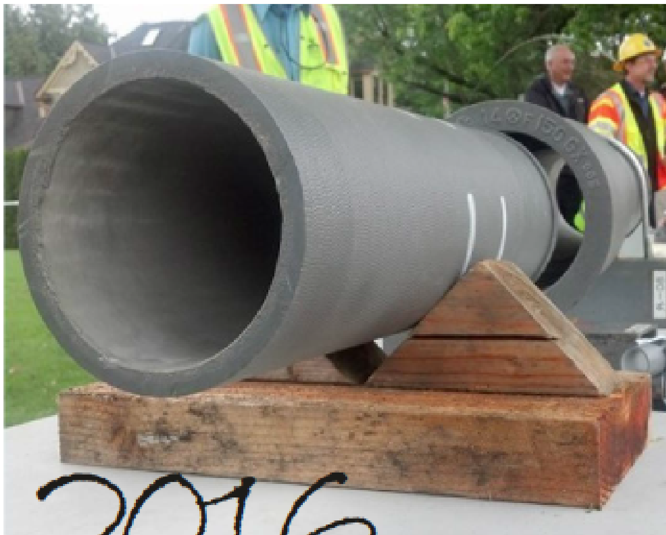
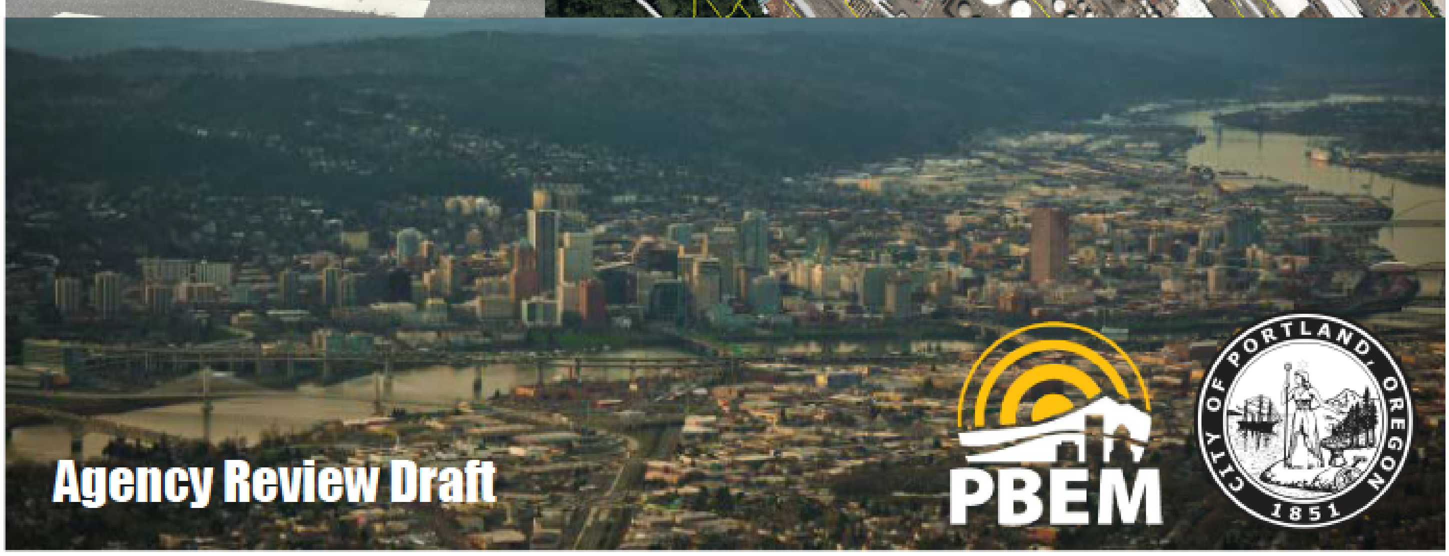


2016 MITIGATION ACTION PLAN (THE MAP)



Agency Review Draft

The Mitigation Action Plan

The City of Portland's Path to Resilience

September 2016

PREPARED FOR

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CONTENTS

Appendices

Tables

Figures

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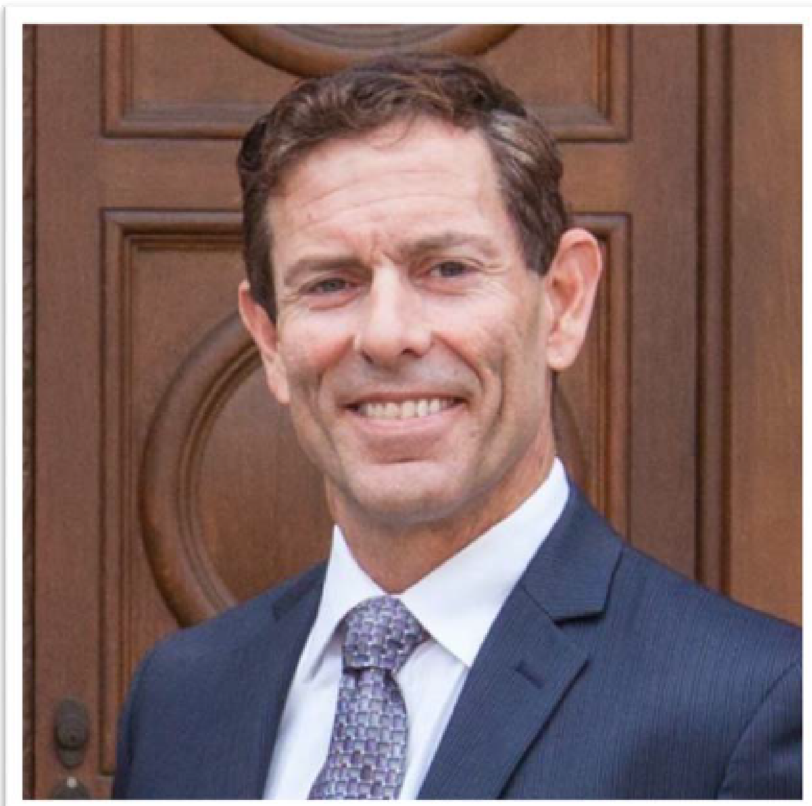
Special Acknowledgments

The development of this plan would not have been possible without the dedication and commitment to this process by the Mitigation Action Plan Steering Committee. The dedication of this volunteer committee to allocate their time to this process is greatly appreciated. Also, the residents of the City of Portland are commended for their participation in the outreach strategy identified by the Steering Committee. This outreach success will set the course to the successful implementation of this plan during its next performance period. The planning team would also like to thank Portland Public Schools for the generous use of their facilities for steering committee meetings and trainings over the course of the planning process.

Dedication

This plan is dedicated to the memory of Glen Collins, who served as a member of the Mitigation Action Plan Steering Committee, and inspired us with his commitment to building resilience in the Portland metropolitan region.



Glen Collins, 1964 - 2016

EXECUTIVE SUMMARY

WHAT IS HAZARD MITIGATION?

Hazard mitigation is action that communities take before a disaster to reduce the potential for death, injury, and property damage. It is about acting to reduce potential impacts when such action is most effective: before a disaster strikes. *The Mitigation Action Plan* (MAP) identifies how natural hazard events like floods, landslides, and earthquakes might affect the City of Portland; it lists actions that City offices can take before a disaster to protect people, critical infrastructure, and natural resources, and ensure the continuation of services, livability, and economic stability for all Portlanders.

The MAP meets hazard mitigation planning requirements for funding eligibility under Federal Emergency Management Agency (FEMA) grant programs. It also meets the floodplain management planning requirements for FEMA's Community Rating System.

UPDATING THE CITY OF PORTLAND PLAN

The MAP is the second comprehensive update to the *City of Portland Natural Hazard Mitigation Plan* (NHMP), which was first developed in 2004. Since the development of the initial plan, the City has made significant progress in its mitigation programs and activities. A 5-year progress report conducted while developing the MAP determined that 75 percent of the 101 mitigation actions identified in the 2010 NHMP were initiated or completed during the plan's performance period. The MAP builds on those successes and enhances the 2010 NHMP in several ways:

- The public engagement strategy was significantly enhanced for development of the MAP, starting with a 32-member steering committee with broad representation from City bureaus, community groups, disability advocates, communities of color, subject-matter experts, and other stakeholders. The steering committee had 10 formal meetings and attended two equity trainings over the 18-month project.
- An equity lens was used throughout the planning process to ensure that the plan process and outcomes benefit people who are most likely to suffer from a natural hazard event.
- The vision, mission and goals were refined to reflect changes in community priorities and to enhance integration among community planning efforts. The vision is aligned with the City's Comprehensive Plan mission.
- The plan addresses eight main hazards of concern, an emerging hazard of concern, and several compounding factors relevant to adverse impacts from natural hazards.
- The risk and vulnerability assessments for all hazards of concern were updated using best available data and a more robust risk assessment platform.
- Significant revisions and enhancements were made to the action plan, including the identification of implementation parameters aimed at enhancing transparency and accountability.
- The updated strategy for implementing and maintaining the MAP includes a working group that will meet annually over the plan's performance period.

The MAP shows a commitment to regional collaboration and resilience by establishing a linkage procedure for special purpose districts in the City to formally link to the plan and establish their own eligibility for federal grant funds.

PLAN DEVELOPMENT APPROACH

Development of the MAP relied on broad participation from many stakeholders. The plan development strategy was designed to result in a plan that sets the stage for equitably reducing the adverse impacts of natural hazards in the City through actions embraced by both elected officials and the people of Portland. The process encompassed eight phases:

- Phase 1—Organize resources and review the prior plan
- Phase 2—Update the risk assessment
- Phase 3—Develop and implement a public engagement strategy
- Phase 4—Update goals, objectives and actions
- Phase 5—Review and update the plan maintenance strategy
- Phase 6—Assemble the updated plan
- Phase 7—Initiate and complete plan review and adoption
- Phase 8—Implement the approved, adopted plan.

Phases 2, 3, 4, 7 and 8 are described below; the MAP has information on all eight phases.

As the plan was developed, a simultaneous process assessed natural hazard risks for the City's Critical Energy Infrastructure Hub along the Willamette River. Results of this study are incorporated into the plan document as appropriate.

Update the Risk Assessment

Risk assessment is the process of measuring the potential loss of life, personal injury, economic injury, and property damage resulting from natural hazards. The risk assessment was used to rank risk and to gauge the potential impacts of each hazard of concern on the City. Risks were assessed for nine geographic "reporting areas" to compare risk throughout the City. Based on the risk assessment, hazards of concern were ranked for the risk they pose to Portland, as shown in Table ES-1. The ranking is based on the probability of occurrence of a hazard and likely impacts in three categories: impacts on people, impacts on property, and impacts on the local economy. The sections below describe key components of the risk assessment for the MAP.

Table ES-1. Hazard Risk Ranking

Hazard Ranking	Hazard[a]	Risk Rating
1	Severe weather	High
2	Earthquake	High
3	Landslide	Medium
3	Wildfire	Medium
4	Flood	Medium
5	Volcanic Activity	Low
6	Dam Failure	Low
7	Drought	Low

a. Space weather was identified as an emerging hazard of concern but a full risk assessment was not conducted and, therefore, risk is not ranked. This will be revisited at the next plan update.

Hazard Identification and Profiling

Eight hazards of concern, and one emerging hazard of concern (space weather) were selected:

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

Assessment of the Impact of Hazards on Physical, Social and Economic Assets

The following are key findings for the five highest ranked hazards (see Table ES-1):

- **Severe Weather**—Since 1950, Portland has experienced at least 150 severe weather events, including high winds, heavy snow and rain, and excessive heat. Climate change and El Niño weather patterns could change the severity and frequency of severe weather events. Older buildings and utilities like power lines are more susceptible to damage from severe weather. People who depend on electricity for life support or people without homes are likely to suffer most from severe weather events.
- **Earthquake**—The Portland area has experienced numerous earthquakes in the past, ranging from Magnitude 4.5 to 9.0. Portland is certain to experience seismic events in the future. Many of Portland's buildings were built before seismic design requirements were included in building codes, or before modern codes were adopted. Over 13,000 of Portland's buildings are in areas with high liquefaction susceptibility, and during a Cascadia Subduction Zone earthquake, nearly 6,000 people in Portland may be displaced from their homes.
- **Landslide**—Hundreds of landslides have occurred in Portland in the past 20 years, and the City can expect many more in the future. Landslides are most likely on steep slopes when the ground is saturated from rainfall or poor drainage. More than 89,000 people in Portland live in landslide hazard areas, along with over $20 billion worth of buildings and contents.
- **Wildfire**—Portland is a wildland-urban interface community, meaning that its structures are near or within natural areas than are prone to wildfire. Wildfire season is usually from June through October, although climate change, increasing fuel load (including from invasive species), and drought conditions may cause this to vary. In Portland, over 68,000 people are estimated to live in wildfire hazard areas, and over 19,000 buildings. Over 96 percent of these buildings are residential.
- **Flood**—Portland is at the confluence of two major rivers, and has many smaller creeks and streams that flow within the city limits. The city is susceptible to flooding from the rivers and streams, as well as urban flooding from overwhelmed or blocked storm drains and runoff from impervious surfaces. There are 2,925 structures in the 1-percent-annual-chance flood hazard area, and over 9,500 people who live in these areas. Only about half of the people who live in the 1-percent-annual-chance flood hazard area have flood insurance. FEMA flood maps do not take into account the residual risk for properties protected by a flood-control levee, so there may be a misperception that the flood risk in these areas is zero.

Vulnerability Identification

Vulnerability identification includes an assessment of social vulnerability using demographic indicators. Vulnerability to natural hazards is affected by a person's social and economic circumstances in everyday life. People who lack access to resources and information are likely to suffer most in a disaster. The key vulnerability factors for this plan include: people under 15, people over 65, renter-occupied housing, people of color, people with disabilities, and limited English-speaking households.

Estimates of the Cost of Potential Damage

Some of the most costly scenarios include the following:

- A 0.2-percent-annual-chance flood (commonly referred to as a 500-year flood) could cause over $19 billion in damage to structures and their contents.
- The Portland Hills Magnitude-6.5 Earthquake Scenario could cause $24 billion in damage to structures and their contents.

Develop and Implement a Public Engagement Strategy

The public engagement strategy was developed through discussion with the steering committee, review of best practices, interviews with community members, and input from experts contracted to assist with development of the equity lens. The implemented strategy promotes effective cooperation between City government and community organizations. It encouraged public participation during the MAP development process and will facilitate continued engagement with residents after adoption of the MAP. The following were key features of the strategy:

- An online platform for information sharing with the MAP steering committee and the public
- Stakeholder involvement through more than 50 in-person meetings or presentations and countless phone calls and emails
- A public survey that received almost 3,000 responses
- Nine community workshops, attended by more than 175 participants, to learn about the public's perception of risk and to identify existing efforts, possible partnerships, and recommended actions
- Five town hall events to answer questions and receive feedback on the draft plan during the 45-day public comment period.

Feedback received from the public engagement strategy was used throughout the plan process, especially in action item identification and selection.

Update Goals, Objectives and Actions

Vision, Mission, Goals, and Objectives

The steering committee reviewed and updated the vision, mission and goals from the 2010 NHMP and developed a set of objectives, as shown in Table ES-2. Goals were selected to support the vision and mission. Objectives were selected that meet multiple goals. Actions were selected and prioritized in part based the number of objectives each would help to accomplish.

Recommended Actions

The MAP's action plan presents 161 mitigation actions to reduce losses from natural hazards. City of Portland bureaus selected these actions from a variety of sources, including a mitigation best practices catalog supplemented with steering committee and other stakeholder recommendations, the results of the risk assessment and identified issues, public input, other plans and programs, the results of the capability assessment, and actions identified in the 2010 NHMP.

Table ES-2. Vision, Mission, Goals, and Objectives

Vision	***Our desired future state.***

Portland is a prosperous, healthy, equitable and resilient city where everyone has access to opportunity and is engaged in shaping decisions that affect their lives

Mission	***What we do, who we do it for, and how.***

To equitably reduce risk and the adverse impacts of natural hazards by building community resilience through collaborative, cost-effective actions and strategies.

Goals	***General guidelines that explain what we want to achieve with the plan.***

1. Protect life and reduce injuries.
2. Engage and build capacity for the whole community.
3. Minimize public and private property damage.
4. Protect, restore, and sustain natural systems.
5. Minimize the disruption of essential infrastructure and services.
6. Integrate mitigation strategies into existing plans and programs.
7. Prioritize multi-objective actions that reduce risk to vulnerable communities.

Objectives	***Broader than actions, but more specific than goals, objectives are specific enough to help determine whether a proposed project or program would advance the values expressed in the mission and vision. Objectives may also be thought of as 'policies.' In the planning process, objectives are used to define and prioritize actions.***

- Strengthen development codes and update land use designations to facilitate effective disaster risk reduction
- Prevent or reduce mitigation-related disparities affecting under-served and under-represented communities through plans, investments and engagement
- Promote the use of natural systems to limit natural hazard related impacts
- Increase the resilience of high-risk and critical infrastructure through monitoring, planning, maintenance, investment, adaptive technology, and continuity planning
- Coordinate land use plans and public facility investments between City bureaus, other public and jurisdictional agencies, businesses, community partners, and other emergency response providers
- Support community outreach activities that increase stakeholder awareness and understanding of hazard risk, mitigation options, and preparedness strategies
- Identify and seek various funding opportunities for mitigation activities and look for ways to leverage existing funds
- Seek opportunities in which hazard mitigation also benefits other community goals
- Collect data to track progress on meeting mitigation goals.
- Use the best available data, science and technologies to improve understanding of the location and potential impacts of natural hazards, the vulnerability of building types and community development patterns, and the measures needed to protect life safety.
- Retrofit, purchase, or relocate structures in high hazard areas, especially those known to be repetitively damaged.
- Promote, incentivize and support the mitigation of private property.
- Improve systems that provide warning and emergency communications.
- Promote mutual information exchange and incorporate existing community networks in the identification and implementation of mitigation actions.
- Build City staff and community capacity to ensure effective implementation and equitable outcomes of mitigation action efforts
- Develop plans to reduce immediate impacts of natural hazard events, and to facilitate rapid and effective social and economic recovery.

Action Evaluation and Prioritization

Several steps were carried out to evaluate each action recommended in the MAP:

- An equity analysis screening was performed.
- Implementation information was identified, such as lead agency and timeline.
- A qualitative benefit/cost review was conducted.

Based on these analyses, multiple priority rankings were assigned to each action:

- Each action was rated high, medium or low for implementation, based on the benefit/cost ratio and funding availability
- Each action was rated high, medium or low for grant pursuit, based on grant eligibility and expected benefits
- Actions were assigned an "E" rating if the target audience/beneficiary identified for the action is one of the groups of focus for the assessment

Selected actions identified as high or medium implementation priority and supporting equity initiatives are identified in Table ES-3.

Table ES-3. High and Medium-Priority Actions from the Mitigation Action Plan Matrix

Action Number and Description	Implementation Priority
PBEM-10—Work with Office of Neighborhood Involvement Disability Program Coordinator to promote participation in the Additional Needs Registry through the Public Alerts system.	High-E
PBEM-11— Support Bureau of Development Services in implementing recommendations from the City's Unreinforced Masonry Seismic Retrofit Project, including promoting and supporting policies for mandatory retrofits of unreinforced masonry buildings. This action needs high-level support from City Council and Office of Government Relations.	Medium-E
PBEM-12—Audit PBEM's suite of plans to evaluate whether plans meet the needs of people with disabilities, people with language barriers, and other access and functional needs populations. Develop a transition plan to update all plans.	High-E
PBEM-23—Develop an emergency communications plan to distribute emergency messages to immigrant and refugee communities in language-appropriate and culturally appropriate ways.	High-E
BPS-1—Promote and fund energy independence projects in low-income neighborhoods and communities.	High-E
BPS-2—Plan for solar + battery storage systems, which can serve as mini power-supply stations or provide residents the ability to shelter in place after any electricity supply-disrupting event, at varying scales (project, neighborhood and district) and locations (critical City facilities, low-income housing, community gathering spots).	High-E
BPS-3—Encourage solar + battery storage demonstration projects at critical City facilities, in low-income neighborhoods and in other strategic locations.	High-E
BPS-7—Support *2015 Climate Action Plan* and *Climate Change Preparedness Strategy* actions that relate to adaptation planning and natural hazard mitigation actions.	High-E
BPS-10—Develop an emergency service plan for solid waste removal in multifamily properties after a disaster event.	High-E
OEHR-1 — Prior to and during implementation, review all actions for negative externalities and to ensure vulnerable populations are protected from displacement or other disproportionate burdens.	High-E

Note: PBEM = Portland Bureau of Emergency Management; BPS = Bureau of Planning and Sustainability; OEHR = Office of Equity and Human Rights

Initiate and Complete Plan Review and Adoption

The MAP was submitted to Oregon's Office of Emergency Management, FEMA Region X, and the Community Rating System contractor (Insurance Services Office, Inc.) for review and approval. The MAP will be presented to and adopted by the City of Portland City Council.

Implement the Approved, Adopted Plan

Plan implementation will occur over the next five years as the lead agencies begin to implement the actions identified in this plan. The Implementation and maintenance strategy developed by the steering committee will guide this phase. This phase will be dependent on the commitment of all City bureaus, elected officials and Portlanders to reducing risk from natural hazards.

The Mitigation Action Plan

PART 1—PLANNING PROCESS AND COMMUNITY PROFILE

1. Introduction to Hazard Mitigation Planning

1.1 ABOUT HAZARD MITIGATION

1.1.1 What Is It?

As the cost of disasters rises, communities must find ways to reduce hazard risks. The term "hazard mitigation" refers to actions that reduce or eliminate long-term risks caused by hazards such as earthquakes, floods, storms, and wildfires. It involves strategies such as planning, policy changes, programs, projects, and other activities that can mitigate the impacts of hazards. These advance actions reduce potential hazard effects or risk and are already in place at the time of impact. Without an investment in hazard mitigation, repeated disasters result in repeated damage and rebuilding. This recurrent reconstruction becomes more expensive as the years go by. Hazard mitigation breaks this costly cycle of damage and reconstruction by taking a long-term view of rebuilding and recovering from disasters.

DEFINITIONS

- **Mitigation**—Advance actions to reduce potential hazard effects or risk. Protections are already in place at the time a hazard event occurs.
- **Preparedness**—Advance actions that strengthen the capability of government, residents, and communities to respond to disasters.
- **Prevention**—Building capabilities to avoid, prevent or stop a threatened or actual act of terrorism.
- **Recovery**—A phase of emergency management in which activities are carried out to restore essential services and repair damage caused by a hazard event.
- **Resilience**—The capability to anticipate, prepare for, respond to, and recover from significant multi-hazard threats with minimum damage to social well-being, the economy, and the environment.
- **Response**—A phase of emergency management that consists of immediate actions to save lives, protect property and the environment and meet basic human needs.

1.1.2 When Does it Apply?

The federal Disaster Mitigation Act (DMA) of 2000 requires state and local governments to develop hazard mitigation plans as a condition for federal disaster grant assistance. The DMA emphasizes planning for disasters before they occur. However, hazard mitigation is also essential to post-disaster recovery. After disasters, repairs and reconstruction often just restore damaged property to pre-disaster conditions. The implementation of additional hazard mitigation actions leads to building smarter, safer, and more resilient communities that are better able to reduce future injuries and damage. *The Mitigation Action Plan* (MAP) is the City of Portland's natural hazard mitigation plan under the DMA.

1.1.3 Who Is Responsible?

The responsibility for hazard mitigation lies with private property owners, business and industry, and local, state and federal governments. The Federal Emergency Management Agency (FEMA) encourages multi-jurisdictional planning under its guidance for the DMA, urging state and local authorities to work together. The planning network called for by the DMA helps local governments articulate needs for mitigation, resulting in faster allocation of funds and more cost-effective risk reduction projects. When feasible, multi-jurisdictional planning presents opportunities in the ability to pool resources and eliminate redundant activities in a planning area that has uniform risk exposure.

Because of these factors, the City of Portland developed the MAP at two levels. The base plan addresses risk and vulnerability within city boundaries and identifies actions within the capabilities of the City. In addition, the City has developed a procedure by which special purpose districts in the City can formally link to the base plan—identifying risk and vulnerabilities to the assets they own and manage and selecting mitigation actions to reduce these risks. This linkage process (see Chapter 20) will ensure that all eligible local governments within the City have the opportunity to establish eligibility for grant funds while fostering collaboration among local governments and other local stakeholders.

1.1.4 How Is It Developed and Implemented?

The DMA promotes sustainability for disaster resistance. "Sustainable hazard mitigation" includes the sound management of natural resources and the recognition that hazards and mitigation must be understood in the largest possible social and economic context. Efforts to reduce risks should be compatible with other community goals, which may be related to equity, economic development, sustainability, public and environmental health, or other issues. As communities plan for new development and improvements to existing infrastructure, mitigation should be an important consideration.

1.1.5 How It Relates to Other Phases of Emergency Management

The main goal of hazard mitigation is to reduce the time that it takes to move through the emergency management cycle and to recover from natural hazard events (see Figure 1-1) because proactive measures have been put in place to reduce the amount of damage that occurs. As a result, planning for hazard mitigation impacts all phases of emergency management.

Because of this, hazard mitigation often gets confused with hazard preparedness. It is important to understand the difference between the two phases in order to understand the main focus of this plan, which is mitigation. Mitigation plans do identify strategies and actions that impact other aspects of the emergency management cycle. Increasing capabilities, for example, is a valid strategy for mitigation; the capabilities may be related to preparedness or response or recovery. Figure 1-2 provides an illustration of how mitigation and preparedness are different yet complementary.

1.2 HAZARD MITIGATION IN THE CITY OF PORTLAND

City of Portland bureaus manage city infrastructure, plan for long-term capital improvement and community-level investments, and administer a wide variety of programs. These activities play a role in the city's resilience to natural hazards. There are many things that bureaus can do now as part of their normal activities—or add to their portfolios when opportunities arise—to reduce Portland's risk from natural hazards over time and improve the City's ability to bounce back when natural hazard events do happen. These projects and programs together contribute to Portland's overall strategy for reducing its risk from natural hazards.

By investing in mitigation projects, the City decreases the risk and consequently the cost of disaster. In the event of a disaster, City response resources will be stretched. Through prior planning and implementation of mitigation projects, the City can decrease the amount of damage to its assets and be able to use resources for the greatest response and rebuilding needs. The intent of this plan is to identify what can be done prior to disaster that will protect the most people, the most essential and critical infrastructure and the most natural resources to enable the continuation of services, livability and economic stability for all Portlanders.

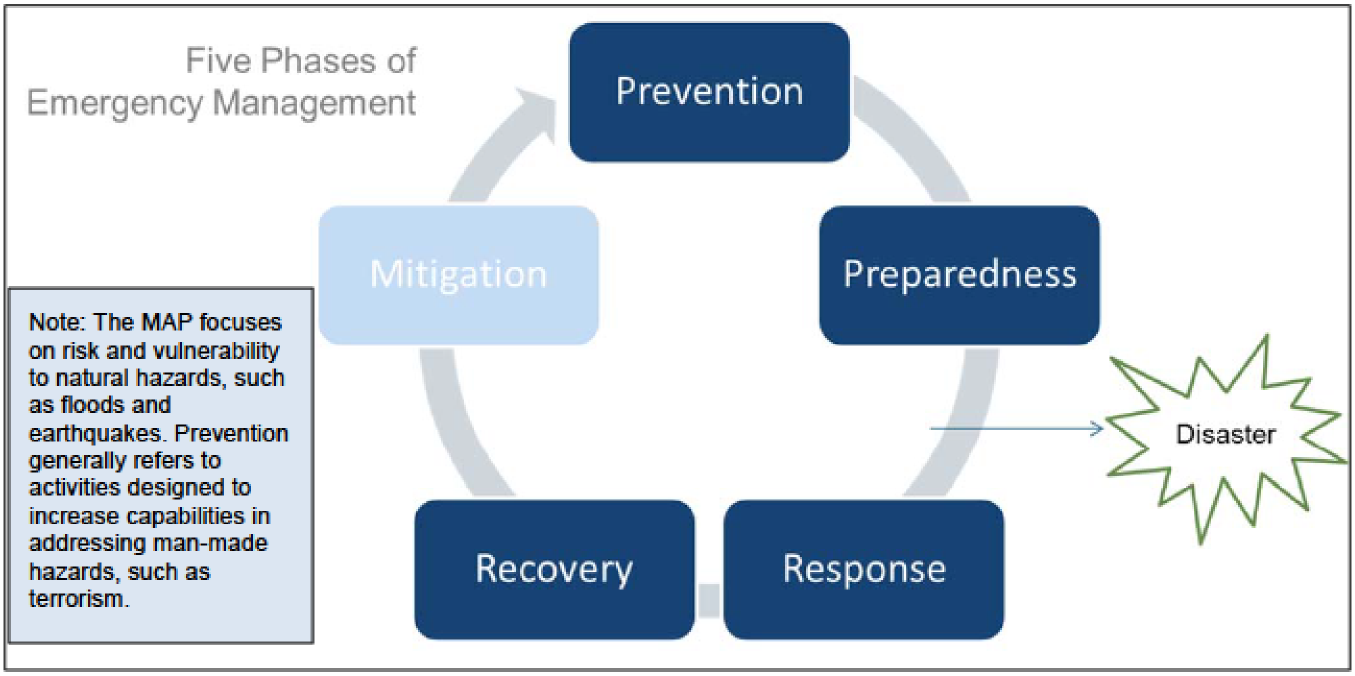


Figure 1-1. Five Phases of Emergency Management

Graphic by Danielle Butsick, PBEM

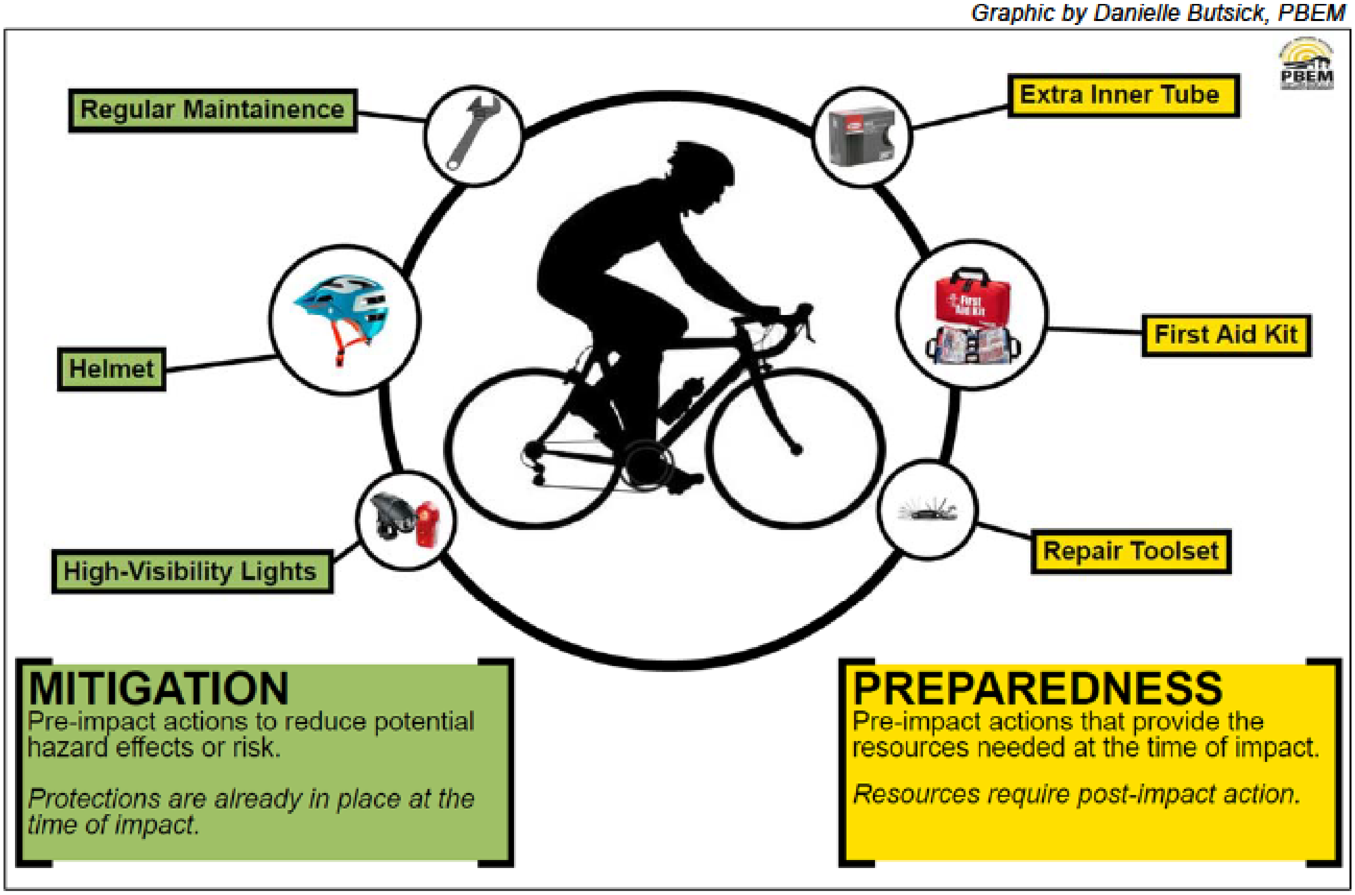


Figure 1-2. Mitigation and Preparedness Examples

The Mitigation Action Plan is the second comprehensive update to the *City of Portland Natural Hazard Mitigation Plan* (NHMP), which was first developed in 2004. This update identifies resources, information, and strategies for reducing risk from natural hazards. Elements and strategies in the plan were selected because they best meet the needs of Portland's bureaus and residents, and they also satisfy FEMA program requirements. The MAP will help guide and coordinate mitigation activities throughout the city. The main purpose of this planning effort was to identify risks posed by hazards and to develop strategies to reduce the impact of hazard events on people and property in the City of Portland; however, the plan was also developed to meet the following objectives:

- Incorporate Portland's equity goals into hazard mitigation planning to emphasize natural hazard risk reduction for Portland's most vulnerable residents.
- Involve people in Portland who represent communities of color, people with disabilities, senior citizens, and other groups who are potentially more vulnerable to natural hazards in the planning process, so that they have a say in the goals and actions selected and can communicate information about natural hazard risks within their communities.
- Develop a plan that reflects the priorities of Portland residents, bureaus, and offices while exceeding the requirements of the DMA.
- Meet the planning requirements of FEMA's Community Rating System (CRS), allowing the City to maintain or enhance its CRS classifications.
- Enable the City and all potential planning partners to use federal grant funding to reduce risk through mitigation.
- Set priorities for allocation of city funds and pursuit of federal and other grant funding opportunities to reduce risks from natural hazards.
- Improve understanding of risks and vulnerabilities specific to the City of Portland for Portland residents and decision-makers in City bureaus.
- Identify actions that will reduce the negative impacts of natural hazards and save lives, reduce displacement and speed recovery.
- Coordinate existing plans and programs so that high-priority actions to mitigate possible disaster impacts are funded and implemented.
- Foster collaboration between local government and residents.

REQUIRED CONTENT FOR LOCAL HAZARD MITIGATION PLANS (44 CFR 201.6(c))

- Documentation of the process used to develop the plan, including who was involved and how the public was involved.
- A risk assessment that provides the following information:

  A description of the type, location, and extent of all natural hazards that can affect the jurisdiction, previous occurrences of hazard events, and the probability of future hazard events.

  A description of the jurisdiction's vulnerability to the hazards in terms of:

  - Buildings, infrastructure and critical facilities located in hazard areas
  - Potential dollar losses
  - Development trends and the ability to consider mitigation in land use decisions.

  Assessment of each participating jurisdiction's risks where they vary from those of the entire planning area.
- A mitigation strategy for reducing potential losses identified in the risk assessment:
  - A description of mitigation goals.
  - A range of mitigation actions and projects to consider.
  - An action plan for each participating jurisdiction recommending and prioritizing specific mitigation actions.
- A plan maintenance process that includes:
  - A schedule for monitoring, evaluating, and updating the mitigation plan.
  - A process for incorporating the requirements of the mitigation plan into other local planning mechanisms.
  - A plan for ongoing public participation.
- Documentation that the plan has been formally adopted by the governing body of each jurisdiction requesting approval of the plan.

1.3 WHO WILL BENEFIT FROM THIS PLAN?

Effective hazard mitigation can provide the following benefits:

- Reduce the loss of life, property, essential services, and critical facilities; and reduce economic hardship.
- Reduce short-term and long-term recovery and reconstruction costs.
- Increase cooperation and communication in the community through the planning process.
- Increase potential for state and federal funding for pre- and post-disaster projects.

All residents, businesses, and visitors of the City of Portland are the ultimate beneficiaries of the MAP. However, the planning process to develop the MAP was performed through an equity lens, in order to focus the benefits of the plan on the people who are likely to suffer the greatest from a natural hazard event. The plan identifies strategies and actions that will reduce risk for those who live in, work in, and visit the City. It provides a viable planning framework for all foreseeable natural hazards that may impact Portland. Participation in the development of the plan by key stakeholders in the area helped ensure that outcomes will be mutually beneficial. The resources and background information in the plan are applicable citywide, and the plan's goals and recommendations can lay groundwork for the development and implementation of local mitigation activities and partnerships.

1.4 HOW TO READ THIS PLAN

In order to fulfill the requirements of the DMA and be eligible for federal disaster funding grant programs, a local hazard mitigation plan must contain a set of information as outlined in the Title 44 of the Code of Federal Regulations (44 CFR; see box at right). The MAP has been organized to provide all the required information. Notations are provided throughout the plan indicating specific requirements being addressed. The plan is divided into three parts:

- Part 1 includes the planning process and community profile.
- Part 2 includes the risk assessment.
- Part 3 includes the mitigation strategy and plan maintenance process.

The following appendices are also included to provide additional information or otherwise support the content outlined in the main document:

- Appendix A—5-year progress report (2010 through 2016)
- Appendix B—Steering Committee Ground Rules
- Appendix C—Public Engagement Materials
- Appendix D—Critical Energy Infrastructure Hub Study
- Appendix E—Reporting-Area-Scale Maps
- Appendix F—Data Sources and Methods used for Mapping
- Appendix G—Risk Assessment Data Gaps and Limitations
- Appendix H—Prior Plan Goals
- Appendix I—Mitigation Best Practices Catalog
- Appendix J—Expectations for Participating Bureaus
- Appendix K—Progress Report Template

The City's linkage strategy is outlined in Chapter 20 so that other eligible jurisdictions in Portland can use the information in this plan to ease their level of effort in meeting DMA requirements and becoming eligible for relevant grant programs.

2. PLAN UPDATE—WHAT HAS CHANGED

2.1 THE PREVIOUS PLANS

The City of Portland responded to the DMA by developing the initial *City of Portland Natural Hazard Mitigation Plan* (NHMP), which was approved on December 9, 2004. The NHMP underwent its initial 5-year update in conformance with DMA requirements and the update was approved on February 15, 2010. During the planning process for that first update, substantial revisions were made to all sections of the plan. Notably, four additional hazards of concern were added: severe weather, invasive plant species, erosion and volcanic activity. The original update process included the following (NHMP, 2010):

- **Preliminary Research**—Portland State University master degree program students in geology or urban studies researched plans, other city or county mitigation action items and the status of 2004 NHMP action items to provide background documents for the update.
- **Organize Resources**—The Portland Office of Emergency Management (now called Portland Bureau of Emergency Management) identified resources that could provide the technical expertise, historical information and research data to update the 2004 NHMP.
- **Update Hazard Profiles**—The planning team reviewed the hazards identified in the 2004 NHMP and assessed other hazards that have historically impacted the city. A hazard analysis was developed for eight hazards.
- **Update Risk Assessment**—The planning team reviewed the City's 2006 vulnerability analysis and used the results to develop a mitigation strategy.
- **Assess Capabilities**—The planning team reviewed the City's administrative, technical, legal, regulatory and fiscal capabilities and determined whether they adequately met existing requirements.
- **Update Mitigation Strategy**—The planning team reviewed the previous mitigation goals and actions to determine whether the goals still met the City's needs and whether the actions had been implemented, were in progress, or were no longer applicable. Based on the updated risk assessment, the planning team prioritized over 100 mitigation actions for implementation in a mitigation action plan.
- **Monitor Progress**—The planning team developed an implementation process for the mitigation action plan.

Changes to the 2004 plan were summarized in the 2010 update as shown in Table 2-1.

2.2 WHY UPDATE?

Portland's 2016 *Mitigation Action Plan* (MAP) is the next update to the City's natural hazard mitigation plan. Development of this new plan achieves a number of important goals, as described in the sections below.

Table 2-1. Summary of Changes in 2010 NHMP

2004 NHMP Section	Items Updated in 2010	2004 Items Deleted in 2010	Items Added in 2010
Planning Process	Planning process, planning team, list of sources, public outreach	N/A	N/A
Risk Assessment	Hazard profile history, asset inventory, vulnerability analysis & summaries	N/A	New hazards, repetitive Loss properties, National Flood Insurance Program requirements
Mitigation Strategy	Mitigation actions status, mitigation action implementation	Implemented & non-relevant mitigation actions	New mitigation actions, capability assessment
Plan Maintenance	Plan maintenance process	N/A	Appendix F

2.2.1 Federal Eligibility

Federal law (44 CFR) requires hazard mitigation plans to include a schedule for being monitored, evaluated and updated. This provides an opportunity to reevaluate recommendations, monitor the impacts of completed actions, and determine if there is a need to change the focus of mitigation strategies. A jurisdiction covered by a plan that has expired is not able to pursue elements of federal funding that require a current hazard mitigation plan.

2.2.2 Changes in Development

Hazard mitigation plan updates must be revised to reflect changes in development in Portland during the previous performance period of the plan (44 CFR Section 201.6(d)(3)). The plan must describe changes in development in hazard-prone areas that increased or decreased vulnerability since the last plan was approved. If no changes in development impacted overall vulnerability, plan updates may validate the information in the previously approved plan. The intent of this requirement is to ensure that the mitigation strategy continues to address the risk and vulnerability of existing and potential development and takes into consideration possible future conditions that could impact vulnerability.

Changes in risk due to development between the 2010 NHMP and the 2016 MAP are difficult to assess. The exposure and vulnerability assessment in the 2010 update was limited, and that update noted that the analysis should be updated and enhanced. No citywide tracking or assessment of exposure occurred during the performance period of the plan. The 2016 update includes a complete reassessment of risk and vulnerability in Portland, using more sophisticated data. It calculates replacement value from assessor records and uses a FEMA loss estimation model called Hazus-MH. More detailed information on the methodology used to assess risk is provided in Chapter 6. Now that the City is equipped with a baseline assessment of hazard vulnerability and a user-defined Hazus–MH model for Portland, a comparative analysis will be possible for future updates.

The MAP assumes that some new development triggered by an increase in population occurred in hazard areas. Because all such new development would have been regulated pursuant to local programs and codes, it is generally assumed that vulnerability did not increase even if exposure did. The City of Portland has a comprehensive plan that governs land-use decisions and policy-making (see Section 4.9.4), as well as a building code and specialty ordinances based on state and federal mandates.

2.2.3 Focus on Public Engagement and Equity

The 2010 NHMP met the federal requirements for community engagement and outreach. However, plan developers noted that the engagement strategy had fallen short of City of Portland standards and expectations. The 2016 planning process was developed to reinvigorate the dialogue between residents, city government and other stakeholders and to use this dialogue to further existing equity goals. *The Portland Plan,* a strategic roadmap for the City, outlines the following vision for equity in the city (City of Portland, 2012):

- All Portlanders have access to a high-quality education, living wage jobs, safe neighborhoods, basic services, a healthy natural environment, efficient public transit, parks and greenspaces, decent housing and healthy food.
- The benefits of growth and change are equitably shared across communities. No one community is overly burdened by the region's growth.
- All Portlanders and communities fully participate in and influence public decision-making.
- Portland is a place where people's futures are not limited by race, gender, sexual orientation, disability, age, income, where they were born or where they live.
- Underrepresented communities are engaged partners in policy decisions.

Responsive to this vision, all City bureaus and offices are charged with promoting equity and reducing disparities. The MAP includes a strong emphasis on working to embrace equity in planning and to empower Portland's most vulnerable people to play a role in building the City's resilience. This is referred to as the application of an equity lens (see Figure 2-1). An equity lens is defined by the Portland Office of Equity and Human Rights (OEHR) as a critical thinking approach to undoing institutional and structural biases, which evaluates burdens, benefits and outcomes to underserved communities (OEHR, n.d. b). This equity lens was developed and applied throughout the planning process in all phases of the MAP's development and is discussed throughout the plan document.

Through this broad engagement and focus on equity, the City is working to reduce vulnerability from natural hazards for all communities so that the benefits of hazard mitigation, such as the following, can be shared by all Portlanders:

- A faster recovery and return to normal life for neighborhoods after a hazard event
- Reduced stress on responders and social services
- Workers' return to work more quickly after a hazard event, resulting in less economic disruption and fewer businesses closing
- Maintenance of the culture, diversity and distinct neighborhoods of the City of Portland.

2.3 THE 5-YEAR PROGRESS REPORT

The 2010 plan update included a plan maintenance protocol that called for annual review of mitigation actions. With the exception of monitoring the status of flood-related actions for the City's CRS program, organized annual progress reporting did not occur during the performance period of the 2010 plan. Therefore, a five-year progress report was completed as part of the 2016 plan update process. This progress report is included in Appendix A of this document and provides information on the following:

- Recent natural hazard events in Portland
- Mitigation success stories over the performance period of the plan
- A review of the action plan
- Recommendations for changes and enhancements.

The template used for the 5-year progress report was reviewed by City bureaus and the steering committee and was enhanced based on their feedback. The 2016 plan implementation and maintenance strategy outlines a reinvigorated approach for actively maintaining the plan and includes a progress report template updated to reflect the comments received during the planning process.

Graphic by Danielle Butsick, PBEM

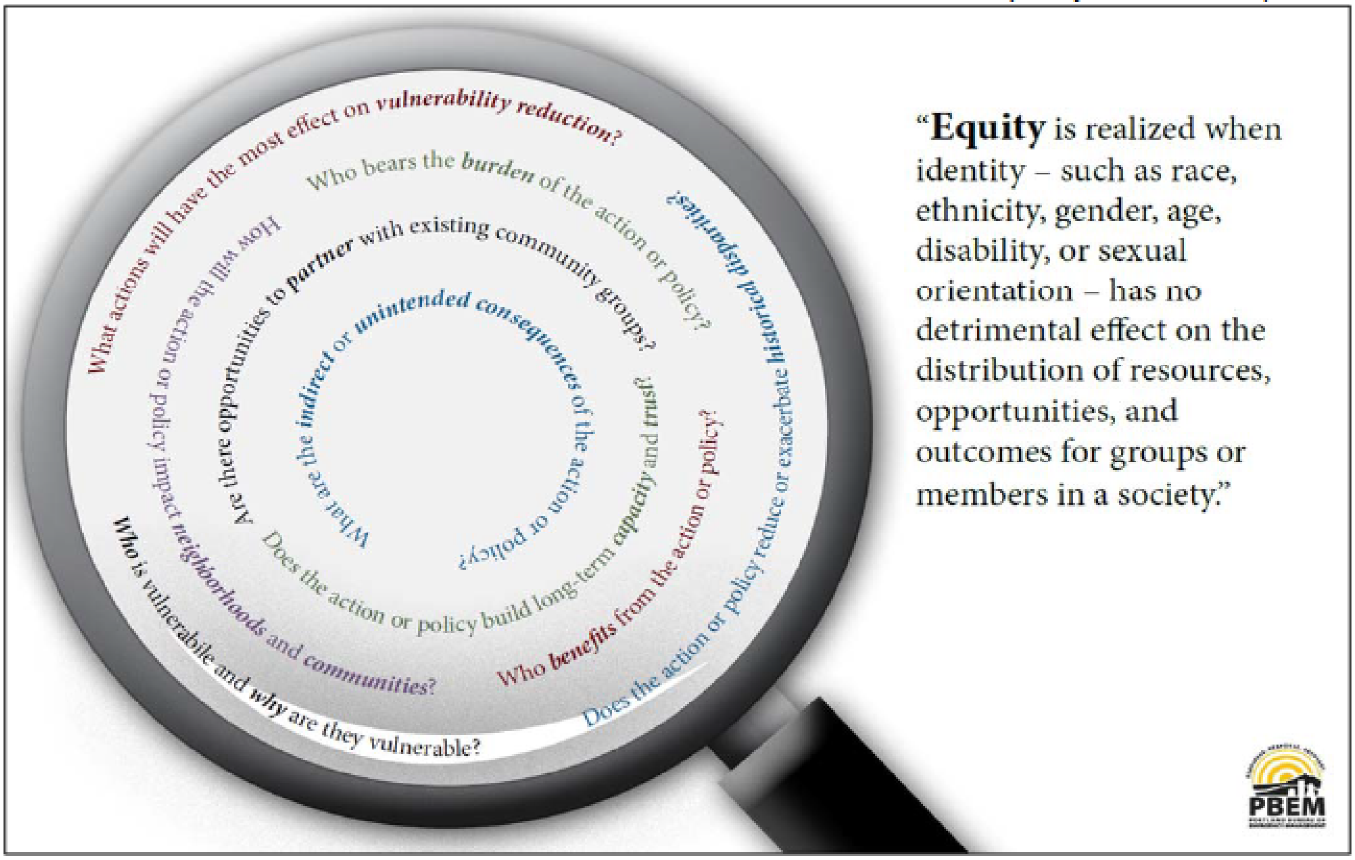


Figure 2-1. Mitigation Equity Lens

2.4 THE UPDATED PLAN—WHAT IS DIFFERENT?

The 2016 updated plan differs from the initial plan and the 2010 update in a variety of ways:

- The public engagement strategy used during the planning process was significantly enhanced, starting with a large number of non-governmental representatives serving on the plan steering committee.
- An equity lens was developed and applied throughout the planning process to assess in the evaluation of risk as well as the development of mitigation actions.
- The vision, mission and goals were revisited and refined to reflect changes in community priorities and to enhance integration among community planning efforts.
- The plan addressed eight main hazards of concern, an emerging hazard of concern, and several compounding factors relevant to adverse impacts from natural hazards.
- The risk and vulnerability assessments for all hazards of concern were updated using best available data and a more robust risk assessment platform.
- Significant revisions and enhancements were made to the action plan, including the identification of implementation parameters aimed at enhancing transparency and accountability.
- The plan implementation and maintenance strategy was revised and updated and includes a Mitigation Action Plan working group that will meet biannually over the plan's performance period.

Table 2-2 indicates the major changes between the 2010 and 2016 plans as they relate to 44 CFR planning requirements.

Table 2-2. Plan Changes Crosswalk

44 CFR Requirement	Previous Plan	Updated Plan
§201.6(b): In order to develop a more comprehensive approach to reducing the effects of natural disasters, the planning process shall include: (1) An opportunity for the public to comment on the plan during the drafting stage and prior to plan approval; (2) An opportunity for neighboring communities, local and regional agencies involved in hazard mitigation activities, and agencies that have the authority to regulate development, as well as businesses, academia and other private and non-profit interests to be involved in the planning process; and (3) Review and incorporation, if appropriate, of existing plans, studies, reports, and technical information.	The 2010 plan update was led by planning team members selected based on their program involvements, expertise and decision-making authority. Members of the public were involved in the planning process through intern assistance from the Portland State University Master's Program of Urban Planning and the Department of Geology; consultation with subject matter experts on hazard information; a website developed to provide information on the update process; a presentation to the City Council that was available for public viewing on the Cable Network; and presentations at citywide workshops. Technical difficulties prohibited the plan's public posting on the City website and the launch of a public survey.	The plan update was facilitated through a Steering Committee made up of stakeholders in Portland. The Steering Committee oversaw all phases of plan development including but not limited to the review and identification of goals and objectives, confirmation of a public involvement strategy, development of a plan implementation and maintenance strategy, and the recommendation of mitigation actions. All Steering Committee meetings were open to the public. Additional public input was received through public events early and late in the planning process and through a public survey. A 45-day public comment period was held before the draft plan was submitted for review. Agency coordination occurred through several avenues, including in-person and phone meetings with relevant agencies, monthly updates on plan progress and steering committee meetings distributed to a mailing list, attendance at steering committee meetings, the composition of the Steering Committee and the dissemination of the draft plan for public comment.
§201.6(c)(2): The plan shall include a risk assessment that provides the factual basis for activities proposed in the strategy to reduce losses from identified hazards. Local risk assessments must provide sufficient information to enable the jurisdiction to identify and prioritize appropriate mitigation actions to reduce losses from identified hazards.	The plan update included the identification, screening and profiling of eight hazards of concern. Five of these were also identified in the 2004 plan (earthquake, flood, landslide, severe weather and wildland urban interface fire). Three hazards were newly added (erosion, volcanic activity and invasive plant species).	A comprehensive risk assessment for Portland was developed that looked at eight natural hazards of concern: dam failure, drought, earthquake, flood, landslide, severe weather, volcanic activity, and wildfire. This assessment used the best available data and science with the Hazus-MH (version 2.2) risk assessment software and GIS analysis. In addition, the plan discussed impacts from an emerging hazard of concern and several compounding factors.
§201.6(c)(2)(i): [The risk assessment shall include a] description of the … location and extent of all natural hazards that can affect the jurisdiction. The plan shall include information on previous occurrences of hazard events and on the probability of future hazard events.	Each hazard of concern was profiled including the history, location and extent, and probability of future impacts.	Comprehensive risk assessments of each hazard of concern are presented in Chapters 7 through 14. Each chapter includes the following: • Hazard profile, including maps of extent and location, historical occurrences, frequency, severity and warning time • Compounding factors and secondary hazards • Exposure of people, property, critical facilities and natural environment • Vulnerability of people, property, critical facilities and natural environment • Future trends in development • Scenarios • Issues. Each hazard is compared to each other hazard via a risk ranking described in Chapter 16.

44 CFR Requirement	Previous Plan	Updated Plan
§201.6(c)(2)(ii): [The risk assessment shall include a] description of the jurisdiction's vulnerability to the hazards described in paragraph (c)(2)(i). This description shall include an overall summary of each hazard and its impact on the community	Vulnerability was described for each hazard of concern although information provided was not specific or detailed in many instances.	Vulnerability was assessed for all hazards of concern. The Hazus-MH computer model was used for the dam failure, earthquake, and flood hazards. These were Level-2 (user-defined) analyses using coordinating agency and local data. Critical facilities and assets were defined and inventoried using the Hazus Comprehensive Data Management System and other available datasets. Outputs were generated for other hazards by applying an estimated damage function to affected assets when available. The asset inventory was extracted from the Hazus-MH model. Best available data were used for all analyses.
§201.6(c)(2)(ii): [The risk assessment] must also address National Flood Insurance Program insured structures that have been repetitively damaged floods	Repetitive loss properties within the City are described.	A description of the National Flood Insurance Program (NFIP) and repetitive loss areas is included to meet DMA and CRS planning requirements. For repetitive loss properties, the type of structure was determined, likely causes of flooding were cited, and the information was reflected on maps. NFIP compliance is assessed.
§201.6(c)(2)(ii)(A): The plan should describe vulnerability in terms of the types and numbers of existing and future buildings, infrastructure, and critical facilities located in the identified hazard area.	A generalized description of critical facilities and infrastructure in Portland is provided, as well as information on future critical facilities and infrastructure. Current and future exposure to the hazards of concern is discussed and Table 4-4-1a provides exposure estimates for Portland populations and buildings. Table 4-4-1b provides exposure estimates for City-owned critical facilities (erosion, invasive plant species and volcano hazards were undetermined).	A complete inventory of the numbers and types of buildings exposed was generated for each hazard of concern. The Steering Committee defined "critical facilities" for Portland, and these facilities were inventoried. Each hazard chapter provides a discussion of future development trends as they pertain to the hazard.
§201.6(c)(2)(ii)(B): [The plan should describe vulnerability in terms of an] estimate of the potential dollar losses to vulnerable structures identified in paragraph (c)(2)(i)(A) and a description of the methodology used to prepare the estimate.	Estimated losses from a 2004 Hazus-MH assessment were provided. Estimated losses were not provided for the invasive plant species and volcanic activity hazards.	Loss estimations were generated for all hazards of concern likely to impact property. These were generated by Hazus for the dam failure, earthquake, and flood hazards. For the other hazards, loss estimates were generated by applying a regionally relevant damage function to the exposed inventory. In all cases, a damage function was applied to an asset inventory. The asset inventory was the same for all hazards and was generated in the Hazus-MH model.
§201.6(c)(2)(ii)(C): [The plan should describe vulnerability in terms of] providing a general description of land uses and development trends within the community so that mitigation options can be considered in future land use decisions.	Nine action areas of *The Portland Plan* that intersect with the NHMP are described. Additional detail was also provided on land use and development trends in Portland.	There is a discussion on future development trends as they pertain to each hazard of concern. This discussion looks predominantly at future land use designated in the recently updated comprehensive plan and the current regulatory environment that dictates this land use.

44 CFR Requirement	Previous Plan	Updated Plan
§201.6(c)(3): The plan shall include a mitigation strategy that provides the jurisdiction's blueprint for reducing the potential losses identified in the risk assessment, based on existing authorities, policies, programs and resources, and its ability to expand on and improve these existing tools.	The mitigation strategy was reviewed and updated from the 2004 plan. It includes a description of mitigation success stories over the 2004-2009 performance period.	The 2010 mitigation strategy underwent a comprehensive review including identified vision, mission and goals, existing capabilities, and previously identified actions. In addition, new mitigation actions were selected to meet the updated goals and objectives as well as to address the issues identified during the risk assessment and public engagement process.
§201.6(c)(3)(i): [The hazard mitigation strategy shall include a] description of mitigation goals to reduce or avoid long-term vulnerabilities to the identified hazards.	The 2010 plan included the same vision statement as the 2004 plan. In addition a mission statement was developed. The 2004 goals were reviewed, edited and updated. Seven goals were identified.	The vision, mission and goals identified in the 2010 plan were reviewed and updated. The plan includes an updated vision and mission statement as well as seven goals and 16 objectives. Goals were selected that support the vision and mission, objectives were selected that meet multiple goals, and actions were selected and prioritized based, in part, on meeting multiple objectives.
§201.6(c)(3)(ii): [The mitigation strategy shall include a] section that identifies and analyzes a comprehensive range of specific mitigation actions and projects being considered to reduce the effects of each hazard, with particular emphasis on new and existing buildings and infrastructure.	Table 5-5-1a identifies 114 mitigation actions that were reviewed by the planning team for implementation over the five-year performance period. For each mitigation action, a brief assessment of benefits versus costs and technical feasibility was included.	A hazard mitigation best practices catalog was developed through an exercise that looked at strengths, weaknesses, obstacles and opportunities in Portland as well as previously identified best practices, and steering committee and other stakeholder input. This catalog identifies actions that manipulate the hazard, reduce exposure to the hazard, reduce vulnerability, or increase mitigation capability. The catalog segregates actions by scale of implementation. A table in the action plan section analyzes each action by mitigation type to illustrate the range of actions selected.
§201.6(c)(3)(ii): [The mitigation strategy] must also address the jurisdiction's participation in the National Flood Insurance Program, and continued compliance with the program's requirements, as appropriate.	A brief discussion on the National Flood Insurance Program and Community Rating System was provided in the flood hazard profile. Appendix I includes a review of NFIP compliance. Actions that address NFIP compliance are called out in Table 5-6-1a.	The NFIP capability of the City is assessed and actions supporting continued compliance and good standing under the program have been identified,
§201.6(c)(3)(iii): [The mitigation strategy shall describe] how the actions identified in Section (c)(3)(ii) will be prioritized, implemented, and administered by the local jurisdiction. Prioritization shall include a special emphasis on the extent to which benefits are maximized according to a cost benefit review of the proposed projects and their associated costs.	The planning team evaluated criteria to identify the action that would have the greatest impact on the most hazards, meet the greatest number of goals, have the resources to implement current projects, and align with citywide and individual bureau priorities and goals. The selection of mitigation actions and their prioritization are described within the plan.	Each recommended action is prioritized using a qualitative methodology that looked at the objectives the project will meet, the timeline for completion, how the project will be funded, the benefits of the project and the costs of the project. In addition, actions with the potential for equity impacts are identified with an "E." This prioritization scheme is detailed in Chapter 19.

44 CFR Requirement	Previous Plan	Updated Plan
§201.6(c)(4)(i): [The plan maintenance process shall include a] section describing the method and schedule of monitoring, evaluating, and updating the mitigation plan within a five-year cycle.	The planning team and the Emergency Management Steering Committee were responsible for monitoring and evaluating the NHMP. An annual review meeting was to be held during the anniversary week of the FEMA approval date. An annual review questionnaire was to be completed. The plan maintenance strategy was not implemented during the performance period of the plan.	A detailed plan maintenance strategy is provided that includes the following: • Annual review and progress reporting • Formation of a working group • Development of an equity implementation guide • Plan update triggers • Plan incorporation guidelines • Strategy for continuing public involvement • Implementation coordination amongst the lead agencies identified.
§201.6(c)(4)(ii): [The plan shall include a] process by which local governments incorporate the requirements of the mitigation plan into other planning mechanisms such as comprehensive or capital improvement plans, when appropriate.	A discussion of how the actions of the NHMP intersect with *The Portland Plan* was included. A discussion is provided on how development and land use planning requirements use hazard information. Information on implementation of the mitigation actions through existing planning mechanisms was provided in the plan maintenance strategy.	This is included in the plan maintenance strategy and discussed in the capability assessment.
§201.6(c)(4)(iii): [The plan maintenance process shall include a] discussion on how the community will continue public participation in the plan maintenance process.	Efforts for continued public involvement are described, including presentations to community organizations, maintenance of the website and contact information, the establishment of a schedule to implement public involvement, and the development of a citizen action plan. The level of continued public engagement specified was not maintained over the performance period of the plan.	This is included in the detailed plan maintenance strategy.
§201.6(c)(5): [The local hazard mitigation plan shall include] documentation that the plan has been formally adopted by the governing body of the jurisdiction requesting approval of the plan (e.g., City Council, County Commission, Tribal Council).	The Portland City Council adopted the 2010 NHMP update via resolution.	The Portland City Council will adopt the 2016 update via resolution.

3. Plan Update Approach

The Mitigation Action Plan was largely funded by a FEMA Pre-Disaster Mitigation grant received by the Portland Bureau of Emergency Management (PBEM) in 2015. It covered 69 percent of the cost for plan development. The balance was funded by City in-kind contributions.

3.1 PLAN UPDATE APPROACH

The approach to developing the 2016 MAP encouraged broad participation from many stakeholders. The plan development strategy was designed to result in the adoption and approval of a plan that sets the stage for equitably reducing the adverse impacts of natural hazards within the City through activities and strategies embraced by both elected officials and the people of Portland. The process encompassed eight key phases:

- Phase 1—Organize resources and review the prior plan
- Phase 2—Update the risk assessment
- Phase 3—Develop and implement a public involvement strategy
- Phase 4—Update goals, objectives and actions
- Phase 5—Review and update the plan maintenance strategy
- Phase 6—Assemble the updated plan
- Phase 7—Initiate and complete plan review and adoption
- Phase 8—Implement the approved, adopted plan.

Phases 1, 3 and 6 are described in Part 1 of this document. Phase 2 is described in Part 2. Phases 4, 5 and 8 are discussed in Part 3. In addition to these phases, a simultaneous process was pursued to assess natural hazard risks for the City's Critical Energy Infrastructure Hub along the Willamette River. Results of this study are incorporated into the plan document as appropriate and the full study is provided in Appendix D.

3.2 FORMATION OF THE PLANNING TEAM

The City of Portland hired Tetra Tech, Inc. to assist in preparation of the MAP. The Tetra Tech project manager and lead planner reported directly to the City of Portland project manager and project coordinator. The following planning team was formed to lead the planning effort:

- Danielle Butsick, Project Coordinator, PBEM
- Jonna Papaefthimiou, Project Manager, PBEM
- Paul Cone, GIS Support, City of Portland Corporate GIS
- Rob Flaner, Project Manager, Tetra Tech
- Kristen Gelino, Lead Planner, Tetra Tech
- Carol Baumann, Risk Assessment Lead, Tetra Tech.

The planning team facilitated the work of the steering committee, coordinated with other agencies, implemented the public engagement strategy, developed the plan document, and led the plan review and adoption process. The team met regularly throughout the planning process. As appropriate, other stakeholders and agency representatives were asked to participate in planning team calls.

3.3 DEFINING THE PLANNING AREA

The planning area was defined to consist of the entire area within the City of Portland city limits. Relevant Portland characteristics are described in Chapter 4.

3.4 PLAN KICKOFF

A kickoff event was held on June 22 (see Figure 3-1). The meeting was open to the public (see Figure 3-2) and had the following objectives:

- Introduce project goals
- Define mitigation and relevant laws
- Introduce the planning team and draft work plan
- Offer opportunities to be engaged.

At the meeting, local stakeholders were solicited to participate in the plan development. Stakeholders for this planning process were defined as persons and agencies that have a vested interest in the recommendations and implementation of the MAP. Stakeholders include residents, community groups, business owners, local, state and federal agencies, elected officials, visitors, and neighboring communities. Two stakeholder groups were identified at the kickoff meeting:

- Participatory stakeholders—Stakeholders who commit to being members of the Steering Committee overseeing the plan update process.
- Coordinating stakeholders—Stakeholders who cannot commit to the Steering Committee, but may attend meetings and want to be informed of plan progress.

Nineteen stakeholders signed up as participatory or coordinating stakeholders at the initial kickoff meeting.

Figure 3-1. Plan Kickoff Meeting

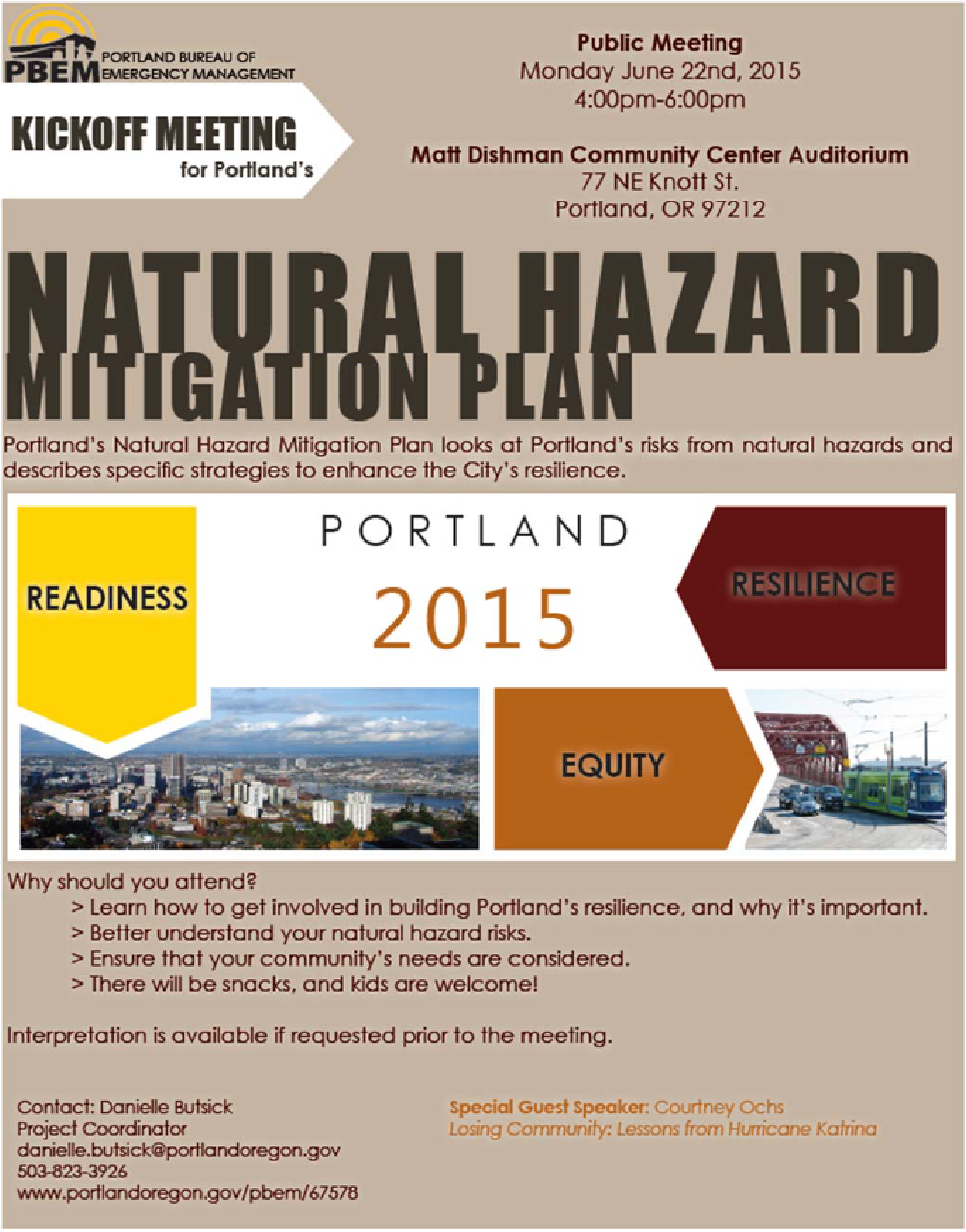


Figure 3-2. Kickoff Meeting Notice Poster

3.5 THE STEERING COMMITTEE

3.5.1 Membership

After the kickoff meeting, a steering committee was formed to guide the planning process for the update and to foster an equitable approach to building Portland's resilience to natural hazards. Steering Committee volunteers were solicited at the kickoff meeting and were also contacted by the planning team. The goal was to assemble a diverse array of committee members who could have recommendations for the plan or be impacted by its recommendations. Selected committee members included City of Portland staff, residents, and other stakeholders from within Portland. A committee of 32 members was confirmed to oversee the plan development process (see Figure 3-3).

Figure 3-3. Steering Committee

The Steering Committee provided guidance and leadership, oversaw the planning process, and acted as a point of contact for local governments, neighborhoods, and community groups interested in the planning effort. It worked to ensure that all Portlanders have equal access to projects that reduce their risk from natural hazards. Members of the Steering Committee represent a cross-section of views and interests across Portland. By including diverse interests, the Steering Committee enhanced the robustness of the planning effort and built support for hazard mitigation activities across stakeholder groups. Table 3-1 lists the Steering Committee members.

Table 3-1. Steering Committee Members

Representation[a]	Name	Title/Agency
Portland Government, Floodplain Management and Environmental Protection[c]		
Primary Member	Maggie Skenderian	Bureau of Environmental Services
Alternate Member	Kate Carone	Bureau of Environmental Services
Portland Government, Land Use and Comprehensive Planning[c]		
Primary Member	Kathryn Hartinger	Bureau of Planning and Sustainability
Alternate Member	Roberta Jortner / Sallie Edmunds	Bureau of Planning and Sustainability
Portland Government[c]		
Primary Member	Danielle Brooks	Office of Equity and Human Rights
Alternate Member	Judith Mowry	Office of Equity and Human Rights
Portland Government, Open Space Management		
Primary Member	Vicente Harrison	Parks & Recreation
Alternate Member	N/A	N/A
Portland Government, Public Safety[c]		
Primary Member	Laurent Picard	Fire and Rescue
Alternate Member	Leo Krick/Don Russ	Fire and Rescue
Stakeholder, Public Health[c]		
Primary Member	Jessica London (Co-Chairperson)	Oregon Health & Science University-Institute on Development and Disability/Oregon Office on Disability and Health
Alternate Member	Justin E. Ross	Oregon Health & Science University-Institute on Development and Disability/Oregon Office on Disability and Health
Stakeholder, Environmental Interests[c]		
Primary Member	Bob Sallinger	Audubon Society of Portland
Alternate Member	Micah Meskel	Audubon Society of Portland
Stakeholder, Community Health and Welfare		
Primary Member	Dean Alby	Oregon Food Bank
Alternate Member	N/A	N/A
Stakeholder, Community Organization		
Primary Member	Simeon Mamaril	Filipino American Community
Alternate Member	N/A	N/A
Stakeholder, Oregon Public Policy Committee[c]		
Primary Member	Jeff Soulages	Oregon Seismic Safety Policy Advisory Commission
Alternate Member	N/A	N/A
Stakeholder, Federal Agency		
Primary Member	Glen Collins	Department of Homeland Security
Alternate Member	N/A	N/A
Stakeholder, Community Organization/Committee[c]		
Primary Member	John Steup	Neighborhood Emergency Team/Amateur Radio Emergency Service/Local Emergency Planning Committee
Alternate Member	N/A	N/A
Stakeholder, Community Organization[c]		
Primary Member	Darlene Urban Garrett	Downtown Neighborhood Emergency Team /Neighbors West/Northwest Neighborhood Association
Alternate Member	N/A	N/A
Stakeholder, Community Organization[c]		
Primary Member	Solamon Ibe (Co-Chairperson)	Portland African American Leadership Forum
Alternate Member	N/A	N/A

Representation[a]	Name	Title/Agency
Stakeholder, Community Organization		
Primary Member	Karen Tam	Brummell Enterprises, Sellwood-Moreland Improvement League Member, Sellwood/Moreland
Alternate Member	Bob Burkholder	Brummell Enterprises, Sellwood-Moreland Improvement League Member, Sellwood/Moreland
Portland Government[c]		
Primary Member	Mary Ellen Collentine	Portland Water Bureau
Alternate Member	Mike Saling	Portland Water Bureau
Stakeholder, Business[c]		
Primary Member	Jim Mattison	Simpson Strong-Tie
Alternate Member	Shalini Prochazka, S.E.	Simpson Strong-Tie
Portland Government, Building and Code Enforcement[c]		
Primary Member	Kathy Roth	Bureau of Development Services
Alternate Member	Mark Fetters	Bureau of Development Services
Stakeholder, Community Organization[c]		
Primary Member	Jeremy O'Leary (Co-Chairperson)	East Portland Action Plan
Alternate Member	N/A	N/A
Portland Government and Community Organization		
Primary Member	Ronault (Polo) LS Catalani	Immigrant and Refugee Community Organization /Office of Neighborhood Involvement New Portlanders
Alternate Member	Lisha Shrestha	Immigrant and Refugee Community Organization /Office of Neighborhood Involvement New Portlanders
Stakeholder, Community Organization		
Primary Member	Jeff Geisler	Hayden Island Neighborhood Network
Alternate Member	Margaret Puckette	Hayden Island Neighborhood Network
Stakeholder, Community Organization[c]		
Primary Member	Rob Lee	Linnton Neighborhood Association
Alternate Member	N/A	N/A
Stakeholder, Community Organization		
Primary Member	Jennifer Levy	St. Johns Neighborhood Association
Alternate Member	Emilie Saks-Webb	St. Johns Neighborhood Association
Stakeholder, Local Government[c]		
Primary Member	Molly Emmons	Portland Public Schools
Alternate Member	N/A	N/A
Stakeholder, Community Organization		
Primary Member	Ranfis Giannettino Villatoro	MRG Foundation/Coalition of Communities of Color
Alternate Member	N/A	N/A
Portland Government, Emergency Management[c]		
Primary Member	Jonna Papaefthimiou	Bureau of Emergency Management
Alternate Member	Peter O'Farrell	Bureau of Emergency Management
Portland Government[c]		
Primary Member	Nickole Cheron	Disability Program, Office of Neighborhood Involvement[d]
Alternate Member	Brian Hoop	Office of Neighborhood Involvement
Stakeholder, Public Health		
Primary Member	Sherrie Forsloff	Oregon Health and Science University Emergency Management
Alternate Member	Mike Nurre	Oregon Health and Science University Emergency Management
Stakeholder, Community Organization[c]		
Primary Member	Casey Milne	Goose Hollow Foothills League
Alternate Member	Tom Milne	Goose Hollow Foothills League

Representation[a]	Name	Title/Agency
Stakeholder, Community Organization		
Primary Member	Dean Stearman	Volunteers of America
Alternate Member	N/A	N/A
Portland Government[c]		
Primary Member[b]	Rich Grant	Portland Bureau of Transportation
Alternate Member	N/A	N/A
Stakeholder, Community Organization[c]		
Primary Member[b]	Darise Weller	Portland Harbor Community Advisory Group
Alternate Member	N/A	N/A

a. Representatives from the Coalition of Communities of Color, Oregon School Boards Association and Rosewood Initiative were originally included on the committee roster, but needed to leave the committee due to a lack of resource, change of positions or other issue.
b. Steering Committee membership was approved by the committee at the fourth steering committee meeting.
c. Indicates that the steering committee member or his or her alternative missed three or fewer meetings over the course of the planning process.
d. Steering Committee member transitioned to representing the Disability Equity Program at the Office of Equity and Human Rights during the planning process.

3.5.2 Ground Rules

Leadership roles, ground rules (see Appendix B), and a charge statement were established at the first Steering Committee's meeting on July 28, 2015 and confirmed on August 19, 2015. The committee was charged with the following:

- Guide the planning process.
- Develop strategies for public involvement that foster mutual information exchange during plan development and implementation.
- Promote and advocate for equity in hazard mitigation.
- Support the development of mitigation strategies that promote a decrease in loss of life, property damage, and long-term impacts on social, environmental and economic systems from natural hazards.

The Steering Committee agreed to meet monthly as needed throughout the course of the plan's development. The planning team facilitated each Steering Committee meeting, which addressed a set of objectives based on the work plan established for the plan. The Steering Committee met 12 times from July 2015 through June 2016, including 10 steering committee meetings (see Figure 3-4) and two equity training sessions. All Steering Committee meetings were open to the public and agendas, handouts and meeting notes were posted to the hazard mitigation website. A summary of meeting objectives is included in the plan milestone table at the end of this chapter. Attendance logs are available for review upon request.

After leadership roles were confirmed at the August meeting, an executive steering committee meeting was held the week prior to each steering committee meeting. These meetings involved the steering committee co-chairs and members of the planning team. The agenda and meeting objectives were reviewed and discussed, as well as the forum in which each agenda item would be discussed (e.g. break out groups, full group discussion, etc.). Agendas were modified based on the executive committee feedback.

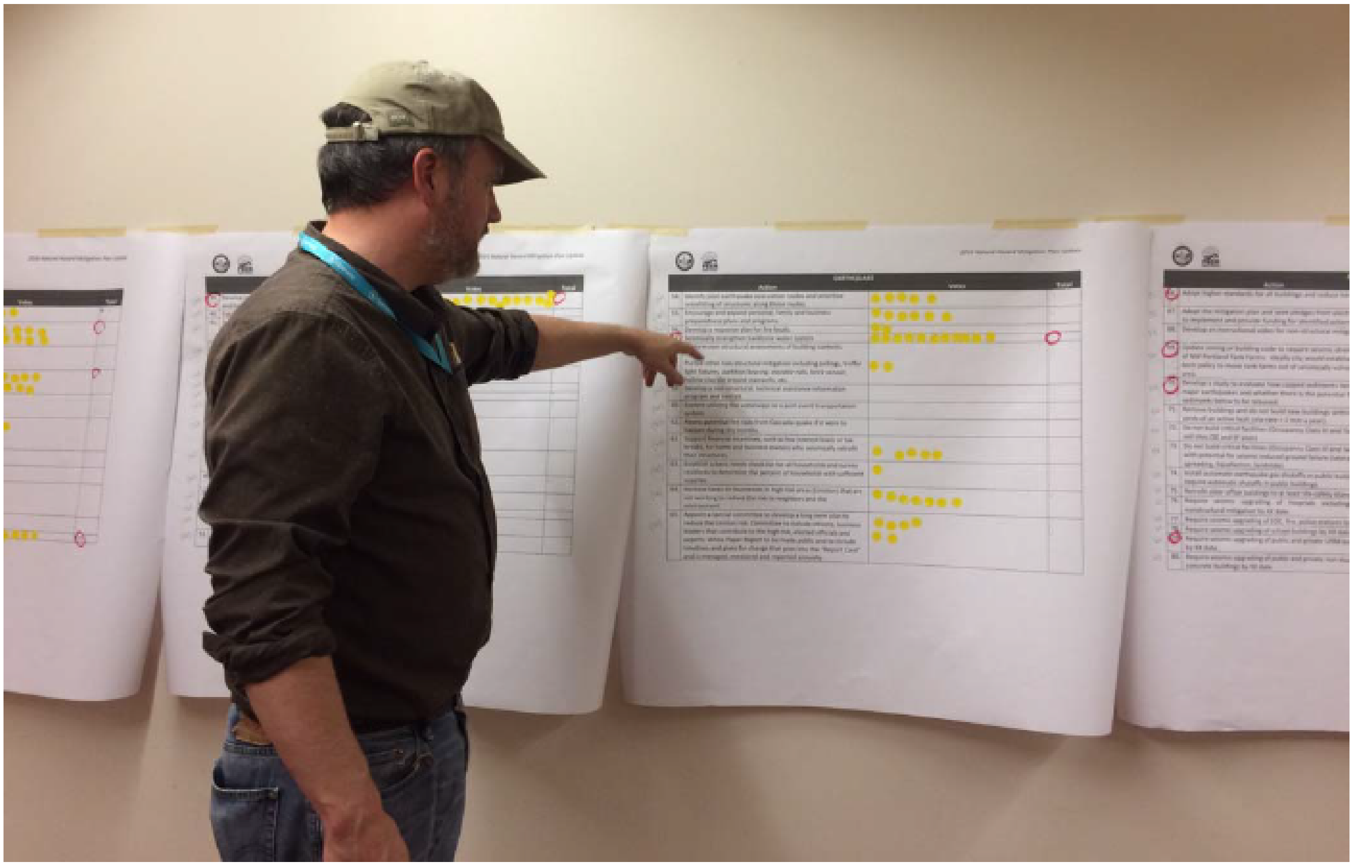


Figure 3-4. Discussion of Mitigation Actions at Steering Committee Meeting

3.5.3 Equity Trainings

In order to provide a baseline level of understanding of equity-related concerns in the City of Portland and in hazard mitigation planning in general, the planning team arranged for two equity training sessions for the steering committee. Interested members of the public and other stakeholders were also invited to attend these events. These trainings were used to inform and enhance the development of the equity lens applied throughout the planning process, including the public engagement strategy, the development of the risk assessment, the development of the mitigation strategy, and the plan implementation and maintenance strategy. City and contracted staff who provided this training also provided feedback and guidance on the development and application of the equity lens through the remainder of the plan development process.

City of Portland Office of Equity and Human Rights Training

On August 10, 2015, the Portland OEHR led a training to help participants recognize institutional and systemic barriers to just access to services and opportunities. Participants were asked to apply their skills to develop strategies that remove barriers in policies, programs, and practices, focusing on race and disability issues, and leading to the elimination of disparities and improved outcomes for all.

A conversational model was used to facilitate discussions, in order to create a supportive learning environment where people could express themselves without fear of judgment or recrimination. Activities at the training included brief presentations, short videos, small and large group conversations, and practical exercises on real world scenarios. The training was designed to convey the following information:

- History of institutional/systemic racial biases and impacts today
- How implicit bias supports the status quo and disparities
- Why equality doesn't mean equity
- How to use equity questions to eliminate disparities and improve outcomes for all
- The City of Portland's commitment to equity as a value and mission.

A focus of the training was the distinction between an equity framework and an equality framework (see Figure 3-5). Equality implies equal treatment, while equity focuses on creating an equal opportunity for successful outcomes, which means that different groups and persons may need different allocations of resources. The working definition of equity applied during the training was as follows:

> Equity is realized when identity—such as race, ethnicity, gender, age, disability, or sexual orientation—has no detrimental effect on the distribution of resources, opportunities, and outcomes for groups or members in a society.

Source: OEHR

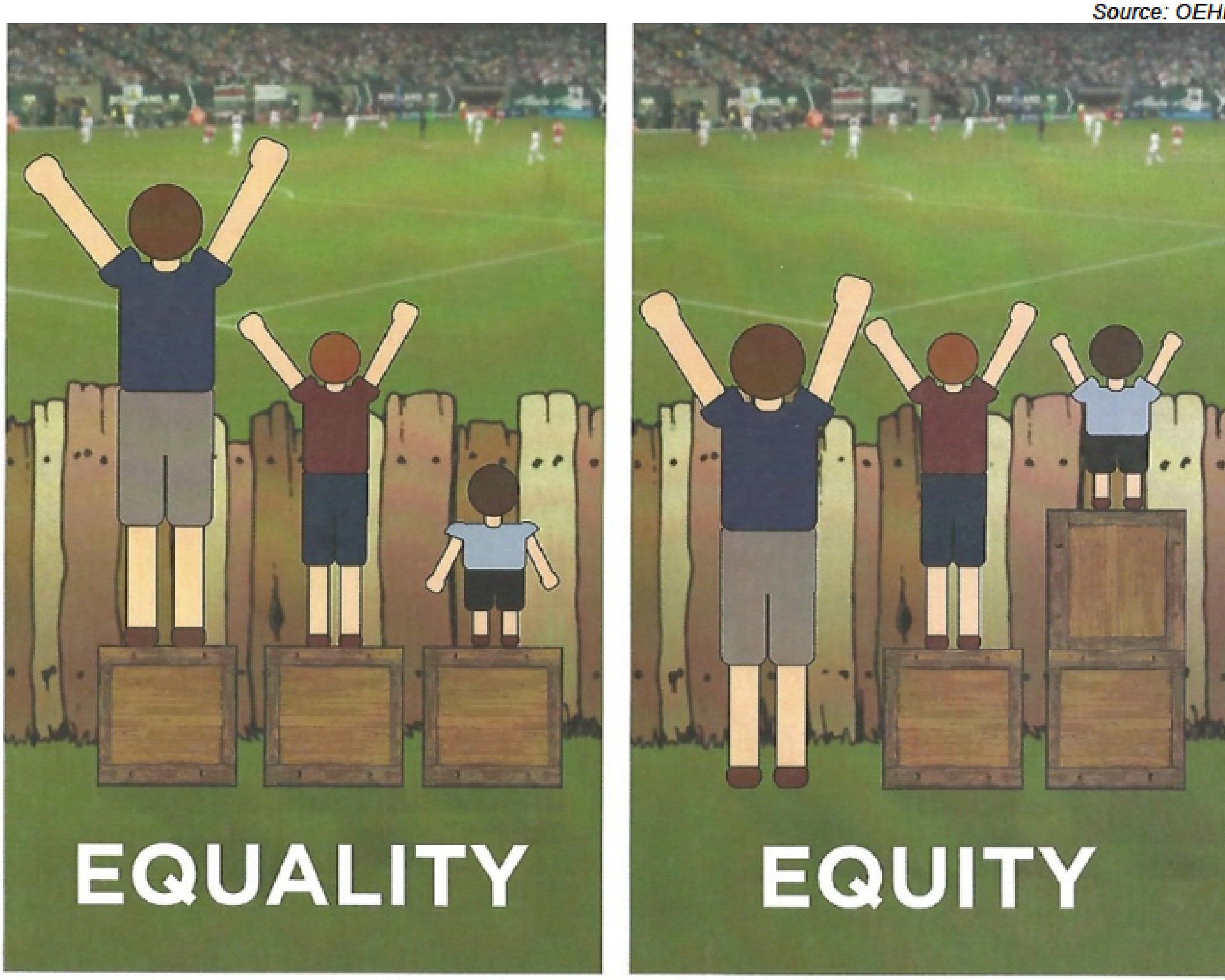


Figure 3-5. Equality versus Equity

Three scenarios were discussed in small groups by training attendees: the development of outreach strategies; communication mechanisms about a public health risk; and a willing-seller property acquisition program. Discussions considered the following:

- What assumptions serve as the basis for this policy, procedure or practice?
- How could this policy, procedure, or practice benefit communities of color or people with disabilities?
- How could this policy, procedure or practice burden communities of color or people with disabilities?
- What are some strategies for reducing negative impacts for communities of color or people with disabilities?

Natural Hazard Mitigation Focused Equity Training

On September 28, 2015 Dr. Himanshu Grover, assistant professor and co-director of the University of Washington's Institute for Hazard Mitigation and Planning, led a training to help participants to understand and recognize key equity issues in the planning and implementation of hazard mitigation policies (see Figure 3-6). The session was based on the "appreciative inquiry" approach to purposeful stakeholder interactions. This approach is useful for engaging with a broad range of stakeholders. It advocates collective inquiry into the development of a desired future state or policies that are compelling enough not to require the use of incentives, coercion or persuasion for implementation.

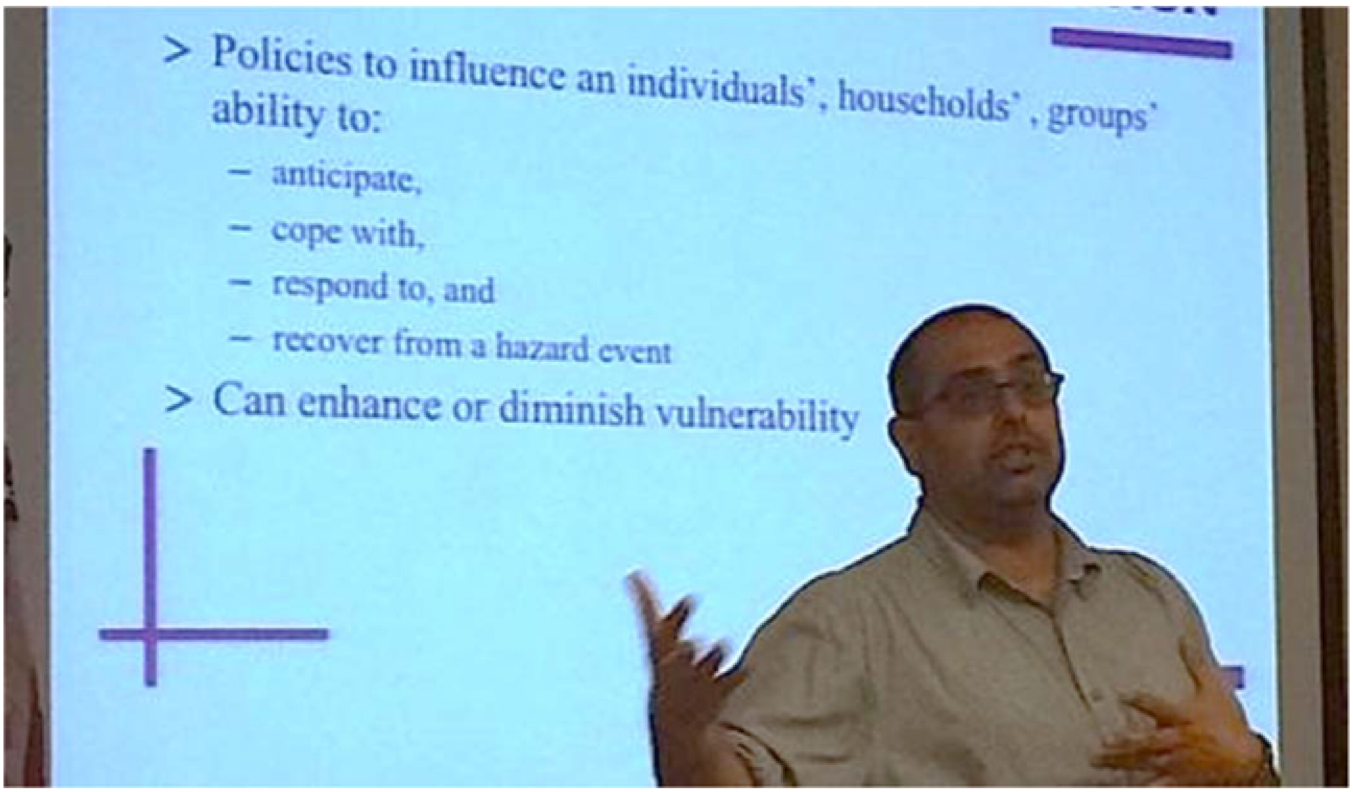


Figure 3-6. Natural Hazard Mitigation Focused Equity Training

This approach overcomes limitations of problem-solving by expanding human horizons and encouraging collective solutions. It assumes that communities are socially constructed phenomena and that problem-solving is limited only by human imagination and the agreements stakeholders make with each other. The session was designed to stimulate a process of inquiry that results in better, more effective, sustainable and vital connections between stakeholders, toward the common objective of mitigating hazard risks to the community.

Participants were introduced to the role of hazard mitigation planning in reducing risks from hazard threats and were then asked to participate in a collaborative exercise to identify issues and challenges in the development and implementation of an effective hazard mitigation strategy for the City of Portland. Learning objectives for the training were as follows:

- Appreciate the role of the MAP in reducing risks and avoiding losses.
- Recognize key equity concerns in hazard mitigation planning.
- Actively participate in development of equity lens questions to eliminate disparities and improve outcomes for hazard mitigation policies and actions.
- Identify specific needs for targeted mitigation actions that can overcome traditional barriers and challenges to equity.
- Identify synergistic opportunities for implementing equitable hazard mitigation policies.

The training session focused on vulnerability and risk reduction in order to identify ways to achieve the following:

- Minimize the impacts of hazard events so that they do not become disasters.
- Provide a better quality of life to all groups and members of the community.
- Build trust and networks that can be relied upon for other developmental activity.
- Promote overall sustainability and resilience (enhance social equity).
-

Key factors identified for decreasing vulnerability and increasing social equity in hazard mitigation included the following:

- Access to resources (including information, knowledge, and technology)
- Social capital, including organizational trust, social networks and connections
- Beliefs and customs
- Age, gender, race
- Health and physical ability.

Common challenges in these processes include the following:

- **Framing**—Different stakeholders may have conflicting views of the issue.
- **Scope**—Who are those impacted and where are the impacts?
- **Transparency**—Trade-offs are not made explicit and hidden agendas seem to determine the outcome.
- **Inequity**—Decisions allot the risk and benefits unfairly.
- **Accountability**—Decision makers are isolated from the impact of their decision.
- **Alienation**—People or organizations are ignored: "authority knows best."
- **Trust**—Lack of trust in the process or the communication channel.
- **Paralysis by analysis**—Overly inclusive process that ultimately leads to a continuation of the status quo.

3.6 COORDINATION WITH OTHER AGENCIES

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

- **Steering Committee Involvement**—Agency representatives were invited to participate on the Steering Committee. Many agencies contacted to participate as steering committee members ultimately elected to participate as coordinating stakeholders instead.
- **Stakeholder Notification**—The following agencies were invited to participate in the plan development process as coordinating stakeholders:
  - Centennial School District
  - City of Maywood Park
  - Clackamas County
  - Clark County
  - David Douglas School District
  - District Office of Congressman Earl Blumenauer, OR-3
  - Oregon Department of Geology and Mineral Industries (DOGAMI)
  - FEMA Region X
  - Marion County
  - Multnomah County Aging & Disability Services
  - Multnomah County Drainage District
  - Multnomah County Emergency Management Multnomah County Health
  - Multnomah County Office of Citizen Involvement
  - Multnomah County Office of Diversity and Equity
  - Multnomah Youth Commission
  - Oregon Advocacy Commissions Office
  - Oregon Department of Environmental Quality
  - Oregon Department of Justice
  - Oregon Department of Land and Development
  - Oregon Department of Transportation (ODOT)
  - Oregon Emergency Management (OEM)
  - Oregon Health Authority (OHA)
  - Oregon Metro
  - Oregon Public Utility Commission
  - Port of Portland
  - Portland Public Schools
  - U.S. Coast Guard, Station Portland
  - Wasco County
  - Washington County

  These agencies received meeting announcements, meeting agendas, meeting handouts and meeting summaries by e-mail throughout the plan development process. Many supported the effort by attending meetings, providing feedback or comment, or providing data or studies. Distribution lists used for agency coordination are available upon request.

- **Pre-Adoption Review**—All the agencies listed above were provided an opportunity to review and comment on this plan, primarily through the City's hazard mitigation website (see Section 3.7.2). Each agency was sent an e-mail message informing them that the draft plan was available for review. In addition, the complete draft plan was sent to Oregon Office of Emergency Management, FEMA Region X, and the Insurance Services Office for a pre-adoption review to ensure program compliance.

3.7 PUBLIC ENGAGEMENT STRATEGY

- DEFINITIONS
- **Community**—All residents of the City of Portland and those who work and play here.
- **Engagement**—A two-way communication between local government and stakeholders.
- **Stakeholders**—Persons and agencies with a vested interest in the recommendations and implementation of the MAP. Stakeholders include residents, community groups, business owners, local, state and federal agencies, elected officials, visitors, and neighboring communities.

Broad public participation in the planning process helps ensure that diverse points of view about local needs are considered and addressed. The public must have opportunities to comment on disaster mitigation plans during the drafting stages and prior to plan approval (44 CFR, Section 201.6(b)(1)). The Community Rating System expands on these requirements by making CRS credits available for optional public involvement activities.

3.7.1 Strategy Development

Significant resources were invested in a public engagement strategy to ensure that the MAP development process benefited from a wide range of perspectives from all stakeholders. The City established the following goals for the public engagement strategy:

- Reach out to all stakeholders, specifically those living in higher risk areas.
- Create authentic opportunities for stakeholders to influence the planning process.
- Make use of existing community outreach capacities and networks.
- Partner with local organizations.
- Promote activities that meet the outreach requirements of the Disaster Mitigation Act and the Community Rating System.
- Propose activities that can be included and summarized in the plan.

The public engagement strategy was developed through discussion with the steering committee, review of best practices, interviews with community members, and input from technical support staff contracted to assist with development of the equity lens. Meetings held as part of this effort are summarized in Table 3-2.

Table 3-2. Equity and Outreach Strategy Development Meetings

Stakeholder	Meeting Date
Portland Office of Neighborhood Involvement	June 12, 2015
Portland Office of Equity and Human Rights	July 16, 2015
Portland Office of Neighborhood Involvement	September 18, 2015
Neighbors West/Northwest, Downtown Neighborhood Association	January 3, 2016
New Portlanders Program	March 14, 2016
Community Engagement Liaison Program	March 17, 2016

A recommended *Community Engagement Plan*, developed and reviewed by the steering committee and planning team, included the following recommended activities (see Appendix C):

- Online platform for information sharing
- Stakeholder identification and involvement
- Public hazard mitigation survey
- “Planning for Real” workshops
- Draft plan review and feedback (town hall meetings and public comment)

- Continued public engagement.

In addition to these activities recommended in the *Community Engagement Plan*, coordination was conducted with internal and external stakeholders as events were identified or information was requested. Although not all plan recommendations were implemented during the MAP development, the plan is a resource for continued public engagement during the performance period of the MAP, as well as a resource for the next hazard mitigation plan update. The following sections describe all public engagement activities carried out during development of the MAP.

The implemented strategy encouraged public participation during the MAP development process, will facilitate continued engagement with local residents after adoption of the MAP, and promotes effective cooperation between City government and civil society organizations within an integrated framework for community engagement. The strategy establishes public involvement that achieves the following:

- Results in City decisions that effectively respond to the needs and priorities of the community
- Makes community members and community resources part of the solution
- Involves the whole community, especially those who have not participated in the past
- Spreads knowledge of and support for public policies and programs
- Keeps government accountable.

3.7.2 Strategy Implementation and Results

Online Platform for Information Sharing

At the beginning of the plan development process, the PBEM hazard mitigation website was updated to provide information on the MAP development process and to serve as the information resource for mitigation within the city (see Figure 3-7): https://www.portlandoregon.gov/pbem/67578. The site includes the following:

- The 2010 NHMP
- Information on public engagement, including the survey, workshops and meetings
- The steering committee roster, ground rules, and meeting packets
- Links to equity resources
- Draft findings and reports
- Calendar of events
- Information on how to get involved in the planning process and where to submit comments and questions.

The site's address was publicized in all press releases, the survey and public engagement events. PBEM intends to keep a website active and up-to-date after the MAP's completion to keep the public informed about successful mitigation projects, progress on identified actions and future plan updates.

Figure 3-7. Sample Page from the Mitigation Action Plan Web Site

Stakeholder Identification and Involvement

The following activities were carried out in addition to formal public engagement meetings recommended in the Community Engagement Plan (meeting dates are listed in Table 3-3):

- **External Stakeholder Recruitment and Coordination—**Stakeholders were invited to join in the plan process as both participatory and coordinating stakeholders as described in Sections 3.5 and 3.6. Additionally, members of the planning team held several steering committee recruitment and stakeholder coordination meetings throughout the course of the planning process.
- **Internal Stakeholder Coordination—**Coordination with internal stakeholders occurred throughout the plan process through participatory and coordinating engagement. Several coordination meetings were held over the course of the MAP development process.
- **Identification of Barriers and Opportunities—**In-person and phone interviews were conducted with 41 representatives of neighborhood associations, community organizations and members of the public during the MAP development process to identify potential barriers to public engagement. City bureaus and offices and community organizations were surveyed to identify ongoing programs and initiatives, in order to leverage existing community linkages during development and implementation of the MAP. The results of these interviews and surveys are provided in Appendix C.
- **General Outreach and Presentations—**Additional outreach was conducted with internal and external stakeholders as events were identified or information was requested.

Table 3-3. Stakeholder Identification and Involvement Meetings

Stakeholder	Meeting Date
External Stakeholder Recruitment and Coordination Meetings	
U.S. Geological Society	May 26, 2015
U.S. Department of Homeland Security	June 11, 2015
Commission on People With Disabilities	June 12, 2015
Red Cross	June 18, 2015
Black Parent Initiative	June 30, 2015
Coalition of Communities of Color	July 2, 2015
Neighbors West/Northwest, Downtown Neighborhood Association	July 8, 2015
Metro	July 8, 2015
Portland Voz	July 14, 2015
Regional Mitigation Planners Meetup	July 28, 2015
Home Forward	August 11 2015
Sunday Parkways Laurelhurst Park	August 23, 2015
Regional Mitigation Planners Meetup	October 12, 2015
Regional Mitigation Planners Meetup	November 9, 2015
Regional Mitigation Planners Meetup	January 12, 2016
Goose Hollow Foothills League	January 12, 2016
Oregon Department of Geology and Mineral Industries	January 20, 2016
Portland State University	April 28, 2016
Oregon Department of Geology and Mineral Industries	May 11, 2016
Portland Public Schools	May 17, 2016
Latino Network	May 18, 2016
Regional Mitigation Planners Meetup	May 19, 2016
Red Cross	June 18, 2016
Black Parent Initiative	June 30, 2016
Coalition of Communities of Color	July 2, 2016
City Club Committee on Earthquake Resilience	July 19, 2016
Internal Stakeholder Coordination Meetings	
Climate Change Preparation Implementation Team	October 29, 2015
Portland Housing Bureau	November 19, 2015
Climate Change Preparation Implementation Team	February 18, 2016
Bureau of Planning and Sustainability	April 28, 2016
Office of Equity and Human Rights	May 4, 2016
Parks and Recreation	May 26, 2016
Bureau of Development Services	May 26, 2016
Portland Fire & Rescue	May 31, 2016
Bureau of Planning and Sustainability	June 15, 2016
Bureau of Planning and Sustainability	June 23, 2016
Office of Neighborhood Involvement	June 29, 2016
Bureau of Planning and Sustainability	July 20, 2016

Stakeholder	Meeting Date
General Outreach and Presentations	
Rosewood National Night Out	August 6, 2015
Oregon Emergency Management Association/Washington State Emergency Management Association Conference	September 23, 2015
Bureau of Development Services Emergency Preparedness Fair	September 30, 2015
Linnton Neighborhood Association Meeting	January 6, 2016
Marion County Emergency Management	February 10, 2016
Parents for Preparedness	March 8, 2016
Goose Hollow Foothills League	March 17, 2016
East Portland Action Plan	March 23, 2016
Eastmoreland Emergency Preparedness Committee	April 21, 2016
Bhutanese Community Workshop[a]	May 21, 2016
Vietnamese Community Workshop[a]	May 28, 2016
Somali Community Workshop[a]	May 29, 2016
Zomi Community Workshop[a]	June 6, 2016
Chinese Community Workshop	June 10, 2016
St. Johns Neighborhood Association Meeting	June 13, 2016
Catlin Gabel People Leading Across City Environments (PLACE) Program	June 28, 2016
Linnton Neighborhood Association Meeting	July 6, 2016

a. No member of the planning team was in attendance at this event. This outreach was conducted by community engagement liaisons and information was reported back to the planning team.

Public Hazard Mitigation Survey

A public survey was developed by the planning team with input from the steering committee. The survey was used to inform action item development and prioritization and to inform the planning team how best to communicate with the public about natural hazard risks and risk reduction. A survey distribution plan was developed (see Appendix C) to meet the goal of reaching a broad cross-section of the Portland population, with an emphasis on the populations most vulnerable to natural hazard risks: economically disadvantaged populations, communities of color, those with limited English proficiency, immigrants or refugees, and others who are historically underrepresented in government activities or experience greater likelihood of negative consequences from natural hazard events.

Survey Distribution

The public survey was launched February 5, 2016 (see Figure 3-8). It was distributed online in English, Spanish, Chinese, Russian, Ukrainian, and Vietnamese, through translation provided by Oregon Translation, LLC. It included questions to gather information about how Portlanders think about preparedness and reducing risk from natural hazards; questions to collect demographic information, such as income level, ethnic identification, household structure; and questions to identify the respondents' country of birth and language spoken at home. Data was also collected related to how the respondent learned about the survey and whether he or she would like to be contacted with additional related information. A sample page is shown on Figure 3-9. The complete survey and results can be found in Appendix C.

Figure 3-8. Flyer Used to Advertise the Public Survey

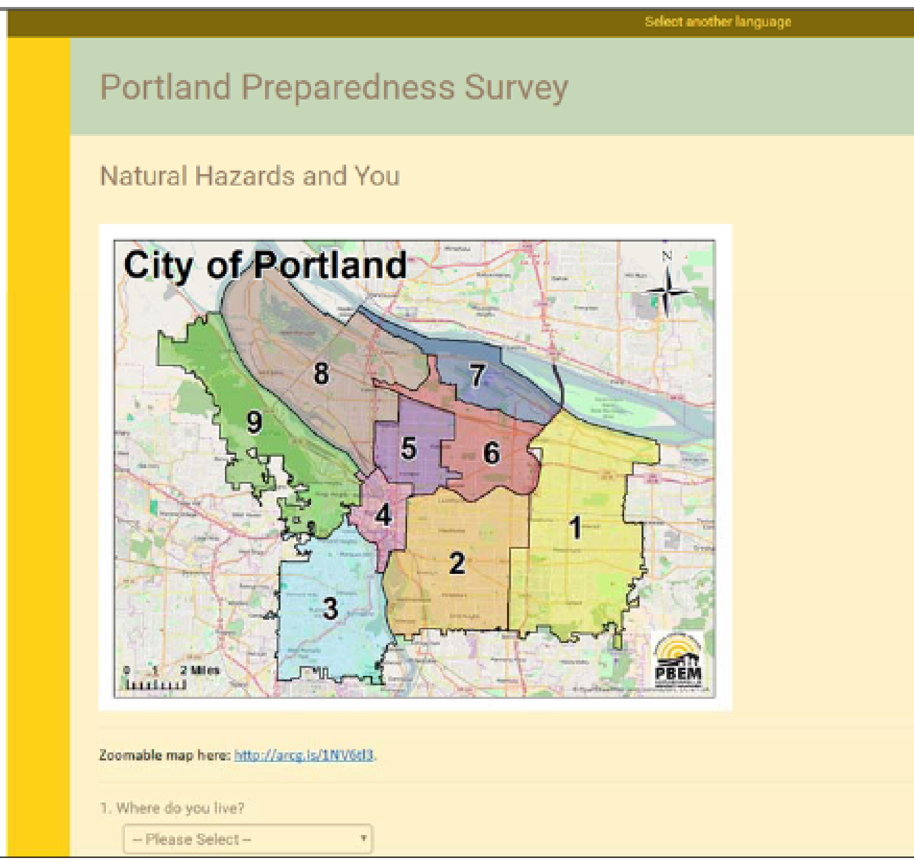


Figure 3-9. Sample Page from Survey Distributed to the Public

Survey Results

The survey remained open through the course of the MAP development; however, early results were compiled in May to inform action item development, plan content, and outreach strategies. There were 2,970 responses to the public survey through early April 2016. Key results are summarized below.

Geographic Representation and Residency Tenure

Survey responses were received from all risk reporting areas and from individuals who live outside of Portland; 75.5 percent of all respondents indicated that they live in Portland. When non-residents are excluded, the percent of responses from risk reporting areas is representative of the estimated population in some cases; however, there are some areas with under- and over-representation. Overrepresented areas included: Northeast, Southeast and Southwest. Under-represented areas include: Central City and East Portland. The remaining reporting areas were within 1 percent of the estimated population. See Table 3-4 for more information.

Table 3-4. Geographic Distribution of Survey Respondents

Reporting Area	Estimated City Population	Estimated % of City Populations	% of Survey Responses[a]	Difference
Airport	2,674	0.4%	0.2%	-0.2%
Central City	37,987	6.2%	3.6%	-2.6%
Central Northeast	47,644	7.8%	7.1%	-0.7%
East Portland	148,712	24.2%	9.6%	-14.6%
North Portland	68,047	11.1%	12.1%	+1.0%
Northeast	57,842	9.4%	15.9%	+6.5%
Southeast	153,952	25.1%	32.6%	+7.5%
Southwest	70,262	11.4%	13.8%	+2.4%
West/Northwest	26,875	4.4%	4.9%	+0.5%

a. Excluding respondents who indicated they reside outside of Portland.

The majority of respondents who live in Portland have lived in the City for 11 or more years (62 percent); 26 percent indicated that they have lived in the City for more than 25 years.

The top three areas where all survey respondents indicated that they and their families spend the most time are Central City (42 percent), Southeast (34 percent) and Southwest (25 percent). When non-Portland residents are excluded, the top areas are Central City (43 percent), Southeast (40 percent), Southwest and Northeast (about 25 percent each).

Demographics

Excluding non-Portland residents, 72 percent of respondents self-identified as middle income and 13 percent identified their household as low income. According to American Community Survey (ACS) estimates, approximately 12 percent of Portland families are surviving on incomes below the federal poverty line.

Excluding non-Portland residents, 99 percent of respondents indicated that they speak English at home. Only nine respondents indicated that they prefer languages other than English. The ACS estimates that limited English speaking households make up approximately 4 percent of Portland households.

Excluding non-Portland residents, 72 percent of respondents indicated that they own their home, and 27 percent indicated that they rent their home. The ACS estimates that 43 percent of the housing units in the City are renter-occupied.

Approximately 9 percent of respondents indicated that they have physical or mental disability. Thirteen respondents who indicated that they had a disability (about 7 percent) also indicated that they were 65 or older. According to U.S. census estimates, 9 percent of Portland residents under age 65 have a disability.

Respondents were able to enter their own racial identity rather than choosing from pre-determined options. The indicated racial identity was white/Caucasian or Anglo for 79 percent of respondents. According to ACS estimates, 78 percent of the Portland population is white.

Hazards of Concern

For Portland residents, the top three hazards of concern were earthquake (96 percent), severe weather (51 percent) and drought (34 percent). Dam failure (3.9 percent) and space weather (8 percent) were the least likely to be selected. The top three hazards remain the same when non-Portland residents are included. Of Portland residents, 53 percent indicated that they had experienced one of the hazards of concern.

Thoughts on Preparedness and Mitigation

Portlanders indicated that they have made efforts to reduce risk to their families. They clear storm drains (50 percent), have made non-structural retrofits, such as securing a water heaters (42 percent), and have planted drought-resistant plants (33 percent). Only 6 percent of Portlanders indicated that they have purchased flood insurance; 27 percent indicated that they have purchased earthquake insurance. Seventeen percent indicated that they had not done any of the options indicated. A large number of respondents indicated that they had not taken these measures because they rent or live in apartment buildings or condominiums.

The top three things Portlanders have done to prepare for a natural hazard event are obtaining emergency food and water (58 percent), having an emergency kit at home (54 percent) and registering for PublicAlerts (46 percent). Only 10 percent of respondents indicated that they had done nothing to prepare. When non-Portland residents are included, the results are similar.

Portlanders indicated the top three reasons for not preparing for emergencies as lack of money (40 percent), being too busy (34 percent) and preparing being too overwhelming (32 percent).

Portlanders indicated that power outage (67 percent), water system damage (65 percent) and bridge closures (43 percent) would impact them the most. Responses were similar when all survey respondents are included.

As the three most important things that the City of Portland government could do to reduce risk from natural hazards, Portlanders selected strengthening infrastructure such as bridges, sewer lines and water pipes (85 percent), strengthening public buildings (44 percent), and helping citizens reduce their individual natural hazard risks (36 percent). Strengthening schools was also commonly mentioned.

Planning for Real Workshops

Nine workshops were held in Portland between April 18 and May 14, 2016 using the "Planning for Real" workshop approach for community engagement:

- Seven of the workshops were open to the public and geographically focused.
- One workshop was held for the Coalition of Communities Color, Native American Youth and Family Center, Portland Voz, the Asian Pacific Network of Oregon (APANO), and the Latino Network
- One workshop was held for community engagement liaisons (CELs) representing Chinese, Zomi, Lao, Bhutanese, Somali, Latino, Iraqi, and Khmer immigrant and refugee communities (see Figure 3-10). CELs are leaders in their communities who are contracted with the City of Portland to act as a bridge between City government and immigrant and refugee communities. Following the CELs workshop, each participant was asked to schedule a meeting with at least 10 members of his or her community to share information about hazards in Portland and to provide any feedback received to the planning team

Figure 3-10. Community Engagement Liaisons (CELs) participate in “Planning for Real” Workshop

Workshop Content

The Planning for Real workshop process is described in the *Community Engagement Plan* provided in Appendix C. The content of each workshop varied based on lessons learned from previous workshops. Earlier workshops focused on the MAP development process and physical exposure to hazards of concern in the geographic area in which the workshop was held (primarily flood, earthquake, landslide, wildfire, and severe weather, with some discussion of drought, space weather, and volcano).

Later workshops were adapted based on feedback from early workshop attendees. The early workshop participants recommended less emphasis on the planning process and more information about projects and programs the City is currently doing to reduce vulnerability, and ways for the City to partner with community organizations. Later workshops briefly covered natural hazard risks, then highlighted current city activities to reduce risk and vulnerability and potential collaborations between the city and community organizations.

For workshops with fewer attendees, discussions involved the whole group; workshops with larger groups were divided into discussion groups focused on specific hazards (wildfire, flood, earthquake, etc.). The following questions were discussed:

- Is your neighborhood in a hazard risk zone? Are there buildings or services you use on a daily basis that are in a hazard risk zone? What would the consequences be if they were impacted by a natural hazard?
- What are some ways that you could reduce the risk impacts and negative consequences at your home, at work, and in your neighborhood?
- What kinds of programs or projects can City offices do to support you and your neighbors in preparing for natural hazards?
- Are there potentially vulnerable populations in your neighborhood that could experience disproportionate impacts from natural hazard events? Can you think of ways to build capacity for these groups now, so that they are better positioned to absorb and recover from a hazard event?

Workshop Results

Feedback received at the Planning for Real workshops was compiled and shared with the Steering Committee, City bureaus and stakeholders. Bureaus were asked to consider this information in the selection of action items to be implemented over the performance period of the plan.

A full compilation of this feedback is included in Appendix C. A summary of key recommendations by topic follows:

- Planning process, communications and outreach:
    - ➢ Include full social and economic recovery after a disaster as a goal of the MAP.
    - ➢ Provide culturally and community-specific training for community leaders on home safety, hazard mitigation (e.g. non-structural seismic strengthening), food and supply storage, response considerations for people with special needs, and household and neighborhood preparedness.
    - ➢ Develop post-disaster safety messages based on the 2013 report Day Labor, Worker Centers & Disaster Relief Work in the Aftermath of Hurricane Sandy.
    - ➢ Provide education for rental property owners and property managers on hazard communication and mitigation actions.
    - ➢ Provide training on evacuation and sheltering for retirement home staff and all licensed nursing homes and assisted living care providers.
    - ➢ Increase PBEM's capacity to provide community trainings and partner with the Office of Neighborhood Involvement, Diversity in Civic Leadership program, and Community Engagement Liaisons program to connect underserved communities with training opportunities.
    - ➢ Expand the NET program (Neighborhood Emergency Team—volunteers trained by PBEM and Portland Fire & Rescue to provide emergency disaster assistance within their own neighborhoods) into every neighborhood in Portland and expand beyond the

neighborhood structure to non-geographic communities (e.g. immigrant and refugee communities).

- Update Portland Maps to be more user-friendly and visually map hazards.
- Culture- and language-appropriate webpage for new Portlanders to access emergency information, videos, and events in their preferred language.
- Postcard mailers to every household in Portland to share natural hazard risks and how to be prepared. Include this information in neighborhood newsletters.
- Hold a storytelling event to share disaster survivor stories and share information about hazards in an emotionally compelling way.
- Citywide preparedness tours to highlight exemplary projects.
- Do outreach for ATC-20 damage assessment trainings at neighborhood land use and transportation meetings. Provide ATC-20 training to NET members to support ATC-20 certified engineers and architects.

- All hazards:

  - Financial assistance and/or regulatory support for low-income residents and renters who are vulnerable to extreme heat or diminished air quality to install air conditioning systems.
  - Training and support for day laborers consistent with guidance in 2013 report *Day Labor, Worker Centers & Disaster Relief Work in the Aftermath of Hurricane Sandy*.
  - Funding for community organizations outside formal neighborhood structure whose projects focus on preparedness and community resilience.
  - Invest in and promote community gardens and local food production.
  - Invest in and promote rainwater collection systems in public, residential, and commercial properties.
  - Require new development to include onsite rainwater storage and/or emergency drinking water storage tanks. Include water storage solutions in seismic retrofit projects for schools and other public buildings.
  - Update city policies to include energy and water purification solutions promoted internationally by Green Empowerment.
  - Invest in and promote solar and other alternative energy in public, residential, and commercial properties.
  - Prioritize clearing bike paths so that non-automobile traffic can flow safely and develop plans to locate aid stations along these routes.
  - Prioritize road access to grocery stores, medical offices, and hospitals. Consider isolated communities in establishing road-clearing priorities.
  - Partner with community groups and critical social service organizations to ensure that they have continuity of operations plans.
  - Develop hazard-specific evacuation plans that consider likely impacts on bridges and other transportation infrastructure.
  - Develop a recovery plan to promote hazard-informed decision-making for post-disaster redevelopment and to take advantage of the opportunity to move critical assets to safer locations.
  - Provide neighborhood tool libraries for mitigation projects and post-disaster reconstruction. Partner with home improvement stores to build tool collections.
  - Require Portland's emergency responders to live within the city. Provide financial support to purchase or rent a home within the city limits.

- Landslide:
  - ➢ Financial support and education for property owners wishing to remediate their properties for erosion.
  - ➢ Emergency moratorium on all development in high landslide risk areas.
  - ➢ Enhanced communication with adjacent property owners and neighbors about how landslide risk is being minimized if development is permitted in landslide risk areas.
  - ➢ Erosion control projects using bio-swales and beneficial drainage systems.
  - ➢ Pre-established detour routes for access in and out of known landslide risk areas.
- Flood:
  - ➢ Replace unsafe or structurally compromised bridges and rebuild to more flood-resistant standards.
  - ➢ Identify high-traffic bridges and flood-prone routes and establish alternative routes to be used in case they are flooded.
  - ➢ Require construction of bio-swales for large construction projects where appropriate.
  - ➢ Promote the use of French drains and other on-site stormwater management systems.
- Earthquake:
  - ➢ Retrofit and/or move fuel infrastructure in Linnton. Maintain fuel reserves in safe locations for use in disaster recovery.
  - ➢ Strengthen levees to seismic standards.
  - ➢ Develop an inventory of and distribute information about which shelter facilities have been retrofitted.
  - ➢ Provide property owners with financial assistance for seismic strengthening, especially owners of multi-family and low-income housing.
  - ➢ Reinforce and fire-proof the Linnton Community Center as a place of refuge for residents who cannot evacuate.
  - ➢ Require automatic shutoff valves for gas lines in all new development.
  - ➢ Evaluate whether current seismic codes are sufficient for a 9.0 subduction zone earthquake. If not, adopt higher standards.
  - ➢ Assess seismic stability of large water towers throughout the city to determine whether they pose a risk or could be used as an emergency water source.
  - ➢ Communicate information about hazardous materials and potential plume areas prior to major event. Ensure firefighters and NET members know hazard types and response considerations.
  - ➢ Label unreinforced masonry buildings to notify occupants of their risks.
  - ➢ Require signage about risks and evacuation routes in hotels.
  - ➢ Retrofit and reinforce schools beyond life-safety standards so that they can be used as neighborhood shelters and storage locations for emergency supplies.
  - ➢ Stage emergency resources on the west side of the river in case bridges fail and east-west access is blocked.
  - ➢ Continually update water and sewer pipe systems, and continue with the project to build a seismically reinforced water pipe that crosses under the Willamette River
- Wildfire:
  - ➢ Require metal or composition roofing materials when replacing greater than 50 percent of a roof in a wildfire risk zone.

  - ➢ Provide NET members with training on fire response, especially how to use fire hydrants and hoses.
  - ➢ Provide clear information to the public on burn restrictions.

- Severe weather:

  - ➢ Primary concerns from workshop participants about severe weather were related to extreme heat and emergency shelters for all extreme weather conditions. All recommendations for severe weather are included under the all-hazards topic above.

- Drought:

  - ➢ Promote homeowners planting native and drought-resistant plants that require less water during drier months.
  - ➢ Provide water conservation education to kids in schools.

Press Releases, Media Coverage and Social Media

Press releases were distributed over the course of the MAP's development as key milestones were achieved and prior to each public meeting. Social media was also used to inform members of the public and other stakeholders on the status of the planning process. The planning effort received the following press coverage:

- Oregon Public Broadcasting, June 23, 2015: http://www.opb.org/news/article/portland-works-on-new-natural-hazard-mitigation-plan/
- Portland Tribune, June 22, 2015: http://portlandtribune.com/pt/9-news/264451-137767-city-event-kicks-off-natural-hazard-planning-
- Flash Alert Portland, June 22, 2015
- KOIN 6, July 28, 2015 http://koin.com/2015/07/28/linnton-most-dangerous-area-when-big-one-hits/
- Neighborhood Activist, Neighbors West-Northwest, July 2015
- Southwest Neighborhoods, October 2015, SW News
- Linnton Neighborhood Association Newsletter, March – April 2016
- Southwest Neighborhoods, Inc. August 2016 Newsletter
- KPAM, August 8, 2016, Get Ready

Draft Plan Review and Feedback

After a draft of the MAP was developed, it was presented to the public for review and comment. A 45-day public comment period was held from August 2, 2016 through September 15, 2016, with the following opportunities for comment:

- **Town Hall Events—**During the public review and comment period, five town hall events were held throughout Portland to give residents an opportunity to ask questions about and provide feedback on the draft MAP. Feedback requested from the public was specifically regarding action framing, opportunities to enhance benefits or diminish burdens, accessibility of the hazard maps, and clarification of items in the MAP that are confusing. Four of the meetings were open to the public and were informal open-house events held in city parks in each quadrant of the city. Participants were encouraged to review maps and interact with planning team and PBEM staff to learn about natural hazard risks in their area. The fifth meeting was held with members of the Coalition of Communities of Color, including Portland Voz, the Latino

Network, Native American Youth and Family, and APANO, to discuss the draft plan and how this group's comments from the Planning for Real workshop were included.

- **Other Public Comments—**Stakeholders were also invited to provide comments via email, postal mail, or phone.

In total, 56 comments were received on the draft MAP. These comments were addressed by the planning team in the draft plan as appropriate and/or forwarded to appropriate City bureaus as they were received. All comments were acknowledged by the planning team via email, phone or in person. A detailed list of all comments received is available upon request.

3.7.3 Critical Energy Infrastructure Hub Stakeholder Outreach

In addition to the outreach conducted as part of *The Mitigation Action Plan* development, focused outreach was carried out for a risk assessment of Portland's Critical Energy Infrastructure (CEI) Hub, which was conducted in conjunction with development of the MAP. Two formal stakeholder meetings were held on October 21, 2015 and February 25, 2016. Details on these meetings is provided in the CEI Hub Study (Appendix D). In addition to these formal meetings, additional outreach was conducted as shown in Table 3-5.

Table 3-5. CEI Hub Stakeholder Recruitment and Coordination

Stakeholder	Meeting Date
U.S. Department of Homeland Security	June 25, 2015
U.S. Department of Homeland Security	July 23, 2015
Multnomah County Local Emergency Planning Committee	August 14, 2015
Multnomah County Local Emergency Planning Committee	October 9, 2015
Multnomah County Local Emergency Planning Committee	November 13, 2015
U.S. Department of Homeland Security	December 2, 2015
Multnomah County Local Emergency Planning Committee	December 11, 2015
Oregon Public Health Division Emergency Operations	January 14, 2016
Audubon Society of Portland	April 1, 2016
Linnton Neighborhood Association	April 4, 2016
Hayden Island Neighborhood Association	April 6, 2016
Multnomah County Local Emergency Planning Committee	April 8, 2016

3.8 PLAN DEVELOPMENT CHRONOLOGY/MILESTONES

Table 3-6 summarizes the key milestones in the MAP development process.

Table 3-6. Mitigation Action Plan Development Chronology/Milestones

Date	Event	Description/Objectives	Attendance
2014			
7/08	Grant	PBEM received notice of the award of a Pre-Disaster Mitigation Grant to fund the hazard mitigation plan update.	N/A
2015			
1/26	Project staffing	• Hazard Mitigation Plan Project Coordinator Position Posted	N/A
1/05	Contractor solicitation	• PBEM advertised for contractor support for the plan update	N/A
3/12	Contractor selection	• PBEM selected Tetra Tech to facilitate plan development	N/A
5/4	Project staffing	• Hazard Mitigation Plan Project Coordinator Position filled	N/A
5/29	Internal Kickoff meeting	• Review project timeline • Form the planning team • Develop strategy for external kickoff • Develop strategy for CEI Hub task	4
6/22	External Kickoff meeting	• Introduce project goals • Define mitigation and relevant laws • Introduce the planning team and draft work plan • Offer opportunities to be engaged	37
7/28	1st Steering Committee Meeting	• Introduce the planning team and Steering Committee members • Introduce project goals, timeline and relevant laws • Develop Steering Committee ground rules • Introduce next steps and review action items	47
8/19	2nd Steering Committee Meeting	• Confirm chairpersons, meeting tools, and ground rules • Clarify the purpose of mitigation in emergency management • Review and briefly discuss the OEHR equity training • Perform a public involvement capability brainstorming session • Review plan review comments and discuss document outline • Identify hazards of concern • Introduce next steps and review action items	33
8/10	Equity Training	• OEHR Equity 101 Training	26
9/28	Equity Training	• Natural Hazard Mitigation Focused Equity Training	37
10/21	3rd Steering Committee Meeting	• Confirm steering committee role in planning process • Provide a brief review of equity training take home messages • Review the planning process and work plan • Present planning team recommendations for the risk assessment based on plan review survey • Confirm the hazards of concern • Confirm the hazard scenarios	27
10/21	1st CEI Hub Stakeholders Meeting	• Provide a natural hazard mitigation plan update overview • Describe CEI Hub component • Describe and discuss desired goals and outcomes • Describe stakeholder role in the planning process • Discuss any gaps in stakeholder representation • Describe information needs • Discuss data availability and possible sources • Identify and address data confidentiality and other concerns	22
11/18	4th Steering Committee Meeting	• Present the results of the vision, mission and goals homework survey • Discuss and confirm vision and mission statements • Discuss and confirm goal statements	28

Date	Event	Description/Objectives	Attendance
12/16	5th Steering Committee Meeting	• Present the planning team recommendation for risk reporting areas • Discuss and confirm risk reporting areas • Discuss and provide input on goals for the natural hazard mitigation public questionnaire including: what you would hope to find out, method of dissemination, method of advertisement, target audiences • Present the results of the critical facility homework survey • Discuss and confirm a critical facility definition • Discuss datasets being utilized for database development • Review the vision and mission • Discuss the results of the goals homework survey • Discuss and confirm goals • Introduce objectives development exercise	29
2016			
1/20	6th Steering Committee Meeting	• Present the Planning Team recommendation for objectives • Discuss and confirm objectives • Describe action plan development and introduce our next steps in moving towards action development • Present and discuss the 2010 Progress Report • Introduce and discuss plan implementation and maintenance	31
2/05	Public Engagement	• Natural Hazard Mitigation Survey opens	N/A
2/17	7th Steering Committee Meeting	• Present the general building stock loss estimate matrix • Describe mitigation best practices catalog development • Present and discuss the recommended public engagement plan	24
2/24	Webinar	• Discuss the results of the general building stock and answer questions pertaining to the risk assessment	6
2/25	2nd CEI Hub Stakeholders Meeting	• Review project objectives • Review results of Literature Review • Present Risk Assessment Model results • Identify possible actions for the City to consider for the Hazard Mitigation Plan	14
3/16	8th Steering Committee Meeting	• Present considerations and lessons learned from the Climate Action Plan for incorporating equity into mitigation planning • Set the stage for discussion about issues and action items • Reflect on issues and discuss capabilities that we have and those that we wish we had • Review mitigation best practices catalog • Small group action-storming	28
4/18	1st Planning for Real Workshop	• Northeast and Central Northeast Portland (joint workshop)	14
4/20	9th Steering Committee Meeting	• Present the recommendations from the CEI Hub report • Discuss the CEI Hub report recommendations and answer questions about the report • Present the planning team recommendation for the prioritization strategy • Discuss the strategy and provide recommendations for improvement • Small group action-voting and action-storming	28
4/23	2nd and 3rd Planning for Real Workshops	• Northeast Portland • North/Northwest Portland Central City (joint workshop)	7 and 29
4/24	4th Planning for Real Workshop	• Southeast Portland	42
4/30	5th Planning for Real Workshop	• North Portland	7
5/3	6th Planning for Real Workshop	• Southwest Portland	45

Date	Event	Description/Objectives	Attendance
5/7	7th Planning for Real Workshop	• Coalition of Communities of Color, Native American Youth and Family Center, and Latino Network	8
5/8	Public Engagement	• Survey Data Capture Date	2,970
5/10	8th Planning for Real Workshop	• East Portland	16
5/11	Bureau Action Selection Workshop	• Provide instruction and guidance on action selection	28
5/14	9th Planning for Real Workshop	• Community Engagement Liaisons (CELs) representing Chinese, Zomi, Lao, Bhutanese, Somali, Latino, Iraqi, and Khmer immigrant and refugee communities	12
6/15	10th Steering Committee Meeting	• Present the results of the MAP survey and the Planning for Real Meetings • Present the actions that have been selected by City bureaus and offices and any comments received to date • Receive additional comments on selected action items • Present the Plan Implementation and Maintenance Strategy • Review the next steps of the planning process • Receive feedback on steering committee's continued involvement • Discuss what worked in this planning process, did not work and ideas for improvement.	26
8/2	Start of the Public Comment Period	• Comment period opens and review draft posted online	N/A
8/9	1st Town Hall Meeting	• Coalition of Communities of Color	15
8/16	2nd Town Hall Meeting	• West/Northwest	15
8/17	3rd Town Hall Meeting	• North/Northeast	15
8/23	4th Town Hall Meeting	• East/Southeast	15
8/30	5th Town Hall Meeting	• Southwest	15
9/15	End of the Public Comment Period	• Comment period closes.	N/A
9/30	Plan Submitted to Review Agencies	• Plan submitted to Oregon Office of Emergency Management and FEMA Region X for concurrent review.	N/A
10/19	Plan Adoption	• Plan adopted by Portland City Council	N/A
X/X	Plan Submitted to Review Agencies	• Plan submitted to Insurance Services Office, Inc. for CRS assessment.	N/A
X/X	Final Plan Approval	• Final Plan Approval received by FEMA Region X	N/A

4. City of Portland Profile

The City of Portland is located primarily in Multnomah County in northwest Oregon, with small portions of the city extending into Washington and Clackamas counties (see Figure 4-1). The city covers 145 square miles centered on the Willamette River and its confluence with the Columbia River. Portland is the center of commerce, industry, transportation, finance and services for a metropolitan area of more than 2 million people. It is the largest city in Oregon, the seat of Multnomah County and the second largest city in the Pacific Northwest (after Seattle).

The Columbia River, which separates Oregon from Washington, is the city's northern boundary. Major jurisdictions adjacent to the city are Beaverton, Tigard and unincorporated Washington County to the west, Lake Oswego, Milwaukie, Happy Valley and unincorporated Clackamas County to the south, and Gresham, Fairview and unincorporated Multnomah County to the east. The small city of Maywood Park is an island within the Portland city limits, in the northeastern part of the city.

Major transportation routes through the city are Interstates 5, 84, 205 and 405, U.S. Highways 26 and 30, the Willamette and Columbia Rivers, and several major railroad lines. Portland International Airport is along the Columbia at the northern edge of the city. There are 10 vehicle bridges across the Willamette River in Portland, and two across the Columbia River. Willamette River crossings also include a railroad-only bridge and a new bridge serving only mass transit, bicycles and pedestrians. An aerial tram provides transportation from the South Waterfront area to the Marquam Hill neighborhood.

The city park system includes almost 12,000 acres in developed parks, natural areas, and built acreage (Portland Parks & Recreation, 2016). This includes Forest Park, the largest urban forest in the United States, at over 5,000 acres (Forest Park Conservancy, 2016).

4.1 HISTORICAL OVERVIEW

Portland was platted on the west bank of the Willamette River in 1845 on land that had been used until then by the Multnomah Chinooks. During the 1850s, Portland passed Oregon City to become the largest city in Oregon, a position it has held ever since. In its early decades, Portland depended on trade by water. The California Gold Rush created a market for Oregon wheat and lumber shipped to San Francisco by river and ocean, Willamette River steamboats delivered farm products from the state's agricultural areas, and Columbia River steamers connected to portage railroads to supply miners in Idaho and Montana (Oregon Historical Society, 2016).

Portland experienced further growth with the expansion of the regional railroad system from the 1880s to the 1910s. The Portland-centered rail network expanded with large and small lines opening the mountains in western Oregon and the Columbia Basin interior to logging, ranching, and agriculture. Flour mills, lumber mills, furniture factories, and shipyards lined the Willamette waterfront and major rail corridors. The first three bridges spanned the Willamette River between 1887 and 1891, and by 1906 the number of eastside residents surpassed the number of westside residents (Oregon Historical Society, 2016).

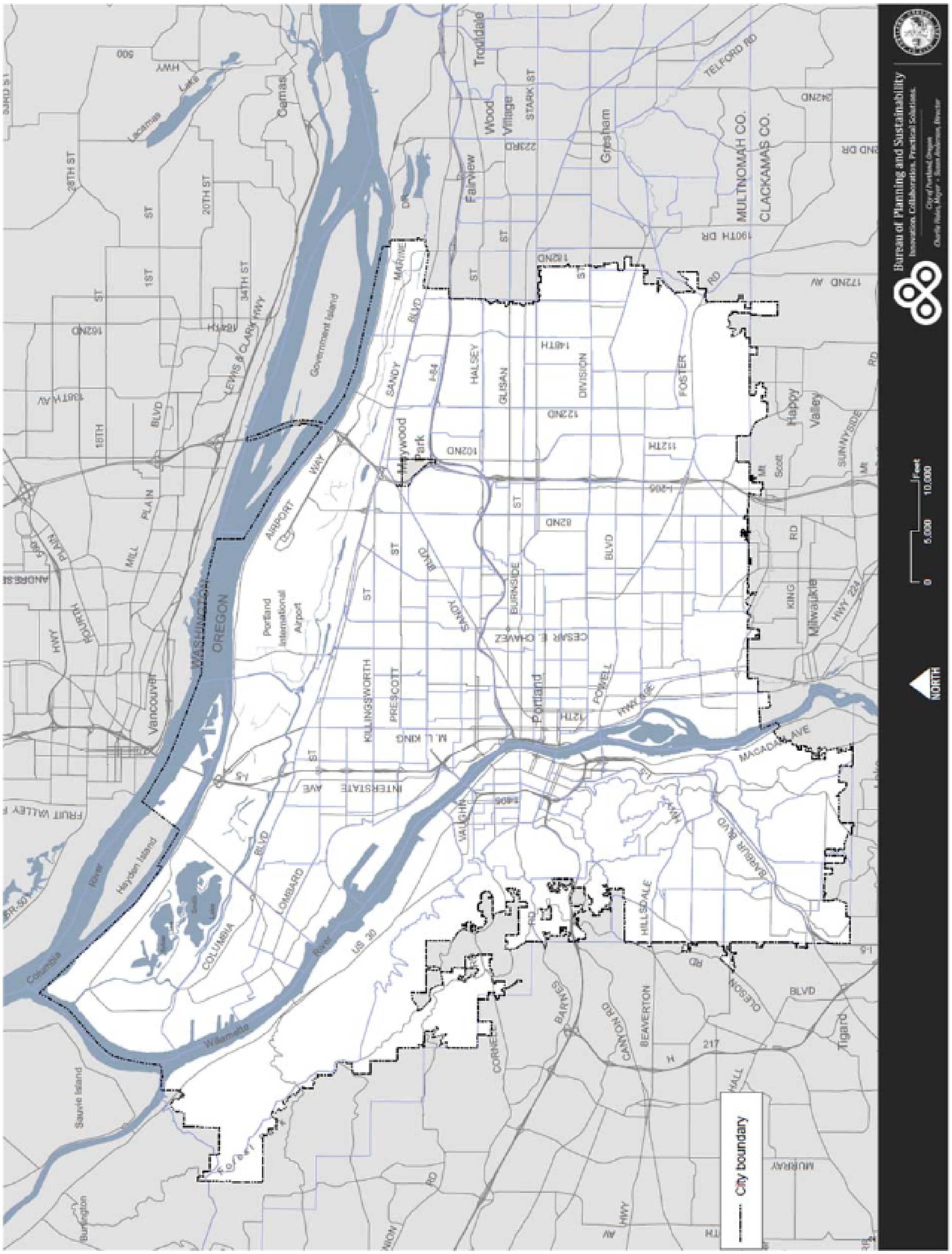


Figure 4-1. Main Features of Portland

Through a practice known as "red-lining" people of color were systematically excluded from living in most areas in Portland. In 1919, and continuing for decades, the Portland Realty Board's Code of Ethics banned members from selling property to people of color, in the interest of protecting property values. Red lines drawn on maps indicated where people of color could live, buy property, or obtain a mortgage. This ultimately concentrated Portland's population of people of color in a small, economically depressed district named Albina. During this time, it was widely known that employment opportunities for people of color were limited to domestic or railroad work. (Portland Housing Bureau, 2016). The effects of this practice can still be seen today, decades after it was declared illegal.

Shipbuilding became a significant local industry with the onset of World War II, with major shipyards on Swan Island and at St. Johns. Portland and Vancouver, Washington produced more than a thousand ocean-going combat and cargo ships from 1941 through 1945. The industry brought about a population boom, including many new African American residents in search of higher-paying jobs in the shipyards. Many newcomers settled in the City of Vanport, which was built in 1942–1943 adjacent to the Columbia River. That community was destroyed by flood in 1948, permanently displacing 18,000 residents, one quarter of whom were African American (Portland Housing Bureau, 2016; Oregon Historical Society, 2016). After the destruction from the flood, the land area making up the City of Vanport was annexed into the City of Portland.

In the late 1960s and 1970s, an expanding electronics industry and growing universities attracted new arrivals, and a new generation of civic activists became involved in city politics. Between 1968 and 1974, Portland leaders opted to replace a multi-lane expressway on the west shore of the Willamette River with what is now Tom McCall Waterfront Park. They also funded the city's first light-rail line, from downtown to Gresham. The Office of Neighborhood Associations was created during this period, and a landmark Downtown Plan was completed (Oregon Historical Society, 2016).

The City of Portland today is the center of a large integrated employment and market region. The U.S. Census Bureau has expanded its definition of the Portland metropolitan area from Multnomah, Washington, and Clackamas Counties in Oregon and Clark County in Washington to include Yamhill County, Columbia County, and Skamania County (Washington). Several public agencies, including Metro (an elected regional government), the Port of Portland, and the Tri-County Metropolitan Transportation District (TriMet) provide services for part or all of the greater Portland area (Oregon Historical Society, 2016).

4.2 PHYSICAL SETTING

4.2.1 Topography and Geology

Portland lies at the northern end of the Willamette River valley, at the Willamette's confluence with the Columbia River. The valley rises to the Coast Range of mountains on the west and to the Cascade Mountains on the east. The Willamette River begins in the Cascade Mountains almost 200 miles south of Portland. From Portland, the Columbia River Gorge flows northwest about 100 miles to the Pacific Ocean. Upstream to the east, the Columbia flows through the Columbia River Gorge, a break across the Cascade Mountains.

Elevations in the city range from about 20 feet above sea level along the Willamette River to over 1,000 feet in the Tualatin Mountains, which are more commonly called the West Hills (NHMP, 2010). The west side of the city is dominated by the West Hills, rising from a narrow terrace along the Willamette River. The east side is flat, with little elevation change except for a few volcanic buttes such as Mt. Tabor and Rocky Butte (Bureau of Environmental Services, 2006).

Soils on the west side of the Willamette River vary from clay loam with low permeability and relatively high erosion potential to gravelly loams, which are relatively well drained and moderately permeable. The flat areas along the west bank of the Willamette River are urban, with highly disturbed soil and unstable fill. On the east side of the Willamette River soils are highly variable, similar to the west side. Much of the area along the Columbia River has been filled with dredged sand, which drains very well. In undisturbed areas along the Columbia River, percolation (water flow through soil) rates are very slow. In the southeast areas of the city, soils vary from moderate to low permeability (NHMP, 2010).

4.2.2 Seismic and Volcanic Features

Most of the Pacific Northwest lies within the Cascadia Subduction Zone, where the Juan de Fuca and North American tectonic plates meet. The convergence of these plates puts most areas from western British Columbia to California at risk for a catastrophic earthquake with a potential magnitude of 9.0 or higher (Modified Mercalli Intensity Scale). Portland lies in this area of risk (NHMP, 2010).

Three major crustal fault lines run through Portland: the Portland fault, the East Bank fault and the Oatfield fault. Each is capable of generating moderately large (6.8) earthquakes (NHMP, 2010).

As a result of the subduction zone, there are active volcanoes nearby, including Mt. St. Helens, Mt. Hood, Mt. Adams and Mt. Jefferson. Major eruptions of these volcanoes may cause significant ash fall in the Portland area (NHMP, 2010).

Portland also lies atop the Boring Volcanic Field, a collection of cones and lava flows formed during one-time eruptive events. These include Mount Tabor, Rocky Butte and Powell Butte in east Portland. All existing Boring Volcanic centers are extinct, and the probability of an eruption in the Portland Metro area is very low (USGS, 2016a).

4.2.3 Surface Waters

The city of Portland lies within the watersheds of five primary surface waters, as described in the sections below.

Columbia Slough

The Columbia Slough Watershed drains an area of 51 square miles. The slough extends from Kelley Point Park on the west to Fairview Lake and Fairview Creek on the east. The watershed boundary includes portions of Portland, Troutdale, Fairview, Gresham, Maywood Park, Wood Village and unincorporated Multnomah County. Over the years, the watershed and waterway have been altered to accommodate industry and agriculture. Beginning in 1918, levees were built to provide flood protection. Wetlands and side channels were drained and filled to allow for development. Waterways were channelized, and dozens of streams were filled or diverted to underground pipes (PBES, 2006).

Today, the Columbia Slough includes an 18-mile main channel and 30 miles of secondary waterways, many ponds and lakes, including the Smith and Bybee Lakes complex near the Slough's confluence with the Willamette. The Upper and Middle Slough elevations and conveyance are managed by the Multnomah County Drainage District. The watershed's designation as an industrial area helps provide nearly 60,000 jobs. It is also the home to almost 160,000 people. Portland's Columbia South Shore Well Field, which supplies supplemental drinking water to a large portion of the region, is also in the Columbia Slough Watershed (PBES, 2006).

Johnson Creek

Johnson Creek originates in Clackamas County and flows west for 25 miles to its confluence with the Willamette River. The watershed covers 54 square miles and includes portions of the cities of Milwaukie, Portland, Gresham, Happy Valley and Multnomah and Clackamas Counties. Crystal Springs Creek and Kelley Creek are Johnson Creek's main tributaries and contribute the largest amount of flow to the main stem. Crystal Springs Creek is fed mostly by cold, clean groundwater from springs on the north side of Johnson Creek. Smaller tributary streams such as Mitchell, Errol, Deardorf, and Wahoo Creeks still flow, but about 38 percent of the watershed's historical tributaries are now piped or diverted to the combined sewer system. The northern watershed is characterized by large, flat floodplains, particularly in Lents neighborhood. The topography south of the main stem, where most of Johnson Creek's tributaries are located, is steep and varied (PBES, 2006).

One of the most significant changes in the watershed occurred in the 1930s when the Works Progress Administration attempted to control flooding by straightening, deepening and rock-lining the creek, creating a trapezoidal channel in 15 of the 25 stream miles. This work substantially altered the creek's ability to dissipate energy and absorb high winter flows. Because of these alterations, steady rainfall and surging stormwater runoff from hard surfaces overwhelm the confined stream channel. As a result, Johnson Creek has flooded 37 times since 1942, and at least seven floods caused major property damage in the last 35 years (PBES, 2006). The Johnson Creek floodplain has undergone substantial restoration in the last decade, after numerous properties in the floodplain were purchased by the City. Over 240 acre-feet of flood storage has been added through floodplain restoration, with a public investment of over $40 million.

Fanno Creek

Fanno Creek flows southwest for about 15 miles from its headwaters in Hillsdale to the Tualatin River near Durham. The Fanno Creek Watershed covers 32 square miles. About 4,529 acres are within the City of Portland. The remaining watershed area is mainly in Washington County. The Fanno Creek Watershed has steep slopes, steep stream gradients, and soils that are slow to infiltrate rain. These characteristics cause relatively high stormwater volumes and velocities, streambank instability and undercutting, erosion, instream sedimentation, and loss of streambank vegetation. More than 80 percent of the Fanno Creek Watershed in Portland is zoned for single-family residential use. The main stem Fanno Creek floodplain area has been cleared of vegetation and filled, reducing historical floodplain interactions and reducing habitat (PBES, 2006).

Tryon Creek

The Tryon Creek Watershed in southwest Portland covers about 6 square miles, about 21 percent of it outside the Portland city limits in Multnomah County, Clackamas County, and the City of Lake Oswego. The watershed is divided into three sub-watersheds: Tryon Creek, Arnold Creek, and Falling Creek. Arnold Creek and Falling Creek are Tryon Creek's main tributaries. Other smaller tributaries flow into Tryon Creek both within and outside Portland's city limits. The main stem of Tryon Creek is about 7 miles long from its headwaters near Multnomah Village (just north of Interstate 5 and Highway 99) to its confluence with the Willamette River in Lake Oswego at the Highway 43 crossing (PBES, 2006).

Significant residential development in the upper watershed above SW Boones Ferry Road has had negative effects on the condition of the watershed. Steep slopes and soils are slow to infiltrate water and increase surface runoff. These characteristics cause relatively high stormwater volumes and velocities, streambank instability and undercutting, erosion, instream sedimentation and loss of streambank vegetation. Residential development, impervious surfaces, and road crossings have severed the creek from its floodplain, decreased habitat and increased stream flow. Tryon Creek State

Natural Area is in the lower watershed, and the riparian area along Tryon Creek is largely intact, providing habitat diversity (PBES, 2006).

Willamette River

Portland's Willamette River Watershed covers about 69 square miles, about 0.5 percent of the river's total drainage basin. It is the most highly urbanized portion of the watershed and is a gateway for migrating salmon to the upper basin. It includes Forest Park, downtown's commercial core, industrial districts on both sides of the river and Portland's most densely populated residential neighborhoods (PBES, 2006).

The watershed is highly urbanized. Its east side is almost completely developed, and the small streams that once crossed the area have been diverted into the sewer system. The steeper slopes in the West Hills developed more slowly, and most of the watershed's remaining open stream channels are on the west side. Development, urban activities and structural changes throughout the watershed have diminished watershed functions and affected hydrology, physical habitat, water quality, and biological communities. Alterations to stream and riverbanks and channels has reduced floodplain functions and increased stream velocities (PBES, 2006).

The volume of water upstream of Portland and the presence there of dams and reservoirs severely constrain the City of Portland's ability to affect the hydrology of the Willamette River. Significant dredging, diking, and channeling of the main stem Willamette and its tributaries have altered habitat conditions. The main stem has been narrowed and deepened for flood control and navigation; off-channel habitat has been virtually eliminated, and the floodplain has been degraded. The river bank has been hardened with retaining walls and riprap, which prevents natural channel changes and minimizes the interaction between the river and riparian and floodplain vegetation (PBES, 2006).

4.2.4 Climate

Portland is in the marine west coast climate zone. The Coast Range helps to shield the Portland area from Pacific Ocean storms. The Cascades offer a steep slope over which moisture-laden westerly winds rise, resulting in moderate rainfall for the region. Precipitation falls mostly as rain, which varies across the Portland metropolitan area. The West Hills receive 60 inches of rain per year, but the airport receives only about 36 inches. The city averages 155 days of measurable precipitation a year. It is not uncommon to see relatively dry summers in Portland. Nearly 90 percent of Portland's annual rainfall occurs between mid-October and mid-May; only about 3 percent occurs in July and August (NOAA, 2016).

Winters can be mild to chilly and very moist, with January averaging 41.4 degrees Fahrenheit (°F). The Cascades generally block colder continental air masses from Canada, although cold air occasionally enters western Oregon through the Columbia River Gorge. Most temperatures during winter reach the 40s and lower 50s during the day and fall into the 30s at night. Temperatures below zero degrees are rare, occurring only six times since 1871. The city's lowest temperature was –3 °F in February 1950. Snow accumulations are not frequent. On average, only four days per year see measurable snow, and rarely more than 2 inches. Snow is most likely in areas above 500 feet or near the Columbia Gorge on Portland's east edge. The average winter snowfall total is 4.3 inches (NOAA, 2016b).

Spring is a transitional season. March and April are often damp and cool, with only a few warm dry days. May and June become drier, with warming weather. Generally, afternoon temperatures warm from the 60s or 70s in May to the 70s or lower 80s in June (NOAA, 2016b).

High pressure over the Pacific builds in the summer, with northwesterly winds prevailing in the afternoons and evenings. This high pressure prevents moisture from flowing into the area, so that summers often are dry and warm. August averages 69.5 °F. Afternoon highs in the 80s occur with regularity beginning in early July. Temperatures above 100 ºF are rare, usually occurring in July or August. The highest recorded temperature is 107 °F, most recently in August 1981 (NOAA, 2016b).

By early to mid- October, fall arrives with high temperatures back into the 60s. As nighttime hours increase, the valley cools more, allowing fog to form on clear nights. Fog can be dense during late night and early morning hours and can persist for several days (NOAA, 2016b).

Destructive storms are rare in Portland. Surface winds seldom exceed gale force (50 mph or greater) and have rarely exceeded 75 mph. Wind speeds average 7.5 mph over the course of a year. Thunderstorms can occur during any month, but are not common. Thunderstorms in winter and spring are weak, producing small hail and brief gusty winds. Those in summer can produce lightning, strong winds and large hail. Occasionally, thunderstorms will produce funnel clouds, but tornadoes are rare (NOAA, 2016b).

On average, the last occurrence of 32 ºF in the spring is March 30; the first of the fall occurs around November 8. First frost of fall is often around October 21, and the last frost of spring is typically near April 26. This makes for a long growing season (NOAA, 2016b).

Average climate conditions at two National Oceanic and Atmospheric Administration (NOAA) weather stations in Portland are shown in Table 4-1 and Table 4-2.

Table 4-1. Downtown Portland Normal Precipitation and Temperatures, 1981 – 2010

		Temperature (ºF)		
	Precipitation (inches)	Minimum	Average	Maximum
January	6.14	37.5	42.2	46.9
February	4.63	38.4	44.6	50.8
March	4.50	41.0	48.5	56.0
April	3.40	44.0	52.4	60.8
May	2.55	48.9	58.1	67.4
June	1.69	53.3	63.1	72.9
July	0.59	57.4	68.5	79.6
August	0.71	58.0	69.0	80.1
September	1.54	54.2	64.4	74.6
October	3.42	47.6	55.2	62.9
November	6.74	41.4	46.7	52.0
December	6.94	36.5	40.8	45.1
Annual	***42.85***	***46.6***	***54.5***	***62.5***

Source: NOAA, 2016.

Table 4-2. Portland International Airport Normal Precipitation and Temperatures, 1981 – 2010

	Precipitation (inches)	Temperature (ºF)		
		Minimum	Average	Maximum
January	4.88	35.8	41.4	47.0
February	3.66	36.3	43.8	51.3
March	3.68	39.6	48.2	56.7
April	2.73	43.1	52.3	61.4
May	2.47	48.6	58.3	68.0
June	1.70	53.6	63.6	73.5
July	0.65	57.8	69.2	80.6
August	0.67	58.0	69.5	81.1
September	1.47	53.1	64.5	75.8
October	3.00	46.0	54.9	63.8
November	5.63	40.5	46.6	52.8
December	5.49	35.2	40.4	45.6
Annual	***36.03***	***45.6***	***54.4***	***63.1***

Source: NOAA, 2016b.

4.3 MAJOR PAST HAZARD EVENTS

Presidential disaster declarations are typically issued for hazard events that cause more damage than state and local governments can handle without assistance from the federal government. Although no specific dollar loss threshold has been established for these declarations, the availability of certain types of funding is limited by the ability to meet federally established damage thresholds. A presidential disaster declaration puts federal recovery programs into motion to help disaster victims, businesses and public entities. Some of the programs are matched by state programs.

FEMA reports presidential disaster declarations by county. Since 1964, 13 such declarations have applied to Multnomah, Washington or Clackamas County. These events are listed in Table 4-3.

Table 4-3. Presidential Disaster Declarations

Disaster Number	Declaration Date	Title	Declared County
DR-4258	2/17/2016	Severe winter storms, straight-line winds, flooding, landslides, and mudslides	Clackamas, Multnomah, Washington
DR-1956	2/17/2011	Severe winter storm, flooding, mudslides, landslides	Clackamas
DR-1824	3/2/2009	Severe winter storm, record and near record snow	Clackamas, Multnomah, Washington
DR-1733	12/8/2007	Severe storms, flooding, landslides, and mudslides	Washington
DR-1632	3/20/2006	Severe storms, flooding, landslides, and mudslides	Clackamas
EM-3228	9/7/2005	Hurricane Katrina evacuation (assistance for evacuees)	Clackamas, Multnomah, Washington
DR-1510	2/19/2004	Severe winter storms	Clackamas, Multnomah
DR-1107	3/19/1996	Severe storms and high winds	Washington
DR-1099	2/9/1996	High winds, severe storms and flooding	Clackamas, Multnomah, Washington
DR-985	4/26/1993	Earthquake	Clackamas, Washington
DR-413	1/25/1974	Severe storms, snowmelt & flooding	Clackamas, Washington
DR-319	1/21/1972	Severe storms & flooding	Clackamas, Multnomah, Washington
DR-184	12/24/1964	Heavy rains & flooding	Clackamas, Multnomah, Washington

Review of these events helps identify targets for risk reduction and ways to increase a community's capability to avoid large-scale events in the future. Still, many natural hazard events do not trigger federal disaster declaration protocol but have significant impacts on their communities. These events are also important to consider in establishing recurrence intervals for hazards of concern.

4.4 REPORTING AREAS

This plan assesses hazard risks for the City of Portland overall and for each of nine smaller areas that make up the city. The areas selected for risk assessment are those used in the City's budget mapping process, which roughly align with neighborhood coalition boundaries (although the central city is treated as a separate area). These risk reporting areas provide linkage to existing financial reporting areas, which is useful because mitigation actions often require financial expenditures. Budget reporting areas exclude the airport, so the airport was added as a separate reporting area for *The Mitigation Action Plan*. Table 4-4 provides summary descriptions of each area. A map of the areas is shown on Figure 4-2.

Table 4-4. Reporting Areas Used for Risk Assessment

Reporting Area	Corresponding Neighborhood Coalition Name	Population (2015)	Jobs (2014)	History	Current Conditions
Airport	None	N/A	N/A	• Mostly annexed 1960s–70s	• Predominantly commercial uses, some light industrial uses • Much of the area is devoted to the Portland International Airport. • There is one small residential area
Central City	Central City	36,087	134,883	• Annexed 1850–1900 • Oldest section of the City	• Smallest, and most densely populated • 34% of the City's jobs • Regional economic and transportation hub • Highest sidewalk coverage • Water and sewer infrastructure is old
Central Northeast	Central Northeast Neighborhood	46,535	27,072	• Annexed 1901–1990 • Largely incorporated by 1910 • Area from NE Prescott to NE Columbia Blvd incorporated after 1980	• Includes industrial lands north of Columbia and Sandy Boulevards • Cully neighborhood was annexed later than the rest of the area and has unimproved and substandard streets and lack of sidewalks.
East Portland	East Portland Neighborhood Office	150,822	48,722	• Mostly annexed in the mid-1980s • At the time of annexation many assets were below City standards	• Largest district in area, 29 square miles • Sewer system is relative new • 25% of the City's residents

Reporting Area	Corresponding Neighborhood Coalition Name	Population (2015)	Jobs (2014)	History	Current Conditions
North Portland	North Portland Neighborhood Services	65,661	38,488	• Annexed 1890–1990 • Inner neighborhoods mostly annexed 1890–1910 • St. Johns annexed by 1920	• Second largest district in area, 27 square miles • Land uses include large open spaces (Smith/Bybee Lakes and Kelly Point Park) and waterfront industrial (private and Port of Portland) • Street network generally meets City's connectivity standards • Water and sewer infrastructure is old
Northeast	Northeast Coalition Neighborhoods	59,723	23,513	• Annexed 1851–1900	• Second most dense district, with few large open spaces • Most inner neighborhoods have no walkable access to green space • Street network generally meets City's connectivity standards • Inner neighborhoods have some of the oldest water infrastructure in the City
Southeast	Southeast Uplift Neighborhood Coalition	153,937	49,487	• Annexed 1891–1990 • Incorporated by 1910, except some areas south of Woodstock Boulevard	• Water and sewer infrastructure is old • Street network generally meets the City's connectivity standards • 75 to 80% of streets have sidewalks • Most inner neighborhoods have no walkable access to green space • 25% of the City's residents
Southwest	Southwest Neighbors, Inc.	66,198	39,958	• Annexed 1891–1990 • Outer neighborhoods annexed in the 1980s	• Many streets are unimproved or unpaved • Most residential streets lack sidewalks • Major arterials follow hilly topography • Streets generally do not meet connectivity standards • Sewer system is relatively new and in good condition • Stormwater system has capacity deficiencies
West/ Northwest	Neighbors West/Northwest	26,815	32,161	• Annexed 1911–1990 • Close-in NW annexed by early 1900s.	• Least dense district, with only 27,000 residents • Forest Park is the largest single use • Home to significant industrial areas along the west bank of Willamette River

Source: Portland City Budget Office, 2016

September 12, 2016

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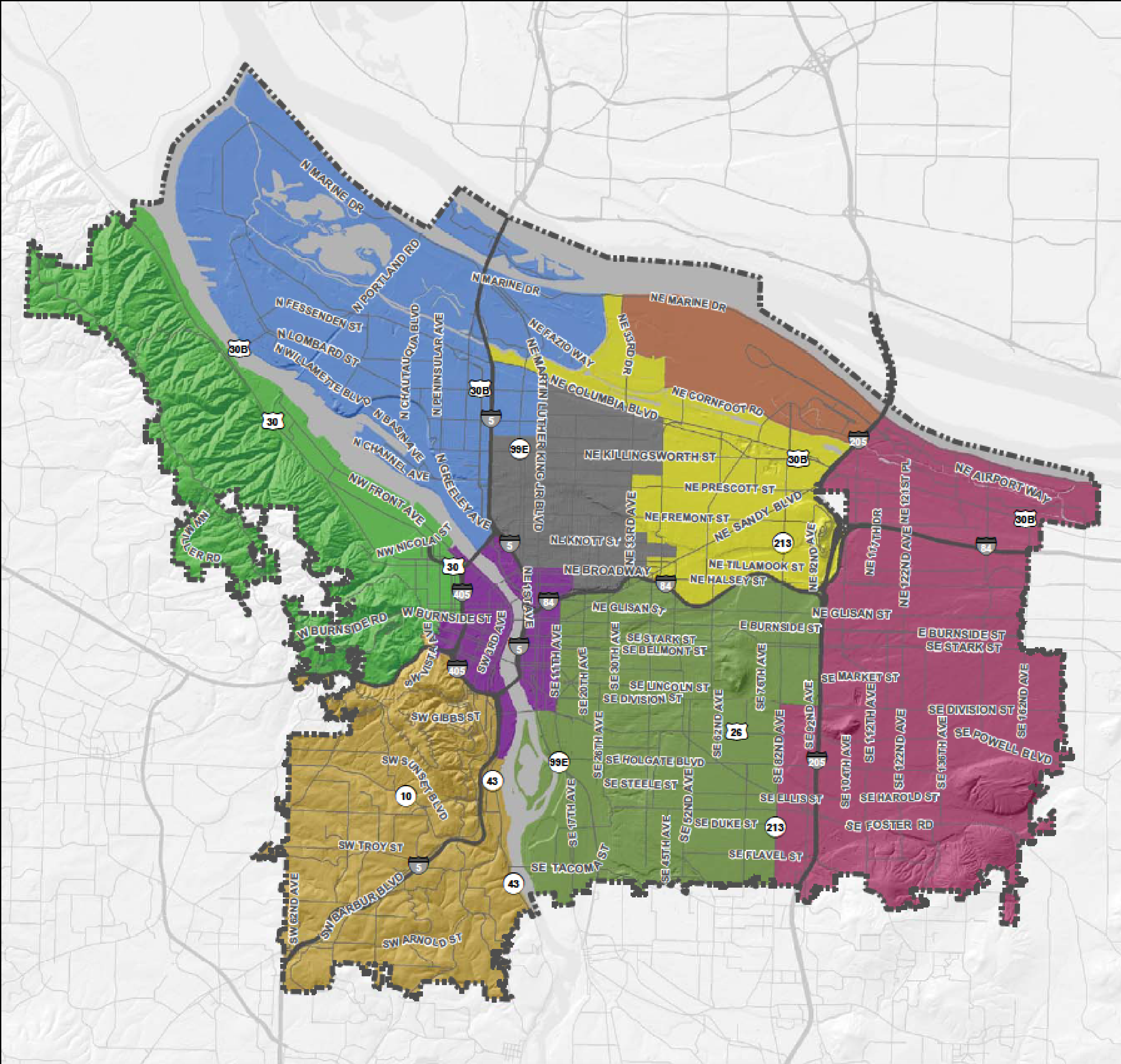
Figure 4-2. Risk Reporting Areas



Legend

City Boundary

Risk Reporting Areas

- Airport
- Central City
- Central Northeast
- East Portland
- West/Northwest
- North Portland
- Northeast
- Southeast
- Southwest

NORTH

0 0.75 1.5 Miles

Source: City of Portland-2016

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4.5 DEVELOPMENT PROFILE

4.5.1 Current Land Use and Zoning

Estimated Land Use

Portland has a total area of 145 square miles, of which 11.66 square miles is water. The City of Portland does not currently have a comprehensive inventory of existing land uses. Table 4-5 shows estimated current land use in the city derived from use descriptions provided in Multnomah County Assessor data. The distribution of land uses within the city will change over time.

Table 4-5. Current Land Use in Portland

Present Use Classification	Area (acres)[a]	% of total
Commercial	12,014	17.3%
Education	1,271	1.8%
Government	914	1.3%
Industrial	6,251	9.0%
Religious	639	0.9%
Residential	31,083	44.7%
Other—Vacant, Open Space, Unknown	17,379	25%
Total	**69,550**	**100%**

a. Area is based on tax lot boundaries and likely excludes public rights-of-way and water bodies.

Building Count

Because an accurate land use inventory is lacking, land use information is analyzed in this plan using building counts as a proxy. Table 4-6 shows the type and distribution of structures throughout Portland. This information is used for each hazard that has a defined spatial extent.

Table 4-6. Structure Type in Portland

	Number of Structures[a]						
	Residential	Commercial	Industrial	Religion	Government	Education	Total
Airport	257	105	170	0	111	0	643
Central City	857	1,587	79	45	64	17	2,649
Central Northeast	16,067	1,100	131	55	24	29	17,406
East Portland	41,422	1,886	97	158	81	111	43,755
North Portland	22,066	1,421	595	257	82	68	24,489
Northeast	19,751	706	22	111	24	66	20,680
Southeast	50,664	2,125	65	215	73	128	53,270
Southwest	22,297	617	21	72	41	76	23,124
West/Northwest	6,278	793	692	18	26	14	7,821
Total	**179,659**	**10,340**	**1,872**	**931**	**526**	**509**	**193,837**

a. Structure type assigned to best-fit present use classification, based on Multnomah County Assessor data. Where conflicting information was available, parcels were assumed to be improved.

4.5.2 Critical Facilities and Infrastructure

Definition and Categories

The 2007 *Critical Infrastructure Protection Plan, Portland/Vancouver Urban Area* presents the following regional definition of critical infrastructure (CH2M Hill, 2007):

> *Publicly and privately controlled systems and assets, including the built and natural environments and human resources, essential to the sustained functioning of the Portland/Vancouver metropolitan area including Clackamas, Columbia, Multnomah and Washington Counties in Oregon and Clark County in Washington. Such systems and assets specifically include those necessary to ensure continuity of security, safety, health and sanitation services, support the area's economy, and/or maintain public confidence. Incapacitation or destruction of any of these systems or assets would have a debilitating impact on the area either directly, through interdependencies, and/or through cascading effects.*

For the MAP, critical facilities and infrastructure were categorized as follows:

- Emergency Services (Emergency Coordination Centers, fire stations, police stations, and medical care facilities)
- Schools
- Transportation Systems
- High Potential Loss Facilities (dams, military facilities, nuclear power plants, hazardous materials)
- Utility Systems:
    - Communications
    - Power
    - Potable water
    - Wastewater
- Other Assets (zoos, jails, nursing/assisted living facilities)

Inventory

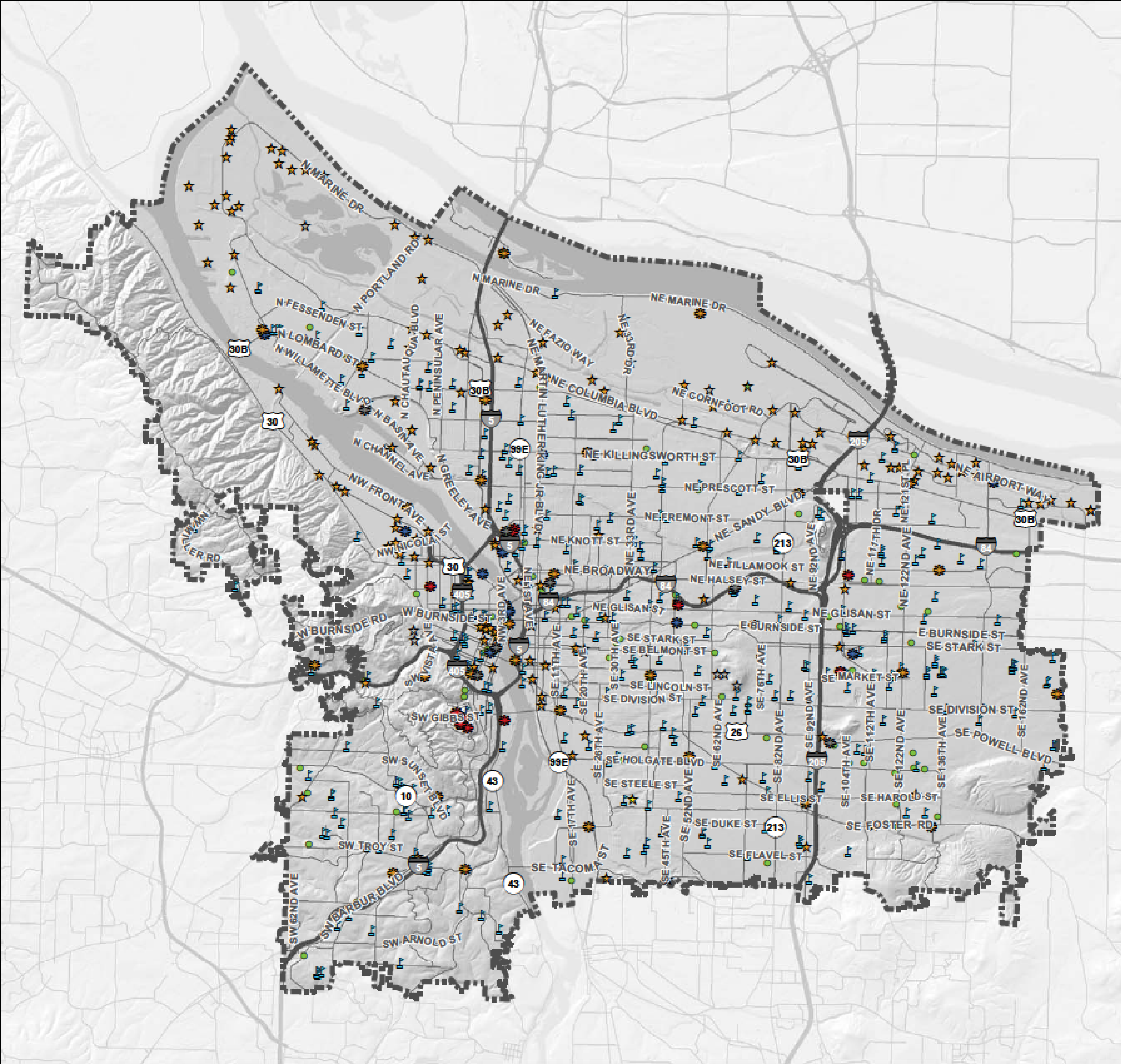
The database was built from the best available data. Additional facilities and infrastructure will be included as new data becomes available. Figure 4-3 and Figure 4-4 show the location of critical facilities and infrastructure in Portland. Due to the sensitivity of this information, a detailed list of facilities is not provided. The list is on file with the City of Portland. Table 4-7 and Table 4-8 provide summaries of the general types of critical facilities and infrastructure, respectively.

The analysis included 75 facilities outside of the city limits. These are facilities owned or operated by the Portland Water Bureau associated with the Bull Run Reservoir. They include three high potential loss facilities and 72 potable water facilities. All point-location critical facilities and infrastructure were analyzed to help rank risk and identify mitigation actions. Linear features, such as roads, pipelines, railroad tracks and levees, are not currently able to be analyzed by the risk assessment model used for this plan. These assets were overlaid with the extent and location of hazard areas as appropriate. Linear asset totals by type are shown in Table 4-9. The linear features not included in the Hazus analysis are not included on Figure 4-3 and Figure 4-4. The risk assessment for each hazard discusses critical facilities.

September 12, 2016

Mitigation Action Plan (MAP)

Figure 4-3. Critical Facilities



Legend

City Boundary

Emergency Services*

- Emergency Coordination Centers
- Fire Station Facilities
- Police Station Facilities
- Medical Care Facilities

High Potential Loss Facilities*

- Dams
- Military
- Nuclear Power Plants
- Hazardous Materials
- Schools
- Other Assets

Zoo, Jails, Nursing/Assisted Living Facilities

*Due to security reasons, some emergency services and high potential loss facilities have been left off of the map.

NORTH

0 0.75 1.5 Miles

Sources: WORD/NID-2015; OSFM-2015; City of Portland-2011, 2015, 2016

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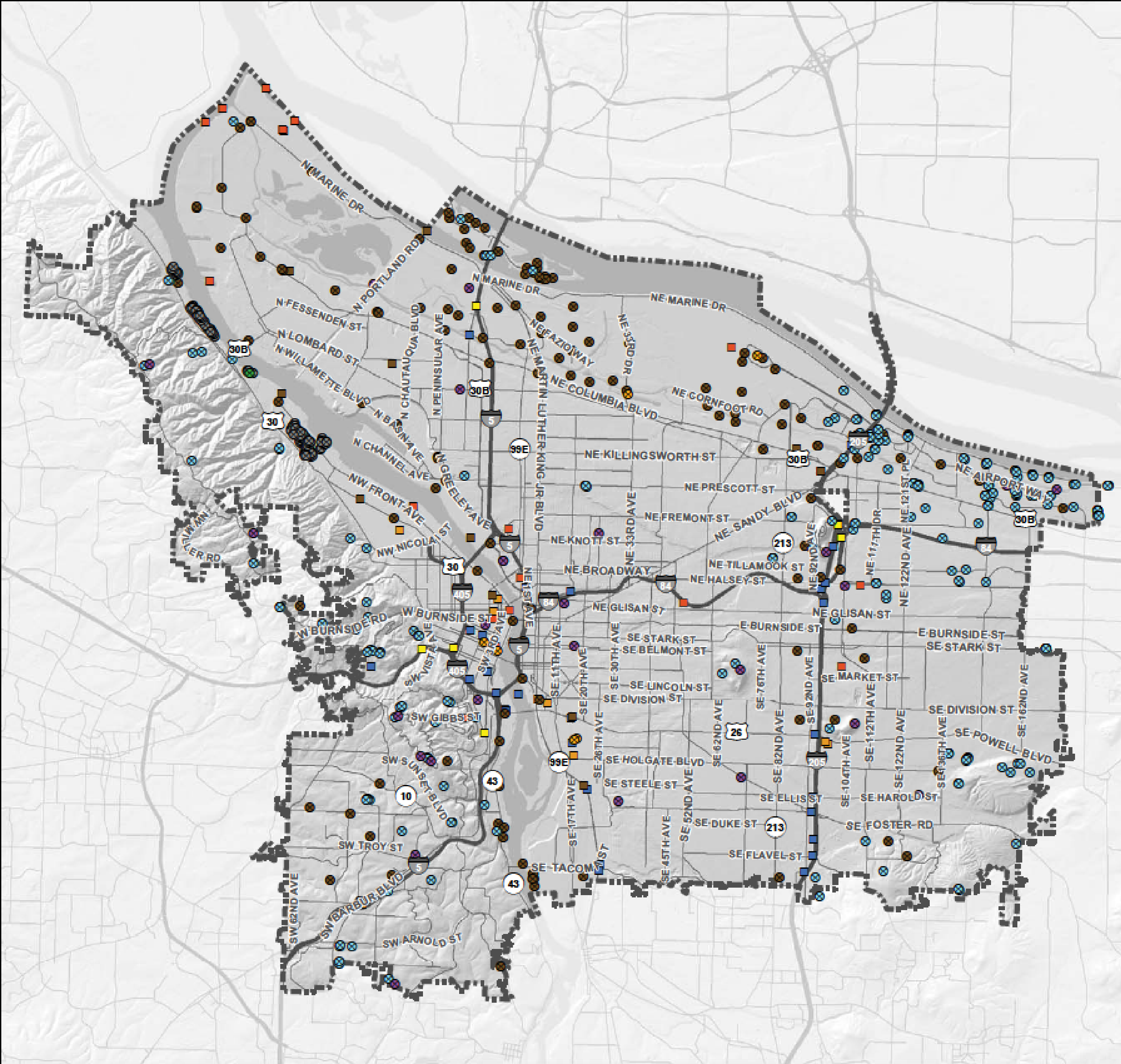

September 12, 2016

Mitigation Action Plan (MAP)

Figure 4-4. Critical Infrastructure

Legend

City Boundary

Utility Systems*

- Electrical
- Natural Gas Facilities
- Communication Facilities
- Petroleum Facilities
- Potable Water Facilities
- Wastewater Facilities

Transportation Systems*

- Railway Tunnels, Bridges, and Facilities
- Light Rail Tunnels, Bridges, and Facilities
- Highway Tunnels and Bridges
- Bus Facilities
- Port and Airport Facilities

*Due to security reasons, some utility and transportation system components have been left off of the map.

NORTH

0 0.75 1.5 Miles

Sources: TriMet-2015; Port of Portland-2015; OPHS-2016; City of Portland-2011, 2015,2016; OPB-2016; PTS-2015; FEMA-2015; Kinder Morgan-2015

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Table 4-7. Portland Critical Facilities

Reporting Area	Number of Critical Facilities: Emergency Services	High Potential Loss Facilities	Schools	Other Assets	Total
Airport	2	9	0	0	**11**
Central City	15	31	29	7	**82**
Central Northeast	2	17	24	3	**46**
East Portland	12	26	73	21	**132**
West/Northwest	6	19	12	2	**39**
North Portland	7	46	27	5	**85**
Northeast	5	3	36	3	**47**
Southeast	8	14	77	18	**117**
Southwest	8	2	45	9	**64**
Outside City Boundary	0	3	0	0	**3**
Total	**65**	**170**	**323**	**68**	**626**

Table 4-8. Portland Critical Infrastructure

Reporting Area	Number of Critical Infrastructure Facilities: Transportation Systems	Utility Systems: Communications	Power	Potable Water	Wastewater	Total
Airport	2	0	5	19	10	**36**
Central City	28	2	11	1	9	**51**
Central Northeast	10	1	8	9	17	**45**
East Portland	11	5	8	173	17	**214**
West/Northwest	8	2	300	25	4	**339**
North Portland	15	3	7	6	63	**94**
Northeast	2	1	8	3	0	**14**
Southeast	11	5	8	2	8	**34**
Southwest	7	6	2	36	12	**63**
Outside City Boundary	0	0	0	72	0	**72**
Total	**94**	**25**	**357**	**346**	**140**	**962**

Table 4-9. Portland Linear Critical Infrastructure

	Infrastructure in Portland
Utility Systems	
Power Lines	476.87 miles
Gas Lines	83.38 miles
Potable Water System Back Bone	146.51 miles
Wastewater System Collection Pipes	2,643.05 miles
Transportation Systems	
Railroads	375.07 miles
Light Rail	52.80 miles
Flood Management Levees	
Levees	20.27 miles

Critical Energy Infrastructure Hub

The City of Portland is a major throughway for oil, gas and electric transmission lines connecting Oregon to California, Washington, and Canada. A significant portion of Portland's energy distribution infrastructure is along a 6-mile stretch of the Willamette River in Northwest Portland between the I-405 Fremont Bridge and Sauvie Island, an area referred to as the Critical Energy Infrastructure Hub (the CEI Hub). The importance of the infrastructure in this hub, as well as the potential risks associated with materials stored there, warrant particular attention for hazard mitigation planning. A separate study was conducted to assess this area's exposure and vulnerability to each of Portland's key hazards of concern. A report summarizing this study is provided in Appendix D. It identifies nine recommendations to improve resilience of the critical infrastructure in the CEI Hub. The recommendations have been incorporated as appropriate into the MAP action plan.

4.5.3 Future Trends in Development

The City of Portland limits new development in known hazard areas through codes and policies. City code outlines hazard-based restrictions on building and development under Title 24 (Building Regulations) and Title 33 (Planning and Zoning). The codes used to evaluate hazard resilience of properties to be developed will be assessed as the MAP is implemented, as will the alignment of mitigation actions in the various projects that address future development.

Portland's 2035 Comprehensive Plan (City of Portland, 2016) guides how and where land will be developed and infrastructure projects will be built to address future growth. The comprehensive plan's five guiding principles include "resilience," which it defines as reducing risk and improving the ability of individuals, communities, economic systems, and the natural and built environments to withstand, recover from, and adapt to changes from natural hazards, human-made disasters, climate change, and economic shifts. The risk assessment and action plan in the MAP, together with the resilience policies in the comprehensive plan, will help ensure that decisions guiding future development consider hazard risks and vulnerability. Future analysis of specific areas conducted during site review and permitting will include greater detail of the environment, demographics, buildings, infrastructure, and hazards. This will aid in a more definitive spatial analysis of buildable land. A study of buildable land inventory is a part of the Comprehensive Plan and hazards are integrated into the analysis.

Goal 7 of Oregon's *Statewide Planning Goals and Guidelines* is to protect people and property from natural hazards. It requires local governments to follow procedures, standards and definitions in statewide planning goals and commission rules to develop programs to achieve this goal. Natural hazards covered by this goal include floods, landslides, earthquakes and related hazards, tsunamis, coastal erosion and wildfires. The Portland Comprehensive Plan includes policies addressing risk related to landslide, wildfire, flooding and earthquake risks. The MAP provides actions that support this Statewide Planning Goal.

Risks to future development are analyzed in this plan for each identified hazard that has a defined spatial extent and location. For hazards that lack this spatial reference, Future land use information based on Comprehensive Plan land use designations is summarized in Table 4-10 by use category for Portland.

Table 4-10. Future Land Use Designations in Portland

Reporting Area	Total Acreage	Percent of total acres: Residential Single-Dwelling	Residential Multi-Dwelling	Commercial	Employment & Industrial	Mixed Use & Institutional	Open Space
Airport	5,309	2.6%	3.8%	0.0%	66.8%	5.0%	21.8%
Central City	2,975	0.0%	6.8%	42.9%	39.0%	0.0%	11.3%
Central Northeast	6,758	43.4%	6.0%	0.0%	31.0%	6.2%	13.4%
East Portland	18,604	50.1%	13.4%	1.2%	12.4%	7.4%	15.5%
North Portland	17,133	19.4%	5.2%	0.0%	44.6%	8.8%	22.1%
Northeast	4,427	65.8%	12.0%	0.0%	4.5%	13.7%	4.0%
Southeast	13,415	58.4%	12.3%	0.0%	4.3%	12.6%	12.4%
Southwest	11,519	65.9%	7.6%	0.0%	0.1%	9.2%	17.2%
West/Northwest	12,699	27.7%	2.8%	0.0%	21.8%	2.5%	45.2%
TOTAL	**92,838**	**40.5%**	**8.2%**	**1.6%**	**21.9%**	**7.8%**	**20.1%**

Source: Future land use categories are based on the proposed comprehensive plan designations as of February 2016.

4.6 POPULATION

Information about population is a critical part of planning because it directly relates to housing, industry, stores, public facilities and services, and transportation. The Population Research Center at Portland State University estimated Portland's population at 613,355 as of July 1, 2015.

4.6.1 Growth

Population changes are useful socio-economic indicators. A growing population generally indicates a growing economy, while a decreasing population signifies economic decline. Figure 4-5 shows the average annual population change from 1990 to 2015 for Portland and the State of Oregon. For both the city and the state, high growth rates in the 1990s dropped significantly in the 2000s and the first few years of the 2010s. Higher growth rates have since returned, and in Portland the 2014–2015 rate of 1.97 percent was greater than the 1.89-percent annual average of the 1990s. Table 4-11 shows the population in Portland since 1990 (PSU, 2016).

Source: PSU, 2016

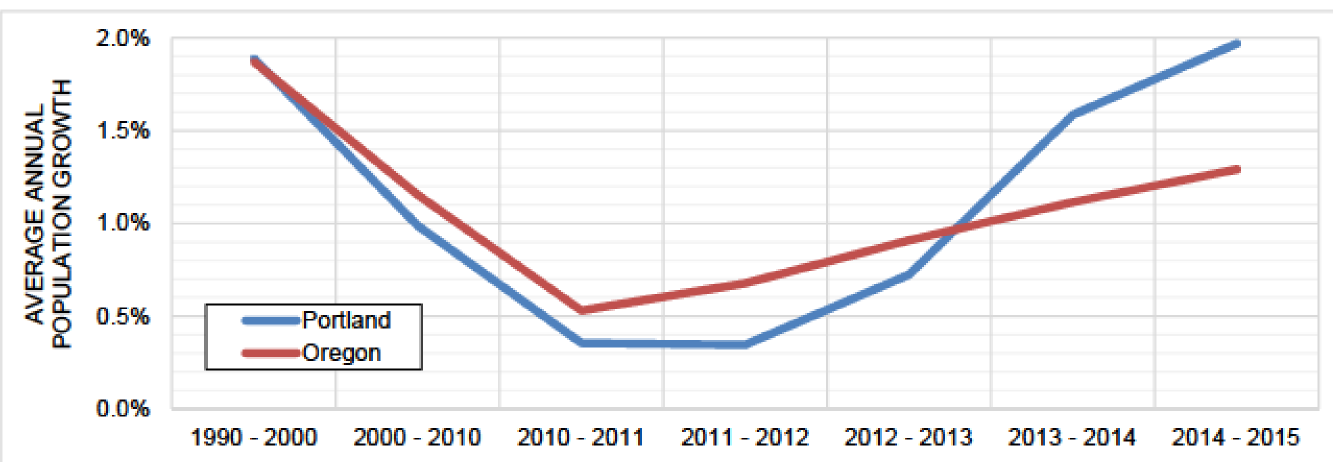


Figure 4-5. Oregon and City of Portland Population Growth

Table 4-11. Annual Population Data

Year	Population	Year	Population
1990	438,802	2012	587,865
2000	529,121	2013	592,120
2010	583,775	2014	601,510
2011	585,845	2015	613,355

Source: PSU, 2016

4.6.2 Age Distribution

The overall age distribution for Portland is illustrated in Figure 4-6. Based on U.S. Census data estimates, 11 percent of Portland's population is 65 or older, compared to the state average of 15 percent. According to U.S. Census data, 38.5 percent of the over-65 population has disabilities of some kind and 11.4 percent have incomes below the poverty line. Among children under 18 years old, 23.7 percent live below the poverty line. It is also estimated that 16 percent of the population is under 15 years old, compared to the state average of 18.2 percent.

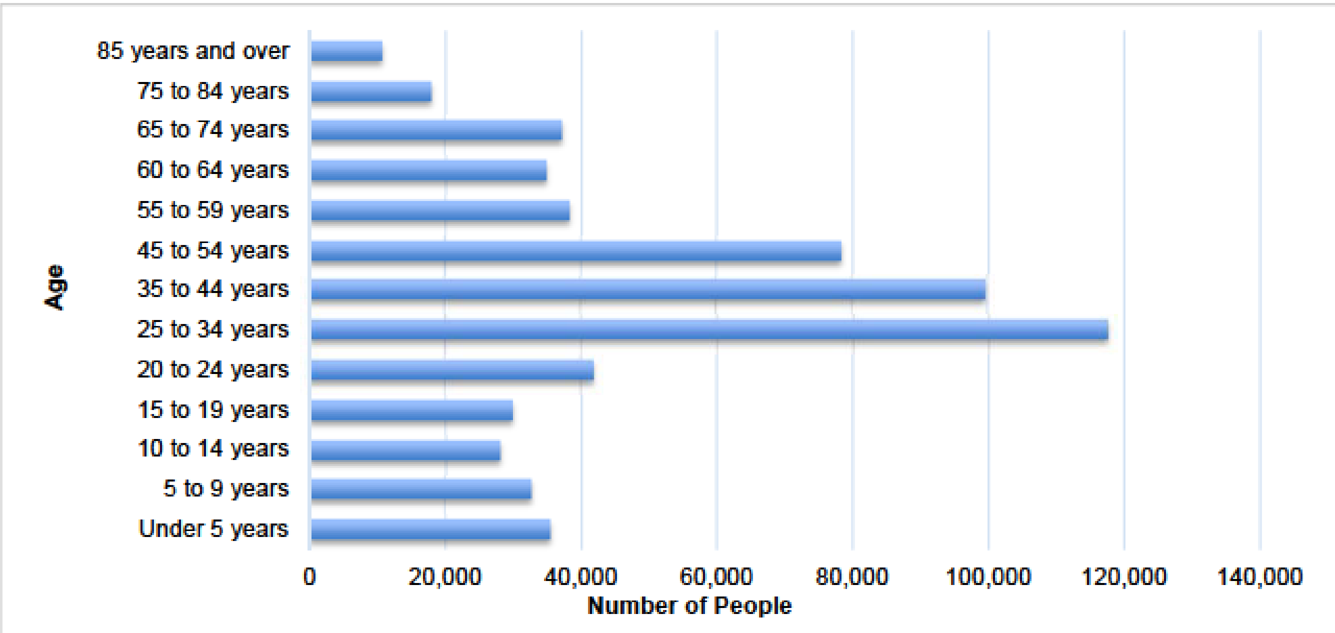


Figure 4-6. Portland Age Distribution

4.6.3 Race and Ethnicity

According to the U.S. Census, the racial composition of Portland is predominantly white, at about 77.3 percent. The largest minority populations are Asian at 7.5 percent and African American at 6.1 percent. Figure 4-7 shows the racial distribution in Portland.

Portland has a 14-percent foreign-born population. Other than English, the most commonly spoken language is Spanish. Portland has identified nine other "safe harbor" languages, defined as those that are spoken as a primary language by at least 1,000 people in Portland with limited English proficiency. They are Vietnamese, Chinese, Russian, Romanian, Ukrainian, Japanese, Somali, and Arabic, and Laotian (Lao communities are just under the 1,000-person threshold) (OEHR, n.d.a). The census estimates 8.9 percent of residents speak English "less than very well."

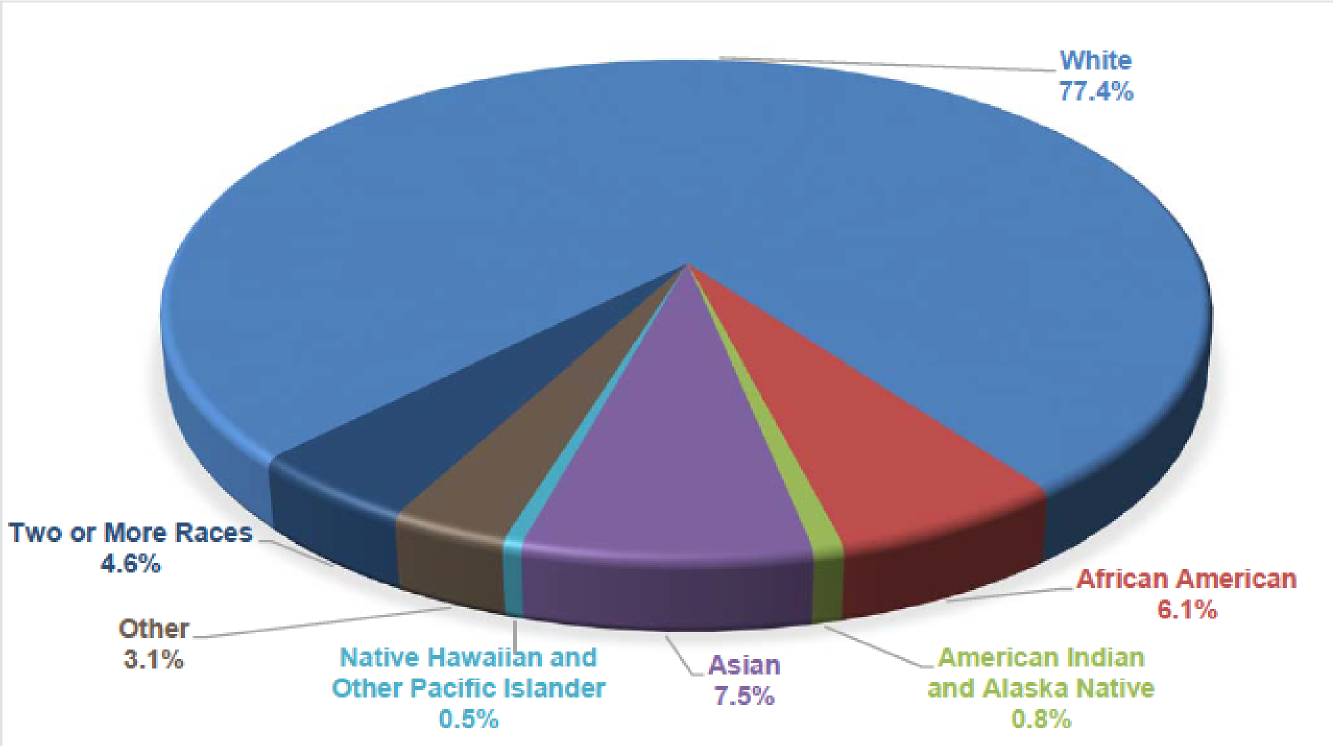


Figure 4-7. Portland Race Distribution

4.7 SOCIAL VULNERABILITY AND HAZARD MITIGATION

Hazard research has firmly established the importance of tailoring local hazard mitigation and emergency response policies to the needs of the community they serve. Vulnerability to natural hazard events arises out of the social and economic circumstances of everyday life (Morrow, 1999). Recent disasters such as Hurricane Katrina and Superstorm Sandy illustrated differences in impacts among different sections of the population, such as the poor, the elderly, immigrants, racial minorities, single-parent-headed households, and recent residents. These population groups are more vulnerable due to lack of material, economic, and political resources.

Identification and recognition of the spatial distribution of these groups is critical for formulating an effective hazard mitigation policy to build long-term community resilience. A social vulnerability lens is a valuable tool because it highlights where vulnerable groups are located within the community. This knowledge results in better hazard mitigation policies and improves the likelihood of achieving desired outcomes because many hazards of concern occur in defined locations.

4.7.1 Understanding Social Vulnerability

A number of broad contextual factors influence a person or household's vulnerability to a given hazard:

- Lack of material and financial resources to prepare for and recover from a hazard event
- Lack of access to information and knowledge required to respond to a hazard event
- Beliefs and norms
- Weak residential structures
- Poor access to infrastructure and lifelines.

Social vulnerability assessment is an innovative and useful way to identify spatial distribution of groups that are likely to suffer disproportionately in case of a hazard event, so that mitigation and capacity-building policies can be directed to these neighborhoods in order to minimize negative impacts of hazard events. Social vulnerability is defined as follows for hazard mitigation (Blaikie et al., 1994):

> "The characteristics of a person or group in terms of their capacity to anticipate, cope with, resist and recover from the impacts of a natural hazard. It involves a combination of factors that determine the degree to which someone's life and livelihood are put at risk."

Vulnerable groups are characterized by demographic and socio-economic conditions such as race, income or employment status (Blaikie et al., 1994; Hewitt, 1997; Tobin and Montz, 1997). Social vulnerability is an outcome of complex interactions between social factors that influence inequality, as well as elements of the built environment that contribute to vulnerability (houses, roads, utilities, etc.). Researchers have studied various dimensions of social vulnerability:

- Race/ethnicity:
  - Bolin 1986; Bolin and Bolton 1986
  - Perry and Mushkatel 1986
  - Peacock et al 1997
  - Bolin and Stanford 1998
  - Fothergill, Maestas, and Darlington 1999
  - Lindell and Perry 2004
- Economic status factors such as class, income, and poverty:
  - Peacock et al 1997
  - Dash et al 1997
  - Fothergill and Peek 2004
- The degree of urbanization and the quality of housing:
  - Cutter, Boruff and Shirley 2003
- Gender:
  - Enarson and Morrow 1997
  - Enarson and Morrow 1998
  - Fothergill 1999
- A host of other factors such as age, education, religion, etc.

Based on these studies, the following have been identified as key dimensions of social vulnerability:

- Income
- Gender
- Race, ethnicity
- Age
- Unemployment, dependence on social services
- Renting as opposed to owning a home
- Infrastructure lifelines
- Occupation/working conditions
- Family structures
- Educational attainment level
- Disabilities or access and functional needs.

While these factors have been identified with social vulnerability in general, demographic characteristics do not cause every person within a group to be more vulnerable to natural hazard events. Individuals with the identified demographic characteristics may have the resources needed to prepare for or respond to an emergency situation. The ability to avoid, withstand, cope with, respond to and recover from a disaster is an outcome of a host of internal and external characteristics, often shaped by circumstances beyond an individual's control. No group should be viewed as a victim group or a rescue group.

4.7.2 Demographic Indicators for Social Vulnerability Risk Assessment

Indicators are measures of abstract concepts, such as social vulnerability, that allow comparisons to be made across levels of assessment. To assess social vulnerability, it is common to use indicators from data that is collected during the decadal census and/or the U.S. Census Bureau's American Community Survey. For the social vulnerability component of the risk assessment for the MAP, the following indicators were selected:

- **Population Under 15 Years of Age—**Children, especially in the youngest age groups, often cannot protect themselves during a disaster because they lack the necessary resources, knowledge, or life experiences to effectively cope with the situation. Hazard mitigation planning needs to be tailored to ensure that the community is prepared to ensure that children are safe during disaster events, and that families with children have access to necessary information and tools.
- **Population Over 65 years of Age—**Persons aged 65 years and older are likely to require financial support, transportation, medical care, or assistance with ordinary daily activities, especially during disasters. Hazard mitigation activities need to account for such needs.
- **Renter Occupied Housing Units—**People who rent often do so because they do not have the financial resources for home ownership. They often lack access to information about financial aid during recovery. In the most extreme cases, renters lack sufficient shelter options when lodging becomes uninhabitable and limited supply causes housing costs to rise dramatically after a disaster. Renters commonly have limited opportunities for implementing mitigation measures at their home, and may not have insurance to cover their personal property. Additionally, renters may not be aware of hazard risks at the property. Hazard mitigation planning needs to explore ways to ensure that renters are aware of risks and opportunities available to them to mitigate known risks.
- **People of color—**Social and economic marginalization of certain racial and ethnic groups, including real estate discrimination, has resulted in greater vulnerability of these groups to all types of hazards. Based on data from a number of studies, African Americans, Native Americans, and populations of Asian, Pacific Islander, or Hispanic origin are likely to be more vulnerable than the broader community. These groups often have limited knowledge of local risks and modes of risk communication, have limited capacity to respond, and are likely to face major hurdles in navigating procedures to receive aid and assistance in a disaster event. Hazard mitigation plans need to identify the spatial distribution of these population groups and direct resources to reduce their vulnerability to hazards.
- **Families below the Poverty Level—**Economically disadvantaged families have limited ability to absorb losses due to hazard impacts. Wealth enables families to absorb and recover from losses more quickly, due to insurance and often the availability of low-cost credit. People with lower incomes tend not to have access to these resources. At the same time, poorer families are likely to inhabit poor quality housing and reside in locations that are most vulnerable to hazard events. Economically disadvantaged neighborhoods are also likely to have relatively

poor infrastructure and facilities, which exacerbate the disaster consequences for residents there.

- **Limited English Speaking Households**—Many households, specifically immigrants, are not fluent in English. For populations with limited English proficiency, disaster communication is difficult. This difficulty is especially true in communities whose first language is neither English nor Spanish and for whom translators and accurate translations of advisories may be scarce. Such households are likely to rely on relatives and local social networks (i.e., friends and neighbors) for information for preparing for a disaster event.
- **Persons with Disabilities**—Persons with disabilities or others with access and functional needs are more likely to have difficulty responding to a hazard event than the general population. Family, neighbors, and local government are the first level of response to assist these individuals, and coordination of efforts to meet their access and functional needs is paramount to life safety efforts. It is important for emergency managers to distinguish between functional and medical needs in order to plan for incidents that require evacuation and sheltering. Knowing the percentage of population with a disability allows emergency management personnel and first responders to understand and anticipate the services needed by those with access and functional needs.

These factors were selected based on factors likely to influence vulnerability, the equity priorities established by the City, and the availability of datasets at a small enough resolution to determine probable characteristics of populations within identified hazard areas. Table 4-12 summarizes the distribution of these social vulnerability indicators by risk-reporting area.

Table 4-12. Distribution of Social Vulnerability Indicators in Reporting Areas

	Percent of Total Population Included in the Indicator Group[a, b]							
							Persons with Disabilities[c]	
Reporting Area	Population Under 15	Population Over 65	Renter Occupied Housing Units	People of Color	Families Below Poverty Level	Limited English Speaking Households	Total Population	Population Under 65[d]
Airport	5.4%	5.1%	68.8%	31.8%	19.8%	20.6%	12.1%	9%
Central City	2.2%	10.1%	83.7%	20.9%	10.6%	3.9%	12.1%	9%
Central Northeast	18.1%	10.3%	35.1%	23.6%	11.7%	4.3%	12.1%	9%
East Portland	21.0%	12.7%	44.5%	30.4%	18.0%	10.2%	12.1%	9%
North Portland	17.1%	8.5%	39.4%	27.8%	14.9%	3.2%	12.1%	9%
Northeast	15.3%	9.1%	45.0%	24.2%	8.5%	0.9%	12.1%	9%
Southeast	14.0%	10.3%	47.4%	16.8%	9.9%	3.2%	12.1%	9%
Southwest	14.7%	14.0%	38.5%	12.6%	4.8%	1.3%	12.1%	9%
West/Northwest	11.4%	12.6%	53.0%	17.1%	4.6%	2.0%	12.1%	9%
Citywide	**16.2%**	**11.2%**	**45.8%**	**22.4%**	**11.7%**	**4.3%**	12.1%	9%

a. These estimates were made using the best available data (American Community Survey estimates), which does not correspond with hazard risk areas. It is expected that there is a degree of over- or under-estimation in these estimates, but they are adequate for planning purposes.

b. Red text fields indicate reporting area values at least 2 percent higher than the citywide average for that indicator.

c. The smallest level of unit for persons with disabilities is the census tract scale, which is not conducive to analysis by hazard extent and location; therefore, it is assumed that the population is evenly distributed in all reporting areas.

d. Percentage of persons with disabilities in the under-65 population is shown to distinguish this indicator from the over-65 indicator; much of the vulnerability of the over-65 population is associated with disabilities.

4.8 ECONOMY

4.8.1 Income

Other than in extreme circumstances, individual households in the United States prepare for, respond to and recover from disasters on their own. This means that households living in poverty are automatically disadvantaged when confronting hazards. Additionally, the poor typically occupy more poorly built and inadequately maintained housing. Mobile or modular homes, for example, are more susceptible to damage in earthquakes and floods than other types of housing. In urban areas, the poor often live in older houses and apartment complexes, which are more likely to be made of un-reinforced masonry, a building type that is particularly susceptible to damage during earthquakes. Furthermore, residents below the federal poverty level are less likely to have insurance to compensate for losses incurred from natural disasters. This means that residents below the poverty level have a great deal to lose during an event and are the least prepared to deal with potential losses. Personal household economics significantly impact people's decisions on evacuation. Individuals who cannot afford gas for their cars often decide not to evacuate. Table 4-13 summarizes recent income data from the U.S. Census Bureau for Portland and for the State of Oregon.

Table 4-13. 2014 Income Data for Portland and Oregon

	Portland	Oregon
2014 Per Capita Income	$32,438	$27,173
2014 Median Household Income	$52,230	$50,521
% of Households with Income of $100,000 or More	23%	20%
% of Households with Income Below $50,000	48%	49%
% of Residents with 2013-2014 Income Below the Poverty Level	18%	17%
% of Families with 2013-2014 Income Below the Poverty Level	12%	12%

Source: U.S. Census, 2016a

4.8.2 Industry, Businesses and Institutions

Portland's economy has slowly diversified over the past decades. Steady growth in nontraditional sectors, such as the manufacture of electrical equipment, instruments and related products, has helped Portland's economy adapt to national and global trends.

The Port of Portland, which is responsible for air and marine port facilities, offers opportunities for expanding export industries, investments, business and travel:

- Portland's location on the Columbia River gives it advantages for freight shipping. The Columbia River navigation channel begins at the Columbia River bar and continues 5 miles upriver at a depth of 55 feet and a width of 2,640 feet. From there, it maintains a depth of 43 feet and a width of 600 feet for 100 miles to the Portland Harbor (Port of Portland, 2016a)
- The Port also manages Portland International Airport, which is served by 19 passenger carriers and eight air-cargo carriers. In 2015, the airport provided 185,000 commercial flights and served nearly 17 million passengers (Port of Portland, 2016b).

The city's economy is strongly based in the educational services, health care, and social assistance industry (25.3 percent), followed by the professional-scientific-management industry (13.7 percent) and arts-entertainment-recreation (11.7 percent) Figure 4-8 shows the breakdown of industry types in Portland.

Source: U.S. Census, 2016a

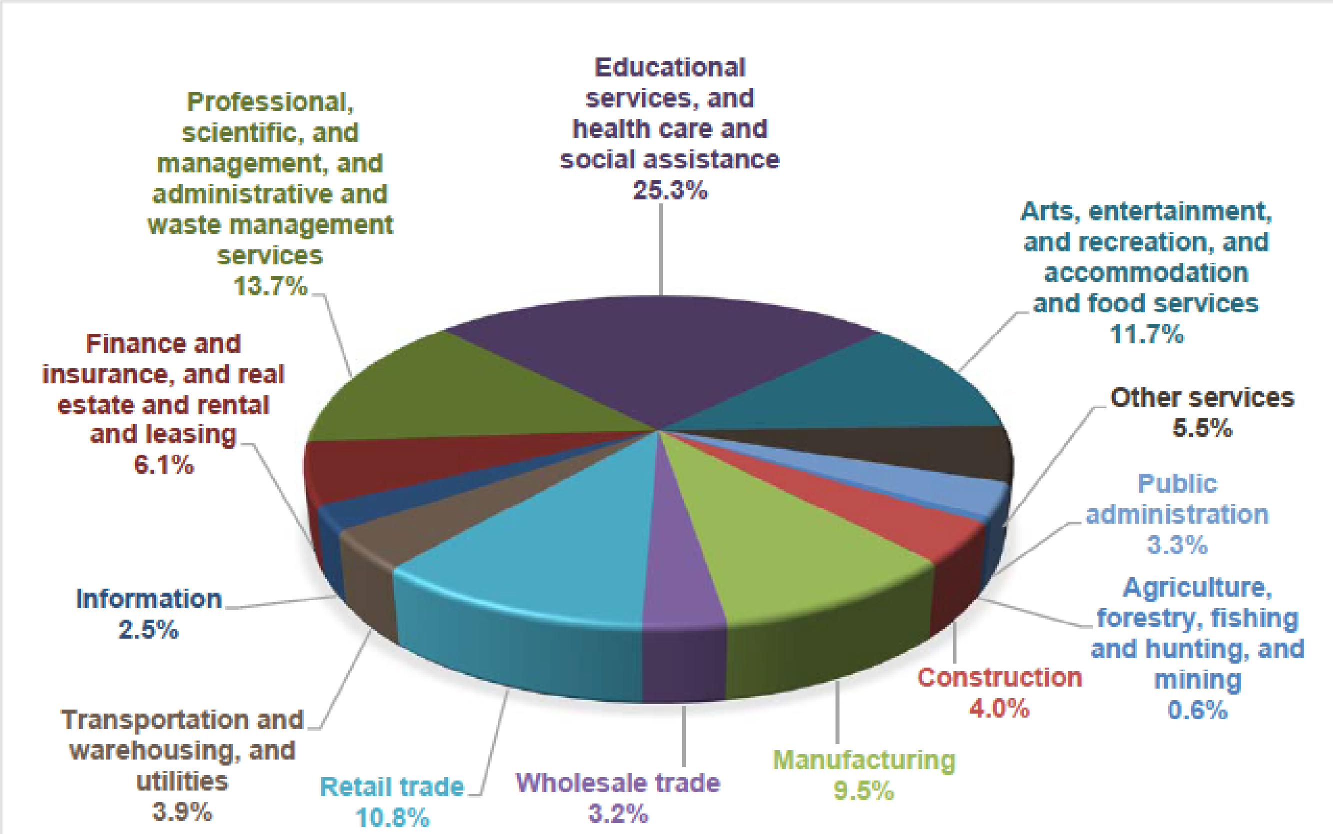


Figure 4-8. Industry in Portland

Semiconductor manufacturers, such as Intel and Siltronic, have established major facilities in the region. Other major private sector employers in the Portland metropolitan area include Tektronix, Nike, health systems Providence, Kaiser Permanente and Legacy, and retailers Safeway, Albertsons and Fred Meyer. Major public employers include Oregon Health and Science University (OHSU) and Portland State University (NHMP, 2010).

4.8.3 Employment Trends and Occupations

According to the American Community Survey, 69.4 percent of Portland's 16-and-older population is in the labor force—65.6 percent of women and 73.4 percent of men (U.S. Census, 2016a). Unemployment in the Portland-Vancouver-Hillsboro metropolitan area as estimated to be 4.4 percent in April 2016, a 0.8-percent decrease from one year earlier. That decrease ranked the area eighth nationally for year-over-year improvement in unemployment. Figure 4-9 compares Oregon's and the Multnomah County's unemployment trends from 2004 through 2014. The county's unemployment rate has generally been slightly below that of the state, though both have followed similar trends through the 2007–2009 recession and subsequent recovery (U.S. BLS, 2016).

Of the five occupation categories defined by the U.S. Census, the highest employment in Portland is in the management, business, science and arts occupation, and the lowest is in the natural resources, construction and maintenance occupation. As shown on Figure 4-10, employment since 2000 has been increasing in the management, business, science, and arts occupation and the service occupation, and decreasing in other occupation classes.

Source: BLS, 2016

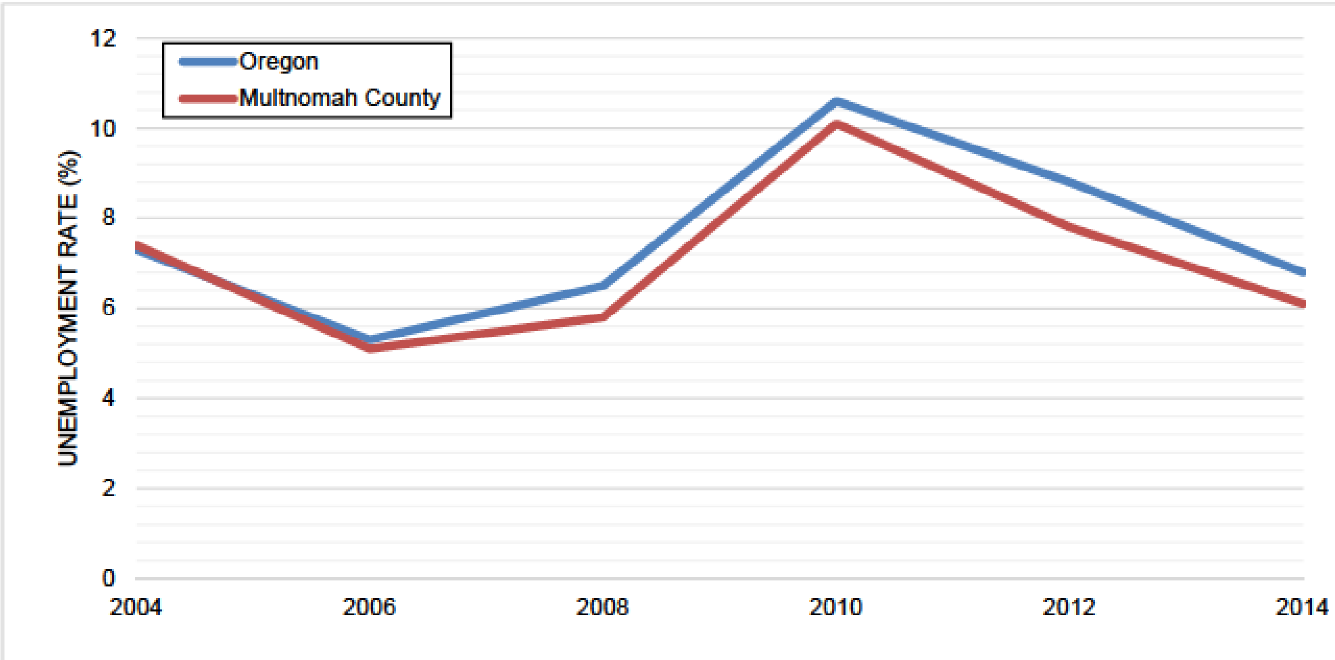


Figure 4-9. Oregon and Multnomah County Unemployment Rate

Sources: PBEM, 2010; U.S. Census Bureau, 2016a

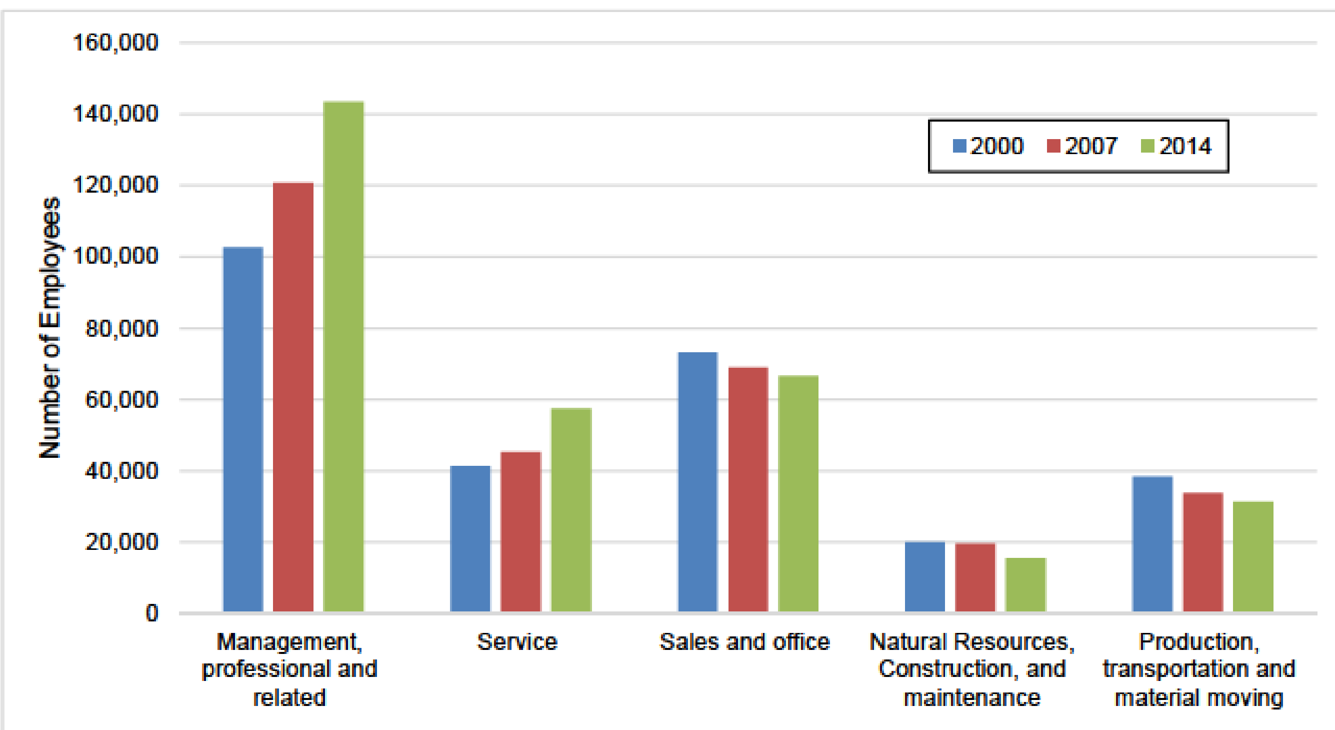


Figure 4-10. Occupations in Portland

The *City of Portland Economic Opportunities Analysis* summarizes key recent trends in city employment, including the following (E.D. Hovee & Company, LLC, 2016):

- In 2013, there were 393,742 jobs in Portland, 38 percent of all jobs in the seven-county metropolitan area.
- From 1980 to 2008, Multnomah County added 114,800 new jobs, a 1.1-percent average annual growth rate and 25 percent of the total metropolitan area job growth.
- From 2000 to 2008, Portland employment increased by 3,120 jobs—an annual average job growth of only 0.1 percent, and 5 percent of the total metropolitan area job growth.
- From 2008 to 2013, Portland had average annual job growth of 1.3 percent—23 percent of the total metropolitan area job growth.
- From 2000 to 2008, manufacturing jobs in the city declined by 3.3 percent per year. Retail jobs also declined. Employment in education and health care sectors increased at an average of 2.3 percent per year.
- Portland's geographic distribution of employment as of 2008 was as follows:
    - 27 percent in the Central City commercial areas
    - 5 percent in regional and town centers (or urban centers)
    - 18 percent in neighborhood commercial areas
    - 30 percent in industrial districts
    - 10 percent each in institutional and residential areas

The U.S. Census estimates that 58 percent of workers in Portland commute alone (by car, truck or van) to work, and mean travel time to work is 24.7 minutes (U.S. Census Bureau, 2016a).

4.9 LAWS, ORDINANCES AND PROGRAMS

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

4.9.1 Federal

Disaster Mitigation Act

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

Americans with Disabilities Act

The Americans with Disabilities Act (ADA) seeks to prevent discrimination against people with disabilities in employment, transportation, public accommodation, communications, and government activities. Title II of the ADA deals with compliance with the Act in emergency management and disaster-related programs, services, and activities. It applies to state and local governments as well as third parties, including religious entities and private nonprofit organizations.

The ADA has implications for sheltering requirements and public notifications. During an emergency alert, officials must use a combination of warning methods to ensure that all residents have all necessary information. Those with hearing impairments may not hear radio, television, sirens, or other audible alerts, while those with visual impairments may not see flashing lights or other visual alerts. Two technical documents for shelter operators address physical accessibility needs of people with disabilities, as well as medical needs and service animals.

The ADA intersects with disaster preparedness programs in regards to transportation, social services, temporary housing, and rebuilding. Persons with disabilities may require additional assistance in evacuation and transit (e.g., vehicles with wheelchair lifts or paratransit buses). Evacuation and other response plans should address the unique needs of residents. Local governments may be interested in implementing a special-needs registry to identify the home addresses, contact information, and needs for residents who may require more assistance.

Clean Water Act

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

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

The CWA is important to hazard mitigation in several ways. There are often permitting requirements for any construction within 200 feet of water of the United States, which may have implications for mitigation projects identified by a local jurisdiction. Additionally, CWA requirements apply to wetlands, which serve important functions related to preserving and protecting the natural and beneficial functions of floodplains and are linked with a community's floodplain management program. Finally, the National Pollutant Discharge Elimination System is part of the CWA and addresses local stormwater management programs. Stormwater management plays a critical role in hazard mitigation by addressing urban drainage or localized flooding issues within jurisdictions. In the State of Oregon, the Department of Environmental Quality (DEQ) develops and administers National Pollutant Discharge Elimination System municipal stormwater permits. The Portland Group permit was reissued on January 31, 2011. Both the Port of Portland and City of Portland have Stormwater Management Plans under this permit.

Community Development Block Grant Disaster Resilience Program

In response to disasters, Congress may appropriate additional funding for the U.S. Department of Housing and Urban Development Community Development Block Grant programs to be distributed as Disaster Recovery grants (CDBG-DR). These grants can be used to rebuild affected areas and provide seed money to start the recovery process. CDBG-DR assistance may fund a broad range of recovery activities, helping communities and neighborhoods that otherwise might not recover due to limited resources. CDBG-DR grants often supplement disaster programs of the Federal Emergency Management Agency, the Small Business Administration, and the U.S. Army Corps of Engineers. Housing and Urban Development generally awards noncompetitive, nonrecurring CDBG-DR grants by a formula that considers disaster recovery needs unmet by other federal disaster assistance programs. To be eligible for CDBG-DR funds, projects must meet the following criteria:

- Address a disaster-related impact (direct or indirect) in a presidentially declared county for the covered disaster
- Be a CDBG-eligible activity (according to regulations and waivers)
- Meet a national objective.

Incorporating preparedness and mitigation into these actions is encouraged, as the goal is to rebuild in ways that are safer and stronger.

Emergency Watershed Program

The USDA Natural Resources Conservation Service (NRCS) administers the Emergency Watershed Protection (EWP) Program, which responds to emergencies created by natural disasters. Eligibility for assistance is not dependent on a national emergency declaration. The program is designed to help people and conserve natural resources by relieving imminent hazards to life and property caused by floods, fires, windstorms, and other natural occurrences. EWP is an emergency recovery program. Financial and technical assistance are available for the following activities (National Resources Conservation Service, 2016):

- Remove debris from stream channels, road culverts, and bridges
- Reshape and protect eroded banks
- Correct damaged drainage facilities
- Establish cover on critically eroding lands
- Repair levees and structures
- Repair conservation practices.

Endangered Species Act

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

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

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

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

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

Federally funded projects, such as those for pre-disaster mitigation or flood mitigation, cannot jeopardize the continued existence of endangered or threatened species or adversely modify critical habitat (FEMA, 2015b). With the listing of salmon and trout species as threatened or endangered, the ESA has impacted most of the Pacific coast states. Some areas have been more impacted by the ESA than others due to the known presence of listed species, but the entire region is impacted by mandates, programs and policies based on the presumption of the presence of listed species. Most West Coast jurisdictions must now take into account the impact of their programs on habitat. The impacts may increase in the near future, resulting from recent court decisions and federal administrative actions involving the nexus between the ESA and the National Flood Insurance Program (NFIP) in the Puget Sound region of Washington (MSRC, 2016).

The Oregon Fish and Wildlife Commission (through the Oregon Department of Fish and Wildlife) maintains the threatened and endangered species list in the state of Oregon. The ESA program in the City of Portland is part of the Science, Fish and Wildlife Division of the Bureau of Environmental Services.

National Flood Insurance Program

The National Flood Insurance Program provides federally backed flood insurance in exchange for communities enacting floodplain regulations. Participation in the NFIP is voluntary; however, participation and good standing under NFIP are prerequisites to grant funding eligibility under the

Robert T. Stafford Act. The City of Portland participates in the NFIP and has adopted regulations that exceed the NFIP requirements. At the time of the preparation of this plan, the City of Portland was in good standing with NFIP requirements.

National Incident Management System

The National Incident Management System (NIMS) is a systematic approach for government, nongovernmental organizations, and the private sector to work together to manage incidents involving hazards. The NIMS provides a flexible but standardized set of incident management practices. Although participation is voluntary, federal departments and agencies are required to make adoption of NIMS by local and state jurisdictions a condition to receive federal preparedness grants and awards.

Presidential Executive Orders 11988 and 13690

Executive Order 11988 requires federal agencies to avoid to the extent possible the long and short-term adverse impacts associated with the occupancy and modification of floodplains and to avoid direct and indirect support of floodplain development wherever there is a practicable alternative. It requires federal agencies to provide leadership and take action to reduce the risk of flood loss, minimize the impact of floods on human safety, health, and welfare, and restore and preserve the natural and beneficial values of floodplains. The requirements apply to the following activities (FEMA, 2015a):

- Acquiring, managing, and disposing of federal lands and facilities
- Providing federally undertaken, financed, or assisted construction and improvements
- Conducting federal activities and programs affecting land use, including but not limited to water and related land resources planning, regulation, and licensing.

Executive Order 13690 expands Executive Order 11988 and acknowledges that the impacts of flooding are anticipated to increase over time due to the effects of climate change and other threats. It mandates a federal flood risk management standard to increase resilience against flooding and help preserve the natural values of floodplains. This standard expands management of flood issues from the current base flood level to a higher vertical elevation and corresponding horizontal floodplain. The goal is to address current and future flood risk and ensure that projects funded with taxpayer dollars last as long as intended (Office of the Press Secretary, 2015).

Presidential Executive Order 11990

Executive Order 11990 requires federal agencies to provide leadership and take action to minimize the destruction, loss or degradation of wetlands, and to preserve and enhance the natural and beneficial values of wetlands. The requirements apply to the following activities (National Archives, 2016):

- Acquiring, managing, and disposing of federal lands and facilities
- Providing federally undertaken, financed, or assisted construction and improvements
- Conducting federal activities and programs affecting land use, including but not limited to water and related land resources planning, regulation, and licensing.

Title VI of the Civil Rights Act of 1964

The Civil Rights Act of 1964 prohibits discrimination based on race, color, religion, sex or national origin and requires equal access to public places and employment. The act is relevant to emergency management and hazard mitigation in that it prohibits local governments from favoring the needs of one population group over another. Local government and emergency response must ensure the continued safety and well-being of all residents equally, to the extent possible.

4.9.2 State

The 2015 *Oregon Natural Hazards Mitigation Plan* has an exhaustive review of policies related to natural hazards in Oregon. Table 4-14 shows the identified polices relevant for the City of Portland. Detailed descriptions are provided in Section 3.4.1.2 of the state's NHMP (Oregon Department of Land Conservation and Development, 2015). Additional state programs and capabilities that are available as a resource to the City of Portland are described in Section 4.9.3.

Table 4-14. Policies Related to Specific Natural Hazards in Oregon

Hazard	Oregon Statewide Planning Goals[a] and Policies	Publications/Studies
Multi-Hazard	• Local Comprehensive Plans • Goal 2: Land use Planning • Goal 7: Natural Hazards • Oregon Building Codes	• Energy Assurance Plan • Natural Hazards Mitigation in Oregon: An Evaluation of Natural Hazards Mitigation Planning and Implementation in Oregon • Oregon Climate Adaptation Framework • Oregon Climate Assessment Report • Oregon Highway Plan • Oregon Resilience Plan • Oregon Transportation Plan • Planning for Natural hazards: Oregon Technical Resource Guide, 2000 • State Emergency Management Plan
Flood	• Goal 5: Natural Resources, Scenic and Historic Areas, and Open Space • Division of State Lands Fill and Removal Permit Program • The Oregon Plan for Salmon and Watersheds • Oregon's Wetlands Protection Program	• Department of Land Conservation and Development Water Quality Model Code and Guidebook
Landslide	• Goal 17: Coastal Shorelands • The Oregon Plan for Salmon and Watersheds • 1997 Senate Bill 12: Rapidly Moving Landslides	
Earthquake	• 2005 Senate Bill 2: Statewide seismic needs assessment for schools and emergency facilities • 2005 Senate Bill 3: Seismic earthquake rehabilitation grant program • 2005 Senate Bill 4 and 5: State bond authorization • 2001 Senate Bill 13: Seismic Event Preparation • 2001 Senate Bill 14: Seismic Surveys for School Buildings • 2001 Senate Bill 15: Seismic Surveys for Hospital Buildings • 1991 Senate Bill 96: Seismic Hazard Investigation	• Seismic Vulnerability of Oregon State Highway Bridges, Mitigation Strategies to Reduce Major Mobility Risks
Wildfire	• 1997 Senate Bill 360: Wildland-Urban Interface • Additional Criteria for Forestland Dwellings—ORS 215.730 • Urban Interface Fire Protection—ORS 477.015- 061	• Oregon's Communities at Risk Assessment • State Fire Services Mobilization Plan
Volcano		• Mount Hood Coordination Plan

a. Local comprehensive plans must address local concerns and issues raised by each of the state's 19 land use planning goals.
Source: Reproduced in part and enhanced from 2015 Oregon Natural Hazards Mitigation Plan

4.9.3 Local

The planning team performed an inventory and analysis of existing authorities and capabilities called a "capability assessment." A capability assessment creates an inventory of an agency's mission, programs and policies, and evaluates its capacity to carry them out. Goals, objectives, policies and actions identified in programs and plans identified were reviewed during the development of the MAP and used to inform the development of the mitigation strategy and assess opportunities for plan integration. Actions that expand or fill gaps identified in existing capabilities were considered during the development of the mitigation strategy. An assessment of legal and regulatory capabilities is presented in Table 4-15.

Table 4-15. Legal and Regulatory Capability

	Local Authority	Other Jurisdiction Authority	State Mandated
Building Code (Bureau of Development Services (BDS))	Yes	No	Yes
***Comment*:** *Portland City Code, Title 24: Building Regulations; last amended December 4, 2015*			
Zoning Code (Bureau of Planning and Sustainability (BPS))	Yes	No	Yes
***Comment*:** *Portland City Code, Title 33: Planning and Zoning; effective January 1, 1991, last amended March 1, 2016* *E-Zones*			
Subdivisions (BDS, BPS)	Yes	No	Yes
***Comment*:** *Portland City Code, Title 33 Section 600s: Land Divisions and Planned Developments; last amended March 1, 2016* *Johnson Creek Plan District*			
Stormwater Management (BDS (enforcement), BES (development and update))	Yes	No	Yes
***Comment*:** *Portland City Code, Title 17 Sections 32 through 39: amendment anticipated July 2016*			
Post-Disaster Recovery Ordinance (PBEM)	No	No	No
Real Estate Disclosure	No	No	Yes
***Comment*:** *Oregon Revised Statutes, Chapter 105 Section 464: Form of seller's property disclosure statement; disclosure is limited to information known by the seller*			
Growth Management (BPS)	Yes	Yes	Yes
***Comment*:** *Metropolitan Service District: Urban Growth Boundary; last expanded in 2011*			
Site Plan Review (BDS/BES)	Yes	No	No
***Comment*:** *Portland City Code, Title 33 Section 800s: Land Use Reviews; last amended July 24, 2015*			
Environmental Protection	Yes	Yes	Yes
***Comment*:** *Portland City Code, Title 33 Chapter 440: Greenway Overlay Zones; last amended January 1, 2015* *Portland City Code, Title 33 Chapter 430 Environmental Zones; last amended July 24, 2015* *Streamlining Committee for Federal, State and Local Code and Regulatory Compliance on City Projects* *Lower Columbia River Salmon and Steelhead Recovery Plan (Title 24; Biological Opinion Compliance)*			
Flood Damage Prevention (BDS, BPS)	Yes	No	Yes
***Comment*:** *Portland City Code, Title 24: Building Regulations–Flood Hazard Areas; last amended November 26, 2010* *Johnson Creek Basin Plan, Environmental Zones, Title 33 Chapter 430*			
Emergency Management (PBEM)	Yes	No	Yes
***Comment*:** *Portland City Code, Title 15: Emergency Code; last amended October 7, 2015*			
Climate Change (BPS)	Yes	Yes	No
***Comment*:** *Resolution 37121 Exhibit A: 2015 Sustainable City Principles and 2030 Environmental Performance Objectives* *ENN-5.04 Implementation by City Bureaus of Policies and Programs; adopted June 24, 2015;* *ENN-5.03 City of Portland and Multnomah County 2015 Climate Action Plan; adopted June 24, 2015*			
Other	Yes	No	No
***Comment*:** *Portland City Code, Title 10: Erosion and Sediment Control Regulations* *Portland City Code, Title 11: Trees* *Portland City Code, Title 12: Air Pollution Emergency Response* *Portland City Code, Title 21: Water*			
Comprehensive Plan (BPS)	Yes	Yes	Yes
Is the plan equipped to provide linkage to this mitigation plan? Yes			
***Comment*:** *The draft Comprehensive Plan includes policies related to hazard-resilient design*			

	Local Authority	Other Jurisdiction Authority	State Mandated
Capital Improvement Plan	Yes	No	Yes
What types of capital facilities does the plan address? Parks, sewer, transportation, water			
How often is the plan updated? Reviewed annually during budget process			
Comment: *Bureau of Development Services, Bureau of Environmental Services, Portland Fire & Rescue, Bureau of Fire & Police Disability & Retirement, Office of Management & Finance, Portland Parks & Recreation, Portland Bureau of Transportation, Portland Water Bureau—all have capital improvement plan summaries listed in the adopted budget*			
Floodplain or Watershed Plan	No	No	No
Stormwater Plan	Yes	No	Yes
Comment: *Environmental Services Systems Plan (March 2012)*			
Habitat Conservation Plan (Portland Water Bureau (PWB))	Yes	Yes	No
Comment: *Bull Run Water Supply Habitat Conservation Plan; last compliance report produced in 1995*			
Economic Development Plan (Portland Development Commission)	Yes	No	No
Comment: *Economic Development Strategy: A Five-Year Plan for Promoting Job Creation and Economic Growth; 3-year status report published July 2012*			
Shoreline Management Plan	No	No	No
Community Wildfire Protection Plan	Yes	Yes	No
Comment: *Multnomah County Community Wildfire Protection Plan*			
Forest Management Plan (Portland Parks & Recreation)	Yes	No	No
Comment: *Portland Urban Forestry Management Plan; 2004*			
Climate Action Plan (BPS)	Yes	Yes	No
Comment: *Climate Action Plan: Local Strategies to Address Climate Change; June 2015 (in conjunction with Multnomah County)*			
Comprehensive Emergency Management Plan (PBEM)	Yes	No	Yes
Comment: *City of Portland Basic Emergency Operations Plan; March 2013*			
Threat & Hazard Identification & Risk Assessment	Yes	Yes	No
Comment: *Portland Urban Area 2015 THIRA Update*			
Post-Disaster Recovery Plan	No	No	No
Continuity of Operations Plan	Yes	No	No
Comment: *All City bureaus have continuity of operations plans, except the Central Budget Office. Several are currently being updated. PBEM is in the process of hiring a planner to assist bureaus with updating their continuity of operations plans.*			
Water System Master Plan	Yes	No	Yes
Comment: *Infrastructure Master Plan:* *Supply System Plan; prepared in 2000, currently being updated* *Distribution System Plan; prepared in 2007*			
Seismic Study	Yes	No	Yes
Comment: *Water System Seismic Study Recommended by State Seismic Resilience Plan*			
Water System Security and Vulnerability Assessment	Yes	No	Yes
Comment: *Federally mandated; Completed in 2003 and 2001, respectively*			
Bull Run Watershed Fire Management Plan	Yes	Yes	Yes
Headworks Facilities Plan	Yes	No	No
Comment: *PWB report; completed in 2014*			

	Local Authority	Other Jurisdiction Authority	State Mandated
Water Management & Conservation Plan ***Comment:*** *Completed in 2010; update underway*	Yes	No	Yes
Public Health Plan	No	Yes	No
Other ***Comment****: Transportation System Plan 2007—currently being updated* *Bull Run Roads Master Plan* *Wildfire Readiness Assessment & Gap Analysis 2009*	Yes	No	No

An assessment of fiscal capabilities is presented in Table 4-16. An assessment of administrative and technical capabilities is presented in Table 4-17. An assessment of education and outreach capabilities is presented in Table 4-18. Classifications under various community mitigation programs are presented in Table 4-19. The Steering Committee also identified the following additional local resources and capabilities:

- The MAP steering committee
- Potential legal authority identified through Unreinforced Masonry (URM) Workgroup to mandate seismic retrofits and other hazard mitigation related actions
- Strong personal and family preparedness for City employees
- Large membership of backyard habitat certified homes with strong natural science understanding; many of them are in landslide areas
- Strong communication system—Multnomah County Amateur Radio Emergency Service (ARES)
- Strong emergency preparedness education program for people with disabilities
- Robust education program for home retrofitting
- Strong network of community and marginalized groups.

Table 4-16. Fiscal Capability

Financial Resources	Accessible or Eligible to Use?
General Funds	Yes
Community Development Block Grants	Yes –Entitlement City
Capital Improvements Project Funding	Yes
Authority to Levy Taxes for Specific Purposes	Yes, with voter approval
User Fees for Water, Sewer, Gas or Electric Service	Yes—water, sewer, stormwater
Incur Debt through General Obligation Bonds	Yes, with voter approval
Incur Debt with Revenue Bonds	Yes, with voter approval
Incur Debt through Special Tax Bonds	Yes, with voter approval
Incur Debt through Private Activity Bonds	Yes, with voter approval or Board of County Commissioners Approval
Withhold Public Expenditures in Hazard-Prone Areas	No
State-Sponsored Grant Programs	Yes
Development Impact Fees for Homebuyers or Developers	Yes—System Development Charges
Other	• Possibly—National Fire Plan; Riparian Lands Tax Incentive; Fisheries Restoration and Enhancement Program

Table 4-17. Administrative and Technical Capability

Staff/Personnel Resources	Available?	Department/Agency/Position
Planners or engineers with knowledge of land development and land management practices	Yes	Bureau of Planning and Sustainability (BPS) - Planner
Engineers or professionals trained in building or infrastructure construction practices	Yes	BPS—Planner; Portland Bureau of Transportation (PBOT)—City Engineer, PWB – Chief Engineer, BES – Chief Engineer
Planners or engineers with an understanding of natural hazards	Yes	PBEM – Planner, PWB, PBOT & BES
Staff with training in benefit/cost analysis	Yes	Business Services/Watershed Services/Engineering Services, PWB – Engineering Planning
Surveyors (Not certified)	Yes	Watershed Services/Engineering Services, PWB – Engineering
Staff capable of making substantial damage estimates	Yes	BDS—ACT-20 Certified Engineers/Architects, PWB – Engineering
Personnel skilled or trained in GIS applications	Yes	CGIS; BPS; other bureaus with GIS experts
Scientist familiar with natural hazards in local area	Yes	DOGAMI; USGS; PSU Geology Department; NWS
Emergency manager	Yes	PBEM – Director, PWB Emergency Manager
Grant writers	Yes	PWB-Engineering; BES—Program Manager; PBEM—Planner; BPS - Planner
Other[a]	Yes	Building Codes Division (BCD) Post-Earthquake Inspection Program Cascadia Regional Earthquake Workgroup Community Rating System Users Group DEQ Emergency Response Program Drought Council Energy Facility Siting Council Hazard Mitigation Grant Review Board Oregon Board of Geologist Examiners Oregon Emergency Management Association Oregon Lidar Consortium Oregon Seismic Safety Policy Advisory Committee Pacific Northwest Seismograph Network Pacific Northwest Wildfire Coordinating Group State Interagency Hazard Mitigation Team Water Resources Dam Safety Program Metropolitan Services District Regional Emergency Management Group Multnomah County Emergency Management Multnomah County Drainage District

a. Many of these are state programs and resources that are described in detail in the *2015 Oregon Natural Hazards Mitigation Plan*. Others are regional agencies and resources connected to hazard mitigation planning.

Table 4-18. Education and Outreach

Criterion	Response
Do you have a Public Information Officer or Communications Office?	Yes – PBEM Public Information Officer and Senior Community Outreach & Information Representative
Do you have personnel skilled or trained in website development?	Yes- Bureau of Technology Services (BTS), Business Solutions/ eGovernment
Do you have hazard mitigation information available on your website?	Yes
If yes, please briefly describe: Resources and links to hazard information Mitigation Action Plan website and related information	
Do you utilize social media for hazard mitigation education and outreach?	Yes
If yes, please briefly describe: PBEM uses Twitter, Facebook, and NextDoor to communicate with the public about hazard mitigation topics.	
Do you have any citizen boards or commissions that address issues related to hazard mitigation?	Yes
If yes, please briefly specify: Unreinforced Masonry Seismic Retrofit Project Mitigation Action Plan Working Group (forthcoming)	
Do you have any other programs already in place that could be used to communicate hazard-related information?	Yes
If yes, please briefly describe: Neighborhood Emergency Teams (NETs) Community Engagement Liaisons (CELs) Mutual Assistance Associations See also key stakeholders and networks in Appendix C	
Do you have any established warning systems for hazard events?	Yes
If yes, please briefly describe: Portland and Multnomah County PublicAlerts system	

Table 4-19. Community Classifications

	Participating?	Classification	Date Classified
Community Rating System	Yes	6	May 1, 2016
Building Code Effectiveness Grading Schedule	Yes	2.2	December 2014
Public Protection	Yes	2	Last rating November 2015
Storm Ready	No	N/A	N/A
Firewise	No	N/A	N/A

The Mitigation Action Plan

PART 2—RISK ASSESSMENT

5. HAZARDS AND COMPOUNDING FACTORS

5.1 IDENTIFIED HAZARDS OF CONCERN

Hazard mitigation planning uses all available information to determine what types of disasters may affect a jurisdiction, how often they can occur, and their potential severity. For this plan, the Steering Committee considered the full range of natural hazards that could impact Portland and then identified hazards that present the greatest concern. The process incorporated review of state and local hazard planning documents, as well as information on the frequency, magnitude, and costs associated with hazards that have impacted or could impact Portland. Anecdotal information regarding natural hazards and the perceived vulnerability of Portland's assets to them was also used. Based on the review, this plan addresses the following hazards of concern:

- Severe weather
- Earthquake
- Landslide
- Wildfire
- Flood
- Volcanic activity
- Dam failure
- Drought

All hazards identified as impacting the region in which Portland is located (Region 2) in the Oregon Natural Hazards Mitigation Plan were included in the assessment. The steering committee elected to discuss windstorms and winter storms under the broader category of severe weather.

In addition the Steering Committee determined that information on space weather should be provided in the plan, although there was not enough information currently available for a full risk assessment. As a result, space weather is addressed as an emerging hazard of concern in this plan.

It is important to note that with the exception of dam failure, technological hazards (e.g., hazardous material incidents) and human-caused hazards (e.g., terrorist acts) are not addressed in this plan. Dam failure was selected for inclusion to enhance the Community Rating System (CRS) aspects of this plan, and because the dam failure hazard shares many similarities in modeling and risk assessment with other natural hazards of concern that other human or technological hazards do not.

In addition to the eight hazards of concern and one emerging hazard of concern, the Steering Committee considered including three additional hazards: air quality, erosion, and invasive species. Two of these hazards, erosion and invasive species, were assessed as hazards of concern in the 2010 natural hazard mitigation plan. After discussion and deliberation, the committee elected to discuss these hazards, along with climate change, as secondary hazards of concern or compounding factors. These hazards are discussed below and in the risk assessment profiles of each hazard of concern, as appropriate.

5.2 COMPOUNDING FACTORS AND SECONDARY HAZARDS

This section of the MAP looks at conditions that contribute to or result from hazard events:

- Compounding factors are characteristics of an area that can contribute to the likelihood or severity of a hazard event's occurrence.
- Secondary hazards are impacts that result from a hazard event in a more indirect way than the immediate hazard effects.

Some local conditions can both contribute to and result from a hazard. Table 5-1 shows how identified compounding factors and secondary hazards relate to the hazards of concern evaluated in this plan. The following sections provide further detail on each. The risk assessment for each hazard of concern addresses the compounding factors and secondary hazards specific to that hazard.

Table 5-1. Relationship Between Hazards, Compounding Factors, and Secondary Hazards

	Related Hazards of Concern	
	Compounding Factor	Secondary Hazard
Climate Change	Dam failure, drought, flood, landslide, severe weather, wildfire	Volcanic activity, wildfire
Air quality	Severe weather	Volcanic activity, wildfire
Erosion	Landslide	Dam failure, drought, flood, landslide, severe weather, wildfire
Invasive species	Flood, landslide, wildfire	

5.2.1 Climate Change

<u>What is Climate Change?</u>

Climate, consisting of patterns of temperature, precipitation, humidity, wind, and seasons, plays a fundamental role in shaping natural ecosystems and the human economies and cultures that depend on them. "Climate change" refers to changes in these patterns over a long period of time. Worldwide, average temperatures have increased 1.4ºF since 1880 (NASA, 2015). Although this change may seem small, it can lead to large changes in climate and weather.

The warming trend and its related impacts are caused by increasing concentrations of carbon dioxide and other greenhouse gases in the earth's atmosphere. Greenhouse gases are gases that trap heat in the atmosphere, resulting in a warming effect. Carbon dioxide is the most commonly known greenhouse gas; however, methane, nitrous oxide and fluorinated gases also contribute to warming. Emissions of these gases come from a variety of sources, such as the combustion of fossil fuels, agricultural production, changes in land use, and volcanic eruptions. According to the U.S. Environmental Protection Agency (EPA), carbon dioxide concentrations measured about 280 parts per million (ppm) before the industrial era began in the late 1700s and have risen 43 percent since then, reaching 399 ppm in 2014 (see Figure 5-1). Furthermore, scientists are able to place this rise in carbon dioxide in a longer historical context through the measurement of carbon dioxide in ice cores. According to these records, carbon dioxide concentrations in the atmosphere are the highest that they have been in 650,000 years (NASA, 2016). According to NASA, this trend is of particular significance "because most of it is very likely human-induced and [it is] proceeding at a rate that is unprecedented in the past 1,300 years" (NASA, 2016). There is broad scientific consensus (97 percent of scientists) that climate-warming trends are very likely due to human activities (NASA, 2016). Unless emissions of greenhouse gases are substantially reduced, this warming trend and its associated impacts are expected to continue.

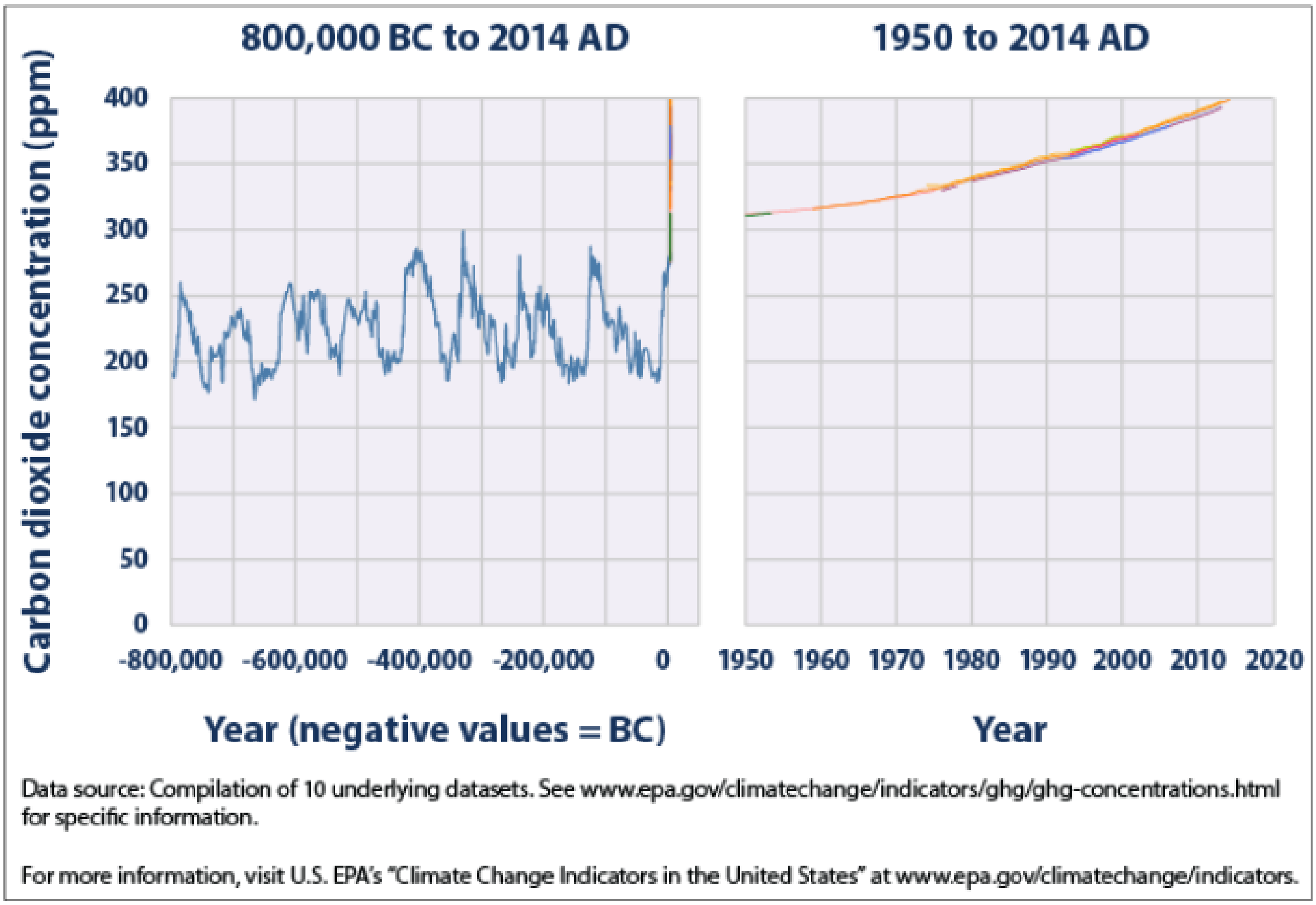


Figure 5-1. Global Carbon Dioxide Concentrations Over Time

Climate change will affect the people, property, economy and ecosystems of the City of Portland in a variety of ways. Climate change impacts are most frequently associated with negative consequences, such as increased flood vulnerability or increased heat-related illnesses/public health concerns; however, other changes may present opportunities. The most important effect for the development of this plan is that climate change will have a measurable impact on the occurrence and severity of natural hazards.

How Climate Change Affects Hazard Mitigation

An essential aspect of hazard mitigation is predicting the likelihood of hazard events in a planning area. Typically, predictions are based on statistical projections from records of past events. This approach assumes that the likelihood of hazard events remains essentially unchanged over time. Thus, averages based on the past frequencies of, for example, floods are used to estimate future frequencies: if a river has flooded an average of once every 5 years for the past 100 years, then it can be expected to continue to flood an average of once every 5 years.

For hazards that are affected by climate conditions, the assumption that future behavior will be equivalent to past behavior is not valid if climate conditions are changing. As flooding is generally associated with precipitation frequency and quantity, for example, the frequency of flooding will not remain constant if broad precipitation patterns change over time. Specifically, as hydrology changes, storms currently considered to be a 1-percent-annual-chance event (100-year flood) might strike more often, leaving many communities at greater risk. The risks of drought, landslide, severe storms, extreme heat, and wildfire are all affected by climate patterns as well. For this reason, an understanding of climate change is pertinent to efforts to mitigate natural hazards. Information about how climate patterns are changing provides insight on the reliability of future hazard projections used in mitigation analysis. This section summarizes current understandings about climate change in order to provide a context for the recommendation and implementation of hazard mitigation measures. Expected impacts of climate change on the frequency or severity of each hazard of concern is assessed in the risk assessment presented in Chapter 7 through Chapter 10.

Current Indications of Climate Change

The major scientific agencies of the United States and the world—including the National Aeronautics and Space Administration (NASA), the National Oceanic and Atmospheric Administration (NOAA) and the Intergovernmental Panel on Climate Change (IPCC)—agree that climate change is occurring. Multiple temperature records from all over the world have shown a warming trend, and the IPCC has stated that the warming of the climate system is unequivocal (IPCC, 2014). Of the 10 warmest years in the 134-year record, all but one (1998) occurred since 2000, and 2015 was the warmest year on record (NASA, 2016). Worldwide, average temperatures have increased 1.4ºF since 1880 (NASA, 2016).

Rising global temperatures have been accompanied by other changes in weather and climate. Many places have experienced changes in rainfall resulting in more intense rain, as well as more frequent and severe heat waves (IPCC, 2014). The planet's oceans and glaciers have also experienced changes: oceans are warming and becoming more acidic, ice caps are melting, and sea levels are rising (NASA, 2016). Global sea level has risen approximately 6.7 inches, on average, in the last 100 years (NASA, 2016). This has already put some coastal homes, beaches, roads, bridges, and wildlife at risk (USGCRP, 2009).

NASA currently maintains information on the vital signs of the planet. At the time of the development of this plan, the following trends and status of these signs are as follows (NASA, 2016):

- Carbon Dioxide—Increasing trend, currently at 403.28 parts per million
- Global Temperature—Increasing trend,, increase of 1.4 degrees Fahrenheit since 1880
- Arctic Ice Minimum—Decreasing trend, 13.4 percent per decade
- Land Ice—Decreasing trend, 287.0 billion metric tons per year
- Sea Level—Increasing trend, 3.4 mm per year.

Projected Future Impacts

The Third National Climate Assessment Report for the United States indicates that impacts resulting from climate change will continue through the 21st century and beyond. Although not all changes are understood at this time and the impacts of those changes will depend on global emissions of greenhouse gases and sensitivity in human and natural systems, the following impacts are expected in the United States (NASA, 2016):

- Temperatures will continue to rise
- Growing seasons will lengthen
- Precipitation patterns will change
- Droughts and heat waves will increase

- Hurricanes will become stronger and more intense
- Sea level will rise 1-4 feet by 2100
- The Arctic may become ice free.

The 2015 Climate Action Plan states that the primary risks facing Multnomah County and the City of Portland (2015) include:

- Hotter, drier summer with more high-heat days
  - Increased temperatures (both day and night) and frequency of high heat days
  - Increased incidence of drought
  - Increased wildfire frequency and intensity
- Warmer winters with the potential for more intense rain events
  - Increased incidence and magnitude of damaging floods
  - Increased incidence of landslides.

Responses to Climate Change

Communities and governments worldwide are working to address, evaluate and prepare for climate changes that are likely to impact communities in coming decades. Generally, climate change discussions encompass two separate but inter-related considerations: mitigation and adaptation. The term “mitigation” can be confusing, because it’s meaning changes across disciplines:

- Mitigation in restoration ecology and related fields generally refers to policies, programs or actions that are intended to reduce or to offset the negative impacts of human activities on natural systems. Generally, mitigation can be understood as avoiding, minimizing, rectifying, reducing or eliminating, or compensating for known impacts (CEQ, 1978).
- Mitigation in climate change discussions is defined as “efforts to reduce carbon emissions in order to slow climate change” (Multnomah County and the City of Portland, 2015). It includes strategies to reduce greenhouse gas sources and emissions and enhance greenhouse gas sinks.
- Mitigation in emergency management is typically defined as the effort to reduce loss of life and property by lessening the impact of disasters (FEMA, 2013).

In this section, mitigation is used as defined by the climate change community. In the other chapters of this plan, mitigation is primarily used in an emergency management context.

Adaptation is defined by the IPCC as “the process of adjustment to actual or expected climate and its effects. In human systems, adaptation seeks to moderate or avoid harm or exploit beneficial opportunities, In some natural systems, human intervention may facilitate adjustment to expected climate and its effects” (IPCC, 2014).

Mitigation and adaptation are related, as the world’s ability to reduce greenhouse gas emissions will affect the degree of adaptation that will be necessary. Some initiatives and actions can both reduce greenhouse gas emissions and support adaptation to likely future conditions. Portland and Multnomah County’s *Climate Action Plan* includes actions to reduce carbon emissions as well as actions to prepare for impacts.

5.2.2 Air Quality

Air quality can be impacted by a variety of natural and non-natural sources. Air pollution can come from human-created stationary sources such as factories, human-created mobile sources such as planes and automobiles, and naturally occurring sources such as volcanic eruptions and dust storms. The EPA defines air pollution as "the presence of contaminants or pollutant substances in the air that interfere with our health or welfare, or produce other harmful environmental effects." The Oregon Department of Environmental Quality (DEQ) is the state administrative agency charged with preserving and enhancing Oregon's air quality to support healthy, clean air for all Oregonians (Oregon DEQ, 2016).

The natural dispersal of air pollutants in Portland is inhibited by interactions of topography and climate. Portland is in a valley with mountains on either side, which limits the ability of winds to disperse pollutants horizontally across areas as they might in a flatter landscape. This is particularly of concern during the summer when winds tend to be lighter and from the north. This lack of dispersal is intensified when the vertical mixing of air is inhibited by an inversion—when warm air is found at higher elevations than cool air. Inversions are common in all seasons In Portland and in western Oregon (Johnson, 1987). Figure 5-2 illustrates the relationship between inversions and air quality during winter, when inversions tend to be strongest (NWS, 2016).

According to DEQ, Portland's air meets all federal air quality health standards for the six principal pollutants regulated under the Clean Air Act: carbon monoxide, ozone, particulate matter, nitrogen oxides, sulfur oxides and lead (Oregon DEQ, 2016). DEQ notes that in recent years concerns have been raised regarding air toxics in Portland. Air toxics are defined as air pollutants known or suspected to cause cancer and come from a variety of sources (cars, consumer products, burning, etc.). No federal standards currently exist for these toxics. The air quality discussion in the MAP is not primarily concerned with controlling or eliminating sources of regulated or non-regulated air pollution. The discussion for this plan is limited to air pollution as a secondary hazard or compounding factor as it relates to natural hazard mitigation.

Air quality forecasts and current conditions can be viewed online at AirNow:

https://www.airnow.gov/index.cfm?action=airnow.local_city&cityid=160

5.2.3 Erosion

The 2010 NHMP assessed erosion as a hazard of concern; however, the plan states that the magnitude and severity of erosion in the City are 'negligible' and that erosion occurrences are typically secondary events that are directly linked to other hazard events. Because of this assessment, the 2016 Steering Committee elected to address erosion as a secondary hazard or compounding factor as appropriate in the MAP.

General Background

The city experiences annual rain and wind events that impact river shorelines combined with landslides and debris flows within the watersheds, loss of plant cover in riparian areas and river-traffic-induced erosion. During severe storm events riverine erosion is magnified due to increased volume and velocity of the water flow. Erosion is a problem in developed areas where the disappearing land threatens development and infrastructure.

Source: NWS, 2016

Figure 5-2. Impact of Inversion on Air Quality

There are two main types of erosion that affect human activity in Portland (NHMP, 2010).

- Riverine erosion results from the force of flowing water in and adjacent to river, creek, and tributary channels. This erosion affects the bed and banks of the channel and can alter or preclude any channel navigation or embankment development. In less stable braided channel reaches, erosion and material deposition are a constant issue. In more stable meandering channels, episodes of erosion may only occur occasionally.

- Wind erosion occurs when wind removes, moves and re-deposits soil. It can cause a loss of topsoil, hindering agricultural production. Blowing dust can also reduce visibility and have a negative effect on air quality (NHMP, 2010).

Runoff from rain cuts rills (channels) and gullies, while wind can strip soil from wide areas. Both types of erosion can move large amounts of sediment, sometimes far from the original site of soil disturbance (NHMP, 2010).

Four main factors influence erosion (NHMP, 2010):

- **Soil erodibility—**Fine soils, impermeable soils and soils lacking organic material tend to be more erodible.
- **Vegetative cover—**Vegetation shields soil from rainfall and wind, increases infiltration, slows runoff velocities, and retains soil moisture for later plant use between rainstorms.
- **Topography—**Long, steep slopes increase runoff amounts and velocities and therefore tend to increase erosion.
- **Weather—**The frequency, intensity, and duration of rainfall influence sediment release amounts. Sediment from disturbed soils can move into neighboring properties, streets, drainage systems and other bodies of water. Excessive sediment damages the functions of both stormwater sewers and natural watersheds (City of Portland, 2008b as cited in NHMP, 2010).

The City has identified riverine erosion areas along its rivers, creeks and tributaries. Erosion of any type rarely causes death or injury. However, erosion can cause significant destruction to property and infrastructure.

The following descriptions provide a brief overview of historic erosion events in the city (NHMP, 2010):

- Riverine erosion in local creeks occurred with minimal damage as culverts were filled and backed-up during the 1964 flood event.
- Wildfires in 2000 and 2001 removed vegetation that had stabilized hillsides. Subsequent erosion damage occurred during rain and snowmelt runoff events.
- Severe weather brings snow, rain and wind impacts to the city. Historical severe weather events surpassed the soil and the built environment's capacity to absorb or manage run-off, which results in erosion damage.

Location

Portland has many streams flowing down canyons in its hilly terrain. The intensity of the flow in the streams during the rainy season causes erosion to the banks. All rivers and creeks are subject to erosion. The city has two rivers and multiple streams and creeks. Some of those streams and rivers that are potentially threatened by erosion include: the Columbia and Willamette Rivers, Johnson, Tryon and Fanno Creeks; and the Columbia Slough. Hillside creeks are subject to erosion as a result of runoff caused by rain or melting snow pack (NHMP, 2010).

A variety of natural and human-induced factors influence the erosion process within the community. River orientation and proximity to upstream and downstream river bends can influence erosion rates. Embankment (earth or rock piled to keep back water or support a road) composition also influences erosion rates, (sand and silt will erode easily, whereas boulders or large rocks are more erosion resistant). Other factors that may influence riverine erosion include (NHMP, 2010):

- Geomorphology (land formations)
- Amount of encroachment in the high hazard zone

- Proximity to erosion-inducing structures
- Nature of the topography
- Density of development
- Structure types along the embankment
- Embankment elevation.

Erosion along the banks of the rivers and streams in the city is generally caused by a combination of factors; the natural process of a watercourse to find the path of least resistance; debris flows within the watershed; loss of riparian area plant cover; logging, wildfires, increased boat traffic close to the shoreline, and runoff from rainfall. While erosion has been identified as occurring within the city, few events have been reported that resulted in substantial damage.

Current Erosion Plan

The 2008 Erosion and Sediment Control Manual is a key reference for actions to be taken to mitigate erosion in development and maintenance situations. This plan describes vulnerability as not only in riverine areas, but any location where land is being moved and therefore impacts the natural areas.

Title 10 and this Erosion Control Manual apply to all ground-disturbing activities, whether or not a permit is required, unless such activities are otherwise exempted by Portland City Code.

Site planning and good site control are best practices that can be used to prevent discharges from a development site. The manual emphasizes careful planning and erosion prevention. Undisturbed groundcover must be retained whenever possible. This emphasis is particularly important in the Pacific Northwest immediately before and during the rainy season, when it is difficult to establish vegetation and the intense rains have high erosion potential.

5.2.4 Invasive Species

Invasive species was addressed as a hazard of concern in the 2010 natural hazard mitigation plan. It was the position of the 2016 Steering Committee that the hazard be assessed as a secondary hazard and compounding factor as appropriate in the MAP.

General Background

Invasive plants are those species that spread at such a rate that they cause harm to human health and the environment. In general, most invasive plants are non-native species, however, not all non-native plants are invasive (City of Portland, 2009 as cited in NHMP, 2010).

Invasive plants have been introduced into an environment in which they did not originate. They lack natural enemies, grow and reproduce quickly and are able to thrive in a wide variety of conditions. These characteristics allow plants to invade new habitats and out-compete natives, resulting in dense thickets of a single plant species. Dense thickets of invasive plants limit native plant diversity which in turn reduces food and shelter for wildlife. Invasive plants are the second leading cause of species extinction. Many invasive plants have shallow root systems that provide limited erosion control. Invasive plants also shade out native seedlings resulting in fewer trees. Less shade creates higher water temperatures, reducing oxygen for fish and other aquatic animals. Reduced tree cover also reduces storm water interception and absorption of $C0_2$ which interferes with the stabilization of the earth's temperature (NHMP, 2010). Invasive aquatic plants can decrease stormwater conveyance or cause debris blockages, increasing flood risk.

The City of Portland Bureau of Planning and Sustainability has developed lists of native, nuisance and prohibited plants. All of the species on the City's nuisance list and all of the species on its prohibited list are considered invasive plants. A native plant is a species that was likely found historically (prior to European settlement) in the Portland area. Nuisance plants are considered harmful to humans and plants and have a tendency to dominate plant communities (NHMP, 2010).

Arrival and Impacts

Most invasive plants arrived in Oregon through intentional introductions, however, in most cases, the uncontrolled spread was not anticipated. The number of new introductions has increased consistently with global trade and travel. Most invasive plant introduction pathways are human induced; the plants and their seeds travel on cars, trains, heavy equipment, boats, shoes and pets. The plants tend to become established along transportation corridors such as roads, utility easements, trails, parks and ports of entry. Humans also introduce new invasive plants through the nursery trade and gardening. Invasive plants are also transported through ecological pathways such as wind, wildlife, streams and other waterbodies. Land management practices such as mowing or constant soil disturbance also facilitate the establishment of and persistence of invasive plants (NHMP, 2010).

The following descriptions provide a brief overview of how invasive species have affected environmental health historically in the city (NHMP, 2010):

- **Water quality**—reduction in soil stability and of canopy diversity from invasive species results in increased stream temperatures and increased erosion.
- **Biodiversity**—rapid spread of invasive plant species creates monocultures by displacing native plants or by preventing their growth and establishment (which has affected water and air quality and stabilization of stream banks).
- **Habitat**—simplification of a plant community structure by an invasive plant monoculture reduces fish and wildlife habitat.
- **Tree Cover**—invasive cover in the shrub and groundcover layer prevents a natural forest regeneration processes.
- **Soil Health**—soils altered through allelopathy (the process of releasing chemicals that alter the soil chemistry and soil fungal processes thereby inhibiting the growth of neighboring plants, by another plant).
- **Wildfire**—some invasive plant species act as "fuel ladders" which facilitate the ability of a fire to travel into the tree canopy of conifers. Presence of invasive species makes the fire hotter, more difficult to control and more likely to continue to spread.
- **Stormwater**—forming monocultures, invasive species often preclude the establishment of native vegetation and tree canopy, altering vegetation cover types which can result in reduced stormwater interception by trees (City of Portland, 2008a as cited in NHMP, 2010).

Extensive infestations of invasive vines can also be implicated in multiple natural hazards. Trees overburdened with ivy or clematis vines are commonly found alongside several important traffic corridors in the city (Hwy. 26, Hwy. 30, Germantown Road). These overburdened trees are unstable and are often uprooted during rain or snow events and fall across power lines or roadways. When found on step unstable slopes these infested trees can be blown down and become involved in localized landslides (NHMP, 2010).

Fungal infestations can damage the health of native vegetation and contribute to increased wildfire risk. Swiss needle cast is a fungal disease affecting Douglas fir forests in Oregon, predominantly over the past 20 years. Although the fungus is native to Oregon, its detrimental impact may be increasing due to rising spring and summer temperatures (Black et al., 2010) Douglas fir is one of the prominent tree species in Forest Park. A decline in the health of Forest Park's trees due to Swiss needle cast could contribute to increased fuel loads and combustibility, leading to greater risk and severity of wildfires in Portland. (Weiskittel et al., 2004).

For more information on invasive species in Portland, please visit the Bureau of Environmental Services Invasive Species Management website:

https://www.portlandoregon.gov/bes/45696

6. Risk Assessment Methodology

In hazard mitigation planning, risk is defined as the potential for damage, loss, or other impacts created by the interaction of natural hazards with community assets (see Figure 6-1).

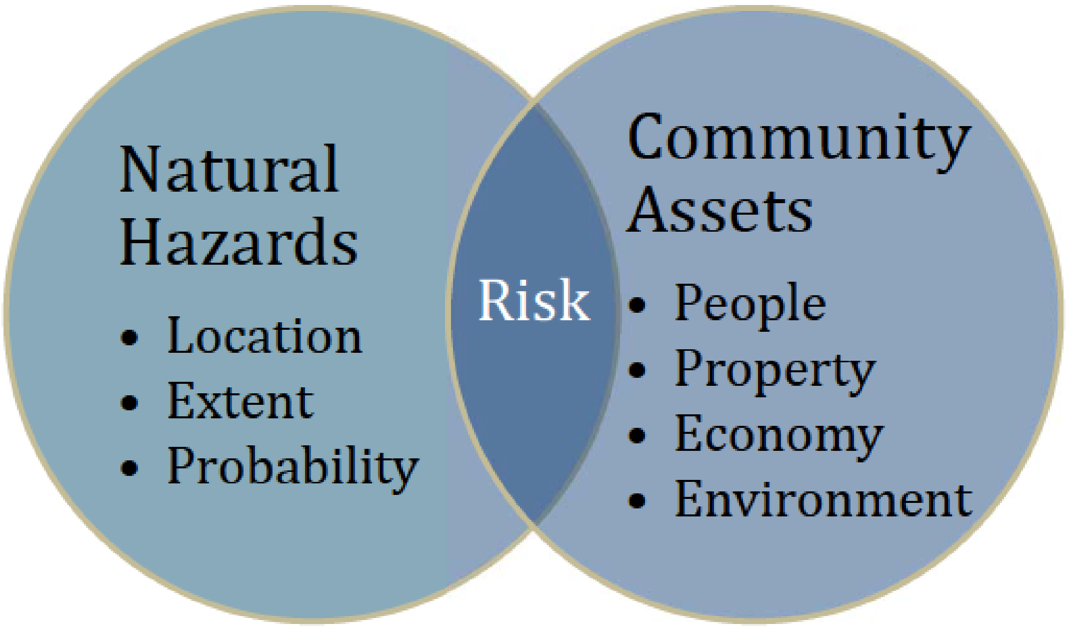


Figure 6-1. Risk in Hazard Mitigation

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

- Vulnerability identification—Identify the people, property, environment, economic assets, and lands of Portland that could experience loss from natural hazard events.
- Cost evaluation—Estimate the cost of potential damage or the cost that could be avoided by taking steps to mitigate the risk.

6.1 OVERALL RISK ASSESSMENT METHODOLOGY

The risk assessments in Chapters 7 through 15 of this plan evaluate the risk of all identified hazards of concern prevalent in Portland. Each chapter describes the hazard, Portland's exposure and vulnerability, and probable event scenarios, meeting the requirements of the DMA (44 CFR, Section 201.6(c)(2)). The planning team reviewed existing studies, reports and technical information to determine the best available data to use in the risk assessment (44 CFR, Section 201.6(b)(3)). Information from these sources was incorporated into the hazard profiles and forms the basis of the exposure and vulnerability assessment. The following steps were used to assess the risk of each hazard:

- **Profile each hazard**—The following information is given for each hazard:
  - Summary of past events
  - Geographic area most affected by the hazard
  - Event frequency estimates
  - A discussion of the severity of the hazard event
  - Warning time likely to be available for response
  - Secondary hazards or compounding factors associated with or resulting from the hazard of concern
  - Future development that may impact risk
  - Worst-case event scenario
  - Key issues related to mitigation of the hazard in Portland.
- **Determine exposure to each hazard**—Exposure was determined by overlaying hazard maps with demographic information and an inventory of structures, facilities and systems to determine which of them would be exposed to each hazard. The best available data was used to delineate the area of effect for each hazard. Data available in a Geographic Information System (GIS)-compatible format with coverage of the full extent of Portland was preferred when available.
- **Assess the vulnerability of exposed assets**—Vulnerability of exposed structures and infrastructure was determined by interpreting the probability of occurrence of each event and assessing the potential level of damage to structures, facilities, and systems exposed to each hazard. Vulnerability of populations is generally discussed qualitatively, although some model outputs are used to describe quantitatively the number of people vulnerable to the hazard event. FEMA's hazard-modeling program, Hazus-MH was used to perform this assessment for some hazards; GIS-based spatial analyses or qualitative assessments were used for others.

6.2 MAPPING

National, state and local spatial databases were reviewed for this planning effort. Maps were produced using GIS software to show the spatial extent of identified hazards when such data was available. These maps are included in the hazard profile chapters of this document. Maps at the reporting-area scale are included in Appendix E. Information on the data sources and methodologies used for hazard mapping is provided in Appendix F.

6.3 ASSESSING DAM FAILURE, EARTHQUAKE, FLOOD

6.3.1 Overview of FEMA's Hazus-MH Software

FEMA developed the Hazards U.S., or Hazus, model in 1997 to estimate losses caused by earthquakes. Hazus was later expanded into a multi-hazard methodology, Hazus-MH, with new models for estimating potential losses from hurricanes and floods. Hazus-MH is a GIS-based software program used to support risk assessments, mitigation planning, and emergency planning and response. The program maps and displays hazard data and the results of damage and economic loss estimates for buildings and infrastructure. The use of Hazus-MH for hazard mitigation planning offers numerous advantages:

- Provides a consistent methodology for assessing risk across geographic and political entities.

- Provides a way to save data so that it can readily be updated as population, inventory, and other factors change and as mitigation planning efforts evolve.
- Facilitates the review of mitigation plans because it helps to ensure that FEMA methodologies are incorporated.
- Supports grant applications by calculating benefits using FEMA definitions and terminology.
- Produces hazard data and loss estimates that can be used in communication with local stakeholders.
- Is administered by the local government and can be used to manage and update a hazard mitigation plan throughout its implementation.

6.3.2 Levels of Detail for Evaluation

Hazus-MH provides a wide range of inventory data, such as demographics, building stock, critical facilities, transportation and utility lifeline, and multiple models to estimate potential losses from natural disasters. The software's default data for inventory, vulnerability and hazards can be supplemented with local data to allow a more refined analysis. The model can carry out three levels of analysis, depending on the format and level of detail of information about Portland:

- **Level 1**—A Level 1 analysis estimates losses using only the software's default data. This data is derived from national databases and describes in general terms the characteristic parameters of a planning area.
- **Level 2**—A Level 2 analysis produces more accurate estimates of losses by supplementing the software's default data with detailed information in a GIS format about local geology, hydrology, hydraulics, building inventory, utilities and critical facilities.
- **Level 3**—This level of analysis generates the most accurate estimate of losses. It requires detailed engineering and geotechnical information to customize it for a local planning area.

6.3.3 Application for This Plan

The Hazus-MH model was used as follows for the hazards evaluated in this plan:

- **Flood**—A Level 2 analysis was performed for general building stock and for critical facilities and infrastructure. The effective Digital Flood Insurance Rate Map (DFIRM) for Portland was used to delineate flood hazard areas and estimate potential losses from the 10-, 100- and 500-year flood events. The effective DFIRM assumes the continued protection of FEMA-certified flood control levees and does not include residual exposure. Using the DFIRM floodplain boundaries and base flood elevation data and the City's 3-foot digital elevation model data, flood depth grids were generated and integrated into the Hazus-MH model. To estimate damage that would result from a flood, Hazus uses pre-defined relationships between flood depth at a structure and resulting damage, with damage given as a percent of total replacement value. Curves defining these relationships have been developed for damage to structures and for damage to typical contents within a structure. By inputting flood depth data and known property replacement cost values, dollar-value estimates of damage were generated.
- **Dam Failure**—The basis for this analysis was dam failure inundation mapping for Mt. Tabor Reservoirs 1, 5, and 6, and Washington Park Reservoirs 3 and 4. Inundation depth grids were created using inundation area boundaries and the City's 3-foot digital elevation model. The depth grids were imported into Hazus-MH and a Level 2 analysis was run using the flood methodology described above. Inundation area boundaries were not available for Portland's flood control levees at the time of this analysis.

- **Earthquake**—A Level 2 analysis was performed to assess earthquake risk and exposure. Earthquake shake maps and probabilistic data prepared by the U.S. Geological Survey (USGS) were used for the analysis of this hazard. National Earthquake Hazard Reduction Program (NEHRP) soils, liquefaction susceptibility and landslide susceptibility data were also integrated into the Hazus-MH model. Two scenario events and two probabilistic events were modeled:
  - ➢ The scenario events were a Magnitude-9.0 event on the Cascadia Subduction Zone and a Magnitude-6.5 event on the Portland Hills Fault.
  - ➢ The standard Hazus analysis was run for the 100- and 500-year probabilistic events.

6.4 ASSESSING LANDSLIDE, SEVERE WEATHER, VOLCANO, WILDFIRE

For landslide, severe weather, volcano and wildfire, historical data was not adequate to model future losses. However, areas and inventory susceptible to some of the hazards of concern were mapped by other means and exposure was evaluated. For other hazards, a qualitative analysis was conducted using the best available data and professional judgment.

6.5 ASSESSING DROUGHT

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

6.6 ASSESSING SPACE WEATHER

Space weather is identified in this plan as an emerging hazard of concern; therefore, a detailed risk assessment of the hazard was not conducted. Additional information pertaining to risk from the space weather hazard will be monitored over the performance period of the plan; the potential for conducting a detailed risk assessment will be evaluated at the next plan update.

6.7 ASSESSING SOCIAL VULNERABILITY

Several demographic variables were extracted from the U.S. Census Bureau's American Community Survey database: total population, population under 15 years of age, population over 65 years of age, white population, people of color, total housing units, occupied housing units, owner-occupied housing units, renter-occupied housing units, total families, families below the poverty line, total households, and households speaking limited English. The number of people affected by a hazard in each demographic subset was first estimated for small areas called block groups, which are defined in the Census data:

- For each block group, the number of residential structures within the defined hazard zone was divided by the total number of residential structures in the block group.
- The resulting multiplier was applied to the population of each demographic subset in that block group to estimate the impacted number of people in each subset in each block group.
- The impacted populations of all block groups in a reporting area were totaled to get the impacted number of people in each subset in each reporting area.

6.8 DATA SOURCES, LIMITATIONS AND GAPS

6.8.1 Building Counts and Replacement Cost Value

The Hazus-MH modeling used GIS-based data on structure type, number and replacement cost. When available, an updated inventory was used in place of the Hazus-MH defaults for critical facilities and infrastructure. Replacement cost is the cost to replace an entire structure with one of equal quality and utility. It is based on industry-standard cost-estimation models published in *RS Means Square Foot Costs* (RS Means, 2015). Replacement cost of a structure is estimated based on its Hazus occupancy class (e.g., multi-family residential, commercial retail trade) and its square footage as indicated in the building data. For single-family residential, the construction class and number of stories also factor into the square foot costs.

6.8.2 Data Used for Spatial Analysis

Table 6-1 describes the data used for spatially based exposure and vulnerability assessments. If no database was available, it was noted as a gap (see Section 6.8.3).

6.8.3 Limitations and Data Gaps

General Limitations

Loss estimates, exposure assessments and vulnerability evaluations rely on the best available data and methodologies. However, results are subject to uncertainties associated with the following factors:

- Incomplete scientific knowledge about natural hazards and their effects on the built environment
- Approximations and simplifications necessary to conduct a study
- Incomplete or outdated structure, demographic or economic parameter data
- The variable nature, geographic extent and severity of each hazard
- Mitigation measures already employed
- The amount of advance notice residents have to prepare for a specific hazard event.

These factors can affect loss estimates by a factor of two or more. Therefore, potential exposure and loss estimates are approximate and should be used only to understand relative risk.

Despite their limitations, risk assessment techniques are able to indicate the possible extremes of hazard events. Their findings should be recognized as identification of potential hazard occurrences rather than as predictions of probable hazard events.

Identified Data Gaps and Specific Limitations

Hazus-MH currently represents the industry best management practice for assessing risk in support of hazard mitigation planning. However, Hazus and other models used for this risk assessment are limited by the availability of data to support their working components. Such models must use assumptions where firm data are not available. Assumptions are used, for example, to estimate ground deformation caused by liquefaction. These model limitations can lead to an understatement or overstatement of risk.

Table 6-1. Summary of Data Used for Spatial Analysis

Data	Source
Base Map Data	City boundaries, roads, water features, risk reporting areas provided by City of Portland.
General Building Stock Update	Building footprints and associated building information provided by City of Portland Bureau of Planning and Sustainability.
Critical Facility Database Update[a]	Emergency services (emergency operations centers, fire stations, medical care facilities, and police stations) provided by City of Portland and Regional Disaster Preparedness Organization.
	Schools provided by City of Portland.
	Transportation systems (airports, bus facilities, highway bridges, highway tunnels, railway bridges, rail facilities, and railway tunnels) provided by City of Portland and Regional Disaster Preparedness Organization
	Light rail bridges, facilities, and tunnels provided by TriMet.
	Port facilities provided by Port of Portland.
	Dams provided by Oregon Water Resources Department and the National Inventory of Dams.
	Hazardous materials facilities provided by the Oregon State Fire Marshall.
	Armories and nuclear reactor facilities provided by the City of Portland Bureau of Emergency Management.
	Military facilities provided by the Regional Disaster Preparedness Organization.
	Communications facilities provided by City of Portland and Hazus-MH default data.
	Electric power facilities provided by City of Portland, Regional Disaster Preparedness Organization, and Hazus-MH default data.
	Natural gas facilities provided by Oregon Public Health and Pacific Terminal Services.
	Petroleum facilities provided by Oregon Public Broadcasting, Regional Disaster Preparedness Organization, and Kinder Morgan.
	Potable water facilities provided by City of Portland Water Bureau.
	Wastewater facilities provided by City of Portland BES.
	Prisons provided by Regional Disaster Preparedness Organization.
	City-owned essential facilities, nursing homes and assisted living facilities provided by City of Portland.
Flood	Effective Digital Flood Insurance Rate Map downloaded from FEMA website.
	2014 3-foot resolution digital elevation model provided by City of Portland.
	Levee data provided by City of Portland.
	Repetitive loss data and active National Flood Insurance Program properties acquired from FEMA and geocoded by City of Portland.
Earthquake	Shake maps for Cascadia M-9.0 and Portland Hills M-6.5 downloaded from USGS website.
	Liquefaction susceptibility, landslide susceptibility, National Earthquake Hazard Reduction Program (NEHRP) soils, and active faults data provided by Oregon Department of Geology and Mineral Industries.
Landslide	Regulatory landslide hazard area and historical landslide deposits data provided by City of Portland.
Dam Failure	Mt Tabor Reservoirs 1, 5 and 6, and Washington Park Reservoirs 3 and 4 inundation areas data provided by City of Portland Water Bureau.
Wildfire	Wildfire fire hazard data provided by City of Portland.
Volcano	Mt. Hood Region volcano hazards data downloaded from USGS Cascade Volcano Observatory (CVO) website.
Demographics	2010-2014 American Community Survey 5-year Estimates (block group level) data downloaded from U.S. Census Bureau website.
Current and Future Land Use	Proposed comprehensive plan designations (future land use) data provided by City of Portland Bureau of Planning and Sustainability.

a. Not all requested data was received, so gaps in the database are present. Future planning efforts will work to address these gaps.

Appendix G presents findings from an evaluation of the data sources used for the risk assessment. It identifies gaps and potential impacts on the risk assessment results. The following are limitations specific to the datasets used in this planning process:

- City of Portland building data lacked certain detailed information, such as first floor elevation, so Hazus default building information was used. Detailed building information like this plays a major role in calculating replacement costs and evaluating how structures will behave during hazard events.
- Model data input requirements necessitate the conversion of building footprints into single-point features. Building locations are represented by single points at the centroid of the building footprint.
- Hazus does not currently have established depth-damage functions for estimating losses to houseboats during flood events.
- The current landslide data was produced at state-level scale. It is in the process of being updated at a county-level scale, which will be more appropriate for future exposure analyses for the City.
- The wildfire data is dated. This data will most likely be updated with LiDAR and new vegetation data that will improve the level of detail and accuracy.
- Not all critical facility data was available or complete. Appendix G outlines the specific gaps.
- Population estimates are generally based on where people are estimated to reside and do not take into account where individuals are likely to be at any given point in the day (e.g. school or work).
- Demographic data on persons with disabilities is aggregated at the tract level by the U.S. Census Bureau. This tract level data could not be used in a meaningful way for estimates for risk reporting areas.
- Potential exposure and vulnerability of linear critical infrastructure may overstate risk, as elevation and existing mitigation measures were not taken into consideration during the assessment.

7. Severe Weather

7.1 GENERAL BACKGROUND

Severe weather refers to any dangerous meteorological phenomena with the potential to cause damage, serious social disruption, or loss of human life. It includes thermal extremes, thunderstorms, tornadoes, windstorms, and winter storms.

The most common severe weather events that impact Portland are windstorms and winter storms, although extreme temperature events are becoming more common in recent years.

7.1.1 Thermal Extremes

Thermal extremes refer to relatively short-lived weather conditions that produce unusually hot or unusually cold conditions for an area. These events are deviations from normal or average seasonal temperatures and, thus, the threshold for an event varies based on average or typical conditions for a given locality. Normal temperatures for Portland are shown in Table 4-1 and Table 4-2.

Excessive Heat Events

Excessive heat events are defined by the U.S. EPA as "summertime weather that is substantially hotter and/or more humid than average for a location at that time of year" (U.S. EPA, 2006). Heat waves are excessive heat events that typically last two or more days. Because extreme heat is relative to the usual weather in a region, criteria that define an extreme heat event differ among jurisdictions and with the time of year. For Multnomah County, heat advisory protocols

DEFINITIONS

- **Freezing Rain**—The result of rain occurring when the temperature is below the freezing point. The rain freezes on impact, resulting in a layer of glaze ice up to an inch thick. In a severe ice storm, an evergreen tree 60 feet high and 30 feet wide can be burdened with up to six tons of ice, creating a threat to power and telephone lines and transportation routes.
- **Heavy Rain**—events during which the amount of rain experienced in a location substantially exceeds what is normal for the location and season.
- **Severe Local Storm**—Small atmospheric systems, including tornadoes, thunderstorms, windstorms, ice storms and snowstorms. Typically, major impacts from a severe storm are on transportation infrastructure and utilities. These storms may cause a great deal of destruction and even death, but their impact is generally confined to a small area.
- **Thunderstorm**—Typically 15 miles in diameter and lasting about 30 minutes, thunderstorms are underrated hazards. Lightning, which occurs with all thunderstorms, is a serious threat to human life. Heavy rains over a small area in a short time can lead to flash flooding. Strong winds, hail and tornadoes are also dangers associated with thunderstorms.
- **Tornado**—Tornadoes are funnel clouds of varying sizes that generate winds more than 300 miles per hour. A tornado is formed by the turbulent mixing of layers of air with contrasting temperature, moisture, density and wind flow. The mixing layers of air account for most of the tornadoes occurring in April, May and June, when cold, dry air meets warm, moister air moving up from the south. They can affect an area up to a mile wide, with a path of varying length. Tornadoes can come from lines of cumulonimbus clouds or from a single storm cloud. They are measured using the Fujita Scale ranging from F0 to F6.
- **Windstorm**—A storm featuring violent winds. Southwesterly winds are associated with strong storms moving onto the coast from the Pacific Ocean. Southern winds parallel to the coastal mountains are the strongest and most destructive winds. Windstorms tend to damage ridgelines that face into the winds.
- **Winter storm**—The National Weather Service defines a winter storm as having significant snowfall, ice, and/or freezing rain; the quantity of precipitation varies by elevation. Heavy snowfall is 4 inches or more in a 12-hour period, or 6 inches or more in a 24-hour period in non-mountainous areas; and 12 inches or more in a 12-hour period or 18 inches or more in a 24-hour period in mountainous areas.

are triggered by three consecutive days with an average maximum temperature above 95°F (City of Portland and Multnomah County, 2014).

Heat Index

Extreme heat events are often a result of ambient air temperature combined with other factors. Heat index tables (see Figure 7-1) provide information about how hot it feels based on meteorological conditions. Heat index values are for shady, light wind conditions; full sunshine can increase heat index values by up to 15°F. Strong winds with hot, dry air also can be hazardous (NWS, 2014a).

Source: National Weather Service/NOAA

Temperature (°F)

Relative Humidity (%)	80	82	84	86	88	90	92	94	96	98	100	102	104	106	108	110
40	80	81	83	85	88	91	94	97	101	105	109	114	119	124	130	136
45	80	82	84	87	89	93	96	100	104	109	114	119	124	130	137	
50	81	83	85	88	91	95	99	103	108	113	118	124	131	137		
55	81	84	86	89	93	97	101	106	112	117	124	130	137			
60	82	84	88	91	95	100	105	110	116	123	129	137				
65	82	85	89	93	98	103	108	114	121	128	136					
70	83	86	90	95	100	105	112	119	126	134						
75	84	88	92	97	103	109	116	124	132							
80	84	89	94	100	106	113	121	129								
85	85	90	96	102	110	117	126	135								
90	86	91	98	105	113	122	131									
95	86	93	100	108	117	127										
100	87	95	103	112	121	132										

Likelihood of Heat Disorders with Prolonged Exposure or Strenuous Activity

Caution | Extreme Caution | Danger | Extreme Danger

Figure 7-1. Heat Index Chart

Heat Islands

The *City of Portland and Multnomah County Climate Change Risk and Vulnerability Assessment* (2014) defines urban heat island effect as "the measureable increase in ambient urban air temperatures resulting primarily from the replacement of vegetation with buildings, roads, and other heat-absorbing infrastructure." Heat islands can increase peak summer energy demand, air pollution, greenhouse gas emissions, heat-related illness and death, and water quality degradation. Portland State University researchers studying of urban heat island effects (see Figure 7-2) have found differences up to 15ºF between paved and vegetated areas of the City.

Source: Image obtained from Profita, 2015 attributed as Courtesy of Portland State University

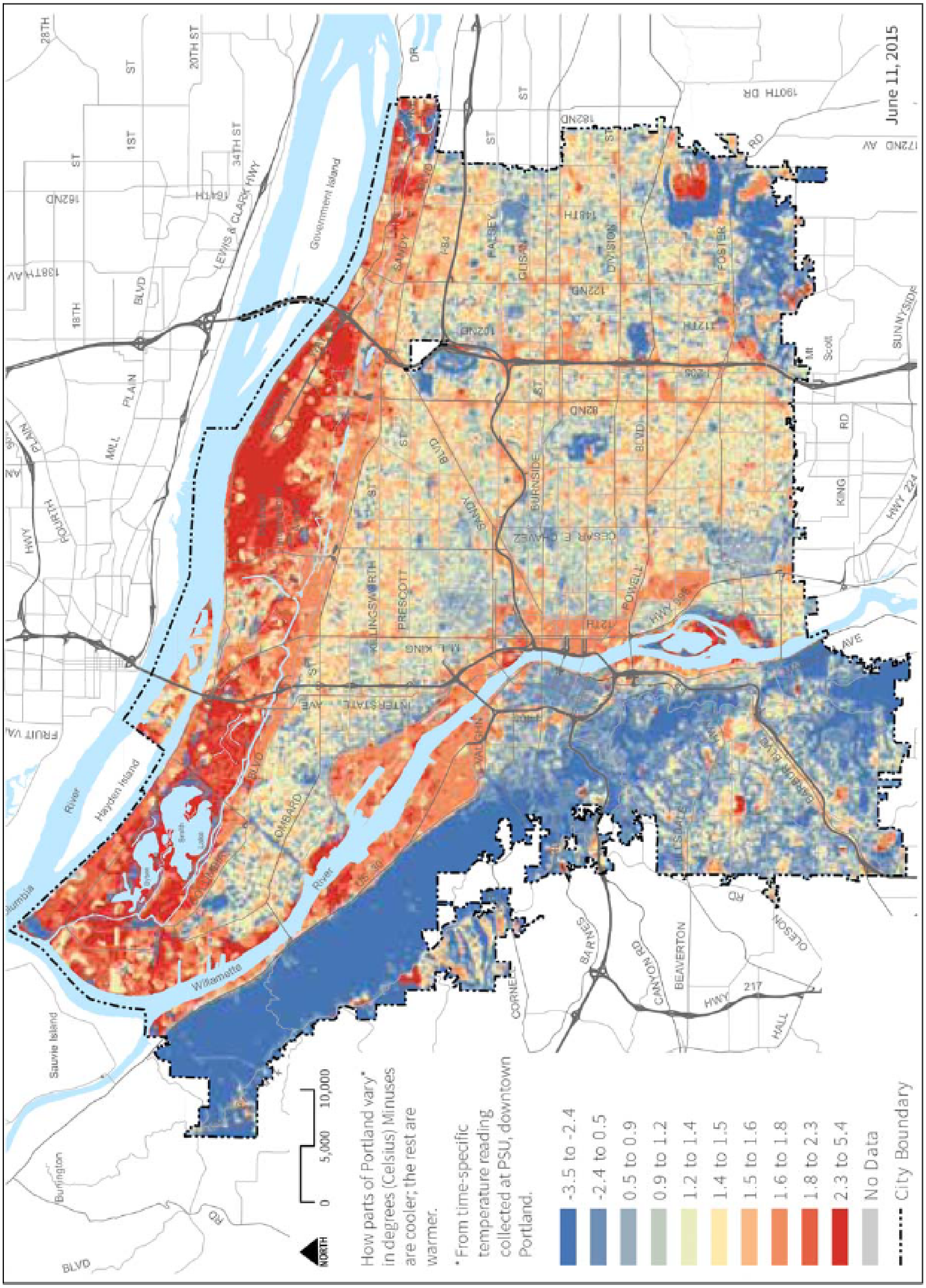


Figure 7-2. Portland's Urban Heat Islands

Extreme Cold and Wind Chill

Weather that constitutes extreme cold varies across different parts of the U.S. In regions relatively unaccustomed to winter weather, near freezing temperatures are considered extreme cold (CDC, 2014). Extreme cold can often accompany severe winter storms. Wind can exacerbate the effects of cold temperatures by carrying heat away from the body more quickly, thus making it feel colder than is indicated by the temperature. This phenomenon is known as wind chill. Wind chill is the temperature that your body feels based on the combination of air temperature and wind speed (CDC, 2014). Figure 7-3 shows the value of wind chill based on ambient temperature and wind speed.

Source: National Weather Service/NOAA

Temperature (°F)

Wind (mph) / Calm	40	35	30	25	20	15	10	5	0	-5	-10	-15	-20	-25	-30	-35	-40	-45
5	36	31	25	19	13	7	1	-5	-11	-16	-22	-28	-34	-40	-46	-52	-57	-63
10	34	27	21	15	9	3	-4	-10	-16	-22	-28	-35	-41	-47	-53	-59	-66	-72
15	32	25	19	13	6	0	-7	-13	-19	-26	-32	-39	-45	-51	-58	-64	-71	-77
20	30	24	17	11	4	-2	-9	-15	-22	-29	-35	-42	-48	-55	-61	-68	-74	-81
25	29	23	16	9	3	-4	-11	-17	-24	-31	-37	-44	-51	-58	-64	-71	-78	-84
30	28	22	15	8	1	-5	-12	-19	-26	-33	-39	-46	-53	-60	-67	-73	-80	-87
35	28	21	14	7	0	-7	-14	-21	-27	-34	-41	-48	-55	-62	-69	-76	-82	-89
40	27	20	13	6	-1	-8	-15	-22	-29	-36	-43	-50	-57	-64	-71	-78	-84	-91
45	26	19	12	5	-2	-9	-16	-23	-30	-37	-44	-51	-58	-65	-72	-79	-86	-93
50	26	19	12	4	-3	-10	-17	-24	-31	-38	-45	-52	-60	-67	-74	-81	-88	-95
55	25	18	11	4	-3	-11	-18	-25	-32	-39	-46	-54	-61	-68	-75	-82	-89	-97
60	25	17	10	3	-4	-11	-19	-26	-33	-40	-48	-55	-62	-69	-76	-84	-91	-98

Frostbite Times: 30 minutes, 10 minutes, 5 minutes

$$\text{Wind Chill (°F)} = 35.74 + 0.6215T - 35.75(V^{0.16}) + 0.4275T(V^{0.16})$$

Where, T= Air Temperature (°F) V= Wind Speed (mph) *Effective 11/01/01*

Figure 7-3. Wind Chill Chart

7.1.2 Thunderstorms

A thunderstorm is a rain event that includes thunder and lightning. Generally, the presence of three factors results in thunderstorm formation: moisture, rising unstable air, and a lifting mechanism. The lifecycle of a thunderstorm (see Figure 7-4) encompasses three stages (NSSL, 2016):

- Developing stage—A cumulus cloud is pushed upward, resembling a tower. Little to no rain is present, but occasional lightning may occur. This stage generally lasts for about 10 minutes.
- Mature stage—An updraft is still feeding the storm; however, precipitation begins to occur accompanied by a downdraft. A line of gusty winds is formed by this downdraft and rain-cooled air. This stage is the most likely time for hail, heavy rain, frequent lightning, strong winds, and tornadoes.
- Dissipating stage—After large amounts of precipitation, the downdraft becomes stronger than the updraft and the storm begins to dissipate. Precipitation generally decreases, but lightning may still be present.

Source: NOAA, 2015

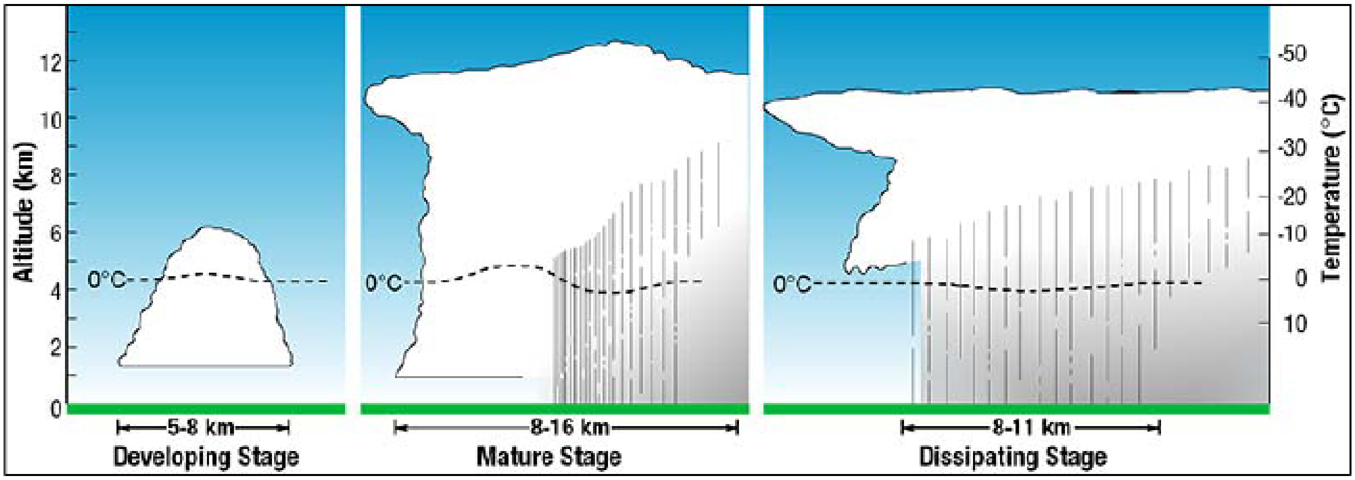


Figure 7-4. The Thunderstorm Life Cycle

A thunderstorm is classified as severe when it contains one or more of the following: hail with a diameter of 1 inch or greater, winds gusting in excess of 50 knots (57.5 mph), or tornado (NSSL, 2016).

Thunderstorms are usually short in duration (seldom more than 2 hours). Heavy rains associated with thunderstorms can lead to flash flooding during the wet or dry season. For more information on flooding see Chapter 11. Strong winds, hail and tornadoes are also dangers associated with thunderstorms.

Lightning

Lightning is an electrical discharge between positive and negative regions of a thunderstorm. A lightning flash is composed of a series of strokes, with an average of about four. The average duration of each stroke is about 30 microseconds (GHRC, 2016).

Lightning is one of the more dangerous weather hazards in the United States. Each year, lightning is responsible for deaths, injuries, and millions of dollars in property damage, including damage to buildings, communications systems, power lines, and electrical systems. Lightning also causes forest and brush fires and deaths and injuries to livestock and other animals. Property damage, increased operating costs, production delays, and lost revenue associated with lightning exceed $6 billion per year (NLSI, 2008). Impacts can be direct or indirect. People or objects can be directly struck, or damage can occur indirectly when current passes nearby.

Hail Storms

Hail is defined by the National Weather Service (2009) as “showery precipitation in the form of irregular pellets or balls of ice more than 5 millimeters in diameter, falling from a cumulonimbus cloud.” Hail generally ranges from pea-size (0.25 inches) to softball size (4.5 inches) (NWS, 2009).

Hail occurs when updrafts in thunderstorms carry raindrops upward into extremely cold areas of the atmosphere where they freeze into ice. Super-cooled water may accumulate on frozen particles near the back-side of a storm as they are pushed forward across and above the updraft by the prevailing winds near the top of the storm. Eventually, the hailstones encounter downdraft air and fall to the ground (U.S. Claim Expert, 2016).

7.1.3 Tornadoes

A tornado is defined by the National Weather Service (2009) as a violently rotating column of air, usually descending from a cumulonimbus cloud, with circulation reaching the ground. Tornadoes can come from lines of cumulonimbus clouds or from a single storm cloud. They nearly always start as funnel clouds and may be accompanied by a loud roaring noise. They can affect an area up to a mile wide, with a path of varying length.

A tornado is formed by the turbulent mixing of layers of air with contrasting temperature, moisture, density and wind flow. Tornadoes can occur throughout the year at any time of day but are most frequent in the spring during the late afternoon. The mixing layers of air account for most of the tornadoes occurring in April, May and June, when cold, dry air meets warm, moister air.

With the potential for wind speeds exceeding 300 mph, a tornado is the most destructive of all atmospheric phenomena on a local scale. Figure 7-5, adopted from FEMA, illustrates the potential impacts and damage from tornadoes of different magnitude. Oregon has a relatively low risk compared to states in the Midwestern and Southern U.S.

7.1.4 Windstorms

Wind is air flow that travels parallel to the Earth's topography. High winds are defined as those that last longer than one hour at 40 mph or greater or wind gusts of 58 mph or greater. Windstorms are generally short-duration events involving straight-line winds or gusts of over 50 mph, strong enough to cause property damage. Wind speeds vary with individual storms. Windstorms often accompany snow, ice and extreme cold temperature during winter months (Wilde, 2009 as cited in NHMP, 2010).

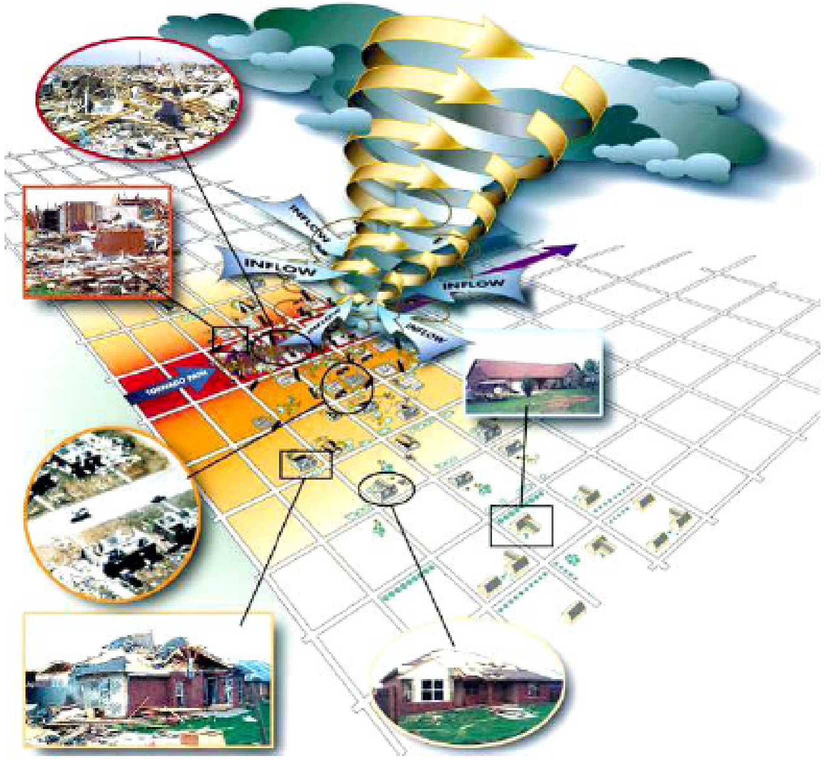
Windstorms are especially dangerous in areas with significant tree stands and areas with exposed property, poorly constructed buildings, mobile homes (manufactured housing units), major infrastructure, and above-ground utility lines. A windstorm can topple trees and power lines, cause damage to residential, commercial and critical facilities, and leave tons of debris in its wake. Windstorms tend to damage ridgelines that face into the winds.

According to the *Oregon Natural Hazard Mitigation Plan* (2015), the most frequent and strongest wind storms impacting the area originate in the Pacific Ocean and travel from the southwest. Eastern winds that travel through the Columbia River Gorge also have impacts in the area.

7.1.5 Winter Storms

Blizzards and Snowstorms

The National Weather Service defines a winter storm as having significant snowfall, ice and/or freezing rain; the quantity of precipitation varies by elevation. Heavy snowfall is 4 inches or more in a 12-hour period, or 6 inches or more in a 24-hour period in non-mountainous areas; and 12 inches or more in a 12-hour period or 18 inches or more in a 24-hour period in mountainous areas.



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

Figure 7-5. Potential Impact and Damage from a Tornado

There are three key ingredients to a severe winter storm:

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

While snow is relatively rare in the lower elevations of western Oregon, the Columbia Gorge provides a low-level passage through the mountains. Cold air, which lies east of the Cascades, often moves westward through the Gorge and into the Portland area. If a wet Pacific storm happens to reach the area at the same time, larger-than-average snow events may result (Taylor and Hannan, 1999 as cited in NHMP, 2010).

Ice Storms

The National Weather Service defines an ice storm as a storm that results in the accumulation of at least 0.25 inches of ice on exposed surfaces. Ice storms occur when rain falls from a warm, moist, layer of atmosphere into a below-freezing, drier layer near the ground. The rain freezes on contact with the cold ground and exposed surfaces, causing damage to trees, utility wires, and structures (see Figure 7-6).

Source: NWS, 2014b

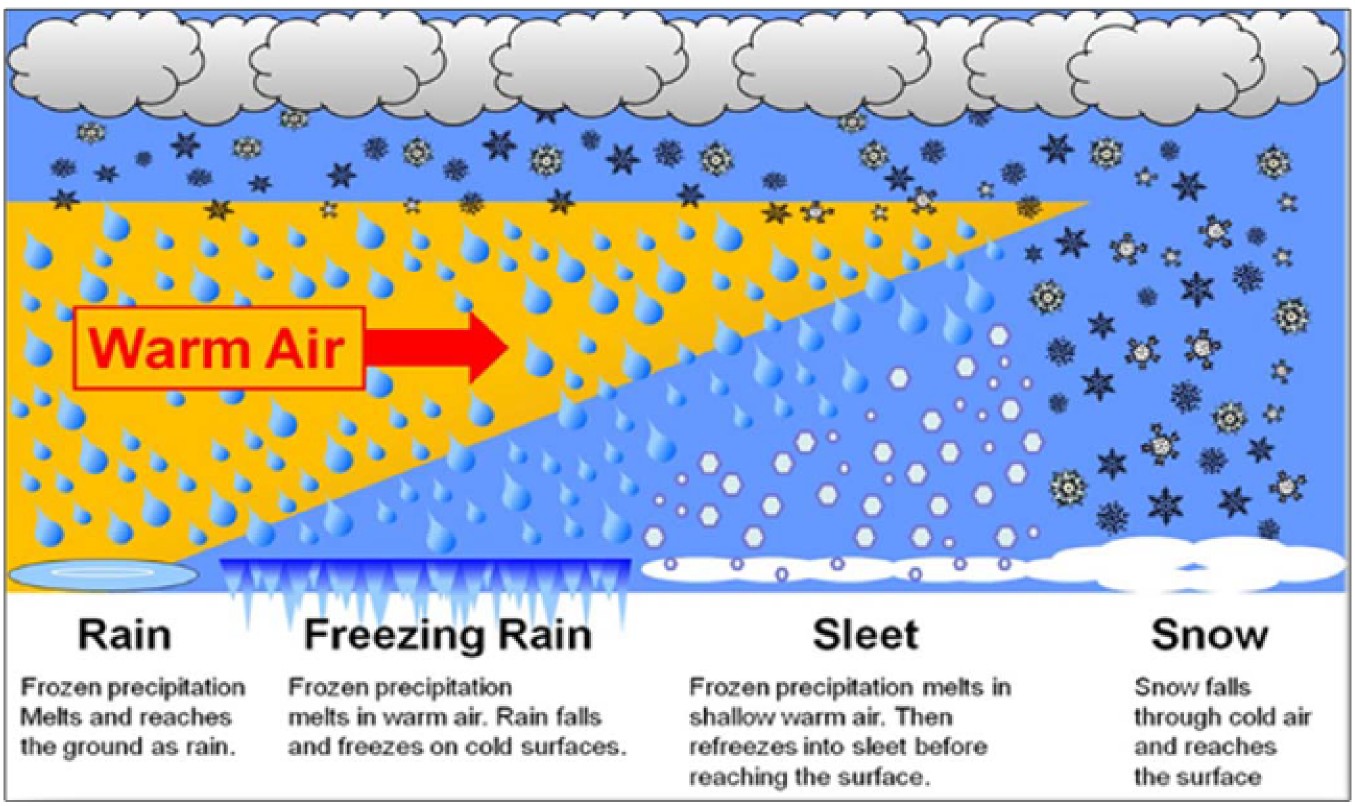


Figure 7-6. The Formation of Different Kinds of Precipitation

Ice accretion generally ranges from a trace to 1 inch. Accumulations between 1/4-inch and 1/2-inch can cause small branch and faulty limb breakage. Accumulations of 1/2-inch to 1 inch can cause significant breakage. Strong winds increase the potential for damage from ice accumulation.

7.2 HAZARD PROFILE

7.2.1 Past Events

Table 7-1 summarizes all severe weather events in and near Portland since 1950, as recorded by the National Oceanic and Atmospheric Administration (NOAA). Almost all of the disaster declarations impacting the City of Portland resulted to some extent from severe weather events. Table 7-2 provides detailed descriptions of severe weather events in Portland since 1991 that were reported to cause death, injuries or property damage.

Table 7-1. Summary of Severe Weather Event Impacts in Portland

Hazard Types Includes	# of Reported Events[a]	# of Events with Deaths, Injuries or Property Loss[a, b]
Strong Wind	15	15
High Wind	24	10
Excessive Heat	8	2
Extreme Cold/Wind Chill	0	0
Ice Storm	2	1
Heavy Snow	28	0
Winter Storm	8	2
Winter Weather	10	0
Lightning	5	3
Thunderstorm Wind	12	4
Hail	6	2
Funnel Cloud	3	0
Tornado	3	3
Heavy Rain	26	5
Total	**150**	**47**

a. Reported events since 1950 impacting Multnomah County and/or the Greater Portland Metro Area zone.
b. Only events that listed injuries and/or dollar amounts are included in these estimates. Some event descriptions include property damage that was not quantified.
Source: http://www.ncdc.noaa.gov/stormevents/

Table 7-2. Past Severe Weather Events Impacting Portland[a]

Date	Type	Deaths or Injuries	Property Damage
4/9/1991	Tornado	0	$250
Description: A thunderstorm produced a very small tornado and hail. A resident of a house which sustained minor damage recalled a steady progression of the wind effect. Initially, the neighbor's roof shingles lifted up, then their pool water was sucked out from underneath the poll cover, next, the first row of shingles on the witness' roof were turned up and small plants and a trellis were uprooted. Hail punctured a hole the size of a silver dollar in the garage screen door. At the same time this occurred, the U.S. Weather Service Office received a call from the same vicinity as the tornado reporting 0.5-inch hail and an unconfirmed report of 1-inch hail.			
11/12/1991	Tornado	0	$25,000
Description: A tornado occurred during a cold frontal passage. Eighty feet of fencing was damaged, part of a roof was torn off, an outbuilding was twisted and part of a wall was ripped out of a steel building.			
8/30/1999	Lightning	1	$0
Description: Lightning struck a boy from Gresham as he was bicycling near NE 230th Court in Wood Village at 1230 PDT. The lightning struck him in the head and exited through his groin. His companion at the time called 911 from a neighbor's house and paramedics arrived in about two minutes. The boy's heart had stopped, and he suffered a concussion and second degree burns on his face, chest, groin, and upper legs. He apparently did not receive the full force of the bolt directly, which spared his life. He was still on his bicycle with his hands on the handlebars when the paramedics arrived. He was revived in the ambulance en route to the hospital and he is expected to recover.			
12/18/2005	High Wind	0	$15,000
Description: A strong wind storm brought damaging winds to inland portions of northwest Oregon. The strongest wind gust reported was measured at 58 mph in the west hills of Portland. Many trees were reported downed by strong winds. Approximately 9,000 customers were reported without power in east Multnomah county. High winds also did damage to a few homes in the Gresham area, either by knocking down trees onto homes, or reported roof damage.			
1/1/2006	High Wind	0	$500,000
Description: A strong low pressure area off the Coast caused high winds in the Willamette Valley. McMinnville airport reported 44 mph sustained winds with a gust to 49 mph. Trees were reportedly blown down near Linfield College in Salem, including an 80 foot tall Cypress tree. A house in Aloha was destroyed by a falling tree. Nearly 22,000 customers were without power due to power lines downed by falling trees.			
2/3/2006	Strong Wind	0	$50,000
Description: A strong winter storm brought high winds to portions of northwest Oregon. Portland Airport reported 21 knots with gusts to 38 knots. Additionally, many residents experienced power outages due to trees blown down by strong winds.			
5/2/2007	Hail	0	$5,000
Description: During an afternoon under an unstable air mass, small thunderstorms moved across northwest Oregon. One storm produced a small hail storm, with enough hail accumulation to cover the ground. Hail covered the ground near the Gateway Transit Center, with biggest stones being half an inch in diameter.			
9/28/2007	Hail	0	$5,000
Description: In an unstable atmosphere, several thunderstorms moved over the forecast area. One such storm produced a short-lived tornado, that did considerable damage to a local farm. Dime size hail was also reported with the storm. Estimated half-inch hail fell near 162nd and Main.			
7/3/2008	Lightning	0	$2,000
Description: Lightning struck the Walt Morey Middle School in Troutdale, damaging some of the computer systems.			
12/20/2008	Winter Storm	0	$9 million property, $11.6 million crop
Description: The third in a series of an unusually cold storm systems brought heavy snow accumulations to northwest Oregon. The heavy snowfall created a significant impact to many communities across northwest Oregon. Fourteen to 24 inches of snow fell across the northern Willamette Valley. Some reports include 14 inches in Canby, 18 inches in Gladstone, 21 inches in Oregon City and 24 inches in Wilsonville. This storm was the most significant storm to hit the Portland Metro Area in the past 40 years. Freezing rain also occurred during this period with 1/4 to 3/4 inch of ice accumulation.			
12/24/2008	Winter Storm	0	$300,000
Description: Another cold storm system brought heavy snow accumulations to northwest Oregon. Four inches of snow fell over the Portland Metro area on Christmas eve. Freezing rain was also reported in the Portland and Troutdale areas. The snowfall combined with accumulations from the previous few days resulted in 4 roof collapses, 10 carports collapses and damage to 62 greenhouses.			

Date	Type	Deaths or Injuries	Property Damage
1/17/2009	High Wind	2	$30,000
Description: Strong winds caused some isolated power outages and downed a few trees in the Portland area.			
1/18/2009	High Wind	0	$25,000
Description: Strong east winds occurred across the Central Oregon Coast and through the Columbia River Gorge. A strong front produced strong winds that caused widespread power outages in Gresham, Troutdale and Multnomah Village. The high winds also downed several trees in southeast Portland, one of which fell on an automobile.			
6/4/2009	Thunderstorm Wind	0	$1,200
Description: A fairly vigorous upper level low pressure system had been blocked offshore and was finally allowed to progress onshore on June 4th. An upper level disturbance rotated around upper level low pressure system, enhancing divergence aloft and turning upper level flow easterly across much of western Oregon. This overall pattern resulted in enhanced vertical wind shear for the Willamette Valley, with southerly winds near the surface backing to easterly flow aloft. The June 4, 2009 was a significant thunderstorm outbreak by Northwestern Oregon standards, with several areas taking damage from strong thunderstorm wind gusts, minor urban area flooding, and rotation in a few storms resulted in one weak tornado. The top of a 70-foot tree was snapped off in downtown Portland at the intersection of SW Salmon Street and Park Avenue. A passer-by was nearly hit as it fell to the ground. Time of the event is estimated based nearby reports from the storm.			
11/16/2009	High Wind	0	$6,000
Description: Strong winds were estimated based on reports of damage to a downtown Portland residential home due to downed trees. Additionally, gusts of 43 – 48 knots were reported at the Portland home of a local television meteorologist. Power outages were reported across Clackamas county, with 1700 homes affected.			
9/22/2013	Strong Wind	0	$8 million
Description: A strong cold front resulted in high winds for the North and Central Oregon coast. This storm was the first storm of the Fall season, and also produced strong winds for the Northern Willamette Valley that resulted in structure damage and power outages for the Portland Metro area. Winds in the valley were 30 to 40 mph. These winds brought a tree down onto a house in SE Portland and left around 5000 people without power. Most of the power outages were in Washington County.			
9/28/2013	Strong Wind	0	$35,000
Description: A strong cold front resulted in strong winds across Northwest Oregon. Media reported via social media that a tree fell onto a mobile home near Hillsboro. Another social media report posted a picture of a tree that fell on two cars at the Fred Meyer in Oak Grove There were other reports of several large trees down around the Portland Metro Area. Portland General Electric reported over 25,000 customers were without power in Clackamas and Multnomah counties.			
11/7/2013	Strong Wind	0	$3,000
Description: A NWS Spotter estimated Winds of 55 mph, and reported several trees down along Highway 47 between Banks and Forest Grove. They reported power lines down and power outages in the area. A local media station KOIN stated that Pacific Power reported 12,500 customers without power in Northeast Portland for several hours. KOIN also said that Concordia University cancelled their morning classes. PGE reported that there were 2800 customers without power in Clackamas County.			
1/23/2014	Strong Wind	0	$7,000
Description: Strong east winds resulted in knocking two large trees over. One of these trees came down on an SUV in Milwaukie, and the other came down on an SUV in southwest Portland. There were also hundreds of people without power for at least an hour due to downed limbs on power lines.			
2/12/2014	Strong Wind	0	$1,000
Description: Strong winds downed a few trees and damaged a vehicle in Gresham.			
2/25/2014	Strong Wind	0	$7,000
Description: Strong and gusty east winds through the Columbia River Gorge resulted in impacts around the Portland Metro Area. Local media reported that a large tree fell onto a Max train and overhead wires in Gresham that closed that line for the rest of the day. Another downed tree crushed a SUV in Lake Oswego. A large tree took out power lines as it fell across Highway 43, disrupting power and closing the highway for a couple of hours. A Large tree branch fell and pierced through a window of a van that was driving on Highway 99 with luckily no injuries.			
3/6/2014	Strong Wind	0	$8,000

Date	Type	Deaths or Injuries	Property Damage
Description: Strong winds resulted in significant damage in the Portland Metro Area with area wind measurements between 30 and 48 mph. There were several reports of 12 to 24 inch diameter trees down. One landed on the Firestone Tire Building in downtown Portland, one closed a busy intersection at Hall and Bonita in Tigard, and another closed 'A' Avenue downtown Lake Oswego. There were numerous power outages, and tens of thousands of PGE customers were without power. Clackamas Community College cancelled all classes on March 6 due to the power outages.			
5/18/2014	Thunderstorm Wind	0	$11,000
Description: Winds from a thunderstorm resulted in a large oak tree falling on two parked cars in downtown Portland.			
10/25/2014	High Wind	0	$140,000
Description: Wind gusts up to 60 mph were reported throughout the Portland Metro Area. There were numerous trees downed by these winds with some landing on power lines. There were at least two homes that had major damage due to downed trees. Portland General Electric reported around 140,000 people without power by the end of the storm. One downed power line burned a hole in the road that it fell on. A NWS employee reported that a large gust blew doors open at a SW Portland restaurant, and ripped large paintings off the wall. Some of the downed trees blocked roads, and 2 lanes were blocked on Highway 30 for a couple of hours			
11/11/2014	High Wind	1	$32,000
Description: Strong winds resulted in downed trees throughout the Metro Area. Downed trees were responsible for the shut-down of several sections of the MAX line for several hours, and the closures of Cornelius Pass Road and Shattuck Road. One tree crashed the roof of a house in Oregon City and pinned the resident under a desk inside. A biker sustained serious injuries when a tree fell on him and a nearby car. A 54 mph easterly wind gust at the Portland Airport was the strongest east wind recorded since 1989.			
12/2/2014	Strong Wind	0	$15,000
Description: East winds blowing through the gorge were strong enough to knock over trees in the Portland Metro Area resulting in minor damage. One tree in Southwest Portland came down onto a house. Another tree knocked down near the Sellwood Bridge resulted in the closing of Highway 43 and caused major traffic delays. Several trees were knocked down in Gresham with at least one falling down on power lines and causing power outages. Another tree in Gresham fell onto a car.			
12/11/2014	High Wind	3	$80,000
Description: Gusty strong winds resulted in several downed trees for the Portland Metro Area. There were widespread road closures and power outages due to the downed trees. One fatality and one injury resulted from a tree falling onto a moving car. The Portland International Airport experienced re-routing and delays of aircraft, and the Portland Mass Transit, MAX system had system-wide delays due to power outages. In downtown Portland, loose material from a roof of a nearby building were lofted and blown against windows of the Standard Insurance Plaza damaging several windows on the fifteenth floor. A parapet of an apartment in NW Portland fell and caused major damage to the apartment building. At least one power pole was downed by the winds in Washington County. A large tree fell onto a moving car injuring a mother and killing her son.			
3/15/2015	Heavy Rain and High Wind	1	$118,000
Description: A series of storms along an atmospheric river of moisture produced a period of heavy rain from March 13 to March 15. Rainfall totals of 3 to 6 inches were measured for many areas of Northwest Oregon and a few local spots had over 7 inches of rain. The prolonged period of rain allowed the saturated soils to make large trees vulnerable to tip over if any winds developed (which did happen). No flooding was reported from this rain, but a mudslide did impact a residence in the west hills of Portland. *Around 50 trees were downed by strong winds in the afternoon on March 15 in the Portland Metro Area. A large tree fell onto a jeep and trapped an injured driver for several hours. Scaffolding was knocked off of a building downtown onto a few cars. A large tree even fell in the parking lot of the National Weather Service Forecast Office. Siding of a chimney in Southwest Portland was peeled off by the winds. Several roads were closed from trees and there were bus and train delays due to power outages. Four airplanes on route to Portland were diverted to other cities. A peak gust of 70 mph was measured at Chehalem Mountain, and a BPA weather station in Troutdale measured gusts of 63 mph.*			
6/7/2015	Heat	1	$0
Description: High Temperatures were in the low to mid 90s June 7 through June 9, which is around 22 degrees higher than the seasonal normal. The low temperatures were also unseasonably warm, and the low temperature on June 7 of 61 degrees at the Portland Airport tied the warmest low record that was previously set in 1948. There is one known indirect heat related fatality where a young man drowned while swimming in the Clackamas River near Gladstone. Multnomah County had 7 hospital visits for heat related illnesses.			
6/26/2015	Excessive Heat	1	$0

Date	Type	Deaths or Injuries	Property Damage
Description: Maximum temperatures were in the mid to upper 90s, which is 20 to 25 degrees above the seasonal normal. The low temperatures were in the mid 60s to low 70s. Several new daily temperature records were set for the warmest low temperatures. One man drowned after he fell off a jet ski in the Columbia River on June 27th. This accident occurred around 1 AM, but the warm nighttime temperatures likely contributed to him going into the river at night. The Multnomah County had 10 emergency room visits for heat related illnesses.			
8/29/2015	Strong Wind	0	$11,000
Description: Several locations measured wind gusts greater than 35 mph with the highest wind of 50 mph measured near the Oregon Zoo. There were several reports of downed trees and power lines that resulted in the loss of power for around 28,000 residents. Downed power lines closed Marine Drive, and a downed tree blocked a lane on US 30 on the Interstate 405 ramp at Thurman. A Twitter report showed a photo of downed tree damage to a couple of parked cars.			
10/31/2015	Heavy Rain	0	$150,000
Description: Heavy rain combined with clogged drains from leaves resulted in urban flooding. Portland Fire and Rescue received 32 calls in regards to street flooding, and assisted travelers in 5 cars from their stalled or trapped cars to dry land. Four roads were closed in the area for high water, and several Max lines were cancelled due to flooding under bridges. Thirteen Max trains were damaged by water and will be out of service for up to 2 weeks. One roof collapsed from the weight of rain water after the roof drains had been clogged, and several homes or businesses had flooded basements. A tree had fallen onto and damaged a parked car.			
12/1/2015	Ice Storm	0	$5,000
Description: A quarter to a half on an inch of ice was observed the eastern portions of the Portland Metro Area, mainly in Gresham and Troutdale. Tree limbs were broken by the ice and resulted in widespread power outages in eastern Multnomah County.			
12/7/2015	Heavy Rain and Strong Wind	0	$1.09 million
Description: Heavy rain resulted in urban flooding and small stream flooding throughout the Portland Metro Area. The rain was heavy enough to collapse a roof of a business in Gresham, Oregon, and cause a sink hole near Mt Hood College. High water flowing into Fairview Creek in Gresham snapped a sewage line. Several roads were closed due to high water and the TriMet Max operations were interrupted. Water crept into businesses and homes. There were at least two landslides in Portland; one on Corbett Hill, and the other on Cornell Road. *The media reported that strong winds resulted in tree damage near 5th and Jefferson in Oregon City. There was another report of a 1.5-foot diameter evergreen tree that fell onto a home in Clackamas and damaged the roof.*			
12/8/2015	Heavy Rain	0	$621,000
Description: Heavy rain resulted in urban flooding across the Portland Metro area. All Amtrak and freight trains were shut down between Portland and Vancouver due to flooding. A mobile home park in Gresham flooded. There were a couple of landslides on Highway 30 where debris covered the highway. One of these slides was near Germantown Road. The other slide was near the St John's Bridge, hit a car (with no injuries) as it happened, and covered all lanes of Highway 30.			
12/9/2015	Strong Wind	1	$107,000
Description: Strong winds combined with saturated soils from heavy rainfall resulted in property damage around the Portland Metro Area. A tree fell down and resulted in extensive damage to a home in Aloha. Another tree fell onto a home in Portland, killing a woman. Winds also damaged the Milwaukie Bridge. Broken tree limbs fell onto power lines that resulted in widespread power outages in Portland, Clackamas, and Beaverton.			
12/10/2015	Strong Wind	0	$60,000
Description: The media reported that a home in Aloha sustained significant damage as a tree downed by strong winds fell onto it.			
12/17/2015	Heavy Rain	0	$311,000
Description: Heavy rain resulted in new daily rainfall records for the Portland International Airport and downtown Portland. A new daily rainfall record of 1.87 inches at the airport broke the previous record of 1.02 inches from 1972. Downtown Portland measured 2.42 inches of rain, which broke the previous record of 2.26 inches from 1884. Standing water was reported on many roads in the area. The heavy rain caused a landslide on Highway 30 near the St Johns Bridge.			
12/21/2015	High Wind	0	$1.3 million
Description: High winds caused significant damage in the Portland Metro area as trees were downed onto homes and cars. Several roads were closed due to downed trees. Marine Drive was closed for several miles due to winds blowing a tractor trailer off of the road. One house caught on fire when a tree downed an electrical wire.			

Date	Type	Deaths or Injuries	Property Damage
3/1/2016	Strong Wind	1	$10,000
Description: Strong winds ahead of the front blew down a weak or dead tree onto a moving vehicle, killing the driver. Winds with the front downed several trees and branches near Beaverton resulting in power outages.			
3/13/2016	Strong Wind	0	$7,000
Description: Strong winds downed several trees in the Portland Metro Area. Some of these trees fell onto power lines and resulted in power outages, and others fell onto roadways and obstructed traffic. One tree fell onto a home in Portland with minor damage to the roof.			

a. Reported events since 1950 impacting Multnomah County and/or the Greater Portland Metro Area zone with reported injuries, fatalities, and/or property damage and event descriptions.

Source: http://www.ncdc.noaa.gov/stormevents/

7.2.2 Location

All areas of Portland are potentially exposed to severe weather events.

Thermal Extremes

Temperature extremes can occur throughout Portland. The Western Regional Climate Center notes several factors that have a significant impact on the local climate including terrain (such as the Cascade Range), the Pacific Ocean, and low pressure regions over the north Pacific Ocean. These climactic controls can cause significant climate differences in relatively short distances.

Thunderstorms

Thunderstorms affect relatively small localized areas, rather than large regions like winter storms and extreme temperature events. Thunderstorms can strike all regions of the United States, although they are most common in central and southern states. It is estimated that there are as many as 40,000 thunderstorms each day worldwide. The City of Portland can experience an average of 10 to 20 thunderstorm days each year (National Weather Service, 2010).

Tornadoes

Approximately 1,200 tornadoes occur in the United States each year, with the central portion of the country experiencing the most. The State of Oregon and the City of Portland have a lower risk for tornados than elsewhere in the country. Tornadoes are usually localized. Severe thunderstorms can result in conditions favorable to the formation of numerous or long-lived tornadoes.

Windstorms

All of the City of Portland is subject to high winds from thunderstorms and other severe weather events. According to FEMA, the City of Portland is located in Wind Zone I, where wind speeds can reach up to 130 mph. The City is also located in a special wind region along the west coast from Washington to Oregon. Figure 7-7 indicates how the frequency and strength of windstorms impacts the United States and the general location of the most wind activity. This is based on 40 years of tornado data and 100 years of hurricane data collected by FEMA.

Source: FEMA n.d.

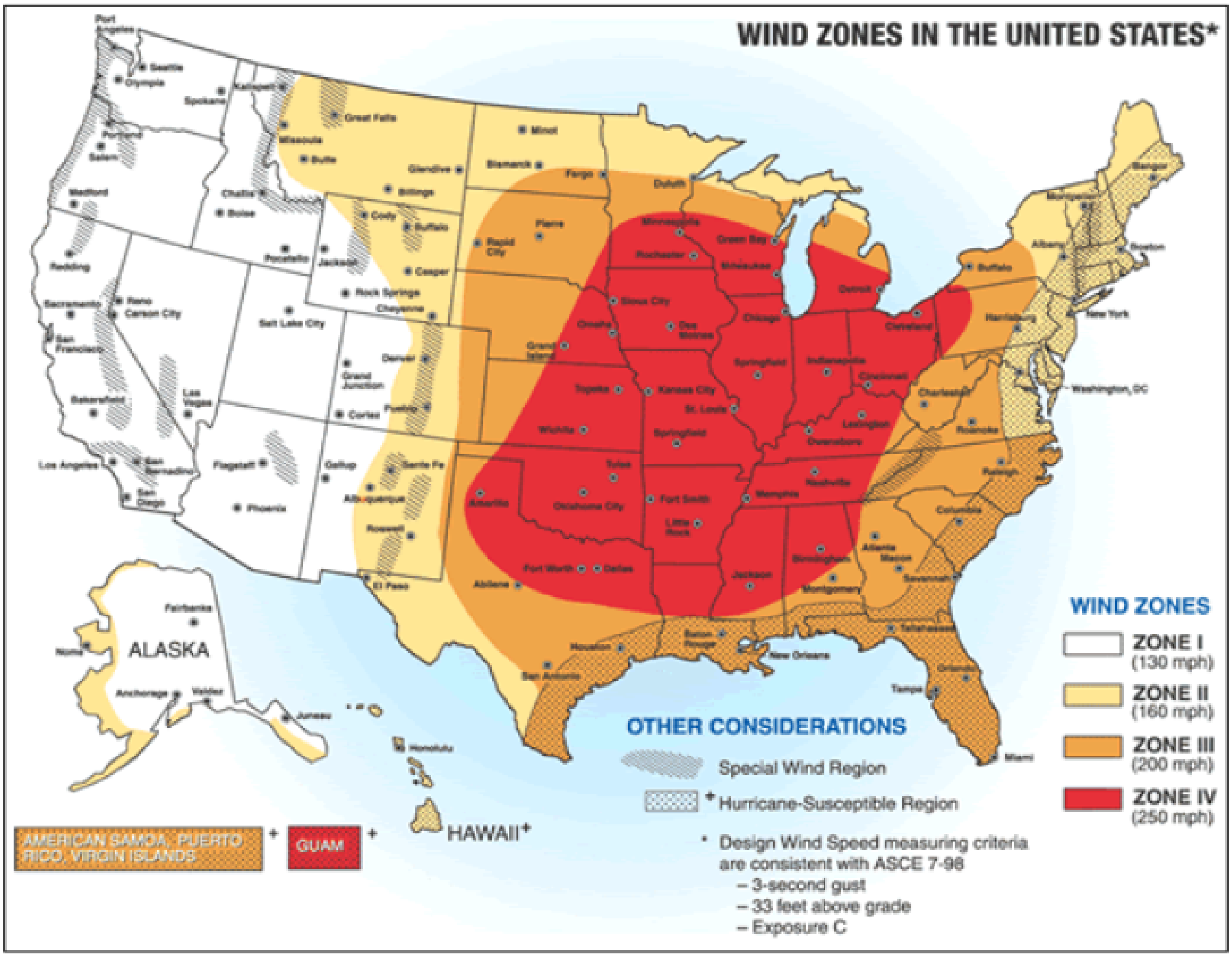


Figure 7-7. Wind Zones in the United States

Winter Storms

Snow accumulation is most common at higher elevations, but can occur anywhere in Portland. Snow events occur if a wet Pacific storm reaches the area when a cold air mass is present. Cold air rarely travels west of the Cascade Range, as the mountains provide a natural barrier separating the Willamette Valley from the cold air to the east (NHMP, 2010). A natural break in the Cascade Mountains does occasionally allow cold air from the east to funnel through the Columbia Gorge into the Portland area, which can eventually settle south in the Willamette Valley and thus create snow and ice events (ONHW, 2004 as cited in NHMP, 2010). Ice events include freezing rain, sleet and hail.

7.2.3 Frequency

Portland can expect to experience exposure to some type of severe weather event at least annually. Many of the severe weather events for the City of Portland shown in Table 7-1 are related to high winds and severe winter weather. According to records, in 66 years, the city has experienced 150 severe weather events, an average of two to three events per year. Thunderstorms, windstorms and winter storms are likely to occur in the region annually. Not all storms produce damage.

The *2015 Oregon Natural Hazard Mitigation Plan*, identifies the following probabilities for winds of varying strength in Region 2, which includes Portland:

- A 25-year event for the region (4-percent annual probability) is 65 miles per hour.
- A 50-year event (2-percent annual probability) is 72 miles per hour.
- A 100-year event (1-percent annual probability) is 80 miles per hour.

Eight instances of thermal extreme events are listed for Portland between 1996 and 2015; however, this data likely underestimates the occurrence of such events. Extreme heat events can occur several times per year, especially in the summer.

There have been six reported funnel clouds or tornadoes in Portland since 1950. This amounts to about one such event every decade. Tornadoes can occur at any time of the year, with peak seasons at different times for different states (NSSL, 2015). In Oregon, tornadoes have been reported during all seasons; however, almost half of reported tornadoes have been reported in April, May and June (Storm events database, 2016). Based on historical records, tornadoes seem to be least likely in the state from January through March. Two of the tornadoes in or near Portland occurred in April and one occurred in November.

7.2.4 Severity

The most common problems associated with severe storms are immobility and loss of utilities. Fatalities are uncommon, but can occur. Roads may become impassable due to flooding, downed trees or a landslide. Power lines may be downed due to high winds or ice accumulation, and services such as water or phone may not be able to operate without power. Lightning can cause severe damage and injury. Physical damage to homes and facilities can be caused by wind, accumulation of snow or ice, and flooding resulting from heavy rain events. Even a small accumulation of snow can cause havoc on transportation systems.

Windstorms can be a frequent problem in Portland and have been known to cause damage to utilities. The predicted wind speed given in wind warnings issued by the National Weather Service is for a one-minute average; gusts may be 25 to 30 percent higher. Lower wind speeds typical in the lower valleys are still high enough to knock down trees and power lines and cause other property damage.

Ice storms accompanied by high winds can have especially destructive impacts, especially on trees, power lines, and utility services. While sleet and hail can create hazards for motorists when they accumulate, freezing rain can cause the most dangerous conditions in Portland. Ice buildup can bring down trees, communication towers and wires, creating hazards for property owners, motorists and pedestrians. Rain can fall on frozen streets, cars, and other sub-freezing surfaces, creating dangerous conditions.

The severity of an extreme heat event depends on how early the event occurs in the summer and the number of consecutive days it lasts (U.S. EPA, 2006). Urban heat island effect can exacerbate the severity of an extreme heat event. While the severity of an extreme heat event may vary, impacts include increased energy consumption, elevated emissions of air pollutants and greenhouse gases, compromised human health and comfort, and impaired water quality (U.S. EPA, 2015). Extreme heat can also impact infrastructure by warping bridges, causing roads to buckle, melting runways, and more.

Lightning severity is typically investigated for both property damage and life safety (injuries and fatalities). The number of reported injuries from lightning is likely to be low.

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

7.2.5 Warning Time

Meteorologists can often predict the likelihood of a severe storm. This can give several days of warning time. However, meteorologists cannot predict the exact time of onset or severity of the storm. Some storms may come on more quickly and have only a few hours of warning time.

7.2.6 Compounding Factors and Secondary Hazards

Secondary Hazards

The most significant secondary hazards associated with severe weather are floods, falling and downed trees, landslides and downed power lines. Rapidly melting snow combined with heavy rain can overwhelm both natural and man-made drainage systems, causing overflow and property destruction. Landslides occur when the soil on slopes becomes oversaturated and fails. Air quality issues can be exacerbated by severe weather events, particularly excessive heat. High temperatures can increase ground level ozone, a local air pollutant (City of Portland and Multnomah County, 2014).

Compounding Factors

El Niño-Southern Oscillation

The El Niño-Southern Oscillation (ENSO) climate pattern creates increased weather volatility such as hotter summers and colder winters, intense thunderstorms, lightning, hail, snow storms, freezing rain/ice storms, high winds and tornadoes. ENSO consists of two weather phenomena: El Niño and La Niña. While ENSO activities are not a hazard, they can lead to severe weather events and large-scale damage throughout Oregon, including Portland. Direct correlations were found linking ENSO events to severe weather across the Pacific Northwest, particularly drought, flooding and severe winter storms (Oregon, 2004 as cited in NHMP, 2010). Therefore, increased awareness and understanding of the impacts of ENSO events on regional weather are important (NHMP, 2010).

Climate Change

Several facets of climate change are likely to have impacts on the severe weather hazard that may increase the frequency of severe weather and result in those events becoming more extreme. Generally, these impacts are related to the following parameters (EPA, 2016):

- **Frequency**—Are events occurring more often than they did in the past?
- **Intensity**—Are events getting more severe, with the potential for more damaging effects?
- **Duration**—Are events lasting longer than "the norm"?
- **Timing**—Are events occurring earlier or later in the season or the year than they used to?

Figure 7-8 illustrates how the shift in climate normal can result in an increased frequency of extreme events.

Source: EPA, 2016

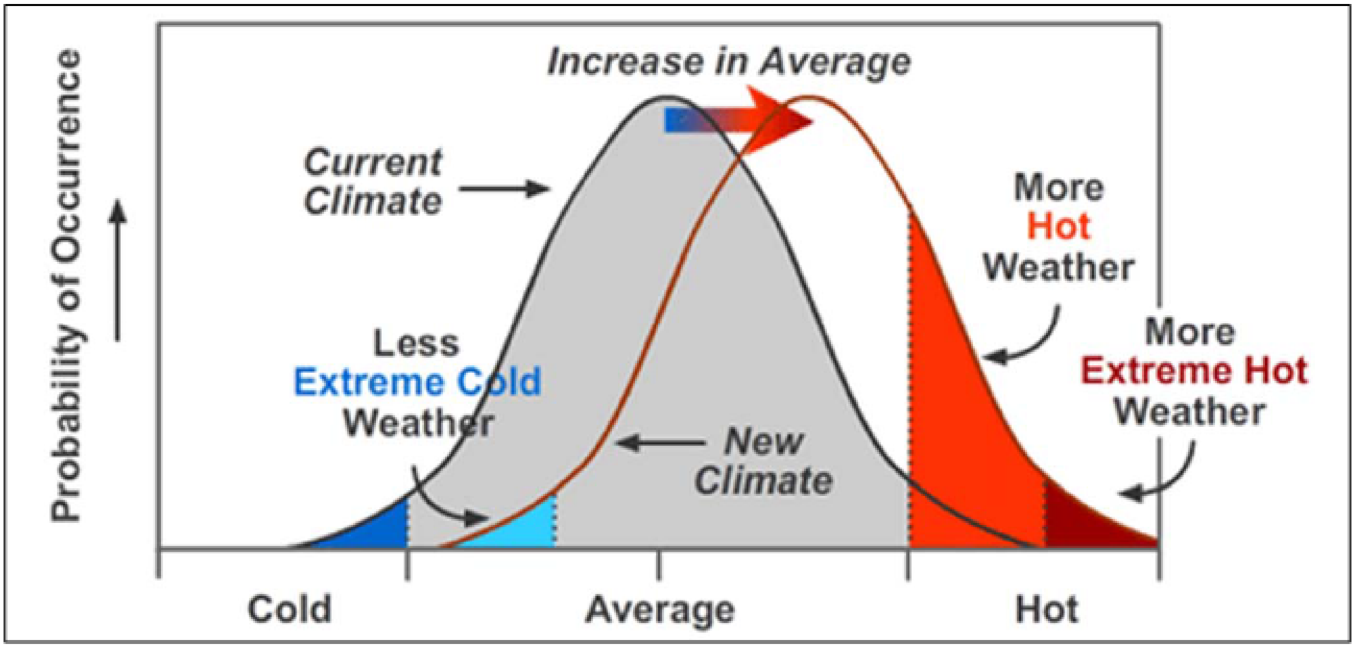


Figure 7-8. Impacts of Climate on Probability of Extreme Events

According to the *City of Portland and Multnomah County Climate Change Risk and Vulnerability Assessment* (2014), the following climate parameters related to severe weather are likely to have impacts for the City of Portland:

- Increase in average annual air temperature and likelihood of extreme heat events
- Changes in hydrology and water supply:
  - Reduced snowpack and water availability in some basins
  - Changes in water quality and timing of water availability (winter precipitation may be increasing)
- Increased incidence and magnitude of damaging floods and frequency of extreme precipitation events.

7.3 EXPOSURE

Portland's many micro-climates, hills and valleys, and the Columbia Gorge all contribute to weather variations. With major transportation routes that could be affected by ice and snow, bridges and hills to cross to get from one part of the city to the next and the economic impact of road closures, the exposure and vulnerability of the City to severe weather events is a reality every year (NHMP, 2010).

7.3.1 Population

All of Portland is exposed to some extent to severe weather. Some areas are more exposed due to geographic location and local weather patterns. People living at higher elevations with large stands of trees or power lines may be more susceptible to wind damage and lightning strikes. People in low-lying areas are at risk for possible flooding. People in densely populated urban areas without air conditioning, working outside, or in industrial corridors are likely to be more exposed to extreme heat events.

Economically disadvantaged households may be more exposed if heat and electricity are turned off during winter months. Residents who lack proper shelter are also more likely to be exposed to negative impacts from severe weather.

7.3.2 Property

According to the Multnomah County Assessor records used for this analysis, there are 193,837 structures in Portland. Most of these buildings are residential. All of these buildings are considered to be exposed to the severe weather hazard, but structures in poor condition or in particularly vulnerable locations (located on hilltops or exposed open areas) may risk the most damage. The frequency and degree of damage will depend on specific locations.

7.3.3 Critical Facilities and Infrastructure

All critical facilities exposed to flooding and landslide (see Chapters 10 and 11) are also likely exposed to severe weather. Additional facilities on higher ground may be exposed to damage from wind of falling trees. The most common problems associated with severe weather are loss of utilities. Downed power lines can cause blackouts, isolating large areas. Phone, water and sewer systems may not function. Roads may become impassable due to ice or snow or from secondary hazards such as landslides.

7.3.4 Environment

The environment is highly exposed to severe weather events. Natural habitats such as streams and trees are exposed to the elements during a severe storm and risk major damage and destruction. Prolonged rains can saturate soils and lead to slope failure. Flooding events caused by severe weather or snowmelt can produce river channel migration or damage riparian habitat.

7.4 VULNERABILITY

7.4.1 Population

Populations most vulnerable to severe weather events are those that are dependent on electricity for life support or that lack proper shelter. The elderly, young and persons with access and functional needs may be more vulnerable during extended power outages, especially if they are isolated. Population vulnerabilities to specific types of severe weather event are as follows:

- **Thermal Extremes—**Individuals with physical or mobility constraints, cognitive impairments, economic constraints, or social isolation are typically at greater risk to the adverse effects of excessive heat events. The average summertime mortality for excessive heat events is dependent upon the methodology used to derive such estimates. Certain medical conditions, such as heat stroke, can be directly attributable to excessive heat, while others may be exacerbated by excessive heat, resulting in medical emergencies. Individuals who lack shelter and heating are particularly vulnerable to extreme cold and wind chill.
- **Thunderstorms—**Nationally, lighting is one of the leading causes of weather-related fatalities (CDC, 2013). Lightning strikes are far more common in other areas of the country than they are in the Pacific Northwest. The majority of injuries and deaths associated with lighting strikes occur when people are outdoors; about one-third of lightning-related injuries occur indoors. Males are five times more likely than females to be struck by lighting and people between the ages of 15 and 34 account for 41 percent of all lightning strike victims (CDC, 2013).
- **Windstorms and Tornadoes—**Debris carried by extreme winds and trees felled by gusty conditions can contribute directly to loss of life and indirectly to the failure of buildings and other

structures that offer protection. Utility lines brought down by thunderstorms have also been known to cause fires, which start in dry roadside vegetation. Electric power lines falling down to the pavement create the possibility of lethal electric shock. Those with physical or mobility constraints may not be able to seek adequate shelter in the event of a tornado.

- **Winter Storms**—Many of the deaths that result from severe winter weather are indirectly related to the actual weather event, including deaths resulting from traffic accidents on icy roads and heart attacks while shoveling snow. Icy road conditions that lead to major traffic accidents can make it difficult for emergency personnel to travel. This may pose a secondary threat to life if police, fire, and medical personnel cannot respond to calls. Homeless populations that lack adequate shelter are also vulnerable to severe winter weather events.

Severe weather may have compounding impacts on socially vulnerable populations. For example, a severe winter storm that prompts school closures may result in the need for a parent to stay home from work to care for the children. Missing work could result in serious economic repercussions for economically disadvantaged households that spiral into much larger issues than a day of missed work.

7.4.2 Property

All property is vulnerable during severe weather events, but properties in poor condition or in particularly exposed locations may risk the most damage. Those in higher elevations and on ridges may be more prone to wind damage. Those that are located under or near overhead lines or near large trees may be vulnerable to falling ice or may be damaged in the event of a collapse. Table 7-3 shows the age of structures in Portland. Modern building code requirements regarding snow load came into effect in 2008. Structures built before 2008 may be more vulnerable to some severe weather events, such as heavy snow.

Table 7-3. Age of Structures in Portland

	Pre-2008[a]		2008-present[a]	
Reporting Area	Number of Structures	Percent	Number of Structures	Percent
Airport	594	92.4%	49	7.6%
Central City	2,575	97.2%	74	2.8%
Central Northeast	17,051	98.0%	355	2.0%
East Portland	42,463	97.0%	1,292	3.0%
North Portland	23,405	95.6%	1,084	4.4%
Northeast	19,932	96.4%	748	3.6%
Southeast	51,502	96.7%	1,768	3.3%
Southwest	22,539	97.5%	585	2.5%
West/Northwest	7,616	97.4%	205	2.6%
Total	**187,677**	**96.8%**	**6,160**	**3.2%**

a. Year built information was collected from Multnomah County Assessor data. When year built information was unavailable, it was estimated based on census block or county-wide average year built dates.

Loss estimations for the severe weather hazard are not based on damage functions, because no such damage functions have been generated. Instead, loss estimates were developed representing 10 percent, 30 percent and 50 percent of the replacement value of exposed structures. This allows emergency managers to select a range of potential economic impact based on an estimate of the percent of damage to the general building stock. Damage in excess of 50 percent is considered to be substantial by most building codes and typically requires total reconstruction of the structure. Table 7-4 lists the loss estimates.

Table 7-4. Loss Potential for Severe Weather

Reporting Area	Exposed Value	Potential Loss @ 1% Damage	@ 2.5% Damage	@ 5% Damage	@ 10% Damage	@ 50% Damage
Airport	$3,953,292,817	$39,532,928	$98,832,320	$1,976,646,409	$395,329,282	$1,976,646,408
Central City	$31,198,797,529	$311,987,975	$779,969,938	$15,599,398,765	$3,119,879,753	$15,599,398,765
Central Northeast	$10,886,322,033	$108,863,220	$272,158,051	$5,443,161,017	$1,088,632,203	$5,443,161,017
East Portland	$26,055,288,004	$260,552,880	$651,382,200	$13,027,644,002	$2,605,528,800	$13,027,644,002
North Portland	$23,502,220,863	$235,022,209	$587,555,522	$11,751,110,432	$2,350,222,086	$11,751,110,432
Northeast	$13,110,911,253	$131,109,113	$327,772,781	$6,555,455,627	$1,311,091,125	$6,555,455,626
Southeast	$30,396,480,542	$303,964,805	$759,912,014	$15,198,240,271	$3,039,648,054	$15,198,240,271
Southwest	$17,794,371,568	$177,943,716	$444,859,289	$8,897,185,784	$1,779,437,157	$8,897,185,784
West/Northwest	$13,908,090,256	$139,080,903	$347,702,256	$6,954,045,128	$1,390,809,026	$6,954,045,128
Total	$170,805,774,865	$1,708,057,749	$4,270,144,372	$85,402,887,433	$17,080,577,487	$85,402,887,433

7.4.3 Critical Facilities and Infrastructure

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

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

7.4.4 Environment

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

7.4.5 Economic Impact

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

7.5 FUTURE TRENDS IN DEVELOPMENT

All future development will be affected by severe storms. The ability to withstand impacts lies in sound land use practices and consistent enforcement of codes and regulations for new construction. The City of Portland has adopted the International Building Code. This code is equipped to deal with the impacts of severe weather events. Land use policies identified in the comprehensive plan also address many of the secondary impacts (flood and landslide) of the severe weather hazard. Additionally, the City of Portland has begun efforts to reduce severe weather impacts through low impact development and green infrastructure standards. With these tools, the City of Portland is well equipped to deal with future growth and the associated impacts of severe weather.

7.6 SCENARIO

A worst-case event would involve prolonged high winds during a snowstorm accompanied by freezing temperatures, followed by warmer weather and continued rain. Such an event would have both short-term and longer-term effects. Initially, schools and roads would be closed due to snow and downed tree obstructions. Power outages would be common. Later, as the weather warms and snow turns to rain, the sudden runoff could produce severe urban flooding in low-lying areas and landslides on steep slopes.

7.7 ISSUES

Important issues associated with a severe weather in Portland include the following:

- Redundancy of power supply throughout Portland must be evaluated to better understand which areas may be vulnerable.
- Many critical facilities in Portland may have limited or inadequate backup power generation, with only enough fuel on hand to run emergency generators for a short amount of time. This may result in loss of services, such as potable water, during extended power outages or may present risks to vulnerable populations such as those in hospitals or other care facilities.
- Debris management (downed trees, etc.) must be addressed, because debris can impact the severity of severe weather events, requires coordination efforts, and may require additional funding. A debris management plan is currently being developed.
- The effects of climate change may result in an increase in frequency of extreme heat events or more frequent, stronger storm systems.
- Older building stock in Portland is built to low code standards or none at all. These structures could be highly vulnerable to severe winter weather effects such as snow loads or high winds.
- Urban forest management programs should be evaluated to help reduce impacts from forest-related damage.
- Severe weather events cause or exacerbate many secondary hazard including power outages, poor air quality and landslides.
- Drainage systems and culverts in Forest Park and other areas throughout the City can and have been overwhelmed by heavy precipitation events, causing erosion and costly damage to fire access roads.

8. EARTHQUAKE

8.1 GENERAL BACKGROUND

8.1.1 How Earthquakes Happen

An earthquake is the vibration of the earth's surface following a release of energy in the earth's crust. This energy can be generated by a sudden dislocation of the crust or by a volcanic eruption. Most destructive quakes are caused by dislocations of the crust. The crust may first bend and then, when the stress exceeds the strength of the rocks, break and snap to a new position. In the process of breaking, vibrations called "seismic waves" are generated. These waves travel outward from the source of the earthquake at varying speeds. There are two main types of seismic waves (Michigan Technical University, 2007):

DEFINITIONS

- **Earthquake**—A sudden slip on a fault, volcanic or magmatic activity, and sudden stress changes in the earth that result in ground shaking and radiated seismic energy.
- **Liquefaction**—The complete failure of soils occurring when soils lose shear strength, flow horizontally, and behave like viscous fluids when liquefaction occurs.
- **Magnitude**—The measure of the strength of an earthquake, typically measured by the Richter scale. Each whole number step in the magnitude scale corresponds to the release of about 31 times more energy than the amount associated with the preceding whole number.

- Body waves travel through the earth's interior. They include P waves (primary waves) and S waves (secondary waves). P waves travel through solids and fluids, sending particles in the same direction that the wave is moving. Some animals, such as dogs, are able to hear P waves. S waves are the waves that are felt during an earthquake. These waves travel more slowly than P waves and are only transmitted through rock. S waves move particles up and down.
- Surface waves travel along the surface. They are lower frequency than body waves and arrive later. It is these waves that are primarily responsible for the destruction resulting from earthquakes. S waves also come in two types: Love waves and Rayleigh waves. Love waves travel exclusively on the surface of the earth and produce horizontal motion. Rayleigh waves travel like ocean waves, rolling the ground up and down. Most of the shaking felt during earthquakes is the result of these waves.

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

8.1.2 Types of Earthquakes

Four types of earthquakes affect the Portland area (see Figure 8-1):

- **Shallow Crustal earthquakes**—Shallow crustal earthquakes occur in the North America plate at depths of 20 miles or less (PNSN, n.d. a). These types of earthquakes occur frequently in the Pacific Northwest. Most are relatively small, but large, damaging events in the region have and will continue to occur. Generally, these earthquakes are expected to last from 20 to 60 seconds, with magnitudes less than 7.5. Aftershocks are likely (see #4 in Figure 8-1) (CREW, 2009).

Source: DOGAMI, 2010

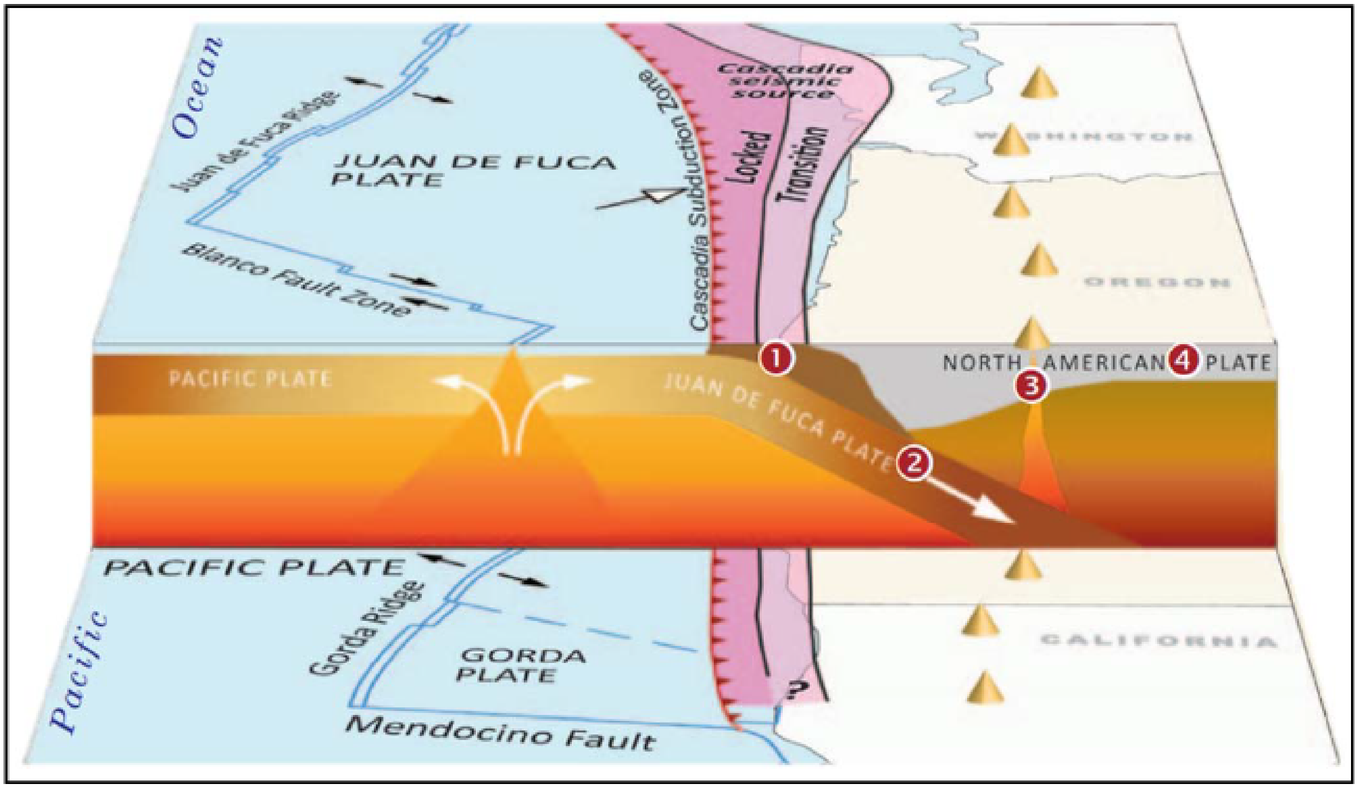


Figure 8-1. Earthquake Types in Oregon

- **Benioff Zone (Deep or Intraplate) Earthquakes**—Benioff Zone earthquakes occur in the Juan De Fuca plate as moves below the North American plate. They are deep earthquakes, 20 miles or more in depth (PNSN, n.d. b). Shaking from these earthquakes can last up to 60 seconds. Due to their depth, aftershocks are typically not felt. Generally, these earthquakes cause less damage than shallow earthquakes of similar magnitude but are felt over a wider area (CREW, 2009) (see #2 in Figure 8-1)
- **Subduction Zone Earthquakes**—Subduction Zone earthquakes occur at the interface between tectonic plates. A subduction zone earthquake affecting the City of Portland would be centered in the Cascadia Subduction Zone off the coast of Washington or Oregon. Such earthquakes typically have a minute or more of strong ground shaking, and are quickly followed by damaging tsunamis and numerous large aftershocks. The potential exists for large earthquakes along the Cascadia Subduction Zone, with a magnitude of 9 or more (CREW, 2009). This could produce a tsunami all along the fault line from British Columbia to Mendocino, California. The tsunami would not impact the City of Portland; however, lateral spreading and ground settlement would likely occur. Such an earthquake would produce catastrophic damage in the region (see #1 in Figure 8-1).
- **Volcanic activity** related seismic events, such as those occurring before an eruption of one of the volcanoes in the nearby Cascade Mountain Range, can also impact Portland. Such earthquakes can reach a magnitude of 5.5. The earthquake preceding the 1980 Mt. Saint Helens eruption was a magnitude 5.1 (see #3 in Figure 8-1) (Oregon Department of Land Conservation and Development, 2015).

8.1.3 Faults

Geologists classify faults by their relative hazards. Active faults, which represent the highest hazard, are those that have ruptured to the ground surface within the last 11,000 years. Potentially active faults are those that displaced layers of rock within the last 1.8 million years. Determining if a fault is active or potentially active depends on geologic evidence, which is not available for every fault. Additionally, earthquakes may occur on faults that have not been mapped and identified.

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

8.1.4 Earthquake Classifications

Earthquakes are typically classified in one of two ways: By the amount of energy released, measured as **magnitude**; or by the impact on people and structures, measured as **intensity**. Magnitude describes the size at the focus of an earthquake and intensity describes the overall felt severity of shaking during the event.

Magnitude

An earthquake's magnitude is a measure of the energy released at the source of the earthquake. It is expressed by ratings on the local magnitude scale (ML), commonly called the Richter scale, or the moment magnitude scale (M_W). Currently the most commonly used magnitude scale is the moment magnitude scale, with the follow classifications of magnitude:

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

One advantage of the moment magnitude scale is that, unlike other magnitude scales, it does not saturate at the upper end. That is, there is no value beyond which all large earthquakes have about the same magnitude. For this reason, moment magnitude is now the most often used estimate of large earthquake magnitudes. The magnitudes referenced in the scenario events used in the risk analysis are expressed in the moment magnitude scale.

Intensity

The intensity of an earthquake is based on the observed effects of ground shaking on people, buildings and natural features. Intensity of a given earthquake varies with location. The Modified Mercalli (MMI) scale expresses intensity of an earthquake and describes how strong a shock was felt at a particular location. Table 8-1 summarizes earthquake intensity as expressed by the Modified Mercalli scale.

Table 8-1. Mercalli Scale and Peak Ground Acceleration Comparison

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

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

8.1.5 Ground Motion

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

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

8.1.6 Effect of Soil Types

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

Table 8-2. NEHRP Soil Classification System

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

8.2 HAZARD PROFILE

8.2.1 Past Events

Table 8-3 summarizes recorded historical earthquakes from before the current era (BCE) to the present that were believed to have been felt or to have caused damage in Portland. The largest recorded earthquake epicenter within 100 miles of Portland occurred in Scotts Mills on March 25, 1993. Its magnitude was 5.6 and it caused minor damage to some buildings. The shaking was intense enough to require damage assessment team deployments to perform bridge and key infrastructure inspections (NHMP, 2010). Federal disaster declaration DR-985, issued in response to this earthquake, applied to Clackamas and Washington Counties. There is geologic evidence that a magnitude 6.5 event may have occurred on the Portland Hills fault zone within the past 10,000 years; but, no events on that fault have been recorded in historic times (DOGAMI, 2001).

Table 8-3. Historical Earthquake Events in or Impacting Portland

Date	Location	Magnitude
February 2001[a]	Nisqually, Washington	6.8
March 25, 1993[b]	33.5 miles from Portland	5.6
1989[b]	82 miles from Portland	5.1
1981[b]	38 miles from Portland	5.5
1980[b]	60 miles from Portland	5.0
1980[b]	53 miles from Portland	5.0
March 27, 1964 [b]	Prince William Sound, Alaska	9.2
December 1963[a]	Portland area	4.5
November 1962[a]	Portland area	5.5
November 1961[a]	Portland area	5.0
December 1953[a]	Portland area	4.5
April 1949[a]	Olympia, Washington	7.1
December 1941[a]	Portland area	4.5
February 1892[a]	Portland area	5.0
October 1877[a]	Portland area	5.2
January 1700[a]	Cascadia Subduction Zone	About 9.0
1400 BCE, 1050 BCE, 600 BCE, 400 BCE, 400, 750, 900[a]	Cascadia Subduction Zone	Probably 8.0-9.0

a. Source: Oregon OEM, 2015

b. Source: NHMP, 2010

8.2.2 Location

Identifying the extent and location of an earthquake is not as simple as it is for other hazards such as flood, landslide or wildfire. The impact of an earthquake is a function of ground shaking, soil condition and type, and distance from the source (both horizontally and vertically). Mapping that shows the impacts of these components was used to assess the risk of earthquakes in Portland. While the impacts from each of these components can build upon each other during an earthquake event, the mapping looks at each component individually.

Identified Faults

The convergence of the Juan de Fuca and North American tectonic plates puts most areas of western Oregon, including the City of Portland, at risk for a catastrophic earthquake with a Magnitude 9 or higher. Figure 8-2 shows identified faults in and near the City of Portland. The City straddles three identified crustal faults (Oregon Department of Land Conservation and Development, 2015):

- The Oatfield fault, west of the northwest hills
- The East Bank fault, traversing the Willamette River into Oregon City
- The Portland Hills fault, running parallel to Forest Park into downtown Portland.

Shake Maps

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

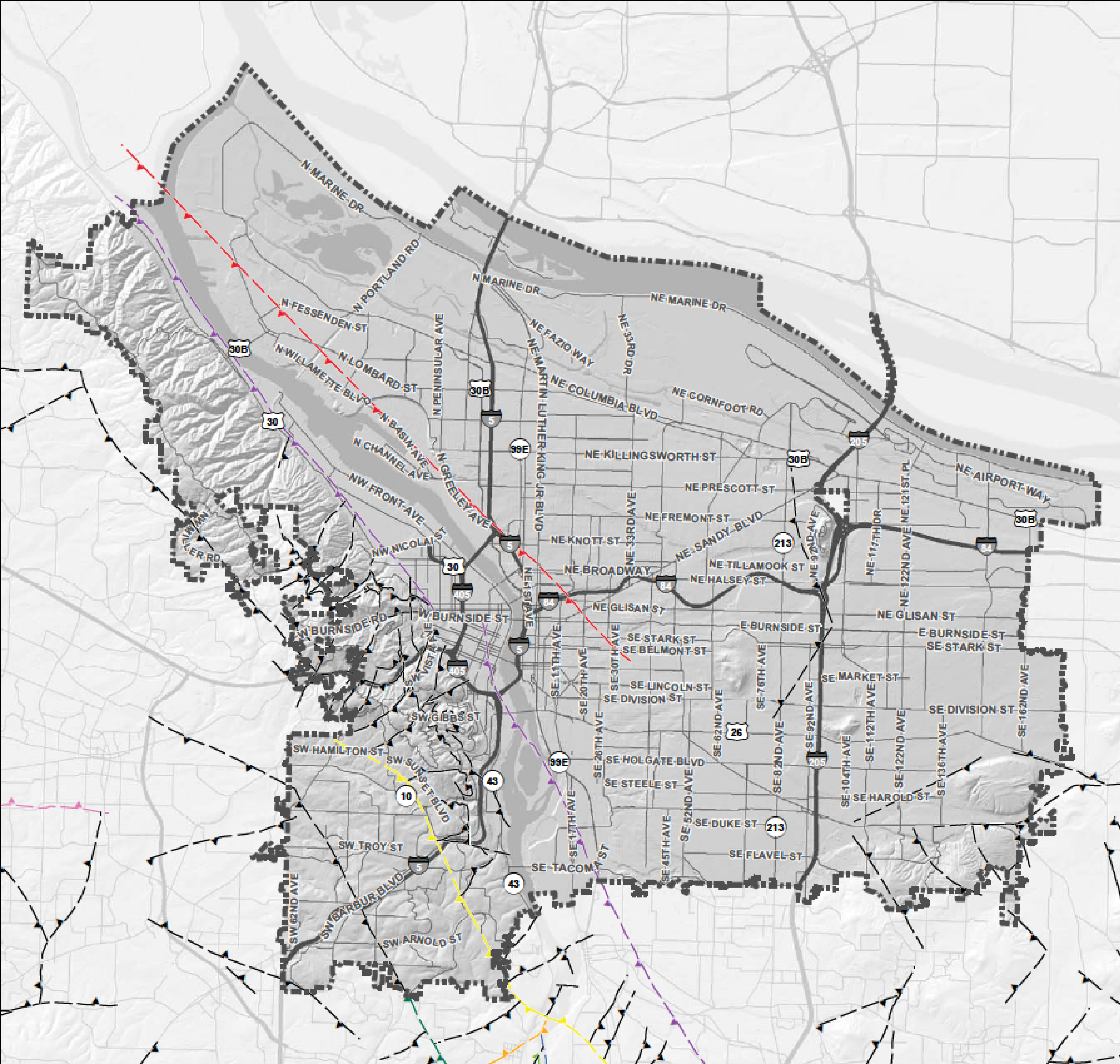
Ground motion and intensity maps are derived from peak ground motion amplitudes recorded on seismic sensors (accelerometers), with interpolation based on estimated amplitudes where data are lacking, and site amplification corrections. Color-coded instrumental intensity maps are derived from empirical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

- A probabilistic seismic hazard map shows the hazard from earthquakes that geologists and seismologists agree are statistically likely to occur in a given time period. Figure 8-3 and Figure 8-4 show the estimated ground motion for the 100-year and 500-year probabilistic earthquakes in Portland.
- Earthquake scenario maps describe the expected ground motions and effects of hypothetical large earthquakes for a region. Two scenarios were chosen for this plan:
    - Cascadia Subduction Zone Scenario—A Magnitude 9.0 event off the Pacific Coast. See Figure 8-5.
    - Portland Hills Fault Scenario—A Magnitude 6.5 event with the epicenter near the border of Washington and Oregon. See Figure 8-6.

September 12, 2016

Mitigation Action Plan (MAP)

Figure 8-2. Earthquake Fault Lines



Legend

City Boundary

Earthquake Fault Lines

- Unnamed Fault
- Beaverton Fault
- East Bank Fault
- Lake Oswego Fault
- Marylhurst Fault
- Oatfield Fault
- Portland Hills Fault
- River Forest Fault
- Sylvania Fault

NORTH

0 0.75 1.5 Miles

Sources: DOGAMI-2011;
City of Portland-2016

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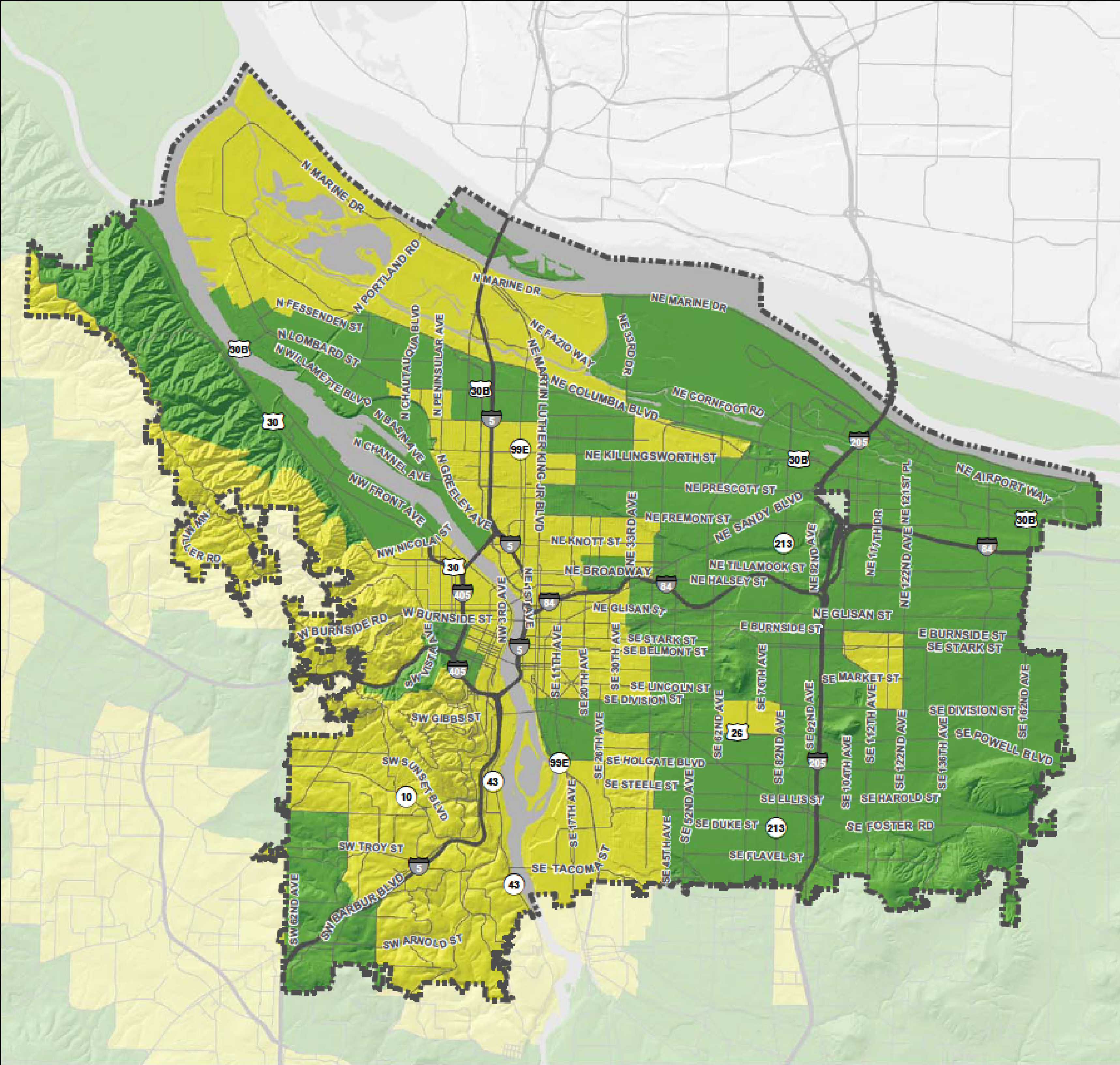


September 12, 2016

Mitigation Action Plan (MAP)

Figure 8-3. 100-year Probabilistic Earthquake--Peak Ground Acceleration

Legend

City Boundary

100-year probabilistic earthquake PGA

Potential Damage - Perceived Shaking

V -- Very Light - Moderate

VI -- Light - Strong

NORTH

0 0.75 1.5 Miles

Sources: FEMA-2014; City of Portland-2016

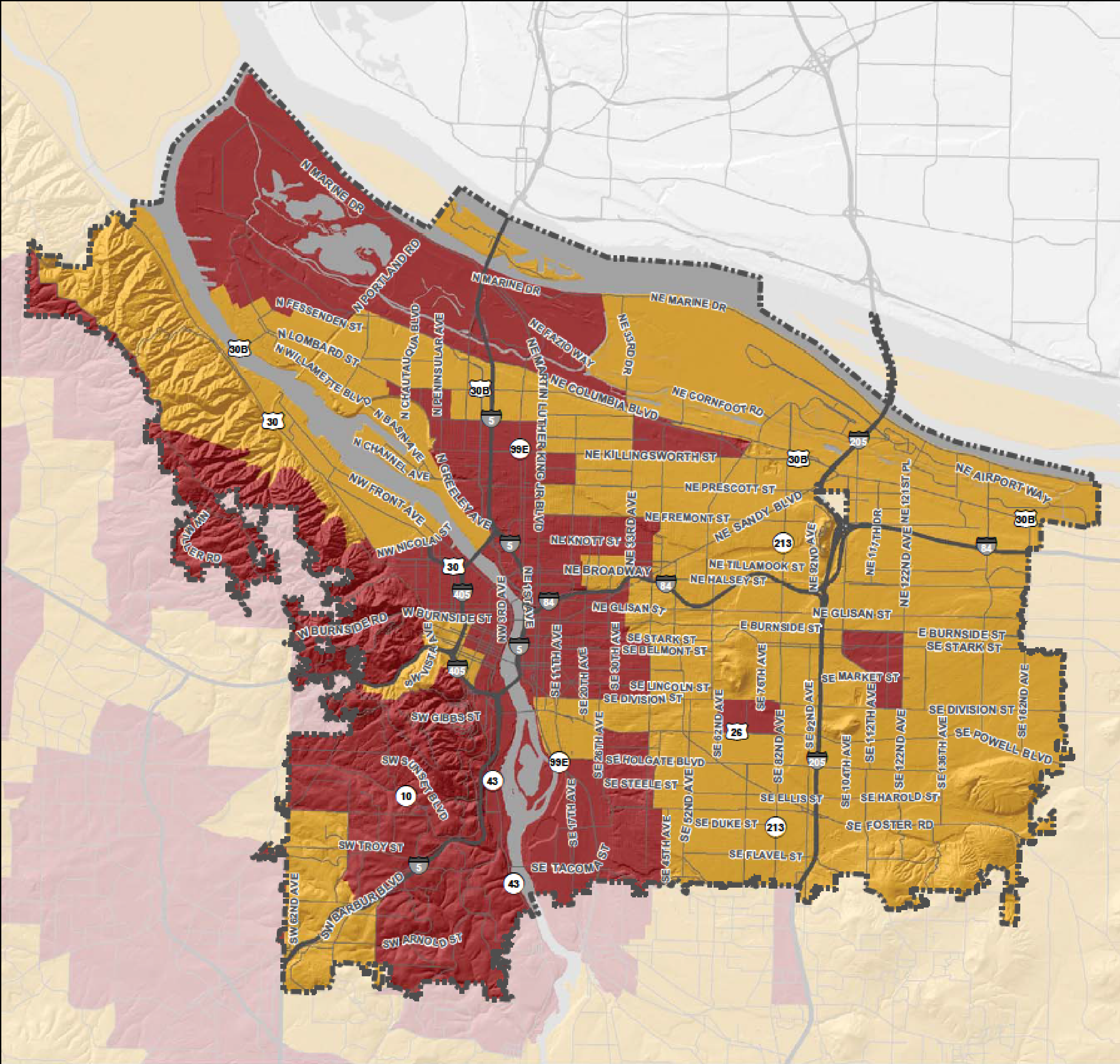
37242

PBEM

September 12, 2016

Mitigation Action Plan (MAP)

Figure 8-4. 500-year Probabilistic Earthquake--Peak Ground Acceleration



Legend

City Boundary

500-year probabilistic earthquake PGA

Potential Damage - Perceived Shaking

VI -- Light - Strong

VII -- Moderate - Very Strong

VIII -- Moderate/Heavy - Severe

NORTH

0 0.75 1.5 Miles

Sources: FEMA-2015; City of Portland-2016

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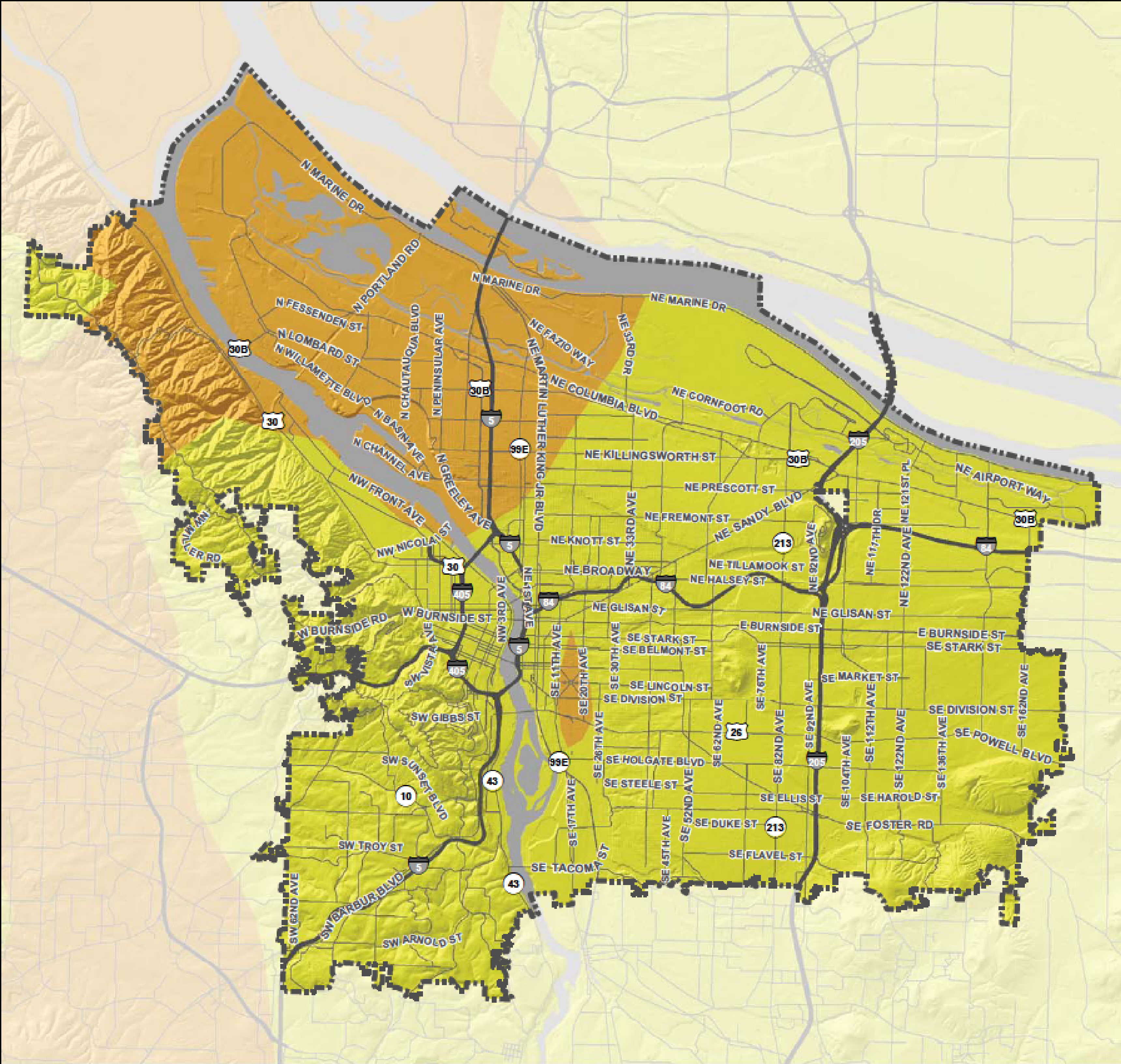
September 12, 2016

Mitigation Action Plan (MAP)

Figure 8-5. Cascadia 9.0 Magnitude Earthquake--Peak Ground Acceleration



Legend

City Boundary

Cascadia M9.0 earthquake PGA

Potential Damage - Perceived Shaking

- V -- Very Light - Moderate
- VI -- Light - Strong
- VII -- Moderate - Very Strong
- VIII -- Moderate/Heavy - Severe

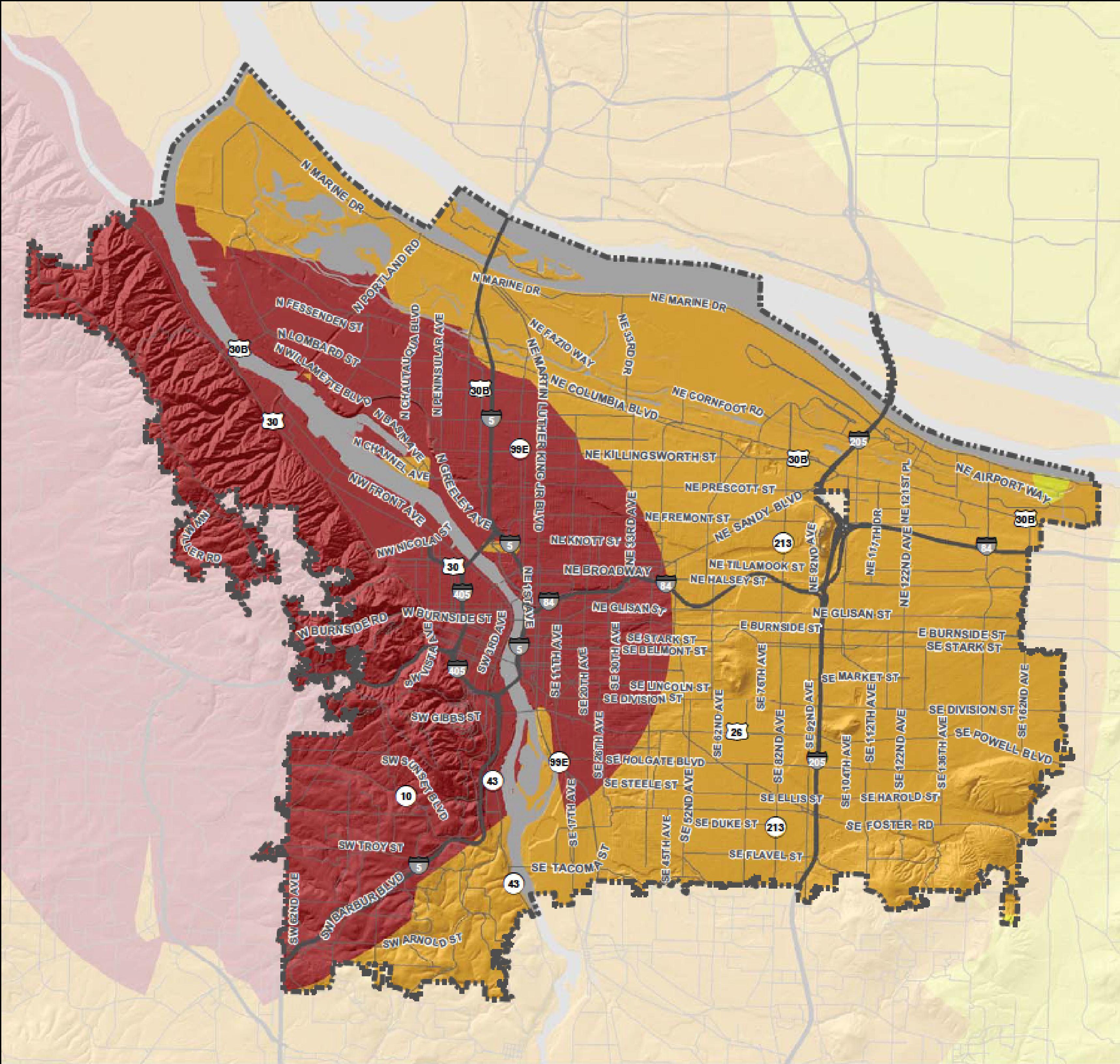
NORTH

0 0.75 1.5 Miles

Sources: USGS-2011; City of Portland-2016

37242

PBEM



September 12, 2016

Mitigation Action Plan (MAP)

Figure 8-6. Portland Hills 6.5 Magnitude Earthquake-Peak Ground Acceleration

Legend

City Boundary

Portland Hills M6.5 earthquake PGA

Potential Damage - Perceived Shaking

- V -- Very Light - Moderate
- VI -- Light - Strong
- VII -- Moderate - Very Strong
- VIII -- Moderate/Heavy - Severe

NORTH

0 0.75 1.5 Miles

Sources: USGS-2009; City of Portland-2016

37242

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NEHRP Soil Maps

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

Liquefaction Maps

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

8.2.3 Frequency

Many earthquake faults capable of producing damaging earthquakes exist in Portland. The greatest risk is from the Cascadia Subduction Zone fault, which lies just offshore of the Oregon coast. The Cascadia Subduction Zone has produced over 40 large magnitude earthquakes during the past 10,000 years, most recently on January 26, 1700. Based on the 10,000-year record of past Cascadia earthquakes, Oregon will certainly experience another Magnitude 8 to 9 earthquake (Goldfinger et al., 2012). The fault is divided into roughly four segments. Geologic records indicate that sometimes the entire fault ruptures at the same time and sometimes only some of the segments are involved (Stauth, 2016). It is believed that the southern portions of the fault rupture more frequently (between 220 and 380 years on average) and northern sections, most likely to impact Portland, rupture every 350 to 430 years on average (Stauth, 2016). Recent research conducted by Chris Goldfinger at Oregon State University indicates that a rupture of the segment off central and northern Oregon has a 15- to 20-percent chance of occurring in the next 50 years, while a rupture on the northern portion of the fault during the same time period has 10 to 17 percent chance of occurring in the next 50 years (Stauth, 2016). A large earthquake on this fault, which has the same type of subduction zone process as the 2011 Magnitude 9 earthquake in Japan, will be accompanied by a coastal tsunami.

The Portland Hills fault is located along the west bank of the Willamette River and can produce a Magnitude 7 earthquake (USGS, 2008a). The estimated likelihood of this earthquake occurring is 1 percent in the next 50 years (USGS, 2016d). The fault is 30 miles long and consists of a complex of fault zones, which include the Oatfield and East Bank faults (DOGAMI, 2001 and Wong et al., 2001).

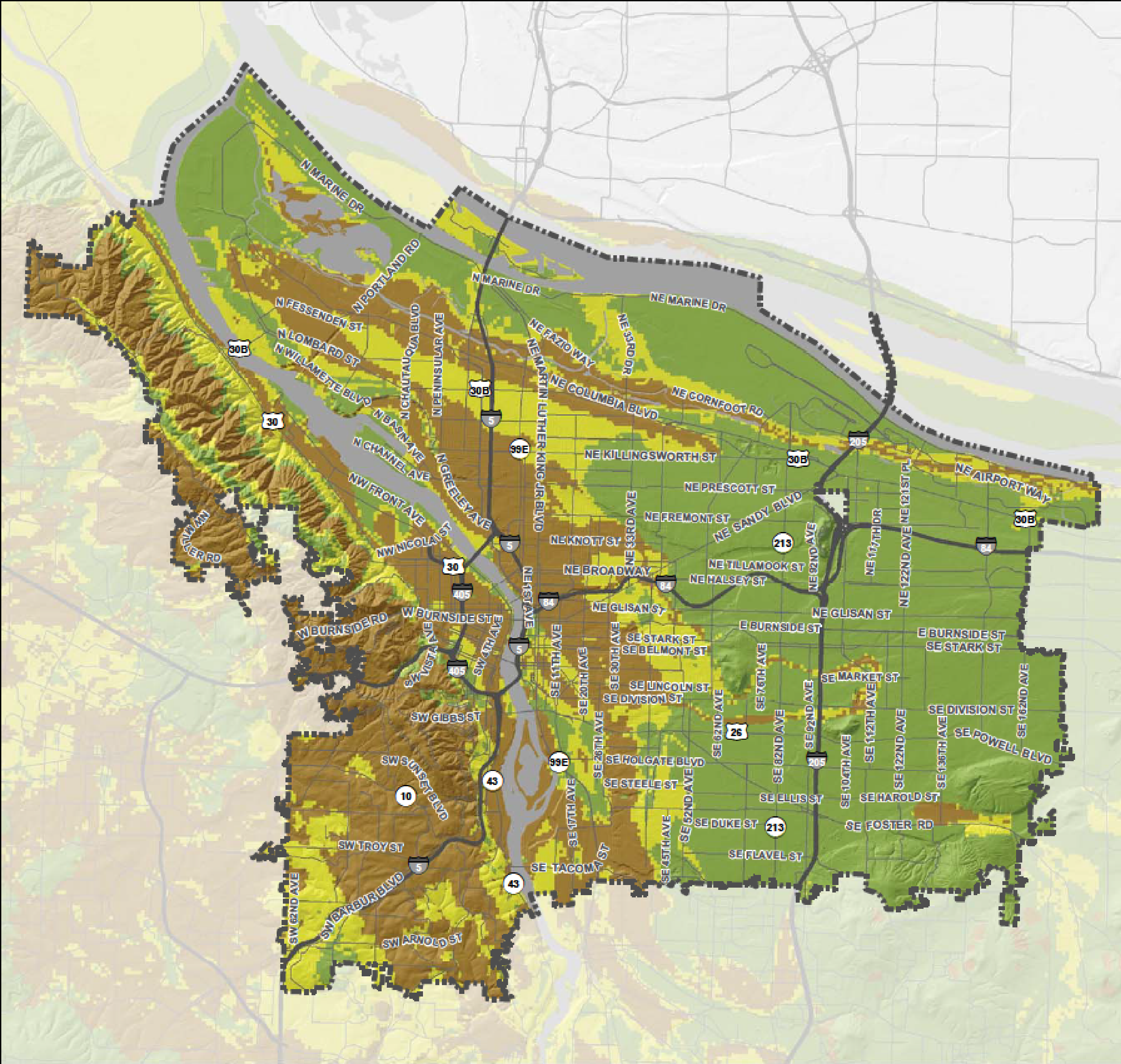
The Portland Hills fault runs northwest to southeast through Portland. According to DOGAMI, "It starts roughly on the northern edge of Forest Park and runs along the foot of Portland's West Hills before turning east on West Burnside Street for a few blocks and then turning southeast again through the heart of downtown. The fault then crosses the Willamette River between the Marquam and Ross Island bridges to Milwaukie and ends about a mile south of the Clackamas River near Oregon City and Gladstone" (DOGAMI, 2001).

The Oatfield fault runs west of Northwest Skyline Road from Sylvan Hill to Germantown Road through Bonny Slope (DOGAMI, 2001). The East Bank fault on the east side of the Willamette River runs under the University of Portland, Mocks Bottom, the Oregon Convention Center, Lloyd Center and Benson and Central Catholic high schools. It appears to have been active within the last 11,000 years (DOGAMI, 2001 and Wong et al., 2001).

September 12, 2016

Mitigation Action Plan (MAP)

Figure 8-7. National Earthquake Hazards Reduction Program (NEHRP) Soils



Legend

City Boundary

NEHRP Soils

Type

- B
- C
- D
- E

NORTH

0 0.75 1.5 Miles

Sources: DOGAMI-2012; City of Portland-2016

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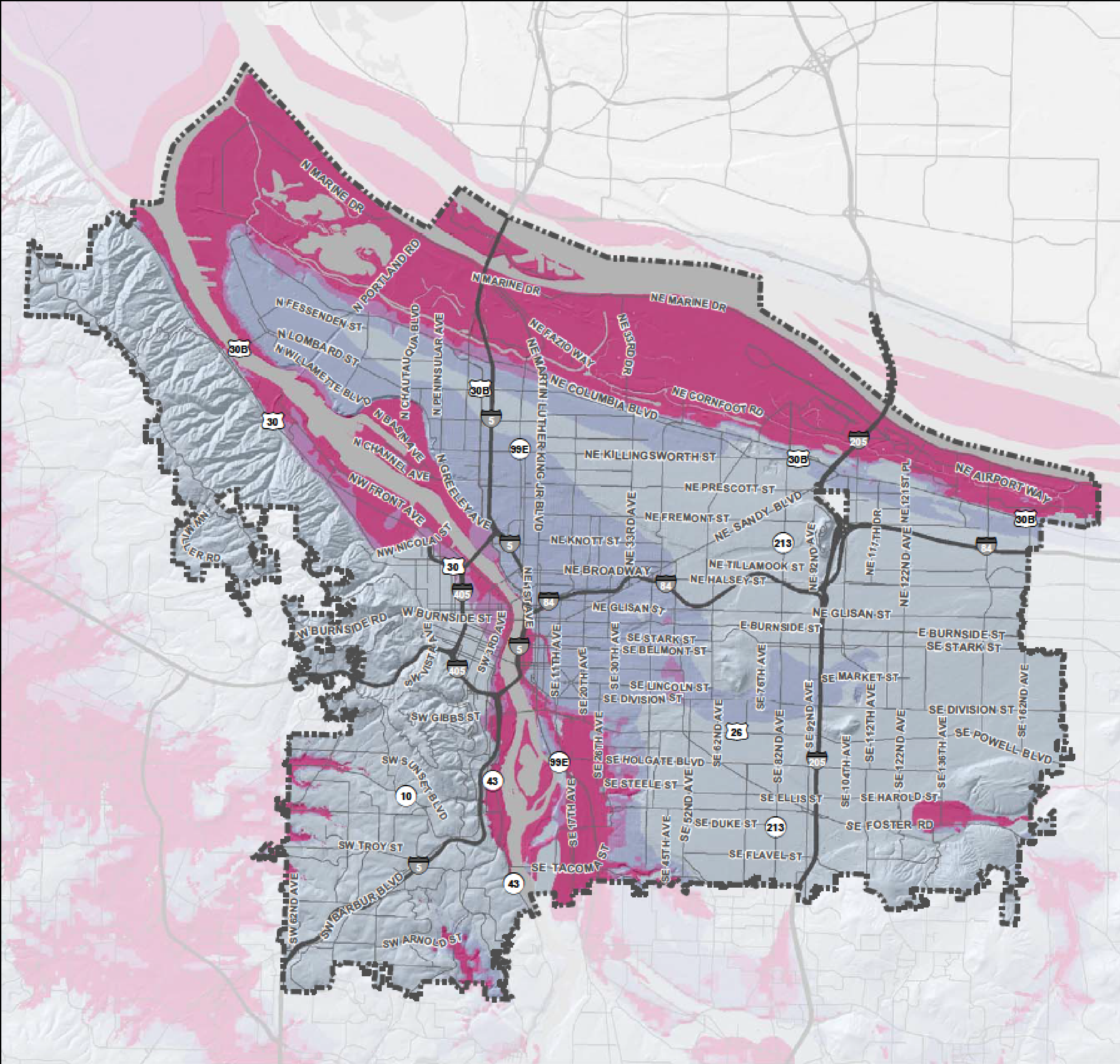
September 12, 2016

Mitigation Action Plan (MAP)

Figure 8-8. Liquefaction Susceptibility



Legend

City Boundary

Liquefaction Susceptibility Type

- 0 -- None
- 1 -- Very Low
- 2 -- Low
- 3 -- Moderate
- 4 -- High
- 5 -- Very High

NORTH

0 0.75 1.5 Miles

Sources: DOGAMI-2013; City of Portland-2016

37242

PBEM

8.2.4 Severity

The severity of an earthquake can be expressed in terms of intensity or magnitude. Intensity represents the observed effects of ground shaking on people, buildings, and natural features. The USGS has created ground motion maps based on current information about several fault zones. These maps show the PGA that has a certain probability (2 percent or 10 percent) of being exceeded in a 50-year period. This can also be understood as a 0.04 percent annual chance of occurrence (roughly a 2,500-year event) or a 0.2-percent annual chance (roughly a 500-year event), respectively. The PGA is measured in numbers of g's (the acceleration associated with gravity). Figure 8-9 shows the PGAs with a 2-percent exceedance chance in 50 years in the United States.

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

Earthquakes can last from a few seconds to over 5 minutes; they may also occur as a series of tremors over several days. The actual movement of the ground in an earthquake is seldom the direct cause of injury or death. Casualties generally result from falling objects and debris, because the shocks shake, damage or demolish buildings and other structures. Disruption of communications, electrical power supplies and gas, sewer and water lines should be expected. Earthquakes may trigger fires, landslides or releases of hazardous material, compounding their disastrous effects. Additionally, earthquakes may induce dam failures. After the 1999 Chi earthquake in Taiwan, the Shi-kang Dam failed after one side of the concrete structure was raised by 30 feet by ground deformation (RMS, 2000).

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

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

- How hard did the ground shake?
- How did the ground move? (Horizontally or vertically)
- How stable was the soil?
- How susceptible is the built environment in the area of impact (for example, building codes used and presence of unreinforced masonry buildings)?

8.2.5 Warning Time

There is currently no reliable way to predict the day or month that an earthquake will occur at any given location. Research is being done with warning systems that use the low energy waves that precede major earthquakes. The USGS and university partners are developing and testing an early warning system called ShakeAlert for the West Coast of the United States. The potential warning ranges from a few seconds to tens of seconds notice that a major earthquake is about to occur (Earthquake Early Warning, 2016). The warning time is very short but it could allow enough time to stop vehicles from crossing bridges, turn on backup generators, open elevators doors, or slow trains.

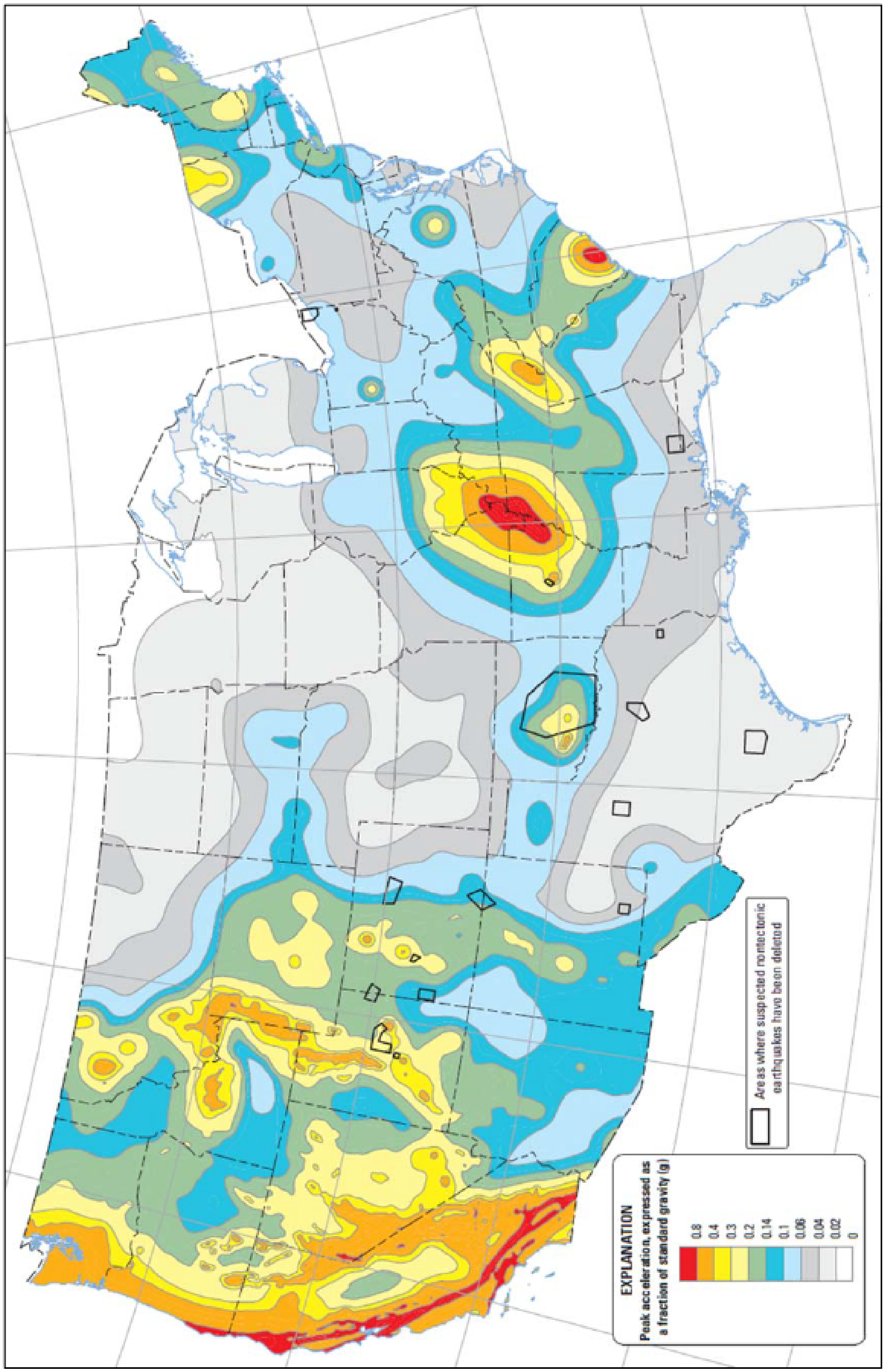


Figure 8-9. PGA with 2-Percent Probability of Exceedance in 50 Years

8.3 COMPOUNDING FACTORS AND SECONDARY HAZARDS

8.3.1 Overview

Earthquakes can cause large and sometimes disastrous landslides and mudslides. River valleys are vulnerable to slope failure, often as a result of loss of cohesion in clay-rich soils. Soil liquefaction occurs when water-saturated sands, silts or gravelly soils are shaken so violently that the individual grains lose contact with one another and float freely in the water, turning the ground into a pudding-like liquid. Building and road foundations lose load-bearing strength and may sink into what was previously solid ground. Unless properly secured, hazardous materials can be released, causing significant damage to the environment and people. Structure fires from broken gas lines also pose a significant hazard after earthquake events.

8.3.2 Climate Change

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

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

8.4 EXPOSURE

8.4.1 Population

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

8.4.2 Property

According to Multnomah County Assessor records, there are 193,837 buildings in Portland, 92.7 percent of them residential, with a total replacement value of $170.8 billion. Since all structures in Portland are susceptible to earthquake impacts to varying degrees, this total represents the citywide property exposure to seismic events.

8.4.3 Critical Facilities and Infrastructure

All critical facilities in Portland are exposed to the earthquake hazard. Table 4-7 and Table 4-8 in Chapter 4 list the number of each type of facility by risk reporting area.

8.4.4 Environment

All environment in Portland is potentially exposed to the earthquake hazard. Habitat could be impacted by lateral spread, ground deformation or secondary impacts of earthquakes, such as landslides. Many of these changes would occur abruptly, such as a change in a stream direction, while others would occur more gradually, such as fallen trees allowing more light into an area and changing the composition of species.

8.5 VULNERABILITY

Earthquake vulnerability data was evaluated using a Level 2 Hazus-MH analysis. Once the location and size of a hypothetical earthquake are identified, Hazus-MH estimates the intensity of the ground shaking, the number of buildings damaged, the damage to critical facilities and infrastructure, the number of people displaced from their homes, and additional information that can be used to estimate the costs of repair and cleanup.

8.5.1 Population

Liquefaction Potential

There are estimated to be 35,966 people—5.6 percent of the total City population—residing in high liquefaction potential areas (see Table 8-4). The Southeast risk reporting area contains the largest share of this population, with an estimated 42 percent (15,111). This is followed by the Southwest risk reporting area with 24.1 percent (8,653), North Portland with 13.7 percent (4,920) and East Portland with 12.6 percent (4,540).

Table 8-4. Population Residing within High Liquefaction Potential Areas

	Population Residing within High Liquefaction Potential Areas [a, b]	
Reporting Area	Population Exposed	% of Exposure
Airport	784	2.2%
Central City	1,625	4.5%
Central Northeast	320	0.9%
East Portland	4,540	12.6%
North Portland	4,920	13.7%
Northeast	0	0.0%
Southeast	15,111	42.0%
Southwest	8,653	24.1%
West/Northwest	12	0.0%
Total	**35,966**	**100.0%**

a. Values based on an analysis of 2010-2014 American Community Survey 5-year estimates at the Census block group level.
b. Values calculated using block group statistics weighted by the number of residential structures in the hazard area as a percentage of the total residential structures in the block.

Table 8-5 shows social vulnerability indicators for the population residing in high liquefaction potential areas. Persons over 65 years of age and renters appear to be disproportionately residing in these areas. Elderly residents may have mobility issues that result in difficulty in moving to safe areas. Renters do not have the authority to make structural changes to their homes and, thus, are unable to pursue structural mitigation measures. They also may lack renters' insurance for their belongings.

Table 8-5. Distribution of Social Vulnerability Indicators in High Liquefaction Potential Areas

Reporting Area	Population Residing in High Liquefaction Potential Areas [a, b, c, d]					
	Percent Under 15 Years	Percent Over 65 Years	Percent of People of Color	Percent of Renter occupied Housing	Percent of Families Below Poverty Level	Percent of Limited English Speaking Households
Airport	5.4%	5.1%	31.8%	68.8%	19.8%	20.6%
Central City	2.6%	7.8%	12.9%	82.4%	13.8%	0.5%
Central Northeast	5.6%	5.2%	32.0%	66.5%	18.9%	19.7%
East Portland	17.6%	14.8%	26.3%	24.9%	10.7%	5.2%
North Portland	14.4%	17.7%	29.2%	22.1%	8.0%	3.8%
Northeast	-	-	-	-	-	-
Southeast	13.6%	12.0%	12.7%	58.4%	7.3%	2.2%
Southwest	12.1%	16.6%	13.8%	54.1%	4.9%	1.4%
West/Northwest	13.6%	13.3%	11.6%	22.3%	1.4%	0.0%
Total	**13.1%**	**13.8%**	**17.5%**	**50.4%**	**7.6%**	**2.5%**

a. Values based on an analysis of 2010-2014 American Community Survey 5-year estimates at the Census block group level.
b. Values calculated using block group statistics weighted by the number of residential structures in the hazard area as a percentage of the total residential structures in the block group.
c. Values in red indicate percentages are at least 2 percent greater than the Citywide average (see Section 4.7).
d. Persons with disabilities not shown because the available data, at a census tract scale, is not conducive to analysis by hazard extent and location.

Displaced Households and Short-Term Shelter Needs

Displaced households and short-term shelter needs in Portland were estimated for the 100-year and 500-year probabilistic earthquakes and the two scenario events. The 100-year event can also be expressed as a 39-percent chance of exceedance in 50 years; 500-year events are also described as having a 10-percent chance of exceedance in 50 years.

Displaced households are estimated based on a loss of habitability, calculated from damage to the residential building stock and anticipated loss of utilities such as water and power. Short-term shelter is estimated based on the assumptions that all households residing in damaged structures will seek alternative shelter; however, some households may stay with friends or relatives or make other accommodations. Studies from past earthquake events also indicate that some households that experienced no damage will also seek shelter, as will most individuals who lacked suitable shelter before the event. These estimates are based on damaged structures and economic data, such as income, that serve as indicators for the need for publicly provided shelters.Injury and Casualty Estimates

Injury and casualty estimates in Portland were estimated for the 100-year and 500-year earthquakes and the two scenario events. Results are broken down into four severity levels:

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

Table 8-6 and Table 8-7 summarize the results. In general, the analysis shows that the Central City risk reporting area would experience the greatest number of persons requiring short-term shelter.

Injury and Casualty Estimates

Injury and casualty estimates in Portland were estimated for the 100-year and 500-year earthquakes and the two scenario events. Results are broken down into four severity levels:

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

Table 8-6. Estimated Earthquake Impact on Persons and Households

	Displaced Households[a]		Persons Requiring Short-Term Shelter[a]			
	100-Year Earthquake	500-Year Earthquake	100-Year Earthquake		500-Year Earthquake	
Reporting Area			Number	% of Total Population	Number	% of Total Population
Airport	0	0	0	0.0%	1	Less than 0.1%
Central City	268	9,185	129	0.3%	4,505	11.9%
Central Northeast	4	204	2	Less than 0.1%	117	0.2%
East Portland	9	717	6	Less than 0.1%	510	0.3%
North Portland	12	724	7	Less than 0.1%	404	0.6%
Northeast	20	1,157	12	Less than 0.1%	676	1.2%
Southeast	48	2,563	24	Less than 0.1%	1,281	0.8%
Southwest	69	2,147	30	Less than 0.1%	935	1.3%
West/Northwest	82	3,029	33	Less than 0.1%	1,246	4.6%
Total	**513**	**19,726**	**243**	**Less than 0.1%**	**9,674**	**1.6%**

a. Calculated using a Census tract level, general building stock analysis in Hazus 2.2.
Note: Values shown are accurate only for comparison among results in this plan. See Section 6.8 for a discussion of data limitations.

Table 8-7. Estimated Earthquake Impact on Persons and Households

	Displaced Households[a]		Persons Requiring Short-Term Shelter[a]			
	Cascadia M9.0	Portland Hills M6.5	Cascadia M9.0		Portland Hills M6.5	
Reporting Area			Number	% of Total Population	Number	% of Total Population
Airport	0	0	0	0.0%	0	0.0%
Central City	2,886	13,762	1,417	3.7%	7,033	18.5%
Central Northeast	130	330	65	0.1%	166	0.3%
East Portland	309	195	233	0.2%	152	0.1%
North Portland	343	927	181	0.3%	547	0.8%
Northeast	278	1,165	161	0.3%	658	1.1%
Southeast	525	2,027	262	0.2%	1,006	0.7%
Southwest	542	1,920	233	0.3%	876	1.2%
West/Northwest	825	4,859	342	1.3%	2,000	7.4%
Total	**5,838**	**25,186**	**2,893**	**0.5%**	**12,437**	**2.0%**

a. Calculated using a Census tract level, general building stock analysis in Hazus 2.2.
Note: Values shown are accurate only for comparison among results in this plan. See Section 6.8 for a discussion of data limitations.

The estimates are provided for three times of day when community members are likely to be pursuing different activities and in different locations and types of buildings:

- 2:00 am—Community members are likely at home sleeping

- 2:00 pm—Community members are likely at school, work or other activities
- 5:00 pm—Peak commute time.

Table 8-8 summarizes the results. In general, the largest number of injuries and causalities are expected to occur during the day while persons are out in the community.

Table 8-8. Estimated Injury and Casualty Estimates from Earthquake Scenario Events

	Injury and Casualty County by Severity Level											
	2:00 AM				2:00 PM				5:00 PM			
	1	2	3	4	1	2	3	4	1	2	3	4
100-Year Earthquake	61	7	0	1	159	25	2	5	101	15	1	3
500-Year Earthquake	2,093	540	78	153	5,816	1,663	264	516	3,940	1,113	176	340
Cascadia Fault, M9.0 Scenario	378	56	4	8	1,370	246	27	53	918	164	18	35
Portland Hills Fault, M6.5 Scenario	2,591	670	97	190	5,032	1,310	196	381	3,599	941	141	271

Note: Values shown are accurate only for comparison among results in this plan. See Section 6.8 for a discussion of data limitations.

The following summarizes the results for each scenario for the 2:00 pm timeframe:

- 100-Year Earthquake—191 persons killed or injured as a result of the earthquake, less than 0.1 percent of the total population
- 500-Year Earthquake—8,259 persons killed or injured as a result of the earthquake, 1.3 percent of the total population
- Cascadia Fault, M9.0 Scenario—1,696 persons killed or injured as a result of the earthquake, 0.3 percent of the total population
- Portland Hills Fault, M6.5 Scenario—6,919 persons killed or injured as a result of the earthquake, 1.1 percent of the total population

8.5.2 Property

Building Age

Building age—along with factors such as the soil a building is located on, retrofits for seismic resistance, and construction materials and methods—is a predictor of how well a building is likely to perform during an earthquake. Oregon first adopted a statewide building code in 1974, and seismic standards were adopted in 1993. Buildings constructed before 1974 are most likely to be damaged in a large earthquake, while those constructed after 1993 are most likely to be able to withstand impacts. It should be noted, however, that some buildings may have been retrofitted since their construction to more fully comply with modern seismic codes. Table 8-9 shows year-built information provided in Multnomah County Assessor records.

Table 8-9. Age of Structures in Portland

	Pre-1974[a]		1974-1993[a]		Post-1993[a]		Total
Reporting Area	Number of Structures	Percent	Number of Structures	Percent	Number of Structures	Percent	Number of Structures
Airport	396	61.6%	109	17.0%	138	21.5%	643
Central City	2,020	76.3%	301	11.4%	328	12.4%	2,649
Central Northeast	15,335	88.1%	870	5.0%	1,201	6.9%	17,406
East Portland	28,675	65.5%	7,116	16.3%	7,964	18.2%	43,755
North Portland	18,899	77.2%	1,793	7.3%	3,797	15.5%	24,489
Northeast	18,521	89.6%	551	2.7%	1,608	7.8%	20,680
Southeast	45,960	86.3%	2,925	5.5%	4,385	8.2%	53,270

Reporting Area	Pre-1974[a]		1974-1993 [a]		Post-1993 [a]		Total
	Number of Structures	Percent	Number of Structures	Percent	Number of Structures	Percent	Number of Structures
Southwest	14,846	64.2%	5,727	24.8%	2,551	11.0%	23,124
West/Northwest	4,369	55.9%	1,142	14.6%	2,310	29.5%	7,821
Total	**149,021**	**76.9%**	**20,534**	**10.6%**	**24,282**	**12.5%**	**193,837**

a. Year built information was collected from Multnomah County tax assessor data. When year built information was unavailable, it was estimated based on census block or county-wide average year built dates.

The age of the building stock in Portland can be summarized as follows:

- 76.9 percent of buildings (149,021) in Portland were built before 1974.
- 10.6 percent of buildings (20,534) were built between 1974 and 1993.
- 12.5 percent of buildings (24,282) were built in 1993 or later.

More than half of the building stock was built before 1974 in all risk reporting areas. Numbers ranges from almost 56 percent in the West/Northwest to almost 90 percent in the Northeast.

Liquefaction Potential

Table 8-10 shows the estimated number and type of structures in high potential liquefaction areas. There are 13,191 structures or 6.8 percent of the total building stock; 36 percent of these buildings (4,774) are in the Southeast and 28 percent (3,777) are in North Portland. In addition, 6,090 structures (3.1 percent of total structures) are in moderate liquefaction susceptibility areas.

Table 8-10. Structures Located in High Liquefaction Potential Areas

Reporting Area	Number of Structures[a]						
	Residential	Commercial	Industrial	Religion	Government	Education	Total
Airport	257	105	170	0	111	0	643
Central City	107	234	29	2	16	1	389
Central Northeast	105	274	81	1	9	0	470
East Portland	844	299	48	2	18	4	1,215
North Portland	2,331	757	465	176	42	6	3,777
Northeast	0	0	0	0	0	0	0
Southeast	4,352	350	44	17	6	5	4,774
Southwest	1,291	118	3	2	-	2	1,416
West/Northwest	6	140	355	3	3	-	507
Total	**9,293**	**2,277**	**1,195**	**203**	**205**	**18**	**13,191**

a. Structure type assigned to best fit Hazus occupancy classes based on present use classifications provided by Multnomah County assessor's data. Where conflicting information was present in the available data, parcels were assumed to be improved.

Loss Potential

Structural and Non-Structural Loss

Property losses were estimated through the Level 2 Hazus-MH analysis for the 100-year and 500-year earthquakes and the two scenario events. Table 8-11 through Table 8-14 show the results for two types of property loss: structural loss (damage to building structures); and non-structural loss (the value of lost contents). A summary of the property-related loss results is as follows:

- For a 100-year probabilistic earthquake, the estimated damage potential is $903.3 million, or 0.5 percent of the total replacement value for Portland.
- For a 500-year probabilistic earthquake, the estimated damage potential is $22 billion or 12.9 percent of the total replacement value for Portland.
- For a 9.0-magnitude Cascadia Fault event, the estimated damage potential is $7.3 billion, or 4.3 percent of the total replacement value for Portland.
- For a 6.5-magnitude Portland Hills Fault event, the estimated damage potential is $23.8 billion, or 14 percent of the total replacement value for Portland.

Table 8-11. Loss Estimates for the 100-Year Earthquake

Reporting Area	Estimated Loss			Estimated Loss as % of Total
	Structure	Contents	Total	Replacement Value
Airport	$6,806,171	$2,097,634	$8,903,805	0.2%
Central City	$212,643,110	$57,878,200	$270,521,310	0.9%
Central Northeast	$21,197,147	$6,219,927	$27,417,074	0.3%
East Portland	$39,255,492	$10,943,469	$50,198,962	0.2%
North Portland	$112,462,142	$37,989,016	$150,451,157	0.6%
Northeast	$53,576,499	$16,961,371	$70,537,870	0.5%
Southeast	$92,205,906	$27,212,453	$119,418,359	0.4%
Southwest	$91,131,036	$28,830,336	$119,961,373	0.7%
West/Northwest	$65,387,493	$20,503,299	$85,890,792	0.6%
Total	**$694,664,997**	**$208,635,705**	**$903,300,702**	**0.5%**

Note: Values shown are accurate only for comparison among results in this plan. See Section 6.8 for a discussion of data limitations.

Table 8-12. Loss Estimates for the 500-Year Earthquake

Reporting Area	Estimated Loss			Estimated Loss as % of Total
	Structure	Contents	Total	Replacement Value
Airport	$132,495,537	$43,060,449	$175,555,987	4.4%
Central City	$5,898,040,710	$1,521,890,941	$7,419,931,651	23.8%
Central Northeast	$442,348,156	$143,099,184	$585,447,340	5.4%
East Portland	$827,045,080	$248,014,229	$1,075,059,309	4.1%
North Portland	$2,836,072,122	$1,012,558,771	$3,848,630,893	16.4%
Northeast	$1,171,804,098	$362,788,692	$1,534,592,790	11.7%
Southeast	$1,932,240,974	$572,621,699	$2,504,862,672	8.2%
Southwest	$1,886,443,065	$627,857,122	$2,514,300,188	14.1%
West/Northwest	$1,823,131,817	$583,155,189	$2,406,287,006	17.3%
Total	**$16,949,621,559**	**$5,115,046,277**	**$22,064,667,836**	**12.9%**

Note: Values shown are accurate only for comparison among results in this plan. See Section 6.8 for a discussion of data limitations.

Table 8-13. Loss Estimates for the Cascadia M9.0 Scenario Earthquake

Reporting Area	Estimated Loss			Estimated Loss as % of Total
	Structure	Contents	Total	Replacement Value
Airport	$274,151,253	$63,821,977	$337,973,230	8.5%
Central City	$1,024,447,659	$160,011,908	$1,184,459,567	3.8%
Central Northeast	$346,048,842	$86,088,583	$432,137,424	4.0%
East Portland	$572,600,541	$144,209,337	$716,809,878	2.8%

Reporting Area	Estimated Loss Structure	Contents	Total	Estimated Loss as % of Total Replacement Value
North Portland	$1,633,971,567	$445,062,992	$2,079,034,559	8.8%
Northeast	$271,997,167	$63,676,196	$335,673,363	2.6%
Southeast	$548,084,058	$139,071,846	$687,155,903	2.3%
Southwest	$310,914,118	$93,055,602	$403,969,720	2.3%
West/Northwest	$902,214,849	$313,611,205	$1,215,826,054	8.7%
Total	**$5,884,430,054**	**$1,508,609,644**	**$7,393,039,699**	**4.3%**

Note: Values shown are accurate only for comparison among results in this plan. See Section 6.8 for a discussion of data limitations.

Table 8-14. Loss Estimates for the Portland Hills M6.5 Scenario Earthquake

Reporting Area	Estimated Loss Structure	Contents	Total	Estimated Loss as % of Total Replacement Value
Airport	$200,222,211	$48,948,351	$249,170,562	6.3%
Central City	$7,510,660,388	$1,938,611,406	$9,449,271,794	30.3%
Central Northeast	$459,914,232	$129,954,308	$589,868,540	5.4%
East Portland	$538,135,332	$173,625,581	$711,760,913	2.7%
North Portland	$2,870,971,346	$937,371,269	$3,808,342,615	16.2%
Northeast	$1,025,801,909	$298,072,759	$1,323,874,669	10.1%
Southeast	$1,648,783,858	$488,124,470	$2,136,908,329	7.0%
Southwest	$1,296,370,256	$445,431,042	$1,741,801,297	9.8%
West/Northwest	$2,907,879,064	$948,284,162	$3,856,163,226	27.7%
Total	**$18,458,738,597**	**$5,408,423,348**	**$23,867,161,945**	**14.0%**

Note: Values shown are accurate only for comparison among results in this plan. See Section 6.8 for a discussion of data limitations.

Building Damage

The Hazus-MH analysis estimated expected building damage by occupancy as follows:

- For a 100-year probabilistic earthquake, about 1.3 percent (2,543) of Portland buildings are expected to be at least moderately damaged. Less than 0.1 percent (31) are expected to be damaged beyond repair, including 17 residential structures.
- For a 500-year probabilistic earthquake, about 19.5 percent (37,739) of Portland buildings are expected to be at least moderately damaged. Approximately 1.8 percent (3,508) are expected to be damaged beyond repair, including 1,136 residential structures.
- For the Cascadia M9.0 scenario earthquake, about 7.1 percent (13,896) of Portland buildings are expected to be at least moderately damaged. Approximately 0.4 percent (848) are expected to be damaged beyond repair, including more than 306 residential structures.
- For the Portland Hills M6.5 scenario earthquake, about 21 percent (40,782) of Portland buildings are expected to be at least moderately damaged. Approximately 1.7 percent (3,225) are expected to be damaged beyond repair, including 1,239 residential structures.

Earthquake-Caused Debris

The Hazus-MH analysis estimated the amount of earthquake-caused debris for the 100-year and 500-year earthquakes and the two scenario events, as summarized in Table 8-15 and Table 8-16.

8.5.3 Critical Facilities and Infrastructure

Hazardous materials releases can occur during an earthquake from fixed facilities or transportation-related incidents. Transportation corridors can be disrupted during an earthquake, leading to the release of materials to the surrounding environment. Facilities holding hazardous materials are of particular concern because of possible isolation of neighborhoods surrounding them. During an earthquake, structures storing these materials could rupture and leak into the surrounding area or an adjacent waterway. This could have a disastrous effect on the environment and impede evacuations and access for emergency response.

Table 8-15. Estimated Earthquake-Caused Debris for Probabilistic Earthquake Events

	100-Year Earthquake		500-Year Earthquake	
Reporting Area	Debris to Be Removed (tons)[a]	Estimated Number of Truckloads [b]	Debris to Be Removed (tons)[a]	Estimated Number of Truckloads [b]
Airport	4,511	180	92,356	3,694
Central City	117,975	4,719	3,147,160	125,886
Central Northeast	9,989	400	227,137	9,085
East Portland	16,580	663	358,808	14,352
North Portland	58,669	2,347	1,708,414	68,337
Northeast	18,847	754	491,166	19,647
Southeast	34,696	1,388	836,790	33,472
Southwest	25,535	1,021	619,965	24,799
West/Northwest	30,614	1,225	969,597	38,784
Total	**317,416**	**12,697**	**8,451,394**	**338,056**

a. Debris generation estimates were based on updated general building stock dataset at a Census Tract analysis level.
b. Hazus-MH assumes 25 tons/trucks
Note: Values shown are accurate only for comparison among results in this plan. See Section 6.8 for a discussion of data limitations

Table 8-16. Estimated Earthquake-Caused Debris for Earthquake Scenario Events

	Cascadia Fault, M9.0 Scenario		Portland Hills Fault, M6.5 Scenario	
Reporting Area	Debris to Be Removed (tons)[a]	Estimated Number of Truckloads [b]	Debris to Be Removed (tons)[a]	Estimated Number of Truckloads [b]
Airport	229,138	9,166	162,131	6,485
Central City	714,776	28,591	4,065,742	162,630
Central Northeast	240,452	9,618	249,708	9,988
East Portland	350,800	14,032	243,030	9,721
North Portland	1,152,746	46,110	1,732,616	69,305
Northeast	139,606	5,584	448,702	17,948
Southeast	286,507	11,460	732,289	29,292
Southwest	99,454	3,978	356,395	14,256
West/Northwest	551,863	22,075	1,519,592	60,784
Total	**3,765,342**	**150,614**	**9,510,206**	**380,408**

a. Debris generation estimates were based on updated general building stock dataset at a Census Tract analysis level.
b. Hazus-MH assumes 25 tons/trucks
Note: Values shown are accurate only for comparison among results in this plan. See Section 6.8 for a discussion of data limitations

Fire can be a secondary hazard of earthquake- or landslide-induced release of hazardous materials. The proximity of Forest Park to this concentration of Portland's fuel infrastructure may increase the risk of landslides or seismic events, leading to wildfires, especially under dry conditions. Much of Portland's critical infrastructure, particularly its energy infrastructure, is concentrated in a small area in the northwest corner of the City, along the Willamette River. A separate study was conducted as part of this plan update to evaluate risks and identify recommendations for improving resilience in the City's Critical Energy Infrastructure (CEI) Hub. This study can be found in Appendix J.

Level of Damage

Hazus-MH classifies the vulnerability of critical facilities to earthquake damage by assigning probabilities of the likelihood of each facility experiencing one of five damage states: no damage, slight damage, moderate damage, extensive damage, or complete damage. The model was used to assign a vulnerability category to each critical facility in Portland based on the likelihood that the facility would meet or exceed these damage states. The analysis was performed for all scenario events. The results from the two Scenario Earthquake Events are shown in Table 8-17.

Table 8-17. Estimated Damage to Critical Facilities from Scenario Events

	Cascadia M9.0					Portland Hills M6.5				
Category[a, c]	None	Slight	Moderate	Extensive	Complete	None	Slight	Moderate	Extensive	Complete
Emergency Services	46	19	0	0	0	12	5	25	21	2
High Potential Loss Facilities[b]	0	70	89	1	0	0	6	50	60	44
Schools	323	0	0	0	0	83	200	40	0	0
Other Assets	0	57	11	0	0	0	1	27	23	17
Transportation Systems	54	40	0	0	0	40	27	26	1	0
Utility Systems										
Communications	0	25	0	0	0	0	9	13	3	0
Power	0	357	0	0	0	0	20	330	7	0
Potable Water	10	336	0	0	0	11	264	45	26	0
Wastewater	0	140	0	0	0	0	90	49	1	0
Total	**433**	**1,044**	**100**	**1**	**0**	**146**	**622**	**605**	**142**	**63**

a. Numbers indicate facilities that were assigned the damage state indicated based on probabilities of meeting or exceeding the criteria for the damage state. Damage states were assigned to the highest state exceeding 50 percent probability, meaning it is more likely than not that facilities in this category will receive at least the amount of damage described by the damage state.

b. Hazus does not calculate damage states for dams.

c. See Table 6-1 for a description of the facilities included in each category.

Time to Return to Functionality

Hazus-MH estimates the time to restore critical facilities to fully functional use. Results are presented as probability of being functional at specified time increments: 1, 3, 7, 14, 30 and 90 days after the event. For example, Hazus-MH may estimate that a facility has 5 percent chance of being fully functional at Day 3, and a 95-percent chance of being fully functional at Day 90. The analysis of critical facilities in Portland was performed for all scenario events. The results for the Cascadia M9.0 Scenario and the Portland Hills M6.5 scenario are summarized below Table 8-18 and Table 8-19.

Liquefaction Potential

The potential for soil liquefaction was utilized in the Hazus model for the damage and functionality results for critical facility and point based features in the table above. Damage to linear based features, such as levees and roads, is not assessed by the Hazus model. Such facilities located on liquefiable soil may be particularly vulnerable to the earthquake hazards. The following describe critical infrastructure located in these areas:

Table 8-18. Functionality of Critical Facilities for Cascadia M9.0 Scenario Event

	# of Critical Facilities	Probability of Being Fully Functional (%)					
		at Day 1	at Day 3	at Day 7	at Day 14	at Day 30	at Day 90
Emergency Services	65	60	60	85	85	94	95
High Potential Loss Facilities[a]	170	3	5	49	49	75	89
Schools	323	82	83	98	98	99	99
Other Assets	68						
Transportation Systems	94	93	96	97	97	97	98
Utility Systems							
Communications	25	91	98	98	99	99	99
Power	357	68	89	95	98	99	99
Potable Water	346	78	95	98	99	99	99
Wastewater	140	54	88	97	97	98	99
Total/Average	**1,588**	**66**	**77**	**90**	**90**	**95**	**97**

a. Hazus does not calculate functionality for dams.

Table 8-19. Functionality of Critical Facilities for Portland Hill M6.5 Event

	# of Critical Facilities	Probability of Being Fully Functional (%)					
		at Day 1	at Day 3	at Day 7	at Day 14	at Day 30	at Day 90
Emergency Services	65	23	24	56	57	75	78
High Potential Loss Facilities[a]	170	1	2	21	21	41	60
Schools	323	34	35	74	75	89	90
Other Assets	68	1	2	22	22	44	66
Transportation Systems	94	76	83	85	86	87	91
Utility Systems							
Communications	25	64	83	87	93	96	99
Power	357	33	54	70	81	88	97
Potable Water	346	64	84	91	93	95	97
Wastewater	140	31	69	87	89	94	99
Total/Average	**1,588**	**36**	**48**	**66**	**69**	**79**	**86**

a. Hazus does not calculate functionality for dams.

Transportation Related Infrastructure

The following major roads in Portland pass through high liquefaction potential areas:

- N Hayden Island Dr.
- N Marine Dr., NE Marine Dr.
- N Martin Luther King Jr. Blvd., NE Martin Luther King Jr. Blvd.
- NE Airport Way
- NE Cascades Parkway
- NW Front Ave.
- NW Naito Parkway, SW Naito Parkway
- SE Bybee Blvd.
- SE Foster Rd.
- SE Grand Ave.
- SE Holgate Blvd.
- SE Johnson Creek Blvd.
- SE McLoughlin Blvd. (State Highway 99E)
- SE Milwaukie Ave.
- SE Powell Blvd.
- SE Water Ave.
- SW Beaverton Hillsdale Hwy
- SW Corbett Ave.
- SW Macadam Ave.
- SW Moody Ave.
- I-205
- I-5
- I-84
- SW Beaverton Hillsdale Hwy

In addition, 237.82 miles (63.4) of railroad lines are located in high potential liquefaction areas and an additional 79.33 miles (21.2 percent) are located in moderate liquefaction potential areas. The light rail lines may also be vulnerable with 12.05 miles (22.8 percent) located in high liquefaction areas and an additional 5.65 miles (10.7 percent) located in moderate liquefaction potential areas.

Utility Systems

Table 8-20 shows the mileage and percent of the citywide system located in high and moderate liquefaction potential areas. The Portland Water Bureau System is currently conducting a Water System Reliability Study to assess risk to the water system from seismic hazards.

Table 8-20. Utility Systems Within Liquefaction Potential Areas

	High Liquefaction Potential Areas		Moderate Liquefaction Potential Areas	
Infrastructure Type	Mileage	%	Mileage	%
Potable Water Backbone	27.49	18.8%	8.80	6.2%
Wastewater System Collection Pipes	406.47	15.4%	165.01	6.2%
Major Power Lines	112.17	23.5%	49.44	10.4%
Major Gas Lines	21.05	25.2%	15.58	18.7%

Levees

Almost all of the levees in Portland are located in high liquefaction potential areas (20.25 miles), with the remaining 0.2 miles in moderate liquefaction potential areas. An assessment of a small portion of the levee system conducted in 2001 determined that this portion of the system was safe for a 0.2-percent seismic risk (Magnitude 6.2 event) and 0.04-percent seismic risk (approximately magnitude 7.0 event). The study also concluded that it would be unlikely for a seismic event alone to cause flooding in areas protected by the levee. It was found that such flooding may occur if the earthquake occurred concurrently with a major flood, although the probability of such events occurring simultaneously was found to be low (USACE, 2001). However, other area levees may perform differently when exposed to the same parameters; further study is needed.

8.5.4 Environment

The environment vulnerable to earthquake hazard is the same as the environment exposed to the hazard. Groundwater supplies and adjacent water courses could be contaminated by spillage from storage tanks. Air quality could be significantly compromised by fires started due to secondary impacts from seismic events. Earthquake-induced landslides can significantly impact surrounding habitat. It is also possible for streams to be rerouted after an earthquake. This can change the water quality, possibly damaging habitat and feeding areas. There is a possibility of streams fed by groundwater drying up because of changes in underlying geology.

8.5.5 Economic Impact

Economic impact will be largely associated with the disruption of services caused by an earthquake event. In general, significant events may cause damage to land, buildings, transportation infrastructure, and businesses. Estimates of functionality for critical facilities and infrastructure for the scenario events are shown in Table 8-18 and Table 8-19. Significant impacts may occur as a result of disruptions in the supply chain, a focus on expending resources to rebuild lost resources (especially for resources not covered by insurance), loss of wages, a downturn in tourism, and possibly a shortage in labor caused by residents relocating outside the damaged area. With an event of such significance, economic recovery could take years or decades, depending on available recovery funds.

8.6 FUTURE TRENDS IN DEVELOPMENT

Land use in Portland will be directed by the City's Comprehensive Plan. Development in Portland will be regulated through building standards and performance measures so that the degree of risk will be reduced. Hazard-resilient design is addressed in the City's Comprehensive Plan and it addresses geological hazards, including liquefaction potential, and the promotion of disaster resilient development. New development in Portland will likely be less vulnerable to earthquake hazards than older development due to higher regulatory standards for earthquake risk in modern building codes. In addition, the City has identified several actions that will seek to strengthen existing development codes and standards to the earthquake hazard.

New development in areas subject to liquefaction are of particular concern due to their increased vulnerability if proper structural measures are not taken. Although existing codes and ordinance should mitigate these risks, not all risk will be mitigated and critical infrastructure providing services to these areas may be negatively impacted. Table 8-21 and Table 8-22 show future land use designations in high and medium liquefaction potential areas, respectively. Citywide, the predominant land use in high potential areas is designated as employment and industrial (58.3 percent), followed by open space (24.9 percent).

8.7 SCENARIO

Any seismic activity of 6.0 or greater on faults in the general Portland region would have significant impacts throughout Portland. An earthquake in the Cascadia Subduction Zone would have disastrous consequences for the entire state and the region. Potential warning systems could give up to tens of seconds' notice that a major earthquake is about to occur.

Large magnitude earthquakes in the region could lead to massive structural failure of property on liquefiable soils. Structural failure may be intensified if the earthquake occurs during winter when soils are saturated. Heavy damage would also be expected in areas with substantial numbers of unreinforced masonry buildings or older building stock that has not been brought up to current seismic codes. Access to, from and around the City would be challenging, given the likelihood that bridges and major transportation routes may be impassable. These events could cause secondary hazards, including landslides and mudslides that would further damage structures. There is also a significant potential for major hazardous materials in the CEI Hub and other areas with large concentrations of hazardous materials on liquefiable soils.

8.8 ISSUES

The following issues have been identified over the course of the planning process:

- It is estimated that 76 percent of buildings (149,021) in Portland were built before 1974 when the first provisions for seismic criteria were implemented. (Note: Some buildings have been retrofitted, but data is not available to estimate the number and types of retrofits).
- It is estimated that an additional 10.5 percent of buildings (20,534) in Portland were built between 1974 and 1993 before modern seismic codes were in place.
- There are estimated to be 13,191 buildings located in high liquefaction susceptibility areas. This is about 7 percent of all buildings in Portland. 36 percent of these buildings (4,774) are located in the Southeast and 28 percent (3,777) are located in North Portland. An additional 6,090 buildings are located in moderate liquefaction susceptibility areas.

Table 8-21. Future Land Use Designations in Portland in High Potential Liquefaction Areas

		Percent of total acres					
		Residential					
Reporting Area	Total Acreage	Single-Dwelling	Multi-Dwelling	Commercial	Employment & Industrial	Mixed Use & Institutional	Open Space
Airport	5,307.9	2.6%	3.8%	0.0%	66.8%	5.0%	21.8%
Central City	1,055.9	0.0%	7.0%	27.4%	40.8%	0.0%	24.8%
Central Northeast	1,657.0	0.0%	0.0%	0.0%	79.0%	0.0%	21.0%
East Portland	2,329.7	15.7%	1.6%	0.0%	63.8%	0.2%	18.8%
North Portland	11,086.1	3.2%	1.4%	0.0%	58.3%	7.7%	29.4%
Northeast	0.0	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Southeast	2,402.7	29.3%	6.4%	0.0%	16.0%	9.8%	38.5%
Southwest	903.8	30.8%	22.0%	0.0%	0.0%	18.7%	28.5%
West/Northwest	2,076.9	0.1%	0.0%	0.0%	97.6%	0.4%	1.8%
TOTAL	**26,820.0**	**6.89%**	**3.1%**	**1.1%**	**58.3%**	**5.7%**	**24.9%**

Source: Future land use categories are based on the proposed comprehensive plan designations as of February 2016.

Table 8-22. Future Land Use Designations in Portland in Moderate Potential Liquefaction Areas

		Percent of total acres					
		Residential					
Reporting Area	Total Acreage	Single-Dwelling	Multi-Dwelling	Commercial	Employment & Industrial	Mixed Use & Institutional	Open Space
Airport	0.0	0.0%	0.0%	0.0%	0.0%	0.0%	0%
Central City	486.8	0.0%	2.7%	0.0%	40.0%	0.0%	4.6%
Central Northeast	151.5	0.0%	0.3%	0.0%	87.9%	2.3%	9.5%
East Portland	147.8	12.2%	0.6%	0.0%	77.8%	4.4%	5.0%
North Portland	843.1	1.9%	1.4%	0.0%	82.9%	7.3%	6.6%
Northeast	15.3	4.4%	0.0%	0.0%	95.5%	0.1%	0.0%
Southeast	697.9	69.5%	6.5%	0.0%	4.0%	14.5%	5.4%
Southwest	634.7	56.4%	7.5%	5.9%	0.3%	5.1%	30.6%
West/Northwest	1,366.0	18.6%	2.7%	0.0%	38.0%	3.5%	37.3%
TOTAL	**4,343.1**	**26.1%**	**3.6%**	**52.7%**	**39.3%**	**5.8%**	**19.4%**

Source: Future land use categories are based on the proposed comprehensive plan designations as of February 2016.

- The following social-vulnerability-related issues have been identified for high liquefaction potential areas:
  - People over 65 years of age may disproportionately reside in these areas in North Portland (18 percent), Southwest (17 percent), and East Portland (15 percent).
  - People of color may disproportionately reside in these areas in the Central Northeast (32 percent), Airport (32 percent), North Portland (29 percent) and East Portland (26 percent).
  - Renters may disproportionally reside in these areas in the Central City (82 percent), Airport (69 percent), Central Northeast (67 percent), Southeast (58 percent) and Southwest (54 percent).
  - Families with incomes below the poverty level may disproportionately reside in these areas in the Airport (20 percent), Central Northeast (19 percent), and Central City (14 percent).
  - Households with limited English speaking abilities may disproportionally reside in these areas in the Airport (21 percent) and Central Northeast (20 percent).
- The following issues have been identified based on the 100-year probabilistic earthquake scenario:
  - All risk reporting areas would experience damage.
  - It is estimated that 513 households will be displaced from their homes after an event and 243 of these people will seek shelter in public shelters. More than half of these people are expected to reside in the Central City.
  - More than 317,000 tons of debris would be expected from the event, which will require approximately 12,680 truckloads to remove. Most debris (more than 30,000 tons) will be in the Central City, North Portland, Southeast, and West/Northwest.
  - All risk reporting areas have estimated damage of less than 1 percent of the total value and about 0.5 percent of the total value of Portland would likely be damaged.
  - It is expected that 346 buildings in Portland will be extensively or completely damaged. An additional 2,197 would be expected to be moderately damaged.
- The following issues have been identified based on the Cascadia M9.0 event earthquake scenario:
  - All risk reporting areas would experience damage.
  - It is estimated that 5,838 households will be displaced from their homes after an event and 2,893 of these people will seek shelter in public shelters. About half of these people are expected to reside in the Central City.
  - More than 3.7 million tons of debris would be expected from the event, which will require approximately 148,000 truckloads to remove. Most debris (more than 500,000 tons) will be in the Central City, West/Northwest, Southwest and Southeast.
  - All risk reporting areas have estimated damaged of more than 2 percent of the total value. The following risk reporting areas are expected to have damage of more than 8 percent of the total value: North Portland, West/Northwest and Airport. About 4.3 percent of the total value of Portland would likely be damaged.
  - It is expected that 5,587 buildings in Portland will be extensively or completely damaged. An additional 8,309 would be expected to be moderately damaged.
- The following issues have been identified based on the 500-year probabilistic earthquake scenario:

  - All risk reporting areas would experience damage.
  - It is estimated that 19,726 households will be displaced from their homes after an event and 9,674 of these people will seek shelter in public shelters. About half of these people are expected to reside in the Central City. Additionally, more than 1,200 people in the West/ Northwest and Southeast may require shelter.
  - More than 8.4 million tons of debris would be expected from the event, which will require approximately 338,000 truckloads to remove. More than half of this debris will be in the Central City and North Portland reporting areas.
  - All risk reporting areas have estimated damaged of more than 4 percent of the total value. The following risk reporting areas are expected to have damage of more than 10 percent of their total value: Central City, West/Northwest, Southwest, and Northeast. About 12.9 percent of the total value of Portland would likely be damaged. About one third of this damage would come from the Central City alone.
  - It is expected that 12,871 buildings in Portland will be extensively or completely damaged. An additional 24,868 would be expected to be moderately damaged.

- The following issues have been identified based on the Portland Hills M6.5 event earthquake scenario:

  - All risk reporting areas would experience damage.
  - It is estimated that 25,186 households will be displaced from their homes after an event and 12,437 of these people will seek shelter in public shelters. More than half of these people are expected to reside in the Central City. Additionally, more than 1,000 people in the West/ Northwest and Southeast may require shelter.
  - More than 9.5 million tons of debris would be expected from the event, which will require approximately 380,400 truckloads to remove. More than 75 percent of this debris will be in the Central City, North Portland, and West/Northwest reporting areas.
  - All risk reporting areas have estimated damaged of more than 5 percent of the total value. The following risk reporting areas are expected to have damage of more than 10 percent of their total value: Central City, West/Northwest, North Portland and Northeast. The Central City and West/Northwest would be expected to have damage in excess of 25 percent of the total value of the areas. About 14 percent of the total value of Portland would likely be damaged.
  - It is expected that 12,948 buildings in Portland will be extensively or completely damaged. An additional 27,834 would be expected to be moderately damaged.

- Critical facility owners should be encouraged to create or enhance continuity of operations plans using the information on risk and vulnerability developed for this plan.
- Earthquakes could potentially trigger other natural hazard events such as dam failures, levee failures and landslides, which could severely impact Portland or regional critical facilities.
- There may be additional faults in or around the City of Portland that have not yet been discovered.
- After a major seismic event, the City of Portland is likely to experience disruptions in the flow of goods and services due to the destruction of major transportation infrastructure across the broader region.
- In many outreach programs residents are instructed to be self-sufficient up to three days following a major earthquake without government response agencies, utilities, private sector services and infrastructure components. It is likely that after a major event, supplies for 72 hours would not be sufficient. Residents should continue to be encouraged to start with three days and over time build up supplies for up to two or three weeks.

- Natural hazards have a devastating impact on businesses. Of all businesses that close following a disaster, more than 43 percent never reopen, and an additional 29 percent close for good within the next two years. The Institute of Business and Home Safety has developed “Open for Business,” which is a disaster planning toolkit to help guide businesses in preparing for and dealing with the adverse effects of natural hazards. The kit integrates protection from natural disasters into companies’ risk reduction measures to safeguard employees, customers, and the investment itself. The guide helps businesses secure human and physical resources during disasters, and helps to develop strategies to maintain business continuity before, during, and after a disaster occurs.
- An early warning system, ShakeAlert, is currently under development, but is not ready for public use.

9. LANDSLIDE

9.1 GENERAL BACKGROUND

Landslide is a general term for the dislodgment and fall of a mass of soil or rocks along a sloped surface. Landslides include mudflows, mudslides, debris flows, rock falls, debris avalanches, debris slides and earth flows. The susceptibility of hillside and mountainous areas to landslides depends on geology, topography, vegetation and weather. Landslides may be triggered or exacerbated by development of sloping ground or the creation of cut-and-fill slopes in areas of inadequately stable geologic conditions (NHMP, 2010).

DEFINITIONS

- **Landslide**—The movement of masses of loosened rock and soil down a hillside or slope. Slope failures occur when the strength of the soils forming the slope is exceeded by the pressure, such as weight or saturation, acting upon them.
- **Mass Movement**—A collective term for landslides, debris flows, falls and sinkholes.
- **Mudslide (or Mudflow or Debris Flow)**—A river of rock, earth, organic matter and other materials saturated with water. Mudslides develop in the soil overlying bedrock on sloping surfaces when water rapidly accumulates in the ground, such as during heavy rainfall or rapid snowmelt. Water pressure in the pore spaces of the material increases to the point that the internal strength of the soil is drastically weakened. The soil's reduced resistance can then easily be overcome by gravity, changing the earth into a flowing river of mud or "slurry."

9.1.1 Landslide Types

Failure Types

Landslides are commonly categorized by the type of initial ground failure. Figure 9-1 through Figure 9-4 show common types of slides (Washington Department of Ecology, 2014). The most common is the shallow colluvial slide, occurring particularly in response to intense, short-duration storms. Deep-seated slides are the largest and most destructive landslides, but they are less common than other types. The point of failure for deep landslides is typically within bedrock (generally more than 15 feet deep); the point of failure for shallow landslides is commonly between the thin soil mantle and the top of the bedrock. Deep landslides can occur in semi-consolidated sedimentary rocks in the Troutdale Formation around the Portland area (Oregon Department of Land Conservation and Development, 2015).

Material and Movement Type

The following landslide types are defined by material type and movement mechanism (see Figure 9-5):

- **Slides—**A slide is a mass movement of material at a discrete weakness area, sliding from stable underlying material. A *rotational slide* occurs when there is movement along a concave surface; a *translational slide* originates from movement along a non-curved surface.
- **Flows—**Flows include debris flows, debris avalanches, mudflows, creeps, earth flows, and lahars. Channelized debris flows are commonly mobilized by other types of landslides on slopes near a channel or by accelerated erosion in a channel during heavy rainfall or snow melt. Debris flows tend to initiate in the upper reaches of a drainage and pick up material as they move down. They can travel for several miles at speeds of more than 35 mph. At the mouth of the channel, the material fans out due to reduced slope and lack of confinement. (DOGAMI, 2013).

Source: Washington Department of Ecology

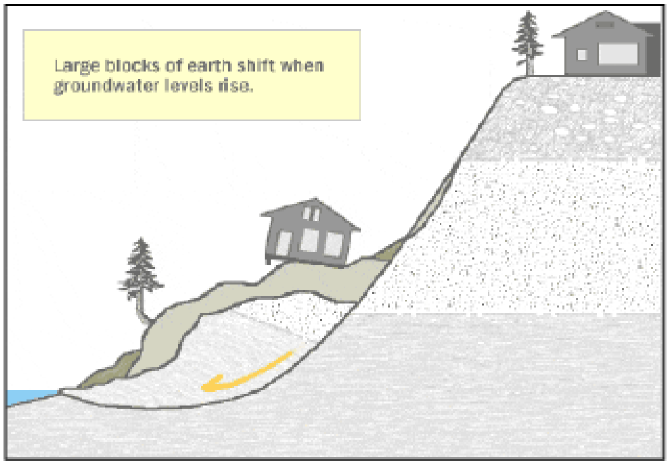


Figure 9-1. Deep Seated Slide

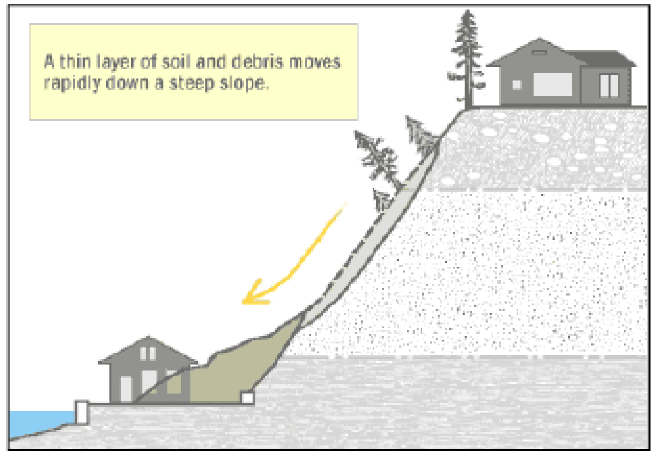


Figure 9-2. Shallow Colluvial Slide

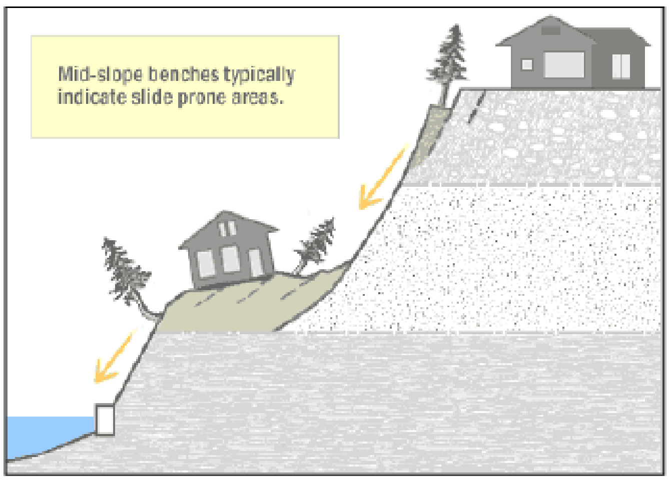


Figure 9-3. Bench Slide

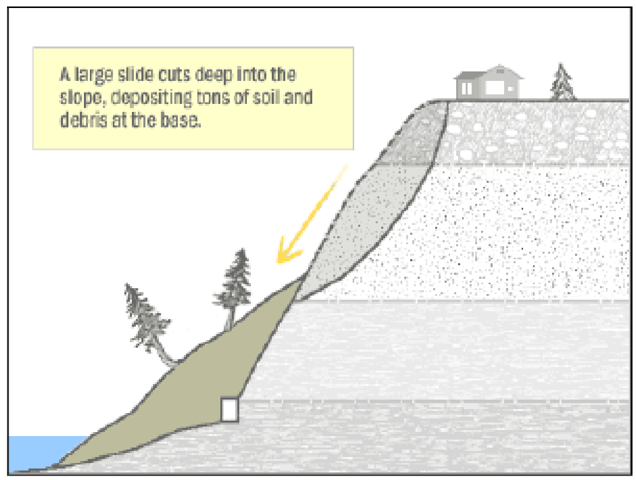


Figure 9-4. Large Slide

- **Spreads**—This type of landslide generally occurs on gentle slope or flat terrain. Lateral spreads are characterized by liquefaction of fine-grained soils. The event is typically triggered by an earthquake or human-caused rapid ground motion.
- **Falls**—Falls are the free-fall movement of rocks and boulders detached from steep slopes or cliffs.
- **Topples**—Topples are rocks and boulders that rotate forward and may become falls.
- **Complex**—Any combination of landslide types (USGS, 2004 and DOGAMI, 2008 as cited in NHMP, 2010).

9.1.2 Landslide Runout

In addition to the failure type, landslide risk assessment evaluates the post-failure movement of loosened material, called "runout." Runout is assessed for its travel distance and velocity. Mapping of landslide risk areas generally indicates the location of the potential failure, but mapping of areas that would be affected by the runout after the failure is not currently well-developed.

Source: DOGAMI Landslide Fact Sheet, 2008

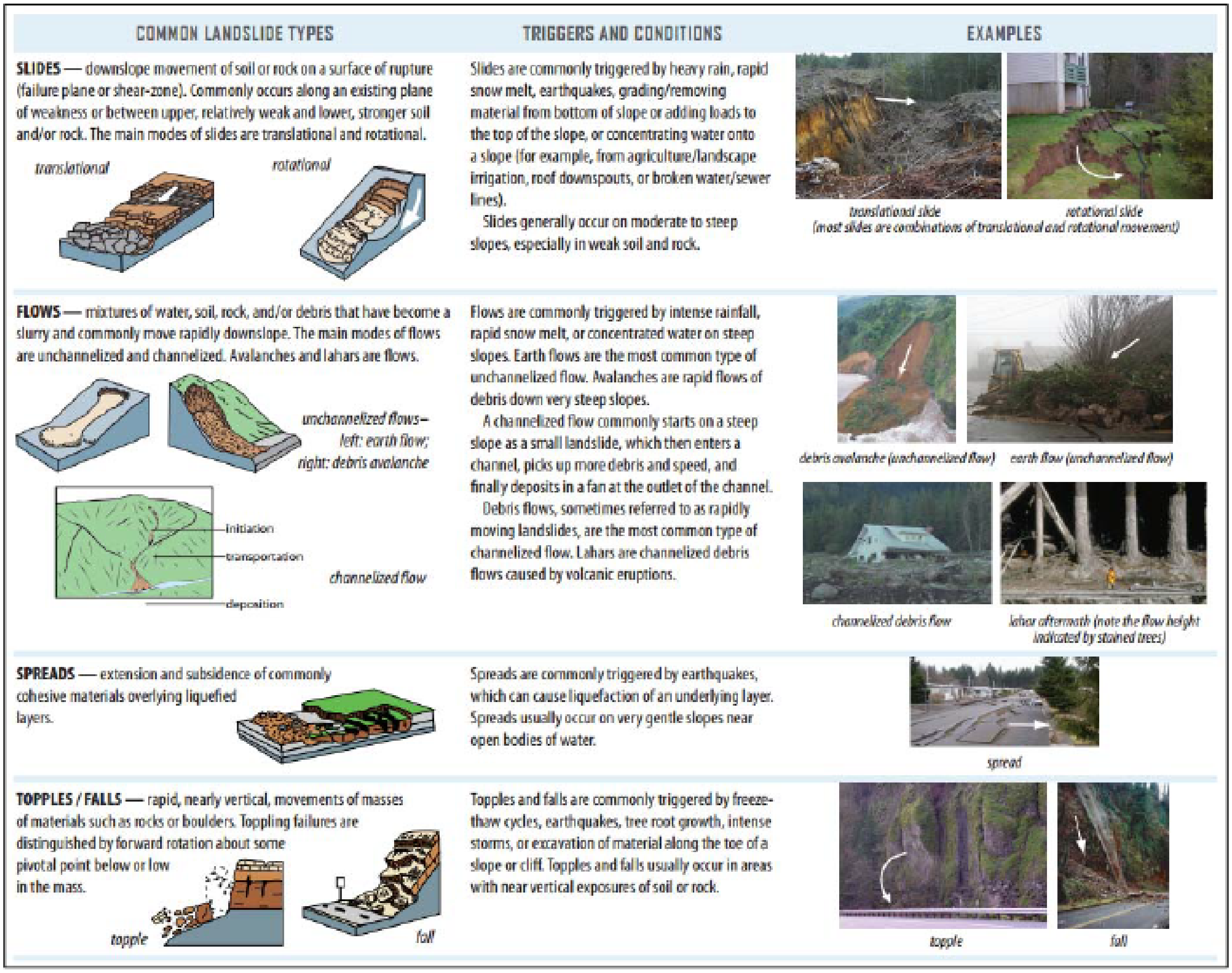


Figure 9-5. Common Landslide Types and Conditions

Recent events such as the Oso landslide in Washington in March 2014 have changed the thinking of the assessment of risk from landslide hazards. The Oso landslide was the deadliest single landslide event in U.S. history (43 fatalities, 49 homes destroyed, damage in excess of $10 million). The damage extended over 2.6 kilometers, although the failure location of the slide was less than a half-kilometer. Most of the area impacted was damaged by the slide runout. This indicates the importance of considering possible runout scenarios to accurately reflect the risk from landslide hazards.

9.1.3 Landslide Causes

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

Natural Conditions

Natural processes can cause landslides or re-activate historical landslide sites. Rainfall-initiated landslides tend to be smaller, while earthquake-induced landslides may be very large, but less frequent. Countless small slides each year result from the removal of supporting material along water bodies by currents and waves or undercutting during construction at the base of a slope. Seismic tremors can trigger landslides on slopes historically known to have landslide movement. Earthquakes can also cause lateral spreading on gentle slopes above steep stream and river banks. Landslides are particularly common along stream banks, reservoir shorelines, large lakes and seacoasts. Concave-shaped slopes with larger drainage areas appear to be more susceptible to landslides than other landforms. Landslides associated with volcanic eruptions can include volumes approaching a cubic mile of material. All soil types can be affected by natural landslide triggering conditions (Oregon Department of Land Conservation and Development, 2000).

Excavation and Grading

Slope excavation is common in the development of home sites or roads on sloping terrain. Grading can result in some slopes that are steeper than the pre-existing natural slopes. Since slope steepness is a major factor in landslides, these steeper slopes can be at an increased risk for landslides. The added weight of fill placed on slopes can also result in an increased landslide hazard. Small landslides can be fairly common along roads, in either the road cut or the road fill. Landslides occurring below new construction sites are indicators of the potential impacts stemming from excavation. In addition, historical landslide areas are more susceptible to construction-triggered sliding than are undisturbed slopes (Oregon Department of Land Conservation and Development, 2000).

A Portland State University study (Burns et al., 1998) found that changes to the slope through cutting or filling increased the risk of 76 percent of inventoried landslides in the Portland Metro region. The study documented 48 landslides that occurred in Oregon City in February 1996 and found that only about half the slides were considered natural. A Seattle landslide study found that human influence played some role in 84 percent of recorded slides (Winters, 2015).

Drainage and Groundwater Alterations

Water flowing through or above ground is often the trigger for landslides. Any activity that increases the amount of water flowing into landslide-prone slopes can increase landslide hazards. Broken or leaking water or sewer lines can be especially problematic, as can water retention facilities that direct water onto slopes. However, even lawn irrigation and minor alterations to small streams in landslide prone locations can result in damaging landslides. Ineffective stormwater management and excess runoff can also cause erosion and increase the risk of landslide hazards. Drainage can be affected naturally by the geology and topography of an area. Development that results in an increase in impervious surface impairs the ability of the land to absorb water and may redirect water to other areas. Channels, streams, flooding, and erosion on slopes all indicate potential slope problems. Road and driveway drains, gutters, downspouts, and other constructed drainage facilities can concentrate and accelerate flow. Ground saturation and concentrated flow are major causes of slope problems and may trigger landslides (Oregon Department of Land Conservation and Development, 2000).

Changes in Vegetation

Removing vegetation from very steep slopes can increase landslide hazards. A study by the Oregon Department of Forestry found that landslide hazards in three out of four steeply sloped areas were highest for roughly 10 years after timber harvesting (Oregon Department of Forestry, 1999). A more recent study of a heavy rain event on Vancouver Island, Canada found that low forest density, indicating regrowth areas, and proximity to forest service roads were jointly associated with a 6- to 9-fold increase in the odds of a landslide (Goetz et al., 2015). Areas that have experienced wildfire and land clearing for development may have long periods of increased landslide hazard. In addition, woody debris in stream channels (both natural and man-made from logging) may cause the impacts of debris flows to be more severe (Oregon Department of Land Conservation and Development, 2000).

9.1.4 Indicators of Possible Landslide

The following are recognized indicators of a possible landslide (NHMP, 2010):

- Springs, seeps or wet ground that is not typically wet
- New cracks or bulges in the ground or pavement
- Soil subsiding from a foundation
- Secondary structures (decks, patios) tilting or moving away from main structures
- Broken water line or other underground utility
- Leaning structures that were previously straight
- Offset fence lines
- Sunken or dropped-down road beds
- Rapid increase in stream levels, sometimes with increased turbidity
- Rapid decrease in stream levels even though it is raining or recently stopped
- Sticking doors and windows, visible spaces indicating frames out of plumb.

9.1.5 Landslide Management

The largest landslides are often naturally occurring phenomena with little or no human contribution. The sites of large landslides are typically areas of previous landslide movement that are periodically reactivated by significant precipitation or seismic events. Such naturally occurring landslides can disrupt roadways and other infrastructure lifelines, destroy private property, and cause flooding, bank erosion and rapid channel migration. Landslides can create immediate, critical threats to public safety, and engineering solutions to protect structures from large active landslides are often prohibitively expensive.

In spite of their destructive potential, landslides can serve functions that are beneficial to the natural environment. They supply sediment and large wood to a stream network, contributing to complexity and dynamic channel behavior critical for aquatic and riparian ecological diversity. Effective landslide management should include the following elements:

- Continuing investigation to identify natural landslides, understand their mechanics, assess their risk to public health and welfare, and understand their role in ecological systems
- Regulation of development in or near existing landslides or areas of natural instability
- Preparation for emergency response to landslides to facilitate rapid, coordinated action among local government and state and federal agencies, and to provide emergency assistance to affected or at-risk residents
- Evaluation of options including landslide stabilization or structure relocation where landslides are identified that threaten critical public structures or infrastructure.

The State of Oregon has statewide planning goals that require comprehensive plans at the local level to reduce risk to people and property from natural hazards, which include geologically hazardous areas such as areas prone to landslide (Oregon Department of Land Conservation and Development, 2002). The City of Portland City Code 33.632 and Title 24 and the Oregon State Structural Specialty Code Section 1803 discourage development in landslide hazard areas; however, development may be allowed when certain requirements are met (Portland Bureau of Development Services, 2016). These requirements include a mandatory landslide hazard study, to include the following (Portland Bureau of Development Services, 2014):

- Review of current landslide inventory and hazard maps, geologic literature, LiDAR, etc. for the site
- A visual reconnaissance of the site and surrounding area
- A description of current topography and observable geologic features and hazards
- Engineering recommendations for the layout and design of the land, including:
  - Identification of portions of the site that are suitable for development in a manner that reasonably limits the risk of landslide potential on the site and nearby properties
  - Recommendations for specific improvements, engineering requirements, or alternative development options to reasonably limit risks
  - Hazardous or no-build areas within the subdivision, if any, and/or building setback distances from slopes
  - Building locations and foundation designs
  - Driveway and/or street locations
  - Utility trench locations
  - Retaining walls, associated drainage and discharge systems, if any
  - Grading requirements for building sites, driveways or streets
  - Impact of tree removal on slope stability
  - Stormwater and groundwater disposal methods for new lots and evaluation of existing systems to remain, as well as evaluation of runoff and stormwater disposal from adjacent property that may impact the proposed development
  - Infiltration testing per the Bureau of Environmental Services Stormwater Management Manual, unless both the certified engineering geologist and professional engineer determine the site is not suitable for onsite infiltration
  - Subsurface exploration logs
  - Slope stability calculations.
- A statement of on-site slope stability after the proposed development is complete
- A statement of the estimated effect of the development on stormwater and groundwater runoff as it relates to slope stability and landslide hazard, and a proposed method of control.

9.2 HAZARD PROFILE

9.2.1 Past Events

Landslides are a major geologic hazard in Oregon and the impact of landslides on property and life safety for Oregonians will increase as population increases and development advances into more landslide-prone urban areas. In a typical year, an estimated $10 million is spent on landslide losses in Oregon (DOGAMI, 2008 as cited in NHMP, 2010). Since 2006, there have been seven Presidential Disaster Declarations in response to landslides in Oregon (FEMA, 2016b). Recent studies by DOGAMI have determined that 35 percent of Oregon is in high or very high landslide susceptibility zones (DOGAMI, 2016).

Landslides have created problems in and around Portland's hills. Landslides result in private property damage, and many impact transportation corridors, fuel and energy conduits and communication facilities. In October 2008, a devastating landslide destroyed two homes and severely compromised another three. There were no casualties from this event, but it displaced the families from the destroyed homes and shut down a transportation route for an extended period of time (NHMP, 2010).

Much of the terrain in northwest Oregon is hilly and susceptible to slides; however, many slides take place in undeveloped areas and are unreported or even unnoticed. A statewide DOGAMI survey of winter storm landslides in 1996 and 1997 reported 9,582 documented slides (NHMP, 2010). This included 700 in the Portland Metropolitan region (Burns et al., 1998). In the City of Portland, 17 homes were completely destroyed and 64 were badly damaged. There were no serious injuries associated with the landslides in Portland or in other urban areas of Oregon during the 1996 storms (Oregon Department of Land Conservation and Development, 2015).

Historically, long periods of winter rain and heavy snowfall trigger landslides. These landslides may affect city roads and key emergency transportation routes. Wildfires have removed vegetation from hillsides and significantly increased runoff and landslide potential. On the steep-sloped Willamette Escarpment (Oaks Bottom and Mocks Crest Park natural areas) fires followed by repeated landslides have left many areas void of vegetation. Table 9-1 and Table 9-2 give an overview of the historical landslides and their impacts.

Table 9-1. Historical Landslides

Date	Approximate Location or Type	Number of Landslides
1895	Washington Park	1
1957	Children's Museum, World Forestry Center, Oregon Zoo	1
1972	I-5 near Portland	1
1996	Dodson, OR – Multnomah County	1
	February & December flood events. Portland Metro Area. Four main areas of concern: • West Hills • Steep slopes along Willamette River (i.e. Oaks Bottom, Swan Island) • SE Portland • Steep Areas along Columbia & north Willamette Rivers	700+
1996-2002	Portland (varied locations)	403
2005	Debris Flow – Mud Flow	1
	Earth Flow	2
	Mud Flow	1
	Slump – Debris Flow	1
	Slump – Earth Flow/Rock Fall	3
2006	Debris Slide	4
	Earth Flow	4
	Earth Flow – Debris Slide	2
	Earth Flow – Mud Flow	1
	Earth Flow – Rock Fall	1
	Rock Fall	1
	Slump – Debris Flow	1
	Slump – Earth Flow	1
	Slump – Earth Flow/Debris	1
	Type Unknown	1
2007	Debris Flow	3
	Debris Slide	3
	Earth Flow	4

Date	Approximate Location or Type	Number of Landslides
	Flow	1
	Rock Fall	5
	Rock Fall – Earth Flow	1
	Slump – Earth Flow	2
	Slump – Debris Flow/Earth	1
	Slump – Earth Flow/Debris	1
	Slump – Earth Flow/Rock Fall	1
2008	Debris Slide	3
	Debris Slide – Rock Fall	1
	Earth Flow	4
	Earth Flow – Debris Flow	3
	Earth Flow – Rock Fall	1
	Fault Scarp	1
	Potential Debris Flow	1
	Rock Fall	2
	Slump – Earth Flow	1
	Slump – Earth Flow/Rock Fall	3
	Type Unknown	2
2009	Debris Slide	4
	Debris Slide – Earth Flow	1
	Debris Slide – Mud Flow	2
	Earth Flow	2
	Earth Flow – Debris Flow	1
	Earth Flow – Mud Flow	1
	Earth Slide	1
	Possible Earth Flow	1
	Rock Fall	3
	Rock Fall – Mud Flow	1
	Slump – Debris Flow	1
	Slump – Earth Flow/Debris	1
	Slump – Earth Flow/Rock Fall	1
	Type Unknown	1
2010	Rock fall	4
	Earth Flow	2
	Debris Flow	1
	Rock Slide	1
	Rotational Earth	1
	Type Unknown	7
2012	Type Unknown	6
2014	Rock Slide	1
	Rock fall	1
TOTAL		**1,221+**

Source: NHMP, 2010 and SLIDO 3.2 last updated December 29, 2014

Highway	Year	Type
US 26	2004 – present	Rock Fall/Rock Slide
	2006	Rock Fall
	2007	Rock Fall/Rock Slide
US 30	2009	Debris Flow
	2010	Rock Fall
	2014	Rock Slide
US 30 Bypass (N. Bridge Ave-North)	2008	Rock Fall
US 99W	2005	Soil Cut-Slope Failure (construction)
	2007	Rock Fall
	2008	Rock Fall
	2009	Soil Cut-Slope Failure (construction)

Table 9-2. Portland Landslide Events: Impacted Highways (2004-2014)

Source: NHMP, 2010 and SLIDO 3.2, last updated December 29, 2014

9.2.2 Location

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

In general, the probability of slope failure increases with an increase in slope incline. However, depending on factors such as soil type and water content, a slope having a relatively low incline could be at greater risk of failure than another slope having a relatively high incline. Other factors that influence susceptibility include rock type, water content, vegetative cover and type, slope aspect, permeability and rate of infiltration, proximity to seismic sources, and magnitude of seismic events. In addition, unconsolidated deposits of alluvial and glacial outwash materials are subject to accelerated stream bank erosion and landslides. The possibility of failure also increases in sloped areas where humans have disturbed the soil and vegetation such as cutback projects and timber reduction areas (NHMP, 2010).

Several data sets identify existing landslide areas for Oregon and Portland. These include DOGAMI SP-34 (landslide points from the 1996-1997 storms) and DOGAMI State Landslide Identification Database of Oregon (SLIDO), which was recently updated to version 3.2 in 2014 (landslide polygons from previous geologic and hazard mapping).

Recent studies have shown that the use of LiDAR to map landslides results in a significant improvement in the ability to locate historical landslides. DOGAMI has compared landslide mapping using existing techniques (time-series air photo survey and three other remote sensing types of data sets) to mapping with LiDAR in the Portland Hills. The LiDAR reveals many more slides and allows spatially accurate delineation of slide boundaries. Oregon City was the first city in the state to have a landslide map created by DOGAMI using the LiDAR technology (Burns and Madin, 2008 as cited in NHMP, 2010). Since then LiDAR maps of landslide hazards have become available for many counties and communities across Oregon (DOGAMI, 2016). The City of Portland has been working with DOGAMI to create such maps, which are now in the process of review (NHMP, 2010).

The most recent product by DOGAMI is a landslide susceptibility map for the entire state of Oregon. This map will provide landslide hazard information for regional planning and specifically identify areas where more detailed landslide mapping is needed (2016).

Two data sets were used for the risk assessment of the landslide hazard (see Figure 9-6):

- DOGAMI historical landslide deposits.
- City of Portland regulatory landslide hazard area—This dataset is currently used for permitting purposes and was created from three sources:
  - Areas identified and mapped by Metro as earthquake hazard areas
  - Areas delineated as zones of high landslide potential in a study conducted by Portland State University based on the mapping of 676 landslide events that occurred as a result of the February 1996 storms
  - All land within the City that has a slope of 15 percent or greater.

The Oregon Department of Forestry's *Storm Impacts and Landslides of 1996: Final Report* assesses the impacts of landslides for the 1996 winter storms. The study included eight study areas, but did not provide a detailed inventory of landslide prone areas outside the very small study area. This study concluded that the highest hazard for shallow rapid landslides in western Oregon occurs on slopes of over 70 percent to 80 percent, depending on landform and geology (NHMP, 2010).

The geographic extent of landslide events is essentially the same as slide location. The effects depend on what infrastructure is in the way of a slide, as well as the magnitude and force of the slide itself. The extent can be limited to one building or property or can be region-wide, as in the case of a major transportation disruption, slide-induced dam failure or utility outage (NHMP, 2010).

9.2.3 Frequency

Landslides are an annual occurrence in Oregon during the rainy months, October through May. They generally result from intense or prolonged rainfall, particularly during a rain on snow event. Slope alteration and shape can affect recurrence-interval. Recurrence intervals for steep terrain can range from 50 to 5,000 years, with some debris flow recurrence intervals of less than 10 years (Oregon, 2004 as cited in NHMP, 2010). Several steep-sloped natural areas are prone to yearly landslides: Forest Park, Terwilliger Wildlands, Marquam Nature Park and the Willamette Escarpment east of the Willamette River are notable (NHMP, 2010).

In general, landslides are most likely during periods of higher than average rainfall. The ground must be saturated prior to the onset of a major storm for significant landslides to occur. Most local landslides occur in January after the water table has risen during the wet months of November and December. Water is involved in nearly all cases; and human influence has been identified in more than 80 percent of reported slides.

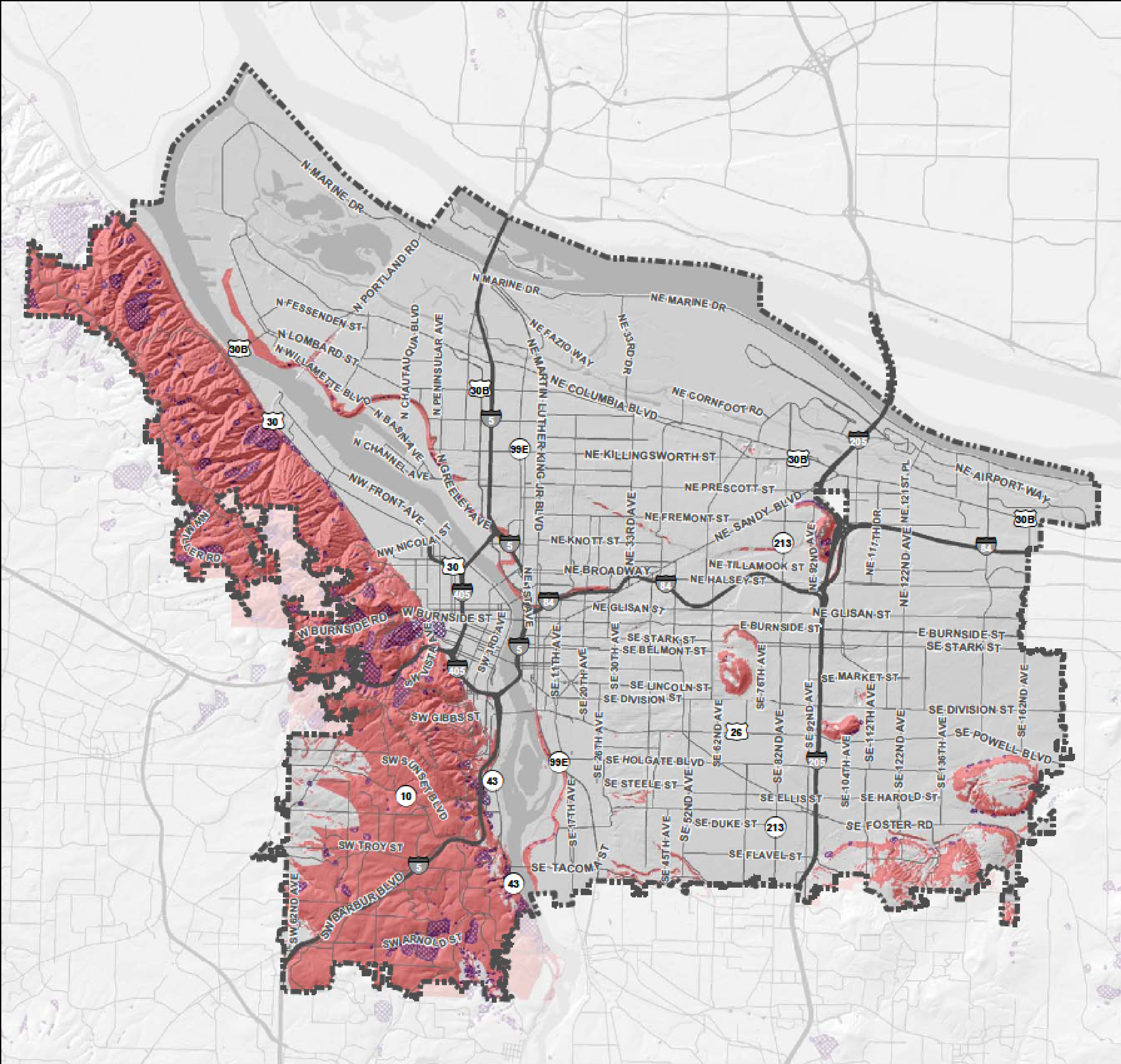
9.2.4 Severity

Landslides destroy property and infrastructure and can take the lives of people. Slope failures in the United States result in an average of 25 lives lost per year and an annual cost to society of about $1.5 billion. According to NOAA, the 1997 and 2006 storms caused in excess of $20 million in property damage due to landslides. This was about half of all damage caused by the storm. The landslides caused by the storm also caused tens of millions of dollars of damage to road infrastructure.

September 12, 2016

Mitigation Action Plan (MAP)

Figure 9-6. Regulatory Landslide Hazard Area



Legend

- City Boundary
- Historic Landslide Deposits
- Landslide Hazard Area

Sources: DOGAMI-2015; City of Portland-2015, 2016

The potential impacts from landslides can be widespread. Landslides can impact transportation and rail routes, utility systems, and water and wastewater treatment infrastructure, along with public, private and business structures adjacent to steep slopes, along riverine embankments, or within alluvial fans or natural drainages. Utility disruptions are usually local and terrain-dependent. Damage may require reestablishing electrical, communications, and gas pipeline connections occurring from specific breakage points. Initial debris clearing from emergency routes and high traffic areas may be required. Water and wastewater utilities may need treatment to quickly improve water quality by reducing excessive water turbidity and reestablishing waste disposal capability (NHMP, 2010).

The 2014 landslide in Oso, Washington showed the devastating damage that can be caused by landslides. The slide traveled over 60 mph, covering over a square mile of land and depositing a thickness of 15 to 75 feet in some areas. The slide caused 43 fatalities and 12 injuries, destroyed 37 homes, and destroyed over a mile of state highway. The debris blocked the North Fork Stillaguamish River for over 24 hours, backing up a pool of water that flooded the valley about 2 miles upstream and reached approximately 20 feet deep, inundating an additional six homes. Total property damage was estimated at $60 million (NOAA, 2015).

9.2.5 Warning Time

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

The USGS has an installation in the West Hills of Portland that monitors and detects changes in local conditions such as rainfall, groundwater pressure and soil water content. Data collection at this site supports research on hydrologic factors that control landslide initiation, and may provide advance warning of landslide conditions in the local area. Residents can also receive hazard alerts through National Weather Service advisories, through the federal Wireless Emergency Alert system, or through the Portland Bureau of Emergency Management's PublicAlerts website (DOGAMI, 2015).

9.3 COMPOUNDING FACTORS AND SECONDARY HAZARDS

9.3.1 Overview

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

Landslides often occur with other natural hazards and human-caused activities, thereby exacerbating conditions, as described below (NHMP, 2010):

- Earthquake shaking can trigger events ranging from rock falls and topples to massive slides.
- Intense or prolonged precipitation can saturate slopes and cause failures leading to landslides.
- Landslides into a reservoir can indirectly compromise dam safety; a landslide can even affect the dam itself.
- Wildfires can remove vegetation from hillsides, significantly increasing runoff and landslide potential.
- Volcanic eruptions have been known to cause some of the largest landslides in the world.
- Development related activities such as increased runoff, excavation in hillsides, non-engineered fill and shocks and vibrations from construction can contribute to or trigger landslides. Construction projects accomplished without regard to geography, landslide toe locations, or historic slide events can increase landslide potential.
- Broken underground water mains can saturate soil and destabilize slopes, initiating slides.
- Blocked culverts can increase and alter water flow, thereby increasing the potential for a landslide event in an area with high natural risk.
- Natural weathering and decomposition of geologic material and alterations in flow of surface water or groundwater can further increase the potential for landslides (NHMP, 2010).

9.3.2 Invasive Species and Erosion

The presence of invasive species and erosion can impact the likelihood of a landslide occurring. Invasive species often have shorter root systems, providing less anchoring capabilities for slopes that may be likely to fail. Invasive fungal species that damage trees and other vegetation, such as Swiss needle cast disease infecting Douglas fir trees throughout Portland, can contribute to increased wildfire risk and lead to increased incidence of landslides. Landslides are impacted by erosion, especially if the erosion is occurring in areas undercutting steep slopes susceptible to slides.

9.3.3 Climate Change

Climate change may impact storm patterns, increasing the probability of more frequent, intense storms with varying duration. Warming temperatures also could increase the occurrence and duration of droughts and insect and fungal infestations, which would increase the probability of wildfire, reducing the vegetation that helps to support steep slopes. All of these factors would increase the probability for landslide occurrences. The City of Portland and Multnomah County Climate Change Preparation Strategy (2014) indicates that an increased incidence of landslides due to climate change as a result of season precipitation patterns is likely.

9.4 EXPOSURE

9.4.1 Population

A population estimate for exposure to the landslide hazard was made by determining the percent of residential buildings in each risk reporting area located in mapped landslide areas and multiplying this percent by the total population for each area. This method may underestimate actual exposure to the landslide hazard area, as potential runout areas have not been identified and were not included in the assessment. Using this approach, the estimated population living in the landslide risk areas is 89,133 or 14.5 percent of the city-wide population. Table 9-3 shows the landslide hazard exposure by risk reporting area. The West/Northwest and Southwest area have substantial exposure to this hazard, with 78 percent and 82 percent of the population exposed, respectively. Table 9-4 shows the estimated percent of the population residing in landslide hazard areas by social vulnerability indicators. City-wide, the elderly population may be disproportionately residing in these hazard areas.

Table 9-3. Estimated Population Residing in Landslide Risk Areas

Reporting Area	Population Exposed[a]	% of Total Population
Airport	0	0.0%
Central City	3,723	9.8%
Central Northeast	454	1.0%
East Portland	3,597	2.4%
North Portland	1,200	1.8%
Northeast	255	0.4%
Southeast	1,574	1.0%
Southwest	57,440	81.8%
West/Northwest	20,890	77.7%
Total	**89,133**	**14.5%**

a. Value calculated as percent of residential buildings exposed multiplied by the estimated population.

Note: Values shown are accurate only for comparison among results in this plan. See Section 6.8 for a discussion of data limitations.

Table 9-4. Distribution of Social Vulnerability Indicators in Landslide Hazard Areas

	Population Residing in High Landslide Hazard Areas [a, b, c, d]					
Reporting Area	Percent Under 15 Years	Percent Over 65 Years	Percent of People of Color	Percent of Renter occupied Housing	Percent of Families Below Poverty Level	Percent of Limited English Speaking Households
Airport	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Central City	4.8%	13.5%	16.0%	75.0%	6.0%	0.3%
Central Northeast	11.4%	24.0%	21.8%	37.8%	13.1%	8.3%
East Portland	22.3%	11.4%	25.8%	22.5%	7.1%	7.2%
North Portland	12.8%	8.8%	17.4%	38.8%	9.5%	1.6%
Northeast	7.0%	21.2%	16.5%	68.3%	2.9%	0.1%
Southeast	12.0%	18.4%	12.2%	29.8%	3.7%	1.9%
Southwest	15.1%	13.1%	12.5%	35.5%	5.1%	1.3%
West/Northwest	14.4%	13.4%	16.9%	33.8%	3.5%	1.2%
Total	**15.0%**	**13.2%**	**14.4%**	**35.4%**	**4.8%**	**1.5%**

a. Values based on an analysis of 2010-2014 American Community Survey 5-year estimates at the Census block group level.

b. Values calculated using block group statistics weighted by the number of residential structures in the hazard area as a percentage of the total residential structures in the block group.

c. Values in red indicate percentages are at least 2 percent greater than the Citywide average (see Section 4.7).

d. Persons with disabilities not shown because the available data, at a census tract scale, is not conducive to analysis by hazard extent and location.

9.4.2 Property

Table 9-5 shows the number and replacement value of structures exposed to the landslide risk. There are more than 26,000 structures in the landslide risk areas, with an estimated value of $20.6 billion. Over 96 percent of the exposed structures are dwellings. Table 9-6 lists the type of structures exposed.

9.4.3 Critical Facilities and Infrastructure

Table 9-7 and Table 9-8 summarize the critical facilities and infrastructure exposed to the landslide hazard.

Table 9-5. Exposure and Value of Structures in Landslide Risk Areas

Reporting Area	Number of Buildings Exposed	Value Exposed			Exposed Value as % of Total Replacement Value
		Structure	Contents	Total	
Airport	0	$0	$0	$0	0.0%
Central City	136	$304,493,439	$228,473,839	$532,967,278	1.7%
Central Northeast	166	$83,602,166	$57,986,469	$141,588,635	1.3%
East Portland	1,021	$299,034,886	$155,669,463	$454,704,349	1.7%
North Portland	458	$446,697,999	$465,509,089	$912,207,088	3.9%
Northeast	97	$100,818,118	$78,368,497	$179,186,615	1.4%
Southeast	554	$356,360,397	$231,647,166	$588,007,563	1.9%
Southwest	18,778	$8,184,557,210	$5,913,498,269	$14,098,055,479	79.2%
West/Northwest	5,160	$2,403,388,313	$1,386,316,435	$3,789,704,748	27.2%
Total	**26,370**	**$12,178,952,528.18**	**$8,517,469,227.39**	**$20,696,421,756**	**12.1%**

Table 9-6. Structure Type Exposed in the Landslide Hazard Area

	Number of Structures[a]						
	Residential	Commercial	Industrial	Religion	Government	Education	Total
Airport	0	0	0	0	0	0	**0**
Central City	84	35	12	0	5	0	**136**
Central Northeast	153	4	0	8	1	0	**166**
East Portland	1,002	17	0	2	0	0	**1,021**
North Portland	389	36	12	1	5	15	**458**
Northeast	87	5	0	0	4	1	**97**
Southeast	518	23	6	0	0	7	**554**
Southwest	18,228	390	3	50	38	69	**18,778**
West/Northwest	4,880	232	28	1	11	8	**5,160**
Total	**25,341**	**742**	**61**	**62**	**64**	**100**	**26,370**

a. Structure type assigned to best fit Hazus occupancy classes based on present use classifications provided by Multnomah County assessor's data. Where conflicting information was present in the available data, parcels were assumed to be improved.

Table 9-7. Critical Facilities in Landslide Risk Areas[a]

Reporting Area	Number of Critical Facilities in Landslide Hazard Areas				Total
	Emergency Services	High Potential Loss Facilities	Schools	Other Assets	
Airport	0	0	0	0	**0**
Central City	0	0	0	0	**0**
Central Northeast	0	0	1	0	**1**
East Portland	0	0	0	0	**0**
West/Northwest	1	3	5	1	**10**
North Portland	0	2	0	0	**2**
Northeast	1	0	0	0	**1**
Southeast	0	0	0	0	**0**
Southwest	8	1	36	7	**52**
Outside City Boundary	0	0	0	0	**0**
Total	**10**	**6**	**42**	**8**	**66**

a. See Table 6-1 for a description of the facilities included in each category.

Table 9-8. Critical Infrastructure in Landslide Risk Areas[a]

Reporting Area	Number of Critical Infrastructure Facilities in Landslide Hazard Areas					
		Utility Systems				
	Transportation Systems	Communications	Power	Potable Water	Wastewater	Total
Airport	0	0	0	0	0	**0**
Central City	0	1	0	1	1	**3**
Central Northeast	2	1	0	2	0	**5**
East Portland	0	1	0	5	1	**7**
West/Northwest	4	2	2	25	1	**34**
North Portland	0	0	0	0	5	**5**
Northeast	1	0	0	0	0	**1**
Southeast	0	1	0	2	3	**6**
Southwest	7	5	1	34	6	**53**
Outside City Boundary	0	0	0	12	0	**12**
Total	**14**	**11**	**2**	**81**	**17**	**125**

a. See Table 6-1 for a description of the facilities included in each category.

The following linear infrastructure can be exposed to landslides:

- **Roads**—Access to major roads is crucial to life-safety after a disaster event and to response and recovery operations. Landslides can block egress and ingress on roads, causing isolation for neighborhoods, traffic problems and delays for public and private transportation. This can result in economic losses for businesses. The following major roads in Portland cross through mapped landslide hazard areas:
  - I-205
  - I-5
  - I-84
  - I-405
  - N Interstate Ave.
  - N Willamette Blvd.
  - NW Cornell Rd.
  - NW Germantown Rd.
  - NW Skyline Blvd.
  - NW St Helens Rd (US Highway 30)
  - SE McLoughlin Blvd (State Highway 99E)
  - SW Barbur Blvd.
  - SW Beaverton-Hillsdale Highway
  - SW Boones Ferry Rd.
  - SW Capitol Highway
  - SW Macadam Ave.
  - SW Montgomery Dr.
  - SW Multnomah Blvd.
  - SW Naito Pkwy
  - SW Sunset Highway (US Highway 26)
  - SW Taylors Ferry Rd.
  - SW Terwilliger Blvd.
  - W Burnside Rd.
- **Bridges**—Landslides can significantly impact road bridges. They can knock out bridge abutments or significantly weaken the soil supporting them, making them hazardous for use.
- **Power Lines**—Power lines are generally elevated above steep slopes, but the towers supporting them can be subject to landslides. A landslide could trigger failure of the soil underneath a tower, causing it to collapse and ripping down the lines. Power and communication failures due to landslides can create problems for vulnerable populations and businesses. There are 87.61 miles (18.4 percent of the city-wide system) of power lines in mapped landslide hazard areas.
- **Gas Lines**—There are 12.43 miles of major gas lines in landslide hazard areas. Almost half of this exposure is in West/Northwest; another 43 percent is in Southwest.
- **Rail Lines**—25.51 miles (6.8 percent) of rail lines and 4.09 miles (7.7 percent) of light rail lines are in mapped landslide hazard areas.

9.4.4 Environment

Environmental problems as a result of mass movements can be numerous. Landslides that fall into streams may significantly impact fish and wildlife habitat, as well as affecting water quality. Hillsides that provide wildlife habitat can be lost for prolonged periods of time due to landslides. The Bull Run Watershed may be adversely impacted by landslides. Although no water supply related structures are located in known landslide hazard areas in the watershed, it is possible that large or numerous slides in the watershed could result in turbidity and the need to close the water source for a time.

9.5 VULNERABILITY

9.5.1 Population

In general, all of the estimated 89,133 persons exposed to the landslide hazard areas are considered to be vulnerable. Elderly and disabled residents and others with access and functional needs may have difficulty evacuating in the event of a quickly moving slide. Additionally, residents with mobility challenges may be less likely to notice the warning signs that typically proceed a slide event (see Section 9.1.4) if they are having challenges keeping up with house and yard maintenance activities.

If population and development on steep slopes or other potential landslide hazard areas increase, vulnerable populations may also increase. The City of Portland Bureau of Development Services regulates and reviews proposed development projects, including residential developments, located in known and potential landslide hazard areas.

9.5.2 Property

Loss estimations for the landslide hazard are not based on damage functions, because no damage functions have been generated. Instead, potential loss estimates were developed representing 10 percent, 30 percent and 50 percent of the replacement value of exposed structures. This allows emergency managers to select a range of economic impact based on an estimate of the percent of damage to the general building stock. Damage in excess of 50 percent is considered to be substantial by most building codes and typically requires total reconstruction of the structure. Table 9-9 shows the general building stock loss potential in landslide risk areas.

Table 9-9. Loss Potential for Landslide

Reporting Area	Exposed Value	Potential Loss @ 10% Damage	Potential Loss @ 30% Damage	Potential Loss @ 50% Damage
Airport	$0	$0	$0	$0
Central City	$532,967,278	$53,296,728	$159,890,183	$266,483,639
Central Northeast	$141,588,635	$14,158,864	$42,476,591	$70,794,318
East Portland	$454,704,349	$45,470,435	$136,411,305	$227,352,175
North Portland	$912,207,088	$91,220,709	$273,662,126	$456,103,544
Northeast	$179,186,615	$17,918,662	$53,755,985	$89,593,308
Southeast	$588,007,563	$58,800,756	$176,402,269	$294,003,782
Southwest	$14,098,055,479	$1,409,805,548	$4,229,416,644	$7,049,027,740
West/Northwest	$3,789,704,748	$378,970,475	$1,136,911,424	$1,894,852,374
Total	**$20,696,421,756**	**$2,069,642,176**	**$6,208,926,527**	**$10,348,210,878**

9.5.3 Critical Facilities and Infrastructure

There are almost 200 critical facilities exposed to the landslide hazard to some degree. No loss estimation of these facilities was performed due to the lack of established damage functions for the landslide hazard. A more in-depth analysis of the mitigation measures taken by these facilities to prevent damage from mass movements should be done to determine if they could withstand impacts of a mass movement. At this time, all infrastructure and transportation corridors identified as exposed to the landslide hazard are considered vulnerable until more information becomes available.

9.5.4 Environment

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

9.6 FUTURE TRENDS IN DEVELOPMENT

The City of Portland is equipped to handle future growth within landslide hazard areas. Its comprehensive plan addresses landslide risk areas through goals and polices related to environmental health, directing growth away from high-risk areas through downzoning, designing with nature and the promotion of hazard resilient design. BDS regulates development in potential landslide hazard areas. A geotechnical report is required for commercial and residential permit applications on steep slopes, as well as recommendations for mitigating the risk from landslide. The City of Portland has committed to the continued integration of the Comprehensive Plan and the MAP. This enhances the opportunity for wise land use decisions as future growth impacts landslide hazard areas.

Table 9-10 shows the future land use designations for mapped landslide hazard area. The majority of the land area is designated as single-dwelling residential (50.3 percent), followed by open space (38.7 percent).

Table 9-10. Future Land Use Designations in Portland in Landslide Hazard Areas

		Percent of total acres					
	Total	Residential			Employment &	Mixed Use &	
Reporting Area	Acreage	Single-Dwelling	Multi-Dwelling	Commercial	Industrial	Institutional	Open Space
Airport	0.8	35.40%	5.70%	0.00%	0.00%	0.00%	58.90%
Central City	166.6	0.60%	12.80%	35.10%	46.70%	0.10%	4.60%
Central Northeast	236.7	37.10%	0.20%	0.00%	4.80%	7.40%	50.40%
East Portland	1,350.50	47.00%	2.00%	0.00%	1.40%	0.00%	49.50%
North Portland	552.7	21.00%	2.70%	0.00%	27.30%	25.10%	23.90%
Northeast	76.1	23.80%	6.50%	0.00%	40.90%	22.00%	6.80%
Southeast	508.2	32.60%	6.60%	0.00%	6.80%	12.00%	42.00%
Southwest	9,266.90	68.80%	5.80%	0.00%	0.10%	8.40%	17.00%
West/Northwest	9,499.50	36.70%	1.40%	0.00%	1.70%	0.50%	59.60%
TOTAL	**21,658.0**	**50.3%**	**3.6%**	**0.3%**	**2.3%**	**4.9%**	**38.7%**

Source: Future land use categories are based on the proposed comprehensive plan designations as of February 2016.

9.7 SCENARIO

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

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

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

9.8 ISSUES

Important issues associated with landslides in Portland include the following:

- There are existing homes in landslide risk areas throughout Portland. The degree of vulnerability of these structures depends on the codes and standards the structures were constructed to. Information to this level of detail is not currently available.
- Future development could lead to more homes in landslide risk areas.
- The risk associated with the landslide hazard overlaps the risk associated with other hazards such as earthquake, flood and wildfire. This provides an opportunity to seek mitigation alternatives with multiple objectives that can reduce risk for multiple hazards.
- All risk reporting areas aside from the Airport area have landslide exposure.
- It is estimated that more than 89,000 people reside in landslide hazard areas. More than half of this exposure is in the Southwest reporting area and an additional 25 percent is in the West/Northwest risk reporting area. Eighty-two percent and 77 percent of the total population in these areas are believed to be exposed to the landslide hazard.
- More than 26,370 buildings are estimated to be exposed to the landslide hazard. The risk reporting areas with more than 1,000 buildings exposed include Southwest, West/Northwest, and East Portland. More than 70 percent of the buildings exposed are in the Southwest reporting area.
- The total value of exposed contents and structures in Portland is estimated to be more than $20.6 billion, or 12.1 percent of the total value of Portland. About 68 percent of this exposure is in the Southwest reporting area.
- The vast majority of buildings exposed are residential (96 percent, 25,341). There are also 742 commercial buildings exposed, 64 government buildings, 62 religious services buildings, and 61 industrial buildings.
- The following social-vulnerability-related issues have been identified for landslide hazard areas:
  - ➢ Children under 15 years of age may disproportionately reside in landslide hazard areas in the East Portland (22 percent) risk reporting area.

- People over 65 years of age may disproportionately reside in landslide hazard areas in the Central Northeast (24 percent), Northeast (21 percent), Southeast (18 percent), Central City (14 percent), Southwest (13 percent) and West/Northwest (13 percent) risk reporting areas.
- People of color may disproportionately reside in landslide hazard areas in the East Portland risk reporting area (26 percent).
- Renters may disproportionately reside in landslide hazard areas in the Central City (75 percent) and Northeast (68 percent) risk reporting areas.
- Households with limited English speaking abilities may disproportionally reside in landslide hazard areas in the Central Northeast (8 percent) and East Portland (7 percent) risk reporting areas.

- There are 192 critical facilities in the landslide hazard area.
- Mapping and assessment of landslide hazards are constantly evolving. As new data and science become available, assessments of landslide risk should be reevaluated. This is especially true for runout modelling, which is not currently well understood.
- The impact of climate change on landslides is uncertain. Climate change impacts that alter vegetation patterns, increase the occurrence of wildfires or alter precipitation patterns may increase exposure to landslide risks.
- Landslides may cause negative environmental consequences, including water quality degradation.
- Areas with significant landslide risk should be monitored, to the extent possible, immediately following a possible triggering event.
- Facilities that contain hazardous materials located in landslide hazard areas may present additional risks for Portland.
- Currently available maps do not indicate runout (where a landslide might go). Current maps show the area that might be unstable, but do not offer a complete picture of areas at risk. New mapping is currently being developed by DOGAMI.

10. WILDFIRE

10.1 GENERAL BACKGROUND

A wildfire is any uncontrolled fire on undeveloped land that requires fire suppression. Wildfires can be ignited by lightning or by human activity such as smoking, campfires, equipment use, or arson. Oregon's Building Code encourages local governments to designate portions of their jurisdictions subject to catastrophic fire as Wildfire Hazard Zones. The purpose of these zones is to define areas where buildings need to be made more survivable from fires spreading through adjacent wildlands. Three factors vital to wildfire risk are included in the methodology for mapping these zones: weather, topography, and vegetative fuel factor.

DEFINITIONS

- **Wildland-Urban Interface (WUI) Area**—An area where structures are adjacent to or are intermingled with natural vegetative fuels which is prone to the occurrence of wildland fires (Oregon OEM, 2015).
- **Wildfire Hazard Zone**— the portion of a local government jurisdiction that has been determined to be at risk of a catastrophic wildfire (Oregon OEM, 2015).

10.1.1 Weather

Extreme weather leads to extreme fire events, and it is often a moderation of the weather that marks the end of a wildfire's growth. High temperatures and low humidity can produce vigorous fire activity. Winds may play a dominant role in directing the course of a fire. Strong, dry winds produce extreme fire conditions. The most damaging firestorms are usually marked by high winds.

10.1.2 Topography

The movement of air over the terrain tends to direct a fire's course. Gulches and canyons can funnel air and act as a chimney, intensifying fire behavior and inducing faster rates of spread. Saddles on ridge tops offer lower resistance to the passage of air and will draw fires. Solar heating of drier, south-facing slopes produces upslope thermal winds that can complicate fire behavior. On steep slopes, fuels on the uphill side of a fire are closer to the source of heat. Fire travels downslope much more slowly than it does upslope, and ridge tops often mark the end of wildfire's rapid spread.

10.1.3 Fuels

Fuels are classified by weight or volume and by type, including living and dead vegetation on the ground, brush and small trees on the surface, and tree canopies above the ground. Fuel loading, often expressed in tons per acre, indicates the amount of vegetative material available. Some fuels burn more easily or release more energy than others. Lighter fuels such as grasses, leaves and needles quickly expel moisture and burn rapidly, while heavier fuels such as tree branches, logs and trunks take longer to warm and ignite.

In Portland, wildfires burn fuels in large natural area parks and open spaces at the wildland urban interface and in the interior of the city. Wildfires can be categorized as occurring in the following locations (NHMP, 2010):

- **Wildland Urban Interface (WUI)**—Fires involving the wildland/urban interface occur in areas where urbanization and the presence of natural vegetation fuels allow a fire to spread rapidly from natural fuels to structures and vice versa. Especially in the early stage of such fires, structural fire suppression resources can be quickly overwhelmed, increasing the potential number of structures destroyed. Such fires are known for the large number of structures simultaneously exposed to fire. Nationally, wildland/urban interface fires commonly produce widespread losses.
- **Urban**—While these fires rarely spread out of control, due to proximity to fire resources and less fuel between buildings, urban conflagration is a hazard in densely populated areas. Many of the same factors that influence hazard in wildland/urban interface areas come into play in urban centers. Drought, high temperatures and fuel load are joined by factors such as flammable building materials, aging electrical wiring and closely packed structures to increase fire hazard.

10.2 HAZARD PROFILE

10.2.1 Past Events

All of Portland's natural ecosystems have been highly modified by humans. Historically, indigenous people purposely ignited large portions of the basin valley annually for agriculture, hunting, communication, warfare, visibility, safety and sanitation. Such systemic burning continued to shape the landscape to protect timber and property in the region (NHMP, 2010). When Anglo settlers arrived, they plowed native prairies and logged or cleared evergreen forests. Strategic seasonal burning ceased. As a result, woodlands grew denser and deciduous trees grew in among the evergreens. The mixed evergreen-deciduous forests we see today are much less fire prone than are pure evergreen forests. In part as a result of historic fires and logging, 70 percent of Forest Park is fairly fire resistant as is much of the forest that rings Powell Butte. But over several decades these forests will grow back to evergreens (NHMP, 2010).

The Multnomah County Community Wildfire Protection Plan (2011), lists the following dates and descriptions of fires that have impacted the City of Portland area:

- **1889**—Balch Creek Canyon Fire started with what is now known as the NW Industrial area burned westerly over Portland's West hills towards the Cascade Mountains in a roughly 2 mile by 7 mile swath, or approximately 9000 acres. Source: Portland Fire & Rescue
- **August 7, 1939**—The fire began in the Dutch Creek Canyon area near Scappoose, just west of Forest Park. The flames spread to Pisgah Mountain Home, an Asylum with about 60 elderly inmates. Despite the efforts of over 200 firefighters, 20 mile per hour winds fanned the fire to jump the canyon into a large timber stand. As the fire spread into Washington County, near North Plains, the Northwest Oregon Forest Protective Association deployed over 1500 men to fight the blaze. Although many farmers and timber operators lost homes and equipment, the most serious loss was to forested timberlands. Over 14,000 acres were lost. Investigators attributed the destruction to a carelessly tossed cigarette. Source: The Chronicle Area news Archives
- **1940**—The Bonny Slope Fire kindled in the southern portion of what is now known as Forest Park and burned westerly along the ridges then turned somewhat north as it crested the west hills towards the housing development now known as Forest Heights. It burned approximately an area approximately 1,000 acres. Source: Portland Fire & Rescue
- **August 19, 1951**—Burma Road Fire was a quick-moving urban wildfire started in Forest Park near Leif Erikson Road. The fire raced up and over view point ridge flames 50 feet high were recorded as the fire consumed over 100 acres in the span of one evening. Over 500 City of

Portland staff battled the blaze. Firefighters made a fire lane on Thompson Road on Skyline Ridge to carry equipment and personnel to the fire. The fire burned to the southwest broke over to Forest Heights. When the fire was finally extinguished 3,000 acres in the heart of forest park were burned. Source: Portland Fire & Rescue

- **August 8, 2001 and 2002**—Mocks Crest Fire caused Residents living on the Willamette Boulevard bluff near University of Portland nearly lost their homes and a large part of their community. In a dramatic team effort firefighters and citizens stopped the 5 Alarm wildland urban interface fire just before it overwhelmed the structures in its path. It burned approximately 38 acres. This area ignited again the following year, burning 10 acres. Source: Portland Fire & Rescue
- **August 2002 and September 2003**—Powell Butte had three relatively small wildland urban interface fires that totaled 54.75 acres. Source: Portland Fire & Rescue

The Oregon Natural Hazard Mitigation Plan records only one significant wildfire event impacting the region surrounding the City of Portland. The Columbia fire, which occurred in 1902 burned approximately 170,000 acres in Clackamas and Multnomah counties (Oregon Department of Land Conservation and Development, 2015). According to the FEMA Disaster Declarations database there have been no federally declared disasters involving fire in Portland (FEMA, 2016b).

10.2.2 Location

Designated Wildfire Hazard Zones

According to the Oregon Natural Hazard Mitigation Plan, the Portland metropolitan area is designated as a wildland-urban interface community (Oregon Department of Land Conservation and Development, 2015). The City of Portland, responsive to changes in Oregon Building code, designated areas of the City as vulnerable to wildfire hazards in 2002 (see Figure 10-1). The purpose of these zones is to define areas where buildings need to be made more survivable from fires spreading through nearby wildlands.

Much of the land area designated as at risk to wildfire in the city includes parks, open space and adjacent areas. The city's park natural areas designated as wildfire hazard areas include Powell Butte, the Willamette Bluffs or Escarpment, (Oaks Bottom and Mock's Crest) Marquam Nature Park, Terwilliger Wildlands, Kelly Butte, Rocky Butte and Mt. Tabor. The two largest areas are Forest Park and Powell Butte (NHMP, 2010). These natural areas have been identified as high risk by Oregon Department of Forestry and Portland Fire and Rescue because high-density commercial and residential development immediately surround the natural area parks and open spaces (NHMP, 2010).

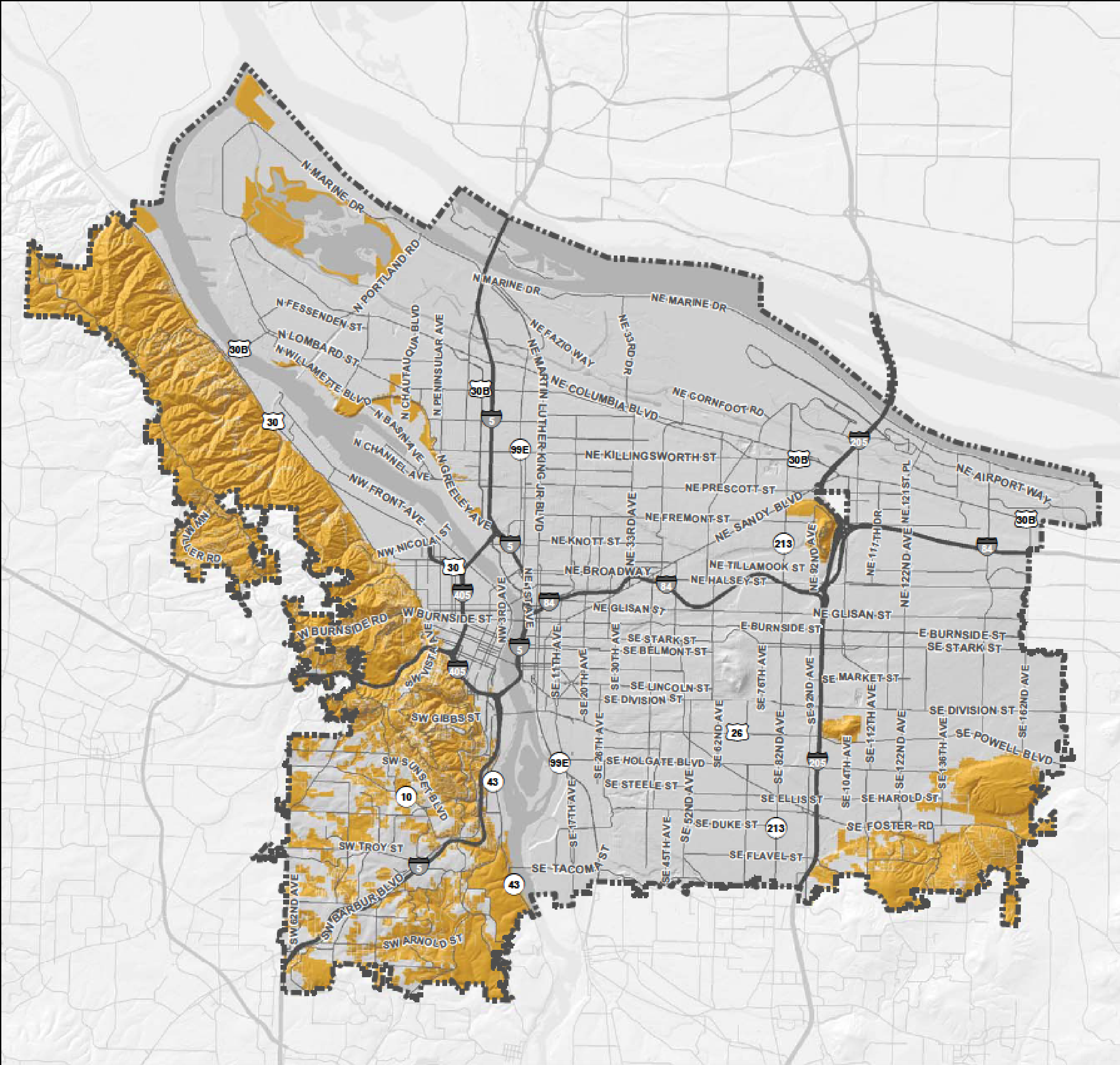
Forest Park comprises the city's largest urban natural area which encompasses over 5,000 acres extending approximately eight miles along the northeast slope of the Tualatin Mountains. This area includes a diverse ecosystem with myriad bird, plant and animal species. Mixed deciduous (70 percent) and conifer (30 percent) growth reduce catastrophic fire potential in this location but could quickly change during intense dry seasons. Grasslands and large patches of flammable invasive species are at the edges of the park and in power line and utility corridors. These areas are often susceptible to fire (NHMP, 2010).

September 12, 2016

Mitigation Action Plan (MAP)

Figure 10-1.

Wildfire Hazard Area



Legend

City Boundary

Wildfire Hazard Area

NORTH

0 0.75 1.5 Miles

Sources: City of Portland-2002, 2016

37242

PBEM

Powell Butte Nature Park, the adjacent Clatsop Butte Park natural area, and the treed Johnson Creek floodplain encompass over 1,000 acres of parks, dense tree canopy and urban interface development in Southeast Portland. Powell Butte is also the site of the Water Bureau's above and underground reservoir system. Powell Butte's vast meadowlands and interspersed forests are the focus of the wildfire threat in this area. The park's east side is at risk due to the close proximity of development to the meadow and the east winds of late summer and early autumn which, if ignited, could spread fires west to the forested area of the park. With the exception of some housing in close proximity to the meadow near the park entrance most development is downhill from the park, on the west slopes, sheltered from the dry winds (NHMP, 2010).

In Southwest and Northwest Portland the steep slopes of Forest Park, Marquam Nature Park and Terwilliger Wildlands, face into the strong, dry, east winds that funnel out of the Columbia Gorge most autumns. In Southeast Portland, Powell Butte, Mt. Tabor Park, Kelley Butte and Rocky Butte have a similar landscape position facing the east winds. Many of the developments that hug the west side of Forest Park or are at the top of the Willamette Escarpment were built without consideration of the path of historic fires (NHMP, 2010).

The Willamette Bluffs fires of 2000 and 2001 refocused the City's attention to reducing fuel loads through intergovernmental coordination. The Portland Wildfire Readiness Assessment and Gap Analysis Plan (City of Portland, 2009) funded through Pre-Disaster Mitigation Grant funds, suggested that work is needed to "reduce wildfire risks to homes and their neighborhoods closest to the city's heavily forested areas. The Plan recommended improving zoning codes that require or encourage fire-resistant building materials, reducing hazardous fuels within a few hundred feet of buildings and maintaining adequate emergency vehicle access (Portland 2009c)." (as cited in NHMP, 2010). According to a recent status report on the implementation of the Gap Analysis recommendations (see Attachment A of the 5-year progress report) such code changes have not yet been adopted and implemented by the City.

Community Wildfire Protection Plan Communities at Risk

In 2010 the Oregon Department of Forestry, Multnomah County Emergency Management, and the City of Portland's Wildfire Technical committee began work on the development of a community wildfire protection plan. Through this planning process local communities at risk were identified that were determined to be particularly vulnerable to wildfire. The results of this assessment are non-regulatory in nature and were intended to provide a starting point for "coordination and collaboration among agencies and the public in the County to identify and prioritize future wildfire projects and assists in meeting federal planning requirements and qualifying for assistance programs" (Multnomah County, 2011). It was noted in the plan that although the mapping produced for the assessment was more recent, the Portland Wildfire Zones provide greater detail (Multnomah County, 2011). Communities at risk within the areas covered by Portland Fire & Rescue and the Port of Portland Airport Fire Department are shown in Table 10-1.

10.2.3 Frequency

In Oregon, wildfire season normally begins in late June, peaks in August, and ends in October. However, a combination of above normal-temperatures and drought can increase the length of the typical fire season. Wildfire hazards would be highest during prolonged periods of drought, especially after periods of below normal rainfall, which would result in a combination of high fuel loads and unusually dry conditions (NHMP, 2010). Based on the historical record of seven fires impacting Portland in the past 127 years, the average recurrence interval for a fire is 18 years.

Table 10-1. Community Wildfire Protection Plan Communities at Risk

Priority Level	Communities at Risk: Portland Fire & Rescue	Communities at Risk: Port of Portland Airport
High	• Linnton • Forest Park/Skyline Road • Forest Heights • Willamette Bluffs Escarpment • Rocky Butte • Kelly Butte • Powell Butte • Johnson Creek Watershed • Oaks Bottom	• Elrose Road • Government Island
Medium	• Mount Tabor • Springwater and Flavel • Pittock Mansion Area • Tryon Creek • Terwilliger Creek • Zoo and Hoyt Arboretum	
Low	• Southwest Portland Cemetery • Sullivan's Gulch • Smith-Bybee Lake	

Source: Multnomah County Community Wildfire Protection Plan, 2011

10.2.4 Severity

Wildfires can range from isolated burns affecting a few acres to severe events that burn hundreds of thousands of acres. Large fires usually occur when groups of smaller fires merge. Property damage from wildfires can be severe and can significantly alter entire communities.

Potential losses from wildfire include human life, structures and other improvements, and natural resources. There are no recorded incidents of loss of life from wildfires in Portland.

10.2.5 Warning Time

Wildfires are often caused by humans, intentionally or accidentally. There is no way to predict when one might break out. Since fireworks often cause brush fires, extra diligence is warranted around the Fourth of July when the use of fireworks is highest. Dry seasons and droughts are factors that greatly increase fire likelihood. Dry lightning may trigger wildfires. Severe weather can be predicted, so special attention can be paid during weather events that may include lightning. Reliable National Weather Service lightning warnings are available on average 24 to 48 hours prior to a significant electrical storm.

If a fire does break out and spread rapidly, residents may need to evacuate within days or hours. A fire's peak burning period generally is between 1 p.m. and 6 p.m. Once a fire has started, fire alerting is reasonably rapid in most cases. The rapid spread of cellular and two-way radio communications in recent years has further contributed to a significant improvement in warning time.

10.3 COMPOUNDING FACTORS AND SECONDARY HAZARDS

10.3.1 Overview

Wildfires can generate a range of secondary effects, which in some cases may cause more widespread and prolonged damage than the fire itself. Fires can cause direct economic losses in the reduction of harvestable timber and indirect economic losses in reduced tourism. Wildfires can contaminate reservoirs, destroy transmission lines and contribute to flooding. They strip slopes of vegetation, exposing them to greater amounts of runoff and erosion. This can weaken soils and cause slope failures. Major landslides can occur several years after a wildfire. Wildfires can bake soils, especially those high in clay content, thus increasing the imperviousness of the ground. This increases the runoff generated by storm events, thus increasing the chance of flooding.

10.3.2 Air Quality

Wildfires across Oregon negatively impacted air quality in the Portland Metro region in August of 2015 causing County health departments to issue warnings. This is a common secondary hazard associated with wildfire and is discussed in more detail in the population vulnerability discussion of this profile.

10.3.3 Invasive Species

Invasive species can contribute to the fuel load in area, thus increasing the severity of fires. Since 2006, Portland Parks and Recreation and the Bureau of Environmental Services have begun work to reduce hazardous wildfire fuels by removing non-native and invasive vegetation in the most highly threatened natural area parks and adjacent open space areas (City of Portland, 2009 as cited in NHMP, 2010).In addition, invasive species can also present issues after a fire as non-native woody plant species frequently invade burned areas. When weeds become established, they can dominate the plant cover over broad landscapes, and become difficult and costly to control (NHMP, 2010).

Fungal infestations can damage the health of native vegetation and contribute to increased wildfire risk. Swiss needle cast is a fungal disease affecting Douglas fir forests in Oregon, predominantly over the past 20 years. Although the fungus is native to Oregon, its detrimental impact may be increasing due to rising spring and summer temperatures (Black et al., 2010) Douglas fir is one of the prominent tree species in Forest Park. A decline in the health of Forest Park's trees due to Swiss needle cast could contribute to increased fuel loads and combustibility, leading to greater risk and severity of wildfires in Portland (Weiskittel et al., 2004).

10.3.4 Climate Change

Climate change can affect multiple elements of the wildfire system: fire behavior, ignitions, fire management, and vegetation fuels. Hot dry spells create the highest fire risk. Increased temperatures may intensify wildfire danger by warming and drying out vegetation. Climate change also may increase winds that spread fires and thunderstorms producing lightning that ignites fires. Forest response to increased atmospheric carbon dioxide could contribute to more tree growth and thus more fuel for fires, although the effects of carbon dioxide on mature forests are still largely unknown. In turn, increased wildfires could release stores of carbon and further contribute to the buildup of greenhouse gases.

According to the City of Portland and Multnomah County Climate Change Preparation Strategy (2014) "in Oregon, the likelihood of increased frequency and intensity of wildfire is very high under the climatic changes expected in the coming decades (State of Oregon, 2010). In addition, an increasing pattern of hot, dry summers and earlier springs increases the likelihood of more and prolonged wildfires."

10.4 EXPOSURE

10.4.1 Population

Population estimates for those residing in wildfire hazard areas were calculated by multiplying the percent of residential structures within the hazard area for each risk reporting area by the total estimated population of that area. These estimates are shown in Table 10-2. Approximately 11 percent of the citywide population is believed to reside in these areas. Exposure as a percent of total population is most significant in the West/Northwest and Southwest reporting areas. Estimates for our social vulnerability indicators are shown in Table 10-3. Citywide estimates indicate that a disproportionate number of young and elderly residents may be residing within these areas. In addition, homeless or transient populations residing in City parks would have considerable exposure to the wildfire hazard.

Table 10-2. Population within Wildfire Hazard Areas

	Population Exposed[a]	% of Total Population
Airport	0	0.0%
Central City	2,925	7.7%
Central Northeast	691	1.5%
East Portland	11,808	7.9%
North Portland	836	1.2%
Northeast	0	0.0%
Southeast	0	0.0%
Southwest	31,550	44.9%
West/Northwest	20,205	75.2%
Total	**68,015**	**11.1%**

a. Value calculated as percent of residential buildings exposed multiplied by the estimated population.

Note: Values shown are accurate only for comparison among results in this plan. See Section 6.8 for a discussion of data limitations.

Table 10-3. Distribution of Social Vulnerability Indicators in Wildfire Hazard Areas

	Population Residing in High Wildfire Hazard Areas a, b, c, d					
Reporting Area	Percent Under 15 Years	Percent Over 65 Years	Percent of People of Color	Percent of Renter occupied Housing	Percent of Families Below Poverty Level	Percent of Limited English Speaking Households
Central City	8.6%	11.6%	15.6%	61.9%	4.5%	0.8%
Central Northeast	8.4%	28.6%	26.4%	44.6%	16.3%	10.0%
East Portland	23.0%	10.5%	25.9%	20.4%	5.9%	6.7%
North Portland	13.1%	9.5%	16.8%	29.9%	7.4%	1.6%
Southwest	14.6%	14.2%	12.8%	35.2%	4.1%	1.1%
West/Northwest	16.9%	13.1%	17.5%	30.2%	4.5%	2.4%
Total	15.5%	13.5%	16.9%	27.3%	3.3%	1.4%

a. Values based on an analysis of 2010-2014 American Community Survey 5-year estimates at the Census block group level.
b. Values calculated using block group statistics weighted by the number of residential structures in the hazard area as a percentage of the total residential structures in the block group.
c. Values in red indicate percentages are at least 2 percent greater than the Citywide average (see Section 4.7).
d. Persons with disabilities not shown because the available data, at a census tract scale, is not conducive to analysis by hazard extent and location.

The entire population of Portland would be exposed to air quality issues resulting from a wildfire, although the extent of exposure would depend on weather conditions. Populations without access to air conditioning or who work outdoors would increase their risk of exposure.

10.4.2 Property

Property damage from wildfires can be severe and can significantly alter entire communities. The number of structures in wildfire hazard areas within Portland and their estimated replacement values are listed in Table 10-4. Table 10-5 lists the structure types. The Southwest and West/Northwest reporting areas have the most exposure in the City, with 55 percent and 24 percent of total value exposed, respectively. Citywide, 9.5 percent of the total replacement value of Portland is believed to be exposed to the wildfire risk. Most of the exposed structures are residential (96.6 percent), followed by commercial (2.2 percent).

Table 10-4. Exposure and Value of Structures in Wildfire Hazard Areas

Reporting Area	Number of Buildings Exposed	Value Exposed			Exposed Value as % of Total Replacement Value
		Structure	Contents	Total	
Airport	0	$0	$0	$0	0.0%
Central City	79	$97,606,665	$60,662,292	$158,268,957	0.5%
Central Northeast	259	$162,630,647	$103,979,744	$266,610,391	2.4%
East Portland	3,328	$928,498,538	$484,931,548	$1,413,430,086	5.4%
North Portland	344	$543,255,169	$641,920,056	$1,185,175,224	5.0%
Northeast	0	$0	$0	$0	0.0%
Southeast	0	$0	$0	$0	0.0%
Southwest	10,277	$5,453,618,530	$4,337,521,920	$9,791,140,450	55.0%
West/Northwest	4,949	$2,161,912,229	$1,230,447,391	$3,392,359,620	24.4%
Total	**19,236**	**$9,347,521,776.57**	**$6,859,462,951.32**	**$16,206,984,728**	**9.5%**

Table 10-5. Structure Type Exposed in the Wildfire Hazard Area

Reporting Area	Number of Structures[a]						
	Residential	Commercial	Industrial	Religion	Government	Education	Total
Airport	0	0	0	0	0	0	0
Central City	66	8	2	2	1	0	79
Central Northeast	233	5	0	20	1	0	259
East Portland	3,289	35	0	4	0	0	3,328
North Portland	271	27	14	1	1	30	344
Northeast	0	0	0	0	0	0	0
Southeast	0	0	0	0	0	0	0
Southwest	10,012	150	21	28	12	54	10,277
West/Northwest	4,720	194	16	1	11	7	4,949
Total	**18,591**	**419**	**53**	**56**	**26**	**91**	**19,236**

a. Structure type assigned to best fit Hazus occupancy classes based on present use classifications provided by Multnomah County assessor's data. Where conflicting information was present in the available data, parcels were assumed to be improved.

10.4.3 Critical Facilities and Infrastructure

Critical facilities and infrastructure exposed to the wildfire hazard in Portland are listed in Table 10-6 and Table 10-7. 104 critical facilities and infrastructure are located in wildfire risk areas within the city (16.9 percent). In addition, it is likely that all Portland Water Bureau facilities located outside of the City boundaries are exposed to wildfire risk to some extent, although, the data used for this analysis did not provide information for these facilities. In addition linear features exposed to the wildfire hazard are shown in Table 10-8.

Table 10-6. Critical Facilities in Wildfire Hazard Area

	Number of Critical Facilities in Wildfire Hazard Areas[b]				
Reporting Area	Emergency Services	High Potential Loss Facilities[a]	Schools	Other Assets	Total
Airport	0	0	0	0	0
Central City	0	0	1	0	1
Central Northeast	0	0	2	1	3
East Portland	0	0	1	0	1
North Portland	0	2	1	0	3
Northeast	0	0	0	0	0
Southeast	0	0	0	0	0
Southwest	5	1	26	6	38
West/Northwest	1	3	4	1	9
Total	6	6	35	8	55

a. Includes 4 hazardous material facilities.
b. See Table 6-1 for a description of the facilities included in each category.

Table 10-7. Critical Infrastructure in Wildfire Hazard Area

	Number of Critical Infrastructure Facilities in Wildfire Hazard Areas[b]					
		Utility Systems				Total
Reporting Area	Transportation Systems	Communications	Power	Potable Water[a]	Wastewater	
Airport	0	0	0	0	0	0
Central City	0	0	0	0	0	0
Central Northeast	1	1	0	2	1	5
East Portland	0	1	1	18	1	21
West/Northwest	4	2	1	23	1	31
North Portland	0	0	0	1	5	6
Northeast	0	0	0	0	0	0
Southeast	0	0	0	0	0	0
Southwest	4	3	1	22	6	36
Total	9	7	3	66	14	99

a. It is likely that the 75 facilities located outside of the City boundaries are also exposed to the wildfire hazard.
b. See Table 6-1 for a description of the facilities included in each category.

Table 10-8. Linear Critical Facilities in Wildfire Hazard Area

	Facilities in Wildfire Hazard Area
Utility Systems	
Power Lines	60.74 miles, 12.7% of citywide total
Gas Lines	5.06 miles, 6.1% of citywide total
Transportation Systems	
Railroads	6.48 miles, 1.7% of citywide total
Light Rail	1.65 miles, 3.1% of citywide total
Major Roads	NW Cornell Rd, NW St Helens Rd (US Highway 30), SE Bybee Blvd, SW Bertha Blvd, SW Scholls Ferry Rd, SW Sunset Hwy (US Highway 26).

Note: The wildfire dataset used for this analysis does not include road right of ways in the hazard area.

10.4.4 Environment

Fire is a natural and critical ecosystem process in most terrestrial ecosystems, dictating in part the types, structure, and spatial extent of native vegetation. Portland natural areas and open spaces are fire-prone and fire-adapted ecosystems. The local forests, woodlands and grasslands evolved with fire over thousands of years. The moist western Oregon, natural plant communities burn less frequently, but when they do, the fires tend to be large and intense. Wildfires are part of the natural ecology and natural life cycles of wildlands. Fires create open spaces with different habitats for both plants and animals than existed previously. Fires also reduce fuel loads in areas, which in turn decreases the potential for large catastrophic fires (NHMP, 2010).

In addition to threatening humans, animals and infrastructure, wildfires in forested areas have a severe impact on natural resources. Wildfires strip the land of vegetation and destroy forest resources. Soil exposed to intense heat may lose its capability to absorb moisture and support life. Exposed soils erode quickly and enhance siltation of rivers and streams, thus increasing flood potential, harming aquatic life and degrading water quality. Lands stripped of vegetation are also subject to increased debris flow hazards (City of Portland, 2004a as cited in NHMP, 2010).

10.5 VULNERABILITY

Structures, above-ground infrastructure, critical facilities and natural environments are all vulnerable to the wildfire hazard. There is currently no validated damage function available to support wildfire mitigation planning. Except as discussed in this section, vulnerable populations, property, infrastructure and environment are assumed to be the same as described in the section on exposure.

10.5.1 Population

All population that is exposed to wildfire risk is vulnerable to wildfire risk. The most vulnerable individuals are those who are not able to evacuate risk areas quickly, such as older populations or those with access and functional needs. Generally, few people die in wildfires because warning time is sufficient to allow for evacuation.

Wildfires also threaten the health and safety of those fighting the fires. First responders are exposed to the dangers from the initial incident and after-effects from smoke inhalation and heat stroke. Smoke and air pollution from wildfire can also be a severe health hazard for those living near or downwind from wildfires. This is especially true for sensitive populations, including children, the elderly and those with respiratory and cardiovascular diseases. Smoke generated by wildfire consists of visible and invisible emissions that contain particulate matter (soot, tar, water vapor, and minerals), gases (carbon monoxide, carbon dioxide, nitrogen oxides), and toxics (formaldehyde, benzene). Emissions from wildfires depend on the type of fuel, the moisture content of the fuel, the efficiency (or temperature) of combustion, and the weather. Public health impacts associated with wildfire include difficulty in breathing, odor, and reduction in visibility.

10.5.2 Property

Loss estimations for the wildfire hazard are not based on damage functions, because no such damage functions have been generated. Instead, loss estimates were developed representing 10 percent, 30 percent and 50 percent of the replacement value of exposed structures. This allows emergency managers to select a range of economic impact based on an estimate of the percent of damage to the general building stock. Damage in excess of 50 percent is considered to be substantial by most building codes and typically requires total reconstruction of the structure. Table 10-9 lists the loss estimates for each risk reporting area.

Table 10-9. Loss Potential for Wildfire

Reporting Area	Exposed Value	Potential Loss		
		@ 10% Damage	@ 30% Damage	@ 50% Damage
Airport	$0	$0	$0	$0
Central City	$158,268,957	$15,826,896	$47,480,687	$79,134,479
Central Northeast	$266,610,391	$26,661,039	$79,983,117	$133,305,196
East Portland	$1,413,430,086	$141,343,009	$424,029,026	$706,715,043
North Portland	$0	$0	$0	$0
Northeast	$0	$0	$0	$0
Southeast	$9,791,140,450	$979,114,045	$2,937,342,135	$4,895,570,225
Southwest	$3,392,359,620	$339,235,962	$1,017,707,886	$1,696,179,810
West/Northwest	$1,185,175,224	$118,517,522	$355,552,567	$592,587,612
Total	**$16,206,984,728**	**$1,620,698,473**	**$4,862,095,418**	**$8,103,492,364**

10.5.3 Critical Facilities and Infrastructure

Critical facilities of wood frame construction are especially vulnerable during wildfire events. In the event of wildfire, there would likely be little damage to most infrastructure. Most roads and railroads would be without damage except in the worst scenarios. Power lines are the most at risk from wildfire because most poles are made of wood and susceptible to burning. Fires can create conditions that block or prevent access and can isolate residents and emergency service providers. Wildfire typically does not have a major direct impact on bridges, but it can create conditions in which bridges are obstructed. Many bridges in areas of high to moderate fire risk are important because they provide the only ingress and egress to large areas and in some cases to isolated neighborhoods.

10.5.4 Environment

The vulnerability risks are the same as those described for exposure. In addition, there are four registered hazardous material containing structures in wildfire risk zones. During a wildfire event, these materials could rupture due to excessive heat and act as fuel for the fire, causing rapid spreading and escalating the fire to unmanageable levels. In addition they could leak into surrounding areas, saturating soils and seeping into surface waters, and have a disastrous effect on the environment.

10.5.5 Economic Impact

A large fire could have significant economic impacts for Portland, especially damage to utilities and the expense incurred fighting.

10.6 FUTURE TRENDS IN DEVELOPMENT

The City's Comprehensive Plan establishes goals, policies and projects for reducing wildfire risk, including through site design, designing with nature, promoting hazard resilient design, managing risk through plans and investments, and ensuring adequate resources and facilities for response. In addition, the City has identified actions that seek to strengthen fire-related development codes.

Table 10-10 shows future land use designations in mapped wildfire risk areas. Over half of the land area is designated as open space, which is a low risk use for landslide hazard areas. Approximately, 42.5 percent of the remaining area is designated as single-family dwelling.

Table 10-10. Future Land Use Designations in Portland

		Percent of total acres					
		Residential					
Reporting Area	Total Acreage	Single-Dwelling	Multi-Dwelling	Commercial	Employment & Industrial	Mixed Use & Institutional	Open Space
Airport	0	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Central City	23	4.0%	57.8%	35.7%	0.0%	0.0%	2.5%
Central Northeast	244	45.9%	3.9%	0.0%	0.0%	13.1%	37.1%
East Portland	2,949	49.1%	2.6%	0.0%	1.7%	0.2%	46.5%
North Portland	1,617	4.9%	0.2%	0.0%	14.4%	6.0%	74.4%
Northeast	0	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Southeast	0	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Southwest	5,761	61.4%	3.5%	0.0%	0.0%	7.5%	27.6%
West/Northwest	8,605	34.8%	1.1%	0.0%	1.4%	0.3%	62.5%
TOTAL	19,200	42.5%	2.1%	0.0%	2.1%	3.1%	50.2%

Source: Future land use categories are based on the proposed comprehensive plan designations as of February 2016.

10.7 SCENARIO

A major fire in Portland might begin with a wet spring, adding to fuels on the forest floor. Flashy fuels would build throughout the spring. The summer could see the onset of insect infestation. A dry summer could follow the wet spring, exacerbated by dry hot winds. Carelessness with combustible materials or a tossed lit cigarette, or a sudden lighting storm could trigger a multitude of small isolated fires. The embers from these smaller fires could be carried miles by hot, dry winds. The potential for large-scale destruction from such fires would be increased if there were an active fire season in the American west. This may lead to thinly spread resources being available to support local crews.

To further complicate the problem, heavy rains could follow the burns, causing flooding and landslides and releasing tons of sediment into rivers, permanently changing floodplains and damaging sensitive habitat and riparian areas. Such a fire followed by rain could release millions of cubic yards of sediment into streams for years, creating new floodplains and changing existing ones. With the forests removed from the watershed, stream flows could easily double. Floods that could be expected every 50 years may occur every couple of years. With the streambeds unable to carry the increased discharge because of increased sediment, the floodplains and floodplain elevations would increase.

10.8 ISSUES

The following issues were identified for the wildfire hazard:

- Wildfire hazard areas have been identified in all risk reporting areas aside from the following: Airport, Northeast and Southeast.
- 68,015 people are estimated to reside in wildfire hazard areas. This includes approximately 75 percent of the West/ Northwest population and nearly 45 percent of the Southwest population.
- There are estimated to be 19,236 buildings exposed to the wildfire hazard. More than half of these are in the Southwest reporting area. The majority of the remaining structures are in the West/Northwest and East Portland reporting areas.
- More than $16.2 billion is estimated to be exposed to the wildfire hazard. This is approximately 9.4 percent of the total value of Portland, more than 55 percent of the Southwest risk reporting area and almost 25 percent of the West/ Northwest area.
- More than 96 percent of the exposed buildings are thought to be residential structures. About 2 percent of the remaining buildings are commercial.
- The following social-vulnerability-related issues have been identified for wildfire hazard areas:
  - Children under 15 years of age may disproportionately reside in wildfire hazard areas in the East Portland risk reporting area (23 percent).
  - People over 65 years of age may disproportionately reside in wildfire hazard areas in the Central Northeast (29 percent) and West/Northwest (13 percent) risk reporting areas.
  - People of color may disproportionately reside in wildfire hazard areas in the Central Northeast (26 percent) and East Portland (26 percent) risk reporting areas.
  - Renters may disproportionately reside in wildfire hazard areas in the Central City (62 percent) risk reporting area.
  - Families with incomes below the poverty level may disproportionately reside in wildfire hazard areas in the Central Northeast risk reporting area (16 percent).
  - Households with limited English speaking abilities may disproportionally reside in wildfire hazard areas in the Central Northeast (10 percent) and East Portland (7 percent) risk reporting areas.
- There are 104 critical facilities located in the wildfire hazard area. The wildfire hazard presents a significant risk to the City's water supply.
- Portland's largest natural area and largest area exposed to wildfire risk—the 5,500 acre Forest Park—is surrounded on three sides by industrial and residential development (NHMP, 2010).
- The risk of loss to homes and businesses built at the wildland urban interface is significant and growing due to the buildup of hazardous wildfire fuels (including invasive species), longer dry seasons and changing weather patterns (NHMP, 2010).
- Public education and outreach to people living in or near the fire hazard zones should include information about and assistance with mitigation activities such as how to maintain defensible space, and advance identification of evacuation routes and safe zones.
- Area fire districts need to continue to train on wildland-urban interface events.
- Continued efforts at vegetation management activities are needed.
- Many of the actions identified in the 2009 Gap Analysis report and 2011 community wildfire protection plan still need to be implemented.
- Additional clarification and guidance is needed when discussing burn restrictions with the public.
- NET members could be trained to assist in fire-fighting when resources are stretched thin.

11. Flood

11.1 GENERAL BACKGROUND

11.1.1 What Is a Floodplain?

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

DEFINITIONS

- **1-Percent Annual Chance Flood (100-Year Flood)**—The flood magnitude that has a 1-percent chance of being equaled or exceeded in any given year. On a statistical average over a long term, this magnitude can be expected to occur once every 100 years; in fact though, such a flood can occur multiple times in a few years, or even in a single year.
- **1-Percent Annual Chance Flood Hazard Area (100-Year Floodplain)**—The area that is inundated during a 1-percent annual chance (100-year) flood.
- **Flood**—The inundation of normally dry land resulting from the rising and overflowing of a body of water.
- **Floodplain**—The land area along the sides of a river that becomes inundated with water during a flood.
- **Riparian Area**—The area along the banks of a natural watercourse.

Floodplain Benefits

Floodplains are a natural component of the City of Portland environment. Understanding and protecting their natural functions can reduce flood damage and protect people and property. The benefits of preserving floodplains include the following:

- **Flood and erosion control**—Floodplains are like natural sponges, storing and slowly releasing floodwaters. This reduces the height of a flood and the speed of a river. When a river is cut off from its floodplain by levees and dikes, flood heights often increase and downstream damage can be greater.
- **Water quality improvement**—As water travels through floodplains, plants serve as natural filters, trapping sediments and capturing pollutants. Floodplains help to moderate temperature fluctuations that can harm aquatic life. They also help remove from the water soil and pollutants that can harm aquatic life.
- **Groundwater recharge**—Floodplains promote infiltration and recharge of underlying aquifers.
- **Fish and wildlife habitat**—Floodplains maintain biodiversity. They provide breeding and feeding grounds, create and enhance waterfowl areas, and protect habitat for rare and endangered species.

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

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

A river and its floodplain together form a complex physical and biological system that supports a variety of natural resources and provides natural flood and erosion control. When a river is separated from its floodplain with levees and other flood control facilities, natural, built-in benefits can be lost, altered, or significantly reduced.

Effects of Human Activities

Because they border water bodies, floodplains have historically been popular sites to establish settlements. Human activities tend to concentrate in floodplains for a number of reasons: water is readily available; land is fertile and suitable for farming; transportation by water is easily accessible; and land is flatter and easier to develop. But human activity in floodplains frequently interferes with the natural function of floodplains. It can affect the distribution and timing of drainage, thereby increasing flood problems. Human development can create local flooding problems by altering or confining drainage channels. This increases flood potential in two ways: it reduces the stream's capacity to contain flows, and it increases flow rates or velocities downstream during all stages of a flood event. Additionally, human development typically results in increases in impervious surfaces, such as paved roadways and roofs. These areas increase stormwater runoff and flood risk, especially when the stormwater is contributing to a system designed for a lower level of flooding. Human activities can interface effectively with a floodplain as long as steps are taken to mitigate the activities' adverse impacts on floodplain functions.

11.1.2 Measuring Floods and Floodplains

The magnitude of floods is commonly rated based on the probability in any given year of the river discharge (flow) level reached during the flood being equaled or exceeded. Flood studies use historical records to determine the probability of occurrence or flood frequency for different discharge levels. The flood frequency equals 100 divided by the probability of occurrence. For example, the flow level with a 1-percent chance of being equaled or exceeded in any given year is referred to as the 100-year flood. These measurements reflect statistical averages only; it is possible for two or more floods with a 100-year or higher flood frequency to occur in a short time period. The same flood can have different flood frequency at different points on a river.

The 1-percent annual chance (100-year) flood is sometimes referred to as the base flood. Many communities have maps that show the extent and likely depth of flooding for the base flood. The inundated area shown on such maps is called the special flood hazard area (SFHA). Its boundary is used as a regulatory boundary as part of the National Flood Insurance Program (NFIP).

11.2 HAZARD PROFILE

11.2.1 Characteristics of Flooding in Portland

Portland is subject to flooding from river overflow from the Columbia, Willamette, Tualatin and Sandy Rivers, smaller rivers and lesser waterways, as well as flooding from local stormwater drainage. The city is susceptible to winter rain flooding between October and April, while between May and July snowmelt and runoff can create floods. Typically, the most severe floods are winter rainfall floods from December to February, when heavy or prolonged rain or snowmelt creates water flows that exceed the carrying capacity of river channels or other water courses and storage facilities. As storms from the Pacific move across the Oregon Coast Range, air rises and cools and heavy rainfall develops over high-elevation streams—as much as 4 to 6 inches of rain over a 24-hour period. Severe and prolonged storms can raise rivers and streams to their flood stages for three to four days or longer (NHMP, 2010). Three types of flooding are typical: riverine floods, urban flooding, and flash floods.

Riverine Flooding

Riverine flooding along channels of rivers and streams due to high water is the most common form of flooding in Portland. Flooding in large river systems typically results from large-scale weather systems that generate prolonged rainfall over a wide geographic area, causing floods in hundreds of smaller streams that drain into major rivers. Terrain helps determine the dynamics of riverine flooding. In relatively flat areas, shallow, slow-moving floodwater may cover the land for days or even weeks (NHMP, 2010).

Human development changes hydrologic systems in a watershed. As land is converted from fields or woodlands to roads and parking lots, it loses its ability to absorb and then slowly release rainfall. Water moves to the ground and into streams at a much faster rate in urban areas, as heavy rainfall collects and flows faster on impervious concrete and asphalt surfaces. These changes can result in floodwaters that rise very rapidly and peak with violent force. The resulting high water volume and turbidity (suspended sediments in the water) both contribute to the erosion of stream banks (NHMP, 2010).

Shallow area flooding is a special type of riverine flooding. FEMA defines shallow flood hazards as areas that are inundated only 1 to 3 feet deep by the 1-percent annual chance flood. These areas are generally flooded by low-velocity sheet flows of water (NHMP, 2010).

Urban Flooding

Urban flooding can occur when the amount of rainfall and runoff exceeds the capacity of a stormwater system, such as a creek, ditch or storm drain, to remove it. A majority of land in Portland is urbanized and has a high concentration of impervious surfaces that either collect water or concentrate flow in unnatural channels. During periods of urban flooding, streets can become swift moving rivers and basements can fill with water. Storm drains and catch basins can back up with vegetative debris and trash and cause additional, localized flooding (NHMP, 2010).

Numerous areas are currently subject to urban flooding, and the number of at-risk areas could increase without proper infrastructure to guide water overflow. The continued increase of impervious surfaces related to development significantly contributes to Portland's future flood risk as increased runoff exceeds the capabilities of drainage infrastructure (NHMP, 2010).

Flash Floods

In hilly areas, a flood can begin only minutes after a heavy rain. Such flash floods provide little or no notice and can move so fast that they are particularly dangerous to people and property in their path.

11.2.2 Past Events

Significant historic flooding occurred in the Willamette and Columbia River basins in 1861, 1880, 1881, 1909, 1913, 1927, 1928, 1942, 1946, 1948, 1961, 1964/65, 1996 and 2007. (NHMP, 2010). Table 11-1 summarizes flood events for which federal disaster declarations have been issued. The sections below provided narrative descriptions of the most significant historical Portland floods.

Table 11-1. Portland Flood Events for Which Federal Disaster Declarations Were Issued

Disaster Number	Declaration Date	Title
DR-4258	2/17/2016	Severe winter storms, straight-line winds, flooding, landslides, and mudslides
DR-1956	2/17/2011	Severe winter storm, flooding, mudslides, landslides
DR-1733	12/8/2007	Severe storms, flooding, landslides, and mudslides
DR-1632	3/20/2006	Severe storms, flooding, landslides, and mudslides
DR-1099	2/9/1996	High winds, severe storms and flooding
DR-413	1/25/1974	Severe storms, snowmelt & flooding
DR-319	1/21/1972	Severe storms & flooding
DR-184	12/24/1964	Heavy rains & flooding

May 1948

Vanport was a residential community at a site that is now occupied by the Portland International Raceway and the Heron Lakes Golf Club. In 1944, it lay between the Portland city limits and the Columbia River and was completely encircled with a levee system and embankments. Its ground elevation was several feet below the Columbia River's normal water level. The community was built to house ship workers employed at Henry Kaiser's shipyards during World War II, and peaked in population in 1944 when it had approximately 42,000 residents and nearly 10,000 housing units (Abott, 2016). By 1948, as the war came to a close, the population of Vanport had declined substantially but it was still home to many of Portland's low-income and minority communities. On Memorial Day 1948, a railroad embankment was breached, resulting in a catastrophic flood. The community of 18,500 was flooded with debris-laden water 10 to 20 feet deep. Most of the buildings were substantially damaged or destroyed, and at least 15 people lost their lives. Many others were never found but were not officially recorded as fatalities. Others were permanently displaced, as the city ceased to exist (NHMP, 2010).

December 1964

Nearly every river in Oregon exceeded its flood stage in December 1964 as weather stations recorded new records for precipitation. Known as the Christmas Flood, the event triggered debris flows, bridge failures and flooding that caused thousands to evacuate and closed airports, railways and hundreds of miles of roads across the state. Ultimately, the event caused more than $157 million in damage and 20 people were killed (NHMP, 2010).

February 1996

One of the more severe flood years on record occurred in 1996, when many rivers and creeks throughout the Willamette River watershed rose to 100-year flood levels due to a combination of warm temperatures, heavy snow pack and four consecutive days of record-breaking rain. The floods caused five deaths statewide, forced thousands of people into shelters, and destroyed hundreds of homes. Portland was forced to erect makeshift barriers to prevent floodwaters from moving into the downtown area. On February 9, 1996, the Willamette River crested just inches away from overtopping the barriers. The Columbia River crested at 11 feet 2 inches above flood stage, testing the strength of levees that protect Portland International Airport and areas north of Columbia Boulevard. Johnson Creek crested at 6 feet 5 inches above flood stage (NHMP, 2010).

Winter 1996-97

In November 1996, a tropical air mass swept across Oregon, again bringing record-breaking precipitation. The stormy weather continued into December and early January as 26 major rivers reached flood stage. Snowmelt and intense rain caused extensive flooding that led to widespread landslides, erosion, power outages, damaged homes and businesses, closed roads and eventually resulted in a Presidential Disaster Declaration (NHMP, 2010).

December 2007

Severe storms, winds, mudslides, landslides and flooding occurred between December 1 and 17, 2007 shutting down roads and highways including Interstate 5. Public infrastructure, homes and personal property were damaged. In Oregon, 73,000 residents were without power. A major disaster was declared for the State of Oregon on December 8, 2007 (NHMP, 2010).

January 2009

A great amount of snow accumulation in late December 2008 (15 inches to 3 foot drifts) and then a sudden warming at the beginning of January 2009 caused significant flooding along local streams. Portland received 24-hour rainfall of 3.04 inches on January 1, 2009. Johnson Creek crested at 3.7 feet above its flood stage. FEMA received 187 flood loss claims from the Portland area, six of which were from repetitive loss properties. This flood was ranked the third largest flood on Johnson Creek in terms of stream flow (2,430 cubic feet per second) and second highest in terms of stream level (14.69 feet) (NHMP, 2010).

11.2.3 Location

The 11,460-square-mile Willamette River Basin is the largest watershed in the state, with 13 major tributaries between its headwaters southeast of Eugene and the confluence with the Columbia River at Kelley Point. Though the city only occupies one percent of the Willamette River's drainage basin, its 17 square miles are the most urbanized and heavily used of all in the basin (NHMP, 2010).

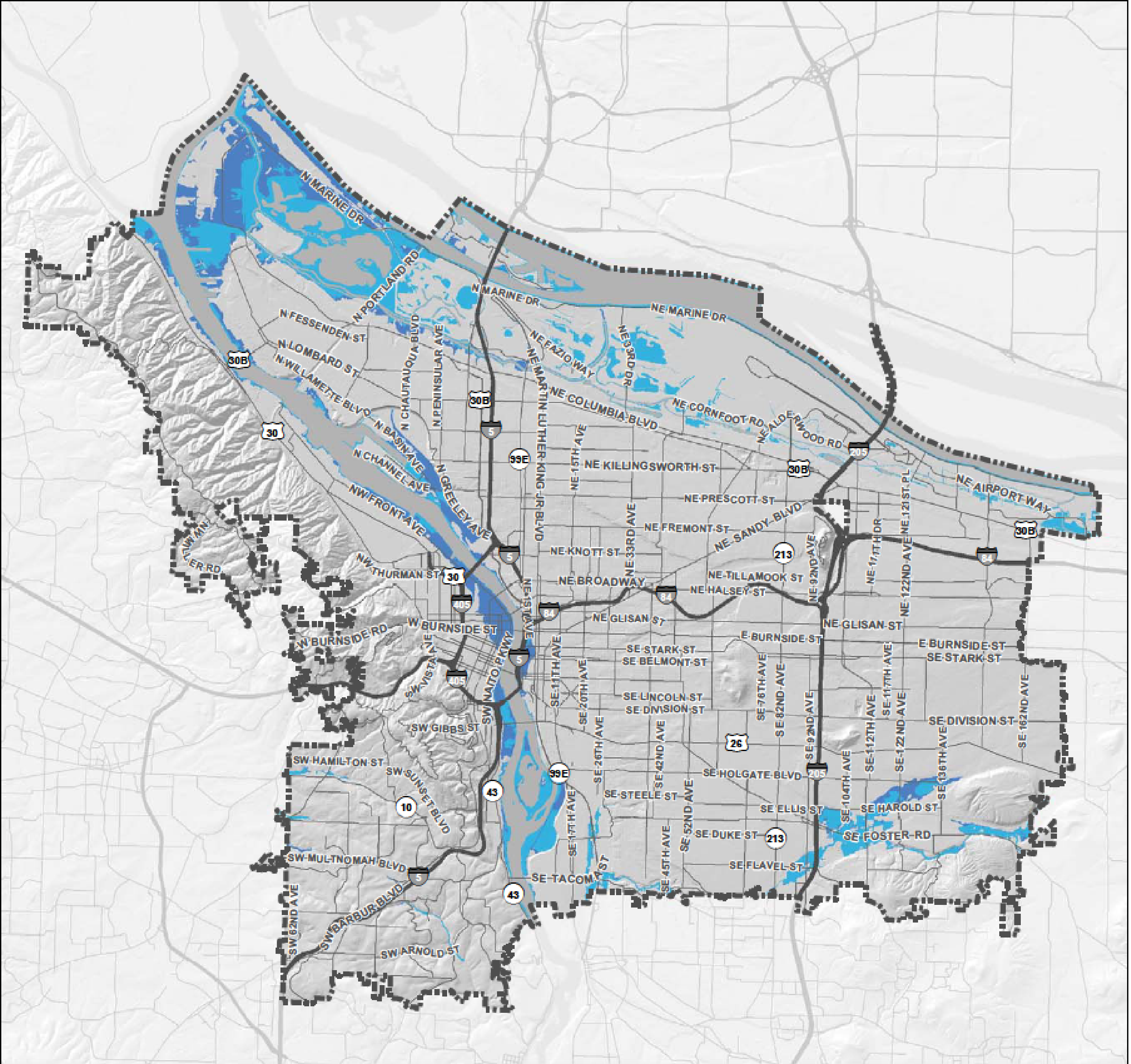
FEMA Flood Insurance Rate Maps for the area depict historical flood extent, defining most of the flood-prone streams and delineating the 1-percent annual chance (100-year) and 0.2-percent annual chance (500-year) flood hazard areas, as shown in Figure 11-1. Other sources of flood location information can be found in the following:

- Lents Neighborhood Climate Resiliency Report (Berger et al., 2015)
- Johnson Creek Floodplain Residential Vulnerability Analysis (Judelman, 2015a)
- Summary Vulnerability of East Lents Floodplain Residents (Judelman, 2015b).

September 12, 2016

Mitigation Action Plan (MAP)

Figure 11-1. Flood Hazard - 100-Year and 500-Year FEMA Flood Zone



Legend

- City Boundary
- 100-year FEMA flood zone
- 500-year FEMA flood zone
- Major Waterbodies

NORTH

0 0.75 1.5 Miles

Sources: FEMA-2014; City of Portland-2016

37242

PBEM

11.2.4 Frequency

The following factors contribute to the frequency and severity of riverine flooding (NHMP, 2010):

- Rainfall intensity and duration
- Antecedent moisture conditions
- Watershed conditions, including steepness of terrain, soil types, amount and type of vegetation and density of development
- The existence of attenuating features in the watershed, including natural features such as wetlands and lakes and human-built features such as dams
- The existence of flood control features, such as levees and flood control channels
- Velocity of flow
- Tide heights and storm surge
- Availability of sediment for transport and the erodibility of the bed and banks of the watercourse.

These factors are evaluated using a hydrologic analysis to determine the probability that discharge of a certain size will occur and to determine the characteristics and depth of the flood resulting from that discharge. Portland typically experiences flooding after more than three days of heavy rainfall or when saturated conditions combine with significant rainfall or storms over short periods of time. Based on previous occurrences, it is probable that a flood has greater than a 33 percent likelihood of occurring in any given year (NHMP, 2010).

11.2.5 Severity

Nationwide, floods result in more deaths than any other natural hazard. Floods result in excessive expenditures for emergency response and generally disrupt the normal function of a community.

Typical flood damage can include the following (NHMP, 2010):

- Inundation of structures
- Erosion of stream banks, road embankments, foundations, footings for bridge piers and other features
- Impact damage from high-velocity flow and from debris
- Debris accumulation on bridge piers and in culverts, increasing loads on these features or causing overtopping or backwater damage
- Destruction of croplands
- Release or runoff of sewage and hazardous or toxic materials from damaged pipelines, tanks and facilities
- Economic loss (local facilities, utilities, communications, agriculture).

Problems related to flooding include sediment deposition and stream bank erosion. Deposition is the accumulation of soil, silt and other particles on a river bottom or delta. It leads to the destruction of fish habitat and presents a challenge for navigational purposes. It reduces channel capacity, resulting in increased flooding or bank erosion. Stream bank erosion is the removal of material from the stream bank. When bank erosion is excessive, it becomes a concern because it results in loss of streamside vegetation, loss of fish habitat and loss of land and property (NHMP, 2010). Erosion on a levee bank can also increase the risk of levee failure.

The principal factors affecting flood damage are flood depth and velocity. The deeper and faster flood flows become, the more damage they can cause. Shallow flooding with high velocities can cause as much damage as deep flooding with slow velocity. Flood severity is often evaluated by examining peak discharges; Table 11-2 lists peak flows used by FEMA to map floodplains in Portland.

Table 11-2. Summary of Peak Discharges in Portland

Source/Location	Drainage Area (sq. mi.)	Discharge (cubic feet/second) 10% Annual Chance	2% Annual Chance	1% Annual Chance	0.2% Annual Chance
Johnson Creek[a]					
Downstream of confluence with Crystal Springs Creek	53	1,890	2,590	2,780	3,230
Upstream of confluence with Crystal Springs Creek	49	1,890	2,590	2,780	3,230
At 82nd Ave	46	1,830	2,660	2,970	3,640
At USGS Gauge 14-211500 (near RM 10.2	28	2,120	2,810	3,090	3,670
Fanno Creek					
At Beaverton-Hillsdale Highway	5.12	940	1,140	1,250	1,550
At extension of 65th Avenue	3.38	600	740	825	1,000
At extension of 59th Avenue	3.24	590	725	800	975
At Southwest 56th Avenue	2.53	470	620	670	800
At Southwest Shattuck Road	2.43	490	625	675	820
At Southwest 45th Avenue	1.71	350	460	490	590
Crystal Springs Creek[b]					
500 feet upstream of Southeast 28th Street	3.6	16	24	28	40
1,200 feet upstream of McLaughlin Street	n/a	22	70	92	169
Upstream of Railroad Bridge	n/a	44	100	126	212
Upstream of confluence with Johnson Creek	n/a	45	60	70	80

a. Decreasing discharge values caused by diversions to the Lents and Eastmoreland Golf Course areas
b. Decreasing discharge values caused by left overbank storage
n/a = data not available

11.2.6 Warning Time

Due to the sequential pattern of meteorological conditions needed to cause serious flooding, it is unusual for a flood to occur without warning. Warning times for floods can be between 24 and 48 hours. Flash flooding can be less predictable, but potential hazard areas can be warned in advanced of potential flash flooding danger.

The Portland Bureau of Emergency Management (PBEM) disseminates advisories relating to flooding. The Bureau of Environmental Services (BES) serves as technical expert to PBEM and other bureaus on local flooding and hydrology. Both PBEM and BES rely upon USGS real-time river gage data and the National Weather Service's (NWS) flood prediction service. Through this service, BES and other City staff receive severe weather and emergency email briefings in real-time. BES performs additional monitoring and analysis of USGS data and NWS predictions throughout the wet season (typically November 1 through March 31). Up to 10 BES staff each year are designated as emergency managers.

During periods of heavy precipitation or contiguous days of moderate precipitation, a subset of BES staff monitor real-time online USGS river gage data and NWS hydrograph predictions. USGS gages continuously collect discharge rates, water surface elevation, and temperature data and transmit that data every 15 minutes. Data is accessible online via USGS and NWS websites within an hour of collection. NWS predictive hydrologic models are run every 12 hours using the most current gage data and are also shared online. The following are the primary USGS gages monitored by the City of Portland:

- USGS 14144700, Columbia River, Vancouver, WA, under the I-5 Bridge
- USGS 14211820, Columbia Slough, Portland, OR, N Lombard St. & N Kelly Point Park Rd.
- USGS 14206900, Fanno Creek, Portland, OR, SW 56th & SW Seymour Ave.
- USGS 14211315, Tryon Creek, Portland, OR, G Ave. & Cumberland Pl.
- USGS 14211720, Willamette River, Portland, OR, under the Morrison Bridge
- USGS 14211550, Johnson Creek, Milwaukie, OR, SE Milport Rd. & SE McBrod Ave.
- USGS 14211500, Johnson Creek, in Portland, OR, SE 152nd Ave. & SE Foster Rd.
- USGS 14211499, Kelley Creek, Portland, OR, SE 159th Dr. & SE Foster Rd.
- USGS 14211400, Johnson Creek, Gresham, OR, SE Regner Rd. & SE Roberts Rd.

Portland's most frequent disruptive flooding occurs along Johnson Creek; as a result, much of the City's flood risk monitoring and response planning efforts are focused in this geographic area.

BES staff access hydrologic data multiple times per day once recorded water surface elevations are within 3 feet of bank-full levels and continue monitoring until the threat has passed. BES issues a Level 1 event advisory in Johnson Creek when the Sycamore Gage height reaches 10 feet (approximately 3 feet below bank-full). Coordinated monitoring intensifies at that point to include emergency conference calls, field checks of gages and river levels at locations most likely to flood, and interpretation of additional data. Technical staff review the hydrograph in depth and assess how quickly discharge rates are increasing at different points along the system; discuss predictions with NWS staff and request models be updated more frequently if conditions are rapidly evolving; review precipitation levels over preceding days; assess soil conditions (saturation, freezing levels, presence of snow, etc.) and likely impacts on river levels; compare current conditions against historic patterns and flood outcomes; and review flood inundation maps to ensure familiarity with modeled outcomes.

11.2.7 Flood Management Programs and Projects

Protecting Portland from Flood Losses

Columbia and Willamette Rivers

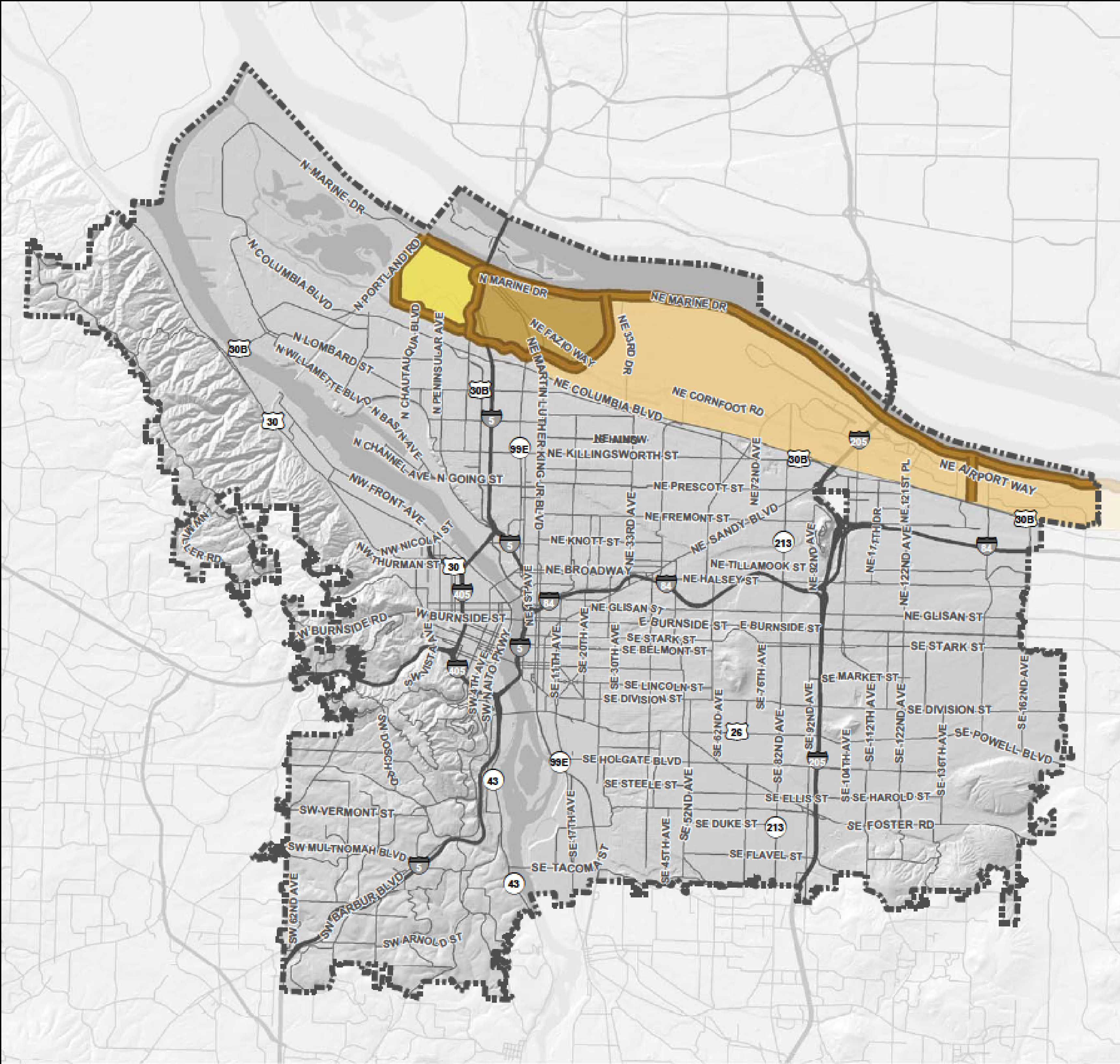
Multnomah County Drainage District maintains flood management systems including 27 miles of levees and 45 miles of ditches, sloughs, streams and culverts along the Columbia Slough and the lower Columbia River (MCDD, 2016). The ditches and sloughs were constructed and are maintained to accommodate a 1-percent annual chance flood. Stormwater enters into these ditches and sloughs through pipes that drain water from the streets and parking lots of Portland. About 20 miles of levees protect the city from flooding due to high water in the Columbia River and Lower Columbia Slough (see Figure 11-2). The system has been extensively improved since the 1996 flood. Pump station, levee and conveyance system upgrades, as well as a series of computers, repeaters and antennas that allow 24-hour real-time monitoring from remote locations, all make the system a reliable means to protect the managed floodplain from catastrophic flooding (NHMP, 2010).

Properties protected by the Multnomah County Drainage District system of levees are valued at more than $5.5 billion and protect approximately $16 billion in economic activity including the Portland International Raceway, the Portland Expo Center, the Portland International Airport, the Columbia Industrial Corridor, several residential neighborhoods, and the City's drinking water well system (MCDD, n.d.). The cost of replacing the infrastructure protected by Multnomah County Drainage District would be devastating (NHMP, 2010).

September 12, 2016

Mitigation Action Plan (MAP)

Figure 11-2. Flood Management Levees



Legend

City Boundary

Flood Control Levees

District

Multnomah County Drainage District

Peninsula Drainage District #1

Peninsula Drainage District #2

NORTH

0 0.75 1.5 Miles

Source: Multnomah County Drainage District

37242

PBEM

Flood control storage reservoirs have substantially reduced flood potential along the Columbia River and other major waterways. Upstream of Multnomah County, the Columbia River has 22 major reservoirs and the Willamette River has 11. These reservoirs have reduced, but not eliminated flood potential (NHMP, 2010).

Johnson Creek

Public acquisition of homes and land in the Johnson Creek floodplain has significantly reduced the impacts of regular flooding. The area surrounding SE Foster Road flooded on average every other year until Portland invested over $40 million in floodplain restoration. Johnson Creek, which provides habitat to several native species of salmon, now floods approximately every 6 to 8 years.

Floodplain property purchases also contribute to the City's rating under the Community Rating System (CRS) program. Floodplain restoration projects along Johnson Creek have added over 240 acre-feet of flood storage to mitigate flood impacts. BES is currently developing a city-wide Stormwater System Plan that will complements the Johnson Creek Restoration Plan, which is focused on mitigating nuisance flooding. The Stormwater System Plan will identify a comprehensive set of actions focused on uplands, tributaries and drainage patterns to minimize the impacts of stormwater runoff on flooding. Implementation of such actions can help improve the City's CRS ranking with FEMA (NHMP, 2010).

Federal Flood Programs

National Flood Insurance Program

The National Flood Insurance Program (NFIP) makes federally backed flood insurance available to homeowners, renters, and business owners in participating communities. For most participating communities, FEMA has prepared a detailed Flood Insurance Study that presents water surface elevations for floods of various magnitudes, including the 1-percent annual chance flood and the 0.2-percent annual chance flood. Base flood elevations and the boundaries of the floodplains are shown on Flood Insurance Rate Maps (FIRMs), which are the principle tool for identifying the extent and location of the flood hazard. FIRMs are the most detailed and consistent data source available, and for many communities they represent the minimum area of oversight for the local floodplain management program.

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

- New buildings and those undergoing substantial improvements must, at a minimum, be elevated to protect against damage by the 1-percent annual chance flood.
- New floodplain development must not worsen existing flood problems or damage to other properties.
- New floodplain development must exercise a reasonable and prudent effort to reduce its adverse impacts on threatened salmonid species.

Since the NFIP's inception, additional legislation has been enacted to strengthen the program, ensure its fiscal soundness and inform its mapping and insurance rate-setting through expert consultation, reports and studies. Most recently, the Biggert-Waters Flood Insurance Reform Act of 2012 (Public Law 141, Title II) and the Homeowner Flood Insurance Affordability Act of 2014 (Public Law 113-89) directed FEMA to make substantial changes to the NFIP by October 1, 2017. Administration, rating and application of key functional components of the NFIP could be directed by this legislation.

The Community Rating System

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

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

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

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

Figure 11-3 shows the nationwide number of CRS communities by class as of October 1, 2015, when there were 1,368 communities receiving flood insurance premium discounts under the CRS program. In Oregon there are 27 CRS communities (FEMA, 2016a). Although CRS communities represent only 6 percent of the over 22,000 communities participating in the NFIP, more than 70 percent of all flood insurance policies are written in CRS communities.

Source: FEMA, 2016a

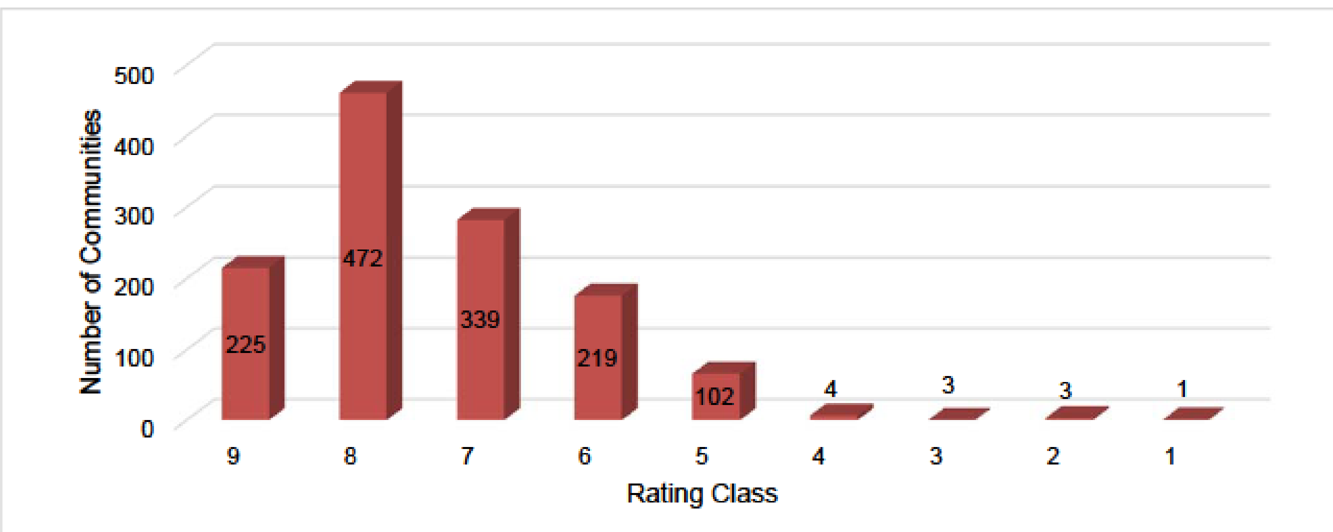


Figure 11-3. CRS Communities by Class Nationwide as of October 1, 2015

Portland Participation in NFIP and CRS

The City of Portland entered the NFIP on October 15, 1980. Currently, structures permitted or built in Portland before then are called "pre-FIRM" structures, and structures built afterwards are called "post-FIRM." However, the rating rules associated with this terminology may be subject to change due to flood insurance reform discussed below. The insurance rate is different for the two types of structures. The effective date for the current FIRM is November 26, 2010. This map is a DFIRM (digital flood insurance rate map).

The City of Portland is currently in good standing with the provisions of the NFIP. Compliance is monitored by FEMA regional staff and by the Oregon Department of Land Conservation and Development (DLCD) under a contract with FEMA. Table 11-3 summarizes the City's current compliance with NFIP requirements. Maintaining compliance under the NFIP is an important component of flood risk reduction. The City of Portland has identified actions to maintain its compliance and good standing.

Table 11-3. National Flood Insurance Program Compliance

Criteria	Response
When did Portland enter the NFIP?	10/15/80
When did the current Flood Insurance Rate maps become effective?	11/26/10
What local department is responsible for floodplain management?	Bureau of Environmental Services
Who is the City's floodplain administrator? (department/position) • Is this a primary or auxiliary role?	Bureau of Development Services Primary
Are any certified floodplain managers on staff in Portland?	Yes
What is the date of adoption of the flood damage prevention ordinance? • Does the floodplain management program meet or exceed minimum requirements? • If so, in what ways?	Last amended in part on November 26, 2010 Yes See CRS Classification status
When was the most recent Community Assistance Visit or Community Assistance Contact?	June 25, 2015
Does Portland have any outstanding NFIP compliance violations that need to be addressed?	No
Do the flood hazard maps adequately address the flood risk within the city? • If no, please state why.	No BES is constantly in the state of revision of the City's currently effective FIRM based on flood mitigation efforts being deployed by BES.
Does Portland's floodplain management staff need any assistance or training to support its floodplain management program? • If so, what type of assistance/training is needed?	Not at this time
Does Portland participate in the Community Rating System (CRS)? • Is Portland seeking to improve its CRS Classification?	Yes BES is always seeking ways to improve its CRS classification within the City's current capabilities and resources
• How many Flood Insurance policies are in force in Portland? • What is the insurance in force? • What is the premium in force? • Average Premium • % of Policies outside SFHA	1,759 $453,478,800 (04/30/2016) $1,338,250 (04/30/2016 $761 (04/30/2016) 62.3% (04/0/2016)
• How many total loss claims have been filed in Portland? • How many claims were closed without payment or are still open? • What were the total payments for losses? • Average Claim Paid	224 (4/30/2016) 70 (4/30/2016) $2,829,285.23 (04/30/2016) $12,868

The City of Portland is currently participating in the CRS program. Its CRS status is as follows:

- NFIP Community #—410183
- CRS Entry Date—10/1/2001
- Current CRS Classification—5
- % Premium Discount, SFHA/non-SFHA—25 percent/10 percent
- Total Annual Premium Savings—$234,329

Many of the mitigation actions identified in this plan are creditable activities under the CRS program. Therefore successful implementation of this plan offers the potential to enhance the CRS classification.

Natural Beneficial Functions

What Are Beneficial Floodplain Functions?

Flooding is a natural event, and floodplains provide many natural and beneficial functions. Riparian areas—the zones along the edge of a river or stream that are influenced by or are an influence upon the water body—generally have a greater diversity and structure of vegetation than upland areas. Shelter, space, food and water available in these areas determine the health of wildlife populations. Riparian communities are of special importance for many animals since water supply is a major limiting factor to the animals' population. Animals depend upon a supply of water for their existence.

CRS Credit for Protecting Natural Floodplain Functions

Wildlife and fisheries are impacted when plant communities are eliminated or fundamentally altered to reduce habitat. Human disturbance to riparian areas can limit wildlife's access to water, remove breeding or nesting sites, and eliminate suitable areas for rearing young. Changes in hydrologic conditions also can alter the plant community. FEMA's Community Rating System provides credits for adopting plans that protect one or more natural functions within a community's floodplain (Activity 510), such as the following (FEMA, 2013):

- A habitat conservation plan that explains and recommends actions to protect rare, threatened, or endangered aquatic or riparian species
- A habitat protection or restoration plan that identifies critical habitat within the floodplain, actions to protect remaining habitat, or actions to restore fully functioning habitat
- A green infrastructure plan that identifies open space corridors or connected networks of wetlands, woodlands, wildlife habitats, wilderness, and other areas that support native species, maintain natural ecological processes, or sustain air and water resources (the corridors or networks must include some floodplains)
- All or part of a comprehensive or other community plan that includes an inventory of the ecological attributes of a watershed or floodplain and recommends actions for protecting them through a mechanism such as a development regulation, development order, grant program, or capital improvement plan.

The credit requires that the following criteria be met:

- The plan may cover more than one community, but it must have an impact on natural floodplain functions within the community seeking credit.
- The plan must be adopted. If the plan is not a community plan adopted by the community's governing body, it must be adopted by an appropriate regional agency.

- The plan must be updated at least once every 10 years. The update must include a review of any changes to conditions as well as progress made since the original plan was prepared. Any changes to the adopted plan must be approved by the original adopting agency.
- The plan must include action items for protecting one or more identified species of interest and natural floodplain functions. The action items must describe who is responsible for implementing the action, how it will be funded, and when it will be done. General policy statements with no means of implementation are not considered action items.
- The plan must include a comprehensive inventory of the natural floodplain habitat within the community. It must identify areas that warrant protection or preservation in order to maintain fully functioning habitat for the species of interest. Where threatened or endangered species are present, each species must be addressed and a restoration plan must be included.
- A community can get credit for other plans that meet these credit criteria. These could be single-issue or single-species plans or plans that cover only one area of the community's floodplain.
- There is no credit under CRS Activity 510 for a plan that addresses water quality issues as a requirement for a permit under the National Pollution Discharge Elimination System (credit for such plans may be available under other CRS activities).

The following sections describe eight City of Portland documents that meet these requirements.

Balch Creek Watershed Protection Plan

The *Balch Creek Watershed Protection Plan* (Portland Bureau of Planning, 1991a), adopted by the City of Portland on February 8, 1991, protects the natural resources of the Balch Creek Watershed. The purpose for this plan was to identify and protect fish and wildlife habitat, ecologically and scientifically significant natural areas, open spaces, water bodies, wetlands and the functions and values of the watershed as a whole. This document is one of several natural resource plans completed by the City of Portland to comply with the State's Land Conservation and Development Commission (LCDC) Statewide Planning Goal 5, which requires all jurisdictions in Oregon to conserve open space and protect natural and scenic resources, using the following steps:

- Inventory—Identify, describe and evaluate the location, quality, and quantity of each natural resource within the City
- Analysis—Evaluate the economic, social, environmental and energy consequences of allowing, limiting and prohibiting uses that conflict with each identified resource
- Decision—Chose to protect or not to protect each identified resource.

The plan inventoried 15 sites, 13 of which were within the City of Portland. Resources identified within the watershed include: a full-year stream with associated floodplain, an isolated population of cutthroat trout and old conifer forest. The plan identifies protection and implementation measures for each of the 15 inventory areas. These protection and implementation measures are still being enforced today.

Columbia Corridor Industrial/Environmental Mapping Project

The Portland Bureau of Planning (now the Bureau of Planning and Sustainability) studied the Columbia River Corridor to make recommendations to the City of Portland Planning Commission for updating city Comprehensive Plan map designations and zones in the Columbia Corridor:

1. **Recommended Industrial and Annexation Rezoning for the Columbia Corridor (Portland Bureau of Planning, 1989a)**—This document contains the Planning Commission recommendations for converting old city industrial Comprehensive Plan map designations and

zones to new city industrial plan designations and zones and applying city plan designations and zones to certain annexed properties.

2. **Inventory and Analysis of Wetlands, Water Bodies and Wildlife Habitat Areas (Portland Bureau of Planning, 1989b)**—This document provides the inventory, analysis and proposal for protection of significant natural resources.
3. **Recommended Mapping for the Columbia Corridor (Portland Bureau of Planning, 1989c)**—This document provides detailed existing and recommended zoning for Phases 1 and 2. The zoning designations appear on the quarter section and full section Multnomah County Assessor's Maps.
4. **Appendix to the Inventory and Analysis of Wetlands, Waterbodies and Wildlife Habitat Areas (Portland Bureau of Planning, 1989d)**—This phase provided additional information that may be of benefit to more clearly understand the purpose and process of the natural resources portion of the project.

The findings and recommendations of this project are still valid and being implemented by the City.

East Buttes, Terraces and Wetlands Conservation Plan

The *East Buttes, Terraces and Wetlands Conservation Plan* (Portland Bureau of Planning, 1993) provides the inventory, analysis and recommendations for protection of significant East Portland natural, scenic, and open space resources. Portland is made up of 10 resource sites in East Portland: Mt. Tabor, Kelly Butte, Rocky Butte and seven additional upland sites. This plan complies with Statewide Planning Goal 5 and was adopted by the City on June 25, 1993. It identified four implementation measures that that are currently in effect:

- Amend the Portland Comprehensive Plan goals and policies to refer to the East Buttes, Terraces and Wetlands Conservation Plan.
- Adopt the East Buttes, Terraces and Wetlands Conservation Plan policies and objectives as the policy document for the area.
- Amend Title 33, Planning and Zoning to implement the conservation plan.
- Amend the official zoning maps to apply the "environmental zone" designation to identified resource areas, apply the open space (OS) zone to certain publicly owned lands and remove the Significant Environment Concern (SEC) zone from Rocky Butte.

Fanno Creek and Tributaries Conservation Plan

The *Fanno Creek and Tributaries Conservation Plan* (Portland Bureau of Planning, 1994a) provides the inventory, analysis and recommendations for protection of significant natural, scenic, and open space resources in the watershed of Fanno Creek and its tributaries. The planning effort identified the following objectives:

- Bring the City's comprehensive plan, zoning code and zoning maps into compliance with Oregon Statewide Planning Goal 5
- Reduce the threat to public health, safety and welfare from erosion, landslides, earthquakes and flooding
- Help the City comply with state and federal water quality regulations
- Facilitate development that maintains and enhances natural values provided by Fanno Creek and its tributaries.

The plan inventories and analyzes eight resource sites. Implementation measures were identified for each site. Each of these implementation measures are still in effect.

Johnson Creek Basin Protection Plan

The *Johnson Creek Basin Protection Plan* (Portland Bureau of Planning, 1991b) identifies, evaluates and protects significant fish and wildlife habitats, ecologically and scientifically significant natural areas, open spaces, water bodies, wetlands and the functions and values of the Johnson Creek basin as a whole. It adopts management recommendations on specific ways to retain and restore the natural habitat areas and values. The plan was designed to comply with Oregon Statewide Planning Goal 5. It identifies three natural resource protection measures that are still relevant and being implemented by the City:

- Limit housing density in areas that are difficult or hazardous to build on due to physical constraints such as floodways, steep slopes, floodplains or wetlands.
- Expand plan district requirements to include natural resource and neighborhood values.
- Protect or restore habitat within the resource area as an approval criterion for new development.

Northwest Hills Natural Areas Protection Plan

The *Northwest Hills Natural Areas Protection Plan* (Portland Bureau of Planning, 1991c) provides the inventory, analysis, and recommendations for protection of significant natural resources on the eastern slope of Portland's Northwest Hills. The study area covers 6,000 acres from NW St. Helens Road and the Willamette Greenway up to NW Skyline Boulevard, and from the Willamette Heights area to the Portland city limits near NW Newberry Road. This plan was written to comply with Statewide Planning Goal 5. It identified five implementation measures that that are currently in effect:

- Amend Portland's Comprehensive Plan goals and policies to refer to the protection plan.
- Adopt the protection plan policies and objectives as the policy document for the area.
- Amend Title 33, Planning and Zoning, and Title 34, Subdivisions and Partitioning Regulations, to implement the plan.
- Amend the Comprehensive Plan map designations and official zoning maps to apply the environmental zones, change base zones and correct open space mapping errors.
- Adopt an exception to Statewide Planning Goal 4, Forest Lands, to meet Federal Clean Water Act requirements and comply with Statewide Planning Goal 6, Air, Water and Land Resources Quality.

Skyline West Conservation Plan

The *Skyline West Conservation Plan* (Portland Bureau of Planning, 1994b) provides the inventory, analysis, and recommendations for protection of significant natural resources along the west slope of Tualatin Mountain ridge in northwest Portland. This plan was written to comply with Statewide Planning Goal 5. It inventories and analyzes three resource areas and identifies four implementation measures that that are currently in effect:

- Amend the Portland Comprehensive Plan goals and policies to refer to the conservation plan.
- Adoption of the conservation plan policies and objectives as the policy document for the area.
- Amend Title 33, Planning and Zoning, to implement the conservation plan.
- Amend the official zoning maps to apply the "environmental zone" designation to identified resource areas, apply the OS zone to certain public lands and remove the interim resource protection zone.

Southwest Hills Resource Protection Plan

The *Southwest Hills Resource Protection Plan* (Portland Bureau of Planning, 1992) provides the inventory, analysis and recommendations for protection of significant natural resources in southwest Portland. The study area covers 7,000 acres south of the Balch Creek basin and downtown Portland, including areas that drain directly into the Willamette River. This plan was written to comply with Statewide Planning Goal 5. The plan authorizes the following actions:

- Amend Portland's Comprehensive Plan goals and policies to refer to the protection plan.
- Adopt the protection plan policies and objectives as the policy document for the area.
- Amend Title 33, Planning and Zoning, to implement the protection plan.
- Amend the official zoning maps to apply the environmental zones to designated resources.
- Adopt a resolution directing the Bureau of Planning to study and prepare a recommendation on the concept of establishing a land bank for parks and natural areas acquisition.
- Repeal water features designations from the Southwest Hills Resource Protection Plan area.

Plan Integration

To ensure full integration of the above referenced natural beneficial functions plans, the City has identified mitigation actions that involve coordination of actions identified in the plans. There is a significant overlap in the goals and objectives of these plans, and coordinating their implementation will help ensure the success of all as well as the MAP. The maintenance strategy for the MAP will enhance the City's abilities to coordinate these plans. Each natural resource plan will be reviewed for its relevance to hazard mitigation and community resilience upon each future update to this plan.

11.3 COMPOUNDING FACTORS AND SECONDARY HAZARDS

11.3.1 Erosion

The most problematic secondary hazard for flooding is bank erosion, which in some cases can be more harmful than actual flooding. Riverine erosion results from the force of flowing water in and adjacent to river and creek channels. It affects the bed and banks of the channel and can alter or preclude any channel navigation or embankment development. During flood events, riverine erosion is magnified due to increased volume and velocity of the water flow. Flooding can generate high volume and velocity runoff that will concentrate in a river's lower drainages. When the stress applied by flood flows exceeds the resistance of the embankment material, erosion will occur. The erosion rate depends on the sediment supply and amount of runoff reaching the watercourse.

Erosion of any type rarely causes death or injury. However, erosion can cause significant destruction to property and infrastructure. Streams and rivers that are potentially threatened by erosion include the Columbia and Willamette Rivers; Johnson, Tryon and Fanno Creeks; and the Columbia Slough (NHMP, 2010).

11.3.2 Climate Change

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

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

As hydrology changes, what is currently considered a 1-percent-annual-chance (100-year flood) may strike more often, leaving many communities at greater risk. Planners will need to factor a new level of safety into the design, operation, and regulation of flood protection facilities such as dams, bypass channels and levees, as well as the design of local sewers and storm drains.

According to the City of Portland and Multnomah County Climate Change Preparation Strategy (2014), floods in Portland are likely to increase, particularly in Portland's urbanized environment. These events will likely be the result of more intense rain events in mid-winter and will most likely take the form of urban nuisance flooding.

11.3.3 Other Secondary Hazards

Flooding is also responsible for hazards such as landslides when high flows over-saturate soils on steep slopes, causing them to fail. Hazardous materials spills and runoff are also a secondary hazard of flooding if storage tanks rupture and spill into streams, rivers or storm sewers.

11.4 EXPOSURE

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

11.4.1 Population

Population counts of those living in the floodplain in Portland were generated by estimating the percent of the total residential buildings in each risk reporting area within the 1-percent and 0.2-percent annual chance flood hazard areas and multiplying this percentage by the total population in the risk reporting area. Using this approach, it was estimated that the exposed population for the entire City is 9,590 persons within the 1-percent annual chance flood hazard area (1.6 percent of the total City population) and 18,333 within the 0.2-percent annual chance flood hazard area (3.0 percent of the total). Table 11-4 shows the population estimates by risk reporting area.

Table 11-5 and Table 11-6 show the estimated percent of the population believed to be residing in mapped floodplains for the social-vulnerability-related demographics of concern. Citywide there is a disproportionate number of elderly residents living in the 1-percent-annual-chance flood hazard area. Additionally, rental properties may make up a substantial portion of development in the 0.2-percent annual chance flood hazard area, particularly in the Airport, Central City, Central Northeast and Southwest.

Table 11-4. Population within Flood Hazard Areas[a]

Risk Reporting Area	1% Annual Chance Flood Hazard Area		0.2% Annual Chance Flood Hazard Area	
	Population Exposed[b]	% of Total Population	Population Exposed[a]	% of Total Population
Airport	2,528	94.6%	2,528	94.6%
Central City	798	2.1%	7,402	19.5%
East Portland	3,048	2.0%	4,893	3.3%
North Portland	2,310	3.4%	2,396	3.5%
Northeast	27	0.1%	27	0.1%
Northeast	0	0.0%	0	0.0%
Southeast	501	0.3%	529	0.3%
Southwest	378	0.5%	558	0.8%
West/Northwest	0	0.0%	0	0.0%
Total	**9,590**	***1.6%***	**18,333**	**3.0%**

a. Exposure estimates are not available for the 10-percent annual flood hazard.
b. Represents the percent of residential buildings that are exposed multiplied by the estimated 2010-2014 American Community Survey 5-year estimates.

Table 11-5. Distribution of Social Vulnerability Indicators in 1% Annual Chance Flood Hazard Area

Reporting Area	Population Residing in 1% Annual Chance Flood Hazard Areas a, b, c, d					
	Percent Under 15 Years	Percent Over 65 Years	Percent of People of Color	Percent of Renter occupied Housing	Percent of Families Below Poverty Level	Percent of Limited English Speaking Households
Airport	5.4%	5.1%	31.8%	68.8%	19.8%	20.6%
Central City	2.9%	9.7%	13.4%	79.4%	10.5%	0.7%
Central Northeast	5.4%	5.1%	31.8%	68.8%	19.8%	20.6%
East Portland	17.0%	14.0%	22.1%	26.9%	9.4%	4.1%
North Portland	12.2%	21.1%	23.0%	20.3%	7.2%	3.2%
Northeast	—	—	—	—	—	—
Southeast	10.7%	16.6%	8.1%	41.4%	2.3%	3.1%
Southwest	9.8%	17.2%	17.2%	60.1%	8.2%	1.3%
West/Northwest	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Total	**13.7%**	**14.8%**	**21.9%**	**33.2%**	**8.8%**	**3.8%**

a. Values based on an analysis of 2010-2014 American Community Survey 5-year estimates at the Census block group level.
b. Values calculated using block group statistics weighted by the number of residential structures in the hazard area as a percentage of the total residential structures in the block group.
c. Values in red indicate percentages are at least 2 percent greater than the Citywide average (see Section 4.7).
d. Persons with disabilities not shown because the available data, at a census tract scale, is not conducive to analysis by hazard extent and location.

Table 11-6. Distribution of Social Vulnerability Indicators in 0.2% Annual Chance Flood Hazard Area

Reporting Area	Population Residing in 0.2% Annual Chance Flood Hazard Areas [a, b, c, d]					
	Percent Under 15 Years	Percent Over 65 Years	Percent of People of Color	Percent of Renter occupied Housing	Percent of Families Below Poverty Level	Percent of Limited English Speaking Households
Airport	5.4%	5.1%	31.8%	68.8%	19.8%	20.6%
Central City	1.5%	9.3%	13.5%	77.2%	10.1%	1.3%
Central Northeast	5.4%	5.1%	31.8%	68.8%	19.8%	20.6%
East Portland	18.6%	13.1%	22.9%	30.3%	11.7%	5.1%
North Portland	12.2%	21.1%	22.8%	20.1%	7.2%	3.2%
Northeast	—	—	—	—	—	—
Southeast	11.2%	16.2%	8.3%	41.5%	2.2%	3.3%
Southwest	8.7%	17.6%	16.3%	59.2%	6.1%	1.5%
West/Northwest	—	—	—	—	—	—
Total	**11.4%**	**13.0%**	**19.8%**	**51.2%**	**10.2%**	**3.2%**

a. Values based on an analysis of 2010-2014 American Community Survey 5-year estimates at the Census block group level.
b. Values calculated using block group statistics weighted by the number of residential structures in the hazard area as a percentage of the total residential structures in the block group.
c. Values in red indicate percentages are at least 2 percent greater than the Citywide average (see Section 4.7).
d. Persons with disabilities not shown because the available data, at a census tract scale, is not conducive to analysis by hazard extent and location.

11.4.2 Property

Structures in the Floodplain

Some land uses, such as single-family homes, are more vulnerable to flooding than others, such as agricultural land or parks. Table 11-7 and Table 11-8 summarize the total area and number of structures in the floodplain by risk reporting area and by structure type. Structure types were based on land use descriptions in Multnomah County assessor data. There are 2,925 structures within the 1-percent annual chance flood hazard area and 4,356 structures within the 0.2-percent annual chance flood hazard area. In the 1-percent annual chance flood hazard area, about 74 percent of these structures are in North Portland or East Portland (43 and 31 percent, respectively). Seventy-four percent (2,153) of the structures in the 1-percent annual chance flood hazard area are residential.

Table 11-7. Area and Number of Structures in the 1% Annual Chance Flood Hazard Area

Reporting Area	Area in Floodplain (acres)	Number of Structures in 1% Annual Chance Flood Hazard Area[a]							
		Residential	Commercial	Industrial	Agriculture	Religion	Government	Education	Total
Airport	2,103.04	243	9	12	0	0	1	0	**265**
Central City	558.29	18	22	7	0	0	3	0	**50**
Central Northeast	432.37	9	30	19	0	0	3	0	**61**
East Portland	1,245.73	849	58	7	0	1	1	0	**916**
North Portland	5,243.72	749	183	135	0	173	4	0	**1,244**
Northeast	0.00	0	0	0	0	0	0	0	**0**
Southeast	978.04	165	51	7	0	0	0	0	**223**
Southwest	307.14	120	9	0	0	0	0	0	**129**
West/Northwest	914.42	0	5	32	0	0	0	0	**37**
Total	**11,782.76**	**2,153**	**367**	**219**	**0**	**174**	**12**	**0**	**2,925**

a. Values based on City of Portland building inventory data received October 2015.

Table 11-8. Area and Number of Structures in the 0.2% Annual Chance Flood Hazard Area

Reporting Area	Area in Floodplain (acres)	Number of Structures in 0.2% Annual Chance Flood Hazard Area[a]							
		Residential	Commercial	Industrial	Agriculture	Religion	Government	Education	Total
Airport	2,110.36	243	9	12	0	0	1	0	**265**
Central City	1,086.13	167	361	20	0	4	21	0	**573**
Central Northeast	438.34	9	30	19	0	0	3	0	**61**
East Portland	1,440.74	1,363	79	11	0	2	1	0	**1,456**
North Portland	7,016.02	777	349	253	0	173	15	0	**1,567**
Northeast	0.00	0	0	0	0	0	0	0	**0**
Southeast	1,056.23	174	53	7	0	0	0	0	**234**
Southwest	342.80	177	15	0	0	0	0	0	**192**
West/Northwest	1,167.48	0	29	158	0	0	1	0	**188**
Total	**14,658.10**	**2,910**	**925**	**480**	**0**	**179**	**42**	**0**	**4,536**

a. Values based on City of Portland building inventory data received October 2015.

Exposed Value

Table 11-9 and Table 11-10 summarize the estimated value of exposed buildings in Portland. This methodology estimated $6.7 billion worth of building-and-contents exposed to the 1-percent annual chance flood, representing 4.0 percent of the total replacement value of Portland, and $19.1 billion worth of building-and-contents exposed to the 0.2-percent annual chance flood, representing 11.2 percent of the total.

11.4.3 Critical Facilities and Infrastructure

Critical facilities and infrastructure in the floodplain are summarized in Table 11-11 through Table 11-14. Details are provided in the following sections. In addition linear features exposed to the flood hazard are shown in Table 11-15.

Table 11-9. Value of Structures in the 1% Annual Chance Flood Hazard Area

Reporting Area	Number of Buildings Exposed	Value Exposed			Exposed Value as % of Total Replacement Value
		Structure	Contents	Total	
Airport	265	$64,994,573	$36,784,946	$101,779,519	2.6%
Central City	50	$912,058,805	$622,430,862	$1,534,489,668	4.9%
Central Northeast	61	$142,697,040	$175,617,039	$318,314,079	2.9%
East Portland	916	$232,653,839	$145,518,166	$378,172,005	1.5%
North Portland	1,244	$1,670,002,621	$1,764,793,553	$3,434,796,173	14.6%
Northeast	0	$0	$0	$0	0.0%
Southeast	223	$320,045,992	$298,404,036	$618,450,028	2.0%
Southwest	129	$131,344,332	$79,503,463	$210,847,795	1.2%
West/Northwest	37	$77,139,870	$97,631,271	$174,771,142	1.3%
Total	**2,925**	**$3,550,937,073**	**$3,220,683,336**	**$6,771,620,408**	**4.0%**

Note: Values shown are accurate only for comparison among results in this plan. See Section 6.8 for a discussion of data limitations.

Table 11-10. Value of Structures in the 0.2% Annual Chance Flood Hazard Area

Reporting Area	Number of Buildings Exposed	Value Exposed			Exposed Value as % of Total Replacement Value
		Structure	Contents	Total	
Airport	265	$64,994,573	$36,784,946	$101,779,519	2.6%
Central City	573	$4,791,643,258	$3,644,727,618	$8,436,370,876	27.0%
Central Northeast	61	$142,697,040	$175,617,039	$318,314,079	2.9%
East Portland	1,456	$369,849,396	$229,502,548	$599,351,944	2.3%
North Portland	1,567	$3,382,875,378	$3,720,243,232	$7,103,118,610	30.2%
Northeast	0	$0	$0	$0	0.0%
Southeast	234	$346,489,138	$311,944,416	$658,433,553	2.2%
Southwest	192	$197,471,492	$128,636,188	$326,107,680	1.8%
West/Northwest	188	$707,179,543	$911,495,837	$1,618,675,381	11.6%
Total	4,536	$10,003,199,819	$9,158,951,823	$19,162,151,642	11.2%

Note: Values shown are accurate only for comparison among results in this plan. See Section 6.8 for a discussion of data limitations.

Table 11-11. Critical Facilities in the 1% Annual Chance Flood Hazard Area

Reporting Area	Number of Critical Facilities in the 1% Annual Chance Flood Hazard Area[a]				
	Emergency Services	High Potential Loss Facilities	Schools	Other Assets	Total
Airport	0	0	0	0	0
Central City	2	0	0	0	2
Central Northeast	0	2	0	0	2
East Portland	0	2	0	0	2
North Portland	0	8	0	0	8
Northeast	0	0	0	0	0
Southeast	0	2	0	0	2
Southwest	0	0	0	0	0
West/Northwest	1	0	0	0	1
Total	3	14	0	0	17

a. See Table 6-1 for a description of the facilities included in each category.

Table 11-12. Critical Facilities in the 0.2% Annual Chance Flood Hazard Area

Reporting Area	Number of Critical Facilities in the 0.2% Annual Chance Flood Hazard Area[a]				
	Emergency Services	High Potential Loss Facilities	Schools	Other Assets	Total
Airport	0	0	0	0	0
Central City	7	3	4	1	15
Central Northeast	0	2	0	0	2
East Portland	0	2	0	2	4
North Portland	0	22	0	0	22
Northeast	0	0	0	0	0
Southeast	0	2	0	0	2
Southwest	0	0	0	0	0
West/Northwest	2	0	0	0	2
Total	9	31	4	3	47

a. See Table 6-1 for a description of the facilities included in each category.

Table 11-13. Critical Infrastructure in the 1% Annual Chance Flood Hazard Area

Reporting Area	Number of Critical Infrastructure Facilities in the 1% Annual Chance Flood Hazard Area[a]					
		Utility Systems				
	Transportation Systems	Communications	Power	Potable Water	Wastewater	Total
Airport	1	0	0	0	0	**1**
Central City	12	0	0	0	0	**12**
Central Northeast	0	0	0	0	4	**4**
East Portland	1	1	1	1	1	**5**
North Portland	9	2	0	1	16	**28**
Northeast	0	0	0	0	0	**0**
Southeast	2	0	0	0	1	**3**
Southwest	0	0	0	0	2	**2**
West/Northwest	0	0	8	0	0	**8**
Total	**25**	**3**	**9**	**2**	**24**	**63**

a. See Table 6-1 for a description of the facilities included in each category.

Table 11-14. Critical Infrastructure in the 0.2% Annual Chance Flood Hazard Area

Reporting Area	Number of Critical Infrastructure Facilities in the 0.2% Annual Chance Flood Hazard Area[a]					
		Utility Systems				
	Transportation Systems	Communications	Power	Potable Water	Wastewater	Total
Airport	1	0	0	0	0	**1**
Central City	18	0	4	0	6	**28**
Central Northeast	0	0	0	0	4	**4**
East Portland	1	1	1	1	2	**6**
North Portland	10	2	3	1	24	**40**
Northeast	0	0	0	0	0	**0**
Southeast	2	0	0	0	1	**3**
Southwest	0	0	0	0	3	**3**
West/Northwest	1	0	52	0	0	**53**
Total	**33**	**3**	**60**	**2**	**40**	**138**

a. See Table 6-1 for a description of the facilities included in each category.

Table 11-15. Linear Critical Facilities in Flood Hazard Areas

	Facilities in Flood Hazard Areas	
	1% Annual Chance Flood Hazard Area	0.2% Annual Chance Flood Hazard Area
Utility Systems		
Power Lines	36.62 miles, 7.7% of citywide total	59.49 miles, 12.5% of citywide total
Gas Lines	1.99 miles, 2.4% of citywide total	10.87 miles, 13.0% of citywide total
Transportation Systems		
Railroads	26.43 miles, 7.0% of citywide total	100.92 miles, 26.9% of citywide total
Light Rail	2.10 miles, 4.0% of citywide total	6.31 miles, 12.0% of citywide total

Hazardous Material Facilities

Hazardous material facilities use or store materials that can harm the environment if damaged by a flood. One facility in the 10-percent annual chance flood hazard area, nine facilities in the 1-percent annual chance flood hazard area flood hazard area and 26 facilities in the 0.2-percent annual chance flood hazard area report having hazardous materials according to the Oregon State Fire Marshal. During a flood event, containers holding these materials can rupture and leak into the surrounding area, having a disastrous effect on the environment as well as residents.

Utilities and Infrastructure

Flood damage to infrastructure presents numerous risks. Roads or railroads that are blocked or damaged can isolate residents and can prevent access throughout the city, including for emergency service providers needing to get to vulnerable populations or to make repairs. Bridges washed out or blocked by floods or debris also can cause isolation. Floodwaters can back up drainage systems, causing localized flooding. Culverts can be blocked by debris from flood events, also causing localized urban flooding. Floodwaters can get into drinking water supplies, causing contamination. Sewer systems can be backed up, causing waste to spill into homes, neighborhoods, rivers and streams. Underground utilities can also be damaged. Dikes and levees can fail or be overtopped, inundating the land that they protect. The following sections describe impacts and exposure to these types of infrastructure.

Roads

The following major roads in Portland pass through the 1-percent annual chance flood hazard area flood hazard area and thus are exposed to flooding. Main highways that intersect the flood zone are all elevated above flood levels although it is possible that scour or debris carried by a flood could damage the support apparatus for elevated structures:

- N Marine Drive
- NE Marine Drive
- SE Foster Road
- SE Holgate Boulevard
- SE Johnson Creek Boulevard
- SE McLoughlin Boulevard
- SE 111th Ave.
- SE 122nd Ave.
- SE Harold St.
- SW Moody Ave.
- SW Shattuck Rd

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

Bridges

Flooding events can significantly impact road bridges. These are important because often they provide the only ingress and egress to some neighborhoods. An analysis showed that there are three light rail bridges, and four highway bridges that are in or cross over the 10-percent annual chance flood hazard area, three light rail bridges, and seven highway bridges in the 1-percent annual chance flood hazard area, and five light rail bridges and seven highway bridges in the 0.2-percent annual chance flood hazard area.

Rail Lines

Rail-based transportation systems can be negatively impacted by flood events. If rails are covered by flood waters trains may need to significantly slow their speed in order to pass or may not be able to pass at all. Flood waters can scour and undermine support systems and block lines with debris.

When a railroad embankment serves as a flood barrier during high water events, the risk of embankment failure is higher because the embankment was not engineered as a levee. In Portland, the railroad embankment that breached in 1948 would still serve as a flood barrier for Peninsula Drainage District #1, where Portland International Raceway and Blue Heron golf course are. This railroad embankment will be considered through Levee Ready Columbia.

Water and Sewer Infrastructure

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

11.4.4 Environment

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

Many species of mammals, birds, reptiles, amphibians and fish live in plant communities that are dependent upon streams, wetlands and floodplains. Changes in hydrologic conditions can result in a change in the plant community. Wildlife and fish are impacted when plant communities are eliminated or fundamentally altered to reduce habitat. Wildlife populations are limited by shelter, space, food, and water. Since water supply is a major limiting factor for many animals, riparian communities are of special importance.

Riparian areas are the zones along the edge of a river or stream that are influenced by or are an influence upon the water body. Human disturbance to riparian areas can limit wildlife's access to water, remove breeding or nesting sites, and eliminate suitable areas for rearing young. Wildlife rely on riparian areas and are associated with the flood hazard in the following ways:

- Mammals depend upon a supply of water for their existence. Riparian communities have a greater diversity and structure of vegetation than other upland areas. Beavers and muskrats are now recolonizing streams, wetlands and fallow farm fields, which are converted wetlands. As residences are built in rural areas, there is an increasing concern with beaver dams causing flooding of low-lying areas and abandoned farm ditches being filled in, which can lead to localized flooding.
- A great number of birds are associated with riparian areas. They swim, dive, feed along the shoreline, or snatch food from above. Rivers, lakes and wetlands are important feeding and resting areas for migratory and resident waterfowl. Other threatened or endangered species (such as the bald eagle or the peregrine falcon) eat prey from these riparian areas.
- Amphibians and reptiles are some of the least common forms of wildlife in riparian areas. However, some state threatened species, such as the western pond turtle and the spotted frog, are known to inhabit the waterways and wetlands.
- Fish habitat throughout Portland varies widely based on natural conditions and human influence. Many ditches were dug throughout the City to make low, wet ground better for

farming. As the water drained away and the wetlands were converted to farm fields, natural stream conditions were altered. Agriculture along many rivers extends to the water's edge and smaller side channels have been tilled to drain better. Within developing areas, small streams were placed in pipes and wetland was filled in to support urban development. While salmonids prefer clear, free-flowing streams, other species like the Olympic mud-minnow inhabit the calm, backwater areas of sloughs and wetlands.

11.5 VULNERABILITY

Many areas exposed to flooding may not actually experience serious flooding or flood damage. This section describes vulnerabilities in terms of population, property, infrastructure and environment.

11.5.1 Population

Generally, there is substantial warning time for flood events in Portland. Populations who may not understand or have access to available flood warning systems may be more vulnerable. In particular, many homeless people in Portland camp along floodplain areas, including along the Springwater Corridor Trail, which runs along Johnson Creek. These groups tend not to have access to technology and are unable to receive electronic evacuation notifications. Additionally, those who have difficulty evacuating, including the elderly and those with access and functional needs, may be more vulnerable if warning time is limited. Persons with limited incomes residing in the floodplain may not have flood insurance and may be more vulnerable to severe economic consequences in the event of a flood. The costs to evacuate during a flood event are also likely to disproportionately impact people with limited incomes. Persons driving or otherwise trying to cross flooded roadways are particularly at risk of physical harm.

Displaced Households and Persons Requiring Short Term Shelter

Impacts on persons and households in Portland were estimated for the 10-percent, 1-percent and 0.2-percent annual chance floods through the Level 2 Hazus-MH analysis. Table 11-16 summarizes the results.

Table 11-16. Estimated Flood Impact on Persons and Households

	Number of Displaced Persons[a]			Number of Persons Requiring Short-Term Shelter[a]		
Reporting Area	10% Annual Chance	1% Annual Chance	0.2% Annual Chance	10% Annual Chance	1% Annual Chance	0.2% Annual Chance
Airport	47	2,425	2,425	37	1,909	1,909
Central City	774	214	6,196	696	193	6,005
Central Northeast	4	6	6	0	3	3
East Portland	1,069	821	1,722	847	645	1,489
North Portland	1,461	848	1,118	1,372	781	1,037
Northeast	0	0	0	0	0	0
Southeast	459	139	168	343	109	133
Southwest	237	46	74	163	25	46
West/Northwest	1	0	0	0	0	0
Total	**4,052**	**4,499**	**11,709**	**3,458**	**3,664**	**10,622**

a. Calculated using a Census block level, general building stock analysis in Hazus, adjusted to reflect the estimated population.

Public Health and Safety

Floods and their aftermath present numerous threats to public health and safety:

- **Unsafe food—**Floodwaters contain disease-causing bacteria, dirt, oil, human and animal waste, and farm and industrial chemicals. Their contact with food items, including food crops in agricultural lands, can make that food unsafe to eat. Refrigerated and frozen foods are affected during power outages caused by flooding. Foods in cardboard, plastic bags, jars, bottles, and paper packaging may be unhygienic with mold contamination.
- **Contaminated drinking and washing water and poor sanitation—**Flooding impairs clean water sources with pollutants. The pollutants also saturate into the groundwater. Flooded wastewater treatment plants can be overloaded, resulting in backflows of raw sewage. Private wells can be contaminated by floodwaters. Private sewage disposal systems can become a cause of infection if they or overflow.
- **Mosquitoes and animals—**Floods provide new breeding grounds for mosquitoes in wet areas and stagnant pools. The public should dispose of dead animals that can carry viruses and diseases only in accordance with guidelines issued by local animal control authorities. Leptospirosis—a bacterial disease associated predominantly with rats—often accompanies floods in developing countries, although the risk is low in industrialized regions unless cuts or wounds have direct contact with disease-contaminated floodwaters or animals.
- **Mold and mildew—**Excessive exposure to mold and mildew can cause flood victims—especially those with allergies and asthma—to contract upper respiratory diseases, triggering cold-like symptoms. Molds grow in as short a period as 24 to 48 hours in wet and damp areas of buildings and homes that have not been cleaned after flooding, such as water-infiltrated walls, floors, carpets, toilets and bathrooms. Very small mold spores can be easily inhaled by human bodies and, in large enough quantities, cause allergic reactions, asthma episodes, and other respiratory problems. Infants, children, elderly people and pregnant women are considered most vulnerable to mold-induced health problems.
- **Carbon monoxide poisoning—**In the event of power outages following floods, some people use alternative fuels for heating or cooking in enclosed or partly enclosed spaces, such as small gasoline engines, stoves, generators, lanterns, gas ranges, charcoal or wood. Built-up carbon monoxide from these sources can poison people and animals.
- **Hazards when reentering and cleaning flooded homes and buildings—**Flooded buildings can pose significant health hazards to people entering them. Electrical power systems can become hazardous. Gas leaks can trigger fire and explosion. Flood debris—such as broken bottles, wood, stones and walls—may cause injuries to those cleaning damaged buildings. Containers of hazardous chemicals may be buried under flood debris. Hazardous dust and mold can circulate through a building and be inhaled by those engaged in cleanup and restoration.
- **Mental stress and fatigue—**People who live through a devastating flood can experience long-term psychological impact. The expense and effort required to repair flood-damaged homes places severe financial and psychological burdens on the people affected. Post-flood recovery can cause, anxiety, anger, depression, lethargy, hyperactivity, and sleeplessness. There is also a long-term concern among the affected that their homes can be flooded again in the future.

Current loss estimation models such as Hazus are not equipped to measure public health impacts such as these. The best level of mitigation for these impacts is to be aware that they can occur, educate the public on prevention, and be prepared to deal with them in responding to flood events.

11.5.2 Property

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

Building Age

Table 11-17 summarizes the age of buildings in the city relative to the initial FIRM date and the enactment of freeboard requirements.

Table 11-17. Pre-FIRM Buildings and Pre-Freeboard Requirement Buildings in 1% Annual Chance Flood Zone

Reporting Area	Pre-FIRM Buildings in Flood Zone[a]		Pre-Freeboard Buildings in Flood Zone[a]	
	Number	% of Total	Number	% of Total
Airport	257	96.6%	260	97.7%
Central City	7	35.0%	13	65.0%
Central Northeast	23	67.6%	24	70.6%
East Portland	684	83.1%	737	89.6%
North Portland	739	62.5%	1130	95.6%
Northeast	0	0.0%	0	0.0%
Southeast	166	91.7%	176	97.2%
Southwest	74	87.1%	81	95.3%
West/Northwest	17	65.4%	23	88.5%
Total	**1,967**	**75.2%**	**2,444**	**93.4%**

a. Indicates that building was built before the Flood Insurance Rate Maps became effective (before 1981).
b. Indicates that building was built before Freeboard requirements were in place (before 1996)

Estimated Losses Due to Flooding

Loss estimates for the 10-percent annual chance, 1-percent annual chance and 0.2-percent annual chance floods are presented in Table 11-18 through Table 11-20. It is estimated that there would be up to $369.2 million of flood loss from a 1-percent annual chance flood in Portland. This represents 0.2 percent of the total replacement value for Portland. It is estimated that there would be $1.9 billion of flood loss from a 0.2-percent annual chance flood, representing 1.1 percent of the total replacement value.

National Flood Insurance Program

The use of flood insurance in Portland is below the national average. Only 22.7 percent of insurable buildings in Portland are covered by flood insurance (see Table 11-21). According to an NFIP study, about 49 percent of single-family homes in special flood hazard areas are covered by flood insurance nationwide.

Table 11-18. Loss Estimates for 10% Annual Chance Flood

Reporting Area	*Structures* Impacted[a]	Estimated Loss Associated with 10% Annual Chance Flood			% of Total Replacement Value
		Structure	Contents	Total[a]	
Airport	N/A	$229,109	$616,420	$845,529	0.0%
Central City	N/A	$58,923,422	$68,904,478	$127,827,900	0.4%
Central Northeast	N/A	$0	$0	$0	0.0%
East Portland	N/A	$3,321,950	$1,920,660	$5,242,610	0.0%
North Portland	N/A	$88,691	$78,391	$167,082	0.0%
Northeast	N/A	$0	$0	$0	0.0%
Southeast	N/A	$259,384	$493,804	$753,188	0.0%
Southwest	N/A	$3,789,745	$2,531,660	$6,321,404	0.0%
West/Northwest	N/A	$12,067,394	$29,135,540	$41,202,934	0.3%
Total	**N/A**	**$78,679,694**	**$103,680,953**	**$182,360,647**	**0.1%**

a. Calculated using a user-defined analysis in Hazus

Note: Values shown are accurate only for comparison among results in this plan. See Section 6.8 for a discussion of data limitations.

Table 11-19. Loss Estimates for 1% Annual Chance Flood

Reporting Area	*Structures* Impacted[a]	Estimated Loss Associated with 1% Annual Chance Flood			% of Total Replacement Value
		Structure	Contents	Total[a]	
Airport	6	$451,242	$891,901	$1,343,143	0.0%
Central City	14	$87,274,869	$85,625,968	$172,900,837	0.6%
Central Northeast	35	$689,694	$2,146,062	$2,835,757	0.0%
East Portland	628	$31,144,067	$19,649,736	$50,793,804	0.2%
North Portland	154	$11,984,444	$23,350,117	$35,334,561	0.2%
Northeast	0	$0	$0	$0	0.0%
Southeast	56	$7,838,379	$29,672,642	$37,511,021	0.1%
Southwest	60	$7,601,119	$4,757,240	$12,358,359	0.1%
West/Northwest	19	$21,049,497	$35,117,159	$56,166,655	0.4%
Total	**972**	**$168,033,311**	**$201,210,825**	**$369,244,136**	**0.2%**

a. Calculated using a user-defined analysis in Hazus. Hazus is not currently able to calculate losses for houseboats, therefore, damage to these structures was not included in this assessment.

Note: Values shown are accurate only for comparison among results in this plan. See Section 6.8 for a discussion of data limitations.

Table 11-20. Loss Estimates for 0.2% Annual Chance Flood

Reporting Area	*Structures* Impacted[a]	Estimated Loss Associated with 0.2% Annual Chance Flood			% of Total Replacement Value
		Structure	Contents	Total[a]	
Airport	14	$635,412	$1,202,789	$1,838,201	0.0%
Central City	409	$330,668,030	$460,921,949	$791,589,978	2.5%
Central Northeast	35	$689,694	$2,146,062	$2,835,757	0.0%
East Portland	910	$47,639,098	$32,733,445	$80,372,543	0.3%
North Portland	569	$207,032,845	$599,086,809	$806,119,654	3.4%
Northeast	0	$0	$0	$0	0.0%
Southeast	74	$24,613,977	$52,138,088	$76,752,065	0.3%
Southwest	106	$19,444,699	$15,060,521	$34,505,220	0.2%
West/Northwest	144	$42,157,111	$80,473,217	$122,630,327	0.9%
Total	**2,261**	**$672,880,866**	**$1,243,762,880**	**$1,916,643,745**	**1.1%**

a. Calculated using a user-defined analysis in Hazus. Hazus is not currently able to calculate losses for houseboats, therefore, damage to these structures was not included in this assessment.

Note: Values shown are accurate only for comparison among results in this plan. See Section 6.8 for a discussion of data limitations.

Table 11-21. Percent of Buildings in Floodplain with Flood Insurance

Reporting Area	1% Annual Chance Flood		0.2% Annual Chance Flood	
	Total Buildings in Flood Zone	% of Buildings with Flood Insurance	Total Buildings in Flood Zone	% of Buildings with Flood Insurance
Airport	266	1.5%	266	1.5%
Central City	20	60.0%	517	14.5%
Central Northeast	34	5.9%	34	5.9%
East Portland	823	35.8%	1321	24.7%
North Portland	1182	16.5%	1473	16.6%
Northeast	0	0.0%	0	0.0%
Southeast	181	33.1%	195	33.3%
Southwest	85	41.2%	136	39.7%
West/Northwest	26	0.0%	171	0.6%
Total	**2617**	**23.0%**	**4113**	**18.8%**

The average claim paid in Portland represents about 3.1 percent of the 2015 average Replacement value of structures in the floodplain.

The percentage of policies and claims outside a mapped floodplain suggests that not all of the flood risk in Portland is reflected in current mapping. Based on information from the NFIP, 37.7 percent of policies in Portland are on structures within an identified SFHA, and 62.3 percent are for structures outside such areas. Of total claims paid, 23.8 percent were for properties outside an identified 1-percent annual chance flood hazard area. These claims are likely the result of urban flooding resulting from a lack of adequately sized stormwater conveyance systems.

Repetitive Loss

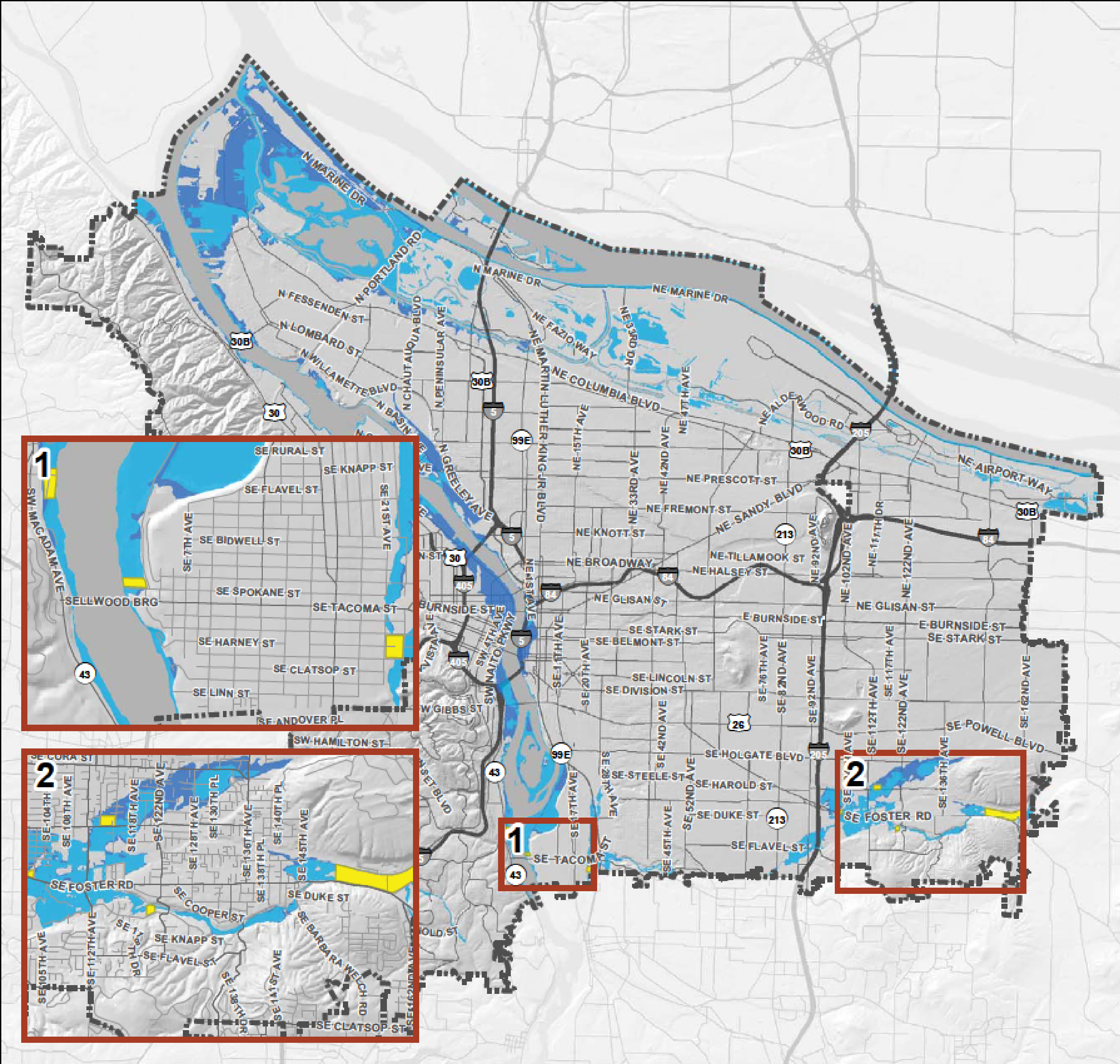
A repetitive loss property is defined by FEMA as an NFIP-insured property that has experienced any of the following since 1978, regardless of any changes in ownership:

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

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

Following the CRS repetitive loss area analysis protocol, the City has identified 83 properties subject to repetitive flooding within 7 geographical areas of the City. Disclosure of these properties is not provided in the plan due to protection under the Privacy Act. All of these properties are residential and are in or immediately adjacent to the FEMA-mapped SFHA. Nine repetitive loss properties throughout the City were identified after the 2009 floods—four of them in the Johnson Creek watershed. BES disseminates an outreach project to all repetitive loss area properties annually.

Figure 11-4 shows the repetitive loss areas in the City of Portland. FEMA's list of repetitive loss properties identifies nine such properties in Portland as of November 30, 2014, none of which have been mitigated.



September 12, 2016

Mitigation Action Plan (MAP)

Figure 11-4. Repetitive Loss Areas

Legend

- City Boundary
- Repetitive Loss Areas
- 100-year FEMA flood zone
- 500-year FEMA flood zone
- Major Waterbodies

NORTH

0 0.75 1.5 Miles

Sources: FEMA-2014; City of Portland-2016

37242

PBEM

Repetitive loss properties make up only 1 to 2 percent of flood insurance policies in force nationally, yet they account for 40 percent of the nation's flood insurance claim payments. In 1998, FEMA reported that the NFIP's 75,000 repetitive loss structures have already cost $2.8 billion in flood insurance payments and that numerous other flood-prone structures remain in the floodplain at high risk. The government has instituted programs encouraging communities to identify and mitigate the causes of repetitive losses. A report on repetitive losses by the National Wildlife Federation (2006) found that 20 percent of these properties are outside any mapped 1-percent annual chance flood hazard area. The key identifiers for repetitive loss properties are the existence of flood insurance policies and claims paid by the policies.

11.5.3 Critical Facilities and Infrastructure

Hazus-MH was used to estimate the flood loss potential to critical facilities exposed to flood risk. Using depth/damage function curves to estimate the percent of damage to the building and contents of critical facilities, Hazus-MH correlates these estimates into an estimate of functional down-time (the estimated time it will take to restore a facility to 100 percent of its functionality). This helps to gauge how long Portland could have limited usage of facilities deemed critical to flood response and recovery. The Hazus critical facility results are as summarized in Table 11-22 through Table 11-24.

Table 11-22. Estimated Damage to Critical Facilities and Infrastructure from 10-Percent Annual Chance Flood

	Number of Facilities Affected	Average % of Total Value Damaged		Days to 100% Functionality
		Building	Content	
Emergency Services	2	56	100	640
Schools	0	–	–	–
Transportation Systems	10	21	–	N/A
High Potential Loss Facilities	1	1	–	N/A
Utility Systems				
Communications	1	16	–	N/A
Power	0	–	–	–
Potable Water	0	–	–	–
Wastewater	4	40	–	N/A
Other Assets	0	–	–	–
Total/Average	**18**	**27**	**100**	**640**

Table 11-23. Estimated Damage to Critical Facilities and Infrastructure from 1-Percent Annual Chance Flood

	Number of Facilities Affected	Average % of Total Value Damaged		Days to 100% Functionality
		Building	Content	
Emergency Services	2	84	100	900
Schools	0	–	–	–
Transportation Systems	14	18	–	N/A
High Potential Loss Facilities	9	7	–	N/A
Utility Systems				
Communications	3	16	–	N/A
Power	0	–	–	–
Potable Water	1	Less than 1	–	N/A
Wastewater	7	40	–	N/A
Other Assets	0	–	–	–
Total/Average	**36**	**26**	**100**	**900**

Table 11-24. Estimated Damage to Critical Facilities and Infrastructure from 0.2-Percent Annual Chance Flood

	Number of Facilities Affected	Average % of Total Value Damaged		Days to 100% Functionality
		Building	Content	
Emergency Services	7	39	71	669
Schools	4	4	20	480
Transportation Systems	21	17	–	N/A
High Potential Loss Facilities	25	9	–	N/A
Utility Systems				
Communications	3	21	–	N/A
Power	6	3	–	--
Potable Water	1	11	–	N/A
Wastewater	21	35	–	N/A
Other Assets	3	8	–	--
Total/Average	**91**	**16**	**46**	**575**

11.5.4 Environment

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

11.6 FUTURE TRENDS IN DEVELOPMENT

Land use can exacerbate flood impacts. Development and fill in the floodplain can push floodwaters into areas that did not previously flood or worsen existing impacts. Development in the uplands can remove vegetation that absorbs and attenuates stormwater. Impervious surfaces shed stormwater toward flood-prone areas. Table 11-25 and Table 11-26 show the proposed distribution of future land uses within the 1-percent annual chance and 0.2-percent annual chance flood hazard areas.

Table 11-25. Future Land Use Designations in the 1% Annual Chance Flood Hazard Area

Reporting Area	Total Area (acres)	Percent of Total Area[a]					
		Residential					
		Single-Dwelling	Multi-Dwelling	Commercial	Employment & Industrial	Mixed Use & Institutional	Open Space
Airport	2,103	6.3%	8.1%	0.0%	23.9%	11.5%	50.3%
Central City	558	0.0%	8.8%	25.7%	28.1%	0.0%	37.4%
Central Northeast	432	0.0%	0.0%	0.0%	66.3%	0.0%	33.7%
East Portland	1,246	31.4%	2.0%	0.0%	20.3%	0.7%	45.7%
North Portland	5,244	3.2%	1.2%	0.0%	46.1%	9.3%	40.1%
Northeast	0	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Southeast	978	9.7%	4.6%	0.0%	6.1%	4.9%	74.7%
Southwest	307	8.9%	16.4%	0.0%	0.0%	16.0%	58.8%
West/Northwest	914	0.0%	0.0%	0.0%	95.7%	0.1%	4.2%
TOTAL	**11,783**	**6.9%**	**3.4%**	**1.2%**	**38.6%**	**7.1%**	**42.7%**

a. Future land use areas based on proposed comprehensive plan designations as of February 2016.

Table 11-26. Future Land Use Designations in the 0.2% Annual Chance Flood Hazard Area

Reporting Area	Total Area (acres)	Percent of Total Area: Residential Single-Dwelling	Residential Multi-Dwelling	Commercial	Employment & Industrial	Mixed Use & Institutional	Open Space
Airport	2,110	6.2%	8.1%	0.0%	23.8%	11.4%	50.5%
Central City	1,086	0.0%	7.5%	36.7%	32.2%	0.0%	23.6%
Central Northeast	438	0.0%	0.0%	0.0%	66.4%	0.0%	33.6%
East Portland	1,441	35.8%	3.5%	0.0%	18.7%	1.1%	40.8%
North Portland	7,016	2.4%	1.0%	0.0%	58.2%	7.6%	30.8%
Northeast	0	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Southeast	1,056	9.3%	4.4%	0.0%	5.8%	4.7%	75.8%
Southwest	343	11.2%	17.2%	0.0%	0.0%	16.3%	55.3%
West/Northwest	1,167	0.0%	0.0%	0.0%	96.2%	0.5%	3.3%
TOTAL	**14,658**	**6.5%**	**3.2%**	**2.7%**	**45.6%**	**6.1%**	**35.81%**

a. Future land use areas based on proposed comprehensive plan designations as of February 2016.

The City of Portland is equipped to handle future growth within flood hazard areas. Its comprehensive plan addresses frequently flooded areas through a variety of goals and polices pertaining to directing growth away from high-risk areas through downzoning; encouraging the preservation of open space and preserving and supporting natural and beneficial functions of floodplains; designing with nature; promoting hazard resilient design; protecting, restoring and preserving environment and watershed health; and ensuring comprehensive flood management. The City has committed to linking the comprehensive plan to the MAP. This creates an opportunity for wise land use decisions as future growth impacts flood hazard areas.

Additionally, the City of Portland participates in the NFIP and has adopted flood damage prevention ordinances in response to its requirements and has committed to maintaining its good standing under the NFIP through actions identified in this plan. The purpose of Chapter 24.50.010 of the Portland City Code is to protect the public health, safety, and welfare by restricting or prohibiting uses that are dangerous to health, safety, or property in times of flood or which cause increased flood heights or velocities and by requiring that uses and structures vulnerable to floods be protected from flood danger at the time of initial construction. The provisions of this chapter regulate development and construction in flood hazard areas.

11.7 SCENARIO

The primary water courses in Portland have the potential to flood at irregular intervals, generally in response to a succession of intense winter rainstorms. Storm patterns of warm, moist air usually occur between early November and late March. A series of such weather events can cause severe flooding in Portland. The worst-case scenario is a series of storms that flood numerous drainage basins in a short time. This could overwhelm the response and floodplain management capability in Portland. Major roads could be blocked, preventing critical access for many residents and critical functions. High in-channel flows could cause water courses to scour, possibly washing out roads and creating more isolation problems. In the case of multi-basin flooding, the City of Portland would not be able to make repairs quickly enough to restore critical facilities and infrastructure without significant disruption.

11.8 ISSUES

The following general issues related to the flood hazard were identified during the planning process:

- Not all structures located within the 1 percent annual chance flood hazard area have flood insurance. Flood insurance uptake is estimated to be 50 percent or less in all risk reporting areas, except in the Northeast where there is no mapped flood risk and the Central City where there is 60 percent uptake in flood insurance.
- Only about 18 percent of structures located in the 0.2 percent annual chance flood hazard area are thought to have flood insurance.
- There are a significant number of Pre-FIRM buildings in Portland. Approximately 75 percent of the buildings in the 1 percent annual chance flood hazard area are believed to have been built before 1981.
- Approximately 93 percent of the buildings in the floodplain were built before freeboard requirements were in place (1996).
- There are 9 repetitive loss properties in Portland that have structures on them. All of these properties are residential and are in or immediately adjacent to the FEMA-mapped SFHA.
- The Flood Insurance Study conducted by the Federal Emergency Management Agency (Flood Insurance Number 410183V000B) in January 2010, serves as the basis for Flood Insurance Rate Maps. This study does not include the impact of the 1996 flood nor the amount of construction which has occurred in the Portland area later than 1977. This is also the document that the buildable land inventory for the City is based on concerning property in floodplain areas.
- FEMA National Levee Accreditation Policies are currently under review and revision. These revisions are likely to impact accreditation of existing flood management systems.
- The risk associated with the flood hazard overlaps the risk associated with other hazards such as earthquake liquefaction. This provides an opportunity to seek mitigation alternatives with multiple objectives that can reduce risk for multiple hazards.
- The potential future impacts of climate change on flood frequency and severity are not well understood. This lack of understanding creates challenges for predicting and planning for various flood scenarios.
- More information is needed on flood risk to support the concept of risk-based analysis of capital projects.
- Ongoing flood hazard mitigation will require funding from multiple sources.
- The concept of residual risk should be considered in the design of future capital flood control projects and should be communicated with residents living in the floodplain.
- Flood insurance should continue to be promoted as a means of protecting private property owners from the economic impacts of frequent flood events.
- A sustained effort should be made to gather historical damage data, such as high water marks on structures and damage reports. The collection of this information will assist with determining the cost-effectiveness of future mitigation projects and will provide more information on the nature of the hazard.
- Flood hazards do not recognize jurisdictional boundaries, and actions in jurisdictions can impact upstream or downstream neighbors. Coordination is necessary to ensure that these connections are understood and hazards are effectively mitigated.
- Floodplain residents need to continue to be educated about flood preparedness and the resources available before, during, and after floods. Flood preparedness can help residents reduce risk to property and lives. Resources that are made available after flood events can help residents make informed decisions that may mitigate future risk to lives and property.

- The location of hazardous materials within the floodplain could result in secondary hazards during or after a flood event.
- FEMA maps do not recognize residual risk outside the mapped area. Where levees are accredited, there may be a misperception that there is no flood risk. Public outreach and awareness efforts should, therefore, emphasize the residual risk behind levees.
- Existing floodplain-compatible uses such as agricultural and open space need to be maintained.

The following issues have been identified specific to the 10-percent annual chance (10-year) flood:

- Immediate impacts will be felt within all risk reporting areas except for the Northeast. However, the Central City and West/Northwest are expected to be most severely impacted.
- It is estimated that 4,052 people will be displaced from their homes after an event and 3,458 of these people will seek shelter in public shelters.
- 82 buildings are expected to be impacted by the flood event resulting in more than $182.3 million in damage. This is less than 1 percent of the total value of the risk reporting areas impacted and just about 0.1 percent of the total value of Portland.
- More than 16,255 tons of debris would be expected from the flood event, which will require approximately 650 truckloads to remove. Most debris will be in the North Portland area, Southeast area and the Central City.
- There are 20 critical facilities located in the flood hazard area.

The following issues have been identified specific to the 1-percent annual chance (100-year) flood:

- Immediate impacts will be felt within all risk reporting areas except for the Northeast. The risk reporting areas with the greatest number of buildings impacted (more than 100) will include East Portland and North Portland.
- It is estimated that 4,499 people will be displaced from their homes after an event and 3,664 of these people will seek shelter in public shelters.
- Of the 2,925 buildings exposed, 972 buildings are expected to be impacted by the flood event resulting in more than $369.2 million in damage. This is less than 1 percent of the total value of the risk reporting areas impacted and just about 0.22 percent of the total value of Portland.
- More than 39,639 tons of debris would be expected from the flood event, which will require approximately 1,585 truckloads to remove. Most debris (more than 5,000 tons) will be in the North Portland area, Southeast area, the Central City and the East Portland.
- There are 80 critical facilities located in the flood hazard area.

- For the social vulnerability demographics of concern, exposure to the 1-percent-annual-chance floodplain exceeds the citywide average by more than 2 percent in individual reporting areas as follows:
  - Population under 15 years of age—17 percent exposure in the East Portland area.
  - Population over 65 years of age—21 percent exposure in North Portland, 17 percent exposure in Southwest and Southeast, and 14 percent exposure in East Portland.
  - People of color—32 percent exposure in the Airport area and Central Northeast.
  - Renter-occupied housing—80 percent exposure in Central City, 69 percent exposure in the Airport area and Central Northeast, and 60 exposure percent in Southwest.
  - Families with incomes below the poverty level—20 percent exposure in the Airport area and Central Northeast

- Households with limited English speaking abilities—21 percent exposure in the Airport area and 20 percent exposure in Central Northeast.

The following issues have been identified specific to the 0.2-percent annual chance (500-year) flood:

- Immediate impacts will be felt within all risk reporting areas except for the Northeast. The risk reporting areas with the greatest number of buildings impacted will include North Portland (1,567 buildings), East Portland (1,456 buildings), and Central City (573 buildings).
- It is estimated that 11,709 people will be displaced from their homes after an event and 10,622 of these people will seek shelter in public shelters.
- Of the 4,536 buildings exposed, 2,261 buildings are expected to be impacted by the flood event, resulting in more than $1.9 billion in damage. This is more than 3.4 percent of the total value of the North Portland and more than 2.5 percent of the total value of the Central City risk reporting areas. In total damage would account for about 1.1 percent of the total value of Portland.
- More than 65,307 tons of debris would be expected from the flood event, which will require approximately 2,612 truckloads to remove. Most debris (more than 15,000 tons) will be in the Central City, North Portland area, and Southeast area
- There are 185 critical facilities located in the flood hazard area.

- For the social vulnerability demographics of concern, exposure to the 0.2-percent-annual-chance floodplain exceeds the citywide average by more than 2 percent in individual reporting areas as follows:
  - Population under 15 years of age—19 percent exposure in the East Portland area.
  - Population over 65 years of age—21 percent exposure in North Portland, 18 percent exposure in Southwest, and 16 percent exposure in Southeast.
  - People of color—32 percent exposure in the Airport area and Central Northeast.
  - Renter-occupied housing—77 percent exposure in Central City, 69 percent exposure in the Airport area and Central Northeast, and 59 exposure percent in Southwest.
  - Families with incomes below the poverty level—20 percent exposure in the Airport area and Central Northeast
  - Households with limited English speaking abilities—21 percent exposure in the Airport area and Central Northeast.

12. Volcanic Activity

12.1 GENERAL BACKGROUND

DEFINITIONS

- Lahar—A rapidly flowing mixture of water and rock debris that originates from a volcano. While lahars are most commonly associated with eruptions, heavy rains, and debris accumulation, earthquakes may also trigger them.
- Lava Flow—The least hazardous threat posed by volcanoes. Cascades volcanoes are normally associated with slow moving andesite or dacite lava.
- Stratovolcano—Typically steep-sided, symmetrical cones of large dimension built of alternating layers of lava flows, volcanic ash, and cinders, rising as much as 8,000 feet above their bases.
- Tephra—Ash and fragmented rock material ejected by a volcanic explosion
- Volcano—A vent in the planetary crust from which magma (molten or hot rock) and gas from the earth's core erupts.

A volcano is a vent or opening in the earth's crust from which molten lava (magma), pyroclastic materials and volcanic gases are expelled onto the surface. Volcanoes can unleash destructive power greater than a nuclear bomb and pose a serious hazard if located near populated areas (NHMP, 2010).

There are four general types of volcanoes found within a short distance of the city (NHMP, 2010 and Allen, 1975):

- **Lava domes** are formed when lava erupts and accumulates near the vent, such as those found at the Boring Volcanic Field.
- **Cinder cones** are formed by accumulation of cinders, ash and other fragmented materials originating from an eruption. Mount Tabor and Powell Butte are local examples of cinder cone volcanoes.
- **Shield volcanoes** are broad, gently sloping volcanic cones of flat domical shape, usually several tens or hundreds of square miles in extent, built chiefly of overlapping and intertwined basaltic lava flows. Larch Mountain, Mount Sylvania and Highland Butte are local examples of shield volcanoes.
- **Composite or stratovolcanoes** are typically steep-sided, symmetrical cones of large dimensions built of alternating layers of lava flows, volcanic ash, cinders and blocks. Most composite volcanoes have a crater at the summit containing a central vent or clustered group of vents.

12.1.1 Cascade Range Volcanoes

The City of Portland is near the Cascade Range, an 800-mile-long chain of volcanoes that extends from northern California to southern British Columbia (see Figure 12-1). There are 20 volcanoes in the Cascade Range, five of which have been active in historical times: Mount Baker, Glacier Peak, Mount Rainier, Mount St. Helens, Mount Adams and Mount Hood. Volcanoes can lie dormant for centuries between eruptions, and the risk they pose is not always apparent. All of the volcanoes in the Cascade Range are stratovolcanoes, which have seven different types of hazard associated with volcanic activity. Figure 12-2 presents a graphic overview of the geological hazards present during a volcanic event.

Source: USGS, 2013

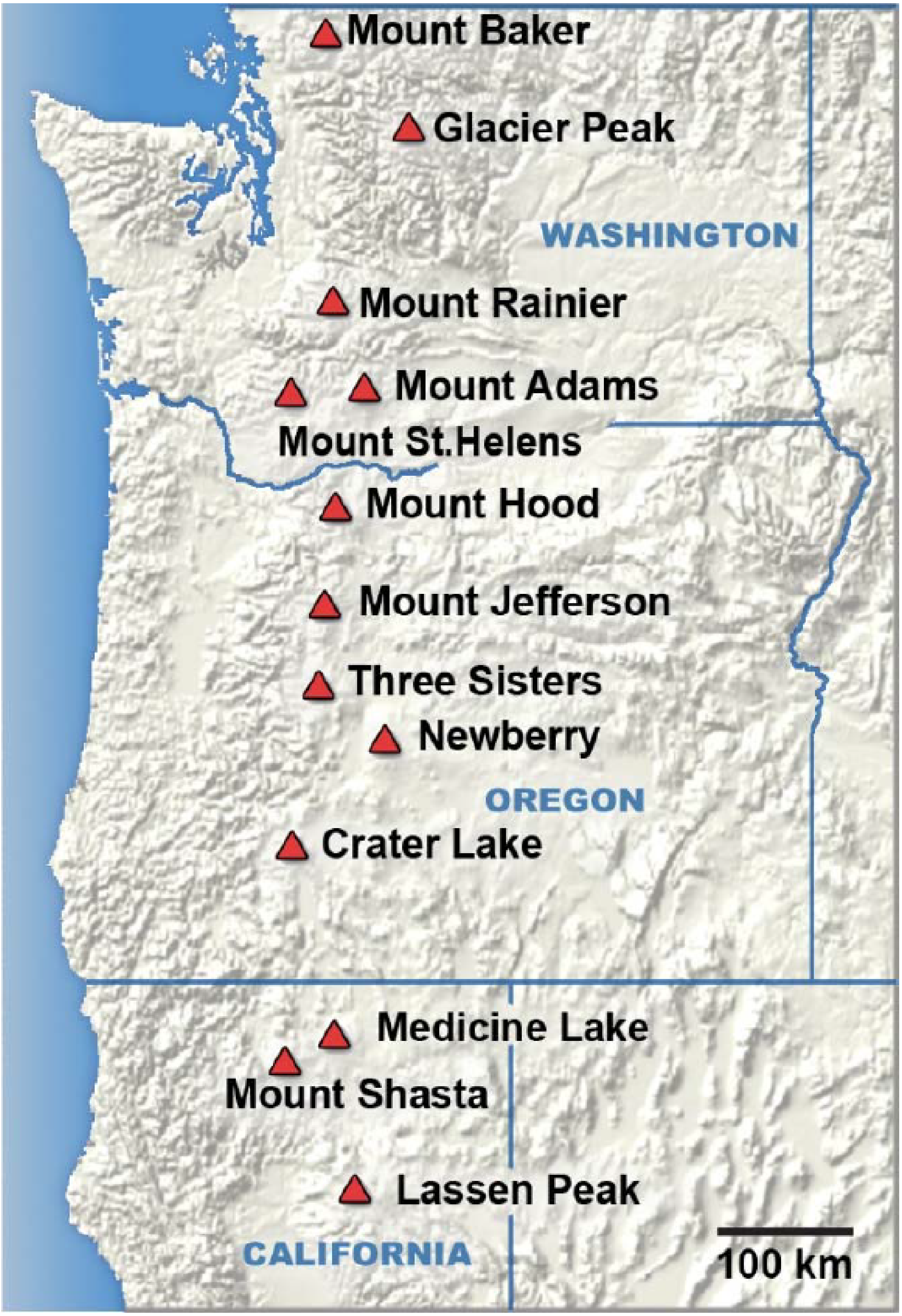


Figure 12-1. Cascade Range Volcanoes

Source: USGS, 2014c

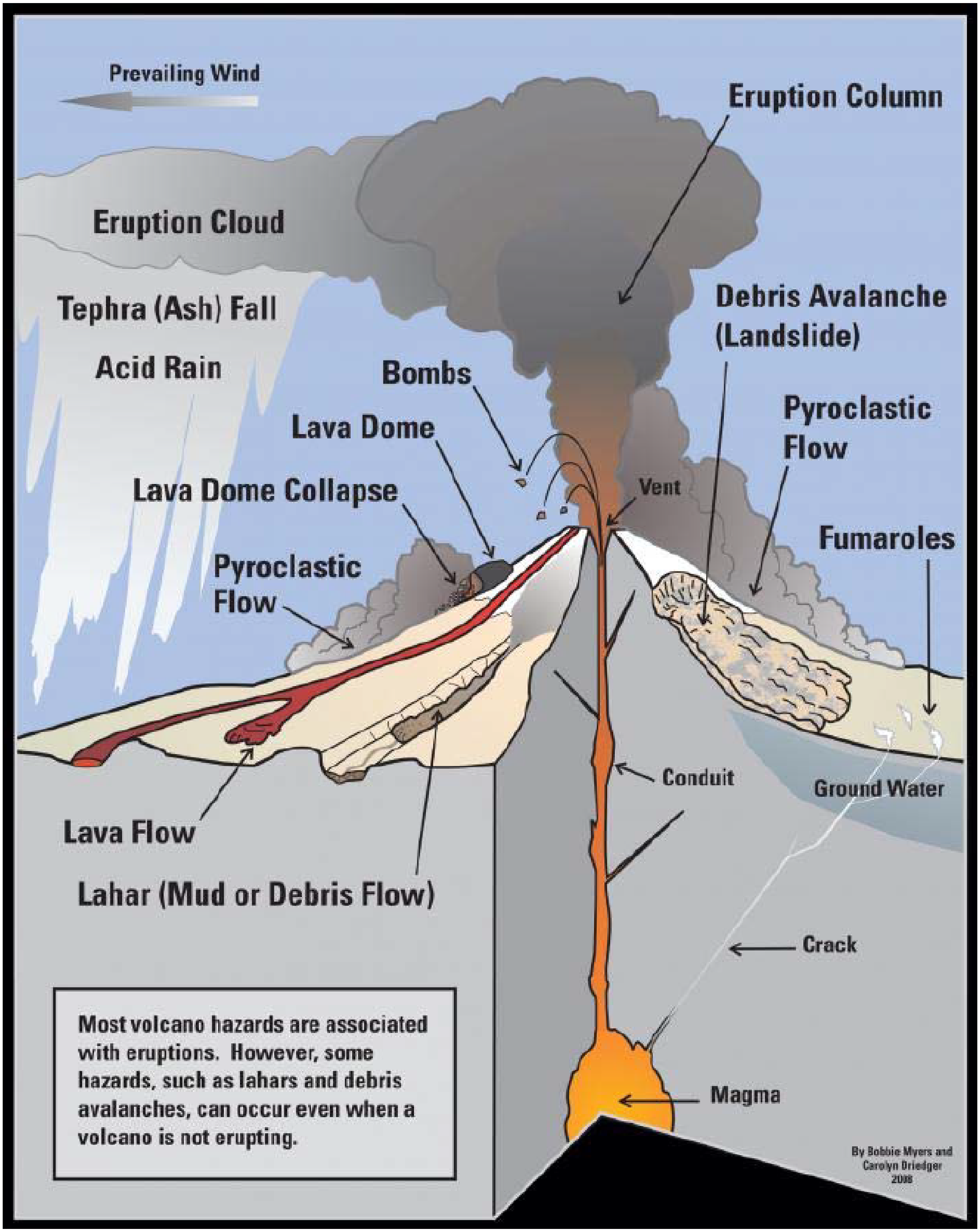


Figure 12-2. Geologic Hazards at Volcanoes

Pyroclastic Flows and Surges

Pyroclastic flows are avalanches of hot (200ºC to 700°C), dry, volcanic rock fragments and gases that descend a volcano's flanks at speeds greater than 50 miles per hour. Pyroclastic flows can form in three ways: a highly explosive eruption, "boiling over" from an eruptive vent, or collapse of a lava dome (USGS, 2016b). Pyroclastic flows and surges are a lethal hazard. They result in incineration, asphyxiation, and burial. Because of their speed they cannot be outrun. Pyroclastic flows are heavier than air and seek topographically low areas. Hot mixtures of gas and rock will flow above the ground and may go over topographical barriers such as ridges and hills.

Lava Flows

Lava flows are normally the least hazardous threat posed by volcanoes. The speed and viscosity of a lava flow are determined by the silica content of the lava. The higher the silica content, the more viscous (thick) the lava becomes. Low silica basalt lava can move 10 to 30 mph. High silica andesite and dacite tend to move more slowly and travel short distances (USGS, 2008b). Cascade volcanoes are normally associated with slow moving andesite or dacite lava. However, 3,000 years ago Mount St. Helens produced a large amount of basalt (USGS, 2014a).

Large lava flows may destroy property and cause forest fires but, since they are slow moving, they pose little threat to human life. The greater hazard presented by lava flows is that their extreme heat can cause snow and ice to melt very quickly, adding to flooding hazards or the lahar and debris avalanche hazards described below.

Tephra

Ash and large volcanic projectiles can erupt from a volcano into the atmosphere. These materials are sometimes called tephra. The largest fragments (bombs, >64 mm) fall back to the ground fairly near the vents, as close as a few yards and most commonly within 2 miles (USGS, 2008b). The smallest rock fragments (ash) are composed of rock, minerals, and glass that are less than 2 millimeters in diameter. Tephra plume characteristics are affected by wind speed, particle size, and precipitation.

Tephra poses a variety of threats. Ash only 1 cm thick can impede the movement of most vehicles and disrupt transportation, communication, and utility systems. During the past 15 years, about 80 commercial jets have been damaged by inadvertently flying into ash, and several have nearly crashed (USGS, 2008b). Airborne tephra will seldom kill people who are a safe distance from the vent. However, ash may cause eye and respiratory problems, particularly for those with existing medical conditions. Short-term exposure should not have any long-term health effects. Some ash fall materials may have acidic aerosol droplets that adhere to them. This may cause acid rain or corrosion of metal surfaces they fall on.

Ash may also clog ventilation systems and other machinery. When ash is mixed with rain it becomes a much greater nuisance. Wet ash is much heavier and it can cause structures to collapse. Wet ash may also cause electrical shorts. Tephra also decreases visibility and may cause psychological stress and panic.

Lahars

Lahars are rapidly flowing mixtures of water and rock debris that originate from volcanoes. While lahars are most commonly associated with eruptions, heavy rains, debris accumulation, and even earthquakes may also trigger them. They may also be termed debris or mud flows. Lahars can travel over 50 miles downstream, reaching speeds between 20 and 40 mph (USGS, 2008b). Beyond the flanks of a volcano, lahars will normally be channeled into waterways. The threat from lahars comes from their speed and from the debris they carry. Abrasion from the heavy sediment and impacts from heavy debris can destroy forests as well as human-made structures, including bridges, dams, roads, pipelines, buildings, and farms. Lahars may also fill in channels, obstructing shipping lanes and impacting a channel's ability to handle large volumes of water.

Debris Avalanches

Debris avalanches occur when the flank of a volcano collapses and slides downslope. The avalanche may initially include rock, soil and snow, and incorporate additional materials, such as trees and buildings, as it moves toward the valley floor. If avalanches incorporate a significant amount of water as they rush down the volcano, they may transition to lahars. Avalanche scars are typically noticeable as horseshow shaped craters (USGS, 2015a).

Volcanic Gases

All active volcanoes emit gases. These gases may include steam (water vapor), carbon dioxide, sulfur dioxide, hydrogen sulfide, hydrogen, and fluorine. Sometimes, these chemicals can be absorbed by ash and impact groundwater, livestock, and metal objects. Even when a volcano is not erupting, gases can escape through small surface cracks. The greatest danger to people comes when large quantities of toxic gases are emitted from several sources or when there are topographic depressions that collect gases that are heavier than air. These gases can accumulate to the point where people or animals can suffocate (USGS, 2016c).

Lateral Blast

Lateral blasts are explosive events in which energy is directed horizontally instead of vertically from a volcano. They are gas-charged, hot mixtures of rock, gas and ash that are expelled at significantly high speeds. Lateral blasts vary in size, but large ones are fairly rare, with only a few historical examples worldwide. The most recent was the 1980 eruption of Mount St. Helens when almost everything within the blast zone (about 230 square miles) perished. The Mount St. Helens lateral blast is estimated to have reached a velocity of 670 mph, and there have been speculations that the velocity may have gone even higher, reaching a supersonic rate of 735+ mph for at least a few moments (USGS, 1997a).

12.2 HAZARD PROFILE

12.2.1 Past Events

Mt. St. Helens has been the most active volcano in the Cascade Range during the past 10,000 years. Early 19th century settlers in the region witnessed eruptions occurring along the north flank area of the mountain. In Oregon, awareness of the potential for volcanic eruptions has greatly increased since the May 18, 1980 eruption, which killed 57 people. The upper portion of the summit collapsed in a massive landslide triggered by volcanic tremors. That portion of the mountain is now a horseshoe-shaped crater partially filled by a lava dome (NHMP, 2010).

As a result of the 1980 Mt. St. Helens eruption and the far-reaching extent of the lateral blast, damage and reconstruction exceeded $1 billion. The coverage area was 230 square miles and reached 17 miles northwest of the crater. Impacts from pyroclastic flows covered six square miles and reached five miles north of the crater. Landslides covered 23 square miles. Lahars (mudflows) affected the North and South Forks of the Toutle River, the Green River and ultimately the Columbia River, as far as 70 miles from the volcano. Mt. St Helens' most recent eruption began in October of 2004, with initial steam and ash eruptions giving away to slow-moving lava flows which ceased in January of 2008. In October of 2004 ash was pushed more than 10,000 feet into the air and lava flows continued until January 2008, after which activity ceased. The volcano has since been downgraded to inactive, although another eruption in the near future is likely (NHMP, 2010).

In 1781, Mount Hood erupted, which resulted in lahar flows that reached the Columbia River (USGS, 2013b). There were additional reports of eruptive activity in 1859 and 1865 from early settlers. Reports included sightings of fire, smoke, flying rock, and steaming (USGS, 2012). Two other minor eruption periods occurred during the last 500 years with some lava flow near the summit. The eruptions created pyroclastic flows and lahars with little ash fall. Other volcanoes throughout the Pacific Northwest have undergone similar formation and eruption cycles (MHFC, 2005 as cited in NHMP, 2010).

Table 12-1 and Figure 12-3 summarize past eruptions in the Cascades. Seven Cascade volcanoes have erupted since the beginning of the 18th century (USGS, 2013b).

Table 12-1. Past Eruptions near the City of Portland

Volcano	Number of Eruptions	Type of Eruptions
Mount Adams	3 in the last 10,000 years, most recent was 1,000 to 2,000 years ago	Andesite lava
Mount Hood	3 in the last 2000 years	Pyroclastic flows, lahars, steam explosions, tephra
Mount Jefferson	Last eruption approximately 15,000 years ago	Lava domes
Mount St Helens	19 eruptions in last 13,000 years	Pyroclastic flows, lahars, lava, and tephra

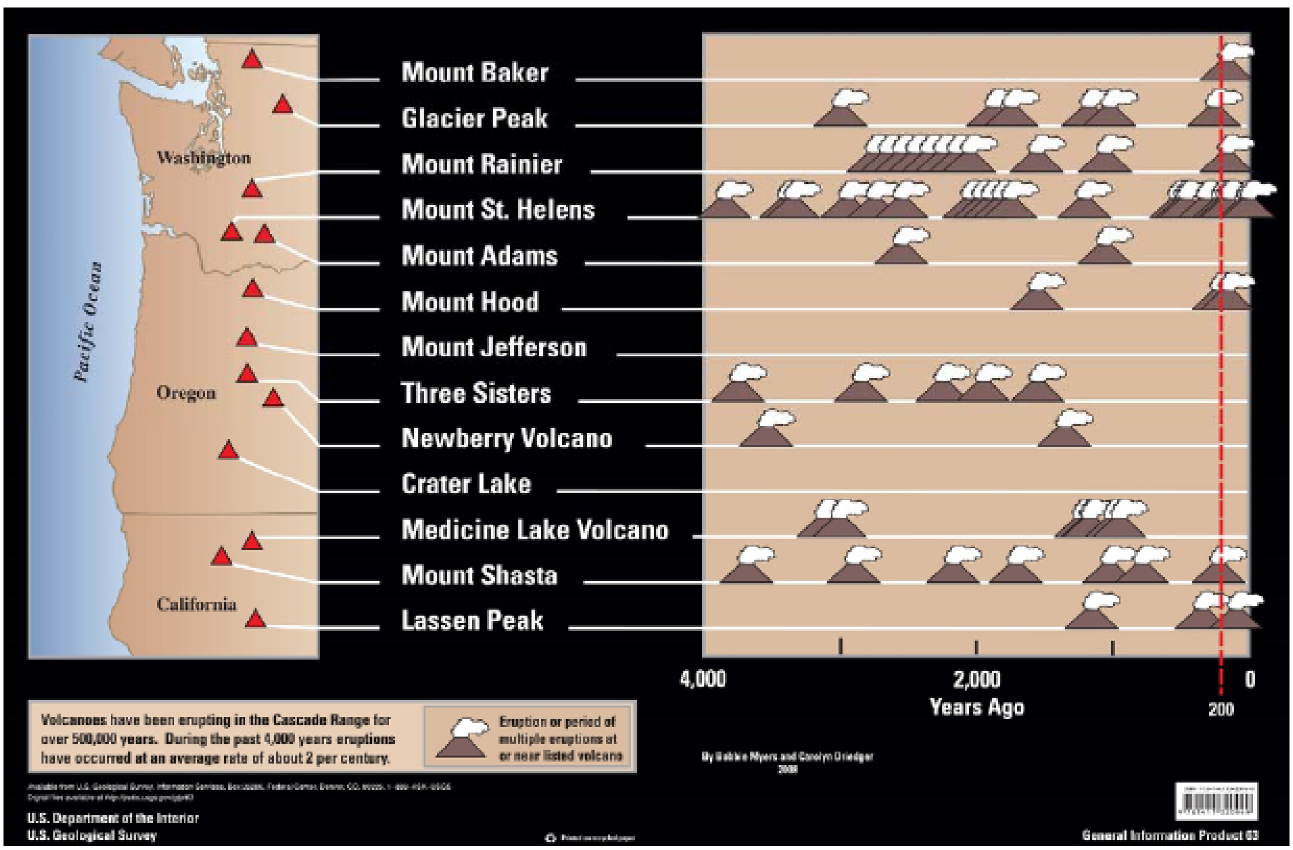


Figure 12-3. Cascade Range Eruptions in the Past 4,000 Years

12.2.2 Location

The extensive north-south chain of volcanoes in the Cascade Range was formed by earthquakes originating from the Cascadia Subduction Zone. As the Juan de Fuca Plate sinks beneath the North American Plate, it heats up and begins to melt, providing a vast reservoir of the heat and molten rock that create the magma chambers that become volcanoes (NHMP, 2010).

The USGS provides descriptions of the four closest volcanoes to the city, Mt. Adams, Mt. Hood, Mt. St. Helens and Mt. Jefferson, all located to the east of the city (USGS, 2009a as cited in NHMP, 2010):

- Mt. Adams stands approximately 31 miles due east of Mt. St. Helens. The towering stratovolcano (12,276 feet) is marked by a dozen glaciers, most of which are fed radially from its summit icecap. In the Cascades, Mt. Adams is second in eruptive volume only to Mt. Shasta and it far surpasses its loftier neighbor Mt. Rainier. Mt. Adams' main cone exceeds 124 cubic miles.
- Mt. Hood is located approximately 47 miles east-southeast of Portland and is the most accessible Oregon volcano. Access to the volcano is provided by US Highway 26 from the south and west and Oregon Highway 35 from the east. Other paved roads provide further access to this most often-climbed peak in the Pacific Northwest. In the winter, the mountain hosts winter sports. At 11,239 feet, Mt. Hood is the highest peak in the state and is part of the Mt. Hood National Forest (USGS, 2009a as cited in NHMP, 2010).
- Mt. Jefferson is located in the Mt. Jefferson Wilderness area and the Warm Springs Indian Reservation, approximately 70 miles from Portland. It is the second highest peak in Oregon at 10,497 feet. Access is provided by Highway 22 east of Salem and US Forest Service roads and trails that lead into the wilderness area (USGS, 2009 as cited in NHMP, 2010).
- Mt. St. Helens, a stratovolcano, is located approximately 50 miles northeast of Portland in Skamania County, Washington and has an elevation of 8,365 feet. Access is provided from the west in Cowlitz County by State Route 504. (USGS 2009a, as cited in NHMP, 2010).

Mt. St. Helens is believed to be the volcano with the greatest potential to have a near-term impact on the region because of its recent activity since the cataclysmic event in May 1980. A large eruption of Mt. St. Helens can eject tephra to altitudes of 12 to 20 miles and to deposit tephra over an area of 40,000 square miles or more. Wind direction and velocity, along with the vigor and duration of the eruption, will control the location, size and shape of the area affected by tephra fall (NHMP, 2010).

Due to proximity, the major hazard for the city would be impacts from ash or tephra. (i.e., minor ash falls from eruptions from Mt. St. Helens, or lesser ash falls from Mt. Hood or more distant volcanoes). Prevailing wind is a factor in how much ash is disbursed within the city. Volcanic eruptions may impact water bodies. River valleys are susceptible to debris flows, landslides and lahars that, under extreme conditions, may require dredging to maintain channel depths for navigation (NHMP, 2010). Figure 12-4 shows the potential area at risk of this hazard.

12.2.3 Frequency

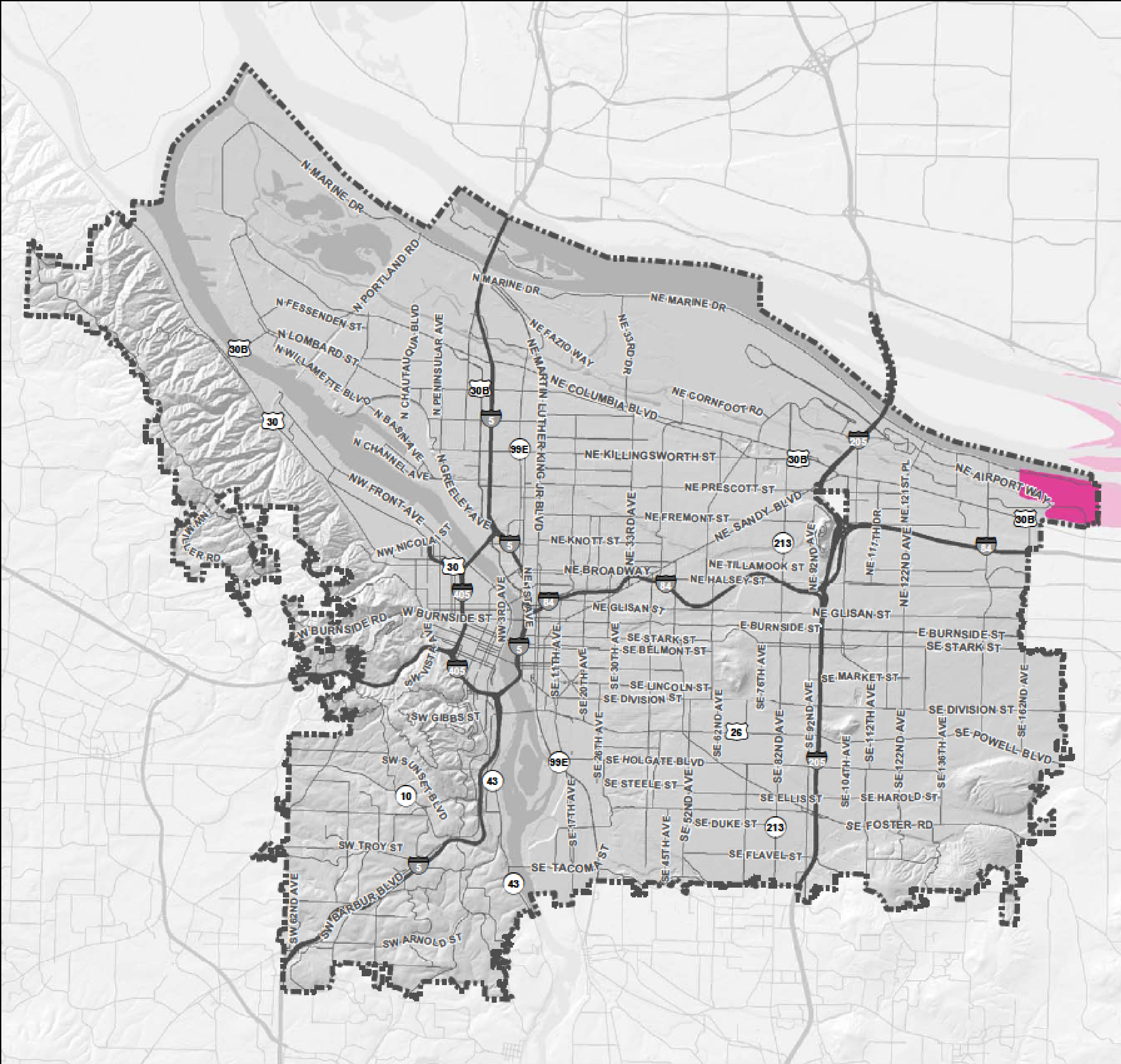
Many Cascade volcanoes have erupted in the recent past and will be active again in the foreseeable future. Given an average rate of one or two eruptions per century during the past 12,000 years, these disasters are not part of our everyday experience; however, in the past hundred years, California's Lassen Peak and Washington's Mount St. Helens have erupted with terrifying results. The U.S. Geological Survey classifies Mount Hood, Mount Jefferson, Three Sisters, Newberry and Crater Lake as potentially active volcanoes in Oregon.

September 12, 2016

Mitigation Action Plan (MAP)

Figure 12-4.

Volcano Hazard Area



Legend

City Boundary

Volcano Hazard Area

NORTH

0 0.75 1.5 Miles

Sources: USGS-1997; City of Portland-2016

37242

Mt. St. Helens, in Washington State, is by far the most active volcano in the Cascades, with four major explosive eruptions in the last 515 years. Still, the probability of an eruption in any given year is extremely low. Figure 12-5 shows the annual probability of an ash fall accumulation of 4 inches or more (10 cm). The eastern portion of the City of Portland sits at the 0.02 percent range, or about once every 5,000 years. The rest of the City of Portland sits in the 0.01 percent range, or once every 10,000 years. However, frequencies of smaller accumulations in shorter timeframes are certainly possible.

Source: USGS, 2011

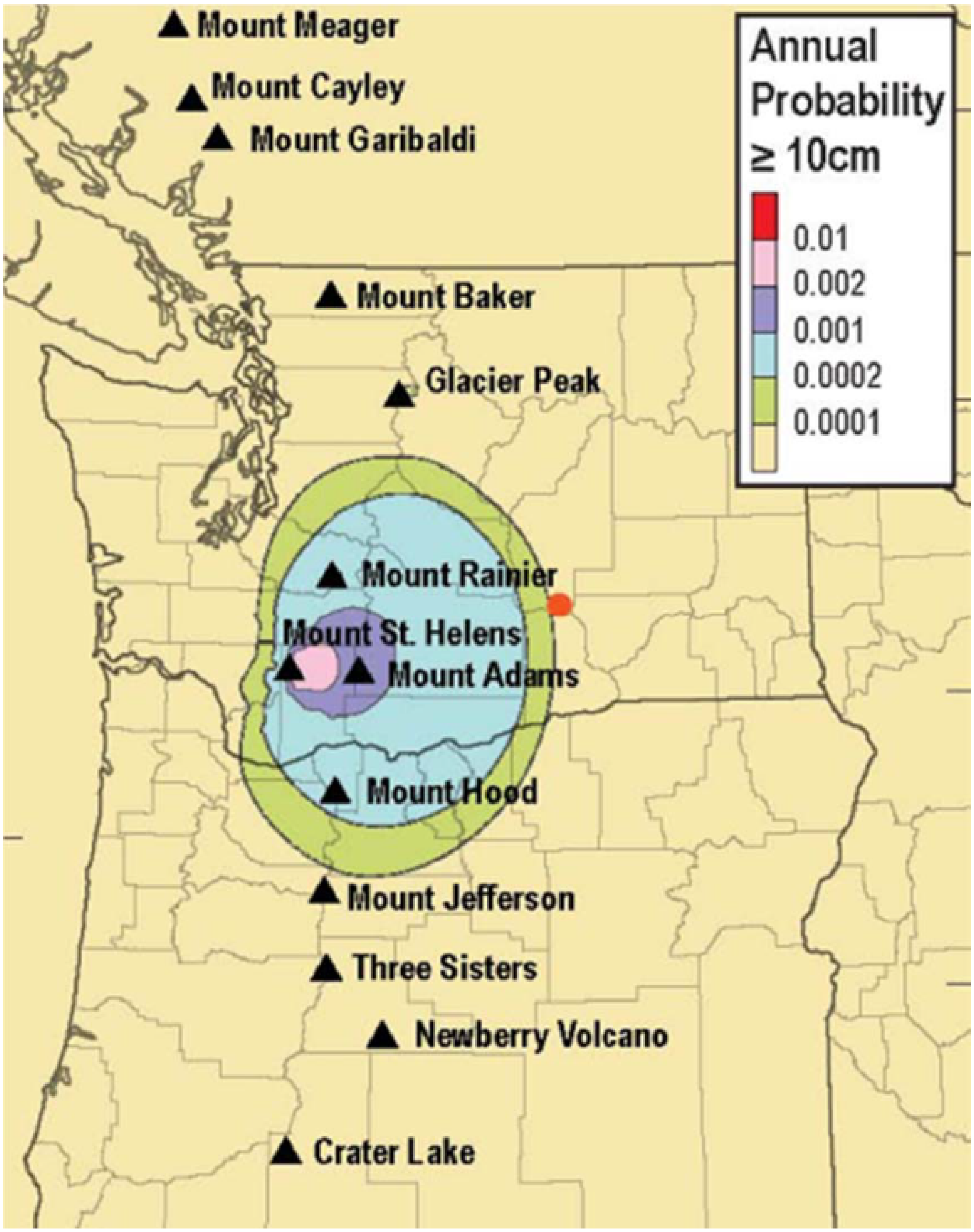


Figure 12-5. Probabilistic Hazard Map of Tephra Accumulation of 10 Centimeters or Greater

12.2.4 Severity

The most predominate threat to the city would occur from volcanic ash clouds, drifting downwind potentially landing several miles from the volcano. Events can vary from minor to heavy, with minor events reducing visibility and increasing respiratory and breathing difficulty. Driving can become potentially treacherous from reduced visibility and particulate ingested engine damage. Other problems common from air-entrained ash particles could include clogged and damaged sewage systems, mechanical equipment failure caused by the abrasive nature of volcanic ash and economic losses caused by business slowdowns and the cost of ash removal. Heavy tephra fall could affect humans and aquatic life as the ash accumulation increases the natural turbidity of waterbodies, causing increased treatment requirements. Heavier ash fall collects on all surfaces such as rooftops, decks and parking lots and requires removal. (NHMP, 2010).

A 1-inch deep layer of ash weighs an average of 10 pounds per square foot, causing danger of structural collapse. In addition to the concern for structural collapse, ash is corrosive and can be electrically conductive. This can lead to metallic roof surfaces experiencing increased deterioration. The abrasive and corrosive nature of ash not only causes potential minor but painful burns to humans, it can also damage computer and electronic systems. While volcanic ash is most often associated with structural instability, it can also cause issues with agriculture, health, power supply, water supply, transportation, and wastewater (USGS, 2015b).

Secondary impacts would be dust clouds generated by ash removal and surface damage from the scratchy nature of the tephra particulates. Ash clouds are especially damaging to jet aircraft as ash clouds can drift great distances at high altitudes. The city's international airport and other area airports are especially vulnerable and temporary flight restrictions and diversions may be required during active ash fall events (NHMP, 2010).

Although it is near both Mount St. Helens and Mount Hood, Portland does not have a large degree of exposure to direct impacts, aside from tephra. Figure 12-6 shows the severity of lahar hazards just to the east of the City of Portland. The severity of impacts from lahar hazards would likely depend on the severity of the eruption. The severity of impacts from tephra would be related to the extent of the accumulation.

12.2.5 Warning Time

Constant monitoring of all active volcanoes means that there will be more than adequate time for evacuation before an event. Since 1980, Mount St. Helens has settled into a pattern of intermittent, moderate and generally non-explosive activity, and the severity of tephra, explosions, and lava flows have diminished. All episodes, except for one very small event in 1984, have been successfully predicted several days to three weeks in advance. However, scientists remain uncertain as to whether the volcano's current cycle of explosivity ended with the 1980 explosion. The possibility of further large-scale events continues for the foreseeable future.

The best warning of a volcanic eruption is one that specifies when and where an eruption is likely and what type and size eruption should be expected. Such accurate predictions are sometimes possible but still rare. The most accurate warnings are those in which scientists indicate an eruption is probably only hours to days away, based on significant changes in a volcano's earthquake activity, ground deformation, and gas emissions. Experience from around the world has shown that most eruptions are preceded by such changes over a period of days to weeks. A volcano may begin to show signs of activity several months to a few years before an eruption. However, a warning that specifies months or years in advance when it might erupt are extremely rare.

Source: USGS, 2013a

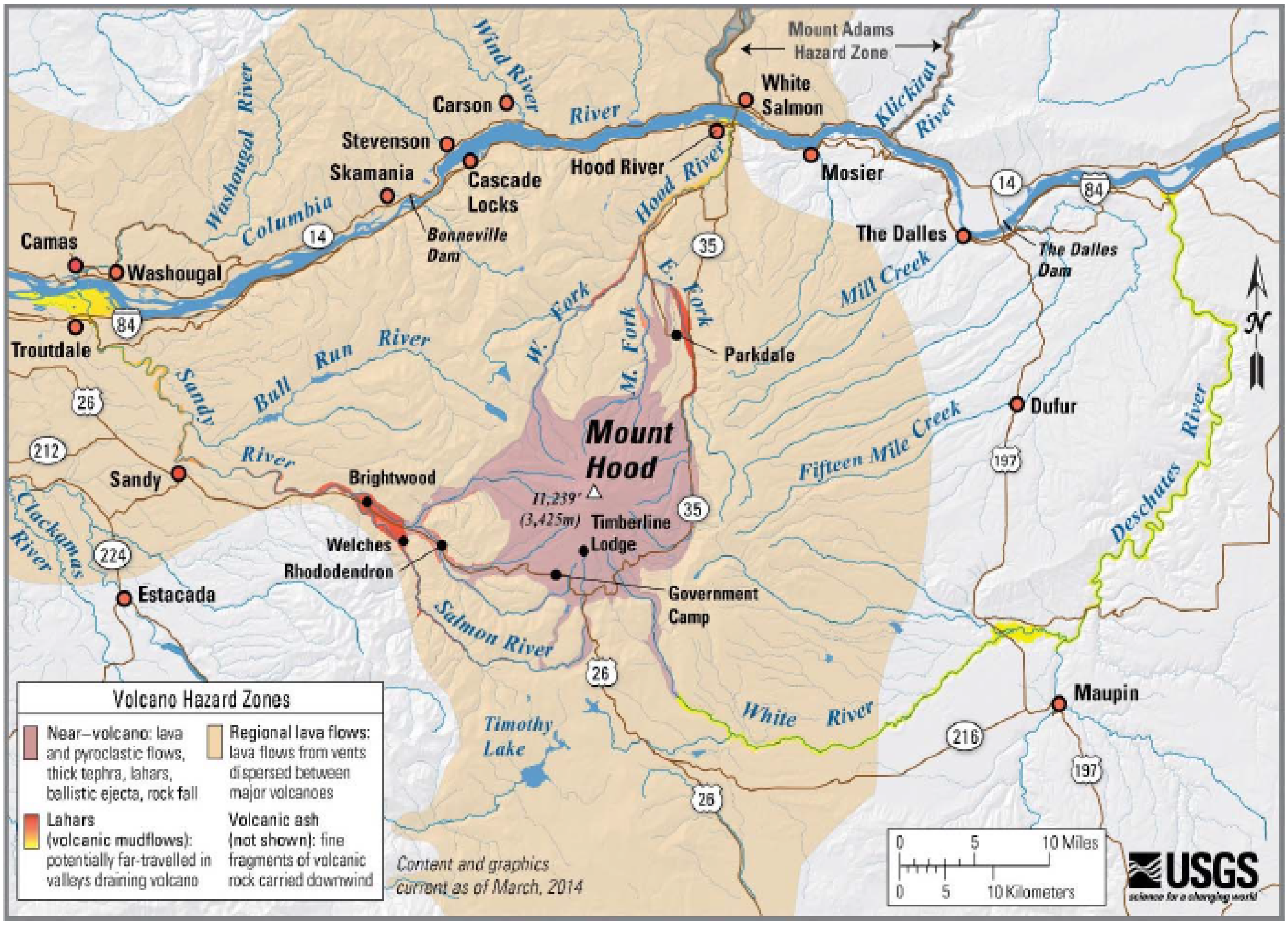


Figure 12-6. Potential Impact Area for Ground-Based Hazards during a Mount Hood Event

Monitoring Volcanic Activity

The USGS and the Pacific Northwest Seismograph Network conduct seismic monitoring of all Cascade volcanoes in Oregon and Washington. During the past decade, monitoring networks on Mount Hood and Mount St. Helens have been expanded (USGS, 2014b).

Volcanic Event Notification

Members of the public may sign up for the USGS Volcano Notification Service email subscription service on the USGS website. Notifications include several types: volcano activity notices; daily, weekly or monthly updates; status reports; volcano observatory notices for aviation; and information statements.

Volcano-alert notifications are based on analysis of data from monitoring networks, direct observations, and satellite sensors. They are issued for both increasing and decreasing volcanic activity and include text about the nature of the activity and about potential or current hazards. Scientists describe a volcano's status using alert levels and color codes and issue different types of notifications to address specific information needs. These alert levels consist of two parts (USGS, 2016e):

- Ranked terms to inform people on the ground about a volcano's status:
  - **Normal**—Volcano is in typical background, non-eruptive state or, after a change from a higher level, volcanic activity has ceased and volcano has returned to non-eruptive background state.
  - **Advisory**—Volcano is exhibiting signs of elevated unrest above known background level or, after a change from a higher level, volcanic activity has decreased significantly but continues to be closely monitored for possible renewed increase.
  - **Watch**—Volcano is exhibiting heightened or escalating unrest with increased potential of eruption, timeframe uncertain, OR, eruption is underway but poses limited hazards.
  - **Warning**—Hazardous eruption is imminent, underway, or suspected.
- Ranked colors to inform the aviation sector about airborne hazards (green, yellow, orange and red generally correspond to alert level term definitions).

This alert level ranking offers a framework that the public and civil authorities can use to gauge and coordinate a response to a developing volcano emergency.

Currently, the City of Portland Bureau of Emergency Management uses the federal system called Wireless Emergency Alerts to warn residents about impending risks posed from different hazards. Combined with the Emergency Alert System and Community Emergency Notification System, residents who sign up for these services will have ample warning about any volcanic hazards.

Lahar Travel Times

According to the United States Geological Survey (2013a), it would take more than 3.5 hours for distal hazard impacts to reach Portland (see Figure 12-7).

12.3 COMPOUNDING FACTORS AND SECONDARY HAZARDS

12.3.1 Overview

The secondary factors most commonly caused by volcanic eruptions are mud flows and landslides. Volcanic ash fall also contributes significantly to poor air quality as discussed in the population vulnerability section of this profile.

12.3.2 Climate Change

Climate change is not likely to affect the risk associated with volcanoes; however, volcanic activity can affect climate change. Volcanic clouds absorb terrestrial radiation and scatter a significant amount of incoming solar radiation. By reducing the amount of solar radiation reaching the Earth's surface, large-scale volcanic eruptions can lower temperatures in the lower atmosphere and change atmospheric circulation patterns. The massive outpouring of gases and ash can influence climate patterns for years following a volcanic eruption.

Source: USGS, 2013a

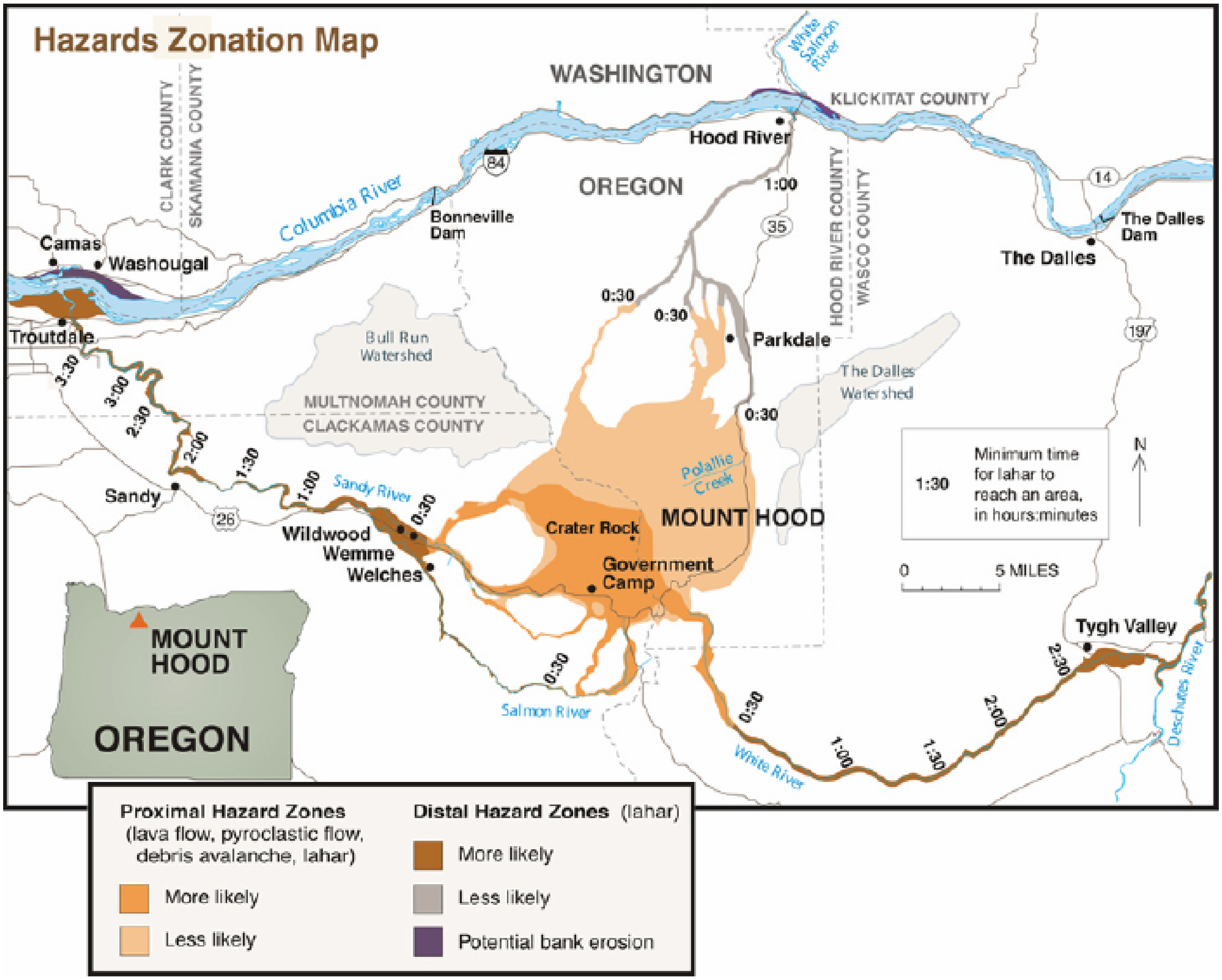


Figure 12-7. Mount Hood Hazard Zones and Lahar Travel Times

12.4 EXPOSURE

The City will likely experience damage only from volcanic eruption columns and clouds that contain volcanic gases, minerals and rock. The columns and clouds form rapidly and extend several miles above an eruption. Solid particles in the clouds present a serious aviation threat, can distribute acid rain (sulfur dioxide gas and water), can create risk of suffocation (carbon dioxide is heavier than air and collects in valleys and depressions) and pose a toxic threat from fluorine, which clings to ash particles, potentially poisoning grazing livestock and contaminating domestic water supplies (NHMP, 2010).

Buildings, streets and roads throughout the City would require minor cleanup with negligible impacts. Temporary utility interruptions are likely and minor cleanup may be required for electrical and other utility services. Water treatment facilities may be required to address highly turbid water. Columbia and Willamette River traffic could be impacted by sediment deposition from a large Mt. St. Helens or Mt. Hood eruption. Channel dredging to restore acceptable depths could be required after such an incident. Health complications associated with respiratory problems may also result (NHMP, 2010).

Portland is exposed to a Mt. Hood eruption that generates lahar and tephra. All that is in the path of the lahar is exposed to potential damage. Tephra exposure is assumed to apply to the entire city.

12.4.1 Population

The entire population of Portland is exposed to the effects of tephra. Populations residing in the northeast portion of the East Portland risk reporting area could be impacted by lahar hazards. Based on the percent of residential structures located in the lahar hazard areas it is estimated that approximately 25 people reside within the hazard area. The estimated social vulnerability indicators for those residing in this area is as follows:

- 7.7 percent under 15 years of age
- 23.8 percent over 65 years of age
- 8.8 percent people of color
- 6.9 percent renters
- 0 percent economically disadvantaged families
- 0 percent limited English speaking households.

12.4.2 Property

Lahar

All property in the lahar inundation areas would be exposed to lahar flows. Table 12-2 lists the total number of Portland structures in the lahar hazard zones and their values. All general building stock exposure is located in East Portland accounting for 1.8 percent of the total replacement value of the risk reporting area and less than 1 percent of the total replacement value of the city.

Table 12-2. Exposure and Value of Structures in Lahar Hazard Zone

Reporting Area	Number of Buildings Exposed	Value Exposed			Exposed Value as % of Total Replacement Value
		Structure	Contents	Total	
Airport	0	$0	$0	$0	0.0%
Central City	0	$0	$0	$0	0.0%
Central Northeast	0	$0	$0	$0	0.0%
East Portland	43	$233,499,088	$247,304,890	$480,803,978	1.8%
North Portland	0	$0	$0	$0	0.0%
Northeast	0	$0	$0	$0	0.0%
Southeast	0	$0	$0	$0	0.0%
Southwest	0	$0	$0	$0	0.0%
West/Northwest	0	$0	$0	$0	0.0%
Total	**43**	**$233,499,087.95**	**$247,304,890.38**	**$480,803,978**	**0.3%**

The 43 buildings located in the lahar hazard area are the following occupancy classes:

- Residential – 7 (16.3 percent)
- Commercial – 24 (55.8 percent)
- Industrial – 7 (16.3 percent)
- Education – 5 (11.6 percent).

Tephra

All property in Portland would be exposed to tephra accumulation from a volcanic eruption.

12.4.3 Critical Facilities

Lahar

Infrastructure exposed to lahar inundation includes highway bridges and a section of Union Pacific Railway that cross the Sandy River in the lahar zone, just outside Portland. Also outside Portland are 46 potable water facilities primarily operated by the Portland Water Bureau that are exposed to a lahar flow. These facilities are mostly wells and pumps in the Columbia South Shore Well Field. Table 12-3 and Table 12-4 summarize the exposed critical facilities in Portland.

Table 12-3. Critical Facilities in Lahar Inundation Zone

Reporting Area	Number of Critical Facilities in Lahar Hazard Areas[a]				
	Emergency Services	High Potential Loss Facilities	Schools	Other Assets	Total
Airport	0	0	0	0	0
Central City	0	0	0	0	0
Central Northeast	0	0	0	0	0
East Portland	0	4	0	0	4
North Portland	0	0	0	0	0
Northeast	0	0	0	0	0
Southeast	0	0	0	0	0
Southwest	0	0	0	0	0
West/Northwest	0	0	0	0	0
Outside City Boundary	0	0	0	0	0
Total	**0**	**4**	**0**	**0**	**4**

a. See Table 6-1 for a description of the facilities included in each category.

Table 12-4. Critical Infrastructure in Lahar Inundation Zone

Reporting Area	Number of Critical Infrastructure Facilities in Lahar Hazard Areas[a]					
	Transportation Systems	Utility Systems				Total
		Communications	Power	Potable Water	Wastewater	
Airport	0	0	0	0	0	0
Central City	0	0	0	0	0	0
Central Northeast	0	0	0	0	0	0
East Portland	0	1	1	35	1	38
West/Northwest	0	0	0	0	0	0
North Portland	0	0	0	0	0	0
Northeast	0	0	0	0	0	0
Southeast	0	0	0	0	0	0
Southwest	0	0	0	0	0	0
Outside City Boundary	3	0	0	46	0	49
Total	**3**	**1**	**1**	**81**	**1**	**87**

a. See Table 6-1 for a description of the facilities included in each category.

There are 1.34 miles of levees (6.6 percent of the total mileage in Portland) exposed to lahar flows in the distal hazard zone. Additionally, 2.60 miles of major power lines (0.6 percent of the total mileage in Portland) are also exposed.

Tephra

All transportation routes are exposed to tephra accumulation, which could create hazardous driving conditions on roads and highways and hinder evacuations and response.

12.4.4 Environment

The environment is highly exposed to the effects of a volcanic eruption. Even if ash fall from a volcanic eruption were to fall elsewhere, it could still be spread throughout Portland by surrounding rivers and streams. A volcanic blast would expose the local environment to many effects such as lower air quality, and many other elements that could harm local vegetation and water quality. Environment in the path of a lahar would be subject to additional impacts.

12.5 VULNERABILITY

12.5.1 Population

Lahar

Since there is generally adequate warning time before a volcanic event, the population vulnerable to distal hazards consists of those who choose not to evacuate or are unable to evacuate. The latter includes the elderly, the very young, those with access and functional needs, and those who may not have access to or be able to understand warnings.

Tephra

The entire population of Portland is vulnerable to the damaging effects of volcanic tephra, or ash fall, in the event of a volcanic eruption. The elderly, very young and those who experience ear, nose and throat problems are especially vulnerable to the tephra hazard. Ash is harsh, acidic, gritty, and smelly. Although the gases are usually too diluted to constitute danger to a person in normal health, the combination of acidic gas and ash may cause lung problems. Extremely heavy ash can clog breathing passages and cause death. When an ash cloud combines with rain, sulfur dioxide in the cloud combines with water to form diluted sulfuric acid that may cause minor, but painful burns to the skin, eyes, nose, and throat. Hydrochloric acid rains following eruptions have also been reported. Additionally, tephra decreases visibility and may cause psychological stress and panic.

12.5.2 Property

Lahar

There are currently no generally accepted damage functions for volcanic hazards in risk assessment platforms such as Hazus-MH. All properties listed in Table 12-5 are considered vulnerable to lahar hazards. The most vulnerable structures would be those that are located closest to the Columbia and Sandy River hazard areas, and those that are not structurally sound. Loss estimates for lahar hazards are shown in Table 12-5 representing 10, 30, and 50 percent of the exposed property value.

Table 12-5. Loss Estimates for Volcano Lahar Hazards

		Estimated Loss Potential from Lahar Hazards		
	Exposed Value	10% Damage	30% Damage	50% Damage
East Portland	$480,803,978	$48,080,398	$144,241,193	$240,401,989

Note: Values shown are accurate only for comparison among results in this plan. See Section 6.8.3 for a discussion of data limitations.

Tephra

All of the property exposed to nature in Portland is exposed to the effects of tephra accumulation. Among these properties, the most vulnerable structures are those that are not as structurally sound and may collapse under the excessive weight of tephra and possible rainfall. There are no current regulations regarding the weight of tephra on roof structures, however current snow load requirements for new buildings built in Portland have been in effect since being adopted in 2008 by the Oregon Building Codes Division. Table 12-6 shows the percentage of properties in the City of Portland that were built before snow load codes went into effect. Pre-2008 properties are likely to be more vulnerable to potential roof collapse due to tephra accumulation. Additional vulnerable property includes equipment and machinery left out in the open whose parts can become clogged by the fine dust. Infrastructure, such as drainage systems, is potentially vulnerable to the effects of tephra, since the fine ash can clog pipes and culverts. This may be more of a problem if an eruption occurs during winter or early spring when precipitation is highest and floods are most likely.

To estimate the loss potential for this hazard, a qualitative approach was used, based on recommendations from FEMA guidelines on state and local mitigation planning. For this study, it was decided to use 0.1 percent as the loss ratio for the tephra hazard. Replacement valuations for all of Portland were the basis for these estimation, resulting in a loss estimate of $170,805,775.

Table 12-6. Age of Structures in Portland

	Pre-2008[a]		2008-present[a]	
Reporting Area	Number of Structures	Percent	Number of Structures	Percent
Airport	594	92.4%	49	7.6%
Central City	2,575	97.2%	74	2.8%
Central Northeast	17,051	98.0%	355	2.0%
East Portland	42,463	97.0%	1,292	3.0%
West/Northwest	7,616	97.4%	205	2.6%
North Portland	23,405	95.6%	1,084	4.4%
Northeast	19,932	96.4%	748	3.6%
Southeast	51,502	96.7%	1,768	3.3%
Southwest	22,539	97.5%	585	2.5%
Total	187,677	96.8%	6,160	3.2%

a. Year built information was collected from Multnomah County tax assessor data. When year built information was unavailable, it was estimated based on census block or county-wide average year built dates.

12.5.3 Critical Facilities

Lahar

Transportation routes that intersect with the lahar inundation zone are most vulnerable, especially depending on their structural stability. This would include roads, bridges and the Union Pacific Railway. The most vulnerable spots are those that directly intersect with a lahar outflow area and are not structurally sound. Utilities are vulnerable to damage from lahars due to the debris that may be carried. Most vulnerable are those that are located on or near parcels that intersect with the lahar outflow area or those that receive input from area streams and rivers that lahar flow through. Water treatment plants, potable water wells and wastewater treatment plants are vulnerable to contamination from debris that may be carried by a lahar.

Tephra

All transportation routes are exposed to tephra accumulation, which could create hazardous driving conditions on roads and highways and hinder evacuations and response. Machinery and equipment using these transportation routes would also be vulnerable. Water treatment plants and wastewater treatment plants are vulnerable to contamination from ash fall. Visibility in the short aftermath of an eruption would also be problematic.

12.5.4 Environment

The environment is very vulnerable to the effects of a volcanic eruption. A lahar could be very damaging to area rivers and streams and could redirect water flow and cause changes in water courses. Tephra accumulation would expose the local environment to lower air quality and other effects that could harm vegetation and water quality. This is particularly significant for the Bull Run watershed, where heavy ash fall could cause turbidity and water quality issues. The sulfuric acid contained in volcanic ash could be very damaging to area vegetation, water, wildlife, and air quality. Rivers and streams are also vulnerable to damage due to tephra.

12.5.5 Economic Impact

Volcanic eruptions can disrupt the normal flow of commerce and daily human activity without causing severe physical harm or damage. Ash that is a few inches thick can halt traffic, cause rapid wear of machinery, clog air filters, block drains, creeks and water intakes, and impact agriculture. Removal and disposal of large volumes of deposited ash can have significant impacts on government and business. The interconnectedness of the region's economy can be disturbed after a volcanic eruption. Roads, railroads and bridges can be damaged by lahars and mudflows. The Mount St. Helens May 1980 eruption demonstrated the negative effect on the tourism industry. Conventions, meetings, and social gatherings were canceled or postponed in cities and resorts throughout Oregon in areas not initially affected by the eruption. Columbia River shipping traffic was disrupted by mudflows that deposited more than 65 million cubic yards of sediment along the river bottom, reducing the depth of the navigational channel from 39 feet to less than 13 feet (USGS, 1997b). However, the eruption did lead to the creation of a thriving tourist industry for decades following the event.

The disruption of regional activity is further demonstrated by the 2010 eruption of Iceland's Eyjafjallajokull volcano, which led to European air travel being halted for several days. The movement of goods via major highways can also be halted due to tephra in the air. The Mount St. Helens event in May 1980 cost trade and commerce an estimated $50 million in only two days, as ships were unable to navigate the Columbia River. Clouds of ash often cause electrical storms that start fires, and damp ash can short-circuit electrical systems and disrupt radio communication. Volcanic activity can also lead to the closure of nearby recreation areas as a safety precaution long before the activity ever culminates in an eruption. Lloyd's City Risk Index estimates that a volcanic eruption from a nearby source could cause as much as $720 million of lost gross domestic product annually.

12.6 FUTURE TRENDS IN DEVELOPMENT

12.6.1 Lahar

Lahar zones are not identified as natural hazard areas under the Oregon Statewide Planning Goals or in the City's Comprehensive Plan. There are no known higher regulatory standards for development in these areas. The lahar inundation areas within the City are quite small (estimated to be less than 530 acres) and the likelihood of an eruption of the magnitude required to produce such lahars is quite low.

Future land use designations in the volcano distal hazard area in East Portland include:

- 66.0 percent Employment and Industrial
- 29.3 percent Open Space
- 4.7 percent Single-Dwelling Residential.

12.6.2 Tephra

All future development in Portland will be susceptible to the potential impacts from volcanic eruptions causing ash fall within the region. While this potential impact on the built environment is not considered to be significant, the economic impact on industries that rely on machinery and equipment such as agriculture or civil engineering projects could be significant. Since the extent and location of this hazard is difficult to gauge because it is dependent upon many variables, the ability to institute land use recommendations based on potential impacts of this hazard is limited. While the impacts of tephra are sufficient to warrant risk assessment for emergency management purposes, they are not sufficient to dictate land use decisions.

12.7 SCENARIO

12.7.1 Lahar

In the event of a volcanic eruption in Portland, there would probably not be any loss of life, due to adequate warnings. However, there could be great loss of property, especially in lahar inundation areas. The potential halting of Columbia River shipping traffic could severely impact the City of Portland's economy. There would also be the possibility of severe environmental impacts due to lahar flows in area rivers and streams.

12.7.2 Tephra

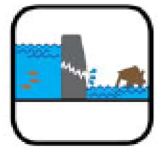
A large area could be affected by tephra accumulation. The most severe impacts would be on the environment. Any eruption of Mt. Hood would likely produce significant amounts of tephra in Portland. This impact is totally dependent upon the prevailing wind direction during and after the event. No one in Portland would likely be injured or killed by tephra, but businesses and non-essential government would be closed until the cloud passes. People and animals without shelter would be affected. Structures would be safe, but private property left out in the open might be damaged by the fine ash dust. Clean-up from such an event could be costly, depending upon the magnitude of the event.

12.8 ISSUES

Since volcanic episodes have been fairly predictable in the recent past, there is probably not much concern about loss of life, but there is concern about loss of property, infrastructure and severe environmental impacts.

- All of Portland may be exposed to a tephra event.
- The East Portland risk reporting area is exposed to lahar hazards from a large magnitude event at Mount Hood.
- 25 people are estimated to reside in areas that may be impacted by lahar hazards.
- 43 buildings at an estimated replacement value of $480 million are exposed to the hazard. This represents about 1.9 percent of the risk reporting area and less than 1 percent of the total value of Portland.

- Buildings exposed are predominately commercial (24). There are also 7 residential, 7 industrial, and 5 educational buildings exposed.
- Residents who are 65 years or ago or older may be disproportionately exposed to the lahar hazard (24 percent).
- There are 91 critical facilities and critical infrastructure facilities located in the volcano hazard area.
- Tephra from volcanic eruptions can cause significant damage to heating and air conditioning systems and combustion systems.
- Tephra could cause turbidity and water quality issues in the Bull Run watershed.
- Tephra increases in weight significantly when wet and cleanup efforts can be extremely challenging.
- Lahars and mudflows could deposit large amounts of sediment into the Columbia River, significantly affecting shipping traffic and the local economy.
- Researchers continue to develop methods to predict volcanic eruptions accurately. Indications that an eruption may be imminent include swarms of small earthquakes as the magma rises up through the volcano, increases in gas emissions, and physical swelling or deformation of mountain slopes. Although warning time should be sufficient to prevent loss of life, the advent of these signs and the beginning of eruptive activity may be short.
- A regional Mount Hood Coordination plan has been developed to coordinate and plan for response activities in the event of an eruption. This plan should continue to be updated.



13. DAM FAILURE

13.1 GENERAL BACKGROUND

13.1.1 Causes of Dam Failure

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

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

The remaining 6 percent of U.S. dam failures are due to miscellaneous causes. Many dam failures in the United States have been secondary results of other disasters. The prominent causes are earthquakes, landslides, extreme storms, massive snowmelt, equipment malfunction, structural damage, foundation failures, and sabotage (ASDSO, 2016).

DEFINITIONS

- **Dam**—A hydraulic structure built above the natural ground grade line that is used to impound water. Dams include all appurtenant structures, and together are sometimes referred to as "the works." Dams include wastewater lagoons and other hydraulic structures that store water, attenuate floods, and divert water into canals (Oregon Administrative Rule, 2015)
- **Dam Failure**—An uncontrolled release of impounded water due to structural deficiencies in dam.
- **Emergency Action Plan**—A formal document that identifies potential emergency conditions at a dam and specifies actions to be followed to minimize property damage and loss of life. The plan specifies actions the dam owner should take to alleviate problems at a dam. It contains procedures and information to assist the dam owner in issuing early warning and notification messages to responsible downstream emergency management authorities of the emergency situation. It also contains inundation maps to show emergency management authorities the critical areas for action in case of an emergency. (FEMA 64)
- **High Hazard Dam**—Dams where failure or improper operation will probably cause loss of human life. (FEMA 333)
- **Significant Hazard Dam**—Dams where failure or improper operation will result in no probable loss of human life but can cause economic loss, environmental damage or disruption of lifeline facilities, or can impact other concerns. Significant hazard dams are often located in rural or agricultural areas but could be located in areas with population and significant infrastructure. (FEMA 333)

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

13.1.2 Regulatory Oversight

The dam failure risk assessment and mitigation strategies developed for this plan focus on impacts on people and property once a dam failure has occurred. The focus is not on dam operations to prevent dam failures from occurring, although a brief synopsis of regulatory programs impacting dam operations is included for reference.

National Dam Safety Act

The potential for catastrophic flooding due to dam failures led to passage of the National Dam Safety Act (Public Law 92-367). The National Dam Safety Program (NDSP) requires a periodic engineering analysis of every major dam in the country. The goal of this FEMA-monitored effort is to identify and mitigate the risk of dam failure so as to protect the lives and property of the public. The NDSP is a partnership between states, federal agencies, and other stakeholders that encourages individual and community responsibility for dam safety. State assistance funds have allowed participating states to improve their programs through increased inspections, emergency action planning, and the purchase of needed equipment. FEMA has also expanded existing and initiated new training programs. Grant assistance from FEMA provides support for improvement of dam safety programs that regulate most of the dams in the United States.

Oregon Dam Safety Guidelines

The Dam Safety Program of Oregon's Water Resources Department monitors dams at the state level. Reservoir storage permits are required for dams that are 10 feet or over in height and store at least 9.2 acre-feet of water (Oregon Water Resources Department, 2016b). The Department reviews design and specifications for dam construction and modification, conducts routine inspections and takes enforcement actions on dams that do not ensure the safety of life and property. Routine inspections for dams are conducted based on the hazard classification of the dam and range from annual inspections for high hazard dams to every six years for low hazard dams. (Oregon Administrative Rule, 2015).

U.S. Army Corps of Engineers Dam Safety Program

The U.S. Army Corps of Engineers is responsible for safety inspections of some federal and non-federal dams in the United States that meet the size and storage limitations specified in the National Dam Safety Act. The Corps has inventoried dams; surveyed each state and federal agency's capabilities, practices, and regulations regarding design, construction, operation and maintenance of the dams; and developed guidelines for inspection and evaluation of dam safety (U.S. Army Corps of Engineers, 2011).

Federal Energy Regulatory Commission Dam Safety Program

The Federal Energy Regulatory Commission (FERC) cooperates with a large number of federal and state agencies to ensure and promote dam safety. More than 3,000 dams are part of regulated hydroelectric projects in the FERC program. Two-thirds of these are more than 50 years old. As dams age, concern about their safety and integrity grows, so oversight and regular inspection are important. FERC inspects hydroelectric projects on an unscheduled basis to investigate the following:

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

Every five years, an independent FERC-approved engineer must inspect and evaluate projects with dams higher than 32.8 feet (10 meters), or with a total storage capacity of more than 2,000 acre-feet.

FERC monitors and evaluates seismic research and applies it in structural analyses of hydroelectric projects. FERC also evaluates the effects of potential and actual large floods on the safety of dams. During and following floods, FERC visits dams and licensed projects, determines the extent of damage, if any, and directs any necessary studies or remedial measures the licensee must undertake. The FERC publication *Engineering Guidelines for the Evaluation of Hydropower Projects* guides the FERC engineering staff and licensees in evaluating dam safety. The publication is frequently revised to reflect current information and methodologies.

FERC requires licensees to prepare emergency action plans and conducts training sessions on how to develop and test these plans. The plans outline an early warning system if there is an actual or potential sudden release of water from a dam due to failure. The plans include operational procedures that may be used, such as reducing reservoir levels and reducing downstream flows, as well as procedures for notifying affected residents and agencies responsible for emergency management. These plans are frequently updated and tested to ensure that everyone knows what to do in emergency situations (FERC, 2005).

13.2 HAZARD PROFILE

13.2.1 Past Events

Dam failures can occur suddenly and without warning. They may occur during normal operating conditions or during a large storm event. Significant rainfall can quickly inundate an area and cause floodwaters to overwhelm a reservoir. If the spillway of the dam cannot safely pass the resulting flows, water will begin flowing in areas not designed for such flows, and a failure may occur.

According to the Association of State Dam Safety Officials, there have been no recorded dam incidents in or near the City of Portland (ASDSO, 2016). Between 1953 and 2015, FEMA has not declared any major disasters or emergencies from dam failure events in Portland. The Oregon Natural Hazard Mitigation Plan notes that a major dam failure occurred near Hermiston in Umatilla County in 2005 and in Klamath Lake in 2006 (Oregon Department of Land Conservation and Development, 2015).

13.2.2 Location

There are seven dams located in Portland, three in the Bull Run Watershed, and one located upstream of the City on the Columbia River. The single dam on the main-stem of the Willamette River is a natural weir-type dam with hydroelectric generation, located at Willamette Falls, 10 miles upriver from downtown Portland. It also has a system of navigation locks, which are out of service as of 2011. The dam, owned by Portland General Electric (PGE), is a run-of-river dam and does not provide usable water storage or flood control (LIHI, 2016). There are also dams on tributaries of the Willamette that could impact Portland, but any such impacts would be expected to be minor. A review of the inundation mapping for these dams indicates that a failure of any of the dams located in the Bull Run Watershed would not be expected to impact the City of Portland. Impacts for the City of Portland from the Bonneville Dam on the Columbia River are not clearly understood at this time.

Information on dams located in or near Portland is listed in Table 13-1. Four are inspected by federal agencies, and the remainder are under the jurisdiction of the state.

Table 13-1. Dams in Portland

Name	National ID #	River	Height (feet)	Storage Capacity (acre-feet)	Last Inspection	Hazard Class
Bonneville Dam[c]	OR00001	Columbia	110.0	277,000	4/3/2008 (Federal)	High
Bull Run Lake Dam[b]	OR00300	Bull Run River	55.0	14,500	4/28/1995 (Federal)	Low
Bull Run Dam 1 (upper)[b]	OR00327	Bull Run River	194.0	33,760	6/12/2012 (Federal)	High
Bull Run Dam 2 (lower)[b]	OR00317	Bull Run River	125	21,000	6/12//2012 (Federal)	High
Mt. Tabor Reservoir #1[a]	OR00667	Bull Run River (off-stream)	30	37	11/12/2015	High
Mt. Tabor Reservoir #5[a]	OR00670	Bull Run River (off-stream)	55	153	11/12/2015	High
Mt. Tabor Reservoir #6[a]	OR00671	Bull Run River (off-stream)	28	230	11/12/2015	High
Washington Park Reservoir #3[a]	OR00668	Bull Run River (off-stream)	53	50	11/12/2015	High
Washington Park Reservoir #4[a]	OR00669	Bull Run River (off-stream)	60	54	11/12/2015	High
Portland International Airport De-icing Lagoon[a]	OR03822	N/A	20	67	03/15/2011	Low
Smith-Bybee Lakes[a]	OR00680	Columbia Slough	14	4,100	8/25/2010	Low
Willamette Falls[c]	OR00596	Willamette River	37	17,000	8/28/2012	High

a. Located in Portland.
b. Located in Bull Run Watershed
c. Located upstream of the City.
Source: Oregon Water Resources Department Dam Inventory Query, 2016a and U.S. Army Corps National Inventory of Dams, 2016

13.2.3 Frequency

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

13.2.4 Severity

Dam failure can be catastrophic to all life and property downstream. The Oregon Dam Safety Program classifies dams and reservoirs in a three-tier hazard rating system primarily using the results of dam breach analyses. Dams are classified as high, medium or low based on the following criteria (Oregon Administrative Code, 2015):

a) An inundation depth of flowing water of at least two feet over the finished floors of dwellings, other frequently occupied buildings, or road surfaces where a vehicle is likely to be present establishes a "high hazard" rating.
b) Any inundation depth of water over the floorboards of structural buildings establishes a "significant hazard" rating.
c) For other roads and vulnerable utilities, an inundation depth of two feet or evidence of depth and velocity capable of creating damage establishes a "significant hazard" rating.
d) Wherever heavy recreational or other frequent use occurs downstream a "high hazard" rating shall be established to prevent probable loss of life. Such designation shall not depend on the presence of downstream infrastructure

e) For water depths close to those listed in the subsections (a) and (c), the Department may also consider water velocity in its determination of hazard rating.

The U.S. Army Corps of Engineers developed the classification system shown in Table 13-2 for the hazard potential of dam failures. The Oregon and Corps of Engineers hazard rating systems are both based only on the potential consequences of a dam failure; neither system takes into account the probability of such failures.

Table 13-2. Corps of Engineers Hazard Potential Classification

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

a. Categories are assigned to overall projects, not individual structures at a project.

b. Loss of life potential based on inundation mapping of area downstream of the project. Analyses of loss of life potential should take into account the population at risk, time of flood wave travel, and warning time.

c. Indirect threats to life caused by the interruption of lifeline services due to project failure or operational disruption; for example, loss of critical medical facilities or access to them.

d. Damage to project facilities and downstream property and indirect impact due to loss of project services, such as impact due to loss of a dam and navigation pool, or impact due to loss of water or power supply.

e. Environmental impact downstream caused by the incremental flood wave produced by the project failure, beyond what would normally be expected for the magnitude flood event under which the failure occurs.

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

13.2.5 Warning Time

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

The City of Portland has established protocols for flood warning and response to imminent dam failure in the flood warning portion of its adopted emergency operations plan. These protocols are tied to the emergency action plans created by the dam owners.

13.3 COMPOUNDING FACTORS AND SECONDARY HAZARDS

13.3.1 Overview

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

13.3.2 Climate Change

Dams are designed partly based on assumptions about a river's hydrograph. If changes in weather patterns have significant effects on hydrographs, the dam can lose some or all of its designed margin of safety, also known as freeboard. If freeboard is reduced, dam operators may be forced to release increased volumes earlier in a storm cycle in order to maintain required margins of safety. Such early releases can increase flood potential downstream. The dams assessed in this risk assessment are off-stream dams meaning that they are not located on a river course. This means that they are not as likely to experience changes in operations resulting from changes in the region's hydrograph.

13.4 EXPOSURE

The flood module of Hazus-MH was used for a Level 2 assessment of dam failure. Hazus-MH uses census data at the block level, which has a level of accuracy acceptable for planning purposes. Where possible, the Hazus-MH data was enhanced for this risk assessment using GIS data from local, state and federal sources. The exposure and vulnerability estimates provided below are based on failure events of Mount Tabor Reservoirs 1, 5, and 6, and Washington Park Reservoirs 3 and 4. Inundation maps and depth grids were prepared for this analysis, but are not included in the publicly available version of this plan due to security concerns. It should be noted that the inundation events used for this analysis were conducted before the recent plans to improve the Washington Park Reservoir and to decommission and make adjustments to the Mt. Tabor reservoirs. Risk and vulnerability to this hazard should be reassessed when improvements, adjustments and decommissioning activities are complete.

13.4.1 Population

All populations in an inundation zone would be exposed to the risk of a dam failure. The potential for loss of life is affected by the capacity and number of evacuation routes available to populations in areas of potential inundation as well as the amount of warning time before the event. The estimated population living in the mapped inundation areas in Portland is 15,277 or 2.5 percent of the city's population; however, there is some overlap between the Mount Tabor inundation areas, so total exposure of those residing in these areas may be overestimated. Table 13-3 summarizes the at-risk population in Portland by risk reporting area. Population exposure is concentrated in the Southeast area for the Mount Tabor reservoirs and in the Central City for the Washington Park reservoirs. Population exposure may increase depending on the time of day and whether or not residents are at home, work, school or commuting. Both Mount Tabor and Washington Park are used heavily by residents and tourists for recreation, so they may have significantly higher populations during pleasant weather conditions.

Table 13-4 shows the estimated percent of the population believed to be residing in mapped inundation areas for our social vulnerability indicators. Based on these estimates, a disproportionate number of limited English speaking households may be exposed to the Mount Tabor reservoir 1 inundation area, while a disproportionate number of renters and families living in poverty may be exposed to Washington Park inundation areas.

Table 13-3. Population within Dam Failure Areas

Reporting Area	Mount Tabor Reservoir 1 Population Exposed[a]	Mount Tabor Reservoir 1 % of Total Population	Mount Tabor Reservoirs 5 and 6 Population Exposed[a]	Mount Tabor Reservoirs 5 and 6 % of Total Population	Washington Park Reservoirs 3 and 4 Population Exposed[b]	Washington Park Reservoirs 3 and 4 % of Total Population
Airport	0	0.0%	0	0.0%	0	0.0%
Central City	0	0.0%	0[b]	0.0%[b]	621	1.6%
Central Northeast	0	0.0%	0	0.0%	0	0.0%
East Portland	0	0.0%	0	0.0%	0	0.0%
North Portland	0	0.0%	0	0.0%	0	0.0%
Northeast	0	0.0%	0	0.0%	0	0.0%
Southeast	2,179	1.4%	12,477	8.1%	0	0.0%
Southwest	0	0.0%	0	0.0%	0 [b]	0.0% [b]
West/Northwest	0	0.0%	0	0.0%	0 [b]	0.0% [b]
Total	**2,179**	***0.4%***	**12,477**	**2.0%**	**621**	**0.1%**

a. Represents the percent of residential buildings that are exposed multiplied by the estimated 2010-2014 American Community Survey 5-year estimates.

b. It should be noted that there are structures exposed to the inundation areas; however, no structures are believed to be residential.

Table 13-4. Social Vulnerability Indicators Residing in Inundation Areas[a, b, c]

Reporting Area	Percent Under 15 Years	Percent Over 65 Years	Percent of People of Color	Percent of Renter occupied Housing	Percent of Families Below Poverty Level	Percent of Limited English Speaking Households
Mt Tabor Reservoir 1 Inundation Scenario						
Southeast	11.6%	9.4%	12.5%	45.4%	10.3%	5.6%
Mt Tabor Reservoirs 5 and 6 Inundation Scenario						
Southeast	15.4%	9.0%	12.5%	37.5%	6.5%	2.5%
Washington Park Reservoirs 3 and 4 Inundation Scenario						
Central City	2.1%	4.6%	19.3%	90.3%	27.1%	1.7%

a. Values based on an analysis of 2010-2014 American Community Survey 5-year estimates at the Census block group level.

b. Values calculated using block group statistics weighted by the number of residential structures in the hazard area as a percentage of the total residential structures in the block group.

c. Values in red indicate percentages are at least 2 percent greater than the Citywide average (see Section 4.7).

13.4.2 Property

Table 13-5 summarizes the value of Portland buildings in the mapped inundation areas. Less than 2 percent of the total replacement value of Portland is exposed to the dam failure hazard. Table 13-6 lists the structure type of buildings in the inundation areas. In the Mount Tabor inundation areas residential properties comprise much of the exposure. A majority of the structures impacted by the Washington Park Reservoirs are believed to be for commercial uses.

Table 13-5. Exposure and Value of Structures in Dam Failure Inundation Areas

Reporting Area	Value Exposed			Exposed Value	
	Structure	Contents	Total	as % of Area Total Replacement Value	as % of City Total Replacement Value
Mt Tabor Reservoir 1 Inundation Scenario					
Southeast	$291,832,348	$175,797,200	$467,629,548	1.5%	0.3%
Mt Tabor Reservoirs 5 and 6 Inundation Scenario					
Central City	$12,883,014	$12,739,561	$25,622,575	0.1%	--
Southeast	$1,406,503,787	$870,603,853	$2,277,107,640	7.5%	--
Total	***$1,419,386,801***	***$883,343,414***	***$2,302,730,215***	--	***1.3%***
Washington Park Reservoirs 3 and 4 Inundation Scenario					
Central City	$85,429,547	$58,155,084	$143,584,631	0.5%	--
Southwest	$334,390	$334,390	$668,780	0.0%	--
West/Northwest	$3,706,933	$3,706,933	$7,413,865	0.1%	--
Total	***$89,470,870***	***$62,196,406***	***$151,667,276***	--	***0.1%***

Note: Values shown are accurate only for comparison among results in this plan. See Section 6.8 for a discussion of data limitations.

Table 13-6. Area and Number of Structures in the Inundation Areas

Reporting Area	Inundation Area (acres)	Number of Structures in the Inundation Areas[a]						
		Residential	Commercial	Industrial	Religion	Government	Education	Total
Mt Tabor Reservoir 1 Inundation Scenario								
Southeast	179.8	717	12	0	1	0	9	739
Mt Tabor Reservoirs 5 and 6 Inundation Scenario								
Central City	37.9	0	9	0	0	3	0	12
Southeast	807.1	4,106	187	0	15	3	7	4,318
Total	***845.1***	***4,106***	***196***	***0***	***15***	***6***	***7***	***4,330***
Washington Park Reservoirs 3 and 4 Inundation Scenario								
Central City	34.4	14	21	5	0	0	0	40
Southwest	3.0	0	0	0	0	1	0	1
West/Northwest	5.4	0	11	0	0	0	0	11
Total	***42.7***	***14***	***32***	***5***	***0***	***1***	***0***	***52***

a. Values based off of City of Portland building inventory data received October 2015.

13.4.3 Critical Facilities

GIS analysis determined that there are critical facilities in the mapped inundation area as listed in Table 13-7 through Table 13-9.

13.4.4 Environment

In general, reservoirs held behind dams affect many ecological aspects of a river. River topography and dynamics depend on a wide range of flows, but rivers below dams often experience long periods of very stable flow conditions or saw-tooth flow patterns caused by releases followed by no releases. Water releases from dams usually contain very little suspended sediment; this can lead to scouring of river beds and banks. The dam failure inundation scenarios assessed for this assessment are located off-stream, so significant impacts on river ecosystems would not be expected. The environment would still be exposed to a number of risks in the event of dam failure.

Table 13-7. Critical Facilities in Inundation Areas

Reporting Area	Number of Critical Facilities in the Inundation Areas[b]				
	Emergency Services	High Potential Loss Facilities[a]	Schools	Other Assets	Total
Mt Tabor Reservoir 1 Inundation Scenario					
Southeast	0	0	1	1	2
Mt Tabor Reservoirs 5 and 6 Inundation Scenario					
Central City	0	1	0	0	1
Southeast	2	0	4	2	8
Total	***2***	***1***	***4***	***2***	***9***
Washington Park Reservoirs 3 and 4 Inundation Scenario					
Central City	0	0	0	0	0
Southwest	0	0	0	0	0
West/Northwest	0	0	0	0	0
Total	***0***	***0***	***0***	***0***	***0***

a. Includes one hazardous material containing facility.
b. See Table 6-1 for a description of the facilities included in each category.

Table 13-8. Critical Infrastructure in Inundation Areas

Reporting Area	Number of Critical Infrastructure Facilities in the Inundation Areas[b]					
	Transportation Systems	Utility Systems				Total
		Communications	Power	Potable Water[a]	Wastewater	
Mt Tabor Reservoir 1 Inundation Scenario						
Southeast	0	0	0	0	0	0
Mt Tabor Reservoirs 5 and 6 Inundation Scenario						
Central City	0	0	1	0	1	2
Southeast	0	0	2	1	0	3
Total	***0***	***0***	***3***	***1***	***1***	***5***
Washington Park Reservoirs 3 and 4 Inundation Scenario						
Central City	0	0	0	0	0	0
Southwest	0	0	0	0	0	0
West/Northwest	0	0	0	3	0	3
Total	***0***	***0***	***0***	***3***	***0***	***3***

a. In addition to the facilities outlined above, there are several potable water facilities exposed to dam failure inundation areas in the Bull Run Watershed. The mapped inundation areas for these dams are not expected to have impacts within the city boundaries.
b. See Table 6-1 for a description of the facilities included in each category.

Table 13-9. Linear Critical Facilities in Inundation Areas

	Facilities in Inundation Area		
	Mount Tabor Reservoir 1	Mount Tabor Reservoirs 5 and 6	Mount Tabor Reservoirs 3 and 4
Utility Systems			
Power Lines	0.43 miles, 0.1% of citywide total	2.39 miles, 0.5% of citywide total	4.69 miles, 1.0% of citywide total
Gas Lines	0.36 miles, 0.4% of citywide total	no exposure	1.58 miles or 1.9% of citywide total
Transportation Systems			
Railroads	No exposure	no exposure	1.19 miles, 0.3% of citywide total
Light Rail	No exposure	0.63 miles or 1.2% of the citywide system	0.76 miles, 1.4% of citywide total
Major Roads	SE Powell Blvd, SE Cesar E Chavez Blvd, SE Division St	SE Powell Blvd, SE Cesar E Chavez Blvd, SE Division St, SE Water Ave, SE Milwaukie Ave, SE Hawthorne Blvd	SW Jefferson St
Highways	Highways in Portland may be exposed to the dam inundation hazard, but they are likely to be elevated above potential inundation areas		

13.5 VULNERABILITY

13.5.1 Population

Vulnerable populations are all populations downstream from dam failures that are unlikely to escape the area within the allowable time frame. This includes the elderly, young or others with access and functional needs, who may be unable to get themselves out of the inundation area. Vulnerable populations also include those who would not have adequate warning from a cell phone, television or radio emergency warning system or are unable to understand warnings provided due to language barriers or other disabilities. It likely that many households living in the inundation areas are not aware that they reside in such areas, renters may be less likely to be so informed.

Estimates for the number of people who would be displaced and require short-term shelter were estimated for dam failure events through the Level 2 Hazus-MH analysis. Table 13-10 summarizes the results.

Table 13-10. Estimated Dam Failure Impact on Persons and Households

	Displaced Population[a]		Persons Requiring Short-Term Shelter[a]	
	Number	% of Population	Persons	% of Population
Mt Tabor Reservoir 1 Inundation Scenario				
Southeast	924	0.6%	754	0.5%
Mt Tabor Reservoirs 5 and 6 Inundation Scenario				
Central City	0	0%	0	0%
Southeast	7,662	5.0%	2,983	1.9%
Total	***7,662***	***1.2%***	***2,983***	***0.5%***
Washington Park Reservoirs 3 and 4 Inundation Scenario				
Central City	285	0.8%	275	0.7%
Southwest	0	0%	0	0%
West/Northwest	0	0%	0	0%
Total	***285***	***Less than 0.1%***	***275***	***Less than 0.1%***

a. Calculated using a Census block level, general building stock analysis in Hazus 2.2, and adjusted to reflect the estimated population.

13.5.2 Property

Vulnerable properties are those closest to the inundation areas. These properties would experience the largest, most destructive surge of water. Low-lying areas are also vulnerable since they are where the reservoir waters would collect.

A failure of the Mount Tabor Reservoirs 5 and 6 would be expected to lead to the most significant damage, with 2,990 structures impacted, resulting in more than $644 million in expected losses (about 0.4 percent of the total replacement value of Portland). Table 13-11 shows loss estimates for each scenario.

Table 13-11. Loss Estimates for Dam Failure

Reporting Area	Number of Structures Impacted	Estimated Loss			Estimated Loss as % of Replacement Value	
		Structure	Contents	Total	Area	City
Mt Tabor Reservoir 1 Inundation Scenario						
Southeast	572	$59,444,985	$35,989,157	$95,434,142	0.3%	0.1%
Mt Tabor Reservoirs 5 and 6 Inundation Scenario						
Central City	7	$43,999	$320,561	$364,561	Less than 0.1%	--
Southeast	2,983	$347,569,555	$296,128,894	$643,698,449	2.1%	--
Total	***2,990***	***$347,613,554***	***$296,449,455***	***$644,063,009***	--	***0.4%***
Washington Park Reservoirs 3 and 4 Inundation Scenario						
Central City	35	$27,788,472	$31,964,599	$59,753,072	0.2%	--
Southwest	1	$317,670	$334,390	$652,060	Less than 0.1%	--
West/Northwest	8	$2,240,150	$3,400,792	$5,640,942	Less than 0.1%	--
Total	***44***	***$30,346,293***	***$35,699,782***	***$66,046,074***	--	***Less than 0.1%***

Note: Values shown are accurate only for comparison among results in this plan. See Section 6.8 for a discussion of data limitations.

Table 13-12 shows the number of buildings in each hazard area that are believed to have active flood insurance policies. Flood insurance uptake in these areas is quite low with approximately 10 active policies in all three inundation areas combined.

Table 13-12. Percent of Buildings in Dam Inundation Areas with Flood Insurance

Reporting Area	Total Buildings in Inundation Area	Buildings with Flood Insurance	% of Buildings with Flood Insurance
Mt Tabor Reservoir 1 Inundation Scenario			
Southeast	739	1	0.1%
Mt Tabor Reservoirs 5 and 6 Inundation Scenario			
Central City	12	1	8.3%
Southeast	4,318	8	0.2%
Total	***4,330***	***9***	***0.2%***
Washington Park Reservoirs 3 and 4 Inundation Scenario			
Central City	40	0	0.0%
Southwest	1	0	0.0%
West/Northwest	11	0	0.0%
Total	***52***	***0***	***0.0%***

13.5.3 Critical Facilities

Estimated damage to critical facilities and infrastructure in the dam inundation areas is summarized in Table 13-13 through Table 13-15.

Transportation routes are vulnerable to dam inundation and have the potential to be wiped out, creating isolation issues. This includes all roads and railroads in the path of the dam inundation. Those that are most vulnerable are those that are already in poor condition and would not be able to withstand a large water surge. Utilities such as overhead power lines, cable and phone lines could also be vulnerable. Loss of these utilities could create additional isolation issues for the inundation areas. Facilities containing hazardous materials or the containers used to store them could be damaged during a dam failure event resulting in material releases that could be harmful to people, property and environment in the area.

Table 13-13. Estimated Critical Facilities and Infrastructure Damage—Mount Tabor Reservoir 1 Failure

	Number of Facilities	Average % of Total Value Damaged		Days to 100%
	Impacted	Building	Content	Functionality
Emergency Services	0	–	–	–
Schools	1	0.7	4.0	480
Transportation Systems	0	–	–	–
High Potential Loss Facilities	0	–	–	–
Utility Systems				
Communications	–	–	–	–
Power	–	–	–	–
Potable Water	–	–	–	–
Wastewater	–	–	–	–
Other Assets	1	0.0	0.0	–
Total/Average	**2**	**0.7**	**4.0**	**480**

Table 13-14. Estimated Critical Facilities and Infrastructure Damage—Mount Tabor Reservoir 5 and 6 Failure

	Number of Facilities	Average % of Total Value Damaged		Days to 100%
	Impacted	Building	Content	Functionality
Emergency Services	2	3.6	4.1	480
Schools	4	8.8	37.5	420
Transportation Systems	0	–	–	–
High Potential Loss Facilities	1	0.0	–	–
Utility Systems				
Communications	0	–	–	–
Power	3	0.13	–	–
Potable Water	1	–	–	–
Wastewater	1	–	–	–
Other Assets	2	–	–	–
Total/Average	**14**	**3.1**	**20.8**	**450**

Table 13-15. Estimated Critical Facilities and Infrastructure Damage—Washington Park Reservoir 3 and 4 Failure

	Number of Facilities Impacted	Average % of Total Value Damaged		Days to 100% Functionality
		Building	Content	
Emergency Services	0	--	--	--
Schools	0	--	--	--
Transportation Systems	0	--	--	--
High Potential Loss Facilities	0	--	--	--
Utility Systems				
Communications	0	--	--	--
Power	0	--	--	--
Potable Water	3	40.0	--	--
Wastewater	0	--	--	--
Other Assets	0	--	--	--
Total/Average	**3**	**40.0**	**--**	**--**

13.5.4 Environment

The extent of the vulnerability of the environment is the same as the exposure of the environment. As with any significant natural hazard event, large of amounts of debris generated from the damaged buildings and infrastructure could have significant environmental impacts. These impacts were estimated for the dam failure event through the Level 2 Hazus-MH analysis. Table 13-16 summarizes the results.

In addition, habitat of plants and animals would be detrimentally effected by the surge of water resulting from the failure. Hazardous materials could be released into the environment during the inundation. This release could have both immediate and long-term impacts to the natural environment as well as human health and safety.

Table 13-16. Estimated Dam Failure-Caused Debris

	Debris to Be Removed (tons) [a]	Estimated Number of Truckloads[b]
Mt Tabor Reservoir 1 Inundation Scenario		
Southeast	12,122	485
Mt Tabor Reservoirs 5 and 6 Inundation Scenario		
Central City	1	0
Southeast	59,740	2,390
Total	***59,741***	***2,390***
Washington Park Reservoirs 3 and 4 Inundation Scenario		
Central City	3,781	151
Southwest	267	11
West/Northwest	8	1
Total	***4,056***	***162***

a. Debris generation estimates were calculated using a census block level, general building stock analysis in Hazus 2.2
b. Hazus-MH assumes 25 tons/trucks
Note: Values shown are accurate only for comparison among results in this plan. See Section 6.8 for a discussion of data limitations.

13.5.5 Economic Impact

In general, dam failure presents the potential for significant disruption, including loss of life, massive property damage, and other long-term consequences. All of these are likely to impact the local economy, directly and indirectly. Economic losses can include the cost to rebuild structures and properties, the cost of response, and recovery, and long-term costs to repair environmental damage. It can also have a hidden impact, by reducing public morale and confidence, resulting in decreased spending in local stores and businesses near the event's occurrence. Such indirect and cascading impacts, however, are difficult to quantify, even though FEMA recognizes their significance and probability. FEMA provides resources to assist jurisdictions in estimating both direct and indirect economic consequences after a dam failure (Homeland Security, 2011)

13.6 FUTURE TRENDS IN DEVELOPMENT

Land use in Portland will be directed by the Portland Comprehensive Plan adopted under state law. The City has established comprehensive policies regarding sound land use in identified flood hazard areas; however, these policies and related regulations in the local municipal code are unlikely to impact land use and development decisions in dam inundation areas, because these areas are off stream and generally unconnected to floodplains.

Table 13-17 shows the future land use designations in the dam inundation areas. The majority of the land area in both the Mount Tabor 1 and 5 and 6 inundation scenarios is designated as single-family dwellings, while the dominant use in the Washington park inundation area is commercial.

Table 13-17. Future Land Use Designations in Dam Failure Inundation Areas

		Percent of total acres					
		Residential					
Reporting Area	Total Acreage	Single-Dwelling	Multi-Dwelling	Commercial	Employment & Industrial	Mixed Use & Institutional	Open Space
Mt. Tabor Reservoir 1							
Southeast	180	58.0%	18.9%	0.0%	0.3%	16.3%	**6.6%**
Total	***180***	***58.0%***	***18.9%***	***0.0%***	***0.3%***	***16.3%***	***6.6%***
Mt. Tabor Reservoirs 5 and 6							
Central City	38	0.0%	0.0%	0.0%	97.5%	0.0%	**2.5%**
Southeast	807	68.2%	13.1%	0.0%	2.4%	13.4%	**2.8%**
Total	***845***	***65.2%***	***12.5%***	***0.0%***	***6.7%***	***12.8%***	***2.8%***
Washington Park Reservoirs 3 and 4							
Central City	34	0.0%	4.9%	80.4%	0.0%	0.0%	**14.8%**
Southwest	3	40.5%	0.0%	0.0%	0.0%	59.5%	**0.0%**
West/Northwest	5	17.7%	0.6%	0.0%	0.0%	3.0%	**78.7%**
Total	***43***	***5.0%***	***4.0%***	***64.7%***	***0.0%***	***4.5%***	***21.8%***

Source: Future land use categories are based on the proposed comprehensive plan designations as of February 2016

13.7 SCENARIO

An earthquake in the region could lead to liquefaction or sliding of soils around a dam. This could occur without warning during any time of the day. Failure of a high hazard dam in the City would likely result in the loss of life, roadways, structures and property and cause severe impacts on the local economy. While the possibility of failure is low, results of such an event would be devastating.

13.8 ISSUES

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

The following issues have been identified based on the Mt Tabor Reservoir 1 inundation scenario:

- Immediate impacts will be contained within the Southeast risk reporting area.
- More than 2,100 people are estimated to reside within the inundation areas. Of these, it is estimated that 924 people will be displaced from their homes after an event and 754 of these people will seek shelter in public shelters.
- Of the 739 buildings exposed, 572 are expected to be impacted by a dam failure event, resulting in more than $95.4 million in damage. This is less than 1 percent of the total value of the Southeast risk reporting area and less than 0.1 percent of the total value of Portland.
- The structures exposed to the hazard are predominantly residential (97 percent); however, there are also 9 structures identified as educational occupancy, 12 commercial structures and 1 religious structure in the exposure area.
- More than 12,120 tons of debris would be expected from the inundation event, which will require approximately 485 truckloads to remove.
- Only 1 building in the inundation area is believed to have flood insurance.
- There are 2 critical facilities located in the inundation area.
- Limited English speaking households may disproportionately reside in inundation areas in the Southeast risk reporting area (6 percent).

The following issues have been identified based on the Mt Tabor Reservoir 5 and 6 inundation scenario:

- Immediate impacts will be contained within the Central City and Southeast risk reporting areas. The vast majority of exposure is in the Southeast (96 percent of inundation area).
- 12,477 people are estimated to reside within the inundation areas. Of these, it is estimated that 7,662 people will be displaced from their homes after an event and 2,983 of these people will seek shelter in public shelters.
- There are 4,300 buildings estimated to be exposed to the dam inundation area.
- The vast majority of exposed structures in the Southeast reporting area are residential (95 percent).
- More than 59,741 tons of debris would be expected from the inundation event, which will require approximately 2,390 truckloads to remove.
- Of the 4,106 buildings exposed, 2,990 are expected to be impacted by a dam failure event, resulting in more than $2.3 billion in damage. This is 1.3 percent of the total value of the Southeast risk reporting area and less than 0.1 percent of the total value of Portland.
- Only 9 buildings in the inundation area are believed to have flood insurance.
- There are 14 critical facilities located in the inundation area.

The following issues have been identified based on the Washington Park Reservoirs 3 and 4 inundation scenario:

- Immediate impacts will be contained predominantly within the Central City and the West/Northwest risk reporting area. There is one government building exposed in the Southwest.
- 621 people are estimated to reside within the inundation areas. Of these, it is estimated that 285 people will be displaced from their homes after an event and 275 of these people will seek shelter in public shelters.
- It is estimated that over 90 percent of the population exposed to the dam failure hazard reside in renter occupied housing and that more than 27 percent of families in the hazard area have incomes below the poverty level.
- Of the 52 buildings exposed, 44 are expected to be impacted by a dam failure event, resulting in more than $66 million in damage. This is less than 1 percent of the total value of the risk reporting areas impacted and less than 0.1 percent of the total value of Portland.
- All structures exposed within the West/Northwest area are commercial structures. Structures exposed in the Central City are mixed: 14 residential, 21 commercial, 5 industrial.
- More than 4,056 tons of debris would be expected from the inundation event, which will require approximately 162 truckloads to remove. Most debris will be in the Central City.
- No buildings in the inundation areas are believed to have flood insurance.
- There are 3 critical facilities located in the inundation area.
- Renters and families with incomes below the federal poverty level may disproportionately reside in the inundation areas in the Central City risk reporting area (90 percent and 27 percent, respectively).

The following general issues have been identified:

- It is unclear whether dam failure warning and notification strategies will be viable if dam failure occurs as a result of a significant earthquake that interrupts communication systems.
- Those with access and functional needs may not be able to evacuate if warning time for an event is limited.
- There is the potential for available warnings to be missed or misunderstood as a result of language or other cultural barriers.
- Downstream populations are often not aware that they are located in a dam failure inundation area and do not know the risks associated with probable dam failure.
- Balancing the need to address security concerns and the need to inform the public of the risk associated with dam failure is a challenge for public officials.
- The vast majority of structures located in the dam inundation areas do not have flood insurance.

14. DROUGHT

14.1 GENERAL BACKGROUND

Most regions experience drought conditions periodically. According to the National Drought Mitigation Center, drought originates from a deficiency of precipitation over an extended period of time, usually a season or more. This results in a shortage of water needed to support a specific activity, group, or environmental sector. Drought is the result of a significant decrease in water supply relative to what is "normal" in a given location. Unlike most disasters, droughts normally occur slowly but last a long time. There are four generally accepted operational definitions of drought (National Drought Mitigation Center, 2006):

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

DEFINITIONS

- **Drought**—The cumulative impacts of several dry years on water users. It can include deficiencies in surface and subsurface water supplies and generally impacts health, well-being, and quality of life.
- **Meteorological Drought**—An abnormally low level of precipitation over a period of time.
- **Agricultural Drought**—When there is not enough soil moisture to support crop needs at a particular time.
- **Hydrological Drought**—Deficiencies in surface and subsurface water supplies.
- **Socioeconomic Drought**—Drought impacts on a population's health, well-being and quality of life.

Defining when drought begins is a function of the impacts on water users, and includes consideration of the supplies available to local users as well as the stored water available in surface reservoirs or groundwater basins. Different water agencies have different criteria for defining drought. Some issue drought watch or drought warning announcements to their customers. Determinations of regional or statewide drought conditions are usually based on a combination of hydrologic and water supply factors. The State of Oregon has a statutory definition of drought (Oregon Revised Statute §539.710), described as a potential state emergency when a lack of water resources threatens the availability of essential services and jeopardizes the peace, health, safety, and welfare of the people of Oregon.

14.2 HAZARD PROFILE

Droughts originate from a deficiency of precipitation resulting from an unusual weather pattern. If the weather pattern lasts a short time (a few weeks or a couple months), the drought is considered short-term. If the weather pattern becomes entrenched and the precipitation deficits last for several months or years, the drought is considered to be long-term. It is possible for a region to experience a long-term circulation pattern that produces drought, and to have short-term changes in this long-term pattern that result in short-term wet spells. Likewise, it is possible for a long-term wet circulation pattern to be interrupted by short-term weather spells that result in short-term drought. The El Niño Southern Oscillation (ENSO), a weather phenomenon that occurs every two to seven years in the Pacific Ocean, causes ocean currents and winds to shift while generating warmer water temperatures. During an ENSO phase, the Pacific Northwest can experience hotter winters that reduce snowpack, which leads to drought the following summer (National Drought Mitigation Center, 2016).

14.2.1 Past Events

In the past century, Oregon has experienced a number of droughts, some of the most severe occurring in 1976-77, 1992, and 2001-2002. The most recent droughts in the state occurred in 2005 and 2015 (Oregon Department of Land Conservation and Development, 2015 and Oregon Office of Emergency Management and Oregon Water Resources Department, 2016). NOAA's National Climatic Data Center does not list any drought events impacting the counties the City of Portland resides in (Multnomah, Washington and Clackamas) between 1950 and 2015.

Between 1954 and 2015, Oregon experienced one FEMA-declared drought-related emergency (EM-3039). This was the 1977 event, which has been identified as the worst drought in state history; however, the counties that the City of Portland resides in were not included in the declaration (FEMA, 2016b). The U.S. Secretary of Agriculture (USDA) is authorized to designate counties as disaster areas to make emergency loans to agricultural producers suffering losses due to drought. One-half to two-thirds of the counties in the U.S. have been designated as drought disaster areas in each of the past several years. Between 2012 and 2015, Oregon has been included in 307 USDA drought declarations. Multnomah, Washington and Clackamas counties have been included in seven of these declarations, all of them in 2015—June 10, 2015; July 22, 2015; August 5, 2015, August 12, 2015, August 19, 2015; and September 2, 2015, September 23, 2015 (USDA, 2016).

14.2.2 Location

Drought impacts could occur anywhere in Portland. NOAA has developed several indices to measure drought impacts and severity and to map their extent and locations. Values are reported in these indices by U.S. Climatological Divisions (NOAA, 2016c). These indices change regularly depending on local weather patterns and are snapshots of drought impacts at a specific point in time:

- The ***Palmer Crop Moisture Index*** measures short-term drought on a weekly scale and is used to quantify drought's impacts on agriculture during the growing season. Figure 14-1 shows this index for the week ending July 2, 2016.
- The ***Palmer Z Index*** measures short-term drought on a monthly scale. Figure 14-2 shows this index for June 2015.

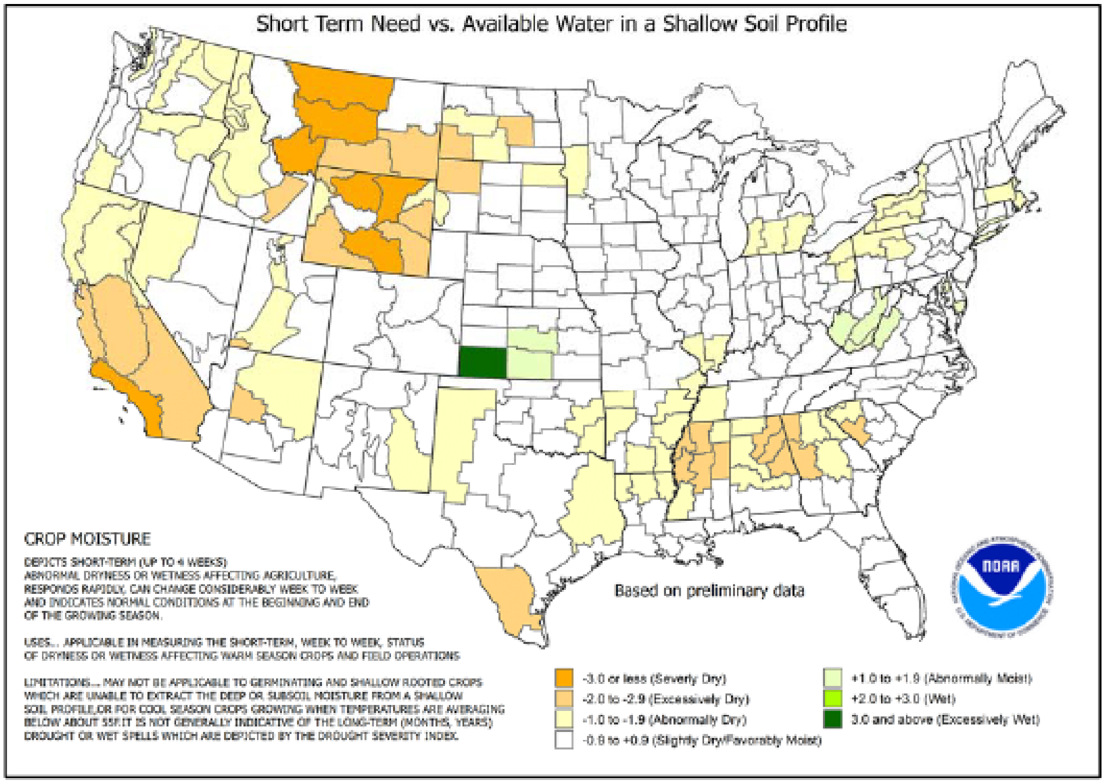


Figure 14-1. Crop Moisture Index for Week Ending July 2, 2016

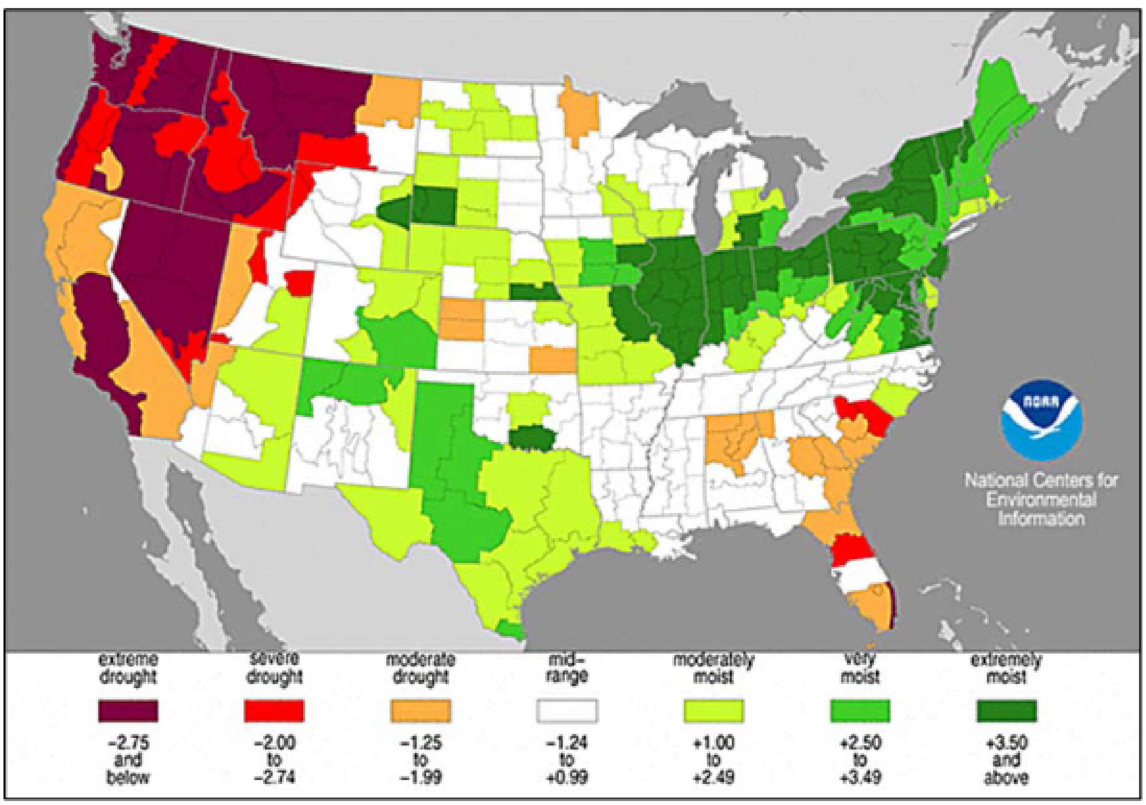


Figure 14-2. Palmer Z Index Short-Term Drought Conditions (June 2015)

- The ***Palmer Drought Index*** measures the duration and intensity of long-term drought-inducing circulation patterns. Long-term drought is cumulative, so the intensity of drought during a given month is dependent on the current weather patterns plus the cumulative patterns of previous months. Weather patterns can change quickly from a long-term drought pattern to a long-term wet pattern, and the Palmer Drought Index can respond fairly rapidly. Figure 14-3 shows this index for June 2015.
- The hydrological impacts of drought (e.g., reservoir levels, groundwater levels, etc.) take longer to develop and it takes longer to recover from them. The ***Palmer Hydrological Drought Index***, another long-term index, was developed to quantify hydrological effects. The Palmer Hydrological Drought Index responds more slowly to changing conditions than the Palmer Drought Index. Figure 14-4 shows this index for August 2015.

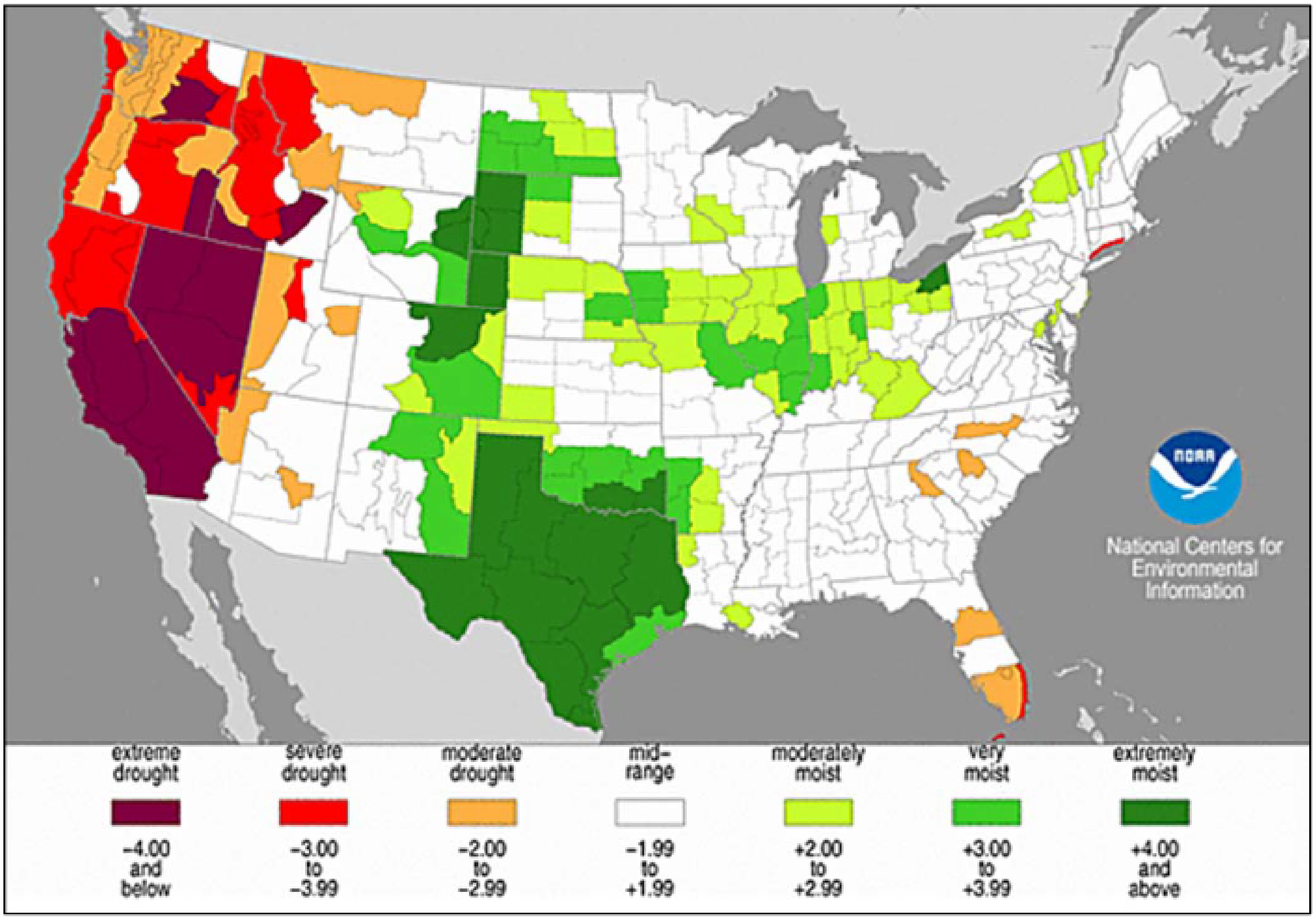


Figure 14-3. Palmer Drought Severity Index (June 2015)

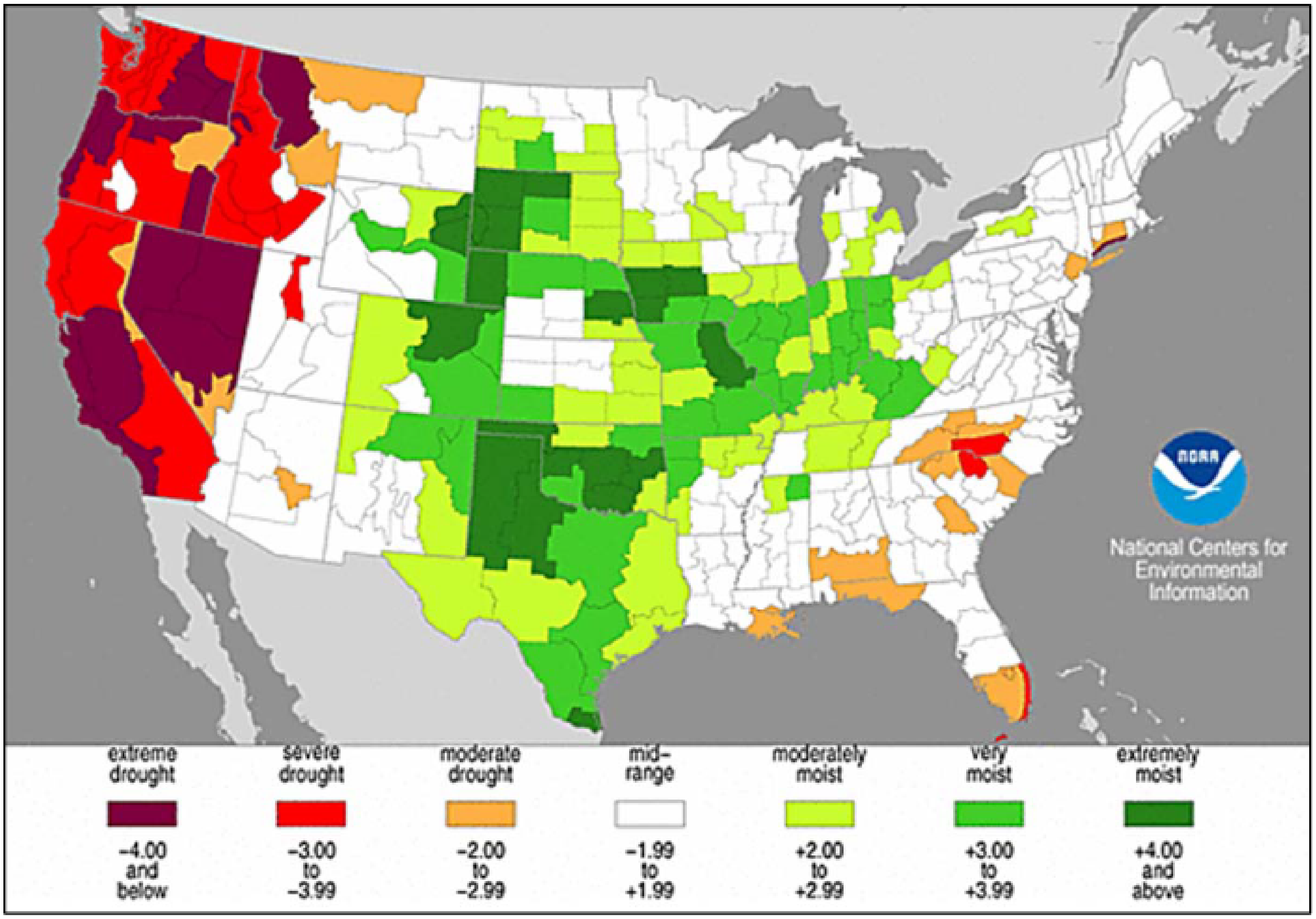


Figure 14-4. Palmer Hydrological Drought Index Long-Term Hydrologic Conditions (August 2015)

14.2.3 Frequency

Historical drought data for the region indicate there have been 7 significant droughts in the last 66 years. This equates to a drought every 9.4 years on average, or a 10.6 percent chance of a drought in any given year. However, severe droughts are uncommon in the Portland metropolitan area. Between 1992 and 2014, there were no Governor-declared droughts in the City of Portland or the surrounding counties (Oregon Department of Land Conservation and Development, 2015).

Drought is a normal, recurrent feature of climate, although many erroneously consider it a rare and random event. It is a temporary condition and differs from aridity because the latter is restricted to low rainfall regions and is a permanent feature of climate. It is rare for drought not to occur somewhere in North America each year. Despite impressive achievements in the science of climatology, estimating drought probability and frequency continues to be difficult. This is because of the many variables that contribute to weather behavior, climate change, and the absence of historic information. Climate change is expected to contribute to increasing drought risk in the future (Department of Land Conservation and Development, 2015).

14.2.4 Severity

Drought can have a widespread impact on the environment and the economy, although it typically does not result in loss of life or damage to property, as do other natural disasters. Nationwide, the impacts of drought occur primarily in the agriculture, transportation, recreation and tourism, forestry, and energy sectors. Social and environmental impacts are also significant, although it is difficult to put a precise cost on these impacts. The National Drought Mitigation Center uses three categories to describe likely drought impacts:

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

The severity of a drought depends on the degree of moisture deficiency, the duration, and the size and location of the affected area. The longer the duration of the drought and the larger the area impacted, the more severe the potential impacts. From 1980 to 2015 there have been 23 drought events in the United States with losses exceeding $1 billion. Of these 23 events, the State of Oregon was impacted by 11 (NOAA, 2016a). When measuring the severity of droughts, analysts typically look at economic impacts. All people could pay more for water if utilities increase their rates due to shortages. Agricultural impacts can result in loss of work for farm workers and those in related food processing jobs, as well as Native American Tribes which depend on local fisheries (Oregon Office of Emergency Management, 2015). Other water- or electricity-dependent industries are commonly forced to shut down all or a portion of their facilities, resulting in further layoffs. A drought can harm recreational companies that use water (e.g., swimming pools, water parks, and river rafting companies) as well as landscape and plant nursery businesses. In Oregon, where hydroelectric power plants generate nearly over 70 percent of the electricity produced, drought also threatens the supply of electricity, with the potential to affect the cost of power (U.S. Energy Information Administration, 2016).

Drought generally does not affect groundwater sources as quickly as surface water supplies, but groundwater supplies generally take longer to recover. Reduced precipitation during a drought means that groundwater supplies are not replenished at a normal rate. This can lead to a reduction in groundwater levels and problems such as reduced pumping capacity or wells going dry. Shallow wells are more susceptible than deep wells. Reduced replenishment of groundwater affects streams. Much of the flow in streams comes from groundwater, especially during the summer when there is less precipitation and after snowmelt ends. Reduced groundwater levels mean that even less water will enter streams when stream flows are lowest.

14.2.5 Warning Time

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

Because drought conditions in Oregon are often related to deficiencies in snowpack accumulation, some warning is available through monitoring snowpack accumulation through the winter. The U.S. Natural Resources Conservation Service's snow survey and water supply forecasting program conducts snow surveys to develop accurate and reliable water supply forecasts (USDA, 2014). The system, called SNOTEL (short for Snow Telemetry) provides information for local governments, water consumers and providers and the general public on snowpack conditions that may impact water resources in future months. When snowpack levels are below average, communities may make changes to their water management programs and practices to reduce impacts from a possible future drought.

NOAA's National Integrated Drought Information System (NIDIS) launched a Drought Early Warning System (DEWS) for the Pacific Northwest in February of 2016. DEWS draws upon new and existing federal, tribal, state, local and academic partner networks to make climate and drought science readily available, easily understandable and usable for decision makers. The system improves stakeholders' abilities to monitor, forecast, plan for and cope with the impacts of drought (NIDIS, 2016).

14.3 COMPOUNDING FACTORS AND SECONDARY HAZARDS

14.3.1 Overview

The secondary hazard most commonly associated with drought is wildfire. A prolonged lack of precipitation dries out vegetation, which becomes increasingly susceptible to ignition as the duration of the drought extends. Millions of board feet of timber have been lost, and in many cases erosion occurred, which caused serious damage to aquatic life, irrigation, and power production by heavy silting of streams, reservoirs, and rivers.

Drought also is often accompanied by extreme heat, exposing people to the risk of sunstroke, heat cramps and heat exhaustion. Pets and livestock are also vulnerable to heat-related injuries. Crops can be vulnerable as well.

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

14.3.2 Climate Change

Global water resources are already experiencing the following stresses without climate change:

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

With a warmer climate, droughts could become more frequent, more severe, and longer-lasting. According to the National Climate Assessment, "higher surface temperatures brought about by global warming increase the potential for drought. Evaporation and the rate at which plants lose moisture through their leaves both increase with temperature. Unless higher evapotranspiration rates are matched by increases in precipitation, environments will tend to dry, promoting drought conditions (Globalchange.gov, 2014).

Portland's drinking water supply is a rain-, rather than a snow-fed system. This means that increases in temperatures may have less of an impact on water supply in Portland than in other areas in the American west. By addressing current stresses on water supplies and by building a flexible, robust program, the City will be able to more adeptly respond to changing conditions and to survive dry years.

14.4 EXPOSURE

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

14.5 VULNERABILITY

Drought produces a complex web of impacts that spans many sectors of the economy and reaches well beyond the area experiencing physical drought. This complexity exists because water is integral to the ability to produce goods and provide services. Drought can affect a wide range of economic, environmental and social activities. The vulnerability of an activity to the effects of drought usually depends on its water demand, how the demand is met, and what water supplies are available to meet the demand.

The 2016 Drought Annex to the State of Oregon Emergency Operations Plan defines counties as being vulnerable to drought if a "severe and continuing drought" is in progress or likely to exist. This determination is made by the Water Supply Availability Committee, which is made up of several state and federal agencies, and evaluates drought status and vulnerability based on these indicators:

- Snowpack
- Precipitation
- Temperature Anomalies
- Long range temperature outlook
- Storage in key reservoirs
- Long range precipitation outlook
- Current stream flows and behavior
- Spring and summer streamflow forecasts
- Ocean surface temperature anomalies
- Soil and fuel moisture conditions
- NRCS Surface Water Supply Index.

This information is supplied to the Drought Readiness Council, which is an advisory body of state agencies involved with natural resources management, public health and emergency services. This council assesses how drought conditions may affect the vulnerability of various sectors across the state and makes recommendations to the Governor regarding the need for drought declarations (Oregon Office of Emergency Management and Oregon Water Resources Department, 2016).

The City of Portland and the counties it resides in, Multnomah, Washington and Clackamas, were not among the 25 counties that were in a state of drought declared by the Governor in 2015, one of the most recent severe droughts on record. Based on a review of Governor drought declarations since 1992, the City of Portland could be considered less vulnerable to drought impacts than many other parts of the state (Oregon Department of Land Conservation and Development, 2015).

14.5.1 Population

The City of Portland has the ability to minimize any impacts on residents and water consumers should several consecutive dry years occur. The nature of the Bull Run Watershed as a rain-fed source, as well as a supplemental aquifer-fed water source in the Columbia South Shore Wellfield, ensures that Portland residents will continue to have sufficient water even during dry years. No significant direct life or health impacts are anticipated as a result of drought in Portland.

14.5.2 Property

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

14.5.3 Critical Facilities

Critical facilities as defined for this plan will continue to be operational during a drought. Critical facility elements such as landscaping may not be maintained due to limited resources, but the risk to Portland's critical facilities inventory will be largely aesthetic. For example, when water conservation measures are in place, landscaped areas will not be watered and may die. These aesthetic impacts are not considered significant.

14.5.4 Environment

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

14.5.5 Economic Impact

The economic impact of drought is largely associated with industries that use water or depend on water for their business. For example, landscaping businesses are affected as the demand for their service significantly declines because landscaping is not being watered. Livestock owners experience increased expenses for watering their herds. Agricultural industries are impacted if water usage is restricted for irrigation. Drought can lead to a reduction in power-generating capacity in hydroelectric-dominated systems, such as those found in Oregon. Reductions in capacity can lead to interruptions in the power supply that may have economic impacts in the region. Lloyd's City Risk Index estimates that a drought in the City of Portland could cause up to $540 million of lost gross domestic product annually.

14.6 FUTURE TRENDS IN DEVELOPMENT

The City of Portland has an established comprehensive plan that includes policies directing land use and dealing with issues of water supply and the protection of water resources. The plan works to increase resilience and manage risk through a variety of policies including promoting the resilience of natural systems, including their ability to withstand drought, and through infrastructure investments that create redundancy in the water supply (City of Portland, 2016). This plan provides the capability at the local level to protect future development from the impacts of drought. Additionally, the City has identified an action to continue to address the potential drought related climate change impacts to the City's primary water supply, the Bull Run watershed.

14.7 SCENARIO

An extreme multiyear drought more intense than the 1977 drought could impact the region with little warning. Combinations of low precipitation and unusually high temperatures could occur over several consecutive years. Intensified by such conditions, extreme wildfires could break out in or near Portland, increasing the need for water. If such conditions persisted for several years, the economy of the City of Portland could experience setbacks, especially in water dependent industries.

14.8 ISSUES

The following drought-related issues have been identified in the course of the planning process:

- The need for the identification and development of alternative water supplies, especially in relation to the potential secondary impacts to water supply form drought-induced wildfire.
- There are no quantitative estimates for general building stock impacts for the drought hazard.
- Water resource management strategies have changed significantly over the last several decades. Managers must now consider the needs of communities, industries, power-generating facilities and the environment. Issues associated with meeting the needs of these competing demands with limited resources will likely increase as population growth continues and the impacts of climate change intensify.
- The use and promotion of water-saving and reclamation technologies even during non-drought periods may decrease the effects of drought in Portland.
- Promotion of native and drought-resistant landscaping should continue.
- Predicting droughts can be challenging, although warning systems are currently under development.
- Changes in the timing, frequency and duration of precipitation events may present challenges for current water storage and management practices in the region. Climate change may also increase the frequency and duration of meteorological drought conditions.

15. SPACE WEATHER

15.1 HAZARD PROFILE

Space weather is identified in this plan as an emerging hazard of concern; therefore, a detailed risk assessment of the hazard was not conducted. Additional information pertaining to risk from the space weather hazard will be monitored over the performance period of the plan; the potential for conducting a detailed risk assessment will be evaluated at the next plan update.

15.1.1 Background Information

According to NOAA's Space Weather Prediction Center, space weather refers to variations in the space environment between the sun and Earth. It includes phenomena that impact systems and technologies in orbit and on Earth. Figure 15-1 shows potential space weather related phenomena.

Source: NOAA and NWS Space Weather Prediction Center

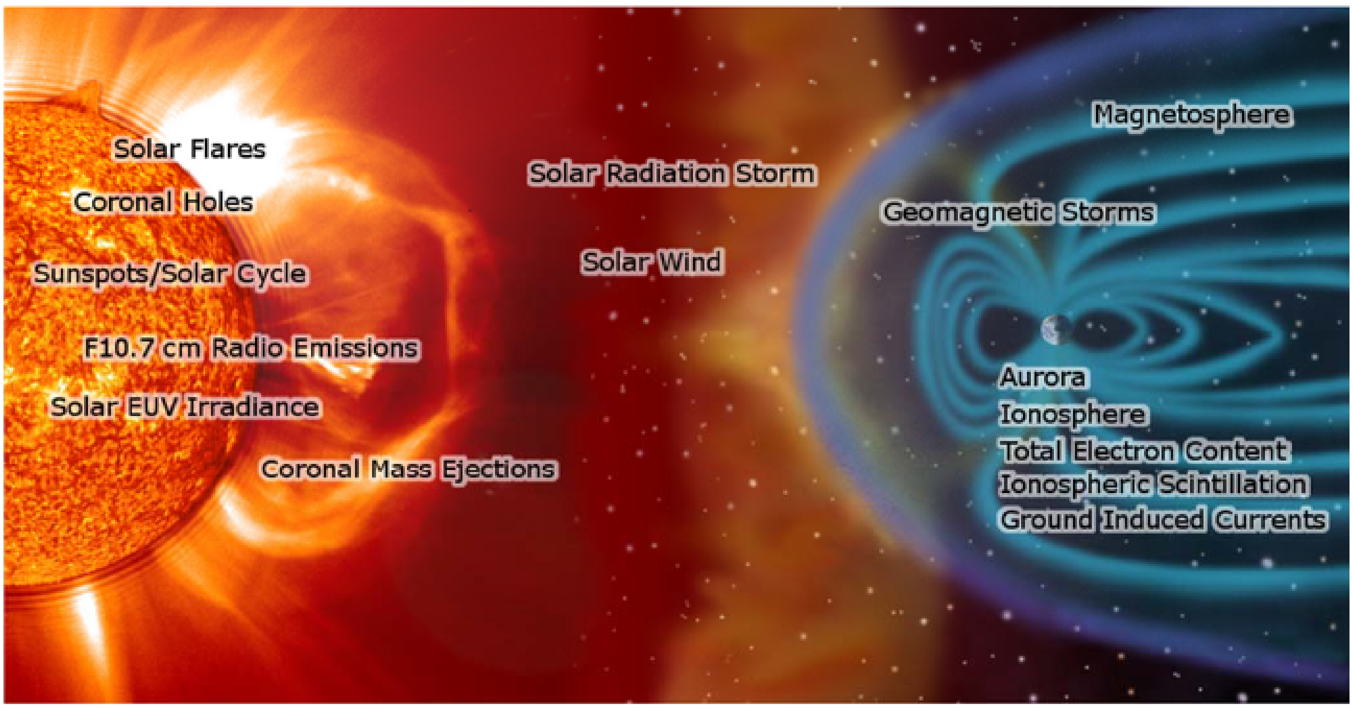


Figure 15-1. Space Weather Phenomena

Most space weather events start as bursts of plasma on the sun called coronal mass ejections. A coronal mass ejection event passes through the sun's corona and into the solar wind. When it reaches Earth, it energizes the magnetosphere and accelerates electrons and protons down to Earth's magnetic field lines, where they collide with the atmosphere and ionosphere, particularly at high latitudes. Different types of space weather can affect different technologies on Earth (NOAA, 2016d):

- During events known as radio blackout storms, solar flares can produce strong bursts of radiation that degrade or block high-frequency radio waves used for radio communication. Solar radiation from these flares also poses risks to passengers and crew of commercial aircraft flying in polar regions during the storm.
- Solar energetic particles can penetrate satellite electronics and cause electrical failure. These particles also block radio communications at high latitudes during solar radiation storms.
- Coronal mass ejections can cause geomagnetic storms on Earth and induce extra currents in the ground that can degrade power grid operations. Geomagnetic storms can also modify the signal from radio navigation systems, causing degraded accuracy.
- Induced current from geomagnetic storms can accelerate corrosion in long pipelines. Most pipelines have corrosion-control systems to prevent this, but not all.

15.1.2 Past Events

The strongest geomagnetic storm on record is the Carrington Event that occurred in September 1859. This storm caused telegraph lines to electrify, in some cases shocking technicians and setting telegraph paper on fire. The aurora generated by the magnetic effects could be seen as far south as Hawaii and Cuba (FEMA, 2016d).

More recent events include a space weather storm on March 13, 1989 that disrupted the hydroelectric power grid in Quebec, Canada. This system-wide outage lasted for 9 hours and left 6 million people without power. In October 2003, space weather cause a simultaneous shutdown of satellites and air traffic precision navigation for several hours. In early December of 2006, geomagnetic storms and solar flare activity disabled Global Positioning System (GPS) signal acquisition over the United States (SDR, 2010).

15.1.3 Warning Time

Space weather prediction services in the United States are provided primarily by the Space Weather Prediction Center and the U.S. Air Force's Weather Agency. The Space Weather Prediction Center draws on a variety of data sources, both space- and ground-based, to provide forecasts, watches, warnings, alerts, and summaries to civilian and commercial users (FEMA, 2016d).

15.2 EXPOSURE

There is no clearly defined extent of space weather exposure. All of Portland is potentially exposed to the direct and indirect impacts of space weather.

15.3 VULNERABILITY

15.3.1 Population

The potential impacts of space weather on human health on Earth are not well known. There are many theories about human health impacts from space weather associated with the disruption of electrical pulses within the body. There have not been enough significant occurrences of space weather events to confirm these theories. If they are accurate, then all populations in the City of Portland would be vulnerable to space weather events.

Power outages induced by space weather can be life-threatening to those dependent on electricity for life support.

15.3.2 Property

All property in the City of Portland would be vulnerable to indirect impacts associated with loss of power triggered by space weather events. The potential impacts from electromagnetic pulses from space weather events on power grids is generally accepted by experts in this field, but has not been widely studied, due to the infrequency of space weather events. Direct structural damage resulting from space weather is not likely.

15.3.3 Environment

Cosmic rays are high energy particles reaching Earth from sources outside our solar system. There is a theory that cosmic rays can create nucleation sites in the atmosphere, which seed cloud formation and create cloudier conditions. If this is true, then there would be a significant impact on climate. During the portion of the sun's 11-year solar cycle called "solar minimum," cosmic rays are at a maximum. Therefore, the duration of solar minimum may have an impact on Earth's climate. (NOAA, 2016d).

15.3.4 Economy

The economic consequences resulting from a citywide power outage caused by space weather would be severe and long-lasting. Without a stable electrical grid, every sector of Portland's economy would be impacted. Lloyd's City Risk Index estimates a solar storm could cause up to $250 million of lost gross domestic product annually (Lloyd's, 2015).

15.4 ISSUES

The October 2015 National Space Weather Action Plan developed by the National Science and Technology Council includes a goal of improving space-weather services by advancing understanding and forecasting. The objectives associated with this goal are as follows:

- Improve understanding of user needs for space-weather forecasting to establish lead-time and accuracy goals.
- Ensure that space-weather products are intelligible and actionable to inform decision-making.
- Establish and sustain a baseline observational capability for space-weather operations.
- Improve forecasting lead-time and accuracy.
- Enhance fundamental understanding of space weather and its drivers to develop and continually improve predictive models.
- Improve effectiveness and timeliness of the process that transitions research to operations.

It should be noted that these actions and challenges associated with space weather are for the most part, outside the control of the City of Portland and its leaders. The most important issue regarding space weather in Portland is the potential for disruption to the electrical systems resulting in cascading impacts on people and property. Additional issues include potential impacts on GPS systems, satellite operations and aviation.

16. RISK RANKING

A risk ranking was performed for the hazards of concern described in this plan for the City of Portland as a whole and for each risk reporting area. These risk rankings assess the probability of each hazard's occurrence as well as its likely impact on the people, property, and economy of Portland:

- The probability of occurrence of a hazard is indicated by a probability factor based on likelihood of annual occurrence.
- Hazard impacts were assessed in three categories: impacts on people, impacts on property and impacts on the local economy:
  - **People**—Values were assigned based on the percentage of the total ***population exposed*** to the hazard event.
  - **Property**—Values were assigned based on the percentage of the total ***property value vulnerable*** to the hazard event.
  - **Economy**—Values were assigned based on the percent of ***critical facilities exposed*** to a hazard in Portland.

The impacts of each hazard category were assigned a weighting factor to reflect the significance of the impact. These weighting factors are consistent with those typically used for measuring the benefits of hazard mitigation actions: impact on people was given a weighting factor of 3; impact on property was given a weighting factor of 2; and impact on the economy was given a weighting factor of 1. Table 16-1, Table 16-2 and Table 16-3 summarize the impacts for each hazard.

Table 16-1. Impact on People from Hazards

Hazard Event	Impact (high, medium, low)	Impact Factor	Multiplied by Weighting Factor (3)
Dam Failure[a]	Medium (2.0%)	2	2 x 3 = 6
Drought[b]	None (0%)	0	0 x 3 = 0
Earthquake	High (100%)	3	3 x 3 = 9
Flood[c]	Low (1.6%)	1	1 x 3 = 3
Landslide	Medium (14.5%)	2	2 x 3 = 6
Severe weather	High (100%)	3	3 x 3 = 9
Volcanic Activity[d]	Medium (estimated)	2	2 x 3 = 6
Wildfire	Medium (11.1%)	2	2 x 3 = 6

a. The Mt. Tabor Reservoirs 5 and 6 scenario is used for risk ranking.
b. The occurrence of a drought event rarely causes direct injury or death.
c. 1 percent annual chance flood event is used for risk ranking
d. Although the entire population is potentially exposed to ash fall, death or injury is unlikely unless an underlying condition is exasperated.

Table 16-2. Impact on Property from Hazards

Hazard Event	Impact (high, medium, low)	Impact Factor	Multiplied by Weighting Factor (2)
Dam Failure[a]	Low (less than 1%)	1	1 x 2 = 2
Drought[b]	Low (estimated)	1	1 x 2 = 2
Earthquake[c]	Medium (4.3%)	2	2 x 2 = 4
Flood[d]	Medium (less than 1%)	1	1 x 2 = 2
Landslide[e]	Low (estimated)	2	2 x 2 = 4
Severe weather[f]	Low (estimated)	1	1 x 2 = 2
Volcanic activity[g]	Low (estimated)	1	1 x 2 = 2
Wildfire	Low (estimated)	1	1 x 2 = 2

a. Mt. Tabor Reservoirs 5 and 6 scenario is used for risk ranking.
b. The occurrence of a drought event rarely causes structural damage.
c. Cascadia M9.0 scenario is used for risk ranking. Estimates were moved to medium due to an increase in severity resulting from more than 1 minute of shaking.
d. Impacts are assigned as medium due to unmapped urban drainage issues.
e. 12.1% of property is exposed, but landslides are unlikely to occur simultaneously as a standalone hazard.
f. Although all property is exposed, it is unlikely that more than 5 percent would be damaged.
g. 9.5% of property is exposed, but is unlikely that all property would be lost in any one event.

Table 16-3. Impact on Economy from Hazards

Hazard Event	Impact (high, medium, low)	Impact Factor	Multiplied by Weighting Factor (1)
Dam Failure[a]	Low (less than 1 percent)	1	1 x 1 = 1
Drought[b]	Low (estimated)	1	1 x 1 = 1
Earthquake[c]	High (100 percent)	3	3 x 1 = 3
Flood[d]	Low (5.0%)	1	1 x 1 = 1
Landslide[e]	Low (estimated)	1	1 x 1 = 1
Severe weather[f]	Medium (estimated)	2	2 x 1 = 2
Volcanic Activity[g]	Medium (5.6% + 100%)	2	2 x 1 = 2
Wildfire	Low (9.7%)	1	1 x 1 = 1

a. Mt. Tabor Reservoirs 5 and 6 scenario is used for risk ranking.
b. The occurrence of a drought event rarely causes large economic impacts in urbanized areas.
c. Cascadia M9.0 scenario is used for risk ranking
d. 1 percent annual chance flood event is used for risk ranking
e. 12% of facilities are exposed, but landslides are unlikely to occur simultaneously as a standalone hazard.
f. All facilities are exposed, but it is unlikely that more than 25 percent would be damaged. Economic impacts would occur as a result of transportation disruptions.
g. 9.7% of facilities are exposed, but is unlikely that all those exposed would impacted in any one event.

16.1 PROBABILITY OF OCCURRENCE

The probability of occurrence of a hazard is indicated by a probability factor based on likelihood of annual occurrence:

- High—Hazard event is likely to occur within 25 years (Probability Factor = 3)
- Medium—Hazard event is likely to occur within 100 years (Probability Factor =2)
- Low—Hazard event is not likely to occur within 100 years (Probability Factor =1)
- No exposure—There is no probability of occurrence (Probability Factor = 0)

The assessment of hazard frequency is generally based on past hazard events in the area, although the likelihood of future events has been taken into consideration in this assessment. Table 16-4 summarizes the probability assessment for each hazard of concern for this plan.

Table 16-4. Probability of Hazards

Hazard Event	Probability (high, medium, low)	Probability Factor
Dam Failure	Low	1
Drought	High	3
Earthquake[a]	Medium	2
Flood[b]	High	3
Landslide	High	3
Severe weather	High	3
Volcanic Activity	Low	1
Wildfire	High	3

a. Cascadia M9.0 scenario is used for risk ranking
b. 1 percent annual chance flood event is used for risk ranking

16.2 IMPACT

Hazard impacts were assessed in three categories: impacts on people, impacts on property and impacts on the local economy. Numerical impact factors were assigned as follows:

- **People**—Values were assigned based on the percentage of the total ***population exposed*** to the hazard event. Impact factors were assigned as follows:
    - High—25 percent or more of the population is exposed to a hazard (Impact Factor = 3)
    - Medium—10 percent to 25 percent of the population is exposed to a hazard (Impact Factor = 2)
    - Low—10 percent or less of the population is exposed to the hazard (Impact Factor = 1)
    - No impact—None of the population is exposed to a hazard (Impact Factor = 0)
- **Property**— Values were assigned based on the percentage of the total ***property value vulnerable*** to the hazard event. Impact factors were assigned as follows:
    - High—Estimated loss from the hazard is 10 percent or more of the total replacement value (Impact Factor = 3)
    - Medium—Estimated loss from the hazard is 5 percent to 10 percent of the total replacement value (Impact Factor = 2)
    - Low—Estimated loss from the hazard is 5 percent or less of the total replacement value (Impact Factor = 1)
    - No impact—No loss is estimated from the hazard (Impact Factor = 0)
- **Economy**—Values were assigned based on ***critical facility exposure*** for critical facilitates and infrastructure on Portland. Impact factors were assigned as follows:
    - High—25 percent or more of total facilities are exposed (Impact Factor = 3)
    - Medium—Between 10 and 25 percent of facilities are exposed (Impact Factor = 2)
    - Low—Less than 10 percent of facilities are exposed (Impact Factor = 1)
    - No Impact—No critical facilities are exposed to the hazard (Impact Factor = 0)

16.3 RISK RATING AND RANKING

The risk rating for each hazard was determined by multiplying the probability factor by the sum of the weighted impact factors for people, property and economy, as summarized in Table 16-5. Based on these ratings, a priority of high, medium or low was assigned to each hazard. City-wide the hazards ranked as being of highest concern are severe weather and earthquake. Hazards ranked as being of medium concern are flood, landslide and wildfire. The hazards ranked as being of lowest concern are volcanic activity, dam failure and drought. Table 16-6 shows the hazard risk ranking for the City of Portland. A similar ranking process was performed for each reporting area; the results from those efforts are summarized in Table 16-7 and Table 16-8.

Table 16-5. Hazard Risk Rating

Hazard Event	Probability Factor	Sum of Weighted Impact Factors	Total (Probability x Impact)
Dam Failure	1	6 +2+1 = 9	9
Drought	3	0+2+1 = 3	9
Earthquake	2	9+4+3 = 16	32
Flood	3	3+4+1 = 8	24
Landslide	3	6+2+1 = 9	27
Severe weather	3	9+2+2 = 13	39
Volcanic activity	1	6+2+2 = 10	10
Wildfire	3	6+2+1 = 9	27

Table 16-6. Hazard Risk Ranking

Hazard Ranking	Hazard Event	Category
1	Severe weather	High
2	Earthquake	High
3	Landslide	Medium
3	Wildfire	Medium
4	Flood	Medium
5	Volcanic activity	Low
6	Dam Failure	Low
7	Drought	Low

Table 16-7. Hazard Risk Rankings by Reporting Area

	Hazard Event								
Hazard Ranking	Airport	Central City	Central Northeast	East Portland	North Portland	Northeast	Southeast	Southwest	West/ Northwest
Dam Failure	None	Low	None	None	None	None	Low	Low	Low
Drought	Low	Low	Low	Low	Low	Low	Low	Low	Low
Earthquake	High	Medium	Medium	Medium	High	Medium	Medium	Medium	High
Flood	High	Medium	Medium	Medium	Medium	Low	Low	Medium	Low
Landslide	None	Medium	Medium	Medium	Medium	Medium	Medium	High	High
Severe weather	High	High	High	High	High	High	High	High	High
Volcanic activity	Low	Low	Low	Low	Low	Low	Low	Low	Low
Wildfire	Low	Medium	Medium	Medium	Medium	Low	Low	High	High

Table 16-8. Hazard Risk Ratings by Reporting Area

Hazard Ranking	Hazard Event								
	Airport	Central City	Central Northeast	East Portland	North Portland	Northeast	Southeast	Southwest	West/ Northwest
1	Severe weather	Severe weather	Severe weather	Severe weather	Severe weather	Severe weather	Severe weather	Wildfire	Landslide
2	Earthquake	Earthquake	Earthquake	Earthquake	Earthquake	Earthquake	Earthquake	Landslide	Wildfire
3	Flood	Landslide	Flood	Flood	Flood	Landslide	Landslide	Severe weather	Severe weather
4	Volcanic activity	Flood	Landslide	Landslide	Landslide	Wildfire	Flood	Earthquake	Earthquake
5	Wildfire	Wildfire	Wildfire	Wildfire	Wildfire	Volcanic activity	Volcanic activity	Flood	Volcanic activity
6	Drought	Volcanic activity	Volcanic activity	Volcanic activity	Volcanic activity	Flood	Wildfire	Volcanic activity	Flood
7	N/A	Dam failure	Drought	Drought	Drought	Drought	Dam failure	Dam failure	Dam failure
8	N/A	Drought	N/A	N/A	N/A	N/A	Drought	Drought	Drought

The Mitigation Action Plan

PART 3—MITIGATION STRATEGY

17. Vision, Mission, Goals and Objectives

Hazard mitigation plans must identify goals for reducing long-term vulnerabilities to identified hazards (44 CFR Section 201.6(c)(3)(i)). The Steering Committee established a vision, a mission, goals and objectives for this plan, based on a review of the 2010 NHMP goals, the State of Oregon Hazard Mitigation Plan goals, and other locally relevant community plans and programs, such as the Portland Comprehensive Plan. Following this review, the 2010 NHMP goals were updated to most accurately reflect current community needs and values and changing community priorities (see Appendix H for 2004 and 2010 goals).

A working draft of the vision, mission, goals and objectives was established through facilitated exercises and group discussion. Figure 17-1 shows the most commonly used terms in steering committee member comments on the vision and mission development process (words shown in larger fonts were mentioned more frequently).

Figure 17-1. Vision and Mission Development Word Cloud

The goals and objectives continued to be revised throughout the plant update process based on the results of the risk assessment and feedback received during the public engagement process. The vision, mission, goals and objectives selected for this plan and presented below, along with the actions outlined in Chapter 19, all support each other. Goals were selected to support the vision and mission. Objectives were selected that meet multiple goals. Actions were prioritized based the number of objectives each would help to accomplish.

17.1 VISION

Vision is defined in this planning process as the City of Portland's desired future state. *The Mitigation Action Plan* was designed to support and inform the comprehensive plan, which is the implementing document for the Portland Plan. Therefore, it was determined that the vision for the MAP should align with the overall community vision for Portland, as follows:

> Portland is a prosperous, healthy, equitable and resilient city where everyone has access to opportunity and is engaged in shaping decisions that affect their lives (City of Portland 2035 Comprehensive Plan).

17.2 MISSION

The mission for the MAP defines what the plan aims to achieve and how:

> To equitably reduce risk and the adverse impacts of natural hazards by building community resilience through collaborative, cost-effective actions and strategies.

17.3 GOALS

The following goals were selected as general guidelines for the MAP that explain what the plan should achieve:

- Protect life and reduce injuries.
- Engage and build capacity for the whole community.
- Minimize public and private property damage.
- Protect, restore, and sustain natural systems.
- Minimize the disruption of essential infrastructure and services.
- Integrate mitigation strategies into existing plans and programs.
- Prioritize multi-objective actions that reduce risk to vulnerable communities.

17.4 OBJECTIVES

Objectives for this planning process are broader than actions but more specific than goals—specific enough to help determine whether a proposed project or program would advance the values expressed in the mission and vision. Objectives were used to define and prioritize actions. They also may be thought of as policies. Each objective meets multiple goals, serving as a stand-alone measurement of the effectiveness of a mitigation action, rather than as a subset of a goal.

Table 17-1 shows the objectives for the MAP and the goals that each objective supports. Some objectives were taken from or adapted from other local programs, and the source of those objectives is provided in parentheses after the description of the objective.

Table 17-1. 2016 Mitigation Action Plan Objectives

		Related Goals						
Objective		Life	Whole Community	Property	Natural Systems	Infrastructure	Integrate	Prioritize
1	Strengthen development codes and update land use designations to facilitate effective disaster risk reduction (Adapted from Portland Comprehensive Plan 4.78)	✓		✓	✓		✓	
2	Prevent or reduce mitigation-related disparities affecting under-served and under-represented communities through plans, investments and engagement (Adapted from Portland Comprehensive Plan 7.2)	✓	✓	✓		✓	✓	✓
3	Promote the use of natural systems to limit natural hazard related impacts (Adapted from Portland Comprehensive Plan 7.4b)				✓		✓	
4	Increase the resilience of high-risk and critical infrastructure through monitoring, planning, maintenance, investment, adaptive technology, and continuity planning (Portland Comprehensive Plan 8.25)	✓		✓		✓	✓	
5	Coordinate land use plans and public facility investments between City bureaus, other public and jurisdictional agencies, businesses, community partners, and other emergency response providers (Adapted from Portland Comprehensive Plan 8.99)		✓	✓		✓	✓	
6	Support community outreach activities that increase stakeholder awareness and understanding of hazard risk, mitigation options, and preparedness strategies (Adapted from Multnomah County NHMP O1.2)	✓	✓	✓	✓			
7	Identify and seek various funding opportunities for mitigation activities and look for ways to leverage existing funds (Adapted from Multnomah County NHMP O1.5)	✓		✓		✓	✓	
8	Seek opportunities in which hazard mitigation also benefits other community goals (Adapted from Multnomah County NHMP O3.4)	✓	✓	✓	✓	✓	✓	✓
9	Collect data to track progress on meeting mitigation goals.	✓	✓	✓	✓	✓	✓	✓
10	Use the best available data, science and technologies to improve understanding of the location and potential impacts of natural hazards, the vulnerability of building types and community development patterns, and the measures needed to protect life safety.	✓		✓	✓			

Objective		Related Goals						
		Life	Whole Community	Property	Natural Systems	Infrastructure	Integrate	Prioritize
11	Retrofit, purchase, or relocate structures in high hazard areas, especially those known to be repetitively damaged.	✓		✓		✓		
12	Promote, incentivize and support the mitigation of private property.	✓	✓	✓				✓
13	Improve systems that provide warning and emergency communications.	✓	✓		✓	✓		
14	Promote mutual information exchange and incorporate existing community networks in the identification and implementation of mitigation actions.		✓				✓	
15	Build City staff and community capacity to ensure effective implementation and equitable outcomes of mitigation action efforts (Adapted from Portland 2015 Climate Action Plan)		✓				✓	
16	Develop plans to reduce immediate impacts of natural hazard events, and to facilitate rapid and effective social and economic recovery.	✓	✓	✓			✓	
TOTAL		**12**	**11**	**12**	**7**	**8**	**11**	**4**

Note: Objectives are numbered for reference, not to indicate priority.

18. MITIGATION ALTERNATIVES

Risk is a function of the hazard, the level of exposure, the level of vulnerability, and the available capability to respond to or prepare for hazard events. Risk can be mitigated by manipulating the hazard, reducing exposure to the hazard, reducing vulnerability, or increasing capability. Where mitigation is not yet possible, risk can be reduced through preparation, response or recovery.

Over the course of the MAP planning process, catalogs of mitigation alternatives were developed (in compliance with 44 CFR (Section 201.6(c)(3)(ii))) from best practices, steering committee recommendations, and stakeholder input. One catalog was developed for each hazard of concern, as well as a catalog for actions that would mitigate all hazards. The catalogs present alternatives that are categorized in two ways:

- By who would have responsibility for implementation:
  - Individuals (public scale)
  - Businesses (private scale)
  - Government (government scale).
- By what the alternative would do:
  - Manipulate the hazard
  - Reduce exposure to the hazard
  - Reduce vulnerability to the hazard
  - Increase the ability to respond to or be prepared for the hazard.

The steering committee brainstormed mitigation actions to be included in these catalogs, voted to identify top-rated actions, and then developed a list of recommended actions. The list of top-rated actions is available in Appendix I, along with the full list of mitigation actions for all hazards.

These catalogs are not exhaustive. Their purpose was to provide a list of what could be considered to reduce risk to hazards within Portland. The City of Portland, in collaboration with stakeholders, reviewed the catalogs to identify ways to apply the actions they contain for specific needs and situations. The catalogs provide a baseline of mitigation alternatives that are backed by a planning process, are consistent with the established goals and objectives, and are likely within the capabilities of the City of Portland to implement. Actions in the catalog that are not included in the City's action plan were not selected for one or more of the following reasons:

- The action is not currently feasible.
- The action is already being implemented.
- There is an apparently more cost-effective alternative.
- The action does not have public or political support.
- The action is not within the capabilities of the City.
- The potential for equitable impacts cannot be assessed at this time.

19. Action Plan and Implementation

19.1 BUREAU ACTION SELECTION WORKSHOP

On May 11, 2016 a workshop was held to provide guidance to City bureaus on selecting the mitigation actions to be included in *The Mitigation Action Plan*. This workshop was attended by 28 staff members from 11 City bureaus or offices. At the workshop, the planning team reviewed and discussed the following:

- The planning process
- The concept of mitigation
- The tool kit assembled by the planning team for use in action selection
- The instructions for completing relevant implementation information for each identified action.

Each bureau participating in development of the MAP was provided with a set of expectations (see Appendix J) and asked to do the following:

- Complete a letter of intent (provided with the set of expectations)
- Designate points of contact
- Attend bureau workshop
- Apply an equity lens to project selection, development and prioritization
- Pursue mitigation implementation opportunities
- Attend annual reporting and update meeting.

In addition, bureaus were encouraged to support the steering committee and the public involvement strategy. All bureaus identified as lead agencies in action items selected for implementation were asked to complete and sign this letter of intent. The following sections of this chapter outline the end result of this workshop and the internal work done within each bureau to reconcile previously identified actions and identify new actions for the MAP.

19.2 STATUS OF PREVIOUS PLAN ACTIONS

The 2010 NHMP identified 101 mitigation actions for implementation. For the current update, these actions were reviewed by City bureaus and offices and other relevant agencies. For each action, it was determined whether the action had been completed, was in progress or had not been started. Incomplete actions were reviewed to determine if they should be carried over to the 2016 plan or removed from the plan due to a change in priorities, capabilities, or feasibility. In total, 75 (75 percent) of the identified actions have been started or completed, and 26 (25 percent) showed no progress. Of the 101 identified actions 39 (39 percent) were carried over to the 2016 plan. Each has a new action number assigned to it for the 2016 plan, and many were reworded to more clearly state their intent.

Table 19-1 summarizes the status of the recommended actions from the 2010 NHMP. More detailed information on many actions, especially those that were completed or are in progress, is provided in the 2016 Progress Report in Appendix A.

Table 19-1. Status of Actions Identified in the 2010 Natural Hazard Mitigation Plan

Action Item	Completed	Carry Over to MAP	Removed; No Longer Feasible
ST MH #1— Continue to involve the public in updating the Natural Hazard Mitigation Plan. (education & outreach)		✓	
Comment*: Carried over, PBEM-15.*			
ST MH #2 — Form a committee to identify and coordinate critical transportation (street and highway) networks. (mapping, asset management)	✓		
Comment*: There is no committee, but we have identified emergency transportation routes for key facilities. If new facilities are built, transportation routes would be re-evaluated.*			
ST MH #3 — Coordinate emergency standard operating procedures and plans between disaster responder organizations in the Portland metro region, to coordinate and expedite decision making during emergencies. (planning)	✓		
Comment*: Regional Multi-Agency Coordination on operations. Internally de-conflicted the County Basic Emergency Operations Plan with the City Basic Emergency Operations Plan. PBEM reviews other bureaus' emergency procedures.*			
ST MH #4 — Develop a multiple-agency multi-hazard evacuation plan (earthquake, flood, fire and landslide at a minimum).	✓		
Comment*: Evacuation Plan developed. Certain areas of highest risk have individualized plans (Linnton).*			
ST MH #5 — Acquire Light Detection and Ranging (LiDAR) images of the Portland Metro area to facilitate natural hazard area risk assessment and vulnerability analysis. (mapping) (NFIP Compliance)	✓		
Comment*: Acquisition complete. Analysis in progress.*			
ST MH #6 — Use findings from Portland's Risk Assessment (HAZUS-MH) to enhance existing debris removal plan. HAZUS-MH will need to be updated. (existing GIS Mapping)	✓		
Comment*: The 2003 HAZUS analysis was used to update Metro's debris removal plan from the 1990s in 2013. Debris modelling is being updated regionally. A new HAZUS analysis is being completed as part of the 2016 plan update.*			
ST MH #7 — Create a mitigation mapping committee to index and maintain GIS mapped inventory and develop prioritized list of critical facilities, residential and commercial buildings within known hazard areas such as earthquake, erosion, the 100-year and 500-year floodplains, invasive plant species, landslide and wildfire areas. (NFIP Compliance) Identify parameters and methods for new maps as needed to meet multi-hazard mitigation goals and to improve communication with the public.	✓		
Comment*: CGIS maintains inventory in Portland Maps. No such committee exists. Much of this will be accomplished through the MAP update. Parks, BES data, PBOT erosion data, and others are included. PBEM also promotes the Map Your Neighborhood initiative.*			
ST MH #8 — Partner with utilities as they ensure continuity of service to the City and the Columbia South Shore Well field to provide for redundancy in case of primary power outage. (asset management)		✓	
Comment*: Carried over, PWB-21.*			
ST MH #9 — Develop a city employee emergency response plan to assure that city employees know what is expected of them to continue City operations. (education, outreach)	✓		
Comment*: All bureaus have submitted Continuity of Operations Plans (COOP) and recognize accountability requirements. PBEM is hiring a COOP planner. The mayor sends out emails informing employees what to do in an emergency.*			
ST MH #10 — Develop educational materials (television and print media) for residents that identify and define their risk to multi hazards: define and offer mitigation measures that residents can take home or share, determine method of distribution of the educational materials and coordinate with the media to reduce conveyance of misinformation. (education, outreach)	✓		
Comment*: PBEM hired a comm. outreach representative, supports preparedness campaigns, promotes preparedness materials, and has offered seismic strengthening programs. Public Information Officer works with local news (KOIN) on post-disaster collaboration.*			

Action Item	Completed	Carry Over to MAP	Removed; No Longer Feasible
ST MH #11 [a] — Implement actions in the 2005 Portland watershed management Plan (planning) (NFIP Compliance)		✓	
Comment: *Carried over, BES-1.*			
LT MH #1 [a] — Revise Portland's Comprehensive Plan to address and implement Citywide policies, land use improvements and mapping changes to natural hazards including, but not limited to, earthquakes, erosion, floods, invasive plants, landslides, volcano, severe weather and wildfires. (mapping, planning) (NFIP Compliance)		✓	
Comment: *Carried over, BPS-5, BPS-6.*			
LT MH #3 — Increase the responsiveness of the emergency permitting procedures for post-hazard event periods through development of a procedural plan and the purchase of a mobile permitting van. (planning)		✓	
Comment: *Carried over, BDS-1. Eliminated "purchase of a mobile permitting van" as this was determined to be cost-prohibitive.*			
LT MH #6 — Promote the development of TriMet communications and dispatch capability to immediately implement changes to transit routes and service due to disruption of streets, roads, bridges, rail transit tracks and the information technology that provides connectivity. (planning)	✓		
Comment: *PBOT has encouraged TriMet to utilize WebEOC as the information sharing tool during severe weather events.*			
LT MH #8 [a] — Review and amend City Code and other compliance documentation to require that all facilities that store or handle hazardous materials (including large tanks) and which are located in the 500-year floodplain, landslide, or other hazard areas, develop a hazardous materials inventory statement. This statement will be made available for Fire Bureau review. Require that these storage tanks are either adequately protected or relocated outside of the 500 year floodplain, landslide, or other hazard areas. (asset management) (NFIP Compliance)		✓	
Comment: *City Resolution 36156 (Water Bureau) requires businesses in the Columbia South Shore Well Field Wellhead Protection Area that meet hazmat thresholds to report a hazardous materials inventory every November 30. 2016 Critical Energy Infrastructure Hub Risk Assessment report includes recommendations to begin accomplishing this. Carry over, PBEM-19.*			
LT MH #9 — Identify and pursue funding opportunities from outside agencies to fund and implement identified mitigation projects and activities. (education, outreach)	✓		
Comment: *FHA grant funding for PBEM/PBOT transportation planner. PDM 13 grant for MAP update, Hazard Mitigation Program grant for seismic retrofitting of private residences, PDM 15 grant application for seismic retrofit of private residences. PBEM annually applies for and receives Emergency Management Performance Grants, Urban Areas Security Initiative grants, and others on a regular basis. *Note: PBEM did not receive the Urban Areas Security Initiative grant in 2013.*			
LT MH #10 — Assess the stability of levees in the Columbia Corridor Area and develop appropriate emergency plans to address potential levee failure and associated hazards. (planning)		✓	
Comment: *Carried over, PBEM-14, OMF-1.*			
LT MH #11 [a] — Support development of a multiple-agency plan for Marine Drive closure coordination. (planning)	✓		
Comment: *PBOT is part of the Multnomah County Drainage District Flood Emergency Action Plan (2016) to install stop log closures along Marine Drive as necessary. Marine Drive closure is outlined in the City's evacuation plan for the Districts, which is an annex to the BEOP.*			
LT EQ #11 [a] — Work with local jurisdictions to assess the capacity of landfill to accommodate earthquake debris: develop coordination plans for disposal of debris in the aftermath of an earthquake. (planning)		✓	
Comment: *Carried over, PBEM-4.*			

Action Item	Completed	Carry Over to MAP	Removed; No Longer Feasible
New MH #1 [a] — Cross reference and incorporate mitigation planning provisions into all community planning processes such as comprehensive, capital improvement and land use plans, to demonstrate multiple bureau benefits and strengthen eligibility from multiple funding sources. This action is also identified in LTFL#8, IS#94 & SW#117. (planning)	✓		
***Comment**: 2010 Natural Hazard Mitigation Plan components incorporated into Climate Action Plan and Comp. Plan update. PBEM regularly provides comments on citywide planning efforts and requests comments or participation from other bureaus on PBEM planning activities*			
New MH #2 — Identify and list repetitively flooded structures and infrastructures, analyze the threat to these facilities and prioritize mitigation actions to protect the threatened population. (NFIP Compliance)		✓	
***Comment**: Carried over, BES-4.*			
New Reworded MH — Acquire (buy-out), demolish, or relocate structures from hazard prone area. Property deeds shall be restricted for open space uses in perpetuity to keep people from rebuilding in hazard areas. (planning) (NFIP Compliance)		✓	
***Comment**: Carried over, BES-4.*			
New MH #3 [a] — Develop and incorporate building ordinances commensurate with building codes to reflect survivability from all hazards to ensure occupant safety. (NFIP Compliance)		✓	
***Comment**: Carried over, BDS-2.*			
New MH #4 [a] — Update the Infrastructure Master Plan and System Vulnerability Assessment, Sewer Failure Response Plan. (asset management, planning)	✓		
***Comment**: The Infrastructure Master Plan was updated in 2014 and was renamed the Citywide Systems Plan. The Sewer Failure Response Plan was updated in 2012 to comply with National Pollutant Discharge Elimination System permit requirements, and named the Sewer Release Response Plan.*			
New MH #5 — Partner with agencies to develop a west side operations center to be used during an emergency if the east side Emergency Control Center and other City facilities become inoperable.		✓	
***Comment**: Carried over, OMF-2.*			
New MH #6 [a] — Promote 09 Climate Action Plan action items with similarities to adaptation planning and mitigation actions. (planning)		✓	
***Comment**: Carried over, BPS-7.*			
ST EQ #2 [a] — Assess existing earthquake related mitigation plans and vulnerability studies to identify areas of conflict, duplication or gaps between studies & secondary hazards of earthquake. (planning)			✓
***Comment**: Removed as it was determined that this is not a priority and not a productive use of staff time.*			
ST EQ #3 [a] — Update the vulnerability analysis of Columbia Boulevard Wastewater Treatment Plant Tryon Creek Wastewater Treatment Plant and wastewater pump stations. (Asset management, planning)		✓	
***Comment**: Carried over, BES-3.*			
ST EQ #4 — Prioritize the return of power to treatment plants (Tryon Creek and Columbia Boulevard) and pump stations.		✓	
***Comment**: Carried over, BES-2.*			
ST EQ #8 — Study the feasibility of mandatory or voluntary installation of seismic shutoff valves on natural gas meters at commercial and residential buildings.	✓		
***Comment**: PBEM pursued this, but it did not come to fruition. Valves are expensive, and take time and professional services to turn back on after being shut off. BPS and BDS have advocated for disclosure of seismic information upon sale of homes.*			
LT EQ #3 [a] — Develop a plan to strengthen sewer infrastructure in areas where street overlays and sewers have potential to collapse in a seismic event. (asset management)		✓	
***Comment**: Carried over, CAMG-1.*			

Action Item	Completed	Carry Over to MAP	Removed; No Longer Feasible
LT EQ #6 — Assess the vulnerability of the water distribution system to seismic events: work toward hardening the system.		✓	
Comment: *Carried over, PWB-1.*			
LT EQ #8 [a] — Study development regulations and policies to ascertain if regulations can be made to limit development of high risk facilities in known areas of earthquake hazards.		✓	
Comment: *Carried over, BPS-4, BPS-13, and BPS-15.*			
SW #2 — Acquire an additional facility for storage of anti-icing materials and expand anti-icing vehicle inventory.		✓	
Comment: *PBOT acquired additional plows, sanders and anti-icing equipment. Storage for additional anti-icing material is planned for the Jerome Sears Westside facility once project is completed. Carried over, OMF-2.*			
ST SW #6 — Insulate residential buildings that house at risk populations.	✓		
Comment: *This action is being accomplished through different means. BPS created Clean Energy Works, Oregon which is now a non-profit organization that conducts energy audits and provides homeowners with low-cost energy efficient upgrades.*			
ST SW #7 — Prioritize existing building stock for active review of Title 29 (Dangerous Building Code) This needs to be updated with intern information or information sent from individuals that are on the team.			✓
Comment: *Removed because it is not feasible, not a productive use of staff time, and not directly related to hazards.*			
ST FL #1 — A covenant is recorded with the deed of new development in the floodplain to ensure that space below the base flood elevation is not converted to habitable space. This should be codified to improve compliance. (NFIP Compliance)		✓	
Comment: *Carried over, BDS-3.*			
ST FL #2 — Continue to co-fund improvements to river and stream gauges in the Portland metropolitan area with the United Geological Survey.		✓	
Comment: *Carried over, BES-7.*			
ST FL #4 — Secure the agreements necessary to design and implement the redevelopment of Freeway Land Company site. (within the Lents Urban Renewal Area)			✓
Comment: *Removed. Determined to be overly specific. Incorporated into BES-18.*			
ST FL #5 — Acquire outside funding to hire a consultant to lead the application process to maintain a Class 5 rating when the City seeks Community Rating System re-certification.	✓		
Comment: *Recently completed reverification. Portland is likely to be a Class 6 Community follow an extremely rigorous reverification process. New, more robust guidelines in the 2013 CRS Coordinators' Manual made it impossible to retain Class 5 status.*			
ST FL #6 [a] — Support Multnomah County Drainage District (MCDD) in the continued calibration and update of hydraulic models for conveyance and internal flood impacts to the four floodplains managed by MCDD #1.		✓	
Comment: *BES-20*			
ST FL #8 — Identify funding for the design and construction of the Springwater Wetlands Complex, a 30-acre floodplain wetland restoration project in the Lents area of Johnson Creek.			✓
Comment: *Removed. Determined to be overly specific. Incorporated into BES-18.*			
ST FL #9 — Secure funding to implement the passive flood management projects that are recommended in the Johnson Creek Restoration Plan & other watershed management plans. Coordinate with Portland Development Commission's urban renewal efforts in Lents and with other partners in other parts of the watershed.			✓
Comment: *Removed. Determined to be overly specific. Incorporated into BES-18.*			
ST FL #10 — Improve definitions and refine standards for stormwater retention in the Storm water Management Manual.	✓		
Comment: *New Stormwater Management guidelines have just been released, with clarifying definitions and standards.*			

Action Item	Completed	Carry Over to MAP	Removed; No Longer Feasible
LT FL #1 — Increase funding for the Johnson Creek Willing Seller Program; establish willing seller programs in other watersheds where flood hazard and priority restoration areas coexist. (NFIP Compliance)		✓	
Comment: *Carried over, BES-6.*			
LT FL #3 [a] — Develop a plan for addressing flooding in the Holgate Lake area. (planning) (NFIP Compliance)			✓
Comment: *Removed. Outside of scope of Johnson Creek Willing Seller area and not identified in Johnson Creek Restoration Plan. Not a current or future priority for BES.*			
LT FL #4 — Improve hydraulic bottleneck that prevents discharge of chlorinated effluent to the Willamette River during high river levels. (NFIP Compliance)			✓
Comment: *Removed. Does not directly address risk from natural hazards.*			
LT FL #5 [a] — As Waterfront Park remodeling is designed, ensure that Portland's downtown property and critical facilities remain protected from floodwaters. (asset management)		✓	
Comment: *Carried over, PP&R-1.*			
LT FL #6/#7 [a] — Partner with Army Corps of Engineers to conduct modeling of the Willamette River upstream of Portland to identify areas that, if acquired or restored, would contribute to mitigate of peak flows in Portland or result in significant reduction of flood damages. (NFIP Compliance)			✓
Comment: *Removed. This is beyond the city's (specifically BES's) capabilities and responsibilities.*			
LT FL #8 [a] — Develop goals, policies and implementation measures to manage the amount of new impervious surface and remove existing impervious surfaces where appropriate. These goals, policies and measures may be at the citywide, watershed, or sub-watershed level. (planning) (NFIP Compliance)		✓	
Comment: *Draft Comprehensive Plan contains goals and policies, and updated CAP and new Climate Change Preparation Strategy include objectives and actions to limit and reduce impervious area. BES would lead implementation measures to actually remove pavement. Carried over, BPS-17.*			
LT FL #9 — Upgrade trestles that carry the main conduits of the water delivery system. (Sandy River Crossing interties completed) (asset management)		✓	
Comment: *Carried over, PWB-55.*			
FL #10 — Create redundancy in the water delivery system at the three Sandy River crossings by burying conduits under the river (in progress).		✓	
Comment: *Carried over, PWB-56.*			
LT FL #11 — Provide funding for and participate in development of a flood inundation model for the managed floodplains and downtown sea wall. (mapping) (NFIP Compliance)			✓
Comment: *Removed. Lead agency would be FEMA. New floodplain mapping requirements under the FEMA biological opinion will require FEMA to do this work with specific climate projections and mapping protocols.*			
LT FL #12 — Install a river gauge in the vicinity of the bridge over Johnson Creek at 108th. The gauge should be able to send data to remote monitoring sites.	✓		
Comment: *The bridge was removed as part of the Foster Floodplain Natural Area construction, which created an additional 120 acre feet of flood storage along SE Foster Rd. We have installed a crest gage however to determine flood levels during over-bank events.*			
LT FL #13 — Install one-way valves on the outlet pipes of the storm inlets on SE Foster Road between 101st and 112th.	✓		
Comment: *These outlets now go to a stormwater facility that is part of the Foster Floodplain Natural Area.*			
FL #1 [a] — Complete update to the Johnson Creek Restoration Plan. Develop individual plans for each sub-watershed to address the sources of excess stormwater runoff that exacerbates flooding. (NFIP Compliance)			✓
Comment: *This action was determined to be redundant with ST MH #11*			

Action Item	Completed	Carry Over to MAP	Removed; No Longer Feasible
FL #2 [a] — Establish flood mitigation priorities for critical facilities and residential and commercial buildings located within the 100- year floodplain using survey elevation data. (NFIP Compliance)		✓	
Comment: *Rolled over, CAMG-2.*			
ST-LS #1 [a] — Continue to maintain and Improve internal City communications to facilitate coordination of landslide mitigation activities. (education, outreach)		✓	
Comment: *Carried over, PBOT-5.*			
ST-LS #3 — Mitigate Portland's water supply infrastructure from landslide hazards. (asset management)		✓	
Comment: *Carried over, PWB-57.*			
ST-LS #4 — Initiate more operations and maintenance pilot projects along roads that inform about the development of standards for managing stormwater in ditches in landslide prone areas. (education, outreach)		✓	
Comment: *Carried over, BES-11.*			
LT-LS #1 — Develop a comprehensive landslide map for the City of Portland to identify hazard areas and to improve communications with the public. (mapping)		✓	
Comment: *Carried over, PBEM-9.*			
New LT LS #3 — Evaluate the role of drainage systems in the West Hills, including pipes, streams and drainage ways and options for protecting and improving their functions and increasing their resiliency. (planning)			✓
Comment: *This action was determined to be redundant with ST MH #11*			
LT LS #4 [a] — Review the effectiveness of existing regulations related to development in landslide hazard areas. (planning)	✓		
Comment: *Complete. Downzoning completed as part of Comprehensive Plan update.*			
LT-LS #6 — Employ alternative construction methods such as trenchless construction on City projects to reduce the impact that development can have in landslide prone areas	✓		
Comment: *PBOT accomplishes this for sewer repair. City bureaus use a variety of practices depending on site and system conditions.*			
LT LS #7 — Continue development of standards for small pump stations as an alternative to gravity sewers in accessible or high risk areas.			✓
Comment: *Removed. Not directly related to reducing risk from natural hazards.*			
ER #1 [a] — Develop recommendations for high and low ranking streamside plants that provide more erosion control, such as reducing erosion from high water and wave actions.		✓	
Comment: *Carried over, BES-12.*			
ER #2 [a] — Implement projects that retain native vegetation, increase vegetation diversity and increase the complexity of the vegetation strata (having three vegetation strata: herbs, shrubs, trees).		✓	
Comment: *Carried over, BES-13.*			
ER #3 [a] — Implement policies to increase the extent of coverage of the Greenway zones along the rivers and further limit proposed activities within these areas.	✓		
Comment: *Complete. Expanded Greenway Zones included in 2035 Comprehensive Plan.*			
ER #4 [a] — Develop standards for soil backfill in vegetated areas, especially sloped areas. (planning)			✓
Comment: *Removed. Not a priority action for City bureaus.*			
ER #5 [a] — Establish regulations that prevent installation of slopes steeper than 3:1 and prohibit development on slopes steeper than 3:1. (planning)			✓
Comment: *Removed. Determined to be an ineffective strategy.*			
ER #6 — Implement projects that layback and/or regrade riverbank slopes and secure wetland sod mats composed of native emergent/grasses, etc.	✓		
Comment: *Complete. Established practice for restoration projects.*			

Action Item	Completed	Carry Over to MAP	Removed; No Longer Feasible
ER #7 — Construct and install bio-engineered slope protective measures to reduce or eliminate erosion	✓		
Comment: *Complete. Established practice for restoration projects.*			
ER #8 — Implement projects that increase large wood structures that act to soften the effect of wave action on shorelines as well as provide habitat for migrating salmonids.		✓	
Comment: *Carried over, BES-14.*			
ER #9 — Secure large wood [boles w/ attached root wads] or log rafts to reduce high wave action that can result in erosion.			✓
Comment: *Removed. Redundant with ER #8/BES-14.*			
ST WF #1 — Consolidate unassigned and/or unmanaged vegetated areas owned by the City under a single land management umbrella. (asset management)			✓
Comment: *Removed. Not a priority and does not directly reduce risk from natural hazards. Intent is served by ST WF #2.*			
ST WF #2 — Procure funding for management of vegetated natural areas with high wildfire danger, including public and private properties.	✓		
Comment: *Parks does not seek funding from outside sources, but this is a typical management practice and is integral to Parks SOPs and management/planning documents.*			
ST WF #4 — Provide wildfire management training to staff. (education, outreach)	✓		
Comment: *Each year, Portland Fire & Rescue (PF&R) provides seasonal wildland training to all line personnel by reviewing and exercising procedures. In 2016, PF&R will conduct a spring Training Block that all line staff will complete, with basic state level hands-on wildland training.*			
ST WF #5 [a] — Amend the Portland Plant List and other related City plant lists and landscaping guides to include/identify fire resistant native plants and planting strategies that could be encouraged or required in local landscaping. (planning)	✓		
Comment: *The Portland Plant List was updated to provide information about fire resistant native plants. Other landscaping and tree guides are maintained by BDS and Portland Parks & Recreation (PP&R).*			
ST WF #6 [a] — Integrate, as appropriate, fire prevention goals and provisions into City policies, plans and codes. Identify and address ambiguities or conflicts among city requirements. (planning)	✓		
Comment: *The draft Comprehensive Plan includes policies and map changes to reduce future risks and impacts from natural hazards, including wildfire. The draft plan also includes new urban forest related policies that recognize the need to manage for wildfire.*			
ST WF #7 [a] — Identify conditions of approval and mitigation strategies that could be applied to new development or redevelopment in high risk areas.		✓	
Comment: *Carried over, BPS-11.*			
ST WF #9 [a] — Improve the system for identifying new construction in areas subject to wildfires and communicating this information to the affected land owners. (planning)	✓		
Comment: *It is not clear what exactly this strategy means. It seems to imply a new mapping tool or interface. BTS upgraded the online mapping platform at PortlandMaps.com, which shows fire risk by parcel.*			
ST WF #10 — Conduct systematic reviews of Portland's large, publicly owned, wildland tracts regarding fire safety and ecological health to ensure informed land management decisions. (asset management)	✓		
Comment: *Complete. This is part of PP&R standard operating procedures and planning documents.*			
ST WF #11 — Adopt the national "Fire Danger Rating System" and install the signs at key points in the City.			
Comment: *This is part of Parks' standard operating procedures and planning documents.*			

Action Item	Completed	Carry Over to MAP	Removed; No Longer Feasible
ST WF #12 — Implement a neighborhood wildland interface disaster planning program. (education, outreach)	✓		
Comment: *"Ready, Set, Go!" was developed and managed by the International Association of Fire Chiefs. We adopted the program last year, and have information on our website and handouts for citizens to learn how to protect themselves.*			
ST WF #13 [a] — Review and potentially refine City contract specifications for machinery operations during "Red Flag" weather conditions. (asset management)	✓		
Comment: *Complete. City of Portland's General Construction Safety Provisions for Owner Controlled Insurance Program document was updated by BES and PWB in January, 2011.*			
ST WF #14 [a] — Convene a standing wildland interface fire technical group. (planning)		✓	
Comment: *Carried over, PF&R-2.*			
ST WF #15 [a] — Index City wildfire mitigation plans and activities. (asset management)	✓		
Comment: *The 2011 Multnomah County Community Wildfire Protection Plan indexes recommendations from the 2010 NHMP, the 2009 Wildfire Readiness Assessment Gap Analysis Report, and the Forested and the 2005 Wildland Interface Areas Protection Annex recommendations into one comprehensive list.*			
WF [a] — Develop and implement protocol for defining and mapping Wildland Urban Interface Zones and develop recommended policies, regulations and landscape options for incorporation into City plans and programs. (planning)		✓	
Comment: *Carried over, PF&R-3.*			
ST WF #16 — Identify water grid engineering requirements for firefighting in wildfire areas. (asset management)	✓		
Comment: *Complete. PWB has extended the infrastructure or grid into some of these wildfire prone areas. There are City requirements for minimum fire flow standards in new developments throughout the WUI.*			
LT WF #2 [a] — Review the feasibility of adopting portions of nationally recognized wildfire interface codes to strengthen building standards in wildfire risk areas.	✓		
Comment: *Complete. The City of Portland has adopted the State of Oregon wildland urban inter-face requirements which are regulated by Bureau of Developmental Services.*			
LT WF #3 — Design and conduct a study to determine the effectiveness of maintenance agreements that are established when new land divisions are approved to manage vegetation in open space tracts.		✓	
Comment: *Carried over, BES-9.*			
LT WF #4 — Complete an assessment to characterize high priority wildfire risk areas and recommend specific mitigation strategies.			✓
Comment: *Removed. LiDAR data collected in 2014 may be processed with vegetation classifications to develop a wildfire risk zones dataset. This data is owned by the region, and this effort would be coordinated regionally.*			
LT WF #5 — Explore avenues for funding wildfire interface home construction upgrades to low income homeowners.			✓
Comment: *Removed. Not a priority - anecdotal cost-benefit analysis does not show this as being an efficient use of city resources.*			
WF [a] — Act upon all Mitigation Actions outlined in the Wildfire GAP Analysis Report		✓	
Comment: *Carried over, PF&R-3.*			
IS #1 — Update Invasive Species Plants List by consolidating nuisance and prohibited plant lists into one "Nuisance Plants List" and assigning priority ranks to the Nuisance Plants List.	✓		
Comment: *Completed in 2010*			
IS #2 [a] — Clarify zoning regulations to require removal of plants on the Nuisance Plants List in the Environmental, Greenway and Pleasant Valley Natural Resources Overlay Zones and the Columbia South Shore and Johnson Creek Basin Plan Districts.			✓
Comment: *There is no additional plan to require removal of all nuisance plants in the specific areas identified in the action.*			
IS #3 [a] — Initiate a process to ensure the Erosion Control Manual be made consistent with City goals to control and eradicate invasive plants. (planning)	✓		
Comment: *The Erosion Control Manual was updated in 2010. In this update, invasive species were called out as specifically prohibited.*			

Action Item	Completed	Carry Over to MAP	Removed; No Longer Feasible
IS #4 [a] — Initiate a process to ensure the Tree and Landscaping Manual, the Recommended Street Tree List and the Stormwater Management Manual be made consistent with City goals to control and eradicate invasive plants. (planning)			✓
Comment: *Removed. Invasive species are considered in all documents as a general practice.*			
IS #5 [a] — Coordinate with the Portland Plan project to help ensure that invasive species are addressed in the Comprehensive Plan update and Portland Plan work plan. (planning)	✓		
Comment: *The draft Comprehensive Plan contains policies to manage and prevent the spread of invasive plants.*			
IS #6 [a] — Research the feasibility of establishing a local noxious or invasive weed law.	✓		
Comment: *Completed. Invasive Plant Policy Review and Regulatory Improvement Project completed in 2011.*			
LT V #1 [a] — Work with the state and other impacted jurisdictions to implement and update the various volcano Inter-Agency Coordination Plans.		✓	
Comment: *Carried over, PBEM-7.*			
V [a] — Work with the state and other impacted jurisdictions to implement and update the various volcano Inter-Agency Coordination Plans.			✓
Comment: *This action was determined to be redundant with LT V #1*			

a. Action was identified as a plan integration action by the planning team. See Section 19.5.5 for more information.

19.3 ACTIONS SELECTED FOR IMPLEMENTATION IN THE 2016 PLAN

City bureaus and offices were encouraged to review a wide variety of sources of actions for inclusion in the MAP:

- **Mitigation Best Practices Catalog**—A catalog that includes FEMA and other agency identified best practices, steering committee and other stakeholder recommendations, and recommendations from the Critical Energy Infrastructure Hub report.
- **Risk Assessment and Issues**—The results of the risk assessment information and issues identified during the planning process including the exposure and vulnerabilities of critical facilities that bureaus and offices may own or operate or upon which they depend.
- **Public Input**—The results of the public survey and summary notes from the Planning for Real workshops.
- **Other Plans and Programs**—Projects or actions that have been identified in other plans and programs such as the Climate Action Plan, Local Energy Assurance Plan, Capital Improvement Program, etc.
- **Capability Assessment**—Items listed in the capability assessment that the City does not currently have and would like to pursue.
- **2010 Natural Hazard Mitigation Plan**—Actions that were identified as “carry-over” actions from the 2010 plan.

Bureaus were asked to include a special emphasis on selecting actions that were identified by the steering committee and/or identified during the course of the broader public engagement efforts.

19.3.1 Equity Analysis Screening

After bureaus had performed a cursory review of potential actions and developed a working list for inclusion, an equity analysis screening for each action was performed using the following question matrix and review tool. Bureaus were encouraged to make revisions based on the review or to hold off on the pursuit of some actions until more information about equitable implementation could be identified.

A NOTE ON EQUITY:

The Portland Plan defines equity as follows:

- When everyone has access to the opportunities necessary to satisfy their essential needs, advance their well - being and achieve their full potential. We have a shared fate as individuals within a community and communities within society. All communities need the ability to shape their own present and future. Equity is both the means to healthy communities and an end that benefits us all.
- Equity concerns that are of particular importance in hazard mitigation include policies and programs that influence an individual's, household's, or group's ability to:
    - Anticipate
    - Cope with
    - Respond to, and
    - Recover from a hazard event.
    - Policies and programs can enhance or diminish vulnerability.

Review Tool

The equity screening review tool presented in Table 19-2 was developed by the Portland Bureau of Planning and Sustainability as part of the Climate Action Plan Equity Implementation Guide and adapted with guidance from the Portland Officer of Equity and Human Rights. Questions were reviewed and discussed by bureaus as appropriate during the equity analysis screening process.

Question Matrix

The question matrix (see Table 19-3) was designed as a conversation tool. Bureaus were asked to talk through these questions for each identified action and were encouraged to have a group discussion about actions so that multiple perspectives were brought into the screening process.

Table 19-2. Equity Screening Review Tool

	Procedural	Distributive	Structural
Programs/ Services	How was the target audience included in the design of the program? What actions will be taken to ensure that services and programs are physically and programmatically accessible and inclusive? What are the criteria for participation or receipt of benefits?	Is the program or service designed to meet the needs of underserved and underrepresented communities? If not what would need to be changed to ensure their equitable participation? How will program dollars be allocated to ensure inclusive and accessible service delivery? Does the cost structure of the program result in disparate use?/Does the fee structure of the service result in increased burdens for low-income communities?	Does this program/service create unintended consequences for communities that are underserved and underrepresented? How will they be mitigated? Is there an opportunity to extend additional benefits through this program/service that can help support the healing of past harms to communities? Does the program empower and build capacity of a community
Capital Investments	What are the criteria for prioritizing projects and investments? Does the data and information used consider the demographic, geographic and real-world experience of residents and businesses in the area? If data gaps exist, what are you using to guide decisions? What process will be used to get input from the community? How will you reach underserved populations?	Will the investment provide improved safety, health, access or opportunity for the communities who need it most? How will the underserved people who currently live and work in the area benefit from the investment?	What measures will be taken to mitigate the potential impacts of involuntary displacement in the project? How will business or employment opportunity created through the project be extended to communities of color, people with disabilities, and low-income people? How will community benefits be negotiated?
Regulation	Has analysis been done on the impacts to communities of color, people with disabilities, low-income populations, seniors, children, renters, and other historically underserved or excluded groups? How will impacted communities be able to learn about and understand changes with the regulation? How will the regulation be enforced?	Will the regulation provide improved safety, health, access or opportunity for the communities who need it most? How will the regulation alleviate any cost-burden for those who are already in a position where it is difficult to pay?	Does the regulation create or inhibit opportunity for communities of color, people with disabilities, and low-income populations? Will enforcement disproportionately negatively affect low-income communities or communities of color? How will this be mitigated?
Planning	How will impacted communities be involved in the planning process? What measures will be taken to ensure the process is fair and inclusive?	How does the plan prioritize and address the needs of the most impacted or vulnerable in the community? Does the plan improve safety, health, access or opportunity for the communities who need it most? How will resources shift to ensure equitable implementation of the plan?	What measures will be taken to mitigate the potential impacts of involuntary displacement? How will policies support community development? What support is needed to build the community's ownership and self-determination with the plan?

a. Procedural equity—ensuring that processes are fair and inclusive in the development and implementation of any program or policy
b. Distributive equity—ensuring that resources or benefits and burdens of a policy or program are distributed fairly, prioritizing those with highest need first.
c. Structural equity—a commitment and action to correct past harms and prevent future negative consequences by institutionalizing accountability and decision-making structures that aim to sustain positive outcomes

Source: BPS Presentation, Climate Action Plan and Equity: Connecting the Dots with the Community

Table 19-3. Equity Screening Question Matrix

Evaluation Question		Response
1. What issue/problem/risk is the action designed to address? And what are the expected benefits?		Issue:
		Benefits:
2. Who is the target audience/beneficiary for this action? Who is affected if no action is taken?		
3. How would you classify the mitigation action? (Programs/Service; Capital Investment; Regulation; Planning). *Refer to questions in table above based on your answer to this question.*		
4. Will any community groups be involved in the design/implementation of this action? (i.e. potential partners)		
5. Will this action reduce risk from natural hazards for the following groups? How?		
	Communities of color	
	Persons with disabilities and/or access and functional needs	
	Households with limited English Proficiency	
	Renters	
	Economically disadvantaged families	
	Seniors (age 65 or older)	
	Children (under 15 years of age)	
6. How could this action benefit the following groups? Or How could this action be modified so that there are benefits?		
	Communities of color	
	Persons with disabilities and/or access and functional needs	
	Households with limited English Proficiency	
	Renters	
	Economically disadvantaged families	
	Seniors (age 65 or older)	
	Children (under 15 years of age)	
7. How could this action burden/negatively impact/leave out the following groups, for example through communication, transportation, physical or programmatic barriers?		
	Communities of color	
	Persons with disabilities and/or access and functional needs	
	Households with limited English Proficiency	
	Renters	
	Economically disadvantaged families	
	Seniors (age 65 or older)	
	Children (under 15 years of age)	
8. If you have identified burdens, barriers, or negative impacts, or opportunities for benefits please revisit the action to identify strategies to reduce or eliminate burdens or negative impacts; remove communication, transportation, physical or programmatic barriers; or enhance potential benefits.		
9. Have you identified a performance metric for evaluating progress on this action? How will you know when this action is complete? (please provide) Have you considered outcomes for communities of color, people with disabilities, low-income families, people with limited English proficiency, renters, seniors, and children?		

19.3.2 Selected Actions

Table 19-4 shows the 161 actions that were selected for implementation during the performance period of the MAP. Actions are named and numbered by the lead agency identified for implementation. This agency will be the primary contact for annual progress reports as discussed in the plan implementation and maintenance strategy described in Section 0. In addition to the action name and description, the following information is provided for each identified action:

- **Lead agency**—The lead agency in administering the project.
- **Potential partners**—Potential partners that may be able to assist with implementation.
- **Hazard addressed**— The specific hazard(s) the action will mitigate.
- **Action Source**—Where the action came from, for example Climate Action Plan or Steering Committee Recommendation.
- **Performance Metric**—How the lead agency will measure progress on this action.
- **New or existing assets**— Indicates whether the action mitigates hazards for new or existing assets or both.
- **Funding**—Funding sources identified for the action.
- **Timeframe**—Timeframe is listed as follows:
  - **Near-term** (plan adoption to May 2018)
  - **Mid-term** (June 2018 to December 2021)
  - **Long-term** (2022 or beyond)
  - **Existing/on-going** (currently underway or annual/semi-annual schedule)
  - **Uncertain** (depends on funding/other factors)
- **Objectives met**—The mitigation plan objectives identified by number that the action addresses (see Table 17-1).
- **In previous plan**—Indicates if the action was a carry-over action from the 2010 plan and the former action item number.

The actions selected are projects, programs, and policies that City of Portland bureaus and offices hope to implement over the next five years. It is important to note that this action plan includes only those actions that fall under the jurisdictional authorities of the City of Portland. Many other agencies, jurisdictions, districts, and organizations exist within the City of Portland, and have responsibilities outside of this plan.

Table 19-4. Actions Selected for Implementation

Hazards Addressed	New or Existing Assets	Funding Options	Timeframe	Objectives Met	In Previous Plan? (# from previous plan)
PBEM-1 — Continue to engage and inform the public about hazards, including through a "disaster survivor" storytelling event and through postcard mailers sent to every household in Portland with easy-to-understand and graphic-heavy information about hazards and actionable instructions on how to be prepared. Include information about how to register for Public Alerts with all outreach efforts.					
Lead Agency: Portland Bureau of Emergency Management (PBEM)		**Partner Agencies:** Office of Neighborhood Involvement (ONI), Immigrant and Refugee Community of Oregon (IRCO), Local media partners, Coalition of Communities of Color			
Action Source: Public Workshops		**Performance Metric:** # of postcard mailers sent; # of new Public Alerts registrants; # of attendees at events			
All Hazards	N/A	Staff Time/Budget Reallocation	Short-term	2, 6, 8, 10, 12, 15	No
PBEM-2 — Expand the Neighborhood Emergency Team (NET) program into every neighborhood in Portland and expand beyond the neighborhood structure to non-geographic and cultural communities (e.g. immigrant and refugee communities, disability community organizations), and work with Community Engagement Liaisons to provide trainings in languages other than English.					
Lead Agency: Portland Bureau of Emergency Management (PBEM)		**Partner Agencies:** Community Engagement Liaisons (CELs) program; Office of Neighborhood Involvement (ONI); neighborhood associations			
Action Source: Public Workshops		**Performance Metric:** # of additional neighborhoods with established NETs; NET diversity reporting			
All Hazards	N/A	Staff Time/Budget Reallocation	Long-term	2, 6, 8, 14, 15	No
PBEM-3 — Expand PBEM's capacity to provide community trainings and partner with the Office of Neighborhood Involvement (ONI), Diversity in Civic Leadership (DCL) program, Community Engagement Liaisons, and Multnomah County programs, as well as Non-Governmental Organizations and community-based programs to connect under-resourced and underserved communities with disaster preparedness, home safety, emergency response, and other training opportunities.					
Lead Agency: Portland Bureau of Emergency Management (PBEM)		**Partner Agencies:** Office of Neighborhood Involvement (ONI), Diversity in Civic Leadership (DCL) program, Community Engagement Liaisons (CELs) program, Multnomah County, Non-Governmental Organizations			
Action Source: Public Workshops		**Performance Metric:** # of additional trainings provided per year; # of trainings provided in underserved communities; geographic distribution of training			
All Hazards	N/A	Staff Time/Budget Reallocation	Long-term	2, 6, 12, 14, 15	No
PBEM-4 — Advocate in regional debris planning process for consideration of equity and environmental justice implications of temporary debris storage sites.					
Lead Agency: Portland Bureau of Emergency Management (PBEM)		**Partner Agencies:** Metro			
Action Source: 2010 NHMP		**Performance Metric:** Equity and environmental justice promoted as a priority in identifying temporary debris storage sites.			
Earthquake	N/A	Staff Time	Long-term	2, 16	Yes (LT EQ #11)
PBEM-5 — Support Multnomah County in developing a robust, inclusive, and equitable sheltering plan.					
Lead Agency: Portland Bureau of Emergency Management (PBEM)		**Partner Agencies:** Multnomah County			
Action Source: Steering Committee		**Performance Metric:** Participation in Multnomah County sheltering plan process.			
All Hazards	N/A	Staff Time	Mid-term	2, 6, 16	No

Hazards Addressed	New or Existing Assets	Funding Options	Timeframe	Objectives Met	In Previous Plan? (# from previous plan)
PBEM-6— Support public school districts in developing a prioritization strategy for seismic strengthening of existing schools to facilitate rapid re-opening of schools.					
Lead Agency: Portland Bureau of Emergency Management (PBEM)		**Partner Agencies:** public school districts			
Action Source: Steering Committee		**Performance Metric:** Participation in prioritization process for seismic strengthening.			
Earthquake	Existing	Staff Time	Mid-term	4, 5, 11, 16	No
PBEM-7— Remain informed about inter-agency volcano coordination planning to communicate and understand agency roles and capabilities and potential sheltering needs for evacuees.					
Lead Agency: Portland Bureau of Emergency Management (PBEM)		**Partner Agencies:** Portland Bureau of Transportation (PBOT), Mount Hood Facilitating Committee			
Action Source: 2010 NHMP		**Performance Metric:** City emergency managers aware of volcano coordination plans.			
Volcano	N/A	Staff Time	Long-term	6, 16	Yes (V #1)
PBEM-8— Coordinate with owners and operators of key communications infrastructure (i.e. internet and telecom) located in unreinforced masonry (URM) buildings or buildings not designed for the purpose of housing this infrastructure; assess risks to these assets, and develop a strategy that identifies alternatives and funding sources for implementing seismic strengthening projects.					
Lead Agency: Portland Bureau of Emergency Management (PBEM)		**Partner Agencies:** Owners/operators of communications infrastructure			
Action Source: PBEM Strategic Plan		**Performance Metric:** Development of a strategy for funding and implementing seismic strengthening projects to protect key communications infrastructure.			
Earthquake	Existing	Staff Time	Long-term	4, 7, 10, 12, 13	No
PBEM-9— Update risk assessment information about landslides and develop new MAP action items based on updated 2017-2018 Department of Geology and Mineral Industries (DOGAMI) landslide data and recommendations.					
Lead Agency: Portland Bureau of Emergency Management (PBEM)		**Partner Agencies:** Department of Geology and Mineral Industries (DOGAMI), BDS, MAP Working Group			
Action Source: Steering Committee		**Performance Metric:** MAP landslide chapters updated in 2017.			
Landslide	N/A	Staff Time	Short-term	10, 16	No
PBEM-10 — Work with Office of Neighborhood Involvement (ONI) Disability Program Coordinator to promote participation in the Additional Needs Registry through the Public Alerts system.					
Lead Agency: Portland Bureau of Emergency Management (PBEM)		**Partner Agencies:** Office of Neighborhood Involvement (ONI), Portland Police Bureau (PPB), PF&R, Bureau of Emergency Communications (BOEC), Multnomah County, Elders in Action			
Action Source: PBEM Strategic Plan		**Performance Metric:** # of additional registrants for Additional Needs Registry;			
All Hazards	N/A	Staff Time/Budget Reallocation	Long-term	2, 6, 9, 13, 15	No
PBEM-11— Support Bureau of Development Services (BDS) in implementing recommendations from the City's Unreinforced Masonry (URM) Seismic Retrofit Project, including promoting and supporting policies for mandatory retrofits of URM buildings. This action needs high-level support from City Council and Office of Government Relations (OGR).					
Lead Agency: Portland Bureau of Emergency Management (PBEM)		**Partner Agencies:** BDS, Portland Development Commission (PDC), Office of Government Relations (OGR), Portland Housing Bureau (PHB), City Council			
Action Source: PBEM Strategic Plan		**Performance Metric:** Adoption of mandatory retrofit codes; # of city buildings retrofitted; # of affordable housing units retrofitted			
Earthquake	Existing	Staff Time	Long-term	1, 4, 11	No

Hazards Addressed	New or Existing Assets	Funding Options	Timeframe	Objectives Met	In Previous Plan? (# from previous plan)
PBEM-12 — Audit PBEM's suite of plans to evaluate whether plans meet the needs of people with disabilities, people with language barriers, and other access and functional needs populations. Develop a transition plan to update all plans.					
Lead Agency: Portland Bureau of Emergency Management (PBEM)		**Partner Agencies:** Regional Disaster Preparedness Organization (RDPO), Office of Equity and Human Rights (OEHR), Office of Neighborhood Involvement (ONI)			
Action Source: PBEM Strategic Plan		**Performance Metric:** Completion of audit.			
All Hazards	N/A	Staff Time/Budget Reallocation	Short-term	2, 15, 16	No
PBEM-13 — Expand ATC-20 damage assessment trainings and certifications to non-city employees to increase pool of qualified post-earthquake building inspectors, including through advertisements to registered Minority, Women-Owned, and Emerging Small Business architecture and structural engineering firms.					
Lead Agency: Portland Bureau of Emergency Management (PBEM)		**Partner Agencies:** Oregon Office of Emergency Management (OEM), University of Portland, Structural Engineers Association of Oregon (SEAO)			
Action Source: Steering Committee, PBEM Strategic Plan		**Performance Metric:** # of additional ATC-20 certifications issued			
All Hazards	N/A	Staff Time/Budget Reallocation	Long-term	6, 14, 15	No
PBEM-14— Support Multnomah County Drainage District (MCDD) and Levee Ready Columbia in risk assessment and flood response planning efforts.					
Lead Agency: Portland Bureau of Emergency Management (PBEM)		**Partner Agencies:** MCDD, Portland Water Bureau (PWB), BES, PBOT			
Action Source: Steering Committee, 2010 NHMP		**Performance Metric:** PBEM participation in Levee Ready Columbia meetings and planning projects.			
Flood	Existing	Staff Time	Long-term	4, 5, 6	Yes (LT MH #10)
PBEM-15 — Continue to involve the public in updating the MAP, including by establishing a standing committee with community representation to oversee progress reporting and implementation of MAP action items, and oversee annual updates to the MAP. Perform outreach consistent with the MAP Community Engagement Strategy, and ensure reports are written in plain, accessible language.					
Lead Agency: Portland Bureau of Emergency Management (PBEM)		**Partner Agencies:** BES, BPS, BDS, PP&R, PF&R, PWB, OEHR, MAP Steering Committee			
Action Source: Steering Committee		**Performance Metric:** Committee established, meets quarterly, and updates plan annually.			
All Hazards	N/A	Staff Time	Long-term	2, 5, 6, 9, 10, 16	Yes (ST MH #1)
PBEM-16 — Maintain and promote registration in Public Alerts system, including registration in languages other than English, and improve accessibility of the online interface for languages other than English. Integrate into other public outreach activities.					
Lead Agency: Portland Bureau of Emergency Management (PBEM)		**Partner Agencies:** Multnomah County, Public Alerts Steering Committee			
Action Source: PBEM Strategic Plan		**Performance Metric:** # of new Public Alerts registrants; # of new Public Alerts registrants in languages other than English			
All Hazards	N/A	Staff Time/Budget Reallocation	Long-term	2, 6, 9, 13	No

Hazards Addressed	New or Existing Assets	Funding Options	Timeframe	Objectives Met	In Previous Plan? (# from previous plan)
PBEM-17 — Hire a permanent planner to help City bureaus update continuity of operations plans and set aside a percentage of time to work with key social services organizations such as food banks and homeless shelters to develop continuity of operations plans.					
Lead Agency: Portland Bureau of Emergency Management (PBEM)		**Partner Agencies:** Oregon Food Bank, local homeless shelters			
Action Source: Steering Committee		**Performance Metric:** Number of social service organizations with continuity of operations plans.			
All Hazards	N/A	Staff Time	Long-term	2, 6, 14, 15, 16	No
PBEM-18— Expand Neighborhood Emergency Team (NET) trainings to include teachers and principals and include information about non-structural retrofits in classrooms.					
Lead Agency: Portland Bureau of Emergency Management (PBEM)		**Partner Agencies:** BDS, public school districts			
Action Source: PBEM Strategic Plan, Steering Committee		**Performance Metric:** # of teachers and principals trained			
All Hazards	N/A	Staff Time	Long-term	2, 6, 14, 15	No
PBEM-19 — Advocate for implementation of Critical Energy Infrastructure (CEI) Hub Risk Assessment recommendations, including establishment of Critical Energy Infrastructure (CEI) Hub Disaster Resilience Workgroup.					
Lead Agency: Portland Bureau of Emergency Management (PBEM)		**Partner Agencies:** Office of Government Relations, Regional Disaster Preparedness Organization (RDPO) Policy Committee, City Council			
Action Source: CEI Hub Stakeholders		**Performance Metric:** CEI Hub Disaster Resilience Workgroup established; CEI Hub recommendations implemented			
All Hazards	Both	Staff Time	Mid-term	4, 5, 10, 11	No
PBEM-20 — Develop a post-disaster recovery plan to guide post-disaster redevelopment that considers hazard exposure and relocation of critical infrastructure outside of high-hazard areas, prioritizes the restoration of natural systems to limit future hazard impacts, and includes whole-community recovery strategies to reduce the potential for involuntary displacement.					
Lead Agency: Portland Bureau of Emergency Management (PBEM)		**Partner Agencies:** BPS			
Action Source: Steering Committee, PBEM Strategic Plan		**Performance Metric:** Recovery plan developed.			
All Hazards	Both	Staff Time	Long-term	2, 3, 5, 8, 11, 16	No
PBEM-21 — Increase the City's capacity to establish post-earthquake communication nodes throughout the city after a major earthquake, including through expansion of training and additional communications equipment cache placements for the Basic Earthquake Emergency Communication Nodes (BEECN) program.					
Lead Agency: Portland Bureau of Emergency Management (PBEM)		**Partner Agencies:** Office of Neighborhood Involvement (ONI), PF&R, Amateur Radio Emergency Service (ARES)			
Action Source: PBEM Strategic Plan		**Performance Metric:** BEECN program at full capacity of 444 trained BEECN volunteers; BEECN diversity reporting (age, gender, racial identity)			
All Hazards	N/A	Staff Time/Budget Reallocation	Long-term	2, 6, 13, 14, 15	No
PBEM-22 — Develop a Transportation Recovery Plan.					
Lead Agency: Portland Bureau of Emergency Management (PBEM)		**Partner Agencies:** Portland State University (PSU)			
Action Source: Steering Committee, PBEM Strategic Plan		**Performance Metric:** Transportation Recovery Plan developed.			
All Hazards	Both	Budget Allocation	Near-term	4, 5, 10, 16	No

<table>
<tr><th>Hazards Addressed</th><th>New or Existing Assets</th><th>Funding Options</th><th>Timeframe</th><th>Objectives Met</th><th>In Previous Plan? (# from previous plan)</th></tr>
<tr><td colspan="6">PBEM-23 — Develop an emergency communications plan to distribute emergency messages to immigrant and refugee communities in language-appropriate and culturally appropriate ways.</td></tr>
<tr><td colspan="2">Lead Agency: Portland Bureau of Emergency Management (PBEM)</td><td colspan="4">Partner Agencies: Community Engagement Liaisons (CELs) program</td></tr>
<tr><td colspan="2">Action Source: PBEM Strategic Plan, Public Workshops</td><td colspan="4">Performance Metric: communications plan developed</td></tr>
<tr><td>All Hazards</td><td>N/A</td><td>Staff Time/Budget Reallocation</td><td>Long-term</td><td>2, 6, 14, 15, 16</td><td>No</td></tr>
<tr><td colspan="6">PBEM-24 —Through a public process with key stakeholders, create an inventory of fossil fuel facilities and infrastructure in Portland that includes characteristics related to seismic safety such as date of construction, construction type, and whether seismic upgrades have been made. This action requires high-level support from City Council.</td></tr>
<tr><td colspan="2">Lead Agency: Portland Bureau of Emergency Management (PBEM)</td><td colspan="4">Partner Agencies: Bureau of Development Services</td></tr>
<tr><td colspan="2">Action Source: Public Comments</td><td colspan="4">Performance Metric: Final inventory of fossil fuel infrastructure and facilities.</td></tr>
<tr><td>All Hazards</td><td>Existing</td><td>New budget allocation</td><td>Short-term</td><td>1, 4, 6, 9, 10, 12</td><td>No</td></tr>
<tr><td colspan="6">PP&R-1 — Consider known natural hazards on Portland Parks & Recreation (PP&R) owned or managed properties when developing future plans for these properties, to ensure future plans do not adversely alter or modify these hazards.</td></tr>
<tr><td colspan="2">Lead Agency: Portland Parks & Recreation (PP&R)</td><td colspan="4">Partner Agencies: various depending on site</td></tr>
<tr><td colspan="2">Action Source: PP&R Master Plans</td><td colspan="4">Performance Metric: Future Park and Trail Master Plans with known natural hazards will include discussion of those hazards.</td></tr>
<tr><td>All Hazards</td><td>Existing</td><td>Staff Time/GF/CIP/System Development Charge (SDC)</td><td>Long-term</td><td>3, 5, 6</td><td>Yes (LT FL #5)</td></tr>
<tr><td colspan="6">PP&R-2 — Consistent with PP&R management practices and standard operating procedures, allocate funding for management of vegetated natural areas with high wildfire danger, including public and private properties.</td></tr>
<tr><td colspan="2">Lead Agency: Portland Parks & Recreation (PP&R)</td><td colspan="4">Partner Agencies: various depending on site</td></tr>
<tr><td colspan="2">Action Source: 2010 NHMP</td><td colspan="4">Performance Metric: Properties identified as high wildfire danger are actively managed.</td></tr>
<tr><td>Wildfire</td><td>Existing</td><td>Staff Time/GF/CIP/System Development Charge (SDC)</td><td>Long-term</td><td>3, 5, 12</td><td>Yes (ST WF #2)</td></tr>
<tr><td colspan="6">PP&R-3 — Conduct systematic reviews of Portland's large, publicly owned, wildland tracts regarding fire safety and ecological health to ensure informed land management decisions.</td></tr>
<tr><td colspan="2">Lead Agency: Portland Parks & Recreation (PP&R)</td><td colspan="4">Partner Agencies: various depending on site</td></tr>
<tr><td colspan="2">Action Source: 2010 NHMP</td><td colspan="4">Performance Metric: Systematic reviews performed per SOPs and Parks and Trails plans.</td></tr>
<tr><td>Wildfire</td><td>Existing</td><td>Staff Time/GF/CIP/System Development Charge (SDC)</td><td>Long-term</td><td>3, 5, 6</td><td>Yes (ST WF #10)</td></tr>
<tr><td colspan="6">PF&R-1 — Adopt the national "Fire Danger Rating System" and install the signs at key points in the City.</td></tr>
<tr><td colspan="2">Lead Agency: Portland Fire & Rescue (PF&R)</td><td colspan="4">Partner Agencies: Parks and Recreation</td></tr>
<tr><td colspan="2">Action Source: 2010 NHMP</td><td colspan="4">Performance Metric: Locations for signage identified and all necessary signage placed in these locations</td></tr>
<tr><td>Wildfire</td><td>Existing</td><td>Existing PF&R FTEs</td><td>Mid-term</td><td>4, 6, 10, 13, 14,</td><td>Yes (WF #11)</td></tr>
</table>

Hazards Addressed	New or Existing Assets	Funding Options	Timeframe	Objectives Met	In Previous Plan? (# from previous plan)
PF&R-2 — Convene a standing wildland interface fire technical group to plan for and address wildland urban interface (WUI) hazards.					
Lead Agency: Portland Fire & Rescue (PF&R) **Action Source:** 2010 NHMP		**Partner Agencies:** PBEM, Parks and Recreation **Performance Metric:** Quarterly meeting of standing wildfire interface technical group to plan for and address WUI hazards of concern			
Wildfire	Existing	Existing PF&R FTEs	Near-term	1, 3, 4, 5, 6, 7, 9, 10, 13, 14	Yes (WF #14)
PF&R-3 — Act upon all Mitigation Actions outlined in the Wildfire Gap Analysis Report.					
Lead Agency: Portland Fire & Rescue (PF&R) **Action Source:** 2010 NHMP		**Partner Agencies:** Parks, PBEM **Performance Metric:** All action items in Gap analysis completed			
Wildfire	Existing	Existing PF&R FTEs	Mid-term	1, 3, 4, 5, 6, 7, 9, 10, 12,13, 14	Yes (WF)
PF&R-4 — Inventory critical PF&R assets and review critical PF&R infrastructure vulnerability and identify a 50-year plan to strengthen, retrofit, relocate or otherwise increase resiliency.					
Lead Agency: Portland Fire & Rescue (PF&R) **Action Source:** Steering Committee		**Partner Agencies:** None **Performance Metric:** Inventory and Review Completed			
Earthquake	New	Existing PF&R FTEs.	Mid-term	4, 5, 10, 11	No
PF&R-5 — Require defensible spaces and water turrets around structures in wildfire risk areas					
Lead Agency: Portland Fire & Rescue (PF&R) **Action Source:** Steering Committee		**Partner Agencies:** BDS **Performance Metric:** N/A			
Wildfire	New	Existing PF&R FTEs.	Mid-term	1, 4, 5, 10, 12	No
PF&R-6 — Partner with the Forest Park Conservancy and individual land owners to develop a fire risk reduction plan for Forest Park.					
Lead Agency: Portland Fire & Rescue (PF&R) **Action Source:** Steering Committee		**Partner Agencies:** Portland Parks & Recreation (PP&R) **Performance Metric:** Development of Forest Park fire risk reduction plan			
Wildfire	New	Existing PF&R FTEs.	Mid-term	6, 8, 12, 13, 14	No
PF&R-7 — Continue to engage and train Neighborhood Emergency Team (NET) volunteers to assists with mitigation, response and recovery efforts post disaster. Ensure training takes place in ADA-accessible fire stations, Neighborhood Emergency Teams (NETs) perform outreach activities to underrepresented groups.					
Lead Agency: Portland Fire & Rescue (PF&R) **Action Source:** Steering Committee		**Partner Agencies:** PBEM **Performance Metric:** Bi-annual fire station-based training opportunities for s members.			
All Hazards	New	Existing PF&R FTEs.	Near-term	2, 6, 13, 14, 15	No
PF&R 8 — Ensure that Additional Needs Registry Data is appropriately utilized and ensure that emergency responders are aware of locations of disabled Portlanders.					
Lead Agency: Portland Fire & Rescue (PF&R) **Action Source:** : Steering Committee		**Partner Agencies:** Multnomah County, Bureau of Emergency Communications (BOEC), PBEM **Performance Metric:** Ensure that BOEC's Computer Aided Dispatch (CAD) system is updated with most recent Additional Needs Registry Data.			
All Hazards	New	Existing PF&R FTEs.	Near-term	2, 6, 13	No
PF&R-9 — Perform non-structural assessments and mitigation activities (e.g. anchor bookcases to the wall).					
Lead Agency: Portland Fire & Rescue (PF&R) **Action Source:** : Steering Committee		**Partner Agencies:** None **Performance Metric:** Prioritize mitigation activities at PF&R facilities and implement high priority mitigation action items.			
Earthquake	New	Existing PF&R FTEs.	Long-term	4, 10, 11	No

Hazards Addressed	New or Existing Assets	Funding Options	Timeframe	Objectives Met	In Previous Plan? (# from previous plan)
BPS-1 — Promote and fund energy independence projects in low-income neighborhoods and communities.					
Lead Agency: Bureau of Planning and Sustainability (BPS)		**Partner Agencies:** PBEM; Private sector; Bonneville Power Administration (BPA)			
Action Source: Public Workshops; BPS Strategic Plan		**Performance Metric:** Promotional materials / communications created; # projects begun or completed			
All Hazards / Earthquake	New	Staff time	Mid-term	2, 8, 12	No
BPS-2 — Plan for solar + battery storage systems, which can serve as mini power-supply stations or provide residents the ability to shelter in place after any electricity supply-disrupting event, at varying scales (project, neighborhood and district) and locations (critical City facilities, low-income housing, community gathering spots).					
Lead Agency: Bureau of Planning and Sustainability (BPS)		**Partner Agencies:** Private sector; Bonneville Power Administration (BPA)			
Action Source: Public Workshops; BPS Strategic Plan		**Performance Metric:** Progress made on complete plan.			
All Hazards / Earthquake	New	Staff time	Mid-term	2, 4, 8, 12	No
BPS-3 — Encourage solar + battery storage demonstration projects at critical City facilities, in low-income neighborhoods and in other strategic locations.					
Lead Agency: Bureau of Planning and Sustainability (BPS)		**Partner Agencies:** Private sector; Bonneville Power Administration (BPA)			
Action Source: Public Workshops; BPS Strategic Plan		**Performance Metric:** Successful formation of coalitions / partnerships; # projects begun or completed			
All hazards / Earthquake	New	Staff time	Mid-term	2, 4, 8, 12	No
BPS-4 — Explore ability to waive System Development Charge (SDC) for change of use if money will be spent on seismic retrofit.					
Lead Agency: Bureau of Planning and Sustainability (BPS)		**Partner Agencies:** PBEM			
Action Source: Steering Committee		**Performance Metric:** Completed studies; enactment of new fee waiver program			
Earthquake	New	Staff time	Near-term	1, 4, 8, 11, 12	No
BPS-5 — Adopt Portland's Comprehensive Plan to address Citywide policies, land use improvements and mapping changes related to natural hazards. This action needs high-level support from City Council.					
Lead Agency: Bureau of Planning and Sustainability (BPS)		**Partner Agencies:** City Council; all City bureaus			
Action Source: 2010 NHMP		**Performance Metric:** Progress made towards adoption of natural hazard elements in Comprehensive Plan			
All hazards	Both	Staff time	Near-term	1, 3, 8, 12, 15	Yes (LT MH #1)
BPS-6 — Support Comprehensive Plan policies and projects that relate to resilience, climate change and natural hazard mitigation, response, adaptation and recovery. This action needs high-level support from City Council.					
Lead Agency: Bureau of Planning and Sustainability (BPS)		**Partner Agencies:** All City bureaus; City Council			
Action Source: 2010 NHMP		**Performance Metric:** # Successful projects or implementation of policies related to resilience, climate change & natural hazard mitigation.			
All hazards	Existing	Staff time	Mid-term	1, 3, 8, 12, 15	Yes (LT MH #1)

Hazards Addressed	New or Existing Assets	Funding Options	Timeframe	Objectives Met	In Previous Plan? (# from previous plan)
BPS-7 — Support 2015 Climate Action Plan and Climate Change Preparedness Strategy actions that relate to adaptation planning and natural hazard mitigation actions.					
Lead Agency: Bureau of Planning and Sustainability (BPS)		**Partner Agencies:** City bureaus; County			
Action Source: 2010 NHMP		**Performance Metric:** # Successful projects or implementation of policies related to resilience, climate change & natural hazard mitigation.			
All hazards	Existing	Staff time	Mid-term	3, 8, 9, 15	Yes (New MH #6)
BPS-8 — Consider natural hazard mitigation in the development of the River Plan/North Reach.					
Lead Agency: Bureau of Planning and Sustainability (BPS)		**Partner Agencies:** BES, PP&R, private sector			
Action Source: BPS Strategic Plan		**Performance Metric:** # of natural hazard and resilience-related elements included in the River Plan/North Reach			
All hazards / Flood	Both	Staff time	Mid-term	3, 8, 12	No
BPS-9 — Develop an emergency resumption of service plan for solid waste removal after a disaster event.					
Lead Agency: Bureau of Planning and Sustainability (BPS)		**Partner Agencies:** PBEM, Portland Housing Authority (PHA)			
Action Source: BPS Strategic Plan		**Performance Metric:** Progress made towards development of plan.			
All hazards / Earthquake	Both	Staff time	Near-term	4, 5, 8, 12. 14. 15	No
BPS-10 — Develop an emergency service plan for solid waste removal in multifamily properties after a disaster event.					
Lead Agency: Bureau of Planning and Sustainability (BPS)		**Partner Agencies:** PBEM, Portland Housing Authority (PHA)			
Action Source: BPS Strategic Plan		**Performance Metric:** Progress made towards development of plan.			
All hazards / Earthquake	Both	Staff time	Mid-term	2, 4, 5, 8, 12. 14. 15	No
BPS-11 — Develop recommended policies, regulations and/or landscape options for areas at risk from wildfires.					
Lead Agency: Bureau of Planning and Sustainability (BPS)		**Partner Agencies:** PBEM, BDS, PF&R, BES, PP&R			
Action Source: 2010 NHMP		**Performance Metric:** Progress made towards development of policies, recommendations and/or regulations.			
Wildfire	New	Staff time	Mid-term	3, 4, 5, 9, 10, 12	Yes (ST WF#7)
BPS-12 — When possible, build mitigation and resiliency education into bureau public events and outreach (e.g., neighborhood meetings, Fix-it Fairs).					
Lead Agency: Bureau of Planning and Sustainability (BPS)		**Partner Agencies:** PBEM, Neighborhood Emergency Team (NET)			
Action Source: BPS Strategic Plan		**Performance Metric:** # of resilience / mitigation outreach events completed			
All hazards	Existing	Staff time	Near-term	2, 6, 8, 12	No
BPS-13 — Develop incentives and regulations that promote, encourage and/or require seismic retrofits of private property (such as multi-family, masonry structures). This action needs high-level support from City Council and Office of Government Relations (OGR).					
Lead Agency: Bureau of Planning and Sustainability (BPS)		**Partner Agencies:** Portland Development Commission (PDC), BDS, PBEM, City Council, Office of Government Relations (OGR)			
Action Source: 2010 NHMP		**Performance Metric:** Progress made towards the development and implementation of incentive program.			
Earthquake	New	Staff time	Near-term	1, 4, 11, 12	Yes (LT EQ #8)

Hazards Addressed	New or Existing Assets	Funding Options	Timeframe	Objectives Met	In Previous Plan? (# from previous plan)
BPS-14 — Identify ways to encourage, promote or require U.S. Resiliency Council Certification for new public buildings. This action needs high-level support from City Council and Office of Government Relations (OGR).					
Lead Agency: Bureau of Planning and Sustainability (BPS)		**Partner Agencies:** PBEM, City Council, Office of Government Relations (OGR)			
Action Source: 2010 NHMP		**Performance Metric:** # of public buildings certified under the U.S. Resiliency Council Certification program			
Earthquake	New	Staff time	Mid-term	1, 4, 5, 15	Yes (LT EQ #8)
BPS-15 — Prioritize retrofitting of structures along emergency transportation routes.					
Lead Agency: Bureau of Planning and Sustainability (BPS)		**Partner Agencies:** PBOT, Multnomah County, Oregon Department of Transportation (ODOT), PF&R, Portland Police Bureau (PPB)			
Action Source: 2010 NHMP		**Performance Metric:** # or % Buildings retrofitted			
Earthquake	New	Staff time	Long-term / Ongoing	5, 8, 11, 13	Yes (LT EQ #8)
BPS-16 — Use updated floodplain data and maps, including potential climate change scenarios, to inform City and County land use, transportation, and other infrastructure planning processes.					
Lead Agency: Bureau of Planning and Sustainability (BPS)		**Partner Agencies:** Multnomah County, BES, PBOT, PBEM, Federal Emergency Management Agency (FEMA), Multnomah County Drainage District (MCDD)			
Action Source: BPS Strategic Plan		**Performance Metric:** Progress made towards full incorporation of new floodplain data into land use planning databases.			
Flood, Severe Weather	Both	Staff time	Near-term	1, 2, 4, 5, 9, 10, 12	No
BPS-17 — Encourage or require private property owners and developers to limit or reduce impervious area at citywide, watershed, site-specific and district scales.					
Lead Agency: Bureau of Planning and Sustainability (BPS)		**Partner Agencies:** BES, PBOT			
Action Source: 2010 NHMP		**Performance Metric:** # of successful outreach and/or communication programs completed.			
Flood / Severe weather	New	Staff time	Mid-term	1, 3, 5, 8, 12	Yes (LT FL #8)
BPS-18 — Provide safety training for day laborers, protect workers' rights, and collaborate with Voz to provide a safe place to locate day laborer services to encourage employment of local day laborers for post-disaster reconstruction and recovery. This action needs high-level support from City Council.					
Lead Agency: Bureau of Planning and Sustainability (BPS)		**Partner Agencies:** Portland Development Commission (PDC), Voz, City Council			
Action Source: 2010 NHMP		**Performance Metric:** worker center established, # safety trainings or certifications provided			
All Hazards	N/A	Staff time	Mid-term	2, 6, 7, 8, 14, 15, 16	No
BPS-19 — Update the environmental overlay zone, codes and maps to reflect best available science and the location and extent of risks associated with natural hazards in Portland					
Lead Agency: Bureau of Planning and Sustainability (BPS)		**Partner Agencies:** BES, BDS, PP&R			
Action Source: New		**Performance Metric:** Acres of natural resources included in the overlay zone			
All Hazards	Existing	Staff time	Near-term	1, 3, 4, 5, 6, 8, 10, 14	No
PWB-1 — Continue to assess the vulnerability of the water system to seismic events and work toward hardening the backbone system.					
Lead Agency: Portland Water Bureau (PWB)		**Partner Agencies:** N/A			
Action Source: 2010 NHMP		**Performance Metric:** Seismic hardening reduces risk by percent of total risk factors			
Earthquake	Both	Capital Improvement Plan (CIP)	Existing/ Ongoing	4, 7, 9, 10	Yes

Hazards Addressed	New or Existing Assets	Funding Options	Timeframe	Objectives Met	In Previous Plan? (# from previous plan)
PWB-2 — Install remote operating valves to isolate existing river crossings.					
Lead Agency: Portland Water Bureau (PWB)		**Partner Agencies:** N/A			
Action Source: Water System Seismic Study		**Performance Metric:** Valve isolation reduces risk of water loss following damage			
Earthquake	Both	Capital Improvement Plan (CIP)	Mid-Term	4, 11	No
PWB-3 — Install isolation valves where distribution system is tied in to backbone.					
Lead Agency: Portland Water Bureau (PWB)		**Partner Agencies:** N/A			
Action Source: Water System Seismic Study		**Performance Metric:** Valve isolation reduces risk of water loss following damage			
All Hazards	Both	Capital Improvement Plan (CIP)	Existing/ Ongoing	4, 11	No
PWB-4 — Seismically upgrade water pump stations.					
Lead Agency: Portland Water Bureau (PWB)		**Partner Agencies:** N/A			
Action Source: Water System Seismic Study		**Performance Metric:** Seismic upgrades reduce risk to water delivery system			
Earthquake	New	Capital Improvement Plan (CIP)	Existing/ Ongoing	4,10	No
PWB-5 — Continue to monitor dam safety at Mt. Tabor and Washington Park reservoirs.					
Lead Agency: Portland Water Bureau (PWB)		**Partner Agencies:** State Water Resources			
Action Source: Steering Committee		**Performance Metric:** Dam safety reduces flooding risk			
Dam Failure	Existing	Capital Improvement Plan (CIP)	Existing/ Ongoing	10, 9	No
PWB-6 — Seismically upgrade water storage tanks.					
Lead Agency: Portland Water Bureau (PWB)		**Partner Agencies:** N/A			
Action Source: Water System Seismic Study		**Performance Metric:** Seismic upgrades reduce vulnerability of water storage tanks			
Earthquake	New	Capital Improvement Plan (CIP)	Existing/ Ongoing	4, 11	No
PWB-7 — Plan, design and construct new Willamette River Crossing.					
Lead Agency: Portland Water Bureau (PWB)		**Partner Agencies:** Division of State Lands, Portland Harbor Master			
Action Source: Portland Water Bureau (PWB) Operations Group		**Performance Metric:** Redundancy of water delivery routes across Willamette River ensures adequate water supply to West side			
Earthquake	New	Capital Improvement Plan (CIP)	Mid-Term	4, 11, 2	No
PWB-8 — Plan, design and construct second new Willamette River Crossing.					
Lead Agency: Portland Water Bureau (PWB)		**Partner Agencies:** Division of State Lands, Portland Harbor Master			
Action Source: Water System Seismic Study		**Performance Metric:** Redundancy of water delivery routes across Willamette River ensures adequate water supply to West side			
Earthquake	New	Capital Improvement Plan (CIP)	Long-Term	4, 2	No

Hazards Addressed	New or Existing Assets	Funding Options	Timeframe	Objectives Met	In Previous Plan? (# from previous plan)
PWB-9 — Plan, design and construct replacement for St. John's River Crossing.					
Lead Agency: Portland Water Bureau (PWB)		**Partner Agencies:** Division of State Lands, Portland Harbor Master			
Action Source: Water System Seismic Study		**Performance Metric:** Redundancy of water delivery routes across Willamette River ensures adequate water supply to West side			
Earthquake	New	Capital Improvement Plan (CIP)	Long-Term	4, 11, 2	No
PWB-10 — Partner with University of Washington to participate in the testing of the Earthquake Early Warning System.					
Lead Agency: Portland Water Bureau (PWB)		**Partner Agencies:** University of WA			
Action Source: Portland Water Bureau (PWB) Engineering		**Performance Metric:** Enhancing early earthquake notification capability saves lives			
Earthquake	Both	Capital Improvement Plan (CIP)	Near-Term	6, 10, 13	No
PWB-11 — Coordinate with electrical utilities on tree fall mitigation measures to prevent impacts to Bull Run watershed supply.					
Lead Agency: Portland Water Bureau (PWB)		**Partner Agencies:** Portland General Electric (PGE), Local Electrical Utilities			
Action Source: Portland Water Bureau (PWB) Operations Group		**Performance Metric:** Water distribution is protected from power outages			
Severe Weather	Both	Capital Improvement Plan (CIP)	Near-Term	10, 11	No
PWB-12 — Continue to work in a co-management role with the Oregon Department of Forestry, US Forest Service and local fire departments to respond to and recover from fires in and near the Bull Run watershed.					
Lead Agency: Portland Water Bureau (PWB)		**Partner Agencies:** Oregon Department of Forestry, United States Forest Service (USFS), Local Fire Departments			
Action Source: Bull Run Watershed Group Recommendations		**Performance Metric:** Water supply and distribution is protected from wildfire damage			
Wildfire	Both	Capital Improvement Plan (CIP)	Existing/ Ongoing	10, 11	No
PWB-13 — Continue to assess the potential impacts of climate change on wildfire in the Bull Run watershed.					
Lead Agency: Portland Water Bureau (PWB)		**Partner Agencies:** National Oceanic and Atmospheric Administration (NOAA)			
Action Source: Bull Run Watershed Group Recommendations		**Performance Metric:** Ongoing assessment helps to address changes timely			
Wildfire	Both	Capital Improvement Plan (CIP)	Existing/ Ongoing	9, 10	No
PWB-14 — Continue to monitor forest health surveys completed by federal and state agency partners for the Bull Run watershed.					
Lead Agency: Portland Water Bureau (PWB)		**Partner Agencies:** United States Forest Service (USFS), Oregon Department of Forestry			
Action Source: Bull Run Watershed Group Recommendations		**Performance Metric:** Monitoring forest health surveys helps address issues timely			
Wildfire	Both	Capital Improvement Plan (CIP)	Existing/ Ongoing	9,10	No

Hazards Addressed	New or Existing Assets	Funding Options	Timeframe	Objectives Met	In Previous Plan? (# from previous plan)
PWB-15 — Update the Bull Run wildfire evacuation plan.					
Lead Agency: Portland Water Bureau (PWB)		**Partner Agencies:** United States Forest Service (USFS), Oregon Department of Forestry, Sandy Fire, Clackamas County Communications, Clackamas Emergency Management			
Action Source: Bull Run Watershed Group Recommendations		**Performance Metric:** Evacuation planning protects people and property			
Wildfire	Existing	Capital Improvement Plan (CIP)	Existing/ Ongoing	4, 16	No
PWB-16 — Identify and prioritize culvert improvements in the Bull Run watershed to manage streamflow and stormwater runoff and reduce risks to water quality and infrastructure.					
Lead Agency: Portland Water Bureau (PWB)		**Partner Agencies:** United States Forest Service (USFS)			
Action Source: Bull Run Watershed Group Recommendations		**Performance Metric:** Culvert improvements protect water supply by reducing runoff			
Flood	Both	Capital Improvement Plan (CIP)	Existing/ Ongoing	4, 11	No
PWB-17 — Continue to assess the potential impacts of climate change on flooding in the Bull Run watershed.					
Lead Agency: Portland Water Bureau (PWB)		**Partner Agencies:** United States Forest Service (USFS), National Oceanic and Atmospheric Administration (NOAA)			
Action Source: Bull Run Watershed Group Recommendations		**Performance Metric:** Ongoing assessment of climate change impacts allows for adjustments to protect water supply and prevent flooding			
Flood	Both	Capital Improvement Plan (CIP)	Existing/ Ongoing	9, 10	No
PWB-18 — Continue to assess the potential impacts of climate change associated with drought in the Bull Run watershed.					
Lead Agency: Portland Water Bureau (PWB)		**Partner Agencies:** United States Forest Service (USFS), National Oceanic and Atmospheric Administration (NOAA), Oregon Water Resources Department			
Action Source: Portland Water Bureau (PWB) Engineering		**Performance Metric:** Ongoing assessment of climate change impacts allows for adjustments to protect water supply from drought impacts			
Drought	Both	Capital Improvement Plan (CIP)	Existing/ Ongoing	9, 10	No
PWB-19 — Perform seismic/dynamic analysis of Bull Run watershed bridges.					
Lead Agency: Portland Water Bureau (PWB)		**Partner Agencies:** United States Forest Service (USFS)			
Action Source: Water System Seismic Study		**Performance Metric:** Seismic analysis helps to plan improvements to prevent damage to critical transportation routes			
Earthquake	New	Capital Improvement Plan (CIP)	Mid-Term	9, 10	No

Hazards Addressed	New or Existing Assets	Funding Options	Timeframe	Objectives Met	In Previous Plan? (# from previous plan)
PWB-20 — Continue to implement with the USFS the Portland Water Bureau (PWB) transportation system management plan for emergency and fire access in Bull Run Watershed.					
Lead Agency: Portland Water Bureau (PWB)		**Partner Agencies:** United States Forest Service (USFS)			
Action Source: Portland Water Bureau (PWB) Engineering		**Performance Metric:** Implementation of a management plan for emergency and fire access transportation routes protects water supply access			
Wildfire	Both	Capital Improvement Plan (CIP)	Existing/ Ongoing	5, 9, 11	No
PWB-21 — Continue to partner with electrical utilities to ensure continuity of electrical service to the City and the Columbia South Shore Well field during power outages					
Lead Agency: Portland Water Bureau (PWB)		**Partner Agencies:** Portland General Electric (PGE), Local Electrical Utilities, Pacific Power & Light			
Action Source: 2010 NHMP		**Performance Metric:** Partnership with electrical utilities to ensure power to the City and South Shore Well field during power outages ensures uninterrupted water supply			
All Hazards	Both	Capital Improvement Plan (CIP)	Existing/ Ongoing	4, 5, 11	Yes (ST MH #8)
PWB-22 — Collaborate with Multnomah County Drainage District and Port of Portland to assess flooding impacts from levee failure, quantify risks, and identify potential mitigation strategies.					
Lead Agency: Portland Water Bureau (PWB)		**Partner Agencies:** Multnomah County Drainage District (MCDD), Port of Portland, Multnomah County Levee Ready Columbia, United States Army Corps of Engineers (USACE)			
Action Source: Steering Committee		**Performance Metric:** Prevent flood damage through assessment and mitigation planning			
Flood	Both	Capital Improvement Plan (CIP)	Mid-Term	4, 5	No
PWB-23 — Make seismic improvements to Columbia South Shore well field and groundwater pump station					
Lead Agency: Portland Water Bureau (PWB)		**Partner Agencies:** N/A			
Action Source: Portland Water Bureau (PWB) Operations Group		**Performance Metric:** Seismic improvements protect water supply and distribution systems			
Earthquake	New	Capital Improvement Plan (CIP)	Existing/ Ongoing	4, 11	No
PWB-24 — Install backup transformer(s) at Groundwater Pump Stations to reduce vulnerability to power outage.					
Lead Agency: Portland Water Bureau (PWB)		**Partner Agencies:** Portland General Electric (PGE)			
Action Source: Portland Water Bureau (PWB) Operations Group		**Performance Metric:** Redundancy of power supply system ensures uninterrupted water distribution			
All Hazards	New	Capital Improvement Plan (CIP)	Mid-Term	4, 11	No

Hazards Addressed	New or Existing Assets	Funding Options	Timeframe	Objectives Met	In Previous Plan? (# from previous plan)
PWB-25 — Investigate well treatment options to increase existing well capacity.					
Lead Agency: Portland Water Bureau (PWB)	**Partner Agencies:** N/A				
Action Source: Portland Water Bureau (PWB) Operations Group	**Performance Metric:** Reducing well deposits increases well holding capacity				
All Hazards	Both	Capital Improvement Plan (CIP)	Long-Term	4, 10, 8	No
PWB-26 — Investigate hypochlorite generation at ground water pump station to reduce or eliminate the need for out of area deliveries.					
Lead Agency: Portland Water Bureau (PWB)	**Partner Agencies:** N/A				
Action Source: Portland Water Bureau (PWB) Operations Group	**Performance Metric:** Reducing dependence on out of area deliveries ensures uninterrupted water treatment when transportation network is damaged				
All Hazards	Both	Capital Improvement Plan (CIP)	Mid-Term	4, 8, 16	No
PWB-27 — Continue to research ways to balance the needs between fire flow requirements and water quality requirements.					
Lead Agency: Portland Water Bureau (PWB)	**Partner Agencies:** Portland Fire & Rescue (PF&R)				
Action Source: Steering Committee	**Performance Metric:** Ensures that water quality is maintained				
Wildfire	Both	Capital Improvement Plan (CIP)	Long-term	9,10	No
PWB-28 — Coordinate with Fleet and PBOT Maintenance Operations to ensure adequate reserves of diesel fuel and gasoline to support extended operations.					
Lead Agency: Portland Water Bureau (PWB)	**Partner Agencies:** Office of Management and Finance (OMF) - Fleet, PBOT Maintenance Operations				
Action Source: Portland Water Bureau (PWB) Operations Group	**Performance Metric:** Adequate fuel storage reserves ensures water distribution systems can continue to operate				
All Hazards	New	Capital Improvement Plan (CIP)	Near-Term	11, 16	No
PWB-29 — Work with other City bureaus to investigate potential for pre-disaster agreements to provide fuel, shelter, food, water, and sanitary facilities, materials, supplies, equipment, and specialty contractors for City response.					
Lead Agency: Portland Water Bureau (PWB)	**Partner Agencies:** City bureaus				
Action Source: Portland Water Bureau (PWB) Engineering	**Performance Metric:** Pre-disaster agreements to provide critical resources will allow for quicker emergency response in the event of a disaster				
All Hazards	Both	Capital Improvement Plan (CIP)	Near-Term	13, 14, 15	No
PWB-30 — Partner with Multnomah County, Metro, Portland Public Schools (PPS), adjacent school districts, and Portland Parks and Recreation (PP&R) to develop a sheltering plan for city responders and their families.					
Lead Agency: Portland Water Bureau (PWB)	**Partner Agencies:** Multnomah County, Metro, PPS, local school districts, PP&R				
Action Source: Portland Water Bureau (PWB) Engineering	**Performance Metric:** Development of a plan and identification of shelter locations for responders and their families allows quicker response in disasters				
All Hazards	Both	Capital Improvement Plan (CIP)	Near-Term	13, 14, 15	No

Hazards Addressed	New or Existing Assets	Funding Options	Timeframe	Objectives Met	In Previous Plan? (# from previous plan)
PWB-31 — Investigate availability, capacity, contracting and delivery of portable water treatment plants					
Lead Agency: Portland Water Bureau (PWB)		**Partner Agencies:** Federal Emergency Management Agency (FEMA), Army National Guard, Regional Water Providers Consortium			
Action Source: Water System Seismic Study		**Performance Metric:** Ensures availability of potable water after an event			
All Hazards	New	Capital Improvement Plan (CIP)	Mid-Term	10, 14	No
PWB-32 — Investigate availability and use of food-grade quality tank trucks for distribution of water following emergencies.					
Lead Agency: Portland Water Bureau (PWB)		**Partner Agencies:** Federal Emergency Management Agency (FEMA)			
Action Source: Water System Seismic Study		**Performance Metric:** Benefit is potential for expanded water delivery system via tank trunks			
All Hazards	New	Capital Improvement Plan (CIP)	Mid-Term	14, 16	No
PWB-33 — Determine number, locations and types of Emergency Water Distribution Systems, and provide location information to the public.					
Lead Agency: Portland Water Bureau (PWB)		**Partner Agencies:** Federal Emergency Management Agency (FEMA), Regional Water Providers Consortium			
Action Source: Water System Seismic Study		**Performance Metric:** Water distribution planning and publication of locations improves critical access to potable water following disasters			
All Hazards	New	Capital Improvement Plan (CIP)	Mid-Term	14, 16	No
PWB-34 — Investigate and implement use of Integrated Public Alert and Warning System (IPAWS) / Wireless Emergency Alerts (WEA) systems to send alerts from specific cell towers to cell phones for those in specific locations affected by an event.					
Lead Agency: Portland Water Bureau (PWB)		**Partner Agencies:** PBEM; Federal Emergency Management Agency (FEMA); Multnomah, Clackamas, and Washington Counties			
Action Source: Steering Committee		**Performance Metric:** Emergency notifications save lives			
All Hazards	Both	Capital Improvement Plan (CIP)	Near-Term	6, 13	No
PWB-35 — Develop measures to rapidly isolate damaged portions of the water conveyance system (most of Vernon 270, Washington Park 229 and Tabor 270) to minimize water loss and preserve storage					
Lead Agency: Portland Water Bureau (PWB)		**Partner Agencies:** Portland Fire & Rescue (PF&R)			
Action Source: Water System Seismic Study		**Performance Metric:** Minimizing water loss ensures adequate water supply			
All Hazards	New	Capital Improvement Plan (CIP)	Mid-Term	4, 16	No
PWB-36 — Further study the feasibility of seismic valve installation at strategic locations to protect water supply & storage.					
Lead Agency: Portland Water Bureau (PWB)		**Partner Agencies:** Portland Fire & Rescue (PF&R)			
Action Source: Portland Water Bureau (PWB) Engineering		**Performance Metric:** Protection of water storage and minimizing seismic impacts protects water supply			
Earthquake	Both	Capital Improvement Plan (CIP)	Mid-Term	4,10	No

Hazards Addressed	New or Existing Assets	Funding Options	Timeframe	Objectives Met	In Previous Plan? (# from previous plan)
PWB-37 — Participate with PBOT, Multnomah County, Oregon Department of Transportation (ODOT), Metro, Clackamas County and USFS in an in depth risk assessment of the bridges to develop and prioritize mitigation projects to ensure connectivity after an event.					
Lead Agency: Portland Water Bureau (PWB)		**Partner Agencies:** PBOT, Multnomah County, Oregon Department of Transportation (ODOT), Metro, Clackamas County, United States Forest Service (USFS)			
Action Source: Steering Committee		**Performance Metric:** Ensuring access to critical transportation, including bridges, ensures water delivery despite disaster damage			
Earthquake	Both	Capital Improvement Plan (CIP)	Mid-Term	4,10,14	No
PWB-38 — Coordinate with Multnomah County, Clackamas County, Metro, Oregon Department of Transportation (ODOT) and PBOT to ensure road system access to critical facilities including Interstate, Lusted Hill, Headworks, Sandy River Station, pump stations, and tank/reservoir sites.					
Lead Agency: Portland Water Bureau (PWB)		**Partner Agencies:** PBOT, Multnomah County, Oregon Department of Transportation (ODOT), Metro, Clackamas County, United States Forest Service (USFS)			
Action Source: Portland Water Bureau (PWB) Operations Group		**Performance Metric:** Access to critical facilities following disasters ensures water delivery			
All Hazards	Both	Capital Improvement Plan (CIP)	Near-Term	4,10,14	No
PWB-39 — Revise current emergency response plans based on recommendations from the Water Bureau Seismic Study.					
Lead Agency: Portland Water Bureau (PWB)		**Partner Agencies:** PBEM			
Action Source: Water System Seismic Study		**Performance Metric:** Including seismic risks in planning emergency response is critical to determine strategies to protect and provide water system maintenance, transportation, supply and delivery			
All Hazards	Existing	Capital Improvement Plan (CIP)	Near-Term	10, 13, 16	No
PWB-40 — Continue to support research of best available science and data for space weather and potential impacts to the City of Portland, and where possible take steps to increase resilience of city infrastructure to space weather events.					
Lead Agency: Portland Water Bureau (PWB)		**Partner Agencies:** National Oceanic and Atmospheric Administration (NOAA)			
Action Source: Steering Committee		**Performance Metric:** Consideration of potential impacts to communication and other systems protects water distribution			
Space Weather	Both	Capital Improvement Plan (CIP)	Existing/ Ongoing	10, 4	No

Hazards Addressed	New or Existing Assets	Funding Options	Timeframe	Objectives Met	In Previous Plan? (# from previous plan)
PWB-41 — Develop main replacement program with earthquake resistant pipe (Kubota ERDIP or US-Pipe TR-EXTREME) in areas of high permanent ground deformation					
Lead Agency: Portland Water Bureau (PWB)		**Partner Agencies:** N/A			
Action Source: Water System Seismic Study		**Performance Metric:** Seismic resiliency for at-risk locations prevents catastrophic failure			
Earthquake	Both	Capital Improvement Plan (CIP)	Mid-Term	4, 11	No
PWB-42 — Support the creation of a City of Portland Seismic Resiliency Officer position under PBEM to drive citywide resiliency efforts. This action needs high-level support from City Council.					
Lead Agency: Portland Water Bureau (PWB)		**Partner Agencies:** City Council, PBEM			
Action Source: Steering Committee		**Performance Metric:** Seismic resiliency officer position would assist resiliency efforts			
Earthquake	Both	Capital Improvement Plan (CIP)	Near-Term	7, 16	No
PWB-43 — Coordinate with Commissioner's Office and Office of Government Relations (OGR) to elevate seismic retrofit funding for water infrastructure to a high priority on the City's legislative agenda. This action needs high-level support from City Council and Office of Government Relations (OGR).					
Lead Agency: Portland Water Bureau (PWB)		**Partner Agencies:** Commissioner's Office, Office of Government Relations (OGR)			
Action Source: Portland Water Bureau (PWB) Engineering		**Performance Metric:** Provides a mechanism for requesting seismic improvement funding			
Earthquake	Both	Capital Improvement Plan (CIP)	Near-Term	4, 7	No
PWB-44 — Collaborate with other City bureaus to encourage and expand personal, family and business preparedness plans and programs.					
Lead Agency: Portland Water Bureau (PWB)		**Partner Agencies:** City bureaus, PBEM			
Action Source: Steering Committee		**Performance Metric:** Personal and family preparedness saves lives; business preparedness allows continuity. Responders are able to assist more readily if families are prepared.			
Earthquake	Both	Capital Improvement Plan (CIP)	Near-Term	6, 13	No
PWB-45 — Develop a West-side emergency operations and staging facility for field crews.					
Lead Agency: Portland Water Bureau (PWB)		**Partner Agencies:** N/A			
Action Source: Portland Water Bureau (PWB) Engineering		**Performance Metric:** Ensures access to materials and personnel to respond in emergencies.			
All Hazards	Both	Capital Improvement Plan (CIP)	Mid-Term	14, 15	No
PWB-46 — Develop a staging plan for stockpiling water system repair materials in strategic locations.					
Lead Agency: Portland Water Bureau (PWB)		**Partner Agencies:** N/A			
Action Source: Portland Water Bureau (PWB) Engineering		**Performance Metric:** Ensures repairs despite transportation system damage			
All Hazards	Both	Capital Improvement Plan (CIP)	Mid-Term	15, 16	No

Hazards Addressed	New or Existing Assets	Funding Options	Timeframe	Objectives Met	In Previous Plan? (# from previous plan)
PWB-47 — Continue to conduct ongoing emergency response training for all Portland Water Bureau (PWB) employees.					
Lead Agency: Portland Water Bureau (PWB)		**Partner Agencies:** PBEM			
Action Source: Water System Seismic Study		**Performance Metric:** Ensures organized and effective response to disasters			
All Hazards	Both	Capital Improvement Plan (CIP)	Long-term	15, 16	No
PWB-48 — Purchase additional vacuum excavator to facilitate access to water system for maintenance and repairs.					
Lead Agency: Portland Water Bureau (PWB)		**Partner Agencies:** N/A			
Action Source: Water System Seismic Study		**Performance Metric:** Protects assets			
All Hazards	Both	Capital Improvement Plan (CIP)	Mid-Term	4, 16	No
PWB-49 — Establish relationships with out-of-state utilities for future Emergency Management Assistance Compact (EMAC) agreements.					
Lead Agency: Portland Water Bureau (PWB)		**Partner Agencies:** National WARN, out-of-state utilities			
Action Source: Water System Seismic Study		**Performance Metric:** Ensures power supply in catastrophic outages			
All Hazards	Both	Capital Improvement Plan (CIP)	Near-Term	14, 16	No
PWB-50 — Establish and document PWB reporting standards for both temporary protective measures and permanent repairs in compliance with Federal Emergency Management Agency (FEMA) guidelines.					
Lead Agency: Portland Water Bureau (PWB)		**Partner Agencies:** Federal Emergency Management Agency (FEMA), PBEM, Oregon Emergency Management (OEM), Multnomah County			
Action Source: Water System Seismic Study		**Performance Metric:** Ensures FEMA reimbursement success			
All Hazards	Both	Capital Improvement Plan (CIP)	Near-Term	14, 16	No
PWB-51 — Train PWB responders to understand and follow protocols for Federal Emergency Management Agency (FEMA) reporting.					
Lead Agency: Portland Water Bureau (PWB)		**Partner Agencies:** Federal Emergency Management Agency (FEMA), PBEM			
Action Source: Water System Seismic Study		**Performance Metric:** Ensures FEMA reimbursement success			
All Hazards	Both	Capital Improvement Plan (CIP)	Near-Term	14, 16	No
PWB-52 — Upgrade trestles that carry Conduits 2 and 3 of the water delivery system.					
Lead Agency: Portland Water Bureau (PWB)		**Partner Agencies:** United States Forest Service (USFS), Clackamas County			
Action Source: 2010 NHMP		**Performance Metric:** Upgrade mitigates loss			
All Hazards	Both	Capital Improvement Plan (CIP)	Mid-Term	4, 11	Yes

Hazards Addressed	New or Existing Assets	Funding Options	Timeframe	Objectives Met	In Previous Plan? (# from previous plan)
PWB-53 — Create redundancy in the water delivery system by burying Conduit 3 under the Sandy River.					
Lead Agency: Portland Water Bureau (PWB) **Action Source:** 2010 NHMP		**Partner Agencies:** Division of State Lands, Clackamas County **Performance Metric:** Ensures water delivery			
All Hazards	Both	Capital Improvement Plan (CIP)	Long-Term	4, 11	Yes
PWB-54 — Continue to mitigate Portland's water supply infrastructure and the Bull Run Watershed from landslide hazards; incorporate landslide hazard reduction techniques into infrastructure projects.					
Lead Agency: Portland Water Bureau (PWB) **Action Source:** 2010 NHMP		**Partner Agencies:** N/A **Performance Metric:** Mitigates loss due to landslide			
Landslide	Both	Capital Improvement Plan (CIP)	Existing/ Ongoing	4, 10, 11	Yes
PWB-55 — Seismically harden Groundwater Transmission Main.					
Lead Agency: Portland Water Bureau (PWB) **Action Source:** Water System Seismic Study		**Partner Agencies:** PBOT **Performance Metric:** Critical location requiring seismic stability – Protects water delivery system			
Earthquake	Both	Capital Improvement Plan (CIP)	Long-Term	4, 11	No
PWB-56 — Seismically harden conduits from Headworks to Powell Butte.					
Lead Agency: Portland Water Bureau (PWB) **Action Source:** Water System Seismic Study		**Partner Agencies:** United States Forest Service (USFS) **Performance Metric:** Seismic resiliency critical to water delivery			
Earthquake	Both	Capital Improvement Plan (CIP)	Long-Term	4, 11	No
PWB-57 — Mitigate landslide hazards for the conduits within the Bull Run watershed.					
Lead Agency: Portland Water Bureau (PWB) **Action Source:** Water System Seismic Study		**Partner Agencies:** United States Forest Service (USFS) **Performance Metric:** Mitigate loss due to landslide			
Landslide	Both	Capital Improvement Plan (CIP)	Long-Term	4, 11	No
PWB-58 — Make seismic improvements at Headworks.					
Lead Agency: Portland Water Bureau (PWB) **Action Source:** Portland Water Bureau (PWB) Operations Group		**Partner Agencies:** N/A **Performance Metric:** Mitigates loss			
Earthquake	Both	Capital Improvement Plan (CIP)	Long-Term	4, 11	No
PWB-59 — Make seismic improvements at Lusted Hill Treatment Facility.					
Lead Agency: Portland Water Bureau (PWB) **Action Source:** Portland Water Bureau (PWB) Operations Group		**Partner Agencies:** Multnomah County **Performance Metric:** Mitigates loss			
Earthquake	Both	Capital Improvement Plan (CIP)	Long-Term	4, 11	No

Hazards Addressed	New or Existing Assets	Funding Options	Timeframe	Objectives Met	In Previous Plan? (# from previous plan)
PWB-60 — Install remote monitoring sensors and alarms at Bull Run dams to provide an early detection of dam movement or change.					
Lead Agency: Portland Water Bureau (PWB)	**Partner Agencies:** United States Forest Service (USFS), Federal Energy Regulatory Commission (FERC)				
Action Source: Portland Water Bureau (PWB) Operations Group	**Performance Metric:** Mitigation and early warning would be possible with monitoring				
Dam Failure	Both	Capital Improvement Plan (CIP)	Mid-Term	4, 9, 13	No
PWB-61 — Continue to monitor Bull Run Dams 1 and 2 for seismic risk, floods and landslides					
Lead Agency: Portland Water Bureau (PWB)	**Partner Agencies:** United States Forest Service (USFS), Federal Energy Regulatory Commission (FERC)				
Action Source: Portland Water Bureau (PWB) Engineering	**Performance Metric:** Monitoring allows for early warning and loss mitigation				
All Hazards	Both	Capital Improvement Plan (CIP)	Existing/ Ongoing	4, 9	No
PWB-62 — Replace Cast Iron piping with seismically resilient pipe material.					
Lead Agency: Portland Water Bureau (PWB)	**Partner Agencies:** N/A				
Action Source: Portland Water Bureau (PWB) Operations Group	**Performance Metric:** Seismic resilience reduces loss				
Earthquake	Both	Capital Improvement Plan (CIP)	Existing/ Ongoing	4, 11	No
PWB-63 — Establish a pre-disaster inter-bureau agreement with Office of Management and Finance (OMF) - Fleet and PBOT Maintenance Operations to assign personnel, equipment, and resources to work in coordination with Portland Water Bureau (PWB) response.					
Lead Agency: Portland Water Bureau (PWB)	**Partner Agencies:** OMF - Fleet, PBOT Maintenance Operations				
Action Source: Portland Water Bureau (PWB) Operations Group	**Performance Metric:** Continuity of operations is enhanced for all departments				
All Hazards	Both	Capital Improvement Plan (CIP)	Near-Term	6, 7, 13	No
PWB-64 — Coordinate with FEMA on results of updated flood-plain mapping on Willamette River for impacts to Portland Water Bureau (PWB) facilities.					
Lead Agency: Portland Water Bureau (PWB)	**Partner Agencies:** Federal Emergency Management Agency (FEMA), BES				
Action Source: Portland Water Bureau (PWB) Operations Group	**Performance Metric:** Flood plain mapping and planning for impacts to Portland Water Bureau (PWB) facilities would help with mitigation and alternative water delivery planning				
Flood	Both	Capital Improvement Plan (CIP)	Near-Term	6, 7, 13	No
OMF-1 — Participate in Oregon Solutions project to recertify Multnomah County Drainage District (MCDD) levees.					
Lead Agency: Office of Management and Finance (OMF)	**Partner Agencies:** BDS, Oregon Solutions				
Action Source: 2010 NHMP	**Performance Metric:** Staff time and funding for levee recertification.				
Flood	Existing	Staff Time/Budget Reallocation	Long-term	4, 5	Yes (LT MH #10)

Hazards Addressed	New or Existing Assets	Funding Options	Timeframe	Objectives Met	In Previous Plan? (# from previous plan)
OMF-2 — Partner with agencies to develop an emergency operations center on the west side of the Willamette River. This action needs high-level support from City Council.					
Lead Agency: Office of Management and Finance (OMF) **Action Source:** 2010 NHMP		**Partner Agencies:** PBOT, City Budget Office (CBO), Bureau of Emergency Communications (BOEC), City Council **Performance Metric:** West side emergency operations center developed and operational.			
All Hazards	New	Staff Time/Budget Reallocation	Long-term	2, 4, 5, 15	Yes (New MH #5)
PBOT-1 — Perform risk assessment of bridges; use findings to develop and prioritize mitigation projects. Ensure equity tools are used in project prioritization.					
Lead Agency: PBOT **Action Source:** Steering Committee		**Partner Agencies:** PWB **Performance Metric:** Risk assessment completed and Plan created. Project prioritization has equity criteria.			
Earthquake	New	Staff Time/ Hazard Mitigation Grant Program (HMGP) /Pre-Disaster Mitigation (PDM) grant	Long Term	4, 5, 7,10,11	No
PBOT-2 — Identify transportation routes likely to be impacted by landslides and identify potential alternate routes based on most likely scenarios. Communicate potential alternate routes with the public, highlighting the fact that routes may change during actual events. Ensure this information is available to those with limited English proficiency, as well as seniors and those with disabilities.					
Lead Agency: PBOT **Action Source:** Steering Committee (Landslide 95)		**Partner Agencies:** PBEM, Oregon Department of Transportation (ODOT) **Performance Metric:** Routes identified, communication to disadvantaged communities.			
Landslide	New	Staff Time/ HMGP /PDM	Mid-term	4, 5, 6	No
PBOT-3 — Design and build facility for PBOT Maintenance Operations that can operate as a Bureau Incident Command Post following a large earthquake. Move existing road clearing equipment to a facility that is not subject to freeway ramp collapse. Engage local community groups, especially communities of color, in design phase and ensure Minority, Women Owned Emerging Small Business contracting meets or exceeds aspirational goals.					
Lead Agency: PBOT **Action Source:** Hazard Mitigation Catalog		**Partner Agencies:** Office of Management and Finance (OMF) – Fleet **Performance Metric:** Facility designed, funded and built. Community engagement.			
Earthquake	New	Staff Time/ HMGP /PDM	Mid-term	4, 5, 11, 13	No
PBOT-4 — Perform drainage assessment and mitigate problem areas of right of way where frequent washouts occur during heavy rains.					
Lead Agency: PBOT **Action Source:** Hazard Mitigation Catalog		**Partner Agencies:** Parks, BES, Oregon Department of Transportation (ODOT) **Performance Metric:** Assessment performed			
Severe weather	New	Staff Time/ HMGP/PDM	Mid-term	3, 4, 5, 7, 11	No
PBOT-5 — Continue to convene city landslide group after each major landslide occurrence (including large single landslides or multiple concurrent landslides) to evaluate the city's response and develop lessons learned.					
Lead Agency: PBOT **Action Source:** 2010 NHMP		**Partner Agencies:** PBEM, BDS **Performance Metric:** Landslide group convenes after landslides.			
Landslide	N/A	Staff Time	Long-term	9, 14, 15	Yes (ST LS #1)
BES-1 — Continue to implement actions in the 2005 Portland Watershed Management Plan.					
Lead Agency: Bureau of Environmental Services (BES) **Action Source:** 2010 NHMP		**Partner Agencies:** N/A **Performance Metric:** # of green infrastructure projects completed			
Erosion, Landslide, Flood	N/A	Staff Time	Long-term	3, 4	Yes (ST MH #11)

Hazards Addressed	New or Existing Assets	Funding Options	Timeframe	Objectives Met	In Previous Plan? (# from previous plan)
BES-2 — Engage with the electric utilities to negotiate prioritizing the return of power to treatment plants (Tryon Creek and Columbia Boulevard), collection system active controls and pump stations.					
Lead Agency: Bureau of Environmental Services (BES)		**Partner Agencies:** PBEM, Utilities			
Action Source: 2010 NHMP		**Performance Metric:** Agreement with electric utilities executed.			
Earthquake	N/A	Staff Time	Near-Term	4, 16	Yes (ST EQ #4)
BES-3 — Complete the BES Resiliency Plan to identify vulnerabilities in the sanitary and combined sewer collection system.					
Lead Agency: Bureau of Environmental Services (BES)		**Partner Agencies:** N/A			
Action Source: 2010 NHMP		**Performance Metric:** Completion of BES Resiliency Plan.			
Earthquake	N/A	Staff Time	Near-Term	4, 16	Yes (ST EQ #3)
BES-4 — Continue BES' land acquisition program to protect or enhance water quality, hydrology and habitat. Consider the presence of floodplain and steep slopes in the program's criteria. When properties are purchased, remove structures and place deed restrictions to limit to open space uses, to protect them as natural resource areas or other green infrastructure in perpetuity.					
Lead Agency: Bureau of Environmental Services (BES)		**Partner Agencies:** PP&R, Metro			
Action Source: 2010 NHMP		**Performance Metric:** # of acres acquired through the Watershed Land Acquisition Program.			
All Hazards	N/A	Staff Time, Budget Allocation	Long-term	11, 12	Yes (New Reworded MH)
BES-5 — Develop permitting and policy tools to offset impacts of floodplain development with mitigation on sites that increase flood storage and enhance ecological functions, consistent with new floodplain regulations.					
Lead Agency: Bureau of Environmental Services (BES)		**Partner Agencies:** BDS, Portland Development Commission (PDC)			
Action Source: BES Strategic Plan		**Performance Metric:** Adoption of policies and new permitting requirements.			
Flood	N/A	Staff Time	Mid-term	3, 4, 5, 7, 8, 12	No
BES-6 — Continue to fund the Johnson Creek Willing Seller Program to reduce the risks of flooding, while improving natural floodplain conditions in the watershed.					
Lead Agency: Bureau of Environmental Services (BES)		**Partner Agencies:** PP&R			
Action Source: 2010 NHMP		**Performance Metric:** # of acres acquired through the Johnson Creek Willing Seller Program.			
Flood	N/A	Staff Time, Budget Allocation	Long-term	3, 7, 11	Yes (LT FL #1)
BES-7 — Continue to partner with United States Geological Survey (USGS) to maintain and improve river and stream gauges in the Portland metropolitan area.					
Lead Agency: Bureau of Environmental Services (BES)		**Partner Agencies:** PBEM, PBOT			
Action Source: 2010 NHMP		**Performance Metric:** N/A			
Flood	N/A	Staff Time	Long-term	9, 10	Yes (ST FL #2)
BES-8 — Continue to provide publicly accessible information on landscaping techniques that reduce water run-off.					
Lead Agency: Bureau of Environmental Services (BES)		**Partner Agencies:** East Multnomah Soil and Water Conservation District, West Multnomah Soil and Water Conservation District, Watershed Councils			
Action Source: BES Strategic Plan		**Performance Metric:** N/A			
Flood	N/A	Staff Time	Long-term	3, 12	No

Hazards Addressed	New or Existing Assets	Funding Options	Timeframe	Objectives Met	In Previous Plan? (# from previous plan)
BES-9 — Design and conduct a study to determine the effectiveness of maintenance agreements that require homeowners associations to manage vegetation in open space tracts when new land divisions are approved.					
Lead Agency: Bureau of Environmental Services (BES)		**Partner Agencies:** BDS			
Action Source: 2010 NHMP		**Performance Metric:** Completion of study.			
Wildfire	N/A	Staff Time	Near-Term	3, 12	Yes (LT WF #3)
BES-10 — Update the Stormwater Management Manual on a regular basis to incorporate best management practices, address development-related issues and work effectively with natural hydrologic conditions.					
Lead Agency: Bureau of Environmental Services (BES)		**Partner Agencies:** BDS			
Action Source: 2010 NHMP		**Performance Metric:** Updates completed.			
Flood	N/A	Staff Time	Long-term	1, 3, 12	Yes (ST FL #10)
BES-11 — Investigate design approaches for effectively managing stormwater in landslide-prone areas.					
Lead Agency: Bureau of Environmental Services (BES)		**Partner Agencies:** PBOT			
Action Source: 2010 NHMP		**Performance Metric:** Design approaches developed.			
Landslide	N/A	Staff Time	Long-term	3, 4, 5, 12	Yes (LT LS #4)
BES-12 — Continue the City's vegetation management, public education programs, and partnerships with watershed councils and the soil and water conservation districts to prevent erosion along streams and rivers.					
Lead Agency: Bureau of Environmental Services (BES)		**Partner Agencies:** PP&R, Watershed Councils, Soil and Water Conservation Districts			
Action Source: 2010 NHMP		**Performance Metric:** # of projects completed.			
Flood, Landslide	N/A	Staff Time	Long-term	3, 6, 12	Yes (ER #1)
BES-13 — Continue to implement projects that retain native vegetation, increase vegetation diversity and increase the complexity of the vegetation strata (having at least three vegetation strata: herbs, shrubs, trees).					
Lead Agency: Bureau of Environmental Services (BES)		**Partner Agencies:** PP&R			
Action Source: 2010 NHMP		**Performance Metric:** Acres managed or restored.			
Flood, Landslide	N/A	Staff Time, Budget Allocation	Long-term	3, 8, 12	Yes (ER #2)
BES-14 — Continue to implement City restoration projects that increase large wood and root wads, which soften the effect of wave action on shorelines as well as provide habitat for migrating salmonids.					
Lead Agency: Bureau of Environmental Services (BES)		**Partner Agencies:** N/A			
Action Source: 2010 NHMP		**Performance Metric:** River or stream miles restored with large wood.			
Flood	N/A	Staff Time, Budget Allocation, Hazard Mitigation Assistance (HMA) (Floodplain & Stream Restoration, Flood Diversion & Storage)	Long-term	3, 8	Yes (ER #8)
BES-15 — Support Early Detection and Rapid Response to control invasive plant and insect populations that threaten forest infrastructure.					
Lead Agency: Bureau of Environmental Services (BES)		**Partner Agencies:** PP&R, United States Department of Agriculture (USDA), Oregon Department of Agriculture (ODA)			
Action Source: BES Strategic Plan		**Performance Metric:** N/A			
Landslide, Wildfire	N/A	Staff Time	Long-term	3, 12	No

Hazards Addressed	New or Existing Assets	Funding Options	Timeframe	Objectives Met	In Previous Plan? (# from previous plan)
BES-16 — Explore options to acquire rights of first refusal for properties that become non-conforming uses in the floodplain due to changing regulations. Right of first refusal would be exercised when properties are substantially damaged by a flood event. Consider establishing an acquisition fund for these properties that amortizes the cost of acquisition over decades.					
Lead Agency: Bureau of Environmental Services (BES)		**Partner Agencies:** PP&R, Metro			
Action Source: BES Strategic Plan		**Performance Metric:** White paper completed documenting the anticipated effectiveness of this tool.			
Flood	N/A	Staff Time, HMA	Long-term	7, 11, 12	No
BES-17 — Complete the Stormwater System Plan, including strategies to reduce risks related to runoff in areas at risk of natural hazards.					
Lead Agency: Bureau of Environmental Services (BES)		**Partner Agencies:** PP&R, PBOT			
Action Source: BES Strategic Plan		**Performance Metric:** Stormwater System Plan completed.			
Landslide, Flood	N/A	Staff Time	Near-Term	3, 4	No
BES-18 — Continue to implement green infrastructure projects and natural area restoration projects identified in BES' watershed management plans and system plans.					
Lead Agency: Bureau of Environmental Services (BES)		**Partner Agencies:** PP&R, PBOT			
Action Source: BES Strategic Plan		**Performance Metric:** # and type of projects completed.			
Landslide, Flood	N/A	Staff Time, HMA (Floodplain & Stream Restoration, Flood Diversion & Storage)	Long-term	3, 4	No
BES-19 — Partner with community groups and residents to plant trees and revegetate natural areas and open spaces to improve local hydrology and stormwater management and to promote resiliency of and equitable benefits provided by the urban forest.					
Lead Agency: Bureau of Environmental Services (BES)		**Partner Agencies:** PP&R, Watershed Councils, Friends of Trees			
Action Source: BES Strategic Plan		**Performance Metric:** # of trees planted; # of acres revegetated.			
Flood, Landslide	N/A	Staff Time	Long-term	2, 3, 15	No
BES-20 — Support Multnomah County Drainage District (MCDD) in their continued calibration and update of hydraulic models for conveyance and internal flood impacts to the four floodplains managed by MCDD #1.					
Lead Agency: Bureau of Environmental Services (BES)		**Partner Agencies:** MCDD			
Action Source: 2010 NHMP		**Performance Metric:** N/A			
Flood	N/A	Staff Time	Long-term	5, 9, 10	Yes (ST FL #6)
BES-21 — Provide technical assistance to support Multnomah County Drainage District in conducting flooding impact studies from levee failure and develop a risk assessment using the updated general building stock, critical facility and demographic information developed for the mitigation action plan.					
Lead Agency: Bureau of Environmental Services (BES)		**Partner Agencies:** BPS, MCDD			
Action Source: BES Strategic Plan		**Performance Metric:** N/A			
Flood, Dam Failure	N/A	Staff Time	Near-term	2, 4, 5, 10	No
BES-22 — Work with the Federal Emergency Management Agency (FEMA) to remap all City of Portland streams to identify changes in peak flows and flood extents due to climate change.					
Lead Agency: Bureau of Environmental Services (BES)		**Partner Agencies:** Federal Emergency Management Agency (FEMA), United States Army Corps of Engineers (USACE)			
Action Source: BES Strategic Plan		**Performance Metric:** N/A			
Flood	N/A	Staff Time	Near-term	3, 9, 10	No

Hazards Addressed	New or Existing Assets	Funding Options	Timeframe	Objectives Met	In Previous Plan? (# from previous plan)
BES-23 — Where feasible, cost effective and supported both publicly and politically, restore the natural and beneficial floodplain functions of appropriate floodplains within the City. For this action, appropriate means a floodplain that has been identified through a master plan or study certified by a qualified agency.					
Lead Agency: Bureau of Environmental Services (BES)		**Partner Agencies:** PP&R, BDS			
Action Source: Community Rating System (CRS)		**Performance Metric:** # of acres of restored floodplain			
Flood	Both	Flood Mitigation Assistance (FMA) grant, PDM, HMGP, Land and Water Conservation Fund, Johnson Creek Willing Seller Program	Long-term	1, 2, 3, 4, 11	No
BDS-1 — Increase the responsiveness of the emergency permitting procedures for post-hazard event periods through development of procedural plan that considers equity implications.					
Lead Agency: Bureau of Development Services (BDS)		**Partner Agencies:** N/A			
Action Source: 2010 NHMP		**Performance Metric:** N/A			
All Hazards	N/A	Staff Time	Near-Term	2, 15, 16	Yes (LT MH #3)
BDS-2 — Enforce codes relating to wildfire, earthquake, flood, and landslide, including Portland City Code (PCC) 24.51 (fire-safe materials), PCC 24.85 (seismic upgrades), PCC 24.50 (local flood hazard mitigation), and develop a publicly accessible landslide code guide in plain language to assist developers in complying with landslide-related building codes.					
Lead Agency: Bureau of Development Services (BDS)		**Partner Agencies:** BPS			
Action Source: 2010 NHMP		**Performance Metric:** N/A			
Wildfire, Earthquake, Flood, Landslide	N/A	Staff Time	Long-term	1, 6, 12	Yes (New MH #3)
BDS-3 — Develop an ordinance requiring a covenant to be recorded on the deed for new development in the FEMA special flood hazard area to ensure that space below the base flood elevation is not converted to habitable space.					
Lead Agency: Bureau of Development Services (BDS)		**Partner Agencies:** N/A			
Action Source: 2010 NHMP		**Performance Metric:** N/A			
Flood	N/A	Staff Time	Mid-term	1, 12	Yes (ST FL #1)
BDS-4 — Encourage and expand personal, family, and business preparedness plans and programs.					
Lead Agency: Bureau of Development Services (BDS)		**Partner Agencies:** All City bureaus			
Action Source: Steering Committee		**Performance Metric:** Preparedness fairs; citywide preparedness surveys			
All Hazards	N/A	Staff Time	Long-term	1, 4, 12	No
BDS-5 — Make information about floodplain zones available to residents when applying for permits.					
Lead Agency: Bureau of Development Services (BDS)		**Partner Agencies:** N/A			
Action Source: Steering Committee		**Performance Metric:** N/A			
Flood	N/A	Staff Time	Mid-term	3, 6, 12, 15	No

Hazards Addressed	New or Existing Assets	Funding Options	Timeframe	Objectives Met	In Previous Plan? (# from previous plan)
BDS-6 — Implement recommendations from the City's Unreinforced Masonry (URM) Work Group.					
Lead Agency: Bureau of Development Services (BDS)		**Partner Agencies:** PBEM			
Action Source: Steering Committee		**Performance Metric:** New codes developed.			
Earthquake	Existing	Staff Time, Budget Allocation, HMA	Long-term	1, 2, 3, 6, 7, 11, 12	No
BDS-7 — Continue to coordinate with Multnomah County Drainage District (MCDD) to review permit applications for development near levees; if a permit is requested for development within the "levee review area", submit the application to MCDD to review and if necessary work with developer to revise plans to meet United States Army Corps of Engineers (USACE) requirements for development on or near federal levees.					
Lead Agency: Bureau of Development Services (BDS)		**Partner Agencies:** Multnomah County Drainage District (MCDD), BPS			
Action Source: Stakeholder Input		**Performance Metric:** N/A			
Dam Failure, Flood	Existing	Staff Time	Long-term	1, 4	No
BDS-8 — Maintain good standing under the National Flood Insurance Program by implementing programs that meet or exceed the minimum NFIP requirements. Such programs include enforcing an adopted flood damage prevention ordinance, participating in floodplain mapping updates, and providing public assistance and information on floodplain requirements and impacts.					
Lead Agency: Bureau of Development Services (BDS)		**Partner Agencies:** Bureau of Environmental Services			
Action Source: NFIP Compliance		**Performance Metric:** Continued good standing under the NFIP			
Flood	New and Existing	Staff Time	Ongoing	1, 9, 10, 12	No
CAMG-1 — Advocate for bureaus to consider seismic and landslide risk when developing capital improvement plans, including plans to replace water and sewer infrastructure.					
Lead Agency: City Asset Managers Group (CAMG)		**Partner Agencies:** PBEM, BES			
Action Source: 2010 NHMP		**Performance Metric:** Criteria established in Capital Improvement Plan (CIP) prioritization process regarding seismic and landslide hazards.			
Earthquake, Landslide	Both	Staff Time	Long-term	1, 4, 5	Yes (LT EQ #3)
CAMG-2 — Consider what the critical assets are in determining mitigation priorities for City assets, incorporating critical facilities risk assessment data from the MAP where relevant.					
Lead Agency: City Asset Managers Group (CAMG)		**Partner Agencies:** PBEM, BES			
Action Source: 2010 NHMP		**Performance Metric:** N/A			
All Hazards	Existing	Staff Time	Long-term	2, 5, 7, 11	Yes (FL #2)
CAMG-3 — Encourage every bureau to inventory critical assets and review critical infrastructure vulnerability, and identify a 50-year plan to strengthen, retrofit, relocate or otherwise increase resiliency. Consider ways to promote city-wide collaboration					
Lead Agency: City Asset Managers Group (CAMG)		**Partner Agencies:** City bureaus, PBEM			
Action Source: Steering Committee		**Performance Metric:** Entire city infrastructure planning is critical to disaster recovery			
Earthquake	Both	Capital Improvement Plan (CIP)	Long-term	5, 7	No

Hazards Addressed	New or Existing Assets	Funding Options	Timeframe	Objectives Met	In Previous Plan? (# from previous plan)
OEHR-1 — Prior to and during implementation, review all actions for negative externalities and to ensure vulnerable populations are protected from displacement or other disproportionate burdens.					
Lead Agency: Office of Equity and Human Rights (OEHR)		**Partner Agencies:** PBEM, BES, BPS, PBOT, PWB			
Action Source: Steering Committee		**Performance Metric:** All actions are reviewed for equity considerations during implementation planning.			
All Hazards	N/A	Staff Time	Long-term	2, 8, 14, 15	No

19.3.3 Action Plan Benefit-Cost Review

The action plan must be prioritized according to a benefit/cost analysis of the proposed actions (44 CFR, Section 201.6(c)(3)(iii)). The benefits of proposed projects were weighed against estimated costs as part of the project prioritization process. The benefit/cost analysis was not as detailed as required by FEMA for eligibility under the Hazard Mitigation Grant Program (HMGP) and Pre-Disaster Mitigation (PDM) grant program. A less formal approach was used because some projects may not be implemented for up to 10 years, and associated costs and benefits could change in that time. Therefore, a review of apparent benefits versus apparent cost was performed by assigning subjective ratings (high, medium, and low) to project costs and benefits.

Benefit ratings were defined as follows:

- **High:** Action will support compliance with a legal mandate or, once completed, will have an immediate impact on the reduction of risk exposure to life and property.
- **Medium:** Once completed, action will have a long-term impact on the reduction of risk exposure to life and property, has a substantial life safety component, or project will provide an immediate reduction in the risk exposure to property.
- **Low:** Long-term benefits of the action are difficult to quantify in the short term.

Cost impact ratings were defined as follows:

- **High:** Would require an increase in revenue via an alternative source (i.e., bonds, grants, fee increases) to implement. Existing funding levels are not adequate to cover the costs of the proposed project.
- **Medium**: Could budget for under existing work-plan, but would require a reapportionment of the budget or a budget amendment, or the cost of the project would have to be spread over multiple years.
- **Low:** Possible to fund under existing budget. Project is or can be part of an existing ongoing program or would not require substantial effort to initiate or appropriate funds.

Using this approach, projects with positive benefit versus cost ratios (such as high over high, high over medium, medium over low, etc.) are considered cost-beneficial and are prioritized accordingly.

For many of the strategies identified in this action plan, the City may seek financial assistance under the HMGP or PDM programs, both of which require detailed benefit/cost analyses. These analyses will be performed on projects at the time of application using the FEMA benefit-cost model. For projects not seeking financial assistance from grant programs that require detailed analysis, the City reserves the right to define "benefits" according to parameters that meet the goals and objectives of this plan.

19.3.4 Action Plan Prioritization

Using the results of the benefit-cost analysis as well as the other information identified in the action development process, all identified actions were prioritized in two categories: implementation and grant pursuit.

Implementation priority was defined as follows:

- **High Priority—**An action that meets multiple objectives, has benefits that exceed cost, has funding secured or is an ongoing project. High priority actions can be completed in the short-term or mid-term (1 to 5 years) or are projects that are long-term projects that can be initiated in the short-term and will have large positive impacts once completed. The key factors for high priority actions are that they have funding secured and can be completed or initiated in the short- or mid-term.
- **Medium Priority**—An action that meets multiple objectives, that has benefits that exceed costs, and for which funding has not yet been secured, but is eligible for funding. Actions can be completed in the short- or mid-term, once funding is secured, or are projects that are long-term projects that can be initiated in the short-term and will have large positive impacts once completed. Medium priority actions will become high priority actions once funding is secured. The key factors for medium priority actions are that they are eligible for funding, but do not yet have funding secured, and they can be completed or initiated within the short- or mid-term.
- **Low Priority**—An action that will mitigate the risk of a hazard, that has benefits that do not exceed the costs or are difficult to quantify, for which funding has not been secured, that is not eligible for grant funding, and for which the time line for completion is long-term or uncertain. Low priority actions may be eligible for grant funding from other programs that have not yet been identified. Low priority projects are generally "blue-sky" or "wish-list." projects. Financing is unknown, and they can be completed over the long term.

Grant pursuit priority was defined as follows:

- **High Priority**—An action that has been identified as meeting grant eligibility requirements, assessed to have high benefits, is listed as high or medium priority, and where local funding options are unavailable or where dedicated funds could be utilized for projects that are not eligible for grant funding.
- **Medium Priority**—An action that has been identified as meeting grant eligibility requirements, assessed to have medium or low benefits, is listed as medium or low priority, and where local funding options are unavailable.
- **Low Priority**—An action that has not been identified as meeting grant eligibility requirements, or has low benefits. Additionally, projects that are already being funded and are likely to continue to be funded are identified as low grant pursuit priority.

In addition, each action was reviewed to determine if the target audience/beneficiary identified for the action is one of the groups of focus for the assessment (e.g. people with disabilities, communities of color, etc.). If so, the priority was noted with an E (e.g. High-E). Results are summarized in Table 19-5.

Table 19-5. Prioritization of Mitigation Actions

Action #	# of Objectives Met	Benefits	Costs	Do Benefits Equal or Exceed Costs?	Is project Grant Eligible?	Can Project be Funded under Existing Programs/ Budgets?	Implementation Priority (High, Med., Low)	Grant Pursuit Priority (High, Med., Low)
PBEM-1	6	Medium	Low	Yes	No	Yes	High	Low
PBEM-2	5	Medium	Medium	Yes	No	No	Medium – E	Low – E
PBEM-3	5	Medium	Medium	Yes	No	No	Medium – E	Low – E
PBEM-4 [a]	2	Low	Low	Yes	No	Yes	High	Low
PBEM-5 [a]	3	Medium	Low	Yes	No	Yes	High	Low
PBEM-6 [a]	4	Medium	Low	Yes	No	Yes	Medium	Low
PBEM-7 [a]	2	Low	Low	Yes	No	Yes	High	Low
PBEM-8 [a]	5	Medium	Medium	Yes	No	Yes	High	Low
PBEM-9 [a]	2	Low	Low	Yes	No	Yes	High	Low
PBEM-10	5	Medium	Low	Yes	No	Yes	High – E	Low – E
PBEM-11 [a]	3	High	High	Yes	Yes	No	Medium – E	High – E
PBEM-12 [a]	3	Medium	Low	Yes	No	Yes	High – E	Low – E
PBEM-13	3	Medium	Low	Yes	No	Yes	High	Low
PBEM-14 [a]	3	Low	Low	Yes	No	Yes	Medium	Low
PBEM-15 [a]	6	Medium	Low	Yes	No	Yes	High	Low
PBEM-16	4	Medium	Medium	Yes	No	No	Medium-E	Low-E
PBEM-17	5	Medium	Medium	Yes	No	No	Medium-E	Low-E
PBEM-18 [a]	4	Medium	Low	Yes	No	Yes	High-E	Low-E
PBEM-19	4	Medium	Medium	Yes	No	No	High	Low
PBEM-20 [a]	6	Medium	Medium	Yes	No	No	Medium-E	Low-E
PBEM-21	5	Medium	Medium	Yes	No	No	High	Low
PBEM-22 [a]	4	Low	Low	Yes	Yes	Yes	High	Low
PBEM-23 [a]	5	High	Medium	Yes	No	No	High-E	Low-E
PBEM-24	6	Medium	Medium	Yes	No	No	Medium	Low
PP&R-1 [a]	3	Low	Low	Yes	No	Yes	Medium	Low
PP&R-2	3	Medium	Low	Yes	No	Yes	High	Low
PP&R-3	3	Low	Low	Yes	No	Yes	High	Low
PF&R-1	5	Medium	Low	Yes	No	Yes	Medium	Low
PF&R-2 [a]	10	High	Low	Yes	No	Yes	High	Low
PF&R-3 [a]	11	Medium	Medium	Yes	Yes	Yes	Medium	Low
PF&R-4 [a]	4	High	High	Yes	Yes	No	Medium	Medium
PF&R-5 [a]	5	Medium	Medium	Yes	No	No	Low	Low
PF&R-6 [a]	5	Medium	Low	Yes	Yes	Yes	Medium/	Low
PF&R-7 [a]	5	Medium	Low	Yes	No	Yes	Low	Low
PF&R-8	3	Medium	Low	Yes	No	Yes	Medium	Low
PF&R-9	3	Medium	Medium	Yes	Yes	No	Medium	Medium
BPS-1	3	High	High	Yes	No	No	High –E	High-E
BPS-2	4	High	High	Yes	No	No	High-E	High-E
BPS-3	4	High	High	Yes	No	No	High-E	High-E
BPS-4	5	Medium	Low	Yes	No	No	Low	Low
BPS-5 [a]	5	High	Low	Yes	No	Yes	High	Low

Action #	# of Objectives Met	Benefits	Costs	Do Benefits Equal or Exceed Costs?	Is project Grant Eligible?	Can Project be Funded under Existing Programs/ Budgets?	Implementation Priority (High, Med., Low)	Grant Pursuit Priority (High, Med., Low)
BPS-6 [a]	5	High	Low	Yes	No	Yes	High	Low
BPS-7 [a]	4	High	Low	Yes	No	Yes	High-E	Medium-E
BPS-8 [a]	3	Medium	Medium	Yes	No	No	Medium	Low
BPS-9 [a]	6	High	High	Yes	Yes (PDM)	No	High	High
BPS-10 [a]	7	High	High	Yes	Yes (PDM)	No	High-E	High-E
BPS-11 [a]	6	Medium	Medium	Yes	No	No	Low	Low
BPS-12 [a]	4	High	Low	Yes	No	Yes	Medium	Medium
BPS-13 [a]	4	High	High	Yes	No	No	High	Medium
BPS-14 [a]	4	Medium	Medium	Yes	No	No	Medium	Medium
BPS-15	4	High	Medium	Yes	No	No	High	High
BPS-16 [a]	7	High	Low	Yes	Yes (PDM, FMA)	Yes	High	Low
BPS-17 [a]	5	Medium	Medium	Yes	No	No	Low	Low
BPS-18	7	Medium	Medium	Yes	No	No	Medium-E	Low-E
BPS-19 [a]	8	High	Medium	Yes	Yes (PDM)	No	Medium	Medium
PWB-1 [a]	4	High	High	Yes	Yes	Yes	High	High
PWB-2	2	High	Medium	Yes	Yes	Yes	Medium	Medium
PWB-3	2	High	High	Yes	Yes	Yes	High	High
PWB-4	2	High	Medium	Yes	Yes	Yes	Medium	Medium
PWB-5	2	High	Low	Yes	Yes	Yes	High	High
PWB-6	2	High	Medium	Yes	Yes	Yes	Medium	Medium
PWB-7	3	High	High	Yes	Yes	Yes	High	High
PWB-8	2	High	High	Yes	Yes	Yes	Medium	Medium
PWB-9	3	High	High	Yes	Yes	Yes	Medium	Medium
PWB-10	3	High	Low	Yes	Yes	Yes	Medium	Medium
PWB-11	2	High	Low	Yes	Yes	Yes	Medium	Medium
PWB-12	2	High	Low	Yes	Yes	Yes	High	High
PWB-13	2	High	Low	Yes	Yes	Yes	Medium	Medium
PWB-14	2	High	Low	Yes	Yes	Yes	Medium	Medium
PWB-15 [a]	2	High	Low	Yes	Yes	Yes	Medium	Medium
PWB-16	2	High	Medium	Yes	Yes	Yes	Medium	Medium
PWB-17	2	High	Low	Yes	Yes	Yes	Medium	Medium
PWB-18	2	High	Low	Yes	Yes	Yes	Medium	Medium
PWB-19	2	High	Low	Yes	Yes	Yes	Medium	Medium
PWB-20 [a]	3	High	Low	Yes	Yes	Yes	High	High
PWB-21	3	High	Medium	Yes	Yes	Yes	Medium	Medium
PWB-22 [a]	2	High	Low	Yes	Yes	Yes	Medium	Medium
PWB-23	2	High	High	Yes	Yes	Yes	High	High
PWB-24	2	High	High	Yes	Yes	Yes	Medium	Medium
PWB-25	3	High	Low	Yes	Yes	Yes	Medium	Medium
PWB-26	3	High	Low	Yes	Yes	Yes	Medium	Medium
PWB-27	2	High	Low	Yes	Yes	Yes	Medium	Medium
PWB-28 [a]	2	High	Low	Yes	Yes	Yes	Medium	Medium

Action #	# of Objectives Met	Benefits	Costs	Do Benefits Equal or Exceed Costs?	Is project Grant Eligible?	Can Project be Funded under Existing Programs/ Budgets?	Implementation Priority (High, Med., Low)	Grant Pursuit Priority (High, Med., Low)
PWB-29 [a]	3	High	Low	Yes	Yes	Yes	High	High
PWB-30 [a]	3	High	Low	Yes	Yes	Yes	Medium	Medium
PWB-31	2	High	Low	Yes	Yes	Yes	Medium	Medium
PWB-32	2	High	Low	Yes	Yes	Yes	Medium	Medium
PWB-33	2	High	Low	Yes	Yes	Yes	Medium	Medium
PWB-34	2	High	Medium	Yes	Yes	Yes	Medium	Medium
PWB-35	2	High	Medium	Yes	Yes	Yes	High	High
PWB-36	2	High	Low	Yes	Yes	Yes	Medium	Medium
PWB-37 [a]	3	High	Low	Yes	Yes	Yes	Medium	Medium
PWB-38 [a]	3	High	Low	Yes	Yes	Yes	High	High
PWB-39 [a]	3	High	Low	Yes	Yes	Yes	Medium	Medium
PWB-40 [a]	2	High	Low	Yes	Yes	Yes	Low	Low
PWB-41 [a]	2	High	High	Yes	Yes	Yes	Medium	Medium
PWB-42 [a]	2	High	Low	Yes	Yes	Yes	Medium	Medium
PWB-43 [a]	2	High	Low	Yes	Yes	Yes	High	High
PWB-44	2	High	Low	Yes	Yes	Yes	High	High
PWB-45	2	High	High	Yes	Yes	Yes	Medium	Medium
PWB-46 [a]	2	High	Low	Yes	Yes	Yes	Medium	Medium
PWB-47	2	High	Low	Yes	Yes	Yes	High	High
PWB-48	2	High	Medium	Yes	Yes	Yes	Medium	Medium
PWB-49	2	High	Low	Yes	Yes	Yes	High	High
PWB-50	2	High	Low	Yes	Yes	Yes	High	High
PWB-51	2	High	Low	Yes	Yes	Yes	High	High
PWB-52	2	High	High	Yes	Yes	Yes	Medium	Medium
PWB-53	2	High	High	Yes	Yes	Yes	Medium	Medium
PWB-54 [a]	3	High	High	Yes	Yes	Yes	Medium	Medium
PWB-55	2	High	High	Yes	Yes	Yes	High	High
PWB-56	2	High	High	Yes	Yes	Yes	High	High
PWB-57	2	High	High	Yes	Yes	Yes	High	High
PWB-58	2	High	High	Yes	Yes	Yes	High	High
PWB-59	2	High	High	Yes	Yes	Yes	High	High
PWB-60	3	High	Medium	Yes	Yes	Yes	Medium	Medium
PWB-61	2	High	Low	Yes	Yes	Yes	High	High
PWB-62	2	High	High	Yes	Yes	Yes	Medium	Medium
PWB-63 [a]	3	High	Low	Yes	Yes	Yes	Medium	Medium
PWB-64 [a]	3	High	Low	Yes	Yes	Yes	Medium	Medium
OMF-1 [a]	2	Medium	Low	Yes	No	Yes	High	Low
OMF-2	4	Medium	Medium	Yes	No	Yes	High	Low
PBOT-1 [a]	5	Medium	Medium	Yes	Yes	Yes	High	Medium
PBOT-2	3	Medium	Low	Yes	Yes	Yes	High	Medium
PBOT-3	4	High	High	Yes	Yes	No	Medium	Medium
PBOT-4	5	Medium	Medium	Yes	Yes	Yes	Medium	Low
PBOT-5 [a]	3	Low	Low	Yes	No	Yes	High	Low

Action #	# of Objectives Met	Benefits	Costs	Do Benefits Equal or Exceed Costs?	Is project Grant Eligible?	Can Project be Funded under Existing Programs/ Budgets?	Implementation Priority (High, Med., Low)	Grant Pursuit Priority (High, Med., Low)
BES-1 [a]	2	High	Low	Yes	No	Yes	High	Low
BES-2	2	High	Low	Yes	No	Yes	High	Low
BES-3 [a]	2	High	Medium	Yes	No	Yes	High	Low
BES-4	2	High	High	Yes	Yes	No	High	High
BES-5 [a]	6	High	Low	Yes	No	Yes	High	Low
BES-6	3	High	High	Yes	No	Yes	High	Low
BES-7	2	High	Low	Yes	No	Yes	High	Low
BES-8	2	Medium	Low	Yes	No	Yes	High	Low
BES-9	2	Medium	Low	Yes	No	No	Medium	Low
BES-10	3	High	Low	Yes	No	Yes	High	Low
BES-11	4	Medium	Low	Yes	No	Yes	High	Low
BES-12	3	High	Low	Yes	No	Yes	High	Low
BES-13	3	High	Low	Yes	No	Yes	High	Low
BES-14	2	Medium	Low	Yes	Yes	Yes	High	High
BES-15	2	Medium	Low	Yes	No	Yes	High	Low
BES-16	3	High	High	Yes	Yes	No	Medium	Medium
BES-17 [a]	2	High	Medium	Yes	No	Yes	High	Low
BES-18 [a]	2	High	Medium	Yes	Yes	Yes	High	High
BES-19	3	Medium	Low	Yes	No	Yes	High	Low
BES-20 [a]	3	Low	Low	Yes	No	Yes	High	Low
BES-21 [a]	4	Low	Low	Yes	No	Yes	High	Low
BES-22 [a]	3	Low	Low	Yes	No	Yes	High	Low
BES-23	5	High	Medium	Yes	Yes	No	Medium	High
BDS-1	3	Medium	Medium	Yes	No	No	Medium	Low
BDS-2 [a]	3	High	Low	Yes	No	Yes	High	Low
BDS-3 [a]	2	Medium	Low	Yes	No	Yes	High	Low
BDS-4	3	High	Low	Yes	No	Yes	High	Low
BDS-5	4	Medium	Low	Yes	No	Yes	High	Low
BDS-6 [a]	7	High	High	Yes	Yes	No	Medium	Medium
BDS-7 [a]	2	Medium	Low	Yes	No	Yes	High	Low
BDS-8[a]	4	High	Low	Yes	No	Yes	High	Low
CAMG-1 [a]	3	Medium	Low	Yes	No	Yes	High	Low
CAMG-2 [a]	4	Medium	Low	Yes	No	Yes	High	Low
CAMG-3 [a]	2	High	Medium	Yes	Yes	Yes	High	High
OEHR-1	4	Medium	Medium	Yes	No	Yes	High-E	Low-E

a. Action was identified as a plan integration action by the planning team. See Section 19.5.5 for more information.

19.3.5 Analysis of Mitigation Actions

Mitigation Types

Each recommended action was classified based on the hazard it addresses and the type of mitigation it involves. Table 19-6 shows the classification based on this analysis. Mitigation types are defined as follows:

- **Prevention**—Government, administrative or regulatory actions that influence the way land and buildings are developed to reduce hazard losses. Includes planning and zoning, floodplain laws, capital improvement programs, open space preservation, and storm water management regulations.
- **Property Protection**—Modification of buildings or structures to protect them from a hazard or removal of structures from a hazard area. Includes acquisition, elevation, relocation, structural retrofit, storm shutters, and shatter-resistant glass.
- **Public Education and Awareness**—Actions to inform citizens and elected officials about hazards and ways to mitigate them. Includes outreach projects, real estate disclosure, hazard information centers, and school-age and adult education.
- **Natural Resource Protection**—Actions that minimize hazard loss and preserve or restore the functions of natural systems. Includes sediment and erosion control, stream corridor restoration, watershed management, forest and vegetation management, and wetland restoration and preservation.
- **Emergency Services**—Actions that protect people and property during and immediately after a hazard event. Includes warning systems, emergency response services, and the protection of essential facilities.
- **Structural Projects**—Actions that involve the construction of structures to reduce the impact of a hazard. Includes dams, setback levees, floodwalls, retaining walls, and safe rooms.
- **Community Capacity Building**—Actions that identify, strengthen or link the community's tangible and intangible resources. Includes investing in food independence projects (ex. community gardens), promoting and supporting rain water collection systems, alternative energy sources (ex. solar power, wind power, micro-level hydro power), culturally appropriate community-level training for emergency and trauma response.

Objectives Met

Each recommended action also identifies the objectives that the action supports. Table 19-7 shows the recommended actions and the corresponding objectives.

Table 19-6. Analysis of Mitigation Actions by Mitigation Type

Hazard	Actions That Address the Hazard, by Mitigation Type						
	Prevention	Property Protection	Public Education and Awareness	Natural Resource Protection	Emergency Services	Structural Projects	Community Capacity Building
All Hazards	• PBEM-12,19, 20, 22 • PP&R-1 • BPS-5, 6, 7, 8, 19 • PWB-21, 25, 26, 46, 49, 50, 51, 64 • BES-4 • BDS-1 • OEHR-1	• PBEM-19,12 • PWB-3, 24, 35, 38, 52, 53 • BES-4 • CAMG-2	• PBEM-1, 2, 3, 10, 15, 16, 18 • PF&R-7 • BPS-3, 12 • PWB-34 • BDS-4	• BES-4	• PBEM-2, 5, 10, 12, 16, 17, 18, 19, 23 • PF&R-7, 8 • BPS-2, 9, 10 • PWB-3, 21, 24, 28, 29, 30, 31, 32, 33, 35, 38, 39, 46, 47, 48, 49, 50, 51, 61, 63 • OMF-2 • BDS-4		• PBEM-2, 3, 15, 17, 18, 19, 23, 24 • PF&R-7 • BPS-1, 2, 18
Severe Weather	• BPS-16, 17 • PBOT-4	• PBOT-4		• BPS-17 PWB-11			
Earthquake	• PBEM-11 • PF&R-4, • BPS-4, 13, 14, 19 • PWB-36, 37, 42, 43, 44 • BES-2, 3 • BDS-2, 6 • CAMG-1	• PBEM-6, 8, • PF&R-4,9 • BPS-15 • PWB-1, 2, 3, 4, 6, 7, 8, 9, 19, 23, 36, 37, 41, 55, 56, 58, 59, 62 • PBOT-1, 3 • BDS-6 • CAMG-1, 3	• BPS-3, 44 • BDS-6		• PBEM-4, 8, • BPS-2, 9, 10 • PWB-2, 10, 44 • BES-2		• BPS-1, • PWB-42 • PBOT-3
Landslide	• PBEM-9 • PBOT-5 • BES-1, 11, 12, 17 • BDS-2 • CAMG-1	• PWB-54, 57 • BES-1 • CAMG-1	• PBOT-2 • BES-1, 12, 19 • BDS-2	• BES-1, 12, 13, 15, 18, 19	• PBOT-2	• BES-1	• BES-19
Wildfire	• PF&R-1, 3, 5, 6 • BPS-6, 11 • PWB-12, 13, 15, 27 • BES-9 • BDS-2		• PF&R-1, 3	• PP&R-2, 3, • PF&R-3 • PWB-14 • BES-9, 15	• PF&R-3 • PWB-12, 15, 20		• PF&R-2, 3, 6

Hazard	Actions That Address the Hazard, by Mitigation Type						
	Prevention	Property Protection	Public Education and Awareness	Natural Resource Protection	Emergency Services	Structural Projects	Community Capacity Building
Flood	• PBEM-14 • BPS-8, 16, 17 • PWB-17, 22, 64 • BES-1, 5, BES-8, 10, 12, 16, 17, 20, 21, 22, • BDS-2, 3, 5, 7, 8	• BES-1, 6, 16 • BDS-3	• BES-1, 7, 8, 12, 19 • BDS-5	• PWB-17 • BES-1, 5, 6, 12, 13, 14, 18, 19, 23	• PBEM-14 • PWB-24 • BES-7, 21	• PWB-16 • OMF-1 • BES-1	• BES-19
Volcanic Activity	•				• PBEM-7		
Dam Failure	• PWB-5 • BDS-7				• PWB-60		
Drought	• PWB-18						
Space Weather	• PWB-40						

Table 19-7. Analysis of Mitigation Actions by Objectives Met

Action #	# of Objectives Met	Objective															
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
PBEM-1	6		✓				✓		✓		✓		✓			✓	
PBEM-2	5		✓				✓		✓						✓	✓	
PBEM-3	5		✓				✓						✓		✓	✓	
PBEM-4	2		✓														✓
PBEM-5	3		✓				✓										✓
PBEM-6	4				✓	✓						✓					✓
PBEM-7	2						✓										✓
PBEM-8	5				✓			✓			✓		✓		✓		
PBEM-9	2										✓						✓
PBEM-10	5		✓				✓			✓				✓		✓	
PBEM-11	3	✓			✓							✓					
PBEM-12	3		✓													✓	✓
PBEM-13	3						✓								✓	✓	
PBEM-14	3				✓	✓	✓										
PBEM-15	6		✓			✓	✓			✓	✓						✓
PBEM-16	4		✓				✓			✓				✓			
PBEM-17	5		✓				✓								✓	✓	✓
PBEM-18	4		✓				✓								✓	✓	
PBEM-19	4				✓	✓					✓	✓					
PBEM-20	6		✓	✓		✓			✓			✓					✓
PBEM-21	5		✓	✓										✓	✓	✓	
PBEM-22	4				✓	✓					✓						✓
PBEM-23	5		✓				✓								✓	✓	✓
PBEM-24	6	✓			✓		✓			✓	✓		✓				
PP&R-1	3			✓		✓	✓										
PP&R-2	3			✓		✓							✓				
PP&R-3	3			✓		✓	✓										
PF&R-1	5				✓		✓				✓			✓	✓		
PF&R-2	10	✓		✓	✓	✓	✓	✓		✓	✓			✓	✓		
PF&R-3	11	✓		✓	✓	✓	✓	✓		✓	✓		✓	✓	✓		
PF&R-4	4				✓	✓					✓	✓					
PF&R-5	5	✓			✓	✓					✓		✓				
PF&R-6	5						✓		✓				✓	✓	✓		
PF&R-7	5		✓				✓						✓	✓		✓	
PF&R-8	3		✓				✓							✓			
PF&R- 9	3				✓						✓	✓					
BPS-1	3		✓						✓				✓				
BPS-2	4		✓		✓				✓				✓				
BPS-3	4		✓		✓				✓				✓				
BPS-4	5	✓			✓				✓			✓	✓				
BPS-5	5	✓		✓					✓				✓			✓	
BPS-6	5	✓		✓					✓				✓			✓	
BPS-7	4			✓					✓	✓						✓	

Action #	# of Objectives Met	Objective 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
BPS-8	3			✓					✓				✓				
BPS-9	6				✓	✓			✓				✓		✓	✓	
BPS-10	7		✓		✓	✓			✓				✓		✓	✓	
BPS-11	6			✓	✓	✓				✓	✓		✓				
BPS-12	4		✓				✓		✓				✓				
BPS-13	4	✓			✓							✓	✓				
BPS-14	4	✓			✓	✓										✓	
BPS-15	4					✓			✓			✓		✓			
BPS-16	7	✓	✓		✓	✓				✓	✓		✓				
BPS-17	5	✓		✓		✓			✓				✓				
BPS-18	7		✓				✓	✓	✓						✓	✓	✓
BPS-19	8	✓		✓	✓	✓	✓		✓		✓				✓		
PWB-1	4				✓			✓		✓	✓						
PWB-2	1				✓												
PWB-3	1				✓												
PWB-4	2				✓						✓						
PWB-5	2									✓	✓						
PWB-6	2				✓							✓					
PWB-7	3		✓		✓							✓					
PWB-8	2		✓		✓												
PWB-9	3				✓							✓	✓				
PWB-10	3						✓				✓			✓			
PWB-11	2										✓	✓					
PWB-12	2										✓	✓					
PWB-13	2									✓	✓						
PWB-14	2									✓	✓						
PWB-15	2				✓												✓
PWB-16	2				✓							✓					
PWB-17	2									✓	✓						
PWB-18	2									✓	✓						
PWB-19	2									✓	✓						
PWB-20	3					✓				✓		✓					
PWB-21	3				✓	✓						✓					
PWB-22	2				✓	✓											
PWB-23	2				✓							✓					
PWB-24	2				✓							✓					
PWB-25	3				✓				✓		✓						
PWB-26	3				✓				✓								✓
PWB-27	2									✓	✓						
PWB-28	2											✓					✓
PWB-29	3													✓	✓	✓	
PWB-30	3													✓	✓	✓	
PWB-31	2										✓				✓		
PWB-32	2														✓		✓

Action #	# of Objectives Met	Objective															
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
PWB-33	2														✓		✓
PWB-34	2						✓							✓			
PWB-35	2				✓												✓
PWB-36	2				✓						✓						
PWB-37	3				✓						✓				✓		
PWB-38	3				✓						✓				✓		
PWB-39	3				✓						✓				✓		
PWB-40	3				✓						✓				✓		
PWB-41	2										✓			✓			
PWB-42	2							✓									✓
PWB-43	2						✓	✓						✓			
PWB-44	2						✓										
PWB-45	2							✓						✓			
PWB-46	2															✓	✓
PWB-47	2															✓	✓
PWB-48	2				✓												✓
PWB-49	2															✓	✓
PWB-50	2														✓		✓
PWB-51	2														✓		✓
PWB-52	2				✓							✓					
PWB-53	2				✓										✓		
PWB-54	3				✓						✓	✓					
PWB-55	2				✓										✓		
PWB-56	2				✓										✓		
PWB-57	2				✓							✓					
PWB-58	2				✓							✓					
PWB-59	2				✓							✓					
PWB-60	3				✓					✓				✓			
PWB-61	2				✓					✓							
PWB-62	2				✓							✓					
PWB-63	3						✓	✓						✓			
PWB-64	3						✓	✓						✓			
OMF-1	2				✓	✓											
OMF-2	4		✓		✓	✓										✓	
PBOT-1	5				✓	✓		✓			✓	✓					
PBOT-2	3				✓	✓	✓										
PBOT-3	4				✓	✓						✓		✓			
PBOT-4	5			✓	✓	✓		✓				✓					
PBOT-5	3									✓					✓	✓	
BES-1	2			✓	✓												
BES-2	2				✓												✓
BES-3	2				✓												✓
BES-4	2											✓	✓				
BES-5	6			✓	✓	✓		✓	✓				✓				

Action #	# of Objectives Met	Objective															
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
BES-6	3			✓				✓				✓					
BES-7	2									✓	✓						
BES-8	2			✓									✓				
BES-9	2			✓									✓				
BES-10	3	✓		✓									✓				
BES-11	2				✓	✓											
BES-12	1			✓													
BES-13	13			✓					✓				✓				
BES-14	2			✓					✓								
BES-15	2			✓									✓				
BES-16	3							✓				✓	✓				
BES-17	2			✓	✓												
BES-18	2			✓	✓												
BES-19	3		✓	✓												✓	
BES-20	3					✓				✓	✓						
BES-21	4		✓		✓	✓					✓						
BES-22	3			✓						✓	✓						
BES-23	5	✓	✓	✓	✓							✓					
BDS-1	3		✓													✓	✓
BDS-2	3	✓					✓						✓				
BDS-3	2	✓											✓				
BDS-4	3	✓			✓								✓				
BDS-5	4			✓			✓						✓			✓	
BDS-6	7	✓	✓	✓			✓	✓				✓	✓				
BDS-7	2	✓			✓												
BDS-8	4	✓								✓	✓		✓				
CAMG-1	3	✓			✓	✓											
CAMG-2	4		✓			✓		✓				✓					
CAMG-3	2					✓		✓									
OEHR-1	4		✓						✓						✓	✓	
Total	529	22	33	32	75	37	35	18	25	25	43	35	38	21	32	29	28
% of actions		14%	21%	20%	47%	23%	22%	11%	16%	16%	27%	22%	24%	13%	20%	18%	18%

19.4 PLAN ADOPTION

A hazard mitigation plan must document that it has been formally adopted by the governing body of the jurisdiction requesting federal approval of the plan (44 CFR Section 201.6(c)(5)). DMA compliance and its benefits cannot be achieved until the plan is adopted. This plan will be submitted for a pre-adoption review to the Oregon Office of Emergency Management, FEMA Region X, and the Insurance Services Office, Inc. prior to adoption. Once pre-adoption approval has been provided, the City of Portland will formally adopt the plan. A copy of the resolution is provided in Figure 19-1.

Insert Adoption Resolution

Figure 19-1. Resolution Adopting The Mitigation Action Plan

19.5 PLAN IMPLEMENTATION AND MAINTENANCE STRATEGY

A hazard mitigation plan must present a plan maintenance process that includes the following (44 CFR Section 201.6(c)(4)):

- A section describing the method and schedule of monitoring, evaluating, and updating the mitigation plan over a 5-year cycle.
- A process by which local governments incorporate the requirements of the mitigation plan into other planning mechanisms, such as comprehensive or capital improvement plans, when appropriate.
- A discussion on how the community will continue public participation in the plan maintenance process.

This section details the formal process that will ensure that *The Mitigation Action Plan* remains an active and relevant document and that the City maintains its eligibility for applicable funding sources. It includes the establishment of a Mitigation Action Plan Working Group and a schedule for monitoring and evaluating the plan annually and producing an updated plan every 5 years. The plan's format allows sections to be reviewed and updated when new data become available, resulting in a plan that will remain current and relevant.

19.5.1 Plan Implementation

The effectiveness of the MAP depends on its implementation and the incorporation of its actions into existing plans, policies and programs. Together, the action items in the plan provide a framework for activities that the City of Portland, with support from stakeholders, will work to implement over the next 5 years. The planning team and the steering committee have established a vision, a mission, goals and objectives and have prioritized mitigation actions that will be implemented through existing plans, policies, and programs. The plan will be evaluated based on how effectively the implementation of the mitigation actions have been at reducing risk in Portland and in meeting plan goals. Lead agencies for all selected mitigation actions have identified performance metrics to help evaluate the success of the MAP. The effectiveness of the MAP will also be assessed at the next update by the new working group through a review of the changes in risk that occurred over the performance period and by the degree to which mitigation goals and objectives were incorporated into existing plans, policies and programs.

The Portland Bureau of Emergency Management (PBEM) will have lead responsibility for coordinating and tracking the plan implementation and maintenance strategy. Plan implementation and evaluation will be a shared responsibility among all bureaus and offices identified as lead agencies in the mitigation action plan and all other jurisdictions that may link to this plan.

19.5.2 Mitigation Action Plan Working Group

The hazard mitigation steering committee was a volunteer body that oversaw this update of the plan. It was the steering committee's position that an oversight committee with representation similar to that of the steering committee should have an active role in the plan implementation and maintenance. Therefore, a Mitigation Action Plan Working Group will be formed to remain a viable body involved in key elements of the plan implementation and maintenance strategy. This working group should strive to include representation from stakeholders in Portland as well as Bureau representatives. The Mitigation Action Plan Working Group will work toward fulfilling the following responsibilities:

- Continuing to provide feedback and guidance on equity concerns;
- Coordinating action implementation;

- Providing feedback on possible avenues for continued public engagement;
- Coordinating with the Office of Governmental Relations annually to determine what hazard mitigation related items should be advocated for during their annual agenda setting;
- Reviewing and contributing to the annual progress report; and
- Providing input and recommendations on possible enhancements to be considered at the next plan update.

Future plan updates will be overseen by a steering committee similar to the one that participated in this update, so keeping an interim group intact will provide a head start on future updates. The Mitigation Action Plan Working Group will meet biannually to work toward the objectives outlined in this implementation and maintenance strategy. PBEM will coordinate the meetings, which likely will be held in March and September.

19.5.3 Equity Implementation Guide

The steering committee recommends that equity analysis and screening be carried forward as actions are implemented. The Mitigation Action Plan Working Group will provide suggestions, guidance and feedback in the development of a natural hazard mitigation equity implementation guide. It is expected that this guide will build upon or be adapted from previous best practices and recommendations such as those in the *Climate Action Plan Equity Implementation Guide* or the *East Portland Action Plan's Involuntary Displacement Prevention Recommendations for East Portland*. Special attention will be paid to best practices for collecting data, using information gathered to inform other processes and identifying and expanding accountability mechanisms.

19.5.4 Annual Progress Report

The lead agencies identified for action item implementation will participate in annual progress reporting, led by PBEM. This progress report will be presented to and reviewed by the Mitigation Action Plan Working Group. The intent of the progress report will be to evaluate the progress on the implementation of the action plan during a 12-month performance period. This review will include items such as the following:

- Summary of any hazard events that occurred during the performance period and the impact these events had on Portland;
- Review of the data utilized for this planning process as well as identified gaps and identification of any newly available or updated datasets;
- Listing of any newly published or updated reports or studies that should be incorporated into the next plan update process;
- Review of any upcoming local planning efforts that should be integrated with the MAP
- Review of any changes that would impact risk in Portland (e.g. decommissioning or reservoir or annexation)
- Review of mitigation success stories;
- Review of continuing public engagement;
- Brief discussion about why actions were not completed or have not been initiated;
- Reevaluation of the action plan to determine if the timeline for identified projects needs to be amended (such as changing a long-term project to a short-term project because of new funding);
- Review of data that was or should be collected for an equity identified actions (e.g. High-E)
- Changes in or potential for new funding options (grant opportunities);

- Review of the Steering Committee recommended actions (see Appendix I) and recommendations for new actions based on new or enhanced capabilities identified by lead agencies or next steps in actions identified in the 2016 action plan;
- Impacts of changes in other planning programs or projects that involve hazard mitigation; and
- Identification of training needs or additional guidance, such as benefit-cost analysis or E-grants training or additional equity guidance.

The planning team has created a template for preparing a progress report (see Appendix K). The Mitigation Action Plan Working Group and identified lead agencies will provide feedback to PBEM on items included in the template. PBEM staff will compile the information into a formal annual report on the progress of the plan, which will be presented to the mitigation action plan working group for their review and comment. This report will be disseminated as follows:

- Posted on the PBEM website dedicated to the MAP;
- Provided to the local media through a press release;
- Presented to the City of Portland City Council to inform them of the progress of mitigation actions implemented during the reporting period; and
- Provided as part of the CRS annual re-certification package.

The annual progress report should be compiled in August of each year, reviewed by the committee in September, and be finalized before October 1 each year.

19.5.5 Incorporation into Other Planning Mechanisms

The information on hazard, risk, vulnerability and mitigation contained in *The Mitigation Action Plan* and cited throughout is based on the best available science and technology. Plan integration is the incorporation of this information into other relevant planning mechanisms, such as general planning and capital facilities planning. It includes the integration of natural hazard information and mitigation policies, principles and actions into local planning mechanisms and vice versa, as well as the encouragement of collaborative planning and inter-agency coordination (FEMA, 2015c).

<u>Plan Integration During the 2010 NHMP Performance Period</u>

The 2010 NHMP identified three main activities to incorporate the NHMP requirements into other planning mechanisms as appropriate during the performance period of the plan (44 CFR Section 201.6(c)(4)(ii)):

- Conduct a review of community-specific regulatory tools to assess the integration of the mitigation strategy. These regulatory tools were identified in the capability assessment section.
- Track implemented mitigation actions to determine their success or failure, to determine road blocks to implementation, and identify potential corrective actions.
- Work with community members to increase awareness of the NHMP and provide assistance in integrating the mitigation strategy into relevant planning mechanisms. Implementation of these requirements may require updating or amending specific planning mechanisms.

Although the status of these specific activities was not tracked closely during the performance period, the City did make progress on integrating and incorporating the NHMP into locally relevant plans and programs. The planning team conducted a review of the 2010 NHMP mitigation actions and identified 51 actions that addressed integration into local planning mechanisms and/or collaborative planning. During the performance period of the plan, 19 (37 percent) of these actions were completed, 23 (45 percent) were carried over to the 2016 MAP, and 9 (18 percent) were removed due to a lack of feasibility. More information on the status of these actions can be found in Table 19-1. The following plans and programs were specifically identified by participating bureaus to have integrated the goals, risk assessment or recommendations of the 2010 NHMP or vice versa:

- Portland Comprehensive Plan
- Climate Action Plan
- PBEM Strategic Plan
- Portland Parks & Recreation Master Plan
- BPS Strategic Plan
- BES Strategic Plan
- Portland Water Bureau (PWB) Water System Seismic Study
- Johnson Creek Restoration Plan
- Portland Watershed Management.

Plan Integration for the Mitigation Action Plan

Implementation of the MAP has and will continue to enhance and expand the integration efforts of the 2010 NHMP. During the update process, *The Portland Plan*, the draft *Comprehensive Plan*, *Capital Investment Plans*, the *Climate Action Plan,* and other plans were reviewed for relevant community goals, policies and actions. Inter-agency coordination occurred through involvement by local, regional, state and federal stakeholders involved in and consulted with during the planning process. This coordination is expected to continue through the Mitigation Action Plan working group activities, annual progress reporting, implementation coordination and the continued public engagement outlined below.

As the plan is implemented, all City bureaus will use information from this updated plan as the best available science and data on natural hazards impacting the City of Portland. Bureaus were asked to review the capability assessment and identify codes, plans and programs that provide opportunities for integration and include these as actions in the MAP. Seventy actions related to plan integration have been identified by the planning team and recommended for implementation in this plan. Progress will be reported annually through the progress reporting process described above. New opportunities for integration will be identified as part of the annual progress report.

19.5.6 Implementation Coordination

It is anticipated that upon completion of this plan, there will be interest among the lead agencies in pursuing grant funding under FEMA hazard mitigation grant programs and other relevant programs. In order to keep lead agencies informed of these opportunities and to coordinate grant pursuits, the PBEM staff person charged with coordinating the implementation of this plan will strive to:

- Coordinate with lead agencies and stakeholders through scheduling mitigation action plan working group meetings; and
- Monitor HMGP grant funding opportunities identified in this plan, maintain accountability of other lead agencies to monitor funding opportunities for their actions, and coordinate with other lead agencies to seek funding when such opportunities become available.

PBEM will strive to coordinate the working group sessions as needed and with enough lead time to plan for pursuing Hazard Mitigation Assistance funds, which typically open in March or April. At working group sessions, agenda topics will be devoted to the following:

- Identify and refine projects or actions that are recommendations of this plan so that eligible, well-planned, vetted projects can be submitted for consideration when funding opportunities arise;

- Identify and develop strategies for incorporating mitigation projects into existing budgets, schedules, and planning mechanisms;
- Identify additional opportunities for plan integration; and
- Provide input for the annual progress report.

Plan Update

The City of Portland intends to continue to update the MAP on a 5-year cycle from the date of final plan approval. This cycle may be accelerated to less than 5 years based on the following triggers:

- A federal disaster declaration that impacts Portland;
- A hazard event that causes loss of life; or
- A comprehensive update of the City's Comprehensive Plan.

It will not be the intent of future updates to develop a complete new natural hazard mitigation plan for Portland. The update will, at a minimum, include the following elements:

- The update process will be convened through a steering committee.
- The goals and objectives will be reviewed to evaluate the effectiveness of the plan.
- The hazard risk assessment will be reviewed and, if necessary, updated using best available information and technologies.
- The action plan will be reviewed and revised to account for any actions completed, dropped, or changed and to account for changes in the risk assessment or new policies identified under other planning mechanisms.
- The equity implementation strategy will be reviewed to see if adjustments are needed and if equity-flagged projects are meeting their equity objectives.
- The draft update will be sent to appropriate agencies and organizations for comment.
- The public will be given an opportunity to comment on the update prior to adoption.
- The City Council and governing boards of any planning partners will adopt the updated plan.

The plan update process will be led by the Portland Bureau of Emergency Management. All lead agencies and relevant stakeholders will be asked to participate in the plan update process.

19.5.7 Continued Public Engagement and Access

The public will continue to be apprised of the plan's progress through the hazard mitigation website and through the provision of copies of the annual progress reports to the media. The website will not only house the final plan, it will continue to be the one-stop shop for information regarding the plan and plan implementation. A mechanism for providing comments on the mitigation plan and on the implementation of actions will be available via the website. Additionally, PBEM will strive to include information on the website that clearly outlines available data on mitigation projects and hazard risk and mechanisms to evaluate progress.

Additional public engagement will be pursued as opportunities arise or as recommended by the Mitigation Action Plan Working Group. This may include activities such as utilizing existing networks and communication systems to distribute the annual progress report, speaking to groups upon request and as resources allow, and recorded webinars or other online engagement.

Upon initiation of future update processes, a new public engagement strategy will be initiated based on guidance from a new steering committee and the recommendations of the mitigation action plan working group. This strategy will be based on the needs and capabilities of the City of Portland and any planning partners at the time of the update.

20. LINKAGE PROCEDURES

The federal Disaster Mitigation Act broadly defines local government to encompass more than city and county governments. The DMA's definition of local government also includes local jurisdictional authorities such as schools or special purpose districts. The benefits of the DMA extend to these governments if the planning requirements are met. Not all eligible local governments in the City of Portland are currently covered by approved, adopted local hazard mitigation plans. Some or all of these local governments may wish to develop and adopt DMA-compliant plans to gain eligibility for relevant grant programs.

In order to promote the wise use of resources, enhance communication and collaboration among local governments, and encourage regional consistency, the City of Portland has developed linkage procedures that define requirements for completing a DMA-compliant annex to this plan. This linkage procedure will substantially reduce the level of effort for linking jurisdictions in plan development, as many of the components of the MAP development process will be used to support annex development. No currently non-DMA compliant jurisdiction in Portland is obligated to link to this plan. These jurisdictions can choose to not seek compliance or to develop their own "complete" plan that addresses all required elements for such plans.

Eligible jurisdictions located in Portland may link to this plan at any point during the plan's performance period (5 years after final approval). Eligibility will be determined by the following factors:

- The linking jurisdiction is a local government as defined by the Disaster Mitigation Act.
- The boundaries or service area of the linking jurisdiction is completely contained within the boundaries of Portland established during the 2016 MAP development process.
- The linking jurisdiction's critical facilities were included in the critical facility and infrastructure risk assessment completed during the 2016 plan development process.

It is expected that linking jurisdictions will complete the following requirements and submit a completed annex to the lead agency (PBEM) for review within six months of submitting a letter of intent to link to the MAP:

- The eligible jurisdiction requests a "Linkage Package" by contacting the Point of Contact (POC) for the plan:

  Jonna Papaefthimiou
  Planning and Preparedness Manager, PBEM
  Phone: 503-823-3809
  Email: jonnap@portlandoregon.gov

- The POC will provide a linkage procedure package that includes linkage information and a linkage tool-kit:
  - Linkage Information

    - Procedures for linking to the Mitigation Action Plan (MAP)
    - Expectations for linking jurisdictions
    - A sample "letter of intent" to link to the MAP
    - A copy of Section 201.6 of 44 CFR, which defines the federal requirements for a local natural hazard mitigation plan.

  - Linkage Tool-Kit

    - Copy of the approved MAP
    - A special purpose district template that will form the basis of the annex
    - Instructions for completing the annex
    - Facility-specific results of the critical facility risk assessment (for official use only)
    - A catalog of mitigation best practices
    - An annex review check-list
    - A sample resolution for plan adoption
    - ArcMap files and associated database for map production consistent with the MAP.

- The linking jurisdiction will be required to review the MAP, which includes the following key components:

  - Vision, mission, goals and objectives
  - Risk assessment
  - Comprehensive review of alternatives
  - Equity analysis screening process
  - Action prioritization scheme
  - Plan implementation and maintenance procedures.

  Once this review is complete, the linking jurisdiction will submit a letter of intent to link to the MAP and complete its annex using the template and instructions provided by the POC.

- The development of the new jurisdiction's annex must not be completed by one individual in isolation. The jurisdiction must develop, implement and describe a public engagement strategy and a methodology to identify and vet jurisdiction-specific actions. The original plan development involved extensive public outreach and engagement and is described in Part 1 of the MAP. Since linking jurisdictions were not explicitly covered by these strategies, they will have to initiate new strategies and describe them in their annex. Although linking jurisdictions will need to conduct their own public engagement, they are encouraged to use the results of the extensive public engagement conducted during development of the MAP to help inform their selection of actions (for example, the results of the public survey and Planning for Real Workshops). For consistency, linking jurisdictions are encouraged to develop and implement strategies similar to those described in this plan; however, the City of Portland recognizes that linking jurisdictions may have fewer staff and resources available to support such efforts. At a minimum, a linking jurisdiction must develop a strategy that meets the minimum requirements outlined in the DMA.
- The methodology to identify actions should include a comprehensive range of specific mitigation actions and projects being considered to reduce the effects of each hazard and a description of the process by which chosen actions were identified. As part of this process, linking jurisdictions should coordinate the selection of actions amongst the jurisdiction's various departments.
- Once its public engagement strategy and template are completed, the new jurisdiction will submit the completed package to the POC for a pre-adoption review to ensure conformance with the plan format and linkage procedure requirements.

- The POC will review for the following:
    - Documentation of public engagement and action plan development strategies
    - Conformance of template entries with guidelines outlined in instructions
    - Chosen actions are consistent with vision, mission, goals, objectives and mitigation catalog of the MAP.
    - A designated point of contact
    - A completed FEMA plan review crosswalk.
- Plans will be reviewed by the POC and submitted to Oregon Office of Emergency Management (OEM) for review and approval.
- OEM will review plans for state compliance. Non-compliant plans are returned to the lead agency for correction. Compliant plans are forwarded to FEMA for review with annotation as to the adoption status.
- FEMA reviews the linking jurisdiction's plan in association with the approved plan to ensure DMA compliance. FEMA notifies the new jurisdiction of the results of review with copies to OEM and the approved plan lead agency.
- Linking jurisdiction corrects plan shortfalls (if necessary) and resubmits to OEM through the approved plan lead agency.
- For plans with no shortfalls from the FEMA review that have not been adopted, the new jurisdiction governing authority adopts the plan and forwards adoption resolution to FEMA with copies to lead agency and OEM.
- FEMA regional director notifies the new jurisdiction's governing authority of the plan's approval.

The new jurisdiction plan is then included with the City plan, and the linking jurisdiction is committed to participate in the ongoing plan implementation and maintenance strategies and should have at least one regularly attending representative on the Mitigation Action Plan working group.

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GLOSSARY

ACRONYMS

ACS—American Community Survey

ADA—Americans with Disabilities Act

APANO—Asian Pacific Network of Oregon

ARES—Amateur Radio Emergency Services

BCD—Building Codes Division

BCE—Before Current Era

BDS—City of Portland Bureau of Development Services

BEECN—Basic Earthquake Emergency Communication Nodes

BES—City of Portland Bureau of Environmental Services

BOEC—City of Portland Bureau of Emergency Communications

BPA—Bonneville Power Administration

BPS—City of Portland Bureau of Planning and Sustainability

BTS—City of Portland Bureau of Technology Services

CAD—Computer Aided Dispatch

CAMG—City of Portland Asset Managers Group

CBO—City of Portland Budget Office

CEI—Critical Energy Infrastructure

CEL—Community Engagement Liaison

CGIS—City of Portland Corporate GIS

CDBG-DR—Community Development Block Grant – Disaster Recovery

CFR—Code of Federal Regulations

CIP—Capital Improvement Plan

COOP—Continuity of Operations Plan

CRS—Community Rating System

CVO—Cascade Volcano Observatory

CWA—Clean Water Act

DCL—Diversity in Civic Leadership

DEQ—State of Oregon Department of Environmental Quality

DEWS—Drought Early Warning System

DFIRM—Digital Flood Insurance Rate Maps

DLCD—Oregon Department of Land Conservation and Development

DMA —Disaster Mitigation Act

DOGAMI—Oregon Department of Geology and Mineral Industries

E—Equity

EMAC—Emergency Management Assistance Compact

ENSO— El Niño-Southern Oscillation

EPA—U.S. Environmental Protection Agency

EQ—Earthquake

ESA—Endangered Species Act

EWP—Emergency Watershed Protection

FEMA—Federal Emergency Management Agency

FERC—Federal Energy Regulatory Commission

FIRM—Flood Insurance Rate Map

GIS—Geographic Information System

GPS—Global Positioning System

Hazus-MH—Hazards, United States-Multi Hazard

HMA—Hazard Mitigation Assistance

HMGP—Hazard Mitigation Grant Program

HVAC—Heating, Ventilation and Air Conditioning

IBC—International Building Code

IPAWS—Integrated Public Alert and Warning System

IPCC—Intergovernmental Panel on Climate Change

IRC—International Residential Code

IRCO—Immigrant and Refugee Community of Oregon

LiDAR—Light Detection and Ranging

MAP—Mitigation Action Plan – refers to City of Portland 2016 plan

MCDD—Multnomah County Drainage District

ML—Local Magnitude or Richter Scale

MMI—Modified Mercalli Scale

M_W—Magnitude

NASA—National Aeronautics and Space Administration

NEHRP—National Earthquake Hazards Reduction Program

NET—Neighborhood Emergency Team

NHMP—Natural Hazard Mitigation Plan – refers to City of Portland 2004 or 2010 plan

NIDIS—National Integrated Drought Information System

NIMS—National Incident Management System

NFIP—National Flood Insurance Program

NOAA—National Oceanic and Atmospheric Administration

NRCS—Natural Resources Conservation Services

NWS—National Weather Service

ODA—Oregon Department of Agriculture

ODOT—Oregon Department of Transportation

OEHR—City of Portland Office of Equity and Human Rights

OEM—Oregon Office of Emergency Management

OGDC—Oregon Geologic Data Compilation

OGR—City of Portland Office of Governmental Relations

OHA—Oregon Health Authority

OHSU—Oregon Health and Science University

OMF—City of Portland Office of Management and Finance

ONI—City of Portland Office of Neighborhood Involvement

OS—Open Space Zone

PBEM—City of Portland Bureau of Emergency Management

PBOT—City of Portland Bureau of Transportation

PCC—City of Portland City Code

PDC—Portland Development Commission

PDM—Pre-Disaster Mitigation Grant Program

PGA—Peak Ground Acceleration

PGE—Portland General Electric

PHA—Portland Housing Authority

PHB—City of Portland Housing Bureau

POC—Point of Contact

PPB—City of Portland Police Bureau

PP&R—Portland Parks and Recreation

ppm—Parts per million

PPS—Portland Public Schools

PSU—Portland State University

PWB—City of Portland Water Bureau

RDPO—Regional Disaster Preparedness Organization

SDC—System Development Charge

SEAO—Structural Engineers Association of Oregon

SEC—Significant Environment Zone

SFHA—Special Flood Hazard Area

SLIDO—State Landslide Database of Oregon

TriMET—Tri-County Metropolitan Transportation District

USACE—U.S. Army Corp of Engineers

USDA—U.S. Department of Agriculture

USFS—U.S. Forest Service

USGS—U.S. Geological Survey

URM—Unreinforced Masonry

WEA—Wireless Emergency Alerts

WUI—Wildland Urban Interface

DEFINITIONS

1-Percent Annual Chance Flood (100-Year Flood): The flood magnitude that has a 1 percent chance of being equaled or exceeded in any given year. On a statistical average over a long term, this magnitude can be expected to occur once every 100 years; in fact though, such a flood can occur multiple times in a few years, or even in a single year.

1-Percent Annual Chance Flood Hazard Area (100 Year Floodplain or Special Flood Hazard Area): The area that is inundated during a 1-percent annual chance (100-year) flood.

Acre-Foot: An acre-foot is the amount of water it takes to cover 1 acre to a depth of 1 foot. This measure is used to describe the quantity of storage in a water reservoir. An acre-foot is a unit of volume. One acre foot equals 7,758 barrels; 325,829 gallons; or 43,560 cubic feet. An average household of four will use approximately 1 acre-foot of water per year.

Adaptation: The process of adjustment to actual or expected climate and its effects. In human systems, adaptation seeks to moderate or avoid harm or exploit beneficial opportunities, In some natural systems, human intervention may facilitate adjustment to expected climate and its effects.

Agricultural Drought: When there is not enough soil moisture to support crop needs at a particular time.

Air Pollution: the presence of contaminants or pollutant substances in the air that interfere with health or welfare, or produce other harmful environmental effects.

Air Toxics: Air pollutants known or suspected to cause cancer and come from a variety of sources.

Asset: An asset is any man-made or natural feature that has value, including, but not limited to, people; buildings; infrastructure, such as bridges, roads, sewers, and water systems; lifelines, such as electricity and communication resources; and environmental, cultural, or recreational features such as parks, wetlands, and landmarks.

Base Flood: The flood having a 1% chance of being equaled or exceeded in any given year, also known as the "100-year" or "1% chance" flood. The base flood is a statistical concept used to ensure that all properties subject to the National Flood Insurance Program (NFIP) are protected to the same degree against flooding.

Benefit/Cost Analysis: A benefit/cost analysis is a systematic, quantitative method of comparing projected benefits to projected costs of a project or policy. It is used as a measure of cost effectiveness.

Benefit: A benefit is a net project outcome and is usually defined in monetary terms. Benefits may include direct and indirect effects. For the purposes of benefit-cost analysis of proposed mitigation measures, benefits are limited to specific, measurable, risk reduction factors, including reduction in expected property losses (buildings, contents, and functions) and protection of human life.

Benioff Zone (Deep) Earthquakes: Benioff Zone earthquakes occur in the Juan De Fuca plate as moves below the North American plate. They are deep earthquakes, 20 miles or more in depth. Shaking from these earthquakes can last up to 60 seconds. Due to their depth, aftershocks are typically not felt.

Body Wave: A type of seismic wave that travels through the earth's interior.

Capability Assessment: A capability assessment provides a description and analysis of a community's current capacity to address threats associated with hazards. The assessment includes two components: an inventory of an agency's mission, programs, and policies, and an analysis of its capacity to carry them out. A capability assessment is an integral part of the planning process in which a community's actions to reduce losses are identified, reviewed, and analyzed, and the framework for implementation is identified.

Community Capacity Building: Actions that identify, strengthen or link the community's tangible and intangible resources. Includes investing in food independence projects (ex. community gardens), promoting and supporting rain water collection systems, alternative energy sources (ex. solar power, wind power, micro-level hydro power), culturally appropriate community-level training for emergency and trauma response.

Community Rating System (CRS): The CRS is a voluntary program under the NFIP that rewards participating communities (provides incentives) for exceeding the minimum requirements of the NFIP and completing activities that reduce flood hazard risk by providing flood insurance premium discounts.

Community: All residents of the City of Portland and those who work and play here.

Compounding Factor: Characteristics of a planning area that can contribute to the likelihood or severity of a hazard event's occurrence.

Coordinating stakeholders: Stakeholders who could not commit to the Steering Committee, but may have attended meetings and wanted to be informed of plan progress.

Critical Facility and Infrastructure: Publicly and privately controlled systems and assets, including the built and natural environments and human resources, essential to the sustained functioning of the Portland/Vancouver metropolitan area including Clackamas, Columbia, Multnomah and Washington Counties in Oregon and Clark County in Washington. Such systems and assets specifically include those necessary to ensure continuity of security, safety, health and sanitation services, support the area's economy, and/or maintain public confidence. Incapacitation or destruction of any of these systems or assets would have a debilitating impact on the area either directly, through interdependencies, and/or through cascading effects. For the MAP, these facilities were categorized as emergency services, schools, transportation systems, high potential loss facilities, utility systems and other assets.

Critical Habitat: specific geographical areas that are essential for the conservation and management of a listed species, whether occupied by the species or not.

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

Dam: A hydraulic structure built above the natural ground grade line that is used to impound water. Dams include all appurtenant structures, and together are sometimes referred to as "the works." Dams include wastewater lagoons and other hydraulic structures that store water, attenuate floods, and divert water into canals

Disaster Mitigation Act of 2000 (DMA); The DMA is Public Law 106-390 and is the latest federal legislation enacted to encourage and promote proactive, pre-disaster planning as a condition of receiving financial assistance under the Robert T. Stafford Act. The DMA emphasizes planning for disasters before they occur. Under the DMA, a pre-disaster hazard mitigation program and new requirements for the national post-disaster hazard mitigation grant program (HMGP) were established.

Distributive Equity: Ensuring that resources or benefits and burdens of a policy or program are distributed fairly, prioritizing those with highest need first.

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

Earthquake: An earthquake is defined as a sudden slip on a fault, volcanic or magmatic activity, and sudden stress changes in the earth that result in ground shaking and radiated seismic energy. Earthquakes can last from a few seconds to over 5 minutes, and have been known to occur as a series of tremors over a period of several days. The actual movement of the ground in an earthquake is seldom the direct cause of injury or death. Casualties may result from falling objects and debris as shocks shake, damage, or demolish buildings and other structures.

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

Emergency Services: Actions that protect people and property during and immediately after a hazard event. Includes warning systems, emergency response services, and the protection of essential facilities.

Endangered: a species of fish, animal or plant is "in danger of extinction throughout all or a significant portion of its range.

Engagement: A two-way communication between local government and stakeholders.

Equity Lens: A critical thinking approach to undoing institutional and structural biases, which evaluates burdens, benefits and outcomes to underserved communities.

Equity: When everyone has access to the opportunities necessary to satisfy their essential needs, advance their well-being and achieve their full potential. We have a shared fate as individuals within a community and communities within society. All communities need the ability to shape their own present and future. Equity is both the means to healthy communities and an end that benefits us all (The Portland Plan).

Excessive Heat Event: Summertime weather that is substantially hotter and/or more humid than average for a location at that time of year.

Exposure: Exposure is defined as the number and dollar value of assets considered to be at risk during the occurrence of a specific hazard.

Extent: The extent is the size of an area affected by a hazard.

Flash Flood: A flash flood occurs with little or no warning when water levels rise at an extremely fast rate

Flood Insurance Rate Map (FIRM): FIRMs are the official maps on which the Federal Emergency Management Agency (FEMA) has delineated the Special Flood Hazard Area (SFHA).

Flood Insurance Study: A report published by the Federal Insurance and Mitigation Administration for a community in conjunction with the community's Flood Insurance rate Map. The study contains such background data as the base flood discharges and water surface elevations that were used to prepare the FIRM. In most cases, a community FIRM with detailed mapping will have a corresponding flood insurance study.

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

Floodplain: Any land area susceptible to being inundated by flood waters from any source. A flood insurance rate map identifies most, but not necessarily all, of a community's floodplain as the Special Flood Hazard Area (SFHA).

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

Floodway Fringe: Floodway fringe areas are located in the floodplain but outside of the floodway. Some development is generally allowed in these areas, with a variety of restrictions. On maps that have identified and delineated a floodway, this would be the area beyond the floodway boundary that can be subject to different regulations.

Floodway: Floodways are areas within a floodplain that are reserved for the purpose of conveying flood discharge without increasing the base flood elevation more than 1 foot. Generally speaking, no development is allowed in floodways, as any structures located there would block the flow of floodwaters.

Freeboard: Freeboard is the margin of safety added to the base flood elevation.

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

Frequency: For the purposes of this plan, frequency refers to how often a hazard of specific magnitude, duration, and/or extent is expected to occur on average. Statistically, a hazard with a 100-year frequency is expected to occur about once every 100 years on average and has a 1 percent chance of occurring any given year. Frequency reliability varies depending on the type of hazard considered.

Fujita Scale of Tornado Intensity: Tornado wind speeds are sometimes estimated on the basis of wind speed and damage sustained using the Fujita Scale. The scale rates the intensity or severity of tornado events using numeric values from F0 to F5 based on tornado wind speed and damage. An F0 tornado (wind speed less than 73 miles per hour (mph)) indicates minimal damage (such as broken tree limbs), and an F5 tornado (wind speeds of 261 to 318 mph) indicates severe damage.

Geographic Information System (GIS): GIS is a computer software application that relates data regarding physical and other features on the earth to a database for mapping and analysis.

Goal: Explain what should be achieved.

Hail: showery precipitation in the form of irregular pellets or balls of ice more than 5 millimeters in diameter, falling from a cumulonimbus cloud.

Hazard Mitigation Grant Program (HMGP): Authorized under Section 202 of the Robert T. Stafford Disaster Relief and Emergency Assistance Act, the HMGP is administered by FEMA and provides grants to states, tribes, and local governments to implement hazard mitigation actions after a major disaster declaration. The purpose of the program is to reduce the loss of life and property due to disasters and to enable mitigation activities to be implemented as a community recovers from a disaster

Hazard of Concern: Hazards that present the greatest concern for a planning area. These hazards are profiled and risk to the planning area is assessed.

Hazard: A hazard is a source of potential danger or adverse condition that could harm people and/or cause property damage.

Hazards U.S. Multi-Hazard (Hazus-MH) Loss Estimation Program: Hazus-MH is a GIS-based program used to support the development of risk assessments as required under the DMA. The Hazus-MH software program assesses risk in a quantitative manner to estimate damage and losses associated with natural hazards. Hazus-MH is FEMA's nationally applicable, standardized methodology and software program and contains modules for estimating potential losses from earthquakes, floods, and wind hazards. Hazus-MH has also been used to assess vulnerability (exposure) for other hazards.

Heat Wave: Excessive heat events that typically last two or more days.

High Hazard Dam: Dams where failure or improper operation will probably cause loss of human life.

High Wind: Those that last longer than one hour at 40 mph or greater or wind gusts of 58 mph or greater.

Hydraulics: Hydraulics is the branch of science or engineering that addresses fluids (especially water) in motion in rivers or canals, works and machinery for conducting or raising water, the use of water as a prime mover, and other fluid-related areas.

Hydrological Drought: Deficiencies in surface and subsurface water supplies.

Hydrology: Hydrology is the analysis of waters of the earth. For example, a flood discharge estimate is developed by conducting a hydrologic study.

Ice Storm: A storm that results in the accumulation of at least 0.25 inches of ice on exposed surfaces.

Intensity: For the purposes of this plan, intensity refers to the measure of the effects of a hazard.

Invasive Plants: those species that spread at such a rate that they cause harm to human health and the environment. In general, most invasive plants are non-native species, however, not all non-native plants are invasive.

Inventory: The assets identified in a study region comprise an inventory. Inventories include assets that could be lost when a disaster occurs and community resources are at risk. Assets include people, buildings, transportation, and other valued community resources.

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

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

Lava Flow: The least hazardous threat posed by volcanoes. Cascades volcanoes are normally associated with slow moving andesite or dacite lava.

Lightning: Lightning is an electrical discharge resulting from the buildup of positive and negative charges within a thunderstorm. When the buildup becomes strong enough, lightning appears as a "bolt," usually within or between clouds and the ground.

Liquefaction: Liquefaction is the complete failure of soils, occurring when soils lose shear strength and flow horizontally. It is most likely to occur in fine grain sands and silts, which behave like viscous fluids when liquefaction occurs. This situation is extremely hazardous to development on the soils that liquefy, and generally results in extreme property damage and threats to life and safety.

Local Government: Any county, municipality, city, town, township, public authority, school district, special district, intrastate district, council of governments (regardless of whether the council of governments is incorporated as a nonprofit corporation under State law), regional or interstate government entity, or agency or instrumentality of a local government; any Indian tribe or authorized tribal organization, or Alaska Native village or organization; and any rural community, unincorporated town or village, or other public entity.

Love Waves: A type of seismic surface wave that produces horizontal motion.

Magnitude: Magnitude is the measure of the strength of an earthquake, and is typically measured by the Richter scale. As an estimate of energy, each whole number step in the magnitude scale corresponds to the release of about 31 times more energy than the amount associated with the preceding whole number value.

Mass movement: A collective term for landslides, debris flows, falls and sinkholes.

Meteorological Drought: An abnormally low level of precipitation over a period of time.

Mission: What the is to be achieved and how.

Mitigation Actions: Mitigation actions are specific actions to achieve goals and objectives that minimize the effects from a disaster and reduce the loss of life and property.

Mitigation Strategy: The long-term blueprint for reducing the potential losses identified in the risk assessment.

Mitigation: Advance actions to reduce potential hazard effects or risk. Protections are already in place at the time a hazard event occurs.

Mudslide (or Mudflow or Debris Flow): A river of rock, earth, organic matter and other materials saturated with water. Mudslides develop in the soil overlying bedrock on sloping surfaces when water rapidly accumulates in the ground, such as during heavy rainfall or rapid snowmelt. Water pressure in the pore spaces of the material increases to the point that the internal strength of the soil is drastically weakened. The soil's reduced resistance can then easily be overcome by gravity, changing the earth into a flowing river of mud or "slurry."

Natural Resource Protection: Actions that minimize hazard loss and preserve or restore the functions of natural systems. Includes sediment and erosion control, stream corridor restoration, watershed management, forest and vegetation management, and wetland restoration and preservation.

Objective: Broader than actions, but more specific than goals, objectives are specific enough to help determine whether a proposed project or program would advance the values expressed in the mission and vision. Objectives may also be thought of as 'policies.' In this planning process, objectives are used to define and prioritize actions.

Participatory Stakeholders: Stakeholders who committed to being members of the Steering Committee that oversaw the plan update process.

Peak Ground Acceleration: Peak Ground Acceleration (PGA) is a measure of the highest amplitude of ground shaking that accompanies an earthquake, based on a percentage of the force of gravity.

Planning Partners: City of Portland bureaus and offices which manage infrastructure and administer programs included or potentially included as part of the city's hazard mitigation strategy.

Planning Team: The Tetra Tech team and PBEM staff responsible for the facilitation of the planning process and the development of the plan document.

Preparedness: Advance actions that strengthen the capability of government, residents, and communities to respond to disasters.

Presidential Disaster Declaration: These declarations are typically made for events that cause more damage than state and local governments and resources can handle without federal government assistance. Generally, no specific dollar loss threshold has been established for such declarations. A

Presidential Disaster Declaration puts into motion long-term federal recovery programs, some of which are matched by state programs, designed to help disaster victims, businesses, and public entities.

Prevention (emergency management): Building capabilities to avoid, prevent or stop a threatened or actual act of terrorism.

Prevention (mitigation typology): Government, administrative or regulatory actions that influence the way land and buildings are developed to reduce hazard losses. Includes planning and zoning, floodplain laws, capital improvement programs, open space preservation, and storm water management regulations.

Primary waves (P waves): A type of seismic body wave that travels through both solids and fluids. These waves are the fastest travelling seismic waves.

Probability of Occurrence: The probability of occurrence is a statistical measure or estimate of the likelihood that a hazard will occur. This probability is generally based on past hazard events in the area and a forecast of events that could occur in the future.

Procedural Equity: Ensuring that processes are fair and inclusive in the development and implementation of any program or policy.

Property Protection: Modification of buildings or structures to protect them from a hazard or removal of structures from a hazard area. Includes acquisition, elevation, relocation, structural retrofit, storm shutters, and shatter-resistant glass.

Public Education and Awareness: Actions to inform citizens and elected officials about hazards and ways to mitigate them. Includes outreach projects, real estate disclosure, hazard information centers, and school-age and adult education.

Rayleigh Waves: A type of seismic surface wave that travels like ocean waves. Most of the shaking felt during an earthquake is the result of these waves.

Recovery: A phase of emergency management in which activities are carried out to restore essential services and repair damage caused by a hazard event.

Repetitive Loss Property: Any NFIP-insured property that, since 1978 and regardless of any changes of ownership during that period, has experienced:

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

Residual Risk: The risk that remains after safeguards have been implemented.

Resilience: The capability to anticipate, prepare for, respond to, and recover from significant multi-hazard threats with minimum damage to social well-being, the economy, and the environment.

Response: A phase of emergency management that consists of immediate actions to save lives, protect property and the environment and meet basic human needs.

Return Period (or Mean Return Period): This term refers to the average period of time in years between occurrences of a particular hazard (equal to the inverse of the annual frequency of occurrence).

Riparian Area: The area along the banks of a natural watercourse.

Risk Assessment: Risk assessment is the process of measuring potential loss of life, personal injury, economic injury, and property damage resulting from hazards. This process assesses the vulnerability of people, buildings, and infrastructure to hazards and focuses on (1) hazard identification; (2) impacts of hazards on physical, social, and economic assets; (3) vulnerability identification; and (4) estimates of the cost of damage or costs that could be avoided through mitigation.

Risk Ranking = Probability + Impact (people + property + economy)

Risk Ranking: This ranking serves two purposes, first to describe the probability that a hazard will occur, and second to describe the impact a hazard will have on people, property, and the economy. Risk estimates are based on the methodology used to prepare the risk assessment for this plan. The following equation shows the risk ranking calculation:

Risk: Risk is the estimated impact that a hazard would have on people, services, facilities, and structures in a community. Risk measures the likelihood of a hazard occurring and resulting in an adverse condition that causes injury or damage. Risk is often expressed in relative terms such as a high, moderate, or low likelihood of sustaining damage above a particular threshold due to occurrence of a specific type of hazard. Risk also can be expressed in terms of potential monetary losses associated with the intensity of the hazard.

Riverine: Of or produced by a river. Riverine floodplains have readily identifiable channels. Floodway maps can only be prepared for riverine floodplains.

Robert T. Stafford Act: The Robert T. Stafford Disaster Relief and Emergency Assistance Act, Public Law 100-107, was signed into law on November 23, 1988. This law amended the Disaster Relief Act of 1974, Public Law 93-288. The Stafford Act is the statutory authority for most federal disaster response activities, especially as they pertain to FEMA and its programs.

Safe Harbor Languages: Those that are spoken as a primary language by at least 1,000 people in Portland with limited English proficiency.

Secondary Hazard: Impacts that result from a hazard event in a more indirect way than the immediate hazard effects.

Secondary Waves (S waves): A type of seismic body wave that travel through rock.

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

Shallow Crustal Earthquake: Shallow crustal earthquakes occur within the North America plate at depths of 20 miles or less. These types of earthquakes occur frequently in the Pacific Northwest. Most are relatively small, but large, damaging events in the region have and will continue to occur. Generally, these earthquakes are expected to last from 20 to 60 seconds, with magnitudes less than 7.5. Aftershocks are likely.

Shallow Flood Hazard Area: Areas that are inundated only 1 to 3 feet deep by the 1-percent annual chance flood.

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

Social Vulnerability (for hazard mitigation): The characteristics of a person or group in terms of their capacity to anticipate, cope with, resist and recover from the impacts of a natural hazard. It involves a combination of factors that determine the degree to which someone's life and livelihood are put at risk (Blaikie et al., 1994).

Socioeconomic Drought: Drought impacts on a population's health, well-being and quality of life.

Special Flood Hazard Area: The base floodplain delineated on a Flood Insurance Rate Map. The SFHA is mapped as a Zone A in riverine situations and zone V in coastal situations. The SFHA may or may not encompass all of a community's flood problems

Stakeholder: Persons and agencies with a vested interest in the recommendations and implementation of the MAP. Stakeholders include residents, community groups, business owners, local, state and federal agencies, elected officials, visitors, and neighboring communities.

Steering Committee: Representative members from the community and city bureaus and offices that serve as the oversight body. They are responsible for many of the planning milestones and decisions prescribed for this process.

Stratovolcano: Typically steep-sided, symmetrical cones of large dimension built of alternating layers of lava flows, volcanic ash, and cinders, rising as much as 8,000 feet above their bases.

Stream Bank Erosion: Stream bank erosion is common along rivers, streams and drains where banks have been eroded, sloughed or undercut. However, it is important to remember that a stream is a dynamic and constantly changing system. It is natural for a stream to want to meander, so not all eroding banks are "bad" and in need of repair.

Structural equity: A commitment and action to correct past harms and prevent future negative consequences by institutionalizing accountability and decision-making structures that aim to sustain positive outcomes.

Structural Projects: Actions that involve the construction of structures to reduce the impact of a hazard. Includes dams, setback levees, floodwalls, retaining walls, and safe rooms.

Subduction Zone Earthquakes: Subduction Zone earthquakes occur at the interface between tectonic plates. Such earthquakes typically have a minute or more of strong ground shaking, and are quickly followed by damaging tsunamis and numerous large aftershocks.

Surface Waves: A type of seismic wave that travels along the earth's surface.

Sustainable Hazard Mitigation: This concept includes the sound management of natural resources, local economic and social resiliency, and the recognition that hazards and mitigation must be understood in the largest possible social and economic context.

- **Tephra:** Ash and fragmented rock material ejected by a volcanic explosion

Threatened: a species “is likely to become endangered within the foreseeable future.

Thunderstorm: Any rain event that includes thunder and lightning. A typical thunderstorm is about 15 miles in diameter and lasts about 30 minutes.

Tornado: Tornadoes are funnel clouds of varying sizes that touch ground. Tornadoes are measured using the Fujita Scale ranging from F0 to F6.

Urban Heat Island Effect: the measureable increase in ambient urban air temperatures resulting primarily from the replacement of vegetation with buildings, roads, and other heat-absorbing infrastructure. The heat island effect can result in significant temperature differences between rural and urban areas.

Vision: A desired future state.

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

Vulnerability: Vulnerability describes how exposed or susceptible an asset is to damage. Vulnerability depends on an asset's construction, contents, and the economic value of its functions. Like indirect damage, the vulnerability of one element of the community is often related to the vulnerability of another. For example, many businesses depend on uninterrupted electrical power. Flooding of an electric substation would affect not only the substation itself but businesses as well. Often, indirect effects can be much more widespread and damaging than direct effects.

Watershed: A watershed is an area that drains downgradient from areas of higher land to areas of lower land to the lowest point, a common drainage basin.

Wildfire Hazard Zone: The portion of a local government jurisdiction that has been determined to be at risk of a catastrophic wildfire

Wildfire: These terms refer to any uncontrolled fire occurring on undeveloped land that requires fire suppression. The potential for wildfire is influenced by three factors: the presence of fuel, topography, and air mass. Fuel can include living and dead vegetation on the ground, along the surface as brush and small trees, and in the air such as tree canopies. Topography includes both slope and elevation. Air mass includes temperature, relative humidity, wind speed and direction, cloud cover, precipitation amount, duration, and the stability of the atmosphere at the time of the fire. Wildfires can be ignited by lightning and, most frequently, by human activity including smoking, campfires, equipment use, and arson.

Wildland-Urban Interface (WUI) Area: An area where structures are adjacent to or are intermingled with natural vegetative fuels which is prone to the occurrence of wildland fires

Windstorm: A storm featuring violent winds. Windstorms are generally short-duration events involving straight-line winds or gusts of over 50 mph, strong enough to cause property damage.

Winter Storm: The National Weather Service defines a winter storm as having significant snowfall, ice, and/or freezing rain; the quantity of precipitation varies by elevation. Heavy snowfall is 4 inches or more in a 12-hour period, or 6 inches or more in a 24-hour period in non-mountainous areas; and 12 inches or more in a 12-hour period or 18 inches or more in a 24-hour period in mountainous areas.

Zoning Ordinance: The zoning ordinance designates allowable land use and intensities for a local jurisdiction. Zoning ordinances consist of two components: a zoning text and a zoning map.

The Mitigation Action Plan

APPENDICES

The Mitigation Action Plan

Appendix A. 5-Year Progress Report

2010 City of Portland Natural Hazard Mitigation Plan

2016 Progress Report

REPORTING PERIOD

March 2010 through March 2016

BACKGROUND

The City of Portland has developed and maintained a hazard mitigation plan, most recently updated in 2010. The *City of Portland Natural Hazard Mitigation Plan* identifies resources, information, and strategies for reducing risk associated with natural hazards in the City. The plan was adopted in 2010 and approved by FEMA Region X on February 15, 2011.

By preparing the 2010 update, the City retained compliance with the federal Disaster Mitigation Act and remained eligible for hazard mitigation grant funding under the federal Robert T. Stafford Act. The plan and annexes are available to the public online at the following website:

https://www.portlandoregon.gov/pbem/53813

An update of the 2010 plan is underway. The new update will be adopted before the end of 2016.

Purpose

This progress report provides an update on implementation of the action plan identified in the 2010 *City of Portland Natural Hazard Mitigation Plan*. This report was prepared by the 2016 update planning team and reviewed by the 2016 update steering committee. The objective is to ensure that there is a continuous planning process that keeps the local hazard mitigation plan responsive to stakeholder needs and capabilities. The contents of this progress report are as follows:

- Summary overview of action plan progress
- Recent natural hazard events
- Changes in risk exposure in Portland
- Mitigation success stories
- Itemized review of the action plan
- Changes in capability in Portland that could impact plan implementation
- Recommendations for changes/enhancement.

The Steering Committee

The update steering committee plays an important role in plan development, and may remain involved during plan implementation. The steering committee has provided technical review and oversight on developing this implementation progress report. Table 1 lists steering committee membership as of March, 2016.

Table 1. 2015-2016 Steering Committee Members

	Agency	Primary Member	Alternate
1	Bureau of Environmental Services (BES)	Maggie Skenderian	Kate Carone
2	Bureau of Planning and Sustainability (BPS)	Kathryn Hartinger	Roberta Jortner / Sallie Edmunds
3	Office of Equity and Human Rights (OEHR)	Danielle Brooks	Judith Mowry
4	Parks & Recreation	Vicente Harrison	
5	Fire and Rescue (PF&R)	Laurent Picard	Leo Krick
6	OHSU Institute on Development and Disability/Oregon Office of Disability and Health	Jessica London	Justin E. Ross
7	Portland Audubon Society	Bob Sallinger	Micah Meskel
8	Oregon Food Bank	Dean Alby	
9	Filipino American Community	Simeon Mamaril	
10	Oregon Seismic Safety Policy Advisory Commission	Jeff Soulages	
11	Department of Homeland Security	Glen Collins	
12	NET/ARES/Local Emergency Planning Committee	John Steup	
13	Neighbors West/Northwest	Darlene Urban Garrett	
14	Portland African American Leadership Forum/Boy Scouts of America	Solamon Ibe	
15	Brummell Enterprises, SMILE Member, Sellwood/Moreland	Karen Tam	Bob Burkholder
16	Portland Water Bureau	Mary Ellen Collentine	Mike Saling
17	Simpson Strong-Tie	Jim Mattison	Shalini Prochazka, S.E.
18	Bureau of Development Services	Kathy Roth	Mark Fetters
19	East Portland Action Plan	Jeremy O'Leary	
20	Immigrant and Refugee Community Organization IRCO/ONI New Portlanders	Ronault (Polo) LS Catalani	Lisha Shrestha
21	Hayden Island Neighborhood Network	Jeff Geisler	Margaret Puckette
22	Linnton Neighborhood Association	Rob Lee	
23	St. Johns Neighborhood Association	Jennifer Levy	Emilie Saks-Webb
24	Portland Public Schools	Molly Emmons	
25	MRG/Coalition of Communities of Color	Ranfis Giannettino Villatoro	
26	Bureau of Emergency Management	Jonna Papaefthimiou	
27	Office of Neighborhood Involvement (ONI)	Brian Hoop	
28	OHSU Emergency Management	Sherrie Forsloff	Mike Nurre
29	Goose Hollow Foothills League	Casey Milne	
30	Volunteers of America	Dean Stearman	
31	Portland Bureau of Transportation (PBOT)	Rich Grant	
32	Portland Harbor Community Advisory Group	Darise Weller	

SUMMARY OVERVIEW OF ACTION PLAN PROGRESS

The 2010 *City of Portland Natural Hazard Mitigation Plan* includes an action plan that identifies specific mitigation actions and a performance period for implementation of those actions. Table 2 summarizes the actions and current progress as of the time of this progress report.

Table 2. Summary Overview of Action Plan Progress

Number of Mitigation Actions	**101**
Mitigation Actions Started or Completed	
Number of Actions	75
Percent of Total	75%
Mitigation Actions Not Started	
Number of Actions	26
Percent of Total	25%

RECENT NATURAL HAZARD EVENTS IN PORTLAND

- **January 2012 Winter Storm**—Heavy flooding, street closures.
- **July 2013 Government Island Wildfire**—Over 20 acres of wildlands on Government Island burned.
- February 2014 Winter Storm—Snow and freezing rain. City of Portland issued Emergency Alert advising residents to remain indoors due to ice.
- **July 2015 Excessive Heat**—County activated cooling centers.
- **August 2015 Smoke Event**—Wildfires across Oregon negatively impacted air quality in the Portland Metro region. County health departments issued warnings.
- **December 2015 Severe Weather**—Heavy flooding, landslides, and wind damage. State Disaster Declaration. Federal Disaster Declaration for December 6-23, 2015.
- **January 2016 Severe Weather**—Significant snow and ice throughout the City. Hazardous conditions due to icy roads and walkways. City offices closed and warming shelters opened.

CHANGES IN RISK EXPOSURE IN PORTLAND

Since 2010, there has been no tracking of risk exposure or changes to risk exposure in Portland.

MITIGATION SUCCESS STORIES

The City of Portland completed restoration on the Foster Floodplain Natural Area in 2012. The project began after a 15-year process to purchase the property from 60 willing sellers and move them out of the Johnson Creek 100-year floodplain. The project added 140 acre-feet of flood storage, which was put to the test in December 2015 during record floods on Johnson Creek. The additional flood storage created by removal of impervious surfaces, planting of native vegetation and wood debris substantially reduced the amount of flooding experienced at homes and businesses in the Foster area.

In 2014 the City of Portland conducted a pilot project for residential seismic strengthening, managed by Clean Energy Works, Inc. Using federal grant dollars from the hazard mitigation grant program (HMGP), the City of Portland helped to seismically strengthen 23 single-family homes in Portland. In 2015 the City of Portland applied for and received funding for a similar project under the pre-disaster mitigation (PDM) grant program to help 150 homeowners seismically strengthen their homes. Clean Energy Works, operating under the new name Enhabit, will be partnering with the City in the management of this project.

REVIEW OF THE ACTION PLAN

This section reviews the action plan and lists the status of each action from the hazard mitigation plan, grouped by the agency or department responsible for its completion. The action plan matrix in Table 3 provides the following information:

- Brief summary of action
- Lead agency responsible for implementation
- Indication of whether any action has been taken (Yes or No)
- Current timeline (Short Term or Long Term)
- Indication of whether the project priority has changed (Yes or No)
- Status (Complete, Ongoing or No Progress)
- Comments, including the following information:

  - Was any element of the action carried out during the reporting period?
  - If no action was completed, why?
  - Is the timeline for implementation for the action still appropriate?
  - If the action was completed, does it need to be changed or removed from the action plan?

PORTLAND CHANGES THAT MAY IMPACT PLAN IMPLEMENTATION

No changes that might impact plan implementation were reported since 2010.

RECOMMENDATIONS FOR CHANGES OR ENHANCEMENTS

Based on the review of this report by the steering committee, the recommendations described below will be noted for future updates or revisions to the plan. In future updates, identified action items should include a timeframe and should clearly indicate the bureau primarily responsible for implementation and progress reporting. Potential partners (community groups, other jurisdictions, etc.) should also be listed. Action items should be organized and prioritized by responsible bureau, and a statement should be included describing whether the action can be accomplished within existing budgets or if additional funds need to be pursued.

An online data-sharing method for tracking action item status should be explored (e.g. GoogleDocs, OneDrive, etc.), as should a method for tracking grants and funding opportunities to implement action items.

Public review notice: *The contents of this report are considered to be public knowledge and have been prepared for total public disclosure. Copies of the report have been provided to local media outlets. The report is also posted on the City of Portland Natural Hazard Mitigation Plan website. Any questions or comments regarding the contents of this report should be directed to:*

Natural Hazard Mitigation
Portland Bureau of Emergency Management
9911 SE Bush Street
Portland, OR 97266
503-823-4375
TheMAP@portlandoregon.gov

Table 3. Action Plan Matrix

Action Taken?	Timeline	Priority Changed?	Comment (Describe progress or changed priority)	Status
ST MH #1— Continue to involve the public in updating the Natural Hazard Mitigation Plan. (education & outreach)				
Lead Agency:				
Yes	Long Term	No	In progress. Outreach is recorded in Emergency Management Performance Grants grant reporting. PBEM does regular outreach and is supportive of MCDD's Levee Ready Columbia outreach efforts.	Ongoing
ST MH #2— Form a committee to identify and coordinate critical transportation (street and highway) networks. (mapping, asset management)				
Lead Agency:				
Yes	Long Term	Yes	There is no committee, but we have identified emergency transportation routes for key facilities. If new facilities are built, transportation routes would be re-evaluated.	Complete
ST MH #3— Coordinate emergency standard operating procedures and plans between disaster responder organizations in the Portland metro region, to coordinate and expedite decision making during emergencies. (planning)				
Lead Agency:				
Yes	Short Term	No	Regional Multi-Agency Coordination on operations. Internally de-conflicted the County Basic Emergency Operations Plan with the City Basic Emergency Operations Plan. PBEM reviews other bureaus' emergency procedures.	Complete
ST MH #4— Develop a multiple-agency multi-hazard evacuation plan (EQ, flood, fire and landslide at a minimum).				
Lead Agency:				
Yes	Short Term	No	Evacuation Plan developed. Certain areas of highest risk have individualized plans (Linnton).	Complete
ST MH #5— Acquire Light Detection and Ranging (LiDAR) images of the Portland Metro area to facilitate natural hazard area risk assessment and vulnerability analysis. (mapping) (NFIP Compliance)				
Lead Agency:				
Yes	Short Term	No	Acquisition complete. Analysis in progress.	Complete
ST MH #6— Use findings from Portland's Risk Assessment (HAZUS-MH) to enhance existing debris removal plan. HAZUS-MH will need to be updated. (existing GIS Mapping)				
Lead Agency:				
Yes	Short Term	No	The 2003 HAZUS analysis was used to update Metro's debris removal plan from the 1990's in 2013. Debris modeling is being updated regionally. A new HAZUS analysis is being completed as part of the 2016 plan update.	Complete
ST MH #7— Create a mitigation mapping committee to index and maintain GIS mapped inventory and develop prioritized list of critical facilities, residential and commercial buildings within known hazard areas such as earthquake, erosion, the 100-year and 500-year floodplains, invasive plant species, landslide and wildfire areas. (NFIP Compliance) Identify parameters and methods for new maps as needed to meet multi-hazard mitigation goals and to improve communication with the public.				
Lead Agency:				
Yes	Long Term	Yes	CGIS maintains inventory in Portland Maps. No such committee exists. Much of this will be accomplished through the MAP update. Parks, BES data, PBOT erosion data, and others are included. PBEM also promotes the Map Your Neighborhood initiative.	Complete
ST MH #8— Partner with utilities as they ensure continuity of service to the City and the Columbia South Shore Well field to provide for redundancy in case of primary power outage. (asset management)				
Lead Agency:				
Yes	Long Term	No	The Groundwater Electrical Improvements project, currently in design, will provide for upgrades and additional redundancy to the Groundwater Pump Station electrical system.	Ongoing

Action Taken?	Timeline	Priority Changed?	Comment (Describe progress or changed priority)	Status
ST MH #9— Develop a city employee emergency response plan to assure that city employees know what is expected of them to continue City operations. (education, outreach)				
Lead Agency:				
Yes	Short Term	No	All bureaus have submitted Continuity of Operations Plans (COOP), and recognize accountability requirements. PBEM is hiring a COOP planner. The mayor sends out emails informing employees what to do in an emergency.	Complete
ST MH #10— Develop educational materials (television and print media) for residents that identify and define their risk to multi hazards: define and offer mitigation measures that residents can take home or share, determine method of distribution of the educational materials and coordinate with the media to reduce conveyance of misinformation. (education, outreach)				
Lead Agency:				
Yes	Long Term	No	PBEM hired a communications outreach representative, supports preparedness campaigns, promotes preparedness materials, and has offered seismic strengthening programs. Public Information Officer works with local news (KOIN) on post-disaster collaboration.	Complete
ST MH #11— Implement actions in the 2005 Portland Watershed Management Plan (planning) (NFIP Compliance)				
Lead Agency:				
Yes	Short Term	No	Dozens of projects implemented since the Portland Watershed Management Plan was completed. BES is developing a Stormwater System Plan that will significantly increase our ability to address drainage and flooding problems. Analysis available Sept. 2016.	Ongoing
LT MH #1— Revise Portland's Comprehensive Plan to address and implement Citywide policies, land use improvements and mapping changes to natural hazards including, but not limited to, earthquakes, erosion, floods, invasive plants, landslides, volcano, severe weather and wildfires. (mapping, planning) (NFIP Compliance)				
Lead Agency:				
Yes	Long Term	No	The draft Comp. Plan includes policies to reduce natural hazard risks and impacts, proposes changes to reduce development in areas prone to natural hazards. City Council hearings started November 2015. Adoption and submittal in spring 2016.	Ongoing
LT MH #3— Increase the responsiveness of the emergency permitting procedures for post-hazard event periods through development of a procedural plan and the purchase of a mobile permitting van. (planning)				
Lead Agency:				
Yes	Short Term	Yes	BDS looked into purchasing a mobile permitting van, and learned that it was much more expensive than originally thought. There are not sufficient resources currently to implement this action.	Ongoing
LT MH #6— Promote the development of TriMet communications and dispatch capability to immediately implement changes to transit routes and service due to disruption of streets, roads, bridges, rail transit tracks and the information technology that provides connectivity. (planning)				
Lead Agency:				
No	Long Term	No	Not started, identified as a need.	No Progress
LT MH #8— Review and amend City Code and other compliance documentation to require that all facilities that store or handle hazardous materials (including large tanks) and which are located in the 500-year floodplain, landslide, or other hazard areas, develop a hazardous materials inventory statement. This statement will be made available for Fire Bureau review. Require that these storage tanks are either adequately protected or relocated outside of the 500 year floodplain, landslide, or other hazard areas. (asset management) (NFIP Compliance)				
Lead Agency:				
No	Long Term	No	City Resolution 36156 (Water Bureau) requires businesses in the Columbia South Shore Well Field Wellhead Protection Area that meet haz-mat thresholds to report a hazardous materials inventory every November 30. Not in Title 33, Title 24 or Fire Code.	No Progress

Action Taken?	Timeline	Priority Changed?	Comment (Describe progress or changed priority)	Status
LT MH #9— Identify and pursue funding opportunities from outside agencies to fund and implement identified mitigation projects and activities. (education, outreach)				
Lead Agency:				
Yes	Long Term	No	FHA grant funding for PBEM/PBOT transportation planner. PDM 13 grant for MAP update, Hazard Mitigation Program grant for seismic retrofitting of private residences, PDM 15 grant application for seismic retrofit of private residences. PBEM annually applies for and receives Emergency Management Performance Grants, Urban Areas Security Initiative grants, and others on a regular basis. *Note: PBEM did not receive the Urban Areas Security Initiative grant in 2013.	Complete
LT MH #10— Assess the stability of levees in the Columbia Corridor Area and develop appropriate emergency plans to address potential levee failure and associated hazards. (planning)				
Lead Agency:				
Yes	Long Term	No	Assessments are being conducted through the Levee Ready Columbia project, and some have already been completed. Emergency response plans have been and will be developed for specific areas of concern.	Ongoing
LT MH #11— Support development of a multiple-agency plan for Marine Drive closure coordination. (planning)				
Lead Agency:				
No	Short Term	No	No multi-agency plan exists between MCDD, Port of Portland, PBOT, and PPB. Plans are developed ad hoc or as needed basis. Associated with winter weather plan/annex.	No Progress
LT EQ #11— Work with local jurisdictions to assess the capacity of landfill to accommodate earthquake debris: develop coordination plans for disposal of debris in the aftermath of an earthquake. (planning)				
Lead Agency:				
Yes	Short Term	No	A debris management plan is under development. PBEM is working with Metro and the Regional Disaster Preparedness Organization.	Ongoing
New MH #1— Cross reference and incorporate mitigation planning provisions into all community planning processes such as comprehensive, capital improvement and land use plans, to demonstrate multiple bureau benefits and strengthen eligibility from multiple funding sources. This action is also identified in LTFL#8, IS#94 & SW#117. (planning)				
Lead Agency:				
Yes	Long Term	No	2010 Natural Hazard Mitigation Plan components incorporated into Climate Action Plan and Comp. Plan update. PBEM regularly provides comments on citywide planning efforts and requests comments or participation from other bureaus on PBEM planning activities	Complete
New MH #2— Identify and list repetitively flooded structures and infrastructures, analyze the threat to these facilities and prioritize mitigation actions to protect the threatened population. (NFIP Compliance)				
Lead Agency:				
Yes	Long Term	No	There are 11 repetitive loss properties throughout the city. Two of these no longer have structures on them.	Ongoing
New Reworded MH— Acquire (buy-out), demolish, or relocate structures from hazard prone area. Property deeds shall be restricted for open space uses in perpetuity to keep people from rebuilding in hazard areas. (planning) (NFIP Compliance)				
Lead Agency:				
Yes	Long Term	No	1-2 properties on the Repetitive Loss Properties list are in target areas for acquisition.	Ongoing
New MH #3— Develop and incorporate building ordinances commensurate with building codes to reflect survivability from all hazards to ensure occupant safety. (NFIP Compliance)				
Lead Agency:				
Yes	Short Term	No	BDS is currently evaluating state seismic building codes adopted in 2014. BDS is also reviewing retrofit triggers for commercial buildings.	Ongoing

Action Taken?	Timeline	Priority Changed?	Comment (Describe progress or changed priority)	Status
New MH #4— Update the Infrastructure Master Plan and System Vulnerability Assessment, Sewer Failure Response Plan. (asset management, planning)				
Lead Agency: City Asset Managers Group (CAMG)				
Yes	Short Term	No	Infrastructure Master Plan was updated in 2014 and renamed the Citywide Systems Plan. The Sewer Failure Response Plan was updated in 2012 to comply with National Pollutant Discharge Elimination System permit requirements and named the Sewer Release Response Plan.	Complete
New MH #5— Partner with agencies to develop a west side operations center to be used during an emergency if the east side Emergency Control Center and other City facilities become inoperable.				
Lead Agency:				
Yes	Long Term	No	The Jerome Sears Center is currently being retrofitted to ADA accessibility to be temporary homeless shelter (6 months). Additional upgrades could be made over time to convert it to a west side operations center.	Ongoing
New MH #6— Promote 09 Climate Action Plan action items with similarities to adaptation planning and mitigation actions. (planning)				
Lead Agency:				
Yes	Long Term	No	This is a multi-bureau effort. A Climate Action Plan Implementation Team with representatives from key implementing bureaus meets regularly to monitor progress on 2015 CAP and 2014 Climate Change Preparation Strategy.	Ongoing
ST EQ #2— Assess existing earthquake related mitigation plans and vulnerability studies to identify areas of conflict, duplication or gaps between studies & secondary hazards of earthquake. (planning)				
Lead Agency:				
Yes	Short Term	No	This is being completed as part of the 2016 natural hazard mitigation plan update.	Ongoing
ST EQ #3— Update the vulnerability analysis of Columbia Boulevard Wastewater Treatment Plant Tryon Creek Wastewater Treatment Plant and wastewater pump stations. (asset management, planning)				
Lead Agency:				
Yes	Long Term	No	This was in the Capital Improvement Plan for 2013, but Bureau of Environmental Services determined at that time that more study was needed and we delayed it, but other related projects have been completed. A resiliency plan will be developed in FY16-18.	Ongoing
ST EQ #4—Prioritize the return of power to treatment plants (Tryon Creek and Columbia Boulevard) and pump stations.				
Lead Agency:				
Yes	Long Term	No	Bureau of Environmental Services has done several things under this umbrella and is otherwise required to have a high priority on power reliability by federal standard for critical assets.	Ongoing
ST EQ #8—Study the feasibility of mandatory or voluntary installation of seismic shutoff valves on natural gas meters at commercial and residential buildings.				
Lead Agency:				
Yes	Short Term	Yes	PBEM pursued this, but it did not come to fruition. Valves are expensive, and take time to turn back on after being shut off. It may be pursued at a state level. BPS and BDS have advocated for disclosure of seismic information upon sale of homes.	Complete
LT EQ #3—Develop a plan to strengthen sewer infrastructure in areas where street overlays and sewers have potential to collapse in a seismic event. (asset management)				
Lead Agency: City Asset Managers Group (CAMG)				
Yes	Short Term	No	City Asset Managers Group is working on this. MAP risk assessment could identify projects and key risk areas.	Ongoing

Action Taken?	Timeline	Priority Changed?	Comment (Describe progress or changed priority)	Status
LT EQ #6—Assess the vulnerability of the water distribution system to seismic events: work toward hardening the system.				
Lead Agency:				
Yes	Long Term	No	The Water Bureau has completed a number of seismic evaluations and upgrades over the last several years. A comprehensive evaluation of the entire water system is planned to be completed in the Fall of 2016.	Ongoing
LT EQ #8—Study development regulations and policies to ascertain if regulations can be made to limit development of high risk facilities in known areas of earthquake hazards.				
Lead Agency:				
No	Long Term	No	Not begun. BPS is leading the Comprehensive Plan and Central City 2035 planning process, which could establish the policy framework to update regulatiions. There are other options too, e.g., changes to fire code.	No Progress
SW #2—Acquire an additional facility for storage of anti-icing materials and expand anti-icing vehicle inventory.				
Lead Agency:				
Yes	Long Term	No	The city has acquired two new anti-icing vehicles. There is one storage location now. This is being addressed in conjunction with other needs at the Jerome Sears facility.	Ongoing
ST SW #6—Insulate residential buildings that house at risk populations.				
Lead Agency: Bureau of Planning and Sustainability				
Yes	Long Term	Yes	This action is being accomplished through different means. BPS created Clean Energy Works, Oregon which is now a non-profit organization that conducts energy audits and provides homeowners with low-cost energy efficient upgrades.	Complete
ST SW #7—Prioritize existing building stock for active review of Title 29 (Dangerous Building Code) This needs to be updated with intern information or information sent from individuals that are on the team.				
Lead Agency:				
No	Short Term	No	No progress at this time.	No Progress
ST FL #1— A covenant is recorded with the deed of new development in the floodplain to ensure that space below the base flood elevation is not converted to habitable space. This should be codified to improve compliance. (NFIP Compliance)				
Lead Agency:				
No	Long Term	No	No progress at this time. Team responsible for these types of codes is not clear on what this action means.	No Progress
ST FL #2—Continue to co-fund improvements to river and stream gauges in the Portland metropolitan area with the United Geological Survey.				
Lead Agency:				
Yes	Long Term	No	BES continues to allocate funding for these important sources of hydrologic (and in some cases, water quality) data.	Ongoing
ST FL #4—Secure the agreements necessary to design and implement the redevelopment of Freeway Land Company site. (within the Lents Urban Renewal Area)				
Lead Agency:				
Yes	Short Term	No	Potential with a current manufacturing company interested in the site. Should know by June if it is a viable project.	Ongoing
ST FL #5—Acquire outside funding to hire a consultant to lead the application process to maintain a Class 5 rating when the City seeks Community Rating System re-certification.				
Lead Agency:				
Yes	Short Term	No	Recently completed reverification. Portland is likely to be a Class 6 Community follow an extrmemely rigorous reverification process. New, more robust guidelines in the 2013 CRS Coordinators' Manual made it impossible to retain Class 5 status.	Complete

Action Taken?	Timeline	Priority Changed?	Comment (Describe progress or changed priority)	Status
ST FL #6—Support Multnomah County Drainage District (MCDD) in the continued calibration and update of hydraulic models for conveyance and internal flood impacts to the four floodplains managed by MCDD #1.				
Lead Agency:				
Yes	Short Term	No	Participated in information sharing for update of the internal drainage study. In addition, developed and calibrated model to predict stormwater volumes from BES stormwater system to the Multnomah County Drainage District #1.	Ongoing
ST FL #8—Identify funding for the design and construction of the Springwater Wetlands Complex, a 30-acre floodplain wetland restoration project in the Lents area of Johnson Creek.				
Lead Agency:				
Yes	Long Term	Yes	Grant funding was identified, but became cost-prohibitive. BES is pursuing a way to self-fund the project. Capital Improvement Plan advisory committee meeting in January to seek funding.	Ongoing
ST FL #9—Secure funding to implement the passive flood management projects that are recommended in the Johnson Creek Restoration Plan & other watershed management plans. Coordinate with Portland Development Commission's urban renewal efforts in Lents and with other partners in other parts of the watershed.				
Lead Agency:				
Yes	Short Term	No	BES is currently working with Housing, PDC, and Mayor's office to submit an application to Oregon Solutions to implement a robust set of projects that will help mitigate 100-year flood impacts to 300+ residential properties and numerous businesses.	Ongoing
ST FL #10—Improve definitions and refine standards for stormwater retention in the Storm water Management Manual.				
Lead Agency:				
Yes	Short Term	No	New Stormwater Management guidelines have just been released, with clarifying definitions and standards.	Complete
LT FL #1—Increase funding for the Johnson Creek Willing Seller Program; establish willing seller programs in other watersheds where flood hazard and priority restoration areas coexist. (NFIP Compliance)				
Lead Agency:				
Yes	Long Term	No	In addition to the Johnson Creek Willing Seller Program, a Watershed Land Acquisition Program is in place that prioritizes properties with significant hydrologic function and/or value. Over 450 acres have been acquired City-wide in partnership with Portland Parks (and in some cases, Metro) under the Watershed Program. Willing Seller funding is available to purchase the additional properties needed to implement the JC Restoration Plan. Over 20 acres acquired through the Willing Seller Program since 2010.	Ongoing
LT FL #3—Develop a plan for addressing flooding in the Holgate Lake area. (planning) (NFIP Compliance)				
Lead Agency:				
Yes	Long Term	No	No progress to date. Anticipate looking at this area as part of the larger Lents Floodplain/Oregon Solutions project.	No Progress
LT FL #4—Improve hydraulic bottleneck that prevents discharge of chlorinated effluent to the Willamette River during high river levels. (NFIP Compliance)				
Lead Agency:				
Yes	Long Term	No	The recent Facilities Plan update anticipates a future improvement of installing a high river bankside outfall to provide access to flow to the Willamette River during the conditions outlined.	Ongoing

Action Taken?	Timeline	Priority Changed?	Comment (Describe progress or changed priority)	Status
LT FL #5—As Waterfront Park remodeling is designed, ensure that Portland's downtown property and critical facilities remain protected from floodwaters. (asset management)				
Lead Agency:				
Yes	Long Term	No	This was considered during the Central City 2035 plan. BPS has contracted with PSU to evaluate flood changes from climate change in the Lower Willamette. The report will be completed by early 2017.	Ongoing
LT FL #6/#7—Partner with Army Corps of Engineers to conduct modeling of the Willamette River upstream of Portland to identify areas that, if acquired or restored, would contribute to mitigate of peak flows in Portland or result in significant reduction of flood damage. (NFIP Compliance)				
Lead Agency:				
Yes	Long Term	No	BPS contracted with PSU for work with the Army Corps to model the Willamette River flood extent through Portland under Climate Change scanarios. Following this, areas will be identifed that may be used to reduce peak flows. Analysis complete in 2018.	Ongoing
LT FL #8—Develop goals, policies and implementation measures to manage the amount of new impervious surface and remove existing impervious surfaces where appropriate. These goals, policies and measures may be at the citywide, watershed, or sub-watershed level. (planning) (NFIP Compliance)				
Lead Agency:				
Yes	Long Term	No	Draft Comprehensive Plan contains goals and policies, and updated CAP and new Climate Change Preparation Strategy include objectives and actions to limit and reduce impervious area. BES would lead implementation measures to actually remove pavement.	Complete
LT FL #9—Upgrade trestles that carry the main conduits of the water delivery system. (Sandy River Crossing interties completed) (asset management)				
Lead Agency:				
Yes	Long Term	No	Several conduit trestles have been eliminated or upgraded over the last several years. Eight more are recommended to be completed over the next five years.	Ongoing
FL #10—Create redundancy in the water delivery system at the three Sandy River crossings by burying conduits under the river (in progress).				
Lead Agency:				
Yes	Long Term	No	Two of these crossings have been replaced as part of a construction project completed in 2010. The Conduit 3 Crossing of the Sandy River is scheduled for completion within the Water Bureau's five year Capital Improvement Plan.	Ongoing
LT FL #11—Provide funding for and participate in development of a flood inundation model for the managed floodplains and downtown sea wall. (mapping) (NFIP Compliance)				
Lead Agency:				
Yes	Long Term	No	BPS contracted with PSU to assess changes to Willamette River floodplains resulting from climate change. Report completion date is in 2017. Levee Ready Columbia is contracting with USGS and Corps of Engineers to conduct an assessment for the Columbia.	Ongoing
LT FL #12—Install a river gauge in the vicinity of the bridge over Johnson Creek at 108th. The gauge should be able to send data to remote monitoring sites.				
Lead Agency:				
Yes	Short Term	Yes	The bridge was removed as part of the Foster Floodplain Natural Area construction, which created an additional 120 acre feet of flood storage along SE Foster Rd. We have installed a crest gage however to determine flood levels during over-bank events.	Complete

Action Taken?	Timeline	Priority Changed?	Comment (Describe progress or changed priority)	Status
LT FL #13—Install one-way valves on the outlet pipes of the storm inlets on SE Foster Road between 101st and 112th.				
Lead Agency:				
Yes	Long Term	No	These outlets now go to a stormwater facility that is part of the Foster Floodplain Natural Area.	Complete
FL #1—Complete update to the Johnson Creek Restoration Plan. Develop individual plans for each subwatershed to address the sources of excess stormwater runoff that exacerbates flooding. (NFIP Compliance)				
Lead Agency:				
Yes	Short Term	No	This work falls under the Stormwater System Plan. See ST-MH #11.	Ongoing
FL #2—Establish flood mitigation priorities for critical facilities and residential and commercial buildings located within the 100-year floodplain using survey elevation data. (NFIP Compliance)				
Lead Agency:				
Yes	Short Term	Yes	The City Asset Managers Group is working to define critical facilities, rather than prioritize, which is the first step. This will also be furthered by the MAP risk assessment and action item update.	Ongoing
ST-LS #1—Continue to maintain and Improve internal City communications to facilitate coordination of landslide mitigation activities. (education, outreach)				
Lead Agency: Portland Bureau of Emergency Management				
Yes	Long Term	No	PBEM continues working to improve internal coordination and communication. It is unclear what this action refers to specifically in terms of landslide mitigation.	Ongoing
ST-LS #3—Mitigate Portland's water supply infrastructure from landslide hazards. (asset management)				
Lead Agency:				
Yes	Long Term	No	Evaluation work continues on PWB facilities considered vulnerable to landslides.	Ongoing
ST-LS #4—Initiate more operations and maintenance pilot projects along roads that inform about the development of standards for managing stormwater in ditches in landslide prone areas. (education, outreach)				
Lead Agency: Bureau of Environmental Services				
No	Short Term	Yes	No progress has been made on this project to date. Project description is vague and does not identify specific actions.	No Progress
LT-LS #1—Develop a comprehensive landslide map for the City of Portland to identify hazard areas and to improve communications with the public. (mapping)				
Lead Agency:				
Yes	Short Term	No	BPS is coordinating with DOGAMI on a project to improve landslide related maps and data. This is currently between Corporate GIS and DOGAMI. CGIS will update landslide data based on DOGAMI work.	Ongoing
New LT LS #3—Evaluate the role of drainage systems in the West Hills, including pipes, streams and drainage ways and options for protecting and improving their functions and increasing their resiliency. (planning)				
Lead Agency:				
Yes	Short Term	No	This work falls under the Stormwater System Plan. See ST-MH #11.	Ongoing
LT LS #4—Review the effectiveness of existing regulations related to development in landslide hazard areas. (planning)				
Lead Agency: Bureau of Planning and Sustainability				
No	Short Term	No	Not started but could be a good Comprehensive Plan implementation project. It could be coupled with project to address impervious area and use new landslide data from DOGAMI.	No Progress
LT-LS #6—Employ alternative construction methods such as trenchless construction on City projects to reduce the impact that development can have in landslide prone areas.				
Lead Agency: Bureau of Environmental Services				
No	Long Term	No	No progress on this project to date. Specific action items are unclear.	No Progress

Action Taken?	Timeline	Priority Changed?	Comment (Describe progress or changed priority)	Status
LT LS #7—Continue development of standards for small pump stations as an alternative to gravity sewers in accessible or high risk areas.				
Lead Agency:				
No	Short Term	No	BES recognizes this as a desirable project but has not begun work yet.	No Progress
ER #1—Develop recommendations for high and low ranking streamside plants that provide more erosion control, such as reducing erosion from high water and wave actions.				
Lead Agency:				
No	Short Term	Yes	No progress has been made on this project to date. Project description is vague and does not identify specific actions.	No Progress
ER #2—Implement projects that retain native vegetation, increase vegetation diversity and increase the complexity of the vegetation strata (having three vegetation strata: herbs, shrubs, trees).				
Lead Agency:				
Yes	Long Term	No	Robust invasive plant removal/native plant installation implementation over the last 5 years.	Ongoing
ER #3—Implement policies to increase the extent of coverage of the Greenway zones along the rivers and further limit proposed activities within these areas.				
Lead Agency:				
Yes	Long Term	No	In progress. Central City 2035 plan anticipates proposing expanded river setback, updated regulations, and riverbank enhancement targets.	Ongoing
ER #4—Develop standards for soil backfill in vegetated areas, especially sloped areas. (planning)				
Lead Agency:				
No	Short Term	Yes	No progress has been made on this project to date. Project description is vague and does not identify specific actions.	No Progress
ER #5—Establish regulations that prevent installation of slopes steeper than 3:1 and prohibit development on slopes steeper than 3:1. (planning)				
Lead Agency: Bureau of Development Services/Bureau of Planning and Sustainability				
No	Short Term	No	No such proposal yet.	No Progress
ER #6—Implement projects that layback and/or regrade riverbank slopes and secure wetland sod mats composed of native emergent/grasses, etc.				
Lead Agency:				
Yes	Long Term	No	These practices are used routinely in our restoration projects. Six projects, 98 acres completed since 2010.	Ongoing
ER #7—Construct and install bio-engineered slope protective measures to reduce or eliminate erosion				
Lead Agency:				
No	Short Term	No	No progress on this project to date. Specific action items are unclear.	No Progress
ER #8—Implement projects that increase large wood structures that act to soften the effect of wave action on shorelines as well as provide habitat for migrating salmonids.				
Lead Agency:				
Yes	Long Term	No	These practices are used routinely in our restoration projects. Six projects, 98 acres completed since 2010.	Ongoing
ER #9—Secure large wood [boles w/ attached root wads] or log rafts to reduce high wave action that can result in erosion.				
Lead Agency:				
Yes	Short Term	No	Large wood has been installed in all major tributaries to the Willamette, including Columbia Slough, Johnson, Tryon, Fanno, and Stephens Creeks. Proposals in progress for mainstream Willamette projects at Powers Marine, Sellwood, and Kelly Point Parks.	Ongoing

Action Taken?	Timeline	Priority Changed?	Comment (Describe progress or changed priority)	Status
ST WF #1—Consolidate unassigned and/or unmanaged vegetated areas owned by the City under a single land management umbrella. (asset management)				
Lead Agency:				
No	Long Term	No	No progress has been made on this project to date.	No Progress
ST WF #2—Procure funding for management of vegetated natural areas with high wildfire danger, including public and private properties.				
Lead Agency:				
Yes	Long Term	No	Parks does not seek funding from outside sources, but this is a typical management practice and is integral to Parks SOPs and management/planning documents.	Complete
ST WF #4—Provide wildfire management training to staff. (education, outreach)				
Lead Agency:				
Yes	Short Term	No	Each year PF&R provides seasonal wildland training to all line personnel by reviewing and exercising procedures. In 2016, PF&R will conduct a spring Training Block that all line staff will complete, with basic state level hands-on wildland training.	Complete
ST WF #5—Amend the Portland Plant List and other related City plant lists and landscaping guides to include/identify fire resistant native plants and planting strategies that could be encouraged or required in local landscaping. (planning)				
Lead Agency:				
Yes	Short Term	No	The Portland Plant List was updated to provide information about fire resistant native plants. Other landscaping and tree guides are maintained by BDS and PP&R.	Complete
ST WF #6—Integrate, as appropriate, fire prevention goals and provisions into City policies, plans and codes. Identify and address ambiguities or conflicts among city requirements. (planning)				
Lead Agency:				
Yes	Short Term	No	The draft Comprehensive Plan includes policies and map changes to reduce future risks and impacts from natural hazards, including wildfire. The draft plan also includes new urban forest related policies that recognize the need to manage for wildfire.	Complete
ST WF #7—Identify conditions of approval and mitigation strategies that could be applied to new development or redevelopment in high risk areas.				
Lead Agency:				
Yes	Long Term	No	The Comprehensive Plan could set the stage to address this in future code amendments (e.g., ezones, land division).	Ongoing
ST WF #9—Improve the system for identifying new construction in areas subject to wildfires and communicating this information to the affected land owners. (planning)				
Lead Agency:				
Yes	Short Term	No	It is not clear what exactly this strategy means. It seems to imply a new mapping tool or interface. BTS upgraded the online mapping platform at PortlandMaps.com, which shows fire risk by parcel.	Complete
ST WF #10—Conduct systematic reviews of Portland's large, publicly owned, wildland tracts regarding fire safety and ecological health to ensure informed land management decisions. (asset management)				
Lead Agency:				
Yes	Short Term	No	This is part of Parks' standard operating procedures and planning documents.	Complete
ST WF #11—Adopt the national "Fire Danger Rating System" and install the signs at key points in the City.				
Lead Agency:				
No	Short Term	No	Portland does not currently have a "Fire Danger Rating System", but this is a system that would be useful and could be maintained by the Parks Bureau.	No Progress

Action Taken?	Timeline	Priority Changed?	Comment (Describe progress or changed priority)	Status
ST WF #12—Implement a neighborhood wildland interface disaster planning program. (education, outreach)				
Lead Agency: Portland Parks and Recreation				
Yes	Short Term	No	"Ready, Set, Go!" was developed and managed by the International Association of Fire Chiefs. We adopted the program last year, and have information on our website and handouts for citizens to learn how to protect themselves.	Complete
ST WF #13—Review and potentially refine City contract specifications for machinery operations during "Red Flag" weather conditions. (asset management)				
Lead Agency:				
No	Short Term	No	No equipment use restrictions exist during Red Flag Warnings other than an advisory generated by the Natural Weather Service. Parks does have contract language that restricts construction and other work during Red Flag days.	No Progress
ST WF #14—Convene a standing wildland interface fire technical group. (planning)				
Lead Agency:				
Yes	Short Term	Yes	A standing wildland interface technical group currently meets to discuss wildland issues but budgets have limited current activity.	Ongoing
ST WF #15—Index City wildfire mitigation plans and activities. (asset management)				
Lead Agency:				
Yes	Short Term	No	The 2011 Multnomah County Community Wildfire Protection Plan indexes recommendations from the 2010 NHMP, the 2009 Wildfire Readiness Assessment Gap Analysis Report, and the Forested and the 2005 Wildland Interface Areas Protection Annex recommendations into one comprehensive list.	Complete
WF—Develop and implement protocol for defining and mapping Wildland Urban Interface Zones and develop recommended policies, regulations and landscape options for incorporation into City plans and programs. (planning)				
Lead Agency: Bureau of Planning and Sustainability				
No	Long Term	No	Not started. This could be a good Comprehensive Plan implementation project. It should be co-led with Portland Fire & Rescue.	No Progress
ST WF #16—Identify water grid engineering requirements for firefighting in wildfire areas. (asset management)				
Lead Agency:				
No	Short Term	No	Have not started, but this could be coordinated between PF&R and the Water Bureau.	No Progress
LT WF #2—Review the feasibility of adopting portions of nationally recognized wildfire interface codes to strengthen building standards in wildfire risk areas.				
Lead Agency:				
Yes	Short Term	Yes	PF&R have worked toward adopting nationally recognized codes, but with little success. Portland does have requirements for new structures built in wildland areas, such as non-combustible siding and roofing.	Ongoing
LT WF #3—Design and conduct a study to determine the effectiveness of maintenance agreements that are established when new land divisions are approved to manage vegetation in open space tracts.				
Lead Agency:				
No	Short Term	No	Not started.	No Progress
LT WF #4—Complete an assessment to characterize high priority wildfire risk areas and recommend specific mitigation strategies.				
Lead Agency:				
No	Short Term	Yes	Metro procured LiDAR data in 2014, and vegetation classification analysis was performed by BPS and PSU. The vegetation data could be used to produce a wildfire risk assessment, but that analysis has not been done.	No Progress

Action Taken?	Timeline	Priority Changed?	Comment (Describe progress or changed priority)	Status
LT WF #5—Explore avenues for funding wildfire interface home construction upgrades to low income homeowners.				
Lead Agency:				
No	Short Term	No	PF&R has not explored this due to the lack of funding for a dedicated wildland position through the Fire Marshall's Office.	No Progress
WF—Act upon all Mitigation Actions outlined in the Wildfire GAP Analysis Report				
Lead Agency:				
Yes	Long Term	No	See Attachment A.	Ongoing
IS #1—Update Invasive Species Plants List by consolidating nuisance and prohibited plant lists into one "Nuisance Plants List" and assigning priority ranks to the Nuisance Plants List.				
Lead Agency:				
Yes	Short Term	No	Completed in 2010.	Complete
IS #2—Clarify zoning regulations to require removal of plants on the Nuisance Plants List in the Environmental, Greenway and Pleasant Valley Natural Resources Overlay Zones and the Columbia South Shore and Johnson Creek Basin Plan Districts.				
Lead Agency:				
No	Short Term	Yes	There is no additional plan to require removal of all nuisance plants in the specific areas identified in the action. DROP.	No Progress
IS #3—Initiate a process to ensure the Erosion Control Manual be made consistent with City goals to control and eradicate invasive plants. (planning)				
Lead Agency:				
Yes	Short Term	No	The Erosion Control Manual was updated in 2010. In this update, invasive species were called out as specifically prohibited.	Complete
IS #4—Initiate a process to ensure the Tree and Landscaping Manual, the Recommended Street Tree List and the Stormwater Management Manual be made consistent with City goals to control and eradicate invasive plants. (planning)				
Lead Agency:				
No	Long Term	Yes	There is no coordination committee in place. Tree and Landscaping Manual maintained by BDS, Recommended Street Tree List maintained by PP&R/Urban Forestry, SWMM maintained by BES. Any such project should be led by the BES Invasive Species Mgmt. Program.	No Progress
IS #5—Coordinate with the Portland Plan project to help ensure that invasive species are addressed in the Comprehensive Plan update and Portland Plan work plan. (planning)				
Lead Agency:				
Yes	Short Term	No	The draft Comprehensive Plan contains policies to manage and prevent the spread of invasvie plants.	Complete
IS #6—Research the feasibility of establishing a local noxious or invasive weed law.				
Lead Agency:				
No	Short Term	No	Not started.	No Progress
LT V #1—Work with the state and other impacted jurisdictions to implement and update the various volcano Inter-Agency Coordination Plans.				
Lead Agency: Portland Bureau of Emergency Management				
Yes	Long Term	No	PBEM attends meetings regarding interagency volcano plans for Mt. St. Helens, Mt. Adams, and Mt. Hood	Ongoing
V—Work with the state and other impacted jurisdictions to implement and update the various volcano Inter-Agency Coordination Plans.				
Lead Agency:				
CHOOSE	CHOOSE	CHOOSE	Redundant.	CHOOSE

ATTACHMENT A – WILDFIRE GAP ANALYSIS REPORT ACTION ITEM STATUS

5. Convene a standing City of Portland wildfire technical working group. *Done*
6. Identify and map the wildland urban interface area within the City. *Done*
7. Modify existing regulations to improve the permitting process and allow an increase of the defensible space around structures. *Not Started.*
8. Integrate fire prevention goals and provisions into policies, plans, and codes. *Not Started.*
9. Secure funding for continued, long term vegetation management projects that maintain safe fuel levels in key locations. *PF&R conducted some vegetation management when grants were available, up to 2012, at which point funding expired.*
10. Conduct a wildland firefighter training assessment. *Done.*
11. Reaffirm wildland firefighting standards for Portland Fire & Rescue. *Done*
12. Analyze and prioritize emergency vehicle access routes. *Not Started.*
13. Conduct a periodic tri-county wildfire coordination meeting. *Done. PF&R regularly attends Fire Defense Board Meetings.*
14. Revisit mutual aid agreements to ensure they are current and applicable. *Done. Most agreements are reviewed periodically, even though they are perpetual in nature and extend from year to year.*
15. Establish an agreed upon fire danger rating system and develop agency protocols. *Not Started.*
16. Continue conduct annual wildland firefighter training for Portland Fire personnel. *Done.*
17. Improve enforcement of park rules in natural areas and open space tracts on approved land divisions. *Not Started.*
18. Improve emergency radio communications between PP&R Nature field staff and City first responders. *Done. Communications between Rangers has improved, but no documented improvements with Nature Field Staff.*
19. Design and conduct an effectiveness study of maintenance agreements that are established when new land divisions are approved to manage vegetation in open space tracts. *Not Started.*
20. Conduct wildfire training for City wildfire response stakeholders. *Not Started.*
21. Develop a comprehensive, long term vegetation treatment program. *Done. Portland Parks is working on a 10-year Restore Forest Park Plan for continued maintenance and removal of non-native trees and vegetation and other ladder fuels.*
22. Educate landowners within the Wildfire Hazard Zone about wildfire hazards. *Done.*
23. Establish a fire information network in Forest Park and Powell Butte. *Not Started.*
24. Create incentives to encourage fuel reduction and defensible space. *Done. Currently Portland Parks works with landowners and participates in outreach with our partner organizations.*
25. Design and install one or more demonstration areas to showcase wildfire resistant plantings. *Done. Station 27 is currently a "work-in-progress" to demonstrate wildfire resistance strategies.*
26. Initiate and maintain training opportunities with regional and City incident management teams. *Done.*
27. Develop a cross-bureau plan for evacuation of citizens in high fire risk areas. *Not Started.*
28. Develop critical GIS map layers for fire response and planning in natural areas. *Done.*
29. Review and update the Forested and Wildland Interface Areas Fire Protection Plan. *Not Started.*
30. Re-Invigorate Neighborhood Emergency Teams with concrete projects. *Done.*
31. Improve the system for identifying new construction in areas subject to wildfires. *Not Started.*
32. Assess and communicate the capacity of the water infrastructure (e.g. pipes, hydrants, water reservoirs). *Not Started.*
33. Review the feasibility of adopting portions of state or nationally recognized wildfire interface codes. *Not Started.*
34. Identify conditions of approval and mitigation strategies for new development or redevelopment in high risk areas. *Not Started.*

The Mitigation Action Plan

Appendix B. Steering Committee Ground Rules

B. Steering Committee Ground Rules

PURPOSE OF THE STEERING COMMITTEE

The role of the Steering Committee is to guide the planning process for the City of Portland Mitigation Action Plan (MAP), and to foster an equitable approach to building Portland's resilience to natural hazards. The Steering Committee will provide guidance and leadership, oversee the planning process, and act as a point of contact for local governments, neighborhoods, and community groups interested in this planning effort, working to ensure that all Portlanders have equal access to projects that reduce their risk from natural hazards. Members of the Steering Committee represent a cross-section of views and interests across Portland. Through this inclusion of diverse interests, the Steering Committee hopes to enhance the robustness of the planning effort and to build support for hazard mitigation activities across stakeholder groups. A successful planning effort will result in the adoption and approval of a plan that sets the stage for equitably reducing the adverse impacts of natural hazards within the City through activities and strategies embraced by both elected officials and the people of Portland.

DEFINITION OF STAKEHOLDER

Stakeholders for this planning process are persons and agencies that have a vested interest in the recommendations and implementation of the MAP. Stakeholders include residents; community groups; business owners; local, state and federal agencies; elected officials; visitors; neighboring communities; and others.

CHARGE STATEMENT

During the course of developing the MAP, the Steering Committee will:

- guide the planning process,
- develop strategies for public involvement that foster mutual information exchange during plan development and implementation,
- promote and advocate for equity in hazard mitigation, and
- support the develop of mitigation strategies that promote a decrease in loss of life, property damage, and long-term impacts to social, environmental and economic systems from natural hazards.

CHAIRPERSON AND VICE CHAIRPERSON

Solamon Ibe, Jessica London, and Jeremy O'Leary have been selected as the co-chairpersons of the Steering Committee. The Co-chairpersons will rotate acting Chairperson and Chairperson Support roles. The role of the acting Chairperson for each meeting is to:

- lead meetings so that agendas are followed and meetings adjourn on-time;

- allow all members to be heard during discussions;
- moderate discussions between members with differing points of view; and
- be a sounding board for staff in the preparation of agendas and on how to best involve the full Committee in work plan tasks.

The role of the Chairperson Support person will be to assist in timekeeping and to assist in tracking the order in which members have indicated they would like to comment, particularly when agenda items are contentious.

QUORUM

A quorum for the Steering Committee will be 17 members. When less than 17 members are present at a meeting, items listed on the agenda may still be reviewed and discussed; however, any committee action as to those items will be postponed until a quorum is present.

ALTERNATES

Committee members were selected for the Steering Committee based on their specific backgrounds and perspectives on matters related to hazard mitigation. Regular attendance by members is needed to understand the issues presented, identify and reflect on various stakeholder perspectives, and reach agreements on plan recommendations. However, there may be circumstances when regular members cannot attend. To address these circumstances, alternates may be designated for each Steering Committee member. An alternate attending on behalf of a Steering Committee member shall have the same rights and responsibilities as the Steering Committee member during that meeting. Alternates will be included on all Steering Committee emails and should remain apprised of the business of the Steering Committee.

DECISION-MAKING

The Steering Committee will strive for consensus in its decision-making process. If consensus cannot be reached as to a particular item or issue, the Steering Committee's decision will be determined by a majority vote of the Committee members in attendance at the meeting, and the meeting summary will reflect the number of votes in favor, opposed, and in abstention. Any Steering Committee member may request that dissenting opinions be included in the meeting summary.

In the event that an issue brought to a vote results in a tie, 20 additional minutes of discussion time will be allotted for the topic. A re-vote will be conducted at the end of the allotted time. If the vote still results in a tie, decision-making authority will be handed over to the lead agency, Portland Bureau of Emergency Management (PBEM). PBEM may choose to decide on the issue, extend the time allotted for discussion or carry the item over to the next agenda.

RECOMMENDATIONS

The Committee's recommendations will be recorded in the meeting summaries and reflected in the MAP, as appropriate. The Committee may also be asked to assist in public outreach efforts and public presentations of the MAP and its recommendations.

STAFFING

The Planning Team for this project includes appropriate personnel from the City of Portland Department of Emergency Management, along with contract consultant assistance provided by Tetra Tech, Inc. The Planning Team will schedule meetings, distribute agendas, prepare information/presentations for Committee meetings, write meeting summaries, and generally seek to facilitate the Committee's activities.

A City designated Public Information Officer, **Dan Douthit 503-823-3928**, will be the designated spokesperson for this planning effort.

MEETING DATES

Meetings generally will be conducted on the third Wednesday of each month from 4:00 PM to 6:30 PM at the Wyeast Conference Room, Level L1, 501 N Dixon St. Portland, OR 97227. A teleconference number will also be provided for those wishing to join the meeting, but who are unable to attend in person. The planning team requests that steering committee members be given first priority for spaces on the conference line in the event those who choose to utilize the call-in option exceeds the line capacity. Meetings that conflict with religious, state or federal holidays will be rescheduled at the Steering Committee's discretion. Such scheduling changes will be noted on the hazard mitigation website. Meetings will be open to the public and will be advertised as such.

ATTENDANCE

Participation of all Committee members in meetings is important and members should make every effort to attend each meeting. If Committee members and their designated alternates are unable to attend a meeting, they should provide as much advance notice as reasonably possible to the Planning Team before the meeting is conducted. If neither a Steering Committee member nor his or her alternate attends 2 consecutive meetings or 3 cumulative meetings, the Steering Committee chairperson will reach out to the member to determine if participation will still be possible. The Steering Committee will strive to maintain the Steering Committee membership at 33 members with a representative makeup similar to the initial committee makeup.

PUBLIC INVOLVEMENT

All Steering Committee meetings will be open to the public. Members of the public wishing to address the Steering Committee at a meeting may do so based on the following protocol:

- While the agenda is reviewed at the beginning of each Steering Committee meeting, the chairperson will ask if anyone wishes to be heard. Anyone wishing to speak will be given three minutes and Steering Committee members may then ask questions. This allotted time cannot be aggregated or passed on to another individual.
- The time allocation for public comment at each meeting will be determined by the chairperson.
- When many people are expected to testify, sign-up lists will be provided. Written materials may also be submitted to the Steering Committee for distribution to members either prior to or at the meeting. Written material for distribution to members may also be submitted by those unable to attend in person.
- Those wishing to make video or PowerPoint presentations should check with the Planning Team prior to the meeting (danielle.butsick@portlandoregon.gov).

- All comments must have relevance to the MAP and Portland. Relevance will be determined by the chairperson.

A member of the public may request clarification from the Steering Committee by raising his or her hand during the normal course of the meeting; permission to speak will be granted at the discretion of the chairperson.

The meeting agendas for all Steering Committee meetings will be posted on the hazard mitigation website a minimum of 72 hours prior to all scheduled meetings (https://www.portlandoregon.gov/pbem/67578).

COURTESY

Committee members will treat each other with respect, listen to each other, work cooperatively, and allow all members to voice their opinions.

STEERING COMMITTEE MEMBERSHIP

Agency	Primary Member	Alternate
Bureau of Environmental Services (BES)	Maggie Skenderian	Kate Carone
Bureau of Planning and Sustainability (BPS)	Kevin Martin	
Bureau of Planning and Sustainability (BPS)	Sallie Edmunds	Roberta Jortner
Office of Equity and Human Rights (OEHR)	Danielle Brooks	
Parks & Recreation	Vicente Harrison	
Fire and Rescue (PF&R)	Leo Krick	Laurent Picard
Bureau of Technology Services	Paul Cone	
OHSU Institute on Development and Disability/Oregon Office of Disability and Health	Justin Ross	Jessica London
Portland Audubon Society	Bob Sallinger	Micah Meskel
Oregon Food Bank	Dean Alby	
Rosewood Initiative	Tony Lamb	
Filipino American Community	Simeon Mamaril	
Intel	Jeff Soulages	
Department of Homeland Security	Glen Collins	
NET/ARES/Local Emergency Planning Committee	John Steup	
Downtown NET/Northwest NET	Darlene Urban Garrett	
Portland African American Leadership Forum, Groundwork Portland	Solamon Ibe	
Brummell Enterprises, SMILE Member, Sellwood/Moreland	Karen Tam	Bob Burkholder
Portland Water Bureau	Mary Ellen Collentine	Mike Saling
Simpson Strong-Tie	Shalini Prochazka, S.E.	David Gilroy
Bureau of Development Services	Kathy Roth	Mark Fetters
East Portland Action Plan	Jeremy O'Leary	
Immigrant and Refugee Community Organization IRCO	Ronault (Polo) LS Catalani	
Coalition of Communities of Color	Maggie Tallmadge	
Hayden Island Neighborhood Network	Jeff Geisler	
Linnton Neighborhood Association	Rob Lee	Darise Weller
St. Johns Neighborhood Association	Jennifer Levy	Emilie Saks-Webb
Portland Public Schools	Molly Emmons	
Portland Voz	Ranfis Giannettino Villatoro	

Bureau of Emergency Management	Jonna Papaefthimiou	
Office of Neighborhood Involvement (ONI)	Nickole Cheron	
Oregon School Boards Association	Siobhan Burke	
OHSU Emergency Management	Sherrie Forsloff	Mike Nurre

GROUND RULES ATTACHMENT A: MEETING FACILITATION

Committee Co-Chairs

- Solamon Ibe – Portland African American Leadership Forum
- Jessica London – Oregon Health and Science University/Oregon Office of Disability and Health
- Jeremy O'Leary – East Portland Action Plan

One Chair and one Vice-Chair will serve at each steering committee meeting. Each Co-Chair will be off-duty approximately once every three months, depending upon scheduling needs. The Co-Chairs will determine scheduling in advance of each meeting. If a substitute is needed, Co-Chairs will work with the other Co-Chairs and the Planning Team to designate an alternate.

Responsibilities

Chair

The Chair will be responsible for facilitating discussion during meetings. During normal discussion, the Chair will manage committee comments and questions, calling on members in the order they requested to speak. The Chair will also receive comments and questions from non-committee members at her or his discretion. If the topic becomes contentious or several members wish to provide comment, the Chair may request assistance from the Vice-Chair.

Vice-Chair

The Vice-Chair will manage committee and public comments when requested by the Chair, or when the topic becomes contentious or several members wish to provide comment. While managing comments, the Vice-Chair may also call on members of the public at her or his discretion. The Vice-Chair will track time spent on agenda items and will alert the Chair when time allotted to an agenda topic is nearing or have been reached.

Self-Representation

While acting as Chair or Vice-Chair, the Co-Chairs may represent their own interests, thoughts, and opinions so long as they do not use their position to overstep others. Comments from the acting Chair or Vice-Chair will be received in the same manner as comments from other members.

Meeting Management

Seating

Whenever possible, the meeting room will have a U-shaped conference table large enough for the entire steering committee. To facilitate accurate consensus and voting representation, conference table seating will be reserved for voting steering committee members and planning team members. In situations where a bureau or organization has both a primary member and a designated alternate present, only the primary member will be seated at the conference table. Additional seating for non-voting stakeholders and members of the public will be provided. The bottom of the U-shape (head of the table) will be reserved for the Co-Chairs and Planning Team members. Committee members are free to choose any other seat at the table that will meet their needs.

Comment/Question Queue

At the discretion of the Chair and Vice-Chair, a whiteboard may be used to keep a running list of names of committee members and members of the public who wish to provide comments or questions. The Vice-Chair is responsible for managing the queue and ensuring committee members are called upon for comment. Members of the public may be added to the list at the Vice-Chair's discretion. Normal conversation is preferred, and this method will be employed only when deemed necessary by the Chair and/or Vice-Chair.

Voting Cards

Each steering committee member will be provided with a set of three colored cards to be used in committee discussions or voting activities. Committee members will use these colored cards to indicate their needs or voting preferences during discussion.

- **Red** indicates a "no" answer during a vote. During discussion, a red card indicates that a committee member wishes to express a dissenting opinion or is uncomfortable with the present discussion. Red cards will be addressed in the order they are received.
- **Yellow** indicates an "undecided" or "abstaining" vote. During discussion, a yellow card indicates that a committee member requires clarification before the conversation can continue. For example, a member might use a yellow card to request a definition when an acronym is used. Yellow cards will be addressed immediately, and should be used judiciously.
- **Green** indicates a "yes" answer during a vote. During discussion, a green card indicates that a member has a supporting comment or question. Green cards will be addressed in the order they are received.

A set of cards will be provided for each committee member at every meeting. Each card will have its color name printed in text, and will include the above definition for its purpose. Cards will be collected from committee members after each meeting.

Handouts

All handouts will be printed and provided for committee members at each meeting.

Committee Membership

The Planning Team will maintain a roster for the steering committee. Committee members are free to designate alternates at their discretion. New voting members will be added at the committee's discretion. If a stakeholder or member of the public wishes to join the committee as a new voting member, she or he will be presented to the committee for confirmation.

The Mitigation Action Plan

Appendix C. Public Engagement Materials

PUBLIC ENGAGEMENT STRATEGY

The Mitigation Action Plan

Community Engagement Plan

CONTENTS

Attachments

EXECUTIVE SUMMARY

This community engagement plan outlines the Community Engagement Strategy for the City of Portland's 2016 Mitigation Action Plan (MAP) development process. The City has invested significant resources in facilitating public participation to ensure that the MAP reflects the relevant needs of the community. This document proposes a number of activities to be undertaken over the next few months as part of the MAP development process. A number of recommendations are also made to ensure continued community engagement following the adoption of the MAP. These recommendations include creation of an E-portal and an online risk atlas, multi-lingual support for planning documents and surveys, hazard mitigation exhibits, increased coordination with other bureaus and civic organizations, and the hazard mitigation ambassador program.

1. Introduction

This community engagement plan provides a framework for public participation in the 2016 Mitigation Action Plan (MAP) development process. The City of Portland believes in the importance of public participation, and has invested significant resources to ensure that this process benefits from a wide range of perspectives from all stakeholders.

BOX–1: COMMUNITY ENGAGEMENT STRATEGY GOALS

1. Reach out to all stakeholders, specifically those that live in higher risk areas.
2. Create authentic opportunities for stakeholders to influence the planning process
3. Make use of existing community outreach capacities and networks.
4. Partner with local organizations
5. Promote activities that meet the Disaster Mitigation Act (DMA) and Community Rating System (CRS) outreach requirements;
6. Propose activities that can be included in the MAP

2. Public Involvement Principles

The City of Portland has a history of promoting community engagement and participation in all areas of local policy making. It is one of the handful of cities in the United States that have intentionally adopted a programs to consult and partner with communities in all aspects of local policy making. The Office of Equity and Human Rights was established within the City Government "to promote equity and reduce disparities based on race and disability within City Government." Also, a number of other departments and agencies have developed numerous programs to promote stakeholder engagement.

BOX–2: NEED FOR PUBLIC PARTICIPATION

Effective public involvement in local planning and policy development:

1. Results in City decisions that effectively respond to the needs and priorities of the community.
2. Makes community members and community resources as part of the solution.
3. Involves the whole community – especially those that have not participated in the past.
4. Spreads knowledge of and support for public policies and programs.
5. Keeps government accountable.

All city departments and local agencies in Portland strive to incorporate the Portland City Council's 2010 Public Involvement Principals in their policy making efforts.

3. Stakeholder Involvement in Hazard Mitigation Planning Process

> **BOX–3: KEY TERMS**
>
> **Community**, refers to all residents of the City of Portland or those who work and play here.
>
> **Stakeholders**, refer to people, groups, or businesses with an interest in findings and projects in the MAP. Stakeholders include residents; community groups; business owners; local, state and federal agencies; elected officials; visitors; neighboring communities; and others.
>
> **Engagement**, is any two-way communication between the local government and stakeholders.

The Planning team listed and prioritized key stakeholders at the beginning of the planning process. The Portland Bureau of Emergency Management reached out to each of these stakeholders through emails and phone calls with invitation to participate as a steering committee member.

The Steering Committee guides the planning process for the MAP and promotes equity in building Portland's resilience to natural hazards. Members of the Steering Committee represent a cross-section of views and interests across Portland. By including diverse interests, the Steering Committee hopes to strengthen the planning effort and to build support for hazard mitigation activities across stakeholder groups. The Steering Committee provides guidance and leadership, oversees the planning process, and is the point of contact for local governments, neighborhoods, and community groups interested in the plan update. The Steering Committee members work with the planning team and other city officials to ensure that all Portlanders have equal access to projects that reduce their risk from natural hazards.

The Portland Bureau of Emergency Management coordinated two equity training sessions for the members of the Steering Committee and other stakeholders during the beginning of the plan update process. These sessions introduced attendees to key issues of equity in local policy making, especially in hazard mitigation planning.

4. CHALLENGES TO EFFECTIVE STAKEHOLDER INVOLVEMENT

To identify challenges to community engagement in the MAP process, the planning team conducted in person and phone interviews with 41 stakeholders. Ten members of Portland Neighborhood Associations were interviewed, 22 people representing community groups, and random visitors to local cafes in the city. Information about interviewees is kept private. It is not shared with city staff or in this report. The planning team conducted semi-structured interviews with a few questions, which allowed for free flow of conversation. Comments were recorded and grouped to show patterns. These interviews happened before the December 2015 floods in Portland. The floods may have changed some responses.

BOX–4: INTERVIEW QUESTIONS

1. How involved is the organization in the hazard mitigation planning process?
2. What do they think a Hazard Mitigation Plan is?
3. What groups do they think should be involved and why?
4. What constituency/ groups can they speak about or know about?
5. Do they think these groups are aware of the hazard risks they face?
6. What are the major concerns of these groups?
7. How do they think, we can involve these groups?
8. What are existing social network mechanisms are they aware of?
9. What role can their organization, or groups they know of, play?
10. Are you involved in any other community outreach program of the city? If so, which ones?

Interview responses were recorded and analyzed for patterns. The results are summarized below:

- Some communities of color and immigrant groups distrust the government.
- Respondents expressed the need to have multilingual notifications and other public outreach material. Interviewees want notifications and outreach materials in multiple languages. Many community members do not understand English very well and do not receive notifications in time. This results in more confusion and distrust.
- Most interviewees from community groups said they were burnt out on participation in city programs. Over the past few years, time commitment to local government public outreach programs has increased significantly for community groups. Each of the respondents said they participated in at least two ongoing outreach programs or committees.
- Members of the neighborhood associations wanted to participate in the MAP process, but were unsure how much influence they could have. They felt the process of hazard mitigation planning required technical expertise beyond their skills. They worried that getting involved in this process would take away time from other initiatives that they had already committed to.
- Most respondents from café interviews said they appreciated that the city started community engagement programs to promote public participation.
- Most respondents felt that there were other important issues that needed to be addressed, and hazard mitigation was low in their order of priority.
- Most respondents see earthquakes as the greatest risk, and said they do not feel prepared. They would like the City to provide more information and resources to help residents prepare for an earthquake.

5. RECOMMENDATIONS

Community engagement and outreach strategies in this section are designed to achieve the following three objectives:

1. Encourage public participation during the MAP development process (Section 5.1).
2. Facilitate continued engagement with local residents after adoption of the MAP (Section 5.2).
3. Promote effective cooperation and coordination between the local government and civil society organizations to promote an integrated framework for community engagement (Section 5.3).

5.1 COMMUNITY ENGAGEMENT AND OUTREACH ACTIVITIES

Community Engagement and Outreach Activity – 1: Stakeholder Participation Review	
Suggested Timeframe:	February 2016
Format:	Self-Evaluation by the Planning Team
Duration:	2 hrs.
Rationale:	After a few months of involvement in the same way (steering committee in this case), the stakeholder interest can start to wane. Attendance at the meetings decreases, and discussions tend to divert without contributing to the MAP development process. By doing a mid-course self-check, the planning team may re-activate participation, and if needed, reach out to more stakeholders who have yet not been involved.
Description of the Activity:	Planning team reassess participation in the steering committee and identify any stakeholders that may have dropped out or not yet participated in the update process.
Outcomes:	This activity will reveal the gaps in stakeholder representation that may cause problems or delay in formal adoption of the plan.
Follow-up Activities:	The project coordinator to reach out to the unrepresented stakeholders and encourage them to participate in the steering committee meetings.
Measures of Performance:	Number of unrepresented stakeholders contacted.

Community Engagement and Outreach Activity – 2: Community Hazard Mitigation Survey	
Suggested Timeframe:	February- April 2016
Format:	Mailed, Online, and Targeted
Duration:	3 months
Rationale:	The planning team should create opportunities for general public to be involved in the planning process. While many members of the public may not be technical experts, they can be a useful resource in identifying critical assets, problem areas, describe past events and provide ideas for continued community engagement. A Natural Hazard Mitigation Survey can help share information about the plan update and assess public awareness of risks.
Description of the Activity:	A Public Hazard Mitigation Survey should be conducted by the planning team. The survey should seek to collect information on how informed the public is about local hazard risks, their perception of their own risks, and how important they think hazard mitigation is. This survey should be multilingual and widely distributed in the community. Suggestions for survey distribution include: • Permanent online link to be displayed on local government website, and partner community organization web pages. • Paper surveys and collection boxes at neighborhood coalition office, and important local government offices. • Distribution of survey at local community events. • Survey kiosks at local popular grocery stores, and cafes.
Outcomes:	This activity will increase transparency of the planning process, build trust, and provide information about public preferences and attitudes towards hazard mitigation.
Follow-up Activities:	The collected data should be formatted and organized in an easily usable format (spreadsheets). Planning team should analyze data to find level of public awareness about local hazards, suggestions for public engagement, perceived risk from natural hazards, and their experiences with hazards. This dataset should be maintained by the local government to be a baseline for later surveys.
Measures of Performance:	Number of surveys conducted.

Community Engagement and Outreach Activity – 3: Planning for Real – Risk Assessment & Policy Development Focus Groups	
Suggested Timeframe:	Mar-April 2016
Format:	Focus Groups (10, in 8 neighborhood coalitions, and 2 special interest groups)
Duration:	3-4 hrs. for each event depending on participation and venue availability (Open House)
Rationale:	The planning team should risk assessment findings and encourage the community to help develop hazard mitigation policies that match community priorities.
Description of the Activity:	Planning for real is a hands-on focus group method that allows for participation by all attendees. Large format maps depicting risk areas are mounted on a horizontal table. The map station shows participants the extent and degree of hazard risks the community faces. The planning team introduces the risk assessment, and provides a brief overview of possible hazard mitigation activities (often based on FEMA and CRS guidance documents). Participants are then asked to place suggestions for the community on cards or flags placed on the map. Each exercise can have 5- 15 people per map station. Hazard risk computer workstations manned by local technical experts can be used instead of maps. The planning team should partner with the Portland's neighborhood coalitions to implement these exercises. Partnering with the neighborhood coalitions will add legitimacy to the process, build trust, and strengthen existing networks between the local government and the community. The Planning team should also partner with local community organizations to do similar workshops with two special interest groups – immigrant and refugee community or coalition of communities of color. The planning team may explore options for partnering with IRCO (Immigrant and Refugee Community Organization) and Communities of Color for implementation of these exercises.
Outcomes:	This activity will help communicate hazards risks to the community and increase public awareness of risk. It will also help collect information on community preferences for specific hazard mitigation actions to be included in the MAP.
Follow-up Activities:	The planning team should use the information collected from these workshops for updating risk analysis and generating hazard mitigation priorities.
Measures of Performance:	Number of attendees in each 'Planning for Real' activity.

Community Engagement and Outreach Activity – 4: Draft MAP Review & Feedback	
Suggested Timeframe:	Jul 2016
Format:	Online Public Brochures (distributed through local government agencies, partner organizations, and neighborhood associations) Hazard Mitigation Displays (at City Hall, and Neighborhood Coalition Centers) MAP Town Hall Meetings (5 Town Hall Meetings)
Duration:	30 days (based on FEMA guidelines)
Rationale:	The preceding engagement and outreach activities will significantly contribute to plan development, there should also be a way for the public to give feedback on the whole draft plan document. This will help identify omissions or inappropriate policies that may place disproportionate burden on specific community groups or neighborhoods.
Description of the Activity:	The planning team should collect feedback from communities on the draft plan. These four types of activities should be conducted during the 30-day comment period. • Online: The City should post the full draft report, an executive summary, and a slide deck of key points online for reviewing and download. There should be a place on the website for comments. • Public Brochures: These should include a summary of outcomes of local risk assessments, summary of public engagement activities, and key hazard mitigation polices in the plan. The brochure should also refers to the webpage where the plan documents are available, and give a location where people can submit and comment on the draft plan. These could be distributed through government agencies, neighborhood associations, and local community organizations. • Hazard Mitigation Displays: The planning team should create Hazard Mitigation displays at key places in the community. The displays could be placed at the City Hall and at the neighborhood coalition offices. The displays could be in form of free standing 3D displays showing hazard risks through photos and text. They should show the benefits of the proposed hazard mitigation policies. • MAP Town Hall Meetings: It is proposed that the City officials and the planning team should partner with Neighborhood coalitions and community organizations to host hazard mitigation town hall meetings where local residents can ask questions about the MAP. This forum gives residents a chance for direct responses to their questions. Venues should match "Planning for Real" sites if possible. There should be 5 town hall meetings
Outcomes:	This activity will help collect feedback on the draft MAP and give residents a chance to influence the final plan.
Follow-up Activities:	The planning team should collect the feedback and respond to the comments as quickly as possible.
Measures of Performance:	Number of activities completed. Number of attendees. Quality of feedback received.

Community Engagement and Outreach Activity – 5: Draft MAP Review & Feedback	
Suggested Timeframe:	Post Adoption Plan Rollout. Annual Review thereafter.
Format:	Online (continuous) Hazard Mitigation Annual Review Town Hall Meeting (in partnership with Neighborhood Coalitions, and communities)
Duration:	60-90 mins each.
Rationale:	Community engagement and outreach activities should continue after the plan is adopted to keep the public informed about hazards risks, continue to build support for implementation of mitigation projects, and prepare for the next plan update. These activities will also help build on the good will and public interest created the planning phase.
Description of the Activity:	These activities should be continued after the plan adoptions. • Online: Maintain a permanent webpage that hosts the digital copy of the MAP and document future planning activities. The webpage should also provide contact information for local agencies and departments involved in implementation of hazard mitigation activities. • Hazard Mitigation Annual Review Town Hall Meeting: City staff should partner with local neighborhood coalitions and civic organizations to host annual plan review town hall meetings. Rollout event should be planned within a month of formal plan adoption. At least one annual event should be planned in the following years. In these meeting the planning team should discuss the following: o Update historical events record with any events in the past year. o Review community profile and individual community assessments for each hazard and note any major changes or mitigation projects that have changed vulnerability. o Note accomplishments and current mitigation projects. o Record status of all action items in the MAP as projects are completed and as new needs or issues are identified. o Address updated Comprehensive Plans and other city plans - how can the two plans be coordinated to make them work for each other? o Incorporate additional hazard risk assessments as funding allows.
Outcomes:	This activity improves transparency in the MAP implementation process. It will also help maintain interest for engagement and outreach in the next update.
Follow-up Activities:	The planning team should prepare annual progress reports and make them available on the permanent website.
Measures of Performance:	Number of activities completed. Number of attendees.

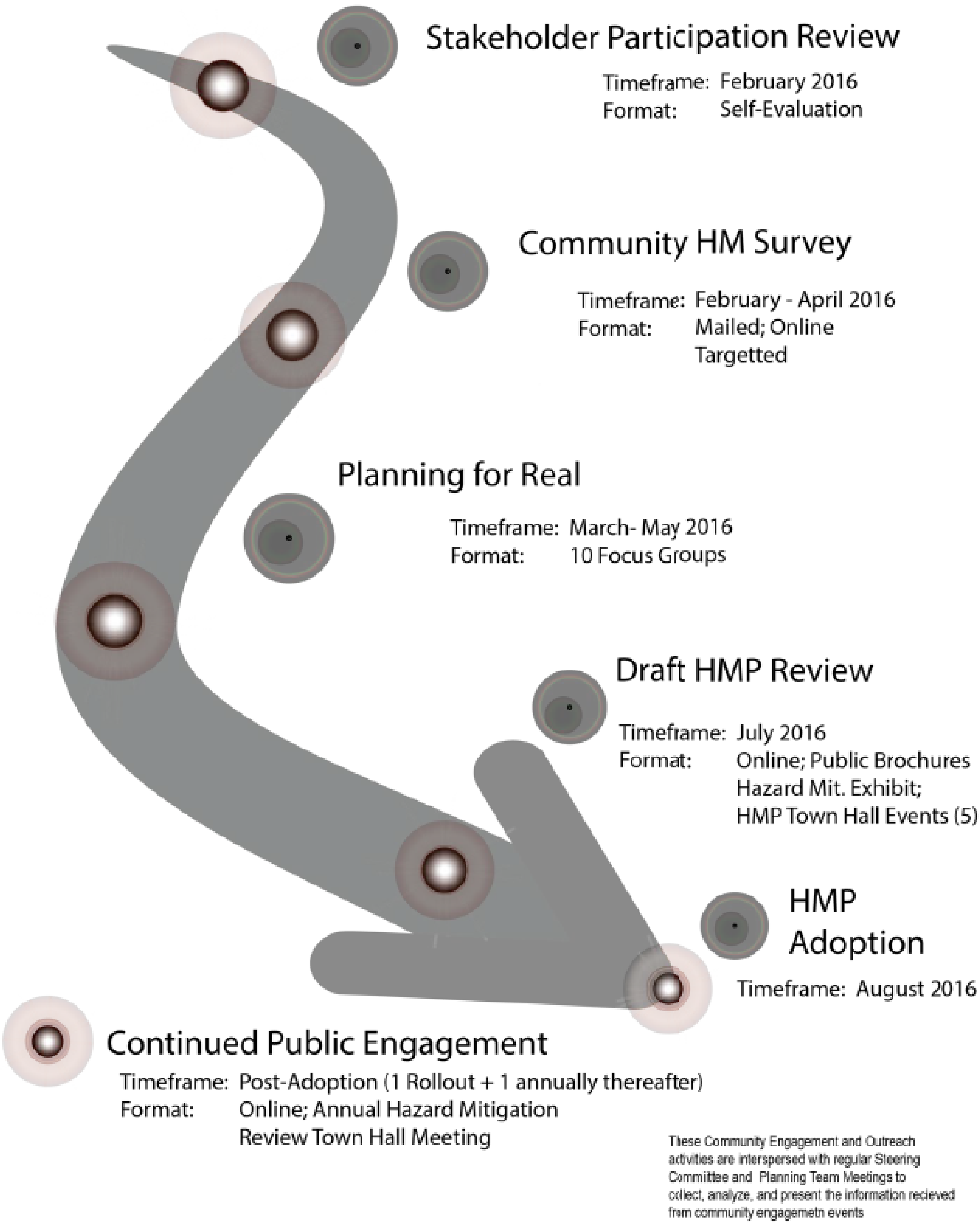

Figure 1. Community Engagement and Outreach Strategy

5.2 COORDINATED AND COOPERATIVE ENGAGEMENT

The city of Portland has an established history of effective community engagement and stakeholder participation in local policy making through its bureaus, and offices. Each of these administrative units continually undertakes programs and outreach activities. At the same time, Portland is home to a large number of civic organizations that have taken on the leadership role in advancing interests of their stakeholders in local policy making. A list of these stakeholders as identified through stakeholder mapping exercise is included in Attachment 1.

The MAP development process can take advantage of these partnerships by directly engaging with these stakeholder networks in the plan making process. Specifically, it is recommended that existing groups and networks be engaged to solicit their views on the following:

- Identification of specific vulnerable groups within the community.
- Assessment of risk awareness among the various communities.
- Identification of preferred means of capacity building and outreach to enhance risk awareness and participation in the planning process.
- Identification and prioritization of hazard mitigation activities to be included in the MAP.
- Identification and training of Hazard Mitigation Ambassadors

In order to leverage existing community linkages and partnerships during the MAP development process, a brief survey of local bureaus and community organizations was conducted to identify ongoing programs and initiatives. The original survey responses are included in Attachment 1. Table 1 summarizes the various programs/activities/evens identified by respondents as possible avenues for outreach as well as continued engagement following the adoption of the MAP.

Table 1. Opportunities for Community Engagement and Outreach

#	Program/ Activity/ Event	Contact Person	Email
1	Small Business Sustainability Workshop for Local Entrepreneurs	City of Portland	danielle.butsick@portlandoregon.gov
2	Residential Education and Engagement Master Recycler Program Community Collection Events	Lauren Norris	lauren.norris@portlandoregon.gov
3	Sustainability at Work	Megan Shuler	megan.shuler@portlandoregon.gov
4	Recycling and Composting Program Multifamily Waste Reduction Program	Jill Kolek	jill.kolek@portlandoregon.gov
5	Green Team	Greg Supriano	greg.supriano@portlandoregon.gov
6	BPS Community Involvement for Comp Plan	Sara Wright	sara.wright@portlandoregon.gov
7	BPS District Liaisons, Central City, and River Plan	Deborah Stein - Manager	deborah.stein@portlandoregon.gov
8	PF&R (Portland Fire & Rescue) All-Hazards Large Incident and Disaster Response Plan	Don Russ - PF&R	don.russ@portlandoregon.gov
9	East Portland Action Plan	Lore Wintergreen	lore.wintergreen@portlandoregon.gov
10	NAMCO, National Association of Minority Contractors	Nate McCoy	nate@namc-oregon.org
11	Urban League of Portland	Nkenge Johnson	NHJ@ulpdx.org
12	SEI (Self Enhancement Inc.)	Tony Hopson	tonyh@selfenhancement.org
13	NAYA (Native American Youth and Family Center)	Loretta Kelly	lorettak@nayapdx.org
14	Wisdom of the Elders	Rose High Bear	raven@wisdomoftheelders.org
15	APANO (Asian Pacific Network of Oregon)	Joseph Santos-Lyons	joseph@apano.org
16	CCC Community and Economic Development Committee (including climate and environmental justice)	Maggie Tallmadge	maggie@coalitioncommunitiescolor.org
17	Climate Justice Collaborative	Cary Watters	cary@coalitioncommunitiescolor.org
18	PAALF (Portland African American Leadership Forum) Environmental Justice Workgroup	Solamon Ibe	s.ibe@hotmail.com
19	Sunday Parkways Summer events on the Columbia Slough Multnomah Days at Multnomah Village Portland Farmer's Market	Megan Callahan	Megan.Callahan@portlandoregon.gov

5.3 BROADER COMMUNITY ENGAGEMENT AND OUTREACH

Community engagement is a continuous process, and requires multiple means of facilitating two-way communication with the citizens. This section highlights a number of important ways to facilitate meaningful community engagements.

5.3.1 E-engagement: Online Risk Atlas & E-Portal

It is recommended that an online spatial risk atlas be hosted on the hazard mitigation website. The atlas will contain socio-economic data along with risk overlays to inform public about the likely hazard risks they face in their neighborhoods. Additional resources for specific mitigation actions, and opportunities for participation in the planning process can also be made available through this website. The interactive web based platform should also an interactive annotation tool for users to post flags, highlight and comment on specific locations on the map. This mapping interface can be developed in partnership with existing low cost mapping initiative underway in the other departments/bureaus at the city. A screenshot of a similar application developed by Institute for Hazard Mitigation and Planning at University of Washington in partnership with Texas A &M University, Galveston is shown in Figure 2.

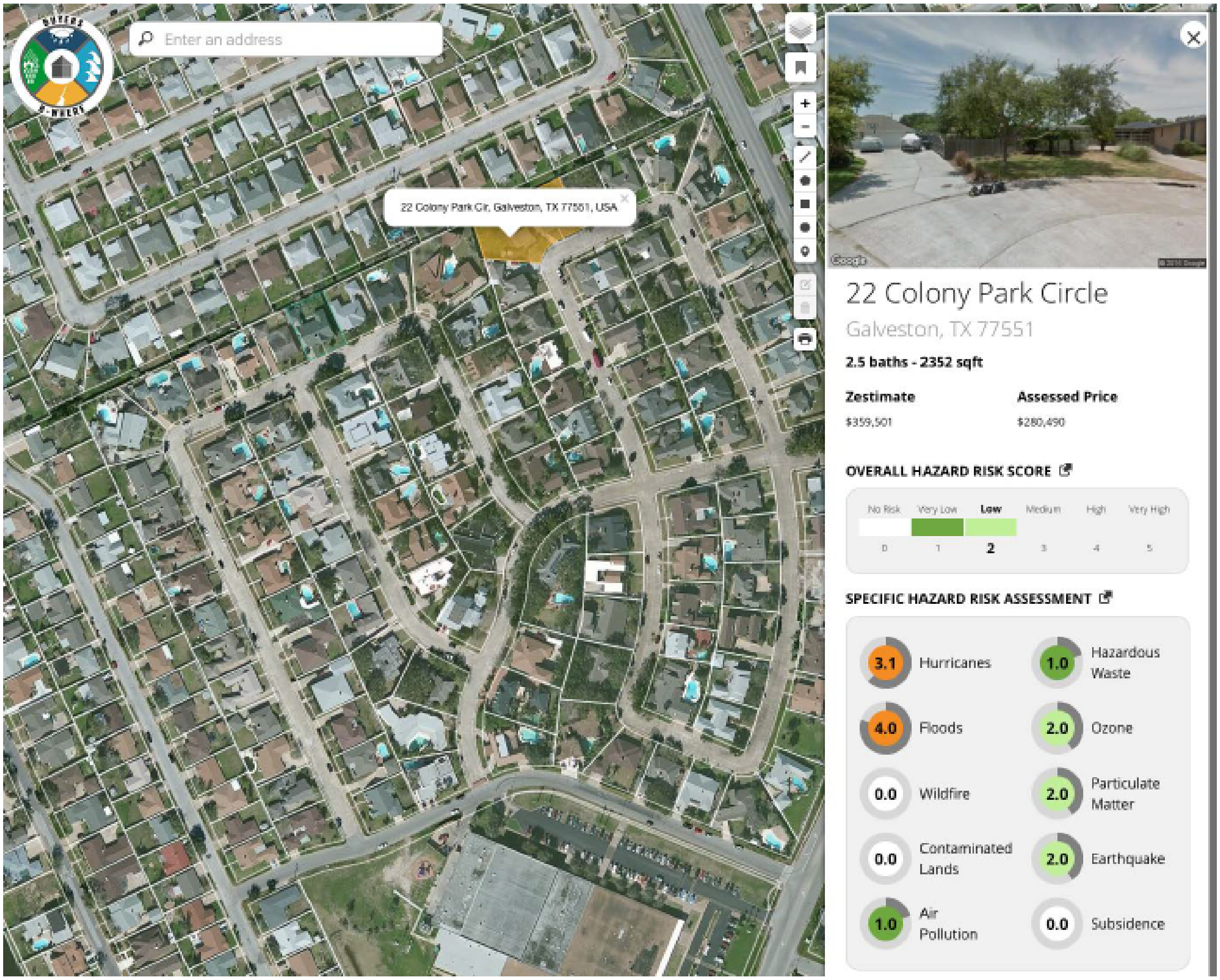

Figure 2. Screenshot of Sample Online Mapping Interface

Presently, the city does have a number of online mapping platforms to share spatial and census data. These include:

- MetroMap (https://gis.oregonmetro.gov/ metromap/)
- Racial equity atlas (http://regionalequityatlas.org/ programs/regional-equity-atlas/equity-atlas-20-mapping-tool)
- Portland Maps (https://www.portlandmaps.com).

While each of these online interface does provide significant data, the ability for users to download and analyze spatial datasets is very limited. Further, none of the online mapping platform accessed at the time of the writing of this report provided hazard risk information at the neighborhood level or linked to possible hazard mitigation information. It is therefore recommended that additional hazard mitigation related information and data be made available either through existing or a new online mapping interface.

The E-portal that will host the online risk atlas can also be designed to include hazard mitigation, and other hazard risk awareness resources for the local stakeholders. Presently, there are a number of hazard mitigation, risk awareness, and disaster preparation documents available online from the city website as well as federal website such as ready.gov. Given the diversity of stakeholders (and associated languages) in Portland, it is recommended that the city actively consider making these resources available online in multi-lingual format.

In addition to the online atlas there a number of other opportunities for engaging with the community using online platforms. The following updates are recommended to the existing Portland Bureau of Emergency Management hazard mitigation homepage:

- To provide updated information about all meetings and events proposed to be conducted as part of the planning process.
- Online questionnaires and surveys can be posted on this website to allow users to access and responds.
- Live Chat Events can be scheduled on this website to allow stakeholders who are unable to participate in steering committee meeting to interact with the planning team to provide feedback and comments.
- A feedback and comments tool can be created specifically to allow people to respond to the issues and concerns specifically for hazard mitigation planning.
- Facebook, twitter and other social media outlets can be utilized to connect with people and stakeholders.

5.3.2 Multilingual Support for Planning Documents and Surveys

A number of participants in the surveys conducted during the preparation of this engaging strategy indicated that a significant number of the residents did not understand English that well. It is therefore recommended that the planning team partner with local civic organizations that represent these minority groups and seek their assistance in conversion of planning documents and surveys into other formats. This will enable a boarder range of stakeholders to access, understand and participate in the planning process. Past experiences reveal that multi-language support is critical in diverse communities that are undergoing significant demographic changes. Lack of access to understandable documents and other outreach material is likely to further alienate communities that have traditionally been excluded from earlier public consultation process.

5.3.3 Hazard Mitigation Exhibits

Exhibits and displays are an effective way of making relevant information accessible to the public at a relatively lower cost. These locations can also serve as the nodes for further distribution of documents, surveys and materials. Over time stakeholders start to visit these locations regularly to seek out specific information regarding new projects and outreach activities. It is therefore strongly recommended that the planning team and the city consider installation of such displays at prominent locations such as the city hall and the neighborhood coalition offices. These displays can be used to provide regular updates on the hazard mitigation planning process, planned activities, and can also serve as nodes for conducting smaller public meetings events as needed. These displays will be particularly useful for public review of the draft plan, and continued engagement following the plan adoption.

5.3.4 Increased participation of Other Bureaus and Offices in Stakeholder Meetings

As highlighted earlier it is often not possible for the stakeholders to distinguish between hazard mitigation priorities and general development concerns. Stakeholders often tend to bring up a variety of concerns (often not necessarily connected to hazard mitigation planning) during steering committee meetings and the other events. It is possible that if these concerns are ignored citing lack of direct connection with hazard mitigation planning, it is likely to result in increased community distrust. It is therefore recommended that representatives from other bureaus, specifically Development services, Environmental services, Office of Equity and Human rights, Planning and Sustainability, and Housing Bureau be invited to these meetings and be allowed to respond to concerns related to their department. At a minimum, a procedure for recording all concerns be established, and forwarded to relevant bureaus for response. These responses could then be shared through email or directly with the stakeholders.

5.3.5 Hazard Mitigation Ambassador Program

The city of Portland is home to a large number of diverse stakeholder civil society organizations that are actively involved and embedded within their respective communities. These existing networks provide an effective means for the continued engagement with the local stakeholders not only during the MAP development process but also after the adoption of the plan. It is therefore recommended that the city consider establishment of a Hazard Mitigation Ambassador program. The primary goal of this program will be to identify and train individuals from diverse community groups about risk awareness, and minimization through effective mitigation actions. These individuals can also be trained to assist community members in preparation of household level emergency response plans, and other disaster mitigation activities, as well as resources to help community members become prepared for other hazard threats. These hazard mitigation ambassadors would serve as the vital link between the city and the community in case of any hazard event, and assist citizens in undertaking appropriate response actions as advocated by the city. Overtime it is expected that the role of these community ambassadors can be diversified to include organization and coordination of other community outreach activities in their community.

Community Engagement Plan

Attachment 1. Copy of Survey Responses

Survey of City Bureaus and Offices

Dear Respondent,

As you may know, Portland Bureau of Emergency Management is in the process of updating the city's Natural Hazard Mitigation Plan (NHMP). The plan outlines a strategy for reducing Portland's risk from natural hazards. Having a FEMA-approved plan also makes the City of Portland eligible for federal grants that can help strengthen city assets and improve community resilience before and after a disaster. Information about the project can be found at the project website here:

https://www.portlandoregon.gov/pbem/naturalhazard

We are asking for information about programs and outreach activities at your bureau or office to find opportunities for resource sharing and collaborative community engagement. We think it's important to team up whenever possible, and we want to find ways we can support each other in our outreach efforts. By working together, we think we can reach more people in more meaningful ways.

Feel free to share this with your colleagues who may also be able to provide relevant information.

Question 1: Which city bureau or office are you associated with?

BPS- Sustainability Education and Assistance

Question 2: Prior to receiving this survey, had you heard about the Natural Hazard Mitigation Plan (NHMP) update process?

○ Yes ◉ No

Question 3: Would you like to receive more information about the NHMP plan update?

○ Yes ◉ No

Please provide your contact information:

Preferred Email:

Telephone:

Question 4: Please list any community outreach and engagement programs at your bureau or office that we might be able to work together on. If known, please provide the contact information of the key person to contact for each of these programs.

#	Name of the program/activity/event	Contact Person	Email	Tel.
1	Example: Small Business Sustainability Workshop for local entrepreneurs to share sustainable practices May 15, 2016	Danielle Butsick, City of Portland	danielle.butsick@portlandoregon.gov	503-823-3926
2	Residential Education and Engagement: • Outreach for the curbside collection system to encourage composting, recycling and proper disposal of hazardous material	Lauren Norris	lauren.norris@portlandoregon.gov	
3	Sustainability at Work: * Assist 1,000 businesses annually to improve sustainability practices; certify 50 businesses annually through Sustainability at Work certification	Megan Shuler	megan.shuler@portlandoregon.gov	
4	Event Recycling and Composting Program Assist and provide equipment to 30 large and 100+ small- to medium-sized events to increase waste diversion at	Jill Kolek	jill.kolek@portlandoregon.gov	
5	Master Recycler Program: * Train 90 community volunteers on waste reduction and prevention, communications and behavior change * Manage 1,400 Master Recycler	Lauren Norris	lauren.norris@portlandoregon.gov	
6	Community Collection Events Partner with Neighborhood Coalitions, Metro and community organizations to host 45+ collection events annually.	Lauren Norris	lauren.norris@portlandoregon.gov	
7	Multifamily Waste Reduction Program: *Provides assistance to 50,000 MF units and 175 property managers, owners and companies annually. * Develops infrastructure policies that	Jill Kolek	jill.kolek@portlandoregon.gov	
8				
9				

Survey of City Bureaus and Offices

Dear Respondent,

As you may know, Portland Bureau of Emergency Management is in the process of updating the city's Natural Hazard Mitigation Plan (NHMP). The plan outlines a strategy for reducing Portland's risk from natural hazards. Having a FEMA-approved plan also makes the City of Portland eligible for federal grants that can help strengthen city assets and improve community resilience before and after a disaster. Information about the project can be found at the project website here:

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We are asking for information about programs and outreach activities at your bureau or office to find opportunities for resource sharing and collaborative community engagement. We think it's important to team up whenever possible, and we want to find ways we can support each other in our outreach efforts. By working together, we think we can reach more people in more meaningful ways.

Feel free to share this with your colleagues who may also be able to provide relevant information.

Question 1: Which city bureau or office are you associated with?

Portland Housing Bureau

Question 2: Prior to receiving this survey, had you heard about the Natural Hazard Mitigation Plan (NHMP) update process?

◉ Yes ○ No

Question 3: Would you like to receive more information about the NHMP plan update?

◉ Yes ○ No

Please provide your contact information:

Preferred Email: michelle.depass@portlandoregon.gov

Telephone: 503 823-6291 or (503) 823-3606

Question 4: Please list any community outreach and engagement programs at your bureau or office that we might be able to work together on. If known, please provide the contact information of the key person to contact for each of these programs.

#	Name of the program/activity/event	Contact Person	Email	Tel.
1	Example: Small Business Sustainability Workshop for local entrepreneurs to share sustainable practices May 15, 2016	Danielle Butsick, City of Portland	danielle.butsick@portlandoregon.gov	503-823-3926
2	East Portland Action Plan	lore wintergreen	lore.wintergreen@portlandoregon.gov	503 823-4035
3	NAMCO, National Association of Minority Contractors	Nate McCoy	nate@namc-oregon.org	
4	Urban League of Portland	Nkenge Johnson, President and CEO	Nkenge Harmon Johnson <NHJ@ulpdx.org>	503 280-2600
5	SEI, Self Enhancement Inc.	Tony Hopson, President	tonyh@selfenhancement.org	503 249-1721
6	Self Enhancement Inc. Housing Programs	Libra Forde	libraf@selfenhancement.org	503 972-3687 office, or 808 372-9240 cell
7	NAYA Native American Youth and Family Center	Loretta Kelly	lorettak@nayapdx.org	503 288-8177
8	Wisdom of the Elders	Rose High Bear	raven@wisdomoftheelders.org	503 775-4014
9	APANO Asian Pacific Network of Oregon	Joseph Santos-Lyons Exec. Dir. or Duncan Hwang Associate Director	joseph@apano.org or duncan@apano.org	971 340-4861

Survey of City Bureaus and Offices

Dear Respondent,

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https://www.portlandoregon.gov/pbem/naturalhazard

We are asking for information about programs and outreach activities at your bureau or office to find opportunities for resource sharing and collaborative community engagement. We think it's important to team up whenever possible, and we want to find ways we can support each other in our outreach efforts. By working together, we think we can reach more people in more meaningful ways.

Feel free to share this with your colleagues who may also be able to provide relevant information.

Question 1: Which city bureau or office are you associated with?

BDS

Question 2: Prior to receiving this survey, had you heard about the Natural Hazard Mitigation Plan (NHMP) update process?

(•) Yes ( ) No

Question 3: Would you like to receive more information about the NHMP plan update?

( ) Yes (•) No

Please provide your contact information:

Preferred Email:

Telephone:

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#	Name of the program/activity/event	Contact Person	Email	Tel.
1	Example: Small Business Sustainability Workshop for local entrepreneurs to share sustainable practices May 15, 2016	Danielle Butsick, City of Portland	danielle.butsick@portlandoregon.gov	503-823-3926
2	Green Team	Greg Supriano	greg.supriano@portlandoregon.gov	503-823-7351
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Survey of City Bureaus and Offices

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Question 1: Which city bureau or office are you associated with?

Question 2: Prior to receiving this survey, had you heard about the Natural Hazard Mitigation Plan (NHMP) update process?

(•) Yes ( ) No

Question 3: Would you like to receive more information about the NHMP plan update?

(•) Yes ( ) No

Please provide your contact information:

Preferred Email: leslie.lum@portlandoregon.gov

Telephone: 503-823-7896

Question 4: Please list any community outreach and engagement programs at your bureau or office that we might be able to work together on. If known, please provide the contact information of the key person to contact for each of these programs.

#	Name of the program/activity/event	Contact Person	Email	Tel.
1	Example: Small Business Sustainability Workshop for local entrepreneurs to share sustainable practices May 15, 2016	Danielle Butsick, City of Portland	danielle.butsick@portlandoregon.gov	503-823-3926
2	BPS Community Involvement for Comp Plan	Sara Wright	sara.wright@portlandoregon.gov	503-823-7728
3	BPS District Liaisons, Central City, and River Plan	Deborah Stein - Manager	deborah.stein@portlandoregon.gov	823-6991
4		Leslie Lum - North Portland	leslie.lum@portlandoregon.gov	503-823-7896
5		Nan Stark - Northeast Portland	nan.stark@portlandoregon.gov	503-823-3986
6		Marty Stockton - Southeast Portland	marty.stockton@portlandoregon.gov	503-823-2041
7		Joan Frederiksen - West Portland	joan.frederiksen@portlandoregon.gov	503-823-3111
8		Troy Doss - Central City	troy.doss@portlandoregon.gov	503-823-5857
9		Sallie Edmunds - River Team	sallie.edmunds@portlandoregon.gov	503-823-6950

Survey of City Bureaus and Offices

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Question 1: Which city bureau or office are you associated with?

Portland Fire & Rescue

Question 2: Prior to receiving this survey, had you heard about the Natural Hazard Mitigation Plan (NHMP) update process?

○ Yes ◉ No

Question 3: Would you like to receive more information about the NHMP plan update?

◉ Yes ○ No

Please provide your contact information:

Preferred Email: don.russ@portlandoregon.gov

Telephone: 503 816-5590

Question 4: Please list any community outreach and engagement programs at your bureau or office that we might be able to work together on. If known, please provide the contact information of the key person to contact for each of these programs.

#	Name of the program/activity/event	Contact Person	Email	Tel.
1	Example: Small Business Sustainability Workshop for local entrepreneurs to share sustainable practices May 15, 2016	Danielle Butsick, City of Portland	danielle.butsick@portlandoregon.gov	503-823-3926
2	PF&R All-Hazards Large Incident and Disaster Response Plan	Don Russ - PF&R	don.russ@portlandoregon.gov	503 816-5590
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Survey of Community Organizations

Dear Respondent,

As you may know, Portland Bureau of Emergency Management is in the process of updating the city's Natural Hazard Mitigation Plan (NHMP). The plan outlines a strategy for reducing Portland's risk from natural hazards. Having a FEMA-approved plan also makes the City of Portland eligible for federal grants that can help strengthen city assets and improve community resilience before and after a disaster. Information about the project can be found at the project website here:

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We are asking for information about programs and outreach activities at your organization to find opportunities for resource sharing and collaborative community engagement. We think it's important to team up whenever possible, and we want to find ways we can support each other in our outreach efforts. By working together, we think we can reach more people in more meaningful ways.

Feel free to share this with your colleagues who may also be able to provide relevant information.

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Question 1: Which organization/s are you associated with?

Coalition of Communities of Color

Question 2: Prior to receiving this survey, had you heard about the Natural Hazard Mitigation Plan (NHMP) update process?

(•) Yes ( ) No

Question 3: Would you like to receive more information about the NHMP plan update?

( ) Yes ( ) No

Please provide your contact information:

Preferred Email: Maggie@coalitioncommunitiescolor.org

Telephone: 781-697-0021

Question 4: Please list any community outreach and engagement programs at your organization that we might be able to work together on. If known, please provide the contact information of the key person to contact for each of these programs. (Add rows as required.)

#	Name of the program/activity/event	Contact Person	Email	Tel.
1	Example: Youth Environmental Justice Program, ongoing monthly meetings every third Wednesday	Danielle Butsick	danielle.butsick@portlandoregon.gov	503-823-3926
2	CCC Community and Economic Development Committee (including climate and EJ) - First Thursday of each month	Maggie Tallmadge	maggie@coalitioncommunitiescolor.org	781-697-0021
3	Climate Justice Collaborative meeting with policy leads - First Thursday of each month	Cary Watters	cary@coalitioncommunitiescolor.org	
4	PAALF EJ Workgroup - Third Friday of each month	Solamon Ibe	s.ibe@hotmail.com	
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Survey of Community Organizations

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We are asking for information about programs and outreach activities at your organization to find opportunities for resource sharing and collaborative community engagement. We think it's important to team up whenever possible, and we want to find ways we can support each other in our outreach efforts. By working together, we think we can reach more people in more meaningful ways.

Feel free to share this with your colleagues who may also be able to provide relevant information.

Question 1: Which organization/s are you associated with?

East Portland Neighborhood Office

Question 2: Prior to receiving this survey, had you heard about the Natural Hazard Mitigation Plan (NHMP) update process?

(●) Yes ( ) No

Question 3: Would you like to receive more information about the NHMP plan update?

(●) Yes ( ) No

Please provide your contact information:

Preferred Email: eliza.lindsay@portlandoregon.gov

Telephone: 971-340-6435

Question 4: Please list any community outreach and engagement programs at your organization that we might be able to work together on. If known, please provide the contact information of the key person to contact for each of these programs. (Add rows as required.)

#	Name of the program/activity/event	Contact Person	Email	Tel.
1	Example: Youth Environmental Justice Program, ongoing monthly meetings every third Wednesday	Danielle Butsick	danielle.butsick@portlandoregon.gov	503-823-3926
2	"Taste of Parkrose" event	Historic Parkrose		
3	Festival of Nations	Division Midway Alliance		
4	Rosewood Initiative Events	Rosewood Initiative		
5	The Slavic Festival in Ventura Park	Galina Nekrova		
6	82nd Ave. of the Roses Parade, end of April			
7	Cambodian Lao Thai Burmese New Years' Festival at Glenhaven Park, end of April			
8	National Night Out Community Fairs/Movie in the Park	Barb Klinger, The Rovers		
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Survey of City Bureaus and Offices

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https://www.portlandoregon.gov/pbem/naturalhazard

We are asking for information about programs and outreach activities at your bureau or office to find opportunities for resource sharing and collaborative community engagement. We think it's important to team up whenever possible, and we want to find ways we can support each other in our outreach efforts. By working together, we think we can reach more people in more meaningful ways.

Feel free to share this with your colleagues who may also be able to provide relevant information.

Question 1: Which city bureau or office are you associated with?

Bureau of Environmental Services (BES)

Question 2: Prior to receiving this survey, had you heard about the Natural Hazard Mitigation Plan (NHMP) update process?

(●) Yes ( ) No

Question 3: Would you like to receive more information about the NHMP plan update?

( ) Yes (●) No

Please provide your contact information:

Preferred Email:

Telephone:

Question 4: Please list any community outreach and engagement programs at your bureau or office that we might be able to work together on. If known, please provide the contact information of the key person to contact for each of these programs.

#	Name of the program/activity/event	Contact Person	Email	Tel.
1	Example: Small Business Sustainability Workshop for local entrepreneurs to share sustainable practices May 15, 2016	Danielle Butsick, City of Portland	danielle.butsick@portlandoregon.gov	503-823-3926
2	Sunday Parkways: East Portland (May 15) Southeast (Aug 21) Sellwood-Milwaukie (Oct 2)	Megan Callahan, Public Affairs Manager	Megan.Callahan@portlandoregon.gov	503-823-4759
3	Summer events on the Columbia Slough: Regatta (Aug 7) Explorando (June 11) Aquifer (Sept 17)	Megan Callahan, Public Affairs Manager	Megan.Callahan@portlandoregon.gov	503-823-4759
4	Multnomah Days at Multnomah Village (Aug 20)	Megan Callahan, Public Affairs Manager	Megan.Callahan@portlandoregon.gov	503-823-4759
5	Arbor Day at the Portland Farmer's Market (April 30)	Megan Callahan, Public Affairs Manager	Megan.Callahan@portlandoregon.gov	503-823-4759
6	"Life in the Floodplain", Oct. 8th at Zenger Farm	Kate Carone, BES	kate.carone@portlandoregon.gov	503-823-5569
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Community Engagement Plan

Attachment 2. Key Stakeholders & Networks

KEY STAKEHOLDERS & NETWORKS

Within the City of Portland, there are service (non-profit) organizations affiliated with different ethnic, racial, economic and other sub-populations that have historically lacked a voice in development and implementation of government policy and programs. Many of these organizations have experience conducting public engagement with their constituencies to develop and implement their own programs. There likely are opportunities for the PBEM to collaborate with and learn from these organizations for how best to engage their constituents. The following information identifies organizations that may provide collaboration and describes each organizations mission, constituency and organization partners. We also identify program areas that may lend themselves to collaboration with PBEM hazard mitigation planning.

Organization: African American Chamber of Commerce of Oregon[1]

Mission: To enhance, educate and empower the African American business and professional community in the Oregon and Southwestern Washington district. To identify and provide avenues for mentoring, professional growth and business development for small business owners and entrepreneurs. To develop and enhance outreach and assistance programs to youth in the areas of business, law, and personal responsibility.

Community Served: The African American Chamber serves the African American business and professional community in the Oregon and Southwestern Washington district.

Programs: The Chamber offers assistance, mentoring and referrals, through a vast network of associates and members, to assistance interested parties in starting, developing or expanding businesses. The Chamber also provides education scholarships, job postings and contract bid postings.

Partners: The Chamber's members are involved and committed volunteers who serve on a diverse range of commissions, boards, and committees connecting all socio-economic levels and racial communities. Whether it is business, education, legal, economic development, arts, social justice, housing, or health issue.

Potential Opportunities for Collaboration: Potential opportunity for communication with the African American business community. Hazard mitigation themes of community and business resilience may be of interest to members of the organization.

[1] African American Chamber, 2015. Web site accessed Dec. 7, 2015. http://blackchamber.info/.

Organization: African American Health Coalition, Inc. [2]

Mission: To promote health and improve wellness among Oregon's African American community through health education, advocacy and research.

Community Served: Oregon's African American community

Programs: Chronic Disease Self-Management Program elderly 60+ years of age, National Diabetes Prevention Program for high risk individuals, Educational Program to Increase Colorectal Cancer Screening, Cover Oregon Insurance Enrollment Assistance, Diabetes Self-Management Program, Racial and Ethnic Approaches to Health, Spice it Up Healthy Eating Program and the Wellness within Reach that is focused on physical activity.

Partners: The African American Health Coalition, Inc. is sponsored by Moda Health, United Way, new Seasons Market, Providence Health & Services, Spirit Mountain Casino, Legacy Health, Family Care Health Plans, Novo Nordisk, M.J.M. Murdock Charitable Trust, Oregon Health & Science University, Safeway, Fred Meyer, the Collins Foundation, Multnomah County Health Department and MacDonalds.

Potential Opportunities for Collaboration: Potential opportunity to communicate with African American adults. The hazard mitigation theme of safety may be of interest to members of the organization.

Organization: Asian Pacific American Network of Oregon (APANO) [3]

Mission: The Asian Pacific American Network of Oregon is a statewide, grassroots organization, uniting Asians and Pacific Islanders to achieve social justice. We use our collective strengths to advance equity through empowering, organizing and advocating with our communities.

Community Served: Asians and Pacific Islanders

Programs: APANO program work is focused on community organizing, leadership development and training, policy advocacy, Civic Engagement, cultural Work and the jade district.

Partners: Partners of APANO in Oregon include The Asian Council of Eugene & Springfield, Chinese American Citizens Alliance, Chinese Consolidated Benevolent Association, COFA Alliance National Network, DisOrient Film Festival, Korean American Coalition of Oregon, Living Islands, Micronesian Islander Community, Mien Professionals Network, Oregon Marshallese Community, Philippine American Chamber of Commerce and Zomi Association of US.

Potential Opportunities for Collaboration: Potential opportunity to collaborate on outreach to Asian and Pacific Islander communities (Primarily younger adult population). Civic engagement, resilience, leadership development/training are APANO work areas that may have synergy with hazard mitigation.

[2] African American Health Coalition, Inc., 2015. Website accessed Dec. 7, 2015. http://aahc-portland.org/.
[3] APANO, 2015. Web site accessed Dec. 3, 2015. http://www.apano.org/.

Organization: Asian Health & Service Center[4]

Mission: To be the bridge between Asian and American cultures and build a harmonious community. Vision: To reduce health inequity and improve health care quality for all Asians.

Community Served: Asian Americans (demographic dominant client base 40 to 80 years of age)

Programs: Arts and cultural community engagement, health education and support, healthcare services, research and studies related to health in Asian American community and Chinese immersion preschool.

Partners: American Association of Retired Persons, American Cancer Society, Avon Breast Health Outreach Program, City of Beaverton, Coalition of Community Health Clinics, Children's Community Clinic, Gilead Sciences, Mercy & Wisdom Healing Center, Multnomah County Health Department, National College of Natural Medicine (NCNM), Native American Rehabilitation Association of the Northwest (NARA), North By Northeast Clinic, National Institutes of Health (NIH), Northwest Health Foundation, Novartis Pharmaceuticals, OHSU Richmond Clinic, Old Town Clinic: with Central City Concern Health Services, Orange County Asian and Pacific Islander Community Alliance, Oregon Health Authority (OHA), Oregon Health & Science University (OHSU), OHSU Family Center at Richmond, Outside In Medical Clinic, PACS Family Health Center, Portland State University, Providence Health & Services, Rosewood Family Health Center, Susan G. Komen for the Cure, SW Community Health Center, The Wallace Medical Concern, United Way of the Columbia-Willamette, Washington County Health & Human Services and West Burnside Chiropractic Clinic.

Potential Opportunities for Collaboration: Potential opportunity to reach older Asian American population. The hazard mitigation theme of safety may be of interest to members of the organization.

Organization: Audubon, Portland[5]

Mission: Audubon Society of Portland promotes the understanding, enjoyment, and protection of native birds, other wildlife, and their habitats.

Community Served: Local environmental community and the Pacific Northwest

Programs: Birding publications and information, education classes and camps, Wildlife Care Center, sanctuaries, and habitat and species conservation and restoration.

Potential Opportunities for Collaboration: Could potentially collaborate with outreach to environmental community. Members may be interested in impact mitigation strategies may have on wildlife or mitigation strategies that could also benefit wildlife and environmental education.

Organization: Black Parent Initiative[6]

Mission: The Black Parent Initiative (BPI) educates and mobilizes the parents and caregivers of Black and multi-ethnic children to ensure they achieve success.

Community Served: Families of Black and multi-ethnic children

[4] Asian Health & Service Center, 2015. Web site accessed Dec. 4, 2015. http://www.ahscpdx.org/.
[5] Audubon Portland, 2015. Web site accessed Dec. 4, 2015. http://audubonportland.org/.
[6] BPI, 2015. Web site accessed Dec. 4, 2015. http://thebpi.org/.

Programs: Parent University focuses on:

- Literacy: home-based support for improved child reading and comprehension
- Culturally Specific Parenting: home-based discipline; home based/school advocacy
- Advocacy: cultivating parent advocates
- And, the Together We Can program provides:
- Intensive Home Visiting: relationship-based; focus on safety, stability, and personal growth
- Group Services: personal growth, consciousness, and connection

Potential Opportunities for Collaboration: Potential opportunity for outreach to African American and mixed race families with children. The hazard mitigation theme of safety may be of interest to members of the organization.

Organization: Center for Intercultural Organizing[7]

Mission: The Center for Intercultural Organizing is a diverse, grassroots organization working to build a multi-racial, multicultural movement for immigrant and refugee rights.

Community Served: Multi-racial, multicultural immigrants and refugees

Programs: The Center for Intercultural Organizing has four focus areas.

Community Education-The Center educates immigrants, refugees and U.S.-born allies on pressing community issues and strengthens and supports existing efforts to bring visibility to immigrant and refugee struggles.

Civic Engagement and Policy Advocacy-Our civic engagement program provides a pathway for immigrants and refugees to participate in democratic processes through training programs, hands-on projects and collective action that produce concrete improvements in their lives.

Organizing and Mobilization-CIO assists immigrant and refugee community members in building the organizing skills necessary to impact policies that affect them and to work collaboratively, mobilizing diverse constituencies.

Intergenerational Leadership Development-CIO develops new leaders through a signature yearlong leadership development program, through strategic trainings, and through on-the-ground leadership positions within our campaigns.

Potential Opportunities for Collaboration: Potential opportunity to collaborate with Community Engagement and Civic Engagement programs.

Organization: Coalition of Communities of Color[8]

Mission: The Coalition of Communities of Color (CCC) addresses the socioeconomic disparities, institutional racism and inequity of services experienced by our families, children and communities; and to organize our communities for collective action resulting in social change to obtain self-determination, wellness, justice and prosperity.

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[7] CIO, 2015. Web site accessed Dec. 4, 2015. http://www.interculturalorganizing.org/.
[8] CCC, 2015. Web site accessed Dec. 4, 2015. http://www.coalitioncommunitiescolor.org/.

Community Served: Coalition of Communities of Color (CCC) is an alliance of culturally-specific community based organizations with representation from the following communities of color: African, African American, Asian, Latino, Native American, Pacific Islander, and Slavic.

Programs: The CCC implements culturally-responsive data and research projects to build an important knowledge base from which to educate and to advocate. Bridges is a leadership development initiative with houses six culturally-specific leadership development programs led by CCC member organizations. Bridges' programs provide ongoing support through leadership placements, mentorship and community networking. The CCC also conducts policy analysis and advocacy to advance policies in Oregon that have the best potential to improve outcomes for communities of color. This program area includes the Education Justice Initiative that creates better outcomes for all students by removing barriers facing students of color, and Community & Economic Development work that focuses on anti-displacement and environmental justice.

Partners: IRCO Africa House, IRCO Asian Family Center, Asian and Pacific American Network of Oregon, Center for Intercultural Organizing, El Centro Milagro, Hacienda Community Development Corporation, Immigrant and Refugee Community Organization (IRCO), Latino Network, KairosPDX, Native American Youth and Family Center (NAYA Family Center), Portland African American Leadership Forum, Portland Community Reinvestment Initiatives, Inc., Portland Youth and Elders Council, Self Enhancement, Inc., Slavic Community Center, Slavic Network of Oregon, Urban League of Portland, Verde and VOZ Workers' Rights Education Project.

Potential Opportunities for Collaboration: The staff could provide insight on how best coordinate with partner organizations.

Organization: Disability Rights Oregon[9]

Disability Rights Oregon (DRO) is a non-profit law office that provides advocacy and legal services to people with disabilities who have an issue related to their disability and that falls within DRO's goals and priorities.

Mission: To promote and defend the rights of individuals with disabilities.

Community Served: People with disabilities who have an issue related to their disability and that falls within DRO's goals and priorities.

- Goals:
  - Stopping Abuse and Neglect,
  - Providing Full Access to Community Participation,
  - Removing significant access barriers in public places with emphasis on barriers in education, transportation and the courts
  - Monitoring the increase in the supply of accessible housing through policy work
  - Providing information about reasonable accommodations for tenants to prevent homelessness and isolation.
  - Enforcing anti-discrimination laws
  - Working to achieve full participation in the electoral process including registering to vote and casting a ballot
  - Getting and Maintaining Quality Community Support Services

[9] Disability Rights Oregon, 2015. Web site accessed Dec. 4, 2015. https://droregon.org/.

- Getting a Free & Appropriate Education for Children
- Other Very Important Issues That Promote the Mission of DRO & That Are Approved by the Executive Director

Potential Opportunities for Collaboration: DRO may be able to provide insight on how best engage individuals with disabilities in HMP update process. They may also be able to provide inputs in development of appropriate hazard mitigation strategies

Organization: East Portland Neighborhood Office (East Portland Action Plan)[10]

The East Portland Neighborhood Office (EPNO) is part of the City of Portland's Office of Neighborhood Involvement.

EPNO acts as a hub for these independent organizations in their work; providing organizing assistance, support in navigating the city's processes, funding opportunities, material resources (meeting space, event equipment, copies, etc), and more.

The East Portland Action Plan (EPAP), a group affiliated with the EPNO, was convened for the specific task of providing leadership and guidance to public agencies and other entities on how to strategically address community-identified issues and allocate resources to improve livability and prevent displacement in East Portland. East Portland is defined by the East Portland Neighborhood Office (EPNO) coalition area.

Goals: To enhance community involvement in efforts to improve neighborhood livability, a sense of community, public safety, organizational and self-empowerment at the neighborhood level, and to implement the goals of The Five Year Plan to Strengthen Community Involvement in Portland.

Community Served: EPNO serves about 25% of the City's population, spread across about 20% of the City's landmass. EPNO exists to support community organizations, community members, and the thirteen neighborhood associations of East Portland as they strengthen their communities and work with local government and other organizations.

Programs: The EPAP has identified strategies and action items for each of the following subject areas:

Housing and Development Policies, Commercial and Mixed Use, Transportation, Public Infrastructure and Utilities, Parks and Open Space. Natural Areas and Environment, Economic Development and Workforce Training, Education Infrastructure and Programs, Public Safety, Housing Assistance and Safety-net Services, Community Building, and Equity. There are working committees staffed by volunteers for several of these subject areas.

Potential Opportunities for Collaboration: With PEMB resource/staff support, EPAP/EPNO staff could provide guidance for effectively engaging community members. In addition, may be able to partner with EPAP members to engage the community through EPAP's monthly general meetings and through digital and print media. Other Portland District Coalitions may be able to provide similar access to their communities.

[10] EPNO, 2015. Web site accessed Dec. 3, 2015. http://eastportland.org/.

Organization: Ecumenical Ministries of Oregon's Russian Oregon Social Services[11]

Mission: To successfully integrate Russian-speaking immigrants and refugees into Oregon and southwest Washington communities by providing services that increase independence, enable economic self-sufficiency, and improve mental and physical well-being.

Community Served: Russian Oregon Social Services (ROSS) was established by Ecumenical Ministries of Oregon (EMO) in 1994 to serve the needs of Russian-speaking refugees and immigrants. More than 100,000 Russian-speaking refugees and immigrants from the former Soviet Union currently reside in the Portland metro area, and the numbers are expected to increase.

Programs: ROSS provides the following services:

- 24-hour crisis response.
- Individual and family crisis counseling.
- One-on-one advocacy, crisis intervention, support safety planning.
- Assistance obtaining stalking orders and restraining orders and filing out other forms and documents.
- Accompaniment to hospitals for forensic medical exams (for clients).
- Accompaniment to court and assistance communicating with police and District Attorney's Office.
- Assistance accessing immigration legal services.
- Domestic violence and sexual assault victims' support groups.
- Assistance applying for crime victims compensation.
- Assistance applying for public benefits.
- Assistance with temporary and transitional housing.
- Mentorship program for survivors of domestic violence and sexual assault.
- Information and referrals.
- Community orientation.
- Assistance obtaining dental services.
- Translation and interpretation services (for clients).
- Cross-cultural education (for other service providers).

Potential Opportunities for Collaboration: May be able to provide guidance on how to effectively conduct outreach to the Russian speaking population, recommendations on translation services and access to the community network.

Organization: El Programa Hispano-Catholic Charities[12]

Mission: El Programa Hispano's mission is threefold: to increase self-sufficiency within the Latino community, to empower individuals to achieve a better quality of life and to promote mutual understanding and respect among cultures.

Community Served: low-income Latinos in the Portland metro area

[11] ROSS, 2015. Web site accessed Dec. 3, 2015. http://www.emoregon.org/ross.php.
[12] El Programa Hispanico, 2015. Web site accessed Dec. 3, 2015. http://www.catholiccharitiesoregon.org/services_latino_services.asp.

Programs: El Programa Hispano offers a wide variety of services for low-income Latino families, including a low-income taxpayer clinic, food stamp assistance, anti-poverty services, skill building classes and outreach to the elderly. Project UNICA assists Spanish-speaking women, men and adolescents affected by domestic violence and sexual assault. El Programa Hispano also offers case management, educational activities, and support groups to Latino parents with children ages birth to five years. El Programa Hispano provides academic support, advocacy, skill building, mentoring, tutoring and recreation to Latino students; as well as family engagement services to Latino parents in Multnomah County school districts.

Potential Opportunities for Collaboration: May be able to provide guidance for outreach to the low income Latino community and access to their network. Safety

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Organization: Hacienda Community Development Corporation (CDC) [13]

Mission: Hacienda CDC is a Latino Community Development Corporation that strengthens families by providing affordable housing, homeownership support, economic advancement and educational opportunities.

Community Served: Low income Latino community

Programs: The Community Economic Development Department provides culturally-specific education and skill-building programs for adult Latinos. Through a variety of programs, including micro-enterprise development, small business training, adult financial education, and workforce development programs, the department makes a long-term impact by increasing the income and assets of Hacienda residents and the broader Latino community.

The Asset Management department seeks to strengthen the performance of the organization's existing housing assets, strengthen the health of our communities through robust on-site services for residents and anticipate and plan for the asset management needs of existing and future properties.

The Housing Development department oversees the construction of new housing, office and commercial space.

Hacienda CDC serves approximately 300 members of the youth resident population through three major **Programs:** Portland Niños, Expresiones, and Avanzamos. The programs offer a variety of important academic and social support services to children from birth to 9th Grade. Hacienda CDC also provides home ownership counseling through its Homeownership Support Program. Services are provided to families and individuals buying their first homes as well as to those who are at risk of losing their homes to foreclosure.

Potential Opportunities for Collaboration: Hacienda CDC may be able to provide guidance on outreach to the Latino community and access to it network. The organization may also be interested as a stakeholder of housing infrastructure in the community.

[13] Hacienda CDC, 2015. Web site accessed Dec. 3, 2015. http://www.haciendacdc.org/.

Organization: Home Forward[14]

Home Forward promotes, operates and develops affordable housing that engenders stability, self-sufficiency, self-respect and pride in its residents and represents a long-term community asset. Home Forward strives to be a community leader to create public commitment, policy and funding to preserve and develop affordable housing.

Mission: The mission of Home Forward is to assure that the people of the community are sheltered, with a special responsibility to those who encounter barriers to housing because of income, disability or special need.

Community Served: those who encounter barriers to housing because of income, disability or special need. Home Forward is a public corporation serving all of Multnomah County, including the cities of Gresham, Fairview, Portland, and Troutdale, and other East County communities.

Programs: Home Forward programs are divided into three major areas: apartment communities, rent assistance and support services. As the largest provider of affordable housing in Oregon, Home Forward offers a variety of housing options to low-income individuals and families: more than 6,000 apartments to rent, including approximately 1,980 units of public housing, and approximately 9,390 Section 8 rent assistance vouchers. Home Forward services include the GOALS (Greater Opportunities to Advance, Learn and Succeed) program that provides Home Forward participants with ways to set and reach their goal of becoming self-sufficient through five years of dynamic supportive services, and partners with programs such as the Portland YouthBuilders where low income youth aged 17-24 are paid to finish school, learn a trade, and plan for their future and the NAYA Family Center offers services relating to health, housing, nutrition, education, transportation and other services.

Partners: Home Forward partners with more than 100 community agencies in the public, nonprofit and private sectors. The services provided by our community partners include financial services, education, substance abuse and youth programs, job training and life skills.

Potential Opportunities for Collaboration: Home Forward could provide guidance and or assistance with outreach to low-income residents of Portland. In addition, as a manager of facilities in the area, the organization may be interested in direct engagement as a stakeholder in the HMP update process.

Organization: Immigrant & Refugee Community Organization (IRCO) [15]

Mission: IRCO's mission is to promote the integration of refugees, immigrants and the community at large into a self-sufficient, healthy and inclusive multi-ethnic society.

Community Served: Immigrant and refugee communities

Programs: IRCO focuses on removing barriers to self-sufficiency and helping individuals and families thrive, by providing more than 100 culturally and linguistically specific social services, from employment, vocational training and English language learning, to community development, early childhood and parenting education, youth academic support and gang prevention. To better provide these services IRCO established the IRCO Asian Family Center in 1994 and the IRCO Africa House in 2006.

[14] Home Forward, 2015. Web site accessed Dec. 4, 2015. http://www.homeforward.org/.
[15] IRCO, 2015. Web page accessed Dec. 4, 2015. http://www.irco.org/.

Potential Opportunities for Collaboration: IRCO could provide guidance and or collaborate with outreach to refugee and immigrant communities. There may be an opportunity to conduct community engagement activities at or collaborate with their established community centers.

Organization: Impact NW -Southeast Multicultural Services Center[16]

Impact NW's Seniors and Adults with Disabilities services and Energy Assistance program are offered through its Southeast Multicultural Services Center.

Mission: Impact NW's mission is to help people prosper through a community of support.

Community Served: Annually, more than 1,500 individuals are supported by Impact NW's Seniors and Adults with Disabilities Services programs.

Programs: Impact NW's Seniors & Adults with Disabilities Services program gives clients the tools and support they need to be healthy, happy, and active, and to live at home safely. Programs include connecting community volunteers to isolated seniors, in-home care coordination, transportation to shopping and medical appointments, money management and legal services, and on-site meal services. The Southeast Multicultural Senior Center provides an activity hub where seniors gather for meals, games, celebrations and friendship.

Potential Opportunities for Collaboration: Impact NW could provide outreach guidance and potentially could collaborate with outreach to seniors through the Southeast Multicultural Services Center.

Organization: JOIN[17]

Mission: JOIN exists to support the efforts of homeless individuals and families to transition out of homelessness into permanent housing.

Community Served: JOIN efforts are directed at individuals sleeping outside or in their car in the Portland Metro area. Service provision is not dependent on age, gender, ethnicity, sexual identity, specific diagnosis or identifiable issues.

Programs: JOIN's outreach program engages homeless individuals to identify and overcome their barriers to housing. The retentions program works with newly placed households to get the support they need to succeed in their housing long-term. The JOIN Day Center provides critical basic day services such as hygiene facilities, laundromat vouchers, referral information, clothing, conversation and a refuge from the weather. And the Immersion program helps people for the greater community learn about homelessness.

Potential Opportunities for Collaboration: JOIN could provide could provide insight on how to serve the homeless during and after a disaster.

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[16] Impact NW, 2015. Web page accessed Dec. 4, 2015. http://impactnw.org/.
[17] JOIN, 2015. Web page accessed on December 7, 2015. http://joinpdx.org/.

Organization: Latino Network[18]

Mission: Latino Network provides transformative opportunities, services, and advocacy for the education, leadership and civic engagement of our youth, families and communities.

Community Served: Latino children and families

Programs: The Latino Network focus on early childhood education, family and youth engagement, transformative youth opportunities and civic leadership.

Potential Opportunities for Collaboration: The Latino Network could provide guidance for outreach to the Latino community. Also, there may be opportunities for collaborative public engagement.

Organization: Native American Youth & Family Center (NAYA) [19]

Mission: To enhance the diverse strengths of our youth and families in partnership with the community through cultural identity and education.

Community Served: Self-identified Native Americans, infant to Elder, from across the Portland, Oregon, metropolitan area

Programs: NAYA provide educational services, cultural arts programming, and direct support to reduce poverty to the Portland Metropolitan Area Native American community. In addition, NAYA supports civic engagement and advocacy by convening the Portland Indian Leaders Roundtable, fostering leadership through the Oregon LEAD cohort, hosting the Portland Youth and Elders Council and holding forums to engage the community and gather input on programming. NAYA also registers voters and educates their community about the importance of being civically engaged.

Partners: Member of the Coalition of Communities of Color

Potential Opportunities for Collaboration: NAYA could provide guidance for conducting outreach to Portland's Native American population. And, they may be willing to collaborate with community engagement.

Organization: Oregon Food Bank[20]

Mission: Oregon Food Bank works to eliminate hunger and its root causes.

Community Served: People in Oregon lacking the resources to reliably secure food for a healthy life.

Programs: OFB works with a cooperative, statewide network of partner agencies to distribute emergency food to hungry families. We fight hunger's root causes through public policy advocacy, nutrition and garden education and work to strengthen community food systems.

Partners: 953 partner organizations in Oregon and SW Washington

Potential Opportunities for Collaboration: The Oregon Food Bank may be able to provide guidance for working with partner organizations and outreach to the low income population. They may also be

[18] Latino Network, 2015. Web page accessed on December 7, 2015. http://www.latnet.org/.
[19] NAYA, 2015. Web page accessed on December 6, 2015. http://www.oregonfoodbank.org.
[20] Oregon Food Bank, 2015. Web page accessed on December 6, 2015. http://www.oregonfoodbank.org.

willing to provide access to their network. The Oregon Food Bank likely is interested in risks to food supply and access, and mitigation actions that help secure food supply and access.

Organization: Oregon Health and Science University, Oregon Office of Disability and Health (OODH) [21]

Mission: To prevent secondary conditions and improve the health and quality of life of Oregonians with disabilities through improved access to health care facilities, public health programs, and effective health promotion and wellness programs.

Community Served: Oregonians with disabilities

Programs: OODH provides healthy lifestyle, breast cancer awareness, emergency preparedness and health care access education and outreach to people with disabilities and service providers. In addition, OOHD conducts research on the health, wellbeing and risk factors of adolescents and adults with disabilities in Oregon.

Potential Opportunities for Collaboration: OODH can provide guidance on how to make public engagement accessible to people with disabilities, and may be willing to collaborate with outreach to these individuals. OODH likely is also interested in potential risks from natural hazards to people with disabilities and mitigation action items that would reduce these risks.

Organization: Portland African American Leadership Forum[22]

Mission: The Portland African American Leadership Forum (PAALF) leverages the power of our community's combined resources to advance the vision of a connected thriving, resilient Black Community.

Community Served: African Americans

Programs: PAALF convenes African American leaders around a public policy agenda that impacts the community in the areas of housing & economic development, education, health, and civic engagement/leadership.

Potential Opportunities for Collaboration: PAALF could provide guidance for outreach to the African American community and may be willing to collaborate with public engagement.

Organization: Portland Community Reinvestment Initiatives (PCRI) [23]

Mission: Preserve, expand and manage affordable housing in the City of Portland and provide access to, and advocacy for, services for residents.

Community Served: Low income families and adults

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[21] OODH, 2015. Web page accessed on December 6, 2015. http://www.ohsu.edu/xd/research/centers-institutes/institute-on-development-and-disability/public-health-programs/oodh/oodh.cfm.
[22] Portland African American Leadership Forum, 2015. Web page accessed December 10, 2015. http://aalfnw.org/portland/
[23] PCRI, 2015. Web page accessed December 10, 2015. http://www.pcrihome.org/

Programs: PCRI focuses on preserving and managing affordable, high quality, scattered site, single family homes; expanding and managing their portfolio of small multiplexes; and acquiring/developing multi-family housing to preserve affordable housing choices in the community.

Potential Opportunities for Collaboration: PCRI could provide guidance and or assistance with outreach to low-income residents of Portland. In addition, as a manager of facilities in the area, the organization may be interested in direct engagement as a stakeholder in the HMP update process.

Organization: REACH CDC[24]

REACH is a nonprofit affordable housing development and property management company

Mission: REACH's mission is to provide quality, affordable housing for individuals, families and communities to thrive.

Community Served: Low income community.

Programs: REACH owns and manages a portfolio of 2,073 units of affordable housing located across the metropolitan region, including properties in Multnomah, Washington, and Clark Counties (state of Washington). The portfolio includes new and renovated plexes, apartment buildings and mixed-use developments.

REACH provide a range of programs focused on housing success and financial stability such as eviction prevention, financial education, employment and career support, and access to emergency food and clothing. In addition, REACH's Community Builders Program provides free volunteer-powered home repairs for low income elderly and disabled homeowners, as well as families with children living in the home experiencing some type of home health hazard (i.e. lead poisoning, radon, mold, etc.).

Potential Opportunities for Collaboration: REACH could provide guidance and or assistance with outreach to low-income residents of Portland. In addition, as a manager of facilities in the area, the organization may be interested in direct engagement as a stakeholder in the HMP update process.

Organization: Slavic Community Center of NW[25] (information in Russian on Web site)

Community Served: Slavic community in Portland

Potential Opportunities for Collaboration: The Slavic Community Center of NW could provide guidance and or collaborate with outreach to Slavic community in Portland.

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[24] REACH CDC, 2015. Web page accessed December 10, 2015. http://reachcdc.org/
[25] Slavic Community Center of NW, 2015. Web page accessed December 9, 2015. http://slavicfamily.org/

Organization: Urban League of Portland[26]

Mission: The Urban League of Portland's mission is to empower African Americans and others to achieve equality in education, employment, health, economic security and quality of life.

Community Served: African Americans and other people of color in the region.

Programs: The Urban League of Portland's programs include a distinctive blend of direct services, organizing, outreach, and advocacy. They offer workforce services, community health services, summer youth programming, senior services, meaningful civic engagement opportunities, and powerful advocacy.

Potential Opportunities for Collaboration: The Urban League Portland could provide guidance on outreach to African Americans and communities of color. In addition, there may be the opportunity to collaborate with their Diversity and Civic Leadership V.O.I.C.E. (Voice Our Importance through Community Engagement) Project, which is a series of forums to provide information, raise awareness and to provide the community with a voice on issues and decision-making in the city and region.

Organization: Verde[27]

Mission: Verde serves communities by building environmental wealth through social enterprise, outreach and advocacy.

Community Served: Low income communities of Portland

Programs: Verde's Social Enterprise work employs and trains low-income adults, creates contracting opportunities for minority-owned and woman-owned businesses and brings environmental assets to low-income neighborhoods.

Verde Outreach works to address the divide that exists between sustainability and low-income communities. Verde and partners bring new environmental investments to the Cully Neighborhood by creating an EcoDistrict. Through Policy Advocacy, Verde and partners create a policy framework that empowers low-income people and people of color to drive environmental resources into their neighborhoods, in response to existing community needs. Other policy focused work includes Clean Energy Works Oregon and Portland Bike Share.

Partners: Hacienda CDC and NAYA

Potential Opportunities for Collaboration: Verde will likely be interested in the potential impacts of natural hazards in the communities that they work and interested in how their projects could help build resilient communities.

[26] Urban League of Portland, 2015. Web page accessed December 9, 2015. http://www.ulpdx.org/.
[27] Verde NW, 2015. Web page accessed December 9, 2015. http://www.verdenw.org/.

PUBLIC SURVEY

Portland Natural Hazard Mitigation Plan (NHMP)

Survey Distribution Plan

Introduction and Purpose

As part of Portland's 2016 Natural Hazard Mitigation Plan update, a public survey will be used to inform action item development and prioritization, as well as inform the planning team how best to communicate with the public about natural hazard risks and risk reduction. The survey will help meet FEMA requirements for public involvement, earn points for the National Flood Insurance Program (NFIP) Community Rating System (CRS), as well as advance the City of Portland's equity objectives. It will reach a broad cross-section of the Portland population, with an emphasis on the populations most vulnerable to natural hazard risks – economically disadvantaged populations, communities of color, those with limited English proficiency, immigrants or refugees, and others who are historically underrepresented in government activities or experience greater likelihood of negative consequences from natural hazard events.

The NHMP survey will be launched Monday February 1st, 2016 and will remain open at a minimum through the close of the 2016 NHMP plan update. Initial results will be compiled April 3rd, 2016 to inform action item development, plan content, and outreach strategies. It will be distributed online in English, Spanish, Chinese, Russian, Ukrainian, and Vietnamese, through translation provided by Oregon Translation, LLC. It includes questions intended to gather information about how Portlanders think about preparedness and reducing risk from natural hazards; questions to collect demographic information, such as income level, ethnic identification, household structure; and questions to identify the respondents' country of birth and language spoken at home. Data is also collected related to how the respondent learned about the survey and whether he or she would like to be contacted with additional related information.

Web Survey

The web survey will be provided through Survey Gizmo at the following link.

http://sgiz.mobi/s3/Portland-Preparedness-Survey

The QR Code below will also be used to direct people to the survey.

The public will be directed to PBEM's website at http://www.portlandoregon.gov/pbem through a variety of outreach methods, to be discussed below. PBEM's main webpage will host the link to the web survey.

Social Media –

The web survey will be distributed via a variety of online social media. PBEM's social media networks to be used include:

- Facebook
- Twitter
- NextDoor

PBEM will also request that its bureau partners share the survey link through their social media networks as well. PBEM will work with Public Information Officers at Portland Fire & Rescue, Portland Police, Portland Water Bureau, and Portland Parks and Recreation.

Survey Cards –

The following will be printed on quarter-sheet postcards to be distributed in strategic locations throughout Portland.

Cards will be placed at computer terminals in all Multnomah County libraries in Portland. Libraries at which the survey cards will be distributed include:

- St. Johns Library
- Kenton Library
- North Portland Library
- Capitol Hill Library
- Northwest Library
- Albina Library
- Central Library
- Hillsdale Library
- Sellwood-Moreland Library
- Woodstock Library
- Belmont Library
- Hollywood Library

- Gregory Heights Library
- Holgate Library
- Rockwood Library
- Midland Library

Cards will also be placed at computer terminals in Portland State University Library and Portland Community College Library.

Other locations throughout Portland to distribute survey cards will be identified as time and resources allow. Possible locations include schools, grocery stores, and the Lloyd Center Mall. If practical and cost-effective, cards may be distributed in water bills through coordination with the Portland Water Bureau.

Flyers –

Flyers with information about the survey will be displayed at strategic locations, where survey cards are not cost-effective or practical. Locations where flyers may be displayed include schools, grocery stores, and major employers in Portland. See flyer in Appendix A.

Email Distribution –

A link to access the survey via PBEM's website will be distributed via email to the following groups:

- NHMP steering committee
- NHMP stakeholders distribution list
- NET distribution list
- All Neighborhood Coalition Offices

Along with the survey link, a flyer in PDF format will be attached to emails for printing and distribution. Steering committee members, NHMP stakeholders, NETs, and Neighborhood Coalition Offices will be asked to share the survey within their networks. If possible, the link and flyer will also be emailed out via the Portland Parks survey distribution list.

Newsletters and Print Media –

To the extent publication deadlines align with the timing of the NHMP Preparedness Survey, notices will be published in the Northwest Examiner and Southwest News via Portland's Crime Prevention Communications Program.

Notices may be placed in city newsletters including the Portland Water Bureau newsletter and Office of Equity and Human Rights newsletters, as possible.

News Media –

During the week of February 1st, 2016 through February 5th, 2016, local news stations will be contacted regarding the survey through a brief press release. Interviews and information will be provided to support news coverage of the survey. The public will be encouraged to participate and will be offered the opportunity to be entered in a prize drawing for preparedness kits and emergency gear. Possible networks include:

- KBOO
- KOIN
- OPB
- Univision/Spanish Radio
- Slavic Family Media

In-Person Outreach –

NHMP Steering Committee members will be encouraged to hold focus groups to discuss the NHMP survey, in order to give an opportunity for constituents to ask questions and provide real-time feedback. PBEM staff will be available to support these efforts as scheduling and resources allow.

PBEM staff will promote the survey at meetings and events, including Parents for Preparedness, Public Involvement Advisory Committee (PIAC), and other community events as possible.

PBEM staff will participate as a vendor at the Portland Fix-It-Fair on February 20th, 2016. Three to five PBEM iPads will be available at the PBEM booth, with which attendees will be encouraged to take the survey. At least 50 paper copies of the survey will be printed and made available at the event. Paper copies will have the information links written out.

Paper Survey

Paper surveys will be printed in English and in all five translated languages. The number of printed copies will depend on opportunities to distribute. Printed surveys will include PBEM contact information in a highly visible place so that participants know who to call with questions or to arrange for the completed survey to be collected. Paper surveys will be distributed at the events/groups below, as well as others as opportunities allow.

- East Portland Action Plan (EPAP) General Meeting – March 23rd, 2016 6:30pm – 8:30pm
  (Spanish)
- Portland Fix-it-Fair – February 20th, 2016 (All Day)
  (All languages available)
- APANO
  (Vietnamese, Chinese)
- IRCO Russian/Slavic Coalition – Civic Engagement Steering Committee every 3rd Monday from 7:00pm-9:00pm. March 15th, 2016. Contact: Oleg Kubrakov, olegk@mail.irco.org
  (Russian, Ukrainian)
- IRCO Asian Family Services
  (Vietnamese, Chinese)
- Fubonn Supermarket, SE 82nd Avenue (Monday – Sunday 9am to 8pm), Contact: 503-517-8899
- Slavic Church Emmanuel
  (Russian, Ukrainian)
- St. John the Baptist Ukrainian Orthodox Church
  (Russian, Ukrainian)
- Vietnamese Community of Oregon

(Vietnamese)

Where paper surveys are left on site to be distributed over a period of time, a locking drop box placarded with PBEM contact information will be provided for returned surveys. During events or meetings where PBEM staff remain on site, paper surveys will be collected real-time if possible. Participants who do not complete their survey at the time of distribution will be encouraged to make arrangements with PBEM staff via phone or email to have the completed survey collected at a public location.

PBEM staff will manually input data received via paper survey into the web-based survey. If comments are received in languages other than English, Oregon Translation Services, LLC will be contracted to translate the surveys. Intervals at which surveys are translated will depend upon the number of surveys requiring translation.

Appendix A – Survey Flyer

How do you prepare?

Help us make Portland ready. Win prizes. Tell us how you prepare here:

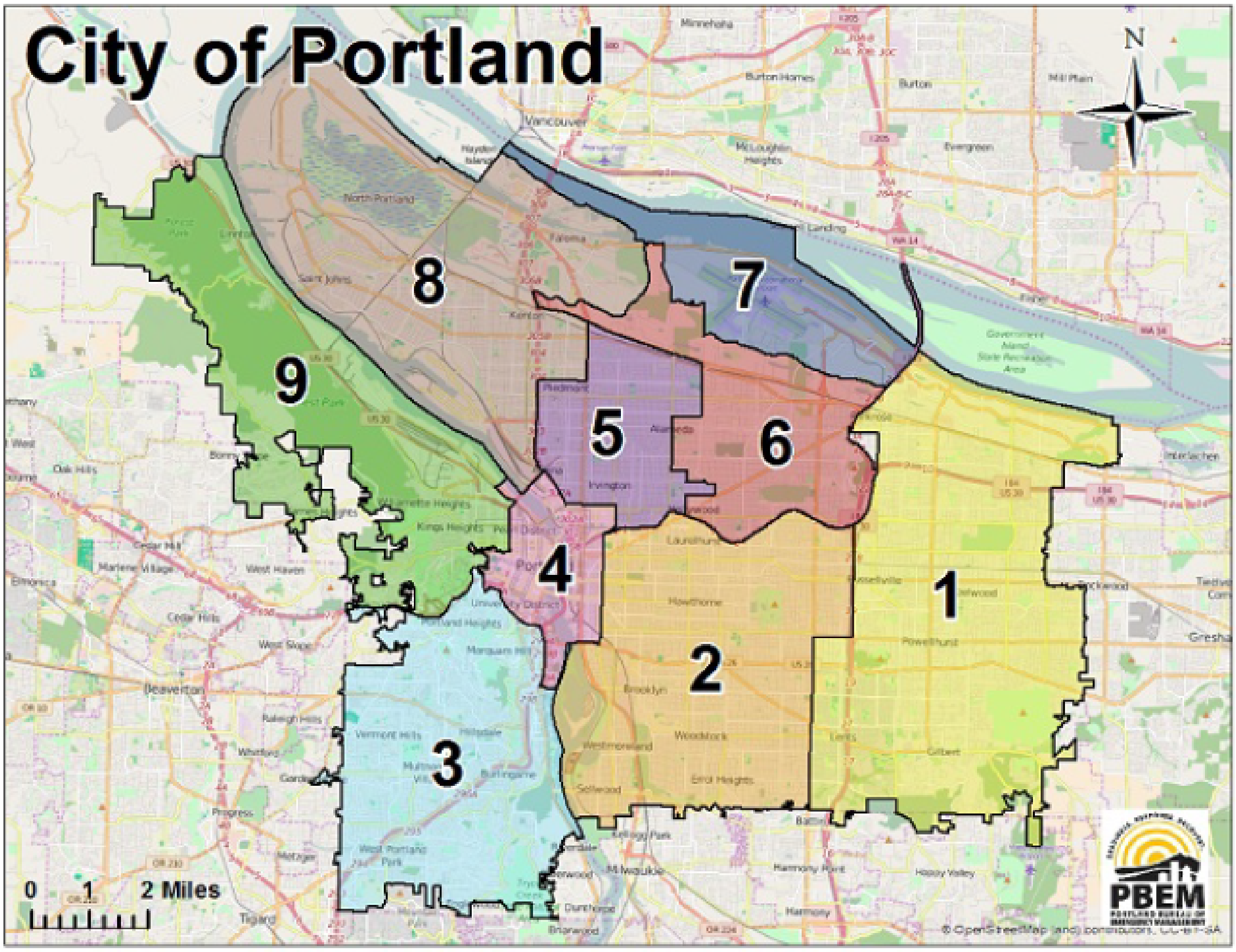
www.portlandoregon.gov/pbem

By taking 10 minutes to complete the Portland Preparedness Survey, you'll help City of Portland offices prioritize projects aimed at reducing our risk from natural hazards. You can also be entered to win prizes, including a $150 emergency kit, and other cool preparedness gear!

русский Tiếng Việt Español український 中文

Portland Preparedness Survey

Natural Hazards and You



Zoomable map here: http://arcg.is/1NV6tl3.

1. Where do you live?

- Area 1 - East Portland
- Area 2 - Southeast
- Area 3 - Southwest
- Area 4 - Central City/Downtown
- Area 5 - Northeast
- Area 6 - Central Northeast
- Area 7 - Airport
- Area 8 - North Portland
- Area 9 - West/Northwest
- Outside of Portland

Where outside of Portland do you live?

How long have you lived in Portland?

- 0-5 Years
- 6-10 Years
- 11-20 Years
- 21-25 Years
- >25 Years

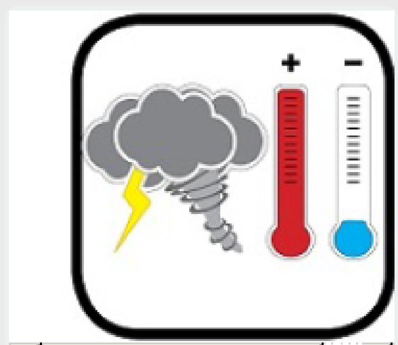
2. Where in Portland do you and your family spend most of your time (school or work)? *Select all that apply.*

- [ ] Area 1 - East Portland
- [ ] Area 2 - Southeast
- [ ] Area 3 - Southwest
- [ ] Area 4 - Central City/Downtown
- [ ] Area 5 - Northeast
- [ ] Area 6 - Central Northeast
- [ ] Area 7 - Airport
- [ ] Area 8 - North Portland
- [ ] Area 9 - West/Northwest
- [ ] Other

3. Select the three (3) natural hazards you worry about most.
To follow links for more information, right click link and select "open in new tab".

Earthquake
Click here for more information about earthquakes.

Flood
Click here for more information about floods.



Severe Weather
Click here for more information about severe weather.

Wildfire

Click [here](#) for more information about wildfire.

Landslide

Click [here](#) for more information about landslides.

Dam Failure

Click [here](#) for more information about dam failure.

Drought

Click [here](#) for more information about drought.

Volcano

Click [here](#) for more information about volcanos.

Space Weather

Click [here](#) for more information about space weather.

Other

4. What other natural hazards do you worry about?

5. Have you experienced any of the hazards above?

- Yes
- No

6. Can you tell us about your experience?

7. Have you done any of these things to make you and your family safer?
To follow links for more information, right click link and select "open in new tab".

- ☐ I buy flood insurance for my home. *More information here.*
- ☐ I buy earthquake insurance for my home. *More information here.*
- ☐ I strengthened my home against earthquakes. *More information here.*
- ☐ I clear debris from my storm drains. *More information here.*
- ☐ I plant drought-resistant plants. *More information here.*
- ☐ I secure my water heater, book cases, or other objects that could fall in an earthquake. *More information here.*
- ☐ I maintain a "defensible space" clear of vegetation and flammable material. *More information here.*
- ☐ I elevated my home or utilities above potential flood levels. *More information here.*
- ☐ I make decisions about where to live based on natural hazard risks. *More information here.*
- ☐ I use fire-resistant landscaping around my home. *More information here.*
- ☐ I regularly trim trees near my house or near power lines. *More information here.*
- ☐ I haven't done any of these.
- ☐ Other

8. Have you done any of these things to be prepared for an emergency? *To follow links for more information, right click link and select "open in new tab".*

- ☐ I work with my neighbors on emergency preparedness. More information here.
- ☐ I have registered for Public Alerts in my preferred language. *Go to PublicAlerts.org to register.*
- ☐ I know where my neighborhood BEECN is. *Find your neighborhood BEECN here.*
- ☐ I have an emergency kit at home. *More information here.*
- ☐ I have an emergency kit in my car. *More information here.*
- ☐ My household has an emergency plan. *More information here.*
- ☐ I have an emergency plan for my pets. *More information here.*
- ☐ I have received emergency training. *More information here.*
- ☐ I have an emergency source of power. *More information here.*
- ☐ I have emergency food and water. *More information here.*
- ☐ I have an emergency contact outside of the area. *More information here.*
- ☐ I know where I would go in an emergency. *More information here.*
- ☐ I have money saved for emergency use. *More information here.*
- ☐ I haven't done any of these.
- ☐ Other

9. Do any of these things make it hard for you to prepare your family for emergencies?

- ☐ I don't have the money.
- ☐ I have more important things to worry about.
- ☐ Thinking about preparedness is just too overwhelming.
- ☐ I'm too busy.
- ☐ I don't know what I need to do.
- ☐ I'm not sure what my risks are.
- ☐ Other

10. Natural hazards can cause damage that makes it hard to carry out our daily lives. Select three (3) things that would impact you most.

- ☐ Bridge closure
- ☐ Loss of public transportation
- ☐ Internet outage
- ☐ Power outage
- ☐ Telephone outage
- ☐ Grocery store closure
- ☐ Water system damage
- ☐ Sewer system damage
- ☐ Road closure
- ☐ Damage to fuel and natural gas infrastructure
- ☐ Hospital or clinic closure
- ☐ Local business closure
- ☐ School or daycare closure
- ☐ Government office closure
- ☐ Other

Natural Hazards and the City of Portland

11. What are the three (3) most important things the City of Portland government offices should do to reduce the risk from natural hazards?

- ☐ Provide more information to the public about natural hazards.
- ☐ Strengthen public buildings.
- ☐ Reduce development in known hazardous areas.
- ☐ Restore natural floodplains and open space.
- ☐ Build or improve man-made protections (levees for example).
- ☐ Strengthen infrastructure such as bridges, sewer lines, and water pipes.
- ☐ Increase safety requirements for building permits.
- ☐ Collect more data and information about hazard areas.
- ☐ Help citizens reduce their individual natural hazard risks.
- ☐ Other

About You

12. How many people are in your household?

13. Do you own or rent your home?

- ○ Own
- ○ Rent
- ○ Other

14. Were you born in another country?

Yes
No

15. Where were you born?

16. Do you speak English at home?

- Yes
- No

17. What language do you prefer?

- Spanish
- Vietnamese
- Russian
- Chinese
- Romanian
- Ukrainian
- Japanese
- Somali
- Arabic
- Laotian
- Other

18. What is your age?

19. Do you have a physical or mental disability?

- No
- Yes

20. How many people in your home work to provide for the family?

21. Would you consider your household income low, middle, or high?

- Low
- Middle
- High

22. How do you identify yourself by race or ethnicity?

23. Are you a trained Community Emergency Response Team/Neighborhood Emergency Team member?

- Yes
- No

24. How did you find out about this survey?

- ○ Library
- ○ Social Media (Facebook, Twitter, NextDoor)
- ○ Neighborhood Association
- ○ City Website
- ○ Radio/News Coverage
- ○ Friend, Family Member, or Colleague
- ○ Email
- ○ Other

Prizes!

25. What is your email address or phone number?

This survey is completely anonymous, but if you want to be entered in our prize drawing to win free preparedness kits and emergency gear, we need to be able to contact you. The raffle drawing will be held on April 11, 2016.

26. Would you like us to contact you with related information and training opportunities?

- ○ Yes
- ○ No

Thank You!

Thank you for telling us about how you think about preparedness! The information you provided will help us prioritize projects, and lets us know how best to share information with you. *Visit our website here: www.portlandoregon.gov/pbem for more information.*

Report for Portland Preparedness Survey

There were 2,970 responses to the public survey between February and April of 2016. Key results are summarized below.

Geographic Representation and Residency Tenure

Survey responses were received from all risk reporting areas and from individuals who live outside of Portland. 75.5 percent of all respondents indicated that they live within Portland.

When non-residents are excluded, the percent of responses from risk reporting areas is representative of the estimated population in some cases; however, there are some areas with under- and over-representation. Over-represented areas included: Northeast, Southeast and Southwest. Under-represented areas include: Central City/Downtown and East Portland. The remaining reporting areas were within 1 percent of the estimated population. See the table below for more information.

Risk Reporting Area	Estimated Population	Estimated Percent of Population	Percent of Survey Responses (excluding outside of Portland)
Airport	2,674	0.4%	0.2%
Central City/Downtown	37,987	**6.2%**	**3.6%**
Central Northeast	47,644	7.8%	7.1%
East Portland	148,712	**24.2%**	**9.6%**
West/Northwest	26,875	4.4%	4.9%
North Portland	68,047	11.1%	12.1%
Northeast	57,842	**9.4%**	**15.9%**
Southeast	153,952	**25.1%**	**32.6%**
Southwest	70,262	**11.4%**	**13.8%**

The majority of respondents who live in Portland have lived in the City for 11 or more years (62 percent). 26 percent of respondents indicated that they have lived in the City for more than 25 years.

The top three areas where all survey respondents indicated that they and their families spend the most time include: Central City/Downtown (42 percent), Southeast (34 percent) and Southwest (25 percent). When non-Portland residents are excluded the top three areas indicated include Central City/Downtown (43 percent), Southeast (40 percent), Southwest and Northeast (about 25 percent each).

Demographics

72 percent of Portland resident respondents self-identified as middle income and 13 percent identified their household as low income. According to American Community Survey (ACS) estimates, approximately 12 percent of Portland families are surviving on incomes below the federal poverty line.

When non-Portland residents are excluded 99 percent of respondents indicated that they speak English at home. Only 9 respondents indicated that they preferred languages other than English. The ACS estimates that limited English speaking households make up approximately 4 percent of Portland households.

72 percent of Portland respondents indicated that they own their home, while 27 percent indicated that they rent their home. The ACS estimates that 43 percent of the housing units in the City are renter occupied.

Approximately 9 percent of respondents indicated that they have physical or mental disability. According to U.S census estimates 8.5 percent of Portland residents under age 65 have a disability. 13 (about 7 percent) of respondents indicating that they had a disability also indicated that they were 65 years of age or older.

Respondents were able to enter their own racial identity rather than choosing from pre-determined options. Approximately 79 percent of respondents indicated that they identified as white/Caucasian or Anglo. According to ACS estimates, 78 percent of the Portland population is white.

Hazards of Concern

For Portland residents, the top three hazard of concern selected were: earthquake (96 percent), severe weather (51 percent) and drought (34 percent). Dam failure (3.9 percent) and space weather (8 percent) were the least likely to be selected. The top three hazards remain the same when non-Portland residents are included.

53 percent of Portlanders indicated that they had experienced one of the hazard of concern.

Thoughts on Preparedness and Mitigation

Portlanders indicated that they have made efforts to reduce risk to their families. Portlanders clear storm drains (50 percent), have made non-structural retrofits, such as securing a water heaters (42 percent), and have planted drought-resistant plants (33 percent). Only 6 percent of Portlanders indicated that they have purchased flood insurance, while 27 percent indicated that they have purchased earthquake insurance. 17 percent of Portlanders indicated that they had not done any of the options indicated. There were a large number of respondents who indicated that they had not taken these measures because they rent or live in apartment buildings or condominiums.

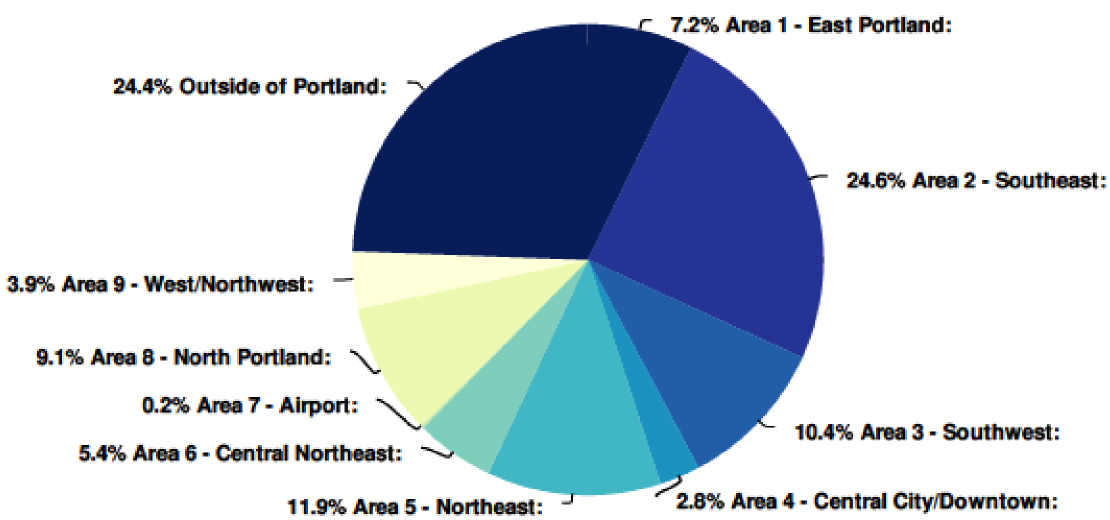
The top three things Portlanders have done to prepare for a natural hazard event include: obtained emergency food and water (58 percent), have an emergency kit at home (54 percent) and registered for public alerts (46 percent). Only 10 percent of respondents indicated that they had done nothing to prepare. When non-Portland residents are included, the results are similar.

Portlanders indicated the top three reasons for not preparing for emergencies included: lack of money (40 percent), being too busy (34 percent) and preparing being too overwhelming (32 percent).

Portlanders indicated that power outage (67 percent), water system damage (65 percent) and bridge closures (43 percent) would impact them the most. Responses were similar when all survey respondents are included.

Portlanders selected strengthen infrastructure such as bridges, sewer lines and water pipes (85 percent), strengthen public buildings (44 percent), and help citizens reduce their individual natural hazard risks (36 percent) as the three most important things that the City of Portland government could do to reduce risk from natural hazards. Strengthening schools was also commonly mentioned.

1. Where do you live?



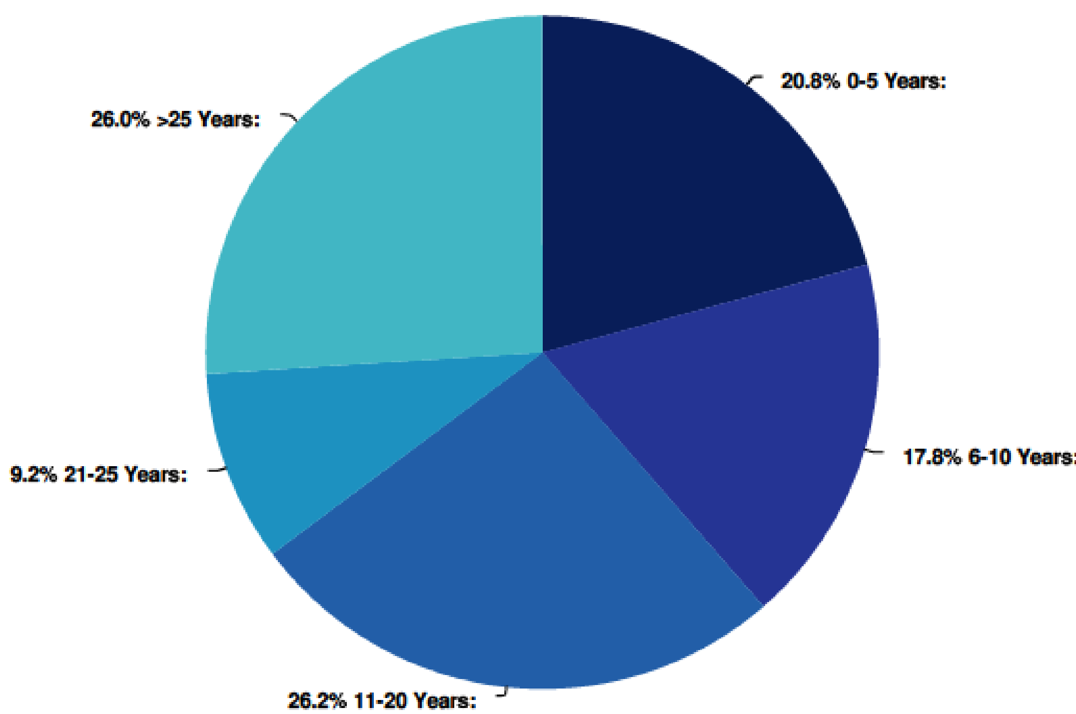
Value	Percent	Count
Area 1 - East Portland	7.2%	215
Area 2 - Southeast	24.6%	730
Area 3 - Southwest	10.4%	309
Area 4 - Central City/Downtown	2.8%	83
Area 5 - Northeast	11.9%	354
Area 6 - Central Northeast	5.4%	161
Area 7 - Airport	0.2%	5
Area 8 - North Portland	9.1%	270
Area 9 - West/Northwest	3.9%	116
Outside of Portland	24.4%	723
	Total	**2,966**

2. Where outside of Portland do you live?

Areas outside of Portland commonly mentioned include:

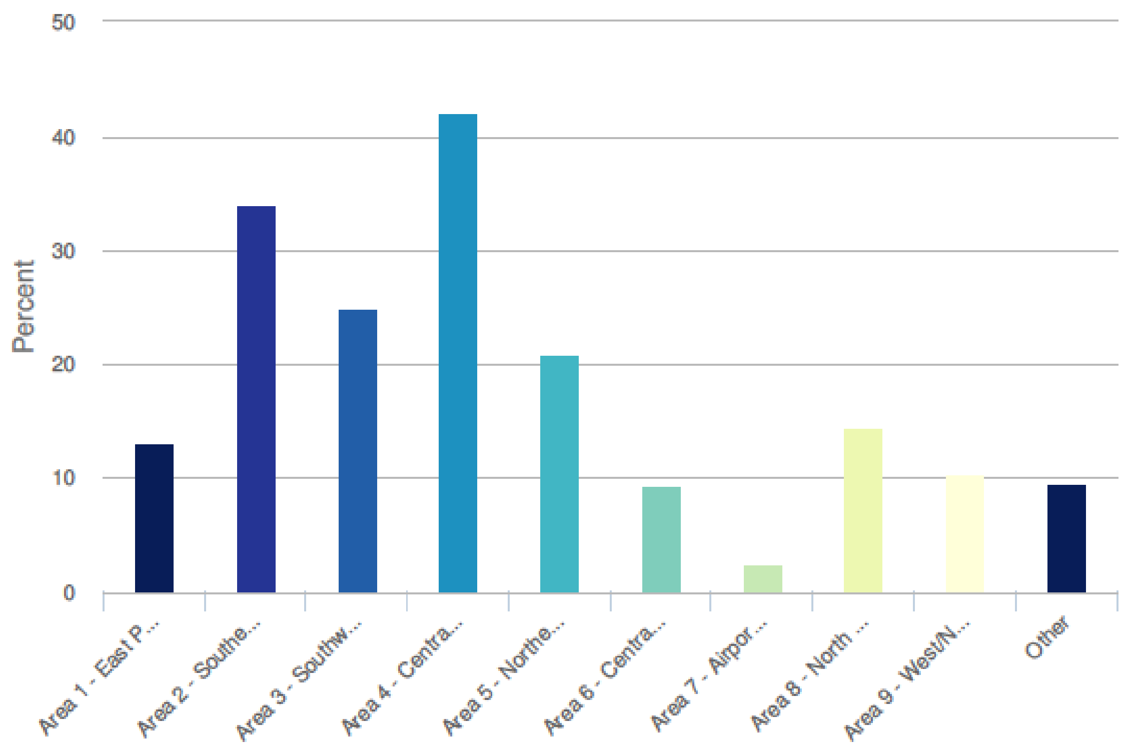
- Beaverton,
- Hillsboro,
- Tigard,
- Gresham,
- Milwaukie,
- Vancouver,
- Oregon City,
- Happy Valley,
- Lake Oswego,
- West Linn,
- Aloha,
- Tualatin,
- Sherwood,
- Troutdale,
- Fairview,
- Clackamas County,
- Gladstone,
- Newberg,
- Washington County,
- Camas,
- Cedar Hills,
- Forest Grove,
- Sandy, and
- Wilsonville.

3. How long have you lived in Portland?



Value	Percent	Count
0-5 Years	20.8%	436
6-10 Years	17.8%	374
11-20 Years	26.2%	550
21-25 Years	9.2%	192
>25 Years	26.0%	544
	Total	2,096

4. Where in Portland do you and your family spend most of your time (school or work)? Select all that apply.

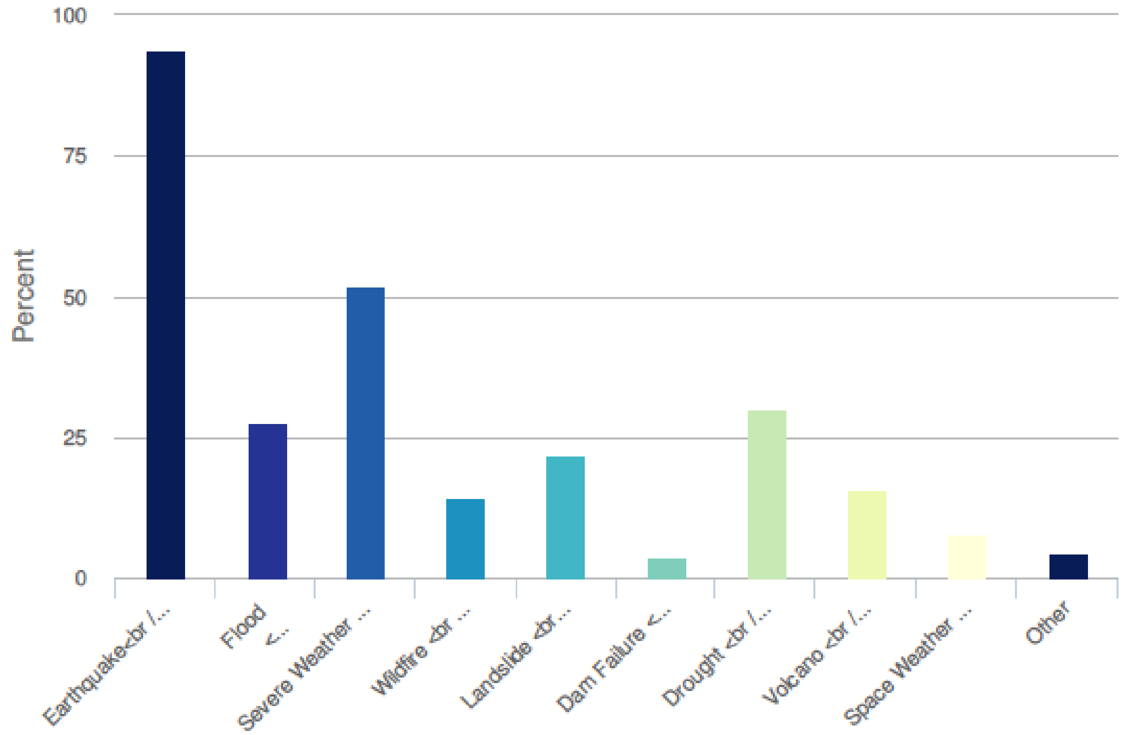


Value	Percent	Count
Area 1 - East Portland	13.1%	404
Area 2 - Southeast	33.9%	1,044
Area 3 - Southwest	25.0%	769
Area 4 - Central City/Downtown	42.0%	1,294
Area 5 - Northeast	20.8%	639
Area 6 - Central Northeast	9.3%	286
Area 7 - Airport	2.4%	75
Area 8 - North Portland	14.4%	442
Area 9 - West/Northwest	10.3%	317
Other	9.5%	291

Other areas commonly mentioned include:

- Beaverton,
- Vancouver,
- Hillsboro,
- Tigard,
- Milwaukie,
- Gresham,
- Oregon City,
- Lake Oswego,
- Hillsboro, and
- Clackamas County.

5. Select the three (3) natural hazards you worry about most.


100
75
50
25
0
Percent
Earthquake<br /...
Flood <...
Severe Weather ...
Wildfire <br ...
Landslide <br ...
Dam Failure <...
Drought <br /...
Volcano <br /...
Space Weather ...
Other

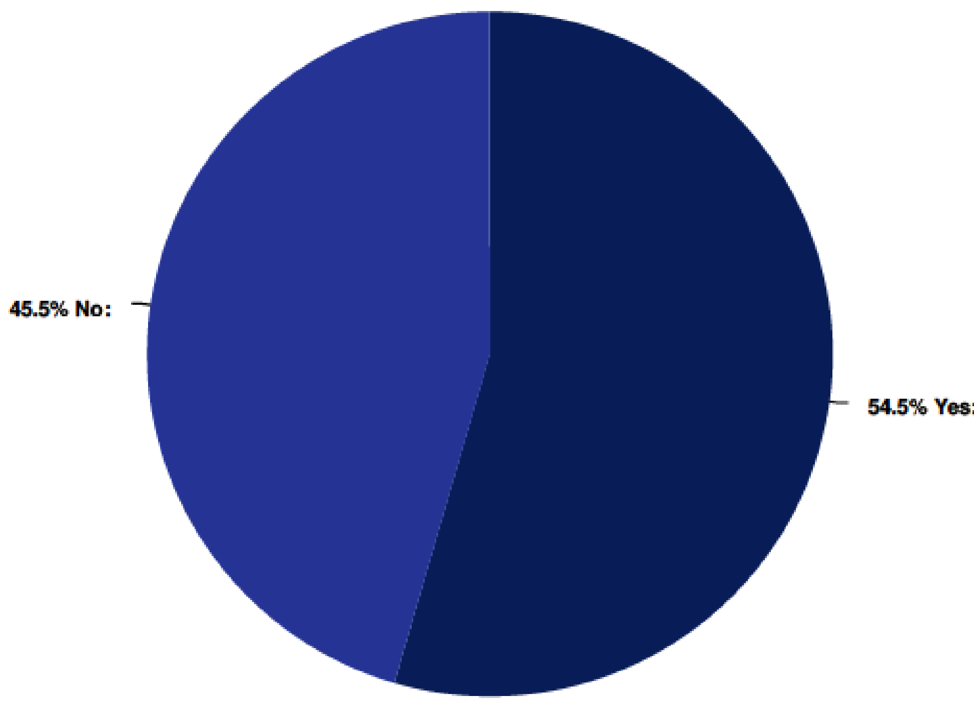
Value	Percent	Count
Earthquake *Click here for more information about earthquakes.*	94.0%	2,862
Flood *Click here for more information about floods.*	27.6%	839
Severe Weather *Click here for more information about severe weather.*	51.7%	1,575
Wildfire *Click here for more information about wildfire.*	14.3%	434
Landslide *Click here for more information about landslides.*	21.9%	666
Dam Failure *Click here for more information about dam failure.*	3.6%	110
Drought *Click here for more information about drought.*	30.2%	919
Volcano *Click here for more information about volcanos.*	15.6%	474
Space Weather *Click here for more information about space weather.*	8.0%	243
Other	4.6%	141

6. What other natural hazards do you worry about?

Other hazards commonly mentioned include:

- climate change,
- tsunami,
- falling trees,
- hazardous material spill/industrial accident,
- loss of electricity,
- economic collapse,
- pandemics,
- radon,
- sinkholes,
- poor air quality, and
- man-made disasters.

7. Have you experienced any of the hazards above?



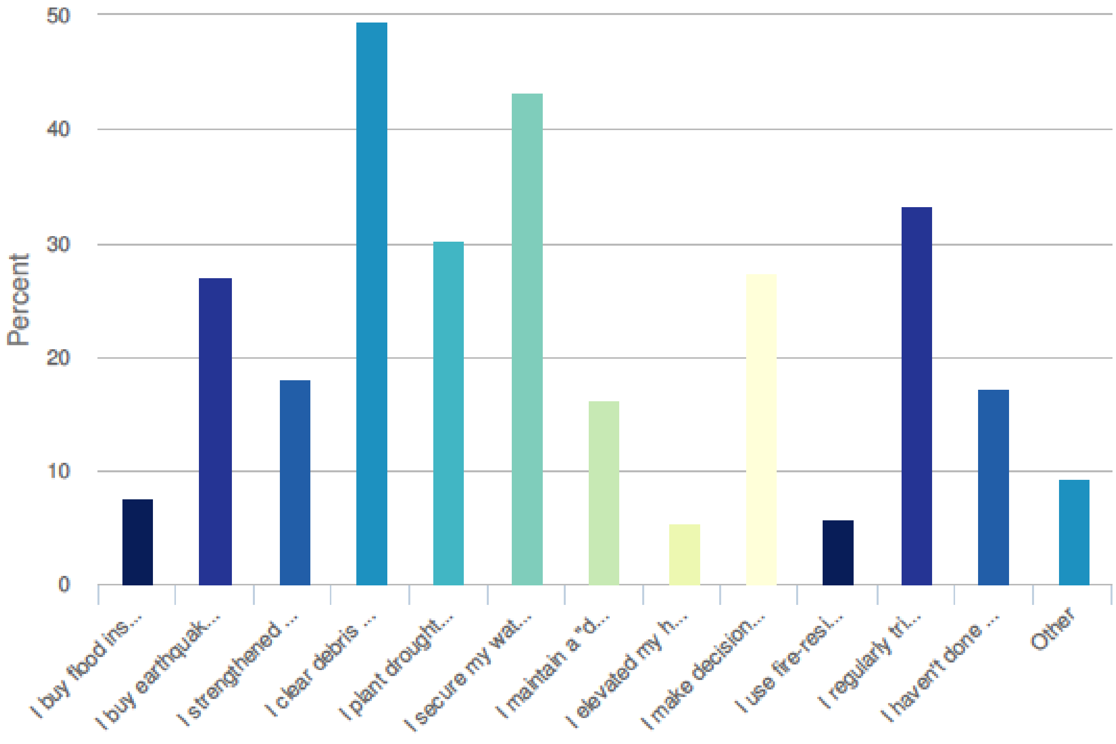
Value	Percent	Count
Yes	54.5%	1,660
No	45.5%	1,386
	Total	**3,046**

8. Can you tell us about your experience?

The vast majority of responses included hazards experienced living, working or vacationing elsewhere. For Portland experienced hazards, respondents most commonly referenced severe weather, earthquakes and flooding. Power outages, difficulty driving/commuting in severe weather, basement flooding and falling trees were commonly mentioned impacts. Many respondents mentioned the following:

- Earthquakes in California or elsewhere
- Portland "Spring Break Quake"
- Minor earthquakes in Portland
- 1996 Floods in Portland
- Eruption of Mt. St. Helens
- Ice storms
- Basement flooding due to severe weather/storms
- Columbus Day storms
- Small-scale nuisance flooding
- Water use restrictions from drought
- Power outages from severe weather/winter weather
- Difficulty driving/commuting in winter weather
- Landslides during the 1996 flood
- Tornadoes, mostly experienced elsewhere
- Hurricanes in other locations
- Wildfire, mostly experienced elsewhere
- Extreme temperatures (heat)
- Downed trees
- High winds
- Flooding in general or experienced elsewhere
- Small landslides in Portland
- Flooding in Johnson Creek, and
- Extreme cold.

9. Have you done any of these things to make you and your family safer?To follow links for more information, right click link and select "open in new tab".


50
40
30
20
10
0
Percent
I buy flood ins...
I buy earthquak...
I strengthened ...
I clear debris ...
I plant drought...
I secure my wat...
I maintain a "d...
I elevated my h...
I make decision...
I use fire-resi...
I regularly tri...
I haven't done ...
Other

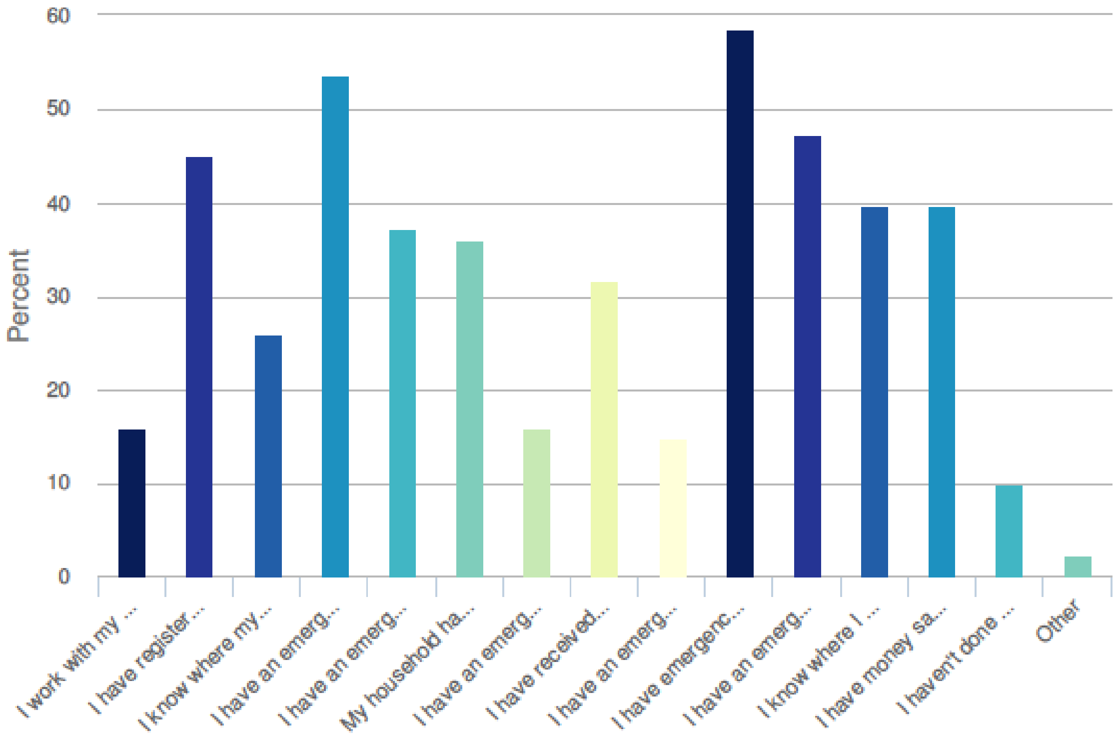
Value	Percent	Count
I buy flood insurance for my home. *More information here*.	7.6%	232
I buy earthquake insurance for my home. *More information here*.	27.0%	825
I strengthened my home against earthquakes. *More information here*.	18.0%	551
I clear debris from my storm drains. *More information here*.	49.5%	1,514
I plant drought-resistant plants. *More information here*.	30.2%	924
I secure my water heater, book cases, or other objects that could fall in an earthquake. *More information here*.	43.3%	1,323
I maintain a "defensible space" clear of vegetation and flammable material. *More information here*.	16.2%	496
I elevated my home or utilities above potential flood levels. *More information here*.	5.5%	168
I make decisions about where to live based on natural hazard risks. *More information here*.	27.3%	835
I use fire-resistant landscaping around my home. *More information here*.	5.8%	178
I regularly trim trees near my house or near power lines. *More information here*.	33.2%	1,016
I haven't done any of these.	17.1%	523
Other	9.4%	286

The vast majority of the comments related to living in an apartment, being a renter or preparing an emergency kit (addressed in the subsequent question). Common responses included:

- I live in an apartment/condo or rent
- Water capture systems, such as rain barrels
- Improved drainage around home, and
- Located/modified gas shutoff valves.

10. Have you done any of these things to be prepared for an emergency?To follow links for more information, right click link and select "open in new tab".

37242



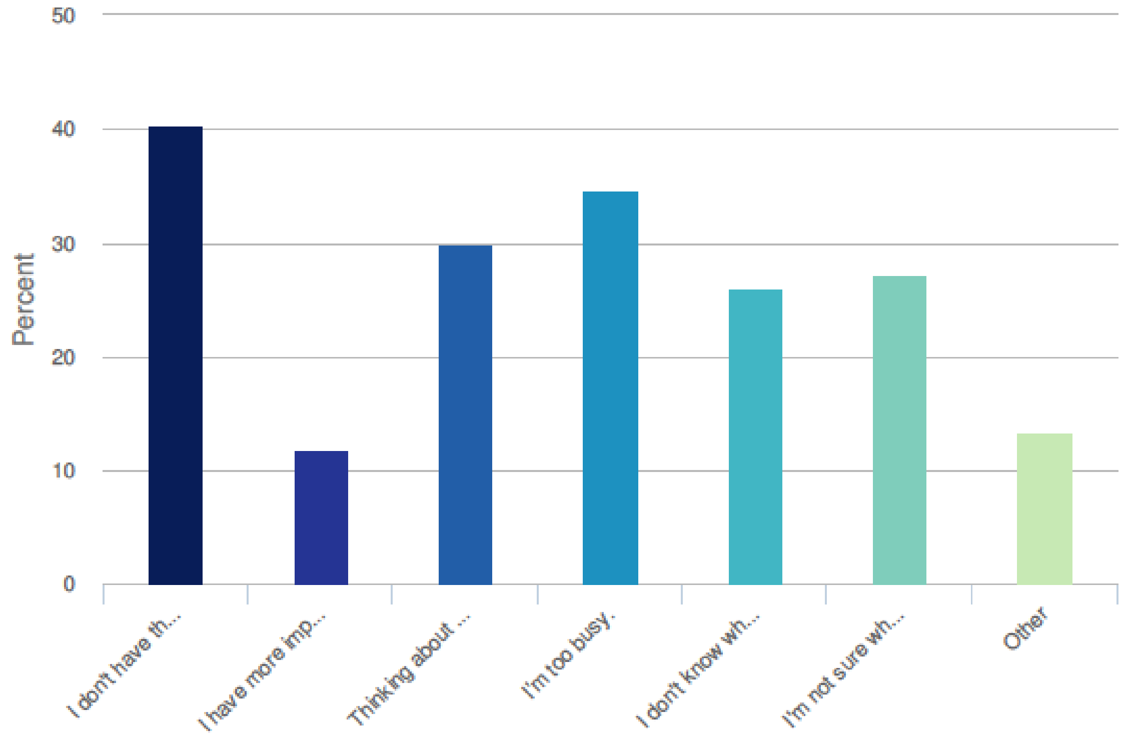
Percent
60
50
40
30
20
10
0
I work with my ...
I have register...
I know where my...
I have an emerg...
I have an emerg...
My household ha...
I have an emerg...
I have received...
I have an emerg...
I have emergenc...
I have an emerg...
I know where I ...
I have money sa...
I haven't done ...
Other

Value	Percent	Count
I work with my neighbors on emergency preparedness. More information here.	15.9%	488
I have registered for Public Alerts in my preferred language. *Go to PublicAlerts.org to register.*	45.0%	1,381
I know where my neighborhood BEECN is. *Find your neighborhood BEECN here.*	25.7%	788
I have an emergency kit at home. *More information here.*	53.6%	1,642
I have an emergency kit in my car. *More information here.*	37.2%	1,141
My household has an emergency plan. *More information here.*	35.9%	1,101
I have an emergency plan for my pets. *More information here.*	15.9%	489
I have received emergency training. *More information here.*	31.6%	969
I have an emergency source of power. *More information here.*	14.9%	457
I have emergency food and water. *More information here.*	58.6%	1,797
I have an emergency contact outside of the area. *More information here.*	47.2%	1,448
I know where I would go in an emergency. *More information here.*	39.5%	1,212
I have money saved for emergency use. *More information here.*	39.6%	1,213
I haven't done any of these.	10.0%	306
Other	2.3%	71

Other common responses included:

- Emergency kit at work
- NET/CERT volunteer
- Emergency communication system (e.g. ham radio), and
- Participate in drills.

11. Do any of these things make it hard for you to prepare your family for emergencies?

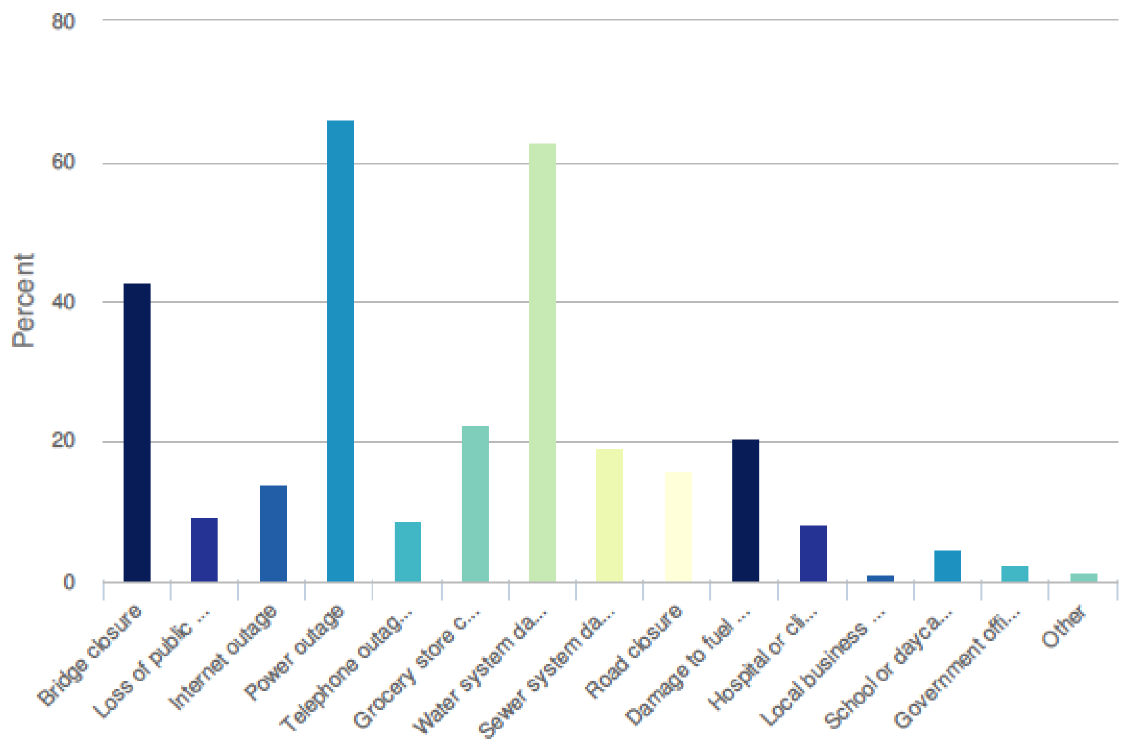


Value	Percent	Count
I don't have the money.	40.3%	997
I have more important things to worry about.	11.8%	293
Thinking about preparedness is just too overwhelming.	29.8%	739
I'm too busy.	34.6%	857
I don't know what I need to do.	25.9%	641
I'm not sure what my risks are.	27.2%	674
Other	13.4%	332

Other common responses included:

- Procrastination
- Laziness
- Denial
- Disability/elderly
- Don't have room or a secure place to store items
- Don't own home or live in an apartment building
- Difficulty retrofitting older homes
- Lack of people taking it seriously (friends/family/neighbors)
- Have started preparations, but have not completed them
- Have not prioritized it
- Lack of urgency
- Issues regarding rotation of food/medicine/water etc.
- Unsure how to address some issues related to planning/preparing
- Issues regarding preparations for pets
- Uncertainty/unknowns

12. Natural hazards can cause damage that makes it hard to carry out our daily lives. Select three (3) things that would impact you most.

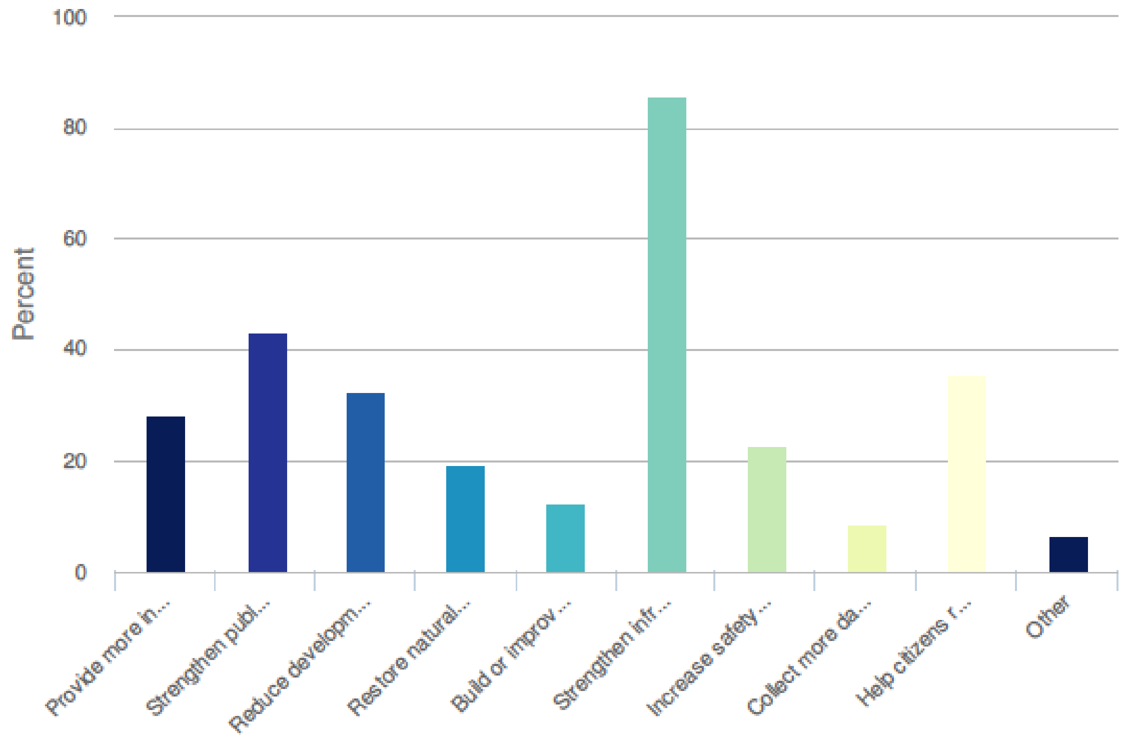


Value	Percent	Count
Bridge closure	42.8%	1,321
Loss of public transportation	9.1%	281
Internet outage	13.7%	423
Power outage	66.0%	2,036
Telephone outage	8.5%	261
Grocery store closure	22.3%	688
Water system damage	62.5%	1,929
Sewer system damage	19.1%	588
Road closure	15.7%	483
Damage to fuel and natural gas infrastructure	20.4%	630
Hospital or clinic closure	7.9%	244
Local business closure	0.7%	21
School or daycare closure	4.5%	138
Government office closure	2.3%	71
Other	1.2%	36

Other common responses included:

- Getting medicine
- Damage to home
- All options listed
- Damage to public schools, and
- Cell phone outages.

13. What are the three (3) most important things the City of Portland government offices should do to reduce the risk from natural hazards?

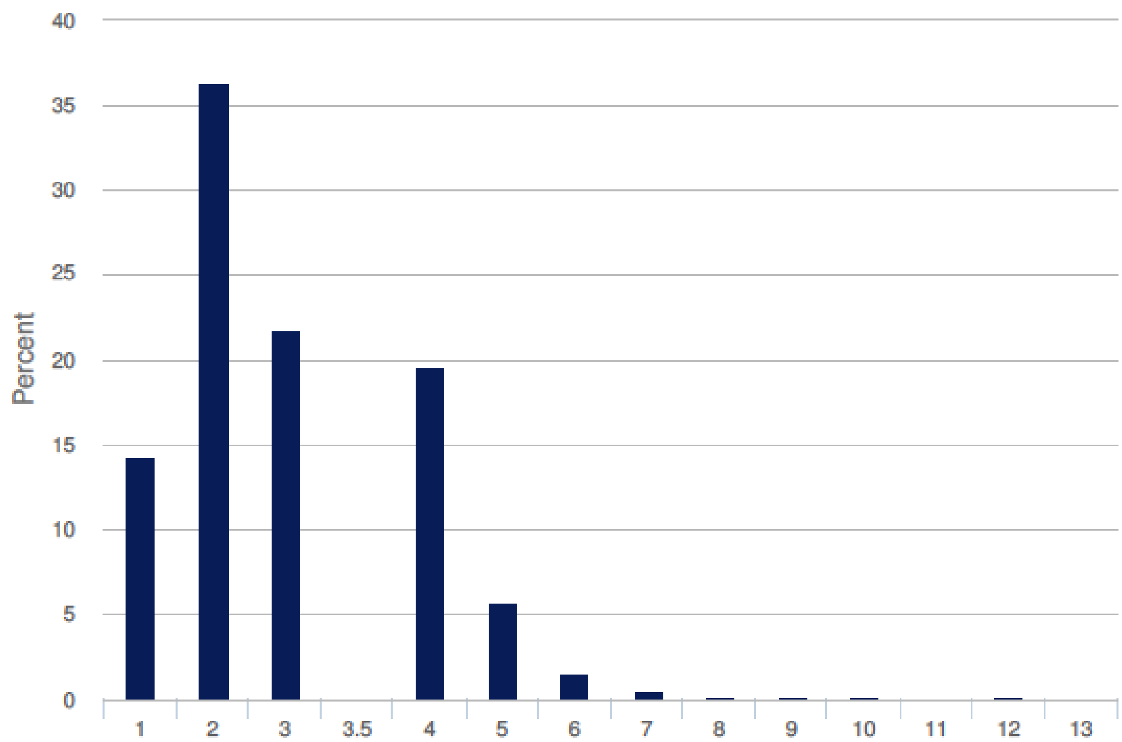


Value	Percent	Count
Provide more information to the public about natural hazards.	28.1%	847
Strengthen public buildings.	43.2%	1,302
Reduce development in known hazardous areas.	32.3%	974
Restore natural floodplains and open space.	19.0%	573
Build or improve man-made protections (levees for example).	12.1%	363
Strengthen infrastructure such as bridges, sewer lines, and water pipes.	85.4%	2,572
Increase safety requirements for building permits.	22.4%	675
Collect more data and information about hazard areas.	8.2%	246
Help citizens reduce their individual natural hazard risks.	35.3%	1,062
Other	6.4%	194

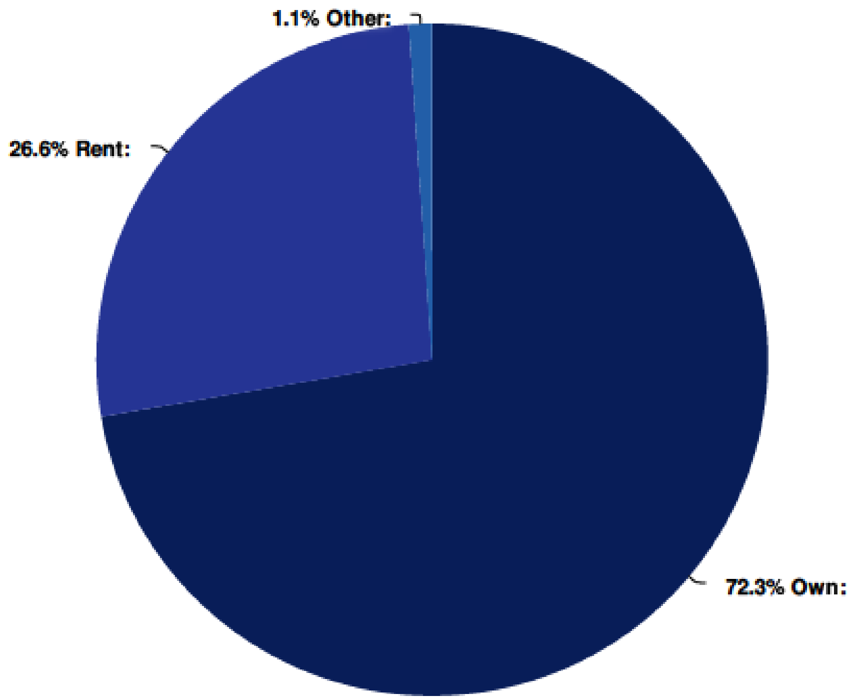
Other common responses included:

- Strengthen schools
- Road infrastructure improvement/address traffic issues
- Subsidize retrofits/preparedness
- Underground utilities
- Tax breaks
- Increase funding/wise use of public resources
- Address oil/gas infrastructure and shutoffs
- Strengthen bridges
- Require upgrades/retrofits
- Provide more information/guidance on planning and preparedness
- Offer more training/classes
- Help make it easier for residents to prepare, especially vulnerable populations.

14. How many people are in your household?

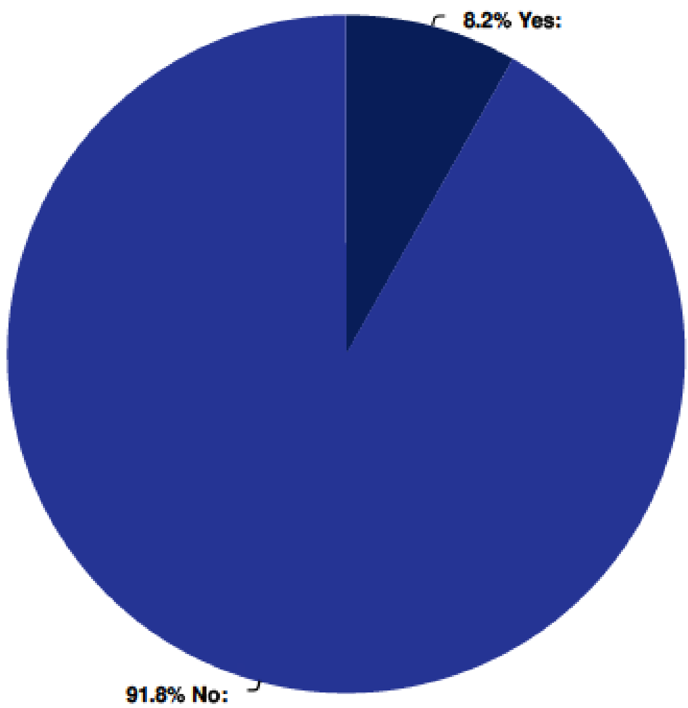


15. Do you own or rent your home?



Value	Percent	Count
Own	72.3%	2,141
Rent	26.6%	789
Other	1.1%	32
	Total	**2,962**

16. Were you born in another country?



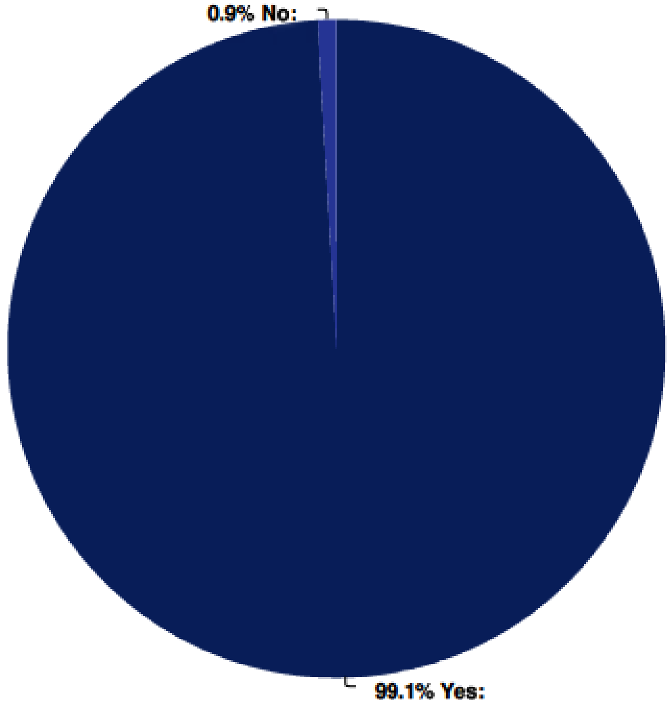
Value	Percent	Count
Yes	8.2%	233
No	91.8%	2,625
	Total	2,858

17. Where were you born?

Other common responses included:

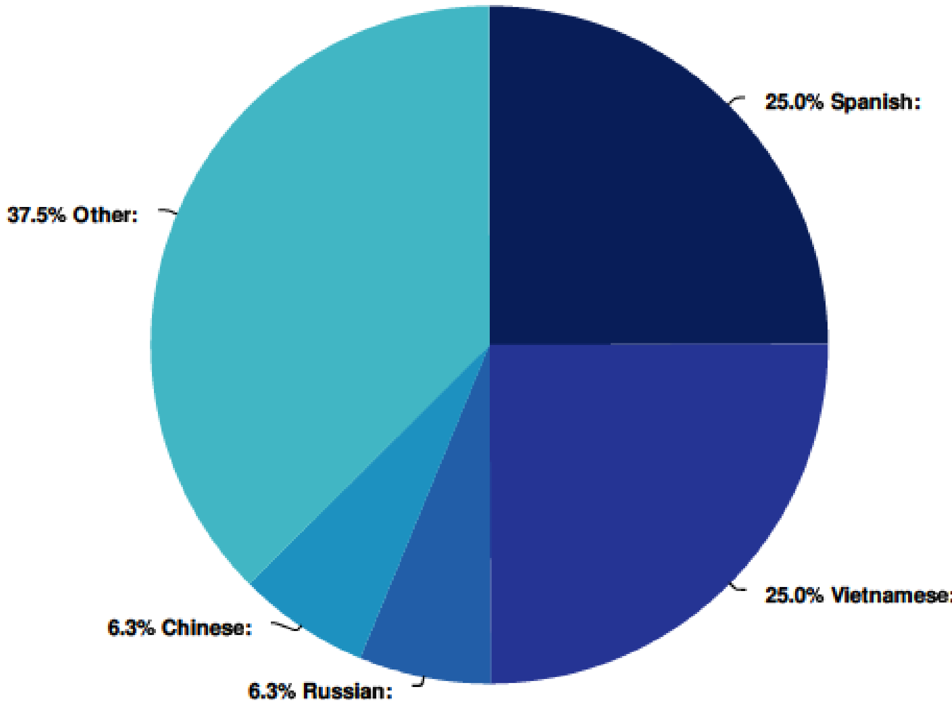
- Germany
- Canada
- Japan
- Philippines
- England
- Mexico
- Ukraine
- Vietnam

18. Do you speak English at home?



Value	Percent	Count
Yes	99.1%	2,941
No	0.9%	27
	Total	**2,968**

19. What language do you prefer?

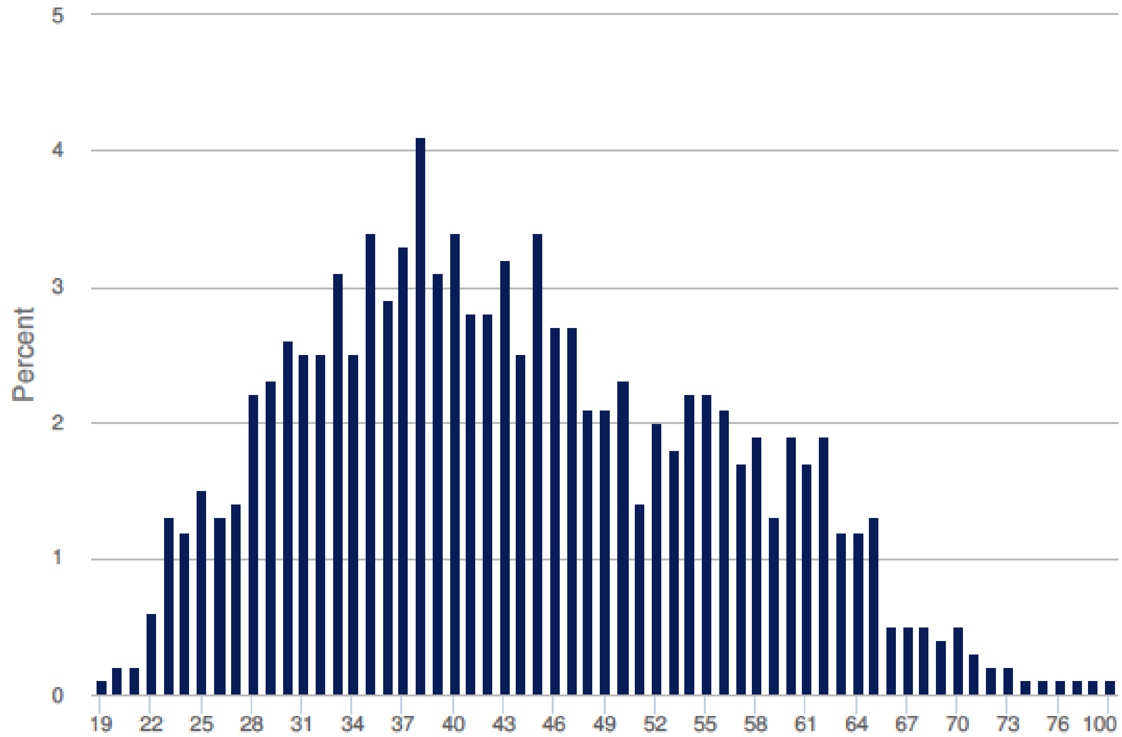


Value	Percent	Count
Spanish	25.0%	4
Vietnamese	25.0%	4
Russian	6.3%	1
Chinese	6.3%	1
Other	37.5%	6
	Total	16

Other responses included:

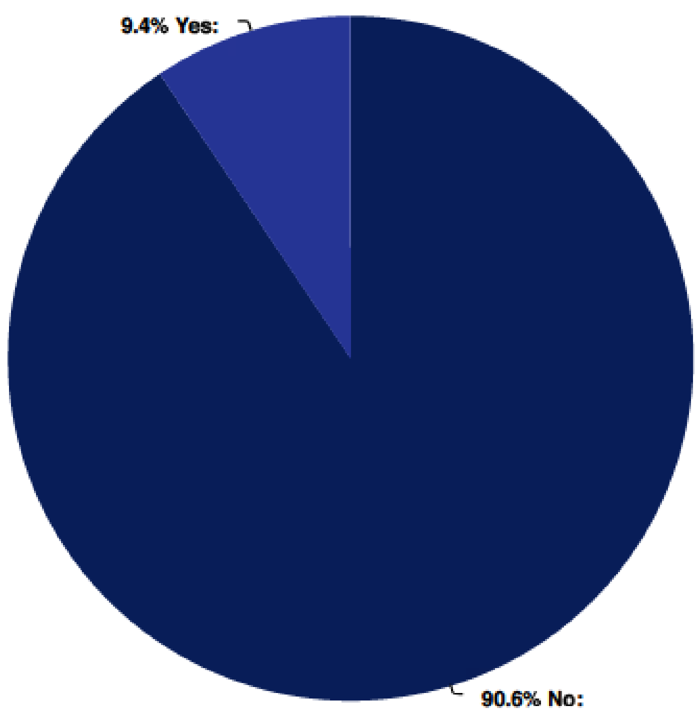
- English
- Hindi
- Nepali
- Persian

20. What is your age?



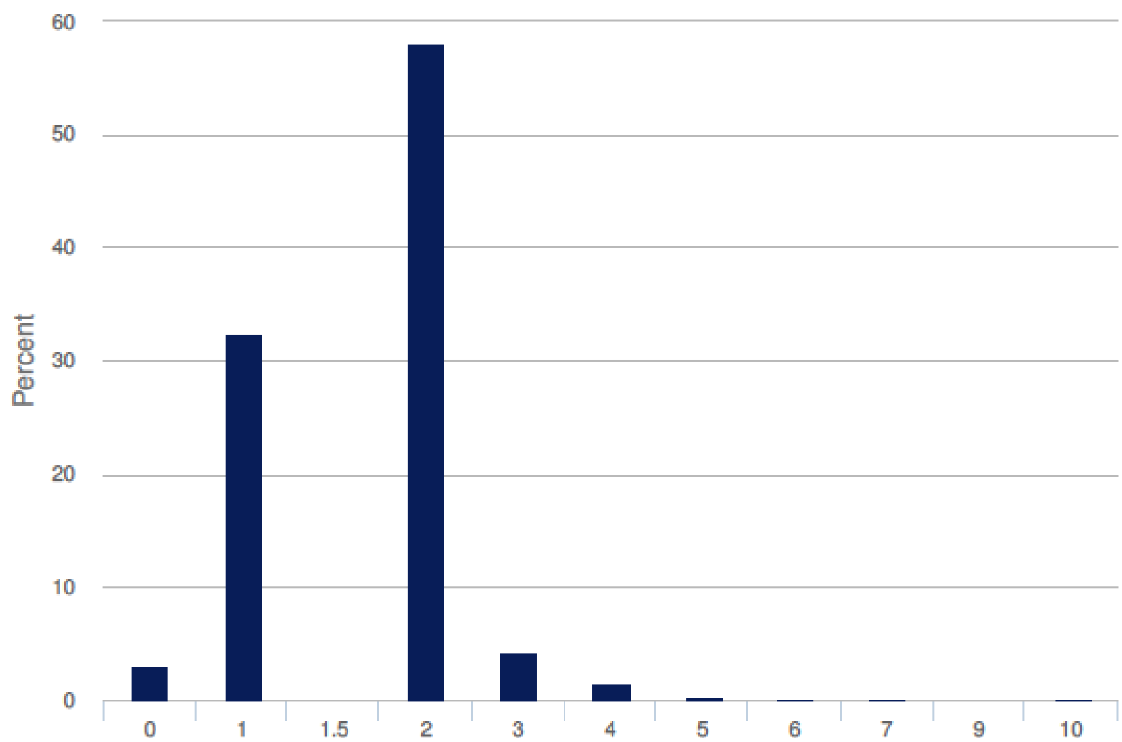
Average age is 43.5 years

21. Do you have a physical or mental disability?



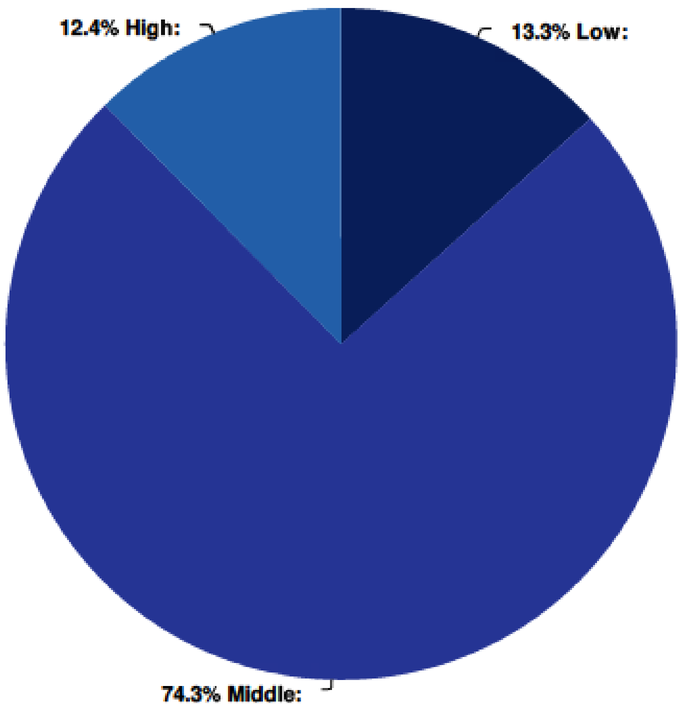
Value	Percent	Count
No	90.6%	1,834
Yes	9.4%	191
	Total	**2,025**

22. How many people in your home work to provide for the family?



Average is 1.7 people.

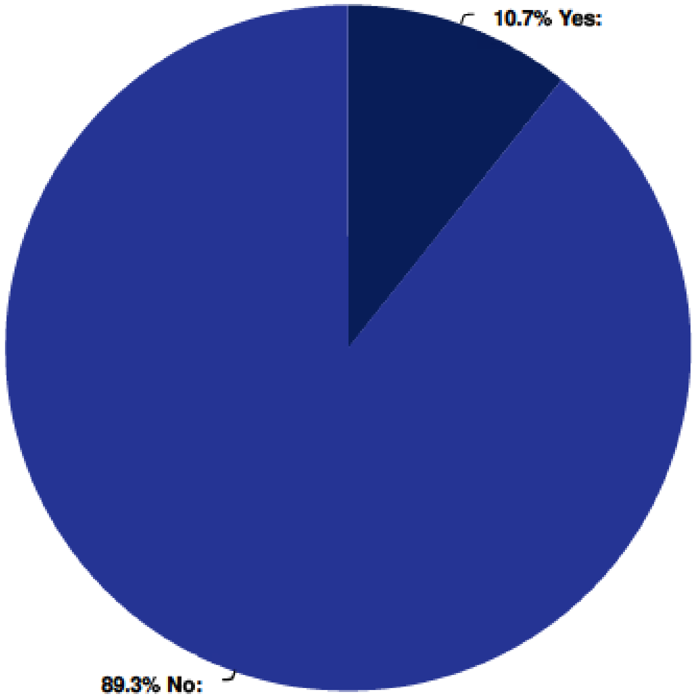
23. Would you consider your household income low, middle, or high?



Value	Percent	Count
Low	13.3%	393
Middle	74.3%	2,197
High	12.4%	366
	Total	**2,956**

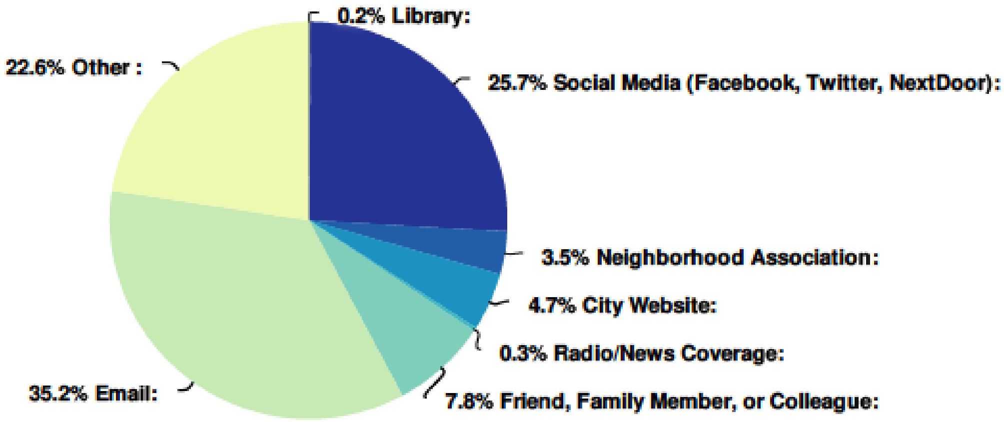
24. How do you identify yourself by race or ethnicity?

25. Are you a trained Community Emergency Response Team/Neighborhood Emergency Team member?



Value	Percent	Count
Yes	10.7%	314
No	89.3%	2,629
	Total	**2,943**

26. How did you find out about this survey?

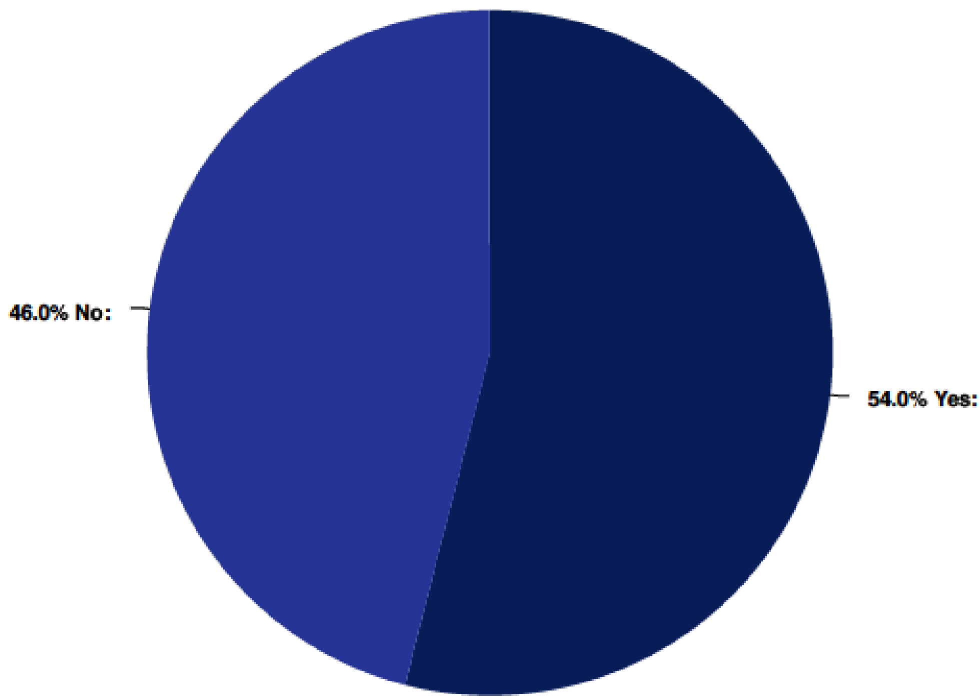


Value	Percent	Count
Library	0.2%	5
Social Media (Facebook, Twitter, NextDoor)	25.7%	761
Neighborhood Association	3.5%	103
City Website	4.7%	140
Radio/News Coverage	0.3%	10
Friend, Family Member, or Colleague	7.8%	231
Email	35.2%	1,040
Other	22.6%	668
	Total	2,958

Other common responses included:

- Work/employer
- OHSU
- ARES
- Ozone
- School
- Flash alert

27. Would you like us to contact you with related information and training opportunities?



Value	Percent	Count
Yes	54.0%	1,561
No	46.0%	1,330
	Total	**2,891**

PLANNING FOR REAL WORKSHOPS

Planning for Real Workshop Report

INTRODUCTION

This report summarizes the public feedback gathered in support of Portland's 2016 update to its natural hazard mitigation plan (NHMP). It is intended to be used by city bureaus and offices to identify and prioritize action items to be included in the NHMP.

As part of the planning process, the planning team, with guidance from the steering committee, developed a public engagement strategy to outline the ways in which the planning team would engage the public in the development of the plan. The public engagement strategy recommended that the planning team hold 10 "Planning for Real" workshops throughout Portland. Eight of these workshops would be open to the public and focused geographically in eight of the nine risk reporting areas used for the plan. The risk reporting areas are roughly aligned with Portland's neighborhood coalitions with the addition of a Central City area. The remaining two workshops would be held with community organizations that work with Portland's communities of color and immigrant and refugee communities.

The NHMP planning team ultimately held 7 geographically-based workshops in the following locations:

- Northeast and Central Northeast Portland (joint workshop), April 18th, 2016
- Northeast Portland, April 23rd, 2016
- North Portland, April 30th, 2016
- Southeast Portland, April 24th, 2016
- Southwest Portland, May 3rd, 2016
- North/Northwest Portland and Central City (joint workshop), April 23rd, 2016
- East Portland, May 10th, 2016

The workshops were promoted through and organized with the support of the following neighborhood coalitions and groups:

- Northeast Coalition of Neighbors
- Central Northeast Neighbors
- North Portland Neighborhood Services
- Southeast Uplift
- Southwest Neighborhoods, Inc.
- Neighbors North/Northwest
- East Portland Action Plan

Two workshops were held with community organizations with the following groups:

- Coalition of Communities of Color, Native American Youth and Family Center, Portland Voz, Asian Pacific American Network of Oregon (APANO) and Latino Network, May 7th, 2016
- Community Engagement Liaisons (CELs) representing Chinese, Zomi, Lao, Butanese, Somali, Latino, Iraqi, and Khmer immigrant and refugee communities, May 14th, 2016

Individuals in the Community Engagement Liaisons group are leaders in their communities and are contracted with the City of Portland to act as a bridge between city government and immigrant and refugee communities. Following the CELs workshop, each participant was asked to schedule a meeting with at least 10 members of his or her community to share information about hazards in Portland and to provide any feedback received to the planning team by June 15th. This work is still in progress.

WORKSHOP CONTENT

The content of each workshop varied based on lessons learned from previous workshops. The planning team recognized that this was an entirely new process and was open to adapting the workshop content to community needs throughout the process. Earlier workshops focused on the NHMP planning process and the local physical exposure to hazards of concern (primarily flood, earthquake, landslide, wildfire, and severe weather, with some discussion of drought, space weather, and volcano) in the geographic area in which the workshop was held.

Based on feedback received during the process (detailed below), the content of later workshops was adapted to align with the PBEM's long-term outreach goals and to establish partnerships with local community groups in building resilience and community capacity. Workshop participants urged the planning team to deemphasize the planning process itself, and provide more information about what projects and programs the city is currently doing to reduce vulnerability, and how the city might partner with community organizations to enhance social and economic benefits to the community. Later workshops took this feedback into account. These workshops were broader in focus, briefly covering natural hazard risks, highlighting current citywide activities to reduce risk and vulnerability, and working to identify potential partnerships and collaborations between the city and community organizations.

For workshops with fewer attendees, discussion sessions involved the whole group, while larger groups were divided into discussion groups focused on specific hazards (wildfire, flood, earthquake, etc.). The following are questions discussed during the discussion sessions:

1) Is your neighborhood in a hazard risk zone? Are there buildings or services you use on a daily basis that are in a hazard risk zone? What would the consequences be if they were impacted by a natural hazard?
2) What are some ways that you could reduce the risk impacts and negative consequences at your home, at work, and in your neighborhood?
3) What kinds of programs or projects can city offices do to support you and your neighbors in preparing for natural hazards?
4) Are there potentially vulnerable populations in your neighborhood that could experience disproportionate impacts from natural hazard events? Can you think of ways to build capacity for these groups now, so that they are better positioned to absorb and recover from a hazard event?

COMMUNITY FEEDBACK

This section describes the feedback received from the Planning for Real workshops, summarized by topic. Topics include planning process, communications, and outreach; all-hazards; landslide; flood; earthquake; wildfire; severe weather; and drought.

Planning Process, Communications, and Outreach

This topic is the broadest in scope and includes feedback related to how the NHMP planning process is implemented, how to communicate messages about natural hazards and other emergencies, and how education and outreach efforts are managed across the city. This topic was the one most frequently discussed during workshops, indicating that activities that fall within this category are high priority for workshop participants.

Participants were generally in support of using the Neighborhood Emergency Team (NET) program to connect neighbors and prepare as a community. Many neighborhoods lack NETs, and the need to expand the program was highlighted. Several outreach tools were also mentioned, including using NextDoor (social media website) to promote preparedness messages, and City of Seattle's Structured Neighborhood Assessment Program (SNAP) was mentioned as an example model for community organizing.
Emergency messaging was also a prevalent topic, particularly communication of emergency messages using a variety of media and in languages other than English. A cohort of Portland residents with hearing impairments attended the East Portland workshop, and emphasized the need to communicate emergency messages using visual means including signs and graphics or flashing lights as emergency signals. Communication through graphics would also help to reach children, people who are unable to read, and people with limited English proficiency. Participants advocated for a registry of addresses with people with special needs that could be shared with emergency responders.

There was a strong emphasis on culturally appropriate and multi-language outreach and preparedness training, as well as safety training for post-disaster reconstruction and recovery. Nearly all of the workshops included a discussion of the need for additional training and education opportunities at the community level. In terms of outreach, workshop participants expressed that outreach about the plan should focus on information about social and economic benefits and investing in community capacity through partnerships. Community members are not likely to emotionally engage with specific plans; they see all of PBEM's work, and often the whole city, as one effort. To the community, there is no difference between each of PBEM's plans and the plans developed by other bureaus; the city's outreach efforts should align with one another rather than operating in "silos". Community members care most about how the city's work will directly impact them.

Some key recommendations in this category were:

- Include full social and economic recovery after a disaster as a goal of the plan.
- Provide culturally and community-specific training for community leaders on home safety, hazard mitigation (e.g. non-structural seismic strengthening), food and supply storage, response considerations for people with special needs, and household and neighborhood preparedness.
- Develop post-disaster safety messages based on 2013 "Day Labor, Worker Centers & Disaster Relief Work in the Aftermath of Hurricane Sandy" report.
- Provide education for rental property owners and property managers on hazard communication and mitigation actions.
- Provide training on evacuation and sheltering for retirement home staff and all licensed nursing homes and assisted living care providers.
- Increase PBEM's capacity to provide community trainings and partner with the Office of Neighborhood Involvement, Diversity in Civic Leadership program, and Community Engagement Liaisons program to connect underserved communities with training opportunities.

- Expand the NET program into every neighborhood in Portland and expand beyond the neighborhood structure to non-geographic communities (e.g. immigrant and refugee communities).
- Update Portland Maps to be more user-friendly and visually map hazards.
- Cultural and language-appropriate webpage for New Portlanders to access emergency information, videos, and events in their preferred language.
- Postcard mailers to every household in Portland to share natural hazard risks and how to be prepared. Include this information in neighborhood newsletters.
- Hold a storytelling event to share disaster survivor stories and share information about hazards in an emotionally compelling way.
- Citywide "Preparedness Tours" to highlight exemplary projects.
- Do outreach for ATC-20 damage assessment trainings at neighborhood land use and transportation meetings. Provide ATC-20 training to NET members to support ATC-20 certified engineers and architects.

All-Hazards

Much of the feedback received during the workshops relates to reducing overall vulnerability and can be applied across multiple hazards. This category includes ideas that address multiple hazards but are not directly related to the hazard mitigation planning process or communication and outreach.

There was widespread interest among workshop participants in identifying a funding mechanism for assisting low-income families, particularly those with elderly or very young members, in the purchase and installation of air conditioners to address the risks posed by severe heat, as well as the diminished air quality during wildfire season and during a potential volcanic eruption. Participants were concerned about the rising summer temperatures over the past few years, and felt that the city should provide assistance for potentially vulnerable residents who don't have access to air conditioning. Participants recognized that most areas in the city are not at direct risk from volcanic lava or debris flows, but there was concern that ashfall after an eruption would pose a significant risk to the elderly and those who suffer from asthma and other respiratory problems. Another option discussed by workshop participants was to place permit requirements on new multi-family and rental housing to include air conditioning systems.

Food, water, and energy independence was another common thread in many workshop discussions. Workshop participants expressed concern about access to food and water in the case of any major natural hazard event in Portland; power outages and fuel shortages were also major concerns. Investments in community gardens and local food production, rainwater collection systems, and solar power systems were suggested as important steps to improving community resilience while simultaneously contributing to the city's sustainability and climate change adaptation goals.

Recognizing the important role day laborers can have in disaster response and recovery, as well as their increased risk of suffering negative consequences after a disaster, workshop participants expressed the desire to see the city take an active role in protecting this group's safety during post-disaster response, reconstruction, and recovery, and preventing post-disaster displacement. Guidelines were developed based on lessons learned from Hurricane Sandy (*Day Labor, Worker Centers & Disaster Relief Work in the Aftermath of Hurricane Sandy*, by Cordero-Guzman et al., 2013) to include these groups in planning activities, protecting workers' rights during reconstruction, provide preparedness and safety trainings, provide access to personal protective equipment, and allocate funds for day labor centers to be established as community resources prior to a major natural hazard event.

Many community-based projects would rely on partnerships with community organizations for implementation. Participants expressed interest in finding ways for the city to financially support community organizations that promote activities related to preparedness and increasing community resilience.

Some key recommendations in this category were:

- Financial assistance and/or regulatory support for low-income residents and renters who are vulnerable to extreme heat or diminished air quality to install air conditioning systems.
- Training and support for day laborers consistent with guidance in "Day Labor, Worker Centers & Disaster Relief Work in the Aftermath of Hurricane Sandy" report from 2013.
- Funding for community organizations outside of formal neighborhood structure whose projects focus on preparedness and community resilience.
- Invest in and promote community gardens and local food production.
- Invest in and promote rainwater collection systems in public, residential, and commercial properties.
- Require new development to include onsite rainwater storage and/or emergency drinking water storage tanks. Include water storage solutions in seismic retrofit projects for schools and other public buildings.
- Update city policies to include energy and water purification solutions promoted internationally by Green Empowerment.
- Invest in and promote solar and other alternative energy in public, residential, and commercial properties.
- Prioritize clearing bike paths so that non-automobile traffic can flow safely and develop plans to locate aid stations along these routes.
- Prioritize road access to grocery stores, medical offices, and hospitals. Consider isolated communities in establishing road-clearing priorities.
- Partner with community groups and critical social service organizations to ensure that they have continuity of operations plans.
- Develop hazard-specific evacuation plans that consider likely impacts to bridges and other transportation infrastructure.
- Develop a recovery plan to promote hazard-informed decision-making for post-disaster redevelopment and to take advantage of the opportunity to move critical assets to safer locations.
- Provide neighborhood tool libraries for mitigation projects and post-disaster reconstruction. Partner with home improvement stores to build tool collections.
- Require Portland's emergency responders to live within the city. Provide financial support to purchase or rent a home within the city limits.

Landslide

Landslides were a major concern for many workshop participants, especially those who live in or near the West Hills in Portland; many were worried about the closure of key access roads and life safety hazards from collapse of bridges and tunnels. Participants were also worried about the dramatic increase in infill development over the past few years and the addition of large multi-family developments in known

landslide hazard areas. There was strong interest in preventing any additional development within the city's regulatory landslide hazard zone.
Some key recommendations in this category were:

- Financial support and education for property owners wishing to remediate their properties for erosion.
- Emergency moratorium on all development in high landslide risk areas.
- Enhanced communication with adjacent property owners and neighbors about how landslide risk is being minimized if development is permitted in landslide risk areas.
- Erosion control projects using bio-swales and beneficial drainage systems.
- Pre-established detour routes for access in and out of known landslide risk areas.

Flood

Flood risks were of particular concern to workshop participants who live in East Portland. Clear communication about safe alternative routes through highly flood-prone areas emerged as a top priority.
Some key recommendations in this category were:

- Replace unsafe or structurally compromised bridges and rebuild to more flood-resistant standards.
- Identify high-traffic bridges and flood-prone routes and establish alternative routes to be used in case they are flooded.
- Require construction of bio-swales for large construction projects where appropriate.
- Promote the use of French drains and other on-site stormwater management systems.

Earthquake

Because of the potential for long-term citywide and regional impact, earthquake is the "model hazard" for many participants in the Planning for Real workshops. Many of the recommendations in the all-hazards category above were discussed in the context of earthquake hazards, but were described in this report as all-hazards recommendations because of their broader applicability to other hazards of concern. It is also important to note that earthquakes may cause or contribute to incidences of other hazard events such as landslides or floods. For that reason, many concerns and recommendations from workshop participants that fall under other categories discussed in this report would also be applicable to earthquake hazards.
The need for enhanced communication about seismic risks and the seismic stability of structures throughout the city was highlighted as a priority during workshop discussions. Participants expressed the need for information about whether public buildings such as schools or office buildings have been seismically strengthened. It was also important to workshop participants that unreinforced masonry buildings be clearly marked so that people who live and work in these buildings are aware of the risks they face.
Participants were also generally unsure about whether current seismic codes were sufficient for a Cascadia Subduction Zone earthquake, and many strongly advocated for higher seismic standards for new buildings and infrastructure. Failure of bridges and overpasses, disrupted communications, and damage to key energy infrastructure and potential hazardous materials in liquefaction zones were major concerns for workshop participants. Many were also concerned about fires caused by broken gas lines and other ignition sources during and after an earthquake.

Some key recommendations in this category were:

- Retrofit and/or move fuel infrastructure in Linnton. Maintain fuel reserves in safe locations for use in disaster recovery.
- Strengthen levees to seismic standards.
- Develop an inventory of and distribute information about which shelter facilities have been retrofitted.
- Provide property owners with financial assistance for seismic strengthening, especially owners of multi-family and low-income housing.
- Reinforce and fire-proof the Linnton Community Center as a place of refuge for residents who cannot evacuate.
- Require automatic shutoff valves for gas lines in all new development.
- Evaluate whether current seismic codes are sufficient for a 9.0 subduction zone earthquake. If not, adopt higher standards.
- Assess seismic stability of large water towers throughout the city to determine whether they pose a risk or could be used as an emergency water source.
- Communicate information about hazardous materials and potential plume areas prior to major event. Ensure firefighters and NET members know hazard types and response considerations.
- Label unreinforced masonry buildings to notify occupants of their risks.
- Require signage about risks and evacuation routes in hotels.
- Retrofit and reinforce schools beyond life-safety standards so that they can be used as neighborhood shelters and storage locations for emergency supplies.
- Stage emergency resources on the west side of the river in case bridges fail and east-west access is blocked.
- Continually update water and sewer pipe systems, and continue with the project to build a seismically reinforced water pipe that crosses under the Willamette River.

Wildfire

Wildfire was primarily a concern for workshop participants who live in or near the West Hills, although participants from other areas in the city recognized the air quality risks associated with wildfire outside of their immediate neighborhoods. Recommendations to address air quality issues are discussed in the all-hazards topic above.

Many participants expressed concerns about hotter, drier summers leading to increased wildfire risk. There was also some concern about invasive or non-native species contributing to wildfire risk, as well as certain diseases affecting trees that can cause massive tree die-outs including Swiss-Cass Needle Disease, which is currently affecting Portland's Douglas Fir tree population.

Workshop participants provided a number of zoning and building code solutions to reduce fire risk in urban-wildland interface zones, such as requiring non-combustible roofing materials in wildfire risk zones. There was also interest in the city providing training to community members and NET members to use firefighting equipment and hoses.

Some key recommendations in this category were:

- Require metal or composition roofing materials when replacing greater than 50% of a roof in a wildfire risk zone.
- Provide NET members with training on fire response, especially how to use fire hydrants and hoses.
- Provide clear information to the public on burn restrictions.

Severe Weather

Primary concerns from workshop participants about severe weather were related to extreme heat and emergency shelters for all extreme weather conditions. All recommendations for severe weather are included under the all-hazards topic above.

Drought

Although drought was not a major concern for most workshop participants, some did provide recommendations for reducing Portland's drought risk. These recommendations were primarily focused on water conservation and planting native and drought-resistant plants that require less water.
Some key recommendations in this category were:

- Promote homeowners planting native and drought-resistant plants that require less water during drier months.
- Provide water conservation education to kids in schools.

NEXT STEPS - INSTRUCTIONS GIVEN TO BUREAUS

This report is intended to inform the development and prioritization of action items for the NHMP. City bureaus and offices should use this feedback from community members to supplement the list of recommended action items from other sources in this planning process. Bureaus and offices should consider which of the recommendations might fit under their portfolios. Those actions that are selected should be included in the final list of actions submitted to the NHMP planning team. They should also be refined using the equity screening process and prioritized using the prioritization tables provided in the bureau toolkit.

Questions? Contact Danielle Butsick at 503-823-3926 or danielle.butsick@portlandoregon.gov.

TOWN HALL MEETINGS

Town Hall Meeting Summary

During the public review and comment period, five town hall events were held throughout Portland to give residents an opportunity to ask questions about and provide feedback on the draft Mitigation Action Plan (MAP) (See Table 1). These events were advertised as Summer Socials (See Figure 1). At the Summer Socials, the public was invited to come and view the maps, review the draft plan, and ask questions of city staff and neighborhood emergency team volunteers. Approximately 60 people attended the events, some even came to multiple events. Attendees learned about liquefaction, talked about natural hazard risks and how to get prepared. The Summer Socials led to several individuals being interested in becoming trained Neighborhood Emergency Team members, and several people registered for PublicAlerts after talking to staff about the voluntary registration program. Planning team staff shared information about city bureau projects currently underway to reduce risks from natural hazards, as well as those listed in the plan that bureaus hope to implement over the next five years.

Table 1. Meeting Dates, Description and Attendance

Date	Town Hall Meeting	Description/Geographic Area	Estimated Attendance
8/9	1st Town Hall Meeting	• Coalition of Communities of Color	15
8/16	2nd Town Hall Meeting	• West/Northwest	15
8/17	3rd Town Hall Meeting	• North/Northeast	15
8/23	4th Town Hall Meeting	• East/Southeast	15
8/30	5th Town Hall Meeting	• Southwest	15

Figure 1. Flyer Announcing Town Hall Events

Source: PBEM

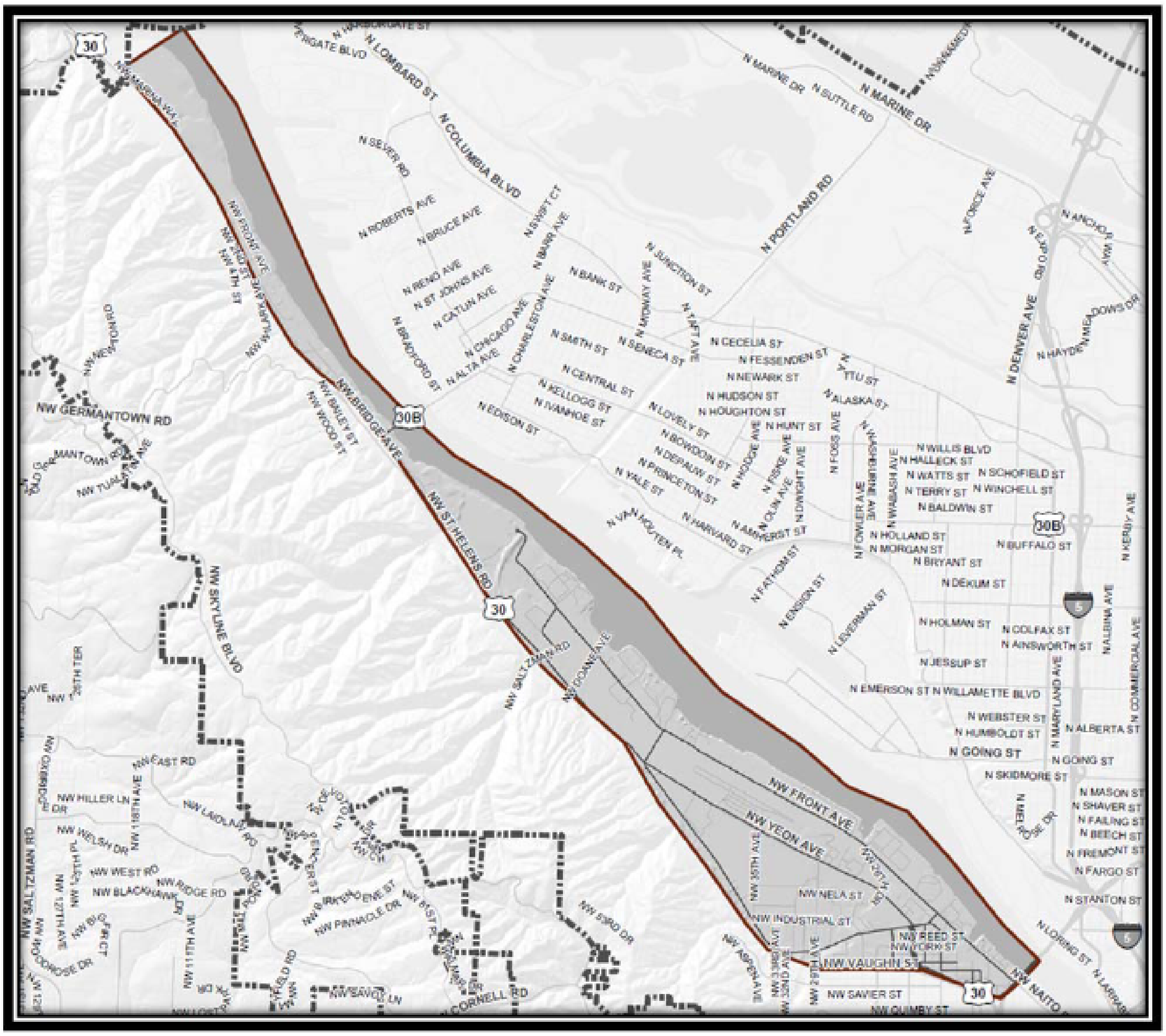
Figure 2. Residents Attending Summer Social Events

The Mitigation Action Plan

Appendix D. Critical Energy Infrastructure Hub Study

Portland Bureau of Emergency Management

2016 Critical Energy Infrastructure Hub Study



TETRA TECH

June 2016

2016 Critical Energy Infrastructure Hub Study

June 2016

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CONTENTS

Tables

Figures

GLOSSARY

BES—Bureau of Environmental Services (Portland)

CDMS—Comprehensive Data Management System

CEI—Critical Energy Infrastructure

CFR—Code of Federal Regulations

CSZ—Cascadia Subduction Zone

DOGAMI—Oregon Department of Geology and Mineral Industries

FEMA—Federal Emergency Management Agency

GIS—Geographic Information System

Hazus-MH—Hazards, United States-Multi Hazard

LEAP—City of Portland Local Energy Assurance Plan

LNG—Liquid natural gas

NEHRP—National Earthquake Hazards Reduction Program

PBEM—Portland of Bureau of Emergency Management

PUC—Public Utility Commission of Oregon

USGS—U.S. Geological Survey

EXECUTIVE SUMMARY

The stability and reliability of local energy importation systems are of paramount importance to the City of Portland and the surrounding region. A significant portion of the energy distribution infrastructure is located along a 6-mile stretch of the lower Willamette River in Northwest Portland, between the I-405 Fremont Bridge and Sauvie Island, commonly referred to as the Critical Energy Infrastructure Hub (the CEI Hub). The energy sector facilities in the CEI Hub receive and distribute 90% of the fuel that powers the State of Oregon (PBEM, 2012). The CEI Hub includes the following types of facilities:

- All of Oregon's major liquid fuel port terminals
- Liquid fuel transmission pipelines and transfer stations
- Natural gas transmission pipelines
- Liquefied natural gas storage facility
- High-voltage electric substations and transmission lines
- Electrical substations for local distribution.

The CEI Hub is strategically located to provide access to navigable waters, rail infrastructure, petroleum pipelines, and highways, all important for both the supply and the distribution of energy products. While the location is vital for its functions, it is also a significant source of risk for the CEI Hub assets and personnel as well as residents who live adjacent to the CEI Hub. The CEI Hub area is especially susceptible to earthquake, flood, landslide, severe weather, volcanic ash fall, and wildfire.

This CEI Hub study was conducted by the Portland Bureau of Emergency Management in coordination with the 2016 update of the City of Portland Hazard Mitigation Plan. The purpose of the study was to develop a stand-alone report that includes a risk assessment and a list of key recommendations, and to incorporate the findings into the update of the city's hazard mitigation plan.

The study also included a comprehensive literature review on five previous studies related to the CEI Hub to pull together key findings and recommendations.

STAKEHOLDER ENGAGEMENT

Stakeholders for this study are local, state and federal agencies, as well as owners and operators of CEI Hub facilities, local residents, and environmental groups, all of whom have a stake in the disaster resiliency of the CEI Hub. In all, over 135 stakeholders were invited to participate in this study. Fewer than 10 percent of the stakeholders invited to participate in this study actually participated. This low level of participation was not surprising, as it tracks with the level of participation in other studies reviewed for this project; but it does have a direct effect on the quality of the risk assessment results.

RISK ASSESSMENT

A comprehensive risk assessment was performed on the CEI Hub facilities using the same tools that are being used to update the City's hazard mitigation plan. Risk assessment software was used to model potential impacts from earthquake and flood. Comprehensive Data Management System software was used to capture property-specific attributes of 323 user-defined facilities.

The CEI Hub risk assessment for each hazard of concern includes an overview of the hazard, an analysis of people, property and environment exposed to the hazard, an analysis of the vulnerability of exposed people, property and environment, and a summary of key findings. The 2016 update to the City of Portland Hazard Mitigation Plan includes a more detailed profile for each hazard of concern for the entire city.

SELECTED KEY FINDINGS

- It is assumed that the modeling results of this analysis are understated due to incomplete data sets. There is a heavy reliance on default level data in the modeling for this study in lieu of the data that was not available from CEI Hub stakeholders. The accuracy of the modeling would be significantly enhanced if key data attributes that help estimate damage in the Hazus-MH models could be provided. Further, the Hazus-MH model employed a "lower bound" analysis, intended to demonstrate cost-effectiveness at the lowest level of expected impact.
- The vast majority of the facilities in the study area are constructed on soft, liquefiable soils that are typically associated with increased seismic vulnerability. The soils and liquefaction data provided by DOGAMI significantly enhanced the results of this study.
- The facilities and infrastructure within the study area range from over 100 years old to new or recent construction. The new construction has been built to heightened code standards, while the older construction was built to little or no code standards. The majority of the facilities were constructed to low, or no code standards. Code construction standards are an important parameter in the modeling of seismic events.
- Models of the Cascadia Subduction Zone event show less damage than the Portland Hills Fault event due to proximity to the source. The CSZ event has an epicenter 67 miles west of the study area, while the Portland Hills fault scenario has an epicenter less than 5 miles west of the study area. The CSZ event would be considered the true worst-case scenario due to its higher probability of occurrence and likelihood of regional impact. USGS has assigned a 15 percent probability in 50 years for a CSZ event, versus a 1 percent probability in 50 years for the Portland Hills event. Additionally, seismologists estimate a CSZ event to last longer than 3 minutes, while estimates for a Portland Hills event are 60 seconds or less. Event duration can play a significant role in the amount of damage associated with seismic events.

RECOMMENDATIONS

This study includes nine recommendations:

- Recommendation 1: CEI Hub Disaster Resiliency Workgroup —Form a workgroup made up of CEI Hub stakeholders that would be recognized by federal, state and local agencies as an authoritative body with a vested interest in the resiliency of the CEI Hub. This workgroup would help guide policy, initiate dialogue, and have some level of funding capability to seed resilience initiatives in the study area.
- Recommendation 2: Update/Enhance CEI Hub Risk Assessment—Address data gaps in the risk assessment performed for this study and update the risk assessment as new data and science become available.
- Recommendation 3: Fossil Fuel Resolution—Apply Fossil Fuel Resolution #37168 to allow expansion of existing infrastructure or installation of new infrastructure only after adjacent infrastructure on the same facility have been retrofitted to address seismic risks, including liquefaction.

- Recommendation 4: Emergency Response/Recovery Regulatory Waivers—Pursue a process for allowing waivers from federal and state regulatory agencies in order to make disaster response and recovery in the CEI Hub more efficient, for example allowing gravity-fed transfers that bypass electricity-dependent overfill alarms during an electrical outage.
- Recommendation 5: Planning—The CEI Hub Disaster Resiliency Workgroup would establish a planning curriculum by assessing the level of planning that currently exists and establishing procedures to improve coordination on planning efforts.
- Recommendation 6: Backup Power—Identify and prioritize backup power needs following local energy assurance planning protocols, and consider the use of microgrids or other alternative energy sources.
- Recommendation 7: Training and Exercise—Commit to periodic, scenario-based City trainings and exercises in the CEI Hub, coordinating between CEI Hub stakeholders and local responders.
- Recommendation 8: Facility retrofits—Via a comprehensive, site-specific risk assessment, identify and prioritize for retrofit or replacement all vulnerable CEI Hub facilities.
- Recommendation 9: Land Use Repurposing—Create regionally acceptable means to repurpose land use within an identified buffer area adjacent to the CEI Hub.

1. Purpose of This Study

1.1 BACKGROUND

1.1.1 Local and Regional Energy Resources

The City of Portland, like all jurisdictions in Oregon, relies on the importation of energy resources from adjacent states (DOGAMI, 2013). The stability and reliability of local energy importation systems are of paramount importance to the City and to the entire region. A significant portion of the local, regional and state energy distribution infrastructure is located along a 6-mile stretch of the lower Willamette River in Northwest Portland, between the I-405 Fremont Bridge and Sauvie Island (see Figure 1-1). This area is commonly referred to as the Critical Energy Infrastructure Hub (the CEI Hub).

The CEI Hub lies on soils that are highly susceptible to the impacts of earthquakes and other hazards. The importance of the CEI Hub to the people and economy of the City of Portland and the State of Oregon warrant a detailed look at the exposure and vulnerability of facilities in the CEI Hub to natural hazards. The 2016 Critical Energy Infrastructure Hub Study was conducted as part of the 2016 update to the *City of Portland Hazard Mitigation Plan*. This report of the study's findings is a companion document to that updated plan.

1.1.2 Hazard Mitigation Planning

Hazard mitigation is defined as any action taken to reduce or alleviate the loss of life, personal injury, and property damage that can result from a disaster. It involves long- and short-term actions implemented before, during and after disasters. Hazard mitigation activities include planning efforts, policy changes, programs, studies, improvement projects, and other steps to reduce the impacts of hazards. The federal Disaster Mitigation Act (Public Law 106 390) emphasizes planning for disasters before they occur by requiring state and local governments to develop hazard mitigation plans as a condition for some federal disaster grant assistance.

The study recommendations presented in Chapter 5 of this report were presented for review and comment at the April 2016 meeting of the City of Portland Hazard Mitigation Plan Steering Committee. Final study recommendations will be included as actions in the updated 2016 Hazard Mitigation Plan.

1.2 OBJECTIVES

The mission of the Portland Bureau of Emergency Management (PBEM) is to build a resilient City through coordinated planning, mitigation, response and recovery. PBEM's objectives for this study are as follows:

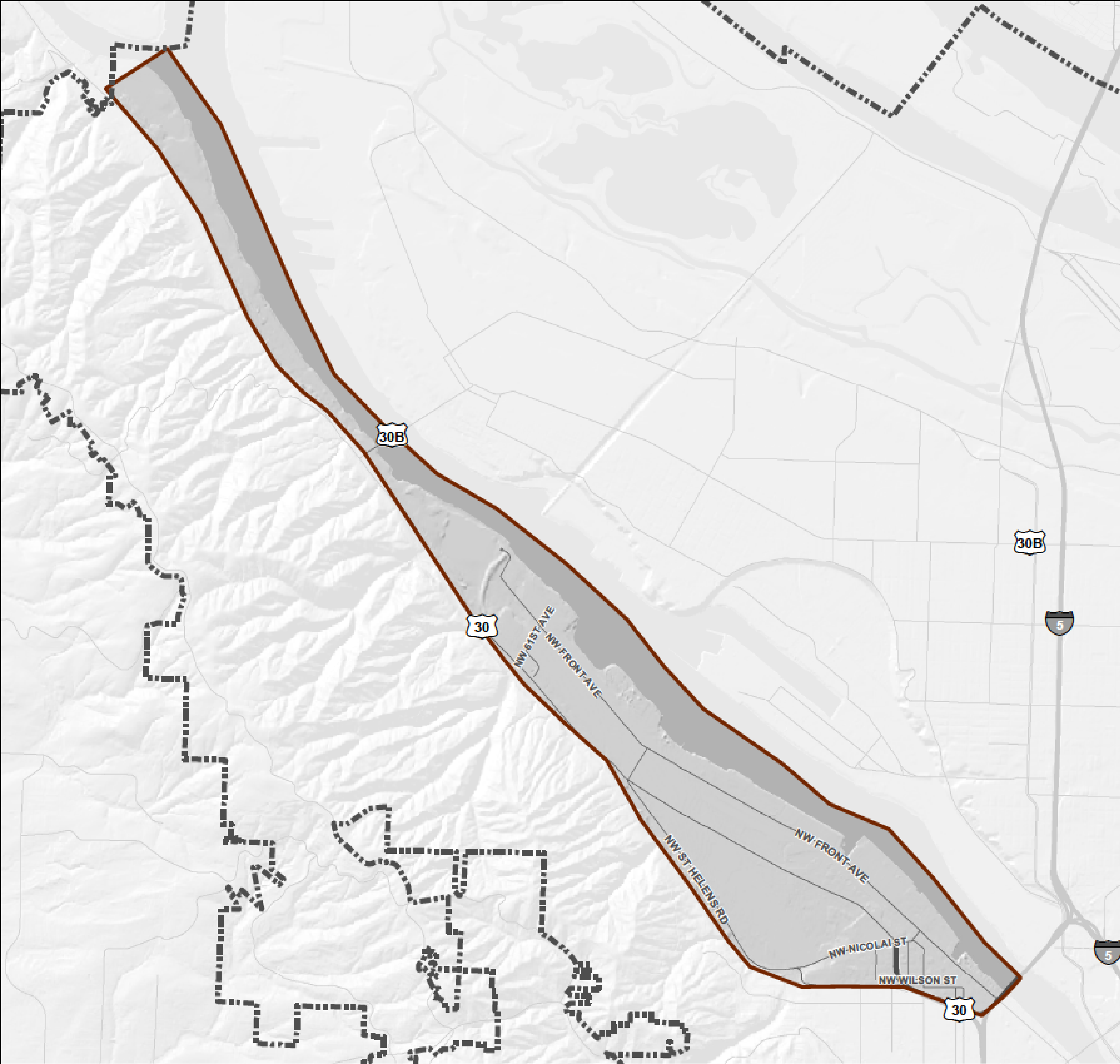
- Conduct a study in conjunction with the update to the City's hazard mitigation plan.
- Perform a risk assessment for the CEI Hub.
- Identify CEI Hub mitigation strategies for the City of Portland and possible funding mechanisms.
- Provide the findings in a stand-alone, companion document.
- Deliver a public presentation on the study for the City Council.
- Incorporate the CEI Hub mitigation recommendations into the final, updated Hazard Mitigation Plan.

September 12, 2016

Mitigation Action Plan (MAP)

Critical Energy Infrastructure Hub Study

Figure 1-1.
Critical Energy Infrastructure (CEI) Hub



Legend

City Boundary

Critical Energy Infrastructure (CEI) Hub Boundary

NORTH

0 0.5 1 Miles

Source: City of Portland-2016

37242

PBEM

1.3 STUDY SCOPE OF WORK

PBEM selected Tetra Tech, Inc. to facilitate the update to the City's Hazard Mitigation Plan, including the development of the CEI Hub study. A planning team composed of PBEM and Tetra Tech staff guided and facilitated the CEI Hub study. The scope of work for the CEI Hub study included the following tasks:

- **Task A: CEI Stakeholder Engagement**—CEI Hub stakeholders were identified and engaged by the planning team to support the development of the study. These stakeholders included owners/operators of CEI Hub facilities; state and federal agencies with relevant data, studies or plans about the facilities; residents of the surrounding Linnton neighborhood; members of the Hazard Mitigation Plan Steering Committee; and relevant staff from City of Portland bureaus. Stakeholders were invited to participate in two meetings:
  - At the first meeting, the planning team explained the purpose of the study, sought committed participation from stakeholders and requested relevant data.
  - At the second meeting, the planning team presented the findings of the risk assessment and identified recommendations for actions to be considered in the City's updated Hazard Mitigation Plan.
- **Task B: CEI Data Analysis**:
  - The planning team reviewed relevant plans, studies and programs to identify data that would augment the a risk assessment for the CEI Hub.
  - Following the literature review, a risk assessment was performed using the Federal Emergency Management Agency's (FEMA's) Hazus-MH risk assessment platform (Version 2.1). The risk assessment was conducted solely on facilities for which information was provided by participating stakeholders identified under Task A. Risk assessment results were generated by facility and by hazard type. Direct damage, indirect damage, and loss-of-function estimates were derived from the Hazus-MH platform.
- **Task C: CEI Facility Report**—The planning team prepared this CEI Hub study report, which provides an overview of the risk and vulnerability of the CEI Hub for each hazard of concern, identifies possible mitigation actions, and identifies possible sources of funding for recommendations that require an alternative source of funding. The report is a companion document to the 2016 update to the City's Hazard Mitigation Plan.
- **Task D: Final CEI Report to City Council**—The planning team will present the findings and recommendations of this report to the Portland City Council.

1.4 STUDY AREA DEFINED

The study area for this assessment was defined as a 6-mile-long area centered on US Highway 30 along the lower Willamette River between the south tip of Sauvie Island and the I-405 Fremont Bridge. Figure 1-1 shows the study area. A significant portion of Oregon's electricity, natural gas, and fuel oil infrastructure is concentrated in this area. The energy sector facilities in the CEI Hub include the following:

- All of Oregon's major liquid fuel port terminals
- Liquid fuel transmission pipelines and transfer terminals
- Natural gas transmission and distribution pipelines
- Liquefied natural gas (LNG) storage facility
- High-voltage electric substations and transmission lines
- Electrical substations for local distribution.

2. STAKEHOLDER ENGAGEMENT

This chapter summarizes the outreach and engagement efforts to CEI Hub stakeholders that the planning team undertook to gather the best available data for this study.

2.1 IDENTIFIED CEI HUB STAKEHOLDERS

A stakeholder is any person or group with an investment, share, or vested interest in something. For this study, stakeholders are all persons and agencies with a vested interest in the disaster resiliency of the CEI Hub, including, but not limited to facility owners and operators, environmental groups, adjacent property owners or residents, and major regional energy customers such as PDX airport. The planning team assembled a list of two key types of stakeholders to engage in the effort:

- Owners, operators and other data providers, such as state regulatory agencies
- Communities or interests that would likely be indirectly impacted by a major hazard event at the CEI Hub, such as neighborhoods adjacent to the CEI Hub and groups representing environmental interests.

Over 135 stakeholders representing these interests were contacted and invited to participate in the development of this study.

2.2 CEI HUB STAKEHOLDER OUTREACH

2.2.1 CEI Hub Stakeholder Meeting #1

A study kickoff meeting was held on October 21, 2015 at the Clean Rivers Cooperative Training Center, located in the study area. Seventeen CEI Hub stakeholders attended, along with five members of the planning team. Stakeholder interests that were represented included: CEI Hub owner/operators, representatives from the Linnton Neighborhood Association, the Oregon Department of Geology and Mineral Industries (DOGAMI), the Federal Emergency Management Agency (FEMA), and the Oregon Department of Environmental Quality. The meeting began with a presentation to introduce the planning team, project goals and expected outcomes as well as the following meeting objectives:

- Ensure that relevant stakeholders have been identified and are participating
- Determine information needs, data availability, and possible sources
- Identify and address data confidentiality and other concerns
- Outline the project timeline
- Determine next steps in the process.

After the presentation, there was discussion among the planning team and stakeholders on project understanding, concerns, information security and data capture and transmission. Most stakeholders in attendance indicated that they were likely to participate in the study.

2.2.2 Data Solicitation

On November 9, 2015 the planning team sent a data capture form to all identified CEI Hub owner and operator stakeholders, along with a set of instructions on how to complete the form. The form was designed to capture necessary information for each facility for input to the Comprehensive Data Management System (CDMS), an extension to FEMA's Hazus-MH risk assessment software (see Chapter 4). CDMS captures facility-specific attributes to establish curves for estimating damage to facilities. Completion of the CDMS form, which was voluntary, indicated each stakeholder's support for the study. Stakeholders were asked to submit completed forms by December 18, 2015.

2.2.3 CEI Hub Stakeholder Meeting #2

A second CEI stakeholder meeting was held at the Clean Rivers Cooperative Training Center on February 25, 2016 to present the results of the risk assessment and to identify recommendations for action. This meeting was attended by 11 CEI Hub stakeholders and three members of the planning team. The agenda was as follows:

- Welcome and introductions
    - Round-table introductions
- Project review
    - Project overview
    - Project status
    - Summary of the literature review
    - Next steps
- Model results
    - Description of the computer model
    - Hazard scenarios analyzed
    - Outputs defined
    - Review of the results
- Alternatives analysis
    - Strengths
    - Weaknesses
    - Obstacles
    - Opportunities to use strengths to address weaknesses and obstacles
    - Possible actions.

Evaluation of Strengths, Weaknesses, Obstacles and Opportunities

Recommended actions for possible inclusion in the City's Hazard Mitigation Plan were identified through consideration of the study area's hazard-related strengths, weaknesses, obstacles and opportunities. Key points discussed included the following:

- Strengths
    - Practical experience—CEI Hub owner/operators have not had to respond to a major disaster, but they do have practical experience in dealing with business interruption from impacts outside the CEI Hub.

- Established relationships—There are strong relationships among CEI Hub owner/operations that have been expanded to other stakeholders, such as the City of Portland, DOGAMI and the Oregon Department of Environmental Quality.
- The City of Portland Local Energy Assurance Plan (LEAP)—The LEAP, developed by the City in coordination with CEI Hub owner/operators, has helped to establish a dialogue among CEI Hub stakeholders on energy resilience that could be applied to disaster resilience.
- Product distribution alternatives—Petroleum/gas stakeholders have the ability to deliver product without power. This is not the ideal method, but it is an option that could be deployed to support continuity of operations.
- Example for disaster resilience—Portland General Electric, the principle energy supplier to the study area, has incorporated disaster resilience into its business plan and is proactively mitigating its vulnerable facilities. This provides a practical example for all CEI Hub stakeholders on embracing disaster resilience.

- Weaknesses
  - Access—The study area has the potential to be isolated in a disaster scenario due to limited points of ingress and egress.
  - Plan awareness—Numerous plans and studies have conducted in-depth assessments of the CEI Hub and its facilities. There is a lack of awareness by CEI Hub owner/operators about these plans.
  - Planning coordination—There is a lack of coordination of all the relevant planning efforts currently underway. This lack of coordination leads to a lack of consistency in data analyzed and plan findings and conclusions.
  - Lack of data—There seems to be a good understanding about potential hazard events and their impacts; however, understanding of how CEI Hub facilities might perform in these events is lacking due to information gaps for the CEI Hub facilities. Needed information probably exists, but is not readily available.
  - Understanding of functional downtime—CEI Hub stakeholders do not have a good understanding of how long after a hazard event their facilities would be unable to operate at their normal level.

- Obstacles
  - Environmental restrictions/regulations and safety restrictions/regulations—CEI Hub stakeholders indicated that existing environmental and safety regulations may impede response and recovery efforts at the CEI Hub after a major disaster.
  - Local regulations—The City of Portland recently adopted regulations that would restrict the expansion of petroleum facilities within the study area (Resolution No. 37168). This could be an obstacle to any incentive to retrofit vulnerable facilities in the CEI Hub. It would also be an obstacle for petroleum facilities to keep up with State of Oregon growth demand.
  - Security—The need for security of sensitive data can create an obstacle to sharing data and requires steps to ensure sure that shared data is secure.

- Opportunities
  - Continuity of operations planning—Determine if all CEI Hub owners and operators have prepared continuity of operations plans and whether existing plans address post-disaster operations and provide consistency in strategies.
  - State of Oregon Energy Plan update—Update the State Energy Plan and incorporate existing data, studies, and plans on the CEI Hub.
  - Work group—Build on the momentum from this study and others by creating a work group for data sharing, analysis, security and policy-making related to the overall resilience of the CEI Hub.

- Regulatory waiver—Consider a waiver to City Resolution No. 37168 that would allow a CEI Hub owner/operator to expand a petroleum facility if it is done as a retrofit to an identified vulnerable facility.
- Legislative strategies—Pursue state legislative strategies to address environmental and safety restrictions related to achieving disaster resilience through preparedness, response or mitigation actions by CEI Hub stakeholders.
- Backup generators—Ensure that all CEI Hub owner/operators own or have access to backup generators. Further analysis is necessary to determine how many generators are needed, the type, capacity, switching capabilities, etc.
- Training and exercises—Build on existing successes, such as LEAP, to provide disaster scenario training that includes and involves CEI Hub stakeholders.
- Ongoing risk assessment updates and enhancements—Continue to update and enhance the risk assessment for the CEI Hub using the best facility data and best available science as they become available.
- Planning—Make a concerted effort among public and private-sector CEI Hub stakeholders to identify existing plans related to CEI Hub disaster resiliency, the level of consistency among them, and needs for additional planning.

Review of Risk Assessment Results

Following the evaluation of strengths, weaknesses, obstacles and opportunities, stakeholders engaged in additional discussion on the risk assessment results. There was a general consensus that the model results were likely understating risk, especially in regard to earthquake risk. Stakeholders suggested several methods by which the data and models could be refined to more accurately portray risk, including greater participation from owners/operators at the CEI Hub and accounting for an increase in severity resulting from shaking duration lasting longer than one minute. Although risk may be understated in this study, the risk assessment results represent a valuable starting point toward understanding the vulnerabilities of the CEI Hub.

2.3 CEI HUB STAKEHOLDER PARTICIPATION

All stakeholder participation was valuable for this study, and participation from owners and operators of CEI Hub facilities was of particular importance. Because all CEI Hub facilities are privately owned, a detailed assessment of the CEI Hub could not be conducted without the participation of facility owners and operators. The risk and vulnerability assessment (described in Chapter 4) was built upon FEMA's Hazus-MH modeling program, which requires detailed, accurate data about existing conditions. The accuracy and reliability of the results depend upon the quality of the input data. When current, detailed data is not provided, the model supplements missing data with default entries and assumptions.

Modeled results presented in this report (see Chapter 4) are based only on the facilities for which data was provided. The total number of owners and operators of facilities in the CEI Hub has not been established, but is substantially more than those who provided full participation. Full participation in this study—defined as attending meetings and providing data to be used in the study—was given by the following stakeholders:

- Kinder Morgan
- Pacific Terminal Services
- Port of Portland
- DOGAMI
- Department of Homeland Security, Region X
- Portland Bureau of Emergency Management
- Portland Bureau of Environmental Services
- Oregon Department of Environmental Quality

- Oregon Public Broadcasting
- Concerned citizen from Sauvie Island
- Public representatives from the 2016 City of Portland Hazard Mitigation Plan Update Steering Committee, including those representing the Linnton Neighborhood Association, the Audubon Society and the Local Emergency Planning Committee.

This rate of participation is consistent with what was observed in the review of previous studies and plans (see Chapter 3). Many of the stakeholders who participated in other plans and studies also participated in this study, and stakeholders who did not participate in this study have generally not participated in other efforts. Early in the process, the planning team determined that success would be defined as any level of participation from CEI Hub stakeholders, because this study marks the beginning of the City's engagement of CEI Hub stakeholders in planning for disaster resiliency. The dialogue and engagement initiated through this study provides a metric on which to improve.

Participation from stakeholders subject to indirect impacts from a hazard event at the CEI Hub also was critical to the findings and recommendations of this study. Representatives from the Linnton Neighborhood Association, Sauvie Island and the Audubon Society all provided insights that had a direct impact on the recommendations of this study. Their engagement and commitment to understanding the risks expanded the perspectives of the study, thus enhancing the creditability of the final report.

3. LITERATURE REVIEW

The importance of the CEI Hub to Portland, the state of Oregon and the Pacific Northwest region has prompted numerous, detailed studies of the area by local, state and federal agencies. Many of these studies have focused on the CEI Hub's exposure and vulnerability to earthquake hazards. The planning team identified five key documents that examined the vulnerability of the CEI Hub to a Cascadia Subduction Zone (CSZ) earthquake or to prolonged loss of power:

- Earthquake Risk Study for Oregon's Critical Energy Infrastructure Hub (DOGAMI, 2013)
- Protected Critical Infrastructure Information, Columbia Basin Resiliency Assessment (U.S. Department of Homeland Security, 2015)
- City of Portland Local Energy Assurance Plan (PBEM, 2012)
- The Energy Cluster in Linnton (Grillo, 2005)
- Port of Portland, Corporate Seismic Risk Assessment Study (Berger ABAM, 2015).

This chapter provides extracts of these documents, providing a brief synopsis of each, along with a summary of key findings and recommendations.

3.1 EARTHQUAKE RISK STUDY FOR OREGON'S CRITICAL ENERGY INFRASTRUCTURE HUB

3.1.1 Synopsis

The Oregon Department of Geology and Mineral Industries conducted an earthquake risk study of the CEI Hub as part of a larger Energy Assurance Project by the Oregon Department of Energy, Public Utility Commission of Oregon (PUC) and DOGAMI (funded by the U.S. Department of Energy). The purpose of this study was to provide a better understanding of the vulnerabilities of the energy sector when confronted with a magnitude 8 or larger Cascadia earthquake. Study goals were as follows:

- Characterize Oregon's natural hazards using qualitative risk scores to estimate the scale of potential disasters.
- Better understand CEI Hub facility operations and learn about site conditions, structures, components, systems and interdependencies.
- Describe potential critical seismic vulnerabilities in the energy sector, and offer recommendations to improve energy sector resiliency to minimize earthquake impacts.

This study did not entail site-specific vulnerability and risk studies and provided only estimates of seismic vulnerability based on visual reconnaissance inspections, site-independent analyses and studies and existing site specific information provided by CEI Hub facilities.

3.1.2 Key Findings

The following are the key findings of the DOGAMI report that are relevant for this study:

- Some infrastructure in the CEI Hub was built 100 years ago, to very antiquated standards. Other infrastructure is new and built to current standards. Because of the wide range of ages and construction practices, the seismic vulnerability of the facilities also spans a wide range.
- Energy companies have operational interdependencies with the transportation and telecommunication sectors. The three energy sources—electricity, natural gas, and liquid fuel—depend upon each other; if one system is inoperable, it impacts another. For example, all sources rely on electricity to operate their systems. Electricity is needed to power the control rooms for natural gas and liquid fuel transmission.
- There are few regulations that require existing structures to be upgraded to today's seismic standards.
- Older building codes and practices did not adequately address many non-building structures that exist in the CEI Hub, such as tanks, pipes, and piers.
- Each energy source has a different level of redundancy in its transmission system. Redundancy influences the level of seismic resilience, with more redundant systems providing higher resilience.
- The following findings were made regarding liquid fuel facilities:

  - **Liquid fuel pipeline**—CEI Hub petroleum facilities receive liquid fuel from a liquid fuel transmission pipeline and from marine vessels. The liquid fuel pipeline was largely constructed in the 1960s when construction techniques had no seismic standards. The pipeline design did not consider ground movements from lateral spreading at river crossings or stresses induced by earthquakes that may cause pipe breaks. A pipe break would have a significant impact on all petrochemical facilities in the CEI Hub and could result in a statewide fuel shortage.
  - **Shipping channel**—Marine vessels use the navigation channel from the Columbia River mouth to the lower Willamette River to transport fuel. A preliminary investigation found that the shipping channel would likely be closed for river navigation after an earthquake until it is cleared for use by the U.S. Coast Guard. Closure of the shipping channel would prevent marine vessels from delivering liquid fuel and limit transport of emergency recovery equipment.
  - **Marine terminals**—Port facilities in the CEI Hub have significant seismic risks. Some older piers constructed without any seismic design may be damaged even in a moderate earthquake. If oil products are released and contaminate the navigable waterway, the waterway may be closed to river traffic, impeding emergency response and the supply chain. Local capacity to fight fires and clean hazardous material spills is limited.
  - **Fuel Tank Farms**—All fuel tank farms in the CEI Hub have significant seismic risk due to unmitigated liquefaction hazards. Most tanks were constructed on potentially liquefiable soils, with little or no seismic design criteria.
  - **Fuel supply**—Fuel terminals in the CEI Hub have a three- to five-day average supply of regular unleaded gasoline and diesel fuel. Premium gasoline is subject to daily delivery. If the supply chain is disrupted, fuel would quickly become scarce. Airlines operating at Portland International Airport receive 100 percent of their liquid fuels from a terminal in the CEI Hub. There is limited on-site fuel supply at the airport. If the transmission pipe between the CEI Hub and the airport fails, then the airport would likely experience a shortfall and operations would be impacted.

- The following findings were made regarding natural gas facilities:

  - **Natural gas pipelines**—Oregon's largest natural gas service provider receives most of its natural gas from pipelines that cross under the Columbia River. Most of these pipelines are 1960s vintage and were constructed without seismic design provisions. The soils at major river crossings are subject to liquefaction and lateral spreading. Pipe breaks could lead to a natural gas shortfall in the state as well as explosions or fires.
  - **LNG storage facility**—The LNG storage facility in the CEI Hub was constructed in the late 1960s on what is suspected to be highly liquefiable soils. As of February 2012, the natural gas operator with facilities in the CEI Hub had not performed seismic vulnerability assessments.

3.1.3 Recommendations

The most critical conclusion from this report is that energy sector companies must pro-actively integrate seismic mitigation into their business practices for Oregon's energy sector to adequately recover from a Magnitude 8.5 to 9 Cascadia earthquake in a reasonable time period. DOGAMI made these recommendations to private and public energy sector stakeholders:

- Energy sector companies should work with local, state tribal and federal government agencies and stakeholders to conduct seismic vulnerability assessments on all systems or facilities.
- Energy sector companies should work with local, state, tribal and federal government agencies and stakeholders to institutionalize long-term seismic mitigation programs to ensure facility resilience and operational reliability.
- The State of Oregon's Homeland Security Council should review the vulnerability and resilience of the energy sector to earthquakes and other natural disasters. This could involve the Energy Assurance Project partners (Oregon Department of Energy, PUC, and DOGAMI) as well as the Oregon Department of Transportation, Building Codes Division, and the Oregon Seismic Safety Policy Advisory Commission. Under Oregon Revised Statute (ORS) 401.109, no outside individual or group has previously been involved in the Homeland Security Council's roles and responsibilities.
- Energy sector companies and the State of Oregon should build Oregon's seismic resilience to a Cascadia earthquake. Adopting pro-active practices and a risk management approach will help achieve seismic resilience. A culture of awareness and preparedness about energy sector seismic vulnerability should be encouraged, including long-range energy planning. Emergency batteries, generators and communication devices should be braced or anchored to withstand a Cascadia earthquake.
- The length of time to resume services after a Cascadia earthquake should be evaluated by each energy company to establish a baseline understanding, and improvements should be made to achieve a satisfactory service level.

3.2 COLUMBIA BASIN REGIONAL RESILIENCY ASSESSMENT PROGRAM

3.2.1 Synopsis

The Regional Resiliency Assessment Program is a cooperative, non-regulatory, assessment of critical infrastructure, led by the federal Office of Infrastructure Protection. The program focuses on infrastructure systems within designated geographic areas, addressing hazards that could have regionally and nationally significant consequences. The goal is to mitigate the risk of loss of life and physical and economic damage from natural and manmade hazards.

The Columbia Basin Regional Resiliency Assessment Program established a working relationship between the Department of Homeland Security and key partners in Washington, Oregon, and Idaho. These included the Washington Military Department, the Oregon Military Department, and the Idaho Bureau of Homeland Security. Other public and private sector organizations contributed to the assessment of hazards and vulnerabilities associated with Columbia Basin transportation, agriculture, and energy infrastructure, and regional infrastructure systems that depend on the river transport system.

Data were gathered from public and private sector organizations to determine the hazards, vulnerabilities, and interdependencies among transportation, energy, and agriculture infrastructure along the Columbia, Willamette, and Snake Rivers. The Office of Infrastructure Protection conducted site assistance visits and enhanced critical infrastructure protection security surveys in all three states. The study included a detailed look at the CEI Hub because of its importance to the assessment area.

Because the document contains protected critical infrastructure information, it is exempt from release under the Freedom of Information Act (5 United States Code 552) and similar state and local disclosure laws (in accordance with Title 6 Code of Federal Regulations (CFR) Part 29). It is to be safeguarded and disseminated in accordance with the Critical Infrastructure Information Act of 2002 (6 United States Code §§ 131 et seq.), the implementing regulation (6 CFR Part 29), and protected critical infrastructure information program requirements.

3.2.2 Key Findings

The following are the key findings of the Columbia Basin Resiliency Assessment that are relevant for this study:

- **Finding # 1**—Planning related to the reopening of river navigation after a CSZ earthquake is insufficient. After a CSZ earthquake, sections of the lower Columbia and Willamette Rivers are likely to be closed to shipping. Reopening of navigation channels will be important to support critical functions in the immediate post-disaster situation, and to reduce economic impacts on the region over the long term.
- **Finding # 2**—Regional, state, local, and private sector disaster plans do not reflect the impacts on and integration necessary for recovery of petroleum infrastructure from a CSZ earthquake.
- **Finding # 5**—Most refined petroleum products destined for the Columbia Basin are received via the Olympic Pipeline and/or Columbia and Willamette River transportation systems, all of which would be significantly disrupted by a CSZ earthquake. East-to-west routes for refined petroleum products from Salt Lake City refineries and other sources may be necessary. Rail could play a pivotal role in emergency transportation. The ability to ship grain and petroleum fuels via rail would be critical until Columbia Basin river transportation systems are restored. It is assumed that rail traffic east of the Interstate 5 (I-5) corridor could be reestablished or rerouted fairly rapidly, providing transportation options. However, greater planning and preparation are needed to allow rail to play this role.
- **Finding # 6**—Reliability and rapid recovery of electricity are critical to recovery of petroleum fuel supply and grain export operations. The electrical grid serving Oregon, Washington, and Idaho is part of a highly interconnected system that will experience short- and long-term outages throughout the Pacific Northwest following a CSZ earthquake.

3.2.3 Recommendations

Finding-Specific Recommendations

The Columbia Basin Resiliency Assessment identified "resiliency options" for each of the identified key findings. The resiliency options for the key findings associated with the CEI Hub are as follows:

- Finding # 1 Resilience Options:
  - Emergency agencies should incorporate information about types and volumes of river commerce into existing recovery planning as an appendix to existing state recovery plans for Oregon and Washington.
  - Washington and Oregon State agencies should work with the U.S. Army Corps of Engineers and the Coast Guard to identify federal, state, local, and private sector resources to assist with waterway recovery (dredging, salvage, and transport vessels).
  - Restoration of channel navigation may be gradual and initially not sufficient to support all demands for passage. The Coast Guard and private industry should institute a study to develop specific guides for priority of service.
  - Mitigation measures such as seismic reinforcement of bridges and soil stabilization at port facilities might prevent CSZ earthquake damage that would otherwise take a long time to repair. Federal, state, and local agencies should build mitigation priorities into long-range planning, budgeting, and funding

requests. These agencies can encourage private terminal owners to install mitigation measures by providing information, scientific analysis, and grants or tax incentives.

- Finding # 2 Resilience Options
  - Emergency management and energy agencies should coordinate with industry associations to assist private sector owners and operators of petroleum and transportation assets to incorporate industry-specific resilience guidance and analysis into business continuity plans.
  - Government emergency planners in Idaho, Oregon, and Washington should use existing cross-jurisdictional planning coalitions, such as the Cascadia Region Earthquake Workgroup, in developing regional CSZ earthquake response plans that address petroleum fuel supply.
  - State energy planning agencies should facilitate collaboration between private petroleum supply chain components and regional, state, and local agencies to help facility owners understand the need for seismic vulnerability assessments and amend their contingency plans to address both infrastructure hardening and alternate supply chain pathways.
  - Emergency management, energy, and regulatory agencies should coordinate with federal authorities and private sector petroleum and transportation infrastructure owners and operators to develop a comprehensive listing of waivers from regulatory requirements that may be necessary so that private sector fuel supply contingency plans can be implemented successfully. Agencies should develop a process to facilitate securing the waivers.
  - State emergency management agencies, FEMA, and the private sector should investigate mitigation actions for regional petroleum supply chain choke points, including identifying alternative transportation modes and paths and alternate storage and dispensing facilities. Potential impacts related to those alternate supply chain strategies should be assessed, including alternative energy supplies and communication modes.

- Finding # 5 Resilience Options
  - The Great Northern Corridor Coalition promotes regional cooperation, planning, and shared project implementation for moving freight in a multistate rail and road freight corridor. Idaho, Oregon and Washington emergency management agencies should join the coalition to help ensure that emergency planning for a CSZ earthquake is considered for improvements being proposed.
  - The Transportation Security Administration, the Federal Railroad Administration, the Association of American Railroads, and the American Short Line and Regional Railroad Association should investigate the availability of railcars, including confirming the number of covered hoppers and tank cars that could be made available from major carriers and smaller railroads.
  - State rail programs could incorporate the impacts of congestion and resilience into future infrastructure planning for a CSZ earthquake.

- Finding #6 Resilience Option
  - State public utility agencies and electric providers need to coordinate restoration of electricity in less earthquake-damaged areas where otherwise unaffected infrastructure critical to alternative transportation options for fuel and grain products have been identified.
  - State public utility agencies and energy planners should collaborate with electric utilities to determine how established best practices could strengthen the regional grid to help mitigate the impacts of a CSZ earthquake. State energy planners should consider changes to response and recovery plans that can facilitate a utility's recovery and review energy assurance plans and emergency operation plans to ensure they address wide-scale electric outages and actions to mitigate impacts and restore the grid.
  - State public utility agencies, electric providers work and the Western Electricity Coordinating Council should study how to gauge recovery and restoration needs after a CSZ earthquake and

develop a regional strategy that inventories electric infrastructure resilience and hardening mitigation projects for all at-risk electrical equipment.

Overall Recommendations

The following overall resilience options are recommended:

- Community infrastructure improvement planning—Resilience measures can be incorporated into community land use or transportation planning.
- Structured approach to risk management—Effective risk management employs approaches to prevent or mitigate the effects of hazards that are likely to cause harm. Many government and industry partners use risk management models that can be applied to critical infrastructure.
- Emergency preparedness plans and exercises—The inclusion of infrastructure restoration activities in plans and exercises can enhance infrastructure resilience.
- Vulnerability identification—Analyzing the vulnerabilities of critical infrastructure enables critical infrastructure partners to take action to mitigate risks.

3.3 CITY OF PORTLAND LOCAL ENERGY ASSURANCE PLAN

3.3.1 Synopsis

The City of Portland Local Energy Assurance Plan was developed to prepare for energy disruptions. Participating stakeholders looked at Portland's reliance on energy and the vulnerability of the energy supply, and developed recommendations to address future energy disruptions. The Portland LEAP links to the Oregon State Energy Assurance Plan, Portland's Hazard Mitigation Plan, the Portland Urban Area's Critical Infrastructure Protection Plan, the city's Climate Action Plan and the recommendations of the Portland Peak Oil Task Force. Two documents were produced:

- An energy emergency plan for the City of Portland (the Energy Annex) describing the roles of emergency response agencies, energy providers and distributors, and the community. The Energy Annex provides a framework to guide the City's response during an energy disruption. The City's response priorities are life safety, incident stabilization, environmental protection and property conservation. Priority is given to provide emergency assistance to vulnerable populations. When the energy supply is disrupted, the City will work collaboratively with critical infrastructure owners and operators to help get facilities back online as quickly as possible. The City's efforts may include helping utilities access and secure their sites, facilitating damage assessments, debris removal, and reopening roads.
- An improvement plan with recommendations to guide next steps.

The Portland LEAP used the following earthquake scenario for planning purposes:

- **What**: Cascadia Subduction Zone earthquake with a magnitude of 8.0 in Portland.
- **Where:** The earthquake occurs 90 miles west of Portland.
- **When**: Noon on a Wednesday in November 2011.
- **Timeline:** 72 hours after the earthquake it is now Saturday.

3.3.2 Key Findings

The following are the key findings of the Portland LEAP process that are relevant for this study:

- **The importance of coordination between the public and private sectors**—Coordination between the City of Portland, energy utilities and industries will be paramount during an energy emergency. During a major energy disruption, utilities will need help from emergency responders to gain access to their sites. Site access, transportation and debris removal for utility crews and emergency response workers will be critical to restoring power in a timely manner.

- **Coordination between local jurisdictions and state agencies can be improved**—There is little understanding in the Portland area of the Oregon Department of Energy's Oregon Petroleum Contingency Plan and minimal awareness of the Fuel Allocation Program. Priority groups identified in the Oregon Department of Energy's plan may not correspond to local government, business and industry priorities.

3.3.3 Recommendations

Recommendations were identified to help the region better prepare for a major energy disruption and build a resilient community. The following are most relevant to the CEI Hub study:

- **Formalize the relationship between the public and private sectors**—A formal public and private sector partnership of energy providers, distributors, energy users and state agencies, including the Public Utility Commission, is needed to strengthen preparations for a major energy disruption. This could better define roles, responsibilities, priorities, technology and protocols for communication between the City of Portland, energy utilities and industries in Portland's Northwest Industrial Area.

  - **Objective**—Work with the PUC and private sector energy providers to formalize a liaison position to the City's Emergency Coordination Center by December 2013.

- **Ensure that the energy assurance plan is used in development of bureau-specific and citywide continuity of operations plans and utility asset management plans**—Align findings from the energy assurance plan with energy profiles of essential facilities to ensure they are adequate to meet emergency needs.

  - **Objective**— By December 2014, ensure that all city bureaus have updated their continuity of operations plans to take into account their energy profile, internal and external interdependencies, necessary service restoration resources, and contingency plans. Work with private sector utilities to evaluate expected lengths of time to resume utility service after a Cascadia earthquake.

- **Certify more damage assessment teams**—The City should work with utilities to coordinate and train more post-earthquake damage assessment teams. This will give utilities the ability to assess their own facilities without relying on city damage assessment teams.

  - **Objective**—Conduct at least two Applied Technology Council post-earthquake damage assessment trainings (ATC-20) for 80 structural engineers, architects and inspectors to serve on damage assessment teams by September 2013.

- **Improve the process for emergency notifications**—Continue to improve the communication process between utilities, government and emergency response agencies and the public.

  - **Objective**—Work with utilities to formalize a process to communicate the impacts of planned and unanticipated outages and restoration actions with potentially affected customers, government and emergency response agencies and the public via a centralized website, by June 2013.

- **Conduct drills**—A regional practice drill should be performed with public and private partners. The exercise should focus on several possible disruptions to the energy system and demonstrate the need for energy resource options (i.e. renewable, petroleum, natural gas and electricity).

- **Objective**—Plan a series of table top and functional exercises that test elements of the Energy Annex by September 2014 and use lessons learned to update the Energy Annex.

- **Recommend changes to the Oregon Department of Energy's Fuel Allocation Program**—When the Oregon Department of Energy implements its Fuel Allocation Program, end users are prioritized into three tiers. Tier 1 includes emergency services sectors (law enforcement, fire, EMS) and Tier 2 includes essential services (public works, transit, telecommunications, utilities). Because emergency vehicles cannot use roads heavily strewn with debris, debris removal operations should be performed early.

  - **Objective**—Work with the Oregon Department of Energy to consider accommodating certain essential functions, including debris management, as part of the Tier 1 Fuel Allocation Program.

3.4 THE ENERGY CLUSTER IN LINNTON

3.4.1 Synopsis

This 2005 report investigated the importance of the CEI Hub (referred to in the report as the Linnton Energy Cluster) to the Northwest region as a whole. It evaluated conditions that contribute to a healthy climate for the energy cluster and how potential land use changes could negatively impact those conditions. The report was prepared by Phillip E. Grillo of Miller Nash LLP for the Olympic Pipeline Company, BP West Coast Products LLC, and Kinder-Morgan Energy Partners, L.P. A principle source document was the City of Portland 2004 Industrial District Atlas.

3.4.2 Key Findings

The following are the key findings of the Linnton Energy Cluster report that are relevant for this study:

- Three property owners own 78.5 percent of the 69.3-acre study area.
- The convergence of freight infrastructure and all the logistical investments that support it have led to a highly efficient and highly regulated petroleum transportation and distribution network.
- The area has the characteristics of an "industry cluster"—a group of firms that are geographically close and share common markets and technologies and draw on similar worker skills and facilities. These clusters can draw competitive advantages from the investment of labor, facilities and other assets that accumulate in certain places, forming a concentration of employees, facilities and service. This can create strong buyer-supplier relationships.
- The zoning in the study area as of 2004 was ideally suited for energy cluster use.
- As a matter of policy, the study area has been preserved for all kinds of industry, especially heavy industries that cannot be located in other portions of the City.
- Protection of the study area for conflicting uses is important to Oregon's economy.
- The study area is subject to earthquakes, landslides, flooding and wildfire.
- There is only one way in and out of the study area—Highway 30—and there is a lack of alternate access.
- Increasing the population in the study area could lead to increased security concerns within the cluster.
- The potential impacts from a tank fire are significant. Studies estimate significant injury would be experienced within 60 seconds at a distance of 695 feet from the fire source.

3.4.3 Conclusions

The report concluded that the energy cluster is vital to the economy of the state and the region and should not be compromised by placing new residential uses nearby. It found that, over time, industries came to be located in the energy cluster because of the convergence of freight infrastructure and other favorable site conditions. The introduction of new residential uses in the area would make it significantly more difficult and risky for the energy cluster to operate and would make it virtually impossible for the cluster to grow.

3.5 PORT OF PORTLAND CORPORATE SEISMIC RISK ASSESSMENT

3.5.1 Synopsis

The Port of Portland conducted a seismic risk assessment of high-value Port assets with the following goals:

- Evaluate the performance of the assets under the effects of an earthquake.
- Identify improvements that would enhance the ability to avoid damage from an earthquake.
- Estimate benefits of such improvements in comparison to cost of implementation.

The seismic risk assessment included the following elements:

- Identify a list of key Port aviation and marine assets to consider.
- Assess the seismic fragility of the identified assets, considering several earthquake magnitudes.
- Estimate duration of service loss or downtime.
- Estimate costs of repair or replacement.
- Estimate economic losses to the Port and to the region resulting from business interruptions.
- Identify potential mitigation actions for selected assets.
- Develop order-of-magnitude estimates of cost for the actions.
- Conduct benefit-cost analyses of potential mitigation actions.
- Identify specific mitigation projects for further study and analysis, potentially leading to incorporation into the Port's capital improvement program.

The only Port facility assessed in this report within the CEI Hub was Marine Terminal # 4, the Kinder-Morgan Berths 410 and 411. The following discussion pertains only to facilities within the CEI Hub.

3.5.2 Key Findings

The following are the key findings of the Port of Portland report that are relevant for this study:

- Berth 410 was constructed in 1962; Berth 411 was constructed in 1959.
- Design capacity for the lateral systems is approximately 30 percent of current code design forces.
- Berth 410 is constructed primarily of timber elements, and Berth 411 is constructed of concrete elements. However, the performance of the two berths is expected to be similar.
- The structures would likely survive a 72-year return period seismic event with repairable damage.
- A 475-year return period seismic event would induce significant soil liquefaction, causing large lateral soil displacements that would result in excessive forces on structural elements. The facilities would not survive the 475-year event.

3.5.3 Recommendations

Benefit-cost ratios for mitigation actions are shown in Table 3-1. The benefit-cost analysis for the potential retrofit mitigation actions at all of the marine facilities evaluated, except Terminal 4 (Berths 410/411), shows benefit-cost ratios greater than 1 considering Port and regional economic impacts.

Table 3-1. Terminal Mitigation Action Benefit/Cost Ratios

Marine Terminal#	Estimated Cost of Mitigation	Benefit/Cost Ratio
#4 (Berths 410 and 411)	$42 million	0.77
#5 (Berth 501)	$20 million	3.47
#5 (Berth 503)	$13 million	1.77
#6 (Berth 601)	$5 million	2.85
#6 (Berths 604/605)	$15 million	2.24

For Terminal 4 (Berths 410/411), the cost of facility replacement and the time out of service take the benefit/cost ratio of retrofit mitigation below 1. The report concluded that, given the age of these facilities and the cost of improvements that would be needed to achieve survivability for the 475-year earthquake, the only mitigation action that would be economically feasible is to replace the berths with a modern facility. It is expected that replacing the two berths with a single combined facility would be the preferred approach. The report's order-of-magnitude estimate of cost for a combined replacement facility was $42 million.

The following are additional general recommendations from the report:

- Evaluate the benefit of designing each new project for greater seismic resilience than required by building code. Considering that code requirements for seismic design forces are based on life safety and collapse prevention, not on property preservation or operational continuity, structures designed to code cannot be expected to maintain uninterrupted functionality after a major earthquake.
- Identify and evaluate mitigations for other key Port assets. This study identified and evaluated potential mitigation actions for only a limited number of the Port's key assets. A similar effort should be undertaken for other assets considered critical for the Port's functions.
- Broaden future seismic risk assessment efforts to include non-Port critical assets and lifelines, in coordination with other agencies and with utility owners.
- Confirm the plan for Port emergency operations and recovery. Immediate occupancy after a significant ground motion should not be expected for any Port facility, as it currently exists. The Port should assess the current emergency response plan to ensure there is an allowance for the probable temporary unavailability of existing Port facilities.

4. Risk Assessment

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

- Vulnerability identification—Determine the impact of natural hazard events on the people, property, environment, economy and lands of the region.
- Cost evaluation—Estimate the cost of potential damage or cost that can be avoided by mitigation.

4.1 HAZARDS OF CONCERN

For this study, the study area was assessed for the hazards of concern identified by the oversight Steering Committee for the update of the City of Portland Hazard Mitigation Plan. The following hazards of concern are relevant in particular to the CEI Hub:

- Earthquake
- Flood
- Landslide
- Severe weather
- Volcanic activity
- Wildfire.

Detailed citywide assessments of all of these hazards of concern, as well as the dam failure hazard, which is not relevant for the CEI Hub, can be found in the 2016 City of Portland Hazard Mitigation Plan.

4.2 RISK ASSESSMENT METHODOLOGY

Risk assessments generally include exposure and vulnerability information for people, property, the environment and the economy. These factors are addressed in more detail for each hazard of concern in the 2016 City of Portland Hazard Mitigation Plan. For this study, the focus is on property; specifically, the facilities operating in the CEI Hub. The exposure and vulnerability of people, the environment and the economy are discussed only if impacts on CEI Hub facilities would result in secondary impacts on people, the environment or the economy. This is a high-level study based on the best available data, technology and industry best management practices available at the time of the study.

Sections 4.3 to 4.10 of this report provide summaries of each hazard, the scenarios assessed, and exposure and vulnerability evaluations for all CEI Hub facilities for which data was available. Not all CEI Hub stakeholders participated in this study. For facilities for which data was not available, the planning team made modeling assumptions that may understate the risk.

4.2.1 Mapping

A review of national, state and local databases was performed to locate spatially based data relevant to this planning effort. Maps were produced using geographic information system (GIS) software to show the extent and location of identified hazards when such data was available.

4.2.2 Earthquake and Flood—Hazus-MH

Overview

In 1997, FEMA developed the Hazards U.S., or Hazus, model to estimate losses caused by earthquakes. Hazus was later expanded into a multi-hazard model, Hazus-MH, able to estimate potential losses from hurricanes and floods. Hazus-MH is a GIS-based program used to support risk assessments, mitigation planning, and emergency planning and response. It provides a wide range of inventory data, such as demographics, building stock, and transportation and utility facilities. The program maps and displays hazard data and estimates damage and economic loss for buildings and infrastructure. Its advantages include the following:

- It provides a consistent methodology for assessing risk across geographic and political entities.
- It provides a way to save data so that it can readily be updated as population, inventory, and other factors change and as mitigation-planning efforts evolve.
- It facilitates the review of mitigation plans because it incorporates FEMA methodologies.
- It supports grant applications by calculating benefits using FEMA definitions and terminology.
- It produces hazard data and loss estimates that can be used in communication with local stakeholders.
- It is administered by the local government and can be used to manage and update a hazard mitigation plan throughout its implementation.

Levels of Detail for Evaluation

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

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

Comprehensive Data Management System

The Comprehensive Data Management System is a complementary tool to Hazus-MH that provides users with the ability to update and manage statewide datasets, which are currently used to support analysis in Hazus-MH. Currently, Hazus-MH users are required to undertake a large amount of manual effort to incorporate new data into the statewide datasets according to their pre-defined formats. To reduce this effort, CDMS streamlines and automates raw data processing, the conversion of external data sources into Hazus-MH compliant data and the transfer of data into and out of the statewide datasets.

Application for This Study

Hazus-MH (Version 2.1) was used to assess risk for the earthquake and flood hazards for this study. The following methods were used:

- **CDMS essential facility update**—The CDMS extension to Hazus-MH was used to update the inventory of assets analyzed for this study. Data provided by the participating CEI Hub stakeholders was formatted for importation into the CDMS platform for analysis. The planning team developed a CDMS data-capture form and accompanying instructions that were distributed to all participating stakeholders. The data-capture form was set up to collect up to 24 attributes on each facility in the CEI Hub to support the earthquake and flood analyses. For attributes not provided by CEI Hub stakeholders, Hazus default values were used. Each facility inventoried was assigned one of eight Hazus occupancy class designations, defined as shown in Table-4-1.
- **Earthquake**—A Level 2 analysis was conducted. Earthquake shake maps and probabilistic data prepared by the U.S. Geological Survey (USGS) were used for the analysis of this hazard. This data was augmented by National Earthquake Hazard Reduction Program soils, liquefaction susceptibility, and landslide susceptibility data provided by DOGAMI. An updated inventory of essential facilities, transportation and utility features was used in place of the Hazus-MH defaults.
- **Flood**—A Level 2 analysis was conducted. An updated inventory was used in place of the Hazus-MH defaults for essential facilities, transportation and utilities. Current study area digital Flood Insurance Rate Map information from FEMA was used to delineate flood hazard areas and estimate potential losses from the 10-year, 100-year, and 500-year flood events. Using the FEMA floodplain boundaries and the City of Portland 3-foot digital elevation model, flood depth grids were generated and integrated into the Hazus model.

Table-4-1. Hazus Occupancy Class Definitions

Facility Categories	Facility Types
Emergency Services	Emergency operation centers, fire, police, medical
Transportation Systems	Ports, airports, bridges, tunnels, rail, bus
High Potential Loss Facilities	Dams, hazardous materials, military, nuclear
Electric Power Facilities	Sub-stations, major power lines
Natural Gas Facilities	Major gas lines
Petroleum Facilities	Tank farms
Potable Water	Pump stations, wells, tanks, reservoirs, essential pipelines
Wastewater	Pump stations, treatment plants, pipelines

4.2.3 Landslide, Severe Weather, Volcanic Activity and Wildfire

For landslide, severe weather, volcano and wildfire, historical data was not adequate to model future losses. However, geospatial analysis can be used to map hazard areas and calculate exposures if geographic information is available on the locations of the hazards and inventory data. Areas and inventory susceptible to some of the hazards of concern were mapped and exposure was evaluated. For other hazards, a qualitative analysis was conducted using the best available data and professional judgment. Locally relevant information was gathered from a variety of sources. The primary data source was the City of Portland GIS database, augmented with state and federal data sets. Additional data sources for specific hazards were as follows:

- **Landslide**—Two data sets were used to support the landslide risk assessment:
    - City of Portland regulatory landslide hazard areas—This dataset was created from three sources: Areas mapped as earthquake hazard areas by Metro, areas delineated as zones of high landslide

potential by Portland State University based on study of hundreds of landslides during storms in February 1996, and areas in the City with slopes of 15 percent or greater.
  - DOGAMI historical landslide deposits.

- **Volcano**—Volcanic hazard data was obtained from the USGS Cascade Volcano Observatory.
- **Wildfire**—Wildland fire hazard data was provided by the City of Portland.

4.2.4 Sources of Data Used in Hazus Modeling

Table-4-2 summarizes the Hazus-MH model data sources for this study.

4.2.5 Limitations

Uncertainties are inherent in loss estimation, partly due to incomplete scientific knowledge concerning natural hazards and their effects on the built environment. Uncertainties for this study also result from the following:

- Approximations and simplifications necessary to conduct a study.
- Incomplete or outdated inventory, demographic or economic parameter data.
- The unique nature, geographic extent and severity of each hazard. For example, in the current Hazus-MH model, the maximum duration of shaking during an earthquake event is 1 minute. It is anticipated that shaking may last for 3 minutes or longer during a Magnitude-9.0 Cascadia event.
- Mitigation measures already employed.
- The amount of advance notice residents have to prepare for a specific hazard event.
- The fact that not all hazards of concern have readily available modeling platforms.

These factors can affect loss estimates by a factor of two or more. Therefore, potential exposure and loss estimates are approximate and should be used only to understand relative risk.

Hazus-MH currently represents the industry best management practice for assessing risk in support of hazard mitigation planning. However, Hazus and other models used for this risk assessment are limited by the availability of data to support their working components. Such models must make assumptions where firm data are not available. Assumptions are used, for example, to estimate ground deformation caused by liquefaction. These model limitations can lead to an understatement or overstatement of risk. Further, the Hazus-MH model employs a "lower bound" analysis, intended to demonstrate cost-effectiveness at the lowest level of expected impact.

Despite their limitations, risk assessment techniques are able to indicate the possible extremes of hazard events. Their findings should be recognized as identification of potential hazard occurrences rather than as predictions of probable hazard events.

Table-4-2. Hazus Model Data Documentation

Data	Source	Date	Format
Flood hazard data	FEMA	12/2014	Digital (GIS) format
Digital elevation model	City of Portland Bureau of Planning and Sustainability	2014	Digital (GIS) format
Shake maps (Cascadia M9.0 and Portland Hills M6.5)	U.S. Geological Survey	2011 and 2009	Digital (GIS) format
National Earthquake Hazards Reduction Program soils	Oregon Department of Geology and Mineral Industries	2013	Digital (GIS) format
Liquefaction susceptibility	Oregon Department of Geology and Mineral Industries	2013	Digital (GIS) format
Landslide susceptibility	Oregon Department of Geology and Mineral Industries	2013	Digital (GIS) format
Regulatory landslide hazard area	City of Portland	Provided in 2015	Digital (GIS) format
Historical landslide deposits	Oregon Department of Geology and Mineral Industries	Provided in 2015	Digital (GIS) format
Wildland fire hazard	City of Portland	2002	Digital (GIS) format
Mt. Hood volcanic hazards	U.S. Geological Survey Cascades Volcano Observatory (CVO)	1997	Digital (GIS) format
CEI Hub Facilities			
Emergency operation centers, armories, nuclear reactors, helipads	City of Portland Bureau of Emergency Management	2015	Digital (GIS) format
Fire stations, hospitals, Police Bureau facilities, schools, airports, transit centers, highway bridges, highway tunnels, railway bridges, rail facilities, rail tunnels, 800 MHz transmitters, CenturyLink offices, City-owned essential facilities, Oregon Zoo, nursing homes/assisted living facilities	City of Portland	various dates	Digital (GIS) format
Well sites, reservoirs, pump stations, potable water facilities	City of Portland Water Bureau	Provided in 2015	Digital (GIS) format
Wastewater facilities	City of Portland Bureau of Environmental Services	Provided in 2015	Digital (GIS) format
Fireboat facilities, law enforcement facilities, military installations, highway bridges, highway tunnels, electric substations, petroleum facilities, prisons	City of Portland Regional Disaster Preparedness Organization	2011	Digital (GIS) format
Bus facilities, light rail bridges, light rail facilities, light rail tunnels, railway bridges	TriMet	Provided in 2015	Digital (GIS) format
Airports, port facilities	Port of Portland	Provided in 2015	Digital (MS Excel) format
Hazardous material facilities	Oregon State Fire Marshal	Provided in 2015	Digital (GIS) format
IRIS data (natural gas facilities)	Oregon Public Health	Provided in 2016	Digital (GIS) format
Petrol tank farms	Oregon Public Broadcasting	Provided in 2016	Digital (GIS) format
Natural gas facilities	Pacific Terminal Services	Provided in 2015	Digital (MS Excel) format
Petroleum facilities	Kinder Morgan	Provided in 2015	Digital (MS Excel) format
Communications facilities, electric facilities	FEMA-Hazus-MH version 2.2 default Comprehensive Data Management System	2015	Digital (GIS) format

4.3 EARTHQUAKE RISK ASSESSMENT

4.3.1 Hazard Profile

This report provides a summary profile of the earthquake hazard in the City of Portland. The 2016 City of Portland Hazard Mitigation Plan and the following additional resources provide discussions that are more detailed:

- Earthquake Risk Study for Oregon's Critical Energy Infrastructure Hub (DOGAMI, 2013)
- Cascadia Subduction Zone Earthquakes: A Magnitude 9.0 Earthquake Scenario (Cascadia Region Earthquake Workgroup, 2013).

Faults Affecting the Study Area

Many earthquake faults capable of producing damaging earthquakes exist in the area of the CEI Hub. The most threatening fault is the Cascadia Subduction Zone fault, which lies just offshore of the Oregon coast. The CSZ fault has produced over 40 large magnitude earthquakes during the past 10,000 years, most recently on January 26, 1700. Based on the 10,000-year record of past Cascadia earthquakes, Oregon will certainly experience another Magnitude 8 – 9 earthquake (Goldfinger et al. 2012). A Magnitude 9 CSZ earthquake has a likelihood as high as 14 percent in the next 50 years (USGS, 2008), although probabilities are likely higher for smaller segments along the fault to break (Goldfinger et al. 2012). A large earthquake on this fault, which has the same type of subduction zone process as the 2011 Magnitude 9 earthquake in Japan, will be accompanied by a coastal tsunami.

The Portland Hills fault is located in the CEI Hub area and can produce a Magnitude 7 earthquake (USGS, 2008). The likelihood of this earthquake occurring is approximately 1 percent in the next 50 years (USGS, 2016).

Earthquake Damage

Earthquakes can last from a few seconds to over 5 minutes. They may occur as a single event or a series of tremors over several days. The actual movement of the ground in an earthquake is seldom the direct cause of injury or death. Casualties generally result from falling objects and debris because the shocks damage or demolish structures. Disruption of communications, electrical power supplies and gas, sewer and water lines should be expected. Earthquakes may trigger fires, landslides or releases of hazardous material, compounding their disastrous effects. Hazardous materials releases can occur during an earthquake from fixed facilities or transportation-related incidents. During an earthquake, structures storing these materials could rupture and leak into the surrounding area or an adjacent waterway, having a disastrous effect on the environment.

The following are the primary seismic characteristics that would impact the CEI Hub area:

- Ground shaking
- Liquefaction (soil behavior phenomenon in which a saturated sand softens and loses strength during strong earthquake ground shaking)
- Lateral spreading (where surficial soil permanently moves laterally due to earthquake shaking)
- Landslides
- Co-seismic settlement (where the ground surface is permanently lowered due to seismic shaking)
- Bearing capacity failures (when the foundation soil cannot support the structure it is intended to support).

Liquefaction and lateral spreading hazards are of primary concern to the waterfront fuel supply facilities. The impact of an earthquake is based on its magnitude as well as its distance from a community. Local faults can produce lower magnitude quakes that result in strong ground shaking and extensive damage because they are nearby. In contrast, large regional faults can generate earthquakes of great magnitudes that, because of their distance and depth, may result in only moderate shaking in an area.

Seismic Mapping

Shake Maps

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

Ground motion and intensity maps are derived from peak ground motion amplitudes recorded on seismic sensors (accelerometers), with interpolation based on estimated amplitudes where data are lacking, and site amplification corrections. Two types of shake map are typically generated from the data:

- A probabilistic seismic hazard map shows the hazard from earthquakes that geologists and seismologists agree could occur. The maps are expressed in terms of probability of exceeding a certain ground motion, such as the 10-percent probability of exceedance in 50 years. This level of ground shaking has been used for designing buildings in high seismic areas. The standard Hazus analysis for the 100- and 500-year probabilistic events were modeled for this study.
- Earthquake scenario maps describe the expected ground motions and effects of hypothetical large earthquakes for a region. Two scenarios were chosen for this plan:
  - ➢ Scenario Earthquake 1—A Magnitude-9.0 event on the Cascadia Subduction Zone Fault with an epicenter at 45.7329° N, 125.125° W (67 miles west of Tillamook) and a focal depth of 20 km.
  - ➢ Scenario Earthquake 2—A Magnitude-6.5 event on the Portland Hills Fault with an epicenter at 45.5544° N, 122.798° W (Forest Park, Portland, OR) and a focal depth of 0 km.

National Earthquake Hazards Reduction Program Soil Maps

Soil classifications under the National Earthquake Hazards Reduction Program (NEHRP) help to identify locations that will be significantly impacted by an earthquake. NEHRP Soils B and C typically can sustain low-magnitude ground shaking without much effect. The areas that are most commonly affected by ground shaking have NEHRP Soils D, E and F. Mapped NEHRP Soils in the CEI Hub Study Area are shown on Figure 4-1.

Liquefaction

Figure 4-2 shows the mapped liquefaction hazard areas within the study area.

4.3.2 Exposure

Population

The entire population of the study area is exposed to direct and indirect impacts from earthquakes. This includes people who live in Linnton Neighborhood within the CEI Hub study area and people who work in the CEI Hub.

Property

All facilities in the study area are exposed to the earthquake hazard.

Environment

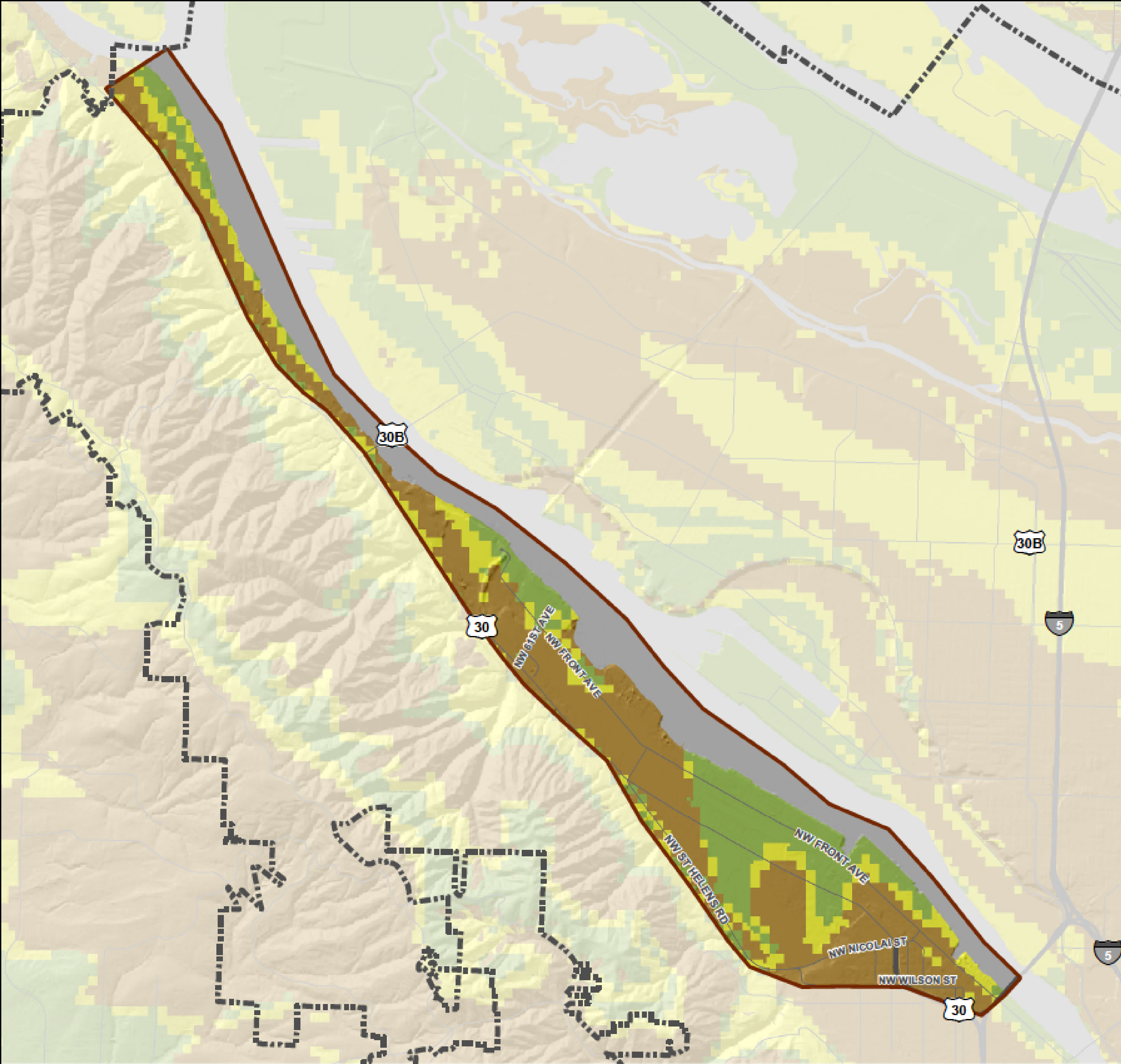
Secondary hazards associated with earthquakes will likely have impacts on the environment in the study area.

September 12, 2016

Mitigation Action Plan (MAP)

Critical Energy Infrastructure Hub Study

Figure 4-1.
National Earthquake Hazards Reduction Program Soils



Legend

City Boundary

Critical Energy Infrastructure (CEI) Hub Boundary

NEHRP Soils

Type

B

C

D

E

NORTH

0 0.5 1 Miles

Sources: DOGAMI-2012;
City of Portland-2016

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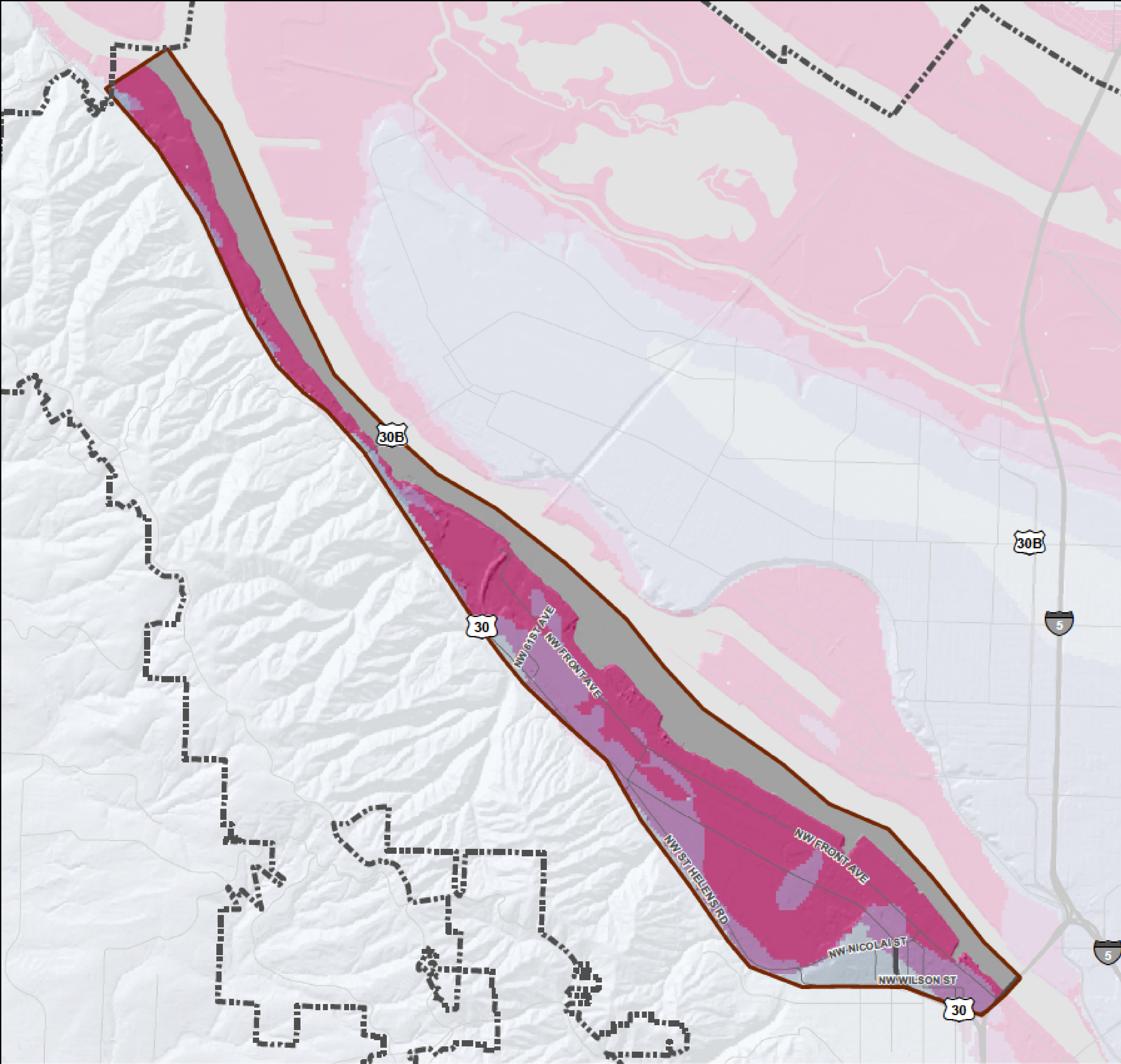
Critical Energy Infrastructure Hub Study

Figure 4-2.
Liquefaction Susceptibility



Legend

City Boundary

Critical Energy Infrastructure (CEI) Hub Boundary

Liquefaction Susceptibility

0 – None
1 – Very Low
2 – Low
3 – Moderate
4 – High
5 – Very High

NORTH

0 0.5 1 Miles

Sources: DOGAMI-2013; City of Portland-2016

37242

PBEM

4.3.3 Vulnerability

Population

The vulnerability of people in the study area depends on factors such as the age and construction type of the structures people live and work in, the soil type these facilities are constructed on, their proximity to the fault, etc. Whether directly impacted or indirectly impact, the entire population will have to deal with the consequences of earthquakes to some degree. Business interruption could keep people from working, road closures could isolate populations, and loss of functions of utilities could impact populations that suffered no direct damage from an event itself. These impacts would not be unique to the CEI Hub, but would be felt city-wide.

It is logical to assume, but difficult to model, secondary impacts from the CEI Hub facilities on population centers in the City after a major earthquake. The secondary impacts could include but are not limited to: reduction in air quality from fires and fume emissions from CEI Hub containment facilities that experience failures from seismic activity, environmental impacts from product entering the Willamette River, and isolation due to road and bridge failure. These impacts could be significant and would tax the response capability of the City.

Property

Level of Damage

Hazus-MH classifies the vulnerability of critical facilities to earthquake damage in five categories: no damage, slight damage, moderate damage, extensive damage, or complete damage. The definitions for each of these damage categories varies based upon the occupancy class of the facility, as shown in Table-4-3. The model was used to assign a vulnerability category to each defined facility in the study area.

The damage analysis was performed for the 100- and 500-year probabilistic events, the Magnitude 9.0 Cascadia Subduction Zone scenario event, and the Magnitude 6.5 Portland Hills fault scenario event. The results are summarized in Table-4-4 through Table-4-7.

Time to Return to Functionality

Hazus-MH estimates the time to restore critical facilities to fully functional use. Results are presented as probability of being functional at specified time increments: 1, 3, 7, 14, 30 and 90 days after the event. For example, Hazus-MH may estimate that a facility has 5 percent chance of being fully functional at Day 3, and a 95-percent chance of being fully functional at Day 90. In this methodology, loss of function is defined as the time that a facility is not capable of conducting business. This, in general, will be shorter than repair time, because businesses will rent alternative space while repairs and construction are being completed.

The functionality analysis of CEI Hub facilities was performed for the 100- and 500-year probabilistic events, the Magnitude 9.0 Cascadia Subduction Zone scenario event, and the Magnitude 6.5 Portland Hills fault scenario event. The results are summarized in Table-4-8 through Table-4-11.

Environment

The environment vulnerable to earthquake hazard is the same as the environment exposed to the hazard. Groundwater supplies and adjacent water courses could be contaminated by spillage from storage tanks. Air quality could be significantly compromised by fires started due to secondary impacts from seismic events. Earthquake-induced landslides can significantly impact surrounding habitat. It is also possible for streams to be rerouted after an earthquake. This can change the water quality, possibly damaging habitat and feeding areas. There is a possibility of streams fed by groundwater drying up because of changes in underlying geology.

Table-4-3. Damage State Definitions by Occupancy Class

Classification	Description
Emergency Services and High Potential Loss	
Slight	Small cracks at corners of door and window openings and wall-ceiling intersections; small cracks on stucco and plaster walls. Some slippage may be observed at bolted connections.
Moderate	Larger cracks at corners of door and window openings; small diagonal cracks across shear wall panels exhibited by cracks in stucco and gypsum wall panels; minor slack (less than 1/8" extension) in diagonal rod bracing requiring re-tightening; minor lateral set at store fronts and other large openings; small cracks or wood splitting may be observed at bolted connections.
Extensive	Large diagonal cracks across shear wall panels; large slack in diagonal rod braces and/or broken braces; permanent lateral movement of floors and roof; cracks in foundations; splitting of wood sill plates and/or slippage of structure over foundations; partial collapse of "soft-story" configurations; bolt slippage and wood splitting at bolted connections.
Complete	Structure may have large permanent lateral displacement, may collapse or be in imminent danger of collapse due to failed shear walls, broken brace rods or failed framing connections; it may fall its foundations; large cracks in the foundations. Approximately 3% of the total area of W2 buildings with complete damage is expected to be collapsed.
Transportation Systems	
Slight	Slight settlement (few inches) or offset of the ground. Minor cracking and spalling.
Moderate	Moderate settlement (several inches) or offset of the ground. Support features experiencing moderate (shear cracks) cracking and spalling (column structurally still sound), moderate movement of the abutment (<2"), extensive cracking and spalling of shear keys, any connection having cracked shear keys or bent bolts, keeper bar failure without unseating, rocker bearing failure or moderate settlement of the approach.
Extensive	Major settlement of the ground (few feet). Support features degrading without collapse—shear failure - (column structurally unsafe), significant residual movement at connections, or major settlement approach, vertical offset of the abutment, differential settlement at connections, shear key failure at abutments.
Complete	Major settlement of the ground. Support features collapsing and connection losing all bearing support, which may lead to imminent deck collapse, tilting of substructure due to foundation failure.
Electric Power	
Slight	Failure of 5% of the disconnect switches (i.e., misalignment), or the failure of 5 % of the circuit breakers (i.e., circuit breaker phase sliding off its pad, circuit breaker tipping over, or interrupter-head falling to the ground), or by the building being in minor damage state. Turbine tripping, or light damage to diesel generator, or by the building being in minor damage state.
Moderate	Failure of 40% of disconnect switches (e.g., misalignment), or 40% of circuit breakers (e.g., circuit breaker phase sliding off its pad, circuit breaker tipping over, or interrupter-head falling to the ground), or failure of 40% of current transformers (e.g., oil leaking from transformers, porcelain cracked), or by the building being in moderate damage state. chattering of instrument panels and racks, considerable damage to boilers and pressure vessels, or by the building being in moderate damage state
Extensive	Failure of 70% of disconnect switches (e.g., misalignment), 70% of circuit breakers, 70% of current transformers (e.g., oil leaking from transformers, porcelain cracked), or by failure of 70% of transformers (e.g., leakage of transformer radiators), or by the building being in extensive damage state. Considerable damage to motor driven pumps, or considerable damage to large vertical pumps, or by the building being in extensive damage state.
Complete	Failure of all disconnect switches, all circuit breakers, all transformers, or all current transformers, or by the building being in complete damage state. Extensive damage to large horizontal vessels beyond repair, extensive damage to large motor operated valves, or by the building being in complete damage state.
Natural Gas	
Slight	Slight damage to building.
Moderate	Considerable damage to mechanical and electrical equipment, or considerable damage to building
Extensive	Building being extensively damaged, or the pumps badly damaged beyond repair.
Complete	Building in complete damage state.
Petroleum	
Slight	Malfunction of plant for a short time (less than three days) due to loss of backup power or light damage to tanks.
Moderate	Malfunction of tank farm for a week or so due to loss of backup power, extensive damage to various equipment, or considerable damage to tanks.

Classification	Description
Extensive	Tanks extensively damaged, or extensive damage to elevated pipes.
Complete	Complete failure of all elevated pipes, or collapse of tanks.
Potable Water	
Slight	Malfunction of facility for a short time (less than three days) due to loss of electric power and backup power if any, considerable damage to various equipment, light damage to sedimentation basins, light damage to chlorination tanks, or light damage to chemical tanks. Loss of water quality may occur. Tanks suffering minor damage without loss of its contents or functionality. Minor damage to the tank roof due to water sloshing,
Moderate	Malfunction of facility for about a week due to loss of electric power and backup power if any, extensive damage to various equipment, considerable damage to sedimentation basins, considerable damage to chlorination tanks with no loss of contents, or considerable damage to chemical tanks. Loss of water quality is imminent. Storage tanks being considerably damaged, but only minor loss of content. Elephant foot buckling for steel tanks without loss of content, or moderate cracking of concrete tanks with minor loss of contents.
Extensive	Damage will likely result in the shutdown of the facility. Buildings extensively damaged, or the pumps being badly damaged beyond repair. Storage tanks being severely damaged and going out of service. Elephant foot buckling for steel tanks with loss of content, stretching of bars for wood tanks, or shearing of wall for concrete tanks fits the description of this damage state.
Complete	Complete failure of all piping, or extensive damage to the filter gallery. Total building collapse. Storage tanks collapsing and losing all of its content.
Wastewater	
Slight	Malfunction of facility for a short time (less than three days) due to loss of electric power and backup power if any, considerable damage to various equipment, light damage to sedimentation basins, light damage to chemical tanks. Loss of water quality may occur.
Moderate	Malfunction of facility for about a week due to loss of electric power and backup power if any, extensive damage to various equipment, considerable damage to sedimentation basins, considerable damage to chemical tanks with no loss of contents. Loss of water quality is imminent.
Extensive	Damage will likely result in the shutdown of the facility. Buildings extensively damaged, or the pumps being badly damaged beyond repair.
Complete	Complete failure of all piping's, or extensive damage to the filter gallery. Total building collapse.

Data Source: Multi-Hazard Loss Estimation Methodology, Earthquake Model, Hazus-MH 2.1, Technical Manual

Table-4-4. Estimated Damage to CEI Hub Facilities from 100-Year Earthquake

		Probability (%)														
	#	No Damage			Slight Damage			Moderate Damage			Extensive Damage			Complete Damage		
Category	Facilities	Avg.	High	Low	Avg.	High	Low	Avg.	High	Low	Avg.	High	Low	Avg.	High	Low
Emergency Services	3	96.64	97.22	95.47	2.99	4.00	2.49	0.33	0.48	0.25	0.02	0.03	0.02	0.00	0.00	0.00
Transportation	3	73.15	73.15	73.15	26.36	26.36	26.36	0.43	0.43	0.43	0.04	0.04	0.04	0.00	0.00	0.00
High Potential Loss	14	23.29	44.82	15.31	64.05	67.76	51.94	9.84	12.97	2.80	2.40	3.37	0.37	0.40	0.58	0.04
Electric Power	5	78.40	91.94	64.27	18.40	29.30	7.51	3.01	6.03	0.51	0.16	0.35	0.02	0.01	0.02	0.00
Natural Gas	1	64.27	64.37	64.37	29.30	29.30	29.30	6.03	6.03	6.03	0.35	0.35	0.35	0.02	0.02	0.02
Petroleum	293	68.74	92.04	64.27	25.94	29.30	7.42	5.00	6.03	0.05	0.28	0.35	0.02	0.02	0.02	0.00
Potable Water	1	64.27	64.27	64.27	29.30	29.30	29.30	6.03	6.03	6.03	0.35	0.35	0.35	0.02	0.02	0.02
Wastewater	3	64.81	65.05	64.59	28.94	29.09	28.78	5.87	5.93	5.80	0.34	0.34	0.33	0.02	0.02	0.02
All Facilities	**323**	**66.70**	**74.11**	**63.21**	**28.15**	**30.55**	**22.89**	**4.57**	**5.49**	**2.74**	**0.49**	**5.18**	**0.65**	**0.06**	**0.09**	**0.01**

Table-4-5. Estimated Damage to CEI Hub Facilities from 500-Year Earthquake

Category	# Facilities	Probability (%) No Damage			Slight Damage			Moderate Damage			Extensive Damage			Complete Damage		
		Avg.	High	Low	Avg.	High	Low	Avg.	High	Low	Avg.	High	Low	Avg.	High	Low
Emergency Services	3	55.14	60.87	43.77	22.11	26.34	19.99	7.32	10.01	5.98	1.03	1.78	0.66	14.37	18.07	12.52
Transportation	3	13.87	13.87	13.87	67.23	67.23	67.23	13.91	13.91	13.91	3.78	3.78	3.78	1.18	1.18	1.18
High Potential Loss	14	0.78	2.59	0.18	24.29	13.93	23.64	23.64	29.17	19.63	19.95	25.25	12.13	31.32	46.04	13.37
Electric Power	5	16.16	27.59	7.39	37.68	43.41	30.34	33.55	41.37	24.22	9.80	16.08	3.92	2.78	6.60	0.70
Natural Gas	1	7.62	7.62	7.62	31.26	31.26	31.26	41.32	41.32	41.32	16.01	16.01	16.01	3.77	3.77	3.77
Petroleum	293	9.67	27.72	7.32	32.84	43.20	30.20	39.07	41.34	24.13	14.22	16.06	3.89	4.17	6.72	0.82
Potable Water	1	7.70	7.70	7.70	31.59	31.59	31.59	41.75	41.75	41.75	16.18	16.18	16.18	2.75	2.75	2.75
Wastewater	3	7.41	7.57	7.32	30.55	31.19	30.20	40.52	41.35	40.09	15.76	16.07	15.58	5.73	6.72	3.79
All Facilities	**323**	**14.79**	**19.44**	**11.90**	**34.69**	**36.02**	**33.06**	**30.14**	**32.53**	**26.38**	**12.09**	**13.90**	**9.02**	**8.26**	**11.48**	**4.86**

Table-4-6. Estimated Damage to CEI Hub Facilities from M 9.0 Cascadia Subduction Zone Earthquake

Category	# Facilities	Probability (%) No Damage			Slight Damage			Moderate Damage			Extensive Damage			Complete Damage		
		Avg.	High	Low	Avg.	High	Low	Avg.	High	Low	Avg.	High	Low	Avg.	High	Low
Emergency Services	3	72.22	75.88	70.39	15.79	16.59	15.39	0.72	0.76	0.70	0.00	0.01	0.00	11.24	13.49	6.73
Transportation	3	21.94	25.01	15.79	65.57	66.44	65.13	9.22	22.18	7.74	2.05	3.08	1.54	1.19	2.48	0.55
High Potential Loss	14	2.63	2.73	2.55	47.78	49.58	46.23	27.11	28.11	24.32	13.91	14.42	13.41	8.55	17.98	5.18
Electric Power	5	34.03	45.71	30.96	42.15	43.45	39.53	19.69	21.59	13.35	2.71	3.11	1.30	1.39	2.20	0.08
Natural Gas	1	31.52	31.52	31.52	43.37	43.37	43.37	21.55	21.55	21.55	3.10	3.10	3.10	0.43	0.43	0.43
Petroleum	293	39.04	45.71	30.96	41.04	43.37	39.39	16.98	21.55	13.31	2.11	3.10	1.29	0.81	2.20	0.08
Potable Water	1	31.58	31.58	31.58	43.45	43.45	43.45	21.59	21.59	21.59	3.11	3.11	3.11	0.25	0.25	0.25
Wastewater	3	35.88	45.71	30.96	41.57	42.59	30.96	18.56	21.17	13.35	2.47	3.05	1.30	1.49	2.20	0.08
All Facilities	**323**	**33.61**	**37.98**	**30.59**	**42.59**	**43.61**	**40.43**	**16.93**	**19.81**	**14.49**	**3.68**	**4.12**	**3.13**	**3.17**	**5.15**	**1.67**

Table-4-7. Estimated Damage to CEI Hub Facilities from M 6.5 Portland Hills Fault Earthquake

Category	# Facilities	Probability (%) No Damage			Slight Damage			Moderate Damage			Extensive Damage			Complete Damage		
		Avg.	High	Low	Avg.	High	Low	Avg.	High	Low	Avg.	High	Low	Avg.	High	Low
Emergency Services	3	25.91	21.00	28.37	34.70	37.04	33.53	7.81	9.92	6.75	1.59	1.97	0.83	29.97	31.18	29.36
Transportation	3	2.93	3.27	2.25	48.96	51.03	44.82	26.43	27.11	26.09	12.44	14.47	12.44	8.54	11.33	7.14
High Potential Loss	14	0.14	0.27	0.00	11.44	17.89	1.82	17.99	22.75	7.51	21.24	21.28	18.17	49.16	72.48	37.78
Electric Power	5	4.38	7.02	1.85	23.02	29.91	15.51	40.98	40.95	40.07	22.97	22.87	16.44	8.64	12.91	5.66
Natural Gas	1	5.05	5.05	5.05	26.14	26.14	26.14	42.92	42.92	42.92	20.71	20.71	20.71	5.15	5.15	5.15
Petroleum	293	5.03	7.17	1.25	25.51	30.57	12.01	41.80	41.85	35.27	20.58	30.76	16.44	7.05	20.68	3.58
Potable Water	1	1.89	1.89	1.89	15.81	15.81	15.81	40.85	40.85	40.85	31.24	31.24	31.24	10.19	10.19	10.19
Wastewater	3	5.30	7.17	1.71	24.94	30.57	14.34	39.95	41.85	37.06	20.53	28.34	16.44	9.26	18.51	3.58
All Facilities	**323**	**6.33**	**6.61**	**5.30**	**26.32**	**29.87**	**20.50**	**32.34**	**33.53**	**29.57**	**18.91**	**21.46**	**16.59**	**16.0**	**22.80**	**12.81**

Table-4-8. Functionality of CEI Hub Facilities for 100-Year Earthquake

Category	# Facilities	Average % Functionality After Event					
		1 Day	3 Days	7 Days	14 Days	30 Days	90 Days
Emergency Services	3	96.60	96.63	99.50	99.60	99.90	99.90
Transportation	3	99.60	99.80	99.90	99.90	99.90	99.90
High Potential Loss	14	23.27	26.31	87.11	87.29	97.16	99.56
Electric Power	5	87.82	98.26	99.82	99.90	99.90	99.90
Natural Gas	1	84	96.5	99.2	99.7	99.9	99.9
Petroleum	293	84.77	96.12	97.22	98.95	99.81	99.90
Potable Water	1	84	96.5	99.2	99.7	99.9	99.9
Wastewater	3	75.00	96.43	99.60	99.70	99.80	99.90
All Facilities	**323**	**79.38**	**88.32**	**97.69**	**98.09**	**99.53**	**99.86**

Table-4-9. Functionality of CEI Hub Facilities for 500-Year Earthquake

Category	# Facilities	Average % Functionality After Event					
		1 Day	3 Days	7 Days	14 Days	30 Days	90 Days
Emergency Services	3	55.10	55.57	76.70	77.23	84.57	85.07
Transportation	3	86.90	93.50	95.80	96.00	96.40	98.30
High Potential Loss	14	0.74	1.90	24.94	25.03	48.67	68.61
Electric Power	5	38.50	71.90	92.28	97.32	98.54	99.90
Natural Gas	1	38.1	61.4	81.4	88.9	96.8	99.9
Petroleum	293	38.87	56.42	65.47	80.15	90.06	98.29
Potable Water	1	38.5	62	82.2	89.7	97.4	99.9
Wastewater	3	22.07	59.03	80.27	82.93	91.07	99.03
All Facilities	**323**	**39.85**	**57.72**	**74.88**	**79.66**	**87.94**	**93.63**

Table-4-10. Functionality of CEI Hub Facilities for M 9.0 Cascadia Subduction Zone Earthquake

Category	# Facilities	Average % Functionality After Event					
		1 Day	3 Days	7 Days	14 Days	30 Days	90 Days
Emergency Services	3	72.13	72.53	87.60	87.93	88.67	88.67
Transportation	3	91.37	95.67	97.20	97.33	97.53	98.67
High Potential Loss	14	2.60	4.87	50.21	50.36	77.48	91.40
Electric Power	5	57.00	86.34	97.16	98.68	99.22	99.90
Natural Gas	1	63.9	85.8	95.6	98.1	99.5	99.9
Petroleum	293	66.49	85.29	89.04	95.04	98.29	99.62
Potable Water	1	64	85.9	95.8	98.2	99.6	99.9
Wastewater	3	51.53	86.53	96.20	96.70	98.00	99.70
All Facilities	**323**	**58.63**	**75.37**	**88.60**	**90.29**	**94.79**	**97.22**

Table-4-11. Functionality of CEI Hub Facilities for M 6.5 Portland Hills Fault Earthquake

		Average % Functionality After Event					
Category	# Facilities	1 Day	3 Days	7 Days	14 Days	30 Days	90 Days
Emergency Services	3	25.87	26.67	59.77	60.60	68.37	69.17
Transportation	3	64.67	77.27	81.83	82.47	84.17	91.20
High Potential Loss	14	0.09	0.61	11.51	11.53	29.54	50.76
Electric Power	5	20.80	51.06	80.16	91.98	95.62	99.90
Natural Gas	1	33.2	55.2	76.5	85.5	95.8	99.9
Petroleum	293	31.76	46.62	56.60	72.84	84.82	97.21
Potable Water	1	24.3	42.4	64.1	76	92.2	99.9
Wastewater	3	18.27	51.37	72.60	76.07	86.77	98.47
All Facilities	**323**	**27.37**	**43.9**	**62.88**	**69.62**	**79.66**	**88.31**

4.3.4 Key Findings

Important findings associated with an earthquake include to the following:

- It is assumed that the modeling results of this analysis are understated due to incomplete data sets. There is a heavy reliance on default level data in the modeling for this study in lieu of the data that was not available from CEI Hub stakeholders. The accuracy of the modeling would be significantly enhanced if key data attributes that help estimate damage in the Hazus-MH models could be provided. Further, the Hazus-MH model employed a "lower bound" analysis, intended to demonstrate cost-effectiveness at the lowest level of expected impact.
- The vast majority of the facilities in the study area are constructed on soft, liquefiable soils that are typically associated with increased seismic vulnerability. The soils and liquefaction data provided by DOGAMI significantly enhanced the results of this study.
- The facilities and infrastructure within the study area range from over 100 years old to new or recent construction. The new construction has been built to heightened code standards, while the older construction was built to little or no code standards. The majority of the facilities were constructed to low, or no code standards. Code construction standards are an important parameter in the modeling of seismic events.
- Models of the Cascadia Subduction Zone event show less damage than the Portland Hills Fault event due to proximity to the source. The CSZ event has an epicenter 67 miles west of the study area, while the Portland Hills fault scenario had an epicenter less than 5 miles west of the study area. The CSZ event would be considered the true worst-case scenario due to its higher probability of occurrence and likelihood of regional impact. For the model, USGS has assigned a 15 percent probability in 50 years for a CSZ event, versus a 1 percent probability in 50 years for the Portland Hills event. Additionally, seismologists estimate a CSZ event to last longer than 3 minutes, while estimates for a Portland Hills event are 60 seconds or less. Event duration can play a significant role in the amount of damage associated with seismic events.
- For a CSZ event, the Hazus-MH model estimated that a 42.6 percent chance that all facilities analyzed would experience "slight" damage. For a Portland Hills event, there is a 32.3 percent chance that all facilities would experience "moderate" damage. Both scenario events approximate at least a 500-year probabilistic event, based on a comparison of the Hazus-MH results.
- For the CSZ event, the Hazus-MH model estimated that the facilities analyzed would be 88.6-percent functional at Day 7 following the event, and that it would take more than 90 days to restore 100-percent functionality. For a Portland Hills Fault scenario, facilities would be 62.89-percent functional at Day 7, and only 88.3-percent functional at Day 90. These results correlate with the 500-year probabilistic model results.

- The focus of the Hazus-MH modeling for this study was the direct impact on facilities in the study area. The modeling does not take into account significant secondary impacts from a CSZ event, such as the loss of use of port facilities due to the impacts from a likely tsunami on the Columbia River, or the loss of transportation corridor access due to road and bridge failures outside the study area. These secondary impacts could be substantial, considering the reliance of the CEI Hub on port access for receipt of its inventory, and the road and bridge network. These are key points identified in other studies reviewed for this study.

4.4 FLOOD RISK ASSESSMENT

4.4.1 Hazard Profile

A floodplain is the area adjacent to a river, creek or lake that becomes inundated during a flood. Floodplains may be broad, as when a river crosses an extensive flat landscape, or narrow, as when a river is confined in a canyon. These areas form a complex physical and biological system that not only supports a variety of natural resources but also provides natural flood and erosion control. When a river is separated from its floodplain with levees and other flood control facilities, natural benefits can be lost, altered or significantly reduced.

The principle flooding sources for the study area are the Willamette River and any localized flooding associated with a lack of drainage infrastructure. The Willamette River drains 11,200 square miles in northwestern Oregon upstream of Portland. Intensive commercial and industrial development borders the Willamette River in Portland, with some residential development near the upstream corporate limits. Major facilities within the 100-year floodplain include terminal and warehouse facilities on the west bank downstream of the Broadway Bridge (including the CEI Hub), portions of the Union Pacific Railroad at the Albina Yard, and industries on the west bank near Ross Island Bridge.

The Willamette River typically floods during the spring, primarily as the result of backwater from the Columbia River. FEMA has established the following flood depths on the Willamette River at the Morrison Bridge:

- 25.5 feet (North American Vertical Datum) for the 10-year flood
- 30.2 feet for the 50-year flood
- 32.3 feet for the 100-year flood
- 37.2 feet for the 500-year flood event.

The peak recorded discharge on the Willamette River at USGS Gage # 14211720 was 283,000 cubic feet per second on January 18, 1974.

A detailed flood hazard profile for all of the City of Portland is provided in the 2016 City of Portland Hazard Mitigation Plan. While there are FEMA-mapped floodplains within the study area, they do not significantly impact the CEI Hub facilities.

4.4.2 Exposure

Property

Facilities in the Floodplain

Table-4-12 shows the number of facilities in the 10-, 100- and 500-year floodplains. All these facilities are in the emergency services, transportation, petroleum or electric power occupancy category. This analysis does not reflect the total exposure within the study area; it only reflects the exposure of facilities for which information was provided to the planning team by participating CEI Hub stakeholders.

Table-4-12. CEI Hub Facilities in the Floodplain

Category	Number of Facilities Exposed 10-Year Flood	100-Year Flood	500-Year Flood
Emergency Services	1	1	1
Transportation	0	0	1
High Potential Loss	0	0	0
Electric Power	0	0	1
Natural Gas	0	0	0
Petroleum	2	2	40
Potable Water	0	0	0
Wastewater	0	0	0
Total	**3**	**3**	**43**

Land Use in the Floodplain

All land in the study area is zoned for industrial uses under the City of Portland Comprehensive Plan and zoning ordinance. While residential land uses exist adjacent to the study area, there are no residential land uses within the study area or the identified floodplains. There are no identified open space uses within the identified floodplains of the study area. While industrial occupancy is not an ideal land use for floodplains because of the potential secondary hazard of hazardous material releases, industrial facilities tend to be less vulnerable due to typical industrial construction classes. For example, petroleum storage tanks are typically constructed of steel or concrete that is flood resistant. Based on the available information, it does not appear that any of the exposed facilities are subject to regulations under the City's Flood Damage Prevention Ordinance (Section 24.50.050 of the Portland Municipal Code) because they were constructed prior to adoption of that ordinance.

Environment

Flooding is a natural event, and floodplains provide many natural and beneficial functions. Nonetheless, flooding can impact the environment in negative ways. At the CEI Hub, secondary hazards include the risk of oil or gas entering floodwaters due to spilling or leakage. Any flooding in the study area could result in surface water or groundwater contamination due to the liquid nature of the products handled in the CEI Hub.

4.4.3 Vulnerability

Property

Hazus-MH calculates losses to structures from flooding by looking at depth of flooding and type of structure and using historical flood insurance claim data to estimate the resulting percentage of damage to structures and their contents. For this analysis, local data on facilities was used instead of the Hazus-MH default inventory data. Modeling results are summarized in Table 4-13 for the 10-, 100- and 500-year flood events.

Environment

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

Table 4-13. Flood Damage Estimates for Flood Scenario Events

Category	10-Year			100-Year			500-Year		
	# Facilities Impacted	% Damage Structure	% Damage Contents	# Facilities Impacted	% Damage Structure	% Damage Contents	# Facilities Impacted	% Damage Structure	% Damage Contents
Emergency Services	1	58.2	100	1	84.86	100	1	88	100
Transportation	0	0	0	0	0	0	1	14	0
High Potential Loss	0	0	0	0	0	0	0	0	0
Electric Power	0	0	0	0	0	0	1	0.66	0
Natural Gas	0	0	0	0	0	0	0	0	0
Petroleum	2	0	0	2	0	0	41	0	0
Potable Water	0	0	0	0	0	0	0	0	0
Wastewater	0	0	0	0	0	0	0	0	0

4.4.4 Key Findings

Important findings associated with the flood hazard in the study area include the following:

- It is assumed that the modeling results of this analysis are understated due to incomplete data sets. There is a heavy reliance on default level data in the modeling for this study in lieu of the data that was not available from CEI Hub stakeholders. The accuracy of the modeling would be significantly enhanced if key data attributes that help estimate damage in the Hazus-MH models could be provided. Further, the Hazus-MH model employed a "lower bound" analysis, intended to demonstrate cost-effectiveness at the lowest level of expected impact. It is evident from review of aerial photography of the study area that the net exposure and possible vulnerability are greater than reflected in these model results.
- Due to construction classes and operations of CEI Hub facilities, floods are more likely to have an indirect impact on these facilities than a direct impact. Issues such as road closures and power interruptions associated with flooding would impact the functions of the CEI Hub.
- Future development or re-development within the floodplains of the study area would trigger regulation under the City's Flood Damage Prevention Ordinance.
- There is a high probability that a flood in the study area would have significant environmental impact due to effects on water quality.

4.5 LANDSLIDE RISK ASSESSMENT

4.5.1 Hazard Profile

A landslide is a mass of rock, earth or debris moving down a slope. Landslides may be small or large, and can move slow or fast. They can be initiated by storms, earthquakes, fires, volcanic eruptions or human modification of the land. Mudslides develop in the soil overlying bedrock on sloping surfaces when water rapidly accumulates in the ground, such as during heavy rainfall or rapid snowmelt. Water pressure in the pore spaces of the material increases to the point that the internal strength of the soil is drastically weakened. The soil's reduced resistance can then easily be overcome by gravity, changing the earth into a flowing river of mud. A mudflow can move rapidly down slopes or through channels and can strike with little or no warning. The material can travel miles from its source, growing as it descends, picking up trees, boulders, cars and anything else in its path.

The site where landslide material initially breaks free is called the failure location; the movement of material away from the failure location to locations downslope is called runout. With these two components, landslides pose a serious hazard to properties on and below hillsides. When landslides deform and tilt the ground surface, they can destroy building foundations, offset roads or break underground pipes at the failure location, and the runout can override downslope properties and structures.

Recent events such as the Oso landslide in Washington in March 2014 have changed the thinking of the assessment of risk from landslide hazards. The Oso landslide was the deadliest single landslide event in U.S. history (43 fatalities, 49 homes destroyed, damage in excess of $10 million). The damage extended over 2.6 kilometers, although the failure location of the slide was less than a half-kilometer. Most of the area impacted was damaged by the slide runout. This indicates the importance of considering possible runout scenarios to accurately reflect the risk from landslide hazards. The science and technology to do this is evolving. Runout studies are costly, and the science to do them is still to be validated. The driver to doing these types of studies is typically historical occurrence.

In general, landslide hazard areas are where the land has characteristics that contribute to the risk of the downhill movement of material, such as the following:

- Steep slopes
- A history of landslide activity or movement
- Stream or wave activity, which has caused erosion, undercut a bank or cut into a bank to cause the surrounding land to be unstable
- The presence of an alluvial fan, indicating vulnerability to the flow of debris or sediments
- The presence of impermeable soils, such as silt or clay, which are mixed with granular soils such as sand and gravel

Two data sets were used for the risk assessment of the landslide hazard:

- DOGAMI historical landslide deposits.
- City of Portland regulatory landslide hazard area—This dataset is currently used for permitting purposes and was created from three sources:
  - Areas identified and mapped by Metro as earthquake hazard areas
  - Areas delineated as zones of high landslide potential in a study conducted by Portland State University based on the mapping of 676 landslide events that occurred as a result of the February 1996 storms
  - All land within the City that has a slope of 15 percent or greater.

A detailed landslide hazard profile for all of the City of Portland is provided in the 2016 City of Portland Hazard Mitigation Plan. While there are landslide susceptible areas identified in the CEI Hub study area, they do not significantly impact the CEI Hub facilities.

4.5.2 Exposure

Table-4-14 summarizes the CEI Hub facilities exposed to the landslide hazard. This analysis does not reflect the total exposure within the study area; it only reflects the exposure of facilities for which information was provided to the planning team by participating CEI Hub stakeholders.

Any landslide exposure for the study area lies in the hillsides to the west. The direct exposure to landslide failure locations on steep slopes with soft soils is very low (on 2 out of 323 facilities analyzed). However, what is not known is the exposure of the study area to landslide runout, as landslide materials move downhill from the initial failure location. Runout maps currently do not exist for the study area. If an event like the Oso slide were to happen in the hillside to the west of the study area, most of the facilities in the CEI Hub would be impacted by runout.

Table-4-14. CEI Hub Facilities in Landslide Risk Areas

Category	Number of Exposed CEI Hub Facilities in Risk Area
Emergency Services	0
Transportation	0
High Potential Loss	0
Electric Power	0
Natural Gas	0
Petroleum	1
Potable Water	1
Wastewater	0
Total	**2**

The following infrastructure components also can be exposed to mass movements:

- **Roads**—Landslides can block egress and ingress on roads, causing isolation for neighborhoods, traffic problems and delays for public and private transportation. This can result in economic losses for businesses.
- **Bridges**—Landslides can knock out bridge abutments or significantly weaken the soil supporting them, making them hazardous for use.
- **Power Lines**—Landslides can trigger failure of the soil underneath a power line tower, causing it to collapse and ripping down the lines.

4.5.3 Vulnerability

Currently, there are no nationally accepted formulas for modeling the damage resulting from landslides in applications such as Hazus-MH. At this time, all CEI Hub facilities, infrastructure and transportation corridors identified as exposed to the landslide hazard are considered vulnerable until more information becomes available.

4.5.4 Key Findings

Important findings associated with the landslide hazard in the study area include the following:

- It is assumed that the modeling results of this analysis are understated due to incomplete data sets. There is a heavy reliance on default level data in the modeling for this study in lieu of the data that was not available from CEI Hub stakeholders. The accuracy of the modeling would be significantly enhanced if key data attributes that help estimate damage in the Hazus-MH models could be provided. Further, the Hazus-MH model employed a "lower bound" analysis, intended to demonstrate cost-effectiveness at the lowest level of expected impact.
- As the science and technology for landslide risk analysis continues to evolve, risk managers within the study area should consider revisiting the risk assessment for this hazard, especially with the development risk assessment tools that can account for landslide runout.
- The risk associated with the landslide hazard overlaps the risk associated with other hazards such as earthquake, flood and wildfire. This provides an opportunity to seek mitigation alternatives with multiple objectives that can reduce risk for multiple hazards.

4.6 SEVERE WEATHER RISK ASSESSMENT

4.6.1 Hazard Profile

Severe weather refers to any dangerous meteorological phenomena with the potential to cause damage, serious social disruption, or loss of human life. It includes thunderstorms, hail storms, damaging winds, tornadoes, excessive heat, snowstorms, ice storms, blizzards, and extreme cold. The most common severe weather events that impact the study area are winter weather and windstorms.

Severe weather events have the potential to happen anywhere in the study area. Low-lying areas adjacent to the Willamette River are more susceptible to flooding. Wind events are most damaging to areas that rely on elevated utilities such as above-ground power lines.

4.6.2 Exposure

Population

The entire population of the study area is exposed to direct and indirect impacts from severe weather. This includes people who live in the Linnton District and people who work in the CEI Hub.

Property

All 323 facilities for analyzed in this study are considered to be exposed to the severe weather hazard. This reflects only the exposure of facilities for which information was provided to the planning team.

4.6.3 Vulnerability

Population

The degree of vulnerability of population in the study area is dependent on many factors, including the age and construction type of the structures/facilities people live and work in. Whether directly or indirectly impacted, the entire population will have to deal with the consequences of severe weather to some degree. Business interruption could keep people from working, road closures could isolate populations, and loss of functions of utilities could impact populations that suffer no direct damage from an event itself.

Property

The range and diversity of severe weather hazards makes it difficult to establish standard estimates of damage to support risk assessment modeling for severe weather. Therefore, severe weather vulnerability assessments are typically qualitative in nature.

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

Incapacity and loss of roads are the primary transportation failures resulting from severe weather, mostly associated with secondary hazards such as landslides or debris or power lines knocked down by high winds. Large storms can have negative economic impacts for an entire region as prolonged obstruction of major routes can disrupt the shipment of goods and other commerce.

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

The biggest impact to the CEI Hub from severe weather events would be the prolonged loss of power. Power is a vital commodity for the CEI Hub for both the receipt and distribution of product, mostly through electricity-powered pumping. While it would be possible for product to be distributed via gravity methods, it is significantly less efficient and requires different operating procedures that would require some down time for conversion. While backup power is available, it is not consistent through all facilities in the CEI Hub.

4.6.4 Key Findings

Important findings associated with severe weather in the study area include the following:

- It is assumed that the modeling results of this analysis are understated due to incomplete data sets. There is a heavy reliance on default level data in the modeling for this study in lieu of the data that was not available from CEI Hub stakeholders. The accuracy of the modeling would be significantly enhanced if key data attributes that help estimate damage in the Hazus-MH models could be provided. Further, the Hazus-MH model employed a "lower bound" analysis, intended to demonstrate cost-effectiveness at the lowest level of expected impact.
- Coordinated continuity of operations planning between CEI Hub stakeholders would significantly aid the operations of CEI Hub facilities during and after severe weather events.

4.7 VOLCANIC ACTIVITY RISK ASSESSMENT

4.7.1 Hazard Profile

A volcano is a vent in the earth's crust through which magma, rock fragments, gases, and ash are ejected from the earth's interior. There are 20 volcanoes in the Cascade Range, five of which have been active in historical times: Mount Baker, Glacier Peak, Mount Rainier, Mount St. Helens, Mount Adams and Mount Hood.

Volcanoes can lie dormant for centuries between eruptions, and the risk they pose is not always apparent. When Cascade volcanoes erupt, high-speed avalanches of hot ash and rock called pyroclastic flows, lava flows, and landslides can devastate areas 10 or more miles away. Huge mudflows of volcanic ash and debris called lahars can inundate valleys more than 50 miles downstream. Falling ash from explosive eruptions can disrupt human activities hundreds of miles downwind, and drifting clouds of fine ash can cause severe damage to the engines of jet aircraft hundreds or thousands of miles away.

Any impacts on the study area from the volcano hazard would be considered to be secondary, indirect impacts associated mainly with ash fall from volcanic activity outside the study area. A detailed volcano hazard profile for all of the City of Portland is provided in the 2016 City of Portland Hazard Mitigation Plan.

Location

Based on currently best available data, there is no lahar exposure to the study area from volcanic activity. There could be ash fall exposure from volcanic activity at any of the Cascade Range volcanos near the study area. As a point of reference to this assertion; during the 9 hours of vigorous eruptive activity of Mt. St. Helens in 1980, about 540 million tons of ash fell over an area of more than 22,000 square miles. Total volume of the ash before its compaction by rainfall was about 0.3 cubic miles (USGS, 2016a). Much of this ash fall affected the City of Portland and the study area. Impacts from volcanic ash fall are dependent on prevailing wind directions at the time of the eruption. Figure 4-3 shows the annual probability of ash fall accumulation across the Pacific Northwest as projected by USGS Cascade Volcano Observatory. The study area is highlighted in the graphic.

Source: Hoblitt and Scott 2011

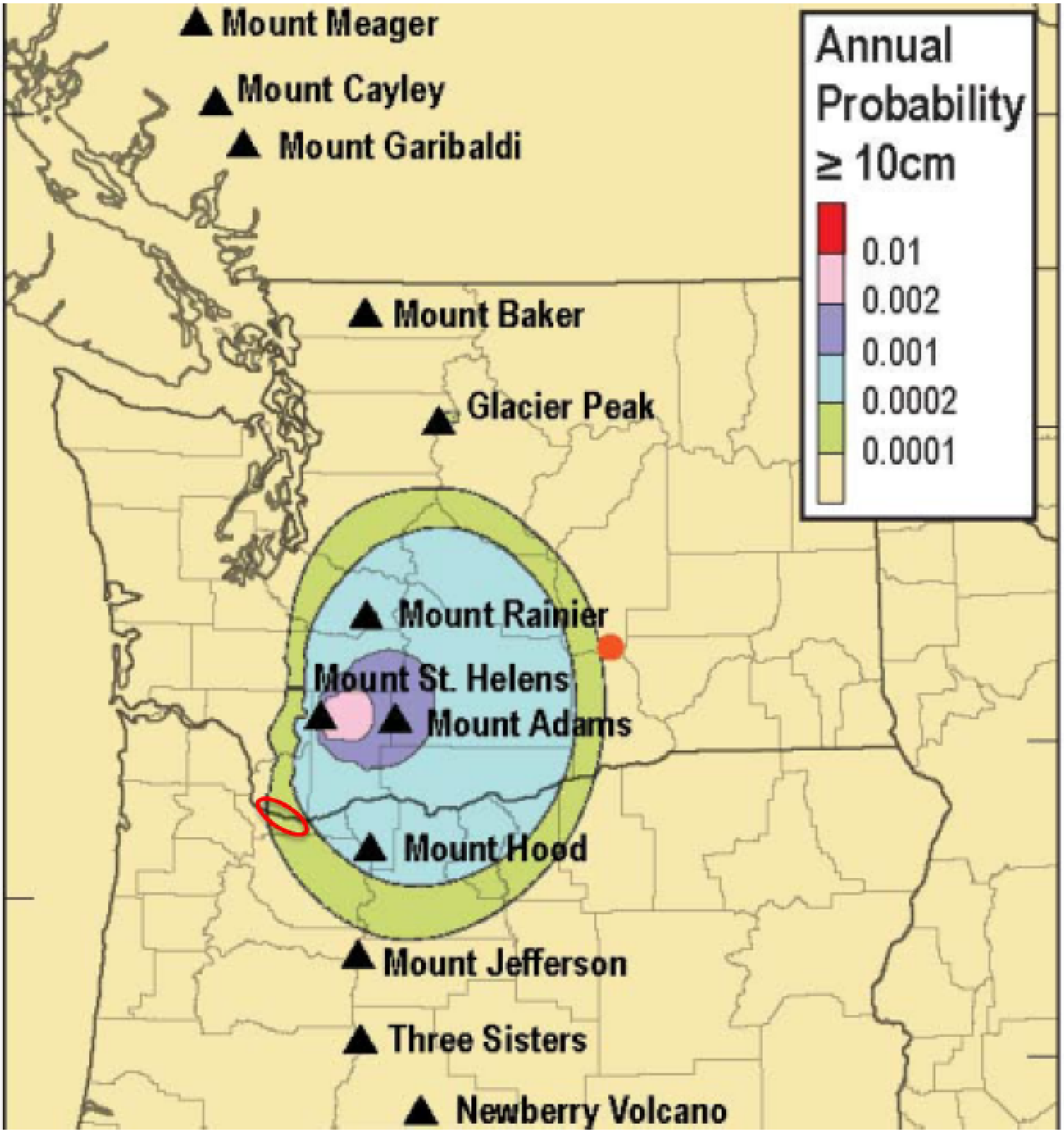


Figure 4-3. Probability of Ash Fall Accumulation in Pacific Northwest

4.7.2 Exposure

The entire study area would be exposed to ash fall accumulation from any of the nearby Cascade Range volcanoes.

4.7.3 Vulnerability

Facilities most vulnerable to ash fall are those that are not as structurally sound and may collapse under the excessive weight of ash and possible rainfall. Vulnerable property includes equipment and machinery out in the open whose parts can become clogged by the fine dust. Infrastructure, such as drainage systems, is potentially vulnerable to the effects of ash fall, since the fine ash can clog pipes and culverts. This may be more of a problem if an eruption occurs during winter or early spring when precipitation is highest and floods are most likely.

All transportation routes are exposed to ash accumulation, which could create hazardous driving conditions on roads and highways and hinder evacuations and response. Machinery and equipment using these transportation routes would also be vulnerable. Water treatment plants and wastewater treatment plants are vulnerable to contamination from ash. Visibility in the short aftermath of an eruption would also be problematic.

Indirect/secondary impacts on CEI Hub facilities could include power interruption, transportation corridor interruption that would impact product distribution, product contamination from ash fall, and public health concerns that could impact the work force of the CEI Hub facilities. These impacts are difficult to quantify by modeling, but could be assessed qualitatively by looking at relevant past occurrences.

Lahar flows from a Mt. Hood eruption would likely have significant impacts on the Columbia River. Mt. Hood lahars are likely to flow through the Sandy River to the Columbia River. This could interrupt marine traffic on the Columbia River, which would impact the CEI Hub, which receives and distributes some of its products via barge traffic up the Columbia River. Also, flood conditions on the Willamette River are dictated by backwater effects from the Columbia River. So it is conceivable that the study area could see flooding on the Willamette from lahar impacts on the Columbia River.

4.7.4 Key Findings

Important findings associated with the volcano hazard include the following:

- There is not a thorough understanding of the indirect impacts volcanic activity would have on CEI Hub facilities and operations.
- Since volcanic episodes have been fairly predictable in the recent past, there is probably not much concern about life safety, but there is concern about loss of property and infrastructure and severe environmental impacts.
- The consideration of a volcanic eruption scenario in continuity of operations planning would be beneficial to CEI Hub stakeholders.
- The volcanic hazard can be underestimated based on the perception that there will be plenty of advance notice of volcanic activity, like there was in 1980 with Mt. St. Helens.

4.8 WILDFIRE RISK ASSESSMENT

4.8.1 Hazard Profile

A wildfire is any uncontrolled fire on undeveloped land that requires fire suppression. Wildfires can be ignited by lightning or by human activity such as smoking, campfires, equipment use, or arson. Oregon's Building Code encourages local governments to designate portions of their jurisdictions subject to catastrophic fire as Wildfire Hazard Zones. The purpose of these zones is to define areas where buildings need to be made more survivable from fires spreading through adjacent wildlands. Three factors vital to wildfire risk are included in the methodology for mapping these zones: weather, topography, and vegetative fuel factor. Fire hazard maps used for this risk assessment were provided by the City of Portland. While there are wildfire severity zones within the study area, they do not significantly impact the CEI Hub facilities. A detailed wildfire hazard profile for all of the City of Portland is provided in the 2016 City of Portland Hazard Mitigation Plan.

Fuels

Fuels are classified by weight or volume and by type, including living and dead vegetation on the ground, brush and small trees on the surface, and tree canopies above the ground. Fuel loading, often expressed in tons per acre, indicates the amount of vegetative material available. Some fuels burn more easily or release more energy than others. Lighter fuels such as grasses, leaves and needles quickly expel moisture and burn rapidly, while heavier fuels such as tree branches, logs and trunks take longer to warm and ignite.

Topography

The movement of air over the terrain tends to direct a fire's course. Gulches and canyons can funnel air and act as a chimney, intensifying fire behavior and inducing faster rates of spread. Saddles on ridge tops offer lower resistance to the passage of air and will draw fires. Solar heating of drier, south-facing slopes produces upslope thermal winds that can complicate fire behavior. On steep slopes, fuels on the uphill side of a fire are closer to the source of heat. Fire travels downslope much more slowly than it does upslope, and ridge tops often mark the end of wildfire's rapid spread.

Weather

Extreme weather leads to extreme fire events, and it is often a moderation of the weather that marks the end of a wildfire's growth. High temperatures and low humidity can produce vigorous fire activity. Winds may play a dominant role in directing the course of a fire. Strong, dry winds produce extreme fire conditions. The most damaging firestorms are usually marked by high winds.

4.8.2 Exposure

Any wildfire exposure for the study area lies in the hillsides to the west. Table 4-15 summarizes the CEI Hub facilities exposed to the wildfire hazard. This analysis does not reflect the total exposure within the study area; it only reflects the exposure of facilities for which information was provided to the planning team by participating CEI Hub stakeholders.

Table 4-15. CEI Hub Facilities in Wildfire Risk Areas

Category	Number of Exposed CEI Hub Facilities in Risk Area
Emergency Services	0
Transportation	0
High Potential Loss	0
Electric Power	1
Natural Gas	0
Petroleum	0
Potable Water	0
Wastewater	0
Total	**1**

4.8.3 Vulnerability

Structures, above-ground infrastructure, critical facilities and natural environments are all vulnerable to the wildfire hazard. Currently, there are no nationally accepted formulas for modeling the damage resulting from wildfire in applications such as Hazus-MH. Therefore, the vulnerability assessment for this hazard is qualitative.

CEI Hub facilities of wood frame construction are especially vulnerable during wildfire events. Power lines are at risk to wildfire if their support poles are made of wood and susceptible to burning.

The combustible nature of the materials on hand within the CEI Hub could increase the degree of risk within the study area. In the event of a wildfire, pipelines could provide a source of fuel and lead to a catastrophic explosion. However, the fact that most if not all of these materials are contained within fire resistant containers, and that there is a fairly significant fire break (Highway 30) between the risk area and those containers, significantly reduces that risk.

In the event of wildfire, there would likely be little damage to the majority of infrastructure in the study area. Most road and railroads would be without damage except in the worst scenarios. Fires can create conditions that block or prevent access and can isolate residents and emergency service providers. Wildfire typically does not have a major direct impact on bridges, but it can create conditions in which bridges are obstructed. Many bridges in areas of high to moderate fire risk are important because they provide the only ingress and egress to large areas and in some cases to isolated neighborhoods.

Most measurable impacts from the wildfire hazard would be indirect/secondary impacts. These impacts would be predominantly business interruption impacts associated with power loss and transportation corridor closures due to the response to wildfire events outside the study area.

4.8.4 Key Findings

Important findings associated with the wildfire hazard in the study area include the following:

- It is assumed that the modeling results of this analysis are understated due to incomplete data sets. There is a heavy reliance on default level data in the modeling for this study in lieu of the data that was not available from CEI Hub stakeholders. The accuracy of the modeling would be significantly enhanced if key data attributes that help estimate damage in the Hazus-MH models could be provided. Further, the Hazus-MH model employed a "lower bound" analysis, intended to demonstrate cost-effectiveness at the lowest level of expected impact.
- Coordinated continuity of operations planning between CEI Hub stakeholders would significantly aid the operations of CEI Hub facilities during and after wildfire events.

5. DISASTER RESILIENCE RECOMMENDATIONS

This chapter presents disaster resilience recommendations that will be considered for inclusion as actions in the 2016 update to the City of Portland Hazard Mitigation Plan. These recommendations are specific to the CEI Hub and were identified through a facilitated process that involved the identification and engagement of stakeholders, collection of data, assessment of risk, and identification of recommendations based on the study area's strengths, weaknesses, obstacles and opportunities (see Chapter 4 for more information on the risk assessment).

5.1 RECOMMENDATION 1—CEI HUB DISASTER RESILIENCY WORKGROUP

The CEI Hub is of paramount importance to the City of Portland, the State of Oregon and the larger region. The literature review and stakeholder engagement undertaken as part of this study highlighted the need for continued and enhanced focus on the development of disaster resilience for the CEI Hub to protect this critical resource and the surrounding areas. This study represents a high-level starting point for a collaborative approach to building resilience in the CEI Hub. To continue this work, it is recommended that a CEI Hub Disaster Resiliency Workgroup be formed and be officially recognized by all CEI Hub stakeholders. The success of the workgroup will depend on the following:

- Support from all CEI Hub stakeholders that were identified for this study
- Recognition by federal, state, local and private-sector entities as a body that can initiate change
- Public support garnered by the authentic involvement of public stakeholders, such as the Linnton Neighborhood Association.

The issues identified by this study and those that preceded it cross multiple public and private sectors and go beyond questions of hazard intensity and the resilience of facilities. The importance of the CEI Hub to the Pacific Northwest warrants a workgroup with strong commitment and recognition from all stakeholders. Because this workgroup would be recognized across multiple sectors, it would become the voice of disaster resilience for the CEI Hub. Goals for the workgroup would include the following:

- Meet regularly to work toward an established mission, vision, goals and objectives, and possible strategic plan.
- Build upon the strong buyer-supplier relationships established by the industry cluster (Grillo, 2005).
- Have dedicated resources to support disaster resilient initiatives for the CEI Hub.
- Provide recommendations on policy, best management practices, interagency coordination, public outreach and education, preparedness, response and recovery—all with regard to disaster resilience for the CEI Hub.

The Cascadia Region Earthquake Workgroup provides an example of the effectiveness of this level of focus on a regionally important subject. That workgroup is a coalition of private and public representatives, funded with a grant through the NEHRP, working together to improve the ability of Cascadia region communities, businesses and homeowners to proactively reduce impacts from earthquakes.

It is assumed that the CEI Hub Disaster Resiliency Workgroup would be established as a private non-profit entity similar to the Cascadia Region Earthquake Workgroup. The workgroup would need access to funding to be effective. Potential funding sources may include the following:

- Federal grants from the NEHRP, similar to those used by the Cascadia Region Earthquake Workgroup
- Sponsorship fees from supporting stakeholders such as the City of Portland, the State of Oregon, FEMA, and CEI Hub owner/operators

The importance of this recommendation to the overall resilience of the CEI Hub is indicated by the fact that all of the following recommendations incorporate a role for this workgroup. Implementation of the recommendations below is not contingent upon this recommendation, but their effectiveness will be enhanced by the existence of a CEI Hub Disaster Resiliency Workgroup.

5.2 RECOMMENDATION 2—UPDATE/ENHANCE CEI HUB RISK ASSESSMENT

The Hazus-MH model that was constructed to support this study and the update of the larger mitigation plan is a tool that can be used to support the implementation of hazard mitigation actions. The ability to look at risk associated with natural hazards at a property-specific level can be leveraged to support all phases of emergency management (preparedness, response, recovery and mitigation); however, model results are only as accurate as the data on which they rely.

As noted several times in this report, the results of the risk assessment for this study are likely to be understated in part due to the incomplete facility data resulting from less than full participation by all CEI Hub owner/operators and limitations of the Hazus model. The magnitude and severity of the hazard events that may impact the CEI Hub are believed to be well understood; however, the fragility of facilities at risk during these hazard events is less clear. This recommendation aims to improve model results and close this data gap by continuing to work with relevant stakeholders to gather data and update the model as new information becomes available from stakeholders as well as new data on event intensity, severity and magnitude of hazard events.

The groundwork for this recommendation was established during the course of this study. Hazard scenarios were identified, mapped and quantified, models were constructed, data capture tools and instructions were created, and data were captured for 323 facilities. The success of this recommendation will require a greater rate of participation by CEI Hub stakeholders than was achieved for this study. The formation of a CEI Hub Disaster Resiliency Workgroup (Recommendation 1) would contribute to the success of this recommendation because of the increased buy-in from CEI Hub stakeholders.

5.3 RECOMMENDATION 3—REGULATORY AMENDMENT

The City of Portland City Council Resolution No. 37168, passed on November 12, 2015, adopted a policy opposing projects that would increase the amount of crude oil being transported by rail through the City of Portland as well as expansion of infrastructure whose primary purpose is transporting or storing fossil fuels in or through Portland or adjacent waterways. Through the stakeholder engagement process for this study, CEI Hub owner/operators stated that this resolution provides no incentive for retrofitting vulnerable facilities and may provide a disincentive. For example, an owner/operator may be more likely to retrofit a vulnerable tank if capacity could be expanded at the same time that retrofitting occurred.

It is recommended that the City consider amending this resolution to allow for the expansion of an existing facility that has been identified as vulnerable to an identified hazard of concern and targeted for retrofit. The facility would have to have be identified as vulnerable based on the risk assessment model (Recommendation 2), and the owner would have to include the retrofit in a resilience-related plan (Recommendation 4). The degree of allowable expansion would be capped (e.g. no more than 20 percent of current capacity). Proposals for retrofits/expansions would be screened by the CEI Hub Disaster Resiliency Workgroup (Recommendation 1). Implementation protocol for the amendment would need to be clearly vetted by stakeholder groups.

5.4 RECOMMENDATION 4—EMERGENCY RESPONSE/RECOVERY REGULATORY WAIVERS

CEI Hub stakeholders participating in this study stressed that federal and state environmental regulations regarding obtaining and transferring fuel are obstacles to effective disaster resilience, especially in disaster response and recovery. This recommendation proposes that parameters or best management practices be identified for waivers from federal and state regulatory agencies to improve ease of response and recovery efforts, with adequate assurances for environmental protection. The CEI Hub Resilience Workgroup would facilitate the development of these waivers and provide approval prior to submittal to the regulatory agency. Although this recommendation calls for waivers, a well-established protocol may achieve the same objective as a waiver under certain circumstances. The principle objective of this recommendation is to increase efficiency in disaster response and recovery by whatever means is most effective. This recommendation is specific to disaster response and recovery. It is not the intent of the recommendation to circumvent effective regulation outside of a disaster response and recovery scenario.

5.5 RECOMMENDATION 5—PLANNING

The current level of disaster-resilience planning by CEI Hub owner/operators is not well known. Some plans may exist, but their scope and degree of consistency have not been evaluated. Therefore, it is recommended that the CEI Hub Disaster Resiliency Workgroup (Recommendation 1) establish a suite of best management practices for a range of resilience-related planning efforts, such as continuity of operations plans, response plans, recovery plans, facility vulnerability assessments, etc. The first step in this process would be to assess existing planning efforts and establish minimum baselines for the promotion of disaster resilience. The assessment and development of the guidelines would seek answers to questions such as the following:

- Does each facility owner/ operator have a continuity of operations plan? A response plan? A recovery plan? A capital facility plan?
- Do these plans acknowledge or address disaster resilience?
- What should a continuity of operations plan for the CEI Hub include?

The establishment of these baselines and best management practices would help to promote consistency within the CEI Hub and promote the wise use of resources through the provision of templates and/or best practices that were vetted through a forum of peers who understand the importance and operations of the CEI Hub. The success of this recommendation would be predicated on stakeholder buy-in on the benefits of the planning curriculum and commitment in the use of the curriculum to develop plans. This would be facilitated through the CEI Hub Disaster Resiliency Workgroup.

5.6 RECOMMENDATION 6—BACKUP POWER

Power is mission-critical for the CEI Hub. Maintaining power supply to the CEI Hub will have a large impact on the region's ability to recover from a disaster. The Portland General Electric (power supplier for the CEI Hub) has built disaster resilience into its business plan, but maintaining consistent power during and after major disaster events cannot be guaranteed. As a result, backup power capability is a necessity for the CEI Hub. Needs should be identified through a systematic look at all facilities that determines the following:

- The current level of backup power capability at the CEI Hub
- How long that capability can be sustained
- The reliability of the capability
- Anticipated functional downtimes of facilities following hazard events
- The size and types of backup power systems that would meet the facility's needs, possibly including solar microgrids and other alternative energy sources.

FEMA has revised its policy on funding emergency generators through hazard mitigation grant programs. By including this recommendation in the Hazard Mitigation Plan, funding for these projects may be able to be secured through these grant programs.

5.7 RECOMMENDATION 7—TRAINING AND EXERCISE

Preparedness is a key element of disaster resilience. This includes training and exercises on multiple scenarios of likely events, so that when a hazard occurs, participants have already practiced responses and improved them based on lessons learned from the practices. Led by PBEM, the City of Portland has a well-established training and exercise program for disaster preparedness and response. This program is bolstered by multiple tabletop and full-scale exercises that examine disaster scenarios likely to occur in the City of Portland.

Through the implementation of this recommendation, the City would commit to periodic, scenario-based trainings and exercises within the CEI Hub, coordinated with CEI Hub stakeholders. This recommendation seeks to build on the existing PBEM training and exercise program. It assumes that implementation of Recommendations 1, 2 and 4 will provide the information and coordination to enhance the program for the CEI Hub. Under this recommendation, PBEM would make a commitment to a CEI Hub-specific training or exercise on a periodic basis (e.g. every 2 years). This recommendation would be coordinated through the CEI Hub Resiliency Workgroup.

5.8 RECOMMENDATION 8—FACILITY RETROFITS

Vulnerable facilities in the CEI Hub should be identified and retrofitted. A comprehensive, site-specific risk assessment should be conducted to identify and prioritize facilities for retrofit and/or replacement. Completion of this recommendation is dependent on the development of a facility vulnerability assessment protocol established by the CEI Hub Resiliency Workgroup. Once facilities have been identified, funding options (capital improvement plans, grants, etc.) and a timeline for completion would be identified for each facility. Additionally, facility retrofit projects potentially impacted by Portland City Council Resolution No. 37168 (Recommendation 3) would be identified.

This recommendation assumes that vulnerability assessment best practices would be performed by the CEI Hub facility owner/operator following the best management practices established in Recommendation 4. The identification of funding alternatives would be a coordinated effort between the facility owner/operator and the CEI Hub Resiliency Workgroup. If facilities are identified as potentially eligible for grant funding, the owner/operator would inform PBEM for incorporation as an action into the City's hazard mitigation plan through the plan implementation and maintenance protocol included in the plan document.

5.9 RECOMMENDATION 9—LAND USE REPURPOSING

Accessibility to the CEI Hub by land and water is necessary for both supply and distribution. The effectiveness of its location to marine, highway, petroleum pipeline, and rail access is a principle reason the CEI Hub is so important to the Pacific Northwest region. Relocating the CEI Hub to mitigate its natural hazard risks would negate the advantages of its current location. Given that it is not feasible to relocate the CEI Hub facilities, the City of Portland needs to consider whether it should continue to support residential land uses in this area, which is likely to experience severe direct and indirect consequences from natural hazard events. The City recognizes the personal connection and long-term investment that Linnton residents have in their community. However, due to increasing evidence of substantial risk, the City has begun taking steps to slow the growth of residential use in the area (City of Portland, 2016). This recommendation for land use repurposing includes the development of regionally acceptable means to repurpose land within an identified buffer area, or hazard zone, adjacent to the CEI Hub.

The first step would be to identify an appropriate buffer zone for which land use repurposing would take place. The CEI Hub Resilience Workgroup should engage all stakeholders who would be directly impacted by land repurposing in a two-step facilitated process: 1) determine factors for consideration in establishing a buffer; 2) use those factors to define the size of buffer needed to ensure safety in the event of a hazard event affecting the CEI Hub.

Once the hazard zone buffer has been established, options for repurposing land use within that region would be identified. These options could include, but would not be limited to, further down-zoning (decreasing allowed density for new development) in addition to zoning changes in the city's 2035 Comprehensive Plan, or a voluntary buy-out program to convert existing properties to open space. These, and other land-use repurposing alternatives should be thoroughly evaluated by the CEI Hub Resilience Workgroup and members of the surrounding community.

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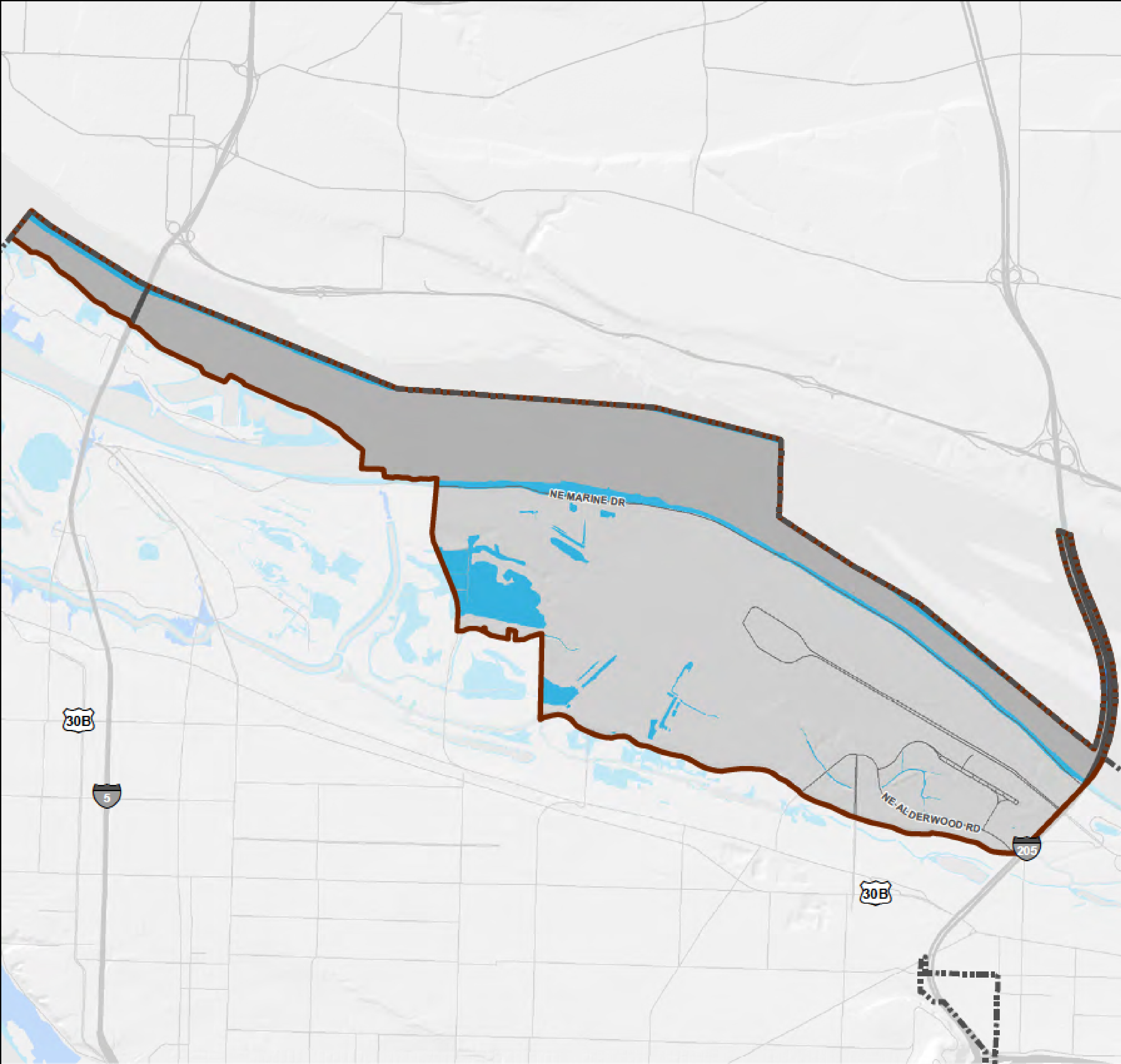
The Mitigation Action Plan

Appendix E. Reporting-Area-Scale Maps

E. Reporting-Area-Scale Maps

Risk assessment maps developed for *The Mitigation Action Plan* are provided by reporting area on the following pages.

AIRPORT



September 12, 2016

Mitigation Action Plan (MAP)

Flood hazard - 100-yr and 500-yr FEMA flood zone

Legend

- City Boundary
- 100-year FEMA flood zone
- 500-year FEMA flood zone
- Risk Reporting Area Airport

NORTH

0 0.35 0.7 Miles

Sources: FEMA-2014; City of Portland-2016

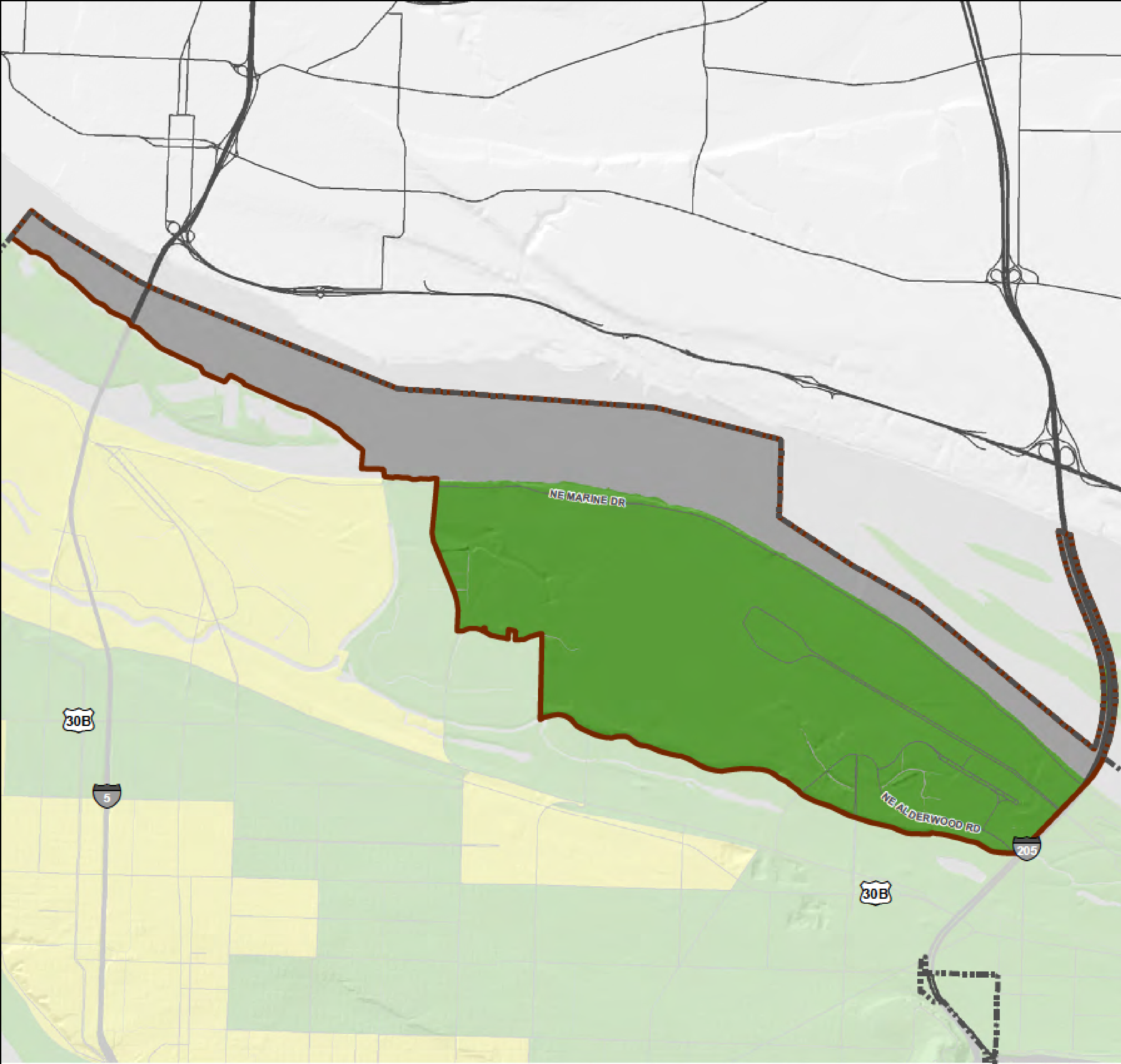
37242

PBEM

September 12, 2016

Mitigation Action Plan (MAP)

100-year Probabilistic Earthquake--Peak Ground Acceleration



Legend

City Boundary

100-year probabilistic earthquake PGA

Potential Damage - Perceived Shaking

V -- Very Light - Moderate

VI -- Light - Strong

Risk Reporting Area Airport

NORTH

0 0.35 0.7 Miles

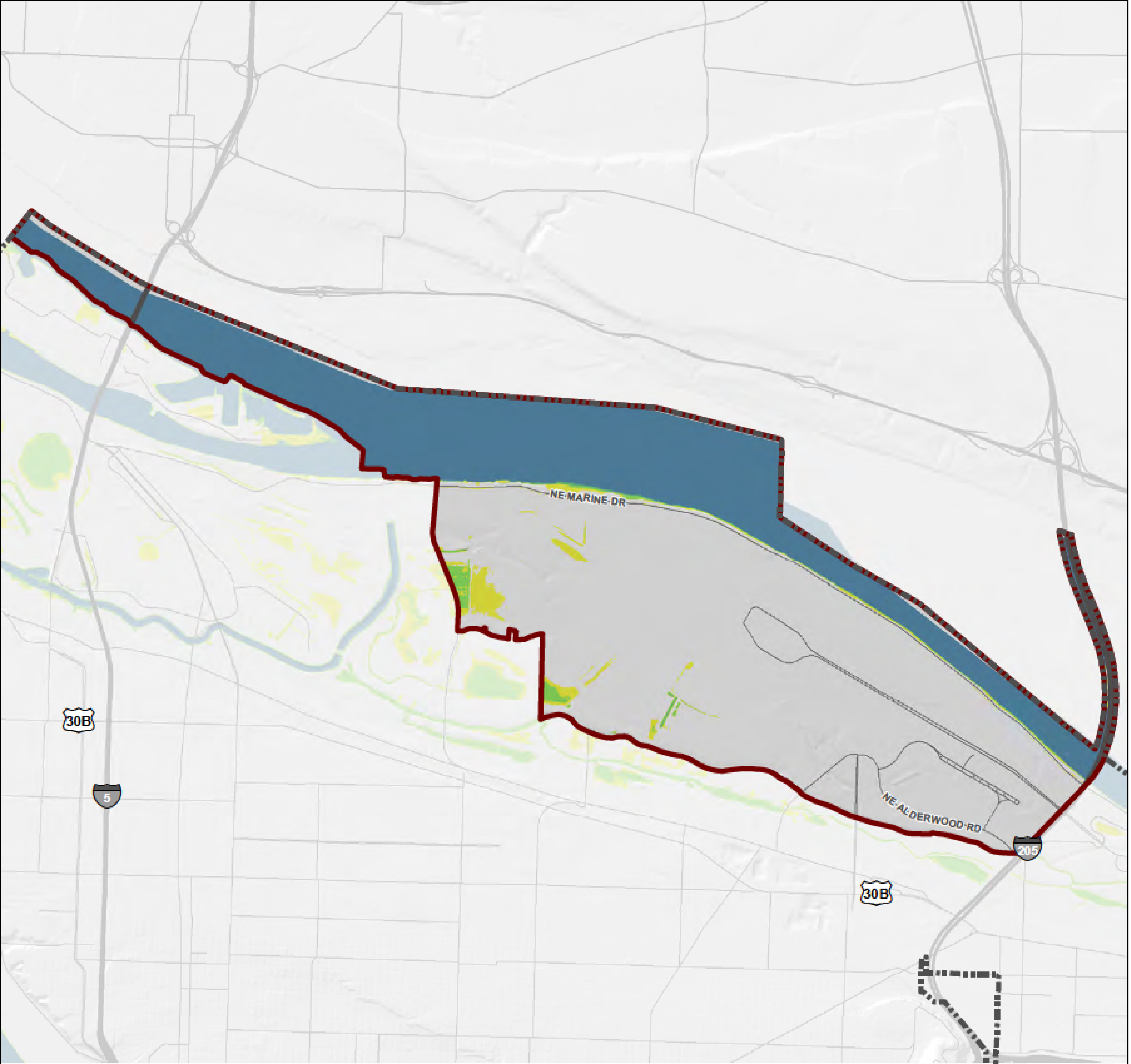
Sources: FEMA-2015; City of Portland-2016

37242

September 12, 2016

Mitigation Action Plan (MAP)

Flood Hazard - 100-yr Flood Depth Grid



Legend

City Boundary

100-year flood depth grid

0.1' - 4.5'

4.6' - 11.5'

11.6' - 19.5'

19.6' - 25.9'

26' - 33.2'

Risk Reporting Area Airport

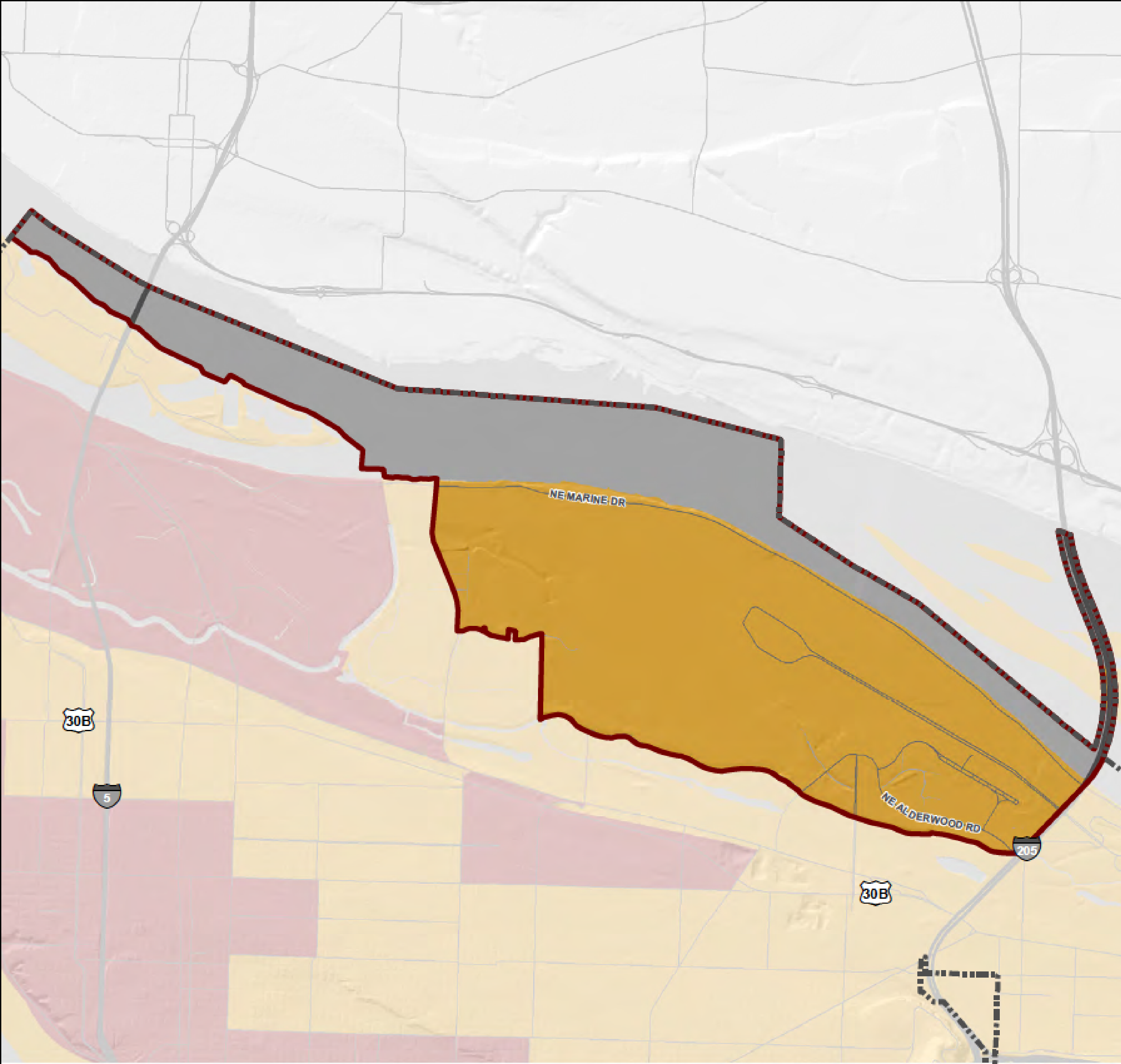
NORTH

0 0.35 0.7 Miles

Sources: Tetra Tech-2016; City of Portland-2016

37242

PBEM



September 12, 2016

Mitigation Action Plan (MAP)

500-year Probabilistic Earthquake--Peak Ground Acceleration

Legend

City Boundary

500-year probabilistic earthquake PGA

Potential Damage - Perceived Shaking

VI -- Light - Strong

VII -- Moderate - Very Strong

VIII -- Moderate/Heavy - Severe

Risk Reporting Area Airport

NORTH

0 0.375 0.75 Miles

Sources: FEMA-2015; City of Portland-2016

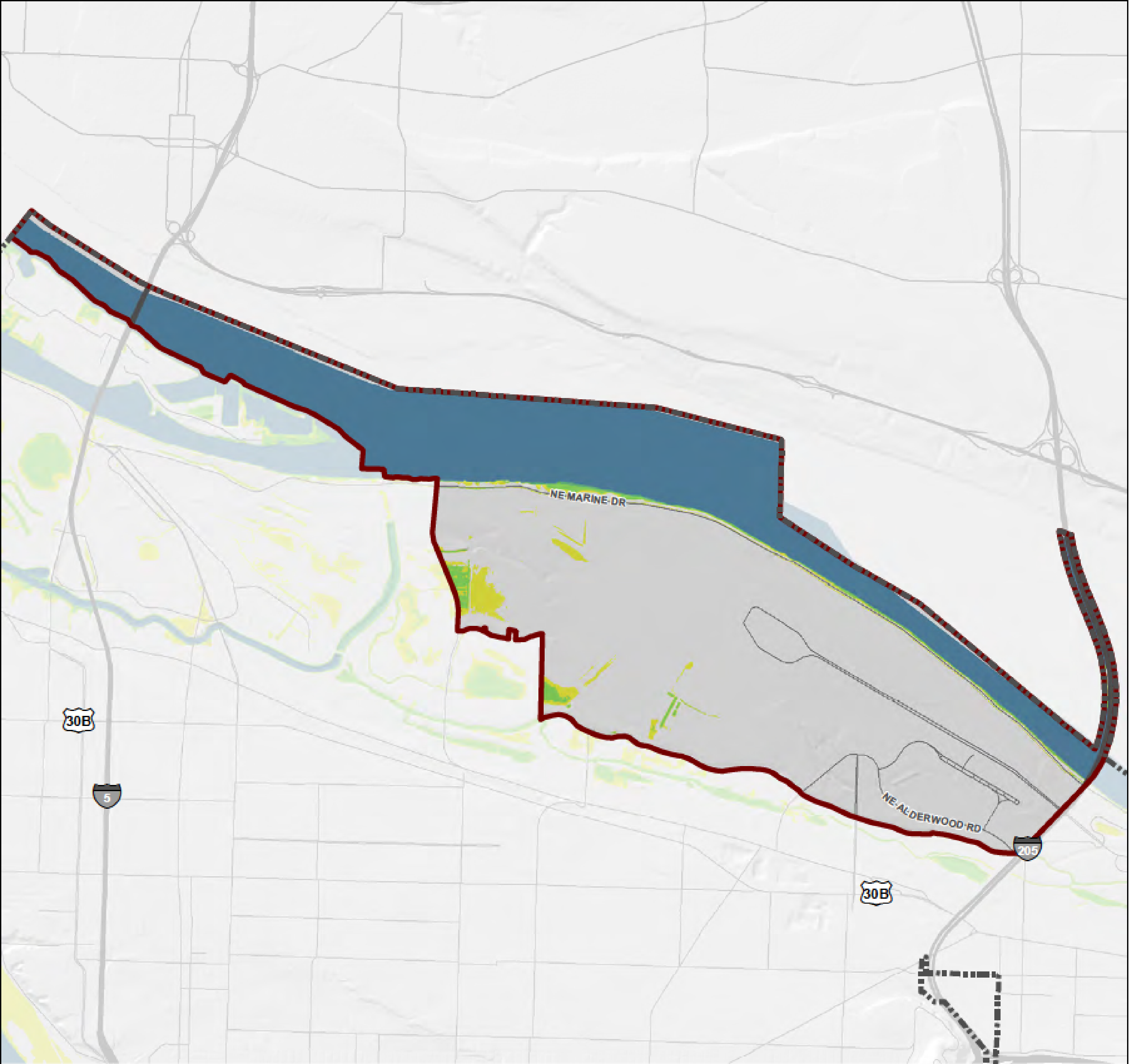
37242

PBEM

September 12, 2016

Mitigation Action Plan (MAP)

Flood Hazard - 500-yr Flood Depth Grid



Legend

City Boundary

500-year flood depth grid

0' - 4.6'

4.7' - 12.9'

13' - 22.6'

22.7' - 28.8'

28.9' - 36.7'

Risk Reporting Area Airport

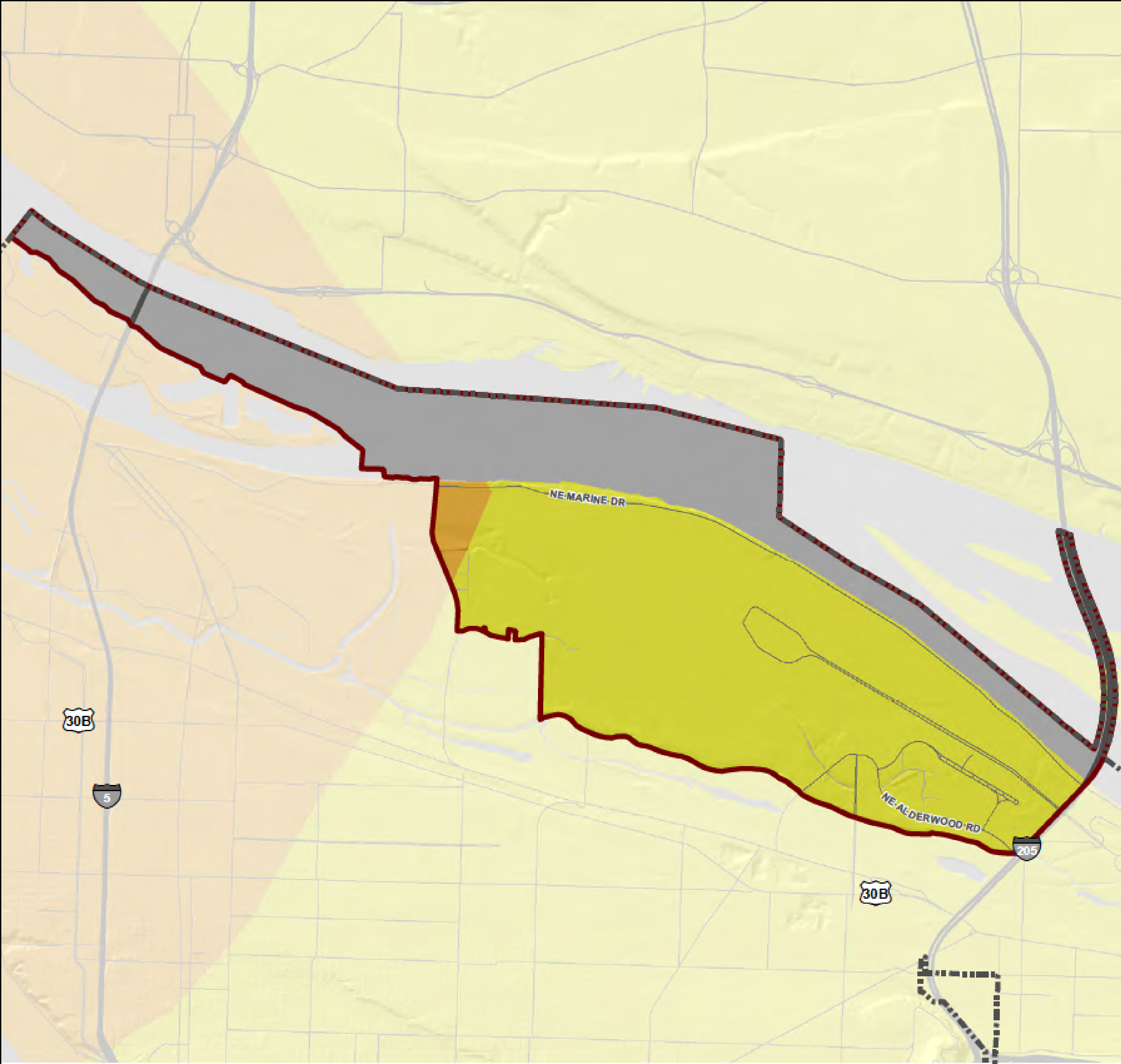
NORTH

0 0.4 0.8 Miles

Sources: Tetra Tech-2016; City of Portland-2016

37242

PBEM



September 12, 2016

Mitigation Action Plan (MAP)

Cascadia 9.0 Magnitude Earthquake--Peak Ground Acceleration

Legend

City Boundary

Cascadia M9.0 earthquake PGA

Potential Damage - Perceived Shaking

V – Very Light - Moderate

VI – Light - Strong

VII – Moderate - Very Strong

VIII -- Moderate/Heavy - Severe

Risk Reporting Area Airport

NORTH

0 0.35 0.7 Miles

Sources: USGS-2011; City of Portland-2016

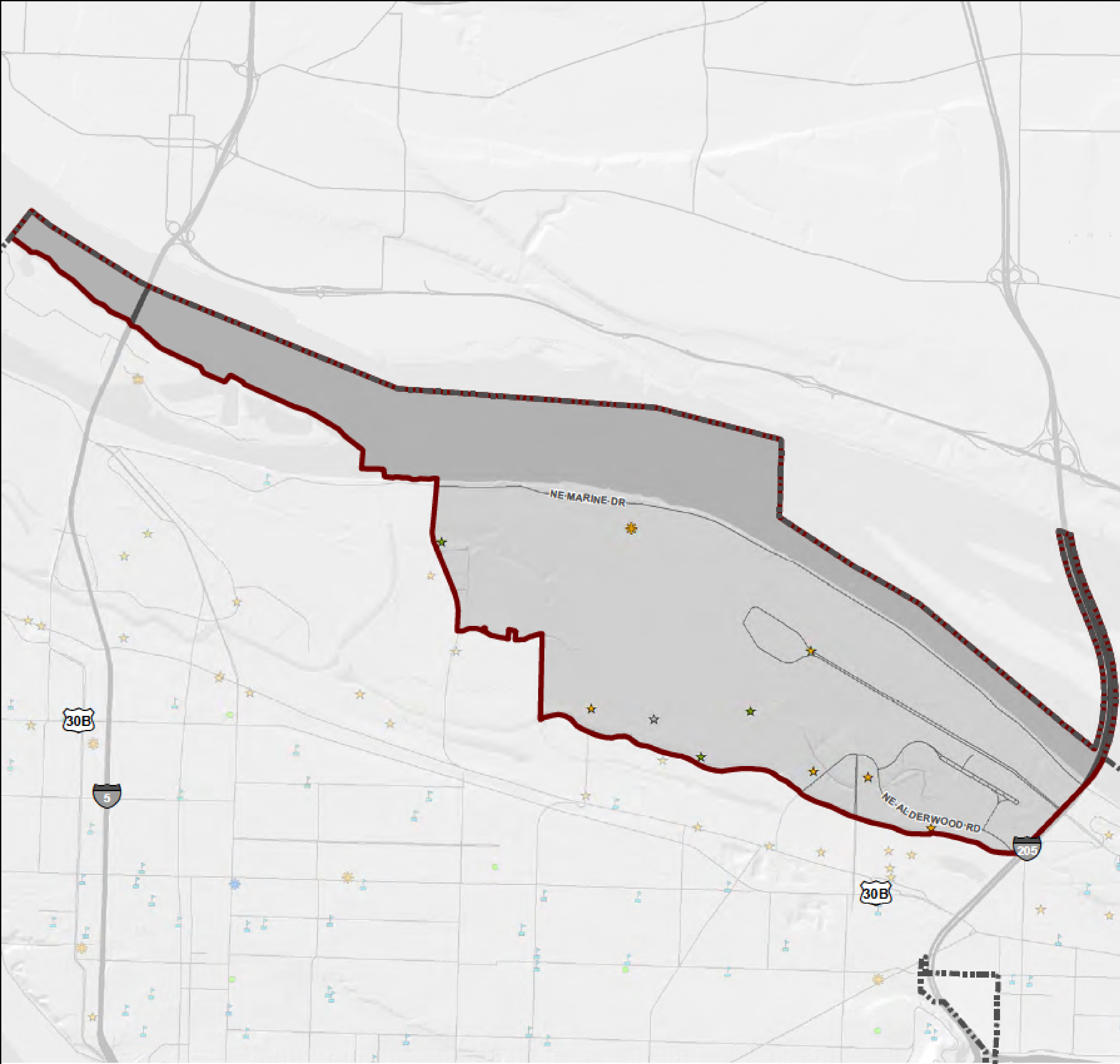
37242

PBEM

September 12, 2016

Mitigation Action Plan (MAP)

Critical Facilities



Legend

City Boundary
Risk Reporting Area Airport

Emergency Services*

Emergency Coordination Centers
Fire Station Facilities
Police Station Facilities
Medical Care Facilities

High Potential Loss Facilities*

Dams
Military
Nuclear Power Plants
Hazardous Materials
Schools
Other Assets
Zoo, Jails, Nursing/Assisted Living Facilities

*Due to security reasons, some emergency services and high potential loss facilities have been left off of the map.

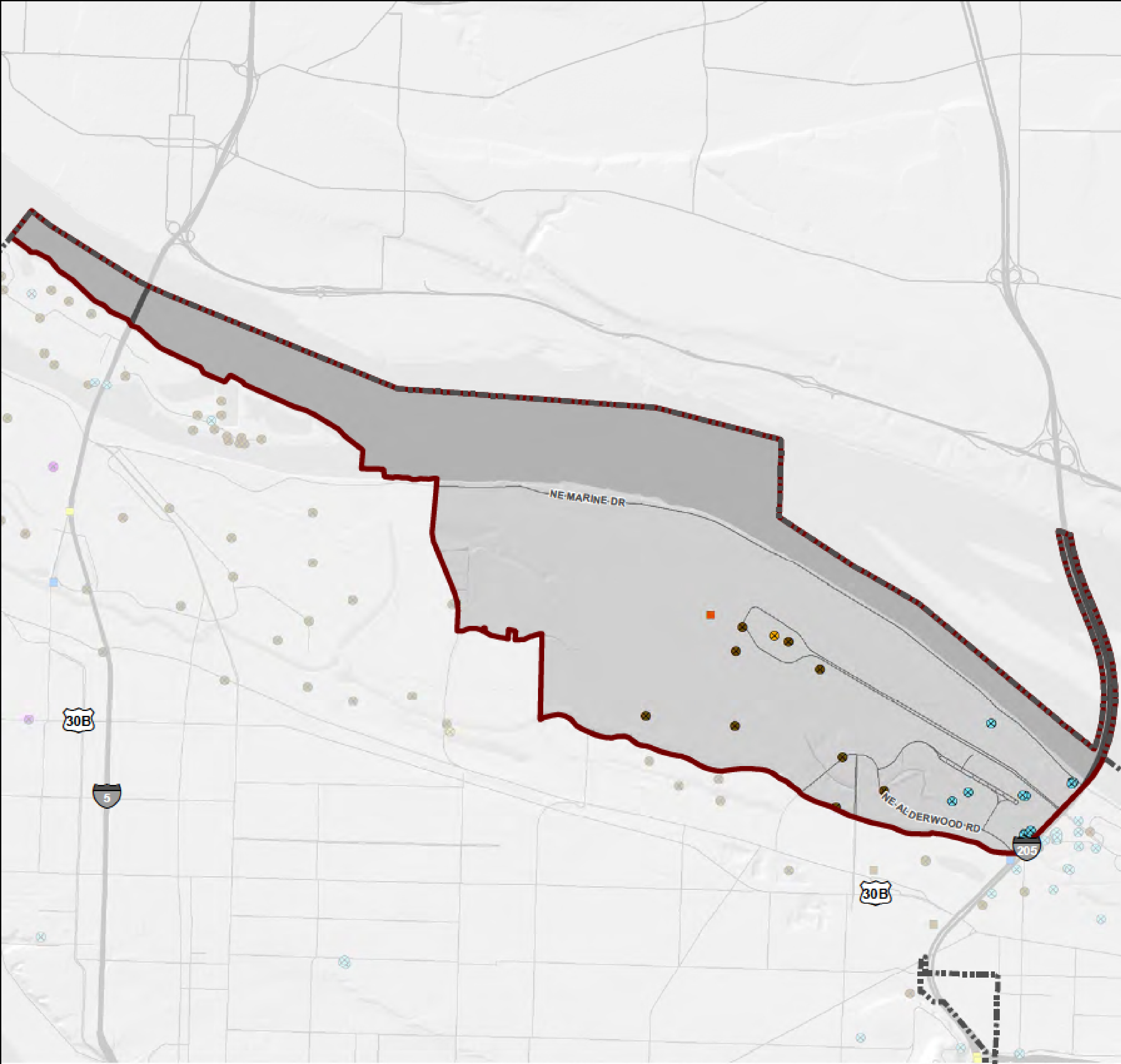
NORTH

0 0.35 0.7 Miles

Sources: WORD/NID-2015; OSFM-2015; City of Portland-2011, 2015, 2016

37242

PBEM



September 12, 2016

Mitigation Action Plan (MAP)

Critical Infrastructure

Legend

City Boundary
Risk Reporting Area Airport

Utility Systems*

Electrical
Natural Gas Facilities
Communication Facilities
Petroleum Facilities
Potable Water Facilities
Wastewater Facilities

Transportation Systems*

Railway Tunnels, Bridges, and Facilities
Light Rail Tunnels, Bridges, and Facilities
Highway Tunnels and Bridges
Bus Facilities
Port and Airport Facilities

*Due to security reasons, some utility and transportation system components have been left off of the map.

NORTH

0 0.35 0.7 Miles

Sources: TriMet-2015; Port of Portland-2015; OPHS-2016; City of Portland-2011, 2015,2016; OPB-2016; PTS-2015; FEMA-2015; Kinder Morgan-2015

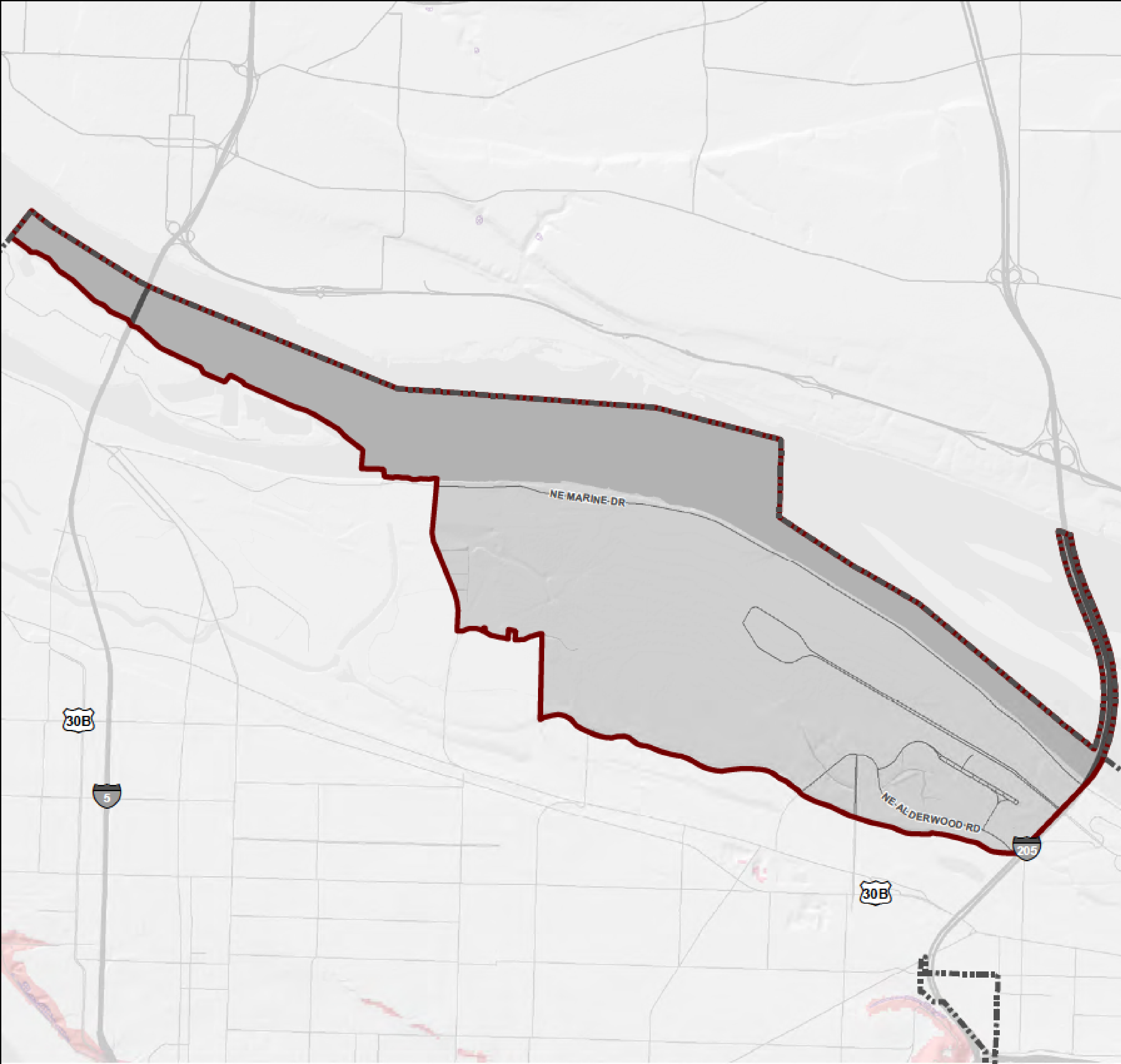
37242

PBEM

September 12, 2016

Mitigation Action Plan (MAP)

Regulatory Landslide Hazard Area



Legend

- City Boundary
- Historic Landslide Deposits
- Landslide Hazard Area
- Risk Reporting Area Airport

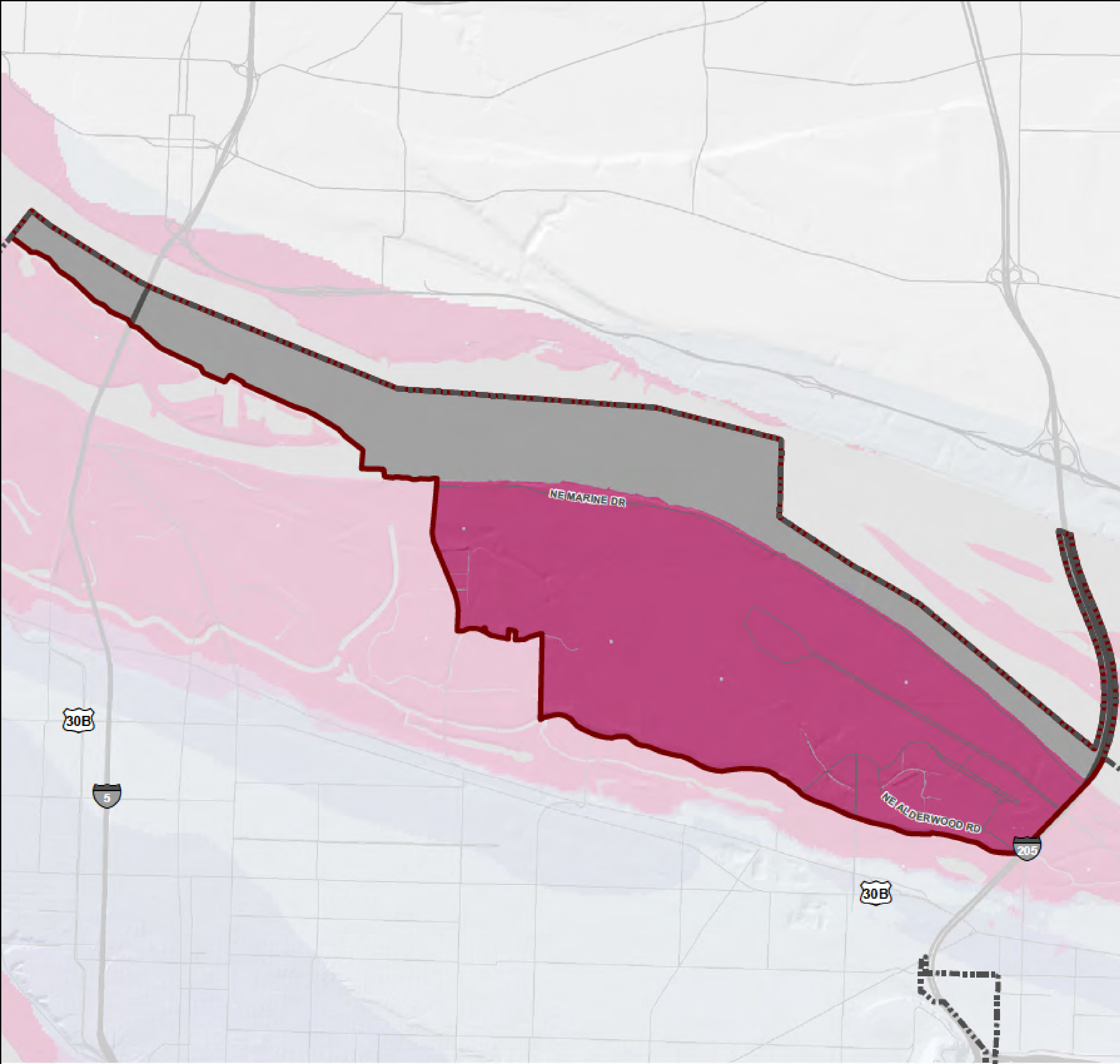
NORTH

0 0.35 0.7 Miles

Sources: DOGAMI-2015;
City of Portland-2015, 2016

37242

PBEM



September 12, 2016

Mitigation Action Plan (MAP)

Liquefaction Susceptibility

Legend

City Boundary

Liquefaction Susceptibility

Type

- 0 – None
- 1 – Very Low
- 2 – Low
- 3 – Moderate
- 4 – High
- 5 – Very High

Risk Reporting Area Airport

NORTH

0 0.35 0.7 Miles

Sources: DOGAMI-2013; City of Portland-2016

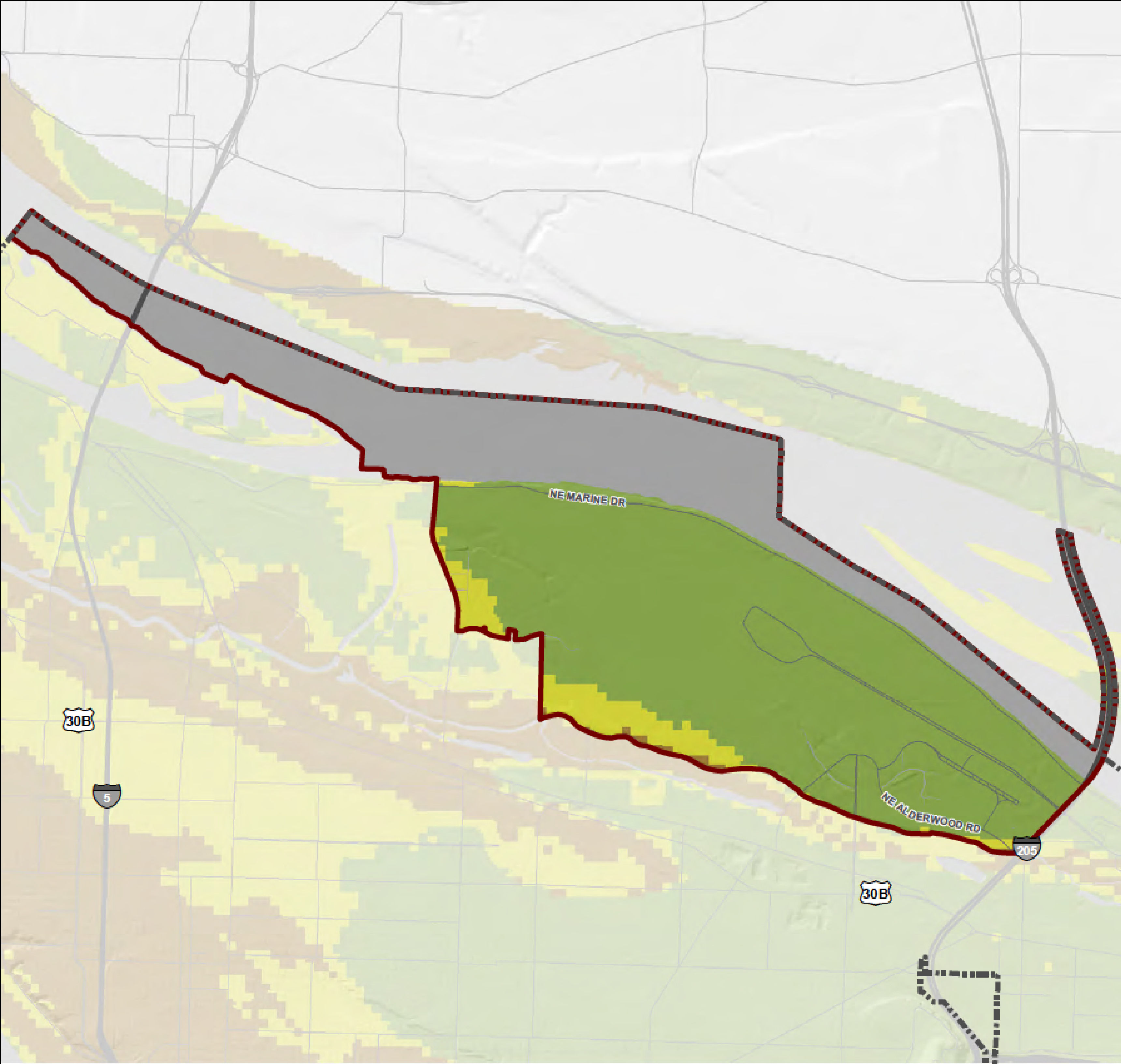
37242

PBEM

September 12, 2016

Mitigation Action Plan (MAP)

National Earthquake Hazards Reduction Program Soils



Legend

City Boundary

NEHRP Soils

Type

B

C

D

E

Risk Reporting Area Airport

NORTH

0 0.35 0.7 Miles

Sources: DOGAMI-2012;
City of Portland-2016

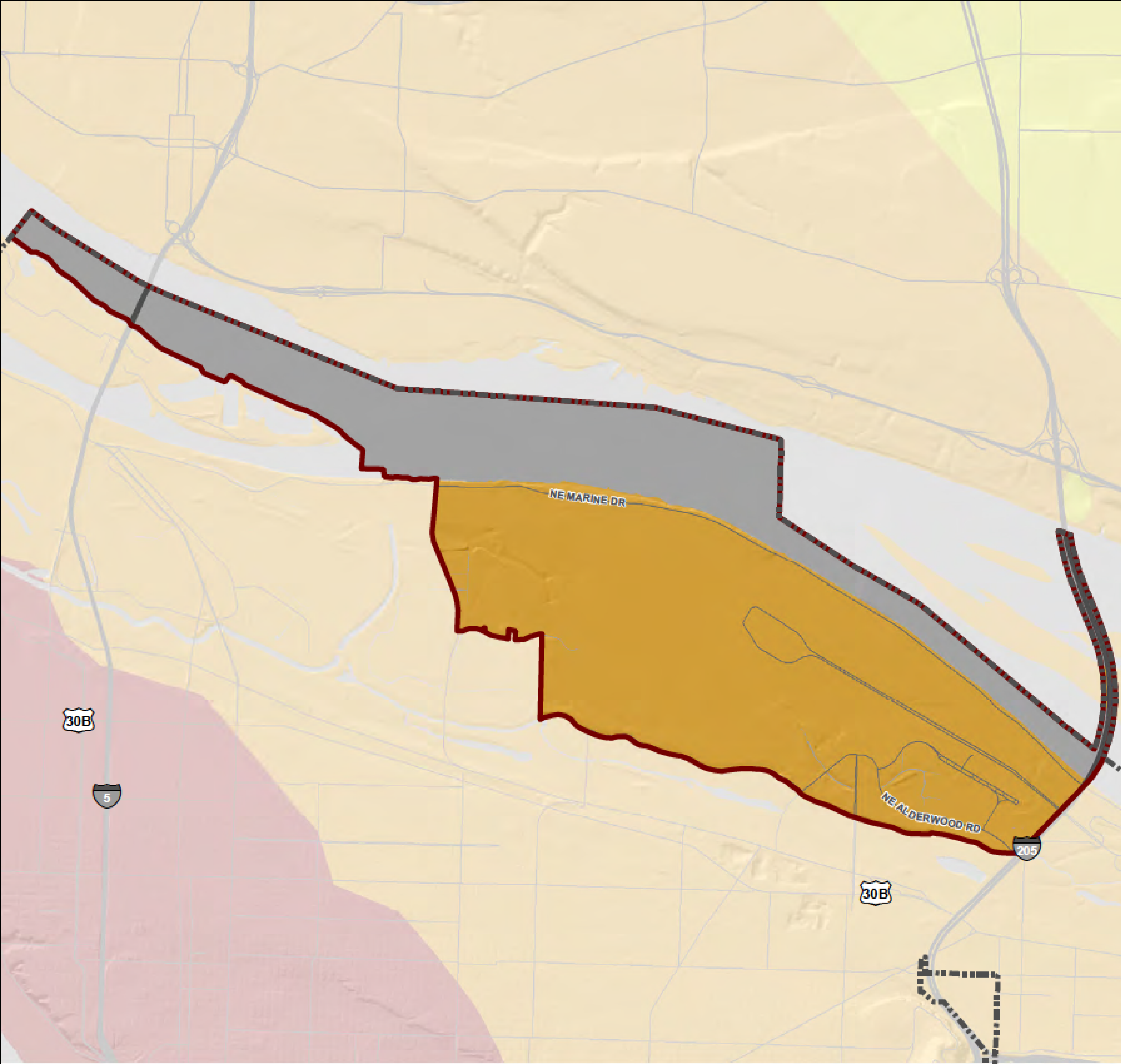
37242

PBEM

September 12, 2016

Mitigation Action Plan (MAP)

Portland Hills 6.5 Magnitude Earthquake-Peak Ground Acceleration



Legend

City Boundary

Portland Hills M6.5 earthquake PGA

Potential Damage - Perceived Shaking

V -- Very Light - Moderate

VI -- Light - Strong

VII -- Moderate - Very Strong

VIII -- Moderate/Heavy - Severe

Risk Reporting Area Airport

NORTH

0 0.35 0.7 Miles

Sources: USGS-2009; City of Portland-2016

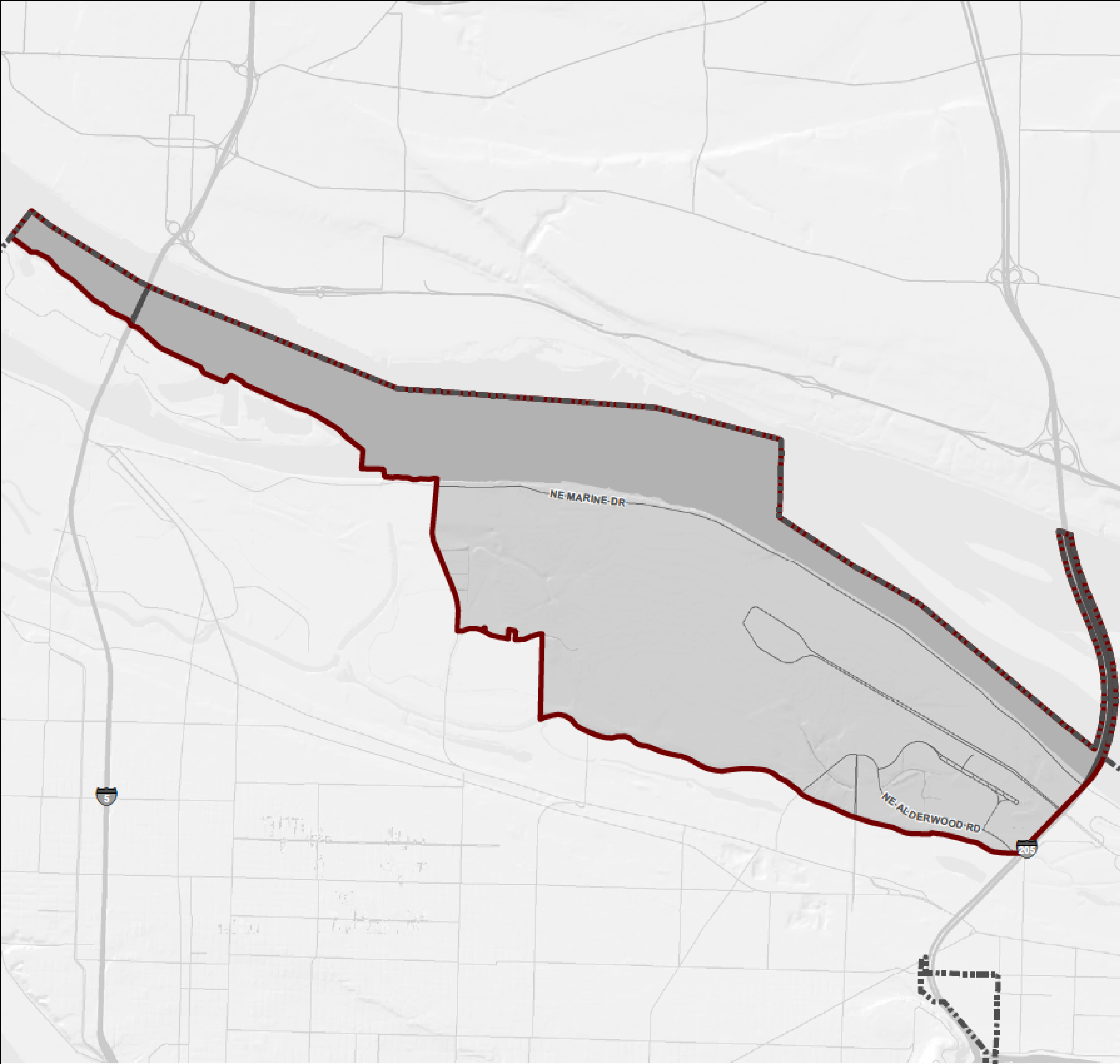
37242

PBEM

September 12, 2016

Mitigation Action Plan (MAP)

Volcano Hazard Area



Legend

City Boundary

Volcano Hazard Area

Risk Reporting Area Airport

NORTH

0 0.35 0.7 Miles

Sources: USGS-1997;
City of Portland-2016

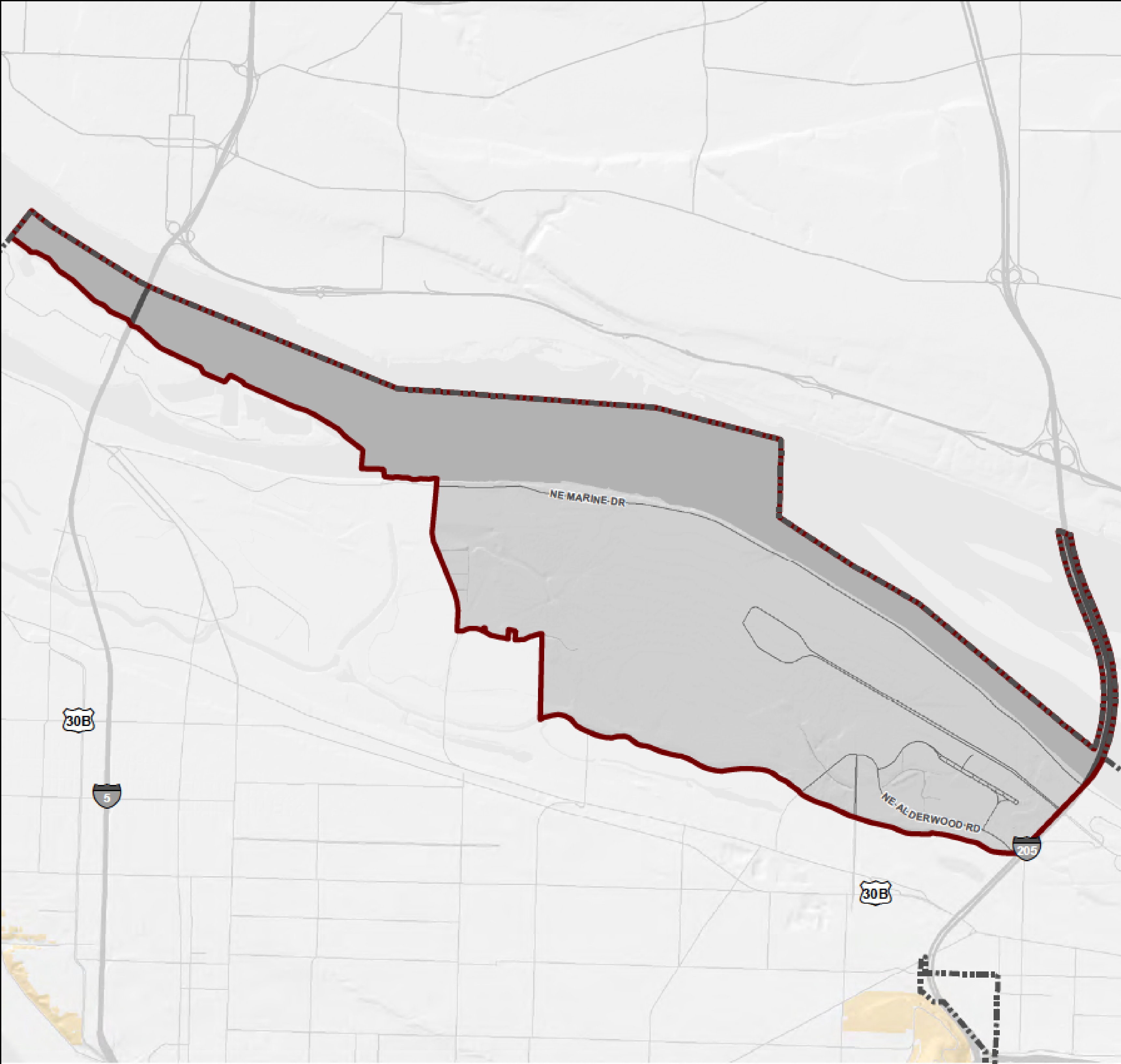
37242

PBEM

September 12, 2016

Mitigation Action Plan (MAP)

Wildfire Hazard Area



Legend

- City Boundary
- Wildfire Hazard Area
- Risk Reporting Area Airport

NORTH

0 0.35 0.7 Miles

Sources: City of Portland-2002, 2016

37242

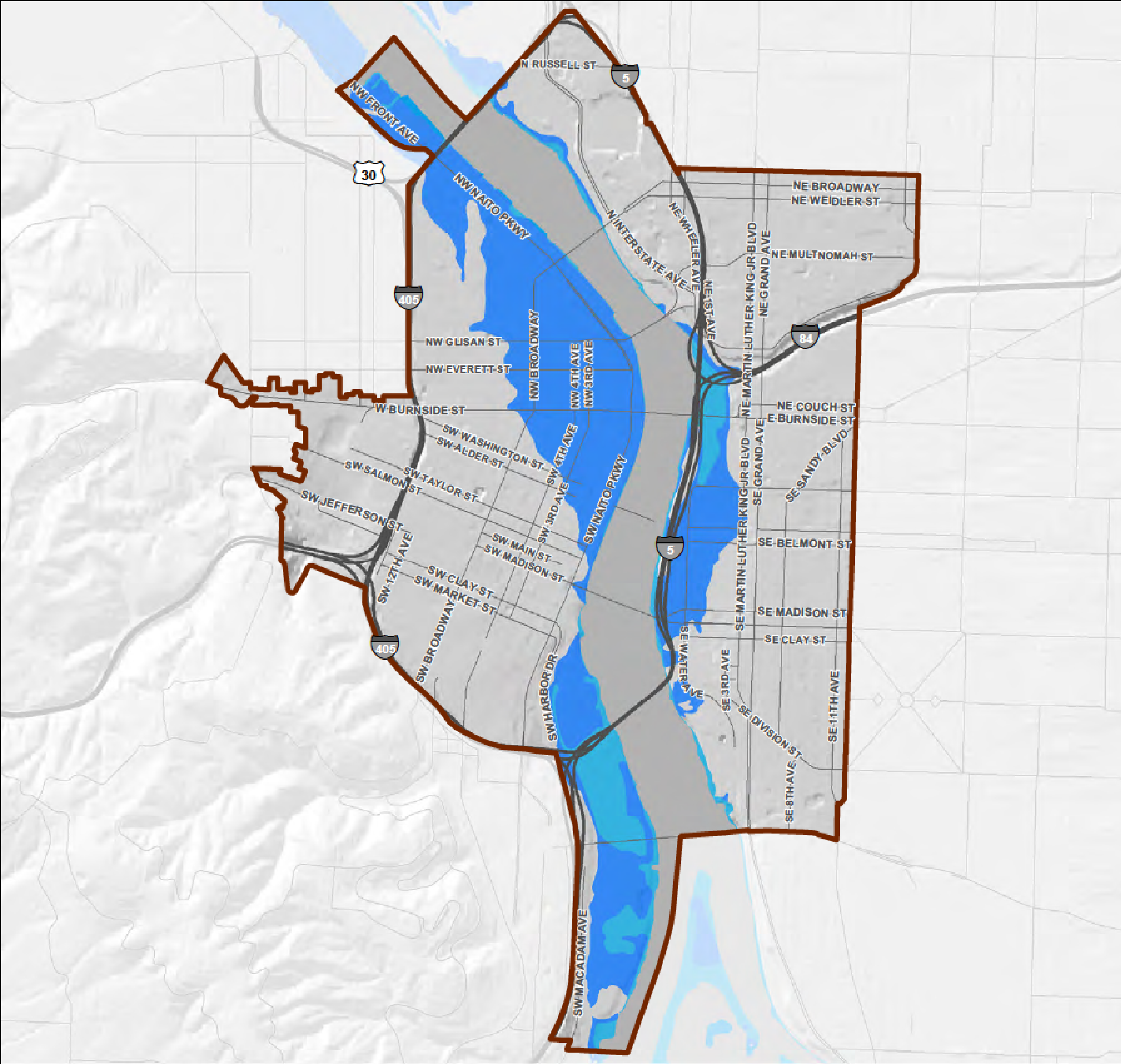
PBEM

CENTRAL CITY

September 12, 2016

Mitigation Action Plan (MAP)

Flood hazard - 100-yr and 500-yr FEMA flood zone



Legend

- City Boundary
- 100-year FEMA flood zone
- 500-year FEMA flood zone
- Risk Reporting Area Central City

NORTH

0 0.175 0.35 Miles

Sources: FEMA-2014; City of Portland-2016

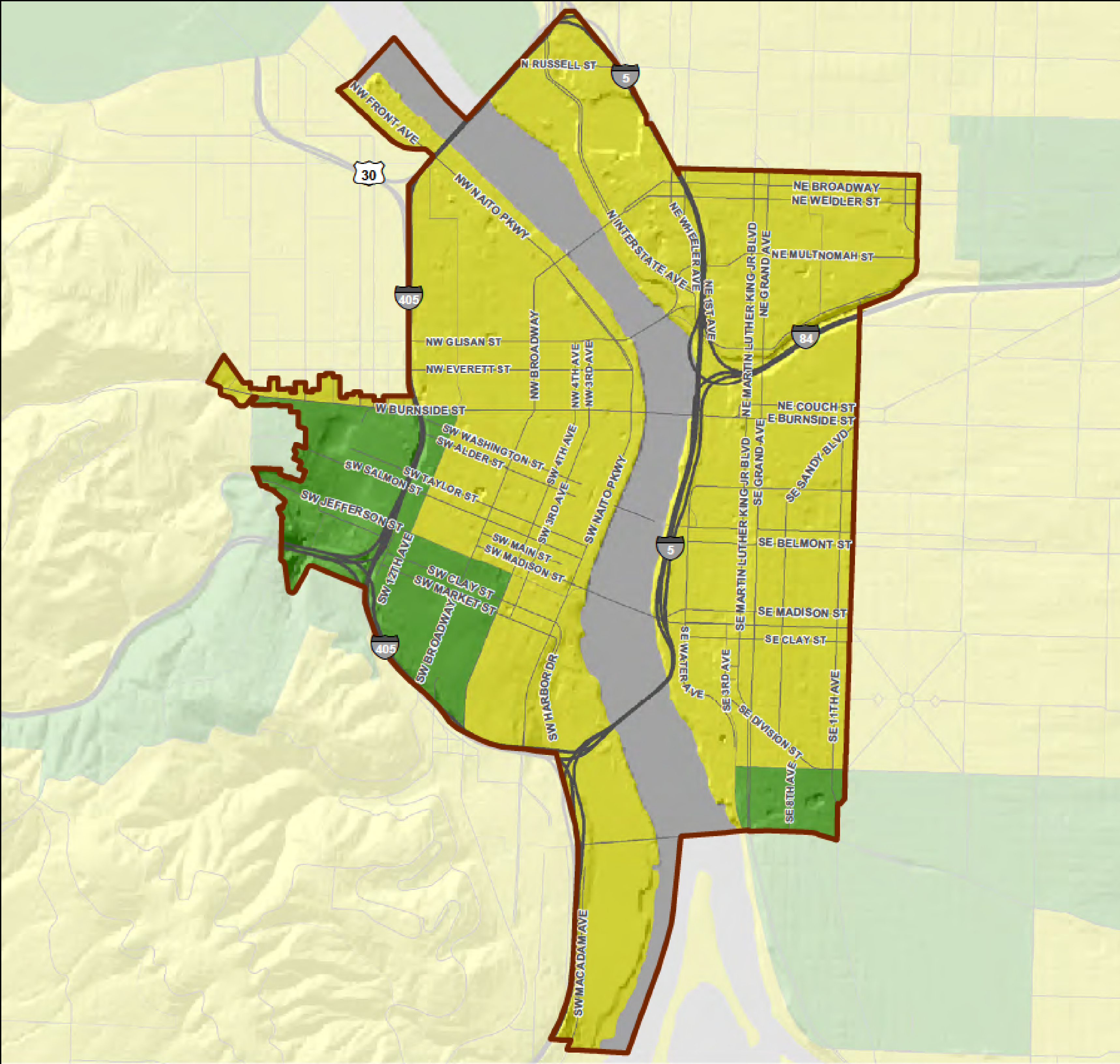
37242

PBEM

September 12, 2016

Mitigation Action Plan (MAP)

100-year Probabilistic Earthquake--Peak Ground Acceleration



Legend

City Boundary

100-year probabilistic earthquake PGA

Potential Damage - Perceived Shaking

V -- Very Light - Moderate

VI -- Light - Strong

Risk Reporting Area Central City

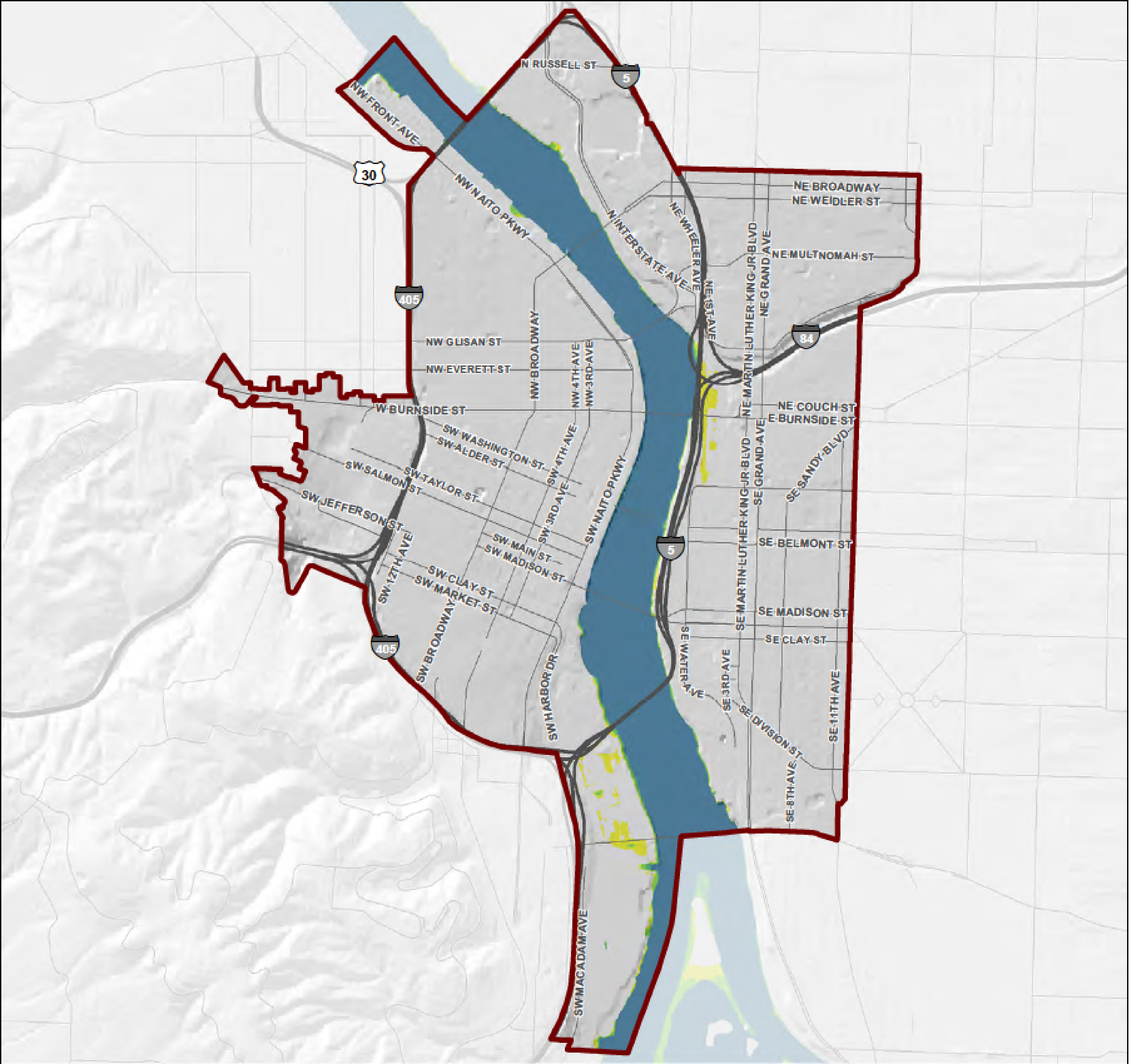
NORTH

0 0.175 0.35 Miles

Sources: FEMA-2015; City of Portland-2016

37242

PBEM



September 12, 2016

Mitigation Action Plan (MAP)

Flood Hazard - 100-yr Flood Depth Grid

Legend

City Boundary

100-year flood depth grid

- 0.1' - 4.5'
- 4.6' - 11.5'
- 11.6' - 19.5'
- 19.6' - 25.9'
- 26' - 33.2'

Risk Reporting Area Central City

NORTH

0 0.175 0.35 Miles

Sources: Tetra Tech-2016; City of Portland-2016

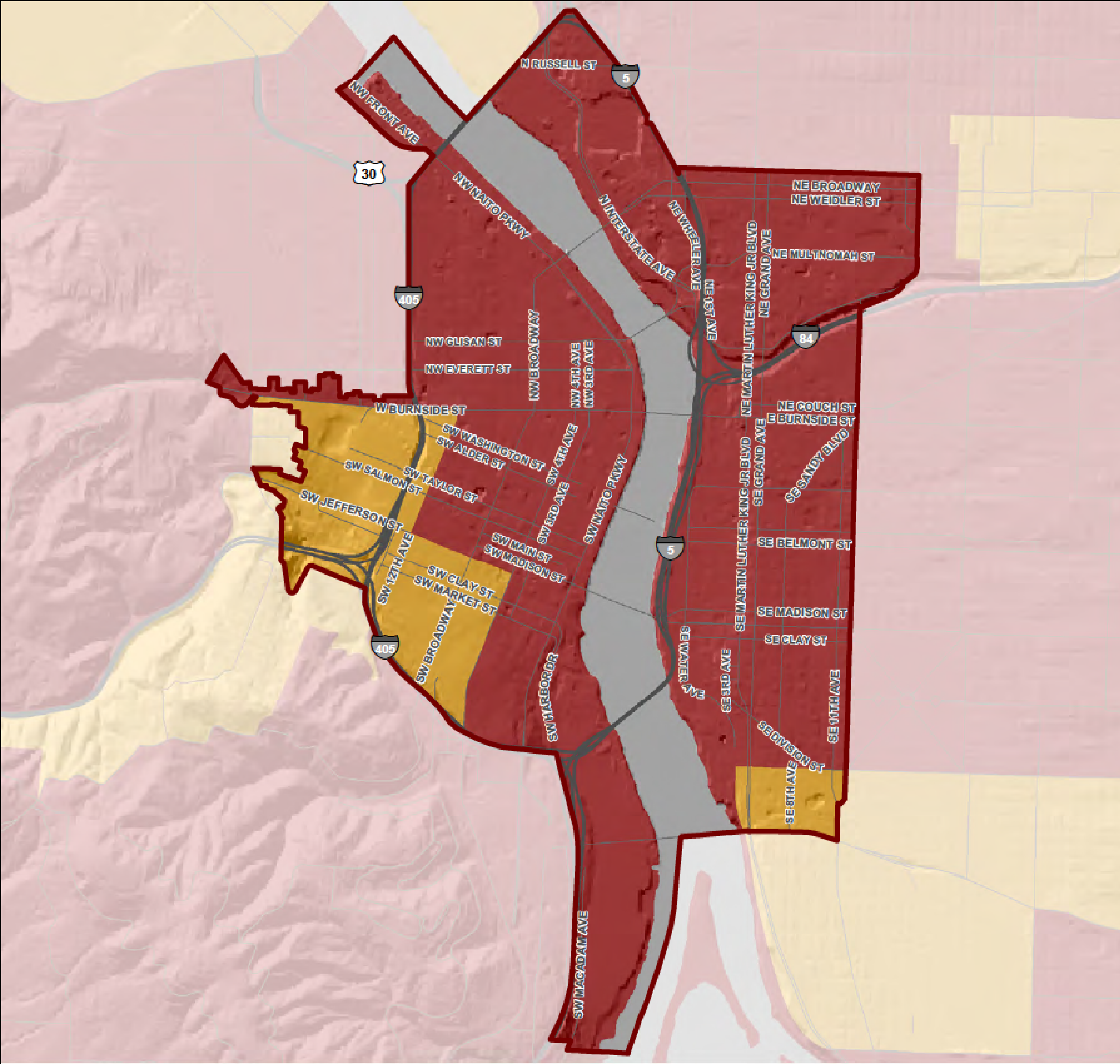
37242

PBEM

September 12, 2016

Mitigation Action Plan (MAP)

500-year Probabilistic Earthquake--Peak Ground Acceleration



Legend

City Boundary

500-year probabilistic earthquake PGA

Potential Damage - Perceived Shaking

- VI -- Light - Strong
- VII -- Moderate - Very Strong
- VIII -- Moderate/Heavy - Severe

Risk Reporting Area Central City

NORTH

0 0.2 0.4 Miles

Sources: FEMA-2015; City of Portland-2016

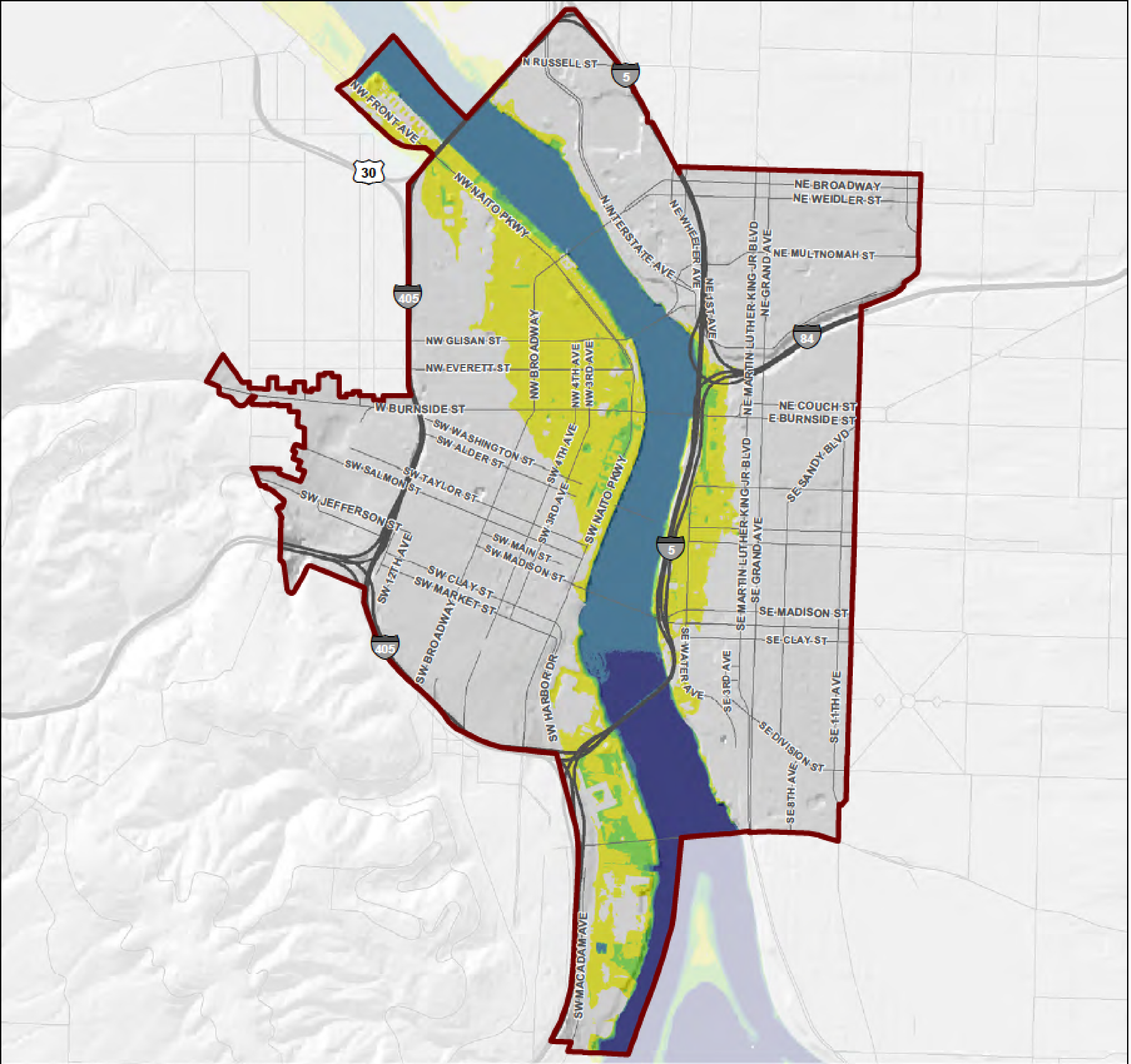
37242

PBEM

September 12, 2016

Mitigation Action Plan (MAP)

Flood Hazard - 500-yr Flood Depth Grid



Legend

City Boundary

500-year flood depth grid

- 0' - 4.6'
- 4.7' - 12.9'
- 13' - 22.6'
- 22.7' - 28.8'
- 28.9' - 36.7'

Risk Reporting Area Central City

NORTH

0 0.225 0.45 Miles

Sources: Tetra Tech-2016; City of Portland-2016

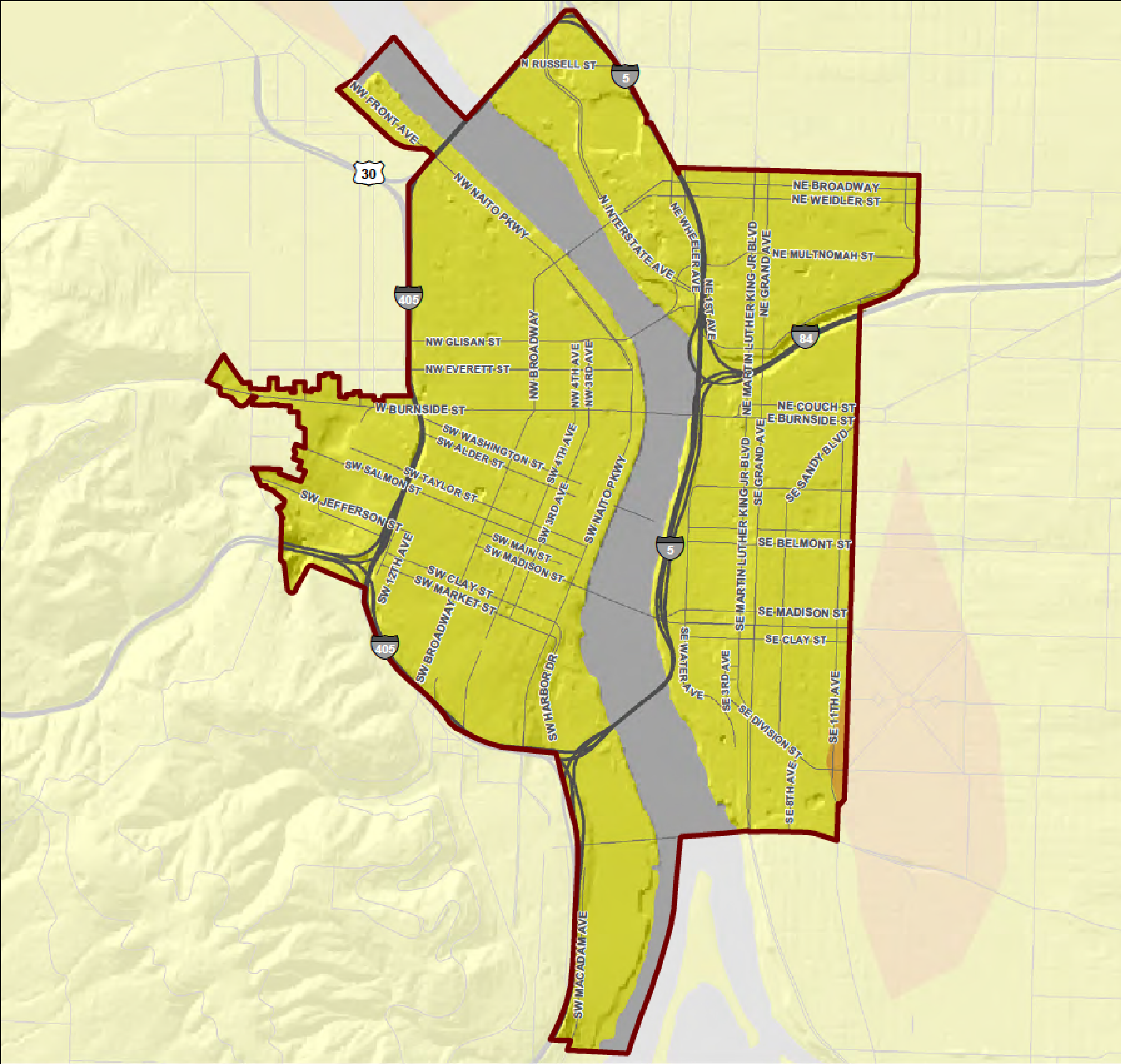
37242

PBEM

September 12, 2016

Mitigation Action Plan (MAP)

Cascadia 9.0 Magnitude Earthquake--Peak Ground Acceleration



Legend

City Boundary

Cascadia M9.0 earthquake PGA

Potential Damage - Perceived Shaking

V – Very Light - Moderate

VI – Light - Strong

VII – Moderate - Very Strong

VIII -- Moderate/Heavy - Severe

Risk Reporting Area Central City

NORTH

0 0.175 0.35 Miles

Sources: USGS-2011; City of Portland-2016

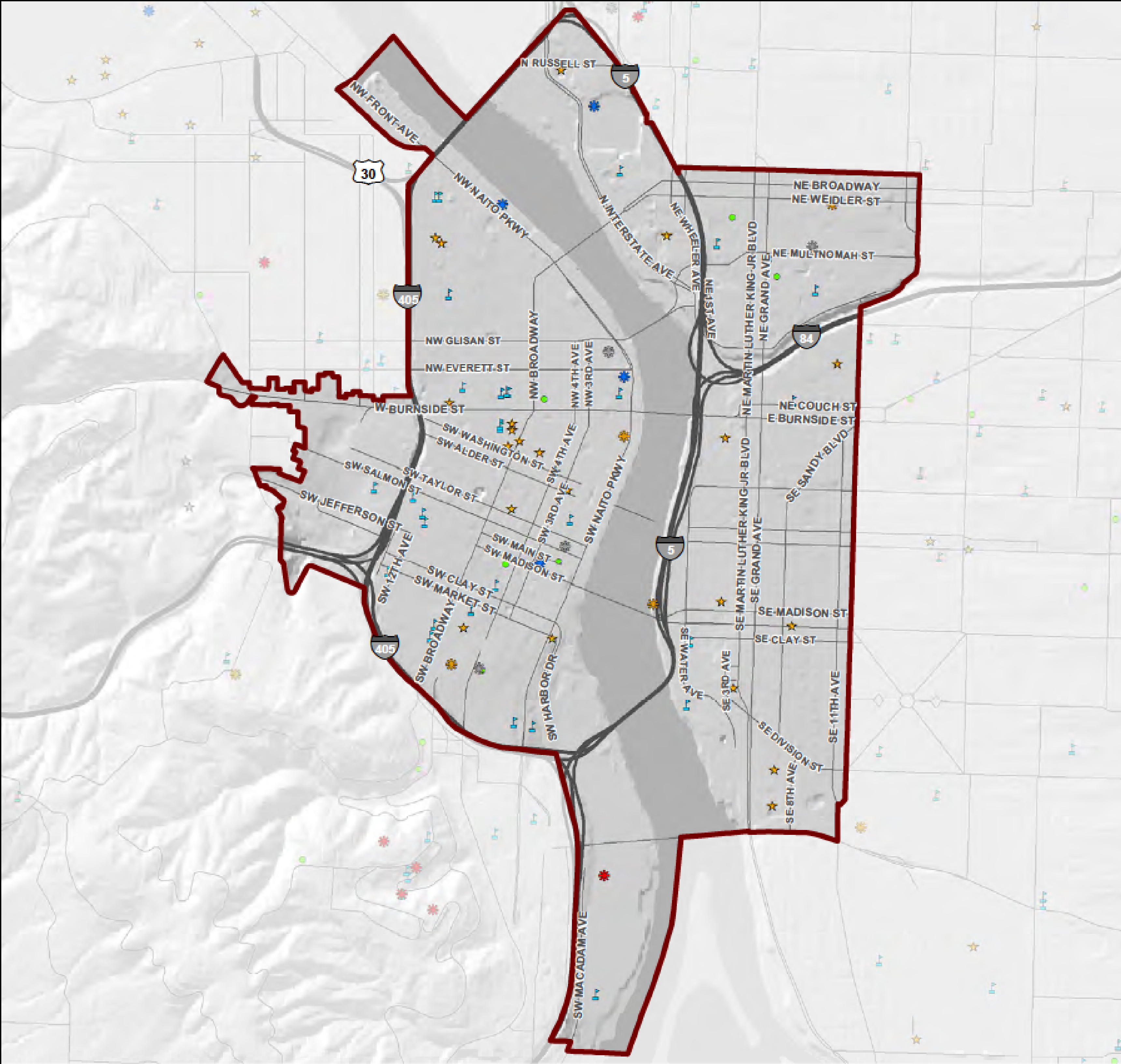
37242

PBEM

September 12, 2016

Mitigation Action Plan (MAP)

Critical Facilities



Legend

City Boundary

Risk Reporting Area Central City

Emergency Services*

Emergency Coordination Centers

Fire Station Facilities

Police Station Facilities

Medical Care Facilities

High Potential Loss Facilities*

Dams

Military

Nuclear Power Plants

Hazardous Materials

Schools

Other Assets

Zoo, Jails, Nursing/Assisted Living Facilities

*Due to security reasons, some emergency services and high potential loss facilities have been left off of the map.

NORTH

0 0.175 0.35 Miles

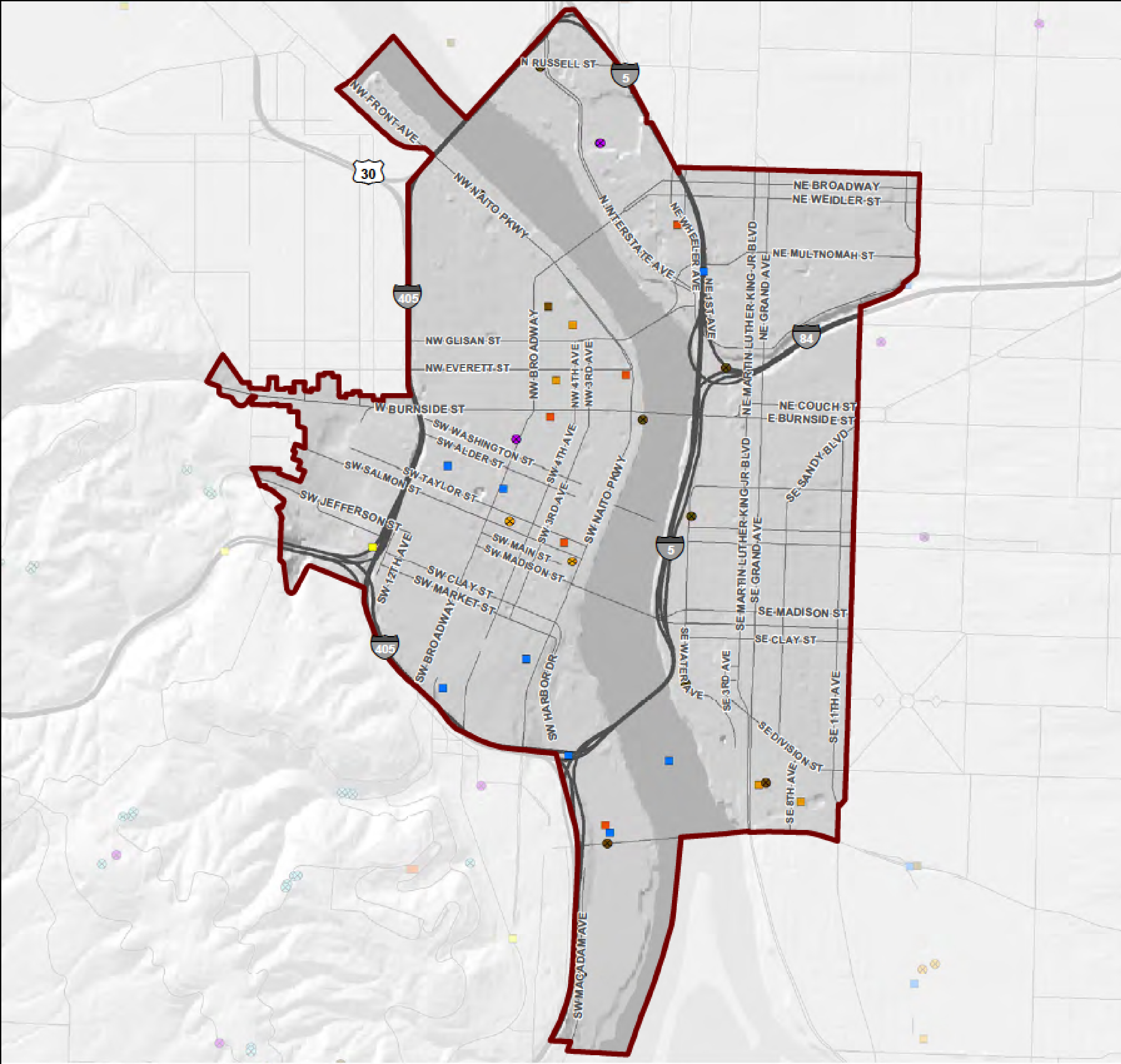
Sources: WORD/NID-2015; OSFM-2015; City of Portland-2011, 2015, 2016

37242

September 12, 2016

Mitigation Action Plan (MAP)

Critical Infrastructure



Legend

City Boundary

Risk Reporting Area Central City

Utility Systems*

- Electrical
- Natural Gas Facilities
- Communication Facilities
- Petroleum Facilities
- Potable Water Facilities
- Wastewater Facilities

Transportation Systems*

- Railway Tunnels, Bridges, and Facilities
- Light Rail Tunnels, Bridges, and Facilities
- Highway Tunnels and Bridges
- Bus Facilities
- Port and Airport Facilities

*Due to security reasons, some utility and transportation system components have been left off of the map.

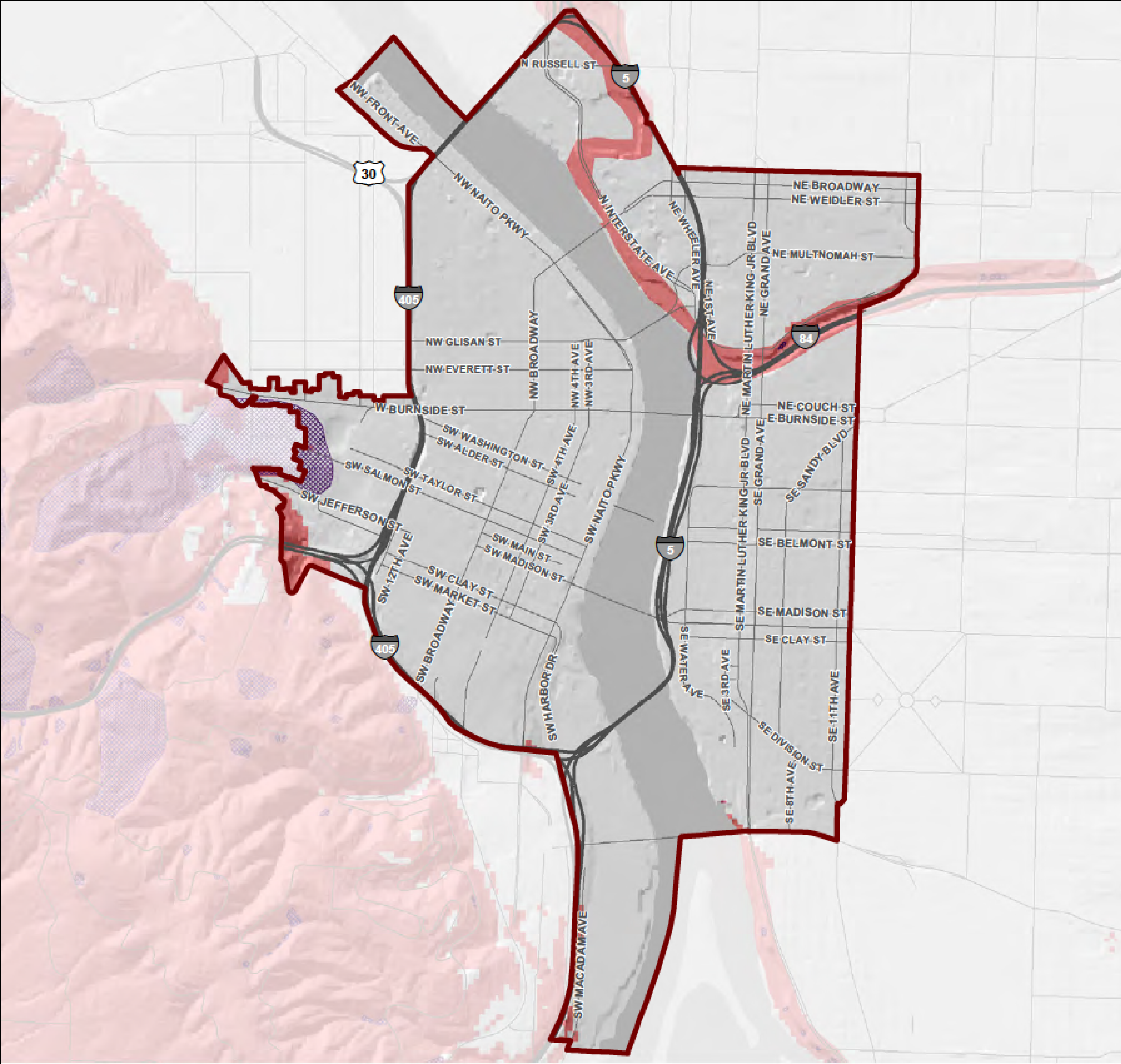
NORTH

0 0.175 0.35 Miles

Sources: TriMet-2015; Port of Portland-2015; OPHS-2016; City of Portland-2011, 2015,2016; OPB-2016; PTS-2015; FEMA-2015; Kinder Morgan-2015

37242

PBEM



September 12, 2016

Mitigation Action Plan (MAP)

Regulatory Landslide Hazard Area

Legend

- City Boundary
- Historic Landslide Deposits
- Landslide Hazard Area
- Risk Reporting Area Central City

NORTH

0 0.175 0.35 Miles

Sources: DOGAMI-2015; City of Portland-2015, 2016

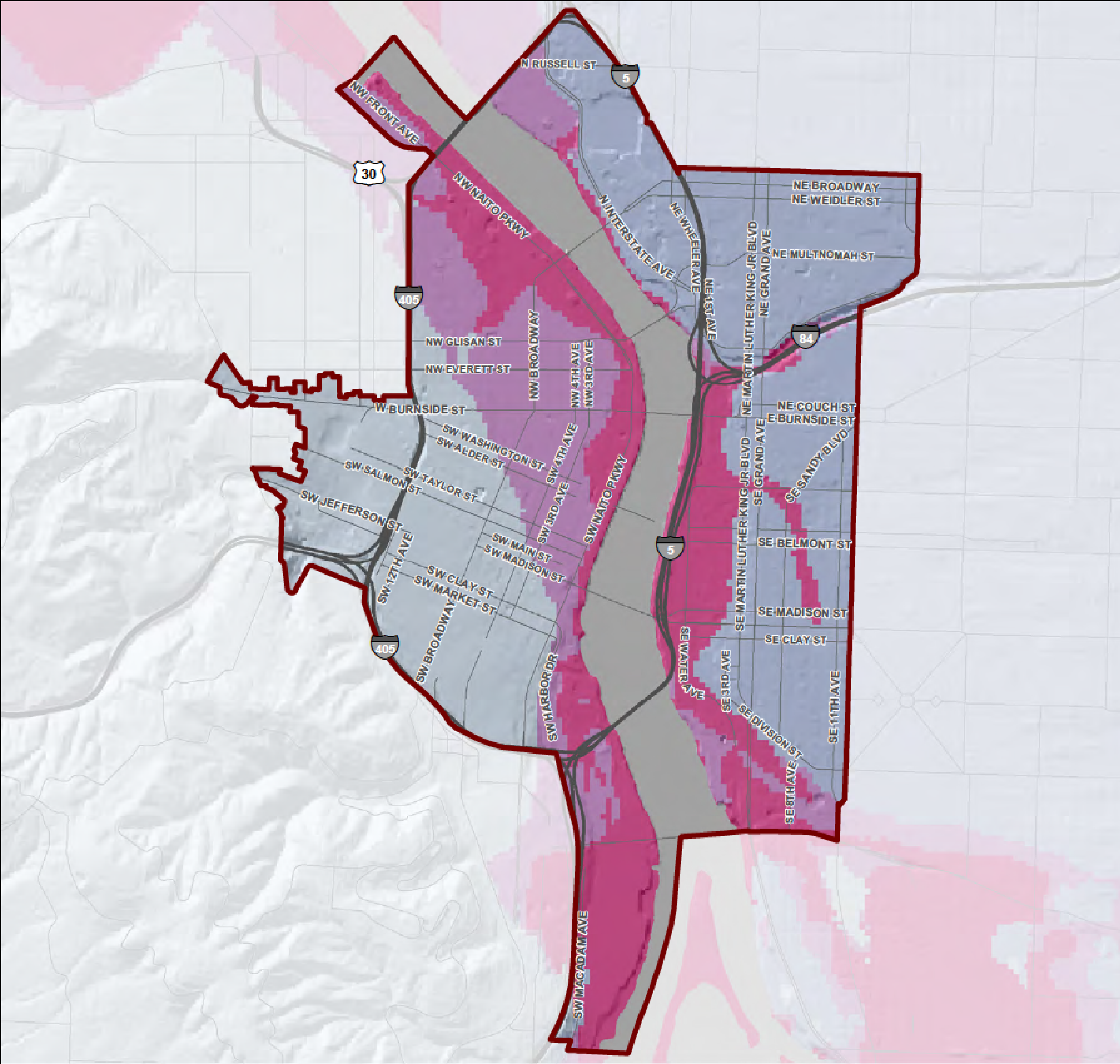
37242

PBEM

September 12, 2016

Mitigation Action Plan (MAP)

Liquefaction Susceptibility



Legend

City Boundary

Liquefaction Susceptibility

Type

- 0 – None
- 1 – Very Low
- 2 – Low
- 3 – Moderate
- 4 – High
- 5 – Very High

Risk Reporting Area Central City

NORTH

0 0.175 0.35 Miles

Sources: DOGAMI-2013; City of Portland-2016

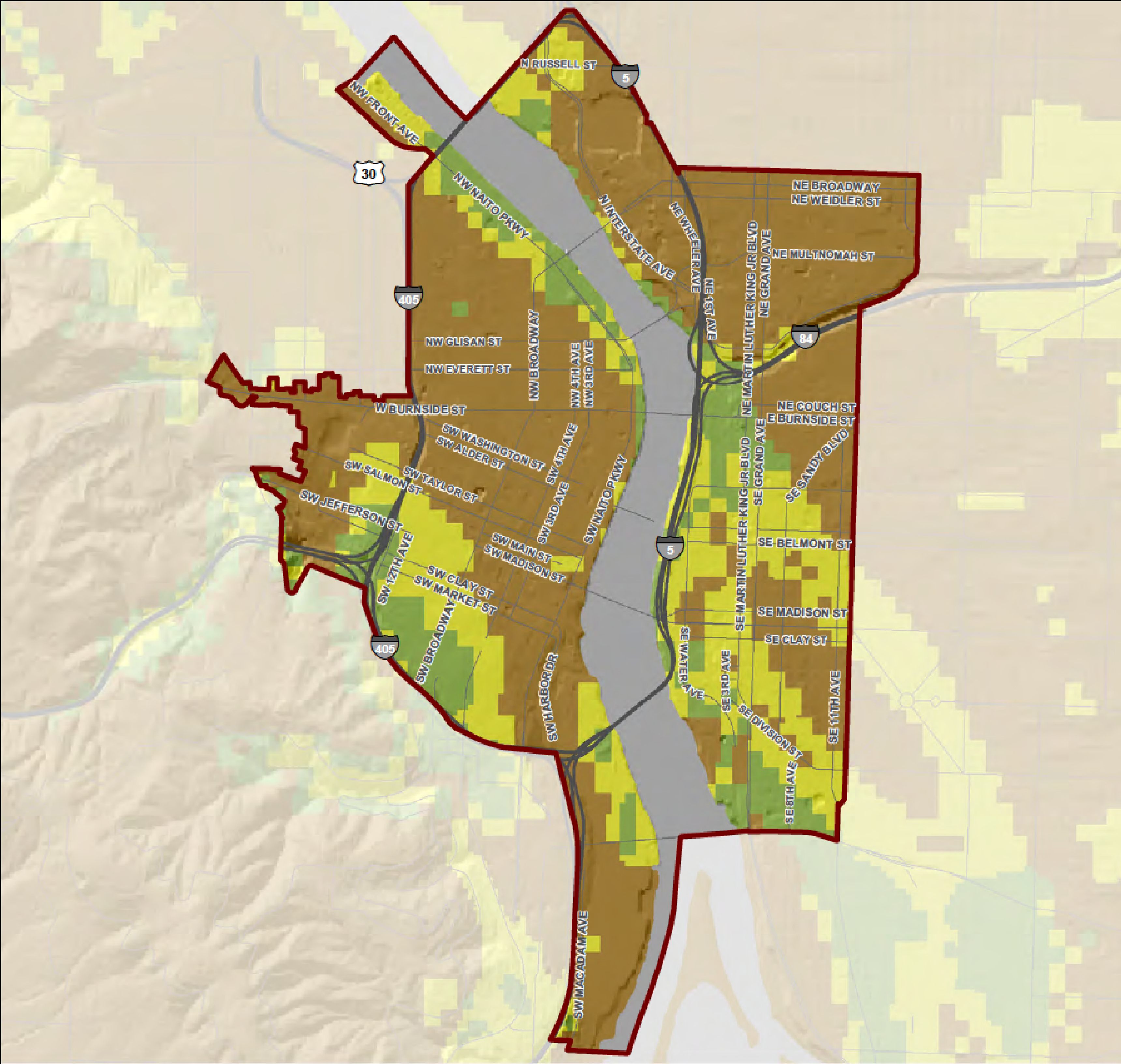
37242

PBEM

September 12, 2016

Mitigation Action Plan (MAP)

National Earthquake Hazards Reduction Program Soils



Legend

City Boundary

NEHRP Soils

Type

- B
- C
- D
- E

Risk Reporting Area Central City

NORTH

0 0.175 0.35 Miles

Sources: DOGAMI-2012;
City of Portland-2016

37242

PBEM

September 12, 2016

Mitigation Action Plan (MAP)

Portland Hills 6.5 Magnitude Earthquake- Peak Ground Acceleration

Legend

City Boundary

Portland Hills M6.5 earthquake PGA

Potential Damage - Perceived Shaking

V -- Very Light - Moderate

VI -- Light - Strong

VII -- Moderate - Very Strong

VIII -- Moderate/Heavy - Severe

Risk Reporting Area Central City

NORTH

0 0.175 0.35 Miles

Sources: USGS-2009; City of Portland-2016

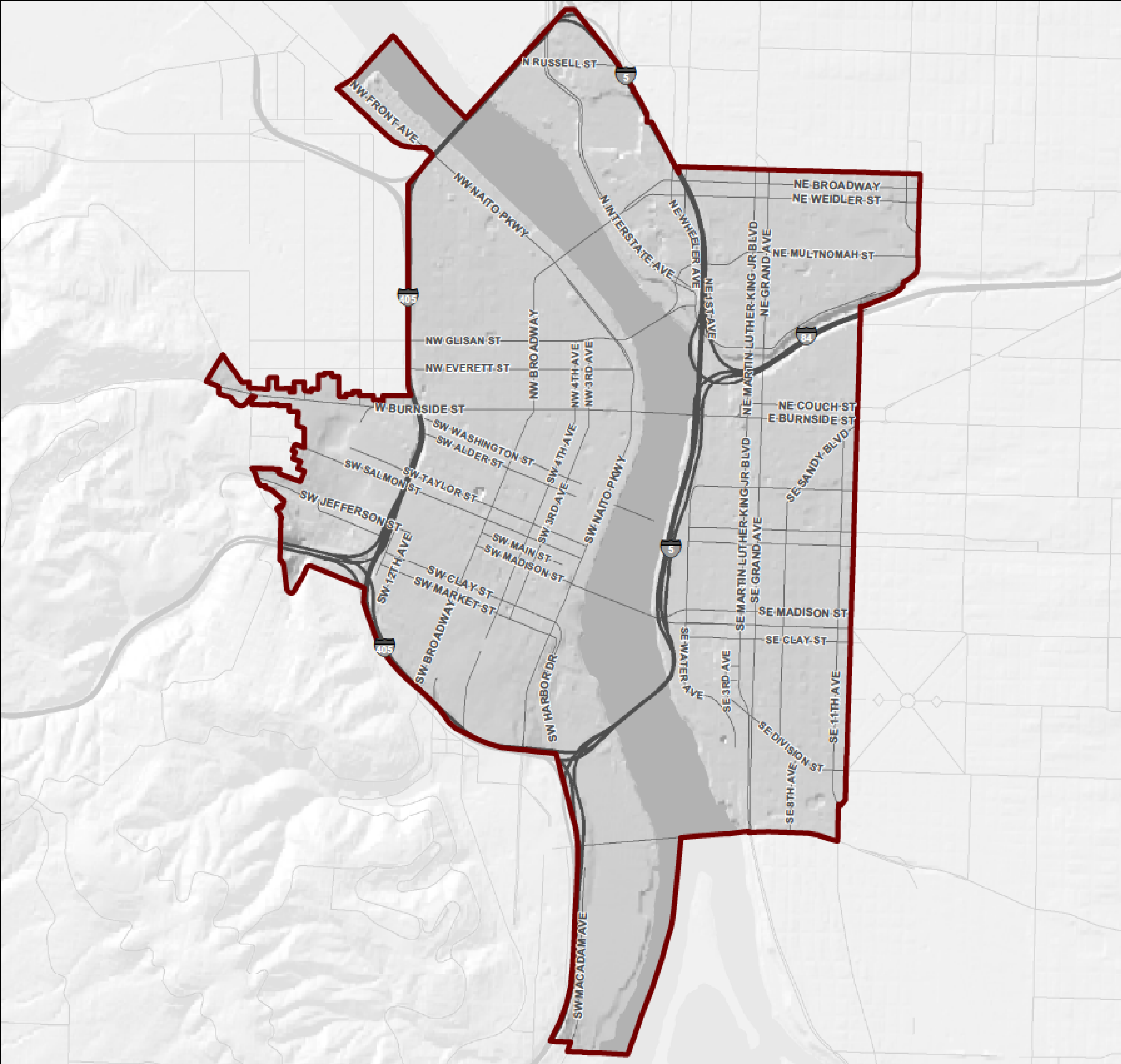
37242

PBEM

September 12, 2016

Mitigation Action Plan (MAP)

Volcano Hazard Area



Legend

- City Boundary
- Volcano Hazard Area
- Risk Reporting Area Central City

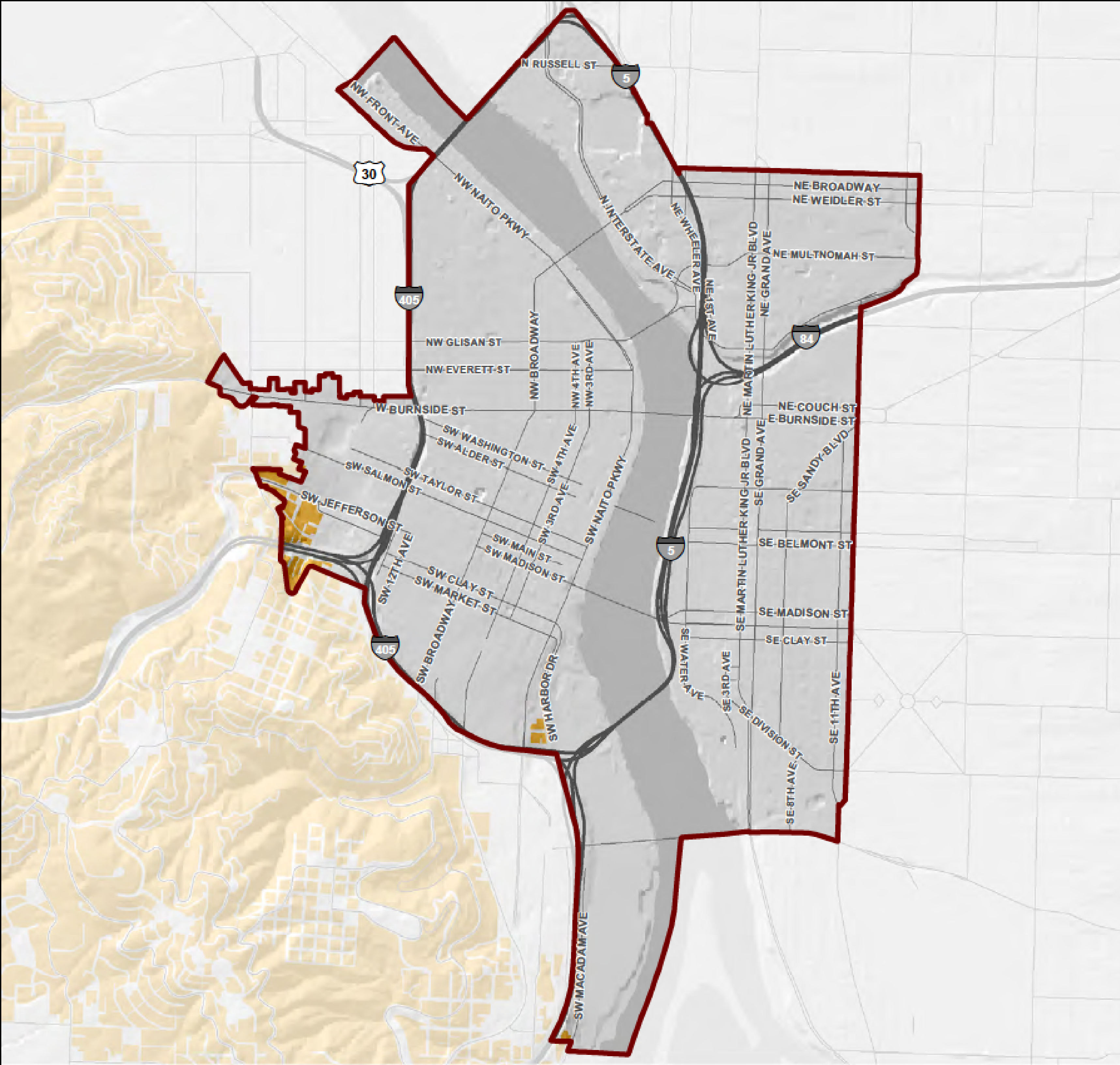
NORTH

0 0.175 0.35 Miles

Sources: USGS-1997;
City of Portland-2016

37242

PBEM



September 12, 2016

Mitigation Action Plan (MAP)

Wildfire Hazard Area

Legend

- City Boundary
- Wildfire Hazard Area
- Risk Reporting Area Central City

NORTH

0 0.175 0.35 Miles

Sources: City of Portland-2002, 2016

37242

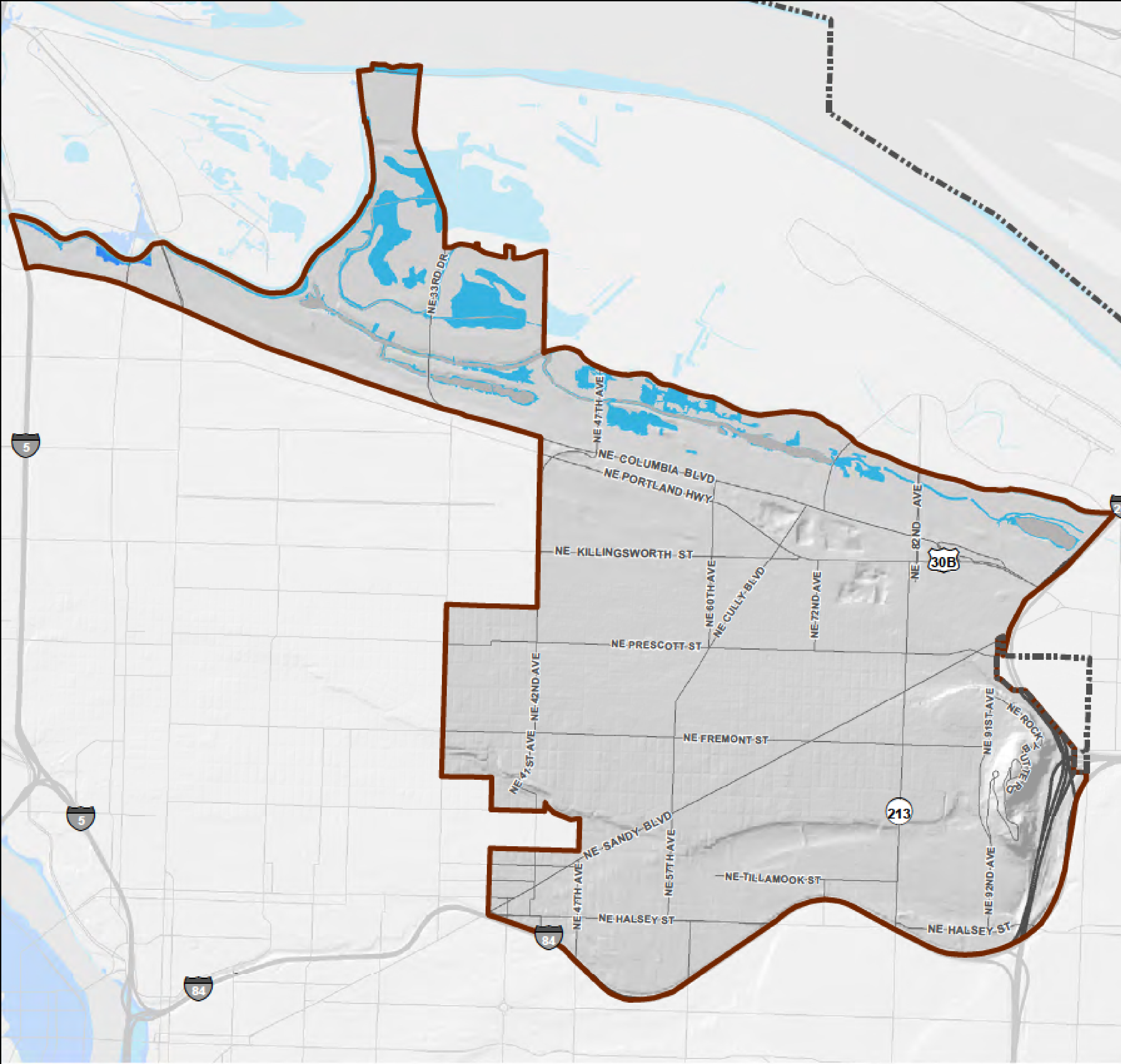
PBEM

CENTRAL NORTHEAST

September 12, 2016

Mitigation Action Plan (MAP)

Flood hazard - 100-yr and 500-yr FEMA flood zone



Legend

City Boundary
100-year FEMA flood zone
500-year FEMA flood zone
Risk Reporting Area Central Northeast

NORTH

0 0.275 0.55 Miles

Sources: FEMA-2014; City of Portland-2016

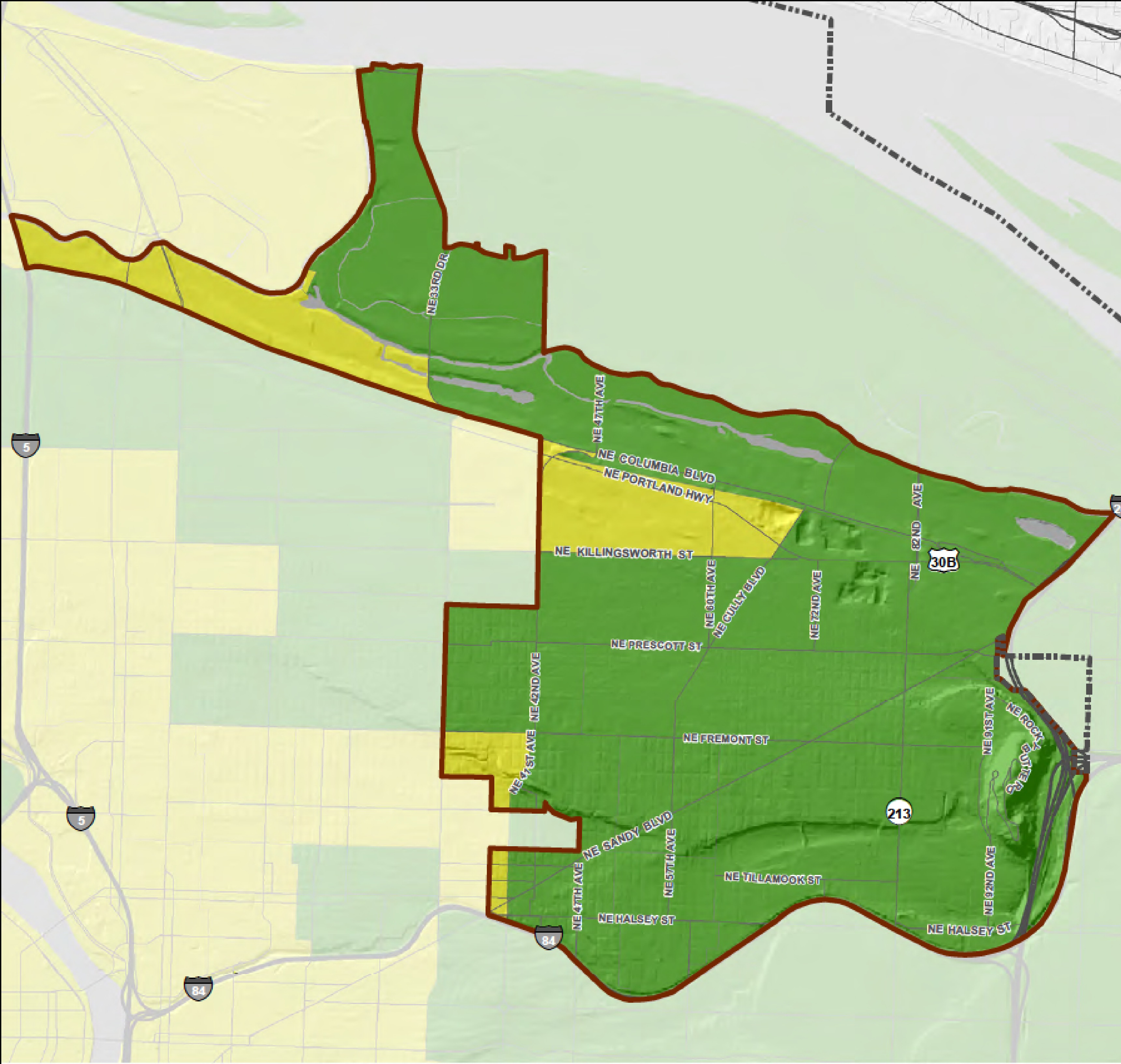
37242

PBEM

September 12, 2016

Mitigation Action Plan (MAP)

100-year Probabilistic Earthquake--Peak Ground Acceleration



Legend

City Boundary

100-year probabilistic earthquake PGA

Potential Damage - Perceived Shaking

V -- Very Light - Moderate

VI -- Light - Strong

Risk Reporting Area Central Northeast

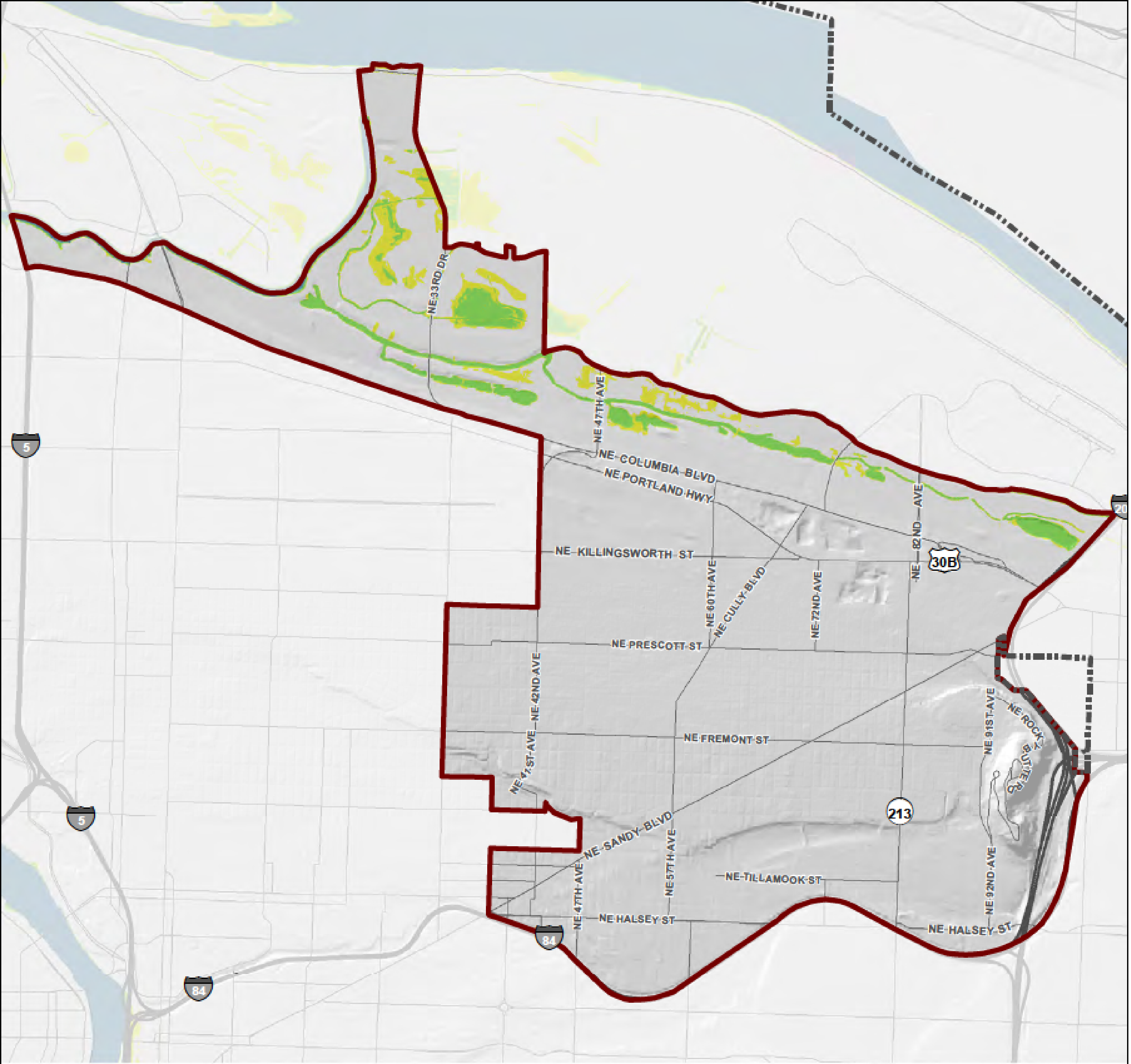
NORTH

0 0.275 0.55 Miles

Sources: FEMA-2015; City of Portland-2016

37242

PBEM



September 12, 2016

Mitigation Action Plan (MAP)

Flood Hazard - 100-yr Flood Depth Grid

Legend

City Boundary

100-year flood depth grid

- 0.1' - 4.5'
- 4.6' - 11.5'
- 11.6' - 19.5'
- 19.6' - 25.9'
- 26' - 33.2'

Risk Reporting Area Central Northeast

NORTH

0 0.275 0.55 Miles

Sources: Tetra Tech-2016; City of Portland-2016

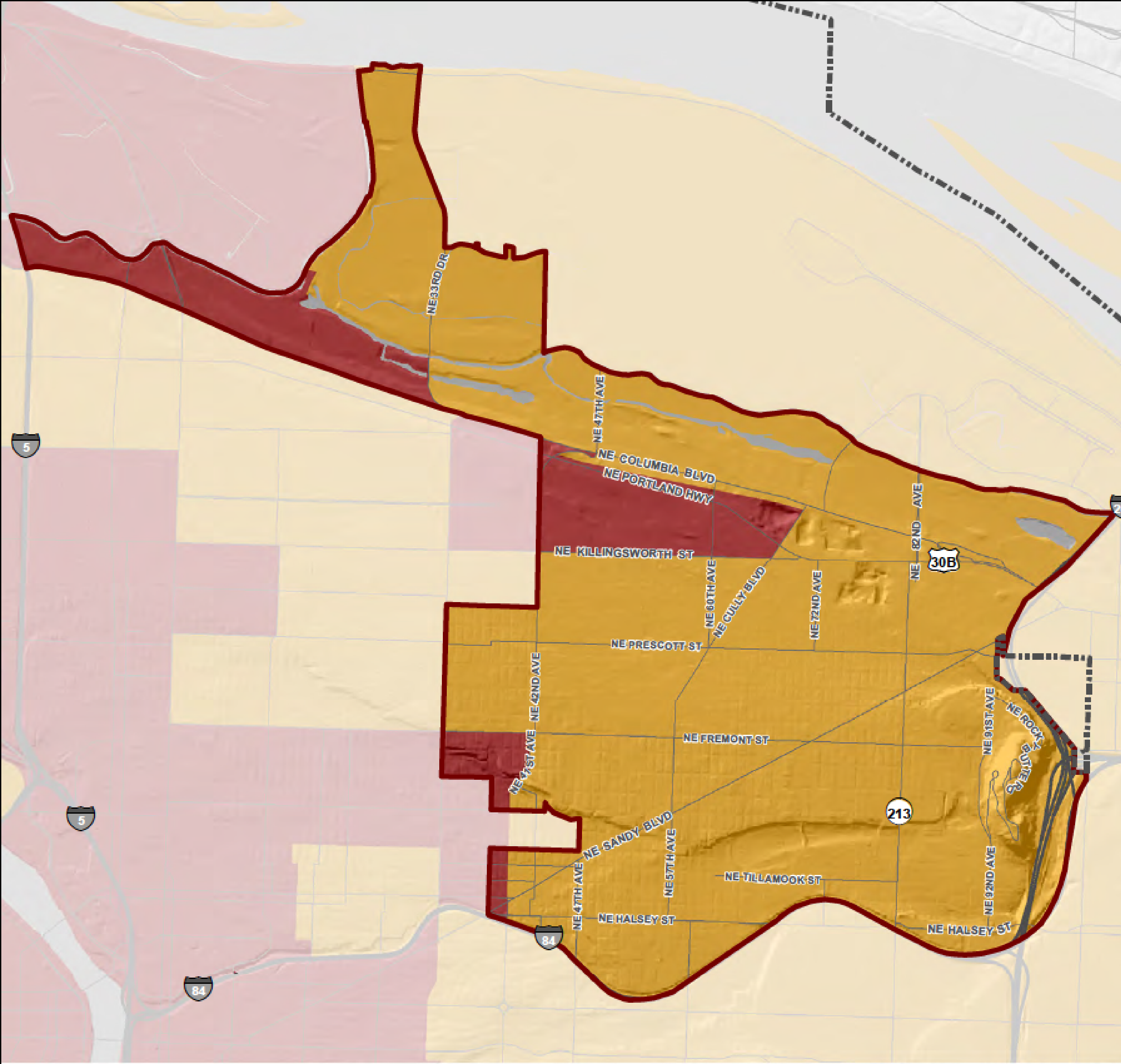
37242

PBEM

September 12, 2016

Mitigation Action Plan (MAP)

500-year Probabilistic Earthquake--Peak Ground Acceleration



Legend

City Boundary

500-year probabilistic earthquake PGA

Potential Damage - Perceived Shaking

VI -- Light - Strong

VII -- Moderate - Very Strong

VIII -- Moderate/Heavy - Severe

Risk Reporting Area Central Northeast

NORTH

0 0.325 0.65 Miles

Sources: FEMA-2015; City of Portland-2016

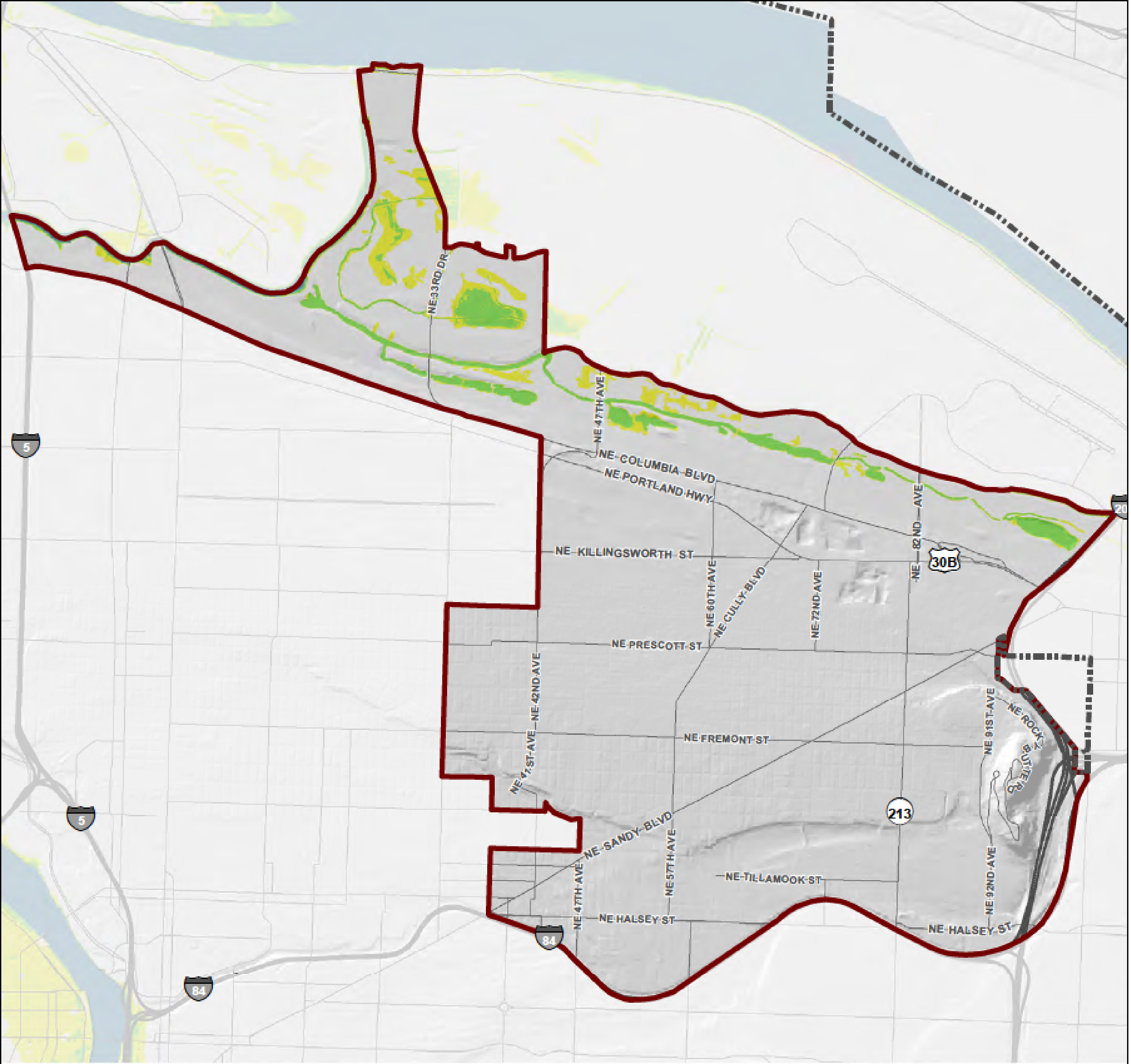
37242

PBEM

September 12, 2016

Mitigation Action Plan (MAP)

Flood Hazard - 500-yr Flood Depth Grid



Legend

City Boundary

500-year flood depth grid

- 0' - 4.6'
- 4.7' - 12.9'
- 13' - 22.6'
- 22.7' - 28.8'
- 28.9' - 36.7'

Risk Reporting Area Central Northeast

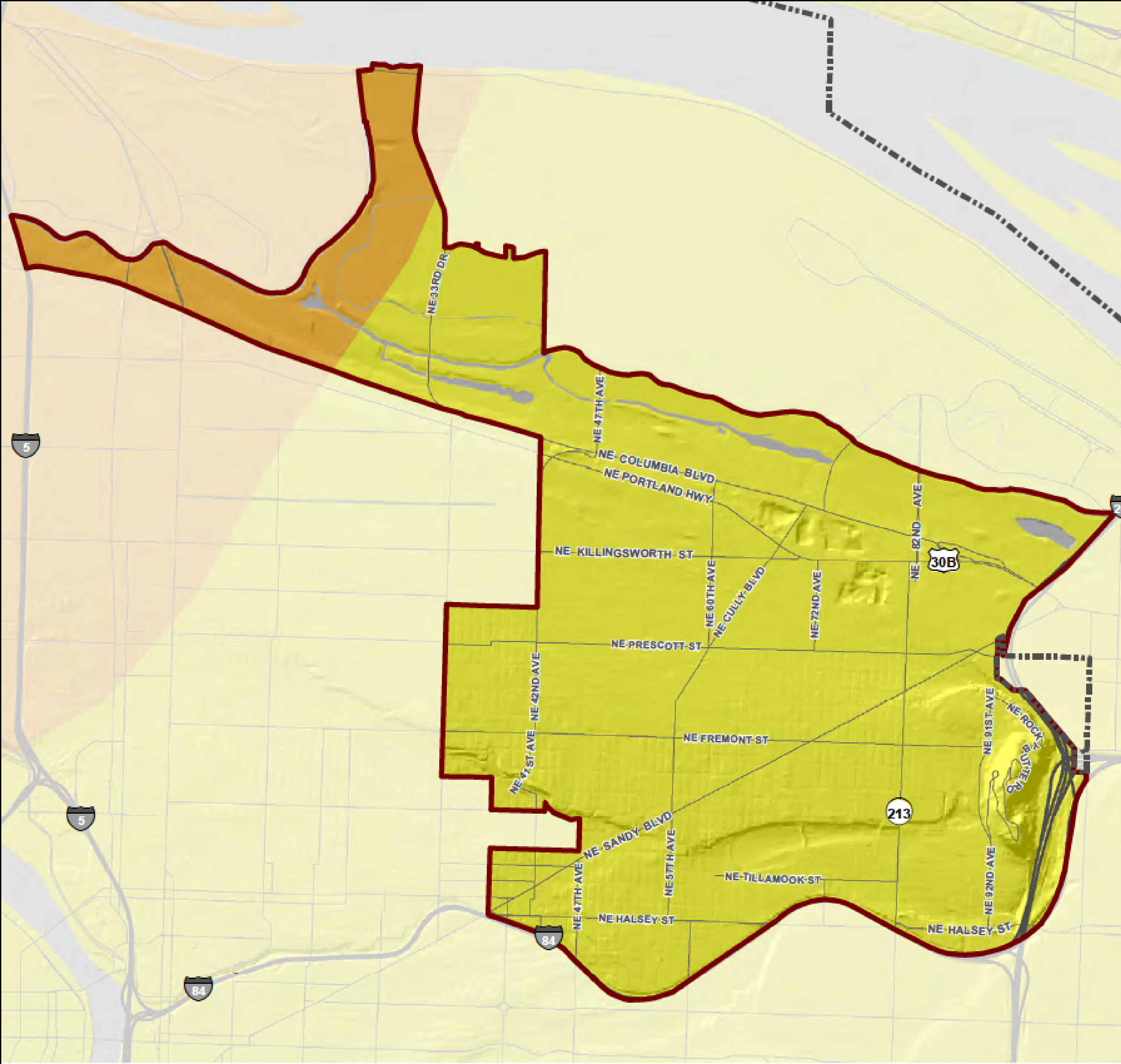
NORTH

0 0.35 0.7 Miles

Sources: Tetra Tech-2016; City of Portland-2016

37242

PBEM



September 12, 2016

Mitigation Action Plan (MAP)

Cascadia 9.0 Magnitude Earthquake--Peak Ground Acceleration

Legend

City Boundary

Cascadia M9.0 earthquake PGA

Potential Damage - Perceived Shaking

V -- Very Light - Moderate

VI -- Light - Strong

VII -- Moderate - Very Strong

VIII -- Moderate/Heavy - Severe

Risk Reporting Area Central Northeast

NORTH

0 0.275 0.55 Miles

Sources: USGS-2011; City of Portland-2016

37242

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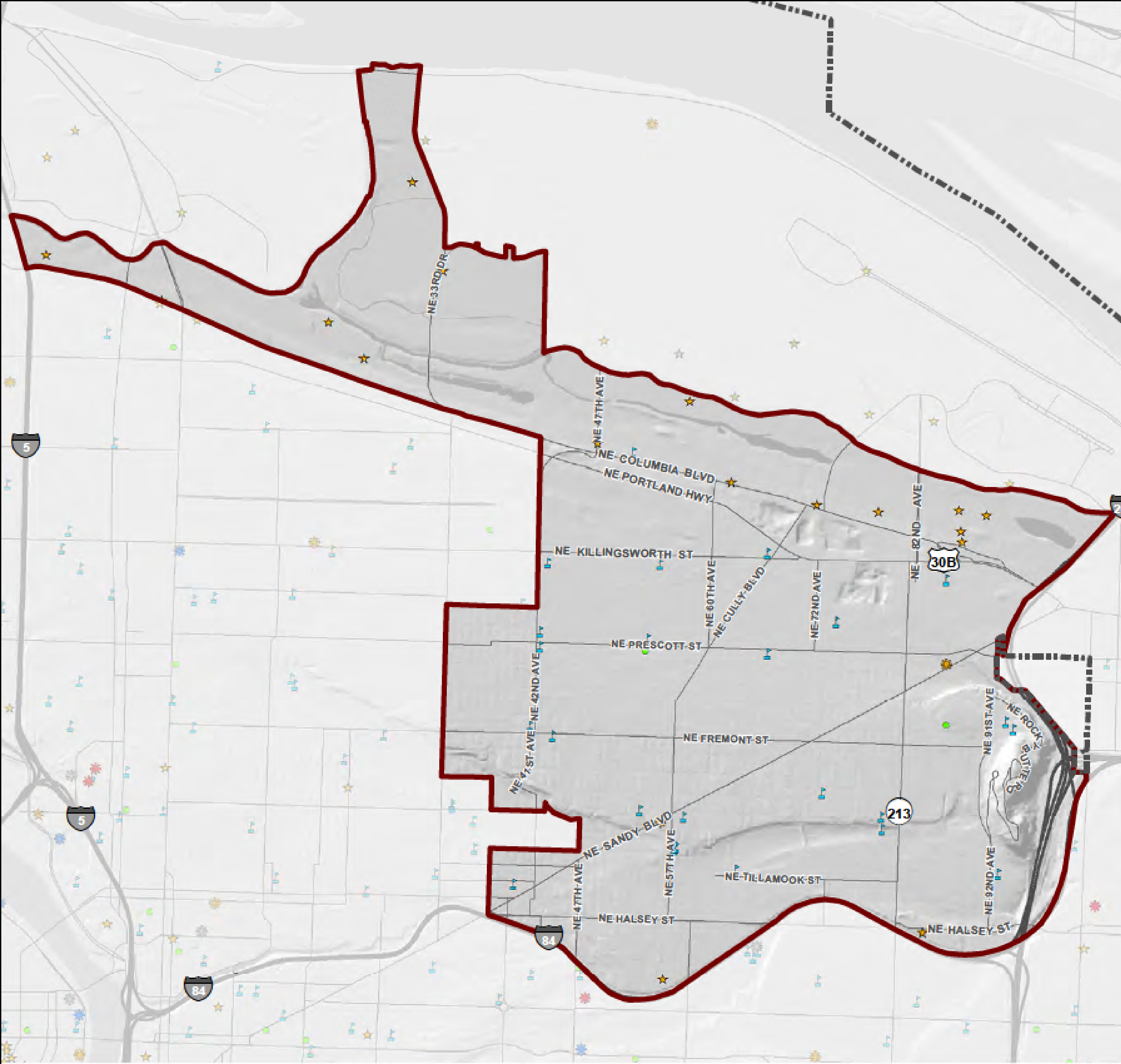
September 12, 2016

Mitigation Action Plan (MAP)

Critical Facilities



Legend

City Boundary

Risk Reporting Area Central Northeast

Emergency Services*

- Emergency Coordination Centers
- Fire Station Facilities
- Police Station Facilities
- Medical Care Facilities

High Potential Loss Facilities*

- Dams
- Military
- Nuclear Power Plants
- Hazardous Materials
- Schools
- Other Assets
  Zoo, Jails, Nursing/Assisted Living Facilities

*Due to security reasons, some emergency services and high potential loss facilities have been left off of the map.

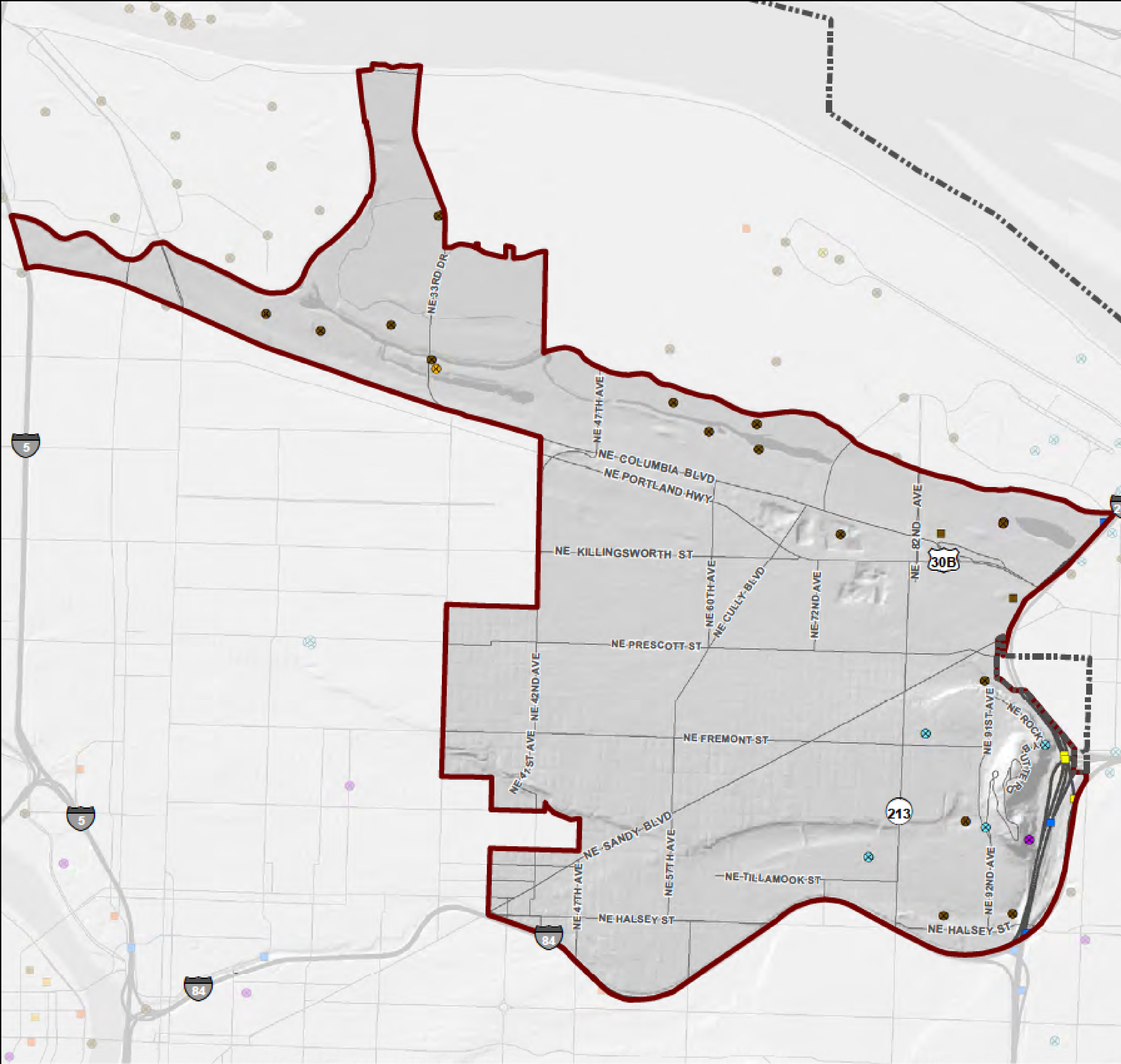
NORTH

0 0.275 0.55 Miles

Sources: WORD/NID-2015; OSFM-2015; City of Portland-2011, 2015, 2016

37242

PBEM



September 12, 2016

Mitigation Action Plan (MAP)

Critical Infrastructure

Legend

City Boundary

Risk Reporting Area Central Northeast

Utility Systems*

- Electrical
- Natural Gas Facilities
- Communication Facilities
- Petroleum Facilities
- Potable Water Facilities
- Wastewater Facilities

Transportation Systems*

- Railway Tunnels, Bridges, and Facilities
- Light Rail Tunnels, Bridges, and Facilities
- Highway Tunnels and Bridges
- Bus Facilities
- Port and Airport Facilities

*Due to security reasons, some utility and transportation system components have been left off of the map.

NORTH

0 0.275 0.55 Miles

Sources: TriMet-2015; Port of Portland-2015; OPHS-2016; City of Portland-2011, 2015,2016; OPB-2016; PTS-2015; FEMA-2015; Kinder Morgan-2015

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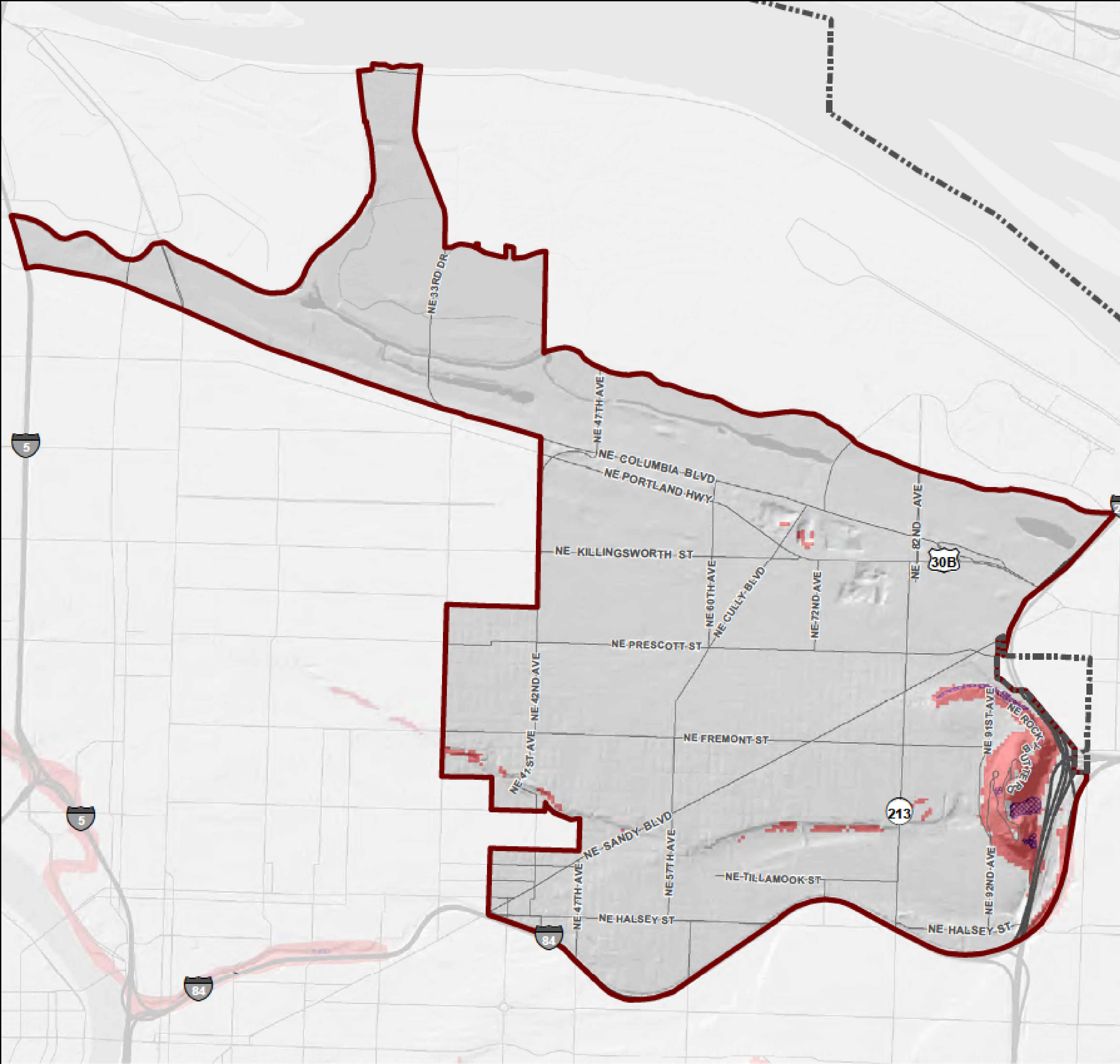

September 12, 2016

Mitigation Action Plan (MAP)

Regulatory Landslide Hazard Area

Legend

- City Boundary
- Historic Landslide Deposits
- Landslide Hazard Area
- Risk Reporting Area Central Northeast

NORTH

0 0.275 0.55 Miles

Sources: DOGAMI-2015; City of Portland-2015, 2016

37242

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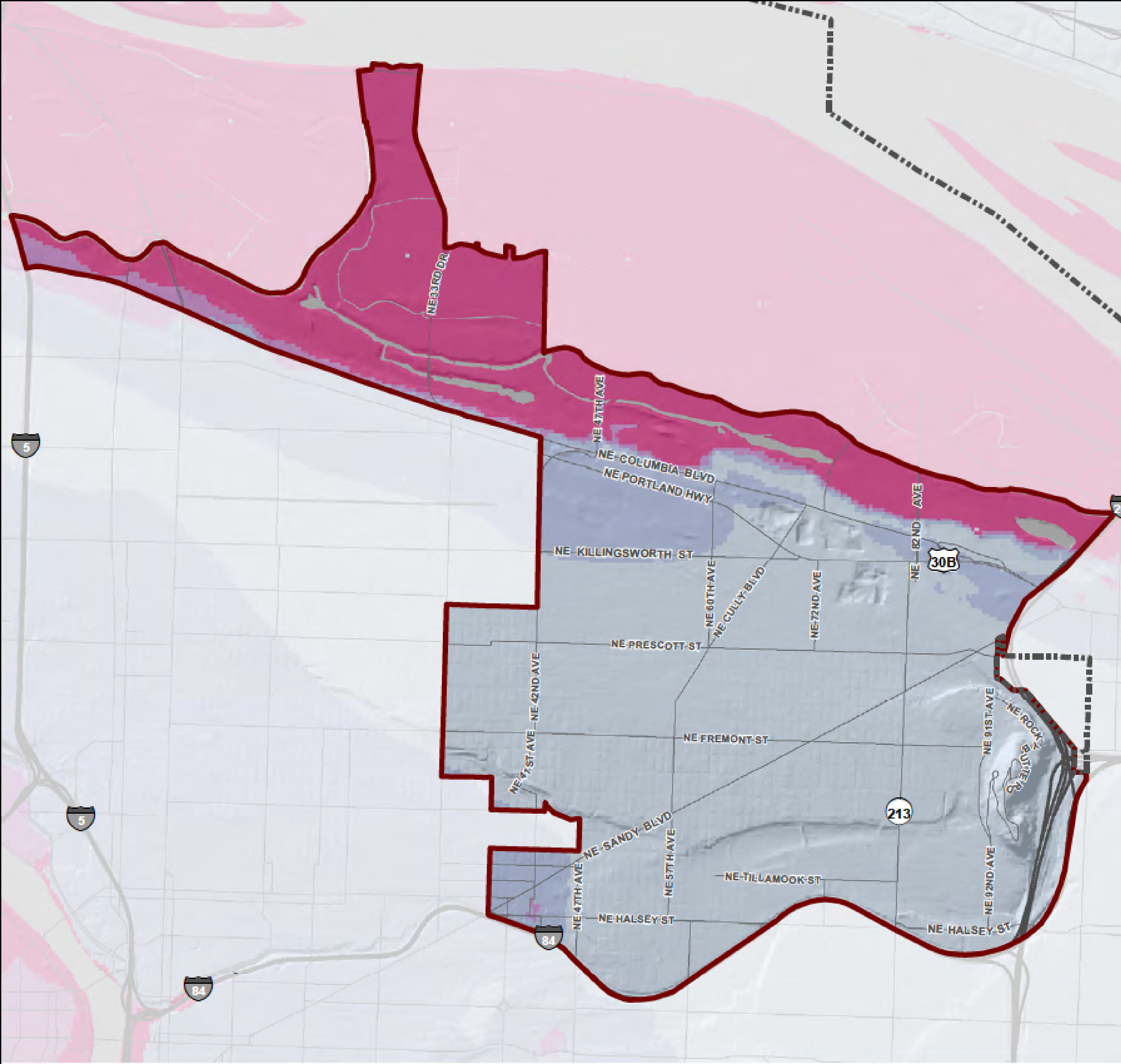
September 12, 2016

Mitigation Action Plan (MAP)

Liquefaction Susceptibility



Legend

City Boundary

Liquefaction Susceptibility

Type

0 – None
1 – Very Low
2 – Low
3 – Moderate
4 – High
5 – Very High

Risk Reporting Area Central Northeast

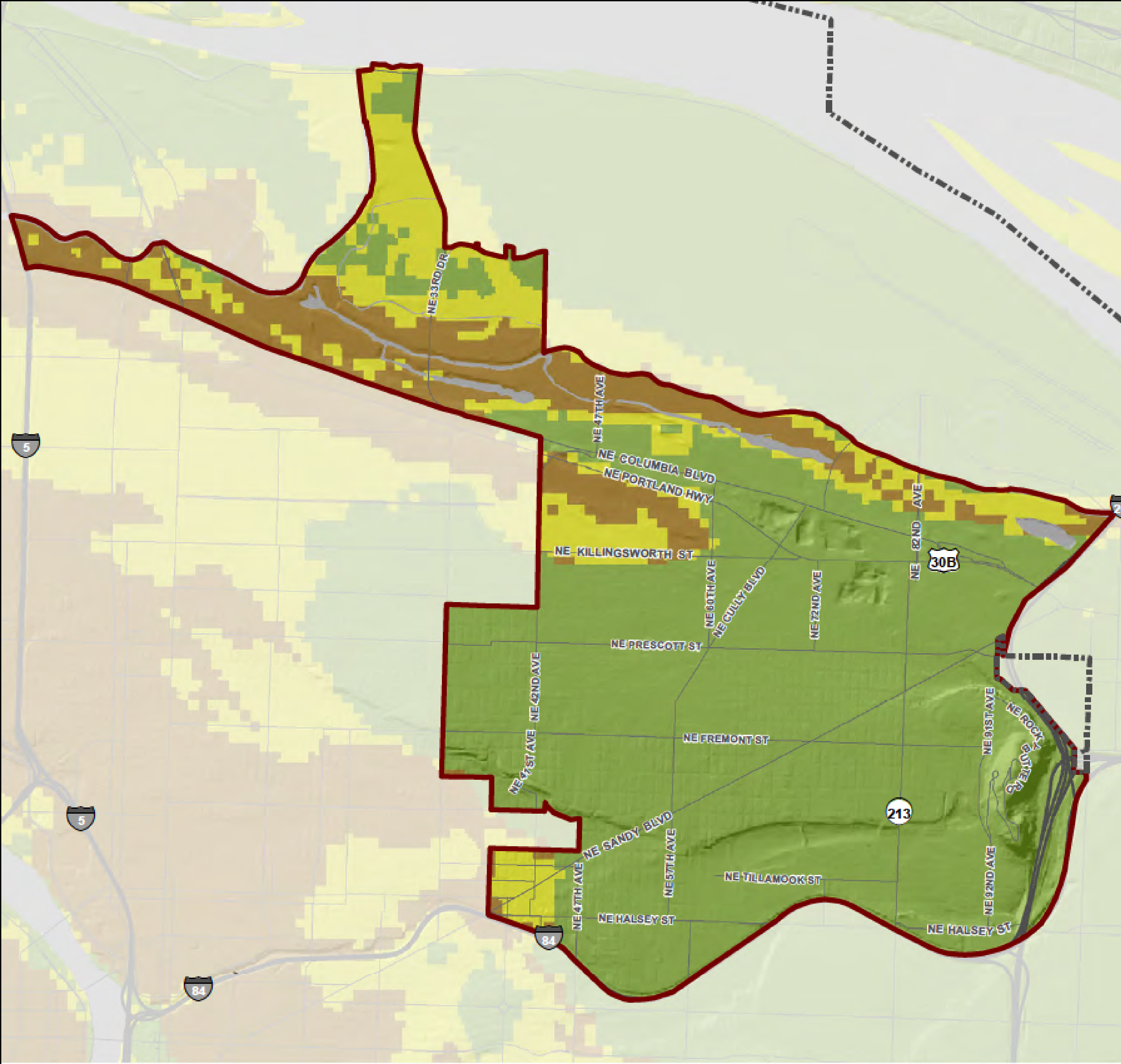
NORTH

0 0.275 0.55 Miles

Sources: DOGAMI-2013; City of Portland-2016

37242

PBEM



September 12, 2016

Mitigation Action Plan (MAP)

National Earthquake Hazards Reduction Program Soils

Legend

City Boundary

NEHRP Soils

Type

- B
- C
- D
- E

Risk Reporting Area Central Northeast

NORTH

0 0.275 0.55 Miles

Sources: DOGAMI-2012; City of Portland-2016

37242

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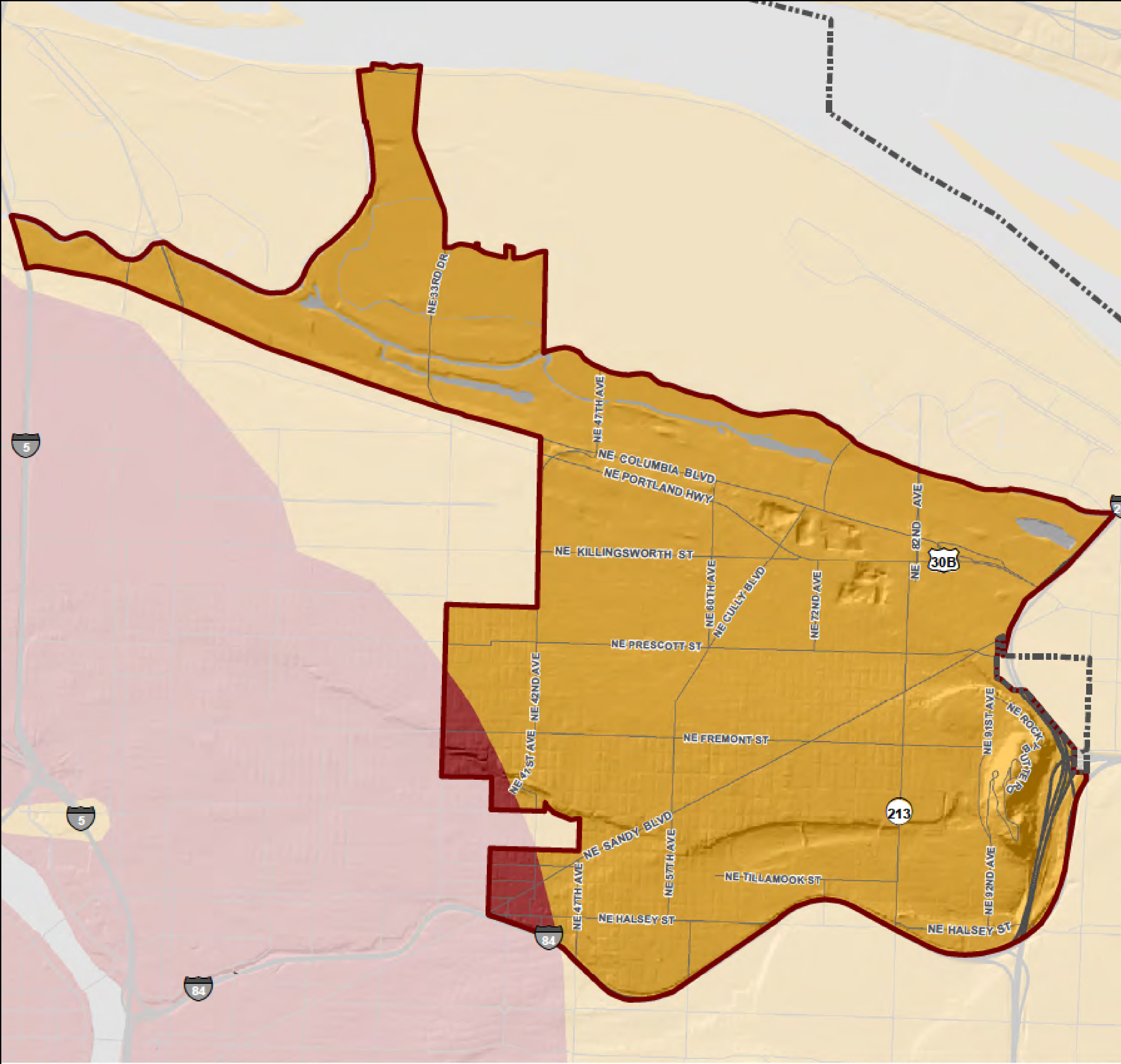
September 12, 2016

Mitigation Action Plan (MAP)

Portland Hills 6.5 Magnitude Earthquake- Peak Ground Acceleration



Legend

City Boundary

Portland Hills M6.5 earthquake PGA

Potential Damage - Perceived Shaking

V -- Very Light - Moderate

VI -- Light - Strong

VII -- Moderate - Very Strong

VIII -- Moderate/Heavy - Severe

Risk Reporting Area Central Northeast

NORTH

0 0.275 0.55 Miles

Sources: USGS-2009; City of Portland-2016

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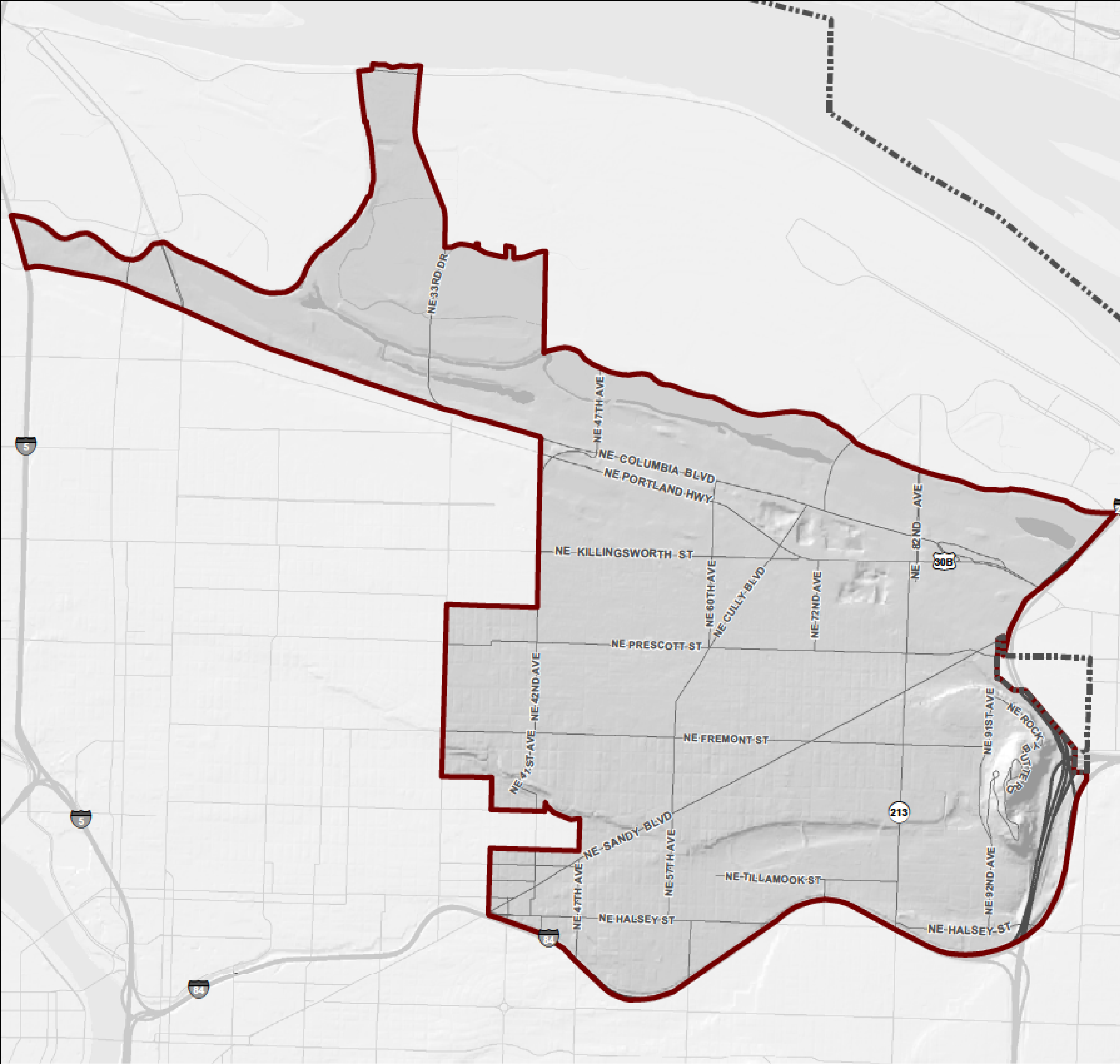
September 12, 2016

Mitigation Action Plan (MAP)

Volcano Hazard Area



Legend

City Boundary

Volcano Hazard Area

Risk Reporting Area
Central Northeast

NORTH

0 0.275 0.55
Miles

Sources: USGS-1997;
City of Portland-2016

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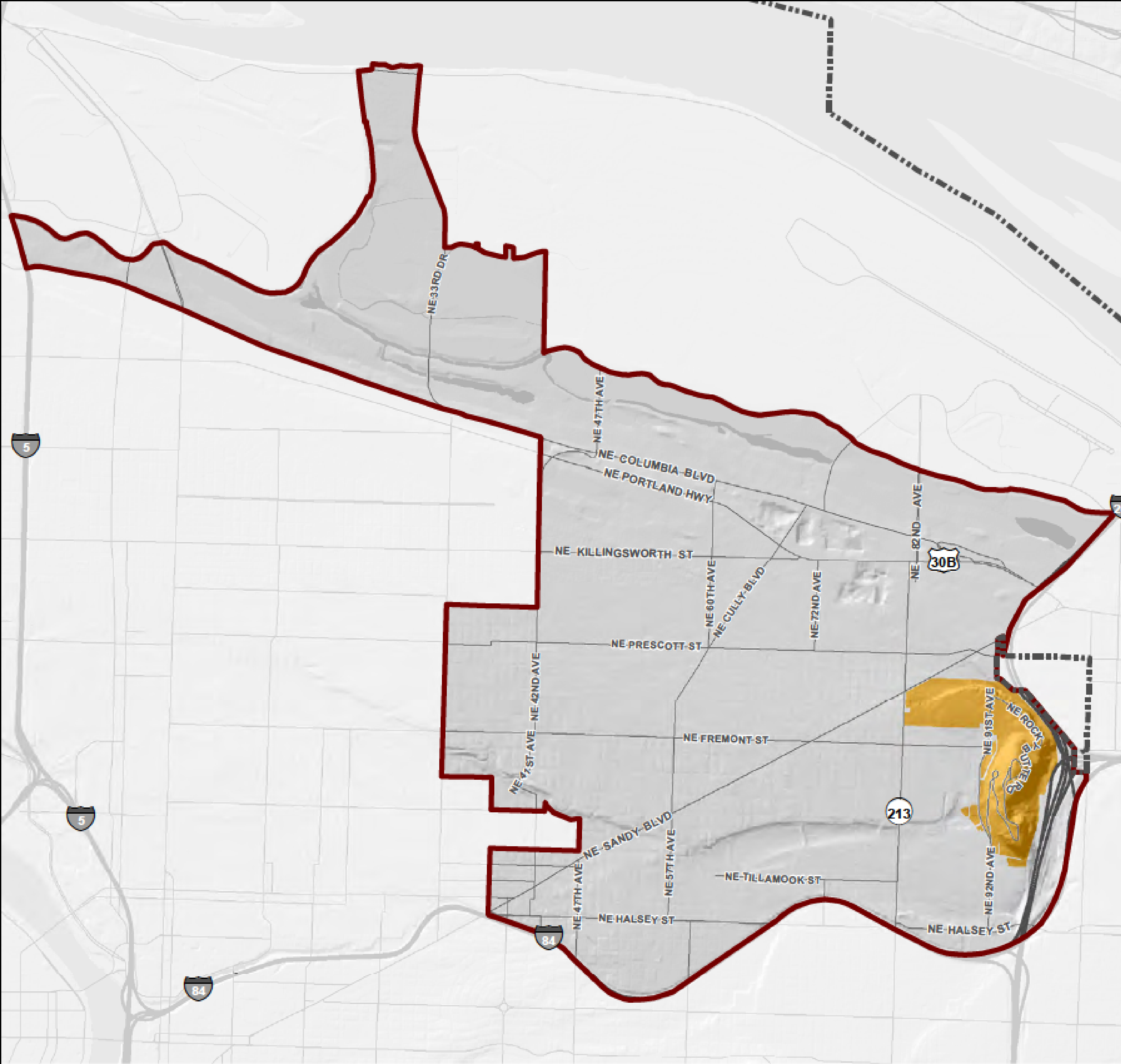

September 12, 2016

Mitigation Action Plan (MAP)

Wildfire Hazard Area

Legend

City Boundary

Wildfire Hazard Area

Risk Reporting Area Central Northeast

NORTH

0 0.275 0.55 Miles

Sources: City of Portland-2002, 2016

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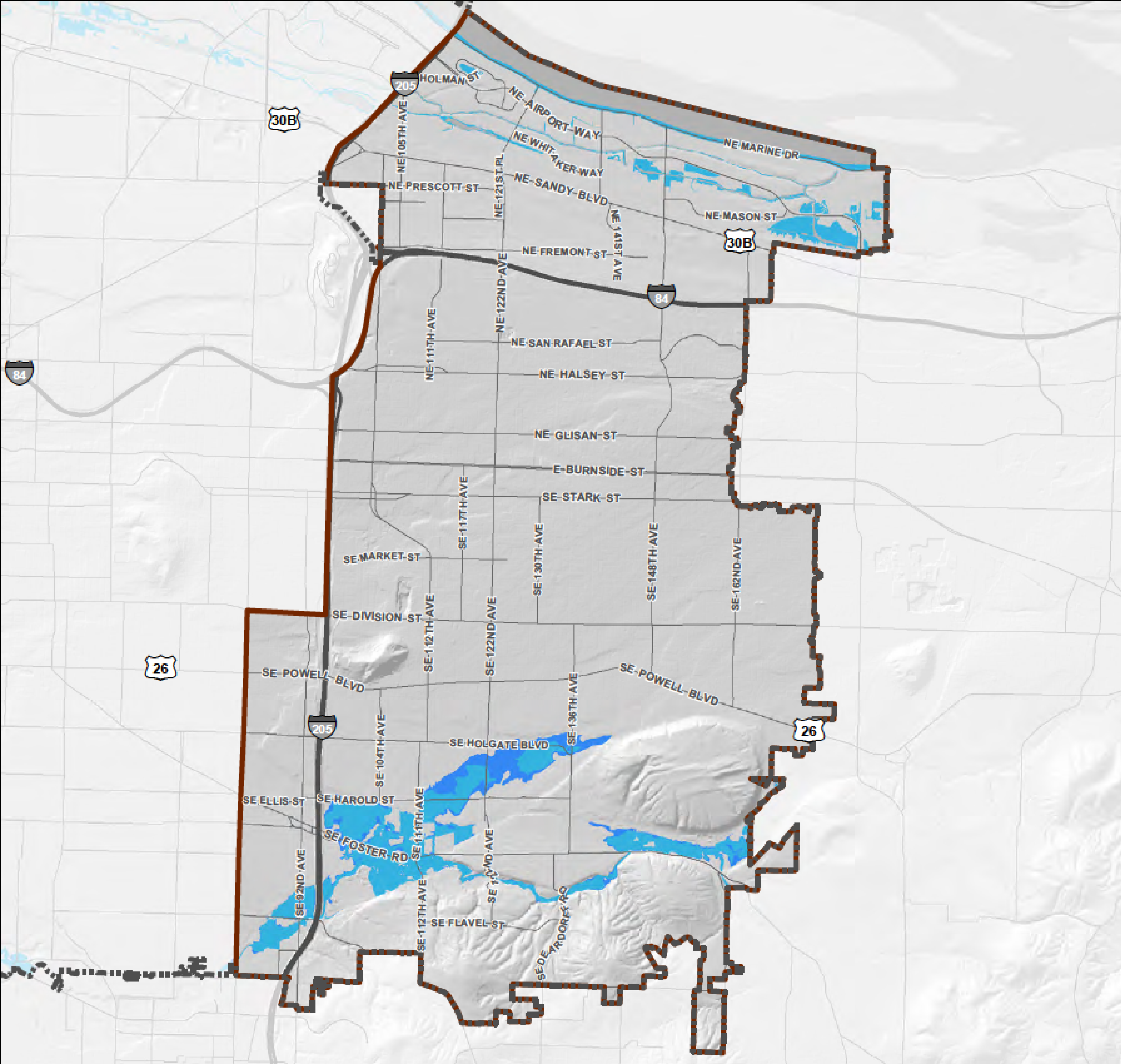
EAST PORTLAND



September 12, 2016

Mitigation Action Plan (MAP)

Flood hazard - 100-yr and 500-yr FEMA flood zone

Legend

City Boundary

100-year FEMA flood zone

500-year FEMA flood zone

Risk Reporting Area East Portland

NORTH

0 0.425 0.85 Miles

Sources: FEMA-2014; City of Portland-2016

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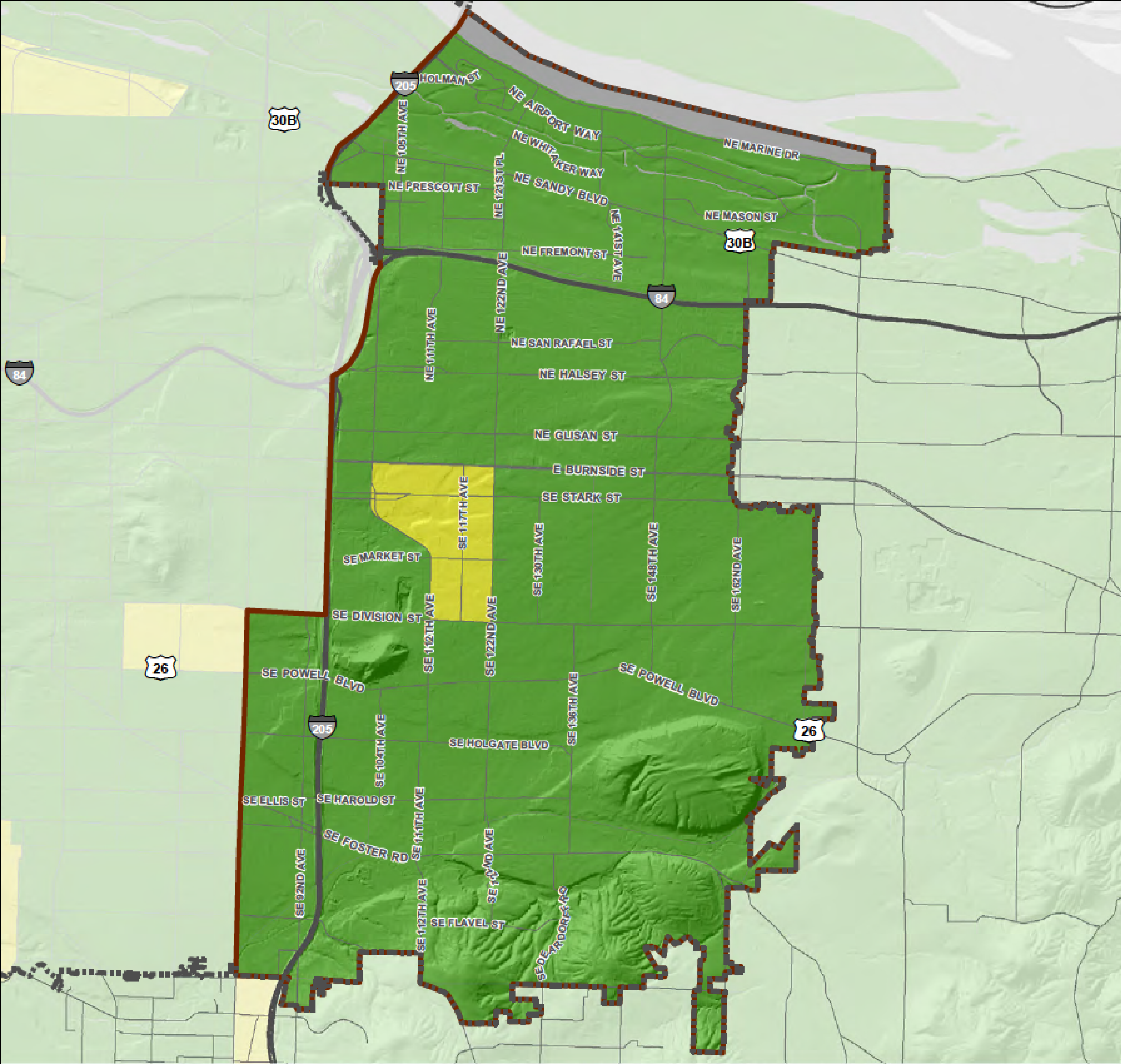
September 12, 2016

Mitigation Action Plan (MAP)

100-year Probabilistic Earthquake--Peak Ground Acceleration



Legend

City Boundary

100-year probabilistic earthquake PGA

Potential Damage - Perceived Shaking

V -- Very Light - Moderate

VI -- Light - Strong

Risk Reporting Area East Portland

NORTH

0 0.425 0.85 Miles

Sources: FEMA-2015; City of Portland-2016

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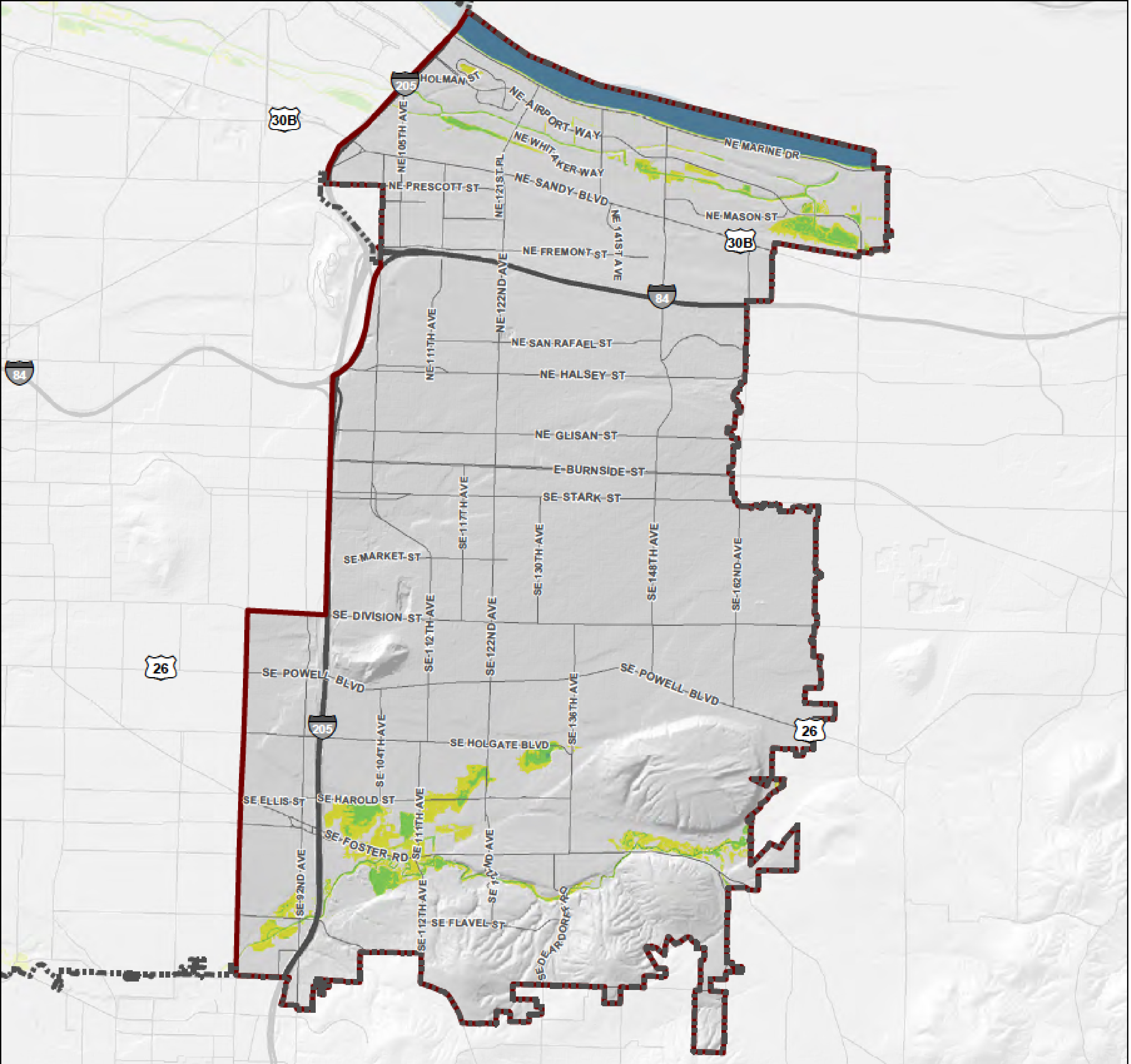
PBEM



September 12, 2016

Mitigation Action Plan (MAP)

Flood Hazard - 100-yr Flood Depth Grid

Legend

City Boundary

100-year flood depth grid

- 0.1' - 4.5'
- 4.6' - 11.5'
- 11.6' - 19.5'
- 19.6' - 25.9'
- 26' - 33.2'

Risk Reporting Area East Portland

NORTH

0 0.425 0.85 Miles

Sources: Tetra Tech-2016; City of Portland-2016

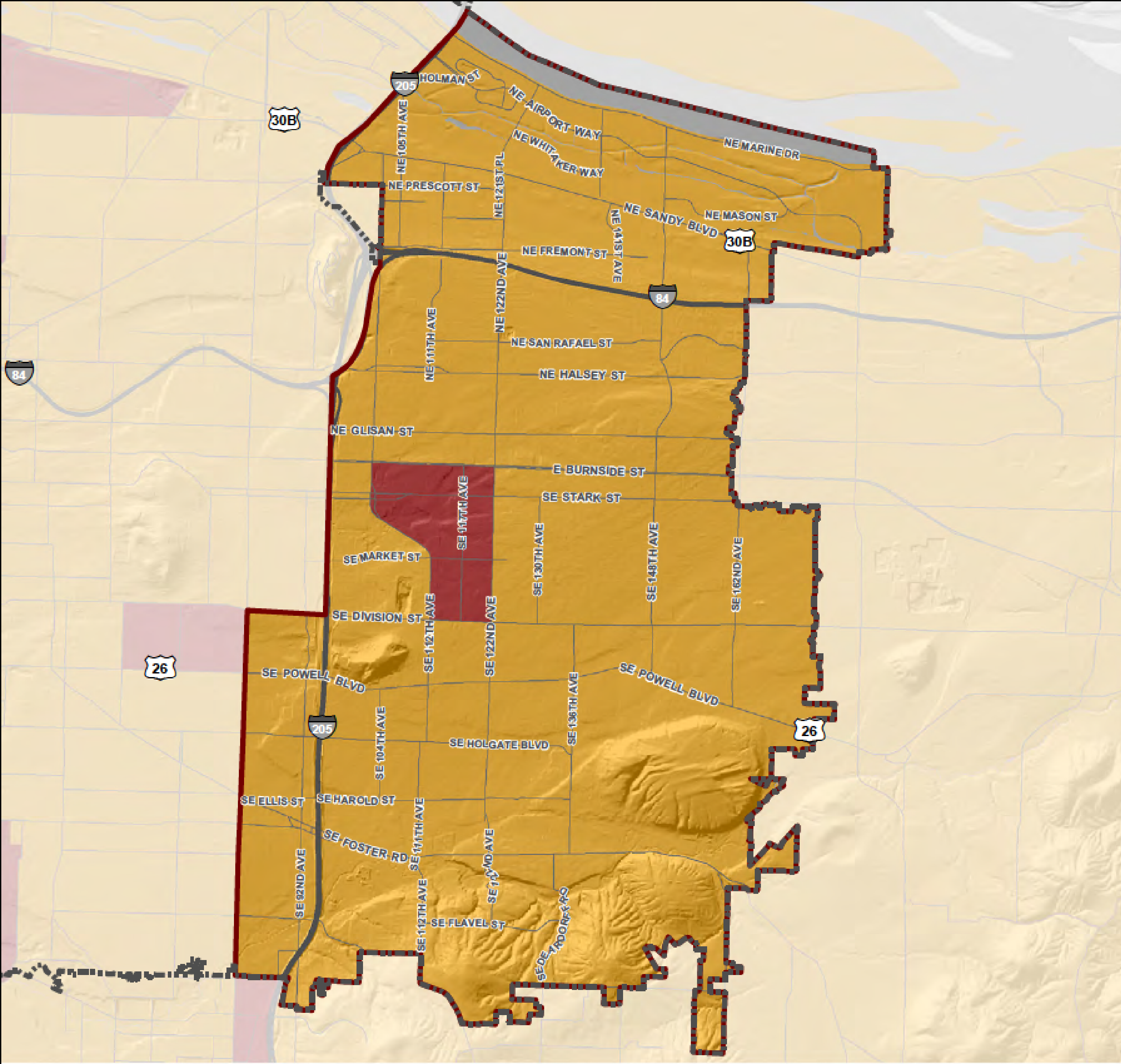
37242

PBEM

September 12, 2016

Mitigation Action Plan (MAP)

500-year Probabilistic Earthquake--Peak Ground Acceleration



Legend

City Boundary

500-year probabilistic earthquake PGA

Potential Damage - Perceived Shaking

VI -- Light - Strong

VII -- Moderate - Very Strong

VIII -- Moderate/Heavy - Severe

Risk Reporting Area East Portland

NORTH

0 0.475 0.95 Miles

Sources: FEMA-2015; City of Portland-2016

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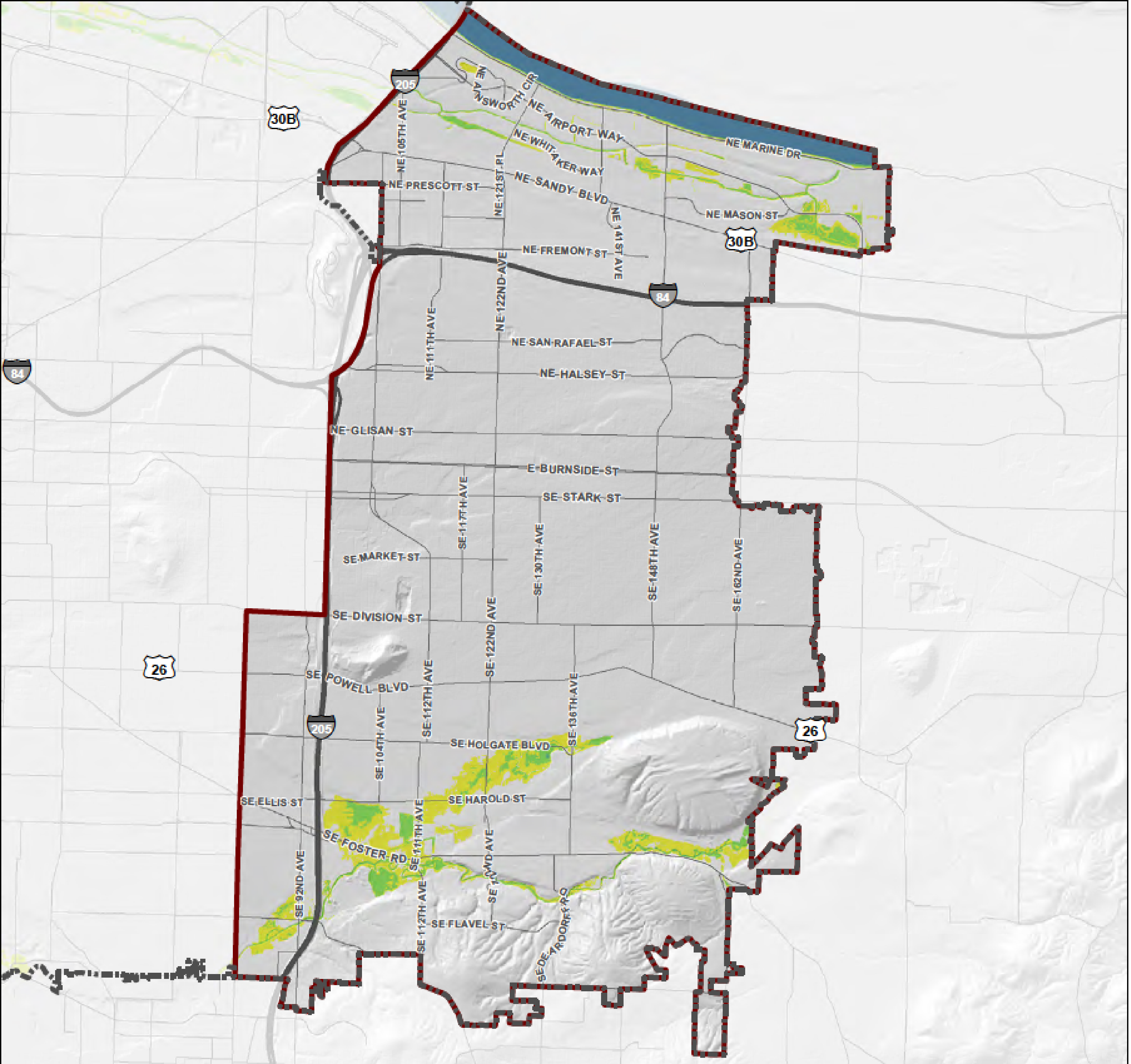

September 12, 2016

Mitigation Action Plan (MAP)

Flood Hazard - 500-yr Flood Depth Grid

Legend

City Boundary

500-year flood depth grid

- 0' - 4.6'
- 4.7' - 12.9'
- 13' - 22.6'
- 22.7' - 28.8'
- 28.9' - 36.7'

Risk Reporting Area East Portland

NORTH

0 0.5 1 Miles

Sources: Tetra Tech-2016; City of Portland-2016

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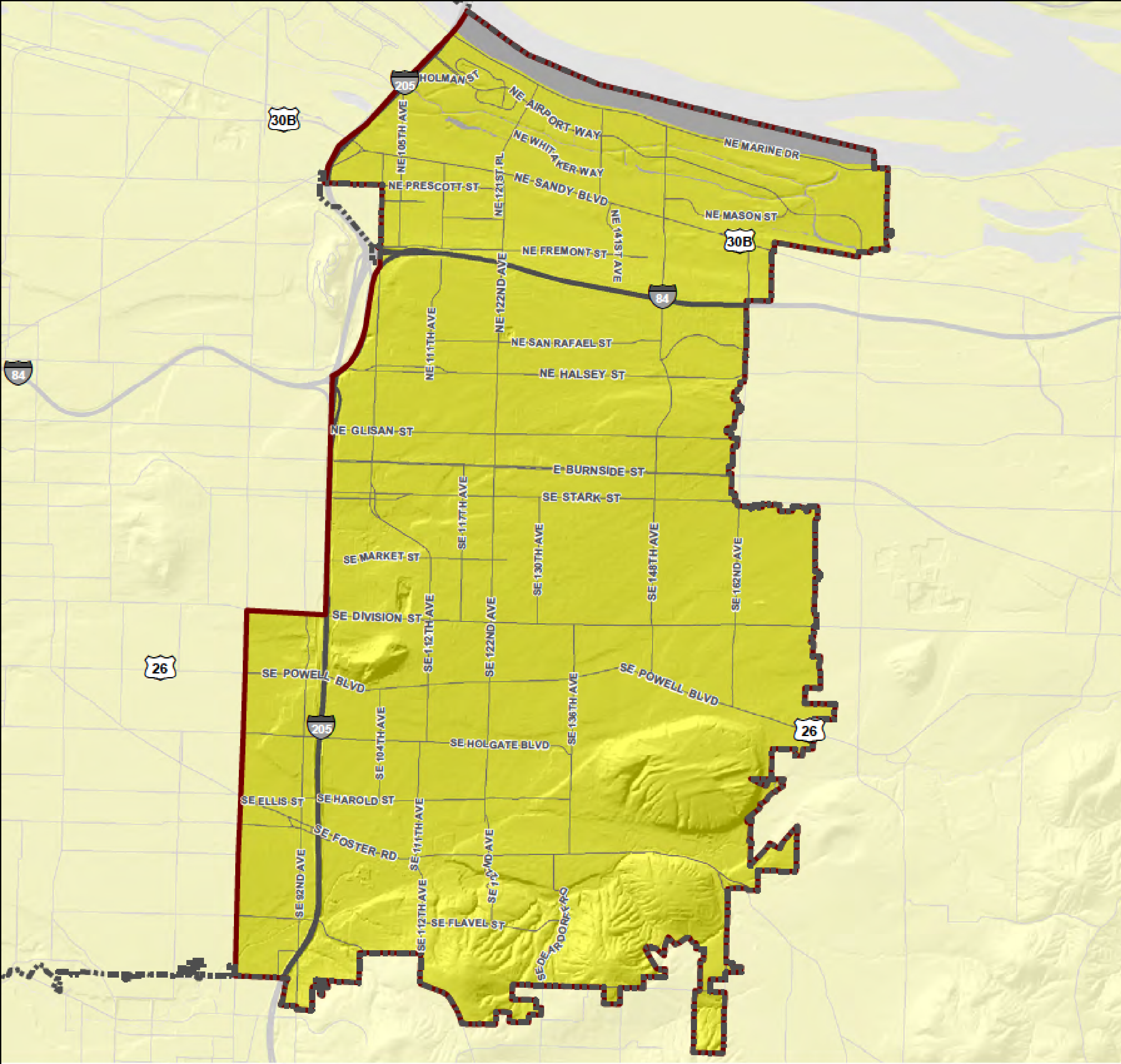
PBEM



September 12, 2016

Mitigation Action Plan (MAP)

Cascadia 9.0 Magnitude Earthquake--Peak Ground Acceleration

Legend

City Boundary

Cascadia M9.0 earthquake PGA

Potential Damage - Perceived Shaking

- V -- Very Light - Moderate
- VI -- Light - Strong
- VII -- Moderate - Very Strong
- VIII -- Moderate/Heavy - Severe

Risk Reporting Area East Portland

NORTH

0 0.425 0.85 Miles

Sources: USGS-2011; City of Portland-2016

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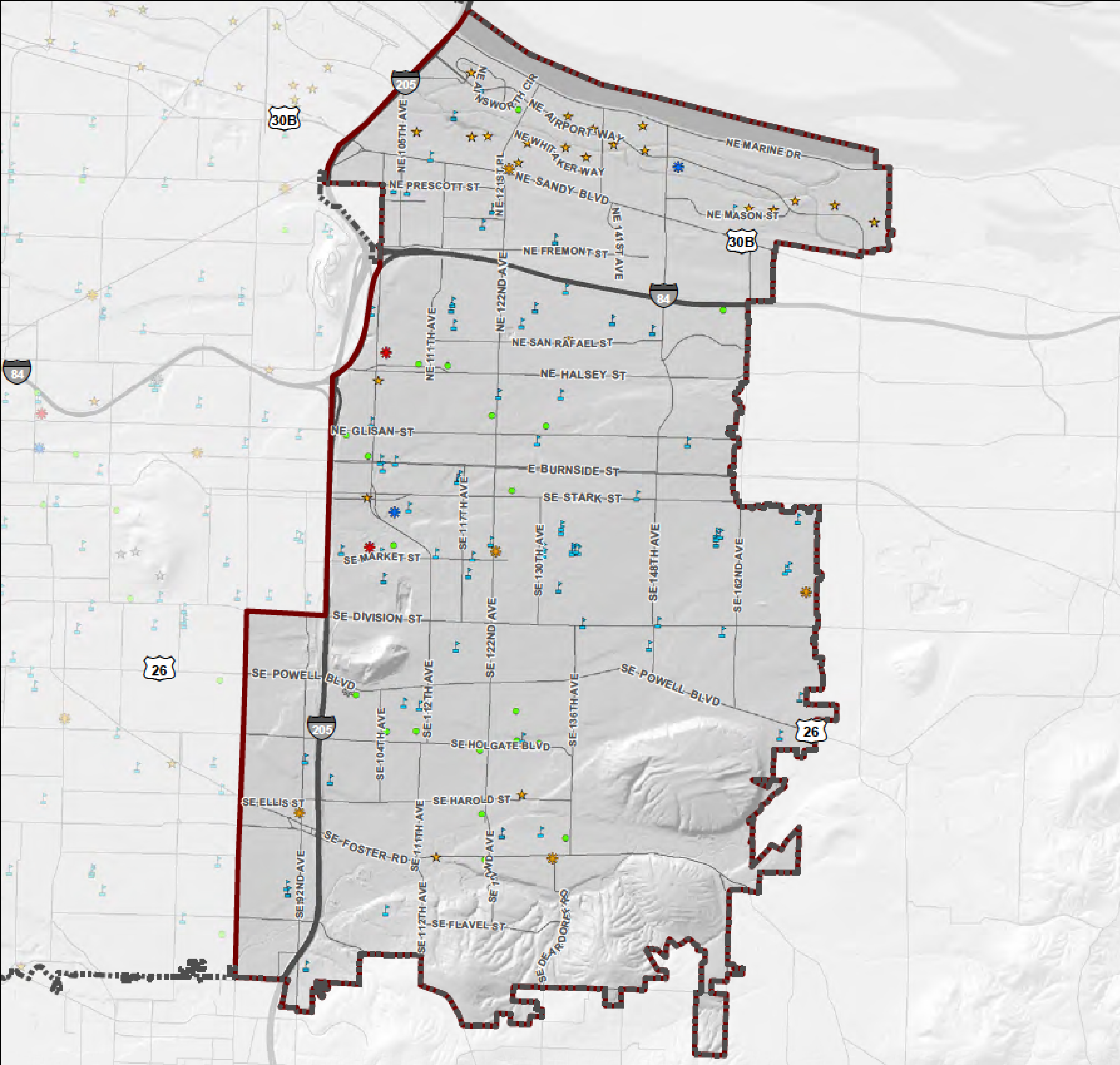
September 12, 2016

Mitigation Action Plan (MAP)

Critical Facilities



Legend

City Boundary

Risk Reporting Area East Portland

Emergency Services*

Emergency Coordination Centers

Fire Station Facilities

Police Station Facilities

Medical Care Facilities

High Potential Loss Facilities*

Dams

Military

Nuclear Power Plants

Hazardous Materials

Schools

Other Assets

Zoo, Jails, Nursing/Assisted Living Facilities

*Due to security reasons, some emergency services and high potential loss facilities have been left off of the map.

NORTH

0 0.425 0.85 Miles

Sources: WORD/NID-2015; OSFM-2015; City of Portland-2011, 2015, 2016

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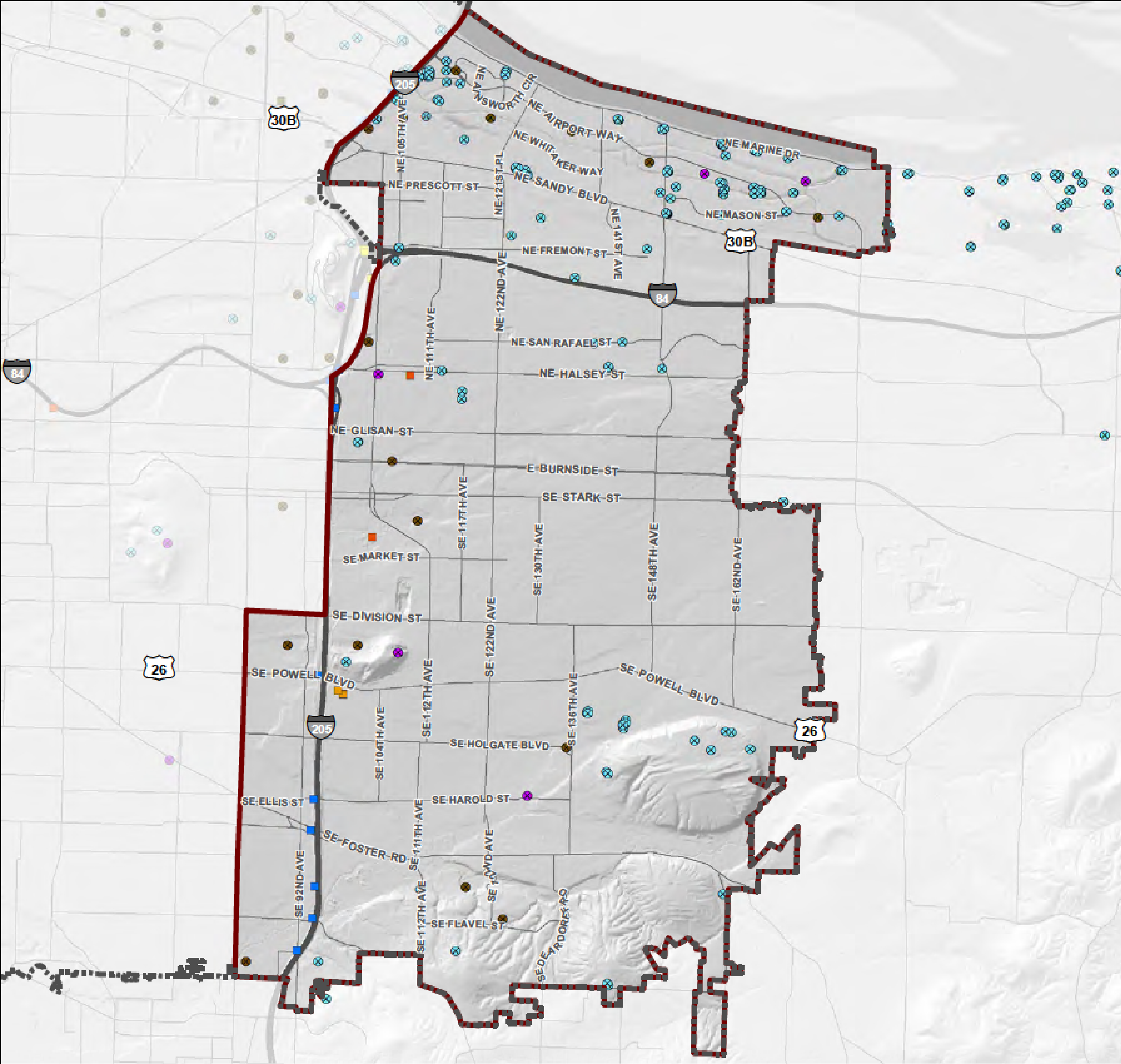
PBEM

September 12, 2016

Mitigation Action Plan (MAP)

Critical Infrastructure



Legend

City Boundary

Risk Reporting Area East Portland

Utility Systems*

- Electrical
- Natural Gas Facilities
- Communication Facilities
- Petroleum Facilities
- Potable Water Facilities
- Wastewater Facilities

Transportation Systems*

- Railway Tunnels, Bridges, and Facilities
- Light Rail Tunnels, Bridges, and Facilities
- Highway Tunnels and Bridges
- Bus Facilities
- Port and Airport Facilities

*Due to security reasons, some utility and transportation system components have been left off of the map.

NORTH

0 0.425 0.85 Miles

Sources: TriMet-2015; Port of Portland-2015; OPHS-2016; City of Portland-2011, 2015,2016; OPB-2016; PTS-2015; FEMA-2015; Kinder Morgan-2015

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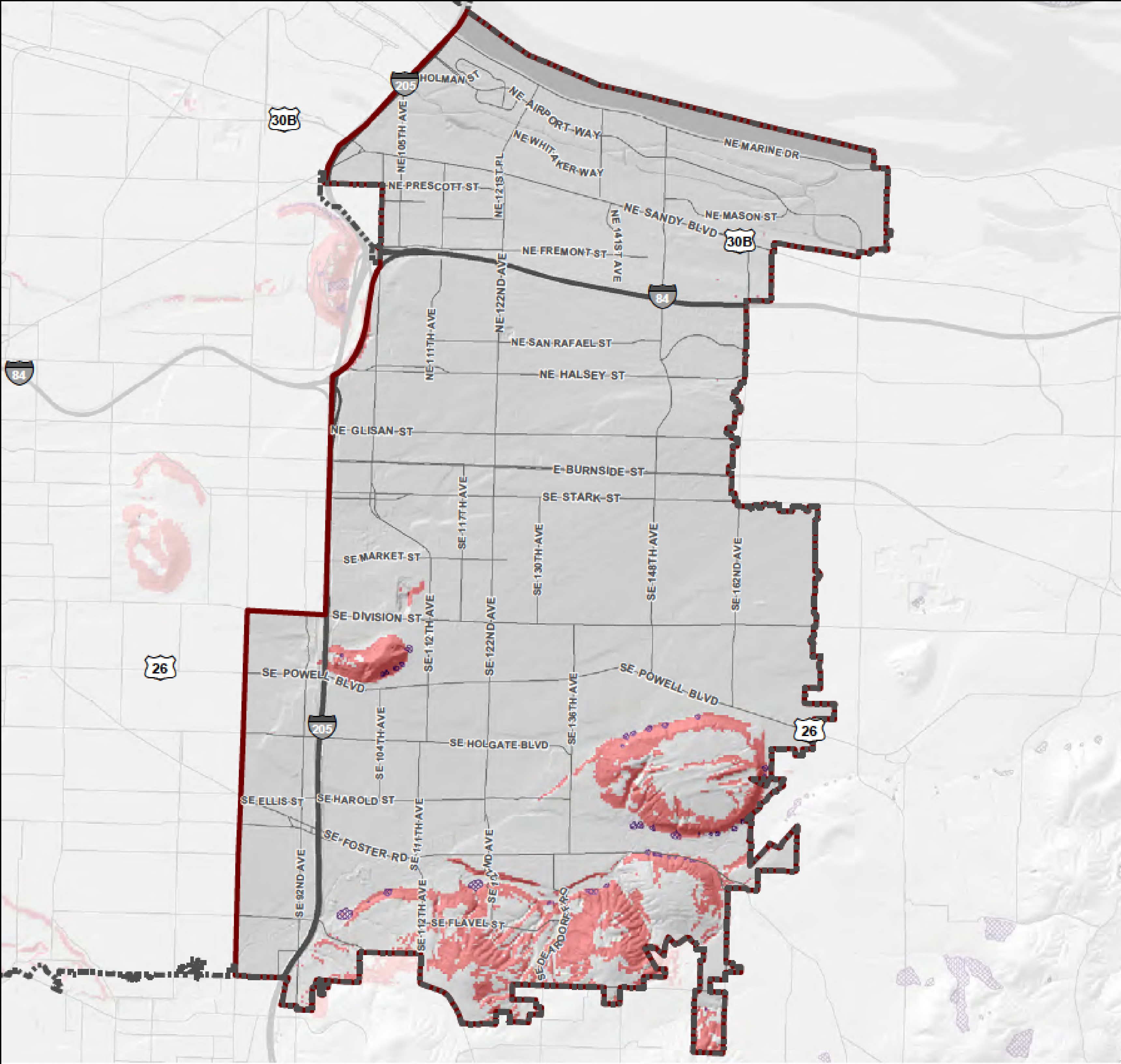
September 12, 2016

Mitigation Action Plan (MAP)

Regulatory Landslide Hazard Area



Legend

- City Boundary
- Historic Landslide Deposits
- Landslide Hazard Area
- Risk Reporting Area East Portland

NORTH

0 0.425 0.85 Miles

Sources: DOGAMI-2015; City of Portland-2015, 2016

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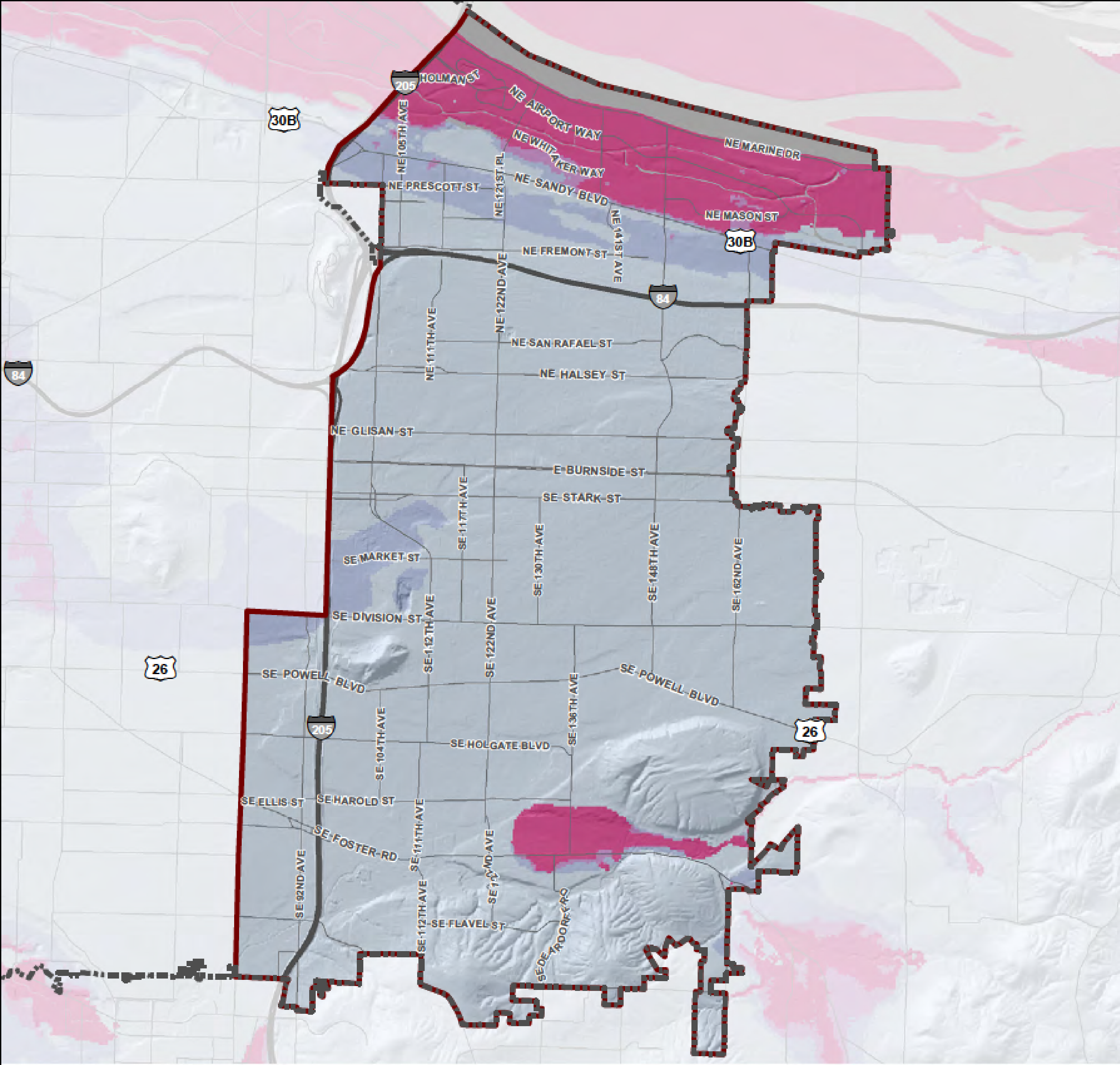
September 12, 2016

Mitigation Action Plan (MAP)

Liquefaction Susceptibility



Legend

City Boundary

Liquefaction Susceptibility

Type

- 0 – None
- 1 – Very Low
- 2 – Low
- 3 – Moderate
- 4 – High
- 5 – Very High

Risk Reporting Area East Portland

NORTH

0 0.425 0.85 Miles

Sources: DOGAMI-2013; City of Portland-2016

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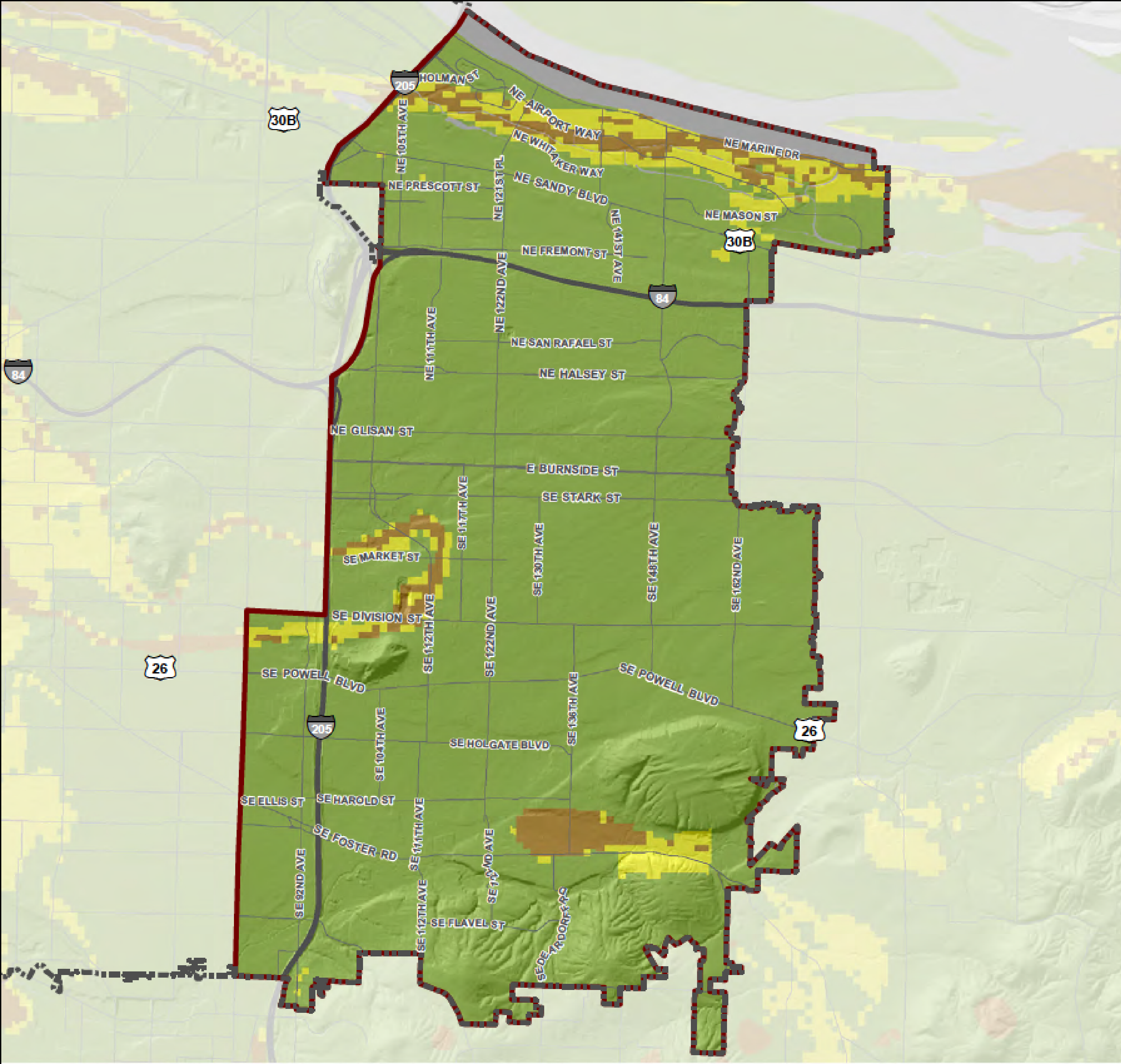
PBEM



September 12, 2016

Mitigation Action Plan (MAP)

National Earthquake Hazards Reduction Program Soils

Legend

City Boundary

NEHRP Soils

Type

- B
- C
- D
- E

Risk Reporting Area East Portland

NORTH

0 0.425 0.85 Miles

Sources: DOGAMI-2012; City of Portland-2016

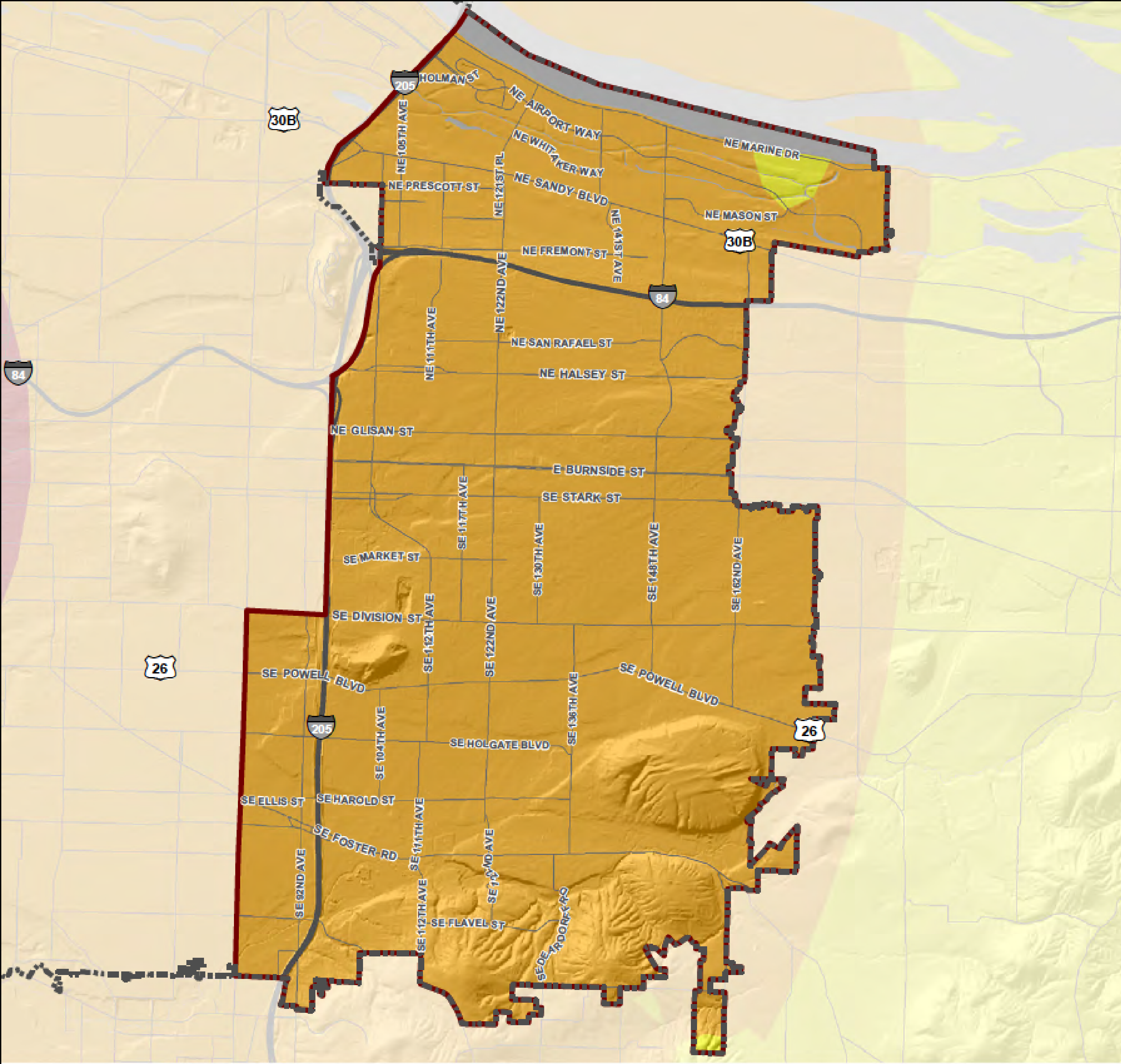
37242

PBEM

September 12, 2016

Mitigation Action Plan (MAP)

Portland Hills 6.5 Magnitude Earthquake-Peak Ground Acceleration



Legend

City Boundary

Portland Hills M6.5 earthquake PGA

Potential Damage - Perceived Shaking

- V -- Very Light - Moderate
- VI -- Light - Strong
- VII -- Moderate - Very Strong
- VIII -- Moderate/Heavy - Severe

Risk Reporting Area East Portland

NORTH

0 0.425 0.85 Miles

Sources: USGS-2009; City of Portland-2016

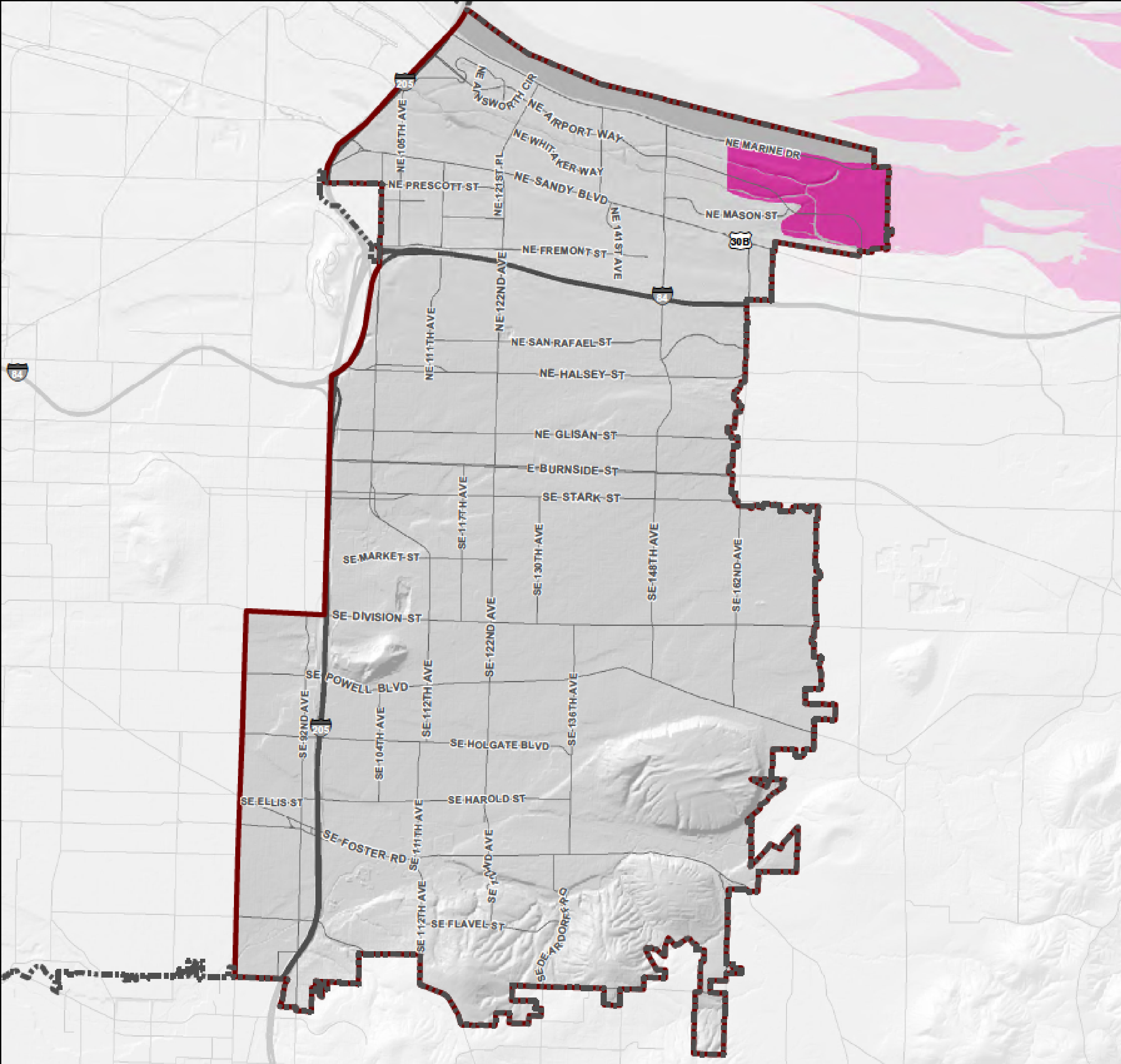
37242

PBEM

September 12, 2016

Mitigation Action Plan (MAP)

Volcano Hazard Area



Legend

City Boundary

Volcano Hazard Area

Risk Reporting Area East Portland

NORTH

0 0.425 0.85 Miles

Sources: USGS-1997;
City of Portland-2016

37242

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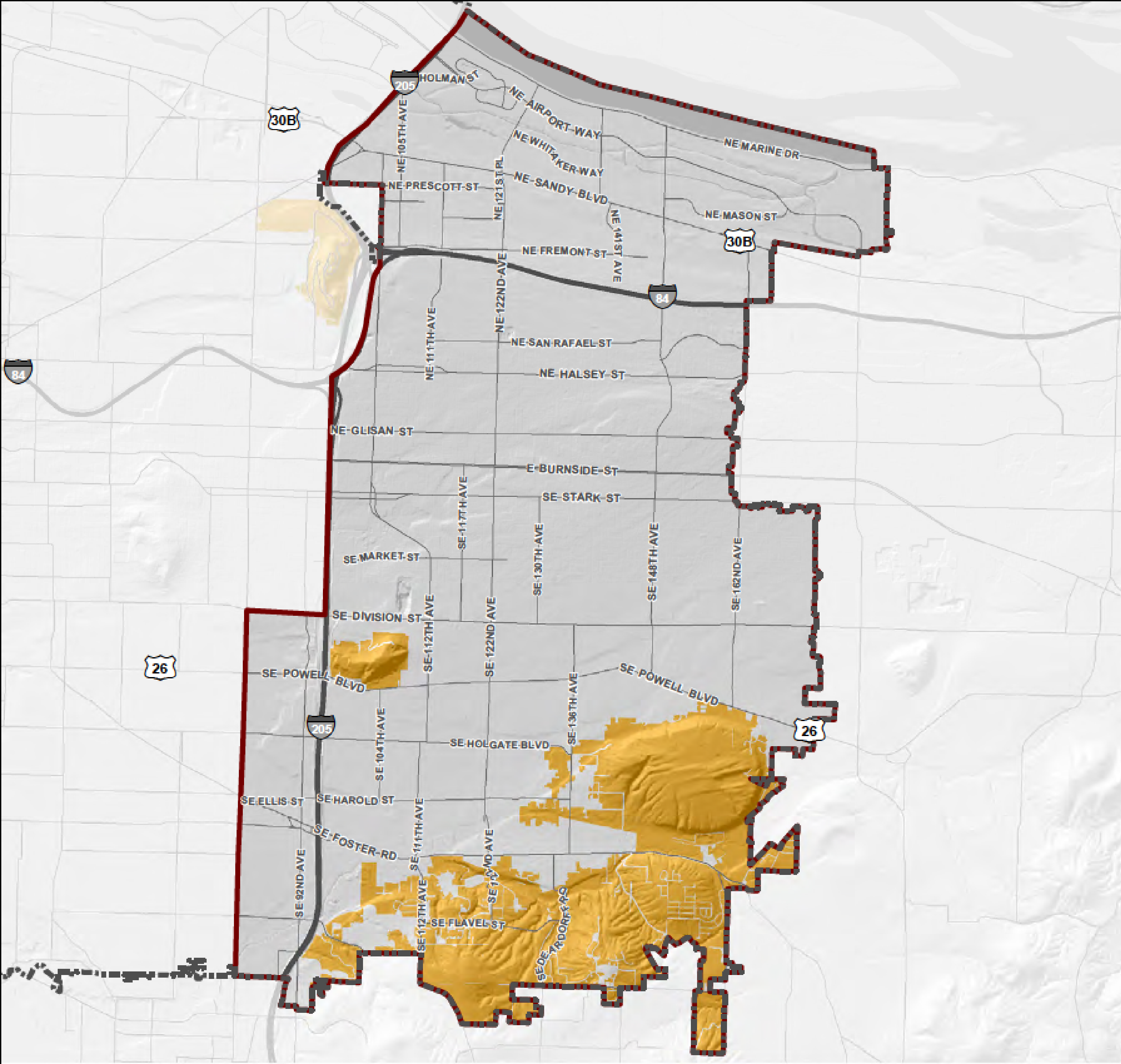
September 12, 2016

Mitigation Action Plan (MAP)

Wildfire Hazard Area



Legend

City Boundary

Wildfire Hazard Area

Risk Reporting Area East Portland

NORTH

0 0.425 0.85 Miles

Sources: City of Portland-2002, 2016

37242

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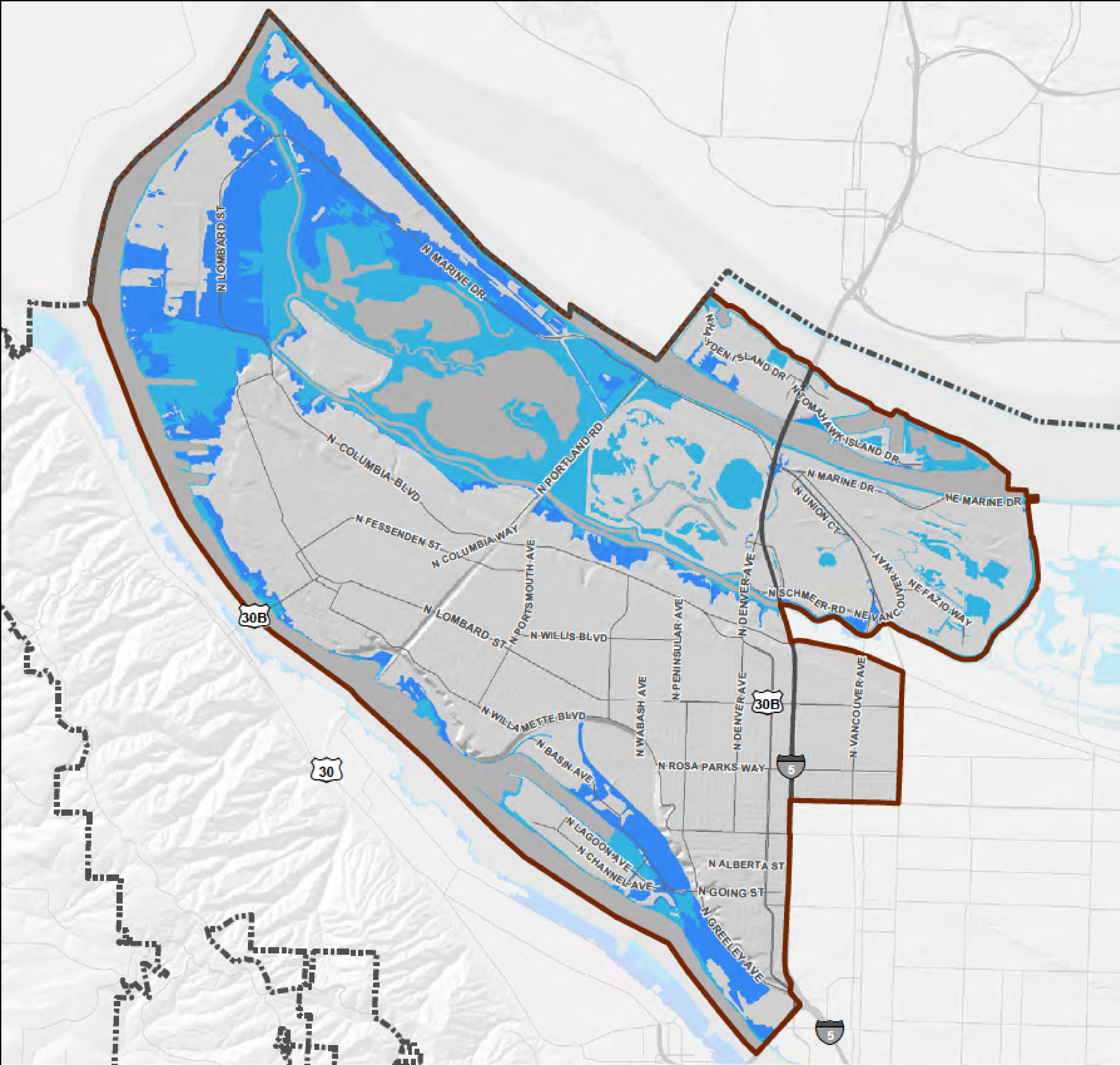
NORTH PORTLAND



September 12, 2016

Mitigation Action Plan (MAP)

Flood hazard - 100-yr and 500-yr FEMA flood zone

Legend

- City Boundary
- 100-year FEMA flood zone
- 500-year FEMA flood zone
- Risk Reporting Area North Portland

NORTH

0 0.4 0.8 Miles

Sources: FEMA-2014;
City of Portland-2016

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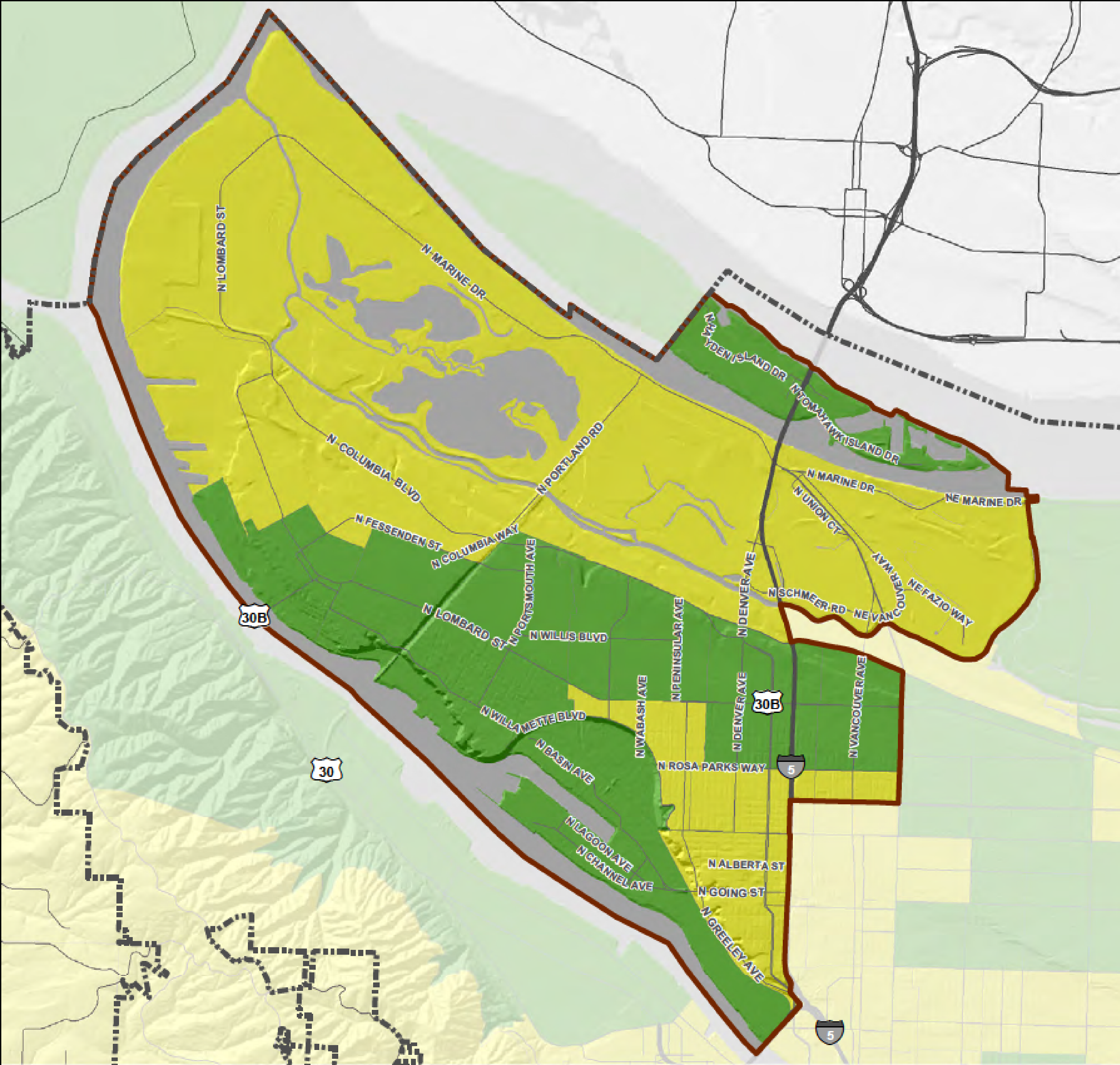


September 12, 2016

Mitigation Action Plan (MAP)

100-year Probabilistic Earthquake--Peak Ground Acceleration

Legend

City Boundary

100-year probabilistic earthquake PGA

Potential Damage - Perceived Shaking

V -- Very Light - Moderate

VI -- Light - Strong

Risk Reporting Area North Portland

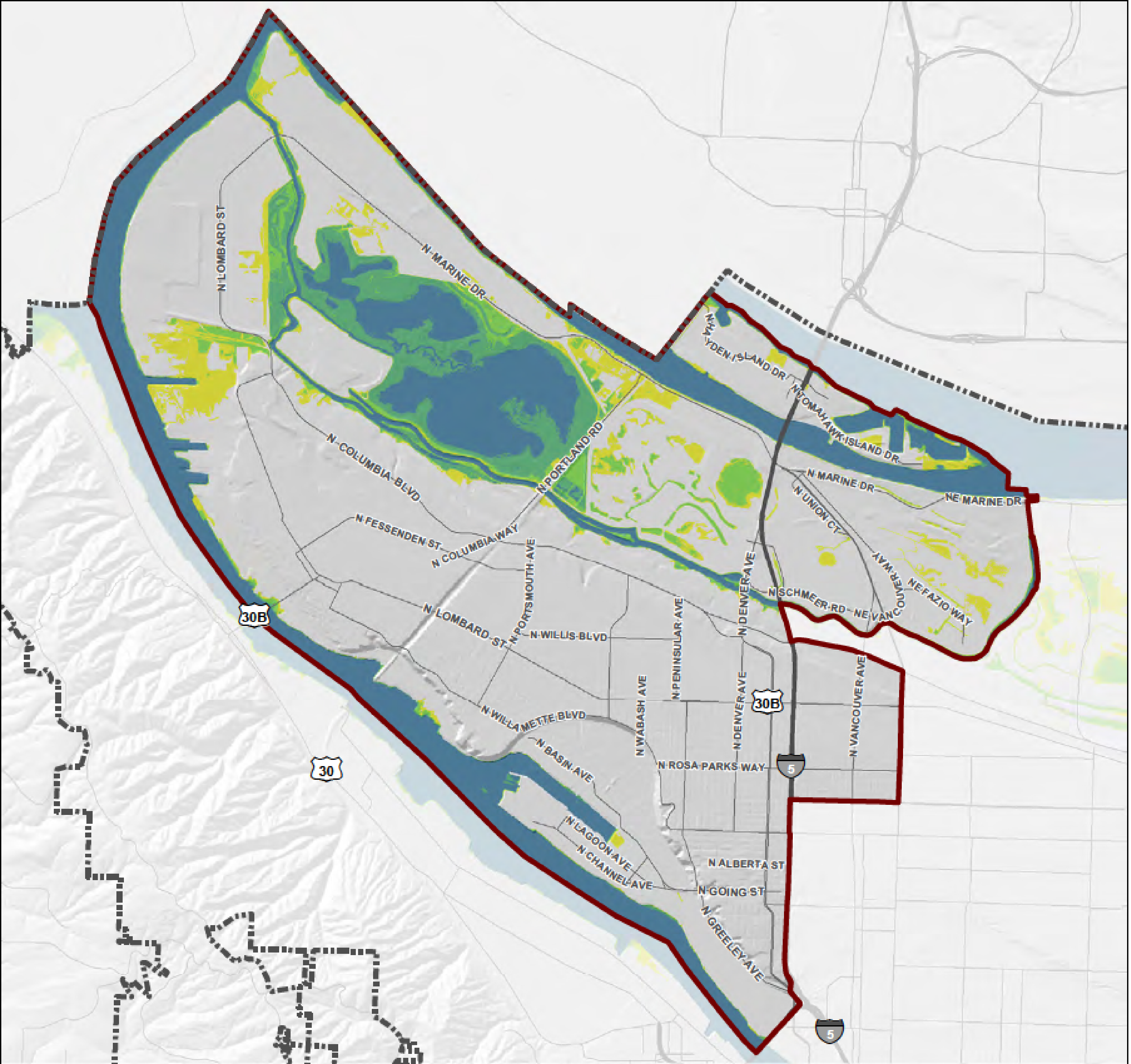
NORTH

0 0.4 0.8 Miles

Sources: FEMA-2015; City of Portland-2016

37242

PBEM



September 12, 2016

Mitigation Action Plan (MAP)

Flood Hazard - 100-yr Flood Depth Grid

Legend

City Boundary

100-year flood depth grid

- 0.1' - 4.5'
- 4.6' - 11.5'
- 11.6' - 19.5'
- 19.6' - 25.9'
- 26' - 33.2'

Risk Reporting Area North Portland

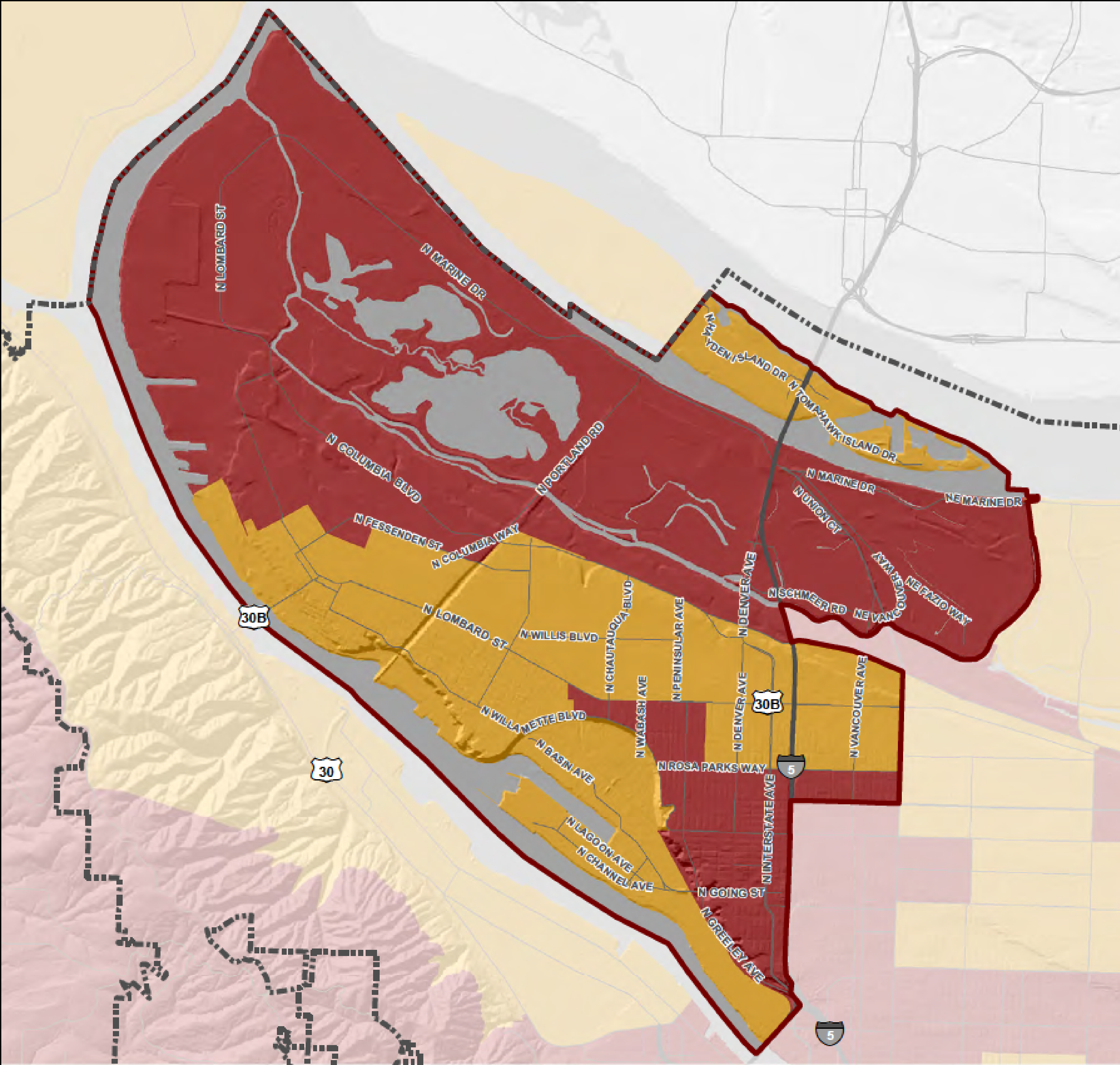
NORTH

0 0.4 0.8 Miles

Sources: Tetra Tech-2016; City of Portland-2016

37242

PBEM



September 12, 2016

Mitigation Action Plan (MAP)

500-year Probabilistic Earthquake--Peak Ground Acceleration

Legend

City Boundary

500-year probabilistic earthquake PGA

Potential Damage - Perceived Shaking

VI -- Light - Strong

VII -- Moderate - Very Strong

VIII -- Moderate/Heavy - Severe

Risk Reporting Area North Portland

NORTH

0 0.45 0.9 Miles

Sources: FEMA-2015; City of Portland-2016

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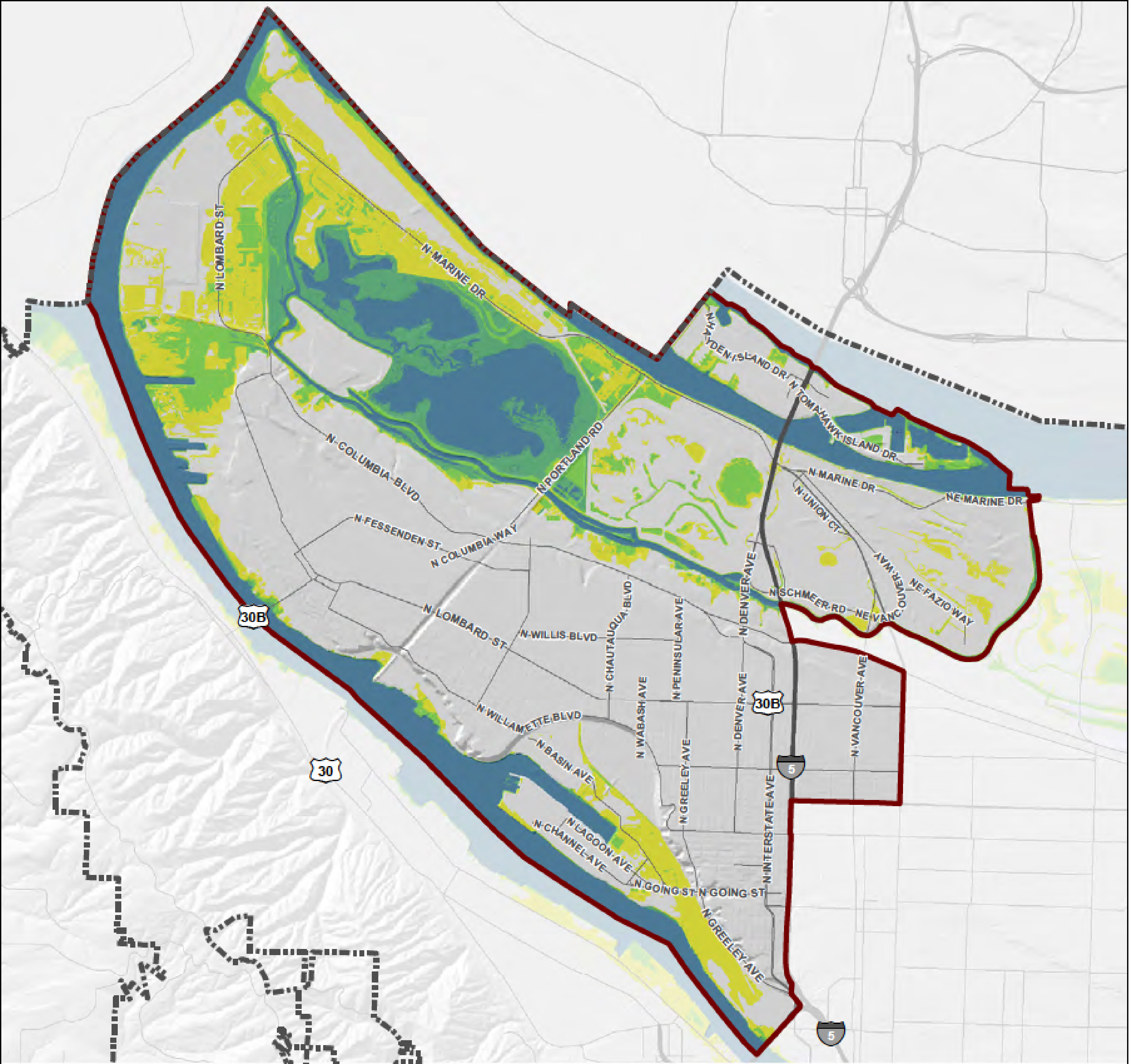


September 12, 2016

Mitigation Action Plan (MAP)

Flood Hazard - 500-yr Flood Depth Grid

Legend

City Boundary

500-year flood depth grid

- 0' - 4.6'
- 4.7' - 12.9'
- 13' - 22.6'
- 22.7' - 28.8'
- 28.9' - 36.7'

Risk Reporting Area North Portland

NORTH

0 0.5 1 Miles

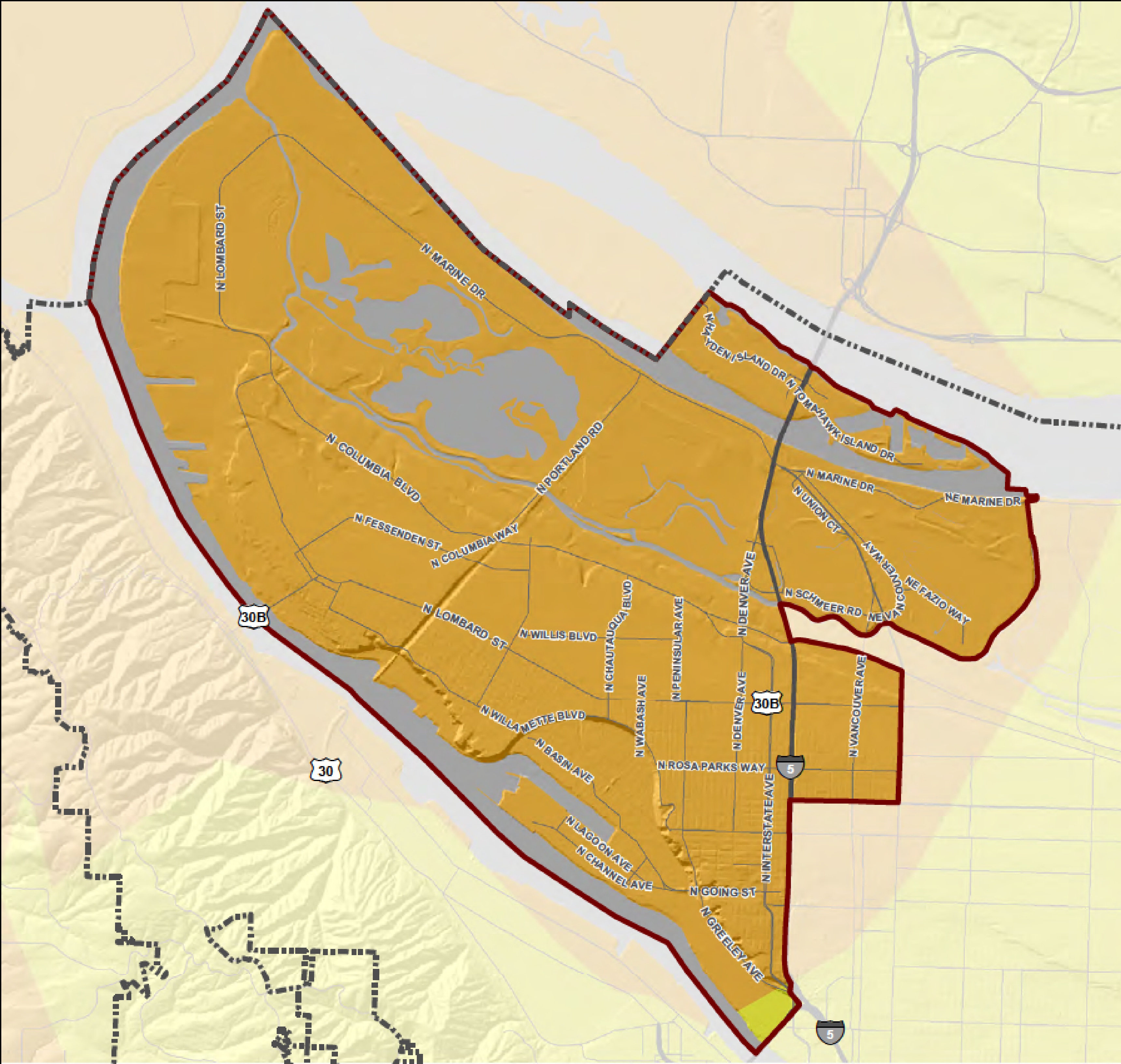
Sources: Tetra Tech-2016; City of Portland-2016

37242

September 12, 2016

Mitigation Action Plan (MAP)

Cascadia 9.0 Magnitude Earthquake--Peak Ground Acceleration



Legend

City Boundary

Cascadia M9.0 earthquake PGA

Potential Damage - Perceived Shaking

V -- Very Light - Moderate

VI -- Light - Strong

VII -- Moderate - Very Strong

VIII -- Moderate/Heavy - Severe

Risk Reporting Area North Portland

NORTH

0 0.4 0.8 Miles

Sources: USGS-2011; City of Portland-2016

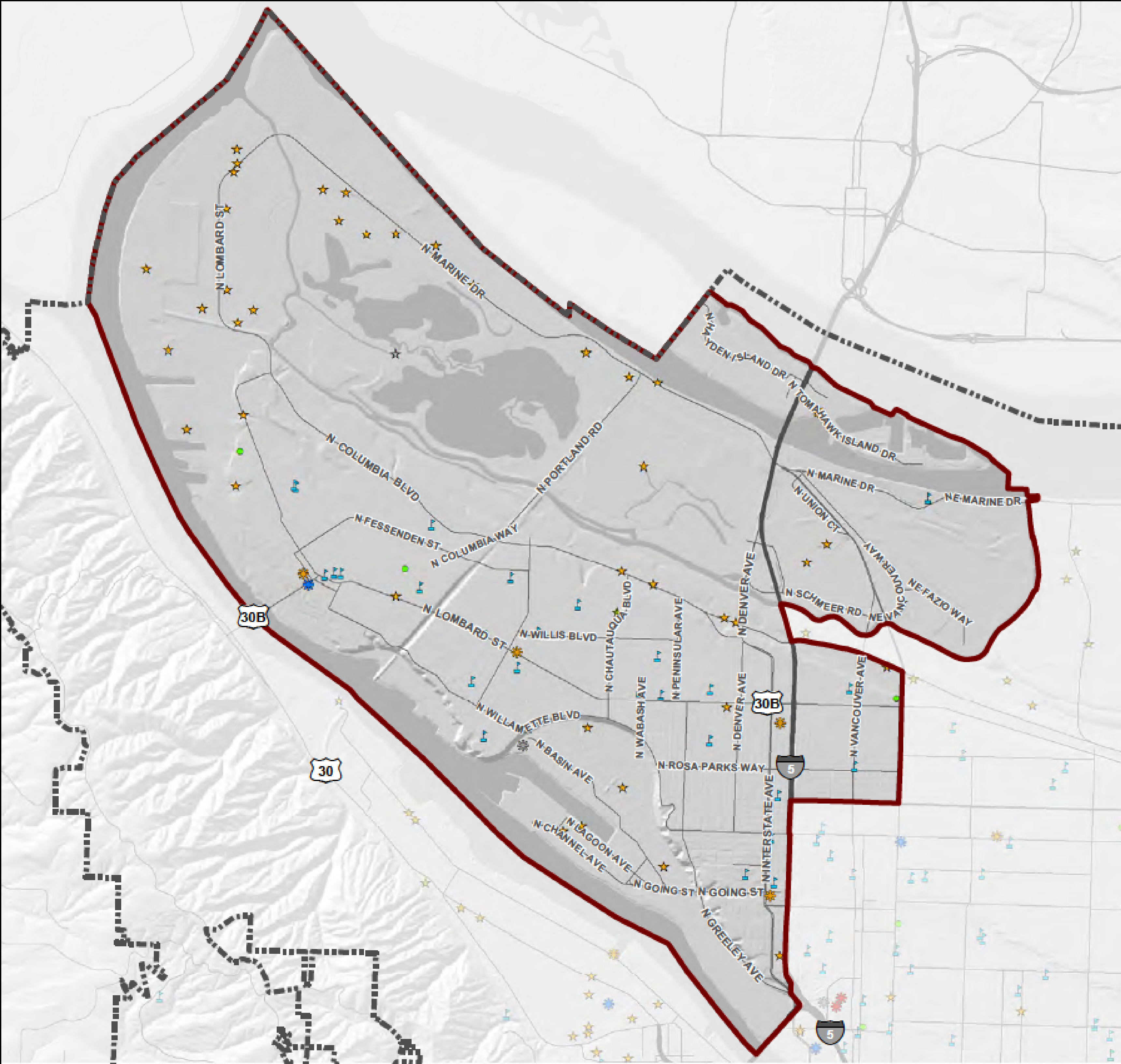
37242

PBEM

September 12, 2016

Mitigation Action Plan (MAP)

Critical Facilities



Legend

City Boundary

Risk Reporting Area North Portland

Emergency Services*

- Emergency Coordination Centers
- Fire Station Facilities
- Police Station Facilities
- Medical Care Facilities

High Potential Loss Facilities*

- Dams
- Military
- Nuclear Power Plants
- Hazardous Materials
- Schools
- Other Assets

Zoo, Jails, Nursing/Assisted Living Facilities

*Due to security reasons, some emergency services and high potential loss facilities have been left off of the map.

NORTH

0 0.4 0.8 Miles

Sources: WORD/NID-2015; OSFM-2015; City of Portland-2011, 2015, 2016

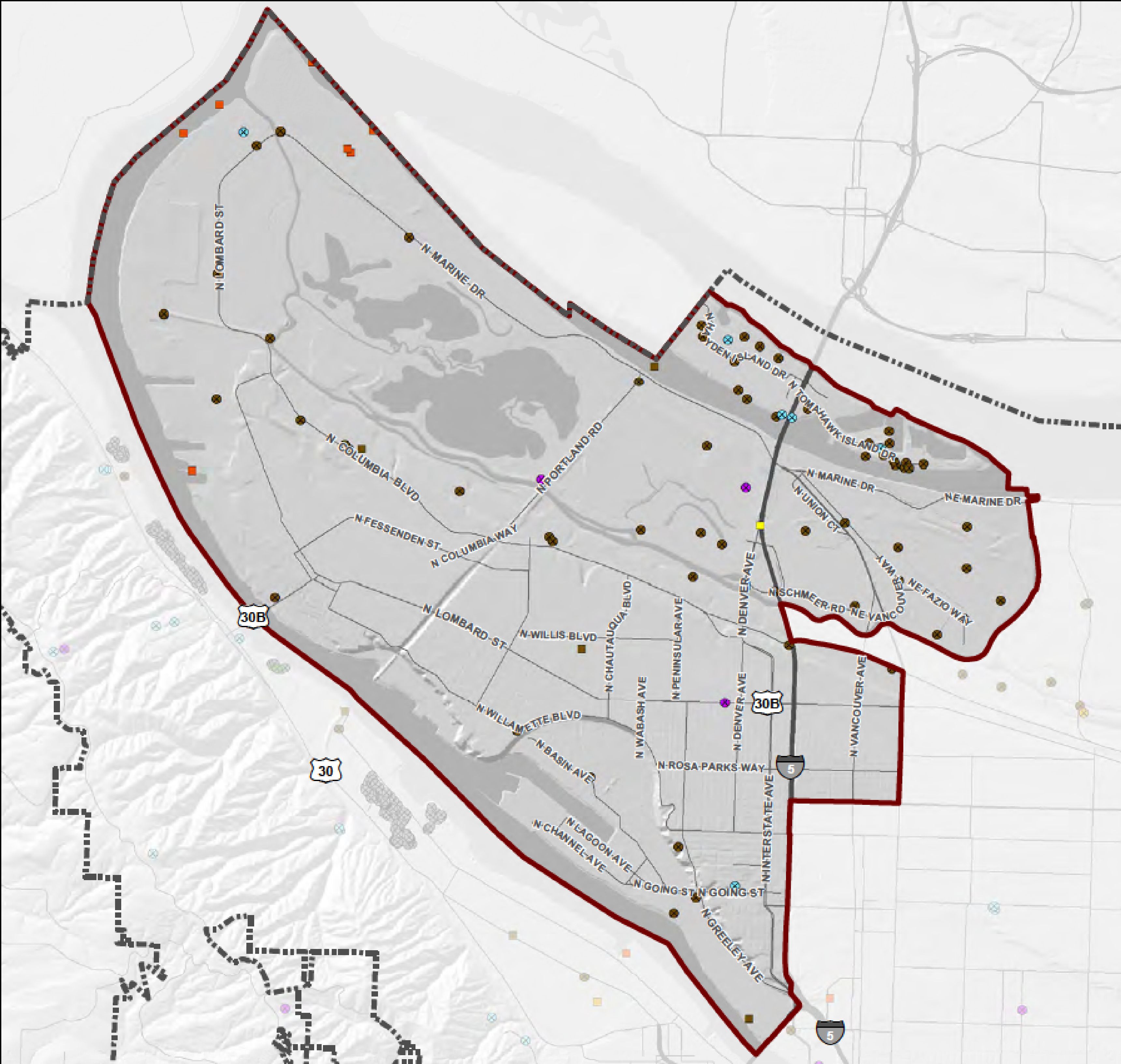
37242

PBEM

September 12, 2016

Mitigation Action Plan (MAP)

Critical Infrastructure



Legend

City Boundary

Risk Reporting Area North Portland

Utility Systems*

- Electrical
- Natural Gas Facilities
- Communication Facilities
- Petroleum Facilities
- Potable Water Facilities
- Wastewater Facilities

Transportation Systems*

- Railway Tunnels, Bridges, and Facilities
- Light Rail Tunnels, Bridges, and Facilities
- Highway Tunnels and Bridges
- Bus Facilities
- Port and Airport Facilities

*Due to security reasons, some utility and transportation system components have been left off of the map.

NORTH

0 0.4 0.8 Miles

Sources: TriMet-2015; Port of Portland-2015; OPHS-2016; City of Portland-2011, 2015,2016; OPB-2016; PTS-2015; FEMA-2015; Kinder Morgan-2015

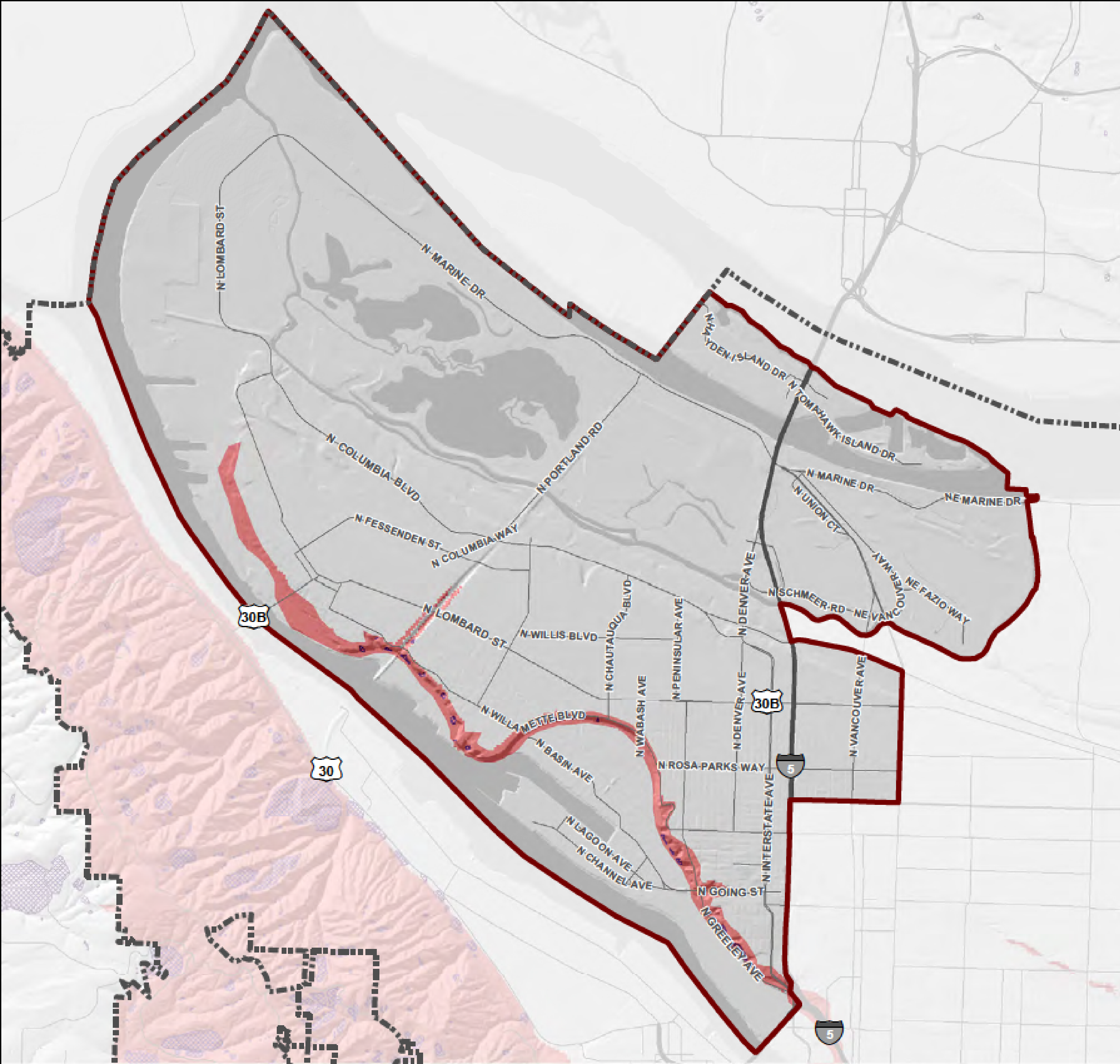
37242

PBEM

September 12, 2016

Mitigation Action Plan (MAP)

Regulatory Landslide Hazard Area



Legend

- City Boundary
- Historic Landslide Deposits
- Landslide Hazard Area
- Risk Reporting Area North Portland

NORTH

0 0.4 0.8 Miles

Sources: DOGAMI-2015;
City of Portland-2015, 2016

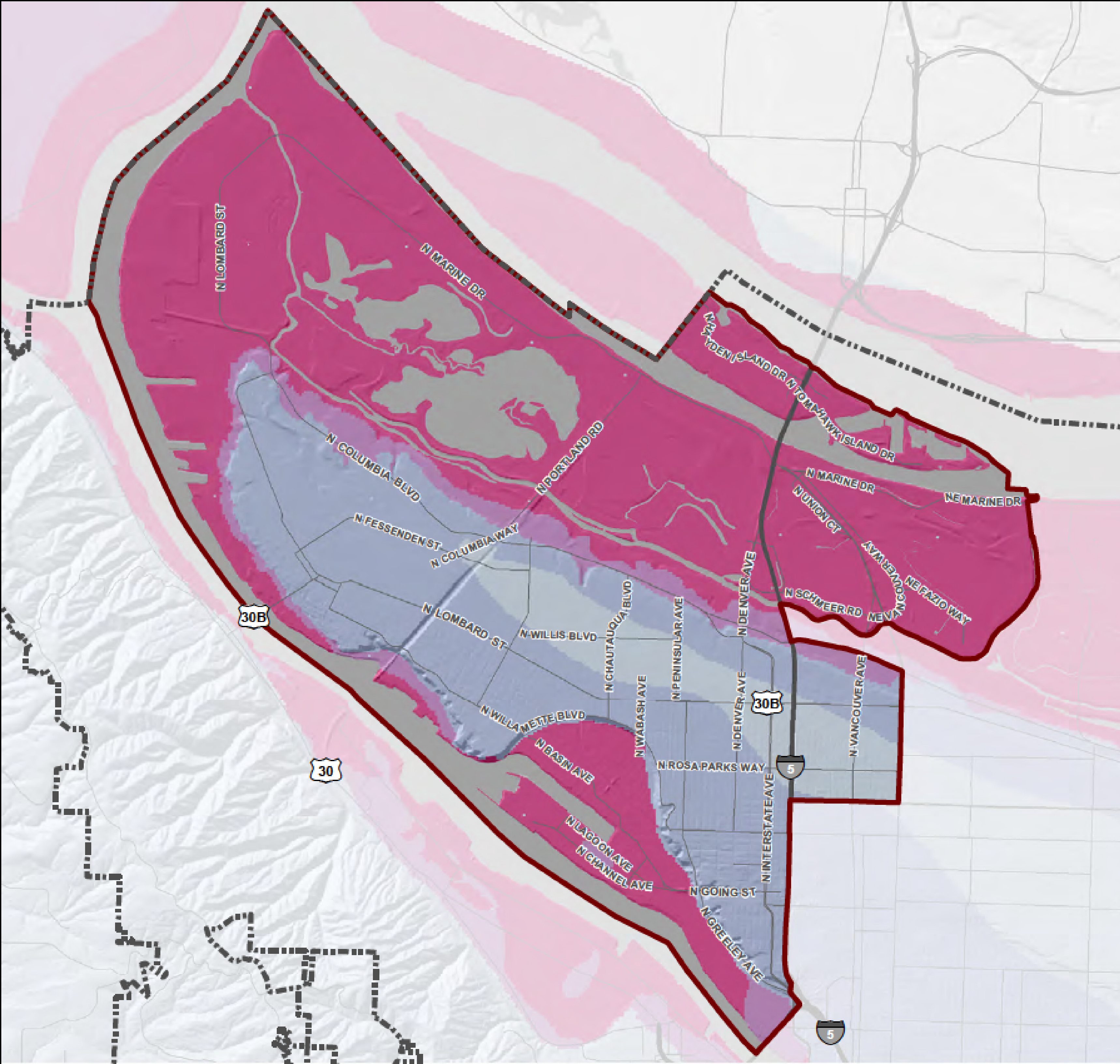
37242

PBEM

September 12, 2016

Mitigation Action Plan (MAP)

Liquefaction Susceptibility



Legend

City Boundary

Liquefaction Susceptibility

Type

- 0 – None
- 1 – Very Low
- 2 – Low
- 3 – Moderate
- 4 – High
- 5 – Very High

Risk Reporting Area North Portland

NORTH

0 0.4 0.8 Miles

Sources: DOGAMI-2013; City of Portland-2016

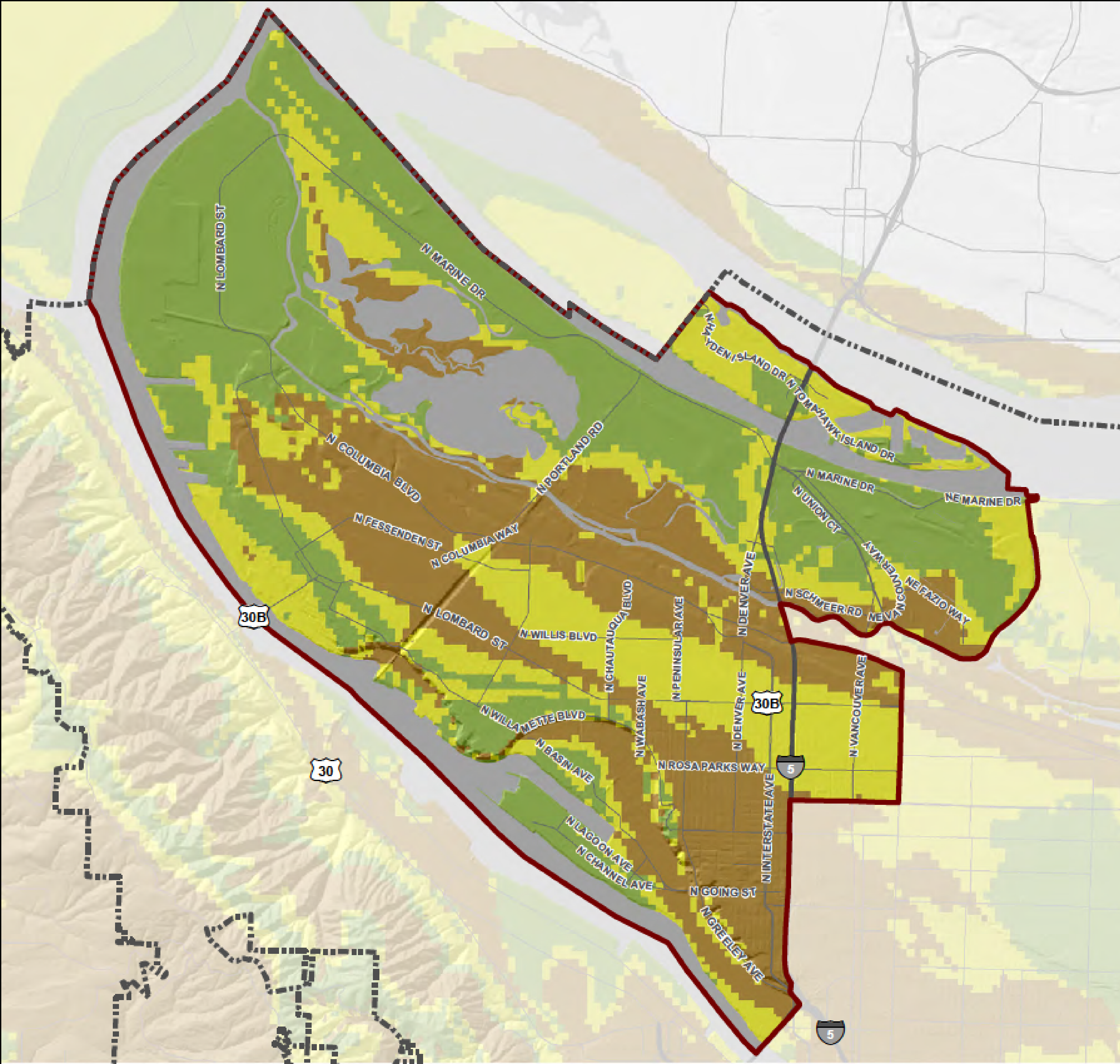
37242

PBEM

September 12, 2016

Mitigation Action Plan (MAP)

National Earthquake Hazards Reduction Program Soils



Legend

City Boundary

NEHRP Soils

Type

- B
- C
- D
- E

Risk Reporting Area North Portland

NORTH

0 0.4 0.8 Miles

Sources: DOGAMI-2012; City of Portland-2016

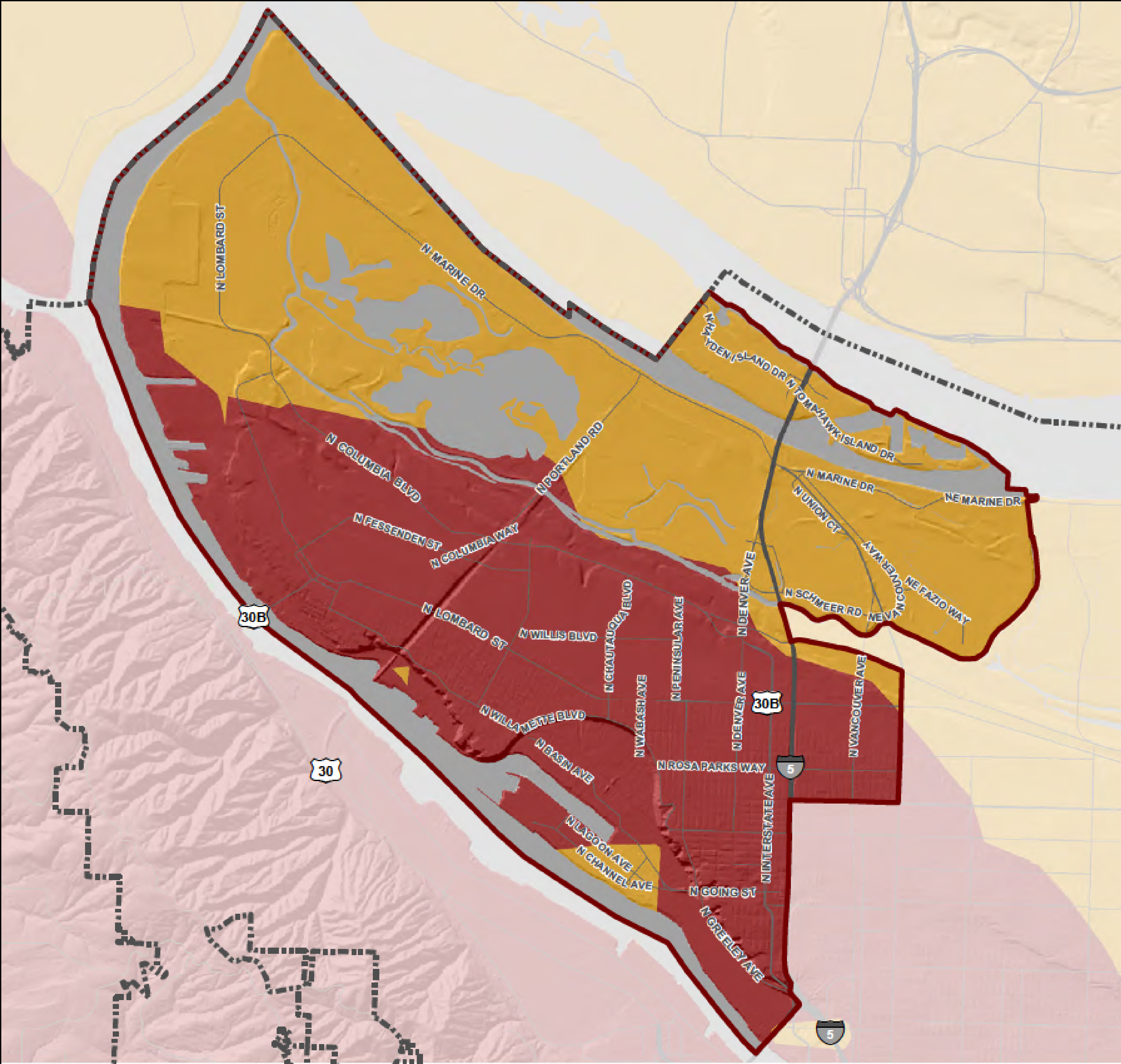
37242

PBEM

September 12, 2016

Mitigation Action Plan (MAP)

Portland Hills 6.5 Magnitude Earthquake- Peak Ground Acceleration



Legend

City Boundary

Portland Hills M6.5 earthquake PGA

Potential Damage - Perceived Shaking

- V -- Very Light - Moderate
- VI -- Light - Strong
- VII -- Moderate - Very Strong
- VIII -- Moderate/Heavy - Severe

Risk Reporting Area North Portland

NORTH

0 0.4 0.8 Miles

Sources: USGS-2009; City of Portland-2016

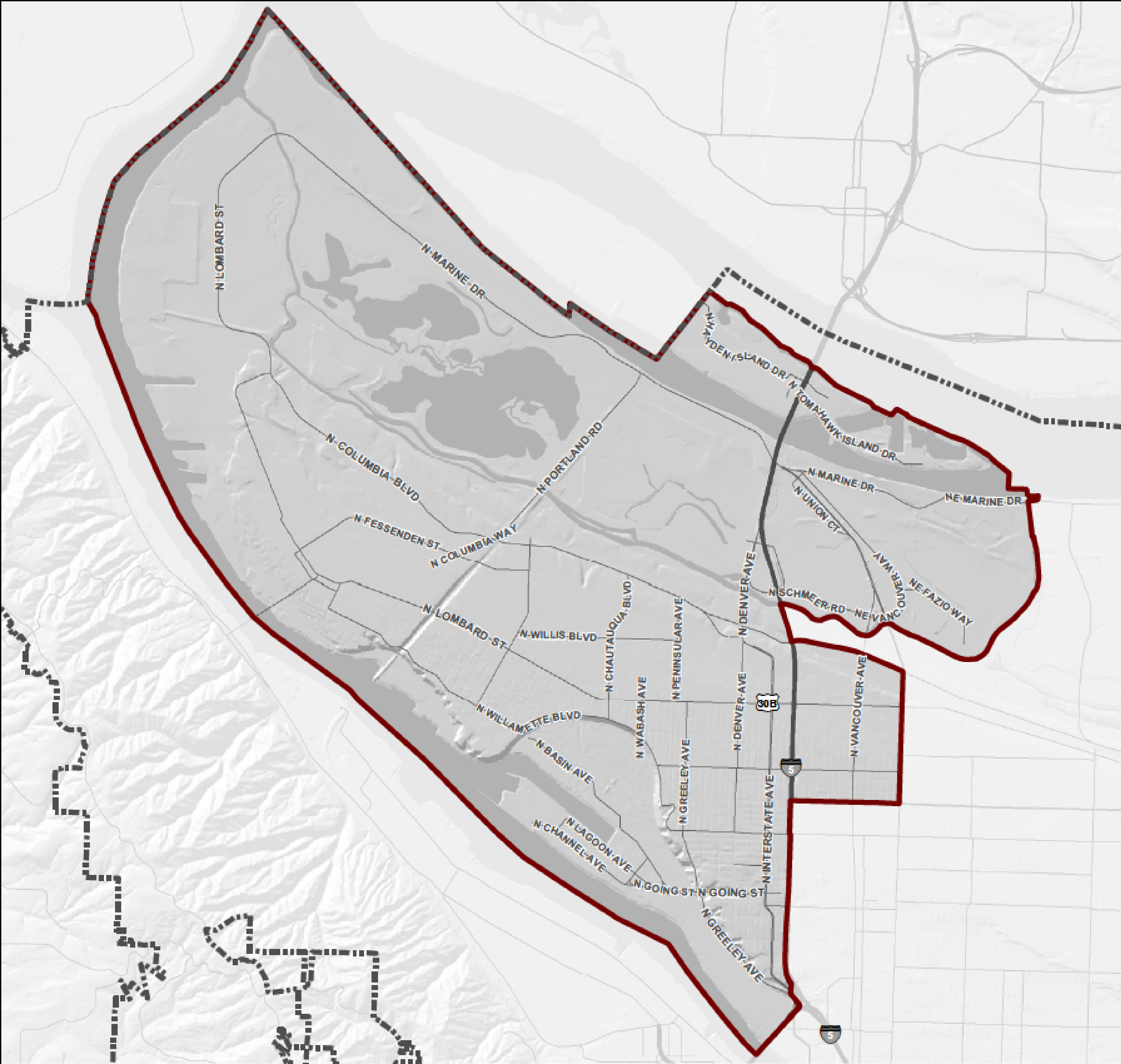
37242

PBEM

September 12, 2016

Mitigation Action Plan (MAP)

Volcano Hazard Area



Legend

City Boundary

Volcano Hazard Area

Risk Reporting Area North Portland

NORTH

0 0.4 0.8 Miles

Sources: USGS-1997;
City of Portland-2016

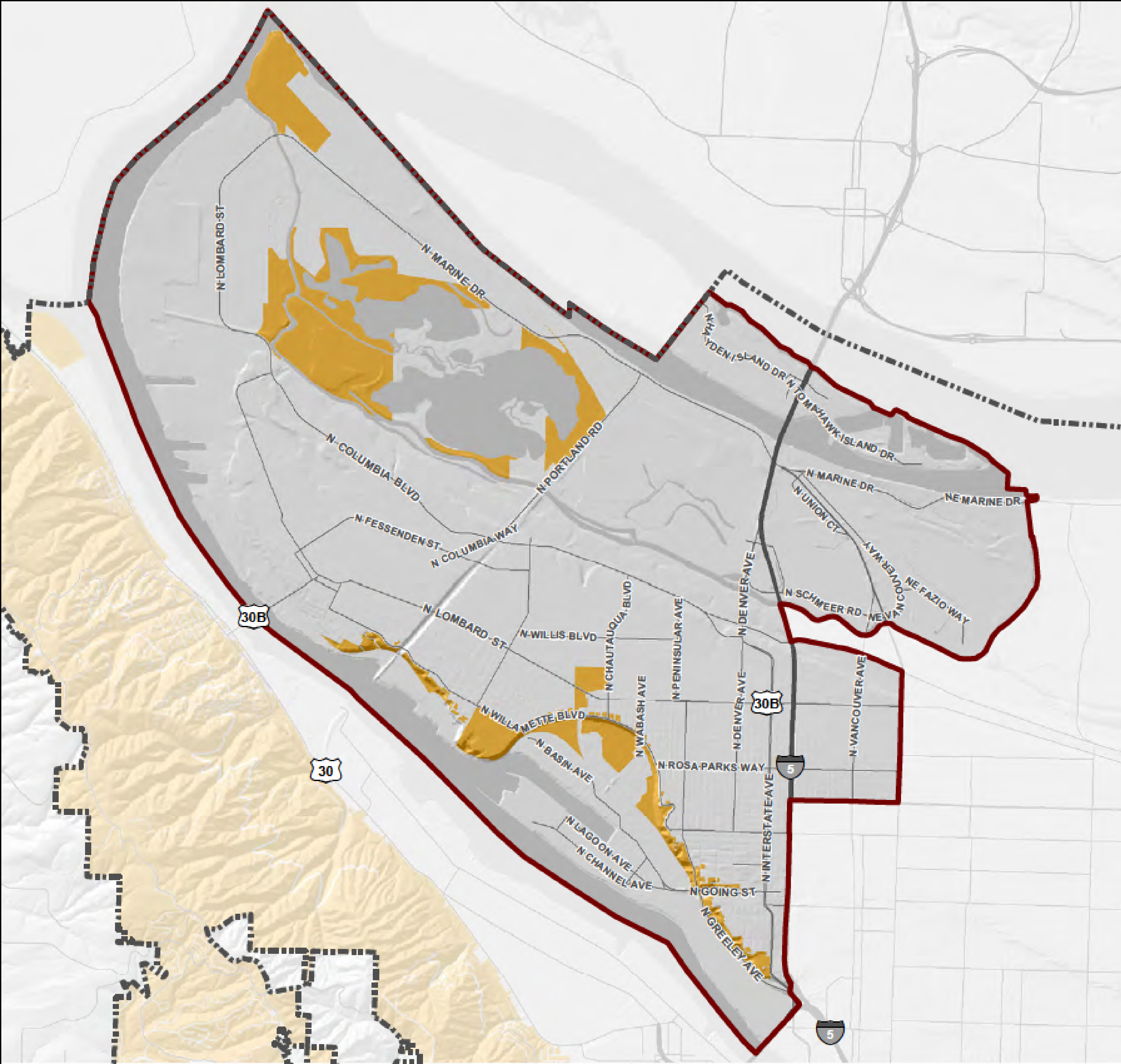
37242

PBEM

September 12, 2016

Mitigation Action Plan (MAP)

Wildfire Hazard Area



Legend

- City Boundary
- Wildfire Hazard Area
- Risk Reporting Area North Portland

NORTH

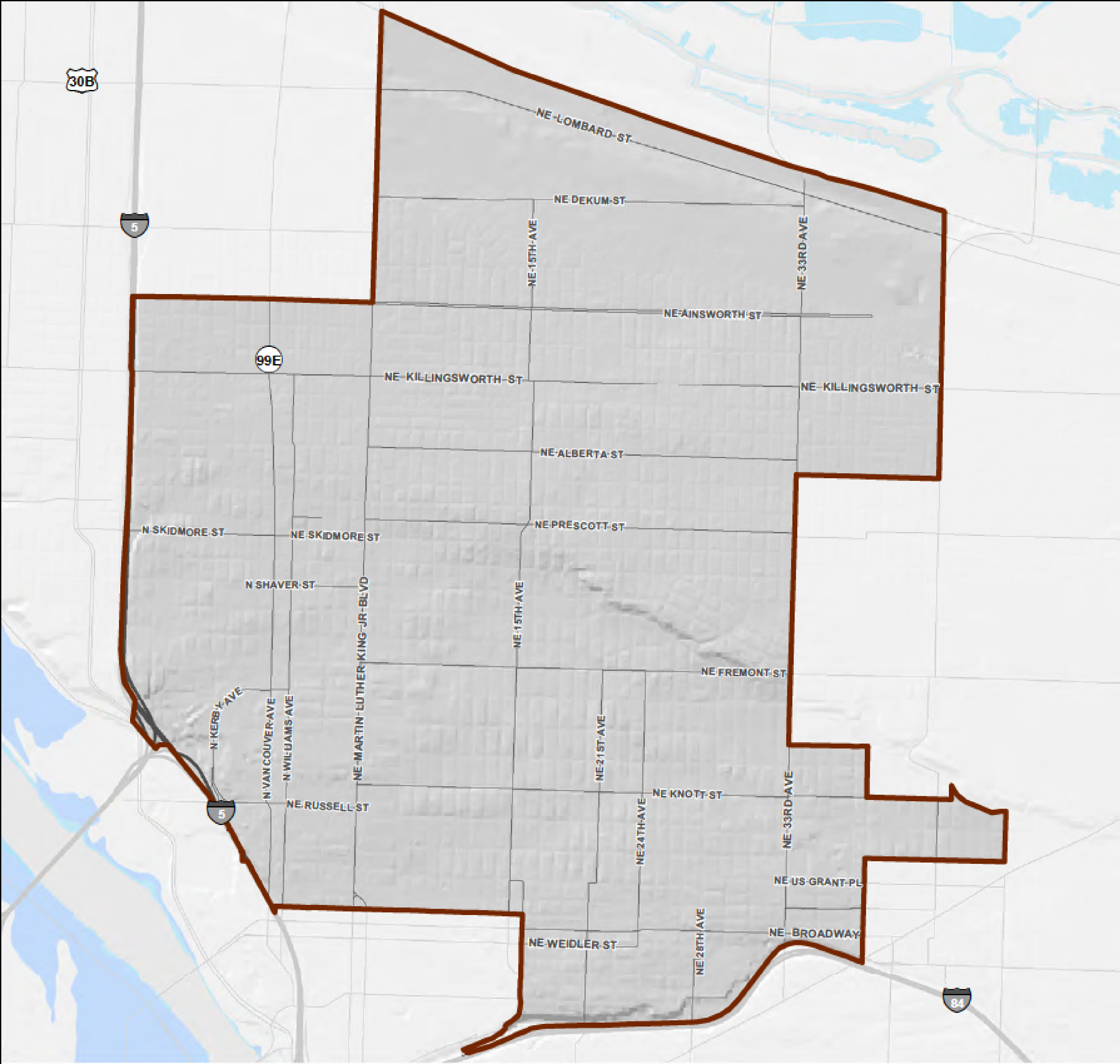
0 0.4 0.8 Miles

Sources: City of Portland-2002, 2016

37242

PBEM

NORTHEAST



September 12, 2016

Mitigation Action Plan (MAP)

Flood hazard - 100-yr and 500-yr FEMA flood zone

Legend

- City Boundary
- 100-year FEMA flood zone
- 500-year FEMA flood zone
- Risk Reporting Area Northeast

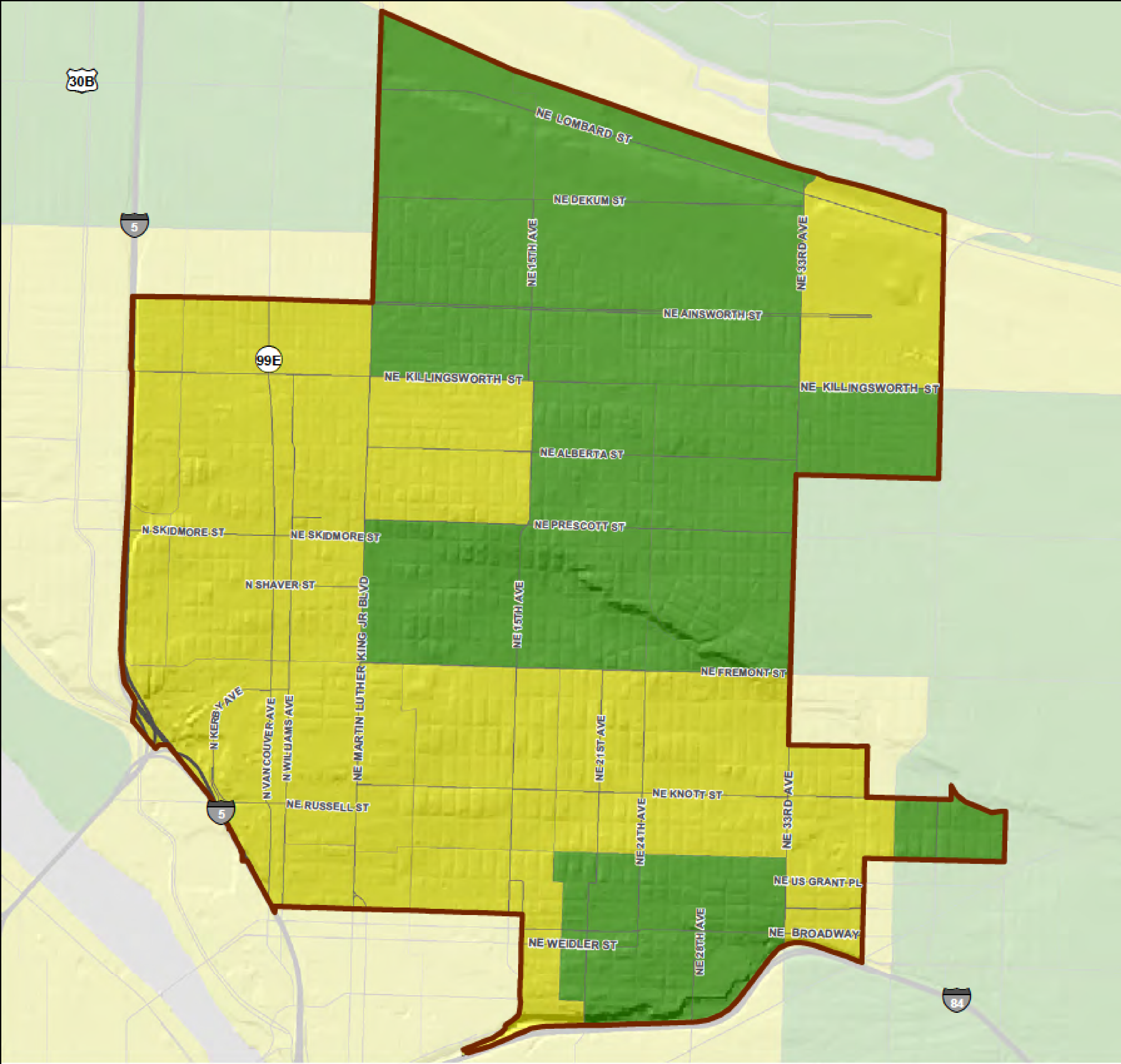
NORTH

0 0.175 0.35 Miles

Sources: FEMA-2014; City of Portland-2016

37242

PBEM



September 12, 2016

Mitigation Action Plan (MAP)

100-year Probabilistic Earthquake--Peak Ground Acceleration

Legend

City Boundary

100-year probabilistic earthquake PGA

Potential Damage - Perceived Shaking

V -- Very Light - Moderate

VI -- Light - Strong

Risk Reporting Area Northeast

NORTH

0 0.175 0.35 Miles

Sources: FEMA-2015; City of Portland-2016

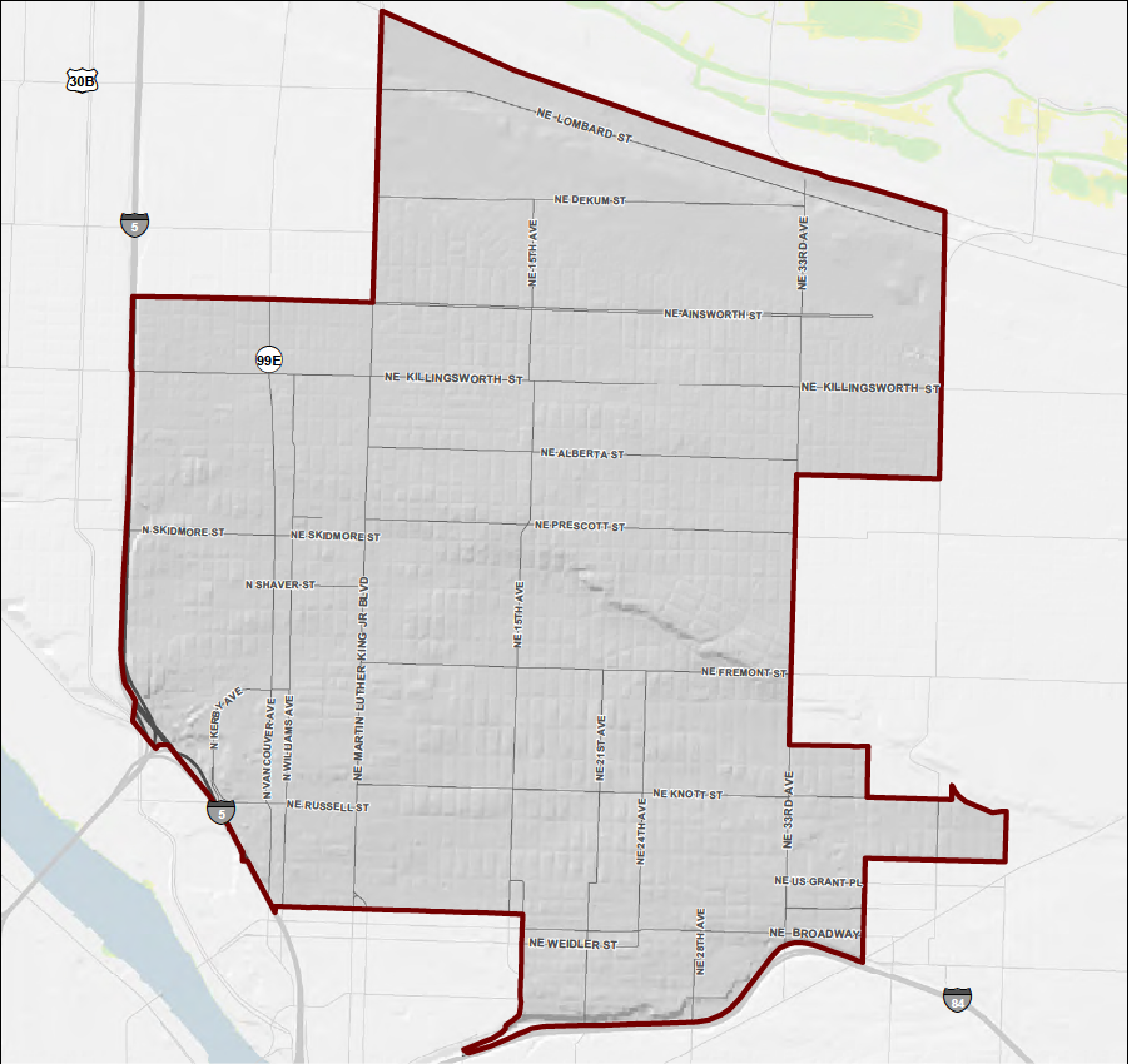
37242

PBEM

September 12, 2016

Mitigation Action Plan (MAP)

Flood Hazard - 100-yr Flood Depth Grid



Legend

City Boundary

100-year flood depth grid

- 0.1' - 4.5'
- 4.6' - 11.5'
- 11.6' - 19.5'
- 19.6' - 25.9'
- 26' - 33.2'

Risk Reporting Area Northeast

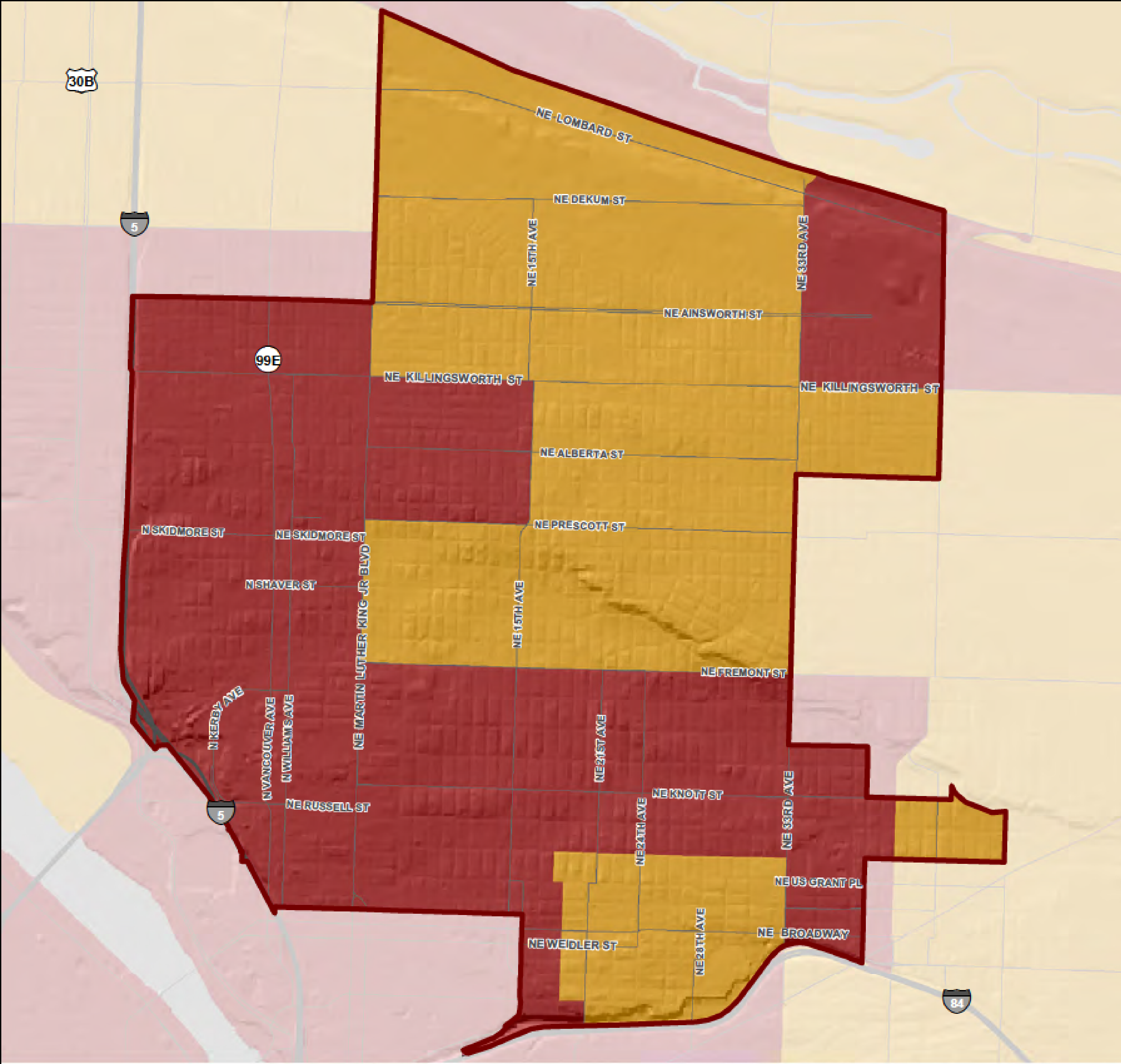
NORTH

0 0.175 0.35 Miles

Sources: Tetra Tech-2016; City of Portland-2016

37242

PBEM



September 12, 2016

Mitigation Action Plan (MAP)

500-year Probabilistic Earthquake--Peak Ground Acceleration

Legend

City Boundary

500-year probabilistic earthquake PGA

Potential Damage - Perceived Shaking

VI -- Light - Strong

VII -- Moderate - Very Strong

VIII -- Moderate/Heavy - Severe

Risk Reporting Area Northeast

NORTH

0 0.2 0.4 Miles

Sources: FEMA-2015; City of Portland-2016

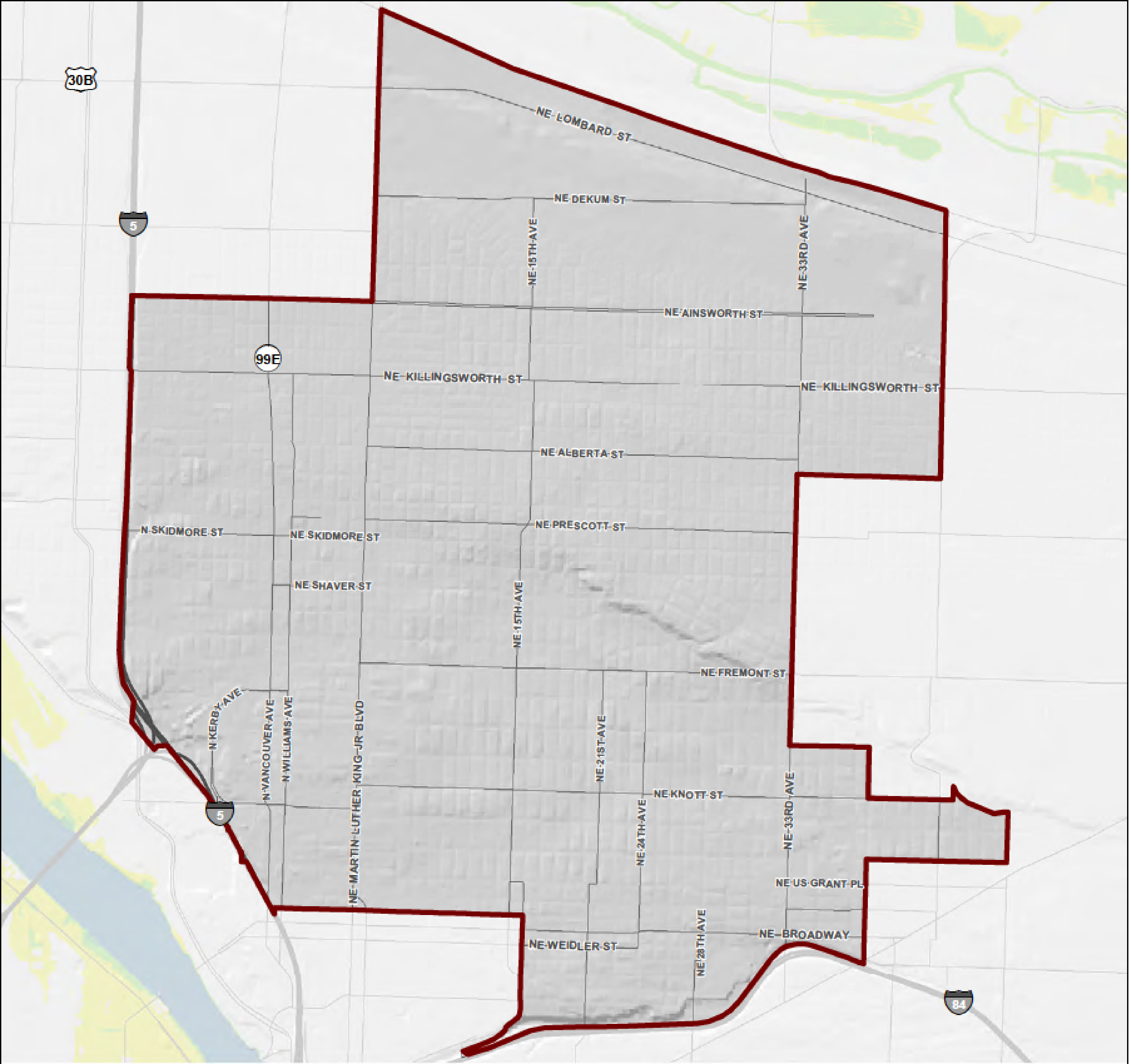
37242

PBEM

September 12, 2016

Mitigation Action Plan (MAP)

Flood Hazard - 500-yr Flood Depth Grid



Legend

City Boundary

500-year flood depth grid

- 0' - 4.6'
- 4.7' - 12.9'
- 13' - 22.6'
- 22.7' - 28.8'
- 28.9' - 36.7'

Risk Reporting Area Northeast

NORTH

0 0.225 0.45 Miles

Sources: Tetra Tech-2016; City of Portland-2016

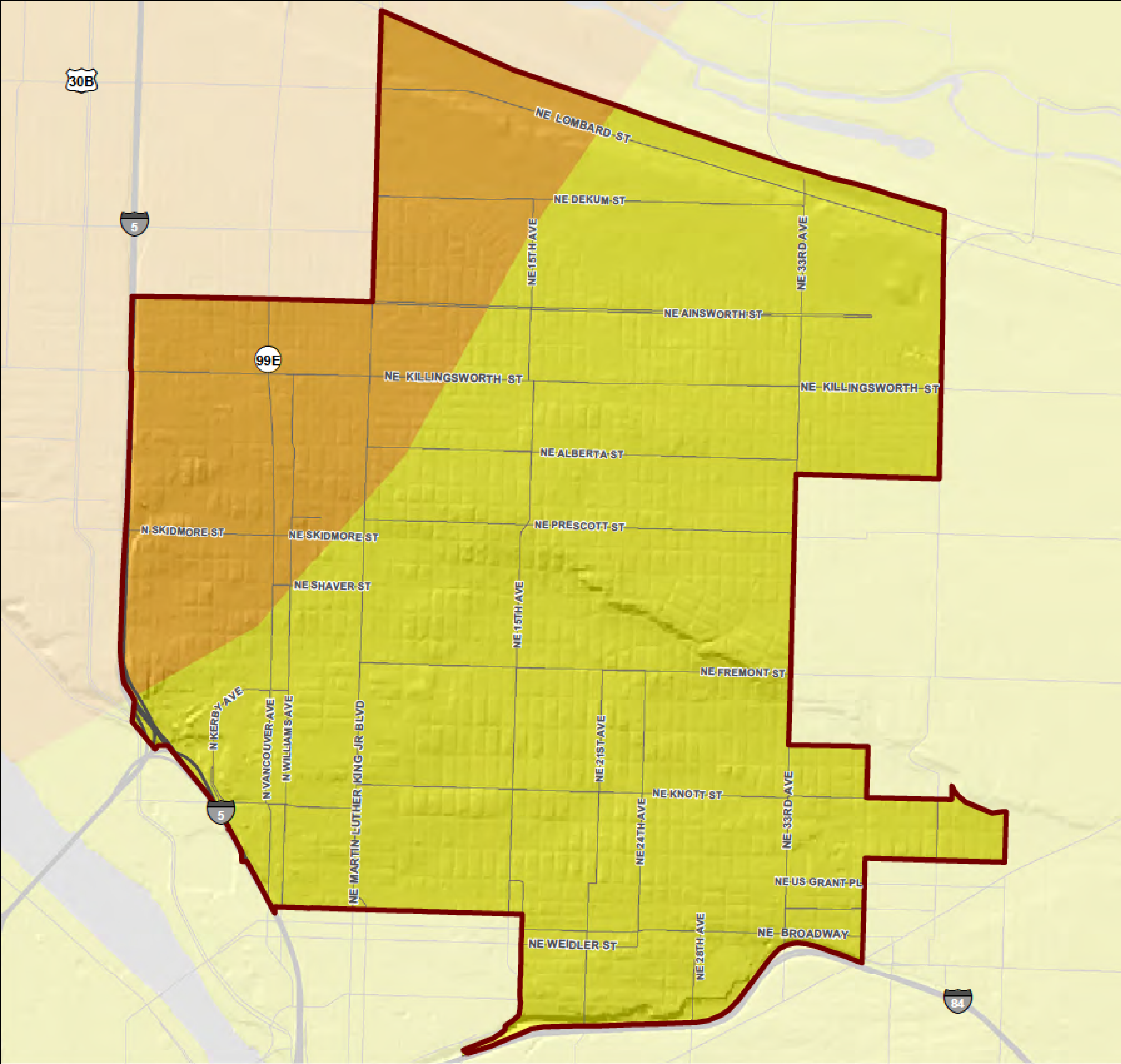
37242

PBEM

September 12, 2016

Mitigation Action Plan (MAP)

Cascadia 9.0 Magnitude Earthquake--Peak Ground Acceleration



Legend

City Boundary

Cascadia M9.0 earthquake PGA

Potential Damage - Perceived Shaking

- V – Very Light - Moderate
- VI – Light - Strong
- VII – Moderate - Very Strong
- VIII -- Moderate/Heavy - Severe

Risk Reporting Area Northeast

NORTH

0 0.175 0.35 Miles

Sources: USGS-2011; City of Portland-2016

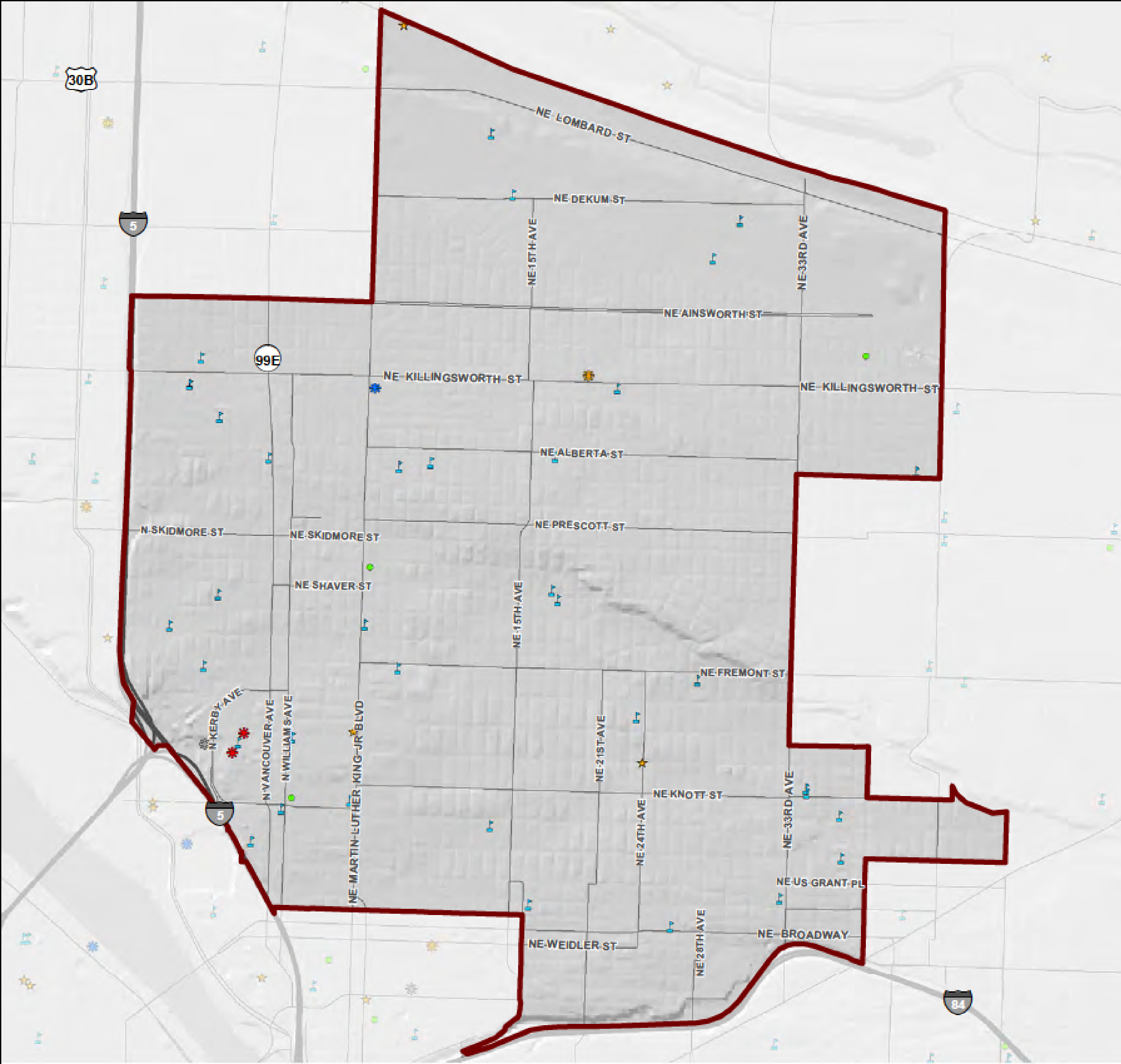
37242

PBEM

September 12, 2016

Mitigation Action Plan (MAP)

Critical Facilities



Legend

City Boundary

Risk Reporting Area Northeast

Emergency Services*

- Emergency Coordination Centers
- Fire Station Facilities
- Police Station Facilities
- Medical Care Facilities

High Potential Loss Facilities*

- Dams
- Military
- Nuclear Power Plants
- Hazardous Materials
- Schools
- Other Assets

Zoo, Jails, Nursing/Assisted Living Facilities

*Due to security reasons, some emergency services and high potential loss facilities have been left off of the map.

NORTH

0 0.175 0.35 Miles

Sources: WORD/NID-2015; OSFM-2015; City of Portland-2011, 2015, 2016

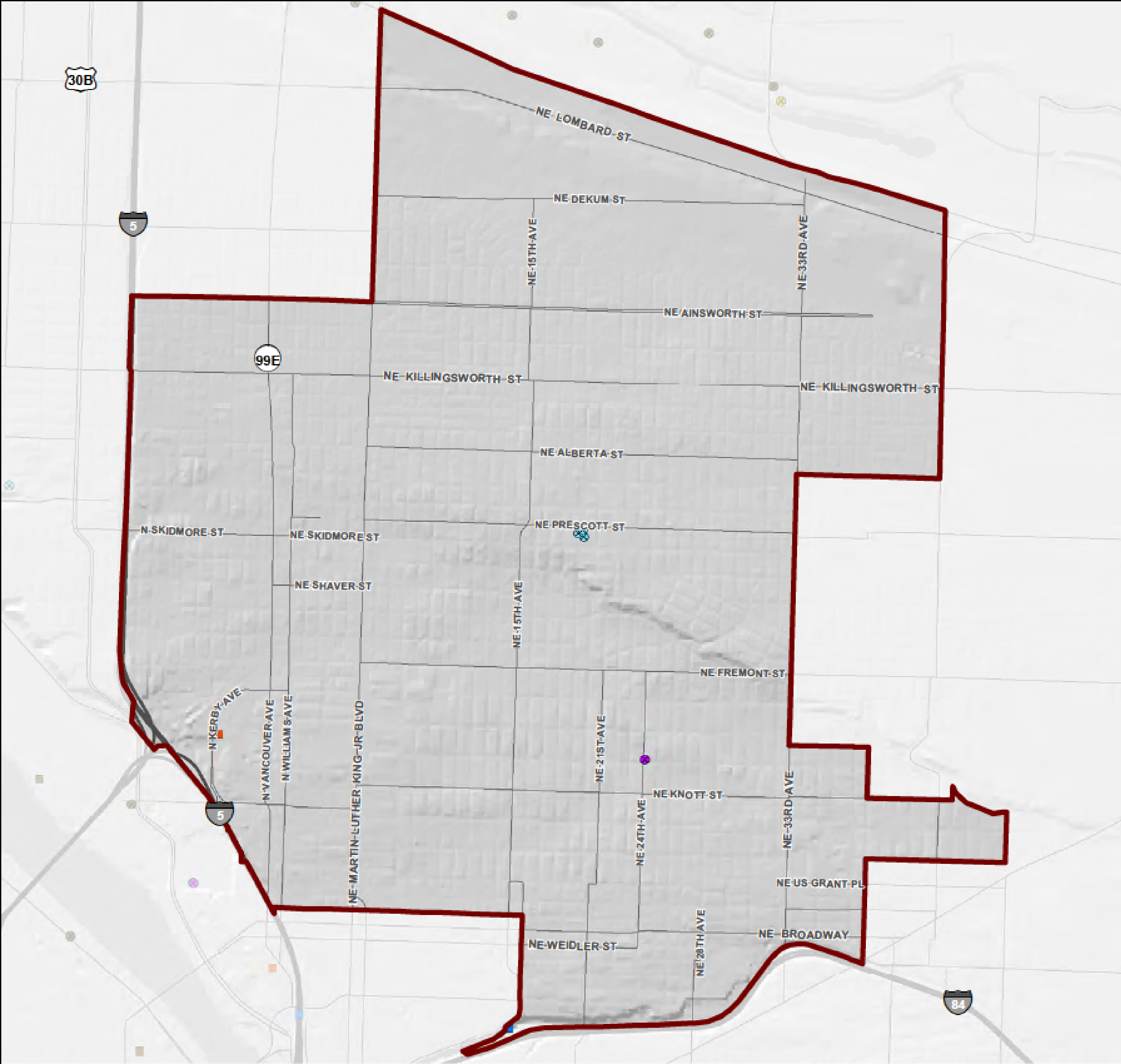
37242

PBEM

September 12, 2016

Mitigation Action Plan (MAP)

Critical Infrastructure



Legend

City Boundary
Risk Reporting Area Northeast

Utility Systems*

- Electrical
- Natural Gas Facilities
- Communication Facilities
- Petroleum Facilities
- Potable Water Facilities
- Wastewater Facilities

Transportation Systems*

- Railway Tunnels, Bridges, and Facilities
- Light Rail Tunnels, Bridges, and Facilities
- Highway Tunnels and Bridges
- Bus Facilities
- Port and Airport Facilities

*Due to security reasons, some utility and transportation system components have been left off of the map.

NORTH

0 0.175 0.35 Miles

Sources: TriMet-2015; Port of Portland-2015; OPHS-2016; City of Portland-2011, 2015,2016; OPB-2016; PTS-2015; FEMA-2015; Kinder Morgan-2015

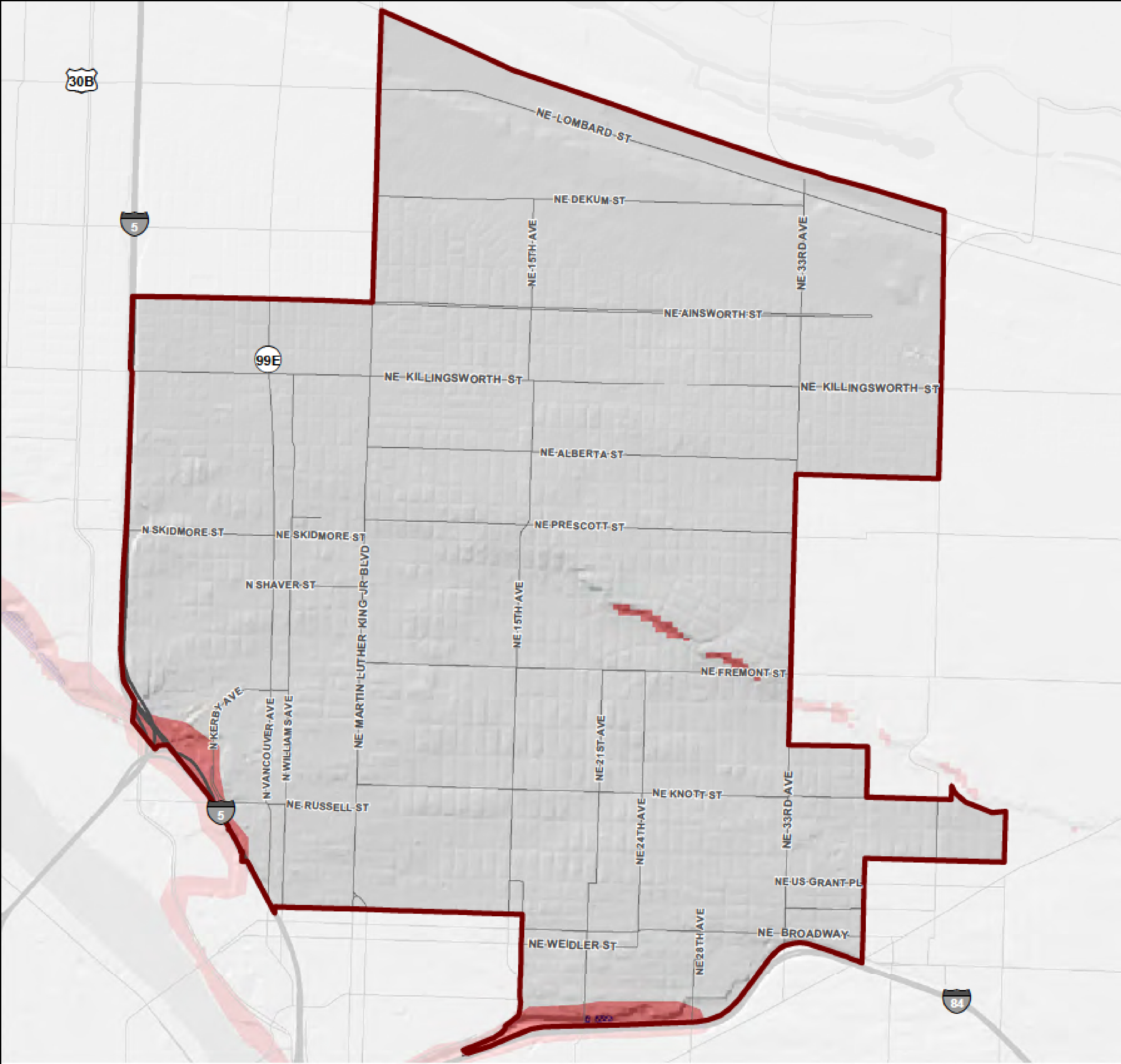
37242

PBEM

September 12, 2016

Mitigation Action Plan (MAP)

Regulatory Landslide Hazard Area



Legend

City Boundary

Historic Landslide Deposits

Landslide Hazard Area

Risk Reporting Area Northeast

NORTH

0 0.175 0.35 Miles

Sources: DOGAMI-2015; City of Portland-2015, 2016

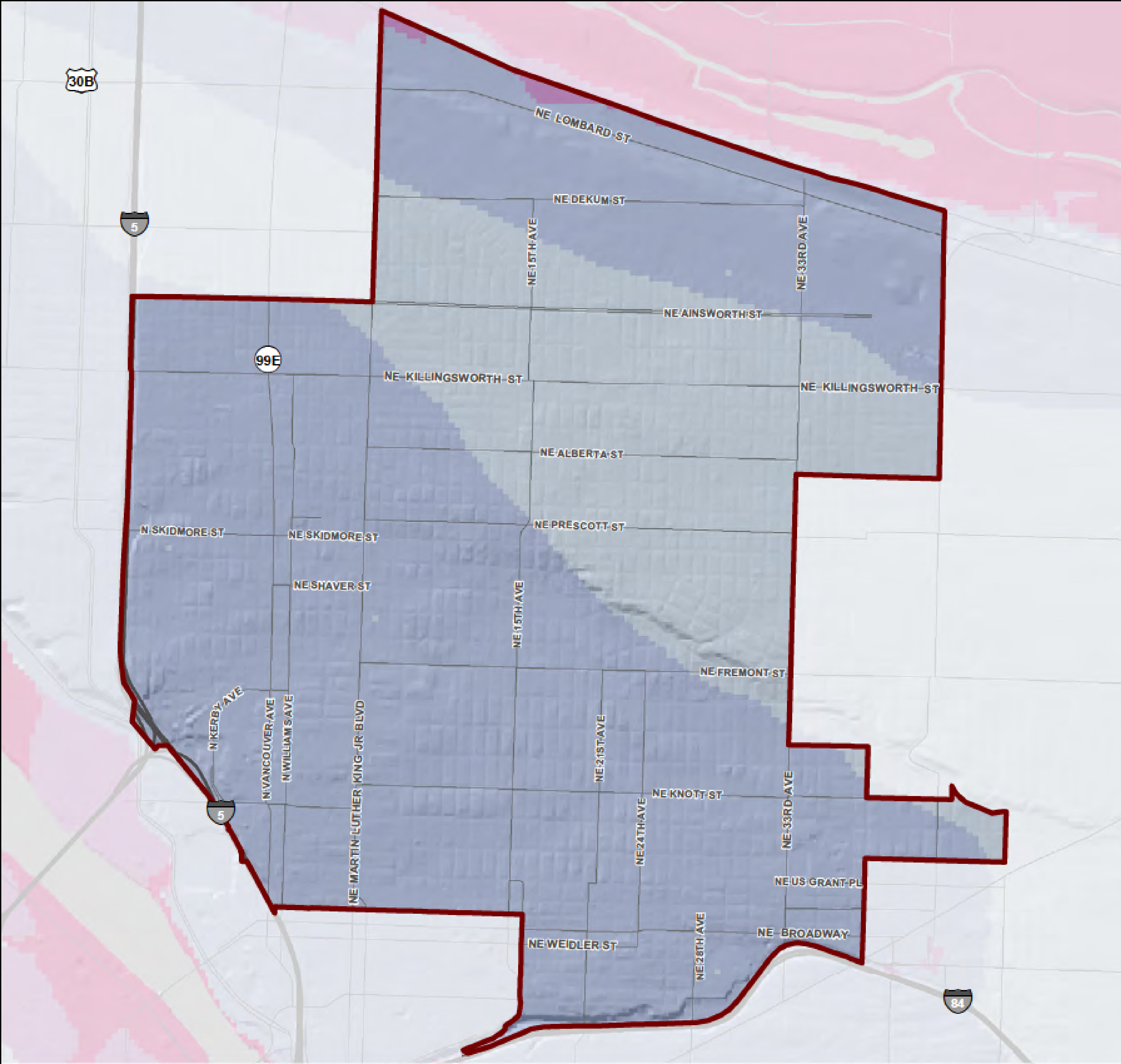
37242

PBEM

September 12, 2016

Mitigation Action Plan (MAP)

Liquefaction Susceptibility



Legend

City Boundary

Liquefaction Susceptibility

Type

- 0 – None
- 1 – Very Low
- 2 – Low
- 3 – Moderate
- 4 – High
- 5 – Very High

Risk Reporting Area Northeast

NORTH

0 0.175 0.35 Miles

Sources: DOGAMI-2013; City of Portland-2016

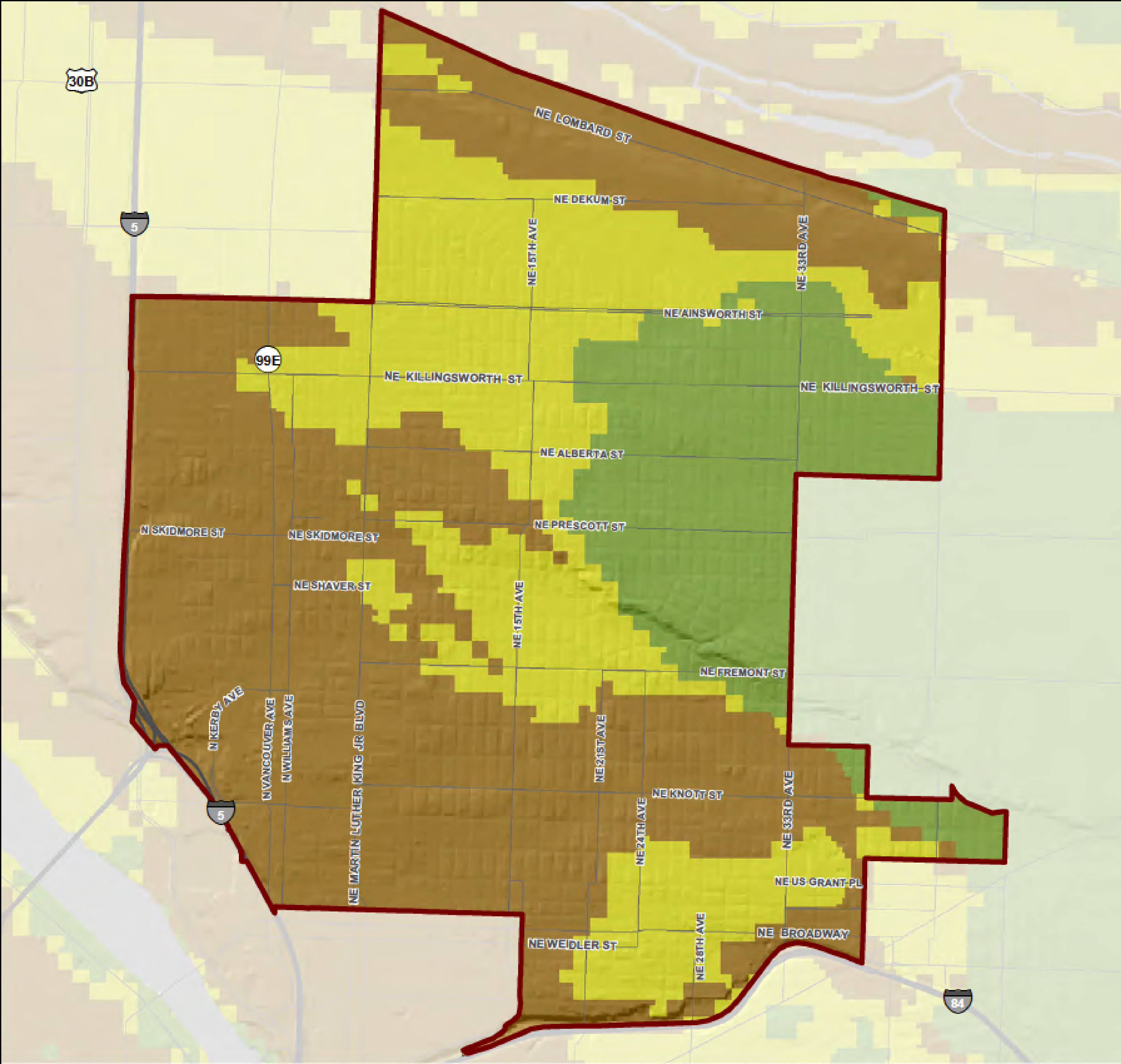
37242

PBEM

September 12, 2016

Mitigation Action Plan (MAP)

National Earthquake Hazards Reduction Program Soils



Legend

City Boundary

NEHRP Soils

Type

B

C

D

E

Risk Reporting Area Northeast

NORTH

0 0.175 0.35 Miles

Sources: DOGAMI-2012; City of Portland-2016

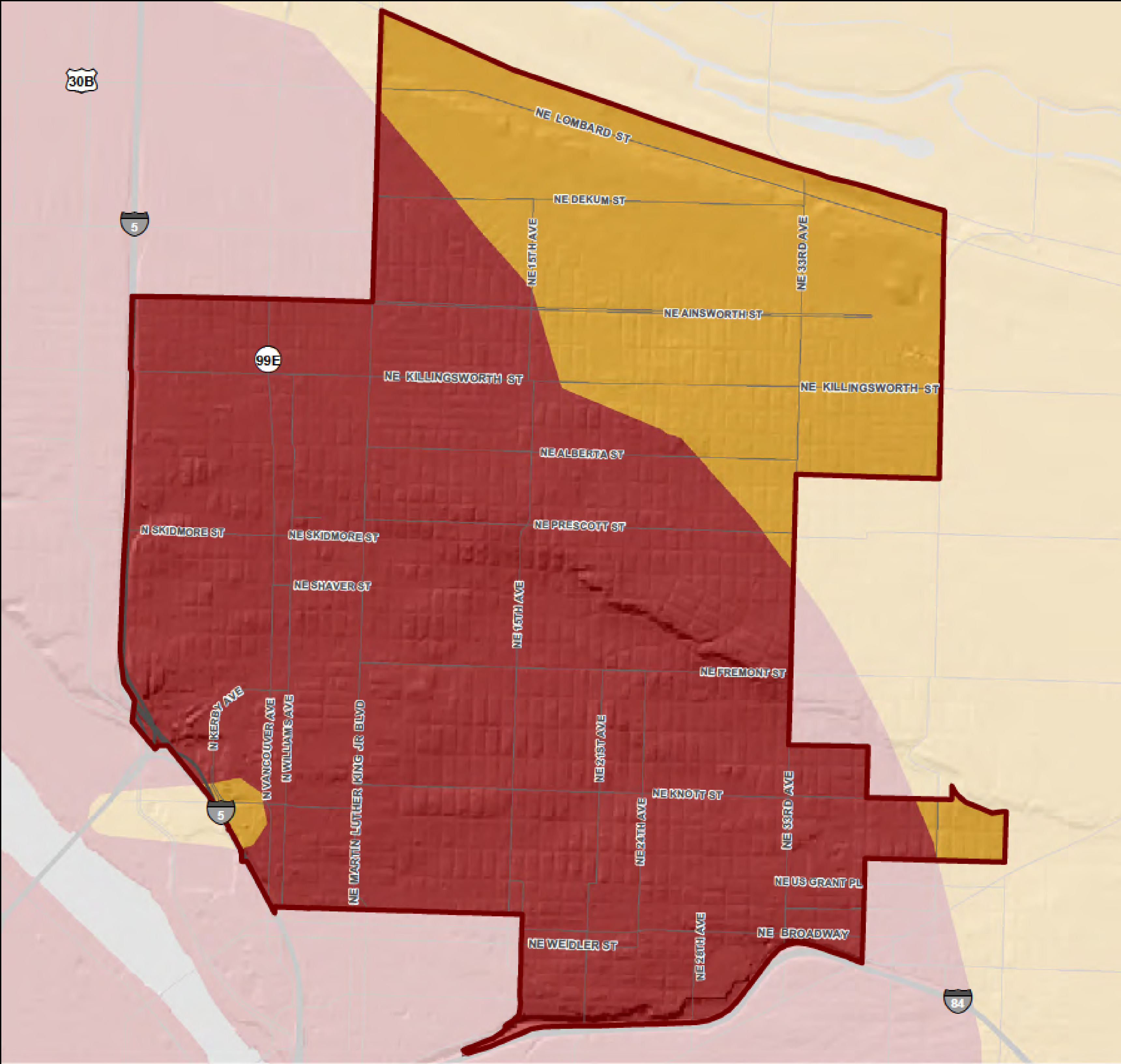
37242

PBEM

September 12, 2016

Mitigation Action Plan (MAP)

Portland Hills 6.5 Magnitude Earthquake-Peak Ground Acceleration



Legend

City Boundary

Portland Hills M6.5 earthquake PGA

Potential Damage - Perceived Shaking

V -- Very Light - Moderate

VI -- Light - Strong

VII -- Moderate - Very Strong

VIII -- Moderate/Heavy - Severe

Risk Reporting Area Northeast

NORTH

0 0.175 0.35 Miles

Sources: USGS-2009; City of Portland-2016

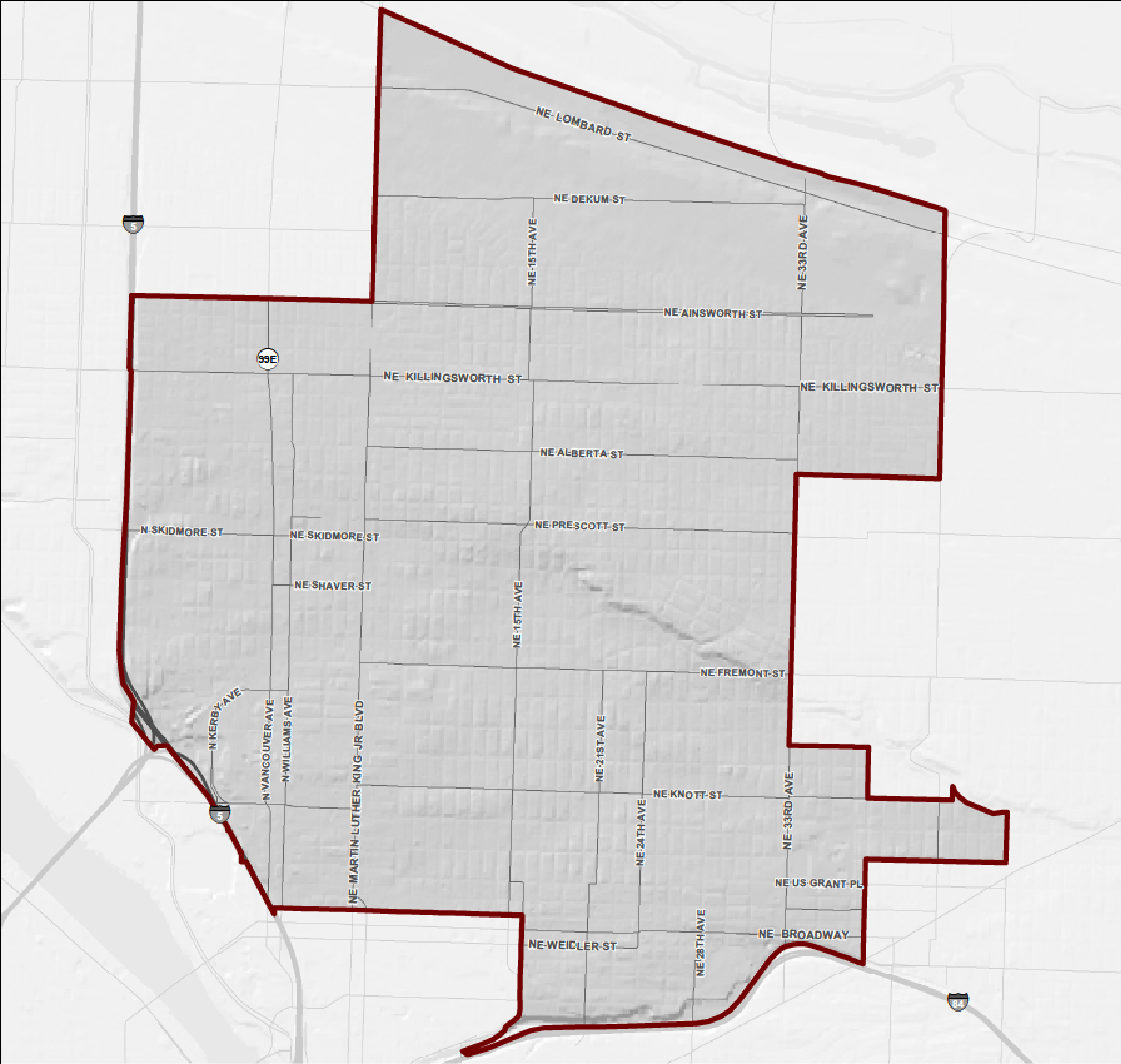
37242

PBEM

September 12, 2016

Mitigation Action Plan (MAP)

Volcano Hazard Area



Legend

City Boundary

Volcano Hazard Area

Risk Reporting Area Northeast

NORTH

0 0.175 0.35 Miles

Sources: USGS-1997;
City of Portland-2016

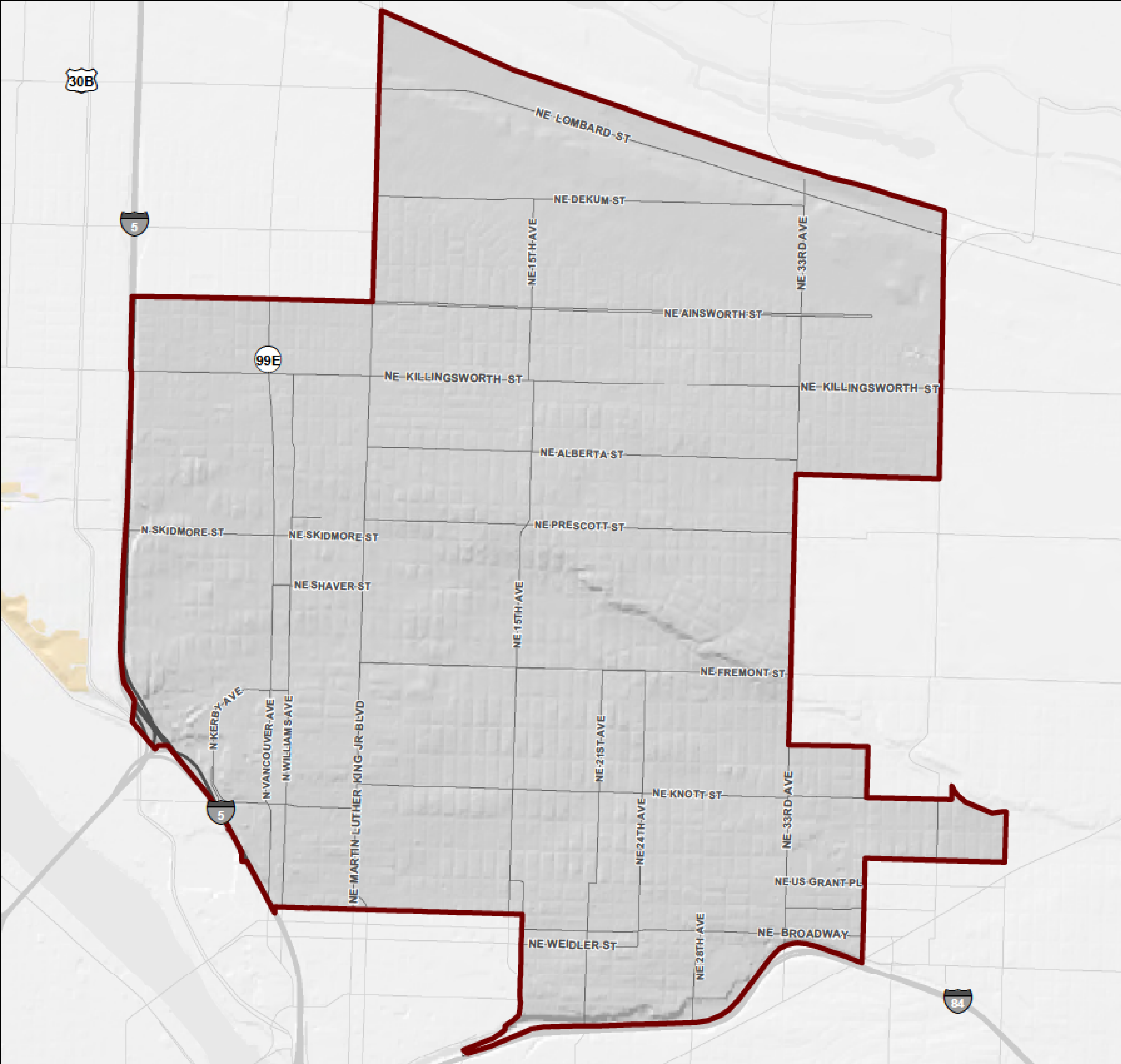
37242

PBEM

September 12, 2016

Mitigation Action Plan (MAP)

Wildfire Hazard Area



Legend

City Boundary

Wildfire Hazard Area

Risk Reporting Area Northeast

NORTH

0 0.175 0.35 Miles

Sources: City of Portland-2002, 2016

37242

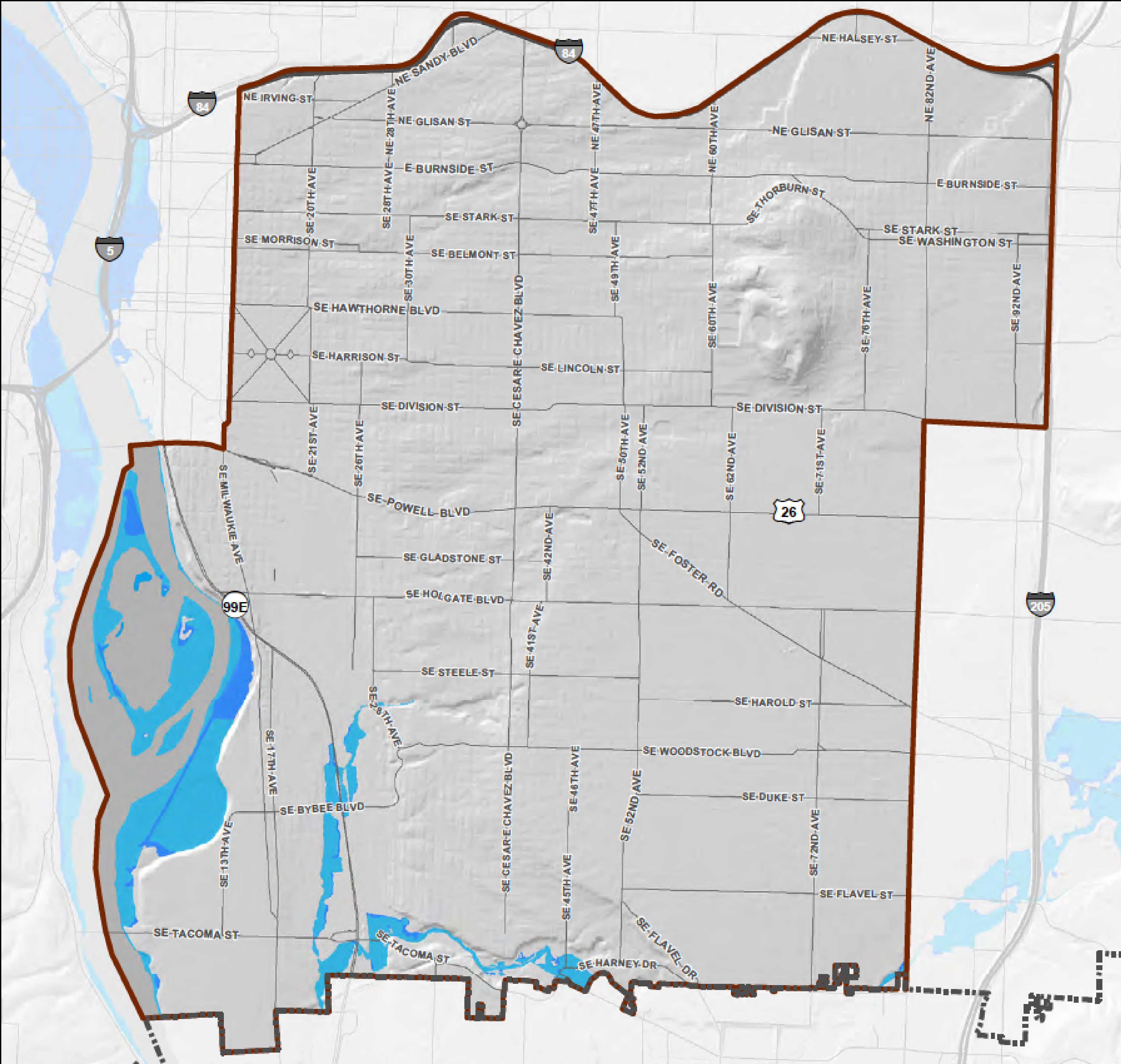
PBEM

SOUTHEAST

September 12, 2016

Mitigation Action Plan (MAP)

Flood hazard - 100-yr and 500-yr FEMA flood zone



Legend

- City Boundary
- 100-year FEMA flood zone
- 500-year FEMA flood zone
- Risk Reporting Area Southeast

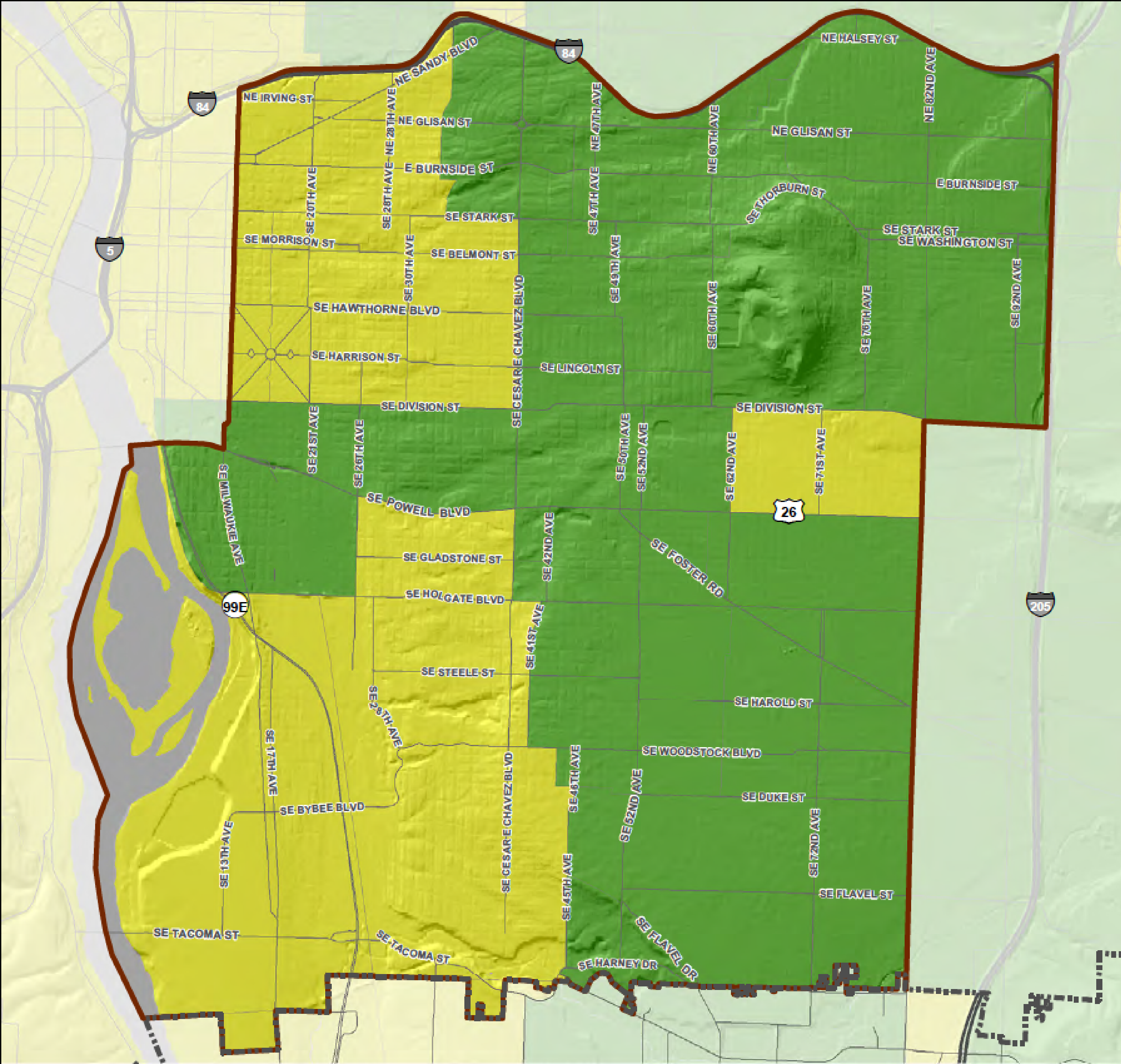
NORTH

0 0.275 0.55 Miles

Sources: FEMA-2014; City of Portland-2016

37242

PBEM



September 12, 2016

Mitigation Action Plan (MAP)

100-year Probabilistic Earthquake--Peak Ground Acceleration

Legend

City Boundary

100-year probabilistic earthquake PGA

Potential Damage - Perceived Shaking

V -- Very Light - Moderate

VI -- Light - Strong

Risk Reporting Area Southeast

NORTH

0 0.275 0.55 Miles

Sources: FEMA-2015; City of Portland-2016

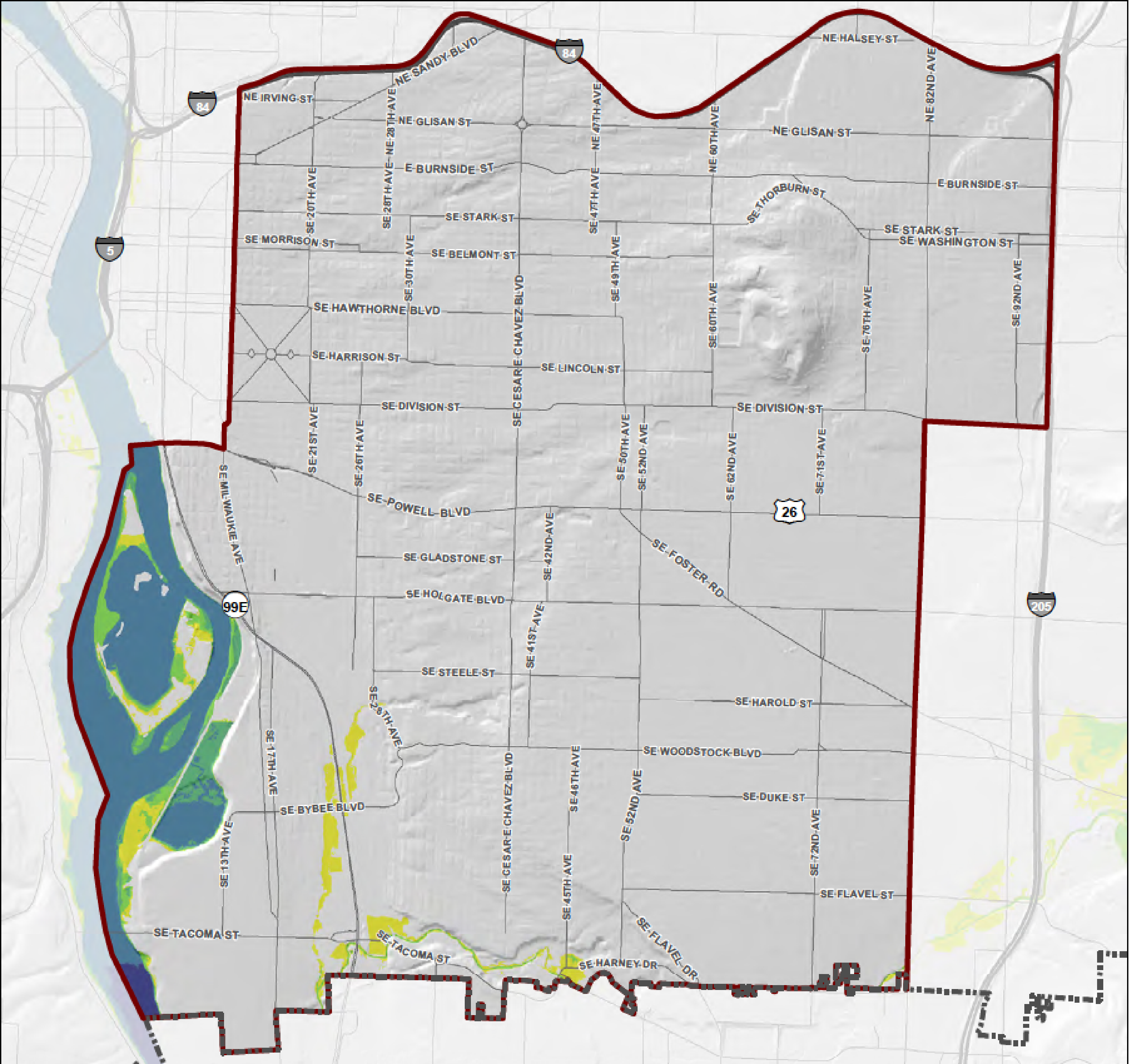
37242

PBEM

September 12, 2016

Mitigation Action Plan (MAP)

Flood Hazard - 100-yr Flood Depth Grid



Legend

- City Boundary
- 100-year flood depth grid
  - 0.1' - 4.5'
  - 4.6' - 11.5'
  - 11.6' - 19.5'
  - 19.6' - 25.9'
  - 26' - 33.2'
- Risk Reporting Area Southeast

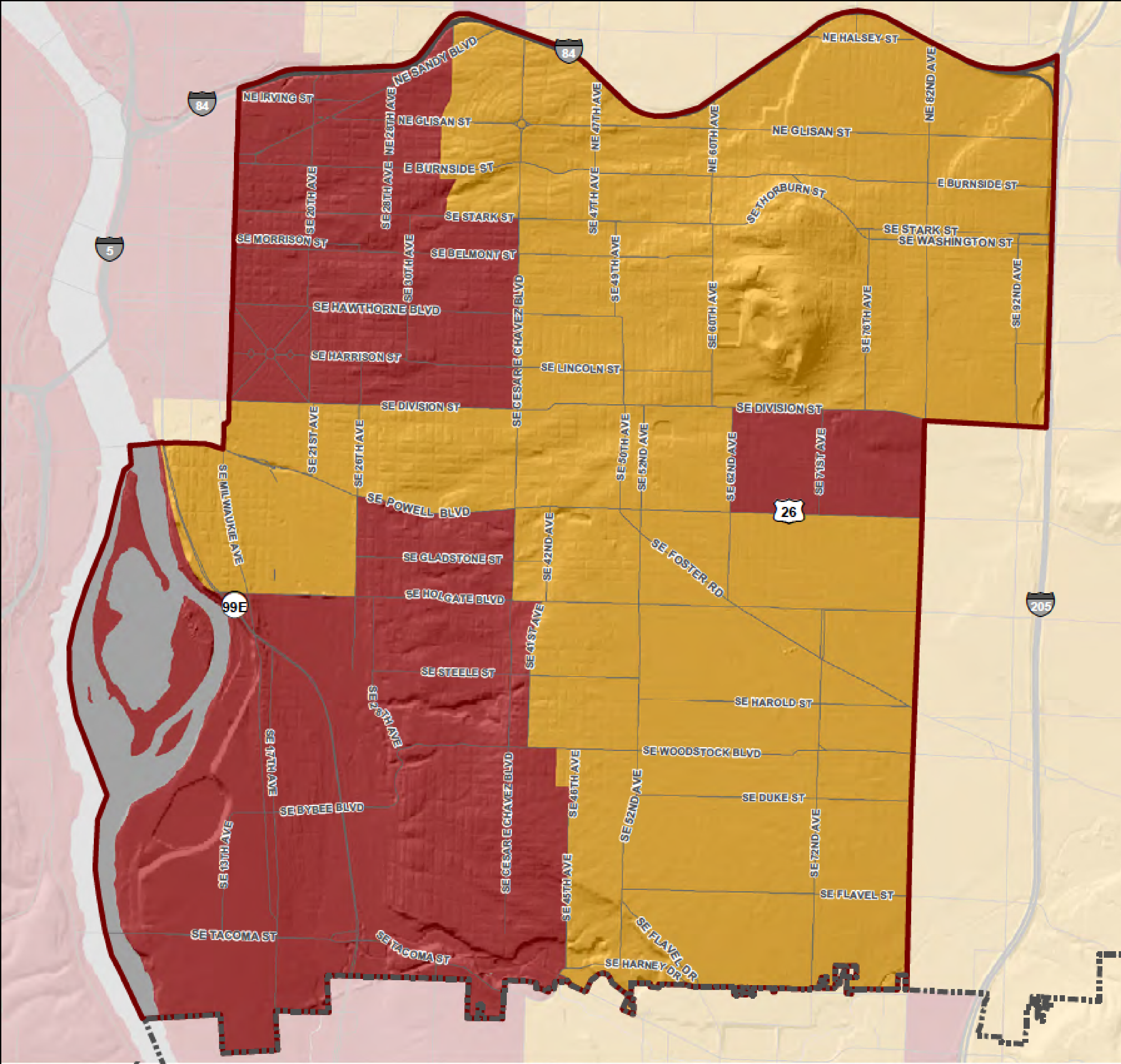
NORTH

0 0.275 0.55 Miles

Sources: Tetra Tech-2016; City of Portland-2016

37242

PBEM



September 12, 2016

Mitigation Action Plan (MAP)

500-year Probabilistic Earthquake--Peak Ground Acceleration

Legend

City Boundary

500-year probabilistic earthquake PGA

Potential Damage - Perceived Shaking

- VI -- Light - Strong
- VII -- Moderate - Very Strong
- VIII -- Moderate/Heavy - Severe

Risk Reporting Area Southeast

NORTH

0 0.3 0.6 Miles

Sources: FEMA-2015; City of Portland-2016

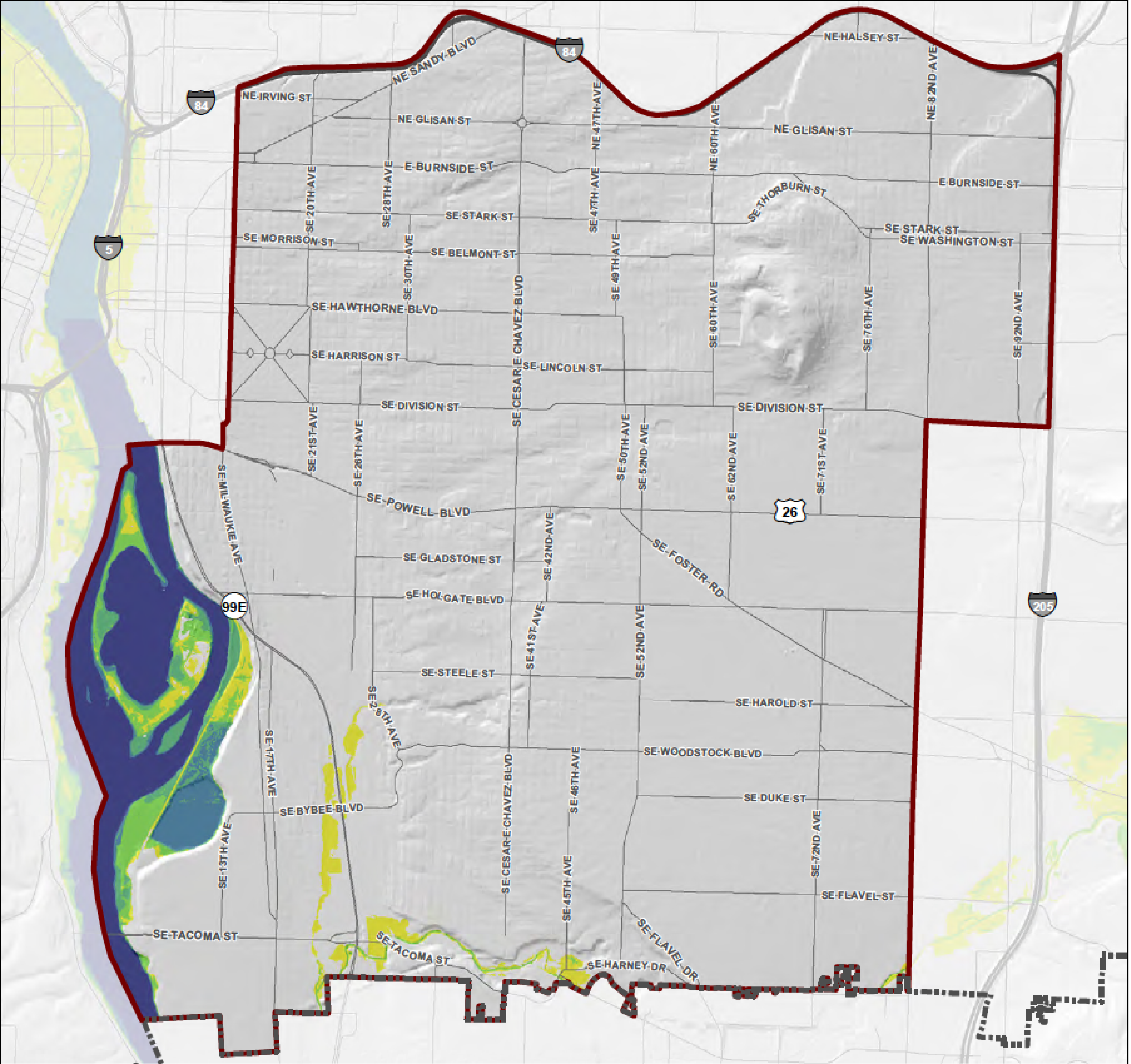
37242

PBEM

September 12, 2016

Mitigation Action Plan (MAP)

Flood Hazard - 500-yr Flood Depth Grid



Legend

- City Boundary
- 500-year flood depth grid
  - 0' - 4.6'
  - 4.7' - 12.9'
  - 13' - 22.6'
  - 22.7' - 28.8'
  - 28.9' - 36.7'
- Risk Reporting Area Southeast

NORTH

0 0.325 0.65 Miles

Sources: Tetra Tech-2016; City of Portland-2016

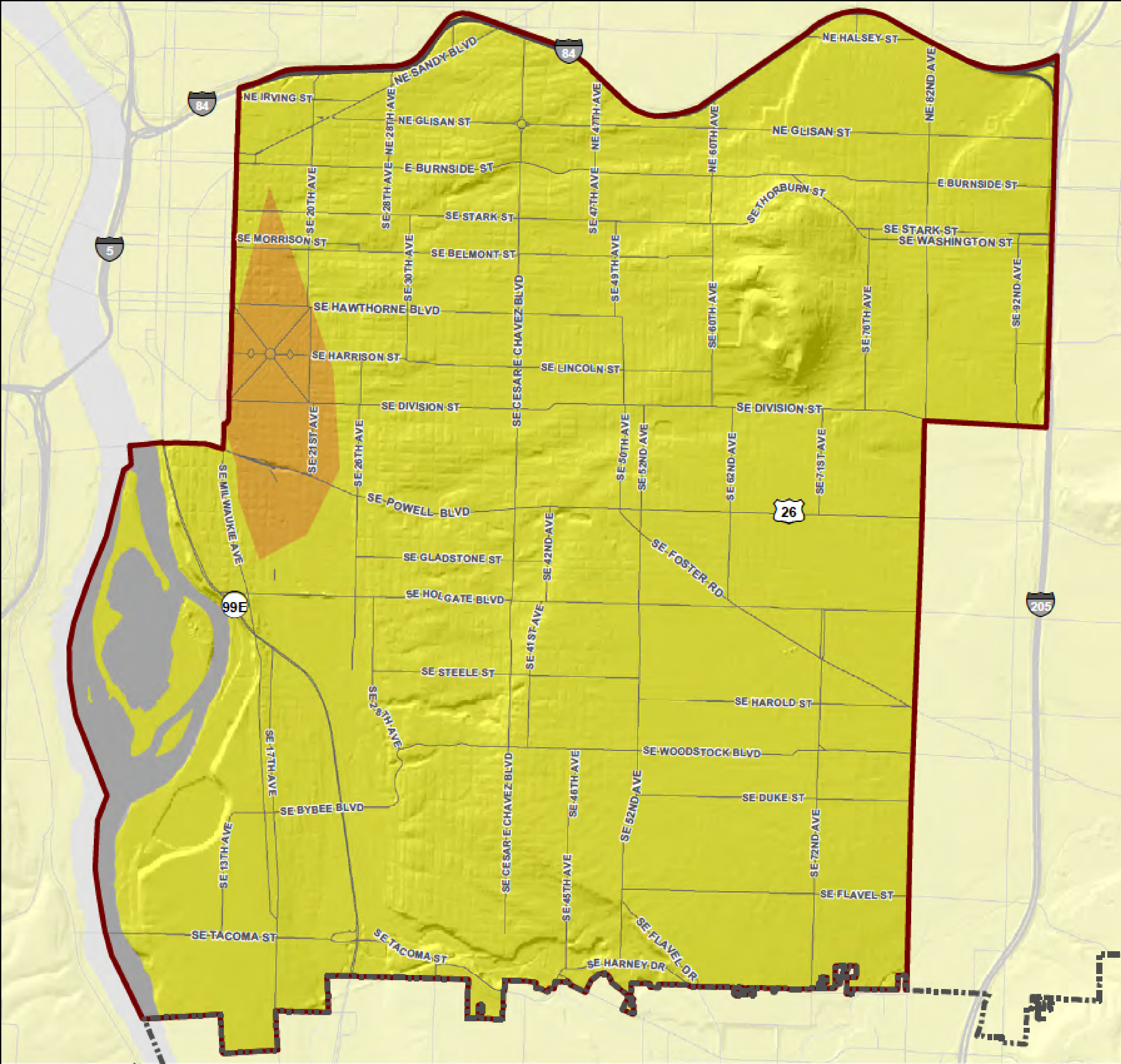
37242

PBEM

September 12, 2016

Mitigation Action Plan (MAP)

Cascadia 9.0 Magnitude Earthquake--Peak Ground Acceleration



Legend

City Boundary

Cascadia M9.0 earthquake PGA

Potential Damage - Perceived Shaking

- V – Very Light - Moderate
- VI – Light - Strong
- VII – Moderate - Very Strong
- VIII -- Moderate/Heavy - Severe

Risk Reporting Area Southeast

NORTH

0 0.275 0.55 Miles

Sources: USGS-2011; City of Portland-2016

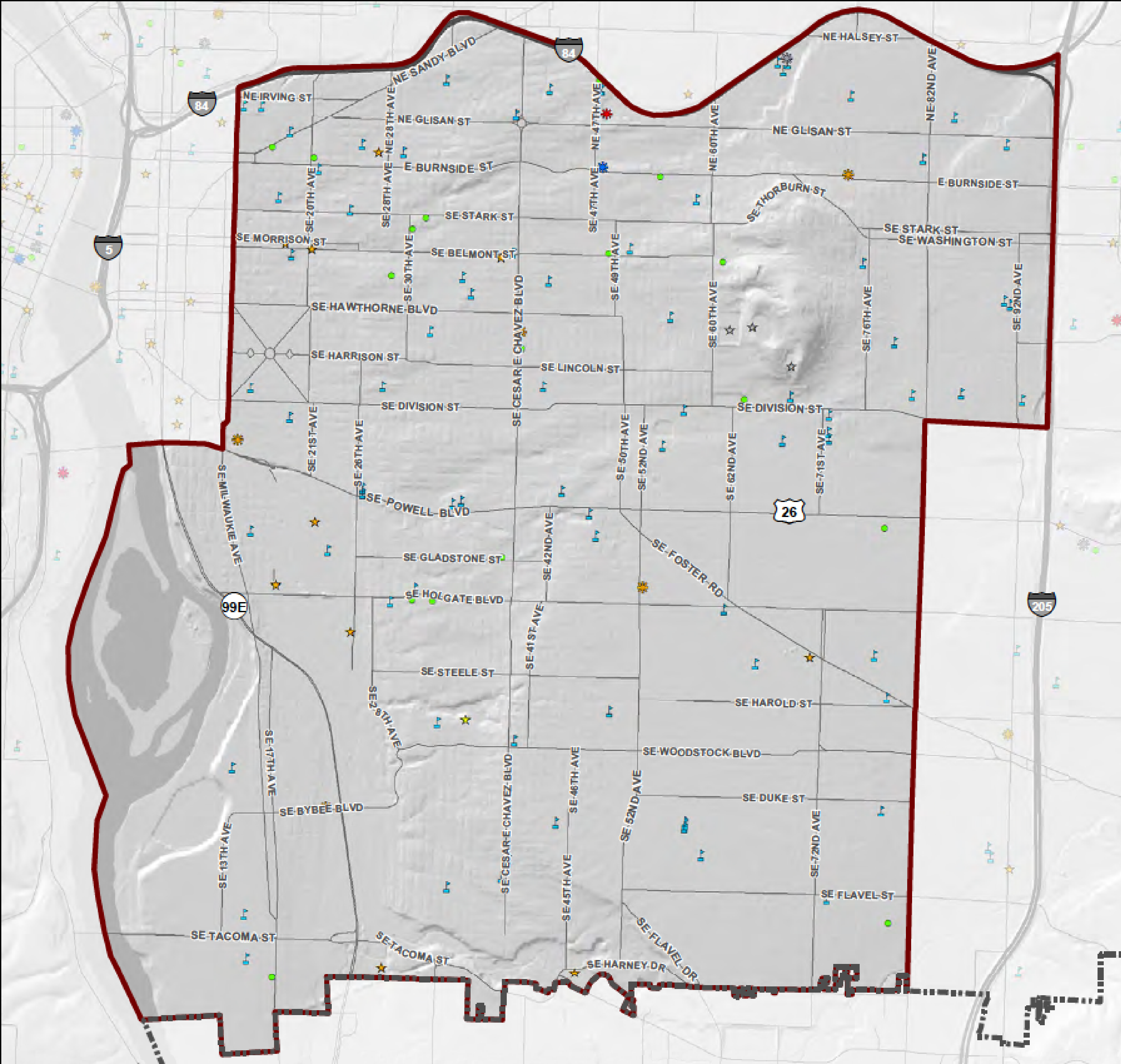
37242

PBEM

September 12, 2016

Mitigation Action Plan (MAP)

Critical Facilities



Legend

- City Boundary
- Risk Reporting Area Southeast

Emergency Services*

- Emergency Coordination Centers
- Fire Station Facilities
- Police Station Facilities
- Medical Care Facilities

High Potential Loss Facilities*

- Dams
- Military
- Nuclear Power Plants
- Hazardous Materials
- Schools
- Other Assets

Zoo, Jails, Nursing/Assisted Living Facilities

*Due to security reasons, some emergency services and high potential loss facilities have been left off of the map.

NORTH

0 0.275 0.55 Miles

Sources: WORD/NID-2015; OSFM-2015; City of Portland-2011, 2015, 2016

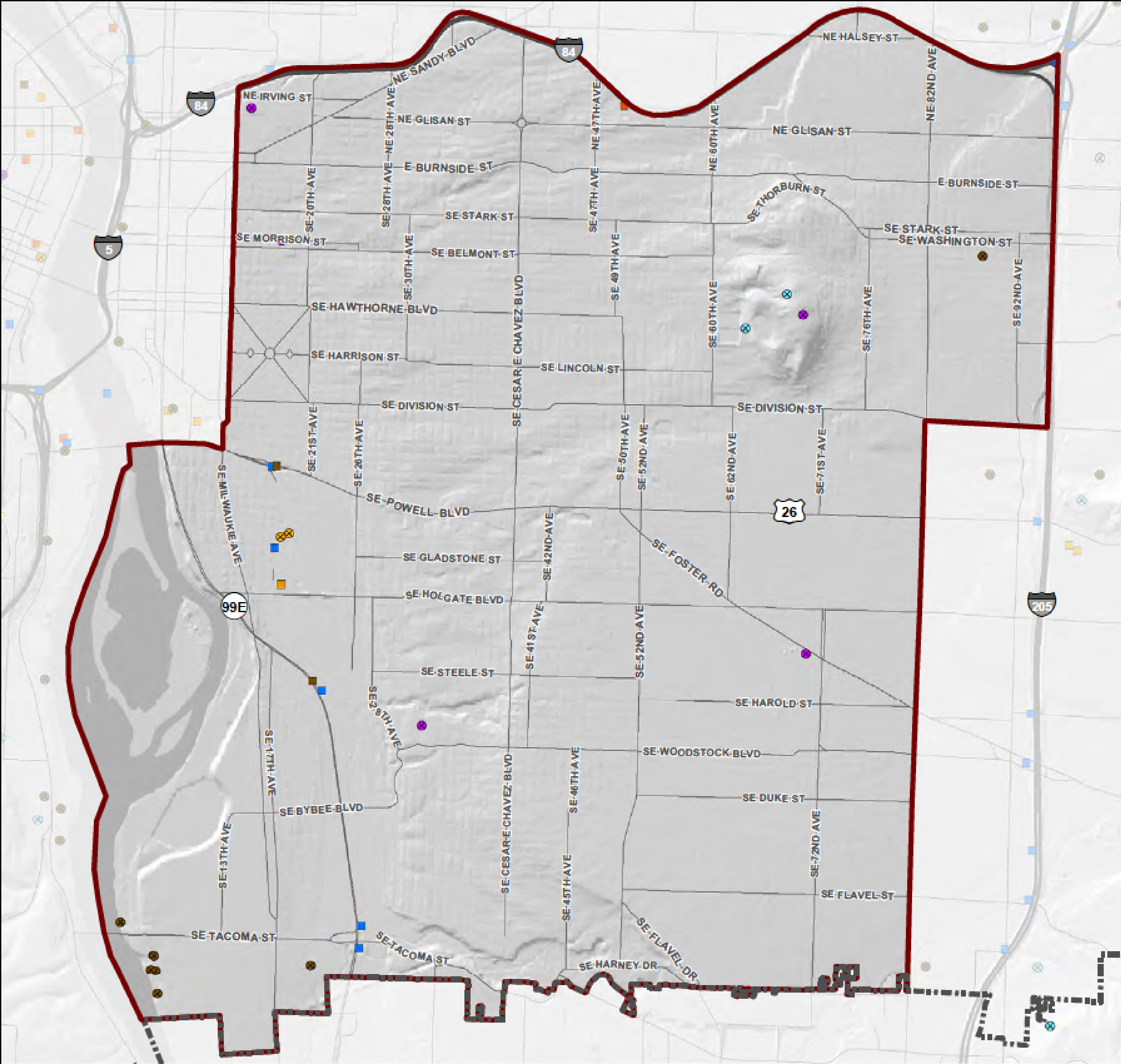
37242

PBEM

September 12, 2016

Mitigation Action Plan (MAP)

Critical Infrastructure



Legend

City Boundary

Risk Reporting Area Southeast

Utility Systems*

- Electrical
- Natural Gas Facilities
- Communication Facilities
- Petroleum Facilities
- Potable Water Facilities
- Wastewater Facilities

Transportation Systems*

- Railway Tunnels, Bridges, and Facilities
- Light Rail Tunnels, Bridges, and Facilities
- Highway Tunnels and Bridges
- Bus Facilities
- Port and Airport Facilities

*Due to security reasons, some utility and transportation system components have been left off of the map.

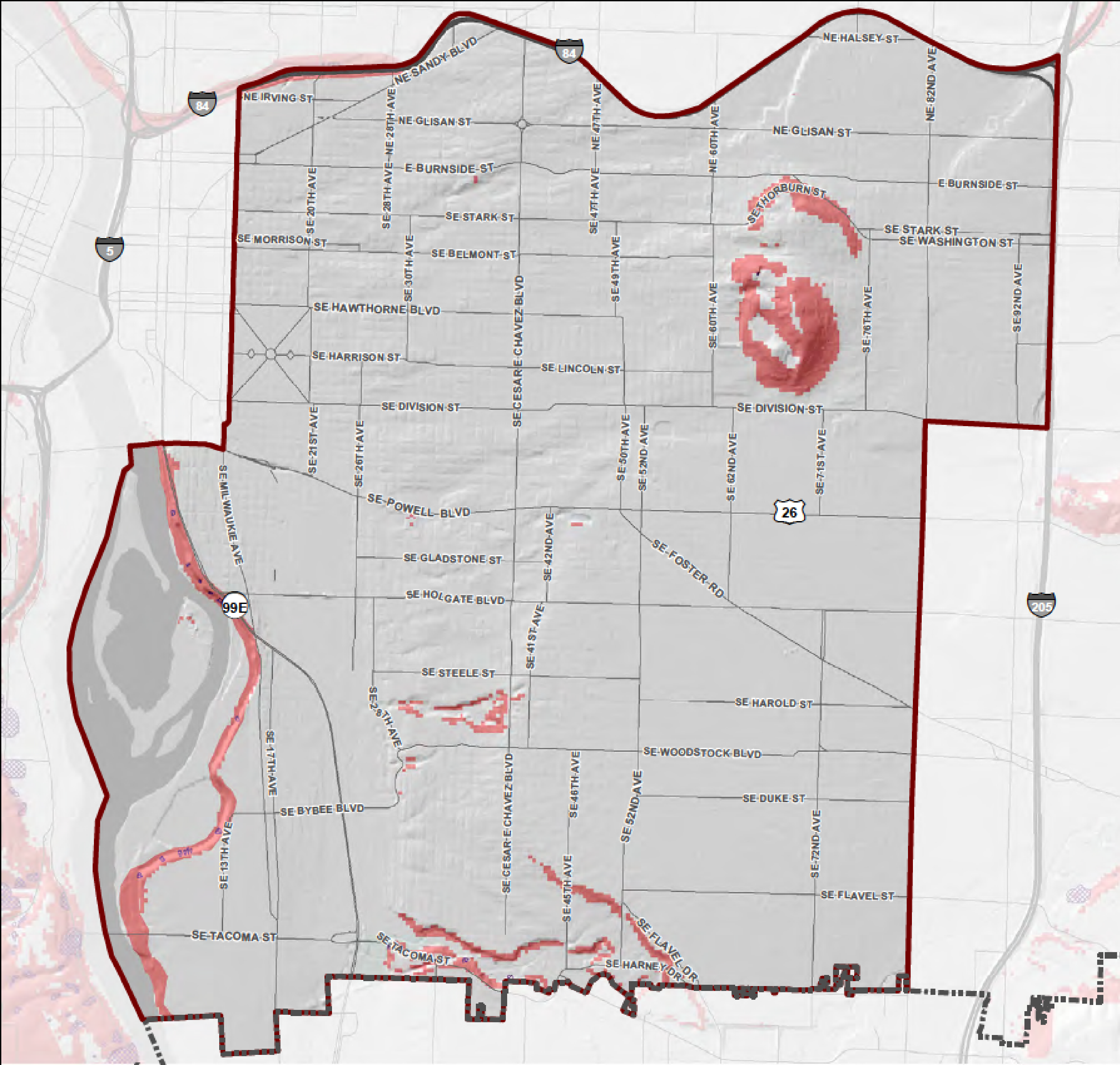
NORTH

0 0.275 0.55 Miles

Sources: TriMet-2015; Port of Portland-2015; OPHS-2016; City of Portland-2011, 2015,2016; OPB-2016; PTS-2015; FEMA-2015; Kinder Morgan-2015

37242

PBEM



September 12, 2016

Mitigation Action Plan (MAP)

Regulatory Landslide Hazard Area

Legend

City Boundary

Historic Landslide Deposits

Landslide Hazard Area

Risk Reporting Area Southeast

NORTH

0 0.275 0.55 Miles

Sources: DOGAMI-2015;
City of Portland-2015, 2016

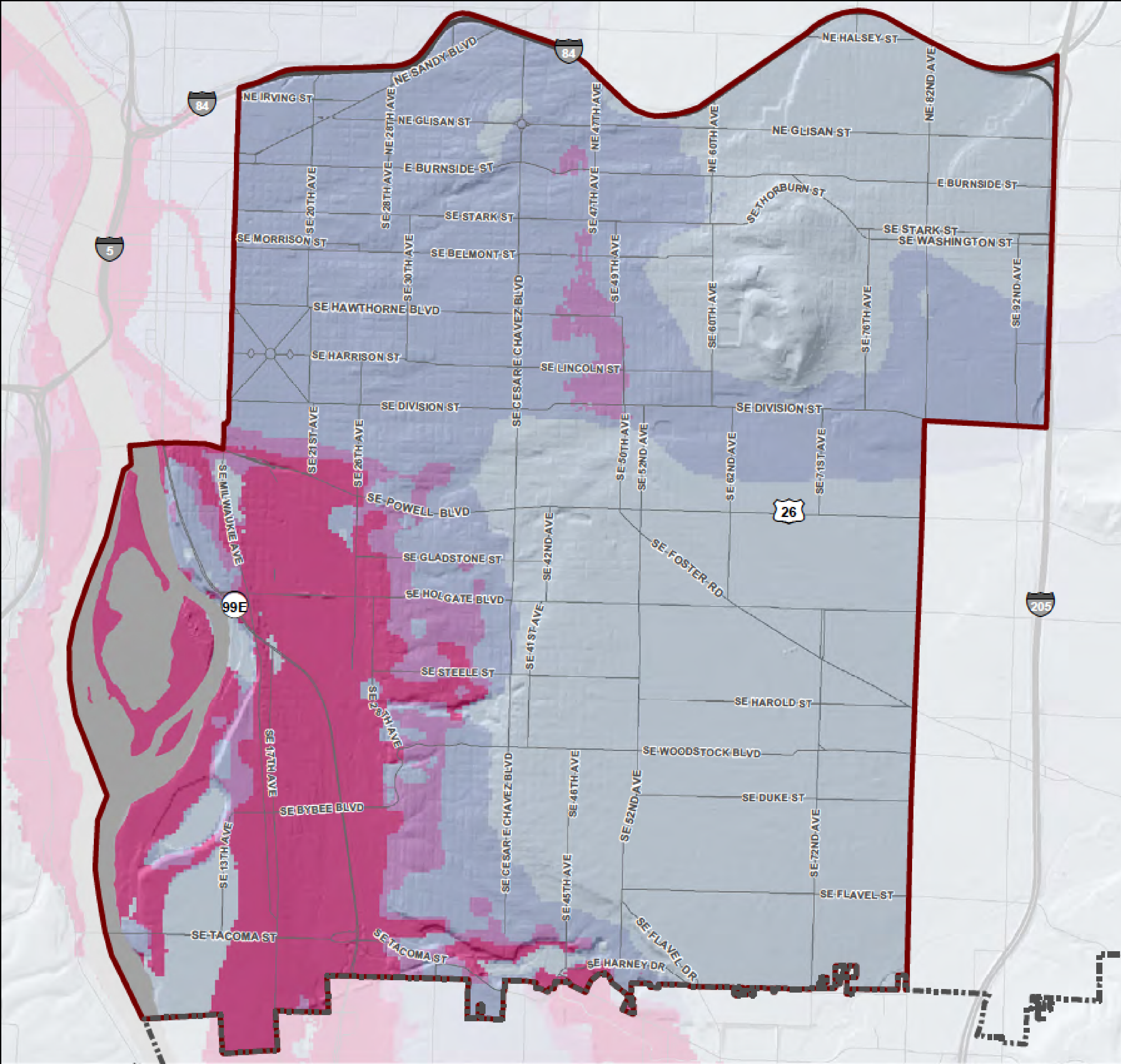
37242

PBEM

September 12, 2016

Mitigation Action Plan (MAP)

Liquefaction Susceptibility



Legend

City Boundary

Liquefaction Susceptibility

Type

- 0 – None
- 1 – Very Low
- 2 – Low
- 3 – Moderate
- 4 – High
- 5 – Very High

Risk Reporting Area Southeast

NORTH

0 0.275 0.55 Miles

Sources: DOGAMI-2013; City of Portland-2016

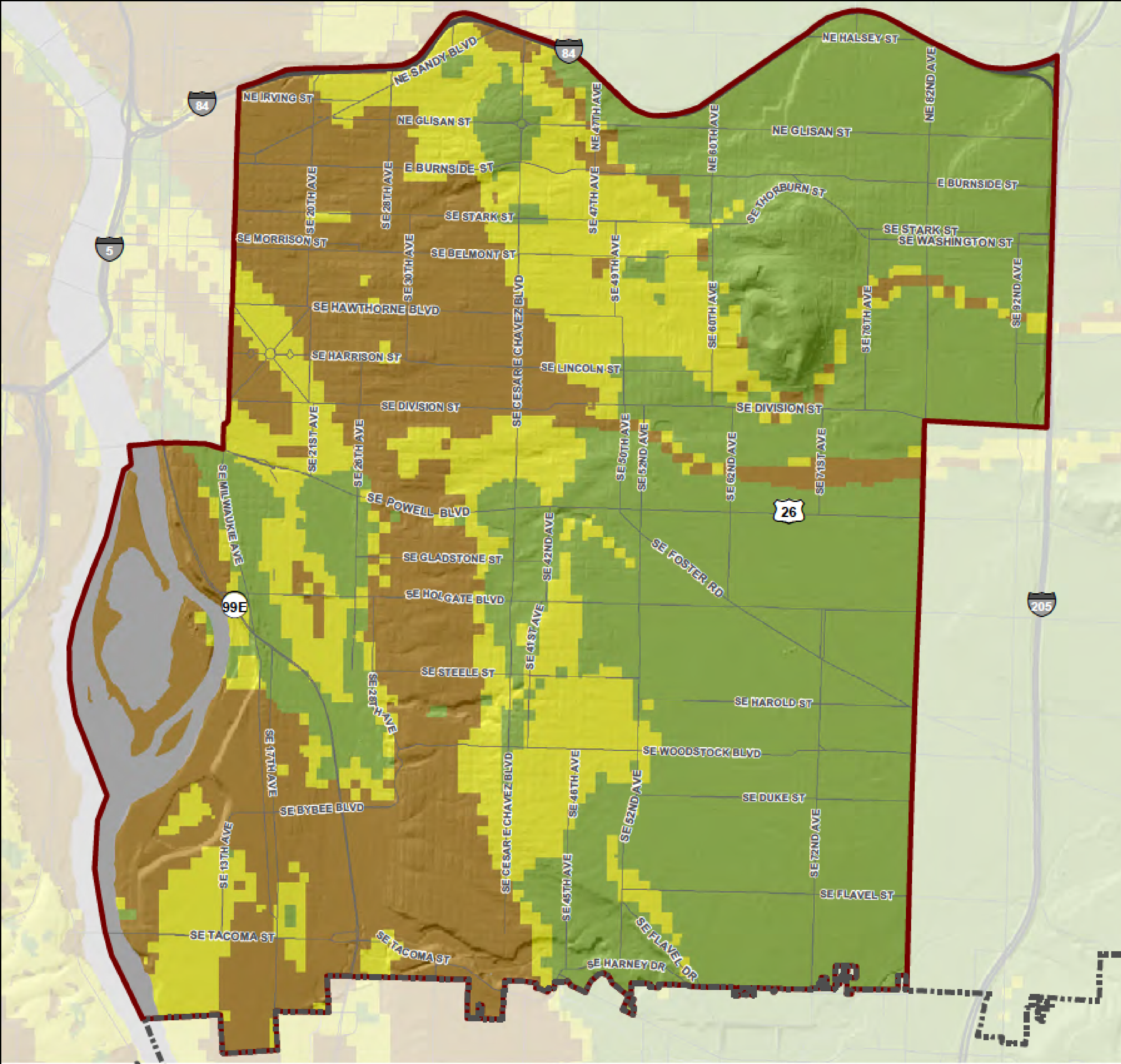
37242

PBEM

September 12, 2016

Mitigation Action Plan (MAP)

National Earthquake Hazards Reduction Program Soils



Legend

City Boundary

NEHRP Soils

Type

- B
- C
- D
- E

Risk Reporting Area Southeast

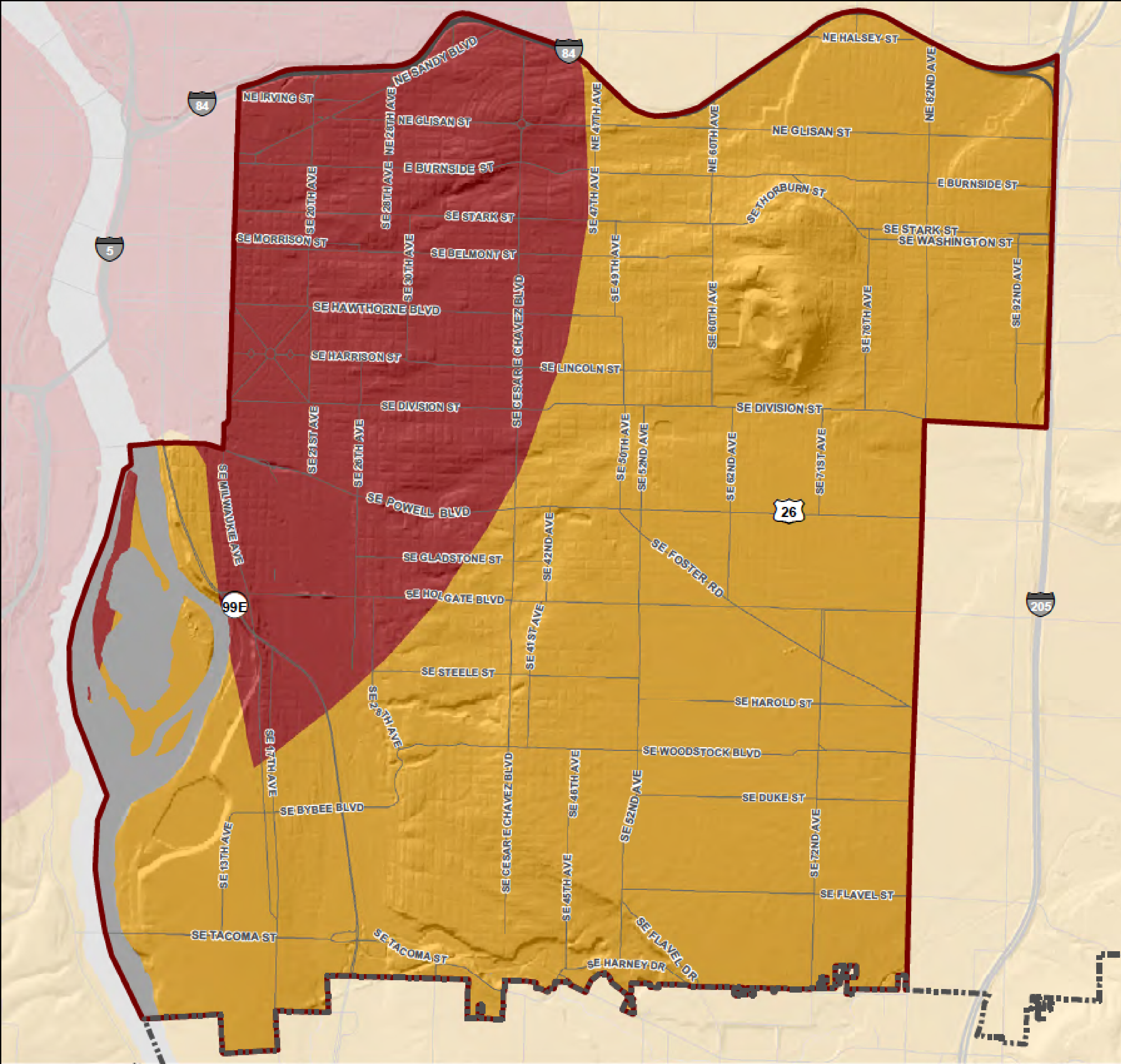
NORTH

0 0.275 0.55 Miles

Sources: DOGAMI-2012;
City of Portland-2016

37242

PBEM



September 12, 2016

Mitigation Action Plan (MAP)

Portland Hills 6.5 Magnitude Earthquake- Peak Ground Acceleration

Legend

City Boundary

Portland Hills M6.5 earthquake PGA

Potential Damage - Perceived Shaking

V -- Very Light - Moderate

VI -- Light - Strong

VII -- Moderate - Very Strong

VIII -- Moderate/Heavy - Severe

Risk Reporting Area Southeast

NORTH

0 0.275 0.55 Miles

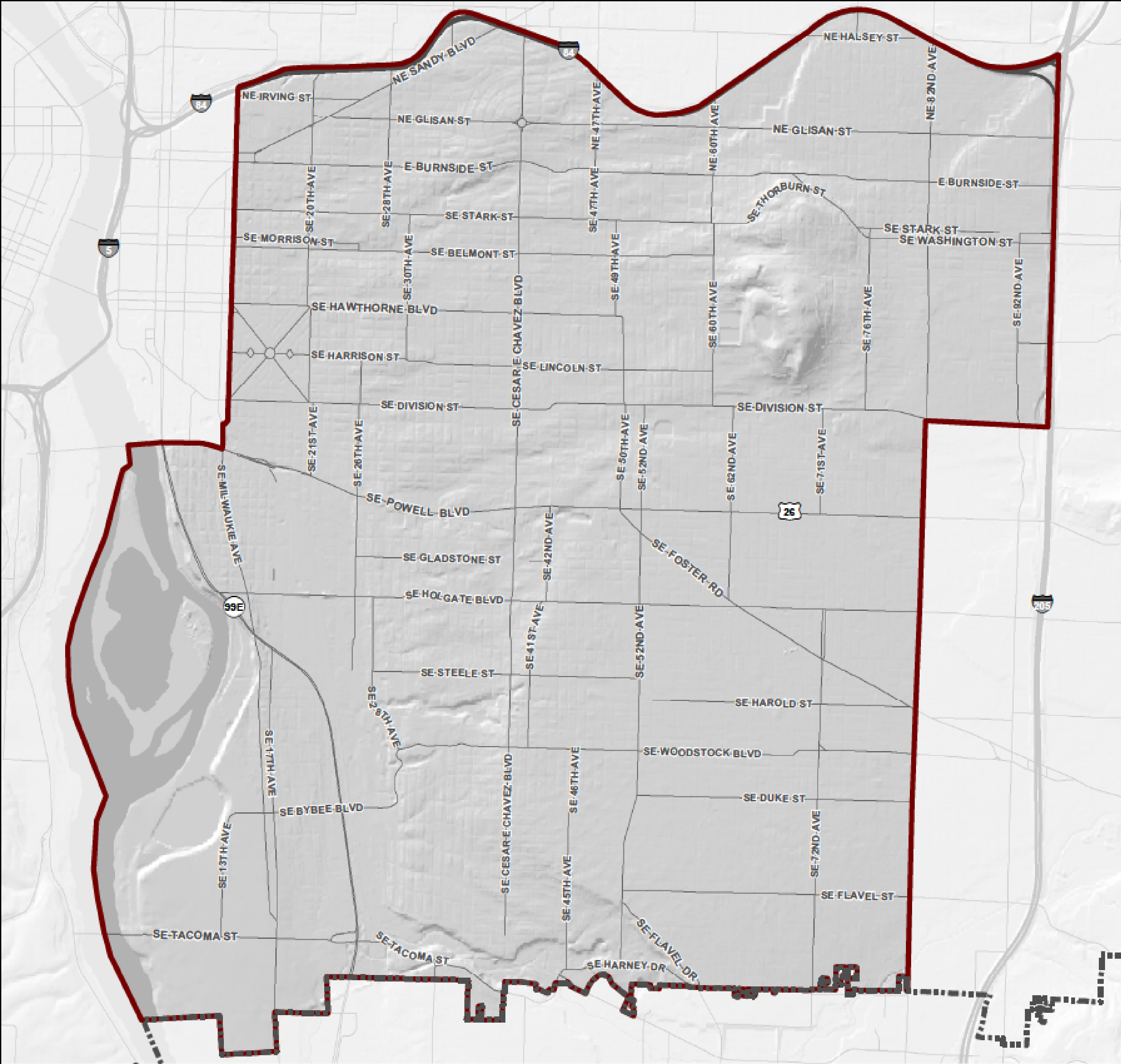
Sources: USGS-2009; City of Portland-2016

37242

September 12, 2016

Mitigation Action Plan (MAP)

Volcano Hazard Area



Legend

- City Boundary
- Volcano Hazard Area
- Risk Reporting Area Southeast

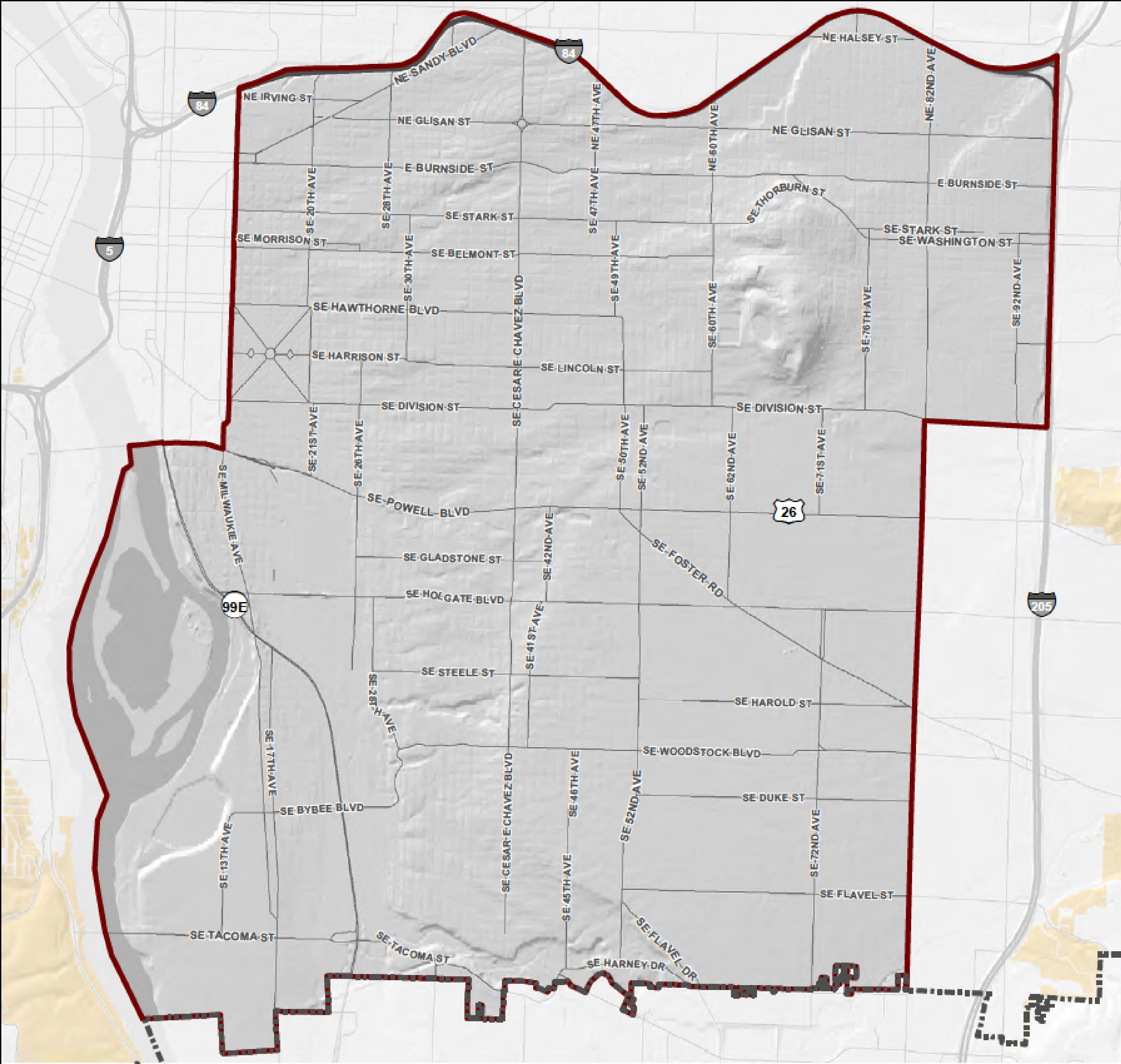
NORTH

0 0.275 0.55 Miles

Sources: USGS-1997; City of Portland-2016

37242

PBEM



September 12, 2016

Mitigation Action Plan (MAP)

Wildfire Hazard Area

Legend

- City Boundary
- Wildfire Hazard Area
- Risk Reporting Area Southeast

NORTH

0 0.275 0.55 Miles

Sources: City of Portland-2002, 2016

37242

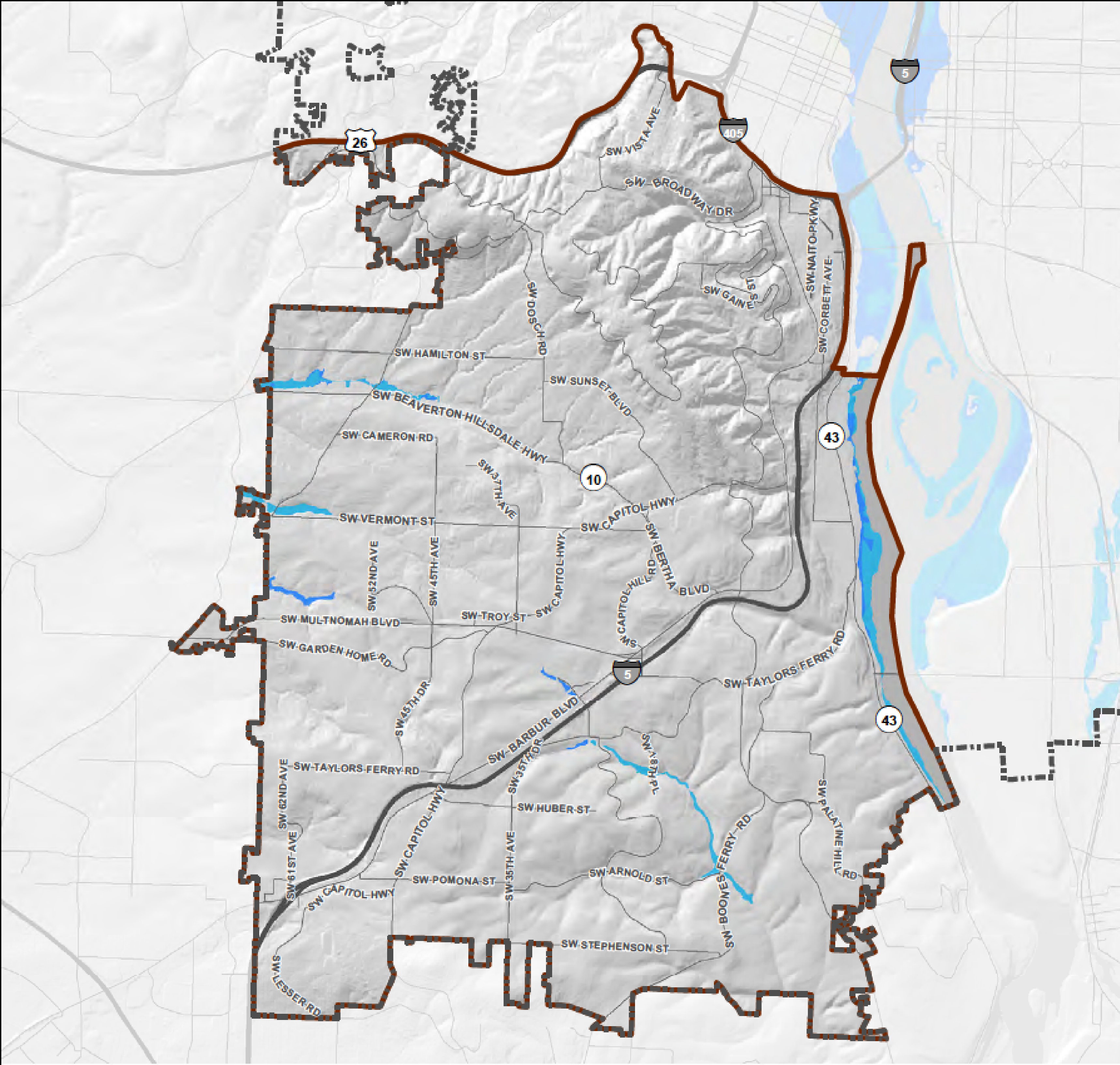
PBEM

SOUTHWEST

September 12, 2016

Mitigation Action Plan (MAP)

Flood hazard - 100-yr and 500-yr FEMA flood zone



Legend

- City Boundary
- 100-year FEMA flood zone
- 500-year FEMA flood zone
- Risk Reporting Area Southwest

NORTH

0 0.3 0.6 Miles

Sources: FEMA-2014;
City of Portland-2016

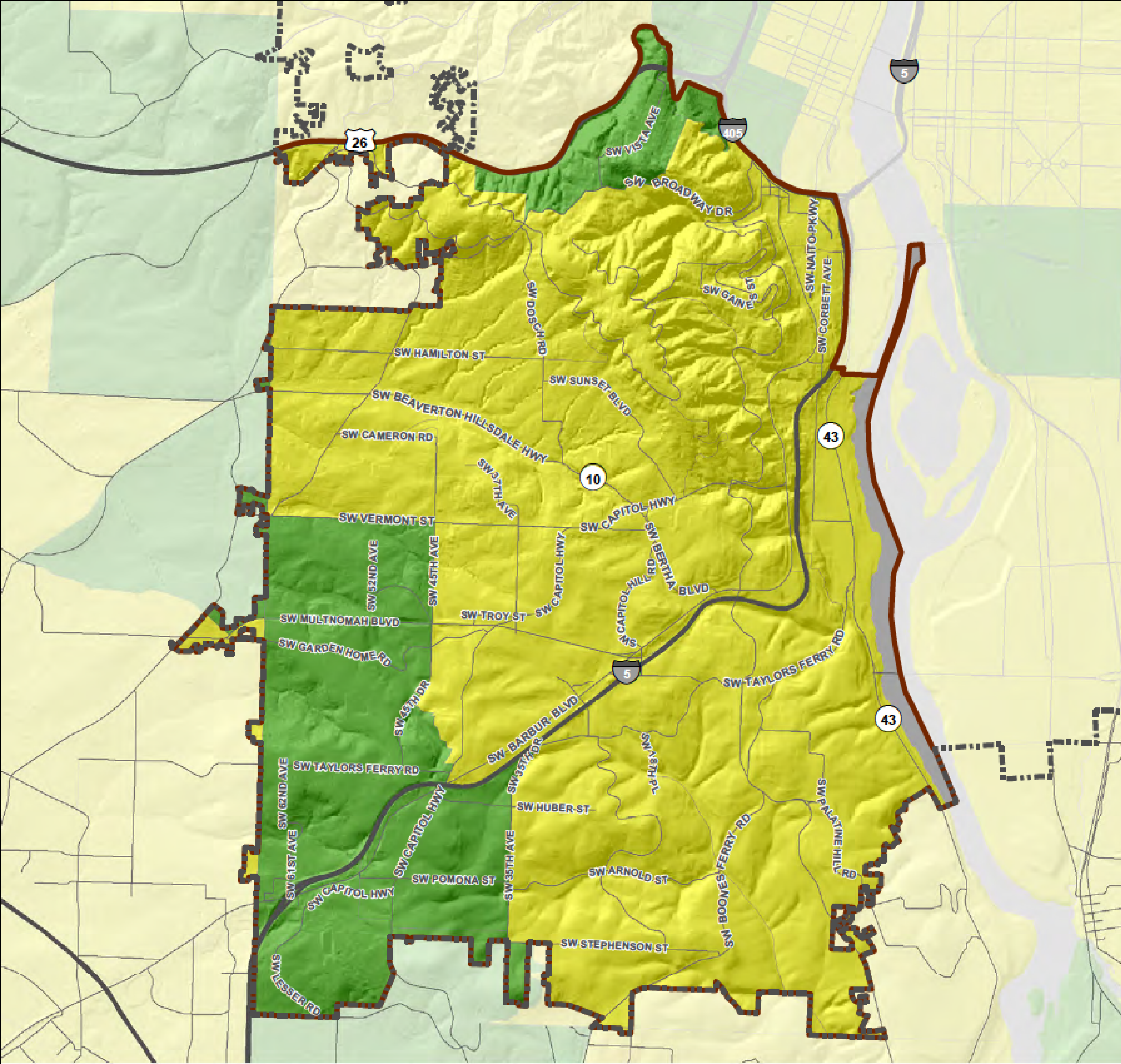
37242

PBEM

September 12, 2016

Mitigation Action Plan (MAP)

100-year Probabilistic Earthquake--Peak Ground Acceleration



Legend

City Boundary

100-year probabilistic earthquake PGA

Potential Damage - Perceived Shaking

V -- Very Light - Moderate

VI -- Light - Strong

Risk Reporting Area Southwest

NORTH

0 0.3 0.6 Miles

Sources: FEMA-2015; City of Portland-2016

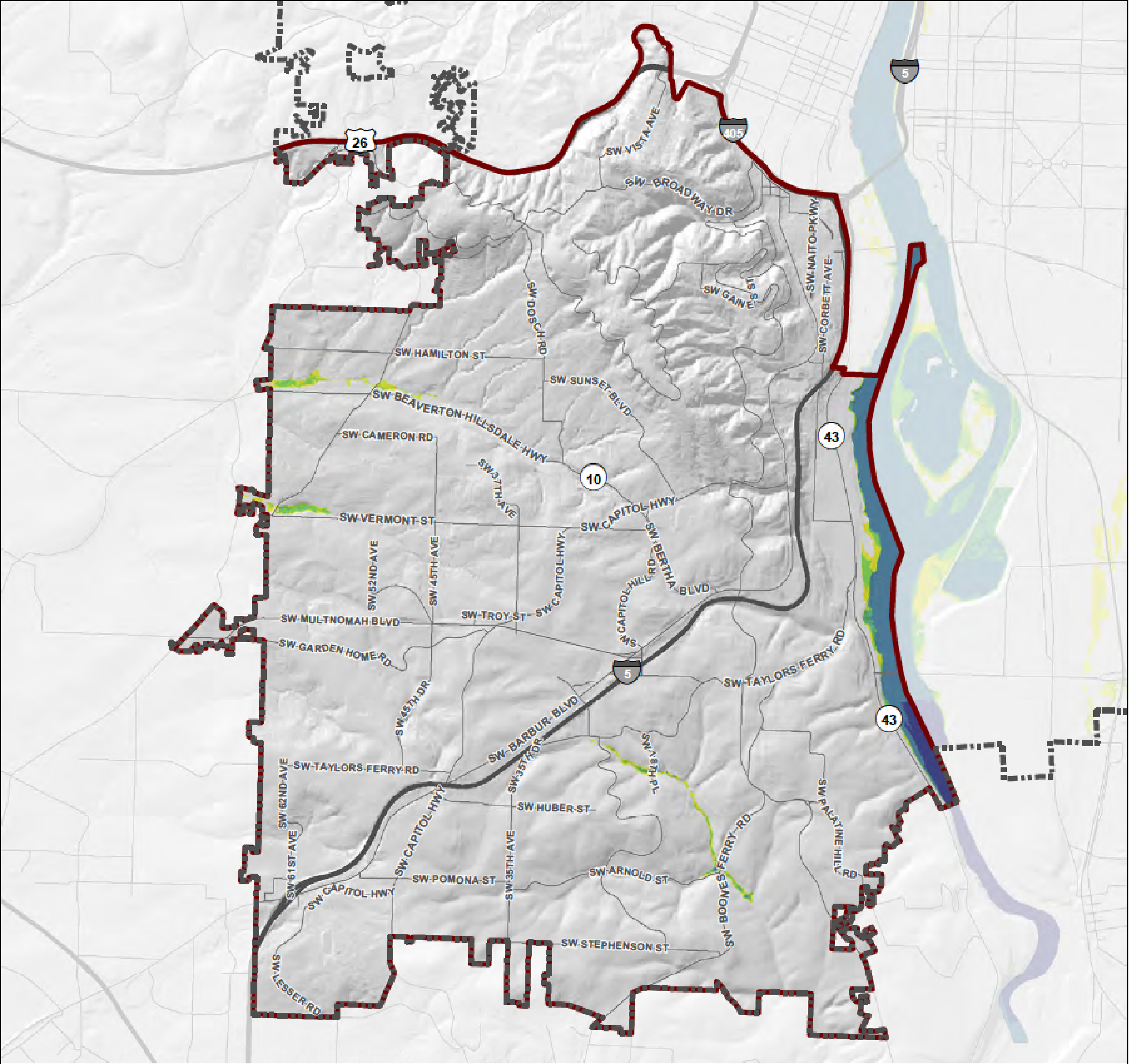
37242

PBEM

September 12, 2016

Mitigation Action Plan (MAP)

Flood Hazard - 100-yr Flood Depth Grid



Legend

City Boundary

100-year flood depth grid

- 0.1' - 4.5'
- 4.6' - 11.5'
- 11.6' - 19.5'
- 19.6' - 25.9'
- 26' - 33.2'

Risk Reporting Area Southwest

NORTH

0 0.3 0.6 Miles

Sources: Tetra Tech-2016; City of Portland-2016

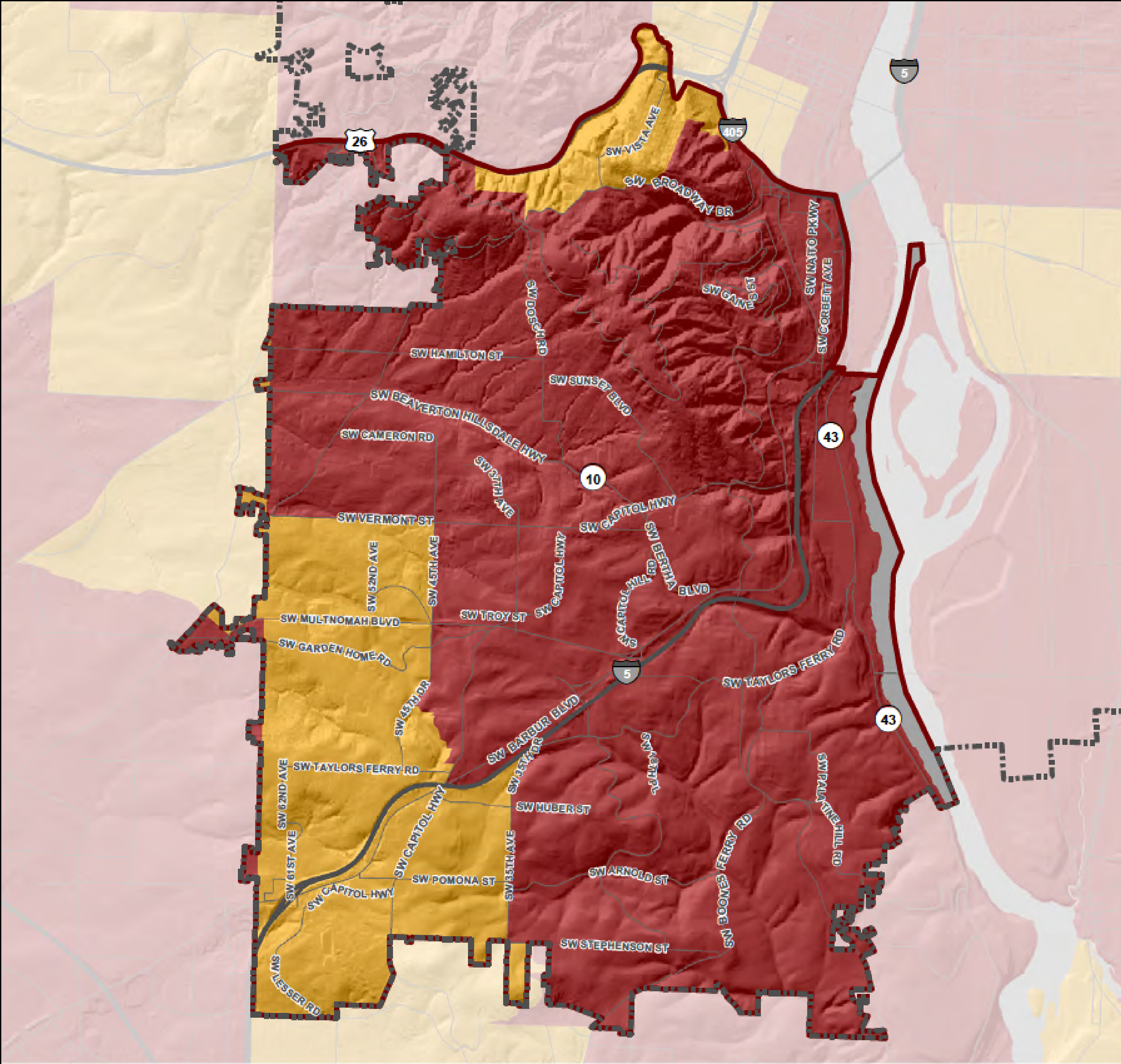
37242

PBEM

September 12, 2016

Mitigation Action Plan (MAP)

500-year Probabilistic Earthquake--Peak Ground Acceleration



Legend

City Boundary

500-year probabilistic earthquake PGA

Potential Damage - Perceived Shaking

VI -- Light - Strong

VII -- Moderate - Very Strong

VIII -- Moderate/Heavy - Severe

Risk Reporting Area Southwest

NORTH

0 0.35 0.7 Miles

Sources: FEMA-2015; City of Portland-2016

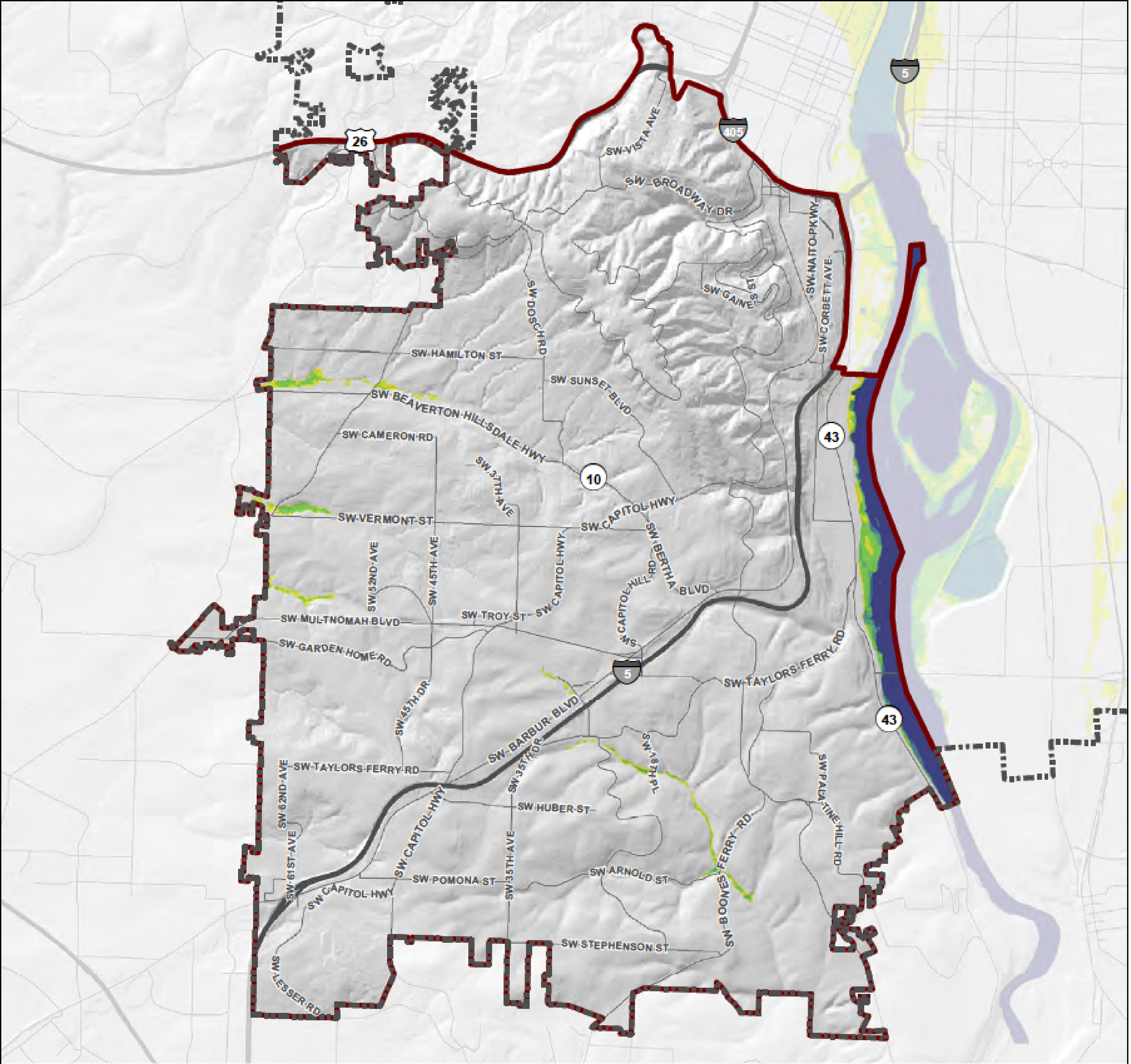
37242

PBEM

September 12, 2016

Mitigation Action Plan (MAP)

Flood Hazard - 500-yr Flood Depth Grid



Legend

- City Boundary
- 500-year flood depth grid
  - 0' - 4.6'
  - 4.7' - 12.9'
  - 13' - 22.6'
  - 22.7' - 28.8'
  - 28.9' - 36.7'
- Risk Reporting Area Southwest

NORTH

0 0.375 0.75 Miles

Sources: Tetra Tech-2016; City of Portland-2016

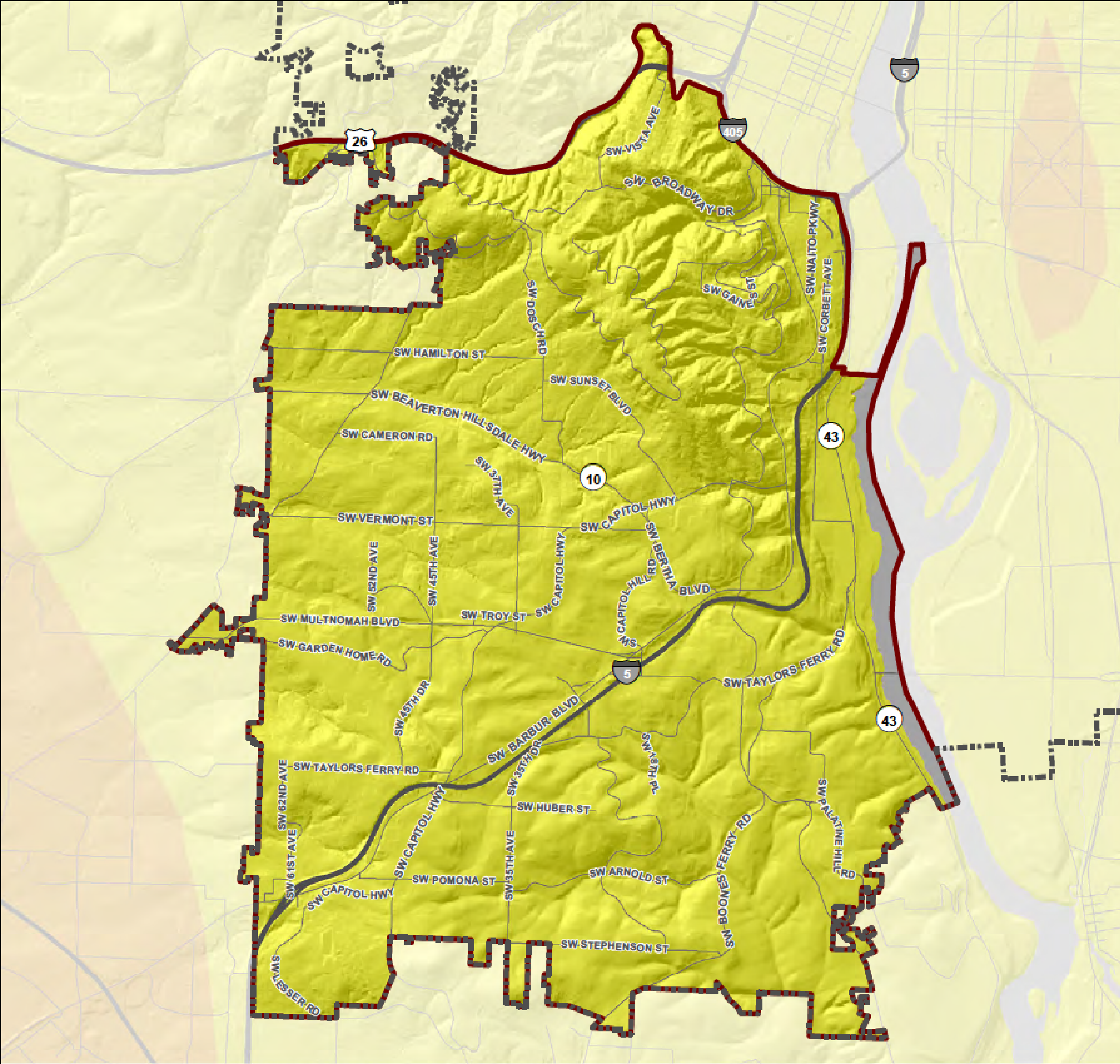
37242

PBEM

September 12, 2016

Mitigation Action Plan (MAP)

Cascadia 9.0 Magnitude Earthquake--Peak Ground Acceleration



City Boundary

Cascadia M9.0 earthquake PGA

Potential Damage - Perceived Shaking

V -- Very Light - Moderate

VI -- Light - Strong

VII -- Moderate - Very Strong

VIII -- Moderate/Heavy - Severe

Risk Reporting Southwest

NORTH

0 0.3 0.6 Miles

Sources: USGS-2011; City of Portland-2016

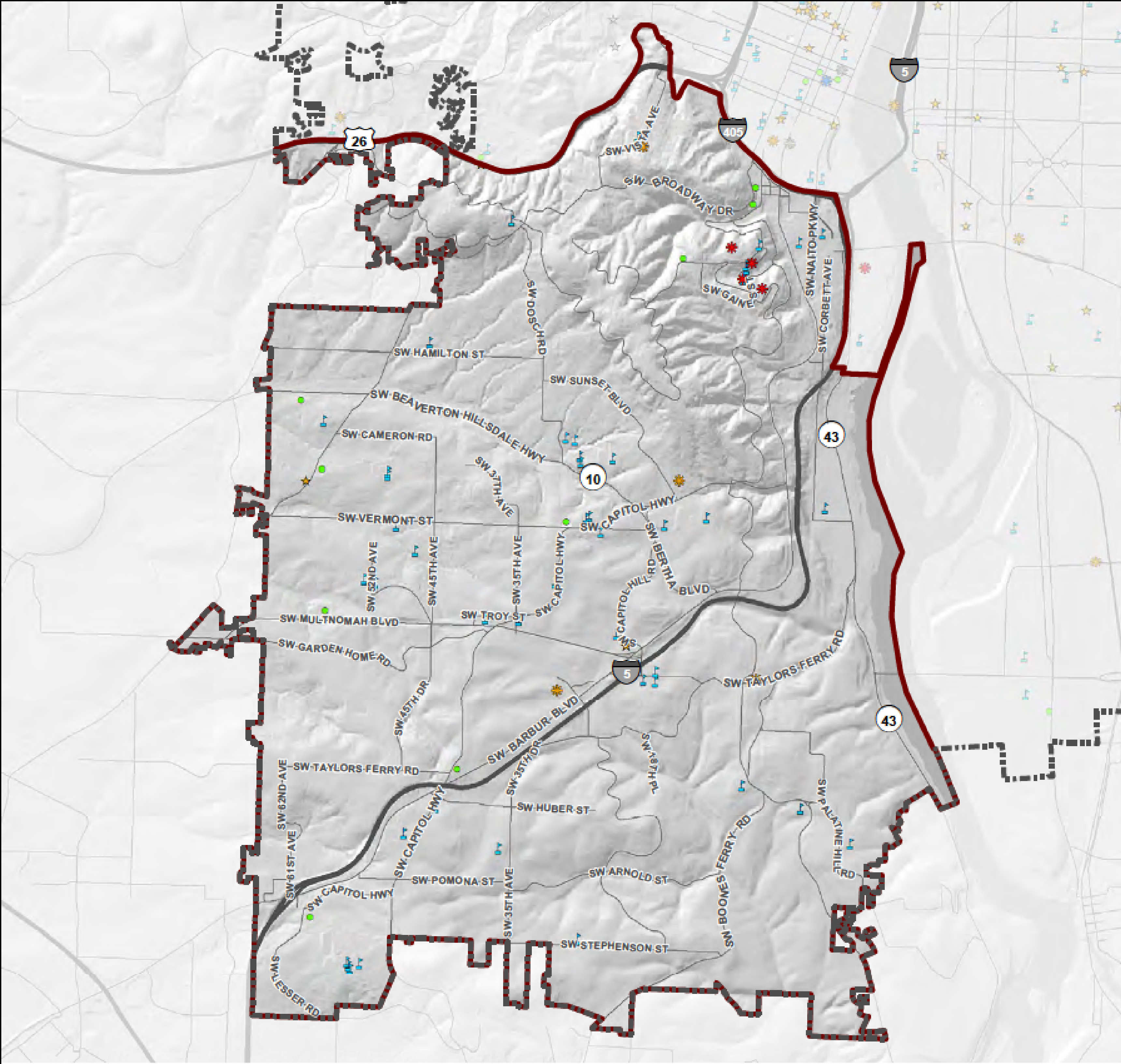
37242

PBEM

September 12, 2016

Mitigation Action Plan (MAP)

Critical Facilities



Legend

City Boundary

Risk Reporting Area Southwest

Emergency Services*

Emergency Coordination Centers

Fire Station Facilities

Police Station Facilities

Medical Care Facilities

High Potential Loss Facilities*

Dams

Military

Nuclear Power Plants

Hazardous Materials

Schools

Other Assets

Zoo, Jails, Nursing/Assisted Living Facilities

*Due to security reasons, some emergency services and high potential loss facilities have been left off of the map.

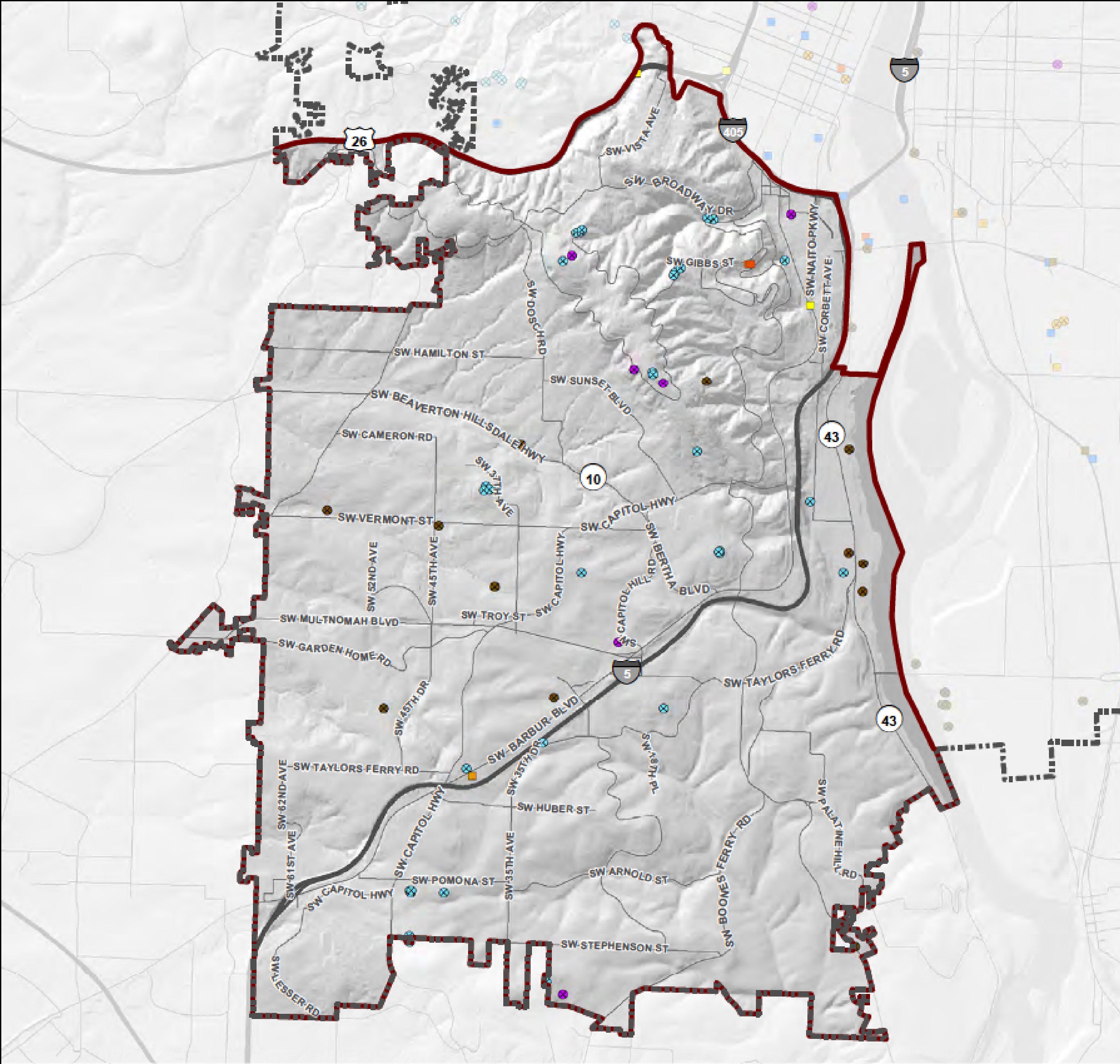
NORTH

0 0.3 0.6 Miles

Sources: WORD/NID-2015; OSFM-2015; City of Portland-2011, 2015, 2016

37242

PBEM



September 12, 2016

Mitigation Action Plan (MAP)

Critical Infrastructure

Legend

City Boundary

Risk Reporting Area Southwest

Utility Systems*

- Electrical
- Natural Gas Facilities
- Communication Facilities
- Petroleum Facilities
- Potable Water Facilities
- Wastewater Facilities

Transportation Systems*

- Railway Tunnels, Bridges, and Facilities
- Light Rail Tunnels, Bridges, and Facilities
- Highway Tunnels and Bridges
- Bus Facilities
- Port and Airport Facilities

*Due to security reasons, some utility and transportation system components have been left off of the map.

NORTH

0 0.3 0.6 Miles

Sources: TriMet-2015; Port of Portland-2015; OPHS-2016; City of Portland-2011, 2015,2016; OPB-2016; PTS-2015; FEMA-2015; Kinder Morgan-2015

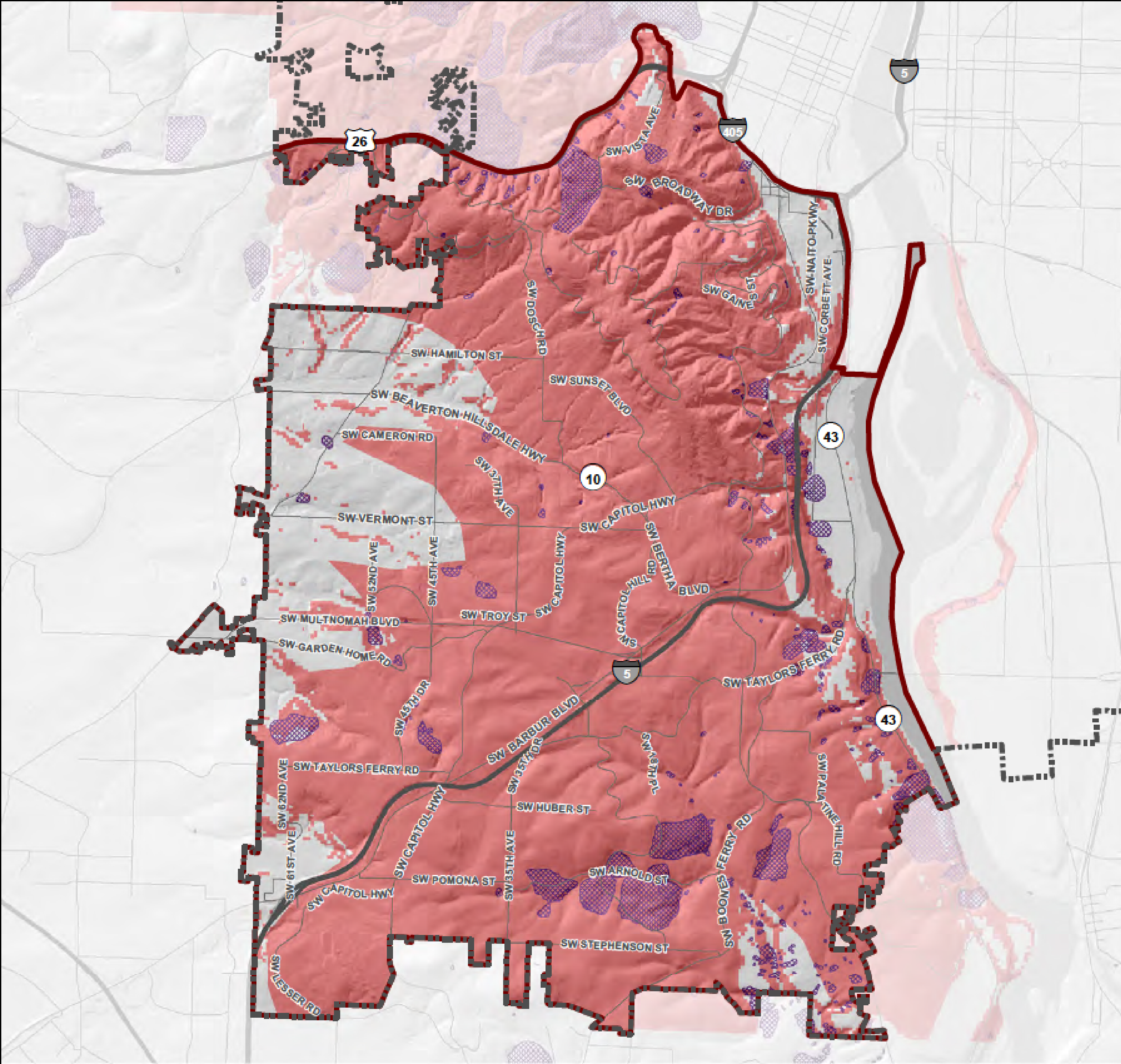
37242

PBEM

September 12, 2016

Mitigation Action Plan (MAP)

Regulatory Landslide Hazard Area



Legend

- City Boundary
- Historic Landslide Deposits
- Landslide Hazard Area
- Risk Reporting Area Southwest

NORTH

0 0.3 0.6 Miles

Sources: DOGAMI-2015; City of Portland-2015, 2016

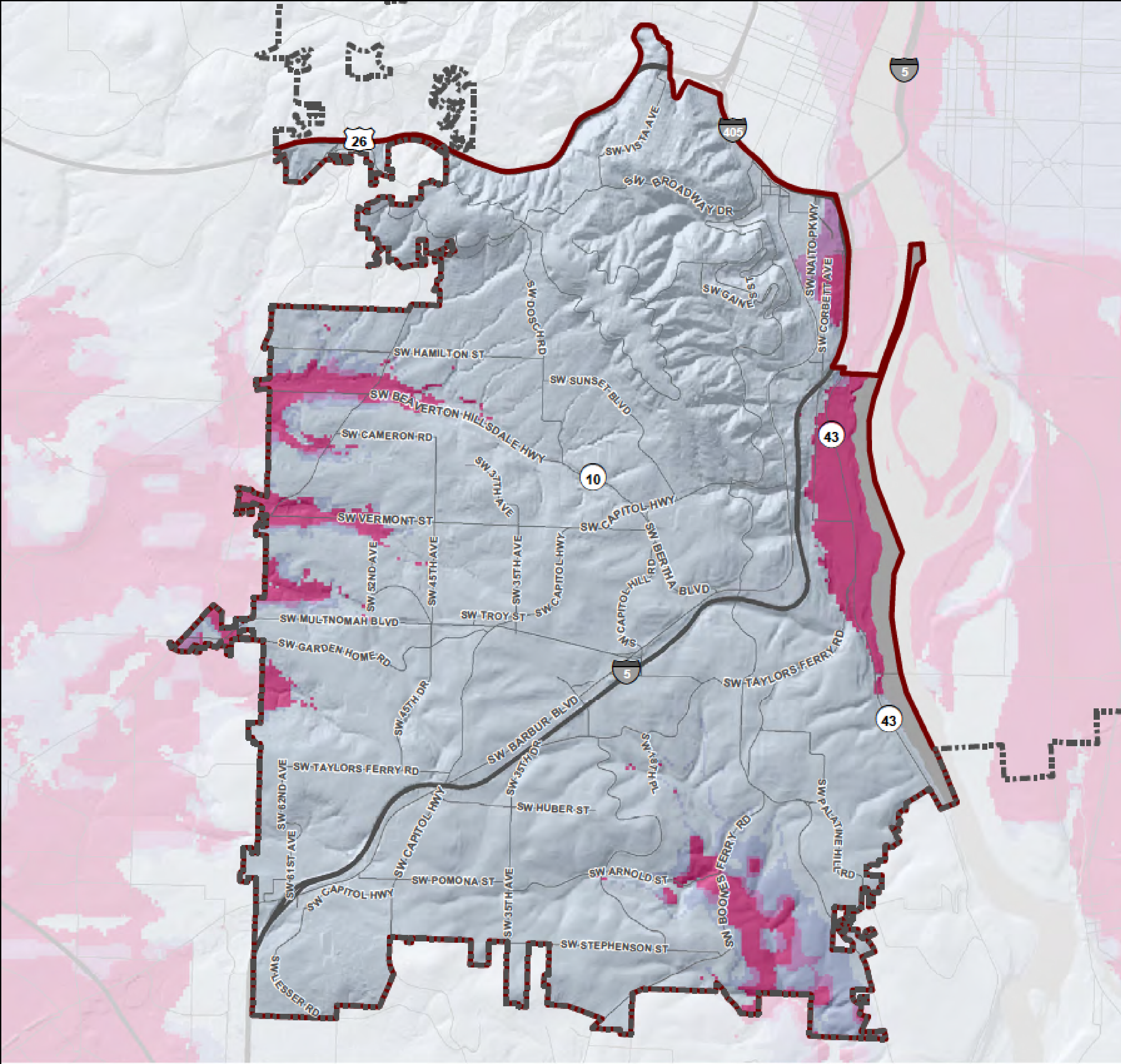
37242

PBEM

September 12, 2016

Mitigation Action Plan (MAP)

Liquefaction Susceptibility



Legend

City Boundary

Liquefaction Susceptibility

Type

0 – None
1 – Very Low
2 – Low
3 – Moderate
4 – High
5 – Very High
Risk Reporting Area Southwest

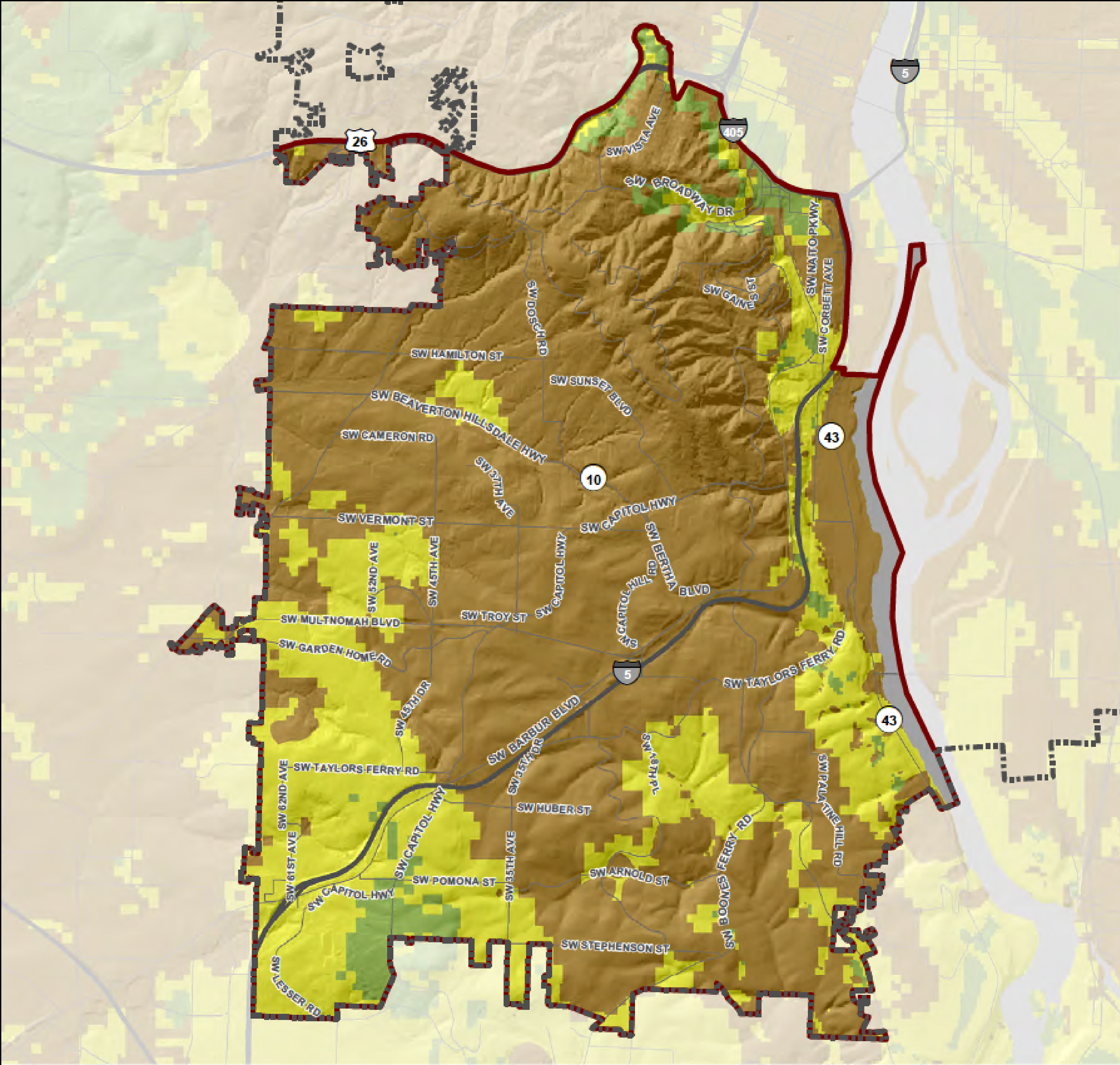
NORTH

0 0.3 0.6 Miles

Sources: DOGAMI-2013; City of Portland-2016

37242

PBEM



September 12, 2016

Mitigation Action Plan (MAP)

National Earthquake Hazards Reduction Program Soils

Legend

City Boundary

NEHRP Soils

Type

B

C

D

E

Risk Reporting Area Southwest

NORTH

0 0.3 0.6 Miles

Sources: DOGAMI-2012; City of Portland-2016

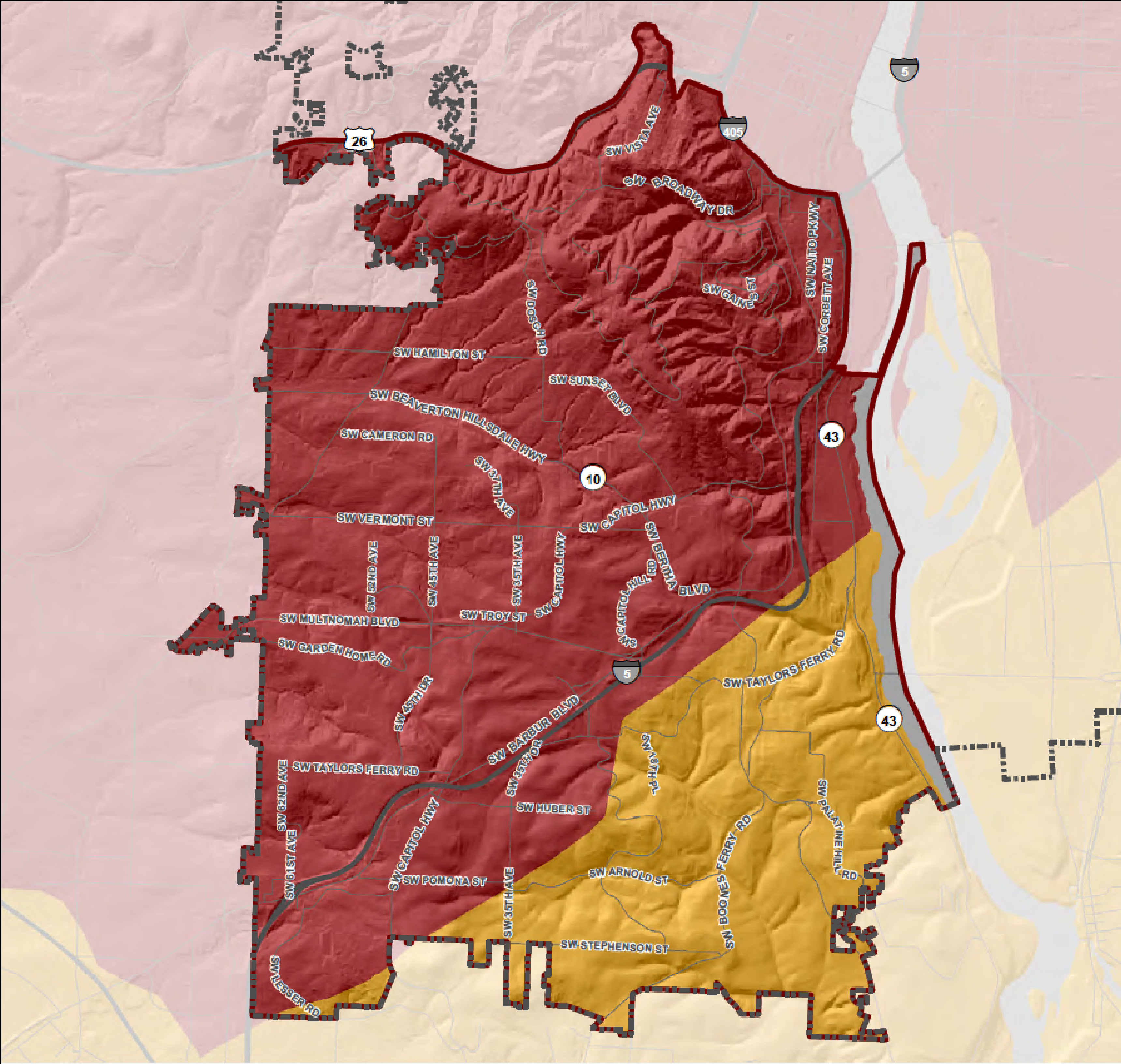
37242

PBEM

September 12, 2016

Mitigation Action Plan (MAP)

Portland Hills 6.5 Magnitude Earthquake-Peak Ground Acceleration



Legend

City Boundary

Portland Hills M6.5 earthquake PGA

Potential Damage - Perceived Shaking

V -- Very Light - Moderate

VI -- Light - Strong

VII -- Moderate - Very Strong

VIII -- Moderate/Heavy - Severe

Risk Reporting Area Southwest

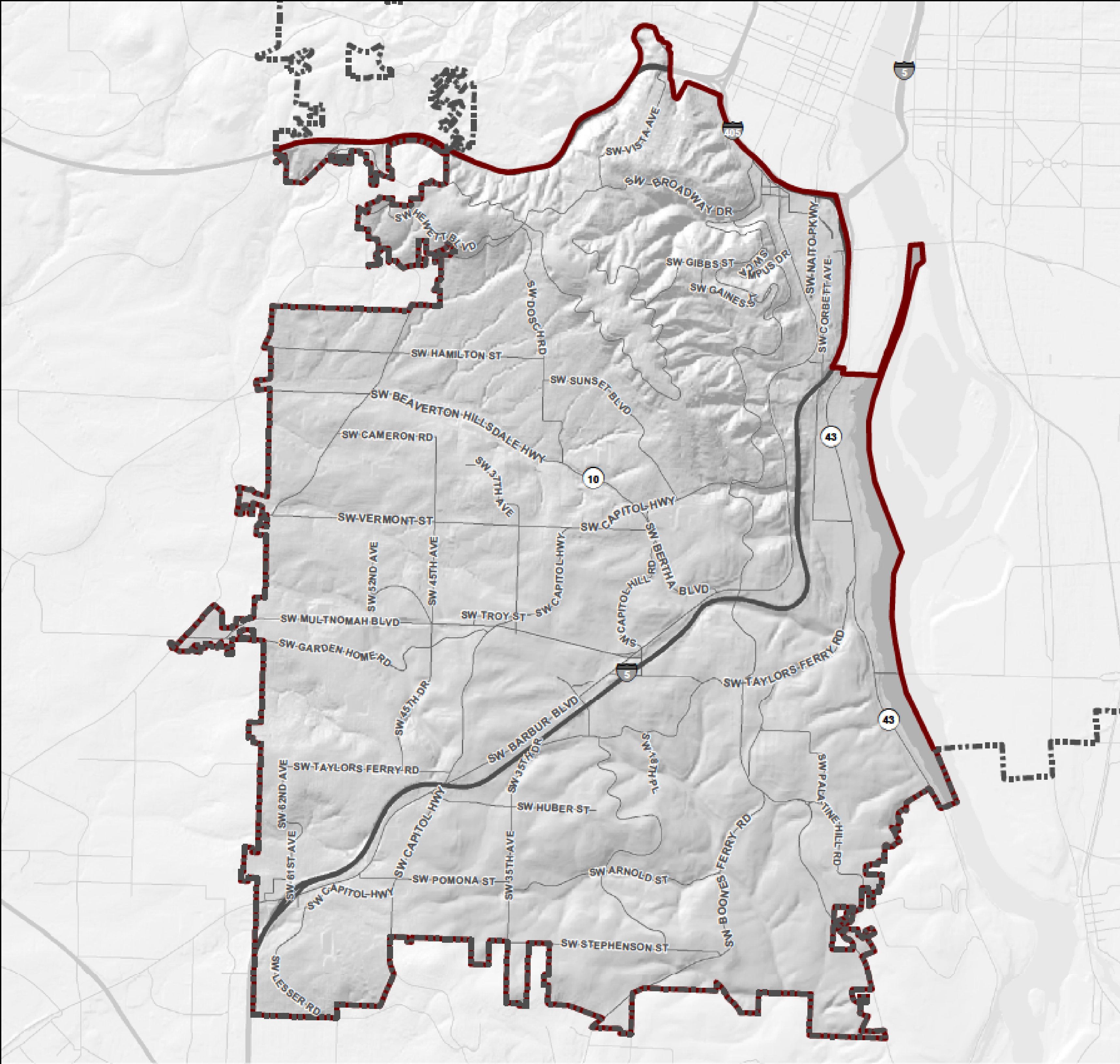
NORTH

0 0.3 0.6 Miles

Sources: USGS-2009; City of Portland-2016

37242

PBEM



September 12, 2016

Mitigation Action Plan (MAP)

Volcano Hazard Area

Legend

- City Boundary
- Volcano Hazard Area
- Risk Reporting Area Southwest

NORTH

0 0.3 0.6 Miles

Sources: USGS-1997;
City of Portland-2016

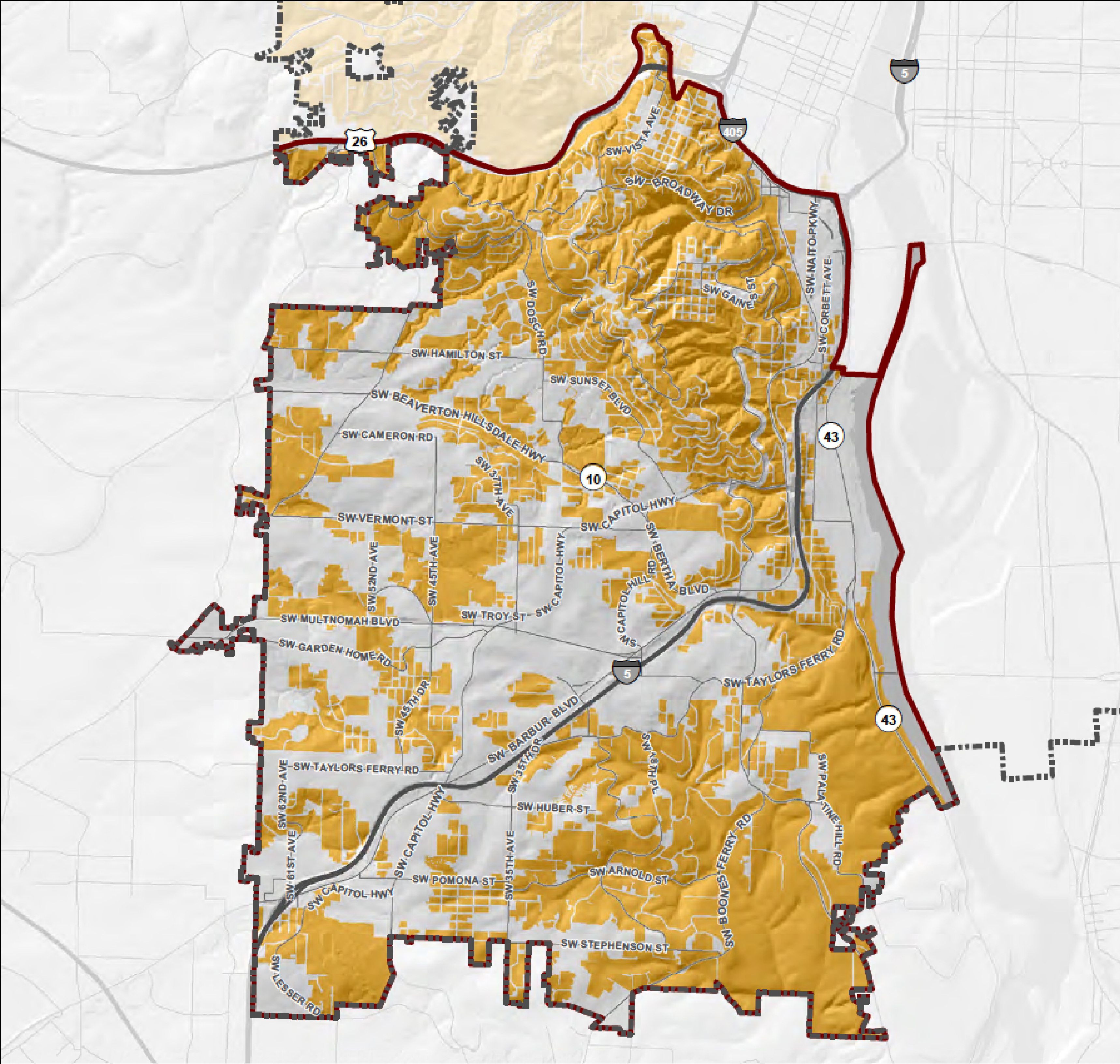
37242

PBEM

September 12, 2016

Mitigation Action Plan (MAP)

Wildfire Hazard Area



Legend

City Boundary

Wildfire Hazard

Risk Reporting Area Southwest

NORTH

0 0.3 0.6 Miles

Sources: City of Portland-2002, 2016

37242

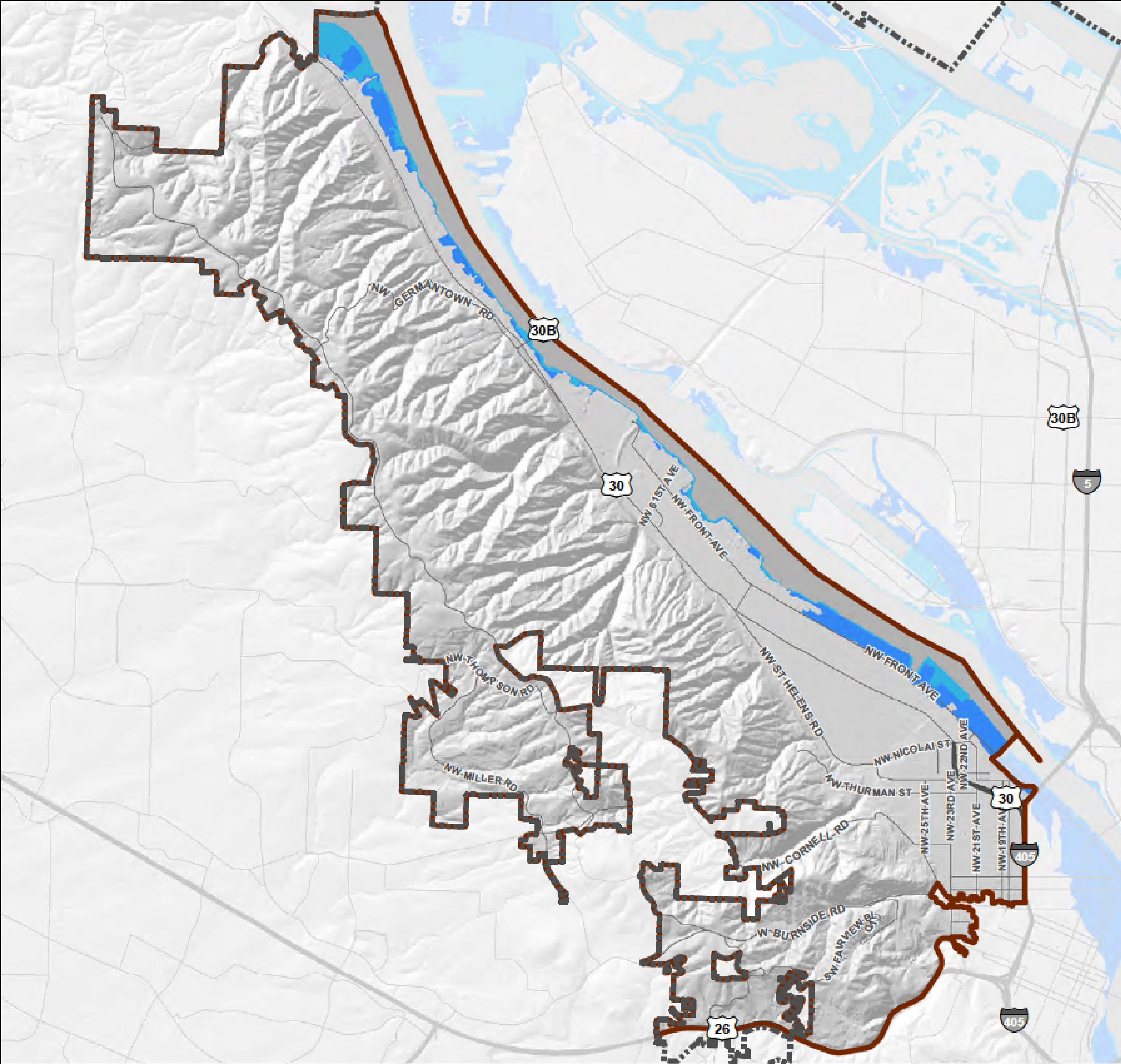
PBEM

WEST/NORTHWEST

September 12, 2016

Mitigation Action Plan (MAP)

Flood hazard - 100-yr and 500-yr FEMA flood zone



Legend

- City Boundary
- 100-year FEMA flood zone
- 500-year FEMA flood zone
- Risk Reporting Area West/Northwest

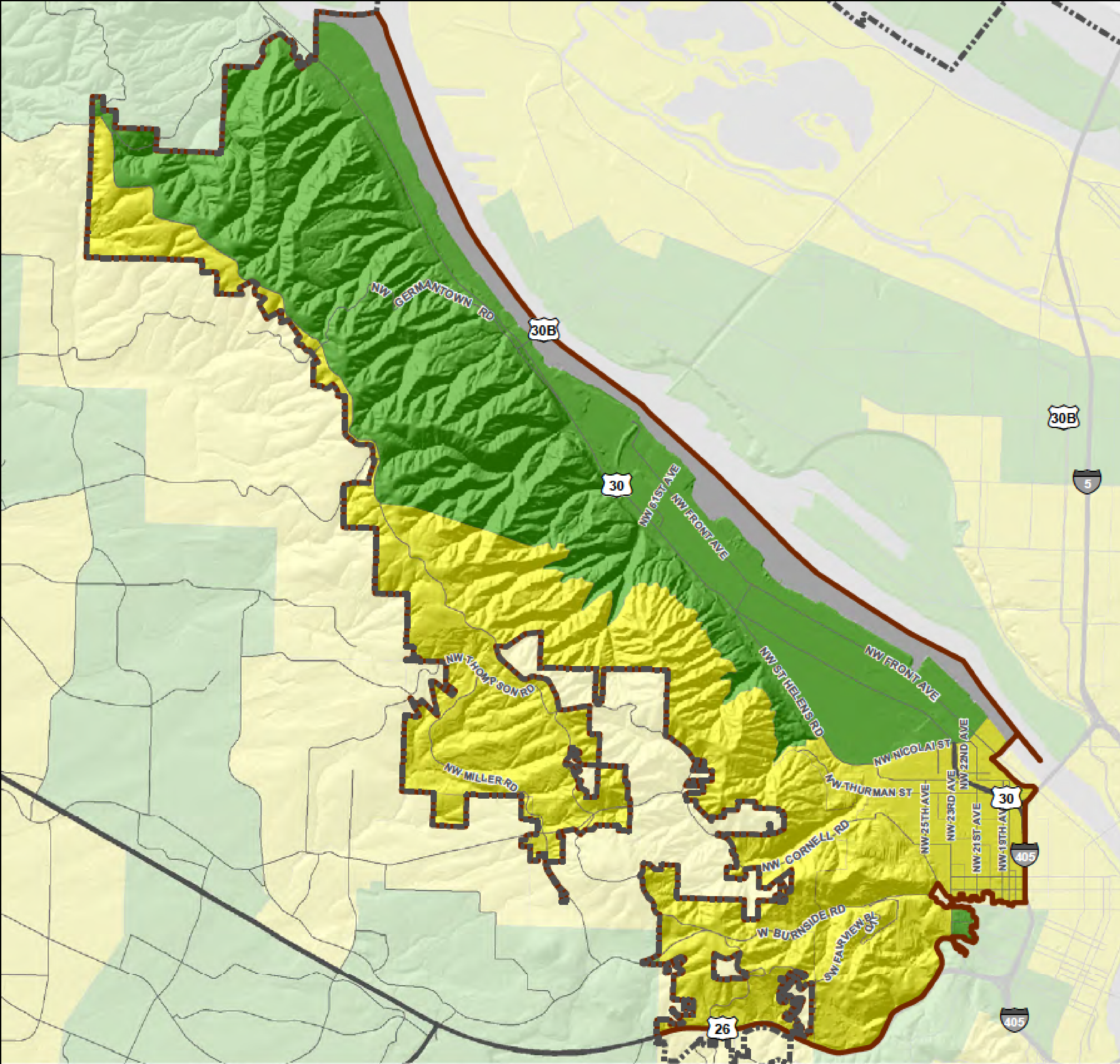
NORTH

0 0.4 0.8 Miles

Sources: FEMA-2014; City of Portland-2016

37242

PBEM



September 12, 2016

Mitigation Action Plan (MAP)

100-year Probabilistic Earthquake--Peak Ground Acceleration

Legend

City Boundary

100-year probabilistic earthquake PGA

Potential Damage - Perceived Shaking

V -- Very Light - Moderate

VI -- Light - Strong

Risk Reporting Area West/Northwest

NORTH

0 0.4 0.8 Miles

Sources: FEMA-2015; City of Portland-2016

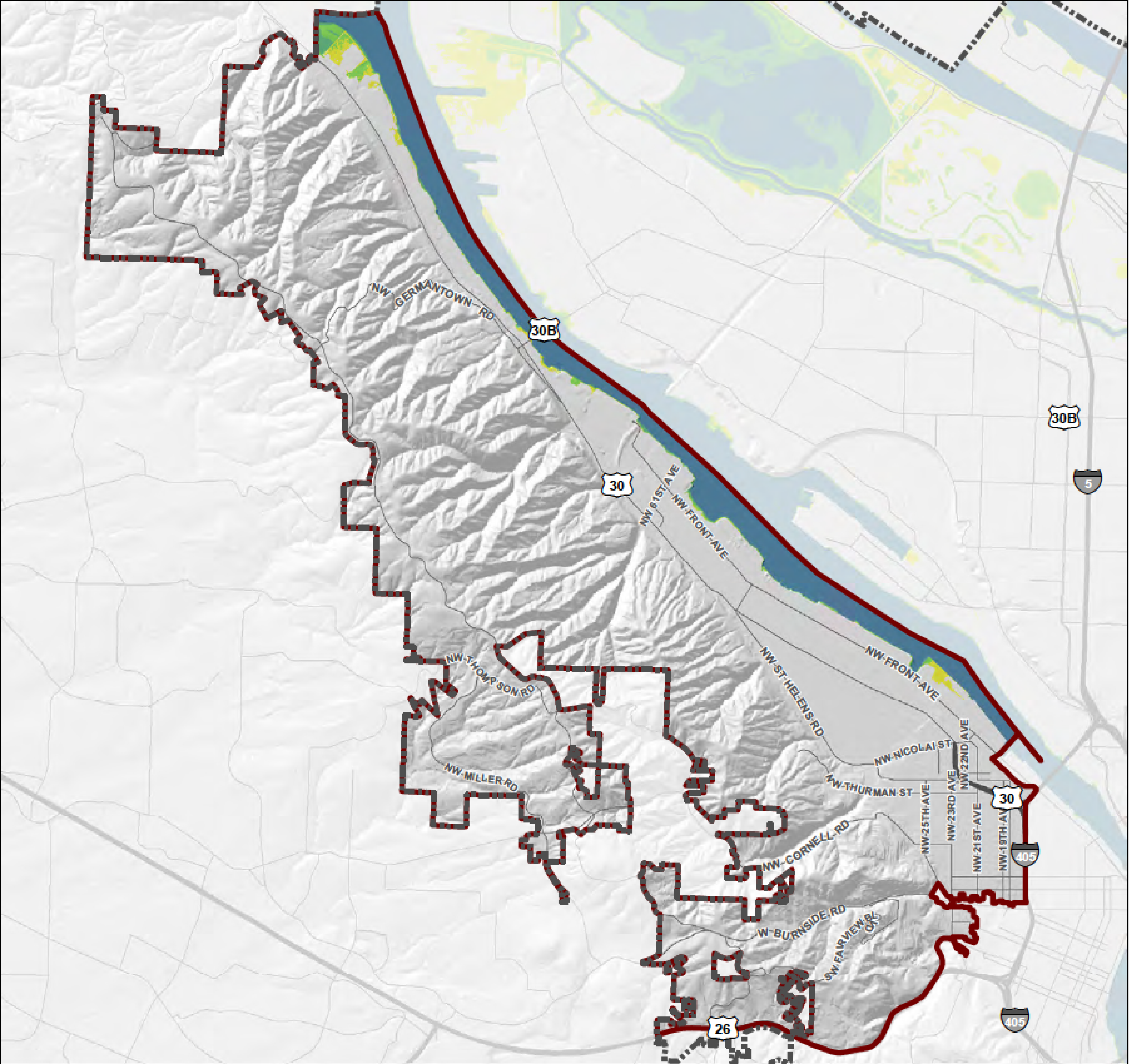
37242

PBEM

September 12, 2016

Mitigation Action Plan (MAP)

Flood Hazard - 100-yr Flood Depth Grid



Legend

City Boundary

100-year flood depth grid

- 0.1' - 4.5'
- 4.6' - 11.5'
- 11.6' - 19.5'
- 19.6' - 25.9'
- 26' - 33.2'

Risk Reporting Area West/Northwest

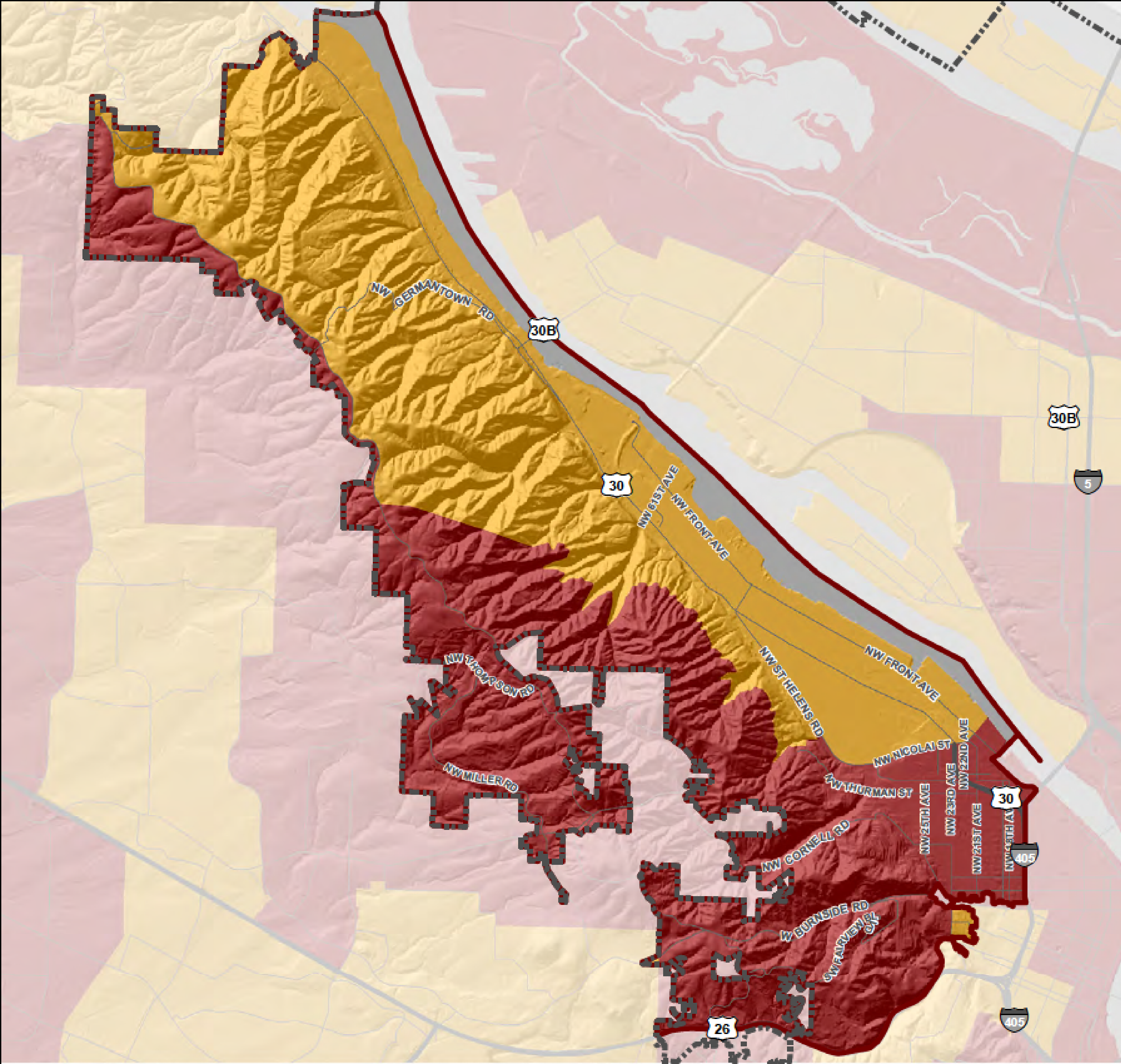
NORTH

0 0.4 0.8 Miles

Sources: Tetra Tech-2016; City of Portland-2016

37242

PBEM



September 12, 2016

Mitigation Action Plan (MAP)

500-year Probabilistic Earthquake--Peak Ground Acceleration

Legend

City Boundary

500-year probabilistic earthquake PGA

Potential Damage - Perceived Shaking

VI -- Light - Strong

VII -- Moderate - Very Strong

VIII -- Moderate/Heavy - Severe

Risk Reporting Area West/Northwest

NORTH

0 0.45 0.9 Miles

Sources: FEMA-2015; City of Portland-2016

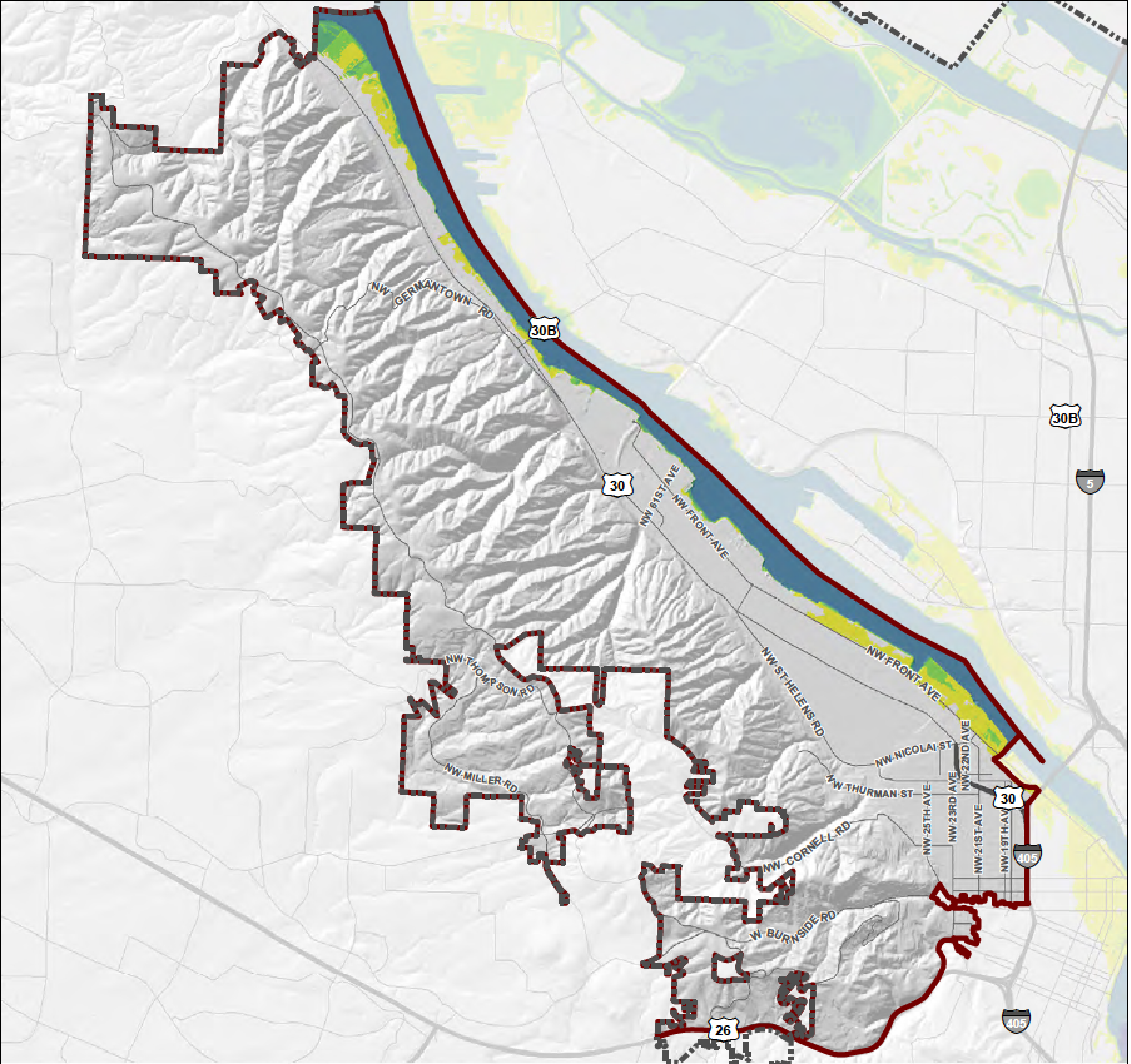
37242

PBEM

September 12, 2016

Mitigation Action Plan (MAP)

Flood Hazard - 500-yr Flood Depth Grid



Legend

City Boundary

500-year flood depth grid

0' - 4.6'

4.7' - 12.9'

13' - 22.6'

22.7' - 28.8'

28.9' - 36.7'

Risk Reporting Area West/Northwest

NORTH

0 0.475 0.95 Miles

Sources: Tetra Tech-2016; City of Portland-2016

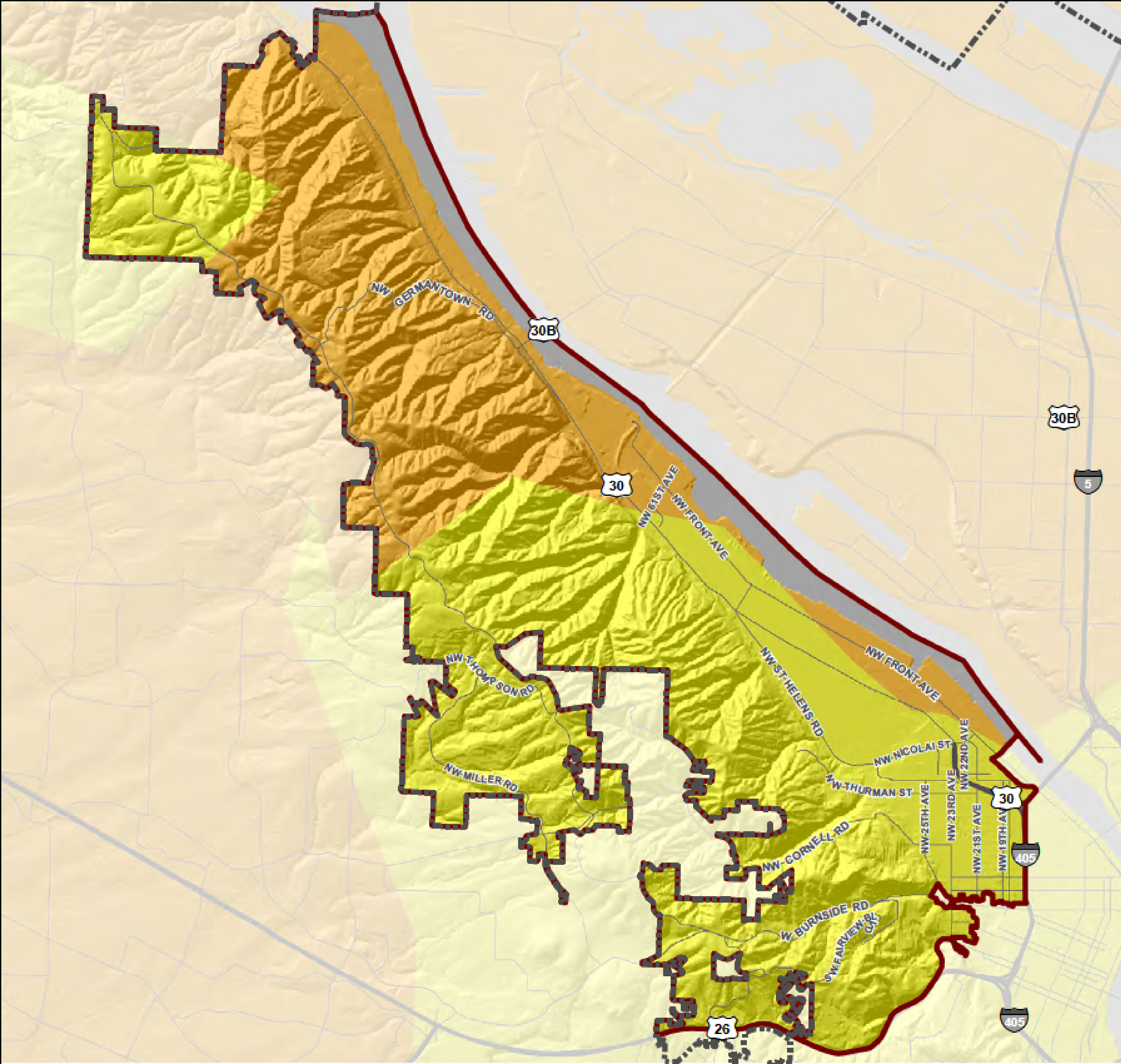
37242

PBEM

September 12, 2016

Mitigation Action Plan (MAP)

Cascadia 9.0 Magnitude Earthquake--Peak Ground Acceleration



Legend

City Boundary

Cascadia M9.0 earthquake PGA

Potential Damage - Perceived Shaking

V – Very Light - Moderate

VI – Light - Strong

VII – Moderate - Very Strong

VIII -- Moderate/Heavy - Severe

Risk Reporting Area West/Northwest

NORTH

0 0.4 0.8 Miles

Sources: USGS-2011; City of Portland-2016

37242

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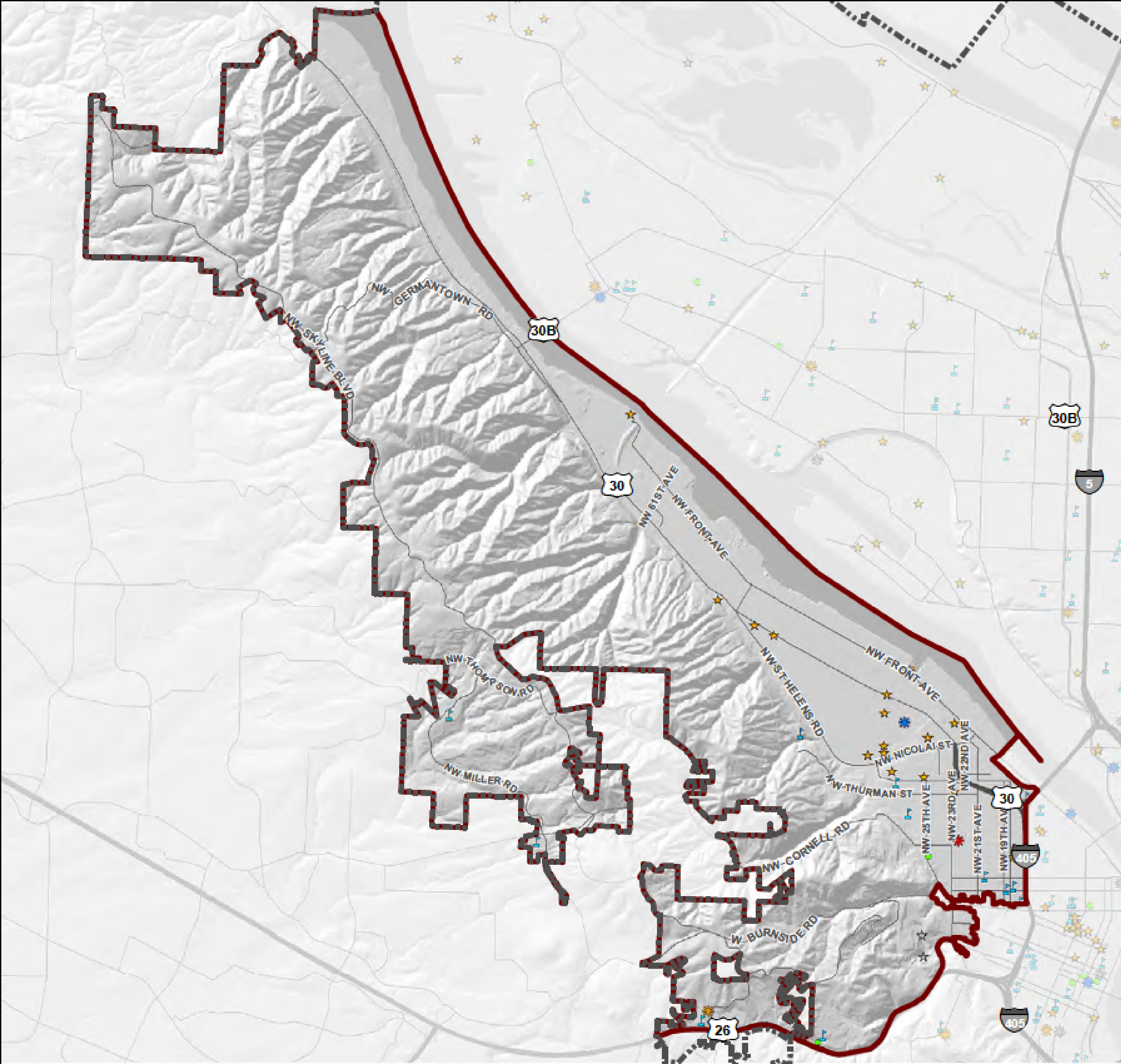
September 12, 2016

Mitigation Action Plan (MAP)

Critical Facilities



Legend

City Boundary

Risk Reporting Area West/Northwest

Emergency Services*

Emergency Coordination Centers

Fire Station Facilities

Police Station Facilities

Medical Care Facilities

High Potential Loss Facilities*

Dams

Military

Nuclear Power Plants

Hazardous Materials

Schools

Other Assets

Zoo, Jails, Nursing/Assisted Living Facilities

*Due to security reasons, some emergency services and high potential loss facilities have been left off of the map.

NORTH

0 0.4 0.8 Miles

Sources: WORD/NID-2015; OSFM-2015; City of Portland-2011, 2015, 2016

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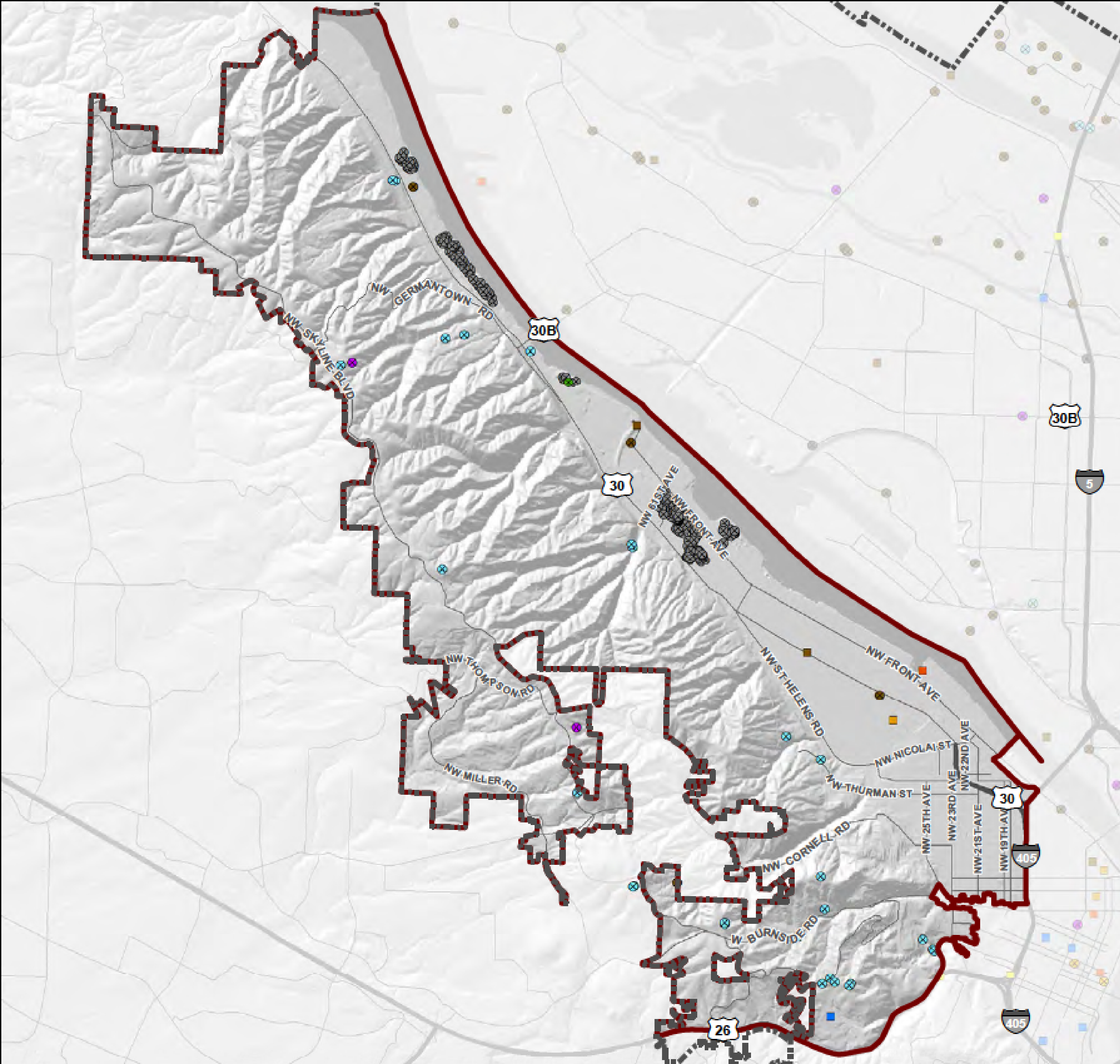
September 12, 2016

Mitigation Action Plan (MAP)

Critical Infrastructure



Legend

City Boundary

Risk Reporting Area West/Northwest

Utility Systems*

- Electrical
- Natural Gas Facilities
- Communication Facilities
- Petroleum Facilities
- Potable Water Facilities
- Wastewater Facilities

Transportation Systems*

- Railway Tunnels, Bridges, and Facilities
- Light Rail Tunnels, Bridges, and Facilities
- Highway Tunnels and Bridges
- Bus Facilities
- Port and Airport Facilities

*Due to security reasons, some utility and transportation system components have been left off of the map.

NORTH

0 0.4 0.8 Miles

Sources: TriMet-2015; Port of Portland-2015; OPHS-2016; City of Portland-2011, 2015,2016; OPB-2016; PTS-2015; FEMA-2015; Kinder Morgan-2015

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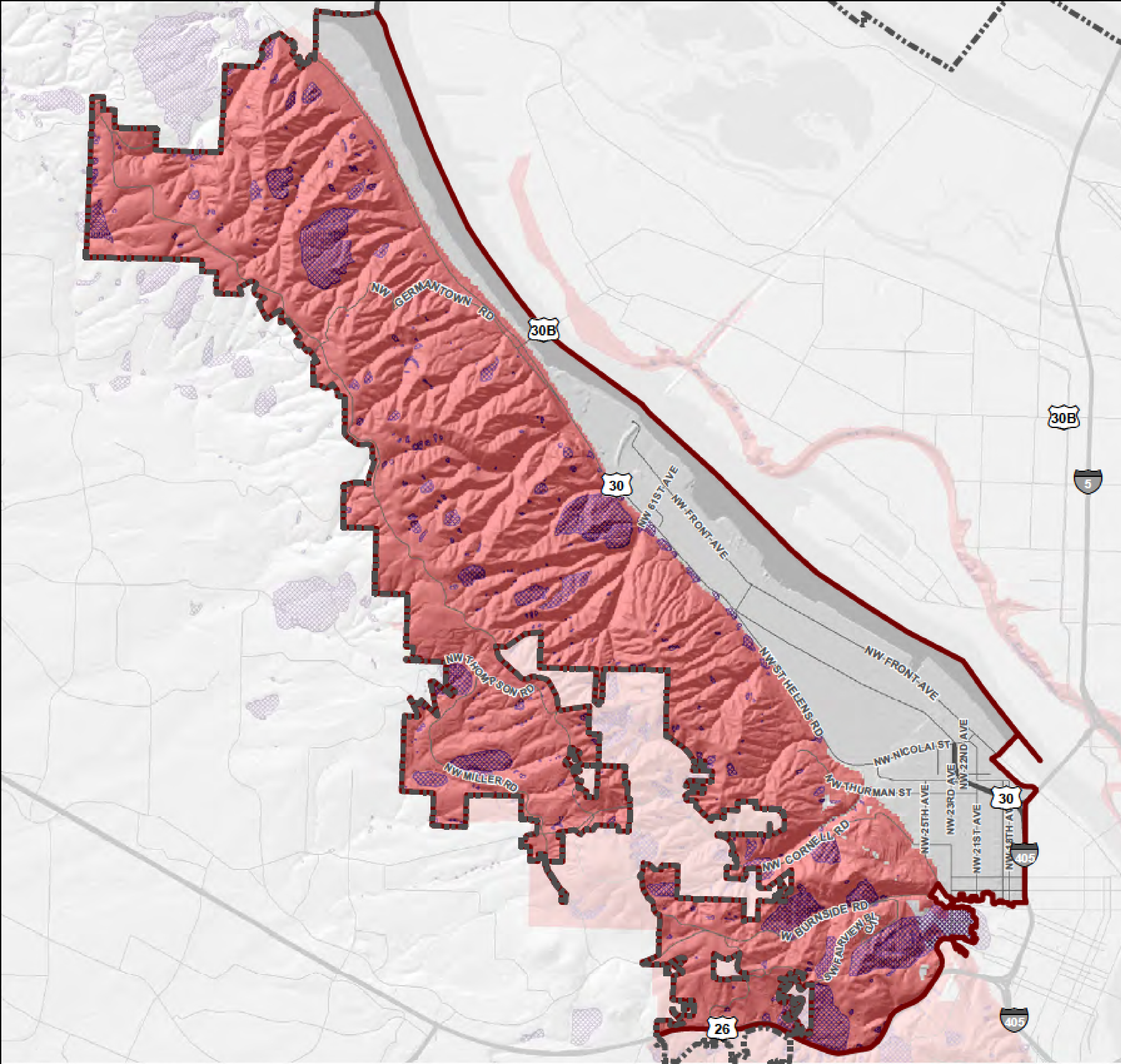
September 12, 2016

Mitigation Action Plan (MAP)

Regulatory Landslide Hazard Area



Legend

City Boundary

Historic Landslide Deposits

Landslide Hazard Area

Risk Reporting Area West/Northwest

NORTH

0 0.4 0.8 Miles

Sources: DOGAMI-2015; City of Portland-2015, 2016

37242

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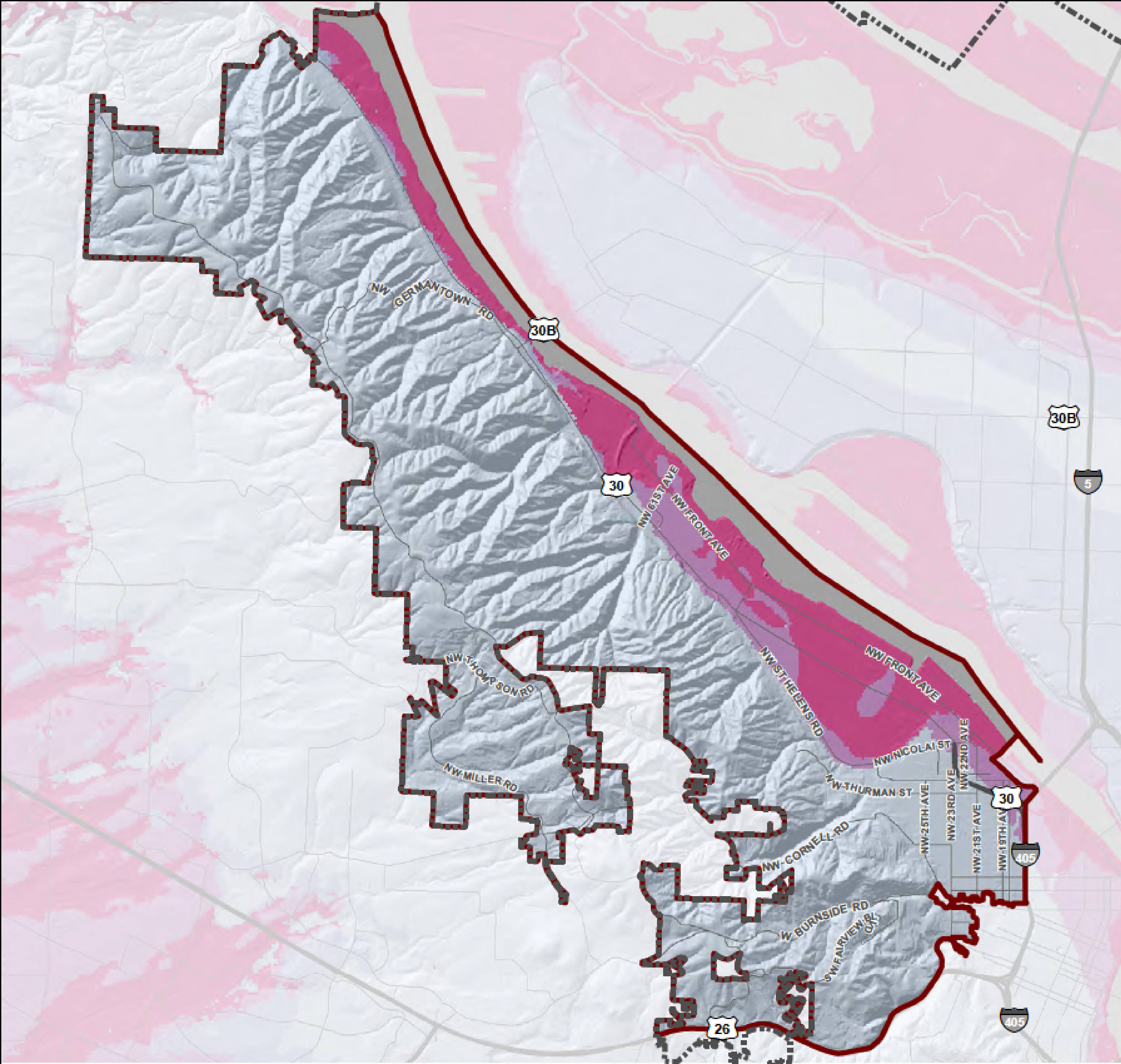
September 12, 2016

Mitigation Action Plan (MAP)

Liquefaction Susceptibility



Legend

City Boundary

Liquefaction Susceptibility

Type

- 0 – None
- 1 – Very Low
- 2 – Low
- 3 – Moderate
- 4 – High
- 5 – Very High

Risk Reporting Area West/Northwest

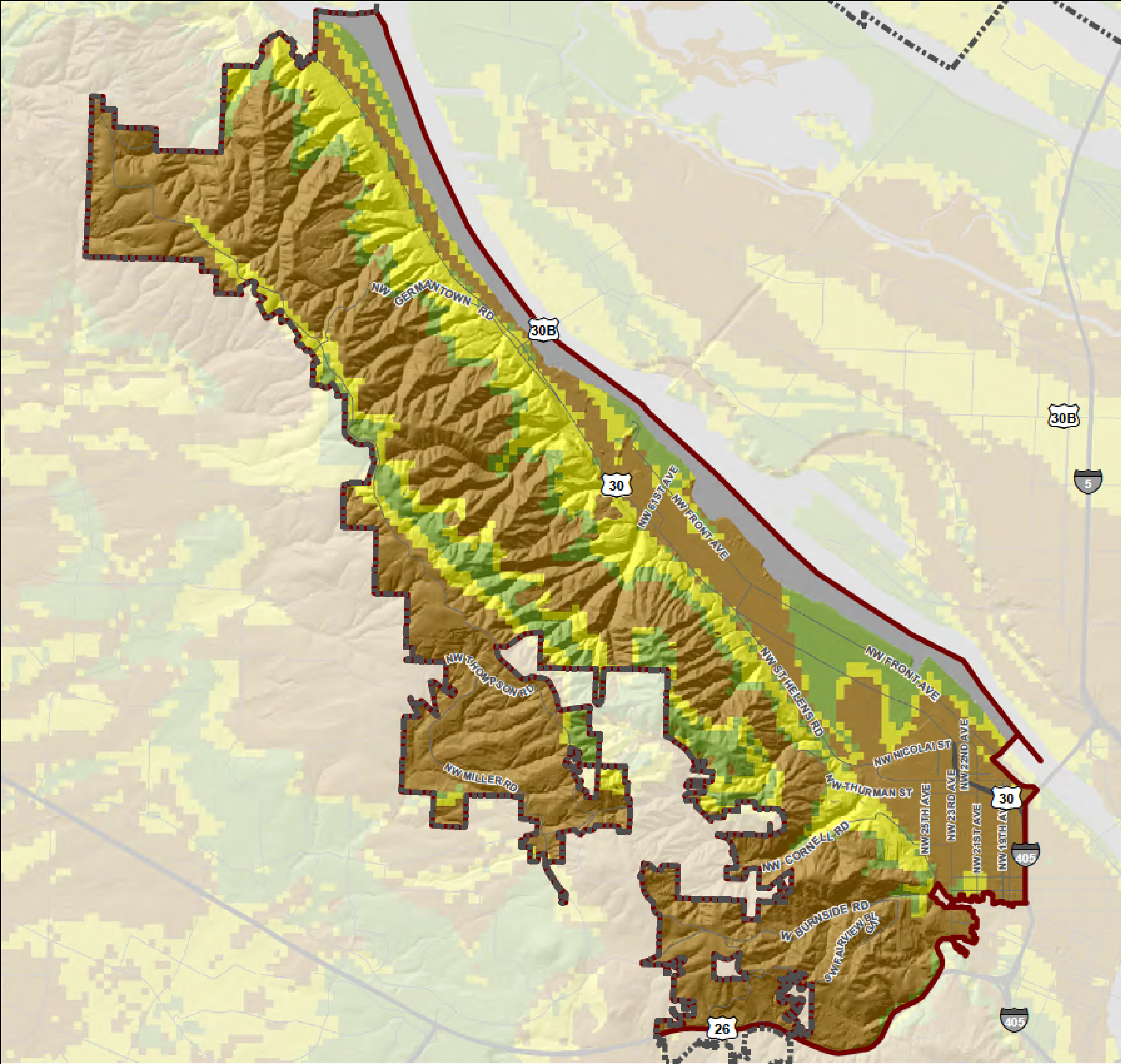
NORTH

0 0.4 0.8 Miles

Sources: DOGAMI-2013; City of Portland-2016

37242

PBEM



September 12, 2016

Mitigation Action Plan (MAP)

National Earthquake Hazards Reduction Program Soils

Legend

City Boundary

NEHRP Soils

Type

- B
- C
- D
- E

Risk Reporting Area West/Northwest

NORTH

0 0.4 0.8 Miles

Sources: DOGAMI-2012; City of Portland-2016

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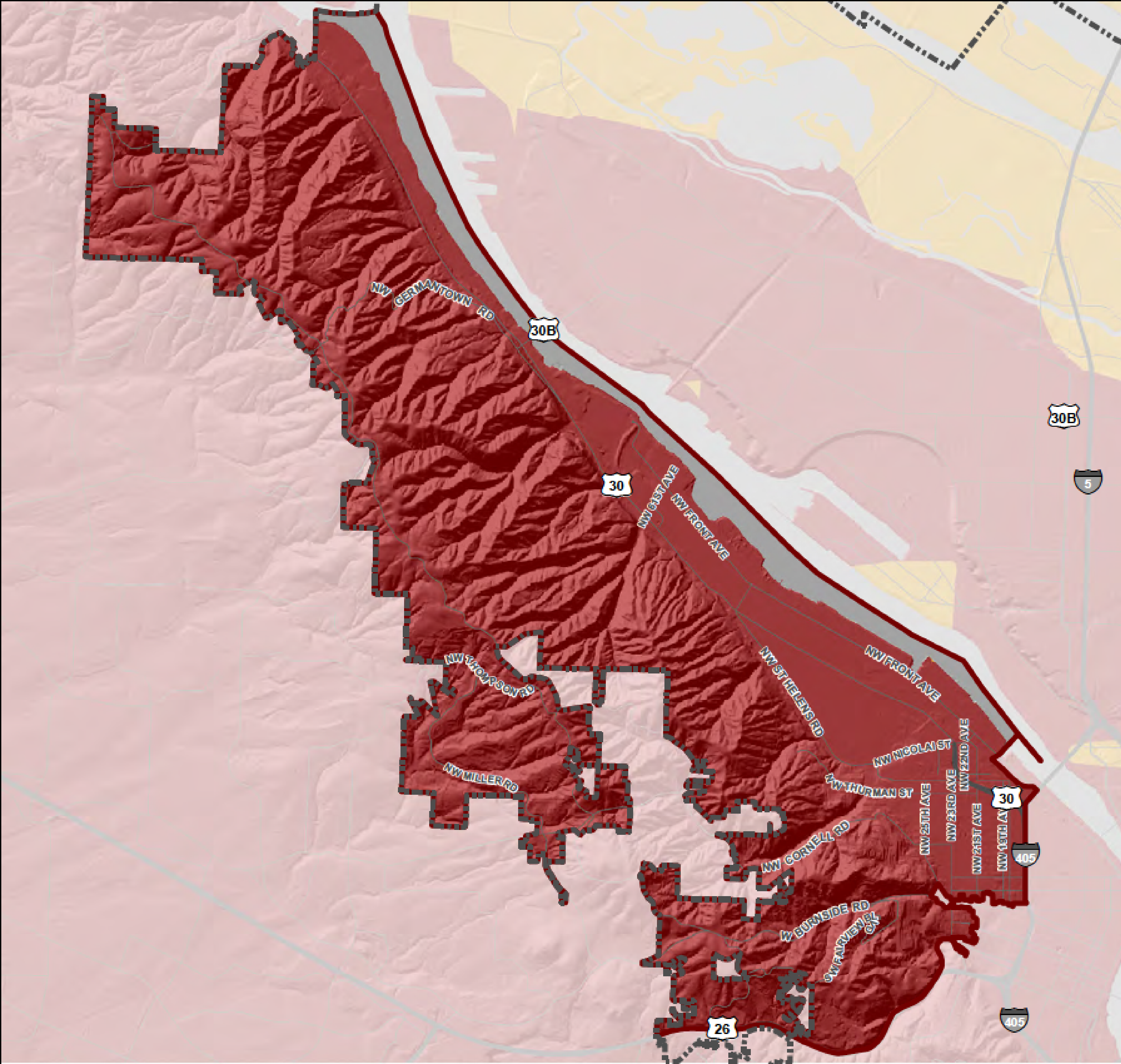
September 12, 2016

Mitigation Action Plan (MAP)

Portland Hills 6.5 Magnitude Earthquake-Peak Ground Acceleration



Legend

City Boundary

Portland Hills M6.5 earthquake PGA

Potential Damage - Perceived Shaking

V -- Very Light - Moderate

VI -- Light - Strong

VII -- Moderate - Very Strong

VIII -- Moderate/Heavy - Severe

Risk Reporting Area West/Northwest

NORTH

0 0.4 0.8 Miles

Sources: USGS-2009; City of Portland-2016

37242

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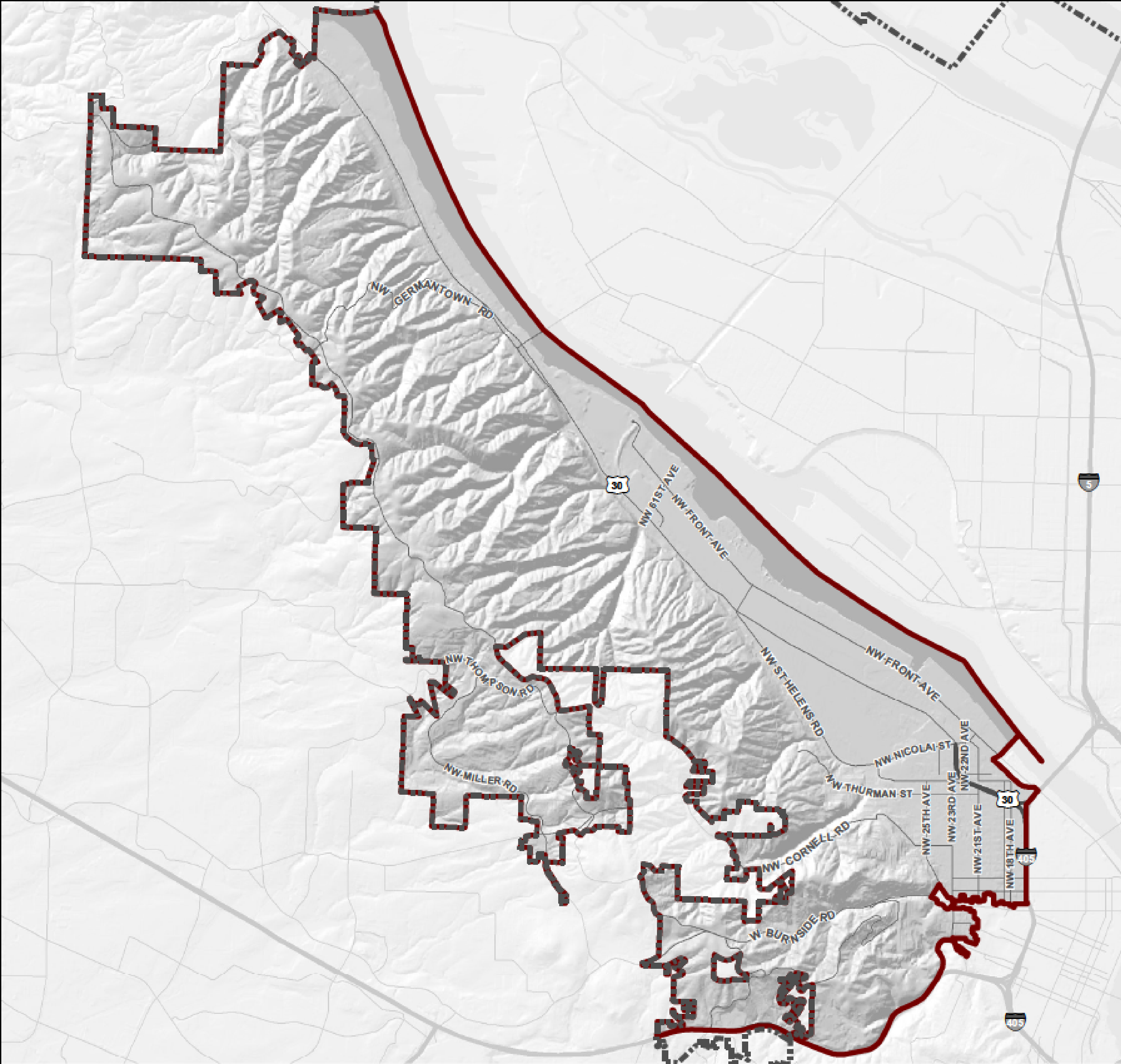
September 12, 2016

Mitigation Action Plan (MAP)

Volcano Hazard Area



Legend

City Boundary

Volcano Hazard Area

Risk Reporting Area West/Northwest

NORTH

0 0.4 0.8 Miles

Sources: USGS-1997;
City of Portland-2016

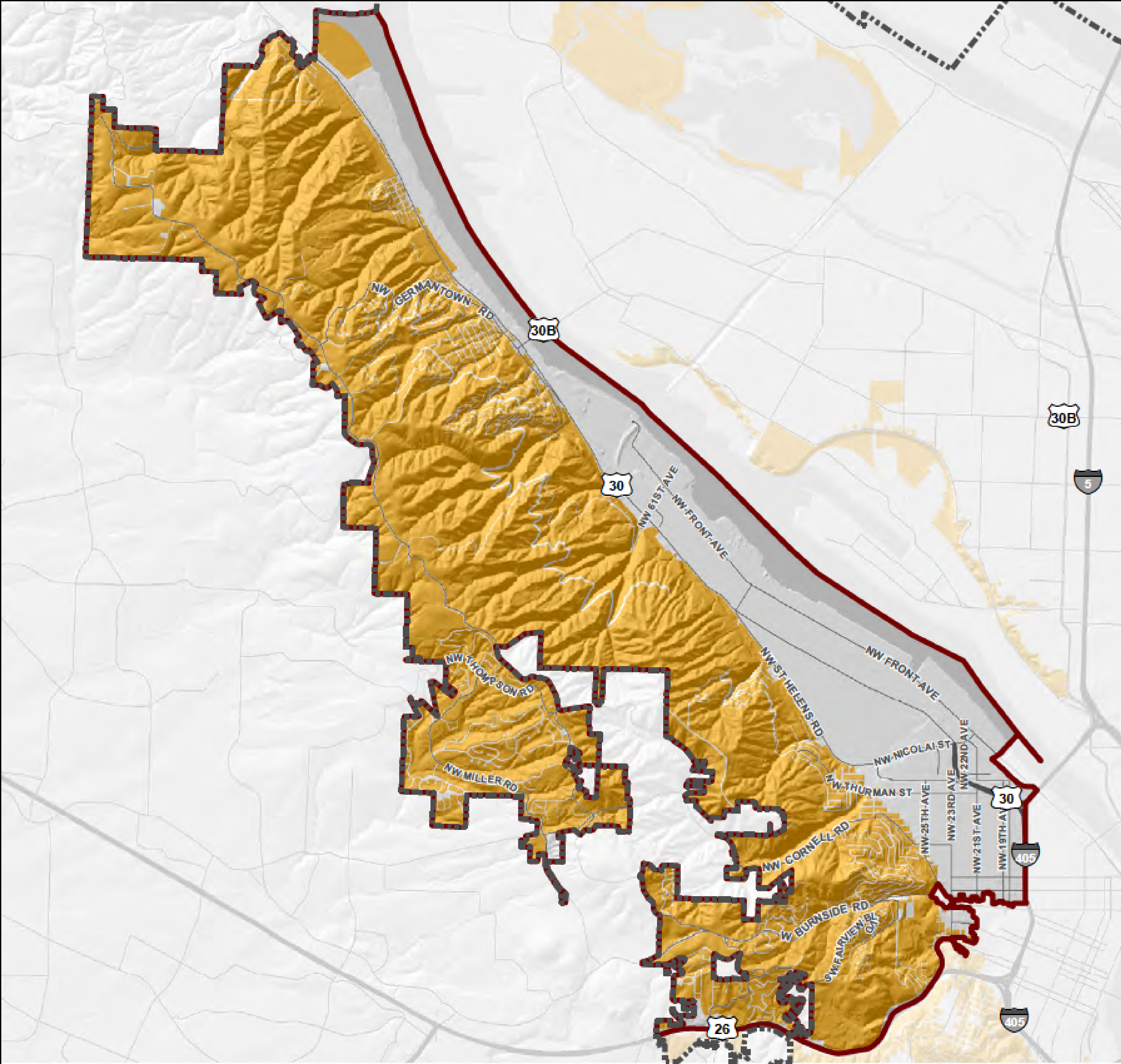
37242

PBEM

September 12, 2016

Mitigation Action Plan (MAP)

Wildfire Hazard Area



Legend

City Boundary

Wildfire Hazard Area

Risk Reporting Area West/Northwest

NORTH

0 0.4 0.8 Miles

Sources: City of Portland-2002, 2016

37242

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Appendix F. Data Sources and Methods Used for Mapping

F. DATA SOURCES AND METHODS USED FOR MAPPING

EARTHQUAKE MAPPING

Liquefaction Susceptibility

Liquefaction data was provided by the Oregon Department of Geology and Mineral Industries (DOGAMI). This database accompanies DOGAMI Open-File Report O-13-06 (Madin and Burns, 2013). The liquefaction mapping uses the methods of Hazus-MH MR4 to create new liquefaction susceptibility data for Oregon. Hazus assigns susceptibility classes based on geology. For this map, the geology was primarily taken from the Oregon Geologic Data Compilation (OGDC 5) and Statewide Landslide Information Layer for Oregon (SLIDO-2), with some coming from published liquefaction studies. The methods and data used to make this map are described in detail in Madin and Burns, 2013.

National Earthquake Hazard Reduction Program Soils

National Earthquake Hazard Reduction Program (NEHRP) site class data was provided by DOGAMI. This database accompanies DOGAMI Open-File Report O-13-06 (Madin and Burns, 2013). The NEHRP soils mapping uses measured shear wave velocity data, estimated shear wave velocity data from the literature, and geologic data primarily taken from OGDC 5 and SLIDO-2, with some coming from published earthquake hazard studies. The methods and data used to make this map are described in detail in Madin and Burns, 2013.

Landslide Susceptibility

Landslide susceptibility data was provided by DOGAMI. This database accompanies DOGAMI Open-File Report O-13-06 (Madin and Burns, 2013). This map uses the methods of Hazus-MH MR4 to create a new landslide susceptibility map for Oregon. Hazus assigns susceptibility classes based on the combination of three geologic material classes and six slope classes. The geologic material classes were derived from the OGDC 5, SLIDO-2, and several other published geologic maps. Slope data was derived from a mosaic of all Oregon Lidar Consortium Lidar topography available at the time and the USGS 30-meter digital elevation model. The methods and data used to make this map are described in detail in Madin and Burns, 2013.

Probabilistic Peak Ground Acceleration Maps

Probabilistic peak ground acceleration data are generated by Hazus-MH 2.2. In Hazus' probabilistic analysis procedure, the ground shaking demand is characterized by spectral contour maps developed by the U.S. Geological Survey (USGS) as part of a 2008 update of the National Seismic Hazard Maps. USGS probabilistic seismic hazard maps are revised about every six years to reflect newly published or thoroughly reviewed earthquake science and to keep pace with regular updates of the building code. Hazus includes maps for eight probabilistic hazard levels: ranging from ground shaking with a 39-percent probability of being exceeded in 50 years (100-year return period) to the ground shaking with a 2-percent probability of being exceeded in 50 years (2,500-year return period). Earthquake mapping for this plan used the 100-year and 500-year probabilistic events.

Shake Maps

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

- An earthquake on the Cascadia Subduction Zone with the following characteristics:
  - Magnitude: 9.0
  - Epicenter: N 45.73 W 125.13
  - Depth: 20 km
- An earthquake on the Portland Hills Fault with the following characteristics:
  - Magnitude: 6.5
  - Epicenter: N 45.55 W 122.8
  - Depth: 0 km

FLOOD MAPPING

Flood hazard areas are mapped as depicted on effective FEMA Digital Flood Insurance Rate Maps dated December 2014. Repetitive flood loss and active NFIP policy data was provided by FEMA as of November 30, 2014. Property addresses were geocoded and then mapped at a citywide scale.

LANDSLIDE MAPPING

The landslide hazard exposure analysis used combination of areas drawn from two sources: regulatory landslide hazard area and historical landslide deposits.

Landslide Hazard Area

Landslide hazard area data was provided by the City of Portland. The regulatory landslide hazard area map was created from three sources:

- Areas identified and mapped by Oregon Metro as earthquake hazard areas
- Areas delineated as zones of high landslide potential in a study conducted by Portland State University based on the mapping of more than 676 landslide events that occurred as a result of the February 1996 storms
- All land within the City that has a slope of 15 percent or greater.

Historical Landslide Deposits

Historical landslide deposit data was provided by the City of Portland and created by DOGAMI as part of the SLIDO Release 3.2 (December 29, 2014). The database is an inventory of existing landslides and includes supplemental photos taken by staff geologists while performing landslide related field work.

The landslide inventory is one of the essential data layers used to delineate regional landslide susceptibility. This inventory is not regulatory, and revisions can happen when new information regarding landslides is found or when future new landslides occur. Therefore, it is possible that landslides within the mapped area were not identified or occurred after the data was prepared.

This data was prepared by following the *Protocol for Inventory Mapping of Landslide Deposits from Light Detection and Ranging (Lidar) Imagery* developed by Burns and Madin (DOGAMI Special Paper 42, 2009). The three primary tasks include compilation of previously mapped landslides, Lidar-based morphologic mapping of landslide features, and review of aerial photographs. Landslides identified by these methods are digitally compiled into this database at varying scales. The recommended map/use scale for these data is 1:8,000.

Each landslide is also attributed with classifications for activity, depth of failure, movement type, and confidence of interpretation. The landslide inventory is intended to provide users with basic information regarding landslides. The geologic, terrain, and climatic conditions that led to landslides in the past may provide clues to the locations and conditions of future landslides, and it is intended that this data will provide useful information to develop regional landslide susceptibility maps, to guide site-specific investigations for future developments, and to assist in regional planning and mitigation of existing landslides.

WILDFIRE MAPPING

Wildfire hazard data created in 2002 by Metro Data Resource Center was provided by the City of Portland. ORS 93.270(4) changed the Oregon Building Code to encourage local governments to voluntarily designate portions of their jurisdictions subject to catastrophic fire as wildfire hazard zones. The purpose of these zones is to define areas where buildings need to be made more survivable from fires spreading through adjacent wildlands. This analysis and map identify wildfire hazard zones within the City of Portland. The methodology used to identify wildfire hazard zones data is described in detail on the Wildfire Hazard Zone Map created by the Metro Data Resource Center for Portland Fire & Rescue, dated October 11, 2002.

DAM FAILURE MAPPING

Inundation area data for Mt. Tabor Reservoirs Nos. 1, 5 and 6 and Washington Park Reservoirs Nos. 3 and 4, provided by the City of Portland Water Bureau, identifies areas where warnings or evacuations may be required due to a failure of the reservoirs. The original inundation area maps were created for the reservoirs' Emergency Action Plans. The DAMBRK model for the Mt. Tabor reservoirs was created and run in March 1999 to develop the original data, using a peak flow of 5,630 cubic feet per second from Reservoir No. 1, 25,400 cubic feet per second from Reservoir No 5, and 23,940 cubic feet per second from Reservoir No. 6.

VOLCANO HAZARD MAPPING

Digital Data for Volcano Hazards in the Mount Hood Region, Oregon was downloaded from the USGS Cascades Volcano Observatory (CVO) website. Scientists at the CVO created the volcanic hazards data to delineate proximal and distal hazard zones that could be affected by lahars in the event of an eruption. This dataset was generated with a combination of computer modeling and geologic evidence of past events at Mt. Hood as recorded in deposits. These volcanic hazard zones are intended for use by public and private agencies to view, overlay with other GIS datasets, and make maps of volcanic hazards from potential future eruptions of Mount Hood.

The hazard zones delineated in this data set portray volcanic events believed most likely from future activity at Mount Hood. Areas outside the hazard zones, especially those having low relief, should not be regarded as hazard-free. Too many uncertainties exist in source, size, and mobility of future events to locate boundaries of zero-hazard zones with confidence. The degree of hazard does not change abruptly at the hazard zone boundaries. Rather, a volcanic hazard decreases gradually with increased distance from the volcano and above the valley floor. Volcanic hazards also span a range of size and recurrence.

REFERENCES

Burns, William J. and Kate Mickelson. Oregon Department of Geology & Mineral Resources.

Costa, John E., 1997, Hydraulic modeling for lahar hazards at Cascade volcanoes: Environmental & Engineering Geoscience, V. 3, No. 1, pp. 21-30.

Madin, I.P., and Burns, W.J., 2013, Ground motion, ground deformation, tsunami inundation, coseismic subsidence, and damage potential maps for the 2012 Oregon Resilience Plan for Cascadia Subduction Zone Earthquakes; Oregon Department of Geology and Mineral Industries Open-File Report O-13-06.

Schilling, Steve P. and Iverson, Richard M., 1997, Automated, reproducible delineation of zones at risk from inundation by large volcanic debris flows: in Chen, C. (editor), Hazards mitigation: mechanics, prediction, and assessment, Proceedings of first international conference, American Society of Civil Engineers, pp 176-186.

Scott, W.E., Pierson, T.C., Schilling, S.P., Costa, J.E., Gardner, C.A., Vallance, J.W., and Major, J.J., 1997, Volcano hazards in the Mount Hood Region, Oregon: U.S. Geological Survey, Open-file Report 97-89, 14 p.

The Mitigation Action Plan

Appendix G. Risk Assessment Data Gaps and Limitations

G. Risk Assessment Data Gaps and Limitations

HAZARD DATA GAPS

Data Layer	Data Gaps	Effect on Risk Assessment
Flood		
Finished floor elevations	This information is only available as individual elevation certificates. In order to incorporate this information into the Hazus analysis, the elevation values would need to be extracted from the certificates into a database that can be linked to the buildings data.	The first floor elevation, in conjunction with the flood depth grid value, is used to determine the depth of flooding at a particular building. The extent of damage to the building and its contents is then estimated from the depth of flooding by the application of a depth-damage curve associated with the Hazus occupancy class for the building. If the building-specific finish floor elevation is not available, a default value is used. This default value is based on the year the structure was built and the foundation type. Using default first floor elevation values results in less accurate damage estimates.
Earthquake		
Liquefaction susceptibility	Portland Water Bureau recently completed a liquefaction susceptibility dataset. This dataset will need to be vetted by other City bureaus. The next MAP update should incorporate this data in the earthquake analysis.	The current DOGAMI data has been produced at a state-level scale. The new Water Bureau data should be at a scale more appropriate for a city-level analysis.
Landslide susceptibility	DOGAMI is currently working on a new landslide susceptibility dataset that will be completed by the end of 2016. The next MAP update should incorporate this data in the earthquake analysis.	The current DOGAMI data has been produced at a state-level scale. The new DOGAMI data is being produced at a county-level scale and should provide more detail for a city-level analysis. The new DOGAMI data is also being produced using LiDAR data and the latest methodology.
Landslide		
Regulatory landslide hazard area	DOGAMI is currently working on a new landslide susceptibility dataset that will be completed by the end of 2016. The next MAP update should incorporate this data in the landslide analysis.	The current DOGAMI data has been produced at a state-level scale. The new DOGAMI data is being produced at a county-level scale and should provide more detail for a city-level analysis. The new DOGAMI data is also being produced using LiDAR data and the latest methodology.
Historic landslide deposits	DOGAMI is currently working on a new landslide susceptibility dataset that will be completed by the end of 2016. The next MAP update should incorporate this data in the landslide analysis.	The current DOGAMI data has been produced at a state-level scale. The new DOGAMI data is being produced at a county-level scale and should provide more detail for a city-level analysis. The new DOGAMI data is also being produced using LiDAR data and the latest methodology.
Wildfire		
Wildfire hazard	This dataset was created in 2002, the City may update this data. The next MAP update should incorporate the updated data in the wildfire analysis.	An updated version of this data will most likely be created from current LiDAR data and include updated vegetation data. Any increase in the level of accuracy and level of detail will improve the exposure analysis.
Climate Change		
N/A	No data available for scenario-based future modeling.	

BUILDING DATA GAPS

Data Layer	Data Gaps	Effect on Risk Assessment
Building footprints with added tax assessor data	The use description attribute was incomplete. Secondary descriptions and zoning attributes were used when the primary use description was not available.	The use description information is critical to assigning the correct Hazus occupancy classes to the buildings. The occupancy class is used in a number of ways including determining replacement costs and assigning damage curves for the flood and earthquake analyses.
	For residential buildings with both finished and unfinished basement square footage there was not information on how the square footage was divided between finished and unfinished. In this situation, it was assumed that the square footage was divided 50/50 between finished and unfinished.	Finished and unfinished square footage are used in the replacement cost calculation. Accurate square footage values result in more accurate replacement cost values.
	Attached garage square footage was not included so only detached garage information was used in the replacement cost calculation.	Garage square footage is used in the replacement cost calculation. Attached garage square footage values would result in more accurate replacement cost values.
	Construction class information (economy, average, luxury) was not available. This information is stored in the permitting system, but it is not possible to extract and associate it with the building data.	Construction class information for single-family residential buildings is used to determine the appropriate cost per square foot values used in the replacement cost calculation. For this risk assessment, all buildings were considered to have an average construction class. Using the actual construction class would result in more accurate replacement cost values.
	Construction material information was not available except for unreinforced masonry buildings.	Construction material information is used to assign damage curves for the earthquake analysis. For this risk assessment, default construction material values based on the Hazus occupancy class and year built were assigned. Using the actual construction material would result in the use of the most appropriate damage curves and more accurate damage estimates.
	Foundation type information was incomplete.	Foundation type information is used to assign damage curves for the flood analysis. For this risk assessment, default foundation type values based on the Hazus occupancy class were assigned when actual values were not available. Using the actual foundation type would result in the use of the most appropriate damage curves and more accurate damage estimates.
Low income URM buildings	Data not available.	

CRITICAL FACILITIES DATA GAPS

Data Layer	Data Gaps	Effect on Risk Assessment
Emergency Operation Centers		
Emergency Operation Centers	Replacement cost values not available.	Damage estimates in dollars not available when ranking risk and determining mitigation actions.
Fire Stations		
Fire stations	Owner and replacement cost values not available.	Damage estimates in dollars not available when ranking risk and determining mitigation actions.
Fireboat facilities	Replacement cost values not available.	Damage estimates in dollars not available when ranking risk and determining mitigation actions.
Medical Care Facilities		
Hospitals	An attribute with the numbers of beds would have been useful when assigning the Hazus analysis class. Replacement cost values not available.	Using the correct Hazus analysis class provides the most accurate estimate of damage. Damage estimates in dollars not available when ranking risk and determining mitigation actions.

Data Layer	Data Gaps	Effect on Risk Assessment
Police Stations		
Police Bureau facilities	Replacement cost values not available.	Damage estimates in dollars not available when ranking risk and determining mitigation actions.
Non-Police Bureau facilities	Replacement cost values not available.	Damage estimates in dollars not available when ranking risk and determining mitigation actions.
Schools		
Schools	Replacement cost values not available.	Damage estimates in dollars not available when ranking risk and determining mitigation actions.
Dams		
Dams	Construction information was incomplete, this information is useful for assigning Hazus analysis class. Replacement cost values not available.	Using the correct Hazus analysis class provides the most accurate estimate of damage. Damage estimates in dollars not available when ranking risk and determining mitigation actions.
Hazardous Materials		
Hazardous material facilities	Replacement cost values not available.	Damage estimates in dollars not available when ranking risk and determining mitigation actions.
Military Facilities		
Armories	Replacement cost values not available.	Damage estimates in dollars not available when ranking risk and determining mitigation actions.
Military installations	Replacement cost values not available.	Damage estimates in dollars not available when ranking risk and determining mitigation actions.
Nuclear Power Plants		
Nuclear reactors	Replacement cost values not available.	Damage estimates in dollars not available when ranking risk and determining mitigation actions.
Air Transportation Facilities		
Airports	Hazus has analysis classes for many of the individual buildings/terminals at an airport. The available data did not have this level of detail.	Building-level information could help refine any mitigation actions specific to the airport.
Helipads	Replacement cost values not available.	Damage estimates in dollars not available when ranking risk and determining mitigation actions.
Bus Facilities		
Transit centers	Information that distinguishes between transit centers that are enclosed structures versus park and ride lots would have been useful when assigning the Hazus analysis class. Replacement cost values not available.	Using the correct Hazus analysis class provides the most accurate estimate of damage. Damage estimates in dollars not available when ranking risk and determining mitigation actions.
Bus facilities	Replacement cost values not available.	Damage estimates in dollars not available when ranking risk and determining mitigation actions.
Highway Facilities		
Highway bridges	City of Portland data provided spatial locations of bridges and HITRAC data provided descriptive information, including the Hazus analysis class, scour index and replacement cost. Unknown if replacement cost values are accurate.	Damage estimates in dollars may not be accurate.
Highway tunnels	Information on type of tunnel - bored or cut and cover - would have been useful when assigning Hazus analysis class. Replacement cost values not available.	Using the correct Hazus analysis class provides the most accurate estimate of damage. Damage estimates in dollars not available when ranking risk and determining mitigation actions.

Data Layer	Data Gaps	Effect on Risk Assessment
Light Rail Facilities		
Light rail bridges	Information about the bridge construction would have been useful when assigning Hazus analysis class. Replacement cost values not available.	Using the correct Hazus analysis class provides the most accurate estimate of damage. Damage estimates in dollars not available when ranking risk and determining mitigation actions.
Light rail facilities	Replacement cost values not available.	Damage estimates in dollars not available when ranking risk and determining mitigation actions.
Light rail tunnel	Replacement cost values not available.	Damage estimates in dollars not available when ranking risk and determining mitigation actions.
Port Facilities		
Port facilities	Data was not provided in a GIS format. Used information in Seismic Risk Assessment report and orthoimagery to locate facilities.	Increased level of effort to analyze these facilities.
Rail Facilities		
Rail bridges	City of Portland data provided spatial locations of bridges and HITRAC data provided descriptive information, including the Hazus analysis class, scour index and replacement cost. Unknown if replacement cost values are accurate.	Damage estimates in dollars may not be accurate.
Rail facilities	Replacement cost values not available.	Damage estimates in dollars not available when ranking risk and determining mitigation actions.
Rail tunnel	Replacement cost values not available.	Damage estimates in dollars not available when ranking risk and determining mitigation actions.
Communications Facilities		
Transmitters 800MHz	Replacement cost values not available.	Damage estimates in dollars not available when ranking risk and determining mitigation actions.
CenturyLink offices	This data only includes CenturyLink offices, offices for other companies are not included. Replacement cost values not available.	Potentially missing facilities that could affect the determination of mitigation actions. Damage estimates in dollars not available when ranking risk and determining mitigation actions.
Communication facilities	Default data is likely out of date and doesn't cover all radio and TV broadcasting facilities in the City. Replacement cost values are not available.	Potentially missing facilities that could affect the determination of mitigation actions. Damage estimates in dollars not available when ranking risk and determining mitigation actions.
Other communications facilities	Data is not available for other internet facilities or switching hubs.	Potentially missing facilities that could affect the determination of mitigation actions.
Electric Power Facilities		
Electric substations	Replacement cost values not available.	Damage estimates in dollars not available when ranking risk and determining mitigation actions.
Electric facilities	Default data is likely out of date and doesn't cover all radio and TV broadcasting facilities in the City. Replacement cost values are not available.	Potentially missing facilities that could affect the determination of mitigation actions. Damage estimates in dollars not available when ranking risk and determining mitigation actions.
Natural Gas Facilities		
Natural gas facilities	This data may be missing natural gas compressor sites. Replacement cost values are not available.	Potentially missing facilities that could affect the determination of mitigation actions. Damage estimates in dollars not available when ranking risk and determining mitigation actions.
Petroleum Facilities		
Petrol tank farms	Data is missing for several tank farms but majority are included. Replacement cost values are not available.	Potentially missing facilities that could affect the determination of mitigation actions. Damage estimates in dollars not available when ranking risk and determining mitigation actions.

Data Layer	Data Gaps	Effect on Risk Assessment
Potable Water Facilities		
Well sites	Replacement cost values not available.	Damage estimates in dollars not available when ranking risk and determining mitigation actions.
Reservoirs	Replacement cost values not available.	Damage estimates in dollars not available when ranking risk and determining mitigation actions.
Pump stations	Replacement cost values not available.	Damage estimates in dollars not available when ranking risk and determining mitigation actions.
Potable water facilities	Replacement cost values not available.	Damage estimates in dollars not available when ranking risk and determining mitigation actions.
Wastewater Facilities		
Wastewater facilities	Pump/lift station data did not include capacity information, which would have been useful when assigning Hazus analysis class. Replacement cost values not available.	Using the correct Hazus analysis class provides the most accurate estimate of damage. Damage estimates in dollars not available when ranking risk and determining mitigation actions.
Other Facilities		
Prisons	Replacement cost values not available.	Damage estimates in dollars not available when ranking risk and determining mitigation actions.
City-owned essential facilities	Replacement cost values not available.	Damage estimates in dollars not available when ranking risk and determining mitigation actions.
Oregon Zoo	Replacement cost values not available.	Damage estimates in dollars not available when ranking risk and determining mitigation actions.
Nursing homes/ assisted living facilities	Replacement cost values not available.	Damage estimates in dollars not available when ranking risk and determining mitigation actions.

The Mitigation Action Plan

Appendix H. Prior Plan Goals

H. Prior Plan Goals

For the 2004 NHMP, the Planning Team used the exposure analysis results as a basis for developing the mitigation goals and actions. The City selected the five goals in 2004 to reduce or avoid long-term vulnerabilities to the identified hazards for the five-year planning period.

- Identify risk level and evaluate Portland's vulnerability to natural hazards
- Implement activities to protect human life, property and natural systems
- Promote public awareness, engage public participation and enhance partnerships through education, outreach and coordination of a diverse and representative group of the City's population
- Establish a disaster resilient economy
- Build and support the capacity and commitment to continuously become less vulnerable to hazards

For the 2010 NHMP update, the Planning Team evaluated the 2004 NHMP's goals and determined they needed to modify them to better meet the city's changing needs. The City determined the seven goals to more clearly focus their long-term efforts to reducing risk and vulnerabilities to the identified hazards.

- Update the Risk Assessment and Vulnerability Analysis every five years
- Implement actions to prepare, protect, preserve and restore life, property and natural systems
- Promote public outreach to a variety of City populations
- Improve City of Portland's economic resilience through inclusion of the private sector into mitigation action implementation
- Commit to continuously reducing the City's natural hazards vulnerability
- Maximize mitigation effectiveness by taking a comprehensive approach to natural resource management via city plans, codes and programs that increase mitigation efforts
- Coordinate mitigation activities with regional communities and agencies

The Mitigation Action Plan

Appendix I. Mitigation Best Practices Catalog

I. Mitigation Best Practices Catalog

BACKGROUND INFORMATION

Risk is defined as being a function of the:

- Hazard
- Exposure
- Vulnerability
- Capability.

Risk can be reduced through mitigation by manipulating the hazard, reducing exposure to the hazard, reducing the vulnerability and/or increasing capability. And, where mitigation is not yet possible, the risk can be reduced through preparation, response or/and recovery.

Over the course of developing *The Mitigation Action Plan* (MAP), the following catalogs were developed from best practices, steering committee recommendations and stakeholder input. These catalogs are not meant to be exhaustive, but to inspire thought. It is expected that the City of Portland, in collaboration with stakeholders, will take these ideas and concepts and look for specific ways to apply them for their own particular needs/situation. These actions should be refined to add additional specificity and clarity as needed.

The City of Portland, its residents and its businesses are already engaged in many of these activities. In addition to identifying new actions, Bureaus may want to select actions that continue existing plans and programs. In general in selecting actions, the City of Portland and its stakeholders should capitalize on strengths and look for opportunities to overcome obstacles and weaknesses.

STEERING COMMITTEE TOP-RATED ACTIONS AND CEI HUB REPORT RECOMMENDATIONS

The following actions were selected as top-rated actions by the steering committee and/or were recommendations developed from the Critical Energy Infrastructure (CEI) Hub report.

Hazard (source)	Refined Action	Total Votes
All Hazards (SC-1)	For each hazard of concern, develop a simple report card that identifies the risk in each category and the progress made on identified performance metrics. Include a sheet with "plain talk" language explaining any references to government reports and emergency codes. Include this information in the annual progress report. Share the results annually in several very public ways (e.g. press release, community group networks, posted on website). Develop a system to ensure that members of the public have received the information.	11
All Hazards (SC-3)	Fund disability community-based organization to build resiliency skills and capacity of people with disabilities to be engaged as a part of a resilient community response	5
All Hazards (SC-4)	Develop an inventory of critical facilities that includes those facilities critical to underserved populations and other community groups. Once developed, keep this inventory up to date.	5
All Hazards (SC-210)	Prior to and during implementation, review all actions for negative externalities and to ensure vulnerable populations are protected from displacement or other disproportionate burdens.	Note – not included in voting
Dam Failure (SC-5)	Collaborate with Multnomah County Drainage District to get flooding impact studies from levy failure and develop a risk assessment using the updated general building stock, critical facility and demographic information developed for the mitigation action plan.	4
Dam Failure (SC-8)	Continue to monitor risk from Mt. Tabor reservoirs. Re-evaluate the proposal to retain 85% capacity, and consider reflecting pools instead.	3
Dam Failure (SC-10)	Collaborate with Clackamas County to get dam inundation areas from upstream dams that might affect Portland and develop a risk assessment using the updated general building stock, critical facility and demographic information developed for the mitigation action plan.	2
Drought (SC-12)	Promote drought-resistant landscaping and planting that supports native fauna including pollinator insects and migratory birds.	5
Earthquake (SC-13)	Expand ATC-20 trainings and certifications to increase pool of damage assessment team members.	6
Earthquake (SC-14)	Lobby for increased funding for seismic retrofits and the creation of a statewide committee on CEI hub partial or complete relocation. (Office of Government Relations)	16
Earthquake (SC-16)	Ensure that every Bureau has inventoried critical assets and reviewed critical infrastructure vulnerability and has identified a 50-year plan to strengthen, retrofit, relocate or otherwise increase resiliency. Consider ways to promote citywide collaboration and prioritization of resiliency efforts.	16
Earthquake (SC-18)	Collaborate with PSU to identify buildings (public and other institutions) that exceed life safety standards and are likely to be useable for government functions and other purposes after various earthquake events.	6
Earthquake (SC-23)	Appoint and fund a City of Portland Seismic Resiliency Officer	9
Earthquake (SC-24)	Develop incentives and regulations that promote, encourage and/or require seismic retrofits of private property (such as multi-family, masonry structures). Potential partner: Home Depot	16
Earthquake (SC-27)	Perform an in depth risk assessment of the transportation network to develop and prioritize mitigation projects to ensure connectivity after an event. Potential partners: PBOT, TSA, Tri-Met and Boat owners/organizations	16
Earthquake (SC-35)	Develop a program with a steady source of funding to provide grants for home retrofits. Devote a certain percentage of available funding to low income homeowners.	6
Earthquake (SC-40)	Encourage and expand personal, family and business preparedness plans and programs.	6

Hazard (source)	Refined Action	Total Votes
Earthquake (SC-42)	Retrofit the water conveyance system.	11
Earthquake (SC-49)	Increase taxes on businesses in high risk areas (Linnton) that are not working to reduce the risk to neighbors and the environment.	7
Earthquake (SC-50)	Appoint a CEI Hub Disaster Resiliency Workgroup to include citizens, business leaders that contribute to the high risk, elected officials and experts. White Paper Report to be made public and to include timelines and plans for change that goes into the "Report Card" and is managed, measured and reported annually.	6
Earthquake (SC-51)	Adopt higher standards for all buildings and reduce height limits.	7
Earthquake (SC-54)	Review alternatives to increase the resilience of the CEI hub and other energy infrastructure. Alternatives may include an update of zoning or building codes, relocation of tank farms out of vulnerable areas, seismic strengthening requirements etc.	12
Earthquake (SC-55)	Develop a study to evaluate how capped sediments behave in major earthquakes and whether there is the potential for toxic sediments below to be released. If such potential exists, promote full removal of sediments.	10
Earthquake (SC-62)	Require seismic upgrading of emergency operations center, fire, police stations by XX date.	7
Earthquake (SC-64)	Incorporate the recommendations of the Unreinforced Masonry Work Group into the mitigation action plan. Ensure work group recommendations are screened using the equity review tool.	12
Earthquake (SC-66)	Require seismic upgrading of public and private soft first story buildings by XX date.	*6*
Earthquake (SC-67)	Review construction plans for all bridges to determine their susceptibility to collapse and retrofit problem bridges. Work with bridge owners to secure funding and prioritize retrofits/upgrades. Potential Partners: PBOT, ODOT, County	11
Earthquake (SC-71)	Require all new schools and other government buildings to meet OC IV so they can be used as an earthquake emergency shelter. Require strategic strengthening of portions of existing schools. Develop a prioritization strategy for these improvements using an equity assessment.	18
Earthquake (SC-79)	Identify ways to encourage, promote or require U.S. Resiliency Council Certification (e.g. tax incentives, minimum standards, requirement for new public buildings).	7
Flood (SC-81)	Make information available about floodplains (10, 25, 50 and 500) when applying for permits (BDS and BES partnership).	4
Flood (SC-85)	Develop and implement a flood emergency warning text alert system that sends notice to cell phones in identified flood evacuation areas.	4
Flood (SC-87)	Clarify rules and responsibilities within Bureaus during a flood and partner with all Portland Bureaus to identify nonessential staff that can be trained to become dispatch operators so that essential "boots on the ground" personnel can be free to perform recovery actions. (Strengthen cross-training programs)	6
Flood (SC-91)	Expand holistic stormwater management program requiring green infrastructure such as eco-roofs where needed to improve hydraulic system capacity.	12
Landslide (SC-95)	Identify transportation routes likely to be impacted by landslides and identify alternate routes. Communicate this information to the public. Lead Agencies: PBOT, BES and PBEM	7
Landslide (SC-99)	Update landslide chapter in 2017 when new DOGAMI data can be included.	3
Landslide (SC-100)	Provide notice to property owners and other residents, including renters and transient populations) of location in high landslide risk areas. Consider mandatory renter disclosure. Consider posting signage. Potential Partners: DOGAMI and PSU	3
Landslide (SC-102)	Encourage property owners and developers to actively manage hillsides and landslide hazard areas to reduce risk from landslides. Develop a brochure describing risk and potential mitigation techniques. Incorporate landslide risk into invasive species management plans. Lead Agencies: BDS and BES	7
Landslide (SC-103)	Perform an assessment of drainage and erosion conditions in identified risk areas.	3

Hazard (source)	Refined Action	Total Votes
Landslide (SC-105)	Examine zoning and building codes and provide recommendations for increasing or decreasing permeable surfaces in landslide risk areas.	4
Landslide (SC-106)	Investigate the feasibility of expanding requirements for eco-roofs to include high landslide risk areas.	6
Landslide (SC-107)	Incorporate the retrofitting of existing infrastructure into the stormwater management plan.	3
Landslide (SC-112)	Adopt higher regulatory standards or rezone for new development within unstable slope areas.	5
Landslide (SC-123)	Consider adding a liability or risk clause to agreements with developers that develop in high risk areas and areas that would be impacted by landslides. Ensure that any actions are reviewed for equity considerations.	8
Severe Weather (SC-126)	Improve public warning and information systems for severe weather events. Ensure that communication is easy to understand, gives clear direction, timely, is available in multiple languages and reaches all populations. Potential Partners: County, disabled population, families and organizations that serve them.	7
Severe Weather (SC-127)	Coordinate and clarify pre- and post-severe weather event responsibilities within and among the Bureaus.	2
Severe Weather (SC-130)	Support redundant public transit systems that are reliable and prepared for severe weather.	2
Severe Weather (SC-134)	Overlay tree database with soils that area likely to saturate. Inform property owners/residents of risk and warning signs and provide information on possible mitigation measures.	3
Severe Weather (SC-137)	Identify ways to increase ice storm/snow response capabilities.	3
Severe Weather (SC-141)	Continue to fund and utilize the LENST text based warning system for severe weather notifications.	2
Severe Weather (SC-147)	Partner with Multnomah County to develop a more robust sheltering plan. Develop an established protocol for partnering with schools that includes a reunification plan. Provide more public outreach and information on cooling and heating shelters and when they are open. Ensure plans and program meet the needs for all populations. Potential Partners: County, disabled population, families and organizations that serve them	8
Space Weather (SC-151)	Continue to research best available science and data for space weather and potential impacts to the City of Portland.	2
Volcanic Hazards (SC-154)	Develop a partnership to use Wireless Emergency Alerts, Emergency Alert System or Community Emergency Notification System on volcano/ash fall alerts and awareness of evacuation procedures (PBEM and OEM)	1
Wildfire (SC-160)	Identify facilities with volatile/hazardous materials from high risk wildfire areas (e.g., hazardous chemicals that can spread the fire, cause additional serious health and environment concerns, trigger a chain reaction with other facilities due to the spread of the chemicals and/or the spreading fire resulting from the chemical release) and consider transfer, relocation or other mitigation efforts.	8
Wildfire (SC-161)	Identify invasive species that are fire hazards (e.g., scotch broom). Educate the public on these species and work to eradicate/greatly reduce them, especially in high risk areas	4
Wildfire (SC-163)	Require defensible spaces and water turrets around structures in wildfire risk areas.	6
Wildfire (SC-165)	Identify and publish a list of plants that are severe fire hazards.	3
Wildfire (SC-173)	Increase funding for Rangers outreach, surveys, patrols in general to let people know about smoking/campfire risk (especially in forest park)	6
Wildfire (SC-180)	Continue to research ways to balance the needs between fire safety flow requirements and water quality requirements.	3
Wildfire (SC-181)	Strengthen site and building design standards in wildfire risk areas.	6
Wildfire (SC-191)	Partner with the Forest Park Conservancy and individual land owners to develop a fire risk reduction plan for Forest Park.	3
Wildfire (SC-206)	Provide funding to better maintain fire access roads in Forest Park for response and evacuation needs as well as increased daily access for disabled/mobility challenged populations	4

Hazard (source)	Refined Action	Total Votes
All Hazards (CEI Hub-1)	CEI Hub Disaster Resiliency Workgroup – see report for more details	N/A
All Hazards (CEI Hub-2)	Update/enhance CEI Hub Risk Assessment – see report for more details	N/A
All Hazards (CEI Hub-3)	Regulatory Amendment – see report for more details	N/A
All Hazards (CEI Hub-4)	Emergency Response/Recovery Regulatory Waivers – see report for more details	N/A
All Hazards (CEI Hub-5)	Planning – see report for more details	N/A
All Hazards (CEI Hub-6)	Back-up power – see report for more details	N/A
All Hazards (CEI Hub-7)	Training and exercises – see report for more details	N/A
All Hazards (CEI Hub-8)	Facility retrofits– see report for more details	N/A
All Hazards (CEI Hub-9)	Land use repurposing – see report for more details	N/A

BEST PRACTICES AND PLANNING PROCESS ACTIONS

The following actions were developed from best practices and other stakeholder input. Actions shown include general mitigation best practices as well as actions identified through the steering committee planning process.

All Hazards

General Mitigation Best Practice—All Hazards			
Manipulate Hazard	Reduce Exposure	Reduce Vulnerability	Increase Capability
Public (Individual) Scale			
• None	• None	• Apply for permits as required and follow established building codes • Perform a vulnerability check on personal property	• Educate yourself on risk reductions methods • Educate yourself on early warning procedures • Purchase insurance for your home and valuables • Volunteer on community mitigation projects. • Develop household mitigation plan, such as creating a retrofit savings account, communication capability with outside, 2 week self-sufficiency during an event • Prepare a family post-disaster action plan • Get to know your neighbors • Participate in perishable data capture programs
Private (Business) Scale			
• None	• None	• Establish/participate in a business-to-business mitigation mentoring program. • Perform a vulnerability check on property	• Educate your employees on the probable impacts from hazard events • Develop a Continuity of Operations Plan • Participate in perishable data capture programs

General Mitigation Best Practice—All Hazards			
Manipulate Hazard	Reduce Exposure	Reduce Vulnerability	Increase Capability
Government Scale			
• None	• Relocate critical facilities out of known hazard areas • Prohibit or limit public expenditures for capital improvements in known hazard areas • Acquire safe sites for public facilities (e.g., schools, police/fire stations, etc.) • Prohibit new facilities for persons with special needs/mobility concerns in hazard areas. • Prohibit animal shelters in known hazard areas	• Retrofit critical facilities within known hazard areas. • Organize a managed retreat from very high-risk areas. • Promote open space uses in identified high hazard areas via techniques such as: PUD's, easements, setbacks, greenways, sensitive area tracks • Acquire property in high hazard areas for use as open space • Offer expanded development rights to developers/businesses for performing mitigation retrofits • Incorporate mitigation retrofits for public facilities into the annual capital improvements program. • Installing quick-connect emergency generator hook-ups for critical facilities	• Develop an all hazards public education campaign and resource center • Promote the purchase of insurance in known hazard areas • Designate high-risk zones as special assessment districts (to fund necessary hazard mitigation projects) • Incorporate a stand-alone element for hazard mitigation into the local comprehensive (land use) plan. • Develop a post-disaster reconstruction plan to facilitate decision making following a hazard event. • Involve citizens in comprehensive planning activities that identify and mitigate hazards • Adopt a post-disaster recovery ordinance based on a plan to regulate repair activity, generally depending on property location. • Adopt the International Building Code (IBC) and International Residential Code (IRC) • Increase the local Building Code Effectiveness Grading Schedule classification through higher building code standards and enforcement practices. • Identify a funding mechanism for a local match to Federal funds that can fund private mitigation practices. • Identify and strengthen facilities so that they can function as public shelters • Provide hazard vulnerability checklists for homeowners to conduct their own inspections • Establish a technical assistance program for residents to access data or resources for mitigation purposes • Develop mutual aid agreements with other local governments/organizations • Warehouse critical infrastructure components such as pipe, power line, and road repair material • Develop a Continuity of Government Plan • Provide technical information and guidance during permitting and development process • Form a citizen plan implementation steering committee to monitor progress of local mitigation actions. Include a mix of representatives from neighborhoods, local businesses, and local government.

Actions Identified by Steering Committee—All Hazards	
Reduce Vulnerability	Increase Capability
Government Scale	
• Continue mitigation programs started by some bureaus (water/BES) and incorporate those programs into the mitigation action plan • Replicate mitigation best practices developed by some bureaus in bureaus that do not have a strategy for incorporating mitigation into standard operating procedures • Follow through with new/stronger Comprehensive Plan policies that set the stage for updating regulations and enhancing investments (implement these policies) • Continue to develop and institutionalize an asset management approach to budgeting and prioritizing infrastructure upgrades • Incorporate all hazard risk information into codes and policies and ensure that permits meet regulations for risk aversion and update as needed (especially environmental overlay zones)	• Continue to collect and update data on population, building stock, etc. and look for opportunities to capture and incorporate missing hazard-related data • Continue to utilize subject matter expertise (e.g. keep certified floodplain managers on staff, partner with Cascade Volcano Observatory) in order to inform residents, businesses and other city staff of hazard risk and mitigation opportunities and gaps • Continue to work on engaging the public in hazard mitigation. Capitalize on civic, city and neighborhood pride. Use this messaging in framing mitigation. • Continue to seek/develop unique funding opportunities for mitigation projects and to seek grant opportunities whenever they are available. • Partner with creative industries that excel at education and marketing ideas and concepts to the general public • Continue to retain and hire City staff that is competent and cares about mitigation • Establish a program to systematically review and update regulations that address hazard risk • Establish a process to coordinate/ partner with local, state and federal agencies to maintain up-to-date hazard data, maps, and assessments. • Continue to build on strong community engagement standards • Continue to develop and expand the NET program and engage NET volunteers • Integrate the mitigation action plan with existing plans and programs such as CRS, climate action plan, Comprehensive Plan etc.) • Develop a bureau-wide mitigation working group for greater collaboration and information sharing • Develop and implement successful, effective, institutionalized systems, especially for equitable mitigation • Continue to seek ways to meaningfully engage non-English speaking and other underserved populations • Seek ways to promote the mitigation of private property. • Incorporate mitigation priorities into goals/missions of applicable bureaus • Seek novel ways to influence traditional processes • Maintain existing hazard databases and establish a program for collection of perishable data after hazard events • Seek opportunities to incorporate psychological preparedness and education into preparedness and mitigation related programs • Emphasize the need for endurance in post-disaster planning (e.g. more than 72 hours preparation) • Develop strategy to overcome risk from existing development patterns and seek opportunities to incentivize mitigation of private property • Utilize the natural features and resources of Portland in planning for and mitigation from natural hazards • Focus on developing strategies that capture opportunities associated with the growing population and growth in the region • Perform an extensive literature and internal review of mitigation processes and practices that have provided beneficial results. Look to other communities such as LA, New Zealand, Japan. • Develop a bumper stick that says "keep" Portland Prepared • Ensure each action is measureable, tracked and shared publicly • Utilize informed, local media to increase publicity about mitigation • Engage local celebrities in sharing the mitigation message (Portlandia's Fred Armisen and Carrie Brownstein, actors from Grimm, the Blazers, the Timbers!) • Establish equitable criteria for action development and prioritization of actions. • Give the City the "right of refusal" after a major event • Develop games/fun activities about preparing ahead and surviving a disasters • Develop a recovery plan for the City of Portland. • Develop one "elevator speech" item per bureau. One action item that cannot be accomplished without additional resources • Ensure all actions have an estimated timeframe for completion that is reviewed and updated during the progress reporting process

Actions Identified by Steering Committee—All Hazards	
Reduce Vulnerability	Increase Capability
• Continue to support, incorporate and participate in projects that increase regional and local understanding of climate change and its impacts • Seek input from emergency responders on land use and development codes and regulation • Ensure that relocation programs are implemented equitably.	• Institute a climate change education program for the public that discusses how climate change will impact risk and vulnerability to hazard events • Work with CIRC to educate bureaus and create standard assumptions and models, internal consistency in application of data • Develop a phone tree with local community organizations, such as IRCO. • Identify a list of pre-approved Minority, Women-Owned, and Emerging Small Business contractors for response/recovery efforts • Align budgeting cycle with hazard mitigation priorities – when new funding is requested, require review of MAP priorities • Provide authority for use of the Resilience Bond Model • Build resiliency of city/county information to bounce back/respond to increased customer service demands such as staffing and increased call/email volume. • Fund vulnerable immigrant/refugee organizations • Incorporation of making all action items accessible for safe harbor languages and disability community. • Search and rescue specific for disability community. • Shelter program specifically meeting needs of disability • Convene a working group to provide recommendations on a citywide requirement for full disclosure of known natural hazard risk at time of property sale or transfer. Ensure the committee reviews and provides recommendations on unintended consequences such as lowering of property values in high risk areas and displacement of low income residents to these areas. • Provide notice to property owners and residents in identified dam inundation areas. • Develop an earthquake scenario and perform a risk assessment that assumes dam failure as a secondary hazard.

Dam Failure

General Mitigation Best Practice—Dam Failure			
Manipulate Hazard	**Reduce Exposure**	**Reduce Vulnerability**	**Increase Capability**
Public (Individual) Scale			
• **None**	• Relocate out of Dam Failure Inundation areas.	• Elevate your home to appropriate levels • Flood-proof your home to appropriate levels	• Learn the evacuation routes for a dam failure event • Educate yourself on early warning procedures. • Purchase flood insurance
Private (Business) Scale			
• **Remove privately owned Dams** • **Strengthen privately owned Dams**	• Replace earthen dams with hardened structures	• Flood proof facilities within Dam Failure Inundation areas • Continue/ensure regularly scheduled engineering assessments of privately owned dams	• Develop and update Emergency Action Plans • Educate employees on dam failure evacuation routes • Educate employees on early warning procedures
Government Scale			
• **Remove government owned Dams** • **Strengthen government owned Dams**	• Replace earthen dams with hardened structures	• Adopt higher regulatory floodplain standards in mapped Dam Failure/Inundation areas. • Consider low density land uses within identified Dam Failure/Inundation areas. • Continue/ensure regularly scheduled engineering assessments • Create easements in impoundment and downstream inundation areas • Study and evaluate impacts from climate change on dam operations	• Enhance Emergency Operations Plan to include a dam failure component. • Institute monthly communications checks with dam operators. Maintain up to date communications list. • Inform the public on risk reduction techniques and develop a communication plan • Adopt real-estate disclosure requirements for the re-sale of property located within Dam Inundation areas. • Establish early warning systems downstream of high hazard dams. • Update evacuation routes and educate the public on those routes • Promote the purchase of flood insurance in inundation areas

Actions Identified by Steering Committee—Dam Failure
Increase Capability
Government Scale
• Update scenario based Dam Failure/Inundation area maps. • Develop an earthquake scenario and perform a risk assessment that assumes dam failure as a secondary hazard. • Provide notice to property owners and residents in identified dam inundation areas.

Drought

General Mitigation Best Practice—Drought			
Manipulate Hazard	Reduce Exposure	Reduce Vulnerability	Increase Capability
Public (Individual) Scale			
• **None**	• Install stored water/captured water techniques, such as rain barrels or down spout gardens • Use permeable paving techniques whenever feasible	• Plant drought resistant landscapes • Reduce water system losses (e.g. fix drips) • Modify plumbing systems, i.e. water saving kits or grey water systems	• Practice active water conservation techniques
Private (Business) Scale			
• **None**	• Install stored water/captured water techniques, such as rain barrels or down spout gardens • Use permeable paving techniques whenever feasible.	• Plant drought resistant landscapes • Reduce private water system losses • Identify alternate water supply sources • Plant drought-resistant crop varieties • Develop and implement grey water systems	• Practice active water conservation techniques • Develop a water conservation plan
Government Scale			
• **Promote groundwater recharge through stormwater management** • **Implement cloud seeding techniques during dry season**	• Identify and create ground water back up sources • Create/identify new impounded water supply points • Use permeable paving techniques whenever feasible	• Plant drought resistant landscapes on community owned facilities • Distribute water saving kits to community members • Implement storm water retention in regions ideally suited for groundwater recharges • Reduce water system losses through regular maintenance • Design water delivery systems to accommodate drought events	• Identify alternative water supplies for time of drought • Develop a drought contingency plan • Develop criteria triggers for drought related actions • Improve accuracy of water supply forecasts • Modify rate structures to influence active water conservation techniques • Consider providing incentives to property owners that utilize drought resistant landscapes in the design of their home • Develop/Implement drought education/notification systems and communication plan • Emphasize droughts relationship to other hazards in hazard awareness messaging • Increase capability to enforce water restrictions when such restrictions are in place.

Actions Identified by Steering Committee—Drought	
Reduce Vulnerability	Increase Capability
Government Scale	
• **Integrate water conservation and green infrastructure into all applicable regulations/programs**	• Update/establish requirements on impervious surfaces • Expand green stormwater infrastructure program and integrate water conservation into messaging – partner with Willamette Week Hydro Hogs lists to increase awareness.

Earthquake

General Mitigation Best Practice—Earthquake			
Manipulate Hazard	Reduce Exposure	Reduce Vulnerability	Increase Capability
Public (Individual) Scale			
• **None**	• Locate outside of hazard area (off soft soils and other seismically induced ground failure areas)	• Retrofit structure (e.g. anchor house structure to foundation) • Secure household items that can cause injury or damage such as water heaters, bookcases, and other appliances • Build to higher design standards	• Practice "drop, cover and hold" • Participate in drills such as the Great Shakeout • Purchase earthquake insurance
Private (Business) Scale			
• **None**	• Locate/relocate mission critical functions outside hazard area where possible (off soft soils and other seismically induced ground failure areas)	• Build redundancy for critical functions/facilities • Retrofit critical buildings/areas housing mission critical functions • Perform non-structural assessments and mitigation activities (e.g. anchor bookcases to the wall) • Anchor rooftop-mounted equipment (i.e., HVAC units, satellite dishes, etc.).	• Adopt higher standard for new construction – Consider "performance based design' when building new structures • Increase capability by having cash reserves for reconstruction • Inform your employees on the possible impacts of earthquake and how to deal with them at your work facility • Participate in drills such as the Great Shakeout

General Mitigation Best Practice—Earthquake			
Manipulate Hazard	Reduce Exposure	Reduce Vulnerability	Increase Capability
Government Scale			
• **None**	• Locate critical facilities or functions outside of hazard area where possible (off soft soils and other seismically induced ground failure areas)	• Harden infrastructure • Provide redundancy for critical functions • Encourage mitigation of private property • Perform non-structural assessments and mitigation activities (e.g. anchor bookcases to the wall) • Require bracing of generators, elevators, and other vital equipment in hospitals. • Use flexible piping (earthquake resistant) when extending water, sewer, or natural gas service. • Install shutoff valves and emergency connector hoses where water mains cross fault lines. • Anchor rooftop-mounted equipment (i.e., HVAC units, satellite dishes, etc.). • Include retrofitting/replacement of critical system elements in Capital Improvements Plan (CIP)	• Produce more accurate hazard maps (e.g. liquefaction and soils maps) • Further enhance seismic risk assessment to target high hazard buildings for mitigation opportunities (e.g. older structures, unreinforced masonry) • Develop a debris management plan • Participate in drills such as the Great Shakeout • Communicate earthquake secondary hazards to public (e.g. landslides, dam failure, fires, hazardous material spills) • Assess emergency response routes and determine back-up options in case of damage or disruption • Educate K-12, residents, developers and businesses on earthquake safety and building codes. • Require/encourage rapid damage assessment training for City staff • Develop and distribute guidelines or pass ordinances that require developers and building owners to locate lifelines, buildings, critical facilities, and hazardous materials out of areas subject to significant seismic hazards. • Support financial incentives, such as low interest loans or tax breaks, for home and business owners who seismically retrofit their structures. • Use Hazus to quantitatively estimate potential losses from an earthquake • Establish a school survey procedure and guidance document to inventory structural and non-structural hazards in and around school buildings • Use rapid visual screening to quickly inspect a building and identify disaster damage or potential seismic structural and non-structural weaknesses to prioritize retrofit efforts, inventory high-risk structures and critical facilities, or assess post-disaster risk to determine if buildings are safe to re-occupy • Develop a technical assistance information program for homeowners. • Create a seismic safety committee to provide policy recommendations, evaluate and recommend changes in seismic safety standards, and give an annual assessment of local and statewide implementation of seismic safety improvements • Develop an inventory of public and commercial buildings that may be particularly vulnerable to earthquake damage.

Actions Identified by Steering Committee—Earthquake		
Reduce Exposure	Reduce Vulnerability	Increase Capability
Public (Individual) Scale		
• Remove buildings and do not build new buildings within 100 yards of an active fault (slip rate > 2 mm a year).	• Install automatic earthquake gas shutoffs	• None
Private (Business) Scale		
• Remove buildings and do not build new buildings within 100 yards of an active fault (slip rate > 2 mm a year). • Do not build critical facilities (Occupancy Class III and IV) on soft soil sites (SE and SF sites). • Do not build critical facilities (Occupancy Class III and IV) on sites with potential for seismic induced ground failure (lateral spreading, liquefaction, landslide).	• Install automatic earthquake gas shutoffs • Retrofit older office buildings to at least life-safety standards • Perform non-structural assessments of building contents • Pursue other non-structural mitigation including ceilings, troffer light fixtures, partition bracing, elevator rails, brick veneer, hollow clay tile around stairwells, etc.	• Purchase earthquake insurance
Government Scale		
• Remove buildings and do not build new buildings within 100 yards of an active fault (slip rate > 2 mm a year). • Do not build critical facilities (Occupancy Class III and IV) on soft soil sites (SE and SF sites) or on sites with potential for seismic induced ground failure (lateral spreading, liquefaction, landslide).	• Review construction plans for all bridges to determine their susceptibility to collapse and retrofit problem bridges. Work with bridge owners to secure funding and prioritize retrofits/upgrades. • Ensure that best available data and science is used in the siting and development of City buildings. • Require all newly built City buildings to exceed life safety standards. • Incentivize or require retrofitting of infrastructure in the CEI hub until complete or partial relocation can be obtained. • Partner with identified high potential loss facilities to encourage individual assessments of seismic risk. Identify and share risk with nearby residential communities. • Update residential building code so that it includes higher seismic standards for new or substantially improved buildings. • Perform non-structural assessments of building contents. Pursue other non-structural mitigation including ceilings, troffer light fixtures, partition bracing, elevator rails, brick veneer, hollow clay tile around stairwells, etc. • Develop a non-structural, technical assistance information program and tool kit.	• Research, develop and implement innovative approaches to implement the recent fossil fuel legislation using established jurisdictional authority (e.g. zoning) • Incorporate the updated liquefaction, lateral spreading and landslide data developed by the Portland Water Bureau into BDS development and design standards. • Develop and maintain a rapid damage assessment program that creates a tiered system of certification so that there can be two trained but uncertified assistants for each certified staff member. • Expand the BDS tie down training program and include information/training on other retrofit activities. • Develop and implement a plan for a system of fuel hubs and stockpiles. Involve public and private stakeholders that provide essential services in this planning process. • Research and develop a plan to ensure adequate sanitation if sewer systems are knocked offline by an event. • Develop a post-event communication plan. • Develop a post-disaster recovery plan based on a seismic event. • Develop method for communities to report mitigation priorities directly to the City. • Ensure that response plans have identified adequate food resources. Partner with food producers and distributors to develop memorandums of understanding and/or responsibilities. • Develop a phased sheltering plan. • Provide resources for businesses to help them identify ways to mitigate for natural hazards.

Actions Identified by Steering Committee—Earthquake		
Reduce Exposure	Reduce Vulnerability	Increase Capability
	• Support financial incentives, such as low interest loans or tax breaks, for home and business owners who seismically retrofit their structures. • Install automatic earthquake gas shutoffs in public buildings and require automatic shutoffs in public buildings. • Retrofit older office buildings to at least life-safety standards • Require seismic upgrading of hospitals including phased nonstructural mitigation by XX date. • Require seismic upgrading of school buildings by XX date. • Require seismic upgrading of public and private non-ductile concrete buildings by XX date. • Seismically retrofit housing bureau buildings on the Unreinforced Masonry (URM) list or constructed prior to 1994 • Update residential building code so that it includes higher seismic standards for new or substantially improved buildings. Initiate triggers guiding improvements such as: < 50% substantial damage/improvements or passive trigger programs for mandatory seismic strengthening • Require higher standards for new construction of Occupancy Category II (and certain I?) buildings. • Perform a sediment seismic stability analysis for Hayden Island and develop appropriate mitigation items	• Assess opportunities for "alternative" evacuation routes, e.g. foot and bicycle paths, helicopter pads • Identify post-earthquake evacuation routes and prioritize retrofitting of structures along those routes. • Develop a response plan for fire boats. • Explore utilizing the waterways as a post event transportation system. • Assess potential fire risks from Cascadia quake if it were to happen during dry months. • Establish a basic needs check-list for all households and survey residents to determine the percent of households with sufficient supplies. • Adopt the mitigation plan and seek pledges from elected officials to implement and provide funding for identified actions. • Develop an instructional video for non-structural mitigation. • Explore capability to have portable temporary bridge to cross Willamette. • Perform geotechnical assessment of subsurface • Capitalize on recent publicity regarding earthquake risk in the Pacific Northwest • Determine a practical method to track buildings that are brought up to current seismic codes due to retrofit or permit requirement • Institute legislation that allows for rent controls after a certain percentage of housing stock is lost (e.g. post disaster) • Appoint an earthquake administrator – similar to a flood administrator • Institute bridge tolls to fund seismic retrofits

Flood

General Mitigation Best Practice—Flood			
Manipulate Hazard	**Reduce Exposure**	**Reduce Vulnerability**	**Increase Capability**
Public (Individual) Scale			
• **Clear stormwater drains and culverts**	• Locate outside of hazard area • Elevate utilities above base flood elevation • Institute low impact development techniques on property	• Retrofit structure (elevate house above base flood elevation) • Elevate items within house above base flood elevation • Build new homes above base flood elevation • Floodproof non-residential structures	• Comply with National Flood Insurance Program (NFIP) • Purchase flood insurance
Private (Business) Scale			
• **Clear stormwater drains and culverts**	• Locate business critical facilities or functions outside hazard area • Institute low impact development techniques on property	• Build redundancy for critical functions/ retrofit critical buildings • Provide flood-proofing measures when new critical infrastructure must be located in floodplains	• Increase capability by having cash reserves for reconstruction • Support and implement hazard disclosure for the sale/re-sale of property in identified risk zones • Solicit 'cost-sharing" through partnerships with public sector stake holders on projects with multiple benefits
Government Scale			
• **Develop an adopt a "storm drain" program** • **Dredge, construct levees, provide retention areas** • **Invest in structural flood control: levees, dams, channelization, revetments** • **Construct regional stormwater control facilities** • **Harden areas with significant erosion concerns** • **Promote/retain natural vegetation in areas with significant erosion concerns**	• Acquire or relocate identified repetitive loss properties • Adopt land development techniques such as density transfers or clustering • Institute low impact development techniques on property • Adopt sediment and erosion control regulations • Adopt zoning and erosion overlay districts • Prohibit any fill in floodplain areas • Encourage the use of porous pavement, vegetative buffers, and islands in large parking areas. • Use stream restoration to ensure adequate drainage and diversion of stormwater.	• Adopt appropriate regulatory standards such as cumulative substantial improvement/damage, freeboard, lower substantial damage threshold, compensatory storage • Develop and implement stormwater management regulations and master planning • Adopt "no-adverse impact" floodplain management policies that strive to not increase the flood risk on down-stream communities • Perform regular inspections/assessments of locally owned or maintained flood control infrastructure • Replace undersized culverts • Provide permanent protection for pump stations at risk of flooding • Identify/mitigate drainage issues resulting in ponding • Enhance road drainage programs or elevate/relocate roads subject to frequent flooding • Ensure permitting process is consistent with the adopted floodplain management ordinance • Develop an erosion protection program for high hazard areas • Construct open foundation systems on buildings to minimize scour	• Join Community Rating System (CRS) program or maintain/improve class • Provide training for staff and decision-makers in floodplain management (e.g. maintain certified floodplain managers on staff) • Create a building and elevation inventory of structures in the floodplain • Develop a Flood Task Force • Pre-stage flood response equipment before events • Integrate floodplain management policies into other planning mechanisms within Portland • Develop framework/continue efforts for cooperation between agencies/districts in flood mitigation activities (e.g. sand and sand bag deployment) • Retain good standing in National Flood Insurance Program • Participate in information sharing with other agencies (e.g. U.S. Army Corps of Engineers, NWS) • Identify and mitigate sources of nuisance flooding • Review and update floodplain damage prevention ordinances • Identify debris collection sites

General Mitigation Best Practice—Flood			
Manipulate Hazard	Reduce Exposure	Reduce Vulnerability	Increase Capability
		• Construct deep foundations in erosion hazard areas • Establish a green infrastructure program • Use subdivision design standards to require elevation data collection during platting and to have buildable space on lots above the base flood elevation • Require tie downs of propane tanks • Require a drainage study with new development • Design a "natural runoff" or "zero discharge" policy for stormwater in subdivision design • Require and maintaining FEMA elevation certificates for all new and improved buildings located in floodplains • Extend the freeboard requirement past the mapped floodplain to include an equivalent land elevation • Include requirements in the local floodplain ordinance for homeowners to sign non-conversion agreements for areas below base flood elevation. • Offer incentives for building above the required freeboard minimum (code plus). • Inspect bridges and identify if any repairs or retrofits are needed to prevent scour • Floodproof critical facilities and infrastructure located in flood hazard areas • Require all critical facilities to meet requirements of Executive Order 11988 and be built 1 foot above the 500-year flood elevation	• Require/encourage rapid damage assessment training for staff • Map locations of storm drains, catch basins and dry wells so that they may be located and cleared • Identify and map erosion hazard areas • Develop a tracking program for erosion hazards and their impacts on the community • Pass and enforce an ordinance that regulates dumping in streams and ditches • Develop a stormwater committee • Form a regional watershed council • Incorporate digital floodplain and topographic data into GIS systems, in conjunction with Hazus, to assess risk • Conduct NFIP community workshops to provide information and incentives for property owners to acquire flood insurance. • Increase drainage or absorption capacities with detention and retention basins, relief drains, spillways, drain widening/dredging or rerouting, logjam and debris removal, extra culverts, bridge modification, dike setbacks, flood gates and pumps, or channel redirection

Actions Identified by Steering Committee—Flood		
Reduce Exposure	Reduce Vulnerability	Increase Capability
Government Scale		
• Relocate (through willing seller) existing development in floodplain	• Continue to improve and expand floodplain development regulations to meet higher standards • Develop maps that include information on climate change risk • Designate flood storage/conveyance areas • Expand the willing-seller program to a citywide program • Consider implementing/providing information on flood-resilient building design (allowing and designing for first floors to flood) • Promote and provide publicly accessible information on landscaping techniques that reduce water run-off. • Continue to develop and implement a public education campaign regarding low impact development. Reach out to community leaders and faith based organizations (possibly as pilot projects, signage about projects etc.) • Continue to improve and publicize the stormwater retention program. • Improve effectiveness of development restrictions in the floodplain • Fix Foster Rd flooding problem	• Produce more accurate flood hazard maps or identify areas for further study. Incorporate updated information from FEMA when available. • Convert hard copy first finished floor elevations for structures located in the floodplain into a digital database • Identify potential risk from flooding/channel migration downstream on Johnson Creek toward city boundary • Review and revise current approach to fill relocation projects to include an area specific "mitigation bank" so that the area is expanded beyond the tax lot (BDS and BES partnership) • Develop a system to communicate safe areas for traffic during a flood, and set up easy systems for citizens to report areas of standing water and dangerous roads (BES, PBEM and PBOT partnership) • Develop standard operating procedures that increase communication between PBOT and other agencies to report on flooded road status. • Develop a system to warn underground garages when a flood event is likely so that cars can be moved. Work with owners and operators to identify flood proofing strategies to reduce contaminated runoff from flooded garages. • Implement flood training exercises for pertinent Bureaus. Include exercises for high frequency, low impact events, such as the 10 year flood. • Enhance the flood risk assessment by incorporating waterfront planning exercises and climate change models (BES and BPS) • Reevaluate the willing seller program using an equity lens. Ensure that the program benefits both homeowners and renters.

Landslide

General Mitigation Best Practice—Landslide			
Manipulate Hazard	**Reduce Exposure**	**Reduce Vulnerability**	**Increase Capability**
Public (Individual) Scale			
• Stabilize slope (de-water, armor toe) • Reduce weight on top of slope • Minimize vegetation removal and the addition • Install rip rap boulders of geotextile fabric • Using bioengineered bank stabilization techniques. • Use a rock splash pad to direct run off and minimize the potential for erosion	• Locate structures outside of hazard area (off unstable land and away from slide-run out area)	• Retrofit homes on steep slopes	• Sign up for warning systems • Learn the warning signs that indicate a landslide may occur • Educate yourself on risk reduction techniques for landslide hazards
Private (Business) Scale			
• Stabilize slope (de-water, armor toe) • Reduce weight on top of slope • Minimize vegetation removal and the addition of impervious surfaces • Using bioengineered bank stabilization techniques. • Use a rock splash pad to direct run off and minimize the potential fort erosion	• Locate structures outside of hazard area (off unstable land and away from slide-run out area)	• Retrofit at risk facilities	• Sign up for warning system and develop evacuation plan • Increase capability by having cash reserves for reconstruction • Educate your employees on the potential exposure to landslide hazards and your emergency response protocol
Government Scale			
• Monitor/review accumulated effects from piecemeal development on steep slopes • Implement post-fire vegetation management plans • Coordinate with resource management agencies to identify potential issues from resource extraction activities • Using bioengineered bank stabilization techniques. • Use a rock splash pad to direct run off an minimize the potential fort erosion	• Acquire properties located in high risk landslide areas • Adopt land use policies that prohibit the placement of habitable structures in high risk landslide areas • Adopt land use policies that limit accumulated effects in landslide risk areas	• Adopt higher regulatory standards for new development within unstable slope areas • Armor/retrofit critical infrastructure from the impact of landslides • Post signage in landslide hazard areas • Prohibit removal of natural vegetation from slopes • Assess vegetation in wildfire-prone areas to prevent landslides after fires (e.g., encourage plants with strong root systems).	• Produce landslide hazard risk maps • Enact tools to help manage development in hazard areas: better land controls, tax incentives, information, limit new impervious/pervious surfaces • Collect and compile landslide event history database • Develop plan/strategy for communicating risk to property owners/communities recently affected by wildfires • Increase regulatory authority for post-fire mitigation enforcement • Establish and communicate post-event repair responsibilities (e.g. roads that are impacted) • Conduct geological/engineering studies of potential slide areas • Notify property owners in high-risk areas • Develop a brochure describing risk and potential mitigation techniques

Actions Identified by Steering Committee—Landslide	
Reduce Vulnerability	**Increase Capability**
Government Scale	
• Prohibit onsite infiltration of collected stormwater (offsite drainage) in landslide hazard areas • Require geotechnical study for building/grading in landslide hazard area • Incorporate landslide risk areas in comprehensive plan and increase regulations for risk reduction (see above) • Evaluate disconnect downspouts program/stormwater disconnect program. Do not promote in landside areas. • Develop new stormwater systems to redirect drainage away from landslide hazard. • Utilize landslide data in maintenance plans – roads, utilities, etc., For example, you can build a trench as a drain if used correctly – add as a standard evaluation. • Revisit density, vegetation, stormwater control in zoning. • Establish post-landslide disaster protocol. Geoengineers on retainer for immediate assessment/safety evaluation. Determine level of hazard – 1, 2, 3? Is it time to evacuate? • Develop regulations regarding building and excavation in landslide hazard areas. • Create acquisition program for land/property in high risk areas	• Perform geotechnical assessment of subsurface • Update/establish requirements on impervious surfaces • Re-run HAZUS with new landslide areas (after DOGAMI study is completed) • Appoint a landslide administrator – similar to a flood administrator • Update landslide chapter in 2017 when new DOGAMI data can be included • Correlate historical data on rainfall and landslide events to develop landslide warning thresholds. • Develop an evacuation plan for the Linnton neighborhood that takes landslide risk into consideration. • Explore the feasibility of providing a disaster response facility (not sure if this means police/fire) in Linnton. • Explore the development of post-slide ordinances that regulate redevelopment. • Strengthen land use regulations on landslide risk areas. • Charge an additional permitting fee for construction in high risk areas and set aside these monies for an acquisition program. • Expand the landslide related policies in the St. Johns neighborhood to be applicable citywide. • Compile and update a landslide event history database. • Partner with DOGAMI to ensure city regulations have incorporated the best available data and science. • Perform an in-depth social vulnerability analysis of landslide risk. • Develop and implement a public outreach campaign that educates property owners about landslide risk and possible mitigation measures. • Modify the City Storm Water Manual to include specific guidance based on localized risks (e.g. reporting districts). • Assess fees or taxes for new development in known high-risk areas to offset costs of additional safety and response-oriented infrastructure. • Develop a landslide risk resource center. • Require landslide risk and history in property disclosure forms, transfer of deeds, and renters agreements • Seek funding to assist homeowners in mitigating risk from landslides. Develop quantitative risk ranking system to prioritize projects and report progress. • Implement tax breaks for land owners that implement mitigation strategies in areas at risk for landslides. • Send a letter to each property owner identified on the water hog list to fix leaky water systems.

Severe Weather

General Mitigation Best Practice—Severe Weather			
Manipulate Hazard	Reduce Exposure	Reduce Vulnerability	Increase Capability
Public (Individual) Scale			
• **Increase tree plantings around buildings to shade parking lots and along public rights-of-way**	• None	• Insulate house • Provide redundant heat and power • Plant appropriate trees near home and power lines ("Right tree, right place" National Arbor Day Foundation Program) • Incorporate passive ventilation in the site design. • Secure loose items (i.e., patio furniture)	• Trim or remove trees that could affect power lines • Obtain a NOAA weather radio • Obtain an emergency generator • Identify locations of emergency shelters • Participate in amateur radio groups • Sign up for reverse 911 systems/other notification options • Post address so as to be visible to first responders • Teach school children about the dangers of lightning and how to take safety precautions.
Private (Business) Scale			
• **Increase tree plantings around buildings to shade parking lots and along public rights-of-way.**	• None	• Relocate critical infrastructure, such as power lines, underground • Install tree wire • Install lightning protection devices and methods, such as lightning rods and grounding, on communications infrastructure and other critical facilities • Install and maintain surge protection on critical electronic equipment. • Avoid placing flag poles or antennas near buildings	• Trim or remove trees that could affect power lines • Create redundancy in critical systems • Equip facilities with a NOAA weather radio • Equip vital facilities with emergency power sources

General Mitigation Best Practice—Severe Weather			
Manipulate Hazard	Reduce Exposure	Reduce Vulnerability	Increase Capability
Government Scale			
• **Increase tree plantings around buildings to shade parking lots and along public rights-of-way.**	• None	• Trim trees back from power lines • Designate snow routes and strengthen critical road sections and bridges • Continue/expand participation in Storm Ready programs • Continue to support/maintain/improve notification and warning systems • Support/continue/formalize shelter agreements • Ensure critical facilities have back-up power generation capabilities • Install lightning protection devices on critical facilities and communications equipment • Inspect/ensure facilities can withstand high winds • Encourage construction of guard rails where appropriate • Ensure critical facilities/shelters can easily transition to generator produced power • Stockpile response/preparedness supplies • Install and maintain surge protection on critical electronic equipment • Review building codes and structural policies to ensure they are adequate to protect older structures from wind damage • Use natural environmental features as wind buffers in site design • Incorporate inspection and management of hazardous trees into the drainage system maintenance process. • Preemptively test power line holes to determine if they are rotting • Use designed-failure mode for power line design to allow lines to fall or fail in small sections rather than as a complete system to enable faster restoration • Avoid placing flag poles or antennas near buildings • Convert traffic lights to mast arms	• Support/continue programs such as "Tree Watch" that proactively manage problem areas by use of selective removal of hazardous trees, tree replacement, etc. • Establish and enforce building codes that require all roofs to withstand snow loads and wind speeds • Improve communication alternatives/redundancy • Modify landscape and other ordinances to encourage appropriate planting near overhead power, cable, and phone lines • Provide NOAA weather radios to the public • Encourage coordination with amateur radio groups • Identify/ear mark funding opportunities for generator purchases • Develop evacuation/ emergency road plans and prioritize roads for response efforts • Encourage residents to sign-up for reverse 911 services or other notification services • Encourage/require residents to post addresses where they are visible to first responders • Include safety strategies for severe weather in driver education classes and materials. • Organize outreach to vulnerable populations, including establishing and promoting accessible heating centers in the community

Actions Identified by Steering Committee—Severe Weather
Increase Capability
Government Scale
• Develop and implement land use codes and policies to reduce the creation of and impacts from urban heat island effect • Update/establish requirements on impervious surfaces • Use current enthusiasm for earthquake preparedness to also encourage preparedness for severe weather. • Support transit providers by quickly communicating schedule changes and cancellations to the public. • Support and promote the development of continuity of operations plans for community groups. Include information on scaling based on the incident and certify those businesses meeting certain requirements. • Develop a resource center for severe weather information and tools. • Identify mechanisms to fund/administer tree maintenance programs. • Partner with appropriate agencies to identify mitigation strategies for Route 30. • Identify ways to address areas of the community where freezing fog and ice are more likely. • Develop on-call contracts for road and sidewalk sanding support. • Develop standard operating procedures to increase communication between schools and city emergency management, especially as it pertains to school closures. • Develop standard operating procedures for coordinating warning and response activities for severe weather events (e.g. moving transient populations away from floodplains and simultaneously opening shelters). • Enhance outreach to populations more likely to be vulnerable to heat events. Provide information on locally available tools and resources. • Continue to research new technologies for urban heat island abatement (e.g. glazing). • Consider implementing/providing information on flood-resilient building design (allowing and designing for first floors to flood) • Develop a public outreach campaign focused on the nexus between heat waves, wildfires, stagnant air and poor air quality. Provide resources for mitigation. • Establish a certification program for shelter leaders and managers. • Partner with local businesses to explore opportunities for increasing access to air conditioned spaces during extreme heat or poor air quality events (e.g. free movie theatre admission). • Identify suitable locations for cooling shelters that can also be used in the event of poor air quality. • Partner with neighborhood organizations to improve Community Emergency Response Team (or equivalent program) awareness and membership in all languages and underserved areas.

Space Weather

General Mitigation Best Practice—Space Weather			
Manipulate Hazard	Reduce Exposure	Reduce Vulnerability	Increase Capability
Public (Individual) Scale			
• **None**	• None	• None	• Sign up for early warning systems and notifications
Private (Business) Scale			
• **None**	• None	• None	• Educate employees on impacts and emergency plans
Government Scale			
• **None**	• None	• None	• None

Actions Identified by Steering Committee—Space Weather
Increase Capability
Government Scale
• Provide links and information to NOAA space weather warning system.
• Develop system to alert businesses with vulnerable communications infrastructure.

Volcanic Hazards

General Mitigation Best Practice—Volcano			
Manipulate Hazard	Reduce Exposure	Reduce Vulnerability	Increase Capability
Public (Individual) Scale			
• **None**	• Identify equipment/resources that may be negatively impacted by ash fall and develop plan to move indoors/protect	• None	• Sign up for early warning systems and notifications
Private (Business) Scale			
• **None**	• Identify equipment/resources that may be negatively impacted by ash fall and develop plan to move indoors/protect	• Build redundancy for critical facilities and functions	• Educate employees on impacts and emergency plans
Government Scale			
• **None**	• Identify equipment/resources that may be negatively impacted by ash fall and develop plan to move indoors/protect	• Retrofit older building stock to be able to support accumulated ash fall loads	• Develop post-event cleanup plan

Actions Identified by Steering Committee—Volcano
Increase Capability
Government Scale
• Identify innovative ways to seek funding for private air conditioners. • Continue to participate in and support updates of regional ash management plan. • Research and develop lessons learned from Mt. St. Helens ash management response.

Wildfire

General Mitigation Best Practice—Wildfire			
Manipulate Hazard	Reduce Exposure	Reduce Vulnerability	Increase Capability
Public (Individual) Scale			
• **Clear potential fuels on property: dry, overgrown underbrush, diseased trees**	• Create and maintain defensible space around structures • Reduce exposure – Locate outside of hazard area • Mow regularly • Stay clear of hazard areas during a wildfire event	• Create and maintain defensible space around structures, provide water on site. • Use fire-retardant building materials • Create defensible spaces around your home	• Employ "Firewise" techniques to safeguard your home • Identify alternative water supplies for fire fighting • Install/replace roofing material with non-combustible roofing materials • Ensure that all fuel-burning equipment should be vented to the outside • Install carbon monoxide monitors and alarms.
Private (Business) Scale			
• **Clear potential fuels on property: dry underbrush, diseased trees**	• Create and maintain defensible space around structures and infrastructure • Reduce exposure – Locate outside of hazard area	• Create and maintain defensible space around structures and infrastructure, provide water on site • Use fire-retardant building materials	• Support "Firewise" community initiatives • Create /establish stored water supplies to be utilized for fire fighting
Government Scale			
• **Clear fuels (dry underbrush, diseased trees) on land that can trigger and maintain wildfires** • **Implement "Best Management Practices" on public lands** • **Partner with local communities to create fire breaks**	• Create and maintain defensible space around structures and infrastructure • Enhance building code to include use of fire resistant materials in high hazard areas • Reduce exposure – Locate outside of hazard area	• Create and maintain defensible space around structures and infrastructure • Use fire-retardant building materials • Develop/implement higher regulatory standards in wildfire hazard areas • Develop/support biomass reclamation initiatives • Increase regulatory requirements/code enforcement for fire risk reduction or incentivize higher standards • Develop fire smart building code regulations • Implement road side vegetation management best practices • Conduct pre-construction building inspections that include fire prevention requirements and provide emphasis on a fire resistant structure • Develop programs to identify/install wildland fire water supply systems such as cisterns, ponds and dry hydrants • Involve fire protection agencies in determining guidelines and standards and in development and site plan review procedures • Enclose the foundations of homes and other buildings in wildfire-prone areas, rather than leaving them open and potentially exposing undersides to blown embers or other materials. • Prohibit wooden shingles/wood shake roofs on any new development in areas prone to wildfires. • Routinely inspect the functionality of fire hydrants • Use prescribed burning to reduce fuel loads that threaten public safety and property.	• Seek alternative water supplies in urban wildland interface areas • Become a "Firewise" community • Utilize academia to study impacts/solutions to wildfire risk • Create/implement/update wildfire protection plans • Develop evacuation/ emergency road plans and prioritize roads for response efforts • Provide public outreach to increase understanding of forest management practices • Enhance/provide redundant communication infrastructure • Require/encourage rapid damage assessment training • Pre-plan responses to wildland urban interface areas • Use zoning and/or a special wildfire overlay district to designate high-risk areas and specify the conditions for the use and development of specific areas • Develop a vegetation management plan • Work with insurance companies, utility providers, and others to include wildfire safety information in materials provided to area residents

Actions Identified by Steering Committee—Wildfire	
Reduce Vulnerability	Increase Capability
Government Scale	
• Develop and implement invasive species management plans. Research best management practices and partner with local, regional organizations (e.g. colleges, fire districts, State) • Take advantage of allowances for City-specific building codes that restrict building materials (more stringent than State) • Partner with regional stakeholders to identify critical facilities that are in hazard risk areas. Review and prioritize mitigation activities, such as the creation of defensible space. • Develop guidelines regarding the construction of critical facilities in wildfire risk areas (disclose the risk, educate the company interested, regulate the land) • Analyze and identify wildfire evacuation routes in different neighborhoods and areas. Take into account bridges, transportation routes and disability access. • Retrofit fire and police stations in order to strengthen their current capabilities and ensure the safety of these emergency responders during a disaster. Where possible, strengthen facilities to higher than life safety standards. • Promote drought tolerant, fire resistant plants and the backyard habitat program.	• Develop regulations that specifically address urban wildfire interface zones • Update hazard maps using the newly developed LiDAR and vegetation class data • Plan for integration of defensible space and natural resource habitat management • Educate the public on wildfire risk and promote wildfire risk reduction measures. • Expand and improve public education and information programs about fire prevention, especially fireworks. • Educate the public and disseminate information about the evacuation routes. • Create wildfire evacuation route signs • Analyze and identify the locations of fire stations/boats and response times of firefighters in communities. See where there are major gaps and lack of fire support-take in to account the use of bridges and other transit routes that may be compromised. • Explore the feasibility of establishing a fire station and/or hazmat response team in or near Linnton. • Identify ways to enhance fire prevention and incorporate forest health (e.g. prescribed burns). • Promote and support the FireWise program in appropriate neighborhoods. • Continue increased patrols in watersheds and continue to help fund water towers. • Continue to identify and seek solutions for problem areas along the Pacifica Crest Trail. • Continue to require water bureau staff in the watershed to carry small fire fighting capabilities when risk level is at 3 or above. • Develop a secondary improved access from Lolo Pass for wildfire fighting Bull Run Watershed. • Develop a protocol for the use of in town reservoir water for emergency water supplies in the event of an urban fire. • Evaluate urban and wildfire risk from Cascadia Subduction Zone event and develop strategy to reduce risks. • Use Mt. Tabor reservoir for firefighting after earthquake • Fill Mt. Tabor reservoir with petroleum

The Mitigation Action Plan

Appendix J. Expectations for Participating Bureaus

J. EXPECTATIONS FOR PARTICIPATING BUREAUS

PLANNING PARTNER EXPECTATIONS

ACHIEVING CITYWIDE RESILIENCE TO NATURAL HAZARDS

City of Portland bureaus manage city infrastructure, plan for long-term capital improvement and community-level investments, and administer a wide variety of programs. These activities play a role in the city's resilience to natural hazards. There are many things that bureaus can do now as part of their normal activities – or add to their portfolios when opportunities arise – to reduce Portland's risk from natural hazards over time and improve the city's ability to bounce back when natural hazard events do happen. These projects and programs together contribute to Portland's *Mitigation Action Plan* (MAP), the city's overall strategy for reducing its risk from natural hazards. They also help achieve compliance with the Disaster Mitigation Act of 2000 (DMA 2000), a federal law that requires local jurisdictions to have a federally-approved hazard mitigation plan to ensure eligibility for pre- and post-disaster grant funding. As stewards of the city's assets and services, bureaus share responsibility for mitigating natural hazard risks and maintaining the city's compliance with DMA 2000. Portland Bureau of Emergency Management (PBEM) oversees the update process for the MAP, but the MAP is not "PBEM's plan". It belongs to the City of Portland as a whole, and each bureau has a stake in the development of the plan and implementation of mitigation actions.

GROUPS INVOLVED IN THE PLANNING PROCESS

Because of Portland's commission form of government, bureaus operate relatively independently of one another. This independence has led the MAP planning team to adopt the approach typically used for multi-jurisdictional plans. One of the goals of the multi-jurisdictional approach to hazard mitigation planning is to efficiently achieve compliance with the Disaster Mitigation Act (DMA) for all participating members in the planning effort, citywide compliance in this case. There are several groups who will be involved in this process at different levels, which include:

- **Planning Team—**the Tetra Tech team and PBEM staff responsible for the facilitation of the planning process and the development of the plan document.
- **Steering Committee—**representative members from the community and city bureaus and offices that serve as the oversight body. They are responsible for many of the planning milestones and decisions prescribed for this process.
- **Planning Partners—**City of Portland bureaus and offices which manage infrastructure and administer programs included or potentially included as part of the city's hazard mitigation strategy
- **Planning Stakeholders—**the individuals, groups, businesses, academia, etc., from which the planning team gains information to support the various elements of the plan. This group may also be referred to as coordinating stakeholders.

ESTIMATED TIME COMMITMENT

The total time required of planning partners is dependent upon the number of mitigation action items each bureau commits to implementing or pursuing funding to implement. At a minimum, bureau representatives should expect to participate in an all-bureau workshop in mid-May, 2016 and an annual reporting and update meeting.

DEFINITION OF PARTICIPATION

For this planning process, planning partners must meet the following participation requirements:

- **Complete a letter of intent.** Provide a "Letter of Intent to participate" (see exhibit A).
- **Designate points of contact.** Designate a primary and secondary point of contact for this effort. These designees will be listed as the hazard mitigation points of contact for your bureau in the plan. Points of contact will be responsible for gathering progress reporting information for the planning team.
- **Attend bureau workshop.** In mid-May, the planning team will hold a workshop for all City of Portland bureaus and offices that manage city assets or administer programs that are included or potentially included in the hazard mitigation strategy. All such bureaus and offices should plan to attend this workshop. At the workshop, bureau representatives will be expected to provide information on existing programs and capabilities, review the 2010 mitigation strategy and recommend actions to roll over, and pledge support for the final mitigation recommendations that fall under their portfolio. Each approved action item must have commitment from one bureau to act as lead implementing bureau.
- **Apply an equity lens to project selection, development, and prioritization.** An equity worksheet has been provided for bureaus to be used in action item selection, development, and prioritization. Bureau representatives have a deep understanding of the work they do and the communities that are affected by their work. Bureaus should use this knowledge to work through the prioritization worksheet provided by the planning team to select action items that provide the most benefit possible to underserved and potentially vulnerable populations, while minimizing any disproportionate burden or adverse effects on these groups. Project implementation should also be carried out with these considerations.
- **Pursue mitigation implementation opportunities.** When opportunities arise to implement actions identified as priorities in the hazard mitigation plan, bureaus should pursue these opportunities to the extent they are able. This may include pursing grant funding, reallocating available resources to mitigation actions, or incorporating mitigation actions into existing or planned projects or programs.
- **Attend annual reporting and update meeting.** Over the five-year implementation period, bureaus will meet on an annual basis to report progress and make updates to the MAP as necessary.

If possible, bureau representatives are also encouraged to:

- **Support the steering committee.** A steering committee is already in place for this planning process, with representation from PBOT, PBEM, OEHR, ONI, BES, BPS, BDS, BPS, PF&R, and PP&R. The committee is tasked with overseeing the development of the plan and will become an oversight body throughout implementation. Steering committee meetings are not mandatory meetings for all planning partners, but all bureaus and offices are encouraged to remain engaged with this process and attend meetings as possible.

- **Support the public involvement strategy.** The planning team will also request support from bureau partners during the implementation of the public involvement strategy developed by the steering committee. Support could be in the form of providing venues for public meetings, attending these meetings as meeting participants, providing technical support, providing access to mailing lists, providing existing public information materials, etc.

EXHIBIT A

Example Letter of Intent to Participate

City of Portland Hazard Mitigation Planning Team
C/O PBEM
9911 SE Bush Street
Portland, OR 97266

Via email at: TheMAP@portlandoregon.gov

City of Portland Mitigation Action Plan Planning Team,

Please be advised that the ____________ (***insert bureau or office name***) is committed to participating in the development and implementation of the City of Portland Natural Hazard Mitigation Plan. As the ____________________ (title, e.g., Chief Administrative Official) for this bureau/office, I certify that I will commit all necessary resources in order to meet expectations as outlined in the "Planning Partners expectations" document provided by the planning team, in order to obtain citywide Disaster Mitigation Act (DMA) compliance and meet citywide equity goals outlined in the 2012 Portland Plan and this hazard mitigation plan process.

Mr./Ms. ________________ will be our bureau/office's primary point of contact for this process and they can be reached at ***(insert: address, phone number and e-mail address)***. Mr./Ms. ________________ will be our bureau/office's secondary point of contact for this process and they can be reached at ***(insert: address, phone number and e-mail address)***.

Sincerely,

____

The Mitigation Action Plan

Appendix K. Progress Report Template

The Mitigation Action Plan

20XX Progress Report

REPORTING PERIOD

MONTH 20XX through MONTH 20XX

BACKGROUND

The City of Portland has developed and maintained a natural hazard mitigation plan, most recently updated in 2016. *The Mitigation Action Plan* (MAP) identifies resources, information, and strategies for reducing risk associated with natural hazards in the city. The plan was adopted in 2016 and approved by FEMA Region X on __DATE__.

By preparing the 2016 update, the City maintained compliance with the federal Disaster Mitigation Act (DMA) and retained eligibility for hazard mitigation grant funding under the federal Robert T. Stafford Act. The plan is available to the public online at the following website:

https://www.portlandoregon.gov/pbem/53813

As part of the 2016 plan update process, a linkage procedure was established whereby eligible special purpose districts and other local governments within Portland could link to the base plan by creating jurisdictional annexes that assess risk to jurisdiction-specific facilities and develop mitigation actions to reduce these risks. During the reporting period X jurisdictions submitted a letter of intent to follow the linkage procedure and gain DMA compliance. *Provide a status update of any linked jurisdictions (e.g. in plan development, submitted to the state for review, etc.). If any eligible jurisdictions have completed linkage, the status their actions should also be included in the progress report.*

Purpose

This progress report provides an update on implementation of the MAP. It was prepared by the MAP planning team and reviewed by the 20XX mitigation action plan working group. The objective is to ensure that there is a continuous planning process that keeps the MAP plan responsive to stakeholder needs and capabilities. This progress reports includes the following:

- Summary overview of action plan progress
- Summary of any hazard events that occurred during the reporting period and the impact these events had on Portland;
- Review of the data utilized for this planning process as well as identified gaps and identification of any newly available or updated datasets;

- Listing of any newly published or updated reports or studies that should be incorporated into the next plan update process;
- Review of mitigation success stories;
- Review of continuing public engagement;
- Brief discussion about why actions were not completed or have not been initiated;
- Reevaluation of the action plan to determine if the timeline for identified projects needs to be amended (such as changing a long-term project to a short-term project because of new funding);
- Review of data that was or should be collected for any equity identified actions (e.g. High-E).
- Review of the Steering Committee recommended actions (see Appendix I of the MAP) and recommendations for new actions based on new or enhanced capabilities identified by lead agencies or next steps in actions identified in the 2016 action plan;
- Changes in or potential for new funding options (grant opportunities);
- Impacts of changes in other planning programs or projects that involve hazard mitigation; and
- Identification of training needs or additional guidance, such as benefit-cost analysis or E-grants training or additional equity guidance.

The Natural Hazard Mitigation Plan Working Group

The natural hazard mitigation plan working group holds an evolving role in plan implementation, based on the hazard mitigation needs of the City. The working group meets on a quarterly basis to discuss issues related to the MAP implementation. There were X meetings held during the reporting period. Issues discussed by the committee included:

- Date—Agenda items, issues or objectives
- Date—Agenda items, issues or objectives
- Date—Agenda items, issues or objectives

Table 1 lists current Mitigation Action Plan Working Group membership.

Table 1. 20XX Steering Committee Members

Name	Title	Bureau or Agency
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
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SUMMARY OVERVIEW OF ACTION PLAN PROGRESS

The MAP includes an action plan that identifies specific mitigation actions and a performance period for implementation of those actions. Table 2 summarizes the actions and current progress as of the time of this progress report.

Table 2. Summary Overview of Action Plan Progress

Number of Mitigation Actions Identified	XX
Mitigation Actions Started or Completed	
Number of Actions	XX
Percent of Total	XX%
Mitigation Actions Not Started	
Number of Actions	XX
Percent of Total	XX%

RECENT NATURAL HAZARD EVENTS IN PORTLAND

To Be Completed

REVIEW AND DATA AND IDENTIFIED GAPS

To be Completed

NEWLY PUBLISHED REPORTS

To be Completed

NEWLY IDENTIFIED OPPORTUNITIES FOR PLAN INTEGRATION

To Be Completed

CHANGES IN RISK EXPOSURE IN PORTLAND

To Be Completed

MITIGATION SUCCESS STORIES

To Be Completed

CONTINUED PUBLIC ENGAGEMENT

To Be Completed

REVIEW OF THE ACTION PLAN

This section reviews the action plan and lists the status of each action from the MAP, grouped by the bureau or jurisdiction responsible for its completion. The action plan matrix in Table 4 provides the following information:

- Brief summary of action
- Indication of whether any action has been taken
- Current timeline
- Indication of whether the project priority has changed
- Status (complete, ongoing or no progress)
- Comments, including the following information:
    - Was any element of the action carried out during the reporting period?
    - If no action was completed, why?
    - Is the timeline for implementation for the action still appropriate?
    - Has a new funding source been identified?
    - If the action was completed, does it need to be changed or removed from the action plan or should the action be revised to reflect the next step in action implementation?
    - If the action was identified as an equity action, what data is or should be collected to assess performance?

PORTLAND CHANGES THAT MAY IMPACT PLAN IMPLEMENTATION

To Be Completed

With these changes in mind, lead agencies have reviewed the steering committee recommended actions developed during the 2016 plan update. Because of newly acquired capabilities (e.g. staff, funding, technical assistance, etc.) the following actions shown in Table 4 will be added to the action plan as they are now feasible.

Table-4. Newly Selected Actions for Implementation

Hazards Addressed	New or Existing Assets	Funding Options	Timeframe	Objectives Met	In Previous Plan? (# from previous plan)
Action# —Action description					
Lead Agency:		**Partner Agencies:**			
Action Source:		**Performance Metric:**			
Action# —Action description					
Lead Agency:		**Partner Agencies:**			
Action Source:		**Performance Metric:**			
Action# —Action description					
Lead Agency:		**Partner Agencies:**			
Action Source:		**Performance Metric:**			
Action# —Action description					
Lead Agency:		**Partner Agencies:**			
Action Source:		**Performance Metric:**			
Action# —Action description					
Lead Agency:		**Partner Agencies:**			
Action Source:		**Performance Metric:**			
Action# —Action description					
Lead Agency:		**Partner Agencies:**			
Action Source:		**Performance Metric:**			
Action# —Action description					
Lead Agency:		**Partner Agencies:**			
Action Source:		**Performance Metric:**			
Action# —Action description					
Lead Agency:		**Partner Agencies:**			
Action Source:		**Performance Metric:**			
Action# —Action description					
Lead Agency:		**Partner Agencies:**			
Action Source:		**Performance Metric:**			
Action# —Action description					
Lead Agency:		**Partner Agencies:**			
Action Source:		**Performance Metric:**			

TRAINING NEEDS OR ADDITIONAL GUIDANCE

To be Completed.

RECOMMENDATIONS FOR CHANGES OR ENHANCEMENTS

Based on the review of this report by the Mitigation Action Plan Working Group, the recommendations described in the preceding sections will be noted for future updates or revisions to the plan.

Public review notice: *The contents of this report are considered to be public knowledge and have been prepared for total public disclosure. Copies of the report have been provided to local media* *outlets. The report is also posted on the City of Portland hazard mitigation website. Any questions or comments regarding the contents of this report should be directed to:*

Name
Address
City, ST Zip
Phone
email

Table 4. Action Plan Matrix

Action Taken?	Timeline	Priority Changed?	Comment	Status
Action #—Description				
CHOOSE	CHOOSE	CHOOSE		CHOOSE
Action #—Description				
CHOOSE	CHOOSE	CHOOSE		CHOOSE
Action #—Description				
CHOOSE	CHOOSE	CHOOSE		CHOOSE
Action #—Description				
CHOOSE	CHOOSE	CHOOSE		CHOOSE
Action #—Description				
CHOOSE	CHOOSE	CHOOSE		CHOOSE
Action #—Description				
CHOOSE	CHOOSE	CHOOSE		CHOOSE
Action #—Description				
CHOOSE	CHOOSE	CHOOSE		CHOOSE
Action #—Description				
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Action #—Description				
CHOOSE	CHOOSE	CHOOSE		CHOOSE
Action #—Description				
CHOOSE	CHOOSE	CHOOSE		CHOOSE
Action #—Description				
CHOOSE	CHOOSE	CHOOSE		CHOOSE

Action Taken?	Timeline	Priority Changed?	Comment	Status
Action #—Description				
CHOOSE	CHOOSE	CHOOSE		CHOOSE
Action #—Description				
CHOOSE	CHOOSE	CHOOSE		CHOOSE
Action #—Description				
CHOOSE	CHOOSE	CHOOSE		CHOOSE
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Action #—Description				
CHOOSE	CHOOSE	CHOOSE		CHOOSE
Action #—Description				
CHOOSE	CHOOSE	CHOOSE		CHOOSE
Action #—Description				
CHOOSE	CHOOSE	CHOOSE		CHOOSE

The Mitigation Action Plan

Appendix L. FEMA Local Mitigation Plan Review Tool

L. FEMA Local Mitigation Plan Review Tool

The *Local Mitigation Plan Review Tool* demonstrates how the Local Mitigation Plan meets the regulation in 44 CFR §201.6 and offers States and FEMA Mitigation Planners an opportunity to provide feedback to the community.

- The Regulation Checklist provides a summary of FEMA's evaluation of whether the Plan has addressed all requirements.
- The Plan Assessment identifies the plan's strengths as well as documents areas for future improvement.
- The Multi-jurisdiction Summary Sheet is an optional worksheet that can be used to document how each jurisdiction met the requirements of the each Element of the Plan (Planning Process; Hazard Identification and Risk Assessment; Mitigation Strategy; Plan Review, Evaluation, and Implementation; and Plan Adoption).

The FEMA Mitigation Planner must reference this *Local Mitigation Plan Review Guide* when completing the *Local Mitigation Plan Review Tool*.

Jurisdiction: **Portland, Oregon**	**Title of Plan:** **The Mitigation Action Plan: The City of Portland's Path to Resilience**	**Date of Plan:** **September 2016**
Local Point of Contact: **Jonna Papaefthimiou**	**Address:** **9911 SE Bush Street** **Portland, OR 97266**	
Title: **Planning and Preparedness Manager**		
Agency: **Portland Bureau of Emergency Management (PBEM)**		
Phone Number: **503-823-3809**	**E-Mail:** **Jonnap@portlandoregon.gov**	

State Reviewer:	**Title:**	**Date:**

FEMA Reviewer:	**Title:**	**Date:**
Date Received in FEMA Region ***(insert #)***		
Plan Not Approved		
Plan Approvable Pending Adoption		
Plan Approved		

SECTION 1:

REGULATION CHECKLIST

INSTRUCTIONS: The Regulation Checklist must be completed by FEMA. The purpose of the Checklist is to identify the location of relevant or applicable content in the Plan by Element/sub-element and to determine if each requirement has been 'Met' or 'Not Met.' The 'Required Revisions' summary at the bottom of each Element must be completed by FEMA to provide a clear explanation of the revisions that are required for plan approval. Required revisions must be explained for each plan sub-element that is 'Not Met.' Sub-elements should be referenced in each summary by using the appropriate numbers (A1, B3, etc.), where applicable. Requirements for each Element and sub-element are described in detail in this *Plan Review Guide* in Section 4, Regulation Checklist.

1. REGULATION CHECKLIST **Regulation** (44 CFR 201.6 Local Mitigation Plans)	**Location in Plan** (section and/or page number)	**Met**	**Not Met**
ELEMENT A. PLANNING PROCESS			
A1. Does the Plan document the planning process, including how it was prepared and who was involved in the process for each jurisdiction? (Requirement §201.6(c)(1))	Part 1, Chapter 3 (Plan Update Approach) and Section 3.8 (Plan Development Chronology/Milestones) and Section 3.2 (Formation of the Planning Team) and Section 3.5 (the Steering Committee) and Section 3.6 (Coordination with Other Agencies) Part 1, Chapter 2 (Plan Update – What Has Changed)		
A2. 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))	Part 1, Chapter 3, Section 3.4 (Plan Kick-off); Section 3.5 (The Steering Committee); Section 3.6 (Coordination with Other Agencies); Section 3.7.3 (Critical Energy Infrastructure Hub Stakeholder Outreach)		
A3. Does the Plan document how the public was involved in the planning process during the drafting stage? (Requirement §201.6(b)(1))	Part 1, Chapter 3, Section 3.7 (Public Engagement Strategy) and Appendix C (Public Engagement Materials)		

1. REGULATION CHECKLIST **Regulation** (44 CFR 201.6 Local Mitigation Plans)	Location in Plan (section and/or page number)	Met	Not Met
A4. Does the Plan describe the review and incorporation of existing plans, studies, reports, and technical information? (Requirement §201.6(b)(3))	Part 1, Chapter 4, Section 4.9 (Laws, Ordinances and Programs) Part 2, Chapter 6, Section 6.1 (Overall Risk Assessment Methodology); Table 6-1 (Summary of Data Used for Spatial analysis); Section 6.8 (Data sources, limitations and gaps) Part 3, Chapter 17 (Vision, Mission, Goals and Objectives) Part 3, Chapter 19, Section 19.3 (Actions Selected for Implementation in the 2016 Plan) and Section 19.5.5, Subsection (Plan Integration for the Mitigation Action Plan) References cited throughout (see References section)		
A5. Is there discussion of how the community(ies) will continue public participation in the plan maintenance process? (Requirement §201.6(c)(4)(iii))	Part 3, Chapter 19, Section 19.5.7 (Continued Public Engagement and Access)		
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))	Part 3, Chapter 19, Section 19.5.4 (Annual Progress Report); Section 19.5.6, Subsection (Plan Update); Section 19.5.1 Plan Implementation		
ELEMENT A: REQUIRED REVISIONS			
ELEMENT B. HAZARD IDENTIFICATION AND RISK ASSESSMENT			
B1. Does the Plan include a description of the type, location, and extent of all natural hazards that can affect each jurisdiction(s)? (Requirement §201.6(c)(2)(i))	Part 2, Chapter 5 (Hazards and Compounding Factors) Part 2, Chapters 7 through 14, Section X.1 General Background, Section X.2 (Hazard Profile) and X.4 (Exposure)		
B2. Does the Plan include information on previous occurrences of hazard events and on the probability of future hazard events for each jurisdiction? (Requirement §201.6(c)(2)(i))	Part 2, Chapters 7 through 14, Section X.2.1 (Past Events); X.2.4 (Frequency) Part 2, Chapter 16, Section 16.1 (Probability of Occurrence)		

1. REGULATION CHECKLIST **Regulation** (44 CFR 201.6 Local Mitigation Plans)	Location in Plan (section and/or page number)	Met	Not Met
B3. Is there a description of each identified hazard's impact on the community as well as an overall summary of the community's vulnerability for each jurisdiction? (Requirement §201.6(c)(2)(ii))	Part 2, Chapter 7 through 14, Section X.4 (Exposure) and X.5 (Vulnerability); , Sections X.8 (Issues) Part 2, Chapter 16 (Risk Ranking)		
B4. Does the Plan address NFIP insured structures within the jurisdiction that have been repetitively damaged by floods? (Requirement §201.6(c)(2)(ii))	Part 2, Chapter 11, Section 11.5.2, Sub-section (Repetitive Loss)		
ELEMENT B: REQUIRED REVISIONS			
ELEMENT C. MITIGATION STRATEGY			
C1. Does the plan document each jurisdiction'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))	Part 1, Chapter 4, Section 4.9.3 (Local)		
C2. Does the Plan address each jurisdiction's participation in the NFIP and continued compliance with NFIP requirements, as appropriate? (Requirement §201.6(c)(3)(ii))	Part 2, Chapter 11, Section 11.2.7 (Flood Management Programs and Projects)		
C3. Does the Plan include goals to reduce/avoid long-term vulnerabilities to the identified hazards? (Requirement §201.6(c)(3)(i))	Part 3, chapter 17 (Vision, Mission, Goals and Objectives)		
C4. Does the Plan identify and analyze a comprehensive range of specific mitigation actions and projects for each jurisdiction being considered to reduce the effects of hazards, with emphasis on new and existing buildings and infrastructure? (Requirement §201.6(c)(3)(ii))	Part 3, Chapter 18 (Mitigation Alternatives) Appendix I Mitigation Best Practices Catalog Chapter 19, Section 19.3 (Actions Selected for Implementation in the 2016 Plan); Section 19.3.2 (Selected Actions)		
C5. Does the Plan contain an action plan that describes how the actions identified will be prioritized (including cost benefit review), implemented, and administered by each jurisdiction? (Requirement §201.6(c)(3)(iv)); (Requirement §201.6(c)(3)(iii))	Part 3, Chapter 19, Section 19.3.4 (Action Plan Prioritization); Section 19.3.3 (Action Plan Benefit-Cost Review); Section 19.3.2 (Selected Actions); and Table 19-4 (Actions Selected for Implementation)		

1. REGULATION CHECKLIST **Regulation** (44 CFR 201.6 Local Mitigation Plans)	Location in Plan (section and/or page number)	Met	Not Met
C6. Does the Plan describe a process by which local governments will integrate the requirements of the mitigation plan into other planning mechanisms, such as comprehensive or capital improvement plans, when appropriate? (Requirement §201.6(c)(4)(ii))	Part 3, Chapter 19, Section 19.5.5, Subsection (Plan Integration for the Mitigation Action Plan) Part 1, Chapter 4, Section 4.9.3 (Local); Part 3, Chapter 19, Section 19.3.2, Table 19-4 (Actions Selected for Implementation); and Section 19.3.4, Table 19-5 (Prioritization of Mitigation Actions) Part 3, Chapter 19, Section 19.5.5, Subsection (Plan Integration During the 2010 NHMP Performance Period)		
ELEMENT C: REQUIRED REVISIONS			
ELEMENT D. PLAN REVIEW, EVALUATION, AND IMPLEMENTATION (applicable to plan updates only)			
D1. Was the plan revised to reflect changes in development? (Requirement §201.6(d)(3))	Part 1, Chapter 2, Section 2.2.2 (Changes in Development) Chapters 7 through 14, Sections X.5 (Future Trends in Development)		
D2. Was the plan revised to reflect progress in local mitigation efforts? (Requirement §201.6(d)(3))	Part 3, Chapter 19, Section 19.2 (Status of Previous Plan Actions)		
D3. Was the plan revised to reflect changes in priorities? (Requirement §201.6(d)(3))	This plan update utilized a different prioritization scheme from original plan. Therefore, all actions were reprioritized. In general, Portland has increased its focus and attention on public engagement and equity and the entire plan and planning process was revised to address this shift in priorities. Part 1, Chapter 2, Section 2.2.3 (Focus on Public Engagement and Equity) Part 3, Chapter 19, Section 19.3.1 (Equity Analysis Screening) and Section 19.3.4 (Action Plan Prioritization)		
ELEMENT D: REQUIRED REVISIONS			

1. REGULATION CHECKLIST **Regulation** (44 CFR 201.6 Local Mitigation Plans)	Location in Plan (section and/or page number)	Met	Not Met
ELEMENT E. PLAN ADOPTION			
E1. Does the Plan include documentation that the plan has been formally adopted by the governing body of the jurisdiction requesting approval? (Requirement §201.6(c)(5))	Pre-adoption review request – Adoption scheduled for October 19		
E2. For multi-jurisdictional plans, has each jurisdiction requesting approval of the plan documented formal plan adoption? (Requirement §201.6(c)(5))	N/A		
ELEMENT E: REQUIRED REVISIONS			
ELEMENT F. ADDITIONAL STATE REQUIREMENTS (OPTIONAL FOR STATE REVIEWERS ONLY; NOT TO BE COMPLETED BY FEMA)			
F1.			
F2.			
ELEMENT F: REQUIRED REVISIONS			

SECTION 2:

PLAN ASSESSMENT

INSTRUCTIONS: The purpose of the Plan Assessment is to offer the local community more comprehensive feedback to the community on the quality and utility of the plan in a narrative format. The audience for the Plan Assessment is not only the plan developer/local community planner, but also elected officials, local departments and agencies, and others involved in implementing the Local Mitigation Plan. The Plan Assessment must be completed by FEMA. The Assessment is an opportunity for FEMA to provide feedback and information to the community on: 1) suggested improvements to the Plan; 2) specific sections in the Plan where the community has gone above and beyond minimum requirements; 3) recommendations for plan implementation; and 4) ongoing partnership(s) and information on other FEMA programs, specifically RiskMAP and Hazard Mitigation Assistance programs. The Plan Assessment is divided into two sections:

1. Plan Strengths and Opportunities for Improvement
2. Resources for Implementing Your Approved Plan

Plan Strengths and Opportunities for Improvement is organized according to the plan Elements listed in the Regulation Checklist. Each Element includes a series of italicized bulleted items that are suggested topics for consideration while evaluating plans, but it is not intended to be a comprehensive list. FEMA Mitigation Planners are not required to answer each bullet item, and should use them as a guide to paraphrase their own written assessment (2-3 sentences) of each Element.

The Plan Assessment must not reiterate the required revisions from the Regulation Checklist or be regulatory in nature, and should be open-ended and to provide the community with suggestions for improvements or recommended revisions. The recommended revisions are suggestions for improvement and are not required to be made for the Plan to meet Federal regulatory requirements. The italicized text should be deleted once FEMA has added comments regarding strengths of the plan and potential improvements for future plan revisions. It is recommended that the Plan Assessment be a short synopsis of the overall strengths and weaknesses of the Plan (no longer than two pages), rather than a complete recap section by section.

Resources for Implementing Your Approved Plan provides a place for FEMA to offer information, data sources and general suggestions on the overall plan implementation and maintenance process. Information on other possible sources of assistance including, but not limited to, existing publications, grant funding or training opportunities, can be provided. States may add state and local resources, if available.

A. Plan Strengths and Opportunities for Improvement

This section provides a discussion of the strengths of the plan document and identifies areas where these could be improved beyond minimum requirements.

Element A: Planning Process

How does the Plan go above and beyond minimum requirements to document the planning process with respect to:

- *Involvement of stakeholders (elected officials/decision makers, plan implementers, business owners, academic institutions, utility companies, water/sanitation districts, etc.);*
- *Involvement of Planning, Emergency Management, Public Works Departments or other planning agencies (i.e., regional planning councils);*
- *Diverse methods of participation (meetings, surveys, online, etc.); and*
- *Reflective of an open and inclusive public involvement process.*

Element B: Hazard Identification and Risk Assessment

In addition to the requirements listed in the Regulation Checklist, 44 CFR 201.6 Local Mitigation Plans identifies additional elements that should be included as part of a plan's risk assessment. The plan should describe vulnerability in terms of:

1) *A general description of land uses and future development trends within the community so that mitigation options can be considered in future land use decisions;*
2) *The types and numbers of existing and future buildings, infrastructure, and critical facilities located in the identified hazard areas; and*
3) *A description of potential dollar losses to vulnerable structures, and a description of the methodology used to prepare the estimate.*

How does the Plan go above and beyond minimum requirements to document the Hazard Identification and Risk Assessment with respect to:

- *Use of best available data (flood maps, HAZUS, flood studies) to describe significant hazards;*
- *Communication of risk on people, property, and infrastructure to the public (through tables, charts, maps, photos, etc.);*
- *Incorporation of techniques and methodologies to estimate dollar losses to vulnerable structures;*
- *Incorporation of Risk MAP products (i.e., depth grids, Flood Risk Report, Changes Since Last FIRM, Areas of Mitigation Interest, etc.); and*
- *Identification of any data gaps that can be filled as new data became available.*

Element C: Mitigation Strategy

How does the Plan go above and beyond minimum requirements to document the Mitigation Strategy with respect to:

- *Key problems identified in, and linkages to, the vulnerability assessment;*
- *Serving as a blueprint for reducing potential losses identified in the Hazard Identification and Risk Assessment;*
- *Plan content flow from the risk assessment (problem identification) to goal setting to mitigation action development;*
- *An understanding of mitigation principles (diversity of actions that include structural projects, preventative measures, outreach activities, property protection measures, post-disaster actions, etc.);*
- *Specific mitigation actions for each participating jurisdictions that reflects their unique risks and capabilities;*
- *Integration of mitigation actions with existing local authorities, policies, programs, and resources; and*
- *Discussion of existing programs (including the NFIP), plans, and policies that could be used to implement mitigation, as well as document past projects.*

Element D: Plan Update, Evaluation, and Implementation (*Plan Updates Only*)

How does the Plan go above and beyond minimum requirements to document the 5-year Evaluation and Implementation measures with respect to:

- *Status of previously recommended mitigation actions;*
- *Identification of barriers or obstacles to successful implementation or completion of mitigation actions, along with possible solutions for overcoming risk;*
- *Documentation of annual reviews and committee involvement;*
- *Identification of a lead person to take ownership of, and champion the Plan;*
- *Reducing risks from natural hazards and serving as a guide for decisions makers as they commit resources to reducing the effects of natural hazards;*
- *An approach to evaluating future conditions (i.e. socio-economic, environmental, demographic, change in built environment etc.);*
- *Discussion of how changing conditions and opportunities could impact community resilience in the long term; and*
- *Discussion of how the mitigation goals and actions support the long-term community vision for increased resilience.*

B. Resources for Implementing Your Approved Plan

Ideas may be offered on moving the mitigation plan forward and continuing the relationship with key mitigation stakeholders such as the following:

- *What FEMA assistance (funding) programs are available (for example, Hazard Mitigation Assistance (HMA)) to the jurisdiction(s) to assist with implementing the mitigation actions?*
- *What other Federal programs (National Flood Insurance Program (NFIP), Community Rating System (CRS), Risk MAP, etc.) may provide assistance for mitigation activities?*
- *What publications, technical guidance or other resources are available to the jurisdiction(s) relevant to the identified mitigation actions?*
- *Are there upcoming trainings/workshops (Benefit-Cost Analysis (BCA), HMA, etc.) to assist the jurisdictions(s)?*
- *What mitigation actions can be funded by other Federal agencies (for example, U.S. Forest Service, National Oceanic and Atmospheric Administration (NOAA), Environmental Protection Agency (EPA) Smart Growth, Housing and Urban Development (HUD) Sustainable Communities, etc.) and/or state and local agencies?*

SECTION 3:

MULTI-JURISDICTION SUMMARY SHEET (OPTIONAL)

INSTRUCTIONS: For multi-jurisdictional plans, a Multi-jurisdiction Summary Spreadsheet may be completed by listing each participating jurisdiction, which required Elements for each jurisdiction were 'Met' or 'Not Met,' and when the adoption resolutions were received. This Summary Sheet does not imply that a mini-plan be developed for each jurisdiction; it should be used as an optional worksheet to ensure that each jurisdiction participating in the Plan has been documented and has met the requirements for those Elements (A through E).

MULTI-JURISDICTION SUMMARY SHEET													
							Requirements Met (Y/N)						
#	Jurisdiction Name	Jurisdiction Type (city/ borough/ township/ village, etc.)	Plan POC	Mailing Address	Email	Phone	A. Planning Process	B. Hazard Identification & Risk Assessment	C. Mitigation Strategy	D. Plan Review, Evaluation & Implementation	E. Plan Adoption	F. State Require-ments