

**CITY OF SEATTLE**

**RESOLUTION** 32011

A RESOLUTION approving the 2021-2026 revision to the Seattle All-Hazards Mitigation Plan.

WHEREAS, the Federal Emergency Management Agency (FEMA) has established a policy that

requires recipients and potential recipients of Hazard Mitigation grant funding to have a

Hazard Mitigation Plan; and

WHEREAS, FEMA's policy requires that the City's All-Hazards Mitigation Plan be formally

adopted by the City Council and submitted for approval by FEMA through the State of

Washington Military Department, Emergency Management Division; and

WHEREAS, the City's All-Hazards Mitigation Plan is one in the suite of plans under the City's

Comprehensive Emergency Management Plan; and

WHEREAS, as cited in the City's All-Hazard Mitigation Plan, Seattle's Hazard Identification

and Vulnerability Analysis identifies Seattle as a hub for land, sea, and air transportation,

giving the City an inherent exposure to transportation incidents including plane crashes;

and

WHEREAS, as cited in the City's All-Hazard Mitigation Plan, Seattle's Hazard Identification

and Vulnerability Analysis reports that excessive heat events are projected to become

more intense due to climate change, disproportionately affecting vulnerable populations

including the elderly, infants, the homeless, the poor, and people who are socially

isolated; and

WHEREAS, the Office of Emergency Management is responsible for the revision to the City's

All-Hazards Mitigation Plan every five years in coordination with representatives of City

departments and external partner organizations; and

1 WHEREAS, the Disaster Management Committee created by Seattle Municipal Code Section  
2 10.02.060 has formally reviewed and recommends adoption of the Plan; NOW,  
3 THEREFORE,

4 **BE IT RESOLVED BY THE CITY COUNCIL OF THE CITY OF SEATTLE, THE**  
5 **MAYOR CONCURRING, THAT:**

6 Section 1. The 2021-2026 Seattle All-Hazards Mitigation Plan, dated February 1, 2021,  
7 attached to this resolution as Exhibit 1, has been reviewed and is approved.

8 Section 2. The City also approves such minor alterations to the Plan approved in Section  
9 1 as are requested by the State of Washington Military Department, Emergency Management  
10 Division and FEMA and are determined by the Office of Emergency Management to be in the  
11 best interest of the City.

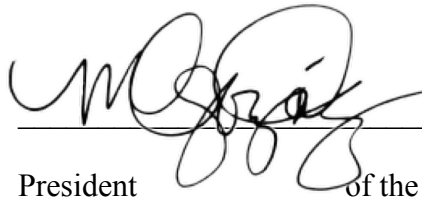
12 Section 3. The City Council requests that the Office of Emergency Management develop  
13 a strategy to brief communities in the City of Seattle under the Sea-Tac International Airport and  
14 King County International Airport flight paths on information on existing City, County, and Port  
15 of Seattle planning that may relate to plane crash hazard mitigation and, following such  
16 briefings, report back to the City Council via Clerk File on deficiencies identified by those  
17 communities for the Office of Emergency Management's consideration in a future plan.

18 Section 4. The City Council requests that the Office of Emergency Management  
19 coordinate a citywide effort to identify approaches and projects which can mitigate the impacts  
20 of excessive heat on vulnerable populations in Seattle. The Office of Emergency Management  
21 should engage multiple City departments, community-based organizations, private sector  
22 partners and other subject matter experts including Public Health Seattle & King County and the



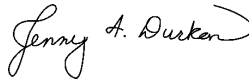
Office of Sustainability and Environment to scope realistic and implementable strategies and approaches and identify needed public and private funding for those strategies.

Adopted by the City Council the 2nd day of August, 2021,  
and signed by me in open session in authentication of its adoption this 2nd day of  
August, 2021.



President \_\_\_\_\_ of the City Council

The Mayor concurred the 12th day of August, 2021.



Jenny A. Durkan, Mayor

Filed by me this 12th day of August, 2021.



Monica Martinez Simmons, City Clerk

(Seal)

Attachments:  
Exhibit 1 – City of Seattle 2021-2026 All-Hazards Mitigation Plan

# **CITY OF SEATTLE**

## **2021-2026 ALL-HAZARDS MITIGATION PLAN**



**DRAFT 2/1/2021**

**V. 1.1**

**Prepared by:**  
**City of Seattle**  
**Office of Emergency Management**

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## Vision, Mission, Guiding Principles

In an effort to align planning documents across all phases of emergency management, the City of Seattle Office of Emergency Management has collaboratively developed a vision, mission, and guiding principles that will provide a conceptual framework for all of the plans that support the City's emergency program, including the 2021 update of the City of Seattle All-Hazards Mitigation Plan.

### Vision

*Disaster ready...prepared people, resilient community*

### Mission

*We partner with the community to prevent, prepare for, respond to, mitigate the impacts of, and recover from disasters.*

### Guiding Principles

**Comprehensive:** We consider and take into account all hazards, all phases, all stakeholders, and all impacts relevant to disasters.

**Progressive:** We anticipate future disasters and take preventive and preparatory measures to build disaster-resistant and disaster-resilient communities.

**Risk-Driven:** We use sound risk management principles (hazard identification, risk analysis, and impact analysis) in assigning priorities and resources.

**Integrated:** We ensure unity of effort among all levels of government and all elements of the community.

**Collaborative:** We create and sustain broad and sincere relationships among individuals and organizations to encourage trust, advocate a team atmosphere, build consensus, and facilitate communication.

**Flexible:** We use creative and innovative approaches in solving disaster challenges.

**Professional:** We value a science and knowledge-based approach based on education, training, experience, ethical practice, public stewardship, and continuous improvement.



## City Council Resolution

To be added following approval

## FEMA Letter of Approval

To be added following approval

## Plan Adoption and Approval

44 CFR §201.6(c)(5) requires that the City of Seattle All-Hazards Mitigation Plan be formally adopted by the Seattle City Council. Council formally adopted the 2021 update of the Seattle All-Hazards Mitigation Plan on [to be filled in following plan approval]. The plan adoption resolution follows.

This plan was approved by the Federal Emergency Management Agency on [to be filled in following plan approval]. The official approval letter follows.

## Acknowledgements

The City of Seattle All-Hazards Mitigation Plan is an ongoing effort of the Seattle Office of Emergency Management to ensure the City's comprehensive approach to preparing for, mitigating the impacts of, responding to, and recovering from a disaster. Preparation of this document, and its continued improvement, requires participation and support from many individuals, agencies, organizations, and businesses. City departments, other agencies, and employees deserve recognition for their efforts to develop this plan.

Additionally, the City would like to acknowledge the efforts of the members of the Seattle Hazard Mitigation Work Group for investment of time and expertise in updating this plan.

Copies of this plan are available online at [www.seattle.gov/emergency/publications](http://www.seattle.gov/emergency/publications) or by request through the Seattle Office of Emergency Management Recovery and Mitigation Coordinator.

## Record of Plan Update and Approval

The City of Seattle All-Hazards Mitigation Plan is required to be updated once every five years and submitted to the City for adoption and the Federal Emergency Management Agency for approval. The City may update the plan on a more frequent basis as needed.

Date of Update	Date of City Adoption	Date of FEMA Approval
July 2009	September 14, 2009	October 14, 2009
May 2015	December 17, 2015	February 11, 2016
To be filled in following plan approval	To be filled in following plan approval	To be filled in following plan approval

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## ACRONYMS AND ABBREVIATIONS

### City of Seattle Departments

ARTS	Office of Arts and Culture
CBO	City Budget Office
DON	Department of Neighborhoods
FAS	Seattle Department of Finance and Administrative Services
HSD	Human Services Department
ITD	Seattle Information Technology Department
OED	Office of Economic Development
OEM	Seattle Office of Emergency Management
OH	Office of Housing
OPCD	Office of Planning and Community Development
OSE	Office of Sustainability and Environment
SC	Seattle Center
SCL	Seattle City Light
SDCI	Seattle Department of Construction and Inspections
SDOT	Seattle Department of Transportation
SFD	Seattle Fire Department
SPD	Seattle Police Department
SPL	Seattle Public Libraries
SPR	Seattle Parks and Recreation
SPU	Seattle Public Utilities

### Other

ADA	Americans with Disabilities Act
BIPOC	Black, Indigenous and people of color
BPA	Bonneville Power Administration
BRIC	Building Resilient Infrastructure and Communities FEMA Grant Program
CIP	Capital Improvement Program
CFR	Code of Federal Regulations
City	City of Seattle
COOP	Continuity of Operations



DMC	Disaster Management Committee
DMA	Disaster Mitigation Act of 2000
DFIRM	Digital Flood Insurance Rate Map
EEB	Emergency Executive Board
EMAP	Emergency Management Accreditation Program
FEMA	Federal Emergency Management Agency
HMGP	Hazard Mitigation Grant Program
IOPE	Inclusive Outreach and Public Engagement Plan
MWG	Mitigation Work Group
NFIP	National Flood Insurance Program
PDMC	Pre-Disaster Mitigation Competitive Grant Program
PoS	Port of Seattle
Seattle HMP	City of Seattle All-Hazards Mitigation Plan
SHA	Seattle Housing Authority
SHIVA	Seattle Hazard Identification and Vulnerability Analysis
SNAP	Seattle Neighborhoods Actively Prepare
SPS	Seattle Public Schools
Stafford Act	Robert T. Stafford Disaster Relief and Emergency Assistance Act of 1988
SWG	Strategic Work Group



## 1 INTRODUCTION

*Chapter 1 describes the authorities and principles that provide the basis for the City of Seattle's (City's) mitigation program as well as provides a description of that organization and how the plan is organized to support it.*

The City of Seattle All-Hazards Mitigation Plan (Seattle HMP) is the guiding document for the City's hazard mitigation program. The plan's goal is to identify the hazards of which the City is at risk and identify a comprehensive strategy for minimizing potential losses and maximizing opportunity to increase the community's resiliency. This introductory chapter presents the authorities on which the City's mitigation program is based, the plan's purpose and scope, and plan organization.

### 1.1 Authority

The Robert T. Stafford Disaster Relief and Emergency Assistance Act of 1988 (Stafford Act), as amended by the Disaster Mitigation Act of 2000 (DMA 2000), Public Law 106-390, and its implementing Code of Federal Regulations (CFR) provisions, 44 CFR § 201, provide the legal authority for local hazard mitigation planning. The DMA 2000 requires state, local, and tribal governments to develop a hazard mitigation plan that identifies the jurisdiction's natural hazards, risks, vulnerabilities, and mitigation strategies. The planning process requirements mandated by the Federal Emergency Management Agency (FEMA) (outlined in 44 CFR §201.6) include the following activities:

- Document the planning process.
- Provide stakeholders with an opportunity to participate.
- Conduct and document public involvement.
- Incorporate existing plans and reports.
- Discuss continued public participation and plan maintenance.
- Provide a method for monitoring, evaluating, and updating the hazard mitigation plan.

Once complete, the hazard mitigation plan must be submitted to FEMA for approval. FEMA's approval of a hazard mitigation plan is a prerequisite for federal Hazard Mitigation Assistance grant program eligibility (outlined in 42 CFR §5165(a)).

The Seattle HMP was prepared in accordance with the requirements of the Stafford Act, as amended by the DMA 2000, and the implementing 44 CFR § 201 provisions. The City will integrate appropriate Americans with Disabilities Act (ADA) standards into mitigation projects and actions implemented as a part of the planning process. For example, alterations to existing facilities, such as seismic retrofits, will comply with all applicable federal accessibility requirements.

### 1.2 What is Hazard Mitigation?

Hazard mitigation is any sustained action taken to reduce or eliminate the long-term risk to human life and property posed by hazards (44 CFR §201.2). Hazard mitigation activities may be implemented prior to, during, or after an event. However, it has been demonstrated that mitigation is most effective when based on an inclusive, comprehensive, long-term plan that is developed before a disaster occurs (2013 Washington State Enhanced Hazard Mitigation Plan).

Additionally, hazard mitigation planning is one of the five mission areas presented in the National Preparedness Goal: Mitigation, Prevention, Protection, Response, and Recovery. The Seattle HMP is an integral piece of the larger emergency management picture and is intrinsically linked to other existing plans and emergency management activities.

Figure 1 illustrates these five emergency management mission areas and provides highlights of the plans that exist at the local, state, and federal level to support them.

**Figure 1 - National Preparedness Goal Mission Areas and Supporting Plans**



Mitigation planning is important because it not only encourages communities to become more flexible and adapt to change more easily, but it also:

- Guides mitigation activities in a coordinated and economic manner.
- Integrates mitigation into existing community plans/programs.
- Considers future growth and development trends.
- Makes a community more disaster resilient.
- Ensures eligibility for grant funding.

## 1.3 Purpose and Scope

### 1.3.1 Purpose

The Seattle HMP assesses the potential impact of the natural and human-caused hazards to the City of Seattle's (City's) communities and provides mitigation goals and strategies to reduce impacts. The Seattle HMP prioritizes the City's mitigation strategies and includes a comprehensive implementation plan. The overall purpose of the Seattle HMP is to strategically guide actions and investments in such a way as to reduce the impacts of natural and human-caused hazards on human life and property. The efforts that have contributed to the development of the Seattle HMP will lead to a safer, stronger, more survivable, and resilient city. The 2021 Seattle HMP is the required five-year update to the City of Seattle HMP prepared in 2015 and approved by FEMA in 2016. Keeping the Seattle HMP current is a good emergency management practice for the people of Seattle and allows the City to maintain its eligibility for state and federal mitigation funds that support the City's mitigation activities, such as:

- Seismic risk assessments.
- Facility seismic retrofit projects.
- Building redundant and resilient infrastructure.
- Planning for sea level rise and other impacts of climate change.
- Public education efforts surrounding risks of unreinforced masonry buildings.

The City has also focused on improving interdepartmental coordination in this update to ensure that the plan meets the needs of all City departments.

### 1.3.2 Scope

The Seattle HMP update covers the jurisdiction of the City and its departments, with the intent of benefitting all residents, businesses, and government and nongovernmental partners. It covers all areas within the City limits, as well as City department services and assets outside the City, such as municipal watersheds, water transmission pipelines, and dams.

Priority elements during this update process included:

- Creating dialogue around protecting the people of Seattle and building the City's resilience in the face of both smaller and catastrophic disaster risks.
- Developing an updated all-hazards mitigation plan that reflects the public and stakeholder input received.
- Ensuring that the process is conducted in accordance with FEMA's Local Multi-Hazard Planning Guidance (requirements identified in Title 44 CFR Part 201.6 and Emergency Management Accreditation Program (EMAP) Standard ANSI/EMAP EMS 5-2019).

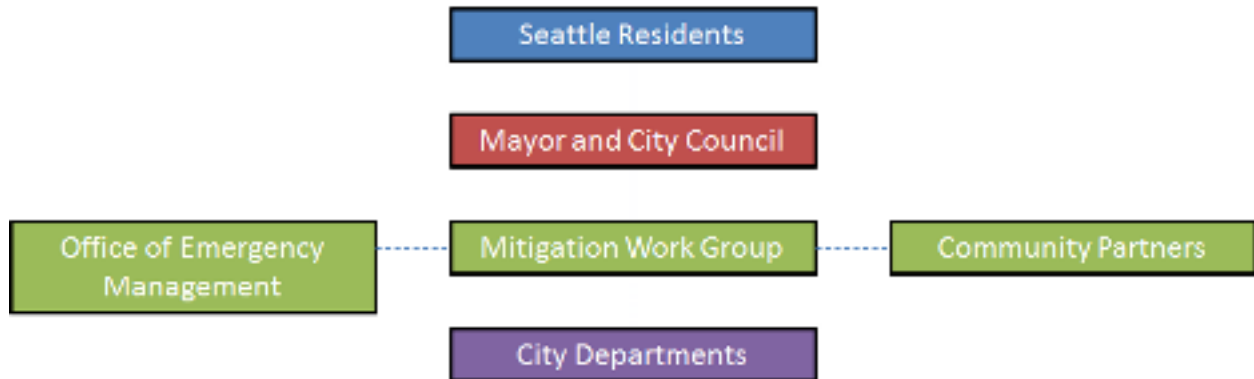
## 1.4 City of Seattle Hazard Mitigation Program

The Seattle HMP is just one aspect of the City's comprehensive approach to hazard mitigation, which includes Seattle residents, elected leadership, City departments, and community partners.

### 1.4.1 Organization

Figure 2 illustrates how the City organizes to ensure an engaged and collaborative approach to mitigation planning and program implementation. This organization is informally referred to in this plan as the City's mitigation program.

**Figure 2 - City of Seattle Mitigation Program Organization**



### 1.4.2 Roles and Responsibilities

#### Seattle Residents

Prepared and educated residents are a critical aspect of the City's resiliency, and the City actively encourages its residents to actively participate in efforts to minimize vulnerability to hazards by engaging in the following activities:

- Participate in the City's hazard mitigation program by engaging in the City's preparedness programs. More information can be found at <http://www.seattle.gov/emergency-management>.

Engage in personal and family preparedness and mitigation activities at home and at work.

#### Mayor and City Council

Seattle's elected leadership plays a key role in the City's mitigation program. As the City's elected representatives, they are responsible for making balanced policy decisions that enhance the City's resiliency. The Mayor and City Council perform the following activities in support of the City's mitigation program:

- Provide policy direction for the City's hazard mitigation program.
- Adopt the hazard mitigation plan.

#### Mitigation Work Group

The Mitigation Work Group (MWG) includes members from various City departments and key stakeholders and convenes regularly to monitor, evaluate, and implement the City's mitigation program. While one of the MWG's main purposes is to serve as the primary mechanism for City participation in updating the Seattle HMP, the City intends its role to continue throughout the planning cycle and serve as a driver for the program's success. Key roles of the MWG include:

- Support ongoing implementation of the City's hazard mitigation program.



- Provide input and technical support for update and maintenance of the Seattle HMP.

*See Chapter 2 for a discussion of the role of the MWG in the 2021 update of the Seattle HMP.*

### Seattle Office of Emergency Management

The Seattle Office of Emergency Management (OEM) serves as the coordinating agency for the City's mitigation program. Under the direction of the OEM Director, the office facilitates mitigation activities, including updates to the Seattle HMP, and provides technical assistance to other City departments. The Director has delegated these coordination and facilitation tasks to the Recovery and Mitigation Coordinator. Key roles of OEM include:

- Facilitate the City's hazard mitigation program.
- Provide technical support to City departments regarding integration of hazard mitigation into department activities.
- Keep the Mayor and City Council apprised of the status of the City's hazard mitigation program.
- Serve as Applicant Agent on behalf of the City to apply for and manage grant awards under FEMA's Hazard Mitigation Assistance programs.

### Seattle Departments

The success of the City's mitigation program is dependent on mitigation being a shared endeavor across all organizational elements of the City. City departments are strongly encouraged to incorporate hazard mitigation into their plans and programs and be active participants in the City's efforts to enhance resiliency. Key roles of City departments include:

- Implement actions identified in the Seattle HMP.
- Incorporate hazard mitigation into other departmental planning efforts.
- Assign a representative to serve as a liaison to the MWG.

### Community Partners

The City is committed to a collaborative mitigation program that strives to integrate with other community efforts to mitigate the impacts of hazards. While the scope of the Seattle HMP primarily includes City departments, the City will continue to look for opportunities to partner with private industry, nonprofit organizations, and community- and faith-based organizations in its mitigation program. Key roles of community partners include:

- Incorporate hazard mitigation into organizational and business activities.
- To the greatest extent possible, coordinate hazard mitigation activities with those of the City and other community partners.

*See Chapter 2 for a discussion of how community partners were engaged in the 2021 update of the Seattle HMP.*

## 1.5 Plan Organization

The 2021 update of the Seattle HMP is organized into the following sections:

- **Chapter 1 – Introduction.** Identifies the authorities on which the plan is based, describes the plan’s purpose and scope, describes how the plan is organized, and identified changes to the plan since 2015.
- **Chapter 2 – Planning Process.** Describes the process used to update the plan, including data sources and plan integration activities, outreach and engagement strategies, MWG activities, and plan development milestones.
- **Chapter 3 – Community Profile.** Provides a summary community profile for the City of Seattle including geographic, demographic, and economic characteristics that make the City unique. A full community profile is provided in the Seattle Hazard Identification and Risk Assessment document in Appendix A.
- **Chapter 4 – Hazard Identification and Vulnerability Analysis.** Contains a summary of the hazards that could potentially impact the City, including a hazard ranking table. Full hazard profiles and vulnerability assessment information is provided in the Seattle Hazard Identification and Risk Assessment document in Appendix A.
- **Chapter 5 – Capability Assessment.** Identifies the existing mitigation capabilities of City departments and highlights mitigation accomplishments over the last planning cycle.
- **Chapter 6 – Mitigation Strategy.** Provides updated goals and objectives for the City’s mitigation program and identifies a comprehensive set of prioritized mitigation actions that would contribute to the City’s resiliency.
- **Chapter 7 – Program Implementation.** Describes the City’s plan for monitoring, evaluating, and updating the Seattle HMP over the next five-year period.

## 1.6 What’s New in the 2021 Update?

The 2021 update of the Seattle HMP includes the following major revisions to the 2015 plan:

- As part of the City’s ongoing enhancement of its emergency program, the Seattle HMP has been aligned with the current planning standards identified in the Emergency Management Accreditation Program (EMAP).
- The complete text of the updated Seattle Hazard Identification and Vulnerability Analysis (SHIVA) is included in Appendix A. No new hazards were identified, but the ranking of hazards changed, and more discussion of climate change was included.
- To increase public participation for the plan update, the City conducted a community survey that resulted in over 152 responses from across the City. The results of that survey are included in Appendix C.
- The methodology by which mitigation actions are identified and prioritized has been modified. A revised Mitigation Action Worksheet and instructions are provided in Appendix D.

Additionally, to aid in plan review and to ensure that all FEMA planning requirements are met, text box callouts have been inserted into the plan that identify the planning element, based on FEMA’s Local Mitigation Plan Review Tool, that is addressed in that particular section of the plan. The plan also strives to make robust use of internal call outs to ensure that plan users can easily find related information. For example, in Chapter 2, which addresses the planning process, the following text box appears:





FEMA

**A1.** Does the Plan document the planning process, including how it was prepared and who was involved in the process for [the City of Seattle]? (Requirement §201.6(c)(1))

The City is also in the process of seeking to renew accreditation through the Emergency Management Accreditation Program (EMAP). EMAP includes a series of standards related to hazard mitigation and those standards are addressed throughout the plan.

## 2 PLANNING PROCESS

*Chapter 2 provides a narrative description of the planning process the City conducted to ensure that the City's mitigation strategy was informed by input from key City departments, community partners, and the public. The process was based on principles of strategies for inclusive engagement and integration with existing planning efforts.*



FEMA

**A1.** Does the Plan document the planning process, including how it was prepared and who was involved in the process for [the City of Seattle]? (Requirement §201.6(c)(1))

A local hazard mitigation plan's organization is driven by the needs of the local community. While the regional FEMA offices provide review and approval of hazard mitigation plans in order for local governments to apply for mitigation project funding, there is no required format for the plan's organization. The following guiding principles are recommended for the development of a local hazard mitigation plan:

- Focus on the mitigation strategy.
- Process is as important as the plan itself.
- Develop the plan in the way that best serves the community's purpose and people.

FEMA recommends nine tasks for developing or updating local hazard mitigation plans. Figure 3 illustrates the nine recommended tasks. Tasks 1 through 3 involve the people and process involved in the all-hazards mitigation plan development or update; Tasks 4 through 8 focus on the analytical and decision steps that need to be taken; and Task 9 includes suggestions for plan implementation.



**Figure 3 - FEMA Recommended Local Mitigation Planning Tasks**

<b>TASK 1</b>	Determine the Planning Area and Resources	<b>TASK 4</b>	Review Community Capabilities	<b>TASK 9</b>	Create a Safe and Resilient Community
<b>TASK 2</b>	Build the Planning Team	<b>TASK 5</b>	Conduct a Risk Assessment		
<b>TASK 3</b>	Create an Outreach Strategy	<b>TASK 6</b>	Develop a Mitigation Strategy		
		<b>TASK 7</b>	Keep the Plan Current		
		<b>TASK 8</b>	Review and Adopt the Plan		


Source: FEMA Local Mitigation Planning Handbook, March 2013

## 2.1 Planning Area

The planning area refers the geographic area covered by the plan (FEMA Local Mitigation Planning Handbook 2013). In the case of the Seattle HMP, the planning area includes all areas within the City limits, as well as City department services and assets outside the City, such as the municipal watersheds and dams.

See Figure 4 for a map of the planning area (not including assets outside the City).

## 2.2 Data Collection and Incorporation of Existing Plans

 <b>FEMA</b>	<b>A4.</b> Does the Plan describe the review and incorporation of existing plans, studies, reports, and technical information? (Requirement §201.6(b)(3))
--	---

Data collection efforts for the Seattle HMP focused on documents pertaining to the planning area and examples of best practices in hazard mitigation planning. The primary source documents for the plan update were the 2015 Seattle HMP and the 2019 update of the Seattle Hazard Identification and Vulnerability Analysis (SHIVA). Additionally, related emergency management plans, current county and state hazard mitigation plans, and City plans with relevant hazard mitigation topics, such as stormwater management, were reviewed as part of the data collection efforts. Examples of hazard mitigation planning best practices were also reviewed for their applicability to the Seattle HMP.

### 2.2.1 City of Seattle All-Hazards Mitigation Plan 2015-2021

The primary source document for this update of the Seattle HMP mitigation strategy was the 2015 version of the plan. As part of the 2021 Seattle HMP update, the following actions were taken to ensure that the update reflected progress in the City's mitigation efforts and any changes in priorities:

- Review and refinement of 2015 plan goals and objectives by the MWG.
- Update of City department mitigation capabilities.
- Update of status for all mitigation actions identified in the 2015 plan.

### 2.2.2 Seattle Hazard Identification and Vulnerability Analysis (SHIVA)

The SHIVA identifies Seattle's hazards and examines their consequences to facilitate smart decisions about how best to prepare for them. The SHIVA document is the foundation for all of the City's disaster planning and preparedness activities. The 2021 update of the Seattle HMP incorporates the most recent

version of the SHIVA. The 2019 SHIVA updates the version published in 2014. It meets FEMA and EMAP requirements, both of which publish standards to guide this work and provide quality and consistency across jurisdictions. It also meets the State of Washington's legal requirement that local governments identify and evaluate their hazards, as specified in Washington Administrative Code 118-30-070.

The following major changes were made as part of the 2019 SHIVA update:

- Added chapter on Cyber-attack / Disruption. The emphasis is on immediate dangers to the public.
- Combined Terrorism and Active Shooter Incidents into one Attacks chapter.
- Renamed Infrastructure Failures to Infrastructure and *Structural* Failures.
- Added new scenarios for Disease, Social Unrest, Infrastructure and Structural Failures, Cyber-attack/ Disruption and Windstorms.
- Updated map of social vulnerability using model developed by the University of South Carolina.
- Incorporated research published between 2014 and 2018.
- Reassessed hazards.

OEM is constantly collecting information from partners to update the SHIVA. It is updated as needed but a major review occurs at least every four years.

*See Appendix A for the full text of the SHIVA.*

### **2.2.3 Citywide Emergency Management Program Multi-Year Strategic Plan 2019-2021**

This strategic plan is intended to meet the vision of the citywide emergency management effort through a multi-year strategy, in coordination with key emergency management stakeholders, to include a vision, mission, guiding principles, goals, objectives, outcomes, ongoing activities and projects and accomplishment tracking. One of the three strategic priorities is focused on mitigation.

*Strategic Priority #3: Support/Facilitate a more resilient community through innovative mitigation and recovery efforts*

Many of the ongoing activities and projects identified to achieve this Strategic Priority #3 relevant to the Seattle HMP include:

- Annually provide briefing on the ability of the City to detect and act on Cyber-threats and hazards.
- Incorporate critical infrastructure planning into city-wide Capital Improvement Plan process to mitigate risk identified in SHIVA/THIRA.
- Continue teaching 'Home Retrofit Program' supported by plan sets managed and maintained by the Department of Construction & Inspection. OEM routinely delivers workshops for residents who are interested in retrofitting their homes for an earthquake.
- Provide training to the Disaster Management Committee on the hazards identified in this SHIVA.
- Conduct annual updates and scheduled major revisions to the Seattle HMP (current version).
- Provide annual training to key personnel in each department on FEMA Public Assistance policies, protocols, and administrative systems.
- Identify procedures and additional planning issues to enhance the Seattle Recovery Framework.

- Maintain and improve a hazard mitigation program that recognizes priorities, activities, and processes to lessen impacts on the Seattle community.
- Identify, apply for, and leverage funding and grants for prioritized mitigation projects.

Action items identified as supporting these objectives are incorporated into this mitigation plan by reference and include, but are not limited to the following:

- Create a strategic integration of the assets management system, Capital Improvement Program, and Seattle HMP.
- Encourage the Emergency Executive Board to adopt mitigation policies.
- Integrate citywide initiatives that enhance resiliency, such as mitigation planning, the race and social justice initiative, Climate Action Plan, and Comprehensive Plan.
- Strengthen awareness of and focus on health systems/disease prevention in the mitigation program.
- Provide training to the Disaster Management Committee on the hazards identified in the SHIVA.
- Create a business outreach plan to build awareness of hazards and the cost-benefit of preparedness.
- Encourage the chambers of commerce and other business advocates to sponsor business efforts to prepare for and mitigate the impacts of hazards.

#### **2.2.4 Washington State Enhanced Hazard Mitigation Plan**

Hazard mitigation policy guidance for the State of Washington is provided in the 2018 Washington State Enhanced Hazard Mitigation Plan. This plan was approved by FEMA on October 1, 2018, and identifies hazard mitigation goals, objectives, actions, and initiatives for the Washington State government. Implementation of the policy guidance provided in the plan will reduce damage and injury caused by natural hazards. The plan meets the requirements for an Enhanced State Plan under Interim Final Rule 44 CFR parts 201.4 and 201.5, published in the Federal Register by FEMA on February 28, 2002. By meeting the requirements of the regulations, the State of Washington as well as qualified local jurisdictions and nonprofit organizations that provide like-government services are eligible to obtain federal Hazard Mitigation Assistance grants. The State of Washington can seek higher funding for the Hazard Mitigation Grant Program following a Presidential Disaster Declaration due to the enhanced portion of the plan (20 percent of federal disaster expenditures versus 15 percent with a standard plan) (Washington Military Department Emergency Management Division 2018).

The Seattle HMP was prepared in accordance with goals and objectives identified in the 2018 Washington State Enhanced Hazard Mitigation Plan.

#### **2.2.5 Integration with Other Plans and Programs**

The City has a long-standing history of hazard mitigation planning at a range of scales, including the neighborhood, city, and regional contexts. Therefore, hazard mitigation policies, plans, and programs have successfully been incorporated into various community plans and emergency management activities. Table 1 summarizes key programs and plans that support existing mitigation actions and the actions that were taken to ensure that they were appropriately aligned, integrated, or referenced in this plan update.

**Table 1 - Plan Review and Integration Actions**

Plan/Study	Plan Alignment/Integration Action
<b>2015 Seattle All-Hazards Mitigation Plan</b>	Superseded by this 2021 Seattle HMP update.
<b>2019 Seattle Hazard Identification and Vulnerability Analysis (SHIVA)</b>	Serves as the basis for the hazards identified in this plan. The full text is included in Appendix A.
<b>Seattle Disaster Readiness and Response Plan</b>	Reviewed to ensure consistency.
<b>Seattle Disaster Recovery Framework</b>	Reviewed to ensure consistency.
<b>Seattle's Comprehensive Plan</b>	Reviewed to ensure consistency. Further alignment efforts will be a focus of the 2024 major update
<b>Seattle Climate Action Plan</b>	Reviewed to ensure consistency.
<b>King County Regional Hazard Mitigation Plan</b>	Reviewed to ensure consistency.
<b>Washington State Enhanced Hazard Mitigation Plan</b>	Reviewed to ensure consistency.

## 2.3 Mitigation Work Group

The MWG was convened at the start of the Seattle HMP update project to facilitate City department and agency input to the Seattle HMP update. The MWG aided in the update of capabilities, review of mitigation goals and objectives, identification of mitigation strategies, refinement of mitigation review criteria, and prioritization and implementation of mitigation strategies. This planning process focused on improving interdepartmental coordination to ensure that the resulting document met the needs of all City departments.

### 2.3.1 MWG Members

The MWG consists of members from various City departments and key stakeholders such as the Seattle Public Schools, Seattle Housing Authority and Port of Seattle. MWG members serve as project liaisons to community groups and interests they represent. Working together, the MWG has established the following mission statement to guide its activities:

“It is the mission of the Mitigation Work Group to develop a comprehensive disaster mitigation program that 1) increases community resilience; 2) builds upon existing mitigation programs; 3) increases knowledge of all hazards to which the City is at risk; and 4) implements interim and long-term mitigation actions that maximize loss reduction.”

The members of the MWG who participated in the plan update and their associated organizations and departments are listed in Table 2.

**Table 2 - Mitigation Work Group Members**

Name	Organization	Department
<b>Flossie Pennington</b>	City of Seattle	Office of Arts and Culture
<b>Dan Foley</b>	City of Seattle	Office of Housing
<b>Patrice Carroll, David Goldberg</b>	City of Seattle	Office of Planning and Community Development
<b>Kara Main Hester, Jennifer Devore</b>	City of Seattle	Seattle Budget Office

Name	Organization	Department
Jae Lee	City of Seattle	Seattle Center
Jana Elliot, Brittany Barnwell	City of Seattle	Seattle City Light
Micah Chappell	City of Seattle	Seattle Department of Construction and Inspections, Planning and Development
Elenka Jarolimek, Julie Matsumoto	City of Seattle	Seattle Department of Finance and Administrative Services
Sarah Sodt	City of Seattle	Seattle Department of Neighborhoods
Lawrence Eichhorn, Mary Wylie	City of Seattle	Seattle Department of Technology
Pattie Quirk	City of Seattle	Seattle Department of Transportation
Andy Collins	City of Seattle	Seattle Fire Department
Jill Watson	City of Seattle	Seattle Human Services Department
Amanda Allen, Jessica Sidhu	City of Seattle	Seattle Office of Economic Development
Lucia Schmit, Erika Lund, TJ McDonald, Laurel Nelson	City of Seattle	Seattle Office of Emergency Management
Edie Gillis, Lylianna Allala	City of Seattle	Seattle Office of Sustainability and Environment
Jon Jainga, Cynthia McCoy	City of Seattle	Seattle Parks and Recreation
Carrie Chitty, Lt. Daniel Nelson	City of Seattle	Seattle Police Department
Dennis Reddinger	City of Seattle	Seattle Public Library
Michael Godfried	City of Seattle	Seattle Public Utilities
Addison Houston	King County	Public Health Seattle King County
Kati Davich	Port of Seattle	N/A
Jared Cummer	Seattle Housing Authority	N/A
Benjamin Coulter	Seattle Public Schools	N/A

### 2.3.2 MWG Meetings

Seattle HMP issues were discussed, and key deliverables were reviewed at the MWG's formal meetings. The MWG convened for a series of five meetings over the course of the project (see Table 3) where representatives from key City departments and other stakeholders had the opportunity to be briefed on project status, to assist in the plan update, and collaboratively work on plan content.

**Table 3 - Mitigation Work Group Meeting Schedule**

MWG Meeting	Date	Objectives
Mitigation Work Group Meeting No. 1 (in person)	January 27, 2020	Review plan process and MWG roles and responsibilities Present updated SHIVA Review status of 2015 Seattle HMP actions Review 2015 Seattle HMP actions Discuss Seattle HMP Capabilities
Planning process paused for Covid-19 response		


MWG Meeting	Date	Objectives
<b>Mitigation Work Group Meeting No. 2 (online)</b>	September 14, 2020	Present revised process, outreach Review Teams online platform Review and discuss outstanding Tasks
<b>Mitigation Work Group Meeting No. 3 (online)</b>	September 28, 2020	Confirm mitigation goals and objectives Present revised Mitigation Action Worksheet Develop department-specific mitigation actions
<b>Mitigation Work Group Targeted Work Sessions (online)</b>	November 2020	Meet with key departments to refine mitigation actions
<b>Mitigation Work Group Meeting No. 4 (online)</b>	November 4, 2020	Review outstanding tasks Updates and questions from MWG members
<b>Mitigation Work Group Meeting No. 5 (online)</b>	December 14, 2020	Review program implementation and monitoring
<b>Mitigation Work Group Meeting No. 6 (online)</b>	January 25, 2021	Review comments Finalize strategy

### 2.3.3 Planning Platform

Seattle HMP update process and draft documents were made available to the MWG through MS Teams, a web-based collaboration platform that allowed MWG members to work together virtually. The Teams platform included a project calendar, group email, SharePoint site, recordings of MWG meetings, chat, project team information, important links, and file management functionalities.

*See Appendix B for documentation of all MWG activities.*

## 2.4 Inclusive Outreach and Public Engagement

	<p><b>A2.</b> Does the Plan document an opportunity for neighboring communities, local and regional agencies involved in hazard mitigation activities, agencies that have the authority to regulate development as well as other interests to be involved in the planning process? (Requirement §201.6(b)(2))</p> <p><b>A3.</b> Does the Plan document how the public was involved in the planning process during the drafting stage? (Requirement §201.6(b)(1))</p>
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A critical component of the Seattle HMP update effort is a robust stakeholder engagement process that provides “an opportunity for the public to comment on the plan during the drafting stage and prior to plan approval” (44 CFR §201.6).

### 2.4.1 Inclusive Outreach and Public Engagement Plan

To facilitate meeting this requirement, OEM developed an Inclusive Outreach and Public Engagement (IOPE) Plan and a designated a public comment period for the Draft Seattle HMP (see Table 4). The IOPE Plan, titled the Outreach and Engagement Plan (November 2020), provides a detailed approach to how



the project team would engage the public and key stakeholders in the Seattle HMP update process. Because of the COVID-19 Pandemic, outreach and public engagement was conducted online and was more narrowly focused than the previous update. The Plan is designed to meeting the following objectives:

- Raise awareness of hazard mitigation, the update process and when opportunities to provide input will occur.
- Provide the opportunity to all who live, work and play in Seattle to participate in the update process.
- Ensure a process that is open and transparent, culturally sensitive, accessible, and ensures that input is considered.
- Gather input in ways that are safe for staff and the public during the COVID-19 Pandemic.
- Ask for input where the public feedback can authentically influence the plan.

*See Appendix C for the full Inclusive Outreach and Public Engagement Plan and materials.*

### **2.4.2 Engagement Strategies**

In September 2020, the planning process was restarted. The following strategies were used to raise awareness about the Seattle HMP update and gather feedback on the Draft Seattle HMP:

#### **Make Information Available on OEM Public Website**

OEM established space on their public website to share information about the HMP. The website included the following:

- Project description
- Downloadable one-page summary about the Seattle HMP update
- Dedicated email address ([HazardMitigationPlanUpdate@seattle.gov](mailto:HazardMitigationPlanUpdate@seattle.gov))
- Narrated presentation about the Draft Seattle HMP
- Draft Seattle HMP and instructions on how to submit comments
- Link to a Public Survey about priorities for future City/ community hazard mitigation partnerships

#### **Online Stakeholder Meetings**

In addition to the MWG, other stakeholders had an opportunity to provide input during development of the plan. The information about the Draft Seattle HMP will be presented during online meetings of following key stakeholder groups to solicit input and feedback:

- Seattle Disaster Management Committee
- Strategic Work Group
- Emergency Executive Board
- Community Safety Ambassadors



### Traditional and Social Media

The broader public will be invited to learn about the project, opportunity to comment on the Draft Seattle HMP and respond to community partnership polling question. The following media will be used to communicate with the broader public:

- OEM general email list
- OEM Newsletter
- Posts on OEM social media
- Press release to various media outlets

### Community Survey

A community survey was conducted as part of the outreach for the Draft Seattle HMP. The survey was designed to solicit input from Seattle residents on their perceived concern regarding various hazards, importance of different risk reduction strategies, and which community services were most important to protect through mitigation.

In total, 152 people responded to the community survey. Key findings included:

- Highest level of concern about earthquake and disease outbreak hazards.
- Most important risk reduction strategies were regulation and structural projects.
- Top four community services that should be protected through mitigation were: health/ mental health, homelessness service/emergency shelter, food assistance/ food banks, and affordable housing/ housing assistance.

**Table 4 - Stakeholder and Public Outreach Activities**

Activity	Timing	Description
Project paused due to COVID-19 Pandemic (March – August 2020)		
OEM Website update	September 2020	Website is updated with HMP description and timeline.
OEM Newsletter	September 2020 and January 2021	HMP information included in the September newsletter distributed to 6000+ people.
Community Survey	November 2020	OEM shares survey about community priorities on website, social media, newsletter.
Stakeholder Meetings (SWG, DMC)	November/ December 2020	Briefings at scheduled meetings to raise awareness and get input on HMP
Public Comment Period (2 weeks)	January 2021	Post HMP on OEM website Solicit public comments on the Draft HMP.

Outreach for Draft Plan	January 2021	OEM email notices, newsletter, press releases, stories to solicit comment on Draft HMP
DMC Review and Approval	February 2021	Final HMP is submitted to DMC
EEB Review and Approval	April 2021	Final HMP is submitted to EEB

## 2.5 Plan Development and Review

The Seattle HMP development process was conducted according to the process outlined above and described in detail in FEMA’s Local Mitigation Planning Handbook. Update of the City’s mitigation strategy was treated as the plan’s primary purpose and the plan serves as the written record of the comprehensive planning process. In addition, the Seattle HMP reflects the City’s current needs and hazard concerns. The development of the Seattle HMP update occurred over a 14-month period from January 2020 to February 2021. The plan development was conducted through a series of seven steps as detailed in Table 5. Many of the steps occurred concurrently. Table 5 also illustrates the corresponding FEMA local mitigation planning task for each Seattle HMP development milestone. The requisite State Hazard Mitigation Officer and FEMA review periods occurred during the Draft and Final Seattle HMP steps.

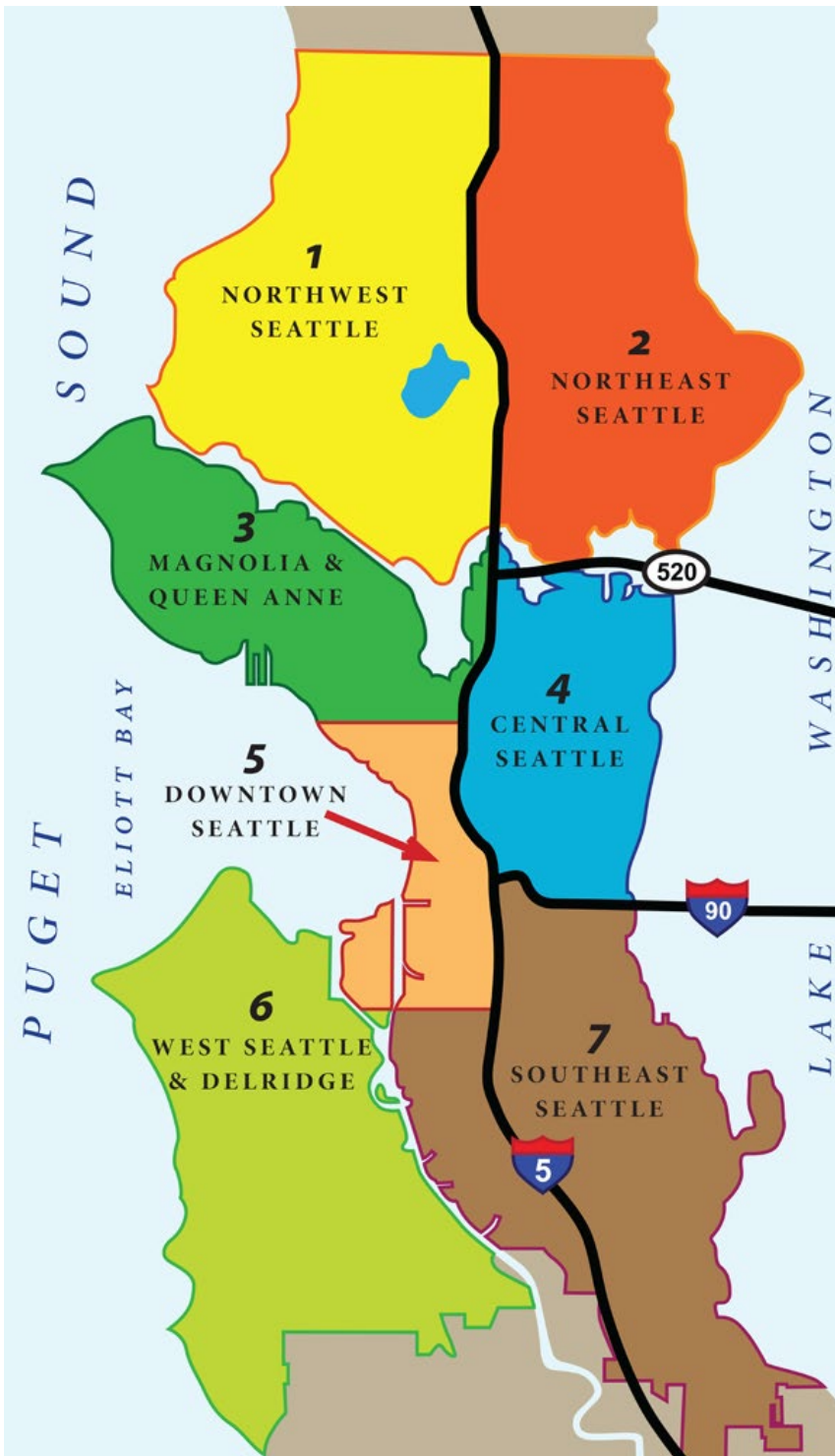
**Table 5 - Seattle HMP Update Timeline**

<b>Seattle HMP Update Development Milestone</b>	<b>Corresponding FEMA Recommended Local Mitigation Planning Task<sup>1</sup></b>	<b>Timeline</b>
1. Data Collection and Document Review	Task 1 – Determine the Planning Area and Resources	January 2020
2. Mitigation Working Group Coordination	Task 2 – Build the Planning Team	January 2020 – January 2021
3. Stakeholder Engagement and Outreach	Task 3 – Create an Outreach Strategy	October 2020 – January 2021
4. Hazard Mitigation Strategy Update	Task 4 – Review Community Capabilities Task 6 – Develop a Mitigation Strategy	September 2020 – December 2020
5. Draft Hazard Mitigation Plan	Written documentation of the planning process (all tasks)	January 2021
6. Final Hazard Mitigation Plan	Written documentation of the planning process (all tasks)	February 2021
7. Plan Adoption	Task 8 – Review and Adopt the Plan	March -July 2021
Notes: Task 5 – Conduct a Risk Assessment was completed through the separate SHIVA process. Task 7- Keep the Plan Current and Task 9 – Create a Safe and Resilient Community are part of the plan implementation process.		





Figure 4 - Seattle HMP Planning





### 3 COMMUNITY PROFILE

*Chapter 3 provides a summary of the community profile provided in full in the Seattle Hazard Identification and Vulnerability Analysis (SHIVA). The City's mitigation strategy is designed to be reflective of the unique characteristics of the community as an economic and cultural hub in the region.*

Seattle is an 84-square-mile isthmus sitting between Puget Sound to the west and Lake Washington to the east. Elliott Bay, an extension of Puget Sound, is located in the middle of the City, giving Seattle an hourglass shape. Downtown is located in this narrow section, which results in many major transportation routes and services competing for land where there is the least space.

Seattle is a hilly city. Many roadways, especially in the downtown, Capitol Hill, Beacon Hill, Queen Anne, West Seattle, and Magnolia neighborhoods have steep inclines that can become hazardous and/or impassable in slippery driving conditions. There are 193 miles of waterfront, 53 of which are tidal. The Seattle Department of Transportation (SDOT) owns, inspects, maintains, and/or operates nearly 280 bridges spanning either natural or artificial barriers, 58 of which are designated vital lifeline structures. Two floating bridges, the Evergreen Point or Albert D. Rossellini (SR-520) and Lacey V. Murrow (I-90) bridges, are the most direct vehicular corridors linking Seattle to the neighboring eastside cities of Bellevue, Kirkland, and Mercer Island. The combination of hilly terrain, barriers, like waterbodies and elevated roadways, and the convergence of transportation pathways in constricted areas makes Seattle vulnerable to hazards like earthquakes that can damage the transportation system in key spots. The importance of these water and slope barriers on emergency response cannot be overstated. The arrangement of hills and water has dictated where transportation routes and large facilities can be located. The resulting patterns create a relationship between the natural and built environments that are fundamental to Seattle's hazard vulnerability.

With over 747,300 residents as of 2019, Seattle is the largest municipality in the Pacific Northwest. In normal times large numbers of people work in or visit Seattle.

Seattle also is home to the main campuses of three major universities: University of Washington, Seattle Pacific University, and Seattle University. In addition, Seattle Colleges, a multi-college district, serves Seattle and its surrounding communities at three comprehensive college campuses and five specialty training centers and has a combined enrollment of 45,000, operates three campuses located in West Seattle, Capitol Hill, and Northgate. The total combined student population for all of these universities and colleges is approximately 102,000.

Seattle is a center for cultural, governmental, and economic activity. It is both a city of neighborhoods with vibrant individual identities and one of the most trade dependent cities in the United States. One in three jobs relies on international trade.

The Seattle-King County area attracts more than 21.3 million overnight visitors each year (as of 2018). Major venues for conferences, conventions, and special events include the Washington State Convention and Conference Center, a wide variety of local hotels, the Bell Harbor International Conference Center, CenturyLink Field Events Center, and the Seattle Center (site of the 1962 World's Fair).

The city is also home for several professional sport teams including: the Mariners at Safeco Field (seats 54,000) and the Seahawks and Sounders at CenturyLink Field (seats 67,000). The renovated Climate



Pledge Arena on the Seattle Center Campus will open in 2021 will be the home arena of the NHL Seattle Kraken (seats 18.000).

King County has a total of 24 hospitals and three stand-alone emergency departments, including 14 in the City of Seattle. Of the 24 hospitals, there is a pediatric hospital, three psychiatric hospitals, and a Veteran's Administration hospital. King County has nine designated trauma hospitals, including one Level I adult and pediatric regional trauma center in the City of Seattle (Harborview Medical Center).

The number of cruise ships that use the Port of Seattle has grown in recent years. Eight major cruise lines used the Seattle facilities in 2012 and in 2019 there were 213 sailings with 1,208,590 passengers.

*See Chapter 3 of the SHIVA including a more detailed community profile.*



## 4 HAZARD IDENTIFICATION AND VULNERABILITY ANALYSIS

### 4.1 General

Seattle is a vibrant city, yet it faces hazards that threaten the very tissue of our community. Seattle can reduce hazard impacts and this document is where we start. The Seattle Hazard Identification and Vulnerability Analysis (SHIVA) identifies Seattle's hazards and examines their consequences so we can make smart decisions about how best to prepare for them.

This document is the foundation for the City's disaster planning and preparedness activities. The City hopes the rest of the Seattle community will use it in the same manner. The Seattle Hazard Identification and Vulnerability Analysis (SHIVA) is a community document. OEM is constantly collecting information from partners to update it. It is updated as needed but, a major review occurs at least every four years.

The SHIVA is intended to serve as the risk assessment portion of the Seattle HMP and provides the foundation for the rest of the mitigation planning process, which focuses on identifying and prioritizing actions to reduce hazard risk. The SHIVA is intended to guide the mitigation strategy outlined in this plan and is hoped to provide insight for other City planning efforts including future updates of the Comprehensive Plan.

#### 2020 An Unprecedented Year

The 2019 SHIVA does not reflect the major incidents Seattle experienced in 2020 pandemic, wildfire smoke, civil unrest, and the West Seattle Bridge closure. The timing of this update has not allowed us to adequately reflect and integrate those events in this HMP. As the disasters, response and recovery from these events are assessed and better understood, changes to the SHIVA and the Seattle HMP may be desired or needed.

The SHIVA, as the City's risk assessment, is intended to accomplish the following:

- Describe hazards. Includes a description of natural and human-caused hazards that may impact the City. Each hazard includes information on the following:
  - **Location.** What areas of the City are most likely to be impacted?
  - **Extent.** What is the expected magnitude of the hazard?
  - **Previous occurrences.** What is the history of the hazard?
  - **Probability of future events.** What is the likelihood of the hazard occurring in the future?

Additionally, the SHIVA summarizes the City's vulnerability to identified hazards including potential impacts and losses that may result.

The 2019 update of the SHIVA replaces the version published in 2014. It meets the requirements of the Federal Emergency Management Agency (FEMA) and the Emergency Management Accreditation Program (EMAP), both of which publish standards to guide this work and provide quality and consistency across jurisdictions. It also meets the State of Washington's legal requirement that local governments identify and evaluate their hazards, as specified in WAC 118-30-070.

*See Appendix A for the full text of the SHIVA.*

## 4.2 Climate Change

The climate has been changing over the past few decades and is projected to change into the future at an increasing rate. Climate change is caused by the build-up of greenhouse gases (GHG) in the atmosphere. According to 2014 data from the Seattle Office of Sustainability and Environment, 66% of the city's GHG emissions comes from road transportation, 32% comes from commercial and residential buildings, and 3% from waste management. Seattle has set a goal to reduce carbon emission by 58% by 2030 and to become carbon neutral by 2050 (with 2008 emissions as the baseline year), in hopes to reduce the future effect of local climate change. Further, the Seattle City Council passed a resolution in 2017 stating the city's commitment to uphold the Paris Agreement, meaning Seattle will take steps to ensure that future warming is limited to 1.5°C. Despite these local efforts to reduce GHG emissions, climate change is caused by global GHG emissions that continue to rise. Further, the Seattle City Council passed a resolution in 2017 stating the city's commitment to uphold the Paris Agreement, meaning Seattle will take steps to ensure that future warming is limited to 1.5°C. Despite these local efforts to reduce GHG emissions, climate change is caused by global GHG emissions that continue to rise.

Climate change presents Seattle with many challenges: flooding, summer heat and drought, rising sea levels, heightened wildfire risk, and declining snowpack. Seattle will also experience indirect impacts. These could include higher commodity prices, increased migration and increased economic and political instability across the globe. The primary effects for the Puget Sound region include:

- **Temperature.** The Puget Sound region is projected to warm between 4.2°F and 5.5°F on average by the 2050s.
- **Sea Level Rise.** The projected range of sea level rise for Seattle is as low as 4 inches, and as high as 56 inches by 2100 (dependent on land movement). Rising sea levels lead to an increased risk of coastal flooding and landslides.
- **Snowpack.** Seattle's water system and power system are dependent on Cascade Mountain snowpack and glacial melt. Mountain snowpack is projected to decline 42-55% by 2070 creating water management challenges. The impact of the decline in snowpack on the city's water supply system has been somewhat mitigated by a dramatic decline in per-capita water usage despite a rise in Seattle's population.
- **Streamflow.** Due to the decreased snowpack and early spring melting, streams that rely on snowmelt are projected to experience peak streamflow earlier in the year, and for some rivers, dry years are becoming drier. Seattle's watersheds will become more reliant on rain than on snowpack. Winter streamflow is projected to increase by about 28% to 34% by 2080, while summer streamflow is projected to decrease by 24% to 31% by 2080.
- **Precipitation.** Heavy rainfall events are expected to become more severe for Washington State. The number of days with more than one inch of rain is estimated to increase 6% to 20% by the 2050s. While projections of seasonal precipitation are mixed, most models point towards drier summers. Drier summers, with more severe precipitation events in other seasons leading to an increased risk of urban flooding and landslides, and more costly stormwater management.
- **Air Quality.** Increasing air temperatures, longer periods of heat, and drier summers have the potential to increase ground-level ozone and fine particulate matter accumulation. Summer deaths attributed to ozone are projected to increase to 132 per year by 2050.



## 4.3 Geophysical Hazards

These hazards originate in the movement of earth. They destroy the built environment over large areas and can cause huge casualties. While they are impossible to prevent there is a lot Seattle can do as a community to decrease their consequences.

### 4.3.1 Earthquakes

Earthquakes are Seattle's most significant hazard. No other hazard has the combination of likelihood and potential destructiveness. Seattle is at risk for earthquakes from three sources: 1) deep earthquakes like those that damaged the City in 1949, 1965 and 2001; 2) shallow earthquakes along the Seattle Fault; and 3) megathrust earthquakes that could reach magnitude 9.0 but would originate outside Seattle. The Seattle Fault is Seattle's most dangerous source. The Seattle Fault last ruptured in 900AD causing a 7.2 magnitude earthquake, massive landslides, and a tsunami. The major consequences are building collapse, lateral spread (where the ground permanently shifts under buildings), landslides, fires, liquefaction (where the ground turns liquid under buildings) and potentially a tsunami. Casualties could exceed 1,000 people and economic damage could easily run into billions of dollars. Seattle has been preparing for earthquakes for many years by enhancing building standards, retrofitting Infrastructure and facilities, and educating the public.

### 4.3.2 Landslides

Landslides are a common Seattle hazard especially when ground water is saturated in the winter. Landslides can always be deadly but more commonly they destroy buildings, block roads, and sever lifelines. The greatest risk is when a storm or earthquake triggers a swarm of landslides throughout the city within several days. The biggest swarm was in 1997 when 300 landslides happened in less than four weeks. A Seattle Fault earthquake could cause massive landslides. The last one in 900 AD caused whole forested hillsides to slide into Lake Washington. The City of Seattle addresses its landslide hazard by mapping its landslide prone areas and through its building codes. The U.S. Geological Survey (USGS) has created a gauge to show when Seattle has a heightened risk of landslides.

### 4.3.3 Tsunamis and Seiches

Tsunamis are a rare but potentially catastrophic hazard in Seattle. They are most often caused by earthquakes and landslides. Tsunamis that originate in the Pacific Ocean do not pose a major threat to Seattle because Puget Sound's shape and complex shoreline will break them up before they reach Seattle. The most dangerous tsunamis are generated locally. A Seattle Fault earthquake presents the greatest potential for a tsunami in Seattle. A large landslide could also trigger a tsunami. A landslide triggered a tsunami in the Tacoma Narrows in 1949. A seiche is a standing (vertical) wave produced by the sloshing of an enclosed water body like a lake, bay, reservoir, or river. The cause can be either earthquake shaking or storms. They are rare occurrences in this area. An 1891 earthquake produced an eight-foot seiche on Lake Washington and the 1964 Alaskan quake generated seiche that damaged property on Lake Union. In 2002 another seiche occurred in Lake Union due to an earthquake in Alaska. Seattle uses tsunami risk as a criterion in siting critical facilities, but it has not pursued additional tsunami or seiche preparedness measures because a tsunami 1) will strike the shoreline within seconds or minutes of being created, 2) will probably occur immediately after a massive earthquake and 3) happen rarely.

#### 4.3.4 Volcanic Hazards

Volcanic material from Mt. Rainier washing down through the Duwamish River and ashfall are the most significant volcanic threats to Seattle. During an eruption, Mt. Rainier's glaciers could melt, mix with volcanic debris and flow down the valleys surrounding it. These flows are called lahars. Based on geologic evidence a lahar from Mt. Rainier would bury low-lying areas west of the mountain but would stop short of Seattle. In the days that follow, rain and erosion could wash the sediment down the Duwamish creating a major navigation and environmental hazard.

Severe ashfall is unlikely in Seattle. Our area's prevailing winds blow from west to east and will probably move ash away from Seattle, but it is possible that rare easterly winds could occur during an eruption producing an ashfall in Seattle. Seattle will need to support more heavily impacted neighbors, cope with transportation closures and help displaced people after an eruption or lahar. Seattle has not undertaken specific volcanic mitigation measures.

### 4.4 Biological Hazards

Biological hazards occur from natural matter in our world such as bacteria, viruses, insects, or animals. The only biological hazard identified for Seattle is disease/pandemic influenza (including bioterrorism).

#### 4.4.1 Disease/Pandemic Influenza (including bioterrorism)

Seattle like all other cities is facing increased exposure to new diseases. The rapid increases in personal mobility, the proximity of people to livestock and global urbanization have created conditions in which it is possible for new diseases, especially influenza, to emerge and spread around the world in days. Global outbreaks are called pandemics. When a new disease emerges, human beings have no immunity against it. This condition increases the chance individuals will get sick when they come into contact with the disease and increase the severity of their symptoms if they do. The potential consequences of disease outbreaks include:

- Patients overwhelming local hospital and health care providers.
- Inability to request mutual aid assistance if impacts involve multiple communities.
- Contaminated water supplies.
- Threats to critical infrastructure if essential operators are absent in high numbers.
- Widespread mental health impacts.
- Closure of community services, schools and larger public events.

Public Health – Seattle & King County has developed plans to attempt to slow the spread of disease by closing public gathering places, increasing the space between people ('social distancing') and opening additional care facilities. Bioterrorism is the use of a biological agent as a weapon to cause fear, illness, or death. Seattle has not experienced a bioterrorist attack but being a densely populated urban hub makes it an attractive target.

### 4.5 Intentional Hazards

These are hazards that some person or group seeks to cause. Often the perpetrators want to disrupt the flow of normal community life, sometimes they want to cause property damage, and other times they

want to hurt people. The adversarial nature of these hazards makes them especially unpredictable and therefore dangerous. Law enforcement is primary in the response to these hazards.

#### **4.5.1 Social Unrest**

Social unrest includes riots, civil disorders, strikes, and mass civil disobedience. Seattle is the central stage for political and social activity in the Puget Sound region and the hub of its social activities. This condition makes social unrest likely to occur in Seattle. Most recent incidents were caused by anarchist groups. The largest centered on the 1999 World Trade Organization (WTO) meeting. Most of Seattle's incidents have targeted property but assaults and one death has occurred. Most incidents can be handled by the Seattle Police Department, but large ones like the WTO protests require outside assistance and can shut down large areas of the City. Most incidents occur in the downtown area and on Capitol Hill.

#### **4.5.2 Attacks**

Attacks can be perpetrated by many different actors with different motivations, but all use violent and destructive tactics to cause harm to people and/or property. Some actors include terrorists (domestic and international), violent extremists, and targeted violent offenders. Examples of tactics are mass shootings, bombings, arson, murder, kidnapping, hijacking, or skyjacking. Not all attacks are politically motivated, some are based on personal grievances. Most attacks happen in public gathering places or institutions, of which Seattle has many. The threat of attacks has grown with the interconnectedness of the internet and social media.

The Puget Sound region has active far-right and eco-terrorist groups, and has experienced activity related to international terrorist groups. Seattle has a heightened eco-terrorism risk. In 2001 the Earth Liberation Front (ELF) firebombed the University of Washington's Center for Urban Horticulture. The number of mass shootings in the U.S. has increased over the past decade. Seattle has experienced three mass shootings in recent history, and an active shooter situation at Seattle Pacific University. In today's security conscious, post-9/11 environment, the main threat appears to be attacks using small-scale tactics such as shootings or vehicle ramming.

Attacks are almost impossible to predict. In the aftermath of 9/11, national security focus shifted to terrorism involving chemical, biological, nuclear, radiological and explosive and cyber means. Locally, Seattle Public Schools are undertaking heightened security measures. The City has been the recipient of several federal grants to bolster local security.

#### **4.5.3 Cyber-attack and Disruption**

To function as a modern city, Seattle is highly dependent on digital systems and the internet. Disruptions to cyber infrastructure can include internet outages, release or deletion of sensitive data and information, compromised infrastructure or services, or physical destruction. Digital systems can face intentional attacks from small scale hackers to sophisticated nation-state actors. Cyber disruption can also occur from human errors or from another hazard (e.g. earthquake). Seattle's utility infrastructure uses Supervisory Control and Data Acquisition (SCADA) Systems to run and maintain basic functions. SCADA systems are generally outdated and vulnerable to hacking, especially if they are connected to the internet.

The likelihood of attack and disruption is increasing as more products and services connect to the internet. The City of Seattle experiences minor hacking attempts daily but has never experienced a major cyber-attack. However, limited information technology resources make a large attack a possibility and large-scale ransomware attacks have recently halted city functions in other areas of the U.S.

## 4.6 Transportation and Infrastructure Hazards

This section comprises failures in the built environment. Their causes are mostly accidental but can be deliberate when used as a means for terrorism. Engineering advances have dramatically improved safety, but Seattle still has many older transportation and infrastructure systems that were not built to modern safety standards. These systems require extra maintenance.

### 4.6.1 Transportation Incidents

Seattle is a hub for land, sea, and air transportation giving it an inherent exposure to accidents. One of the city's deadliest disasters was a plane crash that occurred in 1943, killing 32, including people on the ground. The South of Downtown (SODO) area is the most vulnerable because it is a hub for all major transportation modes, but our bridges and tunnels also have heightened risk. Transportation accidents are usually limited in size but can cause high fatalities, fires, hazardous materials incidents, power outages, transportation network disruptions, and infrastructure failures.

### 4.6.2 Fires

Multi-block and high-rise fires are now rare in the U.S. due to better fire code enforcement, but having a large concentration of high-rise buildings, hotels, entertainment venues and industry makes Seattle vulnerable. In the 1970's several single-room occupancy hotels burned with high fatalities. Seattle also has a large port making marine fires a danger and an underground electrical distribution network that can cause extended outages when fires occur in it. Fires are especially dangerous when they are ignited by other hazards like earthquakes and civil disorders because many fires can ignite in a short period while responders are already occupied.

### 4.6.3 Hazardous Material Incidents (including Wildfire Smoke)

Seattle is a regional industrial center and major transportation hub raising its exposure to hazardous materials incidents that release toxic chemical, combustible, nuclear, or biological agents into the environment. Seattle has not had any truly disastrous hazardous materials incidents but has had several close calls with fuel tanker explosions and a fire at a UW biology lab. There has been an increase in the transport of highly flammable crude oil through Seattle in recent years. Most incidents happen at fixed sites, but those that occur during transport are often more dangerous because they occur in uncontrolled, public spaces.

Smoke from wildfires has become a recurring seasonal air quality hazard in the western United States and British Columbia. In the Puget Sound region in 2018, wildfire smoke led to 24 days of poor air quality, including nine days that were considered either unhealthy for sensitive groups or unhealthy for everyone. In 2020, wildfire smoke led to a record-breaking number of days of poor air quality, including many days that were considered unhealthy for everyone. This smoke created additional risk for people with COVID-19 and worsened symptoms.

#### **4.6.4 Structural Collapse and/or Failure**

Structural collapse or failure includes buildings, dams, and other critical infrastructure such as bridges, and water, sewer, or power lifelines. There are no dams in Seattle, but the City owns a dam south of the city. If this dam failed, the biggest consequence would be flooding in the Duwamish Valley. Seattle is especially vulnerable to bridge collapse due to central role they play in connecting Seattle's transportation network to other areas. Western Washington has had four high profile bridge collapses since 1940. The Seattle Department of Transportation has an active bridge inspection and retrofit program. Regular inspections of the West Seattle High-Rise Bridge indicated accelerated growth of new and existing structural cracks resulting in its closure to all vehicle traffic on March 23, 2020. The City chose repair/strengthening over replacement, pushing for bridge reopening in 2022.

#### **4.6.5 Power Outages**

Power outages are a type of infrastructure failure but are treated as a separate hazard due to the complexity of their consequences. The 2003 Northeast Blackout highlighted the fragility of the U.S. power system. Seattle experienced a week-long power outage from a winter storm in December 2006. Since the wide-spread 2006 outage, Seattle City Light (SCL) has acquired a new power management system that allows it to isolate outages and respond faster. It has also improved fire suppression in its underground electrical system. In the 1980's and 1990's several fires in the underground system caused extended outages in major parts of downtown. About half of Seattle's power is purchased from the Bonneville Power Administration (BPA), making the city vulnerable to disruptions in other areas of the Northwest. While much of BPA's infrastructure is aging, they have been a leader in seismic upgrades to their critical infrastructure. Climate change is projected to decrease hydropower generation in the summer by mid-century.

### **4.7 Weather**

Severe weather events are frequent hazards in Seattle. Except for flooding, they have citywide impacts that vary from minor to debilitating. Their consequences mount the longer they go on. Forecasters are getting better at predicting these events and their severity. The extra time reduces vulnerability by allowing the public and institutions more time to prepare.

#### **4.7.1 Excessive Heat**

Excessive heat events (EHE) can be an extremely deadly hazard. More than 700 people died during the 1995 Chicago heat wave. Because Seattle has a generally mild climate, most people are not acclimatized when EHEs do occur. The temperature itself is just one factor driving the consequences of EHEs. The other important factors are the season, difference between the pre-event and event temperatures, the event duration, nighttime cooling, wind and humidity. Meteorologists can accurately forecast the development of an EHE and the severity of its associated conditions with several days of lead time. The National Weather Service (NWS) has developed a Heat Health Watch/Warning System that tailors excessive heat guidance to specific regions in the country. EHEs are projected to become more intense in the future due to climate change. The most vulnerable people in EHEs are the elderly, infants, the homeless, the poor, and people who are socially isolated.

### **4.7.2 Flooding**

Seattle is susceptible to four flood types: coastal flooding (including king tides), riverine, urban, and dam failure. Atmospheric rivers are storms that occur when the Jet Stream brings moist air from the tropics into the Northwest. They can cause extended periods of heavy rain that can cause riverine and urban flooding. Recent weather patterns have produced very high intensity rain cells, sometimes over narrow geographic storm-tracks.<sup>1</sup> These storms release larger amounts of rain, in short periods of time, which the drainage systems cannot always handle adequately.

- Coastal flooding happens during storms and especially high tides (called ‘king tides’). When the two coincide, the consequences are more severe. Sea level rise will make coastal flooding worse.
- Riverine flooding happens mostly along Seattle’s creeks. The South Park neighborhood is in a 500-year floodplain. Most of Seattle’s floodplains are very narrow.
- Urban flooding occurs when heavy rain overwhelms the drainage system. Seattle’s drainage systems were designed and originally built for longer duration and lower intensity rainstorms. The City has developed mitigation measures like detention ponds to decrease the consequences of urban flooding. The City of Seattle owns dams outside the city limits. Dam failure is mostly a hazard outside the city. The greatest risk is the Howard Hanson Dam. It discharges into the Green River and the Duwamish. Studies suggest that the likelihood of flooding on the Duwamish due to a dam failure is low.

### **4.7.3 Snow and Ice**

Seattle’s winter weather is generally mild. When Seattle does receive snow, accumulations can be large. The consequences are especially severe if the snow lingers for more than several days or triggers secondary hazards like power outages. Seattle has heightened vulnerability to snow and ice storms because of its hilly topography and lack of dedicated snow removal equipment (Seattle has to repurpose general use equipment to plow snow). The City prioritizes major roads and is not able to plow residential streets. Extended snow can lead to severe transportation challenges. Excessive cold exacerbates risks to human health and safety when electric heating sources are inoperable. In 2008 several people died in King County due to carbon monoxide poisoning when they used charcoal grills indoors to heat their homes. Snow load has caused roof collapses in Seattle and rapidly melting snow has caused urban flooding and landslides.

### **4.7.4 Water Shortages**

Seattle can experience water shortages during the summers that follow winters with low snowpack, because nearly all of Seattle’s water comes from watersheds in the Cascades that accumulate their supply from melting snow. Snowpack is projected to decline in future years due to climate change. The main shortage impacts are reduced stream flows for salmon, usage restrictions, and economic hardship for businesses that require large amounts of water. In 2006, Seattle Public Utilities (SPU) updated and adopted a plan to respond to and mitigate water supply problems. Water shortages also have consequences for power. Seattle City Light (SCL) faces challenges during water shortages because most power in the Northwest is generated by hydroelectric dams. During water shortages not as much water is available to turn generators to make electricity. To meet demand SCL must buy more expensive power from outside the region. Besides climate, water shortages can be caused by main breaks. These



shortages due to infrastructure failures are usually localized and short but could be longer if they are the caused by another hazard like an earthquake.

#### 4.7.5 Windstorms

Windstorms with wind speeds equaling those of category one hurricanes can strike Seattle. Sustained winds of 85 miles per hour were recorded in the Seattle area in 1993 and 2006. Seattle's most damaging storm was the 1962's Columbus Day Storm. Windstorms cause power outages, structural damage, transportation blockages, and coastal flooding. Fall and winter is the most common time for windstorms, but the occasional out of season storms can be the most dangerous. Falling trees account for most damage. Windstorms often accompany other weather hazards producing complex emergencies that can include landslides, urban flooding, snow and extreme cold. Windstorms can damage structures with speeds as low as 32 mph. Seattle's new building code requires new structures to withstand 85 mph gusts. The City of Seattle has programs for vegetation management that serve to mitigate damage to electrical systems during windstorms. This tree trimming program intensified after the 2006 storm that caused lengthy power outages.

### 4.8 SHIVA Scoring Methodology

Each hazard has been evaluated using its Most Likely and Maximum Credible scenarios. Both scenarios are evaluated using twelve parameters developed from EMAP and FEMA standards. Ten of these twelve parameters are "base parameters" that directly affect the community, e.g., health effects. Each of these ten base parameters was assigned a score from one through five. The ten base parameters were averaged for a "Base Score" for each of the two scenarios.

The remaining two parameters, "Frequency" and "Cascading Effects," function as multipliers. These two parameters were also assigned a score of one through five. The two scores were added to get a "Combined Multiplier."

The "Base Score" was then multiplied by the "Combined Multiplier" to get a Scenario Ranking. Finally, the Scenario Rankings for the two scenarios were summed and added to the "Future Emphasis" parameter to get a Combined Ranking. The equation is written below.

**Scenario Ranking = Average (Base Parameters) \* Sum (Multipliers)**

**Combined Ranking = (Scenario Ranking – Most Likely) + (Scenario Ranking – Maximum Credible) + Future Emphasis**

Draft scores were assigned by Office of Emergency Management staff with suggestions from the Office of Emergency Management Strategic Working Group.

### 4.9 Risk-Driven Planning

OEM uses hazard identification, risk analysis, and impact analysis as the basis for all plan development, including the Seattle HMP. The mitigation strategy presented in Chapter 6 of this plan is based on the principles of maximizing loss reduction and the data presented in the SHIVA provides the City with the data necessary to identify goals, objectives, and actions that will be most effective. Some concepts in the SHIVA that were key considerations in developing the 2021 update of the Seattle HMP include:





- Earthquakes are Seattle’s top hazard. No other hazard has the combination of likelihood and potential destructiveness.
- Seattle is a hub for land, sea and air transportation giving it an inherent exposure to accidents.
- Seattle is vulnerable to bridge collapse due to central role they play in Seattle’s transportation network. Failure of multiple bridges could result in “islandization” of the community.
- Snow and ice storms rank second. Individually they are less damaging than a powerful earthquake, but they are much more frequent.
- Infrastructure failure is the third biggest risk due to infrastructure’s dependence on networked computers systems that are exposed to attack. The chance of successful, large scale attack is small, but its consequences would be severe.
- A combination of resource concentration, geography and lack of reserve capacity in our transportation system will make access to critical resources a challenge in a disaster.
- Our most vulnerable people live toward the outskirts of the city and along the Rainier Valley.
- Climate change will broadly affect most of the hazards Seattle experiences

*See Appendix A for the full text of the SHIVA including a more detailed risk assessment.*






Table 6 - Hazard Ranking

	Most Likely Scenario														Maximum Credible Scenario																		
	Geographic Scope	Duration	Health Effects	Displacement	Economy	Environment	Structures	Transportation	Critical Services	Confidence in Govt	Base Score	Frequency (F)	Cascading Effects (CE)	Multiplier (F + CE)	Subtotal	Geographic Scope	Duration	Health Effects	Displacement	Economy	Environment	Structures	Transportation	Critical Services	Confidence in Govt	Base Score	Frequency (F)	Cascading Effects (CE)	Multiplier (F + CE)	Subtotal	Future Emphasis	Combined Ranking	
Earthquakes	5	2	2	2	2	2	3	2	2	1	2.3	4	4	8	18.4	5	5	5	5	5	5	5	5	5	5	5	5.0	2	5	7	35	3	56.4
Snow & IceStorm	5	3	2	2	2	1	2	2	2	1	2.2	5	2	7	15.4	5	4	2	3	3	2	2	4	3	3	3	3.1	3	3	6	18.6	5	39.0
Windstorms	5	1	2	2	2	2	2	2	2	1	2.1	5	2	7	14.7	5	2	2	3	3	2	3	4	4	3	3.1	3	3	6	18.6	3	36.3	
Power Outages	3	2	2	2	2	1	1	2	2	1	1.8	5	2	7	12.6	5	4	2	4	3	1	2	3	3	5	3.2	3	3	6	19.2	3	34.8	
Cyber-attack/Disruption	5	4	1	1	2	1	1	2	1	3	2.1	3	1	4	8.4	5	4	2	5	4	3	1	4	4	3	3.5	2	4	6	21	5	34.4	
Landslides	4	3	2	2	1	2	2	3	1	1	2.1	5	1	6	12.6	3	3	3	3	3	3	3	4	2	3	3.0	2	4	6	18	3	33.6	
Disease Outbreaks	5	5	4	1	2	1	1	1	1	1	2.2	4	1	5	11.0	5	5	5	5	4	1	1	3	3	3	3.5	3	2	5	17.5	5	33.5	
Flooding	5	2	1	2	2	2	2	2	1	1	2.0	5	1	6	12.0	5	4	2	4	3	2	3	4	3	3	3.3	2	3	5	16.5	5	33.5	
Excessive Heat Events	5	3	2	2	2	1	1	2	1	1	2.0	5	1	6	12.0	5	4	4	4	3	2	1	3	3	3	3.2	3	2	5	16	5	33.0	
Tsunamis and Seiches	3	2	2	3	3	2	3	2	1	1	2.2	2	2	4	8.8	4	2	4	5	4	3	3	4	3	3	3.5	2	4	6	21	3	32.8	
Infrastructure & Structural Failure	1	2	1	2	2	2	2	2	2	3	1.9	5	2	7	13.3	4	5	3	4	3	3	2	4	3	5	3.6	1	3	4	14.4	5	32.7	
Fires	2	2	2	4	1	1	2	2	2	1	1.9	4	2	6	11.4	2	4	4	3	3	2	2	4	2	3	2.9	2	4	6	17.4	3	31.8	
Transport Incidents	1	1	3	2	1	1	2	2	1	1	1.5	5	2	7	10.5	3	2	4	3	2	2	2	3	2	3	2.6	2	5	7	18.2	3	31.7	
Water Shortages	5	5	1	2	2	2	2	1	3	1	2.4	5	2	7	16.8	5	5	1	3	3	3	2	1	3	3	2.9	2	2	4	11.6	3	31.4	
Social Unrest	3	1	2	3	3	1	2	2	2	3	2.2	5	2	7	15.4	5	3	3	5	3	1	3	2	2	5	3.2	2	2	4	12.8	3	31.2	
Attacks	1	1	2	2	2	2	2	2	1	3	1.8	5	2	7	12.6	4	2	3	3	2	1	2	4	4	3	2.8	2	1	3	8.4	5	26.0	
HazMat Incidents	3	1	3	4	2	2	2	2	2	1	2.2	3	2	5	11.0	3	3	2	2	3	4	2	3	2	5	2.9	1	3	4	11.6	3	25.6	
Volcano Hazards	2	5	1	4	3	2	3	2	3	1	2.6	2	1	3	7.8	5	5	2	2	3	2	4	5	2	1	3.1	1	3	4	12.4	3	23.2	



## 5 CAPABILITY ASSESSMENT

*Chapter 5 identifies the City’s existing mitigation capabilities. These are the plans and policies, programs, and projects that are currently in place to reduce the City’s vulnerability to hazards. It also includes key mitigation accomplishments that have been completed since the last plan update in 2015. As mitigation actions identified in the City’s mitigation strategy (Chapter 6) are completed, they become new mitigation capabilities.*

 <b>FEMA</b>	<b>C1.</b> Does the Plan document each [City department’s] existing authorities, policies, programs and resources and its ability to expand on and improve these existing policies and programs? (Requirement §201.6(c)(3))
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### 5.1 General

The City of Seattle has a long history of commitment to neighborhood, citywide, and regional hazard mitigation planning. Existing hazard mitigation authorities, policies, plans, programs, and resources have reduced impacts from hazards. Where possible, City departments will leverage existing programs to implement mitigation actions (see Chapter 6). Utilizing existing authorities, policies, plans, and programs will provide the best value to the City of Seattle and build on programs already supported by Seattle communities and policymakers.

This chapter identifies planning and regulatory, administrative and technical, financial, education, and outreach capabilities to mitigate hazards; describes recent mitigation accomplishments; and identifies the City’s participation in the National Flood Insurance Program (NFIP) in accordance with the Disaster Mitigation Act (see 44 CFR § 201.6(c)(3)). Seattle hazard mitigation capabilities include the following:

- **Plans and Regulations.** Plans, policies, codes, and ordinances that prevent and reduce the impacts of hazards. Examples of plans and regulations include Seattle’s Comprehensive Plan, the City of Seattle Stormwater Management Plan, the Seattle Building Code, and the Seattle Environmentally Critical Areas Code.
- **Administrative and Technical.** Staff, their skills, and tools that can be used for mitigation planning. Examples of administrative and technical capabilities include Seattle Department of Planning and Development dedicated staff to building code enforcement and the OEM – SHIVA.
- **Financial.** Funding resources that can be utilized for hazard mitigation. Examples of financial capabilities include the Seattle Capital Improvement Program, the Fire Facilities and Emergency Response Levy, and federal funding programs such as the Hazard Mitigation Grant Program (HMGP) and Building Resilient Infrastructure and Communities (BRIC).
- **Education and Outreach.** Education and outreach used to communicate hazard-related information and increase community preparedness and resiliency. Example of education and outreach include Home Retrofit Program.

## CAPABILITY HIGHLIGHT

### Unreinforced Masonry Building Retrofit Policy Development

Unreinforced masonry buildings (URMs), are old brick buildings typically built prior to 1945. Because these buildings were not built using modern building codes, they are much more likely to experience damage or collapse during an earthquake. Most URMs have brick walls and wood-frame floors and roofs. A tell-tale sign of URM construction is what's called header courses- lines of bricks turned on end. Seattle has an estimated 1,164 URMs throughout the city, and many can be found in historic neighborhoods such as Pioneer Square, the International District, Capitol Hill, Columbia City and Ballard.

Right now, there are no retroactive regulations in the City of Seattle requiring owners of URMs to upgrade their buildings through seismic retrofitting. However, property owners who decide on a major renovation, re-occupy a vacant URM, or change the use occupancy of a URM may be required to comply with seismic regulations in the current Seattle Building Code.

The City has been working for many years to develop a policy, program, and funding to seismically retrofit URMs. Prior to COVID-19, SDCI was working with the Mayor's Office and City Council to draft a joint resolution to begin the process to develop and implement a mandatory URM upgrade program. This work was planned to be undertaken in 2020 and would have taken into consideration the recommendations from the 2017 report prepared by the URM Policy Committee. However, these efforts have been placed on hold as the City focuses its resources on response to the COVID-19 pandemic.

The City will continue to consider the development of a URM policy and identify funding opportunities to implement retrofits. Key resources to support ongoing and future work on URM policy include:

- [Recommendations from the Unreinforced Masonry Policy Committee to the City of Seattle](#) (2017)
- [Updated Confirmed URM List](#) (SDCI, December 2020)
- [Funding URM Retrofits](#) (National Development Council, 2019)
- Update Draft Technical Standard to reflect anticipated changes in seismic retrofit codes on the national level (future work)

A new state program, C-PACER (Property Assessed Clean Energy and Resiliency), could provide low cost, long-term loans for commercial properties for qualified building improvements. The C-PACER program aims to address the significant needs for property owners to finance energy efficiency upgrades, renewable energy improvements, stormwater management, water conservation, and resiliency retrofits to address vulnerabilities to earthquakes and other natural disasters. Although the State cannot currently support this new program because of the fiscal shortfalls brought on by COVID-19, counties can take steps to establish a program.

## 5.2 FEMA Funded Hazard Mitigation Projects

Table 7 identifies FEMA-funded hazard mitigation projects conducted in the City of Seattle from 1999 to 2020.

**Table 7 - FEMA Funded Hazard Mitigation Projects 1999-2020**

Project	Funding Source	Award Date	Award Total	Lead Department	Status
Duwamish Head Stabilization Project	HMGP - DR 1159	Mar-1999	\$2,187,500	SPU [DWU]	Completed - Won engineering award!
North Queen Anne Dr. Bridge Seismic Retrofit	HMGP - DR 1361	Aug-2002	\$1,200,000	SDOT	Completed
Low Income Home Seismic Retrofit	HMGP - DR 1361	Jan-2003	\$1,000,000	SPD/OEM	Completed
Mitigation Plan Development	HMGP - DR 1361	Oct-2003	\$100,000	SPD/OEM	Completed
South Lake Union Armory Building Seismic Retrofit	PDMC 2005	Nov-2005	\$713,229	Parks	Completed
Gas Shut Off Valve Project	HMGP - DR 1671	Sep-2008	\$200,000	FFD	Completed
Queen Anne Community Center Seismic Retrofit	HMGP - DR 1671	Aug-2008	\$ 780,000	Parks	Completed
Post Alley Areaway Seismic Retrofit	HMGP - DR 1682	Oct-2010	\$589,055	SDOT	Completed
Urban Flood Hazard Identification Project	HMGP - DR 1817 & 1825 5% Funding	Nov-2010	\$208,500	SPU	Completed
Jefferson Community Center Seismic Retrofit	HMGP - DR 1817 and 1825	May-2011	\$1,371,198	Parks	Completed
Mitigation Plan Update and Seismic Assessment	PDMC 2011	Nov-2011	\$379,220	OEM & FFD	Completed
URM Public Education and Outreach	HMGP Dr 4056 5% Funding	Jul-2012	\$71,905	DPD	Completed
Columbia St. Areaway Seismic Retrofit	HMGP DR 4243	May 2017	\$1,737,885	SDOT	Completed
Bremer Apartments Seismic Retrofit	PDMC 2018	May 2020	\$5,016,312	OEM	Grant Awarded
8th Ave NW Bridge Seismic Retrofit	HMGP DR 4309	Oct 2020	\$2,691,045	SDOT	Grant Awarded
<b>Funding Notes</b> HMGP = Hazard Mitigation Grant Program. State/FEMA funding generated from Presidential Disaster Declarations. PDMC = Pre-Disaster Mitigation Competitive Grant Program. FEMA funding made available for national competition. BRIC = Building Resilient Infrastructure and Communities. FEMA funding made available for national competition.					

Source: City of Seattle Office of Emergency Management.

## 5.3 Citywide Organization Capabilities

### 5.3.1 Race and Social Justice Initiative

The Seattle Race and Social Justice Initiative (RSJI), launched in 2005, is a citywide effort to end institutionalized racism and race-based disparities in City government. RSJI builds on the work of the civil rights movement and the ongoing efforts of individuals and groups in Seattle to confront racism. The Initiative's long-term goal is to change the underlying system that creates race-based disparities in our community and to achieve racial equity. The City's RSJI internally focused work includes core team, change teams, employee training and RSJI Toolkit. Since 2014 RSJI has expanded to include more community partnerships and collaboration with BIPOC communities to guide City investments to achieve equity.

- **Core Team.** A Citywide team of about 30 people that works with key stakeholders on RSJ issues. Provide Citywide technical assistance and strategic planning support; Communicate/facilitate. Team members lead RSJI orientations and workshops for City staff.
- **Change Teams.** This group of employees in each department supports RSJI activities. They work together to extend RSJI's reach in departments, strengthen each departments capacity, offer expertise, work to address departmental issues, and build momentum to advance RSJI throughout the organization.

**Training.** City employees and volunteers who sit on City boards and commissions have access to trainings on various RSJI topics such as implicit bias, leading with race, how to apply the RSJI toolkit.

- **RSJI Toolkit.** This tool is designed to assist departments to analyze the racial equity impact of policies, programs, initiatives, and budget issues.

### 5.3.2 Citywide Plans and Regulations

The City has a foundation of long range, citywide policy and strategic plans that guide growth and City investments in infrastructure, services, and other assets. These plans require substantial interdepartmental collaboration and provide guidance for more detailed functional and operational plans. Some, adopted by ordinance, have statutory authority. Others, adopted by resolution, and are less binding and more aspirational. The following plans and regulations help the City achieve mitigation goals and actions.

#### **Seattle 2035 Comprehensive Plan (OPCD, 2016)**

Comprehensive Plan, a 20-year vision and roadmap for Seattle's future. The Comprehensive Plan guides City decisions about where to accommodate and plan for new jobs and residences, how to improve the transportation system, and where to make capital investments such as utilities, sidewalks, and libraries. It provides a framework to guide most of Seattle's big-picture decisions on how to manage growth to achieve environmental sustainability, racial equity, shared prosperity, and healthy and vibrant neighborhoods. As required by Washington's Growth Management Act, the plan must undergo a major review and update every 8 years. The next major update must be adopted by June 2024.

#### **Move Seattle 10-Year Strategic Vision (SDOT 2015)**

Move Seattle sets out a 10-year plan for a transportation system that meets present demands while looking ahead to future needs for a safe, affordable, connected system that works for people regardless of mode choice.

#### **Parks and Open Space Plan (SPR 2017-2022)**

This six-year plan documents and describes SPR's facilities and lands, looks at Seattle's changing demographics, and lays out a vision for the future. The 2017 Plan is required by the Washington State Recreation and Conservation Office (RCO) to maintain the City of Seattle's eligibility for state grants and funding programs that will help realize outdoor recreation capital projects and open space acquisition projects.

#### **Climate Action Plan (OSE 2013)**

This plan focuses on city actions that reduce greenhouse emissions and support vibrant neighborhoods, economic prosperity, and social equity. Actions are focused on areas of greatest need and impact: road transportation, building energy and waste. The plan also includes actions that will increase Seattle's resilience to the likely impacts of climate change.

#### **Urban Forest Stewardship Plan (OSE 2013)**

This plan set four goals for Seattle's urban forest: create an ethic of stewardship about the urban forest among City staff, community organizations, businesses, and residents; strive to replace and enhance specific urban forest functions and benefits when trees are lost, and achieve a net increase in the urban forest functions and related environmental, economic, and social benefits; Expand canopy cover to 30 percent by 2037; and increase health and longevity of the urban forest by removing invasive species and improving species and age diversity"

#### **Consolidated Plan for Housing and Community Development (HSD 2018-2022)**

This plan includes guidance for the allocation of an estimated \$17 million of federal grant and program revenue funds [approximately \$9.8 million in Community Development Block Grant (CDBG) funds, \$4.2 million in HOME program funds, \$796,000 in Emergency Shelter Grant Program (ESG) funds and \$2.3 million in Housing Opportunity for Persons with AIDS (HOPWA) funds] from the U.S. Department of Housing and Urban Development (HUD). The Plan outlines strategies to address the housing, homeless, community and economic needs of the City's low and moderate-income residents and neighborhoods over the next five years.

#### **Land Use Code (SDCI, OPCD)**

The Land Use Code regulates the use and development of land in Seattle. SDCI reviews permit applications to make sure they comply with this code. With input from residents, designers, developers, and other interested stakeholders, City planners draft amendments to update the code to better address Seattle's land use policies.

#### **Building Code and Residential Code (SDCI)**

The Seattle Building Code (SBC) provides minimum requirements for design and construction of new buildings. The Seattle Residential Code (SRC) provides minimum requirements for design and construction of single-family houses, duplexes, and townhouses with no more than three stories and with separate entrances. Seattle has adopted the 2015 International Building Code and 2015 Residential Code with amendments specific to our city.

### **Stormwater Code (SPU & SDCI)**

The stormwater code contains regulations to protect people, property and the environment from damage related to stormwater runoff. Seattle's stormwater code also satisfies the City's obligation to comply with our Municipal Stormwater Discharge National Pollutant Discharge Elimination System (NPDES) Permit, issued by the Washington State Department of Ecology.

### **Shape Our Water (SPU 2023-2053)**

This community-centered project will plan for the next 50 years of resilient drainage and wastewater systems. As Seattle faces powerful forces like climate change and rapid growth, future investments in water systems will transform the city. This effort will look beyond pipes and green infrastructure to see the broader role in people's lives, including safer neighborhoods, deeply rooted communities that resist displacement, thriving local businesses, and healthy and fun public spaces.

### **5.3.3 Voter Approved Property-Tax Levies**

Many projects and programs are funded by special purpose voter-approved property tax levies. In Seattle, these funds have been an important source of funding for hazard mitigation. Seismic retrofits of transportation infrastructure, libraries, community centers are examples of mitigation projects included in these initiatives. Planning projects to be included in upcoming levies typically begins two to three years prior to the ballot date. The City also prepared a consolidated plan to document how it plans to spend federal funding provided through a number of programs.

#### **Housing Levy (expires 2023)**

Approved by Seattle voters in August 2016, the 7-year, \$290 million levy Seattle Housing Levy provides funding to provide, produce, and/or preserve affordable housing in Seattle and to assist low-income Seattle residents. The Levy funds five programs: Rental Production and Preservation, Operating and Maintenance, Homeownership, Acquisition and Preservation, Homelessness Prevention and Housing Stability Services. OH administers all 2016 Seattle Housing Levy programs except the Homelessness Prevention and Housing Stability Program, which is administered by the HSD.

#### **Move Seattle Levy Fund (expires 2024)**

Approved by Seattle voters in November 2015, the 9-year, \$930 million Levy to Move Seattle provides funding to improve safety for all travelers, maintain our streets and bridges, and invest in reliable, affordable travel options for a growing city. The levy provides roughly 30% of the City's transportation budget and replaces the 9-year, \$365 million Bridging the Gap levy approved by voters in 2006.

#### **Families and Education Levy Fund (expires 2025)**

Approved by Seattle voters in November 2018, the 7-year, \$619 million Families, Education, Preschool and Promise Levy will partner with families and communities to advance education equity, close opportunity gaps, and build a better economic future for Seattle students. A portion of levy funds is allocated to the Seattle Preschool Program Provider Facilities Fund to support capital projects that improve quality or help providers meet preschool facility licensing standards, expand space in existing SPP preschool facilities, start new facilities, either from the ground up or by substantially remodeling existing buildings to use as part of SPP.

#### **Libraries for All Levy (expires 2026)**



Approved by Seattle voters in August 2019, the 7-year, \$219.1 million Libraries for All Levy restores core Library services cut during the Great Recession, invests in critical systems' needs, and support the changing needs and interests of the communities we serve. Funding for earthquake retrofit of the historic Columbia, Green Lake and University branches were included.

#### **Fire Facilities and Emergency Response Levy (expired)**

In the aftermath of the 2001 Nisqually earthquake, in 2004 Seattle voters approved a 7-year, \$167 million Fire Facilities and Emergency Response Levy to provide funding to strengthen the City's ability to respond after a major disaster. Funds were used to renovate or replace all 32 neighborhood fire stations, build a new joint training facility for Seattle Fire and Seattle Public Utilities, construct a new fire alarm center and City emergency operations center, harden fire hydrants so firefighters can draw water directly out of eight City reservoirs, place emergency generators at community centers, and place emergency supply caches in four areas of the City.

#### **Seattle Parks District Funding (no expiration)**

Approved by Seattle voters in 2014, the metropolitan park district is authorized by Chapter 35.61 of the Revised Code of Washington. The Seattle Park District has the same boundaries as the City of Seattle and the Seattle City Council members serve as the Park District's Governing Board. Property taxes collected by the Seattle Park District will provide funding (\$55 million in 2019) for City parks and recreation including maintaining parklands and facilities, operating community centers and recreation programs, and developing new neighborhood parks on previously acquired sites. Seattle Parks and Recreation develops a 6-year Park District budget. However, planning for the next 6-year budget (2021-2026) has been delayed due to challenges in getting community input during COVID-19.

### **5.3.4 Community-led City Investments**

For many years the City has directed City funds to support community-initiated capital projects and education programs. One of the earliest initiatives, the Neighborhood Matching Fund, was created in 1988 to provide matching dollars for neighborhood improvement, organizing, or projects developed and implemented by community members. The number of community grants and the funds allocated has grown. Communities are not only initiating capital projects implemented by City departments, but increasingly communities are leading the implementation of larger capital projects that involves land, buildings, and other physical structures. While programs are still evolving, there is an opportunity to share the City's mitigation goals and values to protect community-led investments and assets from hazards and future disasters.

#### **Equitable Communities Initiative (\$30 million in FY 2021)**

This fund, new in 2021, will focus on ensuring that BIPOC communities thrive. It will be guided by a community-led Equitable Communities Initiative Task Force who will receive the technical assistance of at least 18 City Departments. Potential areas for investment include building opportunity, inclusive economy, community wealth building, preserving cultural spaces, community wellness and climate justice. Task force recommendations could include expanding current programs, refocusing current City investments, creating new programs or investments or pilots, capacity building for community-based organizations, and identifying new and complementary opportunities for investment by philanthropy, regional, state or federal partners.

#### **Strategic Investment (Anti-Displacement) Fund (\$30 million in FY 2021)**



This fund, new in 2021, will support strategic investment in areas at high risk of displacement or in areas of low access to opportunity that present unique opportunities for transformational equitable development. This would include areas with significant planned public investment like light rail station areas and parks, where increased access to opportunities will likely also increase displacement pressure. This fund will focus on sites and projects with the potential to achieve multiple community benefit outcomes through mixed-use and mixed-income development that creates opportunities for housing, affordable commercial and cultural space, public open space, and childcare.

**Participatory Budgeting** (\$18 million in 2021)

This program, new in 2021, will engage communities in a participatory budgeting process. About \$17 million will fund successful project proposals for implementation of community safety strategies.

**Equitable Development Initiative** (\$5.6 million in 2021)

Equitable Development Initiative (EDI) invests in community-led efforts aimed at addressing issues of racial equity, social justice, economic mobility, and residential, cultural and commercial displacement. The Equitable Development Framework guides how the City prioritizes its work; shapes its budgets, policies, programs, and investments; and structures the implementation of targeted strategies and equitable development projects by using clear objectives for reducing disparities and achieving equitable outcomes for marginalized populations. OPCD coordinates this initiative.

**Community Grants** (\$5.0 million in 2021)

Community Grants support to local grassroots projects within neighborhoods and communities by providing funding to implement community-driven improvement or education projects such as community infrastructure, public space, and public health. The programs that support this work include Neighborhood Matching Fund, Duwamish River Opportunity Fund, Find It Fix, Healthy Food Fund. DON also administers grants for the 135 designated Community Emergency Hubs. DON manages these grants.

**Environmental Justice Fund** (\$500,000 in 2020)

The Environmental Justice Fund is a grant opportunity for community-led projects that improve environmental conditions, respond to the impacts of climate change, and get us closer to achieving environmental justice. Community members and Seattle City Council worked together to create the Environmental Justice Fund in 2017. Seattle's Environmental Justice Committee plays a critical role in overseeing the fund to ensure the experiences and priorities of BIPOC communities shape the work. OSE manages this fund.

## 5.4 Department-Specific Capabilities

Departments are listed alphabetically by acronym.

### 5.4.1 Office of Arts and Culture (ARTS)

The Office of Arts & Culture (ARTS) envisions a city driven by creativity that provides the opportunity for everyone to engage in diverse arts and cultural experiences. The office promotes Seattle as a cultural destination and invests in Seattle's arts and cultural sector to ensure the City provides a wide range of high-quality programs, exhibits and public art. ARTS includes eight programs: Cultural Partnerships, Communications and Outreach, Equity and Youth, Cultural Facilities Operations, Public Art, Artwork Conservation, Administrative Services, and Cultural Space. These programs are supported by two funding sources: Arts and Culture Fund (funded through the City's admission tax revenues) and the Municipal Arts Fund (supported by the 1% for Arts contributions from City capital projects).

Existing Mitigation Capability	Capability Type	Description	Hazard Mitigated
<b>Public Art</b>	Administrative and Technical Financial	Oversee the City's public art collection. Manage the Municipal Arts Fund for the commission, purchase, and installation of public art. Funding through 1% for Art ordinance that requires eligible City capital projects to contribute 1% of their budgets to the Municipal Arts Fund. Provides professional assessment, conservation, repair, and routine and major maintenance of permanently-sited works of art. As of 2020 the public art collection includes 400 permanently-sited and 3,200 portable works of art and periodic temporary art installations. All public art installations are subject to regulation by Seattle Municipal Code and ADA guidelines. Recent accomplishments include: <ul style="list-style-type: none"> <li>ARTS created an Inspection List for integrated public portable artworks to prioritize damage assessments after a disaster.</li> </ul>	All Hazards
<b>Cultural Facilities Operations</b>	Administrative and Technical	Provide operational support for Langston Hughes Performing Arts Institute. Support the operation and programming of ARTS at King Street Station, including a public cultural space, office space for ARTS, and meeting spaces. Recent accomplishments include: <ul style="list-style-type: none"> <li>ARTS worked with SDOT and FAS to completely renovate and retrofit 7,500 sf 3rd floor of King Street Station including stabilization support beams and an updated sprinkler system. Renovations completed in 2019.</li> </ul>	Earthquake Fire

### 5.4.2 City Budget Office (CBO)

The City Budget Office (CBO) is responsible for developing and monitoring the City's annual budget, carrying out budget-related functions, overseeing fiscal policy and financial planning activities, policy analysis, and preparing legislation for City Council review. CBO provides strategic analysis relating to the use of revenues, debt, long-term issues, and special events. The office also provides technical assistance, training, and support to City departments in

performing financial functions. The Innovation and Performance team is also in CBO, supporting and advancing initiatives by using data and design to solve problems.

Existing Mitigation Capability	Capability Type	Description	Hazard Mitigated
<b>Oversight of City Fiscal Policy and Financial Planning</b>	Financial	Provide strategic analysis and oversight for financial functions within the city. Work closely with all city departments in their fiscal policy and financial planning. One primary example would be the monitoring and development of the budget for Seattle's Capital Improvement Program (CIP) which allocates funds to rehabilitate, restore, improve, and add to the City's capital facilities. Recent accomplishments include: <ul style="list-style-type: none"> <li>Monitoring and development of the budget for Seattle's 2020-2025 Capital Improvement Program (CIP), which identifies City investments including projects that mitigate hazards.</li> </ul>	All Hazards

#### 5.4.3 Department of Neighborhoods (DON)

The Seattle Department of Neighborhoods provides resources and opportunities for community members to build strong communities and improve their quality of life. With more than 180 neighborhoods in the city, the department plays a key role in helping neighbors develop a stronger sense of place, build closer ties, and engage with their communities and city government.

Existing Mitigation Capability	Capability Type	Description	Hazard Mitigated
<b>Historic Preservation Program</b>	Regulatory	Designate and protect more than 350 historic structures, sites, objects, vessels, and eight historic districts. Recent accomplishments include: <ul style="list-style-type: none"> <li>A number of historic buildings have undergone, or are in the process of undergoing, seismic renovation from damage sustained during the Nisqually earthquake.</li> </ul>	Earthquake
<b>Historic Preservation Program</b>	Education and Outreach	Provides technical assistance for historic preservation. Recent accomplishments include: <ul style="list-style-type: none"> <li>Provided technical assistance to University of Washington for a comprehensive multi-building approach to URM upgrades; provided education resources/best practices/technical assistance in presentations given at URM related conferences and symposiums.</li> </ul>	Earthquake
<b>Community Liaison Program</b>	Education and Outreach	Manage Community Liaisons (CL). CLs are independent contractors who are expert community navigators who provide a number of outreach services in historically underrepresented communities: translations, proofreading, interpretation, facilitation (in native language), constituent support at City-hosted events, feedback and expertise on cultural concerns and barriers, reports of participant feedback and concerns, and community workshops. In 2018, Community Liaisons worked with 15 City departments on 48 outreach and engagement projects.	All Hazards

<b>Community Grants Program</b>	<b>Financial</b>	<p>Provide support to local grassroots projects within neighborhoods and communities by providing funding to implement community-driven improvement projects. The programs that support this work include Neighborhood Matching Fund, Duwamish River Opportunity Fund, Find It Fix It, Healthy Food Fund. Communities could propose mitigation projects through these programs. DON also administers grants for the 135 designated Community Emergency Hubs. Recent accomplishments include:</p> <ul style="list-style-type: none"> <li>In 2020, awarded \$33,360 grant to develop five additional emergency hubs, translate current Hub brochure and videos into multiple languages, and provide interpretation at 2021 outreach events.</li> <li>In 2015, awarded \$15,000 to the South Park Area Redevelopment Committee and South Park Senior Citizens to develop more stable food sources for the Senior Center Meal Program.</li> </ul>	All Hazards
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#### 5.4.4 Finance and Administrative Services (FAS)

The Seattle Department of Finance and Administrative Services (FAS) has the most diverse set of responsibilities of any City department. FAS combines the functions from the former Fleets and Facilities Department and the former Department of Executive Administration with the revenue forecasting, debt management, and tax policy functions that were previously performed by the former Department of Finance. It also houses the Customer Service Bureau, Neighborhood Service Centers, and manages the Find It, Fix It app. As a result, the department provides a variety of services to City departments and the public, including citywide operational responsibilities for accounting, payroll, licensing, revenue collection and processing, animal services, weights and measures, treasury activities, purchasing, construction and consultant contracting, risk management, the City's financial management and personnel data systems, and management of City real estate, buildings, and vehicles, as well as construction and renovation of fire stations as part of the Fire Facilities and Emergency Response Levy. FAS-managed facilities and IT infrastructure. Schedule 1 facilities are comprised of existing and future office buildings located in downtown Seattle, including but not limited to City Hall, the Seattle Municipal Tower and the Justice Center Schedule 2 facilities are comprised of existing and future structures, shops and yards located throughout Seattle, including but not limited to City vehicle maintenance facilities at Haller Lake and Charles Street, FAS shops located at Airport Way S., fire stations, police precincts including the animal shelter, and other FAS managed facilities used for City Services.

Existing Mitigation Capability	Capability Type	Description	Hazard Mitigated
<b>Capital Improvement Program (CIP)</b>	<b>Financial</b>	<p>Develops capital projects for FAS-managed facilities and IT infrastructure, and coordinates with CBO to prepare the CIP, a six-year financial planning tool that identifies future capital investments and potential strategies for funding those investments. Recent accomplishments include:</p> <ul style="list-style-type: none"> <li>The renovation and seismic retrofit of Fire Station 5 was completed in 2018.</li> </ul>	All Hazards
<b>Seismic Program</b>	<b>Administrative and Technical</b>	<p>Perform seismic assessment to identify seismic risk at FAS facilities. Recent accomplishments include:</p> <ul style="list-style-type: none"> <li>A seismic assessment of the North Precinct was performed in 2019.</li> </ul>	Earthquake

<b>Facilities and Emergency Response Program (Fire Facilities and Emergency Response Levy)</b>	Financial	<p>Manage the voter-approved Fire Facilities and Emergency Response Levy. The levy provided \$167 million to enable the Seattle Fire Department to be more resilient in dealing with crisis situations, especially those that could damage critical department assets and disrupt emergency operations. Recent accomplishments include:</p> <ul style="list-style-type: none"> <li>The construction of Fire Station 22 was completed in 2017.</li> <li>The construction of Fire Station 32 was completed in 2017.</li> </ul>	All Hazards
<b>Mail Safety Protocol</b>	Administrative and Technical	<p>Implement bomb detection procedures to screen incoming package for potential threats. Employees are trained in procedures to safely handle suspicious packages in coordination with SPD. Recent accomplishments include:</p> <ul style="list-style-type: none"> <li>Trained mailroom staff to be aware of what to look for in a suspicious mail or package.</li> <li>Conducted training for City Departments by the USPS Postal Inspectors and Seattle Police Bomb Squad on what they should be looking for and what to do if they find something suspicious. Training was completed in October 2018.</li> </ul>	Attacks
<b>Safe and Healthy Buildings for City Workforce</b>	Administrative and Technical	<p>Manage 120 City facilities to be safe and healthy buildings for the City workforce. Recent accomplishments include:</p> <ul style="list-style-type: none"> <li>Implemented safety protocols in response to the COVID-19 pandemic. To improve indoor air quality HVAC filters were upgraded to MERV-13 in 2020.</li> </ul>	Disease Outbreak

#### 5.4.5 Human Services Department (HSD)

The Seattle Human Services Department (HSD) is one of the largest contributors to Seattle's safety net. HSD operates programs, provides services and is responsible for investing more than \$120 million in contracts to more than 170 community-based human service providers that support the city's most vulnerable each year. Through the lens of racial equity, HSD supports programs, initiatives and policies that prepare youth for success, support affordability and livability, address homelessness, promote public health and promote healthy aging.

Existing Mitigation Capability	Capability Type	Description	Hazard Mitigated
<b>Aging Disability Services</b>	Planning, Administrative, Education and Outreach	<p>Prepare clients and home care agencies in Seattle and King County to be ready in case of a disaster. Recent accomplishments include:</p> <ul style="list-style-type: none"> <li>As the Area Agency on Aging (AAA) for Seattle and King County, developed the Area Plan 2020-2023, which includes an Emergency Response Plan.</li> <li>Developed COVID-19 care guidance on various topic areas and provided to home care agencies, case managers and case managed clients. Planning unit worked closely with King County housing providers on resident signage,</li> </ul>	All Hazards

		<p>education and face covering use. Collaborated with Public Health to address availability of influenza vaccinations for underinsured and uninsured for 2019-2020 season.</p> <ul style="list-style-type: none"> <li>• Developed Respiratory Health during Wildfire Smoke Exposure Self-Management Plan.</li> <li>• Coordinate disaster response plans with home care agency directors.</li> <li>• Maintain list of high-risk clients that is used to prepare for and respond to disasters to include weather, wildfire smoke, and changes to roads (e.g., closure of Viaduct).</li> <li>• Provide emergency preparedness information to clients and help clients with personal emergency plans. Distributed Red Cross emergency kits to clients and staff.</li> </ul>	
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#### 5.4.6 Seattle Information Technology Department (ITD)

The Seattle Information Technology Department (ITD) manages the City's information technology infrastructure and performs strategic information technology planning. ITD coordinates strategic technology direction for the City by developing common standards, architectures, and business solutions to deliver City services more efficiently and effectively; builds and operates the City's corporate communications and computing assets, which include the City's telephone, radio, and email systems, networks, and servers; and oversees development of the Democracy Portal, a project to improve the City's government access television station and its accompanying web site by providing new programming, live Web streaming of City Council meetings, live "webcasting" and interactive services that allow residents to access government information and contact decision makers.

Existing Mitigation Capability	Capability Type	Description	Hazard Mitigated
<b>Puget Sound Regional Interoperability Committee</b>	Technical	Plan interoperable infrastructure initiatives across King, Pierce, and Snohomish counties. Tri-County Regional Interoperability, which links the radios from King County, Snohomish County, Tacoma, and the Port of Seattle with conventional radio in Pierce County, Washington State Patrol, and the Federal Integrated Wireless Network.	All Hazards
<b>Regional Communications Board</b>	Administrative	Govern the King County public safety radio network. The Seattle Information Technology Department operates a portion of the radio network system, including nine radio sites and 6,000 800-megahertz public safety radios that link every police and fire agency in the County, as well as Seattle Public Utilities.	All Hazards
<b>Capital Improvement Program (CIP)</b>	Financial	<p>Propose capital projects and coordinate with FAS and CBO to prepare the CIP, a six-year financial planning tool that identifies future capital investments and potential strategies for funding those investments. Recent accomplishments include:</p> <ul style="list-style-type: none"> <li>• Replacement of two old radio towers in Northeast and West Seattle.</li> <li>• Establishment of two separate data centers with 50 miles of separation.</li> <li>• Cloud infrastructure and data back up in place.</li> </ul>	Earthquake

<b>King County Emergency Management Advisory Committee</b>	Administrative	Participate in the ICC EMAC Critical Infrastructure Workgroup. Recent accomplishments include: <ul style="list-style-type: none"> <li>Series of Cybersecurity “Emerald Downs” exercises and workshops to advance the understanding of county and local government responsibilities.</li> <li>Securing funding through State Homeland Security Grants.</li> </ul>	Cyber-attack and Disruption
<b>2020 ITD Digital Security &amp; Risk Register</b>	Administrative	Perform an annual assessment of 73 CIS/NIST framework risk controls. Recent accomplishments include: <ul style="list-style-type: none"> <li>ITD Digital Risk Register Report</li> <li>Projects: Fire Eye, Zen GRC</li> </ul>	Cyber-attack and Disruption

#### 5.4.7 Public Health – Seattle & King County (PHSKC)

Public Health – Seattle & King County (PHSKC) provides public health services for the City, including services for children and youth, persons with chronic disease, and communicable diseases; immunization services; environmental health services; public health emergency preparedness; emergency medical services; violence and injury prevention services; a medical examiner; nutrition support services; and tobacco prevention programs.

Existing Mitigation Capability	Capability Type	Description	Hazard Mitigated
<b>Health Code and other codes</b>	Regulatory	Has legal authority over Code of the King County Board of Health. Updated 2018, and King County Code Title 12: Public Peace, Safety, and Morals. Recent accomplishments include: <ul style="list-style-type: none"> <li>Board of Health Code was updated in 2018.</li> </ul>	All Hazards
<b>Emergency Program</b>	Planning, Administrative, Regulatory	Maintain Emergency Support Functions (ESF) 8 of Comprehensive Emergency Management Plan (CEMP) Basic Plan: Health, Medical, and Mortuary Services and has a designated emergency manager and section to handle emergency management. Implements a training and exercise program to support the general public’s health and safety by training Public Health staff on their role in an emergency and disaster. Maintains a well-developed risk communication plan. Recent accomplishments include: <ul style="list-style-type: none"> <li>ESF-8 Basic Plan updated 2018.</li> <li>ESF-8: Environmental Health Emergency Response Annex updated 2018.</li> <li>ESF-8: Medical Countermeasures Annex updated 2018.</li> <li>Isolation and Quarantine Plan updated 2017</li> <li>Mass Fatality Management Plan updated 2018</li> <li>Equity Response Annex updated 2019</li> <li>Environmental Health Services Division 24HR Emergency Notification Reporting Line established Nov. 2019.</li> </ul>	All Hazards

<b>Services for Vulnerable Populations</b>	Administrative/ Technical	Provide equitable health services, through Healthcare for the Homeless program, to vulnerable populations through engagement with homeless service providers. In addition, Environmental Health Services Division's Community Toxics, Science, and Policy Section provides homeless service providers with guidance and resources to ensure implementation of proper sanitation and hygiene measures within shelters and unsanctioned encampments. Recent accomplishments include: <ul style="list-style-type: none"> <li>2017-2020 Hep-A vaccination strategy, coordinating with homeless service providers to hold Hep-A vaccination clinics for individuals living as homeless.</li> <li>Sanitation &amp; Hygiene Guidance for Homeless Service Providers; issued Oct. 2019.</li> </ul>	Disease Outbreak
<b>Climate Change &amp; Health</b>	Planning	Adopted PHSKC Blueprint for Addressing Climate Change in 2018. This outlines core PHSKC functions, strategies, and actions to develop internal expertise, analyze gaps and opportunities for prioritizing work, and build on current programs and projects to address climate change impacts on health and equity.	Climate Change, All Hazards

#### 5.4.8 Office of Economic Development (OED)

The Office of Economic Development (OED) seeks to foster an inclusive economy that grows family-wage jobs and increases wealth among underserved communities. OED invests in four primary program areas all targeting underserved populations: supporting entrepreneurs; building healthy and vibrant neighborhood business districts; developing the talent of youth and adults; and partnering with key industry sectors. The core services OED provides capitalize on Seattle's economic strengths, particularly in the industry areas of manufacturing and maritime, technology, startups, restaurants, health care, life sciences and global health, clean technology, and the creative economy.

Existing Mitigation Capability	Capability Type	Description	Hazard Mitigated
<b>Neighborhood Business Districts</b>	Financial, Education and, Outreach	Support small businesses and neighborhood business districts through direct funding and technical support. Work through business district organizations and business improvement associations (BIAs) to distribute information and provide assistance. Recent accomplishments include: <ul style="list-style-type: none"> <li>In response to COVID-19, the OED expanded the Small Business Stabilization Fund to provide relief for small businesses financially impacted by the virus. To date, the department has provided \$10,000 grants to over 706</li> </ul>	Disease Outbreak Fire HazMat Incident



		<p>businesses from high risk of displacement/highly disadvantaged areas and anticipates investing an additional \$5 mill to stabilize small businesses in the city of Seattle.</p> <ul style="list-style-type: none"> <li>• In 2020 OED established the language access resource line to support small business owners with resources and information in over 8 different languages.</li> <li>• OED has also hosted webinars directed at small businesses and business outreach organizations to provide information about resources, organize outreach and direct technical assistance to small businesses in need.</li> <li>• OED has distributed information via social media, e-newsletters, ethnic media, and via partners' electronic communication channels.</li> <li>• In response to incidents such as fires and explosions within business districts (Ballard &amp; Chinatown-ID fires and Greenwood gas explosion) OED staff have provided direct technical assistance to businesses to make insurance claims and apply for FEMA and SBA resources.</li> </ul>	
<b>Special Events</b>	Regulations	Support special events through advocacy and permit coordination to encourage and maximize positive business, economic, and cultural activity while ensuring public safety.	All Hazards

#### 5.4.9 Office of Emergency Management (OEM)

The Seattle Office of Emergency Management (OEM) is responsible coordinating the City's resources and responsibilities in dealing with all aspects of emergencies. Its basic mission is devoted to citywide disaster preparedness, response, recovery, and mitigation. It places a strong emphasis on individual and community preparedness and provides a key liaison function between the city and its state and federal emergency management counterparts.

Existing Mitigation Capability	Capability Type	Description	Hazard Mitigated
<b>Hazard Vulnerability and Risk Technical Expertise</b>	Technical	<p>Provide information and expertise about hazard vulnerability and risk. Update the Seattle Hazard Identification and Vulnerability Assessment (SHIVA) every four years. The SHIVA identifies Seattle's hazards and examines their consequences providing a foundation for the City's disaster planning and preparedness activities. Provide technical assistance on hazards and vulnerability to support emergency management planning, projects and other implementation. Recent accomplishments include:</p> <ul style="list-style-type: none"> <li>• Updated the SHIVA in 2019.</li> <li>• Created and updates Hazard Explorer, an online GIS resource providing accessible mapped data of various hazards.</li> <li>• Participated in pilot of One Concern, a disaster simulation tool.</li> <li>• Participated in beta-test for Shake Alert Earthquake Early Warning system to deliver early warning of impending hazardous ground shaking to key public safety officials.</li> <li>• Ongoing. Participated in standing working groups focused on specific hazards such as Tsunami Working Group.</li> </ul>	All Hazards

<b>Hazard Mitigation Grant Funding and Program Coordination</b>	Planning and Administrative	Manage applications and administration of State/FEMA Mitigation grants on behalf of the City. Recent accomplishments include: <ul style="list-style-type: none"> <li>Between 2016 and 2020, the City was awarded approximately \$9.4 million in grant funding for mitigation projects.</li> </ul>	All Hazards
<b>Emergency Management Stakeholder Coordination</b>	Planning and Administrative	Convene internal and external stakeholders to support the City's emergency management functions, including mitigation. City stakeholders include Mitigation Work Group, Strategic Work Group, Tsunami Working Group and the Executive Emergency Board. External stakeholder groups include the Disaster Management Committee, and Community Safety Ambassadors. Recent accomplishments include: <ul style="list-style-type: none"> <li>Participate in the interdepartmental Climate Justice Working Group created in 2020.</li> </ul>	All Hazards
<b>Comprehensive Emergency Plans</b>	Planning	Maintain a suite of plans that guide the city in its mitigation of, response to, and recovery from a disaster. These include Seattle All-Hazards Mitigation Plan, Seattle Comprehensive Emergency Management Plan and Seattle Disaster Recovery Framework. Recent accomplishments include: <ul style="list-style-type: none"> <li>Adopted the Seattle Disaster Recovery Framework in July 2015.</li> <li>Adopted an updated Seattle Comprehensive Emergency Management Plan and Emergency Operations Plan in December 2017.</li> </ul>	All Hazards

#### 5.4.10 Office of Housing (OH)

The mission of the Seattle Office of Housing (OH) is to support the preservation and production of affordable housing through long-term loans to mission-based multifamily developers in Seattle. The Office of Housing also provides home repair and weatherization programs for lower-income residents. A guiding principle of OH is to create a more equitable and affordable community through affordable housing investments.

Existing Mitigation Capability	Capability Type	Description	Hazard Mitigated
<b>Capital Financing and Resources</b>	Regulatory Financial	Serve in the capacity as a lender and compliance monitor for the production of affordable rental housing in the City. Works in close partnership with a network of mission-based non-profits and provides resources and investment for housing initiatives. Resources could potentially provide funding for seismic reinforcement in affordable housing projects. Recent accomplishments include: <ul style="list-style-type: none"> <li>In 2020, received FEMA Pre-Disaster Mitigation Grant funding on behalf of Community Roots Housing for The Bremer Project, a seismic retrofit of an identified URM building of affordable housing. First time this was done and OH is exploring other opportunities to replicate this model.</li> <li>In 2016, voters approved a six-year \$290 million Affordable Housing Levy to create or preserve affordable housing for seniors, low- and moderate-wage workers, and formerly homeless individuals and families. Also, will provides</li> </ul>	Earthquakes

		<p>assistance to more than 900 first-time low-income home buyers and emergency rental assistance to more than 6,500 households.</p> <ul style="list-style-type: none"> <li>In 2018 the City enacted Mandatory Affordable Housing that requires new commercial and multifamily residential development contributes to affordable housing expanding OH's financial resources.</li> </ul>	
<b>HomeWise Weatherization Program</b>	Technical	<p>Provide weatherization services to income eligible households to install improvements such as insulation, duct and air sealing, ductless heat pumps, new hot water tanks, furnace repair or replacement, new kitchen and bathroom fans, and new energy efficient refrigerators. Recent accomplishments include:</p> <ul style="list-style-type: none"> <li>In 2019, the OH Weatherization Program expended \$4.74 million in grant funds and completed the upgrades in 97 single-family homes which benefited low-income renters and homeowners. Also provided weatherization services to nine (9) affordable apartment buildings that contained 469 units.</li> </ul>	Climate Change

#### 5.4.11 Office of Planning and Community Development (OPCD)

The Office of Planning and Community Development (OPCD) supports thriving communities through an integrated and equitable approach to planning and community investment. OPCD works across City departments to assess community needs, prioritize resources, and develop a vision for how Seattle grows to ensure that we are coordinating and implementing our plans with a cohesive vision. We are working toward a city that is inclusive, affordable, vibrant, interconnected, and innovative. We partner with neighborhoods, businesses, agencies and others to bring about positive change and coordinate investments for Seattle communities.

Existing Mitigation Capability	Capability Type	Description	Hazard Mitigated
<b>Seattle Comprehensive Plan</b>	Plans and Regulations	<p>Maintain the Comprehensive Plan, a 20-year vision that guides City big-picture decisions on how to grow while preserving and improving our quality of life. Recent accomplishments include:</p> <ul style="list-style-type: none"> <li>Adopted Seattle 2035 in 2016, an update of the plan to guide how Seattle will grow by 70,000 households and 115,000 jobs over the next 20 years.</li> </ul>	All Hazards
<b>Community Planning</b>	Plans and Regulations	<p>Lead community planning processes in multiple neighborhoods each year. The City engages organizations and individuals to come together to shape the future of their neighborhood by setting long range goals and policies, designing strategies, and coordinating city investments.</p> <ul style="list-style-type: none"> <li>In 2018 OPCD adopted a community prioritization process that includes "environmental burdens" and "public safety concerns" as two factors to determine where community planning resources will be focused.</li> </ul>	All Hazards

#### 5.4.12 Office of Sustainability and Environment (OSE)

Existing Mitigation Capability	Capability Type	Description	Hazard Mitigated
<b>Seattle Climate Action Plan</b>	Planning and Administrative	Implement the Seattle Climate Action Plan (2013) and Climate Action Strategy (2018) to reduce Seattle's greenhouse gas emissions, including goal assessment, action planning, community outreach, and performance measurement. The Seattle Climate Action Plan (CAP) provides a coordinated strategy of short- and long-term City actions to reduce GHG emissions while also supporting other community goals, including building vibrant neighborhoods, fostering economic prosperity, and enhancing social equity. The CAP focuses on road transportation, building energy, and waste as well as actions that will increase our community's resilience to the likely impacts of climate change.	All Hazards
<b>Food Access Action Plan</b>	Planning and Administrative, Financial	Provide direct benefits that increase purchasing power of residents experiencing food insecurity to afford healthy food through Fresh Bucks and Emergency Grocery Vouchers. Implement Seattle's Food Action Plan, a five-year plan, adopted in 2013 containing 40 actions to increase access to get more healthy food to more Seattle residents, expand opportunities to grow food in the city, strengthen our regional food economy, and reduce food related waste.	All Hazards
<b>Duwamish Valley Program and Action Plan</b>	Planning and Administrative	Co-lead (with OPCD) a multi-department effort to mitigate the combined impacts of environmental inequities, climate change, and systemic racism in South Park and Georgetown. Implement the Duwamish Valley Action Plan that includes 87 City and community-led actions in seven priority areas: Healthy Environment, Parks & Open Spaces, Community Capacity, Economic Opportunity & Jobs, Mobility & Transportation, Affordable Housing, and Public Safety. Plan promotes collaboration and guides the City's work and investments in the Duwamish Valley. interdependence. The program also supports community-led projects funded by the Duwamish Valley Opportunity Fund (DVOF). Recent accomplishments include: <ul style="list-style-type: none"> <li>• Since 2015 the DVOF has granted \$1.1 million to 37 community projects including several to mitigate hazards related to flooding, excessive heat events and hazardous materials.</li> <li>• Between 2016 and 2018, the City invested over \$2M in investments to respond to community priorities.</li> <li>• Release the Duwamish Valley Action Plan in 2018.</li> </ul>	All Hazards

#### 5.4.13 Seattle Center (SC)

Seattle Center (SC) is a valued civic asset with community roots that reach back in time to native tribes and pioneers. Today, the 74-acre campus is the region's top visitor destination. Over 14,000 events presented on the campus each year, attracting millions of Seattle residents, arts patrons, out-of-town guests, and global travelers. The Seattle Center grounds and venues support an extraordinary level of arts, cultural, sports, educational and tourism activities. The City looks forward to celebrating the opening of Climate Pledge Arena in 2021 as a world-class venue for sports and entertainment. The

Arena, housed in the landmarked Century 21 Coliseum building that dates to the 1962 World's Fair, represents nearly \$1 billion in private investment, and its operation will support the continued vibrancy and sustainability of Seattle Center for decades to come.

Existing Mitigation Capability	Capability Type	Description	Hazard Mitigated
<b>Capital Improvement Program (CIP)</b>	Financial	<p>Develops capital projects and coordinates with CBO to prepare the CIP, a six-year financial planning tool that identifies future capital investments and potential strategies for funding those investments. Recent accomplishments include:</p> <ul style="list-style-type: none"> <li>• Seismic retrofit and deferred major maintenance of the Mercer Garage</li> <li>• Relining of existing Seattle Center owned sewer main lines</li> <li>• Roof replacements at Cornish Playhouse and the Seattle Children's Theatre</li> <li>• Monorail deferred major maintenance including update of electrical rooms and seismic evaluation of the Seattle Center station</li> <li>• Preservation and redevelopment of the historic Century 21 Coliseum roof, superstructure and façade to reopen as Climate Pledge Arena in 2021</li> </ul>	All Hazards

#### 5.4.14 Seattle City Light (SCL)

Seattle City Light (SCL) was created in 1902 to provide affordable, reliable, and environmentally sound electric power to the City of Seattle and neighboring suburbs. Owned by the community it serves, Seattle City Light is a nationally recognized leader in energy efficiency, renewable resource development, and environmental stewardship. Seattle City Light provides electric power to more than 360,000 residential, business, and industrial customers. Its service area of 131.3 square miles includes the City of Seattle, areas north of Seattle, including the city of Shoreline and parts of Lake Forest Park, and areas south of Seattle, including the cities of Burien, Tukwila, and SeaTac. To serve these customers, City Light owns, maintains, and operates a multi-billion-dollar physical plant that includes: a power generation system consisting of seven hydroelectric plants on the Pend Oreille, Skagit, Cedar, and Tolt rivers; 656 miles of high-voltage transmission lines linking these plants to Seattle; a distribution system with 15 major substations and more than 2,500 miles of overhead and underground cable; a state-of-the-art System Operations Center coordinating the City's electric system; and billing and metering technology tracking approximately 461,000 accounts.

Existing Mitigation Capability	Capability Type	Description	Hazard Mitigated
<b>Mitigation Policy</b>	Planning and Administrative	<p>Conduct structural mitigation, security, and non-structural mitigation projects as facility upgrades are made. Recent accomplishments include:</p> <ul style="list-style-type: none"> <li>• Created the Disaster Recovery and Business Continuity Planning (Information Technology Division)</li> <li>• Installed a fail-over redundancy system with backup at an off-site location for data systems.</li> </ul>	All Hazards

<b>Dam Safety Program</b>	Planning and Administrative	<p>Oversee the Dam Safety Program involving the coordination, monitoring, and oversight of activities for six major dams to reduce the risk and impacts from dam failure due to natural and man-made hazards. Recent accomplishments include:</p> <ul style="list-style-type: none"> <li>▪ Vulnerability and threat assessments for the Skagit and Boundary Hydroelectric Projects and the Cedar Falls/Tolt dams.</li> <li>▪ Skagit Spillway Gate seismic strengthening at Ross and Diablo dams.</li> <li>▪ Hillside and slope stabilization at Boundary, Diablo, and Ross dams.</li> <li>▪ Equipment installation and monitoring to detect dam movement, measure high flows, and dam failure at Cedar Falls and Boundary dams.</li> <li>▪ Annual dam safety inspections by the Federal Energy Regulatory Commission (FERC).</li> <li>▪ Procedures for dam inspections following events</li> <li>▪ Emergency Action Plans for facilities.</li> <li>▪ Annual update/tests of emergency procedures.</li> </ul>	All Hazards
<b>Capital Improvement Program (CIP)</b>	Financial	<p>Develop capital projects and coordinate with CBO to prepare the CIP, a six-year financial planning tool that identifies future capital investments and potential strategies for funding those investments. CIP projects repair, upgrade, and expand SCL's physical plant, and implement a variety of safety improvements, mitigation activities, and licensing requirements. Recent accomplishments include:</p> <ul style="list-style-type: none"> <li>• Completed a joint assessment project for the Cedar Falls/Tolt Dams.</li> </ul>	All Hazards
<b>Hazard tree mitigation (vegetation management) near SCL Right-of-Way</b>	Administrative and Technical	<p>Identify and abate hazard from trees that are likely to fail and cause power outages in all the identified areas. SCL maintains over 300,000 trees adjacent to 1700 miles of distribution power lines throughout Seattle, Burien, Lake Forest Park, Normandy Park, Renton, SeaTac, Shoreline, Tukwila, and unincorporated King County. Also, SCL manages vegetation along 657 miles of transmission power lines passing through five counties across Washington State. Recent accomplishments include:</p> <ul style="list-style-type: none"> <li>• Identified all areas that need vegetation management.</li> </ul>	Fires, Landslides, Power Outages, Snow and Ice Storms, and Windstorms
<b>Remove/sample PCB transformers</b>	Administrative and Technical	<p>Ensure full compliance with laws and regulations for all transformers. The PCB master plan was completed in 2014 and software to track the PCB concentration of all transformers was implemented in 2015. SCL is replacing transformers that need critical attention and establishing procedures for transformer inspections. SCL will complete the project by 2021.</p>	Earthquakes, Snow and Ice Storms, and Windstorms
<b>Charging Stations</b>	Administrative and Technical	<p>Make available a charging station to deploy throughout the greater Seattle area.</p> <ul style="list-style-type: none"> <li>• Locate two mobile trailers.</li> <li>• Purchase equipment for the mobile units.</li> <li>• Complete the study on most vulnerable areas in Seattle.</li> <li>• Deployment of mobile unit procedures.</li> </ul>	Climate Change

#### 5.4.15 Seattle Department of Construction and Inspections (SDCI)

The Seattle Department of Construction and Inspections (SDCI) develops, administers, and enforces standards for land use, design, construction, and housing within the Seattle city limits. SDCI is also responsible for long-range planning, including Seattle's Comprehensive Plan and related projects- transportation improvements, neighborhood business revitalization, and downtown and waterfront planning.

Existing Mitigation Capability	Capability Type	Description	Hazard Mitigated
<b>Seattle Unreinforced Masonry Retrofit Policy (in development)</b>	Regulatory	<p>This policy is under development to mitigate the risks associated with Unreinforced Masonry (URM) structures in the City. Recent accomplishments include:</p> <ul style="list-style-type: none"> <li>• Finalized list of confirmed URM buildings.</li> <li>• Supported National Development Council (NDC) efforts to develop financing report for URM retrofit.</li> <li>• Provided support for Alliance for Safety, Affordability, and Preservation (ASAP!) for development of permitting processes.</li> <li>• Worked with OEM to continue URM Retrofit policy development.</li> </ul>	Earthquakes
<b>Emergency Response and Recovery Roles</b>	Administrative	<p>Provide rapid assessment of damaged buildings following earthquakes. Recent accomplishments include:</p> <ul style="list-style-type: none"> <li>• Trained appropriate staff to conduct ATC-20 building safety assessments.</li> <li>• Trained appropriate staff on required NIMS Incident Command System courses.</li> <li>• Trained appropriate staff on EOC procedures and WebEOC.</li> </ul>	Earthquake
<b>Environmentally Critical Areas (ECA) Code</b>	Regulatory	<p>Administer the ECA Code which governs areas of Seattle that provide critical environmental functions. For example, wetlands can protect water quality and provide fish and wildlife habitat. The ECA code also addresses areas that represent particular challenges for development due to geologic or other natural conditions. The goal of the ECA regulations, (Seattle Municipal Code [SMC] Chapter 25.09) is to effectively protect these areas and to protect public safety, while allowing reasonable development. Specific hazard-related areas identified include:</p> <ul style="list-style-type: none"> <li>• Geologic hazard areas including landslide-prone areas, liquefaction-prone areas, peat-settlement-prone areas, seismic hazard areas, and volcanic hazard areas.</li> <li>• Flood-prone areas.</li> </ul>	Earthquakes Flood Landslides Volcanic Hazards
<b>Floodplain Management</b>	Regulatory	<p>Administer the City's National Flood Insurance Program (NFIP). Recent accomplishments include:</p> <ul style="list-style-type: none"> <li>• Established and maintained eligibility in the Regular Phase of the NFIP since 1977.</li> <li>• Maintains a National Flood Insurance rate map for properties identified as flood prone. These Digital Flood Insurance Rate Maps (DFIRMs) have been updated and will go into effect August 19, 2020. Interim regulations were adopted in Aug 2020 and permanent regulation will be adopted in Feb 2021.</li> <li>• Public outreach through a Community Assistance Visit will occur prior to adopting the updated mapping.</li> </ul>	Flood

		<ul style="list-style-type: none"> <li>Seattle Municipal Code Chapter 25.06, as amended by Council Bill Number 114503 (2003), is the floodplain management chapter; it was reviewed and found to be fully compliant with the NFIP and State floodplain management regulations.</li> <li>The Municipal Code Chapter 25.06 was amended by Ordinance 125781 (Council Bill 119420) to update the referenced vertical datum.</li> </ul>	
<b>Codes, Regulations, Rules, and Memos</b>	Regulatory	<p>Develops, adopts, and enforces codes, ordinances, and policies that regulate construction activities of new and existing buildings. The selected codes, regulations, rules, and memos mitigate damage caused by natural disasters. Key mitigation rules, memos, codes, and policies for which the department is responsible including Directors Rules, Client Assistance Memos, Seattle Construction Codes, Seattle Municipal Code, and other policy provisions. Recent accomplishments include:</p> <ul style="list-style-type: none"> <li>Updates to the building code to reflect changes tsunami standards in the International Building Code.</li> </ul>	All Hazards
<b>Landslide Awareness Program</b>	Education and Outreach	<p>Conduct public outreach with the intent of providing expert advice for property owners to manage landslide-prone areas.</p> <ul style="list-style-type: none"> <li>Conducted public meetings.</li> <li>Updated ECA Steep Slope Area Mapping Units.</li> <li>Updated ECA known landslide area mapping GIS information.</li> </ul>	Landslide

#### 5.4.16 Seattle Department of Transportation (SDOT)

SDOT's mission is to deliver a transportation system that provides safe and affordable access to places and opportunities. SDOT develops, maintains, and operates a transportation system that promotes the mobility of people and goods, and enhances the quality of life, environment, and economy of Seattle. Services are coordinated and delivered through 10 divisions that respond to changes in the function and use of the transportation system and the evolving needs of the businesses and people of the City of Seattle.

Existing Mitigation Capability	Capability Type	Description	Hazard Mitigated
<b>Levy to Move Seattle</b>	Financial	Fund bridge seismic retrofit program through this voter-approved transportation levy.	Earthquake
<b>Move Seattle: 10-Year Strategic Vision for Seattle</b>	Planning	This plan identifies actions to accomplish policies in the Comprehensive Plan and the Puget Sound Regional Council's Transportation 2040 plan, as well as integrate the City's 4 modal plans .	All Hazards
<b>Transportation Asset and Performance</b>	Planning and Administrative	This program focuses on getting the best results of performance for the prevention, improvement, and operation of infrastructure assets given the resources available.	Infrastructure and Structural Failure



Management Program			
<b>Landslide Mitigation Program</b>	Planning, Administrative and Technical	<p>Conduct studies and direct CIP funds towards high priority arterial streets vulnerable to landslides. Track ongoing clean-up and maintenance costs associated with slide area and develop draft standards for tailoring streets and drainage in residential areas. Recent right-of-way landslide repair projects include:</p> <ul style="list-style-type: none"> <li>• 4 - Soldier Pile Walls at various sites along 9700 block to 10300 block of Rainier Ave S</li> <li>• 4 – Gravity walls at various sites along 9700 block to 10300 block of Rainier Ave S</li> <li>• Soldier Pile wall at 10400 block 47 Ave SW</li> <li>• Soldier Pile wall at 9400 block California Ave SW</li> </ul>	Landslides
<b>Areaways Program</b>	Administrative and Technical	<p>Identify and implement mitigation projects for areaways - usable space, generally in the street right-of-way, constructed under sidewalks, and between the building foundation and the street wall. Recent accomplishments include:</p> <ul style="list-style-type: none"> <li>• Monitoring Program – An extensive monitoring system has been installed in the most critical areaways in the Pioneer Square District</li> <li>• Inspection – Condition inspection was performed on areaways in the International District. This inspection provides an important benchmark for determining deterioration.</li> <li>• Reconstruction – elimination of areaway hazard Columbia St.</li> </ul>	Infrastructure and Structural Failure
<b>Capital Improvement Program (CIP)</b>	Financial	<p>Recent accomplishments include:</p> <ul style="list-style-type: none"> <li>• NE 45th St Viaduct (East Approach)</li> <li>• Fairview Ave Bridge (East and West)</li> <li>• Landslide Mitigation Projects.</li> <li>• Areaway Projects</li> </ul>	Earthquakes

#### 5.4.17 Seattle Fire Department (SFD)

The Seattle Fire Department (SFD) has 33 fire stations located throughout the City. SFD deploys engine companies, ladder companies, and aid and medic units to mitigate loss of life and property resulting from fires, medical emergencies, and other disasters. SFD also has units for hazardous materials responses, marine responses, and high-angle and confined-space rescues. In addition, SFD provides leadership and members to several disaster response teams: FEMA Washington Task Force 1 Urban Search and Rescue, USCG Area Maritime Security Committee, and regional wildland firefighting through the Washington State Fire Mobilization Plan. SFD's fire prevention efforts include: fire code enforcement; inspections and plan reviews of fire and life safety systems in buildings; public-education programs; regulation of hazardous materials storage and processes; and regulation of public assemblies. FAS manages the construction, maintenance, and mitigation of all SFD facilities.

Existing Mitigation Capability	Capability Type	Description	Hazard Mitigated
<b>Fire Prevention Division</b>	Regulatory	<p>The Fire Prevention Division (FPD) administers the SFD fire prevention program to provide a reasonable level of life safety and property protection from the hazards of fires, explosions, and dangerous conditions, including releases of hazardous materials for Seattle's residents, workers, and visitors. Recent accomplishments include:</p> <ul style="list-style-type: none"> <li>From 2016-2020 approximately 3,300 facilities that store, dispense, use, or handle hazardous materials were inspected annually by the SFD Operations Division; the FMO processed approximately 300 new hazardous materials operational permit applications annually during the same period. Additionally, the FMO received and issued approximately 2,200 temporary permits related to hazardous activities annually primarily related to hot work (i.e., cutting, welding, and roofing operations).</li> <li>Provided oversight to testing and repairs for over 27,500 fire protection systems in the City of Seattle. More than 4,000 deficient systems were reported and repaired annually.</li> <li>Conducted over 1,600 compliance inspections annually to resolve complex or difficult fire code violations. Inspected over 430 high-rise buildings annually in Seattle to ensure fire and life safety in these uniquely risky structures.</li> </ul>	Fires HazMat Incidents
<b>Local Emergency Planning Committee (LEPC)</b>	Planning	<p>This inter-jurisdictional public/private mitigation partnership is managed by the SFD and addresses hazardous materials issues. The Seattle LEPC actively participates with regional and state partners in the Washington State Emergency Response Commission (SERC). The goal of the SERC is to plan for and mitigate the effects of a release or spill of hazardous materials. Recent accomplishments include:</p> <ul style="list-style-type: none"> <li>In 2020 the Seattle LEPC received and distributed approximately 700 U.S. Department of Transportation Hazardous Materials Emergency Response Guidebooks to response agencies in the City of Seattle. These books provide responders with recommendations for initial identification and isolation actions when responding to hazardous materials incidents.</li> </ul>	HazMat Incidents
<b>Capital Improvement Program (CIP)</b>	Financial	Proposes capital projects and coordinates with FAS and CBO to prepare the CIP, a six-year financial planning tool that identifies future capital investments and potential strategies for funding those investments.	All Hazards

#### 5.4.18 Seattle Police Department (SPD)

The Seattle Police Department's (SPD) primary mission is to prevent crime; enforce the law; and support quality public safety by delivering respectful, professional, and dependable police services. SPD is specifically charged with the enforcement of Title 11 (City of Seattle Traffic Code), Title 12 (City of Seattle Criminal Code), Revised Code of Washington Title 9A (Criminal Code), and statutes in Washington Code 9 (specified sections dealing with Criminal Law). Consistent with its mission, SPD has lead agency responsibility for all criminal investigations, to include civil disorder, bomb threats, and terrorism incidents as codified in Article VI of the Seattle City Charter. SPD operates within a framework that divides the city into five geographical areas called "precincts." These precincts define east, west, north, south, and southwest patrol areas, with a police station in each.

Existing Mitigation Capability	Capability Type	Description	Hazard Mitigated
<b>Incident Management Team</b>	Technical/Operational	Participates in the regional multi-discipline Type 3 Incident Management Team. Maintains a cadre of personnel to effectively manage major incidents or disasters and conducts regular training and exercises.	All Hazards
<b>Washington State Fusion Center</b>	Administrative	Stage representatives with the Washington State Fusion Center to ensure interagency communication and collaboration in preparedness, prevention, and response efforts as they relate to Critical Infrastructure and Key Resources. The Fusion Center supports public safety and homeland security missions.	Attacks
<b>Capital Improvement Program (CIP)</b>	Financial	Proposes capital projects and coordinates with FAS and CBO to prepare the CIP, a six-year financial planning tool that identifies future capital investments and potential strategies for funding those investments.	All Hazards

#### 5.4.19 Seattle Public Libraries (SPL)

The Seattle Public Library, founded in 1891, includes the world-renowned Central Library, 26 neighborhood libraries, a robust "virtual library" available 24/7 through the Library's popular website, a Mobile Services division, as well as leased storage and shops space. The Central Library provides library services for downtown residents and workers, is a hub for planning and developing systemwide programs and services, critical computer and Wi-Fi access for people without internet service, community meeting rooms and an auditorium for cultural and educational programs. The 26 neighborhood libraries provide services and programs close to where people live, go to school and work, and serve as neighborhood anchors for lifelong learning, civic engagement, and economic vitality. In 2019, The Seattle Public Library (SPL) hosted nearly five million in-person visitors and circulated 12.6 million items. More than 12,000 attended the Library's adult learning programs, 34,000 attended STEM-focused Summer of Learning activities and over 1,200 attended homework help sessions. The 2008 Library Levy, known as "Libraries for All", increased the amount of physical space by 80%. The next 2012 Library Levy provided funding to maintain the five new and 22 updated libraries. The 2019 Library Levy focuses on asset preservation and includes seismic retrofits at three century-old Carnegie-era branches.

Existing Mitigation Capability	Capability Type	Description	Hazard Mitigated
<b>Library Levy</b>	Financial	The 2019- 2026 voter-approved Library Levy funds capital projects, services and programs at all 27 libraries. <ul style="list-style-type: none"> <li>Included funding for seismic retrofits for three Carnegie-era branches (Green Lake, University and Columbia)</li> </ul>	Earthquakes
<b>Capital Improvement Program (CIP)</b>	Financial	Develops capital projects for library facilities and coordinates with CBO to prepare the CIP, a six-year financial planning tool that identifies future capital investments and potential strategies for funding those investments. Recent accomplishments include:	Earthquakes

		<ul style="list-style-type: none"> <li>Recent CIP was informed by an SDCI URM building survey that identified seven unreinforced masonry (URM) libraries. Three libraries were identified as high vulnerability (Green Lake, University and Columbia) and four libraries were medium vulnerability.</li> </ul>	
<b>Library Programs</b>	Education and Outreach	Host a variety of educational displays and programs which in past have programs related to disaster preparedness, earthquakes, and other mitigation-related topics.	All Hazards

#### 5.4.20 *Seattle Parks and Recreation (SPR)*

Seattle's Department of Parks and Recreation (SPR) works with all City residents to be good stewards of the environment and to provide safe, welcoming opportunities to play, learn, contemplate, and build community. Seattle Parks and Recreation manages 400 parks and open areas in its approximately 6,200-acre park system. This includes 224 parks, 185 athletic fields, 112 neighborhood play areas, nine swimming beaches, 18 fishing piers, four golf courses, and 22 miles of boulevards. Other Department of Parks and Recreation facilities include 151 outdoor tennis courts, 24 community centers, eight indoor and two outdoor swimming pools, 27 wading pools, a nationally recognized Rose Garden, and the Seattle Aquarium. The Woodland Park Zoological Society operates the zoo with financial support from the City.

Existing Mitigation Capability	Capability Type	Description	Hazard Mitigated
<b>Asset Management Plan (AMP)</b>	Planning	Maintain and update AMP actions to keep the SPR assets in safe and operable condition and to maintain a Tier 1 sheltering system. Recent accomplishments include: <ul style="list-style-type: none"> <li>Installation of Emergency Generators at Tier 1 Emergency Shelters at Garfield Community Center and Southwest Teen Life Center and Pool</li> <li>Helene Madison Pool seismic upgrade</li> <li>Hiawatha Community Center seismic upgrade</li> <li>Magnolia Community Center seismic upgrades</li> <li>Magnuson Building 11 seismic retrofit</li> <li>Cal Anderson Fountain discharge retrofit</li> <li>Freeway Park Fountains (3) retrofit</li> <li>Emma Schmitz Memorial Park seawall</li> </ul>	All Hazards
<b>Urban Forest Management</b>	Maintenance	Maintain healthy forest canopy, provides slope stability in environmentally critical areas and reducing carbon in air.	Windstorms, Snow and Ice, Power Outages, Heat Events, Landslides

<b>Capital Improvement Program (CIP)</b>	<b>Financial</b>	Develops capital projects and coordinates with CBO to prepare the CIP, a six-year financial planning tool that identifies future capital investments and potential strategies for funding those investments. SPR uses the AMP which measures each potential capital project by criteria including safety, asset preservation, race and social justice, legal obligation, and improvements in efficiency to set priorities for capital projects.	All Hazards
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#### 5.4.21 Seattle Public Utilities (SPU)

Seattle Public Utilities (SPU) is comprised of four major utilities: water, drainage, wastewater, and solid waste. The water utility provides a reliable water supply to more than 1.5 million customers in King County; the drainage utility manages stormwater; the wastewater utility collects and disposes of sewage and storm water; and the solid waste utility collects and disposes of recycling, yard waste, and residential and commercial garbage. SPU's mission is to provide vital services to the community that are equitable, environmentally responsible, and resilient. Resilience is a system's ability to incur fewer negative impacts and recover more quickly from stresses and shocks, while adapting to new conditions and opportunities. As a community-centered utility, SPU seeks to proactively address community needs and risks to improve resilience.

Existing Mitigation Capability	Capability Type	Description	Hazard Mitigated
<b>General Response Planning, and Response Capabilities</b>	<b>Planning, Administrative and Technical</b>	<p>SPU assesses and mitigates hazard risks to minimize disruptions to water supply, drainage, wastewater, and solid waste services. Accomplishments include:</p> <ul style="list-style-type: none"> <li>Updated SPU's Continuity of Operations Plan (2018, 2021).</li> <li>Completed SPU's Emergency Management Logistics Plan (2020).</li> <li>Completed the first Comprehensive Emergency Management Plan (2018).</li> <li>Completed the Water Utility's Emergency Response Plan (2020) and Risk and Resilience Assessment (2020) per America's Water Infrastructure Act.</li> <li>Updating Damage Assessment Plan and Training Program (2-year cycle).</li> <li>Completed the Ship Canal Water Quality Incident Management Plan (2020).</li> <li>Completing the Solid Waste Management Plan Amendment (2021) that incorporates resilience to hazards.</li> <li>Updated the Solid Waste Debris Management Plan including contracts (2018).</li> <li>SPU's Wet Weather Readiness and Response Program responds to in-city flooding.</li> <li>SPU's Spill Response Team responds to spills impacting drainage and wastewater, and water systems.</li> <li>SPU's Watershed Wildland Fire Team responds to wildfire in the municipal watersheds.</li> <li>SPU's Operation Response Center (24-hour dispatch) with expanded remote working capabilities and with backup at the North Operations Center.</li> </ul>	All Hazards
<b>Emergency Preparedness</b>	<b>Education and Outreach</b>	<p>SPU supports employees, the public, customers, and partners in being prepared. Accomplishments include:</p> <ul style="list-style-type: none"> <li>Employee preparedness programs, including annual field crew trainings and a Continuity of Operations Plan exercise (2020).</li> </ul>	All Hazards

		<ul style="list-style-type: none"> <li>Manages an alert and warning system for SPU, AlertSeattle. SPU is community notification capable.</li> <li>SPU has developed tools and resources to assist employees and community members. Distributed “SPU for 2” Preparing for the Big One booklet, guides and other materials during preparedness campaigns to encourage staff and their communities to prepare for disasters or emergencies.</li> <li>Continuing partnerships with local community leaders and businesses for Partners in Preparedness annual event and the Annual Night Out Ambassador Program.</li> </ul>	
<b>Stormwater and Wastewater Planning and Programs</b>	<b>Planning and Regulatory</b>	<p>SPU manages wastewater, storm water, and water quality programs and capital projects. These programs are in part required under the National Pollution Discharge Elimination System and a Consent Decree with the Department of Justice, US Environmental Protection Agency (EPA), and the Washington State Department of Ecology. Accomplishments include:</p> <ul style="list-style-type: none"> <li>Completing a Wastewater System Seismic Assessment (2021).</li> <li>Analyzed risk and likelihood of failure for many types of wastewater and drainage assets and have begun capital planning, to address vulnerabilities.</li> <li>Revised storm water code (2021) and Directors Rule to protect against flooding, pollution, landslides, and erosion.</li> <li>Performed Structural Storm Water control projects that include flood mitigation through the use of Green Stormwater Infrastructure.</li> <li>Completion of the Wastewater System Analysis (2019), which in part analyzed sewer system flooding and sewer backups.</li> <li>Completion of the Drainage System Analysis (2020), which in part analyzed property and road surface flooding.</li> <li>Implementing the Plan to Protect Seattle’s Waterways (2015), which reduces combined sewer overflows that occur during storm events.</li> </ul>	<b>Storms, Flood, Earthquake, Landslides</b>
<b>Water System Seismic Mitigation Program</b>	<b>Administrative, Technical and Financial</b>	<p>Seattle Public Utilities (SPU) completed its first water system seismic vulnerability assessment in 1990. This comprehensive assessment evaluated essentially all of SPU’s water system storage reservoirs and tanks, pump stations, transmission pipelines, and support buildings and facilities. The 1990 seismic vulnerability assessment was the impetus for a seismic upgrade program that led to approximately \$100 million of seismic upgrades and facility replacements.</p> <p>Since the 1990 study was completed, there have been several significant developments that affected SPU’s seismic mitigation program:</p> <ul style="list-style-type: none"> <li>Major earthquakes in Northridge, Kobe, Christchurch and Tohoku that show water systems remain highly vulnerable to large earthquakes.</li> <li>The realization that the many Western Washington crustal fault zones, including the Seattle Fault Zone that runs directly below Seattle, are active.</li> <li>The Uniform/International Building Code has significantly evolved since 1990.</li> <li>Earthquake-resistant ductile iron pipe that has performed exceptionally well in Japan is now available in the United States.</li> </ul> <p>In 2018, SPU completed a new water system seismic vulnerability assessment that incorporated the developments listed above. The most significant finding of the 2018 study is that SPU’s transmission and distribution pipeline systems would be expected to sustain significant damage during a catastrophic earthquake. Restoring even minimal service to all of SPU’s customers may take months. Additionally, several facilities that were previously believed to be seismically robust were identified as seismically vulnerable to the stronger ground motions that are now believed possible.</p>	<b>Earthquake, Landslide</b>

		<p>The water system seismic mitigation program direction was updated to reflect the 2018 seismic study findings. In addition to instituting new seismic pipeline standards for all water mains, several critical transmission pipeline locations and critical facilities were identified for seismic upgrade. Earthquake emergency preparedness and response measures are also being augmented.</p> <ul style="list-style-type: none"> <li>• Completed seismic upgrades to four terminal reservoirs.</li> <li>• Completed water system seismic vulnerability assessment and updated seismic mitigation plan.</li> <li>• Developed and instituted seismic design standards for water mains.</li> <li>• Installed earthquake resistant ductile iron pipe in areas subject to pipe damaging permanent ground displacements.</li> <li>• Wrote earthquake hazard-specific response plan for the water system.</li> <li>• Began developing post-earthquake isolation and control plan to mitigate pipeline damage effects.</li> <li>• Identified pipeline emergency repair material deficiencies and developed plan to obtain these materials.</li> <li>• Initiated Trenton, Magnolia, Riverton and Eastside Tank seismic upgrade projects.</li> <li>• Installed drains in ongoing landslide area to reduce ongoing sliding and reduce potential sudden slides in a seismic event.</li> <li>• Initiated more comprehensive/detailed study of SPU water system transmission pipelines.</li> </ul>	
<b>Dam Safety Program</b>	Planning and Administrative	<p>SPU monitors 14 dams to ensure safe operation of reservoirs and storm water detention systems. Accomplishments include:</p> <ul style="list-style-type: none"> <li>• Development of Emergency Action Plans for SPU Dams. Updated Annually, Rewritten every 5 years.</li> <li>• Tabletop and Functional Exercises with Emergency Action Plans for SPU Dams.</li> <li>• Completion of SF Tolt Dam Surveillance and Monitoring Report to FERC (annually).</li> <li>• Physical Modeling of Tolt Dam Valve 15 for extreme hydraulic conditions.</li> <li>• 2019 SF Tolt Emergency Action Plan Full-Scale Exercise.</li> <li>• 2018 SF Tolt Inundation Study (identify flooding risks).</li> <li>• 2017 SF Tolt Ring Gate Rehabilitation.</li> <li>• 2017 SF Tolt Part 12D Follow-up Investigations including Tolt Spillway Condition Assessment and Hydraulic Modeling.</li> <li>• Critical Infrastructure Protection: security enhancements at SPU facilities.</li> </ul>	Flood, Dam Failure
<b>Climate Change Adaptation Program</b>	Planning and Administrative	<p>SPU is committed to understanding and preparing for the impacts that climate change will have on our communities, infrastructure, and essential services, and to reducing the utility's contribution to climate change by: 1) Assessing potential impacts to the water supply, drainage, wastewater, and solid waste systems; tidally influenced infrastructure; and integrating this information into the decision-making process; 2) Collaborating with water utilities, academia, philanthropy, City departments and other regional public agencies, community-based organizations, and the science community locally and nationally to enhance Seattle's capacity to prepare; 3) Centering frontline communities in the planning and preparedness process.</p> <p>Assessments of potential climate change impacts by SPU include:</p>	Drought, Flood, Wildfire, Excessive Heat Events

		<ul style="list-style-type: none"> <li>• Repeated scientific study of hydrology and water supply, as well as water demand.</li> <li>• Study of extreme precipitation events and their effects on urban drainage.</li> <li>• Mapping of exposure to sea-level rise.</li> <li>• Mapping of urban heat islands and exposure to heat stress.</li> <li>• Evaluation wildfire risk in the municipal watersheds and implementation of climate-adaptive forest management.</li> </ul> <p>Measures to reduce vulnerability could include:</p> <ul style="list-style-type: none"> <li>• New infrastructure projects and modifications to existing infrastructure and facilities.</li> <li>• Changing the way infrastructure is operated to reflect changing conditions.</li> <li>• Reducing greenhouse gas emissions through fleet electrification and facility improvements.</li> <li>• Embedding climate information into asset management decision-making tools.</li> <li>• Developing early-warning systems for urban flooding.</li> <li>• Amending or implementing new regulations, codes, and policies.</li> <li>• Supporting capacity building in frontline communities.</li> </ul>	
<b>Facility Capital Improvements</b>	Financial	<p>SPU CIPs allocate funds to rehabilitate, improve, and add to SPU's capital facilities for water, drainage and wastewater, and solid waste utilities. SPU CIP Facilities Projects related to hazard mitigation include:</p> <ul style="list-style-type: none"> <li>• New Watershed Headquarters Building (2018) that serves as an incident management center for wildfire and other incidents.</li> <li>• New North Transfer Station (2016) is built to current seismic standards with emergency backup generator.</li> <li>• New Morse Lake Pump Plant (2015) to provide access to water when the lake level is low due to drought.</li> </ul>	Earthquake, Wildfire, Drought



## 5.5 Continuity of Operations Planning

One notable city-wide planning capability is the requirement that all City departments maintain Continuity of Operations (COOP) plans. These plans play a key role in mitigating the impacts of hazards by ensuring that departments are planning to minimize the potential disruption to their essential functions that may result from a disaster. Key plan information includes:

- Identification of department essential functions.
- Identification of alternate facilities that can be used if the department's normal facility is damaged or uninhabitable.
- Establishment of recovery time objectives for essential functions.
- Assignment of roles and responsibilities for continuity operations.

COOP plans are a vital part of the basic foundation that supports the City's response to and recovery from disasters. Without them, work following a major event is made much more difficult and chaotic. With them our efforts in restoring services and bringing a sense of normalcy to the City will happen quicker and minimize the long-term impacts that disasters have on communities.


## 5.6 Coordination with Community Partners

The City of Seattle is not alone in its efforts to create a more resilient community through hazard mitigation and will actively pursue strategies to ensure effective coordination and integration with the private sector, both for-profit and not-for-profit, including the County's critical infrastructure, key resources, other business and industry components, and not-for-profit organizations (sometimes called nongovernmental organizations (NGOs), including those serving special needs populations, engaged in mitigation activities. These efforts are ongoing, and the City has proactively identified enhanced coordination with community partners as a mitigation action in this update of the plan (OEM1).

**Table 8 - Community Partners by Sector**

<b>Education</b> Seattle Public Schools Seattle Colleges University of Washington Seattle University Seattle Pacific University	<b>Business and Industry</b> Greater Seattle Business Association Seattle Chambers of Commerce Port of Seattle Local Businesses
<b>Finance</b> Area Financial Institutions	<b>Healthcare</b> Area Hospitals and Healthcare Facilities
<b>Private Utilities</b> Puget Sound Energy Seattle Steam Telecommunications Providers	<b>Transportation</b> Burlington Northern Santa Fe Railroad King County Metro Seattle-Tacoma International Airport Sound Transit Washington State Ferries

## 5.7 National Flood Insurance Program Participation

 <b>FEMA</b>	<b>C2.</b> Does the Plan address each jurisdiction's participation in the NFIP and continued compliance with NFIP requirements, as appropriate? (Requirement §201.6(c)(3))
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The Seattle Department of Construction and Inspections manages the City's NFIP. The City has established and maintained eligibility in the Regular Phase of the NFIP since 1977. Seattle Municipal Code Chapter 25.06 is the floodplain management chapter.

On February 19, 2020, FEMA published a Flood Hazard Determination adopting a new Flood Insurance Rate Map (FIRM) and Flood Insurance Study (FIS) for all jurisdictions in King County, including Seattle. FEMA requires that all jurisdictions within King County adopt the new FIRM and FIS within six months which was August 19, 2020. Additionally, local FEMA officials reviewed Seattle's floodplain regulations and this review directed the minimum amendments to the Floodplain Development Regulations (SMC 25.06) to meet 44 CFR Section 60.3 (d and e) for the August 19, 2020 deadline.

In addition to adopting the new FIRM and FIS, the City of Seattle is required to have floodplain regulations that apply to the new maps that did not apply to the existing 1995 FIRM and FIS. These requirements come from the NFIP regulations in Title 44 of the Code of Federal Regulations (CFR). Specifically, 44CFR section 60.3e contains regulations for coastal high hazard flood zones, which were not identified on the 1995 maps. These coastal flood zones are designated as VE zones on the new FIRM.

Seattle Municipal Code Chapter 25.06 was amended by Council Bill Number 119832 (2020) to adopt new interim Floodplain Development Regulations and floodplain maps, and these took effect on August 23, 2020. These interim regulations will be effective for approximately six months while the City works on permanent regulations.

The most recent Community Assistance Visit by the Washington State Department of Ecology was conducted on August 6, 2008, and the City was certified as a participant in good standing in the NFIP. A new Community Assistance Visit has not yet been scheduled.

Within the Seattle city limits, there are currently twelve properties identified as Repetitive Loss and one property identified as Severe Repetitive Loss according to NFIP criteria.

## 6 MITIGATION STRATEGY

### 6.1 General

*Chapter 6 describes the City of Seattle's mitigation strategy which is the primary focus of the City's mitigation planning efforts. This strategy represents the blueprint for the approach chosen by the City to reduce or prevent losses flowing from hazards identified in the SHIVA.*

The strategy is made up of three main required components: mitigation goals and objectives, mitigation actions, and a mitigation action plan for implementation (see Figure 5). These components provide the framework to identify, prioritize, and implement actions to reduce risk from hazards.



Figure 5 - Mitigation Strategy Process



### 6.1.1 Maximizing Loss Reduction


While this mitigation strategy is meant to be comprehensive in nature and address all hazards identified in the SHIVA, the City also recognizes that there are some hazards that pose greater risk to the community in terms of potential losses both in terms of impact to life and to property and the environment. In the City of Seattle's case, the hazard identified as having the potential for the greatest impact to life and property is earthquake. This focus on reducing the City's vulnerability to seismic events is due to following drivers:

- Earthquakes are Seattle's top hazard with the highest combination of likelihood and potential destructiveness.
- Seattle's built environment, which includes vulnerable infrastructure and building types such as unreinforced masonry buildings, creates an increased risk.

The City continues to reduce vulnerability to seismic risk through the Seismic Retrofit Facilities Improvement Program. This program, managed by the Department of Finance and Administrative Services, provides the City with an opportunity to address facilities at risk and support decision making regarding seismic retrofit projects. The mitigation strategy outlined in this chapter will inform how to increase the City's resiliency and reduce the risk of downtime to critical City services post-earthquake.

In addition to a focus on areas of greatest loss, the planning process includes tracking of repetitive loss. Although Seattle does not have a large exposure to repetitive losses due to river flooding, as many communities do (see Section 5.7 on National Flood Insurance Program), as part of the annual review process the City will revisit and address any recurring loss trends that emerge across all hazards.

## 6.2 Mitigation Goals

 <b>FEMA</b>	<b>C3.</b> Does the Plan include goals to reduce/avoid long-term vulnerabilities to the identified hazards? (Requirement §201.6(c)(3)(i))
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Mitigation goals are intended to represent what the City seeks to achieve through mitigation plan implementation. The goals are general guidelines and provide a framework for identification of more detailed objectives and actions. The MWG reviewed the goals and objectives from the 2015 plan update and confirmed these goals and objectives for the 2021 update.



**GOAL 1: Protect life and safety and promote community resiliency.**

- Objective 1.1: Conduct hazard specific public outreach to vulnerable areas.
- Objective 1.2: Reduce the possibility of damages and losses resulting from disease/pandemic hazards.
- Objective 1.3: Promote community resiliency through a comprehensive approach to preparing for the impacts of a changing climate.
- Objective 1.4: Increase the resiliency of the City's food system.
- Objective 1.5: Enhance the City's response capacity.

**GOAL 2: Safeguard critical infrastructure and ensure continuity of service.**

- Objective 2.1: Ensure system redundancies and backup power are available to support key City functions.
- Objective 2.2: Ensure protection of the City's information technology infrastructure.

**GOAL 3: Protect public and private property.**

- Objective 3.1: Reduce the possibility of damages and losses to City facilities and infrastructure from earthquakes and other geo-physical hazards.
- Objective 3.2: Reduce the possibility of earthquake-related damages and casualties due to Unreinforced Masonry Buildings.
- Objective 3.3: Reduce the possibility of damages and losses resulting from weather hazards.
- Objective 3.4: Reduce the possibility of damages and losses resulting from transportation and infrastructure hazards.
- Objective 3.5: Reduce the possibility of damages and losses resulting from intentional acts of destruction.
- Objective 3.6: Ensure that City building codes reflect the latest standards in seismic safety.

**GOAL 4: Protect the natural environment and cultural and historic resources.**

- Objective 4.1: Determine the earthquake vulnerability of historic landmarked properties.
- Objective 4.2: Reduce the use of or minimize the impacts of the use of potentially hazardous substances in City operations.


**GOAL 5: Ensure a resilient economy.**

- Objective 5.1: Collaborate with local business to promote hazard mitigation.

**GOAL 6: Promote a collaborative and integrated mitigation program.**

- Objective 6.1: Incorporate hazard mitigation into other City plans and programs.
- Objective 6.2: Engage external partners in the City's mitigation planning process.

## 6.3 Mitigation Actions

 <b>FEMA</b>	<p><b>C4.</b> Does the Plan identify and analyze a comprehensive range of specific mitigation actions and projects for the [City of Seattle] being considered to reduce the effects of hazards, with emphasis on new and existing buildings and infrastructure? (Requirement §201.6(c)(3)(ii))</p>
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A mitigation action is a specific action, project, activity, or process taken to reduce or eliminate long-term risk to people and property from hazards and their impacts. Implementation of mitigation actions helps achieve the City’s mitigation goals and reduce vulnerability to threats and hazard identified in the plan. Mitigation plan regulations require the City to identify and analyze a comprehensive range of specific mitigation actions and projects to reduce the impacts identified in the City’s risk assessment.

*See Appendix A for the full text of the SHIVA.*

### **6.3.1 Review of 2015 Hazard Mitigation Actions**

As part of the mitigation strategy update, all mitigation actions identified in the 2015 plan were evaluated to determine what the status of the action was and whether any ongoing or incomplete actions should be included as actions in the 2021 plan update.

*See Table 9 for an overview of the status of all actions from the 2015 plan update.*

**Table 9 - Status of 2015 Mitigation Actions**

Actions are listed alphabetically by department acronym.

<b>Action No.</b>	<b>2015 Mitigation Action</b>	<b>Type of Action</b>	<b>Status</b>	<b>Comments</b>
<b>DON-1</b>	Conduct survey of landmarks/historic district resources that have had seismic upgrades/life safety upgrades.	Assessments and Studies	Complete	Part of the work conducted in DPD-1.
<b>DPD-1</b>	Prepare comprehensive list of unreinforced masonry buildings.	Assessments and Studies	Complete	Current department is SDCl.
<b>DPD-2</b>	Update Seattle structural codes to current standards	Plans and Regulations	Ongoing	Current department is SDCl. New seismic standards will be adopted in 1Q 2021. Updates to the structural codes happen regularly. Unclear at this point what structural code changes will be required for future updates.
<b>DPD-3</b>	Identify City-owned unreinforced masonry buildings.	Assessments and Studies	Complete	Current department is SDCl. Information will be used to prioritize retrofits of City-owned URM buildings.
<b>FAS-1</b>	Develop analytical tools to support the asset planning program.	Plans and Regulations	Complete	Completed seismic risk assessment demonstration project completed along with 2015 Seattle HMP update. The project developed a practical screening methodology that can be utilized city-wide to evaluate seismic risks, prioritize mitigation actions and reduce seismic risk over time. Carried forward in the 2021 Seattle HMP as a capability.
<b>FAS-2</b>	Seismic upgrade of Charles Street – Fleets Vehicle Maintenance.	Infrastructure/Capital Project	Incomplete	High priority but on hold pending funding. Dropped and replaced with FAS 1 - Initiate feasibility studies to determine seismic upgrade of critical facilities. This is an ongoing action to conduct assessments and studies to address the earthquake hazard.
<b>FAS-3</b>	Continue the Emergency Generator Program.	Infrastructure/Capital Project,	Ongoing	Use excess capacity on the Seattle Animal Shelter emergency generator to support other critical operational functions. This a non-structural project to address power outages related to Winter Storm, Earthquakes, etc. High priority but on hold pending funding. Electrical components will be evaluated to ensure proper sizing for capacity requirements. This determines costs for potential upgrades.



Action No.	2015 Mitigation Action	Type of Action	Status	Comments
FAS-4	Investigate and perform feasibility studies of new technologies for hazard mitigation.	Assessments and Studies	Ongoing	Dropped and replaced with FAS 2 - Install ShakeAlert technology into express elevator in SMT. This is non-structural project to be completed in next 1-3 years to address earthquake hazards. This project is ongoing through Q2, 2021. Anticipated costs to be \$15,000 and funded through operations budget. Project co-sponsored by OEM to connect city facilities to the USGS supported earthquake early warning system.
FAS-5	Seismic upgrade of South Precinct.	Infrastructure/Capital Project	Incomplete	Dropped and replaced with FAS 1 - Initiate feasibility studies to determine seismic upgrade of critical facilities. High priority but on hold pending funding.
FAS-6	Complete ASCE 31-03 Tier 2 seismic studies on (10) critical FAS facilities.	Assessments and Studies	Complete	Conducted detailed study of Charles Street Vehicle Maintenance Garage and South Precinct. Using the ASCE 31-03 methodology, CD was able to conduct more in-depth review of facilities for structural deficiencies and provided prescriptive retrofit recommendations for future capital projects. Carried forward in 2021 Seattle HMP as a Capability.
FAS-7	Conduct a workshop to share methodology and lessons learned from the seismic risk assessment demonstration project with other departments and building owners	Education and Awareness	Complete	Seismic Prioritization Workshop brought together approx. 70 stakeholders throughout the city to share and exchange mitigation projects, challenges, and successes. Participants included facility planners, asset managers, emergency managers for entities with a portfolio of multiple buildings. Carried forward in 2021 Seattle HMP as a Capability.
HSD-1	Increase the quantity and quality of food available through the emergency food system for people at risk for food insecurity. Through the 3-year investment period work with selected agencies to increase coordination, efficiency, and resiliency of the food system.	Plans and Regulations	Complete	Increased access to healthy foods via HSD and OSE contracts and partnerships, and other City departments. Examples include funding for food banks, congregate meal programs, bulk buy food ordering to purchase discounted food for distribution to food banks and meal programs, investments in farm-to-table programs, new BIPOC grassroots projects.
ITD-1	Upgrade essential network routers, firewalls, and switches for City of Seattle information technology systems.	Infrastructure/Capital Project	Incomplete	Dropped due to ongoing standard IT upgrades and no definable project
ITD-2	Add upgrades to SONET as necessary to improve capacity of existing fiber optic network.	Infrastructure/Capital Project	Incomplete	Dropped due to ongoing standard IT upgrade and no definable project
ITD-3	Upgrade telecommunications systems: Implement Unified Communications System	Infrastructure/Capital Project	Complete	Implemented new City of Seattle digital telecommunications technology



Action No.	2015 Mitigation Action	Type of Action	Status	Comments
ITD-4	Creation of citywide next generation data center site and a secondary alternate data center site for the City of Seattle.	Infrastructure/Capital Project	Complete	Stood up new data centers, West and East.
ITD-5	Implement controls on City owned desktop systems that enforce policy and prohibit installation of non-approved applications.	Infrastructure/Capital Project	Complete	Prevents employees from loading and using unauthorized software
ITD-6	Implement technology for the detection of command and control computer traffic for compromised desktop systems.	Infrastructure/Capital Project	Complete	Provides network & system monitoring, security and risk oversight for cybersecurity
ITD-7	Implement technology to routinely inventory installed, non-Microsoft applications to determine to the extent to which upgrade or patching is required. Transition the information to operations for patch/upgrade of the systems.	Infrastructure/Capital Project	Complete	Provides IT work management system to manage applications, network, systems, and devices
OEM-1	Identify opportunities for integration of community partners into the City's mitigation planning program	Education and Awareness	Ongoing	OEM worked with Community Roots, an affordable housing developer/provider, to secure FEMA funds to complete a seismic retrofit of one building in their portfolio.
OEM-2	Tailor public education messaging to emphasize earthquake preparedness and mitigation in programs delivered in liquefaction-prone areas of the city and on the OEM website.	Education and Awareness	Ongoing	Between 2015 and 2020, OEM conducted approximately 140 public education programs at locations with identified liquefaction prone areas. All of these programs included information on earthquake risk and preparedness. Ongoing but not emphasis on liquefaction areas. Hazard explorer.
OEM-3	Strengthen awareness of and focus on health systems/disease prevention in the mitigation program.	Education and Awareness	Ongoing	Public health impacts associated with fire smoke and pandemic have become more urgent based on recent events. Learnings from these incidents will shape future education and awareness efforts.
OEM-4	Encourage the chambers of commerce and other business advocates to sponsor business efforts to prepare for and mitigate the impacts of hazards. (Ref: City-wide Emergency Management Multi-Year Strategic Plan 2015 – 2017 Action Item 6.c.2.)	Education and Awareness	Complete	OEM led 277 business preparedness programs between 2015 and 2020. In 2018 OEM developed a "Preparing Your Workplace" guide with input from small businesses and promoted to chambers and business improvement areas in the city.
OSE-1	Develop Climate Preparedness Strategy	Plans and Regulations	Ongoing	Scope, policies and plans in development. Office is not resourced to work on preparedness and under-resourced for mitigation.





Action No.	2015 Mitigation Action	Type of Action	Status	Comments
<b>P&amp;R-1</b>	Assessment and seismic retrofit of the North Shops (Densmore)	Infrastructure/Capital Project	Complete	A roof project on the facility included seismic Work. North Shops building now meets current seismic code.
<b>P&amp;R-2</b>	Conduct an assessment of remaining Parks Community Centers and pools for seismic retrofit and other renovations needed for service as secondary emergency shelters.	Assessments and Studies	Complete	Study of pools completed. Bids put out on seven pool buildings. Seismic retrofits completed on two pools, and studies completed on five other pools. Seismic upgrades to Madison, structural work done at Queen Anne, damaged and rotting beams identified in assessments. Seismic retrofits will be made to roofs of pools when it is time for replacement. Community Centers: Loyal Heights, South Park, Magnolia, Hiawatha, Ballard, Ravenna Eckstein conducted seismic evaluations for these locations.  Project in design and planned to begin construction at Magnolia and Hiawatha CC. Queen Anne and Madison pools are now safer and less life safety risk. More in line with current seismic code. Magnolia and Hiawatha CC will now meet current seismic code.
<b>P&amp;R-3</b>	Identify illicit/improper drainage systems by private residents, impacting steep slope areas (in conjunction with SDOT and SPU).	Plans and Regulations Education and Awareness	Ongoing	More work needed. No active projects and no illicit connections fixed. SPR and SPU coordinating on project in Deadhorse Canyon to potentially address drainage impacting steep slopes. Coordination ongoing between departments. Carried forward to 2021 Seattle HMP.
<b>SC-1</b>	Design and install a dedicated power supply and emergency generator and transfer switch in the Seattle Central Armory	Non-Structural Mitigation Measures	Incomplete	No activity on this project since fail to receive a grant. Carried forward to 2021 Seattle HMP.
<b>SC-2</b>	Conduct an electrical assessment/study to determine the best options for installing generators for in key facilities.	Assessments and Studies	Ongoing	need emergency generator for CUP and replace existing generator for Playhouse, which is obsolete, and no replacement parts are available. Completed campus wide preliminary electrical assessment.
<b>SC-3</b>	Reroof and make minor electrical, plumbing and storage improvements to the Seattle Center Pavilion to allow it to be used for sheltering purposes in inclement weather and other hazard conditions.	Infrastructure/Capital Preparedness and Response	Incomplete	Project dropped. Building demolished as part of new Arena.
<b>SCL-1</b>	SCL Systems Operations Center seismic retrofit design	Infrastructure/Capital Project	Complete	2018: Current estimate is \$5 million. 2019 - fully designed and put out to bid. Construction in 2020.
<b>SCL-2</b>	Seismic review of vaults and substations to update 1993 study	Assessments and Studies	Incomplete	Determine if this study still needed. Retrofit design work at individual substations is ongoing.

<b>Action No.</b>	<b>2015 Mitigation Action</b>	<b>Type of Action</b>	<b>Status</b>	<b>Comments</b>
<b>SCL-3</b>	Substation seismic upgrade	Infrastructure/Capital Project	Incomplete	In year 4 of a 15-year process to re-do base isolation. Carried forward in 2021 Seattle HMP as an Action.
<b>SCL-4</b>	Hazard tree mitigation (vegetation management) near SCL Right-of-Way	Non-Structural Mitigation Measures	Ongoing	Required regular maintenance work. Carried forward in 2021 Seattle HMP as a Capability.
<b>SCL-5</b>	Provide seismically designed storage racks for critical parts and supplies	Non-Structural Mitigation Measures	Incomplete	No recorded progress to date.
<b>SCL-6</b>	Secure tall furniture at SCL facilities	Non-Structural Mitigation Measures	Incomplete	No recorded progress to date.
<b>SCL-7</b>	Map cell towers and identify feeders	Assessments and Studies	Incomplete	Currently no capacity to do this project.
<b>SCL-8</b>	Remove/sample PCB transformers	Natural Systems Protection	Ongoing	2019 - part of normal business practice; consider moving to capability section
<b>SCL-9</b>	Preposition supplies needed for restoration efforts at secure locations	Preparedness and Response	Ongoing	2019 - part of normal business practice; consider moving to capability section
<b>SCL-10</b>	Install impact recorders at substations	Non-Structural Mitigation Measures	Incomplete	Need for action to be determined.
<b>SCL-11</b>	Conduct study of downstream consequences from dams to update and improve inundation maps	Assessments and Studies	Complete	Dam Safety Program produced new dam failure inundation models for federally licensed dams; notification and evacuation application tested in 2019. Provides more detailed illustration of risk and timing of inundation for public notification and evacuation planning.
<b>SCL-12</b>	Retrofit electrical transmission towers in Snohomish County against landslide damage.	Infrastructure/Capital Project	Incomplete	2018: Project designed, and application submitted for FEMA funding. 2019: Project pending funding. Currently an alternate for HMGP funding.

Action No.	2015 Mitigation Action	Type of Action	Status	Comments
<b>SDOT-1</b>	Bridge Seismic Retrofit Phase III	Infrastructure/Capital Project	Ongoing	Seismic retrofits for 16 bridges were included Move Seattle Levy. 2 bridge - Construction completed for Cowen Park Bridge, Howe St. Bridge 2 bridges - Design completed & waiting for approval to AD and go to construction: SW Andover Pedestrian Bridge, 8th Ave. NW/NW 133rd St. Bridge 13 bridges - Seismic recommendations reports completed & design and construction deferred due to insufficient funding: Fremont Bridge, Ballard Bridge, Delridge Way Pedestrian Bridge, 15th Ave. NE/NE 105th St. Bridge, 1st Ave. S. Viaduct/Argo Bridge, 4th Ave. S. Viaduct/Argo Bridge, 4th Ave. S. Bridge (Main to Seattle Blvd), McGraw St. Bridge, W., Admiral Way N. Bridge, Admiral Way S. Bridge, N. 41st Pedestrian Bridge, 15th Ave. NW/Leary Way Bridge
<b>SDOT-2</b>	Conduct a Transportation Operations Center implementation assessment to combine the Traffic Management Center (TMC), dispatch, construction coordination, customer inquiry and call center, and emergency operations functions into a 24/7 work center.	Assessments and Studies	Complete	Assessment is complete in 2016. Department readiness and response communications have been streamlined and improved. Response times improved. Incidents in the right of way cleared more efficiently. Carried forward in 2021 Seattle HMP as a Capability.
<b>SDOT-3</b>	Traffic Management Center (TMC) expansion to 24/7 operations (TMC expansion construction, FTE).	Infrastructure/Capital Preparedness and Response	Complete	SDOT's TOC continues to be a critical tool in managing and responding to the City's transportation network. Other agencies such as WSDOT and KC Metro rely on the TOC for regional coordination efforts. Carried forward in 2021 Seattle HMP as a Capability.
<b>SDOT-4</b>	Conduct a security threat assessment of the Seattle rail corridor to identify risk associated with new volume of oil train movement.	Assessments and Studies	Incomplete	While the risk still exists, SDOT does not own the assets and is a support agency. With the layers of regulations related to the rail system, and no authority, SDOT's efforts would be applied to other projects.
<b>SDOT-5</b>	Implement Seattle rail corridor access control measures (fencing, security cameras, improved right of way management).	Non-Structural Mitigation Measures	Incomplete	While the risk still exists, SDOT does not own the assets and is a support agency. With the layers of regulations related to the rail system, and no authority, SDOT's efforts would be applied to other projects.
<b>SDOT-6</b>	Conduct a Seattle earthquake damage spot arterial repair planning/exercise.	Preparedness and Response	Incomplete	The need to test post-earthquake arterial spot repairs still exists. Carried over to 2021 Seattle HMP as an Action.
<b>SDOT-7</b>	Separation of rail and arterial right-of-way for S. Lander Street Grade.	Infrastructure/Capital Project	Complete	Improved reliability of a key east/west arterial in the SODO area. Eliminated the potential for pedestrian/vehicle and train collisions.

<b>Action No.</b>	<b>2015 Mitigation Action</b>	<b>Type of Action</b>	<b>Status</b>	<b>Comments</b>
<b>SPU-1</b>	Develop a plan to protect the drinking water system from earthquakes.	Plans and Regulations	Complete	The completed seismic study provides a good understanding of how the drinking water system will be impacted by a catastrophic earthquake. Based on these findings, SPU has developed a short- and long-term plan, for the next 50 years, that provides a steady path for making significant investments to improve seismic resilience.
<b>SPU-2</b>	Improve Thornton Creek Confluence to reduce upstream flooding and downstream flows.	Infrastructure/Capital Project Natural Systems Protection	Complete	The project removed an undersized culvert, restored the creek channel and provided increased flood storage by removing four homes and 2 acres of fill, which allowed for reconnection of 2.5 acres of floodplain habitat.
<b>SPU-3</b>	Accelerate flooding and sewer backup prevention projects in the Broadview and South Park neighborhoods.	Infrastructure/Capital Project	Incomplete	The South Park Flood Control Pump Station when complete will facilitate drainage to the Duwamish when the tide is high, reducing flooding. The pump station project is in construction and is scheduled to be complete by end of 2021. The South Park Conveyance Project partners with SDOT to improve streets with pavement and provide drainage infrastructure to convey flows safely to the pump station; this project will complete design in 2021 and will be in construction for two years, completing in 2023. The 12 <sup>th</sup> Ave NW Basin Drainage Improvement project builds drainage infrastructure to address priority flooding areas in the Broadview area. Design completes in 2021 and construction will continue through 2022. Carried forward in this 2021-26 HMP as an action item.
<b>SPU-4</b>	Create a comprehensive emergency plan for maintaining and restoring essential services in emergencies.	Plans and Regulations	Complete	The CEMP was prepared by SPU Emergency Management to provide planning and program guidance for implementing emergency management programs and plans. The CEMP assists SPU to maintain the capability to provide critical services during an emergency or large-scale disaster.
<b>SPU-5</b>	Prepare for water supply and utility system threats that may occur from climate change.	Plans and Regulations Natural Systems Protection	Ongoing	A climate change analysis for the City of Seattle water supply was completed for the 2019 Water System Plan. Progress and next steps are detailed in the plan.

### 6.3.2 2021 Mitigation Actions

In order to achieve the mitigation goals identified above, the City has identified a comprehensive series of mitigation objectives and supporting actions that are focused on reducing vulnerability and maximizing loss reduction. The actions can typically be broken out into the following types of activities:

- **Plans and Regulations.** Regulatory actions or planning processes that result in reducing vulnerability to hazards.
- **Assessments and Studies.** Actions taken to better understand the potential impacts of identified hazards. An example would be seismic studies of City facilities.
- **Infrastructure/Capital Projects.** Actions taken to modify existing buildings or structures to protect them from a hazard.
- **Non-Structural Mitigation Measures.** Physical actions taken that don't include structural modifications. An example would be efforts to secure furniture or installation of backup generators.
- **Natural Systems Protection.** Actions that, in addition to minimizing hazard losses, preserve or restore the functions of natural systems.
- **Education and Awareness.** Actions taken to inform and educate residents, elected officials, and property owners about hazards and potential ways to mitigate them.

All mitigation actions identified in the plan are addressed in the Mitigation Implementation Plan provided in Section 6.5. The actions include both interim- and long-term strategies for reducing vulnerability to hazard.

### 6.3.3 2021 Mitigation Actions by Hazard

The 47 mitigation actions identified in the 2021 update of the Seattle HMP are intended to address natural, technological and human-caused hazards. The HMP is comprehensive in addressing all of the hazards identified in the SHIVA, and the inclusion actions to address multiple hazards.

*See Table 10 which identifies which hazards are addressed by each mitigation action.*

Table 10 - Mitigation Actions by Hazard

Hazard <i>listed in order of ranking in SHIVA</i>	FAS			HSD	ITD	OEM				OPCD	OSE	SCL							SDCI	SDOT					SPL	SPR						SPU																				
	1	2	3	1	1	1	2	3	4	1	1	1	2	3	4	5	6	7	1	1	2	3	4	5	1	1	2	3	4	5	6	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17				
All Hazards				X	X	X	X			X														X																												
Earthquakes	X	X	X					X	X			X	X	X	X	X	X	X	X	X	X	X	X		X			X				X	X	X	X	X	X				X	X	X		X	X		X				
Snow and Ice Storms	X																	X							X					X					X																	
Windstorms	X																	X											X														X		X							
Power Outages	X																	X		X													X	X											X							
Cyber-attack/ Disruption																																																				
Landslides																														X	X					X					X							X				
Disease Outbreaks																																																				
Flooding										X																	X		X			X			X		X	X		X		X	X			X	X					
Excessive Heat Events										X															X					X							X															
Tsunamis and Seiches																															X				X																	
Infrastructure & Structural Failures										X										X	X	X	X				X	X			X	X									X							X				
Fires, Including Wildfire																																						X					X									
Transport Incidents																			X	X																																
Water Shortages																											X				X									X		X		X		X						
Social Unrest																																																				
Attacks																																																				
Haz Mat Incidents																										X																										
Volcano Hazards																																																				

## 6.4 Evaluating and Prioritizing Mitigation Actions

Once mitigation actions were identified, the MWG, and other key stakeholders went through the exercise of evaluating and prioritizing each action to determine which actions are most suitable for the City to implement. A Mitigation Action Worksheet was developed for each action that included the following information:

- Description of the action.
- Action status.
- Type of action.
- Mitigation goals supported by the action.
- Lead and supporting departments.
- Timeline for implementation and expected life of the action.
- Hazards addressed by the action.
- Anticipated cost and funding source.
- Race and Social Justice Focus Areas.
- Location description.
- Geographic area (citywide, district, neighborhood) that will benefit from this action.

*See Appendix D for a sample worksheet, worksheet instructions, and completed worksheets for all actions identified in the plan.*

### 6.4.1 STAPLEE Analysis

In addition to the information developed above, each action was self-evaluated using STAPLEE criteria as described in Table 11. Evaluators were asked to rate each STAPLEE criteria to come up with a total score that determined the relative suitability of each action.

**Table 11 - STAPLEE Criteria**

STAPLEE Criteria	Evaluation Rating
S: Is it Socially acceptable?	High Medium Low
T: Is it Technically feasible and potentially successful?	
A: Does the responsible agency/department have the Administrative capacity to execute this action?	
P: Is it Politically acceptable?	
L: Is there Legal authority to implement?	
E: Is it Economically beneficial?	
E: Will the project have either a neutral or positive impact on the natural Environment? (score a 3 if positive impact, 2 if neutral impact)	

### 6.4.2 Mitigation Effectiveness Analysis

In addition to the STAPLEE analysis, MWG members rated each action on criteria for effectiveness in achieving loss reductions or other City goals listed in Table 12.

**Table 12 - Mitigation Effectiveness Criteria**

Criteria	Evaluation Rating
Will the implemented action result in lives saved?	High Medium Low
Will the implemented action result in a reduction of disaster damage?	High Medium Low
Will the action provide multiple community benefits beyond mitigation?	High Medium Low
Will the action involve collaboration between City departments and/or the community?	High Medium Low
Will the action reduce hazard vulnerability for BIPOC communities?	High Medium Low

The STAPLEE and Mitigation Effectiveness ratings for each mitigation action identified in this plan will serve as one of the tools the City uses in prioritizing what mitigation actions it wishes to pursue during the next planning cycle. Of course, actions may also become a higher priority based on available funding, emerging hazards, or because they align with priorities identified in other planning efforts.

FEMA regulations do not require a formal cost-benefit analysis for hazard mitigation plans; however, a formal cost-benefit analysis of mitigation measures is required in order to be approved for Hazard Mitigation Grant Program funding. Therefore, a more formal cost-benefit analysis will be conducted as a component of any future mitigation grant applications.

## 6.5 2021-2026 Mitigation Implementation Plan

The mitigation implementation plan (Table 13) lays the groundwork for how the mitigation plan will be incorporated into existing planning mechanisms and how the mitigation actions will be prioritized, implemented, and administered by the City. The implementation plan includes both short-term strategies that focus on planning and assessment activities, and long-term strategies that will result in ongoing capability or structural projects to reduce vulnerability to hazards.

The “Loss Avoidance Rating” shown in Table 13 is derived from two mitigation effectiveness criteria:

- Will the implemented actions result in lives saved?
- Will the implemented action result in a reduction of disaster damage?

Each project was scored as follows:

- High + High = score of 6





- High + Medium = score of 5
- Medium + Medium = score of 4
- High + Low = score of 3
- Medium + Low = score of 2
- Low + Low = score of 1

*See Appendix D for more details. It contains Mitigation Action Worksheet instructions and detailed Mitigation Action Worksheets for the 47 actions listed in Table 13.*

**Table 13 - 2021-2026 Mitigation Implementation Plan (by Department)**

Lead Depart/ Action #	2021-2026 Mitigation Action	Action Status	Type of Action	Goals Supported	Supporting Departments	Timeline	Anticipated Cost	Funding Available	Loss Avoidance Rating
<b>FAS1</b>	Modify the Seattle Animal Shelter electrical system to accommodate excess power from emergency generator.	New	Non-Structural Measures	Life and Safety Property Protection	Seattle Animal Shelter and Capital Development	3-5 years	TBD	No	2
<b>FAS2</b>	Seismic Retrofit Facilities Improvement Program	Potential	Assessments and Studies	Life and Safety	N/A	5 years +	TBD	No	5
<b>FAS3</b>	Install ShakeAlert Technology into SMT Elevators.	New	Non-Structural Measures	Life and Safety Critical Infrastructure Protection Property Protection	Facility Operations	1-3 years	\$15,000	Yes	2
<b>HSD1</b>	Develop a strategic feeding plan to increase capacity for emergency feeding.	New	Plans and Regulations	Life and Safety	OSE, DON	1-3 years	TBD	Anticipated	2
<b>ITD1</b>	Create stand-alone Communication Site on Wheels to provide localized communications via radio, cellular, Wi-Fi and Point to Point Network.	New	Non-Structural Measures	Life and Safety	SCL, SDOT, SFD, SPD, SPU, FAS, SP&R, HSD, SDCI	1-3 years	\$ 600,000	No	6
<b>OEM1</b>	Expand partnerships for community-led mitigation projects.	New	Plans and Regulations	Life and Safety Property Protection Natural Resource Protection Resilient Economy	DON, OH	3-5 years	TBD	No	4
<b>OEM2</b>	Undertake an analysis to better integrate equity into hazard mitigation program.	New	Assessments and Studies	Integrated Planning		3-5 years	TBD	No	2
<b>OEM3</b>	Update Home Retrofit Education Program materials and guidance to reflect latest changes in design and permitting.	Existing	Education and Awareness	Life and Safety Property Protection	SDCI	3-5 years	TBD	No	5
<b>OEM4</b>	Ongoing support for URM Retrofits	Existing	Plans and Regulations	Life and Safety Property Protection		1-3 years	TBD	No	6



Lead Dept/ Action #	2021-2026 Mitigation Action	Action Status	Type of Action	Goals Supported	Supporting Departments	Timeline	Anticipated Cost	Funding Available	Loss Avoidance Rating
OPCD1	Provide policy guidance regarding resilience, climate adaptation, and hazard mitigation in the Comprehensive Plan Update.	New	Plans and Regulations	Life and Safety Integrated Planning Critical Infrastructure Protection Property Protection Resilient Economy Natural Resource Protection	All Depts	1-3 years	\$ 500,000	Anticipated	1
OSE1	Duwamish Valley Program Resilience and Adaptation Planning will study potential for creating a "resilience district" and the construction of protective multi-purpose sea-level rise infrastructure.	New	Assessments and Studies	Life and Safety Critical Infrastructure Protection Property Protection Resilient Economy Integrated Planning	OPCD, SPR, SPU, SDOT, OH, MO	< 1 year	\$600,000	Yes	3
SCL1	SCL Systems Operation Center Seismic Retrofit	Existing	Infrastructure/ Capital Projects	Life and Safety Critical Infrastructure Protection Property Protection Resilient Economy		1-3 years	\$ 2,700,000	Anticipated	4
SCL2	Seismic Review of Vaults & Substations, an update of a 1993 study.	Existing	Assessments and Studies	Life and Safety Critical Infrastructure Protection		1-3 years	\$ 200,000	Anticipated	4
SCL3	Seismic upgrade of 14 substations.	Existing	Infrastructure/ Capital Projects	Life and Safety Critical Infrastructure Protection		3-5 years	\$ 8,400,000	Yes	4
SCL4	Non-structural Mitigation at SCL Facilities to install seismically designed storage racks for critical parts and supplies, and secure furniture.	Existing	Non-Structural Measures	Life and Safety Critical Infrastructure Protection Property Protection		1-3 years	TBD	Yes	3
SCL5	Install Seismic Impact Recorders at Substations.	Existing	Non-Structural Measures	Life and Safety Critical Infrastructure Protection		1-3 years	TBD	No	3
SCL6	Map Cell Towers & Identify Feeders.	Existing	Assessments and Studies	Critical Infrastructure Protection		1-3 years	TBD	Yes	3
SDCI1	Ongoing Support for URM Retrofits to update URM inventories and proposed technical standard.	Existing	Plans and Regulations	Life and Safety Property Protection		3-5 years	TBD	Yes	6



Lead Depart/ Action #	2021-2026 Mitigation Action	Action Status	Type of Action	Goals Supported	Supporting Departments	Timeline	Anticipated Cost	Funding Available	Loss Avoidance Rating
SDOT1	Seismically retro fit a 66-year old timber and steel seawall that support the roadway and sidewalk of N. Northlake Way.	New	Infrastructure/Capitol Projects	Life and Safety Critical Infrastructure Protection Property Protection Natural Resource Protection	SDCI	1-3 years	\$ 20,000,000	Anticipated	3
SDOT2	Strengthen and seismically upgrade the West Seattle High Bridge.	New	Infrastructure/Capitol Projects	Life and Safety Critical Infrastructure Protection Property Protection Resilient Economy Integrated Planning	WSDOT, US Coast Guard, Port of Seattle, NW Seaport Alliance	1-3 years	\$ 47,000,000	Anticipated	6
SDOT3	Post-Earthquake Arterial Damage Spot Repair Planning and Exercise.	New	Education and Awareness	Life and Safety Critical Infrastructure Protection Resilient Economy Property Protection		< 1 year	\$80,000	No	4
SDOT4	Bridge Seismic Retrofit Program has identified 14 bridges for retrofits. 10 bridges are funded by Move Seattle Levy, and 4 bridges are in need of funding.	Existing	Infrastructure/Capital Projects	Life and Safety Critical Infrastructure Protection Resilient Economy		1-3 years	\$37,260,000	Yes	5
SDOT5	Vision Zero is a plan to reduce speed limits and add pedestrian signals to reduce ped/vehicle collisions which have increased during the pandemic.	Existing	Plans and Regulations	Life and Safety Critical Infrastructure Protection	SFD, KC, WSDOT	3-5 years	\$ 75,000,000	Yes	5
SPL1	Seismic Retrofit of three historic libraries-Green Lake, U-District and Columbia City.	New	Infrastructure/Capital Projects	Life and Safety Critical Infrastructure Protection Property Protection		3-5 years	\$13,800,000	Yes	6
SPR1	Improvements to community centers to ensure they can serve as Clean Air and Cooling Centers .	Existing	Infrastructure/Capital Projects		SCL, OEM, HSD	3-5 years	TBD	Anticipated	3
SPR2	Mitigate Impacts to Park Property and Assets Resulting from Flooding, High Tides and Sea Level Rise.	Existing	Assessments and Studies	Property Protection Natural Resource Protection	SPU	< 1 year	TBD	Yes	2



Lead Depart/ Action #	2021-2026 Mitigation Action	Action Status	Type of Action	Goals Supported	Supporting Departments	Timeline	Anticipated Cost	Funding Available	Loss Avoidance Rating
SPR3	Seismic Retrofits of SPR Programmed Buildings	Existing	Infrastructure/ Capital Projects	Life and Safety Property Protection Natural Resource Protection	Office of Emergency Management/ Facilities and Administrative Services	<1 year	\$10,000,000 - \$20,000,000	Anticipated	6
SPR4	Mitigation of Potential Damage to Environmentally Critical Areas from weather-related hazards.	Existing	Infrastructure/ Capital Projects	Critical Infrastructure Protection Property Protection Integrated Planning	Seattle Parks and Recreation Facilities.	3-5 years	\$ 5,000,000	No	5
SPR5	Steep Slope Restoration of Coastal and Inland Areas	Existing	Natural System Protection	Natural Resource Protection Life and Safety Property Protection	Finance and Performance Management/ Green Seattle Partnership	< 1 year	\$ 6,000,000	No	3
SPR6	Mitigate Impacts to Park Property and Assets Resulting from Water Shortage by maintaining and strategically updating the water shortage contingency plan and implementing water reuse.	New	Natural System Protection	Natural Resource Protection	SPU	< 1 year		Yes	2
SPU01	Evaluate Wastewater Pump Stations for flooding and sea-level rise as they are upgraded or replaced. Potentially impacted pump stations will be modified to improve reliability and increase capacity.	New	Assessments and Studies	Critical Infrastructure Protection		1-3 years	\$ 100,000	Yes	2
SPU02	Seismic Upgrade and Rehabilitation for Eastside Reservoir in Bellevue and Riverton Reservoir in SeaTac.	New	Infrastructure / Capital Projects	Life and Safety Critical Infrastructure Protection		3-5 years	\$ 24,000,000	Anticipated	5
SPU03	Augment Water Pump Station with Emergency Generators.	New	Infrastructure / Capitol Projects	Critical Infrastructure Protection		3-5 years	\$ 1,000,000	Anticipated	3
SPU04	Magnolia Elevated Tank and Trenton Standpipes Recoating and Seismic Upgrade.	New	Infrastructure / Capitol Projects	Life and Safety Critical Infrastructure Protection		3-5 years	\$ 23,000,000	Anticipated	3



Lead Depart/ Action #	2021-2026 Mitigation Action	Action Status	Type of Action	Goals Supported	Supporting Departments	Timeline	Anticipated Cost	Funding Available	Loss Avoidance Rating
SPU05	Complete the Shape Our Water Integrated Plan for drainage and wastewater systems that will assess impacts of flooding, sea-level rise, earthquakes, and identify investments to improve system and community resilience. Project implementation will follow plan completion.	New	Plans and Regulations	Integrated Planning Resilient Economy Natural Resource Protection Property Protection Life and Safety Critical Infrastructure Protection	SDOT, SPR, OPCD, DON, King County, community, and private sector stakeholders	1-3 years and beyond for implementation	TBD	Yes	5
SPU06	Install Piezometers / leachate extraction wells on east slope of Kent Highland Landfill to monitor the stability of the slope and mitigate slope failure risk.	New	Plans and Regulations	Life and Safety Critical Infrastructure Protection	WADOE, USEPA	1-3 years	\$ 200,000	Yes	5
SPU07	Implement flooding and sewer backup projects in Broadview, South Park and Beacon Hill neighborhoods.	Existing	Infrastructure/ Capital Projects	Property Protection	SDOT	Immediate	\$ 20,000,000	Yes	3
SPU08	Add system capacity and resilience to climate change impacts, and decrease polluted runoff, through funding community-identified green stormwater infrastructure projects.	New	Infrastructure/ Capital Projects	Property Protection Natural Resource Protection Integrated Planning		3-5 years	\$ 20,000,000	Yes	2
SPU09	Develop a Wildfire Strategic Plan to study potential wildfire impacts on water supply watersheds, identify, and implement mitigation strategies.	New	Plans and Regulations/Ca pital Projects	Life and Safety Critical Infrastructure Protection Natural Resource Protection Resilient Economy Integrated Planning	USFS, Washington State University, University of Idaho, SCL	1 year for the plan and beyond for implementation	TBD	Yes for Plan, TBD for mitigation strategies	5
SPU10	Perform seismic assessment of Cascade Dam and design seismic upgrade.	New	Assessments and Studies	Life and Safety Critical Infrastructure Protection Property Protection Natural Resource Protection Resilient Economy		0-5 years and beyond	TBD	Anticipated	6
SPU11	Begin implementing short- and long-term Water System Seismic Upgrade Plan to improve water system seismic resilience.	Existing	Infrastructure/ Capital Projects	Life and Safety Critical Infrastructure Protection Property Protection Resilient Economy Integrated Planning		0-5 years and beyond	TBD	Anticipated	6




Lead Depart/ Action #	2021-2026 Mitigation Action	Action Status	Type of Action	Goals Supported	Supporting Departments	Timeline	Anticipated Cost	Funding Available	Loss Avoidance Rating
SPU12	Design of the Landsburg Flood Passage Project that will allow flood waters and large woody debris to pass around the dam to prevent dam failure.	New	Infrastructure/ Capital Projects	Life and Safety Critical Infrastructure Protection Property Protection Natural Resource Protection		1-5 years	TBD	Anticipated	6
SPU13	City acquired a 0.9 acre residential parcel to create the Lake City Floodplain Park to restore and reconnect floodplain in the North Branch of Thornton Creek. When complete it will contain floodplain and upland habitat and increase access to open space for the Lake City community.	New	Natural System Protection Infrastructure/ Capital Projects	Life and Safety Property Protection Natural Resource Protection Integrated Planning	SPR, Mid Sound Fisheries Enhancement Group	1-3 years	TBD	Anticipated	2
SPU14	Cedar Falls Power Service Upgrade that will improve quality, capacity, and redundancy of electrical service for the Cedar River Watershed. Phase I of a potential 2 phase project.	New	Natural System Protection	Critical Infrastructure Protection	SCL	1-3 years and beyond	\$12,000,000	Yes	5
SPU15	Comprehensive Peak Flow Program to replace undersized culverts in the drinking water watersheds to account for flood events and near-term climate change.	New	Infrastructure/ Capital Projects	Critical Infrastructure Protection Natural Resource Protection		1-5 years and beyond	\$2,000,000	Anticipated	2
SPU16	Study and design of a project to increase storage capacity for the Chester Morse Reservoir during drought conditions and provide new opportunities to lower the reservoir more quickly during flood conditions in the fall and winter.	New	Infrastructure/ Capital Projects	Critical Infrastructure Protection Property Protection Natural Resource Protection	SCL	1-5 years	TBD	Anticipated	4
SPU17	Design and repair/replace of the Tolt Dam Spillway used to release water from the Tolt Reservoir in flood and other emergency conditions.	New	Infrastructure/ Capital Projects	Critical Infrastructure Protection Property Protection Natural Resource Protection	SCL	1-5 years	\$9 –22,000,000	Yes	6

## 7 PROGRAM IMPLEMENTATION

*Chapter 7 provides an overview of the overall strategy for plan maintenance and outlines the method and schedule for monitoring, updating, and evaluating the plan. The chapter also discusses incorporating the plan into existing planning mechanisms and how to address continued public involvement.*

The Seattle HMP is intended to be a “living” document that will help inform all interested parties about the City of Seattle’s natural hazard mitigation policies and projects. It will be reviewed and updated on a regular basis. The mitigation strategy will guide for City of Seattle departments in determining projects and priorities for FEMA assistance and other mitigation funding.


### 7.1 Plan Adoption

 <b>FEMA</b>	<b>E1.</b> Does the Plan include documentation that the plan has been formally adopted by the [Seattle City Council]? (Requirement §201.6(c)(5))
---	--

44 CFR §201.6(c)(5) requires that the Seattle HMP be formally adopted by the Seattle City Council. City Council formally adopted the 2015 update of the Seattle HMP on [INSERT DATE]. This plan was approved by FEMA on [INSERT DATE].

*See the front matter of this plan for adoption and approval materials.*

### 7.2 Keeping the Plan Current

 <b>FEMA</b>	<b>A6.</b> Is there a description of the method and schedule for keeping the plan current (monitoring, evaluating and updating the mitigation plan within a 5-year cycle)? (Requirement §201.6(c)(4)(i))
---	--

#### 7.2.1 Monitoring and Evaluating the Plan

OEM is responsible for coordinating annual review of the Seattle HMP and making appropriate revisions. On an annual basis, OEM will gather monitoring information and convene the MWG to review the plan to ensure that all information is current.

Prior to the MWG meeting, departments will track and report the following information on those mitigation actions for which they are the lead:

- Mitigation accomplishments for completed actions, including documentation of actual losses avoided and benefits achieved.
- Overall status of mitigation actions, including justification for any cancelled actions.
- Status of funding for mitigation actions, such as the CIP, levies, and other grant funding.

The MWG will meet to consider the following and determine if any interim changes to the Seattle HMP are needed:

- Emerging or increasing hazards (e.g., wildfire smoke), damage trends and repetitive losses.
- Identification of new mitigation needs and potential new mitigation opportunities and actions.
- Changes in membership to the MWG.
- After-Action Reports or lessons learned reports issued to inform what new initiatives or actions should be added, or how to integrate mitigation into any recovery efforts. A specific mitigation



question was added to the After Action Report survey to capture mitigation actions identified from real world events and exercises.

- Regional perspectives from external partners.
- Major updates of long-range policies and plans underway where mitigation principles or actions can be more fully integrated (e.g., comprehensive plan, climate action plan, capital improvement plan, major levy funding plans, zoning and building codes).
- Potential community partnerships and investments in community-led projects.
- Supporting OEM's equity analysis of mitigation program and actions, as well as learning from relevant analyses from other equity initiatives such as OPCD Equitable Development Initiative, Risk of Displacement Indicators and OSE Environmental Justice Committee.

The results of the annual review will be compiled into an Annual Mitigation Status Report that will be made available to key stakeholders and the public.

### 7.2.2 *Updating the Plan*

Every five years, OEM and the MWG will conduct a revision of the plan based on a thorough evaluation and community engagement. The MWG will develop an updated set of proposed mitigation actions based on emerging needs and the ongoing monitoring and evaluation of the plan and its component actions. The resulting draft plan will be made available for public comment. After the public comments have been reviewed and adjudicated, the plan will be approved by the groups identified in External Plan Review and Approval Summary table in the City of Seattle Emergency Management Planning Policy.

Work on the next update of the Seattle HMP will begin in 2025 and will be adopted in 2026. OEM intends to use the process described in Section 2.0 of this document with some modifications. The future process may include more in-person meetings and public outreach that was not possible in 2020 because of the pandemic.

## 7.3 Continued Public Involvement



**A5.** Is there discussion of how the [City of Seattle] will continue public participation in the plan maintenance process? (Requirement §201.6(c)(4)(iii))

Public involvement is a key component of the plan implementation and update process. The City will prepare and make available via the OEM website an Annual Mitigation Status Report providing an update on the implementation of the current Seattle HMP. OEM's monthly newsletter offer additional opportunities to highlight progress of individual mitigation projects.

The DMC is a broad stakeholder group of senior City staff, emergency management professionals and engaged community volunteers that support the City's Emergency Management Programs. This group is another way to raise awareness or get feedback on mitigation projects and issues on a continuous basis.

OEM has included a mitigation action to expand partnerships between the City and community-based organizations to plan, fund and implement mitigation projects. Implementation will involve targeted outreach to high priority community service organizations. In coming years, the City will make investments in more community-led projects. This could lead to increased level of community involvement in mitigation projects and programs.



#### RECORD OF CHANGES

Change Number	Section	Date of Change	Individual Making Change	Description of Change

#### APPROVALS AND ADOPTION RECORDS

Approval/Adoption Body	Date of Action	Notes

## APPENDIX A SHIVA

Seattle Hazard Identification and Vulnerability Assessment

# SEATTLE HAZARD IDENTIFICATION AND VULNERABILITY ANALYSIS



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## 1. EXECUTIVE SUMMARY

Seattle is a vibrant city, yet it faces hazards that threaten the very tissue of our community. Seattle can reduce hazard impacts and this document is where we start. The Seattle Hazard Identification and Vulnerability Analysis (SHIVA) identifies Seattle’s hazards and examines their consequences so we can make smart decisions about how best to prepare for them.

This document is the foundation for the City of Seattle’s disaster planning and preparedness activities. The City hopes the rest of the Seattle community will use it in the same manner. The Seattle Hazard Identification and Vulnerability Analysis (SHIVA) is a community document. The Office of Emergency Management is constantly collecting information from stakeholders and partners to develop and maintain it. The SHIVA follows the City of Seattle Emergency Management Planning Policy and follows the development and maintenance process for external plans described therein.

### 1.1 Major Findings

- Earthquakes are Seattle’s riskiest hazard. Seattle is susceptible earthquakes ranging from ones like the 2001 Nisqually Earthquake to the one that devastated northern Japan in 2011.
- Snow and ice storms rank second. Individually they are less damaging than a powerful earthquake, but they are much more frequent.
- Cyber Attacks and Disruptions have been broken out from infrastructure failures and added as their own hazard because of our increasing dependence on networked computers to control critical infrastructure and recent successful attacks on local government.
- A combination of resource concentration, geography and lack of reserve capacity in our transportation system will make access to critical resources a challenge in a disaster.
- Our most vulnerable people live toward the outskirts of the city and along the Rainier Valley.
- Climate change will broadly affect most of the hazards Seattle experiences.

### 1.2 Intended Audience and Use

The SHIVA is for anyone who wants to decrease the threat disasters pose to the Seattle community. Residents, employees, visitors, volunteers, government workers, academics, business owners, service providers and infrastructure managers can all benefit from the SHIVA.

Hazard researchers have done tremendous work in the Seattle area. The SHIVA summarizes the best available Seattle-area hazard research and combines it with information about Seattle’s social and physical environment to show how hazards affect our city. These effects have been evaluated with a set of metrics and scored. The results are given in Table 1 – Hazard Rankings. Use it as a starting place.

### 1.3 Document Structure

The SHIVA contains hazard profiles bookended by a hazard summary, community profile and an emerging hazards section at the front and a bibliography and endnotes at the back. It starts with a hazard summary that includes the Hazard Ranking. This section is the ‘one stop’ for anyone who needs a quick overview. It moves on to a community profile that outlines Seattle’s social, physical and built environments and acts as a common foundation for understanding specific hazards. After this comes a chapter on long-term and emerging threats. Next are the chapters on individual hazards. These chapters are grouped into sections common characteristics. Finally, there is an extensive bibliography and the endnotes.

### **1 3.1 Hazard Summary**

This section is the dashboard. It condenses the findings into one matrix. It also contains supporting material to explain the metrics the matrix uses and how the scores were derived. It also has a table that shows how different hazards are related because most disasters involve multiple hazards.

### **1 3.2 Community Profile**

This section is a lens through which to evaluate individual hazards. It describes components of the Seattle community that change the impact of any hazard. These are:

- Physical Geography
- Population and Economy
- Land Use
- Transportation
- Utilities
- Media
- Emergency Services
- Healthcare and Human Services
- History

It finds that Seattle’s population density has increased steadily as has our dependence on the transportation, utility, telecommunication and other infrastructures necessary for our safety and productivity.

### **1 3.3 Climate Change: Effects on Hazards**

This section acknowledges that climate change, while not a direct hazard itself, exacerbates the vulnerabilities and consequences of nearly all of Seattle’s hazards. Climate change is projected to effect air temperatures, sea level rise, precipitation, mountain snowpack, stream flow, and air quality for the Puget Sound area. The main hazards expected to be influenced by climate change are landslides, disease outbreaks, infrastructure failures, power outages, fires, excessive heat events, flooding, and water shortages.

### **1 3.4 Hazard Profiles**

Chapters on Seattle’s hazards follow. Seattle’s hazards are grouped into five main categories, most of which have subcategories describing particular hazards. The hazard groups are:

- Geophysical hazards
  - Earthquakes
  - Landslides
  - Tsunami and seiches
  - Volcanic hazards
- Biological Hazards
  - Disease/Pandemic Influenza (including bioterrorism)
- Intentional Hazards

- Social Unrest
- Attacks
- Cyber-attack and Disruption
- Transportation and Infrastructure
  - Transportation Incidents
  - Fires
  - Hazardous Materials Incidents
  - Infrastructure Failures
  - Power Outages
- Weather Hazards
  - Excessive Heat
  - Flooding
  - Snow, Ice and Extreme Cold
  - Water Shortages
  - Windstorms

### **1 3.5 Bibliography**

The bibliography lists the research that grounds the SHIVA. Anyone who wants to find out more about Seattle’s hazards is encouraged to consult it. To keep the SHIVA as concise as possible much of the research was heavily summarized, especially the parts that provide context. The sources in the bibliography provide papers, books, and websites that cover topics much more fully than the SHIVA.

### **1 3.6 Endnotes**

The SHIVA uses endnotes to make the text flow more smoothly, but the Office of Emergency Management hopes that readers will use the endnotes to understand what sources were used and to then consult these works themselves. They are an excellent way to approach the bibliography.

## **1.4 Hazard Chapter Summaries**

Most of the SHIVA consists of individual hazard profiles. They are grouped into sections based on a set of shared characteristics.

### **1 4.1 Geophysical Hazards**

These hazards originate in the movement of earth. They destroy the built environment over large areas and can cause huge casualties. While they are impossible to prevent there is a lot Seattle can do as a community to decrease their consequences.

#### **Earthquakes**

Earthquakes are Seattle’s most significant hazard. No other hazard has the combination of likelihood and potential destructiveness. Seattle is at risk for earthquakes from three sources: 1) deep earthquakes like those that damaged the City in 1949, 1965 and 2001; 2) shallow earthquakes along the Seattle Fault; and 3) megathrust earthquakes that could reach magnitude 9.0 but would originate outside Seattle.



The Seattle Fault is Seattle's most dangerous source. The Seattle Fault last ruptured in 900AD causing a 7.2 magnitude earthquake, massive landslides and a tsunami. The major consequences are building collapse, lateral spread (where the ground permanently shifts under buildings), landslides, fires, liquefaction (where the ground turns liquid under buildings) and potentially a tsunami. Casualties could exceed 1,000 people and economic damage could easily run into billions of dollars. Seattle has been preparing for earthquakes for many years by enhancing building standards, retrofitting infrastructure and facilities, and educating the public.

### **Landslides**

Landslides are a common Seattle hazard especially when ground water is saturated in the winter. Landslides can always be deadly but more commonly they destroy buildings, block roads, and sever lifelines. The greatest risk is when a storm or earthquake triggers a swarm of landslides throughout the city within several days. The biggest swarm was in 1997 when 300 landslides happened in less than four weeks. A Seattle Fault earthquake could cause massive landslides. The last one in 900 AD caused whole forested hillsides to slide into Lake Washington. The City of Seattle addresses its landslide hazard by mapping its landslide prone areas and through its building codes. The U.S. Geological Survey (USGS) has created a [gauge](#) to show when Seattle has a heightened risk of landslides.

### ***Tsunamis and Seiches***

Tsunamis are a rare but potentially catastrophic hazard in Seattle. They are most often caused by earthquakes and landslides. Tsunamis that originate in the Pacific Ocean do not pose a major threat to Seattle because Puget Sound's shape and complex shoreline will break them up before they reach Seattle. The most dangerous tsunamis are generated locally. A Seattle Fault earthquake presents the greatest potential for a tsunami in Seattle. A large landslide could also trigger a tsunami. A landslide triggered a tsunami in the Tacoma Narrows in 1949.

A seiche is a standing (vertical) wave produced by the sloshing of an enclosed water body like a lake, bay, reservoir or river. The cause can be either earthquake shaking or storms. They are rare occurrences in this area. An 1891 earthquake produced an eight-foot seiche on Lake Washington and the 1964 Alaskan quake generated seiche that damaged property on Lake Union. In 2002 another seiche occurred in Lake Union due to an earthquake in Alaska.

Seattle uses tsunami risk as a criterion in siting critical facilities, but it has not pursued additional tsunami or seiche preparedness measures because a tsunami 1) will strike the shoreline within seconds or minutes of being created, 2) will probably occur immediately after a massive earthquake and 3) happen rarely.

### ***Volcanic Hazards***

Volcanic material from Mt. Rainier washing down through the Duwamish River and ashfall are the most significant volcanic threats to Seattle.

During an eruption, Mt. Rainier's glaciers could melt, mix with volcanic debris and flow down the valleys surrounding it. These flows are called lahars. Based on geologic evidence a lahar from Mt. Rainier would bury low-lying areas west of the mountain but would stop short of Seattle. In the days that follow, rain and erosion could wash the sediment down the Duwamish creating a major navigation and environmental hazard.

Severe ashfall is unlikely in Seattle. Our area's prevailing winds blow from west to east and will probably move ash away from Seattle, but it is possible that rare easterly winds could occur during an eruption producing an ashfall in Seattle.

Seattle will need to support more heavily impacted neighbors, cope with transportation closures and help displaced people after an eruption or lahar. Seattle has not undertaken specific volcanic mitigation measures.

## **1 4.2 Biological Hazards**

Biological hazards occur from natural matter in our world such as bacteria, viruses, insects, or animals. The only biological hazard identified for Seattle is disease/pandemic influenza (including bioterrorism).

### **Disease/Pandemic Influenza (including bioterrorism)**

Seattle like all other cities is facing increased exposure to new diseases. The rapid increases in personal mobility, the proximity of people to livestock and global urbanization have created conditions in which it is possible for new diseases, especially influenza, to emerge and spread around the world in days. Global outbreaks are called pandemics. When a new disease emerges, human beings have no immunity against it. This condition increases the chance individuals will get sick when they come into contact with the disease and increase the severity of their symptoms if they do.

The potential consequences of disease outbreaks include:

- Patients overwhelming local hospital and health care providers.
- Inability to request mutual aid assistance if impacts involve multiple communities.
- Contaminated water supplies.
- Threats to critical infrastructure if essential operators are absent in high numbers.
- Widespread mental health impacts.
- Closure of community services, schools and larger public events.

Public Health – Seattle & King County has developed plans to attempt to slow the spread of disease by closing public gathering places, increasing the space between people ('social distancing') and opening additional care facilities. Bioterrorism is the use of a biological agent as a weapon to cause fear, illness, or death. Seattle has not experienced a bioterrorist attack but being a densely populated urban hub makes it an attractive target.

## **1 4.3 Intentional Hazards**

These are hazards that some person or group seeks to cause. Often the perpetrators want to disrupt the flow of normal community life, sometimes they want to cause property damage, and other times they want to hurt people. The adversarial nature of these hazards makes them especially unpredictable and therefore dangerous. Law enforcement is primary in the response to these hazards.

### **Social Unrest**

Social unrest includes riots, civil disorders, strikes, and mass civil disobedience. Seattle is the central stage for political and social activity in the Puget Sound region and the hub of its social activities. This condition makes social unrest likely to occur in Seattle. Most recent incidents were caused by anarchist groups. The largest centered on the 1999 World Trade Organization (WTO) meeting. Most of Seattle's incidents have targeted property but assaults and one death has occurred. Most incidents can be handled by the Seattle Police Department, but large ones like the WTO protests require outside assistance and can shut down large areas of the City. Most incidents occur in the downtown area and on Capitol Hill.

## ***Attacks***

Attacks can be perpetrated by many different actors with different motivations, but all use violent and destructive tactics to cause harm to people and/or property. Some actors include terrorists (domestic and international), violent extremists, and targeted violent offenders. Examples of tactics are mass shootings, bombings, arson, murder, kidnapping, hijacking, or skyjacking. Not all attacks are politically motivated, some are based on personal grievances. Most attacks happen in public gathering places or institutions, of which Seattle has many. The threat of attacks has grown with the interconnectedness of the internet and social media.

The Puget Sound region has active far-right and eco-terrorist groups, and has experienced activity related to international terrorist groups. Seattle has a heightened eco-terrorism risk. In 2001 the Earth Liberation Front (ELF) firebombed the University of Washington's Center for Urban Horticulture. The number of mass shootings in the U.S. has increased over the past decade. Seattle has experienced three mass shootings in recent history, and an active shooter situation at Seattle Pacific University. In today's security conscious, post-9/11 environment, the main threat appears to be attacks using small-scale tactics such as shootings or vehicle ramming.

Attacks are almost impossible to predict. In the aftermath of 9/11, national security focus shifted to terrorism involving chemical, biological, nuclear, radiological and explosive and cyber means. Locally, Seattle Public Schools are undertaking heightened security measures. The City has been the recipient of several federal grants to bolster local security.

## **Cyber-attack and Disruption**

To function as a modern city, Seattle is highly dependent on digital systems and the internet. Disruptions to cyber infrastructure can include internet outages, release or deletion of sensitive data and information, compromised infrastructure or services, or physical destruction. Digital systems can face intentional attacks from small scale hackers to sophisticated nation-state actors. Cyber disruption can also occur from human errors or from another hazard (e.g. earthquake). Seattle's utility infrastructure uses Supervisory Control and Data Acquisition (SCADA) Systems to run and maintain basic functions. SCADA systems are generally outdated and vulnerable to hacking, especially if they are connected to the internet.

The likelihood of attack and disruption is increasing as more products and services connect to the internet. The City of Seattle experiences minor hacking attempts daily but has never experienced a major cyber-attack. However, limited information technology resources make a large attack a possibility and large-scale ransomware attacks have recently halted city functions in other areas of the U.S.

## **1.4.4 Transportation and Infrastructure**

This section comprises failures in the built environment. Their causes are mostly accidental but can be deliberate when used as a means for terrorism. Engineering advances have dramatically improved safety, but Seattle still has many older transportation and infrastructure systems that were not built to modern safety standards. These systems require extra maintenance.

### ***Transportation Incidents***

Seattle is a hub for land, sea, and air transportation giving it an inherent exposure to accidents. One of the city's deadliest disasters was a plane crash that occurred in 1943, killing 32, including people on the ground. The Sodo area is the most vulnerable because it is a hub for all major transportation modes, but our bridges and tunnels also have heightened risk. Transportation accidents are usually limited in size but can cause high fatalities, fires, hazardous materials incidents, power outages, transportation network disruptions, and infrastructure failures.

### *Fires*

Multi-block and high-rise fires are now rare in the U.S. due to better fire code enforcement, but having a large concentration of high-rise buildings, hotels, entertainment venues and industry makes Seattle vulnerable. In the 1970's several single-room occupancy hotels burned with high fatalities. Seattle also has a large port making marine fires a danger and an underground electrical distribution network that can cause extended outages when fires occur in it. Fires are especially dangerous when they are ignited by other hazards like earthquakes and civil disorders because many fires can ignite in a short period while responders are already occupied.

### *Hazardous Material Incidents*

Seattle is a regional industrial center and major transportation hub raising its exposure to hazardous materials incidents that release toxic chemical, combustible, nuclear, or biological agents into the environment. Seattle has not had any truly disastrous hazardous materials incidents but has had several close calls with fuel tanker explosions and a fire at a UW biology lab. There has been an increase in the transport of highly flammable crude oil through Seattle in recent years. Most incidents happen at fixed sites, but those that occur during transport are often more dangerous because they occur in uncontrolled, public spaces.

### *Structural Collapse and/or Failure*

This chapter includes structural collapse or failure of buildings, dams, and other critical infrastructure such as bridges, and water, sewer, or power lifelines. There are no dams in Seattle, but the City owns a dam south of the city. If this dam failed, the biggest consequence would be flooding in the Duwamish Valley. Seattle is especially vulnerable to bridge collapse due to central role they play in connecting Seattle's transportation network to other areas. Western Washington has had four high profile bridge collapses since 1940. The Seattle Department of Transportation has an active bridge inspection and retrofit program.

### *Power Outages*

Power outages are a type of infrastructure failure but are treated as a separate hazard due to the complexity of their consequences. The 2003 Northeast Blackout highlighted the fragility of the U.S. power system. Seattle experienced a week-long power outage from a winter storm in December 2006. Since the wide-spread 2006 outage, Seattle City Light (SCL) has acquired a new power management system that allows it to isolate outages and respond faster. It has also improved fire suppression in its underground electrical system. In the 1980's and 1990's several fires in the underground system caused extended outages in major parts of downtown. About half of Seattle's power is purchased from the Bonneville Power Administration (BPA), making the city vulnerable to disruptions in other areas of the Northwest. While much of BPA's infrastructure is aging, they have been a leader in seismic upgrades to their critical infrastructure. Climate change is projected to decrease hydropower generation in the summer by mid-century.

## **1.4.5 Weather**

Severe weather events are frequent hazards in Seattle. With the exception of flooding, they have city-wide impacts that vary from minor to debilitating. Their consequences mount the longer they go on. Forecasters are getting better at predicting these events and their severity. The extra time reduces vulnerability by allowing the public and institutions more time to prepare.

### ***Excessive Heat Events***

Excessive heat events (EHE) can be an extremely deadly hazard. More than 700 people died during the 1995 Chicago heat wave. Because Seattle has a generally mild climate, most people are not acclimatized when EHEs do occur. The temperature itself is just one factor driving the consequences of EHEs. The other important factors are the season, difference between the pre-event and event temperatures, the event duration, nighttime cooling, wind and humidity. Meteorologists can accurately forecast the development of an EHE and the severity of its associated conditions with several days of lead time. The National Weather Service (NWS) has developed a Heat Health Watch/Warning System that tailors excessive heat guidance to specific regions in the country. EHEs are projected to become more intense in the future due to climate change. The most vulnerable people in EHEs are the elderly, infants, the homeless, the poor, and people who are socially isolated.

### ***Flooding***

Seattle is susceptible to four flood types: coastal flooding (including king tides), riverine, urban, and dam failure. Atmospheric rivers are storms that occur when the Jet Stream brings moist air from the tropics into the Northwest. They can cause extended periods of heavy rain that can cause riverine and urban flooding. Recent weather patterns have produced very high intensity rain cells, sometimes over narrow geographic storm-tracks.<sup>1</sup> These storms release larger amounts of rain, in short periods of time, which the drainage systems cannot always handle adequately.

- Coastal flooding happens during storms and especially high tides (called ‘king tides’). When the two coincide, the consequences are more severe. Sea level rise will make coastal flooding worse.
- Riverine flooding happens mostly along Seattle’s creeks. The South Park neighborhood is in a 500-year floodplain. Most of Seattle’s floodplains are very narrow.
- Urban flooding occurs when heavy rain overwhelms the drainage system. Seattle’s drainage systems were designed and originally built for longer duration and lower intensity rain storms. The City has developed mitigation measures like detention ponds to decrease the consequences of urban flooding.

The City of Seattle owns dams outside the city limits. Dam failure is mostly a hazard outside the city. The greatest risk is the Howard Hanson Dam. It discharges into the Green River and the Duwamish. Studies suggest that the likelihood of flooding on the Duwamish due to a dam failure is low.

### ***Snow and Ice***

Seattle’s winter weather is generally mild. When Seattle does receive snow, accumulations can be large. The consequences are especially severe if the snow lingers for more than several days or triggers secondary hazards like power outages. Seattle has heightened vulnerability to snow and ice storms because of its hilly topography and lack of dedicated snow removal equipment (Seattle has to re-purpose general use equipment to plow snow). The City prioritizes major roads and is not able to plow residential streets. Extended snow can lead to severe transportation challenges. Excessive cold exacerbates risks to human health and safety when electric heating sources are inoperable. In 2008 several people died in King County due to carbon monoxide poisoning when they used charcoal grills indoors to heat their homes. Snow load has caused roof collapses in Seattle and rapidly melting snow has caused urban flooding and landslides.

### ***Water Shortages***

Seattle can experience water shortages during the summers that follow winters with low snowpack, because nearly all of Seattle’s water comes from watersheds in the Cascades that accumulate their

supply from melting snow. Snowpack is projected to decline in future years due to climate change. The main shortage impacts are reduced stream flows for salmon, usage restrictions, and economic hardship for businesses that require large amounts of water. In 2006, Seattle Public Utilities (SPU) updated and adopted a plan to respond to and mitigate water supply problems.<sup>2</sup> Water shortages also have consequences for power. Seattle City Light (SCL) faces challenges during water shortages because most power in the Northwest is generated by hydroelectric dams. During water shortages not as much water is available to turn generators to make electricity. To meet demand SCL must buy more expensive power from outside the region. Besides climate, water shortages can be caused by main breaks. These shortages due to infrastructure failures are usually localized and short but could be longer if they are the caused by another hazard like an earthquake.

### ***Windstorms***

Windstorms with wind speeds equaling those of category one hurricanes can strike Seattle. Sustained winds of 85 miles per hour were recorded in the Seattle area in 1993 and 2006. Seattle’s most damaging storm was the 1962’s Columbus Day Storm. Windstorms cause power outages, structural damage, transportation blockages, and coastal flooding. Fall and winter is the most common time for windstorms, but the occasional out of season storms can be the most dangerous. Falling trees account for most damage. Windstorms often accompany other weather hazards producing complex emergencies that can include landslides, urban flooding, snow and extreme cold. Windstorms can damage structures with speeds as low as 32 mph. Seattle’s new building code requires new structures to withstand 85 mph gusts. The City of Seattle has programs for vegetation management that serve to mitigate damage to electrical systems during windstorms. This tree trimming program intensified after the 2006 storm that caused lengthy power outages.

## **1.5 Chapter Format**

Each of the hazard-specific chapters follows the same format. The common format enables the same key aspects of each hazard to be considered and allows readers to compare the same sections across hazards. This format causes some repetition but makes the SHIVA easier to use as a reference document.

### **1.5.1 Key Points**

This section consists of bullet points that summarize the most important points about the hazard for a quick overview.

### **1.5.2 Context**

This section explains the hazard’s context and why it is a cause for concern. It provides enough fundamental science, research, and terminology to enable readers to understand subsequent sections without having to consult additional material. When relevant, it outlines disasters from outside the Northwest to illustrate why a hazard has been identified as being a risk to Seattle. These examples are especially important for newer hazards that do not have a long history in the Northwest.

### **1.5.3 History**

This section details the hazard’s presence in Seattle. Most of the section is a list of events that had severe consequences. Events from the Puget Sound region outside Seattle are included when they illustrate similar dangers here or have direct consequences here. Some events, especially the oldest ones, occurred when circumstances were very different than today. For example, Seattle’s deadliest disasters are transportation accidents, but safety standards dramatically improved since these accidents



and have dramatically reduced accident frequency. Despite the lower risk, these older events are important to include because they remind us how dangerous these accidents can be.

### **1 5.4 Likelihood of Occurrence**

This section assesses the chances a hazard will cause a disaster in Seattle within four years of the SHIVA's publication. It does not make predictions, because no disaster can be predicted, especially years ahead of time, but science and engineering have improved our ability to make good bets. If experts feel confident enough to give a numeric probability it is included in the section, but often it is not possible to do so.

### **1 5.5 Vulnerability**

Vulnerability is a property of people, social systems, structures or locations that make them suffer more harm than others for hazards of the same magnitude. For instance, wood structures are more likely to burn than brick structures when exposed to fire. They are more vulnerable. The vulnerability section covers vulnerabilities that pertain to the hazard. Some vulnerabilities pertain to all hazards. They are included in the Community Profile.

### **1 5.6 Consequences**

This section ties the previous sections together to draw out the likely outcomes if the hazard were to manifest. Because consequences vary with hazard magnitude and because smaller incidents are more likely than larger ones the SHIVA uses a "Likely" and "Maximum Credible" scenario to illustrate hazard consequences. The "Most Likely" scenario is often the upper range of the historical magnitude of past occurrences, and the "Maximum Credible" scenario is one that represents the biggest incident that has a reasonable chance of occurring.

### **1 5.7 Conclusion**

The conclusion is a brief summation of the major points of the text in a paragraph or two to help the reader remember the hazard.

## **1.6 Definitions**

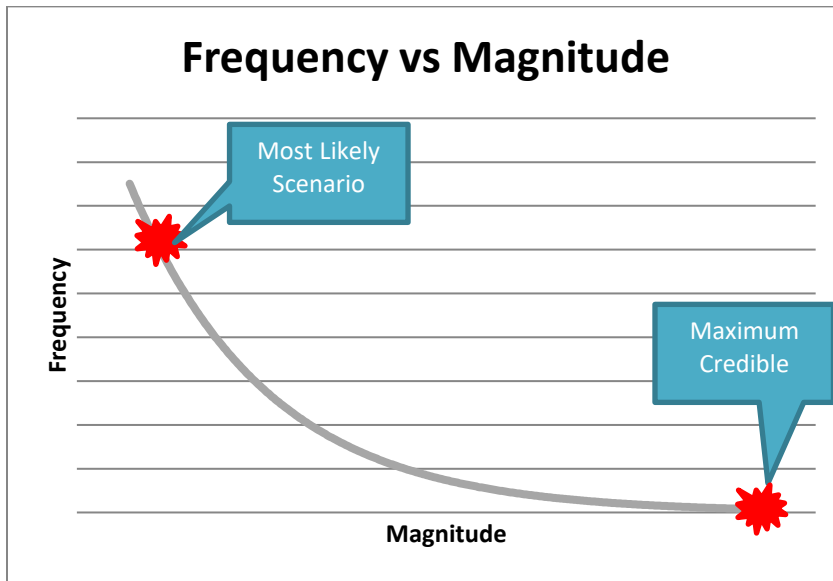
### **1 6.1 Hazard**

A Hazard may be broadly defined as "a source of potential danger or adverse condition."<sup>3</sup> The definition of a hazard may be consequence based, as "something that has the potential to be the primary cause of an incident," where an incident is "an occurrence, natural or human-caused, that requires action by the emergency management program."<sup>4</sup> A hazard is a class of phenomena; an incident, event, or disaster is a manifestation of the hazard.

Hazards are measured by their *frequency* and *magnitude*. Frequency measures how often the hazard creates incidents. Magnitude measures incident intensity. Magnitude is *not* the severity of the consequences. To understand consequences, it is necessary to understand vulnerability. Most hazards have a power law distribution which means that magnitude increases exponentially as frequency decreases: low magnitude incidents are common and high magnitude incidents are rare.

Much of the science surrounding these hazards involves the attempt to determine the precise shape of relationship between frequency and magnitude so that rare high magnitude events can be extrapolated from the more frequent low magnitude events. The challenge for researchers is that they have very few data at the high magnitude end of the scale. Adding to that challenge is a tendency for extreme magnitude events to 'jump the tracks' and stop obeying the linear relationship.

Figure 1-1 Disaster Frequency vs Magnitude



## 1 6.2 Disaster

A disaster is “a severe or prolonged incident which threatens life, property, environment or critical systems.”<sup>5</sup> Disasters require immediate community responses that are made more challenging because disasters also increase the demand for critical resources, cause logistical difficulties, communications bottlenecks and often create unique situations that require rapid policy making.

Disasters are complex events but share some things in common:

- There is often more than one hazard at work: a primary or triggering hazard and secondary hazards. Secondary hazards are also called cascading effects.
- They threaten the community’s foundation.
- They threaten our sense of control.
- They often catch us by surprise.
- They overwhelm our ability to respond.

## 1 6.3 Vulnerability

Vulnerability is a “disaster waiting to happen”. Vulnerable people and things incur more damage than those that are not when exposed to the same event. People, communities, buildings and infrastructure can all have vulnerabilities. The building material used in a house can cause vulnerabilities. Brick is more vulnerable to earthquakes than wood. Communities without strong social cohesion are more vulnerable to all disasters than those with strong social cohesion.

The vulnerabilities considered in this document are:

### Physical Vulnerability

Physical factors include weaknesses in the built environment, lack of redundancies in critical facilities and proximity to hazardous areas. Because many of these vulnerabilities depend on specific hazards, they are covered in the hazard chapters.



## **Social Vulnerability**

A community's social vulnerability reflects the strength of a community's social ties and the collective personal vulnerability of its people.<sup>6</sup> The concept of social vulnerability extends beyond identifying "special needs" populations often included in disaster plans. Research has shown that a disaster's impact closely aligns with key socio-economic indicators. The Center for Disease Control has developed a model of social vulnerability that can be mapped. The result is included in the Community Profile.

## **Concentration**

Concentrating people and assets means that more of them can be hurt in a single incident. Seattle has the densest concentration of people and resources between San Francisco and Vancouver, BC. Within Seattle certain assets like hospitals and lifelines are even more concentrated. Most of Seattle's hospital beds are located near the city center. Many lifelines (power, water, gas, fuel, sewer, and transportation) run through narrow corridors, especially just south of the city. One unfortunately located incident could take out the greater part of a critical resource. Concentration is not solely a liability. Dense population centers like Seattle have more resources to respond than surrounding rural or suburban areas. If they survive intact, these resources become valuable assets during a response and recovery.

## **Interdependence**

Urban populations rely on and provide many services for basic survival. People can be harmed by disaster impacts even if they are not directly affected. Indirect effects can ripple through a community and are often costlier than the direct damage. Interdependence is also a benefit if undamaged communities can aid those that are damaged.

## **Complexity**

Cities are complex systems comprised of many components. Many components mean many failures. Normally, failures are contained, but when a system is tightly interdependent failures can cascade through the system and the whole system fails. Moreover, components in complex systems often interact in unanticipated ways because their connections are poorly understood. For example, Seattle hospitals had to curtail service when a power outage closed a laundry service that supplied them with clean linens. The effects of a small power outage miles from Seattle's hospitals cascaded through the health care system.

## **Pace of Change**

The faster the pace of change in a system, the faster failures propagate, and problems escalate. Critical infrastructure is becoming highly automated. While automation is leading to efficiency gains, it also means that things can go wrong quickly. After Hurricane Katrina, hospital patients became critical within hours of power failure.

## **The Local Economy**

As an area's economy and population grow and shrink, the distribution of wealth changes the location of vulnerable populations. Infrastructure gets built and then starts to decay; hazardous areas are redeveloped or abandoned. These changes cause a city's vulnerability to fluctuate and its most sensitive spots to shift geographically over time. Disaster can exaggerate a city's growth or decline. A declining city will decline more quickly after a disaster, while growth in a booming city can accelerate if new capital enters the city during reconstruction.<sup>7</sup>

### State of Knowledge, the Ability to Predict and the Ability to Act on the Prediction

The ability to accurately predict the occurrence of a hazard has the potential to greatly reduce vulnerability to it. It is the ability to act on a prediction, though, that actually reduces vulnerability. The state of knowledge varies widely from hazard to hazard. The ability to predict ranges from:

- **Deterministic.** The hazard’s location, magnitude and time of occurrence are all reliably known within narrow limits in advance. Pure deterministic examples of hazard prediction are rare.
- **Forecast.** Some of the features of an impending incident can be predicted, usually on the basis of the observation of a precursory signal. The prediction is based on probabilities. The precise magnitude, time and location might not be known but there is some physical connection above the level of chance between the observation of a precursor and the subsequent event. Forecasting includes a precise probability statement. Volcanic eruptions and weather forecasts fall into this category.
- **Time independent.** Assumes that hazards occur randomly within a block of time and uses past hazard locations to constrain the future long-term hazard. An example is an earthquake with an estimated 500-year recurrence rate. A future earthquake could happen at any time in this 500-year span. Locations are estimated based on known faults and past events.
- **Time/Location dependent.** The hazard varies with time. Seasonality is a good example. Major storms tend to occur in the late fall and winter. Seismic hazards are greater along known faults.

## 1.7 Summary of Document Updates

Major changes are as follows:

- Changed “Emerging Hazards” section to “Climate Change”
- Added “Cyber Attack and Disruption” chapter
- Combined the “Terrorism” and “Active Shooter Incidents” chapters into one chapter titled “Attacks”
- Renamed the “Infrastructure Failures” chapter to “Infrastructure and Structural Failures”
- Developed new scenarios for Disease/Pandemic Influenza, Social Unrest, Infrastructure and Structural Failures, and Windstorms.
- Incorporated hazard research published after 2014.
- Reassessed hazards.

## 1.8 Acknowledgements

The Office of Emergency Management (OEM) would like to thank Taylor Bailey for writing the 2018 update and to all of our partners for supplying the data, analysis, and review to make this document the deep look at Seattle’s hazards that it is.

## 1.9 Record of Changes

The follow is a list of changes since version 7.0.



- V7.0.1 Fixed list of major hazards in Executive Summary that didn't match hazard ranking
- V7.0.2 Added language to describe SHIVA's adherence to Emergency Management Planning policy
- V7.0.3 Fixed page numbering issue. Added this Record of Changes.



## 2. HAZARD RANKING AND METHODOLOGY

Any of the 18 hazards included in the SHIVA could cause a terrible disaster. For the purpose of prioritizing strategies to mitigate, plan, and prepare for them with limited resources, this section succinctly summarizes and ranks them. The rankings are not intended to be a precise prediction of hazard occurrence or severity. Like all models the ranking is a simplification of highly complex phenomena.

### 2.1 Hazard Identification Methodology

This analysis uses multiple factors to identify hazards based on best practices. A key touchstone is FEMA 386-2, Understanding Your Risks and Emergency Management Accreditation Program (EMAP) standards 4.1.1, 4.1.2 and 4.1.3.

The first step of hazard identification is defining ‘hazard’. The City of Seattle Emergency Management Strategic Plan states, *“the City’s emergency management program is intended to improve the City’s ability to prevent, mitigate, prepare for, respond to, and recover from natural and human-caused disasters”*. Disasters are defined in section 1.6.2 and the hazards that cause them in section 1.6.1. We used these definitions as a lens to scope what to include in this analysis. It led us to look for phenomenon that threaten public safety, property and the environment, require immediate action and cannot be managed through day-to-day programs.

Using these definitions, we employed the following techniques to identify specific hazards:

- Reviewing media archives, mainly old newspapers, for hazards occurring in Seattle;
- Reviewing plans and reports written by the City of Seattle and key stakeholders;
- Conducting a literature review focusing on local environmental and social issues and the built environment;
- Consulting with subject matter experts (e.g., seismologists, cyber-security specialists)
- Meeting with emergency management partners and community stakeholders.
- Researching emergencies or disasters from other areas that have not occurred locally but have a credible chance of doing so (e.g., cyber-attack disrupting our community on a large scale)

In the end we found over 80 types of hazards described in archives and literature. Many of these hazards demand similar capabilities to prepare for, mitigate, respond to, and recover from. Moreover, most actual modern disasters are multi-hazard. We choose 18 hazards that pushed us to develop the broadest set of capabilities that will be useful no matter what Seattle experiences.

Terrorism and climate change emerged as special cases of ‘meta-hazards’ that manifest through other hazards. Terrorism is a motivation rather than a specific hazard. We found that acts of terrorism in transportation incidents, hazardous materials incidents and small arms attacks. Instead of having a stand-alone terrorism chapter, we address it in chapters that concentrate on the weapon used. The Attacks chapter includes information about the unique aspects of terrorism that are not found in other chapters that include both accidents and attacks. Similarly, climate change is not a specific hazard. It intensifies other hazards like flooding. Because of its complexity, we have a chapter covering climate change, but the hazards it affects are covered in their own chapters.

## 2.2 Ranking Model Structure

Each hazard has been evaluated using its Most Likely and Maximum Credible scenarios. Both scenarios are evaluated using twelve parameters developed from EMAP and FEMA standards. Ten of these twelve parameters are “base parameters” that directly affect the community, e.g., health effects. Each of these ten base parameters was assigned a score from one through five. The ten base parameters were averaged for a “Base Score” for each of the two scenarios.

The remaining two parameters, “Frequency” and “Cascading Effects,” function as multipliers. These two parameters were also assigned a score of one through five. The two scores were added to get a “Combined Multiplier.”

The “Base Score” was then multiplied by the “Combined Multiplier” to get a Scenario Ranking. Finally, the Scenario Rankings for the two scenarios were summed and added to the “Future Emphasis” parameter to get a Combined Ranking. The equation is written below.

*Scenario Ranking = Average (Base Parameters) \* Sum (Multipliers)*

*Combined Ranking = (Scenario Ranking – Most Likely) + (Scenario Ranking – Maximum Credible) + Future Emphasis*

Draft scores were assigned by Office of Emergency Management staff with suggestions from the Office of Emergency Management Strategic Working Group.

### 2.2.1 Comparing Hazards

Ranking and comparing hazards is a subjective but useful exercise to stimulate discussion and develop priorities. Standard metrics are applied throughout and provide a basis for comparison. Each metric is ranked from one to five with one being low and five being high.

### 2.2.2 All Hazards Can Have Serious Consequences

For some people, a minor snowfall is an excuse to stay home from work and play, but for others, even a few inches of snow can be life threatening. Even hazards that don’t directly affect the general population can have ripple effects. Understanding our hazards, our vulnerabilities and their consequences is one of the components necessary to build a resilient community.

### 2.2.3 Hazard Ranking, Summary of Hazard Metrics, and Relationships Between Hazards

Table 1 shows the hazard rankings. Table 2 defines the SHIVA metrics. Many organizations are now using categories given by the Emergency Management Accreditation Program standard 4.3.2. We have cross reference our categories with EMAP. The corresponding EMAP category is noted in Table 2 in the first column. Finally, some hazards induce secondary, tertiary or more hazards as shown in Table 3.

Table 2-1. Hazard Ranking

	Most Likely Scenario											Maximum Credible Scenario											Future Emphasis	Combined Ranking									
	Geographic Scope	Duration	Health Effects	Displacement	Economy	Environment	Structures	Transportation	Critical Services	Confidence in Govt	Base Score	Frequency (F)	Cascading Effects (CE)	Multiplier (F + CE)	Subtotal	Geographic Scope	Duration	Health Effects	Displacement	Economy	Environment	Structures			Transportation	Critical Services	Confidence in Govt	Base Score	Frequency (F)	Cascading Effects (CE)	Multiplier (F + CE)	Subtotal	
Earthquakes	5	2	2	2	2	2	3	2	2	1	2.3	4	4	8	18.4	5	5	5	5	5	5	5	5	5	5	5	5.0	2	5	7	35	3	56.4
Snow & Ice Storm	5	3	2	2	2	1	2	2	2	1	2.2	5	2	7	15.4	5	4	2	3	3	2	2	4	3	3	3	3.1	3	3	6	18.6	5	39.0
Windstorms	5	1	2	2	2	2	2	2	2	1	2.1	5	2	7	14.7	5	2	2	3	3	2	3	4	4	3	3.1	3	3	6	18.6	3	36.3	
Power Outages	3	2	2	2	2	1	1	2	2	1	1.8	5	2	7	12.6	5	4	2	4	3	1	2	3	3	5	3.2	3	3	6	19.2	3	34.8	
Cyber-attack/Disruption	5	4	1	1	2	1	1	2	1	3	2.1	3	1	4	8.4	5	4	2	5	4	3	1	4	4	3	3.5	2	4	6	21	5	34.4	
Landslides	4	3	2	2	1	2	2	3	1	1	2.1	5	1	6	12.6	3	3	3	3	3	3	4	2	3	3	3.0	2	4	6	18	3	33.6	
Disease Outbreaks	5	5	4	1	2	1	1	1	1	1	2.2	4	1	5	11.0	5	5	5	5	4	1	1	3	3	3	3.5	3	2	5	17.5	5	33.5	
Flooding	5	2	1	2	2	2	2	2	1	1	2.0	5	1	6	12.0	5	4	2	4	3	2	3	4	3	3	3.3	2	3	5	16.5	5	33.5	
Excessive Heat Events	5	3	2	2	2	1	1	2	1	1	2.0	5	1	6	12.0	5	4	4	4	3	2	1	3	3	3	3.2	3	2	5	16	5	33.0	
Tsunamis and Seiches	3	2	2	3	3	2	3	2	1	1	2.2	2	2	4	8.8	4	2	4	5	4	3	3	4	3	3	3.5	2	4	6	21	3	32.8	
Infrastructure & Structural Failure	1	2	1	2	2	2	2	2	2	3	1.9	5	2	7	13.3	4	5	3	4	3	3	2	4	3	5	3.6	1	3	4	14.4	5	32.7	
Fires	2	2	2	4	1	1	2	2	2	1	1.9	4	2	6	11.4	2	4	4	3	3	2	2	4	2	3	2.9	2	4	6	17.4	3	31.8	
Transport Incidents	1	1	3	2	1	1	2	2	1	1	1.5	5	2	7	10.5	3	2	4	3	2	2	2	3	2	3	2.6	2	5	7	18.2	3	31.7	
Water Shortages	5	5	1	2	2	2	2	1	3	1	2.4	5	2	7	16.8	5	5	1	3	3	3	2	1	3	3	2.9	2	2	4	11.6	3	31.4	
Social Unrest	3	1	2	3	3	1	2	2	2	3	2.2	5	2	7	15.4	5	3	3	5	3	1	3	2	2	5	3.2	2	2	4	12.8	3	31.2	
Attacks	1	1	2	2	2	2	2	2	1	3	1.8	5	2	7	12.6	4	2	3	3	2	1	2	4	4	3	2.8	2	1	3	8.4	5	26.0	
HazMat Incidents	3	1	3	4	2	2	2	2	2	2	2.2	3	2	5	11.0	3	3	2	2	3	4	2	3	2	5	2.9	1	3	4	11.6	3	25.6	
Volcano Hazards	2	5	1	4	3	2	3	2	3	1	2.6	2	1	3	7.8	5	5	2	2	3	2	4	5	2	1	3.1	1	3	4	12.4	3	23.2	

Table 2-2. Hazard Metric Definitions

Consequence Category	Definition	One	Two	Three	Four	Five
Frequency	How often has the hazard occurred in the past?	Never occurred locally	One in past thousand years	One in past hundred years	One in past fifty years	Nearly every decade.
Geographic Extent	Size of the affected area. Includes areas not damaged, but strongly affected by the incidents. For example, areas backed-up by a transportation accident.	Single site. One or two blocks.	Single Site - Multiple blocks	Community (i.e., all of Downtown	City-wide	Regional. Winter Storms
Duration	How long does the acute crisis part of the disaster last?	Less than 24 hours	1 - 3 days	4 - 7 days	7 - 30 days	30 + days
Environment [EMAP - Environment]	How damaging is the disaster for the natural environment?	No damage / temporary minor damage	Degradation of ecosystem that will repair itself	Degradation of ecosystem that requires intervention	Functional loss of ecosystem, but restoration possible.	Permanent loss of ecosystem
Health Effects, Deaths and Injuries [EMAP - Public]	How dangerous is the hazard to human health and safety?	No deaths or injuries	1 - 10 deaths and/or 1- 100 injuries	11-50 deaths and/or 101 - 500 injuries	51 - 500 deaths and/or 501 - 1500 injuries	Over 501 deaths and/or 1501 injuries
Displacement and Suffering [EMAP - Public]	How likely is the hazard to negatively impact the exposed population in terms of displacement, personal property loss and increased indebtedness?	No displaced people / minor inconveniences	1-100 displaced people. Vulnerable populations begin to have problems with food, water, and access to services	100 - 250 displaced. Vulnerable populations having serious difficulties. General population starting to have problems	251-1000 people displaced. 5 - 30% of population experiencing facing acute shortages.	1000+ displaced people. More than 30% of population facing acute shortages of basic supplies and access to services.
Economy [EMAP - Economy]	How does the hazard affect the local economy?	No measureable impacts.	No impacts to overall economy, but isolated businesses experience hardships	Entire sectors experiencing loss of revenue and capital.	Core sectors of Seattle's economic base are affected and unable to generate revenue. Capital losses between 1 and 10% of assessed value.	Physical losses equal to 10% to assess value. Loss of ability to generate revenue.



Consequence Category	Definition	One	Two	Three	Four	Five
Structures [EMAP - Property, Facilities, and Infrastructure]	How does the hazard affect buildings and physical infrastructure? This includes utilities.	No effects. Heat Wave	1 - 10 structures red tagged. Up to 25% loss of one utility	11 - 250 structures red tagged. Multiple utilities affected up to 25%	251 - 1000 structures red tagged. Multiple utilities affected 25 - 50%	1000+ structures red tagged. At least two major utilities degraded at least 50%
Transportation [EMAP - Property, Facilities, and Infrastructure]	How does the hazard affect the ability of residents and worker to access the resources they need? Watch the combination of high mobility and duration impacts.	No effects on mobility	All critical services accessible, but delays reaching work or non-essential services	One critical service inaccessible. Degradation of at least one mode. Major corridors open, but minor streets degraded or impassible	Many critical services inaccessible. One major mode inoperable. One major corridor inoperable	Most critical services inaccessible. Multiple modes inoperable. Most high volume corridors impassible.
Critical Services [EMAP - Continuity of Operations and Responders]	How likely is the hazard to reduce the community's ability to provide critical services: public safety, social, utilities, financial, food distribution, and medical. This includes the loss of responders due to death or injury.	No impairment of critical services	Temporary degradation of 1 critical service	Temporary degradation of multiple critical services. Long-term degradation of 1 critical service	Temporary degradation of most critical services. Long-term degradation of multiple services.	Unable to deliver Most critical services
Confidence in Government [EMAP - Confidence in Government]	Would public's confidence in government be shaken	No	(not used)	Somewhat	(not used)	Yes

Consequence Category	Definition	One	Two	Three	Four	Five
		Hazard extremely unlikely to cause secondary hazards and if they occur are minor.	Secondary hazards may occur, but are likely to be minor compared to primary hazard	Secondary hazards occur that extend the impact of the disaster and hamper response, but are not disasters in there own right.	Secondary effects generated that significantly increase the magnitude of the disaster. Secondary impacts would likely be considered disasters if they occurred by themselves.	Secondary effects generated and rival or exceed primary hazard. Secondary impacts would definitely be disasters in their own right. Example: train derailment leading to massive chlorine spill.
Cascading Effects	How severe and complexity will the secondary effects be?					
Future emphasis	How much is the level of emphasis in mitigating, planning for, and preparing for this hazard changed based on trends, increasing understanding of the hazard, and changing underlying conditions that give rise to the hazard.	Decreasing emphasis	(not used)	Emphasis unchanged	(not used)	Increasing emphasis

**Table 2-3. Relationships Between Primary and Secondary Hazards**

		Secondary Hazards																	
		Earthquakes	Landslides	Volcano Hazards	Tsunami and Seiches	Disease Outbreaks	Civil Disorder	Attacks	Cyber-attack/Disruption	Transportation Incidents	Fires	HazMat Incidents	Infrastructure/Structural Failure	Power Outages	Excessive Heat Events	Flooding	Snow & Ice	Water Shortages	Windstorms
Primary Hazard	Earthquakes																		
	Landslides																		
	Volcano Hazards																		
	Tsunamis and Seiches																		
	Disease Outbreaks																		
	Civil Disorder																		
	Attacks																		
	Cyber-attack/Disruption																		
	Transportation Incidents																		
	Fires																		
	HazMat Incidents																		
	Infrastructure/Structural Failure																		
	Power Outages																		
	Excessive Heat Events																		
	Flooding																		
	Snow & Ice																		
	Water Shortages																		
	Windstorms																		

This table shows the relationships between primary hazards and secondary hazards (i.e., cascading effects). A secondary hazard is one that can be triggered by the primary hazard. A triggered hazard has its own secondary hazards. These are tertiary hazards. For example, a snowstorm occurs. This is the primary hazard. Then it rapidly melts triggering urban flooding and landslides. These are the secondary hazards. The landslides knock out the supports of a bridge that also carries power, water and gas lines. These outages are the tertiary hazards. These cascading effects can have a huge multiplier effect and make the effects of hazards hard to predict. They are one of the major reasons it is a mistake to equate hazard vulnerability with disaster vulnerability.



### 3. COMMUNITY PROFILE

Seattle is the hub of the Pacific Northwest. With 730,400 residents<sup>8</sup> (2018) and 581,780 jobs (2017)<sup>9</sup>, Seattle is the largest municipality in the region. It is the center of cultural, governmental and economic activity. Paradoxically, Seattle is both a city of neighborhoods that looks inward and one of the most trade dependent cities in the U.S. Forty percent of Washington State jobs are dependent on international trade, with the Port of Seattle serving as the main international trade hub.<sup>10</sup> Seattle is famous for rainy weather, proximity to nature, coffee, software, and airplanes, but as is often the case with things a place is famous for, the truth is more complex and interesting. This chapter builds a picture of Seattle that embraces this complexity while at the same time making it easier to understand how its response to hazards is uniquely, Seattle.

Understanding a community is essential if you want to understand how hazards affect it. This community profile does three things: explains what is at stake, broadly demonstrates the community’s “defenses” against hazards and centralizes the core facts about the community to avoid repetition in the hazard sections.

The topics covered are physical geography, a brief history, population and economy, land use, infrastructure, and services. Because raw statistics by themselves don’t mean much, Seattle is compared with other cities about the same population. The table below lists these “reference cities”.

**Table 3-1. Reference Cities**

Name	land area (sq miles)	Pop 2016 (estimate)	persons / sq mile
Seattle	84	704,532	8,496
Atlanta	133	472,522	3,553
Boston	48	673,184	14,025
Denver	153	693,060	4,530
Nashville	475	660,388	1,390
Portland	133	639,863	4,811
San Francisco	47	870,887	18,530
Vancouver	44	631,486	14,352

#### 3.1 Physical Geography

From the Aurora Bridge, commuters can look east to watch the sun rise over the Cascade Mountains then turn their heads and see the morning light falling on Puget Sound and the Olympic Mountains. The view evokes a strong sense of place and appreciation for how water and mountains have guided Seattle’s development. Those with a role in protecting the public from disasters will also realize that this same geography underlies our vulnerability to disasters.

##### 3.1.1 Location

Seattle is the northernmost major city in the lower 48 states. Fargo, North Dakota and the northern border of Maine are south of Seattle. Even the major cities of eastern Canada are south of Seattle.

Seattle is midway between Vancouver, Canada and Portland, Oregon. If Seattle sometimes feels far from the rest of the U.S., it feels close to Alaska and Asia. As the closest major U.S. city to Alaska, Seattle has deep ties to that state starting with the Alaska-Yukon Gold Rush in 1897. Seattle is also one of the closest U.S. ports to Asia. The proximity has led to strong trade and immigration relationships with

northeastern Asia, especially China, Japan, and Korea. Overall, Seattle's location gives it an outward orientation. It looks as much to the north and west as it does to the east.

Western Washington's Puget Sound region is a large, north-south oriented basin bordered by the Olympic Mountains on the west and the Cascade Mountains on the east. Puget Sound itself is a narrow extension of the Pacific Ocean that runs down the middle of the basin. Seattle sits along Puget Sound's eastern edge.

### **3 1.2 Land Forms**

Seattle is an isthmus sitting on the 84 square miles between Puget Sound to the west and Lake Washington to the east. Right in the middle, Seattle is pinched by Elliott Bay, an extension of Puget Sound. This pinch gives Seattle an hourglass shape. Downtown is in this narrow section, causing many major transportation routes and services to compete for land where we have the least space.

Two waterways—the Duwamish River and the Washington Ship Canal—divide the city into clearly defined sections. The Duwamish River runs north-south through the city's center and divides the southern third of the city into east-west halves as it runs from the southern border into Elliott Bay. The Lake Washington Ship Canal, which connects Puget Sound to Lake Washington through a series of cuts and locks, separates the northern third of Seattle from the rest of the city.

Hills are the other major defining feature in Seattle. During the ice ages, glaciers pushed down from the north over the area that is now Seattle. Ice 3,000 feet thick scoured the land and left north/south trending ridges and troughs. The troughs filled with water to become Puget Sound and Lake Washington. The ridges are our hills with their steep eastern and western sides. The highest hills reach over 500 feet. Like the water barriers, the hills have guided development in Seattle. Roads are forced to jog around obstructions or dead end suddenly. Early in Seattle's history, huge public works projects regraded many areas in an effort to improve transportation.

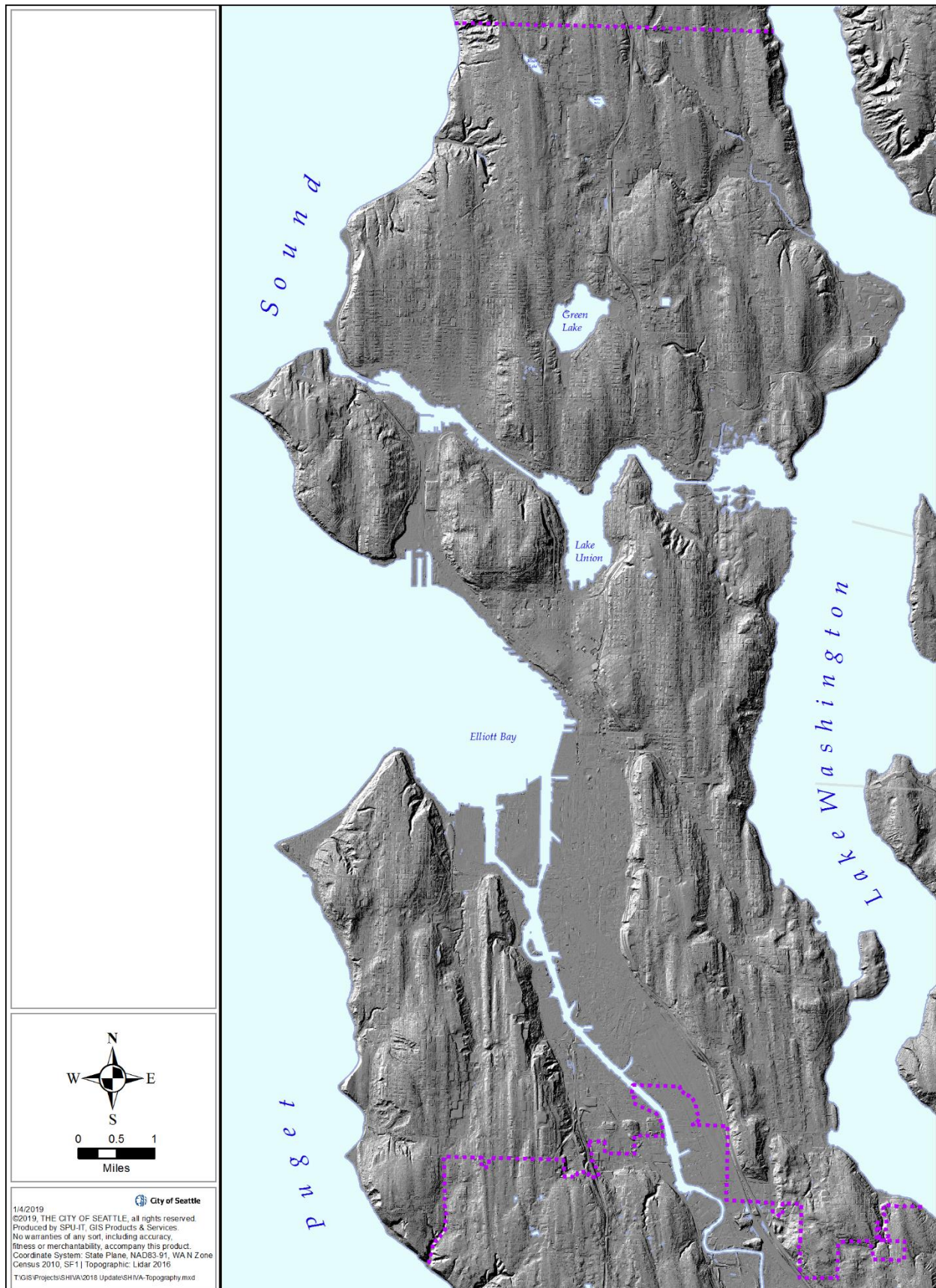
The importance of these water and slope barriers on emergency response cannot be overstated. The arrangement of hills and water has dictated where transportation routes and large facilities can be located. The resulting patterns create a relationship between the natural and built environments that are fundamental to Seattle's hazard vulnerability.

Many government services and employers are located in or near downtown. Most of the hospital beds in the City of Seattle are on First Hill, including Harborview, the only Level 1 Trauma Center for Washington, Idaho, Montana, and Alaska. In addition, there are four hospitals located north of the Ship Canal Bridge, one of which includes nearly all the pediatric hospital capacity in King County. The Veterans Administration hospital is on Beacon Hill and there is a psychiatric hospital in West Seattle that houses most of the involuntarily committed patients in King County, including those that pose a threat to public safety. The locations of hospitals provide broad geographic coverage across Seattle yet impacts to transportation infrastructure during disasters can isolate these facilities and render them only capable of providing medical services to their immediate communities.

The Fire Department's hazardous materials team is housed in Pioneer Square. Normally, this centralization is the most efficient distribution of resources, but during an emergency some neighborhoods could be cut off from these downtown services. West Seattle and Magnolia depend on just three bridges each for their direct connections with the rest of the city. In a major crisis, casualties would have to be transported downtown because there are no hospitals in those areas. If the bridges were down, there would be no way to get medical treatment to the neighborhood quickly. Even after the immediate crisis, isolation could remain an issue. San Francisco Bay commuters were confronted with long-term delays after the Cypress Freeway collapse in the 1989 earthquake. Seattle's dependence on bridges could easily lead to similar transportation problems.



**Figure 3-1. Topography**



### 3.1.3 Geology

The movement of earth and ice created Seattle. Tectonic activity (the movement of large plates of the Earth's crust) have sent whole island chains crashing into the West Coast and scraped up the sea floor creating the Cascade and Olympic Mountains and thrust up Washington's five active volcanoes. As for ice, at least seven times the Cordilleran Ice Sheet ground down from British Columbia covering the Puget Sound basin in ice up to 3000 feet thick. Each time, the surface geology was massively altered. The current shape of the city is almost exactly as the glacier left it.

Nature has not been the only shaper of the city. People have undertaken massive alterations of the landforms. Whole hills have been removed. The tide flats in the Duwamish Valley were filled. A cut was made in Beacon Hill. Massive amounts of garbage were dumped in Union Bay near University Village. In all, nearly 20% of the surface of Seattle is covered with made land.<sup>11</sup> During earthquakes, shaking on this type of land is amplified and is prone to failure. The earthquake chapter has more on the effects of these soils.

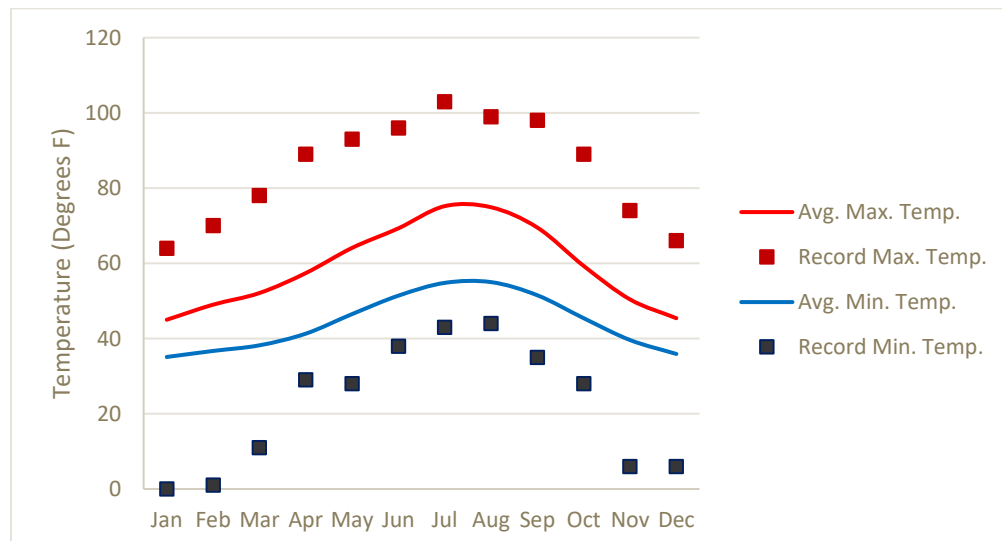
Seattle's steep hills are composed of mainly glacial till (mix of grain sizes) and sand with frequent layers of clay. When the weather is wet, water seeps down through till and sand only to stop at clay layers. The till and sand become saturated, heavier and less cohesive.<sup>12</sup> In many areas human activity has destabilized slopes. In analyzing a century's worth of reports, the engineering firm Shannon and Wilson calculated that 84% of all landslides had some degree of human influence.<sup>13</sup>

In 2006, deposits of volcanic ash were found along Hamm Creek, a tiny tributary of the Duwamish located just south of the city limits.<sup>14</sup> Usually the prevailing winds carry ash from nearby volcanoes east, but the layer suggests that Seattle is not immune to ashfall.

### 3.1.4 Climate

Seattle's climate can generally be described as "mild and moist," even though it gets less annual rain than Nashville, Atlanta, Boston, and Vancouver and has drier summers than only one reference city, San Francisco. Seattle can also receive hurricane force winds and even the rare tornado. To understand these complexities, one must first understand how the Pacific Ocean and Western Washington's mountain ranges influence Seattle's weather.

**Figure 3-2. Temperature Summary (Sea-Tac Airport) 1945 - 2016<sup>15</sup>**

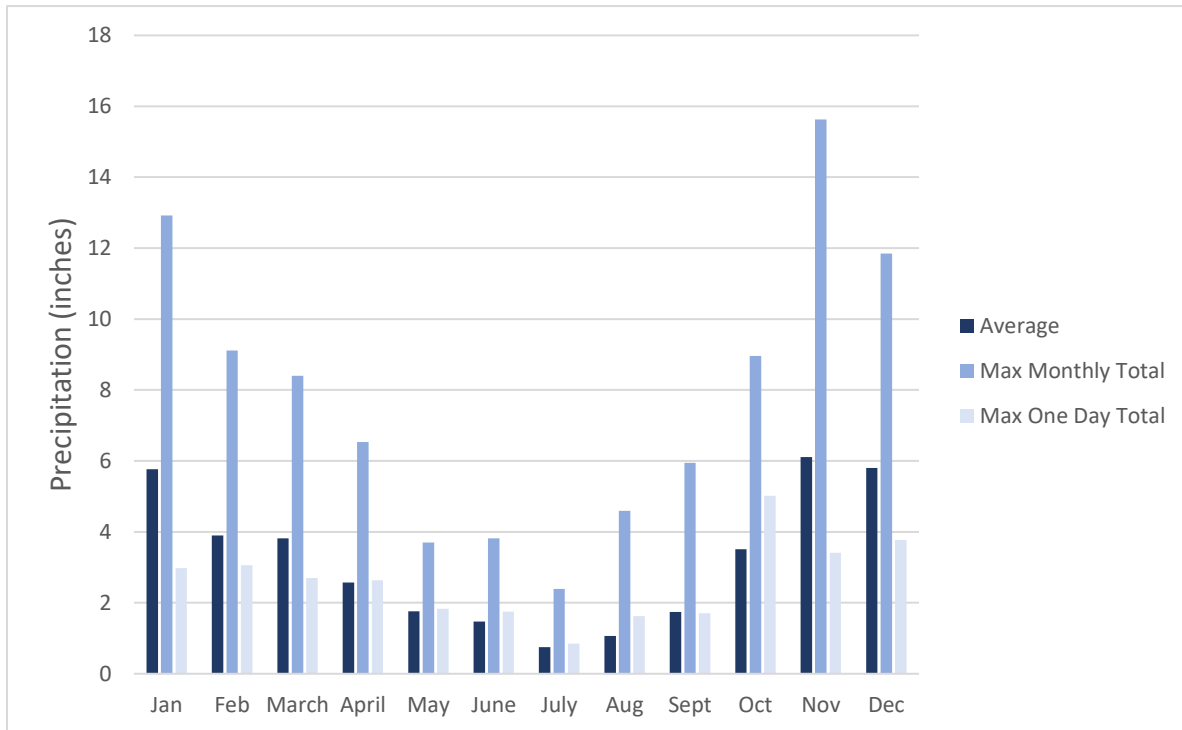




## Pacific Ocean

Prevailing winds bring the city’s weather from the west over the ocean. Because air temperature over water does not vary as much as it does over land, the air that reaches Seattle does not vary widely in temperature giving Seattle cool summers and temperate winters. On average each year there are just 2.8 days over 90 degrees and just 2.7 days where the temperature never gets above freezing.

**Figure 3-3. Seattle Precipitation Summary (Sea-Tac) 1948 - 2012<sup>16</sup>**



The ocean also accounts for the seasonality of our precipitation. Weather systems tend to follow the jet stream, a narrow band of high, strong winds. During the winter the jet stream frequently passes over Seattle, bringing wet, stormy weather. As temperatures rise over the Pacific in the summer, the jet stream is pushed north, taking the clouds and rain with it. Over 75% of Seattle’s precipitation falls between October 1<sup>st</sup> and March 31<sup>st</sup>; just under half falls between November 1<sup>st</sup> and the end of February.

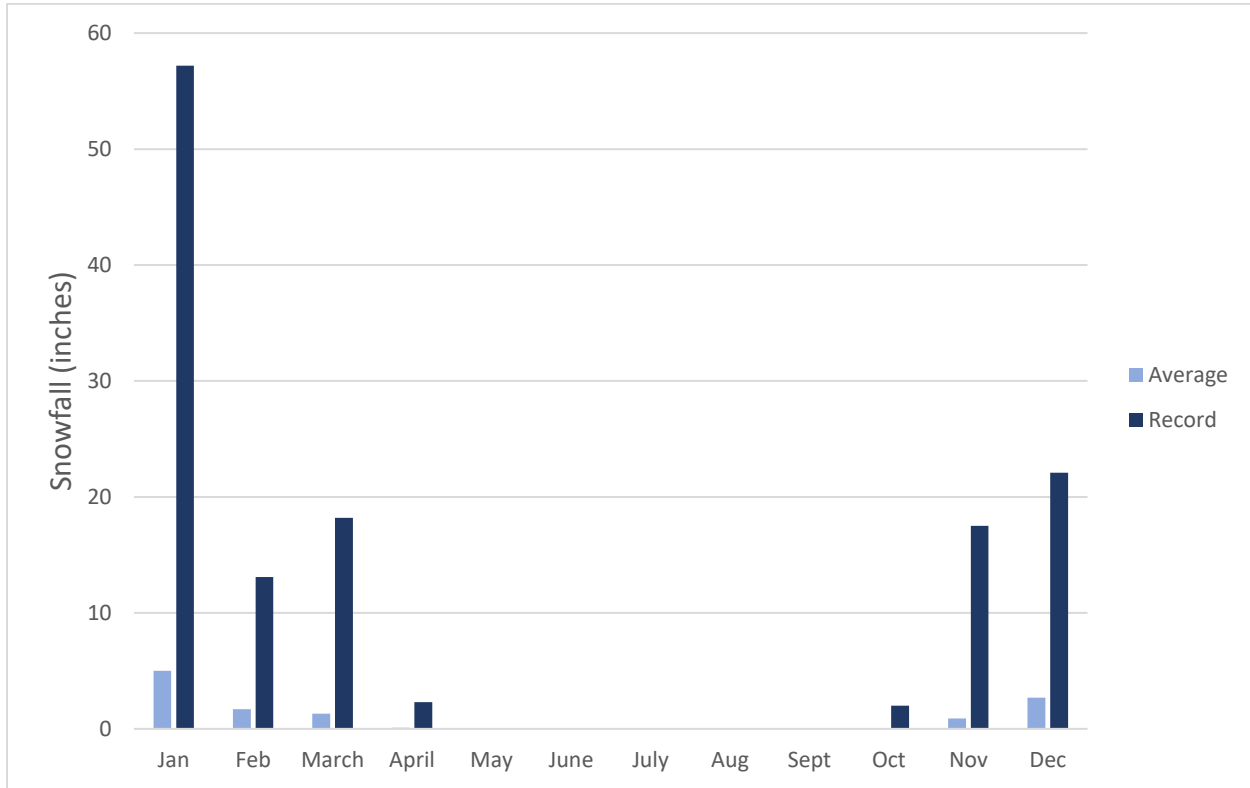
## Olympic and Cascade Mountain Ranges

The Cascade Range is a barrier that keeps dry continental air out of the region and moist Pacific air trapped in it. Continental air is hot in the summer and cold in the winter, but the mountain barriers mean that temperate marine air is the main influence on Seattle’s temperatures. This marine air carries a lot of moisture, especially in the winter. It is blocked by the Cascades as it moves east. It must move up to get over the mountains. As it does so it cools and condenses creating clouds and moderate rain. As a result, Seattle has rainier and overcast days but less total rain per year than many cities.

The snowiest places on earth are less than 100 miles from Seattle. Mt. Baker had 1,147 inches (nearly 100 feet) of snow during the winter of 1998-9 breaking a record set at Mt. Rainier of 1,122 inches. During the same winter, Seattle got only a few inches. On average, Seattle gets 12 inches of snow per year. That is almost twice what Portland and Vancouver receive, but nowhere near Boston’s 42 inches, Minneapolis’s 56 inches, or Denver’s 58 inches. Occasionally, however, Seattle seems transported into the snowy Cascades. Seattle’s one day record of 22.5” beats Minneapolis’s 18.5” by 3 inches. Seattle

record snowfalls far exceed average snowfalls. Most snowfalls happen when cold continental air breaks through the mountains and collides with an incoming Pacific storm. The reasons for the occasional heavy snow are covered in the chapter on snow storms.

**Figure 3-4. Snowfall Summary (Sea-Tac) 1948 - 2012<sup>17</sup>**



Seattle's generally mild climate ironically leads to some dilemmas. The snowfall totals reveal the dilemma most starkly: Seattle is neither a low snow city like Atlanta or San Francisco nor a heavy snow city like Denver. Stuck in the middle, the government, businesses, and residents face difficult choices about how much preparation to make. Adding to the complexities is Seattle's hilly topography that multiplies the effects of heavy rain, mud, and snow.

Weather can complicate emergency response. If a disaster were to strike while snow was on the ground it would greatly complicate the critical tasks. Transporting the injured to hospitals, many of which are located on hills, would be difficult and the fire department could be delayed in responding to emergencies. Even rain can be an unforeseen complication. After the Northridge Earthquake in 1994, many people moved out of their damaged houses and into local parks. The good weather allowed them to do this. In Seattle, they might not be so fortunate.

### 3.1.5 Natural Environment

This section discusses Seattle's natural environment and its two major habitat groups: the urban forest and aquatic environments. The Pacific Northwest is famous for its mountains, forests, and waterways. Despite being a major urban area, Seattle is a functional ecosystem integrated into the larger environment. Seattle still has vestiges of its original forest, wetlands, streams, and marine environments, but they are all fragile and endangered. In recent years, citizens, government, and businesses have become aware that environmental resources are not just found in wild lands, but also in our urban areas.

## Urban Forest

The land on which Seattle sits was originally heavily forested. In 1972, 40% of the city was covered by trees. Seattle's areas with heavy tree canopy, defined as over 50% tree coverage, declined from 5,400 acres in 1972 to 2,800 acres in 1996.<sup>18</sup> The City adopted the Urban Forest Stewardship Plan in 2013, which included a goal of 30% canopy cover by 2037. A 2016 LiDAR analysis showed 28% tree cover in Seattle.<sup>19</sup> New York City in comparison is 24% tree covered.<sup>20</sup>

The species mix is important, too. Native species are declining. In 1999, less than 293 acres of Seattle was covered with the conifer forests that once dominated Seattle's 54,000 acres and this number is declining.<sup>21</sup> Remaining natives, mostly big leaf maple and red alder, replaced the original Douglas fir and western hemlock logged in the 19<sup>th</sup> and early 20<sup>th</sup> century. Now these trees are aging. A natural cycle would see them replaced by conifers, but this is not happening because the Douglas fir and western hemlock were not re-seeded. The 2016 canopy cover report found that 72% of Seattle's tree canopy is deciduous, while only 28% is coniferous.<sup>22</sup>

Trees reduce stormwater runoff and reduce flooding. The City estimates that tree canopy loss costs Seattle \$1.3 million per year by causing an extra 7.5 million cubic feet in stormwater runoff – a factor in urban flooding.<sup>23</sup> Trees also improve urban air quality by removing thousands of pounds of pollutants from the atmosphere.<sup>24</sup> The estimated benefits from carbon storage amount to \$10.9 million in savings.<sup>25</sup>

Trees are also a hazard. During storms they damage houses, power and telephone lines and their roots pull up underground pipes. The 2016 LiDAR analysis shows that most of Seattle's trees are located in residential areas and in the right-of-way, representing 72% and 22% of the canopy cover, respectively.<sup>26</sup> The areas with the densest tree cover in the city, Northeast and West Seattle, have the greatest amount of debris, fallen trees, and associated service disruptions. The potential damage caused by falling trees can be mitigated by trimming the weak limbs and removing weakened trees near buildings and infrastructure.

## Aquatic Environments

Seattle contains lakes, rivers, streams, wetlands, and extensive shorelines. Seattle is bordered by Puget Sound on the west and Lake Washington on the east. In all Seattle has 146 miles of shoreline, 31 of which border Puget Sound. The City contains four small lakes: Haller Lake, Bitter Lake, Green Lake and Lake Union. The single river is the Duwamish. It enters Seattle in the middle of its southern border and flows north into Elliott Bay. The Ship Canal, dividing the city into north-south halves, connects Salmon Bay, Lake Union, and Lake Washington through a series of cuts. In addition to these large channels, Seattle supports five major creeks: Piper, Thornton, Longfellow, Fauntleroy, and Taylor. Many of these water bodies support wetlands. The largest are found at Union Bay, Warren Magnuson Park, North Seattle Community College, and the Fauntleroy area. Seattle also has many former wetlands and bogs that are now covered by development. They cause excessive subsidence when cut off from ground water.

Like Seattle's urban forest these water environments are simultaneously resources to protect and hazard sources. Their environmental quality varies but all have impacted by urbanization. The most severely compromised is the Duwamish River, six miles of which was designated as an Environmental Protection Agency (EPA) Superfund site in 2001. A large clean-up effort is now underway, but it will continue for up to 40 years.<sup>27</sup>

Seattle's shoreline is heavily modified. Only 10% is unaltered.<sup>28</sup> All of Seattle's 31 miles of Puget Sound shoreline is listed as a coastal flood hazard by the Federal Emergency Management Agency (FEMA). The most environmentally productive habitats in Seattle are some of these shoreline areas: Seward Park, Union Bay, West Point, and Magnolia Bluffs and Lincoln Park to Fauntleroy Cove.

Seattle has system of Combined Sewer Overflows (CSO) that sends untreated sewage into local waters during periods of heavy rain. The City of Seattle Shoreline Characterization Report found decreased water quality near these locations after storms.<sup>29</sup>

Many of Seattle's shorelines are ringed by bluffs. In a natural environment Puget Sound bluffs provide material for beaches and shoreline environment below them. Wave action rarely causes slides, but it can steepen slopes making them more susceptible to groundwater induced failure.<sup>30</sup> In Seattle, much of the shoreline has been armored in an effort to prevent beach erosion and landslides. Over 90% of the Puget Sound shoreline between Everett and Tacoma is armored.<sup>31</sup> Armoring is detrimental to shoreline habitat. It increases wave speeds. The faster speeds cause waves to scour beds and reduce food sources for microorganisms forming the bottom of the food chain. Armoring can cause some bluffs recede faster by depriving their bases of sediment. During the 1996-97 landslides many landslides occurred on slopes where a bulkhead had protected the toe for decades.

### **3.1.6 History**

Seattle's real growth did not start until 1880. Even its older buildings seldom date back beyond the 1890's. Despite its youth, Seattle's history has a direct impact on the location of the most vulnerable structures and generates collective institutional memories of past disasters that shape perceptions of all the hazards the city faces.

Seattle grew out from its Pioneer Square location. Many of the oldest buildings in the city are there and in the surrounding Queen Anne and Capitol Hill areas. As the city grew, it spawned several towns that became the roots of several Seattle neighborhoods, notably Ballard, Columbia City, and the University District. Due to the influence of these satellite areas and the area's hilly topography, Seattle developed strong neighborhoods. Consequently, older and more vulnerable structures are scattered throughout the city, especially in the old cores like Ballard and Columbia City. This development suggests a need for a decentralized emergency response to cope with damage to these older structures in the outlying areas.

Past disasters have created a filter through which residents and city leaders perceive the area's hazards. The moderate earthquakes of the mid-1990s jolted the city into an awareness of the risk that a major earthquake poses for it. These collective memories can produce ironic results. After the great fire of 1889, building codes changed to require brick construction. Soon, brick construction became a norm. The new construction introduced a vulnerability to the then unnoticed risk of earthquakes.

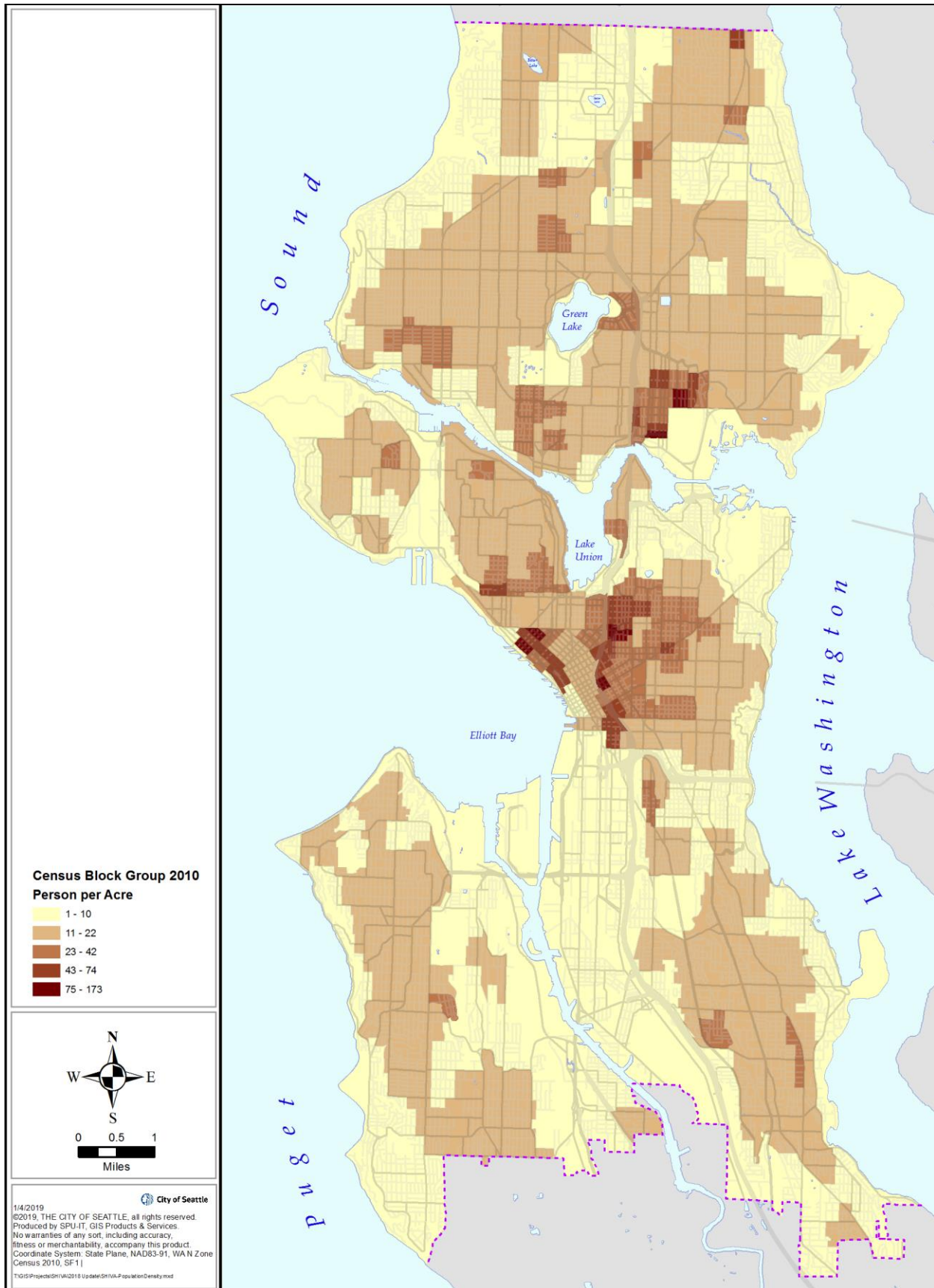
## **3.2 Population and Economy**

Seattle typifies America's social and economic changes in the population and economy of the last half century. Like most cities at the center of urban areas, Seattle declined through the 1960's and 70's only to start growing again after 1980. While its growth has been strong, the suburbs have grown faster until 2012, when for the first time in 102 years, Seattle grew faster than its suburbs. So far, the trend has continued. Seattle's population increased by 15.4% from 2010 – 2016, while the rest of King county saw only 8.9% population growth during the same period. In 2017, Seattle grew by 16,700 people, more than any other city in Washington state.<sup>32</sup> It is not clear if this change is short term or a major demographic shift.

The local economy echoes the national economy with a shift from manufacturing to technology and services. While Seattle used to be centered on manufacturing (Boeing) it has diversified to include the technology (Amazon) and health sectors as key components.

There are signs that Seattle, like Manhattan and San Francisco, is losing its middle class and becoming less diverse than its suburbs. Seattle's median income is rising, but pockets of poverty remain. The

**Figure 3-5. Population Density 2010**





income gap in Seattle is growing and as the cost of living rises, those with lower income are finding it harder to get by. In 2017, The Cost of Living Index ranked Seattle in 6<sup>th</sup> for most expensive place to live, with goods and services costing about 53% higher than the national average.<sup>33</sup>

In 2017, Seattle's population pushed over 700,000 for the first time and has kept growing<sup>34</sup>. As of April 1, 2018, Seattle had an estimated 730,400 residents.<sup>35</sup> About half of the population is between the ages of 25-55 and the majority live alone or with one other person. The growing population is a good first order indicator that Seattle remained fundamentally healthy despite the Great Recession. The overall picture painted by statistics is of a community in which most people have been doing well but also where a sizable chunk of its population has not been able to share in the general prosperity and is experiencing challenges, especially with housing.

Like other American cities, Seattle's population first peaked around 1960, experienced a slow decline through 1980 and then began to rise again. Today Seattle has passed its earlier peak and continues to grow. In the 1990's, Seattle's recent growth was fueled by in-migration from younger, single, well-educated, and relatively affluent people during the 1990s. During the late 2000's Seattle demographics shifted again. The number of children began increasing, especially in the north end and downtown area. The shift has resulted in school crowding in Seattle Public Schools. In 2012, it made plans to open its first new elementary school in decades.<sup>36</sup> Since then, Seattle Public Schools have gained about 1,000 students per year and have opened several schools and added portable classrooms to existing schools to accommodate the growth.<sup>37</sup>

2016 census data show that:

- Seattle has an average household size of 2.12. Almost 40% of Seattleites live alone.
- Over 60% of residents have at least a bachelor's degree.
- 17.9% of Seattle residents are under 19, a decrease from 19.6% in 2014, when Seattle ranked 3<sup>rd</sup> for lowest share of households with children.<sup>38</sup>
- Seattle has seen many new residents in recent years. From 2016-2017 alone, the Seattle metro area gained about 21,000 people from domestic migration and another 21,000 from international migration.<sup>39</sup> In 2017, Seattle ranked 1<sup>st</sup> in population growth out of the top 50 most populous cities in the US.<sup>40</sup>

Seattle is a comparatively affluent city. In 2018, Seattle's economy was ranked 4<sup>th</sup> strongest among the 40 largest cities in the U.S.<sup>41</sup> Median household income has been growing since the 1990s. In 2015, Seattle's median household income grew more than any other large city to \$80,349, placing it third for median income, behind San Francisco and San Jose. Like many other cities, household income is less evenly divided than in the country, and less evenly divided than it is in King County as a whole. A comparison of income distribution among the nine reference cities found that three had a measurable difference. Atlanta, Pittsburg, and New Orleans had a more uneven distribution of income.

In 2000, poverty rates fell to some of the lowest of any large city, especially for children. In 2008, after the Dot-Com bust, but before the Great Recession, Seattle ranked 3<sup>rd</sup> lowest in overall poverty among cities over 500,000. More recently, the Seattle metro area ranked 6<sup>th</sup> lowest in overall poverty among the 25 most populous metro areas for 2016.<sup>42</sup> However, Seattle's poverty rate of 11.5% is higher than the broader metro area (9.6%).

Seattle saw a rise in poverty among its elderly population from 1990 through 2008. This can possibly be explained by an out-migration of younger seniors with more resources, leaving poorer and older seniors in the city. Poverty among the elderly in 2016 was almost identical to the overall rate, at 11.6%.<sup>43</sup>

Growing income inequality and the recent influx in migration of new residents to Seattle is reflected in its housing market. From 2016 to 2017, home prices for the Seattle metro area grew 12.7%, the highest growth in the nation. The median home price has reached a record \$820,000.<sup>44</sup> Renters are struggling to keep up with the market as well. In 2015, almost half of Seattle residents reported putting 30% of their income towards rent, while 22% put over 50% of their income towards rent.<sup>45</sup> While new apartment buildings are rapidly being constructed in the city, many are not affordable and competition for lower-cost rentals is high. 2016 vacancy rates for low-cost rentals were below 3%.<sup>46</sup>

During the 1990s Seattle also grew more diverse, but the rate of diversification in Seattle was exceeded by that of the suburbs. As of 2016, Bellevue, Tacoma, and King County were more racially diverse than Seattle. Immigration followed the same pattern, with rapid increases in Seattle exceeded by even greater increases in the suburbs. In 2008, King County had a slightly higher share of foreign born (19%) than Seattle (18.4%) and Bellevue had a much greater share (29.8%)<sup>47</sup>. This gap has widened in the past 8 years, with Seattle's share slightly decreasing (18%), and King County and Bellevue increasing (21.6% and 37%, respectively) in 2016. Immigrants appear to be migrating directly to the suburbs.

These demographics refer to Seattle residents. Less is known about the demographics of the daytime population that swells as people commute into the city to work. The Seattle Police Department estimates the daytime population to be around 842,000 (2017).<sup>48</sup>

Seattle's demographics suggest a unique hazard vulnerability profile. Several local and national studies linked respondent demographic characteristics to personal preparedness. Combining a region's demographic profile with these studies can hint at the level of preparedness in a community and possible vulnerabilities.

One of the most influential surveys is FEMA's Personal Preparedness in America. A new report was released in 2014. It connects demographic profiles to levels of preparedness, barriers to preparedness, and perception of risk. Those considered more prepared were more likely to own a home, have a college degree, earn at least \$75,000, and live in a low to medium population density area. Those considered less prepared were more likely to live in high population density areas, be unemployed, earn \$25,000 or less, and have a high school diploma or less. It is difficult to apply these findings to the general Seattle population because while median income is high overall, and over half the population has at least a bachelor's degree, Seattle is also very dense, and most people are not home-owners. Along with lack of preparedness, people who live in high-density areas are less confident in their ability to respond, and more reliant on fire, police, and emergency management personnel than those in low to medium-density areas.

### **3.2.1 Social Vulnerability**

Hazards do not affect the population equally. Some people suffer more than others. These people are 'socially vulnerable.' If large numbers of socially vulnerable people are impacted by a hazard, this inequity will make the resulting disaster "bigger." Seattle's most vulnerable people tend to be clustered around Seattle's edges, in Rainier Valley, Beacon Hill, south downtown, and North Seattle (around Northgate and Lake City Way).

Social vulnerability affects all hazards. One of the most effective ways to reduce a community's overall vulnerability is to target social vulnerability.

The University of South Carolina has developed an index to measure social vulnerability. It synthesizes socioeconomic and built-environment variables then maps them to the census tract level. Figure 3.6 summarizes Seattle's Social Vulnerability Index.

**Figure 3-6. Social Vulnerability**

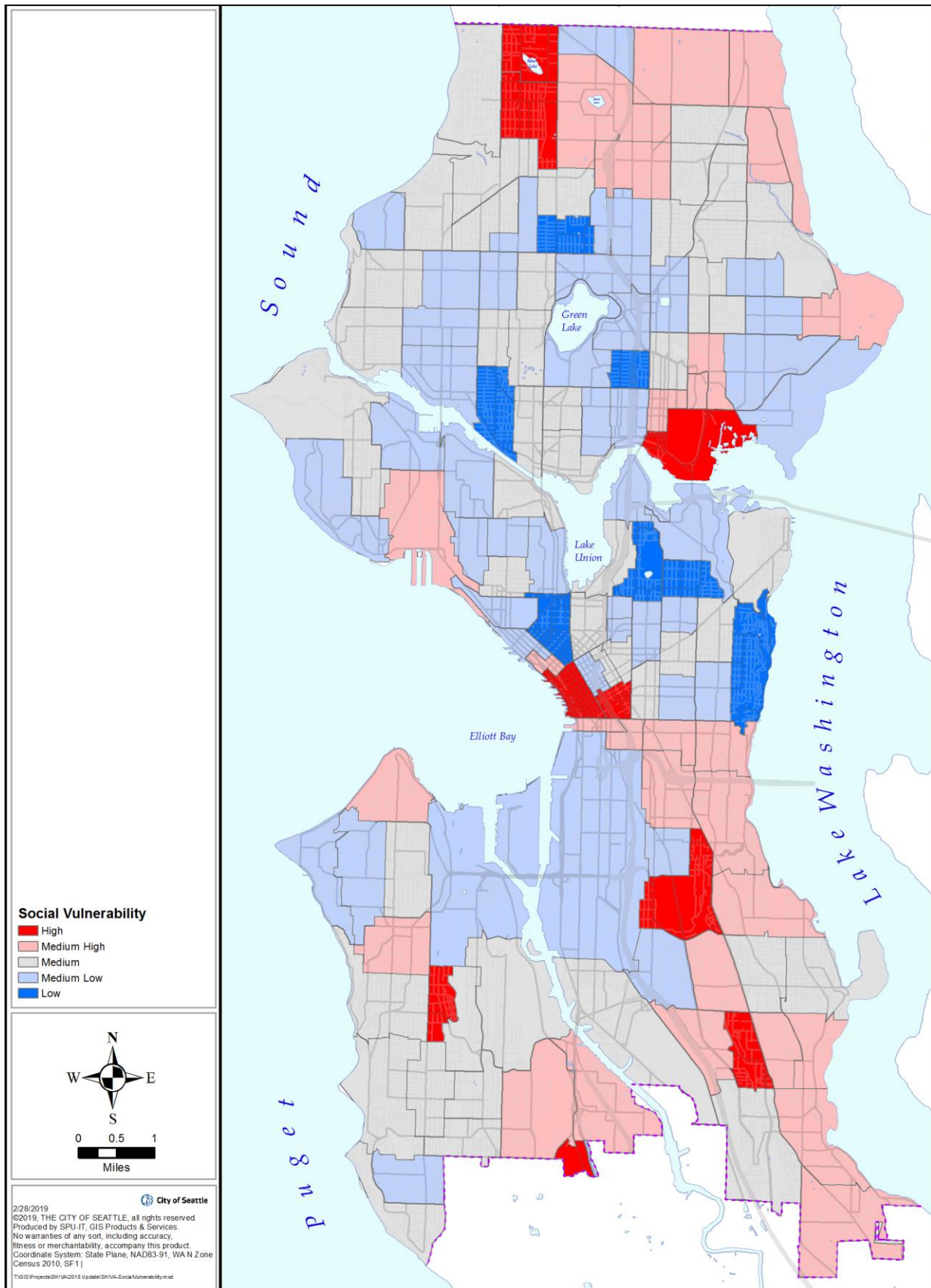




Table 3-2. Demographic Summary of Seattle and Similar Cities<sup>49</sup>

Item	Similar Cities Nationally										Regional Comparison				Nation
	Seattle	Portland	Denver	San Francisco	Minneapolis	Boston	Nashville	Atlanta	Tacoma	Bellevue	King County	U.S.			
Total population	668,849	620,589	663,303	850,282	404,670	658,279	643,771	456,378	205,602	136,718	2,079,550	318,558,162			
Median age	36	37	34	38	32	32	34	34	36	38	37	38			
Pop 25+: Bachelor's or higher	60.4%	46.9%	45.7%	72.3%	47.7%	66.4%	37.6%	48.3%	26.7%	64.1%	49.1%	30.3%			
Average household size	2.12	2.36	2.31	2.33	2.28	2.35	2.4	2.24	2.49	2.48	2.46	2.64			
Average family size	2.89	3.04	3.21	3.14	3.16	3.15	3.15	3.41	3.23	3.01	3.09	3.24			
Disability Status	9.4%	12.9%	9.4%	10.6%	10.9%	12.3%	11.9%	11.9%	15.0%	8.2%	9.6%	12.5%			
Non-English language at home	21.7%	19.0%	27.1%	44.0%	20.9%	37.1%	16.9%	9.8%	19.2%	41.0%	26.5%	21.1%			
Foreign Born	18.0%	13.7%	15.9%	34.9%	15.3%	27.6%	12.5%	7.0%	13.1%	37.0%	21.6%	13.2%			
Foreign Born - Asia	29.0%	40.7%	18.1%	63.8%	26.1%	25.6%	30.1%	38.7%	48.3%	69.0%	53.5%	30.1%			
Foreign Born - Latin America	4.0%	25.0%	62.8%	18.9%	32.6%	49.0%	44.1%	32.6%	26.0%	10.2%	17.8%	51.5%			
Means of Transport to Work															
Mean Travel to Work (minutes)	26.9	25.6	25.1	32.4	22.7	30.3	24.3	25.8	27.1	23.1	28.7	26.1			
Drove alone	49.2%	57.8%	70.2%	35.0%	61.3%	38.9%	79.4%	68.6%	75.5%	65.1%	63.6%	76.4%			
Carpooled	7.7%	8.9%	8.2%	7.2%	8.1%	6.0%	10.1%	7.0%	10.7%	9.0%	9.6%	9.3%			
Public transportation	20.8%	12.1%	6.8%	33.7%	13.1%	33.6%	2.2%	10.0%	4.9%	12.6%	12.6%	5.1%			
Walked	10.1%	6.0%	4.5%	10.6%	7.2%	14.8%	2.0%	4.6%	3.3%	5.3%	5.0%	2.8%			
Other means	5.2%	7.8%	3.4%	6.9%	5.2%	3.4%	1.3%	2.1%	1.8%	1.3%	2.8%	1.8%			
Worked from home	7.0%	7.5%	6.9%	6.6%	5.2%	3.4%	5.0%	7.6%	3.9%	6.7%	6.3%	4.6%			
Mobility: Lived last year in another state/country															
Income	6.6%	5.5%	5.1%	4.0%	5.0%	6.2%	5.2%	4.9%	3.1%	8.3%	5.1%	2.9%			
Per capita income	\$48,686	\$34,778	\$36,616	\$55,567	\$33,490	\$37,288	\$29,427	\$38,686	\$27,947	\$54,883	\$43,629	\$29,829			
Families below poverty	6.9%	10.5%	12.2%	7.0%	14.6%	16.7%	13.3%	18.8%	13.2%	5.4%	6.7%	11.0%			
Individuals below poverty	13.0%	16.9%	16.4%	12.5%	21.3%	21.1%	18.0%	24.0%	17.9%	7.5%	10.7%	15.1%			
Housing															
Owner-occupied	46.2%	53.1%	49.4%	36.8%	47.7%	34.7%	53.5%	43.0%	50.0%	56.5%	57.3%	63.6%			
Renter-occupied	53.8%	46.9%	50.6%	63.2%	52.6%	65.3%	46.5%	57.0%	50.0%	43.5%	42.7%	36.4%			
Median home value	\$484,600	\$319,400	\$292,700	\$858,800	\$212,800	\$423,200	\$174,600	\$222,300	\$212,400	\$608,500	\$407,400	\$184,700			
Median rent	\$1,266	\$1,025	\$1,035	\$1,632	\$898	\$1,369	\$902	\$998	\$980	\$1,629	\$1,273	\$949			
Age															
Under 5	5.0%	5.7%	6.7%	4.6%	6.8%	5.4%	7.1%	5.9%	6.6%	5.8%	6.1%	6.2%			
Under 18	15.3%	18.4%	20.7%	13.5%	20.0%	16.5%	21.5%	18.7%	21.7%	20.8%	20.9%	23.1%			
Over 65	11.9%	11.6%	10.9%	14.4%	8.8%	10.7%	10.8%	10.8%	12.8%	14.1%	12.2%	14.5%			

Source: U.S. Census Bureau American Fact Finder 2012 - 2016 American Community Survey 5-year Estimates (Accessed on 7/9/2018)

Source: U.S. Census Bureau American Fact Finder 2012 - 2016 American Community Survey 5-year Estimates (Accessed on 7/9/2018)

While the Social Index of Vulnerability is a valuable tool, it is a national model. Each community is a bit different. Public Health—Seattle & King County has identified the following groups that are at-risk for disproportionate impacts in an emergency:<sup>50</sup>

- Aging adults and children
- Individuals with medical needs
- Individuals who are blind
- Individuals who are deaf, deaf-blind, hard of hearing
- Individuals with developmental disabilities
- Individuals with mental health conditions
- Individuals with limited mobility
- Individuals who have experienced domestic violence
- Individuals experiencing homelessness or transitional housing
- Immigrant and refugee communities
- Individuals who are undocumented
- Individuals who are limited or non-English speaking
- Clients of the criminal justice system
- Individuals who are drug or alcohol dependent
- People of color

The aging adult and elderly population in Seattle has an increased risk of social isolation, of having a disability that prevents them from leaving their home, and of facing barriers to obtaining information.<sup>51</sup> All of these concerns are exacerbated during a hazard event. In 2016, Seattle joined the age-friendly city initiative to address environmental, economic, and social factors influencing the health and well-being of older adults.<sup>52</sup> Efforts are being made to reduce social isolation among aging adults and to educate the elderly about emergency preparedness.<sup>53</sup>

The Seattle region has seen a rise in the number of people experiencing homelessness. The total number of homeless individuals in King County has grown from about 9,000 in 2009 to over 11,500 in 2017, a 30% increase.<sup>54</sup> The unsheltered population, or those staying in a place not meant for habitation (such as a vehicle or street), has increased by about 90% from 2009 to 2017.<sup>55</sup> The sheltered population, on the other hand, has only grown by about 1%. Those experiencing homelessness are particularly vulnerable to hazards as they may face greater barriers to obtaining information and resources. Additionally, the unsheltered population is likely to face disproportionate affects from weather-related hazards such as winter storms, excessive heat events, or flooding.<sup>56</sup> Almost a quarter of homeless youth in Seattle identify as LGBTQ,<sup>57</sup> a population that has historically faced discrimination that may compound the stress felt in a disaster situation.<sup>58</sup>

### **3.2.2 Economy**

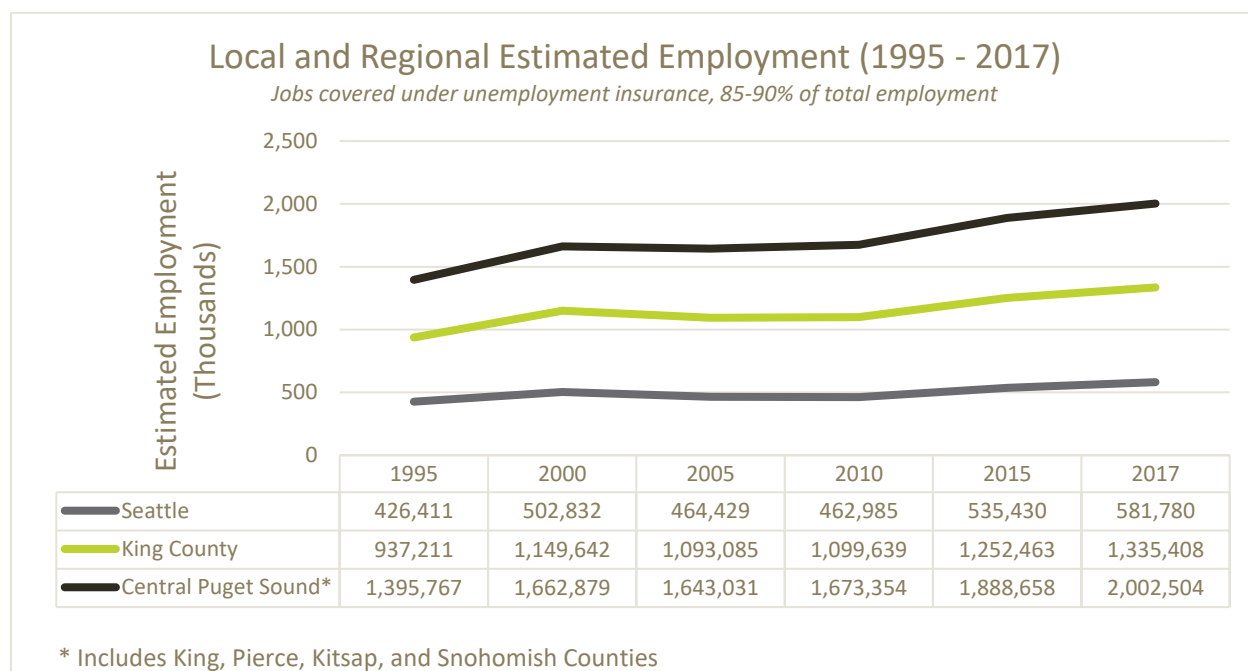
Seattle is the center of the Puget Sound economy and a leading hub of the Western United States. Historically, the regional economy was centered around the timber, shipping, and aerospace industries combined with the military. In the last several decades Seattle's economy has grown much more diverse. The healthcare, biotechnology, software, communications, tourism and transportation industries are now critical components of Seattle's economy. Over the long-term Seattle's growth has

been above average, but it has also been strongly cyclical due to the historically large influence of the aerospace industry.

Seattle supported an estimated 581,780 jobs in 2017 (this number represents jobs covered by unemployment insurance, 85-90% of jobs).<sup>59</sup> Unemployment has dropped from 9.9% in 2010 to 3.7% in 2017, illustrating Seattle's recovery from the Great Recession.<sup>60</sup>

Services account for 53% of jobs, followed by government and education (16%), retail (11%), and manufacturing and construction (9%).<sup>61</sup> These percentages reflect national trends away from manufacturing and into the service sector.

**Table 3-3. Local and Regional Estimated Employment<sup>62</sup>**



The aerospace industry has long been central to Seattle's economy. While Boeing still has a huge presence in the Puget Sound region, its influence is decreasing. It still spends billions in the Seattle area, but it has dramatically cut employment in Seattle proper, with most jobs located in Renton and Everett. The aerospace industry is very cyclical, and the swings of Seattle's economy have been very dramatic, however with the reduction in Boeing's presence and the development of other sectors, Seattle's up and down economy has become more stable.

Most of Seattle's manufacturing sector remains centered along the Duwamish River and in parts of Ballard. Seattle has a much lower concentration of manufacturing than the rest of King County and Washington State, but some manufacturing subsectors remain in higher concentrations in Seattle. These include construction, freight, printing, seafood processing, food and beverage, metal fabrication and stone products. The geographic concentration of Seattle's manufacturing poses a risk. Most of its industry sits in a liquefaction zone on top of the Seattle Fault. Many of these companies are small businesses that may not be able to survive prolonged downtime.

Seattle's healthcare industry has seen steady growth over the past two decades. In 2016, there were 78,099 healthcare and social assistance jobs, accounting for about 13% of the job market.<sup>63</sup> This number does not reflect the growing number of biotech and medical research jobs, which have become a prominent industry in Seattle with organizations like the Fred Hutchinson Cancer Research Center and the Allen Brain Institute. The healthcare and health research sectors are concentrated in First Hill

(hospitals), South Lake Union (medical research and biotech firms) and the U-District (University of Washington).

The software and internet services industry has become essential to Seattle's economy. Since getting its start in 1994, Amazon has had an undeniable influence on the city, now serving as its largest employer with over 40,000 employees.<sup>64</sup> It occupies 19% of all the prime office space in Seattle (8.1 million square feet) and continues to construct new buildings.<sup>65</sup> While its original growth was centered in the South Lake Union area, Amazon has gradually moved south towards the downtown core. Microsoft continues to employ many people in the area but has primarily located jobs in Redmond, a suburb east of the city. There are many linkages between the healthcare and software industries.

The Port of Seattle is an important component of the city's economy. Seattle's shipping industry remains strong. Terminal expansions such as the opening of Terminal 30 are increasing the scope of operations, much of which involve intermodal operations. This industry centers around the mouth of the Duwamish River.

Seattle has become a major tourist destination, and the number of visitors has steadily grown over the past decade. In 2017, the city had 39.9 million visitors, up 2.6% from the previous year.<sup>66</sup> The arts, music, and sports are major contributors to the local economy generating revenues in the billions and employing thousands. Seattle tourists spent \$7.9 billion in 2017, generating over \$760 million in tax revenue.<sup>67</sup> A 2017 survey also found that tourists spend an average of \$195 per day when visiting the downtown area.<sup>68</sup> The city is planning to expand its convention center, which has turned down many requests for events in recent years due to space limitations.

Besides its direct contribution, the cultural sector combines with the outdoor and coffee industries to contribute to Seattle's reputation as an attractive place to live and work. Although its effect is hard to quantify, this attractiveness is cited as a major reason that businesses locate in Seattle. Maintaining Seattle's 'brand' is one of the reasons the perception of the community is included in this study.

Overall, the core of Seattle's economy has recovered from the Great Recession and continues to experience growth.

### 3.3 Land Use

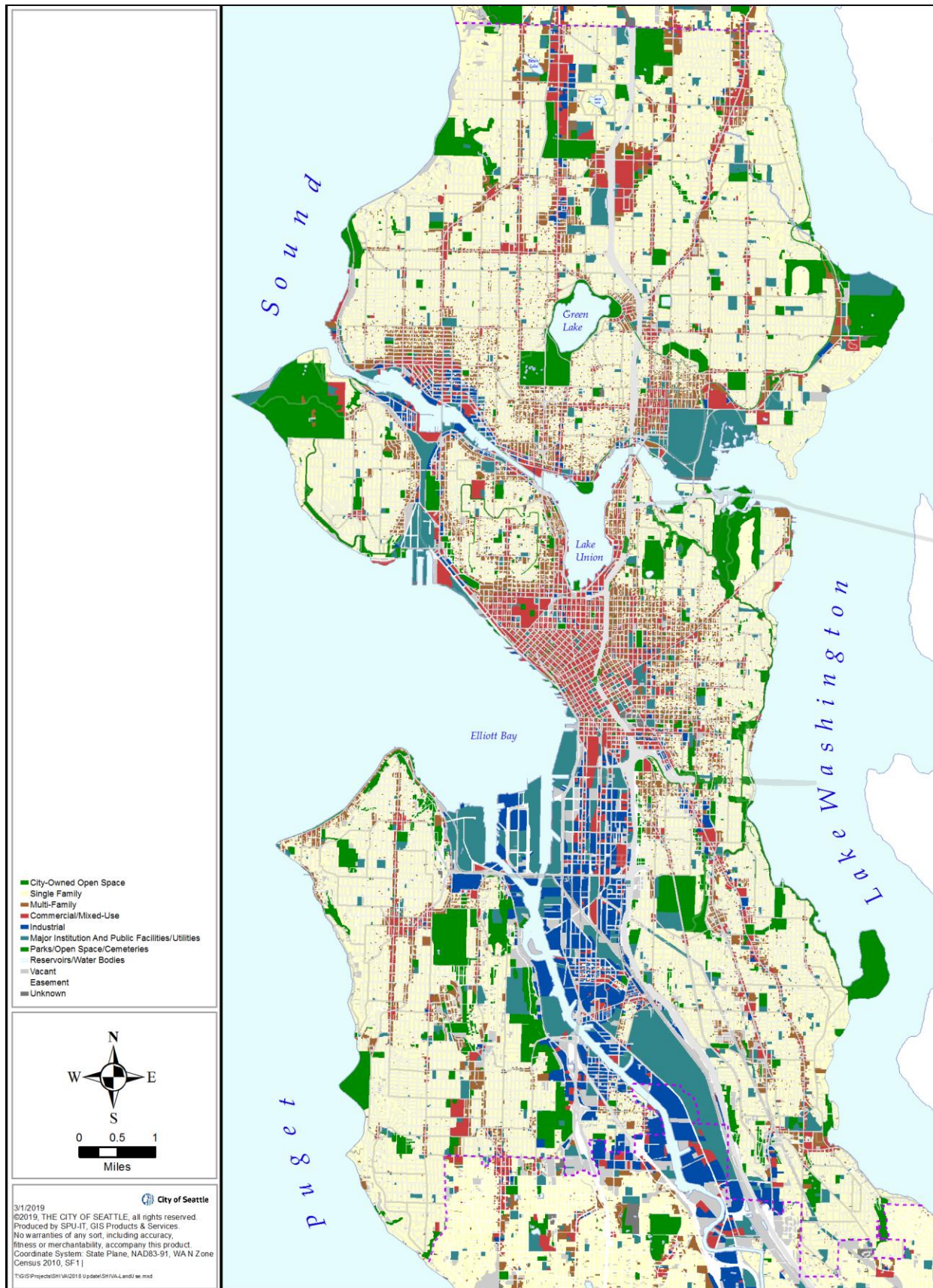
Seattle is a mature city at the core of the Puget Sound metropolitan region. It is approximately 53,500 acres or 84 square miles in size, making it nearly twice as large physically as Boston, San Francisco or Vancouver BC and quite a bit smaller than Portland or Denver. Like other core cities, it has little undeveloped land and a large share of the region's major institutions, government, business and industry. Even so, many areas of the City are covered with smaller single-family homes built in the 1920s, 30s, and 40s that give much of Seattle the atmosphere of an older suburb. This atmosphere is changing, however, as Seattle's density increases under the State's Growth Management Act. Greater densities are being encouraged within urban villages clustered around transportation hubs.

Over one-third of Seattle is covered in single family lots (35%) and just over one-quarter in right of way (26%). Seattle has 10% of its area as city-owned open space but does not have a large regional park like Portland's Forest Park (5,170 acres).

The major employment uses (commercial, industrial, and major institutions) cover 16% of the city's area. Multi-family uses are just 6% of Seattle's area even though they account for over half (51%) of the dwelling units.<sup>69</sup> The reason is that most of Seattle's multi-family units are in larger apartment and condo complexes rather than smaller 2, 3, and 4-plexes. **Error! Reference source not found.** displays data from the City's Office of Planning and Community Development and shows the breakdown of the city's land uses in 2017.



**Figure 3-7. Land Use**



Land use drives population shifts on all time scales, from daily commutes to weekly recreation and long-term residential patterns. The Seattle Police Department estimated that Seattle’s 2017 daytime population grew by 18% every weekday to approximately 842,000 people.<sup>70</sup>

**Table 3-4. 2018 Land Use Summary<sup>71</sup>**

<b>Seattle Land Use excluding Right of Way</b>	<b>Square Feet</b>	<b>Percentage</b>
City of Seattle Facilities	4,124,793	0.15%
Commercial/Mixed-Use	218,741,242	7.69%
Duplex/Triplex	1,273,079	0.04%
Easement	338,209	0.01%
Entertainment	3,086,548	0.11%
Hotel/Motel	1,655,034	0.06%
Industrial	128,049,685	4.50%
Institutions	180,212	0.01%
Major Institution And Public Facilities/Utilities	325,832,738	11.46%
Mixed-Use	374,366	0.01%
Multi-Family	202,298,234	7.12%
Office	3,054,243	0.11%
Open Space	158,253,671	5.57%
Other Housing	387,357	0.01%
Parks/Open Space/Cemeteries	68,973,773	2.43%
Private	1,133,565	0.04%
Public Facilities	41,734	0.00%
Retail/Service	6,802,067	0.24%
Schools	1,179,600	0.04%
Seattle Housing Authority	88,154	0.00%
Single Family	1,351,340,918	47.54%
Transportation/Utility/Communications	26,401,479	0.93%
Unknown	7,978,485	0.28%
Vacant (includes undeveloped 'land' in water)	322,997,092	11.36%
Warehouse	496,133	0.02%
Water Bodies	7,624,079	0.27%

Seattle is home to the region’s biggest sports and entertainment venues as well as cruise ship terminals. In 2017, the Port of Seattle reports that over 1 million passengers came to Seattle by cruise ship, generating over \$500 million in business revenue. The activities located on this land use contribute thousands of people to Seattle’s waterfront, tourist, entertainment and stadium areas at all times of day.

With just under 8,500 people per square mile, Seattle seems to be in transition from a lower density city like Atlanta, Portland, or Denver, dominated by single family neighborhoods, to a higher density city like Vancouver BC, San Francisco, and Boston. The former cities have between 3,500 and 4,800 people per square mile; the later cities have between 14,000 and 18,000. The highest population densities occur in Seattle’s Belltown, Capitol Hill, First Hill, and University District neighborhoods, with over 100 people per acre in some blocks.<sup>72</sup>

Comparing Seattle’s multi-family areas with those of Boston and San Francisco reveals different development patterns. More people living in multi-family residences in Seattle live in big complexes than in Boston and San Francisco, which have whole neighborhoods of smaller, 3 and 4-unit buildings. This development gives Seattle a steep density gradient from multi-family to single-family areas. The implication for emergency management is that the number of residents who may be affected by a disaster can vary more over short distances.

Washington State’s Growth Management ACT (GMA) has strongly influenced development plans for Seattle. The GMA stresses putting growth in already developed areas to prevent urban sprawl. Seattle has responded to the GMA with a Comprehensive Plan that stresses development in urban centers and villages. These are areas built around current commercial, multi-family residential, and transport hubs. The major goal is to locate housing, jobs and stores near each other to reduce the necessity of car use. Tables within hazard chapters show what percentage of these areas fall within mapped hazard areas (e.g., landslide prone).

### **3.4 Transportation**

Seattle is Western Washington’s transportation hub. The region’s most important routes connect within it. Seattle’s system is a complex system of surface, air, and marine modes that moves people and freight inside the region as well as in and out of it. This system must balance the needs of many different user groups. Contention between passenger and freight transport (e.g., freight trains crossing busy streets) and between passenger transport modes (e.g., between car and bicycle) is one of the major challenges facing Seattle today.

The transportation system directly affects the ability to move critical resources (including people) the first few hours after a major disaster strikes. A significant number of employees face long commutes or must cross vulnerable bridges. In major disasters, state and federal assistance is important, but it may be difficult to bring in outside help if the transportation system is heavily damaged.

#### **3.4.1 Passenger Transport**

Like most American cities, Seattle’s ground system has been dominated by cars. However, this dependence on cars may be decreasing slightly as measures designed to reign in urban sprawl begin to take effect. In 2016, 14% of Seattle workers walked or biked to work while 20% used public transit (compared to 5% nationally).<sup>73</sup>

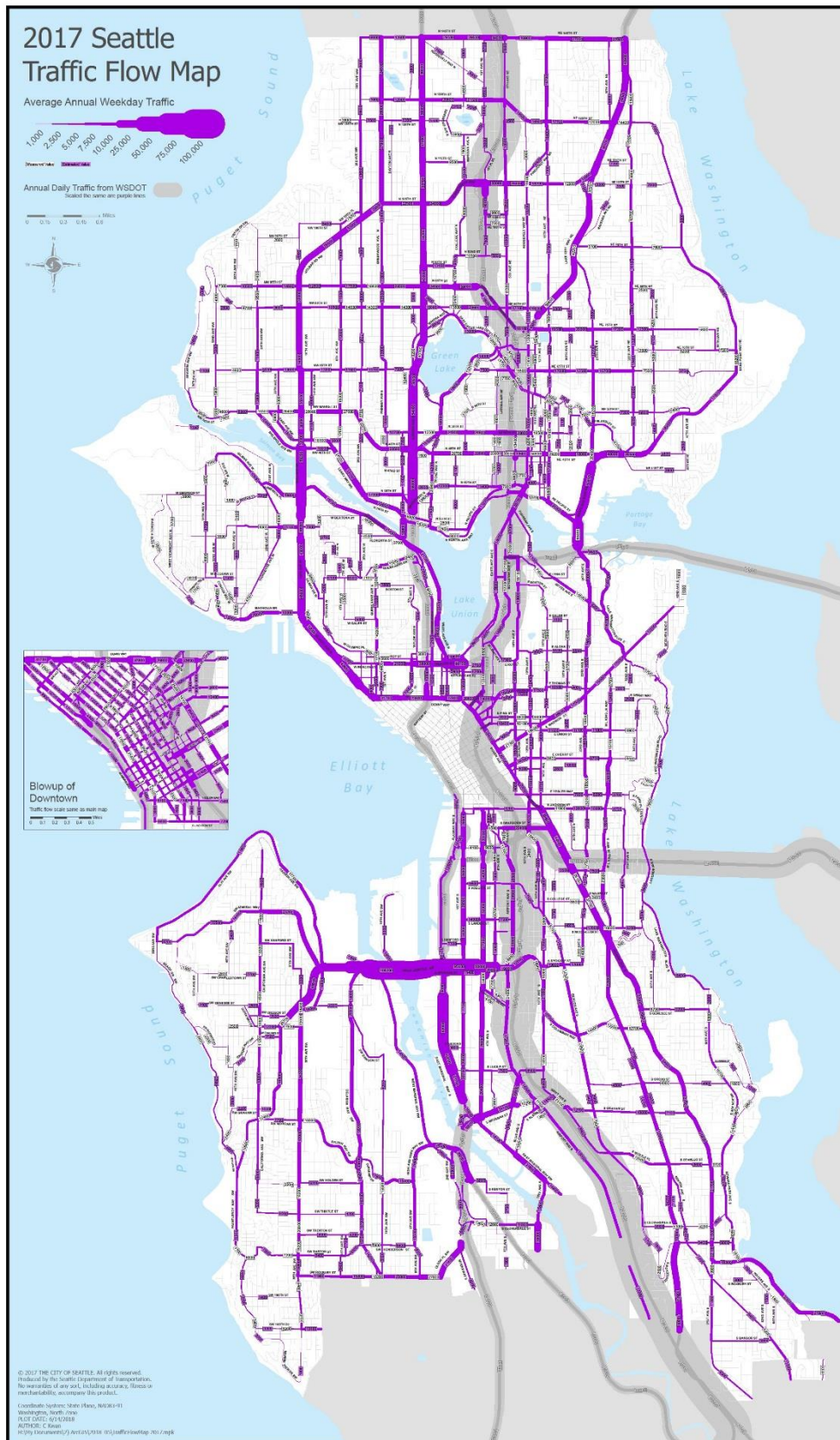
##### **Transit**

Transit is a vital part of Seattle’s transportation system for Seattle’s residents, visitors and workers. Because Seattle is a major business and entertainment hub, much of Seattle’s ground transportation system centers around moving large numbers of people into and out of the downtown core on a daily basis. A 2017 survey completed by Commute Seattle shows that workers who commute into downtown during peak hours rely heavily on public transportation. Almost half of the survey respondents used transit to get downtown, while only a quarter drove alone.<sup>74</sup> People are more likely to use transit for commuting than personal trips.

Transit modes in Seattle are a mix of bus, vanpool, rail and ferry systems. Buses have the largest ridership. The two biggest fleets are run by King County’s Metro system (operating within King County) and Sound Transit (operating between Pierce, King, and Snohomish Counties). County wide, Metro had over 121 million passenger boardings in 2016.<sup>75</sup> Trips involving Seattle make up the biggest share of this number. Sound Transit had over 47 million boardings in 2017, of which about half were on its Link Light Rail service, which spans from the University of Washington in the north down to SeaTac, south of the city.



**Figure 3-8. 2017 Traffic Flows**





Paratransit (mostly vanpools and vanshares) is also popular in the Seattle area, with a combined yearly ridership of about 3.5 million. Microsoft runs its own bus fleet, the Connector, to bring employees to its Redmond campus. The 80-bus fleet shuttles an average of 2,160 round-trip passengers every weekday.<sup>76</sup>

The Seattle Department of Transportation (SDOT) also operates two streetcar lines in Seattle. One in the South Lake Union area and the other in First Hill. In 2017, the two combined have a monthly ridership of about 4,500.<sup>77</sup>

## **Marine**

Seattle has a strong maritime history. Unlike many other cities, marine transport plays an important role in Seattle's passenger transportation. Washington State has the largest ferry system in the United States. Five routes dock in Seattle. Four dock in downtown (Seattle-Bainbridge, Seattle-Bremerton, Seattle-Vashon passenger only, Seattle-Bremerton passenger only) and one docks in West Seattle (Fauntleroy-Vashon). The Edmonds – Kingston ferry, while outside the city, also serves Seattle residents and workers. These routes have a combined ridership of over 16 million. Many of the people using the system are commuters. In 2013, about 19,500 passengers per day were carried into and out of Seattle. The biggest ferries have a capacity equal to 60 40-foot buses. Additionally, cruise ship operations frequent Seattle, increasing demand for air and ground transport.

## **Air**

Most passenger air transport is through Seattle Tacoma International Airport (SeaTac) located south of Seattle. In 2017, SeaTac handled 416,124 total air operations and over 45 million passengers, making it the 9<sup>th</sup> busiest airport in the nation.<sup>78</sup> SeaTac is a vital link for residents of Western Washington who lack another major commercial hub nearby. The next closest hubs are Portland and Vancouver, BC. King County International Airport (Boeing Field), located just outside the city limits handles a smaller number of passengers from small carriers, charters, and general aviation. Paine Field, about 25 miles north of the city, announced in 2017 that it will begin operating commercial passenger flights. So far only three airlines are set to operate out of Paine Field with an expected 24 daily departures between them. The region has two other airports that can handle large aircraft (important during large emergencies). They are Renton Municipal Airport and Joint Base Lewis-McChord.

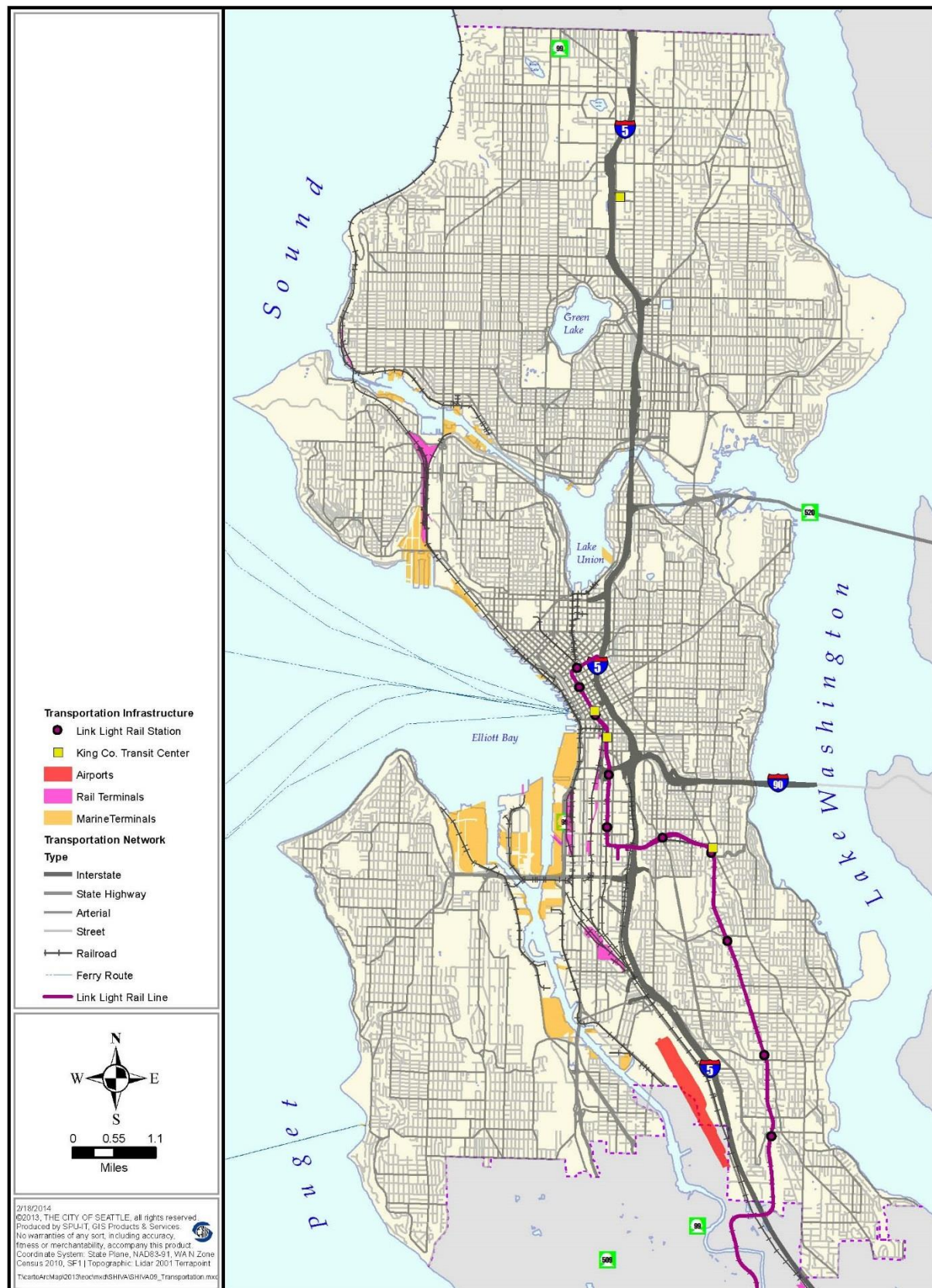
## **Rail**

Seattle is a rail center. Passengers use Amtrak for long-distance travel and Sound Transit commuter rail for short trips. Passenger service in Seattle is centered at the King Street Station. Both Amtrak and Sounder commuter trains use this station. The Sounder is a commuter line running on BNSF track on the weekdays between Tacoma and Everett. Amtrak operates three routes in Seattle. Most significant is the route serving the corridor between Vancouver, B.C. and Eugene, OR. The other two are Seattle / Chicago and Seattle / Los Angeles. In 2017 the Amtrak Cascades route had 817,000 passengers. The number of passengers is declining due to competition with new bus service.<sup>79</sup>

### **3.4.2 Freight Transport**

Trade is essential to Washington State's economy, and Seattle sits at the center of it. In 2017, Washington ranked 3<sup>rd</sup> nationally for foreign exports (\$77 billion) and 12<sup>th</sup> for foreign imports (\$50 billion).<sup>80</sup> Large quantities of goods move through Seattle on a daily basis and the freight system reflects these movements. Freight systems require complex intermodal integration (e.g., ship to truck to rail to air). The look of this integration, in turn, depends on the type of commodity being transported (e.g., aircraft parts vs. grain). Seattle has built intermodal networks around the container, bulk cargo and grain terminals of the Port of Seattle's Marine Division and around the two airports serving Seattle, SeaTac and Boeing Field.

**Figure 3-9. Major Transportation Infrastructure**



Seattle's marine cargo terminals and rail yards are located close to downtown. They must contend with completing land uses and passenger transportation. Trains must go slowly through the many areas of the city where rail lines cross streets and vehicles must wait for them to pass. Similar contention problems face trucks on crowded city streets. A series of docks, terminals, inter-modal rail yards and many designated truck streets serve the marine business.

### **Marine**

Seattle is home to a diverse port that supports container traffic, bulk cargo, a major grain terminal, and a large fishing fleet. About 12 million metric tons of cargo moved through Seattle's port in 2015.<sup>81</sup> In 2015 The Port of Seattle and the Port of Tacoma formed an operating partnership under the name The Northwest Seaport Alliance. Together, the two port systems form the fourth largest container gateway in the nation. In 2017, the Northwest Seaport Alliance saw over 27 million metric tons of cargo move through its ports and had almost 2,000 vessel calls.<sup>82</sup> Most incoming goods are loaded onto trains and shipped to Chicago. There is some indication that Seattle's cargo volume may grow as capacity at other large ports in Los Angeles and Long Beach shrink. Capacity is an emerging issue for many ports. In many cases the ground and intermodal transportation infrastructure surrounding the port is the biggest capacity issue. Seattle's port facilities are exposed to many hazards: earthquake induced liquefaction, tsunami and post-lahar sedimentation (a volcanic hazard).

### **Air**

Air cargo operates differently than marine shipments because of greater time constraints, so the type of goods shipped via air differ from those shipped via marine systems. This business depends on timely ground access to the air terminals for trucks hauling cargo to and from the airports. SeaTac handles 63% of the regional air cargo traffic and Boeing Field handles 22%.<sup>83</sup> SeaTac's air cargo operations have increased significantly in the past decade. In 2017, SeaTac handled 425,856 metric tons of cargo, up from 290,653 metric tons in 2007. The biggest constraints on air cargo capacity are access to ground transportation and facilities to park aircraft. Port businesses are very sensitive to disruption because traffic can easily be routed through competing ports.

### **Rail**

Two major freight carriers operate in Seattle, BNSF and Union Pacific. Rail is a big component of intermodal freight transport. BNSF and Union Pacific operate intermodal rail yards to support transshipment of goods through the Port of Seattle. Intermodal freight makes up most about 75% of Seattle's commodities freight with bulk grain shipped through Seattle's grain terminal on Elliott Bay a distant second. BNSF operates a maintenance facility in Interbay.

Tracks run along Puget Sound north of Lake Washington Ship Canal where they are exposed to landslides and storms. South of Seattle the tracks head inland until they pass Tacoma where they join the Puget Sound. All the yards are in liquefaction zones because they require large flat areas. Two lines cross the Cascades. One crosses under Stevens Pass through a long tunnel and the other goes over Stampede Pass south of I-90. Washington State's most deadly transportation disaster was the 1910 Wellington avalanche that killed 96 people on a train halted along the Steven's pass route.

### **Pipelines**

Pipelines are part of the transportation system. Seattle has one significant pipeline: the Seattle lateral of the British Petroleum (BP) line running from Ferndale to Portland. The Seattle lateral runs from Renton north to Harbor Island along the Seattle City Light right of way. This pipeline transports gasoline and diesel fuel to a regional distribution center on Harbor Island. About 9 million gallons of fuel are

transported annually through the pipeline. In 1999, the pipeline exploded in Bellingham, killing three children. At the time Olympic Pipeline Company operated the pipeline. Today BP owns the pipeline.

### **3 4.3 Infrastructure**

#### **Streets and Highways**

Streets are the backbone of Seattle ground transportation system. The public right of way accounts for over one quarter of Seattle's land area. Because Seattle is a built-out city, very little land is available for the construction of new roadways. While we most often associate streets with vehicles, they serve other important functions such as passageways for pedestrians and bicycles, housing a major part of Seattle's urban forest, and acting as a protective 'skin' for power, gas, water, drainage, and telecommunications lines. Finally, streets are where a lot of a community's public life occurs. Urban designer Allan B. Jacobs asserts that great streets make great communities.<sup>84</sup>

Seattle's streets are laid out in a grid pattern or, more accurately, many grid patterns. Due to historical circumstances, hilly terrain, and an irregular shoreline, early designers laid out grids independently of one another. Streets jog where these grids meet. Steep terrain causes streets to meander around obstacles. Other streets follow old paths (Madison St) or natural features (Lake Washington Blvd) as part of Seattle's Olmstead-designed park system.

Seattle uses several classification systems for its streets. The most fundamental is the designation of a roadway as an Interstate Freeway, arterial or residential street. The system is designed to funnel vehicular traffic from low-volume access streets through progressively bigger arterials (collector, minor and principal) and finally to the Interstate Freeways.

The backbone of motorized transport is the two Interstate Freeways (I-5 and I-90) and three principal arterials (SR-99, SR-520, and the West Seattle Freeway) that have large limited access portions. These five roadways handle the highest traffic volumes. I-5 and SR-99 run north-south and move much of the traffic within the city. SR-520, I-90, and the West Seattle Freeway run east-west. They feed into SR-99 and I-5 and serve to move vehicles into and out of the city and West Seattle. The area with the highest daily traffic volume is on I-5, just south of the I-90 junction, with an average of 245,000 vehicles per day.<sup>85</sup>

Seattle ranked 9<sup>th</sup> in the nation for traffic congestion in 2017.<sup>86</sup> This finding suggests that Seattle possesses little reserve capacity. A prolonged closure of a major roadway would shift traffic onto already overloaded infrastructure.

#### **Bridges**

Seattle is an isthmus divided by waterways. Puget Sound lies to the west and transportation across it depends solely on ferries. To the east is Lake Washington, 22 miles long. Seattle is divided in the middle by the Lake Washington Ship Canal. West Seattle is separated from the rest of the city by the Duwamish Waterway.

Two floating bridges, the SR-520 Bridge (also called the Evergreen Point Floating Bridge) and I-90 Bridge (running over Mercer Island) cross Lake Washington. Together they bring over 200,000 vehicles into Seattle on an average weekday.<sup>87</sup> Washington State began replacing the SR-520 bridge in 2012, due to concerns around hollow support columns that are vulnerable to damage in earthquakes.<sup>88</sup> The new bridge opened to traffic in April 2016, and currently handles 70,000 vehicles per weekday down from its peak of 96,000 in 2010. The new bridge was constructed to withstand wind speeds up to 89 mph. Tolling on SR-520 has reduced usage and diverted some traffic onto the I-90 bridge.



The Ship Canal is spanned by seven bridges (six roadways and one rail). The most important is the I-5 Ship Canal Bridge, handling 172,000 vehicles per weekday. It would be catastrophic for transportation if this bridge went out of commission. The next busiest, the Aurora Bridge, handles just a fraction at approximately 68,000 vehicles per weekday.<sup>89</sup> The four remaining bridges are bascule (draw) bridges that were built between 1914 and 1919.

The Duwamish is crossed by two bridges inside the city limits and two more just outside the city limits. The two inside the city limits combined handle nearly 200,000 vehicles per day. I-5 and East Marginal Way both cross the Duwamish just south of the city.

### **3.4.4 Utilities**

Utilities make urban life possible, but they impose hazards that must be managed. Utility hazards include downed electrical lines, water main breaks and gas and steam pipe explosions. Often these hazards can lead to long duration outages.

Seattle has a mix of publicly and privately owned utilities. All utilities provide a public service. They differ from other public services such as police protection because they require extensive infrastructure. Utilities include electricity, gas, water, drainage, sewage, solid waste, and telecommunications. In the downtown area, steam is also an important utility.

#### **Electricity**

Electricity in Seattle is supplied by Seattle City Light (SCL), a publicly owned utility that is part of the City of Seattle. Unlikely many other municipal electric utilities, Seattle City Light has its own generation facilities and transmission system. It produces about half of its own power and purchases the rest. The largest outside provider is the Bonneville Power Administration (BPA). Over 95% of SCL's generated power comes from the Skagit River (North Cascades) and the Pend Oreille River (northeast Washington). In 2016, they provided electricity to over 447,000 residential and commercial customers.

Seattle's heaviest electrical loads occur in the winter because many Seattle buildings have electric heat.<sup>90</sup> Seattle's mild summer climate reduces the demand for air conditioning, allowing SCL to sell surplus power. Seattle's summer temperatures are projected to rise with climate change. This rise creates financial risks for SCL.

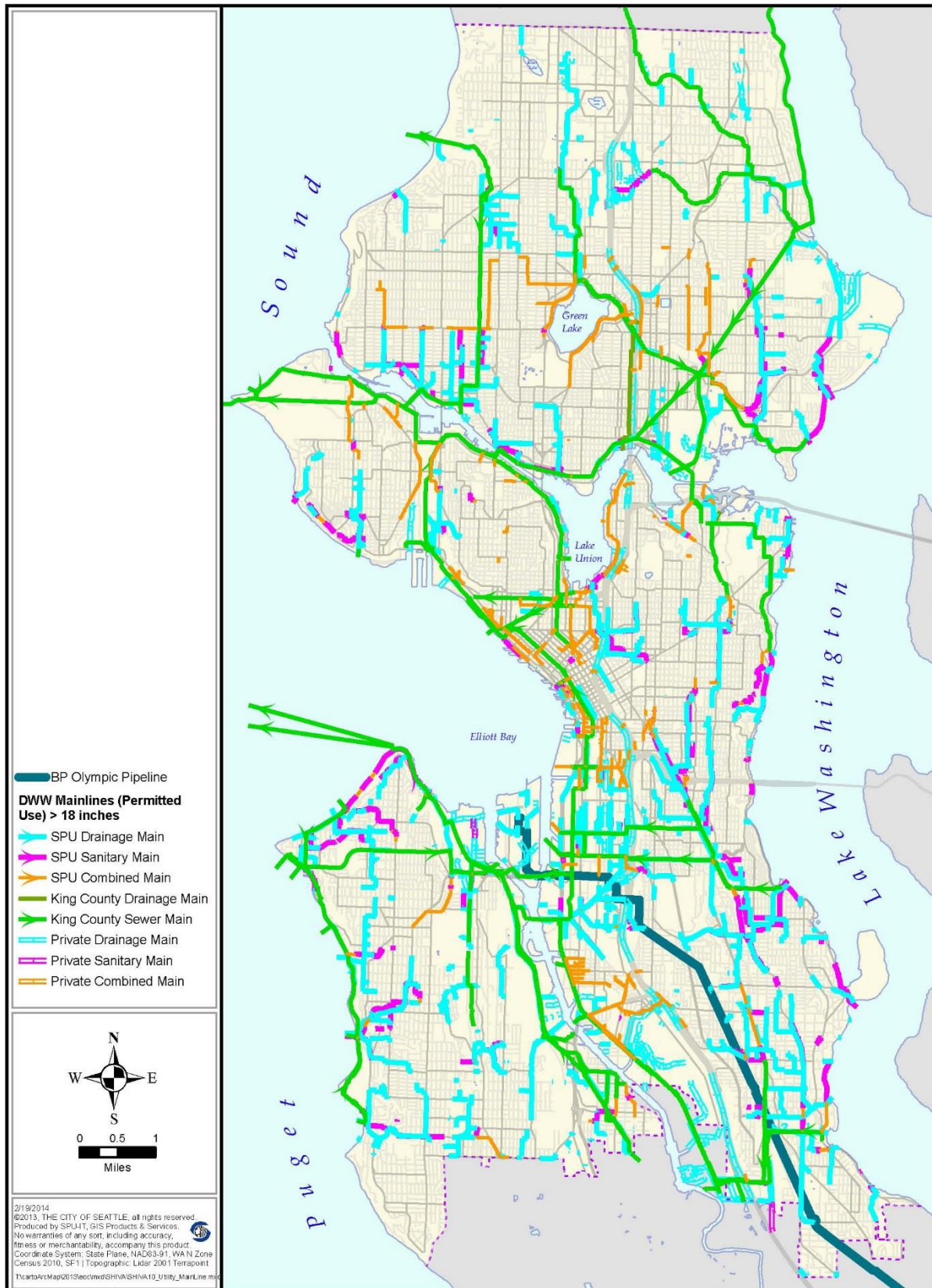
Seattle's use of hydroelectric power makes the city dependent on the snowpack in Washington's mountains. During years of low snowpack SCL must purchase more power from BPA and other providers. Climate change may be reducing the Cascade snowpack. This trend is a major concern for SCL.<sup>91</sup>

#### **Natural Gas**

Natural gas is provided to 131,182 residential and 13,953 commercial customers in Seattle by Puget Sound Energy (PSE), a private, regulated utility. No natural gas is extracted in Washington State. It is imported in about equal amounts from Canada and the Rocky Mountains through the Williams Northwest Pipeline running through the eastern edge of the Puget lowlands. Spur lines take gas through Renton and Lynwood to a distribution system feeding Seattle from both the south and north. There are no transmission lines through Seattle.

Most of the distribution system is buried and was built after the 1950s. Original pipes were cast iron; they have all been replaced by more flexible steel or plastic pipes that perform better in earthquakes. The use of natural gas lagged behind electricity in the Northwest, which still uses less natural gas than in many parts of the country. Cheap hydroelectric power, lack of access to cheap U.S. natural gas fields in the 1960s and early 1970s and the high cost of Canadian sources slowed the development of natural gas in the Pacific Northwest.

Figure 3-10. Major Utility Infrastructure



In Seattle, the use of natural gas has been stable over the past few years. According to U.S. census statistics, 37% of Seattle residences are heated by natural gas.<sup>92</sup> Peak demand is often in the winter. The Jackson Prairie underground storage facility stores reserves near Chehalis, Washington. Gas there is pumped into deep porous sandstone for later retrieval.

## **Water**

Seattle's water is provided by Seattle Public Utilities (SPU), a department of the City of Seattle. SPU controls supply, transmission and distribution of water within the City of Seattle and wholesales water to water districts in King County. SPU provides water to 1.4 million people in the region. Nearly all of Seattle's water comes from two watersheds in the Cascade Mountains east of Seattle. About two-thirds of the supply comes from the Cedar River and one-third comes from the Tolt River. Wells provide less than one percent of Seattle's water. Like electric power, Seattle's water supply is dependent on snow pack in the surrounding mountains. Unlike power, it is more difficult to obtain water from distant sources. Most of the system is gravity fed which means most customers can use water when the power is out.

Per capita water consumption has been dropping throughout King County. Total consumption peaked in the late 1980s near 160 million gallons per day. Now King County uses about 120 million gallons per day despite the population increasing by over 1 million people. The main drivers of the decrease were the 1992 drought that led to higher water rates, a revised plumbing code, and improved conservation. Demand for water is highest in the summer with peak day consumption averaging around 200 million gallons per day.<sup>93</sup>

## **Sewer and Drainage**

The removal of wastewater from buildings and the drainage of runoff have been closely linked historically. Cities create large waste streams from indoor plumbing. Drainage systems are necessary in cities because they have large amounts of impermeable surfaces that cause water to run off them and they have nowhere to store this runoff. One of the great advances in public health was the creation of sanitary sewers to reduce disease. In Seattle, SPU handles the collection and King County Department of Natural Resources and Parks (DNRP) handles the treatment and discharge.

When constructed early in the 20<sup>th</sup> century, sanitary and storm sewers used the same collection system. This design is not good for the environment because untreated waste was frequently discharged into local streams and water bodies when heavy rain overwhelmed treatment capacity. These discharge sites are called Combined Sewer Overflows (CSO). Seattle has 124 of them.

To update the public when CSO discharges are occurring, King County's [CSO website](#) shows CSO status in real-time for its 39 sites, and monitors some of the 85 additional sites maintained by SPU. Although the City has more CSO sites, King County discharges more wastewater because they control mainlines.

The amount of CSO overflow has been reduced since the early 1960s, from the 20 – 30-billion-gallon range to around 1.5 billion gallons in 2016.<sup>94</sup> Both King County and SPU have programs to reduce the number of overflows. Efforts include operations improvements, capital intensive projects and separating sewage from surface runoff.

Despite the problems caused by CSOs, they serve a valuable purpose in the combined system that Seattle has now. Urban flooding is a significant problem in Seattle. When high intensity storms occur, the drainage system reaches capacity and backups can occur. The problem would be much worse without CSOs because the water discharged would have nowhere to go.

## **Steam / District Energy**

District energy systems produce steam, hot water or chilled water at a central plant and then pipe the water or steam to buildings in a district for heating, hot water and air conditioning. Enwave Seattle, formerly known as Seattle Steam, heats approximately 200 buildings in downtown Seattle and First Hill, including many hospitals. The University of Washington also runs a steam system for many of its buildings. Three major Seattle hospitals use steam to sterilize equipment and provide humidification. Loss of steam to hospitals can create an infection control emergency and could compromise patient safety if the outage is lengthy.

Enwave Seattle generates its steam in power plants on Western Avenue. One is near Pike Place Market and the other is near Yesler Way. In 2009, they built a new boiler that will burn wood waste and reduce carbon emissions. While district energy systems have many benefits and high reliability, they have to be managed well to prevent accidents like the 2007 New York steam pipe explosion. The plant near Yesler Avenue is vulnerable in earthquakes because it is on soils that can liquefy in an earthquake.

## **Communications**

Seattle's overall telecommunications infrastructure is a mix of broadcast media (television and radio), landline phone service, cellular networks, internet, and cable television. Although telecommunications is becoming more reliant on digital networks and servers, radio and landline services remain important components of emergency response capabilities.

### *Telephone / Voice*

Like everywhere else, phone service in Seattle has undergone rapid changes in the past two decades. The majority of customers now use voice-over-Internet Protocol (VOIP) phones and smartphones with Internet access. The PEW Research Center reports that in 2018, 95% of Americans own a cell phone of some kind, and that 77% own a smartphone. Traditional landline phones have been on the decline as cellphone popularity has increased. The Center for Disease Control estimates that over half of U.S. households no longer have a landline telephone.

The number of cell phone-only households becomes more of an issue as the use of automated emergency notification software grows. That's because cell phone numbers are not included in the directory listings that these notification systems use as their calling database. People who solely rely on cell phones must be aware of and opt into emergency notifications. Also, landlines are important as safety backups during power outages because they require no commercial power to work or charge.

All the major U.S. cellular providers (AT&T, Sprint-Nextel, Verizon, and T-Mobile) have a strong presence in Seattle. The hilly topography in the area creates problems for all carriers with dead spots reported in some locations. Seattle often is one of the first markets to receive new wireless technologies. Cellular providers, as well as the City of Seattle, have been replacing traditional copper cables with high-speed, longer-lasting fiber optic cables. The City also relies on short-wave radio communications for some functions that require high capacity connections, such as parks, libraries, and some fire stations. The City's main network nodes are linked by a fiber optic ring to provide redundancy to the communications system.<sup>95</sup> If a fiber cable along this ring is cut in one spot, calls can be rerouted the opposite direction and still delivered.

### *Television / Video*

In 2014, 59% of Seattle residents subscribed to cable television, down 13% from 2009. Comcast is the dominant cable provider, with about 200,000 subscribers (94% share of residential customers). The city also franchises with Wave Broadband, mainly servicing the Central District, and Century Link. Many subscribers also get high-speed internet connections from their cable provider.<sup>96</sup> More and more



people are opting to end their traditional cable service and instead consume television through internet streaming services such as Netflix and Hulu.

#### *Internet / Data*

The use of high-speed internet has expanded rapidly in the last two decades. In 2000, only 18% of residents had high-speed connections; now, almost 99% do. Most of these high-speed connections are over cable modems using a cable television connection or DSL, a phone-based technology. The average download speed in Seattle is 40.05 megabits per second (mbps), which is about 8% faster than the state average and 19% faster than the national average.

The fastest way to connect to the Internet is with a fiber optic connection. It is also the most expensive. However, with the growing demand for high speed connections, internet providers are beginning to invest in more fiber optic infrastructure. In 2016, Wave Broadband was building 100 miles of fiber network per month in Seattle area.<sup>97</sup> While large institutions are the biggest users of fiber optics, network expansions have increased availability to business and residential customers. Forty percent of King County residents now have access to fiber optic internet.<sup>98</sup> Most fiber services have download speeds of up to 1,000 mbps. There have been campaigns in recent years to push the City towards investing in its own fiber infrastructure to provide public internet service. So far, none have been successful and internet service remains a private market. The City has over 550 miles of fiber cable for its own network.

Gaps remain in access to the internet and digital literacy skills even as overall usage grows. The biggest barriers to using technology are income, education, race/ethnicity, age, disability, and immigrant status.

#### *Two-way Radio Systems*

There are many two-way systems operating in the City of Seattle. The Seattle Disaster Readiness and Response Plan (SDRRP), Vol. 2 describes these systems in detail. The 800MHz Public Safety Radio has been the backbone of Seattle's emergency wireless communications, but the aging system is based on 1980s technology. The city is replacing the old radio system with the Puget Sound Emergency Radio Network (PSERN), which is scheduled to be completed in 2020.<sup>99</sup> Construction and updates of radio towers and new equipment at radio sites and for users of the system will improve overall coverage and connectivity. Some City departments, such as Transportation and Seattle City Light operate their own radio networks to use during a disaster event.

#### *Broadcast Systems*

Traditional broadcast systems remain important, especially in emergencies. Broadcast radio is the oldest of the telecommunications services. It is also one of the most important because it requires only a transmitter and receivers. During the 2003 east coast blackout, broadcast radio became a major emergency communications tool. Broadcast television is used by only 20% of Seattle residents but importantly reaches communities that have lower rates of access to technology.

### **3.4.5 Media**

Media provides information that residents, businesses and government need to make effective decisions. They range from national corporations to individuals writing a blog for their neighborhood. Before the telecommunications revolution, media were bound to a specific medium of distribution. Now, most are available through multiple pathways. For example, television stations that used to only broadcast their stories now offer internet content including transcript, written stories, photos and video clips. Most Americans use multiple devices to check news and they check throughout the day.<sup>100</sup>

Traditional broadcast and print media outlets are facing more and more competition with online news sources. While almost 60% of Americans still get news through television, 38% are regularly seeking news online.<sup>101</sup> Print newspapers have seen steady declines in readership, with only 20% of Americans getting their news in print in 2016. These patterns change when observing age groups. The elderly population still relies on print news (48%) and television news (85%), while younger people tend to use the internet as their main news source. For those who get news through television, 46% rely on local TV stations.

## **Print**

Print news is still important, especially for reaching the elderly, and other communities that are underserved by the Internet.

Newspapers play a strong role before emergencies by publishing stories on new hazard research, preparedness and mitigation. When the Seattle Post-Intelligencer ceased publication in March 2009, Seattle lost some capacity to bring these valuable stories to the public.

Ethnic newspapers and newsletters are critically important for reaching vulnerable communities who may lack access to mainstream media. The vital role played by ethnic publications was emphasized after a family of five Vietnamese-speaking people died heating their home with a charcoal burner. Many of these publications are highly trusted by the communities they serve. Seattle now standardly contacts ethnic media to put out public safety information during emergencies. One limitation is that many publications do not come out daily, so response can be slow after emergencies.

Blogs are becoming a popular two-way communication tool at the community level and within affiliation groups (e.g., trade groups). Examples include [www.myballard.com](http://www.myballard.com) and [westseattleblog.com](http://westseattleblog.com). These blogs are both current and relevant at the neighborhood level. Most of these blogs offer Twitter feeds for mobile users.

## **Radio**

Broadcast radio remains a powerful medium. 93% of Americans listen to the radio in any given week. Seattle is the 12<sup>th</sup> largest broadcast radio market in the U.S.<sup>102</sup> In emergencies, live radio call-in shows can quickly become effective ways to create a community forum and disseminate information. For example, after Hurricane Katrina local radio stations hosted call-in shows to allow members of the community to question officials, businesses, and one another about the best ways to cope with the emergency at hand. As more stations become automated and play only nationally syndicated content, this vital community resource shrinks.

The Emergency Alert System (EAS) is a national warning system based in broadcast radio (although it now reaches other media, too). National, state, local, and weather alerts can be issued. It is used most commonly for weather emergencies. The state plan can be found [on the Washington State EAS Plan website](#). KIRO radio 710 AM is the primary station in the Seattle area and KPLU is the secondary station. Alerts would start with these stations and propagate to other radio and television stations.

## **Television**

Seattle is the 13<sup>th</sup> largest television market in the United States.<sup>103</sup> Fourteen local television stations broadcast here, including affiliates of all major U.S. networks. These stations are all available via broadcast and over cable television. Nationally, local television news is the most prominent news source for citizens about what is happening in their communities.<sup>104</sup> In 2014 only 59% of Seattle residents said they subscribe to cable television and most of these subscriptions are with Comcast.<sup>105</sup> A smaller percentage of Seattle customers use satellite receivers. More and more people are ending their cable

television contracts as most television and news is now available on the internet either as a stream or in clips. EAS messages propagate to television.

### **3 4.6 Emergency Services**

Seattle gets its emergency protection from its police department and an all-professional fire department. The fire department also provides emergency medical services. American Medical Response, a private company, contracts with the City of Seattle for non-life-threatening emergency transport services.

#### **Law Enforcement**

The Seattle Police Department (SPD) is the primary law enforcement agency operating within the City of Seattle. With 1,376 sworn officers and 513 civilian employees, SPD is the largest law enforcement agency in the State.<sup>106</sup>

Other agencies with limited jurisdiction inside Seattle include: King County Sheriff (public transit), Washington State Patrol (state transportation routes), the University of Washington Police (UW property), the Port of Seattle Police (port property) and railroad police (Amtrak, BNSF).

SPD uses five precincts as its basis for operations. There is a police station in each precinct. SPD also maintains specialty units that operate city wide. They include Special Weapons and Tactics (SWAT), Harbor Patrol, Canine Unit, Mounted Patrol and a Traffic Unit.

Dialing 9-1-1 in Seattle first connects a caller with the Seattle Police 9-1-1 Communications Center. Trained employees transfer calls concerning a fire or medical issues to the Fire Alarm Center; they evaluate calls concerning law enforcement issues and send them to dispatch, as necessary. The 9-1-1 Center handles around 900,000 calls per year.<sup>107</sup>

Overall, major crime in Seattle has declined in the past three decades but there has been a slight uptick in crime in recent years. Seattle saw a 52% drop in crime from 1988 to 2012, but crime has since grown from 34,607 crimes in 2012 to 42,317 crimes in 2017.<sup>108</sup> Seattle ranks 8<sup>th</sup> for highest overall crime rate among the 30 largest cities in the U.S., but only ranks 21<sup>st</sup> for violent crime.<sup>109</sup>

SPD is the lead agency for responding to civil disorder and terrorism investigation. The Office of Emergency Management (OEM), the lead office for community-wide disaster coordination, is part of the Seattle Police Department.

The King County Department of Adult and Juvenile Detention (DAJD) maintains two correctional facilities serving Seattle. The King County Correctional Facility is the primary detention facility in Seattle, and the Kent Regional Justice Center is located south of the city. The DAJD books over 50,000 people per year; 70% of the adult population is released within 72 hours.

In Washington State, county superior courts are the court of general jurisdiction. Several other courts have been established with limited, concurrent jurisdiction. The most important of these for Seattle is the Seattle Municipal Court, the largest limited-jurisdiction court in the State of Washington.

#### **Fire**

The Seattle Fire Department (SFD) provides fire suppression services in the City of Seattle and is the lead agency for most incidents that involve rescue operations, unless a unified command is formed in a large incident. SFD's force consists of 990 uniformed personnel, 37 department chiefs, 924 fire fighters/EMTs, 66 fire fighters/paramedics, and 72 civilian personnel, with an on-duty staffing of 209.<sup>110</sup> These personnel are divided among 33 fire stations, each of which house one engine company. SFD also operates specialized apparatus. Fire accounted for only 17% of all responses in 2017.<sup>111</sup> Recently, SFD





began tracking information about homeless related fire responses in derelict buildings and vehicles/RVs. There were 30 homeless related building fires and 21 homeless related vehicle/RV fires in 2017.<sup>112</sup>

In 2003, voters approved a levy to improve fire infrastructure throughout the city. The project was completed in 2017 and has resulted in the upgrading or replacement of 32 fire stations; the construction of a new training facility, a new Fire Alarm Center and a new Emergency Operation Center; purchase of a new fire boat and other improvements.

The number of total fire responses has steadily increased over the last five years, with 13,388 in 2013 and 16,548 in 2017.<sup>113</sup> Structural fires in Seattle declined nearly 50% between 1994 to 2008, from 784 to 387. It appears they have continued to decline despite the uptick in overall fire response. In 2017, SFD responded to 215 structural fires.

Data suggests that deaths and injuries have declined overall but Seattle still experiences multiple fatality fires; property losses have not declined. Large property losses do not correlate to high casualty rates.

### **Emergency Medical Services (EMS)**

SFD is Seattle's primary provider of emergency medical services provided somewhere other than healthcare facilities. All Seattle fire fighters are certified EMTs or paramedics, as well as about 100 police officers. To provide Basic Life Support (BLS), SFD maintains five basic life support aid units and contracts with a private provider, American Medical Response (AMR). AMR normally operates seven more BLS aid units.

To provide Advanced Life Support (ALS) in life-threatening situations, SFD partners with the University of Washington and Harborview Medical Center to operate the successful internationally recognized Medic One program. Medic One's initial focus was cardiac care. Compared to other large cities, cardiac arrest victims in Seattle are 2-3 times more likely to survive. Seattle's survival rate after cardiac arrest outside of a hospital is 19.9%.<sup>114</sup> Medic One has 78 paramedics and 7 medic units in Seattle.<sup>115</sup> The Medic One system consists of an additional 171 paramedics in neighboring cities and in King County.<sup>116</sup> In 2017, SFD responded to a total of 78,758 EMS calls, with 60,168 BLS responses and 18,590 ALS responses.<sup>117</sup>

Due to a growing number of people experiencing homelessness in Seattle, SFD has seen an increase in low-acuity (non-emergency) calls. This growing demand appears to be concentrated in the downtown area. To try and prevent these calls, an SFD case manager and a social worker provide coordinated care to individuals who chronically use 911 for non-emergency purposes. Other initiatives include providing more specialized medical services to this population to divert people from the Emergency Room and giving local shelters access to a 24-hour nurse hotline.

## **3.4.7 Healthcare and Human Services**

Seattle's healthcare and human services systems are tightly intertwined. A public-private network provides services ranging from a basic social safety net to advanced medical treatment.

### **Healthcare**

Seattle has the largest concentration of medical facilities and personnel in the Pacific Northwest.<sup>118</sup> There are ten hospitals, a public health department shared by the City of Seattle and King County, as well as integral supporting businesses and services—medical laboratories, research institutions, training centers, and medical suppliers. The core of Seattle's healthcare system is direct patient services and its ten hospitals dominate. Many of the hospitals manage ancillary healthcare services across Seattle such as ambulatory care centers, long-term care facilities, home health care and other services. Seattle's healthcare facilities serve many patients from outside the city.

Due to the concentration of many healthcare services within the city limits, Seattle has a very high number of healthcare workers within its residential population. In a regional catastrophic event, Seattle would have large numbers of general medical personnel available, especially during business hours when outpatient clinics are operating. Specialty medical staff such as pediatricians or obstetricians may work in Seattle but tend to live outside the city.

Public Health – Seattle & King County is the 9<sup>th</sup> largest metropolitan health department in the United States. It is a primary provider of local public health services and collaborates with many different partners through an integrated system of healthcare and public health services.

Public Health – Seattle & King County focuses on three major functions:

- Health Protection – Tracking and preventing disease and other threats; regulating dangerous environmental and workplace exposures; and ensuring the safety of water, air and food.
- Health Promotion – Leading efforts to promote health and prevent chronic conditions and injuries.
- Health Provision – Helping ensure access to high quality health care for all populations.

In Washington State, the Local Health Officer of Public Health – Seattle & King County has wide-ranging authority to control public health emergencies. Powers include the ability to quarantine people, close schools and other public institutions and take other measures to control health risks. This considerable authority has been used with discretion. The Washington State Secretary of Health can act in lieu of local health officer under limited circumstances.

### Human Services

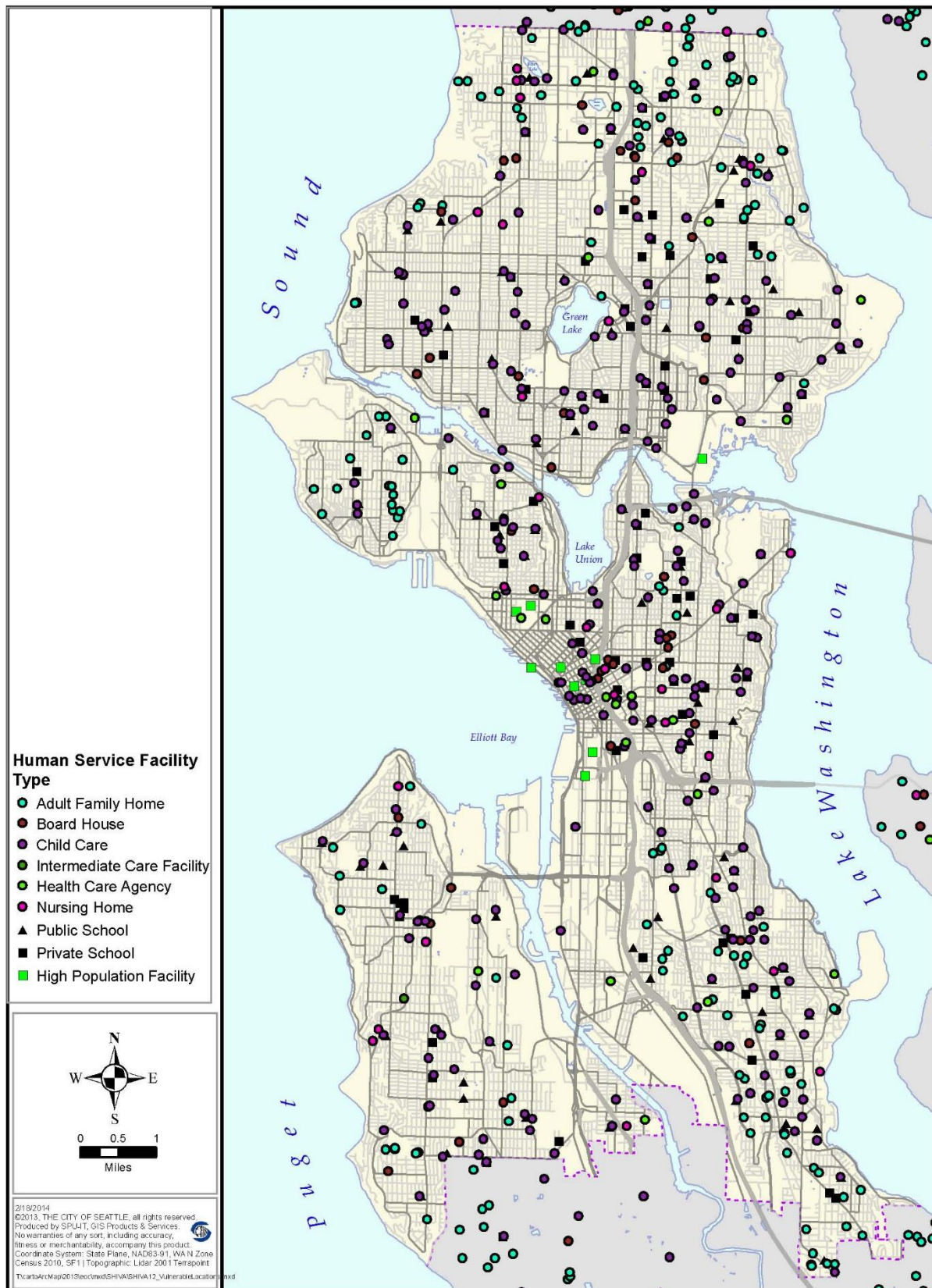
The human service sector addresses the basic needs of the most vulnerable members of the community. After a disaster, basic human needs expand and the human service sector steps in to help the community recover. The sudden spike in demand can pose challenges. A community that is well prepared for emergencies can lessen the demand for post-disaster human services. Seattle has established a community disaster preparedness program, in part, to lessen the burden on the human services sector.

During many disasters, members of the public spontaneously organize themselves to provide help to themselves and those in need. These emergent groups often begin operating before official organizations. Tension can arise between these two groups especially when government attempts to shut down or control these groups. The most successful responses make good use of emergent groups.<sup>119</sup>

Seattle's human services sector is comprised of hundreds of public, quasi-public (e.g., Seattle Housing Authority) and private organizations. These differ so greatly in size, resources, scope, and capacity that it is impossible to make general statements about a "typical" organization. A relatively small number stand out due to their size and scope of operations. They include the Human Services Departments of Seattle, King County, and Washington State, the Seattle Housing Authority, and large nonprofits such as American Red Cross, Salvation Army, and Catholic Community Services. Seattle is also home to many foundations that do not offer direct services but supply funding to providers. In general, government agencies do not provide direct services and rely instead on a network of nonprofit organizations. Funding for these organizations is provided by government grants and contracts as well as donations from individuals, corporations, and foundations.

Seattle's Human Services Department partners with and invests in many (but not all) of the city's local nonprofit and community programs. These programs fall into six areas: preparing youth for success, supporting affordability and livability, addressing homelessness, promoting public health, responding to gender-based violence, and promoting healthy aging. Taken together, 350,000 individuals or households

Figure 3-12. Human Service Facilities





were served in 2017. However, this estimate is likely inflated as it reflects duplicate counts when people receive services within multiple areas. The total number of people served by the entire Seattle human services network is unknown.

The range of services provided by Seattle’s human services organizations varies widely. Roughly stated, the issues concerning the sector cluster around providing the following for all members of the community:

- Enough food;
- Shelter;
- Personal safety;
- Access to healthcare
- Access to training and education to learn job skills;
- A supportive community environment; and
- Access to culturally competent services.

The effectiveness of human service delivery after a disaster depends on strong linkages between the community and the organizations supplying the services. Often it is the smaller organizations that have the strongest ties to the community, but many of them are not prepared for major disasters and often lack viable continuity of operations plans that allow them to remain in business after a disaster. Following the December 2006 Windstorm, the United Way convened a task force to examine the response of nonprofit human service agencies in King County. It reported that “The Task Force concludes that the region is not prepared to deal with the impact on vulnerable and special populations in a major disaster event.”<sup>120</sup> Following the release of this report, the City of Seattle and United Way began a program to assist local nonprofits in planning for disasters.

The local United Way report and many national studies question the ability of nonprofits to lead human service response after a major event. The human service delivery system is so fragmented that sharing information is difficult under normal conditions and impossible given the stress of a disaster. The reports concluded that nonprofits work best in a complimentary role to government.

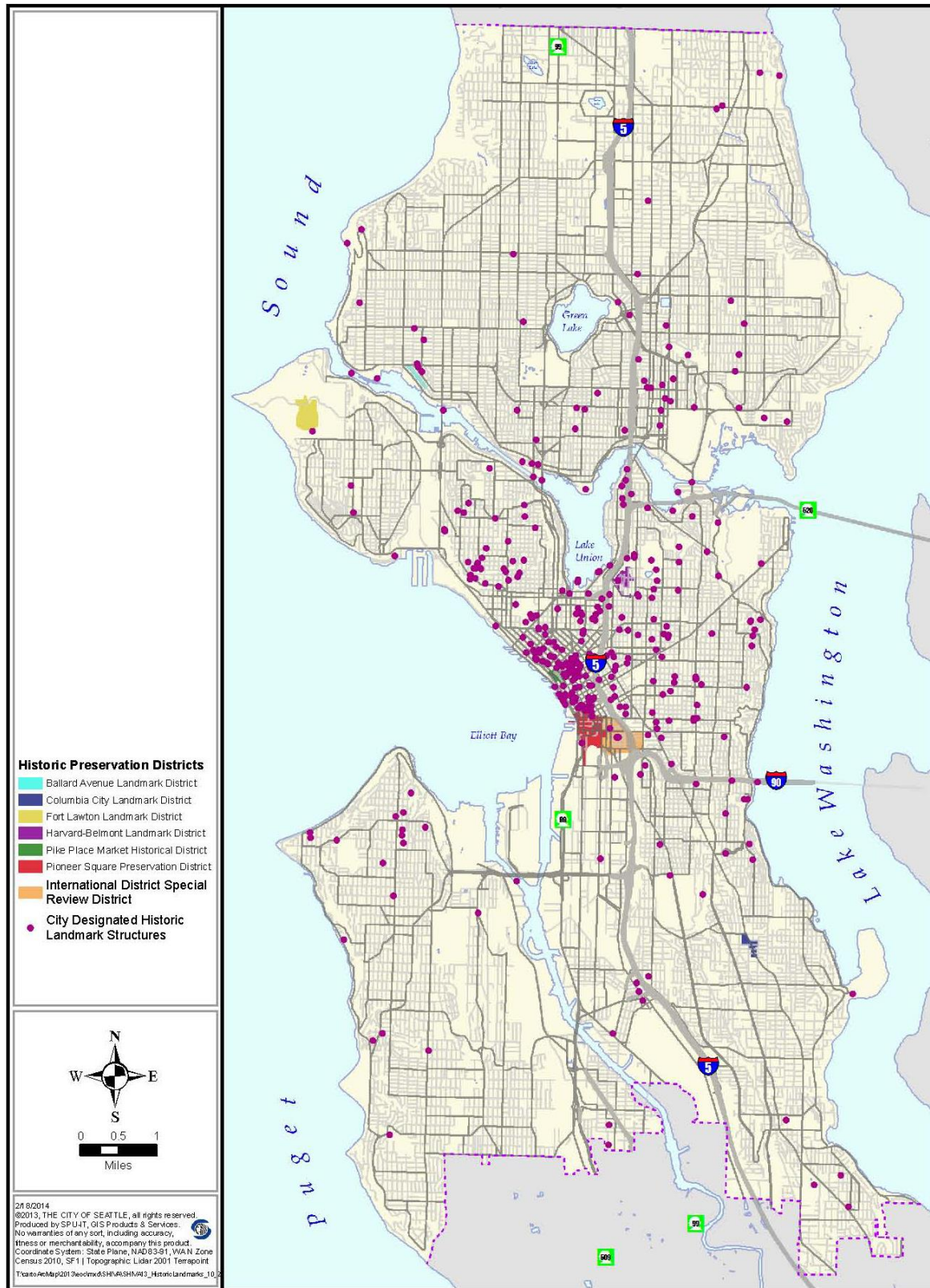
Several tools have been developed to assist with sharing human service information after disasters. For example, the Crisis Clinic uses a database of human service organizations to operate a 2-1-1 information referral service and direct people to organizations that can help them. This service is used for everyday operations as well as during disasters. The [Coordinated Assistance Network](#) (CAN) is an online tool that was piloted nationally as a disaster case management tool. Currently, it lacks the resource information to be a viable tool in Seattle although it is still operational in the Gulf area.

### **3 4.8 Structures**

Seattle is a young city, but over half of its housing units were either built prior to the 1949 building codes that introduced seismic standards, or the city’s 1992 upgrade of its seismic codes. The table below shows the age distribution of the housing stock.

Most of the Seattle’s housing is wood frame construction, which generally performs well in earthquakes. The City of Seattle, the Port of Seattle, and Seattle Public Schools have surveyed their facilities for seismic safety. The City has identified 1,144 unreinforced masonry structures, that are prone to collapse in an earthquake. Other forces like wind and landslides are accounted for in the building code, but there are no studies that determine how the codes have affected the performance of the city’s structures to better withstand these hazards.

Figure 3-13. Historic Districts and Landmarks



### 3.4.9 Summary

Cities have a different hazard exposure profile than rural areas, suburbs or towns. The concentration of people, economic power, services, political institutions and cultural life give cities the vitality to overcome many setbacks. Their complex network of infrastructure, services and economic relationships may have limited redundancy and reserve capability. Seattle's public is well educated and resourceful, but like any urban population it relies on functioning infrastructure. For example, as more people live in high-rises, they become dependent on power to pump water to their apartments and transport them in elevators. Following the 2011 Japanese earthquake and Superstorm Sandy, many urban residents had to temporarily move out of their dwellings for this reason.

**Table 3-5. Age Distribution of Housing Stock (2016)**

<b>Total housing units</b>	<b>322,795</b>	<b>100%</b>
Built 2014 or later	2,657	1%
Built 2010 to 2013	11,227	4%
Built 2000 to 2009	46,414	14%
Built 1990 to 1999	27,279	9%
Built 1980 to 1989	25,372	8%
Built 1970 to 1979	27,995	9%
Built 1960 to 1969	28,998	9%
Built 1950 to 1959	36,017	11%
Built 1940 to 1949	28,702	9%
Built 1939 or earlier	88,134	27%

Often cities have the capacity to quickly rebound after small and medium sized shocks but fail when an event takes out resources for an extended period. Modern urban life depends on a complex, interdependent web of services. Loss of a couple of services for more than several days can bring normal city life to a halt. How long could cities function without power and roads? If the services are out for weeks or months, the result can be an irreversible decline, especially if the city's fortunes were declining already.



## 4. CLIMATE CHANGE

This section recognizes climate change and its effects on the magnitude of hazards identified in the SHIVA. Climate change is not an additional hazard. Rather, it is an ‘overlay’ on hazards covered in the SHIVA.

Climate change is a long-term threat that is expected to persist for decades. This chapter identifies climate change’s direct effects, the implications for the city’s identified hazards, and policy challenges that interact with emergency management but lay mostly outside it. Climate change is a factor that may intensify and/or increase the likelihood of certain hazards. The hazard discussed in this chapter include landslides, disease outbreaks, fires, infrastructure failures, power outages, excessive heat events, flooding, water shortages, and windstorms.

There is evidence that the climate has been changing over the past few decades and is projected to change into the future at an increasing rate. Climate change is caused by the build-up of greenhouse gases (GHG) in the atmosphere. Even if the world stopped burning fossil fuels tomorrow, existing levels of atmospheric GHGs would continue to contribute to warming global temperatures.

- ❖ *4.2°F - 5.5°F increase in average annual temperature in the Pacific Northwest by the 2050s.*
- ❖ *4 – 56 inch increase in sea level rise by 2100 (dependent on land movement). Rising sea levels lead to an increased risk of coastal flooding and landslides.*
- ❖ *Drier summers, with more severe precipitation events in other seasons leading to an increased risk of urban flooding and landslides.*
- ❖ *42-55% decline in mountain snowpack by 2070 creates water management challenges.*
- ❖ *Seattle’s watersheds will become more reliant on variable rainfall than snowmelt.*
- ❖ *63 additional deaths on average per year linked to excessive heat and air pollution.*
- ❖ *Increased risk of wildland fire for both sides of the mountains.*
- ❖ *Degraded salmon habitat.*

According to 2014 data from the Seattle Office of Sustainability and Environment, 66% of the city’s GHG emissions comes from road transportation, 32% comes from commercial and residential buildings, and 3% from waste management.<sup>121</sup> The most prominent GHGs in the Seattle region are carbon dioxide (CO<sub>2</sub>), fluorinated gases (e.g. hydrofluorocarbons), methane (CH<sub>4</sub>), and nitrous oxide (N<sub>2</sub>O).<sup>122</sup>

Seattle has set a goal to reduce carbon emission by 58% by 2030 and to become carbon neutral by 2050 (with 2008 emissions as the baseline year), in hopes to reduce the future effect of local climate change.<sup>123</sup> A 2014 progress report showed that emissions have decreased by 6% overall, and per resident emissions decreased by 17%. Further, the Seattle City Council passed a resolution in 2017 stating the city’s commitment to uphold the Paris Agreement, meaning Seattle will take steps to ensure that future warming is limited to 1.5°C.

Despite these local efforts to reduce GHG emissions, climate change is caused by global GHG emissions that continue to rise. Climate change presents Seattle with many challenges: flooding, summer heat and drought, rising sea levels, heightened wildfire risk, and declining snow pack. Seattle will also experience indirect impacts. These could include higher commodity prices, increased migration and increased economic and political instability across the globe.



## 4.1 Direct Effects

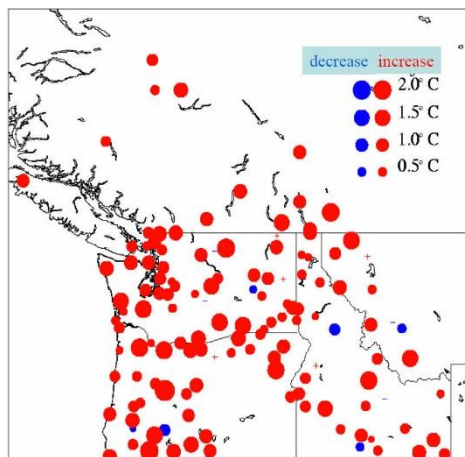
Climate change will not affect the Pacific Northwest uniformly. This section outlines what the primary effects are expected to be for the Puget Sound region. It relies heavily on projections from the [Climate Impact Group](#) (CIG). The CIG is an interdisciplinary research group at the University of Washington. They provide the most rigorous and comprehensive climate change information for the Pacific Northwest.

The average annual temperature for the Pacific Northwest has increased 1.3°F between 1895 and 2011.<sup>124</sup> This warming is statistically significant in all seasons except for spring. The Pacific Northwest climate has a high degree of variability, resulting in short-term cooling or warming trends that may stray from the long-term average temperature increase. For example, there were cooling trends from 2000 to 2011 despite overall long-term warming.<sup>125</sup> In addition, almost all temperature monitoring stations show warming, but the rate of warming has not been consistent across the region, as shown in Figure [Temperature Changes in the 20<sup>th</sup> Century] . The map illustrates the temperature trends in the Pacific Northwest since 1920, with the red dots marking an average annual temperature increase.

### 4.1.1 Temperature

The Puget Sound region is projected to warm between 4.2°F and 5.5°F on average by the 2050s (relative to 1970 – 1999).<sup>126</sup> The range reflects the difference between low and high future GHG scenarios. The low GHG scenario (4.2°F) represents GHG emissions continuing at the current rate until mid-century and then decreasing dramatically thereafter. The high GHG scenario (5.5°F) represents “business as usual,” or, steady increases in GHG emissions until 2100. Much higher warming is possible in the second half of the century, but the magnitude of warming is dependent on GHG emissions.<sup>127</sup> Figure [Projected temperature and precipitation changes for the Puget Sound region] shows the projected temperature changes for the Puget Sound Region, with the lighter colored lines representing individual model projections and the bold colored lines representing the average of the modeled projections.

**Figure 4-1. Temperature Changes in the 20th Century**



Source: Mote, P.W. 2003. Trends in temperature and precipitation in the Pacific Northwest during the twentieth century. *Northwest Science* 77(4): 271-282

Historical data show that the *global* climate has also been warming and trends are measurably accelerating.<sup>128</sup> Average global surface temperatures rose 1.5°F from 1880 to 2012.<sup>129</sup> Regional warming is likely to occur faster than global warming.

### 4.1.2 Sea Level Rise

The global average sea level has risen about 8 inches since 1900. Since the mid-1800s, the rate of sea level rise has surpassed the previous two millennia, indicating an accelerating trend.<sup>130</sup> Land movement can compound or mitigate the effects of sea level rise and create inconsistencies across the Puget Sound region. In Seattle, where the land is experiencing subsidence (gradual sinking) at the rate of about 0.5

inches per decade, one gauge reveals 8.6 inches of sea level rise from 1900 to 2008, averaging 0.8 inches per decade.<sup>131</sup> Subsidence appears to be the trend in most locations, but some places, such as the Northwest Olympic Peninsula, are experiencing uplift of the land and therefore a decrease in relative sea level.

Assuming land subsidence continues at the same rate, Seattle is projected to experience a 24-inch rise in sea level by 2100 (relative to 2000).<sup>132</sup> Factoring in the uncertainties around variations in global sea level rise, vertical land movement, and regional wind and ocean circulation patterns, the projected range of sea level rise for Seattle is as low as 4 inches, and as high as 56 inches by 2100.<sup>133</sup> As with temperatures, the rate of sea level rise is expected to vary over time due to seasonal and decadal climate variability.

Seattle has already begun adapting to the future effects of sea level rise. For example, in designing its new sea wall, the City evaluated its plans against the highest sea level estimates and found that the top of the sea wall would still be 3 feet above the new mean water level projected in 2100.<sup>134</sup>

### **4 1.3 Snowpack**

Seattle's water system and power system are dependent on Cascade Mountain snowpack and glacial melt. Peak snow accumulation and snowmelt-derived streamflow across the West have shifted 10 to 30 days earlier over the past half century.<sup>135</sup> Snowpack in the Washington Cascades has declined by 25% since the mid-1900s.<sup>136</sup> Additionally, there have been observed decreases in glacier area in the North Cascades of around 56% since 1900. Average spring snowpack in the Puget Sound is projected to decline by 42% to 55% by 2070 to 2099 (relative to 1970 - 1999, for both low and high GHG scenarios).<sup>137</sup> Fewer projections have been produced for glaciers, but two studies show that glacial recession is likely to continue over the next century. Figure [Projected future watershed classifications] shows the projected decline in snow-dominant watersheds in the Puget Sound region. The impact of the decline in snowpack on the city's water supply system has been somewhat mitigated by a dramatic decline in per-capita water usage despite a rise in Seattle's population.

### **4 1.4 Streamflow**

Due to the decreased snowpack and early spring melting, streams that rely on snowmelt are projected to experience peak streamflow earlier in the year, and for some rivers, dry years are becoming drier. Seattle's watersheds will become more reliant on rain than on snowpack. Winter streamflow is projected to increase by about 28% to 34% by 2080, while summer streamflow is projected to decrease by 24% to 31% by 2080.<sup>138</sup>

### **4 1.5 Precipitation**

Overall, heavy rainfall events are expected to become more severe for Washington State, but it is likely that the average annual precipitation will continue to be determined by yearly variations. The number of days with more than one inch of rain is estimated to increase 6% to 20% by the 2050s (relative to 1971 – 2000).<sup>139</sup> The estimated changes in annual precipitation are smaller, between -4% to 14% by the 2050s (relative to 1950 – 1999).<sup>140</sup> While projections of seasonal precipitation are mixed, most models point towards drier summers. Figure [Projected temperature and precipitation changes for the Puget Sound region] shows the projected precipitation changes for the Puget Sound Region, with the lighter colored lines representing individual model projections and the bold colored lines representing the average of the modeled projections. Water demand in Seattle is only expected to increase 5% by 2075 likely offsetting some impacts, but the effects of heavier rainfall on stormwater management could be costlier.<sup>141</sup>



## **4 1.6 Air Quality**

While some progress has been made in reducing emissions in Seattle, air quality is expected to decline due to increasing air temperatures, longer periods of heat, and drier summers. These factors have the potential to increase ground-level ozone and fine particulate matter accumulation. Summer deaths attributed to ozone are projected to increase to 132 per year by 2050, up from 69 per year from 1997 to 2006.<sup>142</sup>

## **4.2 Effects of Hazards**

Climate change has the potential to affect some of Seattle’s hazards: landslides, disease outbreaks, fires, infrastructure failures, power outages, excessive heat events, and some weather-related hazards. It affects both the likelihood and the consequences for most hazards.

### **4 2.1 Disease**

Climate change poses more questions than answers for the region’s disease vulnerability. How will warmer temperatures and modest changes in precipitation affect the spread and distribution of zoonotic diseases spread through animals? What if infectious disease carriers that are sensitive to temperature and moisture levels, such as mosquitoes and ticks, change their range? How will climate change affect organisms that cause water and food-borne diseases?

### **4 2.2 Excessive Heat Events**

Historic trends for the 19<sup>th</sup> century do not indicate that daytime heat waves are increasing in frequency. However, daytime heat waves are projected to become more severe when they do occur. By the 2050s, CIG projects that temperatures on the hottest days in the Puget Sound area will increase by 6.5°F on average.<sup>143</sup> This could contribute to increased smog and health problems, particularly for vulnerable populations. There is evidence that the Puget Sound region has been experiencing more nighttime heat waves. Nighttime temperatures are increasing faster than daytime temperatures, reducing the relief of nighttime cooling that many Seattle residents are accustomed to.<sup>144</sup>

### **4 2.3 Fires**

Climate change will mean potential increases in the total area burned in wildland fires. Wildland fires are less frequent in the western Cascades than in the eastern Cascades, but climate change increases fire risk in both regions. A wildland fire in a Seattle watershed could degrade Seattle’s water quality and threaten utility equipment and infrastructure. Due to this risk, Seattle Public Utilities (SPU) has its own fire crew to support wildland fire suppression in the watersheds.

### **4 2.4 Flooding**

Climate change will likely increase urban flooding in winter. If rainfall becomes more severe over shorter periods of time, as is projected, Seattle’s drainage system (built for slower rainfall rates) will be strained. Without upgrades the result could be an increase in urban flooding. Coastal flooding is projected to increase with climate change. Higher sea levels can extend the reach and impact of storm surge.<sup>145</sup> Low-lying areas fronting Puget Sound could be subject to flooding, especially when winter storms coincide with high tides.

### **4 2.5 Infrastructure Failures**

A 2008 analysis of the King County Wastewater Treatment Division revealed that 30 major wastewater treatment facilities are at risk of flooding from sea level rise by 2100, when considering both sea level rise projections and an extreme storm event. Using 2008 CIG projections, the analysis concluded that the risk of flooding at these facilities should remain low until after 2050.<sup>146</sup> The Seattle Office of

Sustainability and Environment estimates that sea level rise above 24 inches could impact 8.2% of bus routes and 0.18% of freight rail.<sup>147</sup> One study of sea level rise on internet infrastructure estimated that 23.6% of Seattle's fiber optic cable could be inundated by 2033.<sup>148</sup> Rising air temperatures also threatens infrastructure. High heat causes steel to expand which can damage older structures. During excessive heat the Seattle Department of Transportation (SDOT) must cool its drawbridges to ensure they can be opened and closed.

#### **4 2.6 Landslides**

Water is a trigger for landslides. Increased soil water content beyond a given threshold can heighten the risk of landslides. Climate change is expected to contribute to an increase in frequency and intensity of heavy rainfall events, resulting in a higher likelihood of landslides.<sup>149</sup>

#### **4 2.7 Power Outages**

While summer power demand for cooling may increase, it will be offset by the decrease in winter demand for heating and overall decreases in demand due to advancements in energy efficiency. Therefore, warmer temperatures are not expected to make power outages more likely. However, if a power outage occurs during an excessive heat event, warmer temperatures along with the inability to power cooling devices could make the consequences of the excessive heat event more severe.

#### **4 2.8 Water Shortages**

Seattle Public Utilities (SPU) states that existing water resources will be sufficient to meet forecasted demand until 2060.<sup>150</sup> The primary impact on SPU's water system is projected to arise from more frequent temperature-driven droughts due to low snowpack and/or early snowmelt that leads to an extended summer dry season. SPU supplies drinking water to roughly 1.4 million people in Seattle and surrounding communities. Most of that water originates in the South Fork Tolt River and Cedar River watersheds, both in the Cascade Mountains.

Seattle City Light's (SCL) hydroelectric projects on the Skagit and Pend Oreille Rivers provide about half of the power its customers need. The remainder comes from a mix of power sources, including long-term contracts with the Bonneville Power Administration (BPA), which produces power in the Columbia River Basin. Hydropower generation in the Columbia River Basin is projected to increase 5% in winter and decrease 12% to 15% in summer by the 2040s (relative to 1970-1999). The same seasonal pattern of change is expected to occur in the Skagit watershed, though the exact amount of change is not well known. In the long term, SCL will look at the potential need to modify operations of its hydroelectric projects. To be consistent with National Energy Reliability Council requirements, SCL has already adopted a more conservative planning standard for its Integrated Resource Plan, effectively reducing the amount of generation the utility can count on from its hydro resources in the future. SCL is also planning for more variability in the precipitation levels in river basins, including the increased potential for drought and floods. The utility's Power Operations and Marketing Division is working closely with the Environmental Affairs Division to determine potential effects on the salmon and steelhead in the watersheds where it operates hydroelectric projects.

#### **4 2.9 Windstorms**

How climate change affects the frequency and intensity of windstorm events in the Pacific Northwest is unclear. CIG partnered with Seattle City Light (SCL) to project changes in extreme wind events and lightning risk for the future period of 2040 to 2070. The model simulations showed no significant change in the frequency of extreme wind events.<sup>151</sup> Small increases in frequency were found in mountain locations but were minor compared to natural variability. Additional modeling is needed to more fully understand the projected effects of climate change on extreme wind events in the Puget Sound region.

## 4.3 Policy Considerations

In addition to intensifying hazards, the slow onset of climate change presents a unique set of challenges around decision making. The effects of climate change will happen over long periods of time, threatening the sense of urgency to mitigate them within the community. Although these risks are outside the traditional emergency management framework, it is important to recognize them. The possible consequences are listed below as policy considerations for our community.

### 4.3.1 Urban Forestry

Climate change projections for the region suggest that plant hardiness zones will change, threatening certain conifer species that exist in Seattle’s urban forest.<sup>152</sup> One analysis reveals that future climate conditions in low elevation forests in Washington will not support the establishment of Douglas Fir, one of Seattle’s native conifer species.<sup>153</sup> It is likely that insect and disease outbreaks will also change, but the effect on Seattle’s urban forest is difficult to predict because it will depend on the particular species of tree, insect, or pathogen and its response to increasing temperatures and precipitation changes.<sup>154</sup> For example, one analysis found that Mountain Pine Beetle outbreaks may increase in frequency and severity in Washington but will likely be a threat to higher elevation forests, as the temperatures in lower elevation forests will be unfavorable to the insect.<sup>155</sup>

### 4.3.2 Sea Level and Sea Temperature Rise

The location and design of shoreline facilities, development regulations, and habitat restoration projects will all face the challenge of adapting to sea level rise. Existing infrastructure may require adaptations as well. Some projections of sea level rise are high enough that the water levels would threaten the separation of Lake Union and Lake Washington from Puget Sound. If this is the case, will the federal government improve the Ballard Locks to maintain the separation?

Sea surface temperatures in the Puget Sound have increased by 0.8°F to 1.6°F since 1950 and are projected to increase another 2.2°F by the 2040s.<sup>156</sup> Increasing water temperatures may promote the growth of harmful algal blooms that can contaminate shellfish, generating public health concerns. This may have harmful impacts on Seattle’s commercial fisheries.

### 4.3.3 Food Systems

Climate change has the potential to impact agriculture that will affect our food and nutrition sources. While the local agricultural system is expected to adapt to climate change, there could be wider impacts to the global food system. The Puget Sound region is expected to see a longer growing season and shifts in crop production due to climate change.<sup>157</sup> In addition, climate change will present challenges with managing water supply, potential increases in pests, increasing winter flood risk, and increasing risk of saltwater intrusion.

### 4.3.4 Coastal Ecology

Unavoidable air temperature and sea surface warming in the next century will have a significant impact on local species and habitats. The larger the degree and rate of change, the harder it will be for most fish and wildlife species to adapt. For example, a significant reduction in the area of estuarine beaches would affect important spawning habitat for forage fish, which make up a critical part of the marine food web. Unless species are able to find alternative spawning areas, their populations could decline.

Sea level rise is projected to both expand and reduce the area of tidal wetlands in Puget Sound, depending on the wetland type, amount of sedimentation, and availability of landward buffers. CIG projects that salt marsh habitat will increase while tidal freshwater marsh habitat will decrease.<sup>158</sup> Inundation of tidal flats in some areas would reduce stopover and wintering habitat for migratory

shorebirds. It could also have a major impact on the region's economically-important shellfish industry. Loss of coastal marshes would affect habitat for thousands of wintering waterfowl that visit the region each year. Changes in the composition of tidal wetlands could significantly diminish the capacity for those habitats to support salmonids, especially juvenile chinook and chum salmon. While rising water temperatures are projected to negatively affect salmon populations,<sup>159</sup> a lesser known factor is how sea-level rise might affect the region's salmonids. Nearshore ecosystems play a critical role in the life cycle of anadromous fish, many of which use coastal marshes and riparian areas for feeding and refuge as they transition between their freshwater and ocean life stages.

Coastal habitats and the fish and wildlife that depend on them are at great risk. Some species may be able to respond to changes by finding alternative habitats or food sources, but others will not. Compounding this dilemma, coastal modifications such as dikes and seawalls have significantly reduced the ability for habitats and wildlife to migrate inland to accommodate for sea level rise.

Changes in freshwater flows into coastal waters are likely to alter salinity, water clarity, stratification and oxygen levels. In addition, higher water temperatures in Puget Sound and the Pacific Ocean could exacerbate the impact of excess nutrient runoff into coastal waters, enhancing harmful algal blooms and hypoxia events.

Many coastal plant and animal species are adapted to a certain level of salinity. As a result, prolonged changes can make habitats more favorable for some species, and less so for others. Sea-level rise will also contribute to the expansion of open water in some areas – not just along the coasts but also inland, where dry land can become saturated by an increase in the height of the water table. Furthermore, sea-level rise will lead to significant beach erosion and make coastal areas more susceptible to storm surges.

## 4.4 Policy Responses

The city's approach is twofold: reduce local levels of climate pollution to slow the rate of climate change and plan for and adapt to the inevitable changes that are already here and will continue into the future. In 2013, Seattle published a [Climate Action Plan](#) to improve preparedness and develop a comprehensive strategy. In 2017, the City published a [follow-up report](#) on the actions it will take to improve climate preparedness of infrastructure and services. The report prioritizes collaborating with community-based organizations and working to advance environmental justice as climate change disproportionately affects communities of color and vulnerable populations. It outlines multiple preparedness and adaptation strategies for the following sectors: transportation, land use and the built environment, city buildings, parks, drainage and water supply systems, electrical systems, and community preparedness.



## 5. GEOLOGIC HAZARDS

This section covers hazards caused by geophysical processes like earthquakes, landslides and volcanic activities. Tsunamis are included because they are generated by earth movement.

## 5.1 Earthquakes

- Earthquakes are the most serious hazard facing Seattle. Unlike other potentially catastrophic hazards, Seattle has had and will experience powerful earthquakes.
- The Seattle area experiences three earthquake types with varying consequences:
  - **Crustal or Shallow Quakes** occur in the North American plate at 0-30 km near the crust's surface along faults. Intense shaking occurs near the epicenter but usually diminishes quickly with distance relative to the other earthquake types. Crustal earthquakes are expected on the Seattle Fault Zone, which is the primary but not only source for this type of quake in Seattle. An example of a crustal earthquake is the magnitude (M)6.2 Christchurch, New Zealand earthquake that occurred in 2011.
  - **Intraplate or Deep Quakes** occur at depths of 30-70 km in oceanic crust as it dives under lighter continental crust. Because of the depth, even buildings located right above them are far enough away that seismic waves are attenuated. An example of a deep earthquake is the M6.8 Nisqually Earthquake that occurred in the Pacific Northwest in 2001.
  - **Subduction Zone or Megathrust Quakes** occur on the interface between the North American plate and the Juan de Fuca plate, a small plate extending from northern California to British Columbia. An example of a megathrust earthquake is the M9.0 Tōhoku Earthquake that occurred off the coast of Japan in 2011.
- The amount of shaking at a location depends on an earthquake's magnitude, the distance between the location and the earthquakes' source, and local geology. Other factors like the frequency of seismic waves also affect how structures shake in earthquakes.
- Earthquake frequency intervals are estimates, not predictions. The estimated occurrence rate of a M6.0 or larger deep earthquake is about every 30-50 years. The estimated occurrence rate of a megathrust earthquake is every 200 to 1,100 years, or on *average*, every 500 years. The estimated frequency of a Seattle Fault earthquake is difficult to determine due to lack of data. Estimated recurrence intervals range from every 200-15,000 years.
- An earthquake on the Seattle Fault poses the greatest risk to Seattle because:
  - The Seattle Fault Zone extends east-west through the middle of the city.
  - A Seattle Fault quake could be as large as M7.5,<sup>160</sup> but less than M7.0 is more probable.
  - The most recent Seattle Fault earthquake was about 1,100 years ago;
  - The Seattle Fault has been active about three or four times in the past 3,000 years.
- Deep quakes are the most common large earthquakes that occur in the Puget Sound region. Quakes larger than M6.0 occurred in 1909, 1939, 1946, 1949, 1965 and 2001.
- Megathrust earthquakes are the greatest risk to the broader west coast region. A megathrust earthquake could reach M9.0+ and affect an area from Canada to northern California. A Cascadia megathrust earthquake could rank as one of the largest earthquakes ever recorded, but because Seattle is several hundred miles from the source seismic waves would weaken slightly before they reach Seattle. Shaking would be violent and prolonged, but not as intense as in a Seattle Fault quake.



- About 15% of Seattle’s total area is soil that is prone to ground failure in earthquakes. The Duwamish Valley, Interbay, and Rainier Valley are vulnerable to ground failure and shaking because of the liquefiable soils in these areas.
- Seattle has over 1100 unreinforced masonry buildings (URMs) that are prone to collapse in earthquakes. These older brick buildings tend to be concentrated in areas expected to experience the strongest ground motion during earthquakes.
- Seattle has many bridges that, despite seismic retrofits, may not be useable after a strong earthquake. Damage to them would impair emergency services and the economy.
- An earthquake will produce costly damage. Combined property damage for quakes in 1949 and 1965 in the region amounted to roughly \$400 million (2010 dollars). The 2001 Nisqually Earthquake resulted in damage to City of Seattle buildings, infrastructure, and response costs that exceeded \$20 million. Adding in the costs of repairing arterial road structures, the figure topped \$36 million.
- Secondary impacts such as landslides, tsunami, fires, infrastructure failures, and hazardous materials releases could become disasters themselves. In past earthquakes, more people have died from fire than building collapse.
  - 2013 research finds that Seattle could experience *thousands* of landslides following a strong (M7.0) Seattle Fault earthquake. Estimates range from 5,000 in dry conditions to 30,000 in the wettest conditions.
  - A large Seattle Fault earthquake could trigger a tsunami up to 16 ft high that would strike the Seattle shoreline within seconds of the earthquake and flood it within 5 minutes. A megathrust earthquake will not cause a tsunami with inundation for Seattle but is expected to cause strong currents in Seattle’s waters that may be dangerous for vessels. A deep earthquake could cause landslides that trigger a tsunami.
  - A M7.0 Seattle Fault earthquake could cause dozens of fires. Suppressing the fires may be more difficult due to severed transportation routes and possible damage to the water system, which could reduce water pressure in many parts of the city.
  - Structural failure and fires would probably cause multiple hazardous materials releases. They could range from minor spills to major incidents with public health and environmental ramifications.

## 5.1.1 Context

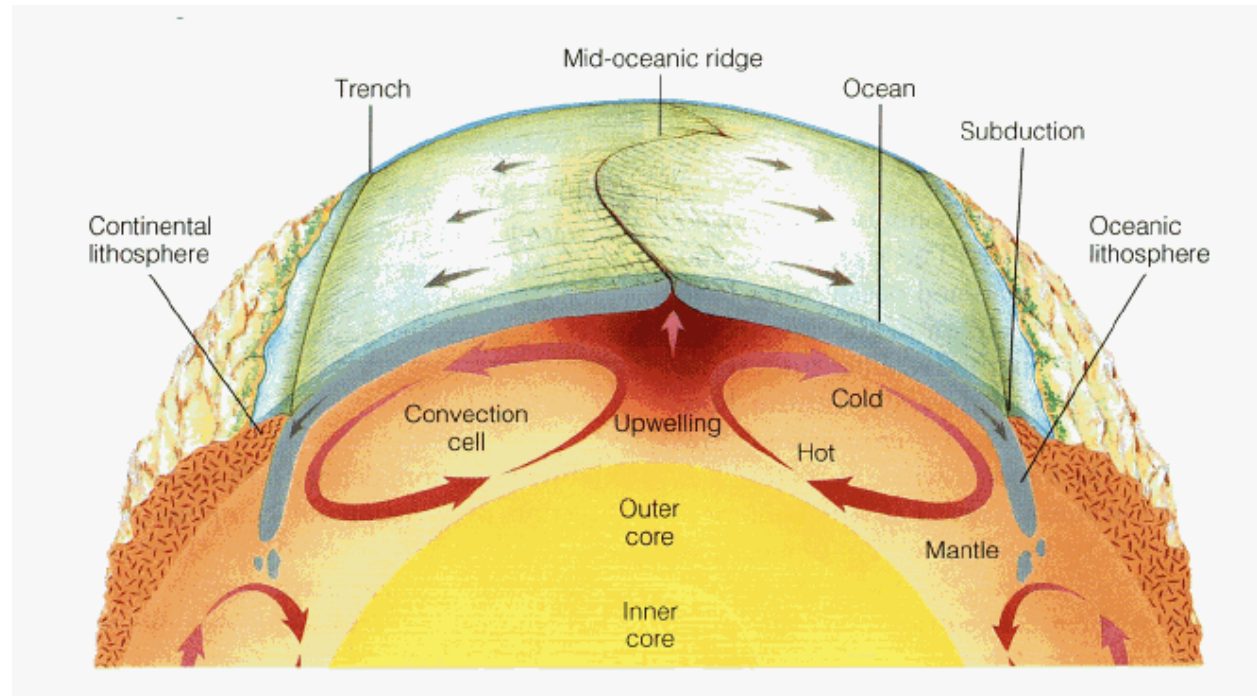
### Plate Tectonics

Earthquakes happen when the strain accumulating in rock becomes greater than the strength of the rock or the pressure keeping it from slipping. Plate movement is primarily driven by very slow convection currents in a hot, dense, plastic rock layer of the Earth called the mantle (see Figure [Convection in the Earth’s Crust]). Just as hot air rises and cool air sinks, hot mantle material rises, cooling as it nears the surface. The cooler material then begins to slowly sink down, which creates a convection cell. Hot rising rock pushes plates across the surface of the earth. When plates collide, the thinner, denser ocean plate is usually forced under the thicker, lighter rock of the continent.

In the Pacific Northwest, the Pacific Plate is moving northwest and is pushing the smaller Juan de Fuca plate clockwise under the North American Plate. This process is known as subduction. The motion of the plates is not smooth. Friction and pressure along the interface of the plates prevents the ocean plate from moving under the continent, locking them together for decades or centuries. Strain builds up until

the fault breaks and a few meters of the Juan de Fuca plate slips under the North America Plate, causing a megathrust earthquake.

**Figure 5-1. Convection in the Earth's Crust**

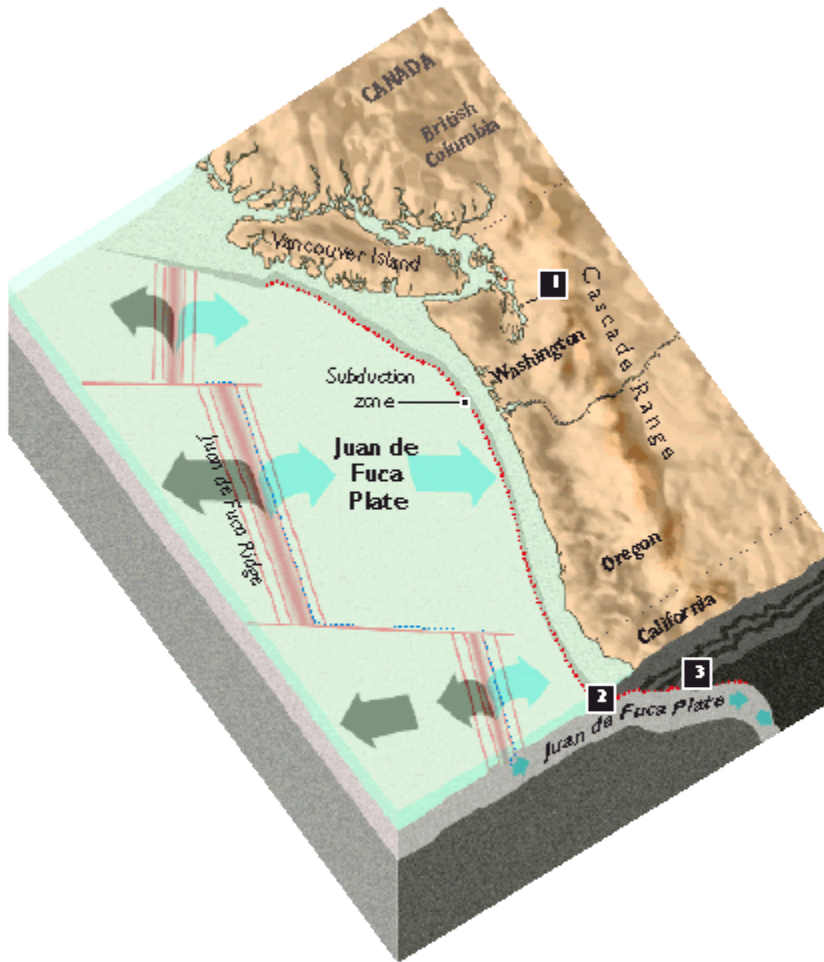


Source: <http://clarkscience8.weebly.com/forces-inside-earth.html>.

### Types of Earthquakes

The Puget Sound region experiences three types of earthquakes:

1. **Crustal earthquakes** (also called “shallow”) occur in the North American Plate as it adjusts to the build-up of strain along the interface of the North American and Juan de Fuca Plates. Depths vary from 0 to 30km (about 21 miles). They are usually felt intensely near their epicenter, but their effects diminish relatively quickly with distance. There is an active shallow fault system running through the middle of Seattle, called the Seattle Fault Zone.
2. **Megathrust earthquakes** (also called “subduction”) happen when pressure at the interface between the Juan de Fuca plate and North American plate unlocks along a sloped plane from where the plates meet off the Washington coast. This fault is over 1,000 km (620 miles) long. Megathrust earthquakes are the largest type of quake, with magnitudes from M8.0 to over M9.0. They have occurred at about 500-year intervals, on average, ranging along the Pacific Coast.<sup>161</sup>
3. **Intraplate earthquakes** (also called “deep”) occur at depths between 35 and 70km (about 21 - 43 miles). Since they are farther from the surface, they are not felt as intensely, but are experienced over a wider area than crustal quakes. They are the most common type of large earthquake in our region. Western Washington has experienced three since 1949.



Source: <http://www.burkemuseum.org/static/earthquakes/bigone/threekinds.html>. Accessed: 3/5/2019

## Measures

### Moment Magnitude

Moment magnitude measured the amount of energy released by an earthquake. It has three components: the size of the area that has slipped, the amount of slippage, and the viscosity of the material. Low viscosity is like fingers scraping a stick of butter; high viscosity is like fingers scraping a blackboard. Earthquakes of magnitude M5 are considered “moderate;” above M8, they are considered “great.”

Moment magnitude is a different measure from the Richter scale, which was designed in 1935 for small to medium earthquakes in California, within 600 km of the recording seismograph. Because of these shortcomings, Moment magnitude is the most common scale used by the United States Geological Survey (USGS).

### Modified Mercalli Intensity (MMI) Scale

The Modified Mercalli Intensity (MMI) Scale is a subjective measurement of earthquake effects and damage (see Table 5-1). The MMI scale uses twelve steps to describe how the earthquake felt to people and its damage to structures. Maps drawn from reports of what people felt are useful in determining

areas of damage concentration. Because effects differ in and across areas, an earthquake can have multiple intensities.

**Table 5-1. Modified Mercalli Intensity (MMI) Scale**

I. Instrumental	Not felt by many people unless in favorable conditions.
II. Feeble	Felt only by a few people at best, especially on the upper floors of buildings. Delicately suspended objects may swing.
III. Slight	Felt quite noticeably by people indoors, especially on the upper floors of buildings. Many do not recognize it as an earthquake. Standing motor cars may rock slightly. Vibration similar to the passing of a truck. Duration estimated.
IV. Moderate	Felt indoors by many people, outdoors by few people during the day. At night, some awakened. Dishes, windows, doors disturbed; walls make cracking sound. Sensation like heavy truck striking building. Standing motor cars rock noticeably. Dishes and windows rattle alarmingly.
V. Rather Strong	Felt outside by most, may not be felt by some outside in non-favorable conditions. Dishes and windows may break and large bells will ring. Vibrations like large train passing close to house.
VI. Strong	Felt by all; many frightened and run outdoors, walk unsteadily. Windows, dishes, glassware broken; books fall off shelves; some heavy furniture moved or overturned; a few instances of fallen plaster. Damage slight.
VII. Very Strong	Difficult to stand; furniture broken; damage negligible in building of good design and construction; slight to moderate in well-built ordinary structures; considerable damage in poorly built or badly designed structures; some chimneys broken. Noticed by people driving motor cars.
VIII. Destructive	Damage slight in specially designed structures; considerable in ordinary substantial buildings with partial collapse. Damage great in poorly built structures. Fall of chimneys, factory stacks, columns, monuments, walls. Heavy furniture moved.
IX. Ruinous	General panic; 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. Disastrous	Some well built wooden structures destroyed; most masonry and frame structures destroyed with foundation. Rails bent.
XI. Very Disastrous	Few, if any masonry structures remain standing. Bridges destroyed. Rails bent greatly.
XII. Catastrophic	Total damage - Almost everything is destroyed. Lines of sight and level distorted. Objects thrown into the air. The ground moves in waves or ripples. Large amounts of rock may move position.

## Acceleration

Acceleration is the rate of change of velocity in a unit of time. During an earthquake, ground shaking experiences acceleration. Peak ground acceleration is the largest increase in velocity experienced by particles on the ground. Spectral acceleration is what is experienced by a building, modeled after the velocity of the ground shaking. In other words, it is what the building would experience at its base during an earthquake. All structures have a “natural period,” or, the rate at which they move back and forth from horizontal force.<sup>162</sup> For example, 10-20 story buildings typically have a natural period of 1 to 2 seconds. The natural period of the ground is between 0.4 and 2 seconds. In an earthquake, if the natural period of the ground movement is close to the natural period of the structure movement, the additional small pushes from the ground can increase acceleration by up to 5 to 6 times. This phenomenon is known as resonance.

Typically, the higher the acceleration, the more stress on a building. Peak ground acceleration can be a good measure for smaller buildings (below 7 stories), while spectral acceleration can be a good measure for larger buildings when also taking building design into account. Seismic acceleration is divided into horizontal (east-west and north-south) and vertical components. The distinction can be critical as some

structures are designed to withstand motion in some directions better than others. Acceleration varies with distance from the epicenter and local conditions, like soil type.

In 2007, the USGS developed a series of maps that estimated the maximum acceleration Seattle neighborhoods would face in the next 50 years. They are explained below.

Sometimes duration is also used as a measure because the longer shaking occurs, the greater the likelihood of damage, especially in soft soils. Duration is most concerning in a megathrust earthquake, where shaking can last several minutes.

## Geology

The upper level of soil greatly modifies seismic waves that travel through it. The amplification and directionality of seismic waves depends on soil type, soil stiffness, soil thickness and soil geometry (see Figure 5-2).<sup>163</sup> Soft soils, especially those that overlay hard rock, amplify seismic waves. The amplification causes more vulnerable soil farther from the epicenter to shake more intensely than less vulnerable soils closer to the epicenter. Notice how in Figure 5-2, the Duwamish Valley area experiences more intense shaking than the surrounding hills even though they are the same distance from the epicenter. This is because the Duwamish Valley sits on artificial fill that is more susceptible to ground shaking.

Local geology contributes to secondary incidents such as liquefaction and landslides. Liquefaction is a special type of ground settlement that occurs in water-saturated sands, silts, and gravels. In an earthquake, loose soils compact, displacing and pressurizing the water. The “solid ground” then liquefies. Whole buildings have overturned when the underlying soils lose enough tensile strength to support the structure. More commonly, only part of a building sinks, causing uneven settling. If liquefaction occurs on a slope, even if it is gentle, the muddy soil can flow laterally and cause severe structural damage. Earthquakes can trigger landslides by shaking unstable or steep slopes. Wet conditions can exacerbate landslide potential because waterlogged soils are less able to resist shear stress in slopes. More information about landslides can be found in the chapter on them below.

### 5.1.2 History

The Puget Sound region is been the most seismically active area in Washington.<sup>164</sup> Nineteen earthquakes that were large enough to be felt by humans (approximately greater than M3.0) have occurred in western Washington since 1880 (see Figure [Major earthquakes since 1880 in Washington State]). Twelve of these ten were centered in the Puget Sound region.

**Around 900.** M7.5 Seattle Fault earthquake. It caused massive landslides and a tsunami. Whole hillsides slid into Lake Washington and Puget Sound. A tsunami estimated to be 16ft flooded much of the low-lying area around the mouth of the Duwamish River. It is estimated that the Seattle Fault has been active 3 – 4 times in the last 3,000 years. Glaciers covering the Puget Sound region probably destroyed any evidence for earthquakes over 15,000 years old.<sup>165</sup>

**Jan. 1700.** M9.0 megathrust earthquake along the Pacific Northwest Coast. Coastal areas dropped 1.5 meters as the Cascadia Subduction Zone ruptured along its 1000 km length. It generated a tsunami that struck Japan.

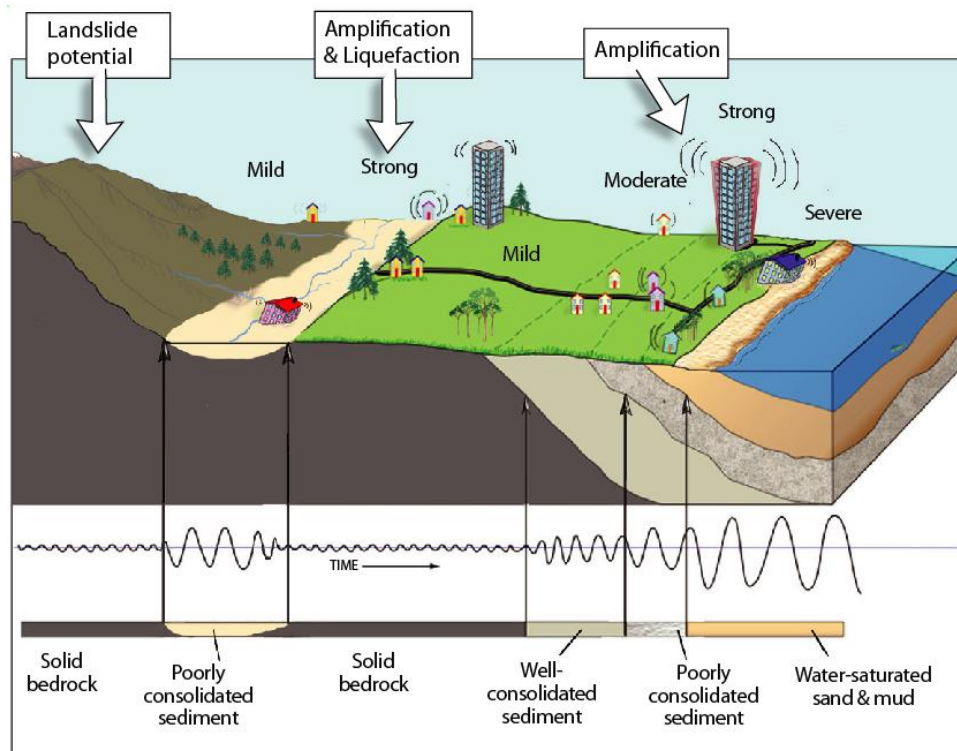
**Dec. 1872.** M6.8 shallow earthquake shook the North Cascades. It triggered a huge landslide that temporarily blocked the Columbia River.

**Jan. 1909.** M6.0 deep earthquake centered in the San Juan Islands.

**Nov. 1939.** M5.75 deep earthquake centered near Olympia. Chimney and building façade damage near the epicenter. No damage reported in Seattle.



**Figure 5-2. Soil Amplification, Liquefaction, and Landslide Hazards from Earthquake Ground Shaking**



**Apr. 1945.** M5.5 (no data on depth) earthquake centered under North Bend. Chimney and building façade damage near the epicenter. Boy hit by falling brick in Cle Elum. No damage reported in Seattle.

**Feb. 1946.** M6.3 deep earthquake centered under mid-Puget Sound. Damage in Seattle mainly limited to the Duwamish Valley and structures built on pilings.

**Apr. 1949.** M7.1 deep earthquake centered near Olympia. The earthquake had a peak acceleration of .3g and produced type VIII MMI damage at its highest intensity. Eight people were killed, mostly from falling brick and the region suffered \$314 million in damages (2010 dollars). In Seattle, the earthquake's effects were felt mainly in the northern section of West Seattle and at the mouth of the Duwamish River.

**Apr. 1965.** M6.5 deep earthquake with the epicenter closer to the city than the 1949 quake. The earthquake's acceleration was lower, .2g. While it did cause type VIII MMI damage, most of its effects were limited to type VII MMI. As in 1949, many ground failures occurred in the Alki and Harbor Island areas, but they were not as concentrated as in the 1949 quake. Six people were killed, mostly by falling debris. Damage was \$104 million (2010 dollars). Based on these records, one report estimates that M6.5 events have a repeat rate of 35 years and M7.0 events have a repeat rate of 110 years.<sup>166</sup>

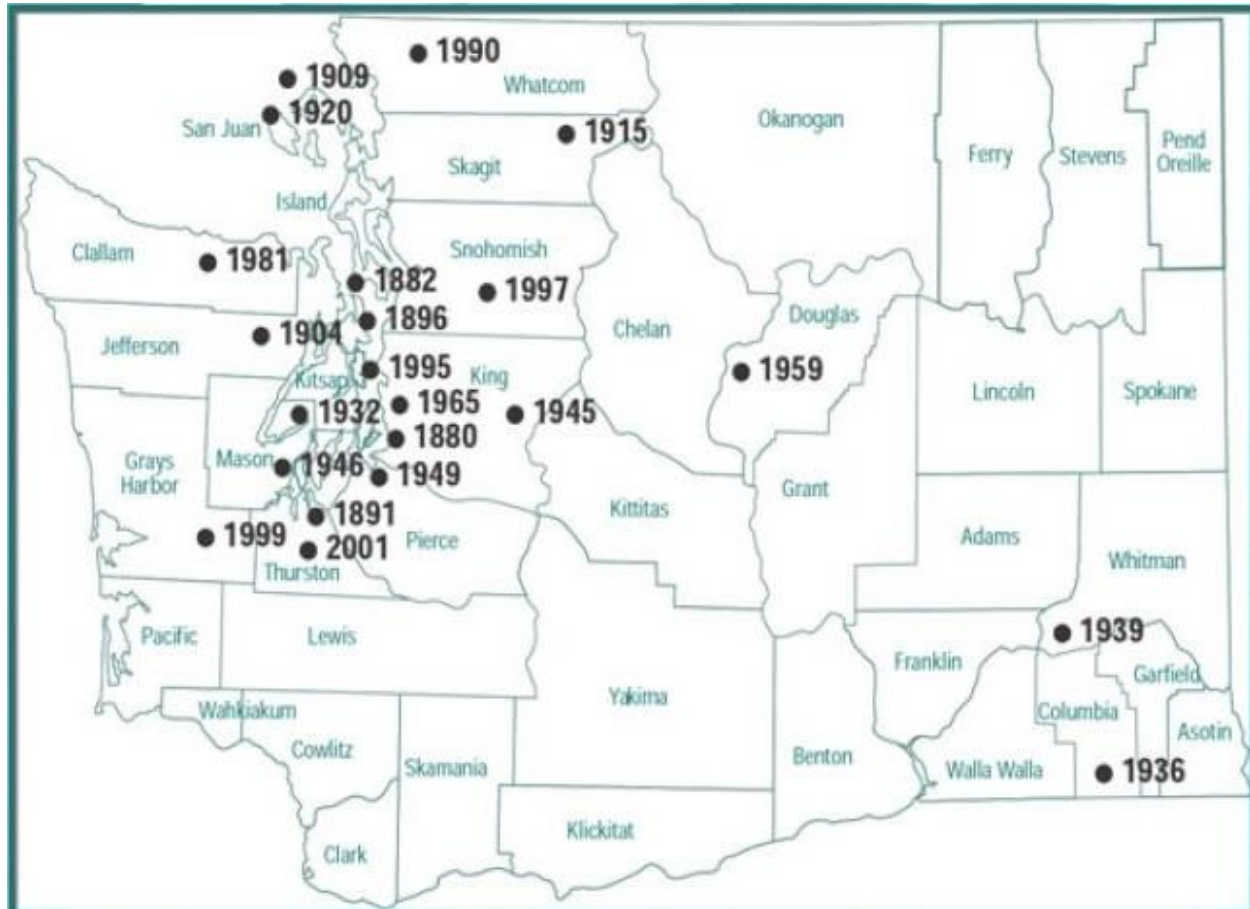
**Jan. 1995.** M5.0 shallow quake, with a depth of 11 miles. Centered under Robinson Point on Bainbridge Island. No damage reported.

**May 1996.** M5.3. A shallow quake centered under Duvall. Some light damage reported, mainly objects falling from shelves. No damage reported in Seattle.

**Jun. 1997.** M4.9. Another shallow quake centered under Bremerton. No damage reported in Seattle.

**Feb. 2001.** M6.8. Large deep quake under South Puget Sound, the "Nisqually Earthquake." One death was attributed to a stress-related heart attack during the earthquake. 400 people were injured, but only 4 were serious injuries.<sup>167</sup>

**Figure 5-3. Major earthquakes in Washington since 1880**



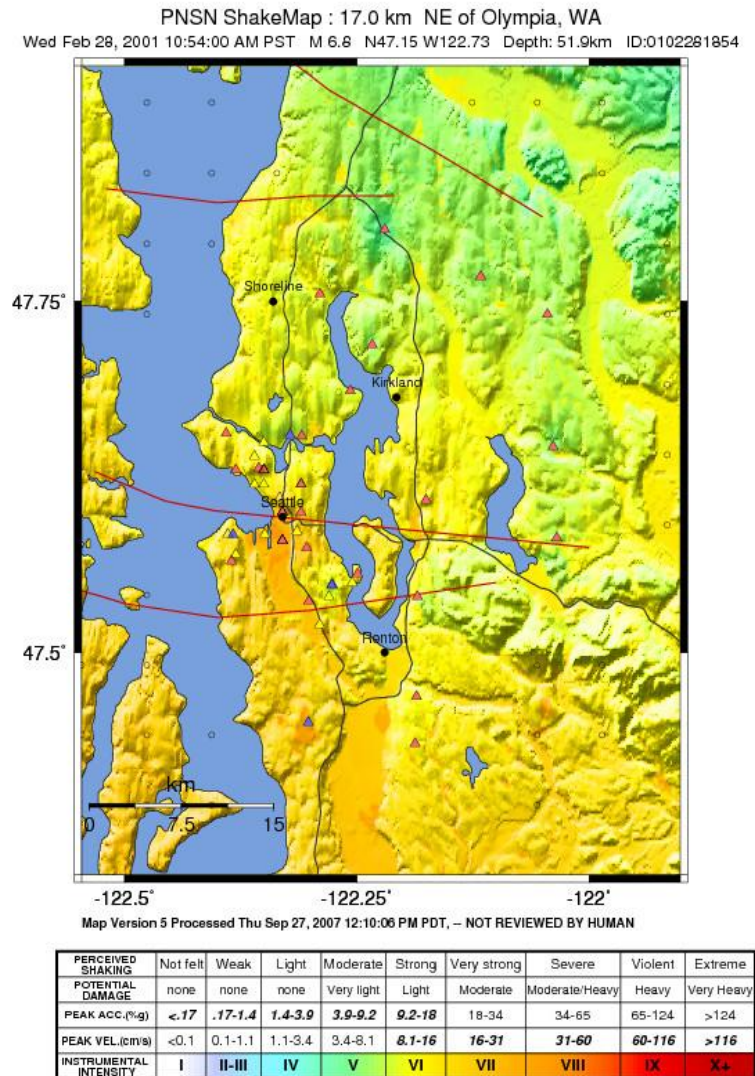
Significant public and private damage occurred as a result of this deep quake. Four residential homes were destroyed, 46 suffered major damage and 120 had minor damage.<sup>168</sup> 217,000 people lost power but only for a few hours. The City of Seattle incurred over \$36 million in response costs and repairs to city-owned facilities and systems, and costs from damage to arterial roads and bridges. Eighteen bridges were damaged in the city.<sup>169</sup> Total damages in Seattle were estimated to be over \$200 million.<sup>170</sup>

The quake's damage to structures serving vulnerable populations raised concerns. Seattle's Office of Housing (OH) did an unofficial survey of 45 non-profit assisted housing properties serving low-income residents post-Nisqually.<sup>171</sup> Most faced minor structural or plaster damage. One men's homeless shelter, the Compass Center, was red tagged and its 75 male residents were forced to vacate. The building was repaired and seismically upgraded in 2005. The Seattle Housing Authority (SHA) also faced damage to its buildings, which house low-income and elderly people. The two buildings that suffered the most damage were older brick structures that were sold after being repaired. In total, the earthquake cost SHA over \$200,000, mostly to repair elevators (most of this cost was reimbursed by the U.S. Department of Housing and Urban Development and FEMA).<sup>172</sup>

The earthquake had direct and indirect impacts on many businesses. The northern end of the Boeing Field runway was closed for two weeks after the earthquake. Results from a survey of 832 small businesses (less than 500 employees) in the Puget Sound area revealed that 20% incurred direct physical losses from the earthquake. Of these, 6.5% suffered losses over \$1,000 and 2% suffered losses over \$10,000. Overall, average losses amounted to 1.3% of annual revenue. The three areas with the most



Figure 5-4. Nisqually Intensity Measured By Modified Mercalli Intensity Scale



identifiable, concentrated small business damage were Downtown Olympia, Seattle's Pioneer Square, and Seattle's Harbor Island.

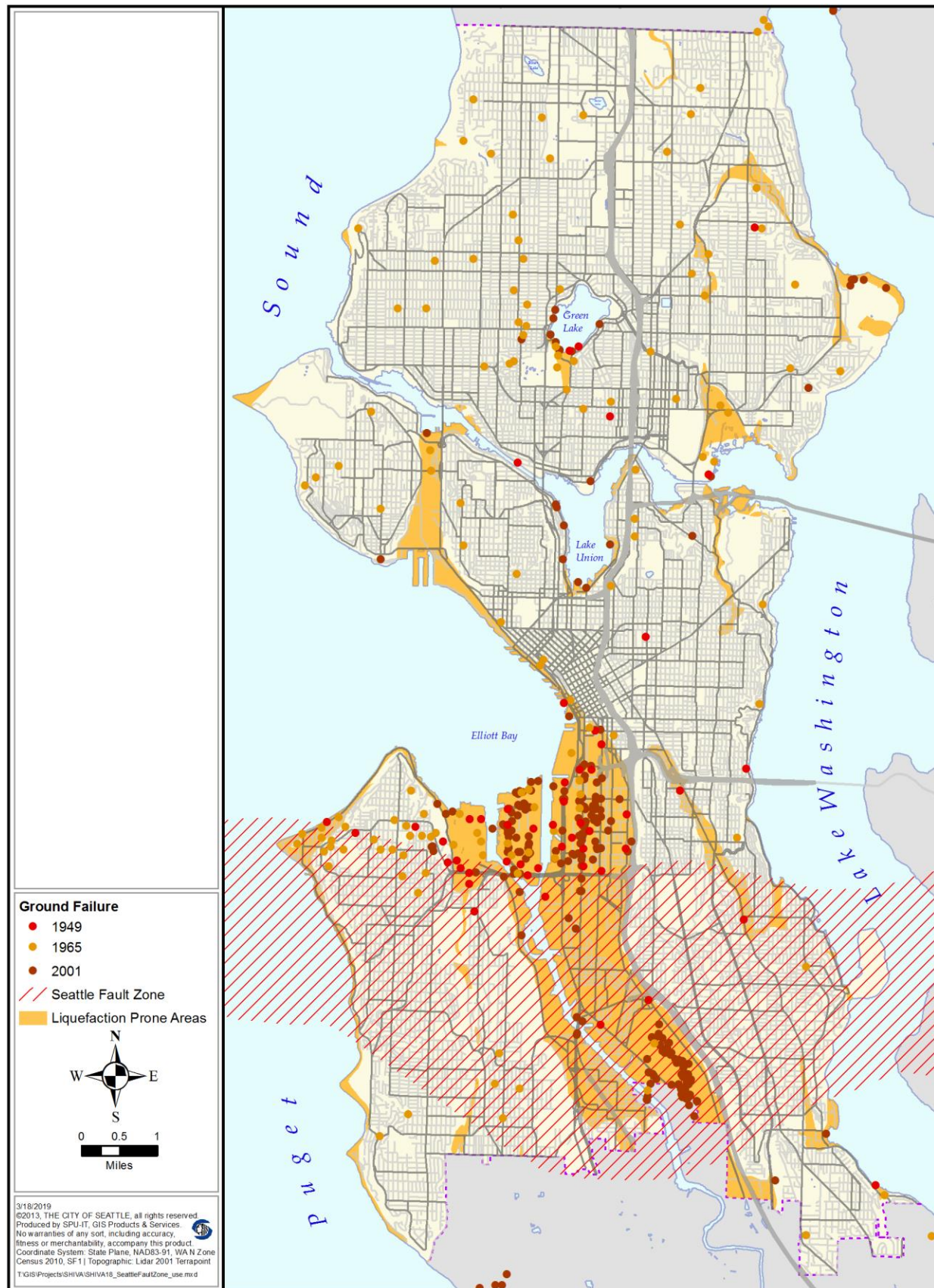
The largely industrial Harbor Island experienced the highest level of shaking in Seattle, similar to that experienced in heavily damaged areas in the 1994 Northridge, California earthquake. Nearly 40% of Harbor Island firms had direct losses exceeding \$20,000. They also suffered high rates of indirect losses from disruption of operations.<sup>173</sup>

### 5.1.3 Likelihood of Future Occurrences

The USGS estimates that intraplate earthquakes of M6.0 or greater (like the Nisqually quake) occur *about* every 30 to 50 years. Crustal earthquakes with a magnitude of 5.5 to 6.5 occur about every 100 years. Megathrust earthquakes occur every 200 to 1,100 years, or on *roughly* every 500 years.

The last megathrust earthquake occurred in 1700 AD. The last Seattle Fault earthquake was around 900 AD, 1,100 years ago. The USGS sees evidence that the Seattle Fault has been active 3 to 4 times in the past 3,000 years, with an earthquake about M6.5 or greater occurring roughly every 1000 years. Due to

Figure 5-5. Seattle Fault Zone, Liquefaction Areas and Ground Failures



**Table 5-2. Earthquake Type and Estimated Frequency**

Type	Size	Estimated Frequency
Deep Earthquakes like Nisqually	Over 6.0	Every 30 to 50 years
Megathrust Earthquakes	8.0 to 9.0+	Every 500 years on average
Seattle Fault	Over 5.5	Every 200 – 12,000 years
Seattle Fault	Over 7.2	Every 5000 – 15,000 years

the lack of data for Seattle Fault events, the estimated recurrence intervals have wide ranges. Taking into account estimates from local earthquake scientists and the USGS, the recurrence interval for smaller Seattle Fault earthquakes is every 200 to 12,000 years, and larger events every 5,000 to 15,000 years.<sup>174</sup>

In 2007, the USGS produced a series of probabilistic earthquake hazard maps for Seattle (**Error! Reference source not found.** [Probabilistic Ground Motions]). These maps illustrate the chance that different areas will exceed a certain level of shaking over a 50-year period. The maps were primarily developed to understand the effects of shaking on tall buildings (over 10 stories) and URMs. However, they display the underlying geology, such as areas with artificial fill and soft soils, which are expected to amplify ground shaking for many building types. Ground shaking is measured as a percentage of the force of gravity. It requires more than 100% of the force of gravity to throw objects up in the air. For comparison, reports of "dishes, windows, and doors disturbed" corresponds to about 1.4% to 4% of gravity. Reports of "some chimneys broken" correspond to a range of 18% to 34% of gravity.<sup>175</sup> Areas in dark red have the potential for the highest level of ground shaking, while areas in green are expected to experience less shaking due to the underlying geology.

### 5.1.4 Vulnerability

Seattle's most vulnerable parts are where fragile populations, soft soils, and weak buildings come together in areas that could be easily isolated due to breaks in the transportation network. These locations produce vulnerabilities for the whole city because of their social, political, or economic importance.

Seattle has a heightened vulnerability to earthquakes because the middle of the city sits on top of the "Seattle Basin," a deep geologic basin filled with glacial deposits, sediments, and sedimentary rock, roughly 7 km deep (see Figure [Sediment thickness in the Seattle Basin]). This looser ground material within the basin amplifies ground shaking in an earthquake and prolongs its duration. The USGS modeled basin effects for a M6.5 Seattle Fault earthquake and estimated that ground motions would last about 25 seconds.<sup>176</sup> Additional modeling is being done by the University of Washington's M9 group, to understand the effects of the Seattle Basin on ground motion in a megathrust earthquake.

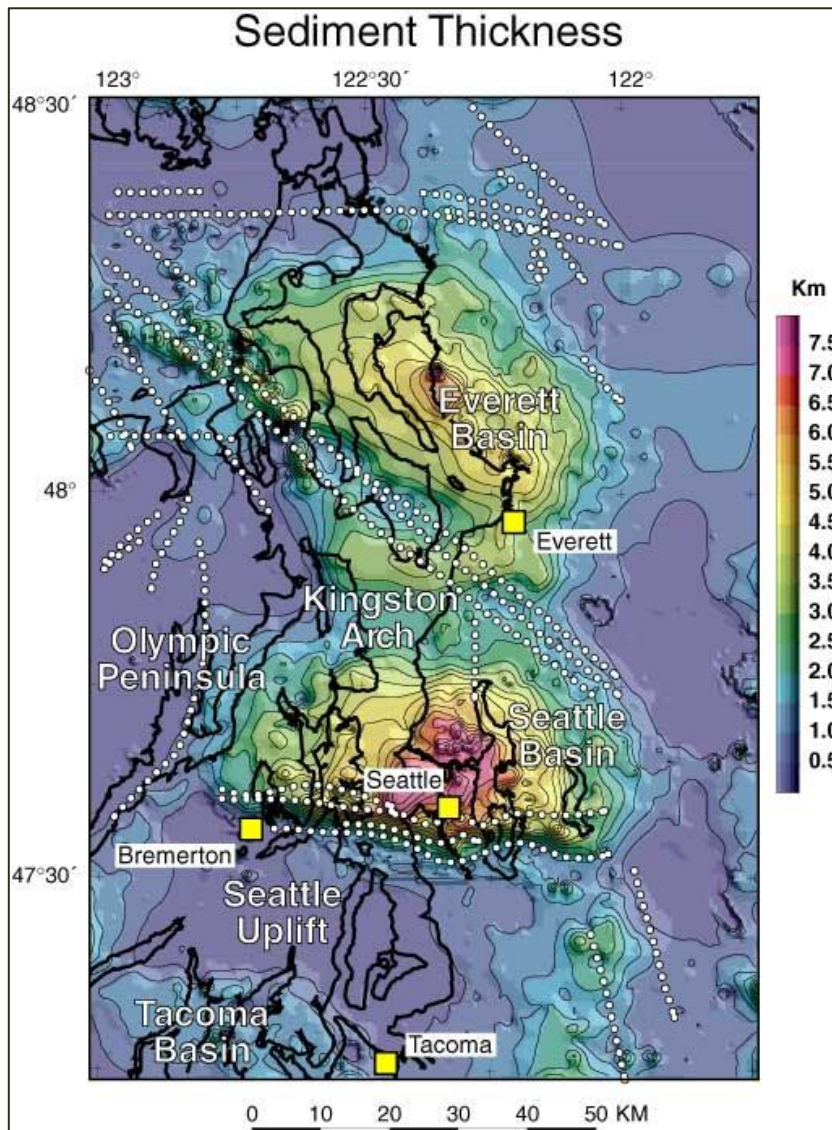
While the Seattle Basin will influence ground motions for all of Seattle, surface geology creates variability in shaking for different parts of the city. The 2007 USGS seismic hazard maps (see Figure 5-9 Probabilistic Ground Motions) reveal that Seattle's neighborhoods experience dramatically different levels of shaking. Seattle's liquefaction and landslide-prone areas appear to experience more severe ground motion than other areas and southeast Seattle is likely to experience serious but comparatively less shaking than the rest of the city.



## Liquefaction

Looser, fill soils that are prone to liquefaction are present in Seattle's Duwamish area, including Harbor Island, the east side of West Seattle, the Interbay area, University Village area and along the Puget

**Figure 5-6. Sediment Thickness in the Seattle Basin**



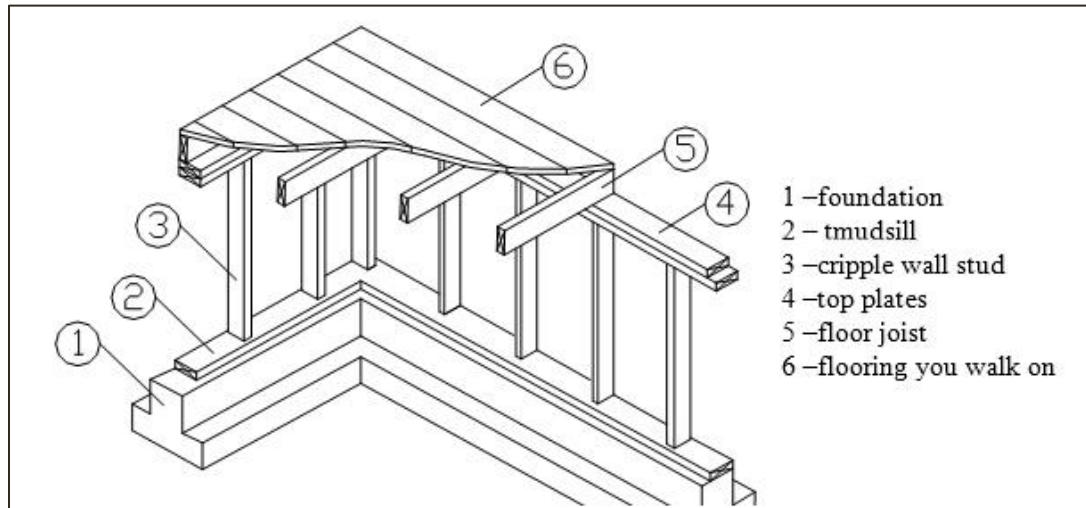
Sound. Ground failures caused by previous earthquakes in Seattle have primarily been located in these areas of artificial fill (see **Error! Reference source not found.** [Seattle Fault Zone, Liquefaction Areas and Ground Failures]). The tables below summarize land use in liquefaction prone areas.

## Structures

Vulnerable structures are not evenly distributed throughout the city. Those constructed with unreinforced masonry (URMs) are the most vulnerable, followed by non-ductile concrete frame structures with masonry infill and tilt-up concrete structures. Seattle has over 1100 identified URMs.<sup>177</sup>

The neighborhoods with the greatest number of URMs include Capitol Hill, Pioneer Square, Duwamish/SODO, Queen Anne, and the University District. The majority of URMs are commercial or office buildings, residential buildings, or public assembly buildings. URM damage in Seattle alone amounted to \$8 million in the Nisqually earthquake.<sup>178</sup>

**Figure 5-7. Cripple Wall Construction**



Source: Homeowner's Guide to Seismic Retrofitting, Bay Area Retrofit. Retrieved July 24, 2018, from <https://www.bayarearetrofit.com/seismic-retrofit/>

The number of non-ductile concrete frame and tilt-up structures is not known; however, these construction types are fairly common in the Pacific Northwest. Many concrete frame structures built before 1980 do not have enough steel reinforcement to withstand the shaking from a strong crustal or megathrust earthquake.<sup>179</sup> Tilt-up structures, commonly used for warehouses or strip malls, often lack adequate connection between their walls and roof, making the roof prone to collapse in an earthquake. There is a concern for structures built before 1995 that have not been retrofitted. Most of these buildings are commercial and older multi-family dwellings. Additionally, many older buildings have parapets that are easily damaged and often fall into the right of way during earthquakes.

Most of Seattle's single family residential housing stock is wood frame, a construction type that performs better than most others in earthquakes. However, having a wood frame does not guarantee that a home will ride out an earthquake problem free. More than half of Seattle homes were built prior to the introduction of modern seismic codes in 1949. Many have short cripple walls (also called "pony walls") between the foundation and floor joists. They are prone to failure, pitching the building off its foundation and causing major utility damage. These homes can be inexpensively retrofitted to eliminate this danger, typically by bolting the home to its foundation. The City of Seattle has sponsored a program since the mid-1990's to promote these retrofits.

Seattle's multi-family structures are vulnerable, too. Many built in the late 1950s and early 1960s have "soft" stories where pillars hold up parking on the ground floors. The soft stories lack shear strength and are prone to failure. Neighborhoods that have concentrations of older and soft-storied multi-family buildings will suffer disproportional impacts. They include Downtown, Belltown, First Hill, Capitol Hill, Queen Anne, University District, and Ballard. Downtown has the highest concentration of high-rise office and apartment buildings. Even if a multi-story building does not sustain much structural damage, there

can be damage to utilities or elevators that could contribute to displacement of workers and residents after an earthquake.<sup>180</sup> After Hurricane Sandy hit New York in 2012, there were 65 residential and office buildings in lower Manhattan alone that suffered long-term utility damage and displaced many residents.<sup>181</sup>

A large-scale study of how Seattle’s building stock would fare in an earthquake has not yet been conducted. Research from other earthquake-prone areas can shed light on the vulnerabilities of the

**Figure 5-8. Home Damage Due to Inadequate Cripple Walls**



Photograph by John K. Nakata. Source: Nakata, J. K., Meyer, C. E., Wilshire, H. G., Tinsley, J. C., Updegrove, W. S., Peterson, D. M., Ellen, S. D., Haugerud, R. A., McLaughlin, R. J., Fisher, G. R., & Diggles, M. F. (1999) The October 17, 1989, Loma Prieta, California, Earthquake – Selected Photographs, U.S. Geological Survey. Retrieved July 24, 2018, from <https://pubs.usgs.gov/dds/dds-29/>

urban environment to intense ground shaking. After reviewing building damage in the 1989 Loma Prieta and 1994 Northridge earthquakes in California, the USGS found that for every collapsed structure, 13 red-tagged buildings can be expected, and for every red-tagged building, 3.8 yellow-tagged buildings can be expected.<sup>182</sup> For the 2001 Nisqually Earthquake, Seattle had 6 yellow-tagged buildings for every red-tagged building.<sup>183</sup>

The Oregon Department of Geology and Mineral Industries (DOGAMI) conducted a study on earthquake damage to structures in an M9.0 Cascadia scenario for a three-county region in Northwest Oregon, including Portland. While the results cannot be directly related to Seattle’s vulnerability, it provides a general idea of the amount of destruction we could possibly expect in an urban area from a megathrust earthquake. For Multnomah County (includes Portland), the researchers estimate that in dry conditions, 3,536 (1%) of buildings would have complete damage and 302 would collapse.<sup>184</sup> In wet conditions, that number jumps to 13,039 (5%) completely damaged and 677 collapsed, due to the increased likelihood of landslides and liquefaction.<sup>185</sup> Wood-frame single-family structures fare best while industrial and commercial buildings fare the worst (it should be noted that Portland has around 50% more URMs than Seattle<sup>186</sup>). Injuries and fatalities were studied at the city level. If an M9.0 megathrust earthquake occurs during the day, they estimate that Portland will experience 10,404 injuries, most of which are minor,

and 604 fatalities.<sup>187</sup> The nighttime estimation drops to 2,491 injuries and 119 fatalities considering that most people will be in wood-frame structures.<sup>188</sup>

Portland does not sit on top of a deep geologic basin of glacial deposits like Seattle. The effect of basin amplification on structures has been studied. Marafi and colleagues analyzed data from earthquakes that occurred in deep basins in Japan that have a similar profile to the Seattle Basin. They found that in a megathrust earthquake, the basin effects lower the threshold at which reinforced concrete moment frame structures collapse for 30 different building archetypes.<sup>189</sup> In other words, if two identical buildings faced the same ground shaking scenario from a megathrust earthquake, the one located in the basin would collapse easier than the one outside of the basin. A second study by Marafi examined the sway of buildings in an earthquake from 4 to 40 stories high and found that buildings within the Seattle Basin sway three times more than those outside of it.<sup>190</sup>

Another study used past ground motion data to quantify the effects of megathrust earthquakes on 24 older and modern buildings in Seattle and Portland. They concluded that megathrust earthquakes are more likely to cause building collapse than crustal earthquakes and contribute this consequence to the longer duration shaking that is expected in a megathrust earthquake.<sup>191</sup>

### **Isolation Vulnerability**

Seattle is highly dependent on bridges. The City of Seattle owns 159 bridges. Fifty-one have received seismic retrofits or were built to current seismic standards, and an additional 17 are scheduled to receive retrofits pending approval of a levy.<sup>192</sup> A remaining 91 bridges have not been retrofitted as of 2018. The improvements should save these bridges from catastrophic collapse, but many will not be functional after a strong Seattle Fault or megathrust earthquake.

The Loma Prieta, Northridge, and Kobe earthquakes showed that even modern freeways and overpasses can collapse. Large portions of I-5 and I-90 rest on columns and run near slopes prone to failure. The Washington State Department of Transportation (WSDOT) owns the rest of Seattle's bridges including critical ones such as the Aurora Bridge and the I-5 Ship Canal Bridge. Through their own seismic retrofit program, they have completed retrofits for 53 out of 102 state-owned bridges in Seattle as of 2018.<sup>193</sup> The bridge being constructed near the south portal of the new SR 99 tunnel uses both flexible rebar and concrete. Not only should these new materials avoid a collapse, but they should also minimize damage, so the road is still usable after an earthquake.<sup>194</sup> It is the world's first "flexible" bridge.

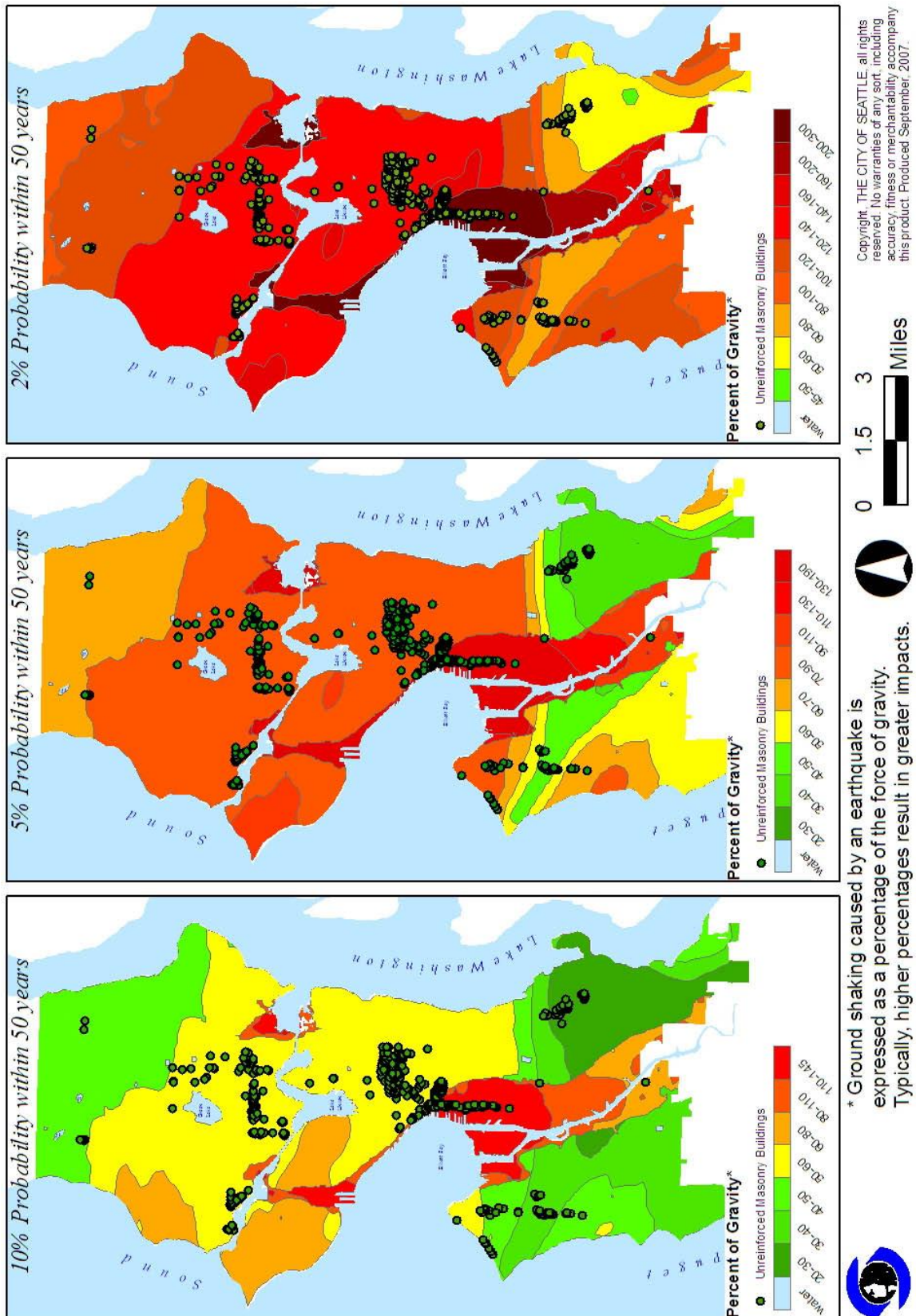
Breaks in the street and bridge network would impair the delivery of emergency services. The region's largest trauma center and most of the city's medical services are on First Hill or Capitol Hill. These medical centers would be difficult to reach if a major bridge or section of freeway collapsed. Police and fire stations are more decentralized, increasing the likelihood that at least some units could reach an emergency. However, moving police and fire vehicles from a lightly impacted area to a heavily impacted one could be very difficult if bridges fail.

### **Transportation Vulnerability**

Surface, marine, and air elements of Seattle's transportation system are exposed to earthquake hazards. Liquefaction is a common element to this exposure. Most of the Duwamish Valley is a liquefaction zone. Both of Seattle's major north-south corridors, I-5 and SR99/SR509 run through this zone, as well as key bridges and elevated structures, including the Alaskan Way Viaduct, the West Seattle Bridge, the First Avenue South Bridge, and approaches to the end of I-90. The King County International Airport is completely in the liquefaction zone as are most of the city's rail and marine terminals.



Figure 5-9. Probabilistic Ground Motions



## Utility Vulnerability

Water systems have suffered significant damage in major earthquakes that have occurred around the world. Damage to treatment facilities, storage (tanks and reservoirs) facilities and pipelines has resulted in significant disruption to water utilities. Power outages and damage to transportation and communications facilities has further complicated water service restoration. In the most catastrophic earthquakes, it has taken over two months to restore water to some customers.

Seattle Public Utilities (SPU) completed a seismic water system evaluation in 1990. Based on this assessment, many SPU water facilities were seismically upgraded or replaced with more seismic-resistant facilities. Examples include the replacement/upgrade of the West Seattle, Myrtle, Beacon and Maple Leaf intown reservoirs, replacement of the Queen Anne Standpipes, building upgrades to the Operations Control Center Warehouse and four pump stations, and upgrades to the Cedar River pipelines where they daylight at Ginger Creek.

A new seismic study was conducted by SPU from 2016 to 2018. Since the original 1990 study was completed, the understanding of the seismicity in western Washington has evolved and building codes have been updated. The determination that large shallow earthquakes are possible in western Washington from such sources as the Seattle Fault Zone has significantly increased the earthquake hazard level that SPU facilities may experience.

The new study estimates that after a M9.0 Cascadia Subduction Zone or M7.0 Seattle Fault earthquake, most or all areas in SPU's direct service area could lose water system pressure within 12-24 hours of the earthquake. The study further estimates that it could take one month to restore customer service to 70% of direct service customers and two or more months before service has been restored to all customers. In smaller, more frequently occurring earthquakes such as the 1949, 1965, and 2001 Puget Sound earthquakes, significantly less damage will occur and little, if any, disruption to the SPU water system is expected.

Efforts in the future to increase seismic resiliency will likely focus on:

- Using isolation and control strategies to mitigate the earthquake effects on the water system
- Improving emergency preparedness and response planning
- Continuing to seismically upgrade existing critical facilities
- Increasing the seismic reliability of the transmission pipeline system that conveys water into Seattle and to SPU's wholesale customers (most of King County)
- Use earthquake-resistant distribution pipe in those areas susceptible to permanent ground displacement

Seattle's power, sewer, and telephone systems have not been recently studied. Their vulnerability can be somewhat deduced from past performance and studies of other earthquakes. A Washington State report mentions that both the 1949 and 1965 quakes interrupted service in water, sewer, gas, and electric systems. The report does not describe any damage to the telephone network. A summary of the infrastructure damages from the 1989 Loma Prieta quake outlines the same problems. It adds that widespread utility outages were common, but most were less than a day long.<sup>195</sup> This performance is quite good, but the epicenters in these quakes were far from the areas studied. Puget Sound Energy has replaced over 8,000 miles of its 12,000-mile network of gas mains with flexible plastic pipe that can withstand earthquakes.<sup>196</sup> During the 2011 Tohoku earthquake in Japan, at least six main submarine fiber optic cables connecting Japan's communication network to other countries were damaged.<sup>197</sup>

The Bonneville Power Administration (BPA), located in Oregon, provides about half of Seattle's power. BPA seismic evaluations have revealed that transmission towers are especially vulnerable to seismically-

induced ground displacement, landslides, and liquefaction. Other vulnerable equipment includes substations and rigid bus connections. BPA has prioritized anchoring high-voltage transformers to their foundations to ensure that power flow is not compromised in an earthquake. They use base isolation technology for protecting transformers.<sup>198</sup>

Liquefaction may threaten critical utility systems by damaging or isolating infrastructure. SPU's water transmission pipelines cross areas with liquefaction and landslide susceptibility and through the Seattle Fault and South Whidbey Island Fault Zones. The Olympic BP Pipeline and sewer main lines cross the Duwamish liquefaction zone. SCL's South Service Center and two of its substations are in a liquefaction zone, but all sit on pilings. SCL uses an uncommon voltage in their system, so if transformers are destroyed due to liquefaction or other earthquake hazards, they must be rebuilt from scratch. The biggest danger for these facilities is the potential loss of access due to transportation system damage.

### **Secondary Hazards**

Secondary hazards can have more impact than the initial ground shaking. The most significant secondary hazards are fires, hazardous materials releases, tsunamis, and landslides. Each of these hazards is described fully in its own chapter.

#### **Fires**

Fires were the most frequent cause of death in the 1995 Kobe earthquake. Additionally, most of the 28,000 buildings destroyed in the 1906 San Francisco earthquake were lost in the conflagration that followed it. Multiple ignitions developing into a conflagration is the most dangerous post-earthquake fire hazard. Khorasani and Garlock (2017) reviewed 20 historic earthquakes of M5.0 or greater, that resulted in multiple fire ignitions. They identified key cause and response factors: wind was a key factor in how much the fire spread; gas pipes, electric wiring, and toppled furniture were the major sources of ignition; and availability of water after an earthquake is a key determinant in the ability to control a conflagration.<sup>199</sup> Scawthorn and colleagues developed an ignition rate based on the MMI scale. For an earthquake with an MMI intensity of VII ("very strong"), one ignition per 18 million square feet of building floor area is expected.<sup>200</sup> In an MMI X ("disastrous") scenario, one ignition per 1.5 million square feet of building floor area is expected.<sup>201</sup> To put these rates in perspective, Amazon, which is believed to occupy about 13.6 million square feet of building space, would experience about 9 ignitions. However, one should note that commercial construction is less vulnerable to fire than wood-frame construction.

Normally, Seattle would call on neighboring city fire departments for help, but in a Seattle Fault earthquake they will probably not be able to provide it. With Seattle's fire-fighting resources spread thin, a conflagration becomes very likely, especially if the water system has been damaged and water pressure drops. There is additional concern for conflagration with the expected increase in development of multi-story wood structures in Seattle (see fires chapter).

#### **Hazardous Materials Incidents**

During earthquakes, stored chemical containers can rupture and release their contents. Most of these spills will be small and contained within structures, but they present a serious hazard to people in these buildings. Krausmann and Cruz collected data on 46 chemical facilities in Japan to review damage caused by the 2011 Tohoku earthquake. They found that 28 of these facilities had equipment damages with possible hazardous materials releases.<sup>202</sup> Additionally, building debris often contain toxic substances like asbestos. The Seattle School District implemented a non-structural mitigation program to limit post-earthquake release of hazardous chemicals. A small number of releases could escape into the atmosphere creating a widespread hazard.

## Tsunami

Tsunamis in Seattle are not likely, but should they occur they have the potential to be extremely dangerous. New tsunami modeling for a Cascadia Subduction Zone scenario is underway. Preliminary findings show that there would be less inundation in this megathrust earthquake compared to a Seattle Fault earthquake.<sup>203</sup> The most dangerous source of tsunami is the Seattle Fault, which is believed to have produced a 16ft tsunami in the past. Although there is no precise correlation between earthquake size and tsunami size, a rough estimate is that earthquakes usually have a magnitude of 7.0 or greater before they generate a tsunami.<sup>204</sup> In 2001, the National Atmospheric and Oceanic Administration (NOAA) modeled a Seattle Fault-generated tsunami. It is covered in full in the Tsunami chapter. The low-lying areas around the downtown sports stadiums, Harbor Island, and Interbay are the most at risk for inundation in a tsunami. Because a tsunami generated inside Elliott Bay would strike within minutes after the most powerful earthquake Seattle has ever experienced, the only realistic escape option would be into the upper floors of buildings, many of which will be severely damaged. The waterfront is a popular and densely packed area, compounding this exposure.

## Landslides

Allstadt and colleagues examined the potential for shallow (less than 2.8 meters deep) landslides following a M7.0 Seattle Fault earthquake. They found that the quake could cause 5,000 landslides in dry conditions and 30,000 in extremely wet conditions. While the study only models a single scenario, and completely wet conditions are unlikely, it is still a sobering look at the potential for landslides following a Seattle Fault earthquake. The study did not model deep seated landslides, which can cause whole hillsides to fail. Landslide prone areas are spread throughout the city along hillsides. These areas are mostly zoned as open space or residential. North Seattle has less landslide-prone areas than the central and southern areas. The major northern landslide area is Golden Gardens in Ballard. In the middle of the city, Magnolia, Queen Anne, Madrona, West Seattle, and the northern end of Beacon Hill are all potential landslide areas.

### 5.1.5 Consequences

Earthquakes cause widespread physical damage across the whole city through intense ground shaking, with higher damage rates in areas that were once valley bottoms or estuaries. The physical damage can cause high casualties, transportation blockages, utility outages, hazardous materials releases, and fires. If the earthquake is powerful enough it can trigger landslides, tsunamis, and seiches.

When estimating annualized earthquake losses in 2017, FEMA ranked Washington second to California.<sup>205</sup> Among metropolitan areas, FEMA ranked Seattle fifth, behind four metropolitan areas in California: Los Angeles, San Francisco, Riverside, and San Jose.<sup>206</sup>

A megathrust earthquake would cause several times more damage than the 2001 Nisqually Earthquake. Damage locally would be just a small fraction of that extending up and down the whole Pacific Northwest coast. A strong Seattle Fault earthquake would be a catastrophe for Seattle, but outside response and recovery resources would be easier to obtain because the damage would be more localized than in a megathrust earthquake.

In 2005, Earthquake Engineering Research Institute (EERI) worked with the region's scientific and engineering community to model impacts of a 6.7 magnitude Seattle Fault earthquake. The EERI scenario predicts ground rupture of approximately 6 vertical feet from Harbor Island to Issaquah. Ground motions would be two to five times that of the Nisqually Earthquake. This type of rupture on the Seattle Fault zone would severely disrupt north-south lifeline systems, including utilities and transportation routes.<sup>207</sup> Estimates are 1,600 fatalities regionally. Despite the enormity of the 2005 scenario, the Seattle Fault is capable of causing earthquakes up to magnitude 7.3, but earthquakes of



that size are probably much rarer. Modern building code in Seattle requires that structures can withstand the types of ground motions that a 6.7 Seattle Fault earthquake would produce.

Effective earthquake response begins with a working transportation system, yet it would be severely impacted by either a megathrust or Seattle Fault earthquake. Due to its dependence on bridges, Seattle could face major difficulties responding if key structures go out of service. It would be difficult to move emergency personnel and resources to where they are needed or to get the injured to hospitals.

If the region experiences a larger shallow/crustal or megathrust quake, most utility services would be severely impacted in large parts of the city. If trunk lines break or critical substations and transformers are broken, outages would occur over a wide area. If many lines are damaged, outages would persist for a longer time. Another deep quake would probably cause only minor interruptions, but these impacts could be severe if the epicenter were closer to Seattle than the Nisqually Earthquake.

Fire suppression is critical after earthquakes. It is highly probable that Seattle's water distribution system would be damaged in a shallow/crustal or megathrust quake, limiting the ability to fight post-earthquake fires. This danger has been mitigated by plans to reroute water, the ability to draw water from open water sources such as reservoirs, lakes, and the Sound, and the use of flexible overland piping.

The economic impacts of a large earthquake would be enormous. In 2005, EERI estimated that losses for an M6.7 Seattle Fault earthquake would amount to \$33 billion (almost \$43 billion in 2018 dollars). It's likely that number would be much higher now, considering Seattle's population has grown by about 27% since 2005. A successful recovery would depend on local, regional, and national political and economic conditions. Additionally, in a megathrust earthquake, where consequences will be felt across the whole region, Seattle will have to rely mainly on itself, with reduced outside assistance. Locally, the city would have to be able to work well as a community to develop a set of shared goals. Recovery can be delayed for years if a community cannot achieve consensus about how it should rebuild post-disaster. A recovery would also depend heavily on favorable economic conditions. Overall community and economic health status trending at the time of a disaster can impact recovery.

Seattle's URM's are likely to suffer heavy structural damage or collapse in a large earthquake. About half of the city's URM's are commercial, industrial, or office buildings, while the other half are residential, public assembly, government, and mixed-use spaces, and schools. The consequences of these facilities collapsing could include major economic losses to businesses, and potential injury or death to their inhabitants.

The larger Seattle business community will face challenges if the transportation and telecommunications networks are disrupted. If these systems remain inoperable for a long period of time, Seattle enterprise could face a permanent loss of business, as Kobe did following the 1995 earthquake.

The 2005 Seattle Fault earthquake scenario estimated that 46,000 households would be temporarily displaced. About half will need short term shelter (less than 2 weeks) but the rest will need housing for a few months. 15% or 6,900 of these would be displaced for over six months. Some of these households would find shelter with family, others would find rentals, but the government would have to assist with locating shelter for a large percentage of these households.

Earthquakes are natural events, but they can cause severe environmental damage. The last Seattle Fault earthquake triggered numerous landslides that sent whole hillsides into Lake Washington and Puget Sound. The trees that grew on these hillsides slid into Lake Washington and became navigational hazards for boats. Earthquakes are also expected to trigger hazardous materials releases when structures that house them are damaged or contaminated sediment in the Duwamish Waterway Superfund site is re-suspended.

One factor that could mitigate the loss of life from an earthquake is the development of the Earthquake Early Warning (EEW) system. Strong ground shaking comes after the first wave of energy that radiates from an earthquake’s epicenter. An EEW system detects this first wave of energy and instantly sends out a warning that strong shaking is to be expected in a matter of seconds to tens of seconds, depending on the location of the earthquake. These few seconds of warning time could allow people to shelter in a safe place, could warn drivers or train conductors to stop, or could allow workers to isolate or shut down industrial systems. Pilot testing for EEW in Washington, called “ShakeAlert,” is underway, with limited public notification set to begin in 2018.<sup>208</sup>

### **5 1.6 Conclusions**

Earthquakes are both high probability and high impact events in Western Washington, making them the most likely source of the most damaging disaster Seattle will face. A large earthquake could cause hundreds of deaths and lasting damage to the city’s economic base. Secondary impacts could include hazardous materials spills, infrastructure failure, landslides, conflagrations, seiches, or even a tsunami. Each of these would cause additional damage and potential casualties. Response to and recovery from a large earthquake would be the largest challenge this community has confronted.





## 5.2 Landslides

- Seattle has steep hills, wet winters, and geology that is prone to landslides. Landslides occur frequently, especially in the winter and early spring.
- 8.4% of the city’s surface is covered by areas identified as slide prone in the city’s Environmentally Critical Areas Ordinance. 81% of the slide-prone area is zoned for open space, the right of way, or single-family residential areas. The City of Seattle is the largest owner of landslide-prone slopes.
- The most common landslides in Seattle are shallow (less than 6 – 10 feet deep), fast moving (up to 60 km per hour) slides that occur on undeveloped slopes. Shallow slides can have run-outs that exceed 50 feet.<sup>209</sup> Less common are deep-seated landslides that cover a wider area and have a depth of movement greater than 6 – 10 feet.<sup>210</sup> Small movements of deep-seated slides occur gradually over weeks or months. They can be very destructive to property and infrastructure if this gradual movement is not identified before a large failure of the slope occurs.
- Landslides are more likely to occur when soils are saturated. Many landslides can occur within a few days when Seattle experiences heavy rainfall or rapid snowmelt.
- Response to landslides can be more difficult when they are triggered by an event like a winter storm, which is often associated with other hazards such as widespread flooding.
- Traditional home-owners insurance policies do not cover landslide damage, making property owners extremely vulnerable to economic loss.<sup>211</sup>
- Freight and passenger rail lines run along landslide-prone slopes. Landslides have disrupted or canceled passenger trains along the Puget Sound over 500 times from 2015 – 2018.<sup>212</sup>
- Landslides can trigger secondary hazards like flooding and hazardous materials incidents.
- The City of Seattle has undertaken measures to mitigate vulnerability to landslides. They include inventorying and mapping landslide prone areas, requirements to stabilize building sites during construction, public education, and slope stabilization projects. Mitigation often requires cooperation between private land owners and the city.

### 5.2.1 Context

Washington state experienced its most deadly landslide in March 2014, when the SR 530 “Oso” Landslide destroyed an entire neighborhood and took 43 lives. Nationally, landslides cause over 25 deaths and cost about \$3.5 billion per year in the U.S. Landslides are a common natural hazard in Seattle, but most result in minor consequences to private property.<sup>213</sup>

A landslide is the movement of a mass of soil, rock, or debris down a slope. Landslides occur when the force of gravity on a slope exceeds the strength of the earth materials that compose the slope. The amount of downslope force and/or slope material strength changes with a variety of factors including precipitation, changes in water level, erosion, ground water, earthquakes, prior landslides, or human activity.<sup>214</sup> There is typically more than one cause. The most frequent triggers of landslides in Seattle are human alteration of the slope, groundwater saturation, or a combination of both. For example, a person may cause a pipe to leak and saturate the ground, triggering a landslide. Landslides that occur under water are called submarine landslides.

While landslides do not always fit neatly into a specific category, Seattle experiences four general types:<sup>215</sup>

- **Shallow landslides:** shallow (less than 6 – 10 ft) and rapid slides on a slope, which may result in a debris flow. These slides can attain speeds of up to 60 km per hour and can have debris runouts that exceed 50 feet.<sup>216</sup> Although they are typically minor, their potential speed and long runout can make them dangerous to humans. Over two-thirds (69%) of all landslides in Seattle are shallow.
- **Deep-seated landslides:** deep (more than 6 - 10 ft), typically ancient, landslides that have been on the landscape for centuries or longer. People build on them, not recognizing the hazard. Deep-seated landslides may reactivate, often due to months or years of above average precipitation or modification of the slope or other processes. Most deep-seated landslides are slow, allowing people to escape them without issue. However, some can be dangerous if they go undetected, and they can cause considerable damage to buildings and infrastructure. Between 18-19% of all landslides in Seattle.
- **High Bluff Peel-off:** blocks of soil fall from the high bluffs primarily along the cliffs of Puget Sound. Between 3-4% of all slides.
- **Groundwater Blowout:** groundwater pressure built up at the contact between overlaying pervious (sand) and underlaying impervious (clay) soil units causes increasing groundwater pressure that may initiate a landslide. Between 5-6% of all slides.

Deep-seated landslides usually occur more suddenly on slopes made of pervious soils, like sand. Slopes with more impervious material like silt and clay, experience gradual movements over weeks to months. There can also be dormant landslides that go unrecognized until they begin to move again. It is believed that there had been smaller landslides at the same location of the 2014 Oso landslide, making the slope more unstable to begin with.<sup>217</sup> When slopes are struck by a sudden event such as an earthquake, heavy rain, or human alteration, landslides can occur.

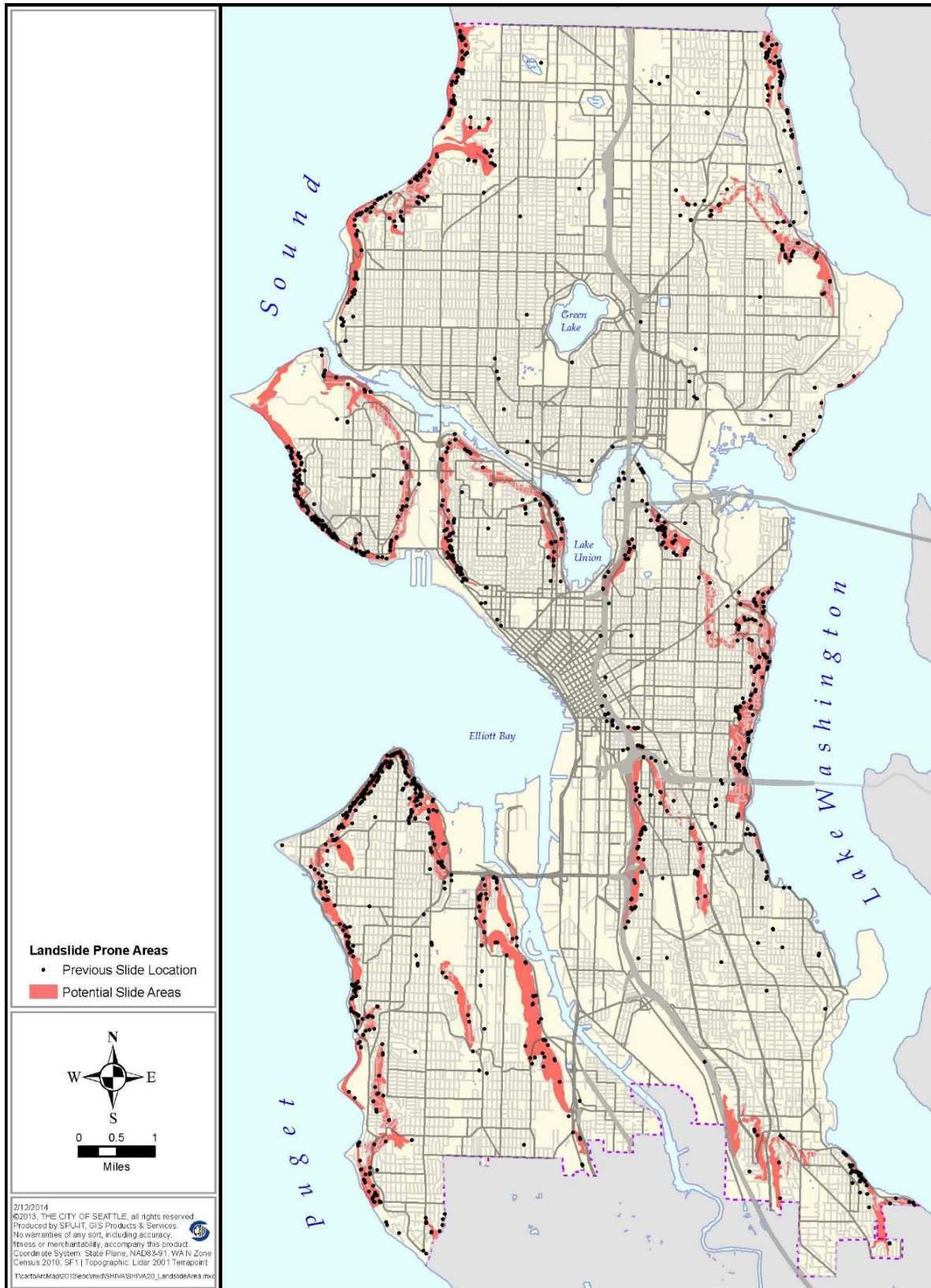
It is difficult to correlate the size of landslides with fatalities. Fatalities have occurred in relatively small slides, many of which happened at construction sites. While deep landslides have caused fatalities when they go undetected, such as with Oso, they are often slower moving, giving people enough time to detect the threat and remove themselves from harm.

Most landslides happen between late October and late March, due to greater levels of precipitation during these months. However, even if the landslide “season” is over, slides can be delayed and occur beyond early spring.<sup>218</sup> According to Tubbs, the probability of sliding rises after a wet, cold winter, especially if a freeze occurs in late winter and early spring.<sup>219</sup> The ground becomes saturated over the winter, and then porous following a freeze, so a subsequent rain will penetrate the surface while the high water table will prevent the ground from absorbing it. The water increases the slope stress by adding weight and increasing pore pressure within the soil.

### **Landslide Monitoring**

The U.S. Geological Survey (USGS) created a tool to help the Seattle public understand when there is a heightened risk for landslides. This tool can be found online at <https://landslides.usgs.gov/monitoring/seattle/>. It consists of various graphs modeled on historic events and current national weather service data. The graphs show the 15-day cumulative precipitation forecast, the intensity of rainfall in the past 70 hours, a rainfall intensity and duration index for the past 14 days, and a water balance model that shows how wet the soils are. The tool also includes graphs that show real-time data from monitoring instruments located north of Seattle on slopes similar to those in the city. Those graphs include rainfall and soil water content. Most of the graphs have thresholds that can be monitored to see whether there is a heightened real-time or forecasted risk for landslides. This work also produced a map of shallow landslide hazards that shows relative likelihood of shallow landslides (i.e., from low to high).

Figure 5-10. Landslide and Landslide Prone Areas



## **5.2.2 History**

From the time records began being kept in the 1890s to 2000, Seattle has recorded 1,326 landslides. The events listed below were found in newspaper articles and city records. Only the events that required significant city response are included. Most of them happened during winter storms and involved multiple slides incidents throughout the city. Shannon & Wilson indicated that Seattle's three worst years for landslides were 1933/34, 1985/86 and 1996/97.<sup>220</sup>

**1921** Six major slides occur during one weekend.<sup>221</sup>

**1933/34** More than 400 Seattleites battle slides in ten areas of the city. These slides prompted numerous repair projects.<sup>222</sup>

**1941** Several slides occur during December around Sand Point.<sup>223</sup>

**1947** Several children die when a slide destroys their home.<sup>224</sup>

**1948** Multiple slide events in Magnolia and Yesler Terrace.<sup>225</sup>

**1950** Many slides occurred in the spring. They may have been connected with heavy snowfall as the 1997 events were.<sup>226</sup>

**1961** Slides occur in many areas of the city during the spring.<sup>227</sup>

**1965** SR 520 threatened, one lane closed, Roanoke interchange closed.<sup>228</sup>

1966 A large slide closes Golden Gardens Drive NW to traffic in January. Shannon and Wilson's Landslide Study reports this as a heavy winter.

**1969** Large slides occur on Magnolia Bluff.<sup>229</sup>

**1971/72** Slides destroy homes in Madrona causing about \$1.8 million in damage. These slides were also probably connected with snowfall.<sup>230</sup> Largest number of landslides since 1933/34.

**1974** West Seattle experiences multiple slides in the winter. Golden Gardens was also damaged. The mayor authorizes assistance.<sup>231</sup>

**1983** Queen Anne slide closes Aurora for a day. Mud travels as far as Lake Union.<sup>232</sup>

**1985/86** Shannon and Wilson's Seattle Landslide Study reports this as a heavy winter.

**1995/96** A large slump along Perkins Lane in Magnolia destroys five homes (January).

**1996/97** Over 100 slides reported in the city (January). These slides and the accompanying snow caused approximately \$100 million in damages. More slides occurred in March in a continuation of the wet winter.

**2014** A deep landslide occurred the morning of March 22 near the city of Oso in Snohomish County. Three weeks of heavy rainfall preceded the event. It was the deadliest landslide in the history of the U.S. with 43 fatalities and several injured. Forty-nine homes and structures were destroyed,<sup>233</sup> and State Route 530 was closed for more than two months. The state estimated capital losses of at least \$50 million.<sup>234</sup>

A study of 50 landslides in Seattle found that hillside excavation for roadcuts and other construction activities contributed to 40% of the slides.<sup>235</sup> During the construction of Interstate 5, and newspaper accounts document several landslides along Beacon Hill and Capitol Hill during this time.

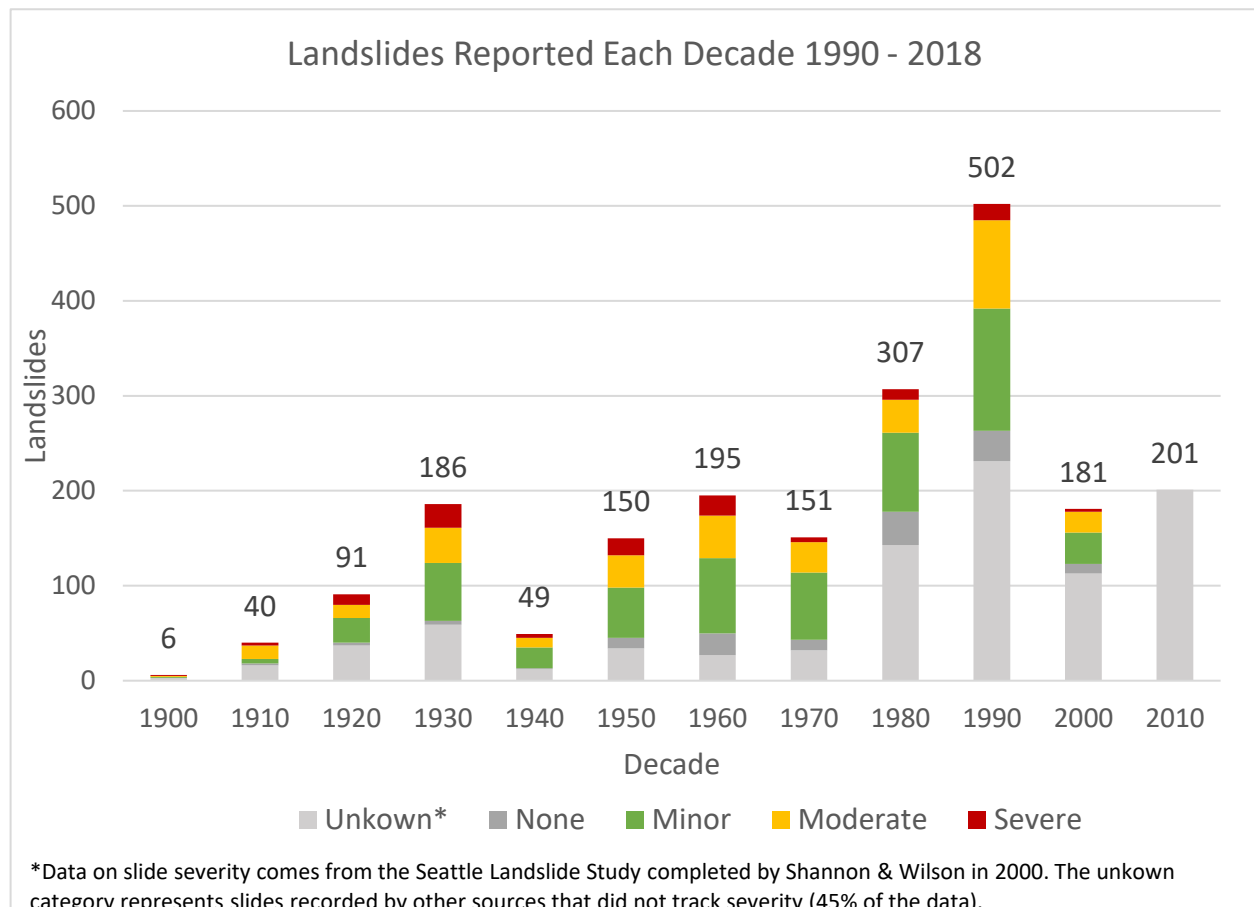
Urban development has the potential to reduce risk but can also expose more people to the consequences of a landslide. When impervious materials like concrete are added to a slope, water is diverted, and soils are less likely to become saturated. Seattle's modern construction codes have specific engineering requirements in slide-prone areas to increase structural safety and reduce the amount of

water that can penetrate the slope.<sup>236</sup> A decrease in landslides in some areas, like the southwest side of Yesler Hill, is presumably a result of its transformation into a dense urban neighborhood. Additionally, some slopes such as the west side of Beacon Hill have benefited from large public works projects, such as construction on I-5 in the 1960s that added concrete reinforcements and drainage.<sup>237</sup>

### 5.2.3 Likelihood of Future Occurrences

The number of landslides recorded by the city increased dramatically from the mid-1900s to the end of the century (Figure 5-11). This increase likely reflects a combination of development on landslide prone slopes and more frequent reporting. In the past, landslides on undeveloped property were underreported. Once developed, property owners in these areas probably reported slides to the city more frequently. The large spike in the 1990s also reflects the extreme number of slides that occurred during the 1996/97 winter. Since the 90s, the number of landslides recorded has decreased to about 190 slides per decade.

**Figure 5-11. Landslides By Decade**

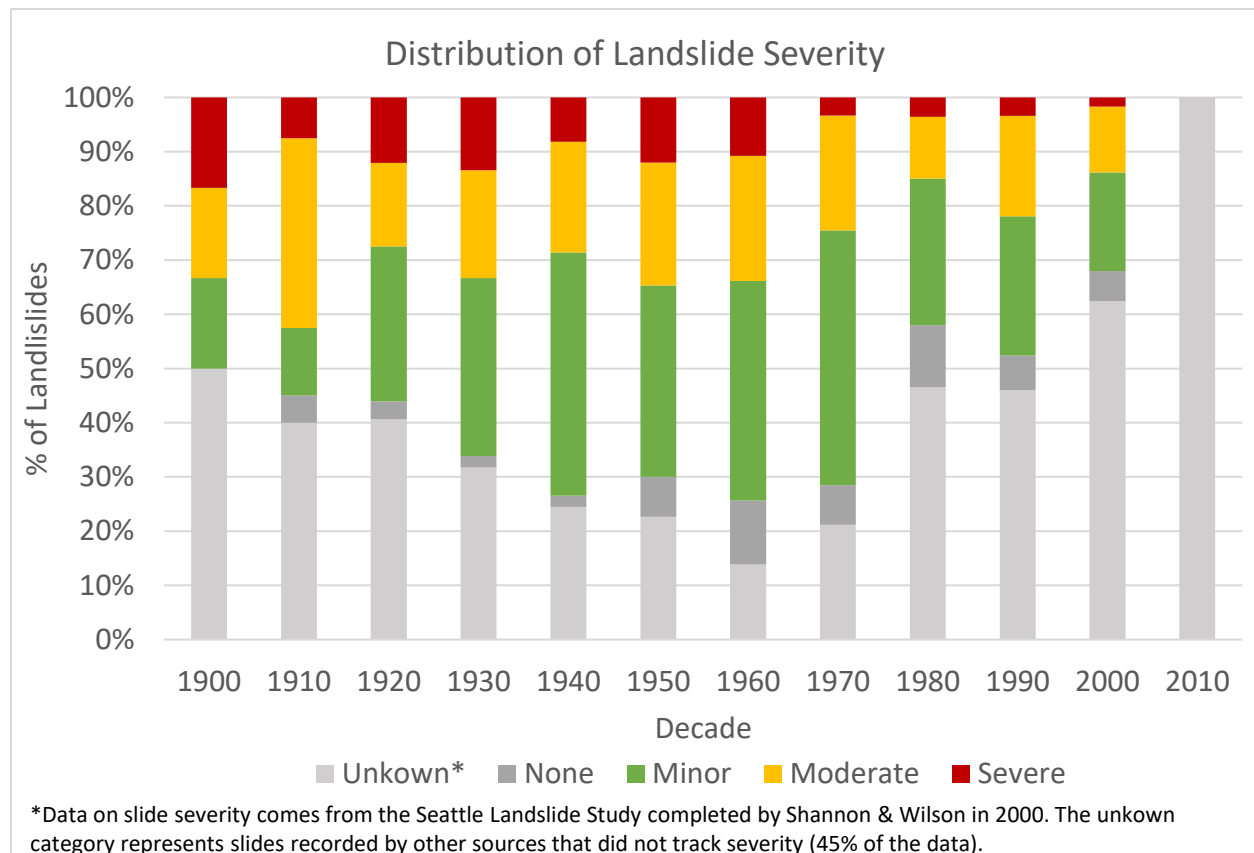


The number of landslides that have severely damaged property decreased between 1980 to 2000 (Figure [Distribution of Landslide Severity by Decade]). While it has not been formally studied, stricter building codes for properties in slide-prone areas could have contributed to the decrease in property damage. Shallow landslides made up a growing proportion of slides from 1950 onward, with deep seated landslides becoming less common (except for the 1990s).



The tragic Oso landslide caused concerns around the risk of a massive landslide occurring in a more densely populated area, like Seattle. A recent study analyzed and dated 25 deep-seated landslides, including the Oso landslide, in the North Fork Stillaguamish River (NFSR) Valley, about 60 miles north of Seattle. The results revealed that deep-seated landslides from our current geologic age (roughly the past 12,000 years) have an average frequency of one slide every 140 to 500 years in the NFSR Valley.<sup>238</sup> The NFSR Valley has different topography and is much less developed than Seattle. However, the soil structure that makes the slopes in the Valley landslide prone, are similar to soil structures in Seattle.

**Figure 5-12. Distribution of Landslide Severity by Decade**



## 5.2.4 Vulnerability

Eighty-eight percent of the documented landslides in Seattle have occurred either within a steep slope area or potential landslide area already mapped by the City of Seattle (see Figure 21 [Landslides and Landslide Prone Areas]).<sup>239</sup> The map reflects slopes where landslides are prone to start. However, it does not account for the potential runout of a slide, which can extend further than 50 feet.<sup>240</sup> The homes that were destroyed in the Oso landslide were not in landslide-prone areas but were reached by the massive debris flow that occurred as a result of the slide. Additional research is needed to understand the potential length of runout for different types of slides. The areas that have had the greatest number of landslides in Seattle are along Alki Avenue in West Seattle and Perkins Lane North in Magnolia, with over 100 documented landslides each. Other areas with large numbers include Beach Drive Southwest, Pigeon Point, Madrona, Rainier Avenue S.E., Interlaken, Magnolia and Northwest Seattle.<sup>241</sup> Human alteration of the slope was at least a partial cause in 84% of landslides in Seattle in the 20<sup>th</sup> century.<sup>242</sup>

Landslides in certain parts of Seattle are increasing, most notably along the slopes along northwest and northeast Seattle, Perkins Lane, and the Duwamish Head. A few areas, such as the areas around southwest Yesler Hill and the slope along the west side of Beacon Hill, are having fewer landslides.

Deep-seated landslides have been located in Southwest Magnolia, Northwest and Southwest Queen Anne, East Queen Anne, Alki, Admiral Way, West Beacon Hill, Interlaken, Madrona and Pigeon Point.<sup>243</sup>

Nearly one third of the area designated as landslide prone is single family residential (33%). As the amount of vacant property dwindles in the city, more people are willing to build on landslide-prone slopes. Additionally, many of these areas are desirable for their proximity to the water and views. The City of Seattle cannot stop people from building their home in a landslide-prone area, but it does require a more intensive geologic assessment and mitigation work to eliminate risk to the home and neighboring properties. Common mitigation measures can include special foundation designs or pipes that divert water from the slope. Nevertheless, there is always a risk of danger when building on a slope. A home built underneath a bluff on Bainbridge Island was buried in a landslide in 1997, tragically killing a family of four. It is unclear how many older properties conform to current standards. Furthermore, mitigation is usually designed to prevent loss of life and not property loss, which is typically uninsured.

### **Transportation / Right of Way**

Public right of way, such as roads, railways, and trails, accounts for one-quarter of the land within landslide prone areas. Landslides can either go over the right of way, undermine it, or both.

The most vulnerable right of way is that which is parallel to a slope. Seattle has many such locations, importantly, the railroad tracks running along Puget Sound in north Seattle, I-5 along parts of Beacon Hill and Capitol Hill, and SR 99 Aurora along Queen Anne. It is estimated that landslides have disrupted or canceled passenger train service along Puget Sound over 540 times between 2015 and 2018.<sup>244</sup> Since 2011, two trains have been derailed by landslides in the Seattle-Everett corridor. BNSF requires that passenger trains suspend service for 48 hours after a landslide, but this rule does not apply to freight trains. In late 2013, BNSF and the State of Washington began a \$16 million, multi-year project to mitigate landslides in this corridor. They are building retaining walls, improving drainage systems, and conducting erosion control in six different areas.<sup>245</sup> They have also installed slide detection fences, which act like a trip wire and automatically send an indicator to train conductors when a slide occurs.

Usually, a landslide going over a right of way does not damage it and the debris can be cleared in a matter of hours. Exceptions occur if crews are unavailable or complications like downed power lines are present.

Landslides that undermine a right of way take longer to repair and cost more. Bridges and other roadway structures are especially vulnerable. In 1996, a landslide destroyed a support of the Magnolia Bridge causing it to remain closed for months. The I-5/I-90 and I-5/Spokane Street Viaduct interchanges are on landslide prone slopes as are ends of the West Seattle Bridge, Ballard Bridge, and I-5 Ship Canal Bridge.

### **Utilities**

Utilities, especially those underground, are vulnerable to landslides. Because drainage systems are close to slopes by necessity, they are most frequently damaged. About 8% of reported landslides have damaged the city's drainage infrastructure. Another 4% have been associated with water leaks, with the leak sometimes causing the landslide and not the reverse.

Seattle's water, power, and sewer lines all cross landslide prone areas. The sewer system is the most exposed to landslide hazards because it has main lines that run parallel along the base of many landslide prone hill sides, especially in West Seattle, the east side of Queen Anne Hill, and in Carkeek Park. Sewer



mainlines cross landslide prone slopes in more than seven locations. Seattle water supply lines cross landslides prone areas in three locations: southeast Seattle, the north end of Beacon Hill, and the Interlaken area of Capitol Hill. Power transmission lines cross landslide prone areas in southeast Seattle.

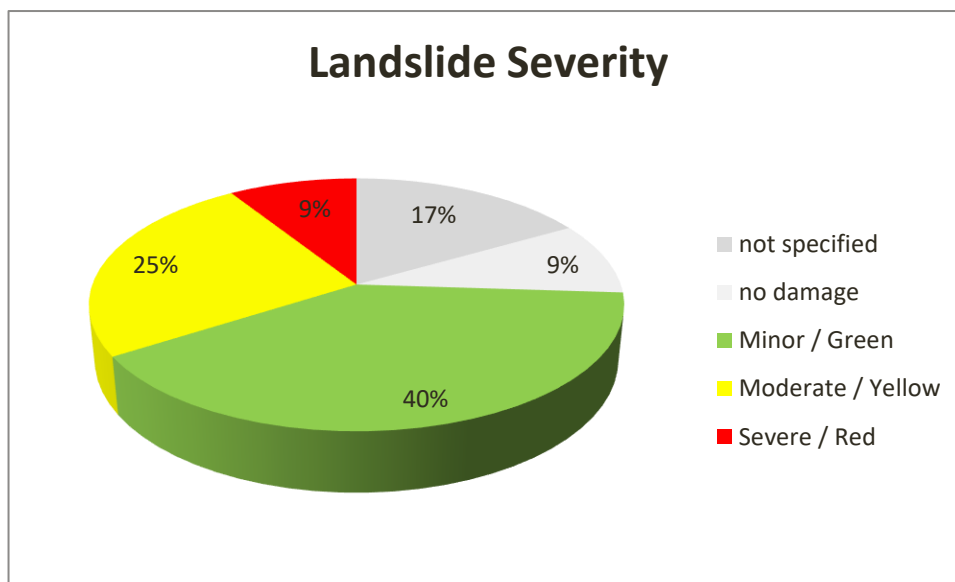
### 5.2.5 Consequences

Landslides will continue to be a threat to property and public safety. Property damage is the most common consequence of landslides, but the 2014 Oso landslide tragedy and the 1997 deaths of a Bainbridge Island family underscored the human costs.

Property damage from the flurries of landslides in 1974 and 1997 was shared roughly equally by the public and private sectors. However, little can be drawn from two occurrences, and this distribution should be studied further. It may reveal trends in property damage pattern that could help prepare the city for future events.

Most of the land in or immediately adjacent to the City’s mapped landslide prone areas is residential so it is to be expected that most future property damage will be private residential. Historically, this has been the case. There is little information about severity (i.e., how many homes were destroyed and how many were only damaged). Newspaper articles making frequent reference to “destroyed homes” yield only anecdotal evidence.

**Figure 5-13. Landslide Severity Summary**



Other significant impacts could include the interruption of lifeline services such as water, sewer, and transportation. The city’s water, gas, sewer, and power lines all cross areas prone to landslides, particularly in Highline, the east side of Beacon Hill, and the east side of West Seattle. Of these areas, Highline is generally the most critical because many of the utility networks have trunks that run through the area. All of the Cedar River water pipelines enter the city in this area.

Transportation corridors could very well be blocked by future slides. Both I-5 and I-90 run through a large landslide area around Beacon Hill. Aurora has been blocked by landslides along the east face of Queen Anne Hill several times. Since each one of these routes handles thousands of vehicles every day, landslides around them have the potential to disrupt large parts of the city.

Landslides often happen in groups over a period of days or even weeks. They usually have the biggest impact in residential areas where they can displace whole blocks of households. Less commonly, they

threaten commercial buildings and facilities that host critical services. Their economic impact comes when they block transportation routes or force businesses to vacate their premises. By blocking roads and damaging lifelines they also inhibit the City's ability to deliver critical services to impacted neighborhoods.

Landslides can induce other disasters. Landslides can cause flooding by blocking rivers, streams, and storm drains, and lead to releases of hazardous materials by destroying waste and storage sites, or derailing freight trains. These trains are increasingly carrying Bakken crude oil, a highly flammable oil that has been known to explode when impacted. Hazardous materials are housed or transported close to potential slide areas in West Seattle, Interbay, and along the Burlington Northern tracks running through the Golden Gardens area.

Future research should look into the potential effects of submarine landslides in water bodies such as Lake Washington. Seattle can also be affected by landslides in other parts of the state. Landslides, rock fall, and avalanches have closed I-90, Washington's main east-west corridor and SR20, which provides access to Seattle City Light facilities in the North Cascades.

### **Cumulative Hazard**

Landslides are a hazard that can best be analyzed by looking at cumulative impacts. While the majority of landslides are insignificant and would not constitute an emergency, their relatively high frequency and their tendency to occur in swarms can compound consequences over time.

## **5.2.6 Conclusions**

Landslides are a common, complex and growing problem in Seattle. There is substantial evidence that landslide losses are growing as more property is developed in landslide prone areas. One bright spot is that safety measures seem to be working. Complicating response is the fact that landslides are often secondary to other hazards, such as earthquakes and storms. Following the major slides of 1996/97, the City convened an Interdepartmental Landslide Team to address the problem. Since then, several structural and non-structural mitigation measures have been taken. In addition, USGS monitoring of rainfall and soil conditions and availability of new landslide susceptibility maps add greater accuracy to the city's predictive ability.



## 5.3 Volcanic Hazards

- Washington State is home to five active volcanoes located in the Cascade Range, east of Seattle: Mt. Baker, Glacier Peak, Mt. Rainier, Mt. Adams and Mt. St. Helens (see figure [Cascades volcanoes]). Washington and California are the only states in the lower 48 to experience a major volcanic eruption in the past 150 years.
- Major hazards caused by eruptions are blast, pyroclastic flows, lahars, post-lahar sedimentation, and ashfall. Seattle is too far from any volcanoes to receive damage from blast and pyroclastic flows.
  - Ash falls could reach Seattle from any of the Cascades volcanoes, but prevailing weather patterns would typically blow ash away from Seattle, to the east side of the state. However, to underscore this uncertainty, ash deposits from multiple pre-historic eruptions have been found in Seattle, including Glacier Peak (less than 1 inch) and Mt. Mazama/Crater Lake (amount unknown) ash.
  - The City of Seattle depends on power, water, and transportation resources located in the Cascades and Eastern Washington where ash is more likely to fall. Seattle City Light operates dams directly east of Mt. Baker and in Pend Oreille County in eastern Washington. Seattle's water comes from two reservoirs located on the western slopes of the Central Cascades, so they are outside the probable path of ashfall.
  - If heavy ash were to fall over Seattle it would create health problems, paralyze the transportation system, destroy many mechanical objects, endanger the utility networks and cost millions of dollars to clean up. Ash can be very dangerous to aviation.
- Lahars are mudflows and debris flows that originate from the slopes of a volcano and travel down river systems. Mt. Rainier is the only volcano connected to Seattle via a river system.
- Lahars from Mt. Rainier have buried the Kent Valley in the past, but there is no evidence a lahar has reached Seattle in the past 10,000 years. A Washington Department of Natural Resources analysis states that it is possible for a lahar to reach Seattle but would be extremely unlikely.<sup>246</sup>
- Seattle faces vulnerabilities from a lahar reaching the Kent Valley. Interstate 405, as well as oil and natural gas pipelines, water lines, power lines, and sewer mains that serve Seattle all cross the potential lahar area in the Kent Valley. This area also hosts many of Seattle's major food distributors.
- Lahars can cause floods that transport massive amounts of sedimentation farther downstream. In a Mt. Rainier eruption, if lahars reach as far as the Kent Valley, Seattle's Duwamish Valley could experience post-lahar sedimentation.

### 5.3.1 Context

Washington's volcanoes are part of the same tectonic motion that gives the Pacific Northwest its seismic activity. As the earth's continents and oceanic plates move, the heavier oceanic plates slip under the lighter continental plates. This process is called "subduction" and it causes friction along the plate faces (see figure [Subduction in the Pacific Northwest]). Typically, the hottest part of the subduction area is under the continental plate about 100-200 miles inland from the coast, where the heat and pressure melt rock into magma. The magma forms reservoirs near the surface. As the rock melts into magma it expands.

Under normal conditions, the constraining pressure of the surrounding rock keeps the expansive force of the magma in check. An eruption is triggered when the balance of forces is upset. Sometimes an increase in pressure from tectonic activity causes the magma to blow out the surface. On other occasions water mixes with the magma, gets superheated, and produces enormous steam explosions.

Washington's volcanoes have explosive eruptions. They produce viscous magma that plugs the vent of the volcano. As the magma rises to the earth's surface, pressure decreases, and gases separate from liquid. When the pressure from the trapped gases exceeds the pressure of the hardened magma, the volcano erupts.<sup>247</sup> These violent eruptions produce several hazards, including pyroclastic flows, landslides, gases, lava flows, tephra (ejected ash and rock) and lahars (see figure [Volcano Hazards]). While the Hollywood image of a volcanic eruption may be fast flowing lava, the viscous lava of Washington volcanoes typically cools and hardens before traveling very far. The major hazards to Seattle are tephra (ash falls) and post-lahar sedimentation.

**Figure 5-14. Cascade Volcanoes**



### Ashfall

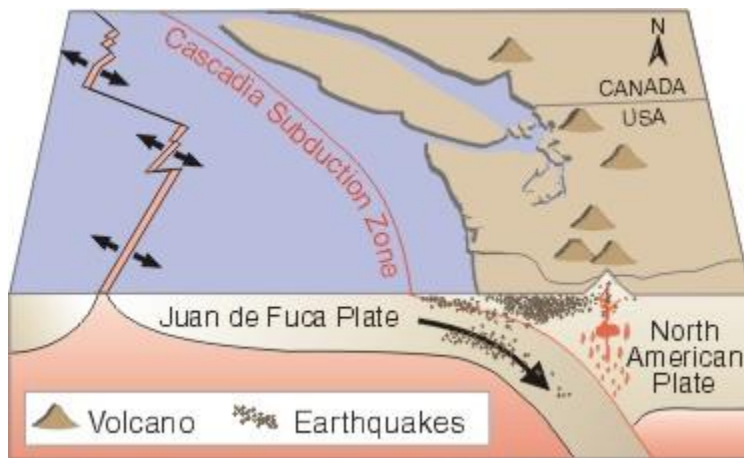
The most widespread eruption impact is ash, which can cover hundreds of square miles. Ash is a health risk to people with respiratory problems. Ash also has many indirect effects by causing hazardous driving conditions, damage to mechanical equipment, and interference with wireless communications. Ash flows can also interfere with aviation. If ash is ingested into a jet engine it can melt and coat turbine blades and eventually cause them to stop running. Roughly 300,000 people fly over or near volcanoes every day, mostly those located in Alaska.<sup>248</sup> In 2010, an ash cloud from a volcanic eruption in Iceland forced the week-long closure of airspace for most of northern Europe.<sup>249</sup> The cost of this disruption was estimated at \$10 billion.

### Lahars

The USGS defines lahars as mudflows and debris flows that originate from the slopes of a volcano. Lahars contain at least a 60% concentration of rock debris. Most, but not all, are preceded by volcanic

and seismic activity. Most commonly, they are triggered by pyroclastic flows. Other possible triggers are intense rainfall on loose volcanic rock deposits, breakout of a lake dammed by volcanic deposits, and debris avalanches.<sup>250</sup> Lahars are especially hazardous in areas of Western Washington along rivers originating on the slopes of volcanoes. Lahars can look and behave much like flowing concrete. They can travel at speeds of a few tens of miles per hour along gently sloping distal valleys. Higher speeds of more than 60 miles per hour are possible on steep slopes near Mt. Rainier. Though spontaneous lahars are possible, most would be preceded by volcanic and seismic activity. Lahars from Cascades volcanoes can travel tens of miles from their source, making them extremely dangerous to communities close to volcanoes. A lahar that occurred 5,600 years ago covered roughly 212 square miles of the Puget Sound lowlands.<sup>251</sup>

**Figure 5-15. Subduction in the Pacific Northwest**



Source: Myers, B., Faust, L., & Janda, C. (2000). Mount Hood—History and Hazards of Oregon’s Most Recently Active Volcano. United States Geological Survey. Retrieved August 2, 2018, from <http://pubs.usgs.gov/fs/2000/fs060-00/>

### Post-Lahar Sedimentation

After a lahar initially stops, the erosion and transport of loose volcanic deposits can lead to large sediment loads that flow downstream. “Post-lahar sedimentation” is the incremental transport of excess sediment from the headwaters of a river to lower river reaches that occurs days, weeks, or even years after a lahar occurrence. The resulting rise in sediment can decrease carrying capacity for river channels and increase flood risk. It is a risk to navigation and the environment that can persist for decades.

### Volcano Hazards That Are Not a Threat to Seattle

Volcanoes produce a variety of hazards that are localized to the volcanoes immediate area and are therefore not a threat to Seattle. These are:

#### *Pyroclastic Flows*

The USGS defines a pyroclastic flow as a chaotic mixture of rock fragments, gas, and ash that travels rapidly (tens of meters per second) away from a volcanic vent or collapsing flow front. Pyroclastic flows hug the ground, flattening most everything in their path. The ejected material melts the glaciers and other snow covering the volcano. The melt water combined with the volcanic material can create muddy slurries called lahars and is even more dangerous since it increases the size of the pyroclastic flow and

enables it to move farther. This process caused the mudflows that raced down the Toutle River following the Mt. St. Helens eruption.

### *Volcanic Landslides*

Volcanoes are naturally weak structures and experience slope collapses, typically during an eruption. Volcanic landslides are huge. When Mt. St. Helens erupted in 1980, 2.5 cubic kilometers of rock collapsed. Despite their large size, these landslides are a direct danger only to the immediate area surrounding the volcano. The major danger they pose to communities farther away is by supplying material that, when mixed with water, can transform into a lahar.

### *Volcanic Gases*

Magma contains dissolved gases. These gases are ejected along with tephra high into the atmosphere during eruptions. They can become attached to tephra particles or water droplets and fall with them back to earth. The major gases are water vapor, carbon dioxide (a greenhouse gas), hydrogen sulfide (acid rain), hydrogen, carbon monoxide, hydrogen chloride, hydrogen fluoride and helium. A few historic eruptions have caused gas concentrations that were acutely lethal to people, animals, and vegetation, but the highest probability effect of volcanic gases is exacerbating existing pollution problems.

### *Lava Flows*

Lava is the classic Hollywood volcano hazard, but the volcanoes of the Pacific Northwest produce a very viscous type of lava that moves very slowly and extends only a few miles from its source if it even moves at all. Much of the lava in nearby volcanoes is so thick and viscous that it builds domes.

## **5.3.2 History**

Only two volcanoes have fully erupted in the Cascades in the 20<sup>th</sup> century, Mt. Lassen in northern California in 1917 and Mt. St. Helens in 1980. The events listed in this section focus on the most recent activity observed for the volcanoes with the greatest hazard risks for Seattle.

### **Mt. Rainier**

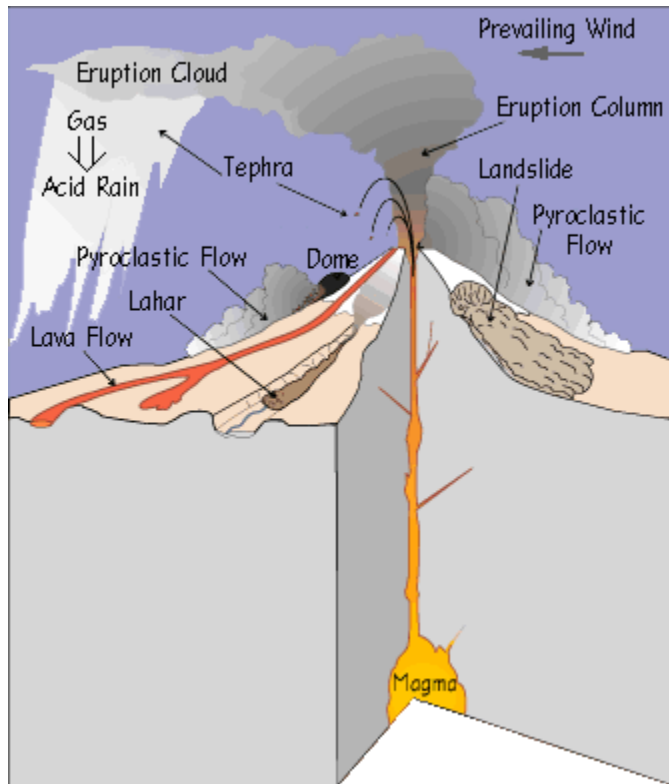
The last magmatic eruption is believed to be about 1,000 years ago.<sup>252</sup> Explorers and pioneers of the 19<sup>th</sup> century reported smoke and earthquakes near the mountain, but there is no physical evidence of eruptive activity during this time. Geologic records show Rainier was active 5,600 to 4,500 years ago and again 2,700 to 2,000 years ago. Both eruptive periods are believed to have produced excess sedimentation in the Duwamish river, near Seattle.

During the past 10,000 years, at least 60 lahars of various sizes have moved down valleys that head at Mount Rainier; but there is no evidence that any have reached Seattle.<sup>253</sup> The two largest lahars that have originated from Mt. Rainier were not triggered by an eruption. One is the Osceola Mudflow that occurred about 4,500 to 5,600 years ago. At least ten times larger than any other known lahar from Mount Rainier, it was the product of a large debris avalanche composed mostly of hydrothermally-altered material. It may have been triggered as magma forced its way into the volcano. Osceola deposits cover an area of about 212 square miles in the Puget Sound lowland; they buried the area around Enumclaw and extended at least as far as Kent and to Tacoma's Commencement Bay.

At least six smaller debris avalanches have spawned lahars in the past 5,600 years. As recently as 500 years ago, the Electron Mudflow nearly reached Puyallup.<sup>254</sup> The Electron Mudflow has not been correlated with an eruption. It is thought to have derived from a slope failure on the west flank of Mount Rainier. The Electron Mudflow was more than 90 feet deep at its head. Its deposits at Orting are



**Figure 5-16. Types of Volcano Hazards**



Source: United States Geological Survey website: <http://pubs.usgs.gov/fs/fs002-97/>

as much as 18 feet thick and contain remnants of an old-growth forest. About 1,200 years ago, a lahar of this type filled valleys of both forks of the White River to depths of 60 to 90 feet and flowed 60 miles. Less than 2,200 years ago, the National Lahar inundated the Nisqually River valley to depths of 30-120 feet and flowed all the way to Puget Sound. More than a dozen lahars of this type have occurred at Mount Rainier during periods of volcanism in the past 6,000 years. In 1963 and 1967, large landslides occurred the slopes of the mountain. Increased heat was responsible, suggesting renewed volcanic activity.<sup>255</sup>

### **Mt. St. Helens**

The 1980 eruption was the largest in the Cascades in recent history but only produced trace ash dustings in Seattle. A magnitude 5.1 earthquake preceded the eruption, which produced the largest debris avalanche in recorded history.<sup>256</sup> Mt. St. Helens has been consistently the most explosive of the Cascade volcanoes, with earlier, smaller eruptions in 1800, 1831, 1842 and 1857.<sup>257</sup> Mt. St. Helens is the most prolific tephra (ash) producer of the past few thousand years because of the frequency of its eruptions. It produced a small ash plume in 2004.<sup>258</sup>

Out of Washington's volcanoes, Mt. St. Helens is believed to be the most likely to erupt in the future. A future eruption probably would not have a major lateral blast or landslide again because of the deep crater that was produced in the 1980 eruption.<sup>259</sup>

### **Mt. Baker**

The last major eruption was approximately 6,700 years ago. Since then, Mt. Baker has experienced a steam eruption in the mid-1800s and an increase in steam and heat in 1975 but did not erupt.<sup>260</sup> Small lahars occur from Mt. Baker every decade or so. It is not showing any current signs of eruption, but the biggest threat of a future eruption would be lahars, which could reach the Puget Lowlands.<sup>261</sup>

### **Glacier Peak**

Glacier Peak generated a sequence of six tephra eruptions over a period of several hundred years about 13,000 years ago. The largest ejected more than five times as much tephra as the 1980 Mt. St. Helens eruption. Ash from these eruptions have been found under Lake Washington and Portage Bay. More recently, Glacier Peak experienced small steam eruptions in the 1700s.<sup>262</sup> The Cascades Volcano Observatory estimates that each year there is a 1 in 1,000 chance that Glacier Peak will erupt.<sup>263</sup>

### **Mt. Adams**

Mt. Adams has erupted in recent geologic time although not during the past 1,000 years. It has had several debris avalanches over the past 10,000 years. Physical evidence suggests that past eruptions were fairly quiet with little ash or pyroclastic material. Some observers speculate that it is dormant or extinct, but the Cascades Volcano Observatory states that it will erupt again but probable future eruptions would be small tephra and lava flows from vents on the summit.<sup>264</sup>

### **Mt. Hood**

Mt. Hood has been very active recently, with an eruptive period in the late 1700s. Early settlers reported eruptive activity in 1859 and 1865, but no deposits have been found that confirm these accounts.<sup>265</sup> Ashfall and pyroclastic flows from Mt. Hood eruptions have been limited to Oregon and southern Washington.<sup>266</sup> Mt. Hood is more of a threat to Portland than Seattle.

### **Mt. Shasta**

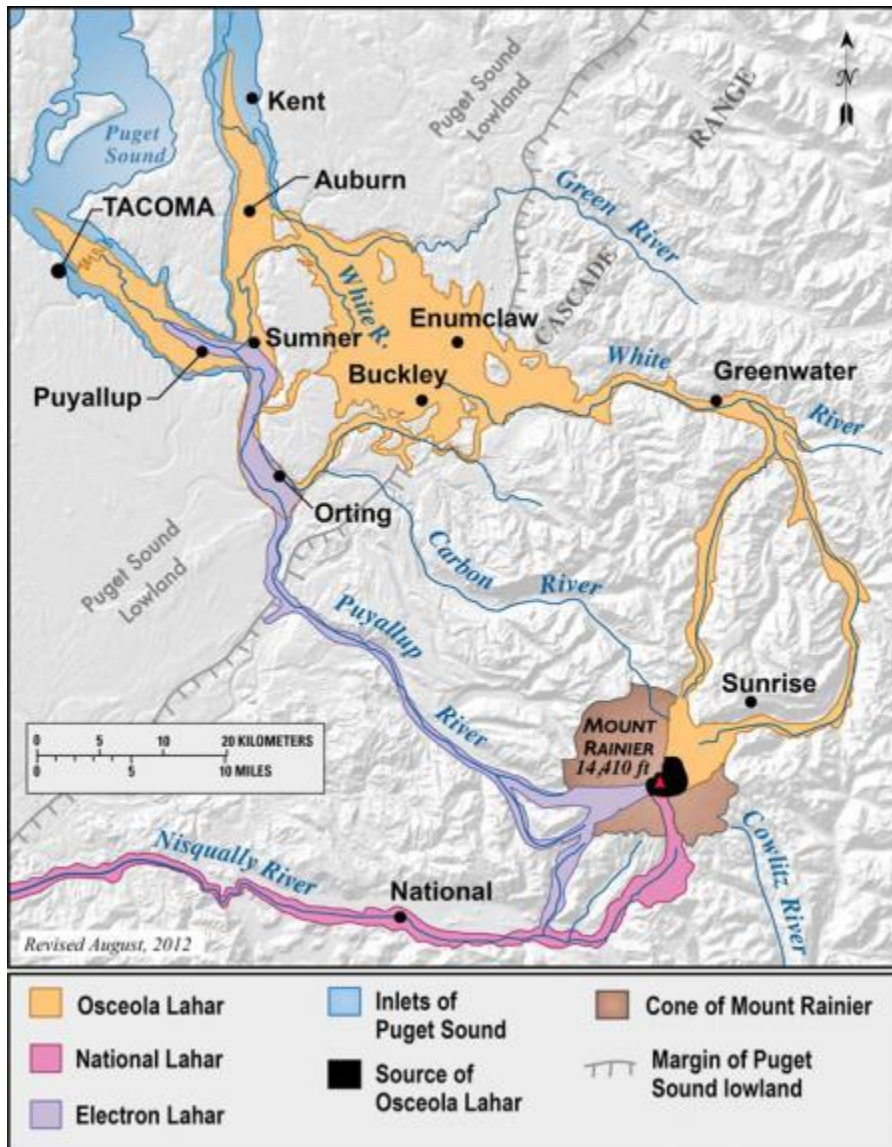
Mt. Shasta has erupted roughly once per 250 years in the past 750 years, with the last eruption in 1786. Eruptions in the past 10,000 years have produced lava flows and pyroclastic flows that have reached as far as 12.4 miles from the summit. It is possible that ash from Mt. Shasta could reach as far as Seattle.

## **5.3.3 Likelihood of Future Occurrences**

The most likely volcanic hazard facing Seattle is ashfall. The USGS estimates that there is a 1 in 5,000, or 0.02% chance per year that Seattle will accumulate 1 centimeter or more of tephra.<sup>267</sup> The USGS has produced a map showing annual probabilities of 1 cm ash accumulation throughout the West Coast (see Figure [Annual Probability of 1cm Ash Accumulation]). Geologists have found volcanic ash deposits from eruptions that happened thousands of years ago in various areas of Seattle. Ash from the Glacier Peak eruption (roughly 13,400 years ago) and the Mt. Mazama/Crater Lake eruption (roughly 7,600 years ago) have been found on the bottom of Lake Washington and Portage Bay.<sup>268</sup> Ash deposits that date roughly 200,000 years ago have also been found under Hamm Creek in the Duwamish Valley, but their origin is unknown.<sup>269</sup> The Glacier Peak ash layer was less than 1-inch thick, and the amount of ash received from the other eruptions is unknown.

Lahars happen more commonly than eruptions. Mt. Rainier is a major producer of lahars because of its size, relatively westward location, and the volume of water trapped in the glaciers along its slopes. Lahars that are not caused by an eruption on Mt. Rainier are more likely to occur in the summer or fall, when melting water is prevalent and intense rain can fall on exposed, unconsolidated ground.<sup>270</sup> Most Cascade glaciers, including those on Mt. Rainier, are shrinking. As they retreat very unstable terrain is exposed. As a result, small debris flows are becoming more common and the released sediment is being

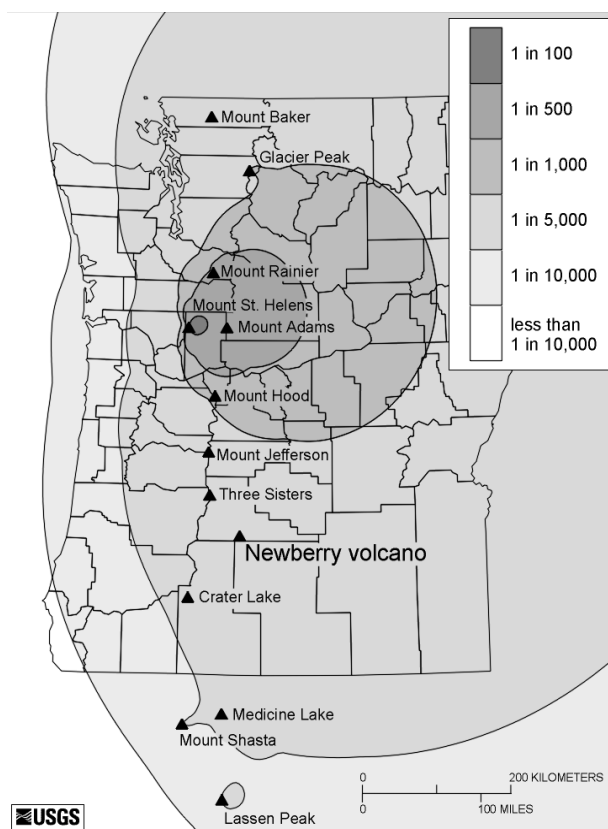
Figure 5-17. Past Mt. Rainier Lahars



Source: United States Geological Survey, Cascades Volcano Observatory  
(website: [https://volcanoes.usgs.gov/volcanoes/mount\\_rainier/hazard\\_lahars.html](https://volcanoes.usgs.gov/volcanoes/mount_rainier/hazard_lahars.html))

washed downstream. This, in turn, decreases the capacity of rivers originating at Mt. Rainier and makes them more likely to overflow their banks with water or lahar debris. These types of lahars would be too small to reach Seattle, and typically do not even go outside the Mt. Rainier National Park boundaries. Larger lahars with the potential for post-lahar sedimentation in the Duwamish Valley are estimated to occur every 500 to 1000 years, according to the Cascades Volcano Observatory.<sup>271</sup> Although the risk of lahars seems quite small, some uncertainty exists because the last major lahars occurred hundreds of years ago before modern development. It is not fully understood whether or how the development will affect a lahar.

**Figure 5-18. Annual Probability of 1cm Ash Accumulation**



Source: Sherrod, D. R., Mastin, L. G., Scott, W. E., & Schilling, S. P. (1997) Volcano Hazards at Newberry Volcano, Oregon. *United States Geological Survey*. Retrieved August 3, 2018, from [http://vulcan.wr.usgs.gov/Volcanoes/Newberry/Hazards/OFR97-513/OFR97-513\\_inlined.html](http://vulcan.wr.usgs.gov/Volcanoes/Newberry/Hazards/OFR97-513/OFR97-513_inlined.html)

### 5.3.4 Vulnerability

Seattle's main vulnerability is to ashfall and post-lahar sedimentation. It is possible that a lahar could reach Seattle because of the connection between the Duwamish river and Mt. Rainier. However, there is no evidence of a past lahar reaching this far.

#### Lahar Vulnerability

Seattle's Duwamish river valley is exposed to lahars and a process known as post-lahar sedimentation. The Kent Valley is more likely than Seattle to be directly affected by a lahar. Seattle is indirectly exposed to potential damage in the Kent Valley because it is heavily dependent on lifelines and facilities located in the area.

Seattle is downstream from Mount Rainier, the Pacific Northwest's major lahar producer. Seattle's major river, the Duwamish, originates on Mt. Rainier's slopes. In theory, a lahar could reach Seattle, but geologists have not found evidence that they have. It is most likely that a lahar would stop south of Seattle in the Kent Valley. Then in the coming days, weeks or months, lahar sediments would push downstream to Seattle in a process known as post-lahar sedimentation.

Hydrologists state that levees will probably contain the sediment inside the river channel but cannot provide guarantees. Therefore, most of the Sodo area should be considered at risk of sediment inundation (see Figure [Potential Post-Lahar Sedimentation Area with Key Transportation

Infrastructure])). Containing the sediment depends on its volume, its speed, the time of year, and the levees' condition. Only about 3% of the area exposed to post-lahar sedimentation is residential. If sediment overtops levees or they fail, low-lying areas along to the river could be inundated.

**Table 5-3. Washington Volcano Hazard Summary**

<b>Volcano</b>	<b>Ashfall</b>	<b>Lahar</b>	<b>Post-Lahar Sedimentation</b>
Mt. Rainier	✓	Highly unlikely	✓
Mt. St. Helens	✓	No	No
Glacier Peak	✓	No	No
Mt. Baker	✓	No	No
Mt. Adams	✓	No	No

Seattle's transportation and utility lifelines would be exposed to post-lahar sedimentation in a worst-case scenario. All major utilities cross the area susceptible to post-lahar sedimentation. They include electrical transmission lines, water supply lines, sewer mains and the BP Olympic Pipeline. The area houses key transportation corridors, including I-5, SR 99, SR 509, and SR 599. It includes the King County International Airport (Boeing Field), rail yards, and large parts of the Port of Seattle.

The Kent Valley is highly exposed to lahar hazards and contains many critical lifelines. They include I-405, the BP pipeline, water lines from Seattle's main watershed, natural gas mainlines, and major power lines. Much of the food that reaches Seattle's grocery stores is distributed from huge centers in this area. Many people who work in Seattle either live in or commute through the Kent Valley.

This indirect vulnerability due to exposure of lifelines outside the city extends to the whole Puget Lowland region. All the Cascade volcanoes can generate lahars that can reach Puget Sound, crossing many transportation and utility trunks along the way.

### **Ashfall Vulnerability**

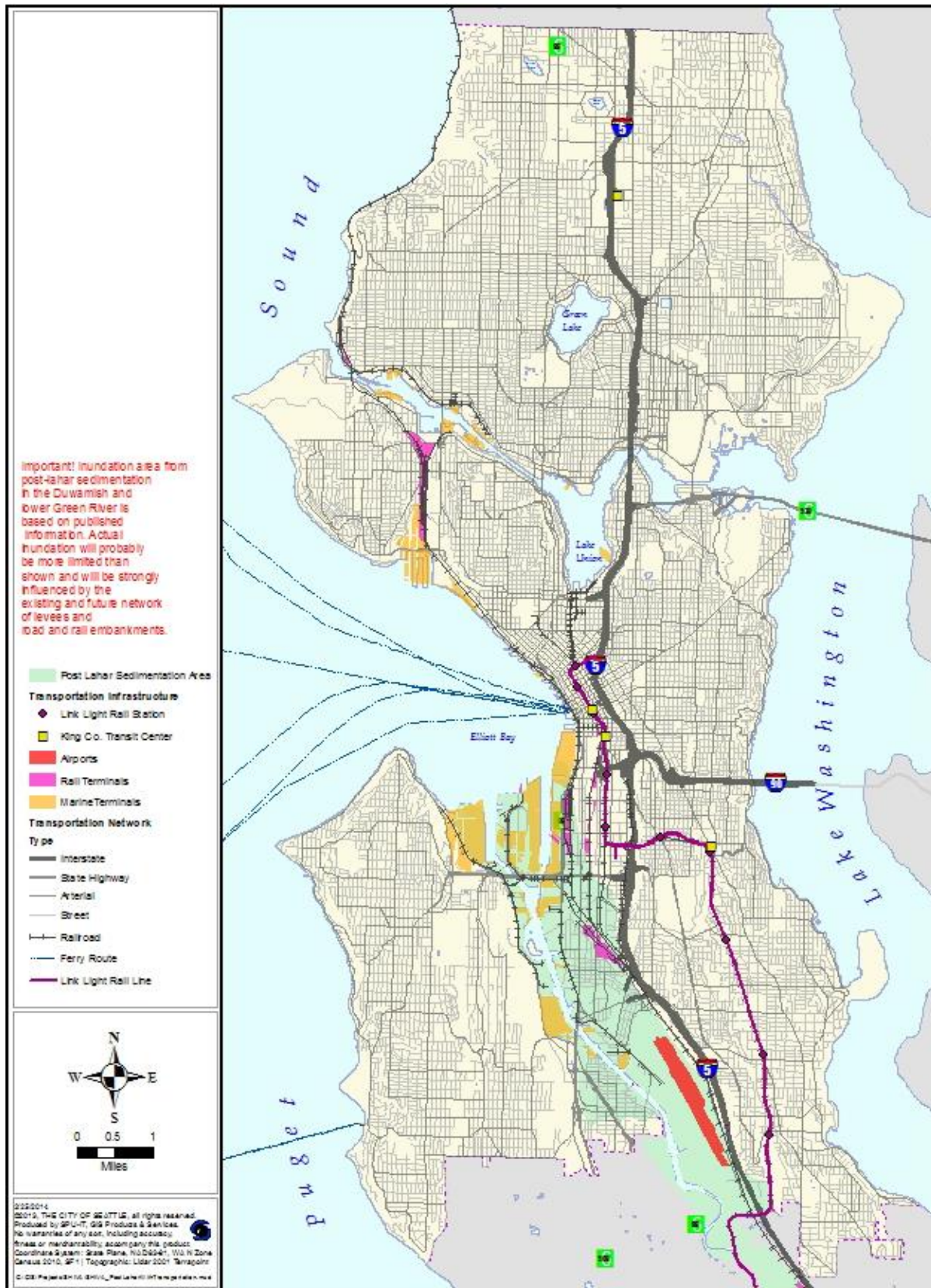
Seattle is exposed to ashfall, but the likelihood of a large event is remote. Volcanic ash deposits from eruptions that occurred thousands of years ago have been found in Seattle, but the severity of these events is unclear. One ash layer found was less than 1-inch thick. If Seattle does receive ash, the most likely source would be Mount St. Helens, which has had the most frequent eruptions and largest ash eruptions of all the Cascade volcanoes in recent history. In the Pacific Northwest, prevailing winds blow from the west to the east. Seattle is west of the Cascade volcanoes. Weather patterns would have to reverse to carry ash into Seattle.

Seattle is made more vulnerable due to its reliance on watersheds and hydroelectric facilities in the Cascades. Seattle is more likely to be impacted by ash falling into its watershed or onto power infrastructure than by ash falling directly on the city. When ash falls into a reservoir it can affect its chemistry and turbidity (clearness).

The power system can be vulnerable in the right conditions. Ash that falls on electrical insulators can cause flashover, a disruptive electrical discharge that can cause outages.<sup>272</sup> Flashover is more likely to happen when the ash has become wet from dew, light rain, or mist. If enough ash accumulates on transmission lines, it can overload them and increase the risk of an outage. Flashovers occurred in areas



Figure 5-19. Potential Post-Lahar Sedimentation Area with Major Transportation Infrastructure



with more than 5 millimeters of ash (and rain) and power lines broke due to ash accumulation during the Mt. St. Helens eruption in 1980. It is difficult to fully assess the vulnerability of the hydroelectric power generation system because there have been so few instances of this happening.

Seattle is vulnerable to impacts of ash on aviation. When ash enters jet engines, it has been shown to cause many damaging and dangerous effects, including mid-flight engine failure.<sup>273</sup> Ash can lead to the closure of airspace, cancelled or delayed flights, and reduced visibility on runways.

Seattle's ground transportation network is vulnerable to ashfall. Reduced visibility and reduced traction on roads can make driving conditions dangerous.<sup>274</sup> Additionally, ash can clog track switches for railways. Both the BNSF railway and Amtrak shut down for a day in Montana due to 1 to 2-millimeter ash accumulation following the Mt. St. Helens eruption.<sup>275</sup>

### **5.3.5 Consequences**

Seattle's consequences to ashfall or post-lahar sedimentation mainly pose threats to property, infrastructure, and the environment. Seattle faces secondary consequences of a Lahar reaching the Kent Valley.

#### **Lahars and Post-Lahar Sedimentation**

The consequences of a lahar would depend on where it originated and how far it traveled. Mt. Rainier poses the biggest risk because it can generate very large lahars and sits closer to the densest part of the Puget Sound area than the other Cascade volcanoes. In the most likely case, Seattle would have to deal with the effects of a lahar in areas outside the city. For example, a lahar from Glacier Peak or Mt. Baker could close Interstate 5, north of Seattle. In the case of a Mt. Rainier lahar, the greatest consequence is post-lahar sedimentation in the Duwamish waterway.

In a post-lahar sedimentation event, sediment could wash down the river for years. Lahar material from the Kent Valley would introduce more polluted debris into the waterway which is already undergoing a cleanup. The increased sediment and dredging operations would set back environmental restoration efforts. Salmon and other wildlife populations in the Duwamish/Green River floodplain could be devastated if their habitat is dramatically altered.

If sediments accumulated, economic activity in Seattle could be affected. Even a short closure could be costly. Portland lost \$13 million (2009 dollars) when its port closed after the 1980 Mt. St. Helens eruption.<sup>276</sup>

Sedimentation could possibly alter the course of several rivers, including the White River which joins the Puyallup River as it flows to Tacoma. A large lahar could alter the White River's course and link it with the Green River instead of the Puyallup River. This would increase water volume and transport sediment to Seattle.

If sediments breach the levees, the consequences grow more severe. Property, lifelines, and critical facilities would be affected. The property exposed to the lahar hazard (surrounding the Duwamish) is predominantly commercial and industrial but includes roughly 117 acres of residential area and all of the King County International Airport. The area is heavily used by the Port of Seattle, Boeing, and commodity distribution centers. The Georgetown and South Park residential communities are in the same area. Given the time sensitivity of many port freight operations and very competitive margins, prolonged outages could have severe economic effects.

If the Duwamish Valley floor is inundated, several vital transportation routes, SR-99 and I-5 could be blocked. Most of Seattle's rail lines, including major railyards occupy this area. These yards include the Union Pacific yard where Seattle's garbage is loaded daily onto trains bound for landfills in Oregon.



If a lahar were to reach Seattle, there could be high loss of life if people did not evacuate. Transportation, utilities, and economic activity would suffer long-lasting damage due to infrastructure damage. The Duwamish Valley and all the other valleys leading up to Mt. Rainier would be buried under mud ranging from a few feet thick near the end of the lahar to hundreds of feet thick closer to Mt. Rainier.

Roughly 3,300 people live in the Post-Lahar Sedimentation Area, mostly in the Georgetown and South Park areas. The precise day time population is unknown, but it is a major employment area. People are exposed to danger only from a lahar reaching Seattle, not from post-lahar sedimentation.

### Ashfall

The experiences of Yakima and Spokane in 1980 reveal a “typical” case of an ashfall emergency. Yakima received about 3 inches; Spokane received 2 inches. Both communities were shut down for days. The ash falls darkened the sky, causing a “midnight at noon” effect in Eastern Washington that lasted for 18 hours. The ash caused power outages and damage to sewer treatment equipment. Interstate 90 was closed for one week, and over 1,000 commercial flights had to be canceled.<sup>277</sup> It took Yakima 10 weeks to clean up the ash. While both cities are well prepared for snowstorms, both were overwhelmed by the ash.

An ashfall in Seattle would have five potentially large direct impacts:

- Ash would irritate people’s eyes and throats, especially those with existing respiratory trouble, but it would rarely cause death.<sup>278</sup> Many people had to wear masks in Eastern Washington or stay inside while the ash fell. The same could happen in Seattle. Blowing ash could prolong these problems, especially if the ash is very fine.
- Traffic would stop if ash covered the roads. Many people would be stuck, and accidents would probably increase. Although the timeframe of an eruption could generally be predicted, an actual eruption could catch many people on the roads, making it worse than a snowstorm.
- Vehicles and other machines would break down as the ash clogged their moving parts. This would compound traffic and clean-up problems.
- Ash could disrupt the city’s utilities. Waste water systems are especially vulnerable to ash, especially if sewage and stormwater are collected in one network as they are in parts of Seattle. In reservoirs, it would increase turbidity, making the water undrinkable until it settled. It could also damage power distribution and generation facilities, prompting expensive emergency power purchases.<sup>279</sup> Wireless communications and public safety would be impeded.
- The City would incur clean-up costs. The City of Yakima paid at least \$1.1 million at the time to remove ash from the streets.<sup>280</sup> Considering that cost would be \$3.5 million in 2018 dollars, and Seattle’s population is over 6 times as large as Yakima, the cost of clean-up in Seattle would be significant. These problems would be worse if it were to combine with water and fall from the sky as mud. When ash becomes wet, it acts like cement. The weight could lead to roof collapses throughout the city.

A heavier ashfall would cause more severe versions of problems expected by the more “typical” scenario. If the ash is acidic or acidic rain falls, injuries and damage would increase. One Alaskan volcano produced acidic ash that burned victims’ eyes, throats, and lips, making eating difficult. Other acidic rains burned the skin. Acidic rains have also destroyed clothing and corroded metal. These alarming effects are rare and did not occur during the 1980 Mt. St. Helens eruption.

The costs of a heavy ashfall would halt economic activity for several days or weeks. Since an ashfall would affect the whole Puget Sound region, Seattle could not rely on aid from neighboring governments. A mudflow would increase the damage and probably stop port activity for several weeks. Aviation would be disrupted. Seattle could be economically impacted even if not physically damaged.

### **5.3.6 Conclusions**

Casualties are likely to be small compared to the economic effects. A lahar, the deadliest volcanic hazard, is extremely unlikely to reach Seattle. Unusual weather patterns could produce ash falls heavier than those in Eastern Washington during the 1980 Mt. St. Helens eruption.

Since geologists can generally detect conditions that precede eruptions, the city would likely have time to prepare itself for ashfall or post-lahar sedimentation. Mitigating sediment loads through dredging and sediment retention dams might make evacuation unnecessary.

Planners should be prepared for ashfall. During the Mt. St. Helens eruption many cities were caught unprepared because they assumed they would not be hit.

## 5.4 Tsunamis and Seiches

### Tsunami

- *Definition:* Tsunamis are water waves caused by earthquakes, volcanic eruptions, or landslides. In deep water tsunamis have long wavelengths, short wave heights, and travel up to 30 mph. As tsunamis enter shallow water they slow down, and the waves increase significantly in height.
- Tsunamis do not have to have large wave heights to be damaging. Tsunami damage is caused by both the forces exerted by flowing water onto structures, and by run-up of the wave onto land that causes flooding and carries debris. Tsunamis can also generate dangerous current speeds that can be hard for vessels to navigate.
- Tsunamis generated in the Pacific Ocean off Washington's coast will not have as great of an effect in Seattle as they will on the Pacific Coast, but low-lying areas may experience flooding, and strong currents will likely be present in Puget Sound for hours after the earthquake.
- Tsunamis can be generated in Puget Sound by both landslides and earthquakes.
- The most frequent cause of Puget Sound tsunamis is landslides. The 1949 Olympia earthquake triggered a landslide in the Tacoma Narrows that caused a 6 to 8-foot tsunami that affected nearby shorelines three days after the earthquake.
- The most damaging tsunami would likely come from a Seattle Fault earthquake, or earthquakes on other local faults. There is evidence that an earthquake on the Seattle Fault that occurred around 900 AD produced a 16-foot tsunami. The National Oceanic and Atmospheric Administration (NOAA) recreated this tsunami using a model.
- The modelled tsunami would flood areas up to one mile inland with depths up to 5 meters. The tsunami would hit immediately after the ground stopped moving. People along the shore would have little time to escape. It would destroy buildings along the shore and flood low-lying areas up to one mile inland. Structures built to modern code would fare better than older ones.
- The 900 AD tsunami was probably a worst-case event. It is more likely (but not certain) that the next Seattle Fault earthquake and tsunami will be smaller.
- The preliminary results from modeling a tsunami generated by an M9.0 megathrust earthquake predict the main impacts to be current speeds of 3 to 5 knots in Elliott Bay and 15 inches of inundation near the Duwamish river.

### Seiche

- *Definition:* Seiches are standing waves in waterbodies caused by most often by seismic waves or atmospheric pressure. They can occur at great distances (100s or 1000s of miles away) from an earthquake epicenter. Because they are *standing* waves they move vertically rather than horizontally.
- Lake Union is especially prone to seiches due to its shape. The east and west sides are roughly parallel, and the V-shaped northern end focuses waves. There is a historical report of a seiche or tsunami on Lake Washington, but it is not clear how large seiches on Lake Washington could be.
- Seiches have occurred multiple times in Seattle, but they have not caused extensive damage so far. Large seiches are a danger to the I-90 and SR 520 floating bridges. A large seiche could strain cables anchoring the bridges. The new SR 520 bridge is designed to take about 12-feet of upward motion

and 8-feet of downward motion from a seiche. Based on models the most damaging seiche would probably be caused by a Cascadia subduction zone earthquake.

## **5.4.1 Context**

### **Tsunami**

Tsunamis are water waves produced by an offshore earthquake, volcanic eruption, landslide, or an impact of an object from space. Any event that suddenly displaces a huge volume of water can generate a tsunami.

Tsunamis generated by four sources have the potential to reach Seattle: 1) distant sources, including subduction zones from around the Pacific, 2) Cascadia Subduction Zone megathrust earthquakes, 3) earthquakes on local faults, such as the Seattle Fault, and 4) landslides.

Tsunamis are hard to detect in the deep, open ocean. The wavelengths of tsunamis are between 93 and 155 miles, with amplitudes of three feet or less, and travel at speeds of about 450 (and up to 600) miles per hour.<sup>281</sup> As a wave approaches the shoreline, its front slows, allowing the rest of the wave to ride up and increasing the wave's height dramatically. Tsunamis nearing the coast can rise to 100 feet in height and move at a speed of 30 miles per hour.

Tsunamis generated in enclosed bodies of water can be especially large. The collapse of a 3,000-foot tall rock wall in a narrow Alaska fjord stripped vegetation over 1,700 feet high on the opposite shore. While the Seattle area does not have any cliffs nearly that size, it does have steep sea bluffs along enclosed bodies of water, and a high susceptibility for submarine landslides.

While tsunamis are often depicted as one large wave, they are actually a series of waves, with a distance between crests of 60 or more miles. The time between successive waves reaching the shore can vary from 5 to 90 minutes.<sup>282</sup> These waves interact with each other, and with shorelines, which is why a single tsunami event can last for several hours.

Whether a tsunami is generated by a potential trigger depends on the volume of water displacement and the speed of the displacement. Most tsunamis are triggered by earthquakes of magnitude 7 or larger.<sup>283</sup> However, magnitude alone is not sufficient in predicting a tsunami. Along with the vertical movement of the earth during an earthquake, horizontal movement and the bathymetry (underwater topography) of the sea floor influence tsunami generation and size.

Some tsunamis break when they reach land. Some rush ashore as a huge mass of water, like a sudden massive tide. Others break far from land and come ashore as a turbulent cascading mass called a bore. The size and speed of the tsunami as well as the coastal area's form and depth are factors that affect the tsunami's shape. The power of a tsunami comes from the huge amount of water behind the wave's leading edge. Normal waves have a small volume, so they dissipate quickly when they strike the shore. Tsunamis do not. Their huge volume pushes the water far inland. This phenomenon is called "run-up" and its size is what often determines a tsunami's destructiveness.<sup>284</sup> The tide at the time of the tsunami can also influence potential run-up. A tsunami or seiche riding on a high tide presents greater danger than one occurring at low tide.

Tsunamis rarely crash ashore without warning. Though localized coastal flooding may precede the first wave, often the shoreline water recedes before the first tsunami wave arrives. This is dangerous since many people, unaware of the looming danger, venture too close to shore and are caught by subsequent waves. During the Indian Ocean Tsunami, a ten-year-old girl who had studied tsunami recognized this phenomenon and saved more than 100 people.

Three main factors could influence the size, shape, volume, and potential destructiveness of a tsunami generated by the Seattle Fault. These are shallow waters above the Seattle Fault, steep shoreline bathymetry, and the shape of Elliott Bay.

- Since Elliott Bay and Puget Sound are shallower than the open ocean, there would be less water displaced by a Seattle Fault earthquake. The resulting tsunami would be slower and have less volume than one generated in the deep ocean.<sup>285</sup>
- Puget Sound's steeply sloping bathymetry may increase the chance that a tsunami will break on the shore, thus enhancing the tsunami's destructiveness.<sup>286</sup>
- The shape of Elliott Bay could increase damage by funneling waves together, thereby increasing wave height.<sup>287</sup>

### Seiches

Seiches are vertical waves in which the largest vertical oscillations are at each end of a body of water with very small oscillations at the center point of the wave.<sup>288</sup> In other words, it is the waves created by the sloshing of water in an enclosed or partially enclosed waterbody, like water sloshing in a bathtub. Pushes from a seismic wave or air pressure cause the water to rock back and forth. Under the right conditions, resonance builds up wave height just like pumping one's legs to make a swing go higher. Since larger bodies of water usually have longer frequencies, it takes longer frequency waves traveling through the ground to create seiches in them. Due to the mechanics of an earthquake, areas close to the epicenter shake at high frequencies. Therefore, seiches tend to occur far from earthquake epicenters.<sup>289</sup> The biggest danger is from subduction zone or megathrust earthquakes that cause powerful, low frequency ground waves.

## 5.4.2 History

Both tsunamis and seiches have occurred in the past 1200 years in Central Puget Sound area.

Tsunami deposits attributed to the Seattle Fault have been found in five locations in Puget Sound, including Seattle.<sup>290</sup> It is not known if they are the result of one event or several closely spaced in time, but the most likely source is an estimated magnitude 7.3 earthquake on the Seattle Fault around 900 AD.

The 1964 Alaskan Earthquake caused a tsunami that was detected in Seattle, with a sea level rise of 0.8 feet detected on the Elliott Bay tide gauge. The waves were higher on the Pacific coastlines of Washington, Oregon, and California. Friday Harbor and Neah Bay recorded maximum wave heights of 2.3 feet and 4.7 feet, respectively. The tsunami's effect was negligible in Seattle because the wave had lost energy as it traveled up the Strait of Juan de Fuca, and Whidbey Island may have acted as a baffle for the incoming waves. New, nuanced models of a Cascadia event show that the main impact would be increased currents in Puget Sound, and very few areas would experience run-up.

A megathrust earthquake on the Cascadia Subduction Zone in 1700 AD generated a tsunami that impacted the Pacific coastline between Vancouver Island and California, and also sent a damaging tsunami across the Pacific Ocean to Japan.<sup>291</sup> This tsunami probably left deposits of the same age that have been found under the tidal marshes of Discovery Bay and the head of Hood Canal in Washington, but there is no geologic evidence for this tsunami elsewhere in Puget Sound.<sup>292</sup>

Landslides have caused localized tsunamis in at least two locations in Puget Sound since the late 1800s. Other records include oral history from the Snohomish Indian people who describe a deadly tsunami in the early 1800s, a small tsunami or seiche in 1891, and a damaging tsunami in 1894 caused by a submarine landslide in Commencement Bay. The most recent was in 1949 when the Tacoma Narrows experienced a landslide that triggered 6 to 8-foot tsunami following that year's magnitude 7.1

earthquake. The 900 AD Seattle Fault earthquake triggered massive landslides into Lake Washington, but there is no geologic evidence that these slides caused tsunamis in the lake.

The 1964 Alaska megathrust earthquake and 2002 Denali earthquake caused seiches in Lake Union.<sup>293</sup> These seiches damaged boats by battering them against docks and moorings in Lake Washington and Lake Union. Interestingly, the seismic waves that caused them could not be directly felt by humans.

Seiches have been more common than tsunamis and have not caused extensive damage so far. In 1891, an earthquake near Port Angeles caused an 8-foot seiche in Lake Washington, big enough to endanger people along the shore.<sup>294</sup> Both Lake Union and Lake Washington experienced seiches during the 1949 Puget Sound deep earthquake, but they did no damage.<sup>295</sup>

### **5.4.3 Likelihood of Future Occurrences**

#### **Tsunami**

Seattle will almost certainly experience tsunami and seiches again, but the question is how often the biggest ones will occur. Seiches and tsunamis from distant earthquakes are the most common instances recorded for Seattle, but they have produced only minor to moderate damage and, to the best of our knowledge, no casualties.

Based on history and the number of landslides in Puget Sound, the most likely source of a tsunami is a large landslide. It is not known how big these waves can get but limited historical evidence suggests at most 6 to 8 feet high, and typically affecting a limited area.

Distant tsunamis originating from around the Pacific Ocean basin (the “Ring of Fire”) are likely, but they will probably have only minor effects on Seattle because they must travel through the Strait of Juan de Fuca then make a 90 degree turn south into Puget Sound and once in the Sound they are disrupted by the many islands and complex shoreline.

Local tsunamis from the Cascadia Subduction zone recur about every 500-600 years on the northern end of the subduction zone. Simulations of a magnitude 9.0 Cascadia earthquake generate a tsunami with wave heights reaching about 4 feet high offshore of Discovery Park and in the channel on the east side of Harbor Island.<sup>296</sup> Despite these wave heights, the simulation predicts almost no inundation of Seattle coastal areas, due in part to steep shorelines.<sup>297</sup> The area most impacted by inundation is Kellogg Island, near the mouth of the Duwamish River, but the model predicts only about 15 inches of inundation there.<sup>298</sup> The greatest predicted hazards are potentially dangerous ocean current velocities off of Discovery Park and Alki Point. Tsunami modeling estimates current speeds of up to 3 knots off of Discovery Park, 3.6 knots off of Alki, and up to 5 knots on the southwest side of Harbor Island.<sup>299</sup> Currents would increase suddenly and potentially last for multiple hours.<sup>300</sup> Such current speeds could make it difficult for maritime traffic, mainly small watercraft, navigate the waters.

The worst tsunami for Seattle would be triggered by a Seattle Fault earthquake.<sup>301</sup> The Seattle Fault runs through Bainbridge Island, across Puget Sound, through West Seattle, Sodo, Beacon Hill and then east to Bellevue (see Figure [Nisqually Shaking Intensity] for a map). The biggest earthquake possible on the Seattle Fault is magnitude 7.3. The frequency estimates for Seattle Fault Earthquakes are difficult to estimate due to lack of data about past events. USGS recurrence interval estimates range between 200 and 12,000 years for any Seattle Fault earthquake.<sup>302</sup> Other local earthquake scientists predict a recurrence interval for M7.2 or larger Seattle Fault earthquakes to be every 5,000 to 15,000 years.<sup>303</sup>

It is likely that the next Seattle Fault earthquake will be smaller than the one in 900 AD. A team of seismologists and earthquake engineers chose to model a magnitude 6.7 Seattle Fault earthquake that they consider more likely than a magnitude 7.3. A magnitude 6.7 earthquake would probably trigger a



smaller tsunami than the one that happened in 900 AD. The Seattle Fault shows evidence of episodic fault rupture of about 6 feet, enough to produce a tsunami.<sup>304</sup>

The size of a tsunami depends on the amount of uplift caused by an earthquake. The 900 AD earthquake caused over 15 feet of uplift. If the fault movement is purely vertical, a magnitude 6.7 earthquake would likely cause about 1 meter (3 feet) or less of displacement on the fault plane, which translates to about 0.5 meters (1.5 feet) of uplift on a 40-degree thrust fault. A tsunami generated by a magnitude 6.7 Seattle Fault earthquake has not been modeled. It would probably cause a fraction of the damage of the NOAA-modeled tsunami following a magnitude 7.3 earthquake or the earthquake-generated tsunami in 900 AD.<sup>305</sup>

Other faults potentially capable of producing tsunamis in Puget Sound include the Tacoma Fault, the South Whidbey Island Fault, the Strawberry Point Fault, the Utsalady Point Fault, and the Darrington-Devils Mountain Fault Zone.<sup>306</sup>

### Seiches

Seiches are more common than tsunamis. Both Puget Sound and Lake Washington experienced them in 1891, 1949, and 1964. These events caused light to moderate damage. It is very likely that similar seiches will happen again. A Cascadia megathrust earthquake may cause a much more dangerous seiche than past occurrences in Lake Union and possibly Lake Washington.<sup>307</sup> Cascadia megathrust earthquakes happen, on average, every 500 years. See the chapter on earthquakes for more details.

## 5.4.4 Vulnerability

Further tsunami modeling is in progress for the tsunami impact to Seattle from magnitude 9.0 Cascadia Subduction Zone earthquake, but preliminary results suggest that the Seattle Fault earthquake presents the greatest tsunami danger to Seattle.<sup>308</sup> Figure [Worst Case Tsunami Inundation Area from M7.3 Seattle Fault Earthquake] shows the worst-case Seattle Fault inundation area.

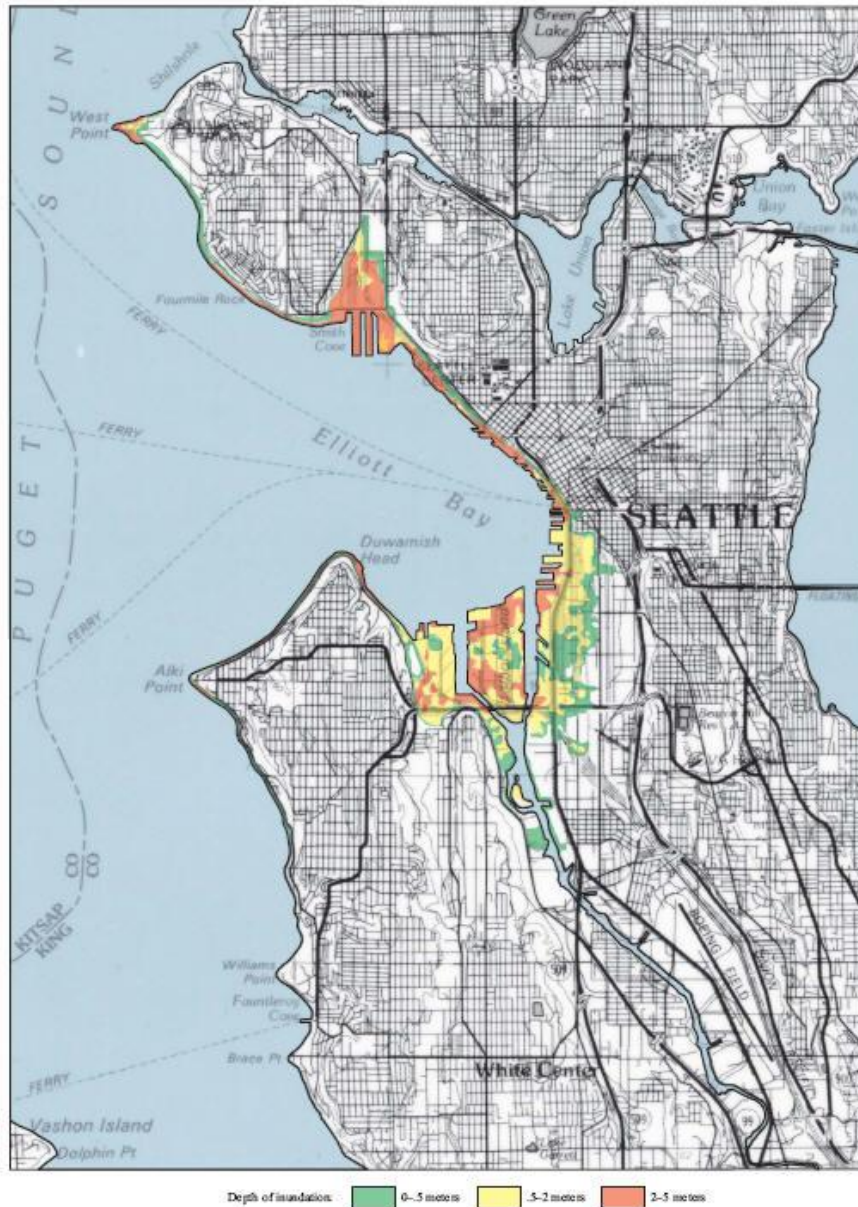
Seattle has a highly developed shoreline that makes it vulnerable to tsunami and seiche damage. Large numbers of people work, play, and live near the water. Major port facilities, tourist attractions, and housing ring Elliott Bay. Lake Union's shoreline is home to houseboats, businesses (including Amazon), parks, and museums.

The short time between a triggering event (e.g. earthquake, landslide) and arrival of the wave train (30 seconds to 5 minutes) would not permit many people to escape.<sup>309</sup> The only possible escape would be trying to get to higher floors in multi-story buildings. Some of these buildings are likely to be severely damaged if the trigger is a Seattle Fault earthquake. Most engineered structures performed fairly well in recent tsunamis.<sup>310</sup> Steel frame and modern concrete frame buildings built to seismic codes fared best in the tsunami following the 2011 Tohoku earthquake in Japan.<sup>311</sup> Likewise, the low death toll in the 2010 Chilean earthquake and tsunami was attributed to the country's strict adherence to building codes.<sup>312</sup> Structures already damaged by a landslide or earthquake would be especially susceptible to more damage from a tsunami.

The effect of the built environment is also important. Sea walls line most of Elliott Bay and the Duwamish Waterway. They provide some protection against waves whether they are storm waves, seiche waves, or tsunami waves. Buildings also affect the propagation of waves inland. The first layer of buildings acts as a barrier and tends to decrease wave velocity, but they can also add debris to the storm water. The worst-case tsunami scenario modeled for Seattle does not include the effects of the built environment. In 2017, Seattle replaced its weak, aging seawall to meet current seismic standards. The new seawall is built to withstand a M6.7 Seattle Fault earthquake and subsequent tsunami. However, waves are expected to top the seawall in the M7.3 worst-case Seattle Fault scenario.

The primary impacts are likely to be from the earthquake itself. The new 520 floating bridge is built to withstand waves in a 100-year wind event. The Washington State Department of Transportation anticipates that these storm-generated wave forces would exceed the forces from a small to moderate-sized tsunami.

**Figure 5-20. Worst Case Tsunami Inundation Area from M7.3 Seattle Fault Earthquake**



**Tsunami Lifeline Exposures:**

- None of Seattle's water supply lines travel through the worst-case tsunami inundation area, but feeder and distribution mains run along the shore from Interbay to Sodo, under 1<sup>st</sup> Ave South and along the West Seattle Bridge.
- The BP Olympic pipeline which carries fuel runs through the area from Harbor Island and along the West Seattle Bridge and the Spokane Street Viaduct.

- Seattle City Light power transmission lines enter the area near the Port of Seattle. 30 transmission towers are in the area.
- Sewer mains run through the Interbay area to Myrtle Edwards Park and in the south, from downtown through the rail corridor serving the Port and along the West Seattle Bridge. In West Seattle a sewer main runs along Harbor Ave SW to the Duwamish Head.
- Enwave's steam plant is located in the area, at Western Avenue and Union Street.

#### Tsunami Transportation Exposures:

- Most of Seattle's marine terminals sit in the tsunami inundation area.
- BSNF's Sodo railyards and about half of its Interbay railyard are in the area; all Seattle's north-south rail corridors touch the area.
- The southern entrance to the new SR 99 tunnel is in the area. See the consequences section below for more on its exposure.
- SR 99, 1<sup>st</sup> Ave S, and the West Seattle Bridge cross the area.
- The King County International Airport is *not* in the inundation area.

## 5.4.5 Consequences

### Tsunamis

Tsunamis have the potential to cause extreme damage and high casualties. The worst tsunami for Seattle would be a repeat of the one that occurred in 900 AD and modelled by the National Oceanic and Atmospheric Administration (NOAA). It is likely that the next Seattle Fault earthquake and tsunami will be smaller, because earthquake occurrence has a power law distribution. In other words, as earthquake frequency increases, magnitude decreases exponentially, meaning there are many very small earthquakes and a few very large earthquakes. Since the 900 AD event was a very high magnitude, we would expect the next one to be smaller based on the high probability of small magnitude earthquakes (see page 22 for additional discussion on power law distribution).

The NOAA model (see Figure [Worst Case Tsunami Inundation Area from M7.3 Seattle Fault Earthquake]) assumes a maximum of 7 meters of uplift on the Seattle Fault's south side (on Bainbridge Island), 4 meters uplift at Alki Point and 1-meter subsidence on the north side at West Point (Magnolia). The model assumes the earthquake happens at high tide. It does not account for the effects of sea walls or buildings. It adjusts for their absence by using a greater bottom friction parameter. Doing so has the effect of decreasing the amount of flooding in flat areas.

The largest part of a Seattle Fault tsunami would be in Puget Sound between Seattle and Bainbridge Island. Most of this part would miss Seattle. Inside Elliott Bay the first wave crest would form a bore with an amplitude of 6 meters (i.e., 6 meters above the normal water level). The biggest wave would form on the northern edge of the fault. It would move north, striking Magnolia, Interbay, Myrtle Edwards Park, and the Downtown Waterfront in two minutes and 20 seconds. It would reflect off the steep bluffs of Magnolia and move south reaching Harbor Island about 5 minutes after the earthquake.

The wave would flood an area up to 1 mile inland around the Duwamish River's mouth. Figure [Worst Case Tsunami Inundation Area from M7.3 Seattle Fault Earthquake] shows the extent and depth of the inundation. The highest vertical run-ups are about 10 meters along Magnolia, Alki Beach, and east of Alki Point.<sup>313</sup>

The consequences of a worst-case tsunami would be catastrophic. Depending on the time of year and day, the shores ringing Elliott Bay are some of the most densely populated parts of Seattle. Survivors of

the triggering earthquake would have minutes to reach higher ground. Many people would be trapped in collapsed or damaged buildings. Roads would be blocked by debris. The best evacuation strategy would be to seek shelter in the upper stories of buildings. Normally, it would be inadvisable to enter potentially severely damaged buildings but doing so is safer than facing a tsunami in the open.

The tsunami would impact most of Seattle's port facilities including critical fuel terminals. Prolonged disruption to the Port would have economic impacts for the city, as essential trade operations would be slowed or halted. The tsunami would also inundate major roadways (SR 99, Elliott Avenue, and the area under the West Seattle Bridge) and railways.

The NOAA tsunami model predicts ½ to 2 meters of inundation in the area surrounding the south portal to the SR99 tunnel. The model is based on a magnitude 7.3 Seattle Fault earthquake that is estimated to have a 1% chance of happening in the next 50 years. The extent of flooding in the tunnel depends not only on the flood depth, but also the total volume of water, the flow rate, the direction of flow and the grade of the entrance, the wavelength of the tsunami, and the co-seismic subsidence. The tunnel was built with possible flooding in mind. It has six feet of space under the lower roadway where water can collect and a pumping system to remove it. Emergency exits are spaced every 650 feet. Sea level rise could increase the reach and depth of a future tsunami.<sup>314</sup>

The tsunami would probably cause many landslides on the south side of Magnolia and the area east of Alki point. It would likely also trigger fires and hazardous materials spills in the port and industrial areas around Harbor Island. Inundation could affect downtown steam systems. If Enwave Seattle (previously Seattle Steam) loses generating capacity, Seattle's major hospitals could lose their ability to sterilize medical instruments.

### **Seiches**

Seiches would cause moderate to severe damage to structures on or adjacent to the shore of Seattle's lakes and Puget Sound. Lake Union is likely to experience the most severe consequences. According to Barberopoulou's 2009 modelling, Lake Union would experience wave heights of up to 6 feet (measured trough to crest) for minutes following the earthquake. Ships, boats, floating docks, and houseboats would pound violently against each other. Power, water, sewer, gas, and communications lines would be severed. People standing on vessels or near the shore could easily fall into the violently sloshing water. Wave motion would be more up and down than side to side because seiches are standing waves. This lack of horizontal movement means that major inland flooding would not occur (See Figure [Area Exposed to Lake Union Seiche]).

The likelihood of a seiche on other local waterbodies is not as well understood, but seiches in these bodies will probably be smaller than those on Lake Union. The consequences of a Lake Washington seiche could include people near the shore being knocked into the water, residential and commercial property damage, and damage to the two floating bridges. A seiche in Elliot Bay could include damage to port and industrial facilities. If a seiche damages buildings over or near the water, it is possible that the building could catch fire or release hazardous materials.

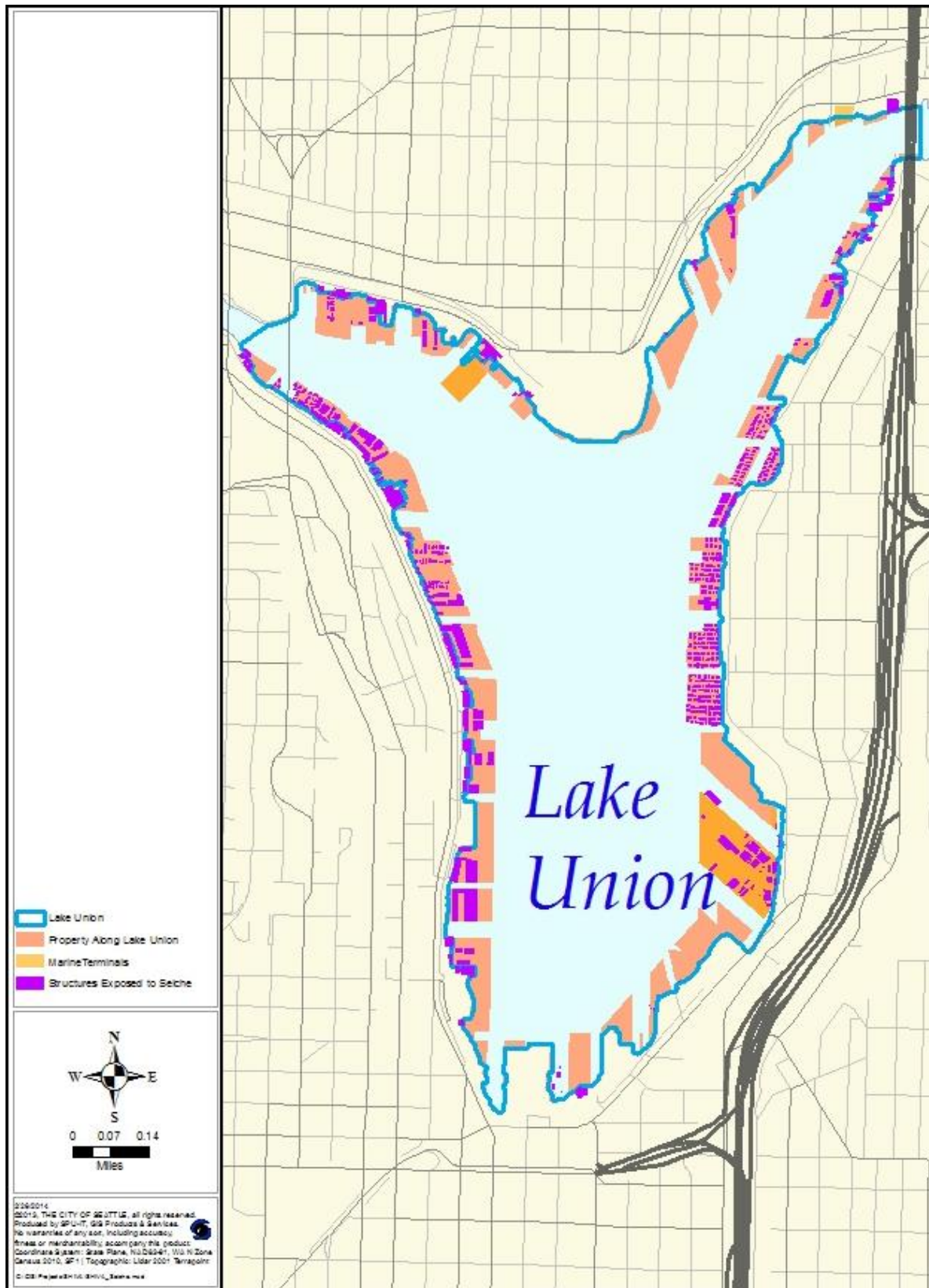
### **5 4.6 Conclusions**

Seattle has an extensive and well-developed coastline. Many recreational and economic activities occur near the shoreline. Both tsunami and seiches would occur with little or no warning. These factors give Seattle an inherent vulnerability to tsunami and seiche hazards. Despite this vulnerability, Seattle's risk is mitigated due to the infrequency of incidents that generate truly powerful tsunami and seiches.

Because of their greater frequency in Puget Sound, landslide-caused tsunamis are the greatest overall risk to Seattle. Landslide-caused tsunami can be very large and can be triggered by cumulative events like small to moderate earthquakes and heavy rainfall.



Figure 5-21. Area Exposed to Lake Union Seiche



The worst case, modeled by the National Oceanic and Aeronautic Administration (NOAA), would be a devastating blow on top of the worst earthquake Seattle has ever faced. It is estimated that this type of event happens only about once every 5,000 to 15,000 years; the last such event occurred 1,100 years ago.





## 6. BIOLOGICAL HAZARDS

## 6.1 Disease - Pandemic Influenza / Bioterrorism

- Disease is considered a hazard because:
  - The chance of widespread disease is relatively high
  - Diseases can affect many people
- Social distancing and other counter measures could mitigate the effects.
- Diseases can have high rates of morbidity (illness) and mortality (death), affect large areas, and impede normal social functions. The impact of these diseases varies based on the virulence of the disease, duration of the illness, susceptibility of the population to the disease, and the spread of the disease within the community.
- Common disease outbreaks include influenza, norovirus, pertussis, hepatitis A, Salmonella, and E. coli. Novel strains of influenza are a great risk to King County, because of the lack of immunity to a new influenza virus strain, the potential for severe illness, and the high degree of transmissibility from person to person. It is estimated that a severe pandemic influenza could cause illness in 540,000 people and over 11,000 deaths in King County.  
The worst-case scenario is the outbreak of a new disease with high rates of morbidity and mortality. New disease outbreaks can quickly overwhelm local healthcare facilities and healthcare providers, and challenge society's ability to maintain critical services.

For King County, the Communicable Disease Epidemiology & Immunization Section within Public Health – Seattle & King County investigates and coordinates the surveillance of communicable disease cases and outbreaks.

### 6.1.1 Context

Disease has been one of the most influential factors in human history. Throughout the 20<sup>th</sup> century great strides in medicine have produced many treatments and cures for the deadliest diseases. These medical advances can give us a false sense of security that all diseases can be treated or cured in a timely manner, even though the potential for a devastating disease outbreak continues to threaten our community.

The impact of a disease can be tracked and characterized using several different indicators. These indicators can help Public Health assess and respond to potential disease outbreaks.

- *Incubation period*: The stage of subclinical disease extending from the time of exposure to onset of disease symptoms.
- *Contagious period*: The duration after infection during which the person can transmit the infection to others.
- *Infectivity*: The proportion of exposed persons who become infected.
- *Pathogenicity*: The proportion of infected persons who develop clinically apparent disease.
- *Virulence*: The proportion of clinically apparent cases that are severe or fatal.

Endemic refers to the usual or predicted rate of a disease for a given area. Epidemic refers to an increase, usually sudden, in the number of cases of a disease beyond what is typically expected for a certain area. Pandemic refers to an epidemic that has spread globally.<sup>315</sup>

Epidemics are not uncommon in the Puget Sound area. Public Health – Seattle and King County monitors dozens of communicable diseases. Some of these, like seasonal influenza, infect many people every year

but most cases are mild. Other epidemics, like whooping cough, are very severe but infect only a small segment of the population. These epidemics can be handled within the normal health care system, and typically do not lead to levels of high morbidity and mortality.

The Center for Disease Control and Prevention (CDC) identifies certain situations that may cause an epidemic to occur.<sup>316</sup> They are:

- A recent increase in the amount or virulence of the disease
- The recent introduction of the disease into a setting where it has not been before
- An enhanced mode of transmission so that more people are exposed
- A change in susceptibility of a person's response to the disease
- Factors that increase a person's exposure or involve introduction through new portals of entry

Although chronic disease has placed a lasting strain on the healthcare system, acute disease is a greater immediate threat to the health system's capacity. Acute disease outbreak has the potential to degrade or paralyze critical medical services.

Many potentially devastating diseases are spread through physical contact, ingestion, insects, animals, and inhalation. Airborne diseases and those spread through physical contact pose higher risks to the community because they are difficult to control. Diseases such as influenza, Pertussis, Tuberculosis, and meningitis are all spread through these methods and pose a significant threat to our community.

Influenza has been the deadliest type of pandemic in Seattle's history. A pandemic influenza is a new influenza virus that is much more severe than the typical seasonal "flu." People have little to no natural resistance to the strain of influenza, so it spreads more easily and can cause more deaths. Adding to the impact is the expected 6-month gap between the virus emerging and the development of a vaccine.<sup>317</sup>

In addition to natural disease outbreaks, there is the possibility of the intentional spread of disease to cause harm, known as bioterrorism. The CDC defines bioterrorism as the biological agents (microbes or toxins) used as weapons to further personal or political agendas (See attacks chapter for other types of terrorism).<sup>318</sup> A biological attack would most likely be covert, meaning people would not express symptoms immediately. Public Health – Seattle and King County identify six priority agents that pose the highest threat due to their high mortality rates and their ease of transmission between people. They are anthrax, botulism, plague, smallpox, tularemia, and viral hemorrhagic fevers.<sup>319</sup> Seattle has never experienced an act of bioterrorism.

## **6.1.2 History**

Throughout the 20th century several epidemics and pandemics have affected our community.

**Influenza. 1918-1919:** The highly virulent influenza pandemic of 1918 killed a large number of young, otherwise healthy adults. The pandemic caused more than 500,000 deaths in the United States and more than 40 million deaths around the world. The 1918 pandemic first arrived in Seattle in October 1918; over the next six months the virus claimed 1,600 lives.

**Influenza. 1957-1958:** The influenza pandemic of 1957 was less severe than the 1918 pandemic and caused a total of 70,000 fatalities nation-wide.<sup>320</sup>

**Influenza. 1968-1969:** The influenza pandemic caused more than 34,000 deaths in the U.S. and caused severe morbidity and mortality around the world.<sup>321</sup>

**E.coli. 1993:** E.coli-contaminated hamburger meat from a local Jack in the Box caused illness in 400 people and led to the death of two people within one month in the Washington area. Cases were seen in California, Idaho, and Nevada as well.

**Pertussis. 2002-2005:** Between 2002 and 2003 Public Health reported an 82% increase in the number of Pertussis infections in infants, and a three-fold increase in the number of cases in children <6 months. The occurrence of Pertussis in adolescents and adults has been on the rise since 1990, culminating in a national epidemic in 2005 when 25,616 reported cases nation-wide. Outbreaks within healthcare facilities can occur quickly because the bacterial infection is highly contagious.

**Influenza. 2009:** Like the 1918 pandemic, the H1N1 outbreak of 2009 affected the young and healthy populations as well as those with chronic diseases. This increase in morbidity caused strain on the local healthcare system. King County activated its Pandemic Disease Plan and Seattle closed 3 schools in response to the disease.<sup>322</sup> Although the H1N1 virus was not virulent and there were not nearly as many fatalities as previous pandemics, the outbreak caused a larger than usual amount of disease in the community than seasonal influenza virus does.

While there are no local instances of bioterrorism, there have been a few instances in the Pacific Northwest, and nationally. In 2013, threatening letters containing ricin were intercepted in Spokane, Washington.<sup>323</sup> They were addressed to military bases and U.S. government officials. Nobody was injured from the letters. In 2001, several locations on the East Coast were struck with anthrax. In 1984, the followers of the Bhagwan Shree Rajneesh spread salmonella on food items in restaurants in the Dalles, Oregon; there were no deaths, but 751 cases of illness were confirmed.<sup>324</sup>

### **6.1.3 Likelihood of Future Occurrence**

Disease outbreaks are not uncommon and can produce devastating effects on a community. While medical advances have increased our ability to counteract disease, increases in the number of people without adequate healthcare, as well as the evolution of antibiotic resistant bacteria and globalization help make outbreaks spread more quickly and increase their magnitude.

Climate change could influence the likelihood or severity of future disease outbreaks, but much remains unknown. Warming temperatures or precipitation changes could alter the range of insects that carry diseases such as mosquitos and ticks. Likewise, warming water temperatures could affect organisms that contribute to water and food-borne diseases in ways we cannot predict now.

There is disagreement among experts about the likelihood of a non-state actor successfully carrying out a bioterrorism attack. Unlike other methods of terrorism, the materials needed to make a biological weapon are readily available, are inexpensive, and only require graduate-level science.<sup>325</sup> However, some believe that there are too many barriers to make it an attractive tactic for terrorists, including creating a successful strain of a disease, producing a large enough amount, and successfully distributing it where it will infect people.<sup>326</sup> While terrorists groups continue to have an interest in obtaining and using biological weapons, experts believe that conventional weapons (e.g. firearms and bombs) will continue to be the weapons of choice in the future attacks, because they are more easily acquired, cause immediate harm, and have fewer countermeasures.<sup>327</sup>

### **6.1.4 Vulnerability**

There are many factors that can increase Seattle's vulnerability to disease exposure and spread.

- Rapid population growth, such as is occurring in King County, increases the potential for acquisition and spread of infectious diseases.
- King County's large international air and seaports (including an active cruise ship industry) increase the number of visitors to our area and the risk for importation of infectious diseases. Diseases that

are not endemic to Washington have the potential for introduction and spread among our residents. Vaccine preventable diseases (e.g., acute viral hepatitis, measles, and influenza) are significant contributors to morbidity and potential mortality in international travelers and can cause local outbreaks among susceptible persons.

- Persons experiencing homelessness often also have limited access to medical care, so many people living homeless and with health problems have difficulty getting prompt treatment. Living conditions – like crowding and fewer opportunities for personal hygiene – can contribute to the spread of disease. If someone has an underlying medical condition, alcohol or drug use, or weakened immune system, they are even more susceptible. In 2017 and 2018, King County’s Communicable Disease Control, Epidemiology & Immunization unit (CD-Imms) responded to increases in several infectious diseases among persons experiencing homelessness; new infections and outbreaks in this population continue to be reported and might continue to rise given the increase in persons experiencing homelessness in King County.

Disease often affects those who are generally considered most vulnerable in our communities. Young children, the elderly, the poor, and those with underlying health conditions typically face the greatest consequences of disease. Those with existing health disadvantages (diabetes, asthma, disabilities, low life expectancy, etc.) appear to be concentrated in south Seattle (Pioneer Square, Sodo, Rainier Valley, Delridge) and north Seattle (Lake City, Bitter Lake, Northgate) (see figure [Map of health disadvantages in Seattle]). The neighborhoods that appear to have both high concentrations of people under 5 years of age and over 65 years of age are Delridge, Fauntleroy, and Beacon Hill.<sup>328</sup>

Seattle has a large concentration of healthcare resources, but in an epidemic or pandemic these resources can be stretched or overwhelmed by the increase in demand that accompanies an outbreak situation. The Seattle area also provides specialized medical care for a large geographic area, including one of the region’s pediatric hospitals and the only Level 1 Trauma center for Washington, Idaho, Montana, and Alaska. In addition, Airlift Northwest, located at Boeing Field, is the only life-flight agency serving the same four-state region. These facilities must continue serving the wider geographic area during a localized outbreak.

Other resources, such as food and water, are also a concern when planning for disease outbreaks. It is unlikely that Seattle’s water reservoirs, which are underground or on secured watershed lands, would be exposed to potential contamination. On the other hand, food sources can become contaminated by improper food handling practices or ill food workers. Public Health conducts ongoing surveillance for food- and waterborne illnesses to identify and quickly control outbreaks. However, Seattle is still home to a dense network of restaurants that rely on regional farmers and distributors that are all vulnerable to spreading food-borne illness.

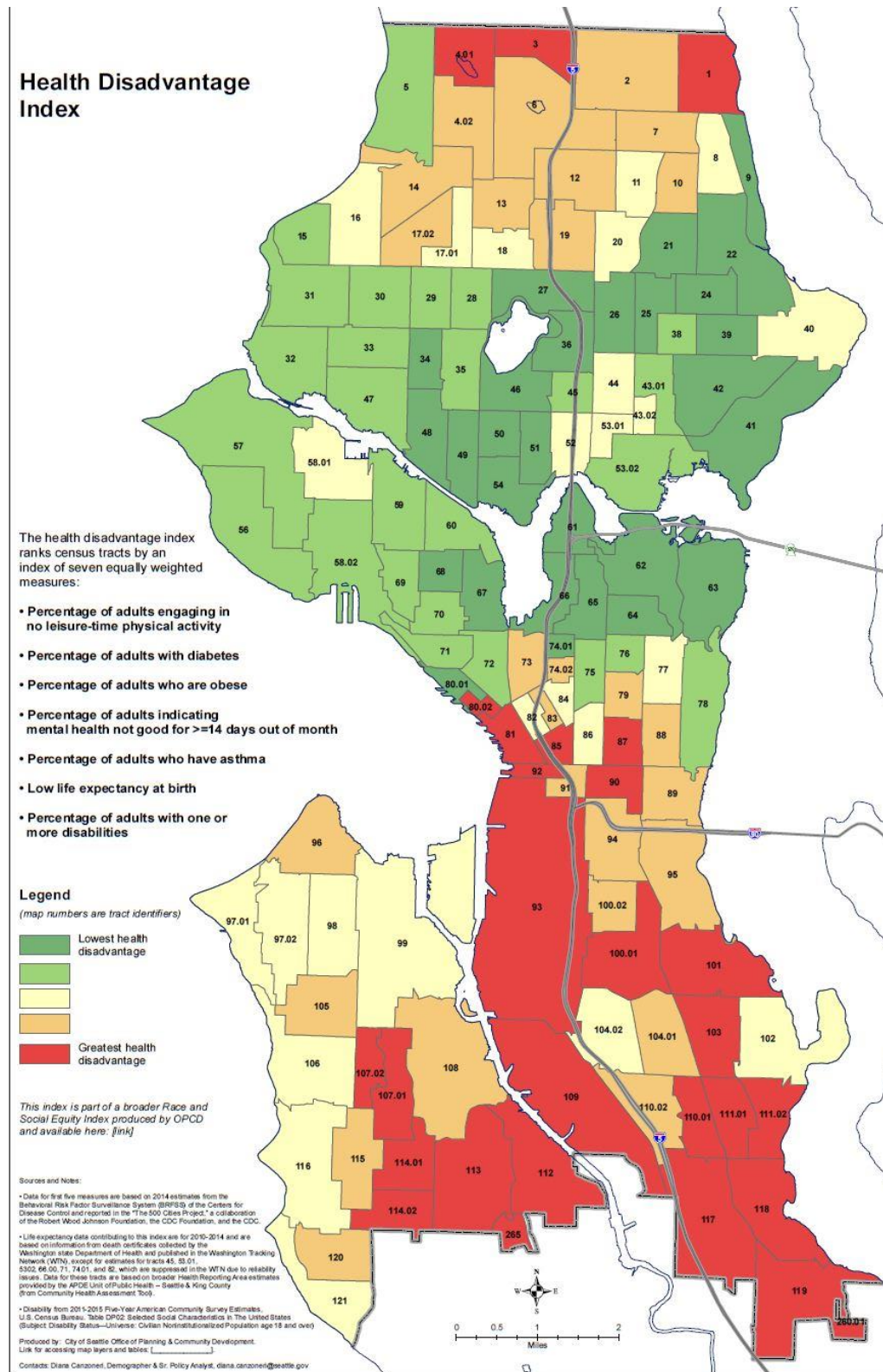
### **6 1.5 Consequences**

Epidemics directly affect the health of people who live, work and visit a community. They have the potential to be one of the deadliest hazards a community can face. Illness is the most notable consequence of an epidemic, but outbreaks can also severely impact the community as schools, businesses, government agencies and non-profit organizations curtail operations due to employee illness or as countermeasures. The effects of these curtailments grow the longer the disease persists.

The most likely scenario that activates the City’s emergency management system would be a disease outbreak that just exceeds our public health system’s capacity and has many indirect socio-economic effects like the need to close schools or businesses. We have chosen a hepatitis A outbreak for the most likely scenario. It occurs in small numbers each year in King County, but more widespread outbreaks occur regularly. It is one of the deadliest food borne pathogens and one of the hardest to investigate because it can be dormant for a while before it makes a person sick.<sup>329</sup> A large outbreak centered in



Figure 6-1. Health Disadvantage Index



Source: Seattle Office of Planning and Community Development

Seattle would cause a strain on the public health system and potentially have strong impacts on local businesses, especially any that the public perceives as responsible for the outbreak.

The most severe disease outbreaks would involve pathogens that would infect a large percentage of an exposed population and hospitalize or kill many people. Pandemic has the potential to cause this disaster. It poses a great threat to the health of our local community as well as the national/international community. In addition to human morbidity and mortality impacts, pandemic influenza has many socio-economic consequences. Cancellations of schools, work, and public gatherings may be enacted to attempt to halt the spread of disease. Staff absenteeism can create a strain on government and healthcare systems causing limitations of services and care. The 2009 H1N1 flu epidemic showed how potentially easy it is to overwhelm the healthcare system, even though H1N1 was an influenza that caused less severe disease than a typical seasonal flu. Seattle-King County Public Health was a leader when the H1N1 flu surprised health officials by not being as severe as feared. The Public Health Director was one of the first in the country to reverse guidance to close schools. A pandemic influenza that caused moderate or severe disease would have a much larger impact on the community. The following table outlines expected disease rates based on Center for Disease Control modeling.

**Table 6-1. Estimated Number of Episodes of Illness, Healthcare Utilization, and Deaths Associated with Moderate and Severe Pandemic Influenza Scenarios for the US Population and King County.**

Characteristic	Moderate (1958/68 - like)		Severe (1918 - like)	
	US	King County	US	King county
Illness	90 million	540,000	90 million	540,000
Outpatient Care	45 million	270,000	45 million	270,000
Hospitalization	865,000	5,190	9,900,000	59,400
ICU Care	128,750	733	1,485,000	8,910
Mechanical Ventilation	64,875	389	742,500	4,455
Deaths	209,000	1,254	1,903,000	11,418

Data Source: Pandemic Influenza Response Plan (2013). Public Health - Seattle & King County. Retrieved August 9, 2018, from <https://www.kingcounty.gov/depts/health/emergency-preparedness/preparing-yourself/~media/depts/health/emergency-preparedness/documents/pandemic/pandemic-flu-response-plan.ashx>

## 6.1.6 Conclusions

Disease outbreaks can be severe and unpredictable. Many diseases can cause epidemics and pandemics such as influenza, pertussis, hepatitis A virus, *Salmonella*, *E. coli*, West Nile virus, and tuberculosis. Outbreaks can cause greatly increased levels of morbidity (illness) and mortality (death) within the community, in addition to overwhelming the healthcare system and disrupting essential community services through staff absenteeism. Public Health – Seattle & King County manages the ESF-8 Health, Medical, and Mortuary Response plan and is responsible for monitoring and responding to any potential disease outbreak.



## 7. INTENTIONAL HAZARDS

## 7.1 Social Unrest

- Social unrest includes civil disorders, acts of mass civil disobedience, and strikes. They differ in their legality and tactics (especially the use or avoidance of violence), but all are acts by groups of people that are intended to disrupt a community or organization.
- Civil disorder is a public disturbance by a group or groups of people involving acts of violence that cause immediate danger, damage or injury to others or their property. They are often but not always politically motivated. They are both illegal and violent.
- Civil disorders can be divided into two rough categories: those in which the perpetrators deliberately set out to harm others and those in which the perpetrators are focused more on crimes against property. Most of Seattle’s disorders have been the latter.
- Civil disobedience is the nonviolent refusal to obey certain laws as an act of political protest. Civil disobedience is illegal but non-violent.
- Strikes are collective work stoppages by employees designed to force an employer to meet employee demands. Most strikes are legal and peaceful, but they can be both illegal and violent.
- There are not clear lines differentiating civil disorder, civil disobedience, and strikes. The World Trade Organization (WTO) protests began with acts of civil disobedience then spiraled into civil disorder.
- The World Trade Organization (WTO) unrest was Seattle’s most damaging experience with social unrest. For five days in late 1999 police battled protesters in downtown and Capitol Hill. There were no fatalities, but the economic disruption was significant, and the unrest was a serious blow to the city’s reputation.
- For the past five years, May Day protests in Seattle have routinely exhibited violence or vandalism that requires police intervention.
- Disorders often occur in dense areas where people naturally gather and in crossroads areas. In Seattle, downtown, Capitol Hill, and the University District have seen the most frequent civil disorder events.
- Looting and arson are the most common crimes in Seattle’s civil disorder events.
- Reputation damage has been a major impact to some areas hit by civil disorders, but Seattle has not seen major, lasting reputation damage.

### 7.1.1 Context

Social unrest includes a wide range of activities from violent to peaceful, legal to illegal, criminal to principled and highly planned to completely spontaneous. With such diversity, it seems impossible to generalize about them as a class of activities. What they share is an effort by a group of people to disrupt the community. Sometimes violence against people and property is added. This section will concentrate on the aspects of community disruption. There is no intention of equating moral parity between mob violence and peaceful protest of the sort championed by Dr. Martin Luther King, Jr. It must be recognized, however, that even peaceful civil disobedience is the application of pressure.

#### Civil Disorder

Civil disorder has been an episodic presence in the United States since its founding. The most widely held theory of modern American civil disorder distinguishes between “communal” and “commodity” riots.<sup>330</sup> Communal riots involve direct battles between two or more ethnic groups. They can cause high

casualties and usually occur on the border between the communities involved or at some contested public spot like a beach or playground. In the 20th century, they were most common from the turn of the century through the 1920s. Commodity riots start within the heart of a community instead of the fringe. The violence is generally aimed at symbols of the prevailing social structure, not at people. Because property is the most common target, casualties tend to be lower in commodity riots than communal riots. The majority riots during the 1960s were commodity riots.<sup>331</sup>

Disorders in Miami and Crown Heights, Brooklyn during the 1980s and 1990s were marked by inter-ethnic violence, suggesting a return to communal type disorders.<sup>332</sup> But the 1992 Los Angeles riots demonstrated that something more complex might be developing. The main targets were stores and structures symbolic of authority, but the ethnic diversity of the arrested persons was something new. There seemed to be a new element of interethnic and interclass conflict involved that had the potential to make disorders more dangerous. These developments showed the importance of taking intergroup tensions seriously.

The 1992 LA riot did not begin with an arrest, as many of the 1960s riots did, but with the announcement of a trial verdict. The difference is important because it began with an anticipated, yet unscheduled event that allowed crowds to gather quickly. Unlike the 1960s, rioters used more firearms and assaulted fire department personnel more frequently. Fifty-five people died as a result of the riots. Unlike riots in the 1960s where most of the fatalities resulted from National Guard and law enforcement fire, most fatalities in LA were caused by rioters or people defending themselves from them.<sup>333</sup> The official studies of the mid-1960s riots, the LA riots, and the Crown Heights riots all noted that municipalities were reluctant to activate their disaster plans and sought to downplay events until they were out of hand.<sup>334</sup>

The turn of the millennium saw a shift back towards commodity riots, aimed at various social issues such as workers' rights, globalization, and the environment. The 1999 World Trade Organization protests in Seattle began peacefully but quickly turned into disorder, with both violence and vandalism. Multiple riots in the 2000s and 2010s have been about police force against African Americans, including riots in Cincinnati, Ohio in 2001, Oakland, California in 2009, and Ferguson, Missouri in 2014. In the past few years, the political landscape appears to be the main motivator behind civil disorder. Many cities in the U.S. have experienced clashes between groups that identify with the far-right or far-left of the political spectrum. The most prominent are white supremacist and anti-fascist ("antifa") groups, both of which have discussed and acted out the use of violence to defend their beliefs.<sup>335</sup> In 2017, a white-supremacist protest in Charlottesville, South Carolina resulted in the murder of a counter-protestor.

Riots do not always stem from protests. Some are situational, such as riots following sporting events or riots developing during power outages. Chicago experienced riots over multiple years in the 1990s, each time the city's basketball team won the NBA championship. After the 1992 victory, riots led to two deaths and almost 700 arrests.<sup>336</sup> A riot arising from the 1977 New York City blackout led to over 1,000 fires and 1,600 stores being looted.<sup>337</sup>

Prolonged power outages and natural disasters like flooding or earthquakes often heighten a community's fear of subsequent civil disorder, mainly looting. However, disaster and recover experts say that the risk of looting is widely overstated and sensationalized by the media, and disaster situations actually promote cooperative behavior in communities.<sup>338</sup> In the week following Hurricane Sandy, crime dropped by one third in New York City. Additionally, after Hurricane Harvey hit Harris County Texas in 2017, there were only 63 people charged with storm-related crimes (including burglary and theft) in a county of 5 million people.<sup>339</sup>



## **Protest and Civil Disobedience**

Organized protest has long been a cherished right of Americans and a hallmark of the right to freedom of speech. Nearly all protest is peaceful. For local governments, the right of citizens to protest must be balanced against the rights of non-protesting citizens to conduct their own business. Typically, this is accomplished by rules designed to permit non-protesting citizens to move freely and to respect private property. Use of the street requires a street use permit because it closes the street to other users for the duration of the demonstration. When conflict arises between demonstrators and law enforcement, it is frequently centered on the use of streets and private property.

Civil disobedience also has a long history in the U.S. It is the peaceful refusal by a group of people to obey laws or pay taxes that they regard as unjust and to persuade the government to change them. Sometimes there is not a direct connection between the law broken (e.g., trespass) and the issue being protested, as when demonstrators blockade a private business to protest what the business is doing.

Despite the peaceful nature of most protest and civil disobedience, they are disruptive and have the potential to degenerate into violence, as illustrated in the examples above. The 1968 Democratic Convention is the archetype of this type of disorder. Most planned events involve a protest rally or march. Protest leaders and law enforcement can meet before the event to develop mutual understanding and often do. Sometimes, this pre-planning does not work because one or both sides will not or cannot control its people on the street. The use of the internet and social media to organize events has allowed law enforcement to obtain intel prior to events. However, both new technology and policy are preventing some surveillance activities. Online communications are increasingly being masked by groups who do not want the police to know about their plans.<sup>340</sup> Additionally, a surveillance ordinance enacted in Seattle in 2017 requires city council approval (after at least one community meeting) of all surveillance equipment used or sought by city departments.<sup>341</sup>

## **Strikes**

Strikes are the organized stoppage or slowdown of work in order to force an employer to grant concessions. Today many strikes are legally protected. Some critically important workers do not have the right to strike. The vast majority of strikes are legal and peaceful. They are disruptive to the businesses or organizations involved, but they have limited impact on the whole community. Examples of strikes that affect the whole community have become rare and are often illegal. The air traffic controllers' strike of 1981 was one example.

There is no clear definition of a general strike, but it involves a work stoppage by a substantial number of workers across industries in a city, region, or country. They are used to achieve broad economic or political objectives, rather than negotiate with a specific company or organization. There has not been a general strike in the United States since the Great Depression. They are very hard to organize and maintain.

### **7 1.2 History**

Seattle has experienced periodic civil disorder, large-scale disruptive protest, and strikes throughout its history. The issues have been different in each case. The tactics used in the disruptions have also evolved.

#### **1886 Anti-Chinese Mob**

Seattle's first large civil disturbance occurred in 1886 when a mob attempted to evict Chinese residents from the city. The mayor called out the militia to prevent the expulsion. The mob resisted. Fighting erupted and the troops fired on the crowd, killing two people.<sup>342</sup>

### ***1919 The Seattle General Strike***

The next wave of civil disorder centered on the labor movement. There were disturbances from 1900 to 1919, but there was no large-scale violence in Seattle itself as there was in other parts of the state. The biggest event was the general strike of 1919 that lasted for three days and passed without violent incident. After 1919, the labor unrest declined.

### ***The 1960s***

After 1919, there were no large incidents of civil disorder until the 1960s. During those upheavals, Seattle remained a secondary site for national trends. As with the rest of the nation, Seattle experienced strife connected with racial tensions, the Vietnam War, and the youth movement.

### ***1967 Post MLK Assassination Disorders.***

The late 60s were a period high racial tension nationally. During the summer of 1967, disorder broke out in many cities. The unrest spread to Seattle, but it was minor compared to other places.<sup>343</sup> Even though Seattle avoided additional large-scale incidents, tensions remained high and resulted in several police officer shootings during the late 1960s and early 1970s. 1969 University District Parties.

The social changes involving young people also led to unrest. In 1969, youths and police confronted each other in the University District over two nights. The flashpoint was the attempt to shut down parties.

### ***1969 – 1973 Vietnam***

Seattle saw several large marches against the Vietnam War, but these were mostly peaceful. Most of these happened from 1969 to 1973. In the last large protest, a crowd of nearly 5,000 university students shut down I-5.<sup>344</sup>

### ***1992 Rodney King Verdict***

The night of the Rodney King verdict, small groups of people roamed the downtown streets smashing windows, lighting dumpster fires and overturning cars. The next day, people angered by the verdict rallied at the Federal Building. Many residents and workers feared more violence and avoided downtown. After the rally broke up, some groups moved around downtown as they did the night before. Others went to Capitol Hill where they set fires and attacked the East Precinct Police Headquarters. The fires provoked a citywide crisis. Suburban fire trucks were called in to help as the city exhausted all its mutual aid. There was a serial arsonist also active at the time. If he had set fires that night, it would have made the situation even more difficult. Another protest occurred in the University District. That protest was largely peaceful, but protesters did occupy I-5 for a while, shutting down traffic.<sup>345</sup>

### ***1999 WTO Protests***

From November 29 to December 3, 1999, Seattle hosted the World Trade Organization (WTO) conference. During the first day of the conference, a large confrontation lasted all day in the area near the convention center. Some of the protesters threw rocks and bottles. The police responded with tear gas, pepper spray, and blunt impact projectiles (bean-bag, cork, and rubber). The Mayor responded by declaring a state of emergency that established a limited curfew in the area surrounding the conference site and hotels. The Washington State National Guard was mobilized. The next day saw a smaller downtown protest and the night required police action on Capitol Hill.

The large number of protesters (over 40,000), their tactics, and their organization overwhelmed the approximately 400 police officers securing the conference venues. The protest was a loosely affiliated federation of activist groups. The organizers divided downtown into thirteen wedges and each group was given one wedge. Their use of the Internet, cell phones, radios, and other technologies combined with a very loose organizational structure and more provocative tactics was unprecedented in Seattle.

Many groups were non-violent but seemed determined to provoke an active police response. A small group of protesters was violent. They were joined by non-politically motivated individuals in committing acts of vandalism, smashing windows, spray painting buildings and setting fires. Both the protest groups and the police seemed to get better at isolating these people and avoiding violent confrontation as the week continued.

Over 600 people were arrested. There were no deaths, but 92 people were treated at local hospitals. 56 police officers filed injury reports, with the most serious being a burned hand. It was estimated that downtown businesses sustained \$3 million in property damage. Retailers lost an estimated \$17 million in sales during the 5-day conference. The protests cost the City of Seattle around \$9.3 million.<sup>346</sup>

### **2001. Mardi Gras Riot**

In February 2001, chaos erupted for two consecutive nights during Mardi Gras. A crowd between 5,000 and 7,000 began to fight and vandalize property. Police officers were withdrawn from the crowd over concerns for officer safety and to avoid inciting the crowd. One person was killed. Damage was estimated between \$100,000 and \$200,000. This was a pure riot, with no element of protest involved. An after-action review recommended intervening to disperse the crowd sooner.

### **2017. Inauguration Day Shooting**

Mostly peaceful protests happened throughout the city on January 20, 2017, the day Donald Trump was inaugurated as president. No violence occurred during the day, although police confiscated wooden poles, pipes, flares, and hammers from protestors in Westlake Park.<sup>347</sup> Confrontations between the president's supporters, anarchists, and socialists began to escalate at the University of Washington campus, where conservative news editor, Milo Yiannopoulos, was scheduled to speak. The crowds threw bricks, fireworks, and paint at police officers. Josh Dukes, a member of the Industrial Workers of the World, was shot in the abdomen but survived.<sup>348</sup> A married couple, who are believed to have come to the protest to invoke violence, were charged with the assault.

## **7.1.3 Likelihood of Future Occurrences**

The social conditions cannot be predicted, but as long as people have strong passions about social issues, there will be instances of unrest. While earlier events seemed to occur when Seattle was the primary focus of a conflict rather than a secondary site, such as the WTO protests, events in recent years show that conflict or injustice in other parts of the United States can also trigger social unrest locally

Every several decades, Seattle seems to go through surges of activity related to a hot button social issue. In the late 19<sup>th</sup> century it was immigration, in the early 20<sup>th</sup>, it was labor unrest; in the 1960s, it was many issues - the Vietnam war, intergenerational conflict, and race; in the 1990s, race and globalization; in the 2000s, race and politics. The 2001 Mardi Gras incident was similar to the 1969 University District events but had more conflict between people in the crowd with alcohol, crowding, and racial tensions as contributing factors. Generally, social unrest has taken on similar patterns of activity, with different motivating factors or details. When Seattle is a secondary site to the main conflict, as was the case with the Ferguson protests in 2014, the unrest has been smaller than that at the primary location.

While it's unclear whether political violence is increasing, there is a perceived political polarization occurring in the United States that has resulted in incidents of violence. This perception of greater divisions between groups could increase the likelihood of civil disorder or riots in the future. Social media may be changing the risk of social unrest as well. "Cyber troops" are government or political party actors who strategically manipulate public opinion over social media. Twenty-eight countries have been identified as using real or fake social media profiles to manipulate foreign or domestic opinions to try and provoke conflict.<sup>349</sup> It is unclear whether these emerging political challenges will increase the amount of social unrest. Seattle's emergence as a leading cultural and economic center increases the chance that controversial events like WTO will occur here in the future.

## **7 1.4 Vulnerability**

Seattle is the social and economic hub of the Puget Sound region, making it highly exposed to social unrest. Social disruptions are often planned and target community vulnerabilities, places, or systems where pressure will be most strongly felt.

Most disorders in Seattle occur in locations that already have a lot of public assemblies (Downtown, Capitol Hill, and the University District), around large public institutions (the Federal Building, the University of Washington, Seattle Central Community College, or the King County Jail), and occasionally on major transportation routes like I-5.

Large-scale incidents require large numbers of police officers. Mutual aid is a critical component of a successful response. Bringing in officers from neighboring jurisdictions is a common occurrence, but it is also a vulnerability because it requires extra time and planning.

The greatest vulnerability is the transportation network, as it creates the greatest disruption to the general public. Seattle lacks significant reserve capacity in its road network. I-5 is by far the most heavily used corridor in the state. Because of its significance, demonstrations have targeted it. The only mitigating factor is that traffic is already frequently bad so many drivers are used to slowdowns.

Many businesses are vulnerable to civil disorder. Downtown is a frequent site of demonstrations. The WTO protests closed large parts of downtown at the start of the holiday season. Some businesses are direct targets of property crime. Others suffer indirectly due a lack of business. The holiday season is an especially vulnerable time for retail businesses.

On several occasions ethnic, racial, religious and political groups have been targets of mob violence. Most of the examples from Seattle's history are long in the past. The Jewish Federation shooting, although it was not mob violence, provides evidence that the sentiments that lead to mob violence are still with us. The current events around police violence and the African American community have increased racial tensions across the U.S. Additionally, hostility appears to be targeted towards political opponents and minority groups, suggesting a shift towards communal conflict. Groups or communities that are perceived to be connected with hot button topics are especially vulnerable.

Confidence in government and community reputation are two factors that are especially vulnerable to these types of events. They are a direct challenge to law enforcement and the political authorities. While the response to any disaster is very important, it is especially critical when people are directly challenging the authorities. Besides the loss of faith in authority, a community's reputation and confidence in itself are sensitive to conflict and disorder.

## **7 1.5 Consequences**

Because the pace of social change is so much faster than the changes in physical forces that cause floods or earthquakes, it is impossible to talk about "100-year civil disorders" the way we talk about "100-year floods." The risk of social unrest is not constant, like many natural hazards, but fluctuates with changing political, economic, and social climates.

Most incidents of unrest are confined to one neighborhood. They feature widespread minor property damage and injuries due the dispersal of crowds or fighting between members of the crowd. Usually they are limited to one or two nights of intense activity, although sometimes they are followed by a longer period of tension and low-level conflict.

### **Public Safety**

Public safety is always the number one concern during socially disruptive events. Any event that involves heated confrontation between groups can degenerate into violence, even if the original event was supposed to be non-violent. Nationally, many civil disorders have resulted in fatalities. Until 2001,

Seattle was very lucky and had not suffered loss of life through many demonstrations, protests and large confrontations. That changed in 2001 when Kris Kime was struck in the head and killed during the 2001 Mardi Gras riots.

We do not know how many injuries have occurred. Many injuries resulted from the WTO protests, but the total is not known. The examples given in the press include bruises, sprains, some broken bones, and the shooting that occurred at the University of Washington. Several police officers have been injured as well.

The growing conflict between political opponents raises concerns about future violence. The University of Washington Inauguration Day shooting, a shooting that occurred at a Republican congressional baseball team practice in 2017 that injured Representative Steve Scalise, and the killing of a counter protestor at the 2017 Charleston protest are some examples of recent political violence. According to the Anti-Defamation League, right-wing and left-wing extremists accounted for 74% of domestic extremist killings in 2017,<sup>350</sup> compared to 29% in 2016.<sup>351</sup> It is possible that extreme political groups will continue to use violence if there continues to be feelings of deep political divides in the U.S.

It is probable that there will continue to be future disorders directed mostly against property. The destruction of property has been selective and will likely be selective in the future. Most of it is aimed at government facilities and establishments that are perceived to be at the root of whatever controversy that sparked the disorder. So far, the damage has been limited to vandalism and, less commonly, arson.

One of the most insidious impacts of civil disorder is psychological. Following a civil disturbance, most people in a community feel violated regardless of their opinion on the issues at hand. The amount of live media coverage today magnifies these feelings. People watching events on their television sets or connected through real-time electronic communications feel personally connected to what they are witnessing. This mood of mass victimization is the most widespread effect of a civil disturbance. These effects can last for years.

There can also be indirect impacts of social unrest. Cities often worry about being stigmatized and losing investment and tourism as a result, especially when violence has been highly visible.<sup>352</sup> The Los Angeles Times reported that commercial real estate investment and tourism slowed down after the L.A. riots, in some areas for years. Seattle's disorders have never been scrutinized as much as those in other locations. If Seattle's disorders continue to be secondary events to larger disturbances elsewhere, it is unlikely the city will suffer any economic backlash.

While it is impossible to know what groups or issues could be involved in a future conflict, the worst type of incident Seattle could face would feature a large, violent crowd, an overwhelmed police force, and conflict between groups. It could be a large, more violent WTO-type protest or large-scale violence directed at a minority group.

These incidents would be spread over several neighborhoods and a longer duration of time. They might involve large groups of people organizing to harm other groups of people. Property damage would be more severe. Given that Seattle's biggest incidents have occurred when Seattle is the focal point for a large international or national issue, there would probably be people from outside the area coming to participate. The reputation of the community and government would probably be severely tarnished.





## 7.2 Attacks

- Attacks can be perpetrated by many different actors with different motivations, such as terrorists, violent extremists, and targeted violent offenders. All use violent tactics to harm people and/or property.
- The consequences of the attack depend on the tactics employed by the threat actor, such as active shooter(s) events, bombings, arson, murder, kidnapping and hostage-taking, maritime attack, and hijacking or skyjacking. Other chapters cover cyber-attacks, biological hazards, infrastructure failure, and hazardous materials incidents (including bombs).
- The 9/11 World Trade Center attacks in New York City critically changed the national perception of our vulnerability and response to terrorism in the United States. However, the use of large-scale tactics remains rare, and has not been successful in the United States since 9/11. Threat actors are more likely to use small-scale tactics in today's security-conscious environment to avoid disruption of their plan.
- The threat of terrorism and violent extremism has grown with the interconnectedness afforded by the internet. Terrorist organizations can reach anyone around the world to support or participate in attacks. The openness of the internet allows for the disconnected/autonomous sharing of ideas, tactics, and successes that motivate others to act.
- The number of active shooter incidents has increased over the last decade. Intense media coverage of active shooter events has created a heightened sense of risk despite these events being relatively rare.
- It remains nearly impossible to predict violent attacks, but security and intervention measures are continuing to evolve with the use of new tactics employed by threat actors.
- Seattle has experienced attacks perpetrated by domestic terrorists and other targeted violent offenders. However, Seattle has most commonly endured attacks targeted at property, active shooter events, and activity related to terrorism.
- Seattle has many public spaces and locations vulnerable to attacks, with the densely-populated downtown area being most vulnerable.

### 7.2.1 Context

Violent attacks can be perpetrated using a wide variety of means, such as bombs, chemicals, firearms, biological agents, and vehicles; all intend to do harm to people and/or property. Some of these means are covered in accompanying chapters. Cyber-attack is covered under cyber-attack and disruption, bombs are covered under hazardous materials, bioterrorism is covered under disease/pandemic influenza, and aircraft under transportation incidents. This chapter focuses on other intentional, violent attacks including terrorism, violent extremism, and targeted violence.

#### Terrorism

Despite nearly two decades of robust counterterrorism and homeland security efforts, forecasting potential terrorist targets and events continues to be a difficult, if not impossible, task at the national and local level. In comparison to other countries, the United States historically has had few terrorist acts committed within its borders. This was completely changed by the attacks by Al-Qaeda terrorists on New York City's World Trade Center and the Pentagon on September 11, 2001. In October-November of 2001, several incidents involving anthrax spores placed in the U.S. mail generated new and real fears about the use of chemical and biological agents. The creation of the federal Department of Homeland

Security and the city's participation in the Top Officials (TopOff) anti-terrorism exercises in May 2003 underlined Seattle's need to confront the threat of terrorism.

The U.S. Code of Federal Regulations defines terrorism as "the unlawful use of force or violence against persons or property to intimidate or coerce a government, the civilian population, or any segment thereof, in furtherance of political or social objective."<sup>353</sup>

Terrorism can be differentiated as international or domestic. International terrorism is "committed by a group or individual, who has some connection to a foreign power or whose activities transcend national boundaries."<sup>354</sup> An example is the September 11, 2001 attacks on the World Trade Center and the Pentagon. Domestic terrorism is "acts of terrorism perpetrated by individuals and/or groups inspired by or associated with primarily designated U.S.-based movements or organizations that espouse extremist ideologies of a political, religious, social, racial, or environmental nature."<sup>355</sup> An example is the 2001 UW Center for Urban Horticulture firebombing.

The other definition associated with terrorism is Homegrown Violent Extremism (HVE). HVE is "a person of any citizenship who has lived and/or operated primarily in the U.S. who advocates, is engaged in, or is preparing to engage in ideologically-motivated terrorist activities (including support to terrorism) in the furtherance of political or social objectives promoted by a foreign terrorist organization but is acting independently of direction by the foreign terrorist organization."<sup>356</sup> An example is the 2013 Boston Marathon bombing.

Some of the groups that have employed terror tactics in the United States include racist groups like the Ku Klux Klan (KKK) and the Aryan Nations, radical environmental groups, and groups with ties to foreign terrorist organizations like Al-Qaeda or Hamas. The Congressional Research Service identifies domestic terrorism ideologies as supporting animal rights, environmental rights, anarchism, white supremacy, anti-government ideals, black separatism, and beliefs about abortion.<sup>357</sup>

The FBI lists three priority factors contributing to the current threat of terrorism.<sup>358</sup> First, the internet allows domestic and international actors to have an accessible platform to radicalize and recruit individuals who are receptive to their extreme messaging. Second, social media sites have allowed terrorists to more easily access and communicate with people living in the U.S. Lastly, identifying HVEs, or sympathizers, who have radicalized and aspire to carry out an attack.

Terrorist organizations are now espousing the "leaderless resistance" model for fighting people that they view as their enemies. By advocating independent actions by individuals or small leaderless cells, this strategy seeks to prevent authorities from connecting illegal activities to the organization's command and control structure. Individuals acting on their own perpetrate acts of "resistance" that support the espoused philosophy of the larger group.

### **Domestic Violent Extremism (DVE)**

There are other acts of violence that are like terrorism events, but that do not have a connection to a foreign or domestic terrorist organization. Domestic Violent Extremism (DVE) is "encouraging, supporting, or committing a violent act to achieve political, ideological, religious, social, or economic goals."<sup>359</sup> An example is the 2015 Planned Parenthood arson in Eastern Washington.

Targeted violence differs from DVE in that it is not motivated by social or political ideologies, but rather uses a terror tactic as a means to satisfy personal grievances. The definition of targeted violence is "an intentional act committed by an individual or group for the purpose of (or resulting in) psychologically and/or physically affecting an organization or person associated with an organization, whereby the attacker selects a particular target prior to their violent attack."<sup>360</sup> This includes hate crimes, workplace violence, rampage shootings, non-terrorism suicide attacks, or cases of violence caused by mental instability. An example is the 2017 Las Vegas mass shooting.

## Active Shooter Incidents

Active shooter incidents are a violent tactic that can be used by terrorism actors, as well as violent extremists or those inciting targeted violence. The number of active shooter incidents have increased and have received greater media attention since the landmark Columbine High School Shooting on April 20, 1999 in Colorado. The definition of an active shooter incident is “an individual (or individuals) actively engaged in killing or attempting to kill people in a confined and populated area.”<sup>361</sup> The active aspect implies that both law enforcement and citizens have the potential to affect the outcome of the event based on their response. The deadliest active shooter incident in recent U.S. history occurred on October 1, 2017, when a gunman killed 58 people at a concert in Las Vegas.

There can be varying motives for an active shooter attack. Media accounts may claim psychopathology as the motive defining an active shooter, as in the student, fired employee or jilted lover who “snaps.” However, active shooters have demonstrated extensive planning, deliberation and cognitive functioning in the commission of the attacks. Not all active shooters impulsively and randomly open fire in a public place. Like context and environment, an active shooter incident is defined by the action, not by the attacker’s motive.

The FBI published a report on active shooter incidents in the U.S. between 2000 – 2013 indicating:<sup>362</sup>

- There were 160 incidents.
- The incidents resulted in 486 fatalities and 557 injuries.
- The trend appears to be that active shooter incidents are becoming more frequent, with an average of 6.4 incidents per year in the first 7 years and 16.4 incidents per year in the last 7 years.
- The incidents took place at commerce/business locations (46%), educational institutions (24%) government institutions (10%), open spaces (9%), residences (4%), places of worship (4%), and healthcare facilities (3%).
- Over half of the incidents ended before police arrived.

The FBI has published two subsequent reports since 2013, detailing active shooter incidents from 2014-2015<sup>363</sup> and from 2016-2017.<sup>364</sup> Since 2014:

- There were 90 incidents.
- The incidents resulted in 313 fatalities and 861 injuries.
- About 14% took place at educational institutions (13 out of 90).

Concern around school shootings in particular has grown in the U.S. due to heightened media coverage and the fact that these incidents violate the widely-held ideal that schools should be a safe place for children. However, while active shooter incidents may be trending upward generally, there is mixed evidence that school shootings are on the rise. One report that looked at school shootings between 1940 and 2018 revealed that the number of school shootings in the last 18 years has already surpassed the total number of school shootings that occurred in the 20<sup>th</sup> century.<sup>365</sup> Another report found that the number of students killed in school shootings has actually decreased since the 1990s.<sup>366</sup> Nevertheless, school districts, including Seattle Public Schools, are actively working on developing stricter security policies. Seattle Public Schools will continue to engage in lockdown drills and promote the “run, fight, hide” training (escape if you can, hide if you can’t, and fight if you must) for situations with a direct encounter with a shooter. All Seattle public schools have the ability to lock all doors and they plan to install cameras at front doors to view visitors before granting access.<sup>367</sup> Any school security measure must be balanced with the fact that schools are public institutions and it is impossible to completely secure such facilities.

## 7 2.2 History

Seattle has experienced activity related to terrorism, but never a large-scale terrorist incident. There have been many small-scale incidents that fit into the terrorist mold and could represent the first step in a pattern of escalation. They relate to both domestic and international terrorist groups. Foreign terrorist groups also use the U.S. for fundraising and recruiting. News stories that feature Americans going to Somalia and Pakistan make it seem as if this is a new phenomenon, but it dates back at least to the early 20<sup>th</sup> century with heavy IRA fundraising in the U.S.

Seattle has also experienced DVE and active shooter incidents. Seattle events are listed as well as events with ties to Seattle.

**1984. Seattle / Whidbey Island.** Members of The Order, a racist Aryan Nations offshoot, robbed an armored car at Northgate mall. They fled to Whidbey Island and were subsequently killed in a confrontation with police.

**1993. Tacoma / Seattle.** Two bombs exploded in Tacoma in July, causing some property damage. A group calling itself the American Front Skinheads was responsible. They are also suspected of bombing a gay bar on Capitol Hill.

**1996. Seattle.** Jason Sprinkle started a bomb scare when he parked his truck in the middle of Westlake Park, slashed the tires and walked away. His truck had a huge metal heart in its bed and the word “bomb” printed on its bumper. He intended the action as a protest to the reopening of Pine Street to traffic, but instead he caused a massive bomb scare. Nine blocks were evacuated during a busy weekday afternoon while the police investigated.

**1999. Port Angeles / Seattle.** Ahmed Ressam (AKA the “Millennium Bomber”) was caught smuggling bomb-making materials into the U.S. at Port Angeles. He was an Algerian man with links to Osama bin Laden. He had hotel reservations in Seattle close to the Seattle Center. The New Year’s celebration at the Center was cancelled as a precaution. It was later determined that the actual terrorist target was Los Angeles.

**2001. Seattle.** The Earth Liberation Front, a domestic terrorist group, claimed responsibility for firebombing attack against a University of Washington building. The fire caused \$6 million in damage and destroyed rare plants, books, and years of research.

**2002. Seattle.** James Ujama pleads guilty to aiding the Taliban government in Afghanistan.

**2006. Seattle.** Naveed Afzal Haq shot six people, one fatally, at the Jewish Federation of Greater Seattle. Haq was not connected with terrorist groups, but his motives were deemed political.

**2006. Seattle.** Kyle Huff killed seven in a mass shooting at a house party in Capitol Hill.

**2009. Seattle.** Christopher Monfort set fire to police vehicles and shot into a police car, killing an officer. His motivations were deemed political.

**2011. Seattle.** Khalid Abdul-Latif and Walli Mujahidh were arrested and charged with conspiracy after planning to attack the Military Entrance Processing Station (MEPS) in Seattle with machine guns and grenades. They had initially planned the attack for Joint Base Lewis-McChord.

**2012. Seattle.** Ian Stawicki shot and killed four people at Café Racer and killed a fifth person near downtown Seattle while attempting to escape.

**2014. Seattle.** Musab Masmari attempted to set fire to a gay nightclub in Capitol Hill while 750 people were attending a New Year’s Eve event.

**2014. Seattle.** Aaron Ybarra open fired at Seattle Pacific University, killing one student and injuring two students.

**2014. Seattle.** Ali Muhammad Brown killed four people, including a gay couple, as part of a personal vengeance against the U.S. government for its actions in the Middle East. In 2004, he was arrested and prosecuted for his role in a bank fraud scheme to finance fighters traveling abroad and had known links to a disrupted terror cell in Seattle in 1999.

**2017. Seattle.** Melvin Neifert was arrested and charged with receiving incendiary explosive device materials to make a bomb that was to be used in connection with 2016 May Day events.

Until early 2001, the Aryan Nations maintained a compound in Northern Idaho not far from Washington and stated that it would like to create a white homeland in the Pacific Northwest. The Southern Poverty Law Center recorded 26 active hate groups in Washington State in 2018, up from 15 in 2010.<sup>368</sup>

A review of the Seattle Police Department bomb disposal unit's incident log since 1995 shows two to six bomb hoaxes per year and a similar number of serious threats. Seven of them appear to be politically motivated. Victims included federal, county and city government facilities, women's clinics, and Jewish organizations.

### **7.2.3 Likelihood of Future Occurrences**

It is impossible to predict the probability of future attacks. Given the number of potential weapons that can be used in violent attacks, it is also difficult to predict what tactic is most likely. Terrorist groups are always seeking new means of attack. In the past, tactics have included bombs, aircraft as missiles, vehicles, stabbing, chemicals, and firearms. Most troubling is the potential for using weapons of mass destruction: nuclear, radiological, chemical, and biological weapons.

The Washington State Fusion Center has statistically analyzed over 1,000 events that have occurred in Washington and in the U.S. over the last decade to identify any trends. Their analysis reveals:<sup>369</sup>

- The *Most Likely Tactics* include: active shooter(s), vehicle attacks, stabbing/cutting, bombings, and cyberattacks.
- The *Least Likely Tactics* include: chemical, biological, radiological, and nuclear bombing, hijacking/skyjacking, and maritime attacks.
- The *Most Likely Targets* include: human targets (particularly military, government, and law enforcement personnel), government facilities, commercial facilities (including public assembly, retail, and entertainment and sports venues), and transportation.
- The *Least Likely Targets* include: amusement parks, bridges, museums, national monuments or icons, and vessels.

The pattern of terrorism, DVE's, and targeted violence in the Seattle area has been a series of smaller scale attacks punctuated by the large arson attack against the University of Washington. Washington state has encountered more than 40 attempted and successful attacks in the past decade, an average of four per year. Recent national trends (2010 – 2016) reveal that right-wing extremist along with religious-extremist attacks are on the rise.<sup>370</sup> The typical trend has become attacks that are carried out by individual perpetrators who are loosely linked to a larger organization or ideological movement.

The growth of internet forums and social media activity increases the likelihood of people becoming radicalized. Threat actors are now using encrypted communication applications to attempt to circumvent authorities from detecting and preventing a threat.<sup>371</sup> Between 2015 and 2017, Twitter removed almost one million accounts for promoting terrorism.<sup>372</sup>

It is probable that future attacks will be small-scale actions carried out by individuals or small independent groups. Most previous attacks, especially those carried out by radical environmentalists and animal rights groups, have targeted property, but the Jewish Federation and Café Racer Shootings

show that people can also be targeted. Based on the past events in Washington, DVE and targeted violence are the most common types of attacks in our region.<sup>373</sup> A large-scale terrorist attack, based on historic events, is assessed to be a low probability event, but cannot be ruled out. Both domestic and international attackers have proven they can deliver devastating attacks. Tall buildings in Seattle were among those on a potential target list leading up to the 9/11 attack. As long as the capability and motives exist, the risk of an attack is real. However, the threat of terrorism appears to be trending towards terrorist organizations promoting individuals to use simple tactics such as stabbing or vehicles to incite violence.<sup>374</sup> It is very difficult to detect individual actors; the expectation that all attacks can be prevented is unrealistic.

Active shooter incidents and other targeted violence are also impossible to predict but have occurred at common locations throughout the U.S. that also exist in Seattle, such as education institutions, places of worship, offices, shopping centers, event venues, parties, bars and restaurants, and family gatherings. Perpetrators of mass shootings are sometimes known to be a threat prior to the event but not all can be detected in order to take preventative actions.

## **7.2.4 Vulnerability**

Being a large, diverse, densely populated, and open city, Seattle has many potential targets for attack. Terrorists and HVEs have demonstrated their desire to attack highly populated or popular areas to gain the greatest media attention and incite the greatest amount of public fear.<sup>375</sup> Downtown and adjacent neighborhoods have the greatest population density, which becomes even denser with the influx of daily commuters. Seattle also has a dense network of critical infrastructure. Many of our transport linkages connect through downtown and would be impacted by a large attack. With limited reserve capacity in surface transportation, this presents a vulnerability. The I-5 corridor is vulnerable to a major attack as it is critical to the local and state economy and transporting both people and goods.

Preparation can reduce vulnerability. After 9/11, all levels of government began efforts to better mitigate the effects of and prepare for terrorist attacks. Citizens have become more aware as well. An attempted 2009 Christmas Day bombing of a Northwest Airlines flight was stopped by alert citizens.

It is very difficult to construct a vulnerability profile for terrorism, DVE, or active-shooter incidents because they can happen in any community and in many different locations. Specific targets of active shooter events have commonly been enclosed facilities where the shooter has an easy choice of victims; where people are crowded together, and escape is difficult. However, recent incidents such as the Las Vegas concert shooting or the vehicle ramming attack in Nice, France show that violent attacks also have occurred at outdoor venues where people are gathered. Seattle's public spaces, institutions, and buildings will never be fully secure, and communities must balance their vulnerability to attacks with their desired quality of life.

## **7.2.5 Consequences**

While Seattle has never experienced a major terrorist attack with massive loss of life, the fact remains that there are groups in existence seeking to do harm to people and property. These groups exist in the Seattle community and can have the means to cause enormous harm. On the other hand, such groups face a number of obstacles that limit their capabilities. Post-9/11 reforms have been put in place to make it harder to act. Citizens are more alert and more likely to report something suspicious. Institutions have tightened security.

The impact of a violent attack depends on the attacker's motivation or desired outcome, the tactic used, the location, weapon type, emergency response, and success of the attack.<sup>376</sup> A successful attack could result in bodily harm and/or loss of human life.



Violent attacks can have a lasting psychological component. The community at-large can become traumatized both because they identify with the victims and because attackers often target well-known, public places. The sense of public trauma is further heightened by the overwhelming media coverage at terrorist, DVE, and active shooter incidents. Through the media, people watching the event on television feel personally attacked. If the place attacked is an important landmark, a community may feel its own identity is under attack.

The physical damage done in an attack, along with the psychological impacts on the community, can have significant negative economic impacts. The 2015 terrorist attacks in Paris cost an estimated \$2 billion in damage to the city. Schools that have experienced an active shooter event often have to remodel or rebuild the school or specific site of the event to mitigate the psychological impact on students. An attack could deter people from going to public places, even if it occurred in a different city or country, which can hurt local businesses and institutions.

Most terrorist, violent extremist, and targeted violence incidents occur at a single site, but multi-site incidents (also known as Complex Coordinated Attacks (CCAs)) are possible and have been deployed by terrorists. While single/paired shooter scenarios can cause a significant amount of damage and casualties, the prospect of a CCA event is even worse and cannot be ruled out, as illustrated by the attack in Mumbai in 2008 or the Paris attacks in 2015. In Mumbai, heavily armed terrorists launched ten coordinated attacks. The attacks lasted almost 72 hours, resulted in 173 deaths and locked down much of downtown Mumbai. In Paris, terrorists used guns and suicide bombs at six different locations across the city, including a concert hall, restaurants, and outside of a sports stadium. The attacks lasted 3 hours and resulted in 130 deaths with hundreds more wounded. The U.S. has had number attacks by individuals or pairs. It is possible that Seattle could experience a CCA with similar or more severe casualties than past incidents.

## **7 2.6 Conclusions**

It is nearly impossible to predict terrorism, DVE, and active shooter events. The pace and severity of attacks appears to be increasing and tactics are continuing to evolve. Seattle has become a major economic and cultural center, increasing its symbolic value and therefore, its likelihood of being targeted. The downtown area is densely populated and thick with attractive targets. Much of Seattle's economic and social life is concentrated in this area and is vulnerable to disruption.



## 7.3 Cyber Attack and disruption

- Modern society is dependent on computer systems and the internet to maintain basic functions. They are increasingly used to run the infrastructure that supports dense, urban environments.
- Computer systems can face disruptions due to human error, intentional cyber-attacks, physical damage from secondary hazards, and electro-magnetic pulse (EMP).
- Cyber-attacks can take varying forms including amateur hacking, “hacktivism,” ransomware attacks, cyber espionage, or sophisticated state-sponsored attacks. These attacks have the potential to cause internet or utility outages, leak or delete sensitive data and information, compromise critical infrastructure or services, or cause physical destruction.
- The City of Seattle faces daily threats of cyber-attack and disruption but has yet to experience a large-scale attack. The biggest concern is an attack on critical infrastructure such as the transportation, water, or power system. Manual backups still exist for these systems but would degrade overall service capabilities if it were required that these systems revert back to non-computerized technology.
- Cyber-attacks are becoming more frequent and sophisticated around the world. Despite improvements in security, the U.S. remains behind in mitigating the threat of cyber-attacks. Many experts believe that a major cyber-attack that will cause widespread harm to a nation’s security and capacity to defend itself and its people by 2025.<sup>377</sup>
- Seattle faces a growing threat of cyber-attack as more of the city’s infrastructure and basic functions are connecting to the internet. Traditionally non-computerized items (e.g. watches, thermostats, printers) are being connected to the internet and providing new avenues for hackers.
- While a catastrophic cyber-attack or disruption has not yet occurred in our world, the consequences of such attack in Seattle could severely harm the public and degrade or halt basic city functions and services.

### 7.3.1 Context

Today, the internet touches almost every aspect of our lives. The internet is a “network of networks that consists of millions of private, public, academic, business, and government networks, of local to global scope, that are linked by a broad array of electronic, wireless, and optical networking technologies.” Seattle, like the rest of the world, has become incredibly dependent on the internet and digital systems to maintain basic city functions such as communications, public safety, critical utilities and services, transportation, business and commerce, and more. Cyber-attack and disruption is a hazardous threat arising from intentional or unintentional incidents that cause a breach in security, damage to digital devices and networks, or a network outage. Digital systems can be damaged by human errors, cyber-attacks, electro-magnetic pulse (natural or man-made), or physical damage as a secondary impact from another hazard. A prolonged outage to digital infrastructure could have catastrophic impacts for the community.

Many modern telecommunications systems rely on digital connections, including large components of Seattle’s private and public communications networks. The City of Seattle’s communications infrastructure is discussed in the Community Profile. While parts of the City’s telecommunications still use analogue connections, many systems are moving towards Voice Over Internet Protocol (VOIP), or communications delivered over Internet Protocol networks. Disruptions to telecommunications are discussed here because of their strong tie to digital systems.

## Causes

### Electromagnetic Pulse (EMP)

Electromagnetic pulse is an intense burst of electromagnetic energy resulting from natural (e.g., solar storms) or man-made (e.g., nuclear and pulse-power device) sources. Both types can destroy or damage unshielded electrical and electronic equipment. Solar storms can induce extreme currents in wires, disrupting power lines, and causing wide-spread blackouts to the communication cables that support the internet.<sup>378</sup> There is still much we do not understand about how effective nuclear weapons are as EMP weapons, especially lower yield bombs that terrorists or small states would probably use. The scale and scope of damage caused by an EMP could vary considerably based on the type of device, and the altitude and latitude of the detonation. A nuclear device detonated at high altitudes (30-400 km) could generate an EMP with a radius of effects from hundreds to thousands of kilometers.<sup>379</sup> While it could disable electrical and electronic systems in general, it would pose the highest risk to electric power systems and long-haul communications.<sup>380</sup>

### Physical Damage

Cyber disruptions can also happen as secondary effects from other kinds of hazards. Earthquakes, floods, and fires can destroy computer and network equipment. Most of the time the effects are limited due to the availability of back-up systems and the ability to route networks around problem sites. Nevertheless, if a significant network node goes down the effects could be wide-spread and possibly prolonged. Communications can be disrupted by physical damage to copper or fiber cables or radio equipment located on buildings. Damage to cables has accidentally occurred during construction or repaving projects, causing temporary internet and phone outages for thousands of customers.<sup>381</sup>

### Indirect Effect

Other hazards or human error can have effects on digital networks and information. Power outages can create cyber disruptions. In 2006 many parts of Seattle lost power for days. Many individuals and small businesses had trouble powering computers and mobile devices. As computers become our primary tools for gathering information and communicating, their loss can endanger public safety and welfare. If the power goes out and fuel delivery to generator sites is impaired, bigger sites like communications hubs and data centers could go down causing disruption if they are not adequately backed up. Additionally, much of the City's communications equipment sits under high-powered sprinklers. If there was a fire in one of these buildings or a sprinkler head was knocked off, it could damage equipment and cause disruptions to City communications.<sup>382</sup> Human error can also play a role in cyber-related incidents. An unintentional release of sensitive digital information presents a potential threat to personal and financial security.<sup>383</sup>

### Cyber Attack

The City of Seattle experiences attempted cyber-attacks on a daily basis but has avoided a major compromise so far. A cyber-attack is "an attempt to gain unauthorized access to system services, resources, or information, or an attempt to compromise system integrity."<sup>384</sup> Cyber-attacks are intentional and can be carried out by individuals, organizations, or government entities. They range from unsophisticated attempts made by amateur hackers using existing computer scripts, to sophisticated attempts sponsored or carried out by international governments. There are many types of attacks in between these extremes (see Table). "Hacktivists" are individuals or groups who use hacking to promote their social or political ideology. Additionally, threat agents may use ransomware, malicious software designed to restrict access to a system or data until a sum of money is paid.<sup>385</sup> Espionage and data theft could degrade public safety, expose the City to financial risk and the public to identity theft. In 2016,

Washington state victims of internet crimes lost over \$24 million, mostly through fraud schemes.<sup>386</sup> Tactics used in cyber-attacks are always changing and becoming more sophisticated.

The U.S. Department of National Intelligence’s 2018 Worldwide Threat Assessment states that multiple nation-state actors pose an increasing threat of cyber-attack to the United States in the next year.<sup>387</sup> The report goes on to say that while cyber-attack as a foreign policy tool has been mostly confined to low-level attacks, these state-sponsored actors have been testing more aggressive tactics in recent years. In 2016, the Department of Homeland Security stated that they were confident that Russia was responsible for hacking the Democratic National Committee (DNC) and leaking thousands of DNC emails during the presidential election.<sup>388</sup>

**Table 7-1. Common Cyber Attacks and their Impacts**

Type	Impact
<b>Malware</b> (ransomware, spyware, viruses, worms) Malicious software used by attackers to breach a network through a vulnerability, such as clicking a link, that automatically downloads the software to the computer. <sup>389</sup>	<ul style="list-style-type: none"> <li>• Blocks legitimate access to components of the network</li> <li>• Installs additional harmful software</li> <li>• Obtains information by transmitting data from the hard drive</li> <li>• Disrupts components and makes the system inoperable</li> </ul>
<b>Phishing</b> Fake communications (typically through email) appearing to be from a trustworthy source that allow hackers to obtain login information or install malware on a computer when someone interacts with their message. <sup>390</sup>	<ul style="list-style-type: none"> <li>• Obtains a person’s confidential information for financial gain</li> <li>• Obtains employee log-in credentials to attack a specific company</li> <li>• Installs malware onto a computer</li> </ul>
<b>Man-in-the-middle attack (MitM)</b> Attackers insert themselves into a two-party transaction. Common points of entry include unsecure public Wi-Fi networks and computers affected with malware. <sup>391</sup>	<ul style="list-style-type: none"> <li>• Interrupts a transaction to steal personal data</li> </ul>
<b>Denial-of-service attack (DoS)</b> Attackers flood a site host or network with digital traffic until the target site/service cannot respond or crashes completely. A distributed denial of service attack (DDoS) is when multiple machines are used to attack a single target. Botnets, which are networks of devices that are infected with malware, are often used in DDoS attacks. <sup>392</sup>	<ul style="list-style-type: none"> <li>• Legitimate users cannot access websites, online services, or devices</li> <li>• Slows down network performance</li> </ul>
<b>Structured Query Language (SQL) injection</b> Attackers use malicious code on vulnerable servers to force the server to reveal	<ul style="list-style-type: none"> <li>• Obtains contents of an entire database, including sensitive information</li> <li>• Allows attackers to modify and delete records in a database</li> </ul>

information. <sup>393</sup> Can be done by submitting malicious code into vulnerable search boxes on websites.	
<b>Zero-day exploit</b>  Attackers hack a network vulnerability before it is noticed and fixed by a patch or permanent solution. <sup>394</sup> Used by nation-state actors and sophisticated hackers.	<ul style="list-style-type: none"> <li>Allows attacker to plant malware into a system without the victim knowing</li> </ul>

## Computer Types and Threat Exposure

Computers permeate our society. Most of our financial and personal data is stored in networked computers systems along with our intellectual capital. They also control the machines that compose and maintain our infrastructure. Computers are increasingly being embedded into every day devices and products, such as phones, coffee makers, vehicles, home heating systems, and watches. Some of the networks connected to these computers are private, but most are connected to the Internet, the primary route for hackers.

### General Purpose Computers

These are computers that built to handle many tasks. They include personal computers, most servers, tablets, and smartphones. They house most of our financial, organizational, and personal data as well as our intellectual capital. They are built from standard commercial off-the-shelf components like the Windows, iOS, or Linux operating systems. Being general purpose gives these computers great flexibility but also creates many openings for hostile actors to exploit. Being built from commercial components reduces cost but also means that the same hostile actors can achieve economies of scale when writing malware.

### Specific Purpose Computers and the ‘Internet-of-Things’

Specific purpose computers are systems with dedicated functions. A computer that assists in the control of a car or controls industrial machinery is a specific purpose computer. Many of these computers are embedded systems that are integrated into a mechanical or electronic device. It is estimated there are over 10 billion embedded systems world-wide.<sup>395</sup> They have a wide range of applications from consumer electronics, industry, transportation, medicine, facility management to defense. Miniaturization is pushing their integration into smaller and smaller devices. Where previously these devices were often isolated from the internet, more are now being connected. Everyday items, from printers to baby monitors, make up a growing body of objects connected to the internet, a term has been coined “the internet of things” (IoT). While this merging of the physical and digital world promotes greater efficiency and convenience, it also poses greater security risks. The scale of the interconnectedness of these devices and their information sharing is being taken advantage of by hackers. They attempt to infect large segments of devices at a time to access data, cause an internet outage, or attack other computers.<sup>396</sup> In 2016, two apartment buildings in Finland had their heating system attacked, leaving them without heat or hot water for over a week.<sup>397</sup> These devices also pose a greater management challenge for IT security departments. IT departments do not always know when a personal device, which can be more vulnerable to hacking, is connected to sensitive servers or databases.<sup>398</sup> Some identified vulnerabilities of these devices include opportunities to hijack communication channels, to access sensitive information, to disrupt vital services, and to alter signals and data for malicious purposes.<sup>399</sup>



## Supervisory Control and Data Acquisition (SCADA) Systems

SCADA is a class of industrial control systems (SCADA can also be referred to as ICS – industrial control system, or OT - operational technology) that can include embedded systems, general purpose computers, and communications equipment. There are many specific types of SCADA systems. They provide real time data flow between sensors, workstations, and other networked devices in a system, as well as allow for monitoring and control.<sup>400</sup> They support both human-to-machine and machine-to-machine interfaces. They are used in power generation, transmission, and distribution; traffic control; water treatment, distribution, drainage, and waste; oil and gas transmission; dams; transportation monitoring; manufacturing; and communications. Many systems incorporate sensors to monitor infrastructure activity (e.g., water flow), a computer system that executes programs to control devices (e.g., a valve) based on sensed information, a database, and a human-machine interface to allow people to program them. Most are now linked on private networks to allow whole systems to be controlled. For example, all the devices in a water distribution system are linked to allow individual sites to behave appropriately given the status of the whole system.

SCADA systems are mainly vulnerable to attack because of issues in design, human interactions, and configuration.<sup>401</sup> Most systems are aging, and were not designed with cyber security in mind, but rather for processing efficiency. Older systems often relied on the “security by obscurity” principal - that the system would be secure as long as its design remained secret. Many now lack security features needed in our increasingly interconnected and sophisticated digital world. While many SCADA functions are machine-to-machine interactions, humans still interact with these systems on some level and can unintentionally provide access to an attack. Weak configuration of operational technology can make a SCADA system vulnerable, especially when it is connected to the internet for convenience. For this reason, many SCADA operators do not allow their networks to connect to the internet. Despite the prevalence of this policy there is pressure to connect and it is easy for staff to mistakenly do so. According to Shodan, a search engine that catalogues online devices, the U.S. has over 57,000 SCADA systems connected to the internet, more than any other country.<sup>402</sup>

Many SCADA operators are not patching systems (a patch is temporary software to address bugs and security vulnerabilities) for concern that it will cause system outages, that a bug in the patch itself will crash the system, that it is not needed because systems are not directly connected to the internet, and that the equipment is so old that there are no patches available. Some organizations simply lack the capacity and resources to keep up with patching.<sup>403</sup> Even if SCADA systems remain disconnected from the internet, past attacks have demonstrated that it is possible to deploy malicious code to computers that are not connected to the internet, as with the Stuxnet virus that was spread through infected flash drives. The U.S. Department of Homeland Security received 295 reports of SCADA-hacking incidents in fiscal year 2015, a 20% increase from the previous year.<sup>404</sup> Additionally, the U.S. Department of Defense has stated that while progress is being made towards more resilient infrastructure, these improvements are not on pace to achieve an acceptable level of risk within the next decade.<sup>405</sup>

### 7.3.2 History

2008 marked a cyber-attack turning point when the U.S. and Israel deployed a computer worm, Stuxnet, that destroyed Iranian centrifuges that are a key component of Iran’s nuclear program. The event was the first documented of offensive cyber warfare that destroyed physical objects. It demonstrated that cyber-attacks can cripple critical, well defended infrastructure.

The following timeline comprises state, national, and international events that show the consequences of cyber-attack and disruptions.

**2003.** A power company representative unintentionally executed malware resulting in power outages for the Northeastern U.S. and part of Canada. The malware disrupted power grids across multiple states.

**2008.** Hackers disabled alarms, communications, and caused a crude oil refinery on the Turkish pipeline to explode, destroying operations and facilities.

**2009 (Local).** An electrical fire took Fisher Plaza data centers offline, bringing down several eCommerce sites including a credit card validation service. It was the third time Fisher had experienced downtime.

**2014 (Local).** Most of Washington State experienced a 6-hour 9-1-1 phone system outage due to human error. Around 4,500 calls went unanswered.

**2015.** The Deputy National Security Advisor confirmed that Russian hackers compromised a non-classified system over a several month-period to obtain information about the President's activities.

**2015.** As many as 22.1 million government employees, contractors, and other personnel records stored within the U.S. Office of Personal Management were compromised by a cyber-attack traced back to the Chinese government.

**2017.** A ransomware virus called WannaCry effected over 230,000 computers throughout the globe.<sup>406</sup> It did not require any user interaction to spread, but rather took advantage of vulnerable public-facing Server Message Block (SMB) ports. Boeing was attacked with the virus, but the vulnerability was small and there was no interruption to business.<sup>407</sup> It affected the UK's National Health Service, causing system outages at hospitals and forcing ambulances to be rerouted. It was the first time the UK convened its emergency committee due to a cyber-attack.<sup>408</sup>

**2018.** The City of Atlanta, Georgia and the Colorado Department of Transportation were hit with ransomware called SamSam. In Atlanta, attackers requested \$51,000 in cryptocurrency to restore the city's data. It also caused a multi-week outage to Atlanta's website, hindering utility payments, business licensing, ticket processing, and court functions.<sup>409</sup> The attack also erased Atlanta Police Department's dashcam archives.<sup>410</sup> Colorado faced multiple attacks in the span of weeks, with the ransomware mainly affecting employee computers and not critical transportation systems.

**2018.** A borough in Anchorage, Alaska and the City of Valdez, Alaska suffered a ransomware attack that remained dormant in their computer systems for weeks before doing any damage.<sup>411</sup> Over 650 computers were compromised, and phone and email systems were inoperable. The borough manager in Anchorage declared the attack as an emergency.

### **7.3.3 Likelihood of Future Occurrences**

The World Economic Forum predicts that the number of devices connected to the internet will grow from 8.4 billion in 2017 to 20.4 billion in 2020, greatly increasing the risk of cyber-attack.<sup>412</sup> Many experts believe that a cyber-attack on critical infrastructure will happen in the future. In 2014, the Pew Research Center asked 1,642 experts in internet evolution and technology if they think by 2025, a major cyber-attack will have caused widespread harm to a nation's security and capacity to defend itself and its people (widespread harm being defined as significant loss of life or property losses, damage, or theft at the level of tens of billions of dollars).<sup>413</sup> Sixty-one percent of experts said yes, citing the increase in sophisticated tactics in recent years, the history of successful attacks on infrastructure (Stuxnet), and the fact that security was not the main priority in designing the internet. The major uncertainty that remains is how widespread an attack would be. Smaller attacks have already occurred that display the potential for major harm. San Francisco and Sacramento have both faced ransomware viruses on their metro systems. Additionally, an undisclosed municipal water system was hacked and had its levels of treatment chemicals changed, affecting 2.5 million customers.<sup>414</sup>

The City of Seattle is constantly facing attempted cyber-attacks on its digital systems. Most are minor and unsophisticated, but it is only a matter of time before a more sophisticated attempt is successful. The type of attack and extent of the damage is very difficult to predict. The recent ransomware attacks on Atlanta, Colorado, and Anchorage could signal that state and municipal governments are increasingly

becoming a target for ransomware. Many government agencies face limited cyber-security budgets and capacity, which could make them an attractive target to the attacker. However, limited fiscal resources also make them less attractive in terms of potential monetary gain.

Seattle is a world leader in the technology and software industries. The city will continue to be on the cutting edge of implementing new technologies and devices that are connected to the internet. If cyber-security does not improve at the same pace, Seattle will face an increasing likelihood of cyber-attack.

### **7.3.4 Vulnerability**

The density and interconnectedness of Seattle and its service network make it especially vulnerable to cyber-attack and disruption. Seattle routinely ranks high on Government Technology's Digital Cities Survey, which recognizes cities using technology to improve citizen services. In 2017, Seattle ranked 6<sup>th</sup> for cities with populations over 500,000, slightly down from 4<sup>th</sup> in 2016.<sup>415</sup> Critical facilities such as hospitals, fire stations, emergency medical services (EMS), and 9-1-1 centers are all increasingly relying on new technologies, which also makes them vulnerable to attack. If their functions were to be disrupted or compromised by hackers, it could threaten the safety and survival of people. Most of these emergency service facilities have back-up generators or battery backups that would allow them to operate during an outage but remain vulnerable to other types of attacks that would limit or interfere with their service capabilities.

Seattle relies on SCADA systems for many of its basic functions including maintaining and monitoring the water and power systems. In 2015, Seattle City Light (SCL) began implementing a new Energy Management System, that modernizes their SCADA system from the 1980s. The new system allows SCL to utilize more "smart grid technologies," such as wireless meters that automatically track wattage and transmit data.<sup>416</sup> Seattle Public Utilities (SPU) also underwent a major upgrade to their SCADA system in 2015.<sup>417</sup> Seattle's water transmission and distribution systems are mostly gravity feed which means that pumps are less important than in many other regions. Less reliance on pumps reduces the water system's vulnerability to cyber disruption. However, if control of the water or sewer system is compromised there could still be public health and environmental consequences. Despite these upgrades, the SCADA systems that the city relies on are still vulnerable to an attack that could disrupt essential water, sewer, power, and heating services.

The City of Seattle began working on "smart city" initiatives in 2015. The initiatives focus on implementing new digital technology to improve city functions, such as traffic lights that can adapt to traffic levels and sensors around the city to provide real time environment and activity data.<sup>418</sup> While these initiatives will bring important information and convenience to the city, they also make Seattle more vulnerable. Increasing the amount of infrastructure that relies on computing technology and the ability to connect to the internet also increases the number of avenues hackers have for an attack.

The "smart" city vulnerability is particularly salient for transportation. As more and more of our transportation systems become "smart" we incur a greater the risk that cyber-attacks and malfunctions will cause disruptions to our transportation system or worse: harmful or fatal accidents. All modes of transport: roads, rail, air, and marine all have major computerized components. These computers run signals, communications, controls and vehicle subsystems. An attack that gains control of these systems could cause major vehicle collisions. One study found that it is possible to hack semi-trucks to take over acceleration functions and remove braking capabilities when the vehicle is at speeds under 30 mph.<sup>419</sup> The same study concludes that these types of attacks are not just limited to the software on semi-trucks, but most other vehicles as well.

As communication networks move towards using VOIP services, they are becoming vulnerable to attack and other digital disruptions. Many critical services, like EMS and utilities have their own radio networks

or satellite phone capabilities to ensure they can still communicate in the event of an attack or natural disaster that disables their VOIP systems.

The Seattle region is home to many large companies that support the local economy such as Amazon, Boeing, and Microsoft, among others. A significant attack on one of these companies that either compromises consumer information or halts business operations would have negative economic implications for regional business. Seattle is also very trade-dependent. The large amount of products and money that move through the port makes the city's trade and business operations a target for cyber-attack.<sup>420</sup>

### **7.3.5 Consequences**

Washington State estimates that a successful breach of critical networks could "severely diminish or destroy basic public utilities, fuel, health care systems, EMS, communications, and governance to at least 50% of the state's population."<sup>421</sup> An extended, local network outage would similarly halt most city functions. It would also harm the local economy, as many businesses would not be able to function. A City data breach that compromises consumer information could cause damage to the City's reputation and trust of its citizens.

The consequences of an attack on city infrastructure would depend on the systems affected and the problem's severity. The worst failures would affect SCADA systems that control critical transportation, power, water, health care, public safety, sewer, finance, and communications systems. While manual workarounds can be implemented, they greatly degrade overall system performance. In most cases the damage from computer failure will be temporary, but in some cases, it could cause physical damage. For a cyber-attack on infrastructure to be most effective, most experts conclude that physical attacks and sabotage would also be involved.

The loss of control over the water SCADA system could force Seattle to rely on manual backup systems that would reduce overall efficiency, and potentially cause a temporary water shortage. Experiments have demonstrated that it is possible to destroy electrical generators by sending them instructions that cause them to overheat.<sup>422</sup> Attacks or accidents could also damage turbines in power generation facilities. Losing generation facilities would reduce Seattle's power capacity and could lead to brownouts especially if an attack on the power system occurred during peak demand (during the winter in the Pacific Northwest).

Physical attacks on infrastructure could also lead to cyber disruptions. The City of Seattle has built two data centers outside of the city, one in Spokane and one in Tukwila, to provide for continuity of operations in the event that local infrastructure is damaged. Terrorist groups and individuals who seek to harm the U.S. and Seattle may turn to cyber-attacks. There are cases of state-sponsored cyber-attacks that have damaged and destroyed critical infrastructure.<sup>423</sup> It is also possible that a conventional attack could be aided by cyber-attacks that disrupt a target's ability to respond. It is even more likely that terrorists would use cyber-espionage to collect intelligence on a target before a physical attack in order to make the attack more successful.

Some of Seattle's natural hazards such as flooding, or earthquakes can cause physical damage that triggers cyber disruption. The cyber disruption could feed back into the consequences of the primary hazard. Having good business continuity plans (BCP) or continuity of operations plans (COOPS) in place will greatly reduce the risk of cyber disruption following natural disasters.

### **7.3.6 Conclusions**

Institutions in the Seattle area face hacking attempts every day. The vast majority of these are not successful, but it only takes one success to cause a major compromise. Moreover, due to the interconnected nature of modern society, Seattle's public and its institutions are dependent on

organizations scattered world-wide. A compromise anywhere in the world could have major consequences for Seattle. Even though computer compromises and data theft pose a significant threat, the world has not yet seen a major disaster precipitated by cyber disruption whether accidental or intentional. Our perception of the severity of cyber-attacks seems to be changing. What once would have been considered a major attack, such as the 2016 WannaCry ransomware virus, is now becoming more commonplace in our computer-dependent world.<sup>424</sup> It is likely we will see an increasing number of cyber disruption incidents and attacks, but the severity of the direct or indirect effects on Seattle are still unclear.

## 8. INFRASTRUCTURE

## 8.1 Transportation Incidents

- This section covers all major transportation modes: aviation, surface (road, rail, and pipeline) and marine. It covers incidents where a vehicle accident is the primary impact.
- Some of Seattle’s deadliest disasters were transportation accidents, but most occurred over 50 years ago when transportation systems were much less reliable. They are:
  - The sinking of the Dix off of Alki in 1906 that killed 42 people.
  - The 1943 crash of a B-29 bomber that killed 32 people.
  - Another bomber crash in 1951 that killed 11 people.
- While there have been huge gains in the safety and reliability of transportation systems, large, deadly accidents still happen today. In 2014, a “Ride the Ducks” vehicle collided with a charter bus full of international students on the Aurora Bridge. Five people died and many more were injured.
- Seattle’s transportation systems have become busier, more congested, more tightly interdependent, and lacking in substantial reserve capacity. Disruptions in one part of the system can produce large consequences far from the site of the disruption and can spread from one transport mode to another.
- **Aviation:** The direct hazard for Seattle is a large aircraft crashing into a crowded part of the city. The odds of such a crash are low. Between 2012 and 2016, there were only 59 fatal aircraft incidents worldwide involving a loss of control inflight or a crash into terrain. In the context of millions of annual flights, aircraft incidents are rare.<sup>425</sup> Crashes are most likely to occur near flight corridors within two miles of an airport. Approaches and departures for SeaTac and Boeing Field, the country’s busiest general aviation airport, take aircraft over the city.
- **Marine:** Seattle has a large port and ferry system. While incidents in the waters surrounding Seattle could be severe, incidents that impact Seattle directly are the greatest hazard. There have been no deadly marine incidents in the past fifty years, but there have been a number of large ship fires and collisions.
- **Rail:** Seattle has an active rail system that has traditionally transported freight but passenger service has been growing in recent years. The main hazards are derailments, collisions, and tunnel incidents. Seattle has several miles of tracks that are exposed to landslides as well. Each week about 1,100 tank cars carrying highly flammable oil pass through the city. One of these trains derailed in 2014, but no oil was spilled.
- **Motor vehicles:** Motor vehicle collisions account for roughly 95% of all transportation related deaths and even more injuries. While this number represents mostly single or two-vehicle accidents, Seattle has had a few large -scale motor vehicle incidents.
- **Pipeline:** A spur of the Olympic/BP pipeline runs from Harbor Island to Renton, mostly along the City Light power transmission right-of-way. This pipeline carries mostly gasoline. Part of the same pipeline exploded in Bellingham killing three children.
- Transportation incidents can cause structural failure. Bridges are especially vulnerable. Barges and ships have collided with several Seattle bridges. The First Avenue South Bridge had to be rebuilt after a strike. Fires can also damage bridges. In 1975, the Alaskan Way Viaduct was damaged in a fuel tanker explosion.



## 8 1.1 Context

Transportation systems have been the source of some of the modern era’s biggest disasters. The September 11<sup>th</sup> attacks exploited the air transportation system to inflict catastrophic damage on New York and the Washington D.C. area. Air, marine, and surface systems have all produced high casualty count disasters.

Much of the vulnerability to transportation accidents is built into a community’s transportation infrastructure. For complete details on Seattle’s infrastructure network, see the Community Profile. Some transportation accidents could fall under multiple categories. For example, the explosion of a fuel tanker on a bridge could fall under this section, hazardous materials, fires, or infrastructure failure.

An accident doesn’t have to happen in Seattle for it to have a major impact on the community. Anytime a vessel originating here is involved in an accident, many Seattle residents are impacted. This was the case in 2000, when Alaska Airlines flight 261 crashed into the Pacific Ocean, killing all 88 passengers and crew. Forty-seven of them were from the Puget Sound area.<sup>426</sup> Figure [Transportation Fatalities by Mode] shows national transportation fatalities by mode for 2016.

### Air Transport

About 95% of all accidents involve general aviation (private aircraft) and only 5% involve commuter, charter, and scheduled airlines. Almost half (48%) of fatal commercial aircraft accidents occur during the final approach and landing phase of flight. The second most common phase is take off and initial climb (13% of fatal accidents).<sup>427</sup> The FAA acknowledges this danger and requires airports to create special emergency plans that detail how they would respond to a crash within five miles from their boundaries. Nationally, despite the hundreds of thousands of planes that fly over urban areas, the number of crashes that have killed or injured non-passengers is very small.

### Marine Transport

Maritime accidents include many different mishaps, such as grounding, capsizing, sinking, collision, fire, explosion and chemical spill. Worldwide, some of the worst maritime accidents have involved the sinking of passenger ferries. Many maritime accidents have a hazardous materials linkage. Great environmental damage has occurred as a result of oil spills.

Seattle is surrounded and bisected by water. Much of it is a working waterfront. Seattle is a major maritime center. The Port of Seattle is one of the largest in the U.S. It handles container, bulk cargo (grain), and cruise ship operations. Additionally, Seattle has three heavily used passenger ferry routes, the Ballard Locks that connect Lake Washington to Puget Sound, and a large commercial fishing fleet.

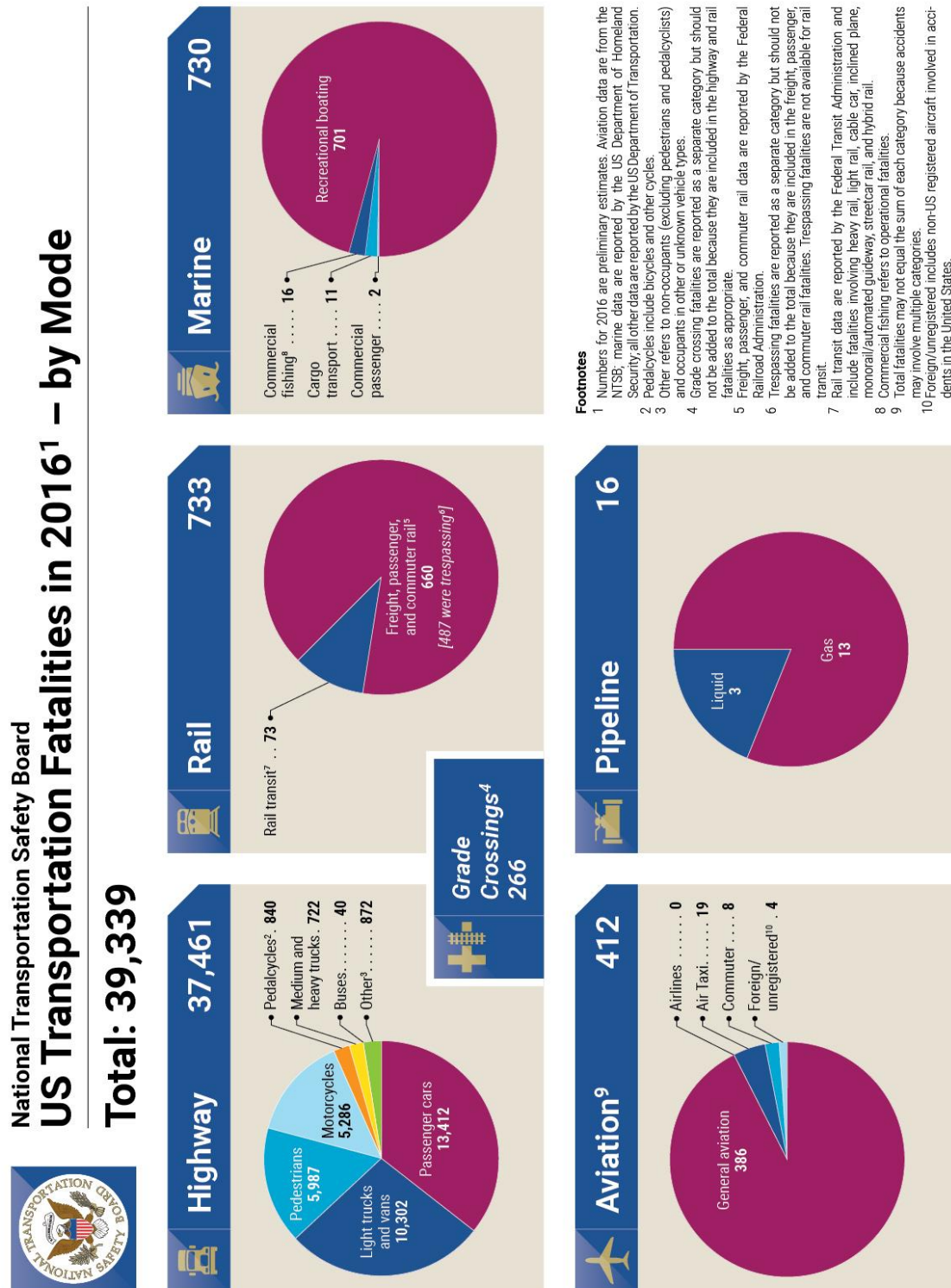
### Surface Transport

Accidents on surface streets, highways, and railways can cause multiple fatalities, large hazardous materials releases, and damage to infrastructure. Nationally, large accidents have involved passenger buses, fuel tankers, and train derailments. According to the Federal Highway Administration, the majority of weather-related car accidents happen on wet pavement or in rain.<sup>428</sup>

## 8 1.2 History

The time line of historic events focuses on accidents involving passenger vehicles. Seattle’s most deadly disasters, aside from the 1919 influenza pandemic, were transportation accidents. The first was the 1906 sinking of a passenger ship off Alki that killed 42 people and the second was the crash of a B-29 bomber during World War II that killed 32 people. While safety standards have vastly improved since both of these events, they illustrate the potential for high loss of life for transportation hazards.

Figure 8-1. Transportation Fatalities by Mode



Source: Data & Stats. National Transportation Safety Board. Retrieved August 16, 2018, from [https://www.nts.gov/investigations/data/Pages/Data\\_Stats.aspx](https://www.nts.gov/investigations/data/Pages/Data_Stats.aspx)

## Aviation Overview

Going back to 1984, the National Transportation Safety Board has recorded 26 incidents regarding commercial aircraft in Seattle, none of them fatal. There was a total of 20 minor injuries that resulted from the incidents.<sup>429</sup> None of the accident reports indicated that aircraft were in danger of striking populated areas. While the Seattle area has not experienced a major crash in decades, there was a span of eight years mid-century when several deadly crashes occurred inside the city limits.

## Maritime Overview

As indicated in the Community Profile, Seattle has an especially large maritime passenger sector. The Washington State Ferry system has never had a major accident. Despite this record, there have been 11 serious incidents since 1980. Five were minor collisions or near misses with other vessels. Four were dock ramming and two were groundings.

Seattle has become a major cruise ship terminal. There has never been a major accident involving them in Puget Sound. There have been some cases of Norwalk virus on Seattle based cruise ships.

Seattle is home to a major fishing fleet working on the Bering Sea. Fishing is a dangerous business and there have been a number of ships that have sunk, most recently the sinking of the F/V Destination in February 2017, taking with it all six of its crewmembers.<sup>430</sup>

## Rail Overview

Seattle is a rail terminus for the BNSF and Union Pacific Railways. Historically, use of the rail network for passenger service has been limited, but has increased with the introduction of the Amtrak Cascades route between Eugene, Oregon and Vancouver, British Columbia, and the local Sounder commuter train. Amtrak Cascades has had roughly 800,000 annual passengers for the past 5 years and has a station in Seattle. While no major incident has happened within Seattle city limits, a new, faster Amtrak train traveling from Seattle to Portland derailed south of Tacoma on December 18, 2017 - its inaugural trip. Three passengers were killed and over 80 were injured.<sup>431</sup> Sounder Commuter rail, which runs between Everett and Tacoma, began in 2003. The Sounder has never had a major accident. As noted in the chapter on landslides, the tracks north of Seattle have been closed due to landslides. In 1997, a freight train was knocked into Puget Sound by a landslide.

## Motor Vehicle Overview

Roadway accidents are a serious cumulative hazard in the Seattle area, but few individual incidents rise to the level of city-wide emergency, however tragic they are for the people involved. Nationally, several recent bus accidents have raised awareness that motor vehicle accidents can cause mass casualties. Several bus related incidents have occurred in Seattle. Accidents involving 10s or even 100s of vehicles have occurred in multiple locations, including Western Washington.

## Major Accidents

**Nov. 18, 1906. Maritime.** The passenger ferry Dix sinks two miles off Alki. 42 fatalities.<sup>432</sup>

**Feb. 18, 1943. Aviation.** A B-29 Superfortress came down short of Boeing Field and struck the Frye slaughterhouse at 2101 Airport Way South. Eleven crew members, two firefighters and nineteen people on the ground were killed.<sup>433</sup> The crash caused a large fire, cut major cross-town power lines and released enough ammonia from the slaughterhouse to kill one fireman.

**Jul. 19, 1949. Aviation.** A C-46 cargo plane crashed shortly after take-off, cutting power lines over wide areas and striking two buildings in Georgetown. After coming to rest, it caught fire and exploded, setting six houses on fire. Flying debris damaged three other houses. A total of eleven homes were damaged or destroyed. Five people on the ground and two passengers were killed. Thirty-three people were injured.

**Aug. 13, 1951. Aviation.** A B-50 bomber crashed into Sick’s Brewing and Malting at 3100 Airport Way and then bounced into the Lester Apartments, destroying one third of the building. The crash killed six people in the plane and five on the ground.<sup>434</sup> The location was about one mile north of King County International Airport, just north of where the West Seattle Freeway and I-5 join. The site is now occupied by I-5.

**August, 1996. Motor Vehicle.** A 42-vehicle accident that caused one fatality and 23 injuries closed I-5 southbound for four hours<sup>435</sup>.

**Nov. 27, 1998. Motor Vehicle.** A passenger on a Metro bus shot and killed the driver as the bus was heading south on the Aurora Bridge. The bus crashed off the bridge, struck an apartment building and then the ground 50 feet below. The shooter, driver, and one passenger died, plus 32 passengers were injured.

**Jan. 31, 2000. Aviation.** Alaska Airlines Flight 261 crashes into the Pacific in route from Puerto Vallarta, Mexico to Seattle. All 83 passengers and five crewmembers died. Although the crash did not occur in Seattle, it had a big impact because Alaska Airlines is headquartered near Seattle and many of the passengers were from Seattle.

**September 24, 2015. Motor Vehicle.** A “Ride the Ducks” vehicle, from the popular Seattle tour company, veered into oncoming traffic on the Aurora Bridge, crashing into a charter bus full of international students. Five people died, and dozens were injured. The bridge was closed to traffic for roughly 12 hours.

Other notable incidents:

- October 18, 1984, Air Force Two and a private aircraft nearly collided eight miles from Boeing Field. The pilot of Air Force Two had to take evasive action to avoid a collision.
- December 19, 1984, only two months after the Air Force Two incident, a DeHavilland DHC-3 helicopter crash-landed on an athletic field and slid into a nearby street.
- October 10, 2001. A mechanical problem forced an emergency landing of Alaska Airlines flight 497. The accident occurred in California, but the plane was bound for Seattle.
- March 14, 2003. A commercial airliner landed on a SeaTac taxiway.
- May 8, 2003. A Seattle-based tour boat sinks in British Columbia. There were no casualties.
- Dec. 19, 2008. After a snowfall, a chartered bus slipped down an icy Capitol Hill street, plowed through a barrier, and teetered over I-5 near downtown Seattle. This was a near tragedy. No casualties resulted.

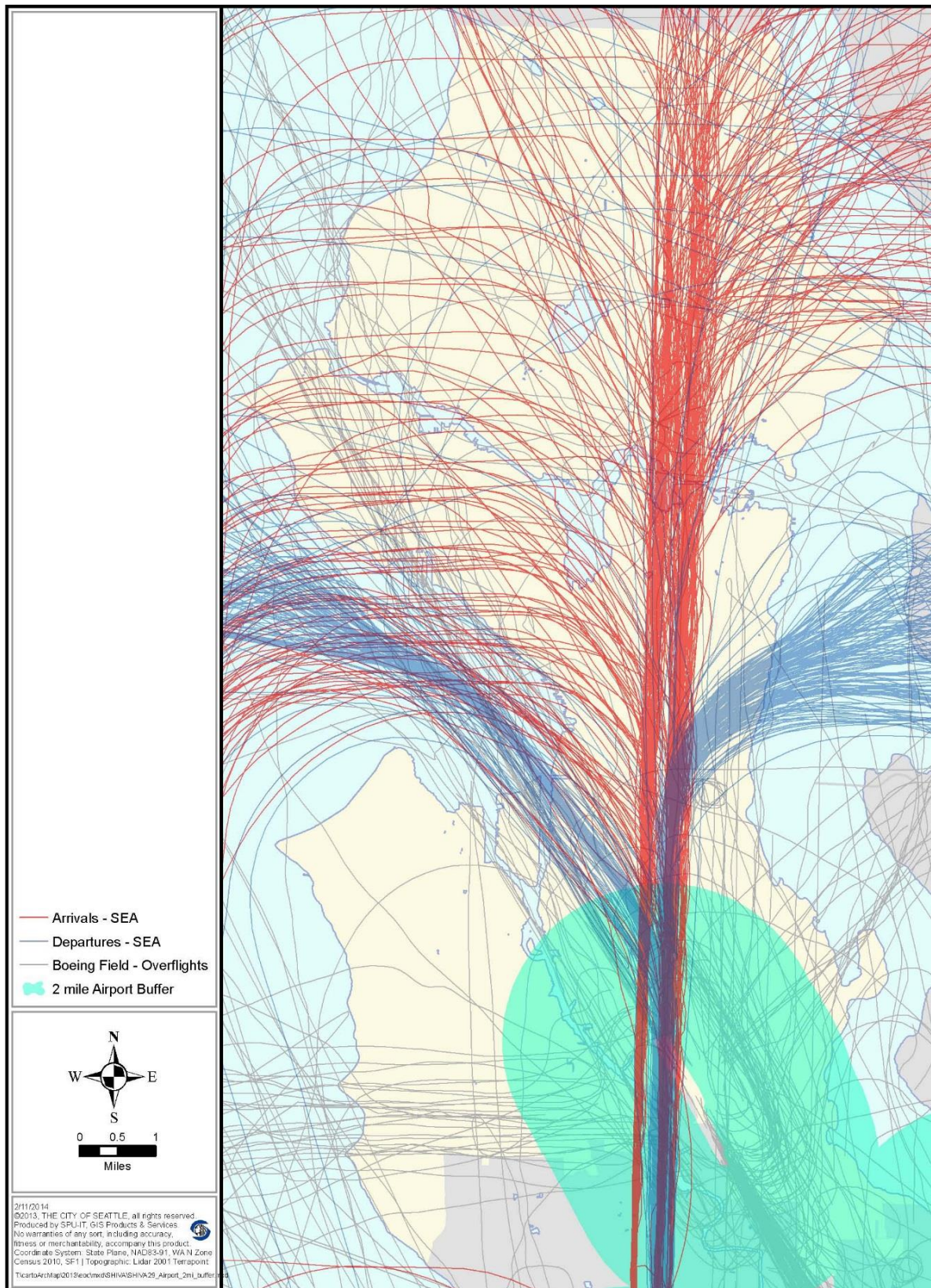
There have been several accidents in other parts of the county involving large commercial aircraft coming in populated areas, but such accidents are rare. Aviation safety systems have vastly improved since mid-century. In Seattle’s case, the changes probably have a lot to do with shifting major commercial operations from King County International Airport to SeaTac and aircraft production to other locations outside the city.

### **8.1.3 Likelihood of Future Occurrence**

Trends in transportation safety have long been pulling in two directions. On one hand, the rate and severity of accidents has been decreasing dramatically. On the other hand, the use of all transportation modes has been increasing. So far, the pull of the safety improvements that decrease the accident rate



Figure 8-2. Flight Corridor and Areas Within Two Miles of Airports



has been dominant. At some point, the saturation of transportation networks or other factors may reverse this trend, but there is no clear indication that that Seattle is reaching this point. Seattle will probably experience another major accident, but this probability seems to be holding steady or decreasing.

### **8 1.4 Vulnerability**

Transportation accidents present two sets of vulnerability. The first is to the vessels and vehicles themselves and the people in them. The second is to everything and everyone around them. People in transit are in an inherently vulnerable position. They are densely packed into vehicles or vessels and then moved at high speed across environments in which they could not often survive without help (e.g. the ocean). When things go wrong, many passengers can get hurt.

As large vehicles and vessels move about, often containing hazardous materials, they are liable to affect people and the built environment around them. Areas near aircraft flight paths, highways, and the shoreline are more likely to be affected by an accident than other areas. Urban areas like Seattle are inherently vulnerable due to high population density and the cost and complexity of the built environment through which transportation systems run. Seattle is continuing to invest in its transportation network to accommodate new residents. The Link Light Rail service will span from Tacoma to Everett by 2040.<sup>436</sup> While safety will be a top priority in its construction, a denser transit network presents more opportunities for incidents.

#### **Areas More Prone to Aviation Accidents**

The areas that are most likely to be hit are the ones under or close to the flight paths, especially if they are within five-miles of an airport. Figure 8-2 -Flight Corridors and Areas Within Two Miles of Airports shows the area within five miles of both airports. Only Seattle’s most southern sections—White Center, South Park, Dunlop, and Rainier Beach—are within five miles of SeaTac, but many planes take flight paths over the southern half of the city. King County International Airport (Boeing Field) is in the city itself. Planes often approach for landing from the north, over the Duwamish Valley and Georgetown, flying quite low as they near the landing area. FAA regulations state that except when necessary for takeoff and landing, aircraft must fly at least 1,000 feet above the highest obstacle over urban areas.<sup>437</sup>

Seattle is also indirectly vulnerable to accidents that disrupt transportation networks. Most of these slowdowns or stoppages are temporary, but they can be an inconvenience to travelers and an economic burden.

### **8 1.5 Consequences**

Transportation accidents are a classic case of a hazard with a vast number of low-impact events and a minute number of high-impact events. Every year roughly 35,000 – 45,000 people die in transportation accidents in the United States.<sup>438</sup> The clear majority of these are the result of motor vehicle accidents. Most motor vehicle fatalities occur in passenger vehicles and small trucks, and on freeways and principal arterials.<sup>439</sup> While individual accidents are not large incidents, they have a large cumulative impact. The long-term trend has been down. Many programs and regulations have been established to improve safety and the means to handle the most frequent incidents fall well within the scope of daily operations of local government.

Occasionally, larger incidents occur that have a bigger, more lasting impact on the community and challenge the response capabilities of local government. Outlined below are characteristics of what we can expect from the “most likely” large incident and what we can expect from the “maximum credible” scenario.

With so many smaller transportation incidents, the most likely scenario is one that just exceeds the normal response capabilities of local government. This is in contrast to incidents like earthquakes in which individual occurrences are more likely to be high impact. The 1998 Metro bus incident was a good example of an incident that nearly exceeded normal response capability. It drew large amounts of resources from the police and fire departments. Special lighting was needed to search for survivors after nightfall and social services, such as lodging, were needed for the families of the victims.

The most likely scenario would present a slightly higher level of impact. Despite the different transportation modes that might be involved, there are some similarities in impacts.

1. There is high likelihood of fatalities. This is in contrast to other hazards in which the “most likely” scenario involves a lot more property damage.
2. The geographic scope would be limited to the immediate scene of the incident with a strong possibility that transportation routes through the impacted area would be blocked. Infrastructure outages are also possible.
3. The duration of the incident would be limited. It would be likely that rescue and recovery operations could be completed in less than a few days. Transportation and infrastructure outages would also be restored in a similar amount of time.
4. Neighboring buildings and the people in them will probably be affected to some degree, but the majority of the casualties will be among those on the vehicle or vessel.
5. Maritime accidents tend to involve more property damage, especially when ships collide with bridges and other infrastructure.
6. There is a high likelihood of secondary hazards, especially fires and hazardous material spills. Transportation incidents can also be secondary hazards themselves.

Overall, the most likely major transportation incident will be short, but intense. Unless there is major infrastructure damage (i.e., to a bridge) the recovery will probably quick and complete.

### **8 1.6 Conclusions**

Transportation safety has improved dramatically since the early days of motorized and air travel. Most of the major historical incidents date back to this earlier time. Still, transportation accidents hold the potential to produce very high casualty counts. As the amount of transportation increases, the total number of serious incidents may also increase despite safety improvements, especially as transportation networks become saturated and lose reserve capacity.

The possibility of terrorist attacking or using transport modes as weapons greatly increases the risks associated with the maximum credible events. The most likely events remain accidents that cause mass casualties among passengers and limited damage to surrounding infrastructure with the major caveat of damage to bridge or overpass structures.



## 8.2 Fires

- Fires include a broad range of incidents from wildland fires especially where urban areas abut natural areas, large single structure fires, multi-structure fires, ship fires, industrial fires, brush fires, and vehicle-related fires.
- Seattle has lost fourteen firefighters since 2000 and 104 civilians since 1994.<sup>440</sup> The trend in the number of casualties seems to be dropping, but it is still statistically impossible to verify the drop because of the small amount of data. The number of structural fires has also been dropping, but the dollar losses have not been.
- Seattle has experienced large fires, including the 1889 fire that destroyed downtown and the 1970 Ozark Hotel fire that killed 20 people. Both fires occurred under different historical circumstances than those that exist today. The 1889 fire occurred before a modern fire code and the Ozark Fire happened when Seattle had many multi-unit dwellings without sprinklers.
- The 1970 Ozark fire led to legislation mandating that safety systems, such as sprinklers, be retrofitted into older buildings. In an unintended consequence, many owners chose to leave floors unoccupied because the costs of retrofitting outweighed the revenues they produced.
- Fires have been a deadly secondary impact of earthquakes and civil disorders. In the 1995 Kobe and 1906 San Francisco earthquakes, more people died from fire than building collapse. Following the 1992 Rodney King verdict, multiple fires were set in Seattle, taxing Fire Department resources.
- While wildfires have not been a threat to the Puget Sound area traditionally, climate change is increasing the likelihood of wildfire west of the Cascade Mountains. A wildfire is still unlikely in Seattle because the city is far from any wildland areas but could threaten some city infrastructure located in wildland areas. Seattle regularly gets brush fires along roadways, such as I-5, that can threaten adjacent homes.
- Large structural fires remain a substantial risk and are most likely to occur in areas with older buildings, such as Downtown, the International District, First Hill, Ballard, and the University District.
- Fires in underground electrical vaults have caused prolonged outages in downtown and other dense areas where power has been placed underground. The effects of these power outages are covered in the chapter on power outages.

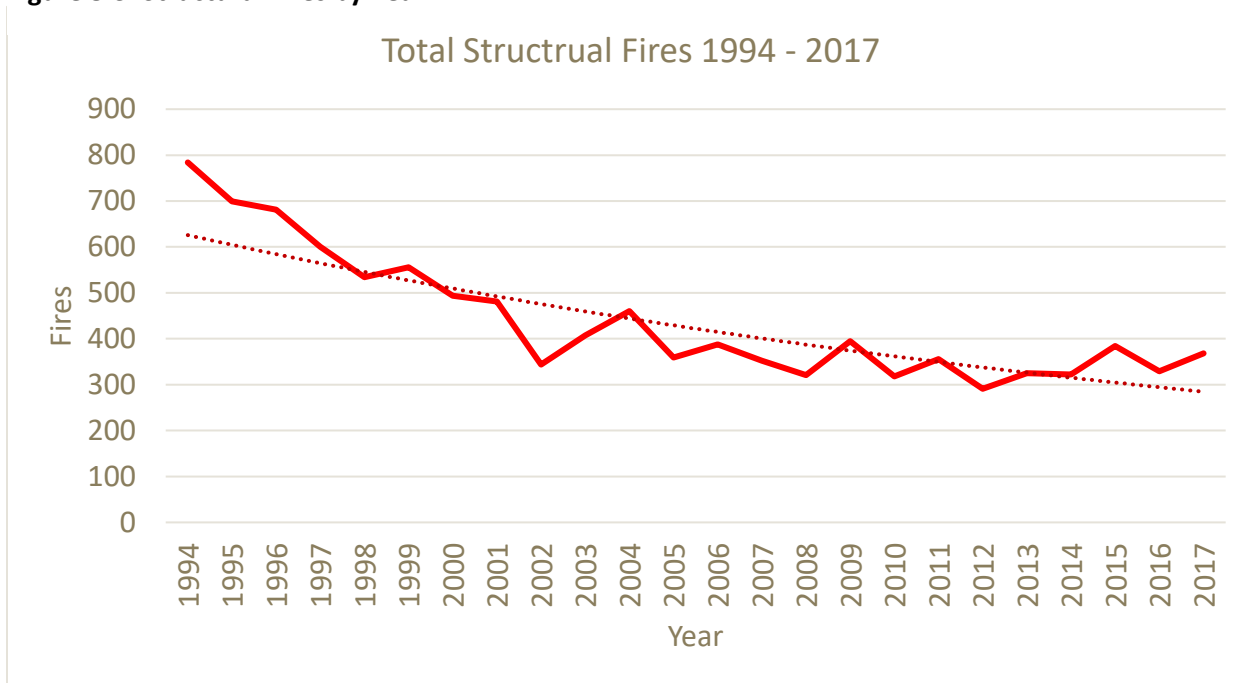
### 8.2.1 Context

Fires have long been a major hazard in urban areas. A series of catastrophic 19th century fires, including one in Seattle, led to the creation of modern fire departments. Even now, fires are among the deadliest of hazards nationally, with around 3,200 deaths per year (since 2006). The functions and capacity of the Seattle Fire Department (SFD) is discussed in detail in the Community Profile.

This section covers all major types of fires: multi-structure fires, large single structure fires, ship fires and fuel tanker fires. Seattle can also be affected by wildland fires in its Cascade watersheds. Electrical fires within the power system are a special category that is covered under the power outage chapter. Nationally, some of the worst urban fires have been in cities with a large urban-wildland interface. Seattle does not have such areas.

Nationally, structural fires are on the decrease, both in total number and in the number of deaths and injuries. Better education, a decline in smoking, and an increase in the number of smoke detectors seems to be behind this decrease.

Figure 8-3. Structural Fires by Year



Effective firefighting depends on speed. Firefighters have the best chance to respond effectively when they can detect a fire and reach it quickly in overwhelming numbers. The first step is to isolate the fire to prevent it from spreading; only then do firefighters try to extinguish it. Fires get out of hand when they spread too quickly to be contained (like the 2017 Santa Rosa fire), when automated suppression systems do not work properly, or when they occur in places that are difficult to reach.

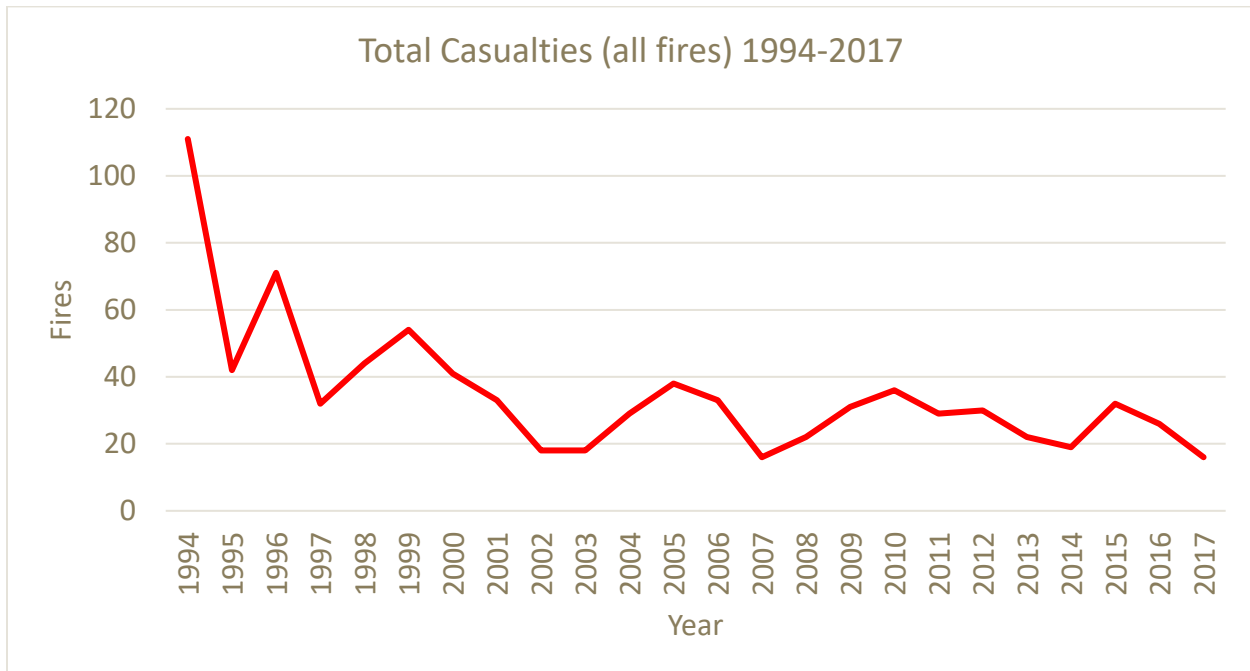
Fires can be a secondary impact of other hazards, as well as a trigger for hazards. Fire following earthquakes and during unrest are especially threatening. Damage to transportation infrastructure or security problems can result in fire fighters being unable to reach fires quickly or in adequate strength. An earthquake may damage the water distribution system, lowering water pressure at hydrants. In these circumstances, unattended fires could grow and threaten large areas. From 1900 to 2014 there have been 11 large fires following earthquakes, including Kobe. They can be extremely devastating. The 1906 San Francisco fire destroyed 28,000 buildings. Civil disorder presents the other major fire risk. Arson fires are commonly set during disorders. The 1992 LA riots produced large fires that engulfed whole city blocks. Some of these fires were left to burn after fire fighters were assaulted. The use of accelerants often makes these fires worse.

Since 2000, the number of structural fires in Seattle has decreased, following national trends, with a very slight increase after 2012 (see figure [STRUCTURAL FIRE TREND]). Since 2012, Structural fires in multi-family dwellings have increased more than fires in single-family dwellings. The overall decline in structural fires has occurred despite a building boom over the last decade that have added a considerable number of new structures. Since 2013, there has been an average of about 345 structural fires per year. As with the rest of the country, a combination of better education, decreases in smoking and increases in the use of smoke detectors has contributed to fewer fires in the 21st century.

Besides the decrease in incidents there has been a decrease in casualties (see figure [Casualty Trend]). The trend in the number of deaths is less clear. Since 1994, the average number of fatalities has been 4, but 2000, 2005, and 2010 saw spikes with 11, 8, and 9 fatalities, respectively.

What has not decreased is the amount of property loss. While the number of casualties correlates with the number of incidents, property loss does not. This is because a few large fires dominate losses every year. This suggest that despite an overall downturn in the number of fires, the magnitude of events are staying large or getting larger. Structural fires result in average yearly property losses of about \$15.5 million.

**Figure 8-4. Fire Casualties by Year**



Non-structural fires (i.e., brush, dumpster, vehicle fires, etc.) are another class tracked by the SFD. Like structural fires, vehicle fires have declined between 1994 and 2012, and stayed relatively flat, with an average of 232 per year since 2012. The other categories have not, they have held steady or slightly increased in recent years. It is not clear why.

## 8.2.2 History

Seattle is a city shaped by fire. The catastrophic Great Seattle Fire of 1889 consumed 60 acres of downtown Seattle just as the city was poised to become Washington State's leading urban center.<sup>441</sup> Amazingly, it caused no fatalities or major injuries. Equally impressive was the speedy and complete recovery. The fire occurred right before the biggest period of growth in Seattle's history. Seattle was able to totally rebuild the downtown within eighteen months, doing so with masonry instead of wood. This experience demonstrates how complete a recovery can be given the right circumstances and how hazard vulnerability can be mitigated during the recovery process.

### **Significant Fires After the Great Seattle Fire**

SFD has kept records of all multiple alarm fires since 1912. While Seattle has not experienced an event as large as the Great Seattle Fire since 1912, there have been a number of large fires.

**July 30, 1914. Colman Dock Fire.** Colman Dock stood at the site of the current ferry dock in downtown Seattle. The dock was the largest on the west coast. Five people were killed and 29 were injured. Wooden docks, often treated with creosote as a preservative, are very vulnerable to fire.

**June 30, 1916. Bell Street Pier.** This fire at an army ammunition depot exploded much ordinance, including artillery shells. A bystander, a young boy, was killed by one of them.

**April 20, 1920. Lincoln Hotel Fire.** A large hotel in downtown Seattle burned completely, resulting in four deaths.

**April 30, 1935. City Light South Lake Union Steam Plant.** The fire caused a power outage and severe traffic disruption but no deaths.

**February 18, 1943. B-29 Crash and Fire.** This fire, detailed above in transportation incidents, resulted in 32 deaths.

**September 9, 1945. St. Vincent de Paul Fire.** An arson fire set by a homeless man destroyed a whole block of property and caused four deaths.

**July 6, 1948. Lyle Branchflower Explosion.** An explosion and fire at a Ballard fish oil producer killed three workers and blew a car off the Ballard Bridge.

**May 20, 1958. Seattle Cedar Lumber.** Another major fire near the north end of the Ballard bridge resulted in no deaths.

**November 11, 1961. Pike Place Market.** Fire destroyed 20 stalls and stores, a pedestrian overpass over Western Avenue, and a meat market connected to Pike Place Market. A new pedestrian overpass was constructed in 2017.<sup>442</sup>

**March 20, 1970. Ozark Hotel.** This arson fire killed 20 people and had a major impact on Seattle's older neighborhoods. The Ozark was a single room occupancy (SRO) hotel, a type of housing that commonly served homeless and seasonal workers. It was a known fire risk. The fire department had inspected in often, but it was still vulnerable. It was in disrepair, had no sprinklers, and a poor escape route.

**April 25, 1971. Seventh Avenue Hotel.** A little over one year after the Ozark fire, another SRO burned, killing 12. Following these fires, stringent new fire ordinances were passed, including requiring buildings to be retrofitted with sprinklers and smoke detectors. Most building owners found it was not financially viable to retrofit upper floors and chose to abandon them.

**December 4, 1975. Fuel Tanker Explosion/Fire on Alaskan Way Viaduct.** (Also listed under Transportation Incidents and Hazardous Materials). A gasoline tanker truck crashed. Gasoline leaking from the truck caught fire, causing extensive damage to surrounding buildings. The fire caused a major downtown power outage when it burned through a power trunk line.

**December 22, 1976. Pike Place Market.** An apparent arson fire burned the Economy Market Building at 89-99 Pike St.

**March 4, 1985. Health Sciences Center.** A complex fire occurred on the 13<sup>th</sup> story of a 17-story building housing an infectious disease lab and trace amounts of radioactive material.

**May 9, 1989. M.V. Golden Alaska.** A 340-foot seafood processor caught fire below decks, initiating a complex incident requiring days to fully extinguish.

**September 9, 1989. Blackstock Lumber.** An arson fire at a lumberyard caused the death of one firefighter and severely injured another.

**September 16, 1991. M.V. Omnisea.** Another fish processor fire involved Seattle Fire units on site for five days.

**September 21, 1991. Villa Plaza Apartment Fire.** The day after the last units left the scene of the M.V. Omnisea fire, a huge fire broke out in the Villa Plaza Apartments. The complex was grandfathered in under the Ozark Ordinance and did not have sprinklers. There were no deaths, but 232 people were displaced. Because of the media stories alleging that it was a haven for criminals, many residents found it hard to find new housing.

**January 5, 1995. Mary Pang Fire.** An arson fire in a warehouse resulted in the deaths of four firefighters. SFD came under heavy criticism and undertook major reforms after this fire.

**May 21, 2001. UW Center for Urban Horticulture.** An arson fire set by environmental extremists caused \$7 million in damage and destroyed years of research.

### **8.2.3 Likelihood of Future Occurrences**

As noted above, the total number of incidents and casualties is decreasing for all structural fires and highway vehicle fires. This is a major success. It reduces the cumulative impact of all fires.

The amount of property loss is increasing rather than decreasing. It seems that the number of large fires is holding steady. Seattle is experiencing fewer fires, but a higher percentage of those that occur are major fires.

One very important fact the data show is that fires do not have to be large to cause injury and death. The number of casualties correlates well with the total number of incidents but very poorly with property loss.

The number of non-structural fires (any fire outside a building: trash fires, grass fires, vehicle, and ship fires) is holding steady with the exception of vehicle fires which are showing a major decrease.

Based on the trends and an analysis of the historical data, there is a strong likelihood that Seattle will continue to have fires that result in high property losses but that are less likely to result in high numbers of casualties.

The 1889 Fire remains the largest in Seattle's history. Seattle was a very different place when it occurred. The chance of another fire like it is remote. The most likely scenario for a multi-block fire is a post-earthquake fire. Large sections of Kobe, Japan were destroyed in a huge blaze following the M 6.9 earthquake. Damage to the water system crippled the response.

### **8.2.4 Vulnerability**

A review of all multiple alarm fires reveals a clear profile of Seattle's vulnerability to major fires. Several factors emerge repeatedly:

- Businesses that contain a lot of fuel. Lumberyards, furniture stores, carpet warehouses, and other businesses using flammable materials are overrepresented in the record because fires started in these businesses are more likely to develop into major blazes.
- Apartments and hotels. These structures are vulnerable because of their high occupancy.
- Nightclubs, stadiums, and theaters are also vulnerable due to high occupancy.
- Substandard buildings.
- Arson Targets.
- Ships.
- Bridges.

In general, there are two types of fire vulnerability: 1) the conditions that allow the fire to spread, and 2) the concentration of people and property. Where the two factors overlap is the area of greatest vulnerability.

In the first category, factors that are more likely to turn an ignition into a major fire, are fuel-rich environments, substandard buildings, arson targets, and ships (because of the challenges in fighting them). To these must be added the capabilities of the fire suppression resources. Response time is a key

variable. The National Fire Protection Association has determined that a “room and contents” fire will flashover to a structural fire within 5 to 10 minutes. The longer a fire burns without response the more likely it will spread to additional structures.<sup>443</sup> Therefore, a response time under five minutes is considered good. SFDs has set their own standard for the first fire engine to arrive on scene within 4 minutes 90% of the time. Between 2013-2017, they met this standard 83% of the time, on average.<sup>444</sup> In comparison, the Portland Fire Department responds under 5 minutes and 20 seconds 60% of the time. The Atlanta fire department has a response time of 7 minutes 90% of the time.

Building architecture governed by building and fire codes the other critical factor in reducing fire risk. Many high-population areas are now made from fireproof materials like brick, steel, and concrete that reduces the risk of fire spread. However, most of the city’s residential structures are wood, which is vulnerable. In these places, the key variables are early detection, spacing between structures to isolate a large fire and easy access for fire trucks. Seattle building officials say that the majority of multi-family structures being built are wood-frame, because it is a cheap and abundant local material. This is the general trend along the West Coast.<sup>445</sup> There have also been recent moves to allow large multi-family structures to use wood and cross-laminated timber in their construction. In 2018, the Seattle City Council approved an ordinance allowing six floors of wood construction on top of two floors of concrete.<sup>446</sup> These new building ordinances could increase the density of wood frame structures in the city, in turn increasing fire vulnerability. Seattle requires smoke detectors in all new and existing residential buildings and most other types as well. This law improves the chances that the Fire Department will detect fires early, decreasing the probability of a fire getting out of control. Due to these factors, the older neighborhoods, where the houses are closer together and the streets are narrower, are more vulnerable to a multi-structure fire than new areas.

The second category is concentration of lives and property. Seattle has the densest residential areas between San Francisco and Vancouver, B.C. and this density is increasing. More people are working and living in large structures. Density has many positives aspects like reducing sprawl but can put more people at danger if a fire does occur. The densest residential areas include Belltown, Capitol Hill, First Hill, and University District neighborhoods, with over 100 people per acre in some blocks.<sup>447</sup> Seattle’s deadliest fire, the Ozark Hotel fire, occurred on the edge of downtown in the Denny Triangle area at 7<sup>th</sup> Avenue and Westlake. Because of the heightened vulnerability of dense areas of the city, more effort has been made to reduce frequency, mitigate the effects of, and heighten the response to fires in these areas.

In large buildings, the most critical factor is the functioning of passive and automatic systems. In high rises, the upper floors are impossible to reach from the outside and HVAC and elevator shafts create corridors to spread a fire throughout the whole structure. Compartmentalized refuge areas, detectors and excellent sprinkler systems are the most effective means to deal with this type of fire. Seattle’s codes employ all of these devices. The most vulnerable area, as measured by the size of the exposed population, is Downtown. Fortunately, most of the high-rise buildings in Downtown were built after 1970, when fire codes improved. Seattle still has some older high-rise buildings, but these buildings are being replaced or retrofitted due to developmental pressures.

Structural fires can occur as a secondary impact from a civil disorder or earthquake. The Seattle Fire Department has prepared plans for triaging incidents in this situation. This planning emphasizes first performing windshield surveys to grasp the extent of the problem, then responding to the most critical situations. If resources are unable to command all incidents, some fires may be left to burn or only enough resources will be committed to prevent the fire from spreading to adjacent structures

Wildfire exposure is greatest near large open areas, especially those with large fuel loads. Few of these areas are close to high population areas. Areas near transportation corridors seem to have an increased frequency of fires, especially in the summer as brush dries out. A few times, brush along I-5 has burned,



threatening homes adjacent to it and slowing traffic. SFD has been able to put these fires out using its own crews. Seattle has never experienced devastating urban wildfires as has happened in California, New Mexico, and Florida because it lacks large wildlands close to the city. Additionally, SFD has good access to most areas where they could occur. Wildland fires are a threat to Seattle's watersheds and power generation and transmission systems, which are in heavily forested, remote locations. Seattle Public Utilities and Seattle City Light maintain their own wildland firefighting capability to combat fires in the City's watersheds and protect power generating equipment.

## **8.2.5 Consequences**

Because of a long-term effort to reduce the effects of fires through fire codes, vehicle safety standard, public education, and professional firefighting services, the number of fires and the number of casualties is dropping, mainly through a reduction in structural and vehicle fires. Reducing yearly property loss has remained elusive mainly because yearly losses are dominated by a few big incidents.

Large fires are likely to happen again because there are so many potential sources. One of the main goals in any response is to contain the fire in the structure, vessel, or location where it started. Despite some tragic fires, the strategy of containing these fires has largely been successful. This reduces the likelihood of another conflagration like the Great Seattle Fire. While unlikely, it is also possible Seattle could experience a large outdoor fire like those that have occurred in southern California. Sometimes, even a single structure fire can be disastrous as in the case of the MGM Grand fire that caused 85 deaths or the Station Nightclub fire that caused 100 deaths.

Seattle could be affected by a wildland fire that threatens water and power infrastructure. If power transmission towers and lines are exposed to fire, it could cause outages, but they would likely be localized. Fire has also threatened dams that generate some of the city's electricity. Damaged equipment in at these sites would not cause outages but would require the City to purchase additional electricity from external providers. A fire in one of the city's watersheds could decrease water quality by increasing turbidity, harming aquatic life, and drawing down the City's reservoirs. The consequences of wildland fire outside the city are discussed further in the power outage and water shortage chapters.

Due to the factors outlined above, the scenario that Seattle is most likely to face directly is a large, deadly structural fire or a fire associated with a transportation incident. Large structural fires still occur every year. Despite all the mitigation efforts, it is not implausible for a major fire to occur in a vulnerable structure. The result could easily be a large number of fatalities and property loss. Damage would probably be contained as long as adequate resources could be brought to bear. Economic effects would probably be limited unless there was destruction of critical infrastructure, such as a bridge that had to be closed, forcing transportation detours.

## **8.2.6 Conclusions**

With many high-occupancy buildings and densely populated areas, Seattle has a high exposure to fire loss. The risk this exposure entails has been reduced by measures to decrease the frequency and mitigate the effects of disastrous fires. They include the adoption of stringent Fire and Building Codes and the maintenance of a four-minute Fire Department response time.



## 8.3 Hazardous Materials Incidents

- The 1984 disaster in Bhopal, India that killed over 2,200 people focused world-wide attention on the dangers of toxic chemical releases. In the U.S., it led to the 1986 Emergency Planning and Community Right-to-Know Act or SARA Title III. This law led to a lot of new planning and response infrastructure.
- The U.S. Department of Transportation (DOT) collects data on hazardous materials incidents occurring in the U.S. during transportation.<sup>448</sup> Most are received from shippers, e.g., UPS or Federal Express. Since 1998, 838 hazardous materials incidents in Seattle resulting in total of \$3,056,573 in damage, but no fatalities or injuries requiring hospitalization. There have been 13 injuries not requiring hospitalization and 15 incidents were classified as serious.
- The Seattle Fire Department (SFD) records hazardous materials-related dispatches. It lists 1,243 incidents from 1995 to 2017, with a spike in 2001 following 9/11 and the 2001 anthrax attack. Forty-four incidents were fires with hazardous materials components.
- Fixed sites are the most frequent locations for accidents, but transportation accidents are often riskier because they happen in uncontained spaces, they can be in close proximity to people, and responders usually have less information about the materials involved.
- Areas up to one-half mile downwind from an accident site are considered vulnerable, according to the US DOT. An incident could affect thousands of people in densely populated sections of Seattle.
- Other hazards, such as earthquakes and landslides, could produce hazardous materials incidents.

### 8.3.1 Context

Harmful material in the environment has been a problem for a long time, but it has only been since the publication of books like *Silent Spring* (1962), and tragedies like the Bhopal chemical disaster (1984), that hazardous materials have become recognized as a significant hazard. Hazardous materials pose problems that vary widely in intensity and duration. While many materials pose long-term problems (e.g. asbestos, PCBs, etc.), this chapter focuses on incidents that pose an immediate threat to large numbers of people. Chronic problems have their own regulatory infrastructure outside of emergency management.

The federal government plays a large role in all phases of hazardous materials management. Title III of the 1986 Superfund Amendments and Reauthorization Act (SARA) and the Clean Air Act of 1990 mandate “cradle to grave” tracking of designated hazardous materials by requiring users to report what chemicals they are using and releasing into the air, and how they will respond to an emergency. Under the act, EPA delegates implementation to the states. Washington State has passed the responsibility to local districts known as Local Emergency Planning Committees (LEPC). Seattle maintains its own LEPC. The reporting requirements mandated by these acts have produced a rich data set of chemicals in the community.

Around 80% - 90% of accidents involving hazardous materials occur at fixed sites such as factories and storage facilities; the remaining 10% - 20% occur during transportation. Most of these incidents are small, however, and not reported to the SFD because facility staff are able to contain and clean them. Facilities that commonly house hazardous materials in the Seattle area include hospitals, metal plating and finishing, aircraft manufacturing, public utilities, cold storage companies, fuel facilities, communications facilities, chemical distributors, research facilities, and high technology firms.<sup>449</sup> Illegal drug labs or dumping can also pose a risk.

Transport incidents are usually more difficult to manage because they often happen in uncontained settings and/or populated areas. Responders to transportation accidents do not have detailed site plans and chemical inventories. Hazardous waste dumps also present problems because they often house unidentified and unstable chemicals. An emerging concern is the increasing transportation of Bakken crude oil. This light, crude oil is more flammable than traditional crude. Bakken crude shipments began in 2012 and have increased to 1,100 tank cars per week being transported through the city in 2018.<sup>450</sup> In 2013, a train carrying Bakken derailed and exploded just outside of the U.S. in Quebec, Canada, killing 47 people and destroying 30 buildings. An oil train carrying Bakken derailed in Seattle under the Magnolia bridge in July 2014. Fortunately, no oil was spilled, and the incident was not catastrophic like the Quebec explosion, but it illuminated the risk of transporting highly flammable materials through dense, urban areas.

The Fire Prevention Division of SFD, commonly referred to as the Fire Marshal's Office, provides the leadership and inspection services to help prevent fires, explosions, and release of hazardous materials and to assure fire and life safety for Seattle's residents, workers, and visitors. The Hazardous Materials Section of the Fire Marshal's Office provides inspection services for the storage and use of flammable and combustible liquids and other hazardous materials and processes as required by the Seattle Fire Code and Administrative Rules.

SFD can call on help from private and governmental resources. On the private side, large companies often have response teams and the Chemical Manufacturers Association has created an organization, CHEMTREC, which runs a 24-hour hotline for emergencies that happen in transit. Additionally, several private companies specialize in responding to chemical emergencies. At the federal level, the EPA, Coast Guard, and the US Department of Transportation's Bureau of Explosives have strike teams that assist local responders in special situations. Washington State provides teams from the Department of Ecology and the Department of Natural Resources.

The Seattle Local Emergency Planning Committee (LEPC) was set up in 2002 to foster a working relationship between private industry and public agencies in addressing hazardous materials issues. In addition to promoting public awareness and industry reporting, the LEPC takes a cooperative approach toward the prevention and preparation for hazardous materials releases. LEPC membership includes City personnel and representatives from the Washington State DOT, Washington State Department of Ecology, Seattle/King County Public Health, Harborview Hospital, Port of Seattle, Boeing, BNSF Railway, Bank of America, and a member of the public.

The number of chemicals in use today makes it critical to know which ones are at a particular site. The Occupational Safety and Health Administration (OSHA) lists 28,000 toxic chemicals and each of them has a unique way of interacting with their environment and with other chemicals, including the ones used to clean up spills. Responders can make matters worse by applying a material that will react adversely with the spilled chemical.

The possible use of chemical, radioactive, and especially explosives in a terrorist act significantly alters the risk profile for hazardous material incidents. Bombs are one of the most common methods of attack in many parts of the world. The use of chemicals is rare due to the difficulty of manufacturing the chemicals; however, the Tokyo Gas Attack that killed 12 and injured thousands in 1995 is an example of chemical weaponry. The use of radiological devices is also rare. Radiological attacks are not nuclear bombs. Rather, they use a variety of means, including conventional explosives, to disperse radioactive substances. There is a debate about the effectiveness of these devices, however. The two examples of actual attacks using radiological devices come from Russia and Chechnya. Neither bomb exploded. The US Department of Homeland Security believes the most likely uses of a radiological attack would be to contaminate facilities where people live and work to disrupt their livelihoods, or to cause anxiety in

people who believe they may have been exposed. The amount of radioactive material released would likely not cause severe illness or death.<sup>451</sup>

### **8.3.2 History**

The hazardous materials historical record does not extend past the early 1980s. Older records mix hazardous materials emergencies with fire emergencies. Constructing a long history is difficult, but since federal reporting requirements have taken effect, there is a wealth of data from local, state, and federal sources.

Prior to 1995, it is difficult to get consistent data. Two incidents stand out, however, in a review of multiple alarm incidents dating back to 1912.

**December 4, 1975. Fuel Tanker Explosion/Fire on Alaskan Way Viaduct.** (Also listed under Transportation Incidents and Fire). A gasoline tanker truck crashed and leaking gasoline caught fire, causing extensive damage to surrounding buildings. The fire caused a major downtown power outage when it burned through a power trunk line.

**March 4, 1985. Health Sciences Center.** A complex fire occurred on the 13<sup>th</sup> story of a 17-story building housing an infectious disease lab and trace amounts of radioactive material.

Hazardous materials responses have been recorded by SFD since 1995. Between 1995 and 2009, SFD responded to 1,082 incidents, of which only three (or 0.2%) required more than one alarm. Of these three, only one was a pure hazardous materials incident; the other two were associated with fires. All three had biological functions. They were:

**March 24, 1997. Fire with Hazardous Materials.** Kincaid Hall, University of Washington. The zoology lab burned.

**June 10, 1999. Bellingham Pipeline Explosion.** Although this incident did not occur in Seattle, it focused attention regionally on pipeline safety. Seattle has a spur of the same pipeline that runs from Harbor Island to Renton. It transports mostly gasoline.

**May 21, 2001.** Center for Urban Horticulture, University of Washington. Arson fire.

**May 26, 2001.** 509 Olive Way. Fire in a building housing many medical offices.

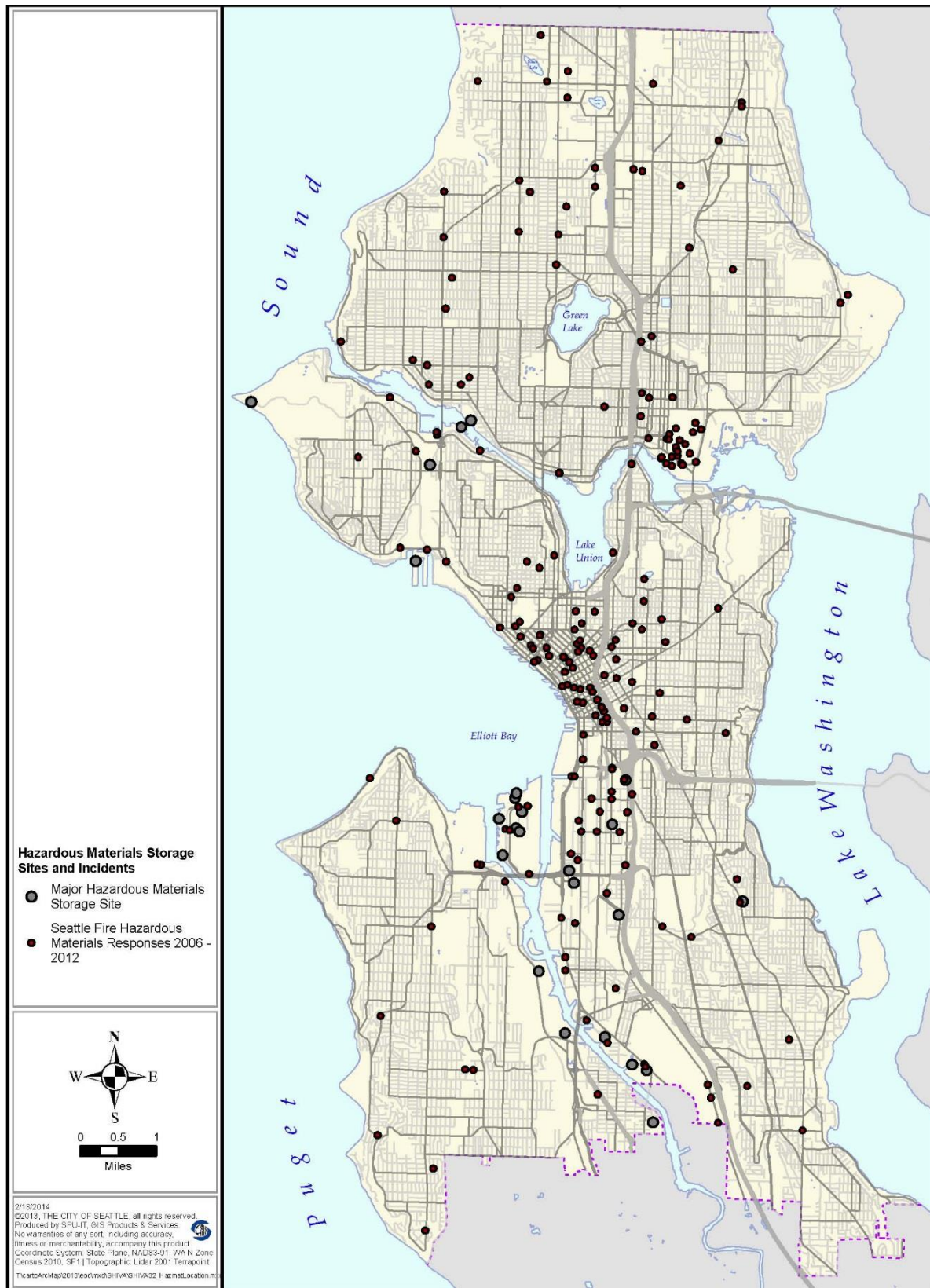
After the spike in 2001, hazardous materials incident dispatches fell steadily until 2008, where they have remained relatively flat since (See figure [Seattle Fire Department Hazardous Materials Dispatches]). Note: After the 2001 Anthrax attack there was huge spike in 911 calls related to white powder. These calls have been removed). There has been an average of about 38 incident dispatches per year from 2008 to 2017.

Some older data exists on transportation of hazardous materials. The Washington State Department of Health studied incidents that occurred in 1992. Most of the analysis covers the whole state and disaggregates the information by county. These data are too general for specific planning but do give some indication of the dangers faced in Seattle, especially when it is correlated with the logs of the SFD.

According to the report, there were 118 events in King County in 1992. Twelve (10.2%) of these involved transportation and 106 (89.8%) were at fixed facilities. Twenty-six incidents caused a total of 66 injuries. The most common injury incidents involved acids and volatile organic compounds. The report states there was one fatality in the state, but it does not indicate if it occurred in King County. Additionally, 29 incidents resulted in the evacuation of nearly 1,400 people. The report indicates that 44 incidents in King County occurred within one-quarter mile of residential areas, indicating some risk to people who are not directly involved with the released chemicals.



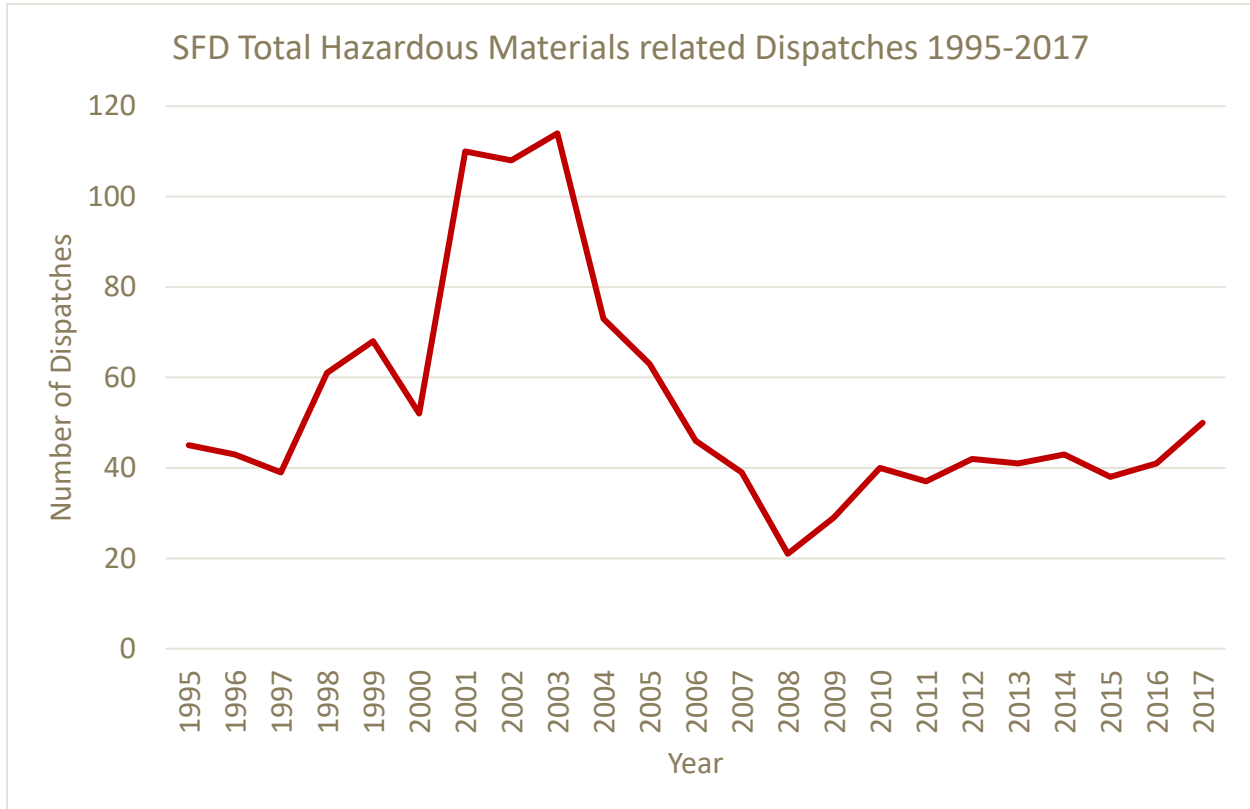
Figure 8-5. Hazardous Materials Incidents 2006 - 2012





A 1994 King County study shows that the most common material transported along I-5 is gasoline.<sup>452</sup> The most commonly released chemicals in transportation accidents were volatile organic compounds, acids, herbicides and insecticides.

**Figure 8-6. Seattle Fire Department Hazardous Materials Dispatches 1995 to 2017**



The federal Environmental Protection Agency has a Toxic Release Inventory (TRI) program. TRI requires facilities in certain sectors (manufacturing, mining, power generation, etc.) who have over 10 employees and produce, process, or use chemicals to report the amounts that were released each year on and off their facility.<sup>453</sup> They monitor chemicals that are either harmful to public health or the environment. In 2017, 105 Seattle facilities released around 50,000 pounds of toxic chemicals on-site.<sup>454</sup> Additionally, about 580,000 pounds of toxic chemicals were released by Seattle facilities off-site. A release does not mean that there was a hazardous materials incident. Rather, it means that a chemical was emitted into the air or water or placed in a type of land disposal.<sup>455</sup> However, these numbers reveal the amount of chemicals that are being used in the city and could potentially pose a risk to public health if handled improperly.

The U.S. Department of Transportation collects incident data at the state level and on the transportation mode. Washington ranks in the middle third in terms of the number of annual incidents. In 2009 it was 22<sup>nd</sup> with 230 and remained ranked at 22<sup>nd</sup> in 2018 with 272 incidents.<sup>456</sup> None were listed as major incidents. The most common transport mode is highway by far.

### 8.3.3 Likelihood of Future Occurrences

The available data on hazardous materials incidents is limited, but what does exist suggests the chance of an acutely disastrous incident has a low probability of occurring. Many programs exist to reduce the likelihood of an accident and to mitigate the effects of releases. These programs seem to be effective in limiting damage. The increase in transportation incidents from 1999 to 2009 runs counter to the general

decline and bears watching. Additionally, the recent increase in the amount of Bakken oil being transported by rail through the city may increase Seattle's likelihood of a disastrous incident. The railcars that carry the majority of Bakken oil in the state were not made to carry oil and have been known to puncture upon impact.<sup>457</sup>

Seattle has never experienced a chemical or radiological attack, or a successful bombing. The difficulty of obtaining or manufacturing chemicals makes an attack unlikely, though not impossible. While explosives have been used around the world in past terror attacks, recent terrorism trends point towards the use of simpler tactics (e.g. vehicles, knives, etc.) to cause harm.

While there may be very significant long-term problems involving the build-up of toxic chemicals in the environment, there have been very few large releases of chemicals that pose immediate risks to large numbers of people. Most of the largest past events have been secondary impacts to fires and transportation accidents. It seems most likely that a future event would be related to another type of hazard, such as an earthquake or fire.

### **8.3.4 Vulnerability**

The most likely location of a hazardous material emergency is at a user site, an abandoned dump or landfill, or on a major transportation route. If the chemical finds its way into the sewer system, treatment facilities or sewer overflow locations could become additional damage locations. Additionally, Seattle is a city surrounded by water and a chemical spill into these water bodies could severely harm aquatic life.

The Washington State and SFD information refine this set of assumptions with some empirical data. The vast majority of accidents in the county (90%) occur at fixed facilities, which theoretically means 90% of the spill locations are identifiable prior to an incident. The State's data shows more transportation accidents happen in rural areas, while most of the fixed facility accidents occur in industrial areas. On the basis of this information, the picture of a typical hazardous material accident site is in an industrial area or along a major transportation corridor such as I-5, I-90, SR 99, SR 520, or the railways within the city. The most vulnerable locations are where high density, vulnerable populations, and critical infrastructure occur close to the areas that are more likely to have incidents. Besides these areas, the University of Washington also has a large share of serious hazardous materials incidents, due to its many research labs.

The most common sources of large accidents are petroleum, metal, and chemical plants. There are relatively fewer of these facilities in Seattle compared to other U.S. cities, decreasing the probability of a large event.

### **8.3.5 Consequences**

The effects of a large hazardous materials incident are unpredictable because there is not a long history of such large incidents in Seattle. Hazardous materials emergencies can be complex because chemicals have so many ways they affect people. They can disperse through the air or water and can enter the body through the lungs, digestive system, or skin. Many can explode. Some will react with water and other common agents that fire-fighters use. Every chemical has a unique set of properties that pose a unique set of dangers and call for a unique response. In most cases, a fire will multiply the threat of direct contact either by causing the material to explode and/or dispersing it.

If future large incidents follow the historical pattern, only magnified, then they would most likely occur as a secondary effect or another type of hazard, especially a fire. It would most likely be at a fixed facility. If a transportation incident occurred in the city, consequences could be significant as was the case with the 1975 tanker fire. A crowded tavern was nearby the incident and could have caused multiple fatalities had it been affected.

These types of incidents are likely to be limited in geographic scope. The city is likely to have a quick and complete recovery. Unless there is a large explosion or fire in a crowded and enclosed location, fatalities are likely to be few, although the number of injuries due to chemical exposure could be quite large. In the 1995 Tokyo sarin gas attack there was about one fatality for each 200 injuries.

The most serious hazardous materials incidents would probably either involve an attack or multiple incidents occurring at the same time as a result of a trigger hazard, like an earthquake or flood. Attacks would be serious because of the deliberate intent to harm. Extremely dangerous substances would most likely be involved and would be released in locations that would impact many people, such as transit systems or entertainment venues. In a scenario where numerous hazardous materials releases occur as a secondary impact to another hazard, response capacity would be diminished. In past events, bystanders have been injured because people were not removed quickly enough or were allowed to return in a prolonged evacuation.<sup>458</sup>

The economic effects extend beyond immediate damage because chemicals produce a high amount of anxiety. A serious event would probably lower property values in the surrounding area, compounding economic damage into the future. They can also cause extreme environmental damage, especially if chemicals enter the water or sewer systems where they can spread and leach into groundwater or discharge into bodies of water. Many large maritime vessels are capable of leaking thousands of gallons of oil into the Puget Sound. If dangerous gases escape in large quantities, or if chemicals enter the water system through a Combined Sewer Overflow or direct runoff, an accident could escalate from a localized emergency to a wider environmental disaster.

### **8.3.6 Conclusions**

Minor hazardous materials incidents are fairly common, making them high probability events that typically do not involve emergency management. Fortunately, more serious threats, including fatal accidents, are extremely rare. Many of the decisions that govern the use of hazardous materials rest with the state and federal governments.



## 8.4 Infrastructure and Structural Failures

- Infrastructure is the network of structures, utilities, and facilities that supply and support our basic needs for mobility, power, water, sewer, and communications.
- This chapter covers large, complex infrastructure failures that are *not* triggered by some other hazard (e.g., an earthquake). Failures to digital and communications infrastructure is discussed in the cyber-attack and disruption chapter.
- The American Society of Civil Engineers (ASCE) gives the infrastructure of the United States an overall D+ grade and estimates it will cost \$2 trillion to fix. The ASCE gives Washington a C grade, with the main concerns being roads and mass transit.
- Infrastructure can be damaged during construction, such as a contractor breaking a water main; or fail after construction due to a design flaw, such as the collapse of the Tacoma Narrows Bridge in 1940.
- Occasionally, our understanding of a threat to infrastructure becomes clear only after we build it. This has occurred with many bridges built in the early 20<sup>th</sup> century before Seattle was aware of its earthquake risk.

### 8.4.1 Context

On May 23, 2013, the I-5 Skagit River Bridge collapsed in Mount Vernon, Washington. Fortunately, there were no fatalities, but traffic on the busiest freeway in the state had to be rerouted for weeks.<sup>459</sup> This bridge collapse, along with other recent infrastructure incidents, such as the I-85 bridge collapse in Atlanta in 2017 and the sinking Millennium Tower in San Francisco, highlight aging and vulnerable infrastructure across the United States. This chapter encompasses infrastructure failures that can rise to the level of a disaster: bridge collapse, building collapse, crane collapse, dam failure, main breaks, pipeline failure, steam pipe explosions, industrial system failure, accidents at nuclear plants, and similar events. Because power failures are especially complex, they are covered in the power outage chapter.

Most complex infrastructure is now controlled with computer systems (called supervisory control and data acquisition or SCADA systems). While SCADA system failure is a type of infrastructure failure, it is covered in detail in the cyber-attack and disruption chapter.

Problems of failing infrastructure are typically small scale and cumulative. For example, a vast number of small leaks can cause some municipal water systems to lose up to 20% of their water during transmission. While reducing the effectiveness of a system, small, cumulative failures do not typically rise to the level of a disaster. This chapter concentrates on the upper end of the problem, large scale failures with immediate consequences. Nevertheless, it is important to note that these large-scale failures represent only part of a wider issue, and cumulative failures can have disastrous impacts, as was the case in Flint, Michigan, where lead contamination in the city's water supply eventually resulted in a public health emergency.

Locally, responsibility for Seattle's infrastructure rests with a collection of public and private agencies. Details of these systems and agencies are described in the Community Profile.

Many, though not all, of the problems are related to the age of American infrastructure. In many places pipelines, bridges, and other structures are over 100 years old. Some systems in Seattle are approaching or are past this age. The Fremont and Ballard bridges, as well as the Hiram M. Chittenden Locks, were all 100 years-old as of 2017. The sheer amount of investment it would take to upgrade all of America's aging infrastructure would be \$2 trillion according to the American Society of Civil Engineers (ASCE), which also assigned an overall D+ grade to the nation's infrastructure.<sup>460</sup> Washington's infrastructure

received a C grade from ASCE, with roads and mass transit systems rating lowest and dams rating highest.<sup>461</sup>

Other causes of infrastructure failures can be structural fatigue, such as increased carrying loads on bridges, corrosion of materials due to environmental exposure, erosion, and stress beyond what the system was designed to do.<sup>462</sup> Infrastructure failures can also be a result of human error or accidents that occur during a construction phase. Workers can accidentally damage utility mains, errors can be made in the building's construction that cause failures later on, and construction equipment, such as cranes or scaffolding, can fail and collapse. Additionally, infrastructure failure is often felt as a secondary hazard to another incident such as an earthquake. While many of these primary hazards would damage even healthy infrastructure, the problem is compounded by weakened infrastructure.

Replacing aging and inadequate infrastructure is costly and politically difficult. Without a clear crisis, it is a challenge to convince taxpayers to replace expensive structures. Nonetheless, some programs have been implemented and are addressing infrastructure improvement needs, such as the \$365 million “Bridging the Gap” levy, which addresses paving, bridge repairs, seismic upgrades, and transit enhancement.<sup>463</sup>

## **8.4.2 History**

The Seattle region has experienced some large failures, but none included major loss of life. This is a list of the major infrastructure failures in Seattle.

**November 7, 1940. Tacoma Narrows Bridge Collapse.** One of the most famous infrastructure failures in the world occurred when a 42-mph wind caused the bridge to twist until its cables snapped. There were no casualties.

**November 11, 1957. Sinkhole.** A sewer line tunnel built in 1909-10 collapsed, causing a massive sinkhole under Ravenna Boulevard. Ten families had to be evacuated. The system took two years to repair and cost \$16 million (in 2013 dollars).

**February 25, 1987. Husky Stadium Collapse.** An addition to the northern deck collapsed during construction. The cause was the premature removal of six temporary wire supports that allowed the structure to sway too much. Workers noticed a support buckling and had time to escape, so there were no casualties.

**November 25, 1990. I-90 Bridge Sinking.** The bridge was under construction and not being used. It sank following a major windstorm. The pontoons that support the bridge had been opened to temporarily store water. The openings allowing additional storm water to enter.

**July 19, 1994. Kingdome Ceiling Tiles and Crane Failure.** Hours before a baseball game, four large waterlogged tiles peeled from the ceiling and plunged into the seats. Two construction workers died during repairs when the basket on top of a crane broke loose and fell 250 feet. The cause of the ceiling tile failure was a badly leaking roof.

**December 14, 2006. Drainage System.** (Also in Flooding). Heavy rains overwhelmed the drainage system along Madison Street. Water built up in a valley in the street. It overtopped the curbs and rushed downhill, slamming into a home and killing one person.

**May 2, 2007. Water Main Break Under University Bridge.** A 24-inch main broke, causing a large sinkhole and worries about the integrity of the bridge abutment. The incident also damaged an 8-inch gas main and a conduit housing Qwest trunk lines. The bridge was not damaged, but water and gas service in the area had to be cut for most of a day.

**January 19, 2009. Howard Hanson Dam.** Engineers learned that parts of the abutment had a void. To reduce the chance of a catastrophic failure, dam operators would not be able to hold as much water in



the reservoir, increasing the chance of flooding in the Kent valley. Temporary repairs were completed before a flood.

**February 9, 2017. West Point Treatment Plant.** Heavy rains and high tides caused flooding at the wastewater treatment plant, which fired an electrical circuit that shut down operating systems.<sup>464</sup> 235 million gallons of untreated waste was dumped into Puget Sound.<sup>465</sup>

### **8.4.3 Likelihood of Future Occurrences**

Infrastructure failures are unavoidable, and often unpredictable. Even if our entire infrastructure system was in top shape, there would still be construction accidents, operations errors, design flaws, and unanticipated environmental issues. These types of failures occur every year but can normally be handled through daily business procedures. The question is how likely are major failures that precipitate large-scale emergencies? Unless a single failure, such as a dam failure or nuclear accident, affects a large area, most infrastructure failures do not scale up to the catastrophic level. There are no dams in the city limits and Seattle is far from the state's only nuclear power plant in Eastern Washington. The likelihood of an infrastructure failure as a secondary hazard seems to be decreasing as we become more aware of the potential effects of hazards, such as earthquakes. Scientific developments have allowed the city to identify its most vulnerable infrastructure and make the necessary upgrades. Developments in building code standards also make newly constructed infrastructure more resilient to hazards.

There is no data source containing all infrastructure failures, making it difficult to examine trends. However, some national trends in infrastructure age and spending point towards an increased likelihood of failures. The 1950s and 60s saw many of the nation's large infrastructure projects, including many of our national interstate highways.<sup>466</sup> Experts believe that many of these systems are now reaching the end of their lifespan and are in need of upgrades.<sup>467</sup> However, funding for these upgrades has slowed since their construction. For example, spending on transportation and water infrastructure at the state and federal levels has flatlined since 2000,<sup>468</sup> despite the average age of government-owned infrastructure systems increasing from 18 years old to 25 years old between 1970 and 2009.<sup>469</sup> This indicates that systems are being replaced at a slower rate than in previous years, and potentially increases the chance of failure due to age.

The effects of climate change could also impact infrastructure. Rising sea levels can extend the reach of coastal flooding and damage facilities located along the water, such as the West Point wastewater treatment facility. King County estimates that 30 major wastewater treatment facilities are at risk of flooding during storms due to sea level rise (assuming a 15-foot rise) by 2100.<sup>470</sup> Additionally, Seattle is projected to experience more extreme high temperatures. High heat can cause steel to expand which may impact older structures like drawbridges.

### **8.4.4 Vulnerability**

Seattle represents the greatest concentration of infrastructure in the Pacific Northwest and one of the oldest settlements in Washington State. Seattle has a bigger collection of infrastructure maintenance needs than anywhere else in Washington State, giving it an intrinsic vulnerability to infrastructure failure. The City also owns or relies on infrastructure in more remote parts of the state, including a number of dams that are used for water supply, power generation, and flood control. The most significant vulnerability is failure of the Howard Hanson Dam, which could cause flooding around the Duwamish River.<sup>471</sup> If other dams were to fail it would mostly affect power generation and water supply capabilities.

The vulnerability of individual systems varies greatly according to the condition of the components, system complexity, the ease and speed with which damage propagates through an infrastructure system and the amount of redundancy in the system.

Virtually every part of Seattle is vulnerable to one type of failure or another because of the ubiquity and dependence of every social and economic function on working infrastructure. However, some places are more sensitive than others. These include locations where multiple facilities or pipelines are co-located or where an area can only be serviced by one utility line, facility or transport route.

The most vulnerable periods in the life of a structure are during construction, right after it is built, and as it nears or exceeds its expected operational life. Most of Seattle's larger-scale failures occurred during one of these phases. Many times, visible signs that are present before a failure allow people time to escape. Warning signs are the major reason there were no casualties during the collapse of the Tacoma Narrows Bridge, Husky Stadium, and the I-90 floating bridge.

Seattle's growing population increases its vulnerability to infrastructure failure. Roads and bridges may be degraded faster with the increased volume of traffic. There is also a major construction boom happening across the city, increasing the likelihood of an infrastructure failure occurring during the building phase. In 2018, Seattle had 45 construction cranes, the most of anywhere in the U.S.<sup>472</sup> Seattle has never experienced a disastrous crane collapse, but other urban cities have. In 2006, a 210-foot crane collapsed in the neighboring city of Bellevue, severely damaging an apartment and office building and killing one apartment resident.<sup>473</sup> The collapse caused millions of dollars in building damage, ruptured water and gas mains, and blocked traffic while crews investigated and cleaned up debris. It was agreed that if the crane had collapsed during business hours, many more casualties would have occurred. The cause of failure was associated with a non-standard base construction, leading to more stringent crane-safety laws in the state. Despite new testing and inspection requirements, large cranes that have passed inspections have proceeded to collapse in cities across the U.S. If Seattle's population continues to grow at a similar pace, construction sites and cranes will continue to be erected throughout the city. Downtown is most vulnerable to the potential damages of a crane or building collapse due to its dense network of office, retail, and residential buildings.

### **8.4.5 Consequences**

Infrastructure and structural failures have caused fatalities, injuries, utility outages, and economic losses in Seattle and are expected to do so again.

Many past failures have involved bridges and the water system. Failures are more frequent in systems under construction or in older components. Consequences would be worse if the failure occurs in a heavily used or populated area, and the failed component is co-located with other key infrastructure. Seattle has a lot of infrastructure and will continue to invest in more, creating many potential failure scenarios.

If Seattle were to experience a major structural failure, such as a bridge or crane collapse, or a large sinkhole, there would likely be fatalities and injuries to those in the immediate vicinity. In the past 50 years, the deadliest bridge collapses in the U.S. have caused between 3 and 114 fatalities.<sup>474</sup> If a major road, such as I-5 or SR-99, is damaged or disrupted from the incident, there would be prolonged increases in traffic as vehicles would have to take alternate routes until the road was repaired or cleared. The economic cost of the traffic impacts in the Minneapolis I-35 bridge collapse was an estimated \$70 million-dollar reduction in economic output (about 0.01% of the state economic output).<sup>475</sup> Collapsing infrastructure has also disrupted power systems. The Skagit River bridge collapse caused a minor power outage for about 250 customers.<sup>476</sup>

Utility infrastructure failures would likely have fewer casualties, unless it involved a pipeline or steam explosion. Nevertheless, there can be delayed impacts on health from a utility failure. In Flint, Michigan, 12 people died and 90 became ill from legionella bacteria in the municipal water system.<sup>477</sup> Additionally, prolonged power outages have led to deaths from carbon monoxide poisoning. There are also cascading

impacts. Water leaks can cause landslides if they are able to saturate slopes, and gas pipe ruptures or failures of waste treatment facilities can lead to hazardous materials incidents.

A break in one of the 42” water mains was chosen as the most likely scenario because Seattle has had large water main breaks in the past, it is critical service and could cause significant ‘collateral damage.’ A collapse of the I-5 Ship Canal Bridge was chosen as the maximum-credible scenario because it is the most heavily trafficked stretch of road in the city and would have many immediate and prolonged impacts.

#### **8 4.6 Conclusions**

Seattle’s growing population will put greater demands on infrastructure systems that were built decades ago with lower-capacity designs. Updating or replacing these systems requires huge investments and will happen slowly. In the meantime, old infrastructure has the potential to fail catastrophically. There were over 450 bridge collapses in the U.S. between 1989 and 2000. The average age of these bridges was 53 years.<sup>478</sup> Even if Seattle were able to update all of its infrastructure, the boom in new structures and infrastructure make the city vulnerable to design flaws, construction errors, and accidents.

Single site or structure failures have been shown to cause high numbers of casualties but have a limited geographic scope, such as the collapse of a pedestrian bridge in a Hyatt Regency hotel in Kansas City, Missouri, that killed 114 people.<sup>479</sup> Single failures can usually be contained relatively easily, and recovery tends to be quick and comprehensive, unless the failed infrastructure plays an essential part to the cities functioning, like a major interstate. On the other hand, infrastructure failures can have less severe impacts that are felt on a broader geographic scope. For example, a dam failure could flood communities many miles downstream from the dam.



## 8.5 Power Outages

- The 2003 Northeast Blackout highlighted the fragility and interdependence of the country's electrical system.
- The United States power grid is made up of three interconnecting networks. Seattle's power infrastructure is linked to the Western Interconnection, a network of public and private power generators and distributors that serve over 80 million people in the Western U.S., from Mexico to Canada.<sup>480</sup>
- About half of Seattle City Light's unplanned power outages are caused by falling trees or branches.
- Almost 90% of Seattle's power comes from hydroelectric power; 47% of the power Seattle consumes is purchased.<sup>481</sup>
- Seattle could face power outages due to electrical vault fires, windstorms, or an issue in the regional grid. Seattle has the ability to isolate itself from the grid but cannot supply enough electricity for the city on its own.
- The largest impacts of an extended power outage would be economic because most businesses in the affected area would likely shut down.
- Seattle's power depends on the health of generating facilities that lay far outside the municipal boundaries, on snow and rain that are the "fuel" for hydroelectric power and finally on the health of the transmission and distribution lines that move the power.
- Expected climate and hydrologic changes will likely alter the annual patterns of hydroelectric supply, lowering supply during the summer and increasing supply during the winter.
- By 2028, peak demand may not be met in winter without purchasing additional power.<sup>482</sup>

### 8.5.1 Context

On August 14, 2003, a large part of the upper Midwest, East Coast, and Ontario, Canada went dark. The power outage affected 50 million people. Some parts of the United States waited four days for the power to be restored. Estimated losses ranged from \$4 billion to \$10 billion. The outage highlighted widespread infrastructure problems in the power grid, and the complexity and consequences of widespread power outages.

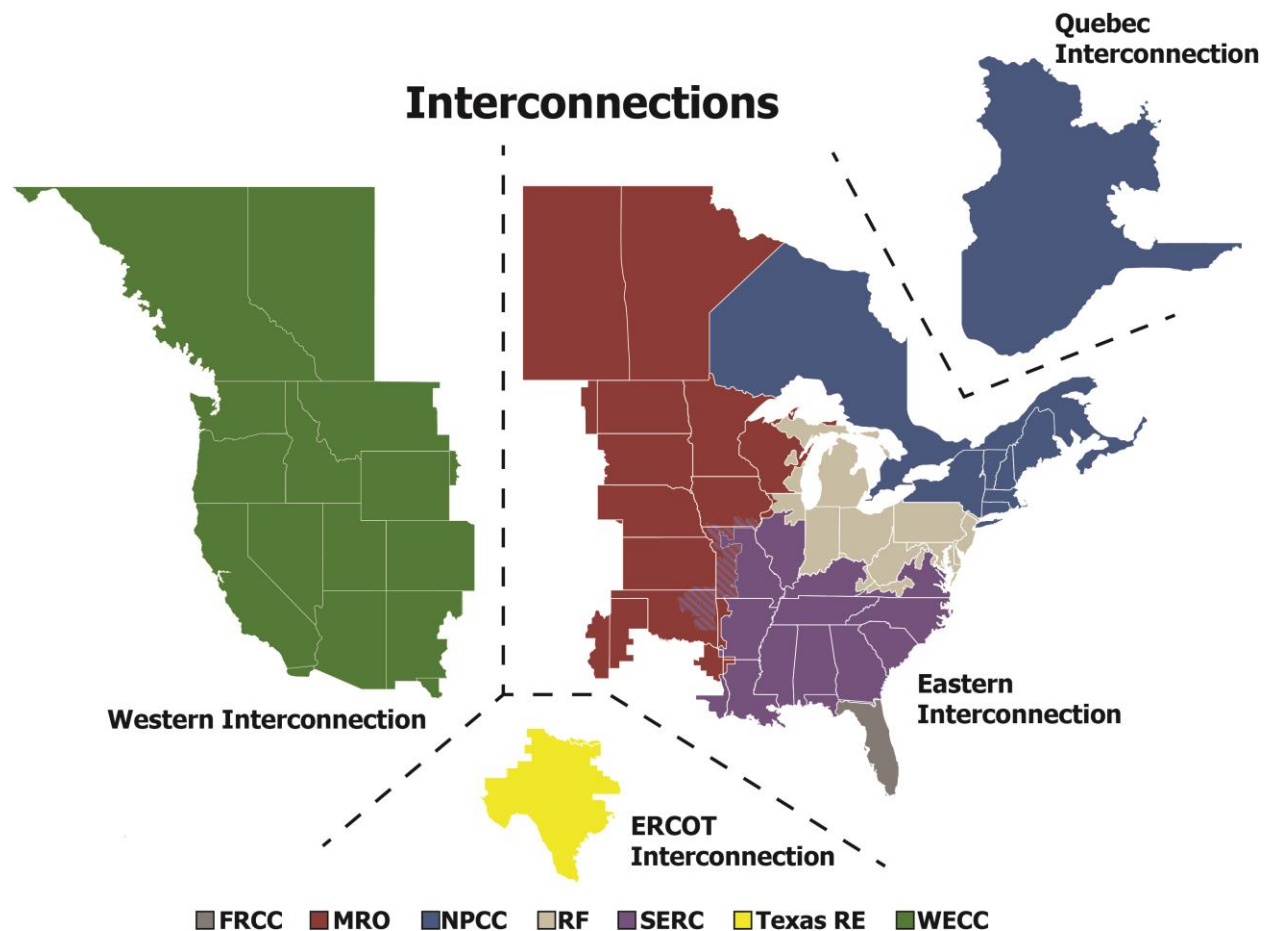
Power is an essential component of modern society and is immediately noticeable when absent. The 2003 outage caused other areas of the country to look at their own networks to analyze the chances of a similar incident and its potential effects on their own networks.

A power outage can affect an isolated area or be widespread. A total loss of power would be considered a "blackout." A "brownout" occurs when the voltage level is below the normal minimum level specified for the system. A brownout may be done intentionally to prevent a full power outage. "Load shedding" or "rolling blackout" is a common term for a controlled way of rotating available generation capacity between various districts or customers, avoiding total, wide-spread blackouts.

The City of Seattle owns its own generating capacity, transmission lines, and distribution system. It is operated by the city's public power utility, Seattle City Light (SCL), and is connected to the Bonneville Power Administration (BPA) network, which is part of the Western Interconnection, an electricity network made up of 11 western states, two Canadian provinces and northern Baja California, Mexico (see Figure [United States electricity networks]). The Western Interconnection has more Balancing Authorities, which make sure that the supply and demand flows of electricity are balanced, than any

other U.S. network, but is served by only one Reliability Coordinator that provides situational awareness and real-time monitoring for the grid.<sup>483</sup>

**Figure 8-7. United States Electrical Interconnections**



Source: Interconnections. North America Electric Reliability Corporation. Retrieved August 23, 2018, from <https://www.nerc.com/AboutNERC/keyplayers/PublishingImages/Interconnections%2024JUL18.jpg>

The high voltage transmission system is near capacity in many parts of the West, including the Pacific Northwest. A seasonal power exchange in this system takes advantage of the seasonal diversity between the Northwest's winter peaking and the Southwest's summer peaking loads. Utilities can transfer firm power from north to south during the Southwest's summer load season and from south to north during the Northwest's winter load season, allowing both regions to maintain less generating capacity than would otherwise be necessary. SCL's existing portfolio includes a seasonal exchange with utilities in Northern California.

SCL serves more than 750,000 customers and is the tenth largest public electric utility in the country. SCL owns seven dams, mostly on the Skagit and Pend Oreille Rivers. Almost 90% of Seattle's power comes from hydroelectric power, both from its own dams and those of the BPA.<sup>484</sup> The remaining 10% comes from a variety of sources such as nuclear, wind, and coal. SCL owns no coal or nuclear generation, but a portion of the power SCL purchases from BPA is generated by these sources. SCL purchases about 40% of the power that Seattle consumes.<sup>485</sup> Seattle's power depends on the health of generating facilities that lay far outside the municipal boundaries, on snow and rain levels that are needed for



hydroelectric power generation, and finally on the health of the transmission and distribution lines that move the power. Seattle has powerlines underground in Downtown and other dense areas of the city. More information on Seattle's power supply can be found in the Community Profile section.

## **8 5.2 History**

All power systems experience unplanned outages. Most are small, resolved within a few hours and do no lasting damage. Larger outages occasionally occur. These outages are usually secondary events caused by other hazards, e.g., winter storms. Some larger outages, such as the 2003 outage, demonstrated that power outages can be a primary incident. Two local examples are two fires in underground vaults serving the downtown areas that caused lengthy outages. This section lists major outages in Seattle and several regional events that did not directly affect Seattle but highlight issues with the Western power grid.

**1958. Seattle. Wind related outages.** Loss of power in many areas of the city, especially in West Seattle and Magnolia.

**1962. Seattle. Columbus Day Storm.** Biggest storm to hit the Pacific Northwest. It affected utilities throughout the region.

**1988. Downtown Seattle Vault fire.** Six electrical cables were damaged resulting in a four-day loss of power to a 50-block area in downtown. The area included the Westin Hotel and the Pike Place Market. The cause was a contractor driving a steel piling through a buried cable. Businesses that lost power sued the City and the contractor. Newspaper reports that the City paid more than \$1.5 million to settle claims.

**1993. Downtown Seattle Vault fire on October 5<sup>th</sup>.** 1,800 customers in about 270 buildings were out of power for up to three days in a 37-block area. Eight large generators were brought in to help the population. Fire destroyed huge underground cables that had to be replaced.

**1996. Western Interconnection.** Two major outages struck the Western power grid in 1996. On July 2, a localized outage caused by a tree in Idaho led to a cascading regional outage that resulted in 10% of the consumers in the western U.S. losing their power for at least a few minutes. The next month, on August 10, more than 7 million people across the West lost power. Areas were affected intermittently for up to several hours. While the outages weren't long, they highlighted the fragility of the network.

**1997. Western Interconnection.** Two separate disturbances in the Western grid that interconnects with Seattle City Light's system. Both outages had minor customer impact but could have been worse.

**2000 – 2001. California.** Rolling blackouts plagued much of California. The Northwest was involved as a power supplier. This event placed strain on transmission lines in the Northwest and caused two major outages during peak demand periods. The energy crisis cost California \$40 billion in added energy costs, and customers saw their energy bills double or triple during that time.<sup>486</sup>

**2006. Seattle. Hanukkah Eve Wind Storm.** Seattle City Light suffered its most extensive outages in the utility's history as a result of a severe regional windstorm. More than 49% of customers lost power. Some customers were without power for more than a week. Neighboring utilities also suffered major damage.

**July 2009. Western Washington.** While Seattle avoided power outages during record heat, Tacoma and Monroe did not. Typically, summer is a low demand time for Pacific Northwest power but the increasing number of HVAC systems in the area can lead to high energy demands. This event demonstrated that Seattle is also vulnerable to demand spikes during the summer.

**August 2015. North Cascades. Goodell Creek Fire.** Lightning in the North Cascades National Park started a wildland fire that forced Seattle City Light to shut off transmission lines from its Skagit hydroelectric

project.<sup>487</sup> The loss of transmission capacity cost the utility an estimated \$100,000 per day. While the threatened dams and powerhouses typically produced 20% of Seattle City Light power, no outages occurred from the fire.

### **8 5.3 Likelihood of Future Occurrences**

Seattle has never suffered a catastrophic blackout like the Northeast nor has it had rolling blackouts like California experienced during 2000 and 2001, however several events on the Western grid have come close to affecting the city.

Seattle has experienced three large unplanned and multi-day outages in the past 30 years. The most likely sources are underground vault fires, regional windstorms, or an issue in the regional power grid.

A regional cascading blackout is a possibility in this region. A problem could originate outside the SCL system because of its interconnectedness with the BPA system. Seattle has the ability to isolate itself but, because the city can only generate a portion of its power, “islanding” could cause short-term, supply-related rolling blackouts.

Wind will continue to be a hazard to power distribution. Although it has fewer trees than the rest of the county, Seattle has successfully been re-growing its tree canopy. About half of SCL’s unplanned power outages are caused by falling trees or branches. SCL has implemented a vegetation management program to trim trees that may grow into or fall on power lines.<sup>488</sup> Vegetation management specialists work with arborists year-round to trim back trees from lines. The whole system is trimmed every four years.

Improvements have been made to underground electrical vaults, including automatic fire suppression and remote vault monitoring capabilities.<sup>489</sup> These improvements have reduced the likelihood and duration of outages. Nevertheless, there have been 20 electrical vault fires in Seattle since 2016. A recent vault fire in the Green Lake neighborhood caused outages for about 5,000 customers, but only for a few hours.<sup>490</sup>

### **8 5.4 Vulnerability**

Power lines are underground in the downtown core and other dense areas. They are vulnerable to vault fires but extremely resistant to wind damage. Locally, more power has been going underground. The underground system is less likely to fail but can be more time consuming and expensive to repair when it does fail. In the rest of the city, wind damage is linked to the number of trees close to power lines. In 2015, SCL began piloting “self-healing” power lines.<sup>491</sup> The technology can detect an outage and isolate the section of the circuit being affected. Power is then restored to areas that are not directly affected by the isolated section. Self-healing lines reduce the number of customers without power as well as pinpoint the outage location more precisely, so workers can respond faster.

SCL relies on BPA mainly for its transmission lines, which are on steel towers that are very resistant to storms. However, an earthquake or wildland fire has the potential to disrupt these lines. Not only can a transmission tower be damaged due to fire, but soot from fires can build up on line insulators and cause electric arcing. Several dams that generate power for Seattle are located many miles outside the city and are vulnerable to wildland fire. Even before the Goodell Creek Fire in 2015, SCL had made fire protection upgrades at its vulnerable dams.<sup>492</sup>

Earthquake vulnerability is not evenly distributed throughout the power system. Historically, transmission towers and lines have fared better in earthquakes than operation centers and substations.<sup>493</sup> SCL has attempted to mitigate this vulnerability by building seismic isolation technology into high voltage transformers.

Communities with older high-rise and commercial buildings are generally more vulnerable to an outage because they often lack backup generators. During the 2006 storms and power outages, it was discovered that many nursing homes lacked back-up power. With many residents dependent on electrical equipment, these facilities are highly vulnerable to outages.

Hospitals are even more sensitive than nursing homes. However, hospitals have emergency power generators that are typically powered by diesel fuel and configured to start automatically as soon as a power failure occurs. During Hurricane Katrina, hospital patients began experiencing life-threatening conditions within hours of power loss. Seattle is the major concentration of hospitals in the region.

Other life-critical systems such as telecommunications are also required to have emergency power. All Seattle fire stations have emergency generators.

General economic health and social climate has a significant effect on what happens during a blackout. The 1978 New York blackout occurred during a time of political instability and discontent. As a result, there was widespread looting. In the 2003 Northeast Blackout, there was none. The social climate is an important external variable in a widespread outage.

Almost all businesses depend on reliable power. Businesses with perishable inventory, like grocery stores and restaurants, stand to take permanent losses during extended outages. When the power is out only in one community, the retail stores in that community lose customers to neighboring communities. If the outage is short but widespread, then retail stores do not suffer because post-incident sales trend accelerate and make up for the downtime.

### **8 5.5 Consequences**

The December 2006 windstorm demonstrated the importance of power. Some parts of the city were without power for nearly a week during very cold weather. The outages led to several fatalities outside the City of Seattle. The response was the second costliest in the City's history after the Nisqually Earthquake.

The largest impacts of an extended power outage would be to the economy as most businesses are likely to shut down in an extended outage. During the 2006 power outages, City financial records indicate that more than \$6.9 million was spent repairing and replacing wires, transformers, and poles. Local transportation networks collapse when traffic signals are out. In 2006, 150 traffic signals went dark.

The maximum credible scenario would probably be some sort of "perfect storm" of disparate elements coming together to create a huge problem. This would probably include a regional outage involving the Western Interconnection during a period of peak power demand in Seattle. Even if Seattle could successfully island its infrastructure, it might not be able to meet all the demand. Since extreme demand tends to be driven by extreme weather, it is likely that Seattle would be facing either very hot or very cold temperatures at the same time. Currently, Seattle's social climate seems very stable, but if it is not, that could be one more potential element in the mix.

### **8 5.6 Future Challenges**

Climate change presents future challenges for the power system. While warming temperatures may increase power demand for cooling purposes, overall energy efficiency is expected to offset this increase in demand. Projected changes in snowpack and streamflow will likely have the biggest impacts on the power system. Hydropower generation in the Columbia River Basin is projected to increase 5% in winter and decrease 12 to 15% in summer by the 2040s (relative to 1970-1999). The same seasonal pattern of change is expected to occur in the Skagit watershed, though the exact amount of change is not well

known. If SCL cannot meet demand in the summer due to the decrease in power generation, they may have to purchase additional power. More impacts are discussed in the climate change chapter.

### **8 5.7 Conclusions**

To plan for the acquisition of new resources, which can take many years, SCL forecasts future power consumption or load in its service area 20 years into the future. Load is only expected to grow by 0.4% by 2035.<sup>494</sup> Additionally, some of the power purchase contracts will expire.

Forecasts estimate that the Pacific Northwest will have more than adequate reserves to meet a 12% recommended reserve margin for the next decade under normal conditions, accounting for climate impacts.



## 9. WEATHER HAZARDS

Seattle has long been known for its mild, damp weather, but as with most things, the reality is more complicated than the image. Not only does Seattle have less rain in a year than many people think, it has a less even distribution of rain throughout the year than most people realize. Seattle's summers are very dry. Water shortages can occur.

Dividing Seattle's weather hazards into distinct categories can be a bit misleading. Most weather events are complex, involving multiple hazards.



## 9.1 Excessive Heat Events

- Excessive heat can be a hidden killer. In August 2003, excessive heat killed more than 15,000 people in France. In Cook County, Illinois in 1995, more than 700 deaths were attributed to heat. Because heat does no physical damage and deaths tend to occur in private dwellings, the extent of a heat disaster is often not visible to the public.
- Since the mid-1970s, an average of three or four heat-related fatalities has occurred each summer in Seattle. During excessively warm summers, such as the summer of 1992, up to 50 to 60 deaths have occurred.
- The season, humidity, duration and availability of cooling systems all strongly influence the impact of excessive heat events.
- Seattle’s typically mild summers result in a population that is less acclimatized to extreme heat compared with that of many other cities in the United States. Health effects associated with heat begin in Seattle at lower temperatures than many other places. The relative temperature, compared to normal seasonal temperatures, is often more important than the actual temperature. Seattle is among the cities with the highest heat sensitivity in the country
- Many Seattle homes and businesses lack cooling systems, increasing our vulnerability.
- The most vulnerable people in heat events are the elderly, infants, the homeless, the poor and people who are socially isolated.
- Heat cramps, heat exhaustion, and heat stroke are examples of negative health effects associated with both average warmer summer temperatures and temperature extremes.
- In Seattle, most fatalities are indirectly caused by heat, e.g., heart attacks, strokes, and respiratory illness.
- Climate research shows that extreme heat events have become more severe in the Pacific Northwest in recent decades. Experts project that temperatures on the hottest days in the Puget Sound area will increase by 6.5°F on average by 2050.<sup>495</sup> Nighttime low temperatures are also increasing, limiting nighttime heat relief.
- Heat can be costly. The costs of one extreme heat wave in California in 2006 were estimated at over \$200 million.

### 9.1.1 Context

On July 29, 2009, the temperature reached 103° at SeaTac airport, an all-time record. Two people in Western Washington died. The most brutal temperatures lasted three days. If the extreme weather had lasted a few days more, the number of fatalities would probably have climbed dramatically. Seattle has a famously mild climate that makes it difficult for the community to acclimate to extreme heat when it occurs.

An excessive heat event (EHE), or heat wave, is a weather pattern that is substantially hotter and/or more humid than average for a location at that time of year. EHE’s can cause dehydration, heat cramps, heat exhaustion, heat stroke, and even death. Seattle’s proximity to the Pacific Ocean generally results in mild summers with low humidity. Onshore air flows off the cool Pacific Ocean act as a natural air conditioner for the region. However, when dry air from the Northwest interior sinks along the western slopes of the Cascade Mountains it gets compressed and heats up. In the summer, when the sun is the strongest, Seattle experiences EHEs when the onshore flows of the Pacific decrease and there is an occurrence of downslope flow on the western slopes of the Cascade mountains. EHEs in Seattle usually

do not last very long because the pressure difference that builds with the warming air eventually grows to the point where marine air will surge in and cool the area once again.<sup>496</sup>

In an average year, about 134 Americans succumb to the effects of summer heat.<sup>497</sup> During the summer of 2006, 253 people in the United States died as a direct result of heat.<sup>498</sup> Heat waves in August 2003 that affected all of Western Europe resulted in more than 15,000 deaths in France alone. In July 1995, “excessive heat” conditions were blamed for more than 700 deaths in Cook County, Illinois. In July 1993, similar temperature extremes led to roughly 120 deaths in Philadelphia, Pennsylvania.

Human bodies dissipate heat by varying the rate and depth of blood circulation, by losing water through the skin and sweat glands, and by panting when the body’s core is heated above 98.6°F. The skin handles about 90% of the body’s heat dissipating function. Sweating, by itself, does nothing to cool the body unless the water is removed by evaporation. High relative humidity delays evaporation. Heat disorders generally have to do with a reduction or collapse of the body’s ability to shed heat by circulatory changes and sweating, or a chemical imbalance of salt caused by too much sweating. When heat gain exceeds the level the body can remove, or when the body cannot compensate for fluids and salt lost through perspiration, the temperature of the body’s inner core begins to rise and can cause damage to the brain and other vital organs. Heat-related illness may develop.

Once the air temperature exceeds skin temperature, convective cooling from the skin is no longer possible. The effects of ventilation/wind reverse, adding heat to the body. This is a dangerous scenario that causes individuals sitting in hot rooms with fans on to accelerate deterioration under hot conditions. Some decedents in the Chicago heat wave were found in indoor spaces with the fan on and are believed to have died as a result of this mechanism.

Statistical analysis of King County mortality data by David Hondula found that adverse health effects for heat begin to rise at 25.9° C (78.6° F). This is several degrees lower than other cities in the United States. The research studied day to day baseline conditions and not extreme events.<sup>499</sup> Understanding our increased vulnerability to high temperatures, researchers have recently examined whether excessive heat days increase the risk of Emergency Medical Service (EMS) demand, hospitalizations, and mortality in King County. Calkins and colleagues found that on excessive heat days, there was an 8% increase in Basic Life Support (BLS) calls and a 14% increase in Advanced life Support (ALS) calls (over a 6-year study period). The risk of these EMS calls increases with each unit increase of the humidity index.<sup>500</sup> Isaksen and colleagues analyzed hospital admissions and mortality associated with EHE in King County over a 30-year period. They report a 2% increase in hospitalizations and a 10% increase in risk of death on EHE days, with risk increasing as heat increases.<sup>501</sup> Both researchers identified the elderly as an especially vulnerable population. More surprisingly, however, their studies revealed an increased risk on EHE days for EMS calls, diabetes-related mortality, kidney disorders, acute renal failure, natural heat exposure, and asthma hospitalizations for young and middle-aged adults, a population generally thought to be more resilient to heat.<sup>502</sup>

The Washington Climate Impacts Group (CIG) projects that EHEs in the northwest will become more severe in the future. They project that the hottest days in the Puget Sound area will increase by 6.5°F, on average, by the 2050s.<sup>503</sup> Based on current models, EHEs are expected to increase in frequency due to climate change.

## **9.1.2 History**

While good meteorological records exist for Seattle, heat waves are more complex than just high temperatures. Other factors like time of year, humidity, duration, extent of nighttime cooling, and the availability of cooling systems all strongly influence the effect. Because of these factors and the recognition of EHEs as a type of disaster only recently, records are marginal.

**1981.** A heat wave lasted several days in the upper 90s.

**1992.** A record 15 heat warnings were issued by the National Weather Service for the Seattle area. An estimated 50 – 60 people died because of the heat<sup>504</sup>.

**1994.** A city-wide heat extreme is set, recorded at 100 degrees.

**2009.** A new all-time record set when the maximum temperature reached 103 degrees. Humidity was unusually high.<sup>505</sup> Two deaths in Western Washington are directly attributable to the heat.

**2015.** Seattle’s hottest summer on record. The average high temperature was 80.2 degrees Fahrenheit. July had 10 days with high temperatures in the 90s.<sup>506</sup>

### 9 1.3 Likelihood of Future Occurrences

The Washington Climate Change Impacts Assessment looked at the likelihood of future extreme heat events. It used three different scenarios of summer warming—low, moderate and high—and developed estimates for the number heat events. In every scenario, they predict a rise. In the worst-case scenario, Seattle could have an average of ten heat events per year with a maximum duration of 57 days by 2085 (Table 47).

Climate data for the Puget Sound area from 1901 to 2009 reveals a trend towards daily low temperatures increasing at a higher rate than daily high temperatures.<sup>507</sup> In other words, night time temperatures are rising, meaning there could be less of a cooling effect at night during future EHE’s.

**Table 9-1. Projected Heat Events**

	1980 - 2006	2025	2045	2085
1980 - 2006				
Mean annual heat events	1.7			
Mean (max) event duration in days	2.2(6)			
Low				
Mean annual heat events		2.6	3.1	3.8
Mean (max) event duration in days		2.2(6)	2.3(7)	2.3(8)
Medium				
Mean annual heat events		3.6	4.7	7.2
Mean (max) event duration in days		2.3(7)	2.6(14)	2.9(18)
High				
Mean annual heat events		5.8	8.8	10.1
Mean (max) event duration in days		2.7(18)	3.2(18)	6.1(57)

Source: Washington State Climate Change Impact Assessment, 2009.

### 9 1.4 Vulnerability

Demographic vulnerability to EHEs is similar to other hazards. Factors that increase vulnerability include: age (65+), ethnicity, preexisting health conditions, education, income. Many residents lack efficient cooling systems in their homes or businesses and remain unaware how to protect themselves. 2015 American Housing Survey data shows that only 33.7% of Seattle area homes have air conditioning. For those aged 65 and older, the percentage only jumps slightly, to 37%.<sup>508</sup> However, building trends suggest

there could be a future increase. About a quarter of new apartment buildings constructed in Seattle in the past decade have air conditioning.<sup>509</sup>

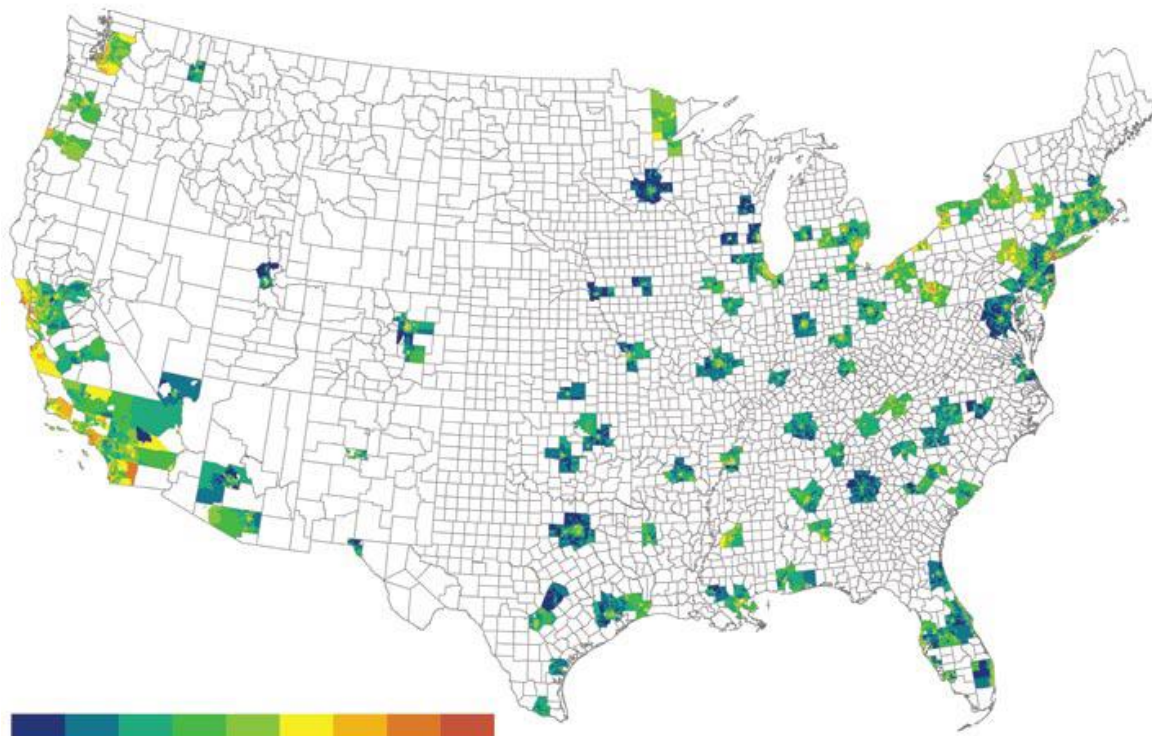
The difference between the normal temperature and the current temperature dictates the real impact that heat has on the individual. Since we normally have fairly mild temperatures, our population can feel more stressed at lower temperatures than many other places, especially if the rise happens suddenly.

Warmer average summer temperatures experienced in cities across the United States and elsewhere have led to premature death among certain populations, including those who are elderly, very young, poor, cognitively or physically impaired and already burdened with chronic disease, such as hypertension and diabetes. The most vulnerable people in Seattle tend to be the elderly.

Urban areas can also have reduced air flow because of tall buildings and increased amounts of waste heat generated from vehicles, factories, and air conditioners. When vegetation in urban areas is replaced with buildings, especially those with dark roofs, and dark paving materials, the heat absorbed during the day increases and cooling from shade and evaporation of water from soil and leaves is lost. These factors can contribute to the development of an urban heat island with higher daytime maximum temperatures and less nighttime cooling than surrounding rural areas.

A 2009 study of heat vulnerability on a national scale found that Seattle is on par with Chicago, site of a 1995 EHE that killed over 700 people. The study uses a Heat Vulnerability Index, driven by four factors: social isolation, lack of air conditioning, the proportion the population with chronic medical conditions, and social vulnerability (race, poverty, age, and housing conditions). The authors suggested that local and regional factors also play a role and suggested research of these as a next step in defining local hazard exposure.<sup>510</sup>

**Figure 9-1. Comparative Heat Vulnerability Nationally**

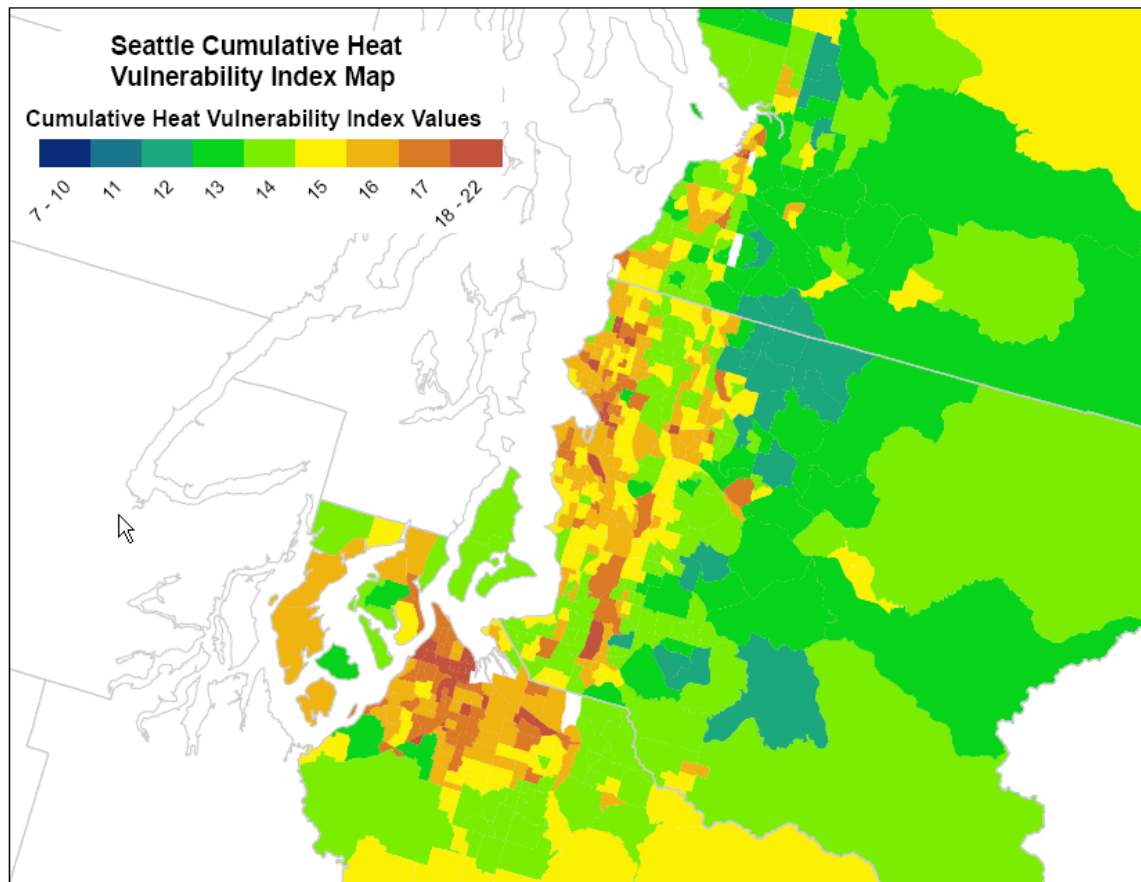


A separate study in 2015 showed that the risk of mortality from EHEs can vary even within cities. For Seattle specifically, postal code areas that have higher percentages of elderly (65+) residents and Pacific Islander residents are associated with a higher risk of heat-related death during EHEs.<sup>511</sup>

### 9 1.5 Consequences

Looking at Seattle area weather and mortality statistics back to the mid-1970s, an average of three or four fatalities have occurred each summer.<sup>512</sup> During excessively warm summers, such as the summer of 1992, up to 50 to 60 deaths have occurred. According to the state health department, hospitalizations for heat-related illness in Washington state range from 25-113 people each year.<sup>513</sup> In Seattle, most fatalities are indirectly caused by heat, such as heart attacks, strokes and respiratory illness.

**Figure 9-2. Seattle Metro Area Heat Vulnerability Index**



Source: Colleen Reid, personal communication. 2009.

Hotter temperatures may also make people with certain health conditions such as diabetes and obesity less likely to pursue physical activity critical to management and improvement of their health conditions. These factors, along with research suggesting increases in the demand of healthcare services during EHEs, means that Seattle's EMS and healthcare institutions could be overwhelmed during a severe EHE.

Warmer temperatures are typically associated with precursors of air pollutants that are in turn linked to respiratory disease and reduced lung function. In addition to causing climate change, high carbon dioxide concentrations in the atmosphere are associated with production of allergens such as ragweed

pollen that can, in turn, contribute to asthma cases by combining with fossil fuel pollutants, especially diesel exhaust.

There are also non-health consequences of heat. EHEs can increase the risk of brush fires as vegetation dries. In July 2018, fire fighters in King County responded to 20 brush fires in one weekend alone.<sup>514</sup> Brush fires can threaten adjacent property and cause traffic delays on major roads. High heat can also cause steel to expand, threatening the function of certain infrastructure like draw bridges. In 2018 firefighters in Chicago had to hose down a steel bridge that would not open to boat traffic due to heat expansion.<sup>515</sup> Seattle has 7 bridges that must open to marine traffic.<sup>516</sup>

EHEs have the ability to lead to power outages if energy demand spikes as more people use cooling units. The majority of Seattle residents still do not have air conditioning units. Despite the growth of air conditioning in new apartment complexes, the technology being used is very energy efficient, so demand is not increasing locally.<sup>517</sup> If Seattle were to increase its air conditioning consumption to national levels, around 75%, it could overload the system to the point where outages could occur.<sup>518</sup> In 2018, Los Angeles experienced unprecedented energy demand levels during a heat wave, causing over 25,000 residents to lose power, some for as long as three days.<sup>519</sup> About 73% of households have air conditioning in Los Angeles.<sup>520</sup> EHEs that coincide with a drought or low snow-pack year for Seattle's watersheds could result in a water shortage. If Seattle's water reserves are already low, high demand during hot days could lead the City to impose water usage curtailments.

Climate research suggests an increase in EHE severity, which is discussed further in the chapter on climate change.

## **9 1.6 Conclusions**

Meteorologists can accurately forecast EHE development and the severity of the associated conditions with several days of lead time. The National Weather Service (NWS) has developed a Heat Health Watch/Warning System that tailors excessive heat guidance to specific regions in the country. The Seattle area implemented this new system in 2005, becoming the 15<sup>th</sup> urban region of at least 500,000 in population to do so. Excessive heat events may be becoming more severe in the Northwest. This may increase the exposure of vulnerable populations.



## 9.2 Flooding

- Nationally, floods are the most costly and destructive disasters. Most of the damage caused by Hurricane Katrina was caused by flooding.
- Western Washington is very prone to flooding, and Seattle’s flood profile is different from the rest of the state. Seattle has three distinct flooding hazards: riverine flooding, coastal flooding, and urban flooding. Urban and riverine flooding are most common.
- Climate change is projected to cause sea level rise and increase the frequency of heavy rain events, heightening Seattle’s future risk of urban and coastal flooding.
- The area in the 100-year floodplains covers South Park and the drainage basins for Thornton and Longfellow Creeks. Flood control structures have been built in all of these areas. Small segments of two high-volume arterials cross the flood plain: SR99 crosses the South Park floodplain and SR 522 cross along three segments of Thornton Creek.
- Federal Emergency Management Agency (FEMA) data reveals that Seattle has 12 buildings (including residential) that have had more than one flood loss.

### 9.2.1 Context

In December 2006, heavy rains overwhelmed the City’s drainage systems and water backed up at the top of an embankment in the Madison Valley area. It overtopped the embankment, rushed downhill, slammed into a home and caused one fatality. This event raised awareness about the seriousness of Seattle’s flood hazard.

Seattle has over 200 miles of waterfront, making coastal and riverine flooding a natural concern in the area. It is surrounded by Puget Sound and Lake Washington and contains the Duwamish River, a ship canal, and several streams. Moreover, flooding outside Seattle can affect the city. For example, flooding along the Cedar River can decrease water quality to the point where it cannot be diverted for drinking water supply and water stored in Lake Youngs needs to be used instead.

Flooding in Seattle falls into three types:

- **Riverine flooding** – Heavy precipitation causes a river or stream to overflow its banks into the adjoining floodplain. This is the classic flood. Seattle’s creeks, especially Thornton and Longfellow, have flooded more often than the Duwamish River, which is managed by the Howard Hanson Dam. Failure of the Howard Hanson dam or the release of large volumes of water from the dam could cause flooding of the Duwamish River.
- **Coastal flooding** – Associated with storms. High tides and wind can push water into coastal areas. Coastal flooding can erode the toes of bluffs and are one factor in landslides. Some areas, like South Park, can experience drainage problems under the same conditions.
- **Urban flooding** – Happens when intense rain overwhelms the capacity of the drainage system. Low lying, bowl-shaped areas like Madison Valley and Midvale are the most likely to flood.

The key factors determining the amount of damage in a flood are the depth and velocity of the water, and the amount of time the water stays above flood level. To project the expected amount of damage, the frequency of high water in a particular area needs to be computed. Usually, this is done by the Federal Emergency Management Agency (FEMA). An area that has a 1% chance of happening in any given year is called a 100-year floodplain. Similarly, a 500-year flood has a 0.2% chance of occurring each year. The elevation and shape of these floodplains, as well as historical and geological records, suggest probable flood depths and velocity.

Riverine floods often develop slowly and give floodplain residents ample time to evacuate. Casualties occur when people cannot or will not leave or try to drive across flooded roadways. Flash floods or dam failures are more dangerous than typical riverine floods because people have less time to escape and are more likely to get trapped. Even small floods can cause heavy structural damage by rotting wooden frames and undermining foundations. More frequently they destroy moveable property and commercial stock.

Riverine floods can also affect city infrastructure when high water cuts transportation routes and pipelines. These lifeline losses can impact people beyond the immediate floodplain. If floodwaters inundate hazardous waste sites or buildings where dangerous chemicals are housed, they also generate secondary incidents such as hazardous material exposures. In New Orleans, flooding from Hurricane Katrina caused a release of 25,000 barrels of crude oil into a neighborhood adjacent to a refinery. 6,500 homes were affected.<sup>521</sup>

The Puget Sound is not considered to have an “open” coastline, where coastal flooding is usually more violent. Storms extend the reach of waves creating floods along the coasts. Storm surges as high as 23 feet have been reported in conjunction with tropical storms. Since they accompany storms, storm surges have enormous destructive potential as winds drive waves ashore at high velocities. Few non-engineered buildings can survive a strong storm surge, especially those constructed of wood. Even stronger structures like port facilities, warehouses, and bridges are vulnerable to coastal floods. Surges are worse when they occur at high tide or king tides, which are extremely high tide events that occur a few times per year when the moon is closest to the earth.

Urban Flooding in Seattle typically occurs during a weather event called an atmospheric river, or colloquially, a “Pineapple Express.” An influx of warm air from the tropics or subtropics rapidly raises winter temperatures. The mix of raised freezing levels and increased water vapor can produce heavy precipitation, causing urban flooding.<sup>522</sup> These events typically happen in winter, but have occurred in late fall and early spring as well.

Currently, all levels of government employ structural and non-structural means to reduce flood risk. In the past, structural methods such as the construction of dams, levees and bulkheads were the most common means used. During the 1950s and 1960s, the emphasis began to shift because these structures failed to completely solve the flood problem. Catastrophic flooding, like that on the Mississippi in 1993, led federal authorities to emphasize a suite of non-structural mitigation strategies, such as flood insurance, government buyouts, and more restrictive land use planning.

## **9.2.2 History**

Early in Seattle’s history, low-lying areas near downtown and at the mouth of the Duwamish flooded. This prompted the construction of landfills and a drainage system downtown and the channeling of the Duwamish. Since that time, there has been no significant flooding downtown or near the mouth of the Duwamish. Because of these changes, listing very early events is irrelevant.

Areas along the city’s streams experience periodic, localized flooding, typically limited to the blocks or neighborhoods immediately adjacent to the streams. These streams include Longfellow and Thornton Creeks. However, the depth and current velocity of the floodwaters have been low, and they generally cause only localized structural damage and bank erosion.<sup>523</sup> The record of flooding in these areas is limited, but FEMA data shows problems in November 1978 and January 1986. Limited urban flooding also occurred in the residential area near Thornton Creek during the winter storms of 1996/1997, and again in October 2003.

The South Park neighborhood lies at a low elevation along the Duwamish and is prone to flooding due to backups in the drainage system when there is a combination of heavy rain and high tide. During major storms, runoff can drain directly into the Duwamish. Because the Duwamish is a tidal river, its elevation

risers with the high tide. High stream flow combined with a high tide can push water through pipes that normally drain the neighborhood.

The rivers in eastern King County are prone to severe flooding. Only a few floods in the area have affected Seattle directly, the most significant being on the Cedar River. Major flooding of the Cedar River occurred in 1975, 1990, 1995 and 1996. The flooding led to water quality issues but occurred in the winter when demand for water is low, minimizing impact to customers. Filtration was added to the Tolt system in 2001, so the impact of floods on water supply is no longer a serious concern for that portion of the system.

Both Seattle City Light (SCL) and Seattle Public Utilities (SPU) own and operate facilities located outside of the city limits on the Cedar and Tolt Rivers, the Skagit River, and the Pend Oreille River. Flooding can be a concern in these areas during times of heavy rains and extraordinary snowpack.

**December 14-15, 2006.** Six landslides of various sizes and approximately 300 flooded homes were reported throughout the city due to intense rainfall (about 2.17 inches in 24 hours) and overwhelmed storm water facilities. Usually, rainfall in Seattle is a few hundredths of an inch per hour. The peak of this storm was a band that ran through the middle of Seattle and produced an inch of rain in one hour.

**December 1-3, 2007.** Three storms came through the Pacific Northwest, with the last being unusually intense.<sup>524</sup> Four-and-a-half to 5.5 inches of rain fell in north and west Seattle in 24 hours, an all-time record. Seattle experienced flooded roads, sinkholes, and landslides. While this storm brought more rain than the 2006 event, it was spread out over a longer period. Unusually dry weather in the previous month also helped mitigate the risk of landslides.<sup>525</sup>

### **9.2.3 Likelihood of Future Occurrences**

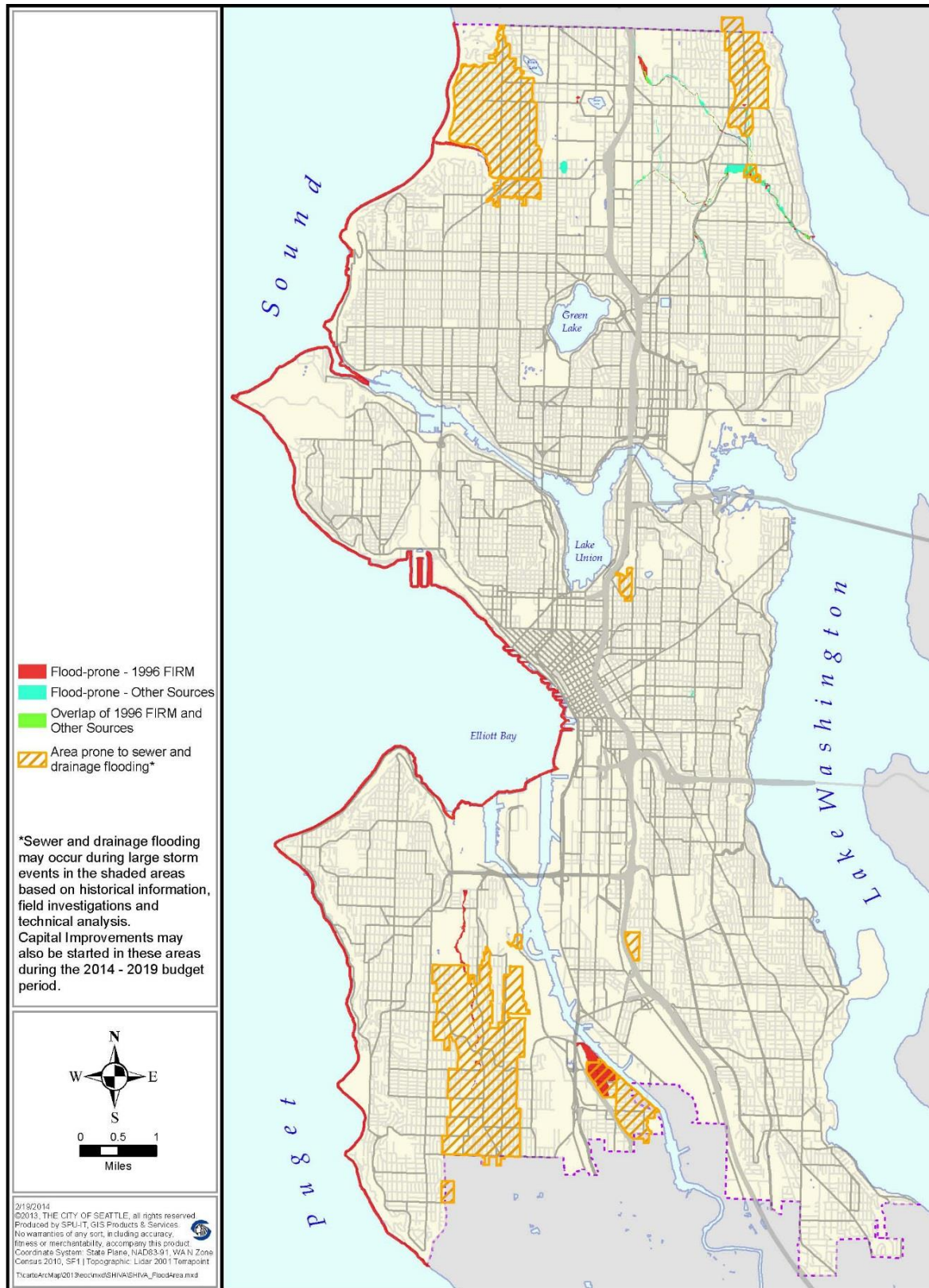
Seattle will experience flooding in the future. The principal unknown factor is the severity of future events. Seattle Public Utilities has examined the amount of rainfall collected in its gauges between 1978 and 2007. It discovered a small but statistically significant trend towards short-duration, high-intensity events. Local meteorology expert, Cliff Mass, analyzed rainfall intensity data and discovered that events like the one on December 14, 2006, have a 1% to 2% chance of occurring each year. These observations are in alignment with the University of Washington's Climate Impacts Group (CIG), who projects that the number of days with more than 1 inch of rain will increase by 6% to 20% by the 2050s.<sup>526</sup> Additionally, CIG projects that coastal flooding will increase due to sea level rise extending the reach of waves in a storm surge.<sup>527</sup> SPU is already upgrading the city's drainage system in critical areas.

### **9.2.4 Vulnerability**

The National Flood Insurance Rate Maps and the U.S. Army Corps of Engineers inundation maps indicate areas prone to flooding in Seattle. The latter shows the area affected by a potential break of the Howard Hanson Dam. These maps show that the locations prone to flooding are quite limited. These areas are most vulnerable from November to February when the city receives most of its rain. The City has adopted a variety of structural controls to prevent flooding. It placed a diversion on Thornton Creek and a storm water detention basin on Longfellow Creek. However, each has its limits. The Thornton Creek diversion is effective up to a 100-year flood; the Longfellow basin was only partially effective during the January 1986 flood.<sup>528</sup> In 2014, SPU completed a restoration project along a flood-prone portion of Thornton Creek, which widened the creek channel to handle greater water capacity and enlarged a main culvert.<sup>529</sup>

The Howard Hanson Dam regulates the only large river in the city, the Duwamish. There are two concerns regarding flooding: 1) a flood event in the upper Green River that causes the dam to be over capacity; or 2) a breach or complete failure of the dam. The dam's reservoir can usually contain the runoff from winter storms and spring snow melt. An extremely heavy rain event during the winter

**Figure 9-3. Areas with Heightened Flood Risk**





months could cause the dam to reach or exceed its design capacity, requiring water to be released. The Army Corps of Engineers has modeled a 500-year flood event (a flood with a 0.02% chance of occurring per year) in the upper Green River. A flood of this magnitude has not occurred since record keeping began. The modeling shows water flows of 25,000 cubic feet per second that would flood parts of the Green River Valley, including Kent.<sup>530</sup> However, by the time the water flow reaches the lower Duwamish in Seattle, flooding is not expected as tidal effects will govern.<sup>531</sup>

The other potential flood scenario would be from a breach or failure of the dam. The Army Corps of Engineers has modeled two scenarios of a dam break. One models a dam break when the reservoir is 10% full, and the other models a dam break when the reservoir is 100% full. In the 10% scenario, the flood could have a large impact upriver, where most of the water would spill over into the Green River Valley.<sup>532</sup> This upriver flooding would relieve pressure on downstream areas like Seattle. In the 100% full scenario, the model shows that flooding could occur in the South Park neighborhood.<sup>533</sup> However, this is a worst-case scenario, and any flooding event will depend on the exact nature of the breach and the water storage level.

In 2009, a void was discovered in the Howard Hanson Dam. Concerns about its strength led to temporary repairs and a reduction in capacity of the reservoir. This means that more water would have to be released from the dam in a heavy storm. At the time, the Army Corps of Engineers, the dam's operator, estimated a 1 in 33 chance of flooding due to releases. Permanent repairs were made to the dam, including a seepage barrier and installation of drains that direct seepage into a drainage tunnel.<sup>534</sup> Other flood control measures include log booms that prevent debris from blocking the spillway and rock installations that prevent erosion of the dam. The Army Corps states that the dam can control water up to a 140-year flood event.<sup>535</sup>

The failure of levees just outside the city limits could produce localized flooding at Boeing Field and SCL facilities, but the Army Corps of Engineers reports that these levees are in good repair.

The Cedar River system, which provides two-thirds of Seattle's water supply, is also vulnerable to flooding. Because of the lack of filtration on the Cedar, diversions from the river are shut down when the water is turbid, and water stored in Lake Youngs is used instead. Since flooding on the Cedar occurs in the fall or winter when demand for water is at its lowest, water from Lake Youngs and the Tolt River system can meet the full needs for water supply.

Coastal problems are another vulnerability. The National Flood Insurance Rate Maps show a coastal flooding hazard directly along the coast but not extending inland. Coastal flooding has occurred in West Seattle and South Park when winter storms coincide with king tides.

Much of Seattle's coastline consists of bluffs with homes built at the top. Coastal storms can erode the toe of these sea cliffs and are a factor in landslides. In parts of West Seattle and Magnolia, homes are built along the shore. These properties are most vulnerable to coastal storm damage.

Many of the low-lying coastline areas, especially the more heavily used parts of the waterfront, are protected by seawalls. In 2017, the City completed major repairs to its aging downtown seawall. The repaired wall is expected to last more than 75 years.

As previously stated, sea-level rise will make coast flooding worse. The projected amount of sea-level rise in Seattle is 4 to 56 inches by 2100, depending on the amount of land movement.<sup>536</sup> The city estimates that the top of the downtown seawall will still be 3 ft above the new water level projections for 2100.<sup>537</sup> Other seawalls could be overtopped if they are not modified or replaced.

#### Lifeline Exposures:

- The sewer and drainage system is naturally exposed to flooding because it is part of the infrastructure to help control runoff. Sewer and drainage mains run along most of Thornton,

Longfellow and Piper’s Creeks; along most of the coast of West Seattle; South Park; Interbay; portions of Magnolia’s coast; and Myrtle Edwards Park.

- About a ½ mile of SCL transmission lines run through the Longfellow Creek 100-year floodplain and the northern transmission lines cross the Thornton Creek floodplain.
- Seattle’s northern water supply line crosses the Thornton Creek floodplain.

#### Transportation Exposures:

- Seattle’s Puget Sound facing marine terminals are exposed to coastal flooding.
- The BNSF rail corridor, which runs along Puget Sound north of the Ship Canal, is exposed to flooding although landslides are a more common threat.
- Lake City Way and 35<sup>th</sup> Ave NE in North Seattle are bisected by Thornton Creek.
- Many residential streets in the South Park neighborhood are in the 100-year floodplain. West Marginal Way runs alongside it.
- Beach Drive SW in West Seattle runs along Puget Sound and is exposed to coastal flooding.

## 9 2.5 Consequences

Flooding in Seattle is a regular occurrence, but Seattle’s flooding problem is not as severe as the rest of Western Washington. The situation may be changing, however, with climate change projections signaling that urban flooding may become a larger threat. Flooding is frequently part of a larger storm event.

Climate researchers project that Seattle will experience more extreme precipitation events, but there is a large amount of uncertainty in their predictions. In response, Seattle’s drainage system is being retrofitted to add surge capacity.

The Duwamish Valley is not likely to flood. Even in the event of a major release of water from the Howard Hanson dam, the river is likely to remain within its banks.

Areas near streams and in natural bowls will be at some risk of localized ponding. The main risk is to property, the majority of which is residential. This residential flooding has a much less pronounced effect on the local economy since the economic base remains unaffected. Nevertheless, a flood could make transportation difficult in the affected areas. The low depth and water velocity of this type of flood mean it is mainly an economic rather than a safety risk.

Coastal flooding in Puget Sound could damage a large area. The most common land use near the shore is residential, but the Port of Seattle and the BNSF Railway might also be affected because of their proximity to the water.

While a Duwamish Valley flood is unlikely, the consequences of a flood would be severe. The dominant land use in the Duwamish Valley is industrial. A flood in this area would cause a severe disruption of the local economy, leading to a decline in tax revenue and a loss of jobs. If firms relocate following a flood, the city could lose some of this income permanently. The Duwamish Valley houses many hazardous materials.

Other severe scenarios include coast erosion caused by coastal flooding extended by sea-level rise. Such events could endanger people living along the shore or near coastal bluffs. The main danger is landslides, which in extreme cases can generate tsunamis.



Lives can also be at risk during flood events, as the fatality that occurred in Madison Valley during the 2006 storm showed. While that case had unique circumstances, with the extra high curb structure acting like a small dam, it is possible for a similar set of circumstances to arise again and put lives in danger.

## **9 2.6 Conclusions**

Changes in the landscape, like the dredging and filling along the Duwamish, have reduced the city's risk to flooding. The Howard Hanson Dam maintains further structural protection, and smaller controls work on Longfellow and Thornton Creeks. These structural solutions are backed up by the city's membership in the National Flood Insurance Program that requires buildings within the floodplain to have flood insurance. All of these factors make flooding one of the most well-studied and funded mitigation efforts in the city. Nevertheless, urban flooding incidents and future climate projections point to a hazard that is shifting and exposing new vulnerabilities.



## 9.3 Snow and Ice

- Seattle’s weather is regulated by the Pacific Ocean, which remains relatively even in temperature throughout the year. Occasionally, cold air from the interior of the continent pushes into the Puget Sound region and causes dramatic cold spells, ice, and snow.
- While Seattle does not receive as much snow on average as many parts of the country, snowfall is not uncommon and can be heavy.
- Accurate weather records began only about 100 years ago, but based on historical accounts, Seattle’s winters seem to have been colder and snowier in the 19<sup>th</sup> and early 20<sup>th</sup> centuries.
- Meteorologists have made great strides in forecasting snow and ice storms. Roughly 80% of snow storms in the Puget Sound lowlands occur when cold air from the interior of the continent pushes through the Fraser Gap near Bellingham and meets a low-pressure system coming off the ocean. If the cold front lingers, snow and ice can be on the ground for weeks.<sup>538</sup>
- Snow and ice impede transportation and because most social and economic activity is dependent on transportation, snow and ice have serious impacts, especially if it remains on roadways for many days.
- Other significant impacts from snow are:
  - Public safety impacts resulting from the inability to get emergency vehicles where they need to go.
  - Utility outages as power demand peaks and pipes freeze. Power losses during extreme cold have resulted in deaths from carbon monoxide poisoning when victims attempted to keep warm by lighting charcoal fires indoors.
  - Economic losses due to business closures and lost wages by workers unable to get to work or required to stay home with children when schools and childcare facilities close.
- Seattle does not have dedicated snow plows. Trucks have to be outfitted with snow removal equipment when snow threatens. There are not enough of these trucks to plow every street in the city.
- Due to Seattle’s steep topography, some streets are too steep to keep open during snow and ice events.
- During snow and extreme cold, Public Health – Seattle & King County issues public warnings about the dangers of carbon monoxide poisoning. A regional “Take Winter by Storm” campaign also helps educate on winter preparedness and safety.
- Occasionally, rapidly melting snow can contribute to saturating the ground and becomes a factor in triggering landslides. The last time this happened was in the winter of 1996/97.
- Snow load has collapsed roofs, most recently in 1996/97.

### 9.3.1 Context

Seattle’s winter weather is shaped by the Cascade and Olympic mountains, and the Pacific Ocean. Our region’s maritime climate usually keeps Seattle warm in the winter. The prevailing westerly winds that blow in from the Pacific keep cold arctic air from reaching the Puget Lowlands most of the time. Occasionally, an arctic front develops in which cold air from the Yukon moves south into British Columbia and through a gap in the Cascade Mountains, northeast of Bellingham. If this push of cold air is

met by moist warm air from the Pacific, snow is often the result. Usually, the snow starts near Bellingham and moves south. Such fronts account for roughly 80% of Puget Sound snow.<sup>539</sup>

Seattle sits within the Puget Sound Convergence Zone, an area of colliding wind currents that can cause lower temperatures and higher precipitation, typically between Everett and North Seattle. The convergence zone can mean that in the winter, Seattle can experience snowfall while areas a few miles north and south of the zone do not, or, that Seattle experiences variability in snowfall between its own neighborhoods.<sup>540</sup> Seattle's steep topography can also create localized events. It is not uncommon for snow to fall at high elevation areas, such as Capitol Hill or Queen Anne Hill, while areas closer to sea level remain snow-free.<sup>541</sup>

Because Seattle does not see routine snow events, the City lacks the snow clearing capacity that cities in the upper Midwest and Northeast have. During major snow storms the transportation system shuts down, sometimes trapping people at home or work. The Seattle Department of Transportation (SDOT) removes snow from arterial streets within 12 hours of a lull in a snow storm.<sup>542</sup> Residents and business owners are responsible for plowing their own property and adjacent sidewalks. Vehicle accidents rise among those who attempt to drive. In 2015, snowy or icy roads contributed to 3% of traffic collisions in Washington State.<sup>543</sup> Access to emergency services can be impaired. During exceptional storms, structures can be damaged. This happened in the 1996/97 storm when a number of roofs collapsed. Energy use skyrockets, placing a demand on power generation and distribution systems. Elsewhere in the nation, energy demand spikes have reached crisis levels. During the 1993/94 winter, some parts of Pennsylvania had to ration power. In some cases, those with low or fixed incomes cannot afford the extra expense and must suffer through the cold.<sup>544</sup>

SDOT monitors winter weather conditions. They use a forecasting tool called SNOWWATCH, to predict the consequences of storms at the neighborhood-level. When possible, SDOT will treat major roads and bridges with salt brine before a storm to prevent ice formation. Once 1 inch of snow has accumulated, SDOT begins plowing roads, prioritizing those that are critical for major institutions and emergency services, and those leading to Seattle's major employers.<sup>545</sup>

While it's difficult to link snow events directly to economic activity, some evidence suggests that widespread, lingering snow can negatively impact the overall economy. Economists believe that severe snowstorms across the United States from 2013-2014 contributed to the economy declining 2.1% in the first quarter of 2014, mainly due to interruptions in supply chains.<sup>546</sup> Another account claims that Massachusetts alone lost around \$1 billion in wages and profits due to snow during the 2014-2015 winter season.<sup>547</sup>

One study that analyzed vehicle accidents caused by winter weather (snow, ice, or sleet) between 1975 and 2011 reported that an average of nearly 900 fatalities occur nationally each year.<sup>548</sup> Additionally, researchers have found that indirect effects of storms have resulted in fatalities, from traffic accidents, sledding accidents, exposure to cold, falls, and carbon monoxide poisoning.

Research by the National Weather Service has found that:

- Ice is deadlier than snow;
- About 70% of deaths occur in automobiles;
- About 25% of deaths are people caught outside;
- 50% of hypothermia cases are over 60 years old, 75% are male and 20% occur at home.

The cold that often lingers after a snow storm can produce its own dangers, especially when accompanied by power outages. The primary danger in this situation is hypothermia. Those most

vulnerable populations are people experiencing homelessness, those without heat, the elderly, and the socially isolated.

### **9.3.2 History**

Seattle's unofficial record for the most snow in one winter is 64 inches in 1880. The single-day record is 21.5 inches in 1916.<sup>549</sup> Other historical records that extend back beyond modern record keeping indicate that Seattle was colder and snowier in the past.

Data from the National Climatic Data Center for the Sandpoint weather station shows that from 1990 to 2018 there have been 45 days of measured snowfall. This includes 19 days of snow accumulation of less than 1 inch and 26 days between 1 to 8 inches. These events occurred as early as November and as late as March. **Error! Reference source not found.** in the Community Profile indicates the snowfall from October through March between 1948 and 2009.

**December 1861.** Very cold, with an unofficial record temperature of -4 degrees Fahrenheit. Newspapers mentioned ice-skating on Lake Union covered in six inches of ice.

**Winter 1880.** Estimated the snowiest winter in Seattle. 64 inches of snow fell during the season. Snow drifted three to five feet at the waterfront, possibly indicating even bigger drifts at higher elevations. Most significantly, roofs collapsed throughout the city.

**January 1893.** 45.5 inches fell in less than two weeks.

**February 1, 1916.** Single-day snow record set at 21.5 inches. The roof of the St. James Cathedral collapsed. Snow drifts were up to five feet.

**January 1920.** A sledding accident on Queen Anne killed four children and injured five more.

**February 1923.** 16 inches of snow.

**January 1943.** Total of 18.4 inches of snow in one week closed schools and caused power outages.

**January 13, 1950.** Near record one-day snowfall of 21.4 inches at SeaTac accompanied by 25-40 mile per hour winds. 57.2 inches fell the entire month at SeaTac. This storm claimed 13 lives in the Puget Sound area. The winter of 1949-50 was the coldest since official records began.

**Winter 1956.** 23 days of measurable snowfall.

**December 1964.** Eight inches of snow.

**December 1968** Ten inches of snow fell on New Year's Eve.

**January 1969.** 19 inches of snow accumulated at SeaTac on the 28th. Nearly 46 inches fell during the month.

**January 1972.** Intense cold. Nine inches of snow fell at SeaTac. Schools closed. This storm was connected to landslides later that year.

**December 1974.** Nearly ten inches of snow fell as the power went out in many parts of the city.

**November 1985.** Eight inches of snow fell on Thanksgiving Day.

**December 1991.** Snow closed SeaTac and brought traffic to a halt.

**December 1996** Near-record snow fell the day after Christmas. Metro halted service completely for the first time in its history. Freeze and snowmelt contributed to flooding and landslides during the following week.

**December 2008.** Seattle experienced a rare, extended period of lingering snow with some areas of the city receiving 3-6 inches. The temperature dropped to a record-tying 14 degrees Fahrenheit. Metro had

fewer than half of their usual bus routes running, and Amtrak trains stopped running altogether. Seattle officials did not salt city streets, making driving difficult. At SeaTac, passengers were stranded for several days due to flight cancellations.<sup>550</sup>

**November 2010.** Seattle received 1-2 inches of snow, causing dangerous road conditions. A cargo plane skidded off the runway at SeaTac airport, causing flights delays. Three fatalities were attributed to accidents caused by the icy road conditions. High winds caused power outages as temperatures dropped into the 20s.<sup>551</sup>

**January 2012.** 3-9 inches of snow fell throughout the area with subsequent freezing rain. Metro reduced service by 30%. 6,500 Seattle City Light customers experienced power outages.

**February 2017.** SeaTac airport records 7.1 inches of snow, almost twice the average yearly amount.<sup>552</sup> Power outages occurred, affecting 110,000 Puget Sound Energy customers and 11,000 Seattle City Light customers.

### **9 3.3 Likelihood of Future Occurrences**

Climate change may be decreasing the frequency of snow events. The University of Washington Climate Impacts Group projects that greater Puget Sound area will see less winter precipitation falling as snow by the 2040s. This change will be most significant in mid-elevation basins that typically receive a mix of snow and rain in the winter. Mountain snowpack is projected to decline 42-55% by 2070, as more precipitation falls as rain rather than snow.<sup>553</sup> A climate change study on snowpack in the Puget Sound lowlands has not yet been conducted.

Other global weather patterns will continue to overlay climate change. These include the El Niño Southern Oscillation (ENSO) that alternately brings El Niño and La Niña to the Pacific Northwest. El Niño is characterized by warmer, somewhat dryer winters; La Niña is characterized by wetter, cooler, and snowier winters. The Pacific Decadal Oscillation (PDO) can also bring climate variability. The PDO is a 20 to 30-year cycle of cooling or warming in the sea-surface temperatures and winds over the Pacific Ocean. It appears the PDO has been in a warming phase since the mid-1970s.<sup>554</sup>

### **9 3.4 Vulnerability**

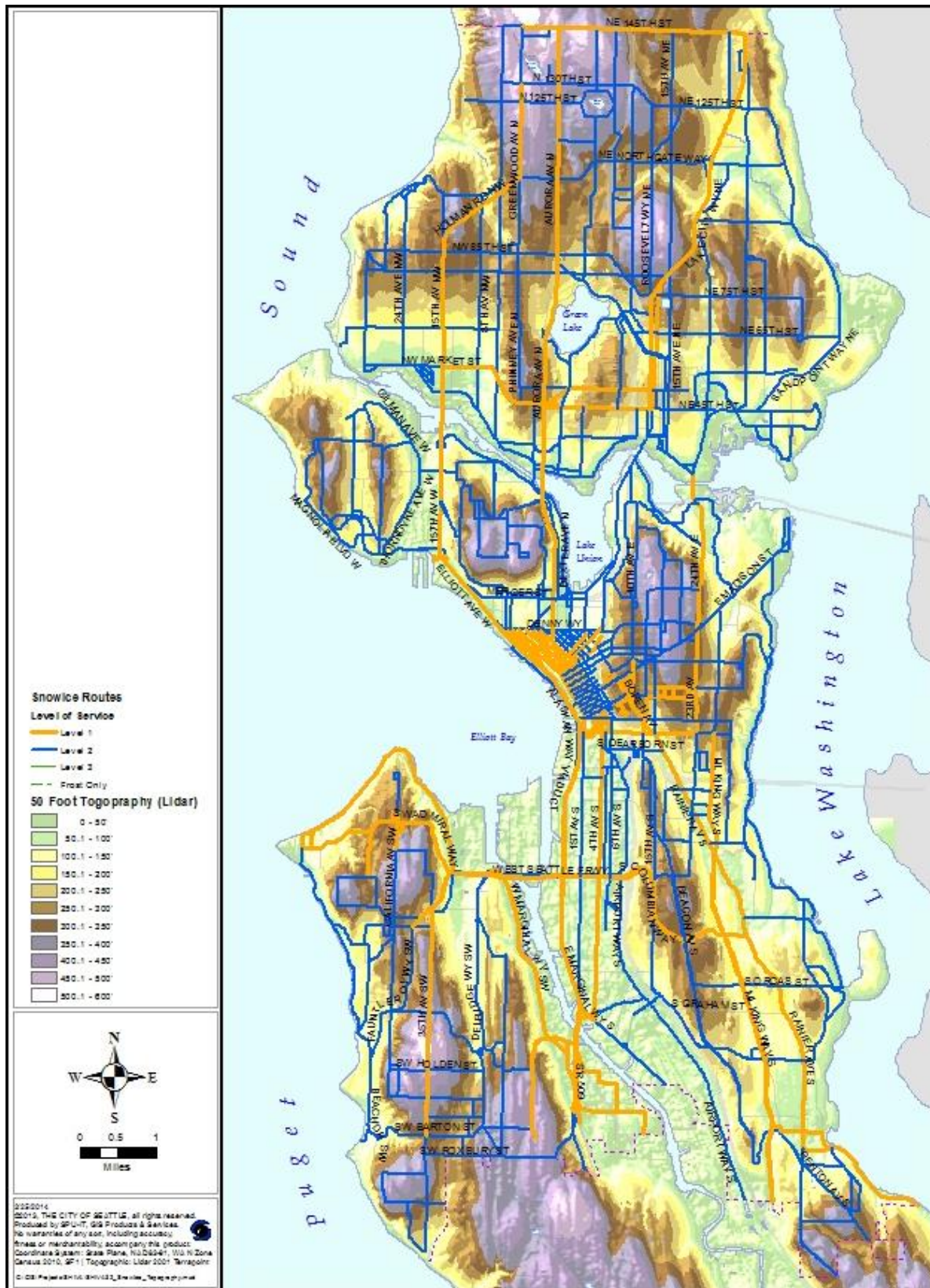
Seattle's geology and climate increase the city's vulnerability to snowstorms. First, the hilly topography makes many areas of the city impassable even after a light snowfall. Queen Anne Hill, Beacon Hill, parts of West Seattle, and areas facing Lake Washington and Puget Sound seem especially prone to isolation during storms because of the many steeply graded streets that serve them. Second, the relative infrequency of heavy snowstorms makes it challenging to plan a response and discourages the use of City funds for dedicated equipment.

Those experiencing homelessness are the most vulnerable to winter weather and are a growing population in Seattle. Although attempts are made to find extra space for them in shelters during winter, many remain on the streets in harsh conditions. Seattle's unsheltered population has grown by around 90% since 2009. The city's low-income and aging residents typically bear the most consequences of winter storms. People without back-up sources of heat suffer from the cold during outages. In 2006, several incidents of carbon monoxide poisoning occurred when people attempted to burn charcoal indoors to maintain heat.

Anyone needing medical care is vulnerable when the transportation system is impaired. Aging residents are indirectly affected since they require medical care most frequently and snow can make it more difficult for them to receive it. When critical outpatient services cannot be accessed, medical needs may escalate. Patients may deteriorate and require ambulance transport and emergency department care and admission. This places an additional burden on the healthcare system in King County. Children are



Figure 9-4. Snow and Ice Routes by Service Level



another vulnerable population because they play on dangerous, icy streets. Several have been killed in sledding accidents.

Seattle retailers are vulnerable because a major part of the snow season overlaps the holiday shopping season. The loss of sales at this time can be critical. Seasonal, temporary, contract, and other workers who lack paid time off can lose income during snow storms if they cannot get to work or their employer closes due to weather conditions.

### **9 3.5 Consequences**

The two biggest direct impacts of snow and ice are cold temperatures and immobility. These drive the main secondary impacts, which get worse the longer the snow and ice remain on the ground. As the 2008 experience demonstrated, snow and ice can linger for weeks in Seattle and the city government, residents, workers and business must be prepared for this situation.

Seattle faces transportation impairments while snow is falling and up to eight hours after it has stopped along most snow routes. Non-designated streets will face longer impairments. The City does not have enough snow removal equipment to plow every street in the city.

Power outages during snow storms and the cold weather that often accompanies them remains a serious threat. Hypothermia and carbon monoxide poisoning will continue to be risks.

A snow storm may slow the local economy. Hourly workers will lose wages, plane flights will be cancelled, and retail stores and restaurants will lose revenue. However, there is a debate about whether these slowdowns cause permanent revenue losses. Productivity and sales may decline temporarily, but often accelerate after a storm. People who cannot make a purchase due to snow will likely still make that purchase later. More permanent effects may occur if Seattle faces a localized snow event (i.e. convergence zone snow). For example, holiday shoppers may go to Bellevue to buy Christmas presents if they cannot get to Seattle stores.

For the local government, responding to a snowstorm will likely be a major unbudgeted expense. Many cities have spent more than their original snow-removal budgets when faced with unexpected or unusually large storms. In 2011, a blizzard that hit New York City cost over \$68 million, \$30 million more than their yearly snow-removal budget.<sup>555</sup> Since snow and ice are common occurrences, it can be very difficult to get an official disaster declaration for snow events and therefore, difficult to receive federal aid.

Climate change may introduce new challenges. The frigid weather places increased demands on the power system as people try to heat their homes. In the past, demand peaks have not reached the point of crisis and there have been no cases of power rationing as in other parts of the country. However, if projections are correct and future snowpack is reduced, Seattle City Light may have to purchase additional power from external sources to meet winter demand.

Secondary hazards of snow storms can be flooding and landslides as the snow melts. In heavy snowstorms, structural damage is likely. During the 1996 snowstorm, over 80 roofs suffered damage. These failures are always a danger since the Seattle area is prone to wet, heavy, and sticky snow.

### **9 3.6 Conclusions**

Despite a relatively mild climate, Seattle is a northern city, so it can and does receive heavy snowstorms. This creates a dilemma for the government and the population. Extensive preparations become very costly if the snow fails to materialize; if snow does come and the city has not prepared, significant transportation problems arise.

## 9.4 Water Shortages

- In 2018, Cape Town, South Africa, became dangerously close to running out of water. Reservoirs were dry, causing the city to impose extreme water restrictions, including a 50-liter limit per person per day.<sup>556</sup> The restrictions have postponed a water shortage crisis for now, but Cape Town’s experience shows how drought, climate change, and water management practices can lead to a water shortage even in a large, well-established city.
- A water shortage occurs when the demand for water exceeds supply. It can be caused by the onset of a drought or sudden infrastructure failure, such as a major pipeline failure or treatment plant shutdown.
- Peak demand for water for people and businesses occurs in the summer. Replenishment of the city’s reservoirs does not occur until the spring, when snow accumulated during the winter melts and runoff from rains is stored. Low winter snow accumulation followed by hot summer weather or later-than-normal return of fall rains can cause a shortage.
- It is extremely unlikely that Seattle would run out of water. To avoid failure of the water supply, a series of increasingly severe usage curtailments would be enacted to ensure that Seattle would have enough water for essential functions. “Phased Curtailments” occur in four stages: Advisory, Voluntary, Mandatory, and Emergency. While the curtailments would mitigate a greater disaster, they would have increasingly severe impacts on residents and businesses.
- The City of Seattle supplies water to people and businesses within the city limits and to many customers in King County and southwest Snohomish County through wholesale water deliveries. It depends on its two Cascade watersheds, the South Fork Tolt and Cedar Rivers, for its water supply. Both of these reservoirs are managed for instream flows for fish.
- Wells in the Highline area provide limited supplemental back-up for peak loads and emergencies.
- Decreasing demand has mitigated the pressure on the water supply. Total water consumption has gone down despite increases in population in the area served by SPU. Since the early 1990s, conservation programs, plumbing code changes and pricing have all contributed to reduced water use in the region.
- Maintaining public health is the highest priority in managing a water shortage. In extreme conditions, shortages can result in a degradation of water quality, reduction in the flow of water available for firefighting or sufficiently low pressure that water cannot reach certain areas.
- In an Emergency Curtailment, both stringent restrictions and surcharges will be imposed. Such restrictions would be an economic burden on businesses that are heavy water users and customers without the means to pay for surcharges.

### 9.4.1 Context

Water shortages develop when the supply of water cannot meet demand. The cause can be either a decreased supply, a rise in demand, or both. They are not the same as droughts, which are prolonged periods without precipitation. Shortages often develop as a result of drought but can also be caused by overconsumption or structural failures such as pipeline breaks.

Seattle uses water for direct consumption, e.g., drinking, washing and watering lawns, and to generate electricity. Both types of consumption are cyclic. Water use peaks in the summer with demand determined by the heat and dryness of the weather. Power consumption peaks during the winter. The extent of its demand also depends on the weather. The colder the winter, the more power required.

Seattle Public Utilities (SPU) manages reservoirs in the Cascade Mountains to provide water supply for consumption and fisheries, as well as to provide flood management and hydropower generation. During the spring, SPU captures runoff from melting water from the winter snowpack and rainfall and stores the runoff in city-owned reservoirs. Water remains there until the demand increases and releases from storage are required. During peak demand, water is drawn from the reservoirs at a greater rate than it is being replaced. This yearly cycle of recharge and draw-downs is the city's "water-budget." For Seattle's drinking water supplies, the end of the yearly drawdown cycle is dependent on the timing of fall rains, which is uncertain and is not forecasted well in advance. If the "water-budget" is not renewed each year, Seattle could face a multi-year water shortage.

SPU draws most of its water for direct consumption from two watersheds in the Cascade Mountains — the South Fork of the Tolt River and the Cedar River—and from well fields in the Highline area. The Cedar supplies two-thirds of the city's water, while the South Fork of the Tolt supplies one-third. The amount of water in these rivers is dependent on the yearly levels of snowpack in the mountains. The Highline wells provide water in emergencies and peak water use periods.<sup>557</sup> This water is delivered to Seattle's retail customers and SPU's wholesale customers through large diameter pipes. Unlike an electric utility that is connected to a regional and national power grid, Seattle must rely on its own watershed resources. There is no "water grid" that can provide water from outside sources in a shortage.

As for power, Seattle City Light (SCL) gets most of the power it generates from dams on the Skagit and Pend Oreille Rivers. When the amount of water in the reservoirs drops, SCL cannot generate as much power. When peak demand exceeds supply, SCL buys power from other sources, mostly the Bonneville Power Administration. Most of these demand peaks are anticipated so the utility can buy power ahead of time or swap power with another utility. The real costs occur when water shortages are unforeseen, and the City must make emergency purchases.

Droughts are slow-onset or "creeping" disasters because their effects accumulate slowly over time. Even with modern forecasting tools, there is always some uncertainty about when to adopt water restriction measures. Water resource managers are never sure if they are overreacting whenever usage restrictions are requested preemptively. This doubt can cause managers to delay action until a drought is well underway. There are three different types of droughts that affect the Seattle regional water supply. Winter/spring drought from low accumulations of snow in the mountains, summer drought from dry conditions and hot temperatures, and fall/early winter drought from delayed fall rains. SPU and SCL, with real-time information about snowpack, can typically forecast supply for the summer and manage resources accordingly. They cannot, however, predict the end of the drawdown cycle and timing of fall rains.

To respond to a water shortage, SPU uses four levels of water use curtailments: advisories, voluntary restrictions, mandatory restrictions, and emergency curtailments. As a shortage worsens, SPU enacts progressively stringent restrictions.

SPU uses several data and forecasting tools to monitor water resources.<sup>558</sup> They work with USGS to monitor stream flows and the Natural Resources Conservation Service (NRCS) to monitor snow. Additionally, SPU monitors daily weather forecasts and 30- and 90-day multi-season climate outlooks. They also track El Niño/La Niña conditions. SPU uses an in-house reservoir management and stream flow forecast model which is updated hourly with meteorological and hydrological data. It can simulate the current snowpack, soil moisture, aquifer storage, and stream flows of the watersheds. It allows SPU to analyze future reservoir operating scenarios.

Nationally, per capita water use has decreased by nearly 30% since 1975 despite a growing population and economy. While the population that is served by SPU has steadily risen since 1975, water demand leveled off during the 1980s then dropped off sharply in 1992 after a severe drought and mandatory



curtailment measures. Since then, the combined effects of higher water rates, the 1993 state plumbing code, conservation programs, and improved system operations have kept both billed and total consumption significantly below pre-drought levels.

Water consumption further declined between 2000 and 2005 due to additional conservation efforts represented by the regional 1% Conservation Program, significant increases in water and sewer rates and an economic slow-down. Between 1990 to 2016, annual water consumption decreased about 28%, while population increased by 28%. SPU currently serves 1.4 million retail and wholesale customers in King and Snohomish counties. Average water consumption in 2015 was 121 million gallons per day (mgd).

Peak water demand has fallen even more than annual average demand since the 1980s. In the 1980s, hot summer weather could produce peak day consumption of over 325 mgd, compared with only 270 mgd in 1994 when temperatures reached 100 degrees. Ten years later, during the two very hot, dry summers of 2003 and 2004, peak day consumption reduced further, barely reaching 250 mgd. Between 2005 and 2010, average peak day consumption has been around 200 mgd.

Droughts do not necessarily cause water shortages. However, they can contribute to shortages. The most common measure of drought intensity is the Palmer Drought Index that describes dryness. The values usually range from -4 (extremely dry) to +4 (extremely wet). The values are a function of precipitation and temperature that are obtained by comparing current local scores with average scores for the area. One significant drawback is that it underestimates the role of water stored in snowpack.<sup>559</sup>

Breaks in the pipeline distribution system or events that force SPU to shut down the water system preemptively, such as a failure at one of the water treatment facilities, can also cause shortages. Pipeline breaks or other infrastructure failure often result from other disasters like earthquakes, floods and explosions, but they can occur as a result of mechanical failure or human error. More information on water pipe breaks can be found in the section on infrastructure failures. A major contamination incident could cause a water shortage. A detection of harmful bacteria such as E. Coli could call for a temporary shutoff to certain affected areas.

## **9.4.2 History**

Water shortages are a regular occurrence in the region's history. This section reviews the significant shortages to reveal the duration, severity and cause. Drought conditions are cited as an indirect and imperfect measure of the shortage. Some short-term shortages were caused by pipeline breaks, none of which precipitated an immediate health danger in the city or prompted water rationing.

**1919.** A hot, dry summer.

**1928/29.** Rain was 20% of normal. This was the longest recorded drought in Washington at that time. It exacerbated the 1930 drought.

**1930/31.** Moderately dry weather occurred in Western Washington. The Palmer Drought Index hovered in the -3 range.

**1938.** A record dry growing season in Western Washington at the time. The state studied the minimum stream flows necessary to preserve fish life. Stream flows are still an issue and complicate the regulation of reservoir levels.

**1941-1945.** During March and April 1941, the Palmer Drought Index was -4, then hovered between -3 and -1.5. Temperatures west of the Cascades were usually above normal.

**1952/53.** Puget Sound was hit with dry weather beginning in January and continuing through April 1953. The worst came during the winter when the Palmer Drought Index reached -4. The state ordered power cuts for hydroelectric dams.

**1965/66.** King County recorded Palmer Indices of roughly -1.5 from June 1965 to December 1966.

**1967.** The summer was dry with no significant rain from the third week in June to the first week in September.

**1976/77.** Precipitation was 57% of normal in Seattle. For three months, the Palmer Drought Index was in the -4 range. Hydroelectric power generation dropped 47%. City Light had to make emergency power purchases at highly inflated prices. As a result, it had to increase its debt and put a surcharge on electric bills.<sup>560</sup>

**1987.** Hot, dry summer weather increased water demand, causing a rapid drop in reservoir levels. Mandatory restrictions were adopted. Consumption dropped by 10%.

**November 1987.** The Tolt pipeline broke, temporarily dropping the supply reaching customers by 30%. This impacted 10,000 customers, but only for several hours. Water was rerouted through the Cedar River pipeline, placing additional demands on the Cedar River Reservoir. Voluntary restrictions dropped consumption by 5%. Luckily, November had low demand and the Cedar River pipeline was able to completely supply the city.

**1988.** The level of Cedar River Reservoir fell below its outlet. The Seattle Water Department responded by installing emergency pumps to extract water. The pumps were left at the site and used again in 1992.

**August 1988.** The Tolt pipeline broke during a period of peak use, threatening 100 suburban customers with loss of service or low water pressure. The public was asked to curtail all unnecessary water use. The goal was a 30% reduction, but only 18% was achieved. The outage lasted several days.

**1992.** Scarce winter rains prompted emergency measures to avoid severe reservoir depletion. Enforced mandatory restrictions reduced water consumption by 25- 30%. Additional emergency pumps installed in 1988 at Cedar River Reservoir were used. The silver lining to the 1992 shortage is that per capita water consumption remained low even after the shortage ended.

**2001.** Snowpack appeared to be very similar to that of 1992. Water supply forecasts made through the end of the year looked dire until a late snowfall occurred in March.<sup>561</sup> Snowpack in SPU's watersheds ended up peaking at 75% of normal and reservoirs were full or nearly full by June. Nonetheless, with a state-wide drought emergency in effect, SPU asked customers starting in early April to voluntarily reduce water use by 10%.

**2002.** Fall rains came later than normal. SPU had to mobilize pumps on Morse Lake. SPU entered into the voluntary curtailment stage and warned customers that water restrictions could occur if the weather continued to be dry. No further restrictions were imposed.

**2005.** The worst snowpack in 60 years at SPU's watersheds, causing SPU to enter into the advisory stage. Effective reservoir management and some late spring/early summer rainfall brought reservoirs back to near normal levels. By early July, the advisory was lifted.

**2015.** A new record-low snowpack occurred in the state, with a historic hot and dry summer. The Governor declared a state-wide drought emergency by mid-May. Even though reservoirs were operated to store more than their typical capacity in anticipation of the drought, SPU entered into the voluntary curtailment stage, asking their customers to decrease water consumption by 10% (which was achieved). Regional water supply conditions returned to normal in November.

Based on significant past events, shortages seem to occur once every five to ten years. In most cases, water shortage response actions were implemented prior to or during the summer. The extent of losses is difficult to determine. The most severe shortages were the result of either low snowpack or dry fall conditions.



### **9.4.3 Likelihood of Future Occurrences**

In the long-term, climate change has the potential to affect the water supply system but is not the only factor that could contribute to future hydrologic changes. Land use, land cover, and reservoir management can all affect streamflow and water availability. The University of Washington Climate Impacts Group (CIG) projects that average spring snowpack in the Cascade Mountains will continue to decline by 42 to 55% by 2070 to 2099.<sup>562</sup> They also project that decreased snowpack and early spring melting will contribute to peak streamflow occurring earlier in the year. Summer streamflow is projected to decrease by at least 24% by 2080.<sup>563</sup> The main implications will be that Seattle's water resources will be more reliant on variable rain than mountain snowpack, and SPU may face more frequent temperature-driven droughts due to low snowpack and/or early snowmelt leading to an extended summer dry season.<sup>564</sup>

Demand is the critical variable. Total consumption and demand is falling, despite population growth, but consumption can still spike, especially in summer months during periods of high heat. These periods are predicted to increase with climate change. If a low snow year is followed by a hot summer, Seattle's water supply will face at least a short-term challenge. SPU forecasts that demand will increase gradually to 147 mgd by 2039, and then decline to stay relatively flat at 137 mgd through 2060.<sup>565</sup> Despite the forecasted increase, SPU states there is less than a 10% probability that Seattle will need a new water supply source before 2060.

The challenges are different for SCL. The CIG forecasted changes to hydropower in the Columbia Basin, where Seattle gets most of its power. It projects that annual production will decline slightly, with increases in the winter offset by declines in the summer.<sup>566</sup> The authors caution that, in the near term, annual production will be more influenced by other factors, like El Niño/La Niña events, than climate change.

Historically, SCL's peak demand is in the winter when stream flows are also at their peak. Demand in the summer is checked by the low market penetration of air conditioning systems locally. Based on American Housing Survey data, only 33.7% of Seattle-area homes have air conditioning. However, central air conditioning is becoming more commonplace in newly constructed apartments. Seattle has seen a fourfold increase in apartments offering air conditioning over the past decade.<sup>567</sup> While this trend may appear to signal increased future energy demands, newly constructed apartments are so energy efficient that overall demand is still expected to decrease.<sup>568</sup> Population increases will lead to a growth in demand for heating, even as per capita demand goes down due to warming winter temperatures. Taken together, these projections suggest that adaption to climate change will be easier in the winter than the summer.

### **9.4.4 Vulnerability**

The main direct vulnerability in urban areas in a water shortage are financial, as water restrictions and/or price increases are put in place to lower demand and protect supply. Both drinking water and power could be affected. It is unlikely that restrictions and price increases would become so severe that there would be public health or public safety impacts. Water is still a cheap commodity in the U.S. and only about 10% is used for direct human consumption.

The history of water shortages shows that the power and water supply systems have different vulnerabilities to drought. Their water demands differ, and Seattle's reservoirs are located far enough apart that precipitation can be significantly different at each location.<sup>569</sup> Often, only one system is affected by dry weather.

Overall, the water system seems to have a higher probability of being affected than the power system. The water system cannot supplement supplies from outside the immediate region; SCL's power system can, as it has access to the regional power supply.

The heaviest water users are affected the most by water shortages. Commercial customers have traditionally been the biggest consumers, but many have succeeded in sharply reducing consumption. Some heavy users remain, such as landscapers and greenhouses.

Maintaining stream flows for salmon is also a challenge for the utilities. To create these flows, SPU and SCL must let water bypass their facilities during the spring when the reservoirs are most easily replenished and, in the fall, when water is being drawn from storage. During dry years, the amount of water they release can cause water reserves to drop significantly.

Wildland fire is becoming a more prominent threat to the water system. Climate change is projected to increase wildland fire risk even west of the Cascade Mountains.<sup>570</sup> Fires that occur near the watersheds can degrade surface water supplies by increasing turbidity, impacting aquatic species, and reducing reservoir storage.<sup>571</sup> SPU maintains a wildland fire crew that works with the Washington Department of Natural Resources to protect Seattle's watersheds from fire. This is particularly important for the Cedar River, which SPU does not filter.

SPU and SCL are publicly owned utilities, and any increased costs from water shortages are often be transferred to their customers in the form of higher rates. SPU rates are projected to increase at 5.2% annually for six years, beginning in 2018.<sup>572</sup> Seattle's low and fixed income residents will be the most vulnerable to rate increases.

A water shortage could indirectly expose Seattle residents to harm if it contributes to power failures, if low stream flows suppress power production at a time of peak demand, or to fires if water pressure is low or vegetation is dry.

#### **9 4.5 Consequences**

Seattle has a water shortage risk that is likely to increase with climate change; however, an even bigger driver will be demand. With good planning, it will be possible to boost supply or enact conservation measures to address demand increases. Climate change impacts can be mitigated through system adaptations and good reservoir management.

While Seattle will certainly face water shortages in the future, these will probably be on the same order of magnitude as previous shortages. Seattle's water supplies seem secure. On the power generation side, the situation seems more challenging, but the likelihood that a water shortage will cause rolling blackouts seems remote. It is more likely that power rates will increase.

With the effects of climate change on top of regular yearly and decadal fluctuations, a severe multiyear drought could have serious consequences for Seattle and extend beyond economic impacts into the public safety and health spheres. Most of these effects are likely to stem from indirect factors such as wildland fire, power failure, and heat exposure risk. Even under the maximum credible scenario, Seattle is better off than some cities that are truly facing a crisis as their entire supply is threatened.

#### **9 4.6 Conclusions**

Experience suggests that Seattle Public Utilities and Seattle City Light can manage shortages effectively. Since droughts require little in the way of emergency equipment, pose little immediate danger to public health, and have a crisis period that lasts for weeks or months, there seems to be little reason to activate the Emergency Operations Center. As with other "creeping" hazards, the City does not presently have a system in place for prolonged multi-department emergency management. Nevertheless, the current system could be used for interdepartmental city involvement to assist the utilities in managing a severe shortage emergency caused by infrastructure failures.

## 9.5 Windstorms

- The Puget Sound region experiences strong windstorms, including ones with hurricane force winds known as mid-latitude cyclones. These storms are wider than tropical storms. The largest of these was the 1962 Columbus Day Storm. The moderating effects of the Pacific Ocean prevent hurricanes.
- Puget Sound is sheltered compared to the Washington Coast, but it can still receive sustained winds of 60-70 mph and gusts up to 90mph.<sup>573</sup> Local terrain has a strong effect on wind speeds. Winds speed up as they move over hills and ridges.
- Pineapple Express storms also pack strong winds, but these storms are known more for their rain than wind. They occur when the jet stream dips into the tropical regions and up into our area. Wind is just one component of these events that also can include flooding, landslides, and power outages.
- Tornadoes are very rare in the Puget Sound region. Washington ranks 43<sup>rd</sup> in tornado frequency. Between 1950 and 2005 there were 94 tornados in Washington and most were weak. Those in the Puget Lowland were mostly associated with the Puget Sound Convergence Zone.<sup>574</sup>
- Power outages are the most wide-spread problem caused by windstorms. The 2006 storm overwhelmed Seattle City Light when 49% of its customers lost power. 95% of customers were restored within two days, but full restoration took a week.
- Structural damage is the costliest consequence of windstorms. Much of the damage comes from falling trees.<sup>575</sup> Damage can occur at wind speeds as low as 32 mph and destroy wood frame structures at speeds around 100 mph. Seattle's building code requires new structures to withstand 85 mph for three seconds (with modifications to be made for location), but Seattle also has many older buildings. Almost 90,000 homes in Seattle were built before 1939.
- People have died from falling trees and branches. Because many windstorms happen in winter and many residents are dependent on electricity for heat, cold-related health problems are a hazard. Several people were killed in King County while heating their homes with charcoal fires during the power outages following the 2006 storm.
- Large windstorms are regional events. The more heavily forested suburban areas are often hit harder than Seattle is. The result is that resources to aid in recovery can be hard to find.
- Floating bridges are vulnerable to wind and wind-driven waves. The Hood Canal Bridge sunk in 1979 and the I-90 Bridge sunk in 1990.

### 9.5.1 Context

The Pacific Northwest experiences windstorms that can reach hurricane strength. Wind strength is measured in terms of sustained winds and gusts. Sustained winds are the speeds averaged over one minute near the surface of the earth. Gusts are the three to five second peaks that are often more than 25 – 50% stronger than the sustained winds. Gusts are often what cause the greatest damage.

The El Niño / La Niña cycle influences the development of major windstorms. El Niño periods bring warmer, drier winters to the Pacific Northwest, while La Niña brings wetter, cooler, and snowier winters. The cycle between these periods, called El Niño Southern Oscillation (ENSO), is typically three to seven years. It appears that the Pacific Northwest sees more frequent windstorms in the “neutral” years between the two extremes.<sup>576</sup> Because these transitions can be predicted three to six months ahead of time, meteorologists can give communities a general warning that the threat of windstorms is elevated.

## Mid-Latitude Cyclones

Pacific Northwest wind storms that can reach hurricane strength are called mid-latitude cyclones. The mid-latitudes, from 30° to 60° north, experience a large difference in temperature between the tropics to the south and the arctic to the north. These temperature differences provide the energy source for the storms. The mixing of cold and warm air can create an area of low pressure as a cold front overtakes a warm front. Mid-latitude cyclones are larger than tropical cyclones and maintain their strength over land more effectively. This means they are typically larger and can reach further inland than tropical storms.

Tropical cyclones can become mid-latitude cyclones when they push into the mid-latitudes (30° - 40°) through a process called *extratropical transition* (ET). The western North Pacific has the greatest number of these events in the world. Current metrological models often fail to anticipate these events. The largest recorded storm to strike the Pacific Northwest, the 1962 “Columbus Day Storm,” was a mid-latitude cyclone.<sup>577</sup>

## Atmospheric Rivers or “Pineapple Express”

Atmospheric Rivers or “Pineapple Express” storms in the Northwest have much weaker, although still considerable, winds and often much more precipitation. They occur when the jet stream funnels warm, moist air up from the tropics to Pacific Northwest. These more common storms cause more flooding and landslides than mid-latitude cyclones. When storms occur outside winter they hit the trees in full leaf. The leaves act as sails causing more stress on the tree.

Western Washington experiences several other kinds of wind that are more localized. They typically do not threaten Seattle but can be damaging to communities near Seattle. They are mentioned here to distinguish them from mid-latitude cyclones and Atmospheric Rivers.

## Strait of Juan de Fuca Wind Surges

The Strait of Juan de Fuca can act as a wind funnel in the right conditions. In the winter, a strong surge can push sustained wind speeds to 50 – 70 mph and gusts to 70 – 80 mph. These events usually occur in north Puget Sound with damage occurring as far south as Mukilteo. Two significant events of this type occurred on December 17, 1990 and October 28, 2003.

## Cascade Downslope Winds

These storms are caused by a build-up of high pressure east of the Cascades. When a low-pressure system moves into the Puget Lowlands, the dammed-up air east of the mountains comes surging through the lower passes. Stampede Pass is the lowest pass in the region and the area immediately below it, Enumclaw, routinely sees strong winds as a result. Occasionally, these winds push all the way to Puget Sound, south of Seattle. During one of these events, Fife and Federal Way can be experiencing winds of 50-60 mph while in Seattle the wind speed is close to zero.

## Tornadoes

Tornadoes are unusual events in the Pacific Northwest. There have been several recorded in the Puget Lowlands. Tornadoes are ranked on the Fujita Scale from 0 to 5. They are an estimate of wind speed based on the damage pattern. The largest tornado to occur in the Puget Sound area was an F3.

## 9 5.2 History

The Pacific Northwest is periodically hit by mid-latitude cyclones and other more localized wind events. Most storms happen in late fall and winter. Of the ten major storms to hit Seattle since 1962, seven have occurred in winter. The other three occurred in March, August, and September.

**1943.** Official records at the Federal Building show one occurrence of 65-69 mph winds.<sup>578</sup> A weather station at the Federal Building in downtown Seattle showed that between 1935 and 1959, wind speed exceeded 50 miles per hour 37 times and 60 mph six times.<sup>579</sup>

**9/28/1962.** An F1 tornado damaged eight homes in the Sand Point/View Ridge area before travelling across Lake Washington and damaging homes in the Juanita area of Kirkland.

**10/12/1962.** The “Columbus Day Storm” had 85 mph sustained winds equal to hurricane speed. Higher wind speeds of 150 mph on the coast demonstrated the protection that the Olympic Mountains give the region. Nevertheless, the damage was widespread. Throughout the region, 46 people died, 53,000 houses were damaged, and the power went out in many areas of Washington. It is not clear how much of this damage was in Seattle. Parts of the power transmission system in Portland were destroyed.

**12/12/1969.** An F3 tornado struck the Kent valley. The storm caused 1 injury. It damaged a billboard and a farm.

**3/26/1971.** Sixty mph winds forced the closure of the Evergreen Point Bridge. The wind also ripped panels off the Seafirst building, forcing the Downtown Library to close. Two people died.

**2/13/1979.** The Hood Canal Bridge broke apart in a violent storm. The western part of the bridge sank into the canal.

**2/19/1981.** Wind and lightning damaged at least one home and left 100,000 without power in Seattle and King County. This storm began as a tropical cyclone.

**11/13/1981.** Two major storms caused power outages, closed bridges, and damaged buildings.

**11/24/1983.** The “Thanksgiving Day Storm.” Downed trees were a leading cause of outages that left 75,000 without power in King County. The wind also damaged roofs and broke boats loose from their moorings. The storm was not predicted, increasing the damage.

**11/25/1990.** The Old Mercer Island Bridge sank in a storm. The sinking was caused in part by construction waste in the floats under the bridge (Also see Infrastructure Failure chapter).

**11/16/1991.** 400,000 were left without power in the Seattle area after the worst storm since the Thanksgiving Day Storm of 1983.

**1/20/1993.** “The Inauguration Day Storm” caused massive outages in Seattle, although the power was out the longest in the suburbs. Debris littered the road and traffic came to a stop as traffic lights failed. Winds gusts in the Puget Sound were 60-70 mph. Six people died in the state.<sup>580</sup>

**12/14/2006.** Unusually intense levels of rainfall in a very short period of time were immediately followed by very heavy winds up to 69 miles per hour that felled power poles and large, mature, healthy trees. Three-fourths of an inch of rain fell in less than 45 minutes in some areas of the city. As a result, more than 1.3 million customers were without power throughout western Washington, some for longer than a week. Making the situation worse, a late-afternoon Seahawk game in Seattle meant many more motorists attending the game were further delayed from getting home because of the storm.

**8/29/2015.** The strongest August windstorm on record hit Western Washington, with winds of 50-60 mph (46 mph at SeaTac). Almost half a million people lost power, two people died from falling trees, two people died from carbon monoxide poisoning, and four people were injured.<sup>581</sup> The damage was increased because the trees were in leaf. The North Puget Sound and coastal areas received the strongest winds.

### **9 5.3 Likelihood of Future Occurrences**

Western Washington will continue to experience periodic windstorms. A storm with 40-50 mph wind gusts is expected at least once per year, with larger storms (60-80 mph wind gusts) expected every decade or so. Advancements in meteorological technology will increase the likelihood that these events will be forecasted before they occur. More research is needed on how climate change will affect the frequency and intensity of future windstorms in the Puget Sound region. One study, conducted by Seattle City Light (SCL) and the University of Washington, concluded that the modeled increases in the frequency of extreme wind events due to climate change was minor compared to the expected natural variability.<sup>582</sup>

### **9 5.4 Vulnerability**

Tree density and wet soils are the biggest factors in the amount of damage produced from windstorms in the Pacific Northwest. Tall conifers are often shallow rooted and prone to being uprooted, especially when the ground is saturated with water. The ground is often saturated in the late fall and winter when the majority of these powerful storms occur. Seattle has fewer trees than suburban and rural areas, but it still has a substantial amount and has been actively working to regrow its tree canopy.

Falling trees and branches are the major hazard in windstorms. They snag power, cable television, and telephone lines, bringing them down and causing outages. When they fall across roads, they interrupt transportation. A downed tree can usually be cleared quickly; when accompanied by downed power lines, the job takes much longer. Finally, trees pose a direct hazard to homes and people.

Wind can cause direct damage to buildings. Seattle's Building Codes, which are built on the International Building Code, specify that structures must withstand a load caused by a three second wind gust of 85 miles per hour. Structural engineers apply this speed to structures using a formula to calculate wind load. Seattle's coast and hills affect this load. Winds are stronger over water and along hillsides. Areas on [Wind Speed Up Areas] that are shown in purple and red are prone to stronger winds. During a windstorm on December 12, 1995, a ship just outside of Elliott Bay reported a gust of 90 mph, exceeding the design threshold.

Areas with limited access, such as Magnolia, can become isolated if trees fall on the few roads that lead into them. North and West Seattle, which are the most heavily forested, may have a higher vulnerability of property damage than the rest of the city.

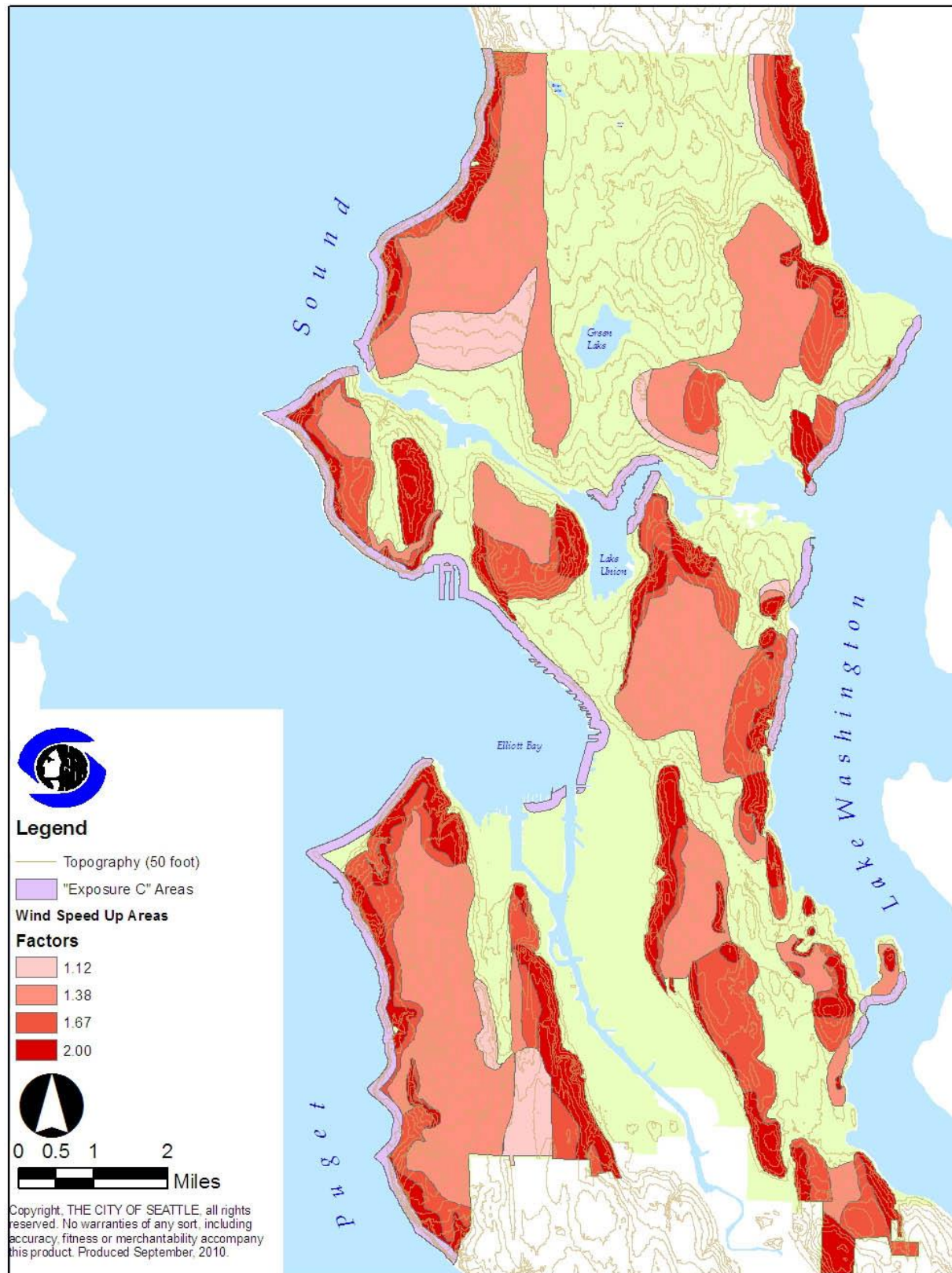
Wind-driven waves are another hazard for the city. Large waves can endanger the I-90 and SR 520 floating bridges. The SR 520 bridge, which was rebuilt in 2012, can withstand wind gusts up to 89 mph. On average, more than 200,000 vehicles move over these bridges daily. Sound Transit is currently building tracks for the Link light rail to travel over the I-90 bridge, adding another 50,000 daily passengers to its load.<sup>583</sup> This traffic gives them enormous socioeconomic importance. Their inherent exposure to wind and their value to the local economy make them vulnerabilities for Seattle.

During the 1993 Inauguration Day Storm, trees falling on buildings, power and telephone lines, and on roads caused most of the damage. In addition, falling trees and limbs damaged hundreds of homes, and fires, started by fallen power lines, damaged several buildings. Some major public structures suffered damage. For example, both floating bridges across Lake Washington, I-90 and SR 520, had damage to pontoons that keep the bridges afloat.<sup>584</sup> Extensive damage occurred from uprooted trees and brittle trees that broke, or whose branches broke off and fell onto power lines, buildings, and roadways.

If windstorms are accompanied by heavy rain or followed by extreme cold, the effects of the windstorm are multiplied. As detailed in other chapters, rain can lead to urban flooding and landslides while extreme cold will increase the hardship caused by power outages.



Figure 9-5. Wind Speed-Up Areas



## 9 5.5 Consequences

Windstorms are a regular part of Pacific Northwest weather as are rain-driven flooding and snow. They cause direct physical damage to structures, infrastructure for power and telecommunications, and coastal bluffs. Falling trees can also cause fatalities. Windstorms cause indirect damage to the economy through power outages and inhibiting the transportation system. Many people cannot or choose not to come to work because they fear long drives or must take care of damage at home. For local governments, debris removal can place a strain on budgets. Despite these costs, the biggest economic problem from windstorms is property damage. Families can incur major expenses even from light damage to roofing or siding. The 2006 record intensity storm of torrential rains and high-velocity winds took a toll on Seattle's residents and their property. Scores of city residents experienced thousands of dollars in damage to their homes and businesses from downed trees falling onto house roofs and cars, flooding inside homes and businesses, and severe roof and siding damage.

Even moderate wind speed can damage buildings. Wind speeds as low as 32 mph can drive objects through walls.<sup>585</sup> Other research shows that wood-frame and unreinforced masonry structures can be damaged or even destroyed at speeds less than 100 mph and that a home constructed according to any of the major codes in the U.S. will lose its roof in winds from 80 to 120 mph.<sup>586</sup> Winds have exceeded this threshold in Seattle, especially in areas where the topography increases wind speeds, demonstrating that widespread structural failures are possible.

Besides doing extensive property damage directly, wind can devastate vegetation and utility lifelines. The 2006 storm caused great damage to City property and infrastructure, with preliminary damage estimates at \$16 million.<sup>587</sup>

Besides being an inconvenience to property owners and municipal governments who must clean up debris, falling trees are also a safety risk. In the 2006 windstorm, over 300 trees blocked roadways in King County,<sup>588</sup> including dozens of arterials in Seattle.<sup>589</sup>

Power outages are another widespread problem. Parts of the Eastside lost electricity for days after the 1993 Inauguration Day Storm. These outages also affect traffic lights, making driving a long and difficult process. Finally, falling trees and branches, downed power lines, and transformer explosions are health risks.

The bridges pose another safety risk. If a windstorm develops suddenly, as in 1983, it could hit them before the State Department of Transportation could close them preemptively.

Seattle has experienced severe windstorms regularly. The most likely situation is that this pattern will not change. Seattle can expect storms up to the magnitude of the Columbus Day storm. While the hazard intensity may not change, Seattle has grown, and our economy has become more time dependent. This increase in vulnerability means that the damage from windstorms is more likely to be higher than in past storms. While windstorms have caused fatalities, their main effect has been economic.

## 9 5.6 Conclusions

The Pacific Northwest experiences windstorms periodically and is prone to severe storms about once per decade. The population growth happening in Seattle means that future windstorms will likely cause more damage, mostly to private property.



## 10. APPENDIX A: EXPOSURE ANALYSIS

This section analyzes patterns of hazard exposure where hazardous areas can be clearly mapped. Not all hazards have a readily mappable component.

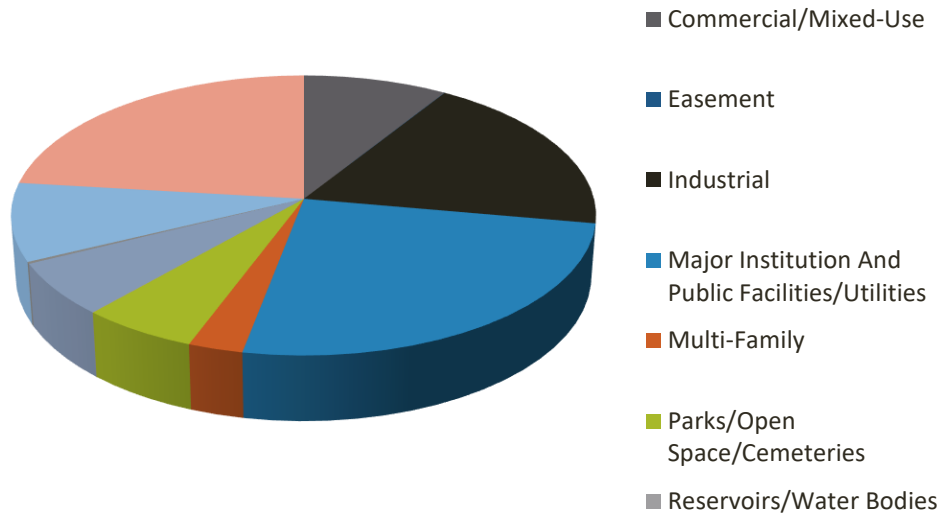
### 10.1 Earthquake Hazard Exposures

For earthquakes, one of the major hazards is liquefaction which occurs when certain soils liquify when shaken. These soils can be identified and mapped. Seattle's liquefaction prone areas have been mapped as shown in Figure x. The tables and charts below summary what is in these zones.

**Table 10-1. Land Use in Liquefaction Prone Areas**

Area	Acres	% of Seattle	% of Area
Seattle	53178.37	100%	
Liquefaction Prone Areas	8029.46	15%	100%
<b>Property in Areas</b>	<b>6172.02</b>	<b>12%</b>	<b>77%</b>
<i>Commercial/Mixed-Use</i>	718.78	1%	9%
<i>Easement</i>	2.07	0%	0%
<i>Industrial</i>	1510.42	3%	19%
<i>Major Institution and Public Facilities/Utilities</i>	2024.07	4%	25%
<i>Multi-Family</i>	217.96	0%	3%
<i>Parks/Open Space/Cemeteries</i>	463.74	1%	6%
<i>Reservoirs/Water Bodies</i>	2.92	0%	0%
<i>Single Family</i>	490.97	1%	6%
<i>Unknown</i>	17.31	0%	0%
<i>Vacant</i>	723.76	1%	9%
<b>Right of Way in Areas</b>	<b>1857.44</b>	<b>3%</b>	<b>23%</b>

**Figure 10-1. Summary of Land Use in Liquefaction Prone Areas**



**Table 10-2. Estimated Population, Structures and Assessed Value in Liquefaction Prone Areas**

Item	Number	Est Pop
Number of Buildings	9,300	na
Number of Single Family Units	4,156	8,561
Number of Multi-Family Units	12,591	25,937
Gross Sq. Footage	103,009,257	
Residential Gross Sq. Footage	22,499,159	
Commercial Gross Sq. Footage	64,599,876	
Total Assessed Value	\$ 21,996,732,623	
Estimated Residential Population Exposed		34,499

**Table 10-3. Critical Facilities in Liquefaction Prone Areas.**

Facility Type	Number
Medical and Health Services	4
Government Function	6
Protective Function	12
Schools	2
Hazardous Materials Storage Sites	23
Bridges	42
Major Tunnels	1
Water	12
Waste Water	12
Communications	0
Energy	22
Human Services	9
High Population	4
<b>Total</b>	<b>149</b>

**Table 10-4. Facilities with Concentrated Vulnerable Populations in Liquefaction Prone Areas**

Facility Type	Number
Adult Family Homes	4
Boarding House	3
Child Care Centers	17
Nursing Home	1
Intermediate Care Facility	0
<b>Total</b>	<b>25</b>



**Table 10-5. Zoning in Liquefaction Prone Areas**

<b>Zoning Area</b>	<b>Acres</b>	<b>% of Seattle</b>	<b>% of Zone</b>
Seattle	53178.37	100%	
Liquefaction Zones	8029.46	15%	100%
<b>Property in Area</b>	<b>6172.02</b>	<b>12%</b>	<b>77%</b>
<i>Unzoned</i>	0.13	0.00%	0.00%
<i>Commercial - C1</i>	121.90	0.23%	1.52%
<i>Commercial - C2</i>	142.57	0.27%	1.78%
<i>Downtown Harborfront - DH1</i>	31.29	0.06%	0.39%
<i>Downtown Harborfront - DH2</i>	10.87	0.02%	0.14%
<i>Downtown Mixed Commercial - DMC</i>	16.30	0.03%	0.20%
<i>Downtown Mixed Residential/Commercial - DMR</i>	2.43	0.00%	0.03%
<i>Industrial Buffer - IB</i>	82.79	0.16%	1.03%
<i>Industrial Commercial - IC</i>	243.83	0.46%	3.04%
<i>Downtown, International District Mixed - IDM</i>	16.33	0.03%	0.20%
<i>Downtown, International District Residential - IDR</i>	0.01	0.00%	0.00%
<i>General Industrial - IG1</i>	2187.77	4.11%	27.25%
<i>General Industrial - IG2</i>	1610.65	3.03%	20.06%
<i>Lowrise - LR1</i>	50.47	0.09%	0.63%
<i>Lowrise - LR2</i>	86.97	0.16%	1.08%
<i>Lowrise - LR3</i>	120.16	0.23%	1.50%
<i>Major Institution - MIO</i>	149.01	0.28%	1.86%
<i>Multi-Family, Midrise - MR</i>	15.53	0.03%	0.19%
<i>Neighborhood Commercial - NC1</i>	23.56	0.04%	0.29%

<i>Neighborhood Commercial - NC2</i>	55.45	0.10%	0.69%
<i>Neighborhood Commercial - NC3</i>	53.43	0.10%	0.67%
<i>Downtown, Pike Place Market - PMM</i>	0.84	0.00%	0.01%
<i>Downtown, Pioneer Square - PSM</i>	36.39	0.07%	0.45%
<i>Single Family - SF 5000</i>	541.63	1.02%	6.75%
<i>Single Family - SF 7200</i>	468.28	0.88%	5.83%
<i>Single Family - SF 9600</i>	85.06	0.16%	1.06%
<i>Neighborhood Commercial, Seattle Mixed-SM</i>	14.27	0.03%	0.18%
<i>Neighborhood Commercial, Seattle Mixed - SMI</i>	3.37	0.01%	0.04%
<i>Neighborhood Commercial, Seattle Mixed Residential - SMR</i>	0.75	0.00%	0.01%
<b><i>Right of Way in Area</i></b>	<b>1857.44</b>	<b>3.49%</b>	<b>23.13%</b>

Table 10-6. Growth Centers in Liquefaction Prone Areas.

Urban Centers / Villages and Manufacturing Centers	Acres	% Seattle	% Area	% Center
Seattle	53178	100%		
<i>All Hub and Residential Urban Villages</i>	<i>5714.5</i>	<i>10.75%</i>		
<i>All Urban Centers</i>	<i>5715.5</i>	<i>6.98%</i>		
<i>All Manufacturing / Industrial Center</i>	<i>5716.5</i>	<i>11.10%</i>		
Liquefaction Zones	8029.46	15%	100%	
<i>Hub and Residential Urban Villages in Zone</i>	<i>590.48</i>	<i>1.11%</i>	<i>10.01%</i>	<i>10.33%</i>
<i>Urban Centers in Zone</i>	<i>386.95</i>	<i>0.73%</i>	<i>4.82%</i>	<i>10.43%</i>
<i>Manufacturing / Industrial Center in Zone</i>	<i>5172.76</i>	<i>9.73%</i>	<i>64.42%</i>	<i>87.67%</i>

**Table 10-7. Wildlife Areas in Liquefaction Prone Areas.**

	Acres	% Seattle
Seattle	53178	100%
Liquefaction Zones	8029.46	15%
All Wildlife Habitat Areas	3749.89	7.05%
<i>Wildlife Habitat in Liquefaction Prone Areas</i>	391.52	0.74%

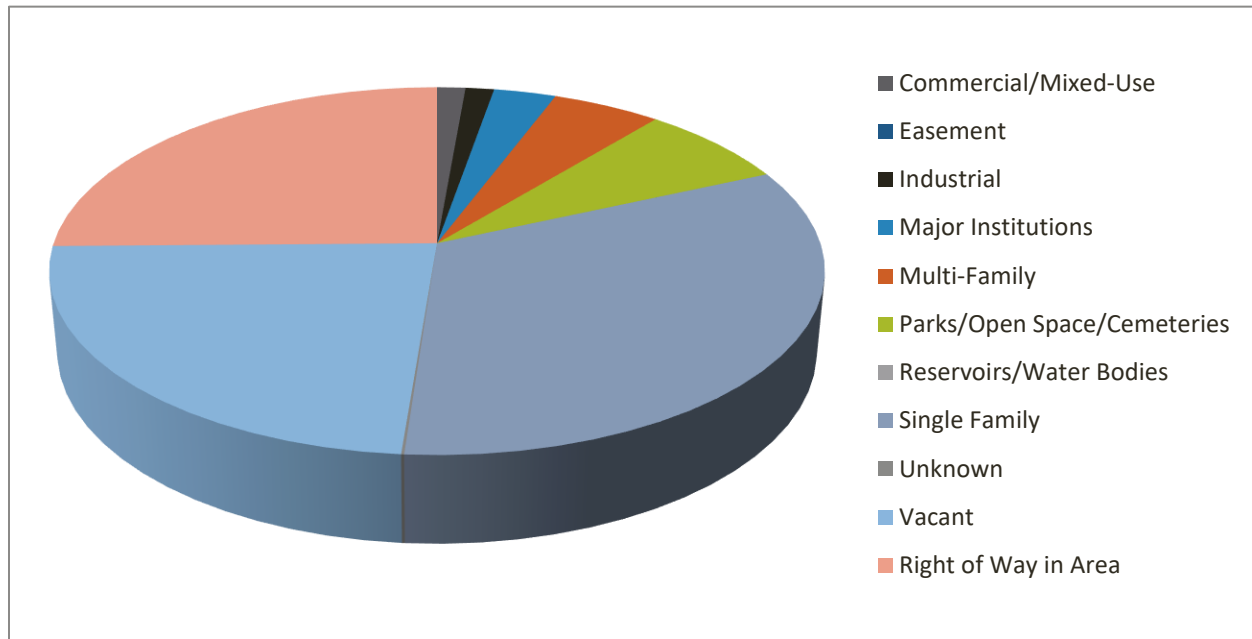
## 10.2 Landslide Hazard Exposures

The major exposures in landslide prone areas are to single family zones and rights of way (roads). One third of all landslide prone areas are single family zones. A quarter are rights of way and another quarter are vacant areas (e.g., greenbelts).

**Table 10-8. Land Use in Landslide Prone Areas**

Area	Acres	% Seattle	% Area
Seattle	53178.37	100%	
Landslide Prone Area	4471.43	8%	100%
<b>Property in Area</b>	<b>3342.46</b>	<b>6%</b>	<b>75%</b>
<i>Commercial/Mixed-Use</i>	61.24	0%	1%
<i>Easement</i>	0.03	0%	0%
<i>Industrial</i>	61.39	0%	1%
<i>Major Institution And Public Facilities/Utilities</i>	134.36	0%	3%
<i>Multi-Family</i>	234.23	0%	5%
<i>Parks/Open Space/Cemeteries</i>	327.83	1%	7%
<i>Reservoirs/Water Bodies</i>	0.00	0%	0%
<i>Single Family</i>	1468.48	3%	33%
<i>Unknown</i>	4.79	0%	0%
<i>Vacant</i>	1050.11	2%	23%
<b>Right of Way in Area</b>	<b>1128.97</b>	<b>2%</b>	<b>25%</b>

**Figure 10-2. Summary of Land Use in Landslide Prone Area**



**Table 10-9. Estimated Population, Structures and Assessed Value in Landslide Prone Area**

Number of Buildings	13,084	Est. Pop
Number of Single Family Units	10,381	21385
Number of Multi-Family Units	10,517	21665
Gross Sq. Footage	49,433,018	
Residential Gross Sq. Footage	40,122,719	
Commercial Gross Sq. Footage	6,055,902	
Total Assessed Value	\$ 12,626,534,807	
Estimated Residential Population		43050

**Table 10-10. Critical Facilities within 50ft of Landslide Prone Areas**

Medical and Health Services	0
Government Function	0
Protective Function	1
Schools	2
Hazardous Materials Storage Sites	0
Bridges	79
Major Tunnels	0
Water	2
Waste Water	1
Communications	1
Energy	1
Human Services	0
High Population	0
<b>Total</b>	<b>87</b>

**Table 10-11. Facilities with Concentrated Vulnerability Populations within 50ft of Landslide Prone Areas**

Adult Family Homes	13
Boarding House	0
Child Care Centers	5
Nursing Home	1
Intermediate Care Facility	0
<b>Total</b>	<b>19</b>



Table 10-12. Zoning in Landslide Prone Areas

Zoning Area	Acres	% of Seattle	% of Area
Seattle	53178.37	100%	
Landslide Prone Area	4471.43	8%	100%
<b>Parcel area in zone</b>	<b>3342.46</b>	<b>6%</b>	<b>75%</b>
Unzoned	0.23	0.00%	0.01%
Commercial - C1	24.03	0.05%	0.54%
Commercial - C2	23.02	0.04%	0.51%
Downtown Harborfront - DH1	0.00	0.00%	0.00%
Downtown Harborfront - DH2	0.00	0.00%	0.00%
Downtown Mixed Commercial - DMC	2.60	0.00%	0.06%
Downtown Mixed Residential/Commercial - DMR	2.00	0.00%	0.04%
Industrial Buffer - IB	45.87	0.09%	1.03%
Industrial Commercial - IC	1.90	0.00%	0.04%
Downtown, International District Mixed - IDM	0.00	0.00%	0.00%
Downtown, International District Residential - IDR	0.00	0.00%	0.00%
General Industrial - IG1	20.42	0.04%	0.46%
General Industrial - IG2	32.96	0.06%	0.74%
Lowrise - LR1	113.40	0.21%	2.54%
Lowrise - LR2	96.33	0.18%	2.15%
Lowrise - LR3	95.17	0.18%	2.13%
Major Institution - MIO	27.85	0.05%	0.62%
MPC			
Multi-Family, Midrise - MR	12.13	0.02%	0.27%
Neighborhood Commercial - NC1	3.88	0.01%	0.09%
Neighborhood Commercial - NC2	3.05	0.01%	0.07%
Neighborhood Commercial - NC3	10.78	0.02%	0.24%
Downtown, Pike Place Market - PMM	0.00	0.00%	0.00%
Downtown, Pioneer Square - PSM	0.00	0.00%	0.00%
Single Family - SF 5000	1215.51	2.29%	27.18%
Single Family - SF 7200	1173.04	2.21%	26.23%
Single Family - SF 9600	431.72	0.81%	9.66%
Neighborhood Commercial, Seattle Mixed- SM	4.12	0.01%	0.09%
Neighborhood Commercial, Seattle Mixed - SMI	0.00	0.00%	0.00%
Neighborhood Commercial, Seattle Mixed Residential - SMR	1.03	0.00%	0.02%
<b>Right of Way</b>	<b>1128.97</b>	<b>2.12%</b>	<b>25.25%</b>

**Table 10-13. Urban Growth Centers / Villages and Manufacturing Centers**

Urban Centers / Villages and Manufacturing Centers	Acres	% Seattle	% Area	% Center
Seattle	53178	100%		
<i>All Hub and Residential Urban Villages</i>	5714.5	10.75%		
<i>All Urban Centers</i>	5715.5	6.98%		
<i>All Manufacturing / Industrial Center</i>	5716.5	11.10%		
Landslide Prone Area	4471.43	8%	100%	
<i>Hub and Residential Urban Villages in Zone</i>	87.20	0.16%	1.95%	1.53%
<i>Urban Centers in Zone</i>	30.85	0.06%	0.69%	0.83%
<i>Manufacturing / Industrial Center in Zone</i>	141.63	0.27%	3.17%	2.40%

**Table 10-14. Wildlife Areas in Landslide Prone Areas**

	Acres	% Seattle
Seattle	53178	100%
Landslide Prone Area	4471.43	8%
All Wildlife Habitat Areas	3749.89	7.05%
<i>Wildlife Habitat in Landslide Prone Areas</i>	1473.54	2.77%

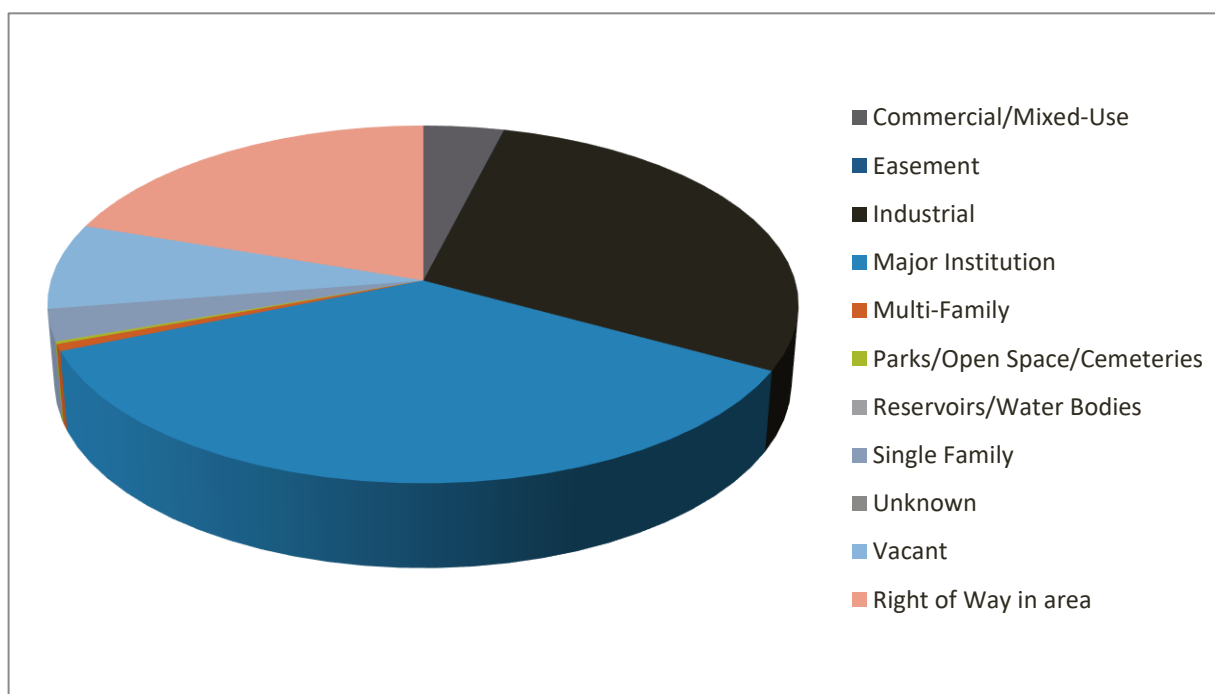
## 10.3 Volcano Hazards Exposures

The entire city is exposed to ashfall but only the low-lying areas along the Duwamish are exposed to lahars or more likely, post-lahar sedimentation. Below is a summary of exposures in this area.

**Table 10-15. Land Use in Post-Lahar Sedimentation Area**

Area	Acres	% Seattle	% Area
Seattle	53178.37	100%	
Post-Lahar Sedimentation Area	3463.73	6.51%	100.00%
<b>Parcel area in area</b>	<b>2778.94</b>	<b>5.23%</b>	<b>80.23%</b>
Commercial/Mixed-Use	136.50	0.26%	3.94%
Easement	0.36	0.00%	0.01%
Industrial	1005.90	1.89%	29.04%
Major Institution And Public Facilities/Utilities	1239.45	2.33%	35.78%
Multi-Family	21.47	0.04%	0.62%
Parks/Open Space/Cemeteries	7.18	0.01%	0.21%
Reservoirs/Water Bodies	1.95	0.00%	0.06%
Single Family	95.92	0.18%	2.77%
Unknown	0.88	0.00%	0.03%
Vacant	269.31	0.51%	7.78%
<b>Right of Way in area</b>	<b>684.79</b>	<b>1.29%</b>	<b>19.77%</b>

**Figure 10-3. Summary of Land Use in Post-Lahar Sedimentation Area**



**Table 10-16. Estimated Population, Structures and Assessed Value in Post-Lahar Sedimentation Area**

Number of Buildings	2,536	Est. Pop
Number of Single Family Units	847	1745
Number of Multi-Family Units	726	1496
Residential Gross Sq Footage	1,906,099	
Commercial Gross Sq Footage	29,047,215	
Total Assessed Value	\$ 4,998,383,962	
Estimated Residential Population		3240

**Table 10-17. Critical Facilities in Post-Lahar Sedimentation Area**

Medical and Health Services	2
Government Function	0
Protective Function	2
Schools	0
Hazardous Materials Storage Sites	15
Bridges	23
Major Tunnels	0
Water	1
Waste Water	2
Communications	0
Energy	2
Human Services	4
High Population	0
<b>Total</b>	<b>51</b>

**Table 10-18. Facilities with Concentrated Vulnerable Population in Post-Lahar Sedimentation Area**

Adult Family Homes	0
Boarding House	0
Child Care Centers	3
Nursing Home	0
Intermediate Care Facility	0
<b>Total</b>	<b>3</b>

Table 10-19. Zoning in Post-Lahar Sedimentation Area

Zoning Area	Acres	% of Seattle	% Area
Seattle	53178.37	100%	
Post-Lahar Sedimentation Area	3463.73	7%	100%
<b>Parcel area in area</b>	<b>2778.94</b>	<b>5%</b>	<b>80%</b>
Unzoned	0.06	0.00%	0.00%
Commercial - C1	13.13	0.02%	0.38%
Commercial - C2	7.07	0.01%	0.20%
Downtown Harborfront - DH1	0.00	0.00%	0.00%
Downtown Harborfront - DH2	0.00	0.00%	0.00%
Downtown Mixed Commercial - DMC	0.00	0.00%	0.00%
Downtown Mixed Residential/Commercial - DMR	0.00	0.00%	0.00%
Industrial Buffer - IB	69.26	0.13%	2.00%
Industrial Commercial - IC	29.04	0.05%	0.84%
Downtown, International District Mixed - IDM	0.00	0.00%	0.00%
Downtown, International District Residential - IDR	0.00	0.00%	0.00%
General Industrial - IG1	1580.59	2.97%	45.63%
General Industrial - IG2	951.69	1.79%	27.48%
Lowrise - LR1	3.99	0.01%	0.12%
Lowrise - LR2	19.94	0.04%	0.58%
Lowrise - LR3	5.91	0.01%	0.17%
Major Institution - MIO	0.00	0.00%	0.00%
Multi-Family, Midrise - MR	0.00	0.00%	0.00%
Neighborhood Commercial - NC1	0.00	0.00%	0.00%
Neighborhood Commercial - NC2	2.60	0.00%	0.08%
Neighborhood Commercial - NC3	10.46	0.02%	0.30%
Downtown, Pike Place Market - PMM	0.00	0.00%	0.00%
Downtown, Pioneer Square - PSM	0.00	0.00%	0.00%
Single Family - SF 5000	84.10	0.16%	2.43%
Single Family - SF 7200	1.10	0.00%	0.03%
Single Family - SF 9600	0.00	0.00%	0.00%
Neighborhood Commercial, Seattle Mixed- SM	0.00	0.00%	0.00%
Neighborhood Commercial, Seattle Mixed - SMI	0.00	0.00%	0.00%
Neighborhood Commercial, Seattle Mixed Residential - SMR	0.00	0.00%	0.00%
<b>Right of Way in Area</b>	<b>684.79</b>	<b>1.29%</b>	<b>19.77%</b>

**Table 10-20. Urban Growth Centers / Village and Manufacturing Centers**

Urban Centers / Villages and Manufacturing Centers	Acres	% Seattle	% Area	% Center
Seattle	53178	100%		
<i>All Hub and Residential Urban Villages</i>	5714.5	10.75%		
<i>All Urban Centers</i>	5715.5	6.98%		
<i>All Manufacturing / Industrial Center</i>	5716.5	11.10%		
Post-Lahar Sedimentation Zone	3463.73	6.51%	100.00%	
<i>Hub and Residential Urban Villages in Zone</i>	127.61	0.24%	3.68%	2%
<i>Urban Centers in Zone</i>	0.00	0.00%	0.00%	0%
<i>Manufacturing / Industrial Center in Zone</i>	3211.49	6.04%	92.72%	54%

**Table 10-21. Wildlife Areas in Post-Lahar Sedimentation Area**

	Acres	% Seattle
Seattle	53178	100%
Post-Lahar Sedimentation Zone	3463.73	6.51%
Wildlife Habitat Areas	3749.89	7.05%
<i>Wildlife Habitat in Post-Lahar Sedimentation Zone</i>	23.06	0.04%



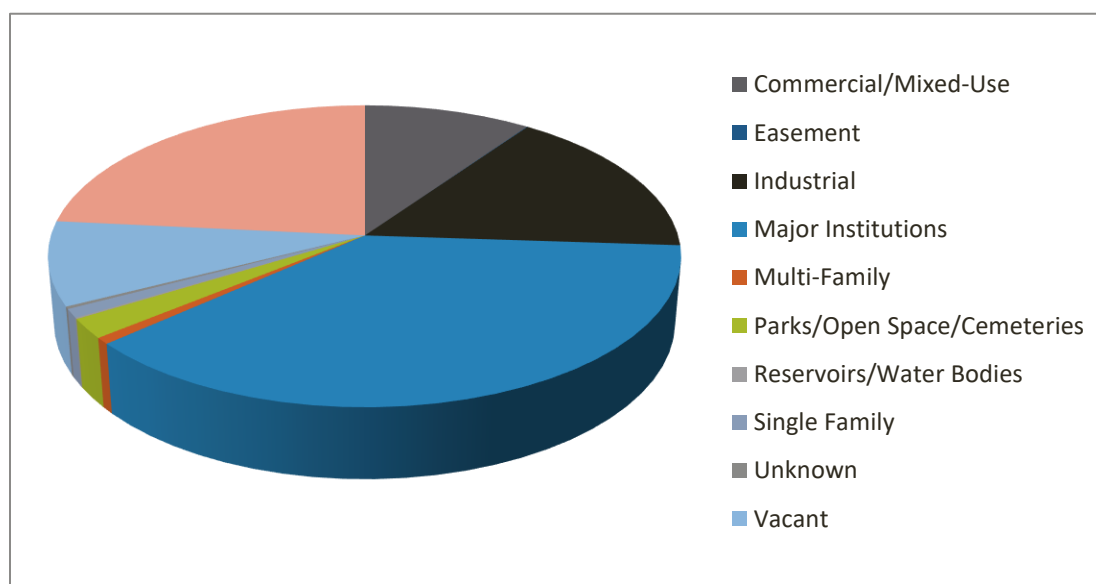
## 10.4 Tsunami and Seiche Exposures

Tsunamis pose the biggest danger to the area around Elliott Bay while seiches threaten all areas along enclosed bodies of water. Unlike tsunamis, seiches do not travel far inland so the only exposures are to structures over the water or immediately adjacent to it.

**Table 10-22. Land Use in Worst Case Tsunami Inundation Area**

Area	Acres	% Seattle	% Area
Seattle	53178.37	100%	
Worst Case Tsunami Inundation Area	2234.58	4%	100%
<b>Parcel area in Area</b>	<b>1710.63</b>	<b>3%</b>	<b>77%</b>
Commercial/Mixed-Use	218.48	0%	10%
Easement	0.70	0%	0%
Industrial	362.80	1%	16%
Major Institutions	835.34	2%	37%
Multi-Family	15.36	0%	1%
Parks/Open Space/Cemeteries	47.21	0%	2%
Reservoirs/Water Bodies	3.02	0%	0%
Single Family	21.03	0%	1%
Unknown	5.58	0%	0%
Vacant	201.12	0%	9%
<b>Right of Way in Area</b>	<b>523.95</b>	<b>1%</b>	<b>23%</b>

**Figure 10-4. Summary of Land Use in Worst Case Tsunami Inundation Area**



**Table 10-23. Estimated Pop., Structures and Assess Value in Worst Case Tsunami Inundation Area**

Number of Buildings	1,339	Est. Pop
Number of Single Family Units	256	527
Number of Multi-Family Units	2,846	5863
Gross Sq. Footage	41,209,932	
Residential Gross Sq. Footage	5,283,843	
Commercial Gross Sq. Footage	26,323,583	
Total Assessed Value	\$ 8,790,180,758	
Estimated Residential Population		6390

**Table 10-24. Critical Facilities in Worst Case Tsunami Inundation Area**

Medical and Health Services	1
Government Function	0
Protective Function	2
Schools	0
Hazardous Materials Storage Sites	11
Bridges	37
Major Tunnels	1
Water	0
Waste Water	0
Communications	0
Energy	2
Human Services	1
High Population	4
<b>Total</b>	<b>59</b>

**Table 10-25. Facilities with Concentrated Vulnerable Pop. In Worst Case Tsunami Inundation Area**

Adult Family Homes	0
Boarding House	0
Child Care Centers	2
Nursing Home	0
Intermediate Care Facility	0
<b>Total</b>	<b>2</b>

Table 10-26. Zoning in Worst Case Tsunami Inundation Area

Zoning Area	Acres	% of Seattle	% of Area
Seattle	53178.37	100%	
Worst Case Tsunami Inundation Area	2234.58	4%	100%
<b>Parcel area</b>	<b>1710.63</b>	<b>3%</b>	<b>77%</b>
<i>Unzoned</i>	0.11	0.00%	0.01%
<i>Commercial - C1</i>	7.83	0.01%	0.35%
<i>Commercial - C2</i>	13.59	0.03%	0.61%
<i>Downtown Harborfront - DH1</i>	32.60	0.06%	1.46%
<i>Downtown Harborfront - DH2</i>	10.73	0.02%	0.48%
<i>Downtown Mixed Commercial - DMC</i>	8.93	0.02%	0.40%
<i>Downtown Mixed Residential/Commercial - DMR</i>	4.15	0.01%	0.19%
<i>Industrial Buffer - IB</i>	3.83	0.01%	0.17%
<i>Industrial Commercial - IC</i>	177.93	0.33%	7.96%
<i>Downtown, International District Mixed - IDM</i>	0.73	0.00%	0.03%
<i>Downtown, International District Residential - IDR</i>	0.00	0.00%	0.00%
<i>General Industrial - IG1</i>	1111.92	2.09%	49.76%
<i>General Industrial - IG2</i>	200.17	0.38%	8.96%
<i>Lowrise - LR1</i>	1.57	0.00%	0.07%
<i>Lowrise - LR2</i>	4.37	0.01%	0.20%
<i>Lowrise - LR3</i>	1.11	0.00%	0.05%
<i>Major Institution - MIO</i>	0.00	0.00%	0.00%
<i>Multi-Family, Midrise - MR</i>	3.64	0.01%	0.16%
<i>Neighborhood Commercial - NC1</i>	25.25	0.05%	1.13%
<i>Neighborhood Commercial - NC2</i>	4.60	0.01%	0.21%
<i>Neighborhood Commercial - NC3</i>	1.22	0.00%	0.05%
<i>Downtown, Pike Place Market - PMM</i>	0.14	0.00%	0.01%
<i>Downtown, Pioneer Square - PSM</i>	26.83	0.05%	1.20%
<i>Single Family - SF 5000</i>	8.92	0.02%	0.40%
<i>Single Family - SF 7200</i>	60.21	0.11%	2.69%
<i>Single Family - SF 9600</i>	0.25	0.00%	0.01%
<i>Neighborhood Commercial, Seattle Mixed- SM</i>	0.00	0.00%	0.00%
<i>Neighborhood Commercial, Seattle Mixed - SMI</i>	0.00	0.00%	0.00%
<i>Neighborhood Commercial, Seattle Mixed Residential - SMR</i>	0.00	0.00%	0.00%
<b>Right of Way in area</b>	<b>523.95</b>	<b>0.99%</b>	<b>23.45%</b>

**Table 10-27. Urban Centers / Villages and Manufacturing Centers in Worst Case Tsunami Inundation Area**

Urban Centers / Villages and Manufacturing Centers	Acres	% Seattle	% Area	% Center
Seattle	53178	100%		
<i>All Hub and Residential Urban Villages</i>	5714.5	10.75%		
<i>All Urban Centers</i>	5715.5	6.98%		
<i>All Manufacturing / Industrial Center</i>	5716.5	11.10%		
Worst Case Tsunami Inundation Area	2234.58	4%	100%	
<i>Hub and Residential Urban Villages in Zone</i>	0.00	0.00%	0.00%	0.00%
<i>Urban Centers in Zone</i>	186.29	0.35%	8.34%	5.02%
<i>Manufacturing / Industrial Center in Zone</i>	1825.89	3.43%	81.71%	30.94%

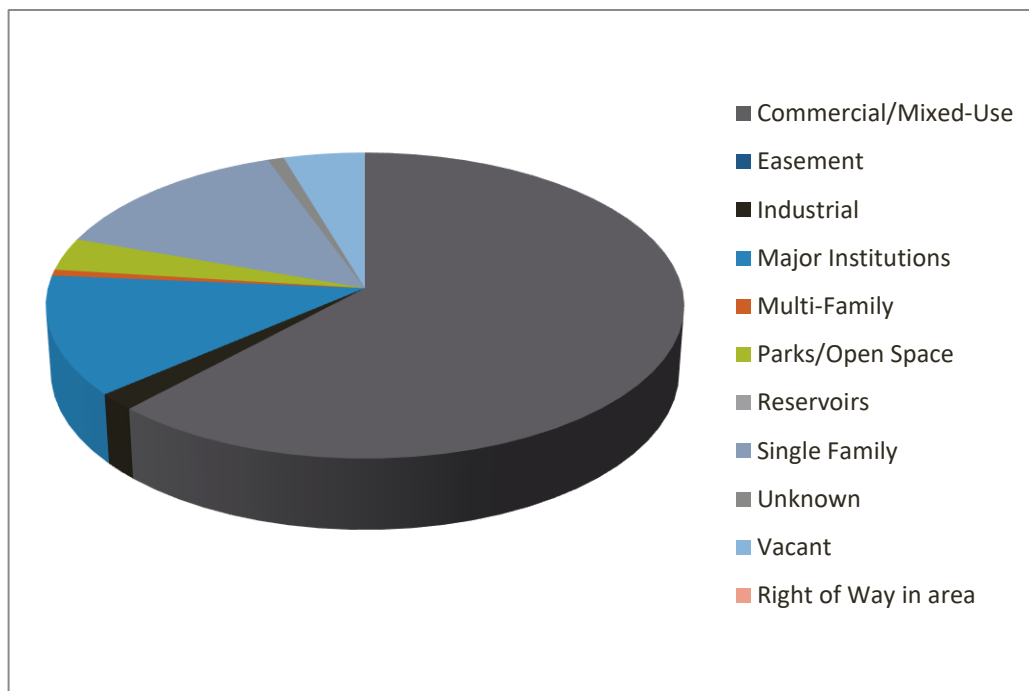
**Table 10-28. Wildlife Areas in Worst Case Tsunami Inundation Area**

	Acres	% Seattle
Seattle	53178	100%
Worst Case Tsunami Inundation Area	2234.58	4%
Wildlife Habitat Areas	3749.89	7.05%
Wildlife Habitat in Worst Case Tsunami Inundation Area	391.52	0.74%

Table 10-29. Land Use in Lake Union Seiche Area

Area	Acres	% Seattle	% Area
Seattle	53178.37	100%	
Lk. Union Seiche Area	144.11	0%	100%
<b>Property in area</b>	<b>144.11</b>	<b>0%</b>	<b>100%</b>
<i>Commercial/Mixed-Use</i>	84.89	0%	59%
<i>Easement</i>	0.00	0%	0%
<i>Industrial</i>	2.46	0%	2%
<i>Major Institutions</i>	17.29	0%	12%
<i>Multi-Family</i>	0.89	0%	1%
<i>Parks/Open Space/Cemeteries</i>	4.74	0%	3%
<i>Reservoirs/Water Bodies</i>	0.01	0%	0%
<i>Single Family</i>	19.24	0%	13%
<i>Unknown</i>	1.26	0%	1%
<i>Vacant</i>	6.30	0%	4%
<b>Right of Way in area</b>	<b>0.00</b>	<b>0%</b>	<b>0%</b>

Figure 10-5. Summary of Land use in Lake Union Seiche Area



**Table 10-30. Estimated Population, Structures, and Assessed Value in Lake Union Seiche Area**

Number of Buildings	530	Est. Pop
Number of Single-Family Units	77	159
Number of Multi-Family Units	100	206
Gross Sq. Footage	2,113,176	
Residential Gross Sq. Footage	281,073	
Commercial Gross Sq. Footage	1,445,938	
Total Assessed Value	\$ 702,618,934	
Estimated Residential Population		365

**Table 10-31. Critical Facilities in Lake Union Seiche Area**

Medical and Health Services	0
Government Function	1
Protective Function	0
Schools	0
Hazardous Materials Storage Sites	0
Bridges	1
Major Tunnels	0
Water	0
Waste Water	0
Communications	0
Energy	0
Human Services	0
High Population	0
<b>Total</b>	<b>2</b>

**Table 10-32. Facilities with Concentrated Vulnerable Populations in Lake Union Seiche Area**

Adult Family Homes	0
Boarding House	0
Child Care Centers	0
Nursing Home	0
Intermediate Care Facility	0
<b>Total</b>	<b>0</b>

**Table 10-33. Zoning in Lake Union Seiche Area**

	Acres	% of Seattle	% of Area
Seattle	53178.37	100%	
Lk. Union Seiche Area	144.11	0.27%	100%
<b>Property in area</b>	144.11	0.27%	100%
<i>Unzoned</i>	0.01	0.00%	0.01%
<i>Commercial - C1</i>	1.86	0.00%	1.29%
<i>Commercial - C2</i>	73.91	0.14%	51.29%
<i>Downtown Harborfront - DH1</i>	32.60	0.06%	22.62%
<i>Downtown Harborfront - DH2</i>	0.00	0.00%	0.00%
<i>Downtown Mixed Commercial - DMC</i>	0.00	0.00%	0.00%
<i>Downtown Mixed Residential/Commercial - DMR</i>	0.00	0.00%	0.00%
<i>Industrial Buffer - IB</i>	20.67	0.04%	14.34%
<i>Industrial Commercial - IC</i>	8.86	0.02%	6.15%
<i>Downtown, International District Mixed - IDM</i>	0.73	0.00%	0.51%
<i>Downtown, International District Residential - IDR</i>	0.00	0.00%	0.00%
<i>General Industrial - IG1</i>	20.40	0.04%	14.16%
<i>General Industrial - IG2</i>	0.00	0.00%	0.00%
<i>Lowrise - LR1</i>	0.00	0.00%	0.00%
<i>Lowrise - LR2</i>	3.74	0.01%	2.59%
<i>Lowrise - LR3</i>	0.62	0.00%	0.43%
<i>Major Institution - MIO</i>	0.00	0.00%	0.00%
<i>Multi-Family, Midrise - MR</i>	0.00	0.00%	0.00%
<i>Neighborhood Commercial - NC1</i>	0.00	0.00%	0.00%
<i>Neighborhood Commercial - NC2</i>	0.00	0.00%	0.00%
<i>Neighborhood Commercial - NC3</i>	0.00	0.00%	0.00%
<i>Downtown, Pike Place Market - PMM</i>	0.00	0.00%	0.00%
<i>Downtown, Pioneer Square - PSM</i>	0.00	0.00%	0.00%
<i>Single Family - SF 5000</i>	14.03	0.03%	9.73%
<i>Single Family - SF 7200</i>	0.00	0.00%	0.00%
<i>Single Family - SF 9600</i>	0.00	0.00%	0.00%
<i>Neighborhood Commercial, Seattle Mixed - SM</i>	0.01	0.00%	0.01%
<i>Neighborhood Commercial, Seattle Mixed - SMI</i>	0.00	0.00%	0.00%
<i>Neighborhood Commercial, Seattle Mixed Residential - SMR</i>	0.00	0.00%	0.00%
<b>Right of Way</b>	<b>0.00</b>	<b>0.00%</b>	0.00%



**Table 10-34. Urban Growth Centers in Lake Union Seiche Area**

Urban Centers / Villages and Manufacturing Centers	Acres	% Seattle	% Area	% Center
Seattle	53178	100%		
<i>All Hub and Residential Urban Villages</i>	<i>5714.5</i>	<i>10.75%</i>		
<i>All Urban Centers</i>	<i>5715.5</i>	<i>6.98%</i>		
<i>All Manufacturing / Industrial Center</i>	<i>5716.5</i>	<i>11.10%</i>		
Seiche Area	2234.58	4%	1551%	
<i>Hub and Residential Urban Villages in Zone</i>	<i>5.79</i>	<i>0.01%</i>	<i>0.26%</i>	<i>0.10%</i>
<i>Urban Centers in Zone</i>	<i>3.02</i>	<i>0.01%</i>	<i>0.14%</i>	<i>0.08%</i>
<i>Manufacturing / Industrial Center in Zone</i>	<i>0.00</i>	<i>0.00%</i>	<i>0.00%</i>	<i>0.00%</i>

**Table 10-35. Wildlife Areas in Lake Union Seiche Area**

	Acres	% Seattle
Seattle	53178	100%
Worst Case Tsunami Inundation Area	2234.58	4%
Wildlife Habitat Areas	3749.89	7.05%
Wildlife Habitat in Seiche Area	0	0.00%

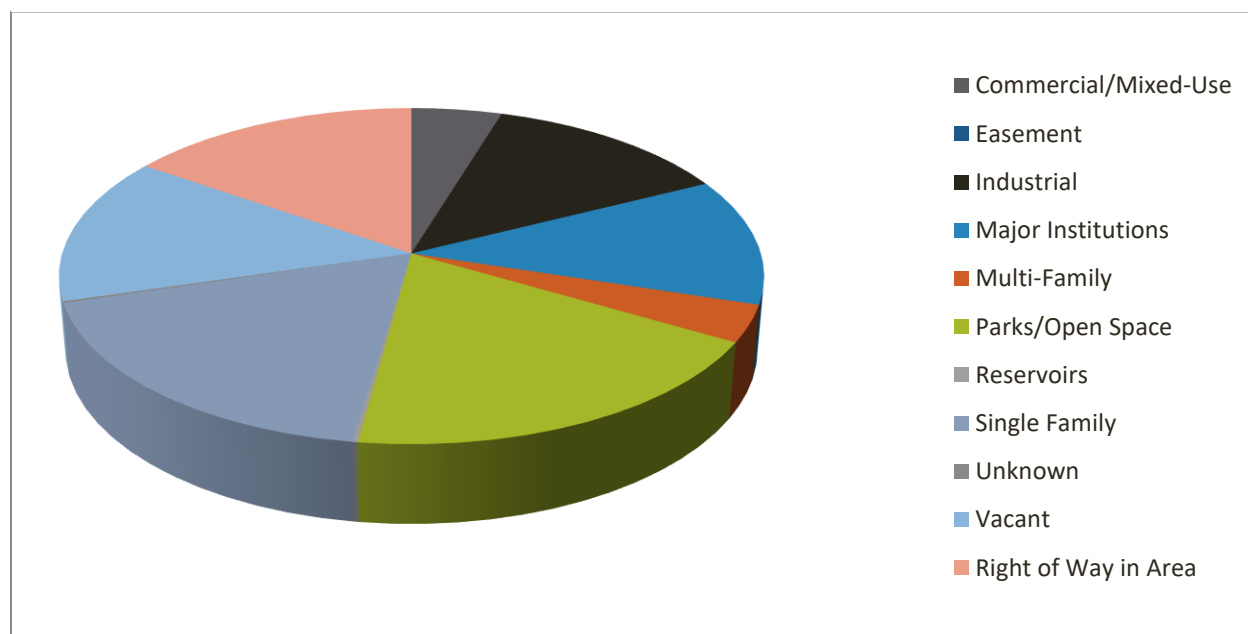
## 10.5 Flooding Exposures

Seattle has two distinct, but related flood hazards each with their own high exposure areas. The first are areas along rivers and streams that can overflow their banks. These areas comprise the first set of tables and figures. The second are urban flood areas that have a higher likelihood of ponding during extreme precipitation when drainage systems are overwhelmed. These areas comprise the second set.

**Table 10-36. Land use in Flood Prone Areas**

	Acres	% Seattle	% Area
Seattle	53178.37	100%	
Flood Area (1996 FIRM & other)	388.39	0.73%	100.00%
<b>Property in area</b>	<b>328.81</b>	<b>0.62%</b>	84.66%
Commercial/Mixed-Use	18.35	0.03%	4.72%
Easement	0.00	0.00%	0.00%
Industrial	50.06	0.09%	12.89%
Major Institutions	47.45	0.09%	12.22%
Multi-Family	13.82	0.03%	3.56%
Parks/Open Space	72.77	0.14%	18.74%
Reservoirs	0.81	0.00%	0.21%
Single Family	69.90	0.13%	18.00%
Unknown	0.62	0.00%	0.16%
Vacant	55.03	0.10%	14.17%
<b>Right of Way in Area</b>	<b>59.58</b>	<b>0.11%</b>	15.34%

**Figure 10-6. Summary of Land use in Flood Prone Areas**



**Table 10-37. Estimated Population, Buildings and Assessed Value in Flood Prone areas**

Number of Buildings	1,722*	Est. Pop
Number of Single-Family Units	1,182	2435
Number of Multi-Family Units	2,038	4198
Gross Sq Footage	9,596,454	
Residential Gross Sq Footage	5,139,396	
Commercial Gross Sq Footage	3,802,382	
Total Assessed Value	\$ 3,569,721,500	
Estimated Residential Population		6633

**Table 10-38. Critical Facilities in Flood Prone Areas**

Medical and Health Services	0
Government Function	0
Protective Function	0
Schools	1
Hazardous Materials Storage Sites	0
Bridges	14
Major Tunnels	0
Water	1
Waste Water	0
Communications	0
Energy	0
Human Service Support	1
High Population	0
<b>Total</b>	<b>17</b>

**Table 10-39. Facilities in Concentrated Vulnerable Populations in Flood Prone Areas**

Adult Family Homes	0
Boarding House	0
Child Care Centers	0
Nursing Home	0
Intermediate Care Facility	0
<b>Total</b>	<b>0</b>

**Table 10-40. Zoning in Flood Prone Areas**

	Acres	% of Seattle	% Area
Seattle	53178.37	100%	
Flood Area (1996 FIRM & other)	388.39	0.73%	100.00%
<b>Zoning</b>	<b>328.81</b>	<b>0.62%</b>	84.66%
<i>Unzoned</i>	0.01	0.00%	0.00%
<i>Commercial - C1</i>	11.36	0.02%	2.92%
<i>Commercial - C2</i>	4.85	0.01%	1.25%
<i>Downtown Harborfront - DH1</i>	4.18	0.01%	1.08%
<i>Downtown Harborfront - DH2</i>	0.00	0.00%	0.00%
<i>Downtown Mixed Commercial - DMC</i>	0.00	0.00%	0.00%
<i>Downtown Mixed Residential/Commercial - DMR</i>	0.00	0.00%	0.00%
<i>Industrial Buffer - IB</i>	2.91	0.01%	0.75%
<i>Industrial Commercial - IC</i>	2.90	0.01%	0.75%
<i>Downtown, International District Mixed - IDM</i>	0.00	0.00%	0.00%
<i>Downtown, International District Residential - IDR</i>	0.00	0.00%	0.00%
<i>General Industrial - IG1</i>	34.64	0.07%	8.92%
<i>General Industrial - IG2</i>	48.22	0.09%	12.41%
<i>Lowrise - LR1</i>	7.89	0.01%	2.03%
<i>Lowrise - LR2</i>	8.55	0.02%	2.20%
<i>Lowrise - LR3</i>	4.62	0.01%	1.19%
<i>Major Institution - MIO</i>	149.01	0.28%	38.37%
<i>Multi-Family, Midrise - MR</i>	0.00	0.00%	0.00%
<i>Neighborhood Commercial - NC1</i>	11.72	0.02%	3.02%
<i>Neighborhood Commercial - NC2</i>	1.60	0.00%	0.41%
<i>Neighborhood Commercial - NC3</i>	1.46	0.00%	0.38%
<i>Downtown, Pike Place Market - PMM</i>	0.00	0.00%	0.00%
<i>Downtown, Pioneer Square - PSM</i>	0.00	0.00%	0.00%
<i>Single Family - SF 5000</i>	51.48	0.10%	13.25%
<i>Single Family - SF 7200</i>	93.45	0.18%	24.06%
<i>Single Family - SF 9600</i>	40.91	0.08%	10.53%
<i>Neighborhood Commercial, Seattle Mixed- SM</i>	0.00	0.00%	0.00%
<i>Neighborhood Commercial, Seattle Mixed - SMI</i>	0.00	0.00%	0.00%
<i>Neighborhood Commercial, Seattle Mixed Residential - SMR</i>	0.00	0.00%	0.00%
<b>Right of Way</b>	<b>59.58</b>	<b>0.11%</b>	15.34%

**Table 10-41. Urban Growth Centers in Flood Prone Areas**

Urban Centers / Villages and Manufacturing Centers	Acres	% Seattle	% Zone	% Center
Seattle	53178	100%		
<i>All Hub and Residential Urban Villages</i>	5714.5	10.75%		
<i>All Urban Centers</i>	5715.5	6.98%		
<i>All Manufacturing / Industrial Center</i>	5716.5	11.10%		
Flood Area (1996 FIRM & other)	388.39	0.73%	100.00%	
<i>Hub and Residential Urban Villages in Zone</i>	11.52	0.02%	0.02%	0.20%
<i>Urban Centers in Zone</i>	7.71	0.01%	0.01%	0.21%
<i>Manufacturing / Industrial Center in Zone</i>	119.58	0.22%	0.22%	2.03%

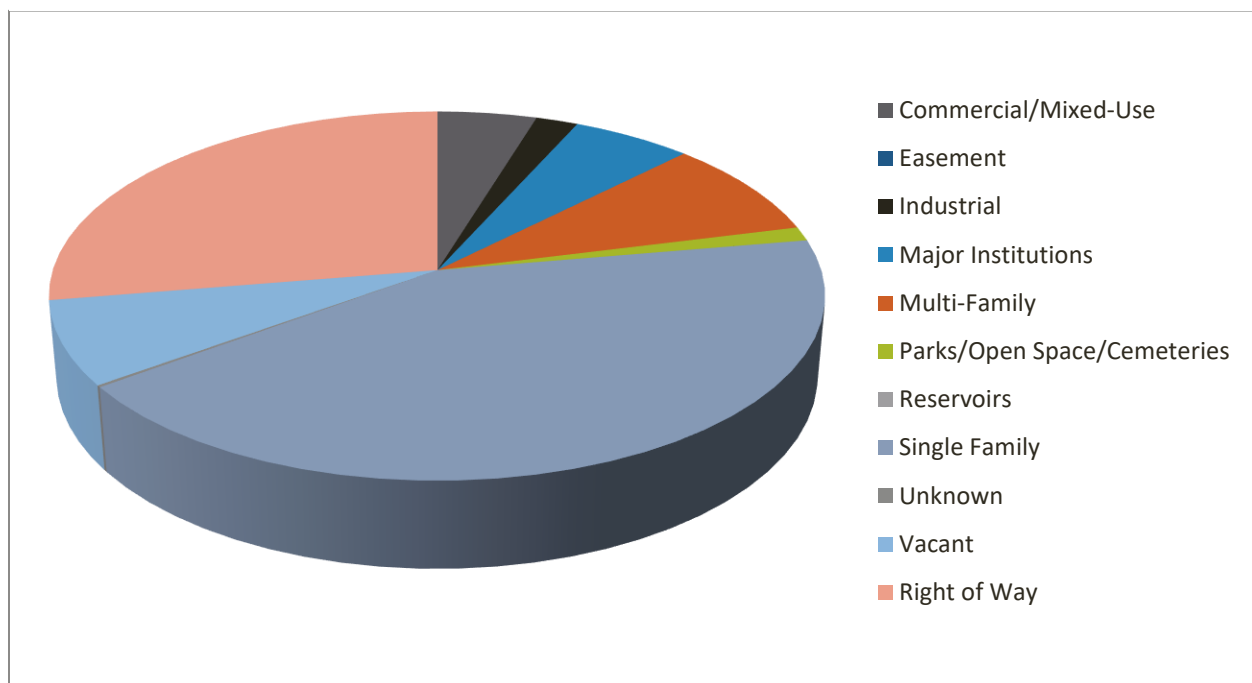
**Table 10-42. Wildlife Areas in Flood Prone Areas**

	Acres	% Seattle
Seattle	53178	100%
Flood Area (1996 FIRM & other)	388.39	0.73%
Wildlife Habitat Areas	3749.89	7.05%
<i>Wildlife Habitat in Urban Flood Areas</i>	56.77	0.11%

Table 10-43. Land Use in Urban Flood Areas

Area	Acres	% Seattle	% Area
Seattle	53178.37	100%	
Urban Flood Prone Areas	3312.57	6.23%	100.00%
<b>Property in Area</b>	<b>2398.31</b>	<b>4.51%</b>	72.40%
Commercial/Mixed-Use	157.00	0.30%	4.74%
Easement	0.00	0.00%	0.00%
Industrial	66.46	0.12%	2.01%
Major Institutions	189.86	0.36%	5.73%
Multi-Family	284.92	0.54%	8.60%
Parks/Open Space/Cemeteries	40.46	0.08%	1.22%
Reservoirs	0.00	0.00%	0.00%
Single Family	1410.64	2.65%	42.58%
Unknown	5.42	0.01%	0.16%
Vacant	243.55	0.46%	7.35%
<b>Right of Way</b>	<b>914.26</b>	<b>1.72%</b>	27.60%

Figure 10-7. Summary of Land Use in Urban Flood Prone Areas



**Table 10-44. Estimated Population, Buildings, and Assessed Value in Urban Flood Prone Areas**

<i>Number of Buildings</i>	<b>11,483</b>	<b><i>Est. Pop</i></b>
<i>Number of Single Family Units</i>	<b>8,505</b>	<b>17,520</b>
<i>Number of Multi-Family Units</i>	<b>10,637</b>	<b>21,912</b>
<i>Residential Gross Sq Footage</i>	<b>27,796,973</b>	
<i>Commercial Gross Sq Footage</i>	<b>4,187,463</b>	
<i>Total Assessed Value</i>	<b>\$ 5,054,230,233</b>	
Estimated Residential Population		39,433

**Table 10-45. Critical Facilities in Urban Flood Prone Areas**

Medical and Health Services	1
Government Function	0
Protective Function	3
Schools	9
Hazardous Materials Storage Sites	0
Bridges	3
Major Tunnels	0
Water	1
Waste Water	2
Communications	0
Energy	3
Human Services	7
High Population	0
<b>Total</b>	<b>29</b>

**Table 10-46. Facilities with Concentrated Vulnerable Populations in Urban Flood Prone Areas**

Adult Family Homes	13
Boarding House	6
Child Care Centers	13
Nursing Home	4
Intermediate Care Facility	0
<b>Total</b>	<b>36</b>



## **11. APPENDIX B: SCENARIOS**

This section provides two scenarios for each hazard: a Most Likely and a Maximum Credible. The scenarios are used to create the hazard rankings found in the beginning of this document.



## 11.1 Earthquakes

### 11.1.1 Most Likely Scenario

A M6.7 deep earthquake centered near Seattle occurs during business hours. The earthquake is similar to the 2001 Nisqually Earthquake but a little more powerful. 10 unreinforced masonry buildings partially collapse in the Pioneer Square and Sodo areas. 200 have to be red tagged and 1000 are yellow tagged. The ground is saturated with water causing widespread liquefaction, lateral spread, and landslides.

Category	Impact 1 = low 5 = high	Narrative
Frequency	4	Events in 1949, 1965 and 2001. Seismologists estimate a 1 in 50 chance (2%) per year.
Geographic Scope	5	Most of the Central Puget Sound Region including all of Seattle
Duration	2	Widespread disruption lasts 3 days but damaged structures and impacted households, businesses and organizations experience effects for weeks to months.
Health Effects, Deaths, and Injuries	2	Fatalities in the low single digits. Injuries in the double digits.
Displacement and Suffering	2	About 70 households displaced for several months. About half find rental housing. The other half requires help. Several hundred vulnerable persons lose access to services that support them (for example, a homeless shelter has to close due to damage).
Economy	2	Damage amounts to approximately \$500 million in Seattle. Isolated businesses are severely impacted. Some close, but overall economy is quick to recover.
Environment	2	Earthquake generates hazardous materials incidents. Responders are not able to get to them as quickly as they normally would. As a result, environmental quality suffers prolonged but temporary degradation.
Structures	3	200 buildings, mostly older and small commercial buildings are 'red tagged' meaning they need to be replaced or massively repaired before they can be re-occupied. 1000 buildings need moderate repairs. Several utilities affected for 2-3 weeks.
Transportation	2	All areas of Seattle remain accessible, but road and bridge damage cause delays in reaching several areas.
Critical Services and Utilities	2	One critical service (e.g., fire, police, and hospitals) is not able to perform at full level for 2-3 weeks.
Confidence in Government	1	The public's opinion of the government's ability is unchanged.
Cascading Effects	4	The earthquake triggers several large secondary incidents. For example, improperly stored hazardous materials spill and catch fire. Due to complications from the earthquake the Fire Department is not able to bring the normal level of resources to bear. Several landslides have also been triggered destroying several homes and damaging 10-20 apartment buildings and businesses.

### 11 1.2 Maximum Credible Scenario

A M7.2 Seattle fault earthquake strikes during the weekday while the Sounders are playing a game. The ground is saturated due to heavy rain during the previous two weeks. Over the next few days the temperatures are expected to drop into the upper 30's and the steady rain transitions to showers. The earthquake generates a 16ft tsunami, triggers thousands of landslides, tens of fire ignitions, and releases tons hazardous materials.

Category	Impact (1- 5)	Effects
Frequency	2	One event known in 900 AD. Evidence of earlier events. Seismologists estimate 1 in 1000 chance per year for a magnitude over 6.5 and 1 in 5000 for a magnitude 7.5, but there is uncertainty in this estimate due to lack of data.
Geographic Scope	5	This earthquake will affect all communities along the fault zone (an area extending through Bremerton, Seattle, Mercer Island, Bellevue and Issaquah). The Kent Valley will also be heavily affected due to the soft soils in the river valley. Very Strong (MMI VII) shaking extends north to Edmonds and south to Tacoma.
Duration	5	This event devastates the Central Puget Sound region. Immediate recovery (e.g., service restoration) takes a month. Full recovery takes years. Main routes into the area require major repairs. Resources must be pulled in from around the country.
Health Effects, Deaths, and Injuries	5	Structural collapses, landslides, fires and a tsunami combine to cause 1,200 deaths and 15,000 severe to critical injuries.
Displacement and Suffering	5	25,000 households are displaced due to damage to their homes. 4,000 will be displaced for more than 6 months. Fans in the stadium and tourists are stranded in Seattle.
Economy	5	The earthquake causes \$20 billion in damage and indirect losses. The industrial area along the Duwamish Waterway is especially hard hit. It will take years for the area to recover. The Port is heavily damaged and seeks to recover as soon as possible to avoid losing customers permanently.
Environment	5	Major marine environmental damage is caused by secondary effects, especially hazardous materials releases and fires. Tank farms on Harbor Island rupture spilling fuel into Puget Sound. The BP pipeline breaks due to movement of the fault zone. Damage to wastewater mains pollutes the marine areas along the shoreline. The earthquake has triggered a tsunami and landslides. These secondary hazards have scoured sensitive coastal eco-systems.
Structures	5	6,000 buildings are destroyed; 21,000 are severely damaged and unsafe to occupy and 80,000 are moderately damaged. Damage is heaviest south of the Ship Canal, but older sections of Ballard, Wallingford and the U-District also have concentrations of damage. Pioneer Square, the International District, Sodo, and the northern area of West Seattle are especially hard hit.

Category	Impact (1- 5)	Effects
Transportation	5	Damage to surface, air and marine transportation systems is extreme. All major surface routes into the city are damaged and impassible. Retrofitting of bridges ensure that critical bridges do not fail, but they suffer major damage and 12 will need to be replaced. 14 minor bridges and overpasses collapse. Both major airports have extensive damage to runways. SeaTac is able to use one runway. Port of Seattle facilities are located at the epicenter and are devastated.
Critical Services and Utilities	5	Large parts of the city lose water pressure, power, and communications. Public safety responders are overwhelmed.
Confidence in Government	5	Recovery from the earthquake is slow and complex. The pace of recovery becomes a source of frustration which is directed at government.
Cascading Effects	5	The earthquake causes multiple secondary hazards each of which is a major disaster in its own right. It triggers a tsunami, numerous massive landslides, hazardous materials spills and over 80 large fires.

### 11 1.3 Alternate Scenario

Because earthquakes are so complex, it is impossible to convey the earthquake hazard consequences without briefly mentioning megathrust earthquakes. Shaking would be rated as ‘Very Strong’ (MMI VII) on the Modified Mercalli Intensity scale and would last several minutes. Well-engineered structures would survive with minimal damage but outdated and poorly designed or maintained structures would suffer extensive damage or collapse. Average structures would have slight to moderate damage. A megathrust earthquake is also likely to generate a powerful seiche on Lake Union and possibly in other waterbodies as well. As bad as this earthquake would be for Seattle, it would be much worse on the coast where the shaking would be much stronger and where a tsunami would be triggered that could devastate the entire coastal area. Seattle would be in a position of having to help coastal communities even as it struggles with huge losses.

## 11.2 Landslide Scenarios

### 11.2.1 Most Likely Scenario

The most likely scenario is an event like the 1996/7 landslide event. 227 mostly shallow landslides occur over a three-day period. Most occur on undeveloped property causing little or no damage. 52 cause significant property damage, mostly non-structural. 11 cause major structural damage. Mostly residential areas affected. Some commercial properties damaged. A few major roads blocked. Several roads undermined. Some water, gas and sewer lines are severed. Mitigation measures protect Aurora from a major landslide.

Category	Impact 1 = low 5 = high	Narrative
Frequency	5	We expect this type of event every 10 - 50 years.
Geographic Scope	4	Landslides occur throughout the City but happen mostly in the 8% of the city previously mapped as prone to landslides.
Duration	3	The landslides occur over a period of three days, but response and clean-up take another two days.
Health Effects, Deaths, and Injuries	2	The landslides cause no deaths. Tension cracks appear at the top of most slopes before they fail allowing residents and businesses to escape before the slides occur. Ten slides occur without warning and strike structures, injuring 15 people.
Displacement and Suffering	2	75 people in 32 households are displaced. All except three households are able to find their own shelter with friends and family.
Economy	1	Although 72 buildings are affected and the property owners incur severe loss, the losses do affect the greater Seattle economy in a measurable way.
Environment	2	The landslides create scars on hillsides increasing the potential for erosion. A sewer line is undermined and breaks spilling untreated sewage but the damage is cleaned and repaired quickly.
Structures	2	28 buildings are red tagged including 1 childcare center. The latter was unoccupied when the landslide struck it. 60 buildings are yellow tagged.
Transportation	3	2 bridges are struck and suffer damage that restricts usage to emergency vehicles only. Previous mitigation prevents the Magnolia bridge from being closed completely. Several non-arterial roads are undermined. Mitigation barrier along Aurora stops a slide from blocking it. Several smaller arterials are covered in debris that is removed within 24 hours. Amtrak and Sounder passenger service is stopped for 48 hours.
Critical Services and Utilities	1	Several slides break water and sewer lines. A high pressure gas line is undermined but doesn't break. This damage causes localized outages

Category	Impact 1 = low 5 = high	Narrative
Confidence in Government	1	The public sees the landslides as natural events. Services are restored quickly. The government is able to maintain the confidence of the public.
Cascading Effects	1	Forecasting of a heightened likelihood of landslides reduced the chance for this incident to trigger secondary hazards. No significant secondary hazards occur.

### 11 2.2 Maximum Credible Scenario

3 large deep-seated landslides occur within 3 hours during a storm along with hundreds of smaller landslides. The landslides occur at night without warning. They destroy multiple structures, destroy roads, start fires and release hazardous materials. A Seattle City Light transmission tower coming into Seattle from the south slides. Many lives are lost as the landslides crush homes in the night. Massive landslides into Puget Sound and Lake Washington cause tsunamis. An explosion occurs when a train carrying Bakken crude oil is knocked into Puget Sound by a landslide.

Category	Impact 1 = low 5 = high	Narrative
Frequency	2	This scenario is considered 1 in 1000 event.
Geographic Scope	3	Almost all of the area identified as landslide prone is affected (8% of the Seattle's landmass).
Duration	3	The slides occur over a 3-hour period. Seattle spends the following 5 days actively responding and many more days in recovery.
Health Effects, Deaths, and Injuries	3	42 people are killed and 35 are injured when 20 houses are crushed
Displacement and Suffering	3	240 people are displaced from their homes. Of these 54 need shelter.
Economy	3	Multiple businesses are affected with concentrations of damage in two areas. Freight trains and Amtrak service is halted for three weeks as the tracks are repaired. The overall City economy suffers minor impacts, but the effects on freight transport and at the neighborhood level are more severe.
Environment	3	The landslides strip hundreds of acres of hillsides of vegetation, break numerous sewer lines and knock a train carrying flammable oil into Puget Sound.
Structures	3	165 buildings are red tagged; 430 are yellow tagged. Several major arterials are undermined; the Magnolia bridge has to be closed when its piers are knocked away.
Transportation	4	Due to bridge and arterial outages, emergency services are delayed reaching Magnolia and parts of West Seattle. Commuters experience long delays. Sounder and Amtrak train service is stopped for three weeks.



Category	Impact 1 = low 5 = high	Narrative
Critical Services and Utilities	2	A large landslide in South Seattle topples a City Light transmission line. Bonneville Power Administration (BPA) transmissions lines outside the City are affected too. The loss causes a widespread outage lasting 36 hours.
Confidence in Government	3	The incident's magnitude surprises the public. The response takes longer than it expects. As a result it becomes impatient with the pace of response.
Cascading Effects	4	The landslides have caused a major hazardous materials release incident, an explosion, and triggered a tsunami.

## 11.3 Volcanic Hazards

### 11.3.1 Most Likely Scenario

A Mt. Rainier lahar devastates the Puyallup, Carbon, and White River valleys stopping at Auburn. In the next few weeks massive amounts of debris begin flushing out the Duwamish blocking the waterway and overflowing the banks of the river in South Park and Georgetown. Major distribution and transportation hubs south of the city are destroyed causing localized food shortages. People who work in Seattle and live in South King County and Pierce County have a hard time commuting to work.

Category	Impacts 1 = low 5 = high	Narrative
Frequency	2	The type of lahar envisioned in this scenario is a 'Case I' flow as categorized by the Cascades Volcano Observatory. Case I lahars are estimated to happen about once every 500 to 1000 years.
Geographic Scope	2	The only affected area in Seattle itself is the Duwamish Waterway, but the Kent Valley south of Seattle will be severely impacted.
Duration	5	Lahar deposits wash down the Duwamish River for weeks. The regional transportation system will be disrupted for weeks. Many people who live South King County but work in Seattle are displaced. Seattle residents who work in South King County lose their work places.
Health Effects, Deaths, and Injuries	1	The incident causes no deaths or injuries in Seattle.
Displacement and Suffering	4	200 households in South Park and Georgetown are displaced and Seattle hosts many people who are displaced from South King County.
Economy	3	The Duwamish waterway must be dredged. This work impacts Port of Seattle and other shipping operations. Transportation routes and distribution centers south of the City are severely impacted. Workers living south of Seattle have longer commutes.
Environment	2	The lahar debris causes extension damage in the Green River and Duwamish waterway as extensive efforts are underway to restore it. The lahar sediments contain hazardous materials from destroyed buildings upstream.
Structures	3	100 structures along the Duwamish waterway are damaged. The lahar debris moves slowly and floods buildings with heavy sludge.
Transportation	2	Transportation routes in Seattle itself are not affected, but those to the south are severely impacted. Bridges, highways and rail lines are heavily damaged.
Critical Services and Utilities	3	The lahar from Mt. Rainier has heavily damaged multiple warehouses and distribution centers in the Kent Valley including food distribution centers. Seattle suffers several days of food and commodity shortages as business adjust.
Confidence in Government	1	The Seattle public is not directly impacted by the eruption and views it as a natural event. It does not hold the City of Seattle responsible for it.
Cascading Effects	1	The post-lahar sedimentation will not be likely to cause secondary hazards but will complicate the Duwamish restoration.

### 11 3.2 Maximum Credible Scenario

Mt. Rainier erupts. Despite lack of known precedent, a lahar reaches Seattle. The city has several hours of warning. At the same time, an unusual weather pattern blows 6" ash into Seattle. Rain moves in after the ashfall. The ash becomes hard and cement-like as it gets wet.

Category	Impacts 1 = low 5 = high	Narrative
Frequency	1	This scenario would be an unprecedented event. No evidence has been found that a lahar has reached the mouth of the Duwamish. The Cascade Volcano Observatory estimates them as a less than 1 in 1000-year events. Multiple ash deposits have been found in several locations throughout Seattle, but the severity of these ash falls is unknown.
Geographic Scope	5	The entire Central Puget Sound region would be affected by this event. Ash would blanket the region and the Green River Valley would be covered by a lahar.
Duration	5	Response and short-term recovery take 4 weeks. Long term recovery will take years. Even with a debris management plan, tapping resources to remove large amounts of ash is difficult. The lahar has also generated large amounts of debris and caused much structural damage which takes time to repair.
Health Effects, Deaths, and Injuries	2	Despite the heavy physical damage, the incident causes no casualties due to timely warning provided by the USGS. Some people with existing respiratory problems are hospitalized from the ash exposure.
Displacement and Suffering	2	89 people require shelter because their homes and apartments have been red tagged due to lahar damage.
Economy	3	The ashfall interrupts commerce until it can be cleared, but the biggest stressor for the economy is the lahar which has caused extensive damage along the Duwamish waterway. The shipping and manufacturing sectors are the most heavily affected.
Environment	2	The lahar scours the Duwamish Waterway setting back restoration efforts. Ash has a short term detrimental effect on plants but will enrich the soil long term.
Structures	4	215 structures along the Duwamish are red tagged. They include businesses, homes and an apartment. The wet compacted ash has a much higher density than settled snow and collapses 125 roofs. Many buildings experience damage to HVAC system. Settled snow has a density of 200-300 kg/m <sup>3</sup> ; wet compacted ash is 1,000 to 2,000 kg/m <sup>3</sup> .
Transportation	5	The ashfall brings transportation to a halt. Airspace is closed for one week. Roads are impassible and ash clogs vehicle air filters, including those on many emergency vehicles. Trains are inoperable. SDOT and SPU implement the City's debris management plan. Ash is first cleared from roadways. The work is complicated due to the ash's density.
Critical Services and Utilities	2	During the recovery of the road network, food distribution and access to medical care are difficult. Wet ash causes some power outages. Ash enters the waste water system where it clogs pipes and damages equipment.

Category	Impacts 1 = low 5 = high	Narrative
Confidence in Government	1	The public perceives the eruption as an outlier. The City was able to warn people living and working in the Duwamish Valley to leave before the lahar reached Seattle. SDOT is able to clear major roadways within several days allowing the City to maintain public confidence.
Cascading Effects	3	The lahar stirs contaminated sediment in the Duwamish. Ash fall triggers some power outages when it weighs down lines and causes insulators to flashover.

## 11.4 Tsunamis and Seiches

### 11.4.1 Most Likely Scenario

During a Cascadia Subduction Zone earthquake (see the Alternate Earthquake Scenario) the water in Lake Union begins to oscillate. Waves that move up and down begin to appear in the Lake. Soon ships, boats, houseboats and floating docks move up and down 6 feet (from wave crest to trough). Vessels and houseboats smash violently together. Power, water, sewer, gas and communications lines are severed. Lake Washington, Elliott Bay, and Greenlake also have seiches, but they are not as extreme. Elliott Bay has strong currents of 4-5 knots in various locations for 4 hours. Cables on the I-90 Bridge over Lake Washington are damaged.

Category	Impacts 1 = low 5 = high	Narrative
Frequency	2	Seiches have occurred on multiple occasions in the Seattle area since the late 19 <sup>th</sup> century, most recently in 2002. Lake Union seems especially prone to seiches, probably because of its Y-like shape. Previous events have caused damage but have not been disastrous. Modelling results published in 2008 indicate that a Cascadia Subduction Zone earthquake would produce the most damaging seiche for Lake Union. Effects on Lake Washington and other water bodies are still not well understood.
Geographic Scope	3	The seiche effects Lake Union and its shoreline, and small watercraft on Elliott Bay.
Duration	2	The seiche continues for 10 minutes after the end of the ground shaking gradually becoming less and less violent. Amidst the overall earthquake response, it takes three days to stabilize response to the seiche and transition to short term recovery.
Health Effects, Deaths, and Injuries	2	1 person falls in the water and drowns and 13 are injured in falls and by debris. Most of the injuries occur to people inside ships or houseboats.
Displacement and Suffering	3	Due to extreme battering and the severing of most utilities 159 people living aboard boats and houseboats need to find temporary shelter. A few boaters and sailors are stranded and Elliott Bay and require rescuing.
Economy	3	The damage from the seiches blends with that of the earthquake. Maritime businesses, especially those on Lake Union suffer significant damage.
Environment	2	The seiche resuspends and redistributes pollutants from the sediments in local water bodies.
Structures	3	15 houseboats are red tagged and another 45 are yellow tagged. Many ships, boats, and seawall docks are heavily damaged.
Transportation	2	The I-90 and SR 520 floating bridges must be closed for inspection and repair. They are closed for one week. Lake Washington Blvd is damaged in two locations.
Critical Services and Utilities	1	The seiche damages utility connections to individual properties but no major lifelines are damaged.
Confidence in Government	1	Local government is able to respond to the seiche in a timely and comprehensive manner. The public retains confidence in government.
Cascading Effects	2	The seiche undermines slopes in 12 locations causing landslides.

### 11 4.2 Maximum Credible Scenario

A Seattle fault earthquake triggers a tsunami like the one that occurred here in 900 AD. This tsunami occurred at high tide and sends waves up to 16 feet high into the area around Elliott Bay minutes after the most powerful earthquake Seattle has ever experienced. The waves cover all Harbor Island, large parts of Sodo and Interbay, and the crowded downtown waterfront. Because the source of the earthquake is so close many people have no chance to escape. The waves destroy many buildings weakened by the earthquake.

Category	Impacts 1 = low 5 = high	Narrative
Frequency	2	Tsunami deposits have been found in Seattle and Whidbey Island. They are from the Seattle Fault earthquake that occurred around 900 AD. Earthquake of this magnitude on the Seattle Fault are rare events. Currently seismologists estimate they have a 1 in 1000 chance of occurring each year.
Geographic Scope	4	The tsunami would affect the area surrounding Elliott Bay and the shoreline of West Seattle.
Duration	2	The tsunami would strike the Seattle shoreline seconds to minutes after the earthquake stops. Active response to the tsunami would take days as urban search and rescue looked for survivors in debris. Recovery would take years and would be part of the larger earthquake recovery project.
Health Effects, Deaths, and Injuries	4	175 people near the waterfront perish. The majority of deaths occur along Alki and the Downtown Waterfront. Cool rainy weather has limited the number of people outdoors.
Displacement and Suffering	5	743 people are displaced by the tsunami. Their residences along Alki, West Seattle, and Magnolia have been destroyed or severely damaged. This number is added to those displaced by the earthquake itself.
Economy	4	The tsunami devastates the critical Seattle port and manufacturing sectors. Fuel depots on Harbor Island are knocked offline. This damage has enormous multiplier effects on the rest of the Seattle economy.
Environment	3	The tsunami ruptures many tanks containing hazardous materials. The biggest is a tank rupture on Harbor Island. Response to the fuel spill is complicated by the damage to Port infrastructure and the need to concentrate on life safety.
Structures	3	245 structures are destroyed and 1200 are yellow tagged. They are a mix of residential, commercial and industrial buildings.
Transportation	4	The tsunami severely damages roads along the waterfront and along the Duwamish waterway. Emergency personnel are slow to reach the affected area. Major downtown arterials are impassible for weeks.
Critical Services and Utilities	3	The collapse of the old viaduct breaks, wastewater, communications, electrical, steam, and gas lines. The outage causes a near lack of service in the downtown waterfront areas.
Confidence in Government	3	Response to the tsunami is complex and slow, especially when combined with the earthquake. The public wonders why more was not done to mitigate tsunami risk.
Cascading Effects	4	The tsunami causes a large hazardous material spill, fires and numerous landslides

## 11.5 Disease

### 11 5.1 Most Likely Scenario

A new strain of influenza sweeps across Seattle in December, affecting the young and healthy as well as those with chronic health conditions. 1,500 people fall ill in Seattle, 190 have to be hospitalized, and 8 people die from the virus. The virus is not as severe as the pandemics of the early and mid-century. The peak exposure period lasts 6 weeks. 5 schools hit especially hard having to close for one week.

Category	Impacts 1 = low 5 = high	Narrative
Frequency	4	Seattle experiences influenza outbreaks every year. Most can be handled by the public health and medical community, but some stand out for their complexity and severity: influenza in 1918, 1957, 1968 and 2009. The scenario here envisions an influenza epidemic similar to the 2009 H1N1 virus.
Geographic Scope	5	The virus strikes the entire Central Puget Sound region.
Duration	5	It takes 4 months for there to be no new confirmed cases of the virus in the population.
Health Effects, Deaths, and Injuries	4	8 people die, 1,500 become ill and 190 need to be hospitalized.
Displacement and Suffering	1	No families are physically displaced from their homes, but 5 schools are closed for a week and major events are cancelled.
Economy	2	Retail businesses feel losses during the holiday season as shoppers avoid going out in public, but the wider City economy is able to absorb the losses.
Environment	1	The environment is not directly affected by this event.
Structures	1	Buildings are not affected by this event.
Transportation	1	The transportation system is not affected by this event.
Critical Services and Utilities	1	Critical services and utilities are not affected by this event.
Confidence in Government	1	The public health system is able to respond quickly to the event. The public's confidence in its public health system grows.
Cascading Effects	1	Affected institutions and businesses must deal with closures, cancellations, business loss and absent workers, but they are not concentrated so they do not cause ripple effects.

### 11 5.2 Maximum Credible Scenario

A severe pandemic influenza sweeps the globe striking Seattle. Seattle has 3,600 deaths and 171,000 illnesses. The crisis lasts a month. Economic activity slows severely. Providers have difficulty maintaining service levels to vulnerable populations. Public health officials implement emergency plans to stand up alternate care facilities, deliver medication and handle remains respectfully.



Category	Impacts 1 = low 5 = high	Narrative
Frequency	3	This scenario is based on planning done by the Seattle / King County Public Health. It envisions an event similar to the 1918 pandemic influenza. It is estimated as a 100-year event.
Geographic Scope	5	The disease is world-wide. It moves quickly around the globe due to air travel. Surveillance systems detect the disease a week before it reaches Seattle. Emergency responders are able to do some planning.
Duration	5	The most acute part of the outbreak lasts four weeks in Western Washington but preparations for the arrival of the disease and recovery from it keeps the emergency management system busy for seven weeks.
Health Effects, Deaths, and Injuries	5	The severe influenza has enormous consequences for Seattle public's health. 170,000 people in Seattle become ill. Half (85,000) need outpatient care. 3,600 people die including many young adults. 2,809 people require ICU care and 1,404 require mechanical ventilation.
Displacement and Suffering	5	Although no households are displaced due to physical damage to their home, nearly everyone in Seattle is directly affected. Schools are closed for weeks. So many people are sick or must care for children or sick people that many businesses and government offices close. The city faces critical shortages of supplies including food.
Economy	4	The economy comes to a standstill for weeks, but surges once the illness subsides. Unfortunately, that is too late for many small businesses that cannot withstand weeks of downtime.
Environment	1	The environment would not be directly affected but would suffer indirect impacts due to staff shortages in agencies that oversee environmental protection and monitoring.
Structures	1	Although the disease does not destroy buildings, absenteeism affects how buildings run. The lack of support staff causes many buildings to close.
Transportation	3	The disease would not cause any direct damage to the transportation system, but high absenteeism would affect it. Public transit, shipping, and infrastructure management operate at 50% capacity. People avoid public transportation and take cars instead, causing heavy traffic on main roadways.
Critical Services and Utilities	3	Governments attempt to keep their public safety personnel healthy, but influenza affects service. Police, fire, and emergency medical services have to greatly reduce service levels. Water, power, wastewater, and communications are able to continue operations with reduced staffing but are unable to respond to outages and other problems.
Confidence in Government	3	The public understands the influenza is a severe natural event. Restrictions on public gatherings are not popular and create frustration. Some people believe they are not getting enough attention from the medical community.
Cascading Effects	2	The disease does not directly cause secondary effects, but the staffing reductions makes the City harder to operate. Several non-life threatening landslides occur during this time, but the City is not able to respond due to staffing shortages.

## 11.6 Attacks

### 11 6.1 Most Likely Scenario

Domestic violent extremist actors target an animal research facility. After first releasing the animals they burn and bomb the facility. One guard is killed in the attack.

Category	Impacts 1 = low 5 = high	Narrative
Frequency	5	Seattle has experienced arson and bombing by extremist on three occasions in the past 25 years. Two planned arson/bombing attempts were prevented in the same timeframe. Most of the events that occur do not require activation of Seattle Emergency Management system.
Geographic Scope	1	One facility is attacked with consequences for the surrounding area.
Duration	1	Incident response is over in less than 24 hours, but investigation takes longer.
Health Effects, Deaths, and Injuries	2	One person is killed in the attack in the fire.
Displacement and Suffering	2	The fire spreads to surrounding buildings one of which is an apartment. Most residents find shelter with friends and family, but four households need assistance.
Economy	2	The facility experiences unrecoverable losses of valuable research that cannot be easily replaced for any amount of money.
Environment	2	The lab contained drugs and biological samples that are released into the environment.
Structures	2	The research lab and the neighboring apartment are destroyed. Four other buildings are damaged.
Transportation	2	Traffic in the surrounding area is halted during response.
Critical Services and Utilities	1	The attack does not inhibit critical service delivery or utilities.
Confidence in Government	3	The public wishes the government had prevented the attack and wants facilities that are likely to be attacked out of the city.
Cascading Effects	2	The attack causes a fire that spreads to surrounding buildings.

### 11 6.2 Maximum Credible Scenario

A well-armed, well organized group affiliated with international terrorists launches a planned attack using a mix of automatic weapons and improvised explosive devices (IED) during the Westlake Mall tree lighting ceremony. The initial attack focuses on blocking natural exit routes in an attempt to move the panicked crowd of several thousand in the direction of several command detonated IEDs. The IEDs, which include metal shrapnel to maximize casualties, cause many critical injuries and fatalities, which overload EMS and hospitals. After the initial assault a splinter group leaves the mall before it is surrounded. The well-armed gunmen engage in a series of running gun battles with law enforcement with the intention of causing confusion, hampering the response, and increasing the number of casualties. This group is cornered in the Sodo area and killed. The gunmen in the mall take hostages and set fires.

Category	Impacts Low = 1 High = 5	Narrative
Frequency	2	This scenario is Complex Coordinated Attack (CCA) similar to the attacks in Mumbai, India and Paris, France. Such an attack has not occurred in the United States. The difficulty of staging this type of attack balanced by two actual occurrences yields an assessment of a 1 in 1000 chance of occurring per year.
Geographic Scope	4	The attack affects a nine-block area of downtown: the mall and the eight blocks surrounding it. It also affects the SODO neighborhood.
Duration	2	Due to the danger to law enforcement, it takes 3 days to subdue the attackers.
Health Effects, Deaths, and Injuries	3	34 people are killed in the attack. 42 people require hospitalization and 212 are treated and released.
Displacement and Suffering	3	The attack occurs in a commercial area so no residences are affected, but people working and visiting downtown need to be moved out of the area. The splinter group that escapes causes the Mayor to order a shelter-in-place for the whole city. Many vulnerable residents are not able to get essential commodities and access medical care.
Economy	2	The attack closes a big section of downtown for three days. Westlake Mall suffers extensive damage. It takes the mall one month to re-open. Retail businesses located in it miss a whole holiday shopping season.
Environment	1	The attack causes no significant damage to the environment.
Structures	2	No buildings are destroyed, but the IEDs and firefight inside the mall heavily damage it.
Transportation	4	The Metro tunnel and surface streets surrounding the Mall are closed causing significant delays getting into and through downtown. The shelter-in-place order does not affect infrastructure but renders many critical services inaccessible.
Critical Services and Utilities	4	The attack severely overtaxes Seattle Police. Shifts are extended, and mutual aid is called upon, but service levels must be reduced to cope with the emergency. 2 responders are killed and 3 wounded. The shelter-in-place order renders many services inaccessible.
Confidence in Government	3	The public is shocked by the attack. Initially the response is given high marks, but later public opinion shifts as many people begin to question security at the tree lighting ceremony.
Cascading Effects	1	The attack is extremely deadly and disruptive, but it does not cause any significant secondary incidents.

## 11.7 Social Unrest

### 11.7.1 Most Likely Scenario

A political protest in the downtown core escalates to violence between the protestors and counter protestors over opposing political ideologies. Nearby properties are vandalized. Anarchist groups join in the violence and property destruction. Around 3,000 people participate in the event. 110 police officers in riot gear intervene with tear gas and rubber bullets but cannot control the unexpectedly large crowd. One person is shot and killed by a protester in the chaos and 24 people are injured. 17 storefronts have been vandalized. Smaller groups of protestors break off from the larger group and disperse throughout the city, vandalizing more property and setting two fires.

Category	Impacts 1 = low 5 = high	Narrative
Frequency	5	Seattle has experienced civil disorder in every decade since the 1960's.
Geographic Scope	3	The riot begins in a localized area of downtown, but spreads to other neighborhoods of the city throughout the night.
Duration	1	The disorder occurs starts during the evening and continues for 8 hours.
Health Effects, Deaths, and Injuries	2	One person is shot and killed when confronting a protestor. 24 people suffer injuries requiring medical attention.
Displacement and Suffering	3	One hotel is evacuated when protestors gain access and will not leave; 250 guests need alternative shelter for the night. Splinter groups target minority neighborhoods for vandalism and destruction of property.
Economy	3	In total, 28 businesses suffer property damage and 7 are looted in the night. Tourism revenue dips in the weeks after the event.
Environment	1	There is no impact on the environment.
Structures	2	Two structures are destroyed in fires. 28 other buildings have property damage but are still habitable.
Transportation	2	The incident closes streets for a major portion of the downtown core. Small groups are caught dropping objects onto I-5.
Critical Services and Utilities	2	Police services are degraded in other areas of the city because many officers are needed at the site of the events.
Confidence in Government	3	Some members of the public think that the authorities should have anticipated the potential for violence and done more to prepare.
Cascading Effects	2	The event results in 2 major fires that burn commercial buildings.

### 11.7.2 Maximum Credible Scenario

Unforeseen political or social conflict raises tensions between social groups to an unprecedented level. An event triggers a flood of anger directed at one of these groups. The larger groups use social media to gain participants and organize attacks against the smaller groups in a deliberate manner, to terrorize them and drive them out of the area. It is difficult for law enforcement to predict attacks because of masked online communications. Government intervenes to prevent widespread violence. Houses,

businesses and gathering places are firebombed. Casualties are high due to the deliberate and premeditated targeting of people. There is no evidence to suggest any specific groups that would be party to this scenario and it does not speculate.

Category	Impacts 1 = low 5 = high	Narrative
Frequency	2	The type of disorder in which one social group attacks another in a semi-organized fashion is rarer than attacks against property or symbols of authority. In Seattle, this type of disorder has only happened once and that was in the 19th century. While contemporary culture seems more enlightened, history can always repeat itself.
Geographic Scope	5	The social conflicts imagined in this scenario are felt throughout the region, but especially strongly in Seattle. Flash points emerge in multiple locations.
Duration	3	The most serious part of the incident lasts for five days. The conflict builds over two days, with the most serious rioting on the third day. The following two days, law enforcement contains further violence.
Health Effects, Deaths, and Injuries	3	19 people are killed when they are attacked in the street or in their homes. 245 people are injured enough to require medical attention.
Displacement and Suffering	5	The attacks terrorize a community causing hundreds of households to seek safety.
Economy	3	Businesses in affected neighborhoods have to close during the incident. 5 businesses are destroyed. Afterwards, people are afraid to return to areas that experienced conflict and investors are reluctant to put their money into the areas.
Environment	1	There are no major environmental problems that arise from this incident.
Structures	3	34 buildings are destroyed and 75 are damaged.
Transportation	2	Transportation in and through affected neighborhoods stops. Law enforcement maintains a strong presence in many parts of the city which impedes traffic flow. There is no structural damage to the transportation system.
Critical Services and Utilities	2	Fire and emergency medical services are overburdened and must call in back-up resources from neighboring cities. Power outages occur due to fires and deliberate sabotage.
Confidence in Government	5	When some members of the public find out that the groups were communicating online, they think that the authorities should have anticipated the potential for violence and done more to prepare. Victims blame the government for allowing them to be attacked. Perpetrators and their sympathizers resent law enforcement for stopping them from doing more damage.
Cascading Effects	2	The civil disorder leads to many fires, mostly homes.

## 11.8 Cyber Attacks and Disruptions

### 11.8.1 Most Likely Scenario

1,500 City of Seattle employee computers are infected by a ransomware attack. Most of the infected computers are from Seattle Public Utilities (SPU) and the Municipal Court. The attackers threaten to delete all computer data if they are not paid \$90,000 in crypto currency. The attackers disable the Seattle Public Utilities (SPU) website and the municipal court electronic filing system. 120,000 SPU customers have their personal and financial information stolen by hackers. It takes 3 weeks to remove the malware from the computers and restore online services to the city.

Category	Impacts 1 = low 5 = high	Narrative
Frequency	3	The City of Seattle has never experienced an attack to this scale but does face hacking attempts daily. Frequency was increased to a 3 however because attacks are becoming increasingly sophisticated, increasing the chances of one being successful. Other urban municipalities have faced ransomware attacks, including Atlanta and Anchorage in 2018.
Geographic Scope	5	The attack has regional impacts in King and Snohomish Counties, as SPU serves nearby cities.
Duration	4	SPU billing and customer services are severely limited for 2 weeks. The attack does not affect water delivery to current customers. The Municipal Court cannot hear cases for 3 weeks due to the electronic filing system outage and is back logged for months. 1,500 city employees cannot use their computers for 3 weeks and must find alternate ways to complete their duties.
Health Effects, Deaths, and Injuries	1	The attack does not cause any fatalities or injuries.
Displacement and Suffering	1	The attack does not displace households. Water delivery is not impacted.
Economy	2	The economic impact is mostly felt in city government. The City of Seattle has to pay millions of dollars to recover and secure files and is faced with hundreds of lawsuits from SPU customers who had their personal data breached.
Environment	1	The attack does not damage the environment.
Structures	1	The attack does no damage to buildings.
Transportation	2	As a precaution, Seattle Department of Transportation stops Seattle Streetcar service and their Intelligent Transportation System, reverting traffic lights back to timers. Commuters who rely on the Streetcar are delayed and traffic backs up heavily in downtown.
Critical Services and Utilities	1	Most disruptions are inconveniences. People cannot pay bills or contact SPU about customer service concerns online. Employees are overwhelmed with the amount of calls they receive and have to work without computers, delaying services. People with court dates have to reschedule.
Confidence in Government	3	The public is frustrated with the slow response to get services back online. Customers affected in the data breach are angry that their local government did not do more to protect their information. SPU faces many lawsuits and customer complaints.

Category	Impacts 1 = low 5 = high	Narrative
Cascading Effects	1	There are no cascading effects.

### 11 8.2 Maximum Credible Scenario

The U.S. has never had a major cyber-attack on its physical infrastructure, but in a first, a state-sponsored group deploys a cyber-attack on the U.S. power generation and transmission system in December, causing nation-wide outages. Operators take down computerized control systems, but manual workarounds are not as efficient as computerized systems they replace. IT staff struggle for three weeks to bring systems back online.

Category	Impacts 1 = low 5 = high	Narrative
Frequency	2	There has been only one confirmed case of a cyberattack destroying equipment, the STUXNET attack on Iranian centrifuges. However, cyber-attacks have disrupted smaller infrastructure systems including power and water. Additionally, experts believe that an attack on U.S. infrastructure is among the likely targets for hackers in the coming years.
Geographic Scope	5	Vulnerable power utilities are affected in every state in the US.
Duration	4	Seattle City Light and Bonneville Power Administration operators lose the ability to control power management systems for three weeks causing blackouts and brownouts.
Health Effects, Deaths, and Injuries	2	5 people die in traffic accidents due to the effects of power outages. 230 people become ill from eating spoiled food. 4 people die from attempting to heat their homes with a charcoal grill.
Displacement and Suffering	5	The extended power outages displace 1000s of people living in high rise buildings because water systems lack pressure to bring water to higher floors and the lack of power shuts down elevators. 300 families with electric heating systems need shelter. The transportation system is disrupted causing some food shortages. Schools close due to lack of power. Water is out in areas that require a pump until the pumps can be connected to a generator.
Economy	4	Most businesses in Seattle are forced to suspend operations for three weeks. Retail suffers especially because the attack occurs during the holiday season. There is a surge in sales after the attack ceases, partially offsetting lost business but 25 smaller businesses cannot recover. The national economy suffers overall and unemployment increases.
Environment	3	The attacks disable King County's sewage treatment plants. Untreated sewage is discharged into Puget Sound at levels harmful to wildlife.
Structures	1	The attack does no damage to buildings but causes many to be temporarily inoperable.
Transportation	4	Traffic control systems are taken offline. The surface transportation system is heavily affected, and vehicle accidents increase. Air traffic control systems continue to operate as do marine navigation systems.



<b>Category</b>	<b>Impacts 1 = low 5 = high</b>	<b>Narrative</b>
Critical Services and Utilities	4	Multiple utilities are inoperable due to extended power loss and a lack of generators: communications, water, and power. Public safety is operating on manual systems which reduce capacity.
Confidence in Government	3	The public is initially sympathetic to the local government but grows impatient as the outages continue. When they learn that an attack was foreseen, they become resentful of government, but it is directed mostly at the federal level.
Cascading Effects	4	The attack causes wide-spread power outages. Many control systems that prevent hazardous materials releases are offline.

## 11.9 Fires

### 11.9.1 Most Likely Scenario

A fire erupts at 1:30 am in an 11-story Seattle Housing Authority apartment building in Capitol Hill. It quickly spreads to half of the building's 220 units. 82 SFD firefighters respond to the fire. It takes them 6 hours to fully extinguish the flames. Fire alarms allow most residents to evacuate without harm but 2 people are killed and 25 are seriously injured. 105 apartments are destroyed, and 150 residents are displaced.

Category	Impacts 1 = low 5 = high	Narrative
Frequency	4	Large fires have occurred with regularity in Seattle, and there have been 3 fires at Seattle Housing Authority (SHA) buildings within the last decade. However, none of the previous SHA fires have resulted in casualties or displaced families of this magnitude. Overall trends show a decrease in the annual number of structural fires, but property losses show no decrease.
Geographic Scope	2	The apartment fire is centered on a single site, but the response requires a few road closures in Capitol Hill.
Duration	2	The fire takes 6 hours to extinguish but it takes inspectors 2 days to secure the building.
Health Effects, Deaths, and Injuries	2	2 people are killed and 25 are critically injured from burns and smoke inhalation.
Displacement and Suffering	4	150 low-income residents are displaced and need new permanent housing, but there are no available vacancies in other SHA buildings. An additional 150 residents need temporary shelter while the building is inspected.
Economy	1	SHA takes a big loss, but the general economy does not suffer.
Environment	1	There are no environmental impacts.
Structures	2	Half of the apartment building is destroyed, and the other half will require repairs to utilities before residents can move back in.
Transportation	2	Most of the city is not impacted, but road closures in Capitol Hill cause increased traffic and cause some busses to reroute.
Critical Services and Utilities	2	SFD must commit many resources. Several eastside companies that would normally backfill are not available because they are on assignment in eastern Washington fighting wildland fires. As a result, SFD must reduce its level of service.
Confidence in Government	1	SFD is able to effectively fight the fire. The public wishes the City of Seattle had stricter regulations on SHA buildings, but ultimately blames SHA for the fire.

Category	Impacts 1 = low 5 = high	Narrative
Cascading Effects	2	The fire causes a hazardous material incident.

### 11 9.2 Maximum Credible Scenario

A freight train carrying crude oil derailed in the BNSF tunnel near the southern entrance. The crash ignites a fire inside the tunnel. The oil train is only partially inside the tunnel. The tunnel lacks modern fire suppression technologies. The Fire Department vents fumes from the southern end of the tunnel. The fire weakens the roof of the tunnel which collapses. The southwesterly wind blows the smoke into downtown forcing the evacuation of much of downtown including the Seattle EOC and the Seattle Municipal campus.

Category	Impacts 1 = low 5 = high	Narrative
Frequency	2	Seattle has not experienced a large tunnel fire but had a fuel tanker catch fire on the viaduct in 1975.
Geographic Scope	2	The fire affects the whole tunnel, SR 99, and areas surrounding the tunnel entrances.
Duration	4	The initial response takes 1 day but stabilizing the tunnel and investigating the accident takes a week. The tunnel remains closed until the damage to tunnel infrastructure is repaired.
Health Effects, Deaths, and Injuries	4	The train conductor and a crew member are killed due to toxic smoke and heat. The lack of adequate safety infrastructure in the tunnel adds to the casualties. 230 people are injured.
Displacement and Suffering	3	143 non-Seattle residents need temporary shelter until they can leave. 34 people have friends and relatives in hospital and want to stay longer to be with them.
Economy	3	The tunnel is severely damaged and must remain closed while repairs take place. The tunnel is a major freight corridor. Trains must use alternate routes that add hours to trips. Seattle shipping and manufacturing suffers as a result.
Environment	2	Venting of smoke and fumes into downtown causes evacuation of areas near the accident site.
Structures	2	The tunnel collapses near the fire. The sudden failure causes the ground above to fail damaging 2 buildings on the surface.
Transportation	4	Public safety personnel cannot access parts of downtown due to toxic smoke, including routes to Harborview hospital. Surface transportation is affected by the evacuation of downtown. I-5 is closed while the plume covers it (12 hours). After the fire is out the tunnel remains closed for repairs. Surface transportation returns to normal, but rail remains severely impacted.
Critical Services and Utilities	2	Toxic smoke drifts into Harborview. Health officials must decide whether to shelter in place or evacuate. Seattle Fire must backfill with mutual aid.

Category	Impacts 1 = low 5 = high	Narrative
Confidence in Government	3	The accident begins a new tunnel controversy and the public blames the government for not making the tunnel safer.
Cascading Effects	4	The fire has major secondary effects. The incident causes a disastrous hazardous materials incident and a tunnel collapse.

## 11.10 Infrastructure and Structural Failure Scenarios

### 11 10.1 Most Likely Scenario

A 42" water main breaks near a bridge. The release of water undermines a bridge pier and co-located utilities (gas, sewer, and communications). There are no fatalities, but the area surrounding the collapse is impacted. Transportation corridors are affected. It impacts surrounding businesses and the environment.

Category	Impacts 1 = low 5 = high	Narrative
Frequency	5	Infrastructure failures happen regularly. This scenario is similar to past events but with some added complexity that demands a higher level of coordination to manage consequences.
Geographic Scope	1	This is a single site incident although some impacts are felt outside the immediate area (e.g., utility outages).
Duration	2	The damage takes 2 days to repair. It takes an additional day for full service restoration.
Health Effects, Deaths, and Injuries	1	There are no deaths or injuries as a result of the break.
Displacement and Suffering	2	Water and gas service to a school and nursing home is shut off. All 65 nursing home residents have to be moved.
Economy	2	24 businesses are forced to close due to water damage
Environment	2	The water main break undermines a sewer line, breaking it. Untreated sewage spills into Lake Washington.
Structures	2	The water floods 5 buildings and undermines their foundations.
Transportation	2	The nearby bridge and streets near the break must be closed, causing a temporary blockage. Fears are voiced about the effect of the water on the bridge, but it is not damaged.
Critical Services and Utilities	2	The breakages of the water, gas, and sewer lines force utility outages in the surrounding neighborhood. Public safety services are not affected.
Confidence in Government	3	The infrastructure is owned by the government. The public believes that it could have been better maintained.
Cascading Effects	2	The initial infrastructure failure leads to others and causes hazardous material (untreated sewage) to be released.

### 11 10.2 Maximum Credible Scenario

The Interstate 5 Ship Canal Bridge collapses over Lake Union at 8:30 am on a weekday. Vehicles plunge into the lake and a ship is struck below. The bridge displaces a large amount of water, causing localized flooding in homes and businesses along the lake's shore. 42 People are killed by debris or water and 181 are injured. A major power transmission tower is damaged in the collapse causing a few neighborhoods to lose power for 48 hours. It will take months to rebuild the bridge, and traffic must be diverted onto lower capacity roads.

Category	Impacts 1 = low 5 = high	Narrative
Frequency	1	A major bridge collapse has never occurred within Seattle, but has occurred in other parts of the state (Tacoma Narrows Bridge, Skagit River bridge) and in other urban cities in the U.S. (Oakland, CA; Minneapolis, MN; Atlanta, GA)
Geographic Scope	4	The area directly affected by the collapse is less than 1 mile, but homes and businesses around Lake Union are affected. The entire city is affected by unprecedented traffic delays for months.
Duration	5	It takes one week to remove debris from the water and secure the remaining parts of the bridge. It will take months to rebuild the bridge and repair structures damaged by the rubble.
Health Effects, Deaths, and Injuries	3	Both levels of the bridge (express lanes and non-express lanes) were full due to rush hour traffic, resulting in 42 fatalities and 160 serious and minor injuries. 21 people are injured by falling debris or tsunami impact on the ground.
Displacement and Suffering	4	330 people who live near the bridge or on houseboats need temporary shelter while their homes are repaired, or the remaining parts of the bridge are secured. 2,500 people experience a 3-day power outage.
Economy	3	The overall economy suffers because goods cannot be transported via I-5.
Environment	3	The bridge strikes a large fishing vessel, causing thousands of gallons of oil to spill into lake union. Intervention is required to clean the spill.
Structures	2	The bridge itself is destroyed. 7 houseboats and businesses along lake union are red-tagged. Power infrastructure must be replaced near the bridge
Transportation	4	Critical services are accessible via alternate routes, but heavy traffic persists for months as vehicles are rerouted to lower-capacity roads. Busses must be rerouted, causing transit delays.
Critical Services and Utilities	3	A power outage lasts for 48 hours in parts of the city. Emergency services are slowed because of heavy traffic on alternative routes. Fiber cables along the bridge are cut, causing a temporary communications outage for 25% of the City. Grocery stores and businesses in North Seattle must wait longer to receive shipments from distributors.
Confidence in Government	5	The public's anger is first directed mostly at Washington State who managed the bridge but shift towards the city when unprecedented traffic delays continue for months.
Cascading Effects	3	The bridge collapse triggers localized flooding and hazardous materials spill in Lake Union, and a power-outage in surrounding neighborhoods.

## 11.11 Power Outage Scenarios

### 11 11.1 Most Likely Scenario

An accident and fire in an underground vault cuts power to a large part of downtown for three days. The City is able to acquire generators to partially meet demand, but many businesses must shut their doors. Many residents of downtown high-rises are unable to walk the stairs to their apartments.

Category	Impacts 1 = low 5 = high	Narrative
Frequency	5	Large power outages occur on a fairly regular basis. Most are associated with storms or accidents. In most cases the outages last less than a day, but occasionally the power takes days to come back. The scenario here is based on two outages in the late 80's and early 90's.
Geographic Scope	3	A major section of downtown and Belltown goes dark during hot weather in August.
Duration	2	Full power is restored in 3 days.
Health Effects, Deaths, and Injuries	2	No one is killed in the incident but one Seattle City Light line worker is critically injured. 18 people contract a food borne illness when they consume non-refrigerated food.
Displacement and Suffering	2	A Seattle Housing Authority property in Pike Place Market loses power. Many residents are disabled or elderly. Most have no other place to go. Altogether 65 people need shelter.
Economy	2	The Pike Place Market loses power in the middle of high tourist season. Many small businesses that operate on the edge of profitability are losing money each day. Several biomedical research projects are destroyed when refrigerators lose power.
Environment	1	The environment is not directly affected by this incident.
Structures	1	No buildings are impacted by the power outage.
Transportation	2	Surface transportation in the affected area is disrupted. Traffic lights are dark and operate as four way stops. The downtown transit tunnel loses power.
Critical Services and Utilities	2	Aside from the power outage itself, critical services and utility services are able to be maintained at street level. High-rises lose elevator and water service.
Confidence in Government	1	The public sees local government response as timely and effective.
Cascading Effects	2	The power outage increases the incidence of food borne illness.

### 11 11.2 Maximum Credible Scenario

The western power grid fails during December when Seattle City Light needs power from it. Cold temperatures are creating a high demand for power for heating. Seattle City Light must attempt to meet demand using only its own resources (which can supply 60% of demand) and must ration it. Several large events are planned for the time period: Seahawks and UW Husky games, and an event at Westlake mall. Holiday shopping is in full swing and businesses are eager to maintain sales. Seattle City Light would have to implement rolling black outs to spread the pain among customers, including vulnerable customers like nursing homes.



Category	Impacts 1 = low 5 = high	Narrative
Frequency	3	Failure of the western grid, called the Western Interconnection, has not had major impact on Seattle, but there have been several close calls. Seattle City Light has its own generating and transmission capability which mitigates vulnerability to problems with the Western Interconnection, but Seattle City Light relies on its power during peak demand. As a result, this scenario is estimated to have a 1 in 100 chance of occurring each year.
Geographic Scope	5	Failure of the Western Interconnection would cause a region wide power outage.
Duration	4	Power is out for 10 days. The transmission is severely damaged in a storm. Local systems also suffer damage in the storm and due to load imbalances when the Western Interconnection is lost.
Health Effects, Deaths, and Injuries	2	Despite the best efforts of public health a family of five dies when they attempt to heat their home with a charcoal grill. Public outreach has saved lives, however.
Displacement and Suffering	4	700 people including 45 residents of a nursing home require shelter from the cold. The prolonged outage reduces the capacity of food distribution centers resulting in shortages of perishable food and medicines. Medical service providers, mainly outpatient services, operate at reduced capacity.
Economy	3	All businesses in Seattle without generators are affected. There is a surge in sales after the outage. Because the outage is so large, consumers are not able to redirect their spending elsewhere. Unfortunately, the post outage surge does not cover losses. The biotech industry loses research when they cannot refuel generators.
Environment	1	The environment is not impacted by the outage.
Structures	2	The power outage cuts water service to high rise buildings without generators. Water pumps fail in some parts of the city.
Transportation	3	Surface transportation is disrupted throughout the region. Airports are able to remain open but have to curtail non-essential functions. Marine terminals continue to operate on generator power. Gas stations lose ability to pump gas. Traffic lights are dark in many areas of the region, causing significant slowdowns on major arterials.
Critical Services and Utilities	3	Critical services operate on generators. As fuel becomes harder to obtain, some facilities run out of power. 800 MHz sites go dark.
Confidence in Government	5	The Western Interconnection is operated by government authorities. As the outage continues past the third day, the public becomes increasingly frustrated with government.
Cascading Effects	3	The outage causes a number of secondary effects: a number of fires start due to people burning wood to stay warm. The outage leads to infrastructure failures in the water and communications systems.

## 11.12 Excessive Heat Events

### 11.12.1 Most Likely Scenario

Seattle experiences an event slightly more extreme than the previous milestone, the 2009 heat wave. Temperatures are over 90° F for seven straight days with two over 100° F. Lows are over 70° F. The heat has built slowly making it easier for people to adjust. A major festival is happening at Seattle Center and a road race is scheduled. One nursing home loses its air conditioning system.

Category	Impacts 1 = low 5 = high	Narrative
Frequency	5	It is projected that Seattle's heat events will become more severe in the future due to climate change. It seems likely that the previous record of 103° will be broken. This scenario captures an event that is more severe than the 2009 extreme heat event. Because a breaking of the current record is viewed as likely by the 2050s this event is given the highest frequency rating.
Geographic Scope	5	The whole region is affected during extreme heat events. Seattle has more paved area than any other city in the region and suffers from an 'urban heat island' effect.
Duration	3	The apex of this event is two days of triple digit temperatures and five more in the 90s. The consequences of heat events rise with duration, especially if temperatures do not drop significantly at night.
Health Effects, Deaths, and Injuries	2	2 people die from heat stroke and 103 need medical attention. One nursing home does not have adequate cooling for residents.
Displacement and Suffering	2	89 people seek overnight shelter in air-conditioned facilities. Thousands of people seek shelter in air-conditioned spaces (malls, libraries, and community centers) during the day.
Economy	2	Significant but hidden costs resulting from excess medical attention (hospitalizations, ER visits, ambulance callouts and premature deaths). The heat prompts a run on fans and air conditioners. Two major events are cancelled and energy use spikes.
Environment	1	The heat stresses plants but does not damage whole areas or ecosystems.
Structures	1	The heat event does not destroy any buildings.
Transportation	2	The Seattle Department of Transportation must cool the older drawbridges over the Ship Canal or risk having them become stuck and unable to open. The Ballard Bridge's leaves expand to the point they are touching. The bridge can't be opened safely. Maritime traffic is impacted. Streets and sidewalks begin to crack in the heat. None of these cracks impeded traffic, but they are a cost to local government.
Critical Services and Utilities	1	Critical services and utilities are able to be maintained, but the City must increase staffing and seek volunteers to help at daytime cooling centers.
Confidence in Government	1	The public views the government's response to the heat as adequate.
Cascading Effects	1	The heat event does not cause significant secondary incidents.

## 11 12.2 Maximum Credible Scenario

Seattle experiences an unprecedented heat event. Temperatures are over 90°F for 14 consecutive days with three over 100°F. Temperatures do not sink below 75°F overnight. The heat has built quickly making it harder for people to cope. A major festival is happening at Seattle Center and a road race is scheduled. Despite cooling efforts, one bascule bridge is stuck open. Crime is a worry for older residents who won't open their windows.

Category	Impacts 1 = low 5 = high	Narrative
Frequency	3	Seattle has never come close to experiencing a heat event this extreme. Because Seattle has broken the 100°F mark, this scenario is not viewed as unrealistic. Additionally, climate change researchers project that future extreme heat days could increase by 6.5 °F by the 2050s. It is viewed as having a 1 in 100 chance of occurring per year.
Geographic Scope	5	The whole region is affected during extreme heat events. Seattle has more paved area than any other city in the region and suffers from an urban heat island effect.
Duration	4	The most severe part of the heat wave lasts for fourteen days. The longer a heat wave lasts the more its consequences grow. The night time temperatures do not dip below 75 °F which makes the event more dangerous.
Health Effects, Deaths, and Injuries	4	70 deaths are attributed to the heat, especially among residents in poorer areas of the city who keep their doors and windows locked and lack air conditioning. Over 1000 people seek medical attention.
Displacement and Suffering	4	854 people seek overnight shelter in spaces with air conditioning systems. Most of the general population is extremely uncomfortable.
Economy	3	The heat event costs \$50 million in excess medical expenses, premature deaths, increased energy costs, and cancelled events.
Environment	2	Air quality significantly decreases in the hot stagnant air. Many plants are stressed and some die.
Structures	1	The heat does not destroy buildings.
Transportation	3	The University and Ballard Bridges are opened to avoid having them expand and damage themselves. This causes disruption to emergency services and the general public. Streets and sidewalks crack. Aircraft coming into Sea-Tac have weight restrictions imposed. Train rails kink and impede freight and passenger traffic.
Critical Services and Utilities	3	Heat out of the area causes high demand on the power generation and transmission system. High heat causes power lines to sag causing shorts and localize outages. Water consumption spikes prompting worries about a water shortage. Fire and police are unable to use the University and Ballard Bridges. The heat does not cause the loss of any responders.
Confidence in Government	3	As the event continues, the public clamors for more assistance with cooling.
Cascading Effects	2	The heat causes power outages and is raising concerns about a water shortage.

## 11.13 Flooding Scenarios

### 11.13.1 Most Likely Scenario

A powerful 'Pineapple Express' brings days of heavy rain to the area. Thornton and Longfellow creeks flood. The drainage system is overwhelmed in two spots. During the storm 8 major landslides occur. Property damage is extensive, but there are no fatalities. Several roads are undermined by sinkholes, taking out water and sewer lines.

Category	Impacts 1 = low 5 = high	Narrative
Frequency	5	Winter storms are regularity in Seattle during the winter. One type of system is known as an atmospheric river. It occurs when moist warm air is pulled up into the Pacific Northwest by the jet stream. Such a storm is colloquially called 'Pineapple Express.' Climate scientists project that heavy rain events will become more intense in the future and flooding will increase with sea level rise.
Geographic Scope	5	This is regional storm. All of Seattle and the surrounding areas are affected.
Duration	2	The storm lasts 4 days.
Health Effects, Deaths, and Injuries	1	No one is killed or injured during the storm.
Displacement and Suffering	2	Urban flooding displaces 25 households. Mitigation in the Madison Valley and Thornton Creek areas lessens the impact of flooding.
Economy	2	Businesses in the Midvale, South Park, and Lake City have minor to moderate flooding.
Environment	2	The storm overwhelms the City's drainage system causing Seattle's combined sewer overflow (CSO) locations to release sewage into Puget Sound, Lake Union, and Lake Washington.
Structures	2	No buildings are destroyed, but 9 buildings have to be evacuated because the basements and ground floors flood. Another 150 buildings have basement flooding only. These buildings can still be occupied.
Transportation	2	Aurora and the Mercer Street underpass and many residential streets fill with flood water. Busses and vehicles must reroute, causing traffic delays.
Critical Services and Utilities	1	No critical services are degraded in the flood incident.
Confidence in Government	1	Local government is able to respond quickly to localized flooding. In areas with riverine flooding (Thornton and Longfellow creeks) the City organizes sandbagging. This effort and the success of detention ponds are credited to the City.
Cascading Effects	1	The release of raw sewage is a significant problem but does not necessitate an immediate emergency response.

### 11.13.2 Maximum Credible Scenario

An atmospheric river remains pointed at Western Washington for nine days. The whole region is flooding. Periods of extremely heavy rain occur (1" per hour). A king tide also occurs during this time. In Seattle, creeks flood. South Park is flooded due to the King Tide and drainage problems. Urban flooding occurs in 12 locations. 36 major landslides are triggered due to increase in ground water. Levees on the Duwamish appear to be weakening.

Category	Impacts 1 = low 5 = high	Narrative
Frequency	2	This scenario is based on ArkStorm, a USGS project. The ArkStorm is estimated to be a 500 to 1000-year event. It is a more extreme form of atmospheric river than has been experienced in Seattle historically, but it has roots in a powerful storm that struck California in 1961-2. Furthermore, climate scientists project that that extreme precipitation events may be increasing and there may be a tendency of the jet stream to remain locked in one pattern for an extended time. It is prudent to plan for the two possibilities to combine. Such an event would be unprecedented, but it is not unrealistic.
Geographic Scope	5	This storm is a regional event. Surrounding jurisdictions would be suffering the same or worse. Area rivers would be at record flood stage. Seattle would not be able to count on assistance from within the region.
Duration	4	The rain lasts for nine days without a break longer than 24 hours.
Health Effects, Deaths, and Injuries	2	4 people are killed in a landslide and 2 people drown in flood waters.
Displacement and Suffering	4	Seattle's creeks which normally only see ponding are actively flooding. King tides drive people along the shore and in South Park from their homes. Areas in the interior of the city flood when the drainage system becomes overwhelmed. Altogether 850 people need shelter. Many people with mobility impairments have difficulty going out to get food and make medical appointments.
Economy	3	Many businesses are flooded and cannot operate. Seattle's core industries: biotech, aerospace, and software are able to continue operation with some difficulties. 800 structures suffer major uninsured losses.
Environment	2	Rain causes erosion and landslides that break 2 major sewer lines. 5 facilities housing large amounts of hazardous materials are flooded releasing chemicals into the water.
Structures	3	34 buildings suffer major damage from king tide flooding and must be red tagged, but the more significant problem is 100s of flooded homes. Most are able to be salvaged when the incident is over but require major work to repair.
Transportation	4	Many residential streets are flooded. Smaller neighborhoods are cut off. I-5 is cut off at Chehalis and I-90 is periodically threatened by rockslides. Rail service north of the ship canal is halted many times due to landslides. Major corridors remain open as do the airport and marine terminals.
Critical Services and Utilities	3	Public safety vehicles are unable to reach smaller neighborhoods cut off by flooding. Food distribution becomes difficult due to I-5 flooding and I-90 rockslides.
Confidence in Government	3	As the flooding continues the public becomes tired of the inconvenience and wonders why more isn't being done to fix problems and obtain more aid from the federal government.
Cascading Effects	3	The storms have caused landslides and hazardous materials releases.

## 11.14 Snow and Ice Scenarios

### 11.14.1 Most Likely Scenario

A major snow storm strikes Seattle during a weekday. The snow had been predicted reducing the commute load. Snow alternates with cold temperatures. A combined 12" of snow accumulates. It remains on the ground for a week. As the snow is melting another storm dumps freezing rain on it. The freezing rain snaps branches causing scattered power outages.

Category	Impacts 1 = low 5 = high	Narrative
Frequency	5	Heavy snowstorms do not occur every year in Seattle but are not rare events either. The most likely future severe snow storm would be similar to those that have occurred recently (e.g., 2008, 1996). Climate scientists project that Seattle will see a decrease in winter precipitation falling as snow by the 2040s, but natural precipitation variability could still cause future snowstorms.
Geographic Scope	5	This snowstorm affects the entire Central Puget Sound region. The snow moves up from the south to the north. South Seattle receives more snow than north Seattle.
Duration	3	Snow falls for three consecutive days. It remains frozen on the ground for four days then a warm front moves in and rapidly melts the accumulation.
Health Effects, Deaths, and Injuries	2	There are no deaths that are directly attributed to the storms. Investments in public warning about using charcoal indoors and sledding on dangerous hills save lives. 15 people are injured in a bus crash, and 8 unsheltered people are hospitalized for hypothermia.
Displacement and Suffering	2	No households are displaced but many people cannot make it out to go shopping and some stores are not receiving supplies. As a result, some vulnerable people are going hungry and not receiving needed medical attention.
Economy	2	The storm hits in mid-December hurting Christmas retail sales. Shoppers forgo purchases or shift to buying online.
Environment	1	Salt is used to melt ice, but the quantities used are not enough to do permanent damage to marine ecosystems when they wash into the waste water system.
Structures	2	The snow collapses the roofs of 5 buildings causing them to be red tagged.
Transportation	2	The storm is forecasted. Seattle is able to start pre-treatment of roads and Metro is able to chain buses. These actions mitigate the effects of the storm beginning mid-day. The commute is very bad but could have been much worse. During the next three days roads have snow accumulations because the snow is falling faster than roads can be plowed. Once the snow stops, the arterials are cleared to specifications in the Seattle Snow and Ice Plan, but residential streets remain snowbound.
Critical Services and Utilities	2	The storm does not cause any large-scale infrastructure outages, but numerous small water lines freeze. Public safety vehicles have a harder time reaching some parts of the city.

Confidence in Government	1	Due to improvements in the City's Snow and Ice Plan, it meets its targets. The public experiences some hardships near the end of the storm but does not blame the government for them.
Cascading Effects	2	During the storm a tour bus slides down a hill crashing into a building injuring 15 people. 140 buildings have their pipes freeze.

### 11 14.2 Maximum Credible Scenario

Seattle has a winter similar to those it had in the 19th century. Multiple snow storms hit the region straining snow removal budgets. In the biggest storm 24" falls in 36 hours on top of 12" existing base. The storm begins as freezing rain and transitions to snow. The intensity of the storm was missed in most forecasts. It begins mid-day. Roofs collapse. After the storm, extreme cold sets in, freezing Lake Union.

Category	Impacts 1 = low 5 = high	Narrative
Frequency	3	Seattle seems to have had snowier weather in the 19th century and is projected to receive less snow in the future due to climate change but could still experience natural climate variability. This scenario envisions a set of storms marginally worse than the 19 <sup>th</sup> century incidents.
Geographic Scope	5	The whole Central Puget Sound region is affected by this storm.
Duration	4	The entire incident lasts two and a half weeks from the first snowfall to the melt.
Health Effects, Deaths, and Injuries	2	9 people are killed falling off roofs, sledding, and burning charcoal indoors. 24 unsheltered people are hospitalized for hypothermia and frostbite.
Displacement and Suffering	3	2 apartment buildings have roof collapses. The collapses do not injure anyone, but residents must seek shelters. Others are driven from their homes when they lose power. All told 235 people need shelter. Many in the general public begin to run out of food and medicine.
Economy	3	The storm hits during the December shopping season. Businesses cannot remain open. 6 close permanently due to lost revenues. Major employers have to close and non-salaried employees lose wages.
Environment	2	Major amounts of salt and sand are used to keep roads open. It washes into the drainage system and ultimately into Puget Sound.
Structures	2	6 buildings suffer collapsed roofs.
Transportation	4	Surface transportation experiences major degradation. While snow is falling Seattle crews are unable to keep up with intensity of the storm. After the snow stops falling they are able to catch up within 48 hours but residential streets remain nearly impassible. Airports must halt flights until the snow stops.
Critical Services and Utilities	3	Public safety personnel have difficulties reaching many parts of the city. The ice accompanying the storm brings down power lines in many areas of the city. The snow impedes power restoration. Many water pipes freeze causing businesses and residences to lose water service.



<b>Category</b>	<b>Impacts 1 = low 5 = high</b>	<b>Narrative</b>
Confidence in Government	3	The public becomes frustrated at their lack of mobility. They need help getting basic supplies and think the government should be doing more to help them.
Cascading Effects	3	The snow storm causes many traffic accidents including a gas tanker that crashes and burns. Ice and extreme cold have caused power and water outages.

## 11.15 Water Shortages

### 11.15.1 Most Likely Scenario

Low winter snowpack followed by a hot, dry summer and a cold fall. Water levels in the Cedar fall below the level of outfall. Seattle Public Utilities (SPU) uses pumps to bring water into transmission pipelines. Mandatory water usage restrictions go into effect. Businesses like landscaping operations experience hardships.

Category	Impacts 1 = low 5 = high	Narrative
Frequency	5	Regional water shortages occur when the amount of water in the City's watersheds is not enough to meet demand. Often weather-related shortages like this one can be somewhat reliably forecast based on climate models. Climate scientists project that snowpack will decline substantially by the end of the 21 <sup>st</sup> century, and summers will become drier. Seattle has had dry conditions at least 14 times in the past 100 years. This scenario is about a once every 10 to 50-year event.
Geographic Scope	5	A weather-related water shortage would affect all of Seattle and the suburban customers of Seattle Public Utilities. This shortage is a regional event.
Duration	5	Weather related water shortages are long duration emergencies. The most serious period of this shortage lasts from June until November.
Health Effects, Deaths, and Injuries	1	No one is directly killed or injured as a result of the water shortage.
Displacement and Suffering	2	No households are displaced due to the shortage and the water supply is sufficient to meet basic human needs. Restrictions on non-essential water usage (e.g., lawn watering) bring inconvenience to the general public.
Economy	2	Businesses that use large amounts of water like landscapers, contractors begin to lose revenue due to curtailed operations.
Environment	2	A dry winter and spring stresses plants. Restrictions on watering cause many to die.
Structures	2	No structures are damaged as a result of the water shortage, but the dry conditions create ideal conditions for brushfires. A car fire on I-5 ignites a slope along Beacon hill. The fire spreads rapidly and destroys 3 homes and heavily damages 7 others.
Transportation	1	The water shortage doesn't have any significant impacts on the transportation system
Critical Services and Utilities	3	The primary impact is on water service. Seattle City Light must curtail power generation to preserve stream flows for endangered salmon. Seattle City Light avoids power surcharges and restrictions but has to forego power sales to other utilities which hurts its bottom-line. Impacts on other critical services are limited. Seattle Public Utilities is able to maintain enough water pressure for firefighting. Hospitals have adequate water for operations.

Category	Impacts 1 = low 5 = high	Narrative
Confidence in Government	1	The effects of the low snowpack and dry weather are apparent to the public. They see mandatory water regulations as an inconvenient but necessary step to preserve water for critical uses.
Cascading Effects	2	The extreme dry weather contributed to a serious brush fire. The fire was not a disaster by itself.

### 11 15.2 Maximum Credible Scenario

Several years of low snowpack, hot summers and cold winters begin to place a severe strain on watersheds. SPU must implement emergency curtailments for the first time in its history. Seattle City Light has to curtail generation to preserve salmon stream flows at a time when demand is high and the water is low. It must buy power during a summer when high demand in other parts of the country have driven prices up.

Category	Impacts 1 = low 5 = high	Narrative
Frequency	2	This scenario is, like the Most Likely scenario, a weather-related drought and water shortage, but it is much more severe. Although Seattle has had other periods of dry weather, Seattle must enact emergency water curtailments for the first time in its history. Climate scientists project that snowpack will decline substantially by the end of the 21 <sup>st</sup> century, and summers will become drier.
Geographic Scope	5	The drought and water shortage are region wide.
Duration	5	The full duration of the drought is years, but the worst period is the summer following an exceptionally dry winter.
Health Effects, Deaths, and Injuries	1	Due to emergency curtailments and surcharges, water supply is adequate for public health needs. As a result, there are no deaths or injuries due to lack of potable water.
Displacement and Suffering	3	No households are displaced due to a lack of potable water, but water restrictions and surcharges are hardships for much of the general public.
Economy	3	Many businesses are impacted by curtailments and surcharges. Use of the Ballard Locks impacts commercial maritime traffic. Seattle City Light implements surcharges to offset borrowing.
Environment	3	The prolonged dry weather has placed severe stress on Seattle's urban forest. The dry conditions weaken plants making them more susceptible to disease.
Structures	2	The dry conditions contribute to 2 urban wildfires that destroy 10 buildings and damage 25 others.
Transportation	1	The water shortage and drought do not have a significant impact on Seattle's transportation system.
Critical Services and Utilities	3	The water system is severely impacted by the shortage. Seattle City Light is able to maintain power without curtailments but implements surcharges. Due to prioritization water pressure remains adequate for firefighting and public health.

Category	Impacts 1 = low 5 = high	Narrative
Confidence in Government	3	The public understands the severity of the drought and water shortage, but the increasing bite of curtailments and the implementation of surcharges is not popular. Many are convinced that government could do a better job shielding the public from the costs of the shortage.
Cascading Effects	2	The extreme dry weather contributed to a serious brush fire. The fire was not a disaster by itself.

## 11.16 Windstorm Scenarios

### 11 16.1 Most Likely Scenario

Seattle faces another storm similar to the 1993 or 2006 storms: numerous downed trees, scattered outages, limited structural damage. Seattle City Light's aggressive tree trimming mitigates power outages and its power outage management system speeds up restoration.

Category	Impacts 1 = low 5 = high	Narrative
Frequency	5	The Seattle had experienced major windstorms similar to this scenario nearly every decade.
Geographic Scope	5	Mid-latitude cyclones are wide storms. The one in this scenario affects the entire Central Puget Sound region.
Duration	1	The storm itself lasts for eight hours. Short term response and recovery lasts for another three days.
Health Effects, Deaths, and Injuries	2	Nobody is killed in the storm, but 8 people are injured by debris.
Displacement and Suffering	2	Building damage, power outages, and urban flooding drive 60 people from their homes. 25% of the city loses power. Seattle City Light's outage management system enables the utility to more quickly respond than it could during previous storms.
Economy	2	Many businesses close during the storm. Retail businesses are hit the hardest, but none close permanently.
Environment	2	The storm produces major amounts of debris. Most is natural but non-compostable debris must be transferred to landfills.
Structures	2	Many buildings have minor roof damage, but 9 have major structural damage (roof failure) and are red tagged. 25% of the city loses power. Seattle City Light's tree trimming operations and outage isolation technology prevent more widespread outages.
Transportation	2	Debris, fallen trees, traffic light outages and downed power lines cause major traffic and transit backups. The airports and marine ports are able to resume operations quickly after the storm.
Critical Services and Utilities	2	Power and fire crews must work together to coordinate service restoration in a way that does not tie up fire units. 25% of the city loses power.
Confidence in Government	1	The public feels that the government responds quickly to the storms. Recovery happens quickly and the public's confidence in government is boosted.
Cascading Effects	2	The storm causes widespread power outages.

### 11 16.2 Maximum Credible Scenario

A mid-latitude cyclone similar to the 1962 Columbus Day storm hits the West Coast. Winds are recorded at 83 mph at West Point. The whole region is affected. Thousands of trees are downed, and millions of people are without power for multiple days. Waves damage a floating bridge. Several piers on waterfront are affected.

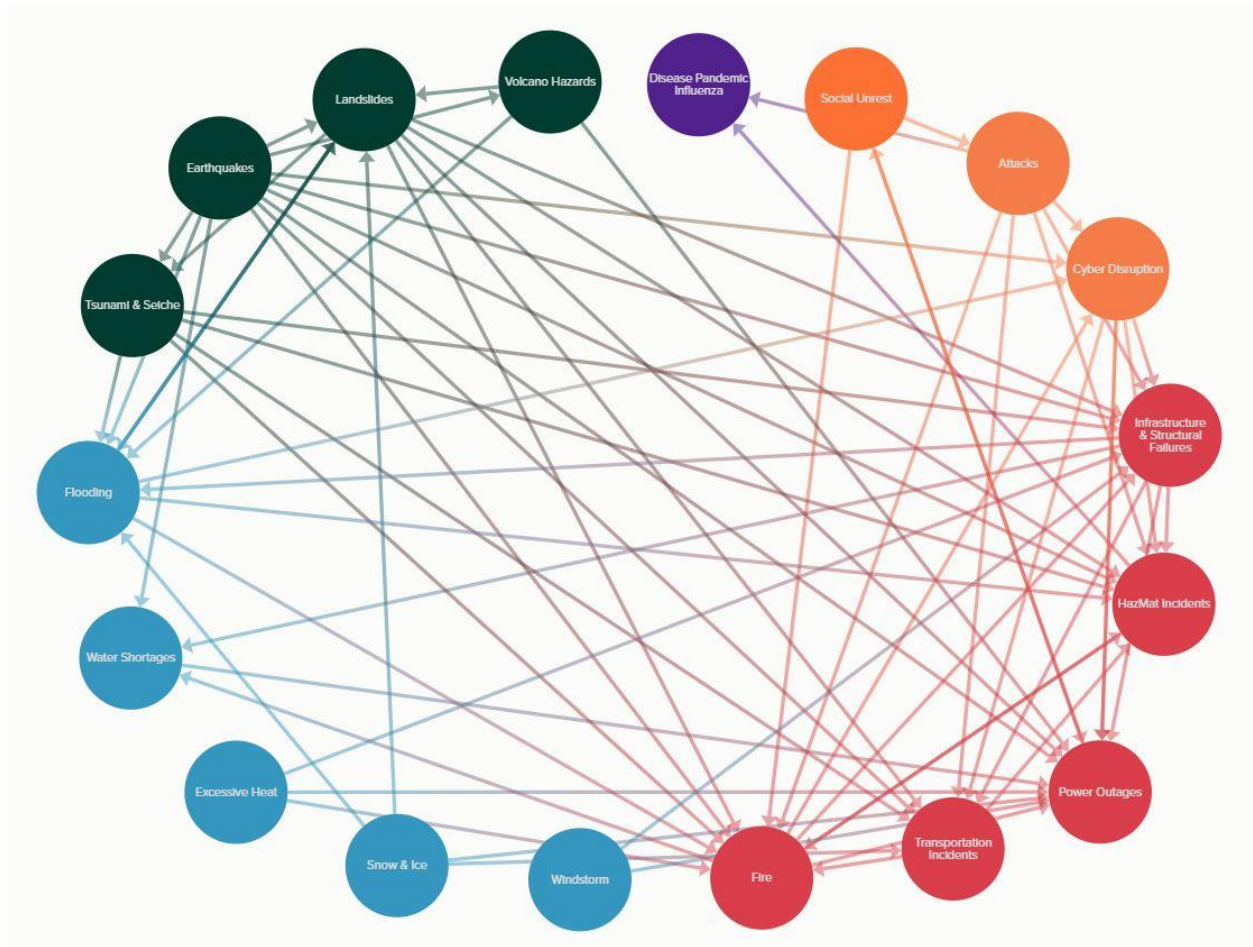
Category	Impacts 1 = low 5 = high	Narrative
Frequency	3	A storm this size has only occurred once in the past 100 years.
Geographic Scope	5	The storm affects much of the West Coast from Northern California to British Columbia. Coastal areas receive the strongest winds of 125 mph.
Duration	2	The storm itself lasts for 6 hours. It takes public safety and infrastructure crews 36 hours to stabilize the incident. Short term recovery takes another 10 days when most services are restored, but heavily damaged areas require months to years to fully recover.
Health Effects, Deaths, and Injuries	2	Regionally, the storm kills 73 people and 450 are hospitalized. In Seattle itself, there are 7 fatalities and 33 people require hospitalization.
Displacement and Suffering	3	Building damage and power outages drive 180 people from their homes. 75% of the city loses power. Seattle City Light's outage management system enables the utility to more quickly respond than it could during previous storms.
Economy	3	Many businesses close during the storm. Retail businesses are hit the hardest. Power is out for an extended period and some business have serious physical damage. Many lack adequate business continuity plans. 25% of the businesses without plans that are damaged fail.
Environment	2	The storm produces massive amounts of debris. Most is natural but non-compostable debris must be transferred to landfills. The storm causes some hazardous material spills from warehouses along the water.
Structures	3	Hundreds of buildings have roof damage. Most damage is minor, but 67 buildings are yellow tagged and 14 are red tagged. Most damage is to residential property. 75% of the city is without power. Wind and waves damage two piers downtown.
Transportation	4	Debris, fallen trees, traffic light outages and downed power lines cause major traffic and transit backups. Due to the overwhelming amount of debris, surface transportation is disrupted for a week Air and marine traffic halt during the storm but resume operations soon after it has passed. Rail traffic is stopped for multiple days due to debris along the tracks.
Critical Services and Utilities	4	Power outages are major problem throughout the city. 75% of the city loses power for up to 6 days. Public safety responders have a difficult time reaching some parts of the city. City Light and Fire must work to coordinate guarding downed power lines, service restoration and fire/ems response.
Confidence in Government	3	As the power outages and transportation disruption lingers, the public becomes impatient. Many cannot understand why short-term recovery is taking so long.
Cascading Effects	3	The storm causes power widespread power outages and hazardous materials incidents.

## 12. APPENDIX C: RELATIONSHIPS BETWEEN HAZARDS

This section expands on Table 2.3 by diagramming the relationships between hazards. Considering hazards individually risks siloing our understanding of the totality of the risk. This section makes clear that most large disasters will be multi-hazard.



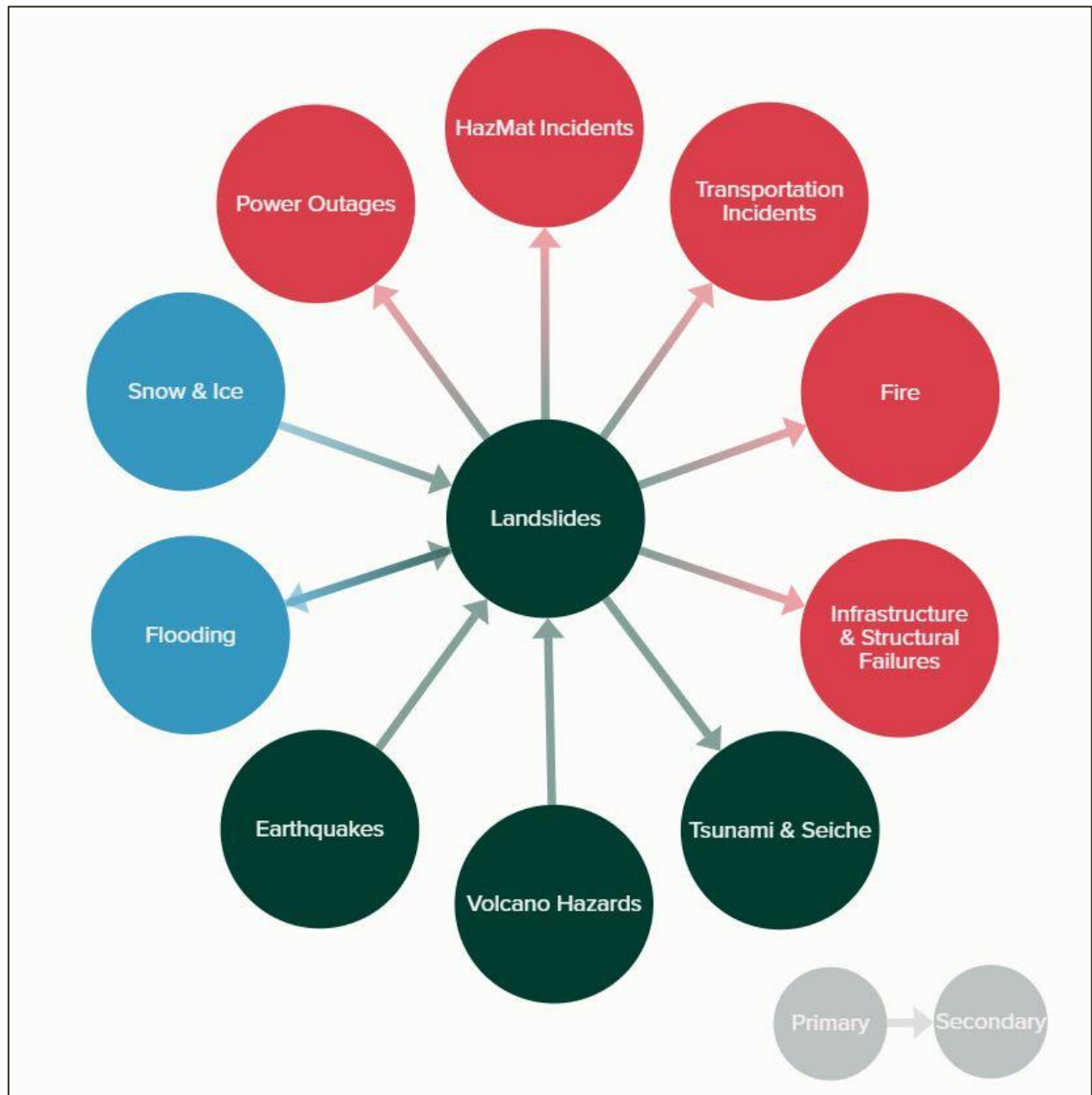
## 12.1 General Relationships



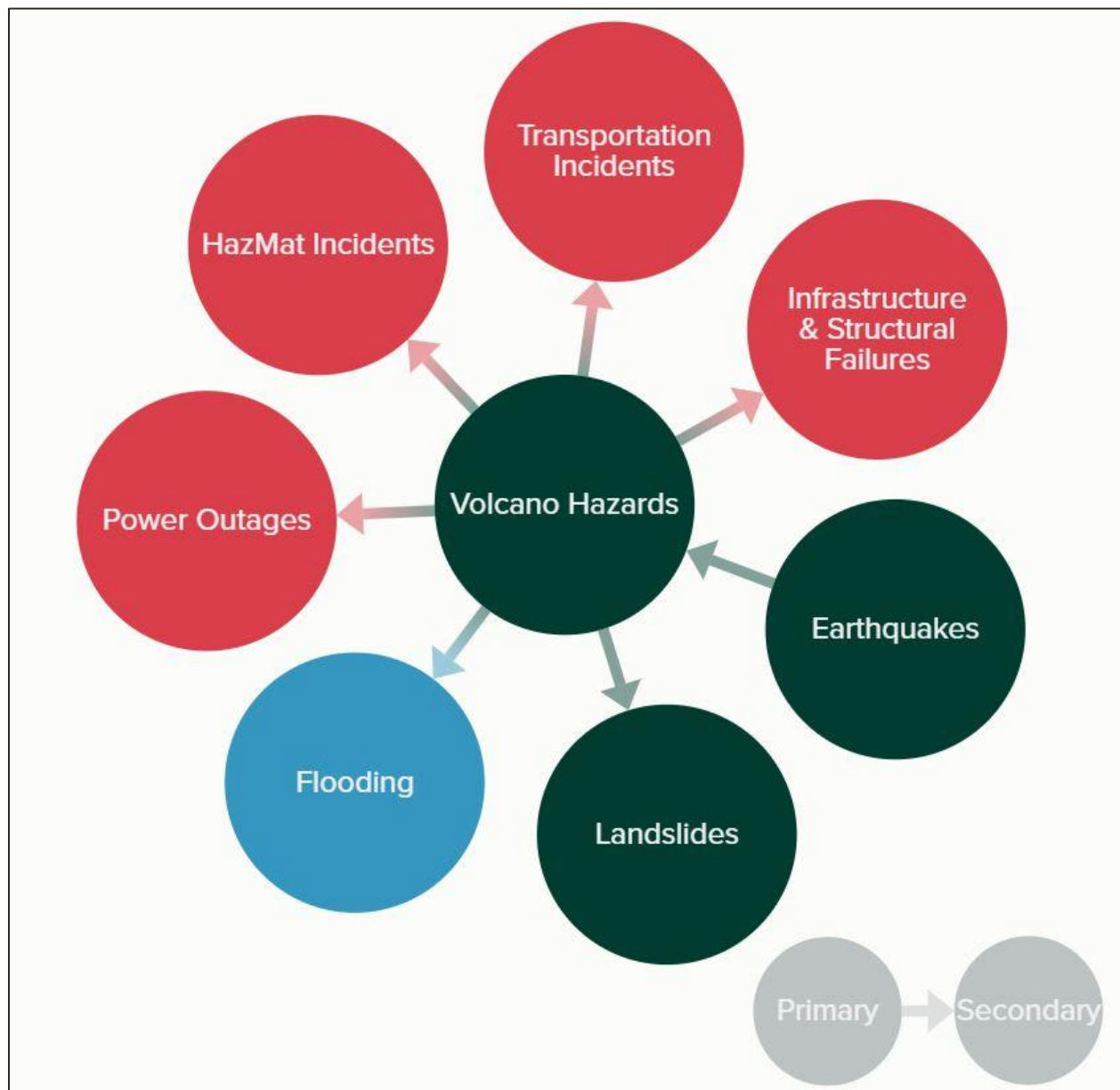
## 12.2 Earthquakes



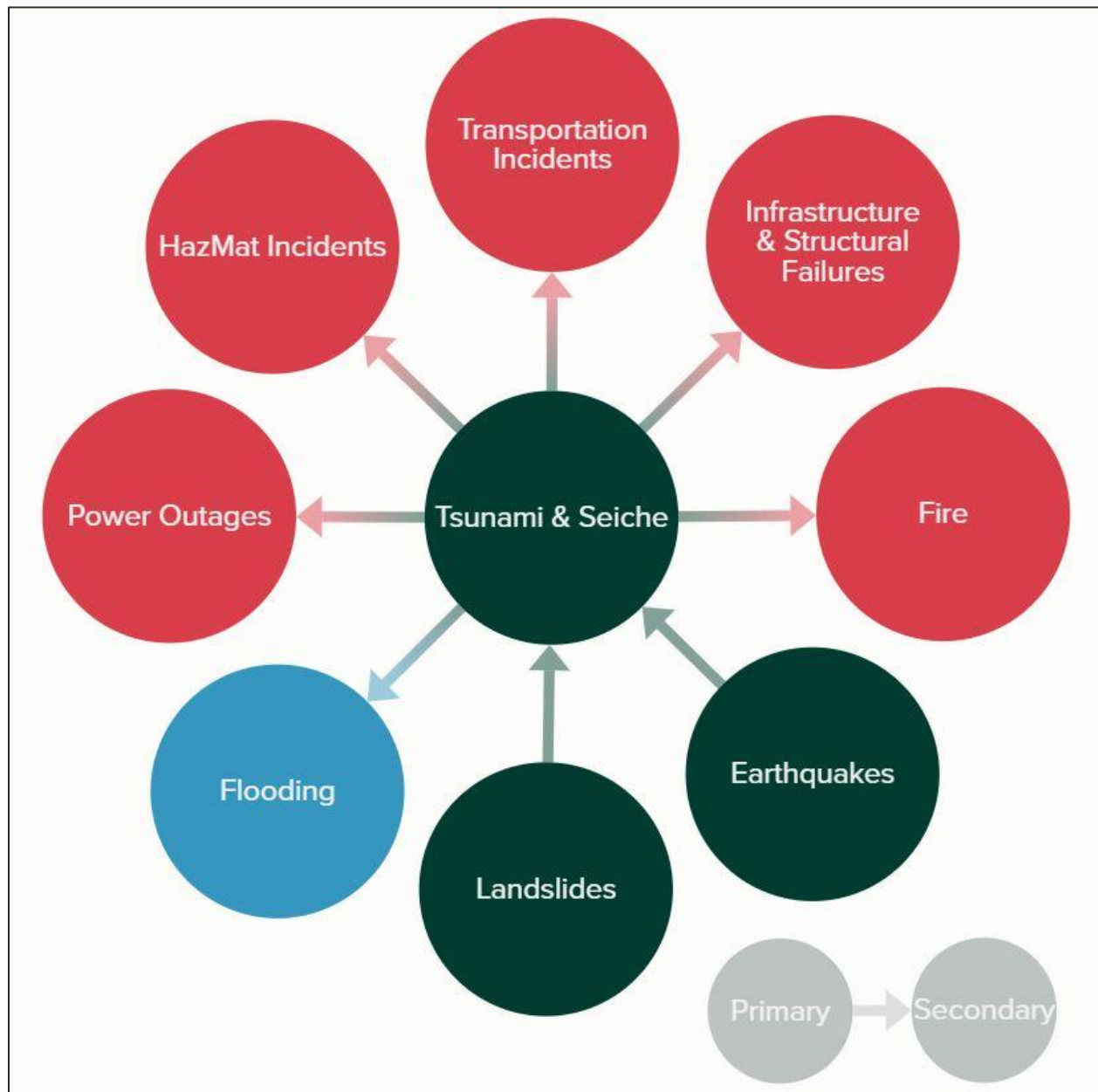
## 12.3 Landslides



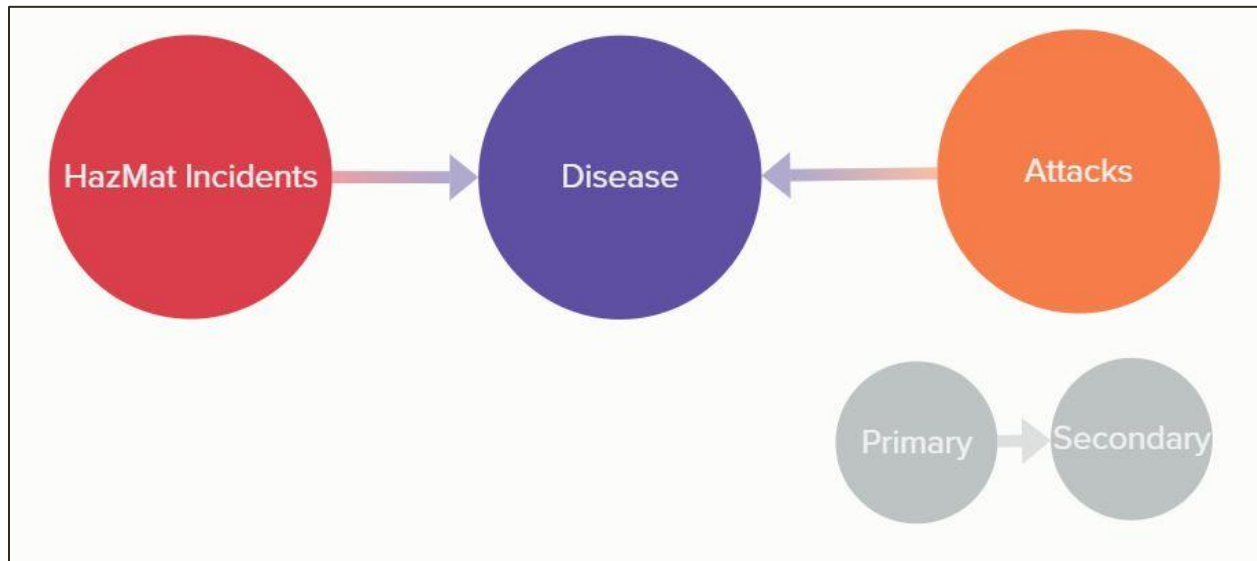
## 12.4 Volcano Hazards



## 12.5 Tsunamis and Seiches

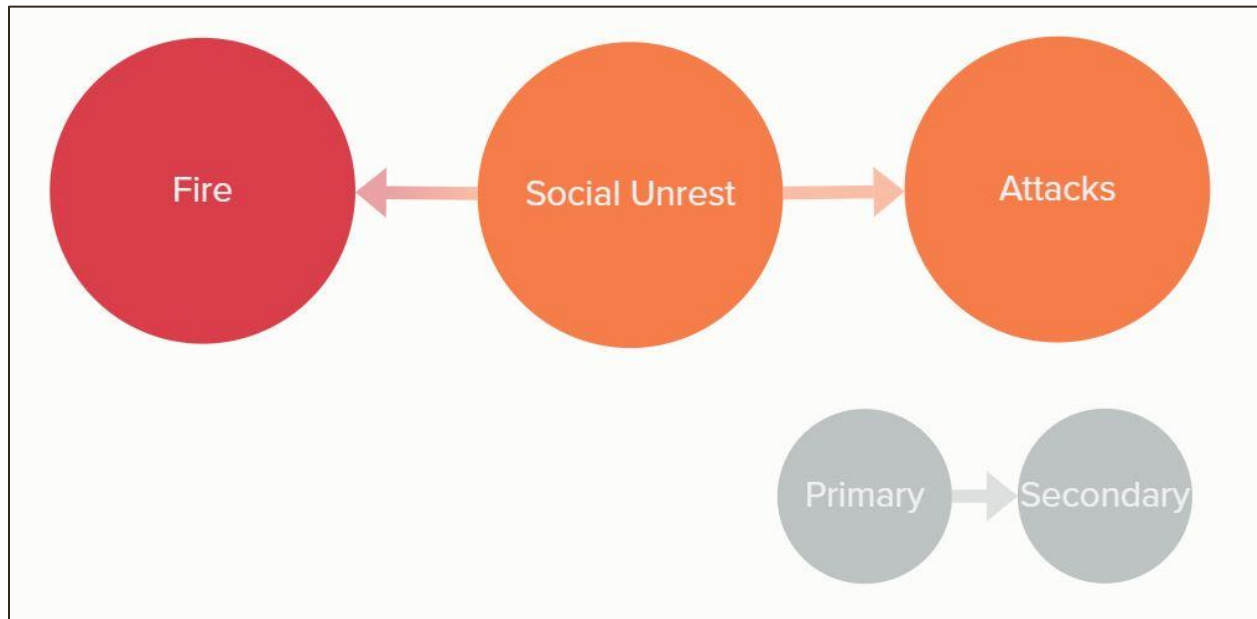


## 12.6 Disease / Pandemic Influenza



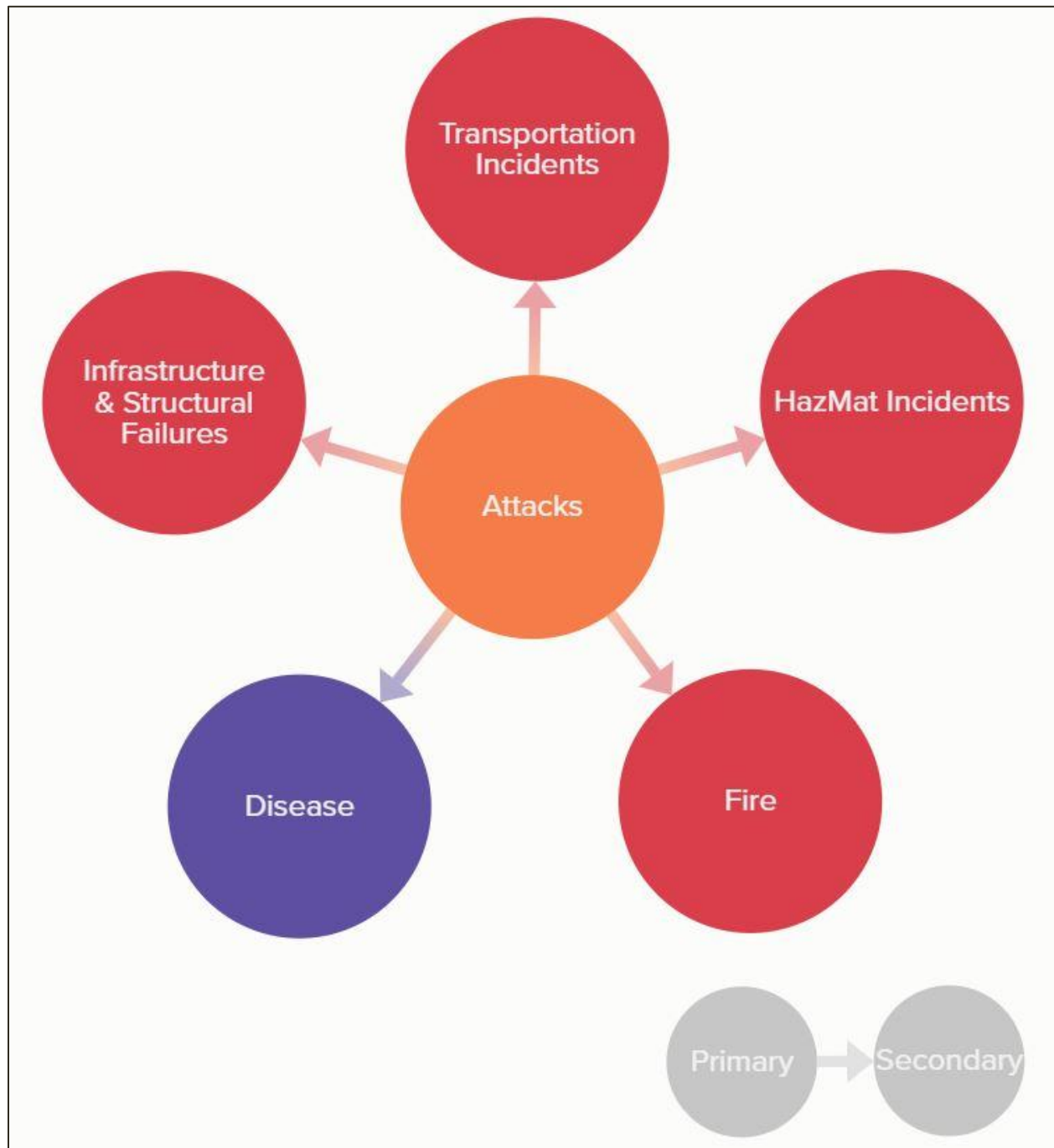


## 12.7 Social Unrest





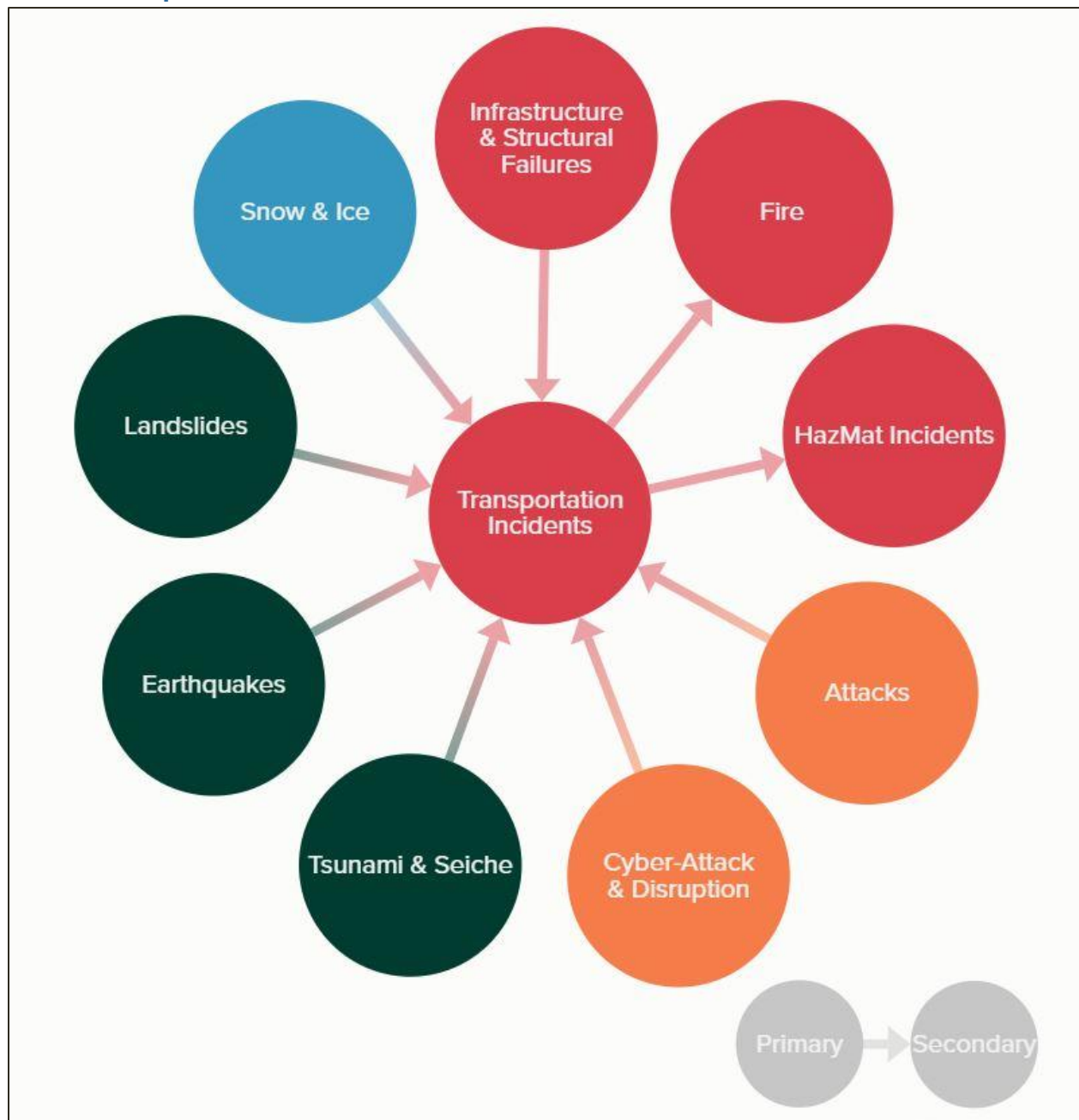
## 12.8 Attacks



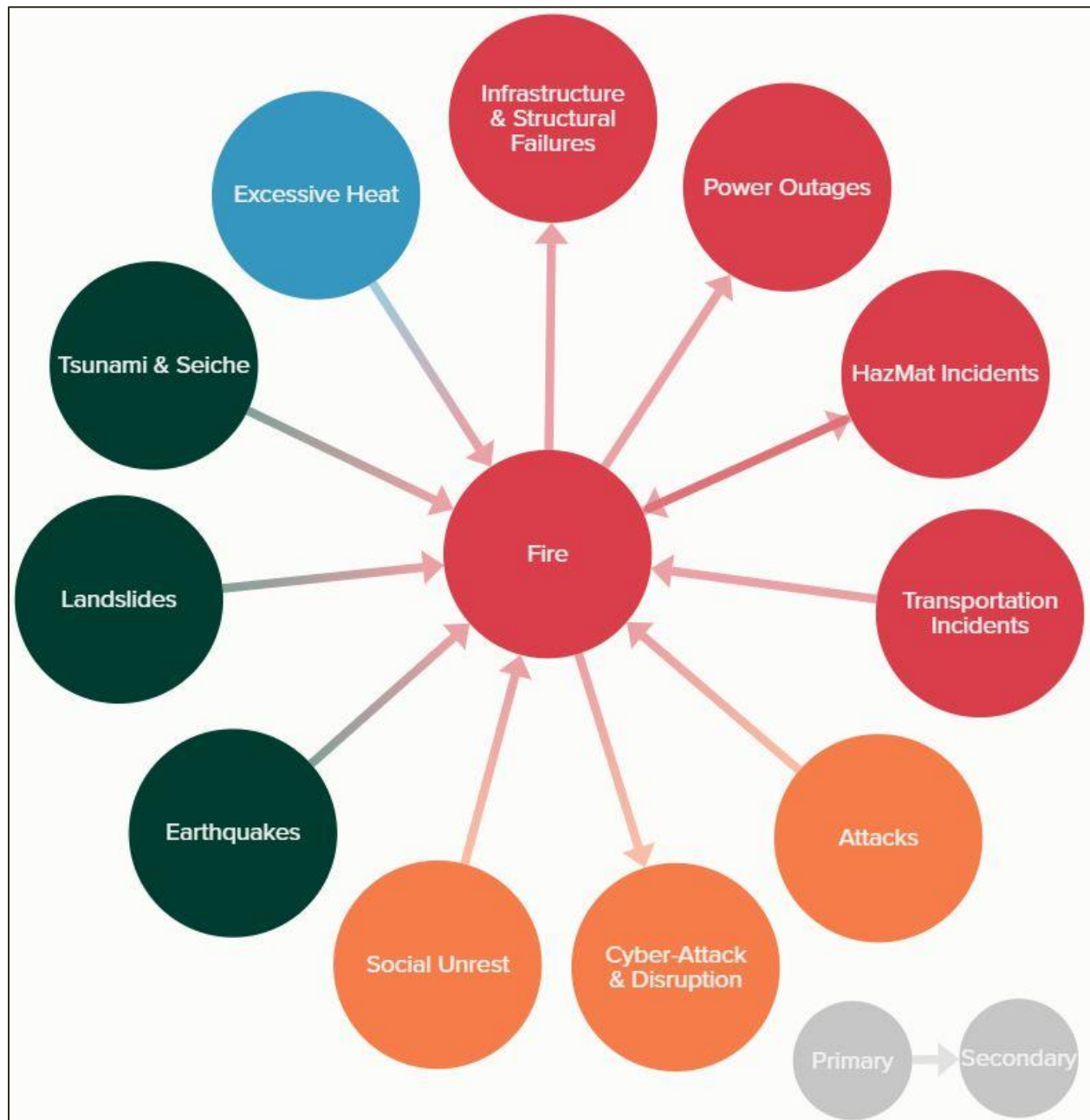
## 12.9 Cyber-Attack and Disruption



## 12.10 Transportation Incidents



## 12.11 Fires



## 12.12 Hazardous Materials Incidents





## 12.13 Infrastructure and Structural Failures

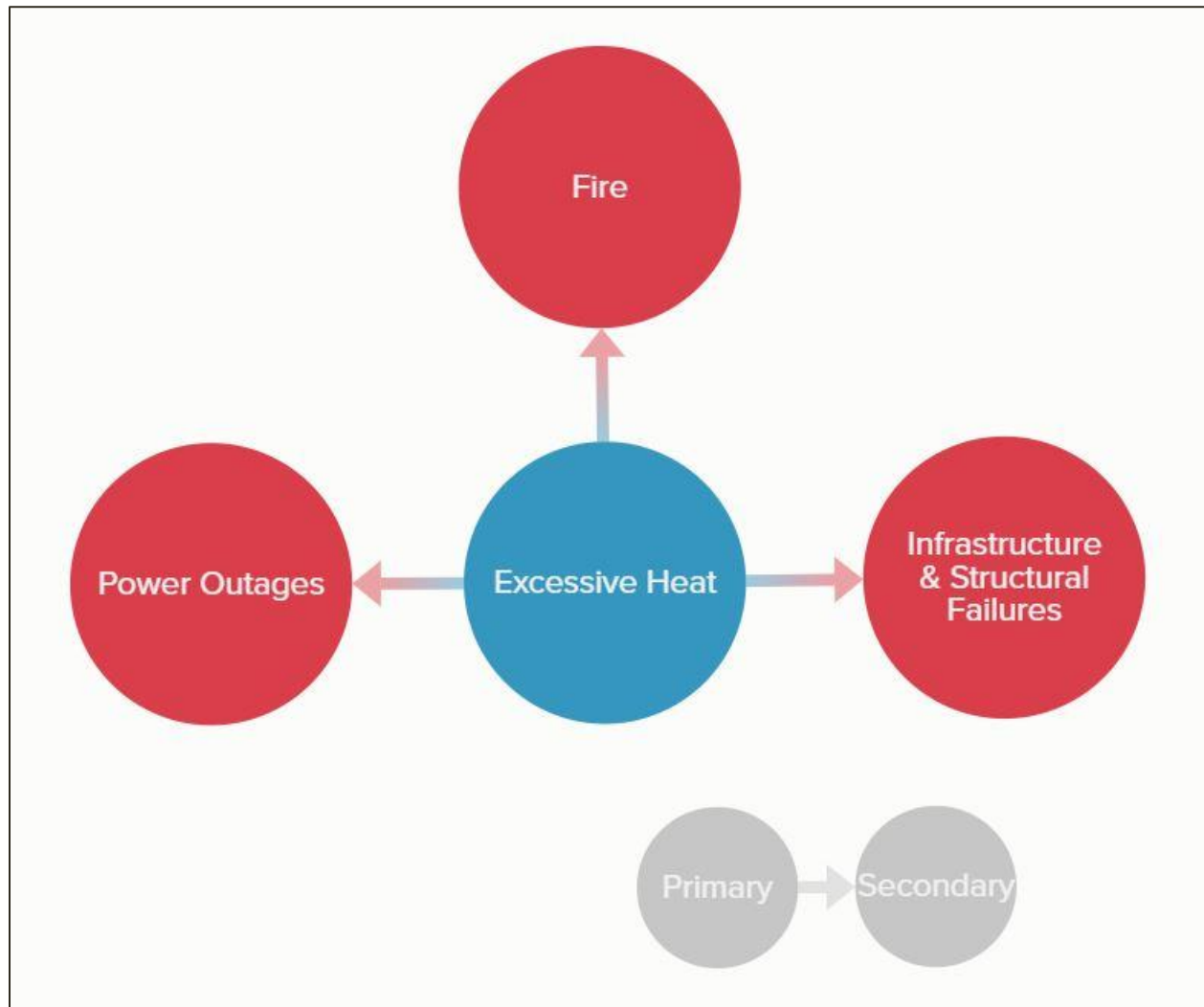


## 12.14 Power Outages





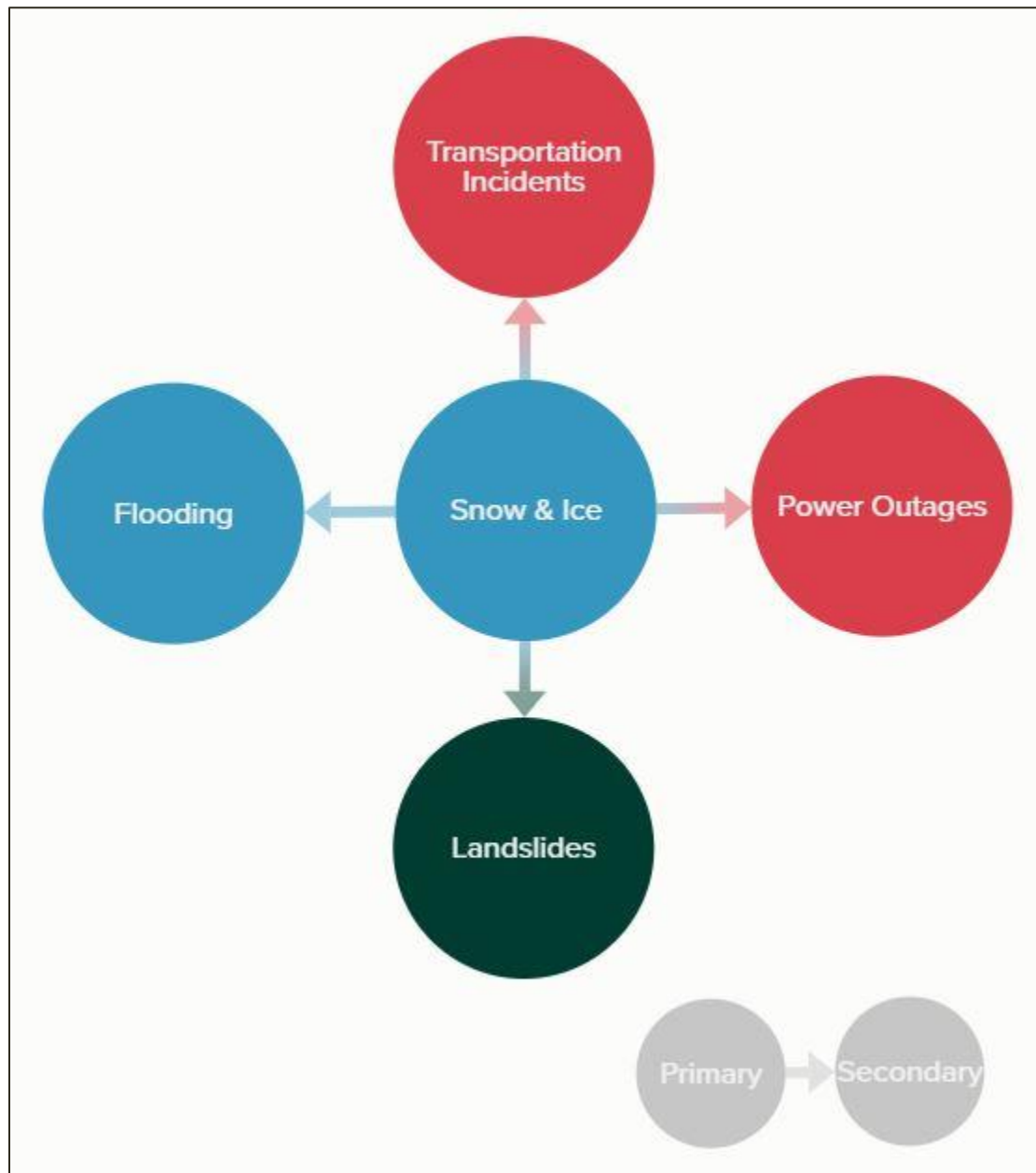
## 12.15 Excessive Heat Events



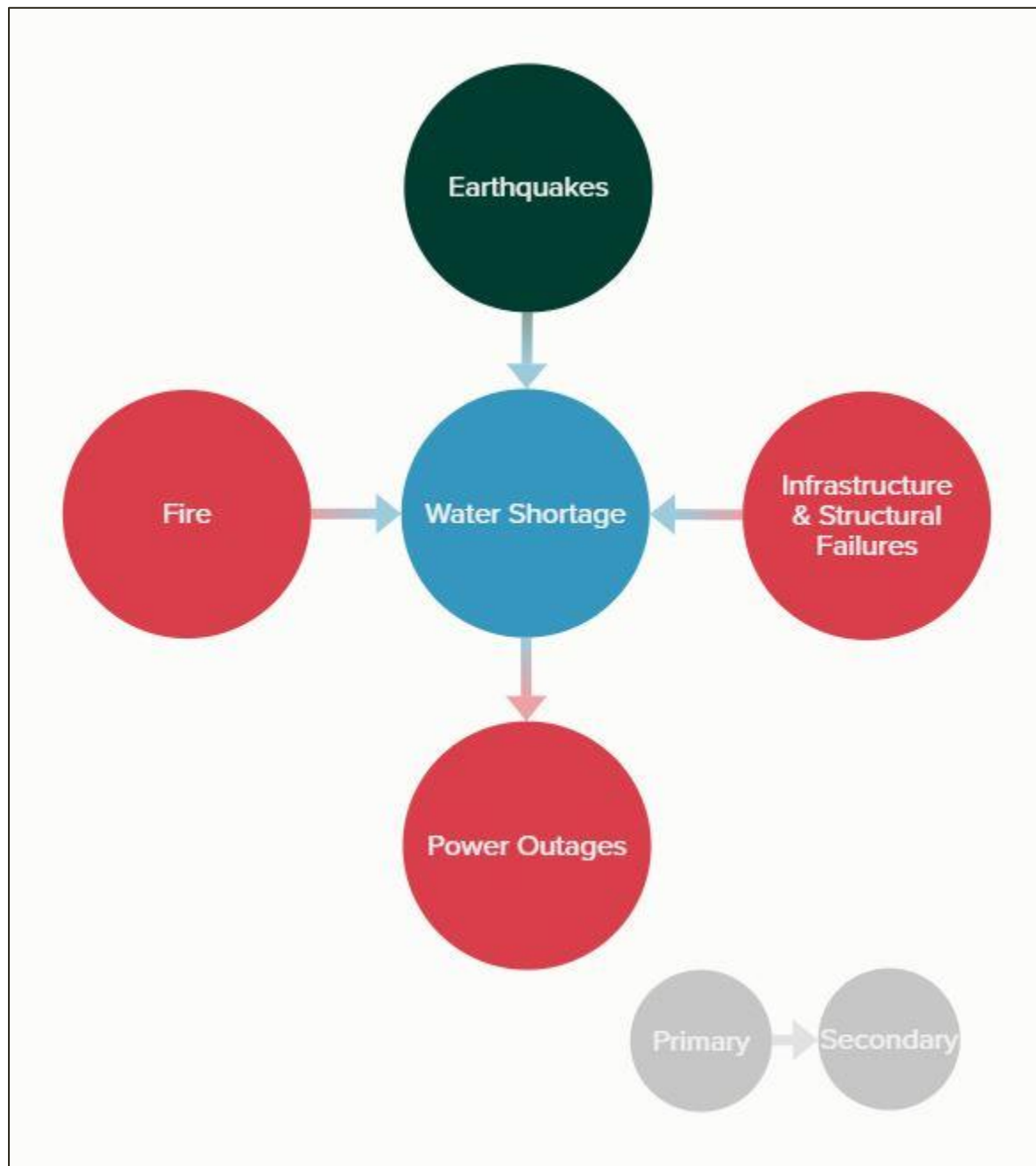
## 12.16 Flooding



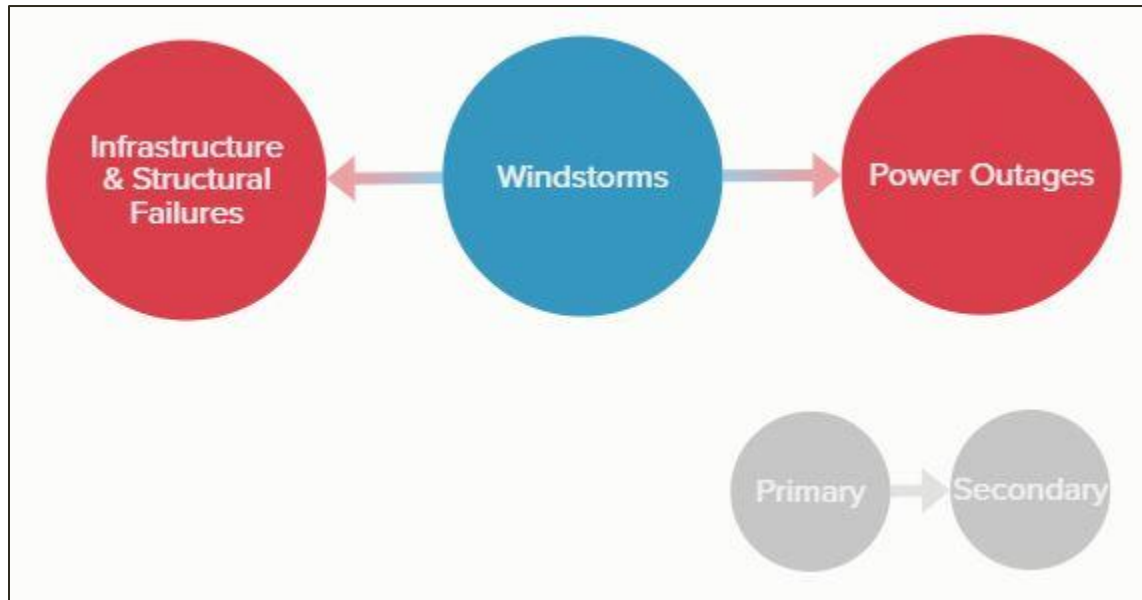
## 12.17 Snow and Ice



## 12.18 Water Shortages



## 12.19 Windstorms



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## APPENDIX B    PLAN PROCESS MATERIALS

Mitigation Work Group Meetings #1

Mitigation Work Group Meetings #2

Mitigation Work Group Meetings #3

Mitigation Work Group Meetings #4

Mitigation Work Group Meetings #5

Mitigation Work Group Meetings #6

Disaster Management Committee Meeting

Emergency Executive Board Meeting

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# Hazard Mitigation Work Group (HMWG) - Meeting #1

## Seattle All Hazards Mitigation Plan – 5 Year Revision Process - Kick Off Meeting Agenda

*Date/Time: Monday, January 27<sup>th</sup>, 2020 10:00AM-12:30 PM*

*Location: EOC Training Room, 105 5th Avenue S*

### Meeting Objectives:

- ☐ Introductions between stakeholders in Hazard Mitigation Work Group and OEM Staff
- ☐ Discuss purpose of hazard mitigation planning in context of FEMA guidelines and Emergency Management Accreditation Program (EMAP) certification
- ☐ Identify roles of Hazard Mitigation Work Group Members
- ☐ Familiarize members with 2019 Seattle Hazard Identification and Analysis (SHIVA)
- ☐ Review main elements of the current Seattle All Hazards Mitigation Plan
- ☐ Lay out plan revision schedule and action items to follow

<b>Introductions</b> 15 min	
<b>Hazard Mitigation Planning: Purpose, Regulations, and Updates</b> 20 min	What is a Hazard Mitigation Plan and why do we have them?  FEMA & EMAP plan requirements  What is new and what has changed in context since the last plan
<b>Roles of HMWG Members</b> 10 minutes	
<b>Open Discussion</b> 20 minutes	Questions: 1. What hazard <b>vulnerabilities</b> are you aware of regarding your department's assets, operations, and/or plans? 2. Are there other planning efforts that we should be aware of that connect to mitigation planning?
<b>Break</b> 10 minutes	
<b>SHIVA</b> 20 minutes presentation 10 minutes Q & A	Highlights of the current Seattle Hazard Identification and Analysis (SHIVA) and changes since 2014
<b>Current Hazard Mitigation Plan</b> 15 min	Review the main elements of the 2015 – 2021 Seattle All Hazards Mitigation Plan



<b>Open Discussion: Plan and Process</b> 20 minutes	<p>Questions: Plan</p> <ol style="list-style-type: none"> <li>1. How have you used this plan?</li> <li>2. How can this plan be useful for you and your departments?</li> </ol> <p>Questions: Process</p> <ol style="list-style-type: none"> <li>1. How can we increase participation and visibility of the plan within your organization?</li> <li>2. How can this process be more meaningful for you and your departments?</li> </ol>
<b>Action Items and Wrap Up</b> 10 in	<ul style="list-style-type: none"> <li>✓ Action Items: 1) <b>Final updates &amp; disposition of 2015-2021 projects</b>; 2) <b>Department Capability Updates</b> – instructions to follow</li> <li>✓ Doodle poll for second Hazard Mitigation Workgroup Meeting, anticipated to be in March</li> <li>✓ Thanks for attending!</li> </ul>

**Hazard Mitigation Plan Process Outline:**

- **Hazard Mitigation Work Group Meeting 2:** March 2020 specific date, location, and time TBD
- **Hazard Mitigation Work Group Meeting 3:** May 2020 specific date, location, and time TBD
- **Presentation of 2021 Plan for Disaster Mitigation Committee approval:** June 2020

**Notes:**

**Hazard Mitigation Work Group 2020 Members:**

Name	Department/Agency
Flossie Pennington	Arts and Culture
Devore, Jennifer	Budget Office
Kara Main Hester	Budget Office
Elliot, Jana	City Light
Chappell, Micah	Construction & Inspection
Sodt, Sarah	DON Historic Preservation
Stickel, Karl	Economic Development
Graff, Barb	Emergency Management
Lund, Erika	Emergency Management
McDonald, TJ	Emergency Management
Nelson, Laurel	Emergency Management
Schmit, Lucia	Emergency Management
Jarolimek, Elenka	FAS
Matsumoto, Julie	FAS
Scriver, Cody	Fire
Foley, Dan	Housing
Watson, Jill	Human Services Department
Dennis Reddinger	Libraries
TBD	OSE
Will Beatie	Parks & Recreation
Stevens, Scott	Parks & Recreation
Carroll, Patrice	Planning and Community Development

Davich, Kati	<i>Port of Seattle</i>
Houston, Addison	Public Health Seattle King County
Worcester, Ned	Public Utilities
Michael Godfried	Public Utilities (Resilience)
Crary, Jill	Seattle Center
Jared Cummer	<i>Seattle Housing Authority</i>
Eichhorn, Lawrence	Seattle IT
Kaku, Clinton	Seattle IT
TBD	Seattle Police Department - facilities
Benjamin Coulter	Seattle Public Schools
Quirk, Patti	Transportation

## Seattle All Hazards Mitigation Plan – 5 Year Revision

### Hazard Mitigation Work Group (MWG) Meeting #1 – Kick Off Meeting Notes

*Hosted by: The Seattle Office of Emergency Management (OEM)*

*Date/Time: Monday, January 27<sup>th</sup>, 2020 10:00AM-12:30 PM*

*Location: EOC Training Room, 105 5th Avenue S*

#### **OBJECTIVES:**

- ☐ Introductions between stakeholders in Hazard Mitigation Work Group and OEM Staff
- ☐ Discuss purpose of hazard mitigation planning within confines of FEMA guidelines and EMAP certification
- ☐ Identify roles of Hazard Mitigation Work Group Members and identify what they would like to take away from this process
- ☐ Familiarize members with 2019 Seattle Hazard Identification and Analysis (SHIVA) profile as well as any updates since the 2014 version
- ☐ Review main elements of the current Seattle All Hazards Mitigation Plan
- ☐ Lay out plan revision schedule and action items to come

#### **AGENDA:**

Meeting Item	Duration	Presenter/Facilitator
Introductions	15 minutes	Erika Lund, Seattle OEM
<b>Hazard Mitigation Planning: Purpose, Regulations, and Updates</b>	15 minutes	Erika Lund, Seattle OEM Barbara Graff, Seattle OEM
<b>Roles of MWG Members</b>	10 minutes	Erika Lund, Seattle OEM Barbara Graff, Seattle OEM
<b>Open Discussion 1: Hazard Vulnerabilities</b>	30 minutes	Erika Lund, Seattle OEM Danté DiSabatino, Seattle OEM
<b>Break</b>	10 minutes	-----
<b>SHIVA 2018 Update</b>	20 minutes	TJ McDonald, Seattle OEM
<b>2015 Hazard Mitigation Plan</b>	10 minutes	Erika Lund, Seattle OEM
<b>Open Discussion 2: HM Planning Process</b>	30 minutes	Erika Lund, Seattle OEM Danté DiSabatino, Seattle OEM
<b>Action items and Wrap Up</b>	5 minutes	Erika Lund, Seattle OEM

#### **ATTACHMENTS:**

1. Sign-in Sheets
2. Meeting Agenda
3. Power point presentations (PDF)

## **MEETING SUMMARY**

### **Introductions**

Introductions were made between Hazard Mitigation Work Group Members in attendance, including past involvement in this group and focus of current position.

Danté DiSabatino introduced as hazard mitigation planning intern assisting with plan update and stakeholder engagement. May follow up as point of contact throughout process through 1:1 conversations and meeting engagement.

Introductions of Hazard Mitigation Work Group 2020 Members outside OEM:

**Michael Godfried (Seattle Public Utilities):** *works on resilience efforts in SPU around wastewater systems. Previously was involved with the City of Everett's Hazard Mitigation Plan*

**Dennis Reddinger (Seattle Public Libraries):** *focuses on capital improvement projects for SPL*

**Jana Elliott (Seattle City Light):** *focuses on emergency management for SCL facilities, etc.*

**Kara Main Hester (City Budget Office):** *Doesn't have a background in hazard mitigation but will serve as an advocate and liaison with the City Budget Office*

**Jill Watson (Seattle Human Services Department):** *serves as the emergency management coordinator and has previously been involved in the last hazard mitigation planning group (2014)*

**Jared Cummer (Seattle Housing Authority):** *Asset Management coordinator overseeing and extensive emergency management plan*

**Lawrence (Seattle IT):** *has over 10 years of experience working with the city initially working with SDOT on their bridges. Currently working on IT mitigation strategies as they are moving to the cloud.*

**Sarah Sodt (Department of Neighborhoods):** *works in historic planning and has been a part of the last hazard mitigation planning group (2014)*

**Patrice Carroll (Planning and Community Development):** *has worked on the City's Comprehensive Plan and been part of the emergency management recovery framework conversation already*

**Julie Matsumoto (Seattle Finance and Administrative Services):** *Works on asset management for FAS*

**Elenka Jarolimek (Seattle Finance and Administrative Services):** *serves as the emergency management coordinator for FAS*

Introductions of Hazard Mitigation Work Group 2020 Members in OEM:

**Barb Graff (Director)**

**Laurel Nelson (Deputy Director)**

**Erika Lund (Recovery and Mitigation Coordinator)**

**Ivan Lee (Training and Exercise Coordinator)**

**Lucia Schmit (Planning Coordinator)**

**TJ McDonald (Technology Coordinator)**

### **Hazard Mitigation Planning: Purpose, Regulations, and Updates**

Erika Lund reviewed what a Hazard Mitigation Plan is and what they are used for, touching on the bullet points listed below:

- Identify the natural hazards for which communities are at risk for
- Assess potential impacts of those hazards
- Develop goals, objectives, and actions to reduce impacts
- Prioritize and implement mitigation actions

She reviewed FEMA planning requirements as dictated by CFR 201.6 Local Mitigation Plans below:

- Documentation of planning process
- Provide stakeholders opportunity to participate
- Conduct and document public involvement
- Incorporate existing plans and reports
- Discuss continued public participation and plan maintenance
- Provide a method for monitoring, evaluating, and updating the plan

She reviewed new items regarding hazard mitigation planning this year and what has changed in context of the last plan touching on:

- Recent changes in FEMA funding and restructuring → Building Resilience in Communities (BRIC)
  - Information is relatively sparse right now but more information can be found here [BRIC Webinar Series](#)
- Review Emergency Management Accreditation Program (EMAP) Accreditation Process: hazard mitigation plan revision will need to be EMAP compliant as OEM is going through the five year re-accreditation process

### **Roles of MWG Members**

Barb Graff: Welcoming message and thank for participation in group. Emphasized the importance of hazard mitigation and the valuable work that will come out of the working group meetings. Highlighted legislation supporting hazard mitigation work.

Erika Lund: Provided baseline expectations OEM staff have of Hazard Mitigation Work Group. Emphasis on the importance of the role and the representative capacity they carry for their respective departments.

- Participate in 3 planning meetings (January, March, and May 2020) & follow up on Action Items
- Serve as Subject Matter Experts (SMEs) on Department mitigation needs and priorities
- Support Public and Stakeholder Outreach
- Provide feedback on
  - The updated risk assessment,
  - City capabilities, and
  - Mitigation strategy
  - Review draft and final plans

## **Open Discussion 1: Hazard Vulnerabilities**

Members were asked around the table to share answers to these questions. Erika emphasized the vulnerability and not the hazard itself. Provided an example: vulnerability of bridges and transportation system from earthquakes.

Discussion Question 1: *What hazard **vulnerabilities** are you aware of regarding your department's assets, operations, and/or plans?*

### ***Seattle Public Utilities***

- Water and wastewater system (transmission, treatment, distribution) underground pipelines and facilities affected by seismic
- Also examining wildfire (treatment facilities), intense rain events and rising sea level (storm drains)
  - Focus on the Duwamish area for intense rain and sea level rise
- Large effort on large stormwater projects
- Capital program is in place

### ***Seattle Public Library***

- Has 8 Unreinforced Masonry (URM) buildings
  - Levee funding will pay for the three most vulnerable URM
- Terrorism concern for Central Library- glass makes up significant portion of structure
- Air filtration / buildings are designed to have doors and windows open. Filtration is hospital grade but has HVAC issues (gets too hot with filtration going/ library must shut down at 85 degrees)→ wildfire smoke hazard
- Libraries serve as community gathering spaces to receive information → immigrants and refugees may view as a trusted space
- Questions were asked about shelving systems and collection preservation but not known what non-structural protective measures are in place

### ***Seattle City Light***

- Systems operations control center construction
- Wildfire impacts
- Transmission lines are highly vulnerable
- South system service center is in liquefaction zone
- Microgrids under discussion, but exploratory only at this point
- Undergrounding of powerlines is only applied in new construction, pros and cons (restoration is easier with above ground)

### ***Seattle Human Services Department***

- Focus on agencies that HSD contracts with external agencies, valued at over 100 million dollars
  - Case management

### ***Seattle Housing Authority***



- One URM building (owned partially with city)
  - Study underway on seismic retrofit
  - Will be placed into capital program pending study result
- Many concrete buildings with extremely vulnerable populations (around 30 buildings)
  - Older buildings built in the 1950s housing elderly and disabled
  - Concrete spalling is evident
  - Some buildings are historical therefore more difficult/expensive to improve
  - Jefferson Terrace is prioritized next due to concerns
- Many duplexes / single resident homes not checked for retrofit (approx. 2000)
- Focus on high rise buildings → 10+ stories

### ***Department of Neighborhoods (Historic preservation)***

- Offered streamlined review process with UW, could be used more broadly
  - Toolkit development on URM buildings

### ***Information Technology Department***

- Cybersecurity
  - People are the greatest exploit/vulnerability, e.g. clicking on unidentified links
- Data center physical security for both west and east centers

### ***Planning and Community Development***

- now a funding agency
- possible to investigate being more equitable

### ***Financial Administrative Services***

- Seismic retrofit work done on first responder facilities, especially Seattle Police Department → West Precinct
- Other facilities that are critical to response (vehicle maintenance shops, etc.)
  - Reliance from SPU and SPD
- Implementing Shake Alert for elevators at Seattle Metro Transit
- Fleets are vulnerable (shops, fuel, garages)

### **SHIVA 2018 Update**

TJ McDonald provided a brief presentation on the Seattle Hazard Identification and Vulnerability Analysis (SHIVA), which drives all of OEM's planning.

### ***General overview of SHIVA***

- Risks to communities can be divided into stressors, like homelessness, and shocks, like earthquakes
- A hazard identification and vulnerability analysis is a comprehensive look at the shocks facing a community using the best available science
- Updated every 4 years

- Considers
  - Likelihood hazard will occur
  - Which areas are exposed to the hazard?
  - Potential consequences
  - State of the community, including stressors

### ***Updates and Changes***

- Added new chapter on Cyber-attack and Disruption
- Emerging Threats section → Climate Change
- Terrorism and Active Shooter Incidents chapters → Attacks
- Infrastructure Failures → Infrastructure and Structural Failures
- New scenarios for Disease/Pandemic Influenza, Social Unrest, Infrastructure and Structural Failures, Cyber-attack, and Windstorms
- New research from past 4-6 years
- Updated statistics in the Community Profile
- Reassessed hazard ratings and rankings

### **2015 - 2021 Hazard Mitigation Plan**

Erika Lund provided an overview of the current Hazard Mitigation Plan. The heart of the plan is the Mitigation Strategy, which has a prioritized set of City actions aimed at reducing hazard vulnerability. The plan is organized as follows:

- Chapter 1 – Introduction. Identifies the authorities on which the plan is based, describes the plan's purpose and scope, describes how the plan is organized, and identified changes to the plan since 2009.
- Chapter 2 – Planning Process. Describes the process used to update the plan, including data sources and plan integration activities, outreach and engagement strategies, MWG activities, and plan development milestones.
- Chapter 3 – Community Profile. Provides a summary community profile for the City of Seattle including geographic, demographic, and economic characteristics that make the City unique. A full community profile is provided in the Seattle Hazard Identification and Risk Assessment document in Appendix A.
- Chapter 4 – Hazard Identification and Vulnerability Analysis. Contains a summary of the hazards that could potentially impact the City, including a hazard ranking table. Full hazard profiles and vulnerability assessment information is provided in the Seattle Hazard Identification and Risk Assessment document in Appendix A.
- Chapter 5 – Capability Assessment. Identifies the existing mitigation capabilities of City departments and highlights mitigation accomplishments over the last planning cycle.
- ***Chapter 6 – Mitigation Strategy. Provides updated goals and objectives for the City's mitigation program and identifies a comprehensive set of prioritized mitigation actions that would contribute to the City's resiliency.***

- Chapter 7 – Program Implementation. Describes the City’s plan for monitoring, evaluating, and updating the Seattle HMP over the next five-year period.

## **Open Discussion 2: HM Planning Process**

### **Discussion Question 2: How can we increase participation and visibility of the plan within your organization?**

General Points:

- More funding will lead to more visibility across departments and organizations
- Focus on dependencies that enhance resilience, e.g. fleets and fuel→ could create chain reactions of weakness or failures
- Coordinate with the Climate Action Board?
- Coordinate with the Capital cabinet→ determines partner directions

### **Discussion Question 3: Are there other planning efforts that we should be aware of that connect to mitigation planning?**

- |  |   |
|--|---|
| • Comprehensive Plan Update (OPCD)                           | (SCL)   |
| • <a href="#">Maritime and Industrial Strategy</a> (OPCD)    | • SPR 2020- 12 year finance plan  |
| • <a href="#">Freight Master Plan</a> (SDOT)                 | • <a href="#">“Green New Deal”</a> (OSE)  |
| • <a href="#">Food Action Plan</a> (OSE)                     | • <a href="#">Capital Improvement Plan</a>  |
| ○ Working on 2020 Update                                     | ○ Helps determine mitigation projects   |
| • <a href="#">2018 Seismic Study</a> (SPU)                   | • List and Timeline of Levies   |
| • <a href="#">Integrated System Plan</a> (SPU)               | • Damage Assessment Annex   |
| • <a href="#">Duwamish Valley Action Plan</a> (OSE and OPCD) | ○ Could use meetings with neighborhood liaisons and can ask local mitigation concerns |
| • Light rail Station Area Plans (OPCD)                       |   |
| • Mitigation Plan and Dam Action Plan                        |   |

Additional plan recommendations provided by HSD following the meeting that may have a connection to mitigation:

- Seattle’s [2018-2022 Consolidated Plan for Housing and Community Development](#)
- [Age Friendly Seattle](#) – Developing an Age-Friendly Seattle Action Plan – 8 domains include outdoor spaces and buildings, housing, etc. (HSD, Aging and Disability Services,
- [Area Plan 2020-2023](#) for Seattle and King County (HSD, Aging and Disability Services
- [Seattle Food Action Plan](#) – in process of being revised first half of 2020 (Office of Sustainability and Environment)

### **Discussion Question 4: How can we make this process more meaningful? (one group provided these responses with OPCD and FAS representation)**

- Make list of mitigation projects (unfunded) more visible. Possibly from the Capital Improvement Program or Comprehensive Plan?
- Make mitigation investment strategy visible in CIP, Comprehensive Plan (List of future projects)

**Other discussion items from Seattle Housing Authority and HSD regarding capabilities, response, and other areas**

- Actions of putting generators in/near large buildings (SHA)
- Working on making air systems better than they were built as in 1970s
- Funding determines what projects get pursued. Buildings are owned and service is provided by Seattle Housing Authority
- Seattle Housing Authority has food and water rations in large meetings; has building assessors
- Focus on homelessness→ a regional effort do we need to think different about inclusion in city efforts?
- CBDG grant funding looks at hazards
- HSD has less connection with mitigation plan because no facilities focus on services that help on RSS increasing resilience of services

**Action Items and Wrap up:**

Further instructions and timelines will be forthcoming on the following two Action Items for City departments represented in 2015 Hazard Mitigation Plan:

**Provide Status Updates for 2019 and Recommend on Carry Over**

- Determine if open projects should: Carry Over to the revised Plan, Be Revised, or Be Removed (and why)

**Provide update to Seattle's Mitigation Capacity**

- *What authorities, policies, programs, and new resources have you instituted in the past 5 years?*
- *Are there any programs that you have stopped? – If so, why?*

**Doodle poll will be forthcoming for second Hazard Mitigation Work Group meeting (to be held in March)**


Thank you for your participation!

## MITIGATION WORK

## GROUP

## SIGN-IN

Office of Emergency Management	Mitigation Work Group Kick Off Meeting	27-Jan-20
Name	Department/Agency	Signature
Flossie Pennington	Arts and Culture	
Devore, Jennifer	Budget Office	
Kara Main Hester	Budget Office	
Elliot, Jana	City Light	
Chappell, Micah	Construction & Inspection	
Sodt, Sarah	DON Historic Preservation	
Stickel, Karl	Economic Development	
Graff, Barb	Emergency Management	
Lund, Erika	Emergency Management	
McDonald, TJ	Emergency Management	
Nelson, Laurel	Emergency Management	
Schmit, Lucia	Emergency Management	
Jarolimek, Elenka	FAS	
Matsumoto, Julie	FAS	
Scriver, Cody	Fire	
Foley, Dan	Housing	
Watson, Jill	Human Services Department	
Dennis Reddinger	Libraries	
	OSE	
Will Beatie	Parks & Recreation	
Stevens, Scott	Parks & Recreation	
Carroll, Patrice	Planning and Community Development	
Davich, Kati	Port of Seattle	
Houston, Addison	Public Health Seattle King County	
Worcester, Ned	Public Utilities	
Michael Godfried	Public Utilities (Resilience)	
Crary, Jill	Seattle Center	
Jared Cummer	Seattle Housing Authority	
Eichhorn, Lawrence	Seattle IT	
Kaku, Clinton	Seattle IT	
TBD	Seattle Police Department - facilities	
Benjamin Coulter	Seattle Public Schools	
Quirk, Patti	Transportation	
Dante, Disabatino	OEM	

Office of Emergency Management	Mitigation Work Group Kick Off Meeting	27-Jan-20
Name	Department/Agency	Signature
Ivan Lee	DEN	

# Seattle All-Hazards Mitigation Plan 5 Year Update

Mitigation Work Group Meeting  
#1: Kick Off Meeting





# MITIGATION WORK GROUP - MEETING #1

## ***Agenda***

- 1. Opening Remarks and Introductions*
- 2. Local Hazard Mitigation Plan Purpose*
- 3. Mitigation Work Group Participation*
- 4. Discussion: Vulnerabilities*
- 5. SHIVA Highlights*
- 6. Overview of Current Seattle HMP*
- 7. Discussion: Making the Plan and Process Meaningful*
- 8. Action Items and Next Steps*

# SEATTLE HAZARD MITIGATION PLAN UPDATE

- What is a Hazard Mitigation Plan and Why do we have one?
- FEMA and EMAP Requirement
- What's new in the planning context?



# WHAT IS HAZARD MITIGATION?

*Mitigation is the effort to reduce loss of life and property by lessening the impact of disasters. Mitigation is taking action now—before the next disaster—to reduce human and financial consequences later (FEMA).*

*Mitigation planning allows communities to:*

- *Identify the natural hazards for which they are at risk*
- *Assess the potential impacts of those hazards*
- *Develop goals, objectives, and actions to reduce impacts*
- *Prioritize and implement mitigation actions*

# WHY IS A MITIGATION PLAN IMPORTANT?

- *Guides mitigation activities in coordinated and economic manner*
- *Integrates mitigation into existing community plans/programs*
- *Considers future growth and development trends*
- *Makes community more disaster resilient*
- *Keeps us eligible for FEMA Hazard Mitigation Funding*



# HAZARD MITIGATION PLANNING PROCESS

Pre-Planning	Plan Development	Plan Implementation
<p>#1: Determine the Planning Area and Resources</p> <p>#2: Build the Planning Team</p> <p>#3: Create an Outreach Strategy</p>	<p>#4: Review Community Capabilities</p> <p># 5: Conduct a Risk Assessment</p> <p>#6: Develop a Mitigation Strategy</p>	<p>#7: Keep the Plan Current</p> <p>#8: Review and Adopt the Plan</p> <p>#9: Create a Safe and Resilient Community</p>

Source: FEMA Local Mitigation Planning Handbook, 2013



# BECAUSE FEMA SAID SO... PLAN REQUIREMENTS



- *Plan will be developed to meet the requirements outlined in 44 CFR §201.6*
- *Local Mitigation Plan Review*

# What's New?

- Changes in FEMA funding: Building Resilience Infrastructure and Communities (BRIC)
- Re-accreditation under the Emergency Management Accreditation Program (EMAP)





# Mitigation Work Group Role

- *Participate in 3 planning meetings (January, March, and May 2020) & follow up on Action Items*
- *Serve as Subject Matter Experts (SMEs) on Department mitigation needs and priorities*
- *Support Public and Stakeholder Outreach*
- *Provide feedback on*
  - *The updated risk assessment,*
  - *City capabilities, and*
  - *Mitigation strategy*
- *Review draft and final plans*

# Break for Discussion #1

- What hazard **vulnerabilities** are you aware of regarding your department's assets, operations, and/or plans?



# 2018 Seattle Hazard Identification and Vulnerability Analysis (SHIVA) Revision

1/27/2020

Seattle Office Of Emergency Management



City of Seattle

# What is it?

- Risks to communities can be divided into stressors, like homelessness, and shocks, like earthquakes.
- A hazard identification and vulnerability analysis is a comprehensive look at the shocks facing a community using the best available science.
- Updated every 4 years
- Considers
  - Likelihood hazard will occur
  - Which areas are exposed to the hazard
  - Potential consequences
  - State of the community, including stressors
- Find at:  
<https://www.seattle.gov/Documents/Departments/Emergency/PlansOEM/SHIVA/SHIVAv7.0.pdf>



# Biggest Changes

- Added new chapter on Cyber-attack and Disruption
- Emerging Threats section → Climate Change
- Terrorism and Active Shooter Incidents chapters → Attacks
- Infrastructure Failures → Infrastructure and Structural Failures
- New scenarios for Disease/Pandemic Influenza, Social Unrest, Infrastructure and Structural Failures, Cyber-attack, and Windstorms
- New research from past 4-6 years
- Updated statistics in the Community Profile
- Reassessed hazard ratings and rankings



# Hazard Ranking Method

*Scenario Ranking = Average (Base Parameters) \* Sum (Multipliers)*

*Combined Ranking = (Scenario Ranking: Most Likely) + (Scenario Ranking: Maximum Credible) + Future Emphasis*

# Hazard Ranking Changes

1. Earthquakes
2. Snow & Ice
3. Infrastructure Failures
4. Windstorms
5. Power Outages
6. Terrorism
7. Disease
8. Flooding
9. Excessive Heat
10. Fires
11. Tsunami & Seiches
12. Landslides
13. Transportation Incidents
14. Water Shortages
15. Social Unrest
16. HazMat Incident
17. Volcano Hazards
18. Active Shooter Incidents

1. Earthquakes
2. Snow & Ice
3. Windstorms
4. Power Outages
5. Cyber-Attack
6. Landslides
7. Disease
8. Flooding
9. Excessive Heat
10. Tsunami & Seiches
11. Infrastructure and Structural Failures
12. Fires
13. Transportation Incidents
14. Water Shortages
15. Social Unrest
16. Attacks
17. HazMat Incidents
18. Volcano Hazards





# Questions?

TJ McDonald  
[tj.mcdonald@seattle.gov](mailto:tj.mcdonald@seattle.gov)



# Current 2015 – 2021 All-Hazard Mitigation Plan Overview

- **Chapter 1 – Introduction.** Identifies the authorities on which the plan is based, describes the plan's purpose and scope, describes how the plan is organized, and identified changes to the plan since 2009.
- **Chapter 2 – Planning Process.** Describes the process used to update the plan, including data sources and plan integration activities, outreach and engagement strategies, MWG activities, and plan development milestones.
- **Chapter 3 – Community Profile.** Provides a summary community profile for the City of Seattle including geographic, demographic, and economic characteristics that make the City unique. A full community profile is provided in the Seattle Hazard Identification and Risk Assessment document in Appendix A.
- **Chapter 4 – Hazard Identification and Vulnerability Analysis.** Contains a summary of the hazards that could potentially impact the City, including a hazard ranking table. Full hazard profiles and vulnerability assessment information is provided in the Seattle Hazard Identification and Risk Assessment document in Appendix A.
- **Chapter 5 – Capability Assessment.** Identifies the existing mitigation capabilities of City departments and highlights mitigation accomplishments over the last planning cycle.
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- **Chapter 7 – Program Implementation.** Describes the City's plan for monitoring, evaluating, and updating the Seattle HMP over the next five-year period.



# Break for Discussion #2

## Questions: **Process**

- How can we increase *participation* and *visibility* of the plan within your organization?
- How can this process be more meaningful for you and your departments?
- Are there other planning efforts that we should be aware of that connect to mitigation planning?



# **Action Item #1:**

## **Revisit 2015 – 2021 Projects**

- Provide Status Updates for 2019 – Maintenance
- Determine if open projects should:
  - Carry Over to the Updated Plan
  - Be Revised
  - Be Removed (and why)

# Action Item #2:

## Update Capabilities

*Provide update to Seattle's Mitigation Capacity*

- *What authorities, policies, programs, and new resources have you instituted in the past 5 years?*
- *Are there any programs that you have stopped?*
  - *If so, why?*

## Seattle All Hazards Mitigation Plan – 5 Year Revision Process

### Hazard Mitigation Work Group (MWG) - Meeting #2

Date/Time: Monday, September 14, 2020 11:00 AM – 12:00 PM

Location: Online Teams Meeting

<b>Introductions</b> 10 min	Erika Lund, Patrice Carroll, New members
<b>Relaunching the Update</b> 15 min	Recap of Meeting 1 Revised Schedule Outreach
<b>Collaborating on Teams</b> 10 minutes	Organization of Teams Site Resources, posting, uploading, editing Discussion Question – Other suggestions how to use Teams for this project?
<b>Outstanding Tasks</b> 20 minutes	Capability Assessment Status of 2015-2021 Actions Discussion Question- “Key Accomplishments” helpful or duplicative?
<b>Wrap Up</b> 5 Minutes	Upcoming Task – Mitigation Actions

#### All-Hazard Mitigation Plan Update Milestones:

Hazard Mitigation Work Group Meeting 1	January 27, 2020
Planning process paused for Covid-19 response	
Hazard Mitigation Work Group Meeting 2	September 14, 2020 11am-12 noon
Hazard Mitigation Work Group Meeting 3 Capabilities & Status of Current Actions Due	September 28, 2020 11am – 12 noon
Mitigation Actions Due	October 19, 2020
Hazard Mitigation Work Group Meeting 4	November 4, 2020 3:30-4:30 pm
<b>Public Draft for Review and Comment</b>	<b>November 16, 2020</b>
Public Comment Period (3 weeks)	November 16 – December 4, 2020
Hazard Mitigation Workgroup Meeting 5	December 14, 2020 11am-12 noon
<b>Final Draft for Review and Approval</b>	<b>December 31, 2020</b>

## Seattle All Hazards Mitigation Plan – 5 Year Revision Process

Begin Approval Process	January 2021
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### Hazard Mitigation Work Group 2020 Members:

Name	Department/Agency
Flossie Pennington	Arts and Culture
Jennifer Devore	Budget Office
Kara Main Hester	Budget Office
Jana Elliot	City Light
Micah Chappell	Construction & Inspection
Sarah Sodt	Dept of Neighborhoods, Historic Preservation
Jessica Sidhu	Economic Development
Erika Lund	Emergency Management
TJ McDonald	Emergency Management
Laurel Nelson	Emergency Management
Lucia Schmit	Emergency Management
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Jill Watson	Human Services Department
Dennis Reddinger	Libraries
TBD	Office of Sustainability and Environment
Jon Jainga	Parks & Recreation
Scott, Stevens	Parks & Recreation
Cynthia McCoy	Seattle Parks and Recreation/ Seattle Public Utilities
Patrice Carroll	Planning and Community Development/ OEM
David Goldberg	Planning and Community Development
Kati Davich	<i>Port of Seattle</i>
Addison Houston	Public Health Seattle King County
Ned Worcester	Public Utilities
Michael Godfried	Public Utilities (Resilience)
Jae Lee	Seattle Center
Jared Cumber	<i>Seattle Housing Authority</i>
Lawrence Eichhorn	Seattle IT
Clinton Kaku	Seattle IT
Benjamin Coulter	<i>Seattle Public Schools</i>
Patti Quirk	Transportation





## **Hazard Mitigation Work Group (MWG) Meeting #2 – Meeting Notes**

*Hosted by: The Seattle Office of Emergency Management (OEM)*

*Date/Time: Monday, September 14, 2020 11:00AM-12:00 PM*

*Location: Online*

### **AGENDA:**

Meeting Item	Duration	Presenter/Facilitator
Introductions	10 minutes	Erika Lund, OEM
<b>Relaunching the Update</b>	15 minutes	Patrice Carroll, OEM/OPCD
<b>Collaborating on Teams</b>	10 minutes	Patrice Carroll, OEM/OPCD
<b>Outstanding Tasks</b>	20 minutes	Patrice Carroll, OEM/OPCD
<b>Action items and Wrap Up</b>	5 minutes	Patrice Carroll, OEM/OPCD

### **ATTACHMENTS:**

- Attendance Sheet
- Agenda and Presentation available on Teams site, MWG Meetings channel

## **MEETING SUMMARY**

### **Introductions**

Erika Lund welcomed back the Mitigation Work Group (MWG) and explained that update for the All-Hazard Mitigation Plan (HMP) was paused due to more urgent work associated with the Covid-19 pandemic. She asked if anyone had any objections to recording the meeting and heard no objections.

Erika Lund introduced Patrice Carroll who is on loan to OEM from the Office of Planning and Community Development (OPCD) to help finish the HMP update. Patrice will be the primary contact for the project and MWG members. New MWG members introduced themselves: Jessica Sidhu, OED; Any Collins, SFD; Jon Jainga, SPR; Cynthia McCoy, SPR/SPU; David Goldberg, OPCD.

### **Relaunch**

Patrice Carroll reviewed topics that were covered in Meeting #1 (Jan 2020) and encouraged members to review the presentation and notes from this meeting (available on Teams, MWG Meetings channel).

Topics in Meeting #1 included:

- Hazard Mitigation Plan Overview
- FEMA and EMAP Requirements
- Role of Mitigation Work Group
- Seattle Hazard Identification and Vulnerability Analysis (SHIVA)
- Discussion: Making the Plan More Useful
- Tasks: Capability Assessment, Status of Actions 2015-2021

Patrice Carroll reviewed the updated, compressed process for completing the HMP. MWG's work will focus on updating the information in Chapters 5 and 6. A Draft Plan for public review will be published in

mid-November and a Final Plan will be completed by end of December 2020 ready to begin the adoption and approval process in 2021.

Outreach and engagement will be very focused and streamlined. Outreach Strategies identified by OEM staff include:

- Posting Information and resources about the project on OEM Website including a downloadable one-page project summary and a video of a narrated online presentation.
- Raising awareness of the update through the OEM Newsletter (monthly).
- Creating a focused polling question for the public to be shared on social media (see below).

**Discussion: What ways could other departments support outreach and engagement?**

- Parks are getting so much use this year, could we put posters, ambassadors have been placing signs in parks during the pandemic. Could this be a way to share information about the HMP more broadly?
- It's possible a poster could go next to existing signs in parks.
- Consider pitching to PIOs an interview with Bill Radke on KUOW's The Record. Opportunity to raise awareness on what is Hazard Mitigation/risk reduction, but also an opportunity to poll the audience for ideas.
- Would any of the PHSKC Health Boards be interested in providing input to the Mitigation Plan?

**Discussion: What types of non-city projects or entities could we list in our polling question?**

For the last plan, outreach helped to raise awareness about hazard mitigation generally, but did not directly influence the HMP content. One area where public input could influence the mitigation program to prioritize potential City/community partnerships for future mitigation projects. In the past the HMP has focused on City-owned assets, but recently the City partnered with an affordable housing non-profit to retrofit an affordable housing building. Suggestions for the list of potential priorities:

- Non-profit housing in City's portfolio
- Make sure people know what you are referring
- Public gathering spots that need retrofitting
- Mixed use buildings that have community uses- e.g. Cooper Square
- Look at data related to King County heat island and where greenways, trees might be needed on public access private property.
- Improvements on SCL vacant lands to address heat islands or discourage negative uses. Lands that could be used for community p-patches or other community uses.
- Suggest looking at reading level for polling question and keep the question direct and simple.
- City has long-term investments in many affordable projects SHA and others. These include covenants/deed restriction and therefore "City infrastructure"
- Heat islands - especially at the intersection of industrial and residential areas - is something to consider
- Raise awareness on the Tool Library with the goal to increase numbers of seismic retrofit of residential homes.

**Collaborating on Teams**

Patrice Carroll oriented the group to the organization of the Teams site, channels and tabs.

- Advantages of collaborating on editing documents: people can work simultaneously, and always have the latest version.
- Many ways to access a shared document for editing- desktop, browser, Sharepoint
- Most important – do not to create a new, unshared version (e.g. download, edit and email a document).
- Set your preference for group email in Outlook (OEM\_MitigationWork Group). Group email can be delivered to “Inbox” and “OEM folder” OR just the “OEM folder.”
- Use Posts instead of email.

**Discussion: Are there other ways to organize or use Teams that would be helpful for collaboration?**

MWG members can make suggestions to Patrice Carroll anytime.

**Outstanding Tasks**

Asking that MWG members complete the following two task by Sept 28. A shared file will be posted on Teams for each task.

- Capability Assessment. All City departments should submit Capabilities. Please review even if you submitted an update earlier to ensure it was captured. Deadline for completing this task is September 28.
- Status of 2015-2021 Actions. Only departments that have actions in the last HMP need to report on the status.
- Desire to make descriptions more succinct.

**Discussion: Is the information included in “Key Accomplishments” helpful?**

- Key accomplishments may be helpful in writing for federal grant application, or efforts to address these issues internally. Unclear if it is actually used for federal grants.
- Might be helpful for the public or city staff that do not do 'deep dives' into the material and give them an overview or high level view that helps them understand what the plan is for or doing....BCal grant application packages.
- Not sure if the key accomplishments help with grants. Can take another look. Not as important as the strategies and the actions.
- Maybe combine description and key accomplishments. Maybe could use this to capture measurable information. Most current information isn't measurable.
- Can capture metrics in the Status Update about “benefits.” This is an EMAP requirement.

**Wrap Up**

- Next meeting Sept. 28, 2020
- Finish outstanding tasks before next meeting
- Start thinking about who else from your department will help identify Mitigation Actions. Consider scheduling some time with them in early Oct. (mitigation actions will be due Oct. 19).
- For those who want to get started, we hope to post a revised Mitigation Action Worksheet soon.

Thank you for participating!

Seattle All Hazards Mitigation Plan – 5 Year Revision

Name	Department/Agency	9/14/20 Mtg
Flossie Pennington	Arts and Culture	
Jennifer Devore	Budget Office	
Kara Main Hester	Budget Office	
Jana Elliot	City Light	X
Micah Chappell	Construction & Inspection	X
Sarah Sodt	Dept of Neighborhoods, Historic Preservation	X
Jessica Sidhu	Economic Development	X
Erika Lund	Emergency Management	X
TJ McDonald	Emergency Management	X
Laurel Nelson	Emergency Management	
Lucia Schmit	Emergency Management	X
Elenka Jarolimek	FAS	X
Julie Matsumoto	FAS	X
Andy (James) Collins	Fire	X
Dan Foley	Housing	X
Jill Watson	Human Services Department	X
Dennis Reddinger	Libraries	X
TBD	Office of Sustainability and Environment	
Jon Jainga	Parks & Recreation	X
Scott, Stevens	Parks & Recreation	X
Cynthia McCoy	Seattle Parks and Recreation/ Seattle Public Utilities	X
Patrice Carroll	Planning and Community Development/ OEM	X
David Goldberg	Planning and Community Development	X
Kati Davich	<i>Port of Seattle</i>	
Addison Houston	Public Health Seattle King County	
Ned Worcester	Public Utilities	
Michael Godfried	Public Utilities (Resilience)	
Jae Lee	Seattle Center	X
Jared Cummer	<i>Seattle Housing Authority</i>	
Lawrence Eichhorn	Seattle IT	X
Clinton Kaku	Seattle IT	
Benjamin Coulter	<i>Seattle Public Schools</i>	X
Patti Quirk	Transportation	





# Seattle All-Hazards Mitigation Plan 5 Year Update

## Mitigation Work Group Meeting #2: Relaunch

9/14/2020 Seattle Office Of Emergency Management

City of Seattle



## Seattle All Hazards Mitigation Plan – 5 Year Revision Process

### Hazard Mitigation Work Group (MWG) - Meeting #3

Date/Time: Monday, September 28, 2020 11:00 AM – 12:00 PM

Location: Online Teams Meeting

<b>Introductions</b> 5 min	Erika Lund, Patrice Carroll, New members
<b>Check In - Tasks &amp; Teams</b> 15 min	Recap of Meeting 2 Troubles with Teams Capability Assessment Status of Actions
<b>Mitigation Goals and Objectives</b> 10 minutes	Discussion: Confirming relevancy
<b>Mitigation Actions</b> 30 minutes	Different Types of Actions Integrating of HMP with Other Plans NEW – Aspirational Actions Discussion: Capability vs. Action vs. Plan
<b>Integrating RSJI</b> 10 minutes	Ideas for this update or future HMP
<b>Next Steps</b> 5 Minutes	Department Mtgs Next MWG Mtg

#### All-Hazard Mitigation Plan Update Milestones:

Hazard Mitigation Work Group Meeting 1	January 27, 2020
Planning process paused for Covid-19 response	
Hazard Mitigation Work Group Meeting 2	September 14, 2020 11am-12 noon
Hazard Mitigation Work Group Meeting 3 Capabilities & Status of Current Actions Due	September 28, 2020 11am – 12 noon
Mitigation Actions Due	October 19, 2020
Hazard Mitigation Work Group Meeting 4	November 4, 2020 3:30-4:30 pm
<b>Public Draft for Review and Comment</b>	<b>November 16, 2020</b>
Public Comment Period (3 weeks)	November 16 – December 4, 2020
Hazard Mitigation Workgroup Meeting 5	December 14, 2020 11am-12 noon
<b>Final Draft for Review and Approval</b>	<b>December 31, 2020</b>
Begin Approval Process	January 2021

## Seattle All Hazards Mitigation Plan – 5 Year Revision Process

### Hazard Mitigation Work Group 2020 Members:

Name	Department/Agency
Flossie Pennington	Arts and Culture
Jennifer Devore	Budget Office
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Patti Quirk	Transportation

### **Hazard Mitigation Work Group (MWG) Meeting #3 – Meeting Notes**

*Hosted by: The Seattle Office of Emergency Management (OEM)*

*Date/Time: Monday, Sept. 28, 2020 11:00AM-12:00 PM*

*Location: Online*

#### **AGENDA:**

Meeting Item	Duration	Presenter/Facilitator
Introductions	5 minutes	Patrice Carroll, OEM/OPCD
Recap of Meeting 2	5 minutes	Patrice Carroll, OEM/OPCD
HMP Framework/ Goals	10 minutes	Patrice Carroll, OEM/OPCD
HMP Actions/ Worksheet	30 minutes	Patrice Carroll, OEM/OPCD
Integrating Equity	5 minutes	Patrice Carroll, OEM/OPCD
Wrap Up	5 minutes	Patrice Carroll, OEM/OPCD

#### **ATTACHMENTS:**

- Attendance Sheet
- Agenda, Presentation and Meeting Video available on Teams- MWG Meetings channel

#### **MEETING SUMMARY**

##### **Introductions**

Michael Godfried from SPU was unable to attend the MWG Meeting #2, so introduced himself to the group.

##### **Recap of Meeting #2**

Patrice Carroll gave a quick recap of what happened at Meeting #2 on Sept. 14<sup>th</sup>

- Revised Schedule – Will complete the update by end of 2020.
- Collaborating on Teams – Using Teams Platform to share information and collaborate on documents. Patrice encouraged people not yet comfortable on Teams to reach out to her for assistance finding information or accessing shared documents.
- Updating the Capability Assessment – All departments should update or draft capabilities. Some are still working on this Word table.
- Updating Status – Depts who had actions in the previous plan should provide status information on those actions. Information is entered in an excel sheet in “colorful” columns at the right side of the sheet.
- Question re: period for status update- through 2019 or 2020.- have a lot of Covid-related actions in 2020. We wanted to capture status as of year-end 2019 for monitoring. Given planning delays, we welcome additional status information in 2020 where it makes sense.
- Re: Covid actions, we need to look more closely internally to see how public health mitigation actions might fit in.
- Patrice encouraged members to complete these tasks ASAP, so they can move on to the next task, generating mitigation actions.

### **Mitigation Strategy Framework**

Patrice Carroll presented the framework used for the current plan. It demonstrates the breadth and depth of the plan.

- Goals (6 goals) Long-term outcome achieved through mitigation planning and implementation
- Objectives (18 objectives) Help to define, group, organize actions. Objectives are broader than specific actions and connect goals with actual mitigation actions.
- Actions (54 actions) Specific action taken to reduce risks from hazards and their impacts.

Patrice noted that the average number of actions per department was 4 to 5 actions/ project. The number per department ranged from 1 action to 12 actions. Erika emphasized that the number of actions could change as we're aiming for actions or projects to be more strategic. It's also possible that some departments may not have any actions.

### **Goals**

Patrice presented the 6 goals included in the current plan and noted that two new goals were added in the last update.

1. Protect life and safety and promote community resiliency.
2. Safeguard critical infrastructure and ensure continuity of service.
3. Protect public and private property.
4. Protect the natural environment and cultural and historic resources. NEW IN 2015
5. Ensure a resilient economy.
6. Promote a collaborative and integrated mitigation program. NEW IN 2015

Discussion: Are these goals still relevant? How do these relate to City's vision for recovery?

- Reconsider using the word "ensure" in goal 5 as mitigation actions have less impact than other actions.
- Add an overall goal to bring in equity to reflect how some communities are less resilient on an ongoing basis. This would be a good place to align with our equity goals. For example, a goal could be "Recognize and address existing stresses experienced by BIPOC communities that may place them at heightened risk or require focused attention." -- open to edits....

### **Types of Actions**

Patrice Carroll presented the list of "type" of actions used in the last plan to generate ideas. We're considering eliminating "Preparedness and Response" from the list as these caused some confusion and generated some "emergency response" actions.

- Agree with removing. The Mitigation Plan is going for longer term, more strategic actions. It's about risk reduction.
- Consider adding a type that helps build capacity for the community to be more resilient.

### **Mitigation Worksheet- Description**

The Mitigation Worksheet is the primary tool used to collect information about potential mitigation actions/projects. Page 1 is descriptive information. Page 2 is prioritization criteria. Suggestions for changes included:

- The list of hazards addressed needs updating.
- Highlight how the project advances equity. Are racial equity outcomes advanced?
- Consider collecting information about the age of infrastructure (e.g. 50 years or older) or note if structure is culturally or historic. Required for BRIC
- Projects carried over from last plan need a new worksheet with any updated cost, timeline, etc.

### **Mitigation Worksheet – Prioritization Criteria**

Erika Lund explained the rationale for using the STAPLEE criteria for the last HMP. Criteria, created by FEMA, are known and widely accepted, and aligns well with criteria for grants. However, we are not required to use these criteria, or we can add other criteria. The group also reviewed the criteria used for the 2020 Building Resilient Infrastructure and Communities which emphasizes vulnerable populations, community lifelines, critical infrastructure, multiple benefits, collaboration and innovative solutions. Comments included:

- Liked criteria about multiple benefits beyond hazard mitigation.
- Not sure about criteria related to community lifelines would fit at the city scale. May not be useful to apply to mitigation. The City already does systemwide/citywide assessments of infrastructure - transportation, utilities, etc. Might be interesting lens to apply for specific lifelines where we are vulnerable. May be an additional complexity that we don't address this year. Might consider criteria about the "network" (communication, electrical grid, transportation, supply chain, etc.)
- Might make sense for a more wholistic criteria related to the health system, but perhaps not an addition this year.
- San Francisco has done some nice work on lifelines and interdependencies. Their reports are readily available online.
- The risk of losing historic and cultural is something we need to look at because of the expense to preserve those.
- More opportunities for collaboration around seismic action. City could definitely step up collaboration earthquake is an area we need more collaboration. will grow
- Emphasis on collaboration before a crisis is important because difficult to do that in the moment.
- BRIC looks more whole community and future focused

### **Integrating Equity**

The group reviewed some ideas generated by OEM staff for integrating equity into the HMP: add a new objective, create a 2nd prioritization screen for equity, highlight which mitigation actions have equity outcomes, gather information should we capture in worksheet for reporting or monitoring. Comments included:

- HSD's work, and many other departments, already include an equity lens, so equity would be considered in identifying mitigation actions would already be considered at dept level.
- ARTS is updating Grant applications so demographic data is prioritized and received at the beginning of the process. We know how many BIPOC/QTPOC groups we give Grants to and where they are located in the City.
- Do we want to capture ongoing programs that address equity?
- Align HMP goals with City values, goals and priorities, e.g. recovery goals
- Prioritize actions that both minimize risk and promote climate justice, RSJI goals.

- Use similar language, mapping and indicators as being used across departments.
- Identifying disparities in how communities might experience hazards. OPCD could help identify and map geographic or socio-economic, race proximity. Maps could identify overall issues such as digital access, "essential worker" that could be addressed. OEM also has some maps that could be pulled in. E.g. By layering seismic vulnerability, or facility location in liquefaction zone, mitigation action could include how compounding factors would be addressed.

Community partnerships are expanding. OEM is proposing to poll community about the services that might be more important for partnership projects. Who are the partners to bring into the mitigation fold?

- Add area concerned with children
- Do we need to add or adapt a goal to encompass these service areas.
- HSD has experience with organizations delivering multiple programs. How might mitigation be integrated into those conversations? We could take closer look at work being done, e.g. CDBG, planning for senior services.
- Might be hard to weave mitigation into all our plans, but there is a carrot- more likely to get our projects funded.

### **Wrap Up**

As you begin to generate mitigation actions/ projects, emphasize those that “move the needle” within five years, not necessary to complete, but can show progress. Also keep a list of more aspirational projects that OEM could “hold” for other, new, longer term grant opportunities.

- Next meeting Nov. 4, 2020
- Finish outstanding tasks (Capability, Status) ASAP
- Plan to submit DRAFT Mitigation Actions by Oct. 28.
- Convene dept colleagues in October to discuss, generate and prioritize DRAFT Mitigation Actions.
- For those who want to get started, we hope to post a revised Mitigation Action Worksheet soon.

Thank you for participating!

Seattle All Hazards Mitigation Plan – 5 Year Revision

Name	Department/Agency	9/28/20 Mtg
Flossie Pennington	Arts and Culture	
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Kara Main Hester	Budget Office	
Jana Elliot	City Light	X
Micah Chappell	Construction & Inspection	
Sarah Sodt	Dept of Neighborhoods, Historic Preservation	
Jessica Sidhu	Economic Development	
Erika Lund	Emergency Management	X
TJ McDonald	Emergency Management	X
Laurel Nelson	Emergency Management	
Lucia Schmit	Emergency Management	X
Elenka Jarolimek	FAS	X
Julie Matsumoto	FAS	
Andy (James) Collins	Fire	
Dan Foley	Housing	
Jill Watson	Human Services Department	X
Dennis Reddinger	Libraries	
TBD	Office of Sustainability and Environment	
Jon Jainga	Parks & Recreation	
Scott, Stevens	Parks & Recreation	
Cynthia McCoy	Seattle Parks and Recreation/ Seattle Public Utilities	X
Patrice Carroll	Planning and Community Development/ OEM	X
David Goldberg	Planning and Community Development	X
Kati Davich	<i>Port of Seattle</i>	
Addison Houston	Public Health Seattle King County	
Michael Godfried	Seattle Public Utilities (Resilience)	X
Jae Lee	Seattle Center	
Jared Cummer	<i>Seattle Housing Authority</i>	
Lawrence Eichhorn	Seattle IT	X
Clinton Kaku	Seattle IT	
Benjamin Coulter	<i>Seattle Public Schools</i>	
Patti Quirk	Transportation	



# Seattle All-Hazards Mitigation Plan 5 Year Update

Mitigation Work Group  
Meeting #3: Goals & Actions



# Agenda Meeting #3

- 1. Welcome & Introductions*
- 2. Recap Meeting 2*
- 3. HMP Framework*
- 4. HMP Actions/ Mitigation Worksheet*
- 5. Integrating Equity*



# Current 2015 – 2021 All-Hazard Mitigation Plan Overview

- **Chapter 1 – Introduction.** Identifies the authorities on which the plan is based, describes the plan's purpose and scope, describes how the plan is organized, and identified changes to the plan since 2009.
- **Chapter 2 – Planning Process.** Describes the process used to update the plan, including data sources and plan integration activities, outreach and engagement strategies, MWG activities, and plan development milestones.
- **Chapter 3 – Community Profile.** Provides a summary community profile for the City of Seattle including geographic, demographic, and economic characteristics that make the City unique. A full community profile is provided in the Seattle Hazard Identification and Risk Assessment document in Appendix A.
- **Chapter 4 – Hazard Identification and Vulnerability Analysis.** Contains a summary of the hazards that could potentially impact the City, including a hazard ranking table. Full hazard profiles and vulnerability assessment information is provided in the Seattle Hazard Identification and Risk Assessment document in Appendix A.
- **Chapter 5 – Capability Assessment.** Identifies the existing mitigation capabilities of City departments and highlights mitigation accomplishments over the last planning cycle.
- **Chapter 6 – Mitigation Strategy.** Provides updated goals and objectives for the City's mitigation program and identifies a comprehensive set of prioritized mitigation actions that would contribute to the City's resiliency.
- **Chapter 7 – Program Implementation.** Describes the City's plan for monitoring, evaluating, and updating the Seattle HMP over the next five-year period.



## RECAP OF MEETING 2

- Revised Schedule
- Collaborating on Teams
- Updating Capability Assessment
- Updating Status of 2015-2021 Actions

*Meeting agenda, video, presentation and notes available on  
“MWG Mtg” Channel*



# Capabilities

## Word Document

### Existing Mitigation Capabilities - Office of Emergency Management

Capability	Capability Type	Description	Key Accomplishments (2009-2015)	Hazard Mitigated
<b>Neighborhood and Individual Preparedness Programs</b>	Education, and Outreach	These programs provide all-hazard preparedness information and training to Seattle's diverse communities, individuals, families, neighborhoods, businesses, schools, and community-based organizations. Programs include Seattle Neighborhoods Actively Prepare (SNAP), the OEM website, Community Emergency Hubs, and Education Campaigns.	<ul style="list-style-type: none"><li>Ongoing programs.</li></ul>	All Hazards
<b>Home Seismic Retrofit Program</b>	Education and Outreach	This free training program promotes home seismic retrofit within Seattle and the region. Introductory class covers how individuals can perform the retrofit themselves, as well as consumer education on working with trained contractors. A course is offered in coordination with Seattle's Department of Planning and Development (DPD), which developed a set of standardized plan sets, issues permits, and performs inspections.	<ul style="list-style-type: none"><li>Over the past five years, home seismic retrofit classes have been consistently well-attended, averaging 25 to 40 attendees per class. Classes are offered six to 10 times a year in libraries throughout Seattle. Seattle DPD issues an estimated 100 seismic retrofit permits a year.</li></ul>	Earthquakes



# Status

## Excel Spreadsheet

Q	R	S	T	U	V
		For Completed Actions		For Uncompleted Actions & 2021 Revision	
Status (e.g. on-going, completed, dropped w/ justification) and activity to date	Date and Source of status information	Mitigation Benefit: Description of how hazard impact has been reduced and/or losses avoided (Refer to outcome studies/reports as appropriate)	Year Completed	Action should be: 1) Carried over as is, 2) Revised, 3) Removed, or 4) Moved to Capability section	Notes, Rationale & Source of Information
Year end: 2019					
Completed. Stood up new data centers, West and East.	Lawrence Eichhorn, May 2018		2018?		





# MITIGATION STRATEGY FRAMEWORK

## **Goals** (6 goals)

Long-term outcome achieved through mitigation planning and implementation

## **Objectives** (18 objectives)

Help to define, group, organize actions. Objectives are broader than specific actions and connect goals with actual mitigation actions.

## **Actions** (54 actions)

Specific action taken to reduce risks from hazards and their impacts.

4.5 Average Actions/Dept (range 1 to 12 actions)



# GOALS

1. Protect life and safety and promote community resiliency.
2. Safeguard critical infrastructure and ensure continuity of service.
3. Protect public and private property.
4. Protect the natural environment and cultural and historic resources. **NEW IN 2015**
5. Ensure a resilient economy.
6. Promote a collaborative and integrated mitigation program. **NEW IN 2015**

***Discussion: Are these goals still relevant? How do these relate to City's vision for recovery?***

# TYPES OF ACTIONS

- **Plans and Regulations.** Regulatory actions or planning processes that result in reducing vulnerability to hazards.
- **Assessments and Studies.** Actions taken to better understand the potential impacts of identified hazards. An example would be seismic studies of City facilities.
- **Infrastructure/Capital Projects.** Actions taken to modify existing buildings or structures to protect them from a hazard.
- **Non-Structural Mitigation Measures.** Physical actions taken that don't include structural modifications. An example would be efforts to secure furniture or installation of backup generators.
- **Natural Systems Protection.** Actions that, in addition to minimizing hazard losses, preserve or restore the functions of natural systems.
- **Education and Awareness.** Actions taken to inform and educate residents, elected officials, and property owners about hazards and potential ways to mitigate them.
- ~~**Preparedness and Response.** Actions that protect people and property during and immediately after a disaster or hazard event.~~



# MITIGATION ACTION WORKSHEET

## Description

- Action Status
- Type of Action
- Goals Supported
- Lead or Supporting; Department/Organization
- Timeline
- Life of Action
- Hazards Addressed
- Anticipated Cost
- Funding Available/ Funding Source

*Link to 2104 worksheet in Chat*



# MITIGATION ACTION WORKSHEET

## Prioritization Criteria

### STAPLEE

Is it **Socially** acceptable?

Is it **Technically** feasible and potentially successful?

Does responsible agency/department have the **Administrative** capacity to execute this action?

Is it **Politically** acceptable?

Is there **Legal** authority?

Is it **Economically** beneficial?

Will the project have a neutral or positive impact on the natural **Environment**

Will historic structures or key cultural resources be saved or protected?

Could it be implemented quickly?

### Mitigation Effectiveness

Will the implemented action result in lives saved?

Will the implemented action result in a reduction of disaster damage?

# MITIGATION ACTION

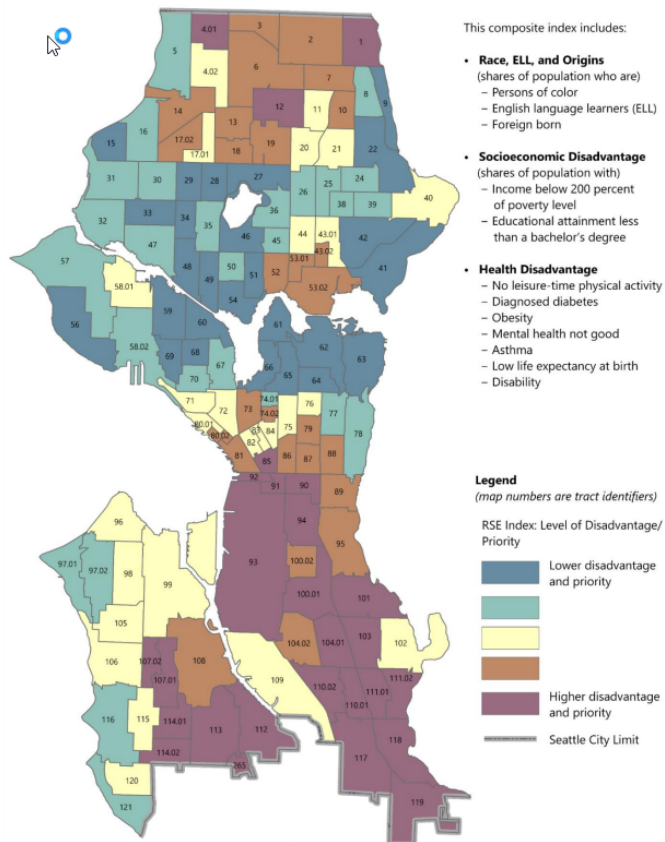
## NEW Prioritization Criteria

### FEMA Building Resilient Infrastructure and Communities (BRIC)

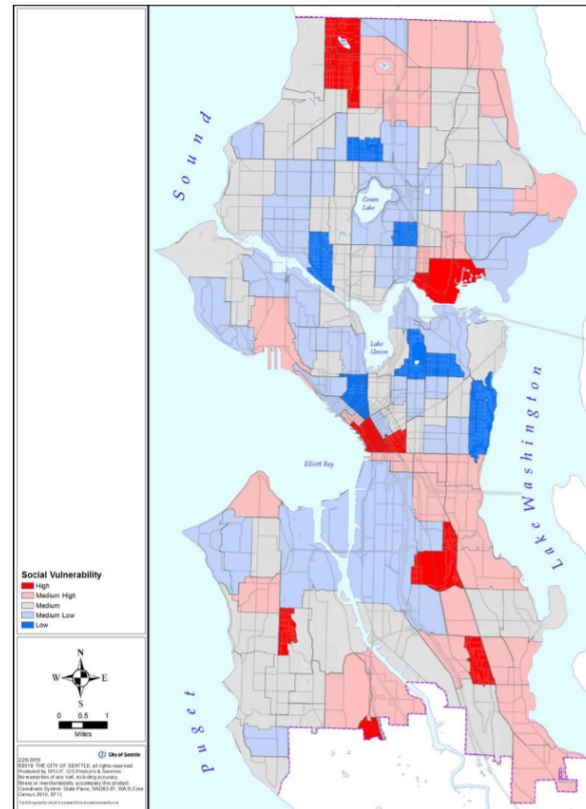
- The proposed project anticipates **impacts on vulnerable populations**, especially regarding equitable risk-reduction outcomes and whole-community approaches to disaster resilience.
- The proposed project addresses **community lifelines and critical infrastructure** vulnerability.
- The proposed project has **multiple benefits** beyond hazard risk reduction, including climate change, regional growth and development, and social vulnerabilities.
- The proposed project is **collaborative** and promotes shared responsibility, partnerships, and is supported by multiple jurisdictions or agencies.
- The proposed project includes **innovative solutions** to mitigate natural hazards, including naturebased solutions when feasible.

## Integrating Equity

What areas or people are a priority?



## Race and Social Equity Index



## Social Vulnerability Index

**Who**  
BIPOC  
Underserved  
Vulnerable  
Marginalized  
Underrepresented  
Low income

## Neighborhoods

South Park  
Georgetown  
Chinatown ID  
Rainier Valley  
Central Area  
Bitter Lake  
Highland Park

# Integrating Equity in this Update

- Amplify “equity” in goals or objectives where appropriate or add new objective.
- Add a 2nd screen to prioritize/score actions
- Graphically highlight actions located in priority areas.
- Capture additional information on the mitigation action worksheet for reporting and monitoring

*Discussion: what information might we include on the worksheet?*



# DEEPER ENGAGEMENT WITH COMMUNITY

Community-based organizations provide critical services to city residents and could benefit from hazard mitigation projects. Which types of services do you think are most critical to protect through mitigation efforts?

Affordable housing/housing assistance

Food assistance

Health and Mental health

Utility assistance

Public safety

Education

Sports and recreation

Art and culture

Aging and disability services

Economic development

Sheltering

Food Banks/food assistance



# WRAP UP

ASAP	Complete Capability Assessment & Status
October	Convene colleagues to help identify and prioritize Mitigation Actions
October 26 <sup>th</sup>	Complete Mitigation Action Worksheets
November 4 <sup>th</sup>	Next MWG meeting



# Seattle All Hazards Mitigation Plan – 5 Year Revision Process

## Hazard Mitigation Work Group (MWG) - Meeting #4

Date/Time: Wednesday, November 4, 2020 3:30 PM – 4:30 PM\*

Location: Online Teams Meeting

\* If you need to join OEM daily call at 4-5 pm, please try to join this meeting from 3:30-4pm.

<b>Introductions</b> 5 min	Erika Lund, Patrice Carroll
<b>Recap</b> 5 minutes	Meeting #3 Capability Assessment Status of Actions Mitigation Actions
<b>Department Round Robin</b> 40 minutes	Sharing your experience, progress, ideas and questions with MWG members
<b>Schedule for Completion</b> 5 minutes	Discussion: What schedule can we commit to?
<b>Next Steps</b> 5 Minutes	Department Mtgs Next MWG Mtg – Dec or sooner?

### All-Hazard Mitigation Plan Update Milestones:

Hazard Mitigation Work Group Meeting 1	January 27, 2020
Planning process paused for Covid-19 response	
Hazard Mitigation Work Group Meeting 2	September 14, 2020 11am-12 noon
Hazard Mitigation Work Group Meeting 3 Capabilities & Status of Current Actions Due	September 28, 2020 11am – 12 noon
Mitigation Actions Due	October 28, 2020
Hazard Mitigation Work Group Meeting 4	November 4, 2020 3:30-4:30 pm
<b>Public Draft for Review and Comment</b>	<b>November 16, 2020</b>
Public Comment Period (3 weeks)	November 16 – December 4, 2020
Hazard Mitigation Workgroup Meeting 5	December 14, 2020 11am-12 noon
<b>Final Draft for Review and Approval</b>	<b>December 31, 2020</b>
Begin Approval Process	January 2021

## Seattle All Hazards Mitigation Plan – 5 Year Revision Process

### Hazard Mitigation Work Group 2020 Members:

Name	Department/Agency
Flossie Pennington	Arts and Culture
Jennifer Devore	City Budget Office
Kara Main Hester	City Budget Office
Jana Elliot	City Light
Micah Chappell	Construction & Inspection
Sarah Sodt	Dept of Neighborhoods, Historic Preservation
Jessica Sidhu	Economic Development
Erika Lund	Emergency Management
TJ McDonald	Emergency Management
Laurel Nelson	Emergency Management
Lucia Schmit	Emergency Management
Elenka Jarolimek	FAS
Julie Matsumoto	FAS
Andy (James) Collins	Fire
Dan Foley	Housing
Jill Watson	Human Services Department
Dennis Reddinger	Libraries
TBD	Office of Sustainability and Environment
Jon Jainga	Parks & Recreation
Scott, Stevens	Parks & Recreation
Cynthia McCoy	Seattle Parks and Recreation/ Seattle Public Utilities
Patrice Carroll	Planning and Community Development/ OEM
David Goldberg	Planning and Community Development
Kati Davich	<i>Port of Seattle</i>
Addison Houston	Public Health Seattle King County
Ned Worcester	Public Utilities
Michael Godfried	Public Utilities (Resilience)
Jae Lee	Seattle Center
Jared Cummer	<i>Seattle Housing Authority</i>
Lawrence Eichhorn	Seattle IT
Clinton Kaku	Seattle IT
Benjamin Coulter	<i>Seattle Public Schools</i>
Patti Quirk	Transportation

## **Hazard Mitigation Work Group (MWG) Meeting #4 – Meeting Notes**

*Hosted by: The Seattle Office of Emergency Management (OEM)*

*Date/Time: Monday, November, 2020 11:00AM-12:00 PM*

*Location: Online*

### **AGENDA:**

Meeting Item	Duration	Presenter/Facilitator
IWelcome	5 minutes	Patrice Carroll, OEM/OPCD
Recap of Meeting 3	5 minutes	Patrice Carroll, OEM/OPCD
Dept Round Robin	40 minutes	Everyone
Schedule for Completion	5 minutes	Patrice Carroll, OEM/OPCD
Next Steps	5 minutes	Patrice Carroll, OEM/OPCD

### **ATTACHMENTS:**

- Agenda

### **MEETING SUMMARY**

#### **Introductions**

Erika Lund and Patrice Carroll welcomed group and acknowledged that some may need to jump off for an election day preparedness call.

#### **Recap of Meeting #3**

Reviewed framework, goals, worksheets and project prioritization criteria, integrating equity, and reviewed the status of projects that were.

Reviewed Capabilities table and the Status Table for 2015 projects

Framework included goals and objectives. Most of the mitigation actions in last plan addressed Goal #2 (safeguarding critical infrastructure) and #3 (protecting property). We talked about adding an equity goal, but choose not to but will collect additional information and criteria about equity aspects of

Most of the type of actions infrastructure and capital projects, assessments and studies account for ¾ of all actions.

Worksheets information for new actions or actions from the last plan that is being carried forward. Note the criteria that we will be using this year, but asking to rate as high, medium and low. Still using STAPLEE criteria.

#### **Dept. Round Robin**

Departments were asked to share stories of their progress- questions and barriers, how they overcame, what help they need from OEM.

**SPR/SPU** – Kicking off by contacting primarily the planning staff. Will be meeting next week. Shared the SHIVA, worksheets, FEMA workbook section 6 about mitigation strategies. Shared actions from the last plan. Looking at other cities (Portland) to see what mitigation projects from those depts.

Patrice – there are some plans from other cities in the Teams site in “Background.” Feel free to add other plans that would be useful.

**FAS** – Looking at prioritizing projects that have a more general goal but have no specific funding. Working primarily with asset managers and capital development group. Number of actions have been completed through grant funding. Have an overarching strategy for seismic rather than specific buildings. Suggest reviewing the Capital Improvement Program for projects that fit categories for mitigation.

**SDCI** – Code adoption and regulation is ongoing. As we go through it automatically updates some hazards. The URM work has been placed on hold due to the pandemic. Working on 2021 Seattle and State code amendments and 2024 International Code updates. Land use staff will be providing updates on waterfront regs. In new codes 20% increase in seismic, will go into effect in Feb 2020.

Erika - What about ECA’s how often is that updated? What about the tall wooden buildings (cross laminated timber (CLT)- can be up to 18 stories in height)?

Micah – Think ECAs are updated on an as needed basis. CLT buildings are allowed in Seattle as part of the 2018 code update. The national code will include CLT in 2021. CLT is considered a carbon sink so mitigates climate issues. Will save \$ in labor In Vancouver a crew of 10 was able to complete 18 story building in 6 months. Some shorter buildings are under construction in Seattle, but no tall buildings yet.

**OAC** – Been hard to get people to respond. Answered your questions re: capabilities. The public art and spaces that partners with. Have an emergency plan for King St Station, but not Langston Hughes (owned by SPR). All public art if subject to city regulations so it built to be earthquake proof. There will be renovations to 2nd floor. Cynthia can help to connect with SPR staff.

**OED** – No updates currently.

Patrice – pulled some info from the 2021 budget book into the capabilities table.

**HSD** – Division directors identified staff to provide information. The HMP seems more organized for “structures” not “people”. Have not yet included criteria. Identified one item to increase community capacity for emergency feeding, and a new plan learning from recent work for winter storm and COVID-19. Continuing capability from last plan carried forward.

Patrice – Not clear how HSD and OSE are working together on food access? Jill, not sure. HSD’s action is different than grocery vouchers and fresh bucks, HSD’s action is a strategic plan.

**OPCD** – Developing a BRIC applications for the Climate Adaptation Strategy for Duwamish Valley including a number of activities. We are accumulating (long term-leases, covenants) for properties not owned by the City- OCR, Equitable Development Initiative, Public Space PDA. What is our strategy for these buildings so they can deliver the benefits? David would like to include a project to have more discussion of these buildings which may be over 50-years old, historic, etc.

Erika – The mitigation grants previously have been City-owned facilities, but we do have the opportunity to apply on behalf of community or PDA for assets the City has an interest in protecting, if they meet FEMA requirements.

Patrice – We are also interested in collecting worksheet info for “potential projects” so this might fit in that category.

**SPU** – Have a lot of mitigation items from the three lines of business. There are a lot of fields to fill out, and staff has limited time. Confusion about the equity fields-e.g., if a water tank serves an entire neighborhood would benefit so difficult to identify as an equity project, but some are just system projects. Will OEM have comments on worksheets.

Patrice – Just give us as much info as possible that OEM can use to do an equity analysis. So, at a minimum include location info.

**SDOT** – Roadway structures was audited including bridge structures. SDOT will be focusing on prioritizing assets to preserve “resilient corridors” – that we need to maintain for first responders if a disaster happens.

**ITD** – No updates at this time.

Seattle Public Schools – KC has a template that SPS can use to be included in the KC Mitigation Plan. Most of SPS projects are planning and funded through levies. BEX 5, most recent levy, allowed all schools to have the same level of security and other safety measures (fencing, card access, etc.). Security will be focused on schools with high crime or schools where superintendent has made a commitment to African American communities.

### **Updated Capabilities**

Patrice highlighted remaining gaps in the capabilities assessment

Discussion:

### **Status of Current Actions**

Patrice Carroll identified remaining gaps in the status table.

### **Actions for 2021**

The Mitigation

### **Schedule & Wrapup**

Our schedule called for having a Public Draft by mid-November. How much time do you need? Note that public comment period can be used to do some additional internal review. We could push the plan back a week or so but can't push it back much if we want to complete by end of year. Could push back but leaves less time after the comment period. Some MWG members could meet deadline, but others would be very difficult to meet a Nov 13 deadline. Can an action be added after the comment period?

Erika – Would need to double check, but I think there is some flex time to add an action after the Draft.

Final Meeting is Dec 14th. If we need to schedule an interim meeting, we could try to do that. Thank you for participating!



Seattle All Hazards Mitigation Plan – 5 Year Revision

Name	Department/Agency	9/28/20 Mtg
Flossie Pennington	Arts and Culture	X
Jennifer Devore	Budget Office	
Kara Main Hester	Budget Office	
Jana Elliot	City Light	X
Micah Chappell	Construction & Inspection	X
Sarah Sodt	Dept of Neighborhoods, Historic Preservation	
Jessica Sidhu	Economic Development	X
Erika Lund	Emergency Management	X
TJ McDonald	Emergency Management	X
Laurel Nelson	Emergency Management	
Lucia Schmit	Emergency Management	X
Elenka Jarolimek	FAS	X
Julie Matsumoto	FAS	
Andy (James) Collins	Fire	X
Dan Foley	Housing	
Jill Watson	Human Services Department	X
Dennis Reddinger	Libraries	
TBD	Office of Sustainability and Environment	
Jon Jainga	Parks & Recreation	
Scott, Stevens	Parks & Recreation	
Cynthia McCoy	Seattle Parks and Recreation/ Seattle Public Utilities	X
Patrice Carroll	Planning and Community Development/ OEM	X
David Goldberg	Planning and Community Development	X
Kati Davich	<i>Port of Seattle</i>	
Addison Houston	Public Health Seattle King County	X
Michael Godfried	Seattle Public Utilities (Resilience)	X
Jae Lee	Seattle Center	
Jared Cummer	<i>Seattle Housing Authority</i>	X
Mary Wylie	Seattle IT	X
Clinton Kaku	Seattle IT	
Benjamin Coulter	<i>Seattle Public Schools</i>	X
Kit Loo	Transportation	X

# Seattle All-Hazards Mitigation Plan 5 Year Update

Mitigation Work Group  
Meeting #4: Finalize Mitigation Actions



# AGENDA MEETING #4

1. *Welcome*
2. *Recap*
3. *Department Round Robin on:*
  - *Updated Capabilities*
  - *Status of Current Actions*
  - *Mitigation Actions for the 2021 Plan*
4. *Schedule*



# Current 2015 – 2021 All-Hazard Mitigation Plan Overview

- **Chapter 1 – Introduction.** Identifies the authorities on which the plan is based, describes the plan's purpose and scope, describes how the plan is organized, and identified changes to the plan since 2009.
- **Chapter 2 – Planning Process.** Describes the process used to update the plan, including data sources and plan integration activities, outreach and engagement strategies, MWG activities, and plan development milestones.
- **Chapter 3 – Community Profile.** Provides a summary community profile for the City of Seattle including geographic, demographic, and economic characteristics that make the City unique. A full community profile is provided in the Seattle Hazard Identification and Risk Assessment document in Appendix A.
- **Chapter 4 – Hazard Identification and Vulnerability Analysis.** Contains a summary of the hazards that could potentially impact the City, including a hazard ranking table. Full hazard profiles and vulnerability assessment information is provided in the Seattle Hazard Identification and Risk Assessment document in Appendix A.
- **Chapter 5 – Capability Assessment.** Identifies the existing mitigation capabilities of City departments and highlights mitigation accomplishments over the last planning cycle.
- **Chapter 6 – Mitigation Strategy.** Provides updated goals and objectives for the City's mitigation program and identifies a comprehensive set of prioritized mitigation actions that would contribute to the City's resiliency.
- **Chapter 7 – Program Implementation.** Describes the City's plan for monitoring, evaluating, and updating the Seattle HMP over the next five-year period.



## RECAP OF MEETING #3

- HMP Framework & Goals
- HMP Actions, Worksheet & Prioritization
- Integrating Equity
- Updating Status of 2015-2021 Actions

*Meeting agenda, video, presentation and notes available on  
“MWG Mtg” Channel*



# Capabilities

## Word Document

### Existing Mitigation Capabilities - Office of Emergency Management

Capability	Capability Type	Description	Key Accomplishments (2009-2015)	Hazard Mitigated
<b>Neighborhood and Individual Preparedness Programs</b>	Education, and Outreach	These programs provide all-hazard preparedness information and training to Seattle's diverse communities, individuals, families, neighborhoods, businesses, schools, and community-based organizations. Programs include Seattle Neighborhoods Actively Prepare (SNAP), the OEM website, Community Emergency Hubs, and Education Campaigns.	<ul style="list-style-type: none"><li>Ongoing programs.</li></ul>	All Hazards
<b>Home Seismic Retrofit Program</b>	Education and Outreach	This free training program promotes home seismic retrofit within Seattle and the region. Introductory class covers how individuals can perform the retrofit themselves, as well as consumer education on working with trained contractors. A course is offered in coordination with Seattle's Department of Planning and Development (DPD), which developed a set of standardized plan sets, issues permits, and performs inspections.	<ul style="list-style-type: none"><li>Over the past five years, home seismic retrofit classes have been consistently well-attended, averaging 25 to 40 attendees per class. Classes are offered six to 10 times a year in libraries throughout Seattle. Seattle DPD issues an estimated 100 seismic retrofit permits a year.</li></ul>	Earthquakes





# Status

## Excel Spreadsheet

Q	R	S	T	U	V
Need ASAP		Need by end of 2020		Need ASAP	Need by end of 2020
		For Completed Actions		For Uncompleted Actions & 2021 Revision	
Status (e.g. on-going, completed, dropped w/ justification) and activity to date	Date and Source of status information	Mitigation Benefit: Description of how hazard impact has been reduced and/or losses avoided (Refer to outcome studies/reports as appropriate)	Year Completed	Action should be: 1) Carried over as is, 2) Revised, 3) Removed, or 4) Moved to Capability section	Notes, Rationale & Source of Information





# MITIGATION STRATEGY FRAMEWORK

## **Goals** (6 goals)

Long-term outcome achieved through mitigation planning and implementation

## **Objectives** (18 objectives)

Help to define, group, organize actions. Objectives are broader than specific actions and connect goals with actual mitigation actions.

## **Actions** (54 actions)

Specific action taken to reduce risks from hazards and their impacts.

4.5 Average Actions/Dept (range 1 to 12 actions)

# GOALS

1. Protect life and safety and promote community resiliency. **11%**
2. Safeguard critical infrastructure and ensure continuity of service. **24%**
3. Protect public and private property. **52%**
4. Protect the natural environment and cultural and historic resources. **NEW IN 2015 4%**
5. Promote a resilient economy. **CHANGED 2020 2%**
6. Promote a collaborative and integrated mitigation program. **NEW IN 2015 7%**

*Note: Did not add a new equity goal. Did add questions and racial equity impact criteria in Worksheet.*

# TYPES OF ACTIONS

- **Plans and Regulations.** Regulatory actions or planning processes that result in reducing vulnerability to hazards. 15%
- **Assessments and Studies.** Actions taken to better understand the potential impacts of identified hazards. An example would be seismic studies of City facilities. 24%
- **Infrastructure/Capital Projects.** Actions taken to modify existing buildings or structures to protect them from a hazard. 39%
- **Non-Structural Mitigation Measures.** Physical actions taken that don't include structural modifications. An example would be efforts to secure furniture or installation of backup generators. 11%
- **Natural Systems Protection.** Actions that, in addition to minimizing hazard losses, preserve or restore the functions of natural systems. 2%
- **Education and Awareness.** Actions taken to inform and educate residents, elected officials, and property owners about hazards and potential ways to mitigate them. 9%

Notes: Examples on page 2-3 of the Worksheet Instructions. Removed "Preparedness and Response" as a type of action.



# MITIGATION ACTION WORKSHEET

## Descriptive Information

- Action Description
- Lead or Supporting; Department/Organization
- Action Status (New, Existing, Potential)
- Type of Action
- Hazards Addressed (18 categories in SHIVA)
- Goals Supported (6 goals)
- RSJI Focus Areas (6 focus areas: Inclusive Economy, Climate Justice, Community Safety, Community Supports, Community Wealth Building, Education Opportunity)
- Location & Benefit Area
- Timeline (Action = 1-5 years; Potential Action = 5+ years)
- Anticipated Cost (High, Medium, Low)
- Funding Available/ Funding Source (existing budget, grants, bond/levy)

*Link to 2020 worksheet and instructions in Chat*



# MITIGATION ACTION WORKSHEET

## Prioritization Criteria

### Mitigation Effectiveness

Mitigation Effectiveness. Will the implemented action result in lives saved?

Mitigation Effectiveness. Will the implemented action result in a reduction of disaster damage?

Multiple Benefits. Will the action provide multiple community benefits beyond mitigation?

Collaboration. Will the action involve collaboration between City departments and/or the community?

Racial Equity. Will the action reduce hazard vulnerability for BIPOC communities?

### STAPLEE

Is it **Socially** acceptable?

Is it **Technically** feasible and potentially successful?

Does responsible agency/department have the **Administrative** capacity to execute this action?

Is it **Politically** acceptable?

Is there **Legal** authority?

Is it **Economically** beneficial?

Will the project have a neutral or positive impact on the natural **Environment**



# MITIGATION ACTION WORKSHEET

## Descriptive Information

- Action Description
- Lead or Supporting; Department/Organization
- Action Status (New, Existing, Potential)
- Type of Action
- Hazards Addressed (18 categories in SHIVA)
- Goals Supported (6 goals)
- RSJI Focus Areas (6 focus areas: Inclusive Economy, Climate Justice, Community Safety, Community Supports, Community Wealth Building, Education Opportunity)
- Location & Benefit Area
- Timeline (Action = 1-5 years; Potential Action = 5+ years)
- Anticipated Cost (High, Medium, Low)
- Funding Available/ Funding Source (existing budget, grants, bond/levy)

*Link to 2020 worksheet and instructions in Chat*



# DEPARTMENT ROUND ROBIN

Share your experience, progress, ideas with MWG

1. Where are you in the process?
2. What **Capabilities** have been added, deleted or still considering?
3. Are you able to fill in all the **Status** info requested for mitigation actions in the current plan?
4. What's your process for generating **Mitigation Actions** for the 2021 Plan?
5. Where is more guidance or clarification needed?
6. Are you getting input from key people in your department?
7. How can OEM help- suggestions, best practices, convening?





# SCHEDULE

Hazard Mitigation Work Group Meeting 1	January 27, 2020
<b>Planning process paused for Covid-19 response</b>	
Hazard Mitigation Work Group Meeting 2	September 14, 2020 11am-12 noon
Hazard Mitigation Work Group Meeting 3 Capabilities & Status of Current Actions Due	September 28, 2020 11am-12 noon
Mitigation Actions Due	October 28, 2020 <b>Nov 13</b>
Hazard Mitigation Work Group Meeting 4	November 4, 2020 3:30-4:30 pm
<b>Public Draft for Review and Comment</b>	<b>November 16, 2020 Nov 23</b>
Public Comment Period (3 weeks)	November 16 – December 4, 2020 <b>Nov 23 - Dec 11</b>
Hazard Mitigation Workgroup Meeting 5	December 14, 2020 11am-12 noon
<b>Final Draft for Review and Approval</b>	<b>December 31, 2020</b>
Begin Approval Process	January 2021

***What schedule can MWG commit to?***

# NEXT STEPS

- 1. Finalize content for release of Draft HMP**
- 2. Final Meeting in Dec**
  - Review comments received
  - Discuss any final changes, additions, prioritization
  - Review and finalize Section 6 - Implementation and Monitoring

## Seattle All Hazards Mitigation Plan – 5 Year Revision Process

### Hazard Mitigation Work Group (MWG) - Meeting #5

Date/Time: Monday December 14, 2020 11am – 12 noon

Location: Online Teams Meeting

<b>Welcome</b> 5 min	Erika Lund, Patrice Carroll
<b>Schedule for Completion &amp; Approval</b> 20 minutes	Schedule for completion and approval by DMC, EEB, State, FEMA Discussion: How to fill remaining information gaps?
<b>Public Comment Period</b> 10 minutes	Discussion: How can your department support outreach during public comment period?
<b>Plan Monitoring &amp; Evaluation</b> 20 minutes	Discussion: How will we keep the plan current- monitoring, evaluating, and updating the mitigation plan within a 5-year cycle?
<b>Next Steps</b> 5 Minutes	Additional MWG Mtg – January 25

#### All-Hazard Mitigation Plan Update Milestones:

Hazard Mitigation Work Group Meeting 1	January 27, 2020
Planning process paused for Covid-19 response	
Hazard Mitigation Work Group Meeting 2	September 14, 2020 11am-12 noon
Hazard Mitigation Work Group Meeting 3 Capabilities & Status of Current Actions Due	September 28, 2020 11am – 12 noon
Mitigation Actions Due	October 28, 2020
Hazard Mitigation Work Group Meeting 4	November 4, 2020 3:30-4:30 pm
Hazard Mitigation Workgroup Meeting 5	December 14, 2020 11am-12 noon
<b>Public Draft for Review and Comment</b>	<b>January 4, 2021</b>
Public Comment Period (3 weeks)	January 4 -22, 2021
Hazard Mitigation Workgroup Meeting 5	January 25, 2021 11am-12 noon
<b>Final Draft – Begin Review and Approval Process</b>	<b>February 1, 2020</b>

## Seattle All Hazards Mitigation Plan – 5 Year Revision Process

### Hazard Mitigation Work Group 2020 Members:

Name	Department/Agency
Flossie Pennington	Arts and Culture
Jennifer Devore	City Budget Office
Kara Main Hester	City Budget Office
Jana Elliot	City Light
Brittany Barnwell	City Light
Micah Chappell	Construction & Inspection
Sarah Sodt	Dept of Neighborhoods, Historic Preservation
Jessica Sidhu	Economic Development
Erika Lund	Emergency Management
TJ McDonald	Emergency Management
Laurel Nelson	Emergency Management
Lucia Schmit	Emergency Management
Elenka Jarolimek	FAS
Julie Matsumoto	FAS
Andy (James) Collins	Fire
Dan Foley	Housing
Jill Watson	Human Services Department
Dennis Reddinger	Libraries
TBD	Office of Sustainability and Environment
Jon Jainga	Parks & Recreation
Scott, Stevens	Parks & Recreation
Cynthia McCoy	Seattle Parks and Recreation/ Seattle Public Utilities
Patrice Carroll	Planning and Community Development/ OEM
David Goldberg	Planning and Community Development
Kati Davich	<i>Port of Seattle</i>
Addison Houston	Public Health Seattle King County
Ned Worcester	Public Utilities
Michael Godfried	Public Utilities (Resilience)
Jae Lee	Seattle Center
Jared Cummer	<i>Seattle Housing Authority</i>
Lawrence Eichhorn	Seattle IT
Mary Wylie	Seattle IT
Benjamin Coulter	<i>Seattle Public Schools</i>
Patti Quirk	Transportation

## **Hazard Mitigation Work Group (MWG) Meeting #5 – Meeting Notes**

*Hosted by: The Seattle Office of Emergency Management (OEM)*

*Date/Time: Monday, December 14, 2020 11:00AM-12:00 PM*

*Location: Online*

### **AGENDA:**

Meeting Item	Duration	Presenter/Facilitator
Welcome	5 minutes	Patrice Carroll, OEM/OPCD
Schedule	20 minutes	Patrice Carroll, OEM/OPCD
Outreach	10 minutes	Patrice Carroll, OEM/OPCD
HMP Monitoring	20 minutes	Patrice Carroll, OEM/OPCD
Next Steps	5 minutes	Patrice Carroll, OEM/OPCD

### **ATTACHMENTS:**

- Agenda, Presentation and Meeting Video available on Teams- MWG Meetings channel

### **MEETING SUMMARY**

#### **Welcome**

Patrice Carroll and Erika Lund welcomed participants.

#### **Schedule**

Patrice Carroll presented the Revised Schedule, including the review and approval phase. Under the new schedule we will issue Draft HMP for public review and comment Jan 4, 2021, and have a plan ready for approvals by Feb. 1, 2021, and have a FEMA approved plan by July 2021. July is also when OEM will begin the EMAP recertification process.

Schedule includes review by two key stakeholder groups will review and approve the plan:

- Disaster Management Committee (DMC) will get a briefing in Dec and will formally review and approve the plan in Feb or March.
- Executive Emergency Board (EEB) will review and take vote to approve plan in April. EEB includes all directors (or representative) so they may have questions for MWG representatives about the plan. Some may have reached out to leadership already.

#### **Information Gathered to Date**

- Capabilities - 21 departments presented capabilities for the plan which is more than the last plan (only 15 departments). Still filling some gaps for three departments.
- Status of 54 actions in the last plan (from 12 departments). Less than half actions (43%) are “complete” and 1/3 are incomplete. We hope this plan will have fewer incomplete actions.
- Mitigation strategy for this plan so far includes about 40 actions from 11 departments. Not concerned this is less than the last plan. About ½ departments have submitted actions.

### **Public Comment Period**

We are planning a 3 week public comment period. OEM will post plan on website, have a narrated presentation and send out notices via OEM media- newsletter, email lists.

Do other depts have networks that could be used to reach people who would be interested in this plan? This is outreach to external audiences. OEM is relying on MWG members to do any internal outreach to other staff in your department.

- Perhaps OEM could use the JIC to share information about the plan. OEM hasn't used the JIC for public outreach in the past.
- Question – Is SPU's integrated plan doing any outreach? Network for Duwamish Valley- may be excited to see a mitigation action.
- When would a link be available? There is a website for the plan, and the Draft will be posted on Jan 4.
- If you have other thoughts, add to the chat or send Patrice a note.

### **Plan Monitoring**

FEMA and EMAP both require us to have a process to monitor the plan. The group reviewed and discussed the process in the last plan. OEM would like to improve this, and proposing:

- Have an annual review to report on progress and accomplishments, new needs, drop off things that aren't moving forward.
- MWG will also review any after action reports to discuss implications for HMP. OEM will issue an annual report.
- Use the LIST app to collect updated information about mitigation actions.
- MWG meets twice a year. Erika proposed the 1st meeting at the beginning of the year would focus on "new" ideas, and the 2nd meeting would focus on reporting on actions. OEM can't produce all this information on our own, so we would rely on MWG members to submit info for the annual report to see if we are meeting our goals. What is the easiest way to provide this information. If HMP is adopted mid-year, the first status report would be at the end of 2021 to show what the format is like, even though there might not be

Who is the audience? For this report the audience is internal. There will be a page in the OEM annual report that would highlight an exciting project or accomplishment.

How would the MWG interact with upcoming after action reports? There will be a citywide after action report on the response to COVID in Oct or Nov 2021, so hope we can add that to the MWG meeting agenda. SPD is also taking a look at the civil unrest incidents that occurred in 2020. Don't anticipate there will be an after action report for wildfire smoke because the EOC was not activated.

Reference to CIP projects should be just that were identified in the mitigation actions.

What is the commitment of the CBO on integrating mitigation projects into the CIP? Currently there isn't a strong commitment to mitigation projects, for example seismic projects are not prioritized. Ideally having a project in the HMP would help departments advocate for including some projects in the CIP, prioritize for CIP funding. The annual update is also an opportunity to capture capital projects that popped up but weren't in the plan.

What formats have other departments used for monitoring projects? Need to have someone responsible for doing it, sent out form (excel spreadsheet) to gather information.

Is the purpose of MWG meetings to make sure that actions are moving forward? Yes, that is a role for the MWG. Trying to focus on actions where the dept has a commitment. In the past, the larger department may not have been committed to progress. Hoping there is more

Are there opportunities to make mitigation priorities part of the levy planning process? Things are already underway for levy planning and happen outside the OEM world. Need to have those conversations early on. Hazard mitigation are not part of CIP or Levy initial planning periods. For the next public safety levy, those conversations need to happen now. The MWG could highlight when that planning is happening. Might include this topic into the briefing for the EEB. With climate change there will be more interdepartmental work that could help to integrate mitigation.

We could include in capabilities the levies and cycles in the plan could be helpful.

What happens following a major disaster? Current plan says there may be some special meetings for MWG after a disaster. OEM has included a mitigation question into after action surveys. Although some people have different interpretations of what mitigation is. What types of actions, capital projects, etc. could lessen impact of this disaster in the future. There isn't always an after action report, but could still be discussed at future MWG meeting (e.g. wildfire smoke). We could say in the plan that question is a tool we are using.

Would like to engage MWG in discussion about "equity actions" – are there equity indicators, are your departments already to RSJI toolkits on mitigation projects. What improvements would we make in future? OPCD's equity indicators and OSE's EJ identified EJ communities- we could build in some questions overall in reporting if work is specifically considering the differential need in these communities. OEM was also considering mapping where projects were benefiting. Perhaps OPCD could do a presentation about their equity work at a future meeting. But this is a question about how we plan in the City to directors, maybe it's a topic that gets integrated across departments? Could OEM pool result from One Concern earthquake scenarios to get a sense of the total numbers from residential and commercial to provide a preliminary idea of where and who is impacts- will change with 2020 census. OEM used it to run URM scenarios, not sure it would work for something like retrofit of a pump station.

### **Next Steps**

We have scheduled a meeting in January in the event we need to discuss any outstanding issues.

Thank you for participating!



Seattle All Hazards Mitigation Plan – 5 Year Revision

Name	Department/Agency	9/28/20 Mtg
Flossie Pennington	Arts and Culture	
Jennifer Devore	Budget Office	
Kara Main Hester	Budget Office	
Brittany Barnwell	City Light	X
Jana Elliot	City Light	
Micah Chappell	Construction & Inspection	
Sarah Sodt	Dept of Neighborhoods, Historic Preservation	
Jessica Sidhu	Economic Development	X
Erika Lund	Emergency Management	X
TJ McDonald	Emergency Management	X
Laurel Nelson	Emergency Management	
Lucia Schmit	Emergency Management	X
Elenka Jarolimek	FAS	X
Julie Matsumoto	FAS	
Andy (James) Collins	Fire	X
Dan Foley	Housing	
Jill Watson	Human Services Department	X
Dennis Reddinger	Libraries	X
TBD	Office of Sustainability and Environment	
Jon Jainga	Parks & Recreation	
Scott, Stevens	Parks & Recreation	
Cynthia McCoy	Parks and Recreation/ Seattle Public Utilities	
Patrice Carroll	Planning and Community Development/ OEM	X
David Goldberg	Planning and Community Development	X
Kati Davich	<i>Port of Seattle</i>	
Addison Houston	Public Health Seattle King County	
Michael Godfried	Seattle Public Utilities (Resilience)	X
Jae Lee	Seattle Center	
Jared Cumber	<i>Seattle Housing Authority</i>	
Lawrence Eichhorn	Seattle IT	X
Mary Wylie	Seattle IT	X
Carrie Chitty	Seattle Police Department	X
Lt. Daniel Nelson	Seattle Police Department	X

Seattle All Hazards Mitigation Plan – 5 Year Revision

Benjamin Coulter	<i>Seattle Public Schools</i>	
Patti Quirk	Transportation	

# Seattle All-Hazards Mitigation Plan 5 Year Update

Mitigation Work Group  
Meeting #5:  
Outreach & Monitoring



# AGENDA MEETING #5

1. *Welcome*
2. *Schedule for Completion & Approval*
3. *Public Comment Period*
4. *Plan Monitoring & Evaluation*
5. *Next Steps*



# SCHEDULE FOR COMPLETION

Public Draft for Review and Comment	January 4, 2021
Public Comment Period (3 weeks)	January 4-22, 2021
Hazard Mitigation Workgroup Meeting #6	January 25, 2021
Final Draft for Review and Approval	February 1, 2020
Current HMP Expires	February 16, 2021
Disaster Management Committee Approval	February 18, 2021
Executive Emergency Board Approval	March or April 2021
State & FEMA Review for Approvability	March – April 2021
City Council Adoption	May 2021
State & FEMA Approval	June/July 2021
EMAP Recertification Process	July 2021

# Disaster Management Committee (DMC)

- Meets monthly
- 200+ members with representatives from:
  - City departments,
  - King County agencies
  - Local non-profits
  - NW Healthcare Response Network
  - University of Washington
  - 211 partners
  - Community Emergency Hubs
- Briefing in December
- Approval in February



# Emergency Executive Board (EEB)

- Meets quarterly
- 37 members
- Sub-cabinet of Department Directors convened by Mayor's Office
- Approval at April Meeting

*Link to EEB membership list in chat*





# Information Gathered

## Capabilities & Status

- 21 departments reported Capabilities (16 in 2015)
- Capabilities Gaps: 3 departments?
- Status of 54 actions (12 depts)
  - 43% complete
  - 24% ongoing
  - 33% incomplete

## Mitigation Actions

- 40 actions (54 in 2015)
- 11 of 21 MWG departments submitted actions (12 depts in 2015)
- Depts with actions: FAS, HSD, ITD, OEM, OPCD, OSE, SCL, SDOT, SPR, SPL, SPU

# Public Comment Period

- January 4-22 (3 weeks)
- Draft HMP Posted on website
- Survey and dedicated email to collect comments
- Narrated PP Presentation on website
- Promote via OEM newsletter, social media, email lists,
- Ask DMC, SWG and Community Ambassadors to review and promote the Draft HMP to their networks

*Discussion: How can your department support outreach for Draft HMP?*



# All-Hazard Mitigation Plan Overview

- **Chapter 1 – Introduction.** Identifies the authorities on which the plan is based, describes the plan's purpose and scope, describes how the plan is organized, and identified changes to the plan since 2009.
- **Chapter 2 – Planning Process.** Describes the process used to update the plan, including data sources and plan integration activities, outreach and engagement strategies, MWG activities, and plan development milestones.
- **Chapter 3 – Community Profile.** Provides a summary community profile for the City of Seattle including geographic, demographic, and economic characteristics that make the City unique. A full community profile is provided in the Seattle Hazard Identification and Risk Assessment document in Appendix A.
- **Chapter 4 – Hazard Identification and Vulnerability Analysis.** Contains a summary of the hazards that could potentially impact the City, including a hazard ranking table. Full hazard profiles and vulnerability assessment information is provided in the Seattle Hazard Identification and Risk Assessment document in Appendix A.
- **Chapter 5 – Capability Assessment.** Identifies the existing mitigation capabilities of City departments and highlights mitigation accomplishments over the last planning cycle.
- **Chapter 6 – Mitigation Strategy.** Provides updated goals and objectives for the City's mitigation program and identifies a comprehensive set of prioritized mitigation actions that would contribute to the City's resiliency.
- **Chapter 7 – Program Implementation.** Describes the City's plan for monitoring, evaluating, and updating the Seattle HMP over the next five-year period.

# Keeping the HMP Current

## EMAP

**4.2.3** The Emergency Management Program has a process to monitor overall progress of the mitigation activities and documents completed initiatives and their resulting reduction or limitation of hazard impact on the jurisdiction.

## FEMA

**A6.** Is there a description of the method and schedule for keeping the plan current (monitoring, evaluating and updating the mitigation plan within a 5-year cycle)? (Requirement §201.6(c)(4)(i))

# MWG Annual Review

- Progress made on plan during the previous 12 months.
- Mitigation accomplishments in projects, programs, and policies.
- Actual losses avoided and benefits achieved by actions.
- Status of mitigation projects included on the City's Capital Improvement Program (CIP) list.
- Emerging disaster damage trends and repetitive losses.
- Identification of new mitigation needs.
- Cancellation of planned initiatives, and the justification for doing so.
- Changes in membership to the MWG.
- After-Action Reports published that year.
- Annual review will be compiled into an Annual Mitigation Status Report.

# Following a Major Disaster

In addition to annual update process, post-disaster MWG deliberations will also consider the following:

- “Lessons Learned” from the disaster and what new initiatives should be added to the plan to help reduce the likelihood of similar damage in the future.
- Follow-up needed on items relevant to mitigation from any after-action reports produced by the City.
- Integration of mitigation into the recovery process and coordination with City recovery planning efforts.

# Mitigation Action Status and Tracking

- Project progress including status of project funding and ongoing needs.
- Actual losses mitigated or benefits gained by project implementation.
- Project needs that may be addressed in the next mitigation planning cycle.

*Discussion: Can this information be captured annually? If not what could be reported?*





# NEXT STEPS

- 1. Fill any information gaps**
- 2. Provide contacts for coordinating outreach**
- 3. Release of Draft HMP**
- 4. Final Meeting in Jan**
  - Review comments received
  - Discuss any final changes, additions, prioritization



## Seattle All Hazards Mitigation Plan – 5 Year Revision Process

### Hazard Mitigation Work Group (MWG) - Meeting #6

Date/Time: Monday January 25, 2021 11am – 12 noon

Location: Online Teams Meeting

<b>Welcome</b> 5 min	Erika Lund, Patrice Carroll
<b>Schedule for Completion &amp; Approval</b> 5 minutes	Schedule for completion and approval by DMC, EEB, State, FEMA
<b>Comments Draft HMP</b> 10 minutes	Discussion: Public Comments and MWG Comments
<b>Prioritization Criteria</b> 20 minutes	Scoring Criteria- Emap other uses
<b>Keeping the Plan Current</b> 10 Minutes	Future MWG Meetings
<b>Questions, Comments Suggestions</b> 10 Minutes	

#### All-Hazard Mitigation Plan Update Milestones:

<b>Public Draft for Review and Comment</b>	<b>January 15, 2021</b>
Public Comment Period (3 weeks)	January 15 -22, 2021
Hazard Mitigation Workgroup Meeting 5	January 25, 2021 11am-12 noon
<b>Final Draft – Begin Review and Approval Process</b>	<b>February 1, 2020</b>
Current HMP Expires	February 11, 2021
Disaster Management Committee Mtg. - Approval	February 25, 2021
Executive Emergency Board Mtg, - Approval	April 9, 2021
State & FEMA Review for Approvability	May 2021
Mayoral Promulgation & City Council Adoption	May 2021
State & FEMA Approval	June/July 2021
EMAP Recertification Process Begins	July 2021

## Seattle All Hazards Mitigation Plan – 5 Year Revision Process

### Hazard Mitigation Work Group 2020 Members:

Name	Department/Agency
Flossie Pennington	Arts and Culture
Jennifer Devore	City Budget Office
Kara Main Hester	City Budget Office
Jana Elliot	City Light
Brittany Barnwell	City Light
Micah Chappell	Construction & Inspection
Sarah Sodt	Dept of Neighborhoods, Historic Preservation
Jessica Sidhu & Amanda Allen	Economic Development
Erika Lund	Emergency Management
TJ McDonald	Emergency Management
Laurel Nelson	Emergency Management
Lucia Schmit	Emergency Management
Elenka Jarolimek	FAS
Julie Matsumoto	FAS
Andy (James) Collins	Fire
Dan Foley	Housing
Jill Watson	Human Services Department
Dennis Reddinger	Libraries
TBD	Office of Sustainability and Environment
Jon Jainga	Parks & Recreation
Scott Stevens	Parks & Recreation
Cynthia McCoy	Seattle Parks and Recreation/ Seattle Public Utilities
Patrice Carroll	Planning and Community Development/ OEM
David Goldberg	Planning and Community Development
Kati Davich	<i>Port of Seattle</i>
Addison Houston	Public Health Seattle King County
Ned Worcester	Public Utilities
Michael Godfried	Public Utilities (Resilience)
Jae Lee	Seattle Center
Jared Cummer	<i>Seattle Housing Authority</i>
Lawrence Eichhorn	Seattle IT
Mary Wylie	Seattle IT
Benjamin Coulter	<i>Seattle Public Schools</i>
Patti Quirk	Transportation

## **Hazard Mitigation Work Group (MWG) Meeting #6– Meeting Notes**

*Hosted by: The Seattle Office of Emergency Management (OEM)*

*Date/Time: Monday, January 25, 2021 11:00AM-12:00 PM*

*Location: Online*

### **AGENDA:**

Meeting Item	Duration	Presenter/Facilitator
Welcome	5 minutes	Patrice Carroll, OEM/OPCD
Updated Schedule	5 minutes	Patrice Carroll, OEM/OPCD
Comments in Draft	10 minutes	Patrice Carroll, OEM/OPCD
Criteria	20 minutes	Patrice Carroll, OEM/OPCD
Keeping Plan Current	10 minutes	Patrice Carroll, OEM/OPCD
Questions, Comments Suggestions	10 minutes	Patrice Carroll, OEM/OPCD

### **ATTACHMENTS:**

- Agenda, Presentation and Meeting Video available on Teams- MWG Meetings channel

### **MEETING SUMMARY**

#### **Welcome**

Erika welcomed MWG and noted that this was the last meeting for the update process and will be Patrice's last meeting as the convener.

#### **Updated Schedule**

Patrice reviewed the schedule for the review and approval of the plan.

Final Draft for Review and Approval	February 1, 2020
Current HMP Expires	February 11, 2021
Disaster Management Committee Approval	February 25, 2021
Executive Emergency Board Approval	April 9, 2021
State & FEMA Review for Approvability	March – April 2021
Mayoral Promulgation	May 2021
City Council Adoption	May 2021
State & FEMA Approval	June/July 2021
EMAP Recertification Process Begins	July 2021

Patrice noted that the EEB meeting includes all directors, so MWG members may get questions about the plan. We do not know exactly how long the process will take but based on previous experience expect to have an approved plan by July 2021.

Some highlights of the plan

- Increased # of departments participating from 16 to 21
- Status of the 54 actions in the 2015 HMP actions included 43% complete, 24% ongoing and 33 % incomplete.
- Actions in 2020 plan totaled 44 actions from 12 departments.

**Comments on Draft**

Comment period ends Friday January 29. Also sent plan to State of WA for preliminary review. So far have not received any public comments. Similar reaction in the last update. Easier to engage people in a location specific project. Much harder for a citywide policy plan.

There is an editable document to capture MWG comment and changes on the Teams site. In future DMC or EEB may reach out to you as a MWG member to share their future comments.

**Criteria**

All of the information from the Mitigation Action worksheets have been entered into a master worksheet using the MS LIST app. Some of the fields are still empty, especially criteria. Please fill in as much information that you can, and especially criteria C1 and C2. If you do not fill it in Patrice and Erika will fill in (likely with “medium”) so we can turn those into a “loss score.” The loss criteria are not the only important ones, but this is a standard in EMAP. Does not mean projects will be implemented in that order, but it is one lens that EMAP wants to see in OEM’s planning.

Patrice recommends working on the Worksheet in Sharepoint because it has some extra features: add comments, attachments (e.g. longer project description).

**Keeping the Plan Current**

This is the last meeting to talk about the HMP Update. MWG will have two meetings each year.

- Spring Meeting: more strategic items, emerging issues, after actions, integrating RSJI
- Fall Meeting: yearly check in on status of plan, annual mitigation status report
- Both Meetings: grant cycles and proposals (e.g. BRIC)

Other ideas for MWG future workplan and items

- Will help to build mitigation awareness in all departments.
- Is idea of new mitigation needs- is that City specific or at-large? Erika would like to talk about needs more broadly as this could be partnerships opportunities. The HMP includes City programs to support partnerships and community-led investments. Mitigation projects could come up through those processes.
- Take a look of the hazard analysis to look at areas outside the City: watersheds, transmission lines, etc. What should we address in the next SHIVA update? TJ and Cynthia offered to work with TJ on these issues. Patrice noted many more actions in the HMP that are beyond the City proper.

**Questions, Comments, Suggestions**

Potential change to timeline. Where actions extend beyond 5 years, could there be a choice for 5+ years to show where long term plans are being implemented? Might think about that next year to think about how we categorized the long-term programs (e.g. SDOT Bridge Seismic project).

It was helpful to have consistent templates to gather information. Could we have that information earlier.

Erika asked how MWG How did people find the Teams for this planning work? Are in-person meetings better for our 2 meetings a year?

- Having the option to be on Teams is good, but like getting out of the office too.
- Some of the elements could have been workshopped, would have been better in-person.
- Hybrid (some in-person/ some online) might work.
- Strategic meetings benefit from face-to-face interactions. Might encourage people to participate in those sessions in person.
- Gathering status information was challenge because of staff changes.
- Many projects are complex but have no funding. How do those projects get funded? Different stakeholder groups that can help or hurt those projects to get funded. How can we help make those projects rise in priority in other decision processes (CIP, levy planning, etc.)?
- Would like to create some mitigation stories to get more involvement from the community. Look at other places to see how they tell their mitigation stories.

Thank you for participating!

Seattle All Hazards Mitigation Plan – 5 Year Revision

Name	Department/Agency	1/25/21 Mtg
Flossie Pennington	Arts and Culture	
Jennifer Devore	Budget Office	
Kara Main Hester	Budget Office	
Jana Elliot	City Light	X
Micah Chappell	Construction & Inspection	
Sarah Sodt	Dept of Neighborhoods, Historic Preservation	
Jessica Sidhu	Economic Development	
Erika Lund	Emergency Management	X
TJ McDonald	Emergency Management	X
Laurel Nelson	Emergency Management	
Lucia Schmit	Emergency Management	X
Elenka Jarolimek	FAS	X
Julie Matsumoto	FAS	
Andy (James) Collins	Fire	
Dan Foley	Housing	
Jill Watson	Human Services Department	X
Dennis Reddinger	Libraries	
TBD	Office of Sustainability and Environment	
Jon Jainga	Parks & Recreation	
Scott, Stevens	Parks & Recreation	
Cynthia McCoy	Seattle Parks and Recreation/ Seattle Public Utilities	X
Patrice Carroll	Planning and Community Development/ OEM	X
David Goldberg	Planning and Community Development	X
Kati Davich	<i>Port of Seattle</i>	
Addison Houston	Public Health Seattle King County	
Michael Godfried	Seattle Public Utilities (Resilience)	X
Jae Lee	Seattle Center	
Jared Cummer	<i>Seattle Housing Authority</i>	
Lawrence Eichhorn	Seattle IT	X
Clinton Kaku	Seattle IT	
Benjamin Coulter	<i>Seattle Public Schools</i>	
Patti Quirk	Transportation	



# Seattle All-Hazards Mitigation Plan 5 Year Update

Mitigation Work Group  
Meeting #6:  
HMP Wrap-Up



# AGENDA MEETING #6

1. *Welcome*
2. *Schedule for Review and Approval*
3. *Comments Draft HMP*
4. *Worksheets/ Prioritization Criteria*
5. *Keeping the Plan Current*



# SCHEDULE FOR REVIEW AND APPROVAL

Final Draft for Review and Approval	February 1, 2020
Current HMP Expires	February 11, 2021
Disaster Management Committee Approval	February 25, 2021
Executive Emergency Board Approval	April 9, 2021
State & FEMA Review for Approvability	March – April 2021
Mayoral Promulgation	May 2021
City Council Adoption	May 2021
State & FEMA Approval	June/July 2021
EMAP Recertification Process Begins	July 2021



# DRAFT HMP AT A GLANCE

## Capabilities & Status

- 21 departments reported Capabilities (16 in 2015)
- Status of 54 actions (from 12 depts)
  - 43% complete
  - 24% ongoing
  - 33% incomplete

## Mitigation Actions

- 44 actions (54 in 2015)
- 12 of 21 MWG departments submitted actions (12 depts in 2015)
- Depts with actions: FAS, HSD, ITD, OEM, OPCD, OSE, SCL, SDCI, SDOT, SPR, SPL, SPU



# PUBLIC COMMENT PERIOD

- January 15-29 (2 weeks)
- Draft HMP Posted on website
- Survey and dedicated email to collect comments
- Narrated PP Presentation on website
- Promote via OEM newsletter and social media
- Ask DMC and SWG to review and promote the Draft HMP to their networks
- State of WA – informal preliminary review



# Mitigation Work Group Comments

- January 15-29 (2 weeks)
- Draft HMP Posted on Teams/SharePoint
- Word Format/ Track Changes
- Gather comments from others in your Dept; add to this version
- Questions / comments?



# MITIGATION ACTION WORKSHEETS

- Info added to List App on Teams/SharePoint
- Check information
- Fill in any gaps as much as possible.
- HIGHEST PRIORITY CRITERIA (Needed for EMAP Accreditation - Don't leave blank)
  - C1 Lives Saved - Will the implemented action result in lives saved?
  - C2 Reduce Damage - Will the implemented action result in a reduction of disaster damage?
- Questions / comments?





# MITIGATION ACTION WORKSHEETS

## Comprehensive Plan Update

### 1a. Mitigation Action Name \*

Comprehensive Plan Update

### Number

OPCD1

### 1b. Mitigation Action Description

WA Growth Management Act requires Seattle to update the comprehensive plan by June 2023. This is a foundational plan that guides Seattle's growth and development. [See more](#)

### 2a. Lead Dept/ Org

OPCD

### 2b. Division/ Line of Business (if applicable)

Long Range Planning

### 2c. Supporting Dept/ Org

All Depts

### 3. Action Status

New

### 4. Type of Action

Plans and Regulations

### 5. Hazards Addressed

All Hazards

### 6a. HMP Goals Supported

Life and Safety, Integrated Planning, Critical Infrastructure Protection, Property Protection, Resilient Economy, Natural Resource Protection

### 6b. RSJI Focus Areas

Inclusive Economy, Community Safety

### 6c. Description

Plan for future growth in ways that enhances equity and mitigates impacts to BIPOC communities..

### 7a. Location \*

Citywide, no specific or targeted location

### 7b. Location Description

citywide plan

### 7c. Benefit Area

Citywide

### 8. Timeline

1-3 years

### 9a. Anticipated Cost (if known)

500,000

### 9b. Funding Available

Anticipated

### 9c. Funding Source

—

### 10. Date

October 8, 2020

### 11a. Contact Name

Michael Hubner

### 11b. Phone

684-8380

### 11.c E-Mail

michael.hubner@seattle.gov

### C1-Lives Saved

Low

### C2-Reduce Damage

Low

### C3 Multiple Benefits

High

### C4-Collaboration

High

### C5-Racial Equity

High

### C6-Social

Medium

### C7-Technical

High

### C8-Administrative

High

### C9-Political

High

### C10-Legal

High

### C11-Economic

Low

### C12-Environment

Medium

### Attachments

Add or remove attachments

## Comments

Add a comment



Be the first one to add a comment



# KEEPING THE HMP CURRENT- ROLE OF MWG

## SPRING MWG MTG - STRATEGIC

- Emerging disaster damage trends and repetitive losses.
- Identification of new mitigation needs.
- Changes in membership to the MWG.
- After-Action Reports published that year.
- Equitable Mitigation

## FALL 2021 MWG MTG - STATUS

- Updates on Mitigation Actions
  - Status
  - Accomplishments
  - Cancelled actions
  - For completed projects - Actual losses avoided and benefits achieved by actions.
- New mitigation projects included in CIP or Upcoming Levies
- Grant Opportunities - BRIC
- Annual Mitigation Status Report

***Discussion: Other topics or activities for MWG Meeting?***



# WE DID IT!!!!!!

- Final questions, comments, suggestions?
- THANK YOU EVERYONE!!!





**City of Seattle**  
**Office of Emergency Management**  
**Disaster Management Committee (DMC) Meeting**  
**February 25, 2021 @ 10:30AM to 12PM**

---

*Welcome & Introductions – Curry Mayer, OEM*

**VOTE** – *Hazard Mitigation Plan – Patrice Carroll & Erika Lund, OEM*

This is the 5-year update to the Hazard Mitigation Plan, which offers us a chance to combine City planning efforts to promote hazard mitigation and allows us to stay eligible for FEMA mitigation grants. Those of you able to attend the 12/17/2020 DMC meeting had a briefing on plan content, process, and status at that time. With the help of Patrice Carroll, on loan from OPCD, and the Mitigation Work Group members, we have completed the review draft. DMC review is the next step in the HMP's approval process, and we will be asking for a vote as part of the upcoming DMC meeting on February 25, 2021. *(See attached email for details.)*

Please share with other interested colleagues and we look forward to you joining us on **Thursday, February 25th at 10:30 AM to 12 PM.**  
Virtual appointment details follow below.

**Disaster Management Committee  
February 25<sup>th</sup>, 2021  
Meeting Summary**

<b>Action Items:</b>	
<b>Item</b>	<b>Lead</b>
• <b>Welcome &amp; Introductions</b>	<b>Curry Mayer - OEM</b>
• <b>Vote on the Hazard Mitigation Plan</b>	<b>Patrice Carroll &amp; Erika Lund - OEM</b>
<b>Next DMC March 25th, 2021 10:30 AM – 12:00 noon WebEX Meeting</b>	

Curry Mayer welcomed everyone to the meeting and introduced Erika Lund and Patrice Carroll.

**VOTE – Hazard Mitigation Plan – Patrice Carroll & Erika Lund, OEM**

5-year update to the Hazard Mitigation Plan, brief pause during COVID response. Patrice has been critical in getting these updates completed.

Sent out draft for review last week and will be voting on it today.

Erika and Patrice provided a PowerPoint presentation (attached to these notes as a PDF) that included history of planning process.

Today's presentation will be a high fly over of the review of the Hazard Mitigation Plan which is a comprehensive document that weaves together all mitigation actions that various city departments have accomplished over the last 5-years as well as including an updated Seattle Hazard Impact and Vulnerability Assessment (SHIVA) Once it is approved today, it will go to the Mayor's Emergency Executive Board (EEB) for approval, the Mayor will promulgate to City Council for their vote, the plan will be sent to State EMD and FEMA for both their approval. This last step is significant as it qualifies Seattle to be eligible for federal reimbursement. Last, but not least, the acceptance of the Hazard Mitigation Plan is an important benchmark in Seattle's re-accreditation with the Emergency Management Accreditation Program (EMAP) which will take place this Fall.

**Mitigation Strategy for the Hazard Mitigation Plan Framework:**

Long-term outcome achieved through mitigation planning and implementation.

**6 Goals:**

- Protect life.
- Safeguard infrastructure.
- Protect public/private property.
- Protect the environment – new in 2015.
- Promote a resilient economy.
- Promote a collaborative mitigation plan.

**What is new for this update?**

- Impacts of COVID-19 on process, staff availability and public engagement.
- Expand the number of departments included in the process.
- Listing of major citywide plans, codes, and funding levels.

# **Disaster Management Committee**

## **February 25<sup>th</sup>, 2021**

### **Meeting Summary**

- Evolving information on community-led investments.
- Adjust criteria to reflect values – RSJI, collaboration, multiple benefits.
- FEMA influences integrated planning, making us more competitive in their Building Resilient Infrastructures and Community (BRIC) grants that fund larger projects.
- Meet EMAP requirements – Seattle seeking recertification.

The Hazard Mitigation Plan began with the SHIVA, which was published in 2013 and updated in 2018-2019.

#### **6 types of hazards likely to happen in the Seattle area according to the Hazard Mitigation plan:**

- Climate change
- Geologic
- Biologic
- Intentional
- Infrastructure
- Weather

#### **Plans for the next 5 years:**

- Continue retrofits to bridges and dams.
- Retrofit of three of the eight Carnegie libraries in Seattle.
- Integrate mitigation policies into the next Comprehensive Plan Update.
- Design multi-purpose infrastructure to protect South Park from sea level rise.
- Replace sea wall on N. Northgate Way.
- Seismic upgrades for the Riverton and Eastside reservoirs (outside Seattle jurisdiction).

#### **Racial Equity and Mitigation**

OEM 1- Expand partnerships for community led mitigation projects.

OEM 2 - Undertake an analysis to better integrate racial equity into the hazard mitigation program.

#### **Outreach and Engagement**

- Developed and outreach plan to account for COVID-19 social distancing restrictions.
- Sharing information via OEM newsletter (Oct, Nov, and Jan)
- Community Safety Ambassadors (CSA) survey
- Accessible materials (handouts and videos)
- 2-week comment period in January
- Input from Key stakeholders SWG, DMC, EEB most input was from these stakeholders, though the public was interested in the content.

#### **Suggestions made from this review by DMC members include:**

- Grammatical edits and corrections.
- Add content re: Seattle Fire Code.

TJ McDonald author of the SHIVA explained how the SHIVA was developed. Hazards are reassessed during each update which does result in re-ranking with each update. Highest hazard will dictate how Seattle Plans for hazards.

# Disaster Management Committee

## February 25<sup>th</sup>, 2021

### Meeting Summary

Next formal update to the SHIVA will be in 2022 though it is in constant review for edits.

#### Additional changes or questions:

**Question:** Does the ranking of Hazards influence out work priorities?

**Answer:** Departments have some influence based on their priorities. Though some things, like earthquakes are a constant. Some projects address multiple hazards, the most heavily addressed of which is earthquakes.

#### Vote

Curry asked for questions or comments prior to the vote.

- Laurel Nelson thanked Patrice on her incredible level of work in getting the HMP updated during this very difficult time responding to COVID.

Curry asked for a motion to accept the Hazard Mitigation Plan.

- Annie Searle motioned to accept the Hazard Mitigation Plan.
- Patti Quirk seconded the motion.
- A vote was taken and the Hazard Mitigation Plan passed unanimously.



DMC

2-25-2021-HMP Pres

#### Good of the Order:

Group and individual KUDOS and appreciation for Patrice Carroll for her work with OEM and the group on the Hazard Mitigation Plan.

<u>Attendees</u>					
Organization	Contact	Present	Organization	Contact	Present
<b>CBO</b>	Kara Hester-Main		<b>DON</b>	Tom Van Bronkhorst	<b>X</b>
<b>CBO</b>	William Chen		<b>SPR</b>	Jon Jainga	<b>X</b>
<b>FAS</b>	Jason Phillips		<b>SPR</b>	Will Beatie	<b>X</b>
<b>FAS</b>	Elenka Jarolimek	<b>X</b>	<b>SCL</b>	Jana Elliott	
<b>FAS</b>	Bruce Hori		<b>SCL</b>	Brittney Barnwell	
<b>FAS</b>	Randy Cox		<b>Mayor's Office</b>	Maritza Rivera	<b>X</b>
<b>FAS</b>	Torie Brazitis		<b>King County</b>	Nicholas Gibbons	
<b>FAS</b>	Chris Wiley		<b>King County Public Health</b>	Ali Levy	
<b>FAS</b>	David Kunselman	<b>X</b>	<b>King County Stormwater Services</b>	Mary Rabourn	



**Disaster Management Committee**  
**February 25<sup>th</sup>, 2021**  
**Meeting Summary**

<b>ART</b>	Flossie Pennington		<b>SHR</b>	Bobby Humes	
<b>HSD</b>	Jill Watson	<b>X</b>	<b>SDCI</b>	Kai Ki Mow	
<b>HSD</b>	Deborah Witmer	<b>X</b>	<b>SPD</b>	Sean O'Donnel	<b>X</b>
<b>HSD</b>	Lisa Gustaveson		<b>SDOT</b>	Patti Quirk	<b>X</b>
<b>ITD</b>	Dave Sutton	<b>X</b>	<b>SDOT</b>	Darren Morgan	
<b>Seattle IT (ITD)</b>	Harvey Arnone	<b>X</b>	<b>SFD</b>	James Collins	
<b>Seattle IT (ITD)</b>	Lawrence Eichhorn	<b>X</b>	<b>SFD</b>	Tony Lucero	<b>X</b>
<b>Seattle IT (ITD)</b>	Mary Wylie	<b>X</b>	<b>SFD</b>	Darian Davis	<b>X</b>
<b>Legislative</b>	Chris Galbraith	<b>X</b>	<b>SFD</b>	David Cuerpo	
<b>PCD</b>	Patrice Carroll	<b>X</b>	<b>DON</b>	Erin Cheuvront	<b>X</b>
<b>CEN</b>	Nate Brend		<b>SPS</b>	Benjamin Coulter	
<b>Seattle Center</b>	Katie Plymale		<b>SPU</b>	Ned Worcester	
<b>OED</b>	Meli Darby	<b>X</b>	<b>SPU</b>	Walter Vining	<b>X</b>
<b>OED</b>	Amanda Allen		<b>SPU</b>	Chad Buechler	<b>X</b>
<b>OIR</b>	Stacey Jehlik		<b>SPU</b>	Mark Jaeger	<b>X</b>
<b>OIRA</b>	Peggy Liao	<b>X</b>	<b>SPU</b>	Katie Dillon	
<b>City Attorney</b>	Gurjot Narwal	<b>X</b>	<b>SPU</b>	Ty Barrett	
<b>City Attorney</b>	Stephanie Dikeaks		<b>PHSKC</b>	Refram Patel	
<b>OEM</b>	Kate Hutton		<b>PHSKC</b>	Carina Elsenboss	
<b>OEM</b>	Matt Auflick		<b>SPU</b>	Linda Johnson	
<b>OEM</b>	Jennifer Carr		<b>SPS</b>	Carrie Nicholson	
<b>OEM</b>	Erika Lund	<b>X</b>	<b>Crisis Connections</b>	Avelino Estrada	
<b>OEM</b>	Ivan Lee	<b>X</b>	<b>OLS</b>	Yolanda Davis	
<b>OEM</b>	TJ McDonald	<b>X</b>	<b>Seattle HUBS</b>	Cindi Barker	<b>X</b>
<b>OEM</b>	Ken Neafcy	<b>X</b>	<b>NWHRN</b>	Cameron Taylor	
<b>OEM</b>	Laurel Nelson	<b>X</b>	<b>NWHRN</b>	Onora Lien	
<b>OEM</b>	Carrie Brazil		<b>City of Shoreline</b>	Jennifer Lord	
<b>OEM</b>	Chris Carmen	<b>X</b>	<b>Sound Transit</b>	Lori Bisping	
<b>OEM</b>	Tey Thach		<b>Port of Seattle</b>	Russ Read	
<b>OEM</b>	Lucia Schmit		<b>Puget Sound Fire</b>	Joe Root	
<b>OEM</b>	Carrie Tittel	<b>X</b>	<b>Visit Seattle</b>	Dave Blandford	
<b>OEM</b>	Curry Mayer	<b>X</b>			
<b>OEM Volunteer</b>	Chris Newling		<b>Seattle University</b>	Chris Wilcoxen	
<b>Seattle U</b>	Craig Buckton		<b>Vashon Be Prepared</b>	John Cornelison	
<b>SMC</b>	Elisa Sansalone		<b>Zone 3</b>	Sarah Miller	
<b>SMC</b>	Elisa Sansalone	<b>X</b>	<b>National Weather Service</b>	Reid Wolcott	<b>X</b>
<b>SDCI</b>	David Hudack		<b>Harborview</b>	Mark Taylor	
<b>SDCI</b>	Andrew Lunde		<b>Volunteer</b>	Bob Chandler	
<b>SPU</b>	Spruce Metzger	<b>X</b>	<b>Volunteer</b>	Diane Sugimura	

**Disaster Management Committee**  
**February 25<sup>th</sup>, 2021**  
**Meeting Summary**

<b>Seattle Housing</b>	Erica Snyder	<b>X</b>	<b>One Concern</b>	Debbie Weiser	
<b>Seattle Housing</b>	Janet Rodriguez	<b>X</b>	<b>Seattle Commission for People with Disabilities</b>	Kristina Sawyckyj	
<b>Washington Department of Commerce</b>	Tristan Allen		<b>SNAP Volunteer</b>	Helen Murphy	
<b>WA. NG 10<sup>th</sup> HRF</b>	Travis Wise		<b>PNWER/CRDR</b>	Eric Holdeman	
<b>Seattle Colleges District</b>	Michelle Valint		<b>PNNL</b>	Jessica Gray	
<b>U of W Emergency Mgmt</b>	Steve Charvat		<b>US Coast Guard</b>	Paul Stocklin	
<b>ACS</b>	Casey Hickerson		<b>US Coast Guard</b>	Aoe Bolling	
<b>Lake City Hubs/ACS</b>	Susanna Cunningham		<b>US Coast Guard</b>	Ed Gailer	
<b>SNAP / Hubs</b>	Ann Forest	<b>X</b>	<b>Martin Smith, Inc</b>	Ryan Smith	
<b>Seattle ACS</b>	Mark Sheppard		<b>American Red Cross</b>	Patrick Zweben	
<b>Boeing.</b>	Leah Rush	<b>X</b>	<b>American Red Cross</b>	Jamie Hill	<b>X</b>
<b>US Attorney's Office</b>	Michael Marzano		<b>Hearing Examiner Office</b>	Bonita Roznos	
<b>WA EMD</b>	Patrich Wicklund		<b>KC Emergency Management</b>	Barnaby Dow	<b>X</b>
<b>Crisis Connections</b>	Sylvia Fuerstenberg		<b>KC Emergency Management</b>	Kimberly Whitehead	
<b>DHS</b>	Jon Richeson		<b>The Seattle Guys</b>	Michael Sperrazza	
<b>DHS</b>	Allen Chung		<b>Wash DOT</b>	Kayla Grayson	
<b>HSD/ADS</b>	Brent Butler		<b>King County Metro</b>	Marcus Deyerin	
<b>HSD/ADS</b>	Cathy Knight		<b>NOAA/NWS</b>	Jeff Michuslki	
<b>UrbanRenGroup</b>	Shawn Wood	<b>X</b>	<b>Seattle Colleges</b>	Michelle Valint	<b>X</b>
<b>Zillow Group</b>	Siri McClean		<b>UW Medical</b>	Danica Little	
<b>UW M</b>	Randy Coggan		<b>UW Medical</b>	Rory McKenna	
<b>UW Edu</b>	Hans Scholl	<b>X</b>	<b>Consultants Seattle</b>	Unknown	
<b>Northeastern U</b>	Anna-Maria Jacobson		<b>National Weather Service</b>	Justin Pullin	
<b>Seattle Animal Shelter</b>	Jocelyn Bouchald	<b>X</b>	<b>Seattle Animal Shelter</b>	Caryn Cantu	<b>X</b>
<b>NetZero</b>	Andy Peck	<b>X</b>	<b>Disney</b>	David Bell	<b>X</b>
<b>King County</b>	Dan Cromwell	<b>X</b>	<b>Boeing</b>	Chris Bruner	<b>X</b>

**Disaster Management Committee**  
**February 25<sup>th</sup>, 2021**  
**Meeting Summary**

<b>UNK</b>	Jim Durand	<b>X</b>	<b>UNK</b>	Kthrailkill	<b>X</b>
<b>UNK</b>	Cameron Taylor	<b>X</b>	<b>UNK</b>	Nate Matthews-Trigg	
<b>UNK</b>	Annie Searle	<b>X</b>	<b>UNK</b>	Osman Huseny	
<b>UNK</b>	Barry Morgan	<b>X</b>	<b>UNK</b>	Mary Rabourn	
<b>UNK</b>	Nicole Johnson	<b>X</b>			

# **2021 Seattle All-Hazards Mitigation Plan Update**

## **Disaster Management Committee Plan Review & Approval**

**February 25, 2021**



# DMC REVIEW AND APPROVAL PROCESS

1. Briefing on Draft HMP at Dec 17 DMC Meeting
2. Draft HMP Plan emailed to DMC members on Feb 11
3. Discussion and vote at Feb 25 DMC Meeting



# PLANNING PROCESS



# WHAT IS THE ALL-HAZARDS MITIGATION PLAN (HMP)

- Comprehensive document
- Detailed information about the types of hazards we face (SHIVA)
- Actions we can take before disaster strikes
- Approved by Federal Emergency Management Agency
- Keeps Seattle eligible for FEMA mitigation grants





# MITIGATION STRATEGY FRAMEWORK

## **Goals** (6 goals)

Long-term outcome achieved through mitigation planning and implementation

## **Objectives** (18 objectives)

Help to define, group, organize actions. Objectives are broader than specific actions and connect goals with actual mitigation actions.

## **Actions** (47 actions)

Specific action taken to reduce risks from hazards and their impacts.

# GOALS

1. Protect life and safety and promote community resiliency.
2. Safeguard critical infrastructure and ensure continuity of service.
3. Protect public and private property.
4. Protect the natural environment and cultural and historic resources. ***NEW IN 2015***
5. Promote a resilient economy. ***CHANGED 2020***
6. Promote a collaborative and integrated mitigation program. ***NEW IN 2015***



# WHAT'S NEW FOR THIS UPDATE?

- Impacts of Covid-19 on process, staff availability, public engagement
- More departments
- Listing of major citywide plans, codes and funding levies
- Evolving information on community-led investments
- Adjust criteria to reflect values – RSJI, collaboration, multiple benefits
- FEMA influences - integrated planning, BRIC funding larger projects
- Meet EMAP requirements – Seattle seeking recertification



# 47 MITIGATION ACTIONS

Infrastructure/Capital Projects – 19 actions

Plans and Regulations - 9 actions

Assessments and Studies – 8 actions

Non-Structural Mitigation Measures – 5 actions

Natural Systems Protection – 4 actions

Education and Awareness – 2 actions

# MITIGATION WORK GROUP MEMBERS

<b>ARTS</b>	Flossie Pennington	<b>OH</b>	Dan Foley	<b>SFD</b>	Andy Collins
<b>CBO</b>	Jennifer Devore Kara Main Hester	<b>OPCD</b>	Patrice Carroll David Goldberg	<b>SPL</b>	Dennis Reddinger
<b>DON</b>	Sarah Sodt	<b>OSE</b>	TBD	<b>SPR</b>	Jon Jainga Scott Stevens
<b>FAS</b>	Elenka Jarolimek Julie Matsumoto	<b>PH- SKC</b>	Addison Houston	<b>SPR/ SPU</b>	Cynthia McCoy
<b>HSD</b>	Jill Watson	<b>SC</b>	Jae Lee	<b>SPU</b>	Michael Godfried
<b>ITD</b>	Lawrence Eichhorn Mary Wylie	<b>SCL</b>	Jana Elliot Brittany Barnwell	<b>PoS</b>	Kati Davich
<b>OED</b>	Jessica Sidhu	<b>SDCI</b>	Micah Chappell	<b>SHA</b>	Jared Cummer
<b>OEM</b>	Erika Lund TJ McDonald Laurel Nelson Lucia Schmit	<b>SDOT</b>	Patti Quirk	<b>SPS</b>	Benjamin Coulter

New for 2021 HMP



An aerial photograph of a city harbor, likely Seattle, featuring a large steel truss bridge spanning the water. The city skyline is visible in the background, and several boats are scattered across the blue water in the foreground.

# TYPES OF HAZARDS

1. **Climate Change** rising temps, sea level rise, less snowpack and stream flow
2. **Geologic Hazards** earthquake, landslides, volcanic, tsunamis, seiches
3. **Biologic Hazards** disease/ pandemic, bioterrorism
4. **Intentional Hazards** social unrest, attacks, cyber attack
5. **Infrastructure Hazards** transportation incidents, fire, hazmat incidents, infrastructure/ structural failure, power outages
6. **Weather Hazards** snow and ice, excessive heat events, water shortages, windstorms

# HAZARD RANKING CHANGES

## 2013

1. Earthquakes
2. Snow & Ice
3. Infrastructure Failures
4. Windstorms
5. Power Outages
6. Terrorism
7. Disease
8. Flooding
9. Excessive Heat
10. Fires
11. Tsunami & Seiches
12. Landslides
13. Transportation Incidents
14. Water Shortages
15. Social Unrest
16. HazMat Incident
17. Volcano Hazards
18. Active Shooter Incidents

## 2018-19

1. Earthquakes
2. Snow & Ice
3. Windstorms
4. Power Outages
5. Cyber-Attack
6. Landslides
7. Disease
8. Flooding
9. Excessive Heat
10. Tsunami & Seiches
11. Infrastructure and Structural Failures
12. Fires
13. Transportation Incidents
14. Water Shortages
15. Social Unrest
16. Attacks
17. HazMat Incidents
18. Volcano Hazards





# WHAT HAVE WE DONE?

<b>Studies and Assessments</b>	<ul style="list-style-type: none"><li>• Unreinforced masonry (URM) building inventory, assessment, policies</li><li>• Seismic assessment of community centers and pools</li><li>• Food security planning</li></ul>
<b>Infrastructure/ Capital Projects</b>	<ul style="list-style-type: none"><li>• Seismic upgrades to key City facilities</li><li>• Partnership with Community Roots Housing on seismic retrofit of affordable housing building</li><li>• Design of seismic retrofit for SCL operations center</li><li>• Separation of rail and arterial road for S. Lander St.</li></ul>
<b>Non-Structural</b>	<ul style="list-style-type: none"><li>• Emergency generators in key City facilities</li><li>• Upgraded technology and procedures to reduce vulnerability to cyber attacks</li></ul>
<b>Natural Systems Protection</b>	<ul style="list-style-type: none"><li>• Improved Thornton Creek confluence</li></ul>



# WHAT DO WE PLAN TO DO IN THE FUTURE?

Some of the 47 mitigation projects in the updated HMP:

- Seismic retrofits of bridges and dams
- Seismic retrofit of three Carnegie branch libraries
- Integrate hazard mitigation policies into the next Comprehensive Plan update
- Design multi-purpose infrastructure to protect South Park from sea level rise
- Replace the seawall on N Northgate Way
- Seismic upgrades for the Riverton and Eastside reservoirs



# RACIAL EQUITY & MITIGATION

- OEM 1 – Expand partnerships for community-led mitigation projects
  - Community survey on priorities & partners
- OEM 2 – Undertake an analysis to better integrate racial equity into hazard mitigation program
  - Mapping/ analysis of vulnerable populations & hazard impacts
  - More info on who benefits from different types of mitigation actions
  - Outreach strategies
  - Project prioritization criteria



# OUTREACH AND ENGAGEMENT

## Strategies

- Developed an Outreach Plan
- OEM newsletter (Oct, Nov and Jan)
- Short, Focused Community Survey (Community Safety Ambassadors)
- Accessible materials (Handout, Video)
- 2-week comment period in January
- Input from Key Stakeholders (SWG, DMC, EEB)

### Seattle All-Hazards Mitigation Plan Update







Every five years the City of Seattle Office of Emergency Management (OEM) updates the [All-Hazards Mitigation Plan \(HMP\)](#). This HMP helps us minimize risks to people, property, and the environment from natural and man-made disasters.

**What is the All-Hazards Mitigation Plan (HMP)?**

The HMP is a comprehensive document that contains detailed information about the types of hazards we face, and the actions we can take before disaster strikes to reduce our vulnerability. Once the HMP is updated, reviewed, and approved by the Federal Emergency Management Agency (FEMA), Seattle keeps its eligibility to apply for FEMA mitigation grants:

- Hazard Mitigation Grant Program (HMGP)
- Building Resilient Infrastructures and Communities (BRIC)
- Flood Mitigation Assistance Program

**What Types of Hazards are Assessed?**

 <b>GEOLOGIC</b> Earthquakes, landslides, tsunamis and seiches etc.	 <b>CLIMATE CHANGE</b> Rising temperatures, Sea level rise etc.	 <b>WEATHER</b> Extreme heat, flooding, snow and ice, windstorms etc.	 <b>BIOLOGICAL</b> Disease/pandemic, bioterrorism etc.	 <b>INFRASTRUCTURE</b> Transportation incidents, fires, infrastructure failure etc.	 <b>INTENTIONAL</b> Attacks, social unrest, cyber attacks etc.
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**Timeline**

The HMP Update needs to be completed in 2021. A technical analysis of known hazards, [Seattle Hazard Identification and Vulnerability Analysis \(SHIVA\)](#), was updated in 2019. Staff from various departments are working together to review the existing HMP, capitol programs and other departmental plans.

Risk Assessment 2019

→

Capability Assessment 1Q/2Q 2020

→


Mitigation Strategies 3Q/4Q 2020

→

Draft HMP for Public Review 4Q 2020




→

Begin Approval Process 1Q 2021

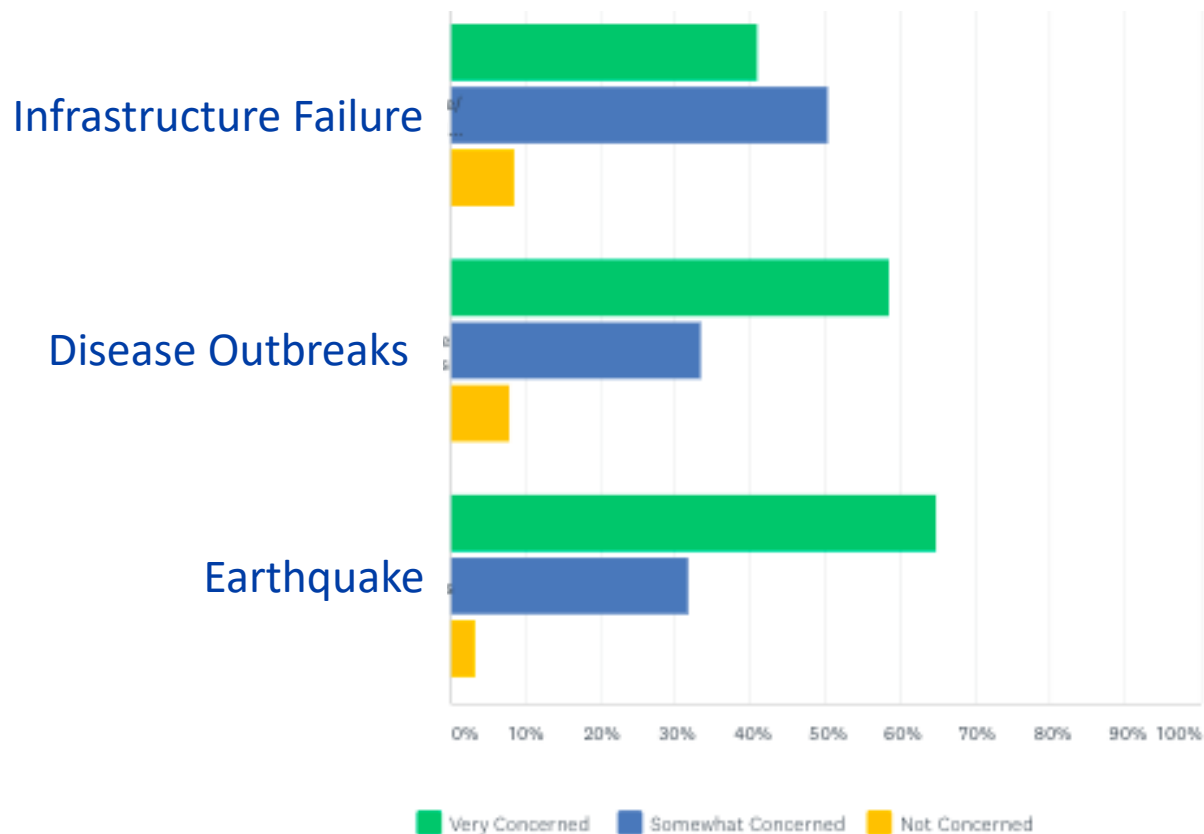
  
Seattle Office of Emergency Management

Email your questions or comments to:  
[HazardMitigationPlanUpdate@seattle.gov](mailto:HazardMitigationPlanUpdate@seattle.gov)

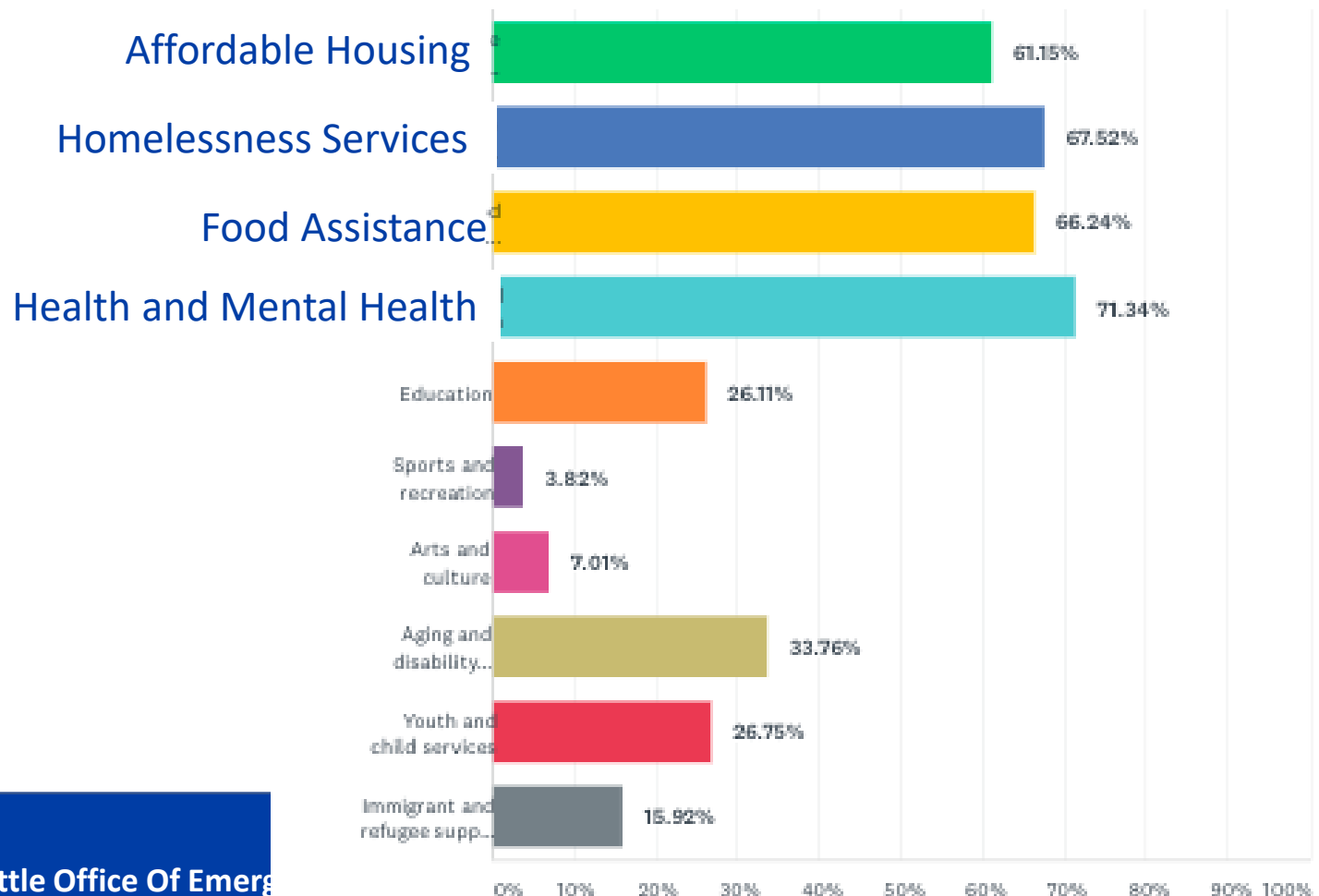
Follow OEM on social media and sign up for our [newsletter](#) to follow the progress of the HMP!



# How concerned are you about the following hazards?



# What types of community services are most important to protect through mitigation projects?



# Questions & Voting

Changes from the previous Draft

- Edits and corrections
- Add content re: Fire Code

Additional Changes Needed?

Vote to Approve





**QUESTIONS?**

**THANK YOU  
FOR HELPING US  
BUILD A MORE RESILIENT SEATTLE**

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**CITY OF SEATTLE**  
**EMERGENCY EXECUTIVE BOARD**

**The Mayor's Emergency Executive Board is composed of the Mayor's Senior Staff and Key Departments or Agency Heads that assemble to address Policy related issues as part of emergencies and disasters.**

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April 9, 2021  
11:00AM to 12:00PM  
Microsoft teams meeting

**Welcome and Introductions**

**Hazard Mitigation Plan - Review and Vote**

The Hazard Mitigation Plan update includes the most current Seattle's Hazard Impact and Vulnerability Assessment (SHIVA) along with all mitigation actions that various city departments have accomplished over the last 5-years. We are asking for EEB to approve this plan so it can move onto Council approval, then on to State and FEMA approval ensuring Seattle continues to be eligible for federal disaster response reimbursement.

**February Snow Event After Action Review (AAR) - Review and Vote**

The Emergency Operations Center activated virtually February 13 - 15 to support operational objectives resulting in snow and cold temperatures. As with all AARs the DMC has reviewed and approved this prior to bringing it to the EEB for approval.

**Updated Training and Exercise Plan - Review and Vote**

The 2019 published and approved Training & Exercise Plan has been updated. This Plan outlines our Training & Exercise efforts and intent for 2021 into 2022 and focuses on preparation for the 2022 Cascadia Earthquake Exercise intended to engage cities, counties, regions, State and Federal level partners. The DMC has reviewed and accepted this update.

**Updated Military Support Operations Annex - Review and Vote**

The 2016 published and approved Military Support Operations Annex has been updated. This Plan outlines how the City will access and leverage state and federal military resources during a catastrophic disaster. The DMC has reviewed and accepted this update.

**2021-2022 Citywide Emergency Management Program Strategic Plan - Review and Vote**

The Strategic Plan has been updated the last seven years. This update was done in consideration of impacts from the 2020 COVID-19 response. As in years past the Strategic Work Group (SWG), key partners and OEM convened to review the current plan, define projects and objectives, and identified adjustments and reprioritization for 2021 and beyond. The Strategic Plan continues to focus specifically on citywide priority projects; working in tandem the Emergency Support Function document lays out

specific work to be accomplished by departmental emergency management personnel. The DMC has reviewed and accepted this update.

**Earthquake Incident Annex Discussion & Prep for May 4 Executive Leadership Seminar**

This annex is part of the City of Seattle Comprehensive Emergency Management Plan (CEMP). It aligns with the processes and structures described in the CEMP, while providing additional detail on how the City would coordinate its response to a severe earthquake and associated hazards detailed in the Seattle Hazard Identification and Vulnerability Analysis (SHIVA) including aftershocks, tsunami, seiche, landslides, and liquefaction. An overview of new key strategies will be presented, including leader's intent and delegation of authority/de-centralized operations.

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**CITY OF SEATTLE**  
**EMERGENCY EXECUTIVE BOARD**

---

**April 9, 2021**  
**11:00AM to 12:00PM**  
**Microsoft Teams Meeting**

**Welcome and Introductions**

Mayor Durkan welcomed everyone. She toured the new light rail station in North Seattle and will be at the COVID vaccine site at Centra De La Raza later today. So proud of the work we have done in this 18-month year of 2020! Seattle will do 30,000 vaccines this week; 55% of the BIPOC population in Seattle has been vaccinated to date. So proud to see hope on the horizon.

Curry welcomed and thanked everyone for the great work they contribute to the overall Emergency Management work being done. We have five (5) plans to review and approve today, as well as review Earthquake Incident Annex in preparation of upcoming May Homeland Security Executive Exercise. She asked if there were any questions?

**Hazard Mitigation Plan**

The Hazard Mitigation Plan update includes the most current Seattle's Hazard Impact and Vulnerability Assessment (SHIVA) along with all mitigation actions that various city departments have accomplished over the last 5-years. We are asking for EEB to approve this plan so it can move onto Council approval, then on to State and FEMA approval ensuring Seattle continues to be eligible for federal disaster response reimbursement.

*Curry asked if there were any questions or discussion points regarding the Hazard Mitigation Plan? There were none. Jesus Aguirre made the motion to approve the Hazard Mitigation Plan; Patty Hayes seconded the motion. Cameras were turned on and EEB members were asked for show of hand for approval, and to post any dissention put in Chat. The Hazard Mitigation Plan passed unanimously.*

**February Snow Event After Action Review (AAR)**

The Emergency Operations Center activated virtually February 13 - 15 to support operational objectives resulting in snow and cold temperatures. As with all AARs the DMC has reviewed and approved this prior to bringing it to the EEB for approval.

*Curry asked if there were any questions or discussion points regarding the February Snow Event AAR? There were none. Pamela Banks made the motion to approve the February Snow Event AAR; Bobby Humes seconded the motion. Cameras were turned on and EEB members were asked for show of hand for approval, and to post any dissention put in Chat. The February Snow Event AAR passed unanimously.*

### **Updated Training and Exercise Plan**

The 2019 published and approved Training & Exercise Plan has been updated. This Plan outlines our Training & Exercise efforts and intent for 2021 into 2022 and focuses on preparation for the 2022 Cascadia Earthquake Exercise intended to engage cities, counties, regions, State and Federal level partners. The DMC has reviewed and accepted this update.

*Curry asked if there were any questions or discussion points regarding Training and Exercise Plan? There were none. Chief Scoggins made the motion to approve the Training and Exercise Plan; Lilly Wilson-Codega seconded the motion. Cameras were turned on and EEB members were asked for show of hand for approval, and to post any dissent put in Chat. The Training and Exercise Plan passed unanimously.*

### **Updated Military Support Operations Annex**

The 2016 published and approved Military Support Operations Annex has been updated. This Plan outlines how the City will access and leverage state and federal military resources during a catastrophic disaster. The DMC has reviewed and accepted this update.

*Curry asked if there were any questions or discussion points regarding the Military Support Operations Annex? There were none. Bobby Humes made the motion to approve the Military Support Operations Annex; Chief Scoggins seconded the motion. Cameras were turned on and EEB members were asked for show of hand for approval, and to post any dissent put in Chat. The Military Support Operations Annex passed unanimously.*

### **2021-2022 Citywide Emergency Management Program Strategic Plan**

The Strategic Plan has been updated the last seven years. This update was done in consideration of impacts from the 2020 COVID-19 response. As in years past the Strategic Work Group (SWG), key partners and OEM convened to review the current plan, define projects and objectives, and identified adjustments and reprioritization for 2021 and beyond. The Strategic Plan continues to focus specifically on citywide priority projects; working in tandem the Emergency Support Function document lays out specific work to be accomplished by departmental emergency management personnel. The DMC has reviewed and accepted this update.

*Curry asked if there were any questions or discussion points regarding the 2021-2022 Citywide Emergency Management Program Strategic Plan? Bobby Humes asked what the logic in having a one-year plan was? Curry answered that this plan is normally updated every two-years, because of COVID we looked at this plan in the scope of COVID response and how we re-prioritize on citywide emergency management priorities. Lilly Wilson-Codega made the motion to approve the 2021-2022 Citywide Emergency Management Program Strategic Plan; Patty Hayes seconded the motion. Cameras were turned on and EEB members were asked for show of hand for approval, and to post any dissent put in Chat. The 2021-2022 Citywide Emergency Management Program Strategic Plan passed unanimously.*

### **Earthquake Incident Annex Discussion & Prep for May 4 Homeland Security Executive Exercise**

This annex is part of the City of Seattle Comprehensive Emergency Management Plan (CEMP). It aligns with the processes and structures described in the CEMP, while providing additional detail on how the City would coordinate its response to a severe earthquake and associated hazards detailed in the Seattle Hazard Identification and Vulnerability Analysis (SHIVA) including aftershocks, tsunami, seiche, landslides, and liquefaction. An overview of new key strategies will be presented, including leader's intent and delegation of authority/de-centralized operations. In the scope of how this document will help queue up the May Homeland Security Executive Exercise we will look at the cascading events that most likely will take place after a significant earthquake. Including an interruption of utility services, roadway arterial and bridge impacts, and lost animals, including Woodlawn Park Zoo. By the way Woodlawn Park Zoo does have emergency plans, that address the chance of some animals not being secure. Animal sheltering is also a large component of sheltering of people that have pets. Isolated neighborhoods, also known as islanding. This is a multi-faceted issue that impacts assistance from neighboring jurisdictions, ability to deliver necessary supplies, staff's ability to report to work and/or respond to emergencies. The concept of Resilient Islands is the strategic placement of supplies that would be needed in areas of isolation. Discussion of Leaders Intent will also be part of the exercise. This is an effort to have your staff to have a clear understanding on their role in response immediately after an event, without the ability to communicate with their superiors. The Federal government has a Community Life Lines concept that prioritize response to bring back critical services such as communication, transportation, technology, and water.

#### ***Question/Answers:***

- Sam asked in preparation of the Executive Exercise for the transportation component to have better coordination with neighboring transportation partners. He has asked his staff to reach out to KC Metro to ensure their plans are aligned. Will any representatives from KC be attending? Curry answered that the KC OEM Director will be present, it might be good to plan a stand-alone exercise with SDOT and their counterparts to go through similar exercise.
- Chief Scoggins asked if other cities are using drones immediately after disasters to access damage? He mentioned Washington State Patrol using drones after train derailment allowing information to be sent to National Transportation Safety Board before their investigators arrived on scene to assist in accessing the accident. Curry said she will find out what other cities are doing nationally and report back to EEB.
- Mariko is concerned about islanding, aside from West Seattle is there a list of locations that could be impacted and community demographic that might be affected? Curry answered One Concern has done some work in GIS mapping on this issue, will share out that information.



<b>ATTENDEES</b>					
<b>Department</b>	<b>Contact</b>	<b>Present</b>	<b>Department</b>	<b>Contact</b>	<b>Present</b>
<b>Mayor</b>	Jenny Durkan	<b>x</b>	<b>PHSKC</b>	Patty Hayes	<b>X</b>
<b>Sr. Deputy Mayor</b>	Mike Fong	<b>X</b>	<b>Seattle Center</b>	Deborah Daoust for Robert Nellams	<b>X</b>
<b>Deputy Mayor</b>	Casey Sixkiller		<b>Office of Housing</b>	Emily Alvarado	<b>X</b>
<b>Deputy Mayor</b>	Tiffany Washington		<b>OSE</b>	Jessica Finn Coven	
<b>Public Safety Advisor</b>	Julie Kline	<b>X</b>	<b>Library</b>	Tom Fay	<b>X</b>
<b>Budget Office</b>	Ben Noble		<b>SCL</b>	Debra Smith	<b>X</b>
<b>Sr. Operations Manager</b>	Maritza Rivera	<b>X</b>	<b>SDCI</b>	Nathan Torgelson	
<b>Mayor's Legal Council</b>	Michelle Chen	<b>X</b>	<b>OIR</b>	Lily Wilson-Codega	<b>X</b>
<b>Communications Director</b>	Kamaria Hightower		<b>SDOT</b>	Sam Zimbabwe	<b>X</b>
<b>Policy Director</b>	Adrienne Thompson	<b>X</b>	<b>SDHR</b>	Bobby Hume	<b>X</b>
<b>FAS</b>	Calvin Goings	<b>X</b>	<b>SFD</b>	Harrold Scoggins	<b>X</b>
<b>City Attorney</b>	Pete Holmes	<b>X</b>	<b>OPCD</b>	Ubax Gardheere for Rico Quirindongo	<b>X</b>
<b>DEEL</b>	Dwane Chappelle		<b>SHA</b>	Andrew Lofton	
<b>DON</b>	Sarah Morningstar for Andres Mantilla	<b>X</b>	<b>Seattle IT</b>	Saad Bashir	
<b>HSD</b>	Helen Howell	<b>X</b>	<b>SPR</b>	Jesús Aguirre	<b>X</b>
<b>Civil Rights</b>	Mariko Lockhart	<b>X</b>	<b>SPU</b>	Keri Burchard-Juarez for Mami Hara	<b>X</b>
<b>OED</b>	Pamela Banks	<b>X</b>	<b>SPD</b>	Adrian Diaz	
<b>OEM</b>	Curry Mayer	<b>X</b>	<b>OIRA</b>	Cuc Vu	
<b>OEM</b>	Laurel Nelson	<b>X</b>	<b>HSD</b>	Joseph Kasperski	<b>X</b>
<b>Library</b>	Rick Sheridan	<b>X</b>			





## APPENDIX C      STAKEHOLDER ENGAGEMENT

Outreach and Engagement Plan

Community Mitigation Survey Highlights

Community Mitigation Survey Results

Seattle HMP 1-pager Handout

OEM Webpage Mitigation Plan 2021 Update Screenshots

OEM Newsletters

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**OUTREACH AND ENGAGEMENT PLAN**

**CITY OF SEATTLE**

**ALL HAZARD MITIGATION PLAN UPDATE**

**November 2020**



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## 1.0 INTRODUCTION

The City of Seattle Office of Emergency Management (OEM) is conducting an update of the Seattle All-Hazards Mitigation Plan (HMP). The purpose of the HMP is to strategically guide actions and investments to reduce the impacts of natural and human-caused hazards on human life and property. Updates are required every five years, and the last update of the HMP was approved by FEMA in February 2016.

This Outreach and Engagement Plan (Plan) describes opportunities for the public and stakeholders to be involved during the update process. This Plan is designed to meet the requirements of:

- FEMA Local Mitigation Planning Handbook, Task 3 Create an Outreach Strategy
- 44 Code of Federal Regulations (CFR) §201.6, and
- Emergency Management Accreditation Program (EMAP) Standard 4.4.

### Impacts of COVID-19 Pandemic

The update process was initiated in January 2020. Once the impact of the emerging pandemic became clear, staff resources were redeployed to address the urgent work of coordinating federal grants and aid to help the City through this emergency.

Work on this update was paused, then restarted in fall 2020. In order to complete the update before the current plan expired, outreach and engagement plans were streamlined and focused. This plan reflects those constraints.

Governor Inslee's Stay Home – Stay Healthy Order issued on March 23, 2020 means that all public outreach and engagement for the All Hazard Mitigation Plan Update must take place virtually. In person community briefings, meetings, and events are not possible because of this global health crisis. Connecting with public sector stakeholders has also been challenging due to the increased demands on staff during this time. We will continue to look for additional opportunities and creative ways to engage with communities, and to focus on feedback essential to this work.

## 2.0 OUTREACH AND ENGAGEMENT OBJECTIVES

The Plan is designed to meeting the following objectives:

- Raise awareness of hazard mitigation, the update process and when opportunities to provide input will occur.
- Provide the opportunity to all who live, work and play in Seattle to participate in the update process.
- Ensure a process that is open and transparent, culturally sensitive, accessible, and ensures that input is considered.
- Gather input in ways that are safe for staff and the public during the COVID-19 Pandemic.
- Ask for input where the public feedback can authentically influence the plan.

## 3.0 OUTREACH STRATEGY

Developing a Hazard Mitigation Plan requires participation and input from a range of City departments and partners in the planning process. To that end, OEM will implement a transparent approach to

providing clear and accurate information through written materials and graphics that allow the public to easily engage in the process, receive information, and have their voices heard.

The key elements of this public involvement strategy include virtual meetings with community members and stakeholder groups to engage them in the HMP update process. The activities and materials outlined in the following sections will be used together to ensure that the public is aware of the project and understands the need for updating the plan.

### 3.1 Key Messages

It is critical that key messages communicated about the project remain consistent. Key messaging will minimize the risk of presenting inconsistent information to the community and help keep the project moving forward efficiently, on schedule.

- The City of Seattle Office of Emergency Management (OEM) is conducting an update of the HMP.
- Updates are required every five years. Keeping the HMP current is a good emergency management practice for the people of Seattle, and allows the City to maintain eligibility for state and federal mitigation funds that support mitigation activities such as:
  - Seismic risk assessments and retrofit projects.
  - Urban flooding hazard identification.
  - Public education efforts surrounding risks of unreinforced masonry buildings.
- The purpose of the HMP is to strategically guide actions and investments to reduce the impacts of natural and human caused hazards on human life and property.
- This HMP is one plan in a suite of plans maintained by OEM as required by City codes. Other plans include the Comprehensive Emergency Management Plan, Continuity of Government, Continuity of Operations Plans, and Disaster Recovery Framework.
- The HMP keeps the City eligible for millions of dollars in federal hazard mitigation grants.

### 3.2 Key Audiences and Stakeholders

Key audiences identified to participate in the HMP may choose various ways to participate including receive project updates, take polls or surveys, review and provide comments on a public draft of the HMP via email. City departments and key external stakeholders participate in the Mitigation Work Group which meets regularly to update status of projects annually and update the HMP every five years.

The DRAFT HMP will be provided directly to a wide variety of stakeholders via email with a request for comment. This will include representatives from neighboring government jurisdictions, city departments, regional transit agencies, healthcare institutions, community-based organizations, colleges and universities, business and economic development organizations, and elected officials.

### 3.3 Key Planning Considerations

Every public outreach process is unique and presents a variety of opportunities and challenges for the planning team. The following key planning considerations have been identified as potentially impacting this project and the planning team, along with strategies to address issues as they arise.

### *Outreach during the COVID-19 Pandemic*

The HMP could potentially benefit anyone within Seattle's borders at the time of a hazardous event. While all members of the public will be encouraged to participate and provide project input, the pandemic has restricted what can be accomplished. Even in normal circumstances, the City has limited resources and must be prioritized to maximize outreach effectiveness across a broad spectrum of stakeholders. The pandemic has made it even more challenging to do extensive outreach. To maximize the project's reach, the project team will leverage resources to invite online participation. OEM will rely on contact lists, social media, newsletters associated with City departments that are part of the Mitigation Work Group.

### *Input from Diverse Communities*

The HMP is intended to mitigate (i.e., reduce exposure to) hazards for all residents of Seattle, and non-residents within the city's borders at the time a hazardous event occurs. The HMP update process will not create disproportionate impacts on a particular population or geographic area. However, access to the planning and decision-making process must ensure that diverse voices are heard, and that priorities and strategies emerge that reflect multi-cultural perspectives and are racially equitable. OEM will use its Community Safety Ambassador program to solicit input from diverse communities. Input sought will be focused on prioritizing the types of potential future mitigation project community partnerships, and which services are most important to protect from future disaster.

## **4.0 INCLUSIVE OUTREACH AND PUBLIC ENGAGEMENT ACTIVITIES**

The following outreach activities will be used to engage the public in the Seattle HMP update process:

### **4.1 Mitigation Work Group**

OEM established a Mitigation Work Group (MWG) made up of City representatives and key stakeholders. The MWG meets regularly to discuss mitigation actions, annual progress, grant opportunities and the 5-year update. Mitigation Work Group members will serve as project liaisons to community groups and interests, they represent. The group will meet five times throughout the HMP update process and are encouraged to assist with public outreach and engagement through their department/agency digital media.

### **4.2 Public Website**

OEM will establish space on their public website to share information about the HMP. The website will include the following basic information:

- Project description
- Downloadable one-page summary about the HMP update
- Dedicated email address ([HazardMitigationPlanUpdate@seattle.gov](mailto:HazardMitigationPlanUpdate@seattle.gov))
- Outreach and Public Engagement materials (see below)

### **4.3 Stakeholder Meetings**

In addition to the MWG, other stakeholders will have opportunity to provide input during development of the plan. The information about the DRAFT HMP will be presented during online meetings of following key stakeholder groups to solicit input and feedback:



- Seattle Disaster Management Committee (includes 200+ representatives of City departments, King County agencies, local non-profits, NW Healthcare response network, University of Washington, 211 partners agencies, community emergency hubs)
- Strategic Work Group (internal working group of representatives of City departments)
- Emergency Executive Board (Sub-cabinet of department directors convened by Mayor's Office)

#### 4.4 Traditional and Social Media

The broader public will be invited to learn about the project, respond to polling question and comment on the DRAFT HMP. The following media will be used to communicate with the broader public:

- OEM general email list
- OEM Community Organizations email list
- Community HUBS email list
- OEM Newsletter
- Posts on OEM social media

#### 4.5 Outreach and Public Engagement Materials

The following materials will be developed to keep the public informed throughout the HMP update process to ensure that a wide range of stakeholders (the public, neighboring communities, interested agencies, private organizations, etc.) are informed about opportunities to comment on the plan at key milestones. Project materials will follow the City's IOPE Guide in striving for multiculturalism, with equal access and respect for all groups and creating conditions for understanding. Materials will include:

- News release. The project team will develop one news release for submittal to local media outlets. The release will be issued upon completion of the Draft HMP to solicit comments on the planning document.
- Website updates. The project team will post periodic updates regarding the HMP update process to the OEM's website.
- Community Partnership Survey. A survey will be developed to solicit input on types of mitigation partnerships OEM could develop in the future.
- Comment form/survey to collect feedback on the Draft HMP.
- Draft HMP Presentation. A narrated presentation about the Draft HMP will be posted on the website to solicit input. It will summarize the HMP process, timeline, changes in hazards and highlight select actions, and ask questions that will help finalize the plan.
- Narrated presentation about the Draft HMP
- Instructions on how to submit comments on the Draft HMP

## 5.0 OUTREACH TIMELINE

The table below provides estimated public outreach dates and milestones related to the HMP update process.

Milestone	Timing	Description
Mitigation Work Group Meeting #1	January 28, 2020	Overview of project
Project paused due to COVID-19 Pandemic (March – August 2020)		
OEM Website update	September 2020	Website is updated with HMP description and timeline.
Mitigation Work Group Meeting #2	September 14, 2020	Restart process; review progress and milestones
OEM Newsletter	September 16, 2020	HMP information included in the September newsletter distributed to 6000+ people
Mitigation Work Group Meeting #3	September 28, 2020	Present results of first open house and comment period to inform work
Community Survey	November	OEM shares survey about community priorities on website, social media, newsletter
Mitigation Work Group Meeting #4	November 4, 2020	Monitoring the HMP; Public outreach for Draft HMP
Stakeholder Meetings (SWG, DMC)	November/ December	Input on HMP
Mitigation Work Group Meeting #5	December 7, 2020	Review public comments, refine and rank mitigation actions
Public Comment Period (3 weeks)	January 2020	Solicit public comments on the Draft HMP
Outreach for Draft Plan	January 2020	OEM and City-media notices, releases, stories to solicit comment on Draft HMP
Mitigation Work Group Meeting #6	January 2020	Review public comments and finalize HMP.
Pre-review of Draft HMP by State and FEMA	January 2020	
DMC and EEB Review and Approval	1Q/2Q 2021	Final HMP is submitted to EEB and DMC



City Council Adoption	2Q 2021	Final HMP is submitted to City Council for review and adoption
State/FEMA Approval	2Q/3Q 2021	Adopted HMP is submitted to State and FEMA for review and approval

# Hazard Mitigation Community Survey Highlights

In November of 2020 OEM released a community survey to collect information about community perceptions of hazards and priorities for hazard mitigation projects. This survey was part of the update to the Seattle Hazard Mitigation Plan (HMP) which will be finalized in 2021. What did you tell us?

## Top 5 hazards that respondents were "VERY CONCERNED" about:



EARTHQUAKE

65%



DISEASE  
OUTBREAKS

59%



INFRASTRUCTURE  
FAILURE

41%



SMOKE/POOR AIR  
QUALITY

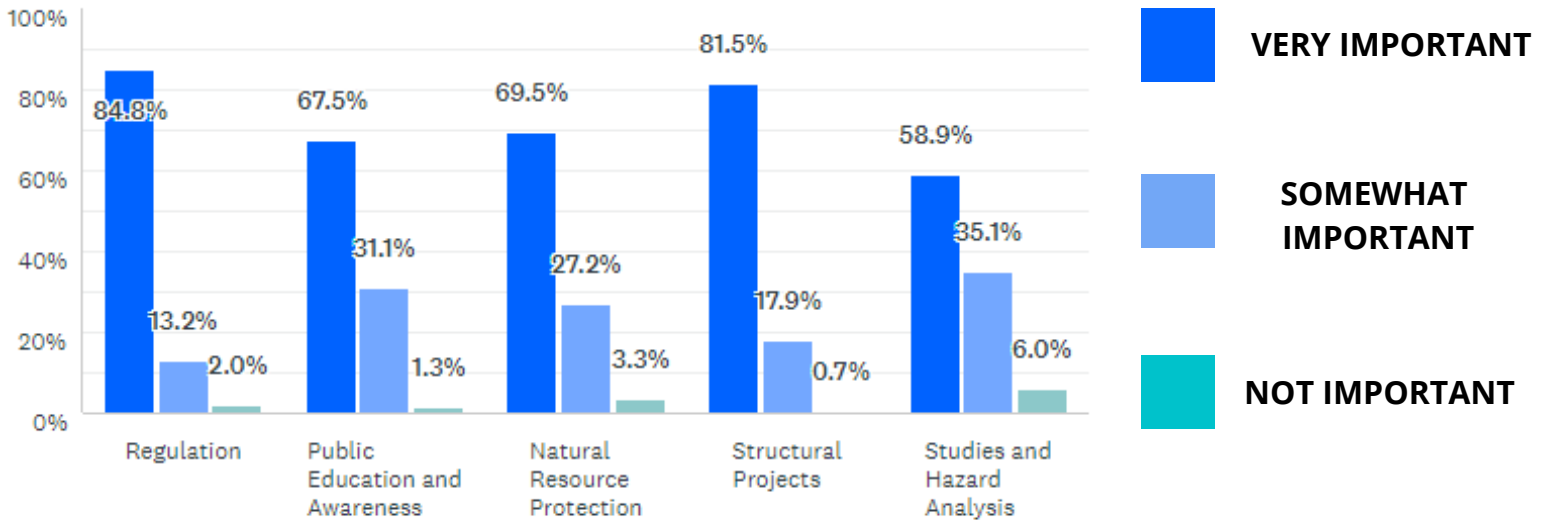
40%



CYBER ATTACK  
/DISRUPTION

37%

## Which risk reduction strategies did respondents think are most important?



## Top Four community services respondents think should be protected through mitigation efforts:



HEALTH AND  
MENTAL HEALTH



HOMELESSNESS SERVICE/  
EMERGENCY SHELTER



FOOD ASSISTANCE/  
FOOD BANKS



AFFORDABLE HOUSING/  
HOUSING ASSISTANCE



Seattle Office of  
Emergency Management

Email your questions or comments to:

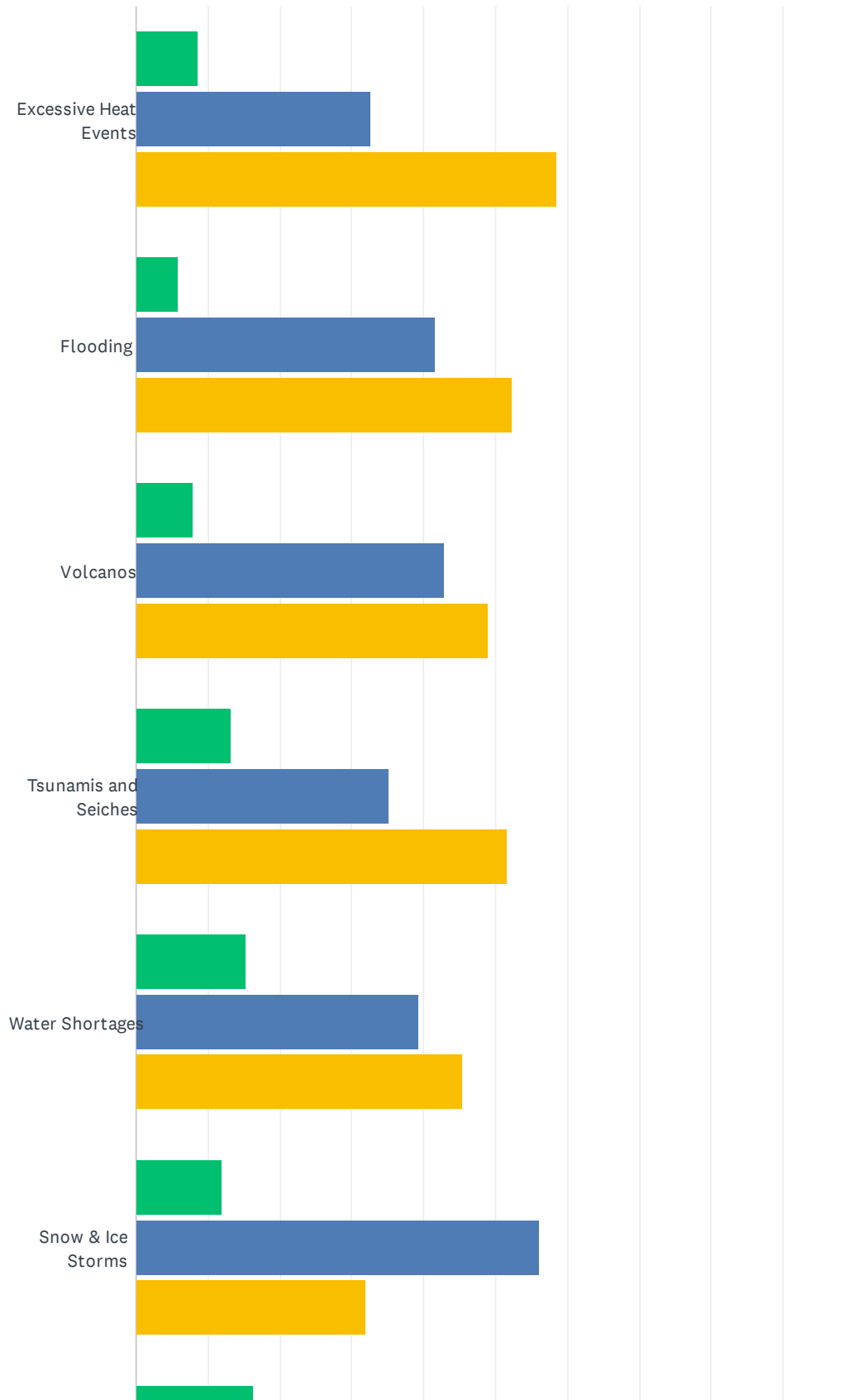
[HazardMitigationPlanUpdate@seattle.gov](mailto:HazardMitigationPlanUpdate@seattle.gov)

Follow OEM on social media and sign up  
for our [Newsletter](#)

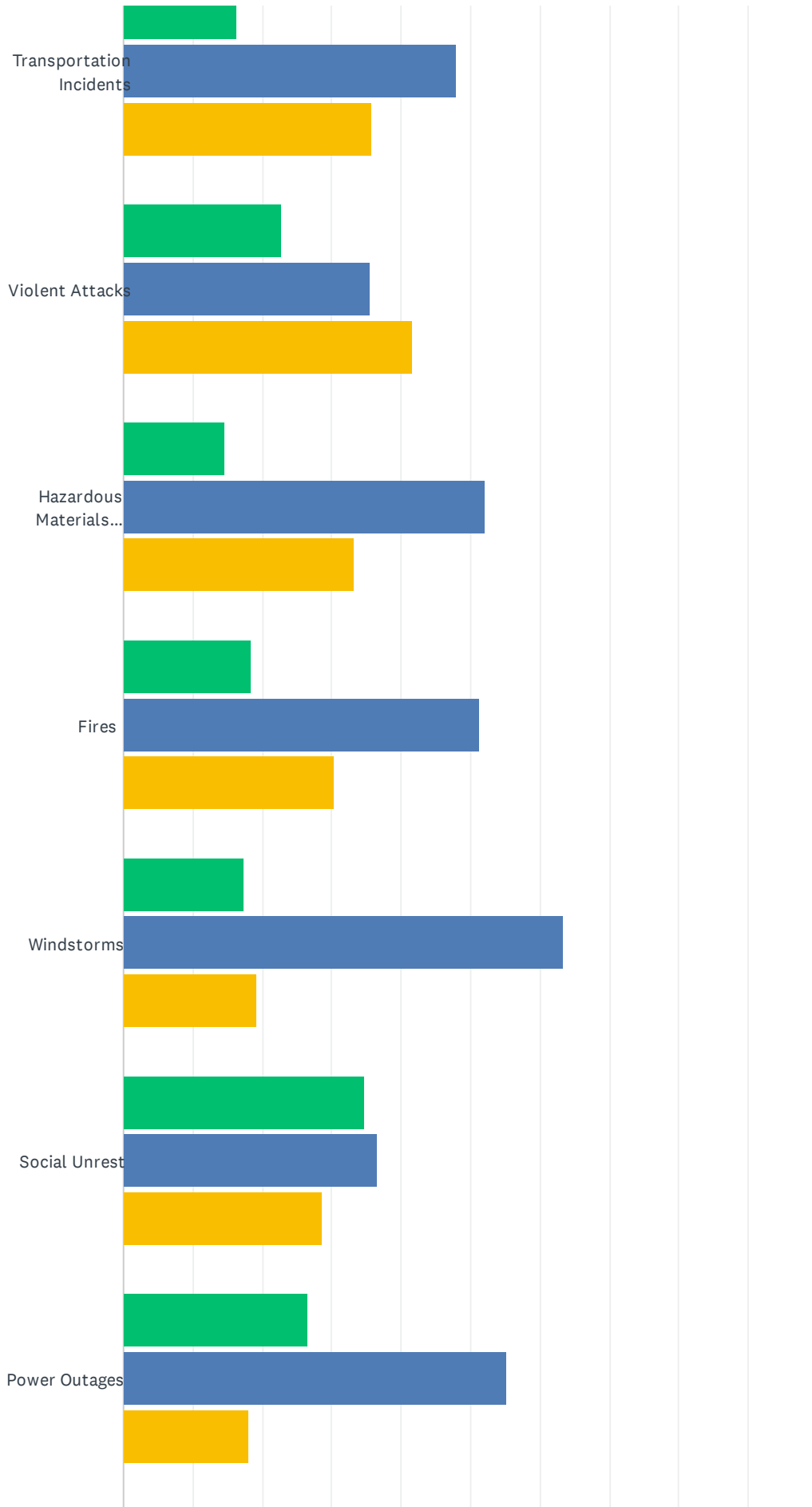


## Q1 How concerned are you about the following hazards in Seattle?

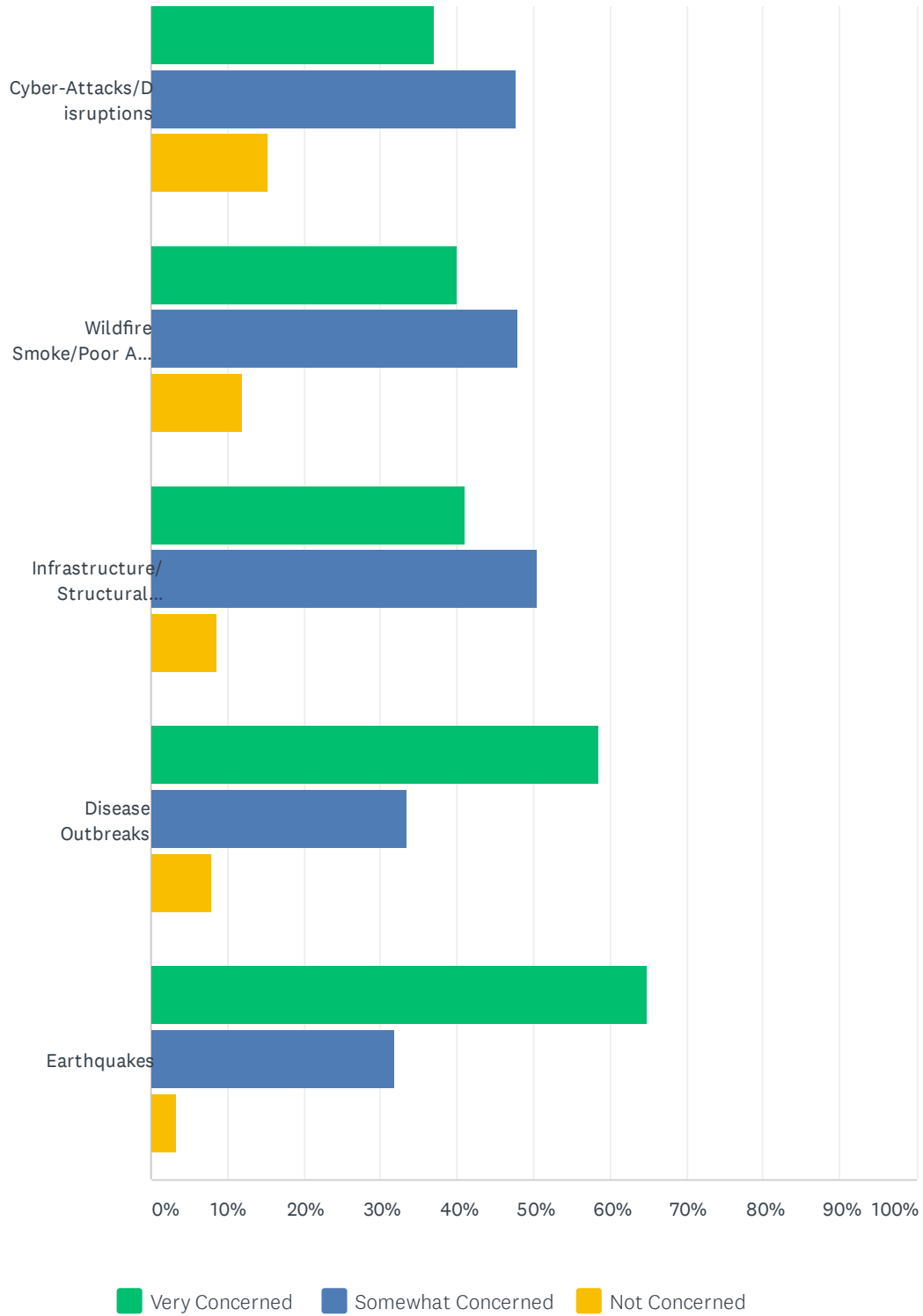
Answered: 152 Skipped: 5



## Community Mitigation Input



## Community Mitigation Input





## Community Mitigation Input

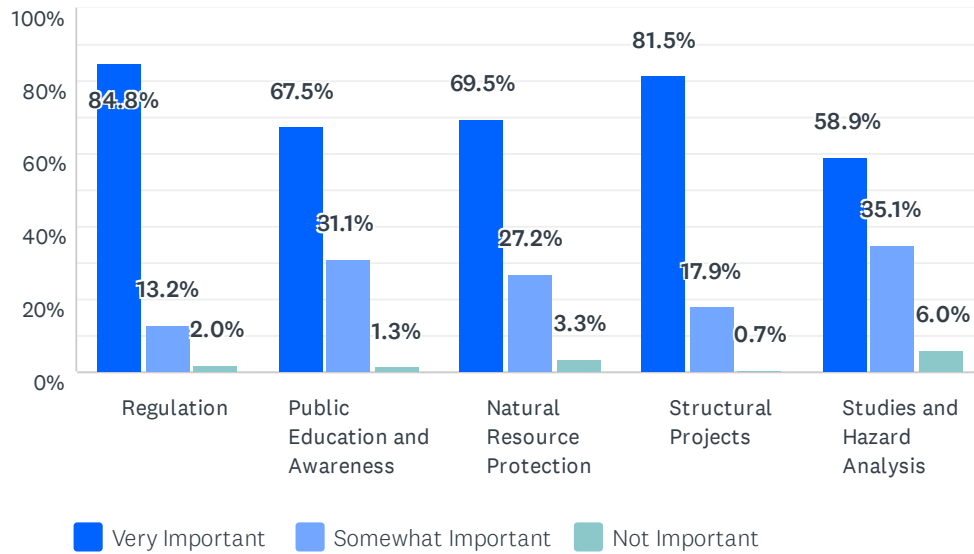
	VERY CONCERNED	SOMEWHAT CONCERNED	NOT CONCERNED	TOTAL	WEIGHTED AVERAGE
Excessive Heat Events	8.67% 13	32.67% 49	58.67% 88	150	2.50
Flooding	5.96% 9	41.72% 63	52.32% 79	151	2.46
Volcanos	8.05% 12	42.95% 64	48.99% 73	149	2.41
Tsunamis and Seiches	13.25% 20	35.10% 53	51.66% 78	151	2.38
Water Shortages	15.33% 23	39.33% 59	45.33% 68	150	2.30
Snow & Ice Storms	12.00% 18	56.00% 84	32.00% 48	150	2.20
Transportation Incidents	16.22% 24	47.97% 71	35.81% 53	148	2.20
Violent Attacks	22.82% 34	35.57% 53	41.61% 62	149	2.19
Hazardous Materials Incidents	14.67% 22	52.00% 78	33.33% 50	150	2.19
Fires	18.42% 28	51.32% 78	30.26% 46	152	2.12
Windstorms	17.33% 26	63.33% 95	19.33% 29	150	2.02
Social Unrest	34.67% 52	36.67% 55	28.67% 43	150	1.94
Power Outages	26.67% 40	55.33% 83	18.00% 27	150	1.91
Cyber-Attacks/Disruptions	37.09% 56	47.68% 72	15.23% 23	151	1.78
Wildfire Smoke/Poor Air Quality	40.00% 60	48.00% 72	12.00% 18	150	1.72
Infrastructure/Structural Failure	41.06% 62	50.33% 76	8.61% 13	151	1.68
Disease Outbreaks	58.55% 89	33.55% 51	7.89% 12	152	1.49
Earthquakes	64.90% 98	31.79% 48	3.31% 5	151	1.38

## Community Mitigation Input

#	OTHER (PLEASE SPECIFY)	DATE
1	Social Unrest: Primarily increasing socioeconomic divide and associated effects.	12/2/2020 8:23 PM
2	SPD officers are the most dangerous hazard to civilian in this city other than COVID.	11/25/2020 3:16 PM
3	Police brutality and abuse of power	11/23/2020 1:36 PM
4	Homeless and Mental Illness living on streets	11/23/2020 12:18 PM
5	militarized police—very concerned	11/21/2020 10:47 PM
6	dangerous homelessness situation in South Park where I live. Seattle is wanting to defund the police so we will have no protection. City Council refuses to remove illegally parked vehicles or do ANYTHING to mitigate crime and unsafe living conditions in South Park on Dallas Avenue, but I am sure no city council member would tolerate this in their own neighborhoods. Police action this week 25 ft from my front door due to homeless criminal living in a tent trailer in front of my house LIT his friend on FIRE and tried to kill him with a knife yet the city does NOTHING to remove this danger from the good people to work and pay taxes and mortgages on their homes in South Park.. I am leaving Seattle to those TOILET DWELLERS and moving out of Seattle ASAP, leaving my home bought and paid for by me, a home I have lived in for 31 years. Tell them thanks a lot for nothing.	11/21/2020 9:43 AM
7	Hazards on streets, sidewalks and public areas from homeless vehicle and tent camping.	11/20/2020 2:42 PM
8	Water pollution due to run off as well as spills	11/20/2020 12:19 PM
9	The influx of homeless camps and campers clogging the streets, road shoulders and parks. They create an unsafe environment and bring an increase in crime.	11/20/2020 6:31 AM
10	Landslides I live on the side of a hill	11/19/2020 10:15 PM
11	Gas line failure at 9th ave SW and SW Holden. Concerned about auto crashes into infrastructure as well as seismic failure.	11/19/2020 9:12 PM
12	Homeless situation is a public health disaster	11/19/2020 7:34 PM
13	Property Crime	11/19/2020 7:11 PM
14	Garbage, needles & human waste on downtown city streets	11/19/2020 6:39 PM
15	playing politicks	11/19/2020 5:32 PM
16	War, nuclear weapons accidents	11/19/2020 5:06 PM
17	deteriorating areas due to drug addicts & mental patients roaming around, in tents, etc.	11/19/2020 4:44 PM
18	filthy homeless camps on the streets and in the parks*****	11/19/2020 4:42 PM
19	Human waste on the ground. Needles on the ground.	11/19/2020 4:21 PM

Q2 Many activities can reduce hazard risks. In general, these activities fall into one of the following categories. Please tell us how important you think each category is for your community.

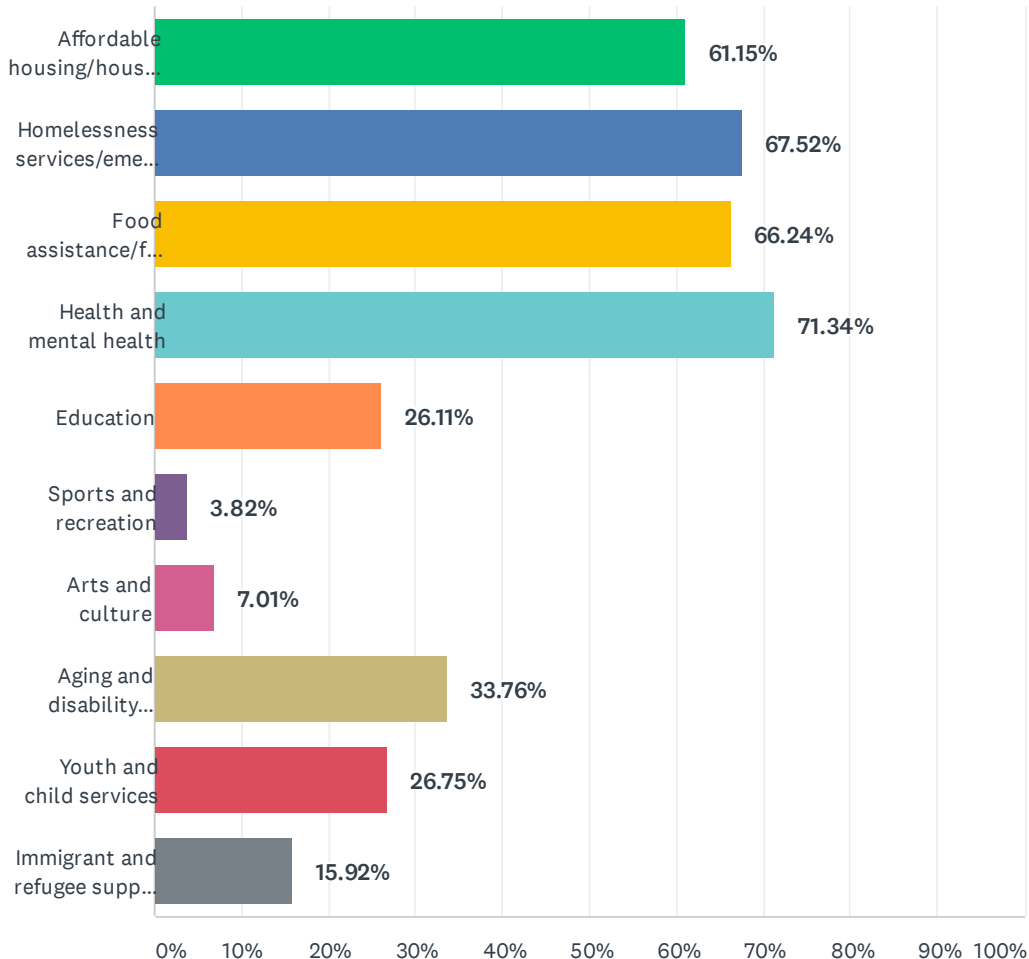
Answered: 151 Skipped: 6



	VERY IMPORTANT	SOMEWHAT IMPORTANT	NOT IMPORTANT	TOTAL	WEIGHTED AVERAGE
Regulation	84.8% 128	13.2% 20	2.0% 3	151	1.17
Public Education and Awareness	67.5% 102	31.1% 47	1.3% 2	151	1.34
Natural Resource Protection	69.5% 105	27.2% 41	3.3% 5	151	1.34
Structural Projects	81.5% 123	17.9% 27	0.7% 1	151	1.19
Studies and Hazard Analysis	58.9% 89	35.1% 53	6.0% 9	151	1.47

Q3 Many mitigation projects in the city benefit from FEMA hazard mitigation grants. Community-based organizations provide critical services to city residents and could benefit from hazard mitigation funding. Which types of community services do you think are most critical to protect through mitigation efforts? Choose up to FOUR services that you think are the MOST CRITICAL.

Answered: 157 Skipped: 0



## Community Mitigation Input

ANSWER CHOICES	RESPONSES	
Affordable housing/housing assistance	61.15%	96
Homelessness services/emergency shelters	67.52%	106
Food assistance/food banks	66.24%	104
Health and mental health	71.34%	112
Education	26.11%	41
Sports and recreation	3.82%	6
Arts and culture	7.01%	11
Aging and disability services	33.76%	53
Youth and child services	26.75%	42
Immigrant and refugee support services	15.92%	25
Total Respondents: 157		

Q4 What specific organizations, buildings, or structures in your community do you think are vital to community well-being and could benefit from hazard mitigation funding? (This would especially apply to older buildings, or buildings in at risk areas including flood prone or landslide prone areas)

Answered: 69   Skipped: 88

## Community Mitigation Input

#	RESPONSES	DATE
1	YWMCA, tiny houses project	12/2/2020 9:12 PM
2	LOCALLY-owned businesses closing due to pandemic, later being purchased by large corporations	12/2/2020 8:23 PM
3	City community center and local school.	12/2/2020 6:05 PM
4	North Seattle Police Precinct building	12/2/2020 5:15 PM
5	Magnolia Bridge and Interbay area	12/2/2020 3:07 PM
6	non-profit affordable housing organizations	12/2/2020 2:59 PM
7	Genesee, Schools (i.e. Orca, Aki, Mercer)	12/2/2020 2:55 PM
8	Libraries, food/medicine distribution points (grocery stores, pharmacies)	11/27/2020 1:33 PM
9	Aki Kurose Middle School	11/26/2020 11:27 AM
10	My neighborhood would be made safer if SPD removed the dangerous wall surrounding East Precinct.	11/25/2020 3:16 PM
11	Hospitals and infrastructure supporting them	11/25/2020 1:38 PM
12	encampments--it's winter, people shouldn't be outside	11/23/2020 2:36 PM
13	Seattle Water Front	11/23/2020 12:18 PM
14	schools	11/21/2020 10:47 PM
15	Bridge maintenance and design - can we ever get this right?	11/21/2020 11:56 AM
16	Take care of the trash on Dallas Avenue South, remove the RVs, tent trailers and abandoned vehicles.	11/21/2020 9:43 AM
17	University Heights	11/21/2020 8:58 AM
18	Parks	11/21/2020 8:11 AM
19	neighborhood associations	11/21/2020 7:22 AM
20	our bridges	11/20/2020 5:38 PM
21	Phinney Neighborhood Center	11/20/2020 2:42 PM
22	More sidewalks north of 85th - people of all types need to safely move from place to place, especially if we ask folks to take public transit, walk and ride bikes	11/20/2020 2:02 PM
23	Kelly Ross	11/20/2020 1:02 PM
24	Am uninformed	11/20/2020 12:19 PM
25	West Seattle Bridge	11/20/2020 9:36 AM
26	no	11/20/2020 9:36 AM
27	Hospitals	11/20/2020 8:08 AM
28	West Seattle Bridge	11/20/2020 7:52 AM
29	Bridges over Fairmount gully and over Schmidt Park, both on Admiral Was SW	11/20/2020 6:29 AM
30	smaller bridges that are critical to my area of West Seattle	11/20/2020 6:16 AM
31	Bridge, ferry docks	11/20/2020 5:56 AM
32	Free childcare for infants and toddlers of low income families	11/19/2020 10:21 PM
33	All our major bridges	11/19/2020 10:18 PM
34	bridges	11/19/2020 9:43 PM
35	Georgetown	11/19/2020 9:41 PM



## Community Mitigation Input

36	homeless camps	11/19/2020 8:55 PM
37	Community Center / Blaine Middle School	11/19/2020 8:50 PM
38	Mirabella	11/19/2020 7:37 PM
39	Schools and bridges	11/19/2020 7:34 PM
40	North Seattle College, USPS postal buildings	11/19/2020 7:11 PM
41	No	11/19/2020 7:09 PM
42	Addison on Fourth	11/19/2020 7:04 PM
43	Pike Place Market PDA	11/19/2020 6:46 PM
44	YMCA	11/19/2020 6:39 PM
45	YMCA	11/19/2020 6:11 PM
46	Seattle Housing Authority buildings in West Seattle	11/19/2020 5:53 PM
47	yes	11/19/2020 5:32 PM
48	Any large building, whether it is a religious building, school or community center where people can go to shelter in case of a disaster.	11/19/2020 5:26 PM
49	West Seattle Bridge	11/19/2020 5:25 PM
50	Public Library buildings	11/19/2020 5:09 PM
51	bridges	11/19/2020 4:58 PM
52	Community Hubs (amateur radio support)	11/19/2020 4:54 PM
53	schools, parks, safe sidewalks and crossings for disabled	11/19/2020 4:42 PM
54	Unreinforced brick buildings are deathtraps. Stop ignoring this problem!	11/19/2020 4:42 PM
55	University Bridge	11/19/2020 4:37 PM
56	Not specifically...	11/19/2020 4:34 PM
57	Apartment buildings unsafe in earthquakes	11/19/2020 4:34 PM
58	Montlake school.	11/19/2020 4:33 PM
59	Seattle Police Department - East Precinct	11/19/2020 4:32 PM
60	Woodland Park Zoo	11/19/2020 4:26 PM
61	Mirabella, 116Fairview Ave N, Seattle WA 98019	11/19/2020 4:24 PM
62	United Tribes Youth Home, labetayah	11/19/2020 4:23 PM
63	West Seattle Bridge	11/19/2020 4:20 PM
64	hpic, gas stations	11/19/2020 4:20 PM
65	Pike Place Market	11/19/2020 4:17 PM
66	West Seattle bridge	11/19/2020 4:16 PM
67	Youngstown Community Center	11/19/2020 4:15 PM
68	all bridges	11/19/2020 4:11 PM
69	El centro de la raza	11/19/2020 4:08 PM

## Q5 What zip code do you live in?

Answered: 149   Skipped: 8

## Community Mitigation Input

#	RESPONSES	DATE
1	98109	12/3/2020 12:17 AM
2	98122	12/2/2020 9:12 PM
3	98108	12/2/2020 8:23 PM
4	98118	12/2/2020 8:04 PM
5	98133	12/2/2020 6:05 PM
6	98115	12/2/2020 5:15 PM
7	98104	12/2/2020 4:16 PM
8	98199	12/2/2020 3:07 PM
9	98105	12/2/2020 2:59 PM
10	98118	12/2/2020 2:55 PM
11	98106	11/27/2020 1:33 PM
12	98118	11/26/2020 11:27 AM
13	98105	11/26/2020 10:45 AM
14	98118	11/25/2020 2:32 PM
15	98125	11/25/2020 2:29 PM
16	98133	11/25/2020 1:38 PM
17	98124	11/24/2020 6:02 PM
18	98109	11/23/2020 2:36 PM
19	98144	11/23/2020 1:36 PM
20	98121	11/23/2020 12:18 PM
21	98136	11/23/2020 10:50 AM
22	98146	11/22/2020 11:12 AM
23	98115	11/21/2020 10:47 PM
24	98115	11/21/2020 9:50 PM
25	98115	11/21/2020 12:01 PM
26	98119	11/21/2020 11:56 AM
27	98108	11/21/2020 9:43 AM
28	98105	11/21/2020 8:58 AM
29	98105	11/21/2020 8:11 AM
30	98107	11/21/2020 7:22 AM
31	98119	11/20/2020 5:38 PM
32	98122	11/20/2020 3:24 PM
33	98107	11/20/2020 2:56 PM
34	98136-1281	11/20/2020 2:55 PM
35	98107	11/20/2020 2:42 PM
36	98121	11/20/2020 2:37 PM
37	98117	11/20/2020 2:02 PM

## Community Mitigation Input

38	98103	11/20/2020 1:55 PM
39	98109	11/20/2020 1:02 PM
40	98109	11/20/2020 12:19 PM
41	98103	11/20/2020 11:41 AM
42	98117	11/20/2020 11:26 AM
43	98144	11/20/2020 11:03 AM
44	98103	11/20/2020 9:46 AM
45	98126	11/20/2020 9:36 AM
46	98030	11/20/2020 9:36 AM
47	98119	11/20/2020 8:55 AM
48	98146	11/20/2020 8:47 AM
49	98115	11/20/2020 8:11 AM
50	98166	11/20/2020 8:08 AM
51	98109	11/20/2020 8:02 AM
52	98116	11/20/2020 7:52 AM
53	98103	11/20/2020 7:32 AM
54	98104	11/20/2020 7:22 AM
55	98119	11/20/2020 6:52 AM
56	98117	11/20/2020 6:31 AM
57	98116	11/20/2020 6:29 AM
58	98116	11/20/2020 6:16 AM
59	98166	11/20/2020 6:02 AM
60	9812y	11/20/2020 5:56 AM
61	98034	11/20/2020 5:50 AM
62	98074	11/19/2020 11:30 PM
63	98168	11/19/2020 11:02 PM
64	98103	11/19/2020 10:21 PM
65	98115	11/19/2020 10:18 PM
66	98119	11/19/2020 10:15 PM
67	98125	11/19/2020 9:43 PM
68	98116	11/19/2020 9:41 PM
69	98106	11/19/2020 9:16 PM
70	98115	11/19/2020 9:16 PM
71	98106	11/19/2020 9:12 PM
72	98117	11/19/2020 9:08 PM
73	98136	11/19/2020 9:02 PM
74	98136	11/19/2020 9:02 PM
75	98109	11/19/2020 8:55 PM

## Community Mitigation Input

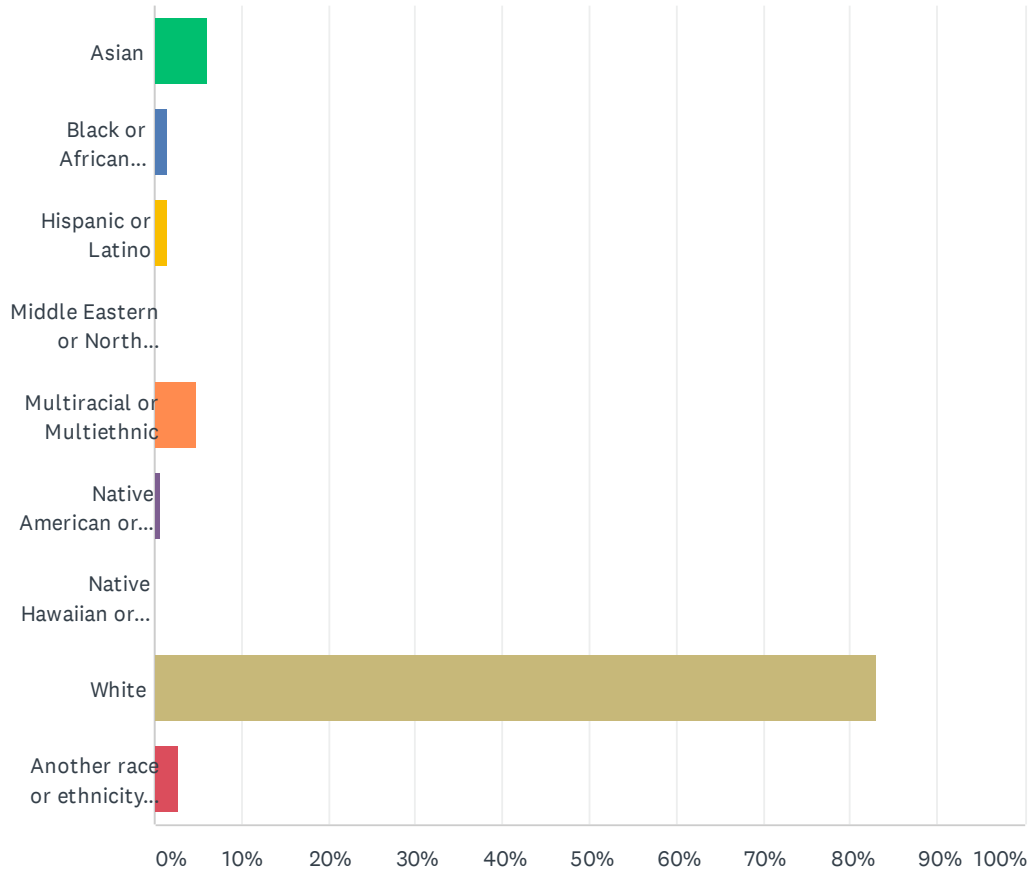
76	98199	11/19/2020 8:50 PM
77	98102	11/19/2020 7:56 PM
78	98074	11/19/2020 7:41 PM
79	98109	11/19/2020 7:40 PM
80	98109	11/19/2020 7:37 PM
81	98198	11/19/2020 7:35 PM
82	98112	11/19/2020 7:34 PM
83	98133	11/19/2020 7:11 PM
84	98112-3006	11/19/2020 7:10 PM
85	98121	11/19/2020 7:09 PM
86	98104	11/19/2020 7:04 PM
87	98126	11/19/2020 6:52 PM
88	98101	11/19/2020 6:46 PM
89	98101	11/19/2020 6:39 PM
90	98125	11/19/2020 6:12 PM
91	98116	11/19/2020 6:11 PM
92	98177	11/19/2020 6:07 PM
93	98116-2835	11/19/2020 5:53 PM
94	98107	11/19/2020 5:45 PM
95	98115	11/19/2020 5:32 PM
96	98102	11/19/2020 5:26 PM
97	98116	11/19/2020 5:25 PM
98	98136	11/19/2020 5:17 PM
99	98109	11/19/2020 5:16 PM
100	98117	11/19/2020 5:16 PM
101	98103	11/19/2020 5:09 PM
102	98122	11/19/2020 5:06 PM
103	98117	11/19/2020 5:04 PM
104	98126	11/19/2020 5:01 PM
105	98117	11/19/2020 4:58 PM
106	98115	11/19/2020 4:58 PM
107	98107	11/19/2020 4:57 PM
108	98115	11/19/2020 4:57 PM
109	98031	11/19/2020 4:54 PM
110	98126	11/19/2020 4:54 PM
111	9815	11/19/2020 4:53 PM
112	98109	11/19/2020 4:47 PM
113	98116	11/19/2020 4:45 PM

## Community Mitigation Input

114	98109	11/19/2020 4:44 PM
115	98102	11/19/2020 4:42 PM
116	98122	11/19/2020 4:42 PM
117	98109	11/19/2020 4:38 PM
118	98115	11/19/2020 4:37 PM
119	98027	11/19/2020 4:36 PM
120	98126	11/19/2020 4:35 PM
121	98107	11/19/2020 4:34 PM
122	98106	11/19/2020 4:34 PM
123	98119	11/19/2020 4:34 PM
124	98109	11/19/2020 4:34 PM
125	98112	11/19/2020 4:33 PM
126	98178	11/19/2020 4:32 PM
127	98122	11/19/2020 4:32 PM
128	98107	11/19/2020 4:27 PM
129	98117	11/19/2020 4:26 PM
130	98028	11/19/2020 4:26 PM
131	98117	11/19/2020 4:26 PM
132	98109	11/19/2020 4:24 PM
133	98117	11/19/2020 4:23 PM
134	98133	11/19/2020 4:23 PM
135	98106	11/19/2020 4:23 PM
136	98117	11/19/2020 4:21 PM
137	98133	11/19/2020 4:20 PM
138	98136	11/19/2020 4:20 PM
139	98106	11/19/2020 4:19 PM
140	98101	11/19/2020 4:17 PM
141	98122	11/19/2020 4:16 PM
142	98136	11/19/2020 4:16 PM
143	98122	11/19/2020 4:16 PM
144	98106	11/19/2020 4:15 PM
145	98125	11/19/2020 4:13 PM
146	98201	11/19/2020 4:12 PM
147	98133	11/19/2020 4:11 PM
148	98144	11/19/2020 4:08 PM
149	98101	11/19/2020 4:08 PM

## Q6 What is your race or ethnicity?

Answered: 147   Skipped: 10



ANSWER CHOICES	RESPONSES	
Asian	6.12%	9
Black or African American	1.36%	2
Hispanic or Latino	1.36%	2
Middle Eastern or North African	0.00%	0
Multiracial or Multiethnic	4.76%	7
Native American or Alaska Native	0.68%	1
Native Hawaiian or other Pacific Islander	0.00%	0
White	82.99%	122
Another race or ethnicity, please describe below	2.72%	4
<b>TOTAL</b>		<b>147</b>

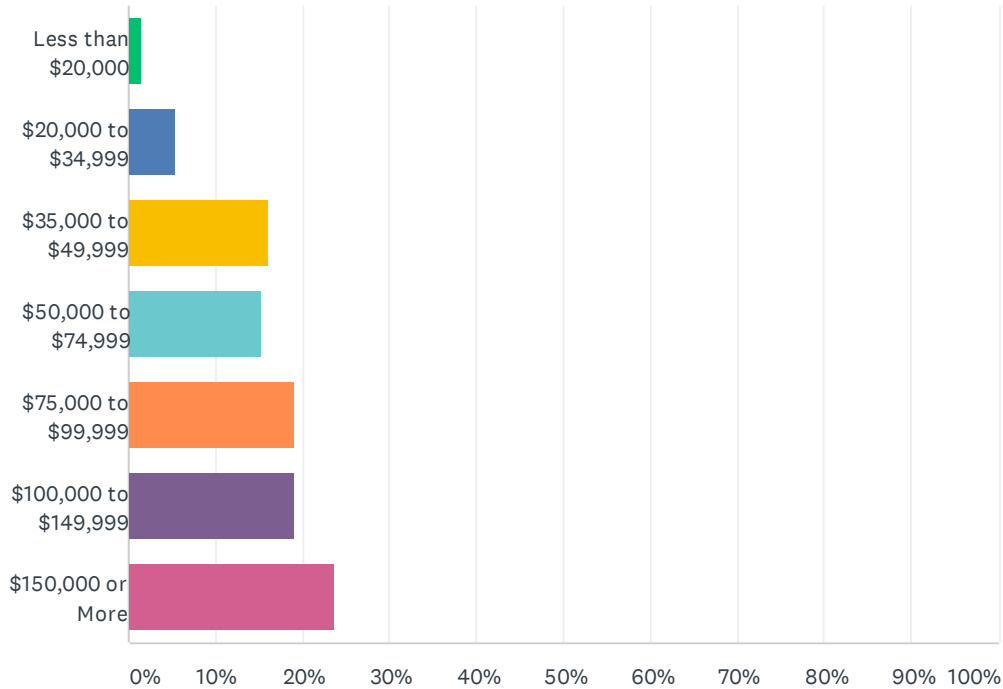


## Community Mitigation Input

#	SELF-DESCRIBE BELOW:	DATE
1	Human	12/2/2020 3:07 PM
2	Fuck you	11/25/2020 2:29 PM
3	I am of the HUMAN race.	11/21/2020 9:43 AM
4	Übermensch	11/20/2020 1:55 PM
5	N/A	11/20/2020 11:03 AM
6	Race should not matter	11/20/2020 6:02 AM
7	Unknown	11/19/2020 7:04 PM
8	87-years old & retired	11/19/2020 4:58 PM

## Q7 What is your total household income?

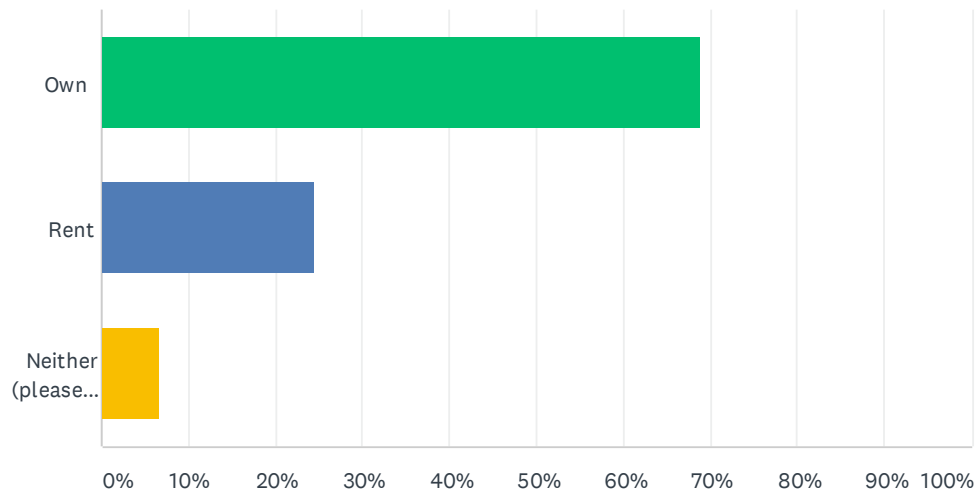
Answered: 131   Skipped: 26



ANSWER CHOICES	RESPONSES	
Less than \$20,000	1.53%	2
\$20,000 to \$34,999	5.34%	7
\$35,000 to \$49,999	16.03%	21
\$50,000 to \$74,999	15.27%	20
\$75,000 to \$99,999	19.08%	25
\$100,000 to \$149,999	19.08%	25
\$150,000 or More	23.66%	31
TOTAL		131

## Q8 Do you rent or own the place where you live?

Answered: 151 Skipped: 6

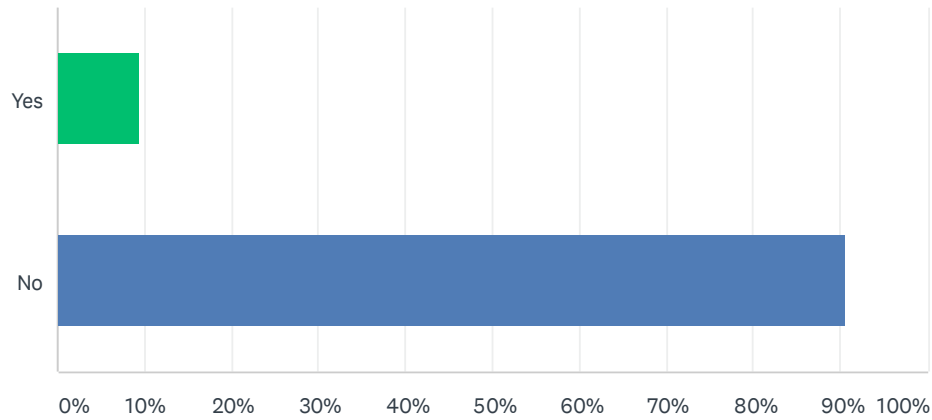


ANSWER CHOICES	RESPONSES	
Own	68.87%	104
Rent	24.50%	37
Neither (please specify)	6.62%	10
TOTAL		151

#	NEITHER (PLEASE SPECIFY)	DATE
1	Couch surfing taking care of sick relatives because I'm disabled, denied by SSDI, and unable to afford a place to live other than in my car	11/25/2020 2:29 PM
2	Retirement community	11/23/2020 2:36 PM
3	Live in a Retirement Community	11/20/2020 1:02 PM
4	Live in a Continuing Care Residence	11/20/2020 12:19 PM
5	Live w family	11/19/2020 10:21 PM
6	CCRC	11/19/2020 7:40 PM
7	CCRC	11/19/2020 5:16 PM
8	Retirement center	11/19/2020 4:38 PM
9	I live in a retirement community	11/19/2020 4:24 PM
10	I live on a boat that I own.	11/19/2020 4:21 PM

## Q9 Do you speak a language other than English at home?

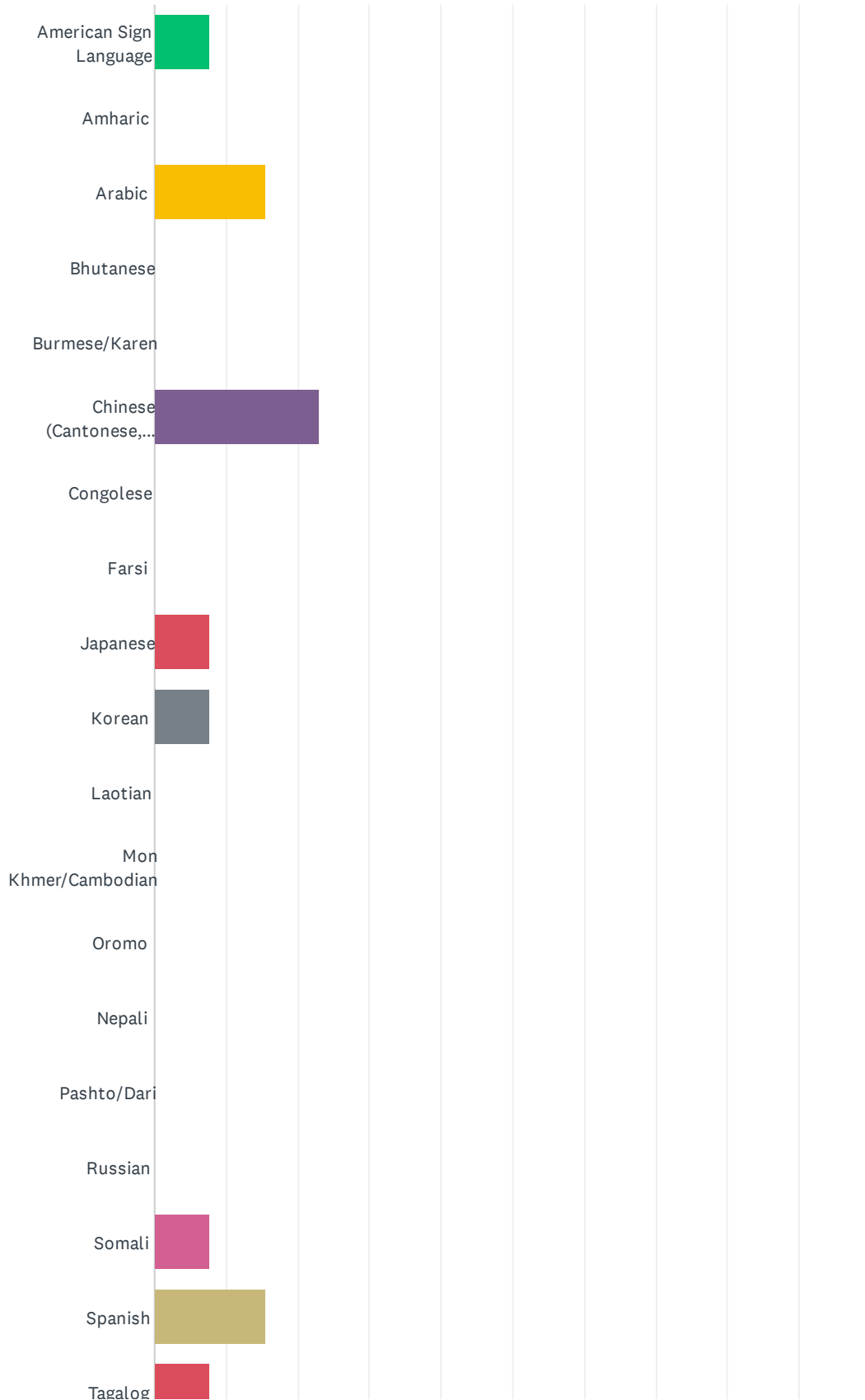
Answered: 150 Skipped: 7



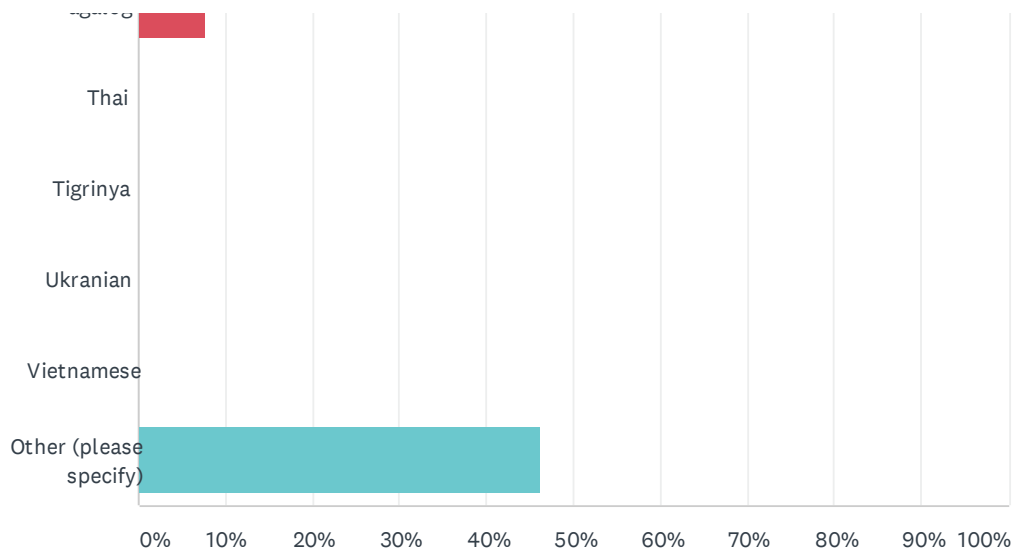
ANSWER CHOICES	RESPONSES	
Yes	9.33%	14
No	90.67%	136
TOTAL		150

## Q10 What language(s) other than English do you speak at home?

Answered: 13   Skipped: 144



## Community Mitigation Input



## Community Mitigation Input

ANSWER CHOICES	RESPONSES	
American Sign Language	7.69%	1
Amharic	0.00%	0
Arabic	15.38%	2
Bhutanese	0.00%	0
Burmese/Karen	0.00%	0
Chinese (Cantonese, Toishanese, or Mandarin)	23.08%	3
Congolese	0.00%	0
Farsi	0.00%	0
Japanese	7.69%	1
Korean	7.69%	1
Laotian	0.00%	0
Mon Khmer/Cambodian	0.00%	0
Oromo	0.00%	0
Nepali	0.00%	0
Pashto/Dari	0.00%	0
Russian	0.00%	0
Somali	7.69%	1
Spanish	15.38%	2
Tagalog	7.69%	1
Thai	0.00%	0
Tigrinya	0.00%	0
Ukranian	0.00%	0
Vietnamese	0.00%	0
Other (please specify)	46.15%	6
Total Respondents: 13		

#	OTHER (PLEASE SPECIFY)	DATE
1	German, Finnish	11/26/2020 11:27 AM
2	German	11/25/2020 2:29 PM
3	French	11/20/2020 1:55 PM
4	Swedish	11/19/2020 8:50 PM
5	Hindi	11/19/2020 7:41 PM
6	Danish	11/19/2020 5:02 PM



# Seattle All-Hazards Mitigation Plan Update

Every five years the City of Seattle Office of Emergency Management (OEM) updates the [All-Hazards Mitigation Plan \(HMP\)](#). This HMP helps us minimize risks to people, property, and the environment from natural and man-made disasters.

## What is the All-Hazards Mitigation Plan (HMP)?

The HMP is a comprehensive document that contains detailed information about the types of hazards we face, and the actions we can take before disaster strikes to reduce our vulnerability. Once the HMP is updated, reviewed, and approved by the Federal Emergency Management Agency (FEMA), Seattle keeps its eligibility to apply for FEMA mitigation grants:

- Hazard Mitigation Grant Program (HMGP)
- Building Resilient Infrastructures and Communities (BRIC)
- Flood Mitigation Assistance Program



## What Types of Hazards are Assessed?



### GEOLOGIC

Earthquakes, landslides, tsunamis and sieches etc.



### CLIMATE CHANGE

Rising temperatures, Ssea level rise etc.



### WEATHER

Extreme heat, flooding, snow and ice, windstorms etc.



### BIOLOGICAL

Disease/pandemic, bioterrorism etc.



### INFRASTRUCTURE

Transportation incidents, fires, infrastructure failure etc.

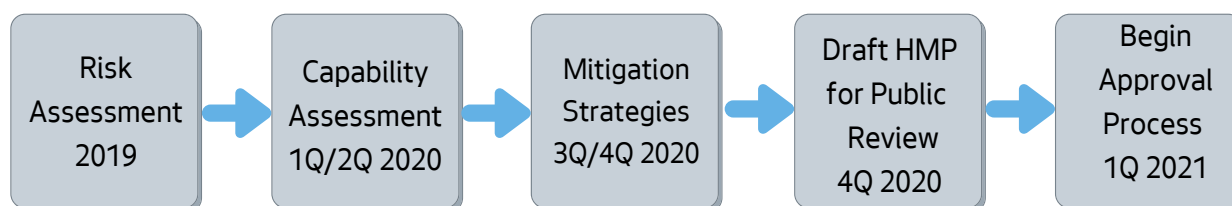


### INTENTIONAL

Attacks, social unrest, cyber attacks etc.

## Timeline

The HMP Update needs to be completed in 2021. A technical analysis of known hazards, [Seattle Hazard Identification and Vulnerability Analysis \(SHIVA\)](#), was updated in 2019. Staff from various departments are working together to review the existing HMP, capitol programs and other departmental plans.



**Seattle** Office of  
Emergency Management

Email your questions or comments to:

**HazardMitigationPlanUpdate@seattle.gov**

Follow OEM on social media and sign up for our [Newsletter](#) to follow the progress of the HMP!





# Community Mitigation Survey

In November, OEM launched a Community Mitigation Survey as part of the Hazard Mitigation Plan update process. We got valuable feedback from the community about which hazards are the biggest concern, which mitigation strategies are most valued, and which community resources should be protected through mitigation efforts. [View a brief summary of the survey results](#)



# Hiring Community Safety Ambassadors

Our office is currently hiring contract positions to provide Disaster preparedness education and outreach in the community. Please click on the following links to view the position descriptions! [Somali speaking CSA](#) , [Mandarin speaking CSA](#) , [Korean speaking CSA](#) , and [Arabic Speaking CSA](#) Please contact Tey Thach at [tey.thach@seattle.gov](mailto:tey.thach@seattle.gov) if you have any questions or are unable to access the form and need an alternative way to apply.

# All-Hazards Mitigation Plan Update

Every five years the City of Seattle Office of Emergency Management (OEM) updates the All-Hazards Mitigation Plan (HMP). This HMP helps us minimize risks to people, property, and the environment from natural and man-made disasters. Learn more about the All-Hazards Mitigation Plan by reading this [summary of the plan update process](#) , or visiting the [HMP Update site](#)!

# Upcoming Events

MAY

27

THU

WEBINAR: City of Seattle Earthquake Response: Overview of Response Priorities and Coordination

Sign Up

Seattle Office of Emergency Management staff will provide an overview of our region's earthquake ris... [more »](#)

JUN

16

WED

WEBINAR: City of Seattle Earthquake Response: Firefighting, Search and Rescue, and Hazardous Materials Response

Sign Up

Staff from the Seattle Fire Department will provide an overview of how the City directs life safety... [more »](#)

JUL

20

TUE

WEBINAR: City of Seattle Earthquake Response: Emergency Shelter and Feeding.

Sign Up

Staff from the Seattle Human Services will provide an overview of how the City will coordinate with... [more »](#)

[See all »](#)

# Multi-language Resources

## Information for Emergency

This site provides access to all of those documents, with language specific instructions on how to become better prepared.

Seattle All-Hazards Mitigation Plan Update

Every five years the City of Seattle Office of Emergency Management (OEM) updates the [All-Hazards Mitigation Plan \(HMP\)](#). This HMP helps us minimize risks to people, property, and the environment from natural and man-made disasters.

**What is the All-Hazards Mitigation Plan (HMP)?**

The HMP is a comprehensive document that contains detailed information about the types of hazards we face, and the actions we can take before disaster strikes to reduce our vulnerability. Once the HMP is updated, reviewed, and approved by the Federal Emergency Management Agency (FEMA), Seattle keeps its eligibility to apply for FEMA mitigation grants.

- Hazard Mitigation Grant Program (HMGP)
- Building Resilient Infrastructure and Communities (BRIC)
- Project Mitigation Assistance Program

**What Types of Hazards are Assessed?**

**GEOLOGIC**  
Earthquakes, landslides, tsunamis, etc.

**CLIMATE CHANGE**  
Rising temperatures, drought, etc.

**WEATHER**  
Severe storms, flooding, wind, etc.

**BIOLOGICAL**  
Invasive species, etc.

**INFRASTRUCTURE**  
Transportation systems, etc.

**INTENTIONAL**  
Terrorism, etc.

**Timeline**

The HMP Update needs to be completed in 2021. A technical analysis of known hazards, [Seattle Hazard Identification and Vulnerability Analysis \(HIVA\)](#), was updated in 2019. Staff from various departments are working together to review the existing HMP, update programs and other departmental plans.

Risk Assessment  
2019

→

Capability Assessment  
1Q-2Q 2020

→

Mitigation Strategies  
3Q-4Q 2020

→

Draft HMP for Public Review  
4Q 2020

→

Final Approval  
1Q 2021

Send your questions or comments to: [HazardMitigationPlanUpdate@seattle.gov](mailto:HazardMitigationPlanUpdate@seattle.gov)

Follow OEM on social media and sign up for our Newsletter to follow the progress of the HMP!



# Emergency Management

Curry Mayer, Director

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> [Plan Updates and Revisions](#)

[All-Hazard Mitigation Plan Update 2020-21](#)

## All-Hazards Mitigation Plan Update 2020-21

### All-Hazard Mitigation Plan Update 2020-21

[Overview](#) [Timeline](#) [Documents](#)

[Current All-Hazards Mitigation Plan \(2015-2021\)](#) 

[Hazard Mitigation Plan Update Summary](#) 

[Past Mitigation Project Highlights](#) 

[Community Outreach Plan for Hazard Mitigation Update](#) 

[Community Mitigation Survey Summary](#) 

[Overview of Hazard Mitigation Plan - Presentation](#) 





## OEM September Preparedness News

City of Seattle sent this bulletin at 09/24/2020 01:58 PM PDT



Seattle Office of  
Emergency Management

### Receive up to \$1,800 to Start a Community Emergency Hub



In partnership with the [Seattle Office of Emergency Management](#), the [Seattle Department of Neighborhoods](#) is offering up to \$27,000 in funding to support Community Emergency Hubs throughout the city. This is enough to provide 15 groups with up to \$1,800 to create their own Hub-in-a-Box.

A Hub-in-a-Box contains the essential materials and supplies your community would need in case of a disaster where help from the City or others is delayed or disrupted. These hubs must be contained within a durable and secured storage box that is in a publicly accessible location.

[Click here to start your Community Emergency Hub!](#)

### High School Student Volunteers Wanted!

Do you know a high school student who is engaged with their community and looking for volunteer opportunities? OEM is recruiting high school students for a unique volunteer role with the Office of Emergency Management. Program volunteers will spread the word in their communities about AlertSeattle, the city's official emergency alert system. People who sign up for AlertSeattle can receive text messages, emails, or phone calls when an emergency is happening in Seattle.

[Download the Youth Volunteer job description](#) or [click here](#) to learn more about all available volunteer opportunities with OEM.

Sign up for emergency alerts from AlertSeattle at [alert.seattle.gov](#) and follow [AlertSeattle on Twitter](#).



### ShakeOut 2020: Drop, Cover, and Hold On!

Get ready to ShakeOut! The annual Great ShakeOut Earthquake Drill is happening **Thursday, October 15**. The ShakeOut is a chance to practice your Drop, Cover, and Hold On at home, school, work, the park... wherever you are, and wherever you might be when an earthquake strikes. Join millions of people around the world on 10/15 at 10:15 to Drop, Cover, and Hold On!

To get more information about the ShakeOut drill, learn how to protect yourself during an earthquake, and register as a participant, visit [ShakeOut.org](#).



*If you feel an earthquake, you should Drop, Cover, and Hold On! Protect your head and neck under a sturdy object or piece of furniture like a table or desk.*

### Hazard Mitigation Plan Updates

The City of Seattle is updating our Hazard Mitigation Plan (HMP). The HMP is a comprehensive document that contains detailed information about the types of hazards we face and the actions we can take before disaster strikes to reduce our vulnerability. A completed HMP approved by the Federal Emergency Management Agency (FEMA) ensures the City of Seattle is eligible for grant funding to address the issues identified in the plan.

You can follow along with the HMP update process, which will be completed in 2021, on our website. [Click here](#) to access the HMP Update pages, including a timeline and documents related to the plan.

### Help Your Community During COVID-19

- Visit the [United Way King County website](#) to learn about ways that you can help during the "Stay at Home" period.
- Running essential errands for yourself or a neighbor? Follow these [Essential Errand Guidelines for the CDC](#).
- Say "Hello, Neighbor!" to neighbors in need with our Hello, Neighbor cards (available in multiple languages). Learn more about how you can let neighbors know you're there for them on our [Hello, Neighbor page](#) and download [Hello, Neighbor cards](#).
- Are you on NextDoor? Use the [NextDoor Help Map](#) to offer help or request assistance from neighbors!
- The [AARP Community Connections Map](#) is another tool to connect with groups offering support such as food delivery. [Also available in Spanish!](#)
- If you are in West Seattle and need assistance or want to offer help, go to the [West Seattle Support site](#).
- In the Madison Valley area? Check out [Homer Harris Hub COVID-19 Support site](#)

### COVID-19 Testing in Seattle

There are several free testing sites currently operating in Seattle:

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- Public Health - Seattle & King County** is regularly updating their list of free testing sites located all over King County, which also includes community health centers and UW Mobile Clinics. Language and mobility access varies by location. Learn more at Public Health – Seattle King County's website (hyperlink <https://www.kingcounty.gov/depts/health/covid-19/care/testing.aspx>).
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### COVID-19 Resources

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## OEM November Preparedness News

City of Seattle sent this bulletin at 11/19/2020 04:03 PM PST



### Seattle Office of Emergency Management

#### Seeking Community Input on Hazard Mitigation



The City of Seattle is seeking community input on a variety of hazard mitigation issues and projects as part of our update to the Hazard Mitigation Plan (HMP). Let us know about what hazards you think are the biggest concern and where you think the City should focus our mitigation efforts. Click the button below to complete the survey, or go to <https://www.surveymonkey.com/r/HL7GP2C>.

The HMP is a comprehensive document that contains detailed information about the types of hazards we face and the actions we can take before disaster strikes to reduce our vulnerability. A completed HMP approved by the Federal Emergency Management Agency (FEMA) ensures the City of Seattle is eligible for grant funding to address the issues identified in the plan.

You can follow along with the HMP update process, which will be completed in 2021, on our website. [Click here](#) to access the HMP Update pages, including a timeline and documents related to the plan, and use the button below to complete the survey.

[Click here to complete the hazard mitigation survey!](#)

#### Hiring Community Safety Ambassadors

OEM is currently hiring contract positions to provide disaster preparedness education and outreach in the community. Click on the following links to view the position descriptions:

- [Somali speaking CSA](#)
- [Mandarin speaking CSA](#)
- [Korean speaking CSA](#)
- [Arabic speaking CSA](#)

Please contact Tey Thach at [tey.thach@seattle.gov](mailto:tey.thach@seattle.gov) if you have any questions or are unable to access the form and need an alternative way to apply.

#### New Stop the Bleed Videos

OEM has added new content to our YouTube channel! As we continue to avoid indoor gatherings like in-person training, OEM has added new free online training videos you can access anywhere, any time. Our most recent addition is **Stop the Bleed**, a bleeding control training that can help during disasters and everyday emergencies alike.

[Click here](#) to see our full YouTube channel which includes a variety of disaster skills trainings, or use the links below to access Stop the Bleed videos directly.

- Stop the Bleed: [Overview](#)
- Stop the Bleed: [Pressure and Wound Packing](#)
- Stop the Bleed: [Applying a Tourniquet](#)



Stop the Bleed: Pressure and Wound Packing will teach you how to stop life-threatening bleeding using direct pressure and everyday items.



Stop the Bleed: Tourniquet will teach you how to stop life-threatening bleeding using a tool called a tourniquet.

#### Youth Volunteers Bringing Emergency Preparedness to Seattle Communities



OEM onboarded our newest cohort of high school volunteers in late October. This exceptional group of young volunteers will learn about emergency preparedness and response while building skills in community outreach by promoting the AlertSeattle program, the City of Seattle's free emergency alert system.

Sign up for AlertSeattle today at [alert.seattle.gov](http://alert.seattle.gov) to receive text messages, phone calls, or emails about emergencies and disasters in your area.

#### Staying Safe and Healthy During the Holiday Season

On November 15, Governor Jay Inslee [issued new statewide restrictions](#) on social gatherings and businesses in response to the surge of COVID-19 across Washington state. These statewide [restrictions](#) took effect Monday, November 16 and will remain in effect until Monday, December 14.

As we head into the holiday season, our instinct is to come together and celebrate with our loved ones. But the reality is that out of public health necessity, this year's holiday celebrations will look and feel different. To slow the spread, it is important to continue basic safety actions like wearing a mask and avoiding indoor gatherings, including holiday celebrations outside your household.

Review the latest public health guidance for COVID safety at [kingcounty.gov/depts/health/covid-19.aspx](http://kingcounty.gov/depts/health/covid-19.aspx).

Connect with financial assistance and other programs for residents and businesses impacted by COVID at [seattle.gov/mayor/covid-19](http://seattle.gov/mayor/covid-19).

#### Help Your Community During COVID-19

- Visit the [United Way King County website](#) to learn about ways that you can help during the "Stay at Home" period.
- Running essential errands for yourself or a neighbor? Follow these [Essential Errand Guidelines for the CDC](#).
- Say "Hello, Neighbor!" to neighbors in need with our Hello, Neighbor cards (available in multiple languages). Learn more about how you can let neighbors know you're there for them on our [Hello, Neighbor page](#) and download [Hello, Neighbor cards](#).
- Are you on NextDoor? Use the [NextDoor Help Map](#) to offer help or request assistance from neighbors!
- The [AARP Community Connections Map](#) is another tool to connect with groups offering support such as food delivery. [Also available in Spanish!](#)
- If you are in West Seattle and need assistance or want to offer help, go to the [West Seattle Support site](#).
- In the Madison Valley area? Check out [Homer Harris Hub COVID-19 Support site](#)

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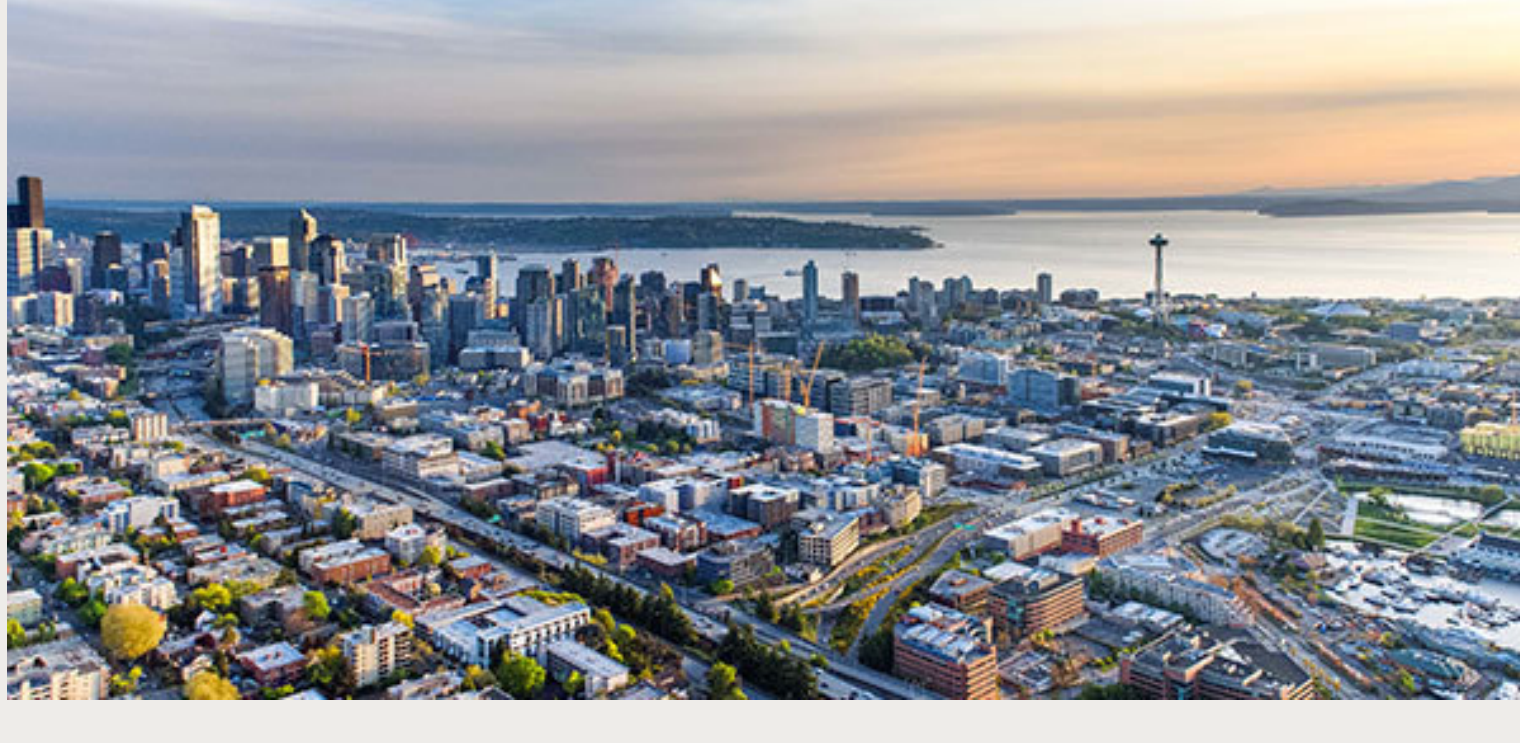
## OEM January Preparedness News

City of Seattle sent this bulletin at 01/21/2021 04:44 PM PST



## Seattle Office of Emergency Management

### Hazard Mitigation Plan: We Want to Hear From You!



A [draft of the Seattle Hazard Mitigation Plan \(2021-2026\)](#) is now available for review and public comment! OEM is accepting public comments until **January 29th**. You can provide feedback through this [survey form](#), or email any comments to [HazardMitigationPlanUpdate@seattle.gov](mailto:HazardMitigationPlanUpdate@seattle.gov).

Every five years, the City of Seattle Office of Emergency Management (OEM) updates the Hazard Mitigation Plan (HMP). This HMP helps us minimize risks to people, property, and the environment from natural and man-made disasters.

Learn more about the HMP and the update process by visiting our [Hazard Mitigation Plan Update page](#). We value your feedback and hope you take time to review the plan and the other project documents.

[Review the Plan and Share Your Thoughts!](#)

### SDCI Presents Seattle Home Fairs: January 30 and February 6



Is your home up-to-date with the latest earthquake safety retrofits? Is your property prone to landslides? The Seattle Department of Construction and Inspections (SDCI) is here to help!

SDCI is hosting the Seattle Home Fairs on January 30 and February 6. This year we're going virtual with a series of presentations and Q&A sessions. These free events are a great opportunity for Seattle residents to talk to our staff and get answers to questions about a wide range of topics, including:

- Landslide prevention
- Earthquake retrofits
- Rental housing rules
- Getting a permit
- Inspection requirements
- Code requirements
- Tree regulations
- And more!

Sessions will be held online on the following dates and times:

**January 30**  
10:00 a.m. – 3:00 p.m.

**February 6**  
10:00 a.m. – 3:00 p.m.

For more information and to RSVP, go to [buildingconnections.seattle.gov/2020/12/31/join-us-for-our-seattle-home-fairs](https://buildingconnections.seattle.gov/2020/12/31/join-us-for-our-seattle-home-fairs)

### OEM Offers Free Online Emergency Preparedness Training Sessions!

Was your New Years Resolution to be more prepared for emergencies? Then join us for a FREE training session conducted online. The training can be tailored to your group by a live trainer via a variety of online platforms. All our training is currently offered online only due to COVID-19.

Neighborhood groups, businesses, community based organizations, and others interested in learning more about area hazards and how they can prepare should request a virtual training with the [Training Request Form](#).

OEM offers a variety of emergency preparedness courses, including:



**Neighborhood Preparedness (SNAP: Seattle Neighborhoods Actively Prepare)**



**Disaster Preparedness: The Basics**



**Workplace and Business Preparedness**



**Emergency Planning for Child Care Providers Workshop**

### Volunteer Spotlight: Helen Murphy



Helen Murphy is a retired epidemiologist and former Family Practice Nurse Practitioner with the US Public Health Service. She worked internationally for twenty years with a variety of NGOs and UN agencies, primarily in emergency relief in politically sensitive refugee camps that at times were under military bombardment.

Her epidemiological research involved developing a home technology to prevent dehydration among Afghan refugee children and spent a number of years studying and preventing the health effects of pesticides among Southeast Asian farmers. She also completed a short tour of duty with the USAID Office of Foreign Disaster Assistance. On returning to the US and before retiring, she ended her working career in occupational health. She was outreach director in an agricultural health and safety research center within the School of Public Health at the University of Washington.

She enjoys volunteering for OEM because she can use her multi-cultural training background and disaster management experience. After so many years out of the country, it is now important for her to serve her city of Seattle and get to know its community groups. OEM has proved the most inclusive organization with whom she has ever volunteered because it offers superb educational seminars. It also highly values their volunteers making them feel part of their team. She has been impressed how OEM allows the volunteers to introduce new training methods and cross-pollinate innovations with each other.

The training is fun to deliver and well accepted by community groups. The biggest hit includes the end-of-session 'Disaster Jeopardy' game and the 2- bucket emergency sanitation system complete with pool-noodle-adapted comfortable seats. Her personal favorite disaster preparedness tool is a lantern constructed from an empty plastic gallon water bottle and head lamp which, when turned inward and on, provides excellent lighting. More recently, Helen has been overwhelmed by the enthusiastic acceptance of the SeattleAlert system when handing out information posters and cards for the program to local businesses.

Although 2020 was a challenge, it has allowed one to be grateful for surviving the pandemic, tightening one's bonds with friends and family, albeit remotely, and the opportunity to build resilience.

OEM thanks Helen and all our volunteers for their contributions to a safer Seattle! To learn more about volunteering with OEM, visit <http://www.seattle.gov/emergency-management/about-us/volunteer>

### COVID-19 Testing and Vaccinations in Seattle

#### COVID-19 Vaccine Information

We are currently in Phase I of Washington's COVID-19 Vaccine distribution plan. [This infographic details the tiers or subphases of Phase I.](#)

- You can learn more about the state's plan for COVID-19 vaccine distribution at [doh.wa.gov/Emergencies/COVID19/vaccine](https://doh.wa.gov/Emergencies/COVID19/vaccine).
- You can learn more about local efforts to distribute the COVID-19 vaccine at [kingcounty.gov/depts/health/covid-19/vaccine.aspx](https://kingcounty.gov/depts/health/covid-19/vaccine.aspx).

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## APPENDIX D    MITIGATION ACTION WORKSHEETS

Blank Mitigation Worksheet

Mitigation Worksheet Instructions

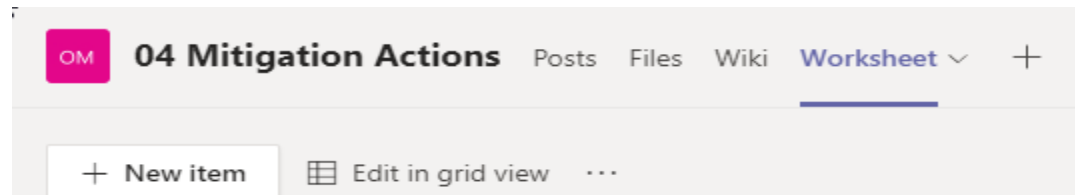
Table Summary of Mitigation Action Worksheets for 47 projects





## City of Seattle Hazard Mitigation Plan – 2020 Mitigation Action Worksheet

Worksheet is also available in MS List format (fill in form linked to Excel) on a new Teams Channel. Click “New Item” to enter each mitigation action.



**1a. Mitigation Action Name:** [Click here to enter text.](#)

**1b. Mitigation Action Description:** Provide a brief description of the action. Note if the action involves a cultural or historic resource.

[Click here to enter text.](#)

**2a. Lead Department/Organization:** [Click here to enter text.](#)

**2b. Division/Line of Business** (if applicable): [Click here to enter text.](#)

**2c. Supporting Departments/Organizations:** [Click here to enter text.](#)

**3. Action Status:** ☐ New ☐ Existing ☐ Potential (will not begin within 5 years)

NOTE: Completed actions should be reported in the Status updates (if in the 2015-2021 HMP) or in Capabilities under “Key Accomplishments.”

**4. Type of Action (Check all that apply):**

- ☐ Plans and Regulations ☐ Assessments and Studies ☐ Infrastructure/Capital Project  
☐ Non-Structural Mitigation Measures ☐ Natural Systems Protection ☐ Education and Awareness

**5. Hazards Addressed (Check all that apply):**

- |   |  |  |
|---|--|--|
| <input type="checkbox"/> All Hazards              | <input type="checkbox"/> Flooding                          | <input type="checkbox"/> Snow and Ice Storm*     |
| <input type="checkbox"/> Attacks                  | <input type="checkbox"/> HazMat Incidents/ Smoke           | <input type="checkbox"/> Transportation Incident |
| <input type="checkbox"/> Cyber-attack/Disruption* | <input type="checkbox"/> Infrastructure/Structural Failure | <input type="checkbox"/> Tsunami/Seiches         |
| <input type="checkbox"/> Disease Outbreaks        | <input type="checkbox"/> Landslides                        | <input type="checkbox"/> Volcanic Hazards        |
| <input type="checkbox"/> Earthquakes*             | <input type="checkbox"/> Power Outages*                    | <input type="checkbox"/> Water Shortages         |
| <input type="checkbox"/> Excessive Heat Events    | <input type="checkbox"/> Social Unrest                     | <input type="checkbox"/> Windstorms*             |
| <input type="checkbox"/> Fires                    |  |  |

NOTE: Hazards with an asterisk (\*) are ranked as the highest risk in the SHIVA.

**6a. Hazard Mitigation Plan Goals Supported (Check all that apply):**

- ☐ Life and Safety    ☐ Critical Infrastructure Protection    ☐ Property Protection  
☐ Natural, Historic or Cultural Resource Protection    ☐ Resilient Economy    ☐ Integrated Planning

**6b. Race and Social Justice Focus Areas (Check all that apply):** The action could reduce race-based disparities in any of the following focus areas (from Taskforce for Investments in the Black, Indigenous and People of Color Community).

- ☐ Inclusive Economy    ☐ Climate Justice    ☐ Community Safety    ☐ Education Opportunity  
☐ Community Supports (safety net)    ☐ Community Wealth Building

**6c. Description:** Briefly describe how the action can have a positive impact in selected focus areas?  
[Click here to enter text.](#)

**7a. Location:** Provide information about the geographic location(s) of an action.

- ☐ Citywide, no specific or targeted location  
☐ District or Neighborhood  
☐ Specific Site(s)

**7b. Location Description:** Provide addition information about location such as the name of the neighborhood or district, or address(es) for specific sites. [Click here to enter text.](#)

**7c. Benefit Area:** Describe the geographic area (citywide, district, neighborhood) that will benefit from this action. [Click here to enter text.](#)

**8. Timeline:** ☐ Immediate    ☐ < 1 year    ☐ 1 – 3 years    ☐ 3 – 5 years

NOTE: Actions that will not begin within five years should be identified as a Potential Action in #3.  
Action Status.

**9a. Anticipated Cost (if known):** [Click here to enter text.](#)

**9b. Funding Available:** ☐ Yes    ☐ Anticipated    ☐ No

**9c. Funding Source:** ☐ Existing Budget    ☐ Grant    ☐ Bond/Levy    ☐ No/minimal cost  
☐ Other: [Click here to enter text.](#)

**10. Date:** [Click here to enter text.](#)

**11. Contact Information:**

**Name:** [Click here to enter text.](#) **Phone:** [Click here to enter text.](#) **E-Mail:** [Click here to enter text.](#)

## 12. Prioritization Criteria:

**Mitigation Impact Criteria** – How effective is this action? How does it impact broader City goals?

Mitigation Impact Criteria	Evaluation Rating	
<b>Mitigation Effectiveness.</b> Will the implemented action result in lives saved?	High = <b>H</b> Medium = <b>M</b> Low = <b>L</b>	
<b>Mitigation Effectiveness.</b> Will the implemented action result in a reduction of disaster damage?		
<b>Multiple Benefits.</b> Will the action provide multiple community benefits beyond mitigation?		
<b>Collaboration.</b> Will the action require collaboration between City departments and/or the community?		
<b>Racial Equity.</b> Will the action reduce hazard vulnerability for BIPOC communities?		

**STAPLEE Criteria** - How implementable is this action?

STAPLEE Criteria	Evaluation Rating	
<b>Social:</b> What is the anticipated level of public support for the overall implementation and specific mitigation action?	High = <b>H</b> Medium = <b>M</b> Low = <b>L</b>	
<b>Technical</b> To what degree Is the proposed action technically feasible?		
<b>Administrative</b> What level of staff and capabilities necessary to implement the action is available?		
<b>Political</b> Is there political support to implement and maintain the action?		
<b>Legal</b> To what degree are proper laws, ordinances, and resolutions in place to implement the action?		
<b>Economic</b> How much do benefits seem to outweigh the costs?		
<b>Environment</b> Will the action positively affect the environment (land, water, endangered species)?		

## City of Seattle Hazard Mitigation Plan – 2020 Mitigation Action Worksheet

### INSTRUCTIONS

The following instructions are designed to assist City of Seattle departments and community partners in identifying and prioritizing mitigation actions for the 2020 Hazard Mitigation Plan Update. The instructions supplement the 2020 Mitigation Action Worksheet and are meant to provide additional information for each of the worksheet elements.

You have two options for filling in and submitting the worksheet:

- **WORD document** – fill in save file with extension your dept acronym and upload to the Teams 04 Mitigation Action, Files. If you choose to submit your mitigation actions as a WORD document, please bundle all the actions for your departments into a single WORD file.
- **MS LIST “Worksheet”** - online form (a fill-in form linked to Excel) on Teams (or Sharepoint). If you enter mitigation actions here, you do not need to send any files to OEM. See page 8 for tips and instructions on using Worksheet.

#### General Guidance for Generating Mitigation Actions and Potential Actions

- Action should address the goals and objectives. Review the goals and strategies. (see #5).
- Action should be strategic, and could be implemented by multiple projects, plans or programs. For example, A group of ten related of capital projects would be one action, not ten actions. It should not be a standard or routine business practice.
- Actions should progress within a five-year period. They do not need to be fully implemented, but projects should begin substantially progress over that period.
- If an action does not meet the five-year criteria, but could become a high priority for your department, identify it as a **Potential Action** in question 3. Status. Potential Actions will not be included in the Mitigation Strategy table in the Plan but will be tracked by OEM for future mitigation funding opportunities.
- Consider your department’s goals and initiatives for race and social justice. Think about how mitigation actions could better address those goals.
- Consider including a Plans action for your department to reflect any longer-range plans that includes or could include strategies or actions that reduce risk to hazards.
- Scan HMPs from other cities for ideas, especially those from large cities or west coast cities. Some plans can be found on Teams – Background - Files.

#### 1. Mitigation Action:

Describe your action in a manner detailed enough to be understood by the plan’s readers. Consider using the SMART method of describing objectives to develop your actions:

- **Specific** – target a specific area for improvement.
- **Measurable** – quantify or at least suggest an indicator of progress.
- **Assignable** – specify who will do it.

- **Realistic** – state what results can realistically be achieved, given available resources.
- **Time-related** – specify when the result(s) can be achieved.

## 2a, 2b, 2c. Lead and Supporting Department/Organization:

Identify what City department(s), or community partner(s), would be primarily responsible for implementing the action. If your department is large, identify the division or line of business associated with the action. Identify any other City departments or community partner(s) that will be supporting the project.

## 3. Action Status:

- **New Action**– The action is new and will be included for the first time in the 2020 plan update.
- **Existing Action** – The action was implemented prior to the 2020 plan update but is ongoing, and additional or ongoing action is required for completion.
- **Potential Action** – The action is speculative. It may not begin within the next five years, but could become a higher priority in future

## 4. Type of Action:

Type of Action	Description	Examples
<b>Plans and Regulations</b>	Regulatory actions or planning processes that result in reducing vulnerability to hazards. These actions include government authorities, policies, or codes that influence the way land and buildings are developed and built.	<ul style="list-style-type: none"> <li>▪ Comprehensive plans</li> <li>▪ Director's Rules</li> <li>▪ Department Standard Operating Procedures</li> <li>▪ Land Use Plans</li> <li>▪ Subdivision regulations</li> <li>▪ Building codes and enforcement</li> <li>▪ NFIP Community Rating System</li> <li>▪ Capital improvement programs</li> <li>▪ Open Space Preservation</li> <li>▪ Stormwater management regulations and master plan</li> </ul>
<b>Assessments and Studies</b>	These actions are taken to better understand the potential impacts of identified hazards.	<ul style="list-style-type: none"> <li>▪ Seismic studies of City facilities</li> </ul>
<b>Infrastructure/Capital Project</b>	These actions involve modifying existing buildings, structures and infrastructure to protect them from a hazard or remove them from a hazard area. This could apply to public or private structures as well as critical facilities and infrastructure. This type of action also involves projects to construct manmade structures to reduce the impact of hazards.	<ul style="list-style-type: none"> <li>▪ Utility undergrounding</li> <li>▪ Structural retrofits</li> <li>▪ Non-structural measures</li> <li>▪ Sea walls and retaining walls</li> <li>▪ Detention and retention structures</li> <li>▪ Culverts</li> </ul>
<b>Non-Structural Mitigation Measures</b>	These actions are physical actions taken that do not include structural modifications.	<ul style="list-style-type: none"> <li>▪ Secure furniture</li> <li>▪ Install backup generator</li> </ul>
<b>Natural Systems Protection</b>	These actions minimize damage and losses and also preserve or restore the functions of natural systems and cultural and historic resources.	<ul style="list-style-type: none"> <li>▪ Sediment and erosion control</li> <li>▪ Stream corridor restoration</li> <li>▪ Green space management</li> <li>▪ Conservation easements</li> <li>▪ Wetland restoration and preservation</li> <li>▪ Identification of historic and cultural resources in high hazard</li> </ul>

Type of Action	Description	Examples
		areas
Education and Awareness	These actions inform and educate residents, elected officials, and property owners about hazards and potential ways to mitigate them. Although this type of mitigation reduces risk less directly than structural projects or regulation, it is an important foundation. A greater understanding and awareness of hazards and risk among local officials, stakeholders, and the public is more likely to lead to direct actions.	<ul style="list-style-type: none"> <li>Radio or television spots</li> <li>Websites with maps and information</li> <li>Real estate disclosure</li> <li>Presentations to school groups or neighborhood organizations</li> <li>Mailings to residents in hazard-prone areas</li> <li>StormReady</li> <li>Firewise Communities</li> </ul>

## 5. Hazards Addressed:

This section lists all the hazards identified in the 2019 update of the *Seattle Hazard Identification and Vulnerability Analysis* (SHIVA). Hazards with an asterisk (\*) are the top five hazards as ranked in the SHIVA, however a comprehensive mitigation plan must identify actions that address all 18 hazards. Check all hazards that will be mitigated by the action. If it is a general action, then check “All Hazards.” Your department may have a specific responsibility for reducing the risk of certain hazards. If so, you may wish to focus your actions on those key hazards. Actions to address wildfire smoke are in the HazMat Incident category.

Examples:

- Seattle City Light should develop actions to reduce the effects of power outages.
- The Seattle Fire Department and Department of Transportation may develop actions to address hazardous materials.
- Seattle Public Schools should develop actions, in coordination with the Seattle Police Department, to address active shooter incidents.

## 6a. Hazard Mitigation Plan Goals Supported:

Identify which of the 2020 Hazard Mitigation Goals the action supports (you may select more than one):

GOAL 1: Protect **life and safety** and promote community resiliency.

- Objective 1.1: Conduct hazard specific public outreach to vulnerable areas.
- Objective 1.2: Reduce the possibility of damages and losses resulting from disease/pandemic hazards.
- Objective 1.3: Promote community resiliency through a comprehensive approach to preparing for the impacts of a changing climate.
- Objective 1.4: Increase the resiliency of the City’s food system.
- Objective 1.5: Enhance the City’s response capacity.

GOAL 2: Safeguard **critical infrastructure** and ensure continuity of service.

- Objective 2.1: Ensure system redundancies and backup power are available to support key City functions.



- Objective 2.2. Ensure protection of the City's information technology infrastructure.

**GOAL 3: Protect public and private **property**.**

- Objective 3.1: Reduce the possibility of damages and losses to City facilities and infrastructure from earthquakes and other geo-physical hazards.
- Objective 3.2: Reduce the possibility of earthquake-related damages and casualties due to Unreinforced Masonry Buildings.
- Objective 3.3: Reduce the possibility of damages and losses resulting from weather hazards.
- Objective 3.4: Reduce the possibility of damages and losses resulting from transportation and infrastructure hazards.
- Objective 3.5: Reduce the possibility of damages and losses resulting from intentional acts of destruction.
- Objective 3.6: Ensure that City building codes reflect the latest standards in seismic safety.

**GOAL 4: Protect the natural environment and cultural and historic resources.**

- Objective 4.1: Determine the earthquake vulnerability of historic landmarked properties.
- Objective 4.2: Reduce the use of or minimize the impacts of the use of potentially hazardous substances in City operations.

**GOAL 5: Promote a **resilient economy**.**

- Objective 5.1. Collaborate with local business to promote hazard mitigation.

**GOAL 6: Promote a collaborative and **integrated** mitigation program.**

- Objective 6.1: Incorporate hazard mitigation into other City plans and programs.
- Objective 6.2. Engage external partners in the City's mitigation planning process.

**6b. Race and Social Justice Focus Areas:**

Integrating race and social equity into the HMP is evolving. Methods proposed in this update may need more work. We look forward to feedback and more conversation with MWG to further refine our approach.

Below are focus areas for the City's Taskforce for Investments in BIPOC Communities. Indicate if the action has the potential to reduce race-based disparities in these focus areas (you may check more than one).

Focus Area	Examples
<b>Inclusive Economy</b>	Develop a contingency planning toolkit for small businesses in multiple languages.
<b>Climate Justice</b>	Accelerate flooding and sewer backup prevention projects in BIPOC neighborhoods.
<b>Community Safety</b>	Provide disaster preparedness training to BIPOC community-based organizations.
<b>Community Supports (safety)</b>	Affordable housing seismic retrofit. Increase the quantity and quality of emergency food available.



net)	
<b>Community Wealth Building</b>	Integrate education about hazards into trainings for low income HH first time home buyer programs.
<b>Education Opportunity</b>	Assess early learning centers for seismic retrofits.

#### 6c. Description:

Briefly describe how the action will have a positive impact in the selected focus areas. Example: Retrofitting early learning centers, which provide services to children from low income HH, will allow these centers to recover/ reopen more quickly after an earthquake.

#### 7a & b. Location and Location Description:

As part of the update, OEM would like to collect location information that could be used to develop a GIS map of mitigation actions. For those projects with a specific location(s) (site, neighborhood, district), provide the name of the neighborhood(s), district(s) or the street address(es). If there is a long list of site addresses, it is not necessary to list in the worksheet. Instead note the number of locations, and if GIS data is available.

#### 7c Benefit Area:

Briefly describe the area that will benefit from the action. Sometimes the location of a mitigation action may provide benefits to a much wider area., note the geographic area (citywide, district, neighborhood) that will benefit from this action. For example, seismic improvements to a major bridge may be in a specific neighborhood but will benefit the whole city.

#### 8. Timeline for Implementation:

Indicate the expected timeline for completion of the action. Mitigation actions included in the plan are expected to begin implantation and show progress within five years. If your mitigation action does not meet this criterion, indicate it is a Potential Action in #3.

#### 9a. Anticipated Cost (if known):

If possible, identify the estimated cost of the action based on best available data. If the cost is unknown, you may make a more qualitative assessment of the cost impact based on the following considerations:

- **High** – Existing funding levels are not adequate to cover the costs for the proposed action, and implementation would require an increase in revenue through alternate sources.
- **Medium** – The action could be implemented with existing funding but would require a reapportionment of the budget or a budget amendment, or the cost of the action would have to be spread out over time.
- **Low** – The action could be funded under the existing budget. The action is part of or can be part of an existing or ongoing program.

#### 9b &c. Funding Available & Funding Source:

Identify whether funding for the action is currently or is anticipated to be available. If funding is available, please identify the anticipated funding source (e.g., existing budget, grants, bond/levy). The cost of some actions may consist only of staff time and administrative resources.

**10. Date:** Indicate the date the Worksheet was completed.

**11. Contact Information:** Contact should be the person could confirm information or provide additional information as needed. This could be you (MWG member) or another staff person at your department.

## 12. Prioritization Criteria

OEM will use the following ratings to identify potential projects for future funding opportunities. As criteria or programs vary, and new criteria or funding may arise, this information is not absolute. At the November 4<sup>th</sup> Meeting the MWG will review methods for developing an overall project ranking based on these criteria.

Mitigation Impact Criteria considers mitigation effectiveness, other benefits, and the City's RSJI goals. Use the prompt questions to evaluate the degree of effectiveness or positive impact of each action.

Mitigation Impact Criteria	Evaluation Rating	
<b>Mitigation Effectiveness.</b> Will the implemented action result in lives saved?	High = <b>H</b> Medium = <b>M</b> Low = <b>L</b>	
<b>Mitigation Effectiveness.</b> Will the implemented action result in a reduction of disaster damage?		
<b>Multiple Benefits.</b> Will the action provide multiple community benefits beyond mitigation?		
<b>Collaboration.</b> Will the action involve collaboration between City departments and/or the community?		
<b>Racial Equity.</b> Will the action reduce hazard vulnerability for BIPOC communities?		

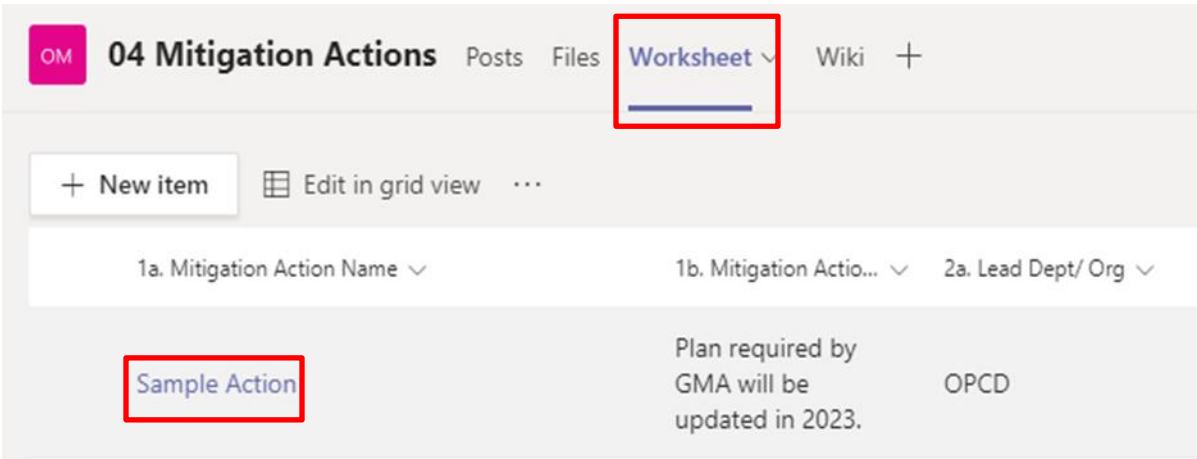
STAPLEE is an acronym for the seven criteria for action feasibility. Use the prompt questions to evaluate how well the criteria for each action is met.

STAPLEE Criteria	Evaluation Rating	
<b>Social:</b> What is the anticipated level of public support for the overall implementation and specific mitigation action?	High = <b>H</b> Medium = <b>M</b> Low = <b>L</b>	
<b>Technical</b> To what degree Is the proposed action technically feasible?		
<b>Administrative</b> What level of staff and capabilities necessary to implement the action is available?		
<b>Political</b> Is there political support to implement and maintain the action?		
<b>Legal</b> To what degree are proper laws, ordinances, and resolutions in place to implement the action?		
<b>Economic</b> How much do benefits seem to outweigh the costs?		
<b>Environment</b> Will the action positively affect the environment (land, water, endangered species)?		

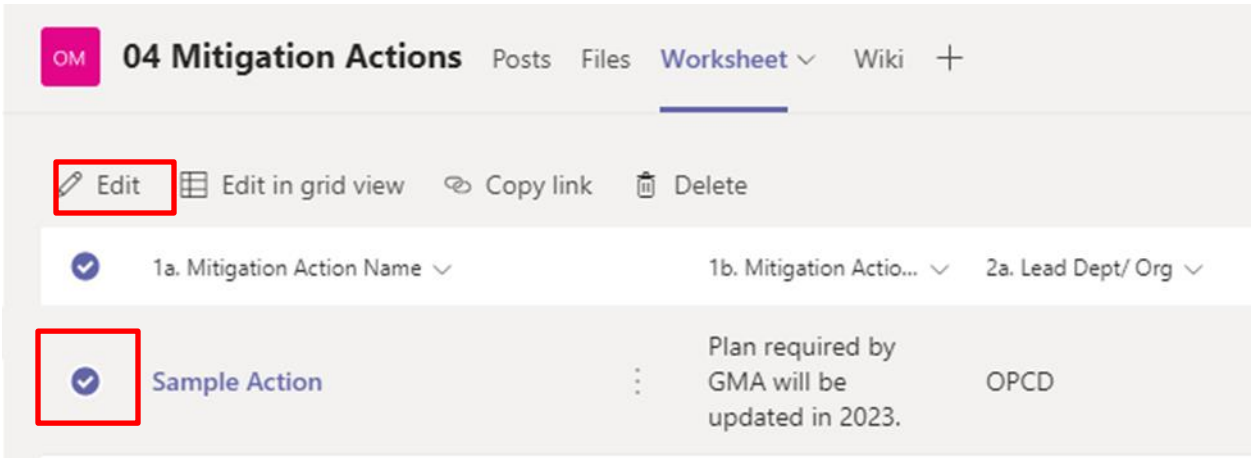
Submitting Mitigation Actions in Worksheet

The “Worksheet” is a fill in form created with the List App. It can be used in Teams or Sharepoint environments. The form has a series of fill in fields and pull-down menus to capture all the needed information for each mitigation action. The form is set up so you can enter some information, save, and return to the form later to edit or add information. Make sure to Save before exiting the form. You do not need to save after changing each item on the form.

- 1. Find Worksheet on Teams



- 2. **Get familiar with the New Item form.** Click the circle for “Sample Action” and then edit above. Explore what the form looks like and how it works. Make a change. Click Save at the top or the bottom left. Reopen the form to see if your change is still there.



OM

04 Mitigation Actions

Posts

Files

Worksheet ▾

Wiki

+

Save

Cancel

Copy link

Sample Mitigation Action

1a. Mitigation Action Name \*

Sample Mitigation Action

1b. Mitigation Action Description

Plan required by GMA will be updated in 2023.

2a. Lead Dept/ Org

OPCD

2b. Division/ Line of Business (if applicable)

Enter value here

2c. Supporting Dept/ Org

All Depts

3. Action Status

New ▾

4. Type of Action

Plans and Regulations ▾

5. Hazards Addressed

All Hazards ▾

6a. HMP Goals Supported

Life and Safety, Integrated Planning

6b. RSII Focus Areas

Inclusive Economy, Community Saf.

6c. Description

Enter value here

7a. Location \*

Citywide, no specific or targete... ▾

C4-Collaboration

Select an option ▾

C5-Racial Equity

Select an option ▾

C8-Administrative

Select an option ▾

C9-Political

Select an option ▾

C12-Environment

Select an option ▾

Attachments

Add attachments

Save

Cancel

- Enter information for a Mitigation Action.** Click “New Item” to enter information for each mitigation action. Don’t forget to Save before closing the form. Click “New Item” to enter your next action.
- Edit or add information for a Mitigation Action.** Find the action you want to edit. Click the circle next to the action and then edit above. The form will open with the information you previously entered. Make changes or additions. Don’t forget to Save before closing the form.
- Delete a Mitigation Action.** Find the action you want to delete. Check the circle next to the action. Choose delete from the menu above.

OM

04 Mitigation Actions

Posts

Files

Worksheet

Wiki

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✎

Edit

📊

Edit in grid view

🔗

Copy link

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Delete

✓

1a. Mitigation Action Name

▼

1b. Mitigation Action...

▼

2a. Lead Dept/ Org

▼

✓

Sample Action

⋮

Plan required by GMA will be updated in 2023.

OPCD

- Sharing with Others.** You can share links and manage access for each action. There is a chat that can be used to ask questions or gather comments about an action from your colleagues. You can also attach documents to each form that has more detailed information.

OM

04 Mitigation Actions

Posts

Files

Worksheet

Wiki

+

Save

Cancel

🔗 Copy link

✎ Edit columns

💬 Conversation

Sample Mitigation Action

1a. Mitigation Action Name \*

Sample Mitigation Action

2b. Division/ Line of Business (if applicable)

Enter value here

4. Type of Action

Plans and Regulations

▼

1b. Mitigation Action Description

Plan required by GMA will be updated in 2023.

2c. Supporting Dept/ Org

All Depts

5. Hazards Addressed

All Hazards

▼

2a. Lead Dept/ Org

OPCD

3. Action Status

New

▼

6a. HMP Goals Supported

Life and Safety, Integrated Planning

Re: Sample Mitigation Action

1:57 PM

This is a great action!!

📎

Re: Sample Mitig...

Mitigation Action Worksheets Table

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG					
Count	Number	Title	1b. Mitigation Action Description	2a. Lead Dept/ Org	2b. Division/ Line of Business (If applicable)	2c. Supporting Dept/ Org	3. Action Status	4. Type of Action	5. Hazards Addressed	6a. NHP Goals Supported	6b. RSI/ Focus Areas	6c. Description	7a. Location	7b. Location Description	7c. Benefit Area	8. Timeline	9a. Anticipated Cost (If known)	9b. Funding Available	9c. Funding Source	10. Date	C1-Lives Saved	C2-Reduce Damage	C3-Multiple Benefits	C4-Collaboration	C5-Racial Equity	C6-Social	C7-Technical	C8-Administrative	C9-Political	C10-Legal	C11-Economic	C12-Environment						
1	FAS1	Seattle Animal Shelter Emergency Generator	The Seattle Animal Shelter existing generator was assessed in the aftermath of an extended power outage during the February 2019 winter storm. The generator was determined to have excess capacity to take on more electrical load. This offers an opportunity to provide backup power for portions of SAS' critical operations (e.g. animal care), above and beyond what the generator powers for life safety requirements. However, during the replacement of the breaker connecting the generator to the buildings electrical system, it was discovered that the current wiring size on the electrical system was inadequate to match the additional load. To safely and properly use this additional capacity, the mitigation project would involve: Further evaluating the Animal Shelter's emergency power needs to continue their critical operations, and Reconfiguring the electrical components by increasing wiring size to match the full capacity of the generator.	Finance and Administrative Services	Facility Operations	Seattle Animal Shelter and Capital Development	New	Non-Structural Measures	Earthquakes;Power Outages;Wind Storms;Snow, Ice and Extreme Cold	Life and Safety;#Property Protection	Community Safety	SAS handles all lost pets within the Seattle city limits, animal control, pet adoptions and licensing. Spay and Neuter Clinic is onsite. Improve preserve health and welfare of the animals and occupants in the facility.	Specific Site, provide address below	2061 15th Ave W	Seattle Animal Shelter is a one-story building located in the Inter Bay commercial/industrial core. Using excess capacity on the emergency generator can support other critical SAS operational functions including animal care, refrigeration and communications.	3.5 years		No	Other		11/2/2008	Medium	Low	Medium	Low	Low	Medium	Medium	Medium	Medium	Medium	Low						
2	FAS2	Seismic Retrofit Facilities Improvement Program	FAS facilities house important City services, many of which will be critical in the event of an earthquake. The average building age of the FAS portfolio is 50 years old and many of these facilities were not built or retrofitted under modern seismic codes. These facilities are at risk of sustaining damage from an earthquake that could render the building unusable, or in even worse scenario of structural failure resulting in injury or death of the occupants. Especially vulnerable are FAS buildings that are not dedicated first-responder facilities, yet still directly support emergency operations. The Seismic Retrofit Facilities improvements program would be initiated to: 1. Hiring consultants to perform a preliminary engineering evaluation of the current FAS real property portfolio including retrofit cost estimates. The program would utilize the Critical Facilities Index, a scoring methodology developed in 2013, and funded through the FEMA Pre-Disaster Mitigation Grant. 2. Seismic retrofits will then be prioritized by developing a Master Plan for FAS facilities. This includes coordinating the evaluation and design processes by synchronizing other non-seismic related projects planned to be executed, and, designating immediate occupancy standards for new construction for City facilities with mission critical functions. The outcome of this program would be to increase the City's seismic resiliency and reduce the risk of downtime to critical City services post earthquake.	Finance and Administrative Services	Capital Development	N/A	Potential	Assessments and Studies	Earthquakes	Life and Safety	Community Safety;#Community Wealth Building;#Community Supports (safety net)	Community Safety	This program would provide City employees greater protection during a seismic occurrence and allow the City to ensure continuity of operations to serve Seattle residents with safer and more expeditious responses. The seismic program supports growth in Urban Centers and Urban Villages by reducing the risk of downtime to critical City services during a seismic event. WMBE vendors, construction contractors and subcontractors may be contracted for design and construction work. This further promotes the City's RSI goal to employ WMBE businesses on City funded projects.	District or Neighborhood, provide name below	FAS-owned properties	Citywide	Seattle Animal Shelter is a one-story building located in the Inter Bay commercial/industrial core. Using excess capacity on the emergency generator can support other critical SAS operational functions including animal care, refrigeration and communications.	No	Other		11/2/2008	Medium	High	Medium	Medium	High	Low	Medium	High	Low	Low	Medium	Low					
3	FAS3	Install ShakeAlert Technology into Elevators	Install ShakeAlert technology into express elevators in SMT to send signal to the automated building emergency system that recalls the elevators to be sent to ground floor. This is nonstructural project is ongoing through Q3, 2021. Anticipated costs to be \$10,000 and funded through operations budget. Where applicable, installation of ShakeAlert will expand to other buildings beyond SMT when an elevator modernization or similar infrastructure project is initiated. Project co-sponsored by OEM to connect city facilities to the USGS supported earthquake early warning system.	Finance and Administrative Services	Logistics and Emergency Management	Facility Operations	New	Non-Structural Measures	Earthquakes	Life and Safety;#Critical Infrastructure Protection;#Property Protection	Community Safety	ShakeAlert can provide seconds to minutes of warning about an earthquake before the ground starts shaking. It can provide verbal alerts to people or automated alerts to equipment.	Specific Site, provide address below	Seattle Municipal Tower	Citywide	1.8 years	\$ 15,000	Yes	Existing Budget	11/2/2008	Medium	Low	Low	Low	Low	Low	High	Medium	Low	Low	High	Low						
4	HSD1	Food Security	Increase community capacity for emergency feeding: In 2021, HSD will develop a 3-5 year strategic feeding plan that will include 1) capacity building to increase food system resilience, 2) continuous improvement from 2019 winter storm and 2020 COVID-19 responses, including the identification of key city departmental roles, 3) new standard operating procedures for emergency feeding, 4) new communications structure and protocol with community agencies for meeting food needs in an emergency, and 5) investments in BIPOC food and meal programs so they can be responsive to their own communities in a hazard.	Human Services Department	Food & Nutrition	DSE, DON	New	Plans and Regulations	All Hazards	Life and Safety	Community Supports (safety net)	Strengthen community capacity for emergency feeding and collaboration	Citywide, no specific or targeted location	Citywide	1.3 years	Anticipated					11/3/2020	Medium	Low	High	Medium	Medium	Medium	High	Medium	Medium	Medium	Medium						
5	ITD1	Communication Site on Wheels	Create 3-6 stand alone Communication Site on Wheels (SOW) intended to provide localized communications in and around a specific venue or larger incident scene. SOW for trunked radio, cellular, Wi-Fi, and Point to Point Network (Ethernet) 3-6 Trunks. Initially provides emergency communication for first responders eventually could be reallocated to provide public Wi-Fi access for residents to allow for incident information and access to city, state, and federal emergency assistance programs.	ITD	Technology Infrastructure	SCL, SDOT, SPD, SPU, FAS, SPBA, HSD, SDO	New	Non-Structural Measures	All Hazards	Life and Safety	Community Safety	Provides access to essential communications during an event or incident	District or Neighborhood, provide name below	North, Central, South, West, locations in Seattle	Seattle Area	1.3 years	\$ 600,000	No			11/17/2020	High	High	High	High	High	High	Medium	High	Medium	High	Medium						
6	OEM1	Community-led Mitigation Projects	Expand partnerships between the City and community based organizations to plan, fund and implement mitigation projects. Incorporate targeted outreach to high priority community service orgs.	OEM		DON, OH	New	Plans and Regulations	All Hazards	Life and Safety;#Property Protection;#Natural Resource Protection;#Resilient Economy	Inclusive Economy;#Climate Justice;#Community Safety;#Education Opportunity;#Community Supports (safety net);#Community Wealth Building	Projects are TBD and could address any of the RSI focus areas.	Citywide, no specific or targeted location	Citywide	3.5 years		No				Medium	Med	Medium	High	High	High	Medium	Medium	Medium	Medium	Medium	Medium						
7	OEM2	Hazard Mitigation Program Equity Analysis	OEM and MWG will undertake an analysis to better integrate equity into the hazard mitigation program. The analysis will use location data (specific sites, benefit areas, socially vulnerable populations) and hazards data to better understand which mitigation actions could improve outcomes for vulnerable and BIPOC communities. The analysis will also be used to create equity criteria that could be used to prioritize mitigation actions.	OEM			New	Assessments and Studies	All Hazards	Integrated Planning	Climate Justice	This project will add transparency to where mitigation investments are being made, and where benefits would accrue.	Citywide, no specific or targeted location	Citywide	3.5 years		No				Medium	Low	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium						
8	OEM3	Update Home Retrofit Education Program	The materials for this existing education program will be updated to reflect the latest changes in the Project Impact plan set and guidance to residents on retrofitting their home and process for obtaining required permits. SDO is expecting a new plan set template to be available some time during 2021.	OEM		SDO	Existing	Education and Awareness	Earthquakes	Life and Safety;#Property Protection	Community Safety		Citywide, no specific or targeted location	Citywide	< 1 year		No																					
9	OEM4	Ongoing support for URM Retrofits	Support ongoing efforts to identify additional financial resources, policies, programs, and partnerships to reduce risks posed by URM. For example, support King County's efforts to develop Commercial Property Assessed Clean Energy + Resilience (C-PACER) program that could provide low cost, long term financing to property owners to implement URM retrofits. Continue outreach and education efforts to promote the benefits of URM seismic retrofits.	OEM			Existing	Plans and Regulations	Earthquakes	Life and Safety;#Property Protection	Community Safety	Chinatown ID and Columbia City have a concentration of URM and would be disproportionately affected by an earthquake.	Citywide, no specific or targeted location	Citywide	1.8 years	No					1/1/2021	High	High	Low	Medium	Medium	Medium	Medium	Low	Medium	High	Low						
10	OPCD1	Comprehensive Plan Update	WEA Growth Management Act requires Seattle to update the comprehensive plan by June 2022. This is a foundational plan that guides Seattle's growth and development. This update will include more data/mapping on hazards and will provide more policy guidance about resilience and climate adaptation.	OPCD	Long Range Planning	All Depts	New	Plans and Regulations	All Hazards	Life and Safety;#Critical Infrastructure Protection;#Property Protection;#Natural Resource Protection;#Resilient Economy;#Integrated Planning	Inclusive Economy;#Community Safety	Plan for future growth in ways that enhances equity and mitigates impacts to BIPOC communities.	Citywide, no specific or targeted location	Citywide plan	Citywide	1.3 years	\$ 500,000	Anticipated		10/8/2020	Low	Low	High	High	High	Medium	High	High	High	High	Low	Medium						
11	OSE1	Duwamish Valley Resilience and Adaptation Planning	Duwamish Valley Program (DVP) is an ongoing partnership between the City and the communities of South Park and Georgetown to address health outcomes, displacement, flooding, and climate change. Two related projects will address flooding due to sea level rise. Funding from the Robert Wood Johnson Foundation will support planning for a "resilience district" including scenario planning for a sea level rise adaptation strategy, research on financial models and equitable investment mechanisms, capacity building, inclusive community engagement, and implementation of "proof of concept" projects. A second project will develop designs and an implementation plan for constructing multi-purpose sea level protection infrastructure in the South Park neighborhood that will protect the area from flooding due to sea level rise, and to help residents and businesses thrive in place. A series of levees and flood walls would promote important maritime industrial businesses, increase community access to the water, create open space, reduce the likelihood of potential future recontamination of the Duwamish River Superfund site, and improve habitat. The technical feasibility of implementing sea level rise protection infrastructure in South Park was documented in the USACE's report "Preliminary Flood Risk Management Study for the Duwamish River at South Park."	OSE/OPCD/DON lead		SPR, SPU, SDOT, OH, MD, RWJF	New	Assessments and Studies	Floods;#Excessive Heat;#Infrastructure Failure	Life and Safety;#Critical Infrastructure Protection;#Property Protection;#Resilient Economy;#Integrated Planning	Inclusive Economy;#Climate Justice;#Community Safety;#Education Opportunity;#Community Wealth Building	Program, to advance environmental justice and equitable development, prioritizing the needs of those most affected by racial inequities and health disparities. This project, a long-term strategy in the Plan, will mitigate and adapt to flood risk, and support the ability of people and businesses to thrive in place. The goals of this strategy include: 1. Define Physical Adaptation Responses in partnership with stakeholders, including a suite of adaptation projects that will advance at various scales and timing. Without the project, the flooded private parcel average (exclusive of all high ground and ROW) during the 1% annual exceedance probability is expected to increase from 11 to 63 acres between 2020 and 2070. This area is home to most of the 6,000 jobs in South Park. 2. Co-develop, through community collaborations, agreement on models, standards, guidelines, and data used in adaptation planning to produce flexible, multi-benefit, policy, regulatory, and financing solutions. 3. Co-develop a Resilience District that for the lower Duwamish Valley, that includes a community-led organizations with the capacity to attract and deploy capital at scale, to enter into formal agreements with agencies, and to lead and partner on environmental justice, equitable development and climate change adaptation projects and programs. Design and implementation of these	District or Neighborhood, provide name below	Duwamish Valley (primarily in the industrial areas of the South Park neighborhood)	South Park and Georgetown neighborhoods	< 1 year	\$ 600,000	Yes	Grant		Low	High	High	High	High	High	High	High	High	High	High	High	High	High	High	High	High	Medium
12	SCL1	SCL Systems Operation Center Seismic Retrofit	Design and construction	SCL			Existing	Infrastructure/Capital Projects	Earthquakes	Life and Safety;#Critical Infrastructure Protection;#Property Protection;#Resilient Economy	Community Safety	A resilient system will support RSI communities who are more impacted by power outages.	Citywide, no specific or targeted location	Systems Operation Center is located in the Fremont neighborhood.	Systemwide	1.3 years	\$ 2,700,000	Anticipated		12/2/2020																		
13	SCL2	Seismic Review of Vaults & Substations	An update of a 1999 study.	SCL			Existing	Assessments and Studies	Earthquakes	Life and Safety;#Critical Infrastructure Protection	Community Safety		TBD		1.8 years	\$ 200,000	Anticipated		12/2/2020																			
14	SCL3	Substation Seismic Upgrade	14 substations require retrofit. Average cost is about \$600,000 per substation. Project began in 2024 and will take 15 years to complete.	SCL			Existing	Infrastructure/Capital Projects	Earthquakes	Life and Safety;#Critical Infrastructure Protection	Community Safety		TBD		3.5 years	\$ 8,400,000	Yes	Existing Budget	12/2/2020																			
15	SCL4	Non-structural Mitigation at SCL Facilities	This project will include seismically-designed storage racks for critical parts and supplies, and will secure furniture.	SCL			Existing	Non-Structural Measures	Earthquakes	Life and Safety;#Critical Infrastructure Protection;#Property Protection	Community Safety		TBD		1.8 years		Yes		12/2/2020																			
16	SCL5	Install Impact Recorders at Substations		SCL			Existing	Non-Structural Measures	Earthquakes	Life and Safety;#Critical Infrastructure Protection	Community Safety		TBD		1.3 years		No			12/2/2020																		
17	SCL6	Map Cell Towers & Identify Feeders		SCL			Existing	Assessments and Studies	Earthquakes;#Power Outages;#Snow, Ice and Extreme Cold;#Wind Storms	Critical Infrastructure Protection		TBD		1.8 years		Yes			12/2/2020																			
18	SDO1	Ongoing Support for URM Retrofits	Support ongoing efforts to reduce risks posed by URM, such as: update the confirmed URM inventory quarterly (remove demolished buildings and retrofitted buildings); update the confirmed URM inventory of City owned buildings to help identify future funding opportunities; update the proposed URM retrofit technical standard to reflect changes in national/ international building standards.	SDO			Existing	Plans and Regulations	Earthquakes	Life and Safety;#Property Protection	Community Safety;#Community Wealth Building;#Community Supports (safety net)	Many URM are located in equity focus areas such as Chinatown ID, Pioneer Square and Columbia City.	Citywide, no specific or targeted location	Citywide	3.5 years			Existing Budget	1/14/2021	High	High	High	High	High	Medium	High	High	High	High	High	Medium	Low						
19	SDOT1	N. Northlake Way Seawall Replacement	Seismically retrofit a failing 66-year-old timber and steel retaining wall. The wall is 423 ft in length and 14 feet high. The retaining wall supports a sidewalk, the N. Northlake Way roadway, and provides access for the adjacent maritime businesses. Overhead power lines and several buried utilities are dependent on the retaining wall. A replacement retaining wall will also provide an environmental benefit by removing the existing eroded timbers and preventing the flow of asphalt and fill into Lake Union. The project schedule is 2020-21 planning and development, 2021-2022 final design and permitting, and construction in 2023.	SDOT	Roadway Structures Division	SDO	New	Infrastructure/Capital Projects	Earthquakes;#Transportation Incident;#Power Outages;#Infrastructure Failure	Life and Safety;#Critical Infrastructure Protection;#Property Protection		The project will protect Lake Union, secure North Northlake Way, protect the historic maritime businesses adjacent to the project, and protect the traveling public from a retaining wall failure.	Specific Site, provide address below	1101 N Northlake Way	The geographic area around the project include Lake Union and the Burke-Gilman Trail.	1.8 years	\$ 20,000,000	Anticipated	Grant;#Existing Budget	11/24/2020	Low	High	Medium	High	Low	High	High	High	High	High	High	High						
20	SDOT2	West Seattle High Bridge	Strengthen and seismically upgrade the diminished structural integrity of the West Seattle Bridge high span. Restore traffic to the West Seattle High Bridge which will improving travel to West Seattle, improve emergency response times, protect the Duwamish water way, and improve Port of Seattle terminal operations.	SDOT	Roadway Structures Division	SDOT, US Coast Guard, the Port of Seattle, Northwest Seaport Alliance	New	Infrastructure/Capital Projects	Earthquakes;#Power Outages;#Transportation Incident;#Infrastructure Failure	Life and Safety;#Critical Infrastructure Protection;#Property Protection;#Resilient Economy;#Integrated Planning	Inclusive Economy;#Climate Justice;#Community Safety	The project will improve emergency response times by reopening the busiest arterial in the city. And the only route to West Seattle that does not cross a movable bridge. The project's purpose is to protect and restore the West Seattle High Bridge. The project will improve Port of Seattle operations, improve commute times for the South and South West Seattle workforces, and improve the accessibility to local businesses. The project will provide a more reliable transit system for BIPOC communities in White Center, along the Delridge Avenue corridor, and in the Duwamish Valley. The project will also reduce noise and air pollution caused by the rerouting of thousands of vehicles each day into BIPOC communities. The project can improve the safety of people who ride bikes and walk in BIPOC communities experiencing high traffic volumes from rerouted West Seattle Bridge traffic.	District or Neighborhood, provide name below	West Seattle, Harbor Island, South Seattle	The West Seattle Peninsula, Harbor Island and South Seattle will benefit directly from this action. The city will benefit economically with improved access to the Port of Seattle terminals on Harbor Island and improved access to the fuel farm on Harbor Island the serves the region.	1.9 years	\$ 47,000,000	Anticipated	Existing Budget;#Grant	11/24/2020	High	High	High	High	High	High	High	High	High	High	High	High	High	High	High	High	High	
21	SDOT3	Post Earthquake Arterial Damage Spot Repair Planning and Exercise		SPB, SCL, SPD, WSDOT	SDOT		New	Education and Awareness	Earthquakes;#Infrastructure Failure	Life and Safety;#Critical Infrastructure Protection;#Resilient Economy;#Property Protection		SDOT will require significant outside resources to patch damaged arterials post earthquake. Impassable arterials will slow post-earthquake emergency response life safety and property protection efforts. Additionally, impassable arterials will impact economic restoration post earthquake. Conducting a post-earthquake arterial spot repair exercise will identify the additional resources required for arterial restoration and coordination restoration activities across departments.	TBD	Citywide	< 1 year	\$ 80,000	No	Grant	12/02/2020	Medium	Medium	Medium	High	Low	High	High	Medium	High	High	High	High	High						



Mitigation Action Worksheets Table

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG	
	Count	Number	Title	1b. Mitigation Action Description	2a. Lead Dept/ Org	2b. Division/ Line of Business (If applicable)	2c. Supporting Dept/ Org	3. Action Status	4. Type of Action	5. Hazards Addressed	6a. NHP Goals Supported	6b. RSI Focus Areas	6c. Description	7a. Location	7b. Location Description	7c. Benefit Area	8. Timeline	9a. Anticipated Cost (If known)	9b. Funding Available	9c. Funding Source	10. Date	C1-Lives Saved	C2-Reduce Damage	C3-Multiple Benefits	C4-Collaboration	C5-Racial Equity	C6-Social	C7-Technical	C8-Administrative	C9-Political	C10-Legal	C11-Economic	C12-Environment	
22	SDOT4		Bridge Seismic Retrofit	Bridge seismic improvements and bridge structures maintenance. 10 bridges are funded through Move Seattle Levy. 4 bridges are deferred unless other funding is identified.	SDOT	Roadway Structures		Existing	Infrastructure/Capital Projects	Earthquakes#Infrastructure Failure	Life and Safety#Critical Infrastructure Protection#Resilient Economy		The Move Seattle levy funds bridge seismic improvements that will increase the resiliency of Seattle's transportation network and preserve critical infrastructure.	TBD	Included in Levy: 2nd Ave Extension 4th Ave S Main to Airport Way Bridge 15th Ave NW/Leary Way Bridge		1-3 years	\$ 37,260,000	Yes	Bond/Levy	12/1/2020	Medium	High	High	High	Medium	High	High	Medium	High	High	High	Medium	
23	SDOTS		Vision Zero	Seattle is experiencing a secondary public health crisis with more people dying or seriously injured from traffic crashes despite fewer vehicles on the road during COVID. Vision Zero is Seattle's plan to reduce the hazards of vehicle and pedestrian accidents and to eliminate serious and fatal crashes by 2030. Vision Zero will reduce speed limits to 25MPH across Seattle, a proven mitigation action to reduce deaths and serious injuries from vehicle collisions. Additionally, Vision Zero will add leading pedestrian signal (LPS) intervals across Seattle allows pedestrians to safely enter an intersection 3-7 seconds before vehicles receive a green light. Leading pedestrian intervals are proven to reduce vehicle and pedestrian crashes at intersections by 13%. SDOT will measure the success of it's mitigation tactics by the reduction of injuries and fatalities and the installation of new infrastructure such as speed limit signs, protected bike lanes, and LPS.	SDOT		SPD, ICF, WSDOT	Existing	Plans and Regulations	All Hazards	Life and Safety#Critical Infrastructure Protection	Community Safety#Education Opportunity	The Vision Zero program saves lives and reduces serious injuries. In addition, as the program is implemented across the city improvement and upgrades are made to the transportation network. These improvements include pavement restoration, upgrades supporting the intelligent transportation system, creating new bicycle infrastructure, and creating and improving pedestrian infrastructure. Lastly, black people are more likely to be killed in traffic crashes and more likely to be stopped and killed by police during routine traffic stops. There is a concentration of fatalities and serious injuries in Seattle's highest disadvantaged neighborhoods. The Vision Zero program is focused on ending these disparities.	Citywide, no specific or targeted location			3-5 years	\$ 75,000,000	Yes	Bond/Levy	11/24/2020	High	Medium	High	High	High	High	High	High	High	High	High	Low	
24	SPL1		Seismic Retrofit of Historic Libraries	A 2016 survey conducted by SDO identified the three unreinforced masonry Carnegie buildings as high-risk for damage and loss of life in the event of a major earthquake. The seismic upgrade to each of these landmark buildings is estimated to take approximately 18 months to complete.	SPL			New	Infrastructure/Capital Projects	Earthquakes	Life and Safety#Critical Infrastructure Protection#Property Protection			Specific Site, provide address below	Green Lake 7364 East Green Lake Dr N University 5009 Roosevelt Way NE Columbia 4721 Rainier Ave S	Green Lake, U District and Columbia City neighborhoods		3-5 years	\$ 13,800,000	Yes	Bond/Levy		High	High	Medium	Medium	Medium	High	High	High	High	Medium	Medium	Low
25	SPL3		Improvements for Clean Air, Cooling Centers	Seattle's Community Centers are critical public facilities for offering safe and healthy spaces during extreme weather events involving wildfire smoke, high heat, snowstorms or intense cold. To support cleaner and cooler air in these buildings, many require extensive renovations to allow the building envelope and allow for new air filtration systems such as heat pumps. Doing so also allows for the installation of hospital-grade filters to support these buildings as shelters in times of health crises such as the current COVID-19 pandemic. SPL will be able to report on successes and progress as each Community Center enters the Planning, Design, Construction, Closeout/Complete phases.	SPL	Planning, Design, and Development Division	SCL, DEM, HSD	Existing	Infrastructure/Capital Projects	Excessive Heat#Snow, Ice and Extreme Cold#Heat/Illness Incidents			Inclusive Economy: any Consultant work could be contracted with BPOC community Climate Justice broadly, this work can bolster resilience of landscape/property assets to make sure these assets continue to be accessible and provide ecological services. Individual studies, design, or operational strategies can distinctly assess impacts and identify actions to help overcome historic disparities.	District or Neighborhood, provide name below	Seattle has experienced many extreme weather events and recognized the importance of having safe places for our vulnerable populations to shelter in that have clean air and cool temperatures, particularly in certain neighborhoods that have more disparities and thus greater need of services. Investing in public buildings to provide safe and healthy shelters to increase health in these populations is a vital response to climate injustices that increase community safety and well-being.	Seattle has identified many Equity Areas where economic, health, and social disparities are greatest. The Community Centers located in these areas of the city will be prioritized to receive the infrastructure improvements to make them more resilient to the impacts from climate change.	The City of Seattle has many distinct and diverse neighborhoods that are impacted differently by extreme weather events. Certain areas near industrial zones have more pollution and more extreme heat potential, as well as a higher proportion of People of Color that have been impacted by historic and current structural racism. While the city overall will benefit from improvements to our Community Centers, which are placed in all neighborhoods, the Central District, South Park, International District, and others will receive priority since they have the greatest need and will receive the greatest impact.	3-5 years		Anticipated		11/22/2020	High	Low	High	Medium	High	High	High	High	High	High	Medium	Low
26	SPL2		Mitigate Impacts to Park Property and Assets Resulting from Flooding, High Tides and Sea Level Rise	Using design and operational strategies, assess and implement stormwater management practices in light of higher surge storm events, and perform study of seawall replacement strategies.	SPL	Planning and Development, Parks and Environment, Facilities Maintenance	SPL	Existing	Assessments and Studies	Floods#Water Shortages#Infrastructure Failure	Property Protection#Natural Resource Protection	Inclusive Economy#Climate Justice		Citywide, no specific or targeted location	Citywide park developed and undeveloped landscapes, shorelines, riparian corridors		< 1 year		Yes	Existing Budget	11/30/2020	Low	Medium	Medium	Medium	High	Medium	High	Medium	Medium	High	High	Medium	
27	SPL3		Seismic Retrofits of SPR Programmed Buildings	This action consists of providing seismic retrofits to a number of buildings within SPL's portfolio to meet life safety standards, reducing the risk of injury or death in the event of an earthquake. Each retrofit will be implemented by Parks Planning and Development division as a project or subproject within the department's Capital Improvement Plan (CIP).	SPL	Planning and Development Division	Office of Emergency Management/ Facilities and Administrative	Existing	Infrastructure/Capital Projects	Earthquakes#Wind Storms	Life and Safety#Natural Resource Protection#Property Protection	Community Safety#Education Opportunity	Programming within facilities owned by SPL are accessed by diverse user groups, all of whom face potential risk if these facilities do not meet seismic standards. Much of the programming offered at these facilities is educational in nature. Loss of these facilities would reduce access to those opportunities.	Citywide, no specific or targeted location	Known sites of project need include Pratt Fine Arts Center, Loyal Heights Community Center, and Magnuson Park Buildings 2 and 3L.	Dead Horse Canyon - in Southeast Seattle is a traditionally under-served end of Seattle, Duwamish Greenbelts - East, located along the western face of Beacon Hill adjacent to I-5, West, located along the eastern portion of West Seattle and the Duwamish at Cliff Greenbelt is on the Northern portion of Alki in West Seattle. South Park Neighborhood - Located in South Seattle in a traditionally economically depressed area. Recent projects in the area have worked to reduce combined sewer overflow and localized flooding. Proposed and Current Park projects in the area seek to mimic natural infiltration conditions and limit the impact to the Duwamish Watershed from storm runoff.	Loyal Heights Community Center is one of Seattle Parks and Recreation's largest community centers and serves the Loyal Heights neighborhood in Ballard. Pratt Fine Arts Center holds classes and provides artist space with a citywide, if not broader, appeal. Magnuson Building 3L is housed by Sail Sand Point, a non-profit that provides sailing instruction, programs, and camps and hosts regional competitions. Magnuson Building 2 will likely be leased to the Sand Point Center of Excellence, which appears to be a regional center for lacrosse, archery, and arts spaces.	< 1 year	\$ 10,000,000	Anticipated	Bond/Levy#Extrine B	11/13/2020	High	High	Medium	Medium	Medium	High	High	Medium	High	High	Low	
28	SPL4		Mitigation of Potential Damage to ECLs	Mitigation of potential damage to Environmentally Critical Areas from Severe weather and stormwater run-off. In 2020-2020 plan was titled: Identify ECLs/Impervious drainage systems by private residents, impacting steep slope areas in conjunction with SDOT and SPL. Coordinate with Seattle Public Utilities (SPL), which owns and maintains the City of Seattle's stormwater and combined sewer conveyance systems to identify, study, define options, design, and construct and / or implement Best Management Practices to minimize potential impacts to Environmentally Critical Areas (Steep Slopes, Potential Slide Areas, Known Slide Areas, Liquidable Soils, Etc) that exist on City-owned land managed by Seattle Parks and Recreation.	SPL	Project Delivery Division	Seattle Parks and Recreation Facilities	Existing	Infrastructure/Capital Projects	Floods#Landslides#Infrastructure Failure	Critical Infrastructure Protection#Property Protection	Integrated Planning	Mitigating adverse land impacts will increase viable space within SPL owned parcels thereby providing additional space for the public to use and recreate. The decrease in potential could mean additional opportunity to develop previously undeveloped land into traditionally defined parks potentially in under-served locations within the City.	Specific Site, provide address below			3-5 years	\$ 5,000,000	No	Grant	11/13/2020	Medium	High	High	Medium	High	Medium	High	Medium	High	High	High		
29	SPL5		Steep Slope Restoration of Coastal and Inland Areas	There are approximately 211 acres of forested parkland in need of restoration that are on severely steep slopes (over 40%) that require technical expertise, time and materials beyond the typical rate of Green Seattle Partnership (GSP) restoration activities. Citywide these slopes can be covered predominantly by invasive weeds, with some tree cover present. These forests maintain slope stability, buffer communities against urban heat, mitigate airborne pollution from industry and transportation and provide wildlife habitat. Success is addressing all 211 acres needing restoration. Success on steep slope means the land is free of invasive weeds, existing trees are protected, and longer-lived plant species thrive to maintain slope stability, mitigate urban heat, sequester air pollution and provide wildlife habitat. The typical sequence of restoration would begin with invasive weed removal. However, such removal of the existing plant cover would put these steep slopes at risk of falling, putting at risk the park property and in some cases private properties above and below the slope. The GSP program has not initiated restoration on most of these slope areas due to this complication and the need for a more robust set of restoration practices. This project will address the additional needs and process required to accomplish restoration of these steep slopes, thereby protecting the upslope and downslope properties while creating a healthy forest providing the associated environmental and community benefits. The project will use innovative bioengineering solutions into a restoration plan and implementation that will remove the invasive plants, protect existing trees, and establish native plants while avoiding slope failure. Many of these slopes in parklands around the city are in travel corridors or other high-visibility areas (e.g. portions of the Duwamish Head Greenbelt along Admiral Way in West Seattle), and are currently eye-sore to the city's residents. This project will also address the necessary restoration, and the slope and property protections, but also to design and utilize attractive, innovative solutions that can be modeled and replicated elsewhere.	SPL	Parks and Environment Division	Partnerships	Existing	Natural System Protection	Excessive Heat#Wildfires#Wind Storms#Snow, Ice and Extreme Cold	Natural Resource Protection, RSI and Safety#Property Protection	Climate Justice#Community Safety	Restoring and reforesting steep hillsides maintain slope stability, buffer communities against urban heat, mitigate airborne pollution from industry and transportation, protect property and provide wildlife habitat.	Inclusive Economy: any Consultant work could be contracted with BPOC community Climate Justice broadly, this work can bolster resilience of landscape/property assets to make sure these assets continue to be accessible and provide ecological services. Individual studies, design, or operational strategies can distinctly assess impacts and identify actions to help overcome historic disparities.	Citywide, no specific or targeted location	Focus on severely steep slope areas (over 40%) on forested areas adjacent to shorelines, streambeds, ravines and creeks/belt.		< 1 year	\$ 6,000,000	No	Other	11/13/2020	Low	High	High	Medium	Medium	High	High	Medium	Medium	High	High	High
30	SPL6		Mitigate Impacts to Park Property and Assets Resulting from Water Shortage	Using design and operational strategies, reduce dependency on irrigation to sustain developed landscapes; periodically (~5 years) update SPR Water Shortage Contingency Plan, implement water use for non-potable needs where feasible to reduce demand on water supply.	SPL	Planning and Development, Parks and Environment, Facilities Maintenance	SPL	New	Natural System Protection	Water Shortages#Infrastructure Failure	Natural Resource Protection	Inclusive Economy#Climate Justice		Citywide, no specific or targeted location	Actions such as irrigation, horticultural practices, or water re-use are citywide.	Citywide parks, developed and undeveloped landscapes, riparian corridors		< 1 year	Yes	Existing Budget#Bond/Levy		Low	Medium	Medium	High	Low	Medium	High	Medium	High	High	High		
31	SPLU21		Pump Station Assessments	Pump stations will be evaluated for flooding and seawater use as they are upgraded or replaced. SPL has three current projects with the potential to be impacted by climate change. On these projects SPL is adding or replacing various system components to improve reliability and increase capacity.	SPL	Drainage and Wastewater		New	Assessments and Studies	Earthquakes#Floods#Infrastructure Failure	Critical Infrastructure Protection			TBD			1-3 years	\$ 100,000	Yes	Existing Budget	11/1/2020	Low	Medium	Low	Low	Low	Medium	High	High	High	High	Medium	Medium	
32	SPLU22		Reservoir Seismic Upgrade and Rehabilitation	The seismic upgrade to this drinking water reservoir as part of an overall rehabilitation project. Eastside Reservoir in Bellevue, Rietzen Reservoir in SeaTac.	SPL	Water		New	Infrastructure/Capital Projects	Earthquakes	Life and Safety#Resilient Economy#Critical Infrastructure Protection	Community Safety	South Park and Georgetown are diverse lower income communities located in Seattle's primary floodplain zone.	District or Neighborhood, provide name below	Eastside Reservoir is located in Bellevue, Rietzen Reservoir is located in SeaTac.	Eastside (Cascade Water Alliance) serves primarily Bellevue, Mercer Island and Kirkland. Rietzen serves West Seattle, South Park, Georgetown, Whitehorse customers southwest of Seattle such as KCW# 420 and KCW# 4125.		3-5 years	\$ 24,000,000	Anticipated	Existing Budget	12/2/2020	Medium	High	Low	Low	Medium	Medium	High	High	High	High	Medium	Low
33	SPLU23		Water Pump Station Emergency Generators	Augment water pump station emergency generators.	SPL	Water		New	Infrastructure/Capital Projects	Earthquakes#Power Outages#Wind Storms	Critical Infrastructure Protection#Resilient Economy		Citywide, no specific or targeted location	Citywide and some regional locations	Citywide and some regional locations		3-5 years	\$ 1,000,000	Anticipated	Existing Budget	11/1/2020	Low	High	Low	Low	Medium	Medium	High	High	High	High	Medium	Low	
34	SPLU24		Water Tank Seismic Upgrade and Rehabilitation	These 3 million-gallon water tanks will be seismically upgraded as part of rehabilitation projects. Manola/Elevated Tanks and Trenton Standpipes.	SPL	Water		New	Infrastructure/Capital Projects	Earthquakes	Life and Safety#Critical Infrastructure Protection#Resilient Economy	Community Safety	South Park and Georgetown are diverse lower income communities located in Seattle's primary floodplain zone.	Manola, South Park and Georgetown	Manola, South Park and Georgetown		3-5 years	\$ 23,000,000	Anticipated	Existing Budget	11/1/2020	Low	High	Low	Low	Medium	Medium	High	High	High	High	Medium	Low	
35	SPLU25		Shape Our Water Integrated Plan	Plan will assess impacts of flooding, sea-level rise and seismic events on drainage and wastewater systems, and identify specific investments to improve resilience over the next 50 years. To be completed in 2023.	SPL	Drainage and Wastewater	SDOT, SPL, ORCA, SDW, King County, community and private sector stakeholders	New	Plans and Regulations	Earthquakes#Floods#Snow, Ice and Extreme Cold#Furans#Seiche#Power Outages#Infrastructure Failure	Integrated Planning#Resilient Economy#Natural Resource Protection#Property Protection#Life and Safety#Critical Infrastructure Protection	Climate Justice	The Shape Our Water Plan will have a positive effect on climate justice by identifying climate resilience investments in Seattle through a process that center's community and racial equity.	Citywide, no specific or targeted location			1-3 years		Yes	Existing Budget	11/1/2020	Medium	High	High	High	High	Medium	High	High	High	High	High	High	
36	SPLU26		Kent Highland Slope Stabilization Parameters	Install two large piezometers/teacheate extraction wells on the east slope of the Kent Highlands Landfill. The piezometers will become an early warning system in the event leachate levels increase in the landfill creating an unstable slope that will not resist earthquake forces. In addition to early warning the wells will allow pump down of leachate to help mitigate the slope failure risk. This will help protect the landfill infrastructure, staff and the Green River.	SPL	Solid Waste	WADW, USEPA	New	Infrastructure/Capital Projects	Earthquakes	Life and Safety#Critical Infrastructure Protection	Community Safety	Protecting the landfill gas extraction system allows SPL to control gas migration to adjacent "Market Rate" housing development.	Specific Site, provide address below	Kent Highlands Landfill 23076 Military Road So. Kent, WA 98032	The community within 1000 feet of the Kent Highlands Landfill at 23076 Military Road South, the Kent Highlands Landfill is adjacent to the protection of the landfill infrastructure		1-3 years	\$ 200,000	Yes	Existing Budget	10/29/2020	Medium	High	High	Medium	Medium	High	High	High	High	High	High	
37	SPLU27		Implement flooding and sewer backup actions	Implement design and construction for prioritized flooding and sewer backup prevention projects in Rainier, South Park and Rainier Hill neighborhoods.	SPL	Drainage and Wastewater		Existing	Infrastructure/Capital Projects	Floods	Property Protection	Community Safety	The projects serve diverse and lower income neighborhoods to address flooding and sewer backup issues.	District or Neighborhood, provide name below	Rainier, South Park, Rainier Hill, Rainier Park, Rainier Hill		Immediate	\$ 30,000,000	Anticipated	Existing Budget	12/2/2020	Low	High	Medium	Low	High	High	High	High	High	High	Medium	Low	

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38		SPU08	Green Infrastructure Incentive Program	Add DWR system capacity and resilience to climate change impacts, in addition to decreasing the impact of polluted runoff to water quality, through funding community identified green stormwater infrastructure.	SPU	Drainage and Wastewater	USFS, Washington State University, University of Idaho	New	Infrastructure/Capitol Projects	Floods#Excessive Heat	Property Protection#Natural Resource Protection#Integrated Planning	Inclusive Economy#Climate Justice#Community Wealth Building	Programs center community in how the projects are developed, and offer economic opportunity through design, construction, and materials supply.	Citywide, no specific or targeted location			3-5 years	\$ 30,000,000	Yes	Existing Budget	11/1/2020	Low	Medium	High	Medium	Medium	Medium	Medium	Medium	Medium	High	High	
39		SPU09	Wildfire Strategic Plan	Study potential wildfire impacts on the water supply watersheds, identify mitigation actions and implement the plan.	SPU	Water		New	Natural System Protection	Fire#Infrastructure Failure#Water Shortages	Life and Safety#Critical Infrastructure Protection#Property Protection#Natural Resource Protection#Resilient Economy#Integrated Planning		Cedar and Tolt watersheds	The Cedar and Tolt watersheds are located in the Cascades.	Seattle and wholesale customers (outside Seattle)	< 1 year		Yes	Existing Budget	11/1/2020	Medium	High	High	Low	Medium	High	Medium	Medium	Medium	High	High	High	
40		SPU10	Cascade Dam Project	The design phase for a project that would replace existing dam with one that meets current seismic standards.	SPU	Water		New	Assessments and Studies	Earthquakes#Floods#Water Shortages	Life and Safety#Critical Infrastructure Protection#Property Protection#Natural Resource Protection#Resilient Economy#Integrated Planning		Near the town of Covington	Lake Youngs	Whole water system service area, 1.5 million people.	3-5 years		Anticipated	Existing Budget	12/29/2020	High	High	High	Medium	Medium	High	High	High	Medium	High	High	High	
41		SPU11	Water System Seismic Plan	This 50-year plan that identifies a series of potential projects to improve seismic resilience in the water system. Projects include investments in critical infrastructure and facilities and emergency response capabilities.	SPU	Water		New	Infrastructure/Capitol Projects	Earthquakes	Life and Safety#Critical Infrastructure Protection#Property Protection#Resilient Economy#Integrated Planning	Community Safety	Loss of water supply will have potentially greater impacts on poorer communities.	Citywide, no specific or targeted location	Regional-wide (water system serves wholesale customers outside Seattle)	Whole water system service area, 1.5 million people.	Immediate	No	Other		12/1/2020	High	High	High	Medium	Medium	High	High	High	Medium	High	High	
42		SPU12	Landburg Flood Passage Project	This project is going to be designed to allow flood waters and large woody debris to pass around the dam to prevent dam failure.	SPU	Water		New	Infrastructure/Capitol Projects	Earthquakes#Floods#Landslides#Water Shortages#Wind Storms#Infrastructure Failure	Life and Safety#Critical Infrastructure Protection#Property Protection#Natural Resource Protection#Resilient Economy#Integrated Planning		Cedar River near Issaquah	Landburg Facility	Regional-wide (water system serves wholesale customers outside Seattle)	3-5 years		Anticipated	Existing Budget	12/1/2020	High	High	High	Medium	Medium	High	High	High	High	High	High	High	
43		SPU13	Lake City Floodplain Park	The project will restore and reconnect the floodplain in the North Branch of Thornton Creek in a 0.9-acre parcel. The site area includes approximately 200 linear ft of stream, 721,000 sq. ft of potential floodplain habitat, and 19,000 sq. ft of upland habitat. Restoration of the site will create multiple benefits including: decreased downstream flooding, improved water quality, reduced erosion and sedimentation, improved creek habitat for fish and aquatic life, greater system resiliency due to lower stream velocities, easier maintenance and future replacement of the undersized NE 125th culvert, and increased public access to greenpace.	SPU	Drainage and Wastewater	SPR, Mid Sound Fisheries Enhancement Group	New	Natural System Protection	Floods	Life and Safety#Property Protection#Natural Resource Protection#Integrated Planning	Climate Justice#Community Safety	The provide will provide more greenspace in the underserved community of Lake City.	2318 NE 125th St	Six block west of Lake City, next to Thornton Creek.	Lake City area	1-3 years		Anticipated	Grant#Existing Budget	1/4/2021	Low	Medium	High	High	High	Medium	Medium	Medium	High	Medium	Low	High
44		SPU14	Cedar Falls power service upgrade project	Cedar Falls power service upgrade project will improve the quality, capacity, and redundancy of electrical service to the Cedar Falls campus, Masonry Dam, and Overflow Dam. Phase 1 of a potential two phase project or provide permanent power to the Morse Lake emergency pump plant project.	SPU	SPU / Water	SCL	New	Natural System Protection	Earthquakes#Fire#Floods#Water Shortages#Wind Storms	Critical Infrastructure Protection		Cedar Watershed	Cedar River Watershed	Whole regional water system, 1.5 million people.	1-3 years	\$ 12,000,000	Yes	Existing Budget		Medium	High	High	Medium	Medium	Medium	High	Medium	High	Medium	High	Medium	
45		SPU15	Comprehensive Peak Flow Program	Comprehensive peak flow program to replace undersized culverts in the Cedar River Watershed to account for 100-year flood events and near-term climate change.	SPU	Water		New	Infrastructure/Capitol Projects	Floods#Landslides#Earthquakes	Critical Infrastructure Protection		Cedar and Tolt watersheds	Cedar and Tolt Watersheds	Whole water system, 1.5 million people.	3-5 years	\$ 1,500,000	Anticipated	Existing Budget		Low	Medium	Medium	Medium	Medium	Medium	High	High	High	High	High	High	
46		SPU16	Storage Capacity for the Chester Morse Reservoir	Study and design of a project to increase the storage capacity for the Chester Morse Reservoir during drought conditions and also providing new opportunities to evacuate the reservoir more quickly in flood conditions in the fall and winter.	SPU	Water	SCL	New	Infrastructure/Capitol Projects	Floods#Water Shortages	Critical Infrastructure Protection		Cedar River Watershed	Cedar River Watershed	1.5 million people. Whole water system.	3-5 years		Anticipated			Medium	Medium	High	Medium	Medium	High	High	High	High	High	High	High	Medium
47		SPU17	Design and repair/replace of the Tolt Dam spillway	Design and repair/replace of the Tolt Dam spillway used to release water from the Tolt Reservoir in flood and other emergency conditions (e.g., earthquakes).	SPU	Water	SCL	New	Infrastructure/Capitol Projects	Floods#Earthquakes#Landslides#Infrastructure Failure	Critical Infrastructure Protection		Tolt Watershed	Tolt Watershed	Whole water system service area, 1.5 million people.	3-5 years	Yes	Existing Budget		High	High	High	High	Medium	Medium	High	High	High	High	High	High	High	High

# Legislation passed August 2, 2021, Presented to Mayor August 4 - Res 32011

Final Audit Report

2021-08-12

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