

Natural Hazards Inventory & Management Program Options and Recommendations

Prepared by:



Contents

Appendices.....	4
Figures.....	4
Acronyms and Abbreviations	5
Introduction and Project Summary	6
McMinnville Comprehensive Plan	7
McMinnville Natural Hazards Mitigation Plan	8
Oregon Natural Hazards Mitigation Plan	8
Statewide Planning Goal 7 (Natural Hazards).....	8
Overlapping Natural Hazards.....	9
Report Organization.....	9
I. Natural Hazards Inventory Methods.....	11
Information Sources.....	11
The McMinnville Natural Hazards Study Area	11
Mappable Hazards	11
McMinnville Slope Hazards.....	12
Yamhill County Zoning	13
II. Geological Hazards Inventory	13
Data Sources	13
Landslide Hazard	14
Earthquake Hazards	14
Crustal and Cascadia Subduction Zone Earthquakes	15
Earthquake Shaking Hazard Areas	18
Earthquake Liquefaction Hazard Areas.....	19
Combined Earthquake Liquefaction and Shaking Hazard Areas.....	20
Composite Geological Risk Maps	21
III. Flood Hazard Inventory.....	23
Flood Hazard GIS Data Sources and Analysis.....	23
IV. Wildfire Hazard Inventory.....	24
Wildfire GIS Data Sources	24
Oregon Wildfire Risk Explorer.....	24

V. Natural Hazards – Multi-Hazard Cumulative Impacts	25
Composite Geological Hazard Mapping Approach	25
Combined Hazard Risk Summary	31
VI. Natural Hazard Program Management Options	32
McMinnville NHMP Multi-Hazard Action Items	32
Table VI.1 McMinnville NHMP Recommended Natural Hazard Mitigation Measures	32
Geological Hazards	33
McMinnville NHMP – Recommended Measures	33
Table VI.2 McMinnville NHMP Recommended Geological Hazard Measures	33
Best Geological Hazard Mitigation Practices in Comparator Cities	34
Table VI.3 Summary of Geological Hazard Management Practices by City	35
Flood Hazards	38
McMinnville NHMP – Recommended Flood Hazard Measures	38
Table VI.4 McMinnville NHMP – Evaluation of Recommended Flood Hazard Mitigation Measures	38
Best Flood Hazard Management Practices in Comparator Cities	39
Table VI.5 Summary of Flood Hazard Management Practices by City	39
Wildfire Hazards	39
McMinnville NHMP – Recommended Measures	39
Table VI.5 McMinnville NHMP – Evaluation of Recommended Flood Hazard Mitigation Measures	40
Best Practices in Comparator Cities	40
Ashland Wildfire Mitigation Program	40
Composite Approach – Cumulative Impacts	42
VII. Natural Hazard Program Recommendations	43
McMinnville’s Existing Natural Hazard Policy Framework	43
McMinnville Comprehensive Plan (2017)	43
McMinnville NHMP Plan Direction	43
Proposed Natural Hazards Comprehensive Plan Amendments	44
Proposed McMinnville Zoning Ordinance Amendments	44
Natural Hazards Inventory	44
Natural Hazards Composite Ranking System	44
Natural Hazard Probability	45
Table VII.1 Natural Hazard Risk Assessment (2021)	45

Natural Hazard Vulnerability – Oregon Natural Hazards Mitigation Plan	45
Table VII.2 Oregon NHMP Risk Assessment for Yamhill County.....	46
Combined (Cumulative) Ranking Applied Individually to Hazard Subareas	46
Table VII.3 Combined Natural Hazard Risk by Natural Hazard Type in McMinnville.....	47
Valley Area Hazard Characteristics	47
West Hills Area Hazard Characteristics.....	48
Natural Hazards – Combined Risk Categories and Related NH Subdistricts Map	48
Table VII.4 Designation of NH Subdistricts Based on Ranking of Natural Hazards Subareas	48
Recommended Natural Hazards Policy Framework	50
Multi-Hazard Policies	50
Geological Hazard Policies	54
Flood Hazard Policies	55
Wildfire Hazard Policies	56

Appendices

The following appendices support this report.

Appendix 1: Best Natural Hazards Mitigation Programs in Comparator Cities

Appendix 2: Natural Hazard Overlay Methodology

Appendix 3: REVISED Natural Hazard Inventory and Natural Hazard Overly Maps

Figures

Figure 0-1 McMinnville 2019 UGB, 2021 UGB, and Natural Hazards Study Area	6
Figure I-1 McMinnville 2021 UGB and Study Areas Slopes.....	12
Figure I-2 County Zoning within Study Area	13
Figure II-1 Geological Hazards: Moderate and High Landslide Risk.....	14
Figure II-2 Geological Hazards: Cascadia Subduction Earthquake Shaking Risk.....	18
Figure II-3 Geological Hazards: Earthquake Liquefaction Susceptibility.....	19
Figure II-4 Geological Hazard: Cascadia Subduction Earthquake Liquefaction and Shaking Risk.....	20
Figure II-5 Geological Hazards Map: Landslide, Liquefaction, Subduction Shaking and Slopes	21
Figure II-6 West Hills Geological Map: Steep Slope, Severe Shaking, Landslide and Liquefaction Risk	22
Figure III-1 Flood Hazard Map.....	23
Figure IV-1 Wildfire – Potential Impacts to People and Property with Steep Slopes.....	25
Figure V-1 Composite Map: Landslide, Liquefaction and Flood Hazards	26
Figure V-2 Composite Map: West Hill Slope, Landslide, High Earthquake Liquefaction Risk.....	27
Figure V-3 Composite Map: East Valley Floodplain, Landslide and Liquefaction Risk.....	28
Figure V-4 Composite Map: West Hills Wildfire, Landslide, and Floodplain Risk	29
Figure V-5 Composite Map: Landslide, Liquefaction, Subduction Shaking, and Steep Slopes	30

Figure VI-1 Ashland's Wildfire Hazard Overlay Zone	41
Figure VII-1 Proposed McMinnville Natural Hazards Overlay – Study Area	49
Figure VII-2 Proposed McMinnville Natural Hazards Overlay – 2021 Urban Growth Boundary	50
Figure VII-3 Greater Yamhill Watershed Council Service Area	53

Acronyms and Abbreviations

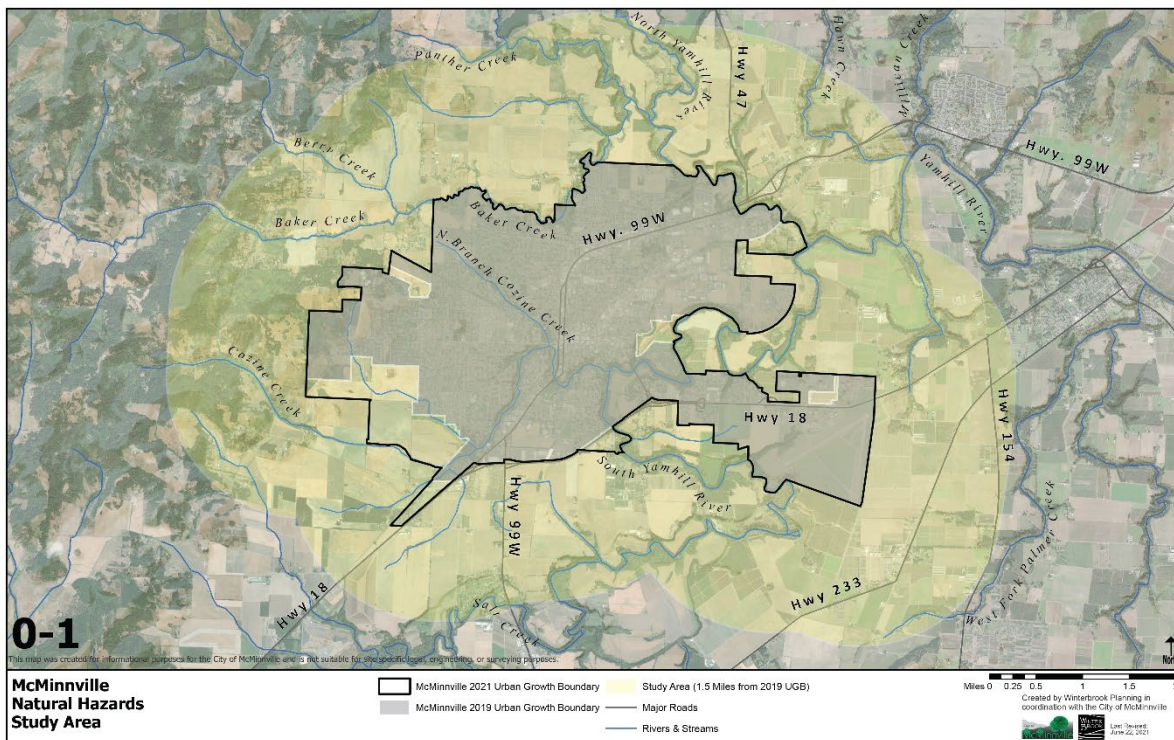
The following acronyms and abbreviations are used in this report.

- **BFE** – Base Flood Elevations
- **Cascadia** or **CSZ** — Cascadia Subduction Zone earthquake
- **CWPP** – *Yamhill County Community Wildfire Protection Plan*
- **DEM** – Digital Elevation Model
- **DOGAMI** – Oregon Department of Geology and Mineral Industries
- **FEMA** – Federal Emergency Management Agency
- **FIRM** – Flood Insurance Rate Map
- **Floodplain** – the 100-year floodplain including the floodway
- **GIS** – Geographic Information System
- **LIDAR** – Light Detection and Ranging
- **McMinnville NHMP** – *McMinnville Addendum to the Yamhill County Natural Hazards Mitigation Plan*
- **NFIP** – National Flood Insurance Program
- **NHO** – Natural Hazards Overlay (Comprehensive Plan Map Overlay)
 - **NH-M Subdistrict** – Natural Hazard Mitigation Subdistrict (Zoning Map Overlay)
 - **NH-P Subdistrict** – Natural Hazard Mitigation Subdistrict (Zoning Map Overlay)
- **OWRE** – *Oregon Wildfire Risk Explorer*
- **Oregon NHMP** – *Oregon Natural Hazards Mitigation Plan (2020)*
- **RFPD** – Rural Fire Protection Districts
- **SFHA** – Special Flood Hazard Area
- **Study Area** – the Natural Hazard Study Area (including land 1.5 miles from the 2019 UGB)
- **UGB** – McMinnville Urban Growth Boundary
- **UGMA** – Urban Growth Management Agreement
- **WUI Zone** – Wildland Urban Interface Zone

Introduction and Project Summary

In 2020, Winterbrook prepared the initial draft of the McMinnville Natural Hazards Inventory, Management Program Options and Recommendations study. The study area included (a) the McMinnville Urban Growth Boundary (UGB) as it existed in June 2020¹ and (b) the UGB expansion study area within 1.5 miles of the existing UGB². The City considered inventory information provided in the initial draft report during the UGB amendment process. In December 2020, the City Council amended its UGB to include approximately 1,280 acres of land (of which 921 acres were considered “buildable”). The County subsequently adopted, and the Land Conservation and Development acknowledged, the UGB amendment. Figure 0-1 shows the 2021 UGB expansion area in relation to the previously existing 2019 and the Natural Hazards Study Area.

Figure 0-1 McMinnville 2019 UGB, 2021 UGB, and Natural Hazards Study Area



In March 2021, the City contracted with Winterbrook Planning to revise the 2020 natural hazards study to (a) focus on the expanded 2021 UGB, (b) include social vulnerabilities described in the *Oregon Natural Hazards Mitigation Plan* (Oregon NHMP) in the natural hazards composite ranking system, (c) amend the proposed Natural Hazard Mitigation and Protection maps accordingly, and (d) prepare draft amendments to the McMinnville Zoning Ordinance to include natural hazard mitigation and protection subdistrict maps and text.

¹ Referenced throughout this document as the 2019 UGB.

² Referenced throughout this document as the 2021 UGB.

The revised study includes an inventory of natural hazards based on available mapping sources, considers alternative management options, and suggests policy and mapping amendments to the McMinnville Comprehensive Plan to systematically address McMinnville’s mappable natural hazards within the 2021 UGB.³

The revised natural hazards inventory includes a series of GIS (geographic information system) overlay maps showing moderate, high and severe hazard areas within the 2021 UGB and study area. The inventory also includes a description of the following natural hazards and how they may adversely affect life and property:

- **Geological Hazards** (areas subject to landslide, steep slope and earthquake liquefaction and shaking impacts)
- **Flood Hazards** (areas within the 100-year floodplain including the floodway)
- **Wildfire Hazards** (areas that are particularly susceptible to wildfires due to topography, fuel and settlement patterns)
- **Composite Hazards** (areas with one or more overlapping natural hazard categories)

McMinnville Comprehensive Plan

This revised study helps to implement recent amendments to the *McMinnville Comprehensive Plan* (Comprehensive Plan) to incorporate Great Neighborhood Principles and implementing policies.

Policy 187.40 *The Great Neighborhood Principles shall guide long range planning efforts including, but not limited to, master plans, small area plans, and annexation requests. The Great Neighborhood Principles shall also guide applicable current land use and development applications.*

Policy 187.50.1 directly addresses natural features (including natural hazard) management:

1. ***Natural Feature Preservation.*** *Great Neighborhoods are sensitive to the natural conditions and features of the land. a. Neighborhoods shall be designed to preserve significant natural features including, but not limited to, watercourses, sensitive lands, steep slopes, wetlands, wooded areas, and landmark trees.*

The existing comprehensive plan addresses flood hazards only – consistent with Federal Emergency Management Agency (FEMA) regulations related to the National Flood Insurance Program (NFIP). The current comprehensive plan does not have a separate natural hazards element. The McMinnville Zoning Ordinance has a separate F-P Flood Hazard Zone that applies to land within the 100-year floodplain. However, the City currently lacks development standards for geological and wildfire hazards. The McMinnville Buildable Lands Inventory (ECONorthwest, 2003) identifies slopes of 25% or greater and floodplains as unbuildable consistent with applicable state law.

³ Winterbrook addresses relationships among natural hazards and natural resources (such as riparian and upland wildlife habitat and scenic views and viewpoints) in a separate white paper.

McMinnville Natural Hazards Mitigation Plan

Recognizing that McMinnville is subject to several other natural hazards, the City has participated in the preparation of the *McMinnville Addendum to the Yamhill County Natural Hazards Mitigation Plan* (McMinnville NHMP).⁴

The mission of the McMinnville NHMP is:

To promote public policy and mitigation activities which will enhance the safety to life and property from natural hazards.

The McMinnville NHMP includes the following natural hazard goals related to the management of natural hazards:

GOAL 4: PREVENTIVE: *Develop and implement activities to protect human life, commerce, and property from natural hazards. Reduce losses and repetitive damage for chronic hazard events while promoting insurance coverage for catastrophic hazards.*

GOAL 6: IMPLEMENTATION: *Implement strategies to mitigate the effects of natural hazards and increase the quality of life and resilience of economies in Yamhill County.*

GOAL 7: DEVELOPMENT: *Communities appropriately apply development standards that consider the potential impacts of natural hazards.*

The McMinnville NHMP includes a series of GIS hazard maps and recommends specific “measures” to implement these goals. These recommended natural hazard mitigation measures, along with the natural hazard management practices of six comparable Oregon cities, provide the foundation for developing a geographically based natural hazards management program.

Oregon Natural Hazards Mitigation Plan

The Oregon NHMP was amended in 2020 and incorporates social equity factors when ranking natural hazard risks. Broadly, the State risk assessment is based on 3 variables, (1) the probability of the event happening, (2) the physical vulnerability of the event happening, and (3) the social vulnerability of the event happening. The Oregon NHMP groups these factors by County. Winterbrook included the State’s ranking for physical and social vulnerabilities with the localized probability of the natural hazard event occurring. This inclusion provides the revised ranking system presented in Chapters V and VI of this report.

Statewide Planning Goal 7 (Natural Hazards)

As recognized by Goal 7 (Natural Hazards), natural hazards pose risks to life and property that can be mitigated by effective planning. Goal 7 requires each local government to identify and develop programs to mitigate impacts for natural hazards.

A. NATURAL HAZARD PLANNING 1. Local governments shall adopt comprehensive plans (inventories, policies and implementing measures) to reduce risk to people and

⁴ The McMinnville NHMP also considers information found in the *Yamhill County Community Wildfire Protection Plan* (Yamhill County CWPP).

property from natural hazards. 2. Natural hazards for purposes of this goal are: floods (coastal and riverine), landslides, earthquakes and related hazards, tsunamis, coastal erosion, and wildfires. Local governments may identify and plan for other natural hazards.

This report meets Goal 7 requirements by (a) inventorying natural hazards and assessing the risks they pose to people and property and (b) recommending a program to mitigate the effects of mapped natural hazards within the McMinnville UGB and study area.

Overlapping Natural Hazards

In this report, Winterbrook also looks at relationships that exist among natural hazards based on a series of geographic information system (GIS) overlay maps.

- For example, McMinnville’s West Hills and associated downslope areas are especially threatened by a combination of geological, wildfire and flood hazards.
- In low-lying areas, the Yamhill River and its tributaries are subject to overlapping flooding, slide hazards (bank failures) and wildfires fueled by riparian vegetation in dry conditions.
- Most of the McMinnville study area outside the West Hills is subject to strong or very strong earthquake liquefaction and shaking hazards due to underlying soil conditions.

Recognizing these inter-relationships and the threats posed by natural hazards to people, public infrastructure and private property, Winterbrook proposes a natural hazards mitigation program that addresses the combined impacts of geological, flood and wildfire hazards. The proposed program includes amendments to the McMinnville Comprehensive Plan and Plan Map that would include:

- **A new Chapter XI: Natural Features that includes policies addressing multi-hazard, geological, flooding and wildfire impacts and mitigation within the McMinnville Natural Hazards Study Area.**
- **A new Natural Hazards Overlay Map that would be implemented by two zoning subdistricts – with graduated development standards depending on the combination of and severity of hazards found in specific geographic subareas in the community.**

Report Organization

In addition to the Introduction, this report is organized into seven sections:

- **Section I Revised Inventory Methods** and information sources. The study area includes land within the McMinnville 2021 UGB and land within 1.5 miles of the 2019 UGB. The Inventory considers mappable geological, flooding and wildfire hazard areas.
- **Section II Revised Geological Hazards Inventory** is based on the McMinnville NHMP (which in turn is largely based on Oregon Department of Geology and Mineral Industries (DOGAMI) data). The Geological Hazards Inventory focuses on land within the McMinnville study area and includes areas susceptible to landslides, earthquake liquefaction and earthquake shaking. Inventory maps show moderate, high and severe hazard areas and include descriptions of and threats from each type of geological hazard.

- **Section III Revised Flood Hazard Inventory** is based on existing FEMA maps of the 100-year floodplain. This inventory will likely change based on planned updates and improved data sources.
- **Section IV Revised Wildfire Hazard Inventory** is based on the McMinnville NHMP, the Yamhill County CWPP, and application of the *Oregon Wildfire Risk Explorer* to the McMinnville study area.
- **Section V Natural Hazards – Cumulative Impacts Analysis** is based on Winterbrook’s analysis of overlapping natural hazards maps to better understand the spatial relationships that exist among McMinnville’s geological, flooding and wildfire hazard areas. The revised Section V incorporates social factors from the Oregon NHMP.
- **Section VI Natural Hazards Management Options** is based on the recommendations of the McMinnville NHMP, the management programs of six comparator communities, the McMinnville-specific natural hazards inventory found in Sections II-V, and recognition of the cumulative impacts of overlapping natural hazards in McMinnville’s West Hills and lower elevation drainage systems.
- **Section VII Natural Hazards Program Recommendations** is based on information found in Sections I – VI, comments from the McMinnville planning staff, evaluation of natural hazards programs in other communities, and Winterbrook’s experience in preparing natural features management plans. Section VII provides the basis for Zoning Ordinance amendments that include text and maps for Natural Hazard Mitigation and Protection Subdistricts.

I. Natural Hazards Inventory Methods

Information Sources

Winterbrook conducted the McMinnville Natural Hazards Inventory in May and June of 2020 using publicly available sources of hazard information from:

- The Oregon Department of Geology and Mineral Industries (DOGAMI). DOGAMI GIS data is publicly accessible via the [Oregon HazVu: Statewide Geohazards Viewer](#);⁵
- The *McMinnville Addendum to the Yamhill County Natural Hazards Mitigation Plan* (McMinnville MHMP); and
- The *Yamhill County Community Wildfire Protection Plan* (CWPP). Wildfire risk information is available for Oregon regions by using the [Oregon Wildfire Risk Explorer](#).⁶
- Winterbrook amended the natural hazards ranking system to incorporate social indicators found in the 2020 Oregon NHMP in April-May 2021.

The McMinnville Natural Hazards Study Area

Working with Senior Planner Tom Schauer in 2020, Winterbrook reviewed GIS data sources for the Natural Hazards Study Area, which included two subareas shown in Figure I-1: (a) land within the McMinnville 2019 UGB and (b) land within UGB expansion study areas – generally 1.5 miles from the 2019 UGB.⁷

Mappable Hazards

In this study, Winterbrook focused on natural hazards within the 2021 McMinnville UGB that are (a) mappable using GIS technology (i.e., flood plains, steep slopes, soils subject to earthquake liquefaction and shaking, landslide areas, and areas susceptible to wildfires) and (b) classified in the McMinnville NHMP (which in turn is based on DOGAMI and CWPP information) as having moderate and high risk. Such areas are potentially subject to natural hazards overlay zones that include development standards to mitigate impacts.

The draft McMinnville NHMP describes and ranks McMinnville’s vulnerability to the following mappable natural hazards⁸ and suggests hazard-specific mitigation measures for moderate and high-risk hazards:

- Earthquake hazards (crustal and Cascadia Subduction Zone);
- Landslide and erosion hazards (including steep slopes);
- Flood hazards; and
- Wildfire hazards.

Working with City staff, Winterbrook prepared GIS base maps for moderate and high-risk natural hazard areas. As noted above, this analysis relies primarily on statewide mapping information provided by

⁵ <https://www.oregongeology.org/hazvu/>

⁶ https://tools.oregonexplorer.info/OE_HtmlViewer/index.html?viewer=wildfireplanning

⁷ The 1.5 mile study area represents an area of mutual interest between the city and county and area that was under consideration by the City of McMinnville for potential UGB expansion in 2020.

⁸ Since only mappable hazards are subject to overlay zoning overlay regulations, Winterbrook did not consider drought, severe weather and volcanic events in this inventory.

DOGAMI for flood and geological hazards. To map wildfire hazards we used the [Oregon Wildfire Risk Explorer](#) to generate several wildfire risks maps.

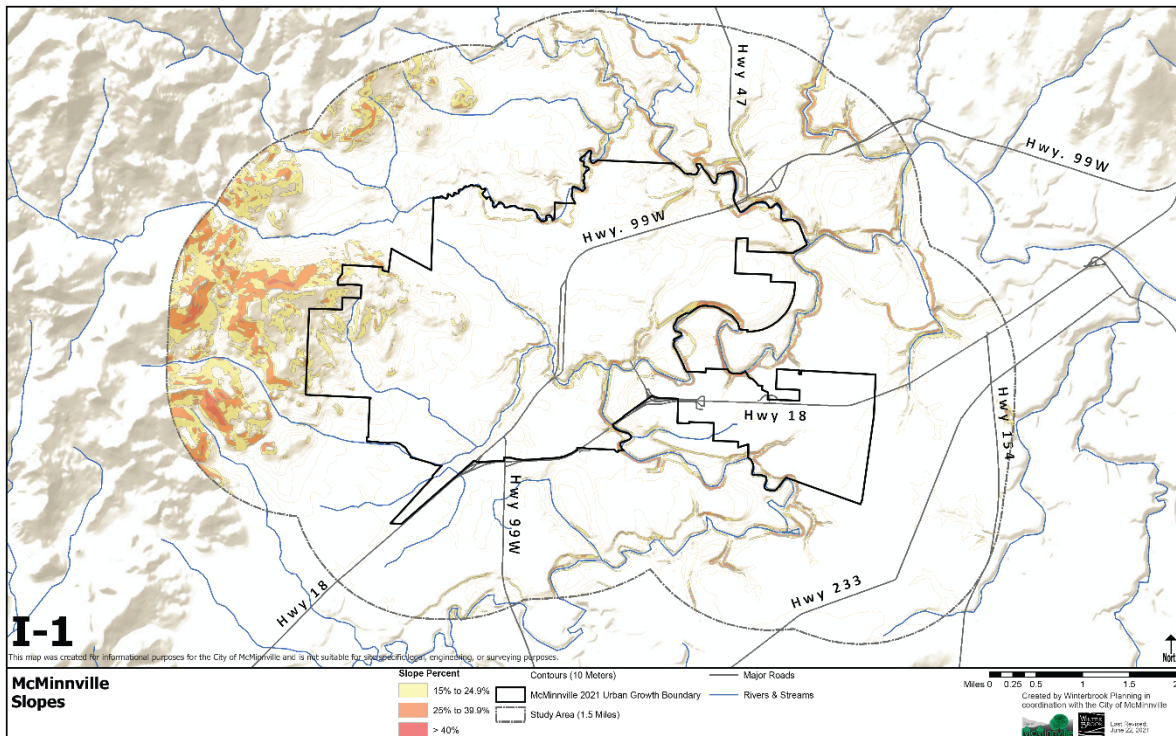
As discussed in Section V of this report, Winterbrook also prepared several composite hazard maps that show spatial relationships among geological, flooding and wildfire hazards. In 2021, Winterbrook worked with Associate Planner Jamie Fleckenstein to incorporate social indicators from the Oregon NHMP into this revised 2021 inventory.

Figure I-1 shows three slope categories within the McMinnville study area that are related to the location and severity of geological, flood (stream bank erosion) and wildfire hazards.

McMinnville Slope Hazards

Steep slopes are associated with wildfire hazards and geological hazards. Slope percentage is used by many jurisdictions to determine whether geological studies should be required prior to development. Slopes of 25% or greater are considered “unbuildable” when preparing buildable lands inventories under state housing rules. (OAR 660-008-005 Definitions) The City of McMinnville also requires sprinkler systems to reduce fire hazards on slopes of 15% or greater. For these reasons, slope percentage is considered in several of the composite maps found in the natural hazards inventory. Steep slopes are found mostly in McMinnville’s West Hills and define the banks of the study area streams and rivers.

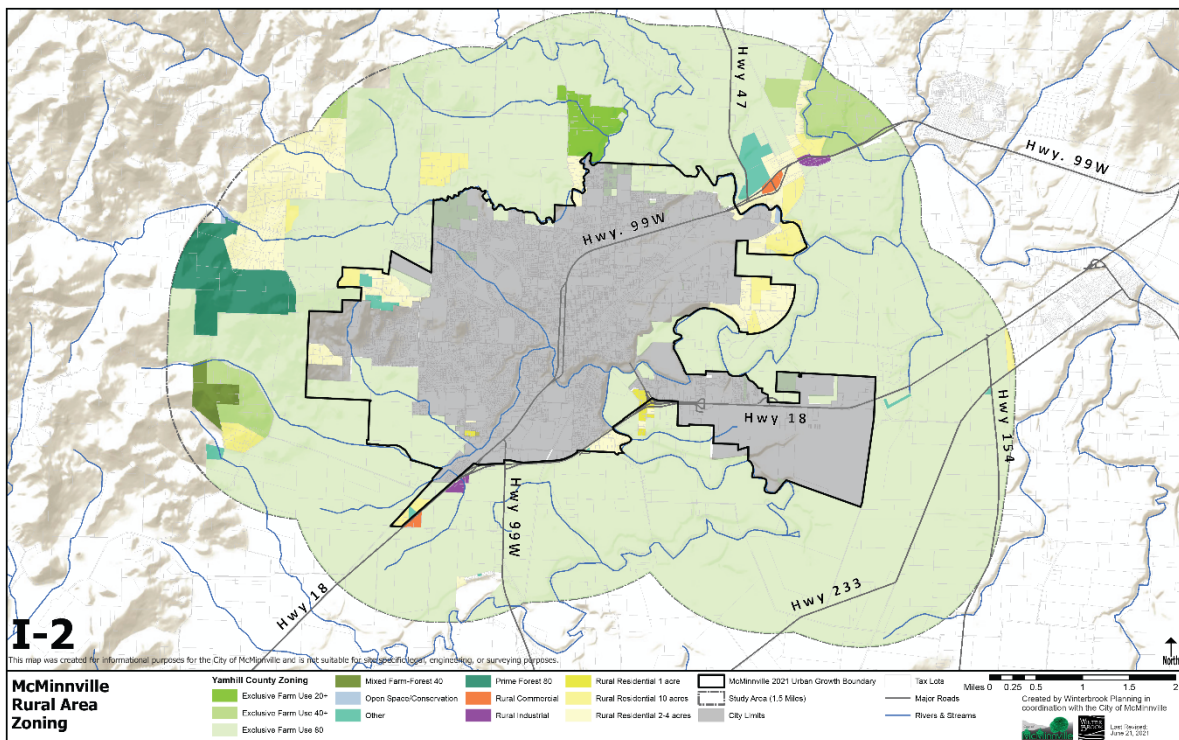
Figure I-1 McMinnville 2021 UGB and Study Areas Slopes



Yamhill County Zoning

Figure I-2 shows Yamhill County zoning outside the McMinnville City Limits. County zoning partially determines land use and density outside the 2021 McMinnville UGB – which in turn is related to hazard vulnerability to life and property. A larger scale and more readable zoning map is available in 11" X 17" format. In Yamhill County land that is zoned for forest use (the Agricultural Forest and Forestry Districts) in the forested West Hills is subject to specific wildfire protection (fuel reduction zones, fire suppression and access) standards for new structures.

Figure I-2 County Zoning within Study Area



II. Geological Hazards Inventory

Section II considers landslide, earthquake and steep slope hazards both individually and in combination.

Data Sources

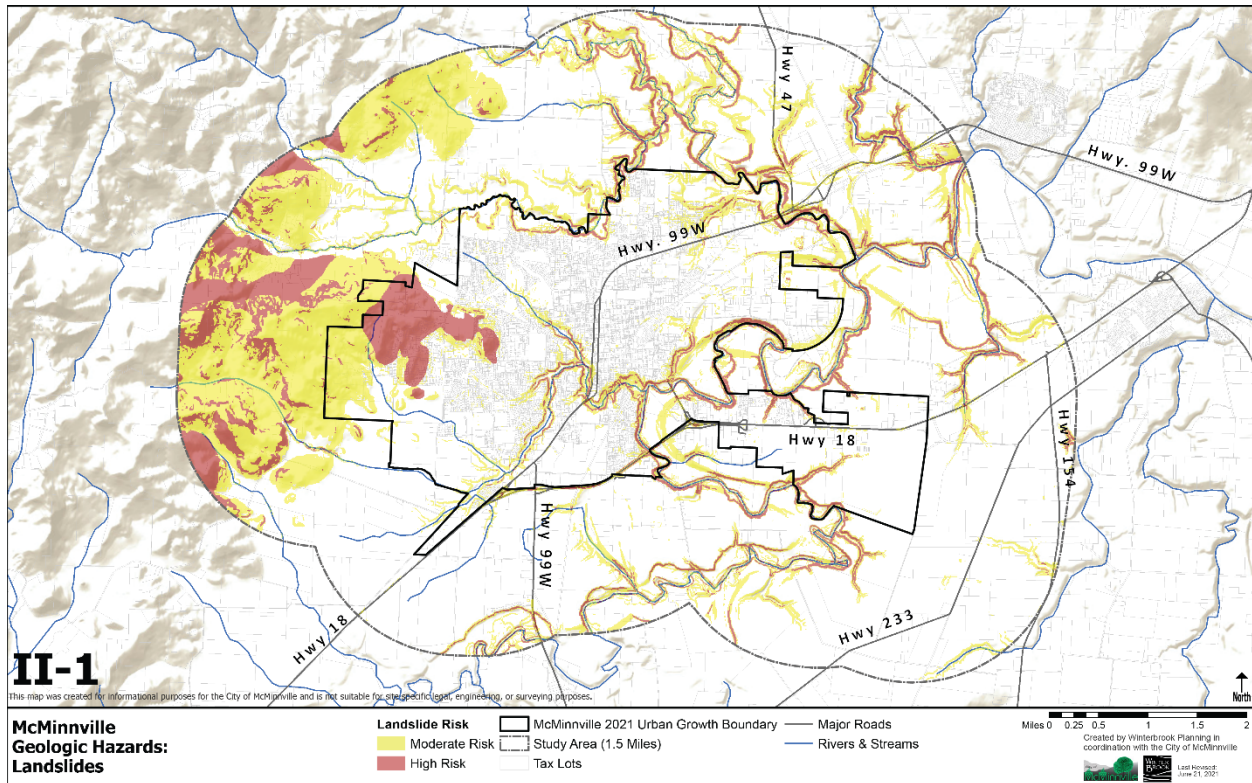
Winterbrook relied on landslide and slope hazard maps available on DOGAMI's Statewide Geohazards Viewer to identify potential landslide and slope hazards:

- DOGAMI: Landslide susceptibility
- DOGAMI: Landslide inventory - Statewide Landslide Information Database for Oregon (SLIDO)
- DOGAMI LIDAR: Hillshade and slope
- DOGAMI: Earthquake shaking and liquefaction risks

Landslide Hazard

The McMinnville NHMP describes and maps areas with moderate and high landslide hazard susceptibility based on the HazVu: Statewide Geohazards Viewer (DOGAMI). Figure II-1 shows moderate and high-risk landslide areas within the study area.

Figure II-1 Geological Hazards: Moderate and High Landslide Risk



Areas that are moderately and highly prone to landslides are found predominately in McMinnville’s West Hills and secondarily along Baker Creek, Berry Creek, Cozine Creek and South Yamhill River embankments. Two high-risk landslide areas are located in McMinnville’s West Hills: at lower elevation in the western extension of the UGB and at higher elevation in the western extension of the study area. Note that a large band of moderate landslide risk separates these two high-risk areas.

Earthquake Hazards

The McMinnville NHMP and this inventory consider and map the effects of two types of earthquakes:

1. Crustal earthquakes that could emanate from nearby faults and/or zones; and
2. The Cascade Subduction Zone Earthquake.

Potential earthquake hazards include two related and mappable effects: shaking from ground motion and liquefaction due to porous or “soft” soils can result from both types of earthquakes. Earthquakes can also trigger landslides in areas shown on Figure II-1.

Crustal and Cascadia Subduction Zone Earthquakes

The Yamhill County Multi-Jurisdictional NHMP describes the two types of earthquakes and explains their hazardous effects as follows (pp. 4-10 and 4-11):

“An earthquake is a sudden motion or trembling of the earth produced by the rupture of rocks due to stresses beyond the rocks’ elastic limits. The effects of an earthquake can be felt far beyond the site of its occurrence. Earthquakes usually occur without warning and, after just a few seconds, can cause massive damage and extensive casualties. The most common effect of earthquakes is ground motion, or the vibration or shaking of the ground during an earthquake.

The severity of ground motion generally increases with the amount of energy released and decreases with distance from the fault or epicenter of the earthquake. Ground motion causes waves in the earth’s interior, also known as seismic waves, and along the earth’s surface, known as surface waves. ...

In addition to ground motion, several secondary hazards can occur from earthquakes, such as surface faulting. Surface faulting is the differential movement of two sides of a fault at the earth’s surface. Displacement along faults, both in terms of length and width, varies but can be significant (up to 20 feet), as can the length of the surface rupture (up to 200 miles). Surface faulting can cause severe damage to linear structures, such as railways, highways, pipelines and tunnels.

Earthquake-related ground failure due to liquefaction is another secondary hazard. Liquefaction occurs when seismic waves pass through saturated granular soil, distorting its structure, and causing some of the empty spaces between granules to collapse. Porewater pressure may also increase sufficiently to cause the soil to briefly become fluid.

Liquefaction causes lateral spreads (horizontal movements of commonly 10 to 15 feet, but up to 100 feet), flow failures (massive flows of soil, typically hundreds of feet, but up to 12 miles) and loss of bearing strength (soil deformations causing structures to settle or tip). Liquefaction can cause severe damage to property.

The most common earthquakes that occur in Oregon are crustal, intraplate or great subduction earthquakes. Yamhill County is most susceptible to deep intraplate and subduction zone earthquakes. These are described as follows:

Crustal earthquakes: *These generally occur along shallow faults near the earth’s surface. Crustal earthquakes make up the majority of earthquakes in the Cascadia area (western Washington, Oregon and northwestern California) and are a result of fault movement in the Earth’s surface. These shallow earthquakes are usually less than 7.5 magnitude and strong shaking generally lasts 20 to 60 seconds. Aftershocks,*

as well as tsunamis and landslides, are anticipated after a crustal event. The Mount Angel Fault is located approximately 15 miles from Yamhill County, and is responsible for the 5.7 magnitude Spring Break Quake in 1993.

Great subduction earthquakes: *occur offshore of the Oregon and Washington Coasts along the Cascadia Subduction Zone. This zone is the result of the Juan de Fuca plate being pushed under the North American plate. Earthquakes centered along this zone can be as great as 9.0 magnitude. Geologic evidence demonstrates approximately 500 years between events with the last significant event on January 26, 1700. Aftershocks up to 7.0 magnitude are anticipated to cause additional damage. Liquefaction, tsunamis and landslides are expected as a result of a great subduction earthquake.*

Quoting from the DOGAMI website <https://www.oregongeology.org/earthquakes/earthquakehome.htm>

Earthquake hazards have been recognized as one of the major natural hazards in Oregon since the late 1980s, a result of the geologic research to identify and characterize the Cascadia subduction zone and crustal faults. The March 1993 Scotts Mills earthquake (M5.6) and the September 1993 Klamath Falls earthquakes (M5.9 and M6.0) demonstrated the potential hazards of crustal earthquakes in Oregon.

According to the McMinnville NHMP (p. MA-37)

Within the Northern Willamette Valley that includes Yamhill County, two potential faults and/or zones can generate high-magnitude earthquakes. These include the Cascadia Subduction Zone and the Gales Creek-Newberg-Mt. Angel Structural Zone (including the Newberg Fault).

Crustal earthquakes can cause serious local damage, as recognized in the Yamhill County Natural Hazard Mitigation Plan (2014):

Crustal earthquakes also occur in the Willamette valley although with smaller expected magnitudes (M 5.0-M 7.0). Although these earthquakes are expected to be much smaller than a Cascadia Subduction Zone earthquake, they are more likely to occur close to population centers and are capable of causing severe shaking and damage in localized areas.

Although crustal earthquakes are more common than great subduction earthquakes (see <https://pnsn.org/earthquakes/recent>), the Cascadia Subduction Zone (CSZ or Cascadia) earthquake is certain to occur sometime in the future and could occur at any time.

Again, according to the McMinnville NHMP:

Cascadia Subduction Zone

The Cascadia Subduction Zone is a 680-mile-long zone of active tectonic convergence where oceanic crust of the Juan de Fuca Plate is subducting beneath the North American continent at a rate of 4 cm per year. Scientists have found evidence that 11 large, tsunami-producing

earthquakes have occurred off the Pacific Northwest coast in the past 6,000 years. These earthquakes took place roughly between 300 and 5,400 years ago with an average occurrence interval of about 510 years. The most recent of these large earthquakes took place in approximately 1700 A.D.

The city's proximity to the Cascadia Subduction Zone, potential slope instability, and the prevalence of certain soils subject to liquefaction, and amplification combine to give the City a high-risk profile. Due to the expected pattern of damage resulting from a CSZ event, the Oregon Resilience Plan divides the State into four distinct zones, and places McMinnville within the "Valley Zone" (Valley Zone, from the summit of the Coast Range to the summit of the Cascades). Within the Northwest Oregon region, damage, and shaking is expected to be strong, and widespread - an event will be disruptive to daily life, and commerce, and the main priority is expected to be restoring services to business and residents.

Quoting from the Cascadia Playbook (Oregon Office of Emergency Management, 2018):

A Cascadia event is based on the threat of a catastrophic magnitude 9.0 Subduction Zone earthquake and resultant tsunami. Coastal counties will experience a devastating tsunami on top of severe ground shaking (up to five minutes). Shaking intensity will be less in the I-5 Corridor and Southern, Central, and Eastern Oregon, but older buildings may incur extended damage. Expected Impacts

- Ground shaking for 4-6 minutes causing massive critical infrastructure damage*
- Liquefaction and landslides causing disruption of transportation routes*
- Tsunami inundation to coastal areas with as little as 15 minutes warning*
- Up to 25,000 fatalities resulting from combined effects of earthquakes and tsunami*
- Tens of thousands of buildings and structures destroyed or damaged*
- Tens of thousands of people in need of shelter because of destroyed or damaged households*
- \$30+ billion in economic loss*

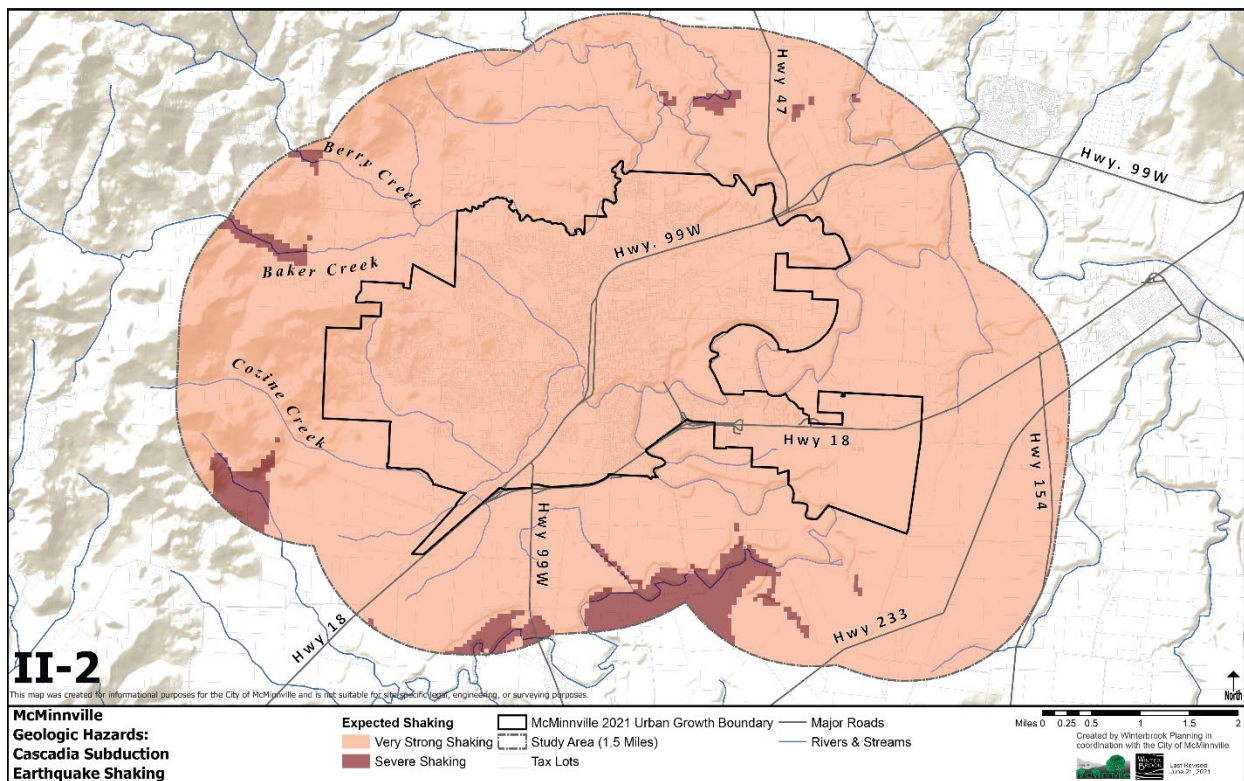
Although coastal communities will experience greater impacts than Willamette Valley communities, McMinnville's location at the base of the Coast Range makes it highly susceptible to Cascadia Subduction Zone earthquake damage. **Because the impacts from the Cascadia Subduction Zone earthquake would be so severe, Winterbrook's analysis and recommendations focus on impacts from the Cascadia event.**

Earthquake Shaking Hazard Areas

DOGAMI provides data and maps for both crustal and subduction earthquakes. Since great subduction earthquakes are more severe and has a high probability of occurring occur over the next 50 years, Winterbrook used DOGAMI subduction earthquake mapping for this analysis.

Figure II-2 shows areas susceptible to “very strong” and “severe” shaking that could result from the Cascadia Subduction Zone Earthquake. As with a crustal earthquake, most of the study area will experience strong shaking in the subduction earthquake. Severe shaking areas include the upper Baker Creek valley and south of Cozine Creek as well as a large area southwest of the airport. The amended UGB did not include severe shaking areas.

Figure II-2 Geological Hazards: Cascadia Subduction Earthquake Shaking Risk

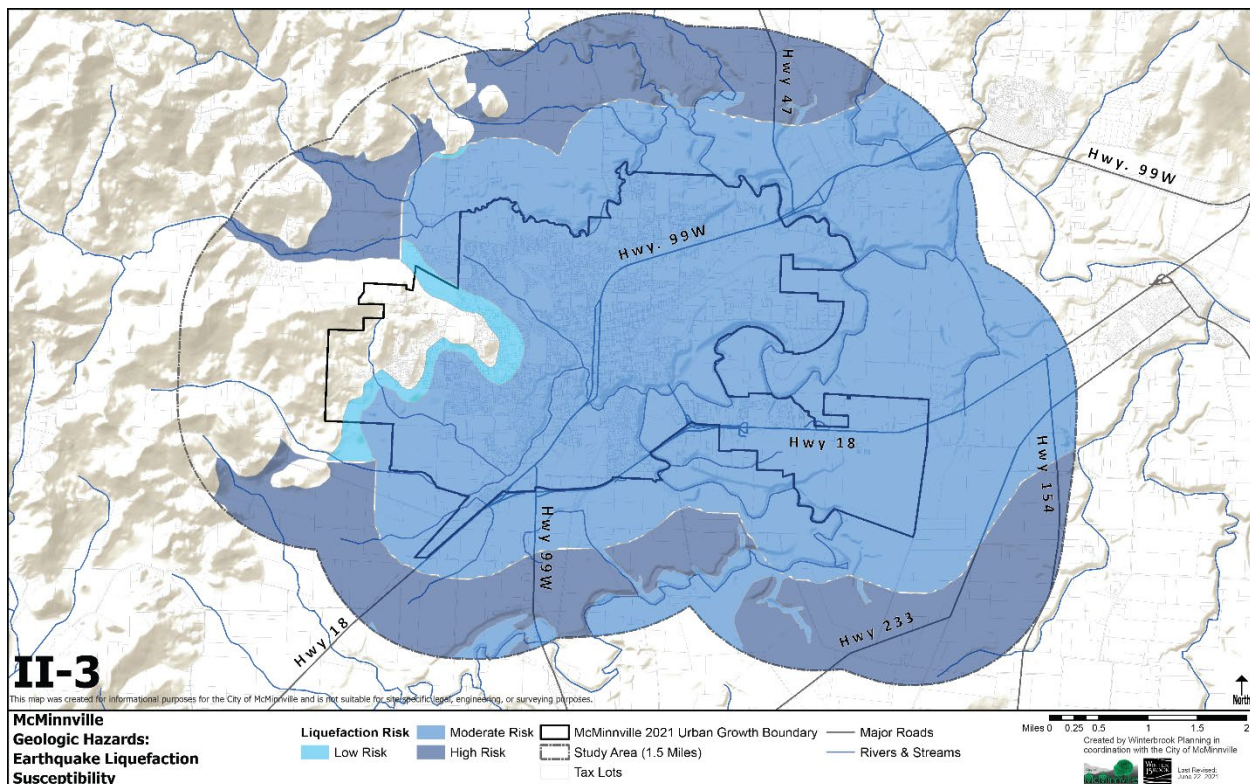


Earthquake Liquefaction Hazard Areas

Liquefaction occurs from both types of earthquakes and results from soft soils. All land within the existing UGB is subject to moderate liquefaction. Areas of moderate liquefaction extend about 0.5 miles north and south of the UGB, and much further beyond the study area boundary east of the UGB.

- Areas of high liquefaction susceptibility extend from 0.5 to 0.75 miles from the UGB to the north and south. The amended UGB did not include high liquefaction areas.
- The West Hills are characterized by high bedrock and less alluvial soil are not subject to liquefaction – except along stream corridors.
- Note the large moderate liquefaction area that extends into the high liquefaction areas southwest of the airport – at the bottom center of Figure II-4. This nodal extension is mapped as a severe shaking area on Figure II-3 which shows the relationship between moderate and high liquefaction and shaking areas.

Figure II-3 Geological Hazards: Earthquake Liquefaction Susceptibility

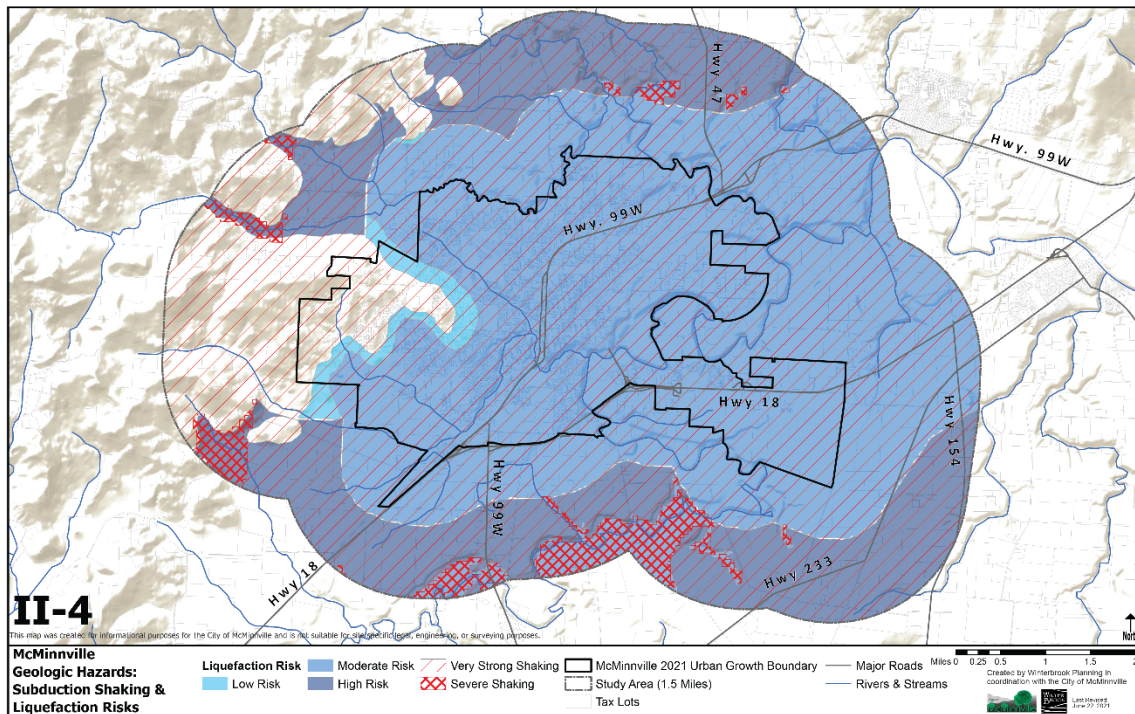


Combined Earthquake Liquefaction and Shaking Hazard Areas

Figure II-4 shows the relationship that exists among high and moderate liquefaction areas and “very strong” and “severe” earthquake shaking areas.

- Note that land within and extending outside the amended McMinnville UGB has moderate liquefaction risk and “very strong” shaking risk.
- However, a large band of high liquefaction risk and “severe” shaking risk is appears the northern and southern areas at a more or less uniform distance from the edge of the study area.
- Finally, note the severe shaking area southwest of the Airport (largely in the South Yamhill River floodplain) shown on Figure II-4 that corresponds roughly with the moderate liquefaction area shown on Figure II-3 above.
- The amended UGB did not include areas with severe shaking risk or high liquefaction risk.

Figure II-4 Geological Hazard: Cascadia Subduction Earthquake Liquefaction and Shaking Risk



Composite Geological Risk Maps

Figure II-5 is a composite map showing slopes of 15% or greater, landslide hazard and earthquake liquefaction hazard areas. We offer the following observations:

- Note the inverse relationship that exists between (a) steep slopes and the moderate to high risk earthquake risks in the West Hills and (b) moderate to high risk earthquake liquefaction areas to the north, south and east of the UGB.
- Moderate risk geological hazard areas (relatively flat areas with moderate liquefaction hazards and low landslide hazards) are found to the north and south of the UGB. High risk earthquake liquefaction areas are located further to the northwest and south.
- In weighing geological hazard risks, it may be more advisable to direct future urban growth to areas that have areas with moderate geological hazard risk rather than higher risk areas.
- As shown more clearly on 11" by 17" maps accompanying this report, there is rough correlation between 15% and greater slopes and landslide hazard areas, indicating that slope percentage should not be the only threshold for requiring erosion control geotechnical studies.

Figure II-5 Geological Hazards Map: Landslide, Liquefaction, Subduction Shaking and Slopes

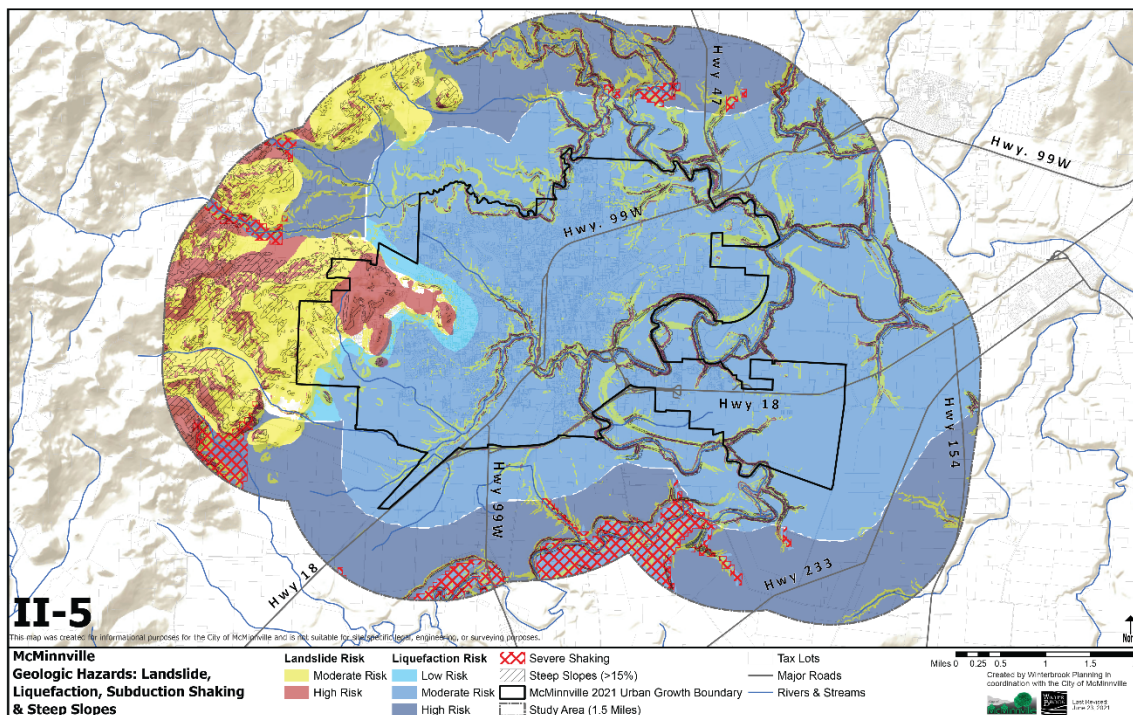


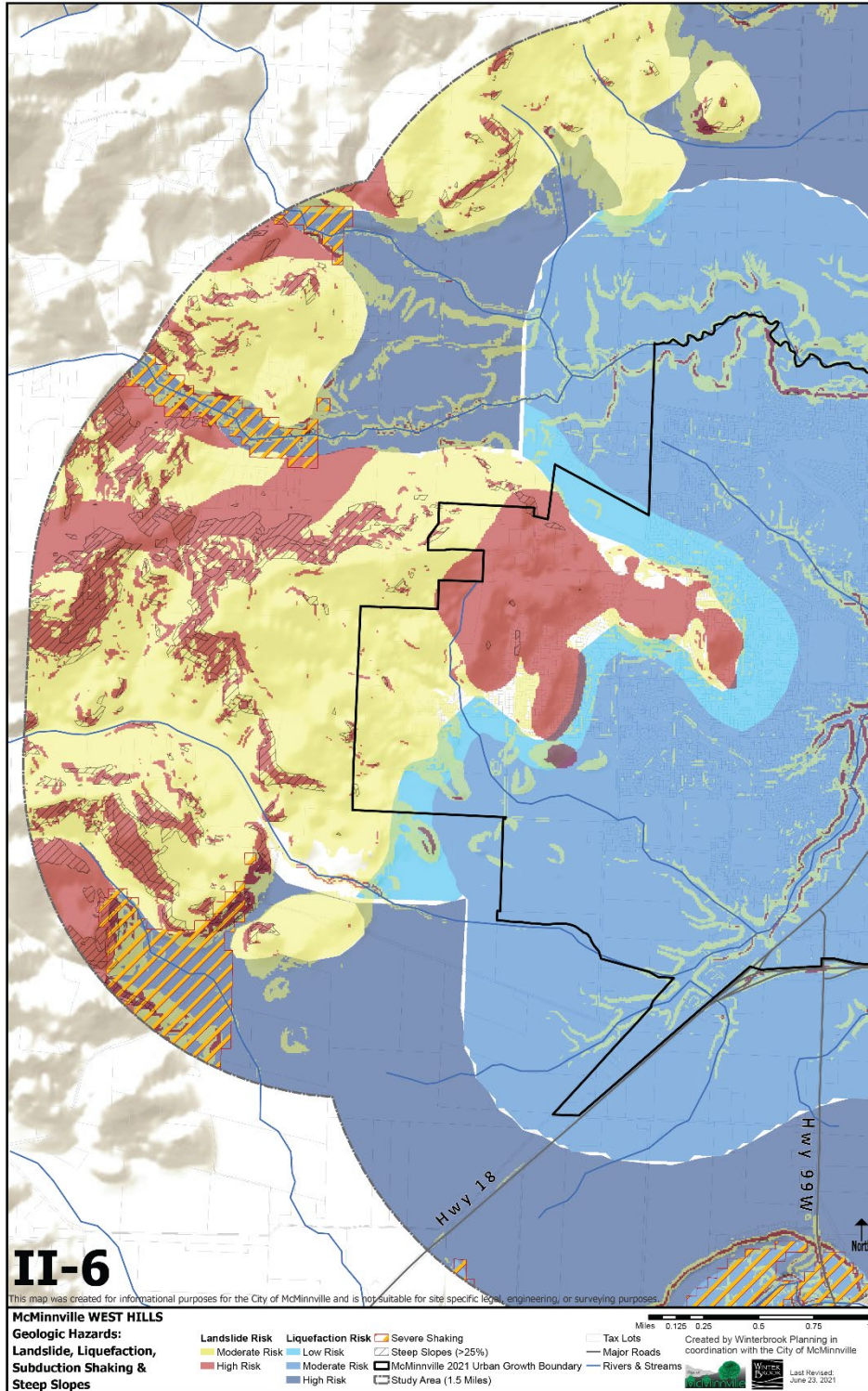
Figure II-6 zooms in on the West Hills to look more closely at the relationships among slopes of 25% and greater, moderate and high risk landslide liquefactions areas, severe risk landslide shaking areas, and moderate to high risk landslide areas.

Please note the following:

- The high correlation between slopes of 25% or greater and high risk landslide areas.

- The inverse relationship between (a) moderate to high risk landslide areas and (b) high risk liquefaction areas and severe earthquake shaking areas north and south of the West Hills.

Figure II-6 West Hills Geological Map: Steep Slope, Severe Shaking, Landslide and Liquefaction Risk

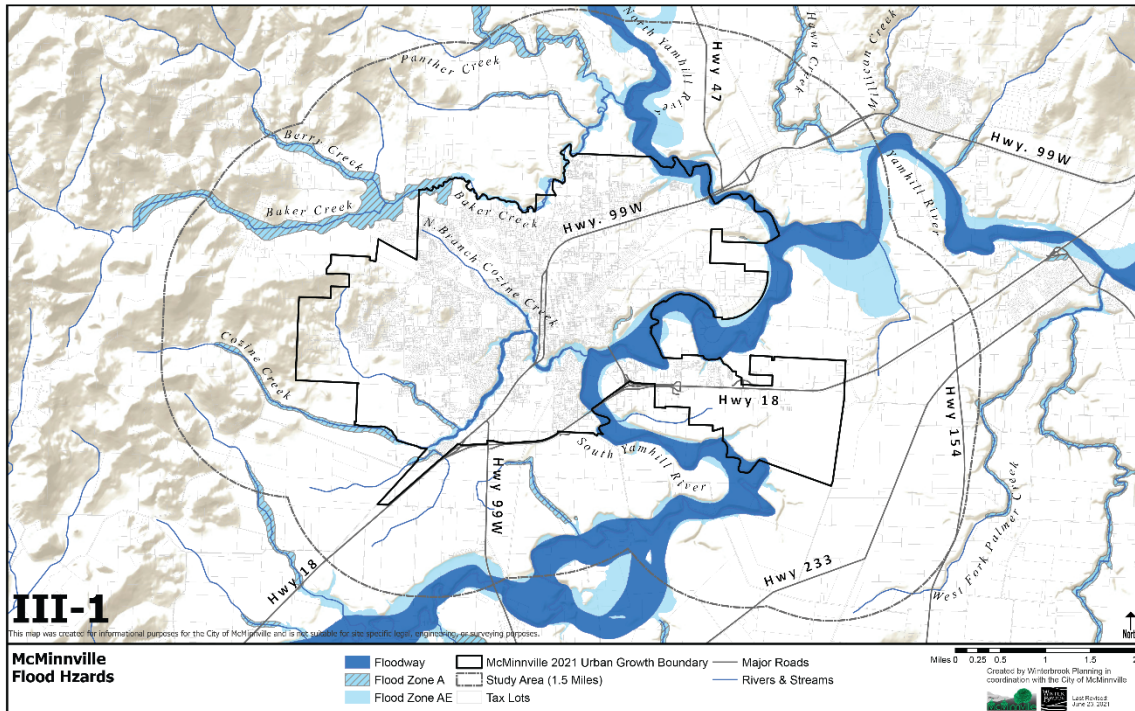


III. Flood Hazard Inventory

Flood Hazard GIS Data Sources and Analysis

Winterbrook relied on flood hazard maps available on DOGAMI’s Statewide Geohazards Viewer found in the McMinnville NHMP. Flood hazards include: Zone A, Zone AE, and the Floodway.⁹ As shown on Figure III-1, flood hazards within the study area are associated with Cozine Creek, Berry Creek, Baker Creek and the Yamhill River.

Figure III-1 Flood Hazard Map



⁹ Winterbrook’s understanding is FIRM maps were used as the basis for DOGAMI’s statewide inventory.

FEMA Floodway Definition/Description:

A "Regulatory Floodway" means the channel of a river or other watercourse and the adjacent land areas that must be reserved in order to discharge the base flood without cumulatively increasing the water surface elevation more than a designated height. Communities must regulate development in these floodways to ensure that there are no increases in upstream flood elevations. For streams and other watercourses where FEMA has provided Base Flood Elevations (BFEs), but no floodway has been designated, the community must review floodplain development on a case-by-case basis to ensure that increases in water surface elevations do not occur or identify the need to adopt a floodway if adequate information is available.

About Flood Zones: Flood hazard areas identified on the Flood Insurance Rate Map are identified as a Special Flood Hazard Area (SFHA). SFHA are defined as the area that will be inundated by the flood event having a 1-percent chance of being equaled or exceeded in any given year. The 1-percent annual chance flood is also referred to as the base flood or 100-year flood. SFHAs on Figure III-1 are labeled Floodway, Zone A and Zone AE. Zone A indicates areas where base flood elevations (BFE) have not been fully determined. Additional work is required to define the BFEs in the upper reaches of the Baker, Cozine and Berry Creek floodplains.

IV. Wildfire Hazard Inventory

Wildfire GIS Data Sources

The **Yamhill County Community Wildfire Protection Plan (CWPP, Revised 2015)** identifies two Wildland Urban Interface Zones (WUI Zones). Zone I is comprised mostly of commercial forest land in West Yamhill County. Zone II includes agricultural land, urban areas and forested uplands in East Yamhill County. The McMinnville study area is mostly within Zone II which includes agricultural, forest and rural residential land within the McMinnville study area.

According to the CCWP, Zone II has a “high” county-wide wildfire hazard ranking. However, some Zone II areas are more at risk than others. For example, rural residential forested slopes near the Newberg and McMinnville urban areas are more at risk than unpopulated agricultural land.

The McMinnville NHMP (pp. MA 50-52) summarizes key findings in the Yamhill County CWPP:

The location, and extent of a wildland fire vary depending on fuel, topography, and weather conditions. Weather, and urbanization conditions are primarily at cause for the hazard level. McMinnville has not experienced a wildfire within City limits. The city is surrounded by developed land, rivers, and/or irrigated agricultural land. However, some wooded areas are a concern in the case of a wildfire event, particularly in the western part of the city.

Oregon Wildfire Risk Explorer

The OWRE Advanced Report provides wildfire risk information for a customized area of interest to support Community Wildfire Protection Plans (CWPPs), Natural Hazard Mitigation Plans (NHMPs), and fuels reduction and restoration treatments in wildfire-prone areas in Oregon. The OWRE Advanced Report provides landscape context of the current fire environment and fire history.

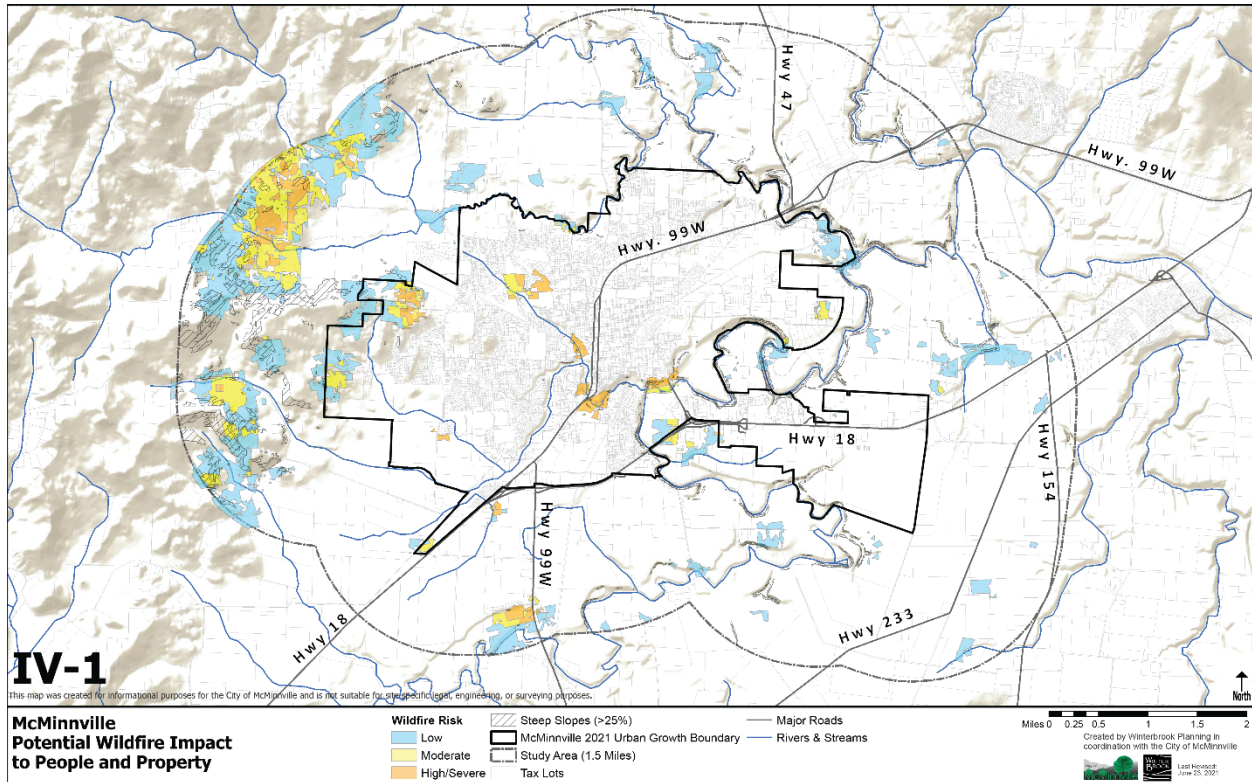
Using the *Oregon Wildfire Risk Explorer*, Winterbrook prepared an *Advanced Report* showing wildfire hazards to potential structures and the people who live and work in them. Figure IV-1 shows Wildfire Hazard to Potential Structures and the general location of McMinnville RFPD Risk Reduction Projects. According to the Risk Explorer:

Hazard to Potential Structures: *Hazard to potential structures depicts the hazard to hypothetical structures in any area if a wildfire were to occur. This differs from Potential Impacts, as those estimates consider only where people and property currently exist. In contrast, this layer maps hazard to hypothetical structures across all directly exposed (burnable), and indirectly exposed (within 150 meters of burnable fuel) areas in Oregon. As with the Potential Impacts layers, the data layer does not take into account wildfire probability, it only shows exposure and susceptibility.*

As indicated in the description above, moderate and high risk areas shown on Figure IV-1 correlate highly with rural residential areas shown on Figure I-2. Moderate risk wildfire areas continue into the western extension of the McMinnville UGB. Please note that “Potential Impacts to People and Property” focuses on areas with structures. Thus, areas without structures (mainly in steeply sloped areas) have a

lower risk to people and property. Finally, as discussed in Section V, hillsides denuded by recent wildfires are more susceptible to erosion and slide hazards due to loss of stabilizing vegetation.

Figure IV-1 Wildfire – Potential Impacts to People and Property with Steep Slopes



As a reminder, Figure I-2 in Section I of this report shows Yamhill County Zoning in the Natural Hazards Study Area. Yamhill County has effective fire prevention standards for structures in County Prime Forest and Mixed Forest zones.

V. Natural Hazards – Multi-Hazard Cumulative Impacts

Composite Geological Hazard Mapping Approach

The draft McMinnville NHMP mapped and evaluated a series of natural hazards more or less in isolation. The location and severity of each was mapped and assessed and potential community impacts and mitigation measures were identified.

As noted in Section I of this report, Winterbrook used GIS maps and information found in the McMinnville NHMP but focused on mappable natural hazards that exist within the McMinnville study area.

Section II went a step further than the McMinnville NHMP by evaluating relationships that exist among overlapping geological hazards. Figures II-3 through II-5 show overlapping geological hazard maps and a brief analysis of what these overlaps mean in terms of natural hazards planning.

The following composite natural hazards map (Figures V-1 through V-3) show relationships among hazards identified in Section II (Geological), Section III (Flooding) and Section IV (Wildfire).

Figure V-1 on the following page shows that land within the McMinnville UGB – with two notable exceptions – is relatively free of high risk areas. The two exceptions within the UGB include:

1. Flood hazards generally; and
2. High landslide risk hazard areas in the lower slopes of the West Hills and adjacent floodplains.

Most of the land within the amended UGB has moderate (as opposed to high) earthquake liquefaction susceptibility. Hazard conditions outside the UGB tell a different story. The moderate risk liquefaction area extends beyond the amended UGB to the north, northwest, southwest and south for about 0.5 to 0.75 miles before reaching high liquefaction risk areas.

Figure V-1 Composite Map: Landslide, Liquefaction and Flood Hazards

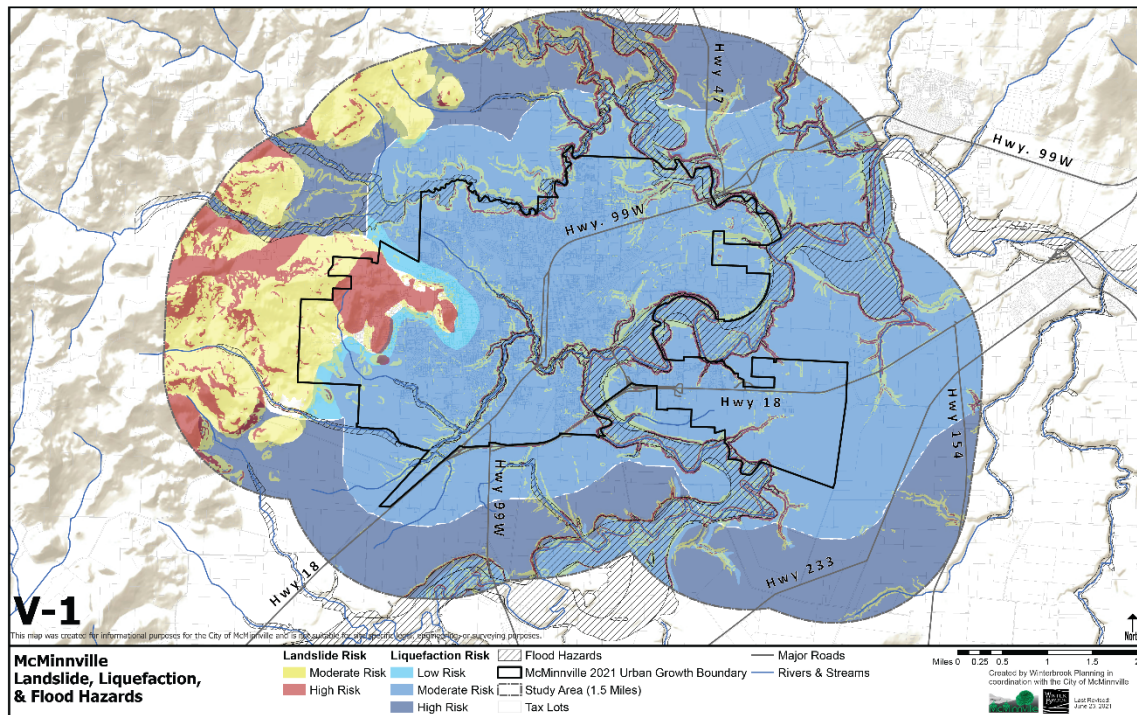


Figure V-1 shows the highest risk areas in the Natural Hazards Study Areas by mapping slopes of 25% and greater; high risk landslide, earthquake liquefaction; and the 100-year floodplain.

- This composite map makes it clear that land within the amended McMinnville UGB is relatively free of high-to-severe hazard risks.
- With the exception of the area served by Highway 18, the UGB has been largely defined by Baker and Cozine Creeks and the North and South Yamhill Rivers. Floodplains in these areas are protected from most types of development by City floodplain regulations.
- The primary high-to-severe hazards within the UGB include high risk landslide hazards in the West Hills and adjacent to protected floodplains.

- As discussed in Section II of this report (and shown on Figure II-4), high risk earthquake liquefaction and severe shaking areas are clearly defined to the west and south of the amended UGB.

To the west of the UGB, there is a moderate risk landslide area that extends to the West Hills’ steeply sloped and high landslide risk areas.

Figure V-2 focuses on the West Hills in relation to lowlands west of Hwy 99W. Please note the following:

- The large high risk landslide area within the amended UGB is separated by a moderate risk landslide area just outside the UGB before reaching another band of high risk landslide area.
- The West Hills are flanked to the north and south by high risk earthquake liquefaction areas. As described earlier in Section II, Figure II-4 shows severe risk landslide shaking areas in Baker Creek and Cozine Creek alluvial plains.

Figure V-2 Composite Map: West Hill Slope, Landslide, High Earthquake Liquefaction Risk

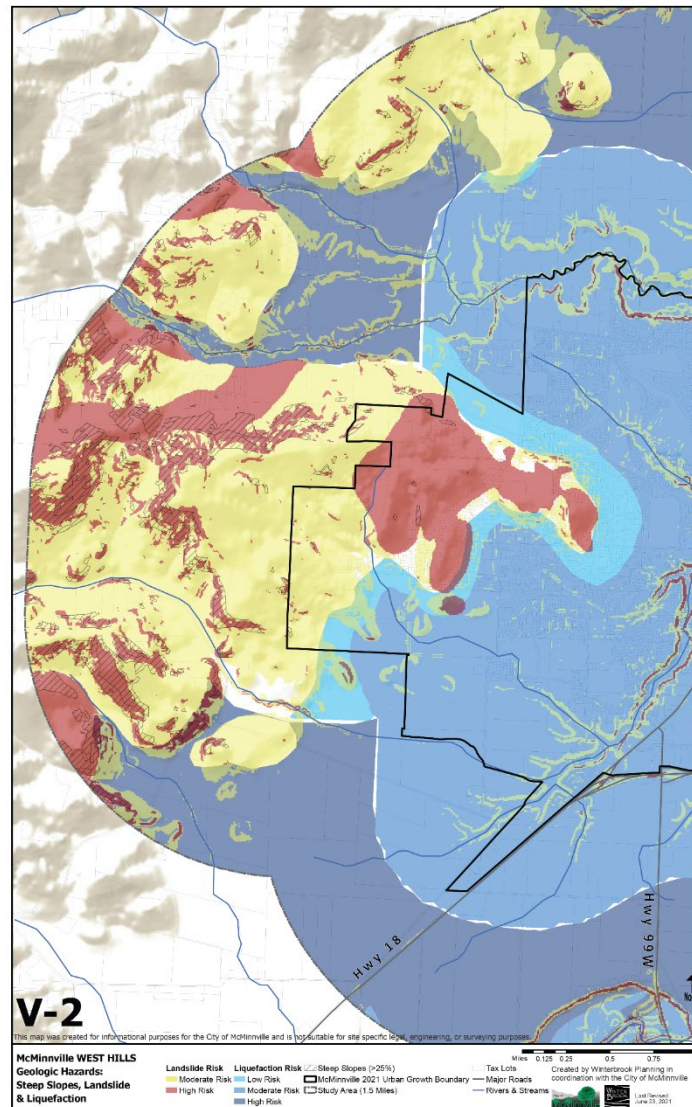


Figure V-3 shows the eastern (Valley) portion of McMinnville study area generally east of Highway 99W. The primary natural hazard in this area is flooding. Landslide hazard areas define the outer boundaries of floodplains that are subject to bank failure in high water conditions or in a major earthquake event. Note the areas of high risk earthquake liquefaction hazards to the north and south of the UGB. In addition, the Yamhill River floodplain southwest of the McMinnville Airport contains a severe earthquake shaking hazard area as shown in Section II on Figure II-4.

Figure V-3 Composite Map: East Valley Floodplain, Landslide and Liquefaction Risk

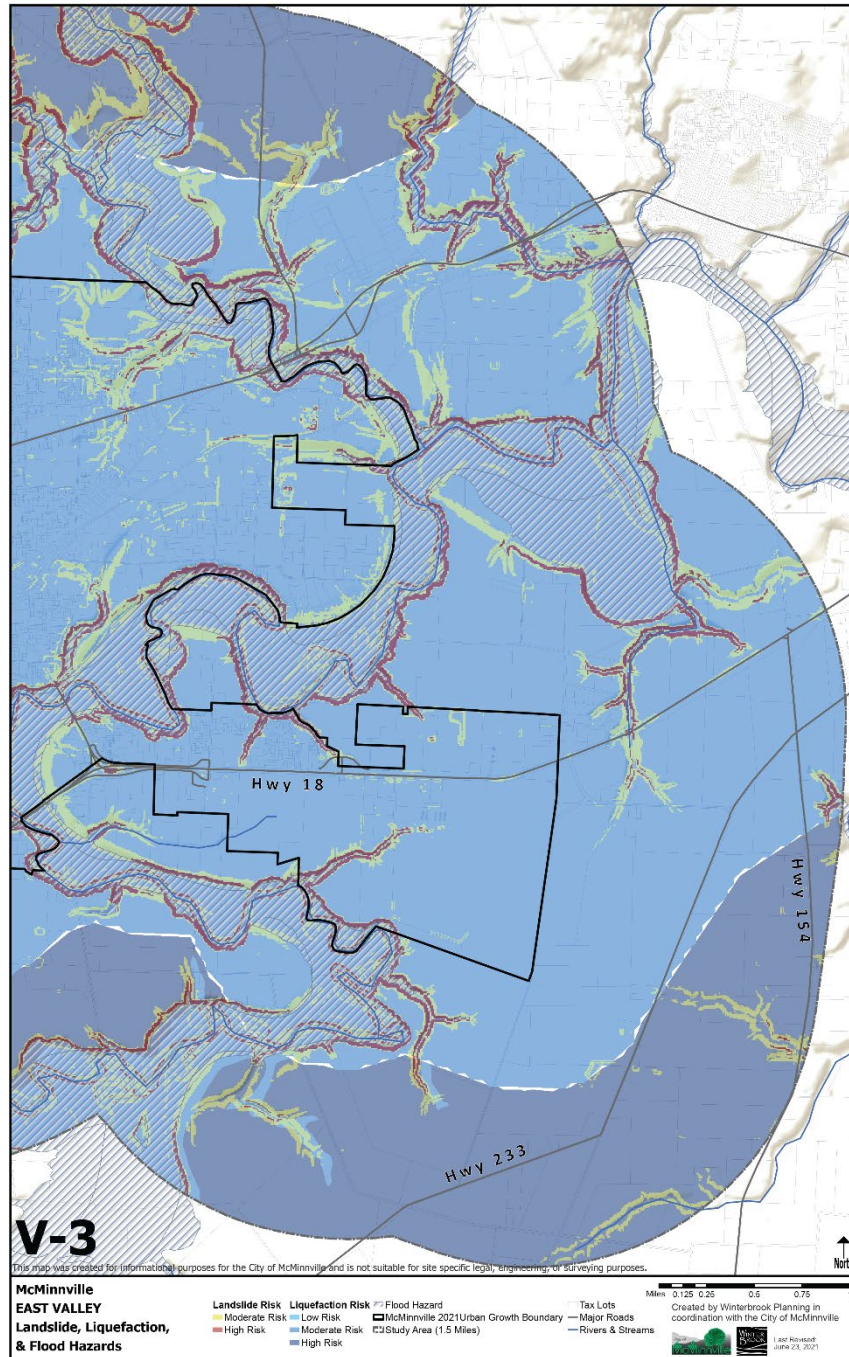


Figure V-4 combines wildfire, landslide and flood hazard risks and focuses on the West Hills and low-lying areas west of Highway 99W.

- Overall, there is some correlation between wildfire and landslide risk. Higher wildfire risk areas correlate more with rural residential development in forested hillside areas with limited access.
- Note that low wildfire risk areas correlate with undeveloped areas because wildfire risk focus on impacts to people and structures. Thus, yellow areas shown on Figure V-4 still have wildfire risk – but are unlikely to damage structures; however, the danger still exists from larger scale wildfires.
- Note also that high wildfire risks occur near vegetated stream and river corridors.
- Finally, the CWPP and the McMinnville Fire Department has observed (6/24/20) that grasslands and grain crop areas are also susceptible to wildfire risk.

Figure V-4 Composite Map: West Hills Wildfire, Landslide, and Floodplain Risk

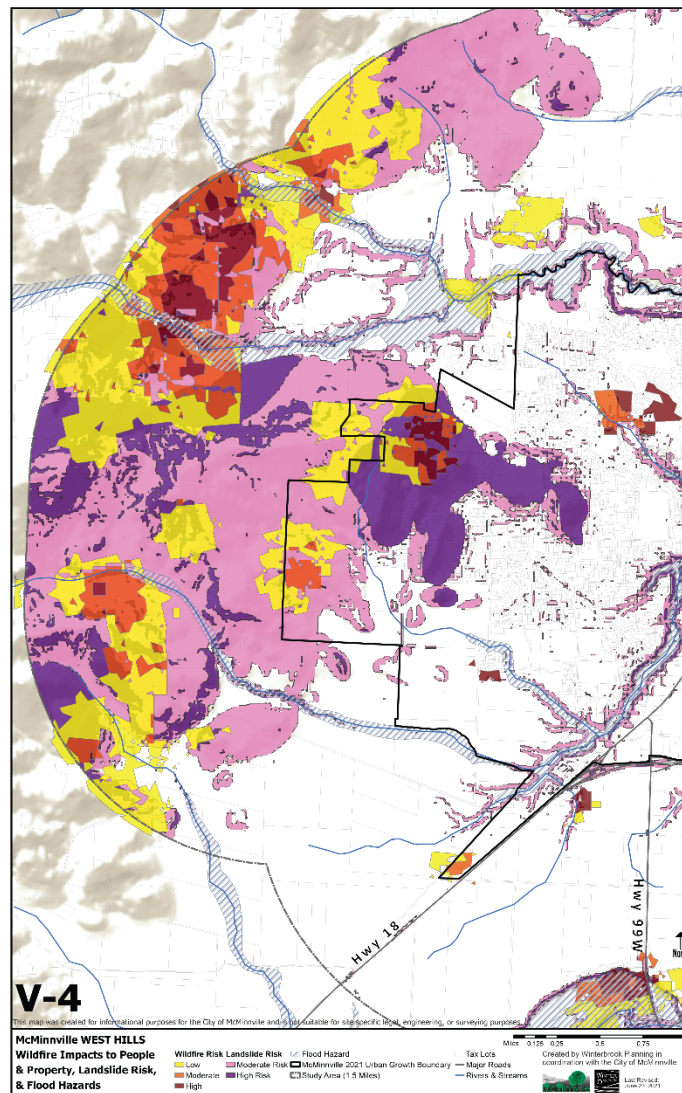
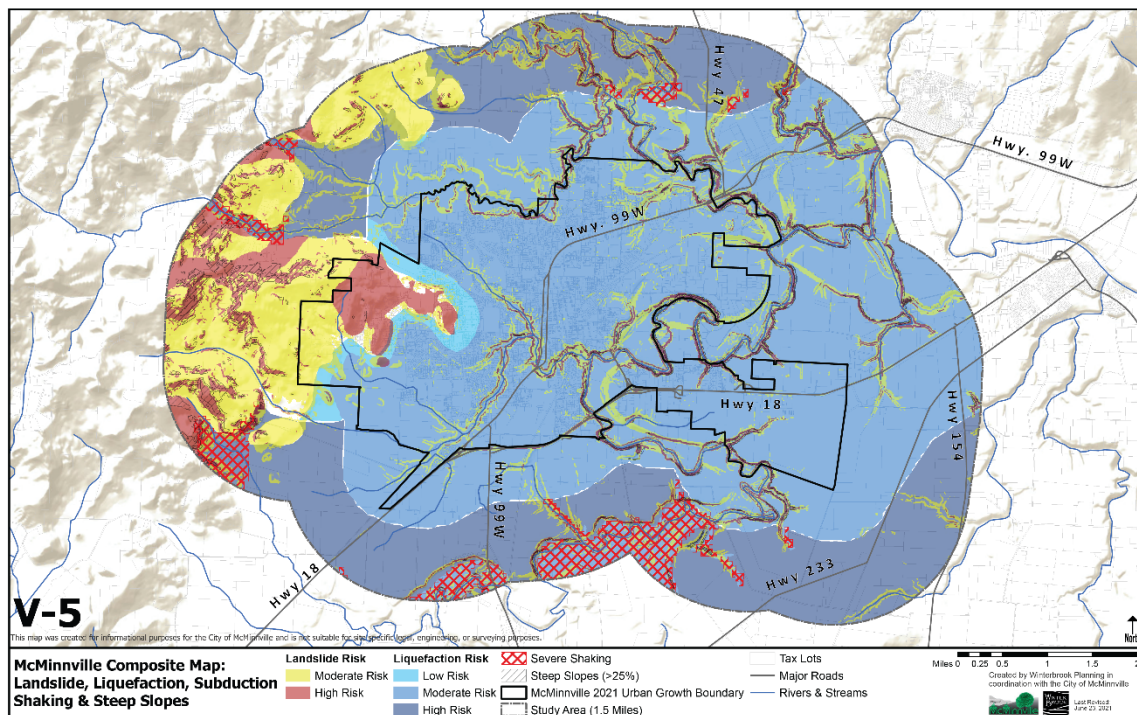


Figure V-5 combines geological hazard risks including landslides, earthquake shaking and liquefaction, and slopes of 25% or greater. As discussed in Section II of this report:

- The entire amended McMinnville UGB is subject to moderate earthquake liquefaction risk and (as shown on Figure II-4) very strong earthquake shaking risk.
- There is a band of moderate geological risk area that extends north, northwest, west, southeast and south of the amended UGB for about a half to three-fourths of a mile.
- Beyond this relatively buildable band, there are:
 - High risk earthquake liquefaction hazard areas (to the north and south);
 - Severe risk earthquake shaking hazards to the south, southwest and northwest; and
 - High risk landslide areas with slopes of 25% or greater to the west.

Figure V-5 Composite Map: Landslide, Liquefaction, Subduction Shaking, and Steep Slopes



Combined Hazard Risk Summary

Figures II-4 through II-VI and Figures V-1 through V-5 show interrelationships among geological and flooding hazards. In summary:

- Although there is a correlation between slopes of 25% and greater and high landslide risk in the West Hills and therefore should be considered unbuildable – consistent with the findings of the 2020 Buildable Lands Inventory.
- Geological hazards (landslide and earthquake liquefaction / shaking) exist on slopes of 15% or less. Therefore, the composite geological maps are a better indicator than steep slopes to determine where geological studies and erosion control measures should be required.
- The composite geological and flooding maps show landslide hazards at the edge of most floodplains and the presence of high earthquake liquefaction and severe shaking hazards within all floodplain boundaries. Even relatively minor flood events can trigger bank failures in such areas. Since a major subduction earthquake would undoubtedly trigger bank failures next to the 100-year floodplain, extending protection to adjacent landslide areas makes sense.
- The composite geological maps show an inverse relationship between earthquake risk on the one hand and landslide risk in the West Hills. Except for floodplain areas in the West Hills and Valley, earthquake liquefaction and shaking risk areas tend to end where landslide areas begin.
- Together, these high to severe geological hazards form a continuous ring located from 0.5 to 0.75 miles to the southeast, south, southwest, west, northwest and north of the amended McMinnville UGB.
- The composite wildfire, geological and flooding maps show that moderate and high wildfire hazards are associated with forested rural residential development in the West Hills. Wildfire hazard areas sometimes occur in moderate-to-steep slope hazard areas and vegetated floodplains throughout the study area.

The overlaps that exist among these types of hazards and supports the concept of a combined natural hazards overlay comprehensive plan map designation. As discussed in Section VII of this report, Winterbrook recommends the assignment of one of two natural hazard subdistricts based on combined natural hazard risk scores in specific geographic subareas. The methods for drawing subdistrict maps are discussed in Chapter VII.

VI. Natural Hazard Program Management Options

In Sections II-IV of this report, we inventoried three types of natural hazards:

- Geological Hazards (including landslides and subduction and crustal earthquakes)
- Flooding Hazards
- Wildfire Hazards

In Section V we analyzed the McMinnville NHMP and the Yamhill County CWPP and determined that substantial overlaps exist among these three general types of hazards.

In Section VI we analyze management options for each of these natural hazard categories based on:

1. Recommendations found in the draft 2020 McMinnville NHMP.
2. Management practices in six comparator cities described in Appendix 1.
3. Advanced natural hazards inventory work related to geological and wildfire hazards found in the draft McMinnville NHMP and Winterbrook’s experience in preparing comprehensive natural hazard inventories and management programs for other Oregon jurisdictions.

McMinnville NHMP Multi-Hazard Action Items

The McMinnville NHMP includes five relevant “multi-hazard” recommendations that will be followed for each of the three natural hazard categories:

Table VI.1 McMinnville NHMP Recommended Natural Hazard Mitigation Measures

Policy Number	Policy Text	Evaluation
Multi-Hazard #2	Incorporate mitigation planning provisions into community planning processes such as comprehensive, capital improvement, land use, transportation plans, zoning ordinances, community development practices, etc.	Section VII includes recommendations for amending the McMinnville Comprehensive Plan to include natural hazard inventory and management policies proposed to be implemented in the McMinnville Zoning Ordinance.
Multi-Hazard #7	Develop and maintain GIS mapped hazard areas within the UGB.	Sections II-V include a series of geological, flooding and wildfire hazards maps within the McMinnville UGB and within potential UGB expansion areas.
Multi-Hazard #10	Establish a process to coordinate with state and Federal agencies to maintain up-to-date hazard data, maps and assessments.	Section VII includes a policy to coordinate with state and federal agencies through periodic updates of the McMinnville NHMP and the Yamhill County CWPP.

Policy Number	Policy Text	Evaluation
Multi-Hazard #11	Limit (e.g., reduced density, etc.) or prohibit development in high hazard areas.	Section VI considers options to limit development in medium and high hazard areas – and to prohibit development in some high hazard areas. Section VII includes recommendations for a consolidated Natural Hazards Overlay District that limits or prohibits development depending on the hazard level and cumulative hazard impacts. As proposed, the NHOD would be applied to land within the McMinnville study area to guide future urban growth. Application of the NHOD outside the McMinnville City Limits would require an amendment to the Urban Growth Management Agreement (UGMA) between the City and Yamhill County.
Multi-Hazard #12	Encourage mitigation practices in developments at risk to natural hazards.	Section VI considers mitigation options and Section VII recommends specific mitigation measures.

Geological Hazards

The text below considers (a) McMinnville NHMP geological hazards measures / action items and (b) geological hazards mitigation programs (comprehensive plan policies and development standards) in six comparator cities.

McMinnville NHMP – Recommended Measures

The draft McMinnville NHMP (Table MA-1 McMinnville Action Items) proposes specific mitigation measures / action items for each moderate-to-high risk geological hazards.

Table VI.2 McMinnville NHMP Recommended Geological Hazard Measures

Policy Number	Policy Text	Evaluation
Earthquake #5	Educate property owners about structural and non-structural retrofitting of vulnerable buildings and encourage retrofit.	Section VII includes a policy recommendation to this effect.
Earthquake #6	Develop an outreach program to educate and encourage homeowners and tenants to	Section VII includes a policy recommendation to this effect.

Policy Number	Policy Text	Evaluation
	secure furnishings, storage cabinets, and utilities to prevent injuries and damage.	
Landslide #1	Utilize technology, geologic resources and other available data (such as DOGAMI LIDAR data) to identify and map potential areas for landslides - high, moderate and low.	Sections I -V of this report include available GIS data sources and tools to identify and map potential landslide areas – both singularly and in combination with earthquake, wildfire and flooding hazards.
Landslide #2	Develop a process to limit future development in high landslide potential areas - permitting, geotechnical review, soil stabilization techniques, etc.	Section VI considers procedural and substantive options to limit development in moderate and high hazard areas. Section VII includes recommendations for a consolidated Natural Hazards Overlay District that includes permitting, geotechnical review and stabilization measures for landslide and earthquake areas.
Landslide #3	Development in steeply sloped areas (greater than 15%) should be subject to specific development requirements to control erosion.	Sections II-V identify the importance of steep slopes in determining the location of severity of landslide and wildfire hazards. Section VI considers the use of a 15% slope threshold for triggering specific erosion control requirements. Section VII includes recommendations for a consolidated Natural Hazards Overlay District that includes slope and other geological triggers for erosion control review. This overlay could be applied within the Natural Hazards Study Area to evaluate risk when considering future UGB expansion areas.
Landslide #4	Complete an inventory of locations where critical facilities, other buildings and infrastructure may be subject to landslides.	Section VII includes a policy recommendation to this effect.

Best Geological Hazard Mitigation Practices in Comparator Cities

Winterbrook has provided a detailed summary of comprehensive plan policies and mitigation practices for geological hazards (steep slopes, earthquakes and landslides) in six comparator communities (Ashland, Grants Pass, Albany, Newberg, Redmond and Bend). **Please see Appendix 1 Best Natural Hazard Mitigation Practices in Comparator Cities.**

The cities of Albany, Ashland, Bend, Grants Pass and Newberg limit development in mapped steeply sloped areas.

- The threshold for application of hillside steep slope standards varies from 12 – 25% slope.
- Most of these cities require the implementation of recommendations from geological studies and erosion control measures prior to development.
- Some cities require reduced residential densities based on slope percentage (slope density ratio).
- Some cities allow for density transfer – often through the planned unit development process.

Table VI.3 summarizes geological hazard management practices by city.

Table VI.3 Summary of Geological Hazard Management Practices by City

City	Percent Slope Threshold	Geotechnical Report Required?	Slope Density Ratio?	Density Transfer Allowed?	Earthquake Impacts Regulated by Zoning?	Other Standards
Albany	12%	Yes	Yes	Yes	Not directly – may be addressed in geotechnical report	Yes – see below
Ashland	25%	Yes	Yes	Yes	Not directly – may be addressed in required geotechnical report	Yes – see below
Bend	10-20%	Maybe	No	Yes	Not directly – may be addressed if geotechnical report required	Yes – see below
Grants Pass	15%	Yes	No	No	Not directly – may be addressed in required geotechnical report	Yes- see below
Newberg	20%	Maybe	No	No	Not directly – may be addressed in required geotechnical report	Yes – see below
Redmond	N/A	Maybe	No	No	Not directly – may be addressed if geotechnical report required	Yes – see below
McMinnville	N/A	No	No	No	No	Yes – see Section VII of this report

- **Albany has several measures that guide implementation of hillside development policies:**
 - Measure 6. Require proposed hillside development to provide for the preservation and, if possible, enhancement of the site’s natural features during all phases of the design and development process. This includes consideration of soils, vegetation, hydrology, wildlife habitat, views and visual orientation, both from the site and to the site, and unusual or unique natural features.
 - Measure 10. Require that all excavation and fill work and structural foundation work be approved by a registered engineer whenever the slope is greater than 30% or where there exists probability of geologic hazards such as perched water tables and/or

landslide areas. Where appropriate, such approval shall include information from a soils engineer and engineering geologist.

- Measure 11. Increase minimum lot sizes (or minimum lot area per unit) on hillside areas, allowing higher densities for cluster developments approved through Planned Development as outlined in the following table:

Slope %	Standard Dev.	(RS 6.5 Lot)	PUD Devel.	(RS 6.5 Avg)
13 to 20	1.25	8125	1.00	6500
21 to 25	1.50	9750	1.15	7475
26 to 30	2.00	13000	1.40	9100
31 above	3.00	19500	2.00	13000

Albany’s **Hillside Overlay District** applies to mapped areas of the city (primarily West Albany) with 12% or greater slope. Allowed density decreases as slope increases; however, density transfer is allowed through the PUD process when 20% of the site remains open space. Cut and fill activity should be minimized. A licensed engineer must approve excavation plans and foundation design.

- **Ashland’s Physical and Environmental Constraints Overlay Zone** (Chapter 18.62) applies to mapped “Flood Plain Corridor Land, Hillside Land (slopes \geq 25%, or Severe Constraint Land (including wildfire lands, floodways and slopes \geq 35%)).
 - *“The above classifications are cumulative in their effect and, if a parcel of land falls under two or more classifications, it shall be subject to the regulations of each classification. Those restrictions applied shall pertain only to those portions of the land being developed and not necessarily to the whole parcel.”*
 - Geotechnical engineering studies are required for development on slopes of 25% or greater.
 - Slopes \geq 35% are considered unbuildable (maximum of 1 unit per acre provided geotechnical report recommendations are followed). No new lots may be created on such slopes. Hazardous or unstable areas of the site must be avoided.
 - The maximum cut slope height is 15 feet and the maximum fill slope height is 20 feet.
 - Trees must be protected based on an arborist report and must consider fire protection plan requirements in designated wildfire areas.

On-site density transfer is allowed from non-buildable to buildable areas of the site (contiguous land under common ownership). The maximum allowable density on buildable areas of the site is twice the allowable density in the underlying zoning district.

- **Bend** maps and regulates development on “**sensitive lands**” which include both Goal 7 natural hazards and Goal 5 natural resources. Natural hazards included in the definition of “sensitive lands” include slopes of 10% or greater and land within the 100-year floodplain.
 - The Bend Comprehensive Plan includes policies to (a) coordinate with DOGAMI to identify fault lines in the community and (b) to review development “on slopes in excess of 10 percent shall give full consideration to the natural contours, drainage patterns,

- and vegetative features of the site to protect against temporary and long-term erosion.” However, we could find no specific development standards to implement these policies.
- Although the Bend Development Code defines steep slopes as 10% or greater (BDC 16.05.060), the threshold for requiring grading and erosion control permits (and possibly engineering reports) is slopes of 20% or greater. As part of grading permit review, the city “may” require an engineering or geologist report if “the City determines that special circumstances warrant such information.”
 - Minimum densities are determined after excluding “sensitive lands.” (BDC 2.1.600) However, density transfer is allowed from land with slopes of 25% or greater to buildable areas on the same site if “sensitive lands” are protected by a conservation easement or dedication. There do not appear to be any restrictions on the amount of density that can be transferred.
- **Grants Pass** evaluated soil types for erosion and shrink-swell potential. The comprehensive plan identified slopes greater than 15 percent on the Slope Hazards map and found that development on slopes between 15 and 35 percent should be reviewed by a soils scientist and an engineer, while development on slopes over 35 percent should require geotechnical review.
 - The Grants Pass Slope Hazard District encompasses areas of at least 15 percent slope and contains two classes of slope: Class A (between 15 and 25 percent) and Class B (greater than 25 percent).
 - Development within the Slope Hazard District requires a Steep Slope Development Report and Grading and Erosion Plans. Class A documentation requires a licensed engineer stamp, while Class B requires a geotechnical engineer or engineering geologist stamp.
 - Restrictions on development within the Slope Hazard District include erosion control measures and retaining wall height is limited to 20 feet.
 - **Newberg’s comprehensive plan** identifies “hazardous areas” as areas with slopes 20 percent or greater, or with geological limitations. Development may be permitted in hazardous areas if consistent with sound engineering and planning criteria.
 - Comprehensive Plan Policy 5 states that “In other areas of potential or existing hazards, development shall be subject to special conditions. Reasonable development may be permitted in these areas when it can be shown, based on sound engineering and planning criteria, that adverse impacts can be mitigated and kept to a minimum. Hazardous areas shall be considered to be lands with slopes 20% or greater, potential and existing slide areas, fault areas, and areas with severe soil limitations.”
 - **The Newberg Development Code** does not appear to have specific geological development regulations. However, sloped areas are regulated by Title 13 Public Utilities and Services, which “may require” additional erosion and sediment controls on slopes of 10 percent or more.
 - **Redmond’s comprehensive plan** includes several policies related to natural hazards:

- Policy 4. Natural hazards that could result from new developments, such as runoff from paving projects and soil slippage due to weak foundation soils, shall be considered, evaluated and provided for.
- Redmond’s **Urbanization Study** indicates that “Redmond has no land that is unavailable for development due to physical constraints: steep slopes, wetlands, riparian areas, and floodplains. This is due to the city’s location and the fact that the dry canyon is mostly in public ownership.”
- However, evaluation of hazards may be required during site and design review:

The Redmond Development Code (RDC 8.3030) states that “Special Studies, Investigations and Reports. Special studies, investigations and reports may be required to ensure that the proposed development of a particular site does not adversely affect the surrounding community, does not create hazardous conditions for persons or improvements on the site. These may include traffic impact studies impact of contaminated soils, soil conditions, flooding of waters and excessive storm water runoff, tree preservation, and other concerns of the development’s impact on adjacent properties or public facilities.”

Flood Hazards

The text below considers (a) McMinnville MHMP flood hazard measures / action items and (b) flood hazard mitigation programs (comprehensive plan policies and development standards) in six comparator cities.

McMinnville NHMP – Recommended Flood Hazard Measures

The draft McMinnville NHMP (Table MA-1 McMinnville Action Items) proposes specific mitigation measures / action items for flood hazards.

Table VI.4 McMinnville NHMP – Evaluation of Recommended Flood Hazard Mitigation Measures

Policy Number	Policy Text	Evaluation
Flood #1	Ensure continued compliance in the National Flood Insurance Program (NFIP) through enforcement of local floodplain management ordinances.	The Comprehensive Plan already includes a policy to this effect.
Flood #2	Work with FEMA to update FIRMs. Request DOGAMI debris flow and lidar data be included in FIRM updates. Use the updated FIRMS for land use and mitigation planning.	Section III Flood Hazard Inventory relies on existing flood hazard information. Section VII includes a policy to update the flood hazard inventory in the future based on DOGAMI debris flow and lidar data.
Flood #4	Develop and maintain GIS mapped critical facility inventory for all structures and residential and commercial buildings located within 100-year and 500-year floodplains.	Section VII includes a policy recommendation to this effect.

Best Flood Hazard Management Practices in Comparator Cities

As discussed below, the cities of Albany, Ashland, Bend, Grants Pass, Newberg and Redmond all limit development in mapped floodplain areas. **Please see Appendix 1 Best Natural Hazard Mitigation Practices in Comparator Cities** for a more detailed discussion of comprehensive plan policies and development regulations that limit development in flood hazard areas.

Table VI.5 Summary of Flood Hazard Management Practices by City

City	Prohibit Development in Floodway	Limit Development in Flood Plain	Density Transfer Allowed?	Erosion Control Measures?	Other Standards
Albany	Yes	Yes	Yes	Yes	Yes – see below
Ashland	Yes	Yes	Yes	Yes	Yes – see below
Bend	Yes	Yes	No	Yes	Yes – see below
Grants Pass	Yes	Yes	No	No	Yes- see below
Newberg	Yes	Yes	No	No	Yes – see below
Redmond	Yes	Yes	No	No	Yes – see below
McMinnville	Yes	Yes	No	No	Yes – see Section VII of this report

The Cities of Ashland, Albany, Bend, Grants Pass, Newberg and Redmond all have standard floodplain management programs consistent with FEMA standards. Development, if allowed within the 100-year floodplain, must be constructed one foot above flood level and meet other standards.

- Ashland’s **Physical and Environmental Constraints Overlay Zone** regulates natural hazards as well as natural resources. Ashland integrates its floodplain management program with related natural resources (wetland and stream corridor) programs. In addition to designated floodplain areas, Ashland limits development in areas that have historically experienced flooding.
- Bend defines the 100-year floodplain as “**sensitive lands**” along with other natural hazards and natural resources (including wetlands and stream corridors).

Wildfire Hazards

Most comparator cities do not have reregulate wildfire hazards in their land use regulations. The text below considers (a) McMinnville NHMP wildfire hazard measures / action items and (b) wildfire hazard mitigation programs (comprehensive plan policies and development standards) in six comparator cities.

McMinnville NHMP – Recommended Measures

The draft McMinnville NHMP (Table MA-1 McMinnville Action Items) proposes specific mitigation measures / action items for wildfire hazards.

Table VI.5 McMinnville NHMP – Evaluation of Recommended Flood Hazard Mitigation Measures

Policy Number	Policy Text	Evaluation
Wildfire #1	Coordinate wildfire mitigation action items through the Yamhill County Community Wildfire Protection Plan.	The CWPP was last revised in 2015. The revised version was considered in this report.
Wildfire #3	Develop, implement, and enforce vegetation management codes/plans to reduce wildfire risk.	Section V considers options for vegetation management measures – depending on the location of the wildfire hazard. Section VII includes recommendations for a consolidated Natural Hazards Overlay District that includes vegetation management provisions – again depending on the location of the hazard.

Best Practices in Comparator Cities

Most comparator cities have participated in county community wildfire protection planning efforts. However, only Ashland has mapped and adopted zoning standards to protect life and property in designated wildfire hazard areas. **Please see Appendix 1 Best Natural Hazard Mitigation Practices in Comparator Cities** for a more detailed discussion of comprehensive plan policies and development regulations that limit development in wildfire hazard areas.

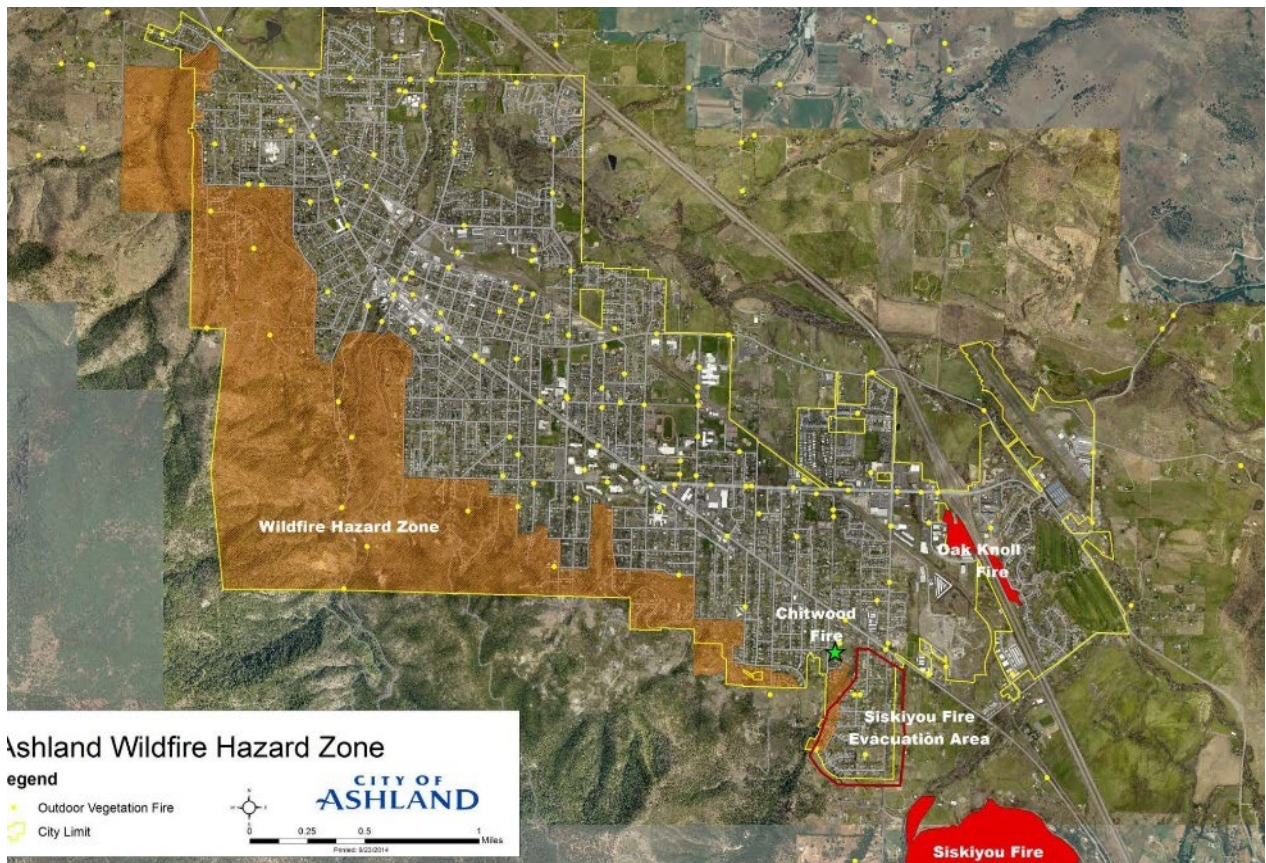
Ashland Wildfire Mitigation Program

Ashland’s standards for wildfire mitigation mirror standards required by the Goal 4 administrative rule for structures in commercial forest zones. Ashland maps urban-wildland interface areas and has adopted several policies to protect life, property, and environmental resources:

- Policy 46. Require installation and maintenance of a 40-foot fuel break around each dwelling unit or structure.
- Policy 47. Require multi-dwelling unit developments to install and maintain a perimeter fuel break to prevent fire from entering the development, or to prevent a fire spreading from the development and threatening the Ashland Watershed. (Width of break is dependent on topography, aspect, vegetation, types and steepness of slopes.)
- Policy 48. Where vegetation needs to be maintained for slope stability in a fuel break area, require plantings of fire-resistant or slow-burning plants. The City shall make a list of such plants available to the public. (See “Wildfire Hazard Management in the Urban/Wildland Interface in Southern Oregon,” by Claude Curran - May 1978.)
- Policy 49. Require more than one ingress/egress route or road widths wide enough to accommodate incoming fire apparatus and evacuating residents simultaneously in an emergency situation.

- Policy 50. Require roofs to be constructed of fire-resistant materials. Wood shake or shingle roofs would not be allowed.
- Policy 51. Encourage road placement to function as fire breaks in urban/wildland interface developments.
- Policy 52. Require chimneys of wood-burning devices to be equipped with spark arrester caps and/or screens.
- Policy 53. Install all new electrical distribution circuits in the urban/wildland interface underground if technically feasible.
- Policy 54. The City shall encourage and support education/ information programs dealing with wildfire hazards in the urban/wildland interface. Information shall be made available through the City Building and Planning Departments to developers and builders wishing to build in the urban/wildland interface.

Figure VI-1 Ashland's Wildfire Hazard Overlay Zone



Ashland integrates natural resource, water quality, and hillside considerations with wildfire mitigation requirements:

- Any development or land division within these areas is required to prepare a Fire Prevention and Control Plan and establish and maintain a fuel modification area (generally crown separation, tall brush removal, tree trimming, etc.).

- “l. Where necessary for erosion control, slope stability, riparian and wetland preservation and enhancement, performing functions considered beneficial in water resource protection, or aesthetic purposes, existing vegetation may be allowed to be retained consistent with an approved Fire Prevention and Control Plan, or upon written approval of the Staff Advisor in consultation with the Fire Code Official.
- m. Fuel modification in areas which are also classified as Hillside Lands or Water Resource Protection Zones shall be included in the erosion control measures outlined in section 18.3.10.090, Development Standards for Hillside Lands, and management plan for water resource protection zones in section 18.3.11.110.

Composite Approach – Cumulative Impacts

As discussed above, most comparator cities separately regulate flooding with geological hazards (to varying degrees).

- All flood maps and regulations are based on FEMA standards and restrict development within floodplains and floodways.
- Most cities have some variation on hillside development overlay zones triggered by minimum slopes – ranging from 10% to 20%.
- Ashland is unique among comparator cities in have a single multi-hazard overlay zone – supported by a series of hazard-specific maps – that includes development standards for geological, flooding and wildfire hazards.

VII. Natural Hazard Program Recommendations

McMinnville's Existing Natural Hazard Policy Framework

McMinnville Comprehensive Plan (2017)

Winterbrook was able to find two Comprehensive Plan policies directly related to natural hazards:

2.00 The City of McMinnville shall continue to enforce appropriate development controls on lands with identified building constraints, including, but not limited to, excessive slope, limiting soil characteristics, and natural hazards.

9.00 The City of McMinnville shall continue to designate appropriate lands within its corporate limits as "floodplain" to prevent flood induced property damages and to retain and protect natural drainage ways from encroachment by inappropriate uses.

Policy 71.07 applies the relatively low density R-1 zoning designation to steeply sloped portions of the West Hills:

71.07 The R-1 zoning designation shall be applied to limited areas within the McMinnville urban growth boundary. These include: 1. The steeply sloped portions of the West Hills.

As noted in the Introduction to this report, McMinnville recently adopted Great Neighborhood Principles that call for consideration of natural features the long-range and land use application planning processes. This report helps to implement these policies.

In addition to these general policies described above, the McMinnville Residential Land Study (ECONorthwest, 2003) excludes slopes of 25% and greater and land within the 100-year floodplain from the buildable lands inventory. It is our understanding that the City requires sprinklers for homes constructed on slopes of 15% or greater.

Otherwise, there do not appear to be any other natural hazard policies in the McMinnville Comprehensive Plan.

McMinnville NHMP Plan Direction

From the McMinnville NHMP (p. MA-13):

Incorporate mitigation planning provisions into community planning processes such as comprehensive, capital improvement, land use, transportation plans, zoning ordinances, community development practices, etc.

Rationale: Comprehensive plans provide the framework for the physical design of a community. They shape overall growth and development while addressing economic, environmental and social issues. Oregon's statewide goals are accomplished through local comprehensive plans. State Law requires local

governments to adopt a comprehensive plan and the zoning and land-division ordinances needed to put the plan into action.

Integration of NHMPs into comprehensive plans and other plans will help to reduce a community's vulnerability to natural hazards, support in mitigation activities, help to increase the speed in which action items are implemented and therefore the speed in which communities recover from natural disasters.

Integration of NHMPs into local plans gives the action items identified in the NHMP legal status for guiding local decision-making regarding land use and/or capital expenditures.

Implementation: Integrate natural hazards information and policies into the comprehensive plan and other plans.

Engage in collaborative planning and integration.

Coordinate future NHMP and comprehensive plan reviews and updates.

Proposed Natural Hazards Comprehensive Plan Amendments

The proposed Comprehensive Plan amendment package would include:

- Natural Hazard Inventory Maps and Descriptions (Sections II-V of this report).
- Natural Hazard Management Policy Framework (a new Chapter XI: Natural Features)
- Natural Hazard Overlay shown on the Comprehensive Plan Map (shown on Figure VII-1)

Proposed McMinnville Zoning Ordinance Amendments

Proposed natural hazards policies call for the adoption of two natural hazards subdistricts (that would overlay the underlying base zones (Residential, Commercial, Industrial, Floodplain and Agricultural Holding). The proposed natural hazards subdistricts are based on a ranking system and policy framework set forth below and would include hazard-specific protection and mitigation standards. The two proposed subdistricts are shown on Map VII-1 and could be referenced in a new Chapter 17.50 Natural Hazard Subdistricts:

- The Natural Hazards Mitigation (NH-M) Subdistrict
- The Natural Hazards Protection (NH-P) Subdistrict

Natural Hazards Inventory

The Natural Hazards Inventory (including text and embedded maps) is included in Sections I-V and VII of this report. Copies of 11" X 17" GIS Inventory maps are provided separately.

Natural Hazards Composite Ranking System

The proposed Natural Hazard composite ranking system is based on two scored variables: the probability of a natural hazard event occurring at a specific location within the 2021 UGB and the vulnerability assessment of the natural hazard event happening. The probability variable is determined by combining the natural hazard inventory maps into a single overlay that describes the combined probability for individual "subareas" (GIS polygons). The vulnerability variable is informed by the 2020

Oregon Natural Hazards Mitigation Plan (Oregon NHMP). The terms “subarea” and “polygon” are used interchangeably to describe the composite ranking system. Appendix 2 contains a detailed methodology of the steps used to create the Natural Hazard Overlays.

Natural Hazard Probability

A combined natural hazard probability can be created by assigning a consistent number scoring system and by using a series of GIS manipulations. The number scoring system used in the rank of the probability score is displayed in Table VII.1. The scores were determined in coordination with McMinnville Associate Planner Jamie Fleckenstein, and they are consistent with the ranking scale used in the Oregon NHMP. The scale runs from 0 to 5, with 0 being no or low probability of the natural hazard event happening at that spatial location and 5 being a high or severe probability of the natural hazard event happening.

- **Natural Hazard Type** shows the types of natural hazards that may be present in any given subarea.
- **Hazard Probability** shows the hazard levels that may be present for each hazard probability in any given subarea.
- **Hazard Probability Score** shows the hazard score for each type and level of hazard probability that may be present in any given subarea.

Table VII.1 Natural Hazard Risk Assessment (2021)

Natural Hazard Type	Hazard Risk Level	Individual Hazard Score	
Landslide	Moderate	2	
	High	5	
Cascadia Subduction Zone Earthquake	Liquefaction	Moderate	2
		High	5
	Shaking	Very Strong	2
		Severe	5
Slope	25%	5	
Flood	Floodplain	5	
Wildfire	Moderate	2	
	High/Severe	5	

Natural Hazard Vulnerability – Oregon Natural Hazards Mitigation Plan

The Oregon NHMP was completed in the Fall of 2020. To remain consistent with the State’s assessment, the plan was considered and incorporated as part of the natural hazard composite ranking system. The Oregon NHMP presents a series of natural hazard risk assessments for all Oregon counties. For simplification at the state level, these risk assessments were calculated county wide. The Oregon NHMP is broadly based on three variables:

1. The probability of the event happening.
2. The physical vulnerability of the event happening, and
3. The social vulnerability of the event happening.

These variables are summarized for Yamhill County in Table V11.2.

Table VII.2 Oregon NHMP Risk Assessment for Yamhill County

Hazards for Yamhill County	Probability	Physical Vulnerability				Social Vulnerability	Vulnerability (Social + Physical)		Risk (Prob. + Physical Social)	
		State Buildings	State Critical Facilities	Local Critical Facilities	Total Combined & Rescaled		Total Combined & Rescaled	Vulnerability	Total Combined & Rescaled	Risk
Earthquake	4	3	3	2	2.67	4	3.33	Very High	3.56	Very High
Flood	4	1	1	2	1.33	4	2.67	Moderate	3.11	High
Landslide	5	1	1	2	1.33	4	2.67	Moderate	3.44	Very High
Volcanic	1.5	1	1	1	1	4	2.5	Moderate	2.17	Low
Wildfire Hazard	2	1	1	1	1	4	2.5	Moderate	2.33	Moderate
County Total									2.92	High

Physical vulnerabilities were determined by assessing the concentration of state-owned or leased facilities and local critical facilities. Social vulnerabilities were based on Centers for Disease Control and Prevention (CDC) social vulnerability index. The Oregon NHMP uses 2016 data and aggregates at the County level, normalizing it with other Oregon Counties, grouping counties into quintiles, and then included state determined “sensitivity” and “adaptive capacity” rankings.

Because the state assessment is county wide, the probability of the natural hazard event occurring is based on the county-wide probability, regardless of spatial sensitivity to the event within the county. For example, wildfire hazards that are more probable in the west hills would be assigned the same probability in that location as if they were to occur in the City center or suburban areas. Since more detailed spatial probability of a natural hazard event occur is available – as detailed in the inventory maps of this report – the composite mapping relies only on the combined physical and social vulnerabilities determined by the Oregon NHMP. The probabilities of the natural hazard event occurring are replaced with the more spatially sensitive information contained in the inventories. The vulnerability index was only applied to a subarea when there was a moderate or high/severe probability of that natural hazard event occurring.

Combined (Cumulative) Ranking Applied Individually to Hazard Subareas

Using GIS, Winterbrook assigned a combined natural hazard risk score based on both the probability of the event happening and the state determined vulnerability of the event happening. This score was calculated for each spatial subarea (polygon) within the 2021 McMinnville UGB. Total probabilities and vulnerabilities were summed and averaged to produce a total risk score on a scale from 0 to 5, where 0 is low to no risk of the natural hazard event and 5 is high/severe risks of multiple hazard events. Each polygon now has 10 contributing variables. The combined natural hazard risk is detailed in Table V11.3.

Table VII.3 Combined Natural Hazard Risk by Natural Hazard Type in McMinnville

Natural Hazard Type	Probability of the Hazard in McMinnville		Social + Physical Vulnerability
Landslide	Moderate	2	2.67
	High	5	2.67
Cascadia Subduction Zone Earthquake			(Earthquake) 3.33
Liquefaction	Moderate	2	
	High	5	
Shaking	Very Strong	2	
	Severe	5	
Slope	≥25%	5	-
Wildfire	Moderate	2	2.50
	High/Severe	5	
Flood	Floodplain	5	2.67
	Floodway	5	

For discussion purposes, the McMinnville study area can be divided into two generalized areas in relation to hazard characteristics: low-lying (Valley) areas and higher-elevation areas (West Hills). Characteristics of Valley and West Hills areas in relation to combined hazard scores are summarized below. Note that the entire McMinnville 2021 UGB has a “very strong” probability of shaking. This hazard is included in the combined natural hazard risk calculations for consistency but does not affect subdistrict determination. Because of this, policies are recommended to address “very strong” shaking risks.

Valley Area Hazard Characteristics

The Cascadia Subduction Earthquake and flooding pose the greatest long-term threats to life and property in low-lying areas. Moderate earthquake liquefaction risk and “very strong” shaking hazards are present on most land within the UGB. These areas overlap with the 100-year flood plain and would trigger river and stream bank failures in the event of a major earthquake.

Valley area hazard scores have several inter-related characteristics:

- Due to the presence of moderate earthquake liquefaction and shaking hazards in most UGB subareas, the highest combined hazard risk score *outside* the 100-year floodplain is 2.75.
- Because floodplain polygons (score of 5) also have moderate earthquake liquefaction and very strong shaking hazards, the combined hazard score for most floodplain subareas is 3.571. Floodplain polygons are also likely to have also has moderate to severe wildfire risk (due to riparian vegetation) and moderate to high landslide risks (bank failure).
- Steep slopes in the valley are also more likely to correlate with floodplain and floodway areas. When outside of the floodplain and floodways, steep slopes occur with moderate to high landslide risks in most areas.

West Hills Area Hazard Characteristics

In the West Hills, landslide, steep slope, and wildfire hazards are common and often overlap. Earthquake liquefaction and shaking risk areas may also be located within the floodplains of Cozine and Baker Creeks.

- Subareas with moderate to severe wildfire risks have a combined score between 0.983 and 2.55. These wildfire risk areas often have moderate to high landslide risks.
- Subareas with steep slopes always overlap with moderate to high landslide risk areas.
- Some moderate liquefaction areas are present along the tributaries of Cozine and Baker Creeks.

Natural Hazards – Combined Risk Categories and Related NH Subdistricts Map

There are three broad categories of natural hazards in the McMinnville 2021 UGB. These categories relate to proposed Natural Hazards Subdistricts (NH-M and NH-P) and are based on the subarea combined hazard risk score (probabilities and vulnerabilities). Table VII.4 summarizes how Winterbrook applied the cumulative hazard score for each of the 87 subareas in the Natural Hazards Study Area to determine the level of natural hazard protection.

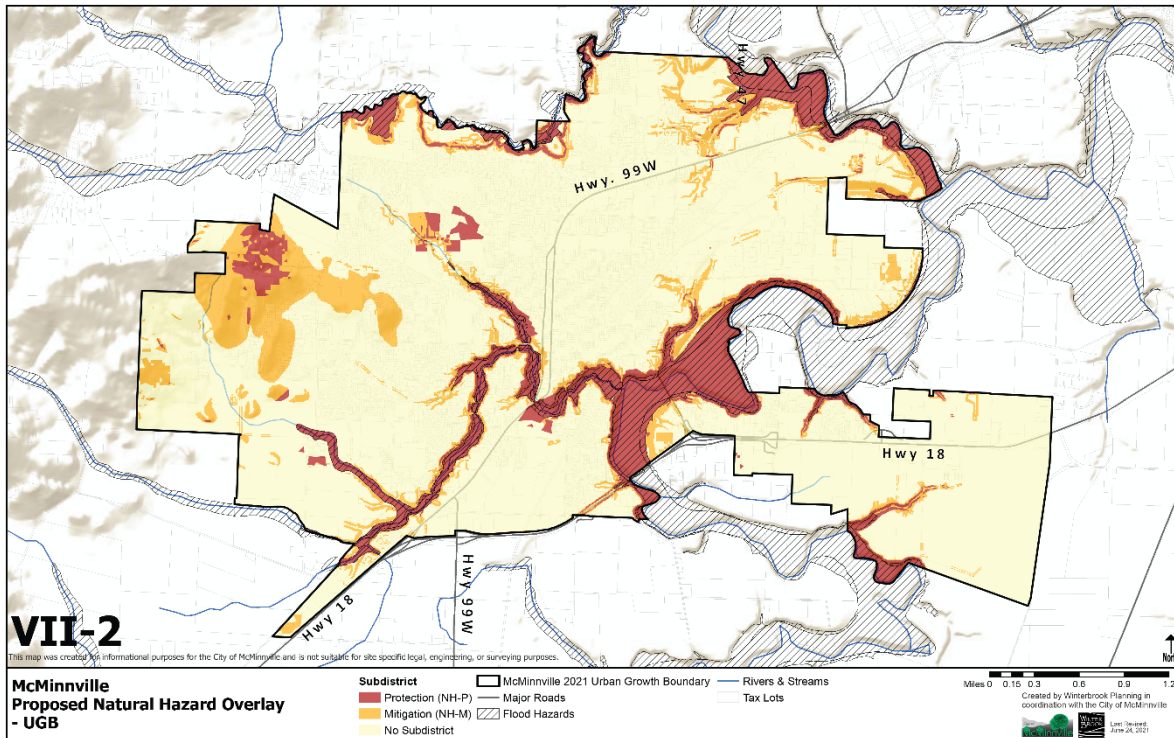
Table VII.4 Designation of NH Subdistricts Based on Ranking of Natural Hazards Subareas

Combined Subarea Hazard Risk	Natural Hazard Overlay Subdistrict
0 to 0.99	No NH-Subdistrict
1 to 1.499	Natural Hazard Mitigation Subdistrict (NH-M)
1.5 to 3.517	Natural Hazard Protection Subdistrict (NH-P)

- **Subareas that have one or more high risk hazards areas with a combined hazard risk of 1.5 or more would be subject to the proposed Natural Hazard Protection (NH-P) Subdistrict.** The NH-P prohibits most types of development; however, uses such as public utilities and resource enhancement are subject to hazard-specific development standards as well as building and fire codes. This category includes land within (a) floodplains and adjacent landslide and wildfire risk areas, and (b) some West Hills subareas with a combination of steep slopes, high landslide risk and moderate to high wildfire risk.
- **Subareas that have one or more moderate-to-high hazard risks with a combined hazard risk between 1 and 1.499 would be subject to the proposed Natural Hazards Mitigation (NH-M) Subdistrict.** Uses allowed by the underlying zoning district are allowed in the NH-M Subdistrict and are subject to hazard-specific development standards as well as building and fire codes. Much of the land within the West Hills falls within this category. Additional areas along creek tributaries, but outside of the floodplain, are included in this subdistrict. A larger mitigation area in the northeast is associated with dense tree groves and therefore severe wildfire hazards.
- **Subareas that are subject to moderate liquefaction or moderate wildfires only have a combined hazard risk of less than 1 and would not be subject to zoning regulation – but are subject to seismic building codes, fire codes and construction standards.** Most of the land within the UGB falls into this category.

Figure VII-1 shows the proposed Natural Hazards Overlay with Natural Hazards Mitigation (NH-M) and Protection (NH-P) Subdistricts that are derived from GIS data and based on Tables VII.1 and VII.2.

Figure VII-2 Proposed McMinnville Natural Hazards Overlay – 2021 Urban Growth Boundary



Recommended Natural Hazards Policy Framework

Winterbrook recommends that the following policy framework be added to the McMinnville Comprehensive Plan as a new Chapter XI: Natural Features.

Multi-Hazard Policies

Policy 197.00 The City of McMinnville shall adopt and maintain a Natural Hazards Inventory as part of the McMinnville Comprehensive Plan (Volume I). The inventory shall include maps and text that identify the location, type and risk level for three types of natural hazards: geological hazards (including steep slopes, earthquakes and landslides), flood hazards (land within the 100-year floodplain) and wildfire hazards within the study area (the UGB and the unincorporated outside the UGB).

Policy 197.00.010 The City of McMinnville shall apply public works construction standards, seismic building codes and fire and life safety codes wherever natural hazards are identified in the Natural Hazards Inventor – including limited, moderate and high combined risk subareas described in Table VII.1 of the Natural Hazards Inventory.

Policy 197.00.020 The City of McMinnville shall establish a **Natural Hazards (NH)** overlay zone to manage the cumulative effects of inventoried natural hazards in “moderate and high combined risk subareas” as described in Tables VII.1 and VII.2 of the Natural Hazards Inventory.

Policy 197.00.030 As shown on Figure VI-2, the NH overlay zone shall include two subdistricts based on cumulative ranking criteria found in Tables VII.1 and VII.2 of the Natural Hazards Inventory:

1. **The Natural Hazards Mitigation Subdistrict (NH-M).** The NH-M is intended to mitigate hazard impacts based on objective development standards for each applicable hazard type and the recommendations of required site-specific hazard studies.
2. **The Natural Hazards Protection Subdistrict (NH-P).** The NH-P Subdistrict is intended to prohibit most types of development and may allow for residential density transfer. Where development is allowed it shall be subject to objective development standards for each applicable hazard type and the recommendations of required site-specific hazard studies.

Policy 197.00.040 The NH-M and NH-P Subdistricts shall include objective development standards for each type of natural hazard identified the Natural Hazards Inventory, including landslide, earthquake (liquefaction and shaking), floodplains and wildfire hazards. Floodplains shall be protected by the underlying F-P Flood Hazard zone and the NH-P Subdistrict.

1. Specific information regarding the location and severity for each type of hazard in each subdistrict are available in 11" X 17" format and in the City's GIS data base.
2. In cases where hazard-specific development standards overlap, the more restrictive standard shall apply.

Policy 197.00.060 Based on objective development standards and required hazard studies, the City of McMinnville may impose conditions of land use approval to protect life and property and mitigate natural hazard impacts in natural hazard subareas. Such conditions may include, but are not limited to, conservation easements or dedication of hazard areas to the City.

Policy 197.00.060 Land division applications shall not result in a lot that lacks sufficient buildable area to meet the minimum lot size and development standards applicable in the underlying zoning district.

Policy 197.00.070 New residential, commercial and industrial construction shall be prohibited within the NH-P Subdistrict with the following exceptions:

1. Public facilities and environmental restoration projects may be permitted under objective development standards.
2. Agricultural and forest uses are permitted within the NH-P Subdistrict in areas zoned for exclusive farm and commercial forest use.
3. Residential density transfer from land within the NH-P Subdistrict to contiguous property under the same ownership that is outside both the NH-M and NH-P Subdistricts may be allowed. The maximum density allowed in the transfer area shall be the maximum density allowed in the next higher residential zoning district. For example, density transfer from the NH-P land with an underlying R1 zone to land outside the Natural Hazards Overlay (NH-P and NH-M) shall be capped at the density allowed in the R2 zone.
4. In situations where density transfer is not feasible, one dwelling unit may be allowed on a vacant residential tract under common ownership that is outside the 100-year floodplain *if* consistent with the recommendations of a geotechnical engineering study and any conditions required by the review authority.

Policy 197.00.080 In cases where application of NH-P provisions would prohibit all reasonable economic use of an existing tract of land under common ownership, the City may grant an exception to allow a use permitted in the underlying zoning district that is not permitted in the NH-P Subdistrict. In making this decision, the applicant and City must:

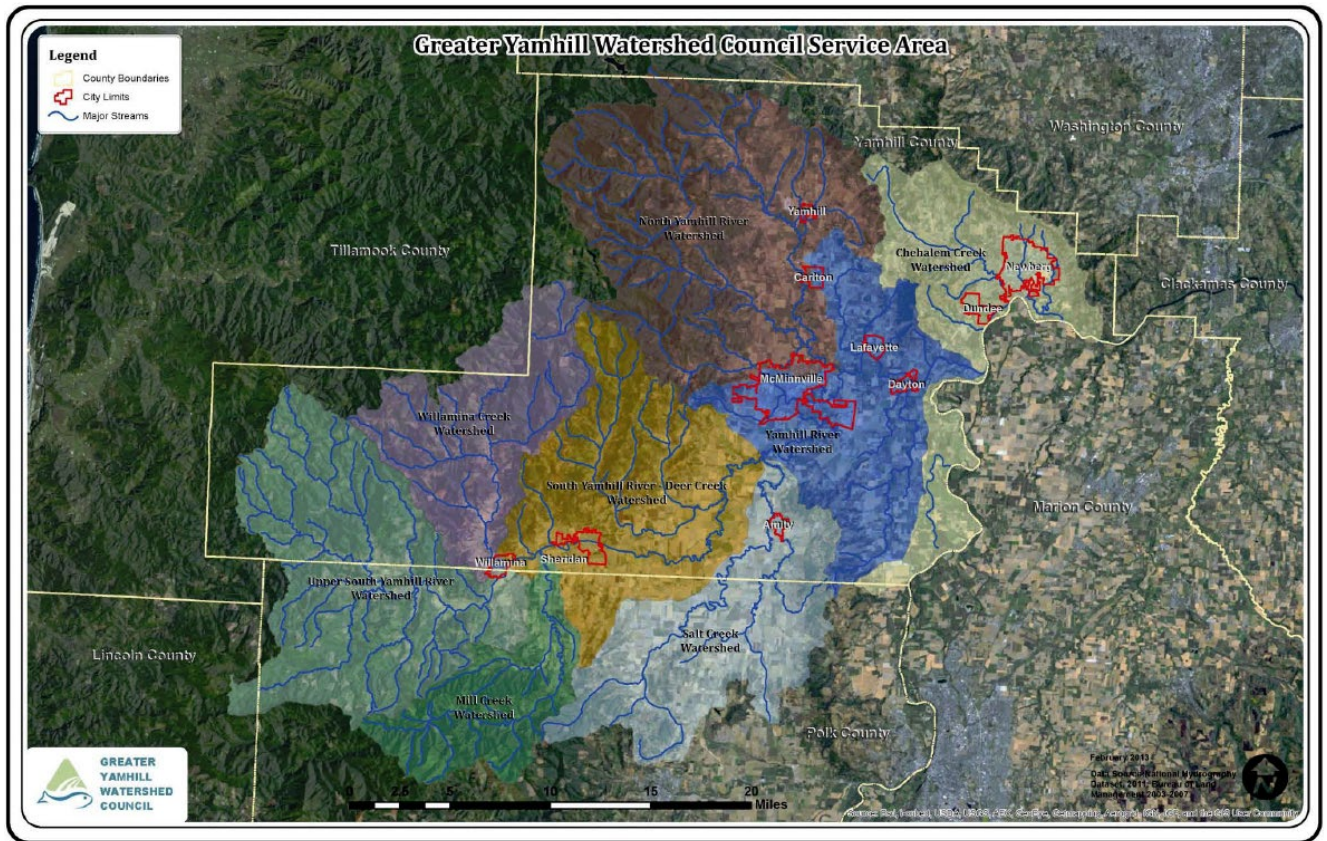
1. Consider first whether the exception provisions of Policy 197.00.070 would relieve the hardship;
2. Consider potential uses that are allowed in the NH-P Subdistrict that could provide reasonable economic value;
3. Consider alternative development layouts and land use intensity that minimize impacts from natural hazards on people and property and other values associated with natural hazard areas;
4. Limit the intensity of the allowed land use to the minimum necessary to retain reasonable economic value of the subject tract; and
5. Meet all applicable development standards that apply to natural hazards in the NH-P zone.

Policy 197.00.090 The City of McMinnville shall coordinate with Yamhill County to apply McMinnville Comprehensive Plan Chapter XI Natural Features Policies to unincorporated land within the Natural Hazards Study Area, including the application of the NH overlay zone (the NH-M and NH-S subdistricts) and related development standards. In cases of conflict with state law governing farm and forest land, state law will prevail over the NH overlay zone standards. For example, agricultural and forest uses allowed in Agricultural and Forest zones shall continue to be allowed; and the more restrictive fire mitigation standards in the County's forest zones will prevail over the less restrictive City fire mitigation standards.

Policy 197.00.100 The City of McMinnville shall coordinate with the Oregon Department of Geology and Mineral Industries (DOGAMI), the Department of Land Conservation and Development (DLCD), the McMinnville Fire Department, and Yamhill County in updates of the Yamhill County Multi-Jurisdictional Natural Hazards Mitigation Plan, the McMinnville Addendum to County NHMP, and the Yamhill County Community Wildfire Protection Plan. Updates to these plans will be considered in future updates to Chapter XI of the McMinnville Comprehensive Plan.

Policy 197.00.110 The City of McMinnville shall coordinate with the Greater Yamhill Watershed Council to facilitate watershed restoration and improvement projects in natural hazard areas such as floodplains and slide hazard areas. Shared natural hazard mitigation goals include: (1) removal of invasive vegetation species (that that increase fuel for wildfires and clog waterways) and replacement with native species that reduce erosion, are more fire resistant and are less likely to clog waterways; and (2) restoration and enhancement of wetlands that provide flood control.

Figure VII-3 Greater Yamhill Watershed Council Service Area



Policy 197.00.120 New development applications shall include a Tree Removal and Mitigation Plan within the NH-M and NH-P Subdistricts. To minimize erosion and landslide potential and to maintain water quality, removal of more than three trees over 6 inches dbh¹⁰ in a calendar year shall require a Tree Removal and Mitigation Plan prepared by a certified arborist. The plan shall ensure replacement of lost trees with fire resistant native trees and vegetation. The following exceptions to this policy shall apply where:

- 1 Tree removal is permitted in the underlying Yamhill County farm or forest zone.
- 2 The proposal is part of a watershed restoration or enhancement project sponsored by a relevant Watershed Council that meets applicable City development standards.
- 3 The proposal is part of a fire protection program approved by the City of McMinnville Fire Department or RFPD. (See Wildfire Hazard Policies below.)
- 4 The proposal is necessary to meet fuel reduction standards in wildfire hazard areas pursuant to Wildfire Policies 200.050.00 and 200.060.00.

¹⁰ Diameter at breast height – or 4'6" above ground.

Geological Hazard Policies

Policy 198.00 Geological hazards appear on the McMinnville Natural Hazards Inventory and include: (1) Slopes of 25% or more; (2) Moderate, high and severe risk earthquake (liquefaction and shaking) risk areas; and (3) Moderate and high risk landslide hazard areas.

Policy 198.10 The NH-P and NH-M Subdistricts shall apply to subareas with geological hazards as shown on Map VII-2 of the Natural Hazards Inventory. Specific geological hazards found in each subdistrict are available in 11" X 17" format and in the City's GIS data base.

Policy 198.20 Residential and commercial construction in areas with moderate or high geological risk hazards – as indicated on the Natural Hazards Inventory – shall meet the seismic and slope stability provisions of the Oregon State Building Codes. The Building Official may require a geotechnical engineering study prior to approval of construction.

Policy 198.30 The City of McMinnville shall require erosion control measures prior to grading or construction in subareas with:

1. Slopes of 15% or greater, and
2. Landslide hazards in the NH-M and NH-P Subdistricts.

Policy 198.040.00 The City of McMinnville shall require geological reconnaissance studies with the submission of land development applications where geological hazards are present within the NH-M and NH-P Subdistricts. The recommendations of the geological reconnaissance study shall become conditions of land use approval unless specifically exempted or modified by the review authority.

Policy 198.50 Where recommended in a required geological reconnaissance study – or where determined necessary by the City Engineer or Building Official in moderate risk landslide hazard areas that are not included in the NH-M Subdistrict – a geotechnical engineering study may be required prior to grading, land development or construction.

Policy 198.60 The City of McMinnville shall retain the services of a qualified geologist or geological engineer to review geological studies prepared for land use applicants.

1. The City Engineer shall determine whether a second professional opinion is required.
2. The costs of peer review shall be borne by the applicant.

Policy 198.70 The City shall consider adopting standards for public street and utility construction to moderate or higher geological hazard areas.

Policy 198.80 Because trees contribute to slope stability and reduce erosion, tree removal shall be limited in the NH-M and NH-P Subdistricts pursuant to Policy 197.120.00.

Flood Hazard Policies

Policy 199.00 Flood hazards areas are located within the designated 100-year floodplain. The City of McMinnville will continue to prohibit most types of development within the 100-year floodplain consistent with the City's F-P Flood Hazard Zone.

Policy 199.10 Natural geological and wildfire hazards associated with the 100-year floodplain, including but not limited to overlapping landslide areas, will be addressed in NH-P Subdistrict development standards. Overlapping wildfire and geological hazards found in NH-P Subdistrict that overlay the F-P Flood Hazard Zone are available in 11" X 17" format and in the City's GIS data base.

Policy 199.20 The City of McMinnville is committed to continued participation in the National Flood Insurance Program (NFIP) through enforcement of local floodplain management regulations.

Policy 199.30 The City of McMinnville will work with the Federal Emergency Management Agency (FEMA) to update Flood Insurance Rate Maps (FIRM). The City will request Oregon Department of Geology and Mineral Industries (DOGAMI) debris flow and lidar data be included in FIRM updates.

Policy 199.40 The City of McMinnville will develop and maintain GIS maps of critical facilities identified in the McMinnville NHMP for all structures and residential development and commercial buildings within the 100-year and 500-year floodplains.

Policy 199.50 Because wetlands serve an important flood control function, wetland fill and removal shall not be permitted within the 100-year floodplain unless there is no reasonable alternative for a planned public works project.

Policy 199.60 The City of McMinnville will coordinate with the Greater Yamhill Watershed Council (or its affiliates) regarding stream and river restoration and enhancements projects to restore native vegetation, improve bank stability and improve water quality.

Policy 199.70 Because trees and vegetation reduce streambank failure and improve water quality, tree removal shall be limited in the NH-M and NH-P Subdistricts pursuant to Policy 197.120.00.

Wildfire Hazard Policies

Policy 200.00 Moderate, high and severe wildfire hazard areas appear on the Natural Hazards Inventory and are generally associated with the West Hills and vegetated floodplains.

1. Where wildfire hazards subareas overlap with geological or floodplain hazards, they may be subject to NH-P or NH-M Subdistrict requirements, consistent with the ranking criteria found in the Natural Hazards Inventory and as shown on Natural Hazards Inventory Map VII-1.
2. Existing fire standards in Yamhill County forest zones shall continue to apply.

Policy 200.10 City staff shall coordinate with the McMinnville Fire Department and RFPD to encourage fire safety planning and education – especially in Wildfire Urban Interface zones and designated Fire Reduction Areas in the West Hills. The City of McMinnville shall continue to coordinate wildfire mitigation action items through the Yamhill County Community Wildfire Protection Plan.

Policy 200.20 Residential, commercial and industrial development shall not be permitted in wildfire risk subareas in the NH-P Subdistrict; However, exceptions may be permitted pursuant to Natural Hazard Policies 197.070.00 and 197.080.00.

Policy 200.30 Development density in wildfire risk areas in the NH-M Subdistrict may be limited where necessary to provide adequate space for fuel breaks in areas that are threatened by two or more natural hazards.

Policy 200.40 In the NH-P and NH-M Subdistricts with identified wildfire hazards, applicants for land divisions and new development (excluding home remodels or additions) shall prepare a Fire Prevention and Control Plan in coordination with the McMinnville Fire Department or RFPD. The plan shall be prepared by a certified arborist and shall consider necessary tree and vegetation removal, erosion control and replacement of lost trees and vegetation with native, fire-resistant trees and vegetation.

Policy 200.50 Based on the Fire Prevention and Control Plan, the following wildfire mitigation standards shall be met:

1. Installation and maintenance of at least a 40-foot fuel break around each new dwelling or structure.
2. Where vegetation needs to be maintained for slope stability in a fuel break area, require plantings of fire-resistant or slow-burning plants. The City shall make a list of such plants available to the public.
3. Provision of one or more than one ingress/egress route or road widths wide enough to accommodate incoming fire apparatus and evacuating residents simultaneously in an emergency situation.
4. Roofs and siding with fire-resistant materials. Wood shake or shingle roofs are not allowed.
5. Design road placement to function as fire breaks in urban wildland interface developments.
6. Chimneys of wood-burning devices to be equipped with spark arrester caps and/or screens.
7. Underground electrical distribution circuits if technically feasible.
8. Sprinkler systems in all dwelling units and occupied buildings.