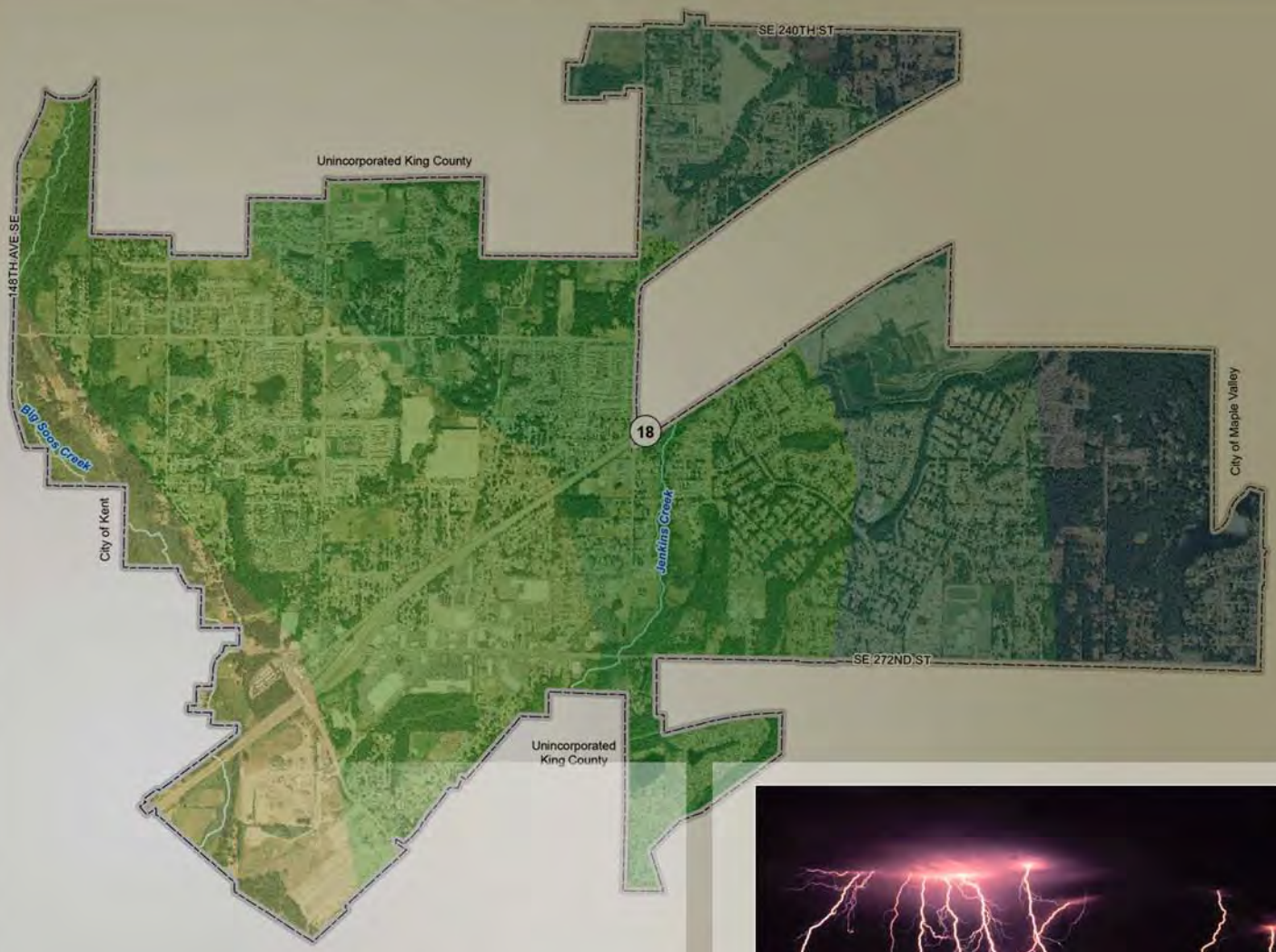

City of Covington
Hazard Mitigation Plan

May 2014

TETRA TECH

City of Covington
HAZARD MITIGATION PLAN

MAY 2014

Prepared for:
City of Covington
Public Works Department
16720 SE 271st Street, Suite 100
Covington, WA 98042

Prepared by:

TETRA TECH
complex world | CLEAR SOLUTIONS™
1230 Columbia Street, Suite 1000, San Diego, CA 92101
Tel 619.525.7188 Fax 619.525.7186 www.tetratech.com

Project #103S2602

City of Covington
Hazard Mitigation Plan

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Project Manager

Shellie Bates, Programs Supervisor
City of Covington Public Works Department
16720 SE 271st street, Suite 100
Covington, WA 98042
Phone: 253-480-2463

Other City of Covington Staff

Don Vondran, Director of Public Works

Anne Mueller, Senior Planner

Shawn Buck, Engineering Technician/GIS Coordinator

Robert Meyers, Chief Building Official

Karla Slate, Communications and Marketing Manager

Linda Graney, Volunteer

Consultants

Rob Flaner, Project Manager/Lead Project Planner, Tetra Tech, Inc.

Kristen Gelino, Junior Planner, Tetra Tech, Inc.

Katie Skakel, Senior Planner, Tetra Tech Inc.

Carol Bauman, Risk Assessment Lead, Tetra Tech, Inc.

Dan Portman, Technical Editor, Tetra Tech, Inc.

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EXECUTIVE SUMMARY

EXECUTIVE SUMMARY

Hazard mitigation is the use of long- and short-term strategies to reduce or alleviate death, injury and property damage that can result from a natural disaster. It is impossible to predict exactly when and where disasters will occur or the extent to which they will impact an area. However, with careful planning and collaboration among public agencies, stakeholders and citizens, it is possible to minimize losses due to disasters. The responsibility for hazard mitigation lies with many, including private property owners; business and industry; and local, state and federal government.

The Disaster Mitigation Act (DMA) is federal legislation that encourages state and local authorities to plan for disasters before they occur. The DMA requires proactive pre-disaster planning as a prerequisite for certain types of federal financial assistance. It promotes "sustainable hazard mitigation," which recognizes that hazard mitigation must be understood in the largest possible context and must include the sound management of natural resources, along with local economic and social resiliency.

To reduce future loss of life and property resulting from disasters, the City of Covington has developed a hazard mitigation plan in compliance with the DMA. The plan outlines planning efforts, policy changes, programs, projects, and other activities to mitigate hazard impacts on the City of Covington.

PLANNING METHODOLOGY

Development of the hazard mitigation plan included five phases:

- **Phase 1, Organize Resources—**In Phase 1, a nine-member steering committee was assembled to oversee development of the plan. The committee includes City staff, citizens and other stakeholders. Technical support to the steering committee was provided by a planning team consisting of key City staff and a technical consultant. Coordination with other local, state and federal agencies involved in hazard mitigation occurred from the outset of this plan's development through its completion. A multi-media public involvement strategy centered on a hazard preparedness questionnaire was also implemented under this phase. Also occurring under this phase was a comprehensive review of the State Hazard Mitigation Plan and of existing City programs that may support or enhance hazard mitigation measures.
- **Phase 2 , Perform the Risk Assessment—**Risk assessment is a way to measure potential loss of life, personal injury, economic loss, and property damage resulting from natural hazards. This process encompasses the following steps:
  - Hazard identification and profiling
  - Evaluation of the impact of hazards on physical, social and economic assets
  - Vulnerability identification
  - Estimates of the cost of damage or costs that can be avoided through mitigation.
  - The risk assessment for this hazard mitigation plan occurred simultaneously with Phase 1 activities, with the two efforts using information generated by one another to create the best possible risk assessment.
- **Phase 3, Engage the Public—**A public involvement strategy developed by the Steering Committee and implemented by the Planning Team included the following:
  - A public meeting early in the plan process

  - A public meeting to review the draft plan
  - A hazard mitigation survey
  - A City-sponsored website dedicated to the planning process
  - Multiple media releases throughout the process.
- **Phase 4, Assemble the Plan—**The planning team and steering committee assembled key information from Phases 1 and 2 into a document to meet DMA requirements. Federal regulations require that a local hazard mitigation plan include the following:
  - A description of the planning process
  - Risk assessment
  - A mitigation strategy defining goals, reviewing alternative mitigation approaches, and outlining a prioritized action plan
  - A strategy for maintaining the hazard mitigation plan
  - Documentation of adoption.
- **Phase 5, Plan Adoption/Implementation—**Final adoption of the hazard mitigation plan will follow pre-adoption approval by both Washington's Emergency Management Division and the Federal Emergency Management Agency (FEMA) Region X. This plan's strategy for implementation and maintenance details the formal process for ensuring that the plan remains an active and relevant document. The plan maintenance process includes a schedule for monitoring and evaluating the plan's progress annually and producing a plan revision every five years. This process seeks to keep a steering body that meets the criteria of the original steering committee intact to perform this annual review. Implementation will include continued public involvement and incorporation of the plan recommendations into other City planning mechanisms, such as the comprehensive plan, capital improvement plan, municipal code, and stormwater management plan.

MITIGATION GUIDING PRINCIPLE, GOALS AND OBJECTIVES

The following guiding principle guided the Steering Committee in selecting mitigation actions contained in this plan:

> Leverage partnerships and available resources and mitigate known risks to preserve the quality of life within the City of Covington.

The following goals were identified to help achieve the guiding principle:

1. Protect life and property.
2. Maintain economic viability during and after a hazard event.
3. Maintain, enhance and restore the natural environment's capacity to deal with impacts of natural hazard events.
4. Promote the development and implementation of cost-effective hazard mitigation projects.
5. Increase the public's awareness of the impacts from hazard events.
6. Improve the community's emergency management capability.
7. Promote hazard-resilient development through the use of best available data and science.

Table ES-1 lists 12 objectives identified to be used in prioritizing actions identified by this plan.

TABLE ES-1.
CITY OF COVINGTON HAZARD MITIGATION PLAN OBJECTIVES

Objective Number	Objective Statement	Goals to Which It Can Be Applied
O-1	Educate the public on the risk from natural hazards and increase awareness, preparation, mitigation, response and recovery activities.	1, 4, 5, 6
O-2	Consider the use of incentives for hazard mitigation to minimize the impacts of natural hazards on current and future land uses.	1, 3, 5, 7
O-3	Establish a partnership among all levels of government and the business community to improve and implement methods to protect private property and delivery of services.	1, 2, 5, 6
O-4	Integrate hazard mitigation goals and policies into the City's Comprehensive Plan.	1, 3, 7
O-5	Create a public outreach strategy that informs the public on the risk exposure to natural hazards and ways to increase the public's capability to prepare for, respond to, recover from and mitigate the impacts of these events.	1, 5, 6
O-6	Pursue implementation of all feasible risk reduction measures that reduce the natural hazard risk exposure to both public and private property.	1, 4, 7
O-7	Use the best available data, science and technologies to improve understanding of the location and potential impacts of natural hazards, the vulnerability of building types and community development patterns and the measures needed to protect life safety and critical facilities.	1, 3, 7
O-8	Retrofit, purchase or relocate at-risk properties, based on one or more of the following criteria: level of exposure, repetitive loss history, and previous damage from natural hazards.	1, 3, 4, 7
O-9	Seek natural hazard mitigation projects that minimize or mitigate their impacts on the environment.	1, 3, 7
O-10	Strengthen codes, land use planning and their enforcement, so that developments avoid or withstand the impacts of natural hazards.	1, 6, 7
O-11	Maintain and restore critical functions of identified critical facilities through proactive planning.	1, 2, 6
O-12	Seek ways to improve emergency management capacity and capability within the whole community.	1, 5, 6

MITIGATION INITIATIVES

The hazard mitigation action plan was developed based on an assessment of the capabilities of the City to implement hazard mitigation initiatives and a review of alternatives. Although grant funding eligibility was one consideration in development of this plan, not all identified mitigation actions are grant-eligible. The focus for some initiatives is their effectiveness in achieving the goals of the plan and whether they are within the City's capabilities. Table ES-2 presents a summary of the hazard mitigation initiatives identified by this plan and their priority.

TABLE ES-2.
SUMMARY OF HAZARD MITIGATION INITIATIVES

Initiative #	Description	Priority
C-1	Work with FEMA to get the City of Covington converted to the regular phase of the National Flood Insurance Program. Once this takes place, the City will continue to maintain compliance and good standing under the National Flood Insurance Program. This will be accomplished through the implementation of floodplain management programs that, at a minimum, will meet the minimum requirements of the National Flood Insurance Program, which include the following: • Enforcement of the adopted flood damage prevention ordinance • Participating in floodplain identification and mapping updates • Providing public assistance/information on floodplain requirements and impacts.	High
C-2	Evaluate flooding potential of publicly owned culverts and prioritize for replacement within the capital improvement program. Pursue grant funding for culvert replacements that are feasible and cost-effective to leverage available city funding.	High
C-3	Identify and evaluate privately owned culverts that contribute, or could contribute, to flooding. Pursue grant funding for culvert replacements that are feasible and cost-effective to leverage available city funding.	High
C-4	Strategize a program of regulations and/or incentives for owners to replace flood-contributing culverts.	Medium
C-5	Conduct a hazardous tree assessment and develop a plan to remove hazardous trees on all city-owned property.	Medium
C-6	Remove hazardous trees on city-owned property.	Medium
C-7	Actively promote and raise awareness of the Community Emergency Response Team training program to staff, council and citizens.	High
C-8	Evaluate the feasibility and interest level of a sub-regional emergency coordinator to serve southeast King County cities and utility districts.	Medium
C-9	If feasible, acquire a sub-regional emergency coordinator position.	Medium
C-10	Conduct a feasibility study for a sub-regional Emergency Coordination Center.	Low
C-11	Evaluate the current Surface Water Management utility rates and establish funding levels for surface water capital projects and operation and maintenance programs.	High
C-12	Partner with utility districts (Covington Water District, Soos Creek Water and Sewer District) on emergency response and continuity of operation plans.	High
C-13	Survey and delineate the floodplain of Little Soos Creek to identify known and potential flood limits.	Medium
C-14	Update Comprehensive Emergency Management Plan and include terrorism and catastrophic events.	High
C-15	Establish an accessible backup fuel supply to maintain emergency power during long-term power disruptions caused by all hazards of concern	Medium
C-16	Acquire a backup mobile emergency 30-KW generator for warming shelters, emergency triage, hospital, etc.	Medium
C-17	Establish linkage between comprehensive plan and hazard mitigation plan.	High
C-18	Rehabilitate and restore drainage facilities back to designed capacities.	Medium

TABLE ES-2.
SUMMARY OF HAZARD MITIGATION INITIATIVES

Initiative #	Description	Priority
C-19	Design and construct the Woodlands drainage project to mitigate erosion and groundwater seepage.	High
C-20	Conduct a drainage study for the 204th Avenue SE corridor.	Low
C-21	Design and retrofit the regional stormwater facility (The Reserve) to increase storage capacity and stability from seismic events.	Low
C-22	Design and construct the Clements drainage pipe upgrade to increase capacity.	Medium
C-23	Design and construct Emerald Downs open space channel rehabilitation.	Medium
C-24	Expand the City's existing 800 MHz radio communication system.	Medium
C-25	Acquire property to stockpile bulk response materials.	Low
C-26	Design and construct Jenkins Creek Park bridge and pedestrian path resistant to future flooding.	High
C-27	Establish mutual aid agreements with local agencies for equipment, materials and supplies.	Medium
C-28	Establish an emergency on call contract with a general contractor to provide assistance with equipment and operators.	High
C-29	Reach out to vulnerable populations (adult family homes, senior apartments) and identify plans to track needs during an emergency.	High
C-30	Improve the maintenance facility to enable use as backup emergency coordination center and City datacenter. • Provide redundant high speed internet connections with static IP addresses • Improve firewall to handle redundancy • Upgrade server capability in order to run critical city systems.	Medium
C-31	Improve data connectivity and redundancy at City Hall to make it more resilient to disruption. • Provide redundant network attached storage to provide failover • Provide redundant high-speed internet connections with static IP addresses.	Medium
C-32	Use cloud services to provide for out-of-area storage of City data. • Provide automated duplication of backup data to a cloud storage provider • Create ability to restore data directly from the cloud copy.	Medium
C-33	Use cloud services to provide continuity of service for critical city software systems in the event of an emergency. • Provide automated copying of critical systems to a cloud provider • Create the ability to turn on the cloud copy of critical systems in the event on-premise systems were down.	Medium
C-34	Evaluate geographic information technology needs related to emergency management. • Purchase Spatial Analyst in order to run the HAZUS model • Purchase ArcServer to host dynamic web maps relating to emergency management.	Medium
C-35	Partner with local homeowners associations and block watch groups to provide training and coordination for ATC 20-21 (rapid visual inspection of disaster-damaged buildings) and disaster preparedness.	Low
C-36	Update and work on improvements to the City's emergency permitting process.	Medium

TABLE ES-2.
SUMMARY OF HAZARD MITIGATION INITIATIVES

Initiative #	Description	Priority
C-37	Provide Community Emergency Response Team training to all city staff.	High
C-38	Provide ATC 20-21 (rapid visual inspection of disaster-damaged buildings) to all city staff, particularly the field staff.	Low
C-39	Use information and principles identified in this plan to support other planning initiatives in Covington, including development and redevelopment plans.	Medium
C-40	Seek opportunities to retrofit vulnerable structures when information identifies them as being a risk to hazards.	Low

IMPLEMENTATION

The Covington City Council will assume responsibility for committing City resources toward implementation of this plan. The plan identifies a strategy that maximizes the potential for implementation based on available and potential resources. It commits the City to pursue initiatives when the benefits of a project exceed its costs. The City used public input through all phases of plan development, which will set the stage for successful implementation of the recommended actions.

Full implementation of the recommendations of this plan will require time and resources. Protocols are provided to evaluate changes in hazard vulnerability and action plan priority after the plan has been adopted. Funding resources and programs are always evolving, based on new state or federal mandates. The true measure of the plan's success will be its ability to adapt to the ever-changing climate of hazard mitigation.

PART 1—
PLANNING PROCESS
AND COMMUNITY PROFILE

CHAPTER 1.
INTRODUCTION TO THE PLANNING PROCESS

1.1 WHY PREPARE THIS PLAN?

1.1.1 The Big Picture

Hazard mitigation is defined as a way to reduce or alleviate the loss of life, personal injury, and property damage that can result from a disaster through long- and short-term strategies. It involves strategies such as planning, policy changes, programs, projects, and other activities that can mitigate the impacts of hazards. The responsibility for hazard mitigation lies with many, including private property owners; business and industry; and local, state and federal government.

The federal Disaster Mitigation Act (DMA) of 2000 (Public Law 106-390) required state and local governments to develop hazard mitigation plans as a condition for federal disaster grant assistance. Prior to 2000, federal disaster funding focused on disaster relief and recovery, with limited funding for hazard mitigation planning. The DMA increased the emphasis on planning for disasters before they occur.

The rising cost of natural disasters and technological disasters has led to a renewed interest in identifying effective ways to reduce vulnerability to disasters. According to the National Oceanic and Atmospheric Administration's National Climatic Data Center, the United States has experienced 151 weather or climate disasters that have resulted in damage costing over $1 billion. In 2013, there were seven such disasters (NOAA, 2014). These rising costs cannot be attributed to any one factor, but are the result of decisions made in larger socio-economic contexts, such as where communities choose to locate infrastructure, population growth in areas at risk to natural disasters, and the path-dependent nature of urban development. Costs associated disasters are likely to be exacerbated by the impacts of climate change. Natural hazard mitigation planning helps communities reduce risk from natural hazards, and therefore reduce costs, by identifying resources, information and strategies for risk reduction, while helping to guide and coordinate sustainable mitigation activities.

The DMA promotes sustainability for disaster resistance. "Sustainable hazard mitigation" includes the sound management of natural resources and the recognition that hazards and mitigation must be understood in the largest possible social and economic context. The enhanced planning network called for by the DMA helps local governments articulate accurate needs for mitigation, resulting in faster allocation of funding and more cost-effective risk reduction projects.

1.1.2 Local Concerns

Residents of the area that is now the City of Covington were exposed to natural hazards long before the city was incorporated. Photos, journal entries, and newspapers from the mid to late 1800s show that the residents of the area dealt with high water, windstorms, winter storms, wildfires, earthquakes, landslides, and even volcanic activity. Natural hazards have adversely affected the citizens, property, environment and economy of Covington, exposing them to the financial and emotional costs of disaster recovery.

Covington is one of the fastest growing cities in King County, situated in an attractive landscape in southern King County. The proximity of desirable amenities and the high quality of life enjoyed by Covington residents have contributed to population growth in the City over the last two decades. The risk associated with natural hazards increases as more people move into areas at risk. In addition to natural

hazards, technological hazards—such as energy shortages and utility outages, food and water contamination, hazardous materials release, transportation accident hazards, civil disorder, and dam failures—are hazards of interest. The following key factors led to the effort to prepare a hazard mitigation plan for the City of Covington:

- The Covington area has exposure to numerous natural hazards that have caused damage in the past.
- Limited local resources make it difficult to be pre-emptive in risk reduction initiatives. Being able to leverage federal financial assistance is paramount to successful hazard mitigation in the area.
- The City seeks to be proactive in preparing for natural and technological hazards.

The City of Covington committed to the preparation of the plan by attaining grant funding for the effort and then securing technical assistance to facilitate a planning process that would comply with all program requirements. A regional planning effort for King County was conducted simultaneously with the City's planning effort, led by King County Emergency Management. There has been a level of coordination between these two efforts, and the City is committed to partnering with King County on future hazard mitigation projects.

1.1.3 Purposes for Planning

DMA compliance is only one of multiple objectives driving this planning effort. Recommended strategies in this plan were selected because they meet a program requirement and because they best meet the needs and capabilities of the City of Covington and its citizens. The inevitability of natural hazard events, coupled with increased population and activity in the City of Covington, creates a need to develop strategies, coordinate resources, and increase public awareness to reduce risk and prevent loss from future hazard events. Identifying risks and developing strategies to reduce the impacts of hazard events can help to protect the life and property of citizens and businesses. While it is impossible to predict exactly when natural disasters will occur or the extent to which they will affect the city, careful planning and collaboration among public agencies, private sector organizations, and citizens within the community can minimize the losses that result from such events.

This hazard mitigation plan presents strategies to reduce risk from natural hazards through education and outreach, the development of partnerships, and implementation of preventive activities, such as code enforcement, land use or watershed programs. Additionally, this plan provides information in support of emergency management planning as it relates to hazard identification, vulnerability assessment and mitigation techniques.

This hazard mitigation plan identifies resources, information and strategies for reducing risk from natural hazards. It will also help guide and coordinate mitigation activities. The plan was developed to meet the following objectives:

- Meet or exceed program requirements specified under the DMA.
- Enable the City of Covington to continue using federal grant funding to reduce risk through mitigation.
- Meet the needs of the City of Covington as well as state and federal requirements.
- Coordinate existing plans and programs so that high-priority initiatives and projects to mitigate possible disaster impacts are funded and implemented.
- Establish a program for ongoing plan maintenance that will help to keep the plan dynamic.

1.2 WHO WILL BENEFIT FROM THIS PLAN?

All citizens and businesses of the City of Covington are the ultimate beneficiaries of this hazard mitigation plan. The plan reduces risk for those who live in, work in, and visit the City of Covington. It provides a viable planning framework for all foreseeable natural hazards. Participation in development of the plan by key stakeholders helped ensure that outcomes will be mutually beneficial. The plan's goals and recommendations can lay groundwork for the development and implementation of local mitigation activities and partnerships.

1.3 HOW TO USE THIS PLAN

This hazard mitigation plan is organized into four primary parts:

- Part 1—Planning process and community profile
- Part 2—Risk assessment for identified hazards of concern and a profile of other non-natural hazards of interest
- Part 3—Risk ranking and mitigation strategy.

Each part includes elements required under federal guidelines. DMA compliance requirements are often cited at the beginning of a subsection to illustrate compliance with the requirement.

The following appendices provided at the end of the plan include information or explanations to support the main content of the plan:

- Appendix A—A glossary of acronyms and definitions
- Appendix B—Public outreach information, including the hazard mitigation survey and summary and documentation of public meetings.
- Appendix C—A template for progress reports to be completed as this plan is implemented

CHAPTER 2.
PLANNING METHODOLOGY

This chapter describes the planning process used to develop the City of Covington Hazard Mitigation Plan, focusing on funding, selection of key participants, and outreach to the public and to relevant oversight agencies. The technical methodologies used to assess risk are described in Chapter 4.

2.1 GRANT FUNDING

This planning effort was supplemented by a grant from the Federal Emergency Management Agency (FEMA). The City of Covington Public Works Department was the applicant agent for the grant. The grant was applied for in 2011, and funding was appropriated in 2012. It covered 75 percent of the cost for development of this plan. The State of Washington covered 12.5 percent of the cost and the City of Covington covered the balance through in-kind contributions.

2.2 FORMATION OF THE PLANNING TEAM

The City of Covington hired Tetra Tech, Inc. to assist with development and implementation of the plan. The Tetra Tech project manager was the lead planner, reporting directly to the City of Covington project manager. A planning team was formed to lead the planning effort, made up of the following members:

- Shellie Bates, City of Covington Project Manager
- Rob Flaner, Tetra Tech, Project Manager/Lead Project Planner
- Kristen Gelino, Tetra Tech, Junior Planner
- Carol Bauman, Tetra Tech, Senior GIS Analyst and Risk Assessment Lead
- Dan Portman, Tetra Tech, Technical Editor.

2.3 DEFINING THE PLANNING AREA

The planning area was defined to consist of the City of Covington's incorporated city limits.

2.4 THE STEERING COMMITTEE

Hazard mitigation planning enhances collaboration among diverse parties whose interests can be affected by hazard losses. A steering committee was formed to oversee all phases of the plan. The members of this committee included key City of Covington staff, citizens, and other stakeholders from within the planning area. The planning team assembled a list of candidates representing interests within the planning area that could have recommendations for the plan or be impacted by its recommendations. The team confirmed a committee of nine members at the kickoff meeting. Table 2-1 lists the committee members.

Leadership roles and ground rules were established during the Steering Committee's initial meeting on March 20, 2013. The Steering Committee agreed to meet monthly as needed throughout the course of the plan's development. The planning team facilitated each Steering Committee meeting, which addressed a set of objectives based on the work plan established for the plan. The Steering Committee met eight times from March 2013 through February 2014. Meeting agendas, notes and attendance logs are available for review upon request. All Steering Committee meetings were open to the public and agendas and meeting notes were posted to the hazard mitigation plan website.

TABLE 2-1.
STEERING COMMITTEE MEMBERS

Name	Title
Shellie Bates (Committee Chair)	City of Covington Programs Supervisor
Glenn Akramoff (Committee Vice Chair)	City of Covington Public Work Director
Don Vondran[a]	City of Covington Public Works Director
Shawn Buck	City of Covington Engineering Technician/GIS Coordinator
Robert Meyers	City of Covington Chief Building Official
Linda Graney	Resident
Ann Mueller	City of Covington Senior Planner
Karla Slate	City of Covington Communications and Marketing Manager
Marcia Milam	Resident

a. Don Vondran replaced Glenn Akramoff after Glenn left the employment of the City.

2.5 COORDINATION WITH OTHER AGENCIES

Opportunities for involvement in the hazard mitigation planning process must be provided to neighboring communities, local and regional agencies involved in hazard mitigation, agencies with authority to regulate development, businesses, academia, and other private and nonprofit interests (Title 44 Code of Federal Regulations (44 CFR), Section 201.6(b)(2)). This task was accomplished as follows:

- **Steering Committee Involvement**—Agency representatives were invited to participate on the Steering Committee.
- **Agency Notification**—The following agencies were invited to participate in the plan development from the beginning and were kept apprised of plan development milestones:
  - King County Emergency Management
  - Washington Department of Ecology
  - Washington Military Department Emergency Management Division
  - FEMA Region X
  - The City of Kent
  - Kent Fire District
  - Covington Water District

  These agencies received meeting announcements, meeting agendas, and meeting minutes by e-mail throughout the plan development process. These agencies supported the effort by attending meetings or providing feedback on issues.
- **Pre-Adoption Review**—All the agencies listed above were provided an opportunity to review and comment on this plan, primarily through the hazard mitigation plan website (see Section 2.7). Each agency was sent an e-mail message informing them that draft portions of the plan were available for review.

As the City of Covington developed this plan, King County was simultaneously developing its regional hazard mitigation plan. It was determined that it would be more beneficial to allow local special purpose districts that would normally be invited to join the City's planning effort to join the County's effort instead. This would reduce the effort required by the local agencies with respect to involvement in two similar planning initiatives occurring simultaneously. It was also determined that information gathered during the County process would be incorporated, when appropriate, within the City's plan to ensure that all available, relevant data is included.

2.6 REVIEW OF EXISTING PROGRAMS

Hazard mitigation planning must include review and incorporation, if appropriate, of existing plans, studies, reports and technical information (44 CFR, Section 201.6(b)(3)). Chapter 5 of this plan provides a review of laws and ordinances in effect within the planning area that can affect hazard mitigation initiatives. In addition, the following plans and programs can affect mitigation within the planning area:

- The 2010 Washington State Enhanced Hazard Mitigation Plan
- The 2005 City of Covington Hazard Identification and Vulnerability Assessment
- The 2003 City of Covington Comprehensive Plan Natural Hazard Mitigation Element
- The 2011 City of Covington Shoreline Master Program
- The 2011 City of Covington Comprehensive Emergency Management Plan
- The 2014 King County Regional Hazard Mitigation Plan
- The 2013 King County Flood Hazard Mitigation Plan.

An assessment of all City of Covington regulatory, technical and financial capabilities to implement hazard mitigation initiatives is presented in Section 5.10. Many of these relevant plans, studies and regulations are cited in the capability assessment.

2.7 PUBLIC INVOLVEMENT

Broad public participation in the planning process helps ensure that diverse points of view about the planning area's needs are considered and addressed. The public must have opportunities to comment on disaster mitigation plans during the drafting stages and prior to plan approval (44 CFR, Section 201.6(b)(1)).

2.7.1 Strategy

The strategy for involving the public in this plan emphasized the following elements:

- Include members of the public on the Steering Committee.
- Use a survey to determine the public's perception of risk and support of hazard mitigation.
- Attempt to reach as many planning area citizens as possible using multiple media.
- Identify and involve planning area stakeholders.

The Steering Committee

All of the Steering Committee members live or work in the City of Covington. This included three residents. The make-up of the steering committee was integral in the success of this planning effort, providing an historical perspective that was valuable in identifying direction for the planning process.

Survey

A hazard mitigation plan survey (see Figure 2-1) was developed by the planning team with guidance from the Steering Committee. The survey was used to gauge household preparedness for natural hazards and the level of knowledge of tools and techniques that assist in reducing risk and loss from natural hazards. This survey was designed to help identify areas vulnerable to one or more natural hazards. The answers to its 36 questions helped guide the Steering Committee in selecting goals, objectives and mitigation strategies. Hard copies of the survey were made available at the public meetings, and a web-based version was made available on the hazard mitigation plan website. A QR code (Figure 2-2) was created so that the survey could be accessed and completed online by users of smart phones and tablets. The survey was advertised via press releases and 1,000 pocket business cards (Figure 2-3) advertising the website and survey were distributed by various means. Over 60 surveys were completed during the course of the planning process. The complete survey and a summary of its findings can be found in Appendix B.

Public Meetings

An open-house public meeting was held on September 5, 2013, from 6:30 to 8:30 p.m. in Covington City Hall Council Chambers (see Figure 2-4 through Figure 2-7). The meeting allowed attendees to examine maps and handouts and have direct conversations with project staff. Stakeholders such as Home Depot, Ham Radio Operators Association and the Community Emergency Response Team participated as vendors. Reasons for planning and information generated for the risk assessment were shared with attendees via a PowerPoint presentation. Tables were set up for each of the primary hazards to which the planning area is most vulnerable. A computer workstation running the HAZUS-MH software program (Hazards of the United States—Multi-Hazard) allowed citizens to see information on their property, including exposure and damage estimates for earthquake and flood hazard events. Participating property owners were provided printouts of this information for their properties. This tool was effective in illustrating risk to the public. Planning team members were present to answer questions. Each citizen attending the open houses was asked to complete the planning survey, and each was given an opportunity to provide written comments to the Steering Committee. Local media outlets were informed of the open houses by a press release from the planning team.

City staff provided surveys, pocket business cards and information on the plan and planning process at the City's booth during Covington Days in July 2013. Covington Days is an official SeaFair-sanctioned event, held on the third weekend of July since 1986. Its focus is on providing family fun while promoting community spirit, and it provided an excellent opportunity to educate citizens about mitigation and the City's planning effort.

Press Releases

Press releases were distributed over the course of the plan's development as key milestones were achieved and prior to each public meeting. The planning effort received the following press coverage:

- Covington/Maple Valley Reporter, October 18, 2012 (http://www.maplevalleyreporter.com/news/174818941.html)
- Covington/Maple Valley Reporter, April 1, 2013 (http://www.maplevalleyreporter.com/news/200926641.html)

  Covington/Maple Valley Reporter, August 19, 2013 (http://www.maplevalleyreporter.com/news/220246791.html)

  Covington/Maple Valley Reporter, March 21, 2014 (http://www.maplevalleyreporter.com/news/251479921.html)

City of Covington: Hazard Mitigation Survey

Survey Introduction

The City of Covington needs your personal knowledge and experience of local hazards and disasters.

The information gathered in this survey will be used during the development of the City's Hazard Mitigation Plan, with the aim of reducing the risk of injury or property damage due to local natural disasters.

Your input is critical. The answers to all questions in this survey are confidential and will be used solely for the preparation of the Hazard Mitigation Plan.

Thank you for contributing to this important project.

1. Please indicate in which area of Covington you live.

- ☐ Within City limits, north of Highway 18
- ☐ Within City limits, south of Highway 18
- ☐ Unincorporated King County
- ☐ Other City limits (Kent, Auburn, Maple Valley, etc.)

Please identify your neighborhood/subdivision (if applicable)

2. In the past 25 years, have you or someone in your household experienced a natural disaster within the City of Covington such as an earthquake, flood, landslide, severe weather, dam failure, volcano (ash fall), wild fire, or other natural disaster?

○ Yes ○ No

3. Which of the following types of natural hazards have you or someone in your household experienced? (Please check all that apply.) If you answered no to the previous question (#2), please move to question 4.

- ☐ Dam Failure
- ☐ Flood
- ☐ Severe weather (wind, winter storm, etc.)
- ☐ Earthquake
- ☐ Volcano (ash fall)
- ☐ Landslide
- ☐ Erosion
- ☐ Wild fire
- ☐ Hazardous material incident
- ☐ Terrorist event

Other (please specify)

Page 1

Figure 2-1. Sample Page from Survey Distributed to the Public

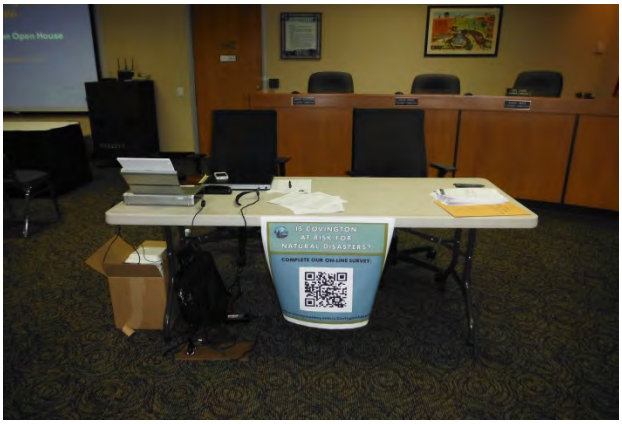


Figure 2-2. QR Code for Survey

Figure 2-3. Pocket Business Card Advertising Website and Survey

Figure 2-4. Home Depot Participates in Public Open House

Figure 2-5. Citizens View Mapping from Risk Assessment at Public Open House

Figure 2-6. Citizens Visit HAZUS Work Station at Public Open House

Figure 2-7. Citizens Watch Presentation on Risk Assessment at Public Open House

Internet

At the beginning of the plan development process, a website was created to keep the public posted on plan development milestones and to solicit relevant input (see Figure 2-8):

- http://www.covingtonwa.gov/hazardmitigation/index.html

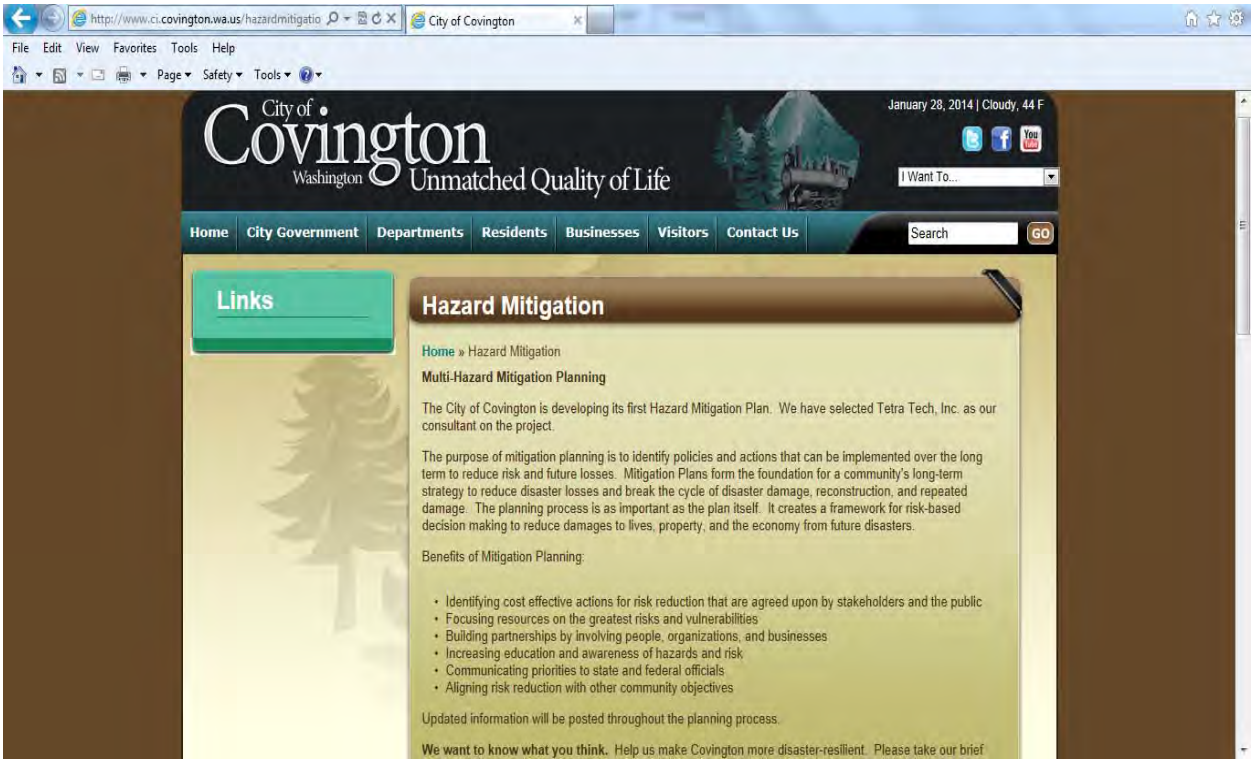


Figure 2-8. Sample Page from Hazard Mitigation Plan Web Site

The site's address was publicized in all press releases, mailings, surveys and public meetings. Information on the plan development process, the Steering Committee, the survey and phased drafts of the plan was made available to the public on the site throughout the process. the City of Covington intends to keep a website active after the plan's completion to keep the public informed about successful mitigation projects and future plan updates.

2.7.2 Public Involvement Results

By engaging the public through the public involvement strategy, the concept of mitigation was introduced to the public, and the Steering Committee received feedback that was used in developing the components of the plan. A public meeting for the hazard mitigation plan was held September 5, 2013 at Covington City Hall. The meeting was attended by 19 citizens. No comments were received, but three surveys were completed.

2.8 PLAN DEVELOPMENT CHRONOLOGY/MILESTONES

Table 2-2 summarizes important milestones in the development of the plan.

TABLE 2-2.
PLAN DEVELOPMENT MILESTONES

Date	Event	Description	Attendance
2012			
11/6	Initiate consultant procurement	Seek a planning expert to facilitate the process	N/A
2013			
1/19	Select Tetra Tech to facilitate plan development	Facilitation contractor secured	N/A
1/13	Identify planning team	Formation of the planning team	N/A
1/24	Kickoff Meeting	Meeting between Tetra Tech and City staff to initiate planning process. The following topics were discussed at this meeting: • Finalization of the planning team • Steering Committee makeup • Agency coordination • Planning stakeholders • Outreach strategy • Future meeting schedule	4
2/22	Steering Committee formed	Potential committee members nominated. The planning team received commitments from members, finalizing the formation of the Steering Committee.	N/A
3/20	Steering Committee Meeting #1	The following topics were discussed at this meeting: • Purposes for planning • Organize Steering Committee • Plan review • Public involvement strategy	7
3/27	Public outreach	First press release on planning process disseminated to all media outlets.	N/A
4/1	Public outreach	Press coverage of the planning process, website and survey in the Maple Valley Reporter.	N/A
4/12	Public outreach	Hazard mitigation website established on City website as a means to provide the public full access to the planning process.	N/A
4/16	Steering Committee Meeting #2	The following topics were discussed at this meeting: • Approve final Steering Committee ground rules • Comments on review of state plan • Identify hazards of concern • Define critical facilities • Select guiding principal for plan	7
5/21	Steering Committee Meeting #3	The following topics were discussed at this meeting: • Risk assessment update • Review final critical facility definition • Goal setting • Introduce objectives exercise • Review survey	7
6/11	Public outreach	Survey deployed on City website and advertised via pocket business cards, website and press releases.	N/A

TABLE 2-2.
PLAN DEVELOPMENT MILESTONES

Date	Event	Description	Attendance
6/18	Steering Committee Meeting #4	The following topics were discussed at this meeting: • Risk assessment update • Approve final goals • Identify objectives • Plan maintenance strategy • Public outreach Strategy	8
7/16	Steering Committee Meeting #5	The following topics were discussed at this meeting: • Risk assessment update • Approve final objectives • Approve plan maintenance strategy • Public outreach strategy	7
7/20	Public outreach	Covington Days community fair. Pocket business cards handed out at City booth, and posters advertising public open house posted.	"Hundreds"
8/19	Public outreach	Second press release advertising public open house disseminated to all media outlets.	N/A
8/19	Public outreach	Coverage in the Maple Valley Reporter on public open house	N/A
9/5	Public outreach	Public open house to present the risk assessment and introduce the public to the planning process held at City Hall.	19
10/15	Steering Committee Meeting #6	The following topics were discussed at this meeting: • Risk assessment update • Where are we with the outreach strategy? • Action plan development • What is next?	8
11/19	Steering Committee Meeting #7	The following topics were discussed at this meeting: • Risk assessment update • Natural hazards history • Action plan development review • Mitigation strategy overview	6
2014			
2/25	Steering Committee Meeting # 8	The following topics were discussed at this meeting: • Internal review draft of the plan • SC review protocol • Public Comment period • Next steps	9
X/X	Public Comment Period	Initial public comment period of draft plan opens. Draft plan posted on plan website with press release notifying public of plan availability	N/A
X/X	Public outreach	Final public meeting on Draft Plan	XX
X/X	Adoption	Adoption window of final plan b opens	N/A
X/X	Plan approval	Final draft plan submitted to Washington Military Department Emergency Management Division for review and approval	N/A
X/X	Plan approval	Final plan approved by the Federal Emergency Management Agency	N/A

CHAPTER 3.
GUIDING PRINCIPLE, GOALS AND OBJECTIVES

Hazard mitigation plans must identify goals for reducing long-term vulnerabilities to identified hazards (44 CFR Section 201.6(c)(3)(i)). The Steering Committee established a guiding principle, a set of goals and measurable objectives for this plan, based on data from the preliminary risk assessment and the results of the public involvement strategy. The guiding principle, goals, objectives and actions in this plan all support each other. Goals were selected to support the guiding principle. Objectives were selected that met multiple goals. Actions were prioritized based on the action meeting multiple objectives.

3.1 GUIDING PRINCIPLE

A guiding principle focuses the range of objectives and actions to be considered. This is not a goal because it does not describe a hazard mitigation outcome, and it is broader than a hazard-specific objective. The guiding principle for the City of Covington Hazard Mitigation Plan is as follows:

> Leverage partnerships and available resources and mitigate known risks to preserve the quality of life within the City of Covington.

3.2 GOALS

The following are the mitigation goals for this plan:

1. Protect life and property.
2. Maintain economic viability during and after a hazard event.
3. Maintain, enhance and restore the natural environment's capacity to deal with impacts of natural hazard events.
4. Promote the development and implementation of cost-effective hazard mitigation projects.
5. Increase the public's awareness of the impacts from hazard events.
6. Improve the community's emergency management capability.
7. Promote hazard-resilient development through the use of best available data and science.

The effectiveness of a mitigation strategy is assessed by determining how well these goals are achieved.

3.3 OBJECTIVES

Each selected objective meets multiple goals, serving as a stand-alone measurement of the effectiveness of a mitigation action, rather than as a subset of a goal. The objectives also are used to help establish priorities. The objectives are as follows:

1. Educate the public on the risk from natural hazards and increase awareness, preparation, mitigation, response and recovery activities.
2. Consider the use of incentives for hazard mitigation to minimize the impacts of natural hazards on current and future land uses.
3. Establish a partnership among all levels of government and the business community to improve and implement methods to protect private property and delivery of services.

4. Integrate hazard mitigation goals and policies into the City's Comprehensive Plan.
5. Create a public outreach strategy that informs the public on the risk exposure to natural hazards and ways to increase the public's capability to prepare for, respond to, recover from and mitigate the impacts of these events.
6. Pursue implementation of all feasible risk reduction measures that reduce the natural hazard risk exposure to both public and private property.
7. Use the best available data, science and technologies to improve understanding of the location and potential impacts of natural hazards, the vulnerability of building types and community development patterns and the measures needed to protect life safety and critical facilities.
8. Retrofit, purchase or relocate, based on one or more of the following criteria: level of exposure, repetitive loss history, and previous damage from natural hazards.
9. Seek natural hazard mitigation projects that minimize or mitigate their impacts on the environment.
10. Strengthen codes, land use planning and their enforcement, so that developments avoid or withstand the impacts of natural hazards.
11. Maintain and restore critical functions of identified critical facilities through proactive planning.
12. Seek ways to improve emergency management capacity and capability within the whole community.

CHAPTER 4.
IDENTIFIED HAZARDS OF CONCERN AND RISK ASSESSMENT METHODOLOGY

Risk assessment is the process of measuring the potential loss of life, personal injury, economic injury, and property damage resulting from natural hazards. It allows emergency management personnel to establish early response priorities by identifying potential hazards and vulnerable assets. The process focuses on the following elements:

- Hazard identification—Use all available information to determine what types of disasters may affect a jurisdiction, how often they can occur, and their potential severity.
- Vulnerability identification—Determine the impact of natural hazard events on the people, property, environment, economy and lands of the region.
- Cost evaluation—Estimate the cost of potential damage or cost that can be avoided by mitigation.

The risk assessment for this hazard mitigation plan evaluates the risk of natural hazards prevalent in the planning area and meets requirements of the DMA (44 CFR, Section 201.6(c)(2)).

4.1 IDENTIFIED HAZARDS OF CONCERN

For this plan, the Steering Committee considered the full range of natural hazards that could impact the planning area and then listed hazards that present the greatest concern. The process incorporated review of state and local hazard planning documents, as well as information on the frequency, magnitude and costs associated with hazards that have impacted or could impact the planning area. Anecdotal information regarding natural hazards and the perceived vulnerability of the planning area's assets to them was also used. Based on the review, this plan addresses the following hazards of concern:

- Dam failure
- Drought
- Earthquake
- Flood
- Landslide
- Severe weather
- Volcano
- Wildfire

Other hazards of interest that warrant discussion fell outside the scope of this plan because they are non-natural hazards. These hazards are profiled, but not assessed or ranked in the same context as the natural hazards of concern.

4.2 CLIMATE CHANGE

Climate includes patterns of temperature, precipitation, humidity, wind and seasons. Climate plays a fundamental role in shaping natural ecosystems, and the human economies and cultures that depend on

them. “Climate change” refers to changes over a long period of time. It is generally perceived that climate change will have a measurable impact on the occurrence and severity of natural hazards around the world. Impacts include the following:

- Snow cover losses will continue, and declining snowpack will affect snow-dependent water supplies and stream flow levels around the world.
- The risk of drought and the frequency, intensity, and duration of heat waves are expected to increase.
- More extreme precipitation is likely, increasing the risk of flooding.
- The world’s average temperature is expected to increase.

Climate change will affect communities in a variety of ways. Impacts could include an increased risk for extreme events such as drought, storms, flooding and wildfires; more heat-related stress; and the spread of existing or new vector-born disease into a community. In many cases, communities are already facing these problems to some degree. Climate change changes the frequency, intensity, extent and/or magnitude of the problems.

Impacts from climate change are expected to vary with time and location. Current modeling efforts are unable to assess likely impacts at a resolution small enough to determine specific impacts for the City of Covington; however, generalized assessments of larger climatic regions can be used to determine the impacts that are most likely to affect individual communities. The Climate Impacts Group at the University of Washington has synthesized currently available information regarding projected changes in the Pacific Northwest. These include the following:

- Temperature—The Pacific Northwest will continue to experience a rise in annual average temperature in all seasons. Extreme heat events are likely to increase in frequency.
- Precipitation—The region will experience small changes in annual precipitation. Model projections are mixed for seasonal precipitation changes, although most models project drier summers. Heavy rainfall events are likely to occur more frequently.
- Sea Level Rise—Sea level rise will occur, although some of this rise may be offset by vertical land thrust.
- Ocean Temperature and Acidification—Both ocean temperature and acidity are projected to increase (Snover et al., 2013).

The Climate Impacts Group projects the following impacts on the social, natural and built systems of the region as a result of these changes:

- Declines in snowpack, increasing stream temperatures, decreasing minimum stream flows and widespread changes in stream flow timing and flood risk
- Changes in the establishment, growth and distribution of tree species
- Changes in the composition of plant and animal communities
- Permanent inundation of low-lying areas, higher tidal and storm surge reach, flooding, erosion, and changes and loss of habitat
- Increased potential for damage and service disruptions to infrastructure
- Higher rates of heat-related illnesses, respiratory illnesses, vector-, water-, and food-borne diseases and mental health stress.

This hazard mitigation plan addresses climate change as a secondary impact for each identified hazard of concern. Each chapter addressing one of the hazards of concern includes a section with a qualitative discussion on the probable impacts of climate change for that hazard. While many models are currently being developed to assess the potential impacts of climate change, there are currently none available to support hazard mitigation planning. As these models are developed in the future, this risk assessment may be enhanced to better measure these impacts.

4.3 METHODOLOGY

The risk assessments in Chapter 6 through Chapter 13 describe the risks associated with each identified hazard of concern. Each chapter describes the hazard, the planning area's vulnerabilities, and probable event scenarios. The following steps were used to define the risk of each hazard:

- Identify and profile each hazard—The following information is given for each hazard:
  - Geographic areas most affected by the hazard
  - Event frequency estimates
  - Severity estimates
  - Warning time likely to be available for response.
- Determine exposure to each hazard—Exposure was determined by overlaying hazard maps with an inventory of structures, facilities, and systems to determine which of them would be exposed to each hazard.
- Assess the vulnerability of exposed facilities—Vulnerability of exposed structures and infrastructure was determined by interpreting the probability of occurrence of each event and assessing structures, facilities and systems that are exposed to each hazard. Tools such as GIS and the Federal Emergency Management Agency's (FEMA's) hazard-modeling program called HAZUS-MH were used to perform this assessment for the flood, dam failure and earthquake hazards. Outputs similar to those from HAZUS were generated for other hazards, using maps generated by the HAZUS program.

4.4 RISK ASSESSMENT TOOLS

4.4.1 Dam Failure, Earthquake and Flood—HAZUS-MH

Overview

In 1997, FEMA developed the standardized Hazards U.S., or HAZUS, model to estimate losses caused by earthquakes and identify areas that face the highest risk and potential for loss. HAZUS was later expanded into a multi-hazard methodology, HAZUS-MH, with new models for estimating potential losses from hurricanes and floods.

HAZUS-MH is a GIS-based software program used to support risk assessments, mitigation planning, and emergency planning and response. It provides a wide range of inventory data, such as demographics, building stock, critical facility, transportation and utility lifeline, and multiple models to estimate potential losses from natural disasters. The program maps and displays hazard data and the results of damage and economic loss estimates for buildings and infrastructure. Its advantages include the following:

- Provides a consistent methodology for assessing risk across geographic and political entities.
- Provides a way to save data so that it can readily be updated as population, inventory and other factors change and as mitigation planning efforts evolve.

- Facilitates the review of mitigation plans because it helps to ensure that FEMA methodologies are incorporated.
- Supports grant applications by calculating benefits using FEMA definitions and terminology.
- Produces hazard data and loss estimates that can be used in communication with local stakeholders.
- Is administered by the local government and can be used to manage and update a hazard mitigation plan throughout its implementation.

Levels of Detail for Evaluation

HAZUS-MH provides default data for inventory, vulnerability and hazards; this default data can be supplemented with local data to provide a more refined analysis. The model can carry out three levels of analysis, depending on the format and level of detail of information about the planning area:

- **Level 1**—All of the information needed to produce an estimate of losses is included in the software's default data. This data is derived from national databases and describes in general terms the characteristic parameters of the planning area.
- **Level 2**—More accurate estimates of losses require more detailed information about the planning area. To produce Level 2 estimates of losses, detailed information is required about local geology, hydrology, hydraulics and building inventory, as well as data about utilities and critical facilities. This information is needed in a GIS format.
- **Level 3**—This level of analysis generates the most accurate estimate of losses. It requires detailed engineering and geotechnical information to customize it for the planning area.

Application for This Plan

The following methods were used to assess specific hazards for this plan:

- **Flood**—A Level 2, user-defined analysis was performed for both general building stock and critical facilities and infrastructure. GIS building and assessor data (replacement cost values and detailed structure information) were loaded into HAZUS-MH. An updated inventory was used in place of the HAZUS-MH defaults for essential facilities, transportation and utilities. Current planning area flood mapping was used to delineate flood hazard areas and estimate potential losses from the 100- and 500-year flood events.
- **Dam Failure**—The basis for this analysis was the Lake Youngs dam failure inundation mapping. This data was imported into HAZUS-MH and a Level 2 analysis was run using the flood methodology described above.
- **Earthquake**—A Level 2 analysis was performed to assess earthquake risk and exposure. Earthquake shake maps and probabilistic data prepared by the U.S. Geological Survey (USGS) were used for the analysis of this hazard. An updated general building stock inventory was developed using replacement cost values and detailed structure information from assessor tables. An updated inventory of essential facilities, transportation and utility features was used in place of the HAZUS-MH defaults. Three scenario events and two probabilistic events were modeled:
  - The scenario events were a Magnitude-7.2 event on the Seattle Fault, a Magnitude-7.4 event on the South Whidbey Island Fault and a Magnitude-7.1 event on the Tacoma Fault.
  - The standard HAZUS analysis for the 100- and 500-year probabilistic events was run.

4.4.2 Landslide, Severe Weather, Volcano and Wildfire

For landslide, severe weather, volcano and wildfire, historical data was not adequate to model future losses. However, HAZUS-MH is able to map hazard areas and calculate exposures if geographic information is available on the locations of the hazards and inventory data. Areas and inventory susceptible to some of the hazards of concern were mapped and exposure was evaluated. For other hazards, a qualitative analysis was conducted using the best available data and professional judgment. Locally relevant information was gathered from a variety of sources. Frequency and severity indicators include past events and the expert opinions of geologists, emergency management specialists and others. The primary data source was the King County GIS database, augmented with state and federal data sets. Additional data sources for specific hazards were as follows:

- **Landslide**—Landslide location dataset from Washington Department of Natural Resources and a landslide hazard dataset from King County.
- **Severe Weather**—Severe weather data was downloaded from the Natural Resources Conservation Service and the National Renewable Energy Laboratory.
- **Volcano**—Volcanic hazard data was obtained from the Washington Department of Natural Resources.
- **Wildfire**—Information on wildfire hazards areas was provided by U.S. Geological Survey and Washington Department of Natural Resources.

4.4.3 Drought

The risk assessment methodologies used for this plan focus on damage to structures. Because drought does not impact structures, the risk assessment for drought was more limited and qualitative than the assessment for the other hazards of concern.

4.4.4 Other Hazards of Interest

The other hazards of interest described in Chapter 14 were profiled but no risk assessment was performed for them.

4.4.5 Limitations

Loss estimates, exposure assessments and hazard-specific vulnerability evaluations rely on the best available data and methodologies. Uncertainties are inherent in any loss estimation methodology and arise in part from incomplete scientific knowledge concerning natural hazards and their effects on the built environment. Uncertainties also result from the following:

- Approximations and simplifications necessary to conduct a study
- Incomplete or outdated inventory, demographic or economic parameter data
- The unique nature, geographic extent and severity of each hazard
- Mitigation measures already employed
- The amount of advance notice residents have to prepare for a specific hazard event.

These factors can affect loss estimates by a factor of two or more. Therefore, potential exposure and loss estimates are approximate. The results do not predict precise results and should be used only to understand relative risk. Over the long term, the City of Covington will collect additional data to assist in estimating potential losses associated with other hazards.

CHAPTER 5.
CITY OF COVINGTON PROFILE

5.1 GEOGRAPHIC OVERVIEW

The City of Covington is located in the east hills of the Puget Sound area in southern King County. Neighboring cities are Kent to the west, Maple Valley to the east, Auburn to the south, and Black Diamond to the southeast. Unincorporated King County lies north and south of the city (see Figure 5-1).

The area of the city is 5.86 square miles and is defined by several geographically distinct portions, notably, the East Hill plateau. Residential development and supporting regional and downtown commercial activity are the predominant land uses in these areas. The major industrial area and southeast industrial district are located on the south side of Covington Way. The majority of the central portion of the city is zoned for residential development. Table 5-1 shows the zoning classifications and the number of acres in each zone within the city from the City's 2010 Comprehensive plan.

TABLE 5-1.
ZONING DESIGNATIONS IN THE CITY OF COVINGTON

Zoning Classification	Area (acres)	% of total
Medium Density Residential	1,045.19	32.02%
Low Density Residential	703.04	21.54%
High Density Residential	492.71	15.09%
Urban Separator	344.16	10.54%
Mixed Commercial	210.50	6.44%
Mineral	132.77	4.07%
Industrial	99.45	3.05%
General Commercial	77.71	2.38%
Town Center	73.10	2.24%
Mixed Housing/Office	57.23	1.75%
Multifamily Residential	18.19	0.56%
Neighborhood Commercial	5.85	0.18%
Community Commercial	4.38	0.13%
Total	**3,264.29**	**100%**

Source: City of Covington GIS

Figure 5-1. Main Features of Planning Area

5.2 HISTORICAL OVERVIEW

The original Covington area was called Jenkins Prairie, a name that remains in today's Jenkins Creek and Jenkins Creek Elementary School. The following historical summary is adapted from a Covington history website (Covington, 2000).

In the 1880s, the Northern Pacific Railroad designated a stop named Covington along its railroad line between Auburn and Kanaskat. This stop became the center of the future community of Covington. In 1890, the Covington Lumber Company was formed at the junction of Soos Creek and the Northern Pacific Railway, just southwest of the Covington depot. The lumber mill produced up to 6,000 board feet of lumber per hour and housed a shingle factory. An abundance of timber and water in the area soon lured other lumber interests to Covington. Charlie Meredith built a mill on Jenkins Creek just north of the whistle stop and the Award Lumber Company was located about 3 miles east of Auburn. One of the best-known mills in the area was the Covington Creek Mill.

By the beginning of the 1900s, the area had a school, a store, a post office, a loan office, a feed mill and a fire station. Meridian Cemetery was started around the same time, as was telephone service. In 1937, Covington had its own school district, housed in a building on Kent-Black Diamond Road.

The area continued to grow with neighborhoods of single-family housing. Covington was officially incorporated as a city on August 31, 1997.

5.3 GOVERNANCE

Covington has a council-manager form of government. The elected governing body, or city council, is responsible for the legislative functions of the city such as establishing policy, passing ordinances, and developing an overall vision. This body will assume the responsibility for the adoption and implementation of this plan. The city council appoints a city manager to oversee the administrative operations and implement the policies. The mayor is selected from the members of the council. City services include the following:

- Police
- Fire protection (contract)
- Land use planning and building inspection
- Parks and recreation
- Solid waste and recycling (contract)
- Emergency management
- Stormwater management
- Street maintenance.

The city has five commissions that advise the council:

- The Planning Commission
- The Parks and Recreation Commission
- The Arts Commission
- The Covington Economic Development Council
- The Human Services Commission.

5.4 MAJOR PAST HAZARD EVENTS

Presidential disaster declarations are typically issued for hazard events that cause more damage than state and local governments can handle without assistance from the federal government, although no specific dollar loss threshold has been established for these declarations. A presidential disaster declaration puts federal recovery programs into motion to help disaster victims, businesses and public entities. Some of the programs are matched by state programs. There have been 26 presidential disaster declarations issued within King County, as listed in Table 5-2.

TABLE 5-2.
FEDERAL DISASTER DECLARATIONS FOR EVENTS AFFECTING COVINGTON AREA

Disaster Number	Incident Description	Event Begin Date
DR-185	Heavy rains & flooding	12/29/1964
DR-196	Earthquake	5/11/1965
DR-328	Heavy rains & flooding	3/24/1972
DR-492	Severe storms & flooding	12/13/1975
DR-545	Severe storms, mudslides, & flooding	12/10/1977
DR-612	Storms, high tides, mudslides & flooding	12/31/1979
DR-623	Volcanic eruption, Mt. St. Helens	5/21/1980
DR-757	Severe storms & flooding	1/16/1986
DR-784	Severe storms & flooding	11/22/1986
DR-852	Severe storms & flooding	1/6/1990
DR-883	Severe storms & flooding	11/9/1990
DR-896	Severe storms & high tides	12/20/1990
DR-981	Severe storms & high wind	1/20/1993
DR-1079	Severe storms, high wind, and flooding	11/7/1995
DR-1100	High winds, severe storms and flooding	1/26/1996
DR-1159	Severe winter storms, land & mudslides, flooding	12/26/1996
DR-1172	Heavy rains, snow melt, flooding, land & mud slides	3/18/1997
DR-1361	Earthquake	2/28/2001
DR-1499	Severe storms and flooding	10/15/2003
DR-1671	Severe storms, flooding, landslides, and mudslides	11/2/2006
DR-1682	Severe winter storm, landslides, and mudslides	12/14/2006
DR-1734	Severe storms, flooding, landslides, and mudslides	12/1/2007
DR-1817	Severe winter storm, landslides, mudslides, and flooding	1/6/2009
DR-1825	Severe winter storm and record and near record snow	12/12/2008
DR-1963	Severe winter storm, flooding, landslides, and mudslides	1/11/2011
DR-4056	Severe winter storm, flooding, landslides, and mudslides	1/14/2012

Note: Presidential disaster declarations from 1964 on are county-specific, and those listed here are for King County.
Source: (FEMA, 2012a).

Many if not all of these events impacted the City in some way. Review of these events helps identify targets for risk reduction and ways to increase a community's capability to avoid large-scale events in the future and supports the concept of risk ranking described Chapter 15 of this plan. Still, many natural hazard events do not trigger federal disaster declaration protocol but have significant impacts on their communities. These events are also important to consider in establishing recurrence intervals for hazards of concern.

5.5 PHYSICAL SETTING

Puget Sound and the Olympic Mountain range lie west of Covington and the Cascade Mountain range is to the east. Covington is approximately 50 miles northwest of Mt. Rainier and 15 miles southeast of Seattle. There are no rivers in Covington, although there are three tributaries that feed the Green River: Big Soos Creek, Little Soos Creek and Jenkins Creek. A portion of Pipe Lake lies within the city along its eastern boundary with Maple Valley; other small lakes nearby include Lake Meridian to the west in Kent, Lake Lucerne to the east in Maple Valley, and Lake Youngs and Shadow Lake to the north in unincorporated King County.

5.5.1 Geology

The geology of the area was largely formed by prehistoric glacial activity and subsequent lee retreats. The surface geology is mainly composed of continental glacial outwash from the Pleistocene era consisting of outwash and moraine. The City has gently rolling terrain with a few areas prone to erosion in the west portion of the City.

5.5.2 Soils

The U.S. Department of Agriculture Soil Survey of King County mapped the soils in the area. The most common soil type in the area is the Alderwood Series, which includes moderately well drained gravelly loams that are 24 to 40 inches deep over consolidated glacial till. The next most common type is the Everett series. Everett soils are gravelly and are underlain by sand and gravel. In certain areas, principally basins and lowlands, organic materials, including peat, can occur in depths up to 10 feet.

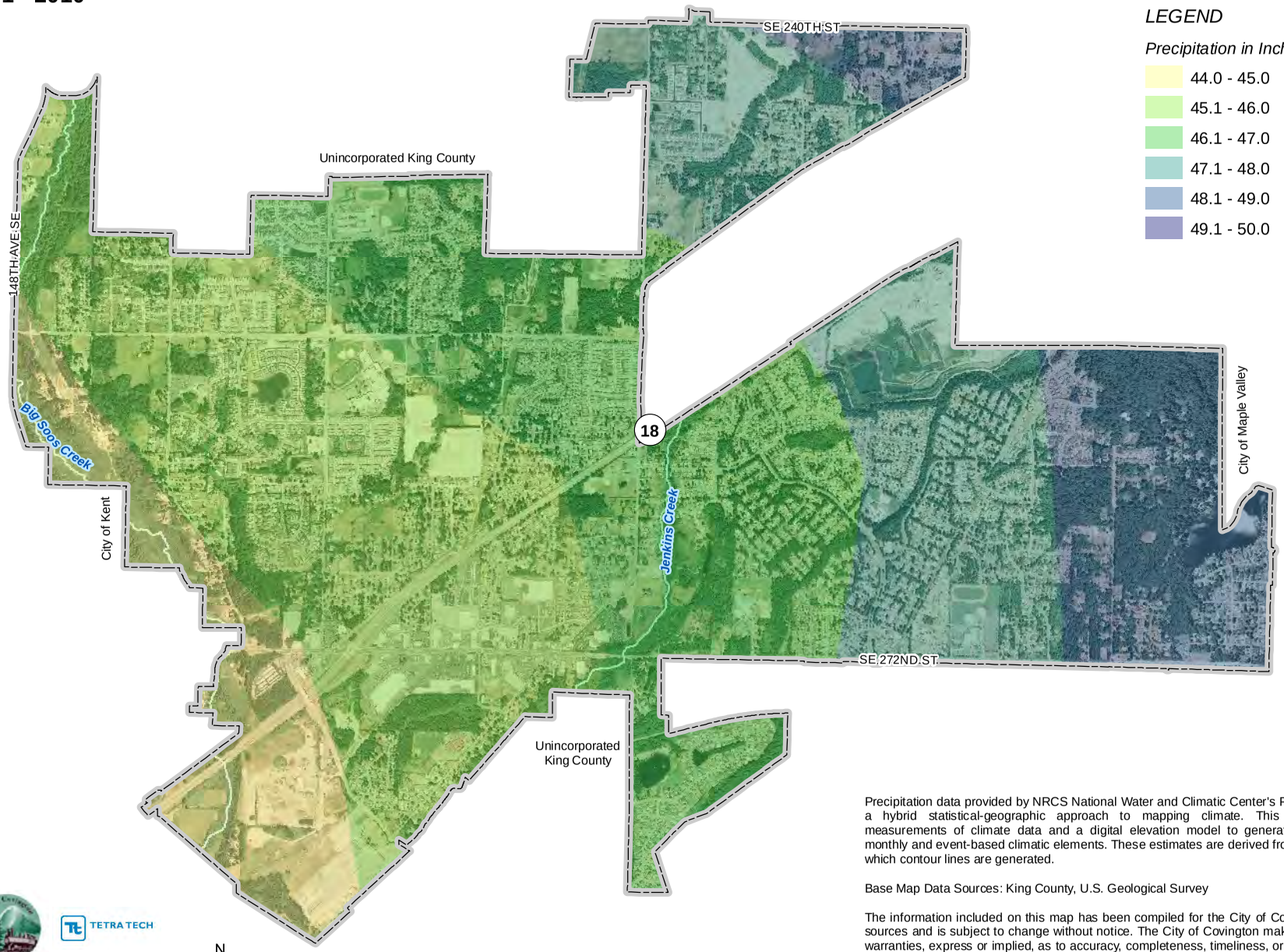
5.5.3 Climate

The City of Covington experiences the mild climate of the Puget Sound Lowlands in the rain shadow of the Olympic Mountains. Microclimate variations in the Lowlands region are determined in part by the distance from Puget Sound, topography and the reach of ocean air. In summer, the prevailing wind is from the northwest; in winter it is from the south or southwest. Wind speeds generally are below 10 miles per hour. Average temperatures generally increase with distance from Puget Sound. Winter snowfall averages 10 to 20 inches, although snow typically melts relatively quickly. The area is in plant-hardiness Zone 8; the growing season typically begins in late April and extends through mid-October (Washington Regional Climate Center, 2013).

The annual average temperature for the City of Covington is 53.2ºF. The annual average high is 61.8ºF and the average annual low is 44.6ºF. The average high in July is 77.8ºF, and the average low in December is 34.8ºF. Annual average precipitation is 39 inches. Most of this precipitation falls between October and May. On average, November is the wettest month with 6.27 inches of precipitation and July is the driest month, averaging 0.83 inches (National Climatic Data Center, 2010). Covington typically experiences 158 precipitation days a year and 153 sunny days per year.

The distribution of average annual precipitation and typical maximum and minimum temperatures over the planning area is shown on Figure 5-2, Figure 5-3 and Figure 5-4.

Figure 5-2
Annual Average Precipitation
1981 - 2010



LEGEND

Precipitation in Inches

- 44.0 - 45.0
- 45.1 - 46.0
- 46.1 - 47.0
- 47.1 - 48.0
- 48.1 - 49.0
- 49.1 - 50.0

TETRA TECH

0 0.25 0.5 Miles

N W E S

Precipitation data provided by NRCS National Water and Climatic Center's PRISM project. PRISM is a hybrid statistical-geographic approach to mapping climate. This approach uses point measurements of climate data and a digital elevation model to generate estimates of annual, monthly and event-based climatic elements. These estimates are derived from a horizontal grid from which contour lines are generated.

Base Map Data Sources: King County, U.S. Geological Survey

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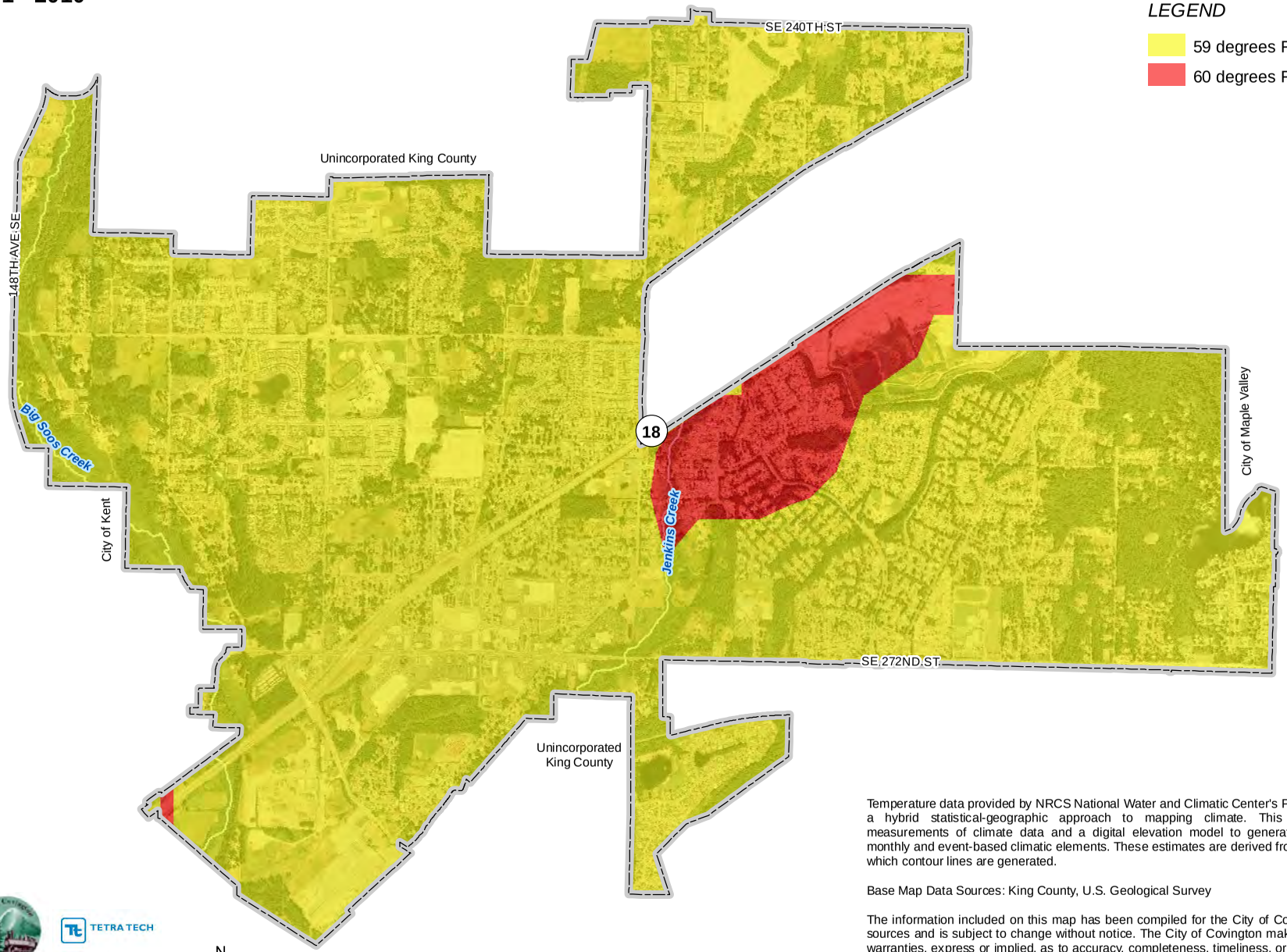
Figure 5-3
Annual Average Maximum Temperature
1981 - 2010



Temperature data provided by NRCS National Water and Climatic Center's PRISM project. PRISM is a hybrid statistical-geographic approach to mapping climate. This approach uses point measurements of climate data and a digital elevation model to generate estimates of annual, monthly and event-based climatic elements. These estimates are derived from a horizontal grid from which contour lines are generated.

Base Map Data Sources: King County, U.S. Geological Survey

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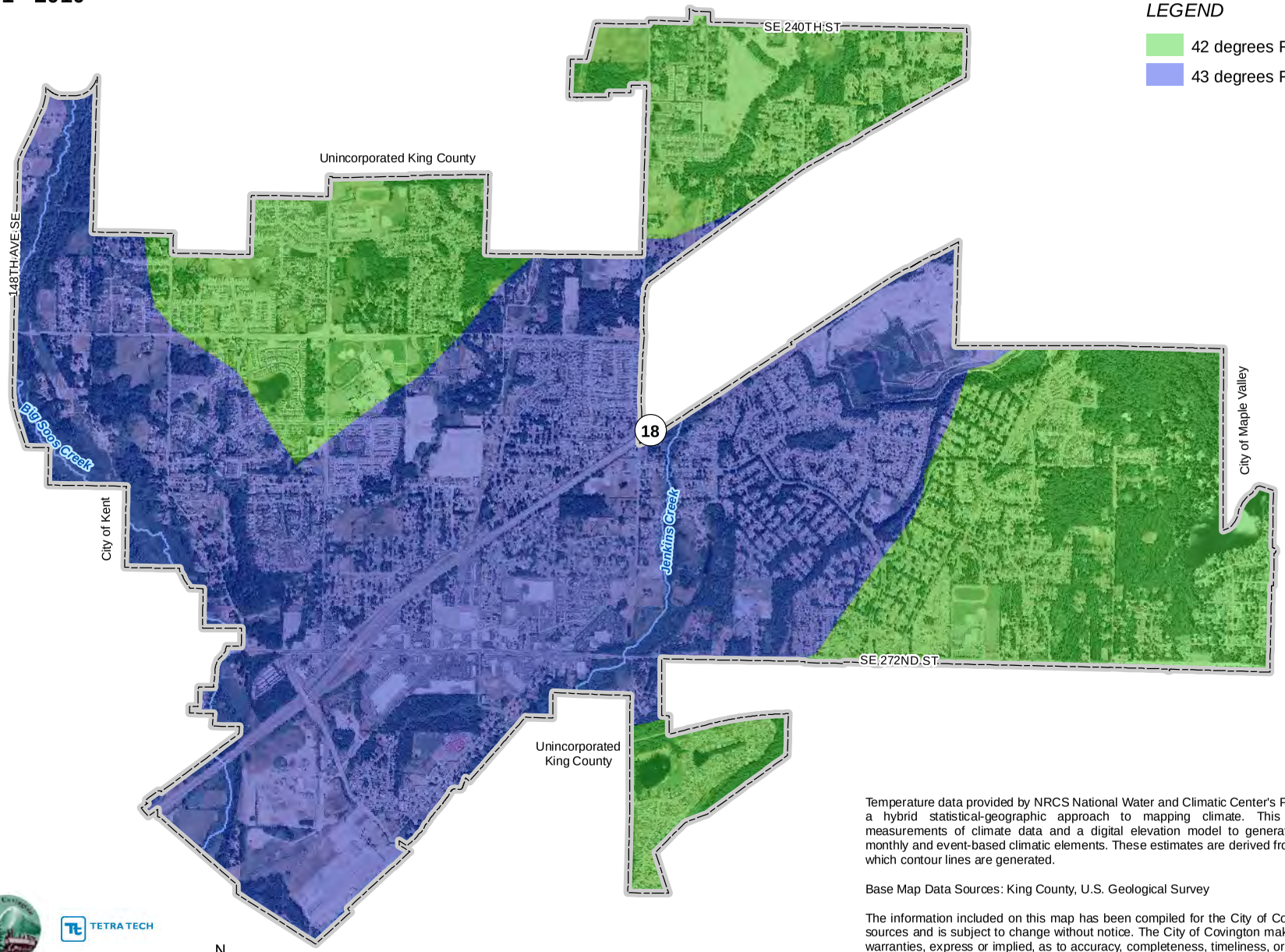
TETRA TECH

0 0.25 0.5 Miles

N W E S

Figure 5-4
Annual Average Minimum Temperature
1981 - 2010



Temperature data provided by NRCS National Water and Climatic Center's PRISM project. PRISM is a hybrid statistical-geographic approach to mapping climate. This approach uses point measurements of climate data and a digital elevation model to generate estimates of annual, monthly and event-based climatic elements. These estimates are derived from a horizontal grid from which contour lines are generated.

Base Map Data Sources: King County, U.S. Geological Survey

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TETRA TECH

0 0.25 0.5 Miles

N W E S

Severe winter storms affecting Covington typically originate in the Gulf of Alaska and in the central Pacific Ocean. These storms are most common from October through March. Puget Sound provides a low-level passage between the Olympic and Cascade mountain ranges for cold air from British Columbia. Cold air often moves south through the Sound and into the Seattle metropolitan area. If a wet Pacific storm happens to reach the area at the same time, snow may result. There is an average of only five days per year of measurable snow; accumulations rarely exceed 2 inches.

In summer, the most common wind directions are from the west or northwest; in winter, they are from the south and east. The most frequent surface winds in Washington are from the southwest. These widespread winds are associated with storms moving onto the coast from the Pacific Ocean. Winds coming from the south are the most destructive. Chinook winds are strong easterly winds coming down the western face of the Cascade Range. The Chinook wind is a warm dry wind that often leads to the rapid disappearance of snow, and can gust up to 100 miles per hour. The gusts are caused by rapid atmospheric pressure changes.

5.6 CRITICAL FACILITIES AND INFRASTRUCTURE

Critical facilities and infrastructure are those that are essential to the health and welfare of the population. These become especially important after a hazard event. Critical facilities are typically defined to include police and fire stations, schools and emergency operations centers. Critical infrastructure can include the roads and bridges that provide ingress and egress and allow emergency vehicles access to those in need and the utilities that provide water, electricity and communication services to the community. Also included are “Tier II” facilities and railroads, which hold or carry significant amounts of hazardous materials with a potential to impact public health and welfare in a hazard event.

The Steering Committee has defined a critical facility for this hazard mitigation plan as a public or private facility vital to the City’s ability to provide essential services and protect life and property. Loss of a critical facility would result in a severe economic or catastrophic impact. Critical facilities can be segregated into three categories:

- Facilities that are essential to the City’s ability to respond to and recover from the impacts of natural hazards, including those potentially used as shelters.
- Facilities that need early warning to enable them to prepare for and respond to the impacts of natural hazards.
- Facilities whose operations create an exposure to secondary hazards of concern.

Under the definition used for this plan, critical facilities include but are not limited to the following:

- Government facilities (including those that house critical information technology and communication infrastructure), vehicle and equipment storage facilities, and emergency operations centers needed for disaster response before, during, and after hazard events
- Public and private utilities and infrastructure, including data and server communication facilities, vital to maintaining or restoring normal services to areas damaged by hazard events
- Educational facilities
- Hospitals, and care facilities likely to contain occupants who may not be sufficiently mobile to avoid death or injury during a hazard event
- Structures or facilities that produce, use, or store highly volatile, flammable, explosive, toxic, and/or water-reactive materials
- Existing shelter facilities or those likely to be used as shelter facilities.

Figure 5-5 and Figure 5-6 show the location of critical facilities and infrastructure in the planning area. Due to the sensitivity of this information, a detailed list of facilities is not provided. The list is on file with the City of Covington but is not available for public review. Table 5-3 and Table 5-4 provide summaries of the general types of critical facilities and infrastructure. All critical facilities/infrastructure were analyzed in HAZUS to help rank risk and identify mitigation actions. The risk assessment for each hazard qualitatively discusses critical facilities with regard to that hazard.

TABLE 5-3.
PLANNING AREA CRITICAL FACILITIES

Facility Type	Number in Planning Area
Medical and Health	4
Government Functions	3
Protective Functions	2
Schools	7
Hazmat	0
Other Critical Functions	14
Total	**41**

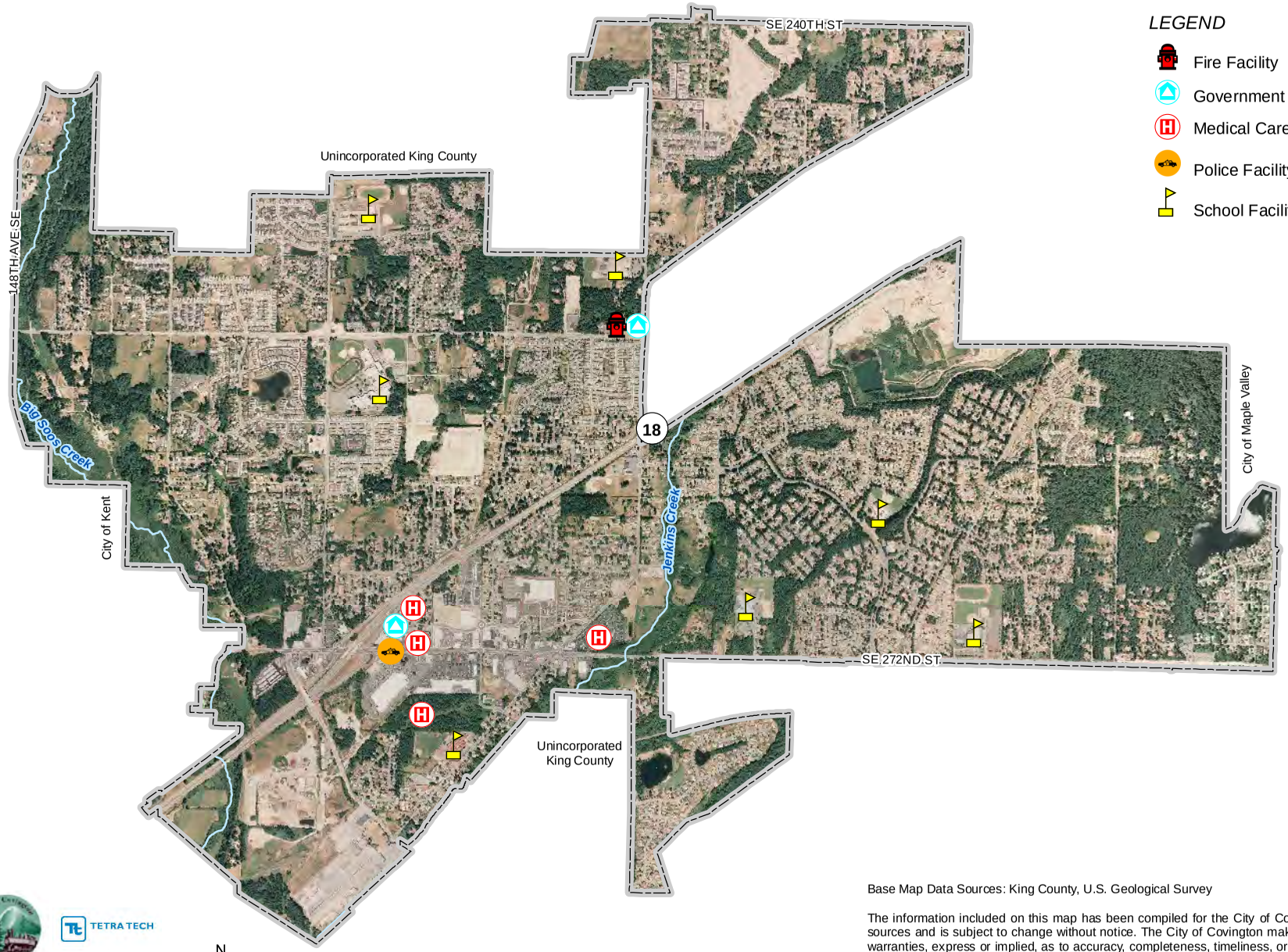
TABLE 5-4.
PLANNING AREA CRITICAL INFRASTRUCTURE

Facility Type	Number in Planning Area
Bridges	11
Water Supply	3
Wastewater	9
Power	2
Communications	0
Other	0
Total	**25**

5.7 DEMOGRAPHICS

Some populations are at greater risk from hazard events because of decreased resources or physical abilities. Elderly people, for example, may be more likely to require additional assistance. Research has shown that people living near or below the poverty line, the elderly (especially older single men), the disabled, women, children, ethnic minorities and renters all experience, to some degree, more severe effects from disasters than the general population. These vulnerable populations may vary from the general population in risk perception, living conditions, access to information before, during and after a hazard event, capabilities during an event, and access to resources for post-disaster recovery. Indicators of vulnerability—such as disability, age, poverty, and minority race and ethnicity—often overlap spatially and often in the geographically most vulnerable locations. Detailed spatial analysis to locate areas where there are higher concentrations of vulnerable community members would help to extend focused public outreach and education to these most vulnerable citizens.

Figure 5-5
Planning Area Critical Facilities



LEGEND

- Fire Facility
- Government Function
- Medical Care Facilities
- Police Facility
- School Facility

TETRA TECH

0 0.25 0.5 Miles

N W E S

Base Map Data Sources: King County, U.S. Geological Survey

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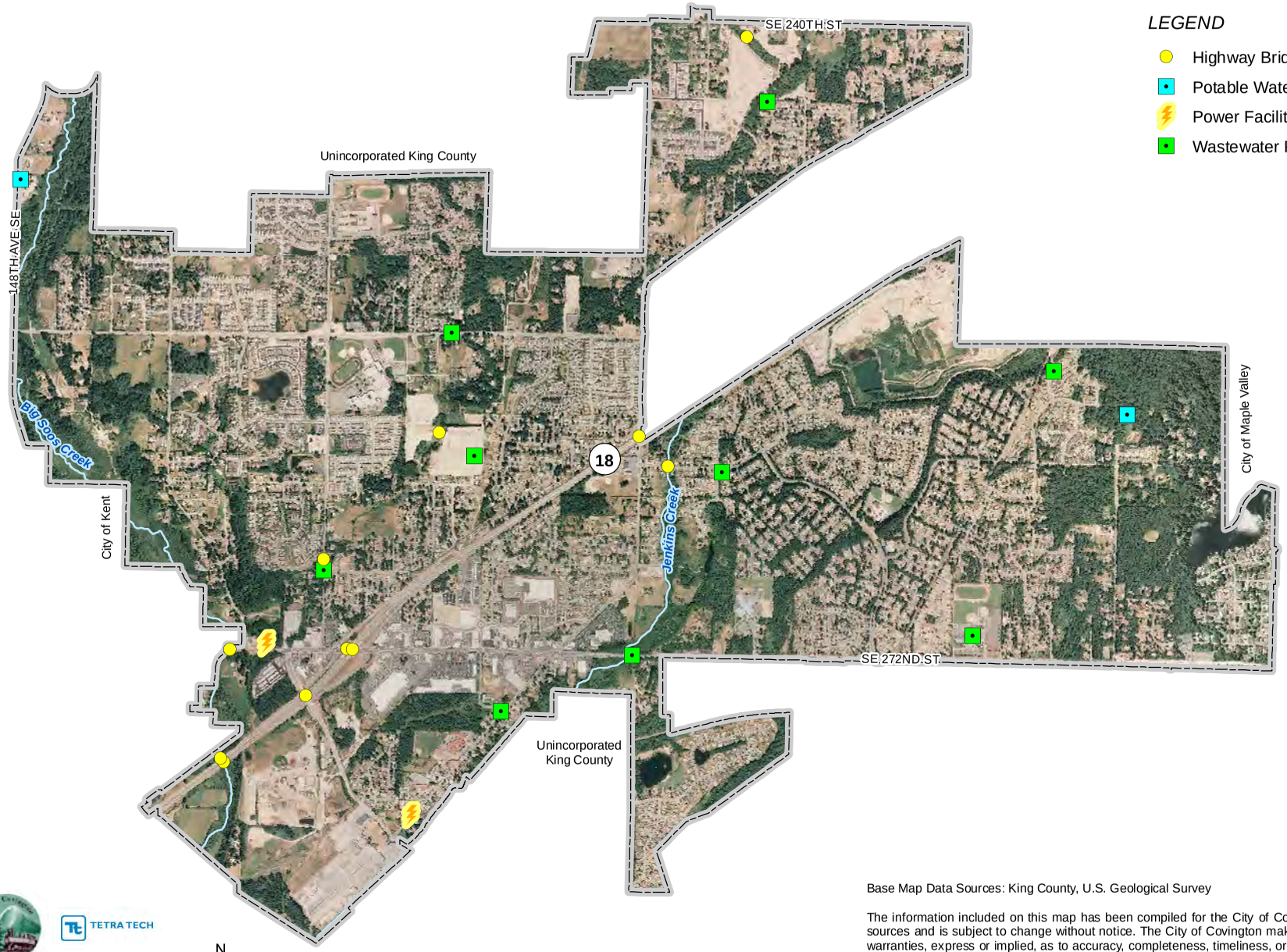
Figure 5-6
Planning Area Critical Infrastructure



LEGEND

- Highway Bridge
- Potable Water Facility
- Power Facility
- Wastewater Facility

TETRA TECH

0 0.25 0.5 Miles

N W E S

Base Map Data Sources: King County, U.S. Geological Survey

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5.7.1 Population Characteristics

Knowledge of the composition of the population and how it has changed in the past and how it may change in the future is needed for making informed decisions about the future. Information about population is a critical part of planning because it directly relates to land needs such as housing, industry, stores, public facilities and services, and transportation. The U.S. Census Bureau estimated the city's population at 17,575 as of 2010.

Population change is a useful socio-economic indicator—a growing population generally indicates a growing economy, while a decreasing population signifies economic decline. Because the City of Covington is newly incorporated, historical population data for the city is limited. The following is a comparison of the city's growth over 10 years with the growth of King County and Washington State (Washington Office of Financial Management, 2012):

- Washington Office of Financial Management lists Covington's 2000 population as 13,783. The 2010 U.S. Census population represents a 27.5-percent increase over the previous decade, an average growth rate of 2.5 percent.
- Over the same period, King County saw average annual growth of 1.1 percent and 10-year growth of 11.2 percent (from 1,737,046 in 2000 to 1,931,249 in 2010).
- Washington state grew 1.3 percent per year from 2000 to 2010, a 10-year total of 14.1 percent (from 5,894,143 in 2000 to 6,724,540 in 2010).

5.7.2 Income

In the United States, individual households are expected to use private resources to prepare for, respond to and recover from disasters to some extent. This means that households living in poverty are automatically disadvantaged when confronting hazards. Additionally, the poor typically occupy more poorly built and inadequately maintained housing. Mobile or modular homes, for example, are more susceptible to damage in earthquakes and floods than other types of housing. In urban areas, the poor often live in older houses and apartment complexes, which are more likely to be made of un-reinforced masonry, a building type that is particularly susceptible to damage during earthquakes. Furthermore, residents below the poverty level are less likely to have insurance to compensate for losses incurred from natural disasters. This means that residents below the poverty level have a great deal to lose during an event and are the least prepared to deal with potential losses. The events following Hurricane Katrina in 2005 illustrated that personal household economics significantly impact people's decisions on evacuation. Individuals who cannot afford gas for their cars will likely decide not to evacuate.

Based on U.S. Census Bureau estimates, per capita income in the planning area in 2010 was $32,802, and the median household income was $90,285. It is estimated that about 36.8 percent of households receive an income of $100,000 or more annually. About 5.6 percent of households in the planning area make less than $25,000 per year and are therefore below the poverty level (U.S. Census Bureau, 2013a).

5.7.3 Age Distribution

As a group, the elderly are more apt to lack the physical and economic resources necessary for response to hazard events and are more likely to suffer health-related consequences making recovery slower. They are more likely to be vision, hearing and/or mobility impaired, and more likely to experience mental impairment or dementia. Additionally, the elderly are more likely to live in assisted-living facilities where emergency preparedness occurs at the discretion of facility operators. These facilities are typically identified as "critical facilities" by emergency managers because they require extra notice to implement evacuation.

Elderly residents living in their own homes may have more difficulty evacuating their homes and could be stranded in dangerous situations. This population group is more likely to need special medical attention, which may not be readily available during natural disasters due to isolation caused by the event. Specific planning attention for the elderly is an important consideration given the current aging of the American population.

Children are particularly vulnerable to disaster events because of their young age and dependence on others for basic necessities. Very young children may additionally be vulnerable to injury or sickness; this vulnerability can be worsened during a natural disaster because they may not understand the measures that need to be taken to protect themselves from hazards.

The overall age distribution for the planning area is illustrated in Figure 5-7. Based on U.S. Census data estimates (U.S. Census Bureau, 2013a), 6.3 percent of the planning area's population is 65 or older, compared to the state average of 12.3 percent. It is also estimated that 28.6 percent of the population is younger than 18, compared to the state average of 23.5 percent. According to U.S. Census data, 6.5 percent of those over age 65 have incomes below the poverty line. Children under 18 account for nearly 12.5 percent of individuals living below the poverty line.

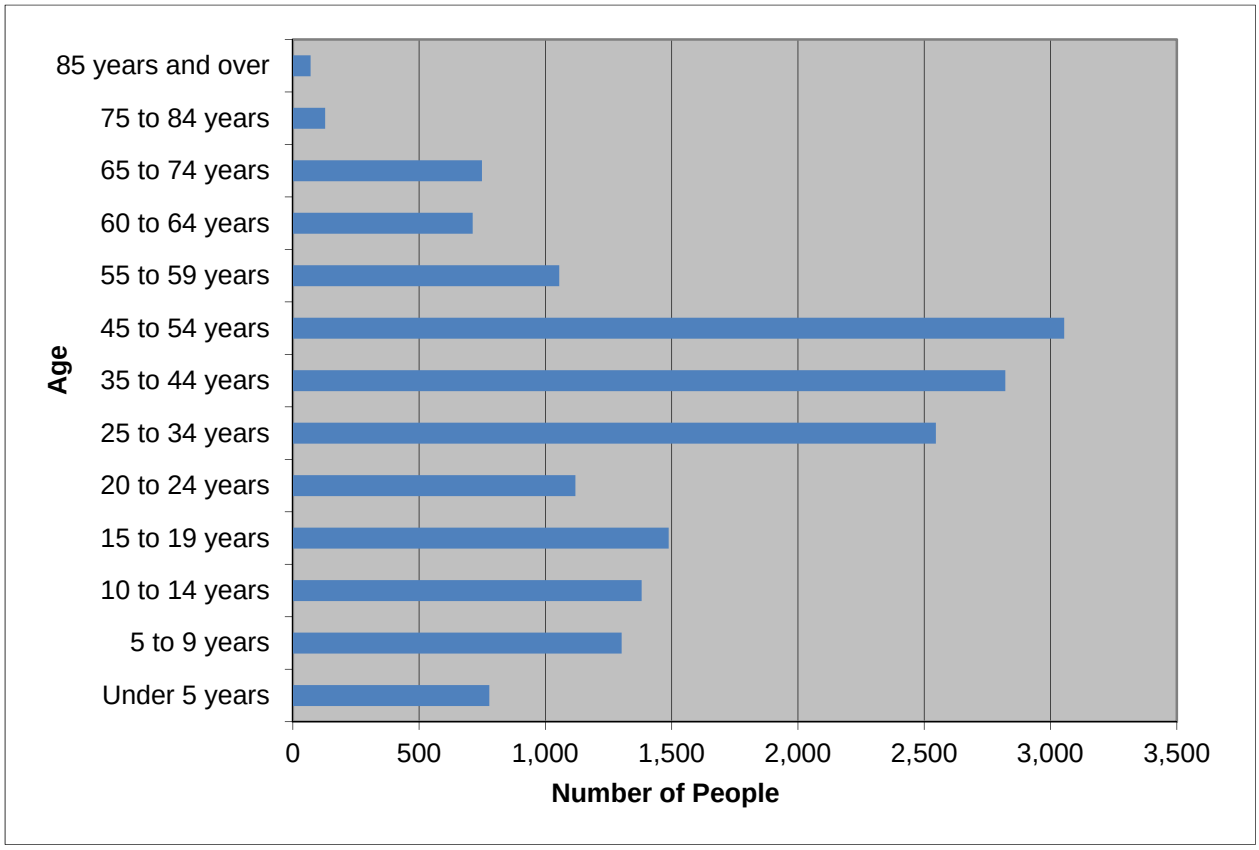


Figure 5-7. City of Covington 2010 Age Distribution

5.7.4 Race, Ethnicity and Language

Research shows that minorities are less likely to be involved in pre-disaster planning and experience higher mortality rates during a disaster event. Post-disaster recovery can be ineffective and is often characterized by cultural insensitivity. Since higher proportions of ethnic minorities live below the poverty line than the majority white population, poverty can compound vulnerability. According to the

U.S. Census, the 2010 racial composition of the City of Covington is predominantly white, at 76.1 percent. The largest minority populations are Asian at 8.5 percent and African American at 4.2 percent. Another 5.8 percent of the population identify as two or more races. Figure 5-8 shows the racial distribution in the planning area (U.S. Census Bureau, 2013a).

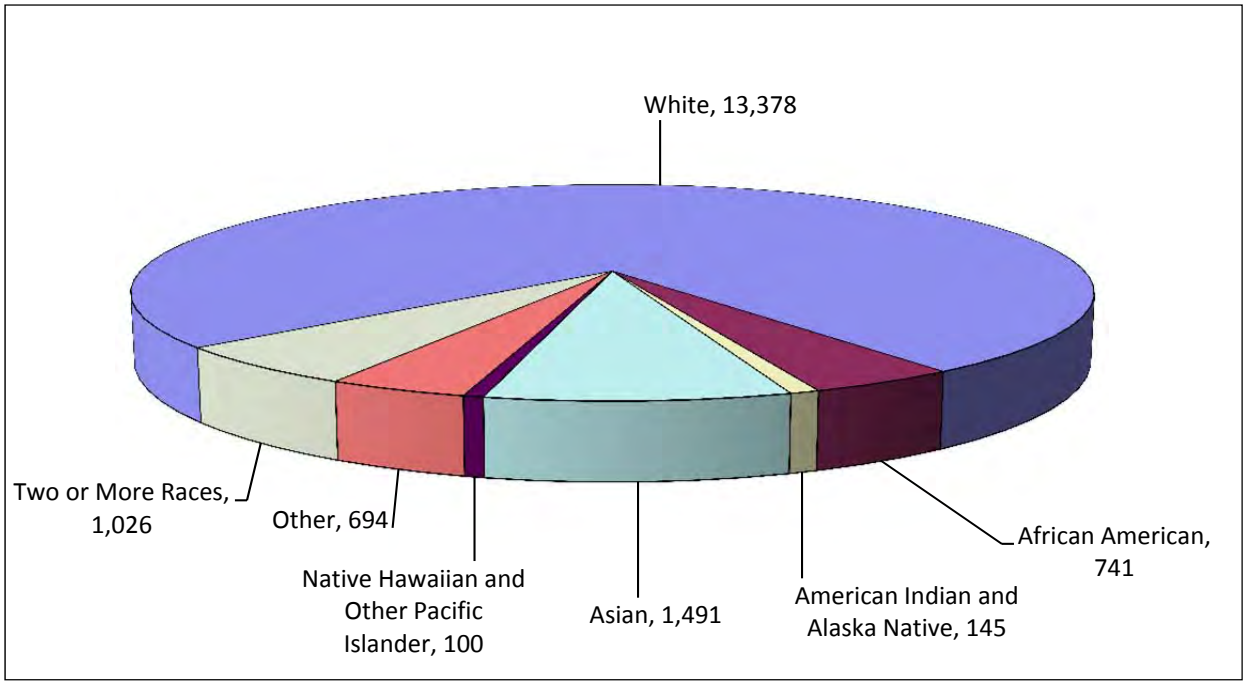


Figure 5-8. Planning Area Race Distribution

The planning area has a 9.8-percent foreign-born population. Other than English, the most commonly spoken language in the planning area is Spanish. The census estimates that 4.0 percent of the residents speak English "less than very well" (U.S. Census Bureau, 2013a).

5.7.5 Disabled Populations

The 2010 U.S. Census estimates that 54 million non-institutionalized Americans with disabilities live in the U.S. This equates to about one-in-five persons. People with disabilities are more likely to have difficulty responding to a hazard event than the general population. Local government is the first level of response to assist these individuals, and coordination of efforts to meet their access and functional needs is paramount to life safety efforts. It is important for emergency managers to distinguish between functional and medical needs in order to plan for incidents that require evacuation and sheltering. Knowing the percentage of population with a disability will allow emergency management personnel and first responders to have personnel available who can provide services needed by those with access and functional needs.

Disability-related Census data is not available for the City of Covington, but it is available for King County and for Washington State. According to the U.S. Census Bureau's American Community Survey for 2011, 10.0 percent of King County's population and 12.6 percent of Washington's population has some form of disability (U.S. Census Bureau, 2013b).

5.8 ECONOMY

5.8.1 Industry, Businesses and Institutions

According to the U.S. Census Bureau's American Community Survey, Covington's economy is strongly based in manufacturing and in education/health care/social assistance, both of which account for about 18 percent of employment in the City. Retail trade is another significant industry, accounting for about 7 percent of the City's employment. The extraction industries of agriculture, forestry, fishing, hunting and mining account for a negligible amount of employment in the City. Other industries with less employment impact are information, wholesale trade and public administration. Figure 5-9 shows the breakdown of industry types in the planning area (U.S. Census Bureau, 2013a). Major business and institutions in the planning area include Wal-Mart, Multicare Health System, Fred Meyer and Costco.

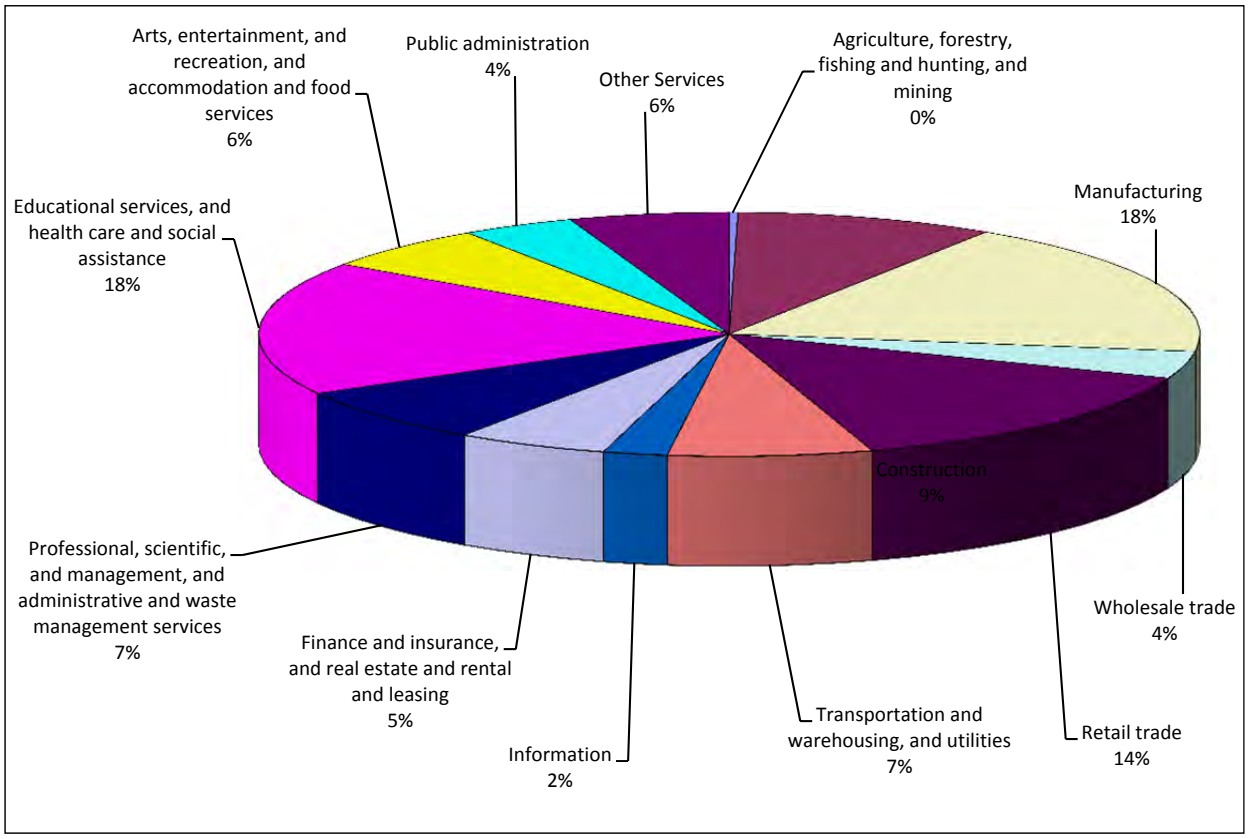


Figure 5-9. Industry in the Planning Area

5.8.2 Employment Trends and Occupations

According to the U.S. Census Bureau's 2011 three-year American Community Survey, 76.3 percent of the planning area's population 16 and older is in the labor force. The greatest number of jobs in Covington is in the retail or services sector. Many of these tend to be relatively low-paying jobs, although service jobs may include higher-paying professional services. There has been a significant increase in jobs in those two sectors since 2000. The construction and resource extraction sector has grown significantly, while the education sector, finance, insurance and real estate sector, and government sector have had modest job growth. Covington has outpaced King County in job growth since 2000. Occupations in management, business, science and arts make up 34 percent of the jobs in the planning area; sales and office occupations account for 28 percent (see Figure 5-10) (U.S. Census Bureau, 2013a). The largest employers in the area are the Kent School District and Wal-Mart.

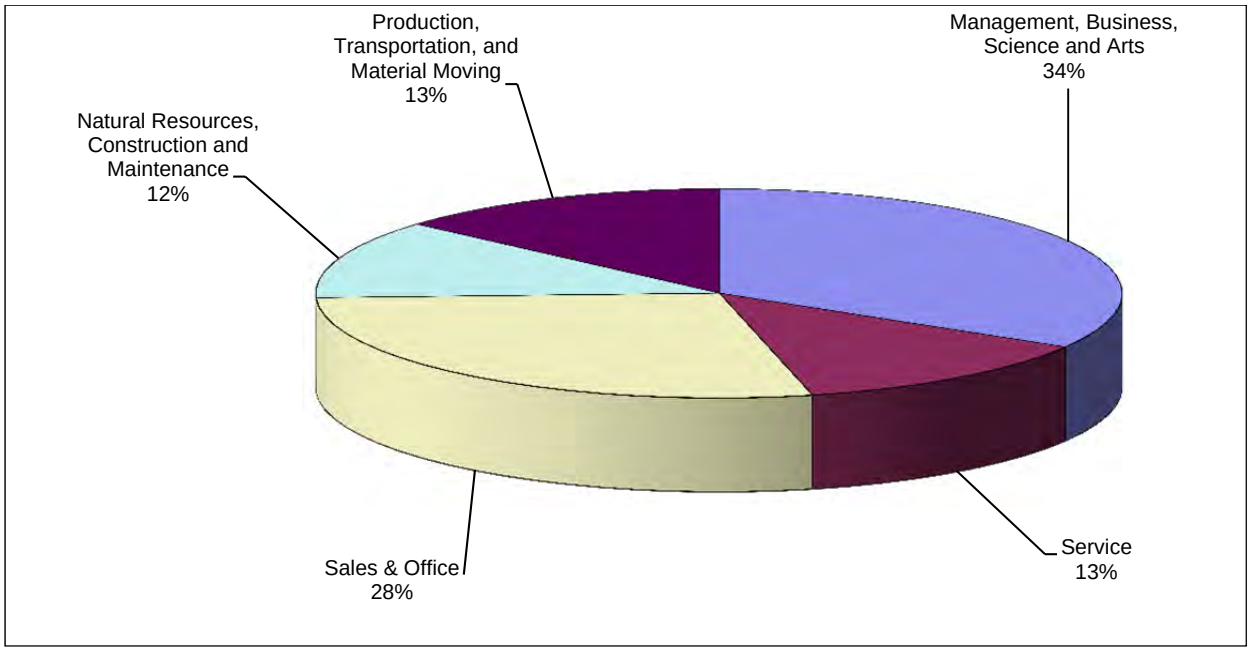


Figure 5-10. Occupations in the Planning Area

Figure 5-11 compares Washington, King County and Seattle metropolitan area unemployment trends from 2000 through 2012 (Washington Employment Security Department, 2013). The unemployment rate in these areas was lowest in 2007, at close to 4 percent. It rose to between 9 and 10 percent in 2010 in response to the national recession, but has been falling again since then. The American Community Survey five-year estimates place the City of Covington unemployment rate at 3.6 percent as of 2011.

The U.S. Census estimates that 79 percent of workers in the planning area commute alone (by car, truck or van) to work, and mean travel time to work is 33.7 minutes (U.S. Census Bureau, 2013a).

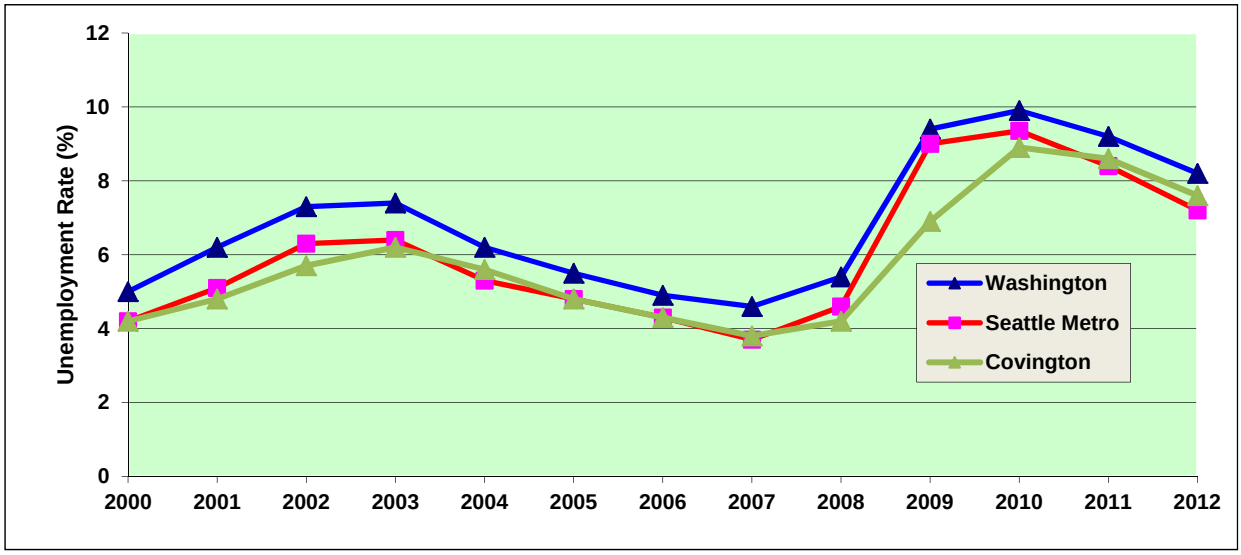


Figure 5-11. Washington, Seattle Metropolitan Area and City of Covington Unemployment Rates

5.9 LAWS AND ORDINANCES

Existing laws, ordinances and plans at the federal, state and local level can support or impact hazard mitigation initiatives identified in this plan. Hazard mitigation plans are required to include a review and incorporation, if appropriate, of existing plans, studies, reports, and technical information as part of the planning process (44 CFR, Section 201.6(b)(3)). Pertinent federal, state and local laws are described below.

5.9.1 Federal

Disaster Mitigation Act

The DMA is the current federal legislation addressing hazard mitigation planning. It emphasizes planning for disasters before they occur. It specifically addresses planning at the local level, requiring plans to be in place before Hazard Mitigation Grant Program funds are available to communities. This plan is designed to meet the requirements of DMA, improving eligibility for future hazard mitigation funds.

Endangered Species Act

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

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

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

Five sections of the ESA are of critical importance to understanding it:

- **Section 4: Listing of a Species**—The National Oceanic and Atmospheric Administration Fisheries Service (NOAA Fisheries) is responsible for listing marine species. The U.S. Fish and Wildlife Service is responsible for listing terrestrial and freshwater aquatic species. The agencies may initiate reviews for listings, or citizens may petition for them. A listing must be made "solely on the basis of the best scientific and commercial data available." After a listing has been proposed, agencies receive comment and conduct further scientific reviews for 12 to 18 months, after which they must decide if the listing is warranted. Economic impacts cannot be considered in this decision, but it may include an evaluation of the adequacy of local and state protections. Critical habitat for the species may be designated at the time of listing.

- **Section 7: Consultation**—Federal agencies must ensure that any action they authorize, fund or carry out is not likely to jeopardize the continued existence of a listed or proposed species or adversely modify its critical habitat. This includes private and public actions that require a federal permit. Once a final listing is made, non-federal actions are subject to the same review, termed a "consultation." If the listing agency finds that an action will "take" a species, it must propose mitigations or "reasonable and prudent" alternatives to the action; if the proponent rejects these, the action cannot proceed.
- **Section 9: Prohibition of Take—**It is unlawful to "take" an endangered species, including killing or injuring it or modifying its habitat in a way that interferes with essential behavioral patterns, including breeding, feeding or sheltering.
- **Section 10: Permitted Take**—Through voluntary agreements with the federal government that provide protections to an endangered species, a non-federal applicant may commit a take that would otherwise be prohibited as long as it is incidental to an otherwise lawful activity (such as developing land or building a road). These agreements often take the form of a "Habitat Conservation Plan."
- **Section 11: Citizen Lawsuits**—Civil actions initiated by any citizen can require the listing agency to enforce the ESA's prohibition of taking or to meet the requirements of the consultation process.

With the listing of salmon and trout species as threatened or endangered, the ESA has impacted most of the Pacific Coast states. Although some of these areas have been more impacted by the ESA than others due to the known presence of listed species, the entire region has been impacted by mandates, programs and policies based on the presumption of the presence of listed species. Most West Coast jurisdictions must now take into account the impact of their programs on habitat.

The City of Covington is located in Water Resource Inventory Area 9 (WRIA 9) the Green/Duwamish and Central Puget Sound Watershed. Citizens, businesses, government and other stakeholders in the watershed have been working to promote salmon habitat recovery. Seventeen governments in WRIA 9, including Covington, have participated in funding coordination for this recovery effort. A Salmon Habitat Plan for the area was completed in 2005. This plan describes and identifies projects and programs that partners in the watershed are now working to complete (King County Department of Natural Resources, 2009). As of 2012 more than $7.3 million has been spent in restoration and habitat protection projects in the watershed (Puget Sound Ecosystem Monitoring Program Salmonid Workgroup, 2013).

The Clean Water Act

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

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

National Flood Insurance Program

The National Flood Insurance Program (NFIP) provides federally backed flood insurance in exchange for communities enacting floodplain regulations. Participation and good standing under NFIP are prerequisites to grant funding eligibility under the Robert T. Stafford Act. The City of Covington participates in the NFIP's emergency program for communities where flood mapping has not yet been prepared. The City entered the emergency program on April 19, 2001. The emergency program provides limited flood insurance as long as the community has adopted minimal regulations for development in flood hazard areas. After FEMA completes flood mapping and the City adopts more stringent ordinances related to the mapping results, Covington will be able to convert to the NFIP's regular program, with full flood insurance available.

5.9.2 State

Washington State Enhanced Mitigation Plan

The Washington State Enhanced Hazard Mitigation Plan approved by FEMA in 2010 provides guidance for hazard mitigation throughout Washington. The plan identifies hazard mitigation goals, objectives, actions and initiatives for state government to reduce injury and damage from natural hazards. By meeting federal requirements for an enhanced state plan (44 CFR parts 201.4 and 201.5), the plan allows the state to seek significantly higher funding from the Hazard Mitigation Grant Program following presidential declared disasters (20 percent of federal disaster expenditures vs. 15 percent with a standard plan).

Growth Management Act

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

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

The Growth Management Act regulates development in these areas, and therefore has the potential to affect hazard vulnerability and exposure at the local level. The Growth Management Act requires certain elements, including land use, housing, capital facilities, utilities and rural areas. Additional optional elements may also be included. The City will strive to integrate this hazard mitigation plan into future updates to its comprehensive plan.

Shoreline Management Act

The 1971 Shoreline Management Act (RCW 90.58) was enacted to manage and protect the shorelines of the state by regulating development in the shoreline area. A major goal of the act is to prevent the "inherent harm in an uncoordinated and piecemeal development of the state's shorelines." Its jurisdiction includes the Pacific Ocean shoreline and the shorelines of Puget Sound, the Strait of Juan de Fuca, and rivers, streams and lakes above a certain size. It also regulates wetlands associated with these shorelines. The Shoreline Management Act defines shorelines of the state as the shores of all streams with an average annual flow greater than 20 cubic feet per second and their associated wetlands, and the shores of all lakes greater than 20 acres and their associated wetlands. Marine shorelines are also included. Three areas in Covington are designated as areas within a shoreline jurisdiction:

- Pipe Lake
- The lower reaches of Jenkins Creek
- The lower reaches of Big Soos Creek.

The Shoreline Management Act is typically administered through a jurisdiction's Shoreline Management Master Program (SMP). The City of Covington's SMP was adopted by the City and approved by the Washington Department of Ecology in 2011 (Washington Department of Ecology, 2011a).

Any development within 200 feet of a shoreline jurisdiction area that is not explicitly exempt under the City's SMP, must obtain a substantial development permit. The City has adopted the exemptions listed by the state in Washington Administrative Code (WAC) 173-27-040 as subsequently amended. If a development is listed as an exemption, developers are required to obtain a shoreline exemption permit. Some uses identified in the SMP require a conditional use permit. Such uses may be approved, provided that the applicant demonstrates all of the use criteria, as listed in the SMP and WAC 173-27-160. Requests for a variance from the shoreline regulations is limited to granting relief to a specific bulk dimension or performance standard as required in the SMP where there are extraordinary or unique circumstances. Shoreline conditional use and variance permits must be reviewed and approved by the Department of Ecology.

Washington State Building Code

The Washington State Building Code consists of several codes. Most are national model codes adopted by reference and amended at the state level. Others, such as the Washington State Energy Code, are state-written, state-specific codes. The Washington State Building Code Council adopted the 2006 editions of national model codes, with some amendments. The Council also adopted changes to the Washington State Energy Code and Ventilation and Indoor Air Quality Code. Washington's state-developed codes are mandatory statewide for residential and commercial buildings. The residential code exceeds the 2006 International Energy Conservation Code standards for most homes, and the commercial code meets or exceeds standards of the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE 90.1-2004). For residential construction covered by ASHRAE 90.1-2007 (buildings with four or more stories), the state code is more stringent. The 2009 IBC went into effect as the Washington model code on July 1, 2010.

Comprehensive Emergency Management Planning

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

- Provides for emergency management by the state, and authorizes the creation of local organizations for emergency management in political subdivisions of the state.
- Confers emergency powers upon the governor and upon the executive heads of political subdivisions of the state.
- Provides for the rendering of mutual aid among political subdivisions of the state and with other states and for cooperation with the federal government with respect to the carrying out of emergency management functions.
- Provides a means of compensating emergency management workers who may suffer any injury or death, who suffer economic harm including personal property damage or loss, or

who incur expenses for transportation, telephone or other methods of communication, and the use of personal supplies as a result of participation in emergency management activities.

- Provides programs, with intergovernmental cooperation, to educate and train the public to be prepared for emergencies.

It is policy under this law that emergency management functions of the state and its political subdivisions be coordinated to the maximum extent with comparable functions of the federal government and agencies of other states and localities, and of private agencies of every type, to the end that the most effective preparation and use may be made of manpower, resources, and facilities for dealing with disasters. The City has developed and adopted a Comprehensive Emergency Management Plan pursuant to this state mandate (third edition, January 2011).

Washington Administrative Code 118-30-060(1)

WAC 118-30-060 (1) requires political subdivisions to base comprehensive emergency management plans on a hazard analysis. It defines hazards as conditions that can threaten human life as the result of three main factors:

- Natural conditions, such as weather and seismic activity
- Human interference with natural processes, such as a levee that displaces the natural flow of floodwaters
- Human activity and its products, such as homes on a floodplain.

The definitions for hazard, hazard event, hazard identification, and flood hazard include related concepts:

- A hazard may be connected to human activity.
- Hazards are extreme events.
- Hazards generally pose a risk of damage, loss, or harm to people and/or their property.

Washington State Floodplain Management Law

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

Flood Control Assistance Account Program

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

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

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

5.9.3 Local

Comprehensive Plan

The City of Covington Comprehensive Plan is the City's long-range guide for growth, development and change over the next two decades, adopted by the City Council in 2001. It provides information about the community and its residents, sets levels of service standards, and provides policy guidance. The Comprehensive Plan includes text, a Future Land Use Plan map and a 20-year Capital Facilities Plan. The text of the plan describes the enabling legislation that is the basis for planning in Washington, followed by 12 elements, including an element for Natural Hazard Mitigation. The 12 elements provide goals and guidelines to direct future growth consistent with the City of Covington's Vision.

The Comprehensive Plan needs to be revised and updated periodically to keep it current and to incorporate changes in community trends and interests. Amendments to the city's Comprehensive Plan may not be adopted more frequently than once a year (with certain exceptions); this restriction ensures that all proposed amendments are considered concurrently so that their cumulative effect can be ascertained. Since the initial adoption of the City's Comprehensive Plan in 2001, it has been periodically reviewed and amended by the City Council to meet the changing needs of the city. According to the City of Covington Municipal Code (CMC 14.25.020), amendments may be proposed no more frequently than once a year (with certain exceptions for emergencies) so that all proposed amendments may be considered during the same time period.

Comprehensive Emergency Management Plan

It is the policy of the City of Covington to mitigate, prepare for, respond to and recover from all natural and technological disasters. Due to the overwhelming nature of disasters, the City encourages its employees, businesses and citizens to be self-sufficient for a minimum of three days should an emergency or disaster occur. The City of Covington Comprehensive Emergency Management Plan presents mitigation, preparedness, response and recovery efforts to protect the general public's health and life safety and to protect businesses and property within the City of Covington:

- Mitigation includes activities taken before or after an emergency that prevent or minimize the risk of recurrence, or reduce the damaging effects of an emergency or disaster.
- Preparedness includes plans or preparations made to get ready for an emergency or disaster to save lives and to help response-and-rescue operations.
- Response is putting the preparedness plans into action to save lives and prevent further property damage in a disaster or emergency situation.

- Recovery is the process taken to return to a normal or even safer situation following an emergency or disaster.

The Comprehensive Emergency Management Plan establishes appropriate governmental actions for emergencies and disasters and delineates what resources are available from the City. It incorporates the City's Continuity of Government Plan and Continuity of Operations Plan. It adopts the National Incident Management System to facilitate restoration of basic city government operations following disasters. The City's Hazard Identification and Vulnerability Analysis was used as the basis for development of the Comprehensive Emergency Management Plan.

Municipal Code

The City of Covington Municipal Code (CMC) regulates development and specifically deals with many hazards. The CMC contains ordinances that regulate different aspects of the city, organized into 18 separate titles. It implements the comprehensive plan and provides opportunities for public participation in planning and permitting processes. The Community Development Department is responsible for implementing most of the development regulations in the CMC, including the following:

- **CMC Title 14, Planning and Development**—The Planning and Development Regulations adopt the comprehensive plan as the principle planning document for development in the city. These regulations also establish protocols for amendments to the comprehensive plan, development regulations and zoning maps and establish standard procedures for permit applications, public notice, hearing and appeals.
- **CMC Title 15, Building and Construction—**The Building and Construction Regulations regulate construction and site work in the City. They establish codes regulating construction to promote the health, safety and welfare of occupants, users and the general public.
- **CMC Title 16, Environment—**The Environment Regulations include the City's regulations implementing the Shoreline Management Plan and State Environmental Policy Act as well as regulations pertaining to flood damage prevention. The flood damage prevention regulations promote public health, safety and general welfare and minimize public and private losses due to flooding in specific areas by creating standards for development.
- **CMC Title 17, Subdivisions—**The Subdivisions regulations establish procedures for segregating land in the City and ensure consistency with the comprehensive plan.
- **CMC Title 18, Zoning—**The Zoning Regulations encourage land use decision making in accordance with the public interest and applicable laws, implement the comprehensive plan's policies, objectives and community vision, provide for orderly development and adequate public facilities and services in conjunction with development, and minimize physical hazards and adverse environmental impacts from development. The City's official zoning map depicts the zoning districts applicable to all properties within the City.

5.10 LOCAL CAPABILITY ASSESSMENT

The planning team performed a "capability assessment," evaluating the City of Covington's capabilities to implement the hazard mitigation actions in this plan. Local communities need to have appropriate resources to implement a mitigation action plan. Increasing such capabilities is a significant way to reduce future losses. A capability assessment creates an inventory of an agency's mission, programs and policies, and evaluates its capacity to carry them out. Table 5-5 summarizes the legal and regulatory capabilities of the City of Covington. Table 5-6 summarizes fiscal capabilities. Table 5-7 summarizes the administrative and technical capabilities. Table 5-8 lists Covington's classification under various community classification programs. Table 5-9 summarizes compliance with the NFIP.

TABLE 5-5.
LEGAL AND REGULATORY CAPABILITY

	Local Authority	State or Federal Prohibitions	Other Jurisdictional Authority	State Mandated	Comments
Codes, Ordinances & Requirements					
Building Code	Yes	No	No	Yes	Ord. 03-13, 05/14/13
Zonings	Yes	No	No	Yes	CMC Title 18
Subdivisions	Yes	No	No	No	CMC Title 17
Stormwater Management	Yes	No	Yes	Yes	CMC 13.25 & 13.30
Post Disaster Recovery	No	No	No	No	
Real Estate Disclosure	No	No	Yes	Yes	RCW 56.06.020
Growth Management	Yes	No	No	Yes	RCW 36.70A (City Planning Under Growth Management Act)
Site Plan Review	Yes	No	No	No	CMC 17.30 & 18.110
Public Health and Safety	Yes	No	No	Yes	CMC 15.05 & 15.20 (Building & Fire Code adopted by reference
Environmental Protection (Critical Areas)	Yes	No	Yes	Yes	CMC 18.65
Planning Documents					
General or Comprehensive Plan	Yes	No	No	Yes	Adopted 12/16/2003, Amended in 2009. Next amendment in 2014
Is the plan equipped to provide linkage to this mitigation plan?			*Yes. Comprehensive Plan has a Natural Disaster Mitigation Element.*		
Floodplain or Basin Plan	No	No	No	No	
Stormwater Plan	Yes	No	No	Yes	Res. 10-11, 04/13/10
Capital Improvement Plan	Yes	No	No	No	Goals & policies outlined in Comprehensive Plan.
What types of capital facilities does the plan address?			*Fire, streets, parks, stormwater, schools, utilities (by reference) and government buildings.*		
How often is the plan revised/updated?			*During the annual Comprehensive Plan update by State or as needed during the required docketing process.*		
Habitat Conservation Plan	No	No	No	No	
Economic Development Plan	Yes	No	No	No	Economic Development Element in the Comprehensive Plan.
Shoreline Management Plan	Yes	No	No	Yes	Goals & policies outlined in Comprehensive Plan. Implementation adopted by Ord. 05-11
Community Wildfire Protection Plan	No	No	No	No	

TABLE 5-5.
LEGAL AND REGULATORY CAPABILITY

	Local Authority	State or Federal Prohibitions	Other Jurisdictional Authority	State Mandated	Comments
Response/Recovery Planning					
Comprehensive Emergency Management Plan	Yes	No	No	Yes	Res. 11-01, 01/11/11
Threat and Hazard Identification and Risk Assessment	Yes	No	No	No	Res. 05-78, 12/13/05 Hazard Identification and Vulnerability Analysis
Terrorism Plan	No	No	No	No	
Post-Disaster Recovery Plan	No	No	No	No	
Continuity of Operations Plan	No	No	No	No	
Public Health Plans	No	No	No	No	

TABLE 5-6.
FISCAL CAPABILITY

Financial Resources	Accessible or Eligible to Use?
Community Development Block Grants	Yes
Capital Improvements Project Funding	Yes
Authority to Levy Taxes for Specific Purposes	Yes
User Fees for Water, Sewer, Gas or Electric Service	Yes (Stormwater)
Incur Debt through General Obligation Bonds	Yes
Incur Debt through Special Tax Bonds	Yes
Incur Debt through Private Activity Bonds	No
Withhold Public Expenditures in Hazard-Prone Areas	No
State Sponsored Grant Programs	Yes
Development Impact Fees for Homebuyers or Developers	Yes
Other: Utility Tax, Real Estate Excise Tax	Yes

TABLE 5-7.
ADMINISTRATIVE AND TECHNICAL CAPABILITY

Staff/Personnel Resources	Available?	Department/Agency/Position
Planners or engineers with knowledge of land development and land management practices	Yes	Community Development, Public Works
Engineers or professionals trained in building or infrastructure construction practices	Yes	Community Development, Public Works
Planners or engineers with an understanding of natural hazards	Yes	Community Development, Public Works
Staff with training in benefit/cost analysis	No	
Floodplain manager	Yes	Public Works Director
Surveyors	Yes	Consultants
Personnel skilled or trained in GIS applications	Yes	Public Works
Scientist familiar with natural hazards in local area	No	
Emergency manager	Yes	Public Works
Grant writers	Yes	Consultants

TABLE 5-8.
COMMUNITY CLASSIFICATIONS

	Participating?	Classification	Date Classified
Community Rating System	No	--	--
Building Code Effectiveness Grading Schedule	Yes	2/2	--
Public Protection	Yes	3	--
Storm Ready	Yes[a]	Blue	--
Firewise Communities	No	--	--
Tsunami Ready (if applicable)	NA	NA	NA

a. Part of King County-wide certification

TABLE 5-9. NATIONAL FLOOD INSURANCE PROGRAM COMPLIANCE	
What department is responsible for floodplain management in your community?	Public Works
Who is your community's floodplain administrator? (department/position)	Public Works/Director
Do you have any certified floodplain managers on staff in your community?	No
What is the date of adoption of your flood damage prevention ordinance?	Title 16, Chapter 16.15, CMC. Note: Emergency phase of program. When appropriate we will adopt the National Flood Insurance Program.
When was the most recent Community Assistance Visit or Community Assistance Contact?	N/A
To the best of your knowledge, does your community have any outstanding NFIP compliance violations that need to be addressed? If so, please state what they are.	N/A
Do your flood hazard maps adequately address the flood risk within your community? (If no, please state why)	At this time, flood maps appear to support the degree of flood risk the City experiences on an annual basis. This may change as future development occurs, and future conditions are impacted by climate change.
Does your floodplain management staff need any assistance or training to support its floodplain management program? If so, what type of assistance/training is needed?	Not at this time
Does your community participate in the Community Rating System (CRS)? If so, is your community seeking to improve its CRS Classification? If not, is your community interested in joining the CRS program?	Not at this time.
Note: Emergency phase of program. When appropriate, the City will adopt the National Flood Insurance Program.	

5.11 FUTURE TRENDS IN DEVELOPMENT

The City of Covington Comprehensive Plan governs land use decision and policy-making. This hazard mitigation plan will support sustainable land use in the future by providing vital information on the risk associated with natural hazards in the planning area. The City of Covington will incorporate by reference the Hazard Mitigation Plan in its Comprehensive Plan. This will allow future development within the city to be undertaken with an understanding of the risk and vulnerability from natural hazards that may impact the city and to implement measures to mitigate those potential hazards. Additionally, the City is equipped with a critical areas ordinance pursuant to the Growth Management Act that regulates development in wetlands, critical aquifer recharge areas, fish and wildlife habitat conservation areas, frequently flooded areas, and geologically hazardous areas.

PART 2—
NATURAL HAZARD RISK ASSESSMENT

CHAPTER 6.
DAM FAILURE

6.1 GENERAL BACKGROUND

6.1.1 Causes of Dam Failure

Dam failures in the United States typically occur in one of four ways:

- Overtopping of the primary dam structure, which accounts for 34 percent of all dam failures, can occur due to inadequate spillway design, settlement of the dam crest, blockage of spillways, and other factors.
- Foundation defects due to differential settlement, slides, slope instability, uplift pressures, and foundation seepage can also cause dam failure. These account for 30 percent of all dam failures.
- Failure due to piping and seepage accounts for 20 percent of all failures. These are caused by internal erosion due to piping and seepage, erosion along hydraulic structures such as spillways, erosion due to animal burrows, and cracks in the dam structure.
- Failure caused by piping of embankment material into conduits through joints or cracks constitutes 10 percent of all failures.

The remaining 6 percent are due to miscellaneous causes. Many dam failures in the United States have been results of other disasters. The prominent causes are earthquakes, landslides, extreme storms, massive snowmelt, equipment malfunction, structural damage, foundation failures, and sabotage.

Poor construction, lack of maintenance and repair, and deficient operational procedures are preventable or correctable by a program of regular inspections. Terrorism and vandalism are serious concerns that dam operators must plan for; these threats are under continuous review by public safety agencies.

6.1.2 Regulatory Oversight

National Dam Safety Act

The potential for catastrophic flooding due to dam failures led to passage of the National Dam Safety Act (Public Law 92-367). The National Dam Safety Program requires a periodic engineering analysis of every major dam in the country. The goal of this FEMA-monitored effort is to identify and mitigate the risk of dam failure so as to protect the lives and property of the public.

DEFINITIONS

Dam—Any artificial barrier and/or any controlling works, together with appurtenant works, that can or does impound or divert water. (Washington Administrative Code, Title 173, Chapter 175.)

Dam Failure—An uncontrolled release of impounded water due to structural deficiencies in dam.

Emergency Action Plan—A document that identifies potential emergency conditions at a dam and specifies actions to be followed to minimize property damage and loss of life. The plan specifies actions the dam owner should take to alleviate problems at a dam. It contains procedures and information to assist the dam owner in issuing early warning and notification messages to emergency management authorities downstream. It also contains inundation maps to show emergency management authorities the critical areas for action in case of an emergency. (FEMA 64)

High Hazard Dam—Dams where failure or operational error will probably cause loss of human life. (FEMA 333)

Significant Hazard Dam—Dams where failure or operational error will result in no probable loss of human life but can cause economic loss, environmental damage or disruption of lifeline facilities, or can impact other concerns. Significant hazard dams are often located in rural or agricultural areas but could be located in areas with population and significant infrastructure. (FEMA 333)

Because dam failure can have severe consequences, FEMA requires that all dam owners develop Emergency Action Plans for warning, evacuation and post-flood actions. The plans outline an early warning system if there is an actual or potential sudden release of water from a dam due to failure. The plans include operational procedures that may be used, such as reducing reservoir levels and reducing downstream flows, as well as procedures for notifying affected residents and agencies responsible for emergency management. These plans are frequently updated and tested to ensure that everyone knows what to do in emergency situations. Although there may be coordination with local government officials, the development of the emergency action plan, including potential flood inundation maps and facilitation of emergency response, is the responsibility of the dam owner.

Washington Department of Ecology Dam Safety Program

The Dam Safety Office (DSO) of the Washington Department of Ecology regulates over 1,000 dams in the state that impound at least 10 acre-feet of water. The DSO has developed dam safety guidelines to provide dam owners, operators, and design engineers with information on activities, procedures, and requirements involved in the planning, design, construction, operation and maintenance of dams in Washington. The authority to regulate dams in Washington and to provide for public safety is contained in the following laws:

- State Water Code (1917)—RCW 90.03
- Flood Control Act (1935)—RCW 86.16
- Department of Ecology (1970)—RCW 43.21A.

Where water projects involve dams and reservoirs with a storage volume of 10 acre-feet or more, the laws provide for the Department of Ecology to conduct engineering review of the construction plans and specifications, to inspect the dams, and to require remedial action, as necessary, to ensure proper operation and maintenance and safe performance. The DSO was established within Ecology's Water Resources Program to carry out these responsibilities. The DSO's five-year periodic inspection program for dams with high and significant hazard classifications achieves the following purposes (Washington Department of Ecology, 2011):

- Assess the structural integrity and stability of project elements.
- Identify obvious defects, especially due to aging.
- Assess the stability of the structure under earthquake conditions.
- Determine the adequacy of the spillways to accommodate major floods.
- Evaluate project operation and maintenance.

The inspections, performed by professional engineers from the DSO, involve a thorough review, inspection and analysis (Washington Department of Ecology, 2011):

- Review and analysis of available data on the design, construction, operation and maintenance of the dam and its appurtenances
- Visual inspection of the dam and its appurtenances
- Evaluation of the safety of the dam and its appurtenances, which may include an assessment of the hydrological and hydraulic capabilities, structural stabilities, seismic stabilities, and any other condition that could constitute a hazard to the integrity of the structure
- Evaluation of the downstream hazard classification

- Evaluation of the operation, maintenance and inspection procedures employed by the owner and/or operator
- Review of the emergency action plan for the dam including review and/or update of dam breach inundation map.

The DSO provides reasonable assurance that impoundment facilities will not pose a threat to lives and property, but dam owners bear primary responsibility for the safety of their structures, through proper design, construction, operation and maintenance. The DSO regulates dams with the sole purpose of reasonably securing public safety; environmental and natural resource issues are addressed by other state agencies. The DSO neither advocates nor opposes the construction and operation of dams.

U.S. Army Corps of Engineers Dam Safety Program

The U.S. Army Corps of Engineers is responsible for safety inspections of some federal and non-federal dams in the United States that meet the size and storage limitations specified in the National Dam Safety Act. The Corps has inventoried dams; surveyed each state and federal agency's capabilities, practices and regulations regarding design, construction, operation and maintenance of the dams; and developed guidelines for inspection and evaluation of dam safety (U.S. Army Corps of Engineers, 1997).

Federal Energy Regulatory Commission Dam Safety Program

The Federal Energy Regulatory Commission (FERC) cooperates with a large number of federal and state agencies to ensure and promote dam safety. More than 3,000 dams are part of regulated hydroelectric projects in the FERC program. Two-thirds of these are more than 50 years old. As dams age, concern about their safety and integrity grows, so oversight and regular inspection are important. FERC requires licensees to prepare emergency action plans and conducts training sessions on how to develop and test these plans. Every five years, an independent engineer approved by the FERC must inspect and evaluate projects with dams higher than 32.8 feet (10 meters) or with a total storage capacity of more than 2,000 acre-feet. FERC also inspects hydroelectric projects on an unscheduled basis to investigate the following:

- Potential dam safety problems
- Complaints about constructing and operating a project
- Safety concerns related to natural disasters
- Issues concerning compliance with the terms and conditions of a license.

FERC evaluates seismic research and applies it in investigating and performing structural analyses of hydroelectric projects. FERC also evaluates the effects of potential and actual large floods on the safety of dams. During and following floods, FERC visits dams and licensed projects, determines the extent of damage, if any, and directs any necessary studies or remedial measures the licensee must undertake.

6.2 HAZARD PROFILE

6.2.1 Past Events

On average, Washington State experiences a dam failure approximately once every two years. The majority of these failures are in whole or in part the result of a failure to perform adequate maintenance and monitoring of the facilities. Three incidents have occurred in King County; accounting for all lives lost due to dam failure in the state.

- 1918—Masonry Dam near North Bend had excessive seepage, which caused a mudflow, destroyed a railroad line and damaged the village of Eastwick; no lives lost.

- 1932—Eastwick railroad fill failed. A slide caused railroad fill to back up and fail, destroyed a railroad line and damaged the village of Eastwick; 7 lives were lost.
- 1976—Increased discharge from Mud Mountain Dam caused a surge in flow killing two children playing in the White River near Auburn.

Another major incident involving dam safety in King County occurred in 2009, when seepage issues were discovered at Howard Hanson Dam after a January flood event. The dam is on the Green River, and dam failure would result in extreme flooding of downstream communities in the Green River valley. The Army Corps of Engineers began improvements to reduce risk at the facility immediately after the seepage was discovered. Most of the construction improvements were completed by 2011 and the dam is now operating at its design capability (U.S. Army Corps of Engineers, 2012).

6.2.2 Location

In King County there are 122 dams that impound 10 acre-feet of water or more. The Washington Department of Ecology classifies these dams as follows:

- 7 Class 1A (a downstream at-risk population of more than 300)
- 8 Class 1B (a downstream at-risk population of 31 to 300)
- 31 Class 1C (a downstream at-risk population of 7 to 30)
- 26 Class 2 (a downstream at-risk population of 1 to 6)
- 50 Class 3 (no downstream at-risk population)

Flood inundation mapping exists for all dams in King County that have emergency action plans. Table 6-1 lists the Class 1A dams in King County. Only one of these dams—Lake Youngs Outlet Dam—has an inundation area that impacts the City of Covington, but failure of any dam in King County is likely to have significant indirect impacts on Covington, especially dams that impact the Green River.

Lake Youngs is a reservoir built and operated by the City of Seattle just north of the Covington city limits. Dikes around its perimeter form the reservoir, including the Lake Young Perimeter Dike that surrounds the entire reservoir and diverts all storm surface water to the south or to Little Soos Creek. The lake's south dam is an earth fill structure with a height of 30 feet, width of 21 feet and total crest length of 1,420 feet. It was constructed in 1921 and was raised in the 1950s to increase the storage capacity. Its last major inspection under the State's five-year periodic inspection program for dams with high and significant hazard classifications was in 2010 (Hu et al., 2012). Seattle Public Utilities inspects and maintains the dam on a regular basis. Reservoir levels, groundwater, and stream flows are continuously monitored by instrumentation and crews perform daily visual inspections. The Lake Youngs Dam meets current engineering standards and is in compliance with state and federal regulation (Seattle Public Utilities, 2014).

Failure of the Lake Youngs dikes could have catastrophic effect on people and property in the immediate downstream area. Flooding could occur along the Little Soos Creek, Soos Creek and the Green River. Failure of the south end dam would cause flooding in Covington, Auburn and Kent. As part of the recent periodic inspection, a dam failure analysis was conducted to determine the flood inundation extents of a hypothetical failure (Hu et al., 2012). These dam failure inundation maps were used for this risk assessment but are not published in the hazard mitigation plan for security purposes.

TABLE 6-1.
HAZARD CLASS 1A DAMS IN KING COUNTY

Name	National ID #	Water Course	Owner	Year Built	Dam Type[a]	Crest Length (feet)	Height (feet)	Storage Capacity (acre-feet)	Drainage area (sq. mi.)
Howard A Hanson Dam	WA00298	Green River South	U.S. Army Corps of Engineers	1962	ER, RE	500	235	136,700	221.00
Masonry Dam	WA00255	Cedar River	City of Seattle	1914	VA	980	225	175,000	81.40
Tolt River Dam	WA00177	South Fork Tolt River	Seattle Public Utilities	1962	RE	980	213	67,200	18.80
Lake Youngs Outlet Dam	WA00254	Little Soos Creek	City of Seattle	1921	RE	1,450	30	18,908	3.94
Green Lake Reservoir	WA00212	Puget Sound Tributary, Off-stream	Seattle Public Utilities	1910	RE	1920	25	181	0.02
Issaquah Highlands Washington Department of Transportation Detention Pond	WA00707	East Fork Issaquah Creek, Off-stream	Port Blakely Communities	2008	RE	380	22	53	0.00
Madsen Creek West Basin Dam	WA01862		King County Natural Resources	2008	RE	775	6.5	28	0.11

a. RE = Earth fill; ER = Rock fill; VA = Concrete single arch

6.2.3 Frequency

Dam failure events are infrequent and usually coincide with events that cause them, such as earthquakes, landslides and excessive rainfall and snowmelt. There is a “residual risk” associated with dams. Residual risk is the risk that remains after safeguards have been implemented. For dams, the residual risk is associated with events beyond those that the facility was designed to withstand. However, the probability of any type of dam failure is low in today’s regulatory and dam safety oversight environment.

6.2.4 Severity

The U.S. Army Corps of Engineers developed the classification system shown in Table 6-2 for the hazard potential of dam failures. The Corps of Engineers hazard rating system is based only on the potential consequences of a dam failure; it does not take into account the probability of such failures.

Loss of life and damage to structures, roads, utilities and crops may result from a dam failure. Economic losses can also result from a lowered tax base and lack of utility profits. These effects would accompany the failure of the Lake Youngs outlet dam. The dam is less than 2 miles north of the City of Covington (just north of SE 224th Street). The reservoir covers an area of 690 acres and serves as a municipal water supply for the City of Seattle. Analysis conducted by the City of Seattle indicates that a dam-break or failure on Lake Youngs would result in severe flooding along Soos Creek. Damage would most likely occur to most structures and road embankments in the inundation area along Soos Creek, downstream to the confluence with the Green River. The timing of a dam failure can have a significant impact on the downstream damage such a failure may cause. The reservoir typically holds more water in summer than it does in winter. If a summer failure were to occur, approximately 2,000 acre-feet of additional water would be released than if a winter failure were to occur (Hu et al., 2012).

TABLE 6-2.
CORPS OF ENGINEERS HAZARD POTENTIAL CLASSIFICATION

Hazard Category[a]	Direct Loss of Life[b]	Lifeline Losses[c]	Property Losses[d]	Environmental Losses[e]
Low	None (rural location, no permanent structures for human habitation)	No disruption of services (cosmetic or rapidly repairable damage)	Private agricultural lands, equipment, and isolated buildings	Minimal incremental damage
Significant	Rural location, only transient or day-use facilities	Disruption of essential facilities and access	Major public and private facilities	Major mitigation required
High	Certain (one or more) extensive residential, commercial, or industrial development	Disruption of essential facilities and access	Extensive public and private facilities	Extensive mitigation cost or impossible to mitigate

a. Categories are assigned to overall projects, not individual structures at a project.
b. Loss of life potential based on inundation mapping of area downstream of the project. Analyses of loss of life potential should take into account the population at risk, time of flood wave travel, and warning time.
c. Indirect threats to life caused by the interruption of lifeline services due to project failure or operational disruption; for example, loss of critical medical facilities or access to them.
d. Damage to project facilities and downstream property and indirect impact due to loss of project services, such as impact due to loss of a dam and navigation pool, or impact due to loss of water or power supply.
e. Environmental impact downstream caused by the incremental flood wave produced by the project failure, beyond what would normally be expected for the magnitude flood event under which the failure occurs.

Source: U.S. Army Corps of Engineers, 1995

Covington's elevation and location within the County make it a likely evacuation point in the event of any dam failure or major flood event impacting the Green River Valley. Additionally, many citizens of Covington work, go to school, and recreate in the Green River Valley. Significant dam failure events affecting the valley would likely have economic impacts on the City.

6.2.5 Warning Time

Warning time for dam failure varies depending on the cause of the failure. In events of extreme precipitation or massive snowmelt, evacuations can be planned with sufficient time. In the event of a structural failure due to earthquake, there may be no warning time. A dam's structural type also affects warning time. Earthen dams do not tend to fail completely or instantaneously. Once a breach is initiated, discharging water erodes the breach until either the reservoir water is depleted or the breach resists further erosion. Concrete gravity dams also tend to have a partial breach as one or more monolith sections are forced apart by escaping water. The time of breach formation ranges from a few minutes to a few hours (U.S. Army Corps of Engineers, 1997).

Lake Youngs Dam is an earthen dam. In the event of a structural failure, it is likely that the resulting flood would slowly rise to a maximum discharge and then slowly recede (Hu et al., 2012). The dam is designed to withstand severe conditions, including major earthquakes. There is a dam failure warning system at the Outlet Dam at the start of the Little Soos Creek reservoir. The system is monitored 24 hours per day every day and includes field instruments to detect dam failure and on-site cameras for remote operators to verify conditions. The emergency action plan for the facility includes two notification avenues, including Weather Radio and an automatic out-dialer (Seattle Public Utilities, 2014).

6.3 SECONDARY HAZARDS

Dam failure can cause severe downstream flooding, depending on the magnitude of the failure. Other potential secondary hazards of dam failure are landslides around the reservoir perimeter, bank erosion on the rivers, and destruction of downstream habitat.

6.4 CLIMATE CHANGE IMPACTS

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

Dams are constructed with safety features known as "spillways." Spillways are put in place on dams as a safety measure in the event of the reservoir filling too quickly. Spillway overflow events, often referred to as "design failures," result in increased discharges downstream and increased flooding potential. Although climate change will not increase the probability of catastrophic dam failure, it may increase the probability of design failures.

6.5 EXPOSURE

6.5.1 Qualitative Exposure Assessment

This section describes the likely effects on the City of Covington of a quickly occurring complete failure of the Lake Youngs Dam. This information is from the City's 2005 Hazard Identification and Vulnerability Assessment and is based on worst-case scenario studies available at that time. Other failures may not have such severe results. In an actual emergency, other failures or partial failures could occur.

The Lake Youngs outlet dam is less than 2 miles north of Covington at the head of Little Soos Creek. The outlet dam controls 14,769 acre-feet of water, which serves the municipal water supply for the City of Seattle. Dam break scenarios predict failure would likely occur as erosion that would take up to an hour to rise to a maximum discharge volume of as much as 36,000 cubic feet per second. Normal flow is approximately 500 cubic feet per second.

The dam break flood would first discharge into Little Soos Creek, which feeds into Big Soos Creek. The dam break flood would be many times greater than any historical flood on Little Soos Creek. The flow depth and velocity in this creek would be severe and would likely damage or destroy most structures in the flood path. Most road crossings in the flood path can be expected to wash out.

A half-hour after the dam break, floodwaters would begin arriving and flow over 172nd Avenue SE where the Little Soos crosses north of SE 240th Street. Depth of floodwaters here may be as deep as 20 feet at full flow. An hour after the dam break, floodwaters would arrive at the SE 244th Street and 180th Avenue SE intersection and spill over into Jenkins Creek, causing flows larger than any historical flood on the creek. Maximum depths of 10 to 11 feet in this area would be realized. Severe flooding and damage would be expected along Jenkins Creek to its confluence with Big Soos Creek. SE 256th street, at the west end of the SR-18 on ramp, SR-516 (Kent Kangley Road) and SR-18 would likely be impassible where Jenkins creek crosses.

Downstream, floodwaters would arrive at Big Soos Creek approximately 1 hour and 30 minutes after the dam break. Floodwaters would peak at 8 feet over the driving surface of Kent Kangley Road and the flows on Little Soos Creek would push floodwaters upstream in the Big Soos Creek to about SE 240th Street. Severe flooding can be expected south of Kent Kangley Road with less severe flooding north to SE 240th Street. SR-18 would be impassible where Big Soos Creek crosses.

Jenkins Creek would overflow and make Kent Kangley Road impassible in the 18000 block. An isolated island can be expected to form between Jenkins Creek and the Soos Creeks from the overflow of Little Soos Creek at SE 244th Street and 180th Avenue SE at its north, to the point at which both creeks rejoin in the Big Soos Creek south of SR-18 to the south. Since the degree of damage to roads in the area cannot be predicted, traffic flow to this island area may not be restored for as long as three days.

Floodwater would continue downstream into the Green River, causing severe flooding in the Green River Valley. Downstream flooding would occur in Auburn and possibly as far north as the Tukwila border.

In addition to flooding concerns, failure of the Lake Youngs outlet dam may have long-term effects on area drinking water supplies. Water from Lake Youngs is pumped to the Cedar Water Treatment Facility, which treats up to 180 million gallons of water per day from the Cedar River and Lake Youngs. Water from this facility accounts for approximately two-thirds of the water supply for Seattle and some surrounding areas. A failure at Lake Youngs would result in a serious reduction of drinking water reserves in the area (Seattle Public Utilities, 2014a).

6.5.2 HAZUS Analysis

The flood module of HAZUS-MH was used for a Level 2 assessment of dam failure. HAZUS-MH uses census data at the block level and FEMA floodplain data, which has a level of accuracy acceptable for planning purposes. Where possible, the HAZUS-MH data for this risk assessment was enhanced using GIS data from local, state and federal sources.

Population

All populations in a dam failure inundation zone would be exposed to the risk of a dam failure. The potential for loss of life is affected by the capacity and number of evacuation routes available to populations living in areas of potential inundation. The estimated population living in the mapped inundation areas within the planning area is 5,881 or 41 percent of the total planning-area population.

Property

Based on assessor parcel data, the HAZUS-MH model estimated that there are 3,037 structures within the mapped dam failure inundation areas in the planning area. The value of exposed buildings in the planning area was generated using HAZUS-MH and is summarized in Table 6-3. This methodology estimated $1,761,309,000 worth of building-and-contents exposure to dam failure inundation, representing 61.81 percent of the total assessed value of the planning area.

Critical Facilities

GIS analysis determined that 10 of the planning area's critical facilities (20.83 percent) are in the mapped inundation areas, as summarized in Table 6-4 and Table 6-5.

TABLE 6-3.
EXPOSURE AND VALUE OF STRUCTURES IN DAM FAILURE INUNDATION AREAS

Number of Buildings Exposed	3,037
Value Exposed	
Structure	$1,026,586,000
Contents	$734,723,000
Total	**$1,761,309,000**
Exposed Value as % of Total Assessed Value	61.81%

TABLE 6-4.
CRITICAL FACILITIES IN DAM FAILURE INUNDATION AREAS

Facility Type	Number in Planning Area
Medical and Health	3
Government Functions	2
Protective Functions	0
Schools	0
Hazmat	0
Other Critical Functions	0
Total	**5**

TABLE 6-5.
CRITICAL INFRASTRUCTURE IN DAM FAILURE INUNDATION AREAS

Facility Type	Number in Planning Area
Bridges	0
Water Supply	0
Wastewater	4
Power	1
Communications	0
Other	0
Total	**5**

Environment

Reservoirs held behind dams affect many ecological aspects of a river. River topography and dynamics depend on a wide range of flows, but rivers below dams often experience long periods of very stable flow conditions or saw-tooth flow patterns caused by releases followed by no releases. Water releases from dams usually contain very little suspended sediment; this can lead to scouring of riverbeds and banks.

The environment would be exposed to a number of risks in the event of dam failure. The inundation could introduce many foreign elements into local waterways. This could result in destruction of downstream habitat and could have detrimental effects on many species of animals, especially endangered species such as salmon.

6.6 VULNERABILITY

6.6.1 Population

Vulnerable populations are all populations downstream from dam failures that are incapable of escaping the area within the allowable time frame. This population includes the elderly and young who may be unable to get themselves out of the inundation area. The vulnerable population also includes those who would not have adequate warning from a television or radio emergency warning system.

6.6.2 Property

Vulnerable properties are those closest to the dam inundation area. These properties would experience the largest, most destructive surge of water. Low-lying areas are also vulnerable since they are where the dam waters would collect. Transportation routes are vulnerable to dam inundation and have the potential to be wiped out, creating isolation issues. This includes all roads, railroads and bridges in the path of the dam inundation. Those that are most vulnerable are those that are already in poor condition and would not be able to withstand a large water surge. Utilities such as overhead power lines, cable and phone lines could also be vulnerable. Loss of these utilities could create additional isolation issues for the inundation areas.

It is estimated that there could be up to $148,521,000 of loss from a dam failure affecting the planning area. This represents 8.43 percent of the total exposure within the inundation area, or 5.21 percent of the total assessed value of the planning area. Table 6-6 summarizes the loss estimates for dam failure.

TABLE 6-6.
LOSS ESTIMATES FOR DAM FAILURE

Estimated Loss Associated with Dam Failure	
Structure	$62,272,000
Contents	$86,249,000
Total	**$148,521,000**
Estimated Loss as % of Total Assessed Value	5.21%

6.6.3 Critical Facilities

On average, critical facilities would receive 8.29 percent damage to the structure and 35.13 percent damage to the contents during a dam failure event. The estimated time to restore these facilities to 100 percent of their functionality is 486 days.

6.6.4 Environment

The environment would be vulnerable to a number of risks in the event of dam failure. The inundation could introduce foreign elements into local waterways, resulting in destruction of downstream habitat and detrimental effects on many species of animals, especially endangered species such as coho salmon. The extent of the vulnerability of the environment is the same as the exposure of the environment.

6.7 FUTURE TRENDS IN DEVELOPMENT

Land use in the planning area will be directed by the City's comprehensive plan, adopted under state law. The natural hazard mitigation element of the comprehensive plan establishes standards and plans for the protection of the community from hazards. Dam failure is currently not addressed as a standalone hazard in the natural hazard mitigation element, but is addressed in the flood hazard assessment. The City of Covington has established comprehensive policies regarding sound land use in identified flood hazard areas. While some of the areas vulnerable to the more severe impacts from dam failure intersect the mapped flood hazard areas, the inundation areas from a dam failure cover a much larger portion of the city. Flood-related policies in the comprehensive plan will help to reduce the risk associated with the dam failure hazard for development in the planning area, but will be unlikely to help reduce risk to all structures within the dam inundation area.

6.8 SCENARIO

An earthquake in the region could lead to liquefaction of soils around a dam. This could occur without warning during any time of the day. A human-caused failure such as a terrorist attack also could trigger a catastrophic failure of a dam that impacts the planning area. Failure of the Lake Youngs Outlet Dam would likely result in the loss of life, roadways, structures and property and cause severe impacts on the local economy. While the possibility of failure is remote, results of such an event would be devastating.

While the probability of dam failure is very low, the probability of flooding associated with changes to dam operational parameters in response to climate change is higher. Dam designs and operations are developed based on hydrographs from historical records. If these hydrographs experience significant changes over time due to the impacts of climate change, the dam design and operations may no longer be valid for the changed condition. Specified release rates and impound thresholds may have to be changed. This would result in increased discharges downstream of these facilities, thus increasing the probability and severity of flooding.

Any dam failure within King or Pierce County would likely have significant indirect impacts on the City of Covington. The city's elevation and accessibility make it a key evacuation point for any significant dam failure event in either county. This scenario could tax city resources beyond current capabilities.

6.9 ISSUES

In the late 1980s, the Department of Ecology DSO was reorganized to better use its resources to minimize public safety problems. The DSO has recognized the key role of other government agencies in carrying out its public safety charge. For example, the dam approval process now requires that dams located above populated areas develop emergency action plans in conjunction with local and county emergency management agencies. An emergency action plan was first prepared in 1999 for Lake Youngs Dam and has periodically been updated.

The most significant issue associated with dam failure involves the properties and populations in the inundation zones. Flooding as a result of a dam failure would significantly impact these areas. There is often limited warning time for dam failure. These events are frequently associated with other natural hazard events such as earthquakes, landslides or severe weather, which limits their predictability and compounds the hazard. Important issues associated with dam failure hazards include the following:

- Currently, the emergency notification plan for Lake Youngs Dam has identified two methods for emergency notification—Weather Radio and an automated out-dialer. It is unclear whether these notification strategies will be viable if dam failure occurs as a result of a significant earthquake that interrupts communication systems.

- Changes in hydrographs in the region as a result of climate change are likely to include more instances of winter flooding. This could alter dam operations and increase the potential for design failures at Lake Youngs Dam.
- Downstream populations are often not aware that they are located in a dam failure inundation area and do not know the risks associated with probable dam failure.
- Addressing security concerns and the need to inform the public of the risk associated with dam failure is a challenge for public officials.
- Dam failure inundation areas are often not considered special flood hazard areas under the National Flood Insurance Program, so flood insurance coverage in these areas is not common.
- Most dam failure mapping required at federal levels requires determination of the probable maximum flood. While the probable maximum flood represents a worst-case scenario, it is generally the event with the lowest probability of occurrence. For non-federal-regulated dams, mapping of dam failure scenarios that are less extreme than the probable maximum flood but have a higher probability of occurrence can be valuable to emergency managers and community officials downstream of these facilities. This type of mapping can show areas potentially impacted by more frequent events, to be used in support of emergency response and preparedness measures.

CHAPTER 7.
DROUGHT

7.1 GENERAL BACKGROUND

Drought is a normal phase in the climatic cycle of most geographical regions. Drought originates from a deficiency of precipitation over an extended period of time, usually a season or more, and results in a water shortage for some activity, group or environmental sector. Unlike most disasters, droughts normally occur slowly but last a long time. There are four generally accepted operational definitions of drought (National Drought Mitigation Center, 2006):

- **Meteorological drought** is an expression of precipitation's departure from normal over some period of time. Meteorological measurements are the first indicators of drought. Definitions are usually region-specific, and based on an understanding of regional climatology. A definition of drought developed in one part of the world may not apply to another, given the wide range of meteorological definitions.
- **Agricultural drought** occurs when there is not enough soil moisture to meet the needs of a particular crop at a particular time. Agricultural drought happens after meteorological drought but before hydrological drought. Agriculture is usually the first economic sector to be affected by drought.
- **Hydrological drought** refers to deficiencies in surface and subsurface water supplies. It is measured as stream flow and as lake, reservoir and groundwater levels. There is a time lag between lack of rain and less water in streams, rivers, lakes and reservoirs, so hydrological measurements are not the earliest indicators of drought. After precipitation has been reduced or deficient over an extended period of time, this shortage is reflected in declining surface and subsurface water levels. Water supply is controlled not only by precipitation, but also by other factors, including evaporation (which is increased by higher than normal heat and winds), transpiration (the use of water by plants), and human use.
- **Socioeconomic drought** occurs when a physical water shortage starts to affect people, individually and collectively. Most socioeconomic definitions of drought associate it with the supply and demand of an economic good.

DEFINITIONS

Drought—The cumulative impacts of several dry years on water users. It can include deficiencies in surface and subsurface water supplies and generally impacts health, well-being, and quality of life.

Hydrological Drought—Deficiencies in surface and subsurface water supplies.

Socioeconomic Drought—Drought impacts on health, well-being and quality of life.

Defining when drought begins is a function of the impacts of drought on water users, and includes consideration of the supplies available to local water users as well as the stored water they may have available in surface reservoirs or groundwater basins. Different local water agencies have different criteria for defining drought conditions in their jurisdictions. Some agencies issue drought watch or drought warning announcements to their customers. Determinations of regional or statewide drought conditions are usually based on a combination of hydrologic and water supply factors. Washington has a statutory definition of drought (RCW 43.83B.400), defining an area as being in a drought condition when the water supply for the area is below 75 percent of normal and water uses and users in the area are likely to incur undue hardships because of the water shortage. Covington's water supply is managed by two water districts: Covington Water District and King County Water District No. 111.

7.2 HAZARD PROFILE

Droughts originate from a deficiency of precipitation resulting from an unusual weather pattern. If the weather pattern lasts a short time (a few weeks or a couple months), the drought is considered short-term. If the weather pattern becomes entrenched and the precipitation deficits last for several months or years, the drought is considered to be long-term. It is possible for a region to experience a long-term circulation pattern that produces drought, and to have short-term changes in this long-term pattern that result in short-term wet spells. Likewise, it is possible for a long-term wet circulation pattern to be interrupted by short-term weather spells that result in short-term drought.

7.2.1 Past Events

In the past century, Washington has experienced a number of droughts, including several that lasted for more than a single season—1928 to 1932, 1992 to 1994, and 1996 to 1997. The droughts of 1977 and 2001, the worst and second worst in state history, provide good examples of how drought can affect the state. The most recent drought in the state occurred in 2005. (Washington Emergency Management Division, 2010). The following are the most significant droughts affecting the Puget Sound lowlands since 1900 (Governor's Ad Hoc Executive Water Emergency Committee Staff, 1977; Washington Emergency Management Division, 2001):

- July – August 1902—No measurable rainfall in Western Washington from July 23 to August 25. Fruit and vegetable crops ripened quicker than expected and hop crops were down in Western Washington.
- August 1919—Drought conditions accompanied hot weather and wildfires. Crop yields were low.
- July 1921—Drought affected all agricultural sections and Northwestern Washington had a large number of wildfires.
- June – August 1922—Statewide precipitation average was only 0.10 inches. Crop yields were down and 311,483,000 board feet of timber were destroyed by fire.
- July 1925—Crop yields were low and fires burned 142,355 acres.
- June 1928—March 1929—Most stations averaged less than 20 percent of normal rainfall for August and September and less than 60 percent for the nine-month period.
- July – August 1930—The driest weather occurred in Western Washington with weather stations averaging 10 percent or less of normal precipitation.
- April 1934 – March 1937—The longest drought in the region's history with the Palmer Index maintaining values less than -1. The driest periods were April—August 1934, September—December 1935, and July—January 1936—1937.
- May – September 1938—It was the driest growing season ever recorded in Western Washington with nearly all stations reporting less than half of normal precipitation levels.
- 1944—July temperatures were above normal in Western Washington and bean yields were down in King County.
- 1952—The hardest hit areas were Puget Sound and the central Cascades. The Palmer Drought Index dropped to a low of -5.06 in the Puget Sound lowlands. The Index was -4 during the winter limiting snow pack reserves for the following summer.
- 1965/1966—The entire state was affected by drought conditions. King County recorded Palmer Indexes of roughly -1.5 from June 1965 to December 1966.

- June – August 1967—No rain fell from the third week in June to the third week in September. 1,767 fires burned throughout the state.
- October 1976 – September 1977—King County experienced precipitation levels 57 percent of normal. Stream flows averaged between 30 and 70 percent of normal, temperatures were higher than normal which resulted in algae growth and fish kills.
- October 1991 – September 1994—Stream flows were between 30 and 60 percent of normal. Agriculture products suffered greatly. Thirty counties were designated as Emergency Drought Impact areas.
- March 14, 2001 – December 31, 2001—Washington became the first Northwest state to make a drought declaration when the Department of Ecology declared a statewide drought emergency in March. The area had experienced several months of record low precipitation. Because of above-average precipitation in the final two months of the year, the drought emergency expired on December 31.
- March 10, 2005 – December 31, 2005—A serious drought in 2005 resulted from the combination of well-below-average precipitation from November 2004 through February 2005, unusually warm fall and winter weather, and a storm with warm temperatures and heavy rain in January that greatly diminished snowpack. The Department of Ecology declared a statewide drought emergency on March 10, 2005. The drought emergency formally expired on December 31, 2005 (Washington Department of Ecology, 2006).

7.2.2 Location

The National Oceanic and Atmospheric Administration (NOAA) has developed several indices to measure drought impacts and severity and to map their extent and locations:

- The ***Palmer Crop Moisture Index*** measures short-term drought on a weekly scale and is used to quantify drought's impacts on agriculture during the growing season. Figure 7-1 shows this index for the week ending February 23, 2013.
- The ***Palmer Z Index*** measures short-term drought on a monthly scale. Figure 7-2 shows this index for January 2013.
- The ***Palmer Drought Index*** measures the duration and intensity of long-term drought-inducing circulation patterns. Long-term drought is cumulative, so the intensity of drought during a given month is dependent on the current weather patterns plus the cumulative patterns of previous months. Weather patterns can change quickly from a long-term drought pattern to a long-term wet pattern, and the Palmer Drought Index can respond fairly rapidly. Figure 7-3 shows this index for January 2013.
- The hydrological impacts of drought (e.g., reservoir levels, groundwater levels, etc.) take longer to develop and it takes longer to recover from them. The ***Palmer Hydrological Drought Index***, another long-term index, was developed to quantify hydrological effects. The Palmer Hydrological Drought Index responds more slowly to changing conditions than the Palmer Drought Index. Figure 7-4 shows this index for January 2013.
- While the Palmer indices consider precipitation, evapotranspiration and runoff, the ***Standardized Precipitation Index*** considers only precipitation. In the Standardized Precipitation Index, an index of zero indicates the median precipitation amount; the index is negative for drought and positive for wet conditions. The Standardized Precipitation Index is computed for time scales ranging from one month to 24 months. Figure 7-5 shows the 24-month Standardized Precipitation Index map for April 2009 through January 2013.

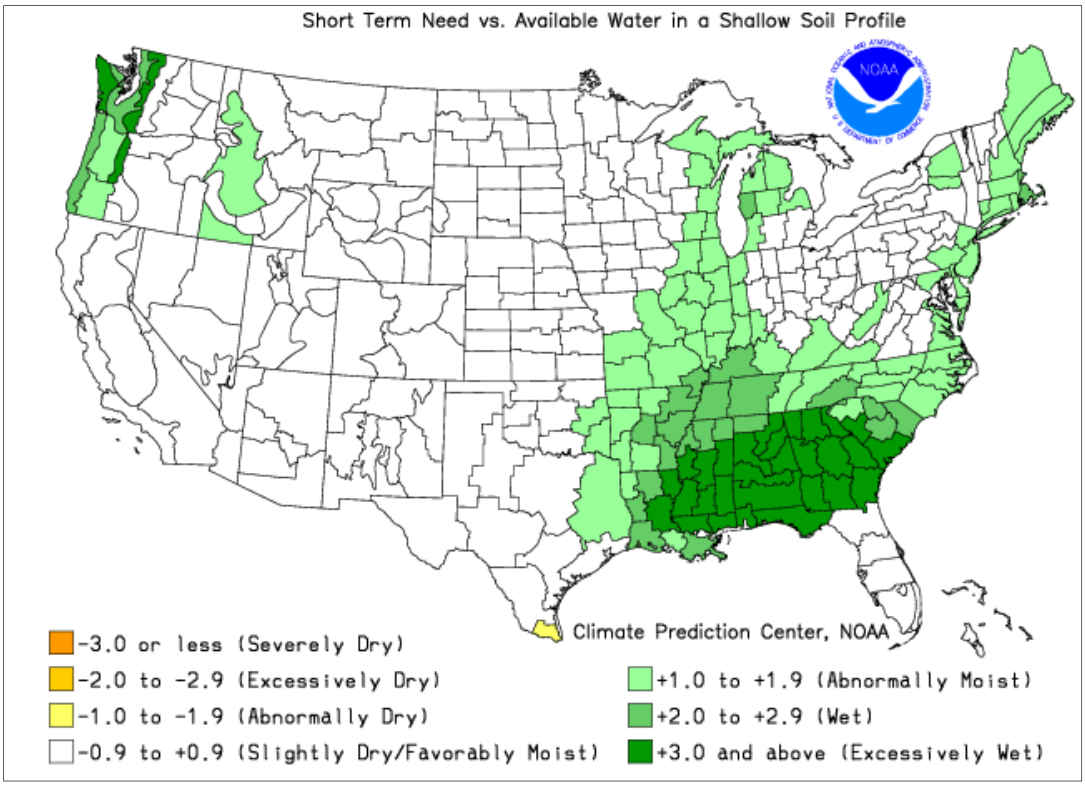


Figure 7-1. Crop Moisture Index for Week Ending February 23, 2013

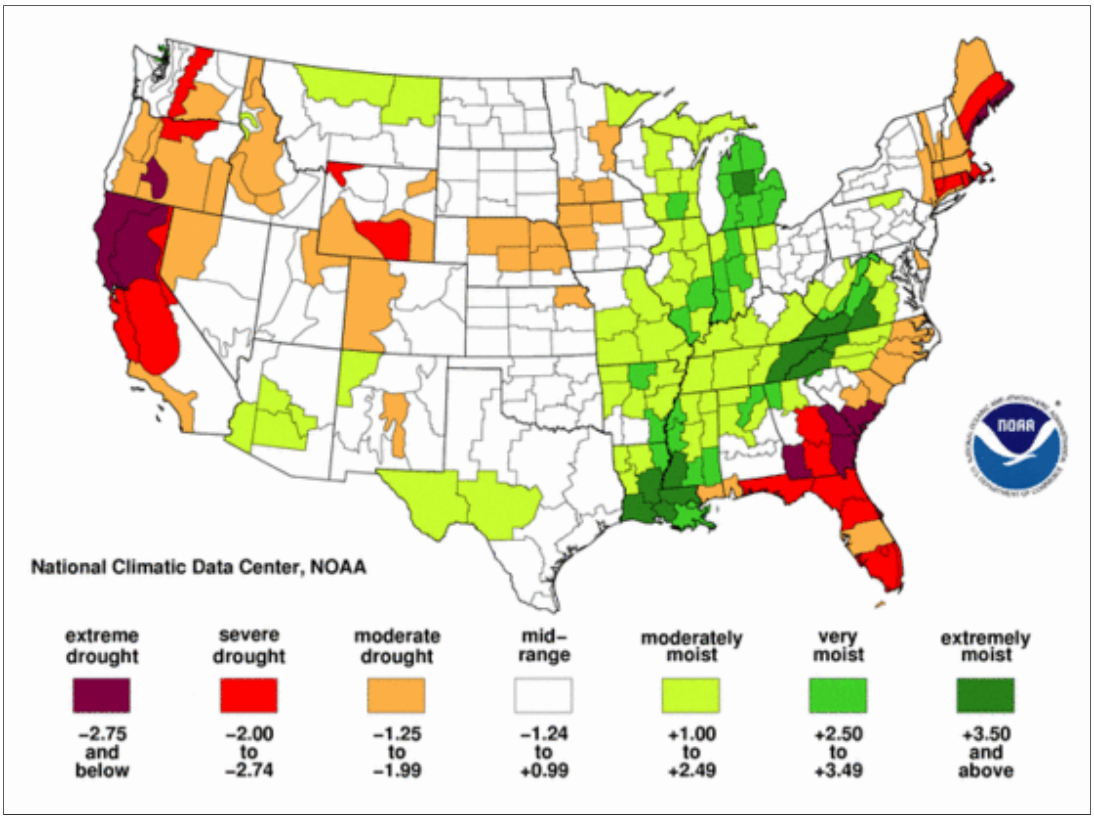


Figure 7-2. Palmer Z Index Short-Term Drought Conditions (January 2013)

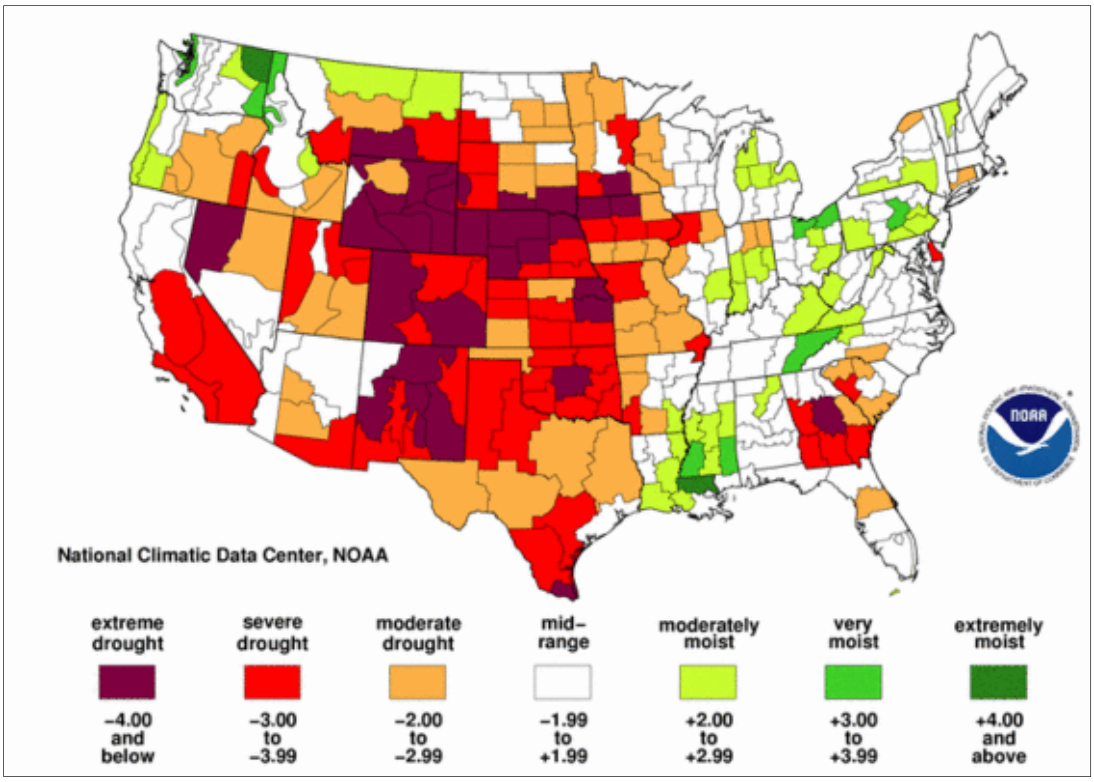


Figure 7-3. Palmer Drought Severity Index (January 2013)

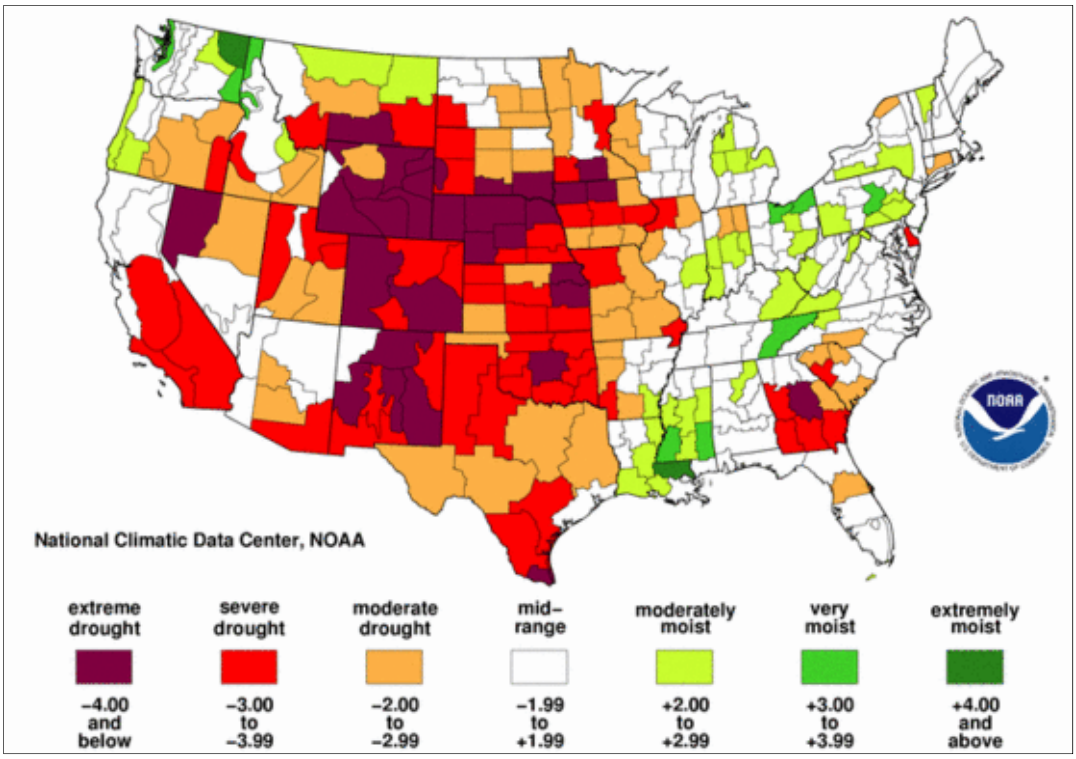


Figure 7-4. Palmer Hydrological Drought Index Long-Term Hydrologic Conditions (January 2013)

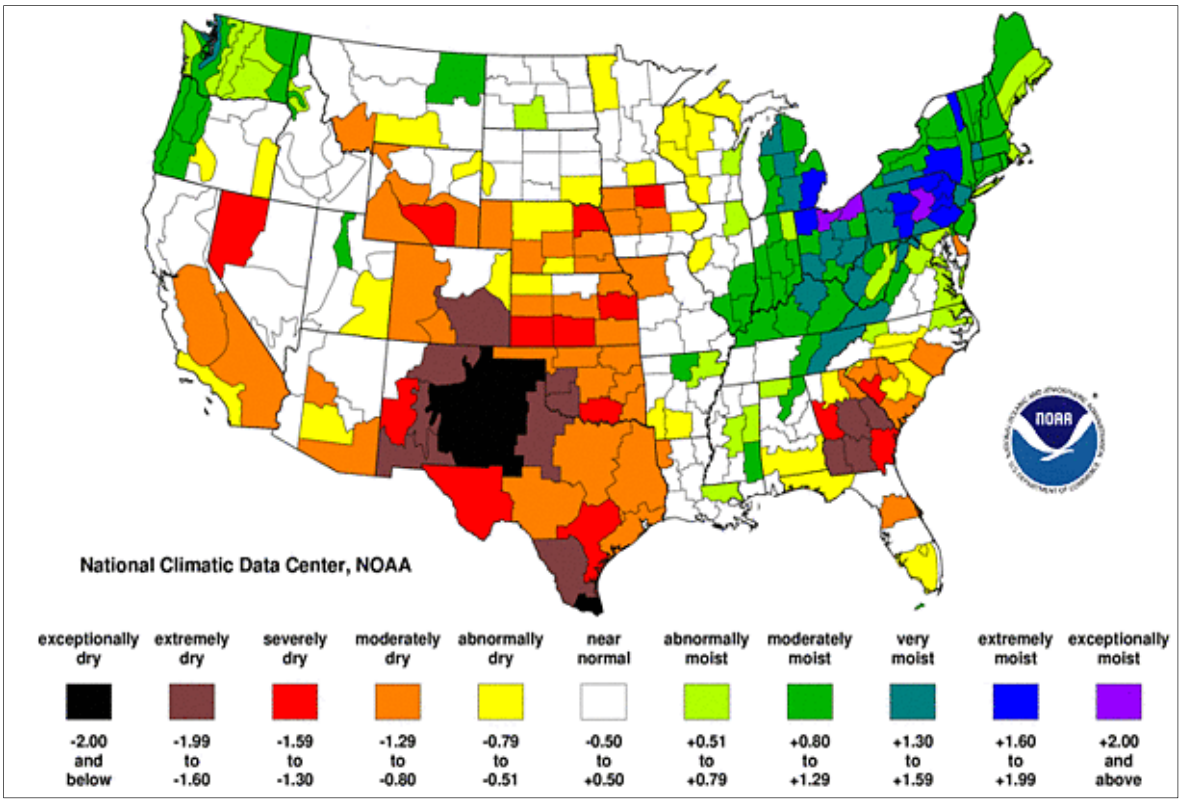


Figure 7-5. 24-Month Standardized Precipitation Index (February 2011—January 2013)

7.2.3 Frequency

Historical drought data for the Puget Sound lowlands indicate there have been 17 significant droughts since 1902. This equates to a drought every 6.5 years on average, or a 15 percent chance of a drought in any given year. Based on Washington's history with drought from 1895 to 1995, the state as a whole can expect severe or extreme drought at least 5 percent of the time in the future.

7.2.4 Severity

Drought can have a widespread impact on the environment and the economy, depending upon its severity, although it typically does not result in loss of life or damage to property, as do other natural disasters. From 1987 to 1989, losses from drought in the U.S. totaled $39 billion (OTA, 1993).

The National Drought Mitigation Center uses three categories to describe likely drought impacts:

- Agricultural—Drought threatens crops that rely on natural precipitation.
- Water supply—Drought threatens supplies of water for irrigated crops and for communities.
- Fire hazard—Drought increases the threat of wildfires from dry conditions in forest and rangelands.

On average, the nationwide annual impacts of drought are greater than the impacts of any other natural hazard. They are estimated to be between $6 billion and $8 billion annually in the United States and occur primarily in the agriculture, transportation, recreation and tourism, forestry, and energy sectors. Social and environmental impacts are also significant, although it is difficult to put a precise cost on these impacts.

The severity of a drought depends on the degree of moisture deficiency, the duration, and the size and location of the affected area. The longer the duration of the drought and the larger the area impacted, the more severe the potential impacts. Droughts are not usually associated with direct impacts on people or property, but they can have significant impacts on agriculture, which can impact people indirectly.

When measuring the severity of droughts, analysts typically look at economic impacts on a planning area. A drought directly or indirectly impacts all people in affected areas. All people could pay more for water if utilities increase their rates due to shortages. Agricultural impacts can result in loss of work for farm workers and those in related food processing jobs. Other water- or electricity-dependent industries are commonly forced to shut down all or a portion of their facilities, resulting in further layoffs. A drought can harm recreational companies that use water (e.g., swimming pools, water parks and river rafting companies) as well as landscape and nursery businesses because people will not invest in new plants if water is not available to sustain them. In Washington, where hydroelectric power plants generate nearly three-quarters of the electricity produced, drought also threatens the supply of electricity, with the potential to affect the cost of power.

Drought generally does not affect groundwater sources as quickly as surface water supplies, but groundwater supplies generally take longer to recover. Reduced precipitation during a drought means that groundwater supplies are not replenished at a normal rate. This can lead to a reduction in groundwater levels and problems such as reduced pumping capacity or wells going dry. Shallow wells are more susceptible than deep wells. About 16,000 drinking water systems in Washington get water from the ground; these systems serve about 5.2 million people.

Reduced replenishment of groundwater affects streams. Much of the flow in streams comes from groundwater, especially during the summer when there is less precipitation and after snowmelt ends. Reduced groundwater levels mean that even less water will enter streams when steam flows are lowest.

7.2.5 Warning Time

Droughts are climatic patterns that occur over long periods of time. Only generalized warning can take place due to the numerous variables that scientists have not pieced together well enough to make accurate and precise predictions.

Empirical studies conducted over the past century have shown that meteorological drought is never the result of a single cause. It is the result of many causes, often synergistic in nature; these include global weather patterns that produce persistent, upper-level high-pressure systems along the West Coast with warm, dry air resulting in less precipitation.

Scientists at this time do not know how to predict drought more than a month in advance for most locations. Predicting drought depends on the ability to forecast precipitation and temperature. Anomalies of precipitation and temperature may last from several months to several decades. How long they last depends on interactions between the atmosphere and the oceans, soil moisture and land surface processes, topography, internal dynamics, and the accumulated influence of weather systems on the global scale.

7.3 SECONDARY HAZARDS

The secondary hazard most commonly associated with drought is wildfire. A prolonged lack of precipitation dries out vegetation, which becomes increasingly susceptible to ignition as the duration of the drought extends.

Drought also is often accompanied by extreme heat. When temperatures reach 90ºF and above, people are vulnerable to sunstroke, heat cramps and heat exhaustion. Pets and livestock are also vulnerable to heat-related injuries and agricultural crops can suffer.

Due to the prevalence of hydroelectric power generation in Washington State, Covington businesses and residents may also experience a decrease in power supply or an increase in electric supply costs as the result of a prolonged drought. In extreme cases planned power outages throughout the region may be implemented.

7.4 CLIMATE CHANGE IMPACTS

Currently, there is no consensus in climate change models regarding the impacts of global warming on precipitation patterns in the Pacific Northwest. A majority of the current models project increases in precipitation in winter, spring and fall, and decreases in precipitation in summer. This decrease in precipitation, coupled with higher average summer temperatures, may contribute to an increase in the frequency, severity and duration of droughts in the region (Dalton et al., 2013). More frequent extreme events such as droughts could end up being more cause for concern than the long-term change in temperature and precipitation averages.

The potential for water shortages may increase as the timing and duration of precipitation events change. Winter snowpack is crucial to water resource management strategies in Puget Sound. Some projections indicate that snowpack in the Cascade Mountain range may decrease as much as 40 percent by the 2040s (Payne et al., 2004). This decline would impact social, natural and built systems within and surrounding the City of Covington. For example, summer hydropower production may decline 9 to 11 percent by the 2020s, while summer demand for energy increases due to higher electricity needs from an increase in cooling days coupled with population growth (Washington Department of Ecology, 2012).

The long-term effects of climate change on regional water resources are uncertain, but global water resources are already experiencing the following stresses without climate change:

- Growing populations
- Increased competition for available water
- Poor water quality
- Environmental claims
- Uncertain reserved water rights
- Groundwater overdraft
- Aging urban water infrastructure.

The best advice to water resource managers regarding climate change is to start addressing current stresses on water supplies and build flexibility and robustness into any system. Flexibility helps to ensure a quick response to changing conditions, and robustness helps people prepare for and survive the worst conditions. Washington State's Integrated Climate Response Strategy identifies four strategies for water resource management in response to a changing climate (Washington Department of Ecology, 2012):

- Mange water resources in a changing climate by implementing integrated water resources management approaches in highly vulnerable basins.
- Improve water supply and water quality in basins most likely to be affected by changing climate.

- Implement water conservation and efficiency programs to reduce the amount of water needed for irrigation and for municipal and industrial users and to improve basin-wide water supply.
- Build the capacity of state, tribal and local governments, watershed and regional groups, water managers, and communities to identify and assess risks and vulnerabilities to climate change impacts on water supplies and water quality.

With this approach to planning, water system managers will be better able to adapt to the impacts of climate change.

7.5 EXPOSURE

All people, property and environments in the planning area would be exposed to some degree to the impacts of moderate to extreme drought conditions.

7.6 VULNERABILITY

Drought produces a complex web of impacts that spans many sectors of the economy and reaches well beyond the area experiencing physical drought. This complexity exists because water is integral to the ability to produce goods and provide services. Drought can affect a wide range of economic, environmental and social activities. The vulnerability of an activity to the effects of drought usually depends on its water demand, how the demand is met, and what water supplies are available to meet the demand. The 2010 Washington State Hazard Mitigation Plan defined counties as being vulnerable to drought if they met at least five of the following criteria:

- History of severe or extreme drought conditions:
  1. The county must have been in serious or extreme drought at least 10-15 percent of the time from 1895 to 1995.
- Demand on water resources based on:
  2. Acreage of irrigated cropland. The acreage of the county's irrigated cropland must be in top 20 in the state.
  3. Percentage of harvested cropland that is irrigated. The percentage of the county's harvested cropland that is irrigated must be in top 20 in the state.
  4. Value of agricultural products. The value of the county's crops must be in the top 20 in the state.
  5. Population growth greater than the state average. The county's population growth from 2000 to 2006 must be greater than state average of 8.17 percent.
- A County's inability to endure the economic conditions of a drought, based on:
  6. The county's median household income being less than 75 percent of the state median income of $51,749 in 2005.
  7. The county being classified as economically distressed in 2005 because its unemployment rate was 20 percent greater than the state average from January 2002 through December 2004.

As summarized in Table 7-1, King County was not among nine counties in the state that met at least five of the criteria at the time of the 2010 statewide hazard mitigation plan and was not considered to be vulnerable to drought. Still, as indicated by the history of drought events listed earlier in this chapter, Covington experiences drought conditions on a somewhat regular basis.

TABLE 7-1.
KING COUNTY VULNERABILITY TO DROUGHT

Criterion	Value for King County	Meets Drought Vulnerability Criterion?
Percent of Time in Serious or Extreme Drought, 1895—1995	<5%	No
Irrigated Cropland (acres) Statewide Ranking for Irrigated Cropland Area	3,565 17	Yes
Percent of Harvested Cropland That Is Irrigated Statewide Ranking for Irrigated Cropland Percentage	35.1% 17	Yes
Market Value of Crops Statewide Ranking for Market Value of Crops	$72,602,000 14	Yes
Population Growth, 2000—2006	5.66%	No
Median Household Income	—	No
Unemployment Rate 20% Greater Than State Average	—	No

Source: 2010 Washington State Hazard Mitigation Plan

Heavy water users, such as landscapers, are negatively impacted by drought. Because much of the City's power comes from hydroelectric plants, heavy power users can also be affected. Drought conditions may have different impacts on the community during different times of the year. A drought during winter that limits snowpack might have a more severe impact on the community than one in late summer, when reservoirs can be used to mitigate problems.

Drought effects on crop yields vary depending on when in the growing season the drought occurs. There are times during a growing season when crops are better able to cope with drought conditions than others. The City of Covington, however, is not an agricultural community. According to the 2012 American Community Survey three-year estimates, only about 1.2 percent of the employed population in Southeast King County is employed in the agricultural, forestry, fishing and hunting, and mining sector. The City contains no agricultural lands of long-term significance (City of Covington Comprehensive Plan, 2012).

7.6.1 Population

Local water districts have the ability to minimize any impacts on residents and water consumers should several consecutive dry years occur. No significant life or health impacts are anticipated as a result of drought within the planning area.

7.6.2 Property

No structures will be directly affected by drought conditions, though some structures may become vulnerable to wildfires, which are more likely following years of drought. Droughts can also have significant impacts on landscapes, which could cause a financial burden to property owners. However, these impacts are not considered critical in planning for impacts from the drought hazard.

7.6.3 Critical Facilities

Critical facilities as defined for this plan will continue to be operational during a drought. The risk to critical facilities will be largely aesthetic. For example, when water conservation measures are in place, landscaped areas will not be watered and may die. These aesthetic impacts are not considered significant.

7.6.4 Environment

Environmental losses from drought are associated with damage to plants, animals, wildlife habitat, and air and water quality; forest and range fires; degradation of landscape quality; loss of biodiversity; and soil erosion. Some of the effects are short-term and conditions quickly return to normal following the end of the drought. Other environmental effects linger for some time or may even become permanent. Wildlife habitat, for example, may be degraded through the loss of wetlands, lakes and vegetation. However, many species will eventually recover from this temporary aberration. The degradation of landscape quality, including increased soil erosion, may lead to a more permanent loss of biological productivity. Although environmental losses are difficult to quantify, growing public awareness and concern for environmental quality has forced public officials to focus greater attention and resources on these effects.

7.6.5 Economic Impact

Economic impact will be largely associated with industries that use water or depend on water for their business. For example, landscaping businesses were affected in the droughts of the past as the demand for service significantly declined because landscaping was not watered. Agricultural industries will be impacted if water usage is restricted for irrigation. Drought conditions can lead to a reduction in power generating capacity in hydroelectric dominated systems, such as those found in Washington State. Reductions in capacity could lead to interruptions in the power supply that may have economic impacts in the region.

7.7 FUTURE TRENDS IN DEVELOPMENT

The City of Covington has an established comprehensive plan that includes policies directing land use and dealing with issues of water supply and the protection of water resources. The Environmental Element of the Plan prioritizes the regulation of development in a manner that protects water quality and quantity. Additionally, the plan prioritizes the active promotion of conservation measures within the regional aquifer (City of Covington, 2003). The City of Covington reviewed its comprehensive plan under the capability assessment performed for this effort. Deficiencies identified by this review can be addressed by mitigation actions to increase the capability to deal with future trends in development.

7.8 SCENARIO

An extreme multiyear drought could impact the region with little warning. Combinations of low summer precipitation and low winter snowpack accumulation could stretch water resources, resulting in increased pressures to meet all users' needs. Intensified by such conditions, wildfires could threaten the planning area, increasing the need for water. Surrounding communities, also in drought conditions, could increase their demand for water supplies relied upon by the City of Covington, causing social and political conflicts. If such conditions persisted for several years, the economy of the City of Covington could experience setbacks, especially in water-dependent industries.

7.9 ISSUES

The planning team identified the following drought-related issues:

- Uncertainty still exists regarding how climate change will affect precipitation in the planning area. Changes in the timing, frequency and duration of precipitation events may present challenges for current water storage and management practices in the region. Climate change may also increase the frequency and duration of meteorological drought conditions.
- Water resource management strategies have changed significantly over the last several decades. Managers must now consider the needs of communities, industries, power-generating facilities and the environment. Issues associated with meeting the needs of these competing demands with limited resources will likely increase as population growth continues and the impacts of climate change intensify.
- The use and promotion of water-saving and reclamation technologies even during non-drought periods may decrease the effects of drought in the planning area.

CHAPTER 8.
EARTHQUAKE

8.1 GENERAL BACKGROUND

8.1.1 How Earthquakes Happen

An earthquake is the vibration of the earth's surface following a release of energy in the earth's crust. This energy can be generated by a sudden dislocation of the crust or by a volcanic eruption. Most destructive quakes are caused by dislocations of the crust. The crust may first bend and then, when the stress exceeds the strength of the rocks, break and snap to a new position. In the process of breaking, vibrations called "seismic waves" are generated. These waves travel outward from the source of the earthquake at varying speeds.

DEFINITIONS

Earthquake—The shaking of the ground caused by an abrupt shift of rock along a fracture in the earth or a contact zone between tectonic plates.

Epicenter—The point on the earth's surface directly above the hypocenter of an earthquake. The location of an earthquake is commonly described by the geographic position of its epicenter and by its focal depth.

Fault—A fracture in the earth's crust along which two blocks of the crust have slipped with respect to each other.

Focal Depth—The depth from the earth's surface to the hypocenter.

Hypocenter—The region underground where an earthquake's energy originates

Liquefaction—Loosely packed, water-logged sediments losing their strength in response to strong shaking, causing major damage during earthquakes.

8.1.2 Types of Earthquakes

The earth's crust is divided into eight major pieces (or plates) and many minor plates. In Western Washington, the primary plates of interest are the Juan De Fuca and North American plates. The Juan De Fuca plate moves northeastward with respect to the North America plate at a rate of about 3-4 cm/yr. The boundary where these two plates converge, the Cascadia Subduction Zone, lies approximately 50 miles offshore and extends from the middle of Vancouver Island in British Columbia to northern California. As it collides with North America, the Juan De Fuca plate slides beneath the continent and sinks into the earth's mantle. More than 90 percent of Pacific Northwest earthquakes occur along the boundary between the Juan de Fuca plate and the North American plate. The collision of the Juan De Fuca and North America plates produces three types of earthquakes, as shown on Figure 8-1 and described below.

Subduction Zone Earthquakes

Subduction Zone earthquakes occur at the interface between tectonic plates. A subduction zone earthquake affecting Covington would be centered off the coast of Washington or Oregon where the plates converge in the Cascadia Subduction zone. Such earthquakes typically have a minute or more of strong ground shaking, and are quickly followed by damaging tsunamis and numerous large aftershocks.

The potential exists for large earthquakes along the Cascadia Subduction Zone. Researchers say the stresses they observe off the coast of Washington could generate an earthquake measuring 9 or more on the Richter scale. This would cause coastal areas to drop up to 6 feet in minutes and would produce a tsunami all along the fault line from British Columbia to Mendocino, California. Such an earthquake would last several minutes and produce catastrophic damage.

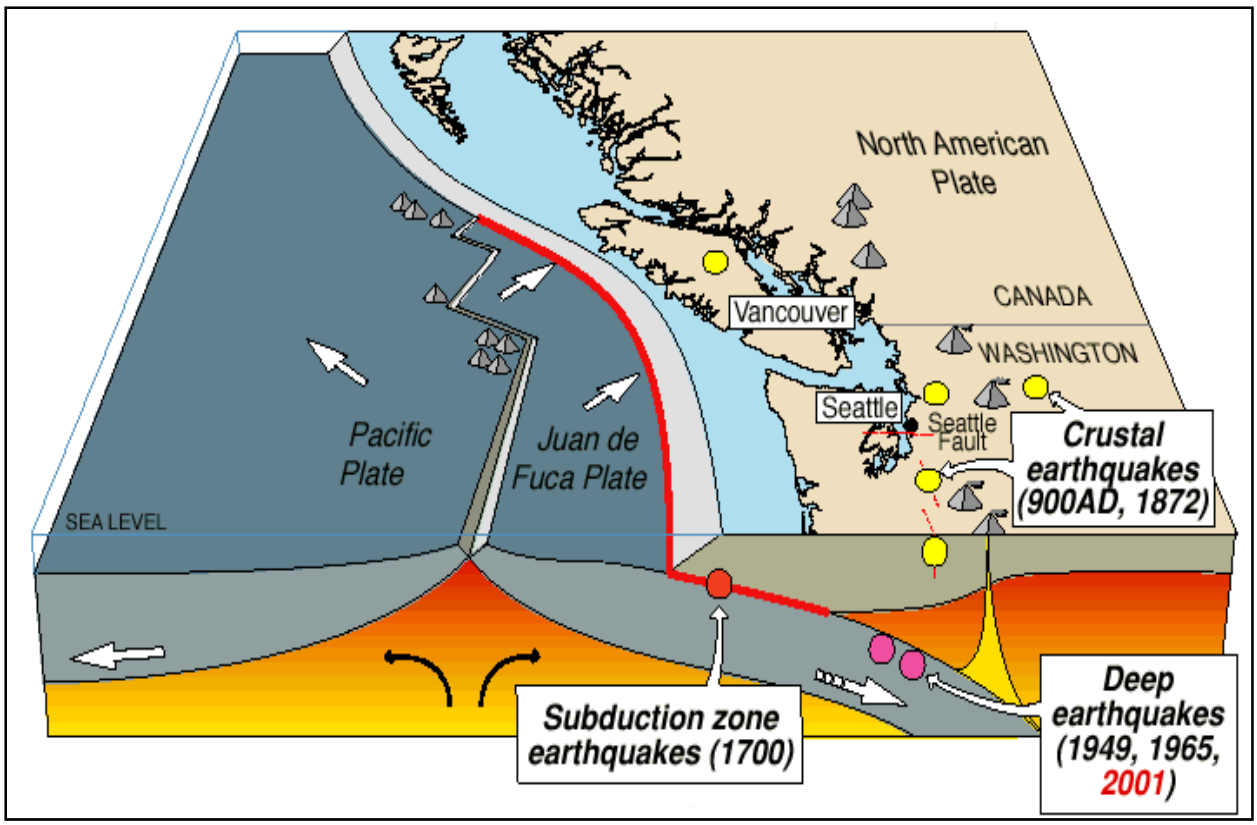


Figure 8-1. Earthquake Types in the Pacific Northwest

Benioff Zone (Deep) Earthquakes

Benioff Zone earthquakes occur within the Juan De Fuca plate as it sinks into the mantle. These are primarily deep earthquakes, 25 to 100 kilometers in depth. Due to their depth, aftershocks are typically not felt in association with these earthquakes. These earthquakes are caused by mineral changes as the plate moves deeper into the mantle. Minerals that make up the plates are altered to denser, more stable forms as temperature and pressure increase. The increase in density results in a decrease in the size of the plate, and stresses build up that pull the plate apart (Washington Department of Natural Resources, 2014). These earthquakes do not generally occur east of the Cascade Mountains.

Deep earthquakes generally last 20 to 30 seconds and have the potential of reaching 7.5 on the Richter scale. The last major one in the Puget Sound region was the 6.8 magnitude Nisqually Earthquake on February 28, 2001.

Shallow Crustal Earthquakes

Shallow crustal earthquakes occur within the North America plate, primarily at shallow depths of 30 kilometers or less. Shallow earthquakes within the North America plate account for most of the earthquakes in the Puget Sound region. Most are relatively small but the potential exists for major shallow earthquakes as well. Of the three types of earthquake, crustal events are the least understood.

Ongoing research on these types of events suggests that magnitude 7 or greater events have occurred on at least eight faults in the Puget Sound basin. Large magnitude events on these faults have the potential to cause greater loss of life and property than any other disaster likely to affect the area. It is estimated that the St. Helens seismic zone could produce a magnitude 6.2 to 6.8 earthquake. Evidence of a fault running

east-west through south Seattle (the Seattle Fault) suggests that a major earthquake with a magnitude of 7 or greater affected the Seattle area about 1,100 years ago. Generally, these earthquakes are expected to have magnitudes less than 8 and last from 20 to 60 seconds.

8.1.3 Faults

Earthquakes tend to reoccur along faults, which are zones of weakness in the crust. Even if a fault zone has recently experienced an earthquake, there is no guarantee that all the stress has been relieved. Another earthquake could still occur.

Geologists classify faults by their relative hazards. Active faults, which represent the highest hazard, are those that have ruptured to the ground surface during the Holocene period (about the last 11,000 years). Potentially active faults are those that displaced layers of rock from the Quaternary period (the last 1,800,000 years). Determining if a fault is “active” or “potentially active” depends on geologic evidence, which may not be available for every fault. Although there are probably still some unrecognized active faults, nearly all the movement between the two plates, and therefore the majority of the seismic hazards, are on the well-known active faults.

Faults are more likely to have earthquakes on them if they have more rapid rates of movement, have had recent earthquakes along them, experience greater total displacements, and are aligned so that movement can relieve accumulating tectonic stresses. A direct relationship exists between a fault’s length and location and its ability to generate damaging ground motion at a given site. In some areas, smaller, local faults produce lower magnitude quakes, but ground shaking can be strong, and damage can be significant as a result of the fault’s proximity to the area. In contrast, large regional faults can generate great magnitudes but, because of their distance and depth, may result in only moderate shaking in the area.

8.1.4 Earthquake Classifications

Earthquakes are typically classified in one of two ways: By the amount of energy released, measured as **magnitude**; or by the impact on people and structures, measured as **intensity**.

Magnitude

Currently the most commonly used magnitude scale is the moment magnitude (M_w) scale, with the follow classifications of magnitude:

- Great—$M_w \geq 8$
- Major—$M_w = 7.0 – 7.9$
- Strong—$M_w = 6.0 – 6.9$
- Moderate—$M_w = 5.0 – 5.9$
- Light—$M_w = 4.0 – 4.9$
- Minor—$M_w = 3.0 – 3.9$
- Micro—$M_w < 3$

Estimates of moment magnitude roughly match the local magnitude scale (ML) commonly called the Richter scale. One advantage of the moment magnitude scale is that, unlike other magnitude scales, it does not saturate at the upper end. That is, there is no value beyond which all large earthquakes have about the same magnitude. For this reason, moment magnitude is now the most often used estimate of large earthquake magnitudes.

Intensity

Currently the most commonly used intensity scale is the modified Mercalli intensity scale, with ratings defined as follows (USGS, 1989):

- I. Not felt except by a very few under especially favorable conditions
- II. Felt only by a few persons at rest, especially on upper floors of buildings.
- III. Felt quite noticeably by persons indoors, especially on upper floors of buildings. Many people do not recognize it is an earthquake. Standing cars may rock slightly. Vibrations similar to the passing of a truck. Duration estimated.
- IV. Felt indoors by many, outdoors by few during the day. At night, some awakened. Dishes, windows, doors disturbed; walls make cracking sound. Sensation like a heavy truck striking building. Standing cars rocked noticeably.
- V. Felt by nearly everyone; many awakened. Some dishes, windows broken. Unstable objects overturned. Pendulum clocks may stop.
- VI. Felt by all; many frightened. Some heavy furniture moved; a few instances of fallen plaster. Damage slight.
- VII. Damage negligible in buildings of good design and construction; slight in well-built ordinary structures; considerable in poorly built or badly designed structures. Some chimneys broken.
- VIII. Damage slight in specially designed structures; considerable damage in ordinary buildings with partial collapse. Damage great in poorly built structures. Fall of chimneys, factory stacks, columns, monuments, walls. Heavy furniture overturned.
- IX. Damage considerable in specially designed structures; well-designed frame structures thrown out of plumb. Damage great in substantial buildings, with partial collapse. Buildings shifted off foundations.
- X. Some well-built wooden structures destroyed; most masonry and frame structures destroyed with foundations. Rails bent.
- XI. Few, if any (masonry) structures remain standing. Bridges destroyed. Rails bent greatly.
- XII. Damage total. Lines of sight and level are distorted. Objects thrown into the air.

8.1.5 Ground Motion

Earthquake hazard assessment is also based on expected ground motion. This involves determining the annual probability that certain ground motion accelerations will be exceeded, then summing the annual probabilities over the time period of interest. The most commonly mapped ground motion parameters are the horizontal and vertical peak ground accelerations (PGA) for a given soil or rock type. Instruments called accelerographs record levels of ground motion due to earthquakes at stations throughout a region. These readings are recorded by state and federal agencies that monitor and predict seismic activity.

Maps of PGA values form the basis of seismic zone maps that are included in building codes such as the International Building Code. Building codes that include seismic provisions specify the horizontal force due to lateral acceleration that a building should be able to withstand during an earthquake. PGA values are directly related to these lateral forces that could damage “short period structures” (e.g. single-family dwellings). Longer period response components determine the lateral forces that damage larger structures with longer natural periods (apartment buildings, factories, high-rises, bridges). Table 8-1 lists damage potential and perceived shaking by PGA factors, compared to the Mercalli scale.

TABLE 8-1.
MERCALLI SCALE AND PEAK GROUND ACCELERATION COMPARISON

Modified Mercalli Scale	Perceived Shaking	Potential Structure Damage		Estimated PGA[a] (%g)
		Resistant Buildings	Vulnerable Buildings	
I	Not Felt	None	None	<0.17%
II-III	Weak	None	None	0.17% – 1.4%
IV	Light	None	None	1.4% – 3.9%
V	Moderate	Very Light	Light	3.9% – 9.2%
VI	Strong	Light	Moderate	9.2% – 18%
VII	Very Strong	Moderate	Moderate/Heavy	18% – 34%
VIII	Severe	Moderate/Heavy	Heavy	34% – 65%
IX	Violent	Heavy	Very Heavy	65% – 124%
X—XII	Extreme	Very Heavy	Very Heavy	>124%

a. PGA measured in percent of g, where g is the acceleration of gravity
Sources: USGS, 2008; USGS, 2010

8.1.6 Effect of Soil Types

The impact of an earthquake on structures and infrastructure is largely a function of ground shaking, distance from the source of the quake, and liquefaction, a secondary effect of an earthquake in which soils lose their shear strength and flow or behave as liquid, thereby damaging structures that derive their support from the soil. Liquefaction generally occurs in soft, unconsolidated sedimentary soils. A program called the National Earthquake Hazard Reduction Program (NEHRP) creates maps based on soil characteristics to help identify locations subject to liquefaction. Table 8-2 summarizes NEHRP soil classifications. NEHRP Soils B and C typically can sustain ground shaking without much effect, dependent on the earthquake magnitude. The areas that are commonly most affected by ground shaking have NEHRP Soils D, E and F. In general, these areas are also most susceptible to liquefaction.

TABLE 8-2.
NEHRP SOIL CLASSIFICATION SYSTEM

NEHRP Soil Type	Description	Mean Shear Velocity to 30 m (m/s)
A	Hard Rock	1,500
B	Firm to Hard Rock	760-1,500
C	Dense Soil/Soft Rock	360-760
D	Stiff Soil	180-360
E	Soft Clays	< 180
F	Special Study Soils (liquefiable soils, sensitive clays, organic soils, soft clays >36 m thick)	

8.2 HAZARD PROFILE

Earthquakes can last from a few seconds to over five minutes; they may also occur as a series of tremors over several days. The actual movement of the ground in an earthquake is seldom the direct cause of injury or death. Casualties generally result from falling objects and debris, because the shocks shake, damage or demolish buildings and other structures. Disruption of communications, electrical power supplies and gas, sewer and water lines should be expected. Earthquakes may trigger fires, dam failures, landslides or releases of hazardous material, compounding their disastrous effects.

Small, local faults produce lower magnitude quakes, but ground shaking can be strong and damage can be significant in areas close to the fault. In contrast, large regional faults can generate earthquakes of great magnitudes but, because of their distance and depth, they may result in only moderate shaking in an area.

8.2.1 Past Events

Each year more than a thousand earthquakes are recorded in Washington State. Fifteen to twenty of these earthquakes are strong enough to be felt. Between February 1969 and February 2013, 232 earthquakes of magnitude 2.0 or greater were recorded in the area centered on Covington, extending from Tacoma in the southwest to Snoqualmie in the northeast (Pacific Northwest Seismic Network, 2013). The events with magnitude of 3.0 or greater are listed in Table 8-3.

TABLE 8-3.
HISTORICAL EARTHQUAKES IN THE VICINITY OF COVINGTON

Date	Magnitude	Location	Depth (miles)
1995/01/28	5	10.9 mi NNE from Tacoma, WA	9.8
1970/10/24	4.1	7.4 mi NNE from Tacoma, WA	8.1
1969/10/15	3.6	5.1 mi SSW from Maple Valley, WA	25.9
1990/12/29	3.5	2.0 mi SW from North Bend, WA	10.6
1975/07/13	3.4	6.0 mi NNE from Tacoma, WA	4.9
2011/09/22	3.2	3.0 mi NNW from Maple Valley, WA	15.4
1999/07/01	3.1	9.2 mi N from Tacoma, WA	16.8
1992/04/19	3.1	3.6 mi N from Maple Valley, WA	14.3
1985/06/16	3.1	4.7 mi SSW from North Bend, WA	10.6
1990/03/17	3	8.6 mi NE from Tacoma, WA	4.2
1985/09/13	3	10.9 mi NNE from Tacoma, WA	12.3
1983/12/16	3	6.4 mi SSE from Maple Valley, WA	8
1983/10/04	3	3.5 mi SW from North Bend, WA	13.5
1974/05/22	3	4.7 mi S from Maple Valley, WA	11.9
1972/08/13	3	6.8 mi SSW from North Bend, WA	9

Earthquake data accessed February 26, 2013 by query of the Pacific Northwest Seismic Network website (pnsn.org). Query parameters selected events of Magnitude 2 to Magnitude 9 between February 14, 1969 and February 26, 2013 in the area between Latitudes 47.25 and 47.5 and between Longitudes -121.8 and -122.4.

The most recent severe earthquake event affecting Covington was the February 28, 2001 Nisqually earthquake. This event was a Benioff Zone earthquake. The Magnitude 6.8 quake was about 30 miles deep, with an epicenter near Anderson Island in Pierce County. Residents as far away as British Columbia and Oregon felt the tremor. The impacts of this quake were most severe in the Puget Sound area, where economic losses (from damage to buildings, roads and bridges, and other infrastructure and loss of business) were estimated at $1 to $2 billion. The earthquake also caused more than 700 injuries. Very little damage was reported in Covington. No transportation routes in the city were interrupted and no structural damage to homes or businesses occurred that required long-term closure.

The earthquakes that caused the most damage in Western Washington in the 20th century were also Benioff Zone events: the 1949 Olympia Fault event (magnitude 7.1) and 1965 Tacoma Fault event (magnitude 6.5). Since 1870, there have been seven earthquakes in the Puget Sound basin with magnitudes thought to be greater than 6.0 (Washington Department of Natural Resources, 2014). The epicenters of these events have been within about 50 miles of each other between Olympia and Tacoma.

Most earthquakes in the Pacific Northwest are shallow crustal events. The 1872 North Cascades earthquake, the 1945 earthquake near North Bend and the 1981 earthquake on the St. Helens seismic zone were all of this type. Studies have found evidence of large shallow earthquakes along the Seattle Fault 1,100 years ago. Massive block landslides into Lake Washington, marsh subsidence and tsunami deposits at West Point in Seattle, tsunami deposits at Cultus Bay on Whidbey Island, and large rock avalanches on the southeastern Olympic Peninsula have all been dated to approximately 900 AD.

The last Cascadia subduction zone event occurred on January 26, 1700.

8.2.2 Location

The impact of an earthquake is largely a function of the following components:

- Ground shaking (ground motion accelerations)
- Liquefaction (soil instability)
- Distance from the source (both horizontally and vertically).

Mapping of these components was used to assess the earthquake risk in the planning area, as described below.

Shake Maps

A shake map is a representation of ground shaking produced by an earthquake. The information it presents is different from the earthquake magnitude and epicenter that are released after an earthquake because shake maps focus on the ground shaking resulting from the earthquake, rather than the parameters describing the earthquake source. An earthquake has only one magnitude and one epicenter, but it produces a range of ground shaking at sites throughout the region, depending on the distance from the earthquake, the rock and soil conditions at sites, and variations in the propagation of seismic waves from the earthquake due to complexities in the structure of the earth's crust. A shake map shows the extent and variation of ground shaking in a region immediately following significant earthquakes.

Ground motion and intensity maps are derived from peak ground motion amplitudes recorded on seismic sensors (accelerometers), with interpolation based on estimated amplitudes where data are lacking, and site amplification corrections. Color-coded instrumental intensity maps are derived from empirical relations between peak ground motions and Modified Mercalli intensity. Two types of shake map are typically generated from the data:

- A probabilistic seismic hazard map shows the hazard from earthquakes that geologists and seismologists agree could occur. The maps are expressed in terms of probability of exceeding a certain ground motion, such as the 10-percent probability of exceedance in 50 years. This level of ground shaking has been used for designing buildings in high seismic areas. Figure 8-2 and Figure 8-3 show the estimated ground motion for the 100-year and 500-year probabilistic earthquakes in the planning area.
- Earthquake scenario maps describe the expected ground motions and effects of hypothetical large earthquakes for a region. Maps of these scenarios can be used to support all phases of emergency management. Three scenarios were chosen for this plan:
  - Seattle Fault Scenario—A Magnitude 7.2 event with a shallow depth and epicenter approximately 6 miles south-southwest of downtown Seattle. See Figure 8-4
  - South Whidbey Island Fault Scenario—A Magnitude 7.4 event with a shallow depth and epicenter approximately 13.5 miles west-northwest of Everett. See Figure 8-5.
  - Tacoma Fault Scenario—A Magnitude 7.1 event with a shallow depth and epicenter approximately 16.5 miles northwest of Tacoma. See Figure 8-6.

NEHRP Soil Maps

NEHRP soil types define the locations that will be significantly impacted by an earthquake. NEHRP Soils B and C typically can sustain low-magnitude ground shaking without much effect. The areas that are most commonly affected by ground shaking have NEHRP Soils D, E and F. Figure 8-7 shows NEHRP soil classifications in the planning area.

Liquefaction Maps

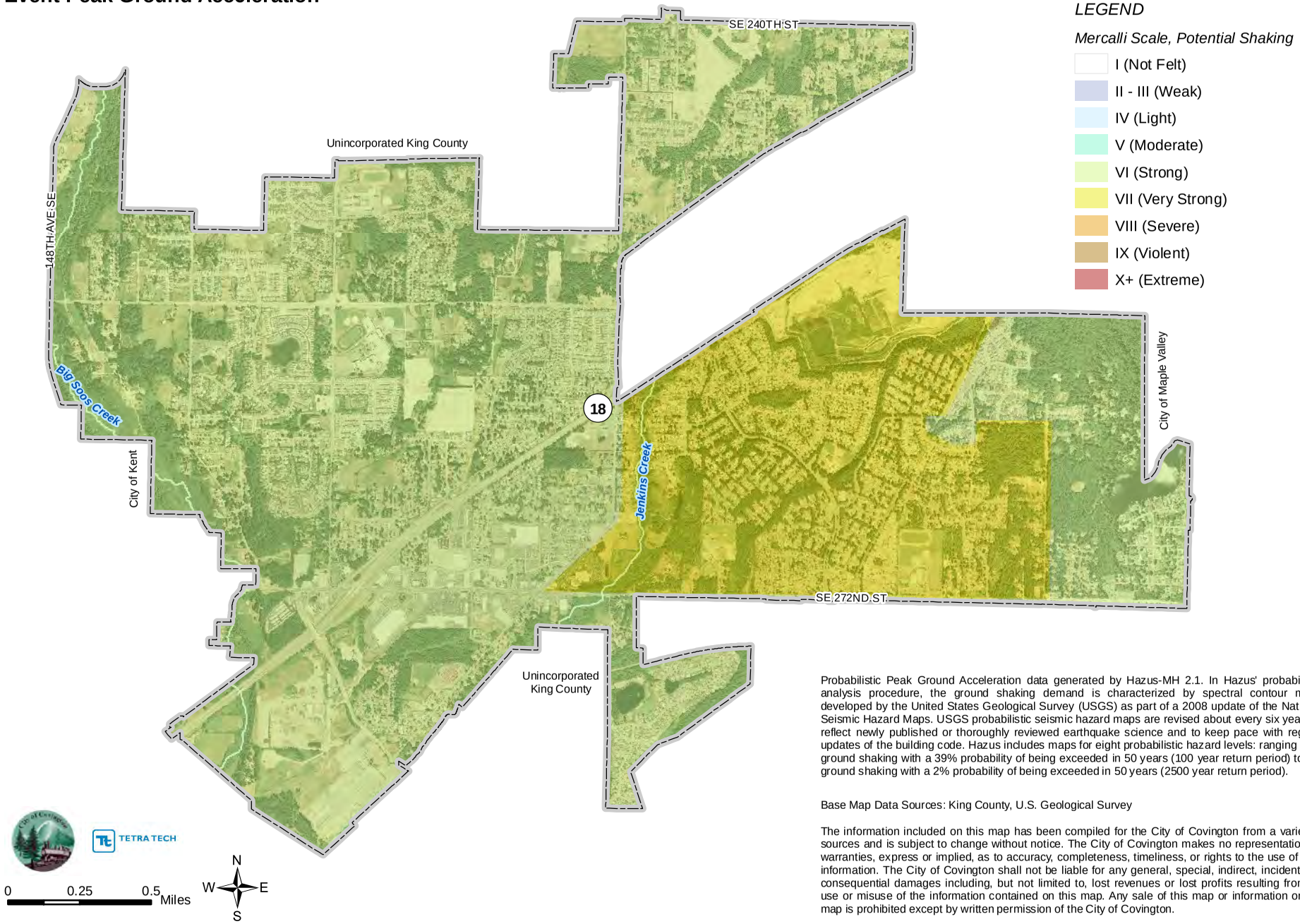
Soil liquefaction maps are useful tools to assess potential damage from earthquakes. When the ground liquefies, sandy or silty materials saturated with water behave like a liquid, causing pipes to leak, roads and airport runways to buckle, and building foundations to be damaged. In general, areas with NEHRP Soils D, E and F are also susceptible to liquefaction. If there is a dry soil crust, excess water will sometimes come to the surface through cracks in the confining layer, bringing liquefied sand with it, creating sand boils. Figure 8-8 shows the liquefaction susceptibility in the planning area.

8.2.3 Frequency

The recurrence rate for a magnitude 6.5 or greater earthquake is estimated to be about 350 years anywhere in the Puget Sound basin and 1,000 years on the Seattle Fault (Washington Emergency Management Division, 2014). Approximate recurrence intervals for Benioff Zone earthquakes are estimated to be 30 to 40 years for magnitude 6.5 and 50 to 100 years for magnitude 7.0. Earthquake events occurring along the Cascadia subduction zone reoccur with far less frequency. Such events occur on average every 550 years, although the recurrence interval appears to be irregular. The intervals between earthquakes in this subduction zone have ranged from 100 years to more than 1,000 years.

The USGS estimated that a Cascadia Subduction Zone earthquake has a 10 to 15 percent probability of occurrence in 50 years, and a crustal zone earthquake has a recurrence interval of about 500 to 600 years. In general, it is difficult to estimate the probability of occurrence of crustal earthquake events. Earthquakes on the South Whidbey Island and Seattle Faults have a 2 percent probability of occurrence in 50 years. A Benioff Zone earthquake has an 85 percent probability of occurrence in 50 years, making it the most likely of the three types.

Figure 8-2
100-Year Probability Earthquake Event Peak Ground Acceleration



Probabilistic Peak Ground Acceleration data generated by Hazus-MH 2.1. In Hazus' probabilistic analysis procedure, the ground shaking demand is characterized by spectral contour maps developed by the United States Geological Survey (USGS) as part of a 2008 update of the National Seismic Hazard Maps. USGS probabilistic seismic hazard maps are revised about every six years to reflect newly published or thoroughly reviewed earthquake science and to keep pace with regular updates of the building code. Hazus includes maps for eight probabilistic hazard levels: ranging from ground shaking with a 39% probability of being exceeded in 50 years (100 year return period) to the ground shaking with a 2% probability of being exceeded in 50 years (2500 year return period).

Base Map Data Sources: King County, U.S. Geological Survey

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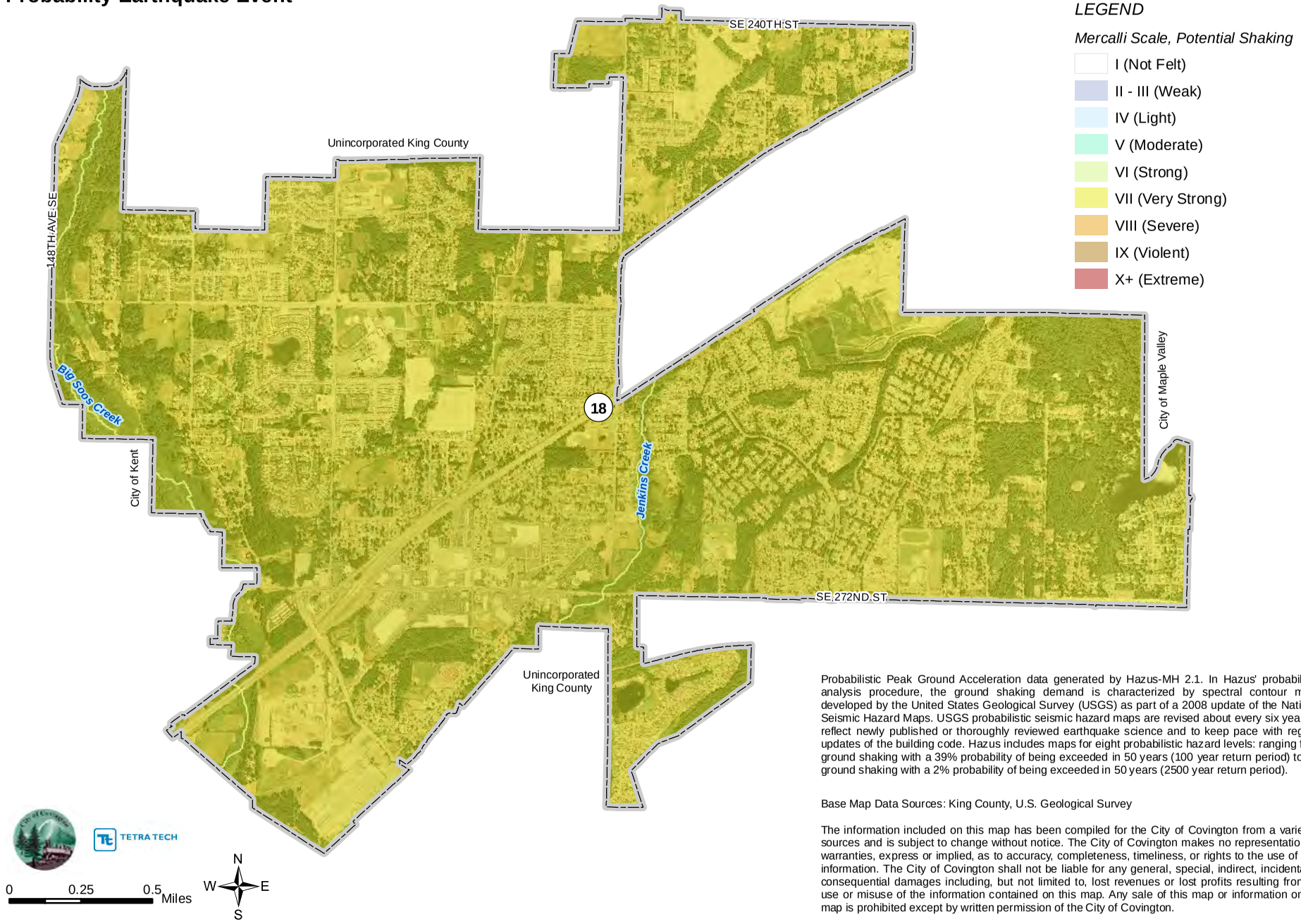
Figure 8-3
Peak Ground Accleration for a 500-Year Probability Earthquake Event



Probabilistic Peak Ground Acceleration data generated by Hazus-MH 2.1. In Hazus' probabilistic analysis procedure, the ground shaking demand is characterized by spectral contour maps developed by the United States Geological Survey (USGS) as part of a 2008 update of the National Seismic Hazard Maps. USGS probabilistic seismic hazard maps are revised about every six years to reflect newly published or thoroughly reviewed earthquake science and to keep pace with regular updates of the building code. Hazus includes maps for eight probabilistic hazard levels: ranging from ground shaking with a 39% probability of being exceeded in 50 years (100 year return period) to the ground shaking with a 2% probability of being exceeded in 50 years (2500 year return period).

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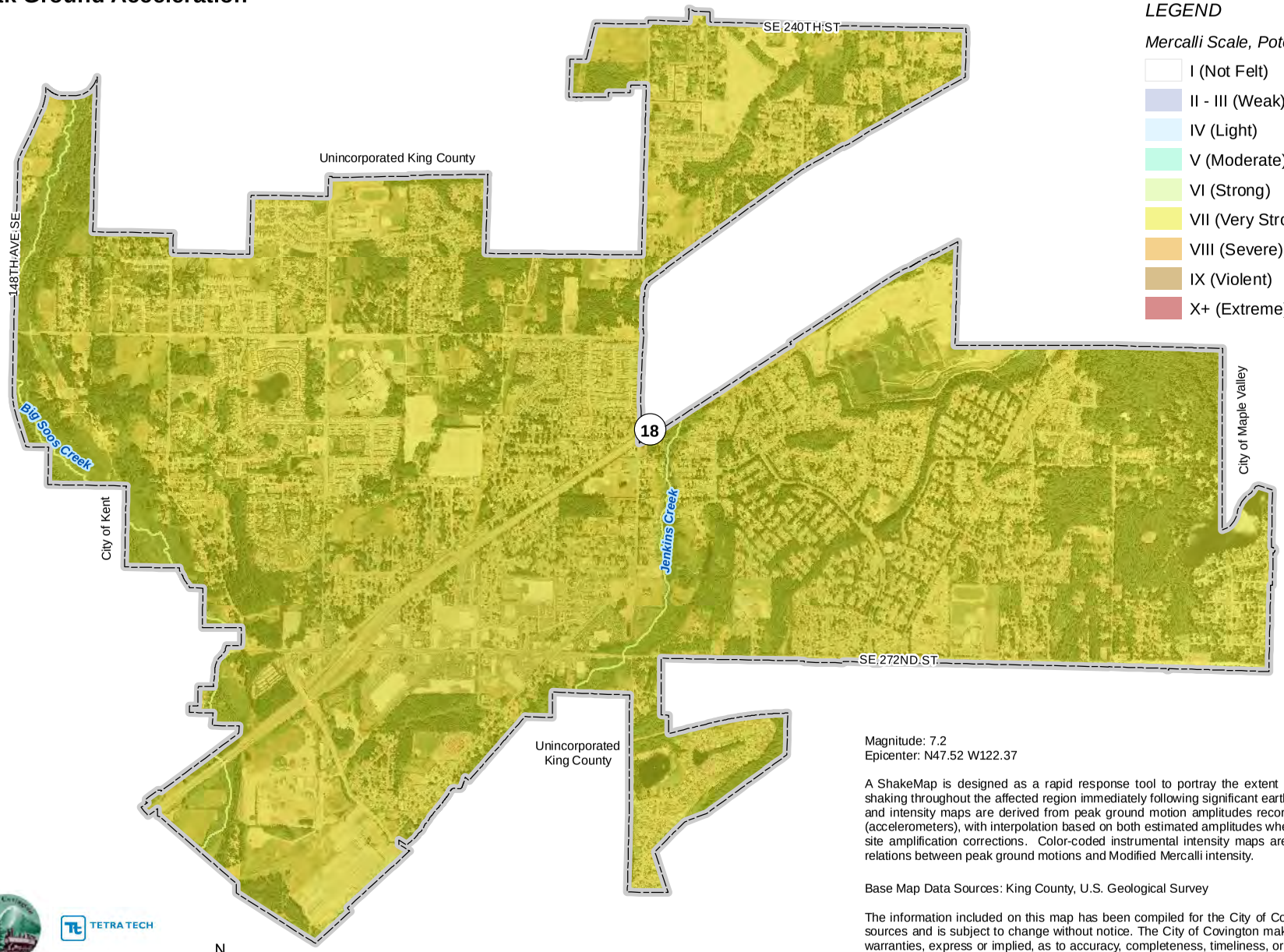
Figure 8-4
Seattle Fault - M7.2 Scenario
Peak Ground Acceleration



LEGEND

Mercalli Scale, Potential Shaking

- I (Not Felt)
- II - III (Weak)
- IV (Light)
- V (Moderate)
- VI (Strong)
- VII (Very Strong)
- VIII (Severe)
- IX (Violent)
- X+ (Extreme)

Magnitude: 7.2
Epicenter: N47.52 W122.37

A ShakeMap is designed as a rapid response tool to portray the extent and variation of ground shaking throughout the affected region immediately following significant earthquakes. Ground motion and intensity maps are derived from peak ground motion amplitudes recorded on seismic sensors (accelerometers), with interpolation based on both estimated amplitudes where data are lacking, and site amplification corrections. Color-coded instrumental intensity maps are derived from empirical relations between peak ground motions and Modified Mercalli intensity.

Base Map Data Sources: King County, U.S. Geological Survey

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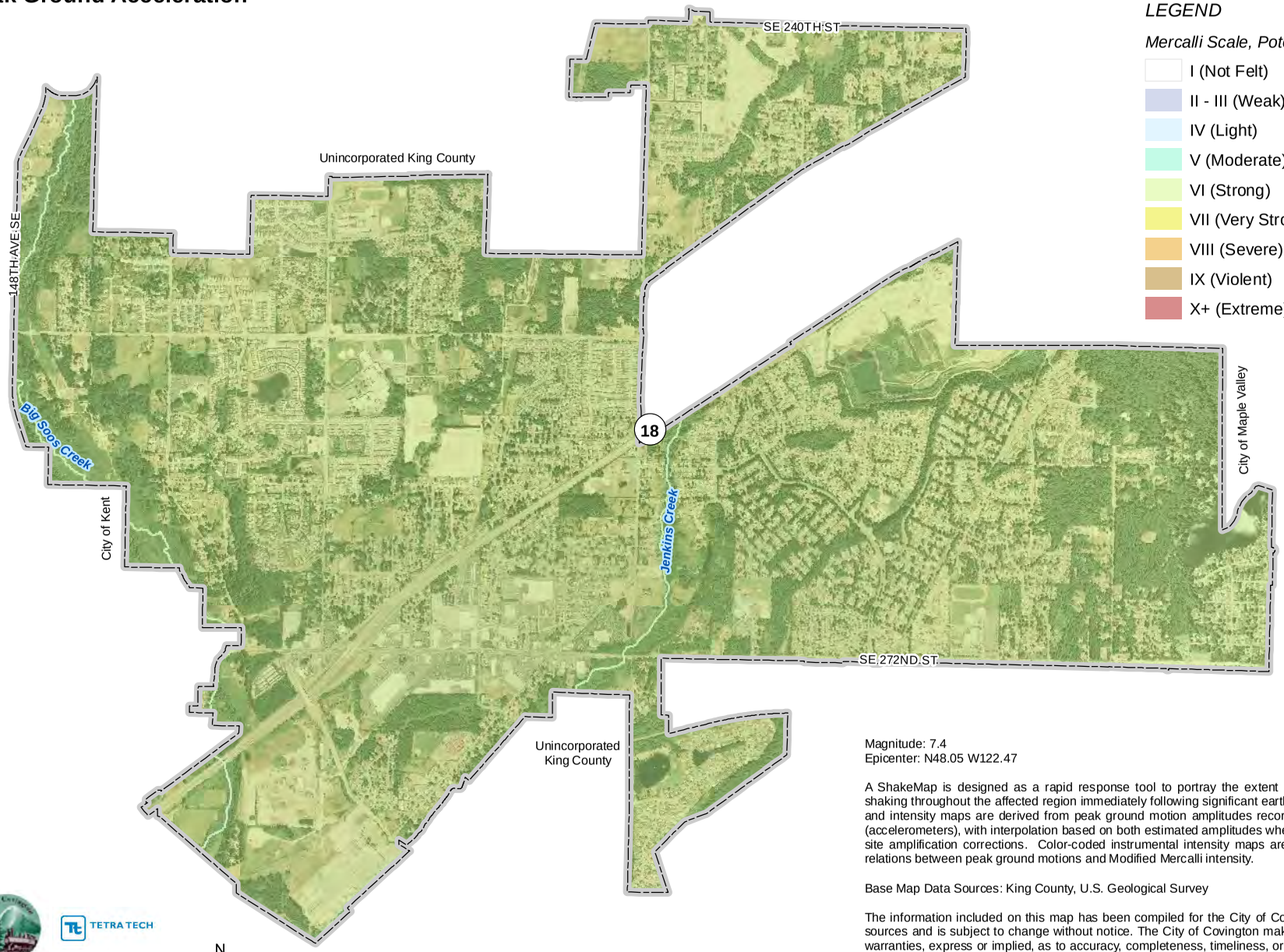
TETRA TECH

0 0.25 0.5 Miles

N W E S

Figure 8-5
South Whidbey Island Fault - M7.4 Scenario
Peak Ground Acceleration



LEGEND

Mercalli Scale, Potential Shaking

- I (Not Felt)
- II - III (Weak)
- IV (Light)
- V (Moderate)
- VI (Strong)
- VII (Very Strong)
- VIII (Severe)
- IX (Violent)
- X+ (Extreme)

TETRA TECH

0 0.25 0.5 Miles

N W E S

Magnitude: 7.4
Epicenter: N48.05 W122.47

A ShakeMap is designed as a rapid response tool to portray the extent and variation of ground shaking throughout the affected region immediately following significant earthquakes. Ground motion and intensity maps are derived from peak ground motion amplitudes recorded on seismic sensors (accelerometers), with interpolation based on both estimated amplitudes where data are lacking, and site amplification corrections. Color-coded instrumental intensity maps are derived from empirical relations between peak ground motions and Modified Mercalli intensity.

Base Map Data Sources: King County, U.S. Geological Survey

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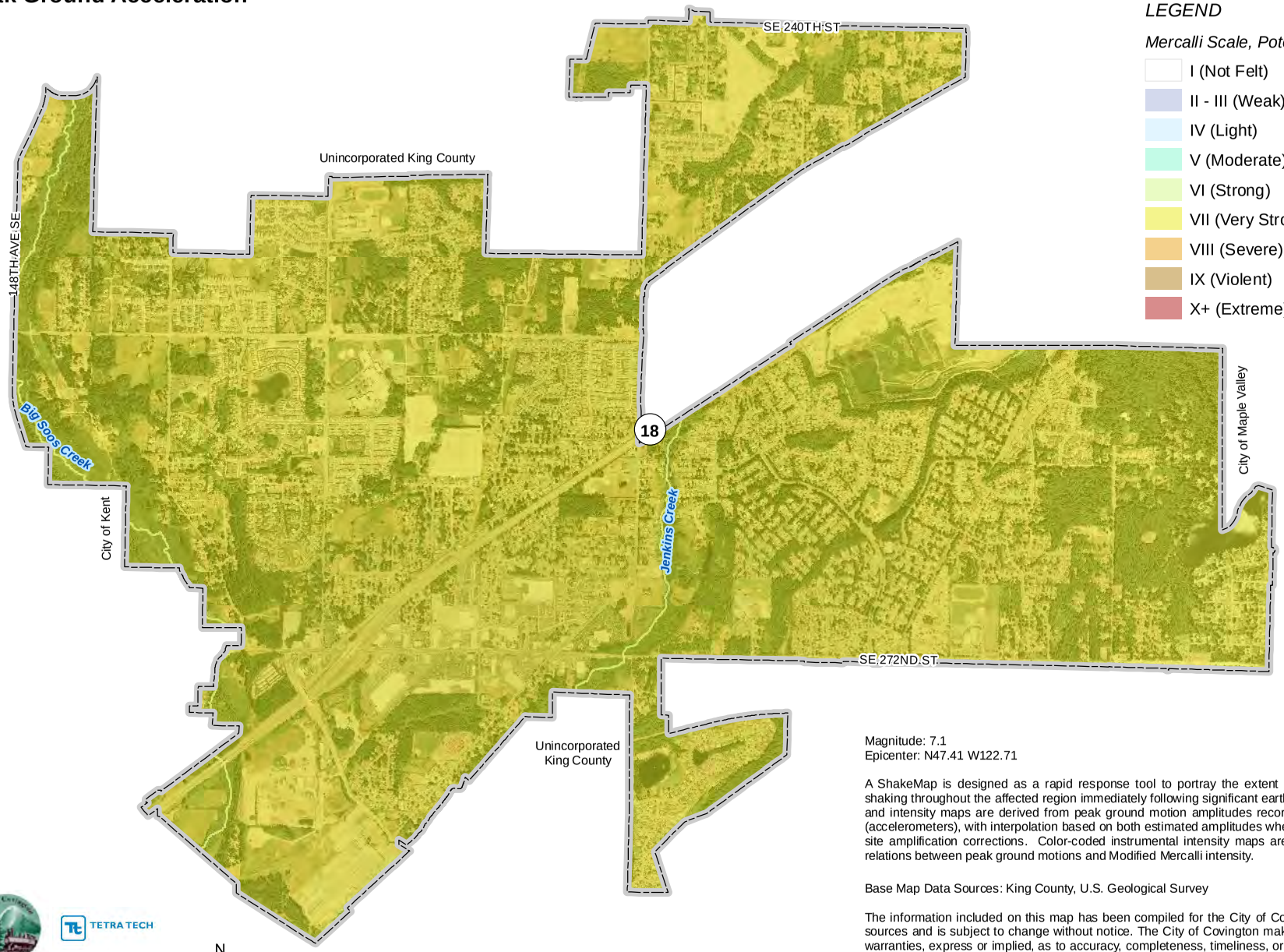
Figure 8-6
Tacoma Fault - M7.1 Scenario
Peak Ground Acceleration



LEGEND

Mercalli Scale, Potential Shaking

- I (Not Felt)
- II - III (Weak)
- IV (Light)
- V (Moderate)
- VI (Strong)
- VII (Very Strong)
- VIII (Severe)
- IX (Violent)
- X+ (Extreme)

Magnitude: 7.1
Epicenter: N47.41 W122.71

A ShakeMap is designed as a rapid response tool to portray the extent and variation of ground shaking throughout the affected region immediately following significant earthquakes. Ground motion and intensity maps are derived from peak ground motion amplitudes recorded on seismic sensors (accelerometers), with interpolation based on both estimated amplitudes where data are lacking, and site amplification corrections. Color-coded instrumental intensity maps are derived from empirical relations between peak ground motions and Modified Mercalli intensity.

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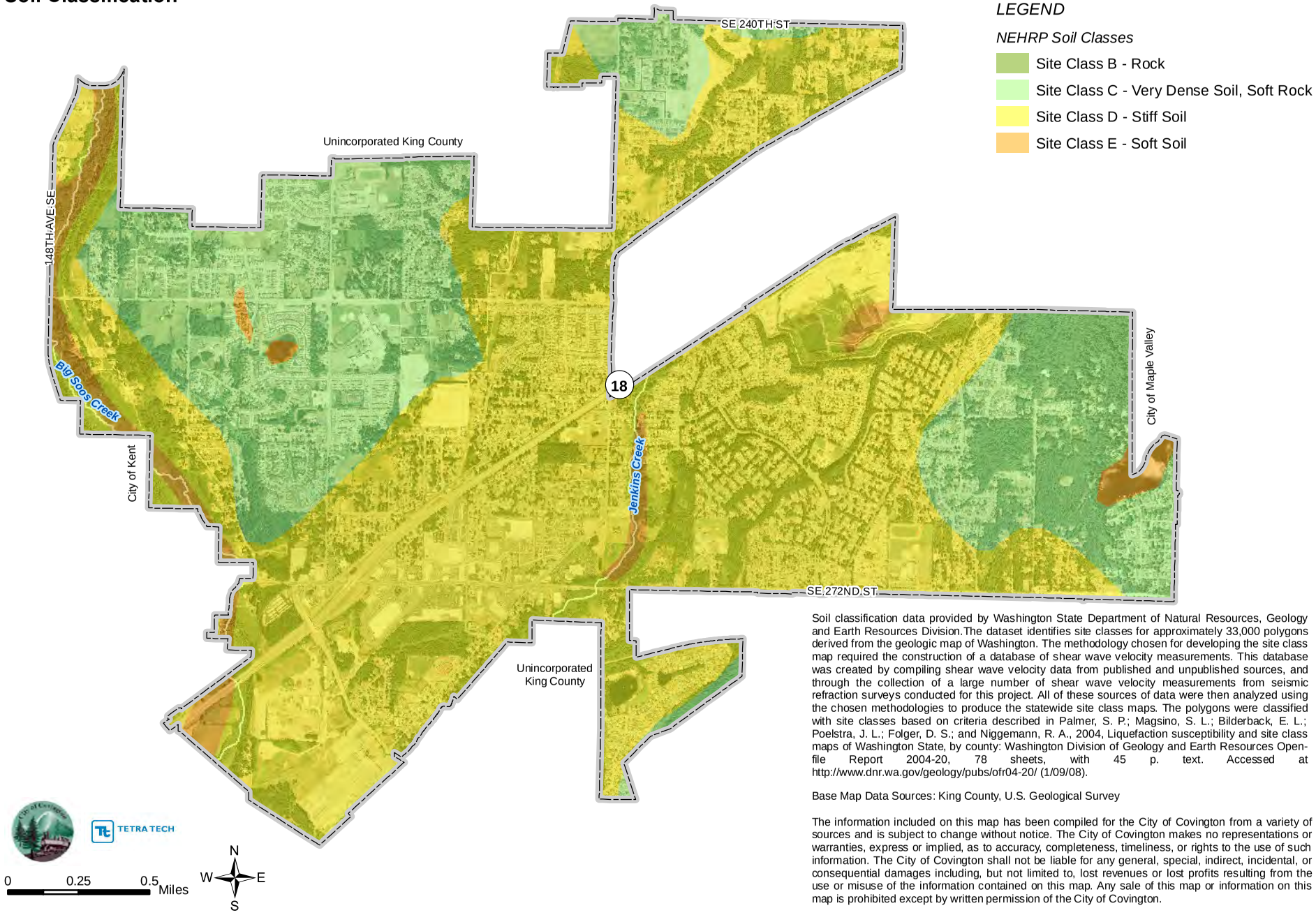
TETRA TECH

0 0.25 0.5 Miles

N W E S

Figure 8-7
National Earthquake Hazard Reduction Program (NEHRP) Soil Classification



Soil classification data provided by Washington State Department of Natural Resources, Geology and Earth Resources Division.The dataset identifies site classes for approximately 33,000 polygons derived from the geologic map of Washington. The methodology chosen for developing the site class map required the construction of a database of shear wave velocity measurements. This database was created by compiling shear wave velocity data from published and unpublished sources, and through the collection of a large number of shear wave velocity measurements from seismic refraction surveys conducted for this project. All of these sources of data were then analyzed using the chosen methodologies to produce the statewide site class maps. The polygons were classified with site classes based on criteria described in Palmer, S. P.; Magsino, S. L.; Bilderback, E. L.; Poelstra, J. L.; Folger, D. S.; and Niggemann, R. A., 2004, Liquefaction susceptibility and site class maps of Washington State, by county: Washington Division of Geology and Earth Resources Open-file Report 2004-20, 78 sheets, with 45 p. text. Accessed at http://www.dnr.wa.gov/geology/pubs/ofr04-20/ (1/09/08).

Base Map Data Sources: King County, U.S. Geological Survey

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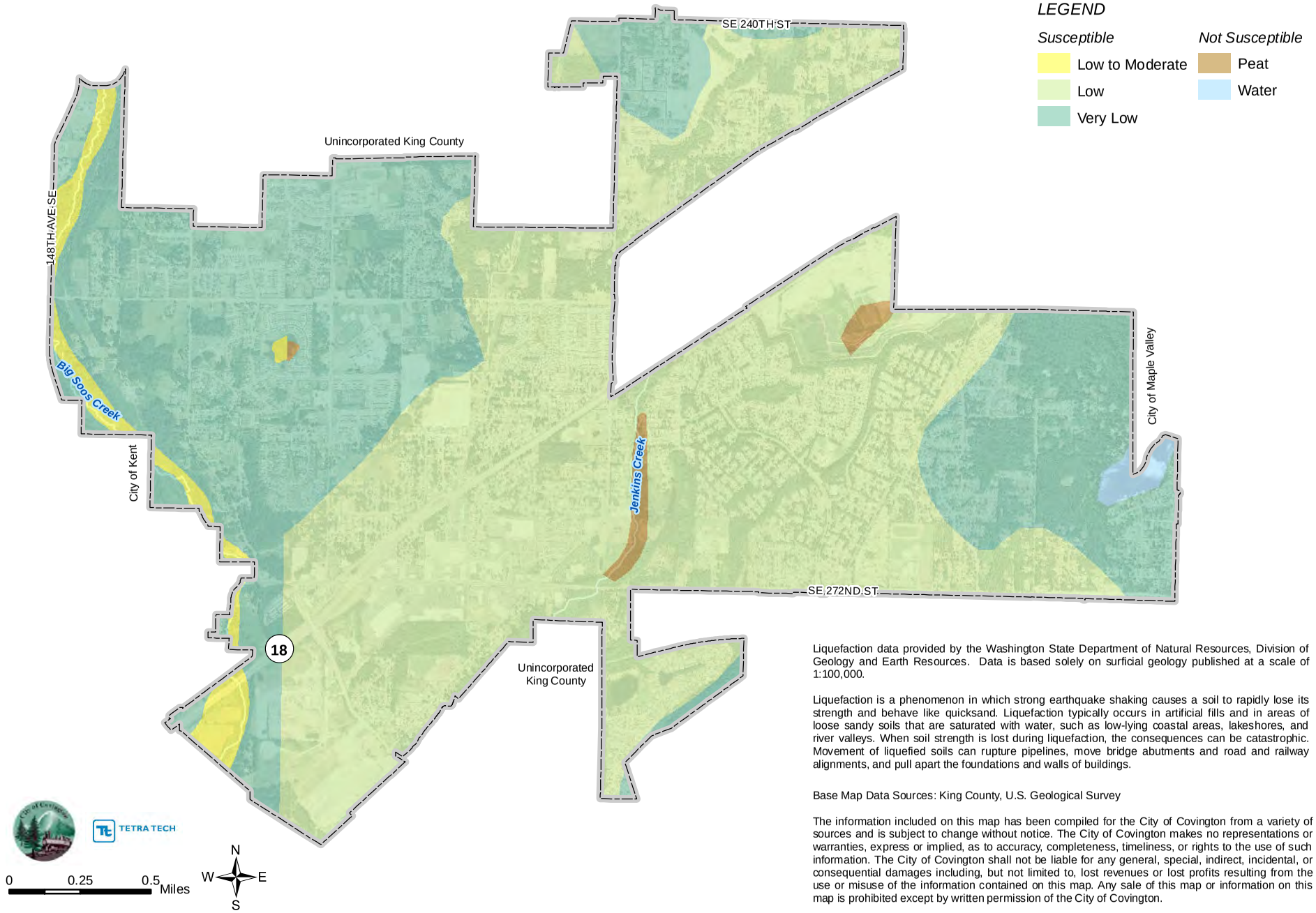
Figure 8-8
Liquefaction Susceptibility



Liquefaction data provided by the Washington State Department of Natural Resources, Division of Geology and Earth Resources. Data is based solely on surficial geology published at a scale of 1:100,000.

Liquefaction is a phenomenon in which strong earthquake shaking causes a soil to rapidly lose its strength and behave like quicksand. Liquefaction typically occurs in artificial fills and in areas of loose sandy soils that are saturated with water, such as low-lying coastal areas, lakeshores, and river valleys. When soil strength is lost during liquefaction, the consequences can be catastrophic. Movement of liquefied soils can rupture pipelines, move bridge abutments and road and railway alignments, and pull apart the foundations and walls of buildings.

Base Map Data Sources: King County, U.S. Geological Survey

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8.2.4 Severity

The severity of an earthquake can be expressed in terms of intensity or magnitude. Intensity represents the effects of ground shaking on people, buildings and natural features. The USGS has created ground motion maps based on current information about several fault zones. These maps show the PGA that has a certain probability (2 percent or 10 percent) of being exceeded in a 50-year period. The PGA is measured in numbers of g's (the acceleration associated with gravity). Figure 8-9 shows the PGAs with a 2-percent exceedance chance in 50 years in Washington. The Covington area is a medium- to high-risk area.

Source: http://earthquake.usgs.gov/earthquakes/states/washington/hazards.php

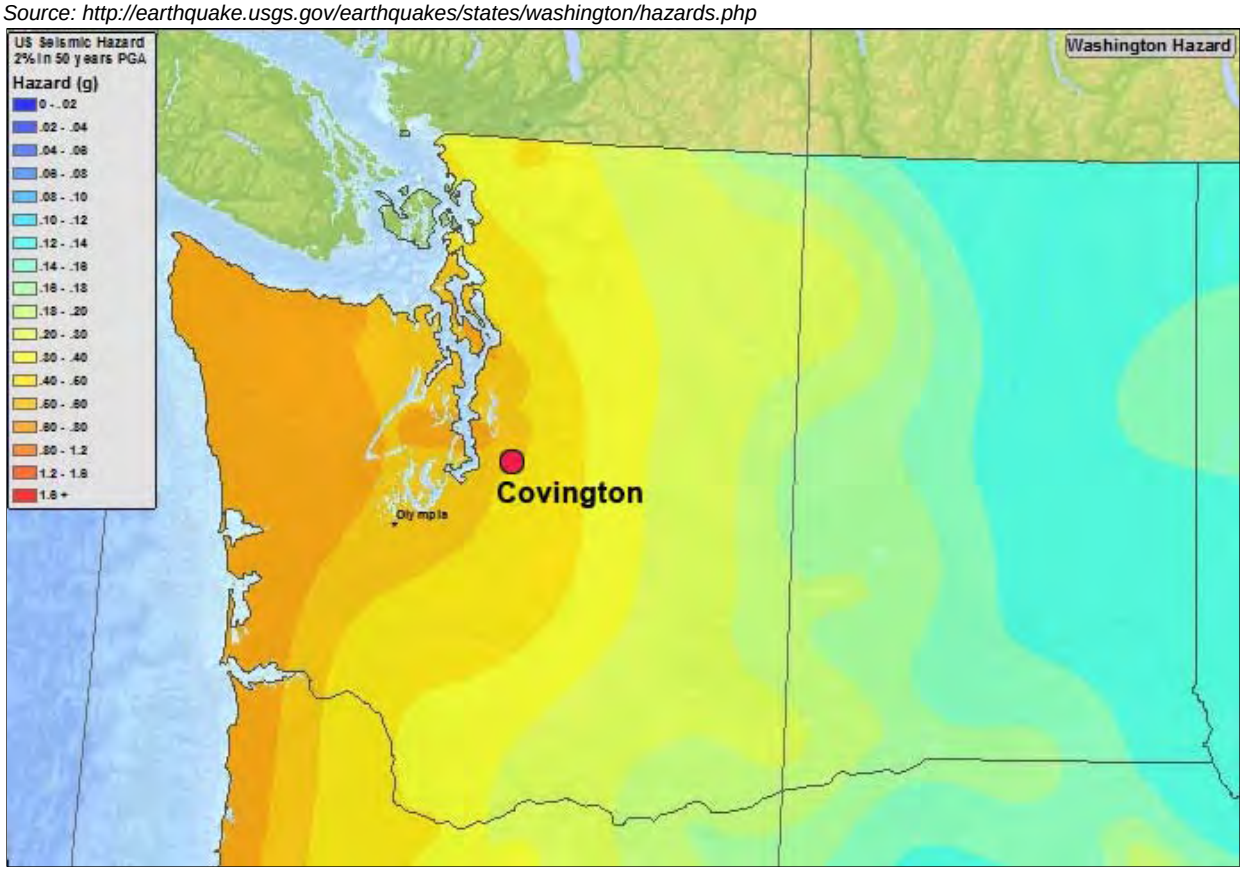


Figure 8-9. PGA with 2-Percent Probability of Exceedance in 50 Years, Washington State

Magnitude is related to the amount of seismic energy released at the hypocenter of an earthquake. It is determined by the amplitude of the earthquake waves recorded on instruments. Whereas intensity varies depending on location with respect to the earthquake epicenter, magnitude is represented by a single, instrumentally determined value for each earthquake event.

In simplistic terms, the severity of an earthquake event can be measured in the following terms:

- How hard did the ground shake?
- How did the ground move? (Horizontally or vertically)
- How stable was the soil?
- What is the fragility of the built environment in the area of impact?

8.2.5 Warning Time

There is currently no reliable way to predict the day or month that an earthquake will occur at any given location. Research is being done with warning systems that use the low energy waves that precede major earthquakes. These potential warning systems give approximately 40 seconds notice that a major earthquake is about to occur. The warning time is very short but it could allow for someone to get under a desk, step away from a hazardous material they are working with, or shut down a computer system.

8.3 SECONDARY HAZARDS

Earthquakes can cause large and sometimes disastrous landslides and mudslides. River valleys are vulnerable to slope failure, often as a result of loss of cohesion in clay-rich soils. Soil liquefaction occurs when water-saturated sands, silts or gravelly soils are shaken so violently that the individual grains lose contact with one another and float freely in the water, turning the ground into a pudding-like liquid. Building and road foundations lose load-bearing strength and may sink into what was previously solid ground. Unless properly secured, hazardous materials can be released, causing significant damage to the environment and people. Earthen dams and levees are highly susceptible to seismic events and the impacts of their eventual failures can be considered secondary risks for earthquakes. Disruptions in utility services including power, communication, gas, wastewater and potable water may also occur.

8.4 CLIMATE CHANGE IMPACTS

The impacts of global climate change on earthquake probability are unknown. Some scientists say that melting glaciers could induce tectonic activity. As ice melts and water runs off, tremendous amounts of weight are shifted on the earth's crust. As newly freed crust returns to its original, pre-glacier shape, it could cause seismic plates to slip and stimulate volcanic activity according to research into prehistoric earthquakes and volcanic activity. NASA and USGS scientists found that retreating glaciers in southern Alaska may be opening the way for future earthquakes (NASA, 2004).

Secondary impacts of earthquakes could be magnified by climate change. Soils saturated by repetitive storms could experience liquefaction or an increased propensity for slides during seismic activity due to the increased saturation. Dams storing increased volumes of water due to changes in the hydrograph could fail during seismic events. There are currently no models available to estimate these impacts.

8.5 EXPOSURE

The greatest concentration of earthquakes in Washington occurs in the Puget Sound lowlands and the western Cascade Range (longitudes 121.5 degrees and 123.0 degrees) and from about Olympia to the Canadian borders (latitudes 47.0 to 49.0 degrees). All of King County is included in this area. All parts and people of King County are vulnerable to all three types of Pacific Northwest earthquakes, including the residents and businesses in Covington.

8.5.1 Population

The entire population of the planning area is potentially exposed to direct and indirect impacts from earthquakes. The degree of exposure is dependent on many factors, including the age and construction type of the structures people live in, the soil type their homes are constructed on, their proximity to fault location, etc. Whether directly impacted or indirectly impact, the entire population will have to deal with the consequences of earthquakes to some degree. Business interruption could keep people from working, road closures could isolate populations, and loss of functions of utilities could impact populations that suffered no direct damage from an event itself.

8.5.2 Property

According to King County Assessor records, there are 5,884 buildings in the planning area, with a total assessed value of $2,849,591,000. Since all structures in the planning area are susceptible to earthquake impacts to varying degrees, this total represents the property exposure to seismic events. Most of the buildings (97.6 percent) are residential.

8.5.3 Critical Facilities and Infrastructure

All critical facilities in the planning area are exposed to the earthquake hazard. Table 5-3 and Table 5-4 list the number of each type of facility by jurisdiction. Hazardous materials releases can occur during an earthquake from fixed facilities or transportation-related incidents. Transportation corridors can be disrupted during an earthquake, leading to the release of materials to the surrounding environment. Facilities holding hazardous materials are of particular concern because of possible isolation of neighborhoods surrounding them. During an earthquake, structures storing these materials could rupture and leak into the surrounding area or an adjacent waterway, having a disastrous effect on the environment.

8.5.4 Environment

Secondary hazards associated with earthquakes will likely have some of the most damaging effects on the environment. Earthquake-induced landslides can significantly impact surrounding habitat. It is also possible for streams to be rerouted after an earthquake. This can change the water quality, possibly damaging habitat and feeding areas. There is a possibility of streams fed by groundwater drying up because of changes in underlying geology.

8.6 VULNERABILITY

8.6.1 Qualitative Assessment

Covington's vulnerability in the event of a major earthquake would be damage to the Highway 18 overpasses at Covington Way SE, SR 516, 180th Avenue SE and SE 256th Street. These are the main east-west and north-south transportation routes. Should the Lake Youngs Dam, just north of the City fail, major portions of Covington would quickly flood. A few residential areas may have landslides, placing some homes and occupants in jeopardy. The natural gas lines running north-south on the eastern part of the City may be subject to rupture. The following sections summarize the vulnerability of key facilities and services in Covington.

Dams

There is an earthen dam less than 2 miles north of Covington holding billions of gallons of water supply for the City of Seattle. Releases of water from this reservoir would cause high floodwaters in Covington. Seismic activity can compromise the dam structures, and the resultant downstream flooding would cause catastrophic flooding. The largest reservoir is Lake Youngs Dam-690 acres of surface area which drains into Little Soos Creek.

Buildings

The built environment is susceptible to damage from earthquakes. Buildings that collapse can trap and bury people. Lives are at risk and the cost to clean up the damage is great. In most Washington communities, including Covington, many buildings were built before 1993 when building codes were not as strict. In addition, retrofitting is not required except under certain conditions and can be expensive. The number of buildings at risk remains high. The Washington State Building Code Council revised its

construction standards for new buildings to make them more resistant to seismic events. Covington, which follows the State Building Codes, is within a seismic Zone 3 (0 = low and 4 = very high).

Infrastructure and Communication

Residents in Covington commute frequently by automobiles and public transportation such as buses. An earthquake can greatly damage bridges and roads, hampering the movement of people and goods. Damaged infrastructure strongly affects the economy of the community because it disconnects people from work, school, food and leisure, and separates businesses from their customers and suppliers.

Bridge Damage

Even modern bridges can sustain damage during earthquakes, leaving them unsafe for use. Some bridges have failed completely due to strong ground motion. Bridges are a vital transportation link -with even minor damage making some areas inaccessible. Because bridges vary in size, materials, siting and design; any given earthquake will affect them differently. Bridges built before the mid-1970s have a significantly higher risk of suffering structural damage during a moderate to large earthquake compared with those built after 1980 when design improvements were made.

Much of the interstate highway system was built in the mid to late 1960s. Most of the bridges in Covington are state-owned. A state-designated inspector must inspect all state bridges every two years, and the inspections are rigorous, looking at everything from seismic capability to erosion and scour. However, private bridges are not inspected, and can be very dangerous. There are four city-owned bridges in Covington that are inspected by King County every two years.

Upon inspection, the bridges are subject to a sufficiency score. This score uses a scale of 1 to 100 with 1 being the worst rating. The bridges are ranked throughout the state according to their score. The state then prioritizes the bridge repair according to each score. If the bridge receives a sufficiency score of less than 50, it is on the list for upgrading and rehabilitation. If it scores over 50, it is not included on the list. Small repairs to county bridges may be done in house, while larger projects require funding through the Highway Bridge Replacement and Rehabilitation program, which provides 80 percent of funding, with the state responsible for the remaining 20 percent.

Damage to Lifelines

Lifelines are the connections between communities and outside services. They include water and gas lines, transportation systems, electricity, and communication networks. Ground shaking and amplification can cause water, sewer, storm and gas pipes to break open, power lines to fall, roads and railways to crack or move, and radio and telephone communication to cease. Disruption to transportation makes it especially difficult to bring in supplies or services. Lifelines need to be usable after an earthquake to allow for rescue, recovery and rebuilding efforts and to relay important information to the public.

Disruption of Critical Services

Critical facilities include police stations, fire stations, hospitals, shelters, and other facilities that provide important services to the community. These facilities and their services need to be functional after an earthquake event. Many critical facilities are housed in older buildings that are not up to current seismic codes.

Businesses

Seismic activity can cause great loss to businesses; both large-scale corporations and small retail shops. When a company is forced to stop production for just a day, the economic loss can be tremendous,

especially when its market is at a national or global level. Seismic activity can create economic loss that presents a burden to large and small shop owners who may have difficulty recovering from their losses.

Individual Preparedness

A survey shows that about 39 percent of respondents think an earthquake will occur in Washington within the next 10 years. Only 28 percent of Washington residents say they are prepared for an earthquake, and 22 percent have earthquake insurance. In addition, only 24 percent correctly identified what to do during an earthquake.

Because the potential for earthquake occurrences and earthquake-related property damage is relatively high, increasing individual preparedness is a significant need. Strapping down heavy furniture, water heaters, and expensive personal property, as well as being earthquake insured, and anchoring buildings to foundations are just a few steps individuals can take to prepare for an earthquake.

Death and Injury

Death and injury can occur both indoors and outdoors due to collapsing buildings and falling equipment, furniture, debris or structural materials. Downed power lines and broken water and gas lines can also endanger human life.

Fire

Downed power lines or broken gas mains can trigger fires. When fire stations suffer building or lifeline damage, quick response to extinguish fires is less likely.

Debris

After damage to a variety of structures, much time is spent cleaning up brick, glass, wood, steel or concrete building elements, office and home contents, and other materials. Developing strong debris management strategies can assist in post-disaster recovery.

8.6.2 HAZUS Evaluation

Earthquake vulnerability data was generated using a Level 2 HAZUS-MH analysis. Once the location and size of a hypothetical earthquake are identified, HAZUS-MH estimates the intensity of the ground shaking, the number of buildings damaged, the number of casualties, the damage to transportation systems and utilities, the number of people displaced from their homes, and the estimated cost of repair and clean up.

8.6.3 Population

Impacts on persons and households in the planning area were estimated for the 100-year and 500-year earthquakes and the three scenario events through the Level 2 HAZUS-MH analysis. Table 8-4 summarizes the results.

8.6.4 Property

Building Age

Table 8-5 identifies significant milestones in building and seismic code requirements that directly affect the structural integrity of development. Using these time periods, the planning team used data provided by the King County assessor to identify the number of structures in the planning area by date of construction.

TABLE 8-4.
ESTIMATED EARTHQUAKE IMPACT ON PERSONS AND HOUSEHOLDS

	Number of Displaced Households	Number of Persons Requiring Short-Term Shelter
100-Year Earthquake	2	1
500-Year Earthquake	26	15
Seattle Fault M7.2 Event	7	4
South Whidbey Island M7.4 Event	0	0
Tacoma M7.1 Event	8	5

TABLE 8-5.
AGE OF STRUCTURES IN PLANNING AREA

Time Period	Number of Current Planning Area Structures Built in Period	Significance of Time Frame
Pre-1933	15	Before 1933, there were no explicit earthquake requirements in building codes. State law did not require local governments to have building officials or issue building permits.
1933-1940	4	In 1940, the first strong motion recording was made.
1941-1960	80	In 1960, the Structural Engineers Association of California published guidelines on recommended earthquake provisions.
1961-1975	1,529	In 1975, significant improvements were made to lateral force requirements.
1976-1994	2,373	In 1994, the Uniform Building Code was amended to include provisions for seismic safety.
1994—2009	1,751	Seismic code is currently enforced.
2010—present	132	
Total	**5,884**	

The number of structures does not reflect the number of total housing units, as many multi-family units and attached housing units are reported as one structure. Approximately 32 percent of the planning area's structures were constructed after the Uniform Building Code was amended in 1994 to include seismic safety provisions. Approximately 0.25 percent were built before 1933 when there were no building permits, inspections or seismic standards.

Loss Potential

Two types of property losses were estimated through the Level 2 HAZUS-MH analysis for the 100-year and 500-year earthquakes and the three scenario events:

- Structural loss, representing damage to building structures
- Non-structural loss, representing the value of lost contents.

Table 8-6 shows results for the two types of property loss and for the total of the two. A summary of the property-related loss results is as follows:

- For a 100-year probabilistic earthquake, the estimated damage potential is $17,054,976, or 0.60 percent of the total assessed value for the planning area.
- For a 500-year probabilistic earthquake, the estimated damage potential is $96,166,457, or 3.37 percent of the total assessed value for the planning area.
- For a 7.2-magnitude event on the Seattle Fault, the estimated damage potential is $60,765,274, or 2.13 percent of the total assessed value for the planning area.
- For a 7.4-magnitude event on the South Whidbey Island Fault, the estimated damage potential is $5,236,118, or 0.18 percent of the total assessed value for the planning area.
- For a 7.1-magnitude event on the Tacoma Fault, the estimated damage potential is $61,359,672, or 2.15 percent of the total assessed value for the planning area.

TABLE 8-6.
LOSS ESTIMATES FOR EARTHQUAKE

	Estimated Loss Associated with Earthquake		
	Structure	Contents	**Total**
100-Year Earthquake	$12,880,273	$4,174,703	**$17,054,976**
500-Year Earthquake	$72,646,564	$16,833,097	**$96,166,457**
Seattle Fault M7.2 Event	$43,932,177	$16,833,097	**$60,765,274**
South Whidbey Island M7.4 Event	$3,467,376	$1,768,741	**$5,236,118**
Tacoma M7.1 Event	$44,578,433	$16,781,240	**$61,359,672**

The HAZUS-MH analysis also estimated the amount of earthquake-caused debris in the planning area for the 100-year and 500-year earthquakes and the three scenario events, as summarized in Table 8-7.

TABLE 8-7.
ESTIMATED EARTHQUAKE-CAUSED DEBRIS

	Debris to Be Removed (tons)
100-Year Earthquake	3,878
500-Year Earthquake	26,927
Seattle Fault M7.2 Event	12,882
South Whidbey Island M7.4 Event	522
Tacoma M7.1 Event	13,336

8.6.5 Critical Facilities and Infrastructure

Level of Damage

HAZUS-MH classifies the vulnerability of critical facilities to earthquake damage in five categories: no damage, slight damage, moderate damage, extensive damage, or complete damage. The model was used to assign a vulnerability category to each critical facility in the planning area except hazmat facilities and "other infrastructure" facilities, for which there are no established damage functions. The analysis was performed for the 100-year event and the Tacoma Fault Scenario event, which have the highest probability of occurrence and the largest potential impact on the planning area. Table 8-8 and Table 8-9 summarize the results.

Time to Return to Functionality

HAZUS-MH estimates the time to restore critical facilities to fully functional use. Results are presented as probability of being functional at specified time increments: 1, 3, 7, 14, 30 and 90 days after the event. For example, HAZUS-MH may estimate that a facility has 5 percent chance of being fully functional at Day 3, and a 95-percent chance of being fully functional at Day 90. The analysis of critical facilities in the planning area was performed for the 100-year and the Tacoma Fault earthquake events. Table 8-10 and Table 8-11 summarize the results.

8.6.6 Environment

The environment vulnerable to earthquake hazard is the same as the environment exposed to the hazard.

8.7 FUTURE TRENDS IN DEVELOPMENT

The land use element of the City's comprehensive plan provides a long-range guide to physical development of the planning area. As one of the faster growing cities in Washington, Covington will need to manage growth in a way that accounts for impacts from potential earthquakes. With tools such as the Washington State Building Code and local critical areas ordinances that define seismic hazard areas, the City is prepared to deal with future growth.

The Covington Community Development Department is the local agency that enforces zoning codes pertaining to earthquake hazards through the Development Review Division. Standards for development are outlined in the Covington Zoning Ordinance, which discourages development in areas that could be prone to flooding, landslide, wildfire or seismic hazards, in favor of "letting such events naturally recur" to achieve "the beneficial effects that natural hazards can have on natural resources and the environment." Developers in potential hazard-prone areas are required to retain a professional engineer to evaluate level of risk onsite and recommend mitigation measures.

8.8 SCENARIO

An earthquake does not have to occur within the planning area to have a significant impact on the people, property and economy of Covington. Any seismic activity of 6.0 or greater on faults within the planning area's general region would have significant impacts throughout the planning area. Potential warning systems could give approximately 40 seconds' notice that a major earthquake is about to occur. This would not provide adequate time for preparation. Earthquakes of this magnitude or higher would lead to massive structural failure of property on NEHRP C, D, E, and F soils. Dams, levees and revetments built on these poor soils would likely fail, representing a loss of critical infrastructure. These events could cause secondary hazards, including landslides and mudslides that would further damage structures. River valley hydraulic-fill sediment areas are also vulnerable to slope failure, often as a result of loss of cohesion in clay-rich soils. Soil liquefaction would occur in water-saturated sands, silts or gravelly soils.

TABLE 8-8.
ESTIMATED DAMAGE TO CRITICAL FACILITIES FROM 100-YEAR EARTHQUAKE

Category[a]	No Damage	Slight Damage	Moderate Damage	Extensive Damage	Complete Damage
Medical and Health	0	15	0	0	**0**
Government Functions	0	3	0	0	**0**
Protective Functions	0	2	0	0	**0**
Schools	0	7	0	0	**0**
Other Critical Functions	0	14	0	0	**0**
Bridges	10	0	0	0	**0**
Water supply	5	0	2	0	**0**
Wastewater	7	0	0	0	**0**
Power	0	2	0	0	**0**
Communications	NA	NA	NA	NA	**NA**
Total	**21**	**45**	**0**	**0**	**0**

a. Vulnerability not estimated for hazmat facilities or for "other infrastructure" facilities due to lack of established damage functions for these type facilities.

TABLE 8-9.
ESTIMATED DAMAGE TO CRITICAL FACILITIES FROM TACOMA FAULT M7.1 SCENARIO

Category[a]	No Damage	Slight Damage	Moderate Damage	Extensive Damage	Complete Damage
Medical and Health	0	1	14	0	0
Government Functions	0	0	3	0	0
Protective Functions	0	0	2	0	0
Schools	0	1	5	1	0
Other Critical Functions	0	1	8	5	0
Bridges	11	0	0	0	0
Water supply	0	1	2	0	0
Wastewater	8	1	0	0	0
Power	0	0	2	0	0
Communications	NA	NA	NA	NA	NA
Total	**19**	**5**	**36**	**6**	**0**

a. Vulnerability not estimated for hazmat facilities or for "other infrastructure" facilities due to lack of established damage functions for these type facilities.

TABLE 8-10.
FUNCTIONALITY OF CRITICAL FACILITIES FOR 100-YEAR EVENT

Planning Unit	# of Critical Facilities	Probability of Being Fully Functional (%)					
		at Day 1	at Day 3	at Day 7	at Day 14	at Day 30	at Day 90
Medical and Health	14	4.6	5.9	60.4	61.7	86.3	91.6
Government Functions	3	4.6	5.9	60.3	61.6	86.2	91.6
Protective Functions	2	4.6	5.9	60.4	61.7	86.3	91.6
Schools	7	6.0	7.4	64.1	65.5	88.2	92.8
Other Critical functions	14	4.6	5.9	60.3	61.6	86.3	91.6
Bridges	10	98.1	98.7	98.9	98.9	99.0	99.5
Water supply	7	65.2	81.0	89.3	91.0	91.9	94.6
Wastewater	7	78.6	94.8	98.8	99.0	99.5	99.9
Power	2	63.2	88.2	97.5	99.2	99.8	99.9
Communications	0	NA	NA	NA	NA	NA	NA
Total/Average	**66**	**36.6**	**43.7**	**76.7**	**77.8**	**91.5**	**94.8**

TABLE 8-11.
FUNCTIONALITY OF CRITICAL FACILITIES FOR TACOMA FAULT M7.1 SCENARIO

Planning Unit	# of Critical Facilities	Probability of Being Fully Functional (%)					
		at Day 1	at Day 3	at Day 7	at Day 14	at Day 30	at Day 90
Medical and Health	15	0.4	0.9	24.5	25.1	54.3	67.0
Government Functions	3	0.4	1.0	25.3	25.9	53.3	67.9
Protective Functions	2	0.4	1.0	24.6	25.2	54.5	67.2
Schools	7	0.5	1.0	25.9	26.5	56.1	68.7
Other Critical functions	14	0.4	1.0	24.8	25.3	54.6	67.7
Bridges	11	95.9	97.4	98.2	98.3	98.4	99.1
Water supply	3	45.5	76.3	89.4	94.6	99.0	99.8
Wastewater	9	48.6	79.5	92.5	93.7	97.3	99.8
Power	2	37.4	67.0	88.7	95.1	98.6	99.9
Communications	0	NA	NA	NA	NA	NA	NA
Total/Average	**66**	**25.5**	**36.1**	**54.9**	**56.6**	**74.0**	**81.9**

8.9 ISSUES

Important issues associated with an earthquake include but are not limited to the following:

- More than two-thirds of the planning area's building stock was built prior to 1994, when seismic provisions became uniformly applied through building code applications.
- Critical facility owners should be encouraged to create or enhance continuity of operations plans using the information on risk and vulnerability contained in this plan.
- Geotechnical standards should be established that take into account the probable impacts from earthquakes in the design and construction of new or enhanced facilities.
- Earthquakes could trigger other natural hazard events such as dam failures and landslides, which could severely impact the planning area.
- There are likely additional faults in the area surrounding the City of Covington that have not yet been discovered.
- The City of Covington is in an area of King County that is less vulnerable than surrounding areas to extensive damage from earthquake events, with most of the City on soils that have a low to very-low susceptibility to liquefaction. After a major seismic event, the City is likely to experience a major influx of residents from surrounding communities that suffered more extensive damage.
- After a major seismic event, the City is likely to experience disruptions in the flow of goods and services due to the destruction of major transportation infrastructure across the broader region.
- Citizens are expected to be self-sufficient up to three days following a major earthquake without government response agencies, utilities, private sector services and infrastructure components. Education programs are currently in place to facilitate the development of individual, family, neighborhood and business earthquake preparedness. Government alone can never make this region fully prepared. It takes individuals, families and communities working in concert with one another to truly be prepared for disaster.
- Natural hazards have a devastating impact on businesses. Of all businesses that close following a disaster, more than 43 percent never reopen, and an additional 29 percent close for good within the next two years. The Institute of Business and Home Safety has developed "Open for Business," which is a disaster planning toolkit to help guide businesses in preparing for and dealing with the adverse effects of natural hazards. The kit integrates protection from natural disasters into companies' risk reduction measures to safeguard employees, customers, and the investment itself. The guide helps businesses secure human and physical resources during disasters, and helps to develop strategies to maintain business continuity before, during, and after a disaster occurs.

CHAPTER 9.
FLOOD

9.1 GENERAL BACKGROUND

A floodplain is the area adjacent to a river, creek or lake that becomes inundated during a flood. Floodplains may be broad, as when a river crosses an extensive flat landscape, or narrow, as when a river is confined in a canyon.

When floodwaters recede after a flood event, they leave behind layers of rock and mud. These gradually build up to create a new floor of the floodplain. Floodplains generally contain unconsolidated sediments (accumulations of sand, gravel, loam, silt, and/or clay), often extending below the bed of the stream. These sediments provide a natural filtering system, with water percolating back into the ground and replenishing groundwater. These are often important aquifers, the water drawn from them being filtered compared to the water in the stream. Fertile, flat reclaimed floodplain lands are commonly used for agriculture, commerce and residential development.

DEFINITIONS

Flood—The inundation of normally dry land resulting from the rising and overflowing of a body of water.

Floodplain—The land area along the sides of a river that becomes inundated with water during a flood.

100-Year Floodplain—The area flooded by a flood that has a 1-percent chance of being equaled or exceeded each year. This is a statistical average only; a 100-year flood can occur more than once in a short period of time. The 1-percent annual chance flood is the standard used by most federal and state agencies.

Return Period—The average number of years between occurrences of a hazard (equal to the inverse of the annual likelihood of occurrence).

Riparian Zone—The area along the banks of a natural watercourse.

Connections between a river and its floodplain are most apparent during and after major flood events. These areas form a complex physical and biological system that not only supports a variety of natural resources but also provides natural flood and erosion control. When a river is separated from its floodplain with levees and other flood control facilities, natural, built-in benefits can be lost, altered, or significantly reduced.

9.1.1 Measuring Floods and Floodplains

The frequency and severity of flooding are measured using a discharge probability, which is the probability that a certain river discharge (flow) level will be equaled or exceeded in a given year. Flood studies use historical records to determine the probability of occurrence for the different discharge levels. The flood frequency equals 100 divided by the discharge probability. For example, the 100-year discharge has a 1-percent chance of being equaled or exceeded in any given year. The “annual flood” is the greatest flood event expected to occur in a typical year. These measurements reflect statistical averages only; it is possible for two or more floods with a 100-year or higher recurrence interval to occur in a short time period. The same flood can have different recurrence intervals at different points on a river.

The extent of flooding associated with the base flood (the 100-year flood) is used as the regulatory boundary by many agencies. Also referred to as the special flood hazard area, this boundary is a convenient tool for assessing vulnerability and risk in flood-prone communities. Many communities have maps that show the extent and likely depth of flooding for the base flood. Corresponding water-surface elevations describe the elevation of water that will result from a given discharge level, which is one of the most important factors used in estimating flood damage.

9.1.2 Floodplain Ecosystems

Floodplains can support ecosystems that are rich in plant and animal species. A floodplain can contain 100 or even 1,000 times as many species as a river. Wetting of the floodplain soil releases an immediate surge of nutrients: those left over from the last flood, and those that result from the rapid decomposition of organic matter that has accumulated since then. Microscopic organisms thrive and larger species enter a rapid breeding cycle. Opportunistic feeders (particularly birds) move in to take advantage. The production of nutrients peaks and falls away quickly, but the surge of new growth endures for some time. This makes floodplains valuable for agriculture. Species growing in floodplains are markedly different from those that grow outside floodplains. For instance, riparian trees (trees that grow in floodplains) tend to be very tolerant of root disturbance and very quick-growing compared to non-riparian trees.

The City of Covington is within the Green River Watershed. This watershed contains three species of salmonids currently covered by the endangered species act and designated critical habitat. Big Soos Creek, Jenkins Creek and Covington Creek are all included in this designation (City of Covington, 2010).

9.1.3 Effects of Human Activities

Human activities tend to concentrate in floodplains for a number of reasons: water is readily available; land is fertile; transportation by water is easily accessible; and land is flatter and easier to develop. But human activity in floodplains frequently interferes with the natural function of floodplains. It can affect the distribution and timing of drainage, thereby increasing flood problems. Human development can create local flooding problems by altering or confining drainage channels. This increases flood potential in two ways: it reduces the stream's capacity to contain flows, and it increases flow rates or velocities downstream during all stages of a flood event. Human activities can interface effectively with a floodplain as long as steps are taken to mitigate the activities' adverse impacts on floodplain functions.

According to the City's Shoreline Inventory and Analysis report, there are two known shoreline modifications of Big Soos Creek within the city limits where the floodplain is restricted. Both modifications are associated with State Route (SR) 18 bridge spans (City of Covington, 2010). There are no known modifications to Jenkins Creek within the planning area (City of Covington, 2010).

9.1.4 Federal Flood Programs

National Flood Insurance Program

The National Flood Insurance Program makes federally backed flood insurance available to homeowners, renters and business owners in communities participating in the NFIP's regular or emergency program. Participants in the regular program must regulate development in floodplains to meet NFIP criteria. Before a permit can be issued to build in a floodplain, three criteria must be met:

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

Communities participating in the NFIP may adopt regulations that are more stringent than those contained in 44 CFR 60.3, but not less stringent. The Washington State Building Code Act requires new construction to be elevated to 1 foot above the base flood elevation or to the design flood elevation, whichever is higher.

For most participating communities, FEMA has prepared a detailed Flood Insurance Study that presents water surface elevations for the 100-year flood and the 500-year flood. Base (100-year) flood elevations and the boundaries of the 100- and 500-year floodplains are shown on Flood Insurance Rate Maps (FIRMs), which are the principle tool for identifying the extent and location of the flood hazard. FIRMs are the most detailed and consistent data source available, and for many communities they represent the minimum area of oversight under their floodplain management program. In participating communities, structures permitted or built in the planning area before NFIP and related building code regulations went into effect are called "pre-FIRM" structures, and structures built afterwards are called "post-FIRM." The insurance rate is different for the two types of structures.

The City of Covington participates in the NFIP's emergency program for communities where flood mapping has not yet been prepared. The City entered the emergency program on April 19, 2001. The emergency program provides limited flood insurance as long as the community has adopted minimal regulations for development in flood hazard areas. As of the date of this planning process, the City does not have an effective FIRM. After FEMA completes flood mapping and the City adopts more stringent ordinances related to the mapping results, Covington will be able to convert to the NFIP's regular program, with full flood insurance available.

The Community Rating System

The CRS is a voluntary program within the NFIP that encourages floodplain management activities that exceed the minimum NFIP requirements. Flood insurance premiums are discounted to reflect the reduced flood risk resulting from community actions meeting the three goals of the CRS:

- Reduce flood losses.
- Facilitate accurate insurance rating.
- Promote awareness of flood insurance.

For participating communities, flood insurance premium rates are discounted in increments of 5 percent. For example, a Class 1 community would receive a 45 percent premium discount, and a Class 9 community would receive a 5 percent discount. (Class 10 communities are those that do not participate in the CRS; they receive no discount.) The CRS classes for local communities are based on 18 creditable activities in the following categories:

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

CRS activities can help to save lives and reduce property damage. Communities participating in the CRS represent a significant portion of the nation's flood risk; over 66 percent of the NFIP's policy base is located in these communities. Communities receiving premium discounts through the CRS range from small to large and represent a broad mixture of flood risks, including both coastal and riverine flood risks. Figure 9-1 shows the nationwide number of CRS communities by class as of May 2012, when there were 1,211 communities receiving flood insurance premium discounts under the CRS program.

The City of Covington is not currently participating in the CRS program. Many of the mitigation actions identified in this plan are creditable activities under the CRS program. Therefore, successful implementation of this plan offers the potential to qualify for a CRS classification.

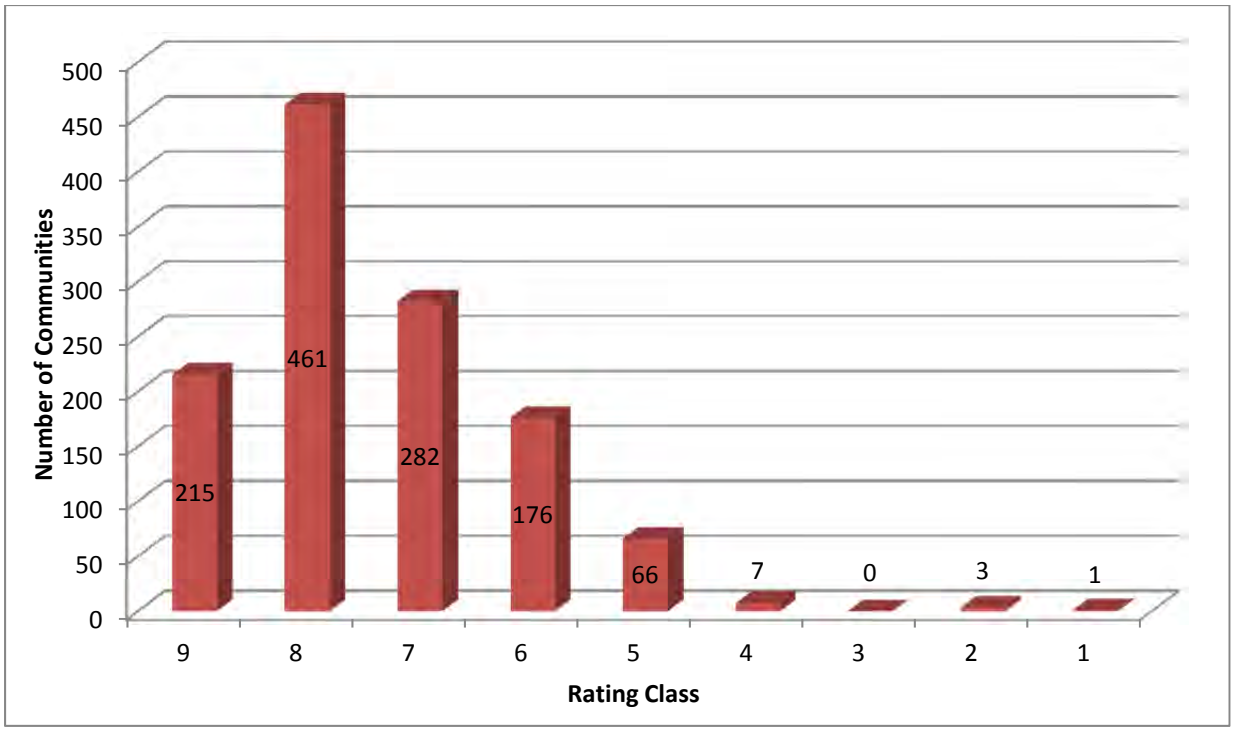


Figure 9-1. CRS Communities by Class Nationwide as of May 2012

9.2 HAZARD PROFILE

Two types of flooding primarily affect Covington:

- Riverine Flooding—Riverine flooding is the overbank flooding of rivers and streams. The natural processes of riverine flooding add sediment and nutrients to fertile floodplain areas. Flooding in large river systems typically results from large-scale weather systems that generate prolonged rainfall over a wide geographic area, causing flooding in hundreds of smaller streams, which then drain into the major rivers. Shallow area flooding is a special type of riverine flooding. FEMA defines shallow flood hazards as areas that are inundated by the 100-year flood with flood depths of only one to three feet. These areas are generally flooded by low velocity sheet flows of water.
- Urban Flooding—As land is converted from fields or woodlands to roads and parking lots, it loses its ability to absorb rainfall. Urbanization of a watershed changes the hydrologic systems of the basin. Heavy rainfall collects and flows faster on impervious concrete and asphalt surfaces. The water moves from the clouds, to the ground, and into streams at a much faster rate in urban areas. Adding these elements to the hydrological systems can result in floodwaters that rise very rapidly and peak with violent force. During periods of urban flooding, streets can become swift moving rivers and basements can fill with water. Storm drains often back up with vegetative debris causing additional, localized flooding.

In addition, any low-lying area has the potential to flood. The flooding of developed areas may occur when the amount of water generated from rainfall and runoff exceeds the capacity of a stormwater system (ditch or sewer) to remove it. The City of Covington has adopted the 2012 Stormwater Management Manual for Western Washington and the Puget Sound Partnership Low Impact Development Stormwater Practices. Adoption of these practices is intended to ensure the effectiveness of runoff controls at sites with new development, redevelopment or construction activities (City of Covington, 2013).

9.2.1 Past Events

King County Flood History

Table 9-1 summarizes flood events in King County since 1964. Some or all of these events may have impacted the City of Covington to some degree. Since 1990, 13 presidential-declared flood events in the planning area have caused in excess of $395 million in property damage. Property damage caused by all floods is much greater than the totals listed below. Damage estimates are not conducted unless the area is declared a federal disaster area.

TABLE 9-1.
HISTORY OF FLOOD EVENTS

Date	Declaration #	Type of event	Estimated Damage[a]
12/29/64	DR 185	Heavy rains, flooding	N/A
03/24/72	DR 328	Heavy rains, flooding	N/A
12/13/75	DR 492	Severe storms, flooding	N/A
12/10/77	DR 545	Severe storms, mudslides, flooding	N/A
12/31/79	DR 612	Storms, high tides, mudslides, flooding	N/A
01/16/86	DR 757	Severe storms, flooding	N/A
11/22/86	DR 784	Severe storms, flooding	N/A
01/06/90	DR 852	Flooding, severe storm	$17.8 million
11/09/90	DR 883	Flooding, severe storm	$57 million
12/20/90	DR 896	High tides, severe storm	$5.1 million
11/07/95	DR 1079	Storms, high winds, floods	$45.9 million
01/26/96	DR 1100	Severe storms, flooding	$113 million
12/26/96	DR 1159	Severe storms, flooding, landslides and mudslides	$83 million
03/18/97	DR 1172	Severe storms, flooding, landslides and mudslides	$6.5 million
10/15/03	DR 1499	Severe storms, flooding	$30 million
11/02/06	DR 1671	Severe storms, flooding, landslides and mudslides	$11.1 million
12/01/07	DR 1734	Severe storms, flooding, landslides and mudslides	$4.9 million
01/06/09	DR 1817	Severe winter storm, flooding, landslides and mudslides	$14 million
01/11/11	DR 1963	Severe winter storm, flooding, landslides and mudslides	N/A
01/14/12	DR 4056	Severe winter storm, flooding, landslides and mudslides	N/A

a. Data obtained from Spatial Hazard Events and Losses Database for the United States
N/A = Information is not available

The most recent presidential-declared flood disaster was the January 2012 severe winter storm. Airports, roads and schools were closed and more than 275,000 customers lost power across the state. Although estimates are not available for the direct economic costs to the City of Covington or King County, over $57.9 million in public assistance was distributed among the 11 affected counties (FEMA, 2012b).

Descriptions of other recent or particularly costly events are as follows:

- January 2011—The weeks leading up to this flood event featured a number of weather systems that left much of Western Washington with saturated soils, healthy snow packs and reservoirs at high levels. Widespread flooding across the Pacific Northwest resulted from rainfall and snowmelt initiated by warm, heavy precipitation. Flood damage resulted in numerous road closures, home evacuations and the inundation of low-lying lands (Washington Emergency Management Division, 2010).
- January 2009—A strong, warm and wet Pacific weather system brought significant rainfall to Washington during January 6-8, 2009. All counties of Western Washington lowlands received 3 to 8 inches of rain. The emergency alert system was activated as 22 Western Washington rivers exceeded the major flood category (Washington Emergency Management Division, 2010).
- In November 1995 and February 1996, storm fronts and melting snowpack caused massive flooding in Washington and Oregon. King County was one of 22 counties that were declared emergencies. All rivers monitored by King County Surface Water Management reached Phase 4 flood alerts. The Green River basin had erosion, flooding, slides and debris problems. At one point the City of Auburn's water supply was off line. Flooding along the Cedar River inundated the Renton airport, impacting airport operations and the Boeing Company. Reservoir storage at Howard Hanson Dam (75 percent) and Mud Mountain Dam (85 percent) was at the highest level on record. SR 169 and the West Valley Highway were closed during the flooding. Other roads were overtopped, isolating communities and causing damage.
- Floods from November 1990 through March 1991 led to a presidential disaster declaration. All river systems in King County reached flood stage, with most of the damage occurring in the Snoqualmie and Cedar River valleys. Flooding in early November swelled major rivers throughout Western Washington. Then on November 23, a heavy downpour of warm rain began to fall on a recent snowfall in the Cascades. The resulting runoff from melting snow and rain hit the already saturated floodplains on the next day, leading to the highest flows ever recorded on most of the rivers and streams draining the western slopes of the mountains. In some cases the flows were so high that stream gages reached their maximum height, unable to record any additional flow. More than $15 million in damage was done in King County alone. Nearly 900 homes were damaged or destroyed and two men drowned. Agricultural areas experienced heavy losses, as hundreds of cattle and other livestock drowned; equipment, feed and buildings were inundated. Dozens of roads were impassable during the flood, and numerous streets, bridges, levees and other public property were heavily damaged.

Covington Flood History

The following description of recent flood events was adapted from the City of Covington Comprehensive Plan Natural Hazard Mitigation Element.

The devastation brought about by the regional floods of February and November 1996 far surpassed the city's (then County's) normal seasonal flood events. The Covington area experienced small-scale flooding destruction during severe weather in February 1996. Prolonged precipitation accompanied by an early snowmelt caused very unstable soil conditions, resulting in many landslides and debris flows in the county. Little Soos Creek, Soos Creek, Jenkins Creek, and their tributaries swelled beyond the 100-year flood level, causing flooding in both rural and urban areas. Floodwaters caused significant damage to a large portion of the rural area in unincorporated King County at the confluence of Soos Creek and Little

Soos Creek. A significant amount of building damage was incurred by structures outside of identified flood hazard areas.

The damage to Covington businesses, residences and infrastructure was significant. The Covington Emergency Management Office estimated that the flood of February 1996 directly or indirectly affected three-quarters of the City's 12,000 residents. No known NFIP claims from Covington residences and businesses were filed, but these records may be combined with King County's records.

The City was hit with a major storm on November 10 and 11, 1996. The storm delivered at least 2.8 inches of rain in one night—a weather event that occurs an average of once every 205 years. Many of the rivers and smaller tributaries in the County quickly reached their flood levels, causing both urban and riverine flooding. Although the damage from this event was not as severe as the February floods, it did warrant road closures and the evacuation of homes in the 100-year floodplain. The 1996 floods caused a statewide loss in the millions of dollars.

9.2.2 Location

The Green/Duwamish and Central Puget Sound Watershed is divided into subwatersheds, and Covington is located in the Middle Green Subwatershed (King County Department of Natural Resources, 2009). The Middle Green River runs from the outlet of the Green River Gorge at about River Mile 45 near Flaming Geyser down to Auburn at about River Mile 31 (King County Flood Control District, 2010). The Green River does not pass through Covington, but three of its tributary streams do. All three streams flow north to south and feed the Soos Creek Basin:

- Big Soos Creek extends down the western border of Covington
- Little Soos creeks originates at Lake Youngs Dam and joins Big Soos Creek in the south of the City
- Jenkins Creek's headwaters are north of Pipe Lake and the creek eventually connects to Soos Creek south of the City.

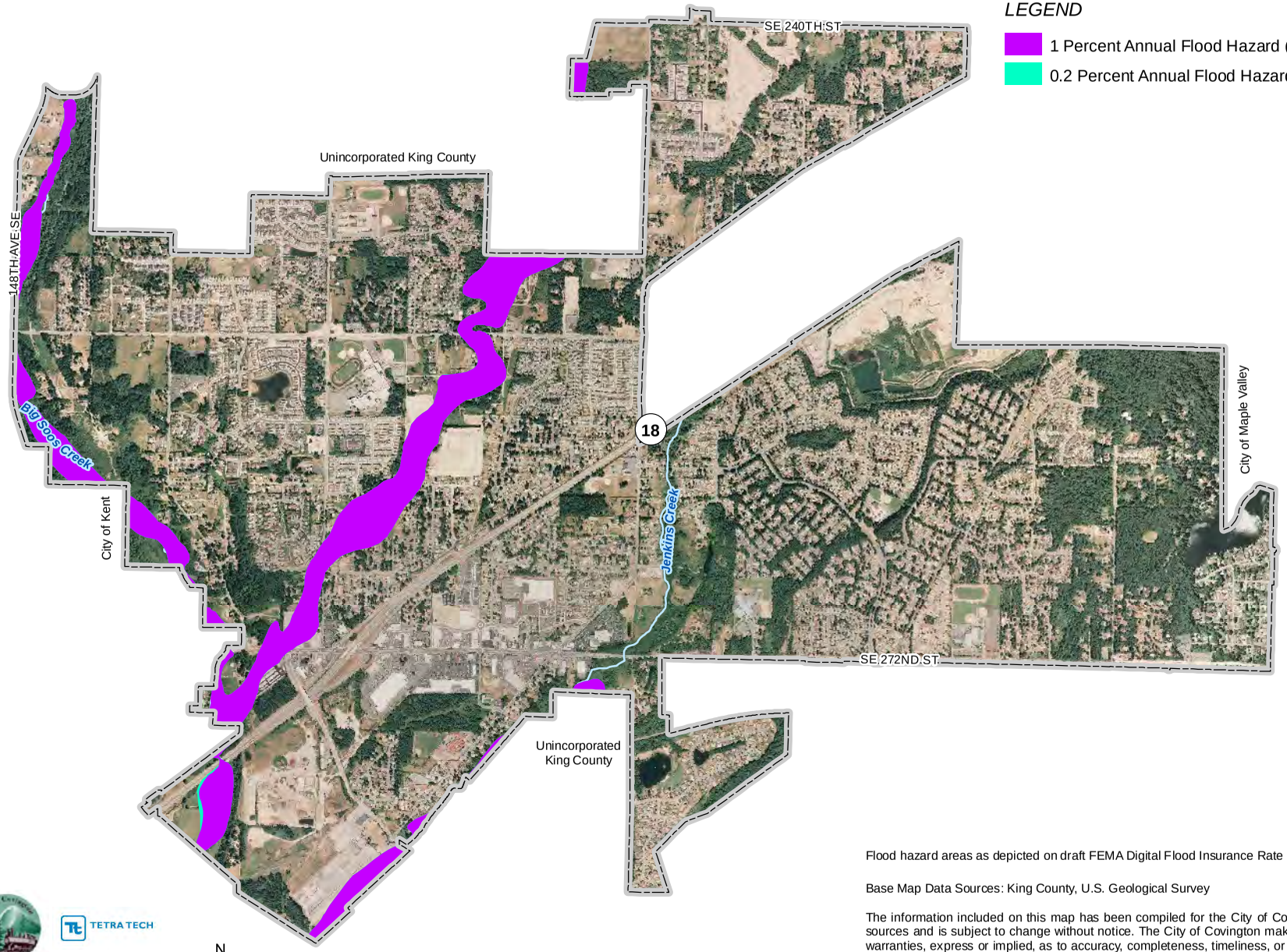
FEMA has mapped some flood areas on Little Soos Creek and Jenkins Creek south of SR 516. The mapping was unable to determine flood elevations north of SR 516 for Jenkins Creek. Some flood-prone areas are not mapped on FIRMs. These include locations next to small creeks, local drainage areas, and areas susceptible to manmade flooding. According to the Covington Comprehensive Plan, about 10 to 20 percent of all flood-related damage from past floods in Covington is located outside the boundaries of the FEMA's FIRMs. Flood hazard areas mapped by FEMA in Covington are shown on Figure 9-2.

9.2.3 Frequency

The planning area experiences episodes of river flooding almost every winter. Large floods that can cause property damage typically occur every 3 to 5 years. Urban portions of the planning area annually experience nuisance flooding related to drainage issues.

Flooding is most common from November through April, when storms from the Pacific Ocean, 60 miles away, bring intense rainfall to the area. Covington receives about 39 inches of rain on average each year. Most of the rainfall occurs in winter and spring from November to April. This results in high water, particularly in December and January. The larger floods are the result of heavy rains of two-day to five-day durations augmented by snowmelt at a time when the soil is near saturation from previous rains. Frozen topsoil also contributes to the frequency of floods.

Figure 9-2
FEMA-Mapped Flood Hazard Areas



Flood hazard areas as depicted on draft FEMA Digital Flood Insurance Rate Maps (DFIRM).

Base Map Data Sources: King County, U.S. Geological Survey

The information included on this map has been compiled for the City of Covington from a variety of sources and is subject to change without notice. The City of Covington makes no representations or warranties, express or implied, as to accuracy, completeness, timeliness, or rights to the use of such information. The City of Covington shall not be liable for any general, special, indirect, incidental, or consequential damages including, but not limited to, lost revenues or lost profits resulting from the use or misuse of the information contained on this map. Any sale of this map or information on this map is prohibited except by written permission of the City of Covington.

9.2.4 Severity

The principal factors affecting flood damage are flood depth and velocity. The deeper and faster flood flows become, the more damage they can cause. Shallow flooding with high velocities can cause as much damage as deep flooding with slow velocity. This is especially true when a channel migrates over a broad floodplain, redirecting high velocity flows and transporting debris and sediment. Flood severity is often evaluated by examining peak discharges; Table 9-2 lists peak flows used by FEMA to map the floodplains of the planning area.

TABLE 9-2.
SUMMARY OF PEAK DISCHARGES WITHIN THE PLANNING AREA

	Discharge (cubic feet/second)			
Source/Location	10-Year	50-Year	100-Year	500-Year
Big Soos Creek				
At USGS Gauge 12-112600	1,300	1,440	1,550	1,790
Below Covington Creek Confluence	870	1,110	1,190	1,380
Above Covington Creek Confluence	580	740	800	920
At S.E. 244th Street	150	200	220	260
At S.E. 208th Street	100	130	150	170
Little Soos Creek	200	250	280	320
Jenkins Creek	270	350	390	450

Floods can cause loss of life and great damage to structures, crops, land resources, flood control structures, roads, and utilities. Flood damage in King County and the State of Washington exceeds damage by all other natural hazards. These impacts result primarily from two types of hazards created by floods: inundation and bank erosion.

Inundation is defined as floodwater and debris flowing through an area. It can cause minor to severe damage, depending on the velocity of flows, the quantity of logs and other debris they carry, and the amount and type of development in the floodwater's path.

Bank erosion can threaten areas that are not inundated by floods. For example, a home on a high bank, above flood levels, can be undermined by the flood's erosive flows. The amount of erosion at a site depends on its location on the channel, flow velocities, the pattern of debris and sediment accumulation in the channel, and the erodibility of the bank. Some rivers, such as the Tolt, experience sudden and dramatic patterns of bank erosion that can create major course changes during a single flood event. To date this has not become a problem in Covington.

It is important to remember that dangers associated with flooding do not end when the rain stops. Electrocution, structural collapse, hazardous materials leaks, and fire are secondary hazards associated with flooding and flood cleanup.

Population growth leads to more development, which extends the amount of impermeable surfaces and therefore urban flooding risks are increased. However, in Covington development has been controlled to ensure a sound stormwater retention and release system.

9.2.5 Warning Time

Due to the extended precipitation needed to cause serious flooding, it is unusual for a flood to occur without warning. King County's flood-warning program warns of impending flooding on major rivers so residents and agencies can prepare before serious flooding occurs. In most locations, the warning system provides at least 2 hours of lead-time before floodwaters reach damaging levels. This is a phased warning program that has established response protocol for four phases of observed stream flow conditions:

- Phase I is an internal alert to King County staff.
- Phase II indicates minor flooding in some areas.
- Phase III indicates moderate flooding in some areas.
- Phase IV indicates major flooding in areas.

Flood phases indicate the severity of flooding and guide King County's response. Flood phases are issued independently for six major rivers. The thresholds for each phase are based on river gages that measure the flow and stage (depth) of the major rivers in various locations. Table 9-3 lists the peak flows by flood phase for each of the Green River watershed, which includes the City of Covington. While there is no direct phased warning system in place on riverine floodplains within the City, the City would receive early warning of potential flooding within the City from the Green River protocol listed above.

TABLE 9-3.
KING COUNTY FLOOD WARNING PHASE THRESHOLDS FOR THE GREEN RIVER WATERSHED

	Green River Actual or Expected Flow at Auburn
Flood Phase I	5,000 cubic feet/second
Flood Phase II	7,000 cubic feet/second
Flood Phase III	9,000 cubic feet/second
Flood Phase IV	12,000 cubic feet/second

9.3 SECONDARY HAZARDS

The most problematic secondary hazard for flooding is bank erosion, which in some cases can be more harmful than actual flooding. This is especially true in the upper courses of rivers with steep gradients, where floodwaters may pass quickly and without much damage, but scour the banks, edging properties closer to the floodplain or causing them to fall in. Flooding is also responsible for hazards such as landslides when high flows over-saturate soils on steep slopes, causing them to fail. Hazardous materials spills are also a secondary hazard of flooding if storage tanks rupture and spill into streams, rivers or storm sewers.

9.4 CLIMATE CHANGE IMPACTS

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

based tools must be developed, and a standard of practice that explicitly considers climate change must be adopted. Climate change is already impacting water resources, and resource managers have observed the following:

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

The amount of snow is critical for water supply and environmental needs, but so is the timing of snowmelt runoff into rivers and streams. Rising snowlines caused by climate change will allow more mountain area to contribute to peak storm runoff. High frequency flood event s (e.g. 10 -year floods) in particular will likely increase with a changing climate. Along with reductions in the amount of the snowpack and accelerated snowmelt, scientists project greater storm intensity, resulting in more direct runoff and flooding. Changes in watershed vegetation and soil moisture conditions will likewise change runoff and recharge patterns. As stream flows and velocities change, erosion patterns will also change, altering channel shapes and depths, possibly increasing sedimentation behind dams, and affecting habitat and water quality. With potential increases in the frequency and intensity of wildfires due to climate change, there is potential for more floods following fire, which increase sediment loads and water quality impacts.

As hydrology changes, what is currently considered a 100-year flood may strike more often, leaving many communities at greater risk. Planners will need to factor a new level of safety into the design, operation and regulation of flood protection facilities such as dams, bypass channels and levees, as well as the design of local sewers and storm drains.

9.5 EXPOSURE

The Level 2 HAZUS-MH protocol was used to assess the risk and vulnerability to flooding in the planning area. The model used census data at the block level and FEMA floodplain data, which has a level of accuracy acceptable for planning purposes. Where possible, the HAZUS-MH default data was enhanced using local GIS data from local, state and federal sources.

9.5.1 Population

Population counts of those living in the floodplain in the planning area were generated by analyzing census blocks that intersect with the 100-year and 500-year floodplains identified on FIRMs. Census blocks do not follow the boundaries of the floodplain. Therefore, the methodology used to generate these estimates counted census block groups whose centers are in the floodplain or where the majority of the population most likely lives in or near the floodplain. HAZUS-MH estimated the number of buildings within the floodplain in each block, and then estimated the total population by multiplying the number of residential structures by the average City of Covington household size of 3.02 persons per household.

Using this approach, it was estimated that the exposed population for the entire planning area is 76 within the 100-year floodplain (0.4 percent of the total planning area population) and 79 within the 500-year floodplain (0.4 percent of the total).

9.5.2 Property

Structures in the Floodplain

Table 9-4 summarizes the total area and number of structures in the floodplain. The HAZUS-MH model determined that there are 25 structures within the 100-year floodplain and 26 structures within the 500-year floodplain. In the 100-year floodplain, about 84 percent are residential, and 16 percent are commercial.

TABLE 9-4.
AREA AND NUMBER OF STRUCTURES IN THE FLOODPLAIN

	100-Year Floodplain	500-Year Floodplain
Area in Floodplain (acres)	213.44	214.49
Number of Structures in Floodplain	25	26
Residential	21	22
Commercial	4	4
Industrial	0	0
Agricultural	0	0
Religion	0	0
Government	0	0
Education	0	0
Total	**25**	**26**

Exposed Value

Table 9-5 summarizes the estimated value of exposed buildings in the planning area. This methodology estimated $10,146,190 worth of building-and-contents exposure to the 100-year flood, representing 0.36 percent of the total assessed value of the planning area, and $10,378,483 worth of building-and-contents exposure to the 500-year flood, representing 0.36 percent of the total.

TABLE 9-5.
VALUE OF STRUCTURES IN THE FLOODPLAIN

	100-Year Floodplain	500-Year Floodplain
Number of Buildings Exposed	25	26
Value Exposed		
Structure	$6,054,221	$6,209,083
Contents	$4,091,969	$4,169,400
Total	**$10,146,190**	**$10,378,483**
Exposed Value as % of Total Assessed Value	0.36%	0.36%

Land Use in the Floodplain

Some land uses are more vulnerable to flooding, such as single-family homes, while others are less vulnerable, such as agricultural land or parks. Table 9-6 shows the existing land use of all parcels in the 100-year and 500-year floodplain, including vacant parcels and those in public/open space uses, broken down for the planning area. About 32 percent of the parcels in the 100-year floodplain are currently vacant or public park spaces. The vast majority of parcels in or near the floodplain are zoned as urban separator or medium density residential. This zoning allows for additional development beyond that which is reflected by the current use.

TABLE 9-6.
LAND USE WITHIN THE FLOODPLAIN

	100-Year Floodplain		500-Year Floodplain	
Land Use	Area (acres)	% of total	Area (acres)	% of total
Church/Welfare/Religious Services	0.62	0.3%	0.62	0.3%
Duplex	92.93	45.2%	93.64	45.3%
Mini Warehouse	5.99	2.9%	5.99	2.9%
Mobile Home	13.93	6.8%	13.93	6.7%
Office Building	0.81	0.4%	0.81	0.4%
Public Park	0.51	0.2%	0.51	0.2%
Public Utility	16.05	7.8%	16.06	7.8%
Retail Store	3.41	1.7%	3.41	1.7%
Right of Way/Utility	0.45	0.2%	0.45	0.2%
River/Creek/Stream	5.12	2.5%	5.12	2.5%
Single Family	7.30	3.5%	7.31	3.5%
Vacant	53.07	25.8%	53.08	25.7%
No Present Land Use Indicated	5.62	2.7%	5.62	2.7%
Total	**205.81**	**100%**	**206.55**	**100%**

9.5.3 Critical Facilities and Infrastructure

Table 9-7 and Table 9-8 summarize the critical facilities and infrastructure in the 100-year and 500-year floodplains of the planning area. Details are provided in the following sections.

Tier II Facilities

Tier II facilities are those that use or store materials that can harm the environment if damaged by a flood. During a flood event, containers holding these materials can rupture and leak into the surrounding area, having a disastrous effect on the environment as well as residents. There was not sufficient data available to inventory these types of facilities within the floodplain. While the number of these facilities is anticipated to be small due to the small amount of floodplain within the City, this planning process has identified acquisition of this type of data as a future need.

TABLE 9-7.
CRITICAL FACILITIES IN THE FLOODPLAIN

	Number of Facilities in 100-Year Floodplain	Number of Facilities in 500-Year Floodplain
Medical and Health Services	0	**0**
Government Function	0	**0**
Protective	0	**0**
Hazardous Materials	0	**0**
Schools	0	**0**
Other	0	**0**
Total	**0**	**0**

TABLE 9-8.
CRITICAL INFRASTRUCTURE IN THE FLOODPLAIN

	Number of Facilities in 100-Year Floodplain	Number of Facilities in 500-Year Floodplain
Bridges	5	5
Water Supply	1	1
Wastewater	0	0
Power	1	1
Communications	0	0
Other	0	0
Total	**7**	**7**

Utilities and Infrastructure

It is important to determine who may be at risk if infrastructure is damaged by flooding. Roads or railroads that are blocked or damaged can isolate residents and can prevent access throughout the planning area, including for emergency service providers needing to get to vulnerable populations or to make repairs. Bridges washed out or blocked by floods or debris also can cause isolation. Water and sewer systems can be flooded or backed up, causing health problems. Underground utilities can be damaged. Dikes can fail or be overtopped, inundating the land that they protect. The following sections describe specific types of critical infrastructure.

Roads

The following major roads in the planning area pass through the 100-year floodplain:

- 164th Avenue SE
- Covington Way SE
- SE 256th Street
- SE 272nd Street
- State Route 18
- State Route 516

Some of these roads are built above the flood level, and others function as levees to prevent flooding. Still, in severe flood events these roads can be blocked or damaged, preventing access to some areas.

Bridges

Flooding events can significantly impact road bridges. These are important because often they provide the only ingress and egress to some neighborhoods. An analysis showed that there five bridges that are in or cross over the 100-year floodplain and five bridges in the 500-year floodplain.

Water and Sewer Infrastructure

Water and sewer systems can be affected by flooding. Floodwaters can back up drainage systems, causing localized flooding. Culverts can be blocked by debris from flood events, also causing localized urban flooding. Floodwaters can get into drinking water supplies, causing contamination. Sewer systems can be backed up, causing wastewater to spill into homes, neighborhoods, rivers and streams.

9.5.4 Environment

Flooding is a natural event, and floodplains provide many natural and beneficial functions. Nonetheless, with human development factored in, flooding can impact the environment in negative ways. Migrating fish can wash into roads or over dikes into flooded fields, with no possibility of escape. Pollution from roads, such as oil, and hazardous materials can wash into rivers and streams. During floods, these can settle onto normally dry soils, polluting them for agricultural uses. Human development such as bridge abutments and levees, and logjams from timber harvesting can increase stream bank erosion, causing rivers and streams to migrate into non-natural courses.

9.6 VULNERABILITY

9.6.1 Population

Floods can cause loss of life. Estimates are that roughly a dozen people have been killed by floods in King County since the turn of the century. The leading cause of flood-related deaths in King County is from motorists attempting to cross inundated roadways or ignoring road closure signs. No fatalities have been recorded within the City of Covington.

Impacts on persons and households in the planning area were estimated for the 100-year and 500-year flood events through the Level 2 HAZUS-MH analysis. Table 9-9 summarizes the results.

TABLE 9-9.
ESTIMATED FLOOD IMPACT ON PERSONS AND HOUSEHOLDS

	Number of Displaced Households	Number of Persons Requiring Short-Term Shelter
100-Year Flood	321	241
500-Year Flood	319	239

9.6.2 Property

HAZUS Results

HAZUS-MH calculates losses to structures from flooding by looking at depth of flooding and type of structure. Using historical flood insurance claim data, HAZUS-MH estimates the percentage of damage to structures and their contents by applying established damage functions to an inventory. For this analysis, local data on facilities was used instead of the default inventory data provided with HAZUS-MH.

The analysis is summarized in Table 9-10 for the 100-year and 500-year flood events. It is estimated that there would be up to $318,589 of flood loss from a 100-year flood event in the planning area. This represents 3.14 percent of the total exposure to the 100-year flood and 0.01 percent of the total assessed value for the planning area. It is estimated that there would be $2,992,507 of flood loss from a 500-year flood event, representing 28.83 percent of the total exposure to a 500-year flood event and 0.11 percent of the total assessed value.

TABLE 9-10.
LOSS ESTIMATES FOR FLOOD

	Structures Impacted[a]	Estimated Loss Associated with Flood			% of Total Assessed Value
		Structure	Contents	**Total**	
100-Year Flood Event	12	$195,286	$123,303	**$318,589**	0.01
500-Year Flood Event	25	$1,861,207	$1,131,300	**$2,992,507**	0.11

a. Impacted structures are those structures with finished floor elevations below the flood event water surface elevation. These structures are the most likely to receive significant damage in a flood event.

National Flood Insurance Program

Table 9-11 lists flood insurance statistics for the planning area. In the planning area there are seven flood insurance policies, providing $1.8 million in insurance coverage. According to FEMA statistics, no flood insurance claims were paid between January 1, 1978 and December 31, 2010.

TABLE 9-11.
FLOOD INSURANCE STATISTICS

Date of Entry Initial FIRM Effective Date	N/A[a]
# of Flood Insurance Policies as of 5/31/2013	7
Insurance In Force	$1,809,200
Total Annual Premium	$6,805
Claims, 11/1978 to 5/31/2013	0
Value of Claims paid, 11/1978 to 12/31/2010	N/A

a. Covington entered the emergency phase of the NFIP on 4/19/2001. As of the date of this planning process, the City does not have an effective FIRM.

Repetitive Loss

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

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

Repetitive loss properties make up only 1 to 2 percent of flood insurance policies in force nationally, yet they account for 40 percent of the nation's flood insurance claim payments. In 1998, FEMA reported that the NFIP's 75,000 repetitive loss structures have already cost $2.8 billion in flood insurance payments and that numerous other flood-prone structures remain in the floodplain at high risk. The government has instituted programs encouraging communities to identify and mitigate the causes of repetitive losses. A recent report on repetitive losses by the National Wildlife Federation found that 20 percent of these properties are outside any mapped 100-year floodplain. The key identifiers for repetitive loss properties are the existence of flood insurance policies and claims paid by the policies. As of this planning process, the City of Covington has no FEMA-identified repetitive loss properties.

FEMA-sponsored programs, such as the CRS, require participating communities to identify repetitive loss areas. A repetitive loss area is the portion of a floodplain holding structures that FEMA has identified as meeting the definition of repetitive loss. Identifying repetitive loss areas helps to identify structures that are at risk but are not on FEMA's list of repetitive loss structures because no flood insurance policy was in force at the time of loss. As of this planning process, the City of Covington has no FEMA-identified repetitive loss areas.

9.6.3 Critical Facilities and Infrastructure

HAZUS-MH was used to estimate the flood loss potential to critical facilities exposed to the flood risk. Using depth/damage function curves to estimate the percent of damage to the building and contents of critical facilities, HAZUS-MH correlates these estimates into an estimate of functional down-time (the estimated time it will take to restore a facility to 100 percent of its functionality). This helps to gauge how long the planning area could have limited usage of facilities deemed critical to flood response and recovery. The HAZUS critical facility results are as follows:

- **100-year flood event**—On average, critical facilities would receive 0.53 percent damage to the structure and 1.06 percent damage to the contents or inventory during a 100-year flood event. The estimated time to restore these facilities to 100 percent of their functionality is less than 180 days.
- **500-year flood event**—A 500-year flood event would damage the structures an average of 19.25 percent and the contents or inventory an average 32.3 percent. The estimated time to restore these facilities to 100 percent of their functionality after a 500-year event is less than 365 days.

9.6.4 Environment

The environment vulnerable to flood hazard is the same as the environment exposed to the hazard. Loss estimation platforms such as HAZUS-MH are not currently equipped to measure environmental impacts of flood hazards. The best gauge of vulnerability of the environment would be a review of damage from past flood events. Loss data that segregates damage to the environment was not available at the time of this plan. Capturing this data from future events could be beneficial in measuring the vulnerability of the environment for future updates.

9.7 FUTURE TRENDS

The City of Covington is equipped to handle future growth within flood hazard areas. Its comprehensive plan addresses frequently flooded areas. The City has committed to linking its comprehensive plan to this hazard mitigation plan. This will create an opportunity for wise land use decisions as future growth impacts flood hazard areas. Additionally, the City of Covington participates in the emergency program of the NFIP and is committed to adopting a flood damage prevention ordinance once FEMA prepares a Flood Insurance Rate Map for the City, enabling it to convert to the regular program of the NFIP.

Covington uses building codes, zoning codes and various planning strategies to restrict development in areas of known hazards and apply appropriate safeguards:

- All habitable floors for all development in the floodplain must be 1 foot above flood level, and developers must complete a floodplain development permit application as outlined in Covington Municipal Code.
- Subsections of the critical areas ordinance prohibit certain types of development in identified hazard areas. This affects all essential facilities, major structures, hazardous facilities and special occupancy structures.
- Urban buffers allowing minimal or zero development affect all development in areas that could be prone to flooding, landslide, wildfire and/or seismic hazards: Protection of Natural Features, Covington Development Standards; Shoreline Master Plan; and ESA best management practices.

In addition, current efforts to increase public open space in the City aim to preserve natural systems that help to mitigate flood events. Public parks and publicly owned open spaces can provide a buffer between flood hazards and private property. Preserved open space in the floodplain can help mitigate flood impacts by reducing the amount of allowable development in flood hazard areas. Preserving natural wetlands systems can assist in absorbing water during flood events and providing storage for treated effluent from wastewater treatment plants.

9.8 SCENARIO

The primary water courses in the planning area have the potential to flood at irregular intervals, generally in response to a succession of intense winter rainstorms. Storm patterns of warm, moist air usually occur between early November and late March. A series of such weather events can cause severe flooding in the planning area. The worst-case scenario is a series of storms that flood numerous drainage basins in a short time. This could overwhelm the response and floodplain management capability within the planning area. Major roads could be blocked, preventing critical access for many residents and critical functions. High in-channel flows could cause water courses to scour, possibly washing out roads and creating more isolation problems. In the case of multi-basin flooding, the City of Covington would not be able to make repairs quickly enough to restore critical facilities and infrastructure.

9.9 ISSUES

Citizens in Covington should understand the flood potential of areas in which they elect to live. Normally, floodplain information is available through City and County building permit offices (King County Department of Development and Environmental Services), and emergency management offices. By law, citizens purchasing property that is located in a floodplain must be notified of that fact. Flood insurance information is available from insurance agents throughout King County. However, only about 14 percent of homes in mapped floodplains are insured against flood losses.

The planning team has identified the following flood-related issues relevant to the planning area:

- It is unclear how potential climate change will impact flood conditions in the planning area.
- More information is needed on flood risk to support the concept of risk-based analysis of capital projects.
- There needs to be a sustained effort to gather historical damage data, such as high water marks on structures and damage reports, to measure the cost-effectiveness of future mitigation projects.

- Ongoing flood hazard mitigation will require funding from multiple sources.
- There needs to be a coordinated hazard mitigation effort between jurisdictions affected by flood hazards in the planning area.
- Floodplain residents need to continue to be educated about flood preparedness and the resources available during and after floods.
- The concept of residual risk should be considered in the design of future capital flood control projects and should be communicated with residents living in the floodplain.
- The promotion of flood insurance as a means of protecting private property owners from the economic impacts of frequent flood events should continue.
- The economy affects a jurisdiction's ability to manage its floodplains. Budget cuts and personnel losses can strain resources needed to support floodplain management.
- While flood risk has been identified as minimal within the City, significant flooding within King County will impact the City as residents from significantly impacted areas look for a place to evacuate. Covington's location, geography and access make it an ideal evacuation center for flood events within King and Pierce Counties. This could have a significant impact on City resources.
- More detailed information on Tier II hazardous material facilities within the floodplain is needed.

CHAPTER 10.
LANDSLIDE

10.1 GENERAL BACKGROUND

A landslide is a mass of rock, earth or debris moving down a slope. Landslides may be minor or very large, and can move at slow to very high speeds. They can be initiated by storms, earthquakes, fires, volcanic eruptions or human modification of the land.

DEFINITIONS

Landslide—The sliding movement of masses of loosened rock and soil down a hillside or slope. Such failures occur when the strength of the soils forming the slope is exceeded by the pressure, such as weight or saturation, acting upon them.

Mass Movement—A collective term for landslides, debris flows, and sinkholes.

Mudslide (or Mudflow or Debris Flow)—A river of rock, earth, and other materials saturated with water.

Mudslides (or mudflows or debris flows) are rivers of rock, earth, organic matter and other soil materials saturated with water. They develop in the soil overlying bedrock on sloping surfaces when water rapidly accumulates in the ground, such as during heavy rainfall or rapid snowmelt. Water pressure in the pore spaces of the material increases to the point that the internal strength of the soil is drastically weakened. The soil's reduced resistance can then easily be overcome by gravity, changing the earth into a flowing river of mud or "slurry." A debris flow or mudflow can move rapidly down slopes or through channels, and can strike with little or no warning at avalanche speeds. The slurry can travel miles from its source, growing as it descends, picking up trees, boulders, cars and anything else in its path. Although these slides behave as fluids, they pack many times the hydraulic force of water due to the mass of material included in them. Locally, they can be some of the most destructive events in nature.

Slides and earth flows can pose serious hazard to property in hillside terrain. They tend to move slowly and thus rarely threaten life directly. When they move—in response to such changes as increased water content, earthquake shaking, addition of load, or removal of downslope support—they deform and tilt the ground surface. The result can be destruction of foundations, offset of roads, breaking of underground pipes, or overriding of downslope property and structures.

10.1.1 Contributing Factors

All mass movements are caused by a combination of geological and climate conditions, as well as the encroaching influence of urbanization. Vulnerable natural conditions are affected by human residential, agricultural, commercial and industrial development and the infrastructure that supports it.

Landslides are caused by one or a combination of the following factors: change in slope of the terrain, increased load on the land, shocks and vibrations, change in water content, groundwater movement, frost action, weathering of rocks, and removing or changing the type of vegetation covering slopes. In general, landslide hazard areas are where the land has characteristics that contribute to the risk of the downhill movement of material, such as the following:

- A slope greater than 33 percent
- A history of landslide activity or movement during the last 10,000 years
- Stream or wave activity, which has caused erosion, undercut a bank or cut into a bank to cause the surrounding land to be unstable

- The presence or potential for snow avalanches
- The presence of an alluvial fan, indicating vulnerability to the flow of debris or sediments
- The presence of impermeable soils, such as silt or clay, which are mixed with granular soils such as sand and gravel.

Although landslides are a natural occurrence, human impacts can substantially affect the potential for landslide failures. Human influence has been identified in more than 80 percent of reported slides. Proper planning can be exercised to reduce the risks to safety, property and infrastructure. The sections below describe key factors associated with human development that can contribute to landslide risk.

Excavation and Grading

Slope excavation is common in the development of home sites or roads on sloping terrain. Grading these slopes can result in some slopes that are steeper than the pre-existing natural slopes. Since slope steepness is a major factor in landslides, these steeper slopes can be at an increased risk for landslides. The added weight of fill placed on slopes can also result in an increased landslide hazard. Small landslides can be fairly common along roads, in either the road cut or the road fill. Landslides occurring below new construction sites are indicators of the potential impacts stemming from excavation.

A study conducted by Portland State University found that changes to the slope through cutting or filling increased the risk of 76 percent of inventoried landslides in the Portland Metro region. The study documented 48 landslides that occurred in Oregon City in February 1996, and found that only about half the slides were considered natural.

Drainage and Groundwater Alterations

Water flowing through or above ground is often the trigger for landslides. Any activity that increases the amount of water flowing into landslide-prone slopes can increase landslide hazards. Broken or leaking water or sewer lines can be especially problematic, as can water retention facilities that direct water onto slopes. However, even lawn irrigation and minor alterations to small streams in landslide prone locations can result in damaging landslides. Ineffective storm water management and excess runoff can also cause erosion and increase the risk of landslide hazards. Drainage can be affected naturally by the geology and topography of an area. Development that results in an increase in impervious surface impairs the ability of the land to absorb water and may redirect water to other areas. Channels, streams, flooding and erosion on slopes all indicate potential slope problems.

Road and driveway drains, gutters, downspouts, and other constructed drainage facilities can concentrate and accelerate flow. Ground saturation and concentrated velocity flow are major causes of slope problems and may trigger landslides.

Changes in Vegetation

Removing vegetation from very steep slopes can increase landslide hazards. A storm impacts study conducted by the Oregon Department of Forestry found that landslide hazards in three out of four steeply sloped areas were highest for a period of roughly 10 years after timber harvesting. Areas that have experienced wildfire and land clearing for development may have long periods of increased landslide hazard. In addition, woody debris in stream channels (both natural and man-made from logging) may cause the impacts from debris flows to be more severe.

10.1.2 Landslide Types

Flows and slides are commonly categorized by the form of initial ground failure. Figure 10-1 through Figure 10-4 show common types of slides. The most common is the shallow colluvial slide, occurring particularly in response to intense, short-duration storms. The largest and most destructive are deep-seated slides, although they are less common than other types.

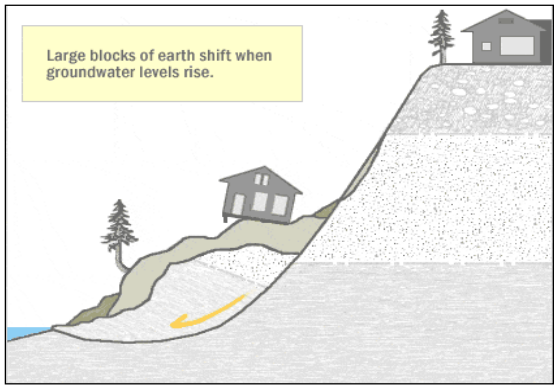


Figure 10-1. Deep Seated Slide

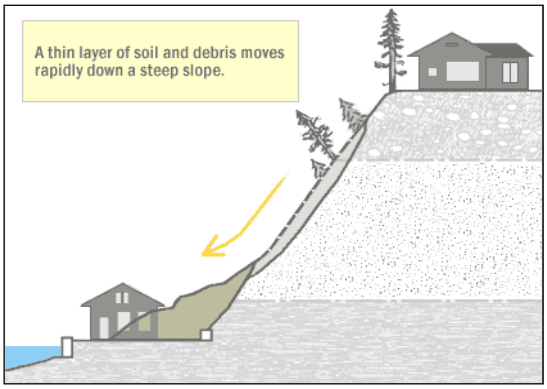


Figure 10-2. Shallow Colluvial Slide

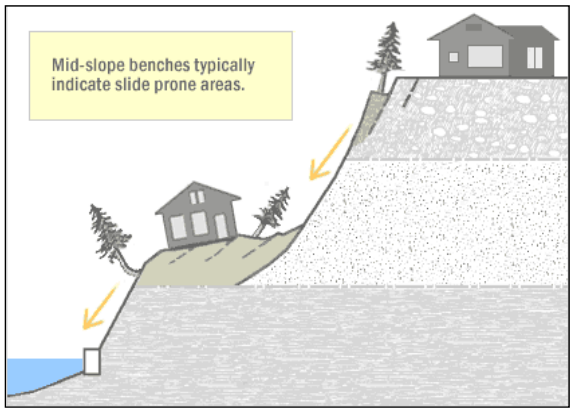


Figure 10-3. Bench Slide

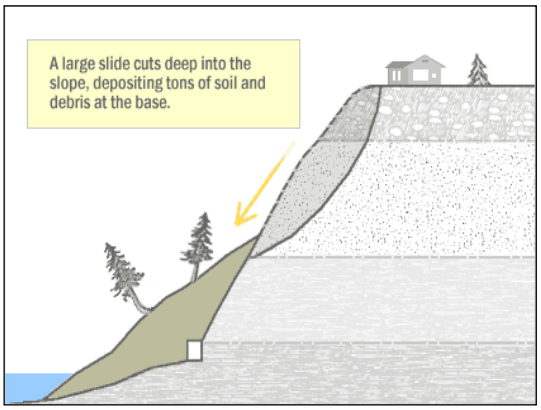


Figure 10-4. Large Slide

10.2 HAZARD PROFILE

The soil covering much of King County was left behind by the Vashon Glacier and is prone to slides. The top layer, Vashon Till, is a stable mix of rocks, dirt, clay and sand that has the consistency of concrete and can be found to depths up to 30 feet. The next layer, Esperance Sand, is a permeable mixture of sand and gravel. This sits upon an impermeable layer of clay, Lawton Clay, made up of fine sediments and large boulders. It is this boundary between the clay and sand in which sliding occurs; water percolates through the sand and runs laterally on top of the denser clay. The buildup of water pressure floats the sand above the clay, creating lubrication for a deep-seated slide.

10.2.1 Past Events

There is little recorded information regarding landslides in the planning area. There are no records in the planning area of fatalities attributed to mass movement. However, deaths have occurred across the Western U.S. as a result of slides and slope collapses.

Recent landslides occurred as secondary hazards associated with severe storms in the Puget Sound region in December 1996 and January 1997. Heavy snow storms were followed by a warming trend that caused quick melting, runoff and flooding. This period was then followed by rain. This led to over 100 slides in King County over the subsequent two month period. Major slides causing damage included:

- A slide along Auburn's Black Diamond Road closed the road for months. Magnolia Bridge supports were knocked out by a slide measuring 300 feet across. The estimated cost of repair is $5 million. (Unrelated slides in Bremerton closed two bridges.)
- A slide in Snohomish near the King County border pushed five freight cars into Puget Sound, debris covered 200 feet of railroad track and extended 900 feet into the water.
- Train service was canceled for two days over Steven's Pass when a 75-foot wide landslide covered the railroad tracks 6 miles east of Skykomish. It was discovered when a freight train struck the debris and was derailed. (This stretch of track normally sees 24 trains a day).
- Major slides caused evacuations throughout the County including Perkins Lane in the Magnolia neighborhood, Avondale Road in Northeast Redmond, Delridge, and West Seattle.

King County was also hard hit by landslide damage in 1972. Damage resulting from numerous landslides totaled $1.8 million. Seventy percent of the slides occurred over a two day period in which more than 1.75 inches of rain fell in 24 hours. To make matters worse, this period was preceded by a cold spell, which lowered the absorption capabilities of the soil.

10.2.2 Location

Although landslides can and do occur in almost any part of the state, the most vulnerable areas are the Puget Sound Basin and King County. Due to the high population density and the fact that many structures are built either on top of or below bluffs and slopes subject to landslides, more lives are endangered and there is a greater potential for damage or destruction to private and public property. Many of the major valleys and shoreline bluffs of Puget Sound are bordered by steeply sloping unconsolidated glacial deposits that are highly susceptible to landslides. Other vulnerable areas include the Cascade Mountain passes leading to eastern Washington. There are no similar formations within Covington.

Covington has few areas that are prone to landslides. Homes in a few residential neighborhoods may be vulnerable to landslides. Only a few roads appear to be subject to minor slide damage. Some surface roads and railroad tracks on the outskirts of the City limits could be vulnerable to minor slides.

In the northwestern portion of Covington, weathering and the decomposition of geologic materials produces conditions conducive to landslides. Human activity has further exacerbated the landslide problem in many parts of the city.

The best available predictor of where movement of slides and earth flows might occur is the location of past movements. Past landslides can be recognized by their distinctive topographic shapes, which can remain in place for thousands of years. Most landslides recognizable in this fashion range from a few acres to several square miles. Most show no evidence of recent movement and are not currently active. A small proportion of them may become active in any given year, with movements concentrated within all or part of the landslide masses or around their edges.

The recognition of ancient dormant mass movement sites is important in the identification of areas susceptible to flows and slides because they can be reactivated by earthquakes or by exceptionally wet weather. Also, because they consist of broken materials and frequently involve disruption of groundwater flow, these dormant sites are vulnerable to construction-triggered sliding.

Identifying hazardous locations is an essential step towards implementing more informed mitigation activities. The Washington Department of Natural Resources Geology and Earth Resources Division is active in developing maps and collecting data on hazard risk. Figure 10-5 shows the landslide hazard areas in the planning area. This map shows areas that are in moderate and high debris flow hazard areas using slope, geology, and soil type as determinates. The Covington Planning Division uses percent slope as an indicator of hill slope stability. The city uses a 20 percent or greater threshold to identify potentially unstable steep slopes. Figure 10-6 shows mapped slope stability.

10.2.3 Frequency

Landslides are often triggered by other natural hazards such as earthquakes, heavy rain, floods or wildfires, so landslide frequency is often related to the frequency of these other hazards. In the planning area, landslides typically occur during and after major storms, so the potential for landslides largely coincides with the potential for sequential severe storms that saturate steep, vulnerable soils. Landslide events occurred during the winter storms of 2006 and 1997. According to records kept by the Spatial Hazard Events and Losses Database for the United States, the planning area has been impacted by severe storms at least once every other year since 1960. Until better data is generated specifically for landslide hazards, this severe storm frequency is appropriate for the purpose of ranking risk associated with the landslide hazard.

In general, landslides are most likely during periods of higher than average rainfall. The ground must be saturated prior to the onset of a major storm for significant landslides to occur. Most local landslides occur in January after the water table has risen during the wet months of November and December.

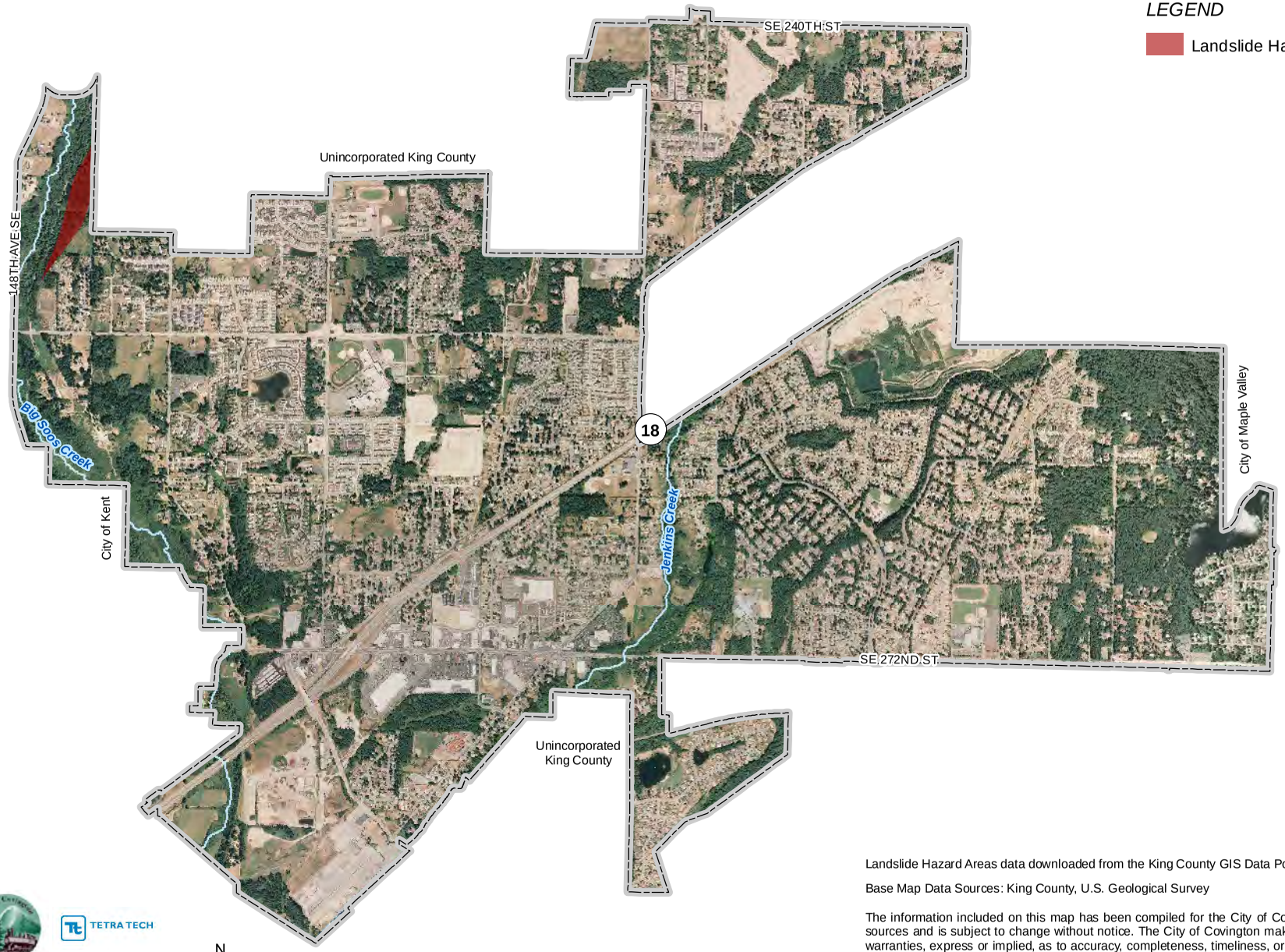
The Washington Department of Transportation spends millions of dollars each year to repair damage caused by slope failures. These slope failures vary from a few rocks falling on to the highway, which work crews can remove in minutes, to a major landslide, that may require months of work and millions of dollars to correct. Some slopes fail year after year; others fail once in 50 years.

10.2.4 Severity

Slope failures in the United States result in an average of 25 lives lost per year and an annual cost to society of about $1.5 billion. Typical effects include damage or destruction of portions of roads and railroads, sewer and water lines, homes and public buildings. Disruption of shipping and travel routes result in losses to commerce. Many of the losses due to landslides may go unrecorded because no claims are made to insurance companies, lack of coverage by the press, or the fact that transportation network slides may be listed in records simply as “maintenance.” Even small scale landslides are expensive due to clean up costs that may include debris clearance from streets, drains, streams and reservoirs; new or renewed support for road and rail embankments and slopes; minor vehicle and building damage; personal injury; livestock, timber, crop and fencing losses and damaged utility systems.

Landslides in Covington are a localized hazard. For example, sediment generated by the slides can affect regional water quality. During a recent winter, a segment of the hillside on the east side of Soos Creek liquefied and move toward the creek, destroying a segment of the park trail. Many landslides are difficult to mitigate, particularly in areas of large historical movement with weak underlying geologic materials. As the city continues to modify the terrain and influence natural processes, it is important to be aware of the physical properties of the underlying bedrock as it, along with climate, dictates hazardous terrain. Without proper planning, landslides will continue to threaten the safety of people, property and infrastructure.

Figure 10-5
Landslide Hazard Areas



TETRA TECH

0 0.25 0.5 Miles

N W E S

Landslide Hazard Areas data downloaded from the King County GIS Data Portal.

Base Map Data Sources: King County, U.S. Geological Survey

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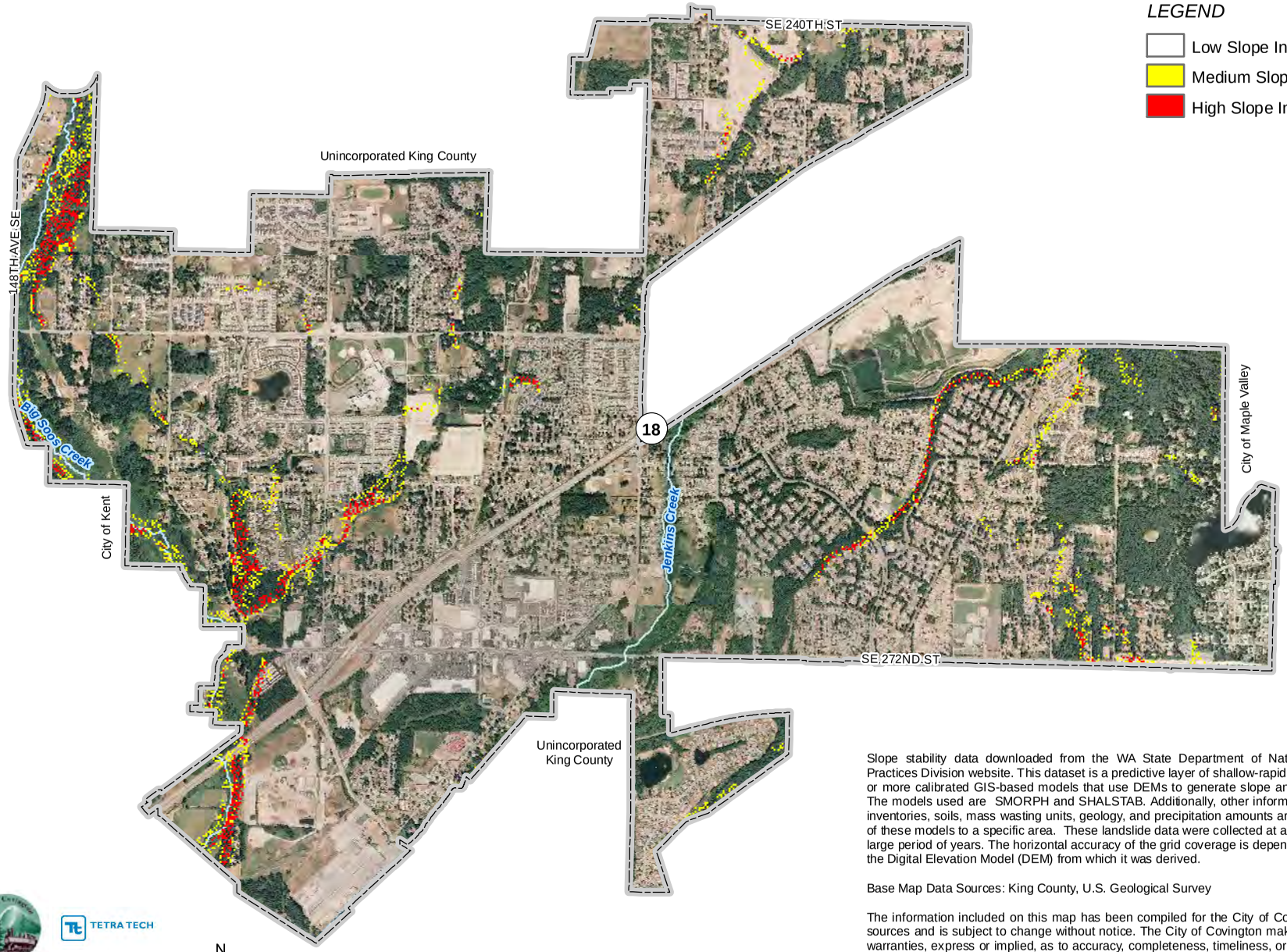
Figure 10-6
Slope Stability



Slope stability data downloaded from the WA State Department of Natural Resources, Forest Practices Division website. This dataset is a predictive layer of shallow-rapid slope stability using one or more calibrated GIS-based models that use DEMs to generate slope and curvature information. The models used are SMORPH and SHALSTAB. Additionally, other information, such as landslide inventories, soils, mass wasting units, geology, and precipitation amounts are used in the calibration of these models to a specific area. These landslide data were collected at a variety of scales, over a large period of years. The horizontal accuracy of the grid coverage is dependent on the resolution of the Digital Elevation Model (DEM) from which it was derived.

Base Map Data Sources: King County, U.S. Geological Survey

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TETRA TECH

0 0.25 0.5 Miles

N W E S

Large losses incurred from landslide hazards in Covington have been associated with roads. The Covington Planning and Public Works Department is responsible for responding to slides that inhibit the flow of traffic or are damaging a road or a bridge. It is not feasible to mitigate all slides because of limited funds and the fact that some historical slides are likely to become active again even with mitigation measures. The city Operations and Maintenance Division alleviates problem areas by grading slides, and by installing new drainage systems on the slopes to divert water from the landslides. This type of response activity is often the most cost-effective in the short-term, but is only temporary.

The impact of closed transportation arteries is increased if the closed road or bridge is critical for hospitals and other emergency facilities. Therefore, inspection and repair of critical transportation facilities and routes is essential and should receive high priority. Losses of power and phone service are also potential consequences of landslide events. Due to heavy rains, soil erosion in hillside areas can be accelerated, resulting in loss of soil support beneath high voltage transmission towers in hillsides and remote areas. Flood events can also cause landslides, which can have serious impacts on gas lines that are located in vulnerable soils.

10.2.5 Warning Time

Mass movements can occur suddenly or slowly. The velocity of movement may range from a slow creep of inches per year to many feet per second, depending on slope angle, material and water content. Some methods used to monitor mass movements can provide an idea of the type of movement and the amount of time prior to failure. It is also possible to determine what areas are at risk during general time periods. Assessing the geology, vegetation and amount of predicted precipitation for an area can help in these predictions. However, there is no practical warning system for individual landslides. The current standard operating procedure is to monitor situations on a case-by-case basis, and respond after the event has occurred. Generally accepted warning signs for landslide activity include:

- Springs, seeps, or saturated ground in areas that have not typically been wet before
- New cracks or unusual bulges in the ground, street pavements or sidewalks
- Soil moving away from foundations
- Ancillary structures such as decks and patios tilting and/or moving relative to the main house
- Tilting or cracking of concrete floors and foundations
- Broken water lines and other underground utilities
- Leaning telephone poles, trees, retaining walls or fences
- Offset fence lines
- Sunken or down-dropped road beds
- Rapid increase in creek water levels, possibly accompanied by increased turbidity (soil content)
- Sudden decrease in creek water levels though rain is still falling or just recently stopped
- Sticking doors and windows, and visible open spaces indicating jambs and frames out of plumb
- A faint rumbling sound that increases in volume as the landslide nears
- Unusual sounds, such as trees cracking or boulders knocking together.

10.3 SECONDARY HAZARDS

Landslides can cause several types of secondary effects, such as blocking access to roads, which can isolate residents and businesses and delay commercial, public and private transportation. This could result in economic losses for businesses. Other potential problems resulting from landslides are power and communication failures. Vegetation or poles on slopes can be knocked over, resulting in possible losses to power and communication lines. Landslides also have the potential of destabilizing the foundation of structures, which may result in monetary loss for residents. They also can damage rivers or streams, potentially harming water quality, fisheries and spawning habitat.

10.4 CLIMATE CHANGE IMPACTS

Climate change may impact storm patterns, increasing the probability of more frequent, intense storms with varying duration. Increase in global temperature could affect the snowpack and its ability to hold and store water. Warming temperatures also could increase the occurrence and duration of droughts, which would increase the probability of wildfire, reducing the vegetation that helps to support steep slopes. All of these factors would increase the probability for landslide occurrences.

10.5 EXPOSURE

10.5.1 Population

Population could not be examined by landslide hazard area because census block group areas do not coincide with the hazard areas. A population estimate was made using the structure count of buildings within the landslide hazard areas and applying the census value of 3.02 persons per household for the City of Covington. Using this approach, the estimated population living mapped landslide hazard areas is 51. This represents less than 1 percent of the population in the planning area.

10.5.2 Property

Table 10-1 shows the number and assessed value of structures exposed to the landslide risk. There are 17 structures on parcels in the landslide risk areas, with an estimated value of $5,656,435. These structures are predominantly residential structures. Table 10-2 shows the general land use of parcels exposed to landslides in the planning area.

TABLE 10-1.
EXPOSURE AND VALUE OF STRUCTURES IN LANDSLIDE RISK AREAS

Number of Buildings Exposed	17
Value Exposed	
Structure	$3,724,289
Contents	$1,932,146
Total	**$5,656,435**
Exposed Value as % of Total Assessed Value	0.2%

TABLE 10-2.
LAND USE IN LANDSLIDE RISK AREAS

Land Use	Area in Landslide Risk Area (acres)	% of total
Single Family Residential	2.6	4%
Mortuary/Cemetery/Crematory	3.88	6%
Public Park	61.21	90%
Total	**67.69**	**100%**

10.5.3 Critical Facilities and Infrastructure

Table 10-3 summarizes the critical facilities exposed to the landslide hazard. No loss estimation of these facilities was performed due to the lack of established damage functions for the landslide hazard.

TABLE 10-3.
CRITICAL FACILITIES AND INFRASTRUCTURE IN LANDSLIDE RISK AREAS

	Number of Exposed Critical Facilities in Risk Area
Medical and Health Services	0
Government Function	0
Protective Function	0
Schools	0
Hazmat	0
Other Critical Function	0
Bridges	0
Water	1
Wastewater	0
Power	0
Communications	0
Total	**1**

A significant amount of infrastructure can be exposed to mass movements:

- **Roads**—Access to major roads is crucial to life-safety after a disaster event and to response and recovery operations. Landslides can block egress and ingress on roads, causing isolation for neighborhoods, traffic problems and delays for public and private transportation. This can result in economic losses for businesses.
- **Bridges**—Landslides can significantly impact road bridges. Mass movements can knock out bridge abutments or significantly weaken the soil supporting them, making them hazardous for use.
- **Power Lines**—Power lines are generally elevated above steep slopes, but the towers supporting them can be subject to landslides. A landslide could loosen soil underneath a tower, causing it to collapse and ripping down the lines. Power and communication failures due to landslides can create problems for vulnerable populations and businesses.

10.5.4 Environment

Environmental problems as a result of mass movements can be numerous. Landslides that fall into streams may significantly impact fish and wildlife habitat, as well as affecting water quality. Hillsides that provide wildlife habitat can be lost for prolong periods of time due to landslides.

10.6 VULNERABILITY

10.6.1 Population

In general, all of the estimated 51 persons exposed to higher risk landslide areas are considered to be vulnerable. Increasing population and the fact that many homes are built on view property atop or below bluffs and on steep slopes subject to mass movement, increases the number of lives endangered by this hazard.

10.6.2 Property

Although complete historical documentation of the landslide threat in the planning area is lacking, the landslides of 1997 and 2006 suggest a significant vulnerability to such hazards. The millions of dollars in damage attributable to mass movement during those storms affected private property and public infrastructure and facilities.

Loss estimations for the landslide hazard are not based on modeling utilizing damage functions, because no such damage functions have been generated. Instead, loss estimates were developed representing 10 percent, 30 percent and 50 percent of the assessed value of exposed structures. This allows emergency managers to select a range of economic impact based on an estimate of the percent of damage to the general building stock. Damage in excess of 50 percent is considered to be substantial by most building codes and typically requires total reconstruction of the structure. Table 10-4 shows the general building stock loss estimates in landslide risk areas.

TABLE 10-4.
POTENTIAL LOSS ESTIMATES FOR LANDSLIDE

Exposed Value	$1,628,780
Potential Loss from Landslide	
10% Damage	$162,878
30% Damage	$488,634
50% Damage	$814,390

10.6.3 Critical Facilities and Infrastructure

There is only one identified critical facility in the planning area that is exposed to landslide risk. A more in-depth analysis of the mitigation measures taken by this facility to prevent damage from mass movements should be done. Although only one critical facility in the planning area is exposed, there may be exposed facilities outside the planning area whose failure could impact residents and the provision of critical services. For example, the City is served by several water and wastewater districts whose jurisdictions do not coincide with those of the City. The services provided by these districts may be impacted by landslide movements outside of Covington city limits. Additionally, regional transportation networks may be exposed to mass movement events. Although these events might occur outside the city, residents and business could be affected.

10.6.4 Environment

The environment vulnerable to landslide hazard is the same as the environment exposed to the hazard.

10.7 FUTURE TRENDS IN DEVELOPMENT

The City of Covington is equipped to handle future growth within landslide hazard areas. Its comprehensive plan addresses landslide risk areas. The City has committed to linking its comprehensive plan to this hazard mitigation plan. This will create an opportunity for wise land use decisions as future growth impacts landslide hazard areas.

10.7.1 Covington City Zoning Code

Covington addresses development on steep slopes in subsection Title 21A the Zoning Code and Title 15 the Construction Code. These sections outline standards for steep slope hazard areas on slopes of 20 percent or more. Generally, the ordinance requires soils and engineering geologic studies for developments proposed on slopes of 20 percent or greater. More detailed surface and subsurface investigations shall be warranted if indicated by engineering and geologic studies to sufficiently describe existing conditions. This may include soils, vegetation, geologic formations, and drainage patterns. Site evaluations may also occur where proposed grading/filling or land clearing might lessen stability.

10.7.2 Community Hazard Mapping

The City intends to develop a consistent and comprehensive community landslide hazard map of the city. This hazard mapping project will expand on the earthquake-induced hazard mapping to include other likely initiation mechanisms (such as heavy rainfall). Complementary products to accompany the hazard map include a landslide inventory database (building on previous efforts) and a digital compilation of known landslide topography. The combination of these digital data sets should be extremely valuable for local geologists, engineers, planners, and policy makers interested in addressing landslide hazards and developing targeted end efficient mitigation programs.

10.8 SCENARIO

Major landslides in the planning area occur as a result of soil conditions that have been affected by severe storms, groundwater or human development. The worst-case scenario for landslide hazards in the planning area would generally correspond to a severe storm that had heavy rain and caused flooding. Landslides are most likely during late winter when the water table is high. After heavy rains from November to December, soils become saturated with water. As water seeps downward through upper soils that may consist of permeable sands and gravels and accumulates on impermeable silt, it will cause weakness and destabilization in the slope. A short intense storm could cause saturated soil to move, resulting in landslides. As rains continue, the groundwater table rises, adding to the weakening of the slope. Gravity, poor drainage, a rising groundwater table and poor soil exacerbate hazardous conditions.

Mass movements are becoming more of a concern as development moves outside of city centers and into areas less developed in terms of infrastructure. Most mass movements would be isolated events affecting specific areas. It is probable that private and public property, including infrastructure, will be affected. Mass movements could affect bridges that pass over landslide prone ravines and knock out rail service through the planning area. Road obstructions caused by mass movements would create isolation problems for residents and businesses in sparsely developed areas. Property owners exposed to steep slopes may suffer damage to property or structures. Landslides carrying vegetation such as shrubs and trees may cause a break in utility lines, cutting off power and communication access to residents.

Continued heavy rains and flooding will complicate the problem further. As emergency response resources are applied to problems with flooding, it is possible they will be unavailable to assist with landslides occurring all over the planning area.

10.9 ISSUES

Landslides are often a secondary hazard related to other natural disasters. Landslide triggering rainstorms often produce damaging floods. Earthquakes often induce landslides that can cause additional damage. The identification of areas susceptible to landslides is necessary to support grading, building, foundation design, housing density, and other land development regulations in reducing the risk of property damage and personal injury. The most significant effect of landslides is the disruption of transportation and the destruction of private and public property. Some work has been done to prevent developments on top of or below slopes subject to sliding. Much more needs to be done to educate the public and to prevent development in vulnerable areas.

Important issues associated with landslides in the planning area include the following:

- There are existing homes in landslide risk areas throughout the planning area. The degree of vulnerability of these structures depends on the codes and standards the structures were constructed to. Information to this level of detail is not currently available.
- Future development could lead to more homes in landslide risk areas.
- Mapping and assessment of landslide hazards are constantly evolving. As new data and science become available, assessments of landslide risk should be reevaluated.
- The impact of climate change on landslides is uncertain. If climate change impacts atmospheric conditions, then exposure to landslide risks is likely to increase.
- Landslides may cause negative environmental consequences, including water quality degradation.
- The risk associated with the landslide hazard overlaps the risk associated with other hazards such as earthquake, flood and wildfire. This provides an opportunity to seek mitigation alternatives with multiple objectives that can reduce risk for multiple hazards.

CHAPTER 11.
SEVERE WEATHER

11.1 GENERAL BACKGROUND

Severe weather refers to any dangerous meteorological phenomena with the potential to cause damage, serious social disruption, or loss of human life. It includes thunderstorms, downbursts, tornadoes, waterspouts, snowstorms, ice storms and dust storms.

Severe weather can be categorized into two groups: systems that form over wide geographic areas are classified as general severe weather; those with a more limited geographic area are classified as localized severe weather. Severe weather, technically, is not the same as extreme weather, which refers to unusual weather events at the extremes of the historical distribution for a given area.

Covington is subject to various local storms that affect the Pacific Northwest throughout the year. Most common in the area are damaging winds (including tornado), thunderstorms and severe winter storms.

11.1.1 Damaging Winds

Damaging winds are classified as those exceeding 60 mph. Damage from such winds accounts for half of all severe weather reports in the lower 48 states and is more common than damage from tornadoes. Wind speeds can reach up to 100 mph and can produce damage over hundreds of miles. There are seven types of damaging winds:

- **Straight-line winds**—Any thunderstorm wind that is not associated with rotation; this term is used mainly to differentiate from tornado winds. Most thunderstorms produce some straight-line winds as a result of outflow generated by the thunderstorm downdraft.
- **Downdrafts**—A small-scale column of air that rapidly sinks toward the ground.
- **Downbursts**—A strong downdraft with horizontal dimensions larger than 2.5 miles resulting in an outward burst or damaging winds on or near the ground. Downburst winds may begin as a microburst and spread out over a wider area, sometimes producing damage similar to a strong tornado. Although usually associated with thunderstorms, downbursts can occur with showers too weak to produce thunder.

DEFINITIONS

Freezing Rain—The result of rain occurring when the temperature is below the freezing point. The rain freezes on impact, resulting in a layer of glaze ice up to an inch thick. In a severe ice storm, an evergreen tree 60 feet high and 30 feet wide can be burdened with up to six tons of ice, creating a threat to power and telephone lines and transportation routes.

Severe Local Storm—Small-scale atmospheric systems, including tornadoes, thunderstorms, windstorms, ice storms and snowstorms. These storms may cause a great deal of destruction and even death, but their impact is generally confined to a small area. Typical impacts are on transportation infrastructure and utilities.

Thunderstorm—A storm featuring heavy rains, strong winds, thunder and lightning, typically about 15 miles in diameter and lasting about 30 minutes. Hail and tornadoes are also dangers associated with thunderstorms. Lightning is a serious threat to human life. Heavy rains over a small area in a short time can lead to flash flooding.

Tornado—Funnel clouds that generate winds up to 500 miles per hour. They can affect an area up to three-quarters of a mile wide, with a path of varying length. Tornadoes can come from lines of cumulonimbus clouds or from a single storm cloud. They are measured using the Fujita Scale, ranging from F0 to F5.

Windstorm—A storm featuring violent winds. Southwesterly winds are associated with strong storms moving onto the coast from the Pacific Ocean. Southern winds parallel to the coastal mountains are the strongest and most destructive winds. Windstorms tend to damage ridgelines that face into the winds.

Winter Storm—A storm having significant snowfall, ice, and/or freezing rain; the quantity of precipitation varies by elevation.

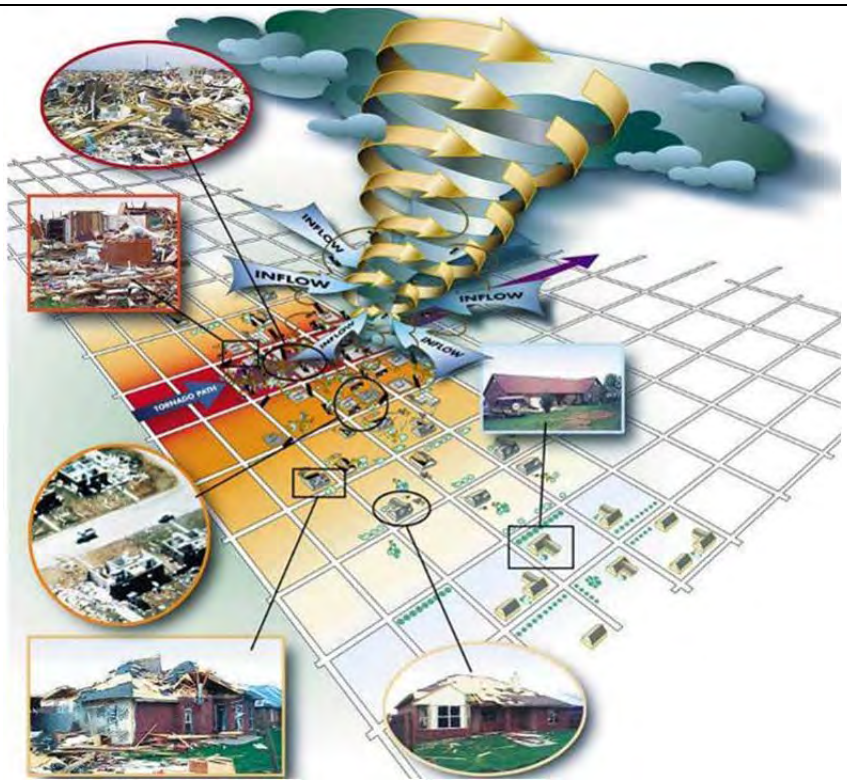
- **Microbursts**—A small concentrated downburst that produces an outward burst of damaging winds at the surface. Microbursts are generally less than 2.5 miles across and short-lived, lasting only 5 to 10 minutes, with maximum wind speeds up to 168 mph. There are two kinds of microbursts: wet and dry. A wet microburst is accompanied by heavy precipitation at the surface. Dry microbursts, common in places like the high plains and the intermountain west, occur with little or no precipitation reaching the ground.
- **Gust front—**A gust front is the leading edge of rain-cooled air that clashes with warmer thunderstorm inflow. Gust fronts are characterized by a wind shift, temperature drop, and gusty winds out ahead of a thunderstorm. Sometimes the winds push up air above them, forming a shelf cloud or detached roll cloud.
- **Derecho**—A derecho is a widespread thunderstorm wind caused when new thunderstorms form along the leading edge of an outflow boundary (the boundary formed by horizontal spreading of thunderstorm-cooled air). The word "derecho" is of Spanish origin and means "straight ahead." Thunderstorms feed on the boundary and continue to reproduce. Derechos typically occur in summer when complexes of thunderstorms form over plains, producing heavy rain and severe wind. The damaging winds can last a long time and cover a large area.
- **Bow Echo**—A bow echo is a linear wind front bent outward in a bow shape. Damaging straight-line winds often occur near the center of a bow echo. Bow echoes can be 200 miles long, last for several hours, and produce extensive wind damage at the ground.

A tornado is a violently rotating column of air extending between, and in contact with, a cloud and the surface of the earth. Tornadoes are often (but not always) visible as a funnel cloud. On a local-scale, tornadoes are the most intense of all atmospheric circulations and wind can reach destructive speeds of more than 300 mph. A tornado's vortex is typically a few hundred meters in diameter, and damage paths can be up to 1 mile wide and 50 miles long. Figure 11-1, adapted from FEMA, illustrates the potential impacts and damage from tornadoes of different magnitude. Tornadoes can occur throughout the year at any time of day but are most frequent in the spring during the late afternoon.

As shown in Figure 11-2, Washington has a relatively low tornado risk compared to states in the Midwestern and Southern U.S. Washington has experienced tornadoes on occasion, some of which have produced significant damage and occasionally injury or death. Washington's tornadoes can be formed in association with large Pacific storms arriving from the west. Most of them however, are caused by intense local thunderstorms. These storms also produce lightning, hail and heavy rain, and are more common during the warm season from April to October.

11.1.2 Winter Weather

Snowstorms or blizzards, which are snowstorms accompanied by blowing wind or drifting snow, occur occasionally in King County. Snowstorms can be associated with other natural hazards such as flooding and landslides, given the right conditions. An ice storm can occur when rain falls out of warm moist upper layer of atmosphere into a cold, dry layer near the ground. The rain freezes on contact with the cold ground and accumulates on exposed surfaces. If this is accompanied by wind, damage can occur to trees and utility wires. Hailstorms occur when freezing water in thunderstorm type clouds accumulate in layers around an icy core. Wind added to hail can batter crops, structures and transportation systems.



Managing Risk	Damage Color Code	Description of Damage
The Threat to Property and Personal Safety Can Be Minimized Through Compliance With Up-To-Date Model Building Codes and Engineering Standards		Some damage can be seen to poorly maintained roofs. Unsecured light-weight objects, such as trash cans, are displaced.
		Minor damage to roofs and broken windows occur. Larger and heavier objects become displaced. Minor damage to trees and landscaping can be observed.
Property and Personal Protection Can Be Improved Through Wind Hazard Mitigation Techniques Not Normally Required by Current Building Codes		Roofs are damaged, including the loss of shingles and some sheathing. Manufactured homes, on nonpermanent foundations can be shifted off their foundations. Trees and landscaping either snap or are blown over. Medium-sized debris becomes airborne, damaging other structures.
		Roofs and some walls, especially unreinforced masonry, are torn from structures. Small ancillary buildings are often destroyed. Manufactured homes on nonpermanent foundations can be overturned. Some trees are uprooted.
Personal Protection Can Only Be Achieved Through Use of a Specially Designed Extreme Wind Refuge Area, Shelter, or Safe Room		Well constructed homes, as well as manufactured homes, are destroyed, and some structures are lifted off their foundations. Automobile-sized debris is displaced and often tumbles. Trees are often uprooted and blown over.
		Strong frame houses and engineered buildings are lifted from their foundations or are significantly damaged or destroyed. Automobile-sized debris is moved significant distances. Trees are uprooted and splintered.

Figure 11-1. Potential Impact and Damage from a Tornado

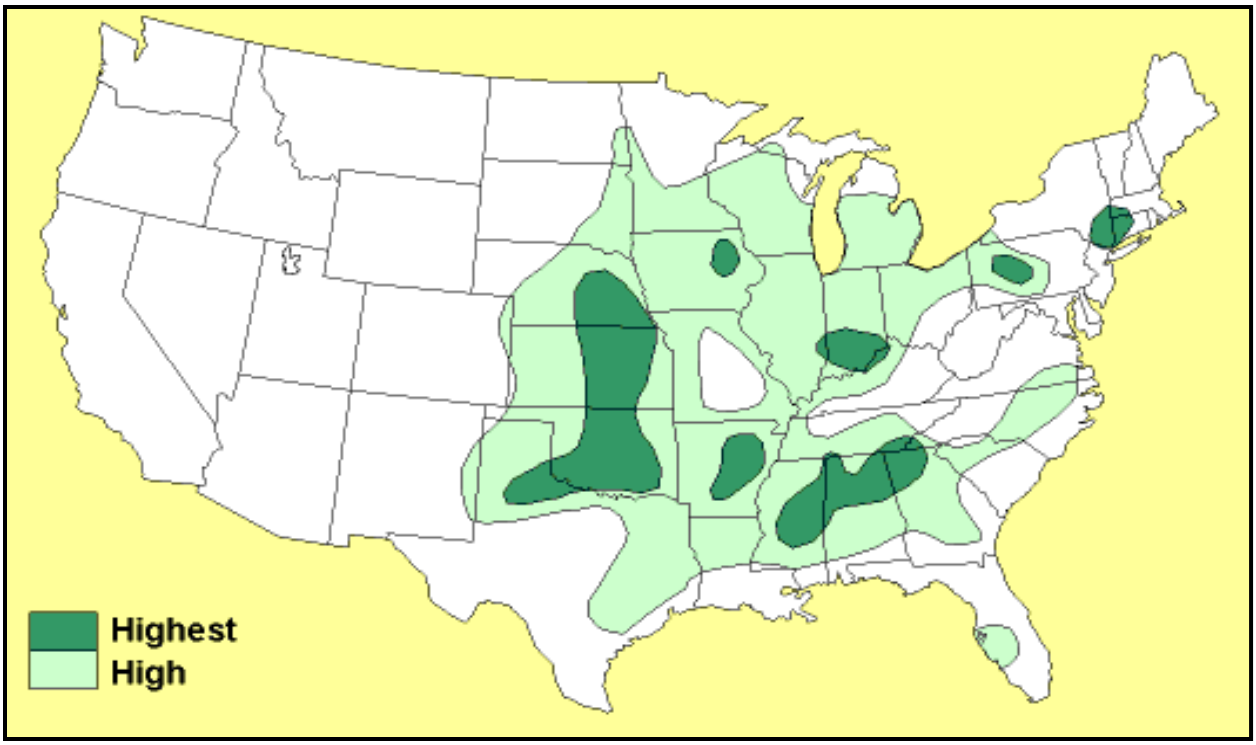


Figure 11-2. Tornado Risk Areas in the United States

Blizzards and Snowstorms

The National Weather Service defines a winter storm as having significant snowfall, ice or freezing rain; the quantity of precipitation varies by elevation. Heavy snowfall in non-mountainous areas is defined as 4 inches or more in a 12-hour period or 6 inches or more in a 24-hour period; in mountainous areas, it is defined as 12 inches or more in a 12-hour period or 18 inches or more in a 24-hour period. There are three key ingredients to a severe winter storm:

- Cold Air—Below-freezing temperatures in the clouds and near the ground are necessary to make snow or ice.
- Moisture—Moisture is required in order to form clouds and precipitation. Air blowing across a body of water, such as a large lake or the ocean, is an excellent source of moisture.
- Lift—Lift is required in order to raise the moist air to form the clouds and cause precipitation. An example of lift is warm air colliding with cold air and being forced to rise over the cold dome. The boundary between the warm and cold air masses is called a front. Another example of lift is air flowing up a mountain side.

Strong storms crossing the North Pacific move onshore along the coastline from California to Washington. The Pacific provides a virtually unlimited source of moisture for storms. If the air is cold enough, snow falls over Washington and Oregon and sometimes in California. As the moisture rises into the mountains, heavy snow closes the mountain passes and can cause avalanches. Cold air from the north has to filter through mountain canyons into the basins and valleys to the south. If the cold air is deep enough, it can spill over the mountain ridge. As the air funnels through canyons and over ridges, wind speeds can reach 100 mph, damaging roofs and taking down power and telephone lines. Combining these winds with snow results in a blizzard.

Heavy snow can immobilize a region and paralyze a city, stranding commuters, stopping the flow of supplies, and disrupting emergency and medical services. Accumulations of snow can collapse buildings and knock down trees and power lines. In rural areas, homes and farms may be isolated for days, and unprotected livestock may be lost. In the mountains, heavy snow can lead to avalanches. The cost of snow removal, damage repair, and loss of business can have large economic impacts on cities and towns.

Areas most vulnerable to winter storms are those affected by convergence of dry, cold air from the interior of the North American continent, and warm, moist air off the Pacific Ocean. Typically, significant winter storms occur during the transition between cold and warm periods.

Ice Storms

Ice storms are regional events that vary considerably in frequency and severity. During ice storms, super-cooled rain falls and freezes on contact with surfaces at or below the freezing point (Figure 11-3). Accumulations have been observed to increase branch weight of trees up to 30 times. The U.S. National Weather Service defines an ice storm as a storm that results in the accumulation of at least 0.25 inches of ice on exposed surfaces. Ice accretion generally ranges from a trace to 1 inch. Accumulations between 1/4-inch and 1/2-inch can cause small branch and faulty limb breakage. Accumulations of 1/2-inch to 1 inch can cause conspicuous breakage. Branch failure occurs when loading exceeds wood resistance or when constant loading further exacerbates a weakened area in a branch. Strong winds increase the potential for damage from ice accumulation.

From 1982 to 1994, ice storms were more common than blizzards and averaged 16 per year. They are not violent storms, but are commonly perceived as gentle rains occurring at temperatures just below freezing. People may be unaware of the danger if an ice storm happens overnight. While meteorologists can predict when and where an ice storm will occur, some still occur with little or no warning

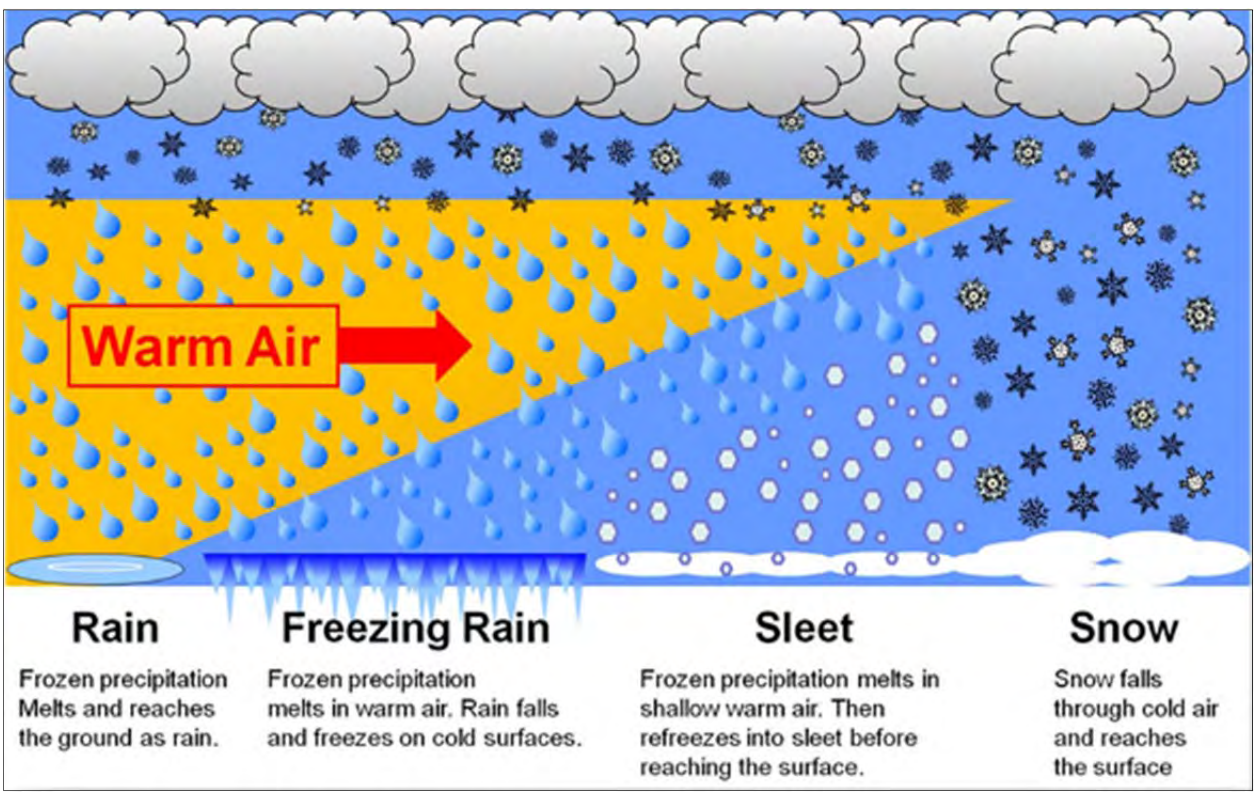


Figure 11-3. The Formation of Different Kinds of Precipitation

Hail Storms

Hail occurs when updrafts in thunderstorms carry raindrops up into cold areas of the atmosphere where they freeze into ice. Recent studies suggest that super-cooled water may accumulate on frozen particles near the back side of a storm as they are pushed forward across and above the updraft by the prevailing winds near the top of the storm. Eventually, the hailstones encounter downdraft air and fall to the ground.

Hailstones grow two ways. In wet growth, a tiny piece of ice is in an area where the air temperature is below freezing, but not super cold. When the tiny piece of ice collides with a super-cooled drop, the water does not freeze on the ice immediately. Instead, liquid water spreads across tumbling hailstones and slowly freezes. Since the process is slow, air bubbles can escape, resulting in a layer of clear ice. Dry growth hailstones grow when the air temperature is well below freezing and the water droplet freezes immediately as it collides with the ice particle. The air bubbles are “frozen” in place, leaving cloudy ice.

Hailstones can have layers like an onion if they travel up and down in an updraft, or they can have few or no layers if they are “balanced” in an updraft. One can tell how many times a hailstone traveled to the top of the storm by counting its layers. Hailstones can begin to melt and then re-freeze together, forming large and very irregularly shaped hail.

11.1.3 Thunderstorms

A thunderstorm is a rain event that includes thunder and lightning. A thunderstorm is classified as “severe” when it contains one or more of the following: hail with a diameter of three-quarter inch or greater, winds gusting in excess of 50 knots (57.5 mph), or tornado.

Three factors cause thunderstorms: moisture, rising unstable air (air that keeps rising when disturbed), and a lifting mechanism to provide the disturbance. The sun heats the surface of the earth, which warms the air above it. If this warm surface air is forced to rise (hills or mountains can cause rising motion, as can the interaction of warm air and cold air or wet air and dry air) it will continue to rise as long as it weighs less and stays warmer than the air around it. As the air rises, it transfers heat from the surface of the earth to the upper levels of the atmosphere (the process of convection). The water vapor it contains begins to cool and it condenses into a cloud. The cloud eventually grows upward into areas where the temperature is below freezing. Some of the water vapor turns to ice and some of it turns into water droplets. Both have electrical charges. Ice particles usually have positive charges, and rain droplets usually have negative charges. When the charges build up enough, they are discharged in a bolt of lightning, which causes the sound waves we hear as thunder. Thunderstorms have three stages (see Figure 11-4):

- The **developing stage** of a thunderstorm is marked by a cumulus cloud that is being pushed upward by a rising column of air (updraft). The cumulus cloud soon looks like a tower (called towering cumulus) as the updraft continues to develop. There is little to no rain during this stage but occasional lightning. The developing stage lasts about 10 minutes.
- The thunderstorm enters the **mature stage** when the updraft continues to feed the storm, but precipitation begins to fall out of the storm, and a downdraft begins (a column of air pushing downward). When the downdraft and rain-cooled air spread out along the ground, they form a gust front, or a line of gusty winds. The mature stage is the most likely time for hail, heavy rain, frequent lightning, strong winds, and tornadoes. The storm occasionally has a black or dark green appearance.
- Eventually, a large amount of precipitation is produced and the updraft is overcome by the downdraft beginning the **dissipating stage**. At the ground, the gust front moves out a long distance from the storm and cuts off the warm moist air that was feeding the thunderstorm. Rainfall decreases in intensity, but lightning remains a danger.

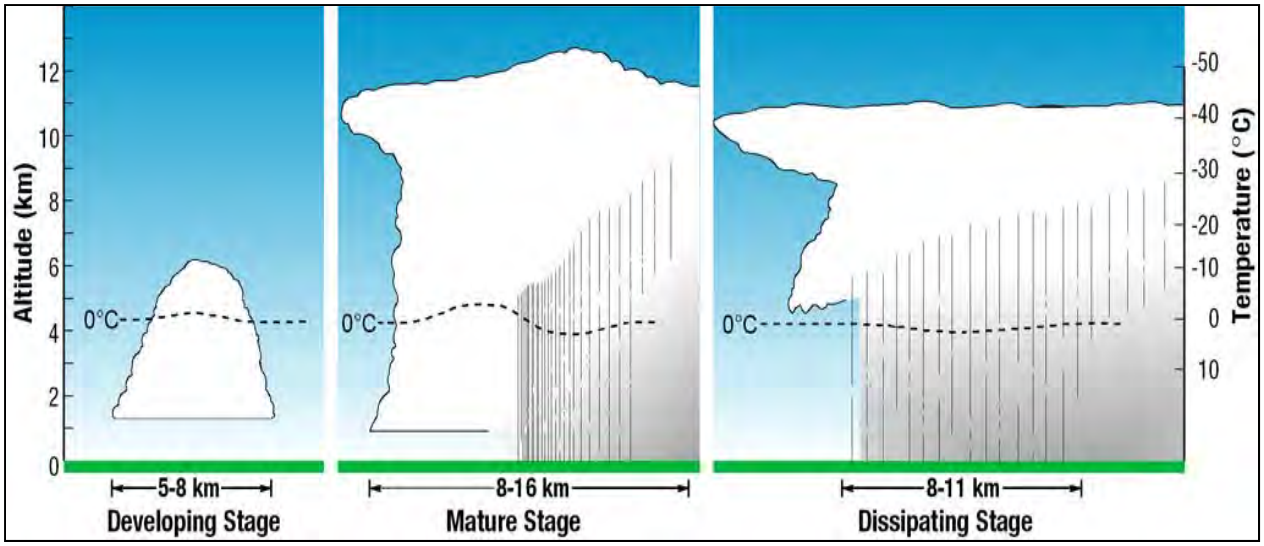


Figure 11-4. The Thunderstorm Life Cycle

There are four types of thunderstorms:

- **Single-Cell Thunderstorms—**Single-cell thunderstorms usually last 20 to 30 minutes. A true single-cell storm is rare, because the gust front of one cell often triggers the growth of another. Most single-cell storms are not usually severe, but a single-cell storm can produce a brief severe weather event. When this happens, it is called a pulse severe storm.
- **Multi-Cell Cluster Storm—**A multi-cell cluster is the most common type of thunderstorm. The multi-cell cluster consists of a group of cells, moving as one unit, with each cell in a different phase of the thunderstorm life cycle. Mature cells are usually found at the center of the cluster and dissipating cells at the downwind edge. Multi-cell cluster storms can produce moderate-size hail, flash floods and weak tornadoes. Each cell in a multi-cell cluster lasts only about 20 minutes; the multi-cell cluster itself may persist for several hours. This type of storm is usually more intense than a single cell storm.
- **Multi-Cell Squall Line—**A multi-cell line storm, or squall line, consists of a long line of storms with a continuous well-developed gust front at the leading edge. The line of storms can be solid, or there can be gaps and breaks in the line. Squall lines can produce hail up to golf-ball size, heavy rainfall, and weak tornadoes, but they are best known as the producers of strong downdrafts. Occasionally, a strong downburst will accelerate a portion of the squall line ahead of the rest of the line. This produces what is called a bow echo. Bow echoes can develop with isolated cells as well as squall lines. Bow echoes are easily detected on radar but are difficult to observe visually.
- **Super-Cell Storm—**A super-cell is a highly organized thunderstorm that poses a high threat to life and property. It is similar to a single-cell storm in that it has one main updraft, but the updraft is extremely strong, reaching speeds of 150 to 175 miles per hour. Super-cells are rare. The main characteristic that sets them apart from other thunderstorms is the presence of rotation. The rotating updraft of a super-cell helps the super-cell to produce extreme weather events, such as giant hail (more than 2 inches in diameter), strong downbursts of 80 miles an hour or more, and strong to violent tornadoes.

11.2 HAZARD PROFILE

11.2.1 Past Events

Table 11-1 summarizes severe weather events in King County since 1958, as recorded by the National Oceanic and Atmospheric Administration (NOAA). The severe weather events for the planning area shown are often related to high winds associated with winter storms and thunderstorms.

TABLE 11-1.
SEVERE WEATHER EVENTS IN KING COUNTY SINCE 1958

Date	Type	Deaths or Injuries	Property Damage
03/03/1956	Thunderstorm Wind (80 knots)	0	0
09/28/1962	Tornado (F1)	0	$250,000
10/12/1962	Severe Windstorm	46	53,000 homes damaged
Description: *The most severe windstorm to affect Western Washington was the 1962 Columbus Day storm. Sustained winds over 85 mph were recorded; 46 people died and 53,000 homes were damaged throughout the region.*			
08/18/1964	Tornado (F0)	0	0
12/12/1969	Tornado (F3)	0	$250,000
12/23/1969	Thunderstorm Wind	0	0
12/22/1971	Tornado (F0)	0	$25,000
06/08/1972	Hail (1.50 in.)	0	0
10/22/1985	Thunderstorm Wind	0	0
05/17/1989	Thunderstorm Wind	0	0
01/20/1993	Severe Windstorm	5	$130 Million
Description: *The western part of the Puget Sound region was heavily impacted by this windstorm. High winds caused tremendous destruction of public and private structures, power and telephone lines, and trees. This storm claimed five lives and left over 750,000 homes and business without power. Over 280,000 Puget Power customers in King County were without electricity. The storm damaged homes, businesses, and public facilities, generated tons of disaster-related debris, and caused local governments to spend several million dollars statewide to deal with its impact. Washington received $130 million through FEMA's Public Assistance program to repair and restore damaged infrastructure.*			
08/23/1993	Lightning	1	0
Description: *A jogger struck by lightning while running in the 5100 block of West Lake Sammamish Parkway never regained consciousness and died 17 hours later.*			
03/21/1994	High Winds	0	0
11/01/1994	High Winds	0	0
Description: *Winds were reported 45 to 55 mph in some areas along the Puget Sound with numerous power outages due to fallen tree limbs on power lines.*			
12/30/1994	High Wind	0	0
01/08/1995	Freezing Rain	0	0
Description: *Several reports of icy roads due to early morning freezing rain were received from the east side of the county where several cars slid off the roads due to slippery conditions*			

TABLE 11-1.
SEVERE WEATHER EVENTS IN KING COUNTY SINCE 1958

Date	Type	Deaths or Injuries	Property Damage
12/29/1996	Ice/snow/rain	0	$31.5 M
Description: *The December 26—31 ice/snow/rain storm caused about $315 million in damage in all of Washington. The storms sparked a state of emergency in 30 counties. Seattle received 8.35 inches of precipitation between Dec. 26 and Jan 2. The total number of customers without power at one time was nearly 300,000 and some people went a week without power. The damage affected people for weeks.*			
04/03/1997	Lightning	0	0
Description: *A woman holding an umbrella was struck by lightning.*			
08/03/1999	Lightning	0	$650,000
Description: *Over 1,000 lightning strikes were recorded in a four-hour period. One man was struck by lightning while standing under a tree, and another man while standing in water next to his boat. At its peak, the storm knocked out power to about 20,000 customers.*			
12/14/2006	High Wind (60-75 mph)	0	$750,000
Description: *In Western Washington, peak winds reached 80 to 90 mph along the coast and 60 to 75 mph elsewhere. A few locations had gusts as high 85 mph in the interior. Mountain areas recorded peak wind speeds in excess of 100 mph. The windstorm, the strongest since the 1993 Inauguration Day Wind Storm, blew down thousands of trees and knocked power out to close to 1.5 million customers in Western Washington. The strong winds damaged major transmission lines, power poles and other power utility infrastructure. Trees also fell onto houses, street signs, streetlights, parked cars, fences, railings and rooftops.*			
12/2008	Record Snowfall	0	No information available
Description: *Record or near-record snowfall impacted most of Western Washington*			
12/14/2010	Thunderstorm Wind	0	$25,000
Description: *A squall line produced outflow winds with gusts between 45 and 70 mph. About 8,600 Seattle City Light customers lost power. About 300 homes in the Sammamish area lost power and one had a tree fall on it. In Maple Valley, a lumber storage building had its roof ripped off.*			
05/13/2013	Thunderstorm Wind	0	$25,000
Description: *Thunderstorms caused local damage and power outages with wind speeds exceeding 39 knots.*			

11.2.2 Location

Severe weather events have the potential to happen anywhere in the planning area. Communities in low-lying areas next to streams or lakes are more susceptible to flooding. Wind events are most damaging to areas that are heavily wooded. Figure 5-2, Figure 5-3 and Figure 5-4 show the distribution of average weather conditions over the planning area.

11.2.3 Frequency

The planning area can expect to experience exposure to some type of severe weather event at least annually. Severe freezes, in which high temperatures remain below freezing for five or more days, occur every 5 to 10 years in Covington. Severe or prolonged snow events occur less frequently, but have widespread impacts on people and property in the city.

11.2.4 Severity

Severe Winter Storms

A severe winter storm is generally a prolonged event involving snow or ice. The characteristics of severe winter storms are determined by the amount and extent of snow or ice, air temperature, wind speed, and event duration. Severe storms can affect the city from the northwest and southeast, and from the western slopes of the Cascade Mountains.

Western Washington has had an average of 11.4 inches of snowfall annually over the past 30 years. The snowfall records in the region are:

- The one day record is 21 inches in January 1950
- The one month record is 57 inches during January 1950
- The winter long record is 67 inches during the winter of 1968—1969.

The most common problems associated with severe snow storms are immobility and loss of utilities. Fatalities are uncommon, but can occur. Transportation routes can get blocked, travelers and commuters can get stranded, and families can be separated. Additionally, because electrical lines are damaged, other utilities such as telephone systems (cell and land lines), natural gas, water and sewer systems can become inoperable. Physical damage to homes and facilities can occur from wind damage or accumulation of snow or ice. Even a small accumulation of snow can cause havoc on transportation systems due to a lack of snow clearing equipment and experienced drivers.

Severe winter storms can produce rain, freezing rain, ice, snow, cold temperatures, and wind. Ice storms accompanied by high winds can have destructive impacts, especially on trees, power lines and utility services. Freezing rain can be the most damaging of ice formations. While sleet and hail can create hazards for motorists when it accumulates, freezing rain can cause the most dangerous conditions within a community. Ice buildup can bring down trees, communication towers and wires creating hazards for property owners, motorists and pedestrians alike. Rain originating from the west can fall on frozen streets, cars, and other sub-freezing surfaces, creating dangerous conditions. If a severe ice storm occurs within Covington, there may be prolonged power outages over widespread areas. The probability of such an ice storm is uncertain due to limited historical records, but is considered less likely than a severe ice storm in the Puget Sound area, given the usual meteorological patterns for the area.

Wind Storms and Tornadoes

A windstorm is generally a short duration event involving straight-line winds and/or gusts in excess of 50 mph. Windstorms affect areas of the city with significant tree stands, as well as areas with exposed property, major infrastructure, and above ground utility lines. The lower wind speeds typical in the lower valleys are still high enough to knock down trees and power lines, and cause other property damage. Mountainous sections of the city experience much higher winds under more varied conditions. Because of the local nature of wind hazards in the mountains, a high-resolution wind speed map would be required to accurately identify the degree of wind hazard throughout the city.

Windstorms can cause power outages, transportation, and economic disruptions, and significant property damage and pose a high risk for injuries and loss of life. They can also be typified by a need to shelter and care for individuals impacted by the events. Several destructive windstorms, (most notably the 1962 Columbus Day storm and the January 20, 1993 windstorm) brought economic hardship and affected the life safety of city residents. Future windstorms may cause similar impacts citywide.

Tornadoes are potentially the most dangerous of local storms, but they are not common in the planning area. If a major tornado were to strike within the populated areas of the planning area, damage could be widespread. Businesses could be forced to close for an extended period or permanently, fatalities could be high, many people could be homeless for an extended period, and routine services such as telephone or power could be disrupted. Buildings may be damaged or destroyed.

Washington averaged three tornadoes per year between 1991 and 2010, none with a rating of F3 or greater. The state ranks low in the U.S. for average annual tornadoes per square mile—only Oregon, Nevada, Utah and Alaska have fewer yearly tornadoes per area than Washington's 0.4 per 10,000 square miles. (http://www.ncdc.noaa.gov/oa/climate/severeweather/tornadoes.html#top)

11.2.5 Warning Time

Meteorologists can often predict the likelihood of a severe storm. This can give several days of warning time. However, meteorologists cannot predict the exact time of onset or severity of the storm. Some storms may come on more quickly and have only a few hours of warning time. The National Weather Service, Seattle Bureau, monitors the stations and provides public warnings on storm, snow and ice events as appropriate.

The Seattle Office of the National Weather Service issues severe winter storm watches and warnings when appropriate to alert government agencies and the public of possible or impending weather events. The watches and warnings are broadcast over NOAA weather radio and are forwarded to the local media for retransmission using the Emergency Alert System.

11.3 SECONDARY HAZARDS

The most significant secondary hazards associated with severe local storms are floods, falling and downed trees, landslides and downed power lines. Rapidly melting snow combined with heavy rain can overwhelm both natural and man-made drainage systems, causing overflow and property destruction. Landslides occur when the soil on slopes becomes oversaturated and fails.

11.4 CLIMATE CHANGE IMPACTS

Climate change presents a significant challenge for risk management associated with severe weather. The frequency of severe weather events has increased steadily over the last century. The number of weather-related disasters during the 1990s was four times that of the 1950s, and cost 14 times as much in economic losses. Historical data shows that the probability for severe weather events increases in a warmer climate (see Figure 11-5). The changing hydrograph caused by climate change could have a significant impact on the intensity, duration and frequency of storm events. All of these impacts could have significant economic consequences.

11.5 EXPOSURE

11.5.1 Population

A lack of data separating severe weather damage from flooding and landslide damage prevented a detailed analysis for exposure and vulnerability. However, it can be assumed that the entire planning area is exposed to some extent to severe weather events. Certain areas are more exposed due to geographic location and local weather patterns. Populations living at higher elevations with large stands of trees or power lines may be more susceptible to wind damage and black out, while populations in low-lying areas are at risk for possible flooding.

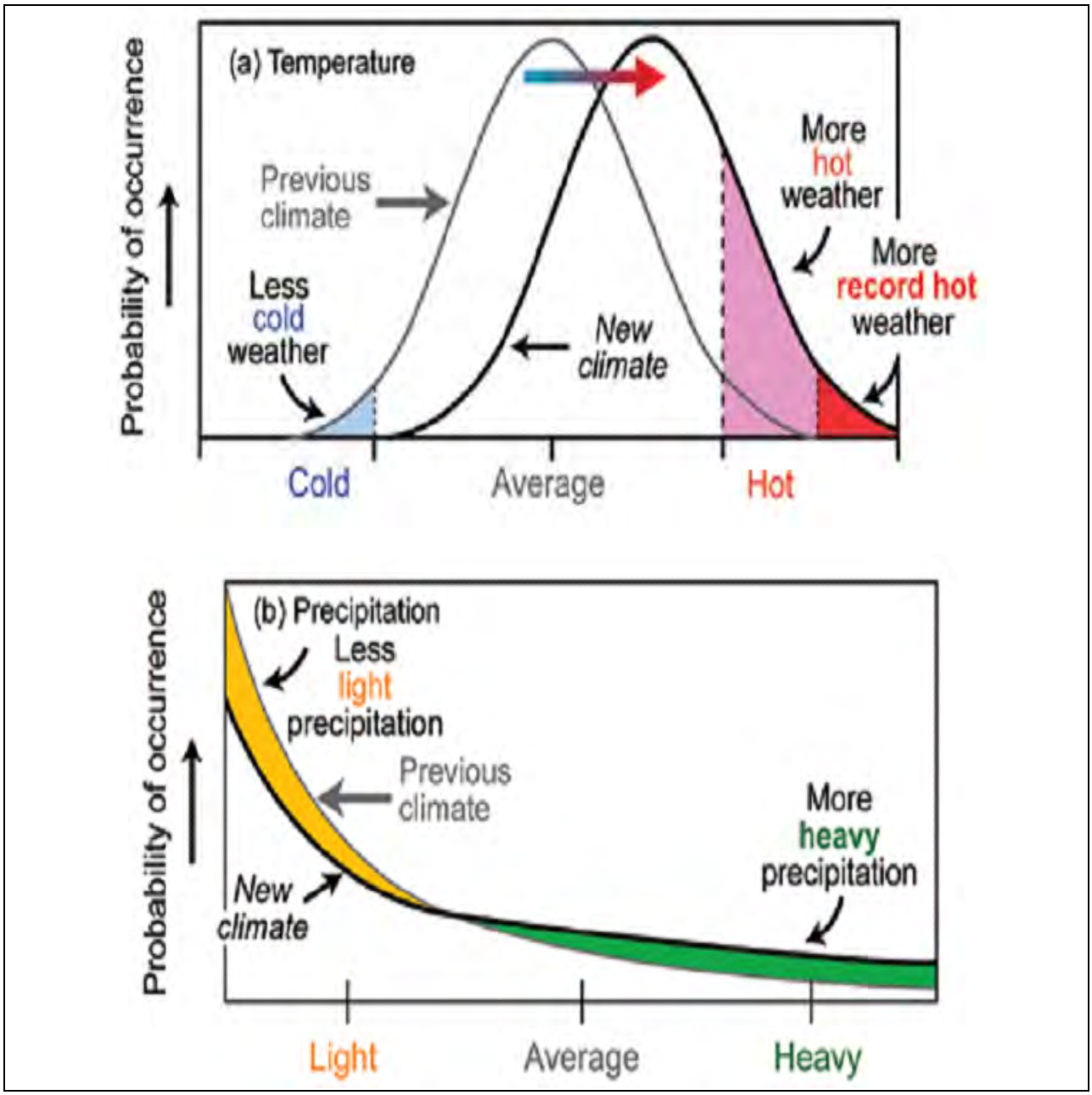


Figure 11-5. Severe Weather Probabilities in Warmer Climates

11.5.2 Property

According to the King County Assessor, there are 5,884 buildings within the census tracts that define the planning area. Most of these buildings are residential. It is estimated that 55 percent of the residential structures were built without the influence of a structure building code with provisions for wind loads. All of these buildings are considered to be exposed to the severe weather hazard, but structures in poor condition or in particularly vulnerable locations (located on hilltops or exposed open areas) may risk the most damage. The frequency and degree of damage will depend on specific locations.

11.5.3 Critical Facilities and Infrastructure

All critical facilities exposed to flooding (Chapter 9) are also likely exposed to severe weather. Additional facilities on higher ground may also be exposed to wind damage or damage from falling trees. The most common problems associated with severe weather are loss of utilities. Downed power lines can cause blackouts, leaving large areas isolated. Phone, water and sewer systems may not function. Roads may become impassable due to ice or snow or from secondary hazards such as landslides.

11.5.4 Environment

The environment is highly exposed to severe weather. Natural habitats such as streams and trees are exposed to severe storms and risk major damage. Prolonged rains can saturate soils and lead to slope failure. Flooding events caused by severe weather or snowmelt can produce river channel migration or damage riparian habitat. Storm surges can erode beachfront bluffs and redistribute sediment loads.

11.6 VULNERABILITY

11.6.1 Qualitative Assessment

Severe Winter Storms

Winter storms are deceptive killers. Many of the deaths that occur are indirectly related to the actual storm, including deaths resulting from traffic accidents on icy roads, heart attacks while shoveling snow, and hypothermia from prolonged exposure to the cold. Property is at risk due to flooding and landslides resulting from heavy snow melt. Trees, power lines, telephone lines, and television and radio antennas can be impacted by ice, wind, snow, and falling trees and limbs. Saturated soil can cause trees to lose their ability to stand and fall on houses, cars, utilities, and other property. Similarly, if streets are icy, it is difficult for emergency personnel to travel and may pose a secondary threat to life if police, fire and medical personnel cannot respond to calls.

Snow and ice events resulting in icy road conditions can lead to major traffic accidents. Roads blocked by fallen trees during a windstorm may have tragic consequences for people who need access to emergency services. The ability to travel after a natural hazard event is a priority issue for city residents, organizations, and providers of essential services such as hospitals and utilities.

Historically, falling trees have been the major cause of power outages resulting in interruption of services and damaged property. In addition, falling trees can bring electric power lines down, creating the possibility of lethal electric shock. Snow and ice can also damage utility lines and cause prolonged power outages. Rising population growth and new infrastructure in the city creates a higher probability for damage to occur from severe winter storms as more life and property are exposed to risk.

The most frequent water system problem related to cold weather is a break in cast iron mainlines. Breaks frequently occur during severe freeze events, as well as during extreme cooling periods during the months of October, November and December. Another common problem during severe freeze events is the failure of commercial and residential water lines. Inadequately insulated potable water and fire sprinkler pipes can rupture and cause extensive damage to property.

Windstorms

Windstorms have the ability to cause damage over 100 miles from the center of storm activity. Isolated wind phenomena in the mountainous regions have more localized effects. Winds impacting walls, doors, windows, and roofs, may cause structural components to fail. Wind pressure can create a direct and frontal assault on a structure, pushing walls, doors and windows inward. Conversely, passing currents can

create lift and suction forces that act to pull building components and surfaces outward. The effects of winds are magnified in the upper levels of multi-story structures. As positive and negative forces impact the building's protective envelope (doors, windows, and walls), the result can be roof or building component failures and considerable structural damage.

Debris carried by extreme winds can contribute directly to loss of life and indirectly to the failure of building envelopes. When severe windstorms strike a community, downed trees, power lines, and damaged property can be major hindrances to emergency response and disaster recovery.

Storm winds can damage buildings, power lines, and other property and infrastructure due to falling trees and branches. During wet winters, saturated soils cause trees to become less stable and more vulnerable to uprooting from high winds. Windstorms can result in collapsed or damaged buildings, damaged or blocked roads and bridges, damaged traffic signals, streetlights, and parks, among others. Roads blocked by fallen trees during a windstorm may have severe consequences to people who need access to emergency services. Emergency response operations can be complicated when roads are blocked or when power supplies are interrupted. Industry and commerce can suffer losses from interruptions in electric service and from extended road closures. They can also sustain direct losses to buildings, personnel, and other vital equipment. There are direct consequences to the local economy resulting from windstorms related to both physical damage and interrupted services.

Historically, falling trees have been the major cause of power outages in Covington. Windstorms can cause flying debris and downed utility lines. For example, tree limbs breaking in winds of only 45 mph can be thrown over 75 feet. As such, overhead power lines can be damaged even in relatively minor windstorm events. Utility lines brought down by summer thunderstorms have also been known to cause ·fires, which start in dry roadside vegetation. Falling trees can bring electric power lines down to the pavement, creating the possibility of lethal electric shock. Rising population growth and new infrastructure in the city creates a higher probability for damage to occur from windstorms as more life and property are exposed to risk.

11.6.2 Population

Vulnerable populations are the elderly, low income or linguistically isolated populations, people with life-threatening illnesses, and residents living in areas that are isolated from major roads. Power outages can be life threatening to those dependent on electricity for life support. Isolation of these populations is a significant concern. These populations face isolation and exposure during severe weather events and could suffer more secondary effects of the hazard. Additionally, people in transit are considered the most vulnerable group because mobility is often rapidly reduced trapping people without the necessary resources. Staying home when such events are forecasted is typically the wisest course of action.

11.6.3 Property

All property is vulnerable during severe weather events, but properties in poor condition or in particularly vulnerable locations may risk the most damage. Those in higher elevations and on ridges may be more prone to wind damage. Those that are located under or near overhead lines or near large trees may be vulnerable to falling ice or may be damaged in the event of a collapse.

Loss estimations for the severe weather hazard are not based on damage functions, because no such damage functions have been generated. Instead, loss estimates were developed representing 10 percent, 30 percent and 50 percent of the assessed value of exposed structures. This allows emergency managers to select a range of potential economic impact based on an estimate of the percent of damage to the general building stock. Damage in excess of 50 percent is considered to be substantial by most building codes and typically requires total reconstruction of the structure. Table 11-2 lists the loss estimates.

TABLE 11-2. POTENTIAL LOSS ESTIMATES FOR SEVERE WEATHER	
Exposed Value	$2,849,591,000
Potential Loss from Severe Weather	
10% Damage	$284,959,100
30% Damage	$854,877,300
50% Damage	$1,424,795,500

11.6.4 Critical Facilities and Infrastructure

Incapacity and loss of roads are the primary transportation failures resulting from severe weather, mostly associated with secondary hazards. Landslides caused by heavy prolonged rains can block roads. High winds can cause significant damage to trees and power lines, blocking roads with debris, incapacitating transportation, isolating population, and disrupting ingress and egress. Snowstorms in higher elevations can significantly impact the transportation system and the availability of public safety services. Of particular concern are roads providing access to isolated areas and to the elderly.

Prolonged obstruction of major routes due to landslides, snow, debris or floodwaters can disrupt the shipment of goods and other commerce. Large, prolonged storms can have negative economic impacts for an entire region.

Severe windstorms, downed trees, and ice can create serious impacts on power and above-ground communication lines. Freezing of power and communication lines can cause them to break, disrupting electricity and communication. Loss of electricity and phone connection would leave certain populations isolated because residents would be unable to call for assistance.

The current use of above-ground utility lines increases the vulnerability to widespread utility outages during weather events.

11.6.5 Environment

The vulnerability of the environment to severe weather is the same as the exposure.

11.7 FUTURE TRENDS IN DEVELOPMENT

All future development will be affected by severe storms. The ability to withstand impacts lies in sound land use practices and consistent enforcement of codes and regulations for new construction. The City of Covington has adopted the International Building Code in response to state mandates. This code is equipped to deal with the impacts of severe weather events. Land use policies in the City's comprehensive plan also address many of the secondary impacts (flood and landslide) of the severe weather hazard. With these tools, the City of Covington is well equipped to deal with future growth and the associated impacts of severe weather.

11.8 SCENARIO

Severe weather could occur during the winter when Chinook winds accompanied by heavy rains drop precipitation over frozen snow and cause heavy runoff and eventually flooding. This scenario could also generate freezing rain that can cause the accumulation of ice on power lines and other ice-related issues. The heavy rain may knock down ice-covered power lines. Also during the winter, the City of Covington

may experience a blizzard that causes white-out conditions, blocking roads and isolating scattered rural homes and communities. During the summer, an isolated thunderstorm can produce a tornado that occurs near a population center and causes significant damage to property. Lightning strikes during the dry, hot summer can cause wildfires that may spread out of control. Wind events can knock down power and phone lines, cutting off communication and electricity.

11.9 ISSUES

Severe local storms are probably the most common widespread hazard. They affect large numbers of people throughout the City of Covington, and region when they occur. These types of storms can quickly overwhelm city and county resources. Citizens should be prepared for these types of storms: family plans should be developed, disaster kits should be put in homes, workplaces, schools and cars and every family member should be taught how to shut off household utilities. Initiating early dismissal from schools and business is an effective mitigation measure and should be encouraged.

Severe weather cannot be prevented, but measures can be taken to mitigate the effects. Critical infrastructure and utilities can be hardened to prevent damage during an event. The secondary effect of flooding can be addressed through decreasing runoff and water velocity. Important issues associated with severe weather in the City of Covington planning area include the following:

- Structures could be highly vulnerable to severe weather events such as windstorms.
- Redundancy of power supply should be evaluated.
- The capacity for backup power generation is limited.
- Public education on dealing with the impacts of severe weather should be provided
- Snow removal measures are required.
- Debris management (downed trees, etc.) should be addressed.

CHAPTER 12.
VOLCANO

12.1 GENERAL BACKGROUND

Hazards related to volcanic eruptions are distinguished by the different ways in which volcanic materials and other debris are emitted from the volcano. The molten rock that erupts from a volcano (lava) forms a hill or mountain around the vent. The lava may flow out as a viscous liquid, or it may explode from the vent as solid or liquid particles. Ash and fragmented rock material can become airborne and travel far from the erupting volcano to affect distant areas.

A volcano is a vent in the Earth from which molten rock (magma) and gas erupts. The molten rock that erupts from the volcano (lava) forms a hill or mountain around the vent. The lava may flow out as a viscous liquid, or it may explode from the vent as solid or liquid particles.

The Cascade Range is a 1,000 mile long chain of volcanoes which extends from northern California to southern British Columbia. Many of these volcanoes have erupted in the recent past and will erupt again in the foreseeable future. Eruptions in the Cascades have occurred at an average rate of 1-2 per century during the last 4,000 years. The USGS classifies Glacier Peak, Mt. Adams, Mt. Baker, Mt. Hood, Mt. St. Helens, and Mt. Rainier as being potentially active Washington state volcanoes.

DEFINITIONS

Lahar—A rapidly flowing mixture of water and rock debris that originates from a volcano. While lahars are most commonly associated with eruptions, heavy rains, and debris accumulation, earthquakes may also trigger them.

Lava Flow—The least hazardous threat posed by volcanoes. Cascades volcanoes are normally associated with slow moving lava.

Tephra—Ash and fragmented rock material ejected by a volcanic explosion

Volcano—A vent in the planetary crust from which magma (molten or hot rock) and gas from the earth's core erupts.

12.1.1 Types of Eruptions

A volcano may exhibit different styles of eruption at different times, and eruptions may change from one type to another as an eruption progresses:

- Hawaiian eruptions, the least violent type of eruption, are characterized by extensive fluid lava flows from central vents or fissures and are occasionally accompanied by lava fountains.
- Strombolian eruptions are characterized by moderately fluid lava flows, usually accompanied by a violent lava fountain that produces an abundance of volcanic bombs and cinders.
- Vulcanian eruptions are characterized by viscous magmas that form short, thick flows around vents; very viscous or solid fragments of lava are violently ejected from these vents.
- Pelean eruptions are similar to Vulcanian eruptions but have even more viscous lava; domes form over the vents, and ash flows commonly accompany the dome formations.
- Plinian eruptions, such as that of Mt. St. Helens in 1980, are the most violent eruptions. They include the violent ejection of large volumes of volcanic ash, followed by collapse of the central part of the volcano.

12.1.2 Hazards Associated with the Eruption of Volcano

Tephra

Tephra is fragmented rock material ejected by a volcanic explosion. It normally accompanies the eruptions of volcanoes in the Cascades. These volcanoes tend to erupt lavas so thick and charged with gases that they explode into ash rather than flow. A 1-inch deep layer of ash weighs an average of 10 pounds per square foot, causing danger of structural collapse. Ash is harsh, acidic, gritty and smelly. Ash may also carry a high static charge for up to two days after being ejected from a volcano. Although the gases are usually too diluted to constitute danger to a person in normal health, the combination of acidic gas and ash may cause lung problems. Extremely heavy ash can clog breathing passages and cause death. When an ash cloud combines with rain, sulfur dioxide in the cloud combines with water to form diluted sulfuric acid that may cause minor, but painful burns to the skin, eyes, nose and throat. Hydrochloric acid rains have also been reported. Acid rains may affect water supplies, strip and burn foliage, strip paint, corrode machinery, and dissolve fabric.

Heavy tephra blots out light. Sudden heavy demand for electric light and air conditioning may cause a drain on power supplies, leading to a partial or full power failure. Ash clogs machinery of all kinds and poses a serious threat to aviation because particles can damage aircraft systems and jet engines. It drifts into roadways, railways and runways where it is slippery and dangerous. Its weight may cause structural collapse. Because winds and air currents easily carry it, it remains a hazard to machinery and transportation (particularly aviation) for months after the eruption.

Lava Flows

Lava flows are coherent masses of hot, partially molten rock that flow downslope; generally following valleys. Lava flows from the Cascade volcanoes tend to be short and slow-moving. They may extrude from the main volcanic cone or from nearby cinder cones formed at or near the base of the mountain. The heat of the lava burns vegetation, potentially causing forest or grass fires. Flows may bury roads or other escape routes. Lava flows that move over snow and ice can produce debris flows. Because lava flows are slow moving and take predictable paths, they generally pose little threat to human life, however, they will destroy structures and property in their paths. Additionally, their secondary effects such as debris flows and wildfires can threaten life and property.

Volcanic Earthquakes

Volcanic earthquakes, often centered within or beneath the volcano, are usually one of three kinds: pre-eruption earthquakes caused by explosions of steam or underground magma movements, eruption earthquakes caused by explosions and collapse of walls inside the volcano, and post-eruption earthquakes caused by the retreat of magma and interior structural collapse.

Although volcanic earthquakes are strong near the volcano, they are generally confined there. There are some exceptions, as with the “St. Helens Fault Zone,” where a tectonic fault is closely associated with the volcano. Tremors may cause large rock falls, snow avalanches, landslides and building collapse. Since all Northwest volcanoes are in a regular seismic zone, tremors are monitored by the USGS and the University of Washington Seismology Lab.

Pyroclastic Flows and Surges

Pyroclastic flows and surges can also occur during explosive eruptions. Pyroclastic flows are avalanches of hot ash, rock fragments and gas that move at high speeds down the sides of a volcano during explosive eruptions or when the edge of a thick, viscous, lava flow or dome breaks apart or collapses. Such flows can be as hot as 800ºC and are capable of burning and destroying everything in their paths. Pyroclastic

surges are more energetic and thus less restricted by topography; they can move over ridge tops. Pyroclastic flows and surges are extremely dangerous. Injury or death can result from a number of factors including burial, impact, burning and asphyxiation. Although pyroclastic flows move down valleys like lava and debris flows, the immediate hazards associated with them are very different. In the case of lava flows, one can usually outrun the advancing front. In the case of debris flows, one can climb quickly up the valley sides to a height above the debris flow. In the case of pyroclastic flows and surges, however, the high mobility of the flow threatens anyone nearby, such that ridge tops and valley slopes may be unsafe.

Lateral Blast

Lateral blasts are explosive events in which energy is directed horizontally instead of vertically from a volcano. They are gas-charged, hot mixtures of rock, gas and ash that are expelled at speeds up to 650 mph. Lateral blasts vary in size, but large ones are fairly rare, with only a few historical examples worldwide. The most recent was the 1980 eruption of Mt. St. Helens when almost everything within the blast zone perished.

12.1.3 Hazards That Can Occur With or Without an Eruption

In addition to the hazards associated with volcanic eruptions (defined as magmatic activity), volcanoes can produce non-magmatic hazards. The USGS differentiates between these two types of volcanic activity because the movement of magma can usually be detected through volcano monitoring; therefore there is generally some warning prior to a magmatic event. In the case of non-magmatic events, such as the generation of debris flows, there is generally no movement of magma and an event may not be detected until it occurs. Thus volcanic activity not directly related to an eruption also poses a serious threat.

Debris Flows

Debris flows (also called mud flows) are dense mixtures of water-saturated debris that move down valley; looking and behaving much like flowing concrete. They form when loose masses of unconsolidated material are saturated, become unstable, and move downslope. The source of water varies but includes rainfall, melting snow or ice, and glacial outburst floods. This danger continues for months, even years following an eruption.

A volcanic mudflow, whether or not related to an eruption, is called a “lahar” which can be hot or cold. Lahars move faster on steep slopes nearest their source and attain speeds greater than ordinary floodwaters downstream. The average speed is between 15 and 60 mph. The highest speed measured on the slopes of Mt. St. Helens during the 1980 eruption was 88 mph and the lowest, in the lower valleys, was about 2.5 mph. They may attain depths of hundreds of feet in the canyons near their point of origin but spread out over valleys and low ridges downstream. Debris flows can erode the sides of river channels, causing bank failures. Buildings, roads, water pipes, or bridge abutments built along those banks may then be incorporated into the debris flow. A large-volume lahar may overtop or destroy a dam. The mudflows that accompanied the Mt. St. Helens eruptions damaged or destroyed more than 200 buildings, ruined 44 bridges, buried 17 miles of railway and more than 125 miles of roadway, badly damaged three logging camps, disabled several community water supply and sewage disposal systems and partly filled channels and reservoirs.

Volcanic Landslides and Debris Avalanches

Volcanic landslides and debris avalanches of glacial ice or rock debris may be set in motion by explosions, earthquakes, or heat-induced melting of ice and snow. They can occur with or without an accompanying magmatic event. Landslides are defined as the downward and outward movement of slope forming materials, natural rock, snow, glacial ice, soils or any combination of these materials. Debris

avalanches are a type of landslide that move at high speeds. Many debris avalanches will, if they contain sufficient water and fine sediment, transform downstream into debris flows. Therefore the down-valley hazards associated with debris avalanches are the same as those associated with debris flows; the main hazard to life and property being burial and impact.

Explosion of Steam and Other Gases

Explosion of steam and other gases may occur any time hot material comes into contact with water, glacial ice or snow. No eruptive activity is necessary for this to occur. These explosions often contain or are accompanied by one or more of the following: pulverized lava and rock particles in suspension, fragments of older rocks from pea sized pebbles to hundred-ton boulders, newly erupted hot lava blocks, and a shock wave that may be minimal or may extend for several miles.

Toxic Gases

Pockets or clouds of toxic gases may develop on or near both active and inactive volcanoes. Their chemical poisons can cause internal and external burns, or asphyxiation through oxygen starvation. Carbon dioxide, which causes asphyxiation, is heavier than air and therefore collects in low-lying areas. It is difficult to detect because it is both odorless and colorless. These gases, mixed with ash, make up the eruptive cloud of a volcano.

12.2 HAZARD PROFILE

12.2.1 Past Events

Figure 12-1 and Table 12-1 summarize past eruptions in the Cascades. In the 1980 Mount St. Helens eruption, 23 square miles of volcanic material buried the North Fork of the Toutle River and there were 57 human fatalities.

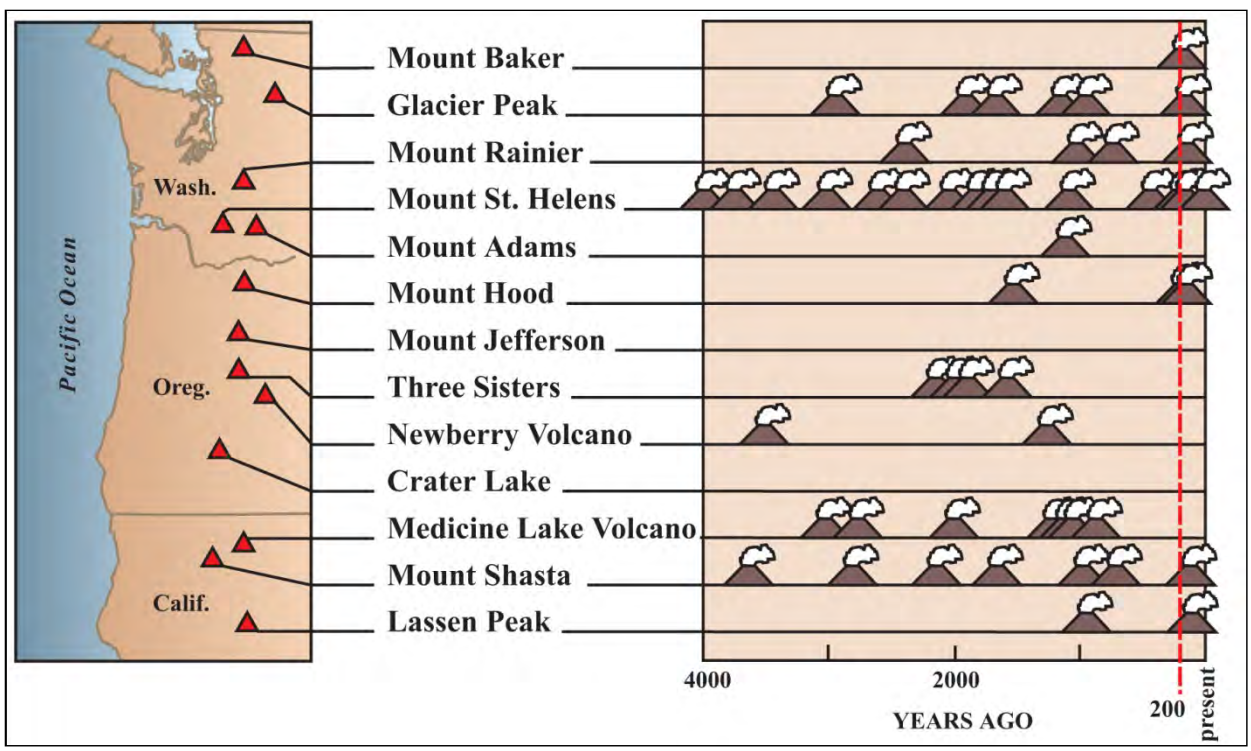


Figure 12-1. Past Eruptions in the Cascade Range

TABLE 12-1.
PAST ERUPTIONS IN WASHINGTON

Volcano	Number of Eruptions	Type of Eruptions
Mount Adams	3 in the last 10,000 years, most recent between 1,000 and 2,000 years ago	Andesite lava
Mount Baker	5 eruptions in past 10,000 years; mudflows have been more common (8 in same time period)	Pyroclastic flows, mudflows, ash fall in 1843.
Glacier Peak	8 eruptions in last 13,000 years	Pyroclastic flows and lahars
Mount Rainier	14 eruptions in last 9000 years; also 4 large mudflows	Pyroclastic flows and lahars
Mount St Helens	19 eruptions in last 13,000 years	Pyroclastic flows, mudflows, lava, and ash fall

Only Mount Rainier and Mount St. Helens are known to have had direct effects in the area of Covington in the past. However, any eruption in the Cascades that affects regional infrastructure, air traffic, bridges, or I-5, I-90, SR 18, SR 516 or SR 169 will have a direct or indirect impact on the city.

12.2.2 Location

Figure 12-1 shows the location of the Cascade Range volcanoes, most of which have the potential to produce a significant eruption. The Cascade Range extends more than 1,000 miles from southern British Columbia into northern California and includes 13 potentially active volcanic peaks in the U.S. Figure 12-2 shows probabilities of tephra accumulation from Cascade volcanoes in the Pacific Northwest (tephra is fragmented rock material ejected by a volcanic explosion).

Volcanoes relatively close to the planning area are Mount Rainier 40 miles to the southeast, Mount St. Helens 80 miles to the south, Glacier Peak 75 miles to the northeast and Mount Baker 110 miles to the north. Mount Adams, also 80 miles to the south but on the east side of the Cascade Range, poses a lower threat because of the direction of prevailing winds. Mount Hood in Oregon constitutes a low hazard because of distance, direction of prevailing winds, and evidence that its previous ash eruptions were confined to its immediate vicinity.

The U.S. Geological Survey Cascades Volcano Observatory (USGS-CVO) produced a volcanic hazard report for Mount Rainier in 1997 and 2000. The latest report includes a description of potential hazards that may occur to immediate communities. Covington is outside the probable zones of lava and pyroclastic flows, as well as lahars, from a potential eruption on Mount Rainier. However, depending on wind direction and velocity as well as type and magnitude of the eruption, the city could be affected by significant ash outfall.

12.2.3 Frequency

Many Cascade volcanoes have erupted in the recent past and will be active again in the foreseeable future. Given an average rate of one or two eruptions per century during the past 12,000 years, these disasters are not part of our everyday experience; however, in the past hundred years, California's Lassen Peak and Washington's Mount St. Helens have erupted with terrifying results. The U.S. Geological Survey classifies Glacier Peak, Mt. Adams, Mt. Baker, Mt. Hood, Mt. St. Helens, and Mt. Rainier as potentially active volcanoes in Washington State. Mt. St. Helens is by far the most active volcano in the Cascades, with four major explosive eruptions in the last 515 years.

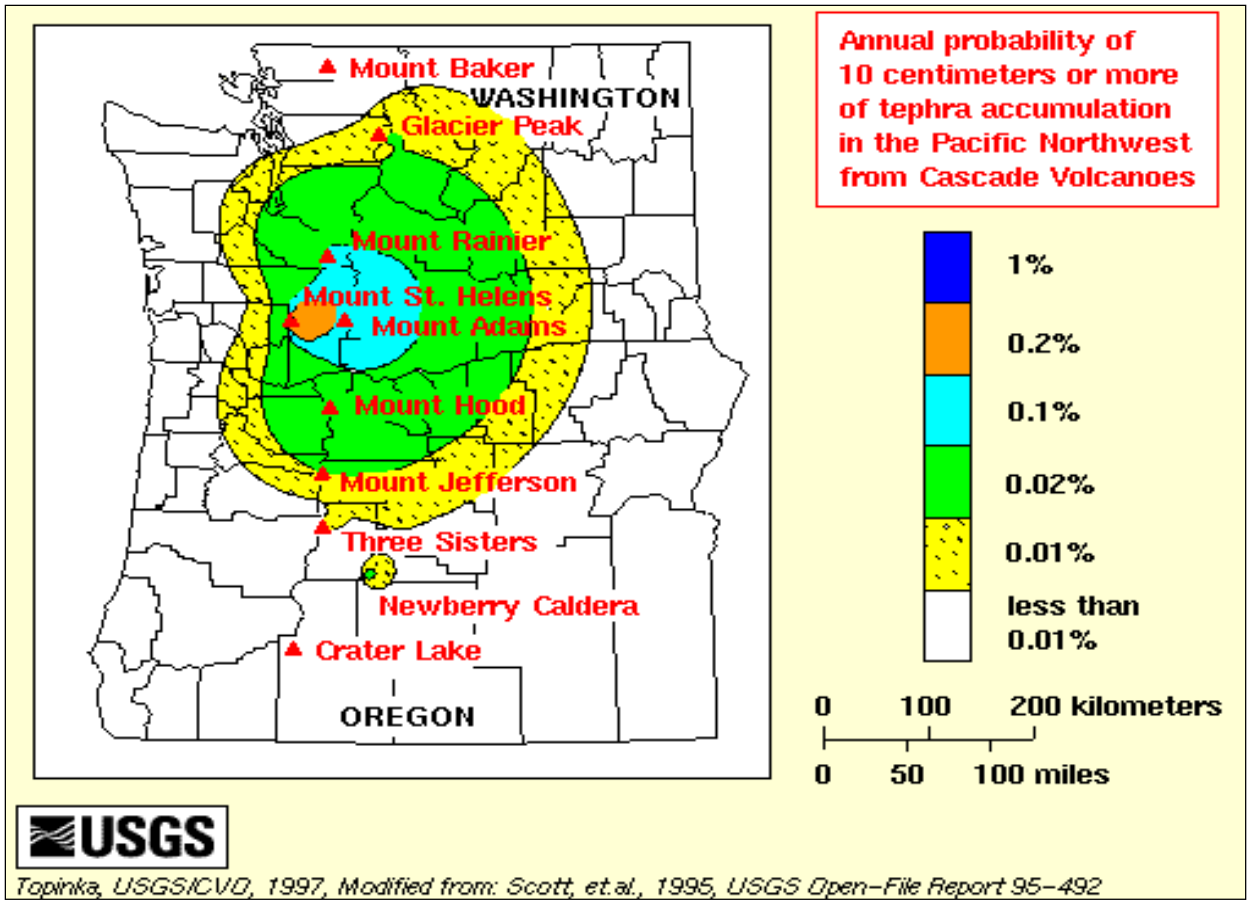


Figure 12-2. Probability of Tephra Accumulation in Pacific Northwest

12.2.4 Severity

Most volcanic dangers are to persons in the near vicinity of the volcano. Other dangers, such as mudflows and tephra, may exist many miles downstream and downwind. Economic losses from volcanic activity can be enormous. For example, Portland lost $5,000,000 when its port closed after Mt. St. Helens erupted.

Debris flows constitute the greatest hazard to surrounding communities. Because various processes, both eruptive and non-eruptive, can generate debris flows and because they can travel such distances, they are the most far-reaching and common hazard associated with snow- and ice-covered volcanoes. The major hazard from debris flows to life and property is burial or impact. Because debris flows follow existing drainages, the risk tends to decrease with distance downstream and with height above the river channel.

The disintegration of Mount St. Helens' north flank in 1980 demonstrated the potential danger of tephra. Persons with respiratory problems are endangered, transportation, communications and other lifeline services are interrupted, drainage systems become clogged, and the economy can be adversely impacted.

The following are summary descriptions of the risk associated with major Cascade volcanoes:

- **Mt. Rainier** is the closest volcano hazard to Covington, about 40 miles to the southeast. Although considered an active volcano, Mt. Rainier has not been active since the late 1800s when minor eruptions occurred. If it erupts, Mt. Rainier will have normal eruption hazards and tephra. Mt. Rainier lahars and debris flows have the potential to destroy dams on the White and Green Rivers, as well as to significantly disrupt the economy of the Auburn/Kent

valley as far north as Tukwila. While Mount Rainier has shown no recent signs of volcanic activity, scientists predict the next eruption may consist of lava dome growth accompanied by small explosions, and lava-dome collapse generating pyroclastic flows, ash clouds and lahars. Future eruptions from Mount Rainier could seriously disrupt transportation, water supplies, and hydroelectric power generation and transmission in Washington.

- **Glacier Peak** is approximately 75 miles northeast of Covington. Glacier Peak has produced larger and more explosive eruptions than any other Washington volcano except Mt. St. Helens. Its largest eruption expelled more than three times as much ash as the 1980 eruption of Mt. St. Helens. Approximately 13,000 years ago, dozens or perhaps hundreds of lahars churned down the White Chuck, Suiattle and Sauk rivers, completely inundating valley floors. At Arlington, more than 60 miles downstream, these lahars deposited more than 7 feet of sediment. The total number of eruptions produced by Glacier Peak in the last 14,000 years, both big and small, makes it one of the most active Cascade volcanoes; yet it produces big eruptions relatively infrequently. Glacier Peak's most recent eruption was around the eighteenth century. Covington is most vulnerable to ash from a Glacier Peak eruption.
- **Mt. St. Helens** is the most active and most explosive of Washington's volcanoes. In the last 515 years, it is known to have produced four major explosive eruptions; two of which were separated by only two years. An eruption approximately 500 years ago was about five times larger than the 1980 eruption and even larger events are believed to have occurred in the volcano's 50,000-year lifetime. The volcano is still capable of producing ash, lava flows and lahars. However, neither a large debris avalanche nor a major lateral blast like those of May 18, 1980 is likely now that a deep, open crater has formed. Covington residents are still vulnerable to complications arising from volcanic ash from future eruptions.
- **Mt. Baker** is located about 110 miles north of Covington. After Mt. Rainier, it is the most heavily glaciated of the Cascade volcanoes. Historical records note several explosions during the mid-19th century. However, geologic deposits indicate that Mt. Baker has not had highly explosive eruptions like those of Mt. St. Helens or Glacier Peak, nor has it erupted frequently. The most frequent and destructive events at Mt. Baker have been debris flows and debris avalanches, most of which were not related to magmatic events. Because Mt. Baker is not highly explosive and debris flows from the volcano would not reach Covington, it does not appear that the City is vulnerable to volcanic activity at Mt. Baker.
- **Mt. Adams** is in southwest Washington. Although Mt. Adams has not erupted in the past 6,800 years, scientists believe those post-glacial eruptions and weak, diffuse emissions in the summit area suggest that the volcano is capable of erupting again. As with Mt. Baker, however, geologic deposits show no sign of highly explosive eruptions in the volcano's past. Numerous debris flows generated by glacial and meteorological processes occur frequently at Mt. Adams, but typically affect areas within only a few kilometers of the volcano. Because of these characteristics it is not likely that volcanic activity at Mt. Adams will affect Covington.

12.2.5 Warning Time

Constant monitoring of all active volcanoes means that there will be more than adequate time for evacuation before an event. Since 1980, Mount St. Helens has settled into a pattern of intermittent, moderate and generally non-explosive activity, and the severity of tephra, explosions, and lava flows have diminished. All episodes, except for one very small event in 1984, have been successfully predicted several days to three weeks in advance. However, scientists remain uncertain as to whether the volcano's current explosive cycle ended with the 1980 explosion. The possibility of further large-scale events continues for the foreseeable future.

Monitoring Volcanic Activity at Mount Rainier and Mount St. Helens

USGS and Pacific Northwest Seismograph Network at the University of Washington conduct seismic monitoring of all Cascade volcanoes in Washington and Oregon. The USGS collaborated with scientists from the Geophysics Program at the University of Washington to monitor seismic activity at both Mount St. Helens and Mount Rainier after the May 1980 eruption at Mount St. Helens. When unusual activity is observed, scientists immediately notify government officials and the public. The U.S. Forest Service serves as the primary dissemination agency for emergency information. As the activity changes, USGS scientists provide updated advisories and meet with local, state, and federal officials to discuss the hazards and appropriate levels of emergency response. The experience since 1980 at Mount St. Helens and elsewhere indicates that monitoring is sufficient for scientists to detect the ascent of fresh magma that must take place before another large eruption. This information will enhance warnings and facilitate updated assessments of the hazard.

In addition, the USGS and the National Weather Service monitor lahar and flood hazards at Mount St. Helens. The latter agency has responsibility for providing warnings of floods, including lahars. These monitoring activities not only help nearby communities, but can also provide significant benefit to the Pacific Northwest, including Covington.

Volcanic Event Notification

An emergency coordination center was established at the U.S. Forest Service office in Vancouver, Washington after the 1980 eruption of Mount St. Helens. A communications network and telephone call-down procedure was developed to facilitate rapid dissemination of information about the activity of the volcano. Information was also disseminated through public meetings, press conferences, and briefings with governmental agencies and private businesses. Emergency coordination and communication is necessary to reduce lessee from potential volcanic eruptions in the Cascade region.

Warning Systems

The best warning of a volcanic eruption is one that specifies when and where an eruption is most likely to occur and what type and size eruption should be expected. Such accurate predictions are sometimes possible but still rare in volcanology. The most accurate warnings are those in which scientists indicate an eruption is probably only hours to days away based on significant changes in a volcano’s earthquake activity, ground deformation, and gas emissions. Experience from around the world has shown that most eruptions are preceded by such changes over a period of days to weeks.

A volcano may begin to show signs of unrest several months to a few years before an eruption. In these cases, however, a warning that specifies when it might erupt months to years ahead of time are extremely rare. The strategy that the USGS-CVO uses to provide volcano warnings in the Cascade Range volcanoes in Washington and Oregon involves a series of alert levels that correspond generally to increasing levels of volcanic activity. As a volcano becomes increasingly active or as incoming data suggest that a given level of unrest is likely to lead to a significant eruption, the USGS-CVO declares a corresponding higher alert level. This alert level ranking thus offers the public and civil authorities a framework they can use to gauge and coordinate their response to a developing volcano emergency.

12.3 SECONDARY HAZARDS

The secondary hazards associated with volcanic eruptions are mud flows and landslides.

12.4 CLIMATE CHANGE IMPACTS

Large-scale volcanic eruptions can reduce the amount of solar radiation reaching the Earth's surface, lowering temperatures in the lower atmosphere and changing atmospheric circulation patterns. The massive outpouring of gases and ash can influence climate patterns for years. Sulfuric gases convert to sub-micron droplets containing about 75 percent sulfuric acid. These particles can linger three to four years in the stratosphere. Volcanic clouds absorb terrestrial radiation and scatter a significant amount of incoming solar radiation, an effect that can last from two to three years following a volcanic eruption.

12.5 EXPOSURE

The planning area is exposed to some degree to any eruption by any of the Cascade range volcanoes, especially those located in Washington. There is no lahar exposure within Covington and tephra exposure is assumed to apply to the entire planning area.

12.5.1 Population

The entire population of Covington would be exposed to tephra accumulation from volcanic activity in the Cascade range.

12.5.2 Property

All property in the planning area would be exposed to tephra in the event of a volcanic eruption.

12.5.3 Critical Facilities

All critical facilities and infrastructure within the planning area would be exposed to tephra accumulation in the event of a volcanic eruption.

12.5.4 Environment

The environment is highly exposed to the effects of a volcanic eruption. Even if ash from a volcanic eruption were to fall elsewhere, it could still be spread throughout the planning area by surrounding rivers and streams. A volcanic blast would expose the local environment to many effects such as lower air quality, and many other elements that could harm local vegetation and water quality. Environment in the path of a lahar would be subject to additional impacts.

12.6 VULNERABILITY

12.6.1 Population

The entire population of the planning area is vulnerable to the damaging effects of volcanic ash fall in the event of a volcanic eruption. The elderly, very young and those who experience ear, nose and throat problems are especially vulnerable to the tephra hazard.

12.6.2 Property

All of the property exposed to nature in the planning area is exposed to the effects of a tephra fall. Among these properties, the most vulnerable structures are those that are not as structurally sound and may collapse under the excessive weight of tephra and possible rainfall. Vulnerable property includes equipment and machinery left out in the open, such as combines, whose parts can become clogged by the fine dust. Infrastructure, such as drainage systems, is potentially vulnerable to the effects of a tephra fall,

since the fine ash can clog pipes and culverts. This may be more of a problem if an eruption occurs during winter or early spring when precipitation is highest and floods are most likely.

To estimate the loss potential for this hazard, a qualitative approach was used, based on recommendations from FEMA guidelines on state and local mitigation planning. Loss estimation tools such as HAZUS-MH currently do not have the ability to analyze impacts from volcano hazards. For this study, it was decided to use 0.05 percent as the loss ratio for the volcano hazard. Assessed valuations for the entire planning area were the basis for these estimation, resulting in a loss estimate of $142,479,555.

12.6.3 Critical Facilities

Ash fall accumulation of less than one-half inch is capable of creating temporary disruptions of transportation operations and sewage disposal and water treatment systems. Highways and roads could be closed for hours, days or weeks afterwards. The series of eruptions at Mount St. Helens in 1980 caused Interstate 90 from Seattle to Spokane to close for a week. The impact of the ash fall caused the Seattle and Portland International Airports to close for a few days.

The fine-grained, gritty ash can also cause substantial problems for internal-combustion engines and other mechanical and electrical equipment. The ash can contaminate oil systems, clog air filters, and scratch moving surfaces. Fine ash can also cause short circuits in electrical transformers, which in tum cause power blackouts.

During an eruption at Mount Rainier, Bonneville Power Administration transmission lines may be severed. A number of high voltage lines are located in the nearby vicinity of Mount Rainier. These lines provide a portion of the electrical power to the Seattle-Tacoma Metropolitan Area.

12.6.4 Environment

The environment is vulnerable to the effects of a volcanic eruption. A lahar could be damaging to area rivers and streams and could redirect water flow and cause changes in water courses. Ash fall would expose the local environment to lower air quality and other effects that could harm vegetation and water quality. The sulfuric acid contained in volcanic ash could be very damaging to area vegetation, waters, wildlife and air quality. Rivers and streams are also vulnerable to damage due to ash fall.

12.6.5 Economy

Volcanic eruptions can disrupt the normal flow of commerce and daily human activity without causing severe physical harm or damage. Ash that is a few inches thick can halt traffic, cause rapid wear of machinery, clog air filters, block drains, creeks, and water intakes, and impact agriculture. Removal and disposal of large volumes of deposited ash can also have significant impacts on government and business. The interconnectedness of the region’s economy can be disturbed after a volcanic eruption. Roads, railroads and bridges can be damaged from lahars and mudflows. The Mount St. Helens May 1980 eruption demonstrated the negative effect on the tourism industry. Conventions, meetings and social gatherings were canceled or postponed in cities and resorts throughout Washington and Oregon in areas not initially affected by the eruption. However, the eruption did lead to the creation of a thriving tourist industry for decades following the event.

Transportation of goods may also be halted. Subsequent airport closures can disrupt airline schedules for travelers. In addition, the movement of goods via major highways can also be halted due to debris and tephra in the air. The Mount St. Helens event in May 1980 cost trade and commerce an estimated $50 million in only two days, as ships were unable to navigate the Columbia River. Clouds of ash often cause electrical storms that start fires and damp ash can short-circuit electrical systems and disrupt radio

communication. Volcanic activity can also lead to the closure of nearby recreation areas as a safety precaution long before the activity ever culminates into an eruption.

12.7 FUTURE TRENDS IN DEVELOPMENT

All future development in the planning area will be susceptible to the potential impacts from volcanic eruptions causing ash fall within the region. While this potential impact on the built environment is not considered to be significant, the economic impact on industries that rely on machinery and equipment such as agriculture or civil engineering projects could be significant. Since the extent and location of this hazard is difficult to gauge because it is dependent upon many variables, the ability to institute land use recommendations based on potential impacts of this hazard is limited. While the impacts of tephra are sufficient to warrant risk assessment for emergency management purposes, they are not sufficient to dictate land use decisions.

12.8 SCENARIO

A large area could be affected by ash fall. The most severe impacts would be on the environment. Any eruption of Mt Rainier or Glacier Peak would likely produce significant amounts of ash fall in the planning area. This impact is totally dependent upon the prevailing wind direction during and after the event. No one in the planning area would likely be injured or killed by tephra, but businesses and non-essential government would be closed until the cloud passes. People and animals without shelter would be affected. Structures would be safe, but private property left out in the open, such as farm equipment, might be damaged by the fine ash dust. Clean-up from such an event could be costly, depending upon the magnitude of the event.

12.9 ISSUES

Volcanic activity at Mt. Rainier is believed to pose the greatest threat to King County and its residents. Because of the inactivity of Mt. Rainier, people have tended to settle on its slopes and along the paths taken by lahar and mudflow drainage. If Mt. Rainier becomes active and erupts or has large lahars or mudflows, all human life and property located on its slopes and along its drainage systems (rivers) are potentially vulnerable.

Explosive eruptions at Glacier Peak or Mt. St. Helens would produce ash that would pose health concerns for residents, damage property, and cause major problems for transportation, local industry, communication and utilities. Non-magmatic events at other active Cascade volcanoes would not directly impact King County. However, County residents could be vulnerable if visiting a volcano during volcanic activity.

Research continues to find methods to predict volcanic eruptions accurately. Indications that an eruption may be imminent include swarms of small earthquakes as the magma rises up through the volcano, increases in sulfur dioxide emissions, and physical swelling of mountain slopes. The USGS is currently experimenting with a variety of sensors on Mt. Rainier in order to attempt predictions. While these methods have not been perfected, scientists were able to predict the eruptions of Mt. Pinatubo in the Philippines and Mt. Unzen in Japan.

Since volcanic episodes have been fairly predictable in the recent past, there is probably not much concern about loss of life, but there is concern about loss of property and infrastructure and severe environmental impacts.

CHAPTER 13.
FIRE

13.1 GENERAL BACKGROUND

The City of Covington experiences three types of fire threats: structure fires, wildfires and wildland urban interface (WUI) fires where development is adjacent to densely vegetated areas.

13.1.1 Structure fires

Structure fires are not typically considered an emergency, except when the fire can spread to adjoining structures.

Often, older structures do not conform to modern building and fire codes and do not contain fire detection devices. These structures are also prone to faulty electrical, heating and other utility systems due to age and lack of proper maintenance. Many of these older structures were constructed in very close together, enabling fire to spread rapidly from one structure to another. Older apartment buildings and hotels also face increased risk of rapid fire spread due to inadequate firewall protection and the lack of fire detection and sprinkler systems.

Some newer residential structures, though still susceptible to high population risk, are not as vulnerable to fire as are older structures. These structures were designed and built to include fire resistive features, which conform to modern fire and building codes. Fire detection and/or extinguishing systems were also installed in these buildings at the time of construction. Though a major fire could occur in these structures, the likelihood of spreading to adjoining structures or units before it can be brought under control is significantly reduced.

Commercial, industrial and multi-family fires present their own unique hazards. Some newer structures, like residential occupancies, are built with fire resistive construction and fire detection and/or sprinkler systems (in buildings over 10,000 square feet) thereby reducing the risk of major fires. Older structures and single-family dwellings, however, share many of the same problems as older housing and are at greater risk of fire.

The storage and use of hazardous materials by commercial and industrial occupancies not only increases the risk of fire, but also poses a significant threat to firefighters and the community if they should become involved in a fire.

DEFINITIONS

Conflagration—A fire that grows beyond its original source area to engulf adjoining regions. Wind, extremely dry or hazardous weather conditions, excessive fuel buildup and explosions are usually the elements behind a conflagration.

Firestorm—A fire that expands to cover a large area, often more than a square mile. A firestorm usually occurs when many individual fires grow together into one. The involved area becomes so hot that all combustible materials ignite, even if they are not exposed to direct flame. Temperatures may exceed 1000°C. Superheated air and hot gases of combustion rise over the fire zone, drawing surface winds in from all sides, often at velocities approaching 50 miles per hour. Although firestorms seldom spread because of the inward direction of the winds, once started there is no known way of stopping them. Within the area of the fire, lethal concentrations of carbon monoxide are present; combined with the intense heat, this poses a serious life threat to responding fire forces. In very large events, the rising column of heated air and combustion gases carries enough soot and particulate matter into the upper atmosphere to cause cloud nucleation, creating a locally intense thunderstorm and the hazard of lightning strikes.

Interface Area—An area susceptible to wildfires and where wildland vegetation and urban or suburban development occur together. An example would be smaller urban areas and dispersed rural housing in forested areas.

Wildfire—Fires that result in uncontrolled destruction of forests, brush, field crops, grasslands, and real and personal property in non-urban areas. Because of their distance from firefighting resources, they can be difficult to contain and can cause a great deal of destruction.

In addition to typical methods of occurrence, structure fires are a potential secondary hazard of earthquakes. One study estimated that 80 to 100 fires would occur from a large earthquake in the Seattle area. Building codes requiring fire detectors and sprinkler systems are in effect for most large structures, therefore reducing some vulnerability.

13.1.2 Wildfires

A wildfire is any uncontrolled fire on undeveloped land that requires fire suppression. Controlled burns are conducted because the fire cycle is an important aspect of management for many ecosystems. These are not considered hazards unless they get out of control. Uncontrolled wildfires can be ignited by lightning or by human activity such as smoking, campfires, equipment use and arson. From 1977 to 1994, people caused 80 percent of the wildfires in Washington State, while nature caused 20 percent.

Wildfire presents a considerable risk to vegetation and wildlife habitats. Short-term loss caused by a wildfire can include the destruction of timber, wildlife habitat, scenic vistas and watersheds. Long-term effects include smaller timber harvests, reduced access to affected recreational areas, and destruction of cultural and economic resources and community infrastructure. Vulnerability to flooding increases due to the destruction of watersheds. An average of 905 wildfires burn 6,488 acres annually in Washington State, with a resource loss of $2,103,884.

The probability of a wildfire in any one locality on a particular day depends on fuel conditions, topography and weather conditions, as described in the following sections.

Fuels

Fuels are classified by weight or volume (fuel loading) and by type. Fuel loading, often expressed in tons per acre, can be used to describe the amount of vegetative material available. If fuel loading doubles, the energy released also can be expected to double. Each fuel type is given a burn index, which is an estimate of the amount of potential energy that may be released, the effort required to contain a fire in a given fuel, and the expected flame length. Different fuels have different burn qualities. Some fuels burn more easily or release more energy than others. Grass, for instance, releases relatively little energy, but can sustain very high rates of spread.

Continuity of fuels is expressed in terms of horizontal and vertical dimensions. Horizontal continuity is what can be seen from an aerial photograph and represents the distribution of fuels over the landscape. Vertical continuity links fuels at the ground surface with tree crowns via ladder fuels.

Another essential factor is fuel moisture. Fuel moisture is expressed as a percentage of total saturation and varies with antecedent weather. Low fuel moistures indicate the probability of severe fires. Given the same weather conditions, moisture in fuels of different diameters changes at different rates. A 1,000-hour fuel, which has a 3- to 8-inch diameter, changes more slowly than a 1- or 10-hour fuel.

Topography

Topography can have a powerful influence on wildfire behavior. The movement of air over the terrain tends to direct a fire’s course. Gulches and canyons can funnel air and act as a chimney, intensifying fire behavior and inducing faster rates of spread. Saddles on ridge tops offer lower resistance to the passage of air and will draw fires. Solar heating of drier, south-facing slopes produces upslope thermal winds that can complicate behavior.

Slope is an important factor. If the percentage of uphill slope doubles, the rate of spread of wildfire will likely double. On steep slopes, fuels on the uphill side of the fire are closer physically to the source of

heat. Radiation preheats and dries the fuel, thus intensifying fire behavior. Fire travels downslope much more slowly than it does upslope, and ridge tops often mark the end of wildfire's rapid spread.

Weather

Of all the factors influencing wildfire behavior, weather is the most variable. Extreme weather leads to extreme events, and it is often a moderation of the weather that marks the end of a wildfire's growth and the beginning of successful containment. High temperatures and low humidity can produce vigorous fire activity. The cooling and higher humidity brought by sunset can dramatically quiet fire behavior.

Fronts and thunderstorms can produce winds that are capable of radical and sudden changes in speed and direction, causing similar changes in fire activity. The rate of spread of a fire varies directly with wind velocity. Winds may play a dominant role in directing the course of a fire. The radical and devastating effect that wind can have on fire behavior is a primary safety concern for firefighters. In July 1994, a sudden change in wind speed and direction on Storm King Mountain in Colorado led to a blowup that claimed the lives of 14 firefighters. The most damaging firestorms are usually marked by high winds.

13.1.3 Wildland/Urban Interface Fires

WUI fires occur where combustible vegetation meets combustible structures, combining the hazards associated with wildfires and structure fires. These types of fires have increased dramatically in the last two decades as more and more people move to rural areas. Between 1970 and 1980 the rural population of the United States increased 23.4 percent, more than twice the gain of 11.4 percent for the nation as a whole. The hazard is bi-directional, wild fires can burn homes, and home fires can burn into wildlands.

WUI fires are increasing as more vacation homes are built and improved transportation systems allow more people to live outside city centers. The longer response times for these out-of-the-way locations gives the fire more time to get out of control, making these fires difficult to fight. Most firefighters are trained to fight either wildfires or structure fires. WUI fires require both skills, and it is very difficult to balance the two. When a WUI fire breaks out, the threat of extreme property and casualty losses often forces firefighters to focus their efforts on protecting homes and structures, sometimes at the expense of protecting wildland resources or working to slow the fire itself.

13.2 HAZARD PROFILE

13.2.1 Past Events

Structure fires

The largest conflagration in King County history is the 1889 Seattle fire, which is estimated to have consumed 60 acres of downtown.

On August 6, 1992, a series of fires began in the north Seattle area. Ultimately, 76 fires occurred, resulting in losses of over $22 million. On February 6, 1993, Paul Keller was arrested and charged with arson. He ultimately pled guilty to setting 32 of the fires.

Wildfires

Fire is a normal part of most forest and range ecosystems in temperate regions of the world. Fires historically burn on a fairly regular cycle, recycling carbon and nutrients stored in the ecosystem and strongly affecting the species within the ecosystem. Annual acreage consumed by wildfires in the lower 48 states dropped from about 40 to 50 million acres per year in the 1930s to under 5 million acres by

1970. A Western Washington study showed that modern wildfires are estimated to consume only about a tenth of the biomass each year that prehistoric fires burned.

The U.S. Department of the Interior maintains a database of federal agency records for 677,000 fires that occurred from 1980 through 2012 (USGS 2013). There are no incidents recorded as occurring within the City of Covington in this database. However, there are 332 events listed that occurred in King County. Of these 332 events, 86 percent were attributed to human causes. Only six of the King County fires burned 10 acres or more; these are listed in Table 13-1.

TABLE 13-1.
WILDFIRES IN KING COUNTY GREATER THAN 10 ACRES, 1980-2012

Forest Service Fire ID	Fire Name	Cause	Start Date	Area Burned (acres)
1483448	Crystal Mine	Natural	8/4/2009	25
285295	Unnamed	Human	5/24/1993	16
251146	Falls Creek	Human	7/26/1988	2,600
246258	Unnamed	Human	7/29/1988	70
246146	Unnamed	Human	9/11/1986	40
246145	Unnamed	Human	9/11/2986	40

Source: Federal Wildland Fire Occurrence Data, http://wildfire.cr.usgs.gov/firehistory/data.html

Wildland/Urban Interface Fires

The City of Covington has not experienced a large WUI fire but the city is susceptible to fires similar to California's October 1991 Oakland Hills fire, which killed 25 people, injured 150 others, destroyed 3,354 single-family homes, 456 apartments, and caused $1.5 billion in damage.

13.2.2 Location

Covington residents are served by King County Fire District #37 and Maple Valley Fire and Life Safety District #43. Data that includes the location of WUI areas in the city can be used to assess the population and total value of property at risk from wildfire, and direct these fire districts in fire prevention and recovery.

Covington has a number of areas that are susceptible to wildfires. Including federal lands, the areas of potential wildfires cover an estimated 20 percent of the city. The forested hills surrounding the outskirts of the City are considered to be WUI areas. The development of homes and other structures is encroaching onto the forest and natural areas, expanding the WUI. The WUI neighborhoods are characterized by a diverse mixture of housing structures, development patterns, ornamental and natural vegetation, and natural fuels.

The King County Office of Emergency Management is in the process of identifying and mapping wildfire hazard areas from aerial photography and GIS analysis under the direction of the Fire District and the Emergency Management Coordinator. Four-section aerial photography maps will be provided for each fire agency in the city and the Covington Emergency Coordination Center. Each agency will receive map books to help define WUI areas, identify structures in the threatened areas, support local interpretation of WUI zones developed on a regional level, and provide a snapshot of vulnerability to assist mutual aid

responders. Additional information layers (hydrants, hazardous materials facilities, schools, etc.) may be displayed, as available. The wildfire hazard maps will assist City and fire districts and departments in developing fire plans to address the areas most vulnerable to wildfires in Covington.

The following sections describe two types of wildfire hazard mapping produced by the U.S. Forest Service and LANDFIRE (a program of the U.S. Forest Service and the U.S. Department of the Interior, under the direction of the Wildland Fire Leadership Council): fire regime mapping and fire behavior fuel model classifications.

Fire Regime Mapping

The LANDFIRE project produces maps of historical fire regimes and vegetation and maps of current vegetation and its departure from historical conditions. The maps categorize mean fire return intervals and fire severities into five fire regimes (Hann et al., 2004):

- Fire Regime I—0 to 35 year frequency, low to mixed severity
- Fire Regime II—0 to 35 year frequency, replacement severity
- Fire Regime III—35 to 200 year frequency, low to mixed severity
- Fire Regime IV—35 to 200 year frequency, replacement severity
- Fire Regime V—200+ year frequency, any severity.

These maps support fire and landscape management planning outlined in the goals of the National Fire Plan, Federal Wildland Fire Management Policy, and the Healthy Forests Restoration Act. Figure 13-1 shows fire regimes in Covington based on LANDFIRE models.

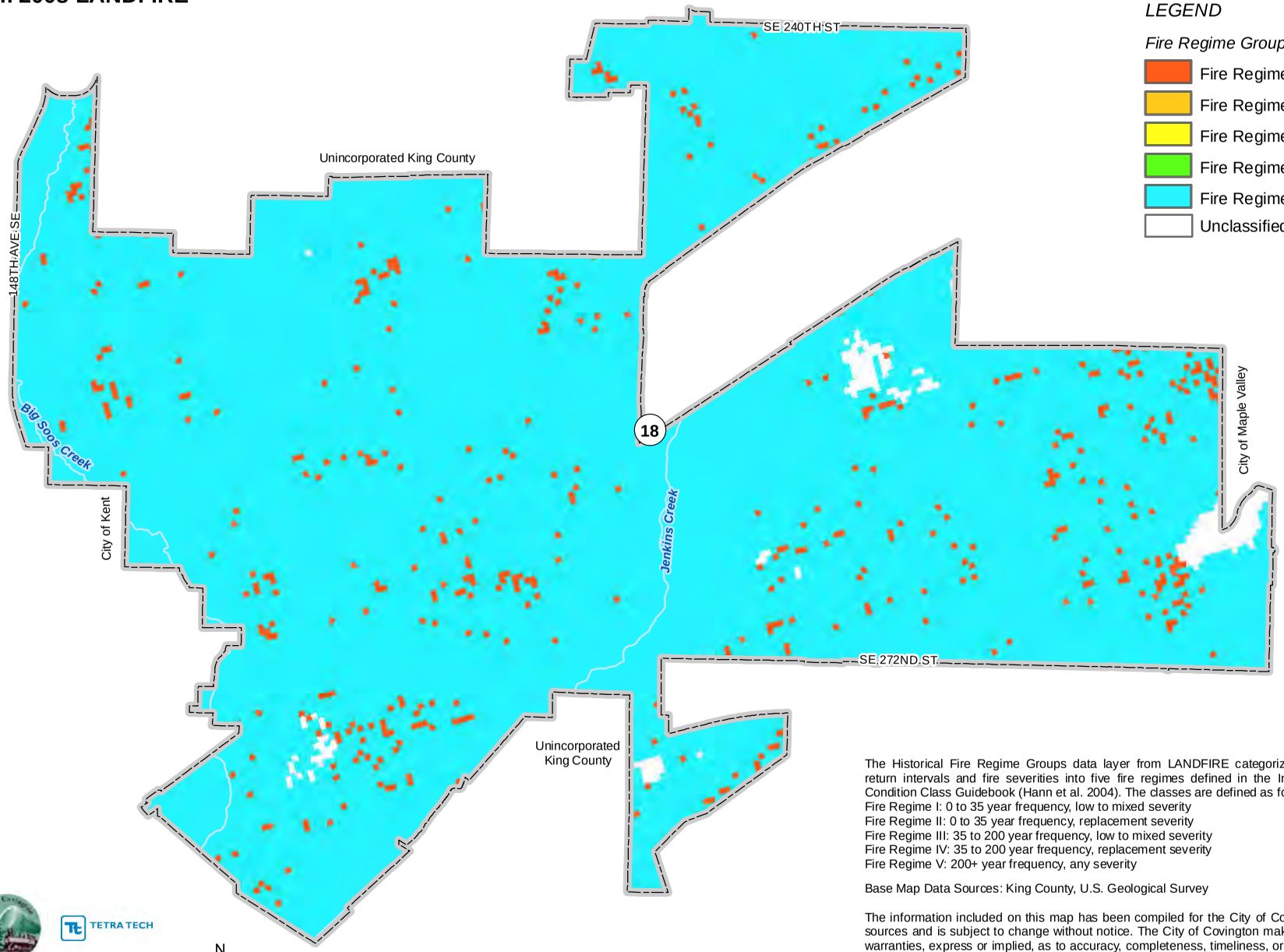
Fire Behavior Fuel Model Classifications

Thirteen standard fire behavior fuel models (FBFM) serve as input to a mathematical model of surface fire behavior and spread. The fire behavior fuel model layer (FBFM13) represents the distribution of fuel loading among live and dead surface fuel components, size classes, and fuel types. The fuel models are described by the most common fire-carrying fuel type (grass, brush, timber litter, or slash), loading and surface area-to-volume ratio by size class and component, fuel bed depth, and moisture of extinction.

The FBFM13 layer was produced by fire and fuels specialists based on vegetation type, cover and height. The 13 classes, shown on Figure 13-2, are defined as follows:

- FBFM 1—Surface fires that burn fine herbaceous fuels, cured and curing fuels, little shrub or timber present, primarily grasslands and savanna
- FBFM 2—Burns fine, herbaceous fuels, stand is curing or dead, may produce fire brands on oak or pine stands
- FBFM 3—Most intense fire of grass group, spreads quickly with wind, one third of stand dead or cured, stands average 3 feet tall
- FBFM 4—Fast spreading fire, continuous overstory, flammable foliage and dead woody material, deep litter layer can inhibit suppression
- FBFM 5—Low intensity fires, young, green shrubs with little dead material, fuels consist of litter from understory

Figure 13-1
Fire Regime Groups from 2008 LANDFIRE



LEGEND

Fire Regime Groups

- Fire Regime Group I
- Fire Regime Group II
- Fire Regime Group III
- Fire Regime Group IV
- Fire Regime Group V
- Unclassified

TETRA TECH

0 0.25 0.5 Miles

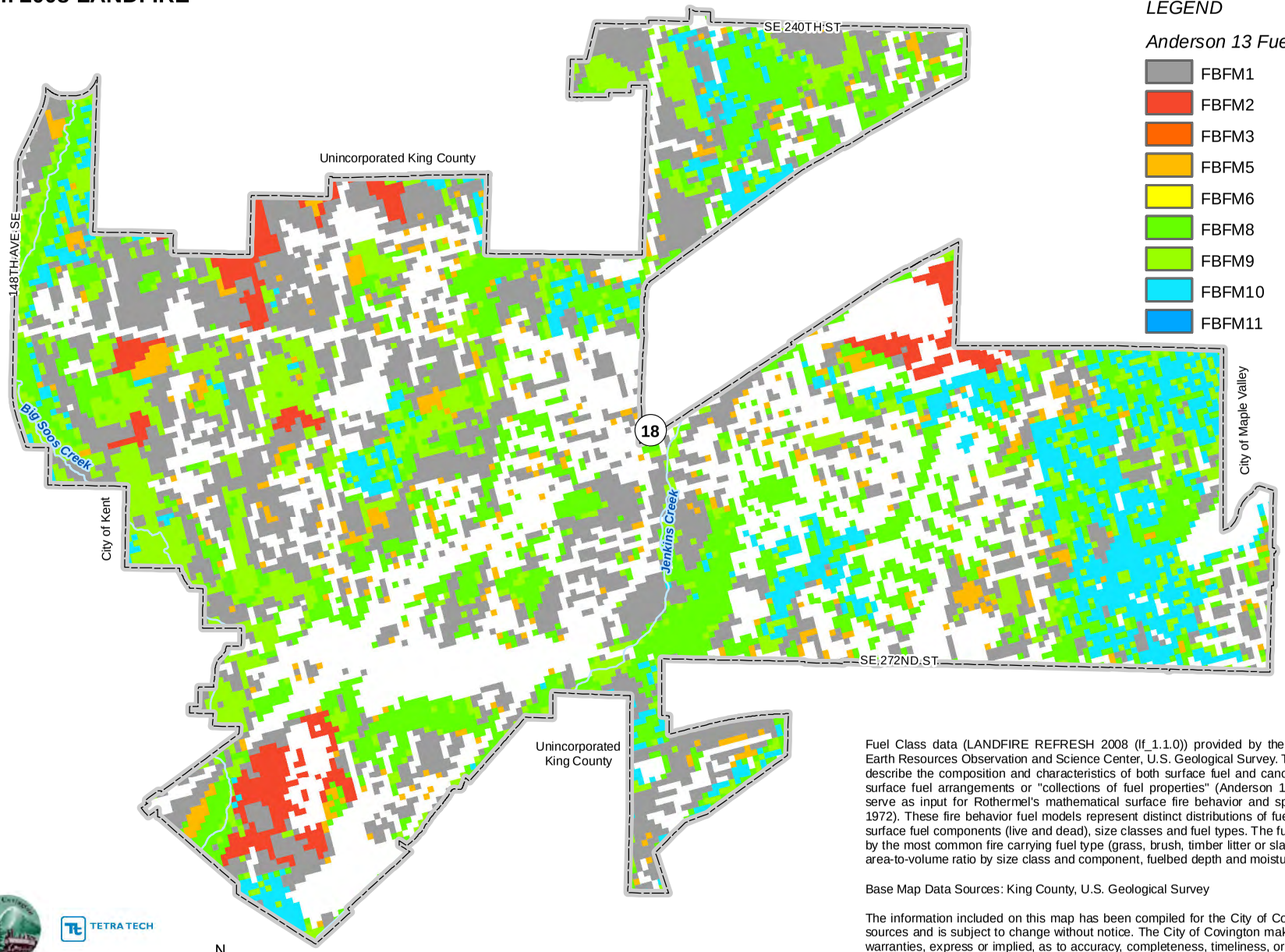
N W E S

The Historical Fire Regime Groups data layer from LANDFIRE categorizes simulated mean fire return intervals and fire severities into five fire regimes defined in the Interagency Fire Regime Condition Class Guidebook (Hann et al. 2004). The classes are defined as follows:
Fire Regime I: 0 to 35 year frequency, low to mixed severity
Fire Regime II: 0 to 35 year frequency, replacement severity
Fire Regime III: 35 to 200 year frequency, low to mixed severity
Fire Regime IV: 35 to 200 year frequency, replacement severity
Fire Regime V: 200+ year frequency, any severity

Base Map Data Sources: King County, U.S. Geological Survey

The information included on this map has been compiled for the City of Covington from a variety of sources and is subject to change without notice. The City of Covington makes no representations or warranties, express or implied, as to accuracy, completeness, timeliness, or rights to the use of such information. The City of Covington shall not be liable for any general, special, indirect, incidental, or consequential damages including, but not limited to, lost revenues or lost profits resulting from the use or misuse of the information contained on this map. Any sale of this map or information on this map is prohibited except by written permission of the City of Covington.

Figure 13-2
Fire Behavior Fuel Model from 2008 LANDFIRE



LEGEND

Anderson 13 Fuel Classes

- FBFM1
- FBFM2
- FBFM3
- FBFM5
- FBFM6
- FBFM8
- FBFM9
- FBFM10
- FBFM11

TETRA TECH

0 0.25 0.5 Miles

N W E S

Fuel Class data (LANDFIRE REFRESH 2008 (lf_1.1.0)) provided by the Wildland Fire Science, Earth Resources Observation and Science Center, U.S. Geological Survey. The LANDFIRE fuel data describe the composition and characteristics of both surface fuel and canopy fuel. Thirteen typical surface fuel arrangements or "collections of fuel properties" (Anderson 1982) were described to serve as input for Rothermel's mathematical surface fire behavior and spread model (Rothermel 1972). These fire behavior fuel models represent distinct distributions of fuel loadings found among surface fuel components (live and dead), size classes and fuel types. The fuel models are described by the most common fire carrying fuel type (grass, brush, timber litter or slash), loading and surface area-to-volume ratio by size class and component, fuelbed depth and moisture of extinction.

Base Map Data Sources: King County, U.S. Geological Survey

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- FBFM 6—Broad range of shrubs, fire requires moderate winds to maintain flame at shrub height, or will drop to the ground with low winds
- FBFM 7—Foliage highly flammable, allowing fire to reach shrub strata levels, shrubs generally 2 to 6 feet high
- FBFM 8—Slow, ground burning fires, closed canopy stands with short needle conifers or hardwoods, litter consisting mainly of needles and leaves, with little undergrowth, occasional flares with concentrated fuels
- FBFM 9—Longer flames, quicker surface fires, closed canopy stands of long-needles or hardwoods, rolling leaves in fall can cause spotting, dead-down material can cause occasional crowning
- FBFM 10—Surface and ground fire more intense, dead-down fuels more abundant, frequent crowning and spotting causing fire control to be more difficult
- FBFM 11—Fairly active fire, fuels consist of slash and herbaceous materials, slash originates from light partial cuts or thinning projects, fire is limited by spacing of fuel load and shade from overstory
- FBFM 12—Rapid spreading and high intensity fires, dominated by slash resulting from heavy thinning projects and clear-cuts, slash is mostly 3 inches or less
- FBFM 13—Fire spreads quickly through smaller material and intensity builds slowly as large material ignites, continuous layer of slash larger than 3 inches in diameter predominates, resulting from clear-cuts and heavy partial cuts, active flames sustained for long periods of time, fire is susceptible to spotting and weather conditions.

13.2.3 Frequency

During 1996, there were more than 900 reported fire incidents within the greater Kent area causing significant monetary loss of property.

Natural fire rotation is defined as the number of years necessary for fires to burn over an area equal to that of the study area. Natural fire rotation is calculated from the historical record of fires by dividing the length of the record period in years by the percentage of total area burned during that period. It represents the average period between fires under a presumed historical fire regime. Since 1980, King County has seen an average of 10 wildfires per year. The vast majority of these fires burn less than 10 acres, with an overall average of 8.6 acres per incident. Fires occur annually, although fires that burn more than 10 acres have only occurred once every 5 years, on average.

13.2.4 Severity

Structure Fires

Injuries and casualties to the occupants of a structure are a primary concern in all structure fires. These events can also cause the release of hazardous materials and disconnect utility lines. Given the immediate response times to reported fires, the likelihood of injuries and casualties is minimal.

Wildfires

Potential losses from wildfire include human life, structures and other improvements, and natural resources. The effects of wildfires vary with intensity, area and time of year. The greatest short-term loss is the complete destruction of valuable resources, such as timber, wildlife habitat, recreation areas, and watersheds. In addition, wildfire can lead to ancillary impacts such as landslides in steep ravine areas and

flooding due to the impacts of silt in local watersheds. Severe fires producing high soil temperatures create a water-repellent layer below the soil surface. The soil above this layer becomes highly prone to erosion, often resulting in mudslides. Long-term effects are reduced amounts of timber for commercial purposes and the reduction of travel and recreational activities in the affected area.

Health impacts, loss of life, and personal property losses occur as well. Smoke and air pollution from wildfires can be a health hazard, especially for sensitive populations including children, the elderly and those with respiratory and cardiovascular diseases. Wildfire may also threaten the health and safety of those fighting the fires. First responders are exposed to the dangers from the initial incident and after-effects from smoke inhalation and heat stroke. There are no recorded incidents of loss of life from wildfires in the planning area.

WUI Fires

The effects of WUI fires are the combined effects of both structure fires and wildfires.

13.2.5 Warning Time

Wildfires are often caused by humans, intentionally or accidentally. There is no way to predict when one might break out. Since fireworks often cause brush fires, extra diligence is warranted around the Fourth of July when the use of fireworks is highest. Dry seasons and droughts are factors that greatly increase fire likelihood. Dry lightning may trigger wildfires. Severe weather can be predicted, so special attention can be paid during weather events that may include lightning. Reliable National Weather Service lightning warnings are available on average 24 to 48 hours prior to a significant electrical storm. If a fire does break out and spread rapidly, residents may need to evacuate within days or hours. A fire's peak burning period generally is between 1 p.m. and 6 p.m. Once a fire has started, fire alerting is reasonably rapid in most cases. The rapid spread of cellular and two-way radio communications in recent years has further contributed to a significant improvement in warning time.

13.3 SECONDARY HAZARDS

Wildfires can generate a range of secondary effects, which in some cases may cause more widespread and prolonged damage than the fire itself. Fires can cause direct economic losses in the reduction of harvestable timber and indirect economic losses in reduced tourism. Wildfires cause the contamination of reservoirs, destroy transmission lines and contribute to flooding. They strip slopes of vegetation, exposing them to greater amounts of runoff. This in turn can weaken soils and cause failures on slopes. Major landslides can occur several years after a wildfire. Most wildfires burn hot and for long durations that can bake soils, especially those high in clay content, thus increasing the imperviousness of the ground. This increases the runoff generated by storm events, thus increasing the chance of flooding.

13.4 CLIMATE CHANGE IMPACTS

Fire in western ecosystems is determined by climate variability, local topography, and human intervention. Climate change has the potential to affect multiple elements of the wildfire system: fire behavior, ignitions, fire management, and vegetation fuels. Hot dry spells create the highest fire risk. Increased temperatures may intensify wildfire danger by warming and drying out vegetation. When climate alters fuel loads and fuel moisture, forest susceptibility to wildfires changes. Climate change also may increase winds that spread fires. Faster fires are harder to contain, and thus are more likely to expand into residential neighborhoods.

Historically, drought patterns in the West are related to large-scale climate patterns in the Pacific and Atlantic oceans. The El Niño–Southern Oscillation in the Pacific varies on a 5- to 7-year cycle, the Pacific

Decadal Oscillation varies on a 20- to 30-year cycle, and the Atlantic Multidecadal Oscillation varies on a 65- to 80-year cycle. As these large-scale ocean climate patterns vary in relation to each other, drought conditions in the U.S. shift from region to region. El Niño years bring drier conditions to the Pacific Northwest and more fires.

Climate scenarios project summer temperature increases between 2ºC and 5°C and precipitation decreases of up to 15 percent. Such conditions would exacerbate summer drought and further promote high-elevation wildfires, releasing stores of carbon and further contributing to the buildup of greenhouse gases. Forest response to increased atmospheric carbon dioxide could also contribute to more tree growth and thus more fuel for fires, but the effects of carbon dioxide on mature forests are still largely unknown. High carbon dioxide levels should enhance tree recovery after fire and young forest regrowth, as long as sufficient nutrients and soil moisture are available, although the latter is in question for many parts of the western United States because of climate change.

13.5 EXPOSURE

13.5.1 Population

Population could not be examined by WUI area because census block group areas do not coincide with the fire risk areas. However, population was estimated using the structure count of buildings in the WUI area and applying the census value of 3.02 persons per household for the City of Covington. These estimates are shown in Table 13-2.

TABLE 13-2.
POPULATION WITHIN FIRE BEHAVIOR FUEL MODEL CLASSES

		Population	
	Number of Buildings	Number	% of Total
FBFM 10	496	1,498	8%
FBFM 9	600	1,812	10%
FBFM 8	1,139	3,440	19%
Total	**2,235**	**6,750**	**37%**

13.5.2 Property

Property damage from wildfires can be severe and can significantly alter entire communities. Table 13-3 shows the number of structures in the various wildfire hazard zones within the planning area and their values. The planning area has exposure to wildfire hazards to some degree. The fire hazard severity zone data was not accurate enough at this scale to perform a land use analysis. Therefore, it is assumed that the predominant land use in the developed portions of the City in the high risk hazard classes is residential.

13.5.3 Critical Facilities and Infrastructure

No inventory of critical facilities in high fire hazard severity zones was created because the GIS data is not accurate enough. In the event of wildfire, there would likely be little damage to most critical infrastructure. Few roads or railroads would be damaged, except in the worst scenarios. Power lines are the most at risk to wildfire because most are made of wood and susceptible to burning.

TABLE 13-3.
EXPOSURE AND VALUE OF STRUCTURES IN WILDFIRE HAZARD AREAS

	FBFM 8	FBFM 9	FBFM 10	**Total**
Number of Buildings Exposed	1,139	600	496	**2,235**
Value Exposed				
Structure	$115,673,609	$169,115,008	$291,825,033	**$576,613,650**
Contents	$67,941,899	$105,682,433	$198,521,164	**$372,145,496**
Total	**$183,615,508**	**$274,797,441**	**$490,346,197**	**$948,759,146**
Exposed Value as % of Total Assessed Value	6.44%	9.64%	17.21%	**33.29%**

In the event of a wildfire, fuel pipelines could experience a catastrophic explosion. Hazardous materials storage containers could rupture due to excessive heat and act as fuel for the fire, causing rapid spreading and escalating the fire to unmanageable levels. In addition they could leak into surrounding areas, saturating soils and seeping into surface waters, and have a disastrous effect on the environment.

13.5.4 Environment

Fire is a natural and critical ecosystem process in most terrestrial ecosystems, dictating in part the types, structure and spatial extent of native vegetation. However, wildfires can cause severe environmental impacts:

- Damaged Fisheries—Critical fisheries can suffer from increased water temperatures, sedimentation and changes in water quality.
- Soil Erosion—The protective covering provided by foliage and dead organic matter is removed, leaving the soil fully exposed to wind and water erosion. Accelerated soil erosion occurs, causing landslides and threatening aquatic habitats.
- Spread of Invasive Plant Species—Non-native woody plant species frequently invade burned areas. When weeds become established, they can dominate the plant cover over broad landscapes, and become difficult and costly to control.
- Disease and Insect Infestations—Unless diseased or insect-infested trees are swiftly removed, infestations and disease can spread to healthy forests and private lands. Timely active management actions are needed to remove diseased or infested trees.
- Destroyed Endangered Species Habitat—Catastrophic fires can have devastating consequences for endangered species.
- Soil Sterilization—Topsoil exposed to extreme heat can become water repellant, and soil nutrients may be lost. It can take decades or even centuries for ecosystems to recover from a fire. Some fires burn so hot that they can sterilize the soil.

Many ecosystems are adapted to historical patterns of fire occurrence. These patterns include temporal attributes (e.g., frequency and seasonality), spatial attributes (e.g., size and spatial complexity), and magnitude attributes (e.g., intensity and severity), each of which have ranges of natural variability. Ecosystem stability is threatened when any of the attributes for a given fire regime diverge from its range of natural variability.

13.6 VULNERABILITY

Structures, above-ground infrastructure, critical facilities and natural environments are all vulnerable to the wildfire hazard. There is currently no validated damage function available to support wildfire mitigation planning. Except as discussed in this section, vulnerable populations, property, infrastructure and environment are assumed to be the same as described in the section on exposure.

13.6.1 Population

There are no recorded incidents of loss of life from wildfires within the planning area. Given the immediate response times to reported fires, the likelihood of injuries and casualties is minimal; therefore, injuries and casualties were not estimated for the wildfire hazard.

Smoke and air pollution from wildfires can be a severe health hazard, especially for sensitive populations, including children, the elderly and those with respiratory and cardiovascular diseases. Smoke generated by wildfire consists of visible and invisible emissions that contain particulate matter (soot, tar, water vapor, and minerals), gases (carbon monoxide, carbon dioxide, nitrogen oxides), and toxics (formaldehyde, benzene). Emissions from wildfires depend on the type of fuel, the moisture content of the fuel, the efficiency (or temperature) of combustion, and the weather. Public health impacts associated with wildfire include difficulty in breathing, odor, and reduction in visibility.

Wildfire may also threaten the health and safety of those fighting the fires. First responders are exposed to the dangers from the initial incident and after-effects from smoke inhalation and heat stroke.

13.6.2 Property

Loss estimations for the wildfire hazard are not based on damage functions, because no such damage functions have been generated. Instead, loss estimates were developed representing 10 percent, 30 percent and 50 percent of the assessed value of exposed structures. This allows emergency managers to select a range of economic impact based on an estimate of the percent of damage to the general building stock. Damage in excess of 50 percent is considered to be substantial by most building codes and typically requires total reconstruction of the structure. Table 13-4 lists the loss estimates for the general building stock for jurisdictions that have an exposure to a fire hazard severity zone.

TABLE 13-4.
POTENTIAL LOSS ESTIMATES FOR WILDFIRE (FBFM 8, 9 AND 10)

Exposed Value	$948,759,145
Potential Loss from Wildfire	
10% Damage	$94,875,915
30% Damage	$284,627,744
50% Damage	$474,379,573

13.6.3 Critical Facilities and Infrastructure

Critical facilities of wood frame construction are especially vulnerable during wildfire events. In the event of wildfire, there would likely be little damage to most infrastructure. Most roads and railroads would be without damage except in the worst scenarios. Power lines are the most at risk from wildfire because most poles are made of wood and susceptible to burning. Fires can create conditions that block or prevent

access and can isolate residents and emergency service providers. Wildfire typically does not have a major direct impact on bridges, but it can create conditions in which bridges are obstructed. Many bridges in areas of high to moderate fire risk are important because they provide the only ingress and egress to large areas and in some cases to isolated neighborhoods.

13.7 FUTURE TRENDS IN DEVELOPMENT

The Covington Municipal Code details development standards incorporating building and site attributes that reinforce passive fire prevention for each zoning district, which provides fire safety and protection for all structures. The International Building Code also contains fire classification standards for roofing materials to prevent the propagation of fire between buildings and to resist wildfires. Building Safety Division personnel verify that these materials are correctly used for the specific type of building and occupancy group in both residential and commercial buildings.

King County Fire District #37 and Maple Valley Fire and Life Safety District #43 serve Covington residents. The District promotes partnerships among the various fire service providers in the City. The County Zone 3 meets on a regular basis to ensure coordination of resources on a regional scale. The members of this zone are responsible for developing and maintaining the Fire and Emergency Resources Plan, which documents the available resources and defined protocol for providing large-scale emergency response and adequate levels of emergency services during an emergency. In addition to King County Fire District #37 and Maple Valley Fire and Life Safety District #43, many of the fire jurisdictions in the area have partnered to form mutual aid areas, to assist in fire prevention education and outreach, train Citizen Emergency Response Teams, and ensure availability of resources.

The fire service providers in the City are dedicated to fire prevention, and use their resources to educate the public to reduce the threat of the fire hazard, especially in the WUI. Fire districts also provide essential public services beyond extinguishing fires, including the following:

- Home fire safety inspection
- Assistance developing home fire escape plans
- Business inspections
- Woodstove installation inspections
- Free smoke detectors to district residents who qualify
- Fire extinguisher operation classes
- Citizen Emergency Response Team training
- School, church and civic group fire safety education presentations
- Fire cause determination
- Counseling for juvenile fire-setters
- Conducting CPR classes
- Teaching proper use of fire extinguishers
- Coordinating educational programs with other agencies, hospitals, and schools
- Answering citizens’ questions regarding fire hazards.

13.8 SCENARIO

A major conflagration in the planning area might begin with a wet spring, adding to fuels already present on the forest floor. Flashy fuels would build throughout the spring. The summer could see the onset of insect infestation. A dry summer could follow the wet spring, exacerbated by dry hot winds. Carelessness with combustible materials or a tossed lit cigarette, or a sudden lightning storm could trigger a multitude of small isolated fires.

The embers from these smaller fires could be carried miles by hot, dry winds. The deposition zone for these embers would be deep in the forests and WUI zones. Fires that start in flat areas move slower, but wind still pushes them. It is not unusual for a wildfire pushed by wind to burn the ground fuel and later climb into the crown and reverse its track. This is one of many ways that fires can escape containment, typically during periods when response capabilities are overwhelmed. These new small fires would most likely merge. Suppression resources would be redirected from protecting the natural resources to saving more remote subdivisions.

The worst-case scenario would include an active fire season throughout the American west, spreading resources thin. Firefighting teams would be exhausted or unavailable. Many federal assets would be responding to other fires that started earlier in the season. While local fire districts would be extremely useful in the WUI areas, they have limited wildfire capabilities or experience, and they would have a difficult time responding to the ignition zones. Even though the existence and spread of the fire is known, it may not be possible to respond to it adequately, so an initially manageable fire can become out of control before resources are dispatched.

To further complicate the problem, heavy rains could follow, causing flooding and landslides and releasing tons of sediment into rivers, permanently changing floodplains and damaging sensitive habitat and riparian areas. Such a fire followed by rain could release millions of cubic yards of sediment into streams for years, creating new floodplains and changing existing ones. With the forests removed from the watershed, stream flows could easily double. Floods that could be expected every 50 years may occur every couple of years. With the streambeds unable to carry the increased discharge because of increased sediment, the floodplains and floodplain elevations would increase.

13.9 ISSUES

Factors related to the fighting of fires include access, firebreaks, proximity of water sources, distance from a fire station, and available firefighting personnel and equipment. Reviewing past WUI fires shows that many structures are destroyed or damaged for one or more of the following reasons:

- Combustible roofing material
- Wood construction
- Structures with no defensible space
- Fire department with poor access to structures
- Subdivisions located in heavy natural fuel types
- Structures located on steep slopes covered with flammable vegetation
- Limited water supply
- Winds over 30 miles per hour.

Road access is a major issue for all emergency service providers. As development encroaches into the rural areas of the city, the number of houses without adequate tum-around space is increasing. Developers

are not required to provide adequate space for emergency vehicles in single-family residential homes, causing emergency workers to have difficulty doing their jobs because they cannot access houses. As fire trucks are large, firefighters are challenged by narrow roads and limited access. When there is doubt concerning the stability of a residential bridge, or adequate turn-around space, firefighters can work to remove the occupants but cannot save the structure. Fires may become conflagration fires caused by reduced setbacks between structures. Narrow setbacks also prevent fire crews from safely laddering the sides of buildings.

Firefighters in remote and rural areas are faced by limited water supply and lack of hydrant taps. Rural areas are adapting to these conditions by developing a secondary water source. Areas that once were considered rural during county control became urban with incorporation and annexation, coupled with development.

Important issues associated with fire in the City of Covington include the following:

- Citizens should know the proper way to handle fire. Public education programs on fire safety, fire alarms and fire response are important.
- Since people start the vast majority of wildfires, wildfire prevention education and enforcement programs can significantly reduce the total number of wildfires.
- People should be encouraged to purchase fire insurance and understand building codes.
- The number of commercial and industrial fires in the City of Covington has been controlled in recent years due to annual fire inspections performed by Kent Fire Department. These inspections identify potential problems and provide an opportunity for business owners and workers to be more aware of fire prevention through education provided at the time of inspection.
- Arson investigation has been a significant factor in the reduction of urban fires. Investigators and fire crews work together to convict and or deter more arsonists than ever before.
- An effective early fire detection program and emergency communications system are essential. The importance of immediately reporting any wildfire must be impressed upon local residents and persons using forest areas.
- An effective warning system is essential to notify local inhabitants and persons in the area of the fire. An evacuation plan detailing primary and alternate escape routes is also essential.
- Fire-safe development planning should be done with local government planners.
- Road criteria should ensure adequate escape routes for new sections of development in forest areas.
- Road closures should be increased during peak fire periods to reduce the access to fire-prone areas.

CHAPTER 14.
OTHER HAZARDS OF INTEREST

The hazards that are assessed in Chapter 6 through Chapter 13 and rated and ranked in Chapter 15 are those that present significant risks within the City of Covington. Additional hazards, both technological and human-caused, were identified by the Steering Committee as having some potential to impact the planning area, but at a much lower risk level than the hazards of concern. These other hazards are identified as hazards of interest.

This chapter presents a short profile of each hazard of interest, including a qualitative discussion of its potential to impact the City of Covington. No formal risk assessment of these hazards was performed. However, City staff and residents should be aware of these hazards and should take steps to reduce the risks they present whenever it is practical to do so.

14.1 CIVIL DISORDER

The term civil disorder refers to incidents that disrupt a community to the degree that law enforcement intervention is required to maintain public safety. These incidents are generally associated with controversial political, judicial or economic issues and may occur at any time of the year, although statistics indicate that they are more frequent during summer. Civil disorder does not refer to the lawful exercise of rights, such as freedom of speech or the right of people to peacefully assemble. Thousands of political demonstrations and protest events occur every year that do not result in violence to people or damage to property.

The City of Covington and King County do not have extensive histories of civil disorder, but U.S. history has been punctuated by episodes of civil unrest. Events in the 1960s and 1970s focused on civil rights and political opposition to the Vietnam War. Washington State witnessed race riots in the 1960s, protests against the Vietnam War in the 1970s, abortion clinic demonstrations in the 1980s, and disturbances stemming from allegations of police brutality in the 1990s. In recent years, civil disturbances have occurred more frequently in response to sporting events and other issues that are not directly related to political reform (King County Office of Emergency Management, 2009). Disturbances referred to as riots are generally classified as either politically motivated or spontaneously occurring in response to another event. In both instances, property damage as well as injuries to civilians and police are of concern.

14.1.1 Past Events

All cities are vulnerable to civil disturbance, although such events are more common in larger urban areas. Incidents are more likely to occur when social and economic tensions within communities are high. Most civil disorder events in King County have occurred in Seattle:

- On May Day in 2013, some members of a crowd turned violent during an otherwise peaceful anti-capitalist march from the Capitol Hill neighborhood to downtown. There were a few instances of broken windows, and police used pepper spray and flash bang devices to disperse the crowd. Seventeen arrests were made and eight police officers suffered minor injuries (http://blogs.seattletimes.com/today/2013/05/reporters-outnumber-protesters-at-may-day-event-in-westlake-park/).
- In 2012, a peaceful May Day rally in the downtown Seattle shopping district turned violent as a fringe group of protestors began to smash glass doors and windows and to vandalize parked

cars. There were reports of homemade incendiary devices and violent assaults. Much of the violence was blamed on the "Black Bloc," a group of protesters in black apparel and faces covered with bandanas. After the violence, members of the group were seen changing back into street clothes in an attempt to blend into the crowd. Seattle police made at least eight arrests (http://www.king5.com/news/cities/seattle/May-Day-protests--149640725.html).

- In 2003, private vehicles and police cruisers were set on fire and injuries were reported after an incident involving drunken youth in the fraternity district of the University of Washington. One person was arrested and the violence was largely blamed on persons not affiliated with the University (King County Office of Emergency Management, 2009 and Washington Emergency Management Division, 2010).
- Interstate-5 was shut down three times in 2002 and 2003 as a result of protest actions. The three instances were in response to different events, but all resulted in a temporary disruption to regional transportation and commerce (King County Office of Emergency Management, 2009). These events resulted in 19 arrests and small amounts of property damage.
- The annual Mardi Gras celebration in Seattle's Pioneer Square in 2001 brought a crowd estimated to be around 9,000 and consisting largely of intoxicated young people. An estimated 350 police officers were on hand for crowd control. During the disturbance, a man was beaten to death during a violent confrontation that may have been racially motivated or gang related. In addition to the homicide, the incident resulted in 43 arrests, 6 injured officers, 69 injured citizens and thousands of dollars in damage to six area businesses.
- In November 1999, the World Trade Organization's annual meeting was held in Seattle. A riot began as a protest by thousands of people challenging free trade policies by attempting to shut down the meeting. The incident resulted in $1.5 million in police costs, $7 million in lost retail sales, more than 250 arrests and more than 120 injuries (King County Office of Emergency Management, 2009).
- After the Rodney King verdict in a California court in 1992, there were localized disturbances in Seattle. Incidents included smashing windows, lighting dumpsters on fire and overturning cars. There were 150 arrests, five major fires and instances of looting and property damage. The following day, rallies were held at the Federal Building downtown and in the University District. These rallies did not result in violent confrontations, but Interstate-5 was shut down temporarily by the demonstrators (King County Office of Emergency Management, 2009).

14.1.2 Impacts

The effects of civil disorders vary with the type, severity, scope and duration. Essential services may be disrupted or property damaged, and loss of life may occur. Looting, injuries to protestors, demonstrators and police officers, and vandalism to public and private property are the most common effects of civil disorder. Fires may also be started, which have the potential to spread if emergency response services are inhibited. Transportation routes can become blocked, making it difficult for non-rioters to leave the area and for emergency personnel to arrive. Depending on the level of property damage or looting, a large-scale civil disturbance could cause a direct economic impact to businesses in Covington.

Indirect economic effects could occur as a result of civil disorder if the event results in an increase in the perception of danger in an area or if essential services or transportation routes are disrupted. Additionally, instances of civil disturbance may result in political reform, new legislation or an increased level of security personnel presence within a jurisdiction.

14.2 ENERGY SHORTAGES AND UTILITY OUTAGES

14.2.1 Water/Wastewater Disruption

Three water service providers operate in the City of Covington: Covington Water District, King County Water District No. 111 and Soos Creek Water and Sewer District. Water and/or wastewater disruption can be a secondary impact from a natural disaster or intentional act. Earthquake, flood, major power outages, or terrorism directed at facilities could disrupt the process of treating millions of gallons of waste. Wastewater treatment plants may also have emergencies internal to the plant such as chlorine gas leaks or oxygen deficiencies that render them incapable of treating waste. The disruption of service may also have significant environmental impacts on the waterways adjacent to the treatment plants. Unanticipated releases of untreated waste may occur if a system is overwhelmed by a significant storm or discharge of materials in such quantities that the treatment plant cannot adequately treat the waste.

14.2.2 Data and Telecommunications

The loss of data and/or telecommunications is often a secondary hazard to natural and human-caused hazards. Data and telecommunications provide a primary method for service to the community by the government and the private sector. A loss of data and telecommunications could result in loss of emergency dispatch capabilities, emergency planning services, infrastructure monitoring capabilities, access to statistical data, and loss of financial and personnel records. There are no major data centers or communication facilities in the City of Covington; however, disruptions from natural hazards outside the city could result in the loss of service provision for Covington residents and businesses.

14.2.3 Power and Gas Service

A power failure is any interruption or loss of electrical service due to disruptions of power generation or transmission caused by accident, sabotage, natural hazards, equipment failure or fuel shortage. These interruptions can last anywhere from a few seconds to several days. Power failures are considered significant only if the local emergency management organization is required to coordinate basic services such as the provision of food, water and heating as a result. Power failures are common with severe weather and winter storm activity.

Nationally, 99 percent of all power lines are above ground and are susceptible to high winds and interference from trees and other vegetation. There are three main types of power outages. A “dropout” occurs when there is a momentary loss of power. A “brownout” refers to a reduction below normal minimum voltage levels. A “blackout” refers to an instance when power is lost completely (City of Seattle, 2010). Power outages generally occur as a secondary effect from another event, such as a windstorm. However, a widespread power outage that affected 50 million people in the Northeast and upper Midwest in 2003 catalyzed interest in assessing primary vulnerabilities in power supply systems across the United States.

Power and gas services are provided to the City of Covington by Puget Sound Energy (PSE). PSE is a private company whose electricity services are regulated by the Washington Utilities and Transportation Commission. PSE is required by law (the Growth Management Act) to supply safe, cost-effective and equitable service to everyone in the service area requesting service. Most of King County receives its electricity and gas service from PSE, except for Seattle, which receives its electricity from Seattle City Light. PSE is Washington’s largest and oldest energy utility, serving 10 counties and more than 6,000 square miles, primarily in the Puget Sound region (PSE, 2014).

Approximately 46 percent of the electricity used by PSE customers comes from PSE-owned power plants. PSE has about 3,000 megawatts of power-generating capacity. The remainder of the power supply is

purchased from other utilities and additional sources in the western United States and Canada. As of 2011, 50 percent of electricity delivered to PSE customers was from hydropower, 32 percent was from coal; 16 percent was from natural gas, 1 percent was nuclear power, and 1 percent was from biomass, landfill gas, petroleum or waste. (PSE, 2014):

PSE owns and operates three hydropower projects in Western Washington, a coal-fired thermal power plant in eastern Montana and nine natural gas-fired facilities. PSE uses additional renewable energy sources including wind power and a large photovoltaic system (solar power). Of these facilities only the Snoqualmie Falls Hydroelectric Project is in King County. This facility is about 20 miles northeast of the City of Covington. As of 2010, PSE serves 514,815 electric customers and 427,702 natural gas customers in King County. Its power delivery and natural gas delivery facilities in the County include the following (PSE, 2011):

- 4,320 miles of underground distribution lines
- 2,984 miles of overhead distribution lines
- 703 miles of high-voltage transmission lines
- 131 distribution substations
- 23 transmission substations
- 5,878 miles of natural gas pipeline, and
- 12 gate stations.

Most of PSE's natural gas infrastructure is underground, in the form of pipelines. PSE receives about half of its natural gas from Canada via a pipeline that goes from Sumas Washington to New Mexico; the remaining half comes from Rocky Mountain states. This area's natural gas system is vulnerable to earthquake damage, third party damage and landslide damage.

14.2.4 Past Events

According to the Annual Blackout Tracker report, Washington State experienced 90 power outages in 2012. Washington State has been within the top 10 of states with the most reported power outages in 2012, 2011 and 2010. The average number of people affected per outage in 2012 was 9,594 and the average duration of outage was over four hours. The majority of these outages were a result of weather or falling trees (38 percent) or faulty equipment or human error (25 percent) (Eaton, 2012).

Citizens of Covington typically experience short-term power outages, more commonly in winter. Most recently, small-scale outages were reported on January 11, 2014 after a heavy rainstorm event with gusty winds. Another recent event occurred after the January 19, 2012 ice storm. Falling tree limbs and transformer explosions resulting from the storm caused major power outages in Covington and the surrounding region. At its peak, PSE estimated that about 280,000 customers were without power, predominantly in Pierce, Thurston and South King counties.

The 1993 Inaugural Day storm in King County brought sustained winds of 65 mph and gusts up to 80 mph. Both floating bridges were closed, 50 transmission lines were down, 120 substations were damaged, and 450 distribution circuits were down or damaged leaving more than 282,000 King County customers without power.

The Arctic Express hit King County on December 18, 1990 and again 10 days later, reversing most of the restoration work that had been done. 73,000 customers were without power following this event and damage totaled $17 million.

Utility outages can also be caused by equipment failure or damage. On December 29, 2009 an unknown source of outage affected the Soos Creek substation. This outage did not appear to have been caused by a downed tree or wind event.

14.2.5 Impacts

The effects of power outages and other utility outages could include inconvenience to consumers, reduced heating and lighting capability, reduced production in all sectors, potential failure of transportation, water and waste, communication, information and banking systems. Additionally, power outages commonly have significant impacts on local economies due to closed businesses and loss of productivity.

Secondary hazards associated with reduced power supply events include traffic accidents, limited patient care at hospitals, injuries due to downed power lines and fires due to gas leaks. Additionally, utility losses could cause a reduction in employment, wholesale and retail sales, utility repairs, and increased medical risks. The City may lose sales tax and the finances of public utility companies and the businesses that rely on them would be disrupted. Loss of electricity could create a potentially life-threatening situation for medically dependent residents. If the loss of electricity were disrupted for some time, a generalized public health threat may ensue.

14.3 FOOD AND WATER CONTAMINATION

14.3.1 Water Supply

According to the U.S. Department of Homeland Security, 84 percent of the U.S. population receives drinking water from public water systems (U.S. Department of Homeland Security, 2014). Water supply systems are vulnerable to incidents resulting from natural hazards, intentional acts, and accidents. Supply or treatment interruptions could occur as a result of contamination, line breaks, water shortages, or equipment failure. Contamination threats to water systems include chemical, biological or radiological agents (Washington Department of Health, 2011). Contamination of these systems could result in widespread loss of service, illnesses and casualties. Contamination and subsequent release could also result in localized or widespread degradation of environmental systems. As a result of any type of disruption, cascading effects may ensue as service levels in other sectors such as healthcare services, fire protection services and agricultural production are diminished.

Federal law requires that all water system service providers that serve more than 3,300 people complete a vulnerability assessment. The two water service providers in Covington—Covington Water District and King County Water District No. 111—are subject to the requirements of this law.

14.3.2 Food Supply

A foodborne hazard is a physical, chemical, or biological object found in food or drink that can cause injury or illness (Washington Department of Health, 2013). Food supply contamination can occur at any time during the production process from pre-harvest conditions to post-processing handling. Contamination may result from intentional acts or accidental incidents. Generally, food safety refers to efforts to reduce contaminants in food that are reasonably likely to occur in the food supply, such as salmonella, E. coli or listeria. Food defense is “the effort to protect the food supply against intentional contamination due to sabotage, terrorism, counterfeiting or other illegal, intentionally harmful means” (U.S. Food and Drug Administration, 2013).

The U.S. Department of Agriculture has developed pre-harvest security guidelines and a checklist for food producers in an effort to increase food safety at the individual farm level (U.S. Department of Agriculture, 2006). These guidelines promote facility-specific risk assessments for producers. The Food

and Drug Administration has developed a food defense plan builder that helps food industry partners reduce risks from intentional contamination in their operations. Currently, participation in both of these risk reduction programs is voluntary. In Washington State, food safety rules and regulations are administered by the Washington Department of Health (Chapter 246-215 WAC).

All people are vulnerable to food-borne illness or injury, whether exposure is the result of intentional or unintentional acts. Some segments of the population are more susceptible to risks from food-borne illnesses (Washington Department of Health, 2013):

- Children younger than 5 years of age
- Individuals older than 65 years of age
- Women who are pregnant
- Immune-compromised individuals.

After eating contaminated food, people can develop anything from a short, mild illness to a life threatening disease. If a contamination outbreak results in widespread illness, it could severely tax the health care system in regards to diagnosis, treatment and prevention. A community could also be affected by loss of productivity and wages.

14.4 HAZARDOUS MATERIALS RELEASE

A hazardous material is a substance or combination of substances that, because of quantity, concentration, physical, chemical or infectious characteristics, may cause or contribute to an increase in serious mortality or an increase in serious irreversible or incapacitating reversible illness, or pose a present or potential hazard to human life, property or the environment. Hazardous materials are present in nearly every city and county in the United States in facilities that produce, store or use them. For example, water treatment plants use chlorine on-site to eliminate bacterial contaminants. Hazardous materials are transported along interstate highways and railways daily. Even the natural gas used in every home and business is a dangerous substance when a leak occurs.

A hazardous material release may be either intentional or unintentional. Examples of unintentional releases include unintended accidents that occur while hazardous materials are in transport, the inappropriate use of a hazardous material as a result of a lack of safety oversight or improper labeling, or a release following a natural disaster. Intentional releases may occur as part of a terrorist attack.

According to FEMA, hazardous material releases may occur from a fixed facility or while the material is being transported. These materials may be in solid, liquid or gaseous form when released. The duration of the hazard could last from hours to days or longer depending on the extent of the release and the swiftness of the appropriate corrective action response. Duration may also be shortened or prolonged due to the chemical structure of the material itself and the amount of time it takes for the chemical to degrade or disperse into an inert form. Chemical composition may also determine the corrosive nature over time, incendiary potential and the ability of the material to move beyond the original point of release. In many cases, weather conditions directly affect how a hazardous material release develops. The micro-meteorological effects of buildings and terrain can alter travel and duration of agents. Shielding in the form of sheltering in place can protect people and property from harmful effects. Non-compliance with fire and building codes, as well as failure to maintain existing fire protection and containment features, can substantially increase the damage from a hazardous materials release (FEMA, 2003).

The following are the most common type of hazardous material incidents:

- **Fixed-Facility Hazardous Materials Incident—**This is the uncontrolled release of materials from a fixed site capable of posing a risk to health, safety and property. It is possible to identify and prepare for a fixed-site incident because federal and state laws require those facilities to notify state and local authorities about what is being used or produced at the site. This type of release could occur after a natural hazard event, such as a flood or earthquake.
- **Hazardous Materials Transportation Incident—**A hazardous materials transportation incident is any event resulting in uncontrolled release of materials during transport that can pose a risk to health, safety and property. Transportation incidents are difficult to prepare for because there is little if any notice about what materials could be involved should an accident happen. Hazardous materials transportation incidents can occur anywhere in the country, although most occur on major federal or state highways or major rail lines.

  In addition to materials such as chlorine that are shipped throughout the country by rail, thousands of shipments of radiological materials—mostly medical materials and low-level radioactive waste—take place via ground transportation across the United States. Many incidents occur in sparsely populated areas and affect very few people. There are occasions, however, when materials are involved in accidents in areas with much higher population densities, such as the January 6, 2005 train accident in Graniteville, South Carolina that released chlorine gas, killing nine, injuring 500, and causing the evacuation of 5,400 residents. Fortunately, such events are rare.
- **Interstate Pipeline Hazardous Materials Incident—**There are a significant number of interstate pipelines carrying hazardous materials running through King County, including the Williams pipeline, which runs through Covington.

According to the King County Local Hazardous Waste Management Program 2010 Plan Update, the City of Covington has four generators of hazardous waste, not including household hazardous waste. Three of these generators are considered to be medium generators and are regulated by the Washington Department of Ecology under the Washington State Hazardous Waste Management Act (Chapter 70.105 RCW). The remaining generator did not report any waste generation during the reporting period (King County, 2010).

Most incidents that involve the release of hazardous materials occur without predictability under circumstances that give responders little time to prepare.

Hazardous-materials spills might cause the short-term or long-term evacuation of an affected area. Depending on the nature of the spill and local weather conditions, residences, businesses, hospitals, schools, nursing homes and roadways may be evacuated or closed until cleanup can be affected. When spills occur as part of an earthquake, this may compound the ability to move response resources and resume commerce. A mass casualty incident resulting from a hazardous materials release would seriously impact the medical response community. In addition to potential harm to people, hazardous material releases can also cause damage to ecological systems. Releases that are unnoticed or improperly cleaned can degrade ecosystem functions and compromise the provision of ecosystem services.

An Area Contingency Plan was developed by the Department of Ecology, in cooperation with federal, state and local agencies, “to provide orderly implementation of response actions to protect the people and natural resources of the states of Washington, Oregon, and Idaho from the impacts of oil or hazardous substances spills.” The plan accounts for potential problems from vessels, offshore facilities, onshore facilities or other sources. The Environmental Protection Agency has responsibility for all spills in inland waters. The U.S. Coast Guard has responsibility for all spills in coastal waters.

14.5 RADIATION HAZARDS

Radiation is a form of energy. There are naturally occurring and man-made sources of radioactive materials. Radiation can occur in two forms: ionizing and non-ionizing. Non-ionizing forms are used in many everyday applications including microwaves for heating food, infrared lamps and radio broadcasting. Ionizing radiation is more energetic and is able to damage tissue and cause health problems. There are many common uses for ionizing radiation including x-rays, irradiators and research reactors. Naturally occurring ionizing radiation can come from radon, processes occurring in the sun and elements found in the earth. Large amounts of radiation exposure can cause cancer and other damage to tissue at the cellular level (Environmental Protection Agency, 2012). Radiation exposure can occur as a result of intentional or unintentional acts.

According to FEMA, radiological contaminants can be dispersed using sprayers/aerosol generators, or by point or line sources such as munitions. The contaminants may remain hazardous for seconds to years depending on the material used. The initial effects will be localized to the site of the attack depending on meteorological conditions; subsequent behavior of radioactive contaminants may be dynamic. Mitigating and exacerbating conditions that will determine exposure to radiation may include the duration of exposure, the distance from the source of radiation, and the amount of shielding between source and targets (FEMA, 2003).

A detonation of a nuclear bomb may occur underground, at the surface, in the air, or at a high altitude. The light, heat flash and blast, and shock wave may last for a few seconds. The resulting radiation and fallout can persist in the environment for years. The initial light, heat and blast effects of a subsurface, ground or air burst are static and determined by the device's characteristics and employment. The fallout of radioactive contaminants may be dynamic depending on meteorological conditions. Possible mitigating and exacerbating conditions may include the reduction of harmful effects by minimizing the time of exposure and shielding or deflection from terrain, forests, structures (FEMA, 2003).

The risk of radiological exposure is low, but the consequences of exposure are high. Impacts would depend on the location and duration of exposure and the level of radioactive release.

14.6 TERRORISM

Acts of terrorism are intentional, criminal, malicious acts. Terrorism is defined as the unlawful use or threatened use of force or violence against people or property with the intention of intimidating or coercing societies or governments. The Federal Bureau of Investigation (FBI) categorizes terrorism in the U.S. primarily as one of two types:

- Domestic terrorism involves groups or individuals whose terrorist activities are directed at elements of our government or population without foreign direction. The bombing of the Alfred P. Murrah federal building in Oklahoma City is an example of domestic terrorism. The FBI is the primary response agency for domestic terrorism. The FBI coordinates domestic preparedness programs and activities of the United States to limit acts posed by terrorists, including the use of weapons of mass destruction.
- International terrorism involves groups or individuals whose terrorist activities are foreign based and/or directed by countries or groups outside the United States, or whose activities transcend national boundaries. Examples include the 1993 bombing of the World Trade Center, the U.S. Capitol, and Mobil Oil's corporate headquarters and the attacks of September 11, 2001 at the World Trade Center and the Pentagon.

International terrorist organizations are said to be frustrated, extremist, culturally or mentally polarized groups of individuals motivated by radical or unconventional thought. Extremists generally adopt

converse concepts of violence, morality, and in the rationale of "means and ends" than that of mainstream Western societies. This characterization of international terrorist organizations bears similar cognitive threads to those of domestic terrorist organizations. However, domestic terrorist advocates and their organizations profess ideologies (left or right) that exaggerate extremist beliefs toward values held by Western democratic or American cultures. Such terrorists groups include:

- Ethnic, religious and racial, sexual separatists
- Left-wing organizations that embrace animal, environmental, religious, abortion, anti-government, and anarchist causes
- Right-wing separatists, militants, survivalists, anti-government, sovereignty, anti-police and anti-regulatory authority organizations.

For the individual homegrown terrorist, personal motives may vary greatly. It could be a desire for collective revenge against the U.S. for the purported "war on Islam," poverty or social alienation, or brainwashing. There is no one path to radicalization. As the Department of Homeland Security's Office of Intelligence and Analysis has indicated, motives and paths to radicalization can vary significantly depending on one's ideology and religious beliefs, geographic location, or socioeconomic condition. Nevertheless, trends seem to exist among those who attempted terror plots thwarted since 9/11, most significantly a seeming aversion to suicide or martyrdom (Zuckerman et al., 2013).

Many people equate terrorism with the use of weapons of mass destruction, which include chemical, biological, radiological, nuclear and explosive weapons. However, terrorism also includes arson, incendiary and explosive devices, school shootings, sabotage (including industrial sabotage), hazardous materials releases, agro-terrorism and cyber-terrorism.

A cyber-attack is a non-kinetic offensive operation intended to create physical effects or to manipulate, disrupt, or delete data. It might range from a denial-of-service operation that temporarily prevents access to a website, to an attack on a power turbine that causes physical damage and an outage lasting for days. Cyber espionage refers to intrusions into networks to access sensitive diplomatic, military, or economic information (Clapper, 2013). Cyber criminals threaten U.S. economic interests. They may sell tools via a growing black market that enable access to critical infrastructure systems. Some commercial companies sell computer intrusion kits on the open market that can give governments and cyber criminals the capability to steal, manipulate, or delete information on targeted systems. Even more companies develop and sell professional-quality technologies to support cyber operations—often branding these tools as lawful-intercept or defensive security research products. Many individuals, groups and foreign governments already use some of these tools to target national and local systems.

The three key elements to defining a terrorist event are as follows:

- Activities involve the use of illegal force.
- Actions are intended to intimidate or coerce.
- Actions are committed in support of political or social objectives.

Terrorism can be distinguished from other types of hazards by three important considerations:

- In the case of chemical, biological, and radioactive agents, their presence may not be immediately obvious, making it difficult to determine when and where they have been released, who has been exposed, and what danger is present for first responders and emergency medical technicians.
- There is limited scientific understanding of how these agents affect the population at large.

- Terrorism evokes very strong emotional reactions, ranging from anxiety, to fear to anger, to despair to depression.

Those involved with terrorism response, including public health and public information staff, are trained to deal with the public's emotional reaction swiftly as response to events occurs. The area of the event must be clearly identified in all emergency alert messages to prevent those not affected by the incident from overwhelming local emergency rooms and response resources, thereby reducing services to those actually affected. The public will be informed clearly and frequently about what government agencies are doing to mitigate the impacts of an event. The public will also be given clear direction on how to protect the health of individuals and families. The following are potential methods used by terrorists that could affect the City of Covington as a direct target or collaterally:

- Conventional bomb
- Biological agent
- Chemical agent
- Nuclear bomb
- Radiological agent
- Arson/incendiary attack
- Armed attack
- Cyber-terrorism
- Agro-terrorism
- Intentional hazardous material and release.

Most terrorist events in the United States have been bombing attacks, involving detonated and undetonated explosive devices, tear gas, pipe bombs, and firebombs. The effects of terrorism can vary from loss of life and injuries to property damage and disruptions in services such as electricity, water supplies, transportation, or communications. Any of the methods above may have an immediate effect or a delayed effect. Terrorists often choose targets that offer limited danger to themselves and areas with relatively easy public access. Foreign terrorists look for visible targets where they can avoid detection before and after an attack such as international airports, large cities, major special events, and high-profile landmarks.

From 1990 through 2013, more than 50 bomb incidents occurred nationwide. According to the Global Terrorism Database maintained by the University of Maryland's National Consortium for the Study of Terrorism and Response to Terrorism, more than 200 terrorist-related events (all incidents, regardless of doubt) occurred from 2001 to 2011 (University of Maryland Global Terrorism Data, 2014). These include active-shooter incidents, including school shootings; bombings; arson, etc.

There have been no known instances of terrorism within the borders of the City of Covington. There have, however, been several instances of terrorism in Western Washington (King County Office of Emergency Management, 2009):

- In June 2011, the FBI raided a warehouse in Seattle that housed two suspects who had arranged to purchase weapons from an anonymous informant in contact with the Seattle Police Department. The two were seeking to purchase automatic machine guns and grenades in preparation for an attack on a military recruiting station in Seattle (FBI, 2011). The men were charged with conspiracy to murder officers and employees of the U.S. government,

conspiracy to use a weapon of mass destruction, and possession of firearms in furtherance of crimes of violence. One was also charged with two counts of illegal possession of firearms.

- In July 2006, a gunman fired on women at the Jewish Federation of Greater Seattle
- From January 2000 to December 2002 there were 208 reported instances of a biological white powder. Individuals in Seattle, Federal Way, Tukwila, Port of Seattle and other cities were affected. There were no reports of injuries or death, but the incidents did cause financial implications through the payment of overtime and service disruptions.
- In May 2001 an incendiary device was deployed at the University of Washington's Urban Horticultural Center by the domestic terrorist group Earth Liberation Front. The firebomb caused over $5 million in damage.
- In December 1999, an Algerian man was arrested by U.S. Customs officials while entering the United States in Port Angeles, Washington, aboard a ferry from Victoria, British Columbia. He was subsequently charged with smuggling explosive material into the United States. The CIA noted that the timing devices and nitroglycerine in his possession were the "signature devices" of groups affiliated with Al-Qaeda.
- The FBI and Bellingham Police interdicted a group of terrorists affiliated with the Washington State Militia on July 27, 1996. The group planned to bomb various infrastructure targets including a radio tower, bridge, and a train tunnel while the train was inside.
- In 1995 a chemical explosive device was detonated at the Burien District Court.
- The American Front Skinheads detonated pipe bombs in Tacoma on July 20 and 22, 1993.

Economic impacts from terrorist events could be significant:

- The cost of a terrorist act would be felt in terms of loss of life and property, disruption of business activity and long-term emotional impacts. Recovery would take significant resources and expense at the local level.
- Utility losses could cause a reduction in employment, wholesale and retail sales, utility repairs, and increased medical risks. The City may lose sales tax and the finances of private utility companies and the businesses that rely on them would be disrupted.
- The economic impact of computer security breaches associated with data and telecommunications losses can be staggering.
- The economic impacts should a transportation facility be rendered impassable would be significant. The loss of a roadway or railway would have serious effects on the city's economy and ability to provide services. Loss of travel routes would result in loss of commerce, and could impact the City's ability to provide emergency services to its citizens by delaying response times or limiting routes for equipment such as fire apparatus, police vehicles, and ambulances. The ability to receive fuel deliveries would also be impacted.

There are no high profile federal or state buildings in Covington; however, there are City-owned critical facilities and large gathering spaces. Most critical facilities and infrastructure in Covington would be vulnerable to acts of terrorism, but the likelihood of such an incident is low.

Issues associated with the threat of terrorism in Covington include the following:

- The City should participate in regional, state and federal efforts to gather terrorism information at all levels and keep public safety officials briefed at all times regarding any local threats.

- The City should continue all facets of emergency preparedness training for police, fire, public works, and city manager/public information staff in order to respond quickly in the event of a terrorism event.
- The City should participate in regional training exercises.

14.7 TRANSPORTATION

Transportation, for the purpose of this analysis, is defined as all forms of transportation that move people and materials through Covington. Aircraft, motorized vehicles and the Williams Pipeline are all potential sources of risk related to transportation.

No major transportation disasters have occurred in Covington, although traffic accidents are a common occurrence. Covington's main transportation routes are SR 18, SR 516, and SE 256th Street. SR 18 cuts diagonally through Covington from the southwest corner to the northeast corner. Of the two main east-west routes, SR 516 (SE 272nd Street) is the most heavily traveled, and SE 256th Street is becoming increasingly used as an alternate to SR 516. In the event of an emergency situation where evacuation is needed, major arterials could become clogged and result in gridlock, limiting egress routes from the City.

Ground transportation collisions have a high probability of occurrence and can result in loss of life or serious injury. In 2011 there were 98,820 collisions on Washington roadways; 421 resulted in fatalities and 1,814 resulted in serious injury (Washington Department of Transportation, 2011). There were 201 collisions in Covington in 2011, 96 of which resulted in serious or minor injuries. Only two incidents in Covington involved a collision with a heavy truck.

Burlington Northern & Santa Fe Railroad transportation routes run through and adjacent to the City of Covington. The hazard potential of railroad systems is much like that of highway transportation. Trains, like any other form of transportation, are vulnerable to accidents with other vehicles, derailment and acts of terrorism. A potential complication involving rail accidents is the extremely large quantities of hazardous materials transported through Covington on a daily basis.

There are no airports within Covington city limits, but several are located nearby: Crest Air Park, SeaTac International, Boeing Field (King County International), Renton Municipal, Auburn Municipal and Cedar Grove Air Park. Collisions involving commercial aircraft have low probability and high risk. Mid-air collisions can spread debris over an impact area covering miles and can have high casualty impacts for those aboard the aircrafts and for individuals on the ground. Hazardous materials could also be realized if such materials were in transport at the time of an incident. Recreational aircraft accidents occur more frequently. They can result in death or serious injury to both those aboard the aircraft and people and property on the ground. Crest Air Park and Cedar Grove Air Park are used for small private and recreational aircraft. Most commercial air traffic is concentrated at SeaTac International and Boeing Field. Renton Municipal and Auburn Municipal may be used as reliever airports by charter and commuter aircraft, but their primary function is use by private and recreational aircraft. There have been no major aircraft transportation disasters that have affected Covington.

No major disasters have occurred within the City of Covington from the Williams natural gas pipeline. An occurrence of a leak, due to an earthquake or other cause, would create a hazardous material emergency of a potentially enormous magnitude affecting property, the public and the environment. In Washington State between 2004 and 2013 there were 20 reported significant pipeline incidents, with a total of one fatality, seven injuries and $4.9 million in property damage (U.S. Department of Transportation, 2014).

PART 3—
RISK RANKING AND MITIGATION STRATEGY

CHAPTER 15.
PLANNING AREA RISK RANKING

A risk ranking was performed for the hazards of concern described in this plan. This risk ranking assesses the probability of each hazard's occurrence as well as its likely impact on the people, property, and economy of the planning area. The risk ranking was conducted via facilitated brainstorming sessions with the Steering Committee. Estimates of risk were generated with data from HAZUS-MH using methodologies promoted by FEMA. The results are used in establishing mitigation priorities.

15.1 PROBABILITY OF OCCURRENCE

The probability of occurrence of a hazard is indicated by a probability factor based on likelihood of annual occurrence:

- High—Hazard event is likely to occur within 25 years (Probability Factor = 3)
- Medium—Hazard event is likely to occur within 100 years (Probability Factor =2)
- Low—Hazard event is not likely to occur within 100 years (Probability Factor =1)
- No exposure—There is no probability of occurrence (Probability Factor = 0)

The assessment of hazard frequency is generally based on past hazard events in the area. Table 15-1 summarizes the probability assessment for each hazard of concern for this plan.

TABLE 15-1.
PROBABILITY OF HAZARDS

Hazard Event	Probability (high, medium, low)	Probability Factor
Dam Failure	Low	1
Drought	High	3
Earthquake	Medium	2
Flood	High	3
Landslide	High	3
Severe Weather	High	3
Volcano	Low	1
Fire	Medium	2

15.2 IMPACT

Hazard impacts were assessed in three categories: impacts on people, impacts on property and impacts on the local economy. Numerical impact factors were assigned as follows:

- **People**—Values were assigned based on the percentage of the total ***population exposed*** to the hazard event. The degree of impact on individuals will vary and is not measurable, so the calculation assumes for simplicity and consistency that all people exposed to a hazard

because they live in a hazard zone will be equally impacted when a hazard event occurs. Planners can use an element of subjectivity when assigning values for impacts on people. Impact factors were assigned as follows:

- High—30 percent or more of the population is exposed to a hazard (Impact Factor = 3)
- Medium—15 percent to 29 percent of the population is exposed to a hazard (Impact Factor = 2)
- Low—14 percent or less of the population is exposed to the hazard (Impact Factor = 1)
- No impact—None of the population is exposed to a hazard (Impact Factor = 0)

- **Property**—Values were assigned based on the percentage of the total ***property value exposed*** to the hazard event:
  - High—25 percent or more of the total assessed property value is exposed to a hazard (Impact Factor = 3)
  - Medium—10 percent to 24 percent of the total assessed property value is exposed to a hazard (Impact Factor = 2)
  - Low—9 percent or less of the total assessed property value is exposed to the hazard (Impact Factor = 1)
  - No impact—None of the total assessed property value is exposed to a hazard (Impact Factor = 0)
- **Economy**—Values were assigned based on the percentage of the total ***property value vulnerable*** to the hazard event. Values represent estimates of the loss from a major event of each hazard in comparison to the total assessed value of the property exposed to the hazard. For some hazards, such as wildfire, landslide and severe weather, vulnerability was considered to be the same as exposure due to the lack of loss estimation tools specific to those hazards. Loss estimates separate from the exposure estimates were generated for the earthquake and flood hazards using HAZUS-MH.
  - High—Estimated loss from the hazard is 15 percent or more of the total assessed property value (Impact Factor = 3)
  - Medium—Estimated loss from the hazard is 5 percent to 14 percent of the total assessed property value (Impact Factor = 2)
  - Low—Estimated loss from the hazard is 4 percent or less of the total assessed property value (Impact Factor = 1)
  - No impact—No loss is estimated from the hazard (Impact Factor = 0)

The impacts of each hazard category were assigned a weighting factor to reflect the significance of the impact. These weighting factors are consistent with those typically used for measuring the benefits of hazard mitigation actions: impact on people was given a weighting factor of 3; impact on property was given a weighting factor of 2; and impact on the economy was given a weighting factor of 1.

Table 15-2, Table 15-3 and Table 15-4 summarize the impacts for each hazard.

TABLE 15-2.
IMPACT ON PEOPLE FROM HAZARDS

Hazard Event	Impact (high, medium, low)	Impact Factor	Multiplied by Weighting Factor (3)
Dam Failure	High	3	(3x3) = 9
Drought	None	0	(0x3) = 0
Earthquake	High	3	(3x3) = 9
Flood	Low	1	(1x3) = 3
Landslide	Low	1	(1x3) = 3
Severe Weather	High	3	(3x3) = 9
Volcano	Low	1	(1x3) = 3
Fire	Low	1	(1x3) = 3

TABLE 15-3.
IMPACT ON PROPERTY FROM HAZARDS

Hazard Event	Impact (high, medium, low)	Impact Factor	Multiplied by Weighting Factor (2)
Dam Failure	High	3	(3x2) = 6
Drought	None	0	(0x2) = 0
Earthquake	High	3	(3x2) = 6
Flood	Low	1	(1x2) = 2
Landslide	Low	1	(1x2) = 2
Severe Weather	High	3	(3x2) = 6
Volcano	Low	1	(1x2) = 2
Fire	Low	1	(1x2) =2

TABLE 15-4.
IMPACT ON ECONOMY FROM HAZARDS

Hazard Event	Impact (high, medium, low)	Impact Factor	Multiplied by Weighting Factor (1)
Dam Failure	Medium	2	(2x1) = 2
Drought	Medium	2	(2x1) = 2
Earthquake	Medium	2	(2x1) = 2
Flood	Low	1	(1x1) = 1
Landslide	Low	1	(1x1) = 1
Severe Weather	Medium	2	(2x1) = 2
Volcano	Medium	2	(2x1) = 2
Fire	Low	1	(1x1) = 1

15.3 RISK RATING AND RANKING

The risk rating for each hazard was determined by multiplying the probability factor by the sum of the weighted impact factors for people, property and operations, as summarized in Table 15-5.

Based on these ratings, a priority of high, medium or low was assigned to each hazard. The hazards ranked as being of highest concern are severe weather and earthquake. Hazards ranked as being of medium concern are flood, landslide and dam failure. The hazards ranked as being of lowest concern are volcano, wildfire and drought. Table 15-6 shows the hazard risk ranking.

TABLE 15-5.
HAZARD RISK RATING

Hazard Event	Probability Factor	Sum of Weighted Impact Factors	Total (Probability x Impact)
Dam Failure	1	(9+6+2) = 17	(1x17) =17
Drought	3	(0+0+2) = 2	(3x2) = 6
Earthquake	2	(9+6+2) = 17	(2x17) = 34
Flood	3	(3+2+1) = 6	(3x6) = 18
Landslide	3	(3+2+1) = 6	(3x6) = 18
Severe Weather	3	(9+6+2) = 17	(3x17) = 51
Volcano	1	(3+2+2) = 7	(1x7) = 7
Fire	2	(3+2+1) = 6	(2x6) =12

TABLE 15-6.
HAZARD RISK RANKING

Hazard Ranking	Hazard Event	Category
1	Severe Weather	High
2	Earthquake	High
3	Flood	Medium
3	Landslide	Medium
4	Dam Failure	Medium
5	Fire	Low
6	Volcano	Low
7	Drought	Low

CHAPTER 16.
MITIGATION ALTERNATIVES

To support action plan development, catalogs of hazard mitigation alternatives were developed that present a broad range of alternatives to be considered for use in the planning area, in compliance with 44 CFR (Section 201.6(c)(3)(ii)). One catalog was developed for each hazard of concern evaluated in this plan. The basis for this catalog was a facilitated session with the Steering Committee looking at strengths, weaknesses, obstacles and opportunities within the planning area. The catalogs for each hazard are listed in Table 16-1 through Table 16-8. The catalogs present alternatives that are categorized in two ways:

- By what the alternative would do:
  - Manipulate a hazard
  - Reduce exposure to a hazard
  - Reduce vulnerability to a hazard
  - Increase the ability to respond to or be prepared for a hazard
- By who would have responsibility for implementation:
  - Individuals
  - Businesses
  - Government.

Many hazard mitigation initiatives recommended in this plan were selected from among the alternatives presented in the catalogs. The catalogs provide a baseline of mitigation alternatives that are backed by a planning process, are consistent with the City's goals and objectives, and are within their capabilities. However, not all the alternatives meet all the City's selection criteria. These catalogs represent the comprehensive range of alternatives considered by the City of Covington.

TABLE 16-1.
CATALOG OF MITIGATION ALTERNATIVES—DAM FAILURE

Personal Scale	Corporate Scale	Government Scale
Manipulate Hazard		
• None	1. Remove dams 2. Remove levees 3. Harden dams	1. Remove dams 2. Remove levees 3. Harden dams
Reduce Exposure		
• Relocate out of dam failure inundation areas.	• Replace earthen dams with hardened structures	1. Replace earthen dams with hardened structures 2. Relocate critical facilities out of dam failure inundation areas. 3. Consider open space land use in designated dam failure inundation areas.
Reduce Vulnerability		
• Elevate home to appropriate levels.	• Flood-proof facilities within dam failure inundation areas	1. Adopt higher regulatory floodplain standards in mapped dam failure inundation areas. 2. Retrofit critical facilities within dam failure inundation areas.
Increase Preparation or Response Capability		
1. Learn about risk reduction for the dam failure hazard. 2. Learn the evacuation routes for a dam failure event. 3. Educate yourself on early warning systems and the dissemination of warnings.	1. Educate employees on the probable impacts of a dam failure. 2. Develop a continuity of operations plan.	1. Map dam failure inundation areas. 2. Enhance emergency operations plan to include a dam failure component. 3. Institute monthly communications checks with dam operators. 4. Inform the public on risk reduction techniques 5. Adopt real-estate disclosure requirements for the re-sale of property located within dam failure inundation areas. 6. Consider the probable impacts of climate in assessing the risk associated with the dam failure hazard. 7. Establish early warning capability downstream of listed high hazard dams. 8. Consider the residual risk associated with protection provided by dams in future land use decisions.

TABLE 16-2.
CATALOG OF MITIGATION ALTERNATIVES—DROUGHT

Personal Scale	Corporate Scale	Government Scale
Manipulate Hazard		
None	None	Groundwater recharge through stormwater management
Reduce Exposure		
None	None	Identify and create groundwater backup sources
Reduce Vulnerability		
1. Drought-resistant landscapes 2. Reduce water system losses 3. Modify plumbing systems (through water saving kits)	1. Drought-resistant landscapes 2. Reduce private water system losses	1. Water use conflict regulations 2. Reduce water system losses 3. Distribute water saving kits
Increase Preparation or Response Capability		
• Practice active water conservation	• Practice active water conservation	1. Public education on drought resistance 2. Identify alternative water supplies for times of drought; mutual aid agreements with alternative suppliers 3. Develop drought contingency plan 4. Develop criteria “triggers” for drought-related actions 5. Improve accuracy of water supply forecasts 6. Modify rate structure to influence active water conservation techniques

TABLE 16-3.
CATALOG OF MITIGATION ALTERNATIVES—EARTHQUAKE

Personal Scale	Corporate Scale	Government Scale
Manipulate Hazard		
None	None	None
Reduce Exposure		
• Locate outside of hazard area (off soft soils)	• Locate or relocate mission-critical functions outside hazard area where possible	• Locate critical facilities or functions outside hazard area where possible
Reduce Vulnerability		
1. Retrofit structure (anchor house structure to foundation) 2. Secure household items that can cause injury or damage (such as water heaters, bookcases, and other appliances) 3. Build to higher design	1. Build redundancy for critical functions and facilities 2. Retrofit critical buildings and areas housing mission-critical functions	1. Harden infrastructure 2. Provide redundancy for critical functions 3. Adopt higher regulatory standards
Increase Preparation or Response Capability		
1. Practice "drop, cover, and hold" 2. Develop household mitigation plan, such as creating a retrofit savings account, communication capability with outside, 72-hour self-sufficiency during an event 3. Keep cash reserves for reconstruction 4. Become informed on the hazard and risk reduction alternatives available. 5. Develop a post-disaster action plan for your household	1. Adopt higher standard for new construction; consider "performance-based design" when building new structures 2. Keep cash reserves for reconstruction 3. Inform your employees on the possible impacts of earthquake and how to deal with them at your work facility. 4. Develop a continuity of operations plan	1. Provide better hazard maps 2. Provide technical information and guidance 3. Enact tools to help manage development in hazard areas (e.g., tax incentives, information) 4. Include retrofitting and replacement of critical system elements in capital improvement plan 5. Develop strategy to take advantage of post-disaster opportunities 6. Warehouse critical infrastructure components such as pipe, power line, and road repair materials 7. Develop and adopt a continuity of operations plan 8. Initiate triggers guiding improvements (such as <50% substantial damage or improvements) 9. Further enhance seismic risk assessment to target high hazard buildings for mitigation opportunities. 10. Develop a post-disaster action plan that includes grant funding and debris removal components.

TABLE 16-4.
CATALOG OF MITIGATION ALTERNATIVES—FLOOD

Personal Scale	Corporate Scale	Government Scale
Manipulate Hazard		
1. Clear stormwater drains and culverts 2. Institute low-impact development techniques on property	1. Clear stormwater drains and culverts 2. Institute low-impact development techniques on property	1. Maintain drainage system 2. Institute low-impact development techniques on property 3. Dredging, levee construction, and providing regional retention areas 4. Structural flood control, levees, channelization, or revetments. 5. Stormwater management regulations and master planning 6. Acquire vacant land or promote open space uses in developing watersheds to control increases in runoff
Reduce Exposure		
1. Locate outside of hazard area 2. Elevate utilities above base flood elevation 3. Institute low impact development techniques on property	1. Locate business critical facilities or functions outside hazard area 2. Institute low impact development techniques on property	1. Locate or relocate critical facilities outside of hazard area 2. Acquire or relocate identified repetitive loss properties 3. Promote open space uses in identified high hazard areas via techniques such as: planned unit developments, easements, setbacks, greenways, sensitive area tracks. 4. Adopt land development criteria such as planned unit developments, density transfers, clustering 5. Institute low impact development techniques on property 6. Acquire vacant land or promote open space uses in developing watersheds to control increases in runoff
Reduce Vulnerability		
1. Retrofit structures (elevate structures above base flood elevation) 2. Elevate items within house above base flood elevation 3. Build new homes above base flood elevation 4. Flood-proof existing structures	1. Build redundancy for critical functions or retrofit critical buildings 2. Provide flood-proofing measures when new critical infrastructure must be located in floodplains	1. Harden infrastructure, bridge replacement program 2. Provide redundancy for critical functions and infrastructure 3 Adopt appropriate regulatory standards, such as: increased freeboard standards, cumulative substantial improvement or damage, lower substantial damage threshold; compensatory storage, non-conversion deed restrictions. 4. Stormwater management regulations and master planning. 5. Adopt “no-adverse impact” floodplain management policies that strive to not increase the flood risk on downstream communities.

TABLE 16-4.
CATALOG OF MITIGATION ALTERNATIVES—FLOOD

Personal Scale	Corporate Scale	Government Scale
Increase Preparation or Response Capability		
1. Buy flood insurance 2. Develop household mitigation plan, such as retrofit savings, communication capability with outside, 72-hour self-sufficiency during and after an event	1. Keep cash reserves for reconstruction 2. Support and implement hazard disclosure for the sale/re-sale of property in identified risk zones. 3. Solicit cost-sharing through partnerships with other stakeholders on projects with multiple benefits.	1. Produce better hazard maps 2. Provide technical information and guidance 3. Enact tools to help manage development in hazard areas (stronger controls, tax incentives, and information) 4. Incorporate retrofitting or replacement of critical system elements in capital improvement plan 5. Develop strategy to take advantage of post-disaster opportunities 6. Warehouse critical infrastructure components 7. Develop and adopt a continuity of operations plan 8. Consider participation in the Community Rating System 9. Maintain existing data and gather new data needed to define risks and vulnerability 10. Train emergency responders 11. Create a building and elevation inventory of structures in the floodplain 12. Develop and implement a public information strategy 13. Charge a hazard mitigation fee 14. Integrate floodplain management policies into other planning mechanisms within the planning area. 15. Consider the probable impacts of climate change on the risk associated with the flood hazard 16. Consider the residual risk associated with structural flood control in future land use decisions 17. Enforce National Flood Insurance Program 18. Adopt a Stormwater Management Master Plan

TABLE 16-5.
CATALOG OF MITIGATION ALTERNATIVES—LANDSLIDE

Personal Scale	Corporate Scale	Government Scale
Manipulate Hazard		
1. Stabilize slope (dewater, armor toe) 2. Reduce weight on top of slope 3. Minimize vegetation removal and the addition of impervious surfaces.	1. Stabilize slope (dewater, armor toe) 2. Reduce weight on top of slope	1. Stabilize slope (dewater, armor toe) 2. Reduce weight on top of slope
Reduce Exposure		
• Locate structures outside of hazard area (off unstable land and away from slide-run out area)	• Locate structures outside of hazard area (off unstable land and away from slide-run out area)	1. Acquire properties in high-risk landslide areas. 2. Adopt land use policies that prohibit the placement of habitable structures in high-risk landslide areas.
Reduce Vulnerability		
• Retrofit home.	• Retrofit at-risk facilities.	1. Adopt higher regulatory standards for new development within unstable slope areas. 2. Armor/retrofit critical infrastructure against the impact of landslides.
Increase Preparation or Response Capability		
1. Institute warning system, and develop evacuation plan 2. Keep cash reserves for reconstruction 3. Educate yourself on risk reduction techniques for landslide hazards.	1. Institute warning system, and develop evacuation plan 2. Keep cash reserves for reconstruction 3. Develop a continuity of operations plan 4. Educate employees on the potential exposure to landslide hazards and emergency response protocol.	1. Produce better hazard maps 2. Provide technical information and guidance 3. Enact tools to help manage development in hazard areas: better land controls, tax incentives, information 4. Develop strategy to take advantage of post-disaster opportunities 5. Warehouse critical infrastructure components 6. Develop and adopt a continuity of operations plan 7. Educate the public on the landslide hazard and appropriate risk reduction alternatives.

TABLE 16-6.
CATALOG OF MITIGATION ALTERNATIVES—SEVERE WEATHER

Personal Scale	Corporate Scale	Government Scale
Manipulate Hazard		
None	None	None
Reduce Exposure		
None	None	None
Reduce Vulnerability		
1. Insulate house 2. Provide redundant heat and power 3. Insulate structure 4. Plant appropriate trees near home and power lines (“Right tree, right place” National Arbor Day Foundation Program)	1. Relocate critical infrastructure (such as power lines) underground 2. Reinforce or relocate critical infrastructure such as power lines to meet performance expectations 3. Install tree wire	1. Harden infrastructure such as locating utilities underground 2. Trim trees back from power lines 3. Designate snow routes and strengthen critical road sections and bridges
Increase Preparation or Response Capability		
1. Trim or remove trees that could affect power lines 2. Promote 72-hour self-sufficiency 3. Obtain a NOAA weather radio. 4. Obtain an emergency generator.	1. Trim or remove trees that could affect power lines 2. Create redundancy 3. Equip facilities with a NOAA weather radio 4. Equip vital facilities with emergency power sources.	1. Support programs such as “Tree Watch” that proactively manage problem areas through use of selective removal of hazardous trees, tree replacement, etc. 2. Establish and enforce building codes that require all roofs to withstand snow loads 3. Increase communication alternatives 4. Modify land use and environmental regulations to support vegetation management activities that improve reliability in utility corridors. 5. Modify landscape and other ordinances to encourage appropriate planting near overhead power, cable, and phone lines 6. Provide NOAA weather radios to the public

TABLE 16-7.
CATALOG OF MITIGATION ALTERNATIVES—VOLCANO

Personal Scale	Corporate Scale	Government Scale
Manipulate Hazard		
None	None	Limited success has been experienced with lava flow diversion structures
Reduce Exposure		
Relocate outside of hazard area, such as lahar zones	• Locate mission critical functions outside of hazard area, such as lahar zones whenever possible.	Locate critical facilities and functions outside of hazard area, such as lahar zones, whenever possible.
Reduce Vulnerability		
None	• Protect corporate critical facilities and infrastructure from potential impacts of severe ash fall (air filtration capability)	• Protect critical facilities from potential problems associated with ash fall. • Build redundancy for critical facilities and functions.
Increase Preparation or Response Capability		
• Develop and practice a household evacuation plan.	1. Develop and practice a corporate evacuation plan 2. Inform employees through corporate sponsored outreach 3. Develop a cooperative	1. Public outreach, awareness. 2. Tap into state volcano warning system to provide early warning to planning area residents of potential ash fall problems

TABLE 16-8.
CATALOG OF MITIGATION ALTERNATIVES—WILDFIRE

Personal Scale	Corporate Scale	Government Scale
Manipulate Hazard		
• Clear potential fuels on property such as dry overgrown underbrush and diseased trees	• Clear potential fuels on property such as dry underbrush and diseased trees	1. Clear potential fuels on property such as dry underbrush and diseased trees 2. Implement best management practices on public lands.
Reduce Exposure		
1. Create and maintain defensible space around structures 2. Locate outside of hazard area 3. Mow regularly	1. Create and maintain defensible space around structures and infrastructure 2. Locate outside of hazard area	1. Create and maintain defensible space around structures and infrastructure 2. Locate outside of hazard area 3. Enhance building code to include use of fire resistant materials in high hazard area.
Reduce Vulnerability		
1. Create and maintain defensible space around structures and provide water on site 2. Use fire-retardant building materials 3. Create defensible spaces around home	1. Create and maintain defensible space around structures and infrastructure and provide water on site 2. Use fire-retardant building materials 3. Use fire-resistant plantings in buffer areas of high wildfire threat.	1. Create and maintain defensible space around structures and infrastructure 2. Use fire-retardant building materials 3. Use fire-resistant plantings in buffer areas of high wildfire threat. 4. Consider higher regulatory standards (such as Class A roofing) 5. Establish biomass reclamation initiatives
Increase Preparation or Response Capability		
1. Employ techniques from the National Fire Protection Association's Firewise Communities program to safeguard home 2. Identify alternative water supplies for firefighting 3. Install/replace roofing material with non-combustible roofing materials.	1. Support Firewise Communities initiatives. 2. Create /establish stored water supplies to be utilized for firefighting.	1. More public outreach and education efforts, including an active Firewise Communities program 2. Possible weapons of mass destruction funds available to enhance fire capability in high-risk areas 3. Identify fire response and alternative evacuation routes 4. Seek alternative water supplies 5. Become a Firewise Community 6. Use academia to study impacts/solutions to wildfire risk 7. Establish/maintain mutual aid agreements between fire service agencies. 8. Create/implement fire plans 9. Consider the probable impacts of climate change on the risk associated with the wildfire hazard in future land use decisions

CHAPTER 17.
MITIGATION INITIATIVES AND IMPLEMENTATION

17.1 SELECTED MITIGATION INITIATIVES

Table 17-1 lists the initiatives recommended by the Steering Committee to provide hazard mitigation benefits, the lead agency for each, and the proposed timeline. The parameters for the timeline are as follows:

- Short Term = to be completed in 1 to 5 years
- Long Term = to be completed in greater than 5 years
- Ongoing = currently being funded and implemented under existing programs.

17.2 BENEFIT/COST REVIEW

The action plan must be prioritized according to a benefit/cost analysis of the proposed projects and their associated costs (44 CFR, Section 201.6(c)(3)(iii)). The benefits of proposed projects were weighed against estimated costs as part of the project prioritization process. The benefit/cost analysis was not of the detailed variety required by FEMA for project grant eligibility under the Hazard Mitigation Grant Program (HMGP) and Pre-Disaster Mitigation (PDM) grant program. A less formal approach was used because some projects may not be implemented for up to 10 years, and associated costs and benefits could change dramatically in that time. Therefore, a review of the apparent benefits versus the apparent cost of each project was performed. Parameters were established for assigning subjective ratings (high, medium, and low) to the costs and benefits of these projects.

Cost ratings were defined as follows:

- **High**—Existing funding will not cover the cost of the project; implementation would require new revenue through an alternative source (for example, bonds, grants, and fee increases).
- **Medium**—The project could be implemented with existing funding but would require a re-apportionment of the budget or a budget amendment, or the cost of the project would have to be spread over multiple years.
- **Low**—The project could be funded under the existing budget. The project is part of or can be part of an ongoing existing program.

Benefit ratings were defined as follows:

- **High—**Project will provide an immediate reduction of risk exposure for life and property.
- **Medium—**Project will have a long-term impact on the reduction of risk exposure for life and property, or project will provide an immediate reduction in the risk exposure for property.
- **Low—**Long-term benefits of the project are difficult to quantify in the short term.

Using this approach, projects with positive benefit versus cost ratios (such as high over high, high over medium, medium over low, etc.) are considered cost-beneficial and are prioritized accordingly.

TABLE 17-1.
HAZARD MITIGATION ACTION PLAN MATRIX

Applies to new or existing assets	Hazards Mitigated	Objectives Met	Lead Agency	Estimated Cost	Sources of Funding	Timeline
C-1—Work with FEMA to get the City of Covington converted to the regular phase of the NFIP. Once this takes place, the City will continue to maintain compliance and good standing under the National Flood Insurance Program. This will be accomplished through the implementation of floodplain management programs that, at a minimum, will meet the minimum requirements of the NFIP, which include the following: • Enforcement of the adopted flood damage prevention ordinance • Participating in floodplain identification and mapping updates • Providing public assistance/information on floodplain requirements and impacts.						
New and Existing	Flood	1, 7, 10	Public Works	Low	General Fund	Ongoing
C-2—Evaluate flooding potential of publicly owned culverts and prioritize for replacement within the capital improvement program. Pursue grant funding for culvert replacements that are feasible and cost-effective to leverage available city funding.						
Existing	Flood, Severe Weather	6, 7, 9	Public Works	Low	SWM Fund, FEMA Hazard Mitigation grants	Short Term
C-3—Identify and evaluate privately owned culverts that contribute, or could contribute, to flooding. Pursue grant funding for culvert replacements that are feasible and cost-effective to leverage available city funding.						
Existing	Flood, Severe Weather	1, 6, 12	Public Works	Low	SWM Fund, FEMA Hazard Mitigation grants	Short Term
C-4—Strategize a program of regulations and/or incentives for owners to replace flood-contributing culverts.						
Existing	Flood	2, 3, 5, 6, 12	Public Works, Community Development	Medium	Flood Control Grant, SWM Fund	Long Term
C-5—Conduct a hazardous tree assessment and develop a plan to remove hazardous trees on all city-owned property.						
Existing	Severe Weather	6, 7, 12	Public Works	Medium	FEMA Hazard Mitigation Grants	Long Term
C-6—Remove hazardous trees on city-owned property.						
Existing	Severe Weather	6, 7, 9	Public Works	Medium	FEMA Hazard Mitigation Grants	Ongoing
C-7—Actively promote and raise awareness of the Community Emergency Response Team training program to staff, council and citizens.						
New and Existing	All Hazards	1,5,12	Public Works	Low	General Fund	Ongoing
C-8—Evaluate the feasibility and interest level of a sub-regional emergency coordinator to serve southeast King County cities and utility districts.						
New and Existing	All Hazards	3, 12	Public Works	Medium	Multi-Agency Shared Funding	Long Term
C-9—If feasible, acquire a sub-regional emergency coordinator position.						
New and Existing	All Hazards	1, 3, 5, 12	Public Works	High	Multi-Agency Shared Funding	Long Term

TABLE 17-1.
HAZARD MITIGATION ACTION PLAN MATRIX

Applies to new or existing assets	Hazards Mitigated	Objectives Met	Lead Agency	Estimated Cost	Sources of Funding	Timeline
C-10—Conduct a feasibility study for a sub-regional Emergency Coordination Center.						
New and Existing	All Hazards	3, 7, 11, 12	Public Works	High	Multi-Agency Shared Funding	Long Term
C-11—Evaluate the current Surface Water Management (SWM) utility rates and establish funding levels for surface water capital projects and operation and maintenance programs.						
New and Existing	Flood, Earthquakes, Severe Weather	6, 7, 8, 9	Public Works	Low	SWM Fund	Short Term
C-12—Partner with utility districts (Covington Water District, Soos Creek Water and Sewer District) on emergency response and continuity of operation plans.						
New and Existing	All Hazards	1, 3, 5, 6, 7, 12	Public Works	Low	General Fund	Short Term
C-13—Survey and delineate the floodplain of Little Soos Creek to identify known and potential flood limits.						
New and Existing	Flood	1, 6, 7, 8, 9, 10	Community Development	High	FEMA RiskMAP, King County Flood Control District	Long Term
C-14—Update Comprehensive Emergency Management Plan and include terrorism and catastrophic events.						
New and Existing	All hazards	1, 3, 4, 6, 7, 11, 12	Public Works	$50,000	Homeland Security Grants, EMPG grants General Fund	Short Term
C-15—Establish an accessible backup fuel supply to maintain emergency power during long-term power disruptions caused by all hazards of concern.						
New and Existing	All Hazards	3, 11, 12	Public Works	Medium	General Fund, EMPG/SAFER grants	Short Term
C-16—Acquire a backup mobile emergency 30-KW generator for warming shelters, emergency triage, hospital, etc.						
New and Existing	All Hazards	3, 11, 12	Public Works	$45,000	General Fund, Bond issue	Short Term
C-17—Establish linkage between comprehensive plan and hazard mitigation plan.						
New	All	4, 7, 10, 11	Community Development Public Works	Low	General Fund	Short Term
C-18—Rehabilitate and restore drainage facilities back to designed capacities.						
Existing	Flood, Severe Weather	6, 8, 9	Public Works	Medium	SWM Fund, King County Flood Control District	Ongoing
C-19—Design and construct the Woodlands drainage project to mitigate erosion and groundwater seepage.						
Existing	Flood, Landslide	6, 7, 8, 9	Public Works	Medium	Ecology Grant, SWM Fund	Short Term

TABLE 17-1.
HAZARD MITIGATION ACTION PLAN MATRIX

Applies to new or existing assets	Hazards Mitigated	Objectives Met	Lead Agency	Estimated Cost	Sources of Funding	Timeline
C-20—Conduct a drainage study for the 204th Avenue SE corridor.						
New and Existing	Flood, Severe Weather	6, 7, 8, 9	Public Works	High	SWM Fund, King County Flood Control District	Long Term
C-21—Design and retrofit the regional stormwater facility (The Reserve) to increase storage capacity and stability from seismic events.						
New and Existing	Flood, Earthquake	6, 7, 9	Public Works	High	Ecology Grant, Flood Control Grant, SWM Fund, FEMA Hazard Mitigation Grants	Long Term
C-22—Design and construct the Clements drainage pipe upgrade to increase capacity.						
Existing	Flood, Severe Weather	6, 7, 8, 9	Public Works	Medium	Flood Control Grant, SWM Fund	Short Term
C-23—Design and construct Emerald Downs open space channel rehabilitation.						
Existing	Flood, Dam Failure, Severe Weather	6, 7, 9	Public Works	Medium	FEMA Hazard Mitigation Grants, SWM Fund	Long Term
C-24—Expand the City's existing 800 MHz radio communication system.						
Existing	All	3, 12	Public Works	Medium	General Fund, EMPG grants	Short Term
C-25—Acquire property to stockpile bulk response materials.						
Existing	Severe Weather	3, 6, 11, 12	Public Works	High	General Fund, Bond Issue	Long Term
C-26—Design and construct Jenkins Creek Park bridge and pedestrian path resistant to future flooding.						
Existing	Flood, Severe Weather	6, 7, 8, 9	Public Works	Medium	CDBG Grant	Short Term
C-27—Establish mutual aid agreements with local agencies for equipment, materials and supplies.						
New and Existing	All Hazards	3, 6, 11, 12	Public Works	Medium	General Fund	Ongoing
C-28—Establish an emergency on call contract with a general contractor to provide assistance with equipment and operators.						
New and Existing	All Hazards	3, 6, 11, 12	Public Works	Low	General Fund	Short Term
C-29—Reach out to vulnerable populations (adult family homes, senior apartments) and identify plans to track needs during an emergency.						
New and Existing	All Hazards	1, 3, 12	Public Works	Low	General Fund	Short Term

TABLE 17-1.
HAZARD MITIGATION ACTION PLAN MATRIX

Applies to new or existing assets	Hazards Mitigated	Objectives Met	Lead Agency	Estimated Cost	Sources of Funding	Timeline
C-30—Improve the maintenance facility to enable use as backup emergency coordination center and City datacenter. • Provide redundant high speed internet connections with static IP addresses • Improve firewall to handle redundancy • Upgrade server capability in order to run critical city systems						
Existing	All	6, 11, 12	IT	Medium	PDM Grant, General Fund	Long Term
C-31—Improve data connectivity and redundancy at City Hall to make it more resilient to disruption. • Provide redundant network attached storage to provide failover • Provide redundant high speed internet connections with static IP addresses						
Existing	All	6, 11, 12	IT	Medium	PDM Grant, General Fund	Long Term
C-32—Use cloud services to provide for out-of-area storage of City data. • Provide automated duplication of backup data to a cloud storage provider • Create ability to restore data directly from the cloud copy						
Existing	All	6, 11, 12	IT	Low	General Fund	Short Term
C-33—Use cloud services to provide continuity of service for critical city software systems in the event of an emergency. • Provide automated copying of critical systems to a cloud provider • Create the ability to turn on the cloud copy of critical systems in the event on-premise systems were down						
Existing	All	6, 11, 12	IT	Low	General Fund	Short Term
C-34—Evaluate geographic information technology needs related to emergency management. • Purchase Spatial Analyst in order to run the HAZUS model • Purchase ArcServer to host dynamic web maps relating to emergency management						
Existing	All	1, 3, 6, 11, 12	IT	Medium	PDM Grant	Short Term
C-35—Partner with local homeowners associations and block watch groups to provide training and coordination for ATC 20-21 (rapid visual inspection of disaster-damaged buildings) and disaster preparedness.						
New and Existing	Earthquake, Flood, Severe Weather, Volcano	1, 3, 5, 12	Community Development	High	CDBG-DR funding, FEMA 9% initiative funding	Long Term
C-36—Update and work on improvements to the City's emergency permitting process.						
New and Existing	Earthquake, Flood, Severe Weather, Volcano	3, 12	Community Development	Low	General Fund	Short Term
C-37—Provide Community Emergency Response Team training to all city staff.						
New and Existing	Earthquake, Flood, Severe Weather, Volcano	3, 12	Community Development	Low	General Fund	Short Term

TABLE 17-1.
HAZARD MITIGATION ACTION PLAN MATRIX

Applies to new or existing assets	Hazards Mitigated	Objectives Met	Lead Agency	Estimated Cost	Sources of Funding	Timeline
C-38—Provide ATC 20-21 (rapid visual inspection of disaster-damaged buildings) to all city staff, particularly the field staff.						
New and Existing	Earthquake, Flood, Severe Weather, Volcano	1, 3, 12	Community Development	High	CDBG-DR funding, FEMA 9% initiative funding	Long Term
C-39—Use information and principles identified in this plan to support other planning initiatives in Covington, including development and redevelopment plans.						
New	All	3, 7, 10	Community Development	Medium	General Fund	Ongoing
C-40—Seek opportunities to retrofit vulnerable structures when information identifies them as being a risk to hazards.						
Existing	All	2, 3, 6, 7, 8, 10	Community Development	High	FEMA Hazard Mitigation Grants, Property Owner contribution	Long Term

For many of the strategies identified in this action plan, the City of Covington may seek financial assistance under the HMGP or PDM programs, both of which require detailed benefit/cost analyses. These analyses will be performed on projects at the time of application using the FEMA benefit-cost model. For projects not seeking financial assistance from grant programs that require detailed analysis, the City of Covington reserves the right to define "benefits" according to parameters that meet the goals and objectives of this plan.

17.3 ACTION PLAN PRIORITIZATION

Table 17-2 lists the priority of each initiative. A qualitative benefit-cost review was performed for each of these initiatives. The priorities are defined as follows:

- **High Priority**—A project that meets multiple objectives (i.e., multiple hazards), has benefits that exceed cost, has funding secured or is an ongoing project and meets eligibility requirements for the HMGP or PDM grant program. High priority projects can be completed in the short term (1 to 5 years) once funded.
- **Medium Priority**—A project that meets goals and objectives, that has benefits that exceed costs, and for which funding has not been secured but that may be grant eligible under HMGP, PDM or other grant programs or requires special funding authorization under existing programs. Project can be completed in the short term, once funding is secured. Medium priority projects will become high priority projects once funding is secured.
- **Low Priority**—A project that will mitigate the risk of a hazard, that has benefits that may or may not exceed costs or are difficult to quantify, for which funding has not been secured, that is not eligible for HMGP or PDM grant funding, and for which the time line for completion is long term (5 to 10 years). Low priority projects may be eligible for other sources of grant funding from other programs.

TABLE 17-2.
MITIGATION STRATEGY PRIORITY SCHEDULE

Initiative #	# of Objectives Met	Benefits	Costs	Do Benefits Equal or Exceed Costs?	Is Project Grant-Eligible?	Can Project Be Funded Under Existing Programs/ Budgets?	Priority
C-1	3	Medium	Low	Yes	No	Yes	High
C-2	3	Medium	Low	Yes	Yes	Yes	High
C-3	3	Medium	Low	Yes	Yes	Yes	High
C-4	5	Medium	Medium	Yes	No	No	Medium
C-5	3	Medium	Medium	Yes	Yes	No	Medium
C-6	3	High	Medium	Yes	Yes	No	Medium
C-7	3	Low	Low	Yes	No	Yes	High
C-8	2	Medium	Medium	Yes	No	No	Medium
C-9	4	High	High	Yes	No	No	Medium
C-10	4	Medium	High	No	No	No	Low
C-11	4	Low	Low	Yes	No	Yes	High
C-12	6	Medium	Low	Yes	Yes	Yes	High
C-13	6	High	High	Yes	Yes	No	Medium
C-14	7	Medium	Medium	Yes	Yes	Yes	High
C-15	3	Medium	Medium	Yes	Yes	No	Medium
C-16	3	Medium	Medium	Yes	No	No	Medium
C-17	4	Low	Low	Yes	No	Yes	High
C-18	3	Medium	Medium	Yes	Yes	No	Medium
C-19	4	High	Medium	Yes	Yes	Yes	High
C-20	4	Medium	High	No	Yes	No	Low
C-21	3	Medium	High	No	Yes	No	Low
C-22	4	High	Medium	Yes	Yes	No	Medium
C-23	3	Medium	Medium	Yes	Yes	No	Medium
C-24	2	Medium	Medium	Yes	Yes	No	Medium
C-25	4	High	High	Yes	No	No	Low
C-26	4	Medium	Medium	Yes	Yes	Yes	High
C-27	4	Medium	Medium	Yes	No	No	Medium
C-28	4	High	Low	Yes	No	Yes	High
C-29	3	Medium	Low	Yes	No	Yes	High
C-30	3	Medium	Medium	Yes	Yes	No	Medium
C-31	3	Medium	Medium	Yes	Yes	No	Medium
C-32	3	Medium	Low	Yes	No	No	Medium
C-33	3	Medium	Low	Yes	No	No	Medium
C-34	5	Medium	Medium	Yes	Yes	No	Medium

TABLE 17-2.
MITIGATION STRATEGY PRIORITY SCHEDULE

Initiative #	# of Objectives Met	Benefits	Costs	Do Benefits Equal or Exceed Costs?	Is Project Grant-Eligible?	Can Project Be Funded Under Existing Programs/ Budgets?	Priority
C-35	4	High	High	Yes	Yes	No	Low
C-36	2	Medium	Low	Yes	No	No	Medium
C-37	2	Medium	Low	Yes	No	Yes	High
C-38	3	High	High	Yes	Yes	No	Low
C-39	3	Medium	Medium	Yes	No	No	Medium
C-40	6	High	High	Yes	Yes	No	Low

17.4 ANALYSIS OF MITIGATION INITIATIVES

Each planning partner reviewed its recommended initiatives to classify each initiative based on the hazard it addresses and the type of mitigation it involves. Mitigation types used for this categorization are as follows:

- **Prevention**—Government, administrative or regulatory actions that influence the way land and buildings are developed to reduce hazard losses. Includes planning and zoning, floodplain laws, capital improvement programs, open space preservation, and stormwater management regulations.
- **Property Protection**—Modification of buildings or structures to protect them from a hazard or removal of structures from a hazard area. Includes acquisition, elevation, relocation, structural retrofit, storm shutters, and shatter-resistant glass.
- **Public Education and Awareness**—Actions to inform citizens and elected officials about hazards and ways to mitigate them. Includes outreach projects, real estate disclosure, hazard information centers, and school-age and adult education.
- **Natural Resource Protection**—Actions that minimize hazard loss and preserve or restore the functions of natural systems. Includes sediment and erosion control, stream corridor restoration, watershed management, forest and vegetation management, and wetland restoration and preservation.
- **Emergency Services**—Actions that protect people and property during and immediately after a hazard event. Includes warning systems, emergency response services, and the protection of essential facilities.
- **Structural Projects**—Actions that involve the construction of structures to reduce the impact of a hazard. Includes dams, setback levees, floodwalls, retaining walls, and safe rooms.

TABLE 17-3.
ANALYSIS OF MITIGATION INITIATIVES

	Initiative Addressing Hazard, by Mitigation Type[a]					
Hazard Type	1. Prevention	2. Property Protection	3. Public Education and Awareness	4. Natural Resource Protection	5. Emergency Services	6. Structural Projects
Dam Failure	C-17, C-27, C-39,	C-30, C-31, C-32, C-33,	C-7, C-29,	C-23	C-7, C-8, C-9, C-10, C-12, C-14, C-15, C-16, , C-24, C-27, C-28, C-29, C-30, C-31, C-33, C-34,	
Drought	C-17, C-27, C-39,	C-30, C-31, C-32, C-33, C-40	C-7, C-29,		C-7, C-8, C-9, C-10, C-12, C-14, C-15, C-16, C-24, C-27, C-28, C-29, C-30, C-31, C-33, C-34,	
Earthquake	C-11, C-17, C-27, C-36, C-39,	C-30, C-31, C-32, C-33, C-40	C-7, C-29, C-35, C-37, C-38,		C-7, C-8, C-9, C-10, C-12, C-14, C-15, C-16, C-24, C-27, C-28, C-29, C-30, C-31, C-33, C-34, C-35, C-37, C-38,	
Flood	C-1, C-2, C-3, C-11, C-13, C-17, C-27, C-36, C-39,	C-26, C-30, C-31, C-32, C-33, C-40	C-1, C-4, C-7, C-29, C-35, C-37, C-38,	C-18, C-23,	C-7, C-8, C-9, C-10, C-12, C-14, C-15, C-16, C-24, C-27, C-28, C-29, C-30, C-31, C-33, C-34, C-35, C-37, C-38,	C-2, C-4, C-18, C-19, C-20, C-21, C-22,
Landslide	C-17, C-27, C-39,	C-30, C-31, C-32, C-33, C-40	C-7, C-29,		C-7, C-8, C-9, C-10, C-12, C-14, C-15, C-16, C-24, C-27, C-28, C-29, C-30, C-31, C-33, C-34,	C-19,
Severe Weather	C-5, C-11, C-17, C-27, C-36, C-39,	C-6, C-26, C-30, C-31, C-32, C-33, C-40	C-7, C-29, C-35, C-37, C-38,	C-6, C-23	C-7, C-8, C-9, C-10, C-12, C-14, C-15, C-16, C-24, C-25, C-27, C-28, C-29, C-30, C-31, C-33, C-34, C-35, C-37, C-38,	C-18
Volcano	C-17, C-27, C-36, C-39,	C-30, C-31, C-32, C-33, C-40	C-7, C-29, C-35, C-37, C-38,		C-7, C-8, C-9, C-10, C-12, C-14, C-15, C-16, ,C-24, C-27, C-28, C-29, C-30, C-31, C-33, C-34, C-35, C-37, C-38,	
Wildfire	C-17, C-27, C-39,	C-30, C-31, C-32, C-33, C-40	C-7, C-29,		C-7, C-8, C-9, C-10, C-12, C-14, C-15, C-16, ,C-24, C-27, C-28, C-29, C-30, C-31, C-33, C-34,	

TABLE 17-3.
ANALYSIS OF MITIGATION INITIATIVES

	Initiative Addressing Hazard, by Mitigation Type[a]					
Hazard Type	1. Prevention	2. Property Protection	3. Public Education and Awareness	4. Natural Resource Protection	5. Emergency Services	6. Structural Projects
Other Hazards of Interest	C-17, C-27, C-39,	C-30, C-31, C-32, C-33, C-40	C-7, C-29,		C-7, C-8, C-9, C-10, C-12, C-14, C-15, C-16, C-24, C-27, C-28, C-29, C-30, C-31, C-33, C-34,	

a. See Section 17.4 for description of mitigation types

17.5 PLAN ADOPTION

A hazard mitigation plan must document that it has been formally adopted by the governing body of the jurisdiction requesting federal approval of the plan (44 CFR Section 201.6(c)(5)). DMA compliance and its benefits cannot be achieved until the plan is adopted. This plan will be submitted for a pre-adoption review to the Washington Military Department Emergency Management Division and FEMA Region X prior to adoption. Once pre-adoption approval has been provided, the City of Covington will formally adopt the plan. A copy of the resolution is provided in Figure 17-1.

17.6 PLAN MAINTENANCE STRATEGY

A hazard mitigation plan must present a plan maintenance process that includes the following (44 CFR Section 201.6(c)(4)):

- A section describing the method and schedule of monitoring, evaluating, and updating the mitigation plan over a 5-year cycle
- A process by which local governments incorporate the requirements of the mitigation plan into other planning mechanisms, such as comprehensive or capital improvement plans, when appropriate
- A discussion on how the community will continue public participation in the plan maintenance process.

This chapter details the formal process that will ensure that the Hazard Mitigation Plan remains an active and relevant document and that the City of Covington maintains its eligibility for applicable funding sources. The plan maintenance process includes a schedule for monitoring and evaluating the plan annually and producing an updated plan every five years. This chapter also describes how public participation will be integrated throughout the plan maintenance and implementation process. It also explains how the mitigation strategies outlined in this Plan will be incorporated into existing planning mechanisms and programs, such as comprehensive land-use planning processes, capital improvement planning, and building code enforcement and implementation. The Plan's format allows sections to be reviewed and updated when new data become available, resulting in a plan that will remain current and relevant.

Insert Plan Adoption Resolution

Figure 17-1. Resolution Adopting Hazard Mitigation Plan

17.6.1 Plan Implementation

The effectiveness of the hazard mitigation plan depends on its implementation and incorporation of its action items into existing local plans, policies and programs. Together, the action items in the Plan provide a framework for activities that the City of Covington can implement over the next 5 years. The planning team and the Steering Committee have established goals and objectives and have prioritized mitigation actions that will be implemented through existing plans, policies, and programs.

The Covington City Council and the Public Works Department will be jointly responsible for overseeing the plan's implementation and maintenance through existing City programs. The Public Works Director or designated appointee will assume lead responsibility for facilitating plan implementation and maintenance meetings. Although the Public Works Department will have primary responsibility for review, coordination, and promotion, plan implementation and evaluation will be a shared responsibility among all departments identified as lead agencies in the action plan.

17.6.2 Steering Committee

The Steering Committee was an all-volunteer body that contributed greatly to the development of this hazard mitigation plan. The purpose of the committee was to oversee the development of the plan and make recommendations on key elements, including the maintenance strategy. It was the Steering Committee's position that a similar oversight committee should have an active role in the maintenance strategy for the plan. Therefore, the plan update recommends that a steering committee remain a viable body involved in key elements of the plan maintenance strategy.

The new steering committee should have a membership similar to that of the initial steering committee, representing the City, the citizens of Covington, and other stakeholders. The committee will convene biannually at a place and time to be determined. Biannual meetings will be responsive to the dynamic nature of the plan and will provide a greater opportunity for course correction, if needed. The make-up of this steering committee can be dynamic, which will allow differing views to have a say in the implementation of the plan. The City of Covington Public Works Department will strive for true stakeholder representation on this committee. Individuals involved in development of this plan will be contacted and given the option to remain involved in the implementation.

17.6.3 Annual Progress Report

A formal evaluation of the progress of the plan during a 12-month performance period will be completed annually. This review will include the following:

- Summary of any hazard events that occurred during the performance period and the impact these events had on the planning area.
- Review of mitigation success stories.
- Review of continuing public involvement.
- Brief discussion about why targeted strategies were not completed.
- Re-evaluation of the action plan to determine if the timeline for identified projects needs to be amended (such as changing a long-term project to a short-term project because of funding availability).
- Recommendations for new projects.
- Changes in or potential for new funding options (grant opportunities).

- Impact of any other planning programs or initiatives within the City that involve hazard mitigation.

Completion of the progress report represents the minimum task of the ongoing steering committee meetings. A template to guide the steering committee in preparing a progress report is provided in Appendix C of this plan. The steering committee will provide feedback to the planning team on items included in the template. The planning team will then prepare a formal annual report on the progress of the plan. This report will be distributed as follows:

- Posted on the City website page dedicated to the hazard mitigation plan.
- Provided to the local media through a press release.
- Presented in the form of a council report to the Covington City Council.

If the City of Covington chooses to participate in the Community Rating System in the future, the annual progress report can be provided as part of the annual re-certification package. The CRS program requires an annual recertification to be submitted by October 1. To meet this recertification timeline, the planning team should strive to complete the progress report between June and September each year.

17.6.4 Plan Update

44 CFR requires that local hazard mitigation plans be reviewed, revised if appropriate, and resubmitted for approval in order to remain eligible for benefits under the DMA (Section 201.6.d.3). This is the City's original hazard mitigation plan. The City intends to update the plan on a 5-year cycle from the date of initial plan adoption. This cycle may be accelerated to less than 5 years based on the following triggers:

- A presidential disaster declaration that impacts the City of Covington.
- A hazard event that causes loss of life.
- A comprehensive update of the City of Covington Comprehensive Plan.

The plan's format allows the City to review and update sections when new data become available. New data can be easily incorporated, resulting in a plan that will remain current and relevant. It will not be the intent of future update processes to start from scratch and develop a complete new hazard mitigation plan. Future updates will, at a minimum, include the following elements:

- The update process will be convened through a steering committee.
- Annual progress reports will determine the need for changes.
- The risk assessment will be reviewed and updated using the best available information and technologies.
- The action plan will be reviewed and revised to account for any initiatives completed, dropped, or changed and to account for changes in the risk assessment or new City policies identified under other planning mechanisms, as appropriate (such as the general plan).
- The draft update will be sent to appropriate agencies and organizations for comment.
- The public will be given an opportunity to comment on the update prior to adoption.
- The Covington City Council will adopt the updated plan.

17.6.5 Continuing Public Involvement

The public will continue to be apprised of the plan's progress through the City website and by copies of the annual progress reports provided to the media. Copies of the plan will be distributed to the Covington Library. Upon initiation of future update processes, a new public involvement strategy will be initiated based on guidance from the Steering Committee. This strategy will be based on the needs and capabilities of the City at the time of the update. At a minimum, this strategy will include the use of local media outlets within the planning area.

17.6.6 Incorporation into Other Planning Mechanisms

The information on hazard, risk, vulnerability, and mitigation contained in this plan is based on the best science and technology available at the time the plan was prepared. Through the planning process, the City reviewed and expanded on policies contained in other planning mechanisms that can support or enhance the recommendations of this plan. The City views these plans and the Covington Hazard Mitigation Plan as complementary documents that work together to achieve the goal of reducing risk exposure for the citizens of Covington.

An update to the City's Comprehensive Plan will trigger an update to this hazard mitigation plan. Many of the ongoing recommendations identified in Table 17-1 are programs recommended by the Comprehensive Plan. Capital improvement programs and specific plan developments dictated by the Comprehensive Plan will be coordinated with the hazard mitigation plan recommendations. Other planning processes and programs the City will coordinate with the recommendations of the plan include the following:

- Capital Improvement Program
- Covington Municipal Code
- Shoreline Master Program
- Stormwater Management Plan
- The King County Flood Hazard Management Plan
- The King County Regional Hazard Mitigation Plan.

Some action items do not need to be implemented through regulation. Instead, these items can be implemented through the creation of new educational programs, continued interagency coordination, or improved public participation.

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APPENDIX A.
ACRONYMS AND DEFINITIONS

APPENDIX A.
ACRONYMS AND DEFINITIONS

ACRONYMS

ASHRAE— American Society of Heating, Refrigerating, and Air-Conditioning Engineers

CDBG—Community Development Block Grant

CFR—Code of Federal Regulations

CIP—Capital Improvement Plan

CRS—Community Rating System

DMA—Disaster Mitigation Act

EMPG—Emergency Management Performance Grant

ESA—Endangered Species Act

FBFM—Fire behavior fuel model

FCAAP—Flood Control Assistance Account Program

FEMA—Federal Emergency Management Agency

FERC—Federal Energy Regulatory Commission

FIRM—Flood Insurance Rate Map

GIS—Geographic Information System

HAZUS-MH—Hazards, United States-Multi Hazard

HMGP—Hazard Mitigation Grant Program

IBC—International Building Code

IRC—International Residential Code

MM—Modified Mercalli Scale

NEHRP—National Earthquake Hazards Reduction Program

NFIP—National Flood Insurance Program

NOAA—National Oceanic and Atmospheric Administration

NWS—National Weather Service

PDM—Pre-Disaster Mitigation Grant Program

PGA—Peak Ground Acceleration

RCW—Revised Code of Washington

SMP—Shoreline Master Program

SWM—Surface Water Management

USGS—U.S. Geological Survey

USGS-CVO—U.S. Geological Survey Cascades Volcano Observatory

WRIA—Water Resource Inventory Area

WUI—Wildland Urban Interface

DEFINITIONS

100-Year Flood: The 100-year flood is the flood that has a 1 percent chance of being equaled or exceeded in any given year. It does not necessarily occur once every 100 years. Rather, it could occur more than once in a relatively short period of time. The Federal Emergency Management Agency defines it as the 1 percent annual chance flood, which is now the standard definition used by most federal and state agencies and by the National Flood Insurance Program.

Asset: An asset is any man-made or natural feature that has value, including, but not limited to, people; buildings; infrastructure, such as bridges, roads, sewers, and water systems; lifelines, such as electricity and communication resources; and environmental, cultural, or recreational features such as parks, wetlands, and landmarks.

Base Flood: The flood having a 1% chance of being equaled or exceeded in any given year, also known as the "100-year" or "1% chance" flood. The base flood is a statistical concept used to ensure that all properties subject to the National Flood Insurance Program are protected to the same degree against flooding.

Basin: A basin is the area within which all surface water—whether from rainfall, snowmelt, springs, or other sources—flows to a single water body or watercourse. The boundary of a river basin is defined by natural topography, such as hills, mountains, and ridges. Basins are also referred to as "watersheds" and "drainage basins."

Benefit: A benefit is a net project outcome and is usually defined in monetary terms. Benefits may include direct and indirect effects. For the purposes of benefit-cost analysis of proposed mitigation measures, benefits are limited to specific, measurable, risk reduction factors, including reduction in expected property losses (buildings, contents, and functions) and protection of human life.

Benefit/Cost Analysis: A benefit/cost analysis is a systematic, quantitative method of comparing projected benefits to projected costs of a project or policy. It is used as a measure of cost effectiveness.

Building: A building is defined as a structure that is walled and roofed, principally aboveground, and permanently fixed to a site. The term includes manufactured homes on permanent foundations on which the wheels and axles carry no weight.

Capability Assessment: A capability assessment provides a description and analysis of a community's current capacity to address threats associated with hazards. The assessment includes two components: an inventory of an agency's mission, programs, and policies, and an analysis of its capacity to carry them out. A capability assessment is an integral part of the planning process in which a community's actions to reduce losses are identified, reviewed, and analyzed, and the framework for implementation is identified. The following capabilities were reviewed under this assessment:

- Legal and regulatory capability
- Administrative and technical capability
- Fiscal capability

Community Rating System: The Community Rating System is a voluntary program under the NFIP that rewards participating communities (provides incentives) for exceeding the minimum requirements of the NFIP and completing activities that reduce flood hazard risk by providing flood insurance premium discounts.

Critical Area: An area defined by state or local regulations as deserving special protection because of unique natural features or its value as habitat for a wide range of species of flora and fauna. A sensitive/critical area is usually subject to more restrictive development regulations.

Critical Facility: Facilities and infrastructure that are critical to the health and welfare of the population. These become especially important after any hazard event occurs. For the purposes of this plan, critical facilities include:

- Structures or facilities that produce, use, or store highly volatile, flammable, explosive, toxic and/or water reactive materials;
- Hospitals, nursing homes, and housing likely to contain occupants who may not be sufficiently mobile to avoid death or injury during a hazard event.
- Police stations, fire stations, vehicle and equipment storage facilities, and emergency operations centers that are needed for disaster response before, during, and after hazard events, and
- Public and private utilities, facilities and infrastructure that are vital to maintaining or restoring normal services to areas damaged by hazard events.
- Government facilities.

Dam: Any artificial barrier or controlling mechanism that can or does impound 10 acre-feet or more of water.

Dam Failure: Dam failure refers to a partial or complete breach in a dam (or levee) that impacts its integrity. Dam failures occur for a number of reasons, such as flash flooding, inadequate spillway size, mechanical failure of valves or other equipment, freezing and thawing cycles, earthquakes, and intentional destruction.

Debris Avalanche: Volcanoes are prone to debris and mountain rock avalanches that can approach speeds of 100 mph.

Debris Flow: Dense mixtures of water-saturated debris that move down-valley; looking and behaving much like flowing concrete. They form when loose masses of unconsolidated material are saturated, become unstable, and move down slope. The source of water varies but includes rainfall, melting snow or ice, and glacial outburst floods.

Disaster Mitigation Act of 2000 (DMA); The DMA is Public Law 106-390 and is the latest federal legislation enacted to encourage and promote proactive, pre-disaster planning as a condition of receiving financial assistance under the Robert T. Stafford Act. The DMA emphasizes planning for disasters before they occur. Under the DMA, a pre-disaster hazard mitigation program and new requirements for the national post-disaster hazard mitigation grant program (HMGP) were established.

Drainage Basin: A basin is the area within which all surface water- whether from rainfall, snowmelt, springs or other sources- flows to a single water body or watercourse. The boundary of a river basin is defined by natural topography, such as hills, mountains and ridges. Drainage basins are also referred to as **watersheds** or **basins**.

Drought: Drought is a period of time without substantial rainfall or snowfall from one year to the next. Drought can also be defined as the cumulative impacts of several dry years or a deficiency of precipitation over an extended period of time, which in turn results in water shortages for some activity, group, or environmental function. A hydrological drought is caused by deficiencies in surface and subsurface water supplies. A socioeconomic drought impacts the health, well-being, and quality of life or starts to have an adverse impact on a region. Drought is a normal, recurrent feature of climate and occurs almost everywhere.

Earthquake: An earthquake is defined as a sudden slip on a fault, volcanic or magmatic activity, and sudden stress changes in the earth that result in ground shaking and radiated seismic energy. Earthquakes can last from a few seconds to over 5 minutes, and have been known to occur as a series of tremors over a period of several days. The actual movement of the ground in an earthquake is seldom the direct cause of injury or death. Casualties may result from falling objects and debris as shocks shake, damage, or demolish buildings and other structures.

Exposure: Exposure is defined as the number and dollar value of assets considered to be at risk during the occurrence of a specific hazard.

Extent: The extent is the size of an area affected by a hazard.

Fire Behavior: Fire behavior refers to the physical characteristics of a fire and is a function of the interaction between the fuel characteristics (such as type of vegetation and structures that could burn), topography, and weather. Variables that affect fire behavior include the rate of spread, intensity, fuel consumption, and fire type (such as underbrush versus crown fire).

Fire Frequency: Fire frequency is the broad measure of the rate of fire occurrence in a particular area. An estimate of the areas most likely to burn is based on past fire history or fire rotation in the area, fuel conditions, weather, ignition sources (such as human or lightning), fire suppression response, and other factors.

Flash Flood: A flash flood occurs with little or no warning when water levels rise at an extremely fast rate

Flood Insurance Rate Map: Flood Insurance Rate Maps are the official maps on which the Federal Emergency Management Agency has delineated the Special Flood Hazard Area.

Flood Insurance Study: A report published by the Federal Insurance and Mitigation Administration for a community in conjunction with the community's Flood Insurance rate Map. The study contains such background data as the base flood discharges and water surface elevations that were used to prepare the Flood Insurance Rate Map. In most cases, a community Flood Insurance Rate Map with detailed mapping will have a corresponding flood insurance study.

Floodplain: Any land area susceptible to being inundated by flood waters from any source. A flood insurance rate map identifies most, but not necessarily all, of a community's floodplain as the Special Flood Hazard Area.

Floodway: Floodways are areas within a floodplain that are reserved for the purpose of conveying flood discharge without increasing the base flood elevation more than 1 foot. Generally speaking, no development is allowed in floodways, as any structures located there would block the flow of floodwaters.

Floodway Fringe: Floodway fringe areas are located in the floodplain but outside of the floodway. Some development is generally allowed in these areas, with a variety of restrictions. On maps that have identified and delineated a floodway, this would be the area beyond the floodway boundary that can be subject to different regulations.

Freeboard: Freeboard is the margin of safety added to the base flood elevation.

Frequency: For the purposes of this plan, frequency refers to how often a hazard of specific magnitude, duration, and/or extent is expected to occur on average. Statistically, a hazard with a 100-year frequency is expected to occur about once every 100 years on average and has a 1 percent chance of occurring any given year. Frequency reliability varies depending on the type of hazard considered.

Fujita Scale of Tornado Intensity: Tornado wind speeds are sometimes estimated on the basis of wind speed and damage sustained using the Fujita Scale. The scale rates the intensity or severity of tornado events using numeric values from F0 to F5 based on tornado wind speed and damage. An F0 tornado (wind speed less than 73 miles per hour (mph)) indicates minimal damage (such as broken tree limbs), and an F5 tornado (wind speeds of 261 to 318 mph) indicates severe damage.

Goal: A goal is a general guideline that explains what is to be achieved. Goals are usually broad-based, long-term, policy-type statements and represent global visions. Goals help define the benefits that a plan is trying to achieve. The success of a hazard mitigation plan is measured by the degree to which its goals have been met (that is, by the actual benefits in terms of actual hazard mitigation).

Geographic Information System: A Geographic Information System is a computer software application that relates data regarding physical and other features on the earth to a database for mapping and analysis.

Hazard: A hazard is a source of potential danger or adverse condition that could harm people and/or cause property damage.

Hazard Mitigation Grant Program: Authorized under Section 202 of the Robert T. Stafford Disaster Relief and Emergency Assistance Act, the Hazard Mitigation Grant Program is administered by FEMA and provides grants to states, tribes, and local governments to implement hazard mitigation actions after a major disaster declaration. The purpose of the program is to reduce the loss of life and property due to disasters and to enable mitigation activities to be implemented as a community recovers from a disaster

Hazards U.S. Multi-Hazard (HAZUS-MH): HAZUS-MH is a GIS-based program used to support the development of risk assessments as required under the DMA. The HAZUS-MH software program assesses risk in a quantitative manner to estimate damage and losses associated with natural hazards. HAZUS-MH is FEMA's nationally applicable, standardized methodology and software program and contains modules for estimating potential losses from earthquakes, floods, and wind hazards. HAZUS-MH has also been used to assess vulnerability (exposure) for other hazards.

Hydraulics: Hydraulics is the branch of science or engineering that addresses fluids (especially water) in motion in rivers or canals, works and machinery for conducting or raising water, the use of water as a prime mover, and other fluid-related areas.

Hydrology: Hydrology is the analysis of waters of the earth. For example, a flood discharge estimate is developed by conducting a hydrologic study.

Intensity: For the purposes of this plan, intensity refers to the measure of the effects of a hazard.

Inventory: The assets identified in a study region comprise an inventory. Inventories include assets that could be lost when a disaster occurs and community resources are at risk. Assets include people, buildings, transportation, and other valued community resources.

Landslide: Landslides can be described as the sliding movement of masses of loosened rock and soil down a hillside or slope. Fundamentally, slope failures occur when the strength of the soils forming the slope exceeds the pressure, such as weight or saturation, acting upon them.

Lightning: Lightning is an electrical discharge resulting from the buildup of positive and negative charges within a thunderstorm. When the buildup becomes strong enough, lightning appears as a "bolt," usually within or between clouds and the ground. A bolt of lightning instantaneously reaches temperatures approaching 50,000ºF. The rapid heating and cooling of air near lightning causes thunder. Lightning is a major threat during thunderstorms. In the United States, 75 to 100 Americans are struck and killed by lightning each year (see http://www.fema.gov/hazard/thunderstorms/thunder.shtm).

Liquefaction: Liquefaction is the complete failure of soils, occurring when soils lose shear strength and flow horizontally. It is most likely to occur in fine grain sands and silts, which behave like viscous fluids when liquefaction occurs. This situation is extremely hazardous to development on the soils that liquefy, and generally results in extreme property damage and threats to life and safety.

Local Government: Any county, municipality, city, town, township, public authority, school district, special district, intrastate district, council of governments (regardless of whether the council of governments is incorporated as a nonprofit corporation under State law), regional or interstate government entity, or agency or instrumentality of a local government; any Indian tribe or authorized tribal organization, or Alaska Native village or organization; and any rural community, unincorporated town or village, or other public entity.

Magnitude: Magnitude is the measure of the strength of an earthquake, and is typically measured by the Richter scale. As an estimate of energy, each whole number step in the magnitude scale corresponds to the release of about 31 times more energy than the amount associated with the preceding whole number value.

Mass movement: A collective term for landslides, mudflows, debris flows, sinkholes and lahars.

Mitigation: A preventive action that can be taken in advance of an event that will reduce or eliminate the risk to life or property.

Mitigation Actions: Mitigation actions are specific actions to achieve goals and objectives that minimize the effects from a disaster and reduce the loss of life and property.

Objective: For the purposes of this plan, an objective is defined as a short-term aim that, when combined with other objectives, forms a strategy or course of action to meet a goal. Unlike goals, objectives are specific and measurable.

Peak Ground Acceleration: Peak Ground Acceleration (PGA) is a measure of the highest amplitude of ground shaking that accompanies an earthquake, based on a percentage of the force of gravity.

Preparedness: Preparedness refers to actions that strengthen the capability of government, citizens, and communities to respond to disasters.

Presidential Disaster Declaration: These declarations are typically made for events that cause more damage than state and local governments and resources can handle without federal government assistance. Generally, no specific dollar loss threshold has been established for such declarations. A presidential disaster declaration puts into motion long-term federal recovery programs, some of which are matched by state programs, designed to help disaster victims, businesses, and public entities.

Probability of Occurrence: The probability of occurrence is a statistical measure or estimate of the likelihood that a hazard will occur. This probability is generally based on past hazard events in the area and a forecast of events that could occur in the future. A probability factor based on yearly values of occurrence is used to estimate probability of occurrence.

Repetitive Loss Property: Any NFIP-insured property that, since 1978 and regardless of any changes of ownership during that period, has experienced:

- Four or more paid flood losses in excess of $1000.00; or
- Two paid flood losses in excess of $1000.00 within any 10-year period since 1978 or
- Three or more paid losses that equal or exceed the current value of the insured property.

Return Period (or Mean Return Period): This term refers to the average period of time in years between occurrences of a particular hazard (equal to the inverse of the annual frequency of occurrence).

Riverine: Of or produced by a river. Riverine floodplains have readily identifiable channels. Floodway maps can only be prepared for riverine floodplains.

Risk: Risk is the estimated impact that a hazard would have on people, services, facilities, and structures in a community. Risk measures the likelihood of a hazard occurring and resulting in an adverse condition that causes injury or damage. Risk is often expressed in relative terms such as a high, moderate, or low likelihood of sustaining damage above a particular threshold due to occurrence of a specific type of hazard. Risk also can be expressed in terms of potential monetary losses associated with the intensity of the hazard.

Risk Assessment: Risk assessment is the process of measuring potential loss of life, personal injury, economic injury, and property damage resulting from hazards. This process assesses the vulnerability of people, buildings, and infrastructure to hazards and focuses on (1) hazard identification; (2) impacts of hazards on physical, social, and economic assets; (3) vulnerability identification; and (4) estimates of the cost of damage or costs that could be avoided through mitigation.

Risk Ranking: This ranking serves two purposes, first to describe the probability that a hazard will occur, and second to describe the impact a hazard will have on people, property, and the economy. Risk estimates are based on the methodology used to prepare the risk assessment for this plan. The following equation shows the risk ranking calculation:

Risk Ranking = Probability + Impact (people + property + economy)

Robert T. Stafford Act: The Robert T. Stafford Disaster Relief and Emergency Assistance Act, Public Law 100-107, was signed into law on November 23, 1988. This law amended the Disaster Relief Act of 1974, Public Law 93-288. The Stafford Act is the statutory authority for most federal disaster response activities, especially as they pertain to FEMA and its programs.

Sinkhole: A collapse depression in the ground with no visible outlet. Its drainage is subterranean. It is commonly vertical-sided or funnel-shaped.

Special Flood Hazard Area: The base floodplain delineated on a Flood Insurance Rate Map. The Special Flood Hazard Area is mapped as a Zone A in riverine situations and zone V in coastal situations. The Special Flood Hazard Area may or may not encompass all of a community's flood problems

Stakeholder: Business leaders, civic groups, academia, non-profit organizations, major employers, managers of critical facilities, farmers, developers, special purpose districts, and others whose actions could impact hazard mitigation.

Stream Bank Erosion: Stream bank erosion is common along rivers, streams and drains where banks have been eroded, sloughed or undercut. However, it is important to remember that a stream is a dynamic and constantly changing system. It is natural for a stream to want to meander, so not all eroding banks are "bad" and in need of repair. Generally, stream bank erosion becomes a problem where development has limited the meandering nature of streams, where streams have been channelized, or where stream bank structures (like bridges, culverts, etc.) are located in places where they can actually cause damage to downstream areas. Stabilizing these areas can help protect watercourses from continued sedimentation, damage to adjacent land uses, control unwanted meander, and improvement of habitat for fish and wildlife.

Steep Slope: Different communities and agencies define it differently, depending on what it is being applied to, but generally a steep slope is a slope in which the percent slope equals or exceeds 25%. For this study, steep slope is defined as slopes greater than 33%.

Thunderstorm: A thunderstorm is a storm with lightning and thunder produced by cumulonimbus clouds. Thunderstorms usually produce gusty winds, heavy rains, and sometimes hail. Thunderstorms are usually short in duration (seldom more than 2 hours). Heavy rains associated with thunderstorms can lead to flash flooding during the wet or dry seasons.

Tornado: A tornado is a violently rotating column of air extending between and in contact with a cloud and the surface of the earth. Tornadoes are often (but not always) visible as funnel clouds. On a local scale, tornadoes are the most intense of all atmospheric circulations, and winds can reach destructive speeds of more than 300 mph. A tornado's vortex is typically a few hundred meters in diameter, and damage paths can be up to 1 mile wide and 50 miles long.

Vulnerability: Vulnerability describes how exposed or susceptible an asset is to damage. Vulnerability depends on an asset's construction, contents, and the economic value of its functions. Like indirect damage, the vulnerability of one element of the community is often related to the vulnerability of another. For example, many businesses depend on uninterrupted electrical power. Flooding of an electric substation would affect not only the substation itself but businesses as well. Often, indirect effects can be much more widespread and damaging than direct effects.

Watershed: A watershed is an area that drains downgradient from areas of higher land to areas of lower land to the lowest point, a common drainage basin.

Wildfire: These terms refer to any uncontrolled fire occurring on undeveloped land that requires fire suppression. The potential for wildfire is influenced by three factors: the presence of fuel, topography, and air mass. Fuel can include living and dead vegetation on the ground, along the surface as brush and small trees, and in the air such as tree canopies. Topography includes both slope and elevation. Air mass includes temperature, relative humidity, wind speed and direction, cloud cover, precipitation amount, duration, and the stability of the atmosphere at the time of the fire. Wildfires can be ignited by lightning and, most frequently, by human activity including smoking, campfires, equipment use, and arson.

Windstorm: Windstorms are generally short-duration events involving straight-line winds or gusts exceeding 50 mph. These gusts can produce winds of sufficient strength to cause property damage. Windstorms are especially dangerous in areas with significant tree stands, exposed property, poorly constructed buildings, mobile homes (manufactured housing units), major infrastructure, and aboveground utility lines. A windstorm can topple trees and power lines; cause damage to residential, commercial, critical facilities; and leave tons of debris in its wake.

Zoning Ordinance: The zoning ordinance designates allowable land use and intensities for a local jurisdiction. Zoning ordinances consist of two components: a zoning text and a zoning map.

City of Covington
Hazard Mitigation Plan

APPENDIX B.
PUBLIC OUTREACH

City of Covington: Hazard Mitigation Survey

Survey Introduction

The City of Covington needs your personal knowledge and experience of local hazards and disasters.

The information gathered in this survey will be used during the development of the City's Hazard Mitigation Plan, with the aim of reducing the risk of injury or property damage due to local natural disasters.

Your input is critical. The answers to all questions in this survey are confidential and will be used solely for the preparation of the Hazard Mitigation Plan.

Thank you for contributing to this important project.

1. Please indicate in which area of Covington you live.

- [ ] Within City limits, north of Highway 18
- [ ] Within City limits, south of Highway 18
- [ ] Unincorporated King County
- [ ] Other City limits (Kent, Auburn, Maple Valley, etc.)

Please identify your neighborhood/subdivision (if applicable)

2. In the past 25 years, have you or someone in your household experienced a natural disaster within the City of Covington such as an earthquake, flood, landslide, severe weather, dam failure, volcano (ash fall), wild fire, or other natural disaster?

- ◯ Yes
- ◯ No

3. Which of the following types of natural hazards have you or someone in your household experienced? (Please check all that apply.) If you answered no to the previous question (#2), please move to question 4.

- [ ] Dam Failure
- [ ] Flood
- [ ] Severe weather (wind, winter storm, etc.)
- [ ] Earthquake
- [ ] Volcano (ash fall)
- [ ] Landslide
- [ ] Erosion
- [ ] Wild fire
- [ ] Hazardous material incident
- [x] Terrorist event

Other (please specify)

City of Covington: Hazard Mitigation Survey

Understanding Natural Hazards

Preparing for natural hazards and disasters can take many forms. Individuals and households can prepare for emergencies by stocking vital supplies and taking the steps needed to protect their families and homes.

Another important tool for preparing for natural hazards is knowledge. Informational resources about natural hazards and disasters are available from the City of Covington and many other organizations.

4. Do you consider yourself informed about the probable impacts of hazard events that may occur within Covington?

- ◯ Yes
- ◯ No

5. If you answered yes to question 4, what caused you to become better informed? (Please check all that apply.) If you answered no to question 4, please move to question 6.

- ☐ Emergency preparedness information from a government source (e.g., federal, state, or local emergency management)
- ☐ Personal experience with one or more natural hazards or disasters
- ☐ Locally provided news or other media information
- ☐ Schools and other academic institutions
- ☐ Attended meetings that addressed or taught disaster preparedness
- ☐ Community Emergency Response Training (CERT)
- ☐ Self-informed

Other (please specify)

6. Please rate how prepared you feel you and your household are for the probable impacts of natural hazard events likely to occur within Covington.

	Not at all prepared	Somewhat prepared	Adequately prepared	Well prepared	Highly prepared
Rank	◯	◯	◯	◯	◯

7. What steps, if any, have you or someone in your household taken to prepare for a natural disaster? (Check all that apply.)

- ☐ Stored food
- ☐ Stored water
- ☐ Disaster supply kit
- ☐ Flashlight(s)
- ☐ Batteries
- ☐ Battery-powered radio
- ☐ Medical supplies (first aid kit, medications)
- ☐ Fire extinguisher
- ☐ Smoke detector on each level of home
- ☐ First aid and CPR training
- ☐ Fire escape plan
- ☐ Reconnection plan (where to go/who to call)
- ☐ Utility shut-off plan
- ☐ CERT
- ☐ Ham radio operators
- ☐ None

Other (please specify)

8. How concerned are you about the following natural hazards impacting the City of Covington? Please rank each hazard.

	Not Concerned	Somewhat Concerned	Concerned	Very Concerned	Extremely Concerned
Dam Failure	○	○	○	○	○
Earthquake	○	○	○	○	○
Flood	○	○	○	○	○
Household Fire	○	○	○	○	○
Landslide	○	○	○	○	○
Other	○	○	○	○	○
Pipeline Exposure	○	○	○	○	○
Powerline Exposure	○	○	○	○	○
Severe Weather	○	○	○	○	○
Terrorism	○	○	○	○	○
Transportation of Hazardous Materials	○	○	○	○	○
Volcano (ash fall)	○	○	○	○	○
Wild Land Fire	○	○	○	○	○

Other (please specify)

9. Which of the methods below do you feel are the most effective ways to disseminate information on the preparedness for and response to disaster events that can impact Covington? (Please check all that apply)

- ☐ Newspapers
- ☐ Informational Brochures
- ☐ Public Meetings and Town Halls
- ☐ Workshops or Classes
- ☐ Schools/Academic Institutions
- ☐ TV News
- ☐ TV Public Service Announcements
- ☐ Radio News
- ☐ Radio Public Service Announcements
- ☐ City of Covington Newsletter
- ☐ Informational mail from the City (such as postcards)
- ☐ City of Covington website
- ☐ King County website
- ☐ National Weather Service website
- ☐ WA State Emergency Management Dept. website
- ☐ FEMA website
- ☐ Regional Public Information Network (RPIN) website
- ☐ Books/Booklets
- ☐ Public Awareness Campaigns (e.g., Flood Awareness Week, Winter Storm Preparedness Month)
- ☐ Covington Day's Festival
- ☐ Chamber of Commerce
- ☐ Fire Department/Rescue
- ☐ Churches
- ☐ Public Libraries
- ☐ Home Owners Association Forums
- ☐ Social Media (Twitter, Facebook)
- ☐ CERT
- ☐ Other City events

Other (please specify)

10. To the best of your knowledge, is your property located in a FEMA designated floodplain?

○ Yes ○ No ○ Not Sure

11. To the best of your knowledge, is your property located in close proximity (less than 10 mile) to an earthquake fault line?

○ Yes ○ No ○ Not Sure

12. To the best of your knowledge, is your property located in an area at risk for wild fires?

○ Yes ○ No ○ Not Sure

13. To the best of your knowledge, is your property located on or near a steep slope?

○ Yes ○ No ○ Not sure

14. To the best of your knowledge, is your property located in close proximity to the BPA powerline?

- ◯ Yes
- ◯ No
- ◯ Not sure

15. To the best of your knowledge is your property located in close proximity to the Williams pipeline?

- ◯ Yes
- ◯ No
- ◯ Not sure

16. If you own your home, do you have home owners insurance coverage on your home?

- ◯ Yes
- ◯ Not sure
- ◯ No
- ◯ Not applicable

17. Do you have flood insurance?

- ◯ Yes
- ◯ Not Sure
- ◯ No
- ◯ Not applicable

18. Do you have earthquake insurance?

- ◯ Yes
- ◯ Not Sure
- ◯ No
- ◯ Not applicable

City of Covington: Hazard Mitigation Survey

Planning and Mitigation

The term mitigation means to make something become less harsh or severe, in other words, to alleviate.

Hazard mitigation activities are those types of actions you can take to protect your home and property from hazard events such as floods, storms, fires, and earthquakes.

The answers to the following questions will help the City of Covington better understand the knowledge citizens have about their options to protect their property from natural hazards.

19. Did you consider the impact natural hazards might have on your home before you purchased or moved into your home?

- ◯ Yes
- ◯ No

20. Was the presence of a hazard risk zone (e.g., flood zone, earthquake hazard area, landslide area, urban wild land interface) disclosed to you by a real estate agent, seller, or landlord before you purchased or moved into your home?

- ◯ Yes
- ◯ No
- ◯ Not applicable

21. Would the disclosure of this type of information influence your decision to purchase or move into a home?

- ◯ Yes
- ◯ No
- ◯ Maybe

22. How much would you be willing to invest to retrofit or better protect your home and family from the impacts of natural disasters? (Examples of retrofitting are elevating a flood prone home, bolting a foundation for seismic impacts, or replacing a combustible roof covering with non-combustible roofing.)

- ◯ $5,000 or above
- ◯ $2,500 to $4,999
- ◯ $1,000 to $2,499
- ◯ $500 to $999
- ◯ $100 to $499
- ◯ Less than $100
- ◯ Zero
- ◯ Not Sure
- ◯ Not applicable

Other (please specify)

23. If you own your home, which of the following incentives would encourage you to invest in retrofitting your home from the possible impacts of natural disasters? (Please check all that apply.)

- [ ] Building permit fee waiver
- [ ] Insurance premium discount
- [ ] Mortgage discount
- [ ] Property tax break or incentive
- [ ] Low interest rate loan
- [ ] Grant funding that requires a "cost-share"
- [ ] All
- [ ] None
- [ ] Not Applicable

Other (please specify)

24. If your property were located in a designated "high hazard" area or had received repetitive damages from a natural hazard event, would you consider a "buyout" or relocation offered by a public agency?

- ( ) Yes
- ( ) No
- ( ) Maybe

25. How supportive are you of the regulation of land uses in known high hazard areas?

- ( ) Very Supportive
- ( ) Somewhat Supportive
- ( ) non-committal
- ( ) Not very supportive
- ( ) Adamantly oppose

26. Who do you think has the primary responsibility for helping people during the first 12 hours after a disaster?

- ( ) Federal Government (FEMA/DHS)
- ( ) State Government (WAEMD, National Guard)
- ( ) Local Government (City/County)
- ( ) The people in the area affected (myself, my neighbors)

Other (please specify)

27. What types of projects do you believe the City, County, State or Federal agencies should be doing in order to reduce damage and disruption from hazard events within the City of Covington? Please rank each option as a high, medium or low priority.

	High	Medium	Low
Retrofit and strengthen essential facilities such as police, fire, schools and hospitals.	◯	◯	◯
Retrofit infrastructure such as roads, bridges, drainage facilities, levees, water supply, waste water and power supply facilities.	◯	◯	◯
Fund capital projects such as dams, levees, flood walls, drainage improvements and bank stabilization projects.	◯	◯	◯
Strengthen codes and regulations to include higher regulatory standards in hazard areas.	◯	◯	◯
Acquire vulnerable properties and maintain as open space.	◯	◯	◯
Assist vulnerable property owners with securing funding for mitigation.	◯	◯	◯
Provide better public information about risk, and the exposure to hazards within the City.	◯	◯	◯
Implement projects that restore the natural environments capacity to absorb the impacts from natural hazards.	◯	◯	◯
Implement projects that mitigate the potential impacts from climate change.	◯	◯	◯

City of Covington: Hazard Mitigation Survey

Household Demographic Information

The information gathered in this section of the survey will assist the Hazard Mitigation Committee to quantify answers. For example, by knowing whether you own a home or are a tenant will help the committee determine similar and differing needs of homeowners and tenants.

The answers to all questions in this survey are confidential and will be used solely for the preparation of the Hazard Mitigation Plan.

28. Please indicate your age range.

- ◯ 18 to 30
- ◯ 31 to 40
- ◯ 41 to 50
- ◯ 51 to 60
- ◯ 61 or older

29. Please indicate the primary language spoken in your household.

- ◯ English
- ◯ Spanish
- ◯ Other Indo-European Language
- ◯ Asian and Pacific Island Languages

Other (please specify)

30. Gender

- ◯ Female
- ◯ Male

31. Please indicate your level of education.

- ◯ Grade school
- ◯ Some high school
- ◯ High school graduate or GED
- ◯ Some college and/or trade school
- ◯ Undergraduate college degree
- ◯ Graduate college degree

Other (please specify)

32. How long have you lived in Covington?

- ◯ Less than 1 year
- ◯ 1 to 5 years
- ◯ 6 to 10 years
- ◯ 11 to 19 years
- ◯ 20 years or more

33. Do you own or rent your place of residence?

- ◯ Own
- ◯ Rent

34. How much is your gross household income?

- ◯ $20,000 or less
- ◯ $20,001 to $29,999
- ◯ $30,000 to $44,999
- ◯ $45,000 to $59,999
- ◯ $60,000 to $74,999
- ◯ $75,000 or More
- ◯ Prefer not to answer

35. Do you have access to the Internet or "World Wide Web"?

- ◯ Yes
- ◯ No

City of Covington: Hazard Mitigation Survey

Comments (Optional)

If you have additional information you would like to share about your knowledge and experience regarding local natural hazards and disasters in Covington, we welcome you to provide your information on this page. This survey and your comments are completely confidential.

For more information on this plan and process please vist our website at:
http://www.covingtonwa.gov/hazardmitigation/index.html

36. Comments

City of Covington: Hazard Mitigation Survey

1. Please indicate in which area of Covington you live.

	Response Percent	Response Count
Within City limits, north of Highway 18	**32.2%**	**19**
Within City limits, south of Highway 18	30.5%	18
Unincorporated King County	11.9%	7
Other City limits (Kent, Auburn, Maple Valley, etc.)	27.1%	16
Please identify your neighborhood/subdivision (if applicable)		33
answered question		**59**
skipped question		**0**

2. In the past 25 years, have you or someone in your household experienced a natural disaster within the City of Covington such as an earthquake, flood, landslide, severe weather, dam failure, volcano (ash fall), wild fire, or other natural disaster?

	Response Percent	Response Count
Yes	**54.2%**	**32**
No	45.8%	27
answered question		**59**
skipped question		**0**

3. Which of the following types of natural hazards have you or someone in your household experienced? (Please check all that apply.) If you answered no to the previous question (#2), please move to question 4.

	Response Percent	Response Count
Dam Failure	0.0%	0
Flood	7.5%	3
Severe weather (wind, winter storm, etc.)	**85.0%**	**34**
Earthquake	62.5%	25
Volcano (ash fall)	15.0%	6
Landslide	0.0%	0
Erosion	2.5%	1
Wild fire	2.5%	1
Hazardous material incident	0.0%	0
Terrorist event	0.0%	0
	Other (please specify)	3
	answered question	**40**
	skipped question	**19**

4. Do you consider yourself informed about the probable impacts of hazard events that may occur within Covington?

	Response Percent	Response Count
Yes	**70.4%**	**38**
No	29.6%	16
	answered question	**54**
	skipped question	**5**

5. If you answered yes to question 4, what caused you to become better informed? (Please check all that apply.) If you answered no to question 4, please move to question 6.

	Response Percent	Response Count
Emergency preparedness information from a government source (e.g., federal, state, or local emergency management)	**83.8%**	**31**
Personal experience with one or more natural hazards or disasters	73.0%	27
Locally provided news or other media information	48.6%	18
Schools and other academic institutions	16.2%	6
Attended meetings that addressed or taught disaster preparedness	24.3%	9
Community Emergency Response Training (CERT)	24.3%	9
Self-informed	51.4%	19
Other (please specify)		2
answered question		**37**
skipped question		**22**

6. Please rate how prepared you feel you and your household are for the probable impacts of natural hazard events likely to occur within Covington.

	Not at all prepared	Somewhat prepared	Adequately prepared	Well prepared	Highly prepared	Rating Average	Rating Count
Rank	7.4% (4)	**40.7% (22)**	24.1% (13)	25.9% (14)	1.9% (1)	2.74	54
answered question							**54**
skipped question							**5**

7. What steps, if any, have you or someone in your household taken to prepare for a natural disaster? (Check all that apply.)

	Response Percent	Response Count
Stored food	64.8%	35
Stored water	66.7%	36
Disaster supply kit	42.6%	23
Flashlight(s)	90.7%	49
Batteries	90.7%	49
Battery-powered radio	70.4%	38
Medical supplies (first aid kit, medications)	79.6%	43
Fire extinguisher	75.9%	41
Smoke detector on each level of home	**94.4%**	**51**
First aid and CPR training	70.4%	38
Fire escape plan	46.3%	25
Reconnection plan (where to go/who to call)	44.4%	24
Utility shut-off plan	38.9%	21
CERT	20.4%	11
Ham radio operators	14.8%	8
None	3.7%	2
	Other (please specify)	2
	answered question	**54**
	skipped question	**5**

8. How concerned are you about the following natural hazards impacting the City of Covington? Please rank each hazard.

	Not Concerned	Somewhat Concerned	Concerned	Very Concerned	Extremely Concerned	Rating Average	R C
Dam Failure	**70.4% (38)**	14.8% (8)	11.1% (6)	3.7% (2)	0.0% (0)	1.48	
Earthquake	3.8% (2)	21.2% (11)	**40.4% (21)**	23.1% (12)	11.5% (6)	3.17	
Flood	**50.9% (27)**	35.8% (19)	9.4% (5)	3.8% (2)	0.0% (0)	1.66	
Household Fire	9.3% (5)	**38.9% (21)**	37.0% (20)	13.0% (7)	1.9% (1)	2.59	
Landslide	**66.0% (35)**	26.4% (14)	7.5% (4)	0.0% (0)	0.0% (0)	1.42	
Severe Weather	1.9% (1)	24.5% (13)	**39.6% (21)**	28.3% (15)	5.7% (3)	3.11	
Volcano (ash fall)	32.1% (17)	**39.6% (21)**	24.5% (13)	3.8% (2)	0.0% (0)	2.00	
Wild Land Fire	**43.4% (23)**	41.5% (22)	13.2% (7)	1.9% (1)	0.0% (0)	1.74	
Transportation of Hazardous Materials	26.4% (14)	**37.7% (20)**	28.3% (15)	5.7% (3)	1.9% (1)	2.19	
Pipeline Exposure	**41.5% (22)**	28.3% (15)	22.6% (12)	7.5% (4)	0.0% (0)	1.96	
Powerline Exposure	**31.4% (16)**	**31.4% (16)**	25.5% (13)	11.8% (6)	0.0% (0)	2.18	
Terrorism	**49.1% (26)**	26.4% (14)	18.9% (10)	3.8% (2)	1.9% (1)	1.83	
Other	**83.9% (26)**	6.5% (2)	9.7% (3)	0.0% (0)	0.0% (0)	1.26	

Other (please specify)

	answered question
	skipped question

9. Which of the methods below do you feel are the most effective ways to disseminate information on the preparedness for and response to disaster events that can impact Covington? (Please check all that apply)

	Response Percent	Response Count
Newspapers	33.3%	18
Informational Brochures	48.1%	26
Public Meetings and Town Halls	35.2%	19
Workshops or Classes	38.9%	21
Schools/Academic Institutions	20.4%	11
TV News	50.0%	27
TV Public Service Announcements	35.2%	19
Radio News	33.3%	18
Radio Public Service Announcements	25.9%	14
City of Covington Newsletter	63.0%	34
Informational mail from the City (such as postcards)	53.7%	29
City of Covington website	**74.1%**	**40**
King County website	42.6%	23
National Weather Service website	27.8%	15
WA State Emergency Management Dept. website	25.9%	14
FEMA website	18.5%	10
Regional Public Information Network (RPIN) website	16.7%	9
Books/Booklets	3.7%	2
Public Awareness Campaigns (e.g., Flood Awareness Week, Winter	55.6%	30

Storm Preparedness Month)		
Covington Day's Festival	53.7%	29
Chamber of Commerce	18.5%	10
Fire Department/Rescue	37.0%	20
Churches	35.2%	19
Public Libraries	48.1%	26
Home Owners Association Forums	38.9%	21
Social Media (Twitter, Facebook)	51.9%	28
CERT	25.9%	14
Other City events	16.7%	9
	Other (please specify)	1
	answered question	**54**
	skipped question	**5**

10. To the best of your knowledge, is your property located in a FEMA designated floodplain?

	Response Percent	Response Count
Yes	1.9%	1
No	**83.3%**	**45**
Not Sure	14.8%	8
	answered question	**54**
	skipped question	**5**

11. To the best of your knowledge, is your property located in close proximity (less than 10 mile) to an earthquake fault line?

	Response Percent	Response Count
Yes	7.4%	4
No	38.9%	21
Not Sure	**53.7%**	**29**
	answered question	**54**
	skipped question	**5**

12. To the best of your knowledge, is your property located in an area at risk for wild fires?

	Response Percent	Response Count
Yes	14.8%	8
No	**59.3%**	**32**
Not Sure	25.9%	14
	answered question	**54**
	skipped question	**5**

13. To the best of your knowledge, is your property located on or near a steep slope?

	Response Percent	Response Count
Yes	15.4%	8
No	**78.8%**	**41**
Not sure	5.8%	3
	answered question	**52**
	skipped question	**7**

14. To the best of your knowledge, is your property located in close proximity to the BPA powerline?

	Response Percent	Response Count
Yes	29.6%	16
No	**51.9%**	**28**
Not sure	18.5%	10
	answered question	**54**
	skipped question	**5**

15. To the best of your knowledge is your property located in close proximity to the Williams pipeline?

	Response Percent	Response Count
Yes	9.3%	5
No	**46.3%**	**25**
Not sure	44.4%	24
	answered question	**54**
	skipped question	**5**

16. If you own your home, do you have home owners insurance coverage on your home?

	Response Percent	Response Count
Yes	**100.0%**	**53**
No	0.0%	0
Not sure	0.0%	0
Not applicable	0.0%	0
	answered question	**53**
	skipped question	**6**

17. Do you have flood insurance?

	Response Percent	Response Count
Yes	7.4%	4
No	**75.9%**	**41**
Not Sure	13.0%	7
Not applicable	3.7%	2
	answered question	**54**
	skipped question	**5**

18. Do you have earthquake insurance?

	Response Percent	Response Count
Yes	37.0%	20
No	**48.1%**	**26**
Not Sure	14.8%	8
Not applicable	0.0%	0
	answered question	**54**
	skipped question	**5**

19. Did you consider the impact natural hazards might have on your home before you purchased or moved into your home?

	Response Percent	Response Count
Yes	**60.0%**	**30**
No	40.0%	20
	answered question	**50**
	skipped question	**9**

20. Was the presence of a hazard risk zone (e.g., flood zone, earthquake hazard area, landslide area, urban wild land interface) disclosed to you by a real estate agent, seller, or landlord before you purchased or moved into your home?

	Response Percent	Response Count
Yes	8.0%	4
No	**60.0%**	**30**
Not applicable	32.0%	16
	answered question	**50**
	skipped question	**9**

21. Would the disclosure of this type of information influence your decision to purchase or move into a home?

	Response Percent	Response Count
Yes	**58.0%**	**29**
No	14.0%	7
Maybe	28.0%	14
	answered question	**50**
	skipped question	**9**

22. How much would you be willing to invest to retrofit or better protect your home and family from the impacts of natural disasters? (Examples of retrofitting are elevating a flood prone home, bolting a foundation for seismic impacts, or replacing a combustible roof covering with non-combustible roofing.)

	Response Percent	Response Count
$5,000 or above	18.0%	9
$2,500 to $4,999	14.0%	7
$1,000 to $2,499	16.0%	8
$500 to $999	10.0%	5
$100 to $499	6.0%	3
Less than $100	0.0%	0
Zero	4.0%	2
Not Sure	**26.0%**	**13**
Not applicable	6.0%	3
	Other (please specify)	1
	answered question	**50**
	skipped question	**9**

23. If you own your home, which of the following incentives would encourage you to invest in retrofitting your home from the possible impacts of natural disasters? (Please check all that apply.)

	Response Percent	Response Count
Building permit fee waiver	32.0%	16
Insurance premium discount	**52.0%**	**26**
Mortgage discount	40.0%	20
Property tax break or incentive	46.0%	23
Low interest rate loan	32.0%	16
Grant funding that requires a “cost-share”	30.0%	15
All	34.0%	17
None	10.0%	5
Not Applicable	6.0%	3
Other (please specify)		0
answered question		**50**
skipped question		**9**

24. If your property were located in a designated “high hazard” area or had received repetitive damages from a natural hazard event, would you consider a ”buyout” or relocation offered by a public agency?

	Response Percent	Response Count
Yes	**58.0%**	**29**
No	10.0%	5
Maybe	32.0%	16
	answered question	**50**
	skipped question	**9**

25. How supportive are you of the regulation of land uses in known high hazard areas?

	Response Percent	Response Count
Very Supportive	**40.0%**	**20**
Somewhat Supportive	34.0%	17
non-committal	18.0%	9
Not very supportive	4.0%	2
Adamantly oppose	4.0%	2
	answered question	**50**
	skipped question	**9**

26. Who do you think has the primary responsibility for helping people during the first 12 hours after a disaster?

	Response Percent	Response Count
Federal Government (FEMA/DHS)	4.0%	2
State Government (WAEMD, National Guard)	6.0%	3
Local Government (City/County)	24.0%	12
The people in the area affected (myself, my neighbors)	**66.0%**	**33**
	Other (please specify)	4
	answered question	**50**
	skipped question	**9**

27. What types of projects do you believe the City, County, State or Federal agencies should be doing in order to reduce damage and disruption from hazard events within the City of Covington? Please rank each option as a high, medium or low priority.

	High	Medium	Low	Rating Average	Rating Count
Retrofit and strengthen essential facilities such as police, fire, schools and hospitals.	**74.0% (37)**	24.0% (12)	2.0% (1)	1.28	50
Retrofit infrastructure such as roads, bridges, drainage facilities, levees, water supply, waste water and power supply facilities.	**84.0% (42)**	14.0% (7)	2.0% (1)	1.18	50
Fund capital projects such as dams, levees, flood walls, drainage improvements and bank stabilization projects.	38.0% (19)	**52.0% (26)**	10.0% (5)	1.72	50
Strengthen codes and regulations to include higher regulatory standards in hazard areas.	28.0% (14)	**58.0% (29)**	14.0% (7)	1.86	50
Acquire vulnerable properties and maintain as open space.	18.0% (9)	40.0% (20)	**42.0% (21)**	2.24	50
Assist vulnerable property owners with securing funding for mitigation.	12.2% (6)	**55.1% (27)**	32.7% (16)	2.20	49
Provide better public information about risk, and the exposure to hazards within the City.	**52.0% (26)**	46.0% (23)	2.0% (1)	1.50	50
Implement projects that restore the natural environments capacity to absorb the impacts from natural hazards.	30.0% (15)	**48.0% (24)**	22.0% (11)	1.92	50
Implement projects that mitigate the potential impacts from climate change.	20.0% (10)	**44.0% (22)**	36.0% (18)	2.16	50
				answered question	**50**
				skipped question	**9**

28. Please indicate your age range.

	Response Percent	Response Count
18 to 30	6.0%	3
31 to 40	26.0%	13
41 to 50	18.0%	9
51 to 60	**28.0%**	**14**
61 or older	22.0%	11
	answered question	**50**
	skipped question	**9**

29. Please indicate the primary language spoken in your household.

	Response Percent	Response Count
English	**100.0%**	**50**
Spanish	0.0%	0
Other Indo-European Language	0.0%	0
Asian and Pacific Island Languages	0.0%	0
	Other (please specify)	0
	answered question	**50**
	skipped question	**9**

30. Gender

	Response Percent	Response Count
Male	**61.2%**	**30**
Female	38.8%	19
	answered question	**49**
	skipped question	**10**

31. Please indicate your level of education.

	Response Percent	Response Count
Grade school	0.0%	0
Some high school	0.0%	0
High school graduate or GED	4.1%	2
Some college and/or trade school	**38.8%**	**19**
Undergraduate college degree	**38.8%**	**19**
Graduate college degree	18.4%	9
	Other (please specify)	1
	answered question	**49**
	skipped question	**10**

32. How long have you lived in Covington?

	Response Percent	Response Count
Less than 1 year	4.3%	2
1 to 5 years	17.0%	8
6 to 10 years	23.4%	11
11 to 19 years	**27.7%**	**13**
20 years or more	**27.7%**	**13**
	answered question	**47**
	skipped question	**12**

33. Do you own or rent your place of residence?

	Response Percent	Response Count
Own	**95.8%**	**46**
Rent	4.2%	2
	answered question	**48**
	skipped question	**11**

34. How much is your gross household income?

	Response Percent	Response Count
$20,000 or less	2.0%	1
$20,001 to $29,999	2.0%	1
$30,000 to $44,999	4.1%	2
$45,000 to $59,999	6.1%	3
$60,000 to $74,999	10.2%	5
$75,000 or More	**59.2%**	**29**
Prefer not to answer	16.3%	8
	answered question	**49**
	skipped question	**10**

35. Do you have access to the Internet or “World Wide Web”?

	Response Percent	Response Count
Yes	**100.0%**	**50**
No	0.0%	0
	answered question	**50**
	skipped question	**9**

36. Comments

	Response Count
	8
answered question	**8**
skipped question	**51**

City of Covington
Hazard Mitigation Plan

APPENDIX C.
EXAMPLE PROGRESS REPORT

APPENDIX C.
EXAMPLE PROGRESS REPORT

City of Covington
Hazard Mitigation Plan
Annual Progress Report

Reporting Period: *(Insert reporting period)*

Background: The City of Covington has developed its Hazard Mitigation Plan to provide a vision for reducing the City's risk from all hazards. The Plan identifies resources, information, and strategies for risk reduction. The federal Disaster Mitigation Act of 2000 requires state and local governments to develop hazard mitigation plans as a condition for federal disaster grant assistance. To prepare the Plan, the City assessed the risks associated with natural hazards in the planning area, developed planning goals and objectives, reviewed mitigation alternatives, and developed an action plan to address probable impacts from natural hazards in Covington. By completing this process, the City achieved compliance with the Disaster Mitigation Act, becoming eligible for mitigation grant funding under the Robert T. Stafford Act. The plan can be viewed on-line at:

http://www.covingtonwa.gov/hazardmitigation/index.html

Summary Overview of the Plan's Progress: The performance period for the Hazard Mitigation Plan became effective on ____, 2014, with the final approval of the plan by FEMA. The initial performance period for this plan will be 5 years, with an anticipated update to the plan to occur before _____, 2019. As of this reporting period, the performance period for this plan is considered to be __% complete. The Hazard Mitigation Plan has targeted 40 hazard mitigation initiatives to be pursued during the 5-year performance period. As of the reporting period, the following overall progress can be reported:

- __ out of __ initiatives (__%) reported ongoing action toward completion.
- __ out of __ initiatives (__%) were reported as being complete.
- __ out of __ initiatives (___%) reported no action taken.

Purpose: The purpose of this report is to provide the Covington City Council, stakeholders and the citizens of Covington an annual update on the implementation of the action plan identified in the City of Covington Hazard Mitigation Plan. This report has been prepared by the planning team and was reviewed and confirmed by the Hazard Mitigation Plan Steering Committee in accordance with Section 17.6.3 of the Plan. The Steering Committee reviewed and approved this progress report at its meeting held _____, 201__. The objective of this annual evaluation is to ensure that there is a continuing and responsive planning process that will keep the Hazard Mitigation Plan dynamic and responsive to the needs and capabilities of the City of Covington. This report discusses the following:

- Natural hazard events that have occurred within the last year
- Changes in risk exposure within the planning area (all of the City of Covington)
- Mitigation success stories
- Review of the action plan

- Changes in capabilities that could impact plan implementation
- Recommendations for changes/enhancement.

The Hazard Mitigation Plan Steering Committee: The development of the Plan was overseen by a 9-member Steering Committee that was made up of stakeholders within the planning area. This oversight committee operated under a set of ground rules that supported the primary objectives of the planning process. It was determined that a Steering Committee should remain as a viable body to oversee the maintenance aspects of the plan as established in Section 17.6.1. This body will remain as organized in the established ground rules. It is anticipated that there will be turnover in its membership annually, which will be monitored via the progress reporting mechanism. It is also anticipated that the Steering Committee role in overall plan implementation will be dynamic, based on the hazard mitigation needs of the City. At a minimum, the Steering Committee will provide technical review and oversight on the development of the annual progress report. For this reporting period, the Steering Committee Membership is indicated in Table 1.

TABLE 1.
STEERING COMMITTEE MEMBERS

Name	Title	Jurisdiction/Agency

Natural Hazard Events within the Planning Area: During the reporting period, there were __ natural hazard events in the planning area that had a measurable impact on people or property. A summary of these events is as follows:

- _____
- _____

Changes in Risk Exposure in the Planning Area: The Hazard Mitigation Plan addressed the probable impact for the following natural hazard events within the City of Covington:

- Dam Failure
- Drought
- Earthquake
- Flood
- Landslide
- Severe Weather
- Volcano
- Wildfire

(Insert brief overview of any natural hazard event in the planning area that changed the probability of occurrence or ranking of risk for the hazards addressed in the hazard mitigation plan)

Mitigation Success Stories: *(Insert brief overview of mitigation accomplishments during the reporting period)*

Review of the Action Plan: Table 2 reviews the action plan, reporting the status of each initiative. Reviewers of this report should refer to the Hazard Mitigation Plan for more detailed descriptions of each initiative and the prioritization process.

Address the following in the "status" column of the following table:

- Was any element of the initiative carried out during the reporting period?
- If no action was completed, why?
- Is the timeline for implementation for the initiative still appropriate?
- If the initiative was completed, does it need to be changed or removed from the action plan?

TABLE 2.
ACTION PLAN MATRIX

Action Taken? (Yes or No)	Time Line	Priority	Status	Status (X, O,✓)
Initiative #__ —			_____[description]	
Initiative #__ —			_____[description]	
Initiative #__ —			_____[description]	
Initiative #__ —			_____[description]	

TABLE 2.
ACTION PLAN MATRIX

Action Taken? (Yes or No)	Time Line	Priority	Status	Status (X, O,✓)
Initiative #__—_____[description]				
Initiative #__—_____[description]				
Initiative #__—_____[description]				
Initiative #__—_____[description]				
Initiative #__—_____[description]				
Initiative #__—_____[description]				
Initiative #__—_____[description]				
Initiative #__—_____[description]				
Initiative #__—_____[description]				
Initiative #__—_____[description]				
Initiative #__—_____[description]				
Initiative #__—_____[description]				
Initiative #__—_____[description]				
Initiative #__—_____[description]				
Initiative #__—_____[description]				
Initiative #__—_____[description]				
Initiative #__—_____[description]				

TABLE 2.
ACTION PLAN MATRIX

Action Taken? (Yes or No)	Time Line	Priority	Status	Status (X, O,✓)
Initiative #__ — _____			[description]	
Initiative #__ — _____			[description]	
Initiative #__ — _____			[description]	
Initiative #__ — _____			[description]	
Initiative #__ — _____			[description]	
Initiative #__ — _____			[description]	

Completion status legend:
✓= Project Completed
O = Action ongoing toward completion
X = No progress at this time

Changes That May Impact Implementation of the Plan: *(Insert brief overview of any significant changes in the planning area that would have a profound impact on the implementation of the plan. Specify any changes in technical, regulatory and financial capabilities identified during the plan's development)*

Recommendations for Changes or Enhancements: Based on the review of this report by the Hazard Mitigation Plan Steering Committee, the following recommendations will be noted for future updates or revisions to the plan:

- _____
- _____
- _____
- _____
- _____
- _____

Public review notice: *The contents of this report are considered to be public knowledge and have been prepared for total public disclosure. Copies of the report have been provided to the City of Covington governing board and to local media outlets and the report is posted on the City of Covington Hazard Mitigation Plan website. Any questions or comments regarding the contents of this report should be directed to:*

Insert Contact Info Here

Shellie Bates, Programs Supervisor
City of Covington
Public Works Department
16720 SE 271st Street, Suite 100
Covington, WA 98042
253-480-2463
sbates@covingtonwa.gov