MEMORANDUM

EUGENE WATER & ELECTRIC BOARD

Rely on us.

TO:	Commissioners Carlson, Mital, Helgeson, Schlossberg and Brown
FROM:	Rod Price, Chief Operating Officer; Jeannine Parisi, Customer Relationship Manager
DATE:	May 24, 2019
SUBJECT:	Eugene/Springfield Natural Hazard Mitigation Plan Update
OBJECTIVE:	Provide General Direction

Issue

The Federal Emergency Management Agency (FEMA) requires state, tribal, and local governments to develop and adopt hazard mitigation plans as a condition for receiving certain types of non-emergency disaster assistance, including grant funding for mitigation projects. The current Eugene/Springfield Natural Hazard Mitigation Plan (NHMP) expires in January 2020. The Board is requested to review the 2020 NHMP prior to submission to State and Federal approval bodies for their comments.

Background/Discussion

The NHMP is updated every five years. In general, the plan identifies and prioritizes actions for risk reduction with the intent of building partnerships to reduce the physical and economic losses caused by natural disasters. Attachment 1 is a FEMA Fact Sheet describing the purpose and general process for local mitigation plan development.

There are new FEMA requirements associated with this year's plan. First, special districts, including EWEB, Springfield Utility Board, and Rainbow Water District, are required to submit a condensed version of the plan as an 'Annex' to the community's overarching NHMP (aka base plan). Second, elected bodies of all jurisdictions covered by the plan, including Special District Boards, are required to adopt the plan once it has gone through the State and Federal review and comment periods. For the EWEB Board of Commissioners, this would include the EWEB Annex, as well as the first several chapters of the base plan covering community hazard vulnerability assessments, the plan development process, and public outreach strategies.

Attachment 2 contains the EWEB Annex, which follows the layout prescribed by FEMA. Because resiliency is one of EWEB's strategic priorities, the utility has numerous risk mitigation activities and investments relevant to the NHMP. Per FEMA guidelines, mitigation items can include infrastructure projects, natural systems protection, and education and awareness programs. Note that on-going maintenance, such as tree-trimming, and compliance-related activities do not count as mitigation. The first two chapters of the 2020 base plan (still draft) are included as Attachment 3.

Recommendation
The EWEB Annex is provided for Board review and comment prior to submission to State and Federal agencies. In order for the 2020 Eugene/Springfield NHMP to be in effect in January, the City intends to submit the draft plan to the State of Oregon Office of Emergency Management (OEM) by July for the 45 – 60 day review period. Once OEM comments are incorporated, the NHMP will then be submitted to FEMA in early fall for another review and comment period. The intent is for elected bodies to adopt the final 2020 NHMP in December.

In adopting the plan, the Board is committing to working on the mitigation actions described in the EWEB Annex. However, there are no penalties associated with delaying, changing or otherwise not completing any of the listed actions.

Requested Board Action
No formal action is requested at this time. Per the General Manager, feedback is requested by Monday, July 1, and should be provided directly to rod.price@eweb.org and jeannine.parisi@eweb.org.

FEMA

Fact Sheet

Federal Insurance and Mitigation Administration

LOCAL HAZARD MITIGATION PLANNING

Hazard Mitigation Planning for Resilient Communities

Disasters can cause loss of life; damage buildings and infrastructure; and have devastating consequences for a community's economic, social, and environmental well-being. Hazard mitigation is the effort to reduce loss of life and property by lessening the impact of disasters. In other words, hazard mitigation keeps natural hazards from becoming natural disasters.

Hazard mitigation is best accomplished when based on a comprehensive, long-term plan developed before a disaster strikes. Mitigation planning is the process used by state, tribal, and local leaders to understand risks from natural hazards and develop long-term strategies that will reduce the impacts of future events on people, property, and the environment.

The Local Mitigation Planning Process

The mitigation plan is a community-driven, living document. The planning process itself is as important as the resulting plan because it encourages communities to integrate mitigation with day-to-day decision making regarding land use planning, floodplain management, site design, and other functions. Mitigation planning includes the following elements:

Public Involvement – Planning creates a way to solicit and consider input from diverse interests, and promotes discussion about creating a safer, more disaster-resilient community. Involving stakeholders is essential to building community-wide support for the plan. In addition to emergency managers, the planning process involves other government agencies, businesses, civic groups, environmental groups, and schools.

Risk Assessment – Mitigation plans identify the natural hazards and risks that can impact a community based on historical experience, estimate the potential frequency and magnitude of disasters, and assess potential losses to life and property. The risk assessment process provides a factual basis for the activities proposed in the mitigation strategy.

Mitigation Strategy – Based on public input, identified risks, and available capabilities, communities develop mitigation goals and objectives as part of a strategy for mitigating hazard-related losses. The strategy is a community's approach for implementing mitigation activities that are cost-effective, technically feasible, and environmentally sound as well as allowing strategic investment of limited resources.

Disaster Mitigation Act of 2000

The Robert T. Stafford Disaster Relief and Emergency Assistance Act, as amended by the Disaster Mitigation Act of 2000, is intended to "reduce the loss of life and property, human suffering, economic disruption, and disaster assistance costs resulting from natural disasters."

Under this legislation, state, tribal, and local governments must develop a hazard mitigation plan as a condition for receiving certain types of non-emergency disaster assistance through the Hazard Mitigation Assistance Programs. The regulatory requirements for local hazard mitigation plans can be found at Title 44 Code of Federal Regulations §201.6.

For more information about FEMA's Hazard Mitigation Assistance Grants, visit: www.fema.gov/hazard-mitigation-assistance.

"FEMA's mission is to support our citizens and first responders to ensure that as a nation we work together to build, sustain, and improve our capability to prepare for, protect against, respond to, recover from, and mitigate all hazards."

Benefits of Hazard Mitigation

Mitigation is an investment in your community's future safety and sustainability. Mitigation planning helps you take action now, before a disaster, to reduce impacts when a disaster occurs. Hazard mitigation planning helps you think through how you choose to plan, design, and build your community and builds partnerships for risk reduction throughout the community. Consider the critical importance of mitigation to:

- Protect public safety and prevent loss of life and injury.
- Reduce harm to existing and future development.
- Maintain community continuity and strengthen the social connections that are essential for recovery.
- Prevent damage to your community's unique economic, cultural, and environmental assets.
- Minimize operational downtime and accelerate recovery of government and business after disasters.
- Reduce the costs of disaster response and recovery and the exposure to risk for first responders.
- Help accomplish other community objectives, such as capital improvements, infrastructure protection, open space preservation, and economic resiliency.

Having a hazard mitigation plan will increase awareness of hazards, risk, and vulnerabilities; identify actions for risk reduction; focus resources on the greatest risks; communicate priorities to state and federal officials; and increase overall awareness of hazards and risks.

Mitigation Activities for Risk Reduction

Possible mitigation activities may include:

Adoption and enforcement of regulatory tools, including ordinances, regulations, and building codes, to guide and inform land use, development, and redevelopment decisions in areas affected by hazards.

Acquisition or elevation of flood-damaged homes or businesses retrofit public buildings, schools, and critical facilities to withstand extreme wind events or ground shaking from earthquakes.

Creating a buffer area by protecting natural resources, such as floodplains, wetlands, or sensitive habitats. Additional benefits to the community may include improved water quality and recreational opportunities.

Implement outreach programs to educate property owners and the public about risk and about mitigation measures to protect homes and businesses.

Mitigation Plan Implementation & Monitoring

History shows that hazard mitigation planning and the implementation of risk reduction activities can significantly reduce the physical, financial, and emotional losses caused by disasters. Putting the plan into action will be an ongoing process that may include initiating and completing mitigation projects and integrating mitigation strategies into other community plans and programs. Monitoring the plan's implementation helps to ensure it remains relevant as community priorities and development patterns change.

Planning Guidance, Tools, and Resources

FEMA provides a variety of guidance, tools, and resources to help communities develop hazard mitigation plans. These resources and more can be found online at: www.fema.gov/hazard-mitigation-planning-resources.

- Hazard mitigation planning laws, regulations, and policies guide development of state, local, and tribal FEMA-approved hazard mitigation plans.
- The Local Mitigation Planning Handbook is the official guide for governments to develop, update, and implement local plans. The Handbook includes guidance, tools, and examples communities can use to develop their plans.
- Mitigation Ideas: A Resource for Reducing Risk to Natural Hazards provides ideas for mitigation actions.
- Visit www.fema.gov/hazard-mitigation-planning-training for more information on available online and in-person mitigation planning training.

Annex A
EUGENE WATER & ELECTRIC BOARD

1.1 HAZARD MITIGATION PLAN POINT OF CONTACT

Primary Point of Contact

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1.2 JURISDICTIONAL PROFILE

The Eugene Water & Electric Board (EWEB) is the largest publicly owned electric and water utility in Oregon. The City of Eugene (the City) commenced utility operations in 1908 with the purchase of a privately-owned water system. In 1911, upon completion of the City's first municipal hydroelectric power plant, the City organized the Eugene Water Board to operate the City's electric and water utilities. The name of the Eugene Water Board was changed to the Eugene Water & Electric Board in 1949.

EWEB is chartered by the City and supplies electric and water service within the city limits of Eugene and to certain areas outside the city limits. Employing about 500 people, EWEB operates as a primary government, and is not considered a component unit of the City. EWEB is governed by a five-member Board of Commissioners who are elected by voters residing in the City. The Board is responsible for the adoption of this plan and funding for priority activities. The General Manager will oversee plan implementation.

Population served: 168,916 (2017 estimate, U.S. Census Bureau)

Land area served: 236 square miles

Land area owned: 44.15 square miles

Electric System

The Electric System supplies service to 93,000 residential, commercial, and industrial customers within the City of Eugene and areas along the McKenzie River between the cities of Walterville and Vida, where two of EWEB's hydro-power plants are located.

Power delivered to customers is supplied by the Bonneville Power Administration (BPA), via EWEB-owned generation resources, other contracted resources, and purchases from the wholesale energy markets. EWEB's power supply sources are primarily hydro-power, but also include wind, biomass, and solar. The electric utility's 2019 operating budget is $212 million. The budget for capital improvements is $37 million and the budget for debt service is $16 million.

Total Electric System Service Area: 236 square miles

Transmission and distribution lines: 1,300 miles

Substations: 38

Utility-owned hydroelectric facilities: 4

Electric System operating assets historical costs[1] are listed below. A new operating license for the Carmen-Smith Hydroelectric Project was issued in May 2019. Capital improvements at this facility under the new licensing requirements are projected to cost $116 million. The insured value of all hydro-electric production facilities, which approximates replacement value, is over $320 million as of March 2019.

	Historical Cost (as of Dec 2018)
Land	$ 8,969,999
International Paper Biomass (Turbine #4)	$ 10,363,488
Foote Creek[2] Wind Farm	$ 11,789,767
Hydro Production [3]	$ 162,579,170
Transmission	$ 84,785,666
Distribution	$313,808,256
General Plant[4]	$ 158,027,521
Telecommunications	$ 19,452,088
Completed Construction, not yet classified	$ 16,979,283
Construction Work in Progress	$ 16,972.396
TOTAL:	**$803,727,634**

[1] Cost when the asset was first placed in service and capital improvement costs to that asset over time.
[2] Windfarm located in Carbon County, Wyoming, co-owned with Pacific Power Corp.
[3] Includes $29 million for the Stone Creek Hydroelectric project located on Clackamas River, Oregon.
[4] Includes electric utility portion of fleet and administration/operational buildings.

Current and Anticipated Service Trends
Studies commissioned by the City of Eugene estimate the area's population will grow by 34,000 people by 2031, or by an average annual rate of 1.4 percent. However, unless a large industrial facility locates in our service territory, electric consumption trends are expected to stay relatively flat, with most new customers served through existing facilities and energy resources. This is due to higher energy efficient buildings and equipment, use of natural gas for heating and industrial uses, and the on-going success of utility energy conservation programs.

<u>Water System</u>

EWEB provides treated drinking water to 61,000 residential, commercial, industrial, and public sector customers with its Eugene service territory in the Eugene. EWEB also supplies wholesale water to the River Road and Santa Clara water districts in unincorporated North Eugene and has wholesale water contracts with the City of Veneta and the Willamette Water Company.

The water utility maintains three waters right for drinking water at a single point of delivery on the McKenzie River. EWEB efforts to diversify water supply sources include a groundwater permit issued in 2008 and a surface water registration and permit issued on the Willamette River. Water permits will not be certificated until a sufficient volume of water from these sources is distributed for municipal use.

Raw water is collected via two river intake structures located at Hayden Bridge in Springfield and delivered to a nearby treatment plant. The water treatment plant pre-treats, filters and treats the raw water for consumption. Two large transmission lines in a seven-mile long corridor bring treated water to the Eugene city limits. From there, transmission and distribution pipelines deliver water to customers.

EWEB operates three primary baseline reservoirs to store water, and a number of smaller reservoirs at upper elevations. Pressure to deliver the water is controlled largely from the filtration plant which is capable of serving approximately 85 percent of EWEB consumers. A system of pumps and reservoirs serve EWEB's remaining consumers. The Water System's 2019 operating budget is $20 million. The budget for capital improvements is $15 million and the budget for debt service is $5 million.

Reservoirs: 23 (89 million gallons capacity)

Pump stations: 27

Water distribution system: 800 miles

The estimated value of major water utility assets, in historical cost and insured values (when value approximates replacement costs) is listed below.

	Historical Cost (as of Dec 2018)	Insured Value (as of March 2019)
Land	$ 1,258,733	-
Hayden Bridge Treatment Plant	$ 35,742,975	$ 99,332,597
Source of Supply	$ 24,411,213	-
Water Transmission & Distribution	$ 145,416,693	-
Reservoirs/Pumping	$38,653,795	$ 74,279,546
General Plant	$ 37,847,775	-
Completed Construction, net yet classified	$ 6,418,961	-
Construction Work in Progress	$ 6,551,690	-
TOTAL:	**$ 293,301,835**	

Current and Anticipated Service Trends

Similar to the electric utility, water consumption remains nearly flat despite population growth. While annual usage is highly weather dependent, the growth trend is marginal over time due to efficiency standards in plumbing codes and changing irrigation practices. Additional wholesale water contracts to nearby small cities are technically feasible but not likely in the near future.

1.3 APPLICABLE REGULATIONS AND PLANS

- **Eugene City Charter Chapter X, Section 44**
  Conveys authority to maintain and operate the electric and water utility to EWEB.
- **Eugene City Code 2.175 – 2.212**
  Sets forth powers and duties of the Eugene Water & Electric Board.
- **Annual Electric and Water 10-Year Capital Improvement Plans**
  Describes routine capital work like pole and water main replacements, specific upgrades over $1 million such as reservoir rebuilds, and large multi-year projects typically financed through bonds. The $311 M electric and $212 M water plans have a strategic focus on reliability and resiliency.

- **2018 – 2022 Water Management and Conservation Plan**
  Required submission to Oregon Water Resources Board that includes water curtailment response

- **2016 Emergency Action Plans for Carmen-Smith Hydroelectric Project and Leaburg/Walterville Power Canals**
  Provides guidance to EWEB staff and emergency response personnel to safeguard the lives and property of people living in close proximity to and downstream of EWEB hydroelectric facilities; required and approved by the Federal Energy Regulatory Commission (FERC).

- **2015 EWEB Water System Master Plan**
  Outlines long term planning options for resiliency, reliability and optimization of EWEB's water System.

- **2012 EWEB Emergency Water Supply Plan**
  Analyzes options for secondary drinking water supplies and outlines a path forward to provide provisional water to EWEB customers.

- **Mutual Aid Agreements for Electric & Water Restoration Efforts**
  - Lane Mutual Aid Agreement (2017)
  - Western Region Mutual Assistance Agreement (2014)
  - EWEB, Springfield Utility Board and Rainbow Water District Mutual Aid Agreement (2006)

- **NERC Emergency Operations Plans**
  Specifies electric load shedding required under emergency conditions. Dictates communications with outside electrical supply entities and required restoration actions and coordination.

1.4 JURISDICTION-SPECIFIC NATURAL HAZARD EVENT HISTORY

This table lists past occurrences of natural hazards within the jurisdiction over the past 15 years.

Table 1-1: NATURAL HAZARD EVENTS

Type of Event	FEMA Disaster # (if applicable)	Date	Preliminary Damage Assessment
Severe Winter Storm	TBD	February 25-March 4, 2019	$4.3 M
Wind Storm	N/A	April 7, 2017	
Winter Storm/Freezing Rain	DR-4296-OR	December 14 -17, 2016	$4.2 M
Severe Winter Storm	DR-4258-OR	December 6 – 23, 2015	$195,000
Severe Winter Storm	DR-4169-OR	February 6 – 14, 2014	$1.9 M
Severe Winter Storm	DR-4055-OR	January 17-21, 2012	$35,000
Severe Winter Storm		March 21-26, 2012	

Wind Storm		March 13 - 16, 2011	
Severe Winter Storm		December 27 – 29, 2008	
Wind Storm		February 2 - 4, 2006	
Wind Storm	FEMA-1405-DR-OR	February 7, 2002	$1.5 M

1.5 HAZARD RISK RANKING

This table presents the ranking of hazards of concern, based on (V) Vulnerability as defined by percent of population or assets affected, (P) Probability as determined by the frequency of an incident occurring within given timeframes, and Capacity in terms of the need for outside resources to respond to each hazard.

Table 1-2: HAZARD RISK PLANNING			
Rank	Hazard Type	Risk Rating Score	RISK
1	Earthquake – Cascadia Subduction Zone	V (3) * P(2) / C (1) = 6	Very High
2	Wind storm	V (3) * P (3) / C (2) = 4.5	High
2	Winter storm	V (3) * P (3) / C (2) = 4.5	High
3	Wildfire	V (2) * P (3) / C (2) = 3	High
4	Flood – Riverine	V (2) * P (2) / C (2) = 2	Moderate
5	Drought	V (1) * P (3) / C (2) = 1.5	Moderate
6	Geomagnetic Disturbance (GMD)	V (1) * P (2)/ C (2) = 1	Low
6	Landslide	V (1) * P(2) / C(2) = 1	Low
7	Volcano	V(1) * P (1) / C (3) = 0.33	Low

1.6 EVALUATION OF RECOMMENDED ACTION ITEMS

Table 1 – 3 lists the initiatives that make up the jurisdiction's hazard mitigation plan. EWEB is the lead agency and funding source for these initiatives unless otherwise noted. As the list below indicates, resiliency is a priority strategic issue for the utility.

Table 1-3: HAZARD MITIGATION ACTION ITEMS

New Assets	Existing Assets	Hazards Mitigated	Objectives Met	Estimated Cost	Timeline
	X	Earthquake; GMD	Seismic upgrades of critical facilities: Rebuild Currin Substation using IEEE[5] standards which reduces interference with electrical equipment during GMD events.	$750K[6] (substation)	2021
X	X	Earthquake; Flood	Seismic upgrade of critical facilities: Changes to EWEB Roosevelt Operations Center (ROC) to remain operational after earthquake event; move EWEB dispatch into ROC from EWEB Headquarters and build new back-up control center in seismically sound building at Hayden Bridge.	$3.5 M	2019-2025
	X	Earthquake	Seismically anchor transformers, control building and add flexible bus connections at each substation.	$1.2 M	2019 - 2027
X		Multi-Hazard (earthquake, riverine flood, winter/wind storms, GMD).	Seismic upgrade to critical facilities: New Holden Creek Substation built to seismic standards replacing Leaburg Substation on riverbank using IEEE standards; remove 17 miles overhead electric lines. Add second transformer for resiliency.	$7.5 M	2018-2020

[5] Institute of Electrical and Electronics Engineers (IEEE) 693

[6] Total project cost of Currin Substation Rebuild is estimated at $7.5M. Only costs associated with seismic upgrade, estimated at 10% of new construction overall costs, are included.

X		Earthquake	Replace baseline reservoirs[7] with seismic-code facilities	$10M per site	2023 (first reservoir)
X		Earthquake, Landslide	Use all-restraint water mains in areas prone to landslides	2 times cost of standard pipe	2030
X		HazMat, earthquake, riverine flood	Replace gaseous chlorine at filtration plant with on-site liquid hypochlorite system with 90 days on-site storage	$3.5 M	2019
	X	HazMat, winter storm, wind storm	Change out mineral oil to non-toxic FR3[8] in new transformers to reduce spill risk when poles fall or transformers fail	Approx. $800k/ year	2030
X		Multi-Hazard (earthquake, wildfire, drought)	Establish micro-grids and emergency pumping and filtration systems at critical facilities for drinking water distribution and independent electric operation. Micro-grids at Howard Elementary School has been installed, and a 1 MW system at EWEB Roosevelt Operations Center are currently under development.	$1M per site[9]	2018 - 2023
	X	Multi-Hazard (earthquake, wildfire, volcano, windstorm)	Test blackstart capabilities, load requirements and transmission switching needs for Leaburg hydro-electric plant to power critical facilities in Eugene during major outages.	$50,000	2019 - 2023
	X	Multi-Hazard (windstorm & winter storms)	Re-frame 4.3 miles of electric line and undergrounding 1.5 miles of line in 16 high outage areas.	$2.7M[10]	2019-2021
X		Multi-Hazard (earthquake, wildfire,	Develop emergency water distribution sites using wells at area schools/community centers – two sites completed and three	$200K per site	2018 - 2023

[7] EWEB has three 'base' elevation reservoirs that serve over 80% of our customers.
[8] FR3 fluid is a natural ester derived from renewable vegetable oils – providing improved fire safety, transformer life/loadability, and environmental benefits.
[9] Howard Elementary School installation supported in part by Oregon Department of Energy grant ($300k).
[10] 75% of project funded via FEMA Public Assistance grant award (DR-4296) following 2016/17 winter storms.

		drought, hazmat spill)	others sites are in design or construction.		
X		Multi-Hazard (earthquake, wildfire, drought, hazmat spill)	Construct new water filtration plant on the Willamette River for secondary source of supply and treatment/delivery options for drinking water.	$50M	2025-2033
X		Multi-Hazard (earthquake, wildfire, drought)	Construct and test mobile treatment trailer that can deliver potable water from sources like rivers or pools.	$80,000	2020

The Eugene-Springfield NHMP identifies the following Plan Goals:

Goal 1: Save lives and reduce injuries

Goal 2: Minimize damage to buildings and infrastructure, especially critical facilities

Goal 3: Minimize economic losses and strengthen the economic well-being of the Metro area.

Goal 4: Decrease disruption and speed restoration of public services, business, schools and families.

Goal 5: Protect environmental resources and utilize natural systems to hazard impacts.

Goal 6: Foster public-private partnerships to achieve mitigation outcomes.

Goal 7: Utilize the land development code to mitigate risks posed by natural hazards.

Goal 8: Protect natural, historic and cultural resources.

Goal 9: Maintain and enhance current spirit of communication, collaboration, and coordination among public, private and non-profit hazard mitigation partners.

Goal 10: Integrate local natural hazard mitigation strategies into significant community-wide plans.

Goal 11: Document and evaluation the metro region's progress in implementing hazard mitigation strategies.

Table 1-4 lists the action items contained in EWEB's hazard mitigation plan and identifies the priority for each item based on plan goals met, probable benefits, funding availability and project timeline. Per plan guidelines, projects with longer timeframes are generally not considered to be high priorities. This assessment is not intended for use as a formal cost/benefit analysis.

TABLE 1-4: MITIGATION STRATEGY PRIORITY

Rebuild/Seismic Upgrades to Currin Substation						
Plan Goals Met	Costs	Benefits	Benefits Equal or Exceed Cost?	Grant Eligible?	Can be funded under existing programs or budgets?	Priority
#2, #4	LOW	MEDIUM	YES	YES	YES	HIGH
Seismic Upgrades to Critical Facilities: EWEB Operations and Dispatch						
Plan Goals Met	Costs	Benefits	Benefits Equal or Exceed Cost?	Grant Eligible?	Can be funded under existing programs or budgets?	Priority
#2, #4	MEDIUM	MEDIUM	YES	YES	YES	MEDIUM
Anchor Substation Transformers						
Plan Goals Met	Costs	Benefits	Benefits Equal or Exceed Cost?	Grant Eligible?	Can be funded under existing programs or budgets?	Priority
#2, #4	MEDIUM	MEDIUM	YES	YES	YES	HIGH
Replace Leaburg Substation w/New Holden Creek Substation						
Plan Goals Met	Costs	Benefits	Benefits Equal or Exceed Cost?	Grant Eligible?	Can be funded under existing programs or budgets?	Priority
#2, #4, #5	LOW	HIGH	YES	YES	YES	HIGH
Rebuild/Replace Baseline Reservoirs						
Plan Goals Met	Costs	Benefits	Benefits Equal or Exceed Cost?	Grant Eligible?	Can be funded under existing programs or budgets?	Priority
#2, #4	HIGH	HIGH	YES	YES	YES	HIGH

All-Restraint Water Mains						
Plan Goals Met	Costs	Benefits	Benefits Equal or Exceed Cost?	Grant Eligible?	Can be funded under existing programs or budgets?	Priority
#4	LOW	MEDIUM	YES	YES	YES	LOW

Build Hypochlorite System at Filtration Plant						
Plan Goals Met	Costs	Benefits	Benefits Equal or Exceed Cost?	Grant Eligible?	Can be funded under existing programs or budgets?	Priority
#1, #4, #8	MEDIUM	HIGH	YES	YES	YES	HIGH

Replace Mineral Oil with FR3 in Transformers						
Plan Goals Met	Costs	Benefits	Benefits Equal or Exceed Cost?	Grant Eligible?	Can be funded under existing programs or budgets?	Priority
#5	LOW	MEDIUM	YES	NO	YES	LOW

Establish Micro-Grids @ Emergency Water Sites						
Plan Goals Met	Costs	Benefits	Benefits Equal or Exceed Cost?	Grant Eligible?	Can be funded under existing programs or budgets?	Priority
#4, #9	MEDIUM	LOW	NO	YES	NO	LOW

Enable Localized Generation to Power Critical Facilities						
Plan Goals Met	Costs	Benefits	Benefits Equal or Exceed Cost?	Grant Eligible?	Can be funded under existing programs or budgets?	Priority
#3, #4, #6	MEDIUM	MEDIUM	YES	YES	YES	MEDIUM

Undergrounding/Re-Framing Electric Distribution						
Plan Goals Met	Costs	Benefits	Benefits Equal or Exceed Cost?	Grant Eligible?	Can be funded under existing programs or budgets?	Priority
#4	LOW	HIGH	YES	YES	YES	HIGH

Develop Emergency Water Distribution Sites						
Plan Goals Met	Costs	Benefits	Benefits Equal or Exceed Cost?	Grant Eligible?	Can be funded under existing programs or budgets?	Priority
#3, #4, #9	LOW	MEDIUM	YES	YES	YES	HIGH
Secondary Water Filtration Plant						
Plan Goals Met	Costs	Benefits	Benefits Equal or Exceed Cost?	Grant Eligible?	Can be funded under existing programs or budgets?	Priority
#3, #4, #9	HIGH	HIGH	YES	YES	NO	MEDIUM
Mobile Water Treatment Trailer						
Plan Goals Met	Costs	Benefits	Benefits Equal or Exceed Cost?	Grant Eligible?	Can be funded under existing programs or budgets?	Priority
#1, #3	LOW	MEDIUM	YES	YES	YES	HIGH

1.7 Future Needs to Better Understand Risk/Vulnerability

EWEB will be conducting a water system risk and resilience assessment in accordance with recent updates to Section 1433 of the Safe Drinking Water Act. This risk assessment of both natural disasters and bio-terrorist attacks is to be submitted to the Environmental Protection Agency by March 31, 2020.

Additional analysis is also planned around improving our ability to isolate and serve critical facilities using just our localized energy resources. Studies planned include modeling the load capabilities of additional generation supplies beyond EWEB hydro-electric facilities such as the University of Oregon natural gas plant and industrial co-generation plants, and assessing what electric distribution system automation is needed to quickly shed load and redirect power to critical facilities.

As part of our focus on resiliency, the utility will be developing staff evacuation plans for flood/wildfire events and updating EWEB business continuity plans.

1.8 Additional Comments

Since the adoption of the 2014 NHMP, EWEB has completed a number of initiatives that mitigate community risk to the hazards of concern. Some of these were listed in the plan, while others were not included at the time but are relevant to hazard risk mitigation.

- Seismic upgrades of critical facilities: $3 million upgrade to the Hayden Bridge Filtration Plant was completed in 2017. Constructed seismically-rated Holden Creek Substation.
- Back-up power at critical facilities: $1.0 million project to add back up power to the Hayden Bridge raw water intake system and treatment plan was completed in 2018. The back-up generation is sufficient to deliver 20 million gallons of water per day and has the fuel capacity to run 24- hours without re-fueling.
- Purchased property and completed preliminary design for construction of secondary water treatment plant on the Willamette River ($2.5M).
- Installed seismic early warning systems at two hydro-electric plants to automate safety actions and reduce risk to life/property in partnership with the University of Oregon ($25K).
- Provided approximately 15,000 three-gallon emergency water containers to EWEB customers at discounted price to use at emergency distribution sites/mobile trailers, with considerable outreach and education as part of the distribution process (approximately $100k).
- Purchased and equipped three mobile water distribution trailers to provide emergency drinking water during outages ($80,000 each). Two trailers were loaned to Salem/Keizer personnel to provide drinking water to residents during a multi-week water curtailment due to algal bloom in summer 2018.
- Completed two emergency water distribution well sites and hosted utility/community drills where residents could fill free water storage containers using distribution equipment and learn how to disinfect water for public safety (October 2018 and May 2019). Next steps are to create an operating manuals so that non-utility personnel can set up and disperse water during emergencies, enabling EWEB staff to focus on system repairs and service restoration. Our goal is to have another two sites up and running by the end of 2019.
- Installed microgrid for back-up power to the emergency well and other facilities at Howard Elementary School. Final commissioning will be completed this summer.
- Conducted power system and generator capability studies in 2018 for islanded operation of critical loads at Leaburg facility.
- Completed seismic anchoring retrofit of Spring Creek and Prairie Substation transformers.

Eugene-Springfield Multi-Jurisdictional

NATURAL HAZARDS MITIGATION PLAN

2020
Rough Draft
Version 2

Prepared for:

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Mitigation Plan

1.1 What is Natural Hazard Mitigation?

Natural hazard mitigation is defined as permanently reducing or alleviating the losses of life, property, and injury resulting from natural hazards through long and short-term strategies. Strategies can include policy changes, such as updating ordinances; projects, such as seismic retrofits to critical facilities; or education and outreach to targeted audiences, such as residents with limited English skills and the elderly.

Hazard mitigation is the responsibility of individuals, private businesses, and industries as well as all levels of government.

Engaging in mitigation activities provides jurisdictions with many benefits, including reduced loss of life and property, improved delivery of essential services, economic stability, reduced cost, and a shortened recovery period following natural hazard events.

Finally, mitigating hazards makes financial sense. A report submitted to Congress by the National Institute of Building Science's Multi-Hazard Mitigation Council (MMC) indicated for every dollar spent on mitigation society can expect an average savings of up to six dollars.[1]

1.1.1 Why Develop a Mitigation Plan?

The Cities of Eugene and Springfield along with Eugene Water & Electric Board (EWEB,) Rainbow Water District, Springfield Utility Board (SUB), and the University of Oregon jointly developed this Natural Hazards Mitigation Plan in an effort to identify risks and prioritize actions to reduce future loss of life and property resulting from natural disasters. The planning process not only aids in prioritization, it increases cooperation and communication within the community. Additionally, maintaining a current Natural Hazards Mitigation Plan (NHMP) increases potential for State and Federal funding for mitigation and recovery projects.

When a community understands the relationship among the natural hazards it faces, its vulnerable systems, and its existing response capacity it becomes better equipped to identify and implement actions aimed at reducing the community's overall risk from

[1] "Natural Hazard Mitigation Saves: 2017 Interim Report" Multihazard Mitigation Council - National Institute of Building Sciences. 2017. Accessed October 23, 2017 http://www.wbdg.org/files/pdfs/MS2_2017Interim%20Report.pdf

disasters.

1.1.2 What Natural Hazards Are Addressed?

This plan focuses on the primary natural hazards that could affect Eugene, Springfield, Rainbow Water District, EWEB, SUB, and the University of Oregon including droughts, earthquakes, floods, landslides, severe wind storms, volcanoes, and wildland-urban interface fires. This plan also addresses dam or levee failures, civil unrest, epidemics, and hazardous material spills; four anthropogenic hazards closely connected to natural hazards. Referred to as impacts, these hazards can occur independently, or because of natural hazards which is this plan's focus.

This plan does not address three natural hazards: pandemics; algal blooms in water; and asteroid or meteor strikes. This plan does not address these natural hazards for two primary reasons:

- The risk is very low with extremely costly and limited mitigation activities, thus mitigating the natural hazard is not warranted or is not practical; and/or
- The Cities of Eugene and Springfield do not have authority to mitigate the natural hazard.

Lane County Public Health Department is the primary agency responsible for mitigating pandemics. As such, the Cities of Eugene and Springfield will assist the Health Department to mitigate pandemics, as needed. Mitigating asteroid or meteor strikes is beyond the financial capacity of the Cities. Mitigation is largely left to the Federal government. Since the Cities get water from the McKenzie River, which is fed from reservoirs far outside the Cities' jurisdictional boundaries, or wells, mitigating this natural hazard is the primary responsibility of the reservoir owners with assistance from the water utilities.

1.1.3 How Does the Plan Work?

This plan is strategic and non-regulatory in nature, meaning it does not set forth any new policies. It does, however, provide: (1) a foundation for coordination and collaboration among agencies and the public; (2) identification and prioritization of future mitigation activities; and (3) aids in meeting Federal requirements for assistance programs.

This mitigation plan works in conjunction with other municipal plans and programs including local comprehensive land use plans, the Eugene-Springfield Multi-Jurisdictional Emergency Operations Plan, the Lane County Natural Hazards Mitigation Plan, local capital improvement plans, Eugene's Public Facilities and Services Plan, and the State of Oregon's Natural Hazards Mitigation Plan.

The actions described in this plan are intended to be implemented primarily through existing plans and programs within Eugene and Springfield; however, some of the mitigation actions described would require new programs, policies, or adjustments to existing ones.

1.1.4 How Was the Plan Developed?

In 2013, staff from Eugene and Springfield, with support from the Oregon Partnership for Disaster Resilience, conducted a Climate and Hazards Vulnerability Assessment[2], or Vulnerability Assessment for short. This assessment become the foundation for the 2015 NHMP update. Section 1.4: Summary of Risk and Vulnerability Assessment provides a brief overview of assessment findings. Complete findings are in Section 4: Risk and Vulnerability. This assessment, in conjunction with new more area specific studies, continues to be the foundation for the 2020 NHMP update.

After conducting the Vulnerability Assessment, Eugene and Springfield staff, the NHMP Steering Committee, and partner agencies developed and refined appropriate mitigation actions to address some of the most significant risks revealed by the assessment. These new actions, as well as several relevant actions carried over from the 2009 NHMP, guided the development of the 2015 mitigation strategies.

In 2016 and 2017 the Cities of Eugene and Springfield conducted extensive seismic evaluations of some critical infrastructure of concern. The Oregon Department of Transportation (ODOT) also completed seismic evaluations of priority bridges[3], and the Oregon Department of Geology and Mineral Industries (DOGAMI) concluded an extensive landslide study[4]. In addition to the 2013 Vulnerability Assessment, this new information guided the NHMP Steering Committee in determining what mitigation actions items to add, and which items should carry over from the 2015 plan.

In 2017 EWEB and SUB, both long time participants in the Eugene-Springfield Multi-Jurisdictional NHMP, Rainbow Water District, and the University of Oregon decided to become official jurisdictional partners for the 2020 update. This included extensive work by the utilities and the university culminating in their formal addition as multi-jurisdictional partners. EWEB's utility specific NHMP information is in Annex A, SUB's is in Annex B, Rainbow Water Districts is Annex C, and the University of Oregon is represented in Annex D. These utilities developed their own specific annexes to better

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[2] United States. City of Eugene. Emergency Management. *Climate and Hazards Vulnerability Assessment.* December 2014. Accessed April 2019. https://www.eugene-or.gov/DocumentCenter/View/20644/2014-EugeneSpringfield-Climate-and-Hazards-Vulnerability-Assessment?bidId=.

[3] United States. Oregon Department of Transportation. Bridge and Geo-Enviromental Sections Technical Services Branch. *Oregon Highways Seismic plus Report*. OR: Oregon Department of Transportation, 2014. 1-114.

[4] United States. Oregon Daprtment of Geology and Mineral Industries. *Interpretive Map 60: Landslide Hazard Adn Risk Study of Eugene-Springfield and Lane County, Oregon*. By Nancy Calhoun, William Burns, Jon Franczyk, and Gustavo Monteverde. Portland, OR: Oregon Department of Geology and Mineral Industries, 2018. 1-42.

explain sector-specific risks and mitigation strategies.

The Project Team supported the Natural Hazards Mitigation Plan update and was composed of the following individuals:

- Jessica Gourley – Project Manager – City of Eugene
- Kevin Holman – City of Eugene
- Ken Vogeney – City of Springfield
- Jeannine Parisi – Eugene Water and Electric Board
- Tracy Richardson – Springfield Utility Board
- Jamie Porter – Rainbow Water District
- TBD – University of Oregon

In addition to the Project Team and Steering Committee, individuals from more than 20 businesses, non-profits, and government agencies consulted on the Vulnerability Assessment due their professional expertise and perspective. A list of these participants is located at the end of Section 4: Risk and Vulnerability. This update also relied on significant input from the Lane Preparedness Coalition (described in section 1.10 Plan Implementation and Maintenance). Greater documentation of the planning process can is located in Appendix B: Planning and Public Process.

1.2 Mission

Identify and reduce vulnerabilities to natural hazards, and their impacts, to make the Cities of Eugene and Springfield more resilient to disasters.

1.3 Plan Goals

The NHMP Project Team and Update Committed identified the following goals. These two entities compared the goals identified in the Oregon and Lane County NHMPs along with those from the existing (2015) Eugene-Springfield Multi-Jurisdictional NHMP. Based on this review and discussion, the team adjusted the goals to better align with companion plans and reflect current community hazard mitigation needs.

Goal 1: Save lives and reduce injuries.

Goal 2: Minimize damage to buildings and infrastructure, especially to critical facilities.

Goal 3: Minimize economic losses and strengthen the economic well- being of the Eugene-Springfield Metro Area.

Goal 4: Decrease disruption and speed restoration of public services, businesses, schools, and families.

Goal 5: Protect environmental resources and utilize natural systems to reduce natural hazard impacts.

Goal 6: Foster public-private partnerships to achieve mitigation outcomes.

Goal 7: Utilize the land development code to mitigate risks posed by natural hazards.

Goal 8: Protect natural, historic, and cultural resources.

Goal 9: Maintain and enhance current spirit of communication, collaboration, and coordination among public, non-governmental organizations (NGO,) and private sector hazard mitigation partners.

Goal 10: Integrate local natural hazard mitigation strategies into significant community-wide plans.

Goal 11: Document and evaluate the Eugene-Springfield metro region's progress in implementing hazard mitigation strategies.

1.4 Summary of Risk and Vulnerability Assessment

Table 1.1 is the risk assessment matrix for the 2020 NHMP update. It provides an overview of each hazard and the associated risk in the Eugene-Springfield area. Capacity is a new variable to the Risk Matrix. Capacity is a community's ability to respond to, and recover from, a natural hazard event. Below the matrix is a summary of the Vulnerability Assessment conducted in Eugene and Springfield. It provides extensive detail about some of the risks of greater concern as well as area specific studies developed out of these findings.

Table 1.1. Risk Matrix

Vulnerability X Probability/Capacity = Risk Total

Hazard	Vulnerability High = 3 Moderate = 2 Low = 1	Probability High = 3 Moderate = 2 Low = 1	Capacity High Capacity = 3 Moderate = 2 Low=1	Risk Total <1.5 = Low 1.5-2.9 = Moderate 3-4.5 = High >4.5 = Very High	Risk
Geomagnetic Disturbance (GMD)	3	3	1	9	Very High
Earthquake	3	2	1	6	Very High
Winter storm	3	3	2	4.5	High
Flood-Riverine: Springfield	2	3	2	3	High
Wildfire	2	3	2	3	High
Windstorm	2	3	2	3	High
Drought	2	2	2	2	Moderate
Landslide: Springfield	1	3	2	1.5	Moderate
Landslide: Eugene	1	3	2	1.5	Moderate
Flood-Riverine: Eugene	1	2	2	1	Low
Flood: Stormwater	1	3	3	1	Low
Volcano	1	2	2	1	Low
Extreme Weather	1	2	3	0.7	Low

Table 1-1

Vulnerability	
High = 3	More than 70% of population or assets affected
Moderate = 2	10% - 69% of population or assets affected
Low = 1	Less than 9% of population or assets affected

Table 1-2

Probability	
High = 3	One incident likely within 10-35 years
Moderate = 2	One incident likely within 35-75 years
Low = 1	One incident likely within 75-100 years

Table 1-3

Capacity	
High = 3	No outside resources needed
Moderate = 2	Less than 49 outside resources needed
Low = 1	More than 50 outside resources needed

Table 1-4

1.4.1 Vulnerability Assessment

In 2013 and 2014 the Cities of Eugene and Springfield conducted a Climate and Hazards Vulnerability Assessment to inform the update of the 2014 NHMP. City staff, with support from the Oregon Partnership for Disaster Resilience, conducted group interviews totaling six hours for each community sector. The team met with local and regional experts representing the communication, drinking water, electricity, food, healthcare, housing, natural systems, public health, public safety, stormwater, transportation, and wastewater sectors. A natural system is one that exists in nature, independent of human involvement. The system consists of all the physical and biological material and their intertwined processes.

Working from a standard list of questions, the team collected information about the adaptive capacity and sensitivity of each system to specific hazards. The summary of findings below provides a description of key themes from across all sectors.

Detailed findings from the Vulnerability Assessment can is in Section 4: Risk and Vulnerability. These sector summaries include sector descriptions, an assessment of adaptive capacity, critical vulnerabilities, hazard specific sensitivities, and key sector interdependencies.

1.4.2 Crucial Sectors and Crucial Hazards

The Vulnerability Assessment reflects sensitivities to earthquakes, floods, wildfires, winter storms, climate changes, and rising fuel prices. The assessment does not reflect all hazards for all sectors.

There are three sectors fundamental to the maintenance, and restoration of all other sectors: electricity, fossil fuels, and transportation. These sectors are disproportionately important; the resiliency of these systems is paramount to building, maintaining, and restoring all other systems assessed.

1.4.3 Sector Findings

A unique culture of collaboration and information sharing exists within our community. Overall, this enhances regional adaptive capacity in several sectors. Information sharing, and active collaboration are particularly visible within the electricity, health, public safety, and transportation sectors. There is also a noticeable willingness to share information within other sectors including the food and communications sectors.

For several sector managers, finding and keeping qualified staff is an important concern over the next decade with few obvious solutions. Interdependence is high among all sectors. Many sectors are heavily dependent on resources and decisions made outside of the Eugene-Springfield area, most notably the electricity, and fossil fuel sectors. Nearly every sector relies on several other sectors to function, with stormwater and natural systems being the least dependent.

1.4.4 Hazard-Specific Findings

While flood and wildfire events have the potential to cause severe loss, damage, inconvenience, and drain emergency response resources in localized areas these hazards are not likely to result in systemic failures across multiple sectors. Both large earthquake and severe winter storm events have the potential to cause region-wide cascading system failures.

Much of the region's adaptive capacity stems from our ability to draw resources, personnel, and expertise from nearby communities, particularly during an emergency. This capacity is severely restricted during region-wide events such as a Cascadia Subduction Zone earthquake or severe winter storms such as the big snow of 1969[5].

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[5] Darling, Dylan, and Dylan Darling. "50 Years Ago: Remembering the 'Big Snow' That Blanketed Eugene-Springfield." The Register. February 04, 2019. Accessed March 08, 2019. https://www.registerguard.com/news/20190126/50-years-ago-remembering-big-snow-that-blanketed-eugene-springfield.

1.4.5 Earthquake-Specific Findings

Except for natural systems, all sectors are extremely vulnerable to a Cascadia Subduction Zone earthquake. Little has been done to prepare any systems, infrastructure, or personnel to handle the initial impact, response, and recovery to this event.[6]

Exceedingly limited staff availability in the aftermath of a severe earthquake will create problems and challenges difficult to predict or solve in advance. Every sector will experience substantial failures and interruptions unfamiliar and therefore difficult (though not impossible) to plan for. Very few local residents have first-hand experience with a major earthquake, making the potential experience and results difficult to describe.

1.4.6 Winter Storms

Severe winter storms disrupt two of the three sectors all others depend upon: electricity and transportation. This disruption is more pronounced if the storm lasts more than a couple of days and if snow and ice accumulation is significant.

1.4.7 Climate Change

The sectors most likely to experience negative impacts associated with climate change are drinking water, natural systems, and, to a lesser extent, electricity, and public health. Several sector managers in the drinking water, public health, and natural systems sectors are actively planning for the impacts of climate change. For the most part, other sectors are not.

Most built community sectors do not appear to be at severe risk from projected climate-related impacts such as increasing temperatures, reduced snowpack, or changes in precipitation. However, the region's natural systems are highly sensitive to climate change and the resulting secondary impacts on community sectors and regional economy could be substantial. Climate change appears to have the greatest overall negative impact on forest and water resources[7]

Due to these findings, this 2020 NHMP takes a brief look at how each natural hazard may, or may not, be affected by climate change. Though mitigation items need to align with the hazards we face today, it is productive to consider future conditions to ensure mitigation

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[6] United States. Oregon State. Emergency Management. February 28, 2013. https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&cad=rja&uact=8&ved=2ahUKEwjPnp3hjvPgAhVriVQKHYjxB14QFjAAegQICRAC&url=https://www.oregon.gov/oem/documents/oregon_resilience_plan_final.pdf&usg=AOvVaw2QZ2ex4alua5M-9GduJoS3.

[7] Willamette Water 2100 is a research project currently underway, designed to evaluate the effects of climate change, population growth, and economic growth on the water resources of the Willamette basin. It is a partnership project of Oregon State University, University of Oregon, and Portland State University that will provide greater clarity and specificity about climate change impacts on water and forest resources in our region. More information is available online at: https://pnwcirc.org/willamette-water-2100

actions taken now will not be obsolete or counterproductive in the next few decades.

1.4.8 Fossil Fuel Dependency

All but one group indicated their sectors rely heavily on fossil fuels and fossil fuel-derived products to operate. Electricity, food, healthcare, housing, public safety, transportation, and water appear most dependent. The natural systems sector was the only sector with a low dependency on fossil fuels to function.

There is not yet widespread planning for how sectors will manage the rising fuel prices anticipated in the coming decades. Most participants indicated customers will bear weight of the added cost. A notable exception is public safety, where sector managers indicated service levels would be reduced if there is no customer or political will to absorb cost increases.

Nearly every group indicated the rate of fuel price increase makes all the difference when considering how disruptive price increases might be. A slow increase in prices is manageable, but a sharp increase would strain sectors–some of them dramatically.

Almost all backup power systems in Eugene-Springfield rely on diesel transported by pipeline from Portland and beyond.

There is an information gap regarding the fossil fuel sector. Because the Vulnerability Assessment Project Team was unsuccessful at convening representatives from this sector, a need for more information on how this sector operates locally was identified. In the absence of local information, regional information sources shed light on some of the potential challenges facing the fossil fuel system.

- As part of the Oregon Resilience Plan, DOGAMI completed an Earthquake Risk Study for Oregon's Critical Energy Infrastructure Hub containing useful information about the petroleum hub and its operability following an earthquake–with some implications for performance following other natural hazards.[8]

- The 2012 Oregon Energy Assurance Plan offers insights into the existing risks to energy infrastructure and systems statewide.[9]

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[8] https://www.oregon.gov/energy/safety-resiliency/Documents/2013%20Earthquake%20Risk%20Study%20in%20Oregon%e2%80%99s%20Critical%20Energy%20Infrastructure%20Hub.pdfsafety%2Fsafety%2FDocuments%2F2013%2520Earthquake%2520Risk%2520Study%2520in%2520Oregon%25E2%2580%2599s%2520Critical%2520Energy%2520Infrastructure%2520Hub.pdf&usg=AOvVaw3BQIwnkMteimcb69O8WEBQ

[9] http://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=2&ved=0ahUKEwifu4CWhYfXAhUGyWMKHfrNAXkQFggsMAE&url=http%3A%2F%2Fwww.oregon.gov%2Fenergy%2FData-and-Reports%2FDocuments%2F2012%2520Oregon%2520State%2520Energy%2520Assurance%2520Plan.pdf&usg=AOvVaw0Fkrrznu1j4YuYNMQb1g9B

Based on these findings, the City of Eugene, in cooperation with several neighboring cities, applied for, and received a 2016 Oregon State Homeland Security Program Grant award to fund a Fossil Fuel Assessment Study for the majority of Lane County.

1.5 Impacts

In previous versions of this NHMP two impacts, dam failures and hazardous materials, were their own standalone hazards. A natural hazard is harm or difficulty created by a meteorological, environmental, or geological event. Impacts are the consequences of these hazards on the community and its assets.[10] For this update, four significant impacts: civil unrest; dam or levee failures; epidemics; and hazardous material spills or releases, were reviewed as secondary life threats to the primary natural disaster. These events can occur in the absence of a natural hazard, but such an event would be manmade, and not due to a natural force which is this plan's focus.

When a natural event causes a man-made technological disaster, it is referred to as a **natech** event or incident. These large-scale impacts are rare, so determining the exact likelihood of their occurrence is difficult. Nevertheless, they may occur, so careful consideration of how Eugene and Springfield's natural hazards could cause them is imperative to understanding the risks faced by the Cities. To accomplish this, data and events throughout modern history, across the United States, and in some cases around the world, were reviewed. For each hazard the likelihood of it causing the four major impacts was evaluated and categorized (Table 1-5 and Figure 1-1). Below is a summary of the evaluation process. An in-depth review is located throughout Chapter 2.

[10] United States of America. FEMA. *Local Mitigation Planning Handbook* . 2013. 5-1.

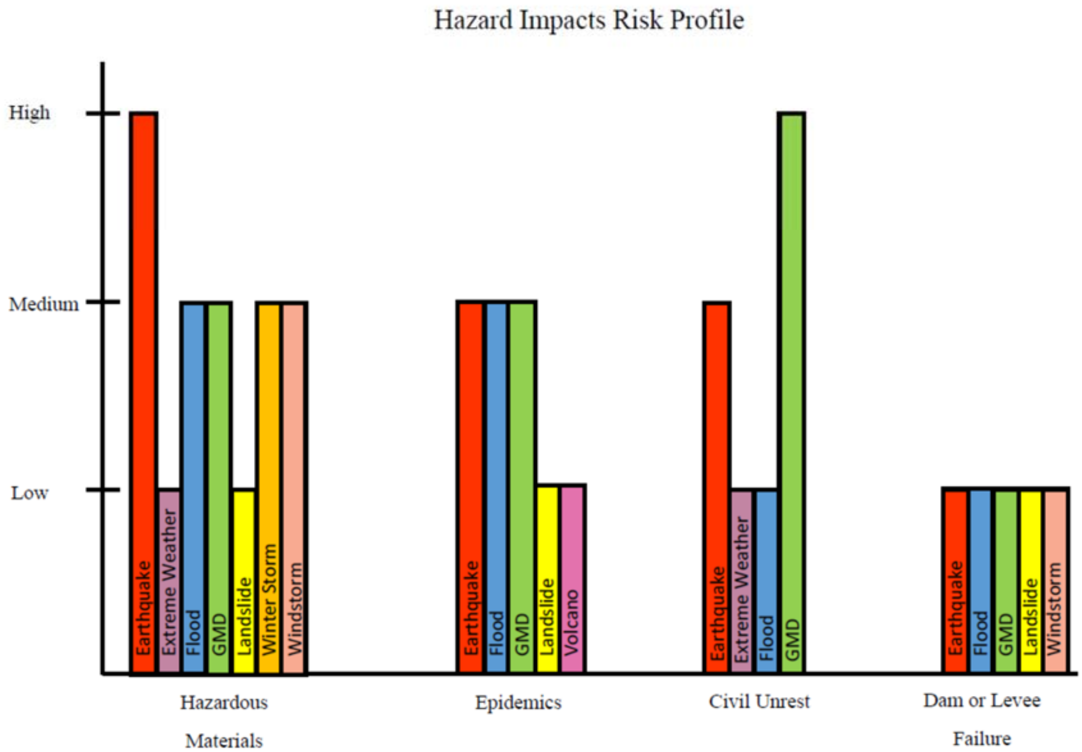

Figure 1-1 The y axis repersents the level of risk each impact poses to the Cities of Eugene and Sptirngfield while the x axis repersents the impact for each specific hazard (the individual bars).

Impact Risk	
No Known	No known (significant) possibility for impact to occur.
Low	Very unlikely for impact to occur with mitigation.
Medium	Significant mitigation needed to prevent impact.
High	Still likely to occur even with mitigation.

Table 1-5

1.5.1 Dam or Levee Failure

Dam and levee failures are extremely uncommon. Due to the rarity of natural hazard induced dam failures, determining the odds of such an event is difficult. Less than one percent of dams fail, and only a very small portion of those that do are caused by natural events.[11] Additionally, for most natural hazard-induced dam failures structural (design),

[11] "Dams' Safety Is at the Very Origin of the Foundation of ICOLD." Dams' Safety Is at the Very Origin of the Foundation of ICOLD. Accessed April 2016. https://www.icold-cigb.org/GB/dams/dams_safety.asp.

operational, and/or construction problems compounded the natural hazard's impact on the structure or its components.

To evaluate the risk posed by this impact, 90 substantial dam failures since 1802 were evaluated (Appendix A). Levee failures were not evaluated due to the regulatory variances found throughout the country complicating accurate record keeping. The mode of failure was then cross reference to ensure natural hazards were, in fact, the cause. This plan only considered dam or levee failure a significant impact of a natural hazard if the hazard culminated in at least one failure. The review only included manmade dams and did not take into account the failure of natural dams.

More information on dams and levees affecting the Eugene-Springfield area is located in Annex E.

1.5.2 Hazardous Materials

In general, hazardous material releases and spills occur more frequently than dam or levee failures but are still difficult to identify due to security issues concerning release of information, different reporting standards and regulations, as well as differing classification of what constitutes a hazardous material. Despite this, industries which handle hazardous materials and have strict reporting policies can be used to better understand the odds of a natural hazard induced hazardous material spills or releases from oil pipelines.

This plan reviewed indirect unintentional releases to determine the risks of a hazardous materials natech events in Eugene or Springfield (Figure 1-2). This plan considered any natural hazard responsible for releasing 500 or more barrels a significant impact. Additionally, hazards which could release large quantities of household hazardous materials were considered.

A JRC Science and Policy Report was especially helpful in determining the frequency of natural hazard induced HazMat incidents. The report analyzed the U.S. Department of Transportation's hazardous liquid transmission pipeline incident data from 1986-2012. The review included crude, hot, and white oil (paraffin, liquid petroleum, etc.) products in pipelines, terminals, tank farms, pumps, and metering stations. This report determined 5.5% of all oil industry spills in the United States were due to natural hazards.[12]

[12] Girgin, Serkan, and Elisabeth Krausmann. "Lessons learned from oil pipeline natech accidents and recommendations for natech scenario development." *JRC Science and Policy Report, EUR* 26913 (2015).

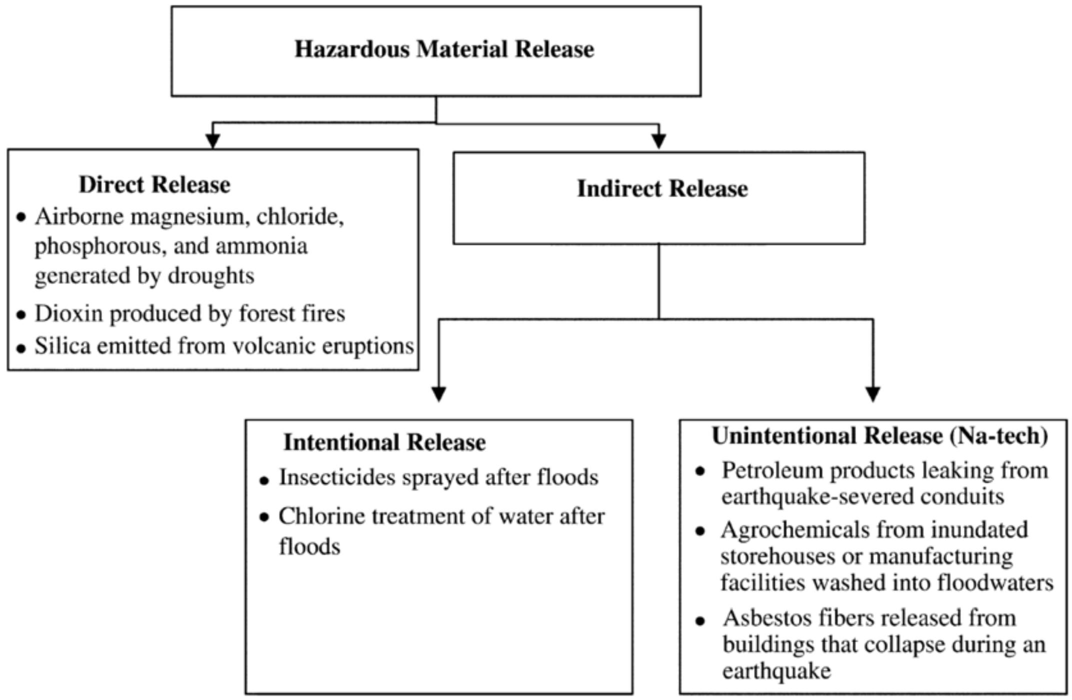

Figure 1-2 Source: Science of the Total Environment – *Classification of hazardous material releases associated with natural disasters. 2004.*[13]

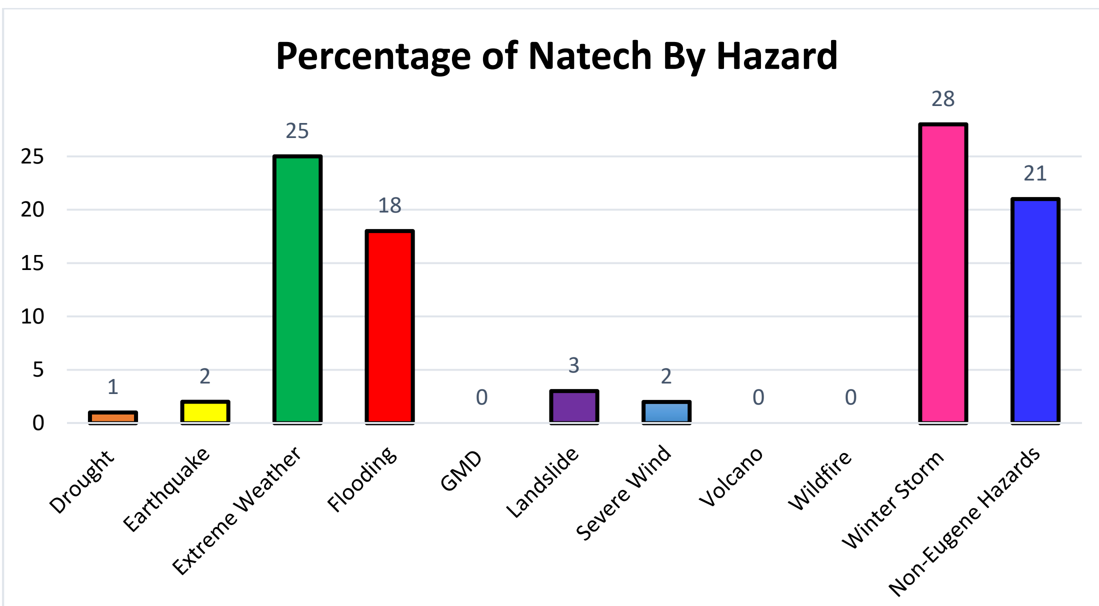

Table 1-6. Source: Data from "Lessons learned from oil pipeline natech accidents and recommendations for natech scenario development" – *Percentage of natechs broken down by hazard. 2015.*

[13] Young, Stacy, Lina Balluz, and Josephine Malilay. "Natural and technologic hazardous material releases during and after natural disasters: a review." *Science of the Total Environment* 322, no. 1-3 (2004): 3-20. doi:10.1016/s0048-9697(03)00446-7.

1.5.3 Epidemics

An epidemic is the spread of an infectious disease affecting, or tending to affect, a disproportionally large number of individuals within a population, community, or region at the same time. Epidemics are not rare following a natural disaster, but typically manifest themselves in under developed countries. The cholera epidemic in 2010-2011 after the Haitian earthquake spread quickly affecting more than 500,000 people at a significant cost to the community. Worldwide risk assessments have been determined for many natural hazard-induced epidemics.[14] Identified risk factors and data from the worldwide risk assessment was reviewed to determine the Eugene-Springfield area's risk to such an event.

1.5.4 Civil Unrest

Research suggests natural disasters increase the risk of civil unrest by at least 30% especially when there is motive, incentive, and opportunity for such actions (Figure 1-3).[15] The exact number of civil unrest events induced by a natural hazard is hard to determine due to different reporting methods, classifications, and societal compositions. For this plan, significant civil unrest is considered as any large-scale illegal event law enforcement would have difficulty responding to. This was weighed against the area's incentives, motives, opportunities, and history to determine the likelihood of such events occurring for each specific hazard.

[14] Lemonick, David M. "Epidemics after natural disasters." *American Journal of Clinical Medicine* 8, no. 3 (2011): 144-152.

[15] Nel, Philip, and Marjolein Righarts. "Natural disasters and the risk of violent civil conflict." *International Studies Quarterly* 52, no. 1 (2008): 159-185.

NATURAL DISASTERS
hydro-meteorological, geological, 'other'

Type of Impact	*Type of Natural Disaster*	*MOTIVES*	*INCENTIVES*	*OPPORTUNITIES*
Proximate (immediate impact)	Rapid onset, mostly, but slow onset can also reach discrete crisis points	Widespread suffering Destruction of living space and means of survival Refugees and Internally Displaced Persons	Acute competition for scarce resources Incentives for elite resource grabs	State capacity stretched, or focus shifts creating 'space' for resistance Declining legitimacy of state if its response is inadequate or if it is partially to blame for disaster Capture of relief resources by combatants and insurgent groups
Structural (longer-term impact)	Slow onset and Rapid onset	Increased resource allocation inequality Increased poverty Population displacement Rising income inequality	Increased competition for scarce resources Incentives for elite resource grabs	Weakening of state (Reduce resources while constraining state capacity. Distribution of collective action resources shifts away from state)
		Grievances	***Calculations of potential gains from violent civil conflict***	***Distribution of collective action resources***

VIOLENT CIVIL CONFLICT

Figure 1-3. Source*:* International Studies Quarterly, 2008 - *Summary of Casual Argument Linking Natural Disasters and Violent Civil Conflict*[10]

1.6 Seismic Evaluations

Since the completion of the Vulnerability Assessment and 2015 NHMP, both Eugene and Springfield conducted seismic evaluations on some critical infrastructure of concern.

Place holder

1.7 Landslide Updates

Place holder

1.8 Mitigation Strategy Summary

Based on the existing (2015) Eugene-Springfield Multi-Jurisdictional NHMP as well as findings from numerous studies and projects completed since its release, emergency management staff, the NHMP Steering Committee, and a broad group of regional partners represented by the NHMP Update Committee have developed a number of mitigation actions as summarized in Table 1-7.

1.8.1 Prioritization of Mitigation Actions

Mitigation actions in bold type indicate high priority items. Eugene and Springfield Emergency Management staff placed a higher priority on a small number of mitigation actions using the following information:

- The Vulnerability Assessment indicated actions bolstering the transportation and electricity sectors are of importance because these sectors are crucial to the operation of all other sectors. Actions that support these systems were raised in priority.

- During the Vulnerability Assessment process, sector experts determined which hazards posed the greatest risk to their sectors. Ultimately, those hazards of greatest concern were earthquake, winter storm, flood, and wildfire events. Therefore, these hazards were given greater priority.

- Finally, many community members took time to provide feedback at numerous NHMP public outreach events and provided input on local hazard mitigation priorities (Survey results are detailed in Appendix B). Respondents indicated earthquakes, geomagnetic disturbances, flooding, and winter storms are the hazards the two City governments should prioritize. Respondents also indicated a strong preference for actions protecting utilities and critical facilities.

Based on these criteria and an understanding of local conditions, emergency managers selected those actions most likely to mitigate these priority vulnerabilities.

Additional detail about each of the mitigation actions is outlined in Appendix A, within the action item table (TBD). For annex plan holders, short form mitigation action item tables are located in their specific annex and on the full action item table in Appendix A. A full description of the status of actions from the 2015 version of the Eugene-Springfield NHMP is in Appendix E.

Table 1-7. Summary of Mitigation Actions

Hazard	Ref #	Action Name	Mitigation Action
Drought	1	Resistant Landscaping	Adopt drought resistant landscaping policies
	2	Water Reuse	Pursue a water reuse partnership with MWMC
Earthquakes	3	Local Active Transportation Infrastructure Evaluation	Evaluate off-street path bridges that cross over the Willamette River to complete a high-level seismic assessment of all major City bridges.
	4	Local Transportation Infrastructure Seismic Upgrades	Eugene Public Works Engineering identified 13 priority transportation structures as part of the vulnerability assessment study for the first phase of seismic improvements to transportation infrastructure. Complete seismic improvements to three priority transportation structures.
	5	Unreinforced Masonry Building Database	Develop a database of unreinforced masonry buildings (URMs) for first responders to utilize for planning and response operations. Areas include Springfield, Eugene, and parts of Lane County.
	6	Springfield Critical Facilities Retrofit	Implement phase two of the seismic retrofit of Springfield City Hall and three Springfield Fire Stations.
	7	Emergency Fuels Assessment	Finish phase two of the Emergency Fuels Assessment for Lane County to determine the best allocation and rationing methods for fossil fuels after a catastrophic event such as a Cascadia Subduction Zone (CSZ) earthquake when usable fuel to run emergency response operations will be very limited.
	8	Increased Fuel Capacity	Research methods to increase fossil fuel capacity around critical facilities such as upgrading generator fuel tanks to high capacity tanks.
	9	Seismically Retrofit Pump Station - Eugene	The City of Eugene owns one fueling station. It needs to be seismically upgraded to ensure it is usable after a CSZ earthquake.
	10	Earthquake Damage Study	In partnership with DOGAMI, update the earthquake damage estimate study for the Eugene-Springfield area.
	11	Seismic Upgrades - Eugene	Finish seismic upgrades to city own facilities.

Hazard	Ref #	Action Name	Mitigation Action
Extreme Weather	12	Outreach Awareness	Research and incorporate extreme weather safety awareness into the Cities of Eugene and Springfield's public outreach program.
Flood: Riverine - Eugene	13	Updated Floodplain Maps - Eugene	Actively seek funding to update the Eugene-Springfield floodplain maps focusing on the Willamette River through Eugene.
Flood: Riverine - Springfield	14	Updated Floodplain Maps - Springfield	Actively seek funding to update the Eugene-Springfield floodplain maps focusing on the Mill Race, Willamette River through Glenwood, and the 42nd St Levee seclusion zone in Springfield.
	15	Levee Certification	Seek and maintain certification of the 42nd Street Levee and other flood control structures within Springfield
	16	Streambank and Erosion Control	Stream bank stabilization in the vicinity of the 42nd street levee.
Flood: Stormwater	17	Stormwater Improvements	For locations that experience regular flooding and significant damages or road closures, and for locations that experience streambank stability issues, determine and implement mitigation measures such as upsizing culverts or stormwater drainage ditches, and stabilizing streambanks. Projects include culvert replacements and streambank stabilization. Using prioritization criteria, the highest priority stormwater capital projects are selected for inclusion in the Cities' Capital Improvement Programs. Project prioritization criteria include whether a project addresses a potential risk to live or property (e.g. flooding), and whether it resolves an ongoing repetitive issue.
	18	Stormwater Facility Master Plan Update	Update Stormwater facility master plans to identify stormwater related flooding issues.
	19	Stormwater and Climate Change Impacts	Evaluate stormwater designs standards taking into consideration climate change modeling.
Geomagnetic Disturbance (GMD)	20	Continuity of Operations Plans	Develop Continuity of Operations Plans (COOP) for the City of Eugene Public Works, Police, Fire departments, and all Springfield departments.
Landslide - Springfield	21	Analysis of 2018 DOGAMI Landslide Study	Using the DOGAMI landslide study released the summer of 2018, determine areas and buildings at risk from landslides and propose comprehensive land use policies and construction standards accordingly.

Hazard	Ref #	Action Name	Mitigation Action
Landslide - Eugene	22	Analysis of 2018 DOGAMI Landslide Study	Using the DOGAMI landslide study released the summer of 2018, determine areas and buildings at risk from landslides and propose comprehensive land use policies and construction standards accordingly.
Wildfire	23	Fuels Reduction	Reduce fuels on public lands focusing on the hillsides in the Southernly portions of both Cities.
	24	Community Wildfire Protection Plan (CWPP)	Develop the Eugene-Springfield Community Wildfire Protection Plan (CWPP).
	25	Update the Wildland-Urban Interface (WUI) Plan	Update the Eugene-Springfield WUI plan and address access routes.
Windstorm	26	Tree Species Specific Tree Removal	We have a number of tree species in our inventory that are known to be susceptible to failure in storms and under normal weather conditions. This due to pest (i.e. emerald ash borer), disease (i.e. thousand canker disease) and structural problems endemic to the species (i.e. sweetgum with included bark, big leaf maple) with decay, etc. Identify species with known failure profiles and individual trees with potential defects that may lead to premature failure. Remove and replace these trees with species known to perform well during drought and storms and have little susceptibility to pest and disease. Work with contractors and Friends of Trees (non-profit tree planting organization) to complete the work.
Winter Storm	27	Defective Tree Removal	Wind, ice, and heavy snow can topple trees or cause large limb failure leading to blocked roads, infrastructure damage, and electrical hazards and outages. With the recent additional funding, contract crews will be performing maintenance pruning on trees to provide street clearance and mitigate defects such as overextended branches that are prone to failure under increased load. Unhealthy or structurally unsound trees will be removed and replanted.
	28	Sheltering	Develop a consolidated plan for community outreach and sheltering.
Volcano	29	Lahar Risk Study	Evaluate the lahar risk to the McKenzie River valley.
	30	Ash Removal	Research ash removal methods.

Hazard	Ref #	Action Name	Mitigation Action
Multiple Hazard	31	Food Supplier Coalition	Develop a coalition of food suppliers to consider options to address supply chain concerns after a major disaster.
	32	Vulnerable Populations Two Weeks Ready	Utilizing relevant vulnerable populations maps developed for the Lane Livability Consortium, develop an outreach plan for vulnerable populations to encourage community members to be two weeks ready with emergency supplies.
	33	Public Safety Communications Reliability	Work with the LRIG Radio System develop a public safety grade reliability to the system.
	34	Phase II - Fossil Fuel Assessment	Complete phase II of the Fossil Fuels Assessment and develop and Emergency Fossil Fuel Plan after its completion.
	35	Damage Assessment Plan	Finalize the Eugene-Springfield Damage Assessment Plan
	36	Mass Evacuation	Develop and exercise a full city evacuation plan.

1.9 Plan Implementation and Maintenance

This section details the formal process to ensure the Eugene-Springfield NHMP remains an active and relevant document. The plan implementation and maintenance process includes a schedule for monitoring and evaluating the plan annually, as well as producing an update every five years. Finally, this section describes how Eugene and Springfield will integrate public participation throughout the plan's maintenance and implementation process.

1.9.1 Plan Review and Adoption

After the plan is locally reviewed and deemed complete, the Emergency Managers will submit it to the State Hazard Mitigation Officer at the Oregon Military Department, Office of Emergency Management (OEM) who will also review the plan. Once OEM concurs the plan is complete, they submit it to the Federal Emergency Management Agency (FEMA Region X) for review. This review addresses the Federal criteria outlined in the FEMA Interim Final Rule 44 CFR Part 201.

After receiving FEMA's Approvable Pending Adoption notice, the City Councils of Eugene and Springfield will adopt the plan via resolution. EWEB's Board of Commissioners as well as Rainbow Water District, SUB, and the University of Oregon's various governing boards will also adopt the plan by motion per their governing process. Upon adoption by their governing boards, each plan partner is responsible for submitting proof of adoption to FEMA. Once FEMA receives this documentation each multi-jurisdictional partner will be awarded their acceptance letter. At that point Eugene, Springfield, EWEB, SUB, and the University of Oregon will retain eligibility for the Pre-Disaster Mitigation Grant Program, the Hazard Mitigation Grant Program, and the Flood Mitigation Assistance Program.

1.9.2 Roles and Responsibilities

To ensure all aspects of the community are involved, this NHMP update better defines the roles and responsibilities of NHMP members. There are four main entities responsible for developing this multi-jurisdictional plan. These entities together compose the NHMP Update Committee:

- Project Team–the group responsible for physically compiling, updating, and editing the NHMP.
- Steering Committee–composed of departments and partners responsible for implementing mitigation items.
- Advisory Board–stake holders, though not responsible for implementing mitigation items, lend knowledge, specialties, or insight needed to help develop them. Many members of the Lane Preparedness Coalition are also Advisory Board members.
- The Community– residents of Eugene and Springfield are engaged throughout the NHMP process to offer their insight, input, and concerns for hazards as well as possible mitigation items.

1.9.3 Convening

Eugene and Springfield Emergency Management will jointly convene an implementation Steering Committee for the Eugene-Springfield NHMP.

As conveners, Eugene and Springfield are responsible for:

- coordinating Steering Committee meeting dates, times, locations, agendas, and member notification;
- engaging Advisory Board members;
- documenting outcomes of Committee meetings;
- serving as a communication conduit between the Steering Committee and key plan stakeholders;
- incorporating, maintaining, and updating the jurisdiction's natural hazard risk GIS data elements;

- utilizing the Risk Assessment as a tool for prioritizing proposed natural hazard risk reduction projects;
- prioritizing new study and hazard research needs; and
- submitting future plan updates to OEM for review.

1.9.4 Implementation Coordination

Emergency Management staff from each NHMP partner will lead the implementation of the plan in coordination with Steering Committee members. Staff is responsible for:

- evaluating funding opportunities such as the Pre-Disaster Mitigation Grant Program, Hazard Mitigation Grant Program, and Flood Mitigation Assistance Program;
- consulting with partner agencies, businesses, and organizations on implementing projects;
- convening the NHMP Steering Committee on a quarterly basis;
- consulting and briefing the Lane Preparedness Coalition on migration strategies and plan updates;
- documenting successes and lessons learned;
- evaluating and updating the NHMP following a disaster; and
- evaluating and updating the NHMP in accordance with the prescribed maintenance schedule.

1.9.5 Partner Outreach

The Cities of Eugene and Springfield have identified the Lane Preparedness Coalition as the supporting body for public participation. The responsibilities of this group include:

- providing perspective and insight from a wide range of preparedness and response organizations on possible mitigation items;
- review this Multijurisdictional NHMP update every four years to coincide one year prior to the plan's expiration date;

- bring potential mitigation items to the Steering Committee and/or jurisdictional partners;
- develop and coordinate ad hoc and/or standing subcommittees, as needed, for public training and outreach.

As of October 2017, members of the Lane Preparedness Coalition (LPC) include the following organizations:

- Central Lane 911
- City of Cottage Grove
- City of Eugene
- City of Springfield
- Eugene-Springfield Community Emergency Response Team (CERT)
- Eugene-Springfield Fire Department
- Eugene Water & Electric Board
- Food for Lane County
- Lange County Community Organizations Active in Disaster (COAD)
- Lane County Public Health
- PeaceHealth Oregon Network
- Rainbow Water District
- Red Cross
- University of Oregon

Members from any of these organizations may advise on or provide NHMP events for the general public while working with the appropriate jurisdiction. Regular participants are listed in the meeting attendance list in Appendix B, Planning and Public Process.

1.9.6 Plan Maintenance

The NHMP Steering Committee is required to meet at least two times each year. Eugene and Springfield Emergency Management staff schedule four meetings each year and typically meet every quarter. During these meetings the NHMP Steering Committee reviews progress on mitigation actions, discusses implementation challenges and opportunities, invites guest presenters to provide technical information, and annually reviews priorities (as detailed below under Annual Review and Update).

At least once a year, staff from Eugene and Springfield will brief the LPC Steering Committee on the NHMP progress to gain regular participation from a diverse group of organizations concerned with hazards mitigation. Plan maintenance is a critical component of the NHMP as it ensures the plan will maximize each jurisdictions' effort to reduce the risks posed by natural hazards.

1.9.7 Annual Review and Update

The Steering Committee will use at least one of the quarterly meetings to review and maintain the NHMP, including the following tasks:

- review progress toward mitigation goals made over the previous year;
- review and re-evaluate priority of remaining mitigation actions;
- annually review and adjust priorities, as needed;
- consider new mitigation actions for inclusion within the plan;
- consider adjustments to existing mitigation actions to improve feasibility, add critical detail, or refocus the strategy;
- consider additional implementation partners as necessary, and develop a plan for their inclusion;
- review public outreach conducted over previous year, as outlined within multi-hazard action Community Education and Outreach; and
- identify opportunities for outreach over the coming year.

1.9.8 Public Involvement

The City of Eugene, the City of Springfield, EWEB, Rainbow Water District, SUB, and the University of Oregon will continue to share information about, and gather input on, the Natural Hazards Mitigation Plan. At least twice a year the Cities will host presentations for the public that a) provide information about the NHMP, b) describe progress toward implementation, and c) collect feedback on the NHMP. These presentations will be conducted as part of ongoing outreach through the Eugene Springfield CERT program, an education and coordination program for residents seeking to volunteer in their neighborhood following a disaster, and the Lane Preparedness Coalition. LPC Full Coalition meetings are hosted multiple times each year and provide in-depth engagement opportunities for the interested public.

During the last two years of the NHMP update cycle, each jurisdiction will hold a minimum of one NHMP event. For the City of Eugene this also includes National Flood Insurance Program (NFIP) and Community Rating System (CRS) outreach. During these events, the community will be updated on mitigation projects, and the opportunity to provide input on mitigation items.

2 Hazard Descriptions

2.1 Hazard Descriptions

The Cities of Eugene and Springfield are subject to the following natural hazards:

- Drought
- Earthquake
- Extreme Weather
- Flood
- Geomagnetic Disturbance (GMD)
- Landslide
- Volcano
- Windstorm
- Wildfire
- Winter Storm

Additionally, the Eugene-Springfield NHMP addresses four "non-natural" hazards or impacts that present significant potential exposure. These four impacts may occur due to natural hazard events:

- Dam Failure
- Hazardous Materials
- Epidemics
- Civil Unrest

The following sections identify and profile the location, extent, previous occurrences, and future probability of each hazard listed above. Additional information on many of these hazards can be found in the Oregon Natural Hazards Mitigation Plan – Region 3: Regional Profile.

2.2 Drought

Drought is a prolonged period of dry weather which persists long enough to cause adverse deficiencies in the water supply. Droughts are a slow-onset hazard, meaning over time they can have sever impacts on agriculture, municipal water supplies, recreational resources, and wildlife. A prolonged drought poses a significant threat to the economy.

2.2.1 Causes and Characteristics of the Hazard

Droughts are caused by the lack of precipitation in large geographic areas typically across counties, states, or regions. Generally, precipitation accumulates in the Pacific Northwest as rain in the coastal regions and snow in the higher elevation mountainous areas. Rain and snowfall help to sustain the State's aquifers and provide river flow. Aquifers and rivers play a critical role by providing irrigation and potable water throughout the region. Snowpack and aquifers act as a form of natural water storage. Our mountain snow pack and aquifers provide a water source, balancing out the ups and downs of annual precipitation levels.

Short term effects of drought include declining stream, river, reservoir, lake, and ground water levels. The decline reduces agricultural yields, increases the potential for wildfires, and makes it difficult to maintain satisfactory quantities of municipal and private water levels. Long term effects of a depleted water supply can affect the economic viability of a community. According to NOAA, drought ranks second for the most economically destructive weather- related event with losses around $9 billion per year.[1]

There are three types of drought. They are meteorological, hydrological, and agricultural.

1. Meteorological drought is the most well-known. It is due to low or no precipitation compared to the regional average. It is highly specific to a region.
2. Hydrological drought is when decreased precipitation affects soil moisture, groundwater, and snowpack as well as streamflow, lake, and reservoir levels.
3. Agricultural drought occurs when the available water supply cannot meet crop demand.

[1] "DROUGHT: Monitoring Economic, Environmental, and Social Impacts." National Climatic Data Center. Accessed October 23, 2017. https://www.ncdc.noaa.gov/news/drought-monitoring-economic-environmental-and-social-impacts.

An Agricultural Drought can occur in the absence of a Meteorological Drought due to timing of water availability or decreased access. (Figure 2-1)

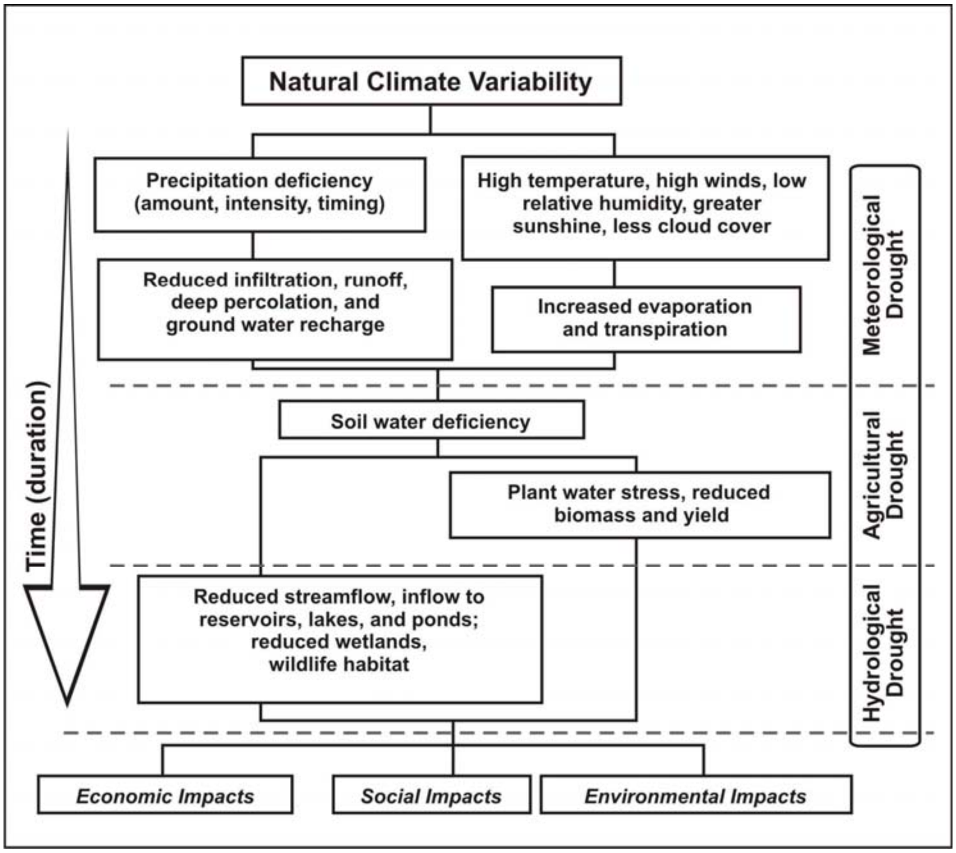

Figure 2-1. Source: National Drought Mitigation Center – *Types of Drought*
http://drought.unl.edu/DroughtBasics/TypesofDrought.aspx

2.2.2 Climate Change

Since the mid-1900s, the mountains in the Pacific Northwest have experienced a decline in spring snowpack. This is due to a reduction in precipitation falling as snow with more falling as rain. There has also been a shift in the timing of snowmelt. Warmer temperatures are causing earlier snowmelts which can lead to the water supply being increasingly out of sync with the area's water demands.[2] The National Climate Assessment predicts a slight decrease in the average annual precipitation and an increase in temperatures. This could mean longer, more severe, droughts.[3]

[2] Cook, Edward R., Richard Seager, Mark A. Cane, and David W. Stahle. "North American drought: reconstructions, causes, and consequences." *Earth-Science Reviews* 81, no. 1 (2007): 93-134.
[3] "Overview: Regional Impacts." National Climate Assessment. 2014. Accessed October 23, 2017. http://nca2014.globalchange.gov/highlights/overview/overview.

2.2.3 History of the Hazard in Eugene-Springfield

The National Drought Mitigation Center at the University of Nebraska-Lincoln tracks drought conditions across the country. Data can be broken down at the county or watershed basin levels. This data is recorded as a percentage of the area experiencing abnormally dry conditions. As shown in Figure 2-2, 100% of Lane County experienced severe droughts in 2001, 2014, and 2015.

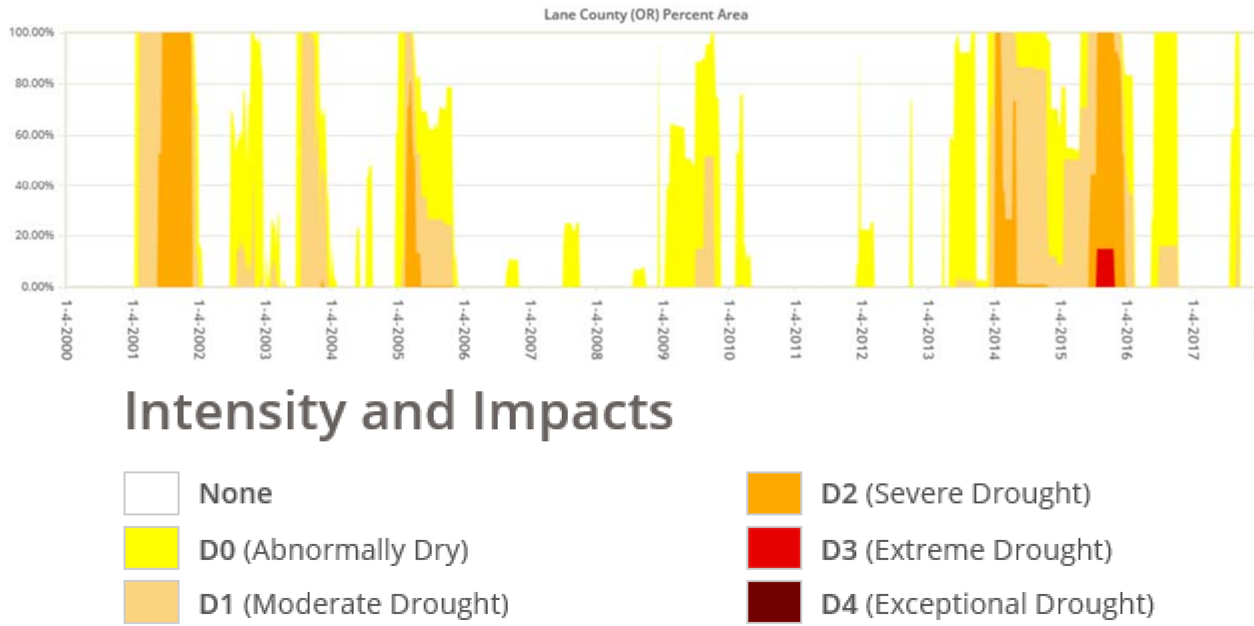

Figure 2-2. Source: National Drought Mitigation Center – *http://droughtmonitor.unl.edu/Data/Timeseries.aspx*

2.2.4 Impacts

Dam or Levee Failure

Dam or levee failure is not a known impact of droughts.

Hazardous Materials

Hazardous Material spills are not a known significant impact of droughts.

Epidemics

Epidemics are not a known significant impact of droughts in the Eugene-Springfield area.

Civil Unrest

In the Eugene-Springfield area, civil unrest is not a known impact of droughts.

2.2.5 Probability of Future Occurrence

On September 30, 2015 some of the nation's top water scientists, lawyers, and policy-makers convened in Eugene, Oregon to discuss the severe drought the area was experiencing. They concluded droughts in Oregon are likely to become more frequent and severe, largely due to climate change.[4]

2.2.6 Vulnerability and Capacity Assessment

Droughts are typically associated with summer, but often start during winter months with declining precipitation levels. Drought forecasting is generally generated through temperature and ocean current patterns relative to recent and current conditions. This allows scientist to predict future droughts well before they occur. Despite being vulnerable to droughts, the Eugene-Springfield area has a high capacity to respond to, and recover from, one. This is largely due to the slow onset of a drought, and available resources. A severe drought can impact every citizen in the Eugene-Springfield area which classifies this hazard as having a high vulnerability level.

2.2.7 Risk Assessment

The probability of drought in the Eugene-Springfield area is moderate while vulnerability and capacity to deal with a drought is high. Based on the probability of future occurrence, vulnerability, and capacity, the Eugene-Springfield area's risk to this hazard is categorized as moderate. For a summary of Impact Risks see Table 2-1.

Drought - Impact Risks	
Dam or Levee Failure	No Known
Hazardous Materials	No Known
Epidemic	No Known
Civil Unrest	No Known

Table 2-1

2.2.8 Existing Hazard Mitigation Activities

Droughts are a new addition to this NHMP update, so hazard specific mitigation

[4] Samantha, Murray. "Drought is the "New Normal"." Oregon Environmental Council. September 30, 2015. Accessed October 23, 2017. http://www.oeconline.org/drought-is-the-new-normal/.

activities have yet to occur.

2.3 Earthquake

The 2015 Oregon State Natural Hazards Mitigation Plan determined the most devastating future earthquakes will probably originate along shallow crustal faults in the region and along the Cascadia Subduction Zone.[5] Given the potential for damage and the probability of a CSZ occurrence, Eugene and Springfield are primarily focused on a potential CSZ event for earthquake mitigation planning purposes.

2.3.1 Causes and Characteristics of the Hazard

Seismic events were once thought to pose little or no threat to Oregon communities. However, recent earthquakes and scientific evidence indicates the risk to people and property is much greater than previously thought. Oregon, and the Pacific Northwest in general, is susceptible to earthquakes from four sources:

1. The offshore Cascadia Subduction Zone;
2. Deep intraplate events within the subducting Juan de Fuca Plate;
3. Shallow crustal events within the North American Plate; and
4. Earthquakes associated with renewed volcanic activity.

An earthquake could impact the entire Eugene-Springfield metro as well as surrounding areas. The specific hazards associated with an earthquake include the following:

Ground Shaking

Ground shaking is defined as the motion of seismic waves felt on the Earth's surface caused by an earthquake. Ground shaking is the primary cause of earthquake damage.

Ground Shaking Amplification

Ground shaking amplification refers to the soils and soft sedimentary rocks near the surface that can modify ground shaking from an earthquake. Such factors can increase or decrease the amplification (i.e. strength) as well as the frequency of the shaking.

Surface Faulting

[5] United States of America. Oregon Military Department. Office of Emergency Management. *Oregon Natural Hazards Mitigation Plan.* Salem, OR, 2015. 2015. Accessed October 27, 2017. http://www.oregon.gov/LCD/HAZ/docs/2015ORNHMP/2015ORNHMPApproved/Approved_2015ORNHMP.pdf.

Surface faults are planes or surfaces in Earth materials along which failure occurs. Such faults can be found deep within the earth or on the surface.

Earthquakes occurring from deep-lying faults usually create only ground shaking.

Earthquake-Induced Landslides

Landslides occur due to the shaking motion of an earthquake destabilizing the ground. Areas already prone to landslides have a much higher risk of such an event occurring during an earthquake.

Liquefaction

Liquefaction takes place when ground shaking causes granular soils to turn from a solid into a liquid state. This in turn causes soils to lose their strength and their ability to support weight.

Severity

The severity of an earthquake is dependent upon a number of factors including the distance from the earthquake's source (epicenter,) the ability of the soil and rock to conduct the earthquake's seismic energy, the degree (i.e. angle) of slope materials, the composition of slope materials, the magnitude of the earthquake, and the type of earthquake.

Maps showing the location of various earthquake related hazards are located in Section 3.

2.3.2 Climate Change

At this point, it is unknown how climate change may affect how an earthquake is felt in Eugene and Springfield. Changing soil conditions, due to climate change, could affect how earthquakes propagate throughout the area, but the extent or effect of this is unknown at this time.

2.3.3 History of the Hazard in Eugene-Springfield

Historically, earthquakes have occurred in Oregon as offshore Cascadia Subduction Zone earthquakes of around 8 to 9 magnitudes. Approximate years of significant CSZ events are:

- 1400 BCE
- 1050 BCE
- 600 BCE
- 400 CE
- 750 CE

- 900 CE
- 1700 CE

The Cascadia Subduction Zone is a 620 mile fault line off the coast of Northern California, Oregon, Washington, and Southern British Columbia. When the fault moves, causing an earthquake, it is called a "rupture." The CSZ does not always rupture along its entire length. Research suggests, over the last 10,000 years the entire fault has ruptured 20 times with a magnitudes 9.0 or larger. Three quarters of the fault has ruptured 2 to 3 times producing an earthquakes between 8.8 and 8.5 magnitudes. The southern portion has ruptured 19 times producing earthquakes between a magnitude 7.6 and 8.5.[6] (Figure 2-3 and 2-4)

Native American oral records and geologic evidence has shown the most recent Cascadia Subduction Zone (CSZ) earthquake occurred in January 1700 with an approximate magnitude of 9.0. The earthquake generated a tsunami that struck Oregon, Washington, and Japan. This event destroyed Native American villages along the Oregon coast. There are no known reports of earthquake damage in Eugene-Springfield in recent history. A map of local historic earthquakes is included in Section 3, within the hazard maps.

Since November 2014 there have been three smaller crustal earthquakes in the Eugene and Springfield area. These events occurred on:

- 11/12/2014 – 14 Km East of Coburg, Oregon – Magnitude 2.6
- 01/12/2015 – 13 Km East of Coburg, Oregon – Magnitude 2.6
- 07/04/2015 – 15 KM East Northeast of Springfield, Oregon – Magnitude 4.8

No major damages were reported for these events, but they are reminders a CSZ earthquake is not the only threat the area faces. Due to the potential severity of a CSZ earthquake, however, it is the goal of the Multijurisdictional NHMP partners to prepare for, and mitigate the risks of, such an events. By doing this, the Cities of Eugene and Springfield will not only be prepared for a major earthquake from the Cascadia Fault, but also from those closer and more centrally located.

[6] United States of America. Oregon Department of Geology and Mineral Industries (DOGAMI). *Cascadia Earthquake Facts: What You Need To Know.* Slide 15. Accessed November 13, 2017. http://slideplayer.com/slide/3475601/.

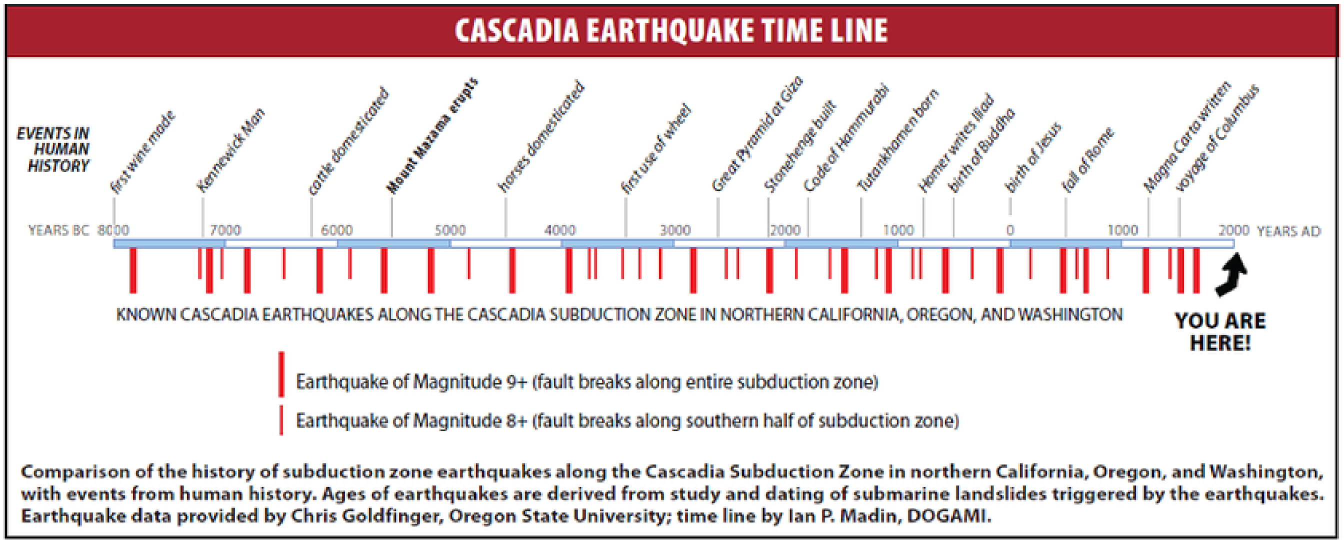

Figure 2-3. Source: Oregon Resilience Plan – *Cascadia Earthquake Time Line*

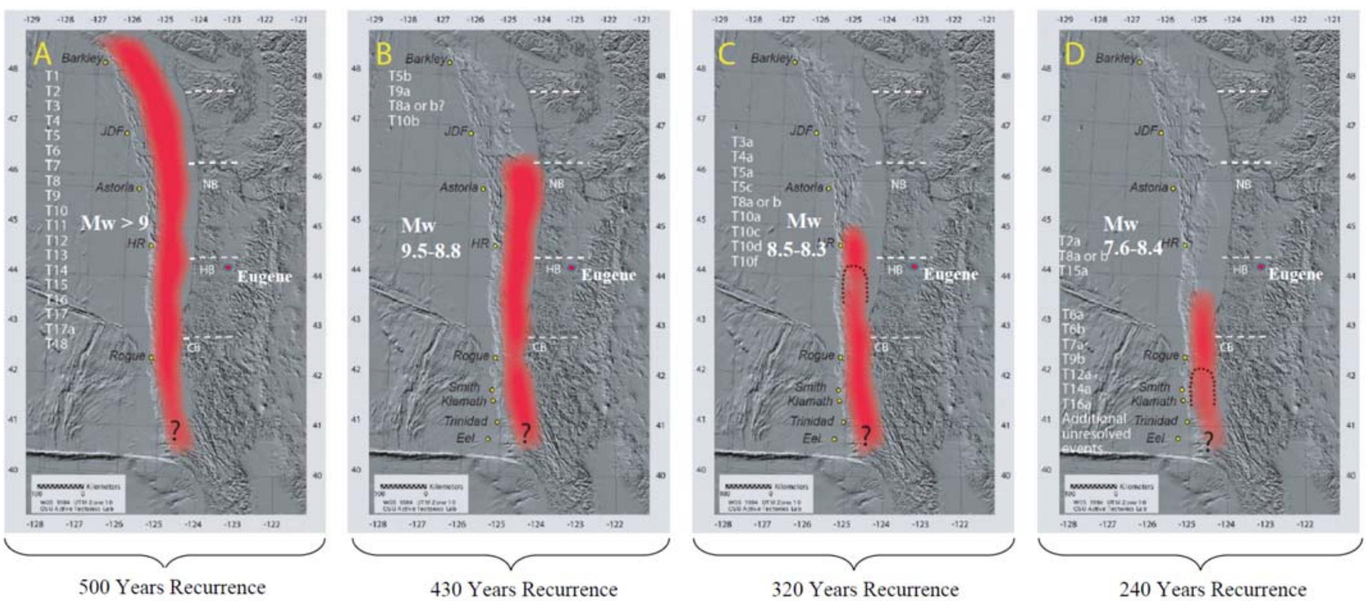

Figure 2-4. Source: Oregon Department of Geology and Mineral Industries – *Cascadia Subduction Zone Earthquakes.* The white lettering and numbering on the left indicates significant turbidite samples showing over 42 earthquakes in the last 10,000 years. Mw denotes the average magnitude of different fault ruptures.[6]

2.3.4 Impacts

Dam or Levee Failures

Dam failures can occur at any time in a dam's life. Failures are most common when water storage is at or near design capacity, however. At high water levels, the water force on a dam is higher and several of the most common failure modes are more likely to occur. Correspondingly, for any dam, the probability of failure is much lower when water levels are substantially below the design capacity for the reservoir.

There are several ways an earthquake can cause an earthen fill dam, embankment dam, or levee to fail.

Compaction failure

The most common form of dam failure, due to an earthquake, occurs when fill, is not properly compacted. Dams can settle or spread laterally. By itself, such settlement does not generally lead to immediate failure. However, if the dam is full, relatively minor amounts of settling may cause overtopping to occur, resulting in scour and erosion which could progress to failure.

Structural failure

Ground shaking can also cause structural failures or overtopping of dams. For any dam, improper design or construction, or inadequate preparation of foundations and abutments can also cause failures.

Landslide tsunamis

Landslides into the reservoir, which may occur on their own or triggered by earthquakes, may lead to surge waves which overtop dams, or hydrodynamic forces which cause dams to fail under the unexpected load.

Seiches waves

Overtopping or overloading of a dam structure can also occur when an earthquake causes seiches (waves) in the reservoirs. A seiche is a standing wave in which the largest vertical oscillations are at each end of a body of water with very small oscillations at the center.

Equipment Failure

An earthquake can damage spill ways, gates, turbines, and electrical equipment used to operate the dam. When such failures occur water can quickly rise behind a dam causing it to be overtopped.

More information on local dams can be located in Annex D.

History of Impact in Eugene-Springfield

There have been no dam failures in Oregon due to an earthquake. Despite having no historical occurrences, how large earthquakes impact dams has been observed. Only 1.5 percent of embankment dam failures have been attributed to earthquakes, which is the most common form of dam to fail in a seismic event.[7]

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[7] Untied States. US Army Corps of Engineers and US Department of the Interior. *Best Practices in Dam and Levee Safety Risk Analysis.* April 2, 2015. Accessed October 03, 2017. https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=4&ved=0ahUKEwjM6_3dqqHZAhVQ2GMKHUMdBs8QFgg9MAM&url=https%3A%2F%2Fwww.usbr.gov%2Fssle%2Fdamsafety%2Frisk%2FBestPractices%2FPresentations%2FIV-4-20141210-PP.pdf&usg=AOvVaw2RdtodGJiV64xwtiFBJuZu.

According to the International Commission on Large Dams (ICOLD), until the 2011 earthquake in Japan no casualties had been attributed to a dam or levee failure induced by an earthquake.[8]

The 2008, magnitude 8.0, earthquake in China caused 1,803 concrete and embankment dams, and 403 hydropower plants to be damaged with no complete failures. The 2010, 8.8 magnitude, earthquake in Chile damaged several dams, also with no complete failures.[7] During the 2011 earthquake in Japan roughly seven dams and hundreds of levees had suffered damage. Only one of these, the Fujinami irrigation dam, had a complete failure resulting in the only known casualties from an earthquake induced dam failure. This failure destroyed five homes and killed eight people. It is thought this impact was magnified by inadequate design and construction.[9]

Risk of Impact

Based on history and the condition of the dams and levees in and around the Eugene and Springfield area, the risk from an earthquake induced failure is considered to be low.

Hazardous Materials

Worldwide, there have been many earthquake induced hazardous material (HazMat) spills.[10] These events are often referred to as natural-technologic, or "natech", events. Given increases in industrial development and population density in areas prone to natural hazards, the odds of human exposure to hazardous materials, after a seismic event, is also increasing.[11]

Earthquakes not only cause HazMat spills, they may also obstruct emergency personnel responding to an incident. Response to the natural disaster itself may divert resources which would otherwise be dedicated to the spill or release. Restricted site and life line access along with limited resources such as personnel and equipment can further slow a HazMat response. This chaotic post disaster environment poses significant challenges to first responders' primary missions of containing the hazardous material and stabilizing the scene.

[8] Wieland, Martin. "Dam safety and earthquakes." *International Water Power & Dam Construction,* August 2010, 12-14. Accessed October 03, 2017. www.preventionweb.net/files/15259_9694491.pdf.
[9] Portland Corps. "Don't freak out: Dams generally do well in earthquakes." Don't freak out: Dams generally do well in earthquakes. January 26, 2016. Accessed October 04, 2017. http://usaceportland.armylive.dodlive.mil/index.php/2016/01/shakeout-dont-freak-out-dams-generally-do-well-in-earthquakes/.
[10] Reitherman, Robert K. *Earthquake-Caused Hazardous Material Releases*. Proceedings of 1982 Hazardous Material Spills Conference Proceedings, Wisconsin, Milwaukee. Rockville, MD: Government inst., 1984. 170-77
[11] Young, Stacy, Lina Balluz, and Josephine Malilay. "Natural and technologic hazardous material releases during and after natural disasters: a review." *Science of the Total Environment* 322, no. 1-3 (2004): 3-20. doi:10.1016/s0048-9697(03)00446-7.

More information on HazMat spills and releases can be located in Annex E.

History of Impact in Eugene-Springfield

There have been no earthquake induced HazMat spills or releases in the Eugene-Springfield area. Despite this, with the threat posed by the Cascadia Subduction Zone, and numerous sources of hazardous materials within the Cities, such an incident occurring is of great concern. Historically, earthquakes have caused HazMat incidents by sloshing vat spills, damage to connections and piping on tanks, complete tank collapses, truck accidents, and train derailments.[4]

Some notable earthquake induced hazardous material incidents include:

- 1994 Northridge, CA-magnitude 6.7: 9 petroleum pipeline ruptures, 752 natural gas line breaks, and 60 emergency HazMat incidents[5]
- 1987 Whittier Narrows, CA-magnitude 5.9: 1411 natural gas line breaks and 30 HazMat releases[5]
- 1989 Loma Prieta, California-magnitude 6.9: 300-400 natural gas line breaks and 300 hazmat releases[5]

Risk of Impact

Based on the amount of hazardous materials in and around the Eugene-Springfield area, and historical occurrence of earthquake induced HazMat spills or releases, the risk from this impact occurring is high.

Epidemics

Historically, fears of disease outbreaks after a natural disaster have been a prominent concern. Despite this, epidemics following natural disasters are rare, especially in developed countries.[12] [13] After a natural disaster, water related communicable diseases and large populations of displaced citizens are primary concerns.

Though diseases can be introduced to a population by emergency personnel, such as the 2010 Cholera outbreak in Haiti, generally, a disease must be endemic prior to the disaster for it to become an epidemic after. Cold conditions favor airborne pathogens while warm weather favors waterborne pathogens.[6] Large dust clouds generated by an earthquake can also disperse a variety of spores causing respiratory illnesses.[6]

History of Impact in Eugene-Springfield

[12] Lemonick, David M. "Epidemics after natural disasters." *American Journal of Clinical Medicine* 8, no. 3 (2011): 144-152.

[13] Watson, John T., Michelle Gayer, and Maire A. Connolly. "Epidemics after natural disasters." *Emerging infectious diseases* 13, no. 1 (2007): 1.

There have been no post-earthquake epidemics in the Eugene-Springfield area. The worldwide risk of communicable diseases after an earthquake is deemed a moderate risk for person to person, water, and food borne transmission paths.[6] Contributing factors to disease transmission are environmental considerations, endemic organisms, population characters, overcrowding, pre-event structure and type of healthcare system, immunization levels, and the magnitude of the disaster itself.[14]

Though not an epidemic per say, our area may see an increase of respiratory illnesses after a major earthquake in which homes and buildings are destroyed. This is due to dangerous mold, common to our area, being released into the surrounding environment. Those with compromised immune systems or existing respiratory complications would be at a higher risk than the general population.

Risk of Impact

Based on historical occurrences of earthquake induced epidemics along with our area's societal composition, the risk from this impact occurring is moderate.

Civil Unrest

Due to misinformation and the chaotic nature of events after a major natural disaster, it is difficult to determine how common natural hazard induced civil unrest is. One study cites the events of hurricane Katrina and the media's role in over broadcasting minor looting or rioting activities giving an impression such actions were prevalent.[15]

A study by the University of Otago determined earthquakes and volcanic eruptions pose the highest risk of civil unrest in areas with income inequality, mixed political regimes, marginalization of certain groups, and when the state's capacity and legitimacy is weakened.[16] Figure 1-3 highlights several conditions noted as contributing factors for civil unrest after a natural disaster.[16]

History of Impact in Eugene-Springfield

There have been no incidents of civil unrest in the aftermath of an earthquake in

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[14] Sandrack, C. "Infectious Diseases After Natural Disasters." *California Preparedness Education Network.* A program of the California Area Health Education Centers. March 7, 2006. Funded by HRSA Grant. PowerPoint presentation online. Available at http://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=2&cad=rja&uact=8&ved=0ahUKEwixjd6Gv6HZAhVC-GMKHTK1CMAQFgguMAE&url=http%3A%2F%2Fwww.aapsus.org%2Fwp-content%2Fuploads%2Fajcmsix.pdf&usg=AOvVaw3FpqcwnfbDsr_FktcQtDGn. Accessed October 09, 2017.

[15] Tierney, Kathleen, Christine Bevc, and Erica Kuligowski. "Metaphors matter: Disaster myths, media frames, and their consequences in Hurricane Katrina." *The annals of the American academy of political and social science* 604, no. 1 (2006): 57-81

[16] Nel, Philip, and Marjolein Righarts. "Natural disasters and the risk of violent civil conflict." *International Studies Quarterly* 52, no. 1 (2008): 159-185.

Eugene or Springfield. While some studies have determined disaster victims respond to and adapt well following major disasters, others have concluded there is a higher chance of violence when certain conditions are met.[9, 10] Conflicting data and a wide range of contributing factors make it difficult to determine the likelihood of some form of civil unrest occurring in the Eugene-Springfield area after a major earthquake.

Despite the difficulties of predicting such an event, it is safe to assume the area will experience many, if not all, of the contributing factors identified for civil unrest. This could result in anything from small ad-hoc looting events to large scale violent civil unrest. Additionally, on multiple occasions riots not associated with a disaster have occurred in Eugene which indicates the area is already susceptible to such events.

Risk of Impact

Based on historical occurrences of civil unrest after disasters along with our area's societal composition, the risk of an earthquake induced civil unrest event occurring is moderate.

2.3.5 Probability of Future Occurrence

The State estimates earthquake probability for the mid-Willamette Valley region in two ways. First, they uses a probabilistic model taking into account all known information about possible earthquakes on Oregon faults. This model presents an expected level of damage associated with an earthquake with a 2-percent chance of occurring in the next 50-years. This probabilistic model suggests the Eugene-Springfield area can expect the partial collapse of weak buildings and the movement of unsecured wood-frame houses.

While all earthquakes possess the potential to cause major damage, subduction zone earthquakes pose the greatest danger due to the severity, duration, and extent of ground shaking. Within Oregon, a major CSZ event could generate an earthquake with a magnitude of 9.0 or greater, likely resulting in significant damage and loss of life in Eugene-Springfield. Another way to assess the probability of an earthquake for Oregon communities west of the Cascades is to consider the CSZ event independently.

According to the Oregon NHMP, the return period for the largest of the CSZ earthquakes (magnitude 9.0+) is 530 years with the last CSZ event occurring 320 years ago in January of 1700. The probability of a 9.0+ CSZ event occurring in the next 50 years ranges from 7 - 12%. Notably, 10 - 20 "smaller" magnitude 8.3 - 8.5 earthquakes identified over the past 10,000 years affected only the southern half of Oregon and northern California. The average return period for these events is roughly 240 years. The combined probability of any CSZ earthquake occurring in the next 50 years is 37 - 43%. This puts the odds of having a significant (magnitude 8.0+) earthquake from the Cascadia fault line at roughly one in three over the next 50 years.[17]

Eugene-Springfield categorizes the probability of a CSZ event as moderate and the probability of intraplate and crustal earthquakes as low. Given the potential for damage and the probability of occurrence, Eugene-Springfield is primarily focused on a potential CSZ event for earthquake mitigation planning purposes.

2.3.6 Vulnerability and Capacity Assessment

In 2013 and 2014 the Cities of Eugene and Springfield conducted a Climate and Hazards Vulnerability Assessment to inform this NHMP. The assessment team met with local and regional experts in the drinking water, healthcare, public health, electricity, transportation, food, housing, communication, stormwater, wastewater, natural systems, and public safety sectors. The assessment identifies the following specific earthquake-related vulnerabilities:

- Except for natural systems, all sectors are extremely sensitive to a magnitude 9.0 CSZ earthquake event.
- Very little has been done to prepare any systems, infrastructure, or personnel to handle the initial impact and ongoing response and recovery from a CSZ event.
- Exceedingly limited staff availability in the aftermath of a severe earthquake will create problems and challenges difficult to predict or mitigate.
- Every sector will experience unfamiliar and substantial failures and interruptions therefore difficult (though not impossible) to plan for.
- Very few Eugene and Springfield residents have first- hand experience with a major earthquake, making it difficult to describe the potential experience and results.

Additional system vulnerability details are included in Chapter 4 as part of the Hazard and Climate Vulnerability Assessment Report.

In 2007, DOGAMI completed a rapid visual screening (RVS) of educational and emergency facilities in communities across Oregon, as directed by the Oregon legislature in Senate Bill 2 (2005). RVS is a technique used by the Federal Emergency Management Agency (FEMA), known as FEMA 154, to identify, inventory, and rank buildings' potentially vulnerable to seismic events. DOGAMI surveyed a total of 3,349 buildings, giving each a low, moderate, high, or very high rating for collapse potential in the event of a high magnitude earthquake.

[17] United States of America. Oregon National Guard. Office of Emergency Management. *Oregon Natural Hazards Mitigation Plan: Region 3 - Mid/South Willamette Valley*. Salem, OR: Office of Emergency Management, 2015. 534-46.

The RVS assessed a total of 174 buildings in the Eugene-Springfield area.[18]

It is important to note these rankings represent a probability of collapse based on limited observed and analytical data and are therefore approximate rankings.[19] To fully assess a building's collapse potential, a more detailed engineering study completed by a qualified professional is required, but the RVS study can help prioritize which buildings to survey.

Table 2-2 shows the number of buildings surveyed in Eugene and Springfield with their respective rankings. Based on the RVS study, Eugene and Springfield performed further seismic evaluations on much of their critical infrastructure. These more detailed assessments resulted in a prioritized list of facilities in need of seismic retrofits. Several of these sites have already undergone seismic retrofitting work, and funding for more projects is being actively pursued.

Table 2-2. Building level of collapse potential for Eugene and Springfield

City	Level of Collapse Potential			
	Low (< 1%)	Moderate (>1%)	High (>10%)	Very High (100 %)
Eugene	56	52	29	0
Springfield	28	4	3	2

Table 2-2. Source: DOGAMI 2007 – *Open File Report 07-02. Statewide Seismic Needs Assessment Using Rapid Visual Assessment.*

More recently, Oregon published the Oregon Resilience Plan. Findings in the plan suggest communities in the Willamette Valley can expect the following potential impacts to critical service sectors following a CSZ event:

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[18] The full data set can be found on http://www.oregongeology.org/sub/projects/rvs/SSNA-abridged-data.pdf.[18] State of Oregon Department of Geologic and Mineral Industries, *Implementation of 2005 Senate Bill 2 Relating to Public Safety, Seismic Safety and Seismic Rehabilitation of Public Building,* May 22, 2007, iv.

Table 2-3. Critical service impacts	
Critical Service	**Estimated Time to Restore Service**
Electricity	1 to 3 months
Police/Fire Stations	2 to 4 months
Drinking Water	1 year
Critical Service	**Estimated Time to Restore Service**
Sewer	1 month to 1 year
Top-priority Highways (partial restoration)	6 to 12 months
Healthcare Facilities	18 months

Table 2-3. Source*:* Oregon Resilience Plan, February 2013.

Earthquake impact analysis conducted for prior versions of this plan indicate many buildings will have no damage or light to moderate damage, with heavy damage concentrated in vulnerable buildings (wood frame buildings with cripple walls, unreinforced masonry, etc.). At the time, casualties were expected to include up to 30 deaths and roughly 1,600 injuries in Eugene-Springfield. Casualties will be higher in a daytime event than a nighttime event because most wood-frame residential buildings have a lower life-safety risk. Refer to the risk analysis section below for HAZUS-based property and casualty loss estimates.

The Steering Committee ranked their vulnerabilities to crustal, intraplate, and subduction earthquake events as 'high'. This would indicate more than 10% of the population would be impacted in an earthquake. Due to the large geographical scale of an earthquake and limited resources to deal with such an event, Eugene and Springfield's capacity to respond to, and recover from, an earthquake is low.

2.3.7 Risk Assessment

The Oregon Department of Geology and Mineral Industries (DOGAMI) has developed two earthquake loss models. One is for a Cascadia Subduction Zone earthquake, and one is for a magnitude 6.5 arbitrary crustal earthquake. DOGAMI determined these two events are the most likely sources for an Oregon earthquake. Both models are based on HAZUS-MH software currently used by FEMA as a means of determining potential losses from earthquakes.

The CSZ event is based on a potential 9.0 earthquake generated off the Oregon coast. The model does not take into account a tsunami, which would likely develop from the earthquake event. The M6.5 arbitrary crustal earthquake scenario does not look at a single earthquake (as in the CSZ model). Rather, it encompasses many faults, each with a 2% chance of producing an earthquake in the next 50 years. The model assumes each fault will produce a single "average" earthquake during this time.

DOGAMI investigators caution that the models contain a high degree of uncertainty and should be used only for general planning purposes. Also, individual cities were not modeled. Despite their limitations, the models do provide some approximate estimates of damage. Results for Lane County are found in Tables 2-4, 2-5, and 2-6.

For a summary of Impact Risks see Table 2-7.

Table 2-4. Estimated losses from M9 CSZ and a local crustal event

Region 3 Counties	Building Value (Billions)	Total Building-Related Losses From A 9.0 Csz Event (Billions)	Total Building-Related Losses From A Crustal Earthquake (Billions)
Lane	$21.055	$5.0	$3.4

Table 2-4. Source: DOGAMI, 2008, *Geologic Hazards, Earthquake and Landslide Hazard Maps, and Future Earthquake Damage Estimates.*

Table 2-5. Estimated losses associated with a magnitude 8.5-9.0 subduction event

Categories	Lane
Injuries (5 pm time period)	3,945
Deaths (5 pm time period)	264
Displaced Households	7,633
Economic Losses For Buildings	$4,652 million
Operational the day after: Fire stations[5] Police Stations Schools Bridges	 100% 100% 100% 84%
Economic Loss to Infrastructure: Highways Airports Communications	 $211 million $13.3 million $0.33 million
Debris Generated (thousands of tons)	2,000

Table 2-5. Source: DOGAMI, 2008, *Geologic Hazards, Earthquake and Landslide Hazard Maps, and Future Earthquake Damage Estimates.*

Table 2-6. Estimated losses associated with an arbitrary magnitude 6.5-6.9 crustal event	
Categories	**Lane County**
Injuries (5 pm time period)	1821
Deaths (5 pm time period)	96
Displaced Households	7,716
Economic Losses: Buildings	$3,351.03 million (2008 dollars)
Operational the day after: Fire stations Police Stations Schools Bridges	 100% 91% 99% 97%
Economic Losses: Infrastructure Highways Airports Communications	(2008 dollars) $106 million $16 million $0.63 million
Debris Generated:	1,000,000 tons

Table 2-6. Source: DOGAMI, 2008, *Geologic Hazards, Earthquake and Landslide Hazard Maps, and Future Earthquake Damage Estimates.*

Earthquake - Impact Risks	
Hazardous Materials	High
Epidemic	Medium
Civil Unrest	Medium
Dam or Levee Failure	Low

Table 2-7

Eugene and Springfield categorize the probability of a Cascadia Subduction Zone (CSZ) earthquake as moderate. The probability of intraplate and crustal earthquakes is considered to be low over the next 100 years. Vulnerability to an earthquake is high while capacity to deal such events is low.

2.3.8 Existing Hazard Mitigation Activities

Eugene and Springfield have taken steps to mitigate earthquake risks. Efforts include:

- Enforcing of the International Building Codes and Oregon State Structural Specialty Code, which both address earthquake mitigation measures for new construction.
- Creating and training a Damage Assessment team for evaluating structural damage to buildings and bridges after an earthquake. This team includes members of Lane County, Eugene, and Springfield. The team has held table-top and field exercises, and hopes to do so every other year.
- Moving the City of Eugene police, fire, city management, and administration functions out of City Hall due to seismic deficiency of the building. Eugene is currently in the process of designing a new city hall.
- Constructing an enlarged, seismically sound, emergency operations center (EOC) with increased food, water, backup generator, and fuel storage for Emergency Management personnel to operate from. The EOC acts on the City's behalf to link our emergency responders with mutual-aid, local partners, State, and Federal Response Agencies like FEMA.
- Conducting community outreach to support our resiliency strategy by increasing community personal preparedness. A prepared community eases the burden on first responders by reducing the immediate need for food, water, and other personal care for individuals in the days and weeks following a disaster or emergency.
- Connecting the City of Eugene to data and voice through a portable redundant communications system using satellite technology. The system allows the Eugene EOC to communicate beyond our local radio and microwave footprint in a communications degraded environment.

2.4 Extreme Weather

Extreme weather includes hail, tornados, lightening, and severe heat. The Eugene-Springfield area has had documented occurrences of all four of these meteorological events though they tend to be infrequent causing little to no damage. Despite this, it is possible more damaging events could occur in the future.

2.4.1 Causes and Characteristics of the Hazard

Thunderstorms

Thunderstorms can produce wind, hail, lightning, and even tornadoes. To form, a thunderstorm needs unstable air, moisture, and an upward lifting motion. Generally, this upward motion is produced by surface heating in which convection occurs. Convection forces the warmer air up into a cooler air mass causing instability.

A thunderstorm has three stages of development:

- Developing Stage
- Mature Stage
- Dissipating Stage

The mature phase of a thunderstorm is the most likely time for hail, heavy rain, lightening, strong winds, and tornadoes. Once enough precipitation is produced the updraft is overcome by the downdraft and the dissipating stage begins. Lightning can remain a danger throughout all three stages of a storm.[20] (Figure 2-5)

[20] "Thunderstorm Basics." NOAA National Severe Storms Laboratory. Accessed November 08, 2017. http://www.nssl.noaa.gov/education/svrwx101/thunderstorms/.

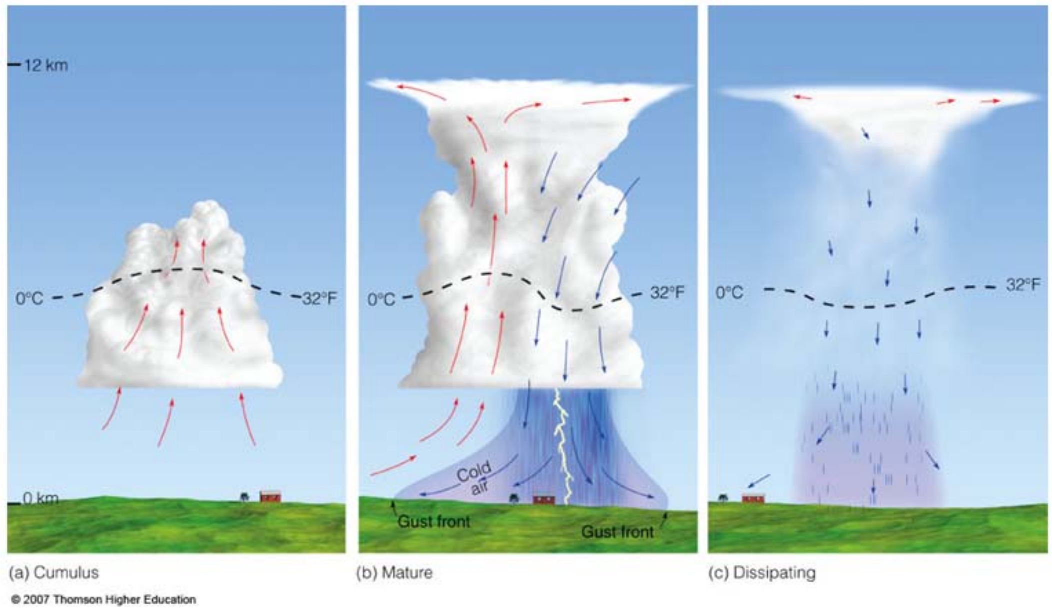

Figure 2-5 Source: Global Sailing Weather - h*ttp://globalsailingweather.com/thunderstorms.php*

Hail

Hail occurs when updrafts in a thunderstorm carry raindrops into extremely cold areas of air where they freeze into balls of ice. This cycle is repeated, and the ball of ice grows, until the storm's updraft is no longer able to support the weight of the ice. This occurs when the size of hail is too large for the storm to support or the updraft weakens. When this occurs the hail falls to the ground.

Large hail can cause significant damage. Usually, hail is pea to marble size, but large storms can produce larger hail. The largest hail ever recorded in the United States was in Vivian, SD. It had a diameter of 8 inches, a circumference of 18.62 inches, and weighed 1 lb. 15 oz.[21] Hail with an inch diameter is considered severe, but there are only anecdotal accounts of such weather phenomenon occurring in the Eugene-Springfield area.

Tornadoes

Tornadoes are the most violent of all atmospheric storms.[22] They are a narrow fiercely rotating column of air. Tornadoes become visible when there is enough condensation of water droplets, or they make contact with the ground collecting dust and debris. Once on the ground, tornadoes can cause significant property damage and threaten human life (Picture 2-1).

Tornadoes form at the base of a thunderstorm (Figure 2-6). This weather phenomenon can happen any time of the year, but in Oregon they most often

[21] "Hail Basics." NOAA National Severe Storms Laboratory. Accessed November 08, 2017. http://www.nssl.noaa.gov/education/svrwx101/hail/.
[22] "Tornado Basics." NOAA National Severe Storms Laboratory. Accessed November 08, 2017. http://www.nssl.noaa.gov/education/svrwx101/tornadoes/.

occur during milder months of fall and spring.[23] When over water, a tornado is referred to as a waterspout.

Picture 2-1. Source: KPTV-*Manzanita, Oregon tornado damage October 2016*

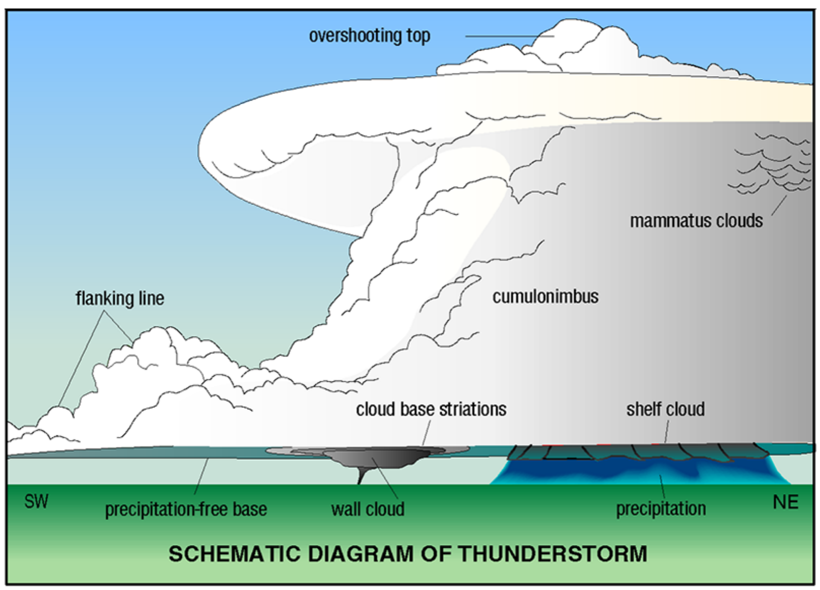

Figure 2-6. Source: National Severe Storms Laboratory NOAA - *http://globalsailingweather.com/thunderstorms.php.*

Severe Heat

Severe heat events are possible, though historically rare, in Eugene and Springfield. When they do occur, severe heat events tax utility systems and endanger the health of some citizens, particularly the elderly, the very young,

[23] Livingston, Ian. "Monthly tornado averages by state and region." U.S. Tornadoes. March 16, 2013. Accessed November 08, 2017. http://www.ustornadoes.com/2013/03/19/monthly-tornado-averages-by-state-and-region/.

and those with compromised health. Heat is the number one weather related killer in the United States.[24] Heat related illnesses include heat cramps, exhaustion, and stroke. Heat stroke is a life-threatening condition.

Generally, a period of severe heat, often referred to as a "heat wave," is caused by a trapped or stagnant air pattern. When this occurs, the air mass does not move, but rather remains in an area progressively warming. This is commonly seen when high pressure systems push air downward preventing it from rising to cooler portions of the atmosphere.

2.4.2 Climate Change

Climate change will affect all four of these weather events. To what extent and severity is unknown, however. Climate change is expected to increase both summertime high temperatures and the summertime low temperatures that allow natural cooling of homes, buildings, and heat absorbing surfaces such as concrete and asphalt.[25] Most residents in Eugene and Springfield lack mechanical cooling systems, putting them at greater risk of heat illness during an extreme heat event.

2.4.3 History of the Hazard in Eugene-Springfield

Thunderstorms

Lightning also occurs in the Eugene-Springfield area (Picture 2-2). Lightning damage to buildings or infrastructure is generally minor and few practical mitigation alternatives are applicable to lightning, other than installing lightning arrestors on critical facilities subject to lightning damage. In Oregon, however, casualties from lightning are very low, with a total of only 7 deaths and 19 injuries reported over a 35 year period (NOAA). Thus, the level of risk posed by lightning strikes, while not zero, is very low. Public education about safe practices during electrical storms is the only available mitigation measure to reduce casualties from lightning.

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[24] Borden, Kevin A., and Susan L. Cutter. "Spatial patterns of natural hazards mortality in the United States." *International Journal of Health Geographics* 7, no. 1 (2008): 7 . doi:10.1186/1476-072x-7-64.

[25] The Oregon Climate Adaptation Framework. Oregon Department of Land Conservation and Development. December 2010. http://www.oregon.gov/energy/GBLWRM/docs/Framework_Final_DLCD.pdf

Picture 2-2. Source: The Register Guard - *Skinner Butte Aug. 22, 2013.*

Hail

Hail events are possible in the Eugene-Springfield area, generally during summer thunderstorms. Hail damage is generally minor and few practical mitigation alternatives are applicable, however.

Tornadoes

Tornadoes do occasionally occur in Oregon. Oregon is not among the 39 states with any reported tornado deaths since 1950, however. The largest tornado to touch down in Oregon happened on April 5, 1972. This tornado was an EF-3 on the Fujita scale with 200 mph winds. The tornado originated in Portland Oregon causing significant damage and traveled north. It crossed over the Columbia River, and entered Vancouver Washington where it killed 6 people. Total, 300 people were injured during this event.[26]

NOAA records (Portland office) show four historical tornadoes in Lane County. On November 24, 1989, a tornado touched down in the south hills of Eugene, uprooting several tall fir trees, and damaging utility lines and a camper, but causing no injuries. Another poorly documented tornado may have occurred in 1975 near Eugene, with very minor damage. In 1984, a small tornado was reported near Junction City with damage to a barn and shelter. In 1937, a possible tornado uprooted hundreds of trees and demolished summer homes and camps near McKenzie Bridge.

On April 14, 2015 an EF-0 tornado touched down at Lane Community College. Reports suggest the tornado was on the ground for about a minute.[27] Several cars

[26] "Your stories: The 1972 North Portland-Vancouver tornado." Online posting. April 6, 2017. KGW Portland. Accessed November 6, 2017. http://www.kgw.com/news/local/vancouver/your-stories-the-1972-north-portland-vancouver-tornado/429234745.
[27] Tomlinson, Stuart. "Weather Service rates Eugene twister as EF-0, with 65-85 mph winds." OregonLive.com. April 15, 2015. Accessed November 06, 2017. http://www.oregonlive.com/weather/index.ssf/2015/04/weather_service_rates_lane_cou.html.

were tossed around. One of the cars had two people in it, but no injuries were reported. This tornado resulted in $25,000 dollars in damage.[28] (Picture 2-3)

Picture 2-3. Source: Oregon Live – *Lane Community College Tornado.*

Severe Heat

The summer of 2014 set a new record for the number of days with high temperatures over 90 degrees.[29] From the end of July into the beginning of August 2017 the area saw one of its longest heat waves in history. The first nine days were the hottest such period on record according to data compiled by the Southeast Regional Climate Center.[30] During this period of severe heat the City of Eugene opened several "cooling centers" for people to escape the unsafe temperatures.[31] According to Kathie Dello at the Oregon Climate Change Research Institute, these are the types of conditions we should expect to see in the future.

[28] United States of America. Lane County. Emergency Management. *Lane County Multi-Jurisdiction Hazard Mitigation Plan.* April 2017. Accessed November 6, 2017. https://www.lanecounty.org/UserFiles/Servers/Server_3585797/File/Government/County%20Departments/Sheriff%20Office/Lane%20County%20Emergency%20Management/Hazard%20Mitigation%20Plan/Table%20of%20Contents.pdf.

[29] http://registerguard.com/rg/news/local/32166313-75/hot-summers-better-get-used-to-em.html.csp

[30] Erdman, Jon. "Record Pacific Northwest Heat Wave Finally Comes to a Close." The Weather Channel. August 13, 2017. Accessed November 08, 2017. https://weather.com/forecast/regional/news/pacific-northwest-heat-relief-washington-oregon-aug2017.

[31] Wakayama, Brady. "City of Eugene Offers Cooling Centers during Heat Wave." KEZI News. July 31, 2017. Accessed November 08, 2017. http://www.kezi.com/story/36017101/city-of-eugene-offers-cooling-centers-during-heat-wave.

2.4.4 Impacts

Dam or Levee Failure

Extreme weather may cause a dam or levee failure if electrical systems are effected and/or conditions are severe enough to cause overtopping or erosion. It is difficult to determine how many levees have failed due to this hazard because of the incomplete inventory and monitoring systems in place within the United States for such structures.

More information on dams and levees can be located in Annex D.

History of Impact in Eugene-Springfield

There have been no incidents for a dam or levee failures due to an extreme weather event in the Eugene-Springfield area. After reviewing 90 dam failures dating from 1802 until 2015 only one was found to of been caused by extreme weather.

In 1986 a lightning strike caused electrical failures at two Upriver power plants in Spokane, Washington. Due to this, the turbines were not working and water quickly rose behind the dam. Backup power systems failed, and spillway gates were not raised in time causing the dam to be overtopped. This event caused almost 11.5 million in damages to the facility, but no reported fatalities. The subsequent investigation determined several design and operational errors contributed to the failure.[32]

As the Upriver Dam event shows, a direct hit by an extreme weather event could cause a dam or levee to fail though this is extremely rare

Risk of Impact

Based on historical occurrences and the condition of dams and levees in and around the Eugene and Springfield area, the risk from an extreme weather induced failure is considered to be low.

Hazardous Materials

Hazardous material incidents can occur if any of these weather events made a direct hit on a hazardous material facility, or the components needed to run one. Due to the limited scale of these weather phenomenon, response to such a HazMat situation would experience little to no interference.

More information on HazMat spills and releases can be located in Annex E.

History of Impact in Eugene-Springfield

[32] Hokenson, Reynold A., W. Lowell Shelton, William M. Verigin, George W. Miller, and Mallur R. Nandagopal. "Upriver Dam Hydroelectric Project Rehabilitation After Failure, Part A: Failure Investigation and Lessons to be Learned." Civil Engineering Database. January 01, 1988. Accessed November 30, 2017. http://cedb.asce.org/CEDBsearch/record.jsp?dockey=0055754.

There have been no incidents of hazardous material spills or releases in the aftermath of an extreme weather event in Eugene or Springfield. Data collected throughout the United States shows tornadoes and thunderstorms do cause some HazMat incidents.[33] A 2015 review of natech events effecting the U.S. oil industry determined, though hail, heat, and tornadoes can cause oil spills, they do not account for a significant amount of incidents.

Lightning does account for a sizable portion of natech events in regards to the oil industry. In the United States, 8,121 barrels were released from pipelines, 6,134 barrels from aboveground storage units, and 7,786 barrels form pump/meter stations due to lightning damage. Lightning is the third most costly natural hazard to the oil infrastructure with over 120 million in damages. Lightning accounts for five of the twenty four most significant natech incidents, with respect to economic costs, from 1994 to 2012.[34]

Risk of Impact

Based on the amount of hazardous materials in and around the Eugene-Springfield area, and historical occurrence of extreme weather impacting HazMat facilities, the risk from this impact occurring is low.

Epidemics

Epidemics are not a known significant impact of an extreme weather event.

Civil Unrest

In the Eugene-Springfield area, due to the limited scale of hail, thunderstorms, or tornados a civil unrest event is unlikely. It is possible, a prolonged heat wave could produce many of the contributing factors often seen with civil unrest (Figure 1-3). Such an event has not been experienced by the area, however, and would have to be significant in size and scope. Though this is possible, the Eugene-Springfield area does not expect such a situation to occur within the next five to ten years.

History of Impact in Eugene-Springfield

There have been no incidents of civil unrest in the aftermath of an extreme weather event in Eugene or Springfield.

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[33] Sengul, Hatice, Nicholas Santella, Laura J. Steinberg, and Ana Maria Cruz. "Analysis of hazardous material releases due to natural hazards in the United States." *Disasters* 36, no. 4 (2012): 723-743.

[34] Girgin, Serkan, and Elisabeth Krausmann. "Lessons learned from oil pipeline natech accidents and recommendations for natech scenario development." *JRC Science and Policy Report, EUR* 26913 (2015).

Risk of Impact

Based on historical occurrences of civil unrest after natural disasters along with the area's societal composition, the risk of a civil unrest event developing after an extreme weather event is low. The risk of this impact occurring was deemed low mainly due to the possibility of such events developing during a severe and prolonged heat wave.

2.4.5 Probability of Future Occurrence

The probability of experiencing an extreme weather event is moderate for the Eugene-Springfield area. It is likely at least one of these extreme weather events will happen on a scale severe enough to cause property damage or threaten life within the next 35 to 75 years.

2.4.6 Vulnerability and Capacity Assessment

The loss of life as well as economic and property concerns are significant with extreme weather events. Unlike severe heat, a tornado, hail, or thunderstorm may geographically affect a small portion of the population. For this reason it is determined the Eugene-Springfield area's vulnerability to such events is low. Additionally, the area's capability to respond to, and recover from, an extreme weather incident is very high.

2.4.7 Risk Assessment

Based on the probability of future occurrence, vulnerability, and capacity to deal with extreme weather, the Eugene-Springfield area's risk to this hazard is categorized as low.

For a summary of Impact Risks see Table 2-8.

Extreme Weather - Impact Risks	
Hazardous Materials	Low
Civil Unrest	Low
Epidemic	No Known
Dam or Levee Failure	No Known

2.4.8 Existing Hazard Mitigation Activities

Extreme Weather is a new addition to this NHMP update, so hazard specific mitigation activities have yet to occur.

2.5 Flood

The probability of riverine flooding in Eugene and Springfield is moderate, and the probability is high for stormwater system flooding. The vulnerability in Eugene and Springfield for riverine flooding is moderate and for stormwater system flooding it is low. A moderate vulnerability indicates 1% to 10% of the population would be impacted, and a low vulnerability indicates that less than 1% of the population would be impacted (pg. 1-7).

2.3.1 Cause and Characteristics of the Hazard

The Eugene-Springfield area considers two primary flood hazard categories: riverine flooding and stormwater system (urban) flooding. Riverine flooding occurs when water overtops the banks of a naturally occurring waterway, while urban flooding is most often caused by inadequate stormwater drainage systems or maintenance.

The Eugene-Springfield area is subject to flooding from several sources, including:

- Riverine flooding from the Middle Fork of the Willamette River, the Willamette River, and the McKenzie River;
- Riverine flooding from numerous smaller creeks and sloughs;
- Local stormwater drainage flooding.

Flooding in Eugene and Springfield typically occurs in December and January. Events are usually associated with La Niña conditions, which result in prolonged rain and rapid snowmelt on saturated or frozen ground. This sudden influx of water causes rivers to swell, forcing tributary streams to back up and flood communities. Eugene-Springfield is largely protected from riverine flooding by multiple upstream flood control dams in both the McKenzie and Willamette River watersheds.

2.5.1 Climate Change

Though the full extent of climate change’s effect on flooding is unknown, existing research shows it will influence this hazard. Summer precipitation is projected to decline by as much as 30%. This will be accompanied by less frequent, but heavier downpours.[35] Already, the Northwest has experienced a 12% increase in very heavy precipitation events (the heaviest 1%) from 1958 to 2012.[36] Though there are many contributing factors for flooding, climate change is expected to increase flood risk in water basins with both rainfall and late spring snowmelt-related runoff peaks.[34]

Warmer winter temperatures will lead to more precipitation falling as rain instead of snow, which reduces the amount of water stored as snow and increases wintertime river flows. There is also a possibility of heavier precipitation events exacerbating the risk of flooding. The Oregon Climate Adaptation Framework lists 11 risks including "increased frequency of extreme precipitation events and incidence and magnitude of damaging floods."[37] The Army Corps of Engineers operates several dams upstream of Eugene-Springfield with the specific aim of mitigating flood risk. The Corps is preparing a study to better understand the future risk of flood and the ability of dams to mitigate any change in flood risk.[38]

2.5.2 History of the Hazard in Eugene-Springfield

Flooding has been recorded in Eugene and Springfield ever since the first European settlers arrived in the area in the mid-1800s. The FEMA Flood Insurance Study for Lane County (June 2, 1999) summarizes the history of major historical floods in the Eugene- Springfield area. Major floods occurred in 1861, 1890, 1945, 1956, 1964 and 1996. The 1964 flood was the largest flood event recorded in Lane County.

Notably, the construction of flood control dams in the 1940s-1960s has substantially reduced the potential for significant riverine flooding in Eugene and Springfield. These dams have reduced the expected base flood discharges of water flowing into the local rivers. Accordingly, expected flood elevations and overall flood potential for major events along the rivers have been substantially reduced.

In addition to the flood control dams, the U.S. Department of Agriculture Soil Conservation Service (now known as the Natural Resource Conservation Service) and Lane County constructed a flood control levee in 1960 to protect a large area of Springfield from McKenzie River flooding. Ownership and maintenance

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[35] USGCRP. U.S. Global Change Research Program. *Climate Change Impacts in the United States: The Third National Climate Assessment*. By Jerry M. Melillo, Terese Richmond, and G.W. Yohe. 2014. 487-513.

United States. Environmental Protection Agency. Office of Policy. *Adapting to Climate Change Northwest.* June 2016. Accessed November 13, 2017. https://www.epa.gov/sites/production/files/2016-07/documents/northwest_fact_sheet.pdf.

[37] The Oregon Climate Adaptation Framework. Oregon Department of Land Conservation and Development. December 2010. http://www.oregon.gov/energy/GBLWRM/docs/Framework_Final_DLCD.pdf

[38] A memo from the Army Corps of Engineers regarding the purpose and extent of the study can be found in Appendix F.

responsibilities for this levee transferred to the City of Springfield in 1983. This levee, known today as the 42nd Street Levee, successfully contained the January 1964 and February 1996 flood events.

The flood hazard areas shown on the current Flood Insurance Rate Maps (FIRM) for Eugene-Springfield assume the dams are operating properly. Dam failure hazards are not addressed by the FIS or the FIRM.

Despite the reduction in flood potential from the construction of dams, the Eugene-Springfield area continues to have flood risk from major rivers as well as from the numerous creeks and sloughs running through the area. Flood risk on these smaller streams has not been reduced by the dams on the larger rivers and their tributaries.

A historic statewide flood event with local impacts occurred in February 1996. Unusually heavy rains over the four-day period from February 5th to February 8th resulted in significant flooding on numerous rivers and streams throughout western Oregon. During the event, rising waters in the McKenzie River forced the evacuation of 1,200 to 1,500 people in low-lying areas of Springfield. In the Springfield/Thurston area along the McKenzie River, 35-40 homes, about 20 private roads and bridges, and roughly 20 vehicles were damaged.

Widespread flooding during the February 1996 event was also experienced in the Mohawk Valley from Marcola to Springfield with flooded homes on Sunderman Road and Goat Road. The Springfield Golf Course suffered substantial damage with about 6 inches of silt and debris deposited on the greens and fairways. There were widespread road closures in Lane County and Interstate 5 had water flowing across it just north of Eugene near the Boston Mill Road overpass.

In December of 2005, days of heavy rains led to flooding on the Mohawk River near Springfield. The flood stage of the Mohawk is 15 feet. On December 31st, the river was at 18 feet. This area flooded again in January 2006 (reaching 17.8 feet), in 2012 [reaching 17.8 feet on January 19th (Figure 2-4)], and in December 2015 (reaching 15.42 feet.)[39]

[39] US Department of Commerce, NOAA, National Weather Service. "Mohawk River (OR) Near Springfield Water Gauge - Historic Crests." NOAA. Accessed November 17, 2017. http://water.weather.gov/ahps2/crests.php?wfo=pqr&gage=spro3&crest_type=historic.

Picture 2-4 Source: Michael Ciaglo/Oregon Daily Emerald. *University of Oregon student watches water from the Mohawk River flow over a driveway in northern Springfield 2012.*

2.5.3 Impacts

Dam or Levee Failure

It is important to note the information located within this subsection only covers basic methods of flood-induced dam failure. There are many flood control measures employed by dams. What measures the nine dams upstream of the Eugene-Springfield area utilize is unknown, however. Generally, information on dams and dam operations is protected due to security concerns; known public information on local dams can be found in Appendix D.

The failure rates for dams is below 1%.[40] Of that 1%, overtopping due to flooding accounts for 34-35% of failures.[41] Embankment dams cannot normally withstand a significant overtopping event. For embankment dams, the most common failure mode is erosion during prolonged periods of rainfall and flooding.

When dams are full and water inflow rates exceed the capacity of the controlled release mechanisms (spillways and outlet pipes), overtopping may occur. When overtopping occurs, scour and erosion of the dam itself and/or the abutments may lead to partial or complete failure of the dam. Especially for embankment dams, internal erosion, piping, or seepage through the dam's foundation or abutments

[40] "Dams' safety is at the very origin of the foundation of ICOLD." ICOLD. Accessed November 15, 2017. http://www.icold-cigb.net/GB/dams/dams_safety.asp.
[41] United States. Environmental Protection Agency. Office of Policy. *Adapting to Climate Change Northwest.* June 2016. Accessed November 13, 2017. https://www.epa.gov/sites/production/files/2016-07/documents/northwest_fact_sheet.pdf.

can also lead to failure.

The dams in the Willamette River Basin were designed to open the spillways only infrequently during severe events. The spillways are being used more frequently now, causing wear on spillway parts. This has led to greater maintenance needs and risk of spillway failure. For smaller dams, erosion and weakening of dam structures by growth of vegetation and burrowing animals is a common cause of failure.

Levees are very similar to dams, but are only used for flood control. They run parallel to the body of water. Both dams and levees fail in similar ways. The majority of levees in the United States (85%) are owned by local governments or private entities.[42] There is no definitive record of how many levees there are nor requirements for maintaining or upgrading them.

History of Impact in Eugene-Springfield

There have been no reported flood-induced dam failures for the Eugene or Springfield area. Although the likelihood of failure is very low, all dams upstream from the Eugene-Springfield area have the potential of causing widespread flooding, should they fail. Nine dams in the area could significantly impact the area if any one of them was to fail (Annex D).

All of the major dams which could affect the area were built to flood standards and the probability of a failure is low according to the Army Corp of engineers. Additionally, the Hills Creek Dam is likely to withstand floods at least as large as a 1,000 year event without damage expected.

There are several non-certified levees in the Eugene-Springfield area. Though a failure of one of these structures would be limited in scope, compared to a dam failure, the likelihood of such an event occurring is unknown.

Risk of Impact

Though a flood-induced dam failure is slightly more likely to occur than an earthquake-induced one, the likelihood of such an event happening is still low.

Hazardous Materials

Though the size and scope of a HazMat release is largely dependent on the type of material involved, the release of the material may be caused by natural hazards such as floods and rain.[33] Whether it is biological waste released from backed up sewer systems, the release of household chemicals, or large scale releases from chemical plants, almost all floods release some hazardous materials. These events can occur when tanks are swamped or equipment needed to contain a chemical is compromised or destroyed by flood water.

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[42] United States of America. American Society of Civil Engineers. *So, You Live Behind a Levee!* 2010. 1-17.

In addition to potentially causing a release of hazardous materials, floods can spread the spill further than normal. Floods can also severely hamper response to such an event as well as any necessary evacuations.

History of Impact in Eugene-Springfield

There have been no reports of significant flood-induced hazardous material spills or releases in the Eugene-Springfield area. Some notable flood-induced HazMat events from around the world include:

- 1976 floods in Southern Idaho where at least 2000 pounds of granular Di-Syston® and 200 gallons of liquid Furadan® in addition to unknown quantities of DDT, PCBs, Guthion®, Dinitro®, 2,4-D, Thimet®, Syston®, and malathion were released from three commercial facilities and storehouses on farms[11];
- 1993 Midwest floods in the U.S. where 22 Superfund sites possibly containing toxins such as benzene, toluene, lead, and chromium, as well as household paints, solvents, and insecticides, were released in varying quantities[11];
- 1993 and 1995 floods on the River Meuse which runs through the Netherlands, France, and Belgium where cadmium, zinc, lead, copper, pesticides and PAHs were released[11]; and
- 2017 floods caused by Hurricane Harvey; though exact chemicals and release totals are unknown, at this point, the refrigeration system of one plant was disabled resulting in an evacuation before one of the peroxide tanks spontaneously combusted.[43]

There are many flood-induced hazardous material spills, most of which are considered small in scale. Water treatment facilities often back up and accidentally release material. The risk of flooding to facilities housing hazardous materials is well known, and thus generally well mitigated against.

Risk of Impact

Considering the relatively frequency hazardous materials are released or spilt due to floods, along with the amount of floods and hazardous material facilities in the area, the risk of a HazMat release occurring in the Eugene-Springfield area, due to a flood, is considered to be moderate.

Epidemics

The risk of a flood-induced epidemic is low unless there is significant population

[43] "Arkema Inc. Chemical Plant Fire." U.S. Chemical Safety Board. Accessed November 17, 2017. http://www.csb.gov/arkema-inc-chemical-plant-fire-/.

displacement and/or water source contamination.[44] A study in the American Journal of Clinical Medicine determined the possibility of contracting a person-to-person, waterborne, or foodborne communicable disease during a flood is a moderate risk.[12] The World Health Organization (WHO) does note an increase in water- and vector- borne diseases seen with floods. Flood waters also increase the risk of infection.[40]

The only epidemic-prone infection is leptospirosis which is transmitted from items contaminated with rodent urine. Vector-borne diseases often seen after flooding are malaria and West Nile virus. Waterborne diseases include leptospirosis, hepatitis A, and cholera.

History of Impact in Eugene-Springfield

There have been no cases of flood-induced epidemics in the Eugene-Springfield area. Nationally, there have been several increases in communicable diseases after a water-related disaster, but the vast majority of these were small in size. The major factor in flood-induced epidemics is the contamination of drinking water. The risk of outbreaks can be minimized, however, if the risk is recognized and alternative water treatment measures utilized, both of which occurred in the Iowa and Missouri floods of 1993.[40]

Risk of Impact

Since the odds of an epidemic increase after a flood, and some actions, possibly significant ones, need to be taken to prevent an epidemic from occurring, the risk from this impact is categorized as moderate.

Civil Unrest

In the Eugene-Springfield area, a civil unrest event induced by a flood would be unlikely. Many of the motives, incentives, and opportunities highlighted in Figure 1-3 would not be present in the area during a flood. Nevertheless, though currently unlikely, a flood-induced civil unrest event could occur under the right conditions.

History of Impact in Eugene-Springfield

There have been no incidents of civil unrest in the aftermath of a flood in Eugene or Springfield.

Risk of Impact

This impact is categorized as having a low risk to the area.

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[44] "Flooding and communicable diseases fact sheet." WHO. Accessed November 17, 2017. http://www.who.int/hac/techguidance/ems/flood_cds/en/.

2.5.4 Probability of Future Occurrence

The probability of riverine flooding in Eugene-Springfield is moderate and the probability of stormwater flooding is high. A moderate probability indicates that one riverine flooding event is likely in the next 35 to 75 years. A high probability indicates that one stormwater flooding event is likely within the next 10 to 35 years.

For a summary of Impact Risks see Table 2-9.

Flood- Impact Risks	
Hazardous Materials	Medium
Civil Unrest	Low
Epidemic	Medium
Dam or Levee Failure	Low

Table 2-8

2.5.5 Vulnerability Assessment and Capacity

The level of flood hazard (frequency and severity of flooding) is not determined simply by whether the footprint of a given structure is or is not within the base floodplain (also referred to as the 100-year floodplain). A common error is to assume structures within the base floodplain are at risk of flooding while structures outside of the base floodplain are not. Some important guidance for interpreting flood hazard is given below.

- Being in the 100-year (or base) floodplain does not mean that floods happen once every 100 years. Rather, it means that the probability of a flood to that 100-year base flood level or higher has a 1% chance of happening each year.
- Much flooding happens outside of the mapped base floodplain. First, the 100-year flood is by no means the worst possible flood. For flooding along the Willamette River, the 500- year flood is 4 feet higher than the 100-year base flood. Second, many floodprone areas flood because of local stormwater drainage conditions. Such floodprone areas may have nothing to do with the base floodplain boundaries.
- The key determinant of a structure's flood hazard is the relationship of the structure's elevation to the flood elevations for various flood events. Thus, homes with first floor elevations below or near the 10-year flood elevation have

drastically higher levels of flood hazard than other structures with first floor elevations near the 50-year or 100-year flood elevation.

- Areas protected by FEMA-accredited flood control levees, such as Springfield's 42nd Street Levee, were originally mapped as being protected from the 100-year flood event. However, in response to numerous levee failures during Hurricane Katrina, levees now must also be certified as being structurally adequate to retain their accreditation as flood control structures. In the event that Springfield is unable to obtain certification for the 42nd Street Levee, the next update of the flood control maps for this reach of the McKenzie River will be prepared as if the levee was not in place. This would greatly increase the area of the city within the mapped 100-year floodplain.
- In Oregon, Oregon Administrative Rule 660-008 requires that local governments, when planning for needed housing, ensure that such needed housing may be located on buildable land that is "…suitable, available and necessary for residential uses." Land "within the 100-year flood plain" is not considered "suitable and available" under the buildable land definition. Due to State planning requirements, City floodplain development requirements, and the small number of dwelling units located in Special Flood Hazard Areas, the vulnerability of residential development to the flood hazard is low.

As noted above, Eugene and Springfield are in the process of identifying resources to update flood hazard information through new mapping. Once complete, a thorough quantification of vulnerable structures can be completed, provided the resources are available.

The 2014 Eugene-Springfield Regional Climate and Hazards Vulnerability Assessment found, while flood events have the potential to cause severe loss and damage in localized areas, flooding is not likely to result in significant damage to critical systems or systemic failures across multiple sectors. The reason vulnerability to this hazard is rated as moderate for riverine flooding relates to the primary impacts and potential inconvenience for many members of the population (transportation impacts, drain on emergency response resources, etc.). The area's capability to respond to this hazard is high due to resources and the prolonged onset period of flood hazards.

Refer to Chapter 4 for specific vulnerabilities related to flooding.

2.5.6 Risk Assessment

FEMA Flood Insurance Rate Maps (FIRMs) are the most comprehensive resource for identifying hazards in the Eugene-Springfield area. The Eugene-Springfield area's most recent FIRMs became effective on June 2, 1999. It is common knowledge that the Eugene-Springfield metro area flood maps are based on outdated information. The availability of LiDAR data and other technologies offers superior ability to project and map riverine flooding in the area. Eugene and Springfield are actively working with FEMA and the state of Oregon to identify resources needed to update the Eugene-Springfield regulatory floodplain maps.

Notably, some areas within Springfield have recently been re-mapped. These include the Willamette River through the southern portion of Glenwood, as well as the confluence of the Middle Fork and Coast Fork of the Willamette River, and the area surrounding RiverBend Hospital.

Floodprone areas of the Eugene-Springfield area include the FEMA-mapped floodplains for major rivers including the Mohawk, McKenzie, and Willamette (including the Middle Fork and the Coast Fork). FEMA-mapped floodplains also include areas along Amazon Creek, Mill Race and several smaller creeks (mostly in the western portion of Eugene).

Historical experience and hydrologic/hydraulic modeling suggests that the most problematic areas for local stormwater drainage flooding in Eugene are the Amazon Creek, Willow Creek, and Laurel Hill basins in the South Hills. Drainage problems in these areas are exacerbated by relatively thin, impermeable soils.

Maps showing the location of the floodway and the special flood hazard area (SFHA) are included in Chapter 3.

2.5.7 Existing Hazard Mitigation Activities

Historically, the focus of local stormwater maintenance practices has been limited to drainage and flood control. More recently, the focus has widened to include management of riparian vegetation by allowing it to remain in streams and channels for the beneficial effects of slowing runoff for filtration and sedimentation.

Eugene and Springfield have actively pursued several flood hazard mitigation activities in an effort to reduce vulnerability to damage and disruption from flooding events. Efforts include:

- Both cities participate in the National Flood Insurance Program, which enables property and business owners to qualify for federally underwritten flood insurance.
- Eugene is a participant in the Community Rating System (CRS) program and has a rating of 7.

- Both Eugene and Springfield have Stormwater Management Plans. The first goal of these plans is to protect citizens and property from urban flooding through planning for and building adequate stormwater systems.Springfield owns, operates and maintains the 42nd Street Levee to protect a large area of the city from McKenzie River flooding.

2.5.8 National Flood Insurance Program Participation

Eugene and Springfield both participate in the National Flood Insurance Program (NFIP). Eugene's initial Flood Hazard Base Map is dated June 7, 1974 and its initial Flood Insurance Rate Map (FIRM) became effective September 29, 1986. As mentioned above, the current effective FIRM date is June 2, 1999.

As of November 6, 2014, the City of Eugene has 1,003 NFIP policies in force at a total value of $282,375,600. There have been 17 claims total, 10 of which are closed and 7 of which closed without payment. Total loss payments amount to $116,465.04. Eugene's last Community Assistance Visit (CAV) occurred November 17, 2011. No visits or Community Assistance Contacts (CACs) have occurred since 1991. There have been 632 Letters of Map Change in Eugene.

Eugene also participates in the FEMA Community Rating System (CRS) program. The City has a CRS classification of 7 which translates to a 15% reduction to all NFIP policy premiums in Eugene.

Springfield's initial Flood Hazard Base Map is dated June 18, 1971 and its initial FIRM is dated September 27, 1985. Like Eugene, Springfield's current effective FIRM is dated June 2, 1999. As of November 6, 2014, Springfield has 142 NFIP policies valued at $41,431,500. There have been 27 claims, 22 of which are closed and 5 of which closed without payment. There have also been 8 BCX claims for property damage outside the mapped special flood hazard area. Total loss payments amount to $402,491.98. Springfield's last CAV occurred on July 6, 2006. There have been no CACs since that time. There have been 76 Letters of Map Change in Springfield.

2.5.9 Repetitive Flood Loss Properties

There are no properties on FEMA's repetitive loss or severe repetitive loss lists within Eugene or Springfield's jurisdictional boundaries. The prior edition of this Natural Hazards Mitigation Plan (and the current FEMA database) identified four repetitive loss properties with Springfield addresses. Subsequent research has determined all of the identified repetitive loss properties are located outside the Springfield City limit and urban growth boundary. The City of Springfield is working with the state floodplain coordinator to notify FEMA and have the error corrected in the FEMA database, as described in the Flood Mitigation Action section under Repetitive Loss Records.

2.6 Geomagnetic Disturbance (GMD)

The probability and vulnerability of a GMD affecting the Eugene-Springfield area is high for the worse case predictions. A geomagnetic disturbance is a naturally occurring energy pulse similar to an electromagnetic pulse (EMP). These events are most commonly caused by solar flares, but can also come from other natural sources such as lightning. Due to the large scale of GMDs caused by solar flares, this plan will focus primarily on this source for mitigation purposes.

2.6.1 Causes and Characteristics of the Hazard

As mentioned previously, there are several natural causes for geomagnetic disturbances, but solar flares are the largest and potentially most destructive. They occur when there is an explosion which emits the “solar flare” from the magnetic canopy of a sunspot on the Sun. The side-effects of a solar flare are the elements of a GMD which is very similar to a manmade EMP.

When the sun emits a solar flare, X-rays and UV radiation travel to earth at the speed of light ionizing the upper layer of the atmosphere. A severe GMD starts with radio blackouts and GPS navigation errors when the x-ray and UV radiation arrives first. Minutes to hours later, when the energetic particles (protons, electrons, and high atomic number and energy ions) arrive satellites can be electrified and their electronics damaged. This can be followed a day or more later by the arrival of coronal mass ejections (CMEs,) which are clouds of magnetized plasma. It is believed a direct hit by an extreme CME may cause widespread power blackouts which could disable everything plugged into a wall socket.[45] Anything running on electricity or utilizing electronics could be damaged or ruined unless properly shielded.

2.6.2 Climate Change

At this point, it is unknown how climate change may affect a major GMD event.

2.6.3 History of the Hazard in Eugene-Springfield

There are no known instances of a significant GMD effecting the Eugene-Springfield area. Solar flares hit the earth often, also seen as the phenomenon known as the “Northern Lights”. Most of the time, however, they do little to no damage. Most people have experience GMDs in the form of radio and satellite

[45] Phillips, Tony. "Near Miss: The Solar Superstorm of July 2012." NASA. July 23, 2014. Accessed November 17, 2017. https://science.nasa.gov/science-news/science-at-nasa/2014/23jul_superstorm.

disruptions. What is not as common is the more destructive portion of a solar flare, the CMEs, directly striking earth.

Geomagnetic disturbances fluctuate with the Sun's 11 year Solar Cycle. More solar flares are observed during the Solar Maximum when sunspots and solar activity is at its highest. Scientists number these cycles in sequential order as they occur. Solar Cycle 24 started around December 2008, and the solar maximum was seen around November 2014. Solar Cycle 25 is predicted to start around 2019 or 2020.

One of the strongest GMD events to hit earth occurred in 1859, and is dubbed the Carrington Event. This is believed to be near the peak of Solar Cycle 10. At the time, the Northern Lights could be seen as far as Cuba, and global telegraph lines sparked causing many fires and service disruptions. The National Academy of Sciences predicts a similar event occurring now would exceed $2 trillion in damages and recovery would take years. In February 2012 earth had a near miss as the strongest CME seen since the Carrington Event missed earth by merely a week.

The strongest modern era GMD to hit earth occurred on March 13, 1989 during Solar Cycle 22's maximum. It immediately caused short-wave radio interference. The Northern Lights were reported as far as Southern Florida and Cuba. Several satellites lost control, and the Shuttle Discovery experienced mysterious electrical problems. The large GMD caused a blackout across all of Quebec, Canada. There were hundreds of power grid problems in the U.S. though no blackouts due to low demands on the grid in the early morning hours.[46] This event registered a disturbance storm time (Dst) of 600 nT (nanoTesla). The 1859 Carrington Event is believed to of been between 800 and 1750 nT. The Northern Lights around the Arctic Circle register 50 nT.[43]

2.6.4 Impacts

Dam or Levee Failure

Scientists are still studying GMDs and their effects on modern technology. It is known these events, especially large ones due to solar flares, have the potential of causing devastating damage to electronics not properly protected. With this in mind, more research is needed. It is plausible a GMD could cause damage to a dam utilizing electronics in its operations. The extent of this damage, and if it could lead to failure is unknown, however.

More information on dams or levees can be located in Annex D

History of Impact in Eugene-Springfield

There is no known history of dam or levee failure due to a geomagnetic

[46] Odenwald, Sten. "The Day the Sun Brought Darkness." NASA. May 13, 2015. Accessed November 30, 2017. http://www.nasa.gov/topics/earth/features/sun_darkness.html.

disturbance.

Risk of Impact

Base on the predicted probability and potential damage from a large GMD, Eugene-Springfield's risk from this impact has been determined to be moderate.

Hazardous Materials

Much like a dam or levee failure as an impact of a GMD, hazardous material spills due to one are also very plausible. Many of these facilities are highly dependent on technology to keep the dangerous materials contained. Often, the backup power source for these facilities are generators which could also be effected by a GMD, if not properly shielded.

More information on HazMat spills and releases can be located in Annex E.

History of Impact in Eugene-Springfield

There is no known history of a hazardous material incident due to a geomagnetic disturbance.

Risk of Impact

The risk of a GMD induced HazMat impact has been determined to be low due to the potential damage, condition of local dams, and probability of a large GMD occurring.

Epidemics

Epidemics could also be an impact of a GMD based on its size, severity, and the recovery time for damages. The probability of this, however, is extremely hard to predict due to the vast number of variables involved. If Earth was to receive a direct hit from a large GMD in which medical and pharmaceutical manufacturing facilities are non-operational for an extended period of time, the rise of epidemics should be expected. If this were to happen containment and palliative care of sick individuals may be the only option until health care services are fully restored. Water and waste water services could also be affected increasing the likelihood of an epidemic.

History of Impact in Eugene-Springfield

There is no known history of epidemics due to a geomagnetic disturbance.

Risk of Impact

Due to the possibility of a large GMD occurring that could incapacitate electronic devices, which the medical community relies on, for some time the risk from this impact has been determined to be moderate.

Civil Unrest

A large scale and destructive GMD could easily generate all of the contributing factors identified for violent conflict or civil unrest to occur (Figure 1-3). With reliable news limited or absent, tensions and anger can rise. Little information is known on how a GMD could trigger this impact, due to the fact such an event has not been witnessed since the advent of modern technology, but it's not hard to see how civil unrest could quickly spring from such a situation.

History of Impact in Eugene-Springfield

There is no known history of a civil unrest events due to a geomagnetic disturbance.

Risk of Impact

A large GMD has the potential of causing widespread confusion and panic, especially if it effects the entire country. Due to the large scale of such an event, and the fact one has not occurred since the advent of modern technology, the risk of a civil unrest incident occurring, due to one, has been determined to be high.

2.6.5 Probability of Future Occurrence

Current research suggests, the probability of a significant GMD effecting the Eugene-Springfield area is high. The odds of a Carrington size GMD hitting Earth in the next ten years is currently 12%.[41]

2.6.6 Vulnerability and Capacity Assessment

Due to the potential size and severity of a GMD, the damages from such an event could be wide ranging and severe. Eugene and Springfield's vulnerability to a GMD event is high while capacity to deal with such an event is moderate.

For more information on vulnerability and capacity please see EWEB's Annex A and SUB's Annex B.

2.6.7 Risk Assessment

Based on the probability of future occurrence, vulnerability, and capacity to deal with a geomagnetic disturbance, the Eugene-Springfield area's risk to this hazard is categorized as high.

For a summary of Impact Risks see Table 2-10.

Geomagnetic Disturbance- Impact Risks	
Hazardous Materials	Medium
Civil Unrest	High
Epidemic	Medium
Dam or Levee Failure	Low

Table 2-9

2.6.8 Existing Hazard Mitigation Activates

Geomagnetic disturbances are a new addition to the 2020 NHMP update. Hazard specific mitigation activities have yet to occur.

2.7 Landslide

The probability of a landslide is high in Eugene and moderate in Springfield. Springfield's probability rating is lower due to the fact that Springfield has fewer dramatic changes in elevation. Vulnerability to landslide is low in both cities.

2.7.1 Causes and Characteristics of the Hazard

The term "landslide" refers to a variety of slope instabilities that result in the downward and outward movement of slope-forming materials including rocks, soils, and artificial fill. The Eugene-Springfield area is susceptible to four types of landslides:

- Rockfalls are abrupt movements of masses of geologic materials (rocks and soils) that become detached from steep slopes or cliffs. Movement occurs by free-fall, bouncing, and rolling. Falls are strongly influenced by gravity, weathering, undercutting, and/or erosion.
- Rotational slides are those in which the rupture surface is curved concavely upwards and the slide movement is rotational about an axis parallel to the slope. Rotational slides usually have a steep scarp at the upslope end and a bulging "toe" made of the slid material at the bottom of the slide. Roads constructed by cut and fill along the side of a slope are prone to slumping on the fill side of the road. Rotational slides may creep slowly or move large distances suddenly.
- Translational slides are those in which the moving material

slides along a more or less flat surface. Translational slides occur on surfaces of weaknesses, such as faults and bedding planes or at the contact between firm rock and overlying loose soils. Translational slides may creep slowly or move large distances rather suddenly.

- Flows are plastic or liquid in nature and the slide material breaks up and flows during movement. This type of landslide occurs when a landslide moves downslope as a semi-fluid mass, scouring or partially scouring rock and soils from the slope along its path. A flow landslide is typically rapid-moving and tends to increase in volume as it moves downslope and scours out its channel.

Though immediate damage is limited to where the slide occurs, landslides can have far reaching repercussions if infrastructure or water ways are involved. Landslides in Eugene-Springfield tend to be small slides or slumps near waterways or slides related to development activity. The potential for larger slides does exist in the south hills of Eugene and Springfield.

Rockfall events are primarily limited to quarry sites where rock has been exposed (e.g. the west face of Skinner's Butte).

The primary factors that could affect or increase the likelihood of landslides in Eugene-Springfield are (Figures 2-7 and 2-8):

- Natural conditions and processes including the geology of the site, rainfall, water action, seismic activity, and volcanic activity.
- Excavation and grading on sloping ground for homes, roads, and other structures.
- Natural or human-caused drainage and groundwater alterations can trigger landslides. Human activities such as broken or leaking water or sewer lines, water retention facilities, irrigation, stream alterations, ineffective stormwater management, and excess runoff due to increased impervious surfaces may cause slides.
- Change or removal of vegetation on very steep slopes due to timber harvesting, land clearing, and wildfire.
- The water content of soils/rock is a major factor in determining the likelihood of sliding for any given slide-prone location. Thus, most landslides happen during rainy months, when soils are saturated with water. Winter storms with intense rainfalls are the most common trigger for landslides in the Eugene-Springfield area.

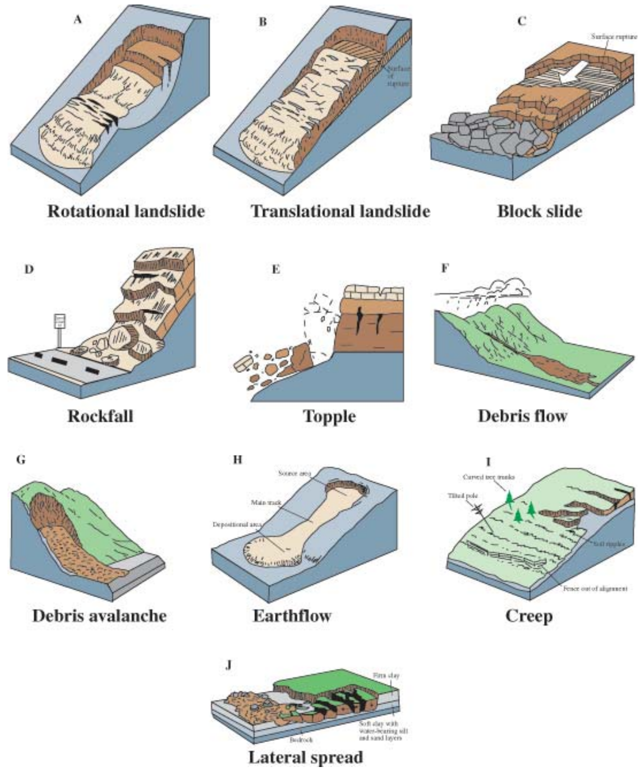

Figure 2-7. Source: USGS – *Types of Landslides. 2004.*
https://pubs.usgs.gov/fs/2004/3072/fs-2004-3072.html

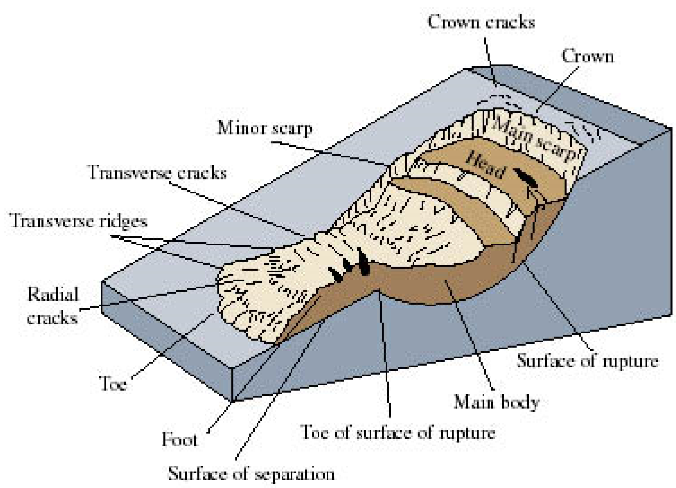

Figure 2-8. *Source USGS* – Common Landslide Anatomy. 2004.
https://pubs.usgs.gov/fs/2004/3072/fs-2004-3072.html

2.7.2 Climate Change

Though the full extent of climate change's effect on landslides is unknown, existing research suggests it will influence this hazard. Precipitation is expected to decline with less frequent, but heavier downpours.[36] This, along with shifting peak snowmelt periods, will change how and when soil levels have reached saturation each year. With soil saturation being a significant factor for landslides, we should expect to see changes in this hazard, if climate predictions are correct.

2.7.3 History of the Hazard in Eugene-Springfield

The Eugene-Springfield area has experienced small landslides throughout its history. Given the regional topography, the majority of these incidents have occurred in the south hills of the two Cities. For a list of landslides occurring in recent decades, refer to Table 2-11.

Table 2-11. Historic landslide events in or near Eugene-Springfield

Date	Event
February 1996	Heavy rains and rapidly melting snow contributed to hundreds of landslides and debris flows across the state.
January 2008	The 64-acre Frazier landslide occurred near the City of Oakridge, approximately 50 miles from Eugene. The landslide disrupted freight and Amtrak service south of Eugene-Springfield until May 2008.
February 2008	On South 67th and Ivy, alongside Potato Hill in Springfield, a landslide threatened homes during construction of the Mountain Gate subdivision. Four homes were evacuated for fear of landslide from a recently constructed roadway embankment. Residents were advised to evacuate until the hazard was removed. The roadway embankment was reconstructed in March 2008.

Table 2-10

The following list summarizes landslide events in Eugene over the past 10-years:

- **Moon Mountain** – This was a development-related slide that threatened a private residence and impacted the City of Eugene right-of-way and stormwater system. The slide mitigation strategy entailed removing 8-10’ of fill off of the slide area, installing a 20’ deep French-drain and diverting surface water away from the slide.
- **Videra Park** – This was a development- related slide that threatened private residence and City of Eugene wastewater and stormwater lines. The slide mitigation strategy entailed removing 6-8’ of fill material by placing it back into the excavation for the dwelling and stabilizing the surface with seed and mulch.
- **The Highlands** – Woodcutter Way – A leaking water main

triggered slope movement. The slide mitigation strategy entailed installation of drains, placing a large rip-rap at the slide's toe and stabilizing the surface.

- **Local creek bank failures** – (primarily along the Amazon Creek) – Within the past 5 years, Eugene Parks and Open Space staff have observed between 5 and 7 slides and slumps along major waterways. Slide mitigation strategies have entailed completion of roughly 80,000 linear feet of willow planting along channel banks, in addition to repairs to the slides and slumps. In 2013-2014, Eugene Public Works completed a stabilization and enhancement project along 1,800 linear feet of the Amazon Creek that widened the channel and created a flood bench, slowing the velocity of the water during high water events.

2.7.4 Impacts

Dam or Levee Failure

As discussed in section 2.3.4, landslides do have the potential to cause dam failure due to overtopping. This is more likely to occur when a dam is at full capacity. The Army Corp of Engineers takes this into account, however, so failure due to this impact is very low.

More information on dams and levees can be located in Annex D.

History of Impact in Eugene-Springfield

There have been no landslide induced dam or levee failures in the Eugene or Springfield area. Additionally, such events are extremely rare. Out of the 90 dam failures between 1802 and 2015 reviewed, only one was due to a landslide. The Vajont Dam was overtopped by a wave produced by a massive landslide in 1963. This event destroyed five villages, killing 2,000 people. Once again, poor construction and operation was thought to of worsened the impact to the dam.[47]

Risk of Impact

Based on historical occurrences, the condition of local dams and levees, and the probability of a large landslide into a large body of water contained by such structures, the risk from this impact has been determined to be low.

Hazardous Materials

[47] Bressan, David. "Expecting A Disaster: The 1963 Landslide of the Vajont Dam." Forbes. October 10, 2017. Accessed November 30, 2017. https://www.forbes.com/sites/davidbressan/2017/10/09/expecting-a-disaster-the-1963-landslide-of-the-vajont-dam/#34fc306f11f8.

A hazardous material spill or release can occur any time there is a landslide in a developed area. Commonly, spills are seen when household chemicals, gas tanks, and wastewater components are involved. Larger spills can occur when a landslide damages hazardous material infrastructure such as holding tanks or power supplies.

More information on HazMat spills and releases can be located in Annex E.

History of Impact in Eugene-Springfield

There have been no known significant landslide induced hazardous materials spills or releases in the Eugene-Springfield area. For reported U.S. oil industry spills, pipelines were the only system part effected by this hazard with 10,177 barrels spilt. Only one of the top twenty four most significant natech events for the oil industry, with respect to economic costs, was due to a landslide.[35]

Risk of Impact

Due to historical occurrences and the number and location of hazardous materials within the area, the risk of this impact occurring has been deemed to be low.

Epidemics

Though the odds of landslide induced epidemics is unknown, a landslide could cause this impact. Search and rescuers may come into contact with contaminated biological waist. Additionally, a slide may contaminate water supplies, though this should be detected relatively quickly thus limiting transmission.

History of Impact in Eugene-Springfield

There have been no landslide induced epidemics in the Eugene-Springfield area.

Risk of Impact

Though no noted historical occurrences of a large scale landslide induced epidemic has been documented, there is a possibility such an event could cause one. Unless water sources are contaminated, such an outbreak would be limited to responders and, potentially, those they come into contact with. Due to this, some mitigation would be necessary to prevent the spread of viral or bacterial contaminants. The risk of this impact occurring is low.

Civil Unrest

Civil unrest is not a known significant impact of a landslide.

2.7.5 Probability of Future Occurrences

The probability of a landslide occurring in the Eugene-Springfield area depends upon a number of factors, including steepness of slope, slope composition (i.e.

soil type), local geology, vegetative cover, human activity, and water. There is a strong correlation between intensive winter rainstorms and the occurrence of rapidly moving landslides. Most landslides occur during rainy months of the year. The Steering Committee rated the probability of a landslide occurrence as high in Eugene and moderate in Springfield. Springfield's probability rating is lower due to the fact that Springfield has fewer dramatic changes in elevation. A high rating means that one incident is likely in a 10 to 35 year period; a moderate rating means that one incident is likely in a 35 to 75 year period.

2.7.6 Vulnerability and Capacity Assessment

Landslides can occur during any season in the Eugene-Springfield area. Given local development patterns, residential and public land use is most likely to be impacted by landslides. In Oregon, residential development is explicitly prohibited or restricted in areas with steep slopes. Specifically, Chapter 197 of the Oregon Revised Statute in the Oregon Administrative Rules provides for needed housing that is "…suitable, available and necessary for residential uses." Lands that "(c) [have] slopes of 25 percent or greater" are not considered "suitable and available" under the buildable land definition. As such, residential vulnerability to landslides is low.

The Eugene-Springfield steering committee rated the Cities' vulnerability to landslides as low, meaning 1% of the population and/or regional assets would be affected by a landslide event. Additionally, due to available resources and the limited scale of a landslide, the area's capacity to deal with such an event is high.

2.7.7 Risk Assessment

Specific areas with historical debris flows and/or landslides problems in the Eugene-Springfield area are summarized below in Table 2-12. A more detailed landslide hazard assessment requires a site- specific analysis of the slope, soil, rock, vegetation, and groundwater characteristics. Such assessments are often conducted prior to major development projects in areas with moderate to high landslide potential to evaluate the specific hazard at the development site.

Based on the probability, vulnerability, and capacity to deal with a landslide Eugene's risk to this hazard is categorized as moderate while Springfield's risk is low.

For a summary of Impact Risks see Table 2-13.

Table 2-12. Debris flow and landslide problem areas in Eugene-Springfield
Eugene
Capital-Essex Lane
Dillard Road
Brookside Drive
Cresta de Ruta
Goodpasture Island Road
Springfield
Thurston Hills area
Willamette Heights area
Kelly Butte area

Table 2-11

Landslide- Impact Risks	
Hazardous Materials	Low
Civil Unrest	No Known
Epidemic	Low
Dam or Levee Failure	Low

Table 2-12

2.7.8 Existing Hazard Mitigation Activities

In Eugene and Springfield, mitigation of the landslide hazard is accomplished through land use and development regulations. Both require geotechnical analysis of steep slopes prior to development in order to determine whether or not a development is appropriate for the area. In 2017 the City of Eugene employed the DOGAMI to re-map possible and historical landslide points. The project discovered multiple, previously unknown, historical landslide sites. This information was then used to influence development within the urban growth boundaries.

2.8 Volcano

The probability of volcanic activity impacting Eugene-Springfield is low. Vulnerability to volcanic activity is moderate for Eugene and high for Springfield.

2.8.1 Causes and Characteristics of the Hazard

The Cascades, which run from British Columbia through Washington, Oregon, and into northern California, contain more than a dozen major volcanoes and hundreds of smaller volcanic features. In the past 200 years, seven of the Cascade volcanoes have erupted, including Mt. Baker, Glacier Peak, Mt. Rainier, Mount St. Helens, Mt. Hood, Mt. Shasta, and Mt. Lassen.

Over the past 4,000 years, Oregon has experienced three eruptions of Mt. Hood, four eruptions in the Three Sisters area, and two eruptions in the Newberry Volcano area. Minor eruptions have taken place near Mt. Jefferson, at Blue Lake Crater in the Sand Mountain Field (Santiam Pass) near Mt. Washington, and near Belknap Crater. During this time period, the most active volcano in the Cascades has been Mount St. Helens over 14 eruptions.

Volcanic eruptions often involve several distinct types of hazards to people and property, as evidenced by the Mount St. Helens eruption in 1980. Major volcanic hazards include lava flows, blast effects, pyroclastic flows, ash flows, lahars, landslides, and debris flows. Some of these hazards (e.g. lava flows) only affect areas very near to the volcano. Other hazards may affect areas 10 to 20 miles away. Ash falls may affect areas many miles downwind of the eruption site. The primary volcanic hazards of concern for Eugene-Springfield are:

- **Ash falls** result when explosive eruptions blast rock fragments into the air. Such blasts may include tephra (solid and molten rock fragments). The largest rock fragments (sometimes called "bombs") generally fall within two miles of the eruption vent. Smaller ash fragments (less than about 0.1") typically rise into the area forming a huge eruption column. In very large eruptions, ash falls may total many feet in depth near the vent and extend for hundreds or even thousands of miles downwind.
- **Lahars** are common during eruptions of volcanoes with heavy loading of ice and snow. These flows of mud, rock, and water can rush down channels at 20 to 40 miles an hour and can extend for more than 50 miles. For some volcanoes, lahars are a major hazard because highly populated areas are built on lahar flows from previous eruptions.

2.8.2 Climate Change

Climate change may affect a volcanic eruption in many ways. The most plausible, and perhaps most significant, is the severity of a lahar. Warming temperatures are causing a steady decline in mountain snowpack.[2, 3] This directly correlates to the amount of snow and ice available to form a lahar during an eruption. Significant long-term climate change implications for volcanic eruptions will, more than likely, not be known for some time.

2.8.3 History of the Hazard

The history of volcanic activity in the Cascades is contained in its geologic record and the age of the volcanoes vary considerably. Figure 2-10 shows the history of volcanic events in the Cascades. Scientists utilize a range of techniques to identify areas subject to volcanic hazards. For more information on volcano hazard identification in Oregon, refer to the Oregon Natural Hazards Mitigation Plan.

Several of the 20 active volcanoes in Oregon are located along the crest of the Cascades near the eastern boundary of Lane County. These volcanoes include the Three Sisters and Mount Jefferson. The active volcanoes that pose the most threat to the Eugene-Springfield area are the Three Sisters, which are approximately 50 miles away. Lava flow, pyroclastic flows, debris flows, and avalanches from an eruption in the Sisters will be limited to the immediate area of the eruption, and will not impact Eugene and Springfield. However, hazard zone maps for the Three Sisters show that landslides, debris flows, and lahars from an eruption could enter the McKenzie River and its tributaries. This would cause flooding on the McKenzie that could extend to the Thurston area on the east side of the Eugene-Springfield metro area (Figure 2-9).

Lahars can occur both during an eruption and when a volcano is quiet. The water that creates lahars can come from melting snow and ice (especially water from a glacier melted by a pyroclastic flow or surge), intense rainfall, or the breakout of a summit crater lake. Some lahars contain so much rock debris (60 to 90% by weight) that they look like fast-moving rivers of wet concrete. Historically, lahars are one of the deadliest volcano hazards. Close to their source, these flows are powerful enough to rip up and carry trees, houses, and huge boulders miles downstream. Farther downstream, they can entomb everything in their path in mud. In Eugene- Springfield, lahar impacts are expected to be very similar to the FEMA- mapped floodplains of the McKenzie River.

Lahars running through the McKenzie River could also lead to high turbidity in the water. This could cause degradation of water quality and operational problems at water treatment plants. While this could impact the City of Eugene, which currently relies on the McKenzie River as its sole source of drinking water, EWEB has developed procedures to manage high- turbidity events and is actively seeking alternate sources of drinking water, as outlined in the multi-hazard mitigation action “Water Source.” Minimal impact is expected in the upper Willamette tributaries, presenting low risk to the SUB’s treatment plant on the middle fork of the Willamette.

Ash fall could extend to the Eugene-Springfield area from an eruption in the Sisters, as well as from other eruptions including Mount St. Helens. In all but the most extreme events, ash falls in the Eugene-Springfield Metro Area are likely to be very minor, with an inch or less of ash likely. There is also the possibility a major eruption in the Cascades could affect public water supplies via heavy ash falling into streams and rivers upstream from public water supply intakes.

In Oregon, awareness of the potential for volcanic eruptions was greatly increased by the 1980 eruption of Mount St. Helens in Washington, which killed 57 people. The sonic boom from the eruption was heard in Eugene-Springfield. In this eruption, lateral blast effects covered 230 square miles and reached 17 miles northwest of the crater. Pyroclastic flows covered six square miles and reached 5 miles north of the crater. Landslides covered 23 square miles. Ash accumulations were 10 inches deep at 10 miles downwind, 1 inch deep at 60 miles downwind, and ½ inch deep at 300 miles downwind. Lahars 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.

There are no known damages, due to volcanoes, for Eugene or Springfield in recorded history.

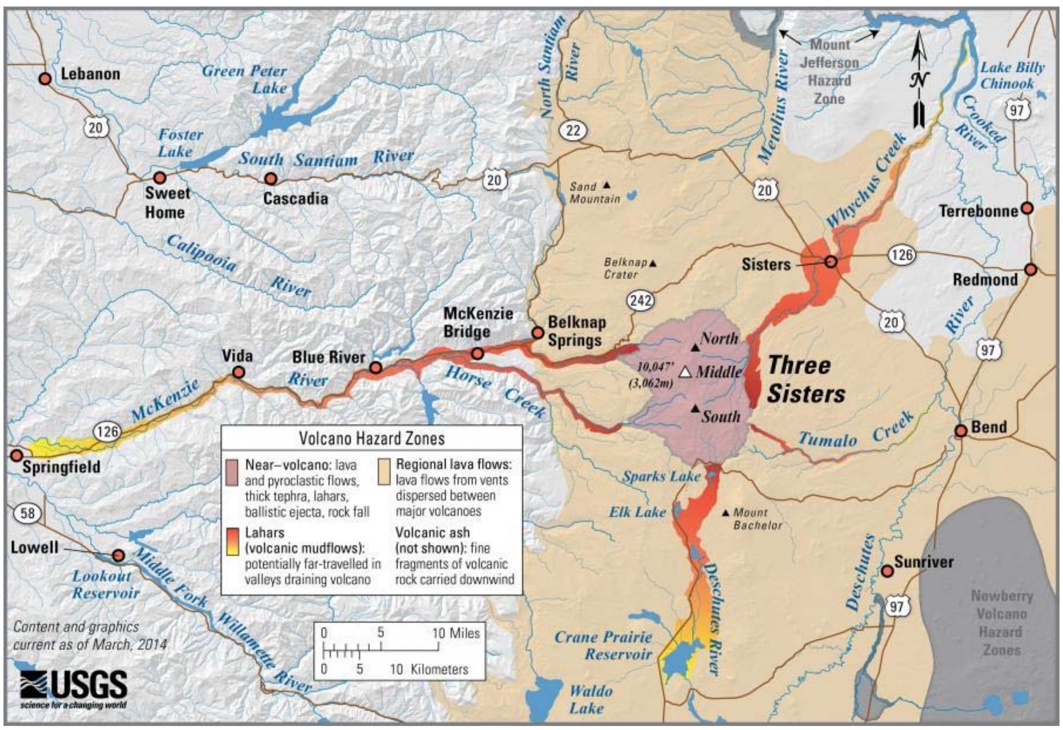

Figure 2-9. Source: USGS 2014 – *Three Sisters, Oregon simplified hazards map showing potential impact area for ground-based hazards during a volcanic event.*

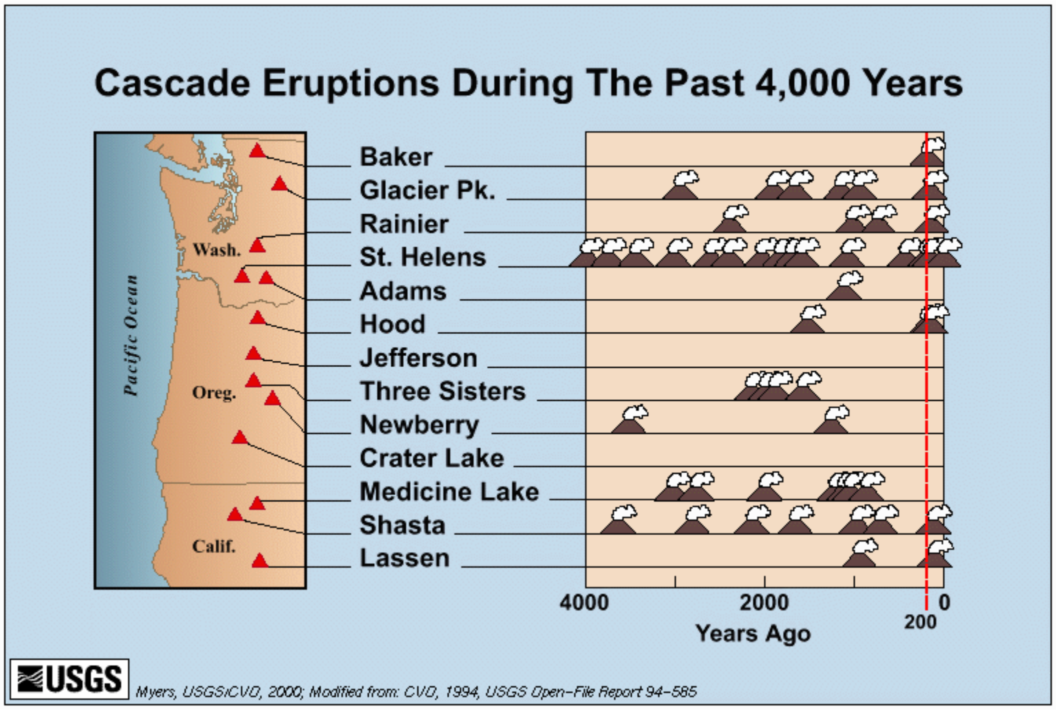

Figure 2-10. Source: W.E. Scott et al., 1997 - *http://vulcan.wr.usgs.gov/Volcanoes/Cascades/EruptiveHistory/cascades_eruptions_4000yrs.html*

2.8.4 Impacts

Dam or Levee Failure

Dam failure is not a significant impact of a volcanic event for the Eugene or Springfield area since all major dams or levees are outside of the predicted lahar flow. Additionally, there are no historical records of such an event occurring.

Hazardous Materials

Volcano induced hazardous material spills or releases are not a significant impact for the Eugene or Springfield area.

Epidemics

Though the risk of communicable diseases after a volcanic event is deemed moderate for person to person, water born, and food born modes of transmission, the data is largely collected from undeveloped countries in which volcanic events displaced large populations.[12] Due to the limited implications of a volcanic event for the Eugene-Springfield area, it is believed the risk of epidemics arising from such an event is also limited. The most significant threat would be if the area's water source was no longer usable. As noted previously noted, multiple water sources throughout the area make such loss unlikely, however.

History of Impact in Eugene-Springfield

There have been no volcano induced epidemics in the Eugene-Springfield area.

Risk of Impact

Though worldwide risk of an epidemics arising after a volcanic eruption has been deemed as moderate geography, the healthcare system, and demographics of an area must be considered. Due to these facts the Eugene-Springfield area's risk has been determined to be low.

Civil Unrest

Civil unrest is not a significant impact of a volcanic event for the Eugene or Springfield area.

2.8.5 Probability of Future Occurrence

The latest update to the Oregon Natural Hazards Mitigation Plan indicates that the annual probability of the South and Middle Sister entering a new period of eruptive activity is estimated from 1 in several thousand to 1 in 10,000. However, the ability to calculate the probability of a volcanic eruption is limited due to the fragmented nature of the geologic history for these volcanoes.

Of note, uplift was discovered on South Sister in 2001 when geologists and volcanologists observed an area roughly 10 miles in diameter rise by roughly 4 inches at the center. The center of this area was approximately 3 miles from the summit of the South Sister volcano. Uplift continued at roughly 1 inch per year until 2004, when it decreased to one half inch per year. As of 2017, the rate of inflation decreased to 0.2 inches per year. [48] While this uplift is significant, it does not indicate an eruption is imminent.

Given the presence of active volcanoes in the Cascades that could impact the Eugene-Springfield area, including the Three Sisters and Mount St. Helens, Eugene and Springfield estimate the probability of a new volcanic occurrence as low. A low rating means that one incident is likely within a 75 to 100 year period.

2.8.6 Vulnerability and Capacity Assessment

The Eugene Steering Committee rated the vulnerability to a volcanic event as moderate, meaning 1-10% of the population and/or regional assets could be

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[48] USGS, Long-Term Monitoring Tracks Subtle Surface Changes at some Cascade Range Volcanoes – Uplift at South Sister, December 05, 2017. https://volcanoes.usgs.gov/observatories/cvo/

impacted by a volcanic event. This moderate rating is due to the fact the repercussions of an eruption for Eugene would be limited to ash fall, and a decrease in water quality from the McKenzie River. The Springfield Steering Committee listed its vulnerability as high given large portions of Springfield are located in the McKenzie River floodplain and any lahars entering the McKenzie River could flood portions of the city. A high vulnerability means more than 10% of the population or regional assets would be affected. Due to advance warning and available resources, Eugene-Springfield's capacity to respond to a volcanic event is high.

2.8.7 Risk Assessment

Based on the vulnerability, probability, and capacity scores determined by the Steering Committee this hazard poses a low risk to the Cities. Volcanic eruptions can occur any time in the Eugene-Springfield area, but the average recurrence interval is 1,540 years making this hazard rather rare compared to others within this plan.[29] Despite this, we know such events have affected the area and will affect it in the future.

For a summary of Volcanic Impact Risks see Table 2-14.

Volcano- Impact Risks	
Hazardous Materials	No Known
Civil Unrest	No Known
Epidemic	Low
Dam or Levee Failure	No Known

Table 2-13

2.8.8 Existing Hazard Mitigation Activities

Currently, there are no hazard specific mitigation activities under way for a volcanic eruption. Several existing mitigation items are multi-hazard items that also mitigate the effects of a volcano, however. More detail on these mitigation action items can be located on Table 1-2 and Appendix A.

2.9 Windstorm

The probability of a windstorm in the Eugene-Springfield area is high while vulnerability to a windstorm is moderate. Windstorms are storms with damaging "straight-line" winds. The term "straight-line" is used to differentiate from wind damage caused by tornadoes.

2.9.1 Causes and Characteristics of the Hazard

Windstorms are relatively common for the Eugene-Springfield area. These storms can occur any time of the year, but are more typical during winter months. Destructive winds are generally from the southwest. These winds are associated with cyclone storms which move in from the Pacific Ocean. Winds from the west are generally slowed by the Coast Mountain Range before reaching the Willamette valley.[5]

Windstorm damage generally consists of fallen trees and power outages. Damage may be much worse if the ground is heavily saturated with water increasing the likelihood of trees falling. Typically, these storms have sustained winds in excess of 50 mph.[29]

2.9.2 Climate Change

At this time it is unknown how climate change may affect the severity or frequency of windstorms in the Eugene-Springfield area.

2.9.3 History of the Hazard in Eugene-Springfield

Oregon's most destructive windstorm was the Columbus Day Storm in October 1962. Wind speeds of 116 mph were recorded in the Willamette Valley. Eighty-four homes were destroyed, five thousand were severely damaged, and total damage was estimated at one hundred seventy million.[5] Some other notable events can be located on table 2-15.

Table 2-15: Significant Eugene-Springfield Windstorms since 1990		
Date	**Location**	**Comments**
January 7-8, 1990	Statewide	Peak gusts up to 58 mph in Eugene
December 1995	Statewide	Peak gusts up to 49 mph in Eugene and up to 62 mph in the Willamette Valley in general. Saturated soils compounded damage. (FEMA-1107-DR-Oregon)
February 7, 2002	Lane County	Peak gusts up to 70 mph in Eugene. Damages of public properties were greater than $6 million.(FEMA-1405-DR-Oregon)
February 3-4, 2006	Western Oregon	Peak gusts of 46 mph in Eugene. 3500 residence without power in Lane County and $300,000 in damages.
May, 2006	Lane County	$5,000 in property damage in Eugene, and Approximately 13,000 customers without power.
March 13, 2011	Lane County	Peak gusts of 60 mph in Eugene. 25,000 residence without power in Lane County. Trees toppled and buildings damaged.
December 10, 2015	Lane County	Peak gusts of 47 mph in Eugene and Creswell due to a thunderstorm. Widespread electrical outages and $260,000 in damages.
January 16, 2016	Lane County	Peak gusts of 63 mph winds from a thunderstorm. Several down trees, damaged roofs, electrical outages, and $15,000 in damages reported.

Table 2-14

2.9.4 Impacts

Dam or Levee Failure

Dam or levee failure is not a known impact of windstorms.

Hazardous Materials

Hazardous Material spills or releases may occur when debris impacts holding tanks, pipelines, or equipment vital to operating a facility.

History of Impact in Eugene-Springfield

There have been no known HazMat spills or releases due to a windstorm in the Eugene or Springfield area. Additionally, high wind only accounts for 636 bbl spilt in oil natech incidents, barely making the cutoff for what this plan deemed "significant."

Risk of Impact

Due to historical events the risk from this impact is low.

Epidemics

Epidemics are not a known impact of windstorms.

Civil Unrest

In the Eugene-Springfield area, civil unrest is not a known impact of windstorms.

2.9.5 Probability of Future Occurrence

Windstorms with sustained speeds of 37-47 mph have a two year recurrence interval in Lane County. These storms cause limited damage.[29] A 25-year windstorm has average wind speeds of 47 to 61 mph. A 50-year event has wind speeds between 62-75 mph, and a 100-year event, for the Willamette Valley, is considered a storm with average speeds over 75 mph.[5] These storms can cause significant damage (Figure 2-11).

Beaufort	1-min Wind speed	Effects on land
0 Calm	0 - 1 mph	Calm. Smoke rises vertically.
1 Light air	1 - 3 mph	Smoke drift indicates wind direction and wind vanes cease moving.
2 Light breeze	3 - 7 mph	Wind felt on exposed skin. Leaves rustle and wind vanes begin to move.
3 Gentle breeze	7 - 12 mph	Leaves and small twigs constantly moving, light flags extended.
4 Moderate breeze	12 - 17 mph	Dust and loose paper raised. Small branches begin to move.
5 Fresh breeze	17 - 24 mph	Branches of a moderate size move. Small trees in leaf begin to sway.
6 Strong breeze	24 - 30 mph	Large branches in motion. Whistling heard in overhead wires. Umbrella use becomes difficult. Empty plastic bins tip over.
7 Near gale	30 - 38 mph	Whole trees in motion. Effort needed to walk against the wind.
8 Gale	38 - 46 mph	Some twigs broken from trees. Cars veer on road. Progress on foot is seriously impeded.
9 Severe gale	46 - 54 mph	Some branches break off trees, and some small trees blow over. Construction/temporary signs and barricades blow over.
10 Storm	54 - 63 mph	Trees are broken off or uprooted, saplings bent and deformed. Poorly attached asphalt shingles and shingles in poor condition peel off roofs.
11 Violent storm	63 - 73 mph	Widespread damage to vegetation. Many roofing surfaces are damaged; asphalt tiles that have curled up and/or fractured due to age may break away completely.
12 Hurricane	73 - 99 mph	Very widespread damage to vegetation. Some windows may break; mobile homes and poorly constructed sheds and barns are damaged. Debris may be hurled about.

Figure 2-11 Source: Ben Lee-Rodgers, 2017- *Beaufort Scale http://nw3weather.co.uk/BeaufortScale.php.*

2.9.6 Vulnerability and Capacity Assessment

Property damage concerns are significant with windstorms. These events could affect almost every Eugene-Springfield resident which classifies the Cities' vulnerability to this hazard as high. The area's capability to respond to, and recover from, a windstorm is also high, at this time. This is largely due to the frequency in which these storms occur as well as the resources available to respond to them.

2.9.7 Risk Assessment

Based on the probability of future windstorms, the area's vulnerability, and capacity to deal with them, the Eugene-Springfield NHMP Steering Committee determined the overall risk from this hazard is moderate.

For a summary of windstorm impact risks see table 2-16.

Windstorm- Impact Risks	
Hazardous Materials	Low
Civil Unrest	No Known
Epidemic	No Known
Dam or Levee Failure	No Known

Table 2-15

2.9.8 Existing Mitigation Actions

Throughout the years many actions were undertaken to mitigate negative effects of windstorms. In previous Eugene-Springfield NHMPs windstorms were located under the winter storm section. The Cities of Eugene and Springfield along with EWEB and SUB routinely trim trees in an effort to prevent power outages due to fallen limbs and trees. Additionally, funding is being actively pursued to equip all Eugene fire states with backup generators.

2.10 Wildfire

The probability of wildfire is high in Eugene-Springfield while vulnerability is moderate in Eugene and low in Springfield.

2.10.1 Causes and Characteristics of Wildfires

Fire is an essential part of Oregon's ecosystem, but it is also a serious threat to life and property particularly where urban areas encroach upon forested, open range, or grassland areas. Wildfires occur when fire consumes large vegetated areas requiring a suppression response.

In this region, changes in historic vegetation, climate, and fire occurrence are resulting in changes to the patterns and character of fire. In short, the risks and potential impacts of wildfire are increasing.

The Eugene-Springfield area is bordered by grassland, agricultural land, and forest. The wildfire hazard is primarily located in the south hills of both Eugene and Springfield where forested areas interface directly with homes, businesses, and infrastructure. Other areas, like northeast Springfield, have large areas with high vegetative fuel loads that interface with, or are located very close to, developed and developing areas.

For wildfire hazard maps, refer to Chapter 3.

Areas in Eugene and Springfield are vulnerable to wildfire, depending on the following factors:

- Amount of vegetative fuel loads on the property, and the degree of continuity of fuel load (i.e. amount of significant firebreaks). If properties are surrounded by large amounts of fuel without significant firebreaks, vulnerability to wildfire is greater. Risk may be particularly high if the fuel load is grass, brush, and smaller trees. These types of vegetation have very low moisture levels in short-duration drought periods.
- Degree of slope. Steeper slopes cause fire to spread more rapidly than on flatter terrain.
- Fire suppression capacity. Limited fire suppression capacity includes limited water supply for fire suppression purposes, limited firefighting personnel and apparatus, and typically long response times for fire alarms. These limitations increase vulnerability to wildfire events.
- Access for firefighting apparatus and resident evacuation. Limited access and egress increases vulnerability.
- Construction materials.
- Maintenance of firebreaks and defensible space around structures.

Oregon wildfires

Recent major wildfires in Oregon include the Long Draw fire and the Miller Homestead fire. The Long Draw and Miller homestead fires of 2002 were started by lightning and dry thunderstorms. The Long Draw fire burned over 500,000 acres in south west Oregon, and was the worst fire the State had seen in150 years.[49] The Bureau of Land Management owned a majority of the land burnt. However, forty, mainly agricultural, property owners were affected.[50] The Miller homestead fire alone caused over $8 million in damage.[51]

In July 2017 the Chetco Bar fire in south west Oregon burnt over 191,000 acres. The fire threated Brookings, Oregon, but was contained before mandatory evacuation of the City occurred. During the same year a series of fires collectively

[49] Blackwood, Jeff D. Long Draw/Miller Homestead Fire Review. April 2013. http://www.blm.gov/or/news/files/long-draw.pdf

[50] Oregon.gov. Governor Kitzhaber announces funds to help repair fences, re-seed land, and retail rural jobs in Southeastern Oregon. http://www.oregon.gov/gov/media_room/pages/press_releases/press_060613.aspx

[51] Bureau of Land Management. BLM Oregon Post-Fire Recovery Plan. August 23, 2012. http://www.blm.gov/or/districts/burns/plans/files/MilleESRPlan_1.pdf. http://www.denverpost.com/colorado/ci_23518579/officials-511-homes-burned-black-forest-fire

known as the Horse Creek Complex fire occurred east of Eugene in the Deschutes National Forest area. The fires burnt over 42,480 acres and cause several evacuation orders.

Fires in other parts of the West

The Black Forest fire occurred in Colorado in 2013, and damaged 595 homes. 498 of those homes were completely destroyed.[52] It cost nearly $8.5 million to contain the fire.[53] The Carlton Complex fire occurred in Washington in 2014, damaged over 300 homes, and cost the state over $23.3 million in damages, bringing the total damages from wildfires in Washington to over $50 million in 2014.[54]

Wildfires are not just a rural phenomenon. The impact on urban areas from wildfire can be huge. In 1990, Bend's Awbrey Hall fire destroyed 21 homes, caused $9 million in damage, and cost over $2 million to suppress. In 1991, the Oakland Hills firestorm in Oakland, California killed 25 people, injured 150 others, destroyed 3,791 dwelling units, and resulted in roughly $1.5 billion in economic losses. The 1996 Skeleton fire in Bend burned over 17,000 acres and damaged or destroyed 30 homes and structures.

Wildfire can be divided into three categories: interface, wildland, and firestorms.

- Interface fires occurs where wildland and developed areas come together at the wildland-urban interface with both vegetation and structural development combining to provide fuel.
- A wildland fire's main fuel source is natural vegetation. Often referred to as forest or rangeland fires, these fires occur in national forests and parks, private timberland, and on rangeland. A wildland fire can become an interface fire if it encroaches on developed areas.
- Firestorms are events of such extreme intensity effective suppression is virtually impossible. Firestorms often occur during dry, windy weather and generally burn until conditions change or the available fuel is consumed.

Ignition of a wildfire may occur naturally from lightning or from human causes such as debris burns, arson, careless smoking, recreational activities, and

[52] 12 FEMA. Colorado Black Forest Wildfire. http://www.fema.gov/media-library-data/c25715894278ad44c82ddd9d0c7e3243/PDA_Report_FEMA-4134-DR-CO.pdf

[53] The Denver Post. Officials: 511 homes burned in Black Forest Fire. June 2013.

http://www.denverpost.com/colorado/ci_23518579/officials-511-homes-burned-black-forest-fire

[54] The Oregonian. Washington Wildfire-Fighting Costs Soar past $50 Million for Season. July 27, 2014. http://www.oregonlive.com/pacific-northwest-news/index.ssf/2014/07/washington_wildfire-fighting_c.html

industrial accidents. Once started, four main conditions affect the fire's behavior: fuel, topography, weather, and urban development.

- Fuel feeds a fire. Fuel is classified by volume and type. As a western state, Oregon is prone to wildfires due to its prevalent conifer, brush, and rangeland fuel types.
- Topography influences the movement of air and directs a fire's course. Slope and hillsides are key factors in fire behavior. Unfortunately, hillsides with steep topographic characteristics are also desirable areas for residential development.
- Weather is the most variable factor affecting wildfire behavior. High-risk areas in Oregon share a hot, dry season in late summer and early fall with high temperatures and low humidity. By 2030, climate change is expected to result in: average annual temperature increases of 2-4°F; reduced precipitation in spring, summer and fall; and an increase in extreme heat events. These changes will likely result in an increase in wildfire frequency and intensity.
- The degree of urban development influences the amount of fuel available.

2.10.2 Climate Change

Global climate change is expected to increase the length and severity of summer drought along with an increase in summer high and low temperatures. All of these changes are expected to increase the future probability of wildfires in the Eugene-Springfield area.

2.10.3 History of the Hazard

While some small wildfires have been recorded by the Eugene and Springfield fire departments, there is no history of large wildfires in the immediate area.

2.10.4 Impacts

Dam or Levee Failure

Dam or Levee failures are not a known significant impact of wildfires.

Hazardous Materials

Hazardous material spills or releases are not a known significant impact of wildfires.

Epidemics

Epidemics are not a known significant impact of wildfires.

Civil Unrest

Civil unrest is not a known significant impact of wildfires.

2.10.5 Probability of Future Occurrence

The Steering Committee identified the probability of a wildfire occurring in the Eugene-Springfield area as high given the high fuel load in nearby forested areas, hilly topography, and dry summers. A high probability means one event is likely to occur within a 10 to 35 year period. As previously noted, it is believed climate change will make wildfires more likely, as well.

2.10.6 Vulnerability and Capacity Assessment

Given the amount of residential development in the south hills of Eugene, the Eugene Steering Committee rated their vulnerability to wildfire as moderate, meaning a wildfire could impact 1-10% of the population and/or local assets in Eugene. The Springfield Steering Committee rated the vulnerability of the wildfire hazard in Springfield as low given the smaller amount of development in the south hills and northeastern areas of Springfield. A low rating means that less than 1% of the population and/or regional assets would be affected.

The recent Hazard and Climate Vulnerability Assessment confirmed these ratings. Specifically, the assessment found that, while wildfire events have the potential to cause severe loss and damage in localized areas, the wildfire hazard is not likely to result in systemic failures across multiple sectors or significant damage to critical systems. Refer to Chapter 4 for specific vulnerabilities related to the wildfire hazard.

Capacity to respond to and recover from a forest fire is high for both Eugene and Springfield. This is due to the amount of available resources as well as an established conflagration process the State of Oregon instituted through the Fire Marshal's office.

2.10.7 Risk Assessment

The 2008 update to the Lane County Community Wildfire Protection Plan's (CWPP) risk assessment identifies specific neighborhoods in Eugene and

Springfield as areas at risk. The areas of concern include the south hills neighborhoods in Eugene, the southwest Eugene/Spencer Creek area, Thurston Hills in Springfield and the Harbor Drive/South 2nd area in Springfield.[55] Generally speaking, based on the vulnerability, probability, and capacity ratings determined by the Steering Committee, Eugene's wildfire risk is high while Springfield's is moderate.

Table 2-17 shows the percentage of each community at risk by risk category.

For a summary of Impact Risks see Table 2-18.

Table 2-17. CWPP Communities at Risk Summary for Eugene-Springfield

Community At Risk	Total Acreage	Percentage of Community at Risk		
		High	Medium	Low
Eugene	37,747	2.1	17.7	80.2
Springfield	9,445	3.9	15.8	80.2

Table 2-16

Windstorm- Impact Risks	
Hazardous Materials	Low
Civil Unrest	No Known
Epidemic	No Known
Dam or Levee Failure	No Known

Table 2-17

2.10.8 Existing Mitigation Activities

In 2010, the Springfield and Eugene Fire Departments began operating under an intergovernmental agreement to share the services of key administrative positions in both departments. In 2014, the two departments merged into one department. This union has facilitated better sharing and utilization of resources, and it has facilitated better communication related to wildfire planning. For example, Eugene Springfield Fire offers educational campaigns to inform residents about actions they can take to reduce wildfire hazards on their property. In addition, Eugene Springfield Fire and EMS completed a south hills fire plan in 2012 that addresses specific wildfire hazards for the area. A similar wildfire plan is currently under development for the wildfire-prone areas of Springfield.

[55] Lane County. *Lane County Community Wildfire Protection Plan*, (Eugene, OR: 2008), 2-9, 2-11

2.11 Winter Storm

The probability of, and vulnerability to, winter storms in Eugene and Springfield is high. In previous Eugene-Springfield NHMPs extreme weather, windstorms, and heavy rain were included under winter storms. For accuracy, this update provides extreme weather, wind storms, and the repercussions of heavy rain (flooding and landslides) with dedicated sections within Chapter 2. Winter storms are storms where below freezing temperatures and precipitation combine to produce adverse conditions. These storms could include snow, ice, extreme cold, and/or frost heave.

2.11.1 Causes and Characteristics of the Hazard

Extreme Cold

Extreme cold periods vary in severity based on temperature and duration. Long durations and/or extreme lows increase the severity of a cold wave event. Extreme cold events can be life-threatening for those exposed to the elements. These conditions can worsen when mixed with wind creating dangerous "wind chill" (Figure 2-12).

Frost Heave

Frost heave is a winter weather phenomenon many are unfamiliar with. It occurs when soil swells upwards due to ice forming within the ground. Generally, its effects are mild in the Eugene-Springfield area. When subzero temperatures occur, and the ground is saturated with water, more damaging frost heave events can occur. Primary damage from frost heave is seen when structures such as utility poles and storage tanks tilt or topple due to destabilization of the supporting ground.

Snow and Ice

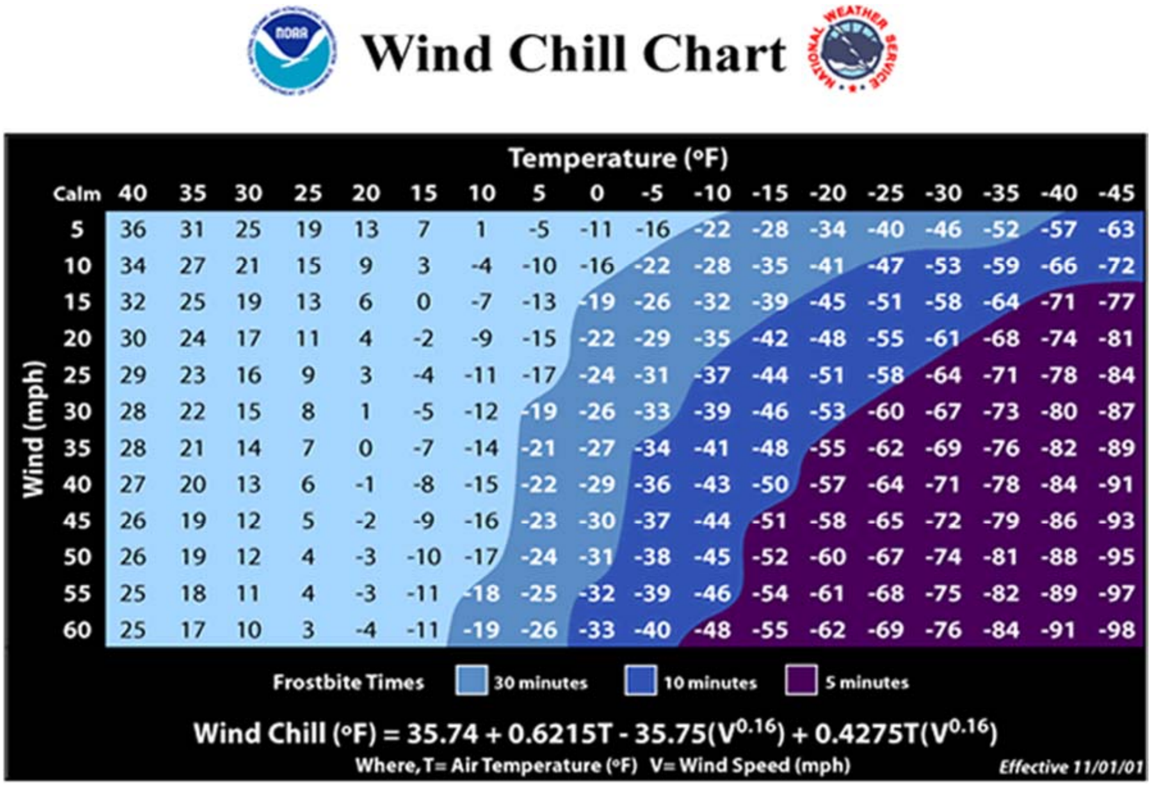
In 2013 and 2014 the Cities of Eugene and Springfield conducted a Climate and Hazards Vulnerability assessment to inform this NHMP. The assessment team met with local and regional experts from the Drinking Water, Health Care, Public Health, Electricity, Transportation, Food, Housing, Communication, Stormwater, Wastewater, Natural Systems, and Public Safety sectors. Findings from the assessment confirmed severe winter storms in Eugene-Springfield have the potential to cause region-wide cascading system failures. Specifically, severe winter storms disrupt Electricity and Transpiration sectors, two of the three sectors all others depend upon. This is especially true if the storm lasts more than a couple of days and especially if snow and ice accumulations are significant. Additional system vulnerability details are included in Chapter 4: Risk and Vulnerability.

Much of the metro area's regional adaptive capacity stems from Eugene and

Springfield's ability to draw resources, personnel, and expertise from nearby communities during an emergency. This capacity is severely restricted during winter storm events. Many buildings, utilities, and transportation systems in the Eugene- Springfield area are vulnerable to winter storm damage. This is especially true in forested areas along tree-lined roads with electrical transmission lines, and on residential parcels where trees have been planted or left for aesthetic purposes.

Fallen trees are especially troublesome. They can block roads and rails for long periods, which can affect emergency operations and delay restoration of critical services. In addition, uprooted or shattered trees can down power and/or utility lines effectively bringing local economic activity and other essential activities to a standstill. Much of the problem may be attributed to a shallow or weakened root system in saturated ground. Many roofs have been damaged or destroyed by uprooted trees growing next to a house. In some situations, strategic pruning may be the answer. Eugene and Springfield work with utility companies in identifying problem areas and establish a tree maintenance / removal programs and assess opportunities for relocating utility lines.

The most likely effects of snow and ice events are road closures limiting access to and from the Eugene-Springfield area. Closures especially affect roads to higher elevations, such as the highways into the Cascades or Coast Range. Winter storms with wet heavy snow and ice storms may also result in significant power outages from downed transmission lines and/or poles.


Wind Chill Chart

Wind (mph) \ Temperature (°F) 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

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

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

Figure 2-12. Source: National Weather Service – *Wind Chill Chart*

2.11.2 Climate Change

As previously discussed in section 2.2.2 (Drought: Climate Change,) average annual temperatures along with high and low temperatures are expected to rise in the coming decades. Along with this, total precipitation is predicted to decrease. This will produce fewer winter storms for the Eugene-Springfield area. Winter storms that do occur could be severe, however, due to the fluctuating climatic conditions as discussed in section 2.5.1 (Flood: Climate Change.)

2.11.3 History of the Hazard in Eugene-Springfield

For the Eugene-Springfield area, most winters result in little snowfall. Major storms of 10" or more snow typically occur every 10 to 20 years. Significant winter storms have a reoccurrence rate of 2.9 years.

Major snow storms affecting the Willamette Valley occurred in 1884, 1892, 1909, 1916, 1919, 1937, 1950, 1969, 1989, 2002, 2004, 2008, 2010, 2012, 2013 and 2014. January 1950 snowfalls were especially high, with 54" in Albany and 36" in Eugene. In January 1969, Eugene had 47" of snow. In December 2008, January 2012, February 2014, and December 2016 significant snow and ice disrupted electrical service and transportation systems throughout the Willamette Valley.

All four of these storms resulted in a Federal Disaster Declaration (Table 2-16).

Average annual snowfall gauged by the Eugene Airport weather station is 6.4”. Since the weather station was established in 1939, maximum monthly snowfall has been 47.1” (January 1969), with maximum seasonal snowfall also at 47.1” (1969).

More winter storm events can be located on Table 2-19.

Table 2-19: Significant Eugene-Springfield winter storm events since 1990

Date	Location	Comments
February 11-16, 1990	Statewide	Heavy Snow: Average of 8 inches across the Willamette Valley
December 16-17, 1992	Western Oregon	Heavy Snow
February 18-19, 1993	Northwestern Oregon	Heavy Snow: 6 to 12 inches snow fell in the Willamette Valley
Winter 1998-1999	Statewide	Series of Snow Storms: One of the snowiest winters in Oregon history
March 12, 2002		Snow
December 2003- January 2004		Snow
NOTE: the following events were compiled from the list of Eugene Public Works Emergency Command Center activations between 2009 and 2014 and crossed referenced with State and County NHMPs as well as news outlets to ensure accuracy		
December 2008- January 2009	Southern Willamette Valley	Heavy Snow/Ice Event. **Federal Disaster Declaration**
November 23-24, 2010	Cascades and Foothills in Lane County	Heavy Snow
December 27-29, 2010	Cascades and Foothills in Lane County	Ice Event: Road icing
March 13, 2011		Rain storm: Downed trees
January 17 to 21, 2012		Snow and Ice event. 2,000 power outages. **Federal Disaster Declaration (DR-4055)**

March 21-24, 2012	Southern Willamette Valley	Heavy Snow: Eugene received eight inches of snow in eight hours. Reports of trees down, powerlines down, local roads closed. $317,612 in damages to the City of Eugene and several power outages.
January 10, 2013	Lane County	De-icing event: Freezing Temps
December 4-13, 2013	Central & Southern Willamette Valley	Heavy Snow & Extreme Cold: 8-9 inches of snow recorded in Creswell. De-iced
February 6-24, 2014	Northwest Oregon	Heavy Snow & Freezing Rain: Reports of up to 0.75 inches of ice in Eugene. $1.7 million in damages to the City of Eugene and roughly 10,000 power outages lasting up to six days. **Federal Disaster Declaration (DR-4169)**
December 15-22, 2016	Lane County	Ice Storm. $1.6 million in damages to the City of Eugene and roughly 20,000 power outages lasted several days. **Ice Strom 16 -Federal Disaster Declaration (DR-4269)**

Table 2-18

2.11.4 Impacts

Dam or Levee Failure

Winter storms can cause dam or levee failures when ice and snow compound flooding events or clog drainage. Such incidents cause failures due to overtopping or erosion similar to what has already been discussed throughout this plan.

History of Impact in Eugene-Springfield

Dam or levee failure has not been an impact from a winter storm in the Eugene or Springfield area.

Historically, two dams have failed during winter storms. Both events occurred in the United States. In 1890 heavy snow, flooding, and poor design contributed to the failure of the Walnut Grove Dam killing 100 people. The Meado Pond Dam failed in 1996 due to heavy icing and was compounded by poor design and construction. The failure killed one person.

Risk of Impact

Based on historical occurrences, and the condition of the dams and levees in and around Eugene and Springfield, the risk of this impact occurring is low (Appendix A).

Hazardous Materials

There is a moderate risk of winter storms causing hazardous material spills or releases. Adverse winter driving conditions make transportation of hazardous materials via trains or surface roads dangerous. Tanks and pipes can also be severely damaged from freezing or due to frost heave.

History of Impact in Eugene-Springfield

There have been no significant HazMat incidences in the Eugene or Springfield area due to winter weather. Nationally, winter weather related-natech events have resulted in over 6 million USD in damages and account for roughly 25,000,000 bbls spilt by the US oil and gas industry.[35] These events tend to be small in scope, and companies take protective measures to prevent them, but they are a possibility.

Risk of Impact

Based on the frequency and volume of previous HazMat incidences induced by winter storms, this impact poses a moderate risk to the Eugene-Springfield area.

Epidemics

Epidemics are not a known significant impact of winter storms.

Civil Unrest

Civil unrest is not a known significant impact of winter storms.

2.11.5 Probability of Future Occurrence

The Oregon NHMP Hazard Profile for the region indicates the probability of winter storms in the area is high. Significant winter storms have a reoccurrence rate of 2.9 years while major snow storms reoccur every 10 to 20 years. This means, on average, two or more severe winter storm occur each decade.

Eugene-Springfield list the probability for local winter storms as high, which indicates at least one event is likely within a 10 to 35 year period.

2.11.6 Vulnerability Assessment and Capacity

The Steering Committee rates winter storm vulnerability as high, indicating a winter storm would impact more than 10% of the region's population. With the electric and transportations sectors particularly vulnerable to winter storms, almost every citizen in Eugene and Springfield is impacted.

The Eugene-Springfield area's capacity to deal with such events is moderate. Historically, it takes a very significant winter storm to drain the area's resources.

2.11.7 Risk Assessment

Based on the probability of future occurances, vulnerability, and capacity to respond to, and recover from, winter storms, the Eugene and Springfield's risk to this hazard is categorized as being high. One factor limiting the area's capacity to respond to these events is the large scale of the storms themselves. Historically, these events tend to involve multiple counties and, at times, the entire State, if not multiple states, which limits mutual aid resources.

For a summary of winter weather impact risks see table 2-120.

Winter Storm- Impact Risks	
Hazardous Materials	Medium
Civil Unrest	No Known
Epidemic	No Known
Dam or Levee Failure	Low

Table 2-19

2.11.8 Existing Hazard Mitigation Activities

Eugene and Springfield are participating in winter storm mitigation activities.

- Development Codes: Both jurisdictions require utilities in all new subdivision developments to be installed underground. This assists in the prevention of damaged power and communication lines during an event.
- Tree-Trimming: The Eugene Water & Electric Board and the Springfield Utility Board engage in tree-trimming around power lines.
- Building Codes: Eugene and Springfield Building Codes adhere to the Oregon Structural Specialty Code guidelines for new development.
- In 2017, after Ice Storm 16, Eugene purchased another storage tank for deicer.

M E M O R A N D U M

EUGENE WATER & ELECTRIC BOARD

Rely on us.

TO:	Commissioners Carlson, Mital, Helgeson, Schlossberg and Brown
FROM:	Megan Capper, Interim Power Planning Supervisor, and Catherine Gray, Senior Energy Resource Analyst
DATE:	May 29, 2019
SUBJECT:	EWEB's 2018 Oregon Renewable Portfolio Standard Report
OBJECTIVE:	Information Only

Issue
In accordance with the Oregon Renewable Portfolio Standard (RPS), EWEB's 2018 RPS Compliance report is included with this memorandum for Board review.

Background
The Oregon Renewable Energy Act of 2007 established a Renewable Portfolio Standard (RPS) for all Oregon electric utilities. The statute applicable to EWEB that governs compliance reporting, ORS 469A.170, states "A consumer-owned utility shall make the report available to the members or customers of the utility" by June 1 of each year. Each year EWEB has met the reporting requirements of this standard by providing a detailed report to its governing Board and posting a copy on the website for its customer owners.

Recommendation and Requested Board Action
This item is information only and accordingly there is no requested Board action.

Eugene Water Electric Board

Oregon Renewable Portfolio Standard
2018 Compliance Report

May 29, 2019

2018 Oregon Renewable Portfolio Standard Compliance

EWEB's 2018 Oregon Renewable Portfolio Standard (RPS) compliance obligation, after exemptions, is zero.

Figure 1, below, contains annual megawatt hour (MWh) information used to calculate EWEB's RPS compliance:

Figure 1. EWEB 2018 RPS Compliance Obligation Calculation

Category	MWh
Sales to Customers	2,412,055
RPS Target	15%
RPS Obligation BEFORE Exemption	361,808
Exempt Resources	
BPA Tier 1 net purchases	2,413,299
Mid-C hydro (contract)	13,816
EWEB hydro (owned)	348,497
Total Exempt Resources	2,775,612
Fraction of Retail Sales from Exempt Resources	115%
RPS Obligations AFTER Exemption	0

EWEB interprets the results of Figure 1 to mean EWEB does not have any RPS compliance obligation in 2018. However, EWEB did retire a number of renewable energy credits (RECs) to satisfy the portion of the Oregon Renewable Energy Act (Act) that refers to voluntary renewable purchases by EWEB customers under the Greenpower program. Surplus RECs will be banked for future use or sold.

The Greenpower program allows customers the choice to voluntarily pay an additional one cent per kWh which contributes to the development and use of renewable energy. Just as RECs are retired to satisfy any obligations under the mandatory RPS, RECs are also retired to match the volume of sales under EWEB's voluntary retail Greenpower program, with one REC retired for every MWh of program sales.

In 2018, sales to EWEB customers under the Greenpower program totaled 22,593 MWhs. EWEB has retired this amount of RECs from its available portfolio. For additional information on EWEB's Greenpower program please see: Greenpower | EWEB.

EWEB will publish the 2019 Oregon RPS Compliance Report by June 1, 2020.

Oregon RPS Compliance Background

In 2007, Oregon enacted Senate Bill 838, the Oregon Renewable Energy Act (Act), which created an RPS that all Oregon electric utilities must follow. The purpose of the RPS is to decrease Oregon utilities' reliance on fossil fuels for electric generation, and increase their use of renewable energy sources. In 2016, SB 1547 further increased RPS targets for investor-owned utilities (IOUs) only.

Oregon's RPS establishes standards for electric utilities, requiring that a percentage of their annual retail sales must come from qualifying renewable resources. The exact percentage required, and the year the compliance obligation begins differs for large and small electric utilities, and specifically for large IOUs, as shown in Figure 2, below. Therein, the "Utility Size" is determined as a percentage of Oregon's total retail electric sales in the year. EWEB is the only Consumer Owned Utility (COU) classified as a "Large Utility." PacifiCorp and Portland General Electric are assigned an even larger target based on both size and utility type (IOU).

Figure 2. Annual percentage target of qualifying electricity by year

	Utility Size	2011	2015	2020	2025	2040
Large IOU	3% or more			20%	27%	50%
Large Utilities	3% or more	5%	15%	20%	25%	
Smaller Utilities	From 1.5% to 3%				10%	
Smallest Utilities	Under 1.5%				5%	

The Oregon Public Utilities Commission (PUC) oversees IOU reporting and compliance with the RPS. However, Oregon COUs are not regulated by the PUC. The statute governing RPS compliance reporting, ORS 469A.170, states: "A consumer-owned utility shall make the report to the members or customers of the utility." EWEB's long term RPS compliance strategy is addressed in its Integrated Resource Plan (IRP) which is updated every 5 years, or as determined by the EWEB Board of Commissioners.

The Act also defines which types of renewable generation are considered "qualifying electricity." In general, qualifying renewable resources must have an on-line date of January 1, 1995 or later, with some exceptions.[1]

In recognition of the low-emission resources already existing in the region, and other reasonable barriers to compliance, there are four exemptions in the Act that allow utilities to reduce their annual compliance target, by specifically exempting utilities from taking actions for compliance that:

- Would cause the utility to spend over 4 percent of annual costs to comply with RPS;
- Force COUs to replace Bonneville Power Administration (BPA) Tier 1 power with new renewable electricity;
- Force a utility to acquire resources in excess of their load requirement, or
- Force a utility to replace older renewable or non-fossil fuel generation (i.e. legacy hydroelectric projects) with new renewable generation.

[1] See link for a list of conditions under which pre-1995 resources are eligible to produce qualifying electricity, https://olis.leg.state.or.us/liz/2016R1/Downloads/MeasureDocument/SB1547/Enrolled
A later amendment to the RPS allows for pre-1995 woody biomass to qualify, but the RECs will not be eligible for use in compliance until 2026.

Currently, the vast majority of EWEB's energy supply source is from BPA Tier 1 resources and EWEB owned or contracted legacy hydro. EWEB's understanding of the policy rationale for these exemptions is that the intent of the RPS is to displace fossil fuels, not to require EWEB to replace energy from our existing legacy hydro projects with other renewable energy resources. As a result, it is EWEB's interpretation that these resources can be used towards the exemption.

Oregon RPS Compliance Rules

Per rules adopted by the Oregon Department of Energy, qualifying generation volumes are based on values recorded and reported to the Western Renewable Energy Generation Information System (WREGIS). WREGIS is a large database that receives monthly generation volumes of renewable generation and serves as the regional system of record to issue, monitor, account for or transfer Renewable Energy Certificates (REC). Each MWh of renewable generation equals one REC. The RECs have identification numbers that indicate the generation project and the month the electricity was generated. The purpose of this system is to ensure that renewable generation and its associated REC are not used to meet the requirements of more than one program.

As detailed above, EWEB's compliance target for 2018 is 15 percent of retail sales, subject to exemptions. Compliance is demonstrated by retiring a quantity of WREGIS RECs equal to the compliance target. Once a REC is retired in WREGIS it is no longer available to be used in any other program. However, as long as a REC has not been retired it can be retained, or banked, for a future use such as compliance, a voluntary program, or sold to another entity.

Under EWEB's interpretation, two exemptions significantly reduce EWEB's current and projected compliance targets. The first exemption releases EWEB from reducing purchases of BPA Tier 1 energy in order to take in qualifying electricity. The second exemption releases EWEB from replacing energy produced by non-fossil resources (such as our legacy hydro) with qualifying electricity.

Under Oregon's RPS rules, if exempt generation in 2018 exceeds 85 percent of total retail sales, then EWEB can reduce the 15 percent compliance target by the amount the exempt generation exceeds 85 percent. If exempt generation exceeds 100 percent of total retail sales, then EWEB can reduce its compliance target to zero.

As a result, and in accordance with Oregon's RPS rules, EWEB's 2018 RPS compliance obligation is zero.

MEMORANDUM

EUGENE WATER & ELECTRIC BOARD

Rely on us.

TO: Commissioners Carlson, Mital, Helgeson, Schlossberg and Brown

FROM: Jason Heuser, Public Policy and Government Affairs Program Manager

DATE: May 23rd, 2019

SUBJECT: State Legislative Update

Issue

The 2019 State Legislative Session convened January 28, 2019. This memo is to apprise the Board of key issues of interest to EWEB, and the current status of these issues in the legislative process.

Background

Prior to the start of each legislative session, the Board adopts general policy directives for advocacy at the Capitol, which guide the work of EWEB's lobbying activities. When political considerations test the applicability of those directives, the General Manager makes a determination as to whether a fundamental shift in direction is required. The Board may be asked to reaffirm its policy or direct staff to make necessary adjustments.

Discussion

The following is a summary of state legislative activity in May of interest to EWEB:

HB 2020 – Oregon Climate Action Program/Clean Jobs/Cap and Invest

On May 17th, the Join Carbon Policy Committee adopted the -94 amendment to HB 2020 and advanced the bill to the Joint Ways and Means Committee with a "do-pass" recommendation. With the amendment, the bill is now termed HB 2020 A-Engrossed, or "HB2020A."

The -94 amendment made only a few changes to the electric sector. One of the two most significant overall changes approved in the -94 was a change in the allowance allocation for industries classified as Energy Intensive Trade Exposed (EITE). Instead of an initial 100 percent free allowance allocation, as proposed in HB 2020 as drafted, as amended HB 2020A will now award 95 percent free allowances to an EITE if they could demonstrate they were using the best available technology from a carbon intensity perspective. This determination on best available technology would be updated periodically by the Carbon Policy Office (CPO.

The second significant change was the allowance allocation for natural gas companies. As introduced, HB 2020 only would have awarded free allowances to gas companies necessary to mitigate rate increases for low income customers. HB 2020A will now allocate to a gas company allowances equal to 60 percent of their historic emissions at the start of the program, which will decline over time with the economy wide cap. The gas company will also retain the allowance allocation targeting rate mitigation for low income customers. In total, it is estimated that a gas companies overall allowance allocation could be as high as 80 percent of historic emissions, at the start of the program.

In the electric sector, the design remained largely the same as proposed in HB 2020 as drafted. However, notably, as amended, HB 2020A now provides the state ample authority to adopt by rule an alternative approach to electricity imported into Oregon via the Western Energy Imbalance Market (EIM) or any other future organized market. This was a key priority for EWEB and a central part of the advocacy agenda during the EWEB Board's March 14th meetings with legislators in Salem. This authority should prove useful to keep the program adaptable to future changes in wholesale power markets, as well as mitigate any unexpected hurdles in linking Oregon's program to California's program and/or the Western Climate Initiative.

Additionally, EWEB partnered with other Oregon BPA customers to advocate for a provision in the bill that would provide flexibility to Oregon DEQ or the Carbon Policy Office to use a longer time frame of greenhouse gas reporting data from BPA for the purposes of calculating BPA's allowance allocation, rather than the shorter time frame that will be used for other sectors. Using the longest time frame possible would best address the year to year variability of hydropower production and result in the most accurate projection of BPA's future exposure to carbon liability. Additionally, HB 2020A now includes a smoother transition for any consumer-owned utility with non-federal power purchases/emissions below 25,000 annual tons that finds its emissions rise above that figure in the future to result in a carbon compliance liability, by adjusting a utility's allowance allocation to account partially for new load growth.

SB 408 – Flexibility in Siting Utility Infrastructure in Exclusive Farm Use (EFU) Zone

SB 408A was approved on May 23rd by the House of Representatives on a 55-0 vote and previously was approved on March 14th by the Senate on a 30-0 vote. Due to the changes made by a small technical amendment in House Committee, SB 408A will now return to the Senate floor for concurrence.

EWEB has submitted testimony twice in support of SB 408, co-sponsored by Senator Bill Hansell of Pendleton and Senator James Manning of Eugene and has actively lobbied legislators on behalf of this legislation. This bill will help utility providers reduce their footprints on farm land by allowing the creation of parcels based on the amount of land actually needed for a utility facility, rather than based on the larger minimum lot sizes associated with the Exclusive Farm Use zone. Because of these large minimum lot sizes, properties in the Exclusive Farm Use zone are often larger than what would otherwise be needed for a utility facility.

HB 2769 – Flexibility to consider price in Qualifications Based Selection (QBS) Public Contracting

This legislation was approved by the House and Senate and signed into law by Governor Brown on May 3rd. EWEB and several other local governments, over multiple legislative sessions, have advocated for restoring some ability for public agencies to consider price in the procurement of professional services such as architects, engineers and land surveyors.

HB 2769 allows local public contracting agencies to evaluate and score price as part of a two-step process. Agencies would issue a request for qualifications as step one and select up to three (3) of the highest ranked firms based solely on qualifications. After the initial qualifications-based selection, local public contracting agencies must then provide a detailed statement of work and request pricing information from the three most qualified firms as part of a second evaluation step. To retain a focus on qualifications, the local contracting agency may use pricing information for up to 15 percent of the points used during this second evaluation step.

HB 2769 was negotiated as a compromise between local governments and professional associations representing architects, engineers and land surveyors. The bill is expected to be signed by the Governor soon.

SB 935 – Scope of Work for Landscape Contracting Limited License

EWEB actively worked with other water utilities and met with legislators to press for changes in the bill to meet our concerns about water conservation and health and safety. These efforts were successful and on May 22nd the House Business and Labor Committee adopted a -2 amendment removing residential irrigation from the scope of work allowed under the Landscape Contracting Limited License. The -2 amendment will add decks and patios instead to the scope of allowed work.

SB 935 as introduced would have allowed for irrigation work to be done by holders of the new limited license, with a limit to 4 zones and 12 gallons per minute and a monetary cap on what work can be completed.

While the bill as written would have prohibited actually connecting an irrigation system to an electrical source or water supply, there would have been concerns that in practice unqualified individuals would connect to the public system rather than paying a licensed plumber or backflow installer to do that work. A backflow assembly is an important health protection for water supply. Furthermore, the limited license is not subject to required training on water conservation. Water efficiency training in landscape irrigation is a critical component of managing peak summer water demand when water supplies are at their lowest.

Recommendation/Requested Board Action

This memo is for informational purposes. No board action is requested.