 4.3.4 through 4.3.14.

Nearly 34,621 acres or 7.3 percent of the planning area is within the 100-year flood, whereas only 3,644 acres or 0.8 percent of the planning area is within the 500-year Special Flood Hazard Area. A nearly equal portion of the county, 34,214 or 7.3 percent, is within high groundwater hazard areas. Combined, nearly 14 percent of the county is exposed to natural flood hazards. Rural unincorporated Thurston County has the largest flood-prone areas of any community in the planning area (55,138 acres). However, 67 percent of the Chehalis Reservation is exposed to flood hazards and nearly 54 percent for the Town of Bucoda. Tables 4.3.4 and 4.3.5 summarize the total flood hazard delineation area by jurisdiction and special districts.

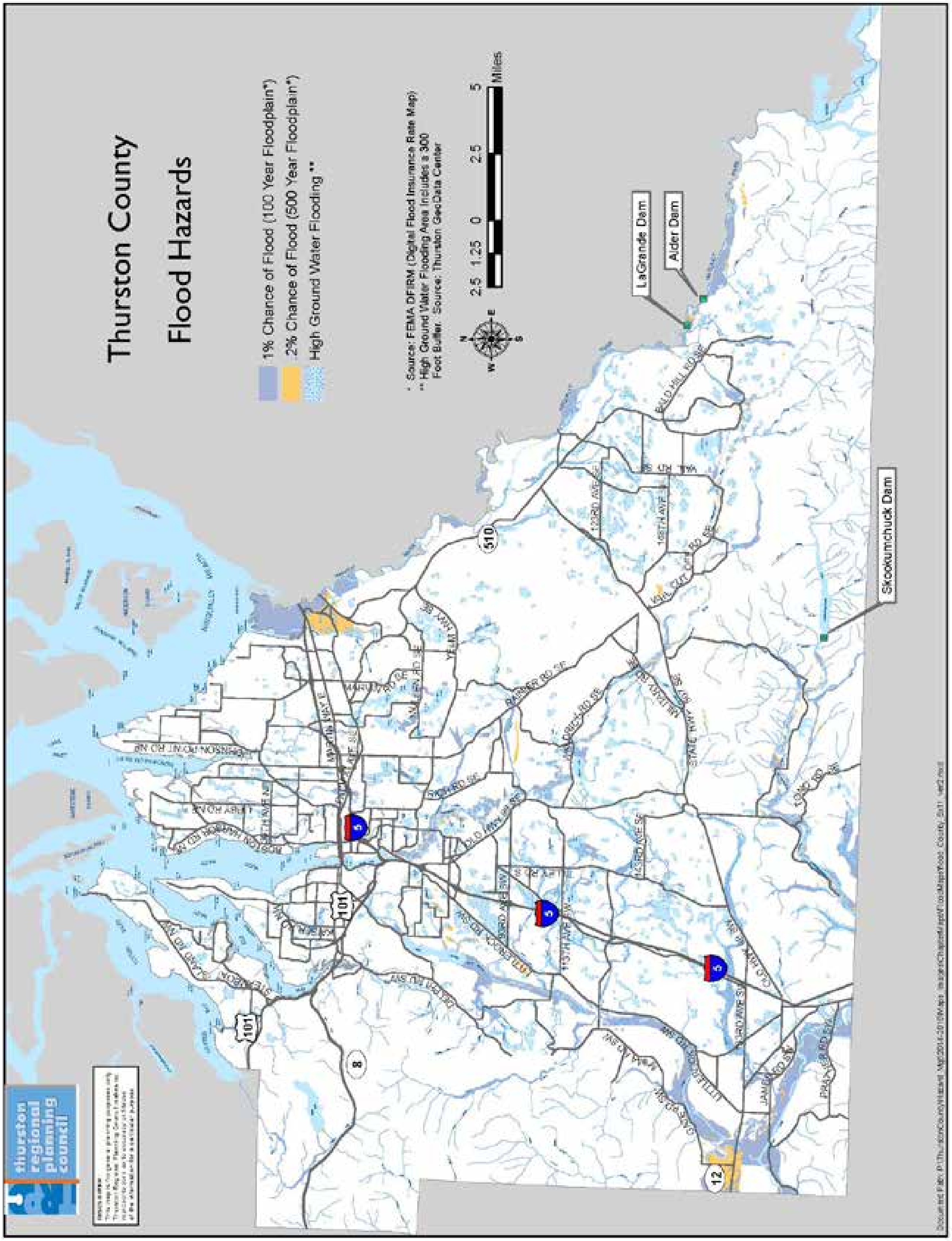
Population and Employment in the Hazard Area

Approximately 19,300 people (7.3 percent) and 8,400 employees (6.3 percent) live and work within the flood hazard area. Presently, rural unincorporated Thurston County has the greatest number of residents living in flood prone areas (9,750). By the year 2040, population growth in the cities and the present day UGAs will represent a larger portion (64 percent) of the planning area's population affected by floods than in the rural unincorporated county (36 percent). Estimates of the region's population and employment in the flood hazard area are summarized in tables 4.3.6 through 4.3.9. 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 and 2040.

Residential Dwellings in the Hazard Area

Countywide, approximately 8,200 dwelling units (7.2 percent) are in flood hazard areas. That number could grow to 13,900 by 2040.

Map 4.3.3: Thurston County Flood Hazard Areas



Inventory of Assets and Dollar Value in the Hazard Area

Estimates of the region's structures and their contents in the flood hazard area are summarized in Tables 4.3.12 and 4.3.13. These tables provide an estimate of the existing structures and contents which may be at risk to flooding. The estimated value of at-risk residential property is over $1 billion in 2014 dollars. Seventy-five percent of the Town of Bucoda's housing value is in flood prone areas, the largest share by far of any other community in the planning area. Countywide, nearly $141 million in commercial/industrial and $360 million in government/institutional building valuation is within flood prone areas.

Essential Facilities and Infrastructure in Hazard Area

Flooding can destroy or damage facilities critical for responding to emergency events and for maintaining a safe environment and public order. These include communications, electrical generation and transmission, natural gas transmission, water storage and purification and pumping facilities, sewage treatment, hospitals, and police and fire stations. In addition, floods can seriously disrupt the transportation network.

Specific information on the location of essential facilities and infrastructure is housed with Thurston County Emergency Management. Essential facilities include both public and private facilities. Table 4.3.14 lists the type and number of essential facilities located in the flood hazard area.

Summary Assessment

The history of major flooding within the Thurston Region clearly demonstrates a high probability of occurrence. The December 2007 and January 2009 floods were not as costly as the February 1996 flood, but suggest that the region remains vulnerable to flood impacts. Because only around seven percent of the county's land area, population, and valuation is exposed, a moderate vulnerability is assigned.

On a jurisdictional basis, an exception is the Town of Bucoda, which has a high vulnerability to flooding due to its location and high exposure to floods within the 100-year floodplain. The combined frequency of flooding, the potential for simultaneous flood events, and the historic records of recurrent damaging floods, lead to an overall high risk rating for the entire planning area.

Tidal flooding currently poses little risk within the entire planning area. It is a primary focus for the City of Olympia for developing a mitigation and adaptation strategy to safeguard downtown Olympia and combat the effects of sea-level rise. Climate change is likely to increase the risk of urban flooding as existing stormwater systems may be insufficient to handle more intense future precipitation events.

Risk Assessment for Flood in the Thurston Region

Flood Type	Probability of Occurrence	Vulnerability	Risk
Riverine	High	Moderate	High
Groundwater	High	Moderate	High
Tidal	Moderate	Low	Low
Urban	High	Moderate	Moderate
Overall Assessment	High	Moderate	High

Table 4.3.4: Flood Hazard Area, by Jurisdiction

Jurisdiction		Total Acres	1% Chance Flood In Hazard Area Acres	%	0.2% Chance Flood In Hazard Area Acres	%	High Ground Water In Hazard Area Acres	%	Any Flood Hazard In Hazard Area Acres	%
Bucoda	**Total**	**380**	**182**	**48.0%**	**7**	**1.9%**	**57**	**15.1%**	**204**	**53.8%**
Lacey	City	10,778	517	4.8%	16	0.1%	861	8.0%	1,203	11.2%
	UGA	10,416	796	7.6%	5	0.0%	411	3.9%	1,187	11.4%
	Total	**21,193**	**1,313**	**6.2%**	**20**	**0.1%**	**1,272**	**6.0%**	**2,390**	**11.3%**
Olympia	City	12,089	938	7.8%	4	0.0%	870	7.2%	1,555	12.9%
	UGA	3,887	309	7.9%	5	0.1%	321	8.3%	589	15.1%
	Total	**15,976**	**1,247**	**7.8%**	**10**	**0.1%**	**1,191**	**7.5%**	**2,144**	**13.4%**
Rainier	City	1,105	1	0.1%	0	0.0%	72	6.5%	72	6.5%
	UGA	320	2	0.7%	0	0.0%	16	4.9%	18	5.6%
	Total	**1,425**	**3**	**0.2%**	**0**	**0.0%**	**87**	**6.1%**	**90**	**6.3%**
Tenino	City	922	34	3.7%	7	0.7%	79	8.5%	96	10.4%
	UGA	65	8	11.5%	0	0.0%	0	0.0%	8	11.5%
	Total	**987**	**42**	**4.2%**	**7**	**0.7%**	**79**	**8.0%**	**104**	**10.5%**
Tumwater	City	11,354	915	8.1%	243	2.1%	1,730	15.2%	2,494	22.0%
	UGA	2,875	152	5.3%	80	2.8%	657	22.8%	857	29.8%
	Total	**14,229**	**1,067**	**7.5%**	**323**	**2.3%**	**2,387**	**16.8%**	**3,351**	**23.5%**
Yelm	City	3,634	145	4.0%	5	0.1%	362	10.0%	429	11.8%
	UGA	2,396	75	3.1%	0	0.0%	407	17.0%	420	17.5%
	Total	**6,030**	**220**	**3.7%**	**5**	**0.1%**	**769**	**12.8%**	**849**	**14.1%**
Grand Mound UGA	**Total**	**983**	**11**	**1.1%**	**0**	**0.0%**	**145**	**14.8%**	**149**	**15.2%**
Chehalis Res.[1]	**Total**	**833**	**557**	**66.9%**	**0**	**0.0%**	**0**	**0.0%**	**557**	**66.9%**
Nisqually Res.[1]	**Total**	**2,147**	**293**	**13.7%**	**0**	**0.0%**	**0**	**0.0%**	**293**	**13.7%**
Total Cities		**40,261**	**2,732**	**6.8%**	**282**	**0.7%**	**4,031**	**10.0%**	**6,053**	**15.0%**
Total UGAs[2]		**20,943**	**1,352**	**6.5%**	**90**	**0.4%**	**1,957**	**9.3%**	**3,227**	**15.4%**
Total Reservations[1]		**2,979**	**851**	**28.6%**	**0**	**0.0%**	**0**	**0.0%**	**851**	**28.6%**
Rural Uninc. County[3]		**406,934**	**29,685**	**7.3%**	**3,271**	**0.8%**	**28,226**	**6.9%**	**55,138**	**13.5%**
Thurston County Total		**471,117**	**34,621**	**7.3%**	**3,644**	**0.8%**	**34,214**	**7.3%**	**65,270**	**13.9%**

Explanations: Flood Hazard includes the Special Flood Hazard Areas Subject to Inundation by the 1% and 0.2% Annual Chance of Flood and Thurston County High Groundwater Hazard Areas. (Source: Flood Insurance Rate Map, Thurston County Washington October, 2012; Thurston Geo Data).

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 4.3.5: Flood Hazard Area, by Special Districts

Jurisdiction	Total Acres	1% Chance Flood In Hazard Area Acres	1% Chance Flood In Hazard Area %	0.2% Chance Flood In Hazard Area Acres	0.2% Chance Flood In Hazard Area %	High Ground Water In Hazard Area Acres	High Ground Water In Hazard Area %	Any Flood Hazard In Hazard Area Acres	Any Flood Hazard In Hazard Area %
Fire Protection Districts									
1,11 West Thurston RFA	100,131	11,559	11.5%	1,091	1.1%	9,638	9.6%	20,012	20.0%
2, 4 S.E. Thurston RFA	56,030	3,167	5.7%	356	0.6%	7,341	13.1%	9,999	17.8%
3 Lacey	36,820	4,588	12.5%	1,105	3.0%	2,252	6.1%	7,264	19.7%
5, 9 McLane-Black Lake	51,828	2,748	5.3%	87	0.2%	814	1.6%	3,520	6.8%
6 East Olympia	19,677	2,417	12.3%	152	0.8%	2,186	11.1%	4,062	20.6%
8 South Bay	20,974	869	4.1%	0	0.0%	1,700	8.1%	2,524	12.0%
12 Tenino	19,914	1,938	9.7%	185	0.9%	2,465	12.4%	3,889	19.5%
13 Griffin	14,864	543	3.7%	0	0.0%	873	5.9%	1,398	9.4%
16 Gibson Valley	18,038	1,744	9.7%	48	0.3%	1,533	8.5%	2,495	13.8%
17 Bald Hills	13,926	1,431	10.3%	179	1.3%	1,119	8.0%	2,543	18.3%
School Districts									
Centralia[1]	12,851	1,722	13.4%	44	0.3%	1,187	9.2%	2,140	16.7%
Griffin	21,355	529	2.5%	0	0.0%	869	4.1%	1,392	6.5%
North Thurston	47,081	4,393	9.3%	1,013	2.2%	3,445	7.3%	8,078	17.2%
Olympia	49,895	1,977	4.0%	28	0.1%	1,662	3.3%	3,434	6.9%
Rainier	35,550	1,459	4.1%	155	0.4%	1,929	5.4%	3,233	9.1%
Rochester[1]	55,061	7,951	14.4%	923	1.7%	2,782	5.1%	10,575	19.2%
Tenino	70,500	5,071	7.2%	328	0.5%	6,697	9.5%	10,328	14.6%
Tumwater	73,846	5,588	7.6%	573	0.8%	7,579	10.3%	12,440	16.8%
Yelm[1]	104,854	5,974	5.7%	580	0.6%	8,069	7.7%	13,695	13.1%
Other Districts									
Intercity Transit	64,390	6,823	10.6%	382	0.6%	5,325	8.3%	11,383	17.7%
LOTT Clean Water Alliance[2]	16,016	530	3.3%	29	0.2%	835	5.2%	1,259	7.9%
Port of Olympia	471,117	34,621	7.3%	3,644	0.8%	34,214	7.3%	65,270	13.9%
Thurston County PUD	471,117	34,621	7.3%	3,644	0.8%	34,214	7.3%	65,270	13.9%

Explanations: Flood Hazard includes the Special Flood Hazard Areas Subject to Inundation by the 1% and 0.2% Annual Chance of Flood and Thurston County High Groundwater Hazard Areas. (Source: Flood Insurance Rate Map, Thurston County Washington October, 2012; Thurston Geo Data).
1. Data are for Thurston County portion of the district only.
2. Includes the sewered area.

Table 4.3.6: Flood Hazard Area, Population by Jurisdiction, 2015 and 2040

Jurisdiction		2015 Population Estimate Total #	2015 In Hazard Area #	2015 In Hazard Area %	2040 Population Forecast Total #	2040 In Hazard Area #	2040 In Hazard Area %
Bucoda	**Total**	**565**	**410**	**72.6%**	**1,215**	**710**	**58.4%**
Lacey	City	46,230	2,600	5.6%	55,160	2,800	5.1%
	UGA	33,980	990	2.9%	59,030	2,080	3.5%
	Total	**80,210**	**3,590**	**4.5%**	**114,190**	**4,880**	**4.3%**
Olympia	City	51,020	1,740	3.4%	71,840	3,580	5.0%
	UGA	11,920	700	5.9%	16,770	1,300	7.8%
	Total	**62,940**	**2,440**	**3.9%**	**88,610**	**4,880**	**5.5%**
Rainier	City	1,880	70	3.7%	2,810	105	3.7%
	UGA	110	5	4.5%	640	35	5.5%
	Total	**1,990**	**75**	**3.8%**	**3,450**	**140**	**4.1%**
Tenino	City	1,730	40	2.3%	3,675	190	5.2%
	UGA	15	0	0.0%	110	0	0.0%
	Total	**1,745**	**40**	**2.3%**	**3,785**	**190**	**5.0%**
Tumwater	City	22,370	1,460	6.5%	37,350	5,100	13.7%
	UGA	3,270	560	17.1%	8,960	1,750	19.5%
	Total	**25,640**	**2,020**	**7.9%**	**46,310**	**6,850**	**14.8%**
Yelm	City	8,170	700	8.6%	25,080	2,800	11.2%
	UGA	1,420	160	11.3%	5,690	630	11.1%
	Total	**9,590**	**860**	**9.0%**	**30,770**	**3,430**	**11.1%**
Grand Mound UGA	**Total**	**1,285**	**40**	**3.1%**	**1,990**	**40**	**2.0%**
Chehalis Reservation[1]	**Total**	**70**	**40**	**57.1%**	**190**	**110**	**57.9%**
Nisqually Reservation[1]	**Total**	**605**	**20**	**3.3%**	**705**	**30**	**4.3%**
Total Cities		**131,970**	**7,020**	**5.3%**	**197,120**	**15,300**	**7.8%**
Total UGAs[2]		**52,000**	**2,460**	**4.7%**	**93,190**	**5,840**	**6.3%**
Total Reservations[1]		**670**	**60**	**9.0%**	**890**	**140**	**15.7%**
Rural Unincorporated County[3]		**82,770**	**9,750**	**11.8%**	**102,470**	**11,870**	**11.6%**
Thurston County Total		**267,400**	**19,300**	**7.2%**	**393,700**	**33,100**	**8.4%**

Source: Thurston Regional Planning Council Population Forecast, 2015
Explanations: Flood Hazard includes the Special Flood Hazard Areas Subject to Inundation by the 1% and 0.2% Annual Chance of Flood and Thurston County High Groundwater Hazard Areas. 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 4.3.7: Flood Hazard Area, Population by Special Districts, 2015 and 2040

	2015 Population Estimate			2040 Population Forecast		
	Total	In Hazard Area		Total	In Hazard Area	
Jurisdiction	#	#	%	#	#	%
Fire Protection Districts						
1,11 West Thurston	22,010	3,160	14.4%	31,120	4,870	15.6%
2, 4 S.E. Thurston	24,650	2,450	9.9%	50,770	5,580	11.0%
3 Lacey	91,660	5,290	5.8%	128,070	6,850	5.3%
5, 9 McLane-Black Lake	15,890	920	5.8%	20,770	1,140	5.5%
6 East Olympia	11,140	800	7.2%	14,810	1,550	10.5%
8 South Bay	11,820	1,020	8.6%	15,380	1,170	7.6%
12 Tenino	6,230	900	14.4%	9,530	1,220	12.8%
13 Griffin	5,060	500	9.9%	5,700	540	9.5%
16 Gibson Valley	590	170	28.8%	1,130	210	18.6%
17 Bald Hills	4,090	430	10.5%	5,440	560	10.3%
School Districts						
Centralia[1]	490	180	36.7%	1,180	330	28.0%
Griffin	5,950	570	9.6%	6,710	610	9.1%
North Thurston	99,300	5,720	5.8%	138,340	8,170	5.9%
Olympia	66,140	2,690	4.1%	87,700	3,930	4.5%
Rainier	5,210	570	10.9%	13,800	1,080	7.8%
Rochester[1]	14,060	1,370	9.7%	18,080	1,700	9.4%
Tenino	9,850	1,760	17.9%	15,510	2,510	16.2%
Tumwater	39,500	3,760	9.5%	63,820	9,310	14.6%
Yelm[1]	26,900	2,670	9.9%	48,530	5,510	11.4%
Other Districts						
Intercity Transit	176,450	8,850	5.0%	269,860	19,350	7.2%
LOTT Clean Water Alliance[2]	120,960	5,100	4.2%	249,110	16,610	6.7%
Port of Olympia	267,400	19,300	7.2%	393,700	33,100	8.4%
Thurston County PUD	267,400	19,300	7.2%	393,700	33,100	8.4%

Source: Thurston Regional Planning Council Population Forecast, 2015
Explanations: Flood Hazard includes the Special Flood Hazard Areas Subject to Inundation by the 1% and 0.2% Annual Chance of Flood and Thurston County High Groundwater Hazard Areas.
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 4.3.8: Flood Hazard Area, Employment, 2014 and 2040

		2014 Employment Estimate			2040 Employment Forecast		
		Total	In Hazard Area		Total	In Hazard Area	
Jurisdiction		#	#	%	#	#	%
Bucoda	**Total**	**90**	**70**	**77.8%**	**200**	**140**	**70.0%**
Lacey	City	25,610	1,300	5.1%	41,180	1,800	4.4%
	UGA	5,620	140	2.5%	8,520	210	2.5%
	Total	**31,230**	**1,440**	**4.6%**	**49,700**	**2,010**	**4.0%**
Olympia	City	53,350	1,810	3.4%	74,950	2,600	3.5%
	UGA	1,800	80	4.4%	2,230	120	5.4%
	Total	**55,150**	**1,890**	**3.4%**	**77,180**	**2,720**	**3.5%**
Rainier	City	455	10	2.2%	690	20	2.9%
	UGA	25	0	0.0%	80	0	0.0%
	Total	**480**	**10**	**2.1%**	**770**	**20**	**2.6%**
Tenino	City	870	40	4.6%	1,505	60	4.0%
	UGA	0	0	-	5	0	0.0%
	Total	**870**	**40**	**4.6%**	**1,510**	**60**	**4.0%**
Tumwater	City	22,350	1,610	7.2%	33,720	2,230	6.6%
	UGA	760	210	27.6%	1,420	350	24.6%
	Total	**23,110**	**1,820**	**7.9%**	**35,140**	**2,580**	**7.3%**
Yelm	City	3,830	340	8.9%	11,490	1,050	9.1%
	UGA	430	90	20.9%	670	110	16.4%
	Total	**4,260**	**430**	**10.1%**	**12,160**	**1,160**	**9.5%**
Grand Mound UGA	**Total**	**1,115**	**50**	**4.5%**	**1,375**	**60**	**4.4%**
Chehalis Reservation[1]	**Total**	**760**	**310**	**40.8%**	**1,550**	**650**	**41.9%**
Nisqually Reservation[1]	**Total**	**975**	**0**	**0.0%**	**1,865**	**0**	**0.0%**
Total Cities		**106,560**	**5,190**	**4.9%**	**163,730**	**7,900**	**4.8%**
Total UGAs[2]		**9,740**	**570**	**5.9%**	**14,300**	**850**	**5.9%**
Total Reservations[1]		**1,740**	**310**	**17.8%**	**3,410**	**650**	**19.1%**
Rural Unincorporated County[3]		**15,880**	**2,320**	**14.6%**	**18,270**	**2,660**	**14.6%**
Thurston County Total		**133,900**	**8,400**	**6.3%**	**199,700**	**12,100**	**6.1%**

Source: Thurston Regional Planning Council Population Forecast, 2015
Explanations: Flood Hazard includes the Special Flood Hazard Areas Subject to Inundation by the 1% and 0.2% Annual Chance of Flood and Thurston County High Groundwater Hazard Areas. 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 4.3.9: Flood Hazard Area, Employment – Special Districts, 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	1,250	19.9%	8,480	1,960	23.1%
2, 4 S.E. Thurston	6,710	710	10.6%	15,170	1,490	9.8%
3 Lacey	34,540	1,800	5.2%	54,170	2,380	4.4%
5, 9 McLane-Black Lake	3,630	200	5.5%	4,350	230	5.3%
6 East Olympia	1,960	190	9.7%	2,350	240	10.2%
8 South Bay	1,830	270	14.8%	2,250	280	12.4%
12 Tenino	1,500	190	12.7%	2,210	220	10.0%
13 Griffin	990	150	15.2%	1,060	160	15.1%
16 Gibson Valley	150	50	33.3%	180	50	27.8%
17 Bald Hills	470	60	12.8%	570	70	12.3%
School Districts						
Centralia[1]	120	40	33.3%	170	60	35.3%
Griffin	1,110	160	14.4%	1,190	160	13.4%
North Thurston	42,280	2,120	5.0%	66,290	3,010	4.5%
Olympia	48,850	1,950	4.0%	65,910	2,450	3.7%
Rainier	980	80	8.2%	1,860	120	6.5%
Rochester[1]	4,630	800	17.3%	6,230	1,320	21.2%
Tenino	2,340	390	16.7%	3,320	520	15.7%
Tumwater	25,670	2,080	8.1%	38,080	2,910	7.6%
Yelm[1]	7,850	760	9.7%	16,580	1,500	9.0%
Other Districts						
Intercity Transit	115,570	5,500	4.8%	176,500	8,340	4.7%
LOTT Clean Water Alliance[2]	91,010	3,700	4.1%	162,020	7,310	4.5%
Port of Olympia	133,900	8,400	6.3%	199,700	12,100	6.1%
Thurston County PUD	133,900	8,400	6.3%	199,700	12,100	6.1%

Source: Thurston Regional Planning Council Population Forecast, 2015
Explanations: Flood Hazard includes the Special Flood Hazard Areas Subject to Inundation by the 1% and 0.2% Annual Chance of Flood and Thurston County High Groundwater Hazard Areas.
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 4.3.10: Flood Hazard Area, Residential Dwellings, 2015 and 2040

		2015 Dwelling Estimate			2040 Dwelling Forecast		
		Total	In Hazard Area		Total	In Hazard Area	
Jurisdiction		#	#	%	#	#	%
Bucoda	**Total**	**245**	**180**	**73.5%**	**535**	**310**	**57.9%**
Lacey	City	19,840	1,130	5.7%	24,400	1,240	5.1%
	UGA	13,500	380	2.8%	23,930	800	3.3%
	Total	**33,340**	**1,510**	**4.5%**	**48,330**	**2,040**	**4.2%**
Olympia	City	24,170	810	3.4%	35,610	1,770	5.0%
	UGA	4,850	280	5.8%	7,100	540	7.6%
	Total	**29,020**	**1,090**	**3.8%**	**42,710**	**2,310**	**5.4%**
Rainier	City	775	30	3.9%	1,140	40	3.5%
	UGA	50	0	0.0%	290	15	5.2%
	Total	**825**	**30**	**3.6%**	**1,430**	**55**	**3.8%**
Tenino	City	755	20	2.6%	1,855	100	5.4%
	UGA	5	0	0.0%	40	0	0.0%
	Total	**760**	**20**	**2.6%**	**1,895**	**100**	**5.3%**
Tumwater	City	9,970	640	6.4%	16,870	2,120	12.6%
	UGA	1,420	230	16.2%	3,820	720	18.8%
	Total	**11,390**	**870**	**7.6%**	**20,690**	**2,840**	**13.7%**
Yelm	City	3,000	270	9.0%	9,820	1,070	10.9%
	UGA	550	60	10.9%	2,280	260	11.4%
	Total	**3,550**	**330**	**9.3%**	**12,100**	**1,330**	**11.0%**
Grand Mound UGA	**Total**	**415**	**10**	**2.4%**	**740**	**20**	**2.7%**
Chehalis Reservation[1]	**Total**	**20**	**10**	**50.0%**	**65**	**40**	**61.5%**
Nisqually Reservation[1]	**Total**	**200**	**10**	**5.0%**	**255**	**10**	**3.9%**
Total Cities		**58,770**	**3,060**	**5.2%**	**90,230**	**6,650**	**7.4%**
Total UGAs[2]		**20,790**	**960**	**4.6%**	**38,190**	**2,350**	**6.2%**
Total Reservations[1]		**220**	**20**	**9.1%**	**320**	**50**	**15.6%**
Rural Unincorporated County[3]		**34,250**	**4,110**	**12.0%**	**41,730**	**4,900**	**11.7%**
Thurston County Total		**114,000**	**8,200**	**7.2%**	**170,500**	**13,900**	**8.2%**

Source: Thurston Regional Planning Council Population Forecast, 2015
Explanations: Flood Hazard includes the Special Flood Hazard Areas Subject to Inundation by the 1% and 0.2% Annual Chance of Flood and Thurston County High Groundwater Hazard Areas. 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 4.3.11: Flood Hazard Area, Residential Dwellings – Special Districts, 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	1,250	14.7%	11,930	1,920	16.1%
2, 4 S.E. Thurston	9,800	1,000	10.2%	20,190	2,200	10.9%
3 Lacey	38,120	2,270	6.0%	54,160	2,880	5.3%
5, 9 McLane-Black Lake	6,490	390	6.0%	8,670	500	5.8%
6 East Olympia	4,510	330	7.3%	6,010	630	10.5%
8 South Bay	4,940	420	8.5%	6,370	480	7.5%
12 Tenino	2,580	370	14.3%	4,200	510	12.1%
13 Griffin	2,580	250	9.7%	2,910	280	9.6%
16 Gibson Valley	240	70	29.2%	440	80	18.2%
17 Bald Hills	1,770	180	10.2%	2,370	240	10.1%
School Districts						
Centralia[1]	200	70	35.0%	470	140	29.8%
Griffin	3,030	290	9.6%	3,430	310	9.0%
North Thurston	41,820	2,480	5.9%	59,460	3,590	6.0%
Olympia	29,690	1,160	3.9%	41,150	1,770	4.3%
Rainier	2,190	240	11.0%	5,690	440	7.7%
Rochester[1]	5,260	540	10.3%	6,670	650	9.7%
Tenino	4,130	730	17.7%	6,720	1,060	15.8%
Tumwater	16,930	1,560	9.2%	27,630	3,820	13.8%
Yelm[1]	10,790	1,090	10.1%	19,260	2,170	11.3%
Other Districts						
Intercity Transit	76,200	3,770	4.9%	119,200	8,230	6.9%
LOTT Clean Water Alliance[2]	53,760	2,240	4.2%	111,730	7,190	6.4%
Port of Olympia	114,000	8,200	7.2%	170,500	13,900	8.2%
Thurston County PUD	114,000	8,200	7.2%	170,500	13,900	8.2%

Source: Thurston Regional Planning Council Population Forecast, 2015
Explanations: Flood Hazard includes the Special Flood Hazard Areas Subject to Inundation by the 1% and 0.2% Annual Chance of Flood and Thurston County High Groundwater Hazard Areas.
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 4.3.12: Flood Hazard Area, Valuation of Building and Contents, 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**	**9**	**75.0%**	**1**	**0**	**0.0%**	**3**	**3**	**100.0%**
Lacey	City	2,394	138	5.8%	914	37	4.0%	602	38	6.3%
	UGA	1,715	46	2.7%	69	1	1.4%	273	9	3.3%
	Total	**4,109**	**184**	**4.5%**	**983**	**38**	**3.9%**	**875**	**47**	**5.4%**
Olympia	City	2,695	105	3.9%	1,199	47	3.9%	1,941	80	4.1%
	UGA	785	44	5.6%	27	1	3.7%	26	0	0.0%
	Total	**3,480**	**149**	**4.3%**	**1,226**	**48**	**3.9%**	**1,967**	**80**	**4.1%**
Rainier	City	76	3	3.9%	5	0	0.0%	30	0	0.0%
	UGA	5	0	0.0%	0	0	-	1	0	0.0%
	Total	**81**	**3**	**3.7%**	**5**	**0**	**0.0%**	**31**	**0**	**0.0%**
Tenino	City	50	1	2.0%	12	0	0.0%	67	9	13.4%
	UGA	1	0	0.0%	0	0	-	0	0	-
	Total	**51**	**1**	**2.0%**	**12**	**0**	**0.0%**	**67**	**9**	**13.4%**
Tumwater	City	1,209	71	5.9%	528	21	4.0%	556	151	27.2%
	UGA	130	25	19.2%	13	3	23.1%	7	1	14.3%
	Total	**1,339**	**96**	**7.2%**	**541**	**24**	**4.4%**	**563**	**152**	**27.0%**
Yelm	City	357	31	8.7%	105	10	9.5%	140	24	17.1%
	UGA	49	5	10.2%	6	2	33.3%	13	0	0.0%
	Total	**406**	**36**	**8.9%**	**111**	**12**	**10.8%**	**153**	**24**	**15.7%**
Grand Mound UGA		**34**	**1**	**2.9%**	**13**	**1**	**7.7%**	**5**	**4**	**80.0%**
Chehalis Reservation[1]		**1**	**1**	**100.0%**	**4**	**0**	**0.0%**	**0**	**0**	**-**
Nisqually Reservation.[1]		**16**	**0**	**0.0%**	**3**	**0**	**0.0%**	**0**	**0**	**-**
Total Cities		**6,793**	**358**	**5.3%**	**2,763**	**116**	**4.2%**	**3,338**	**306**	**9.2%**
Total UGAs[2]		**2,719**	**121**	**4.5%**	**128**	**8**	**6.3%**	**325**	**15**	**4.6%**
Total Reservations[1]		**17**	**1**	**5.9%**	**6**	**0**	**0.0%**	**0**	**0**	**-**
Rural Unincorp. County[3]		**4,977**	**551**	**11.1%**	**113**	**17**	**15.0%**	**1,033**	**40**	**3.9%**
Thurston County Total		**14,506**	**1,031**	**7.1%**	**3,010**	**141**	**4.7%**	**4,696**	**360**	**7.7%**

Source: Thurston Regional Planning Council Population Forecast, 2015
Explanations: Flood Hazard includes the Special Flood Hazard Areas Subject to Inundation by the 1% and 0.2% Annual Chance of Flood and Thurston County High Groundwater Hazard Areas. 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 4.3.13: Flood Hazard Area, Valuation of Building and Contents – Special Districts, 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	151	15.4%	57	10	17.5%	216	25	11.6%
2, 4 S.E. Thurston	1,073	114	10.6%	133	14	10.5%	202	24	11.9%
3 Lacey	4,823	264	5.5%	1,008	41	4.1%	896	52	5.8%
5, 9 McLane-Black Lake	1,121	73	6.5%	31	2	6.5%	676	2	0.3%
6 East Olympia	743	47	6.3%	14	2	14.3%	49	1	2.0%
8 South Bay	939	80	8.5%	13	2	15.4%	47	10	21.3%
12 Tenino	277	48	17.3%	17	1	5.9%	73	10	13.7%
13 Griffin	430	47	10.9%	3	1	33.3%	26	0	0.0%
16 Gibson Valley	20	7	35.0%	0	0	-	1	1	100.0%
17 Bald Hills	176	15	8.5%	6	0	0.0%	7	0	0.0%
School Districts									
Centralia[1]	17	7	41.2%	0	0	-	1	1	100.0%
Griffin	498	52	10.4%	3	1	33.3%	26	0	0.0%
North Thurston	5,394	295	5.5%	1,292	48	3.7%	969	62	6.4%
Olympia	3,990	190	4.8%	960	44	4.6%	2,344	42	1.8%
Rainier	241	27	11.2%	11	0	0.0%	34	0	0.0%
Rochester[1]	539	52	9.6%	42	5	11.9%	187	22	11.8%
Tenino	462	83	18.0%	21	2	9.5%	81	14	17.3%
Tumwater	2,155	196	9.1%	546	26	4.8%	877	195	22.2%
Yelm[1]	1,208	128	10.6%	135	14	10.4%	176	24	13.6%
Other Districts									
Intercity Transit	9,247	472	5.1%	2,865	121	4.2%	4,172	305	7.3%
LOTT Clean Water Alliance[2]	6,724	313	4.7%	2,498	96	3.8%	2,443	135	5.5%
Port of Olympia	14,506	1,031	7.1%	3,010	141	4.7%	4,696	360	7.7%
Thurston County PUD	14,506	1,031	7.1%	3,010	141	4.7%	4,696	360	7.7%

Source: Thurston Regional Planning Council Population Forecast, 2015
Explanations: Flood Hazard includes the Special Flood Hazard Areas Subject to Inundation by the 1% and 0.2% Annual Chance of Flood and Thurston County High Groundwater Hazard Areas.
1. Data are for Thurston County portion of the district only.
2. Includes the sewered area.

Table 4.3.14: Essential Facilities in Flood Hazard Area

Facility Type	Total #	In Hazard Area #	In Hazard Area %
Medical Care			
Adult Family Home	124	5	4.0%
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	0	0.0%
Pharmacy	42	3	7.1%
Primary Care	91	7	7.7%
Urgent Care	6	0	0.0%
Government			
Court Services	3	1	33.3%
Cultural Significance	2	0	0.0%
Detention/Corrections	1	0	0.0%
Fairgrounds	35	1	2.9%
Fire Service	53	4	7.5%
Government Services	56	18	32.1%
Health and Human Services	2	0	0.0%
Law and Justice	4	1	25.0%
Law Enforcement	8	0	0.0%
Port Facilities	35	1	2.9%
Public Education	344	18	5.2%
Public Higher Education	52	5	9.6%
Public Works	33	2	6.1%
Solid Waste	20	18	90.0%
Transit	4	0	0.0%
Utilities	238	26	10.9%
Transportation (Centerline Miles)			
Roads	2,210	200	9.0%
Intercity Transit Routes	157	9	5.5%
Rural Transit Routes	96	16	16.5%

Explanations: Flood Hazard includes areas in the 100 and 500-year flood plains, and high groundwater areas.

Endnotes

[1] Hazards & Vulnerability Research Institute. 2016. The Spatial Hazard Events and Losses Database for the United States, Version 15.2 [SHELDUS Online Database]. Columbia, SC: University of South Carolina. Available from http://www.sheldus.org.

[2] Thurston County Water and Waste Management. 2017. Unpublished Data, Courtesy of Mark Biever, Thurston County Environmental Monitoring Program Supervisor

[3] Ibid

[4] Tacoma Power. 2016. Emergency Action Plan for the Nisqually Hydroelectric Project FERC Project No. 1862

[5] Contributed by Nadine Romero, Hydrogeologist, Thurston County Environmental Health. April 22, 2009.

[6] Parametrix. 2003. Scatter Creek Habitat Conservation Plan and Associated Reports. Prepared for Thurston Conservation District.

[7] Thurston County Development Services. 2009. Unpublished Data, Thurston County Flood of Record Reference Monument Locations. Courtesy of Joe Butler.

[8] TransAlta Centralia Generation LLC. 2007. Emergency Action Plan: Skookumchuck Hydroelectric Project FERC Project No. 4441 NATDAM No. WA00153. Revision H, December 2007.

[9] United States Geological Survey. 2017. National Water Information System: Web Interface, USGS Water Data for Washington, Surface Water Data. http://waterdata.usgs.gov/wa/nwis/

[10] Thurston County Emergency Management. 2007. Supplemental Justification Report. December 2-7, 2007 Severe Storm.

[11] Washington State Department of Transportation. 2008. Storm-Related Closures of I-5 and I-90: Freight Transportation Economic Impact Assessment Report Winter 2007-2008.

[12] FEMA. 2016. HAZUS-MH Flood Results for Thurston County RISK MAP Project. Prepared by STARR for FEMA Region X.

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	%
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

		Landslide Hazard Area		
		Total	In Hazard Area	
Jurisdiction		Acres	Acres	%
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

	2015 Population Estimate			2040 Population Forecast		
	Total	In Hazard Area		Total	In Hazard Area	
Jurisdiction	#	#	%	#	#	%
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%

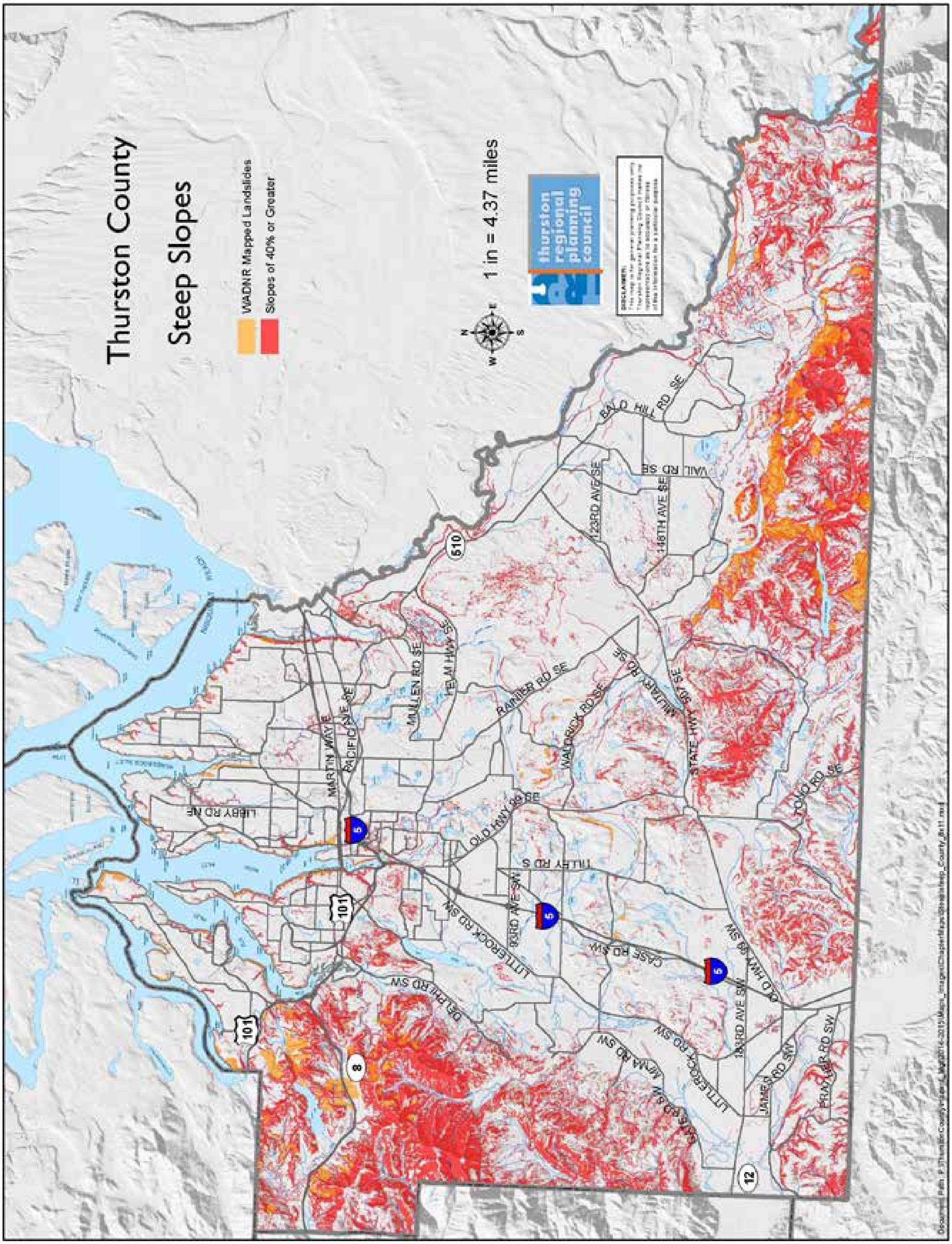
Source: Thurston Regional Planning Council Population Forecast, 2015
Explanations: Landslide Hazard includes areas with a 40% slope or greater.
1. Data are for Thurston County portion of the district only.
2. Includes the sewered area.

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



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Hazard Type
WILDLAND FIRE
Probability of Occurrence
HIGH
Vulnerability
MODERATE
Risk
MODERATE

Chapter 4.5
Wildland Fire Hazard Profile

Introduction

Wildland fires can rapidly destroy forests and other natural resource lands, recreational areas, habitat, neighborhoods, and infrastructure. Wildland fires can injure or kill people, pets, livestock, and wildlife. Although lightning strikes sometimes ignite wildland fires, most are started by negligent human behavior. Eastern Washington regularly experiences massive wildland fires that require thousands of firefighters that may battle the blazes for several months. In 2015, a combined 2,013 wildland fires on all state and federal lands burned 1,137,664 acres in Washington State.[1]

The Thurston County region experiences an average of 63 wildland fires a year, but they are typically contained by local and state fire suppression efforts. In the future, the risk for hazardous wildland fires is likely to increase due to drought, warmer weather, and longer lasting summers from the effects of climate change. Increasing recreational activities in open spaces due to population growth will also further exacerbate the risk. Lacey, Olympia, and Tumwater have each adopted ordinances banning the use of fireworks as a means of reducing urban wildland fire starts. Areas of human development interface with extensive forest lands, prairies, and other open spaces throughout the county. Under the right conditions, a large wildland fire could consume more forest, grasslands, homes, and other public and private owned assets within the region. Due to the high probability of occurrence and the number of wildland urban interface communities that are moderately vulnerable, the region has a moderate risk rating for wildland fire.

The wildland fire hazard is unique from other hazards in Thurston County in that:

- It is the most frequently occurring hazard, with approximately 63 wildland fires per year
- It can be prevented; poor human judgement and accidental causes start over 99 percent of fires
- It is the only natural hazard in this plan that can be actively contained in real time. To date, local fire districts and the Washington State Department of Natural Resources (DNR) have effectively suppressed wildland fires in Thurston County before they became a larger problem

Hazard Identification

A wildland fire hazard is an uncontrolled fire that spreads through undeveloped, highly vegetated areas. These areas may contain infrastructure such as roads, railroads, power lines, and similar facilities, but are typically characterized with low population and employment density. Wildfires can start unnoticed and spread quickly.

Ecologists, foresters, and other natural resource land managers view wildland fires as a natural process necessary to sustain the health of forests and prairie ecosystems. Nevertheless, when a fire threatens commercial forest lands, precious natural resources, property, cultural assets, or human life, the natural process becomes a hazard.

Wildland Urban Interface (WUI) communities are geographical zones where human development meets or mixes with grasslands, shrub lands, woodlands, and forest. People are attracted to less developed areas and seek to build homes in undisturbed natural settings for the lifestyle and treasures that the country offers. These communities and the adjacent wildlands are at risk because a fire may originate in the wildland area and spread to structures and dwellings and vice versa.

Source and Factors of Wildland Fires

All fires require fuel, oxygen, and an ignition source. In Thurston County, lightning strikes only account for one percent (28 total) of all wildland fire starts. Fires here are predominantly ignited by human activities such as: debris burning (30 percent); miscellaneous activities

Photo courtesy of Steve North

such as fireworks, sparks from engines, and electric fences (28 percent); children (15 percent); and recreational activities such as camping and hunting (11 percent). Other lesser causes include arson, smoking, and railroad operations.

The Washington State Hazard Mitigation Plan identifies fuel, weather, and terrain as essential elements that influence the behavior of a wildland fire. [2] Thurston County also possesses unique conditions that create favorable conditions for wildland fires. The following factors contribute to wildland fires in Thurston County:

Fuel

- Lighter fuels such as grasses, leaves, and needles quickly expel moisture and burn rapidly, while heavier fuels such as tree branches, logs, and trunks take longer to warm and ignite
- Snags and hazard trees - those that are diseased, dying, or dead - are larger west of the Cascades, but more prolific east of the Cascades. In 2012, approximately 1.2 million acres of the state's 21 million acres of forestland contained trees killed or defoliated by forest insects and diseases

Weather

- West of the Cascades, strong, dry, east winds in late summer and early fall produce extreme fire conditions. East wind events can persist up to 48 hours with wind speed reaching 60 miles-per-hour; these winds generally reach peak velocities during the night and early morning hours
- East of the Cascades, summer drying typically starts in mid-June and runs through early September, with drought conditions extending this season. Passage of a dry, cold front through this region can result in sudden increase in wind speeds and a change in wind direction affecting fire spread
- Thunderstorm activity, which typically begins in June with wet storms, turns dry with little or no precipitation reaching the ground, as the season progresses into July and August. Thunderstorms with dry lightning are more prevalent in Eastern Washington

Terrain

- Topography of a region or a local area influences the amount and moisture of fuel
- Barriers, such as highways and lakes, can affect the spread of fire
- Elevation and the slope of landforms – fire spreads more easily as it moves uphill than downhill

Soil Conditions

- Thurston County's glacial outwash prairie soils drain quickly

- Prairies are typically vegetated with grasses and other low growing herbaceous plants and shrubs which quickly dry out during the summer months
- Thurston County prairies interface with Douglas-fir stands, making these areas particularly vulnerable to larger wildland fires

Severity

The severity of a wildland fire depends upon the extremity of the factors listed above, the extent of the fire, the size of the population at risk, the value of structures at risk, and the ability of firefighters to effectively mobilize and suppress the fire. In general, the cooler, wetter climate of Western Washington is less prone to wildland fires because fuel sources have higher moisture content and are less susceptible to ignition. Furthermore, Thurston County is more populated and developed with a road network providing greater access to areas at risk for wildland fire.

Between 1985 and 1990, an average of 149 wildland fires occurred annually, however the county experienced a record 198 fires in 1998. On June 23, 1993, Thurston County adopted a county wide burn permit program for yard waste. The cities already prohibited outdoor burning. The county's program requires a permit for outdoor burning, and references the use of burn barrels and burning of prohibitive materials. A burn ban period is effective each year from July 15 to October 15. This measure has resulted in significant reductions in wildland fires in Thurston County, demonstrating it is an effective hazard mitigation measure.

Although a major wildland fire has not impacted Thurston County in modern times, wildland fires are persistent. They can occur during every month of the year, particularly during prolonged dry periods due to drought or near-drought conditions. Wildfires are most common during the local dry season, mid-May through mid-October, but 75 percent of all wildfires occur between July and September when temperatures are usually at their highest.

Map 4.5.1 shows areas in Thurston County with steep slopes. Steep slopes are located throughout the county, but are more pronounced in fire districts along the western and southern boundary. This map also illustrates the Natural Resource Conservation Service (NRCS) designation of Category 1 soil types, which are referred to as excessively-drained, glacial-outwash soils. The map clearly illustrates that almost all fire districts contain some glacial-outwash soils and are therefore rich with tinder during the dry season.

Map 4.5.2 shows the land cover for Thurston County. The map identifies areas of forest, dry grasses, soils, and non-forest vegetation with an overlay of the fire districts. Vegetative ground cover varies widely in Thurston County. For example, the forest vegetation type in the Griffin, McLane, and Black Lake fire districts are characterized by a large amount of salal and Oregon grape, whereas the Tenino Fire District is chiefly composed of grasses and Scotch

Photo courtesy of Robert W. Scott

broom. Often the ground cover or understory layer of vegetation burns, leaving the timber. During extremely dry conditions, fires can consume a significant portion of the canopy and destroy a forest. Dry grasses are prolific, burn rapidly once ignited, and can generate flames up to 40 feet tall.

Road access and mobility for emergency vehicles is mission critical in wildfire suppression efforts. Limited access delays response time and hampers mobilization of personnel and apparatuses to reach the affected area. Limited route options also pose challenges for evacuation of residents from the affected area such as the Summit Lake neighborhood in Fire District 9 and Clear Lake community in Fire District 17.

Impacts

Wildland fire impacts vary depending on the size and location of the fire. Most wildland fires in Thurston County are small (one acre or less), with minimal historic economic losses. However, larger fires can be catastrophic as evidenced by the 2014 Carlton Complex Fire in Eastern Washington, the largest in state history. This event consumed over 255,164 acres and destroyed over 350 homes. An estimated $35 million in public infrastructure was lost.

Heat from intense wind driven flames can destroy virtually any combustible material in a wildfire's path. People caught off guard by a rapidly spreading fire can suffer burn and non-burn injuries, or death while trying to escape a fire. People recreating in remote roadless forests are especially at risk. The loss of a loved one, home, or business is a traumatic experience and fire victims suffer post-traumatic stress disorder following a fire-related loss.

Physical damages include loss of timber, wildlife habitat, and recreational areas such as trails, parks, and campground facilities. The loss of vegetation on steep slopes increases the risk for mudslides or landslides during periods of heavy precipitation. Stream and creek channels could fill with sediment and debris increasing flood risks. Fish habitat recovery could take years.

While Thurston County's smaller rural communities' economies are less dependent on timber and tourism from public lands, JBLM and Capitol forest lands are socially and culturally important natural resources for both subsistence and recreation to South Sound residents.

Within the wildland urban interface areas, fires destroy buildings and their contents, utility lines, and vehicles. Power and communication disruptions can occur, even in unaffected areas, if the fire damages or destroys major transmission lines. Temporary disruptions to transportation networks can occur during the suppression and recovery stages, causing residents to seek detour routes. Some residents may not be able to reach their homes until authorities indicate it is safe to reopen restricted areas.

Firefighting can consume significant local and state resources. Even a small wildland fire in Thurston County requires rapid containment to protect property and preserve public safety. Local fire districts often rely on DNR assets such as helicopters to reach remote areas or provide rapid response. Should multiple wildland fires occur simultaneously in different locations during an extremely warm and dry season, local capabilities could quickly become overwhelmed. This is particularly problematic when major wildland fires on federal lands require the mobilization of firefighting assets across the western U.S., further minimizing local firefighting capacity. Fire crews from Thurston County fire districts regularly assist wildland fire fighting operations in Eastern Washington.

Firefighting is strenuous work and extended firefights can result in fatigue and equipment wear. Commanders strive to reduce risk and protect the safety of firefighting crews, but large scale wildland fires sometimes result in accidental injury or tragic death of firefighters.

Probability of Occurrence

With an average of 63 wildfires per year, the Thurston region has a high probability of occurrence of wildland fires. Between 1972 and 2015, 81.5 percent of wildland fires burned less than one acre and 11.5 percent burned one to two acres. The record of wildland fires in Thurston County suggest that most fires will continue to be five acres or smaller. The region can expect at least one fire exceeding 100 acres over the next 25 years. A warmer and drier future climate will create more suitable conditions for more frequent, and possibly larger fires that may result in greater losses.

Effects of Climate Change on Wildland Fires

Research and climate forecasts offer evidence that long-term climate change will have a measurable impact on the risk of wildland fires for Puget Sound lowlands. 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 wildland fires for communities around the Puget Sound.

Air temperatures are increasing in the 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. Warmer, drier, and longer summers will result in a greater supply of fire fuels. The Wildland Urban Interface areas and heavily forested, but less developed areas will both face a greater risk for fires than they do at present.

Photo courtesy of Lacey Fire District 3

Wildland Fire Historical Occurrences and Impacts

While Thurston County experiences numerous wildland fires resulting in loss of vegetation and the occasional destruction of one or more structures, the region has not experienced a major wildfire with substantial economic or environmental losses, or loss of life. Neighboring Lewis, Grays Harbor, and Mason counties also have not experienced major wildland fires in recent history. However, historic fires are notable for their impacts to the region and demonstrate that wildland fire is a formidable hazard that requires ongoing prevention activities.

Between 1972 and 2015, DNR recorded 2,708 fires (about 63 fires per year) in the county. Since many fires may go unreported to DNR, the total number may likely be higher than what is shown. A total of 2,465 acres have burned with an average of one acre burned per fire. The largest wildland fire recorded in Thurston County burned 140 acres on August 5, 1998 in Tenino Fire District.[3] The table below summarizes by fire district, the historic (1972-2015) wildland fire events in Thurston County. Map 4.5.3 shows the location of wildland fires for the same period.

Summary of Wildland Fires in Thurston County, 1972 to 2015

Fire District	Fire District and Municipal Fire Department Response Areas	Total Fires	Fires/ Year	Total Acres Burned	Max Size (acres)	Average Acres
	Bucoda Fire Department	8	0.2	1.2	50	0.1
	Olympia Fire Department	26	0.6	8.3	0.5	0.3
	Tumwater Fire Department	54	1.3	35.5	4	0.7
1 and 11	West Thurston Regional Fire Authority	494	11.5	581.7	50	1.2
2 and 4	South East Thurston Regional Fire Authority	430	10.0	416.9	59	1.0
3	Lacey	758	17.6	431.3	54	0.6
5 and 9	McLane/Black Lake	204	4.7	128.3	14	0.6
6	East Olympia	209	4.9	147.1	13	0.7
8	South Bay	183	4.3	44.6	8	0.2
12	Tenino	113	2.6	372.8	140	3.3
13	Griffin	68	1.6	118.8	96	1.7
16	Gibson Valley	35	0.8	51.4	25	1.5
17	Bald Hills	126	2.9	128	23	1.0
Grand Total		**2,708**	**63.0**	**2,465.9**	**140**	**0.9**

August 11, 2014 Haven Lake Fire, Mason County[4]

A 168-acre wildfire with unknown origins burned timber on second growth forest land near Haven Lake, approximately 10 miles northwest of Shelton. Fire suppression efforts involved both air and ground crews from DNR and local fire districts. While this fire occurred in neighboring Mason County, forest lands in Thurston County present the same conditions illustrating the threat of wildland fire to Western Washington communities.

August 10, 2014 Tenino Complex Blazes[5]

A series of three fires in south Thurston County and Pierce County ignited during one of the warmest and driest summers on record. A 10-acre fire near Crane Road was ignited by a forest debris pile within a 40-acre parcel. It is suspected that the pile may have been deliberately started by the property owner or by adjacent campfires on the property which was the site of a multi-day music event. Fire fighters battled the blaze and continued to monitor the hot spots for several days.

On the same day, a separate 10-acre fire burned in a large rock pit – east of Johnson Creek Road in Rainier. The rock pit is apparently a popular site for recreational target shooting, albeit an unsanctioned one. The fire was likely caused by the shooting and subsequent discharge of a large exploding target.

A third fire near Kinsman Court in Roy sparked several forest debris piles within a 30-acre clear cut. The fire was believed to have been caused by arson.

August 31, 2006 Sweetbriar Loop Neighborhood Brush Fire

A nine-acre brush fire came within 20 feet of homes in the Sweetbriar Loop neighborhood of Thurston County off Marvin Road in Fire District 3. Firefighters from five fire districts and DNR plus two helicopters were deployed to suppress the fire. No injuries or structural damage was reported with this fire. The cause of the fire remains unknown.[6]

July 3, 2003, Littlerock Woodland Blaze[7]

A hazardous mix of fireworks and dry conditions resulted in a brush fire that grew to consume four acres of woodland west of the community of Littlerock. A helicopter, 44 firefighters from DNR, firefighters from fire districts 1, 5, and 11, and 20 inmates from the Cedar Creek Corrections Facility responded to the fire. Fire trucks quickly deployed to defensive positions to protect homes from the blaze. No structures were affected.

April 4, 2002, Lacey Brush Fire[8]

Thirty firefighters from fire districts 3, 5, and DNR extinguished a 15-acre brush fire possibly started by children. The fire occurred on the site of a former farm that was overgrown with Scotch broom. No structural damage occurred.

August 20, 2001, Littlerock Grass Fire[9]

A 10-acre grass fire threatened 11 homes west of the community of Littlerock. The fire was ignited by sparks during a welding task. Nearly 20 firefighters from eight districts as well as home owners and neighbors joined to fight the fire which came within 20 to 30 feet from some homes.

August 5, 1998, Offut Lake Vicinity Grassfire10

At 4:30 p.m. a truck dragging an unhitched trailer on Old highway 99 generated sparks, igniting nearby grass near Offut Lake, just north of the City of Tenino. Twenty mile per hour winds fanned 40-foot flames and caused the fire to spread east. The fire was located at the border of East Olympia Fire District 6 and Tenino Fire District 12. Firefighters from eight fire districts and DNR, plus two helicopters put the flames to rest before it threatened nearly 100 homes. The fires prompted some residents to prepare to evacuate. By the time the fire was suppressed, it burned 140 acres (nearly a quarter square mile) of grasslands. No injuries were reported and no structures were damaged. Fire crews continued to extinguish hot spots into the next day. Two days later, Thurston County fire districts issued burn bans countywide.

Historic Western Washington Wildfires

While major forest fires are not common in Western Washington, the Yacolt Fire in Clark and Skamania Counties are the largest known Washington fires in recorded history. In 1902, the Yacolt Fire burned 238,900 acres (373 square miles) resulting in 38 deaths.[10] More recently, the Jordan Creek Fire occurred near Marblemount in Skagit County, burned 1,162 acres of forest land and threatened several homes in 1998. The reported cost to fight the Jordan Creek Fire exceeded $3 million dollars.[11]

Wildland Fire Hazard Exposure Analysis

Delineation of Wildland Fire Hazard Area

DNR in partnership with federal and local stakeholders delineated wildland urban interface communities throughout Washington, including Thurston County. Communities were evaluated for fire behavior potential, fire protection capability, and risk to social, cultural, and community resources. Risk factors included area fire history, type and density of vegetative fuels, extreme weather potential, topography, number and density of structures and their distance from fuels, location of municipal watersheds, and potential for loss of housing or businesses.

The delineation process used the criteria in the wildfire hazard severity analysis of the National Fire Protection Association's NFPA 299 Standard for Protection of Life and Property Wildfire (now NFPA 1144). Map 4.5.4 shows the results of this delineation process, indicating those areas of the county at high risk of a wildland urban interface fire. In 2009, the Thurston County Association of Fire Chiefs recommended that the Hazards Mitigation Plan use this information for delineating high risk wildland urban interface communities within Thurston County, until more suitable data becomes available. Information from this map is used to assess population, employment, assets, and essential infrastructure in the hazard area.

Communities Most Vulnerable to Wildland Fires

The location of historic wildland fires (Map 4.5.3) combined with the sufficient open space with fuels throughout the county suggest that significant portions of the county are vulnerable to wildland fires. Nineteen percent of Thurston County's land area is considered at high risk as shown on Table 4.5.1 and on Map 4.5.4. The following neighborhoods are considered at risk for wildland urban interface fires:

- Boston Harbor/Fishtrap Loop/Woodard Bay/South Bay Peninsula
- Capitol State Forest vicinity
- Grand Mound/Rochester/Confederated Tribes of the Chehalis Reservation vicinity
- Johnson Point Peninsula
- Lake Lawrence, western shore vicinity
- Nisqually River Valley, south east of Yelm
- Steamboat Island Peninsula
- Tenino (upland vicinity south of city limits)

Three forests within the county are also a special concern for wildland fires due to the prevalence of fuels, human activities, and limited road access:

- Capital Forest
- Joint Base Lewis McChord
- Commercial forests in southeast Thurston County

Photo courtesy of Robert W. Scott

Population and Employment in the Hazard Area

Approximately 30,500 residents (11.4 percent) and 6,600 employees (4.9 percent) live and work in the area designated as a high risk for wildland fires. Tables 4.5.3 through 4.5.6 summarize estimates of the region's population and employment in the wildland fire 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 and 2040.

Residential Dwellings in the Hazard Area

Presently, nearly 12,900 or 11.3 percent of residential dwelling units were in the wildland fire hazard area. By 2040, that number is expected to grow to 16,200. Tables 4.5.7 and 4.5.8 show estimates of the region's dwelling units in the wildland fire hazard area in the years 2015 and 2040.

Inventory of Assets and Dollar Value in the Hazard Area

No detailed wildland fire hazard scenario analysis of potential losses was conducted during the planning process. Countywide, an estimated $2.2 billion in assets is in the wildland fire hazard area. Estimates of the region's structures and their contents in the hazard area is summarized in tables 4.5.9 and 4.5.10. 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 to provide information on potential dollar losses.

Essential Facilities and Infrastructure in the Hazard Area

Essential facilities are located within the wildland fire hazard area, although many of the buildings have sufficient defensible space and are unlikely to be damaged or destroyed by fire. However, services and operations that are based from these facilities are likely to be indirectly affected due to power outages and or road closures, particularly facilities that are in more remote areas. Table 4.5.11 lists the type and number of essential facilities located in the wildland fire hazard area.

Photo courtesy of Steve North

Summary Assessment

Wildland fires have a high probability of occurrence. The vulnerability of the county to this hazard is also believed to be of a moderate level. Despite the relatively diminutive size of wildland fires in the county, they have great potential to destroy multiple homes or businesses. Past fires have threatened to damage or quite possibly destroy 10 to 20 or more homes in a single event. A moderate vulnerability rating is assigned because even small fires have the potential to impact multiple properties with devastating results in a very short time. Finally, the subjective estimate of the probability of occurrence and vulnerability threat are combined to classify the wildland fire hazard as a moderate risk.

Summary Risk Assessment for Wildland Fires in the Thurston Region

Probability of Occurrence	Vulnerability	Risk
High	Moderate	Moderate

Table 4.5.1: Wildland Urban Interface Hazard Area, by Jurisdiction

		Wildfire Hazard Area		
		Total	In Hazard Area	
Jurisdiction		Acres	Acres	%
Bucoda	**Total**	**380**	**0**	**0.0%**
Lacey	City	10,778	2	0.0%
	UGA	10,416	61	0.6%
	Total	**21,193**	**63**	**0.3%**
Olympia	City	12,089	307	2.5%
	UGA	3,887	875	22.5%
	Total	**15,976**	**1,182**	**7.4%**
Rainier	City	1,105	0	0.0%
	UGA	320	0	0.0%
	Total	**1,425**	**0**	**0.0%**
Tenino	City	922	14	1.5%
	UGA	65	46	71.0%
	Total	**987**	**60**	**6.1%**
Tumwater	City	11,354	0	0.0%
	UGA	2,875	24	0.8%
	Total	**14,229**	**24**	**0.2%**
Yelm	City	3,634	0	0.0%
	UGA	2,396	0	0.0%
	Total	**6,030**	**0**	**0.0%**
Grand Mound UGA	**Total**	**983**	**250**	**25.4%**
Chehalis Reservation[1]	**Total**	**833**	**789**	**94.7%**
Nisqually Reservation[1]	**Total**	**2,147**	**0**	**0.0%**
Total Cities		**40,261**	**323**	**0.8%**
Total UGAs[2]		**20,943**	**1,257**	**6.0%**
Total Reservations[1]		**2,979**	**789**	**26.5%**
Rural Unincorporated County[3]		**406,934**	**88,100**	**21.6%**
Thurston County Total		**471,117**	**90,469**	**19.2%**

Explanations: High risk wildland urban interface areas are shown on Map 4.5.4 as identified by DNR and USFS using National Fire Protection Association standards.
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 4.5.2: Wildland Urban Interface Hazard Area, by Special District

	Wildfire Hazard Area		
	Total	In Hazard Area	
Jurisdiction	Acres	Acres	%
Fire Protection Districts			
1,11 West Thurston Reg. Fire Authority	100,131	26,248	26.2%
2, 4 S.E. Thurston Reg. Fire Authority	56,030	2,198	3.9%
3 Lacey	36,820	2	0.0%
5, 9 McLane-Black Lake	51,828	21,342	41.2%
6 East Olympia	19,677	0	0.0%
8 South Bay	20,974	14,900	71.0%
12 Tenino	19,914	2,741	13.8%
13 Griffin	14,864	13,596	91.5%
16 Gibson Valley	18,038	2,018	11.2%
17 Bald Hills	13,926	9	0.1%
School Districts			
Centralia[1]	12,851	165	1.3%
Griffin	21,355	14,126	66.1%
North Thurston	47,081	8,479	18.0%
Olympia	49,894	20,701	41.5%
Rainier	35,550	0	0.0%
Rochester[1]	55,061	16,935	30.8%
Tenino	70,500	9,564	13.6%
Tumwater	73,845	18,065	24.5%
Yelm[1]	104,853	2,554	2.4%
Other Districts			
Intercity Transit	64,390	2,303	3.6%
LOTT Clean Water Alliance[2]	16,016	467	2.9%
Port of Olympia	471,117	90,469	19.2%
Thurston County PUD	471,117	90,469	19.2%

Explanations: High risk wildland urban interface areas are shown on Map 4.5.4 as identified by DNR and USFS using National Fire Protection Association standards

1. Data are for Thurston County portion of the district only.
2. Includes the sewered-area.

Table 4.5.3: Wildland Urban Interface 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**	**0**	**0.0%**	**1,215**	**0**	**0.0%**
Lacey	City	46,230	0	0.0%	55,160	0	0.0%
	UGA	33,980	260	0.8%	59,030	430	0.7%
	Total	**80,210**	**260**	**0.3%**	**114,190**	**430**	**0.4%**
Olympia	City	51,020	290	0.6%	71,840	1,350	1.9%
	UGA	11,920	2,820	23.7%	16,770	3,730	22.2%
	Total	**62,940**	**3,110**	**4.9%**	**88,610**	**5,080**	**5.7%**
Rainier	City	1,880	0	0.0%	2,810	0	0.0%
	UGA	110	0	0.0%	640	0	0.0%
	Total	**1,990**	**0**	**0.0%**	**3,450**	**0**	**0.0%**
Tenino	City	1,730	0	0.0%	3,675	0	0.0%
	UGA	15	5	33.3%	110	80	72.7%
	Total	**1,745**	**5**	**0.3%**	**3,785**	**80**	**2.1%**
Tumwater	City	22,370	0	0.0%	37,350	0	0.0%
	UGA	3,270	10	0.3%	8,960	140	1.6%
	Total	**25,640**	**10**	**0.0%**	**46,310**	**140**	**0.3%**
Yelm	City	8,170	0	0.0%	25,080	0	0.0%
	UGA	1,420	0	0.0%	5,690	0	0.0%
	Total	**9,590**	**0**	**0.0%**	**30,770**	**0**	**0.0%**
Grand Mound UGA	**Total**	**1,285**	**435**	**33.9%**	**1,990**	**890**	**44.7%**
Chehalis Reservation[1]	**Total**	**70**	**55**	**78.6%**	**190**	**140**	**73.7%**
Nisqually Reservation[1]	**Total**	**605**	**0**	**0.0%**	**705**	**0**	**0.0%**
Total Cities		**131,970**	**290**	**0.2%**	**197,120**	**1,350**	**0.7%**
Total UGAs[2]		**52,000**	**3,530**	**6.8%**	**93,190**	**5,280**	**5.7%**
Total Reservations[1]		**670**	**50**	**7.5%**	**890**	**140**	**15.7%**
Rural Unincorporated County[3]		**82,770**	**26,650**	**32.2%**	**102,470**	**31,300**	**30.5%**
Thurston County Total		**267,400**	**30,500**	**11.4%**	**393,700**	**38,100**	**9.7%**

Source: Thurston Regional Planning Council Population Forecast, 2015
Explanations: High risk wildland urban interface areas are shown on Map 4.5.4 as identified by DNR and USFS using National Fire Protection Association standards. 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 4.5.4: Wildland Urban Interface Hazard Area, Population by Special District, 2015 and 2040

	2015 Population Estimate			2040 Population Forecast		
	Total	In Hazard Area		Total	In Hazard Area	
Jurisdiction	#	#	%	#	#	%
Fire Protection Districts						
1,11 West Thurston	22,010	3,950	17.9%	31,120	5,970	19.2%
2, 4 S.E. Thurston	24,650	1,450	5.9%	50,770	1,670	3.3%
3 Lacey	91,660	0	0.0%	128,070	0	0.0%
5, 9 McLane-Black Lake	15,890	11,630	73.2%	20,770	13,880	66.8%
6 East Olympia	11,140	0	0.0%	14,810	0	0.0%
8 South Bay	11,820	8,100	68.5%	15,380	9,090	59.1%
12 Tenino	6,230	290	4.7%	9,530	560	5.9%
13 Griffin	5,060	4,760	94.1%	5,700	5,390	94.6%
16 Gibson Valley	590	0	0.0%	1,130	100	8.8%
17 Bald Hills	4,090	0	0.0%	5,440	0	0.0%
School Districts						
Centralia[1]	490	0	0.0%	1,180	10	0.8%
Griffin	5,950	4,900	82.4%	6,710	5,550	82.7%
North Thurston	99,300	4,390	4.4%	138,340	5,040	3.6%
Olympia	66,140	11,980	18.1%	87,700	15,050	17.2%
Rainier	5,210	0	0.0%	13,800	0	0.0%
Rochester[1]	14,060	2,310	16.4%	18,080	4,080	22.6%
Tenino	9,850	300	3.0%	15,510	580	3.7%
Tumwater	39,500	5,200	13.2%	63,820	6,090	9.5%
Yelm[1]	26,900	1,450	5.4%	48,530	1,670	3.4%
Other Districts						
Intercity Transit	176,450	3,740	2.1%	269,860	5,830	2.2%
LOTT Clean Water Alliance[2]	120,960	2,870	2.4%	249,110	5,650	2.3%
Port of Olympia	267,400	30,500	11.4%	393,700	38,100	9.7%
Thurston County PUD	267,400	30,500	11.4%	393,700	38,100	9.7%

Source: Thurston Regional Planning Council Population Forecast, 2015
Explanations High risk wildland urban interface areas are shown on Map 4.5.4 as identified by DNR and USFS using National Fire Protection Association standards.
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 4.5.5: Wildland Urban Interface Hazard Area, Employment by Jurisdiction, 2014 and 2040

		2014 Employment Estimate			2040 Employment Forecast		
		Total	In Hazard Area		Total	In Hazard Area	
Jurisdiction		#	#	%	#	#	%
Bucoda	**Total**	**90**	**0**	**0.0%**	**200**	**0**	**0.0%**
Lacey	City	25,610	0	0.0%	41,180	0	0.0%
	UGA	5,620	20	0.4%	8,520	30	0.4%
	Total	**31,230**	**20**	**0.1%**	**49,700**	**30**	**0.1%**
Olympia	City	53,350	50	0.1%	74,950	190	0.3%
	UGA	1,800	360	20.0%	2,230	420	18.8%
	Total	**55,150**	**410**	**0.7%**	**77,180**	**610**	**0.8%**
Rainier	City	455	0	0.0%	690	0	0.0%
	UGA	25	0	0.0%	80	0	0.0%
	Total	**480**	**0**	**0.0%**	**770**	**0**	**0.0%**
Tenino	City	870	0	0.0%	1,505	0	0.0%
	UGA	0	0	-	5	0	0.0%
	Total	**870**	**0**	**0.0%**	**1,510**	**0**	**0.0%**
Tumwater	City	22,350	0	0.0%	33,720	0	0.0%
	UGA	760	0	0.0%	1,420	10	0.7%
	Total	**23,110**	**0**	**0.0%**	**35,140**	**10**	**0.0%**
Yelm	City	3,830	0	0.0%	11,490	0	0.0%
	UGA	430	0	0.0%	670	0	0.0%
	Total	**4,260**	**0**	**0.0%**	**12,160**	**0**	**0.0%**
Grand Mound UGA	**Total**	**1,115**	**580**	**52.0%**	**1,375**	**650**	**47.3%**
Chehalis Reservation[1]	**Total**	**760**	**760**	**100.0%**	**1,550**	**1,550**	**100.0%**
Nisqually Reservation[1]	**Total**	**975**	**0**	**0.0%**	**1,865**	**0**	**0.0%**
Total Cities		**106,560**	**50**	**0.0%**	**163,730**	**190**	**0.1%**
Total UGAs[2]		**9,740**	**950**	**9.8%**	**14,300**	**1,110**	**7.8%**
Total Reservations[1]		**1,740**	**760**	**43.7%**	**3,410**	**1,550**	**45.5%**
Rural Unincorporated County[3]		**15,880**	**4,840**	**30.5%**	**18,270**	**5,560**	**30.4%**
Thurston County Total		**133,900**	**6,600**	**4.9%**	**199,700**	**8,400**	**4.2%**

Source: Thurston Regional Planning Council Population Forecast, 2015
Explanations: High risk wildland urban interface areas are shown on Map 4.5.4 as identified by DNR and USFS using National Fire Protection Association standards. 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 4.5.6: Wildland Urban Interface 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	2,090	33.2%	8,480	3,130	36.9%
2, 4 S.E. Thurston	6,710	230	3.4%	15,170	250	1.6%
3 Lacey	34,540	0	0.0%	54,170	0	0.0%
5, 9 McLane-Black Lake	3,630	2,120	58.4%	4,350	2,380	54.7%
6 East Olympia	1,960	0	0.0%	2,350	0	0.0%
8 South Bay	1,830	1,190	65.0%	2,250	1,450	64.4%
12 Tenino	1,500	60	4.0%	2,210	70	3.2%
13 Griffin	990	850	85.9%	1,060	920	86.8%
16 Gibson Valley	150	0	0.0%	180	10	5.6%
17 Bald Hills	470	0	0.0%	570	0	0.0%
School Districts						
Centralia[1]	120	0	0.0%	170	0	0.0%
Griffin	1,110	880	79.3%	1,190	950	79.8%
North Thurston	42,280	680	1.6%	66,290	900	1.4%
Olympia	48,850	2,290	4.7%	65,910	2,690	4.1%
Rainier	980	0	0.0%	1,860	0	0.0%
Rochester[1]	4,630	1,840	39.7%	6,230	2,870	46.1%
Tenino	2,340	60	2.6%	3,320	70	2.1%
Tumwater	25,670	620	2.4%	38,080	680	1.8%
Yelm[1]	7,850	230	2.9%	16,580	250	1.5%
Other Districts						
Intercity Transit	115,570	980	0.8%	176,500	1,290	0.7%
LOTT Clean Water Alliance2	91,010	305	0.3%	162,020	650	0.4%
Port of Olympia	133,900	6,600	4.9%	199,700	8,400	4.2%
Thurston County PUD	133,900	6,600	4.9%	199,700	8,400	4.2%

Source: Thurston Regional Planning Council Population Forecast, 2015
Explanations: High risk wildland urban interface areas are shown on Map 4.5.4 as identified by DNR and USFS using National Fire Protection Association standards.
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 4.5.7: Wildland Urban Interface 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**	**0**	**0.0%**	**535**	**0**	**0.0%**
Lacey	City	19,840	0	0.0%	24,400	0	0.0%
	UGA	13,500	110	0.8%	23,930	170	0.7%
	Total	**33,340**	**110**	**0.3%**	**48,330**	**170**	**0.4%**
Olympia	City	24,170	130	0.5%	35,610	600	1.7%
	UGA	4,850	1,100	22.7%	7,100	1,580	22.3%
	Total	**29,020**	**1,230**	**4.2%**	**42,710**	**2,180**	**5.1%**
Rainier	City	775	0	0.0%	1,140	0	0.0%
	UGA	50	0	0.0%	290	0	0.0%
	Total	**825**	**0**	**0.0%**	**1,430**	**0**	**0.0%**
Tenino	City	755	0	0.0%	1,855	0	0.0%
	UGA	5	0	0.0%	40	30	75.0%
	Total	**760**	**0**	**0.0%**	**1,895**	**30**	**1.6%**
Tumwater	City	9,970	0	0.0%	16,870	0	0.0%
	UGA	1,420	0	0.0%	3,820	60	1.6%
	Total	**11,390**	**0**	**0.0%**	**20,690**	**60**	**0.3%**
Yelm	City	3,000	0	0.0%	9,820	0	0.0%
	UGA	550	0	0.0%	2,280	0	0.0%
	Total	**3,550**	**0**	**0.0%**	**12,100**	**0**	**0.0%**
Grand Mound UGA	**Total**	**415**	**140**	**33.7%**	**740**	**330**	**44.6%**
Chehalis Reservation[1]	**Total**	**20**	**20**	**100.0%**	**65**	**50**	**76.9%**
Nisqually Reservation[1]	**Total**	**200**	**0**	**0.0%**	**255**	**0**	**0.0%**
Total Cities		**58,770**	**130**	**0.2%**	**90,230**	**600**	**0.7%**
Total UGAs[2]		**20,790**	**1,350**	**6.5%**	**38,190**	**2,170**	**5.7%**
Total Reservations[1]		**220**	**20**	**9.1%**	**320**	**50**	**15.6%**
Rural Unincorporated County[3]		**34,250**	**11,410**	**33.3%**	**41,730**	**13,340**	**32.0%**
Thurston County Total		**114,000**	**12,900**	**11.3%**	**170,500**	**16,200**	**9.5%**

Source: Thurston Regional Planning Council Population Forecast, 2015
Explanations: High risk wildland urban interface areas are shown on Map 4.5.4 as identified by DNR and USFS using National Fire Protection Association standards. 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 4.5.8: Wildland Urban Interface 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	1,530	18.0%	11,930	2,300	19.3%
2, 4 S.E. Thurston	9,800	600	6.1%	20,190	680	3.4%
3 Lacey	38,120	0	0.0%	54,160	0	0.0%
5, 9 McLane-Black Lake	6,490	4,660	71.8%	8,670	5,690	65.6%
6 East Olympia	4,510	0	0.0%	6,010	0	0.0%
8 South Bay	4,940	3,430	69.4%	6,370	3,830	60.1%
12 Tenino	2,580	120	4.7%	4,200	220	5.2%
13 Griffin	2,580	2,430	94.2%	2,910	2,750	94.5%
16 Gibson Valley	240	0	0.0%	440	40	9.1%
17 Bald Hills	1,770	0	0.0%	2,370	0	0.0%
School Districts						
Centralia[1]	200	0	0.0%	470	0	0.0%
Griffin	3,030	2,500	82.5%	3,430	2,830	82.5%
North Thurston	41,820	1,780	4.3%	59,460	2,040	3.4%
Olympia	29,690	4,950	16.7%	41,150	6,360	15.5%
Rainier	2,190	0	0.0%	5,690	0	0.0%
Rochester[1]	5,260	870	16.5%	6,670	1,550	23.2%
Tenino	4,130	120	2.9%	6,720	230	3.4%
Tumwater	16,940	2,090	12.3%	27,630	2,450	8.9%
Yelm[1]	10,780	600	5.6%	19,260	680	3.5%
Other Districts						
Intercity Transit	76,200	1,360	1.8%	119,200	2,320	1.9%
LOTT Clean Water Alliance[2]	53,760	1,130	2.1%	111,730	2,410	2.2%
Port of Olympia	114,000	12,900	11.3%	170,500	16,200	9.5%
Thurston County PUD	114,000	12,900	11.3%	170,500	16,200	9.5%

Source: Thurston Regional Planning Council Population Forecast, 2015
Explanations: High risk wildland urban interface areas are shown on Map 4.5.4 as identified by DNR and USFS using National Fire Protection Association standards.
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 4.5.9: Wildland Urban Interface 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**	**0**	**0.0%**	**1**	**0**	**0.0%**	**3**	**0**	**0.0%**
Lacey	City	2,394	0	0.0%	914	0	0.0%	602	0	0.0%
	UGA	1,715	7	0.4%	69	0	0.0%	273	0	0.0%
	Total	**4,109**	**7**	**0.2%**	**983**	**0**	**0.0%**	**875**	**0**	**0.0%**
Olympia	City	2,695	16	0.6%	1,199	9	0.8%	1,941	0	0.0%
	UGA	785	173	22.0%	27	6	22.2%	26	0	0.0%
	Total	**3,480**	**189**	**5.4%**	**1,226**	**15**	**1.2%**	**1,967**	**0**	**0.0%**
Rainier	City	76	0	0.0%	5	0	0.0%	30	0	0.0%
	UGA	5	0	0.0%	0	0	-	1	0	0.0%
	Total	**81**	**0**	**0.0%**	**5**	**0**	**0.0%**	**31**	**0**	**0.0%**
Tenino	City	50	0	0.0%	12	0	0.0%	67	0	0.0%
	UGA	1	0	0.0%	0	0	-	0	0	-
	Total	**51**	**0**	**0.0%**	**12**	**0**	**0.0%**	**67**	**0**	**0.0%**
Tumwater	City	1,209	0	0.0%	528	0	0.0%	556	0	0.0%
	UGA	130	0	0.0%	13	0	0.0%	7	0	0.0%
	Total	**1,339**	**0**	**0.0%**	**541**	**0**	**0.0%**	**563**	**0**	**0.0%**
Yelm	City	357	0	0.0%	105	0	0.0%	140	0	0.0%
	UGA	49	0	0.0%	6	0	0.0%	13	0	0.0%
	Total	**406**	**0**	**0.0%**	**111**	**0**	**0.0%**	**153**	**0**	**0.0%**
Grand Mound UGA		**34**	**10**	**29.4%**	**13**	**0**	**0.0%**	**5**	**5**	**100.0%**
Chehalis Reservation[1]		**1**	**1**	**100.0%**	**4**	**4**	**100.0%**	**0**	**0**	**-**
Nisqually Reservation.[1]		**16**	**0**	**0.0%**	**3**	**0**	**0.0%**	**0**	**0**	**-**
Total Cities		**6,793**	**16**	**0.2%**	**2,763**	**9**	**0.3%**	**3,338**	**0**	**0.0%**
Total UGAs[2]		**2,719**	**190**	**7.0%**	**128**	**7**	**5.5%**	**325**	**5**	**1.5%**
Total Reservations[1]		**17**	**1**	**5.9%**	**6**	**4**	**66.7%**	**0**	**0**	**-**
Rural Unincorp. County[3]		**4,977**	**2,013**	**40.4%**	**113**	**27**	**23.9%**	**1,033**	**692**	**67.0%**
Thurston County Total		**14,506**	**2,220**	**15.3%**	**3,010**	**47**	**1.6%**	**4,696**	**697**	**14.8%**

Source: Thurston Regional Planning Council Population Forecast, 2015
Explanations: High risk wildland urban interface areas are shown on Map 4.5.4 as identified by DNR and USFS using National Fire Protection Association standards. 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 4.5.10: Wildland Urban Interface 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	193	19.7%	57	11	19.3%	216	7	3.2%
2, 4 S.E. Thurston	1,073	71	6.6%	133	0	0.0%	202	2	1.0%
3 Lacey	4,823	0	0.0%	1,008	0	0.0%	896	0	0.0%
5, 9 McLane-Black Lake	1,121	874	78.0%	31	17	54.8%	676	625	92.5%
6 East Olympia	743	0	0.0%	14	0	0.0%	49	0	0.0%
8 South Bay	939	642	68.4%	13	8	61.5%	47	37	78.7%
12 Tenino	277	16	5.8%	17	0	0.0%	73	0	0.0%
13 Griffin	430	405	94.2%	3	2	66.7%	26	26	100.0%
16 Gibson Valley	20	0	0.0%	0	0	-	1	0	0.0%
17 Bald Hills	176	0	0.0%	6	0	0.0%	7	0	0.0%
School Districts									
Centralia[1]	17	0	0.0%	0	0	-	1	0	0.0%
Griffin	498	414	83.1%	3	2	66.7%	26	26	100.0%
North Thurston	5,394	349	6.5%	1,292	4	0.3%	969	21	2.2%
Olympia	3,990	956	24.0%	960	29	3.0%	2,344	637	27.2%
Rainier	241	0	0.0%	11	0	0.0%	34	0	0.0%
Rochester[1]	539	90	16.7%	42	10	23.8%	187	7	3.7%
Tenino	462	16	3.5%	21	0	0.0%	81	0	0.0%
Tumwater	2,155	324	15.0%	546	2	0.4%	877	4	0.5%
Yelm[1]	1,208	71	5.9%	135	0	0.0%	176	2	1.1%
Other Districts									
Intercity Transit	9,247	205	2.2%	2,865	20	0.7%	4,172	612	14.7%
LOTT Clean Water Alliance[2]	6,724	185	2.8%	2,498	6	0.2%	2,443	2	0.1%
Port of Olympia	14,506	2,220	15.3%	3,010	47	1.6%	4,696	697	14.8%
Thurston County PUD	14,506	2,220	15.3%	3,010	47	1.6%	4,696	697	14.8%

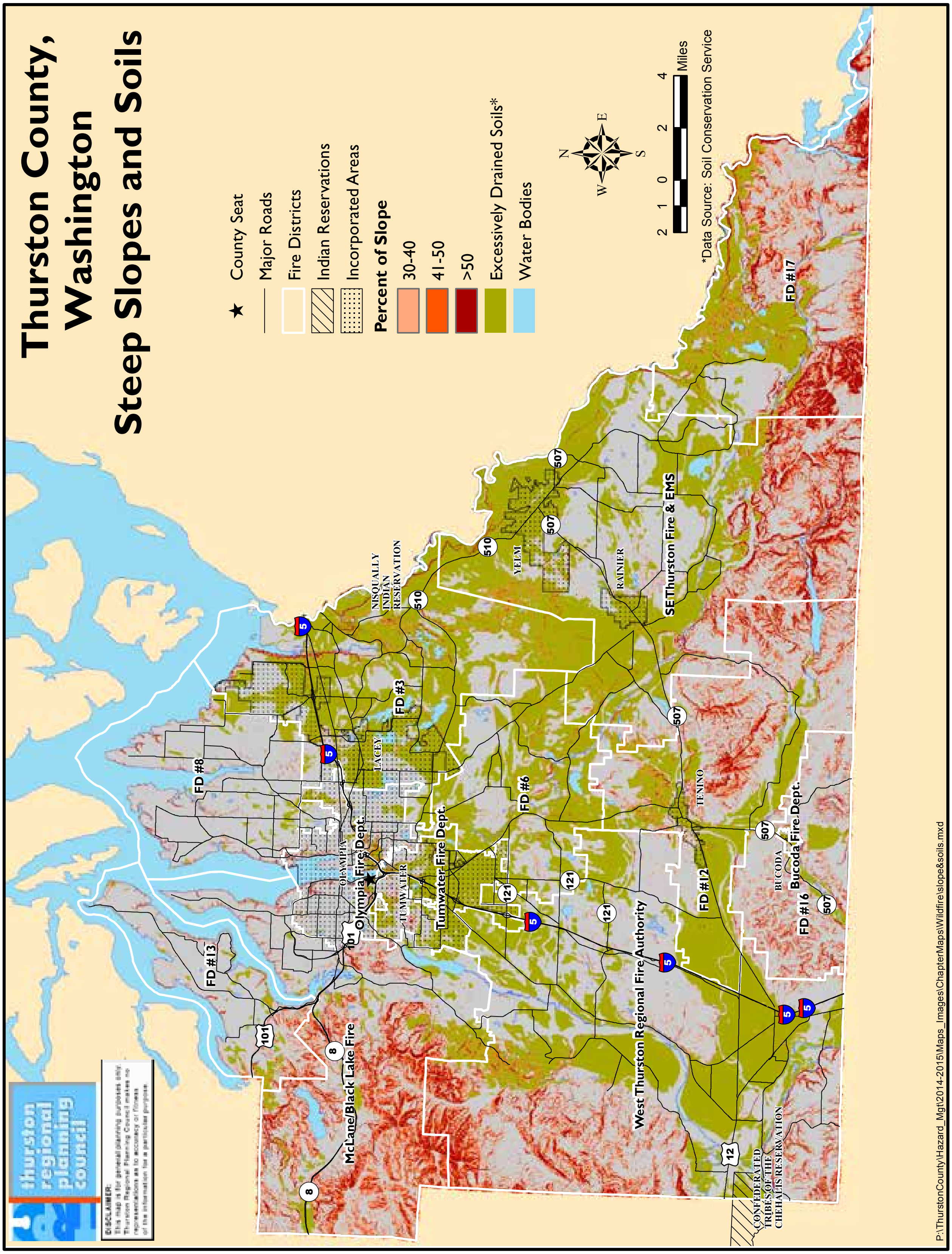
Source: Thurston Regional Planning Council Population Forecast, 2015
Explanations: High risk wildland urban interface areas are shown on Map 4.5.4 as identified by DNR and USFS using National Fire Protection Association standards.
1. Data are for Thurston County portion of the district only.
2. Includes the sewered-area.

Table 4.4.11: Essential Facilities in the Wildland Urban Interface Hazard Area

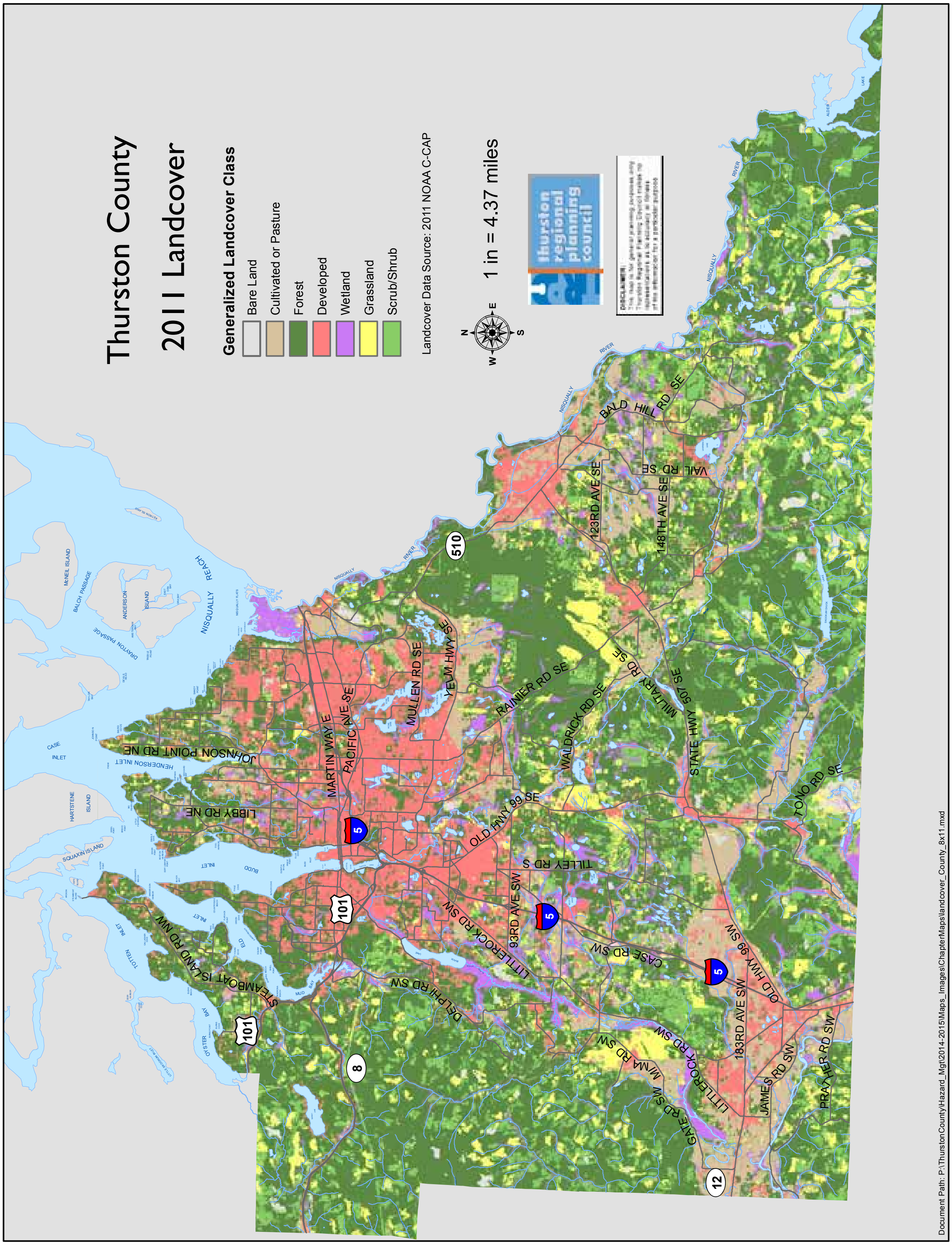
Facility Type	Total #	In Hazard Area #	In Hazard Area %
Medical Care			
Adult Family Home	124	2	1.6%
Assisted Living	14	0	0.0%
Dentist	110	3	2.7%
Dialysis Center	3	0	0.0%
Funeral Home	6	0	0.0%
Hospital	2	0	0.0%
Nursing Home	7	0	0.0%
Pharmacy	42	0	0.0%
Primary Care	91	3	3.3%
Urgent Care	6	0	0.0%
Government			
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	12	22.6%
Government Services	56	1	1.8%
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	21	6.1%
Public Higher Education	52	27	51.9%
Public Works	33	2	6.1%
Solid Waste	20	0	0.0%
Transit	4	0	0.0%
Utilities	238	23	9.7%
Transportation (Centerline Miles)			
Roads	2,210	384	17.4%
Intercity Transit Routes	157	3	2.1%
Rural Transit Routes	96	5	5.4%

Explanations: High risk wildland urban interface areas are shown on Map 4.5.4 as identified by DNR and USFS using National Fire Protection Association standards.

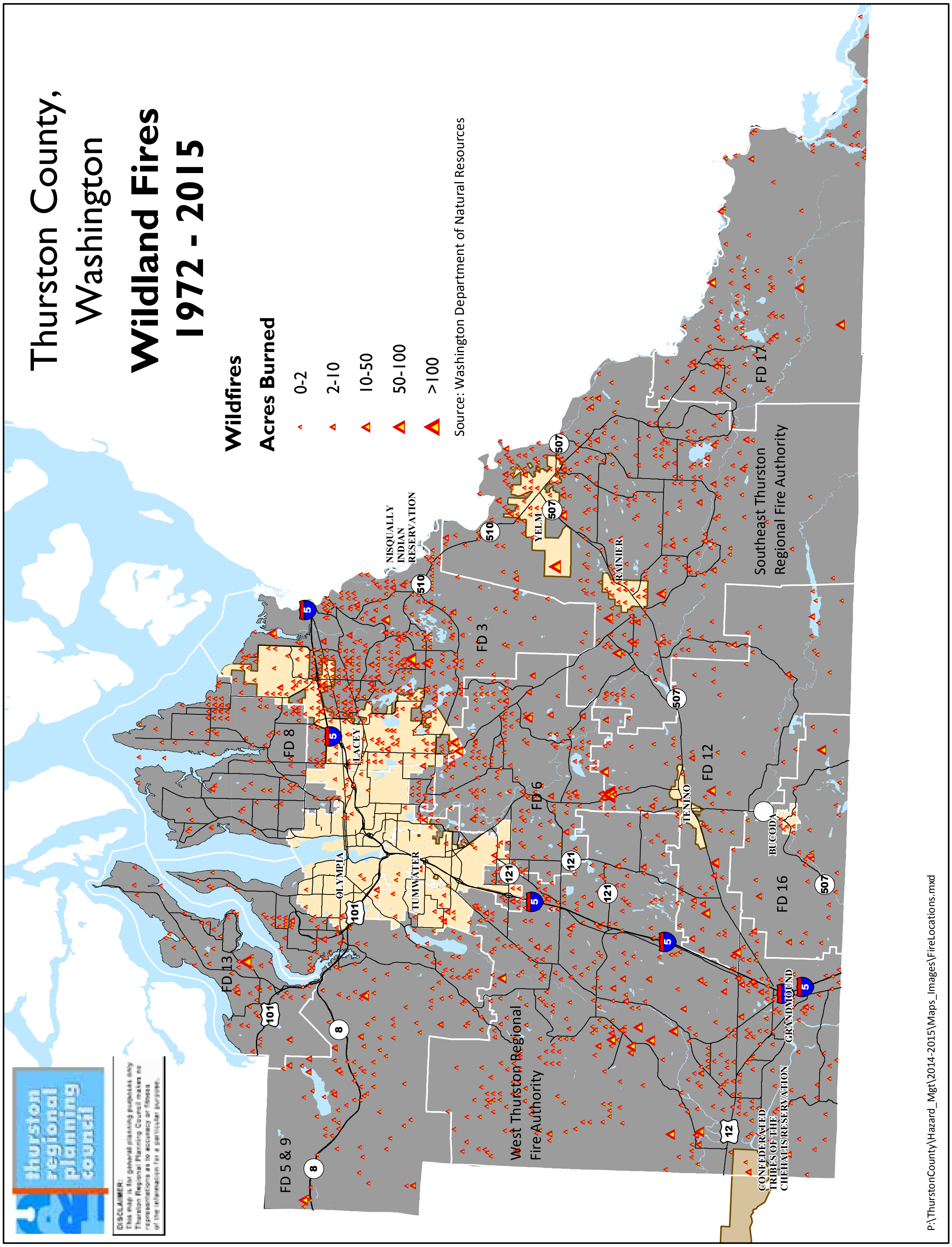
Map 4.5.1.: Steep Slopes and Soils



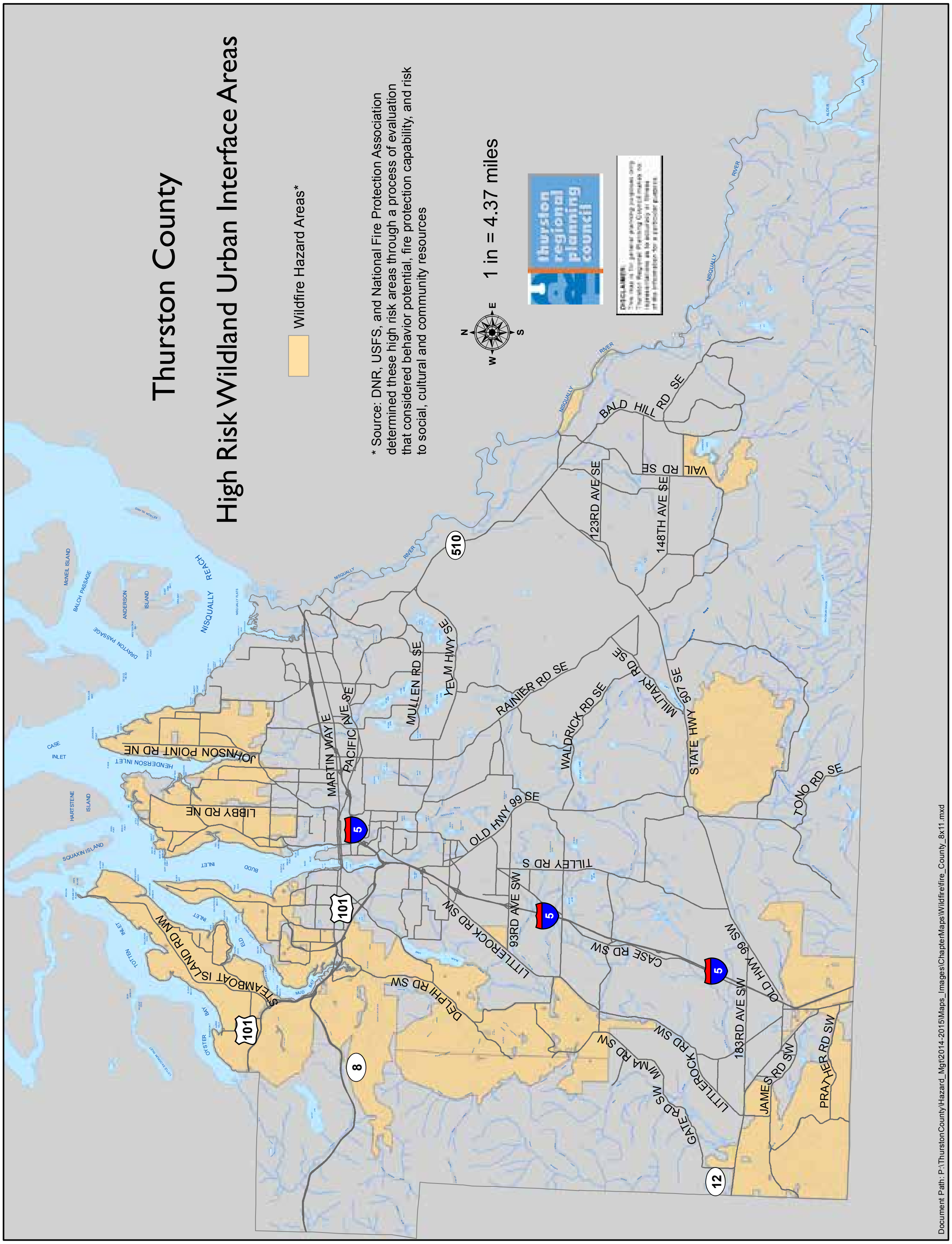
Map 4.5.2 Land Cover of Thurston County, Washington



Map 4.5.3 Wildland Fires, 1972-2015



Map 4.5.5 High Risk Wildland Urban Interface Areas



Endnotes

[1] National Interagency Coordination Center. 2016. 2015 Statistics and Summary. https://www.nifc.gov.

[2] Washington State Emergency Management Division. 2014. Washington State Enhanced Hazard Mitigation Plan: Wildland Fire Hazard Profile.

[3] Washington State Department of Natural Resources, Resources Protection Division. 2015. Wildland Fire Starts GIS database.

[4] Incident Information System. 2016. Haven Lake Fire. http://inciweb.nwcg.gov/incident/4075

[5] Rolf Boone. Fire investigations provide clearer picture of Tenino Complex Blazes – 3 fires last summer had separate origins, but all share elements of mystery. 2015. Published in The Olympian, January 5, 2015.

[6] Diane Huber. 2006. Volatile Brush Erupts – Eight Acres Burn in Lacey; Conditions Ripe for more Fires. Published in The Olympian, September 1, 2006.

[7] Scott Gutierrez. 2003. Fireworks Spark 3-Acre Blaze. Published in The Olympian, July 4, 2003.

[8] Jim Carlile. 2002. Lacey Brush Fire Chars 15 Acres. Published in The Olympian., August 21, 2001.

[9] Liona Tannesen. 2001. Brush Fire Draws Swift Response. Published in The Olympian, August 21, 2001.

[10] Jerry Weatherhogg and Joel Coffidis. 1998. Brush Blazes Spread Havoc. Published in The Olympian, August 6, 1998.

[11]Skagit County. 2003. Skagit County Natural Hazards Mitigation Plan.

Hazard Type
LAHAR
Probability of Occurrence
LOW
Vulnerability
HIGH
Risk
MODERATE

Chapter 4.6
Volcanic Hazard Profile

Introduction

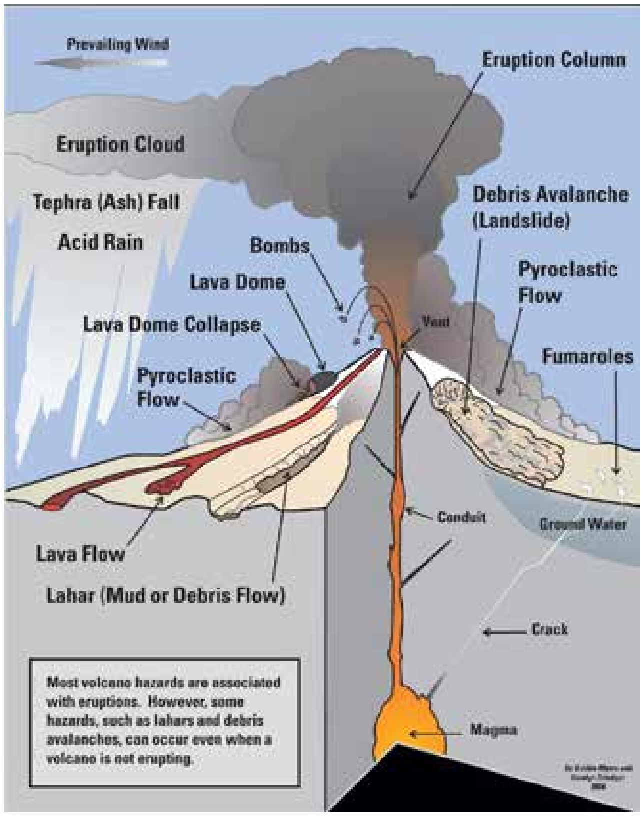
The May 18, 1980 Mount St. Helen's eruption killed 57 people and caused over $1 billion in damage. Both this major volcanic eruption and the mountain's activity leading up to and following it provide ample evidence of Cascade volcanoes' ability to reawaken with destructive force and severely impact Pacific Northwest communities. The Cascade Range extends from British Columbia to northern California, containing over a dozen active volcanoes. Washington State is home to five: Mount Baker, Glacier Peak, Mount Rainier, Mount St. Helens, and Mount Adams. Each can generate ash plumes, lahars (mud or debris flows), lava, pyroclastic flows, and debris avalanches. In the last 4,000 years, 11 Cascade volcanoes erupted an estimated 100 times; a rate of two events per century.[1]

Thurston County is within range of two of the most active and hazardous volcanoes in the United States. The faces of Mount Rainier and Mount St. Helens are located only 22 and 39 miles, respectively, from the southeast corner of the county. The proximity of these volcanoes places the county at risk to volcanic hazards. While these volcanoes pose a low risk for ash fall, Mount Rainier presents a moderate risk for a lahar within the Nisqually Valley.

Hazard Identification

Gas, ash, ballistic projectiles, rock fragments, and magma are forced to the surface from rising pressures within and below the volcano. Many volcanic events such as pyroclastic flows, lava flows, landslides, and explosive blasts can devastate an area of tens of miles or greater from the source of the eruption (Figure 4.6.1). Although these events can destroy almost everything in their path, it is unlikely these impacts will extend beyond the boundary of Mount Rainier National Park.[2]

Figure 4.6.1: Volcanic Hazards



Graphic courtesy of USGS.

An explosive eruption could create an ash plume that could deposit ash across Thurston County, although the predominant wind direction would likely carry the bulk of ash east of the Cascades. A volcanic event could also trigger a massive debris avalanche or mudflow, known as a lahar. A lahar could originate on the flanks of the mountain and flow downhill, creating a path of destruction and inundation as far as the Nisqually River Delta. These two volcanic hazards pose the greatest risk to the county and are described in this hazard profile.

1. Tephra Hazard

Tephra – the most widespread and frequent volcanic hazard – is the term for any type and size of rock fragment that travels in an airborne path from a forceful volcanic eruption. Cascade volcanoes can produce a hazardous column of suspended debris that subsequently falls to the ground in the direction of prevailing winds (Figure 4.6.1). A tephra plume can travel for hundreds of miles and deposit ash in significant quantity. Both the thickness of the deposition and the size of the particles decrease with increasing distance from the site of eruption. Ash particles are less than 0.08-inch diameter.

Figure 4.6.2: Removal of ash from Mount St. Helens near the Yakima Airport

Graphic courtesy of the Yakima Herald

Severity

It's plausible that Thurston County could receive ash fall from Mount Rainier or other Cascade volcanoes under the right wind conditions. The severity of the hazard depends on the depth and geographic extent of ash deposition. Ash can travel great distances and cover areas over hundreds or thousands of square miles. The 1980 eruption of Mount St. Helens projected an ash column 15 miles into the atmosphere. Over the course of the day of the eruption, winds blew nearly 540 million tons of ash to the east.[3] Fallout from the ash created complete darkness in Spokane, nearly 250 miles away; dropping one half inch of ash only a few hours after the start of the eruption.

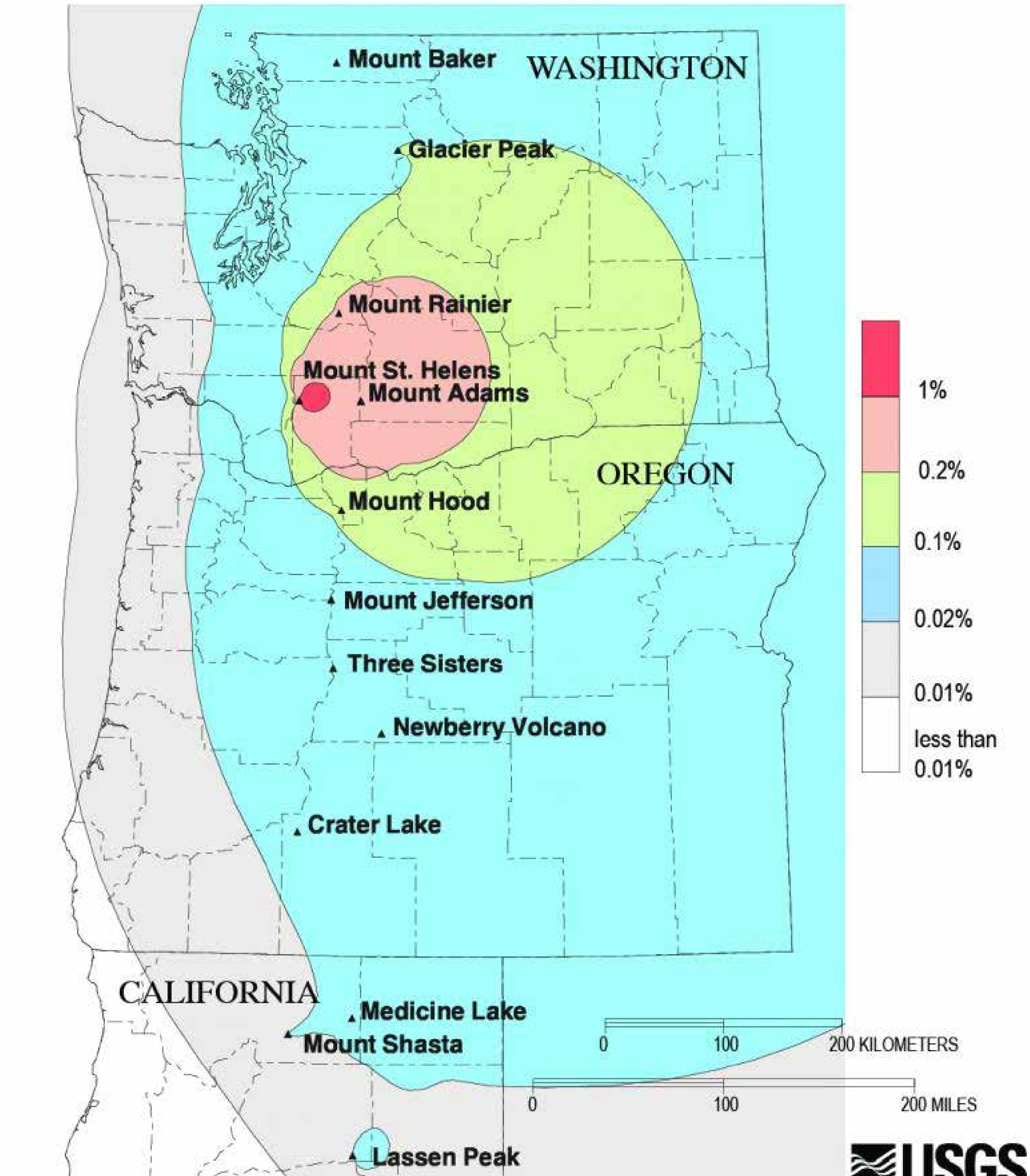
Impacts

A quarter inch or more of ash fall will disrupt nearly every mode of transportation. Ash fall obscures visibility and wet ash creates hazardous driving conditions. Aircraft is especially vulnerable as it can disable engines, therefore air transportation would be grounded in the affected area while conditions pose a hazard. Inhalation of ash particles can cause respiratory irritation and pose more serious problems for people with respiratory diseases; but this can be mitigated by simply avoiding exposure. Ash can destroy crops, reduce livestock access to pastures, contaminate lakes and streams, clog stormwater systems, and damage exposed motors and outdoor mechanical systems. Three inches of ash begins to exceed load capacities of some building rooftops and can cause structural failure. Failure may also occur with lower depths of ash when combined with excess precipitation. Wet ash is known to cause power lines to short. Ash removal and disposal would likely be the greatest cost to both the public and private sectors. The 1980 eruption of Mount St. Helens posed a major nuisance for communities in Eastern Washington. In Yakima, ash removal took 10 weeks and cost $2.2 million.[4]

Probability of Occurrence

The United States Geological Survey (USGS) reports that Mount Rainier has only produced moderate quantities of ash in past eruptions. The eruptions of Mount St. Helens in 1980 deposited a scant layer of ash in Thurston County, but the fallout did not pose a significant hazard to the region. Thurston County winds prevail from the south and west, therefore ash is more likely to disperse east of Cascades. If Mount Rainier or Mount St. Helens were to erupt, a resultant ash plume would require an easterly wind to deposit ash in Thurston County. The USGS calculated a 0.02 percent annual probability for a significant ash deposit of one centimeter or greater for the southeastern tip of the county and 0.01 percent for most of the county and its most populated areas (Figure 4.6.3).[5] There is a low probability of a volcanic tephra event impacting Thurston County.

Figure 4.6.3: Probability of Cascades Tephra Hazard



Annual probability of the deposition of 1 centimeter (0.4 inch) or more of tephra (ash) from eruptions in the Cascade Range. Graphic courtesy of USGS.

2. Lahar Hazard

Steep Cascade volcanoes and their lower elevation valleys are ideal settings for massive debris flow- and mudflow-disasters because of the immense quantity of ice, water, rock, and sedimentary materials available that can suddenly mobilize downslope under the action of gravity. Such events, triggered by volcanoes, are known as lahars. The USGS describes a lahar:

> A lahar is a flowing mixture of water-saturated debris that moves downslope under the force of gravity. Debris flows consist of material varying in size from clay to blocks several tens of meters in maximum dimension. When moving, they resemble masses of wet concrete and tend to flow downslope along channels or stream valleys. Debris flows are formed when loose masses of unconsolidated wet debris become unstable. Water may be supplied by rainfall or by melting of snow or ice. Debris flows may be formed directly if lava or pyroclastic flows are erupted onto snow and ice. Debris flows may be either hot or cold, depending on their manner of origin and temperature of their constituent debris.[6]

Figure 4.6.4: Lahar originating in the Mount St. Helens crater after an explosive eruption on March 19, 1982

Graphic courtesy of USGS.

The scientific literature for Cascade lahars identifies several size and origin classifications. Lahars can be either large or small. The USGS has summarized two types of Mount Rainier lahar origination events that could pose a hazard to communities within the Nisqually River valley:

Meltwater Generated Lahar - A volcanic eruption can produce an explosive event which releases a mixture of hot gases and rock debris, known as a pyroclastic flow. A pyroclastic flow behaves almost like a fluid and flows down the topography of the mountain. This hot churning debris flow swiftly melts snow and ice and subsequently mixes with the meltwater to form a lahar. Such lahars are often preceded by volcanic events or seismic activity which can provide some warning of an impending eruption. Geological evidence indicates that several of Mount Rainier's past lahars were formed by this phenomenon.

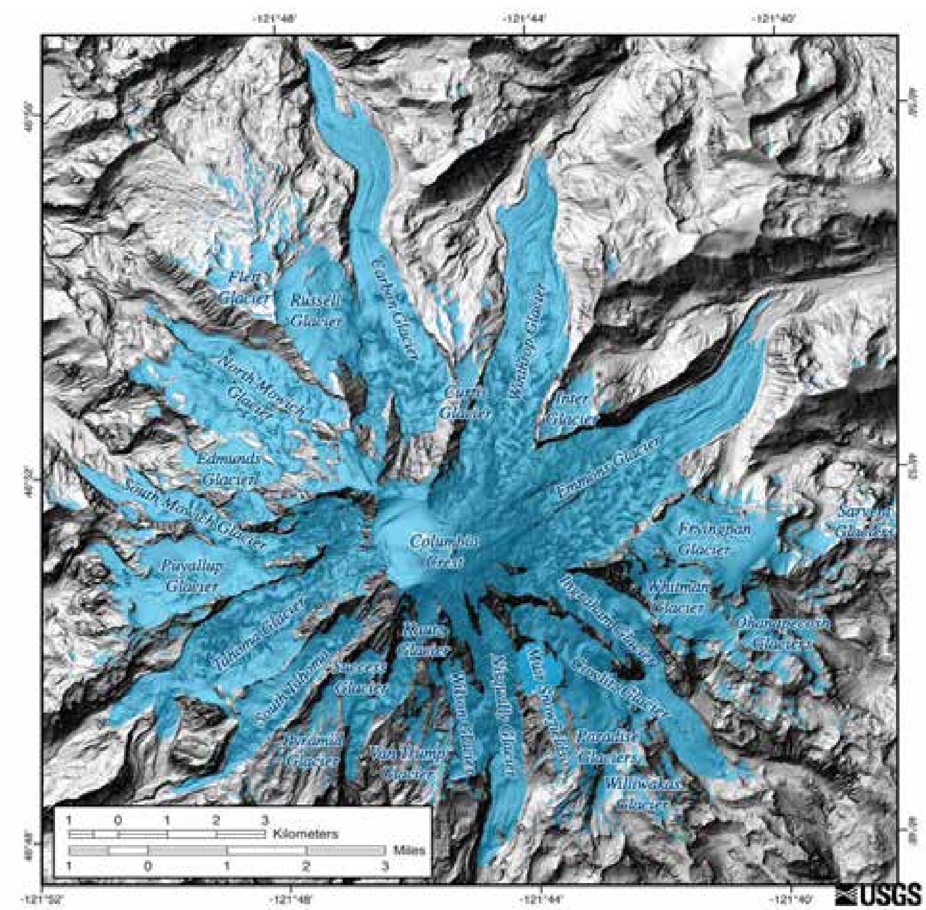
Landslide Generated Lahars - Landslides can occur on the flanks of Mount Rainier that can displace significant volumes of earth and water to form a substantial lahar. Magma can rise and force pressure against the internal structures of a mountain causing deformation and destabilization of the mountain's edifice. A modern example of this type of effect occurred with the bulge that formed on the north flank of Mount St. Helens in the months preceding the May 18, 1980 eruption. This bulge eventually collapsed creating one of the largest known landslides in modern times. Earthquakes can also initiate a landslide of unstable structures. Landslides can also occur from an eventual failure of a rock mass's cohesive strength. Rocks can be weakened by the chemical action of acidic fluids that are created from volcanic gases, heat, and ground water. Over time, this acidic fluid infiltrates the rock and eventually converts the hard volcanic rock into weak, clay-rich rock. This process is called hydrothermal alteration or metamorphism. These altered rocks and water-saturated clay-rich deposits could eventually slough away from the mountain from the force of a volcanic eruption. These landslides can rapidly transform into a lahar. Many large scale lahars on Mount Rainier have formed in this fashion. Hydrothermally altered rock landslides have also produced lahars without the trigger of a volcanic eruption. One such lahar, known as the 500-year-old Electron Mudflow, is believed to have originated without a volcanic eruption. No eruptive volcanic deposits have been discovered that coincide with the age of this lahar. This lahar deposited debris as high as 20 feet thick, and contains remnants of an old-growth forest in the vicinity of the City of Orting in Pierce County.

Severity

At 14,410 feet, Mount Rainier is the highest peak in the Cascade Range. It is estimated to contain nearly one cubic mile of glacial ice, more than all the other Cascade volcanoes combined (see Figure 4.6.5).[7] The sheer volume, mass, rate of speed, and churning contents of a massive debris flow could destroy virtually all human made structures in its path. Past Cascade lahars surged nearly 45 to 50 miles per hour at steep slopes and were 100 feet or more thick. Scientists have identified more than 60 lahars originating from Mount Rainier in the past 10,000 years. Deposits of past lahars are found in all the valleys that originate on Mount Rainier's flanks.[8] The Washington State Hazard Mitigation Plan states that more than 150,000 people live on historic lahar deposits in the Puget Sound lowlands. The USGS rates the risk of a large lahar from Mount Rainier to the surrounding Western Washington population, as the Puget Sound Region's greatest volcanic hazard.

Scientific research and mapping of hydrothermally altered rocks on Mount Rainier's high altitude slopes suggests that the west flank of the mountain, including the head of the Puyallup River, has the greatest potential for generating large landslides that are likely to initiate far-reaching lahars.[9] The Puyallup River valley, and to a lesser extent, the Nisqually River valley, whose basin also includes weakened rock, are at the most risk from large landslide-generated lahars. Lahars generated by eruptions could descend any of the mountain's valleys.[10]

Figure 4.6.5: Glaciers of Mount Rainier overlaid on base map LIDAR image



Steep Cascade volcanoes, rich with glaciers, and their lower elevation valleys are ideal settings for massive debris flow- and mudflow-disasters. Graphic courtesy of USGS.

Scientists with the USGS have studied artifacts from past lahars to predict future impacts. Deposits are analyzed to determine the type, frequency, and magnitude of past events. Through these studies, scientists predicted a potential inundation hazard in the lower Nisqually River valley caused by a lahar entering and possibly flowing beyond Alder Reservoir. Because Alder Dam exists for power generation, Alder Lake is never empty. Scientists are concerned that a lahar entering the reservoir could either cause dam failure or catastrophically displace a significant volume of the stored water.

Volcanologists consider a Case 1 lahar originating from Mount Rainier, the most appropriate scenario for hazard mitigation planning.[11] This type of lahar event is best historically represented by the Electron Mudflow. The risk of this lahar type exceeds that of all smaller but more frequent flows. In addition, the risk is increased by a potential to occur without a major volcanic eruption, which may not afford downstream populations an early warning. A non-eruptive event could be initiated by non-magmatic seismic activity, by steam eruptions, or just by gravity in places where a failure plane has been loosened by clay and hydrothermal fluids.

The Alder Dam and the Alder Lake Reservoir, owned and operated by Tacoma Power for power generation, creates uncertainty about the potential lahar flow dynamics downstream from the dam. This dam is vulnerable to a Case 1 lahar. The travel time of a Case 1 flow from the edifice of Mount Rainier to the reservoir may be less than two hours. High reservoir water levels do not offer sufficient capacity to contain the volume of the lahar flow. Scientists report that the reservoir is most vulnerable to failure caused by a wave of translation, because the relatively confined valley upstream can convey a large lahar without great volume loss.[12] A wave of translation would likely cause water to overtop the dam and send waves of water downstream from the reservoir. Smaller lahars entering the reservoir may not pose immediate risks for downstream flooding, but could increase the rate of sedimentation for the dam and thereby shorten its term of operation.

The 1999 Tacoma Power “Emergency Action Plan for the Nisqually Hydroelectric Project FERC Project No. 1862 [LaGrande and Alder Dams)” includes the following excerpt:

> *Another possible [hazard] event is that of a lahar or mudflow originating from Mt. Rainier. Travel time of a lahar or mudflow to Alder lake is estimated between 0.5 and 4.2 hours. Most lahars having sufficient volume to cause a significant rise in the lake level will travel in less than 2 hours. Because of the rapid nature of the inflow, it is not possible to affect any meaningful advance spill to increase reservoir capacity. An advance spill of 20,000 cubic feet per second for one hour will only yield approximately half-foot of reservoir capacity at full lake. Therefore, should*

lake levels rise rapidly (>3 feet/hour) no spill is recommended and evacuation to an observation post should be made. The combined outflow of both a large spill and overtopping may be more adverse than would result from overtopping only. In the unusual case of a lahar causing more gradual rise in inflow, spill could be implemented, but is not recommended unless reduction in spill can be made remotely. Rapid evacuation should be planned prior to local operation of the spillway.

There are no lahar sensors on the southwest flank of Mount Rainier to provide notice of a lahar emerging in the Nisqually River valley, but sensors and gauges at the Alder Dam would provide indication of changes in the level of water at the reservoir. Tacoma Power will notify multiple state and local emergency response agencies if failure of the Alder or LaGrande dams appeared imminent. Residents within the Nisqually River valley could evacuate to higher ground if given sufficient warning of a catastrophic dam failure. The Alder and LaGrande Sequential Dam Failure Flood Inundation zones approximate the USGS's extent of the inundation zone for a Case 1 lahar in the Nisqually River valley (Map 4.6.1).

Should a Case 1 lahar adversely affect the Alder Dam, flood inundation could occur at the Nisqually River bridge at SR507 (McKenna, Pierce Co.) in two hours and 30 minutes. The inundation would peak at this same location in four hours and 36 minutes.[13]

Impacts

Case 1 lahars could be high in consequence and pose a major hazard to human life and property in the Nisqually River Valley. Upriver from the reservoir, people and animals could be severely burned by such flows carrying hot debris. Downriver, buildings and other structures in the path of a debris flow can be buried or carried away. Because of their relatively high density and viscosity, these flows can move and even carry away vehicles and other objects as large as bridges. The following major bridges/routes are located within the Case 1 inundation zone and could be adversely impacted or destroyed: State Route 507 Bridge between Yelm and McKenna, Old Pacific Highway, and I-5. There are also three railroad bridge crossings: The Tacoma Rail Mountain Division railroad, the Yelm Prairie Line (non-operational), and the BNSF Railway mainline near I-5. The Centralia City Light Yelm Hydroelectric Project plant would also be adversely impacted from a Case 1 lahar.

Because debris flows are confined to areas down-slope and down-valley from their points of origin, people can avoid them by seeking high ground. The debris-flow hazard decreases gradually down-valley from possible source volcanoes, but more abruptly with increasing altitude above valley floors. People seeking to escape flows should climb valley sides rather than try to outrun the flows in valley bottoms. During eruptive activity or precursors to eruptions, local government officials may ask for prompt evacuation of areas likely to be affected.

Probability of Occurrence

The historical occurrences of lahars are classified by size. The largest lahar, historically represented by the Osceola mudflow, is designated a Case M lahar for a maximum lahar event. Scientists offer this scenario as "low probability and high consequence," with the implication that the risk may be unacceptable at even very small probabilities.[14] This lahar is estimated to occur about every 10,000 years. When compared with other historic lahars from postglacial times, scientists consider this maximum lahar a statistical outlier. There is no geologic record of a Case M lahar affecting Thurston County.

A Case I lahar is estimated to have a recurrence interval of approximately every 500 to 1,000 years. The Washington State Hazard Mitigation Plan indicates there is a one in 100 to one in 500 annual probability of occurrence of lahar inundating the Nisqually River. The probability of a Case 1 lahar is low.

Lahar Historical Occurrences and Impacts

Lahars originating from Mount Rainier are historically a relatively common occurrence. They vary in size and magnitude and are unpredictable. No significant lahars have impacted Thurston County in modern times. Past Nisqually River valley lahars are known to have flowed down the slopes of Mount Rainier all the way to the Puget Sound. The USGS provides the following short history of major lahar events originating from Mount Rainier:

> *The largest lahar originating from Mount Rainier is known as the Osceola Mudflow. This cohesive lahar occurred about 5,600 years ago, and was at least 10 times larger than any other known lahar from Mount Rainier. It was caused by a large debris avalanche composed mostly of hydrothermally-altered material, and may have been triggered by magma forcing its way into the volcano. Osceola deposits cover an area of about 550 square kilometers (212 square miles) in the Puget Sound lowland, extending at least as far as the City of Kent, and to Commencement Bay, now the site of the Port of Tacoma. The communities of Orting, Buckley, Sumner, Puyallup, Enumclaw, and Auburn are also wholly or partly located on top of deposits of the Osceola Mudflow and, in some cases, of more recent debris flows as well.*

At least six smaller debris avalanches have spawned lahars in the past 5,600 years. One of these, the Electron Mudflow, which was derived from a slope failure on the west flank of Mount Rainier about 600 years ago, has not been correlated with an eruption. The Electron Mudflow was more than 30 yards deep where it entered the Puget Sound lowland at the community of Electron. Its deposits at Orting are as much as 6 yards thick and contain remnants of an old-growth forest.

Large non-cohesive lahars at Mount Rainier are associated with volcanism. About 1,200 years ago, a lahar of this type filled valleys of both forks of the White River to depths of 20 to 30 meters (60 to 90 feet) and flowed 100 km (60 miles) to Auburn. Hot rock fragments flowing over glacier ice and snow generated huge quantities of melt water, which mixed with the rock debris to form lahars. Less than 2,200 years ago, another lahar of similar origin, named the National Lahar, inundated the Nisqually River Valley to depths of 30-120 feet and flowed all the way to Puget Sound. More than a dozen lahars of this type have occurred at Mount Rainier during periods of volcanism in the past 6,000 years.[15]

Figure 4.6.6: Remnants of a lahar on the Toutle River

Graphic courtesy of USGS.

Lahar Hazard Exposure Analysis

Delineation of the Lahar Hazard Area

The USGS produced a map for the inundation zone for a Case I lahar. Map 4.6.2 shows the lahar hazard area for Thurston County. On the lower Nisqually River below Alder Dam, the inundation area shown downstream from Alder Dam is a sub-case of the Case I lahar. Inundation could result from dam failure caused by lahar impact, displacement by the lahar of some of the water impounded by the Alder Lake and LaGrande reservoirs, or possible continuation of the lahar past the dam site. Some part of a Case I lahar may be impounded by the reservoir. Thus, without dam failure, lahar-related inundation downstream from Alder Dam would most probably affect less area than shown in Map 4.6.2. Approximately 9,828 acres (2.1 percent in Thurston County lie within the Case I Lahar hazard area. Tables 4.6.1 and 4.6.2 show the total acres, by jurisdiction and special district, within the Case 1 lahar hazard area.

Communities Most Vulnerable to a Lahar

Based on the Case 1 lahar scenario, properties along the Nisqually River Valley are the most susceptible to lahar hazards. Following the Nisqually River southeast to northwest, the following general vicinities and communities along the Nisqually River may be most affected under this scenario:

- Properties north of Clear Lake along Peissner Road SE and Hobson Road SE
- Properties north east of Bald Hills Rd near Cook Road SE and Dan Cook Street SE
- McKenna Elementary School (Pierce County), Yelm Community School District
- Wa He Lut Indian School
- Properties between the Nisqually River and the Yelm Urban Growth Area Boundary near Bridge Street SE and Flume Road SE
- Properties northeast of Yelm in the northeast section of the Nisqually Pines residential community near Port Orford Boulevard SE, Heather Lane SE, and Briar Street SE
- The City of Centralia Power Plant off Mud Run Road (eight employees and family members live on site) [16]
- Properties on the Nisqually Indian Reservation adjoining the Nisqually River migration zone
- Virtually all properties in the Nisqually Valley from Durgin Road SE north to the Puget Sound.

Population and Employment in the Hazard Area

A major Tephra fall could affect the entire county. As a result, tephra hazard area tables were not developed. The “total” columns in the Population and Assets tables provided for the lahar hazard provides information in assessing the population and assets at risk from a countywide tephra fallout.

Approximately 2,000 residents (0.7 percent) and 600 employees (0.4 percent) live and work in the area designated as at risk for a Case 1 lahar. Estimates of the region’s population and employment in the lahar hazard area is summarized in Tables 4.6.3 through 4.6.6. The population and employment in the tephra fall hazard zone is represented by the “total” columns. These tables assess an aspect of current and future vulnerability by providingdata on the number of people living and working within the hazard area as compared to total population, by jurisdiction, in the years 2015 and 2040.

Residential Dwellings in the Hazard Area

Presently, nearly 900 or 0.8 percent of residential dwelling units are in the lahar hazard area. By 2040, that number is expected to grow to 1,000. Tables 4.6.7 and 4.6.8 show estimates of the region’s dwelling units in the lahar hazard area in the years 2015 and 2040.

Inventory of Assets and Dollar Value in the Hazard Area

Estimates of the region’s structures and their contents in the lahar hazard area are summarized in tables 4.6.9 and 4.6.10. A combined $70 million in residential, commercial/industrial, and government/institutional assets are within the Case 1 lahar hazard area.

Essential Facilities and Infrastructure in Hazard Area

A lahar could destroy or damage facilities that may be critical for responding to the disaster and for maintaining a safe environment and public order, particularly roads, rail lines and bridges. The event would also likely impact wired communication infrastructure, power lines; water storage, purification, and pumping facilities. Approximately 26 centerline miles of state- and county-owned roads in Thurston County are within the Case 1 lahar hazard area. Table 4.6.11 lists the type and number of essential facilities located in the hazard area.

Summary Assessment

Under certain meteorological conditions, a tephra fall could adversely affect the entire county. The fallout could produce hazardous travel conditions, disrupt a range of utilities, and result in significant cleanup and recovery costs. The region's vulnerability is rated as moderate; however, the probability of a major ash fall is low, therefore overall the risk of ash fall to the Thurston County region is low.

A lahar could pose immediate danger to the nearly 2,000 residents and 600 people that work in the lahar hazard zone. Although no lahar warning system exists for the upper Nisqually River Valley, the Tacoma Power Alder and La Grande Dam warning system could notify appropriate authorities to initiate evacuation efforts for downstream residents. Thurston County Emergency Management could notify area residents and businesses with its emergency notification system and local emergency personnel could be deployed to help people evacuate to higher ground. Nearly 900 residential properties may be at risk to lahar impacts. Surface transportation routes across the Nisqually River could be closed or destroyed and affect the mobility of the entire Puget Sound Region. The combination of these impacts suggests that the region is highly vulnerable. In summary, the overall risk of a Case 1 lahar is moderate, as an event of this magnitude has a low probability of occurrence.

Summary Risk Assessment for Tephra Fall and Case 1 Lahar Hazards in the Thurston Region

VOLCANIC HAZARD	PROBABILITY OF OCCURRENCE	VULNERABILITY	RISK
Tephra (Ash) Fall	Low	Moderate	Low
Lahar	Low	High	Moderate

Table 4.6.1: Case 1 Lahar Hazard Area by Jurisdiction

Jurisdiction		Lahar Hazard Area Total Acres	In Hazard Area Acres	In Hazard Area %
Bucoda	**Total**	**380**	**0**	**0.0%**
Lacey	City	10,778	0	0.0%
	UGA	10,416	0	0.0%
	Total	**21,193**	**0**	**0.0%**
Olympia	City	12,089	0	0.0%
	UGA	3,887	0	0.0%
	Total	**15,976**	**0**	**0.0%**
Rainier	City	1,105	0	0.0%
	UGA	320	0	0.0%
	Total	**1,425**	**0**	**0.0%**
Tenino	City	922	0	0.0%
	UGA	65	0	0.0%
	Total	**987**	**0**	**0.0%**
Tumwater	City	11,354	0	0.0%
	UGA	2,875	0	0.0%
	Total	**14,229**	**0**	**0.0%**
Yelm	City	3,634	0	0.0%
	UGA	2,396	8	0.3%
	Total	**6,030**	**8**	**0.1%**
Grand Mound UGA	**Total**	**983**	**0**	**0.0%**
Chehalis Reservation[1]	**Total**	**833**	**0**	**0.0%**
Nisqually Reservation[1]	**Total**	**2,147**	**638**	**29.7%**
Total Cities		**40,261**	**0**	**0.0%**
Total UGAs[2]		**20,943**	**8**	**0.0%**
Total Reservations[1]		**2,979**	**638**	**21.4%**
Rural Unincorporated County[3]		**406,934**	**9,182**	**2.3%**
Thurston County Total		**471,117**	**9,828**	**2.1%**

Explanations: Lahar Hazard includes the inundation zone for the USGS Case I Lahar scenario.
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 4.6.2: Case 1 Lahar Hazard Area by Special District

Jurisdiction	Lahar Hazard Area Total Acres	In Hazard Area Acres	In Hazard Area %
Fire Protection Districts			
1,11 West Thurston Reg. Fire Authority	100,131	0	0.0%
2, 4 S.E. Thurston Reg. Fire Authority	56,030	2,074	3.7%
3 Lacey	36,820	3,950	10.7%
5, 9 McLane-Black Lake	51,828	0	0.0%
6 East Olympia	19,677	0	0.0%
8 South Bay	20,974	0	0.0%
12 Tenino	19,914	0	0.0%
13 Griffin	14,864	0	0.0%
16 Gibson Valley	18,038	0	0.0%
17 Bald Hills	13,926	1,592	11.4%
School Districts			
Centralia[1]	12,851	0	0.0%
Griffin	21,355	0	0.0%
North Thurston	47,081	3,673	7.8%
Olympia	49,894	0	0.0%
Rainier	35,550	0	0.0%
Rochester[1]	55,061	0	0.0%
Tenino	70,500	0	0.0%
Tumwater	73,845	0	0.0%
Yelm[1]	104,853	5,934	5.7%
Other Districts			
Intercity Transit	64,390	2,681	4.2%
LOTT Clean Water Alliance[2]	16,016	0	0.0%
Port of Olympia	471,117	9,828	2.1%
Thurston County PUD	471,117	9,828	2.1%

Explanations: Lahar Hazard includes the inundation zone for the USGS Case I Lahar scenario.
1. Data are for Thurston County portion of the district only.
2. Includes the sewered area.

Table 4.6.3: Case 1 Lahar Hazard Area, Population by Jurisdiction, 2015 and 2040

Jurisdiction		2015 Population Estimate Total #	2015 In Hazard Area #	2015 In Hazard Area %	2040 Population Forecast Total #	2040 In Hazard Area #	2040 In Hazard Area %
Bucoda	**Total**	**565**	**0**	**0.0%**	**1,215**	**0**	**0.0%**
Lacey	City	46,230	0	0.0%	55,160	0	0.0%
	UGA	33,980	0	0.0%	59,030	0	0.0%
	Total	**80,210**	**0**	**0.0%**	**114,190**	**0**	**0.0%**
Olympia	City	51,020	0	0.0%	71,840	0	0.0%
	UGA	11,920	0	0.0%	16,770	0	0.0%
	Total	**62,940**	**0**	**0.0%**	**88,610**	**0**	**0.0%**
Rainier	City	1,880	0	0.0%	2,810	0	0.0%
	UGA	110	0	0.0%	640	0	0.0%
	Total	**1,990**	**0**	**0.0%**	**3,450**	**0**	**0.0%**
Tenino	City	1,730	0	0.0%	3,675	0	0.0%
	UGA	15	0	0.0%	110	0	0.0%
	Total	**1,745**	**0**	**0.0%**	**3,785**	**0**	**0.0%**
Tumwater	City	22,370	0	0.0%	37,350	0	0.0%
	UGA	3,270	0	0.0%	8,960	0	0.0%
	Total	**25,640**	**0**	**0.0%**	**46,310**	**0**	**0.0%**
Yelm	City	8,170	0	0.0%	25,080	0	0.0%
	UGA	1,420	10	0.7%	5,690	10	0.2%
	Total	**9,590**	**10**	**0.1%**	**30,770**	**10**	**0.0%**
Grand Mound UGA	**Total**	**1,285**	**0**	**0.0%**	**1,990**	**0**	**0.0%**
Chehalis Reservation[1]	**Total**	**70**	**0**	**0.0%**	**190**	**0**	**0.0%**
Nisqually Reservation[1]	**Total**	**605**	**45**	**7.4%**	**705**	**50**	**7.1%**
Total Cities		**131,970**	**0**	**0.0%**	**197,120**	**0**	**0.0%**
Total UGAs[2]		**52,000**	**10**	**0.0%**	**93,190**	**10**	**0.0%**
Total Reservations[1]		**670**	**40**	**6.0%**	**890**	**50**	**5.6%**
Rural Unincorporated County[3]		**82,770**	**1,970**	**2.4%**	**102,470**	**2,250**	**2.2%**
Thurston County Total		**267,400**	**2,000**	**0.7%**	**393,700**	**2,300**	**0.6%**

Source: Thurston Regional Planning Council Population Forecast, 2015
Explanations: Lahar Hazard includes the inundation zone for the USGS Case I Lahar scenario. 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 4.6.4: Case 1 Lahar Hazard Area, Population by Special District, 2015 and 2040

	2015 Population Estimate			2040 Population Forecast		
	Total	In Hazard Area		Total	In Hazard Area	
Jurisdiction	#	#	%	#	#	%
Fire Protection Districts						
1,11 West Thurston	22,010	0	0.0%	31,120	0	0.0%
2, 4 S.E. Thurston	24,650	850	3.4%	50,770	990	1.9%
3 Lacey	91,660	1,000	1.1%	128,070	1,100	0.9%
5, 9 McLane-Black Lake	15,890	0	0.0%	20,770	0	0.0%
6 East Olympia	11,140	0	0.0%	14,810	0	0.0%
8 South Bay	11,820	0	0.0%	15,380	0	0.0%
12 Tenino	6,230	0	0.0%	9,530	0	0.0%
13 Griffin	5,060	0	0.0%	5,700	0	0.0%
16 Gibson Valley	590	0	0.0%	1,130	0	0.0%
17 Bald Hills	4,090	140	3.4%	5,440	190	3.5%
School Districts						
Centralia[1]	490	0	0.0%	1,180	0	0.0%
Griffin	5,950	0	0.0%	6,710	0	0.0%
North Thurston	99,300	1,010	1.0%	138,340	1,110	0.8%
Olympia	66,140	0	0.0%	87,700	0	0.0%
Rainier	5,210	0	0.0%	13,800	0	0.0%
Rochester[1]	14,060	0	0.0%	18,080	0	0.0%
Tenino	9,850	0	0.0%	15,510	0	0.0%
Tumwater	39,500	0	0.0%	63,820	0	0.0%
Yelm[1]	26,900	1,010	3.8%	48,530	1,200	2.5%
Other Districts						
Intercity Transit	176,450	70	0.0%	269,860	90	0.0%
LOTT Clean Water Alliance[2]	120,960	0	0.0%	249,110	0	0.0%
Port of Olympia	267,400	2,000	0.7%	393,700	2,300	0.6%
Thurston County PUD	267,400	2,000	0.7%	393,700	2,300	0.6%

Source: Thurston Regional Planning Council Population Forecast, 2015
Explanations: Lahar Hazard includes the inundation zone for the USGS Case I Lahar scenario.
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 4.6.5: Case 1 Lahar Hazard Area, Employment by Jurisdiction, 2014 and 2040

		2014 Employment Estimate			2040 Employment Forecast		
		Total	In Hazard Area		Total	In Hazard Area	
Jurisdiction		#	#	%	#	#	%
Bucoda	**Total**	**90**	**0**	**0.0%**	**200**	**0**	**0.0%**
Lacey	City	25,610	0	0.0%	41,180	0	0.0%
	UGA	5,620	0	0.0%	8,520	0	0.0%
	Total	**31,230**	**0**	**0.0%**	**49,700**	**0**	**0.0%**
Olympia	City	53,350	0	0.0%	74,950	0	0.0%
	UGA	1,800	0	0.0%	2,230	0	0.0%
	Total	**55,150**	**0**	**0.0%**	**77,180**	**0**	**0.0%**
Rainier	City	455	0	0.0%	690	0	0.0%
	UGA	25	0	0.0%	80	0	0.0%
	Total	**480**	**0**	**0.0%**	**770**	**0**	**0.0%**
Tenino	City	870	0	0.0%	1,505	0	0.0%
	UGA	0	0	-	5	0	0.0%
	Total	**870**	**0**	**0.0%**	**1,510**	**0**	**0.0%**
Tumwater	City	22,350	0	0.0%	33,720	0	0.0%
	UGA	760	0	0.0%	1,420	0	0.0%
	Total	**23,110**	**0**	**0.0%**	**35,140**	**0**	**0.0%**
Yelm	City	3,830	0	0.0%	11,490	0	0.0%
	UGA	430	0	0.0%	670	0	0.0%
	Total	**4,260**	**0**	**0.0%**	**12,160**	**0**	**0.0%**
Grand Mound UGA	**Total**	**1,115**	**0**	**0.0%**	**1,375**	**0**	**0.0%**
Chehalis Reservation[1]	**Total**	**760**	**0**	**0.0%**	**1,550**	**0**	**0.0%**
Nisqually Reservation[1]	**Total**	**975**	**10**	**1.0%**	**1,865**	**10**	**0.5%**
Total Cities		**106,560**	**0**	**0.0%**	**163,730**	**0**	**0.0%**
Total UGAs[2]		**9,740**	**0**	**0.0%**	**14,300**	**0**	**0.0%**
Total Reservations[1]		**1,740**	**10**	**0.6%**	**3,410**	**10**	**0.3%**
Rural Unincorporated County[3]		**15,880**	**550**	**3.5%**	**18,270**	**570**	**3.1%**
Thurston County Total		**133,900**	**600**	**0.4%**	**199,700**	**600**	**0.3%**

Source: Thurston Regional Planning Council Population Forecast, 2015
Explanations: Lahar Hazard includes the inundation zone for the USGS Case I Lahar scenario. 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 4.6.6: Case 1 Lahar 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	0	0.0%	8,480	0	0.0%
2, 4 S.E. Thurston	6,710	140	2.1%	15,170	140	0.9%
3 Lacey	34,540	400	1.2%	54,170	410	0.8%
5, 9 McLane-Black Lake	3,630	0	0.0%	4,350	0	0.0%
6 East Olympia	1,960	0	0.0%	2,350	0	0.0%
8 South Bay	1,830	0	0.0%	2,250	0	0.0%
12 Tenino	1,500	0	0.0%	2,210	0	0.0%
13 Griffin	990	0	0.0%	1,060	0	0.0%
16 Gibson Valley	150	0	0.0%	180	0	0.0%
17 Bald Hills	470	20	4.3%	570	30	5.3%
School Districts						
Centralia[1]	120	0	0.0%	170	0	0.0%
Griffin	1,110	0	0.0%	1,190	0	0.0%
North Thurston	42,280	400	0.9%	66,290	410	0.6%
Olympia	48,850	0	0.0%	65,910	0	0.0%
Rainier	980	0	0.0%	1,860	0	0.0%
Rochester[1]	4,630	0	0.0%	6,230	0	0.0%
Tenino	2,340	0	0.0%	3,320	0	0.0%
Tumwater	25,670	0	0.0%	38,080	0	0.0%
Yelm[1]	7,850	160	2.0%	16,580	170	1.0%
Other Districts						
Intercity Transit	115,570	20	0.0%	176,500	30	0.0%
LOTT Clean Water Alliance[2]	91,010	0	0.0%	162,020	0	0.0%
Port of Olympia	133,900	600	0.4%	199,700	600	0.3%
Thurston County PUD	133,900	600	0.4%	199,700	600	0.3%

Source: Thurston Regional Planning Council Population Forecast, 2015
Explanations: Lahar Hazard includes the inundation zone for the USGS Case I Lahar scenario.
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 4.6.7: Case 1 Lahar Hazard Area, Residential Units by Jurisdiction, 2015 and 2040

		2015 Dwelling Estimate			2040 Dwelling Forecast		
		Total	In Hazard Area		Total	In Hazard Area	
Jurisdiction		#	#	%	#	#	%
Bucoda	**Total**	**245**	**0**	**0.0%**	**535**	**0**	**0.0%**
Lacey	City	19,840	0	0.0%	24,400	0	0.0%
	UGA	13,500	0	0.0%	23,930	0	0.0%
	Total	**33,340**	**0**	**0.0%**	**48,330**	**0**	**0.0%**
Olympia	City	24,170	0	0.0%	35,610	0	0.0%
	UGA	4,850	0	0.0%	7,100	0	0.0%
	Total	**29,020**	**0**	**0.0%**	**42,710**	**0**	**0.0%**
Rainier	City	775	0	0.0%	1,140	0	0.0%
	UGA	50	0	0.0%	290	0	0.0%
	Total	**825**	**0**	**0.0%**	**1,430**	**0**	**0.0%**
Tenino	City	755	0	0.0%	1,855	0	0.0%
	UGA	5	0	0.0%	40	0	0.0%
	Total	**760**	**0**	**0.0%**	**1,895**	**0**	**0.0%**
Tumwater	City	9,970	0	0.0%	16,870	0	0.0%
	UGA	1,420	0	0.0%	3,820	0	0.0%
	Total	**11,390**	**0**	**0.0%**	**20,690**	**0**	**0.0%**
Yelm	City	3,000	0	0.0%	9,820	0	0.0%
	UGA	550	0	0.0%	2,280	0	0.0%
	Total	**3,550**	**0**	**0.0%**	**12,100**	**0**	**0.0%**
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**	**20**	**10.0%**	**255**	**20**	**7.8%**
Total Cities		**58,770**	**0**	**0.0%**	**90,230**	**0**	**0.0%**
Total UGAs[2]		**20,790**	**0**	**0.0%**	**38,190**	**0**	**0.0%**
Total Reservations[1]		**220**	**20**	**9.1%**	**320**	**20**	**6.3%**
Rural Unincorporated County[3]		**34,250**	**880**	**2.6%**	**41,730**	**950**	**2.3%**
Thurston County Total		**114,000**	**900**	**0.8%**	**170,500**	**1,000**	**0.6%**

Source: Thurston Regional Planning Council Population Forecast, 2015
Explanations: Lahar Hazard includes the inundation zone for the USGS Case I Lahar scenario. 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 4.6.8: Case 1 Lahar Hazard Area, Residential Units 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	0	0.0%	11,930	0	0.0%
2, 4 S.E. Thurston	9,800	340	3.5%	20,190	380	1.9%
3 Lacey	38,110	480	1.3%	54,160	500	0.9%
5, 9 McLane-Black Lake	6,490	0	0.0%	8,670	0	0.0%
6 East Olympia	4,510	0	0.0%	6,010	0	0.0%
8 South Bay	4,940	0	0.0%	6,370	0	0.0%
12 Tenino	2,580	0	0.0%	4,200	0	0.0%
13 Griffin	2,580	0	0.0%	2,910	0	0.0%
16 Gibson Valley	240	0	0.0%	440	0	0.0%
17 Bald Hills	1,770	60	3.4%	2,370	80	3.4%
School Districts						
Centralia[1]	200	0	0.0%	470	0	0.0%
Griffin	3,030	0	0.0%	3,430	0	0.0%
North Thurston	41,820	490	1.2%	59,460	500	0.8%
Olympia	29,690	0	0.0%	41,150	0	0.0%
Rainier	2,190	0	0.0%	5,690	0	0.0%
Rochester[1]	5,260	0	0.0%	6,670	0	0.0%
Tenino	4,130	0	0.0%	6,720	0	0.0%
Tumwater	16,940	0	0.0%	27,630	0	0.0%
Yelm[1]	10,780	410	3.8%	19,260	470	2.4%
Other Districts						
Intercity Transit	76,200	30	0.0%	119,200	40	0.0%
LOTT Clean Water Alliance[2]	53,760	0	0.0%	111,730	0	0.0%
Port of Olympia	114,000	900	0.8%	170,500	1,000	0.6%
Thurston County PUD	114,000	900	0.8%	170,500	1,000	0.6%

Source: Thurston Regional Planning Council Population Forecast, 2015
Explanations: Lahar Hazard includes the inundation zone for the USGS Case I Lahar scenario.
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 4.6.9: Case 1 Lahar 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**	**0**	**0.0%**	**1**	**0**	**0.0%**	**3**	**0**	**0.0%**
Lacey	City	2,394	0	0.0%	914	0	0.0%	602	0	0.0%
	UGA	1,715	0	0.0%	69	0	0.0%	273	0	0.0%
	Total	**4,109**	**0**	**0.0%**	**983**	**0**	**0.0%**	**875**	**0**	**0.0%**
Olympia	City	2,695	0	0.0%	1,199	0	0.0%	1,941	0	0.0%
	UGA	785	0	0.0%	27	0	0.0%	26	0	0.0%
	Total	**3,480**	**0**	**0.0%**	**1,226**	**0**	**0.0%**	**1,967**	**0**	**0.0%**
Rainier	City	76	0	0.0%	5	0	0.0%	30	0	0.0%
	UGA	5	0	0.0%	0	0	-	1	0	0.0%
	Total	**81**	**0**	**0.0%**	**5**	**0**	**0.0%**	**31**	**0**	**0.0%**
Tenino	City	50	0	0.0%	12	0	0.0%	67	0	0.0%
	UGA	1	0	0.0%	0	0	-	0	0	-
	Total	**51**	**0**	**0.0%**	**12**	**0**	**0.0%**	**67**	**0**	**0.0%**
Tumwater	City	1,209	0	0.0%	528	0	0.0%	556	0	0.0%
	UGA	130	0	0.0%	13	0	0.0%	7	0	0.0%
	Total	**1,339**	**0**	**0.0%**	**541**	**0**	**0.0%**	**563**	**0**	**0.0%**
Yelm	City	357	0	0.0%	105	0	0.0%	140	0	0.0%
	UGA	49	0	0.0%	6	0	0.0%	13	0	0.0%
	Total	**406**	**0**	**0.0%**	**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**	**0**	**0.0%**	**2,763**	**0**	**0.0%**	**3,338**	**0**	**0.0%**
Total UGAs[2]		**2,719**	**0**	**0.0%**	**128**	**0**	**0.0%**	**325**	**0**	**0.0%**
Total Reservations[1]		**17**	**0**	**0.0%**	**6**	**0**	**0.0%**	**0**	**0**	**-**
Rural Unincorp. County[3]		**4,977**	**58**	**1.2%**	**113**	**5**	**4.4%**	**1,033**	**6**	**0.6%**
Thurston County Total		**14,506**	**59**	**0.4%**	**3,010**	**5**	**0.2%**	**4,696**	**6**	**0.1%**

Source: Thurston Regional Planning Council Population Forecast, 2015
Explanations: Lahar Hazard includes the inundation zone for the USGS Case I Lahar scenario. 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 4.6.10: Case 1 Lahar 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	0	0.0%	57	0	0.0%	216	0	0.0%
2, 4 S.E. Thurston	1,073	25	2.3%	133	0	0.0%	202	2	1.0%
3 Lacey	4,823	27	0.6%	1,008	5	0.5%	896	5	0.6%
5, 9 McLane-Black Lake	1,121	0	0.0%	31	0	0.0%	676	0	0.0%
6 East Olympia	743	0	0.0%	14	0	0.0%	49	0	0.0%
8 South Bay	939	0	0.0%	13	0	0.0%	47	0	0.0%
12 Tenino	277	0	0.0%	17	0	0.0%	73	0	0.0%
13 Griffin	430	0	0.0%	3	0	0.0%	26	0	0.0%
16 Gibson Valley	20	0	0.0%	0	0	-	1	0	0.0%
17 Bald Hills	176	6	3.4%	6	0	0.0%	7	0	0.0%
School Districts									
Centralia[1]	17	0	0.0%	0	0	-	1	0	0.0%
Griffin	498	0	0.0%	3	0	0.0%	26	0	0.0%
North Thurston	5,394	28	0.5%	1,292	5	0.4%	969	5	0.5%
Olympia	3,990	0	0.0%	960	0	0.0%	2,344	0	0.0%
Rainier	241	0	0.0%	11	0	0.0%	34	0	0.0%
Rochester[1]	539	0	0.0%	42	0	0.0%	187	0	0.0%
Tenino	462	0	0.0%	21	0	0.0%	81	0	0.0%
Tumwater	2,155	0	0.0%	546	0	0.0%	877	0	0.0%
Yelm[1]	1,208	32	2.6%	135	1	0.7%	176	2	1.1%
Other Districts									
Intercity Transit	9,247	4	0.0%	2,865	0	0.0%	4,172	1	0.0%
LOTT Clean Water Alliance[2]	6,724	0	0.0%	2,498	0	0.0%	2,443	0	0.0%
Port of Olympia	14,506	59	0.4%	3,010	5	0.2%	4,696	6	0.1%
Thurston County PUD	14,506	59	0.4%	3,010	5	0.2%	4,696	6	0.1%

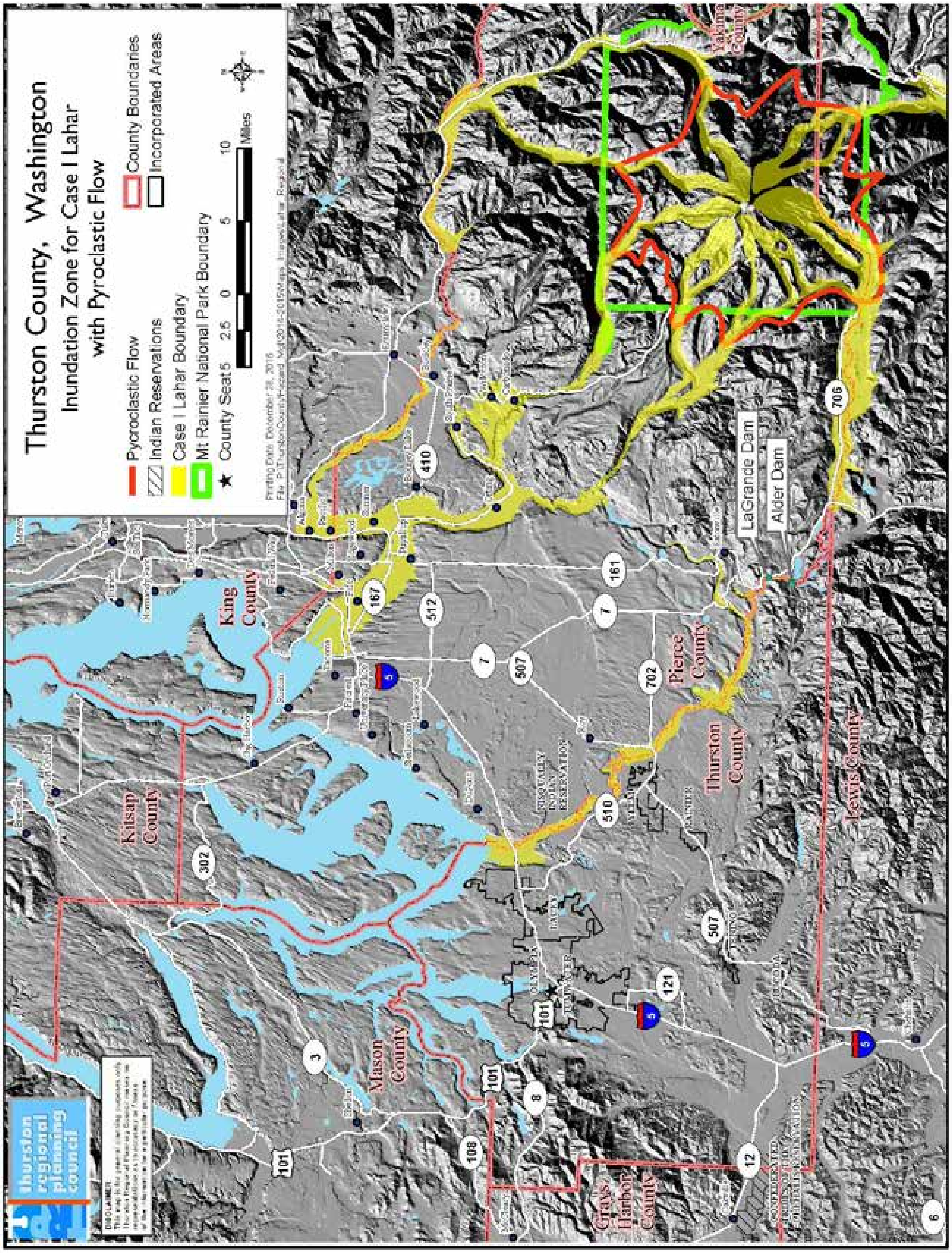
Source: Thurston Regional Planning Council Population Forecast, 2015
Explanations: Lahar Hazard includes the inundation zone for the USGS Case I Lahar scenario.
1. Data are for Thurston County portion of the district only.
2. Includes the sewered area.

Table 4.6.11: Essential Facilities in Case 1 Lahar Hazard Area

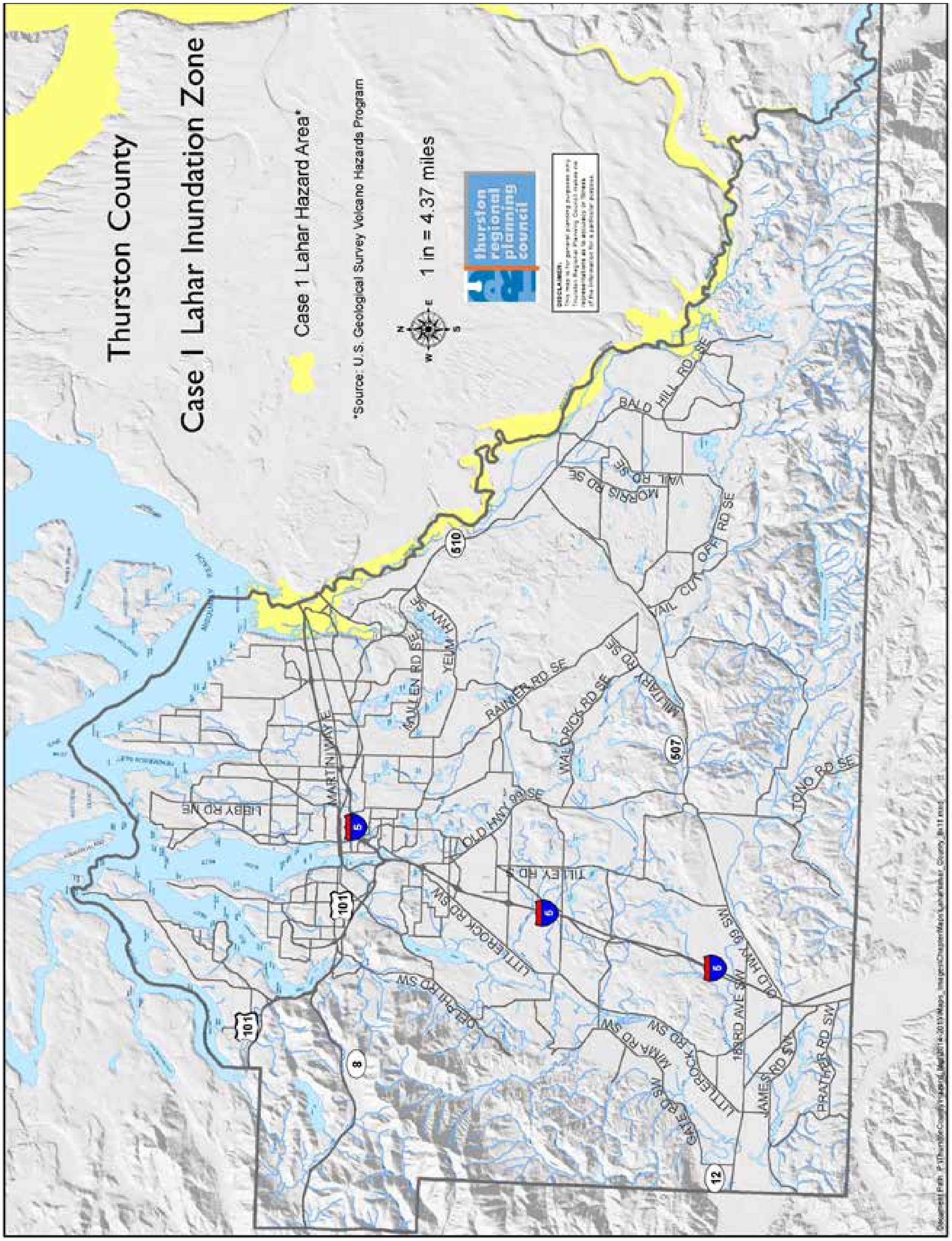
Facility Type	Total #	In Hazard Area #	In Hazard Area %
Medical Care			
Adult Family Home	124	0	0.0%
Assisted Living	14	0	0.0%
Dentist	110	0	0.0%
Dialysis Center	3	0	0.0%
Funeral Home	6	0	0.0%
Hospital	2	0	0.0%
Nursing Home	7	0	0.0%
Pharmacy	42	0	0.0%
Primary Care	91	0	0.0%
Urgent Care	6	0	0.0%
Government			
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	0	0.0%
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	2	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	5	2.1%
Transportation (Centerline Miles)			
Roads	2,210	26	1.2%
Intercity Transit Routes	157	3	1.7%
Rural Transit Routes	96	0	0.0%

Explanations: Lahar Hazard includes the inundation zone for the USGS Case I Lahar Scenario.

Map 4.6.1: Inundation Zone for Case I Lahar (Puget Sound Region) with Pyroclastic Flow



Map 4.6.2: Inundation Zone for Case I Lahar Thurston County, Washington



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Chapter 5.0

Review, Adoption, Implementation, Evaluation, and Maintenance

Keeping the Plan Current

No community ever achieves a state of invulnerability from storms, floods, earthquakes, wildfires, or other hazards, so hazard mitigation should be a continuous process. To achieve the plan's goals and objectives, each community's mitigation activities must keep pace with other plans, policies, funding opportunities, and changing conditions or emerging threats. Science, technology, and best practices for creating disaster resilient communities is expanding. The region has updated the Hazards Mitigation Plan for the Thurston Region every five years since first adoption in 2003. This plan will be reviewed periodically to add or replace activities to make our communities stronger and safer. All partners to the plan will collectively monitor and evaluate any accomplishments or shortcomings so that communities can incorporate lessons learned into long-term mitigation strategies.

This chapter describes how both Washington State Emergency Management Division (WAEMD) and the Federal Emergency Management Agency (FEMA) review the plan before adoption. More importantly, it outlines the process for how participants will adopt, implement, evaluate, and maintain the plan.

Review Process

Prior to adoption, jurisdictions first submit their plans to WAEMD and FEMA for review to ensure compliance with the Disaster Mitigation Act planning requirements in 44 CFR Section 201.6. The review also provides an opportunity for the state and federal reviewers to offer feedback that supports the development of effective mitigation strategies.

Each jurisdiction performs an internal review of their plan using FEMA's Local Mitigation Plan Review Tool. If a community believes the plan satisfies all the planning requirements, the community submits the plan for state and federal review. The State Hazard Mitigation Officer may take up to 30 days to review the plan and provide feedback. If no substantive revisions are required, WAEMD will forward the plan to FEMA Region X for review. FEMA may take up to 45 days to review the plan and provide feedback. If no revisions are necessary, FEMA issues an "approvable pending adoption" status meaning that the plan is ready for federal approval, once evidence of local adoption is established. If FEMA or WAEMD identify unmet planning requirements, they notify the community and help, as necessary, to satisfy unresolved requirements.

Adoption Process

Adoption by a jurisdiction's governing body demonstrates the community's commitment to fulfilling the mitigation goals, objectives, and initiatives outlined in their annex. Adoption legitimizes the plan and authorizes designated individuals or departments to execute the plan's recommendations. Each participant will follow their established processes including adequate public notice for their governing body to adopt the plan. Through the multi-jurisdictional planning process, participants have one year to adopt the plan after receiving an "approvable pending adoption" notification from FEMA.

Plan Review Process

Submit plan to State EMD for review → State EMD submits plan to FEMA Region X for review → FEMA issues "approvable pending adoption" status → Local jurisdictions adopt plan and submits evidence of adoption → FEMA issues approval letter

Adoption Requirements

All participants to the *Hazards Mitigation Plan for the Thurston Region*, or an update thereof, must adopt the core plan including chapters 1 through 6 and the appendices. In addition, each agency must adopt their annex. The core plan plus the jurisdiction's annex constitutes a complete plan.

Federal Approval and Plan Expiration

The final step for approval involves submitting evidence of adoption to FEMA. FEMA certifies the plan and issues an approval letter which includes the date of approval. The first jurisdiction to formally adopt the plan initiates the five-year approval period and sets the expiration date for the plan for all participating plan partners, regardless of when each adopts their plans. The approval letter is amended each time one or more communities submit evidence of adoption.

Implementation

This plan intends to implement effective mitigation strategies. The nature of a multi-jurisdictional plan provides flexibility in implementation mechanisms, since each jurisdiction has unique resources and capabilities for implementing their priorities. Jurisdictions with approved plans must implement the mitigation initiatives identified in their annex. Every mitigation action includes an estimated timeline, funding source, and project lead. The community will complete mitigation activities based on their priorities, funding availability, and other resources. This section provides an overview of the implementation mechanisms available in Thurston County.

Goal 8 of this plan is to "Implement effective mitigation strategies." Objective 8B calls for the plan partners to integrate adopted mitigation strategies into other planning documents such as response plans, comprehensive plans, strategic plans, Critical Areas Ordinances, Capital Facility Plans, zoning code, and development regulations. Objective 8C is the call to action for the partners to apply for federal mitigation assistance grants and leverage other funding sources to finance mitigation projects.

Some jurisdictions have Comprehensive Emergency Management Plans (CEMPs). When the CEMPs are updated, they should include relevant parts of this plan, if appropriate, or reference this plan as appropriate.

Plan Stewardship

To fulfill the goals and objectives outlined in Chapter 5, the plan must be monitored and maintained throughout its five-year cycle. A multi-jurisdictional plan requires coordination and collaboration among its partners. The Emergency Management Council (EMC) of Thurston County is a formally organized intergovernmental board familiar with a variety of key community stakeholders involved with disaster preparedness, response, recovery, and hazard mitigation. As such, the EMC will serve as the steward for the *Hazards Mitigation Plan for the Thurston Region*. As it did in the previous two editions, the EMC will assume the lead role for maintaining the plan and promoting its relevancy among the plan stakeholders. The remaining sections describe how the plan will be evaluated and maintained.

Plan Evaluation

The plan will be evaluated annually as part of the EMC's regularly scheduled October meeting (the schedule may be revised to accommodate emerging issues). The EMC will include a special work session agenda item dedicated to a region wide assessment of the plan. The EMC will invite all plan partners to attend the meeting. This annual work session will assess the following:

1. Progress toward the plan's goals and objectives
2. Progress toward countywide and jurisdiction specific mitigation initiatives
3. Implementation problems such as technical, legal, or coordination issues among local agencies, the state, or FEMA
4. Public involvement activities
5. General information sharing (best practices) related to mitigation planning among the plan partners

Assessment after a Significant Disaster Event

It is routine practice for the EMC to conduct an after action review within 60 to 80 days following a Federal Disaster Declaration or a significant emergency event that occurred within the planning area. As part of this meeting, a specific agenda item will be added to the after action review process to capture any lessons learned to enhance the plan (Goal 7, Expanding Understanding of Hazards). The EMC Council will assess:

1. The characteristics and severity of the hazard to determine if the region's risks have changed
2. Any response and recovery costs
3. The type and extent of damage and losses to determine if any new mitigation initiatives are warranted to offset impacts from similar future hazard events

The results of the assessment will be provided to all hazards mitigation planning partners for their review. If applicable, this information can be used for evaluating modifications to existing initiatives or new initiatives following the disaster event or during the next plan update cycle.

Plan Maintenance

Done properly, plan maintenance is performed throughout the plan's five-year cycle. Regular maintenance keeps information current and helps inform decisions. Periodic revisions can also make the plan update less arduous.

Changes to the mitigation plan are initiated based on outcomes that are realized as part of annual monitoring, reviews after a major disaster, or as needed to reflect the needs of jurisdictions. Changes are also made when new planning partners join the region's hazard mitigation planning process and adopt their plan outside of the 5-year update cycle. Each jurisdiction is responsible for maintaining their annex. Thurston County Emergency Management assumes responsibility for executing all revisions to the core multi-jurisdictional plan, except for local annexes.

Minor Revisions

Adding new maps, data, or making simple corrections will be handled by Thurston County Emergency Management.

Major Revisions

If the state or FEMA specify significant changes to the plan, it will require a meeting, review, and approval by the Natural Hazards Mitigation Plan Workgroup. Major changes to a jurisdiction's annex are the responsibility of the affected community. Major revisions may require subsequent review and approval by EMD or FEMA.

Technical Revisions

Requests for changes that will alter the technical content of the general plan such as additions or deletions of data, maps, or alterations to risk assessments will be the responsibility of Emergency Management staff. Such changes would require a review by the EMC and the Workgroup, or if applicable, the affected community.

Distribution of Revisions

Thurston County Emergency Management staff will maintain a master copy of the plan and distribute updates to all adopted plan holders. Any revisions made to the plan, copies of any correspondence from the state or FEMA, along with supporting analysis and revised plan pages, will be sent to all the entities and holders of the plans. Conversely, any local agency that makes changes to the contents of its local annex should provide Thurston County Emergency Management a copy of its revised annex and documentation of the process that was used for revision.

When possible, plan updates will be sent by email or by other electronic file sharing services. A current version of the plan will be accessible online at www.co.thurston.wa.us/em or at www.trpc.org. The general public may request paper copies through Thurston County Emergency Management.

Procedure to Add a Community to the Hazards Mitigation Plan

All local governments and special districts are encouraged to develop a hazards mitigation plan through the region's planning framework. Communities are invited to participate in the plan update process, however other priorities may prevent a community from participating as a full partner during that process. A local government entity can develop a plan between the 5-year update interval.

The following steps outline the process by which local governments, special districts, tribes, or non-profit entities can develop and adopt a hazard mitigation plan through this plan's multi-jurisdictional planning framework:

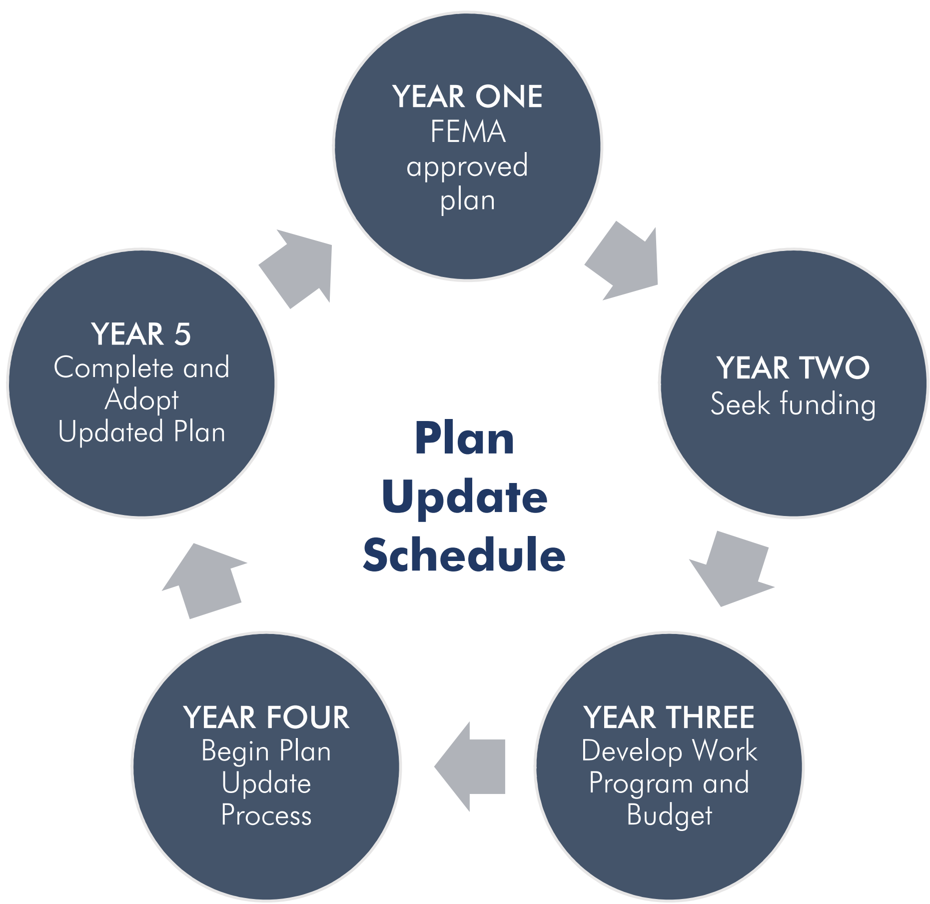
1. Interested communities should contact Thurston County Emergency Management.
2. Thurston County Emergency Management will notify the EMC of the community's intent to join the regional plan. County staff will direct the community to resources for building a plan including a copy of the *Hazards Mitigation Plan for the Thurston Region*, online resources, and contact information for state and federal mitigation planners, and the necessary forms and instructions for developing an annex.
3. The community would review the plan and the plan requirements. The entity would develop a plan that is consistent with the regional plan and meets all the planning requirements specified in 44 CFR Section 201.6 (201.7 for tribes. Portions of the regional plan that meet the planning requirements for that entity should be referenced in the plan eliminating the need for redundancy.
4. The community would submit their draft plan to Thurston County Emergency Management for review to ensure conformance with the regional plan.
5. The community would follow the steps described in the "Review Process" and "Adoption Process" sections at the beginning of this chapter.

Future Plan Updates

Hazard mitigation planning is a multi-step process that may take between one to two years to complete. Sufficient time must be allotted to educate newly elected officials and staff about the purpose of the plan and its development process. Multijurisdictional plans are costly to produce, local funding is scarce, and the availability of federal mitigation grants to update plans are highly competitive and often insufficient. It may take 12 months or more to secure funding to perform a plan update and local governments need to establish work programs and approve budgets prior to starting work on a plan.

To attempt to overcome these challenges, the EMC and the region's planning partners will use the following schedule to guide a future plan update:

1. Two years after FEMA approves a plan, the EMC will coordinate with partners to apply for planning grants and seek other funding sources.
2. Assuming funds are secure by the third year, the plan partners will establish work programs, refine a scope of work, and approve budgets.
3. At the beginning of the fourth year, the EMC and the plan partners will initiate the planning process.
4. Midway through the fifth year, a draft plan will be available to the public, and submitted to the state and FEMA for review.
5. The plan partners will adopt the updated plan within one to two months of the expiration date of the current plan.



Hazard Profiles

During future updates of the plan, consideration will be made to expand the plan to address additional hazard profiles such as catastrophic dam failure, cyber-attack, or sea level rise. As this information is developed, the plan partners will evaluate the information to consider new mitigation initiatives.

Continued Public Involvement

The Emergency Management Council, and the plan partners will continue engaging plan stakeholders, residents, property owners, and businesses about the risks the region faces from the hazards identified in this plan. The EMC and staff will explore opportunities to educate and involve the public about the region's mitigation strategy. This plan includes policies and mitigation initiatives to promote public involvement and education. The Thurston County Emergency Preparedness Expo, the Executive Disaster Recovery Seminars, meetings with neighborhood and home owners associations, and the online GIS Thurston Region Hazards Assessment story map are examples of effective ongoing public outreach activities. The EMC will continue evaluating options to promote the plan and educate the public about hazard mitigation within existing emergency preparedness education and outreach programs.

Hazard mitigation is more effective when integrated into existing programs and factored into community decisions about land use and capital investments. Incorporating mitigation strategies into comprehensive plans and other strategic plans will provide additional opportunities to promote public dialogue about hazard mitigation.

Copies of the plan will be accessible online from Thurston County Emergency Management's website at www.co.thurston.wa.us/em and from www.trpc.org.

Chapter 6.0
Plan Process and Development

Introduction

Chapter 6 describes the process for developing this plan, including who was involved and how it was completed. It documents the jurisdictions that participated in the update, the various committees that shaped the plan, and public engagement activities.

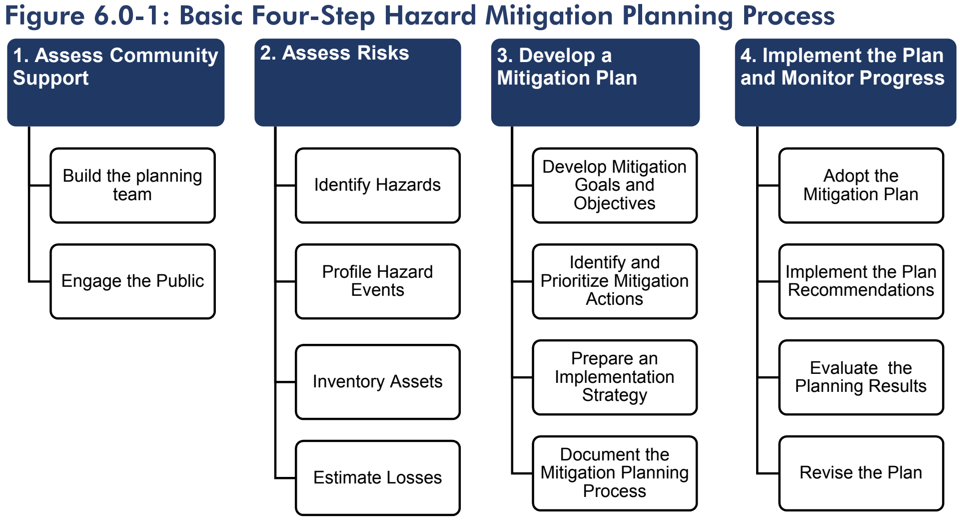
Process Overview

This multi-jurisdictional plan consists of two parts: 1) A core plan, which encompasses the entire planning area; and 2) The annexes or subsets of this plan, reflecting information for a single jurisdiction.

The partners developed the two parts of the plan in tandem. The regional planning process brought representatives from multiple jurisdictions together to craft the core plan, and to supply guidance to the plan partners for developing their jurisdiction's annex. Each jurisdiction also followed their own unique local process to update or create their annex. This chapter documents the regional process and the annexes speak to each jurisdiction's local process.

Both the regional and the local planning processes follow the basic four-step hazard mitigation planning process (Figure 6.0-1).

Figure 6.0-1: Basic Four-Step Hazard Mitigation Planning Process



Federal Planning Requirements

This chapter documents the federal hazard mitigation planning process requirements specified in 44 CFR Section 201.6(b) and Section 201.6(c)(1):

> …(b) Planning process. An open public involvement process is essential to the development of an effective plan. In order to develop a more comprehensive approach to reducing the effects of natural disasters, the planning process shall include:
>
> > (1) An opportunity for the public to comment on the plan during the drafting stage and prior to plan approval;
> >
> > (2) An opportunity for neighboring communities, local and regional agencies involved in hazard mitigation activities, and agencies that have the authority to regulate development, as well as businesses, academia and other private and non-profit interests to be involved in the planning process; and
> >
> > (3) Review and incorporation, if appropriate, of existing plans, studies, reports, and technical information.
>
> (c) Plan content. The plan shall include the following:
>
> > (1) Documentation of the planning process used to develop the plan, including how it was prepared, who was involved in the process, and how the public was involved.

In general, the federal planning requirements with the words "**shall**" and "**must**" indicate a mandatory item that must be included in the plan. Absent such items, the Federal Emergency Management Agency (FEMA) will not approve the plan. Regulations with the word "**t**" indicate that the item is strongly recommended for inclusion, but its absence will not cause FEMA to disapprove the plan.

Guiding Principles

The Guiding Principles reflect the partners' values and continuing commitment to making the region safer and more disaster resilient. These principles have carried over from the previous two editions of this plan and continue to guide the plan update process. They describe the purpose of the plan, the importance of educating and engaging the public about hazards, how the plan supports local decision making, how the plan complies with federal requirements, encourages coordination across jurisdictions, and identifies actions to reduce losses.

1. **Provide a Methodical Approach to Mitigation Planning** – The process identifies vulnerabilities to future disasters and proposes the mitigation initiatives necessary to avoid or minimize those vulnerabilities. Each step in the planning process builds upon the previous, providing a high level of assurance that the mitigation initiatives proposed by the participants have a valid basis for both their justification and priority for implementation.
2. **Enhance Public Awareness and Understanding of Hazards** – This plan contains data and information that can be used in a variety of ways to enhance public awareness about the most destructive hazards that threaten the region. This information gives community members a better understanding of each hazard's historical significance, and how each hazard is likely to impact or threaten the public health, safety, economic vitality of businesses, and the operational capability of important institutions in the future. The process provides opportunities for public involvement and information. This multi-jurisdictional effort reaches out to stakeholders from municipalities, academia, and special districts, as well as county and tribal government.
3. **Create a Decision-Making Tool for Policy and Decision Makers** – This document provides basic information needed by managers and leaders of local government, business and industry, community associations, and other key institutions and organizations to take actions to address vulnerabilities to future disasters. It also articulates proposals for specific projects and programs that are needed to eliminate or minimize those vulnerabilities. The mitigation actions in this plan are reviewed to assess their benefits and costs, and are prioritized for implementation. This approach creates a decision-making tool for the management of participating organizations and agencies regarding the purpose of the initiatives, their priority, cost, and timeline.
4. **Promote Compliance with State and Federal Program Requirements** – At a minimum, local hazard mitigation plans must satisfactorily comply with the federal requirements in 44 CFR Section 201.6 to receive federal mitigation assistance program grants. It is crucial for local government decision-makers to take an active role in preparing their communities for future disasters – because the effects of natural and human-induced hazards are unique to each community, understood best and felt by the community. Developing flexible plans that factor for the unknown is a good practice in risk management.

5. **Assure Inter-Jurisdictional Coordination of Mitigation-Related Programming** – The planning process aims to ensure that the participating jurisdictions review and coordinate proposals for mitigation initiatives. This approach creates a high level of confidence that the initiatives proposed by one jurisdiction or participating organization will, when implemented, be compatible with the interests of adjacent jurisdictions and unlikely to duplicate or interfere with other's mitigation initiatives.
6. **Create Jurisdiction Specific Hazard Mitigation Plans for Implementation** – A key purpose of the plan is to provide each participating local jurisdiction with a specific plan of action that each can adopt and implement pursuant to its own authorities and responsibilities. Each participating jurisdiction develops an annex, that is adopted as part of this plan, with jurisdiction-specific information, including their mitigation initiatives. The jurisdictions will implement their mitigation initiatives according to their individual needs and schedule. In this way, the plan format and the operational concept of the planning process ensures that proposed mitigation initiatives are coordinated and prioritized effectively among jurisdictions and organizations, while allowing each jurisdiction to adopt only the proposed mitigation initiatives that fall within its authority or responsibility to implement when resources are available.

Plan Funding

In 2012, Thurston County submitted a Hazard Mitigation Grant Program (HMGP) application to secure funding to update the plan. In 2014, FEMA awarded Thurston County $50,741 under the DR-4083 call for projects. Washington State provided $8,750 match (12.5 percent), and the county provided the remaining match ($10,509) in the form of in-kind staff time. The county managed the grant and Thurston Regional Planning Council (TRPC) led and facilitated the plan development process. Plan partners supplied additional in-kind staff support for participating in the regional planning process and developing their annexes.

Planning Process

Plan Participants and Roles

The plan was updated through a proven regional planning process that resulted in successful plan approval, adoption, and implementation of both the original plan (2003-2008) and the second edition (2009-2014). Thurston County, cities, special districts, and a variety of stakeholders contributed to the creation of this plan (Figure 6.0.2).

Public and Community Stakeholders – Residents, business owners, employees, and community organizations have an interest in the outcome of the planning process. Engaging the public builds support for prioritizing and implementing mitigation initiatives. Public sector interests were engaged and their interests were considered at the beginning of the planning process and before adoption.

Plan Partners – Local governments including the county, cities, towns, and special districts that intend to develop and adopt a mitigation plan serve as partners to the *Hazards Mitigation Plan for the Thurston Region*. Prior to submitting the HMGP grant application in 2012, 16 local government partners signed a "Statement of Intent to Participate" in the update of the plan. Partners participate in both the regional planning process and simultaneously produce an annex for concurrent adoption with the core plan.

Plan Partner Hazards Mitigation Plan Adoption and Annex Development Status

Plan Partners	2009 Plan Adoption Date	Signatory to Statement of Intent to Participate	2017 Plan Annex Development
Cities/Town/County			
Bucoda	12/22/2009	Yes	Pending
Lacey	12/17/2009	Yes	Pending
Olympia	03/02/2010	Yes	Yes
Rainier	06/08/2010	Yes	Pending
Tenino	04/27/2010	Yes	Pending
Tumwater	01/19/2010	Yes	Yes
Yelm	11/24/2010	Yes	Pending
Thurston County	10/27/2009	Yes	Yes
School Districts			
North Thurston	01/05/2009	Yes	
Olympia	01/25/2010	Yes	Pending
Rochester	N/A	No	Pending
Tenino	N/A	No	Pending
Tumwater	12/10/2009	Yes	Pending
Yelm	12/17/2009	Yes	Pending
Fire Districts			
SE Thurston Regional Fire Authority	12/03/2009	Yes	No
Fire District No. 8, South Bay	11/20/2009	Yes	Pending
Fire District No. 17, Bald Hills	N/A	Yes	Pending
Other Special Districts			
Thurston County PUD No. 1	N/A	No	Yes
Intercity Transit	04/07/2010	Yes	Yes
Higher Education			
South Puget Sound Community College	04/08/2010	Yes	Pending
The Evergreen State College	11/11/2009	Yes	Yes

Figure 6.0.2 Thurston Region Hazard Mitigation Planning Participants

Steering Committee – As in the previous plan development cycles, the Emergency Management Council of Thurston County (EMC) is responsible for updating and maintaining the plan (see Chapter 5). Composed of designated representatives from Thurston County, the Nisqually Indian Tribe, the Confederated Tribes of the Chehalis Reservation, the Town of Bucoda, and the cities of Lacey, Olympia, Tumwater, Rainier, and Yelm, the EMC serves as the plan's steering committee. The hazard mitigation plan remained a standing agenda item at the EMC's fourth Tuesday monthly meeting throughout the plan update process. Thurston County staff briefed the EMC on the plan's status throughout the project.

The EMC provides leadership and direction to the mitigation planning process, with responsibility for:

- Inviting local governments, tribes, and other mitigation partners to participate in the plan update

- Fostering stakeholder and public involvement at all stages of the planning process
- Ensuring consistency between the goals and policies of the region's hazard mitigation plan, the Washington State Hazard Mitigation Plan, and the region's comprehensive emergency management plans
- Identifying, prioritizing, and considering the benefit to cost effectiveness of the countywide mitigation actions
- Finding resources to maintain the plan
- Approving how the plan will be monitored and maintained (see Chapter 5)

Members of the Emergency Management Council of Thurston County

Member	Representative
Town of Bucoda	Alan Carr, Mayor
Confederated Tribes of the Chehalis Reservation	Cal Bray, Emergency Manager
City of Lacey	Joe Upton, Police Commander
Nisqually Indian Tribe	Ken Choke, Emergency Management Director
City of Olympia	Greg Wright, Deputy Fire Chief
City of Rainier	Randy Schleis, Mayor
Thurston County	Kurt Hardin, Vice Chair Director of Emergency Services
City of Tumwater	Scott LaVielle, Fire Chief
City of Yelm	Todd Stancil, Chair, Chief of Police

Project Manager – TRPC managed and facilitated the multi-jurisdictional hazard mitigation planning process, performing all primary project management functions including:

- Coordination and facilitation of the Hazard Mitigation Workgroup
- Coordination and facilitation of the plan partners
- Research and data development
- Production of maps and Geographical Information Systems analysis
- Provision of technical assistance to plan partners for all phases of annex development
- Coordination of public participation
- Writing the plan
- Ushering the plan through the state and federal review processes

Hazard Mitigation Planning Workgroup – Each plan partner designates a representative to serve on a regional planning team known as the workgroup. Additional stakeholders who wanted to be involved in the process, but not develop an annex to the plan, also participated on the workgroup. The workgroup met regularly throughout the planning process to shape the core plan and seek guidance for developing an annex. The members' primary responsibilities include:

- Reviewing and recommending planning methodologies
- Evaluating and updating the plan's hazard information and the risk assessments
- Participating in public education and outreach events
- Assessing and documenting the region's mitigation capabilities
- Revising and prioritizing the countywide mitigation strategy
- Considering opportunities to leverage neighboring jurisdictions' mitigation strategies where appropriate
- Contributing data and information as appropriate
- Overseeing all aspects of their jurisdiction-specific planning efforts for the development of their annex, including final adoption

Members of the Hazard Mitigation Workgroup

Member	Representative
Cities/Town/County	
Bucoda	Katrina Van Every, Associate Planner
Lacey	Bracy DiLeonardo, Human Resources Analyst Tom Palmateer, Mngt. Analyst, Public Works
Olympia	Greg Wright, Deputy Fire Chief Patrick Knouff, Emergency Mngt. Sr. Program Specialist
Rainier	Katrina Van Every, Associate Planner
Tenino	Katrina Van Every, Associate Planner
Tumwater	David Ginther, Senior Planner
Yelm	Todd Stancil, Chief of Police
Thurston County	Sandy Eccker, Emergency Mngr. Andrew Kinney, Emergency Mngt. Coord. Vivian Eason, Emergency Mngt. Coord. James Yates, Emergency Mngt. Coord.
School Districts	
Griffin	Randy Martin, Facilities Supervisor
North Thurston	Brian Eko, Director of Facilities Robbi Wright, Loss Prevention Coord./Risk Mngt.
Olympia	Wendy Couture, Safety & Risk Reduction Mngr.
Rochester	Larry Quarnstrom, Maintenance Director
Tenino	Brock Williams, Principal, Parkside Elementary School
Tumwater	Mel Murray, Supervisor, Construction & Capital Projects
Yelm	Chris Hansen, Dir. of Facilities
Fire Districts	
Fire District No. 8, South Bay	Brian VanCamp, Chief
Fire District No. 17, Bald Hills	Beverly Wright, Lieutenant
Other Special Districts	
Port of Olympia	Bill Helbig, Dir. of Engineering
Thurston County PUD No. 1	Carrie Bowen, Administrative Assistant
Timberland Regional Library	Bill Wilson, Director of Facilities
Intercity Transit	Jessica Brandt, Environmental and Sustainability Coord.
Higher Education	
South Puget Sound Community College	Robert Shailor, Director of Safety and Security
The Evergreen State College	William Mikesell, Emergency Response Coord. Matt Lebens, Envir. Health & Safety Coord.
Workgroup Facilitator	
Thurston Regional Planning Council	Paul Brewster, Senior Planner

Technical Partners – Local, state, and federal government staff from a variety of agencies contributed data, guidance, and information to support the update of the risk assessment.

Regulatory Partners – The Washington State Emergency Management Division, FEMA Region X, Washington State Department of Ecology, and other federal and state agencies provided data, training, guidance on mitigation planning requirements, best practices, and other planning resources.

Planning Activities

Invitation to Participate in the Plan Update

On September 4, 2014, the EMC chair sent an invitation to every tribe, city, town, college, fire district, school district, and other special districts in Thurston County to participate in the update of the plan. Mayors, chairs, board members, and directors of 39 organizations received information about the plan update process, a statement of intent to participate form, and the date of the first Hazard Mitigation Workgroup Meeting. Twenty-one jurisdictions attended the first workgroup meeting.

Hazard Mitigation Workgroup Meetings

The Hazard Mitigation Workgroup met 15 times between September 2014 and December 2016. The meetings were generally scheduled from 1:00 to 3:00 p.m. at the Thurston County Emergency Coordination Center and all were open to the public. Throughout the planning process, TRPC maintained correspondence with the workgroup members by email, telephone, and through a SharePoint site. The following table summarizes the date and agenda items of each workgroup meeting.

Hazard Mitigation Workgroup Meeting Dates and Agenda Topics

Meeting	Date	Agenda Topics
1	18 Sept 14	Overview of planning process, schedule, member roles and responsibilities
2	16 Oct 14	Goals and policies discussion #1, new hazards, Share Point demonstration
3	20 Nov 14	Washington State Enhanced Hazards Mitigation Plan and federal grant programs, Elizabeth Minor (Washington State)
4	18 Dec 14	Goals and policies discussion #2, mitigation strategy development introduction, and mitigation categories
5	15 Jan 15	Hazard delineation data for GIS analysis, goals and policies discussion final review
6	19 Mar 15	Countywide mitigation initiatives review #1, essential facilities inventory data discussion #1, National Estuary Grant Program – Climate Adaptation Plan discussion
7	23 Apr 15	Countywide mitigation initiatives review #2, community profile contents discussion
8	18 Jun 15	Community mitigation capabilities assessment review essential facilities inventory data discussion #2, public outreach strategy discussion
9	20 Aug 15	Hazard exposure analysis and risk assessment discussion #1, public outreach strategy discussion #2, local planning process update
10	15 Oct 15	Distribution and discussion of draft vicinity maps, draft hazard maps, and draft hazard exposure analysis results, local planning process update
11	15 Nov 15	The Evergreen State College Seismic Retrofit Activities Presentation by Richard Davis, hazard exposure analysis updates, developing problem statements for mitigation activities exercise
12	21 Dec 15	Community hazards assessment GIS story map, Hazus earthquake modeling loss estimation results, risk assessment parameters, DR-4242 and DR4243 grant program call for projects information sharing
13	21 Jan 16	Review and update plan adoption, implementation, monitoring and maintenance chapter, plan partner local process updates
14	19 May 16	Review draft countywide mitigation strategy and prioritization, plan partner mitigation strategy development updates
15	1 Dec 16	Final risk assessment rating, public open house meeting and materials discussion, core plan development activities and next steps for state and federal review

Technical Assistance Activities

TRPC sought assistance, information, and training from local, state, and federal agency staff during the plan update process. These activities informed the development of the risk assessment. The following table provides a summary of these activities.

Technical Assistance Meetings, Training, and Plan Coordination

Date	Activity	Subject
26-27 Mar 13	Training, Tacoma Washington	Hazus MH Comprehensive Data Management System (CDMS) Training
19 Sept 13	Meeting at Thurston County ECC w/ Andrew Kinney, Thurston County Emergency Mngt. and Kelly Stone, FEMA	Reviewed Thurston County earthquake Hazus modeling results and its applications for the Hazard Mitigation Plan
17 Nov 14	Teleconference w/ Elizabeth Minor, WA Emergency Mngt. Division	Washington State Hazard Mitigation Grant Programs Assistance Presentation Planning for the Hazard Mitigation Workgroup
19 Feb 15	Meeting w/ Andrew Kinney and Stephen Slaughter and Tim Walsh, WA State Dept. of Natural Resources, Hazards Div.	Earthquake, landslide, and tsunami hazards and data
6 May 15	Webinar	The role of hazard mitigation planning in post-disaster Recovery CM 1
26 May 15	Meeting w/ Chief Brian VanCamp, Fire District 8, Chief Steve North, Fire District 5 and 9, and Jane Potter, WA Dept. of Natural Resources	Wildland fire hazards, prevention, regulation, and wildfire starts data for the DNR South Sound Region
28 May 15	Meeting w/ EMC and Randy Tarter, Williams Pipeline Company	Discussion of pipeline hazardous materials transport and Executive Disaster Seminar Planning
18 Sept 15	Meeting w/ Kelly Stone, FEMA and Jerry Franklin, WA Dept. of Ecology	RISK MAP and Hazus Data meeting and data exchange
27 Oct 15	Training at FEMA Region X, Lynnwood, WA	G318 Hazard Mitigation Planning Course
11 Nov 15	Teleconference with Kelly Stone, FEMA	Hazus data analysis and mapping
27 Jan 16	Meeting w/ the Thurston County Fire Chiefs Association	Wildland Fire Hazard Risks and Countywide Wildland Urban Interface area mapping initiative
9 Feb 16	TRPC participated in webinar	HMGP Grant Application – Environmental Planning and Historic Preservation
23 Feb 16	TRPC participated in webinar	HMGP Grant Application – Eligible Activities
7 Mar 16	Teleconference with Kelly Stone, FEMA	Flood Hazus data update for Thurston County RISK MAP
20 Jan 17	Teleconference with Kelly Stone, FEMA	Flood Hazus data update for Thurston County RISK MAP
17 Mar 17	Draft Plan Submitted to Derrick Hiebert, State Hazard Mitigation Strategist	State review of Draft Plan
21 Mar 17	Meeting with Derrick Hiebert, WA Emergency Mngt. Division and Sandy Johnson and Andrew Kinney, Thurston County Emergency Mngt.	Orientation to Draft Plan for state review of draft plan for compliance with federal planning requirements. A printed copy was provided to attendees.

Public Involvement

The hazard mitigation planning process offers an ideal opportunity to inform community members about local hazard conditions. Community outreach events can also help property owners identify measures they can take to protect their property and loved ones such as securing hot water heater tanks, installing earthquake brace and bolt reinforcements in home foundations, purchasing flood insurance, or completing preparedness activities like the acquisition of essential supplies and medications. The near- and long-term economic vitality and sustainability of the Thurston Region is important to residents, employees, and business owners. Their involvement in the planning process can help shape priorities and build support for local mitigation strategies.

TRPC and the planning partners engaged the public in a variety of ways including a project website, public events, community meetings, and an open house. The events and community meetings allowed people to speak one-on-one with staff about the region's hazards and learn what actions communities are taking to make the region more disaster resilient.

Emergency Preparedness Expos

The EMC hosts an annual free Emergency Preparedness Expo to inform and engage community members about the importance of emergency and disaster preparedness. Local government programs and services, vendors, demonstrations, and guest speakers provide day-long activities for people to enhance their disaster awareness and readiness. TRPC and Thurston County Emergency Management used the 2014, 2015, and 2016 expos to engage community members and solicit feedback on the mitigation plan during its development stage.

TRPC staff hosted a mitigation planning booth at each expo, showcasing information about the plan update process, and encouraging people to sign up for more information. Maps of the hazard areas, data about hazard exposure, and copies of mitigation activities were displayed.

Expo attendees received bookmarks with links to the project website, and comment forms. In 2016, TRPC showcased a cloud-based Thurston Region Hazards Assessment story map. This online interactive GIS map allows users to enter an address, zoom and pan to the county or property level, and explore what natural hazards they may be exposed to. The story map includes facilities data. Users can click on the facilities to learn what is potentially at risk to hazards, its valuation, and construction and design quality information.

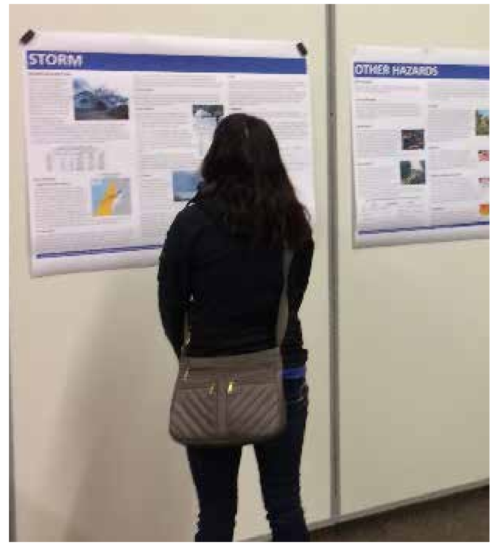
Thurston County Emergency Management Staff hosted a booth to promote information about flood awareness and the flood insurance process. The EMC invited Tim Walsh, a geologist with the Washington State Department of Natural Resources Geological Hazards Division, to present information about hazards. In 2016, Thurston County offered attendees an opportunity to sign-up for the county's AlertSense Emergency Alert System: http://public.alertsense.com/SignUp/?regionid=1186.

Emergency Preparedness Expos: Hazard Mitigation Plan Public Outreach Activities

Date	Location	Number of Attendees
September 24, 2014	Peter G. Schmidt Elementary School, Tumwater	300
September 26, 2015	Yelm High School, Yelm	275
September 17, 2016	Rochester Middle School, Rochester	250

Community Meetings

The following table summarizes the numerous community meetings Thurston County Emergency Management attended to present information about local hazard conditions, individual preparedness, and the region's mitigation activities.



Thurston County Emergency Management Community Meetings

Date	Location	Number of Attendees
April 11, 2014	Thurston County Water Utility: hazards of Thurston County, preparedness and mitigation	32
April 28, 2014	City of Yelm: hazards of Thurston County, preparedness and mitigation	18
June 19, 2014	Delphi Homeowners Association: hazards of Thurston County, preparedness and mitigation	15
September 10, 2016	Lake Saint Clair: Flooding and flood mitigation	12
May 2, 2015	Thurston County Fire Chiefs Association: hazards of Thurston County, preparedness and mitigation	15
September 25, 2015	Steamboat Island Homeowners Association: hazards of Thurston County, preparedness and mitigation	33
September 25, 2015	The Evergreen State College: hazards of Thurston County, preparedness and mitigation	18
January 28, 2016	Steamboat Island Homeowners Association at the Griffin Fire Station: hazards of Thurston County, preparedness and mitigation	85
May 2, 2016	KXXO MIX96 Radio Interview: AlertSense Emergency Alert System, preparedness, and mitigation	n/a

Executive Seminars

Independent of, but related to the plan update, the EMC invited local elected officials, key decision makers and planning directors of the county, cities, tribes, special districts, key infrastructure, and utility providers to attend a series of Executive Seminars on Catastrophic Disasters and Recovery. These seminars set a stage for recovery planning under the National Disaster Recovery Framework. The seminars introduced policy makers to a variety of topics on major natural and human-induced hazards. Using a combination of presentations, group exercises, and facilitated discussions, the seminars brought in industry representatives and disaster recovery planning experts from local, state, and federal governments. The seminars evaluated a variety of tools and planning formats that may serve as the basis for recovery planning in the region, including the *Hazards Mitigation Plan for the Thurston Region*. TRPC presented an overview of the mitigation planning process at the October 2014 seminar.

All the meetings were held in the evenings from 5:00 to 8:00 p.m. at the Thurston County Emergency Coordination Center. While open to the general public, the seminars' content and discussions were intended to engage the region's decision makers and build support for all phases of emergency management, but most importantly to develop recovery planning strategies. The seminars were also useful for building and maintaining relationships among the region's policy makers.

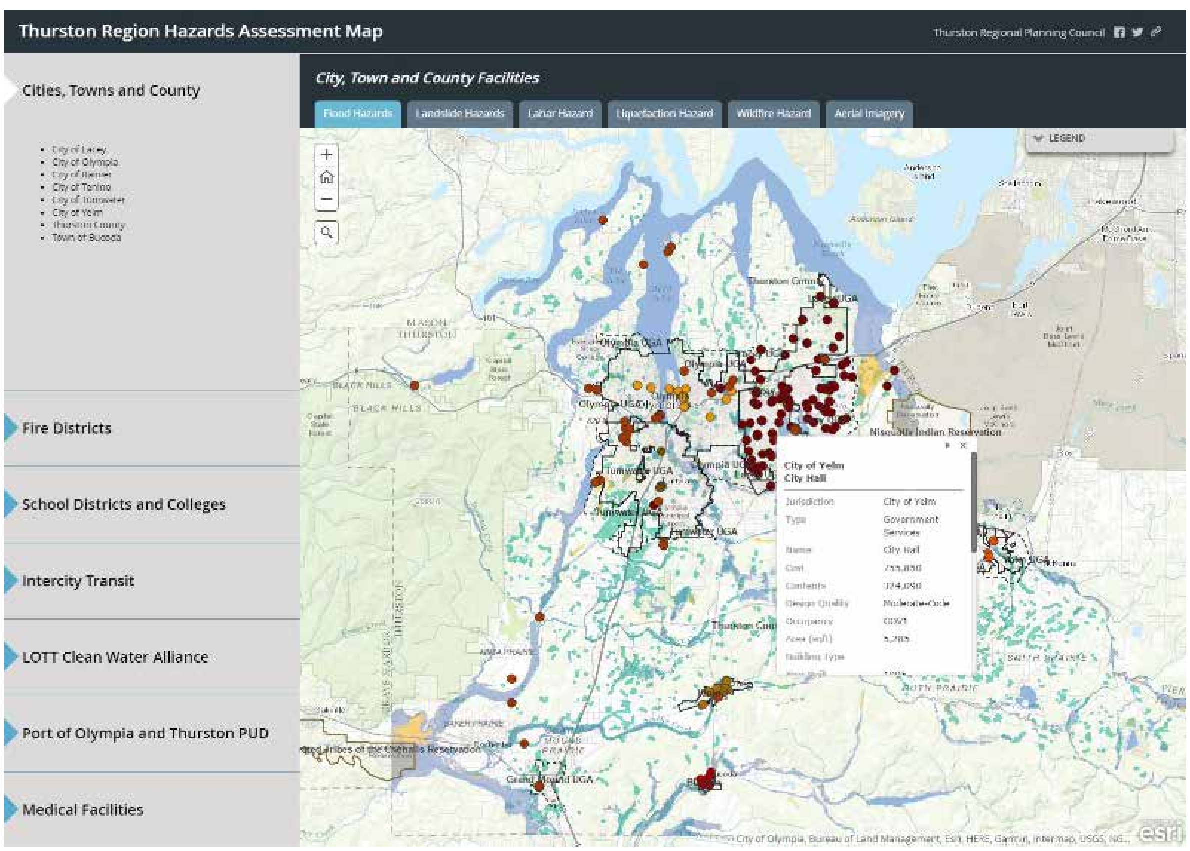
Executive Seminar on Catastrophic Disasters and Recovery Events

Date	Meeting Topic
May 30, 2013	Introduction to Catastrophic Disaster Recovery
March 27, 2014	The earthquake of Christchurch, New Zealand and its implications for Thurston County
October 20, 2014	Floods and Winter Storms in Thurston County and an introduction to the hazards mitigation process
March 15, 2015	Mount Rainier Hazards
October 19, 2015	Hazardous Materials Transport in Thurston County
December 12, 2016	Recovery Prioritization

Open House Meeting on Draft Plan

The planning partners held an open house meeting for community members to review the draft plan. Meeting notifications were distributed by email, social media, and a press release, as well as cross-promoted through individual partner's communications networks. The meeting was held at the Thurston County Emergency Coordination Center on December 14, 2016 from 5:00 to 7:00 p.m. Thirteen community members attended the meeting.

Staff were on hand to answer questions and solicit feedback. A variety of posters and other printed materials were displayed. Attendees could access two computer workstations: 1) The Thurston Region Hazards Assessment GIS story map; and 2) A Thurston County GeoData Flood Hazard and Assessors Office Database. The workstations enabled attendees to explore the hazards around their property, neighborhood, and community.



The open house presented several large format posters:

- Hazards mitigation process overview
- Risk assessment introduction
- Earthquake hazards
- Flood hazards
- Lahar hazards
- Landslide hazards
- Storm hazards
- Wildland fire hazards
- Other hazards
- Vision, Goals, and Objectives
- Countywide initiatives

Meeting handouts included: copies of the planning partners' mitigation initiatives for review; bookmarks with the project website and the hazard story map website; comment forms soliciting feedback on the risk assessment, mitigation strategy, and other topics; and a meeting evaluation form. No one submitted comment or evaluation forms, however the attendees' interactions with staff expressed support for the planning process and the information presented at the open house.

Find examples of public outreach materials in ***Appendix A****.*

Final Draft Plan Review

Thurston Regional Planning Council published a draft plan for a two-week public comment period from 8:00 a.m. March 22 to 5:00 p.m. April 5, 2017. Public comment notifications were distributed by email, social media, and a legal notice, as well as cross-promoted through individual partner's communications networks. The Olympian published an article about the plan and the public comment period in both the March 31 online edition and in print on April 1. The plan was posted online and copies were made available upon request. An online comment form with instructions and staff contact information accompanied the plan. Written public comments were accepted by email and mail. A total of eight comments were received and are shown in Appendix A. TRPC responded to everyone that submitted comments. The public comments were shared with the plan partners. The EMC reviewed the comments during their April 27 meeting.

Regulatory Review (Pending)

The final draft plan was submitted to the Washington State Emergency Management Division on March 17, 2017. The state and FEMA reviewed the draft plan for its compliance with federal hazard mitigation planning requirements in 44 CFR Section 201.6.

The outcomes of the state and federal review process will be documented in this section.

Find additional information about state and federal regulatory review process: ***Chapter 5: Review, Adoption, Implementation, Evaluation, and Maintenance****.*

Appendix A

Public Participation and Outreach Materials

The hazards mitigation planning process engaged the public and a variety of stakeholders at Emergency Preparedness Expos, community meetings and events, and an open house meeting. Appendix A includes a sample of these materials.

- A-1: Invitation to Plan Partners to Participate in the Plan Update
- A-2: Statement of Intent to Participate
- A-3: 2014, 2015, and 2016 Emergency Preparedness Expo Flyers
- A-4: Disaster Declarations of Thurston County Poster
- A-5: Hazards Assessment GIS Story Map Poster
- A-6: Bookmarks
- A-7: Hazards Mitigation Plan Open House Press Release
- A-8: The Chronicle News Article for Open House Meeting
- A-9: Open House Meeting Flyer
- A-10: Risk Assessment Poster
- A-11: Earthquake Hazards Poster
- A-12: Storm Hazards Poster
- A-13: Flood Hazards Poster
- A-14: Landslide Hazards Poster
- A-15 Wildland Fire Hazards Poster
- A-16: Lahar Hazards Poster
- A-17: Other Hazards Poster
- A-18: Plan Goals and Objectives Poster
- A-19: Countywide Mitigation Initiatives Poster
- A-20: Draft Plan Comment Form
- A-21: Open House Meeting Feedback and Evaluation Form
- A-22: Project Website
- A-23: The Olympian News Article for Draft Plan
- A-24: Legal Notice for Draft Plan
- A-25: Public Comments

A-1: Invitation to Plan Partners to Participate in the Plan Update

Paul Brewster

From:	Steve Romines <romines@co.thurston.wa.us>
Sent:	Thursday, September 04, 2014 6:25 PM
To:	chairman@chehalistribe.org; aryder@ci.lacey.wa.us; citymanager@ci.lacey.wa.us; sbuxbaum@ci.olympia.wa.us; shall@ci.olympia.wa.us; mayor@ci.tenino.wa.us; jdoan@ci.tumwater.wa.us; pkmet@ci.tumwater.wa.us; mayor@ci.yelm.wa.us; shellyb@ci.yelm.wa.us; Cliff Moore; Sandra Romero; Karen Valenzuela; Cathy Wolfe; teninocityhall@comcast.net; mayorofrainier@fairpoint.net; iyall.cynthia@nisqually-nsn.gov; mayorofbucoda@scattercreek.com; Rainier@ywave.com
Cc:	ALoudermilk@chehalistribe.org; rwyman@chehalistribe.org; bdileona@ci.lacey.wa.us; gwright@ci.olympia.wa.us; dginther@ci.tumwater.wa.us; todds@ci.yelm.wa.us; Kathy Estes; Sandy Johnson; Andrew Kinney; Cushman.joe@nisqually-nsn.gov; kautz.joe@nisqually-nsn.gov; Fred Evander
Subject:	Invitation to Make Our Communities Safer
Attachments:	Hazard Mitigation Plan Overview.docx; HMP_Statement_of_Intent.doc

Dear Community Leader,

On behalf of the Thurston County Emergency Management Council, I invite your community to participate in the update to the Thurston County region's Hazards Mitigation Plan. While the region is generally safe and secure, we are vulnerable to the effects of earthquakes, volcanic eruptions, landslides, severe winter storms, flooding, and wildfires. Natural disasters and technological hazards are devastating and can severely disrupt life in our communities. Recent events in neighboring counties illustrate this fact. While we can't prevent nature's outbursts, we can understand the risks that certain hazards pose and take steps to avoid or minimize their impacts.

The *Hazards Mitigation Plan for the Thurston Region* is a multi-jurisdictional plan that identifies and prioritizes sustained measures that if enacted, will help communities break the disaster cycle. States, local governments, and tribes perform hazard mitigation planning and adopt federally approved strategies as a precondition for receiving funding from a variety of federal grants such as the Hazard Mitigation, Pre-disaster Mitigation, and Flood Mitigation Assistance programs. These grant programs help finance important projects that make our communities safer. To maintain compliance with these programs, the Federal Emergency Management Agency (FEMA) requires that communities maintain and update their plans every five years. The current plan (second edition) was adopted in 2009 and will expire this November.

In 2012, we asked communities to sign a "Statement of Intent to Participate" in the plan update. Your jurisdiction's commitment assisted Thurston County with receiving a grant to update the plan. While this grant covers most of the cost to update the plan, it requires a local match. Your organization's participation, in the form of in-kind staff contributions to the planning process, will fulfill the grant's match requirements.

Thurston County Emergency Management is partnering with Thurston Regional Planning Council to facilitate and manage the planning process. This planning process is expected to run from September 2014 to October 2015. Local adoption is likely to occur around December 2015. Your jurisdiction can learn more about the plan and the update process by attending a Mitigation Planning Workgroup meeting on September 18 at the Thurston County Emergency Coordination Center (Tilley Road) at 1:00 p.m.

To reconfirm your jurisdiction's commitment to the plan update process, please review and re-sign the "Statement of Intent to Participate" (attached with this email). This statement will serve as a partners' agreement to fulfill all of the prerequisite planning requirements that are necessary to obtain FEMA's approval prior to local adoption. Your Emergency Management Council representative will assist you in completing this first step.

Please contact Paul Brewster, Senior Planner at TRPC if you have questions: brewstp@trpc.org or 956-7575.

Sincerely,

Steve Romines, Director
Thurston County Emergency Services
Chair, Thurston County Emergency Management Council

cc: City Managers
Emergency Management Council Representatives

A-2: Statement of Intent to Participate

NATURAL HAZARDS MITIGATION PLAN UPDATE
STATEMENT OF INTENT TO PARTICIPATE
FOR THE
THURSTON COUNTY, WASHINGTON REGION

PURPOSE: The purpose of this Statement of Intent (SOI) is to provide a mutual understanding in support of the signatory local governments, school districts, special purpose districts, colleges and universities, and other organizations that will be working in cooperation to complete an update to the multi-jurisdictional "Natural Hazards Mitigation Plan for the Thurston Region." This SOI serves as the "partners' agreement."

BACKGROUND AND FEDERAL POLICY: The Hazard Mitigation Grant Program (HMGP) is a federally funded program managed by the Washington Military Department's Emergency Management Division (State EMD). It provides grant funds for hazard mitigation plans and projects that reduce casualties and damage to structures in future disasters. This grant program, made available following Presidential Disaster Declarations, is funded by the Federal Emergency Management Agency (FEMA), and authorized by Section 404 of the Robert T. Stafford Disaster Relief and Emergency Assistance Act.

Cities, towns, counties, tribes, ports, school districts, and other special purpose local governments must have a FEMA- approved mitigation plan developed under 44 CFR Part 201 as a condition of receiving federal HMGP funds for mitigation plans or projects. Plans must be updated every five years in order to remain eligible for federal mitigation assistance. The current "Natural Hazards Mitigation Plan for the Thurston Region" (2nd edition) expires on November 24, 2014.

ROLES AND EXPECTATIONS: Consistent with the region's previous planning framework, the Thurston County Emergency Management Council will serve as the Steering Committee to direct the development of the plan. A multi-jurisdictional Hazard Mitigation Planning Workgroup composed of designees from each of the participating partners, will build the plan.

For the Hazard Mitigation Plan update process, signatory participation is defined as:

1. Designating a lead point of contact to represent the partner agency's interests on the regional Hazard Mitigation Plan Workgroup
2. Participating in the planning process including the Hazard Mitigation Plan Workgroup meetings, public meetings or open houses, workshops, planning partner specific training sessions, or public review and comment periods.
3. Providing reasonable support in the form of data, mailing lists, meeting space, and public information materials to solicit public participation in the planning process.
4. Conducting relevant jurisdiction specific meetings to review and refine its hazard mitigation capabilities, its risk assessment, and prioritize its mitigation strategy
5. Creating and prioritizing a mitigation strategy that will identify each project, the responsible entity for overseeing the project, how it will be financed, and when it is estimated to occur.
6. Formally adopting the regional plan and a jurisdiction-specific mitigation strategy.

JOINABILITY: It is expected that there will be interested parties not currently included in this SOI that will request inclusion at a later date. Other jurisdictions may be included in the regional plan update considering that they actively participate in all of the roles and expectations as outlined above.

AGREEMENT:

Whereas, the Federal Disaster Mitigation Act of 2000 requires that for all disasters declared on or after November 1, 2004, local and tribal government applicants must have an approved local mitigation plan in accordance with 44 CFR 201.6 prior to receipt of Hazard Mitigation Grant Program project funding; and

Whereas, Thurston County residents, businesses, and local governments are subject to frequent impacts from the destructive effects of flooding, winter storms, landslides, earthquakes, wildland fires, and other natural hazards that has resulted in 24 Presidential Disaster Declarations since 1965; and

Whereas, a multi-jurisdictional mitigation plan represents the commitment of jurisdictions to reduce risks from multiple hazards, serving as a guide for decision makers as they commit resources to reducing the effects of natural hazards, and is in the public interest to proceed with the multi-jurisdictional grant application and planning process in a timely manner; and

Whereas, an open public involvement process is essential to the development of an effective plan, and the process will be coordinated with affected jurisdictions, agencies, businesses, academia and other private and non-profit interests in the county to insure a comprehensive approach to mitigating the effects of natural disasters; and

Whereas, the plan shall include documentation of the planning process, and a risk assessment that provides the factual basis for activities proposed in the strategy to reduce losses, sufficient to enable each jurisdiction to identify and prioritize appropriate mitigation actions, a detailed mitigation strategy that provides the blueprint for reducing the potential losses identified in the risk assessment, a five year cycle for plan maintenance, and documentation of formal adoption by each participating jurisdiction; and

Whereas, the signatories agree to the best of their abilities and within the limits of their resources to work cooperatively on the project; and

Now, Therefore, this SOI is established to create a framework for coordinating efforts related to successfully completing the work funded under a Hazard Mitigation Grant Program grant or other relevant source of funding.

SIGNATORIES:

The undersigned individuals hereby commit to this SOI on behalf of their respective agencies. This SOI may be executed in one or more counterparts, each of which shall be deemed an original, but all of which together shall constitute one and the same instrument. Each Party has signed this two-page SOI. The original signature pages are on file at the Thurston Regional Planning Council: 2424 Heritage Ct. SW, Suite A, Olympia, WA 98502-6031, Phone: (360) 956-7575.

Pete Kmet   9/11/14

Signature   *Date*

Pete Kmet, Mayor
City of Tumwater

CITY OF TUMWATER
Washington's First Community

Natural Hazards Mitigation Plan Update Statement of Intent to Participate Page 2 of 2

A-3: 2014, 2015, and 2016 Emergency Preparedness Expo Flyers

Hope for the Best. . . Prepare for the Worst

Emergency Preparedness Expo

FREE!

Saturday, September 26, 2015
10:00 a.m. ~ 3:00 p.m.

Yelm High School
1315 W. Yelm Ave., Yelm, WA

Prizes!

Guest Speakers:

10:30 a.m.
Ted Buehner, National Weather Service
Winter Weather Outlook & Impacts

1:00 p.m.
Andrew Kinney, TC Emergency Mgmt.
Thurston County Hazards

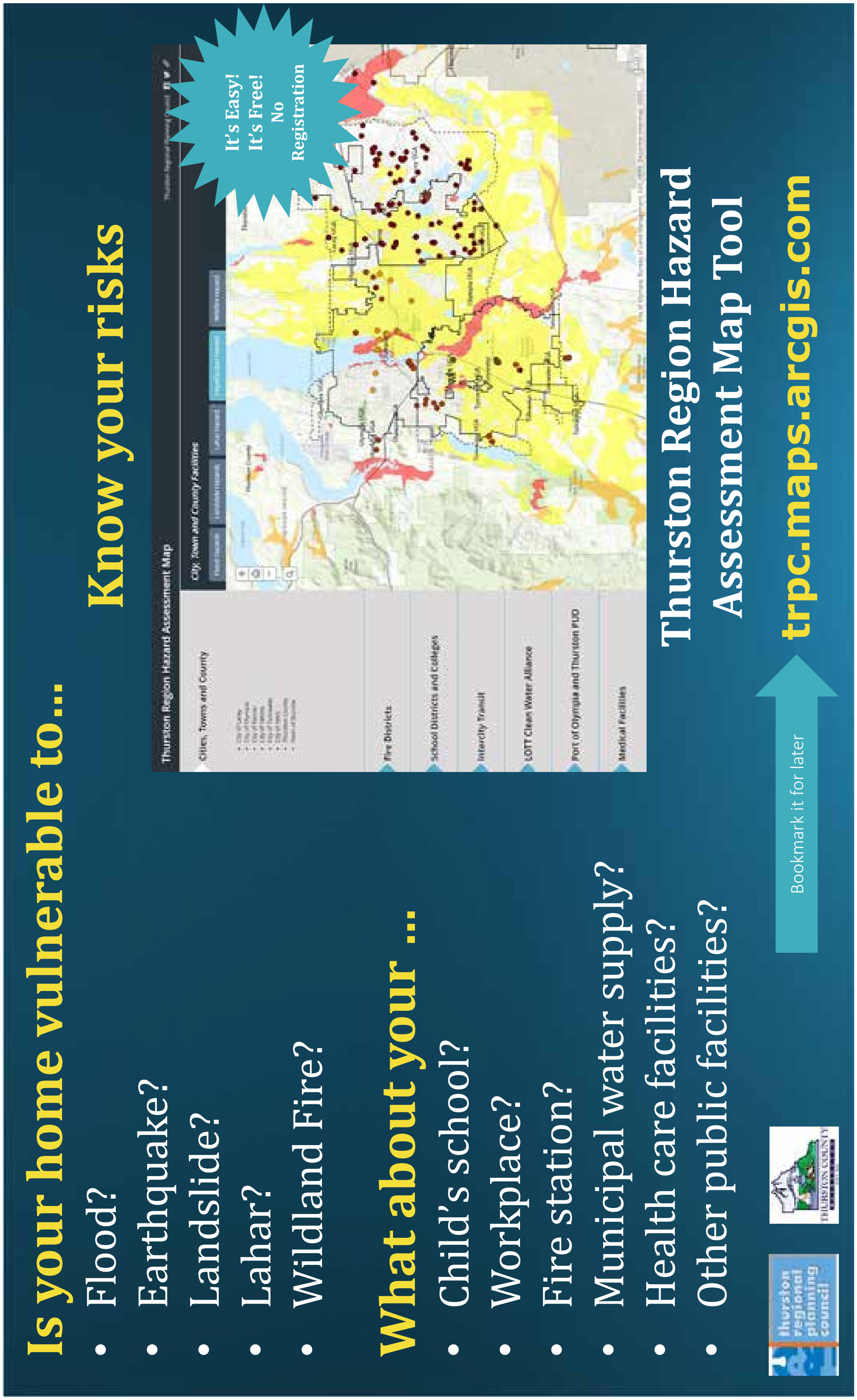
Expert speakers and vendors with information on emergency preparedness, food storage and other topics.
Games, door prizes and more!

Details: 360-867-2825
www.co.thurston.wa.us/em/expo


EMERGENCY
Preparedness
Expo
BECAUSE EVERYTHING CAN CHANGE IN A HEARTBEAT . . .
Saturday, Sept.17 2016
10:00 am — 3:00 p.m.
Get in FREE for
Rochester Middle School
9937 US-Hwy 12
Rochester, WA
Expert Speakers and Vendors with information on getting YOU prepared!
Learn about food storage, what supplies to have and taking care of your pets. Learn to prepare for the unexpected!
Guest Speakers:
10:30 a.m.
Tim Walsh, DNR
Natural Hazards in Your Backyard
1:00 p.m.
Capt. Lanette Dyer, West Thurston Fire
Learn Pet CPR
Details: 360-867-2825
www.co.thurston.wa.us/em/expo
Sponsored by Thurston County Emergency Management Council and West Thurston Fire

A-4: Disaster Declarations of Thurston County Poster

A-5: Hazards Assessment GIS Story Map Poster



A-6: Bookmarks

A-7: Hazards Mitigation Plan Open House Press Release

THURSTON COUNTY
WASHINGTON
SINCE 1852
Creating Solutions for Our Future

News Release

COUNTY
COMMISSIONERS

Cathy Wolfe - District One
Sandra Romero - District Two
Bud Blake - District Three

FOR IMMEDIATE RELEASE: Friday, December 9, 2016

CONTACT: Paul B. Brewster, Senior Planner, Thurston Regional Planning Council, 360-741-2526, or brewstp@trpc.org

Public Invited to Hazard Mitigation Plan Open House
Help map out plans that will lessen the impacts from future disasters

OLYMPIA – Thurston County residents are invited to review local government efforts to reduce losses from future disasters and help update current plans. The *Hazards Mitigation Plan for the Thurston Region* is a multi-jurisdictional plan that identifies and prioritizes sustained measures that will help communities break the disaster cycle.

States, local governments, and tribes perform hazard mitigation planning and adopt federally approved strategies as a precondition for receiving a variety of federal grants. They include Hazard Mitigation, Pre-disaster Mitigation, and Flood Mitigation Assistance programs. These grants finance projects to make our communities safer. To maintain eligibility for these programs, the Federal Emergency Management Agency (FEMA) requires that communities maintain and update their plans every five years.

Thurston Regional Planning Council (TRPC) is partnering with local governments to update the plan. Community members are invited to attend an open house on Wednesday, December 14 from 5-7 p.m. Attendees will learn about the hazards that pose the greatest risks to the region. Participants can view information about the hazards, how they may pose a risk to their property, and comment on the plan's draft mitigation activities. No presentations are scheduled, but staff will be available to answer questions and solicit feedback for the plan update.

Attendees can-

- Discover which hazards pose the greatest risk
- Use interactive maps to see what hazards affect where they live or work
- View and comment on elements of the Draft Hazards Mitigation Plan
  - Goals and objectives
  - Mitigation activities
  - And Share your ideas

What- Thurston County Hazards Mitigation Plan Open House
When- 5pm, Wednesday, December 14, 2016
Where- Thurston County Emergency Management, 9521 Tilley Road S. Olympia WA 98512

-30-

Thurston County Board of Commissioners, 2000 Lakeridge Drive SW, Olympia, WA 98502-6045
www.co.thurston.wa.us (360) 786-5440 Fax: (360) 754-4104 TDD: (360) 754-2933

A-8: The Chronicle News Article for Open House Meeting

Public Invited to Thursto ×

www.chronline.com/news/public-invited-to-thurston-county-hazard-mitigation-plan-open-house/article_45da9d92-c160-

The Chronicle

SERVING THE GREATER LEWIS COUNTY, WASH., AREA SINCE 1889

PROUDLY SERVING LEWIS COUNTY FOR 125 YEARS 1889 2014

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Public Invited to Thurston County Hazard Mitigation Plan Open House

By The Chronicle Dec 13, 2016 0

Thurston County residents are invited to review local government efforts to reduce losses from future disasters and help update current plans.

The Hazards Mitigation Plan for the Thurston Region is a multi-jurisdictional plan identifying and prioritizing sustained measures that will help communities break the lisaster cycle, stated a press release from the Thurston Regional Planning Council.

'he council is partnering with local governments to update its plan. To maintain ligibility for programs that include hazard mitigation, pre-disaster mitigation and ood mitigation assistance, the Federal Emergency Management Agency requires that communities maintain and update their plans every five years.

States, local governments and tribes perform hazard mitigation planning and adopt federally approved strategies as a precondition for receiving a variety of federal grants, stated the release.

Community members are invited to attend the open house from 5 to 7 p.m. on Wednesday, Dec. 14. Those in attendance will learn about the hazards that pose the greatest risks to the region. Participants can view information about the hazards, how they may pose a risk to their property, and comment on the plan's draft mitigation activities.

County staff will be available to answer questions and solicit feedback for the plan update. No presentations are scheduled.

The open house will be held at Thurston County Emergency Management, 9521 Tilley Road S., in Olympia.

A-9: Open House Meeting Flyer

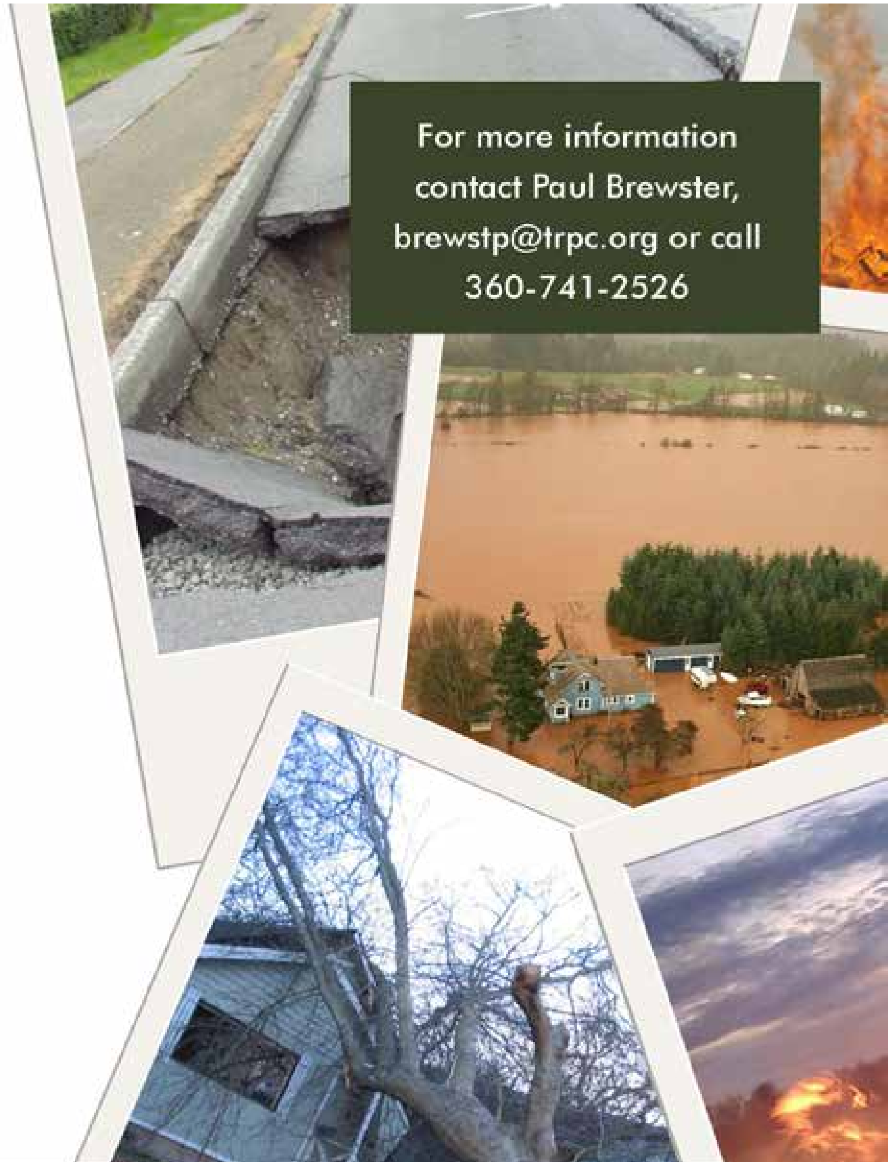
HAZARDS MITIGATION PLAN OPEN HOUSE

DEC 14	5-7 PM

THURSTON COUNTY EMERGENCY MANAGEMENT
9521 TILLEY RD S, OLYMPIA, WA 98512

All sectors of the community work together to create a more disaster resilient region

- Discover which hazards pose the greatest risk
- Use interactive maps to see what hazards affect where you live or work
- View and comment on elements of the Draft Hazards Mitigation Plan
  - Goals and objectives
  - Mitigation activities
  - Share your ideas



For more information contact Paul Brewster, brewstp@trpc.org or call 360-741-2526

TRPC ensures full compliance with Title VI of the Civil Rights Act of 1964 by prohibiting discrimination against any person based on race, color, national origin, or sex in the provision of benefits and services resulting from its federally assisted programs and activities. For questions regarding TRPC's Title VI Program, you may contact the Department's Title VI Coordinator at 360.956.7575.

If you need special accommodations to participate in this meeting, please call us at 360.956.7575 by 10:00 a.m. three days prior to the meeting. Ask for the ADA Coordinator. For TDD users, please use the state's toll-free relay service, 711 and ask the operator to dial 360.956.7575.

A-10: Risk Assessment Poster

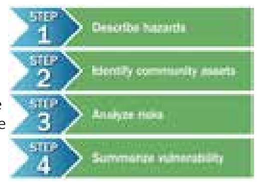
RISK ASSESSMENT

RISK

Risk, for the purpose of hazard mitigation planning, is the potential for damage, loss, or other impacts created by the interaction of natural hazards with community assets.

STEPS TO CONDUCT A RISK ASSESSMENT

For multi-jurisdictional hazard mitigation plans, the risk assessment must result in an evaluation of potential impacts and overall vulnerability that each particpating jurisdiction will use to develop specific mitigation actions. Assets, vulnerabilities, and overall risk are unique to each community and must be addressed. Although hazards may be described for the entire planning area, the plan also must explain any hazards that are unique or varied within communities. For the Thurston Region Hazards Mitigation Plan, each community assesses its unique impacts in their annex to the plan.



Describing Hazards

The plan is requied to include a description of the type of all of the natural hazards that can affect the community. The Thurston Region's plan includes both natural and other technological or human-induced hazards. For each hazard affecting the planning area, the risk assessment must include a description for each of the following:

- Location
- Extent
- Previous occurrences
- Probability of future events

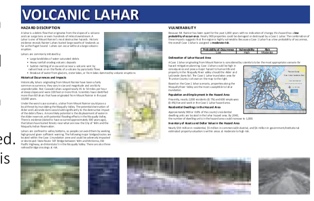
Hazard Profiles

Every hazard that is profiled in this plan meets one or all of the following criteria:

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

The following hazards meet one or more of the above criteria and are profiled in this plan: 1) Earthquake; 2)Flood; 3)Landslide; 4) Storm; 5) Volcanic Lahar; and 6) Wildland Fire.

For each of these hazards, an assessment of the region's population, employment, residential units, valuation of assets, and essential facilities is provided. The portion of these attributes, that are in or out of an area potentially affected by the hazard, is summarized. Additional data and maps of hazard areas are also included. Loss estimation analysis, provided by HAZUS modeling software, is also included. At present, loss estimation analysis is only available for earthquake and flood. The hazard posters are simplified summaries of the hazard profiles.



The hazard posters are representative of the hazard profiles.

MEASURING RISK

Hazard Analysis Definitions

The Thurston Region Hazard Mitigation Plan uses a subjective risk measurement process based on Thurston County's Hazard Inventory and Vulnerability Assessment or HIVA. This methodology rates elements of each hazard's risk characteristics using adjective descriptors such as high, moderate, and low. These descriptors are applied to the hazards' probability of occurrence, vulnerability, and overall risk. The following is an overview of the risk measurement process:

Risk Rating: An adjective description (High, Moderate, or Low) of the overall threat posed by a hazard is assessed for the next 25 years. Risk is the subjective estimate of the combination of any given hazard's probability of occurrence and the region's vulnerability to the hazard.

- **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.
- **Moderate:** There is medium 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.

Probability of Occurrence: An adjective description (High, Moderate, 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.
- **Moderate:** There is medium 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: Vulnerability can be expressed as combination of the severity of a natural hazard's effect and its consequential impacts to the community. An adjective description (High, Moderate, 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 worst case scenario, there could be a disaster of major to catastrophic proportions.
- **Moderate:** 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 worst 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 worst case scenario, there could be a disaster of minor to moderate proportions.

RISK ASSESSMENT SUMMARY

Using this criteria, the six hazards profiled in this plan receive the following risk ratings:

Hazard	Probability of Occurrence	Vulnerability	Risk Rating
Earthquake	High	High	High
Flood	High	Moderate	High
Landslide	Moderate	Low	Moderate
Storm	High	High	High
Volcanic Lahar	Low	High	Moderate
Wildland Fire	High	Moderate	Moderate

For further information or to view the current "Hazards Mitigation Plan for the Thurston Region," visit www.trpc.org/hazards.

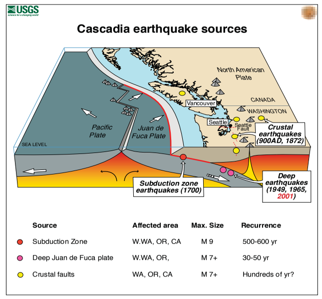
Thurston Regional Planning Council, 2016

A-11: Earthquake Hazards Poster

EARTHQUAKE

HAZARD DESCRIPTION

An earthquake is the sudden release of energy bound in a fault within the earth. They cause the most widespread damage to transportation, communications, utilities, buildings, business, and disruption to services across all sectors of society. Earthquakes are among the most feared natural hazards because they strike without warning and cause ground shaking, ground failures, liquefaction, tsunamis, and fires.



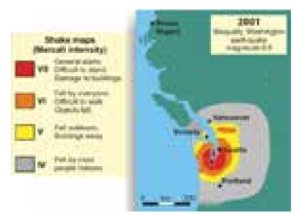
Spotlight: 2001 Nisqually Earthquake

On February 28, 2001, a 6.8 magnitude earthquake from 30 miles below the Nisqually River Delta shook the Pacific Northwest. In the days after the quake, a Presidential Disaster Declaration was issued.

Impacts

- Deaths and injuries: 1 death; 400 injuries
- Applicants for federal disaster assistance: 41,414
- Total damage estimates: $1- $4 billion.
- Federal assistance to date: $334 million
- Building Damage:
  - » Downtown Olympia and Seattle's Pioneer Square area hit hard.
  - » Several of the government buildings in Olympia, including the capitol, were significantly damaged.
  - » Damage to homes came in a variety of forms; chimney failure was the most common.
- Transportation Damage:
  - » Serious damage to Seattle-Tacoma International Airport
  - » 4th Avenue Bridge and Deschutes Parkway in Olympia were destroyed and remained closed until reconstructed.
- Other Impacts: landslides, power outages, some damage to dams, landline and wireless communications were overwhelmed by caller demands.

2001 Nisqually Earthquake - Ground Shaking Intensity



ASSESSING VULNERABILITY

There is a **high probability** of a destructive earthquake occuring in the next 25 years. A significant portion of the population lives in areas prone to liquefaction. Damage estimates from earthquake models and losses from historic events indicate that the region remains **highly vulnerable.** Accordingly, Thurston County is assigned a **high risk rating** for major earthquakes.

Probability of Occurrence	Vulnerability	Risk
High	High	High

Delineation of the Liquefaction Hazard Area

Liquefaction is the phenomenon of soils behaving like viscous fluid from strong ground shaking. 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 a structures liquefies, causing structures to subside and/or tip.

Liquefaction typically occurs in artificial fills and in areas with loose sandy soils that are saturated with water, such as low-lying coastal areas, lakeshores, and river valleys. Areas at risk to liquefaction are shown on the map on the right.

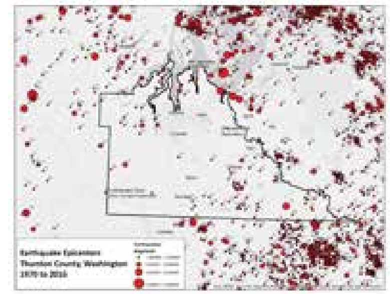
Population and Employment in the Hazard Area

Presently, nearly 99,000 people (37%) and 43,400 dwellings are located in areas with a moderate to high risk for liquefaction. Countywide, approximately 70,300 people work in liquefaction prone areas.

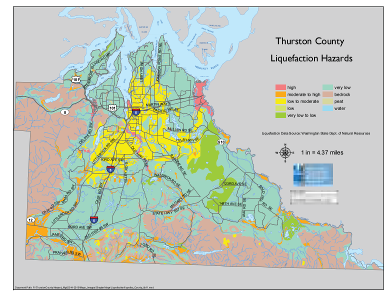
Inventory of Assets and Dollar Value in the Hazard Area

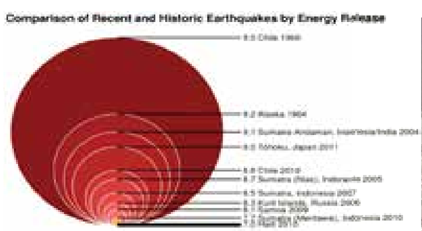
Nearly $5.3 billion in residential, $1.5 billion in commercial/ industrial, and $2.1 billion in government/institutional estimated property valuation is within areas at moderate to high risk.

Earthquake Epicenters, Thurston County, 1970 - 2016



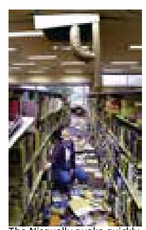
Since 1970, over 5,300 earthquakes with epicenters within a 40-mile radius from Thurston County have been detected . Most events are data points by seismographs and pass without notice. 93 of these seismic events had epicenters in Thurston County; the vast majority were less than magnitude 2.



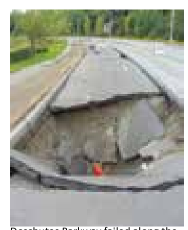


Each whole number increase in magnitude represents a ten-fold increase in measured amplitude, and about 32 times more 'elastic' energy released in the form of seismic waves than the magnitude that precedes it.

Unreinforced masonry and facades were rattled loose from downtown Olympia buildings during the 2001 Nisqually Earthquake.

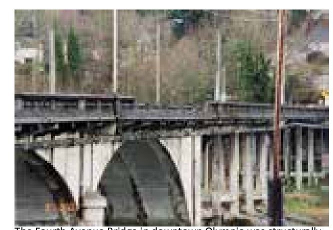


The Nisqually quake quickly emptied the stacks at TESC Library.



Deschutes Parkway failed along the entire corridor due to liquefaction

Unreinforced masonry chimneys commonly fail in the South Sound as evidenced during the 1949, 1965, and 2001 earthquakes.



The Fourth Avenue Bridge in downtown Olympia was structurally compromised and closed to vehicles immediately following the 2001 Nisqually Earthquake.

For further information or to view the current "Hazards Mitigation Plan for the Thurston Region," visit www.trpc.org/hazards.

Thurston Regional Planning Council, 2016

A-12: Storm Hazards Poster

STORM

HAZARD DESCRIPTION

Thurston County is subject to a variety of storms that deliver wind, rain, snow, and ice — often in successive events, and sometimes in combination. Nearly all destructive storms that affect Thurston County generally occur from November through April when the jet stream and low-pressure systems are more prevalent over the Northwest.

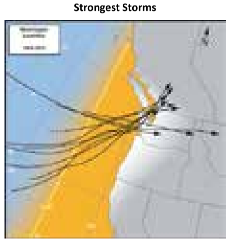
Between 1965 and 2016, 18 of 22 Presidential Disaster Declarations involving Thurston County were attributed to damage resulting from winter storms (principally flood damage). Storms cause significant property damage, disrupt utilities and transportation, and frequently cause injuries and sometimes death. Between 2010 and 2015, severe storms killed 77, injured 75, and caused $430.6 billion in damages statewide in Washington (43 of the deaths were caused by the 2014 Oso mudslide.)

Hazardous Weather Fatalities, Injuries, and Damage Costs in Washington State, 2010 – 2015

Year	Fatalities	Injuries	Damage (millions $)		
			Property	Crops	Total
2010	3	8	$11	$0.09	$11.09
2011	6	5	$18.82	$0.68	$19.49
2012	6	5	$27.32	$1.13	$28.45
2013	4	16	$12.84	$0.5	$13.33
2014	50	34	$328.16	$1.12	$329.28
2015	8	7	$28.94	$0.02	$28.96
Total	**77**	**75**	**$427.08**	**$3.54**	**$430.6**

Storm Elements

Trajectories of Washington's Strongest Storms



1. High Winds/Windstorms

The National Weather Service defines high winds as "sustained wind speeds of 40 mph or greater lasting for 1 hour or longer, or winds of 58 mph or greater for any duration." Generally, winds above 30 mph can cause widespread damage and those above 50 mph can lead to more serious disasters. Most large windstorms that affect the region are delivered by mid-latitude Pacific cyclones. While not as powerful as tropical hurricanes, these cyclones can generate wind speeds in excess of 100 mph and can maintain their strength farther inland.

2. Heavy Rain

Heavy rainfall is any amount of rain produced in a relatively short period that exceeds the capacity of natural systems' or stormwater infrastructures' ability to effectively and safely convey the flow of stormwater. The most common impacts from heavy rainfall are flooding and erosion. Prolonged rain delivered by weather systems north of the Hawaiian Islands dubbed atmospheric rivers, can rapidly melt snow in the Cascade Mountains and lowlands. This precipitation causes: rivers to rise quickly; cause flooding downstream in valleys; and widespread landslides both in the uplands and the lowlands. Local rainfall also swells local creeks and streams, exacerbating local flood potential.

3. Freezing Rain

Freezing rain occurs when rain descends through a cold air mass, cools, and subsequently freezes on contact with cold surfaces. An ice coat will continue to accumulate on surfaces as long as conditions exist. Ice can accumulate to thicknesses greater than one inch.

4. Heavy Snow

The Washington State Hazard Mitigation Plan defines heavy snow as four inches of snowfall in 12 hours or six inches in 24 hours for non-mountainous areas. This amount is sufficient to disrupt activities in Thurston County.

Falling snow mixed with high winds produces a blizzard. The National Weather Service defines a blizzard as, "... [three hours or more of] sustained wind or frequent gusts to 35 miles an hour or greater; and considerable falling and/or blowing snow (i.e., reducing visibility frequently to less than ¼ mile)."

Total days with 12 inches or greater of snow on the ground in Thurston County, 1948 to 2015

Year	12-inch Snow Days
1950	7
1954	4
1969	7
1972	8
1980	3
2008	10
2012	4

The average annual snowfall for Thurston County is approximately 17 inches (average maximum of all weather stations in Thurston County, 1948-2015). Most snow events are less than six inches within a 24-hour period. However, local weather station records indicate that local heavy snowfall events have occurred 39 times since 1948.

5. Tornado

EF1 Tornado near Gig Harbor, WA on January 19, 2015

The National Weather Service defines a tornado as "a violently rotating column of air, usually pendant to a cumulonimbus [cloud], with circulation reaching the ground. It nearly always starts as a funnel cloud and may be accompanied by a loud roaring noise. On a local scale, it is the most destructive of all atmospheric phenomena."

In western Washington, tornados have occurred during the months of January, March, April, May, June, August, September, October, November, and December. A total of 94 tornados have been documented in Washington State between 1950 and 2005. Of these, 46 were F0, 29 were F1, 12 were F2, and 3 were F3. Damaging tornados are rare in Thurston County, and none have adversely affected densely populated areas. Between 1950 and 2008, four small tornados (three F0, and one F1) occurred in Thurston County near Bucoda, Tenino, Yelm and Lacey in 1994, 2003, 2004, and 2006 respectively.

6. Hail

Hail is precipitation that takes the form of ice balls or clusters of ice clumps, ranging from two-tenths of an inch to several inches in diameter. Hail forms in cumulonimbus or thunderstorm clouds that have strong updrafts.

Most hail storms in Thurston County produce small non-destructive hail. The records of damaging hail storms are scant and suggest limited damage from these events with only small geographical areas likely affected. Hail storms may damage crops, but the extent of hail damage to agriculture within Thurston County is unknown.

7. Lightning

Lightning is an atmospheric discharge of electricity that occurs with thunderstorms. A lightning bolt can travel at 60,000 meters per second and reach temperatures of 54,000°F.

Lightning storms in Thurston County are short lived and generally only affect a small area. Historically, lightning has not caused widespread damage locally. Since 1960, at least 11 lightning storms have caused $207,808 in property damage in Thurston County. Since 1972, lightning ignited at least 28 wildland fires. A total of 28 acres are known to have burned. The largest fire burned 15 acres on private timberland in a remote area of southeast Thurston County in June 2004.

Major Historic Storms in Thurston County

- January 14-23, 2012, Federal Disaster 4056: Severe Winter Storm, Flooding, Landslides, and Mudslides
- December 12-27, 2008, Federal Disaster 1825: Severe Winter Storm
- December 1-7, 2007 Federal Disaster 1734: Severe Winter Storm, Landslides, and Flooding
- October 18, 2007 Windstorm
- January 5, 2007 Windstorm
- December 14-15, 2006 "The Hanukkah Eve Storm" Federal Disaster 1682: Severe Winter Storm, Landslides, and Mudslides
- November 2-11, 2006 Federal Disaster 1671: Severe Winter Storm, Flooding, Landslides, and Mudslides
- May 27, 2004 F1 Tornado
- January 6, 2004 Snow Storm
- May 17, 2003 Lightning Strike
- October 15-23, 2003 Federal Disaster 1499: Severe Storms and Flooding
- June 17, 2002 Lightning Strike
- September 5, 2002 Lightning Strike
- December/January 1996/1997 Federal Disaster 1159: Ice, Wind, Snow, Landslides, and Flooding
- September 1, 1997 Hail Storm.
- December 12, 1995 Windstorm
- April 6, 1994 F0 Tornado
- January 20, 1993 Inaugural Day Windstorm, Federal Disaster 981: Windstorm.
- January 1986 Strong Winds and Rain

VULNERABILITY

Severe storms have a **high probability of occurrence.** Historical damage and cumulative costs of destructive storms suggest **high vulnerability**. Accordingly, a **high risk** rating is assigned.

Probability of Occurrence	Vulnerability	Risk
High	High	High

For further information or to view the current "Hazards Mitigation Plan for the Thurston Region," visit www.trpc.org/hazards.

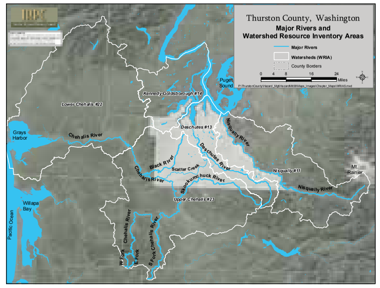
Thurston Regional Planning Council, 2016

A-13: Flood Hazards Poster

FLOOD The Region's Most Pervasive Hazard

HAZARD DESCRIPTION

Flooding is a natural cycle of streams and rivers. It occurs when the volume of precipitation or melting snow pack exceeds the capacity of river banks to keep flowing waters contained. Of all natural hazards that affect Thurston County, floods are the most common and, on an annual average basis, the most costly. Thurston County has been declared a Federal Disaster Area 18 times for flood since 1962.



Several factors determine the severity of floods:

- Precipitation intensity and duration
- Soil saturation conditions
- Topography and ground cover
- Amount of snow

Four types of flooding occur in Thurston County:

1. **River or stream flooding** occurs with prolonged heavy rainfall, a rapidly melting snow pack or a combination of these.
2. **Urban flooding** results from intense storms dropping large volumes of rain within a short period of time, exceeding the capacity of stormwater management systems.
3. **Tidal flooding** results when extremely high tides combine with low atmospheric pressure, excessive run-off, or strong northerly winds. The tides can also enhance flooding in delta areas when rivers or creeks are at or near flood stage. Sea level rise will exacerbate tidal flooding.
4. **Groundwater flooding** occurs when 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 1998-1999 flood is the groundwater flood of record.

December 2007 Chehalis River Basin Flooding. Photo courtesy Thurston County

Cooper Point Rd/Black Lake Blvd Intersection: West Olympia urban flooding. Photographer unkown.

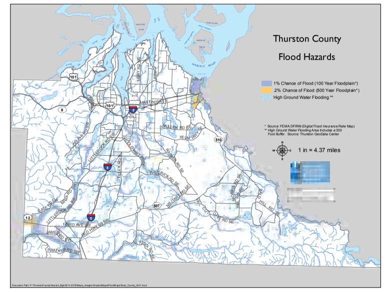
ASSESSING VULNERABILITY

The history of major flooding within the Thurston Region clearly demonstrates a **high probability of occurrence**. Because of the relative land area and population affected by flooding, the county's **vulnerability is rated as moderate**. On a jurisdictional basis, an exception is the Town of Bucoda, which has a high vulnerability due to the extent of the 100-year flood plain in the community. Countywide, the frequency of flooding, the potential for simultaneous flooding events, plus the historical record of recurrent flooding and cumulative costs, all lead to the assignment of a **high risk rating**.

Probability of Occurrence	Vulnerability	Risk
High	Moderate	High

Delineation of Flood Hazard Area

For the purpose of hazard mitigation planning, the flood hazard area is delineated as the combined boundaries of the 100- and 500-year floodplains, and areas of high groundwater flooding. Flooding has and will continue to occur outside of these boundaries. See the map below for the extent of flood hazards in Thurston County.



Population in Hazard Area

Presently, nearly 19,300 or 7.2% of the county's population resides in an area at risk for flood. By 2040 nearly 33,100 people are forecast to live within flood risk areas.

Residential Dwellings in the Hazard Area

There are nearly 8,200 (7.2%) residential units located in areas at risk for flood.

Inventory of Assets and Dollar Value in Hazard Area

Nearly $1 billion in residential, $141 million in commercial/ industrial, and $360 million in government/ institutional estimated property valuation is within areas at high risk to flood.

Flooding and debris over Independence Road, December 2007. Photo courtesy Thurston County

The Effects and Costs of Floods

The effects of floods can be devastating. Aside from inundation of lands and property with sediment-filled waters, floods can result in:

- Death or injury to people, pets, and livestock
- People stranded or isolated for long periods of time
- Physical destruction of buildings and other structures
- Contaminated water sources and treatment systems
- Foul septic systems
- Destroyed electrical and heating systems
- Damaged, destroyed, or closes bridges, transportation routes, railroads, and pipelines and utility systems
- Limited access for emergency responders and critical personnel

The potential consequences are enormous as the following summaries of damages from flooding in 1996, 1997 and 2007 demonstrate:

The December 1996 and March 1997 winter storm and ground water 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
- Cost uninsured private property losses in excess of $1.75 million

The December 2007 Flood and Severe Storm

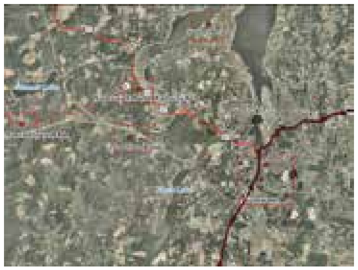
- 25 Rescue Missions (17 by Helicopter) to rescue 63 people
- 400 properties affected, 96 households isolated by washout of Cedar Flats Road
- 44 Road and Bridge Closures with damages likely to exceed $2.7 million
- LOTT Alliance Wastewater Treatment Facility overloaded by runoff and forced to discharge one million gallons of untreated stormwater per hour into Budd Inlet

For further information or to view the current "Hazards Mitigation Plan for the Thurston Region," visit www.trpc.org/hazards.

A-14: Landslide Hazards Poster

LANDSLIDES AND DEBRIS FLOWS

HAZARD DESCRIPTION


Locations of landslides during the December 2007 storm/flood event. (DNR)

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, and shallow or deep failure of slope.

Debris flows (or mudflows) are conglomerations 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 landform's stability can be compromised by human activity such as construction of buildings or other infrastructure, logging, and mining near or along steep slopes.

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 area having the greatest vulnerability.

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

On March 22, a massive landslide occurred 2 miles east of Oso along State Route 530. Higher than normal rainfall contributed to the collapse of an unstable slope north of the Stillaguamish River. The landslide generated 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.


The 2015 Oso Landslide killed 43 people and buried over 40 homes and other structures.

This tragic landslide was much larger, traveled much further, and had a greater destructive force than others previously experienced at or near the site. The United States Geological Survey states that 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 travled 40 miles per hour.

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. Washington State Department of Natural Resources 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. The debris clogged the culvert where Swift Creek flows under Cedar Flats Road." The clogged culverts impeded creek flow and forced the surrounding embankment under the road to wash out. The county opened a temporary 1.5 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 bridges cost $891,000.


A debris flow destroyed Cedar Flats Road, the primary access to the neighborhood in northwest Thurston County.

On December 3, another mudslide on Kennedy Creek Road in northwestern Thurston County destroyed the Ranch House BBQ restaurant and surrounding structures. Damage was estimated at $1 million. Slides also caused at least two homes to be tagged as uninhabitable off Sunset Beach Road.

Winter 1998-99, South Puget Sound Landslides

Three years of above average winter rainfall contributed to a massive slide in the Carlyon Beach area. The 66-acre landslide left 40 homes uninhabitable.

December 1996 to March 1997 Rainstorms

Following several 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. A separate slide south of the City of Rainier 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 Flooding

Sections of a bluff slid into the Nisqually River near Yelm. Several residences were declared unsafe to occupy. Another landslide broke the two main sewer lines that carried the majority of Tumwater's and the former Olympia Brewery's wastewater to the LOTT treatment plant in Olympia.

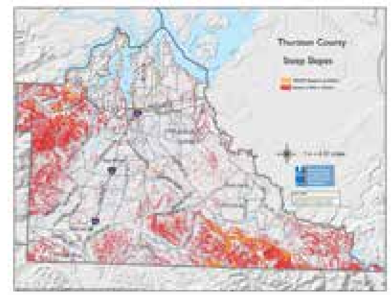
VULNERABILITY

Thurston County has a history of landslides and their numbers seem to be increasing, suggesting a **high probability of occurrence**. Landslides tend to occur in isolated, sparsely developed areas, suggesting **low vulnerability**. Because of the high probability of occurrence and the trend to more frequent landslides a **moderate risk** rating is assigned.

Probability of Occurrence	Vulnerability	Risk
High	Low	Moderate

Delineation of Landslide Hazard Area

For the Hazards Mitigation Plan, a landslide hazard area is defined as those parcels in the county on which slopes of 40 percent or more occur. The majority of these areas are in unpopulated areas to the south and to the west. Steep bluffs are also present in the Nisqually Valley, Olympia, Tumwater and Lacey.



Population and Employment in the Hazard Area

Presently, approximately 12,600 residents (4.7%) 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%) work within the hazard area.

Residential Dwellings in the Hazard Area

Nearly 5,400 or 4.7% of residential dwelling units are located in areas with steep slopes.

Inventory of Assets and Dollar Value in the Hazard Area

Countywide, an estimated $861 million in assets is located within the landslide hazard area.

For further information or to view the current "Hazards Mitigation Plan for the Thurston Region," visit www.trpc.org/hazards.

Thurston Regional Planning Council, 2016

A-15 Wildland Fire Hazards Poster

WILDLAND FIRE

HAZARD DESCRIPTION

Wildland fires are uncontrolled fires in grasslands, brush, woodlands, or forests. Most are caused by human error. Wildland fires destroy valuable resource lands, wildlife habitat, powerlines, pipelines, communications, and transportation infrastructure. The impact of a major fire would be amplified by subsequent effects of landslides and flooding during heavy rains.

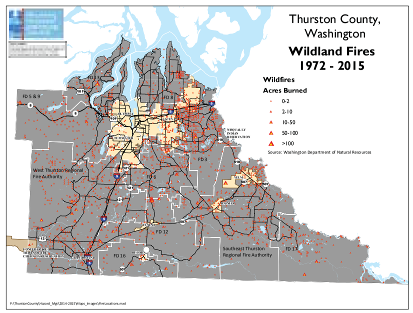
Wildland fires also pose threats to people, pets, and livestock in areas that intermingle with wildland vegetation. This area is termed the Wildland-Urban Interface (WUI).

Historical Occurrences and Impacts

Over 2,700 wildfires have been documented in Thurston County since 1972; an average of 63 fires per year. The average fire burns about one acre. The largest wildfire recorded in Thurston County burned approximately 140 acres near Offut Lake north of Tenino in 1998. The map below shows the size and locations of local wildland fires.

Wildland Fires 1972 - 2015

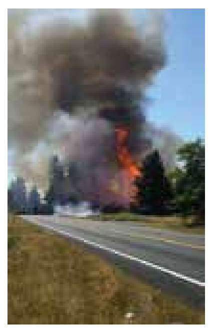
Fire District and Municipal Fire Department Response Areas	Total Fires	Fires/ Year	Total Acres Burned	Max Size (acres)	Average Acres
Bucoda Fire Department	8	0.2	1.2	50	0.1
Olympia Fire Department	26	0.6	8.3	0.5	0.3
Tumwater Fire Department	54	1.3	35.5	4	0.7
West Thurston Regional Fire Authority	494	11.5	581.7	50	1.2
South East Thurston Regional Fire Authority	430	10.0	416.9	59	1.0
Lacey	758	17.6	431.3	54	0.6
McLane/Black Lake	204	4.7	128.3	14	0.6
East Olympia	209	4.9	147.1	13	0.7
South Bay	183	4.3	44.6	8	0.2
Tenino	113	2.6	372.8	140	3.3
Griffin	68	1.6	118.8	96	1.7
Gibson Valley	35	0.8	51.4	25	1.5
Bald Hills	126	2.9	128	23	1.0
Grand Total	**2708**	**63.0**	**2465.9**	**140**	**0.9**



Three areas of the county are a special concern for wildland fire due to the prevalance of fuels, human activities, and limited road access:

1. Capital Forest
2. Joint Base Lewis McChord
3. Commercial forests in southeast Thurston County

Virtually all open spaces within the county are vulnerable to a wildfire, especially those areas surrounded by brush and grass which are quick to ignite during the drier and hotter months.



VULNERABILITY

Wildland fires have a **high probability of occurence** in Thurston County. The county's combination of large forest and grassland areas, its growing population, and increasing recreational activities in open spaces result in a **moderate vulnerability**. Accordingly, a **moderate risk rating** is assigned. The effects of climate change is likely to alter Thurston County's risk for wildland fires as longer, warmer, and drier summers are expected for the Puget Sound Region by mid-century.

Probability of Occurrence	Vulnerability	Risk
High	Moderate	Moderate

Risk Factors

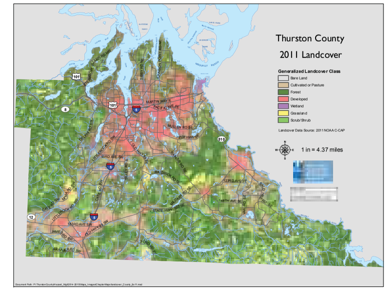
The "Washington State Hazard Mitigation Plan," lists three factors that contribute to wildfires:

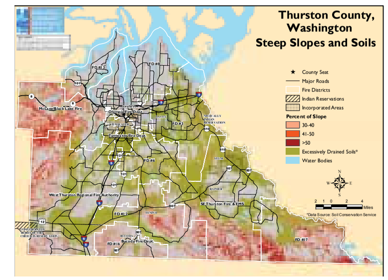
Fuel: Lighter fuels such as grasses, leaves, and needles quickly expel moisture and burn rapidly, while heavier fuels such as tree branches, logs, and trunks take longer to warm and ignite (see the landcover map on the right).

Weather: West of the Cascades, strong, dry, east winds in late summer and early fall produce extreme fire conditions. East wind events can persist up to 48 hours with wind speed reaching 60 mph ; these winds generally reach peak velocities during the night and early morning hours.

Terrain: Topography of a region or a local area influences the amount and moisture of fuel. Barriers, such as highways and lakes, can affect the spread of fire. Fires spread more easily uphill than downhill (see the steep slopes map on the right).

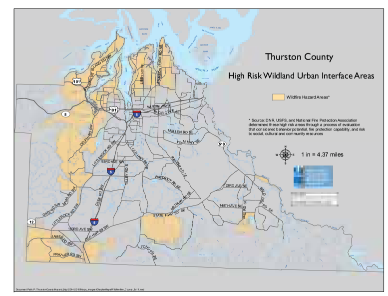
Limited road access to open spaces also increases risk for larger uncontrolled wildland fires. Fewer roads can delay response times for firefighters to make contact with the fire.





Delineation of Wildland Fire Hazard Area

Washington State Department of Natural Resources, the U.S. Forest Service, and stakeholders identified WUI communities throughout Washington, including Thurston County. Communities were evaluated for fire behavior potential, fire protection capability, and risk to social, cultural and community resources. Risk factors included fire history, type and density of vegetative fuels, extreme weather potential, topography, number and density of structures and their distance from fuels, location of municipal watersheds, and potential for loss of housing or businesses. The map on the bottom right shows areas of the county that are within WUIs and are at risk for wildland fire hazards.



Population and Employment in the Hazard Area

Approximately 30,500 residents (11.4%) and 6,600 employees (4.9%) live and work in the area designated as a high risk for wildland fires.

Residential Dwellings in the Hazard Area

At present, nearly 12,900 or 11.3% of residential dwelling units are located in the wildland fire hazard area. By 2040, the number of dwelling units in the hazard area may increase to 16,200.

Inventory of Assets and Dollar Value in the Hazard Area

Countywide, an estimated $2.96 billion in assets is located in the wildland fire hazard area.

For further information or to view the current "Hazards Mitigation Plan for the Thurston Region," visit www.trpc.org/hazards.

Thurston Regional Planning Council, 2016

A-16: Lahar Hazards Poster

VOLCANIC LAHAR

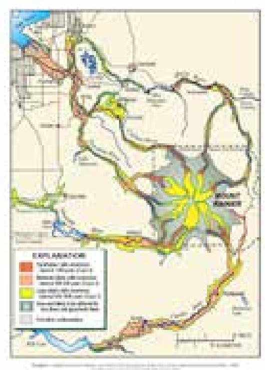
HAZARD DESCRIPTION

A lahar is a debris flow that originates from the slopes of a volcano and can surge tens or even hundreds of miles downstream. A Lahar is one of Mount Rainier's most destructive hazards. Historic evidence reveals Rainier Lahars buried large swaths of lowlands as far as the Puget Sound. Lahars can occur without a large volcanic eruption.

Lahars are commonly initiated by:

- Large landslides of water-saturated debris
- Heavy rainfall eroding volcanic deposits
- Sudden melting of snow and ice near a volcanic vent by radiant heat or on the flanks of a volcano by pyroclastic flows
- Breakout of water from glaciers, crater lakes, or from lakes dammed by volcanic eruptions

Historical Occurrences and Impacts



Historically, lahars originating from Mount Rainier have been a fairly common occurrence; they vary in size and magnitude and are fairly unpredictable. Past Cascade lahars surged nearly 45 to 50 miles per hour at steep slopes and were 100 feet or more thick. Scientists have identified more than 60 lahars that have originated from Mount Rainier in the past 10,000 years.

Under the worst-case scenario, a lahar from Mount Rainier could pose a local threat by inundating the Nisqually Valley. The potential destruction of Alder and LaGrande dams would add significantly to the destructive impact of the debris flows. A more likely potential is the displacement of water in the Alder reservoir, with potential flooding effects in the Nisqually Valley. There is evidence (dated to have occurred approximately 300 years ago), that lahars have buried forests near what are now the City of Yelm and the Nisqually Indian Reservation.

Lahars are confined to valley bottoms, so people can avoid them by seeking high ground given sufficient warning. The following major bridges/routes are located within the Case 1 inundation zone and could be adversely impacted or destroyed: State Route 507 Bridge between Yelm and McKenna, Old Pacific Highway, and Interstate 5 in the Nisqually Valley. There are also three railroad bridge crossings at risk.

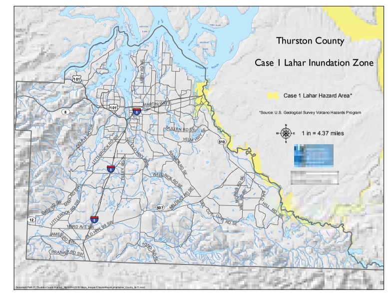
VULNERABILITY

Because Mt. Rainier has been quiet for the past 1,000 years with no indication of change, this hazard has a **low probability of occurrence**. Nearly 900 properties could be damaged or destroyed by a Case 1 Lahar. The combination of these impacts suggests that the region is highly vulnerable. Because a Case 1 Lahar has a low probability of occurence, the overall Case 1 lahar is assigned a **moderate risk**.

Probability of Occurrence	Vulnerability	Risk
Low	High	Moderate

Delineation of Lahar Hazard Area

A Case 1 lahar originating from Mount Rainier is considered by scientists to be the most appropriate scenario for hazard mitigation planning. Case 1 lahars could be high in consequence and pose a major hazard to human life and property in the Nisqually River valley should the Alder and LaGrande dams fail. The Case 1 Lahar inundation area for Thurston County is shown on the map to the right.



Based on the Case 1 lahar scenario, properties along the Nisqually River Valley are the most susceptible to lahar inundation.

Population and Employment in the Hazard Area

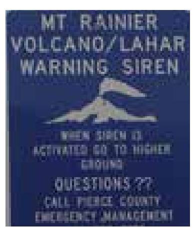
Presently, nearly 2,000 residents (0.7%) and 600 employees (0.4%) live and work in the Case 1 Lahar hazard area.

Residential Dwellings in the Hazard Area

Approximately 900 or 0.8% of the county's residential dwelling units are located in the lahar hazard area. By 2040, the number of dwelling units in the hazard area could increase to 1,000.

Inventory of Assets and Dollar Value in the Hazard Area

Nearly $59 million in residential, $5 million in commercial/industrial, and $6 million in government/institutional estimated property valuation is within areas at moderate to high risk.



For further information or to view the current "Hazards Mitigation Plan for the Thurston Region," visit www.trpc.org/hazards.

Thurston Regional Planning Council, 2016

A-17: Other Hazards Poster

OTHER HAZARDS

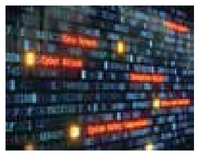
Other Hazards

Thurston County is subject to a variety of both natural and human-caused hazards. The following threats may impact the region, but are not profiled in detail in the Hazards Mitigation Plan.

Critical Shortage

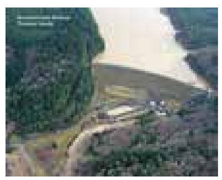
Critical shortages are the lack or reduction of essential goods or services due to a disruption in their supply. They are caused by events that occur elsewhere. These events could include embargoes, strikes, natural disasters, epidemics, crop failures, over exploitation of a natural resource, terrorist activities and political unrest. A fuel shortage would have a major impact to the region's economy.

Cyber-attack



A cyber-attack is an offensive maneuver against individuals or organizations that targets computer information systems, infrastructure, networks, or personal devices. These attacks attempt to disable operations, steal information, or hold systems ransom. They may be launched by nation states, criminal organizations, or hackers acting with malicious intent. Local government infrastructure such as signal controllers, water systems, and other utilities that are controlled remotely by computers may be at risk.

Dam Failure



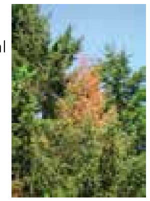
There are 38 dams in or adjacent to Thurston County. There are three dams classified as high hazard dams in the county, Alder and LaGrande Dams on the Nisqually River and the Skooumchuck Dam on the Skookumchuck River. The Dam Safety Office of the Washington State Department of Ecology rates each dam's downstream hazard classification. This classification provides a simple characterization of the downstream setting to reflect the general nature of consequences if the dam were to fail and release the reservoir into affected areas.

Downstream Hazard Classification of Thurston County Dams

Dam	Classification	Rating
Alder and Skookumchuck	1A	High – Greater than 300 lives at risk
LaGrande	1B	High – From 31 to 300 lives at risk
All others	3	Low – No lives at risk

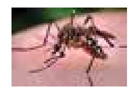
Dam failures can be caused by flooding or an earthquake, but most are caused by human error such as poor construction, operation, maintenance, or repair. The effects of a dam failure vary by dam, the amount of water stored behind it, stream flow conditions, and the size and proximity of the population downstream. Major dam failure may result in loss of life, destruction of homes and property, damage to roads, bridges, powerlines, and other infrastructure, loss of power generation and flood control capabilities, disruption of fish stock and spawning beds, and the erosion of stream and river banks. The Thurston County Hazard Inventory and Vulnerability Analysis report has assigned a low risk rating for dam failure.

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. Thurston County experienced drought conditions in 2015. While there were no major losses during this period, there were reports of some residential wells drying up and countless young trees died. Climate change projects for the Puget Sound Region indicate that longer, warmer, and drier summers will become more the norm by mid-century. Drought can destroy or lower crop yields, impact fish habitat, and increase risk for wildland fires.

Epidemic

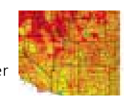


Epidemics are outbreaks of disease that may affect a significant portion of a population in a relatively short period of time. Although usually referring to a human contagious disease, epidemics can also affect domstic and wild animals as well as crops. Epidemic diseases are usually introduced into an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

Hazardous Material Incident

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 public property and the environment at risk from their inadvertent or intentional release. Local communities have little to no knowledge of when and what type of hazardous materials are being transported by highways or railroads through Thurston County.

Heat Wave



A heat wave is 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. Prolonged periods of extreme temperatures can result in heat injuries or dehydration for the young, elderly, and people who work outdoors.

Space Weather/Solar Wind/Geomagnetic Storm

The behavior and energy output of our nearest star, the Sun, varies according to a cycle that lasts around 11 years. A coronal mass ejection or other solar phenomena can release magnetic storms from the Sun that can severely disrupt and damage electrical distribution systems and devices on Earth. In March 1989, transformers at power stations in Canada were affected by a current surge that was induced by the changing magnetic fields at ground level. The surge led to power blackouts throughout Quebec that lasted for several hours, and the power company lost more than 21,500 megawatts of its production capacity. In addition, a transformer at a nuclear-power plant in New Jersey was damaged beyond repair as a result of the induced current.

Terrorist Attack

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. Bombings and mass shootings 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. Wave lengths may exceed sixty miles and travel 300-600 mph. They can be of local origin or originate from distant origins such as Alaska or Japan. Tsunamis are incredibly destructive. It is unlikely that Thurston County would be directly impacted by such a tsunami. The wave energy would be depleted by the time it reaches the South Sound. However the county could be indirectly affected by tsunami impacts to communities on the coast.

For further information or to view the current "Hazards Mitigation Plan for the Thurston Region," visit www.trpc.org/hazards.

Thurston Regional Planning Council, 2016

A-18: Plan Goals and Objectives Poster

VISION, GOALS AND OBJECTIVES

Vision: All sectors of the community work together to create a disaster resilient region.

Mitigation Goals and Objectives

The plan's goals are the overarching principles that communities will base their mitigation-decision-making upon. The objectives define actions or results that can be placed into measurable terms, and translated into specific assignments for implementation. Each objective fulfills an important role and is integral to the creation of more disaster resilient communities. The goals and objectives listed below are not prioritized and should be fulfilled concurrently.

1. Protect life

A. Design, build, operate, and maintain disaster resistant communication systems that provide emergency notifications and instructions.

B. Decrease the impacts of hazards on at risk individuals or special needs populations .

C. Address emergency evacuation needs, prioritizing areas of the community where mitigation strategies are ineffective or cost prohibitive.

D. Train and equip emergency service providers o effectively respond to hazard events.

2. Protect Infrastructure

A. Maintain and upgrade roads, bridges, and other transportation infrastructure and services to withstand the effects of hazards without prolonged disruptions to their operation.

B. Maintain and upgrade utility systems and services to withstand the effects of hazards.

C. Maintain or replace public buildings such as offices, schools, and other facilities to withstand the effects of hazards.

D. Strengthen or relocate critical facilities or create protective spaces or infrastructure around them so they are not significantly affected by the effects of hazards.

3. Protect property

A. Minimize the number of properties that are situated in hazard prone locations.

B. Protect and preserve vital records, data, information technology systems, and facility contents.

C. Safeguard objects or places that have cultural or historic significance.

4. Protect the environment

A. When possible, use mitigation strategies that preserve ecological functions of natural systems.

B. Consider mitigation actions that restore natural systems that provide protective measures to surrounding properties.

C. Evaluate the effectiveness of existing Critical Areas Ordinances and development regulations and revise them as necessary to ensure development does not occur in areas prone to hazards or changing environmental conditions that threaten public safety.

D. Support efforts to increase local jurisdictions' abilities to appropriately respond to hazardous material releases.

5. Sustain the economy

A. Develop and maintain efforts to prepare recovery plans.

B. Focus on mitigation strategies that protect medical treatment centers, employment centers, commercial districts, and schools.

C. Coordinate with regional, state, and federal agencies to identify and prioritize continuity of operations on lifeline transportation corridors and systems.

D. Strengthen public-private partnerships to reinforce or establish redundancy for critical supply systems.

E. Develop and maintain continuity of operations plans for essential public safety services.

6. Build community support

A. Coordinate and provide leadership in the hazard mitigation planning process among local, tribal, state, and federal government entities.

B. Engage residents, businesses, employers, medical centers, utility companies, subject matter experts, community, and faith-based organizations as partners to help identify opportunities to strengthen the region's hazard resilience.

C. Update the region's Hazards Mitigation Plan every five years, or sooner if necessary to respond to emerging threats.

7. Expand understanding of hazards

A. Monitor and evaluate precipitation, groundwater, stream flow levels, and survey flood high water marks.

B. Partner with state and federal agencies, colleges, universities, and non-governmental organizations to participate in modeling programs to map high risk hazard areas.

C. Participate in regional or statewide disaster scenario exercises to assess mitigation, preparedness, response, and recovery capacities and apply lessons learned to mitigation activities.

D. Develop a better understanding of the location and mitigation needs of vulnerable and special needs populations within the communities.

E. Document, share, and act on lessons learned following disaster events.

8. Implement effective mitigation strategies

A. Focus mitigation efforts on the region's greatest risks and vulnerabilities.

B. Integrate adopted mitigation strategies into other planning documents such as response plans, comprehensive plans, strategic plans, Critical Areas Ordinances, Capital Facility Plans, zoning codes, and development regulations.

C. Apply for federal mitigation assistance grants and leverage other funding sources to finance mitigation projects.

9. Increase public awareness

A. Develop and sustain ongoing communication campaigns with residents, customers, businesses, and other stakeholders about the known risks of hazard events and the actions that community members or organizations can take to prevent or minimize losses.

B. Conduct broad outreach activities to engage all sectors of the community in the hazards mitigation planning process.

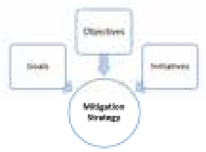
For further information or to view the current "Hazards Mitigation Plan for the Thurston Region," visit www.trpc.org/hazards.

A-19: Countywide Mitigation Initiatives Poster

COUNTYWIDE MITIGATION INITIATIVES

MITIGATION INITIATIVES

A mitigation strategy is central to reducing risks from the hazards that impact a community. The mitigation strategy is comprised of multiple actions, referred to as mitigation initiatives. When implemented, these initiatives will have a long-term sustained effect of neutralizing recurrent hazards and will reduce the loss of life and property, if implemented.



Countywide Mitigation Initiatives

There are 12 draft mitigation initiatives that reduce hazard risks countywide. Multiple stakeholders will be responsible for overseeing their implementation. The draft countywide initiatives are shown in order of priority in the table to the right.

Jurisdiction Initiatives

Each jurisdiction also identifies actions that are specific to their community. The implementation of these activities will be the responsibility of the jurisdiction that adopts them. These actions are listed in each participating jurisdiction's annex to the Hazards Mitigation Plan.

Priority	ID-Number	Category	Countywide Mitigation Initiatives
1	CW-MH 4	Hazard Damage Reduction	Create a lifeline transportation route GIS map for the Thurston region and integrate the data into the Thurston County Emergency Operations Plan and other local planning needs.
2	CW-MH 7	Hazard Preparedness	Develop interjurisdictional capabilities - to share critical resources during emergencies and natural disaster events.
3	CW-MH 6	Public Information	Develop a public information and outreach website, complementary printed materials, use social media, and convene community events to increase the awareness and participation in hazards mitigation for...
4	CS-FH 1	Data Collection and Mapping	Develop emergency evacuation routes, and update affected agencies comprehensive Emergency Management Plans for areas affected by potential catastrophic dam failure.
5	CW-SH 1	Hazard Preparedness	Improve the capabilities of disaster debris management.
6	CW-WH 1	Data Collection and Mapping	Map the region's high risk wildland urban interface communities.
7	CS-MH 1	Data Collection and Mapping	Continue to refine the list of the region's critical facilities and jurisdictional asset data and develop database to support hazard mitigation planning and emergency management.
8	CW-EH 2	Data Collection and Mapping	Improve the technical analysis of earthquake hazards in the county and integrate modeling capacity into emergency management work programs.
9	CW-MH 11	Data Collection and Mapping	Sheltering Facilities Assessment
10	CW-MH 9	Data Collection and Mapping	Map transportation infrastructure that is subject to frequent flooding or is prone to landslide hazards.
11	CW-MH 10	Plan & Coordination Implementation	Develop and adopt a Climate Adaptation Plan
12	CW-MH 8	Hazard Preparedness	Strengthen the capabilities of the Disaster Medical Coordination Center (DMCC) Hospital.

Mitigation Categories

Each mitigation initiative falls into one of seven categories described below.

1. **Public Information:** Information available in a variety of formats to inform community members, elected officials, property owners, and businesses about hazards and opportunities to mitigate them.
2. **Plan Coordination and Implementation:** Activities that support a jurisdiction's mitigation planning process and implementation strategy, internally and externally.
3. **Data Collection and Mapping:** Actions related to gathering and analyzing new data to improve decision making.
4. **Development Regulations:** Government administrative or regulatory actions to influence the way land is developed and buildings are constructed to protect people, property, and the environment.
5. **Hazard Preparedness:** Actions that protect people and property during and immediately after a disaster or hazard event.
6. **Hazard Damage Reduction:** Actions that involve the modification of existing buildings or structures to protect them from a hazard or remove or relocate them outside of the hazard area.
7. **Critical Facilities Replacement/Retrofit:** Refers specifically to hazard damage reduction activities targeted specifically at protecting or replacing critical facilities.

A-20: Draft Plan Comment Form

Thurston Region Hazards Mitigation Plan Update Comment Form

Please use this form to share your comments on the Hazard Mitigation Plan topics below.

Hazard Identification and Risk Assessment:

____

____

____

____

____

Mitigation Strategy (Goals, Objectives, and Initiatives):

____

____

____

____

____

Other Topics:

____

____

____

____

____

Your Name: ____

Organization or Affiliation: ____

For questions or comments about the Thurston Region Hazards Mitigation Plan, please contact:

Paul Brewster, Thurston Regional Planning Council, 360-741-2526 or brewstp@trpc.org.

The entire draft Hazard Mitigation Plan will become available online at www.trpc.org/hazards.

A-21: Open House Meeting Feedback and Evaluation Form

Open House Meeting Feedback and Evaluation

HAZARDS
MITIGATION PLAN
OPEN HOUSE

Thank you for attending today's meeting. Your feedback is important. Please take a moment to complete this questionnaire. Your responses will remain confidential.

1. Where do you live?

- ☐ Bucoda
- ☐ Lacey
- ☐ Olympia
- ☐ Rainier
- ☐ Tumwater
- ☐ Tenino
- ☐ Yelm
- ☐ Thurston County (outside of city limits)
- ☐ Nisqually Indian Reservation
- ☐ Confederated Tribes of the Chehalis Reservation
- ☐ Other____________________

2. How did you find out about today's meeting?

- ☐ Email
- ☐ Facebook/Twitter
- ☐ TRPC Website
- ☐ Newspaper
- ☐ Friend/Neighbor/Co-Worker
- ☐ Other____________________

3. Why did you attend the Open House?

____

____

____

4. Would you agree that you had adequate opportunity to participate today?

Strongly Agree	Agree	Neutral	Disagree	Strongly disagree
☐	☐	☐	☐	☐

5. Of the information presented at the open house, which did you find **most** useful?

____

6. Of the information presented at the open house, which did you find **least** useful?

____

7. Would you say the amount of time available to review the information at the meeting was:

Too long	Just right	Not enough
☐	☐	☐

8. Is there anything else you want to comment on about today's meeting?

____

____

____

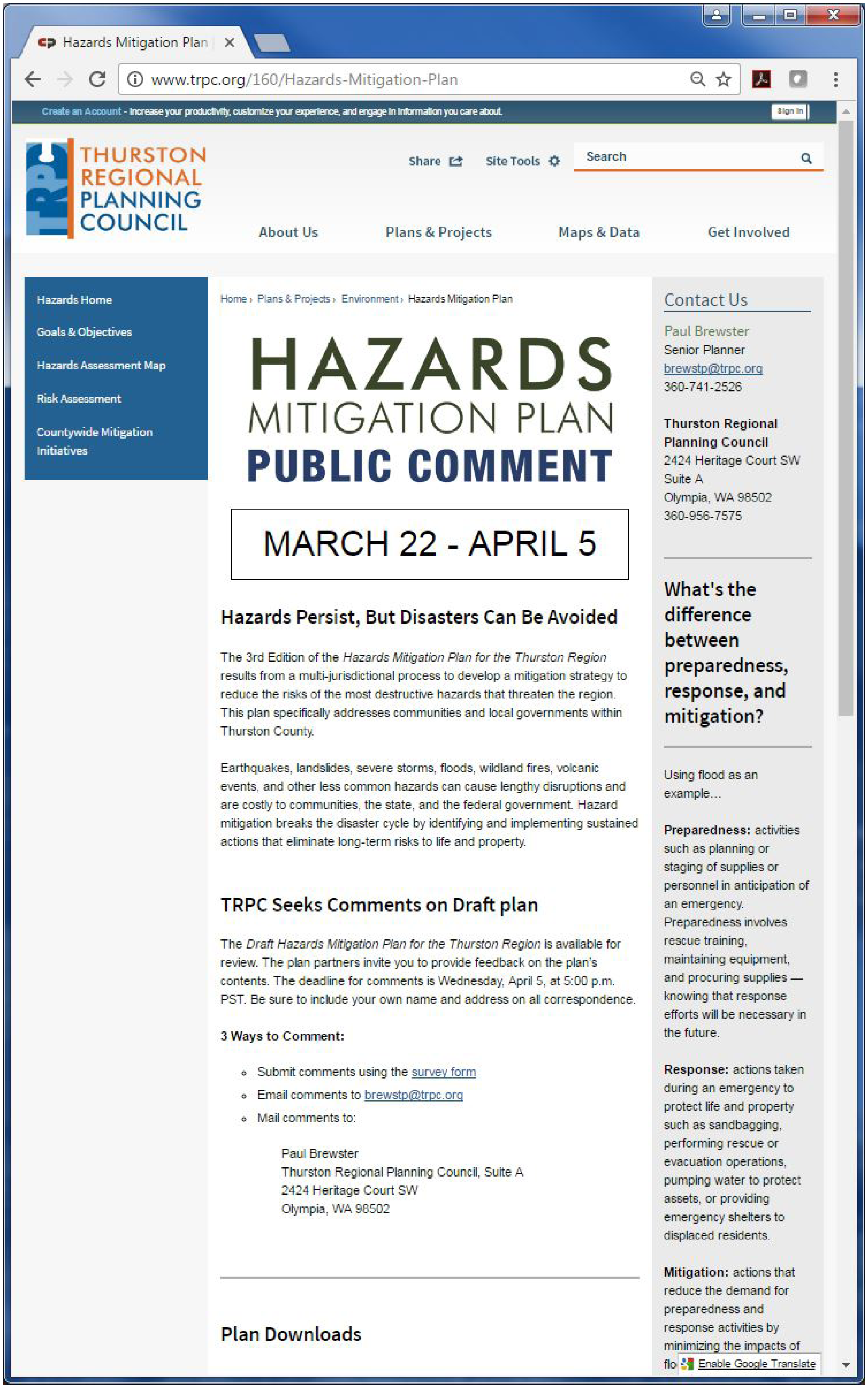
____

____

Thank you for sharing your responses with us.

Thurston Regional Planning Council. www.trpc.org/hazards

A-22: Project Website



Hazards Mitigation Plan

www.trpc.org/160/Hazards-Mitigation-Plan

Create an Account - Increase your productivity, customize your experience, and engage in information you care about.

Sign In

THURSTON REGIONAL PLANNING COUNCIL

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- Hazards Assessment Map
- Risk Assessment
- Countywide Mitigation Initiatives

Home › Plans & Projects › Environment › Hazards Mitigation Plan

HAZARDS MITIGATION PLAN PUBLIC COMMENT

MARCH 22 - APRIL 5

Hazards Persist, But Disasters Can Be Avoided

The 3rd Edition of the *Hazards Mitigation Plan for the Thurston Region* results from a multi-jurisdictional process to develop a mitigation strategy to reduce the risks of the most destructive hazards that threaten the region. This plan specifically addresses communities and local governments within Thurston County.

Earthquakes, landslides, severe storms, floods, wildland fires, volcanic events, and other less common hazards can cause lengthy disruptions and are costly to communities, the state, and the federal government. Hazard mitigation breaks the disaster cycle by identifying and implementing sustained actions that eliminate long-term risks to life and property.

TRPC Seeks Comments on Draft plan

The *Draft Hazards Mitigation Plan for the Thurston Region* is available for review. The plan partners invite you to provide feedback on the plan's contents. The deadline for comments is Wednesday, April 5, at 5:00 p.m. PST. Be sure to include your own name and address on all correspondence.

3 Ways to Comment:

- Submit comments using the survey form
- Email comments to brewstp@trpc.org
- Mail comments to:

Paul Brewster
Thurston Regional Planning Council, Suite A
2424 Heritage Court SW
Olympia, WA 98502

Plan Downloads

Contact Us

Paul Brewster
Senior Planner
brewstp@trpc.org
360-741-2526

Thurston Regional Planning Council
2424 Heritage Court SW
Suite A
Olympia, WA 98502
360-956-7575

What's the difference between preparedness, response, and mitigation?

Using flood as an example...

Preparedness: activities such as planning or staging of supplies or personnel in anticipation of an emergency. Preparedness involves rescue training, maintaining equipment, and procuring supplies — knowing that response efforts will be necessary in the future.

Response: actions taken during an emergency to protect life and property such as sandbagging, performing rescue or evacuation operations, pumping water to protect assets, or providing emergency shelters to displaced residents.

Mitigation: actions that reduce the demand for preparedness and response activities by minimizing the impacts of flo

Enable Google Translate

A-23: The Olympian News Article for Draft Plan

POLITICS & GOVERNMENT MARCH 31, 2017 6:29 PM

Local officials outline ways to minimize impacts of earthquakes and other hazards

BY LISA PEMBERTON
lpemberton@theolympian.com

Earthquakes, floods and ice storms are hazards that can't be stopped.

But with the right planning, those events don't have to cripple communities and turn into disasters, local emergency management officials say.

A new, nearly 400-page document outlines the top emergency hazards and how local officials plan to minimize their damage.

The Hazards Mitigation Plan for the Thurston Region was prepared by the Thurston Regional Planning Council, and is under review for public comment through Wednesday afternoon. A work group of nearly 30 emergency response representatives from Thurston County's cities and towns, tribes, school districts, fire districts and other groups worked for the past two years to develop the plan.

Local governments also worked together on hazards mitigation plans in 2003 and 2009.

"Our first two plans were somewhat more response and preparedness orientated," said Paul Brewster, a senior planner with Thurston Regional Planning Council, which represents 21 jurisdictions and organizations in the area. "The whole point of mitigation is to prevent the disaster from occurring in the first place, and minimizing the impact."

Thurston County has the fifth-highest rate of federal disaster declarations in the state. Between 1965 and 2016, the county received 22 federal declarations, including ones tied to a 6.7 magnitude earthquake that rocked the Puget Sound region on April 29, 1965, the eruption of Mount St. Helens on May 18, 1980, and the 6.8 magnitude Nisqually Earthquake on Feb. 28, 2001.

The most recent declaration was in 2012 when a winter storm buried Thurston County in a foot of snow and ice.

In 2014, Thurston County was awarded nearly $60,000 in grants to update the hazards mitigation plan, and that amount was matched by the county in staff time and resources, according to Brewster.

The plan is designed to keep South Sound communities from having to issue future federal disaster declarations, which are used to free up money for recovery efforts, according to Andrew Kinney, emergency management coordinator for Thurston County. The plan defines mitigation as actions that reduce the demand for preparedness and response activities, such as elevating or removing structures in areas that are prone to flooding or regulating future development in those areas.

“The whole point of the plan is to break that disaster cycle,” Brewster said.

Many activities in the plan continue efforts outlined in previous editions, such as a remapping of flood plains for all rivers, streams and high groundwater areas in the region.

Two new activities proposed in the plan are designed to help prevent potential harm after an event. They include training county engineers to conduct seismic evaluations for bridges after an earthquake to determine safety levels and developing a plan to address medical needs of people who rely on electricity-powered medical equipment, such as motorized scooters and dialysis machines.

Each participating municipality or district that participated created their own annex, or local plan, and “should be conducting their own public outreach process on their initiatives before they adopt it,” Brewster said.

The regional plan covers work that will be done over the next five years to protect lives, infrastructure, property and the environment during future hazards. It mixes history with the latest science and technology to identify hazard areas and predict potential impacts.

People can view the plan at www.trpc.org.

One of the outcomes of a past mitigation plan is AlertSense, a new community notification system, Kinney said. People can subscribe to the system to get emergency alerts on river flooding, extreme storms and other hazards. Officials can also use the system to send notifications to mobile devices in certain areas of the county, even if they don’t subscribe to the system.

But there’s much more work that can be done to improve communications during a disaster, Kinney said.

“There are still pockets in the county that you can only reach by landline,” he said.

In addition, the hazards mitigation plan is only one portion of keeping disaster at bay, Kinney said. Emergency preparedness also saves lives when hazards strike, he said.

Lisa Pemberton: 360-754-5433, @Lisa_Pemberton

PROVIDE INPUT

Community members are invited to review and provide feedback on the most recent edition of the Hazards Mitigation Plan for The Thurston Region through 5 p.m. Wednesday. View the plan at www.trpc.org.

MORE POLITICS & GOVERNMENT

SUGGESTED FOR YOU

A-24: Legal Notice for Draft Plan

#3086

NOTICE OF PUBLIC REVIEW AND COMMENT ON DRAFT HAZARDS MITIGATION PLAN FOR THE THURSTON REGION

NOTICE IS HEREBY GIVEN THAT in accordance with the Code of Federal Regulations 44 Part 201.6 and the Disaster Mitigation Act, Thurston Regional Planning Council invites all interested stakeholders to review and comment on the Draft Hazards Mitigation Plan for the Thurston Region. This plan was prepared through the cooperative effort of local governments in Thurston County. The plan contains proposals to mitigate the effects of natural hazards.

The public review and comment period ends at 5:00 p.m. on April 5, 2017. The plan is available online at www.trpc.org/hazards.

Please submit all comments in writing to Thurston Regional Planning Council, 2424 Heritage Court SW, Suite A, Olympia, WA 98502. Be sure to include your name and address on all correspondence.

For more information contact Paul Brewster at brewstp@trpc.org or (360) 741-2526.

If you need special accommodations to participate in this process, please call us at 360-956-7575 by 5:00 p.m. Ask for the ADA Coordinator. For TDD users, please use the state's toll-free relay service, (800) 833-6388, and ask the operator to dial 360-956-7575. Arrangements can be made to review and comment in other languages.

THURSTON REGIONAL PLANNING COUNCIL

Publish: March 29, 2017

A-25: Public Comments

Public Comments Received March 22 to April 5, 2017

March 23, 2017, Pete Kmet

Overall, great job on this plan. I have only a few minor comments.

Page 2.0-22, Priority 10 or 12. Recommend this be expanded to assess the earthquake vulnerability of bridges.

I'm not sure where to add this, but I also think we should consider assessing critical components of our water and sewer infrastructure systems for potential earthquake damage and whether relocation or upgrades are necessary. For example, water storage tanks and water supply pumping facilities, key sewerage lift stations and mains (I'm assuming LOTT has assessed its facilities). These assessments could be done as our water and sewer plans are updated. This be a qualitative analysis, at least initially, to keep costs down.

I continue to remain concerned that we have significant power outages whenever we have a modest storm event and typically at least one major power outage every storm season. I realize there are UTC limitations on PSE paying for undergrounding but these outages are not only inconvenient, they affect our commerce and could be critical should an earthquake coincide with these events. At a minimum, we should ask PSE to provide us with information to map locations where powerlines have been severed and the cause of these breaks. Where there are segments with frequent breaks, we should ask the UTC to direct them to develop a plan to address these problem segments.

Page 3.0-21. I'm not sure the purpose of this list but if you want to be complete, there are also Lake Management Districts. For example, in Tumwater, we have the Barnes Lake Mgt. District.

Page 3.1-2. 2nd paragraph. In 2016, Tumwater has also updated our flood control ordinance and adopted the new maps for the Deschutes River.

Page 3.1-9. The Oregon Spotted frog is also a listed species for our area. There are several others as well in our area but the ones identified (plus the frog) are probably the most relevant ones. As far as I know, only Tumwater (in partnership with the Port) and Thurston County are currently preparing HCPs, not "all affected jurisdictions". Tumwater has also updated our flood ordinance to reflect changes required by the federal government to address certain endangered fish species.

Page 3.1-16. Tumwater has updated our Comprehensive Plan and it has been accepted by Commerce. While I think there is one more administrative step in the adoption process, we should be done by the time this plan is finalized.

Page 3.1-18. It might be helpful to list the status of the WRIA plans here. My understanding is that the Deschutes WRIA plan has never been brought to a conclusion, for example. I'm not sure of the status of the other WRIA plans. It's misleading to list them as if these are ongoing.

Chapters 4.0 through 4.6. These Chapters represent a significant amount of work and I appreciate the effort here. Recognizing that the City boundaries are a moving target as we annex areas, and would be a major effort to update the work here, I recommend you add a note to all tables and maps indicating what date these represent. You may also want to add a statement to the Chapter 4.0 that the facility numbers and estimates of damage are planning level estimates, as one could get the impression these values are more precise than they really are.

Chapter 4.1. See my comments above about earthquake vulnerability.

Chapter 4.5. Should probably state here somewhere that Lacey, Olympia and Tumwater (effective 2018) have banned personal fireworks, helping reduce that risk.

March 24, 2017, E.J. (Ed) Pole II

Forcing someone to download multiple small PDF files to review the plan is extremely inconvenient. There should be a link to download the entire plan in one scannable PDF. file. It is almost as if you really don't want comments.

March 25, 2017, Michelle Underwood

[Page] 4.3-13

Replace Department of General Administration with Department of Enterprise Services.

Thank you

March 26, 2017, Paul Froehlich

Given the housing situation in Thurston County, many of us have no choice but to live in neighborhoods with Homeowners Associations. Many HOAs have highly restrictive covenants on antennae which amateur radio operators could use to help with communication after a disaster. Local government could encourage HOAs to allow amateur radio antennae, as well as rain barrels and solar panels (dare I add "Victory Gardens" with backyard chickens?).

March 27, 2017, Michelle Zenner

I'm not finished reading the entire plan. I hope I'm not limited to "one comment".

Tacoma Power has not been taken to task for dam EAP - Emergency Action Plan with regards to dam release or flooding & #CascadiaEQ .

Chapter 4.4-6   First paragraph, line 3 - date descrepancy should be 2014 regarding #OsoSlide, but the following page had the correct year in heading.

Tacoma Power's peers (if that can be said of PGE) have "at least" provided disaster preparedness links. Although, Red Cross, isn't my first pick for a disaster preparedness link. Tisk tisk #TacomaPower Who is responsible for getting the EAP? FERC Federal Energy Regulatory Commission or WA AGO with WA RCW creation that specifies privately owned dams in WA state must provide EAP? How about the Governor's new commission on resiliency? Good Luck.

April 2, 2017, David Knoblach

I like the idea of the mitigation plan very much. I apologize that these quick notes are not well written. But here are some ideas and quick comments about improving the presentation of the mitigation plan. 4.1-1: The stated fact of 5300 historic earthquakes in Thurston county does not apply as useful information because nearly all of these were not felt and caused no damage. No one can feel a 2.0 magnitude earthquake and few people can feel a 4.0 earthquake. Damage here generally is relatively minimal until the earthquake magnitude approaches the 6.0 range (unless it is a shallow quake). The New Yorker article was great for increasing awareness, but had significant flaws stating everything west of I-5 would be "scraped off the map" in a big earthquake. That statement is misleading and not true. My opinion it is best to inform people without providing unnecessary exaggeration or including information that doesn't apply, or is too technical to be useful--like I noted in the above examples.

4.1-2: again the earthquake map shown is hard for most people to interpret since most earthquakes plotted are nonevents that were not even felt by people. There is too little information there to help people interpret the meaning of the map.

4.1-3: strike-slip, reverse, and thrust fault terms are not defined well in the publication and is not needed for the public. These terms are too complex and most people are fine with just “earthquakes” or simple terms like “deep” or “shallow” earthquakes, without confusing them with jargon terminology.

4.1-4: the attempt to explain magnitude is important but I think this is too complex and nebulous for most people. You should couple general damage on the Richter scale with general examples from the Mercalli scale. Example: magnitude 4 and below = generally not felt and no damage and no injuries. Magnitude 5 felt by everyone but generally no severe damage or many significant injuries. Magnitude 6: potential significant damage to localities containing buildings with poor construction, unstable slopes, unstable subsurface sediment, and with localized injuries and has potentials of death in some areas to dozens of people. Plus similar information for stronger quakes.

4.1-5: ground accelerations maybe a bit too complicated on the first half of the description but the second half is more useful and meaningful to understand.

4.1-6: good map but more interpretation is needed. Should include information that localities with unstable slopes and soft lowland areas along beaches, valley bottoms may receive significantly more severe shaking than nearby areas of known hard-packed soils from glacial times.

4.1-7: informative page, perhaps should be integrated more directly with previous Richter scale information covered earlier.

4.1-8 to 4.1-12: the technical names for the different types of earthquakes maybe too much here, and are poorly defined in the text. The map is good but should contain more information for people to interpret correctly. The information in the following pages has some excellent information but also gets too technical in some places with jargon. Most people just want to know what can happen, and too much technical information can get too confusing and overwhelming, and the key message can get lost in too much jargon and technical details. I would provide the shake maps on 4.1-8 with additional scenario maps for a subduction and shallow earthquakes and have separate explanations for each of these scenarios.

4.1-12 to 4.1-15: Listed effects of earthquakes and impacts are good--although a bit too technical in areas. The debris destruction information is interesting but not really well interpreted. People want to know how much damage, and deaths, and time to recover from such events. Even smaller earthquakes can cause potential damage to houses from loosening siding to open routes to cause future interior water damage from rain. People want to know general potentials of time disruptions for roads, the port, schools, and key services, and things that could affect them and their families. For example a strong earthquake could destroy the port and would cause loss of port business for many years. A subduction earthquake could kill 15,000 people in the entire region that includes Thurston county, but most people would survive just fine. However emphasis on personal preparation would make a big difference regarding initial recovery. Without preparation many people may have to leave the area to receive proper services of food and shelter. Two weeks of food should be emphasized. The tables that follow, on the other pages in this report, are good technical specifications for civil planning, but general statements are best for average people to understand an earthquake related to them.

Landslides: missing information of the large landslide near Salmon Beach in Tacoma that happened shortly after the 1965 earthquake. Should note tsunami potential in Puget Sound for local shallow earthquakes.

Volcanoes: the Election mudflow may have been triggered by an earthquake or just started spontaneously. Little warning would happen from a similar event, compared to a lahar triggered from a volcanic eruption.

Again, I apologize about these rather hasty notes. But if there is some interest in these comments I would be glad to chat with someone on your team. I'm teach geology at SPSCC.

April 5, 2017, Bob Jacobs

Hi Paul --

This is my official comment on the draft plan. Just under the wire -- better late than never.

General Impression

This is an amazing piece of work. You and your team have compiled a much more detailed and informative report than I would have expected. And it is very readable and nearly free of typos. Congratulations to all.

My Focus

My primary interest is the risks of earthquake damage in our county, esp. the risks of subduction zone earthquakes. This is because this is by far the biggest risk we face here. And as an expert has pointed out, a single subduction zone earthquake would be more dangerous for us that all the U.S. hurricanes and tornadoes put together -- due to the large area involved and the extensive damages that will occur to vital infrastructure -- termed "lifeline systems" on page 4.1-22).

Detailed comments (not in priority order)

1. Under the goal of protecting property, (item 3.A, page 2.0-2), the plan calls for minimizing the number of properties that are situated in hazard prone locations. Unfortunately, the city of Olympia has been doing the opposite -- encouraging lots of development (residential development, at that) -- in downtown areas that are at the highest risk of liquefaction. I have to question the value of planning like this when the local governments clearly are not complying. And by the way, Tumwater's plans for densifying the I-5/ Capitol Boulevard corridor with dense housing have the same problem.

2. Public education about risks is listed as an important goal on pages 2.0-4,-5, -9, -15 and 2.0-9. I agree strongly. However, this is one area where all of the jurisdictions in the county, to my knowledge, have fallen down badly. Our local public officials seem unwilling to "tell it like it is". When people are not prepared -- mentally as well as physically -- survival and recovery will be far worse. If the Big One happened today, there would be nearly universal shock and bewilderment among our county's population because very few people really understand the dangers we face. It is imperative that our public officials start telling the truth on this topic, so that the public can be physically and mentally prepared. And it is also imperative that serious survival planning be started by our local governments.

3. The more I learn about subduction zone quakes -- the terrible immediate damage, the hundreds of aftershocks (some strong enough to do more damage), the inability to restore basic infrastructure for long periods), the more I am convinced that many people will want to evacuate, at least for a period. I suggest that evacuation planning be added as an alternative in the subduction zone earthquake scenario.

4. I suggest that maintenance of communications facilities for cell phones and email after a subduction zone quake be given very high priority. It will be most important for everyone to be able to share information about viable transportation routes, water supplies, food supplies, fuel supplies, medical assistance, etc. These cannot be known in advance, especially transportation routes.

5. After page 4.1-18, I strongly suggest that a section be added about recovery times. Available documents indicate that recovery of basic utilities can take up to several years. Transportation facilities can take longer. And these times could be underestimated if they do not take into account the vast area potentially destroyed -- northern California to British Columbia -- which implies both a huge job and difficulty in getting assistance from outside.
6. In the economy section, page 3.0-5, the report repeats the common misperception that increased economic diversity would make our area more resistant to recessions. That is a good general rule, but one that does not apply universally. Olympia's government-based economy is an exception, along with university towns, etc. This section of the report also suggests that we should increase local employment, which would increase our population, but not our economic stability (as explained above), nor our economic welfare. It would just increase our taxes. I suggest that this verbiage be removed from the report.

I trust that these comments will be helpful in improving an already-excellent document.

April 5, 2017, Henry Cervantes

Chapter 4, under Hazard Identification, on page 4.0-8, "Epidemic" is identified. Although FEMA does not require inclusion of bio-hazards the WA State Hazard Mitigation Plan, dated Nov 2012 includes a Hazard Profile on "Communicable Disease Outbreaks, Epidemics, Pandemics". This is something you may want to add to the Thurston plan.

Chapter 3, under Regional Planning you may want to add the Thurston County Public Health and Social Services, the Region 3 Healthcare Preparedness Coalition, the Homeland Security Region 3, Thurston County Chamber of Commerce, Providence Saint Peter Hospital, Capital Medical Center and Group Health Olympia Medical Center as planning partners. Chapter 3, under Comprehensive Plans, you may want to add the Thurston County Hazard Identification and Vulnerability Assessment (HIVA) as a resource document.

The plan is well organized and written, and should meet FEMA's requirements.

Appendix B

Hazards Mitigation Workgroup and Plan Partner Forms & Templates

The Hazard Mitigation Plan Workgroup and plan partners were supplied a variety of forms and tools to evaluate their mitigation strategy and compose their annex. Appendix B includes samples of these materials.

- B-1: Hazard Problem Statement Form
- B-2: Mitigation Evaluation (Benefit/Cost Review) Form
- B-3: Mitigation Initiative Template Instructions
- B-4: Mitigation Initiative Template
- B-5: Countywide Mitigation Initiatives Prioritization Survey

B-1: Hazard Problem Statement Form

Thurston Hazards Mitigation Plan Problem Statement and Alternative Mitigation Actions Worksheet

1. **Define the problem (the effect of a particular hazard on the community)**

Example: *In wildland-urban interface areas, two critical facilities (a school and a county maintenance shop) and $500 million in property value are at risk, and there is increasing development pressure.*

2. **Identify 2-3 possible actions (mitigation initiatives) to overcome the problem**

Examples:

a. Adopt a wildfire mitigation code
b. Retrofit school and maintenance shop with fire-resistant materials
c. Implement a Firewise Program to educate property owners

Alternative 1:

Alternative 2:

Alternative 3:

B-2: Mitigation Evaluation (Benefit/Cost Review) Form

Thurston Region Hazards Mitigation Plan - Mitigation Evaluation Worksheet

Hazard Being Addressed:

Describe the vulnerability your community needs to overcome:

Scoring Criteria

2 Great benefits/highly effective or high chance of implementation
1 Moderate effectiveness or good chance of implementation
0 Not applicable or neutral
-1 Not effective or challenging to implement
-2 Could cause indirect adverse effects or is very difficult to implement

Mitigation Action	Life Safety	Property Protection	Technical	Political	Legal	Environmental	Social	Administrative	Local Champion	Other Community Objectives	Total Score
Example: Implement a Firewise Program	*1*	*1*	*2*	*2*	*1*	*0*	*2*	*1*	*2*	*2*	*14*
Public Outreach and Information											
1											0
2											0
3											0
Plan Coordination and Implementation											
1											0
2											0
3											0
Data Collection and Mapping											
1											0
2											0
3											0
Development Regulations											
1											0
2											0
3											0
Hazard Preparedness											
1											0
2											0
3											0
Hazard Damage Reduction											
1											0
2											0
3											0
Critical Facilities Replacement/Retrofit											
1											0
2											0
3											0

B-3: Mitigation Initiative Template Instructions

Hazard Mitigation Initiatives Form Instructions

Prioritization

The mitigation initiatives are prioritized by the individual jurisdictions based on the conditions and needs of each community. They should be ranked according to their overall benefit and their relationship to the plan's goals and objectives. FEMA does not require a numeric rating. They could be ranked high, medium, or low. They could be ranked as tier 1, tier 2, etc.

Category

Every mitigation initiative is categorized according to the type of mitigating function it provides. Seven mitigation initiative categories were identified in the original plan and remain the same as follows:

1. **Public Outreach and Information**: Information delivered in a variety of formats intended to inform and educate community members, elected officials, and property owners about the hazards and potential ways to mitigate them. Such actions include websites, outreach projects, real estate disclosure, fairs and expos, and school-age and adult education programs.

2. **Plan Coordination and Implementation**: Activities that support a jurisdiction's hazards mitigation planning process and implementation strategy within their organization and in conjunction with neighboring jurisdictions and relevant stakeholders.

3. **Data Collection and Mapping**: Actions that relate to the process of gathering and analyzing new data and then mapping or utilizing the information in such a manner that it improves communities' ability to make informed decisions about increasing their disaster resilience.

4. **Development Regulations**: Government administrative or regulatory actions or processes that influence the way land and buildings are developed and built. These actions also include public activities to reduce hazard losses. Examples include planning and zoning, building codes, capital improvement programs, open space preservation, and storm water management regulations.

5. **Hazard Preparedness**: Advance actions that serve to protect people and property during and immediately after a disaster or hazard event. These could include the development or improvement of warning systems, emergency response services, and the stockpiling of supplies and materials.

6. **Hazard Damage Reduction**: Actions that involve the modification of existing buildings or structures to protect them from a hazard, or removal from the hazard area.

Examples include acquisition, elevation, relocation, structural retrofits, storm shutters, and shatter-resistant glass.

7. **Critical Facilities Replacement/Retrofit**: Refers specifically to hazard damage reduction activities targeted specifically at protecting or replacing critical facilities.

Mitigation Initiative Format

A mitigation initiative form is provided so every jurisdiction can document their mitigation initiatives consistently. A brief description of each input field is described below.

Priority: the current ranking of the mitigation initiative as assigned by the jurisdiction, for example 1 of 10. If an initiative was completed or removed, a ranking is not applicable and is shown as “N/A”

Status: “New” refers to a mitigation initiative newly created as part of the plan update process; “existing” refers to an unfinished initiative that is carried over from previous Hazards Mitigation Plans, or imported from another planning document; “modified” refers to an existing initiative that carried over from the previous plan, but has been modified to suit current need (a revised scope); “completed” refers to an initiative that was successfully fulfilled; and “removed” refers to an initiative that is no longer considered relevant or is replaced by another initiative.

Hazard Addressed: refers to the specific hazard, profiled in the risk assessment that the mitigation
initiative addresses, for example “earthquake,” or “multi-hazard.”

Category: refers to one of the seven function mitigation categories identified above, for example,
“data collection and mapping.”

Mitigation Initiative Identification Number: this refers to the unique administrative code of each mitigation initiative. The unique code allows local agencies and plan reviewers to monitor the progress of each initiative through its lifecycle. The codes from previous plans will be carried over as appropriate. The convention of the identification number is as follows:

Agency Code + Hazard Category Code + Sequential number.

Title: a brief description of the action to be taken.

Rationale: a statement of justification as to why the mitigation initiative is necessary.

Relates to Plan Goal(s) and Objectives: refers to the specific goal(s) and objective(s) that the mitigation initiative supports.

Implementer: refers to the agency department or title of the staff member responsible for implementing the initiative.

Estimated Cost: refers to the current estimated cost of the initiative.

Time Period: refers to when the agency believes it will be able to accomplish the initiative. For example, 2012 or 2025.

Funding Source: refers to the anticipated source of revenue that will be used to fund the initiative.

Source and Date: refers to an agency document from which an initiative may have been originally identified. For example, "2003 Natural Hazards Mitigation Plan for the Thurston Region."

Adopted Plan Number: refers to the identifier of the initiative within the sourced adopted document.

Reference Page: refers to the page which the initiative can be found in the adopted document.

Implementation Status: a narrative assessment of the progress made on the initiative.

B-4: Mitigation Initiative Template

Priority: Number **of** Total **Status:** Select one.

Agency Code-Hazard Category Code Sequential Number**:** Title: The title should be a brief, but descriptive explanation of the action to be taken. Type it here or copy from the previous plan or another source.

Hazard Addressed: Hazard Type
Category: Category

Rationale: This is a statement of justification for why the mitigation initiative is necessary. A brief narrative should include a problem statement (what is the real or potential impact from the hazard?) A description of how the action will mitigate the problem should also be included.

Relates to Plan Goal(s) and Objectives: Identify relevant planning goals and objectives that the mitigation initiative will support. These are the mitigation goals and objectives located in Chapter 5. Example, 1A, 1B.

Implementer: Enter the department or lead position of the staff member responsible for implementing the initiative.

Estimated Cost: Enter the approximate dollar amount of the cost to implement the action, i.e. $450,000. If unknown, state reason the cost is unknown. If the initiative is a carry-over from the original plan, do the cost estimates require updating? If so, enter new cost estimate.

Time Period: Enter the estimated timeline when the initiative will be accomplished. For example, 2016 or 2025. If it was completed since the last plan, state the month and year the initiative was completed. If the initiative is a carry-over, update the new estimated timeline for completion.

Funding Source: Describe the sources of revenue that will be used to finance the initiative. If a carry-over initiative, consider a new funding source, if appropriate.

Source and Date: Refers to an agency document from which an initiative may have been originally identified. For example, Natural Hazards Mitigation Plan, Thurston County 1999 Flood Hazard Management Plan. Include Capitol Facility Plans, Storm Water Utility Plans, etc. If not applicable, please enter N/A.

Adopted Plan Number: Refers to the identifiers of the initiative within the adopted document. If not applicable, please enter N/A.

Reference Page: Refers to the identifiers of the initiative within the adopted document. If not applicable, please enter N/A.

Initiative and Implementation Status: Explain the status of this action item if it carries over from the last plan, was modified, or was completed. If new, enter “New”.

B-5: Countywide Mitigation Initiatives Prioritization Survey

Prioritizing the Countywide Hazard Mitigation Initiatives

Survey Participant Information

Name

Agency

The following Countywide Hazard Mitigation Initiatives are listed in the order they were ranked in the 2009 Hazard Mitigation Plan for the Thurston Region. A copy of the draft initiatives was sent by email to the survey participants. Please prioritize each initiative with a unique rank from 1 (highest priority) to 11 (lowest priority). No two initiatives can have the same rank.

Initiative	1	2	3	4	5	6	7	8	9	10	11
1 of 11, CW-MH 4, Hazard Damage Reduction - Create a lifeline transportation route GIS map for the Thurston region and integrate the data into the Thurston County Emergency Operations Plan and other local planning needs.	○	○	○	○	○	○	○	○	○	○	○
2 of 11, CW-MH 7, Hazard Preparedness - Develop interjurisdictional capabilities to share critical resources during emergencies and natural disaster events.	○	○	○	○	○	○	○	○	○	○	○
3 of 11, CW-SH 1, Hazard Preparedness - Improve the capabilities of disaster debris management.	○	○	○	○	○	○	○	○	○	○	○
4 of 11, CS-FH 1, Data Collection and Mapping - Develop emergency evacuation routes, and update affected agencies comprehensive Emergency Management Plans for areas affected by potential catastrophic dam failure.	○	○	○	○	○	○	○	○	○	○	○
5 of 11, CW-MH 6, Public Information - Develop a public information and outreach website, complementary printed materials, use social media, and convene community events to increase the awareness and participation in hazards mitigation for...	○	○	○	○	○	○	○	○	○	○	○
6 of 11, CW-WH 1, Data Collection and Mapping - Map the region's high risk wildland urban interface communities.	○	○	○	○	○	○	○	○	○	○	○
7 of 11, CS-MH 1, Data Collection and Mapping - Continue to refine the list of the region's critical facilities and jurisdictional asset data and develop database to support hazard mitigation planning and emergency management.	○	○	○	○	○	○	○	○	○	○	○

1

1	2	3	4	5	6	7	8	9	10	11

8 of 11, CW-EH 2, Data Collection and Mapping - Improve the technical analysis of earthquake hazards in the county and integrate modeling capacity into emergency management work programs.

9 of 11, CW-MH 8, Hazard Preparedness - Strengthen the capabilities of the Disaster Medical Coordination Center (DMCC) Hospital.

10 of 11, CW-MH 9, Data Collection and Mapping - Map transportation infrastructure that is subject to frequent flooding or is prone to landslide hazards.

11 of 11, CW-MH 10, Plan & Coordination Implementation - Develop and adopt a Climate Adaptation Plan

The results of this exercise will be shared with the Hazard Mitigation Workgroup Members.

Appendix C

Risk Assessment Data Sources and Methodology

Planning partners used a variety of data sources to analyze risk and develop the hazard profiles for the Risk Assessment in Chapters 4.1 through 4.6. Thurston Regional Planning Council's (TRPC) Geographical Information System (GIS) supported creation of the hazard exposure analysis for addressing the portion of the region's affected area, population, employment, residential dwellings, valuation, and essential facilities for Thurston County jurisdictions.

Image courtesy of the Association of Bay Area Governments

Parcel Data – Estimates of Building Value

For all assets, other than those owned and maintained by participating jurisdictions, the plan assumes replacement building value as equivalent to assessed building value. The Thurston County Office of the Assessor (2014 assessment) provided tax-parcel level valuations. The Assessor does not perform assessments for non-taxable structures, such as state and federal government owned buildings. The plan partners and other stakeholders supplied additional valuation data for publicly owned buildings with their essential facilities data.

Building Contents – Estimates of Value

For all assets other than those owned and maintained by participating jurisdictions, the plan estimates building contents value based on general criteria defined for HAZUS-MH, a GIS hazard modeling tool. Each building in Thurston County is categorized based on its occupancy class, and building contents value is estimated as a percentage of the building replacement value based on that class.

Table C-1: Contents Valuation Classification

Occupancy Class	Contents Value % 1
Residential (including temporary lodging, dormitory, and nursing homes)	50
Commercial (including retail, wholesale, professional, services, financial, entertainment and recreation)	100
Commercial (including hospitals and medical office/clinic)	150
Commercial Parking	50
Industrial (including heavy, light, technology)	150
Agriculture	100
Religion/Non-Profit	100
Government Emergency Response	150
Government General Services	100
Education Schools/Libraries	100
Education Colleges/Universities	150

[1]Note: Contents are calculated as a percentage of a building's replacement value.

Hazard Data Sources

Thurston County, Washington State Departments of Natural Resources and Ecology, the United States Geological Survey, the Federal Emergency Management Agency (FEMA), and others contributed spatial hazard data. Table C-2 lists the hazard data sources used to support the plan's risk assessment.

Table C-2: Spatial Hazard Data Sources

Spatial Data	Source
Special Flood Hazard Areas • 100-Year Plain • 500-Year Floodplain • Coastal Flood Zones High Groundwater Hazard Area	2012 Thurston County DFIRM and Deschutes River SFHAs (adopted 2016). Thurston County High Groundwater Hazard Area.
Liquefaction Data	Washington State Department of Natural Resources Open File Report 2004-20: Liquefaction Susceptibility and Site Class Maps of Washington State, by County, Stephen P. Palmer, Sammantha L. Magsino, Eric L. Bilderback, James L. Poelstra, Derek a. Niggemann. 2004. Data is available online: http://www.dnr.wa.gov/
Case I Volcanic Lahar	United States Geological Survey, Cascade Volcano Observatory. Digital Data for Volcano Hazards from Mount Rainier, Washington: Revised 1998: Case1. By S.P. Schilling, S. Doelger, R.P. Hoblitt, J.S. Walder, C.L. Driedger, K.M. Scott, P.T. Pringle, J.W. Vallance. Data available online: http://www.usgs.gov/
Historic Landslides	Washington State Department of Natural Resources, Geology and Earth Resources Division, from the Landslides and Landforms dataset, First Quarter, 2015
Landslide Hazards, Steep Slopes	Thurston GeoData Center, areas of 40% or greater slope, revised 12/12/2013
Wildland Urban Interface Areas	Washington State Department of Natural Resources
Dam Data	Washington State Department of Ecology

Essential Facilities

Image courtesy of the Association of Bay Area Governments

The plan partners supplied over 1,300 records containing public essential facilities data, creating a catalog of point location information for key assets such as city halls, fire stations, law enforcement facilities, correctional facilities, communications, water treatment systems, wells, schools, and many other facilities and utilities. The inventory gathered data on the common names of facilities, location, replacement cost, contents valuation, design quality, construction type, year built, square footage, and occupancy classification. The data was geocoded and used for level 2 flood and earthquake HAZUS analysis performed by FEMA and its Risk MAP program contractor, STARR.

Thurston County Public Health and Social Services furnished additional private essential facilities data for hospitals, medical clinics, treatment centers, dental clinics, pharmacies, and other licensed medical facilities. Location data on nursing homes, assisted living facilities, and other licensed health care residences was acquired from Washington State Department of Social and Health Services.

Both sets of essential facilities data supported the hazard exposure analysis for each hazard profile. TRPC maintains the essential facilities database for this plan.

Population, Dwelling Unit, and Employment Estimates and Forecasts

The hazard exposure analysis uses TRPC's population and employment forecasts. Updated every three to five years, the forecasts support transportation, sewer, water, land use, school, and other local governmental planning purposes.

TRPC adopted a new county-wide forecast on July 13, 2012. Employment allocations and population distributions to small areas such as cities, towns, tribes, school districts, fire districts, and other special districts and taxing boundaries were adopted on July 10, 2015. The 2015 update extended the population and employment allocations to cities and towns to the forecast year 2040 and the employment forecast base year to 2014. These forecasts comprise the base-year and forecast year datasets for the hazard exposure analysis presented in this plan.

Hazard Exposure Analysis Methodology

The proportion of the jurisdictions' land area, population, employment, residential units, and building valuation, exposed to the hazards identified in the risk assessment, was calculated using GIS. For each hazard, the hazard boundaries or layers were superimposed on tax-parcels to assess the portion of the parcel covered by the hazard layer. The value of the portion of the affected parcel was used to estimate the portion of the exposed population, residential dwellings, employment, and building valuations. For example, if 25 percent of a parcel was within the 100-year flood plain, then 25 percent of the dwelling was estimated at risk for flood and so on for the other attributes for all hazard profiles except storm.

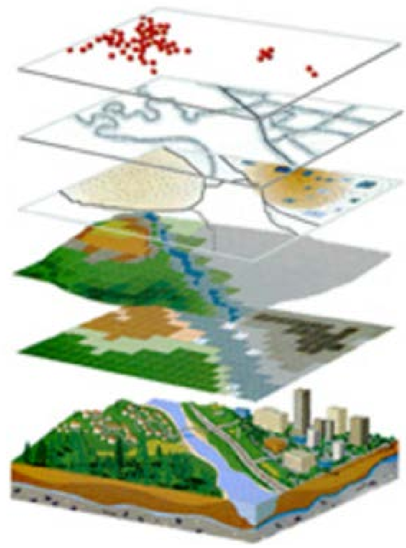


Image courtesy of Ventura County, California

For the essential facilities, each facility location was identified as in or out of the affected hazard area. The detailed results were shared with the jurisdictions. The essential facilities in the hazard area are aggregated to the entire planning area.

Appendix D

Federal Hazard Mitigation Assistance Grant Programs

The Department of Homeland Security Federal Emergency Management Agency (FEMA) Hazard Mitigation Assistance programs offer a variety of federal grant opportunities to states, tribes, and local governments. Appendix D includes a FEMA fact sheet about these programs, eligibility, match requirements, and the application process.

The Washington State Military Department Emergency Management Division acts as the grantee, with responsibility for notifying potential applicants of the availability of funding, defining the project selection process, ranking and prioritizing projects, and forwarding the projects to FEMA for funding.

- D-1: FEMA Hazard Mitigation Assistance Program Fact Sheet
- D-2: Washington State Military Department Hazard Mitigation Grant Program DR-4242 and DR-4243 Fact Sheet

D-1: FEMA Hazard Mitigation Assistance Program Fact Sheet

FEMA

The Hazard Mitigation Assistance Grant Programs

HMA
Hazard Mitigation Assistance

Hazard Mitigation Assistance

The Department of Homeland Security (DHS) Federal Emergency Management Agency (FEMA) Hazard Mitigation Assistance (HMA) programs present a critical opportunity to reduce the risk to individuals and property from natural hazards while simultaneously reducing reliance on Federal disaster funds.

A Common Goal

While the statutory origins of the programs differ, all share the common goal of reducing the loss of life and property due to natural hazards.

Funding Disaster Recovery Efforts

The Hazard Mitigation Grant Program (HMGP) may provide funds to States, territories, federally-recognized tribes, local governments, and eligible private non-profits following a Presidential major disaster declaration.

The Hazard Mitigation Grant Program (HMGP) is authorized by Section 404 of the Robert T. Stafford Disaster Relief and Emergency Assistance Act, as amended (the Stafford Act), Title 42, United States Code (U.S.C.) 5170c. The key purpose of HMGP is to ensure that the opportunity to take critical mitigation measures to reduce the risk of loss of life and property from future disasters is not lost during the reconstruction process following a disaster. HMGP is available, when authorized under a Presidential major disaster declaration, in the areas of the State or territory requested by the Governor. The amount of HMGP funding available to the Applicant is based upon the total Federal assistance to be provided by FEMA for disaster recovery under the Presidential major disaster declaration. Federally-recognized tribal governments can submit a request for a major disaster declaration within their impacted areas.

The Pre-Disaster Mitigation (PDM) program is authorized by Section 203 of the Stafford Act, 42 U.S.C. 5133. The PDM program is designed to assist States, territories, federally-recognized tribes, and local communities in implementing a sustained pre-disaster natural hazard mitigation program to reduce overall risk to the population and structures from future hazard events, while also reducing reliance on Federal funding from future disasters.

The Flood Mitigation Assistance (FMA) program is authorized by Section 1366 of the National Flood Insurance Act of 1968, as amended (NFIA), 42 U.S.C. 4104c, with the goal of mitigating flood damaged properties to reduce or eliminate claims under the National Flood Insurance Program (NFIP).

Additional HMA resources, including the HMA Guidance, may be accessed at http://www.fema.gov/hazard-mitigation-assistance

OR SCAN HERE

Available Funding

PDM and FMA funding depend on the amounts Congress appropriates each year.

HMGP funding is usually 15 percent of the amount of Federal assistance provided to a State, territory, or federally-recognized tribe following a Presidentially declared disaster.

General Requirements

All mitigation projects must be cost-effective, technically feasible and effective, and meet Environmental Planning and Historic Preservation (EHP) requirements in accordance with HMA Guidance. In addition, all mitigation activities must adhere to all relevant statutes, regulations, and requirements including other applicable Federal, State, territorial, federally-recognized tribal, and local laws, implementing regulations, and Executive Orders.

All Applicants and subapplicants must have hazard mitigation plans that meet the requirements of 44 CFR Part 201.

Program Comparisons

Cost Sharing

In general, HMA funds may be used to pay up to 75 percent of the eligible activity costs. The remaining 25 percent of eligible costs are derived from non-Federal sources.

The table below outlines the Federal and State cost share requirements.

Program Cost Share Requirements	Mitigation Activity Award (Percent of Federal/ Non-Federal Share)
HMGP	75 / 25
PDM	75 / 25
PDM (subrecipient is small impoverished community)	90 / 10
PDM (federally-recognized tribal Recipient is small impoverished community)	90 / 10
FMA (Insured properties and planning grants)	75 / 25
FMA (repetitive loss property with repetitive loss strategy)	90 / 10
FMA (severe repetitive loss property with repetitive loss strategy)	100 / 0

Eligible Applicants and Subapplicants

States, territories, and federally-recognized tribal governments are eligible HMA Applicants. Each State, territory, and federally-recognized tribal government shall designate one agency to serve as the Applicant for each HMA program. All interested subapplicants must apply to the Applicant.

Individuals and businesses may not apply directly to the State, territory, or FEMA, but eligible local governments may apply on their behalf.

The table below identifies, in general, eligible subapplicants.

Eligible Subapplicants	HMGP	PDM	FMA
State agencies	✔	✔	✔
Federally-recognized tribes	✔	✔	✔
Local governments/communities*	✔	✔	✔
Private nonprofit organizations (PNPs)	✔		

✔ = Subapplicant is eligible for program funding

* Local governments/community may include non federally-recognized tribes, or consistent with definition of local government at 44 CFR 201.2, may include any Indian tribe or authorized tribal organization, or Alaska Native village or organization that is not federally-recognized per 25 U.S.C. 479a et seq.

Eligible Activities

The table below summarizes eligible activities that may be funded by HMA programs. Detailed descriptions of these activities can be found in the HMA Guidance.

Eligible Activities	HMGP	PDM	FMA
1. Mitigation Projects	✔	✔	✔
Property Acquisition and Structure Demolition	✔	✔	✔
Property Acquisition and Structure Relocation	✔	✔	✔
Structure Elevation	✔	✔	✔
Mitigation Reconstruction	✔	✔	✔
Dry Floodproofing of Historic Residential Structures	✔	✔	✔
Dry Floodproofing of Non-Residential Structures	✔	✔	✔
Generators	✔	✔	
Localized Flood Risk Reduction Projects	✔	✔	✔
Non-Localized Flood Risk Reduction Projects	✔	✔	
Structural Retrofitting of Existing Buildings	✔	✔	✔
Non-Structural Retrofitting of Existing Buildings and Facilities	✔	✔	✔
Safe Room Construction	✔	✔	
Wind Retrofit for One- and Two-Family Residences	✔	✔	
Infrastructure Retrofit	✔	✔	✔
Soil Stabilization	✔	✔	✔
Wildfire Mitigation	✔	✔	
Post-Disaster Code Enforcement	✔		
Advance Assistance	✔		
5 Percent Initiative Projects*	✔		
Miscellaneous/Other**	✔	✔	✔
2. Hazard Mitigation Planning	✔	✔	✔
Planning-Related Activities	✔		
3. Technical Assistance			✔
4. Management Costs	✔	✔	✔

* FEMA allows increasing the 5% Initiative amount up to 10% for a Presidential major disaster declaration under HMGP. The additional 5% Initiative funding can be used for activities that promote disaster-resistant codes for all hazards. As a condition of the award, either a disaster-resistant building code must be adopted or an improved Building Code Effectiveness Grading Schedule is required.

** Miscellaneous/Other indicates that any proposed action will be evaluated on its own merit against program requirements. Eligible projects will be approved provided funding is available.

Management Costs

For HMGP only: The Recipient may request up to 4.89 percent of the HMGP allocation for management costs. The Recipient is responsible for determining the amount, if any, of funds that will be passed through to the subrecipient(s) for their management costs.

Applicants for PDM and FMA may apply for a maximum of 10 percent of the total funds requested in their award application budget (Federal and non-Federal shares) for management costs to support the project and planning subapplications included as part of their application.

Subapplicants for PDM and FMA may apply for a maximum of 5 percent of the total funds requested in a subapplication for management costs.

National Flood Insurance Program (NFIP) Participation

There are a number of ways that HMA eligibility is related to the NFIP:

Subapplicant Eligibility:

All subapplicants for FMA must be participating in the NFIP, and not be withdrawn or suspended, to be eligible to apply for grant funds. Certain political subdivisions (i.e., regional flood control districts or county governments) may apply and act as subrecipients if they are part of a community that is participating in the NFIP where the political subdivision provides zoning and building code enforcement or planning and community development professional services for that community.

Project Eligibility:

HMGP and PDM mitigation project subapplications for projects sited within a Special Flood Hazard Area (SFHA) are eligible only if the jurisdiction in which the project is located is participating in the NFIP. There is no NFIP participation requirement for HMGP and PDM project subapplications located outside of the SFHA.

Property Eligibility:

Properties included in a project subapplication for FMA funding must be NFIP-insured at the time of the application submittal. Flood insurance must be maintained for the life of the structure.

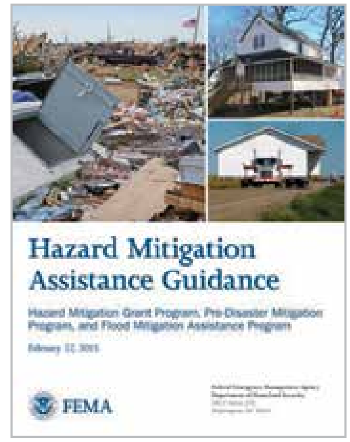
Application Process

Applications for HMGP are processed through the HMGP system (formerly known as National Emergency Management Information System [NEMIS]). Applicants use the Application Development Module of the HMGP System, which enables each Applicant to create project applications and submit them to the appropriate FEMA Region within 12 months of a disaster declaration.

Applications for PDM and FMA are processed through a web-based, electronic grants management system (eGrants), which encompasses the entire grant application process. The eGrants system allows Applicants and subapplicants to apply for and manage their mitigation grant application processes electronically. Applicants and subapplicants can access eGrants at https://portal.fema.gov.

FEMA Review and Selection

FEMA will review all subapplications for eligibility and completeness, cost-effectiveness, technical feasibility and effectiveness, and for EHP compliance. Subapplications that do not pass these reviews will not be considered for funding. FEMA will notify Applicants of the status of their subapplications and will work with Applicants on subapplications identified for further review.



Details about the HMA grant application process can be found in the HMA Guidance, which is available at http://www.fema.gov/hazard-mitigation-assistance

GovDelivery Notifications

Stay up-to-date on the HMA Programs by subscribing to GovDelivery notifications. Have updates delivered to an e-mail address or mobile device. To learn more, visit http://www.fema.gov

FEMA

Contact Information

HMA Helpline: 866-222-3580

FEMA eGrants Helpdesk: 1-855-228-3362

Benefit-Cost Analysis Helpline: BCHelpline@fema.dhs.gov

For HMA independent study and classroom courses, visit http://training.fema.gov

To find your State Hazard Mitigation Office, visit http://www.fema.gov/state-hazard-mitigation-officers

D-2: Washington State Military Department Hazard Mitigation Grant Program DR-4242 and DR-4243 Fact Sheet

HAZARD MITIGATION GRANT PROGRAM
DR-4242 & DR-4243
Fact Sheet

Washington State Military Department | Emergency Management Division | Camp Murray, WA 98430

The Hazard Mitigation Grant Program (HMGP) is available to the State of Washington following a Presidential declaration of a major disaster. This state-administered program is authorized by the Robert T. Stafford Disaster Relief and Emergency Assistance Act, Section 404 of Public Law 93-288, as amended. HMGP funds mitigation planning initiatives and mitigation projects designed to reduce or eliminate the effects and costs of future disaster damage.

ELIGIBLE APPLICANTS

-State Government	-Special Districts	-Certain Private Nonprofit Organizations providing
-Local Government	-Indian Tribes	Like-Government Services and Facilities

Applicants must be jurisdictions that are participating in and in good standing with the National Flood Insurance Program, and in compliance with State Growth Management Act requirements, or located in a community that is.

FUNDING CONSTRAINTS

The grants are available to eligible applicants on a competitive basis with the following cost share: 75 percent federal and 25 percent non-federal (applicant and state may split this share, based on legislative approval). The amount available for the HMGP is based on a percentage of FEMA expenditures on disaster assistance, which may limit the size of projects and grant awards. All mitigation project proposals will be evaluated against federal and state program criteria and they must be must be cost-effective.

APPLICATION & FUNDING PROCESS

1. Potential applicants submit pre-applications to participate in the program.
2. Following review of pre-applications, the State Emergency Management Division (State EMD) provides application packets to eligible applicants with potentially eligible projects.
3. State EMD reviews submitted applications for eligibility, with site visits conducted as necessary.
4. A state-local review committee evaluates and scores the applications.
5. State EMD recommends projects to FEMA for funding based upon scores and available funds.
6. FEMA makes grant awards following its review, which includes environmental and historic preservation considerations, as required.
7. Upon notification of approval and funding, State EMD prepares a grant funding agreement with the applicant and provides a notice to proceed.

ELIGIBLE PLANS & PROJECTS

Among the eligible mitigation projects are (see FY 2015 Hazard Mitigation Assistance Program Guidance, page 33):

- Property Acquisition and Structure Demolition
- Property Acquisition and Structure Relocation

- Structure Elevation
- Mitigation Reconstruction
- Dry Flood-proofing of Historic Residential Structures
- Dry Flood-proofing of Non-Residential Structures
- Generators (for critical facilities/infrastructure)
- Localized Flood Risk Reduction Projects
- Non-localized Flood Risk Reduction Projects
- Structural Retrofitting of Existing Buildings
- Non-structural Retrofitting of Existing Buildings and Facilities
- Safe Room Construction
- Wind Retrofit for One- and Two-Family Residences
- Infrastructure Retrofit (utility systems, roads, bridges)
- Soil Stabilization
- Wildfire Mitigation
- Post-Disaster Code Enforcement
- 5% Initiative Projects
- **Climate Resilient Mitigation** (Aquifer Storage and Recovery; Floodplain and Stream Restoration; Flood Diversion and Storage; and Green Infrastructure. See FEMA Fact Sheets for more information on these newly eligible activities
- **(*) Miscellaneous/Other**

(*) Any proposed action will be evaluated on its own merit against program requirements. Eligible projects will be approved provided funding is available. There is an emphasis on projects that address Climate Change and Resilience.

NOTE: Applicants *must* have a FEMA-approved Hazard Mitigation plan in order to be eligible to apply for *project* grant funds.

INELIGIBLE MITIGATION ACTIVITIES

Among the ineligible mitigation projects are (see FY 2015 Hazard Mitigation Assistance Program Guidance, pages 42-44):

- Projects that do not reduce the risk to people, homes, neighborhoods, structures, or infrastructure
- Projects dependent on a contingent action to be effective and/or feasible (i.e., not stand-alone)
- Projects with the sole purpose of open space acquisition of unimproved land
- Property acquisition projects that are not compatible with open space and do not maintain open space for the conservation of natural floodplain functions or properties that include encumbrances that may allow for horizontal drilling or fracking
- Non-localized flood risk reduction projects specific to FMA
- Flood control projects related to the repair or replacement of dams or flood control structures and repair of dams for the purpose of regular pre-scheduled or damage-induced maintenance
- Projects for which actual physical work such as groundbreaking, demolition, or construction has occurred prior to grant award
- Projects for preparedness activities or temporary measures (e.g., sandbags, bladders, geotubes)
- Projects that create revolving loan funds
- Activities required as a result of negligence or intentional actions that contributed to the

conditions to be mitigated; activities intended to remedy a code violation; or the reimbursement of legal obligations, such as those imposed by a legal settlement, court order, or State law

- All projects located in Coastal Barrier Resources System (CBRS) Units, other than property acquisition and structural demolition or relocation projects for open space under HMA
- Projects located in an OPA that require flood insurance after project completion
- Activities on Federal lands or associated with facilities owned by another Federal entity
- Projects related to beach nourishment or re-nourishment
- Projects for hazardous fuels reduction in excess of 2 miles from at-risk buildings and structures
- Projects that address unmet needs from a disaster that are not related to mitigation
- Retrofitting facilities primarily used for religious purposes, such as places of worship (or other projects that solely benefit religious organizations)
- Activities that only address manmade hazards
- Projects that address, without an increase in the level of protection, the operation, deferred or future maintenance, rehabilitation, restoration, or replacement of existing structures, facilities, or infrastructure (e.g., dredging, debris removal, replacement of obsolete utility systems or bridges)
- Landscaping for ornamentation (e.g., trees, shrubs)
- Site remediation of hazardous materials (with the exception of eligible activities)
- Water quality infrastructure projects
- Projects that address ecological issues related to land and forest management
- Prescribed burning or clear-cutting
- Creation and maintenance of fire breaks, access roads, or staging areas
- Irrigation systems
- Preparedness measures and response equipment (e.g., response training, electronic evacuation road signs, interoperable communications equipment)
- Studies no directly related to the design and implementation of a proposed mitigation project
- Information dissemination activities that exceed 10 percent of the total planning application
- Limited plan revisions that do not result in comprehensive hazard mitigation plan update

CONTACTS:

For more information on the Hazard Mitigation Grant Program, contact:
Hazard Mitigation Grant Program Section All-Staff E-mail, HMGP@mil.wa.gov

Tim Cook, State Hazard Mitigation Officer, (253) 512-7072, tim.cook@mil.wa.gov
Cindy Carroll, Hazard Mitigation Grant Coordinator, (253) 512-7042, cindy.carroll@mil.wa.gov
David Spicer, Hazard Mitigation Grant Coordinator, (253) 512-7082, david.spicer@mil.wa.gov
Maximilian Dixon, Hazard Mitigation Coordinator, (253) 512-7017, maximilian.dixon@mil.wa.gov
Courtney Merwin, Hazard Mitigation Program Assistant, (253) 512-7460, courtney.merwin@mil.wa.gov