

City of Tigard

Natural Hazards Mitigation Plan

An addendum to the Washington County Natural Hazards Mitigation Action Plan

Earthquake



Landslide



Wildfire



Flooding



Wind and Winter Storms

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Preface

Natural features provide our community with valuable resources but, under certain conditions, these resources may also present a hazard. For example, rivers and creeks are important for storm water conveyance, wildlife habitat, and water quality. However, these resources can quickly threaten people and property unless careful planning has documented flooding risk and adequate precautions are taken. It is important for local governments to have an understanding of underlying natural conditions and past event history to help develop hazard mitigation and prevention programs. The City of Tigard is committed to protecting its people and property from natural hazards.

Tigard's citizens value a safe community where natural resources are protected and there is minimal danger from both natural and man-made hazards. Tigard residents value the importance of natural systems in protecting the community from hazards, and additionally recognize that although landslides, earthquakes, wildfires, and floods occur naturally, the effects of these events are often made worse by human activities. Hazards can have a significant negative impact on a community's quality of life. It is important for the Natural Hazard Mitigation Plan Addendum (NHMPA) to provide policy direction on how the city will manage and mitigate hazardous conditions and events. Land use and mitigation planning, development regulations, and emergency management play key roles in assessing and reducing the risk to people and property from natural hazards.

Section 1: Planning Process

The City of Tigard Natural Hazards Mitigation Plan includes resources and information to assist city residents, public and private sector organizations, and others interested in participating in planning for natural hazards. The mitigation plan provides a list of activities that may assist the City of Tigard in reducing risk and preventing loss from future natural hazard events. Tigard has developed this plan as an addendum to the Multi-Jurisdictional Washington County Natural Hazards Mitigation Plan, dated April 2004, which was an effort to take a more regional approach to planning for natural hazard scenarios.

Who Participated in Developing the Plan?

Tigard Hazard Mitigation Working Group

The City of Tigard Natural Hazards Mitigation Plan Addendum is the result of a collaborative effort between the City of Tigard, public agencies, non-profit organizations, city residents, and regional and statewide organizations. The Tigard Hazard Mitigation Working Group (HMWG) participated in the process of developing the plan. The HMWG is comprised of representatives from:

- City of Tigard Community Development Department:
 - Long Range Planning Division
 - Building Division
 - Capital Construction and Transportation Division
- City of Tigard Public Works:
 - Waste Water/Storm Division
 - Emergency Management
- City of Tigard Police Department
- City of Tigard Risk Management
- Tualatin Valley Fire and Rescue
- Tigard-Tualatin School District
- Washington County Office of Consolidated Emergency Management



External Agencies

The following agencies and organizations have been given the opportunity to review the plan during its development. They will also be given the opportunity to participate and comment on plan implementation:

- City of Beaverton
- City of King City
- City of Durham
- City of Sherwood
- City of Tualatin
- Clean Water Services
- Joint Water Commission
- Kinder Morgan
- PGE
- Verizon
- Portland Community College, Sylvania Campus
- NW Natural Gas
- Tigard/Tualatin School District
- Trimet
- Portland Western Railroad
- Oregon Department of Transportation
- Tualatin Valley Fire and Rescue
- Tualatin Valley Water District
- Tualatin Valley Parks and Recreation District
- Washington County
- Oregon Office of Emergency Management

Public Involvement

In 2007, the City initiated a Comprehensive Plan amendment to update the Natural Hazards section of the Comprehensive Plan. This effort included citizen participation through an open house, citizen interest team meetings, and throughout the legislative process. The citizen involvement efforts from this process were rolled into the development of the Tigard Natural Hazards Mitigation Plan Addendum. In addition to the Comprehensive Planning process, Tigard citizens had an opportunity to participate during two workshop meetings held on February 28, 2008 and March 12, 2008 specific to the NHMPA.

Multi-Jurisdictional Planning Effort

City of Tigard is dedicated to taking a regional approach to planning for natural hazards as hazards do not abide by jurisdictional boundaries. The City of Tigard has representation on the Washington County Hazard Mitigation Working Group through the Local Emergency Managers (LEM) to ensure the city's interests are represented in the larger scale planning effort. The city will partner with the county in implementation of appropriate action items, and will work with other jurisdictions to reduce losses from future natural hazards.

Who will participate in Plan Implementation, Monitoring, and Evaluation?

Coordinating Body

The Tigard Hazard Mitigation Working Group (HMWG) will be responsible for coordinating implementation of plan action items and undertaking a biannual review process. In order to develop momentum for plan implementation, the HMWG will establish an appropriate timeframe for the meeting schedule as plan implementation begins. The HMWG will meet biannually to identify funding for the implementation of mitigation strategies, evaluate the effectiveness of the plan, and develop new mitigation strategies to reduce loss from natural hazards.

Due to the nature of this project-based working

group, technical advisory committees, as well as other ad hoc committees, may be established to implement appropriate mitigation projects and tasks, and will meet as needed. The attendees of these technical advisory committees will report on their actions to the HMWG at the regularly scheduled meetings.

The City Manager will assign representatives from appropriate city departments, including, but not limited to, one representative from the Tigard Police Department, Community Development Department, Public Works Department, Risk and Emergency Management. In order to make this working group as broad and useful as possible, the HMWG will engage other relevant organizations and agencies in hazard mitigation. The recommendations for adding to the Hazard Mitigation Working Group include:

- A representative from the Committee for Citizen Involvement (CCI); and
- A representative from the business community, or from the Tigard Chamber of Commerce.

Convener

The Emergency Management Coordinator for the City of Tigard will serve as a convener to facilitate the Hazard Mitigation Working Group meetings, and will assign tasks such as updating and presenting the Plan to the members of the working group. Plan implementation and evaluation will be a shared responsibility among all of the Natural Hazard Working Group members.

How Will the Plan be Implemented, Monitored, and Evaluated?

The plan maintenance process includes a schedule for implementing, monitoring, evaluating, and reviewing this plan addendum. It is essential to have this process to ensure plan sustainability.

Implementation through Existing Programs

The City of Tigard addresses Oregon Statewide Planning Goals and legislative requirements through the Comprehensive Plan, Community

Development Code, Community Investment Program, and the Oregon Building Codes. The Natural Hazard Mitigation Plan Addendum provides a series of recommendations that are closely related to the goals and objectives of these existing planning programs. The City of Tigard will have the opportunity to implement recommended mitigation action items through existing programs and procedures.

Formal Review Process

The Tigard City Council will be responsible for adopting the multi-jurisdictional Washington County Natural Hazards Mitigation Plan including the City of Tigard Addendum. This governing body has the authority to promote sound public policy regarding natural hazards.

The City of Tigard Addendum to the Washington County Natural Hazards Mitigation Plan will be evaluated on a biannual basis to determine the effectiveness of programs, and to reflect changes in land development or programs that may affect mitigation priorities. The convener will be responsible for contacting the Hazard Mitigation Working Group members and organizing the annual meeting. Working Group members will be responsible for monitoring and evaluating the progress of the mitigation strategies in the Plan.

The Working Group will review the goals and action items to determine their relevance to changing situations in the county, as well as changes in state or federal policy, and to ensure they are addressing current and expected conditions. The Working Group will also review the hazard assessment portion of the Plan to determine if this information should be updated or modified, given any new available data. The coordinating organizations responsible for the various action items will report on the status of their projects, the success of various implementation processes, difficulties encountered, success of coordination efforts, and which strategies should be revised.

The convener will assign the duty of updating the plan to one or more of the Working Group mem-

bers. The designated Working Group members will have ninety days to make appropriate changes to the plan before submitting it to the Hazard Mitigation Working Group members for review prior to presenting an update to the City Council. The HMWG will also notify all holders of the plan when changes have been made. Every five years, the convener or designee will submit the updated plan through Washington County to the State Hazard Mitigation Officer and the Federal Emergency Management Agency for review and approval.

Continued Public Involvement

The City of Tigard is dedicated to involving the public directly in review and updates of the Natural Hazard Mitigation Plan Addendum. The public will have the opportunity to provide feedback about the plan through a variety of forums. A copy of the plan and any proposed changes will be posted on the city's website and available at City Hall. This site will also contain an email address and phone number to which people can direct their comments and concerns.

A public meeting will be held after each annual evaluation or when deemed necessary by the Hazard Mitigation Working Group. The meetings will provide the public a forum for which they can express their concerns, opinions, or ideas about the Plan. The HMWG will be responsible for using city resources to publicize the annual public meetings and for maintaining public involvement through Tualatin Valley Community Television (TVCTV), the City's webpage, the *Cityscape* Newsletter, and local newspapers.



Economic Analysis of Mitigation Projects

The Federal Emergency Management Agency's (FEMA) approach to identifying the costs and benefits associated with natural hazard mitigation strategies, measures, or projects fall into two general categories: benefit/cost analysis and cost-effectiveness analysis. Conducting benefit/cost analysis for a mitigation activity can assist communities in determining whether a project is worth undertaking now, in order to avoid disaster-related damages and costs later. Cost-effectiveness analysis evaluates how best to spend a given amount of money to achieve a specific goal. Determining the economic feasibility of mitigating natural hazards can provide decision-makers with an understanding of the potential benefits and costs of an activity, as well as a basis upon which to compare alternative projects.

Given federal funding, the Hazard Mitigation Working Group will use a FEMA-approved benefit/cost analysis approach to analyze and prioritize mitigation action items. For other projects and funding sources, the Hazard Mitigation Working Group may use other approaches to understand the costs and benefits of each action item and develop a prioritized list. For more information regarding the economic analysis of mitigation action items, please see Appendix C of the Washington County Natural Hazards Mitigation Plan.

Section 2: Community Profile

Geography and the Environment

The City of Tigard is located in Washington County in northwestern Oregon. The city has grown steadily since its incorporation in 1961, and has an area today of 11.71 square miles. It is centrally located in the Portland metropolitan region, located 10 miles southwest of downtown Portland and adjacent to Portland's southwestern border and the cities of Beaverton, Tualatin, King City, Lake Oswego, and Durham.

Transportation

In the City of Tigard, transportation has played a major role in shaping the community. From the first railroad tracks that established Tigardville, to the development of Highway 99W straight through its center, Tigard's commercial areas developed along primary routes, and residential development followed nearby.

Today mobility, or lack thereof due to heavy traffic, continues to define Tigard and the daily experience of its residents and businesses as they move from point A to point B. In addition to Hwy 99W, the City also has two other highways within its borders: Highway 217 and Interstate 5. The railroad still exists, but now passengers will return to its cars with the 2008 opening of Commuter Rail, one of the few U.S. suburban-to-suburban commuter rail lines. This complements two transit centers within the City that provide regional bus service. In addition, the regional Fanno Creek Trail provides an alternative route for bicyclists and pedestrians to travel along the creek.

By far, motor vehicles represent the dominant mode of travel through and within Tigard. Because of Tigard's central location, much of the City's transportation system has regional significance: two regional shopping centers, employment areas, and five state highways draw thousands of non-



Tigard residents through the City each day. At the same time, the City's transportation system must provide local access and service for residents and also connections to neighborhoods.

Population and Demographics

In 2006, the City of Tigard had 46,715 residents (Population Research Center, Portland State University). Tigard's population has continued to grow incrementally. Census 2000 data provides the most recent age demographics (Figure 2-1).

Year	Population
2006	46,300
2005	45,500
2004	44,650
2003	45,130*
2002	44,070
2001	43,040

* Data collection error corrected in 2004

Land and Development

In the mid-1800s, the first settlers located in Tigard because of "game in abundance, a great wealth of timber and a very productive soil with good natural drainage" (from Mary Payne's Tigardville). By the late 1920s, only 328 residents lived in the area. Most of Tigard's residents were self-sufficient

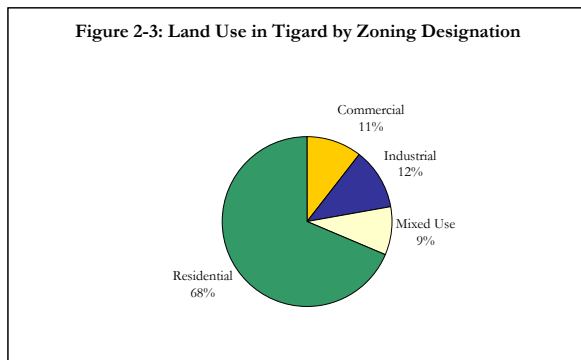
farmers who had all the services they needed on their own property. The City of Tigard did not incorporate until 1961.

According to the Oregon State Board of the Census there were 1,749 residents and 572 occupied residences at the time of incorporation. Today, the City has 46,715 residents and approximately 18,872 residences (as of April 30, 2006). The biggest boom period took place in the 1960s, averaging 26% population growth, followed by the 1970s, (8.6%), 1980s (6.7%), 1990s (3.4%). In the current decade, the average population growth is approximately 4.4%.

The City of Tigard includes a diversity of land uses, including commercial, residential, and industrial. Tigard is primarily residential, with almost 70% of the land area zoned for residential use. Based on current zoning designations, the distribution of land use in Tigard is shown in Figure 2-3.

Employment and Industry

Tigard is sometimes perceived as a bedroom com-



munity for nearby cities. However, this is not the case. Tigard businesses provide 37,861 full and part time jobs (State of Oregon Employment Department, 2004). This number is greater than the number of Tigard residents over the age of 16 in the workforce: 25,537 (State of Oregon Employment Department, 2006). Considering that 70% of Tigard residents work outside the City, thousands of workers from throughout the region are regularly commuting to Tigard jobs (2000 Census).

A recent study found that Tigard was a “hub for innovation” for a city its size. A study of patents and communities by the research firm iPiQ found that in 2005, Tigard had a high percentage of patents granted to individuals and small business (29). The study attributed this to Tigard’s lower rents and taxes attracting professionals from Portland and Beaverton.

Tigard collects annual data on private businesses that pay the Tigard Business Tax. Because it is self-reported, the data has some limitations, but it gives a good picture of the types of businesses located here. According to 2005 Tigard Business Tax information, there were 3,124 private businesses operating in the city limits. Typically, each year, an equal number of businesses (between 300 and 500) pay the tax for the first time, as stop paying (due to going out of business, or moving from the City). In 2005, considered a “typical year,” 462 new businesses paid the business tax, of which 372 renewed the following year.

A diverse range of businesses have chosen to locate in Tigard. According to the business tax data, contractors represent the largest number of businesses (about ¾ of which have 10 or fewer employees). From a breakdown of the business tax data, roughly 75% of jobs can be classified as Commercial (Retail, Health, Real Estate, Finance, and Insurance, etc.) and 25% can be classified as Industrial (Wholesale Trade, Manufacturing, Construction and Transportation, etc.). About half of Tigard businesses employ four people or fewer. There are 420 home-based businesses, which employ 640 people.

The average wage for all jobs in Tigard is \$40,375. This is below the average for jobs in Washington County as a whole (\$45,757), and above the average for the State of Oregon as a whole (\$35,620) (2004 Oregon Employment Department). Tigard has about 5.8% of the workforce of Washington and Multnomah Counties.

A Location Quotient (LQ) is a ratio of employment sectors in a local area compared to a larger area (Table 3-19). It shows sectors where a local

area has attracted more employment than average in the region. A Location Quotient of 1.0 indicates the same share as the region, while a LQ of greater than 1.0 shows a higher than average concentration and lower than 1.0 a lower than average concentration.

Tigard Employment sectors with a high LQ (compared to the Washington/Multnomah County Region) include Retail Trade, Financial Activities, and Construction. All of the sectors with LQs greater than 1.0, except Retail, have jobs with higher than average wages. These “employment clusters” are important drivers of the local economy and influence business location decisions.

A Location Quotient Analysis was also done to compare Tigard employment against the statewide figures. This found Tigard to have a significant concentration of Finance and Insurance employment, an LQ of 3.04 (these jobs have a propensity to locate here 3 times greater than average).

There are several new infrastructure projects planned for the Downtown Urban Renewal area, including new streetscapes, expansion of Fanno Creek Park, and the new Commuter Rail station. It is expected that these public investments will spur new private investment in the Downtown area and result in an increase in jobs in the area.

Section 3: Hazard Assessment

Definition of Hazard Assessment

Introduction

Conducting a hazard assessment can provide information on the location of hazards, the value of existing land and property in hazard locations, and an analysis of risk to life, property, and the environment that may result from natural hazard events. Hazard assessments are subject to the availability of hazard-specific data. Tigard conducted a hazard assessment for all of the hazards for which data was available. The three levels of a hazard assessment are as follows:

- Hazard Identification** identifies the geographic extent, the intensity of the hazard, and the probability of its occurrence. Maps are frequently used to display hazard identification data. Tigard identified five major hazards that consistently affect this geographic area. These hazards – floods, landslides, wildfires, earthquakes, and severe storms: wind and winter – were identified through an extensive process that utilized input from the Hazard Mitigation Working Group. The geographic extent of each identified hazard has been identified using GIS and is illustrated by the maps listed in Table 3-1.
- Vulnerability Assessment/Inventorying Assets** combines hazard identification with an inventory of the existing (or planned)



property and population exposed to a hazard. A summary of community assets vulnerable to each hazard is located in Table 3-2. Additionally, a more detailed description of the vulnerability of these assets is located in the specific hazard sections.

- Risk Analysis/Estimating Potential Losses** involves estimating the damage, injuries, and financial losses likely to be sustained in a geographic area over a given period of time. This level of analysis involves using mathematical models. The two measurable components of risk analysis are magnitude of the harm that may result and the likelihood of the harm occurring. Describing vulnerability in terms of dollar losses provides the community and the state with a common framework in which to measure the effects of hazards on assets.

Map Number	Type of Map	Section of the Plan
1	Base Map of Tigard	Section 2
2	Critical Facilities	Section 3
3	Essential Facilities	Section 3
4.1	Infrastructure: Water/Waste Water	Section 3
4.2	Infrastructure: Major Utilities	Section 3
4.3	Infrastructure: Bridges and Overpasses	Section 3
5	FEMA 100-Year Floodplain and 1996 Flood Inundation	Section 5
6	Landslide Hazards	Section 6
7	Wildfire Hazards	Section 7
8	Storm Hazard Sanding Priorities	Section 8
9	Earthquake Hazards	Section 9

Federal Requirements for Hazard Assessment

The Disaster Mitigation Act of 2000 (DMA) reinforced the importance of pre-disaster mitigation planning. Section 322 of the DMA specifically set out the importance mitigation planning at the state and local levels. The DMA requires local jurisdictions to have an approved mitigation plan in place before receiving Hazard Mitigation Grant Program funds. Table 3-3 lists how each Section 322 requirement for local mitigation plans is incorporated into the Tigard NHMPA.

Section 322 Requirement	How is this addressed?
Identifying Hazards	Each hazard section includes a map illustrating the geographic extent of the hazards affecting Tigard using the best available data.
Profiling Hazard Events	The hazard sections of the Washington County Natural Hazard Mitigation Plan provide documentation for all of the large-scale hazard events affecting the region. Where data is available, City of Tigard has provided local impacts from historical hazard events.
Assessing Vulnerability: Identifying Assets	Table 3-3 documents the community assets that are vulnerable to natural hazards. A more detailed description of the vulnerability of these assets is located in the specific hazard sections.
Assessing Vulnerability: Estimating Potential Losses	Using the best available data, an estimate of potential losses from natural hazards is located in the hazard specific sections.
Assessing Vulnerability: Analyzing Development Trends	The Community Profile Section of this plan provides a description of the development trends in City of Tigard.

To implement the new DMA 2000 requirements, FEMA prepared an Interim Final Rule, at 44 CFR Parts 201 and 206, which established planning and funding criteria for local mitigation programs. Outlined in the Code of Federal Requirements under Title 44: Emergency Management and Assistance, in Chapter I: Federal Emergency Management Agency, Part 201: Mitigation Planning, Section 201.6: Local Mitigation Plans is the requirement for hazard assessment. This risk assessment requirement is intended to provide information that will help the community to identify and prioritize mitigation activities that will reduce losses from the identified hazards.

Hazard Assessment Mapping Methodology

Floodplain

1. Query taxlots that intersect floodplain and are within City Limits, remove records with BLDGVAL=0, calculate number of taxlots, bldgval, acres, and percent of land in City
2. Query taxlots that intersect floodplain & 1996 flood and within City Limits, remove records with BLDGVAL=0, calculate number of taxlots, bldgval, acres, and percent of land in City of Tigard
3. Query taxlots that intersect 1996 flood and within City Limits, remove records with BLDGVAL=0, calculate number of taxlots, bldgval, acres, and percent of land in City of

Tigard

4. Query critical, essential, and infrastructure facilities that intersect floodplain and are within City Limits

Landslide

1. Query street segments that intersect slopes > 25%
2. Query critical, essential, and infrastructure that intersect slopes
3. Query taxlots that intersect slopes and are within City limits and remove records with bldgval=0
4. Calculate number of taxlots, bldgval, acres, and percent of land in City of Tigard

Wildfire

1. Query street segments that intersect wildfire zone
2. Query critical, essential, and infrastructure that intersect wildfire zone
3. Query taxlots that intersect wildfire zone and are within City limits and remove records with bldgval=0
4. Calculate number of taxlots, bldgval, acres, and percent of land in City of Tigard

Earthquake

1. Query earthquake zones
2. Query critical, essential, and infrastructure that intersects each zone
3. Query taxlots that have center in each zone
4. Query streets that intersect zone a & b
5. Calculate number of taxlots, bldgval, acres, and percent of land in City of Tigard

Community Assets: Vulnerability Assessment

This section outlines the resources, facilities, and infrastructure that, if damaged, could significantly impact the public safety, economic conditions, and environmental integrity of Tigard. The exposure of community assets to natural hazards is provided in Table 3-3 Tigard Vulnerability Assessment. The community assets are defined as follows:

Hazard	Critical Facilities	Essential Facilities	Infrastructure
Flood	0	0	15
Landslide	0	0	0
Earthquake	18	27	31
Severe Storm	-	-	-
Wildfire	3	5	9

Critical Facilities

Facilities that are critical to government response and recovery activities (i.e. life, safety, property, and environmental protection). These facilities include: 911 Centers, Emergency Operations Centers, Police and Fire Stations, Public Works facilities, sewer and water facilities, hospitals, bridges, roads, shelters, and more. Facilities that, if damaged, could cause serious secondary impacts may also be considered “critical.” A hazardous material facility is one example of this type of critical facility. The locations of critical facilities are shown on Map 2.

- Fire Stations:
Tualatin Valley Fire and Rescue Station 51
Tualatin Valley Fire and Rescue Station 50
- Law Enforcement:
City Hall
- Military:
Oregon Army National Guard
- Public Works:
Public Works Building
Streets and Parks Operations Building
- City Buildings:
Permit Center
Tigard Senior Center
Tigard Library
Niche
- Private:
Washington Square
Lincoln Center
Suburban Propane
Pool and Spa House

Essential Facilities

Facilities that are essential to the continued delivery of key government services and/or that may significantly impact the public’s ability to recover from the emergency. These facilities may include: City buildings such as the Public Services Building, the City Hall, and other public facilities such as schools. Map 3 shows Tigard’s essential facilities.

- Hospitals/Immediate Medical Care Facilities:
Legacy Immediate Care Clinic suite 104
Metropolitan Clinic PC
Tigard Family Medical Center
The Portland Clinic
Scholls Ferry Urgent Clinic
Providence St. Vincent Urgent Care Clinic
- Public Schools:
Tigard High School
Durham School
Templeton School
Tuality Middle School
Fowler Middle School
Charles F. Tigard School
Mary Woodward School
Metzger School
Deer Creek School
Phil Lewis School
Tigard-Tualatin School District Administration Building
First Student Transportation Center
- Private Schools:
MITCH Charter School
St Anthony School
- Potential Shelter Sites:
Calvin Presbyterian
Hall Blvd Baptist Church
Christ the King Lutheran
Good Neighbor Center
St. Anthony Roman Catholic Church
All Tigard-Tualatin Schools
Church of Christ Southwest
Tigard Church of Christ
St. James Episcopal
First Baptist Church of Tigard
Horizon Community Church

Tigard Senior Center
Tigard Christian Church
Tigard Covenant Church
Latter Say Saints/Chapel
Tigard First Church of Christ Scientist
Tigard Friends Church
Assembly of God
Tigard United Methodist

Table 3-3 identifies the number of facilities and infrastructure exposed to each of the natural hazards affecting the City of Tigard. The implications of exposure to the various hazards are outlined in each of the hazards sections. Additional tax lot information is also included in the hazard specific sections.

Infrastructure

Infrastructure that provides services for Tigard Maps 4.1 through 4.3 show the infrastructure portion of the community assets.

- Transportation Networks:
 - Highway 99W
 - Highway 217
 - Hall Blvd
 - Durham
 - 72nd
 - Interstate 5
 - Walnut
 - Gaarde
 - Bull Mountain Rd
 - Beef Bend Rd
 - Scholls Ferry Rd
 - Bonita
 - Greenberg Rd
 - McDonald

- Water Facilities:
 - 8 City Reservoirs
 - 6 Pump Stations
 - 5 Wells
 - 2 SCADA System
 - 1 36" Main
 - 2 Double Sewerage Siphon Structure

- Special Service Districts:
 - Clean Water Services Treatment Plant

- Private Utilities:
 - 2 NW Natural Gas Pipelines
 - 5 Portland General Electric Substations
 - 2 Verizon Central Switch Offices
 - 3 Communication Towers
 - 1 Kinder Morgan Liquid Petroleum Line

Section 4: Multi-Hazard Goals and Action Items

What is the Plan Mission?

Introduction

The mission of the Tigard Natural Hazard Mitigation Plan Addendum is to support the Washington County Natural Hazards Mitigation Plan (County Hazards Plan) and to assist in reducing risk, preventing loss, and protecting life, property, and the environment from future natural hazard events.

The Tigard NHMPA is also intended to implement the Tigard Comprehensive Plan goals, policies, and recommended action measures. Comprehensive Plan Goal 7.1 is to “Protect people and property from flood, landslide, earthquake, wildfire, and severe weather hazards.”

What are the Plan Goals?

The plan goals describe the overall direction Washington County, the City of Tigard, outside organizations, and local citizens can take to work towards mitigating the risk of natural hazards. The Washington County Natural Hazard Mitigation Goals are provided below. The City’s goals are in addition to the Washington County goals. The City’s goals are more specific to Tigard and also incorporate the Tigard Comprehensive Plan.

City of Tigard Natural Hazard Mitigation Goals:

Life, Property, and Natural Systems

Evaluate city guidelines, codes, and permitting processes in addressing natural hazard mitigation.

Emergency Services

Ensure public safety providers (law enforcement, fire safety, and emergency service providers) have the capability to respond to hazard events.



Implementation

Promote the use of non-structural approaches to hazard mitigation

Washington County Natural Hazard Mitigation Goals:

Life, Property, and Natural Systems

Develop and implement activities to protect human life, commerce, property, and natural systems from natural hazards.

Reduce insurance losses and repetitive claims for chronic hazard events while promoting insurance coverage for catastrophic hazards.

Evaluate county guidelines, codes, and permitting processes in addressing natural hazard mitigation.

Link watershed planning, natural resource management, and land use planning with natural hazard mitigation activities to protect vital habitat and water quality.

Preserve and rehabilitate natural systems to serve natural hazard mitigation functions.

Public Awareness and Partnerships

Education: Develop and implement education programs to increase awareness among citizens, local, county, and regional agencies, non-profit organizations, business, and industry.

Outreach: Develop and conduct outreach programs to increase the number of local, county, and regional activities implemented by public and private sector organizations.

Partnerships and Coordination: Strengthen communication and coordinate participation in and between public agencies, citizens, non-profit organizations, business, and industry.

Emergency Services

Strengthen emergency operations by increasing collaboration and coordination among public agencies, non-profit organizations, business, and industry.

Coordinate natural hazard mitigation activities, where appropriate, with emergency operations plans and procedures.

Implementation

Promote leadership within public agencies to implement natural hazard mitigation activities.

What are the Mitigation Strategies Identified by the City of Tigard?

The action items are a list of activities in which city departments and citizens can be engaged to reduce the risk associated with Natural Hazards. Each action item includes an estimate of the timeline for implementation. Short-term action items (ST) are activities that city departments may implement with existing resources and authorities within one to three years. Long-term action items (LT) may require new or additional resources or authorities, and may take between three and five years to

implement. The action items are organized in an Action Item Matrix, which lists all of the multi-hazard and hazard-specific action items included in the Mitigation Plan Addendum. The Action Item Matrix can be found in Appendix A.

Multi-Hazard Action Items (MH)

Multi-hazard action items are those activities that pertain to more than one of the five hazards in the mitigation plan: flood, landslide, wildfire, severe storm: wind and winter, and earthquake. The County's multi-hazard mitigation action items are found in Section 3 of the County's NHMA Plan.

ST-MH#1: Improve and attain resources and equipment essential for responding to and recovering from disasters.

Ideas for Implementation:

- Contact local facilities that have large trucks that could serve as water tenders in emergency situations, or purchase water tenders for the city;
- Partner with the National Guard, local businesses, contractors and developers;
- Attain funding to purchase one fixed generator for each critical City facility;
- Attain funding to purchase one 250 KW portable generator and transfer system for the City Hall/Permit Center and shelter sites;
- Attain funding to purchase one storage trailer for emergency supplies; and
- Attain funding to purchase a mobile command center (bus or trailer).

Coordinating Organization:

City of Tigard

Partner Organizations:

None

Timeline:

1-3 Years

Plan Goals Addressed:

Life, Property, and Natural Systems, Public Awareness and Partnerships, Emergency Services, and Implementation

ST-MH#2: Ensure there are adequate shelter facilities in hazard-free zones to serve Tigard residents.

Ideas for Implementation:

- Identify and contact potential shelter sites to see if there is an interest in becoming a designated Red Cross shelter site;
- Contact Red Cross Shelter Sites to renew and maintain agreements; and
- Maintain mapping of existing approved Red Cross shelters.

Coordinating Organization:

City of Tigard

Partner Organizations:

Red Cross

Timeline:

Ongoing

Plan Goals Addressed:

Life, Property, and Natural Systems, Public Awareness and Partnerships, Emergency Services, and Implementation

ST-MH#3: Enhance communications network capabilities during hazard events.

Ideas for Implementation:

- Recruit and provide training for Amateur Radio Operators;
- Address 800 MHz communication deficiencies;
- Seek to improve communication between school officials and parents during hazard events;
- Ensure student emergency contact information is kept up-to-date;
- Coordinate with Tigard-Tualatin School District to attain funding for emergency communications equipment and/or software;
- Continue to improve the City's Emergency Management web page;
- Partner with Tigard-Tualatin School District to coordinate and maintain public emergency notification procedures, including procedures to post emergency notification

bulletins on the internet and Tualatin Valley Community Television (TVCTV); and

- Utilize county network for the Education Service District.

Coordinating Organization:

City of Tigard

Partner Organizations:

Tigard-Tualatin School District, Tualatin Valley Community Television, Radio Operators Network

Timeline:

Ongoing

Plan Goals Addressed:

Life, Property, and Natural Systems, Public Awareness and Partnerships, Emergency Services, and Implementation

ST-MH#4: Develop, enhance, and implement education programs designed to reduce loss from natural hazards.

Ideas for Implementation:

- Gather hazard related information and public information materials, and disseminate to public through local publications;
- Identify property owners in hazard zones, and conduct a target mailing to educate them about natural hazard risks and preparedness/ mitigation measures;
- Conduct public education and outreach as hazard seasons approach;
- Target neighborhood associations for public education and outreach;
- Add emergency preparedness and response curriculum to school programs; and
- Develop public education flyers as billing inserts.

Coordinating Organization:

City of Tigard

Partner Organizations:

Washington County Office of Consolidated Emergency Management, Tigard-Tualatin School District

Timeline:

Ongoing

Plan Goals Addressed:

Life, Property, and Natural Systems, Public Awareness and Partnerships, and Implementation

ST-MH#5: Promote the Citizen Emergency Response Team (CERT) program in Tigard and recruit new members for training.

Ideas for Implementation

- Provide information about the CERT program to Tigard residents through local publications, neighborhood organizations, churches, etc.;
- Identify the needs of local CERT programs and attain funding to purchase CERT supplies; and
- Provide information about 72-hour preparedness to Tigard residents through local publications, neighborhood organizations, churches, etc.

Coordinating Organization:

City of Tigard

Partner Organizations:

None

Timeline:

Ongoing

Plan Goals Addressed:

Life, Property, and Natural Systems, Public Awareness and Partnerships, Emergency Services, and Implementation

ST-MH#6: Develop and enhance strategies for debris management during natural hazard events.

Ideas for Implementation:

- Develop a Debris Management Plan to further detail the equipment needed to clean up after each type of hazard;
- Develop an intergovernmental agreement (IGA) with surrounding jurisdictions, businesses, and tree service outfits to share equipment and manage debris during disasters; and
- Update and maintain a list of potential debris sites within Tigard.

Coordinating Organization:

City of Tigard

Partner Organizations:

Washington County Office of Consolidated Emergency Management, Washington County Local Emergency Managers, Tigard Chamber of Commerce

Timeline:

Ongoing

Plan Goals Addressed:

Life, Property, and Natural Systems, Public Awareness and Partnerships, Emergency Services, and Implementation

ST-MH#7: Integrate the goals and action items from the Tigard Natural Hazard Mitigation Plan Addendum into existing regulatory documents and programs, where appropriate.

Ideas for Implementation:

- Ensure the Tigard Comprehensive Plan Chapter 7: Natural Hazards is consistent with the Tigard NHMPA;
- Integrate the city's mitigation plan into current regulatory documents to ensure development does not encroach on known hazard areas; and
- Partner with other organizations and agencies with similar goals to promote building codes that are more disaster resistant at the state level.

Coordinating Organization:

City of Tigard

Partner Organizations:

None.

Timeline:

Ongoing

Plan Goals Addressed:

Life, Property, and Natural Systems, Public Awareness and Partnerships, and Implementation

ST-MH#8: Increase technical knowledge of natural hazards and mitigation strategies in Tigard and implement policies and programs on the basis of that knowledge.

Ideas for Implementation:

- Partner with Portland Western Railroad (P&W) to maintain vegetation along the railroad;
- Encourage planting of native species along the waterways;
- Identify interface zones and target them for public education about defensible space, landscaping techniques, etc; and
- Identify research institutions and programs that can provide technical assistance in natural hazards research and mitigation.

Coordinating Organization:
City of Tigard

Partner Organizations:
None

Timeline:
Ongoing

Plan Goals Addressed:
Life, Property, and Natural Systems, Public Awareness and Partnerships, and Implementation

ST-MH#9: Develop public and private partnerships to foster natural hazard program coordination and collaboration in Tigard.

Ideas for Implementation:

- Develop partnerships between land use planners, geologists, and emergency responders to implement specific mitigation projects; and
- Establish neighborhood emergency service and mitigation teams to collaborate with the City Emergency Manager.

Coordinating Organization:
City of Tigard

Partner Organizations:
None

Timeline:
Ongoing

Plan Goals Addressed:

Life, Property, and Natural Systems, Public Awareness and Partnerships, and Implementation

ST-MH#10: Develop an inventory of at-risk public buildings and infrastructure and prioritize mitigation projects based on those providing the most benefit (at the least cost) to the city and residents.

Ideas for Implementation:

- Develop an inventory of un-reinforced masonry buildings to target for mitigation;
- Develop an inventory of mobile homes for flood, windstorm, and earthquake mitigation;
- Identify at-risk bridges for flood and earthquake hazards, identify enhancements, and implement projects needed to reduce the risks; and
- Review and improve utility operations and services to mitigate for natural hazards.

Coordinating Organization:
City of Tigard

Partner Organizations:
None

Timeline:
Ongoing

Plan Goals Addressed:
Life, Property, and Natural Systems, Public Awareness and Partnerships, and Implementation

LT-MH#1: Develop, enhance and implement outreach and educational programs aimed at mitigating and reducing the risk of natural hazards.

Ideas for Implementation:

- Identify the informational needs of the community and develop corresponding outreach programs;
- Encourage planting of native species along waterways;
- Identify research institutions and programs that can provide technical information

about natural hazards research and mitigation.

Coordinating Organization:

City of Tigard

Partner Organizations:

Community Interest Groups

Timeline:

1-5 Years

Plan Goals Addressed:

Life, Property, and Natural Systems, Public Awareness and Partnerships, and Implementation

LT-MH#2: Identify and pursue funding opportunities to develop and implement mitigation activities.

Ideas for Implementation:

- Continue to seek and apply for competitive federal grant sources
- Identify contractors who can assist in development of high priority mitigation projects.

Coordinating Organization:

City of Tigard

Partner Organizations:

None

Timeline:

Ongoing

Plan Goals Addressed:

Life, Property, and Natural Systems, and Implementation

Section 5: Flooding

Why are floods a threat to Tigard?

Introduction

As discussed in the County Hazards Plan, Oregon's largest economic loss from natural disasters has resulted from flooding. Floods are also Oregon's most frequently occurring natural disaster. Floods can have a devastating impact on almost every aspect of the community, including private property damage, public infrastructure damage, and economic loss from business interruption. Floods are influenced by a number of factors, including the amount and intensity of precipitation, geography and geology, and development activity. The City of Tigard cannot control precipitation or the community's soil type but can control development activity which contributes to, and is affected by, flooding. The last major flood event in 1996 inundated 2.2% of the land area in Tigard.

100-Year Floodplain

The Oregon Natural Hazard Technical Resource Guide defines a floodplain as a land area adjacent to a river, stream, lake, estuary, or other water body that is subject to flooding. These areas, if left undisturbed, act to store excess flood water. The 100-year floodplain is an area of land that has a 1% chance of being inundated by flood waters in any year. The 100-year floodplain includes a number of streams in the community: Tualatin River, Fanno Creek, Red Rock Creek, Summer Creek, Ash Creek, and Hiteon Creek.

Soil Characteristics

The physical qualities of soil contribute to ground stability, water infiltration and suitability for vegetation. Soils which are less permeable, or have high water tables, allow less infiltration and result in more water flowing over the surface. A large proportion of Tigard has high water tables and less permeable soils. With greater amounts of flowing water, such as storm events, the velocity may lead to erosion.

by the numbers...

20 Historic Events, 49% Probability, 0 Critical Facilities Exposed, 0 Essential Facilities Exposed, 15 Infrastructure Facilities Exposed, Hazard Score of 3, 382 Tax Lots Exposed, 475.1 Acres Exposed, \$231,045,080: Value of Structures Exposed

The drainage class assigned to each soil type is based on the soil composition and roughly indicates the degree, frequency, and duration of wetness, which are factors in rating soils for various uses. There are seven natural drainage classes: excessively, somewhat excessively, well, moderately well, somewhat poorly, poorly, and very poorly drained. No soils in Tigard are classified as excessively or somewhat excessively drained, and only 6% of soils in Tigard are "well" drained, meaning that water is removed from the soil readily but not rapidly. The largest proportion of Tigard soils (covering 48% of the City) are classified as "moderately well" drained. Water is removed slowly from the remaining soils (42.73%) classified as "somewhat poorly" and "poorly" drained, 28% and 14.5% respectively.

Characteristics of Flooding in Tigard

Floods can have a devastating impact on almost every aspect of the community, including private property damage, public infrastructure damage, and economic loss from business interruption. It is important for the City to be aware of flooding impacts and assess its level of risk. The City has been proactive in mitigating flood hazards by purchasing floodplain property.



The City of Tigard is located in the Tualatin Basin, with the Tualatin River defining the city's southern border. Streams within the city's border include Fanno Creek, which has two primary tributaries, Ash Creek and Summer Creek, and eight smaller tributaries, including Red Rock, Pinebrook, Ball, Derry Dell, Krueger, Hiteon and two unnamed streams. Two small perennial streams, Copper Creek and an unnamed stream, flow directly into the Tualatin River. Tigard also has two lakes and ponds in residential areas. All of these water sources are susceptible to annual flooding events.

The City is at risk from two types of flooding: riverine and urban. Riverine flooding occurs when streams overflow their banks and inundate low-lying areas. This is a natural process that adds sediment and nutrients to fertile floodplain areas. It usually results from prolonged periods of precipitation over a wide geographic area. Most areas are generally flooded by low velocity sheets of water. Urban flooding occurs as land is converted to impervious surfaces and hydrologic systems are changed. Precipitation is collected and transmitted to streams at a much faster rate, causing floodwaters that rise rapidly and peak with violent force. During urban flooding, storm drains can back up and cause localized flooding of streets and basements.

The Tualatin River and Fanno Creek are susceptible not only to heavy rain but also to the potential failure of Scoggins Dam at Hagg Lake. At times of heavy rain these rivers, creeks, and lakes can

overflow. Fanno Creek is the most susceptible to flooding in these instances, with many bridges contributing to the high water.

Historical Flood Events

Before flood control systems were in place, widespread flooding occurred throughout the Tualatin Basin on a regular basis. Human activities within the Tualatin Basin have significantly changed the hydrology of the watershed: dams and flood control systems have been constructed, citizens have altered wetlands and floodplains, and urbanization has recently occurred at a steady pace. To evaluate historical flood events, consideration must be given to the impacts of these activities. Flood events in 1964 and 1996 were the most damaging in the modern flood control era. Below are the most significant flood events that have occurred in Tigard in recent years:

- Dec. 1964
- Jan. 1972
- Jan. 1973
- Jan. 1974
- Nov./Dec. 1977
- Dec. 1981
- Jan. 1982
- Jan. 1991
- Nov. 1995
- Feb. 1996

Repetitive Flood Loss

The City of Tigard works to mitigate problems regarding flood issues when they arise. Some areas in the city are more susceptible to flooding than others. The County Plan states that according to the National Flood Insurance Program (NFIP), a repetitive loss is one that has had two or more losses reported where \$1,000 or more was paid on each loss. The two losses must have occurred within ten years of each other and be at least ten days apart. According to the most current data from Oregon Emergency Management, there is one repetitive loss property in Tigard.

Flood Hazard Assessment

Hazard Identification

Hazard identification is the first step of flood hazard assessment. The geographic extent of the flooding hazard was determined using the designated FEMA 100-year floodplain data, as well as the inundation line for the 1996 flood. Map 5 illustrates the flood hazard area for Tigard and shows that there are 595 acres identified in the FEMA 100 year floodplain, which is 7.9% of the total 7,501 acres in the City.

The probability of flooding events in Tigard was determined using historical occurrences, local knowledge, and other data. The probability of flooding in Tigard is described in Section ten.

Vulnerability Assessment

Vulnerability assessment is the second step of flood hazard assessment. Table 5-1 shows tax lots that intersect the floodplain, their acreage, and the value of structures on the property. Only tax lots with an existing structure are included. Tax lots that intersect the 1996 flood inundation area are also included. This information was calculated to provide an estimate for potential flood losses.

Flood Plain	Tax Lots	Acres	Value*
FEMA100-Year & 1996 Combined	382	475.1	\$231,045,080
FEMA 100-Year Only	371	473.0	\$228,863,100
1996 Only	34	74.2	\$31,322,220

* From Washington County Assessor. The structures are on tax lots that intersect the floodplain and may or may not physically reside within the floodplain themselves.

There is a potential for property damage from the Tualatin River, Tigard creeks, and Scoggins Dam. Inadequate size and moderate grade of the channel for the Tualatin River and Fanno creek causes over-bank flooding even in mild storms. The flow of Fanno Creek is constricted by many culverts and bridges resulting in increased upstream heights. The potential for damage is significant due to extensive development in the Fanno Creek flood-basin.

Currently, no critical or essential facilities are located in the floodplain. However, there are 14 bridges and one Portland General Electric power station located inside the floodplain. There is no financial impact data available of this infrastructure. Streets within the city that could be impacted by a 100-year flood event include 6.1 miles. If major flooding affected all of the bridges in Tigard, traffic flow in an out of the City would be significantly affected, but would not cut all off all avenues. Highway 99W and Highway 217 are major transportation routes between Portland and cities such as Tigard, Sherwood, Lake Oswego and Tualatin. The amount of property in the flood plain is not a large area but damage could be significant as it would affect residential, commercial, and public property. Floodwaters can affect building foundations, seep into basements, or cause damage to the interior, exterior, and contents of buildings, dependent upon the velocity and depth of the water and by the presence of floating debris. The city sewer system can overflow during flood events and cause further property damage.

Risk Analysis

The flood season for Tigard extends from late October through April. Historically, the majority of flooding has occurred in December, January, and February. Tigard has recurrent and substantial flood problems from Fanno Creek, Ash Creek, Summer Creek and the Tualatin River.

Mitigation Plan Goals and Existing Activities

Mitigation Plan Goals and Public Priorities

In 2007, the City of Tigard initiated a Comprehensive Plan amendment to update the Natural Hazards section of the Comprehensive Plan. This effort included citizen participation through an open house, citizen interest team meetings, and through the legislative process. The City's Comprehensive Plan contains the following policies related to floods:

- Goal 7.1 Protect people and property from flood, landslide, earthquake, wildfire, and severe weather events.

Policies:

7. The City shall comply with the Federal Emergency Management Agency (FEMA) flood regulations, which include standards for base flood levels, flood proofing, and minimum finished floor elevations.
8. The City shall prohibit any land form alterations or developments in the 100-year floodplain which would result in any rise in elevation of the 100-year floodplain.
9. The City shall not allow land form alterations or development within the 100-year floodplain outside the zero-foot rise floodway unless:
 - A. The streamflow capacity of the zero-foot rise floodway is maintained; and
 - B. Engineered drawings and/or documentation shows there will be no detrimental upstream or downstream effects in the floodplain area.
10. The City shall work with Clean Water Services to protect natural drainage-ways and wetlands as valuable water retention areas and, where possible, find ways to restore and enhance these areas.
11. The City shall comply with Metro Title 3 Functional Plan requirements for balanced fill and removal in the floodplain.
12. The City shall encourage pervious, and minimize impervious, surfaces to reduce storm water runoff.

Existing Mitigation Activites

The City has experienced a number of flood events in recent history and coordinates with several agencies to mitigate the risk of flooding. The Federal Emergency Management Agency (FEMA) coordinates the effort to reduce the community’s risk to flooding by mapping the 100-year floodplain. The 100-year floodplain includes six streams and 7.9% of all land area in Tigard. Oregon state law then regulates development within the 100-year



floodplain and Tigard complies through adoption of Metro’s Urban Growth Management Functional Plan, Title 3. The Sensitive Lands chapter of the Tigard Community Development Code implements Title 3 and includes Clean Water Services’ Design and Construction Standards. The Oregon Division of State Lands (DSL), jointly with the U.S. Army Corps of Engineers, requires a permit for development within the waters of the United States. Any disturbance to a water body and its associated floodplain is covered through this process. The City of Tigard is required to sign off on any permits issued by DSL.

Projects by the City of Tigard and Clean Water Services conducted in coordination with citizen volunteers, Ash Creek Forest Management, Harris Stream Services and the Tualatin Riverkeepers include: riparian area native plantings along Fanno Creek, Hiteon Creek and Derry Dell Creek and in-stream work in Hiteon Creek and Fanno Creek to improve their associated floodplains. This work includes channel modifications, installation of woody debris, construction of step-down ponds, and bio-swale/side channel construction.

The 1997 Fanno Creek Watershed Management Plan (Fanno Plan), prepared by Clean Water Services (CWS) for all jurisdictions within the Tualatin Basin, is the principal drainage plan in Tigard. The Fanno Plan covers 85% of Tigard (the remaining 15% of the jurisdiction drains directly into the Tualatin River) and has been adopted by the City. Included in the Fanno Plan is an inventory of

drainage structures, an evaluation of their adequacy of capacity, and recommended city infrastructure improvements to reduce flooding.

The Fanno Plan divides recommended projects by priority, with the highest being the replacement of bridges and culverts determined to have inadequate openings to pass a 100-year flood. Three bridges spanning Fanno Creek and one culvert on Summer Creek have been rated as high priority. Medium priority projects replace inadequate culverts along tributary streams. The Fanno Plan recommends culvert replacement be evaluated for fish passage as required by the Endangered Species Act. A number of low priority projects were recommended, with two bridge replacements on Ash Creek included. Funding for these projects is available through the Storm Sewer Fund that results from the collection of systems development charges.

Flood Mitigation Action Items

The flood mitigation action items provide direction on specific activities that organizations and residents in the City of Tigard can undertake to reduce risk and prevent loss from flood events. Each action item is followed by ideas for implementation, which can be used by the steering committee and local decision makers in pursuing strategies for implementation. The County's flood mitigation action items are presented in Section four of the County NHMA Plan.

ST-FL#1: Continue to maintain eligibility for the National Flood Insurance Program.

Ideas for Implementation:

- Comply with the Federal Emergency Management Agency (FEMA) flood regulations, which include standards for base flood levels, flood proofing, and minimum finished floor elevations;
- Comply with Metro Title 3 Functional Plan requirements for balanced fill and removal in the floodplain; and
- Research the feasibility of reducing flood insurance premiums in Tigard by becoming a participant in FEMA's Community Rating System (CRS) program.

Coordinating Organization:

City of Tigard

Partner Organizations:

FEMA Region X

Timeline:

1-2 Years

Plan Goals Addressed:

Life, Property, and Natural Systems, Public Awareness and Partnerships, and Implementation

ST-FL#2: Update and maintain a list of critical public infrastructure and facilities located in known flood hazard areas and highlight those facilities as a focus for mitigation and preparedness measures.

Ideas for Implementation:

- Update and maintain a list of critical facilities based on the standardized thresholds in the Critical Infrastructure Protection Plan; and
- Develop strategies to mitigate risk to these facilities, or to utilize alternative facilities should flood events cause damage to the primary facility.

Coordinating Organization:

City of Tigard

Partner Organizations:

None

Timeline:

1-3 Years

Plan Goals Addressed:

Life, Property, and Natural Systems, Emergency Services, and Implementation

LT-FL#1: Update the Storm Water Management Master Plan (SWMMP), and identify appropriate mitigation strategies.

Ideas for Implementation:

- The updated SWMMP should:
 - Identify and reduce development encroachment into storm water detention basins,
 - Address the Removal of dry wells, prioritize replacements, and attain

- funding for upgrades, and
- Identify areas that are frequently inundated due to low elevation and storm water run-off and develop mitigation strategies including public education materials;
- Refer to FEMA and the United States Army Corps of Engineers for information to assist in mitigation efforts; and
- Work with Clean Water Services to protect natural drainage ways and wetlands as valuable water retention area and, where possible, find ways to restore and enhance these areas.

Coordinating Organization:

City of Tigard

Partner Organizations:

Clean Water Services, FEMA Region X

Timeline:

3-5 Years

Plan Goals Addressed:

Life, Property, and Natural Systems, Public Awareness and Partnerships, and Implementation

LT-FL#2: Develop and implement strategies to restore and enhance the natural functions of floodplains and open space.

Ideas for Implementation:

- Partner with local jurisdictions and outside organizations;
- Identify sites where environmental restoration work can benefit flood mitigation, fish habitat, and water quality; and
- Work with landowners to restore natural drainageways and floodplain property.

Coordinating Organization:

City of Tigard

Partner Organizations:

Clean Water Services

Timeline:

3-5 Years

Plan Goals Addressed:

Life, Property, and Natural Systems, Public Awareness and Partnerships, and Implementation

LT-FL#3: Integrate a flood hazard component into local watershed education programs.

Ideas for Implementation:

- Identify existing watershed education programs and determine which program(s) would support a flood education component; and
- Collaborate with existing program managers to develop a flood education component to local programs.

Coordinating Organization:

City of Tigard

Partner Organizations:

None

Timeline:

3-5 years

Plan Goals Addressed:

Life, Property, and Natural Systems, Public Awareness and Partnerships, and Implementation

Section 6: Landslide

Why are landslides a threat to Tigard?

Introduction

People and property are best protected from landslides when building structures and roads are not built within areas prone to mass movement. Landslides, the lateral or downhill movement of rock, debris, or soil mass, pose a serious threat in Oregon. They are typically triggered by periods of heavy rainfall or rapid snowmelt; however, earthquakes, volcanic activity, and excavations may also trigger landslides. Landslides are classified by the rate at which they move, either fast debris flow, or slow. Both have the ability to cause significant property damage, but slow-moving landslides are less likely to cause significant human injuries.

The effects of landslides are often more widespread than the physical area they inhabit. Landslides can affect utility services, transportation systems, and critical lifelines as identified in the County NHMA Plan. Disruption of infrastructure, roads, and critical facilities may also create a lingering effect on the economy. The loss of electricity has the most widespread impact on other utilities and on the whole community. Natural gas pipes may also be at risk from landslide movements as small as an inch or two. Roads and bridges are subject to closure during landslide events, the impact of which can be amplified if the closed road or bridge is a critical lifeline to hospitals and other emergency facilities.

Drainage Characteristics

The soils permeability significantly affects site drainage by permitting or restricting the seepage of water underground. Permeability depends on the soil's structure, porosity, and texture. The permeability of roughly half of Tigard's soils are considered to be moderate to moderately slow, while the other half has slow to very slow permeability. Soil features also affect the amount of runoff and the risk of erosion; however, the degree to which

by the numbers...

6 Historic Events, **35%** Probability, **0** Critical Facilities Exposed, **0** Essential Facilities Exposed, **0** Infrastructure Facilities Exposed, Hazard Score of **1**, **624** Tax Lots Exposed, **286.2** Acres Exposed, **\$192,435,982**: Value of Structures Exposed

each soil type contributes to these events depends also on the steepness of the slope. The conditions which can lead to landslides are discussed in detail in the County NHMA Plan.

Characteristics of Landslides in Tigard

The most common type of landslides in Washington County are slides caused by erosion. Slides move in contact with the underlying surface, are generally slow moving, and can be deep. Rainfall-initiated landslides tend to be smaller; while earthquake induced landslides may be quite large. All soil types can be affected by natural landslide triggering conditions.

The County NHMA Plan reports that although landslides are a natural geologic process, the incidence of landslides and their impacts on people can be exacerbated by human activities. Such human activities include grading for road construction and development, excavation, drainage and groundwater alterations, and changes in vegetation. The County NHMA Plan gives three examples of development-related actions that can put people at an increased risk of landslides: 1) creating steeper slopes; 2) development on or adjacent to, existing landslides; and 3) development on gentle slopes.

Historical Landslide Events

Landslide events within the City have not significantly impacted residents or caused major property damage in the past; however, landslides have had an impact in Washington County. In 1996, for example, there were 39 landslides within Washington County. The 1996 landslide events were caused by heavy rain on snow at higher elevations and caused several fatalities in Oregon. The effect of the 1996 landslides on Washington County is detailed in the County NHMA Plan.

Landslide Hazard Assessment

Hazard Identification

An essential step towards mitigation of landslide hazards is to identify where these hazards are located. The two state agencies involved in mapping debris flow, or fast moving landslides, are the Oregon Department of Forestry (ODF) and DO-GAMI. The ODF’s flow maps include locations subject to naturally occurring debris flows, the initiation sites and projected paths. Using a 25% or greater threshold to identify potentially unstable slopes, 286.2 acres of land in Tigard are at risk of landslides. The geographic extent of the landslide hazard is illustrated using percent slope, soil type, and bedrock type. The landslide hazard is depicted on Map 6, and shows that landslides would affect less than 3% of the city’s land area.

Vulnerability Assessment

Landslide loss estimates are shown in Table 6-1 using a 25% or greater threshold to identify potentially unstable slopes. The landslide hazard threatens 4.3 miles of critical streets in Tigard; potentially landslides could inhibit traffic flow, cause damage to roads, as well as damage buildings.

	Number	Acres	Estimated Value
Critical Facilities	0	-	-
Essential Facilities	0	-	-
Infrastructure	0	-	-
Tax lots with structure	624	286.2	\$192,435,982

Risk Analysis

Due to insufficient data, Tigard is unable to perform a quantitative risk assessment at this time. The city has addressed this issue in the action

items, and will be completing a risk assessment as data and resources become available.

Mitigation Plan Goals and Existing Activities

Mitigation Goals and Public Priorities

In 2007, the City of Tigard initiated a Comprehensive Plan amendment to update the Natural Hazards section of the Comprehensive Plan. This effort included citizen participation through an open house, citizen interest team meetings, and through the legislative process. The City’s Comprehensive Plan contains the following policies related to landslides:

Goal 7.1 Protect people and property from flood, landslide, earthquake, wildfire, and severe weather events.

Policies:

1. The City shall not allow development in areas having the following development limitations except where the developer demonstrates that generally accepted engineering techniques related to a specific site plan will make the area suitable for the proposed development:
 - A. areas having a severe soil erosion potential;
 - B. areas subject to slumping, earth slides, or movement;
 - C. areas having slopes in excess of 25%; or
 - D. areas having severe weak foundation soils.
10. The City shall work with Clean Water Services to protect natural drainage-ways and wetlands as valuable water retention areas and, where possible, find ways to restore and enhance these areas.
13. The City shall retain and restore existing vegetation with non-invasive species in areas with landslide potential to the greatest extent possible.



Existing Mitigation Activities

Existing mitigation activities are implemented by city, county, regional, state, or federal agencies and organizations. The Tigard Municipal Code addresses erosion specifically in Chapter 16.28, stating that “temporary and permanent measures for all construction projects shall be required to lessen the adverse effects of erosion and sedimentation.” The City regulates development on steep slopes in the Community Development Code Section 18.775.070. Any proposed development on either steep slopes (slopes of 25% or greater) or unstable ground must obtain a sensitive lands permit, and approval is granted based on findings that:

1. The extent and nature of the proposed land form alteration or development will not create site disturbances to an extent greater than that required for the use;
2. The proposed land form alteration or development will not result in erosion, stream sedimentation, ground instability, or other adverse on-site and off-site effects or hazards to life or property;
3. The structures are appropriately sited and designed to ensure structural stability and proper drainage of foundation and crawl space areas for development with any of the following soil conditions wet/high water table; high shrink-swell capability, compressible/organic; and shallow depth-to-bedrock; and

4. Where natural vegetation has been removed due to land form alteration or development, the areas not covered by structures or impervious surfaces will be replanted to prevent erosion in accordance with Chapter 18.745, Landscaping and Screening.

The City also maintains a buildable lands map including a steep slopes layer pointing to areas within the city that have slopes greater than 25%. The map is available online in the GIS section of the City website, or by contacting the Long Range Planning Department.

Although the city currently uses steep slopes to define sensitive lands in the Community Development Code and has special requirements for development in these areas, when LIDAR information is available, the city will evaluate the effectiveness of this approach to identifying landslide hazards and limiting their impact on the community.

Landslide Mitigation Action Items

The landslide mitigation action items provide direction on specific activities that the City of Tigard, outside organizations, and citizens can undertake to reduce risk and prevent loss from landslide events. Each action item is followed by ideas for implementation, which can be used by the steering committee and local decision makers in pursuing strategies for implementation. The County’s landslide mitigation action items are found in Section five of the County NHMA Plan.

LT-LS #1: Seek to improve knowledge of landslide hazard areas and of vulnerability and risk to life and property in those areas.

Ideas for Implementation:

- Update and maintain current maps of areas within the city that are subject to mass movement;
- Identify the location and extent of hazard areas and establish a baseline to support implementation of future measures; and

- Analyze the risk of these life, property, and infrastructure exposures.

Coordinating Organization:

City of Tigard

Partner Organizations:

Metro Data Resource Center, US Geological Survey, Oregon Department of Forestry

Timeline:

Ongoing

Plan Goals Addressed:

Life, Property, and Natural Systems, and Implementation

LT-LS #2: Protect existing development in landslide prone areas.

Ideas for Implementation:

- Provide information to residents on landslide prevention;
- Retain and restore existing vegetation with non-invasive species in areas with landslide potential to the greatest extent possible;
- Encourage private property owners to restrict certain activities on landslide-prone properties;
- Construct debris flow diversions to protect existing properties; and
- Use and publicize the Oregon Department of Forestry’s (ODF) debris flow warning system.

Coordinating Organization:

City of Tigard

Partner Organizations:

Oregon Department of Forestry, Washington County Office of Consolidated Emergency Management

Timeline:

Ongoing

Plan Goals Addressed:

Life, Property, and Natural Systems, Public Awareness and Partnerships, Emergency Services, and Implementation

LT-LS #3: Maintain public and private drainage systems.

Ideas for Implementation:

- Ensure that ditches, water quality facilities, and culverts are inspected and cleared prior to the wet season each year; and
- Encourage pervious, and minimize impervious, surfaces to reduce storm water runoff.

Coordinating Organization:

City of Tigard

Partner Organizations:

None

Timeline:

Ongoing

Plan Goals Addressed:

Life, Property, and Natural Systems, Public Awareness and Partnerships, and Implementation

Section 7: Wildfire

Why are wildfires a threat to Tigard?

Although wildfire is commonly perceived to happen in densely forested or rural areas, the realities of urban interface wildfire are becoming more apparent. An example of which is the significant rise in cost of fire suppression as a large number of homes have been threatened or burned by wildfire, according to the Oregon Natural Hazards Plan. Wildfire, or any fire occurring on wildlands that requires response by firefighters, is characterized in the County NHMA Plan by an increased fire risk in the urban interface zone. The Oregon Natural Hazards Plan reports the probability that a fire will occur in the interface area of Washington County is moderate. The conditions conducive to significant interface wildfires include hot, dry, and windy weather; the inability of fire protection forces to contain or suppress the fire; the occurrence of multiple fires that overwhelm committed resources; and a large fuel load (dense vegetation).

Urban Interface Zone

The County NHMA Plan defines the urban interface zone as the urban-rural fringe where homes and other structures are built into a densely forested or natural landscape. The increasing number of houses being built in the urban interface zone has produced a significant increase in threats to life and property from fires, and has pushed existing fire protection systems beyond original or current design and capability. Oftentimes, property owners in the interface are not aware of the problems and threats they face, so many have done very little to manage or offset fire hazards or risks on their own property.

Characteristics of Wildfire in Tigard

In Tigard, the wildfire hazard zone exists primarily at the perimeter of the city, as this is where the urban interface zone also exists. The Oregon Natural Hazards Plan declares that although wildfires may result from natural causes, a mechanical failure,

by the numbers...

16 Historic Events, 49% Probability, 3 Critical Facilities Exposed, 5 Essential Facilities Exposed, 9 Infrastructure Facilities Exposed, Hazard Score of 2, 5241 Tax Lots Exposed, 2395.2 Acres Exposed, \$1,345,812,798: Value of Structures Exposed

or human causes, most wildfires can be linked to human carelessness. The ONHP also states that the intensity and behavior of wildfire depends on a number of factors including fuel, topography, weather and density of development. An Oregon Department of Forestry study found approximately 122,982 acres of wildland/urban interface in Washington County.

Historical Wildfire Events

Statistics provided by Tualatin Valley Fire and Rescue show the City of Tigard had 191 brush and grass fires from 2001 until present. Earlier wildfire history specific to Tigard was not available. The large-scale wildfires affecting the region are described in the Washington County Natural Hazards Mitigation Plan and the Washington County Wildfire Protection Plan.

Wildfire Hazard Assessment

Hazard Identification

Map 7 was generated using data from Washington County GIS and identifies Tigard's wildfire hazards based upon fuels, weather, and topography, as defined by ORS 629-044-0240. The map identifies more than 30% of all land in Tigard as vulnerable to wildfire.



Vulnerability Assessment

Wildfire loss estimates are shown in Table 7-1. About 31.6 miles of critical streets are exposed to the wildfire hazard zone. Property can be damaged or destroyed with one fire as structures, vegetation, and other flammables easily merge to become unpredictable and hard to manage. Other factors that affect ability to effectively respond to a wildfire include access to the location and to water, response time from the fire station, availability of personnel and equipment, and weather (e.g., heat, low humidity, high winds, and drought).

	Number	Acres	Estimated Value
Critical Facilities	3	-	-
Essential Facilities	5	-	-
Infrastructure	9	-	-
Tax lots with Structure	5241	2395.2	\$1,345,812,798

Risk Analysis

Due to insufficient data, Tigard is unable to perform a quantitative risk assessment at this time. The city has addressed this issue in the action items, and will be completing a risk assessment as data and resources become available.

Mitigation Plan Goals and Existing Activities

Mitigation Goals and Public Priorities

In 2007, the City of Tigard initiated a Comprehensive Plan amendment to update the Natural Hazards section of the Comprehensive Plan. This effort included citizen participation through an open house, citizen interest team meetings, and

through the legislative process. The City's Comprehensive Plan contains the following policies related to wildfires:

Goal 7.1 Protect people and property from flood, landslide, earthquake, wildfire, and severe weather events.

Policies:

14. The City shall enforce standards requiring the creation and maintenance of defensible space around habitable structures located in wildfire hazard areas.

Existing Mitigation Activities

The City of Tigard works with Tualatin Valley Fire and Rescue to mitigate the effects of wildfire. The City's Municipal Code includes provisions aimed at controlling vegetation before becoming a fire hazard (Section 8.04.110). Tualatin Valley Fire and Rescue is responsible for all fire prevention and education, including counseling for juvenile fire-setters, teaching fire prevention in schools, conducting CPR classes, teaching proper use of fire extinguishers, coordinating educational programs with other agencies, administering the smoke alarm program, and answering citizens' questions. In addition, TVF&R has the opportunity to comment on all development applications and maps the urban interface zone in Tigard.

The Oregon Department of Environmental Quality (DEQ) controls both backyard and agricultural burning in Oregon; however, Tigard is within the DEQ permanent burn-ban area in an effort to reduce the risk of wildfire as a result of backyard burning. Back yard burning is a key contributor to fires in the interface.

The Oregon Department of Forestry implements the Oregon Forestland-Urban Interface Fire Program, which is expected to be fully implemented by 2011, in order to protect interface communities in Oregon from wildfire. Also, the Fire Defense Board provides daily burn messages and restrictions for the community to prevent interface fires. This information originates from both the State Department of Forestry and the US Forest Service for all regions of the state.

Wildfire Mitigation Action Items

The wildfire mitigation action items provide direction on specific activities that the City of Tigard, citizens, and local organizations can undertake to reduce risk and prevent loss from landslide events. Each action item is followed by ideas for implementation, which can be used by the HMWG and local decision makers in pursuing strategies for implementation. The County's wildfire mitigation action items are found in Section eight of the County NHMA Plan.

ST-WF#1: Inventory and map alternative firefighting water sources and encourage the development of additional sources.

Ideas for Implementation:

- Identify alternative water sources such as ponds and reservoirs, and partner with owners to access this resource during emergencies.
- Maintain access roads and ramps to man-made natural water sources
- Promote water storage facilities with fire-resistant electrical pump systems in housing developments outside of the fire protection district that are not connected to a community water or hydrant system.

Coordinating Organization:

City of Tigard

Partner Organizations:

Tualatin Valley Fire and Rescue

Timeline:

1 Year

Plan Goals Addressed:

Life, Property, and Natural Systems, Emergency Services, and Implementation

LT-WF#1: Adopt the Tualatin Valley Fire and Rescue Wildfire Hazard Map and implement the Wildfire Hazard Mitigation section of the Oregon Residential Specialty Code.

Ideas for Implementation:

- Partner with Tualatin Valley Fire and Res-

cue to update and maintain a map of the Urban Interface Zone within Tigard.

Coordinating Organization:

City of Tigard

Partner Organizations:

Tualatin Valley Fire and Rescue

Timeline:

1-2 Years

Plan Goals Addressed:

Life, Property, and Natural Systems, Public Awareness and Partnerships, and Implementation

LT-WF#2: Work with Tualatin Valley Fire and Rescue Community Safety Program to provide information and education about urban interface wildfire to Tigard citizens.

Ideas for Implementation:

- Target neighborhoods within the Urban Interface Zone to conduct education and outreach activities.
- Conduct community-based demonstration projects of fire prevention and mitigation in the urban interface.

Coordinating Organization:

City of Tigard

Partner Organizations:

Tualatin Valley Fire and Rescue

Timeline:

1-2 Years

Plan Goals Addressed:

Life, Property, and Natural Systems, Public Awareness and Partnerships, and Implementation

Section 8: Weather: Wind and Winter Storms

Why are wind and winter storms a threat to Tigard?

Introduction

The Oregon Natural Hazards Mitigation Plan (NHMP) characterizes severe winter weather in the Metro area by extreme cold, snow, ice, and sleet. As discussed in the Oregon NHMP there are many buildings, utilities, and transportation Systems within the Portland Metropolitan Area that are vulnerable to wind damage. Fallen trees are a concern because they can affect emergency operations when they block roads and rail lines, in addition to the destruction caused by falling trees to power and/or utility lines, roofs, people, and property. According to the state's NHMP, the probability and vulnerability of significant wind and winter storms in Washington County is high.

Climate of Washington County

Washington County is located in the Willamette Valley where the climate is relatively mild throughout the year, characterized by cool, wet winters and warm, dry summers. The Willamette Valley has a predominant winter rainfall climate; about 50% of the total annual precipitation falls between December and February each year. Average temperatures range from the low 80's in the summer down to about 40 degrees in the coldest months. Only rarely do extreme temperatures occur in the Willamette Valley, with temperatures above 90 degrees Fahrenheit occurring an average of 5-15 times per year, and temperatures below zero degrees occurring only about once every 25 years.

According to Washington County's Climate History and Data as prepared by the state climatologist and posted online through the National Oceanic and Atmospheric Administration, although snow falls every year, amounts are generally quite low. Locations on the floor of the Willamette Valley average between 5-10 inches per year, mostly dur-

by the numbers...

16 Historic Events, 42% Probability,
Hazard Score of 5

ing December through February. Ice storms occur occasionally in Washington County as a result of cold air flowing westward through the Columbia Gorge; high winds occur several times per year in association with major weather systems.

Characteristics of Wind and Winter Storms in Tigard

Tigard is subject to a number of severe local storms such as freezing rain, high winds, snow, sleet, and hail. Ice storms bearing freezing rain and/or sleet occur every few years and can last from one day to several days. Prolonged precipitation or just prolonged cold can cause/prolong destructive ice build-up. Coastal hurricane force winds occasionally penetrate inland to the City of Tigard, resulting in wind gusts of 75 to 80 miles per hour. Approximately 60% of the recorded high winds are from the south or the west.

Heavy snowfall rarely occurs in Tigard. When it does occur, many of the subsequent problems are directly related to the public's unfamiliarity with such conditions. Ice storms may occur as a result of a combination of weather factors, either with or without a related snowfall. The heavy ice on power lines nearly always results in power outages throughout the city and the region.

Historic Wind and Winter Storm Events

The following dates represent occurrences of high winds that caused major damage:

- November 1962
- October 1967
- January 1971
- November 1981
- November 1982

- January 1991
- December 1995
- December 2007

The following dates represent occurrences of heavy snow fall for this area:

- January 1962
- January 1969
- January 1979
- January 1980
- December 1983
- February 1989
- December\January 1991
- January\February 1993
- February 1995
- January 2004
- January 2007

Wind and Winter Storm Assessment

Hazard Identification

The severe weather hazard is difficult to illustrate. The City of Tigard has mapped regular sanding routes, denoting areas most susceptible to snow and ice. However, the sanding routes map (Map 7) does not accurately portray the geographic extent of a severe storm in Tigard, as the entire city would be affected by large-scale storms.

Vulnerability Assessment

The City of Tigard has identified 59.3 miles of streets and roadways that would be sanded during severe weather. The city has not done a study on actual number of individuals or properties



that can be affected during a severe winter storm. Severe storms can bring power outages and cause transportation and economic disruptions. Specific problems for residences in the city are the number of electrical wires; trees, and tree limbs that come down during severe storms that cause both major and minor property damage as well as a threat to life. Downed wires and trees can make accessibility to residences by Police and Fire difficult.

Risk Analysis

Damage from high winds generally has resulted in downed utility lines and trees. Electrical power can be out anywhere from a few hours to 2 to 3 days. Outdoor signs have also suffered damage. If the high winds are accompanied by rain (which they often are), blowing leaves and debris clog drainage-ways, which in turn causes localized urban flooding. During a typical event, an estimated 25% of the population suffers some impact and up to 25% of all property would be affected. Tigard experiences severe weather two to three times a decade.

Mitigation Plan Goals and Existing Activities

Mitigation Goals and Public Priorities

In 2007, the City of Tigard initiated a Comprehensive Plan amendment to update the Natural Hazards section of the Comprehensive Plan. This effort included citizen participation through an open house, citizen interest team meetings, and through the legislative process. The City's Comprehensive Plan contains the following policies related to wind and winter storms:

Goal 7.1 Protect people and property from flood, landslide, earthquake, wildfire, and severe weather events.

Policy:

15. The City shall work to reduce the risk of loss of life and damage to property from severe weather events.

The proposed Land Use Planning section of the Comprehensive Plan contains an Urban Forest section which contains the following policy addressing hazardous trees:



Goal 2.3 To balance the diverse and changing needs of the City through well-designed urban development that minimizes the loss of existing trees to create a living legacy for future generations.

Policy:

4. The City shall address public safety concerns by ensuring ways to prevent and resolve verified tree related hazards in a timely manner.

Existing Mitigation Activities

The City sands streets during ice and/or snow events according to the designated sanding routes map. The City requires the undergrounding of utilities for all new subdivisions, which are required to place telephone, cable, and power lines underground. New single lot residential development is required to have service lines from the street to the home underground.

Wind and Winter Storm Mitigation Action Items

The wind and winter storm mitigation action items provide direction on specific activities that the City of Tigard, citizens, and local organizations can undertake to reduce risk and prevent loss from wind and winter storm events. Each action item is followed by ideas for implementation, which can be used by the HMWG and local decision makers in pursuing strategies for implementation. The County's wind and winter storm mitigation action

items are found in Section six of the County's NHMA Plan.

ST-WS #1: Increase public awareness of severe wind and winter storm mitigation activities.

Ideas for Implementation:

- Partner with Washington County Office of Consolidated Emergency Management to coordinate outreach and education annually during the fall.
- Develop and distribute educational material to Tigard citizens, businesses, and organizations about weather hazards.

Coordinating Organization:

City of Tigard

Partner Organizations:

Washington County Emergency Management and the CERT Program

Timeline:

Ongoing

Plan Goals Addressed:

Life, Property, and Natural Systems, Public Awareness and Partnerships, and Implementation

ST-WS #2: Develop and implement programs to keep trees from threatening lives, property, and public infrastructure during wind and winter storm events.

Ideas for Implementation:

- Work with property owners to abate hazardous trees on private property which threaten the public right-of-way;
- Conduct outreach to property owners about proper tree care and maintenance; and
- Abate hazardous trees on City owned property.

Coordinating Organization:

City of Tigard

Partner Organizations:

Portland General Electric, Pacific Northwest Chapter of the International Society of Arboriculture

Timeline:
Ongoing
Plan Goals Addressed:
Life, Property, and Natural Systems, Public Awareness and Partnerships, and Implementation

LT-WS #1: Map and publicize locations around the city that have the highest incidence of damage from extreme weather.

- Ideas for Implementation:
- Identify a responsible agency for central collection and reporting of storm data; and
 - Identify public infrastructure and facilities subject to closure due to snowfall, wind and ice hazards during severe winter storms.

Coordinating Organization:
City of Tigard
Partner Organizations:
None
Timeline:
1-3 Years
Plan Goals Addressed:
Life, Property, and Natural Systems, Public Awareness and Partnerships, Emergency Services, and Implementation

LT-WS #2: Develop and implement, or enhance strategies for debris management for windstorm and severe winter storm events.

- Ideas for Implementation:
- Develop coordinated management strategies for sanding roads, plowing snow, clearing roads of fallen trees, and clearing debris from public property;
 - Enhance tree-trimming efforts especially for transmission and trunk distribution lines;
 - Consider a tree pruning ordinance; and
 - Conduct a public awareness campaign to encourage property owners to trim trees near service drops to individual customers.

Coordinating Organization:

City of Tigard
Partner Organizations:
Pride Disposal, Waste Management
Timeline:
3-5 Years
Plan Goals Addressed:
Life, Property, and Natural Systems, and Implementation

Section 9: Earthquake

Why are earthquakes a threat to Tigard?

Introduction

A few years ago, the state ranked third nationally for future earthquake damage estimates: according to the 2004 Washington County Natural Hazards Mitigation Action Plan (County NHMA Plan), losses in the Cascadia region -- which includes Washington and Oregon -- could exceed \$12 billion, 30,000 destroyed buildings, and 8,000 lives lost in the event of a magnitude 8.5 Cascadia Subduction Zone earthquake (County NHMA Plan, p. 9-1). Because hazards, such as earthquake faults, extend across jurisdictional boundaries, it is essential to coordinate planning and emergency response services region-wide and with the state and federal governments. For example, due to the scale and complexity of earthquakes, Tigard coordinates with the Oregon Department of Geology and Mineral Industries (DOGAMI), Metro, Washington County, and surrounding jurisdictions to mitigate the risk associated with earthquakes.

Sources of Earthquakes in the Portland Metro Region

Oregon's Natural Hazard Mitigation Plan (NHMP) cites four possible sources of earthquakes in the northern Willamette Valley: the off-shore Cascadia Fault Zone, deep intraplate events within the subducting Juan de Fuca plate, shallow crustal events within the North America Plate, and earthquakes associated with renewed volcanic activity. The US Geological Survey released new earthquake hazard maps in April 2008 showing that earthquakes remain a serious threat in 46 of the United States. However, for most of the United States, the ground shaking estimates are lower than the maps released in 1996 and 2002. In Western Oregon and Washington, the new maps contain higher estimates for how hard the ground will shake.

Just off the Oregon Coast lies the Cascadia Subduction Zone, where two major geologic plates come together: Juan de Fuca and North America.

by the numbers...

6 Historic Events, 21% Probability, 15 Critical Facilities Exposed, 13 Essential Facilities Exposed, 23 Infrastructure Facilities Exposed, Hazard Score of 4, 8168 Tax Lots Exposed, 2768.0 Acres Exposed, \$1,939,484,614: Value of Structures Exposed

The State's NHMP reports that Subduction zone earthquakes, occurring at the boundary between the descending oceanic Juan de Fuca Plate and the overriding North American Plate, pose the greatest hazard. According to DOGAMI's relative earthquake hazard data, the Cascadia Subduction Zone could potentially cause a 9+ magnitude earthquake, affecting the entire Pacific Northwest.

Characteristics of Earthquakes in Tigard

While the Cascadia Subduction Zone could cause a large-magnitude earthquake that would affect the Tigard area, Tigard would more likely be subject to more frequent shallow earthquakes, or crustal fault earthquakes. According to the County NHMA Plan, most crustal fault earthquakes rate less than a magnitude 4 but can produce magnitudes up to 7 and cause extensive damage. The County NHMA Plan identified four faults within Washington County: Tualatin-Sherwood, Oatfield, Costco, and Gales Creek faults. In addition, the Oregon Department of Geology and Mineral Industries (DOGAMI) confirmed the nearby Portland Hills Fault as an active fault in May 2001, which could bring a magnitude 6.5 or larger earthquake (County NHMA Plan, p. 9-2, 9-3). According to the Oregon NHMP, hazards associated with Earthquakes include severe ground shaking, liquefaction of fine-grained soils, and landslides.



Historical Earthquake Events

According to the County NHMA Plan, the Portland metropolitan region has encountered 17 earthquakes of an estimated magnitude of 4 and greater, with major earthquakes in 1877 (magnitude 5.3), 1962 (magnitude 5.2), and 1993 (magnitude 5.6). In addition, earthquakes originated from both the North Plains and Mt. Angel faults in the 1990s. The dates and locations of significant northwest earthquakes are:

- 1946 Vancouver Island (7.3)
- 1949 Olympia (7.1)
- 1965 Seattle (6.5)
- 1993 Scotts Mills (5.6)
- 2001 Nisqually (near Olympia) (6.8)

The Scotts Mills earthquake on March 25, 1993 (dubbed Spring Break Quake) was the first significant earthquake (in recorded history) to originate in close proximity to Tigard. It was widely felt. Although Tigard experienced minor damage, there was enough damage done in Clackamas and surrounding counties, to be declared a federal disaster.

Earthquake Hazard Assessment

Hazard Identification

The geographic extent of the earthquake hazard in Tigard is illustrated using data derived from the Oregon Department of Geology and Mineral Industries. The relative hazards were determined by slope, soils, and bedrock characteristics. The original dataset shows the hazards in four relative

hazard zones, and the city broke earthquake hazard information into two categories, moderate and severe. Fifty-eight percent of the city is subject to the greatest earthquake hazard level, with an additional 21% falling into the next hazard level. These areas include developed residential and commercial areas, as well as the Washington Square Regional Center. The data is reflected on Map 9.

Vulnerability Assessment

The potential impact of an earthquake on facilities and infrastructure is shown in Table 9-1. Of the critical facilities affected, Zone A includes one fire station and seven city buildings; Zone B includes two city buildings. Of the essential facilities affected, Zone A includes six schools, one assisted living facility, three urgent care facilities, and three emergency shelters; Zone B includes four schools, one assisted living facility, and two urgent care facilities. Infrastructure affected includes 19 bridges, two power stations, and two communication towers in Zone A; Zone B includes three bridges and three power stations.

	Greatest Hazard		Least Hazard	
	Zone A	Zone B	Zone C	Zone D
Critical Facilities	15	2	1	0
Essential Facilities	13	9	2	3
Infrastructure	23	6	1	1
Total	51	17	4	4

Potential earthquake impacts on all structures within the city are shown in Table 9-2. Area affected in Zone A is 37% of total City area, while Zone B affects 14% of the entire city. Critical streets affected by Zone A totals 32.6 miles.

	Greatest Hazard			Least Hazard
	Zone A	Zone B	Zone C	Zone D
Tax lots	8168	2774	1483	1382
Acreage	2768	1019.2	520.2	455.9
Structure Value	\$1,939,484,614	\$710,249,115	\$410,062,062	\$313,307,486

The area within Tigard vulnerable to earthquakes is larger than the area potentially affected by any other hazard identified in the Plan, and could potentially produce more damage to life and property; although degree of damage is clearly related to degree an earthquake is felt. Transportation routes

and economics within the city can also be affected. Demand on resources such as Police, Fire, Emergency Medical Services (EMS) and Public Works would also be impacted. Older buildings and the sewer system are most vulnerable to damage from the hazards associated with earthquakes.

Risk Analysis

The County Plan provides a quantitative analysis of nine potential earthquake scenarios for the county. This analysis includes an estimation of fatalities, direct damage losses, number of buildings in complete damage state, and number of people requiring shelter. Tigard does not have the resources to conduct a local risk assessment for earthquakes, so the data reported in the county plan is the best quantitative assessment for earthquake hazards in Tigard.

Mitigation Plan Goals and Existing Activities

Mitigation Goals and Public Priorities

In 2007, the City of Tigard initiated a Comprehensive Plan amendment to update the Natural Hazards section of the Comprehensive Plan. This effort included citizen participation through an open house, citizen interest team meetings, and through the legislative process. The City's Comprehensive Plan contains the following policies related to floods:

Goal 7.1 Protect people and property from flood, landslide, earthquake, wildfire, and severe weather events.

Policies:

16. The City shall apply and enforce the most current building code standards to protect the built environment from natural disasters and other hazards.

Existing Mitigation Activities

To minimize loss of life and property from earthquakes, the city requires all new commercial, industrial, and multi-family structures to conform to Oregon Structural Specialty Code requirements, while single-family construction must conform to



the Oregon One and Two Dwelling Specialty Code for seismic category D1.

Earthquake Mitigation Action Items

The flood mitigation action items provide direction on specific activities that organizations and residents in the City of Tigard can undertake to reduce risk and prevent loss from earthquake events. Each action item is followed by ideas for implementation, which can be used by the steering committee and local decision makers in pursuing strategies for implementation. The County's earthquake mitigation action items are found in Section nine of the County's NHMA Plan.

ST-EQ#1: Retrofit existing public facilities and services to contemporary standards to better withstand natural disasters and hazardous occurrences.

Ideas for Implementation:

- DOGAMI lead a statewide seismic assessment of schools and critical facilities, as part of the GO bonds authorized in 2002, Tigard will seek access to the findings;
- Seek outside sources of funds to conduct the retrofit of seismically vulnerable facilities;
- Address planning for the protection of public facilities and services from seismic hazards in the Tigard Public Facilities Plan and Community Investment Plan; and
- Prioritize seismic upgrades based on criticality of need and population served.

Coordinating Organization:
City of Tigard
Partner Organizations:
Oregon Department of Geology and Mineral Industries
Timeline:
1-2 Years
Plan Goals Addressed:
Life, Property, and Natural Systems, Emergency Services, and Implementation

ST-EQ#2: Encourage City residents and businesses to purchase earthquake hazard insurance.

Ideas for Implementation:

- Provide earthquake information and access to resources for property owners who wish to assess the ability of their buildings to withstand a seismic event; and
- Design and implement a natural hazards home inspection program.

Coordinating Organization:
City of Tigard
Partner Organizations:
None
Timeline:
3-5 Years
Plan Goals Addressed:
Life, Property, and Natural Systems, Public Awareness and Partnerships, and Implementation

ST-EQ#3: Seek to reduce nonstructural hazards in homes, schools, businesses, and government offices.

Ideas for Implementation:

- Provide training to government building and school facility managers on securing bookcases, filing cabinets, light fixtures and other objects that could cause injuries or block exits.

Coordinating Organization:
City of Tigard

Partner Organizations:
Tigard-Tualatin School District
Timeline:
3-5 Years
Plan Goals Addressed:
Life, Property, and Natural Systems, Public Awareness and Partnerships, and Implementation

LT-EQ#1: Expand earthquake hazard mapping in Tigard and improve technical analysis of earthquake hazards.

Ideas for Implementation:

- Complete and continue to update mapping of earthquake hazards throughout Tigard; and
- Ensure that city officials reference Metro's earthquake hazards reports and maps when making land use decisions.

Coordinating Organization:
City of Tigard
Partner Organizations:
None
Timeline:
3-5 Years
Plan Goals Addressed:
Life, Property, and Natural Systems, Public Awareness and Partnerships, and Implementation

LT-EQ#2: Improve local capabilities to perform earthquake building safety evaluations and to record and manage building inventory data.

Ideas for Implementation:

- Offer periodic training in ATC-20 and ATC-21 procedures for earthquake building safety evaluations and encourage local building officials and other public and private officials to attend.

Coordinating Organization:
City of Tigard
Partner Organizations:
None.

Timeline:

3-5 Years

Plan Goals Addressed:

Life, Property, and Natural Systems, Emergency Services, and Implementation

LT-EQ#3: Enforce current building code standards and ensure only the appropriate land uses are allowed in high seismic hazard areas.

Ideas for Implementation:

- Consideration should be given to seismic hazard zones when siting essential public facilities.

Coordinating Organization:

City of Tigard

Partner Organizations:

None

Timeline:

3-5 Years

Plan Goals Addressed:

Life, Property, and Natural Systems, Public Awareness and Partnerships, Emergency Services, and Implementation



Section 10: Mitigation Planning Priority System

Action Item Prioritization Methodology

The Hazard Mitigation Working Group (HMWG) has prioritized the identified mitigation strategies in order to better allocate resources for plan implementation. The criteria used for prioritizing the action items are the plan goals, hazards addressed, criticality of need, population served, and likelihood of success.

Although this methodology provides a guide for the HMWG in terms of implementation, the HMWG has the option to implement any of the action items at any time. This option to consider all action items for implementation allows the HMWG to consider mitigation strategies as new situations or opportunities arise, such as capitalizing on funding sources that could pertain to an action item that is not the highest priority.

Step 1: Prioritize Plan Goals

The Tigard and Washington County mitigation goals were considered during each phase of the mitigation planning process. As the mitigation action items were developed, the HMWG identified which plan goals were addressed by each action item. The HMWG ranked the plan goals to determine the priorities for Tigard, and each goal was given a score of one point to five points, in ascending order. The points for the plan goals were then totaled for each action item. The prioritized plan goals are as follows:

- 4 Points: Life, Property, and Natural Systems
- 3 Points: Emergency Services
- 2 Points: Public Awareness and Partnerships
- 1 Point: Implementation

Step 2: Prioritize Hazards

The natural hazards addressed by the Tigard Natural Hazard Mitigation Plan Addendum were prioritized using a FEMA-accepted hazard analysis

methodology for Emergency Operations Plans. This methodology considers the history of the hazard, the vulnerability to the hazard, the maximum threat of the hazard (worst case scenario), and the probability of the hazard. Each of these criteria is weighted, and the final score is used for prioritizing the hazards. The following is a full description of the methodology used:

Categories Considered:

HISTORY:

The record of occurrences of previous major emergencies or disasters (weight factor = 2).

LOW	0 - 1 event per 100 years
MEDIUM	2 - 3 events per 100 years
HIGH	4 + events per 100 years

VULNERABILITY:

The percentage of population and property likely to be affected (weight factor = 5).

LOW	< 1% affected
MEDIUM	1 - 10% affected
HIGH	> 10% affected

MAXIMUM THREAT

The maximum percentage of population and property that could be impacted under a worst-case scenario (weight factor = 10).

LOW	< 5% affected
MEDIUM	5 - 25% affected
HIGH	> 25% affected

PROBABILITY:

The likelihood of occurrence within a specified period of time (weight factor = 7).

LOW	> 1 chance per 100 years
MEDIUM	> 1 chance per 50 years
HIGH	> 1 chance per 10 years

Severity Ratings:

LOW	= 1 - 3 points
MEDIUM	= 4 - 6 points
HIGH	= 7 - 10 points

Although the methodology used allows Tigard to quantify and compare natural hazards, it is flawed in that it compares hazards with high probabilities and relatively low consequences with hazards that have low probabilities and high consequences. The HMWG took this into consideration during the prioritization process, and the results are shown in Table 10-1. The hazards were given a score of one point to seven points, in ascending order of importance. The Multi-Hazard action items were given the highest score (6), as they address more than one hazard. The points for the hazard scores were then totaled for each action item.

Hazard	History	Vulnerability	Max. Threat	Probability	Total	Hazard Score
Multi-Hazard	-	-	-	-	-	6
Weather Storm	16	35	100	42	193	5
Earthquake	6	50	100	21	177	4
Flood	20	25	75	49	169	3
Wildfire	16	25	50	49	140	2
Landslide	6	25	40	35	106	1

Step 3: Incorporate Criticality of Need, Large Number of Population Served, Likelihood of Success

The final score for each action item was computed by summing the plan goal score and the hazard score. The Work Group then considered the criticality of need, the number of population served, and the likelihood of success. The HMWG is given an opportunity to add five points to the action item that has a high criticality of need, four points were given to the action item that has a high probability of success, and three points were given to an action item that serves a large number of the population. The Action Item Prioritization Score is given in Appendix A.

Appendix A: Action Item Matrix

Natural Hazard	Action Item	Coordinating Organizations	Partner Organizations	Timeline	Ideas for Implementation	Plan Goals Addressed				Score
						Life, Property, and Natural Systems	Public Awareness and Partnerships	Emergency Services	Implementation	
Multi-Hazard Mitigation Action Items										
ST-MH #1	Purchase, Enhance, and develop partnerships to access resources and equipment essential for responding to and recovering from disasters.	COT	Tigard Chamber, Oregon National Gaurd	1-3 Years	Pg. 22	x	x	x	x	16
ST-MH #2	Ensure Tigard citizens have access to adequate shelter facilities in hazard-free zones.	COT	Red Cross	Ongoing	Pg. 23	x	x	x	x	20
ST-MH #3	Enhance communication capabilities during hazard events.	COT	TTSD, TVCTV,	Ongoing	Pg. 23	x	x	x	x	21
ST-MH #4	Develop, enhance, and implement education programs designed to reduce loss from natural hazards.	COT	Wa. Co. OCEM, TTSD	Ongoing	Pg. 23	x	x	x	x	13
ST-MH #5	Promote the Citizen Emergency Response Team (CERT) program in Tigard and recruit new members for training.	COT	None	Ongoing	Pg. 24	x	x	x	x	20
ST-MH #6	Develop and enhance strategies for debris management during natural hazard events.	COT	Wa. Co. OCEM, Wa. Co. LEM, Tigard Chamber	Ongoing	Pg. 24	x	x	x	x	20

Natural Hazard	Action Item	Coordinating Organizations	Partner Organizations	Timeline	Ideas for Implementation	Plan Goals Addressed				Score
						Life, Property, and Natural Systems	Public Awareness and Partnerships	Emergency Services	Implementation	
Multi-Hazard Mitigation Action Items, ctd.										
ST-MH #7	Integrate the goals and action items from the Tigid Natural Hazard Mitigation Plan Addendum into existing regulatory documents and programs, where appropriate.	COT	None	Ongoing	Pg. 24	x	x		x	17
ST-MH #8	Increase technical knowledge of natural hazards and mitigation strategies in Tigid and implement policies and programs on the basis of that knowledge.	COT	None	Ongoing	Pg. 25	x	x		x	13
ST-MH #9	Develop public and private partnerships to foster natural hazard program coordination and collaboration in Tigid.	COT	Community Organizations	Ongoing	Pg. 25	x	x		x	13
ST-MH #10	Develop an inventory of at-risk public buildings and infrastructure and prioritize mitigation projects based on those providing the most benefit (at the least cost) to the city and residents.	COT	Wa. Co. OCEM, TTSD	Ongoing	Pg. 25	x	x		x	18
LT-MH #1	Develop, enhance and implement outreach and educational programs aimed at mitigating and reducing the risk of natural hazards.	COT	Community Organizations	1-5 Years	Pg. 25	x	x		x	13
LT-MH #2	Identify and pursue funding opportunities to develop and implement mitigation activities.	COT	None	Ongoing	Pg. 26	x			x	14

Natural Hazard	Action Item	Coordinating Organizations	Partner Organizations	Timeline	Ideas for Implementation	Plan Goals Addressed				Score
						Life, Property, and Natural Systems	Public Awareness and Partnerships	Emergency Services	Implementation	
Flood Mitigation Action Items										
ST-FL #1	Continue to maintain eligibility for the National Flood Insurance Program.	COT	FEMA Region X	1-2 Years	Pg. 31	x	x		x	15
ST-FL #2	Update and maintain a list of critical public infrastructure and facilities located in known flood hazard areas and highlight those facilities as a focus for mitigation and preparedness measures.	COT	None	1-3 Years	Pg. 31	x		x		15
LT-FL #1	Update the Storm Water Management Master Plan (SWMMP), and identify appropriate mitigation strategies.	COT	None	3-5 Years	Pg. 31	x			x	14
LT-FL #2	Develop and implement strategies to restore and enhance the natural functions of floodplains and open space.	COT	CWS	3-5 Years	Pg. 32	x		x		10
LT-FL #3	Integrate a flood hazard component into local watershed education programs.	COT	TTSD, CWS, Community Organizations	3-5 Years	Pg. 32	x		x		10
Landslide Mitigation Action Items										
LT-LS #1	Seek to improve knowledge of landslide hazard areas and of vulnerability and risk to life and property in those areas.	COT	None	Ongoing	Pg. 35	x			x	6

Natural Hazard	Action Item	Coordinating Organizations	Partner Organizations	Timeline	Ideas for Implementation	Plan Goals Addressed				Score
						Life, Property, and Natural Systems	Public Awareness and Partnerships	Emergency Services	Implementation	
Landslide Mitigation Action Items, ctd.										
LT-LS #2	Protect existing development in landslide prone areas.	COT	Wa. Co. OCEM, ODF	Ongoing	Pg. 36	x	x	x		16
LT-LS #3	Maintain public and private drainage systems.	COT	None	Ongoing	Pg. 36	x	x	x		12
Wildfire Mitigation Action Items										
ST-WF #1	Inventory and map alternative firefighting water sources and encourage the development of additional sources.	COT	TVF&R	1 Year	Pg. 39	x		x		10
LT-WF #1	Adopt the Tualatin Valley Fire and Rescue Wildfire Hazard Map and implement the Wildfire Hazard Mitigation section of the Oregon Residential Specialty Code.	COT	TVF&R	1-2 Years	Pg. 39	x	x	x		13
LT-WF #2	Work with Tualatin Valley Fire and Rescue Community Safety Program to provide information and education about urban interface wildfire to Tigard citizens.	COT	TVF&R	Ongoing	Pg. 39	x	x	x		9
Weather: Wind and Winter Storm Mitigation Action Items										
ST-WS #1	Increase public awareness of severe wind and winter storm mitigation activities.	COT	Wa. Co. OCEM	Ongoing	Pg. 43	x	x	x		12
ST-WS #2	Develop and implement programs to keep trees from threatening lives, property, and public infrastructure during wind and winter storm events.	COT	PGE, PNISA	Ongoing	Pg. 43	x	x	x		12

Natural Hazard	Action Item	Coordinating Organizations	Partner Organizations	Timeline	Ideas for Implementation	Plan Goals Addressed				Score
						Life, Property, and Natural Systems	Public Awareness and Partnerships	Emergency Services	Implementation	
Weather: Wind and Winter Storm Mitigation Action Items, ctd.										
LT-WS #1	Map and publicize locations around the city that have the highest incidence of damage from extreme weather.	COT	None	1-3 Years	Pg. 44	x	x	x	x	19
LT-WS #2	Develop and implement, or enhance strategies for debris management for windstorm and severe winter storm events.	COT	Pride Disposal, Waste Management	3-5 Years	Pg. 44	x	x			10
Earthquake Mitigation Action Items										
ST-EQ #1	Retrofit existing public facilities and services to contemporary standards to better withstand natural disasters and hazardous occurrences.	COT	DOGAMI	1-2 Years	Pg. 47	x		x		11
ST-EQ #2	Encourage City residents and businesses to purchase earthquake hazard insurance.	COT	None	3-5 Years	Pg. 48	x	x			12
ST-EQ #3	Seek to reduce nonstructural hazards in homes, schools, businesses, and government offices.	COT	TTSD	3-5 Years	Pg. 48	x	x			12
LT-EQ #1	Expand earthquake hazard mapping in Tigard and improve technical analysis of earthquake hazards.	COT	DOGAMI	3-5 Years	Pg. 48	x	x			16
LT-EQ #2	Improve local capabilities to perform earthquake building safety evaluations and to record and manage building inventory data.	COT	None	3-5 Years	Pg. 48	x		x		11

Natural Hazard	Action Item	Coordinating Organizations	Partner Organizations	Timeline	Ideas for Implementation	Plan Goals Addressed				Score
						Life, Property, and Natural Systems	Public Awareness and Partnerships	Emergency Services	Implementation	
LT-EQ #3	Earthquake Mitigation Action Items, ctd. Enforce current building code standards and ensure only the appropriate land uses are allowed in high seismic hazard areas.	COT	None	1-3 Years	Pg. 49	x	x	x	x	17

Appendix B: List of Acronyms

AASHTO	American Association of State Highway and Transportation Officials	IP	Industrial Park
AGC	Associated General Contractors	KW	Kilowatt
AOC	Association of Oregon Counties	LEM	Local Emergency Managers
ATC	Applied Technology Council	LIDAR	Light Detection and Ranging
bc/a	benefit cost/analysis	LS	Landslide
BCD	Building Codes Division	LT	Long Term
BFE	Base Flood Elevation	LUT	Land Use and Transportation
BLM	Bureau of Land Management	MH	Multi-Hazards
BPA	Bonneville Power Administration	MHz	Mega-Hertz
BSSC	Building Seismic Safety Council	MUC	Mixed Use Commercial
CCI	Committee for Citizen Involvement	MUE	Mixed Use Employment
CDBG	Community Development Block Grant	NOAA	National Oceanic and Atmospheric Administration
CERT	Community Emergency Response Team	NFIP	National Flood Insurance Program
CFR	Code of Federal Regulation	NFPA	National Fire Protection Association
COT	City of Tigard	NHMPA	Natural Hazard Mitigation Plan Addendum
CPR	Cardio Pulmonary Resuscitation	NRCS	Natural Resource Conservation Service
CPW	Community Planning Workshop	NW	North West
CWS	Clean Water Services	NWS	National Weather Service
DEQ	Department of Environmental Quality	OAR	Oregon Administrative Rule
DOC	Department of Commerce	OCEM	Office of Consolidated Emergency Management for Washington County
DOD	Department of Defense	ODF	Oregon Department of Forestry
DOGAMI	Department Of Geology And Mineral Industries	ODFW	Oregon Department of Fish and Wildlife
DSL	Division of State Land	ODOT	Oregon Department Of Transportation
EDA	Economic Development Administration	OEM	Oregon Emergency Management
EPA	Environmental Protection Agency	Ord	Ordinance
EQ	Earthquake	PGE	Portland General Electric
FDB	Fire Defense Board	P&W	Portland and Western Railroad
FEMA	Federal Emergency Management Agency	SBA	Small Business Administration
FL	Flood	ST	Short Term
FSA	Farm Service Agency	TVFR	Tualatin Valley Fire and Rescue
FWS	Fish and Wildlife Service	USACE	US Army Corps of Engineers
FWS	Fish and Wildlife Service	USDA	US Department of Agriculture
HMWG	Hazard Mitigation Working Group	USFA	United States Fire Administration
HUD	Housing and Urban Development	USFS	United States Forest Service
GIS	Geographic Information System	USGS	United States Geological Survey
IGA	Inter-Governmental Agreement	VA	Vulnerability Assessment

WCNHMP Washington County Natural Hazard Mitigation Plan
WF Wildfire
WS Weather Storms